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Atmospheric Transport and Diffusion Modeling of Rocket Exhaust

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ATMOSPHERIC TRANSPORT AND DIFFUSION MODELING OF ROCKET EXHAUST

THESIS

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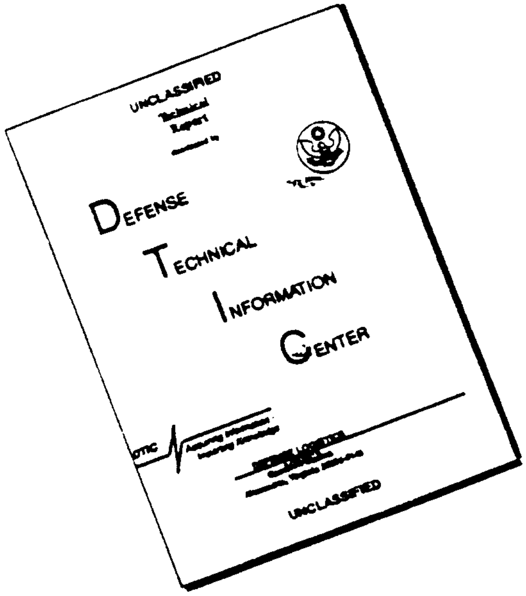

ATMOSPHERIC TRANSPORT AND DIFFUSION MODELING OF ROCKET EXHAUST

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air Education and Training Command
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Masters of Science in Engineering and Environmental Management

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PREFACE

This thesis developed and tested an improved meteorological averaging scheme for use by the Rocket Effluent Diffusion Model to perform the Gaussian Diffusion calculations for down range concentration, dose and time weighted concentration. The improved algorithms used more realistic assumptions and improved the accuracy of the model.

This area of research was chosen for several reasons. Captain Burel had previous experience in emergency response to hazardous materials spills and desired to further his knowledge of atmospheric transport and diffusion. Space launch events create acute releases similar to hazardous substance releases, albeit on a significantly larger scale, and are presently under intense scrutiny to protect human health without unnecessarily jeopardizing launch schedules. This topic was both academically and practically significant.

This research has value by providing launch safety officials insight into the sensitivity of the Rocket Effluent Diffusion Model to assumptions made in meteorological parameter averaging. It may contribute to decision making regarding the allocation of resources for future model improvement.

Acknowledgments

Above all, I want to thank God for all that He is and all that He makes possible for me. "It is God who arms me with strength, And makes my way perfect. He makes my feet like the feet of deer, And sets me on my high places." (Psalms 18, 32-32)

I thank my wonderful bride Shannon. Her patience and support during this thesis effort were equaled only by her love.

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I offer a special thanks and my highest regards to my sponsors, Dr. Dave Mattie of Armstrong Laboratories and Mr. Darryl Dargitz from the Range Safety Office at Vandenberg AFB. They have fully supported this effort and have been helpful beyond even gracious expectations.

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LIST OF ABBREVIATIONS

AFB	Air Force Base
AFIT	Air Force Institute of Technology
AL	Armstrong Laboratories
AL2O3	Aluminum Oxide
C1-Min	Maximum 1-Minute Average Ground-level Centerline Concentration
CCAS	Cape Canaveral Air Station
CEGL	Continuous Exposure Guidance Level
cm	Centimeter
Cmax	Maximum Instantaneous Ground-level Centerline Concentration
CO	Carbon Monoxide
CO2	Carbon Dioxide
COT	Committee on Toxicology
DASS	Doppler Acoustic Sounding System
Dmax	Maximum Ground-level Centerline Dose
DoD	Department of Defense
Dshear	Mixing Level Average Wind Direction Shear
EEGL	Emergency Exposure Guidance Level
EPA	Environmental Protection Agency
ETR	Eastern Test Range
FDH	Formaldehyde Dimethylhydrazine
g	Gram
HCl	Hydrogen Chloride
IDLH	Immediately Dangerous to Life and Health
IV&V	Independent Verification and Validation
km	Kilometer
KSC	Kennedy Space Center
LaRC	The Langley Research Center
LOC	Level Of Concern
m	Meter
Mix Hgt	Height of the Ground-Based Mixing Layer
MSFC	Marshall Space Flight Center
N2H4	Hydrazine
N2O4	Nitrogen Tetroxide
NAS	National Academy of Science
NASA	National Air and Space Administration
NDMH	Nitrosodimethylamine
NIOSH	National Institute of Occupational Safety and Health
NRC	National Research Council
OBOD	Open Burn Open Detonation
ppm	Parts Per Million
REEDM	Rocket Exhaust Effluent Diffusion Model
sec	Second
SigA	Mixing Level Average Azimuth Standard Deviation of Wind Direction
SigE	Mixing Level Average Elevation Standard Deviation of Wind Direction
SODAR	Sonic Detection and Ranging
SPEGL	Short-term, Public Emergency Exposure Guidance Level
SPW/SEY	Space Wing Safety Office
SShear	Mixing Level Average Wind Speed Shear
THC	Toxic Hazard Corridor
TRAG	Toxic Release Assessment Group
U.S.	United States
Ubar	Mixing Layer Average Wind Speed
UDMH	Unsymmetrical Dimethylhydrazine
VAFB	Vandenberg Air Force Base

ABSTRACT

Space launches at Vandenberg Air Force Base (VAFB) and the Cape Canaveral Air Station (CCAS) produce exhaust from the solid rocket boosters and liquid hypergolic fuels containing several toxic substances including hydrogen chloride and hydrazine. In order to estimate the health risk that would be imposed upon the public by proposed launches, range safety officials rely on the Rocket Exhaust Effluent Diffusion Model to predict where the exhaust chemicals will go after the launch and how strong the concentrations will be. The original REEDM program averaged the meteorological parameters (wind speed, wind direction, shear, etc.) across the entire mixing level and used these averages in its Gaussian calculations to predict instantaneous concentration, dose and time weighted average concentration. This thesis modified the model program to perform its meteorological parameter averaging using only those parameters which affected source material transport in diffusion, excluding from the averaging, those parameters which did not affect the calculation.

The difference in before and after modification REEDM output was statistically, significantly different for maximum centerline instantaneous concentrations and maximum centerline doses . However, the magnitude of the difference may not be considered practically significant by launch safety officials.

ATMOSPHERIC TRANSPORT AND DIFFUSION MODELING OF ROCKET EXHAUST

INTRODUCTION

Overview

Commanders at Vandenberg Air Force Base (VAFB) and the launch facility at Cape Canaveral Air Station (CCAS) assess the health risk imposed on both military and surrounding civilian populations in advance of the launches of large space vehicles. The health hazard of concern is exposure to the airborne toxic constituents of the exhaust cloud left in the aftermath of a space launch. The toxic constituents include hydrogen chloride, nitrogen dioxide, and hydrazine to name a few. Safety personnel at both ranges use an atmospheric transport and diffusion model entitled the Rocket Exhaust Effluent Diffusion Model (REEDM) to predict resultant downwind concentrations and doses from proposed launches (2:3). The launch commanders decide whether or not to proceed with a launch based on the severity of the health hazard predicted by the model. If the exhaust cloud is predicted to rise above surrounding populations, reaching ground-level only in concentrations insufficient to present significant health risk, the mission is able to proceed. Otherwise, if predicted ground-level concentrations pose non-negligible or significant health risks, then the launch commanders must at least reconsider and possibly hold the launch. Recent interpretation and lowering of the acceptable military and public exposure limits for the toxicants in question have greatly increased the probability that any given launch will produce ground-level concentrations of the hazardous constituents in excess of the re-interpreted and lowered acceptable exposure limits. The effect of this reevaluation of the exposure limits has been the dramatic reduction of the number of days which are available for launch. This is referred to as reduced launch availability.

Consequently, there has been concerted effort by the U.S. Air Force, its contractors and other affected organizations to remedy the problem. Important among the efforts made to ameliorate the problem have been the efforts to validate, verify, and improve the accuracy of the diffusion model used to make the concentration predictions. It is the intent of this thesis to identify and implement, on an experimental scale, a method of improving the accuracy of the Rocket Exhaust Effluent Diffusion Model. The goal is to dispel uncertain conservative estimates with more realistic, less conservative predictions. The improvement method presented in this thesis is to upgrade specific subroutines within the computer program to make better, more realistic use of available meteorological data.

Practical Problem

Introduction

As was introduced in the previous section, there is a significant problem at hand which the Air Force is interested in resolving quickly. The dilemma is a pressing one because launch holds exact extreme financial and operational costs yet the protection of public safety must remain tantamount (2:3; 13:1). A more detailed explanation of the existing conditions and recent events is required to fully appreciate the changes that have taken place and the severity of the conundrum.

Normal Launch Scenario

Prior to a launch, commanders estimate and evaluate the health hazards created by the toxic exhaust from any of three possible launch events (31:4). The most probable launch event to take place is that of a successful launch. In this scenario, the space vehicle generates a significant cloud of exhaust around the launch pad as the vehicle velocity gradually accelerates from zero. Once the launch vehicle clears the launch pad and picks up speed, the exhaust is distributed in a trail rather than a cloud. Within minutes of the launch, the hot buoyant exhaust gasses in the ground cloud have lifted off the ground and begun to cool. When the gasses have cooled to neutral buoyancy, the cloud reaches its stabilization height of about 2 kilometers above the pad and somewhat down wind. While the cloud rises and stabilizes, it is transported in different directions and at differing speeds as a result of the wind speed and direction varying with altitude. As the cloud rises, it entrains both ambient air and that portion of the rocket exhaust trail which it may overtake due to differing buoyancy in the exhaust trail and the rising ground cloud. Exhaust material continues to transport and disperse downwind from both the stabilized ground cloud and the exhaust trail above the cloud.

Conflagration Failure Scenario

Another launch scenario that is modeled by REEDM is the catastrophic failure referred to as conflagration (31:5). In this scenario, the solid rocket booster motors explode, scattering burning solid propellant on and around the launch pad. The propellant then continues to burn at a constant rate. This failure can occur while the vehicle is in the vicinity of the pad or at any distance above the ground until the solid fuel is depleted (31:5). The cloud from such an explosion on the launch pad would have the most solid fuel to combust and would be closer to ground than an explosion at a higher altitude. Consequently a ground conflagration would pose a more serious health hazard than one at a higher altitude.

Deflagration Failure Scenario

A final mode of failure that is modeled is referred to as deflagration (31:5). This involves the rapid combustion of the liquid hypergolic fuel. In this failure scenario, an explosion causes the rapid combustion of the liquid fuel and oxidizer, resulting in a large, rapidly rising fireball. The fireball expands as it rises and entrains ambient air until it too stabilizes and cools. The Deflagration failure produces several different chemical toxicants than either the normal launch or the conflagration.

Health Hazards

The health hazards posed to surrounding populations from these launch scenarios is presented by the hazardous constituents pertinent to the different launch scenarios (25:2-16). The normal launch and conflagration failure release similar toxicants. Those presently modeled are: hydrogen chloride gas (HCl), carbon monoxide (CO), carbon dioxide (CO2) and aluminum oxide particulates (AL2O3). Those chemicals modeled from the deflagration failure are: hydrazine (N2H4), nitrogen tetroxide (N2O4), unsymmetrical dimethyl hydrazine (UDMH), formaldehyde dimethylhydrazone (FDH) and nitrosodimethylamine (NDMH). At present, it is the risk of acute health hazards from these chemicals that is impacting the space launch operations. A summary description of the three launch scenarios presented in Table 1.

Table 1: Launch Scenario Summary

LAUNCH SCENARIO	DESCRIPTION	CHEMICALS
Normal Launch	Ground cloud forms at launch and rises to stabilized height. Exhaust trail extends from top of stabilized cloud through troposphere.	hydrogen chloride gas (HCl), carbon monoxic (CO), carbon dioxide (CO2) and aluminum oxide particulates (AL2O3)
Conflagration Failure	Solid rocket booster motors explode before solid fuel is depleted. Solid fuel scatters to the ground and continues to burn until consumed.	hydrogen chloride gas (HCl), carbon monoxic (CO), carbon dioxide (CO2) and aluminum oxide particulates (AL2O3)
Deflagration Failure	Liquid hypergolic fuels explode causing large rising fireball.	hydrazine (N2H4), nitrogen tetroxide (N2O4) unsymmetrical dimethyl hydrazine (UDMH), formaldehyde dimethylhydrazone (FDH) and nitrosodimethylamine (NDMH)

CEQ, EPA, and NIOSH Limits

The human exposure limits presently employed by range safety officials at the two ranges are a combination of guidance put out by the National Academy of Science (NAS) - National Research Council's (NRC) Committee on Toxicology (COT), the National Institute of Occupational Safety and Health (NIOSH) and the U.S. Environmental Protection Agency (9:93). The COT has recommended exposure guidance levels for the Department of Defense (DoD) for over 40 years. The guidance is primarily intended for the exposure of military populations during military operations, where assumptions are made that the population is relatively healthy and includes women of child bearing age. However, the COT has also recommended short-term, public emergency exposure guidance levels or (SPEGLs) for use by the DoD in emergency planning of exposures of the general public. SPEGLs are peak concentrations to which the general public may be exposed to for a single, unpredicted, short-term exposure without significant risk of adverse health effects. These SPEGLs are a fundamental part of assessing the health hazard to the public.

A second type of exposure limit used by range safety officials at the launch ranges is the NIOSH immediately dangerous to life and health (IDLH) limit. The IDLH is a maximum concentration to which an average person may be exposed for up to 30 minutes without experiencing escape-impairing adverse health effects. The third type of exposure limit used for health hazard assessment is the EPA level of concern (LOC). The LOC is actually an extension of the NIOSH IDLH as the EPA defines its LOC as 1/10 of the IDLH, where the LOC is also a maximum concentration, not to be exceeded. These three types of exposure limits are integrated into a system of decision making for launch operations, based upon human health risk. The three types exposure limits are summarized in Table 2.

Table 2: Exposure Limit Summary

EXPOSURE LIMIT	SOURCE	DESCRIPTION
SPEGL (Short-term, Public Emergency Exposure Guidance Level)	National Academy of Science (NAS) - National Research Council's (NRC) Committee on Toxicology (COT)	Maximum concentration exposure level for one-time emergency use with general public which if not exceeded should prevent adverse health effects.
IDLH (Immediately Dangerous to Life and Health limit)	National Institute of Occupational Safety and Health (NIOSH)	Maximum concentration exposure level to which an average person may be exposed for up to 30 minutes without experiencing escape-impairing adverse health effects.
LOC (Level Of Concern)	U.S. Environmental Protection Agency (US EPA)	1/10 of the IDLH, also a maximum concentration exposure level, not to be exceeded

The Three Tier System

A three tiered system of health risk categorization is employed by commanders at VAFB and CCAS in order to assess the potential health impact of scheduled space launches (9:93). The three tiers are mapped as predicted concentration isopleths superimposed over a regional map of the launch area. The tier 1 isopleth contains those areas predicted to experience ground-level concentrations equal to or greater than 1/2 the NIOSH IDLH limit for the toxic rocket exhaust constituents. Concentrations within this first tier are expected to engender immediate adverse health effects on the general population within that exposure tier. Therefore, tier one areas warrant evacuation or isolation of the predicted effected population. The tier 2 isopleth defines that area expected to experience ground-level concentrations at or greater than the SPEGL or LOC for each constituent, but less than 1/2 the IDLH. Exposures within the second tier are expected to produce adverse health effects in some of the general exposed population. The tier 3 isopleth covers the largest area and represents that area predicted to experience concentrations at or above 1/10 the SPEGL or LOC but less than the tier 2 concentrations. Exposures at these concentrations are expected to induce some adverse health effects in sensitive sub-populations like asthmatics, but not in the average population. Predicted concentrations outside of the tier 3 isopleth are believed to have no adverse health effects on the exposed population. That area which is predicted to experience ground-level concentrations that may cause adverse health effects is considered the toxic hazard corridor (THC). If this THC extends into populated areas, commanders must consider holding the launch (13:1; 30:8-9, 5:4-5). The three tiers are summarized in Table 3. The exposure limits presently applicable for chemicals of concern under the three tier system are shown in Table 4 and the launch go/no-go criteria are shown in Table 5.

Table 3: Three Tier Exposure Summary

TIER LEVEL	DESCRIPTION	DESCRIPTION
TIER 1	(>= 1/2 IDLH) A ceiling concentration not to be exceeded.	Exposures at these concentrations are expected to engender immediate adverse health effects on the general population.
TIER 2	(>= SPEGL or LOC) and (< 1/2 IDLH) A ceiling concentration not to be exceeded.	Exposures at these concentrations are expected to produce adverse health effects in some of the general exposed population.
TIER 3	(>= 1/10 SPEGL or LOC) and (< SPEGL or LOC)	Exposures at these concentrations are expected to induce some adverse health effects in sensitive sub-populations like asthmatics, but not in the average population.

Table 4: Three Tier Exposure Limits (10:1)

CHEMICAL	TIER 1	TIER 2	TIER 3
NO_2	25 ppm 1/2 IDLH Ceiling	5 ppm EPA LOC Ceiling	1 ppm SPEGL Ceiling
UDMH	25 ppm 1/2 IDLH Ceiling	5 ppm EPA LOC Ceiling	N/A
MMH	25 ppm 1/2 IDLH Ceiling	0.52 ppm SPEGL 60 min TAV	N/A
N_2H_4	40 ppm 1/2 IDLH Ceiling	2 ppm SPEGL 60 min TAV	N/A
HCL	50 ppm 1/2 IDLH Ceiling	5 ppm TLV Ceiling	1 ppm SPEGL Ceiling

Table 5: Launch Go/No-Go Criteria

CATASTROPHIC ABORT SCENARIO	NOMINAL LAUNCH SCENARIO
Tier 2 Criteria for public and base housing	Tier 3 Criteria for public and base housing

Recent Ceiling Interpretation

The definitions and values of the exposure limits used to define the THC have recently been reviewed. The exposure limits for HCl in tiers 2 and 3 have been recently changed at both ranges, increasing the size of the THC. Furthermore, and perhaps of even more significance, the guidance limits above issued by the COT, NIOSH and EPA are defined as maximum concentrations which are not to be exceeded. However, past sampling technology and methodology prevented the measurement of 'instantaneous' concentrations. Rather, a sample would be taken over an hour, 30 minutes, 10 minutes or some similar time scale which then rendered an average of the concentrations experienced during that time. Therefore, past modeling of 'peak concentrations' also reflected a similar time average of 30 to 60 minutes. Recently, Armstrong Laboratory and others have been critically reviewed the definition of the exposure limits and have determined that it is inappropriate to compare hourly or 30 minute averages against exposure limits that are defined as instantaneous peak values. The assertion is that during any given averaging time, peak concentrations will vastly exceed the time average concentration but will be hidden by averaging with off-setting lower values. Research has shown that instantaneous peak concentrations can exceed time averaged concentrations by as much 30 times. Consequently, a predicted 30-minute concentration average that is just below an exposure limit actually represents many instantaneous peak concentrations that greatly exceed the limit and many that are well under it. The adverse health effects of the toxicants in the rocket exhaust are believed to be very fast acting, in which case even brief exposures to high instantaneous concentrations could prove quite harmful. Although sampling capability has improved to allow the measurement of peak instantaneous concentrations, many problems now exist. The term instantaneous changes with the capability of technology to measure concentrations over shorter and shorter increments of time (3:1; 18:1; 21:5). At present, 1-minute time averaged concentrations are predicted as an estimate of peak concentration values. Another major problem that exists because of the requirement to predict instantaneous concentrations is inherent to the model theory being used.

Large THC

Concentration predictions made by the dispersion model are based upon Gaussian theory. This theory does not assert that at any instant the source material is Gaussian distributed but rather that over time, the material will exhibit a Gaussian distribution. As a result, when the Gaussian model is used to predict short time averaged concentrations, the effected areas within the isopleths are greatly increased. Peak instantaneous concentrations predictions are much higher than the time averaged values. This has caused predicted toxic hazard corridors to extend beyond installation boundaries into surrounding populations. Sample concentration isopleth predictions set at 1 ppm (Tier 3) and 10 ppm (Tier 2) for HCl are shown in Figure 1 and demonstrate the predicted Toxic Hazard Corridor.

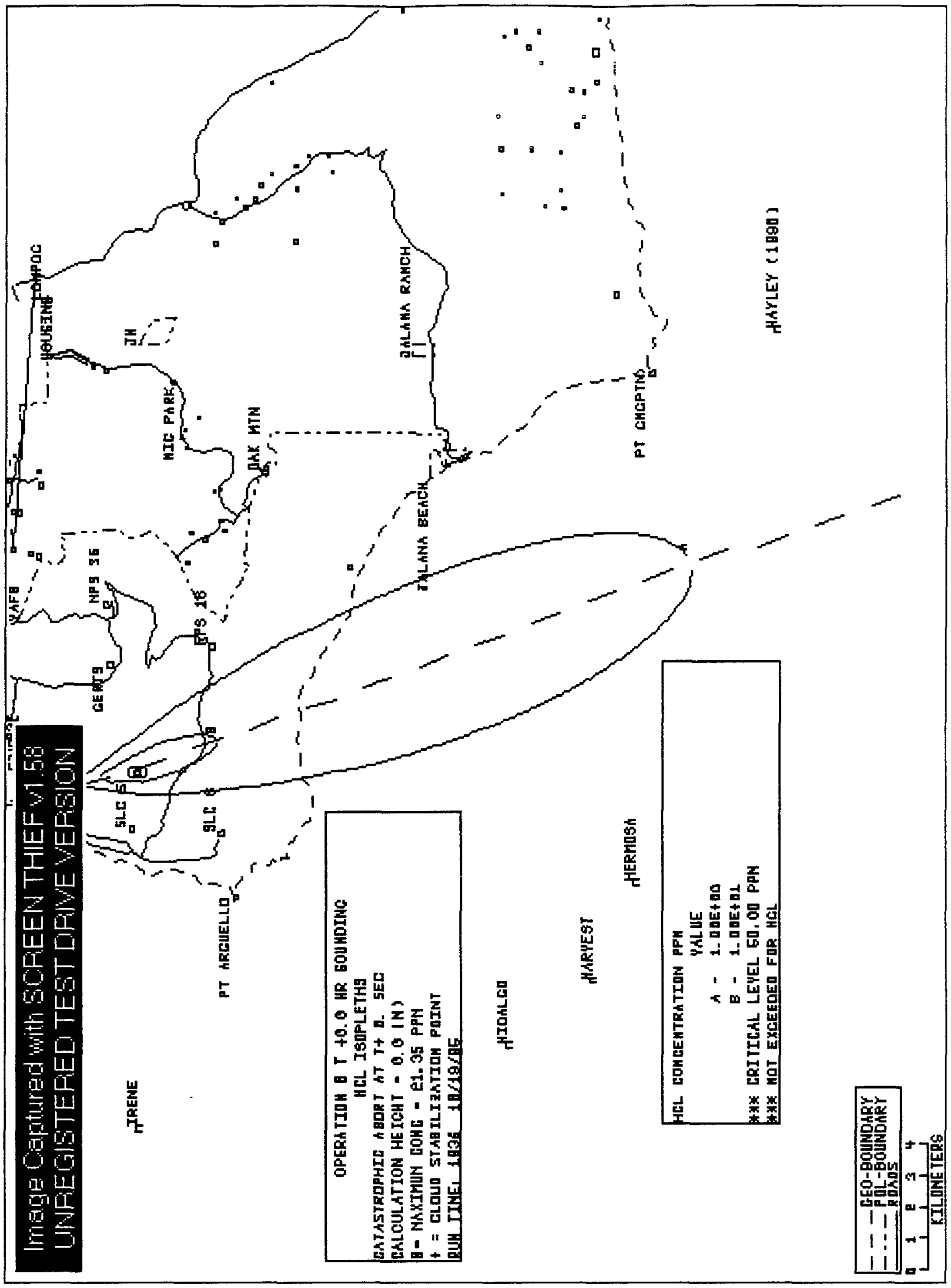


Figure 1: Toxic Hazard Corridor

This output from the REEDM displays the downwind area expected to be effected by the exhaust from a space launch. The two elliptical areas shown indicate isopleths of HCl concentration at 1 and 10 ppm.

Aborts and reduced launch availability

The expansion and extension of the predicted toxic hazard corridors is what has caused the reduce in launch availability. If the weather conditions are particularly favorable then the predicted THC is minimized and oriented in a direction that does not impact surrounding populations. However, these ideal conditions are not common. A combination of model uncertainties, input parameter uncertainties and weather conditions usually cause THC predictions extend into neighboring populations. The net effect of the increased THC predictions is a decrease in the likelihood that scheduled space launches can occur without predictions of adverse health impacts on surrounding population. This makes it increasingly difficult to conduct space launch operations.

Academic Problem

The academic goal of this thesis effort is to increase the accuracy of the predicted concentration isopleths by improving the assumptions upon which the calculation of those isopleths are made. A more technical introduction of the model and the input parameters is required to better explain the specifics of the academic problem.

Gaussian basis of model -- assumptions

As mentioned previously, the Rocket Exhaust Effluent Diffusion Model (REEDM) is based on a Gaussian vertical line source model. Additionally, REEDM is a multi-layer model that addresses the transport and diffusion of the source material in multiple meteorological layers within the lower mixing layer and that mixing layer which is above an elevated inversion if such an inversion exists. This layered division of the atmosphere is shown in Figure 2.

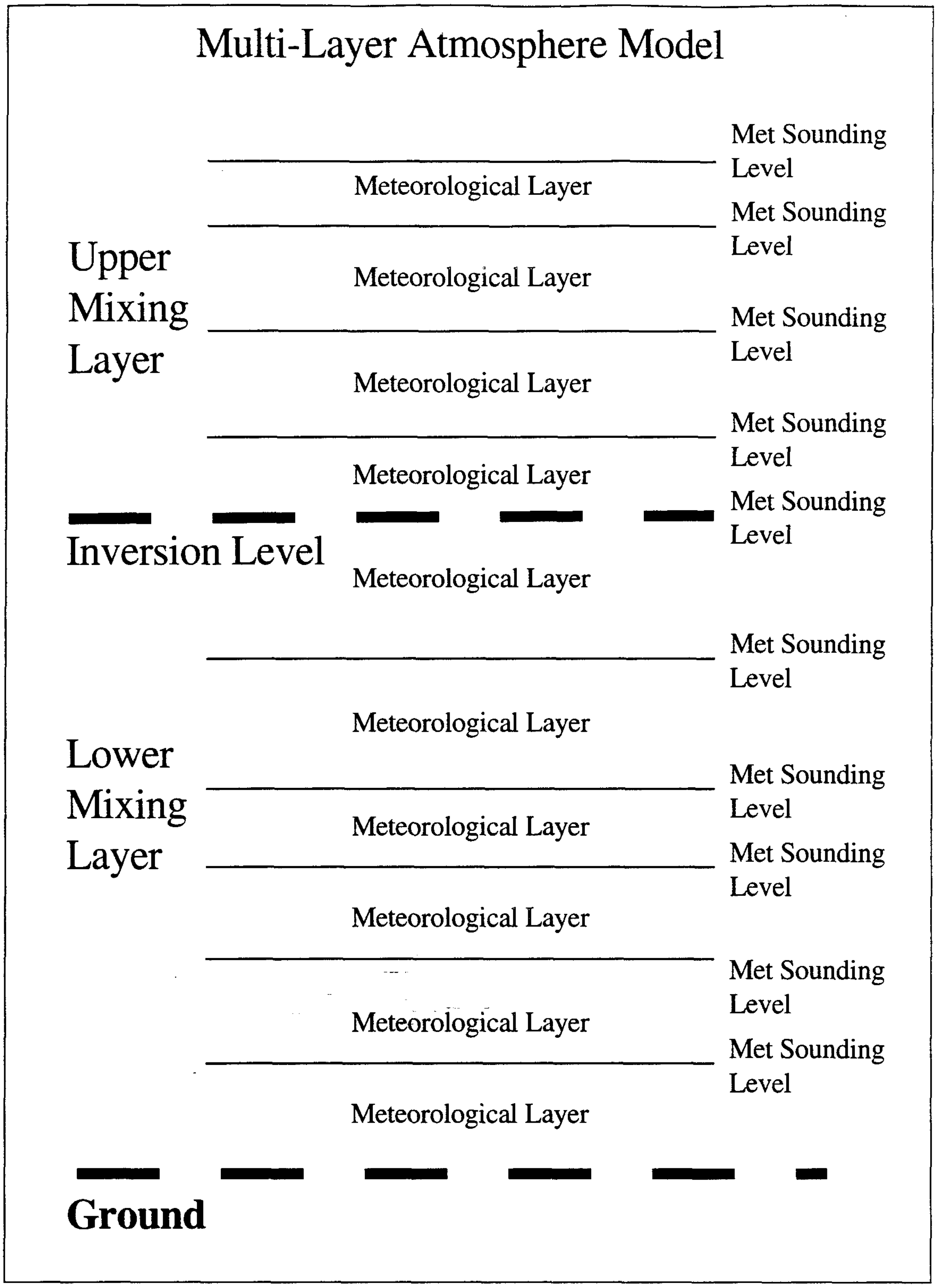


Figure 2: Atmospheric Layers

The multi-layer application of the Gaussian theory helps overcome some of the limiting assumptions of the Gaussian theory. There are two basic assumptions in the Gaussian line source model that are of particular relevance to this thesis. First, Gaussian theory assumes that the source material is distributed evenly in the vertical direction. This is serious departure from reality. The normal launch scenario approaches this assumption better than the conflagration or deflagration explosion failures. In the normal launch scenario, the rocket leaves a large stabilized ground cloud and an exhaust trail which, comparatively, are not uniformly distributed. Very little concentration persists near the ground after the cloud stabilizes. The stabilized cloud contains large amounts of source material which is assumed to be normally distributed in the vertical throughout the cloud, not uniformly. Similarly, the exhaust trail above the stabilized ground cloud contains significantly less source mass per unit height than the stabilized ground cloud. Furthermore, that amount of mass per unit height in the exhaust trail decreases with altitude because of the rocket's acceleration. These discrepancies make the application of the multi-layer methodology particularly valuable. The REEDM identifies multiple meteorological layers from ground-level to 3048 meters. Each layer is then modeled with a vertical line source that is a segment of the vertical source stretching from the stabilized cloud up to the highest meteorological layer. The line sources in these smaller meteorological layers are then assumed to be uniformly distributed within the layers. This allows the application of the Gaussian line source model with a much closer approximation of the actual source. This source distribution is depicted in Figure 3.

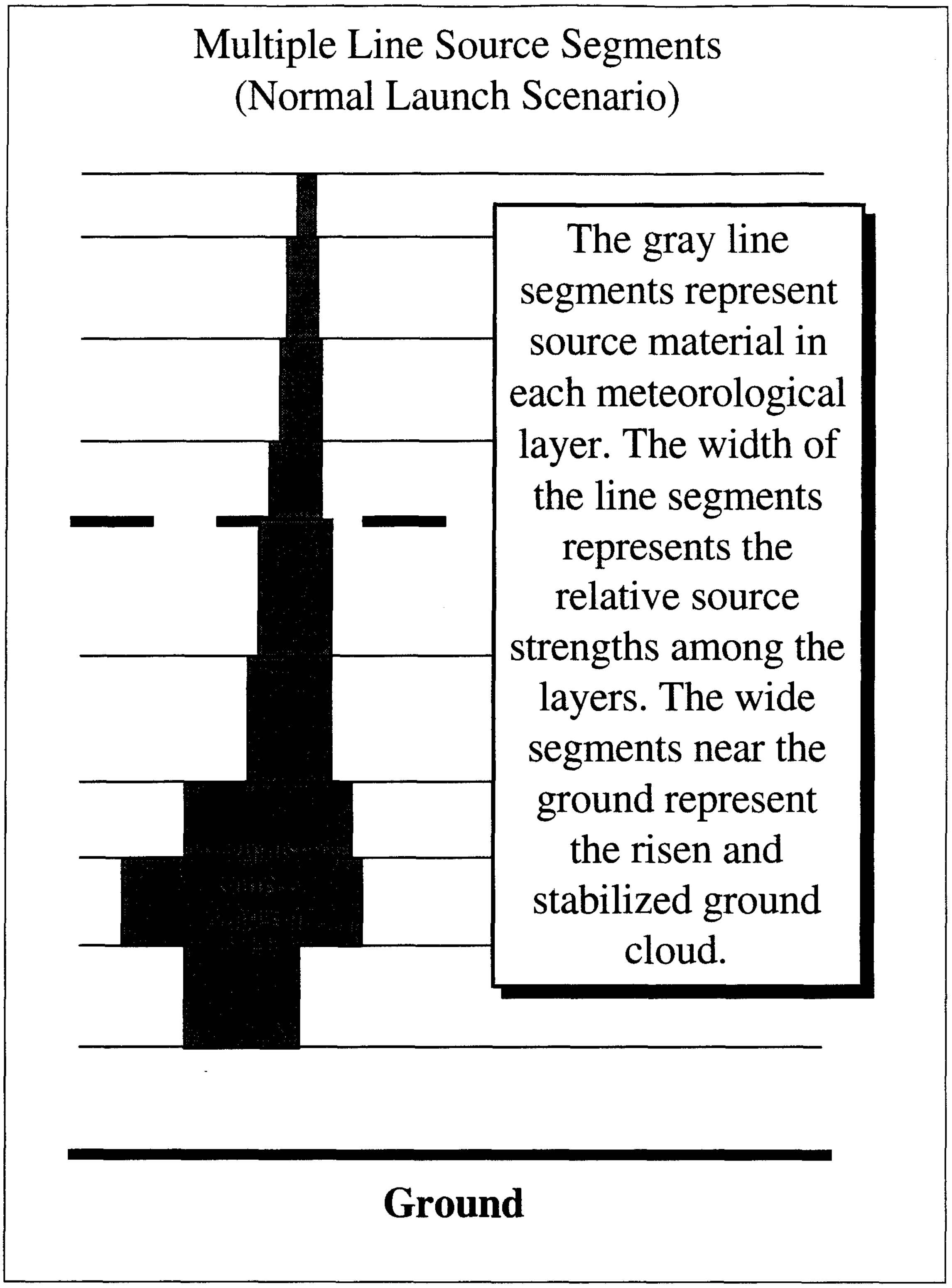


Figure 3: Line Source Distribution

Second, the wind direction and speed affecting the transport of the source material are assumed in the Gaussian model to be constant over time and space. Without a multi-layer approach, this would propagate the entire line source along the same trajectory at the same speed. This departs from reality because the wind direction and speed are not constant with altitude, but vary significantly. The Gaussian theory prevents a single line source from being transported and diffused by differing wind vectors. By dividing the actual source into many adjacent line source segments in the meteorological layers, it becomes possible to apply the different wind speeds and directions to different line segments of source material. The original REEDM, however, transports and diffuses all these line source segments with one wind speed average and one wind direction average, both averaged across the entire mixing layer. Consequently, the potential realism of the multi-layer model is not fully utilized with respect to the wind direction and speed. This broaches the heart of the academic problem to be addressed in this thesis.

Meteorological profiles

The primary source of input meteorological data for REEDM is acquired by rawinsonde measurements of wind speed, wind direction, relative humidity, and other meteorological data (31:12). These measurements are taken at intervals from ground-level up to 3048 meters. The rawinsonde data files used for this thesis are available in Appendix A, Rawinsonde Data Files. If the distance between soundings exceeds 1000 feet, interpolated values are inserted to provide a meteorological input file for the REEDM with data at intervals of 1000 feet or smaller increments. The rawinsonde sounding levels (or interpolated levels) define the meteorological layers discussed in the preceding paragraphs. The wind speeds and directions at these sounding levels are fundamental to the REEDM calculations. It should also be noted that these data are augmented in several ways where possible. Within the first 100 meters, additional data is integrated from tower-mounted measuring devices. VAFB uses Doppler Acoustic Sounding System (DASS) measurements of atmospheric turbulence in the lower mixing layer (30:35). Both ranges use climatological estimates of meteorological parameters as necessary where rawinsonde data is unavailable. The purpose of this meteorological data is to define atmospheric conditions at discrete sounding levels from the ground to the functional ceiling of the REEDM code at 3048 meters.

Model calculations

The REEDM code uses the meteorological data from the discrete sounding levels to perform several averages (22:34). The inversion level (when present) is assumed to separate the lower mixing layer from the upper mixing layer. Transport and diffusion of gaseous toxicants is assumed to be contained within these mixing layers. The REEDM uses the sounding level data to compute average wind speeds and directions for each meteorological layer defined by two sequential sounding levels. This calculation is a simple average, where the wind speed at the lower sounding level is summed with the wind speed from the next higher sounding layer and the total is divided by 2. The wind direction is calculated similarly. By this method, each meteorological layer is given an average wind speed and direction. The REEDM then uses these individual meteorological layer average wind speeds and directions to calculate a thickness-weighted average for each of the two mixing layers (or one big mixing layer if no inversion is present). This calculation involves multiplying each meteorological layer average (as defined previously) by the thickness of its layer, summing those products across the given mixing layer and dividing the sum by the total thickness of the mixing layer. This produces a weighted average of averages which describes, if grossly, the wind speed and direction of each of the two mixing layers. The meteorological layer and mixing layer averaging is shown in Figure 4.

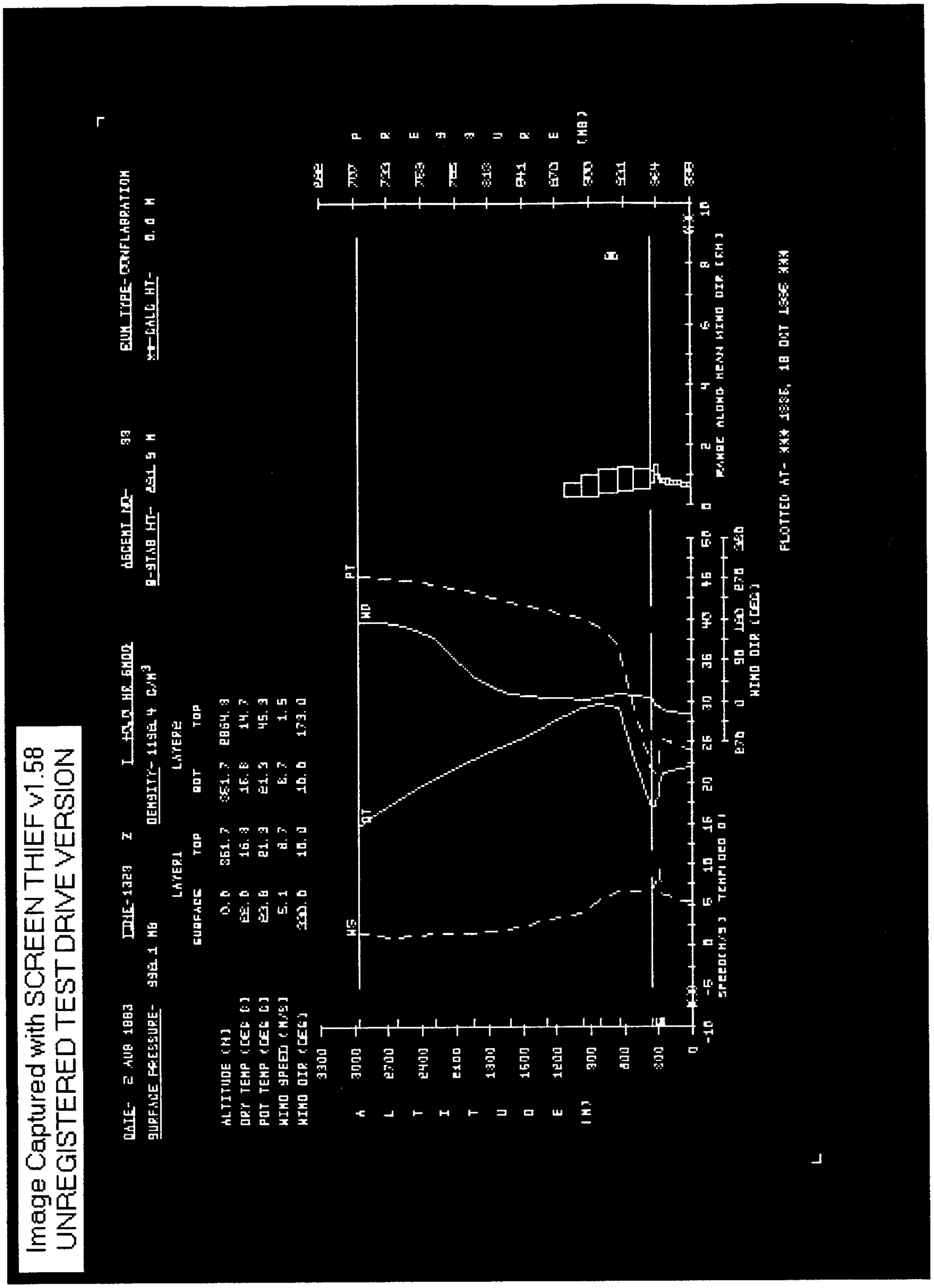


Figure 4: Graphical Meteorological Profile

Once these averages have been calculated, REEDM is able to make the calculations of downwind dose, concentration and time-weighted average concentration. Each segment of the line source contained within the meteorological layers is modeled using the Gaussian line source equation assuming perfect reflection of gasses from any present inversion layer and some user specified reflection from the ground. The mixing layer average wind speed and direction are applied in the Gaussian equation for each line source segment to produce the downwind concentration, dose, and time-weighted concentration prediction contribution from that line source segment. The total concentration, dose, and time-weighted concentration experienced at the downwind location is the sum of the contributions from each line source in all the meteorological layers. It should be pointed out that gaseous contributions are made only by those line source segments in the lower mixing layer if an inversion is present because the inversion acts as a barrier for gaseous dispersion. However, particulates settle through an inversion if one is present and so the particulate contribution includes all line source segments up to 3048 meters. The transport and diffusion of source material from the different meteorological levels is shown conceptually in Figure 5.

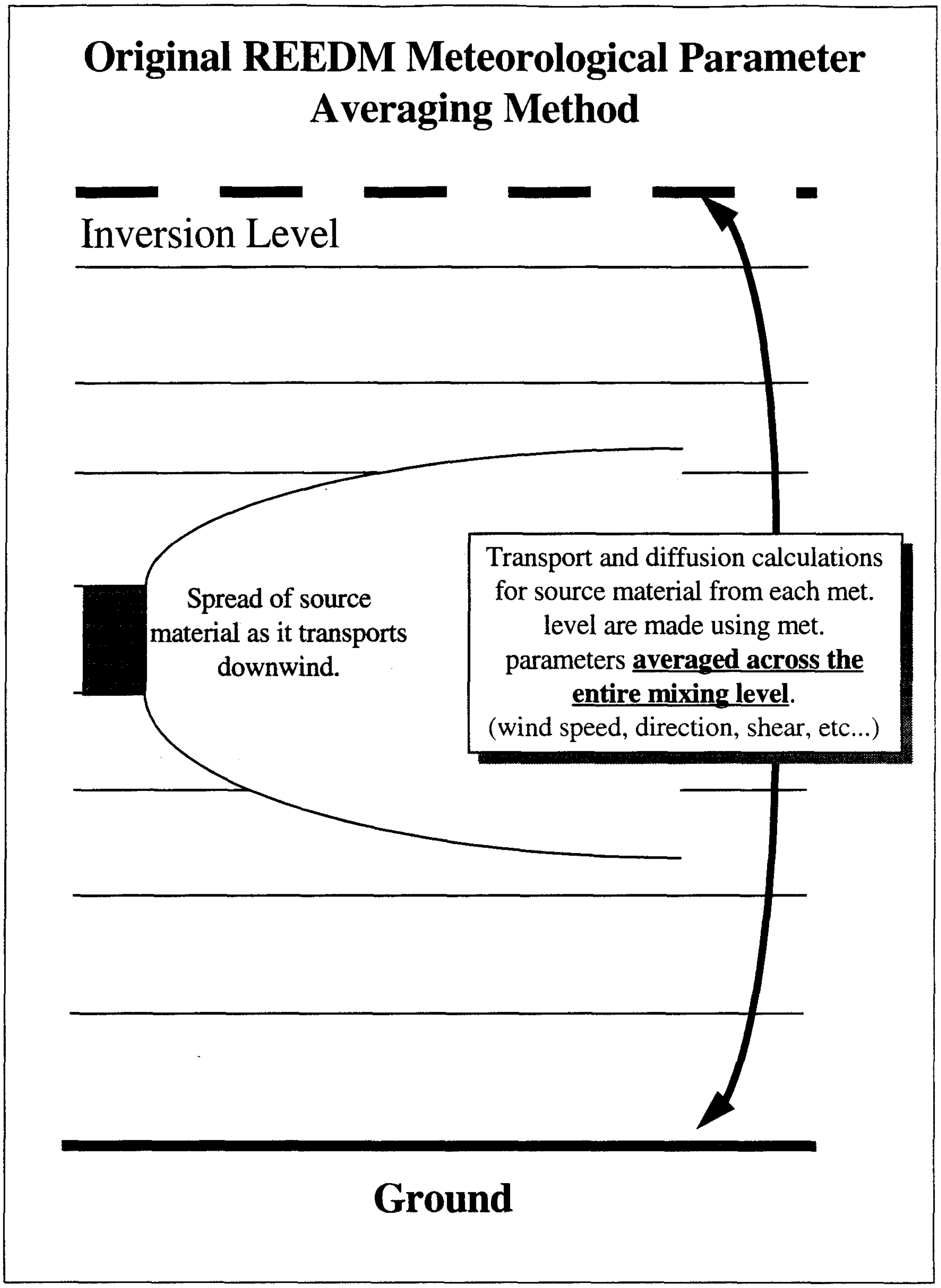


Figure 5: Original Source Transport And Diffusion

Improvement method

ACTA Inc. has pointed out that averaging the wind speed and direction across the entire mixing layer is a somewhat gross assumption and an unnecessary departure from reality (21:88; 32:1-2). For example: under the condition of a high elevated inversion or no inversion at all, the discrepancy of this assumption becomes more clear. The line source segment in the meteorological layer containing the bottom of the stabilized cloud may not experience any influence at all from the wind speed and direction in the highest meteorological layer in the mixing layer before the concentration from that source segment reaches the ground. This is especially evident at downrange distances of only a few kilometers where source material reaching the ground would have been affected by only the winds within the lower meteorological layers through which it passed on its way to the ground. Yet the present method of averaging includes irrelevant upper wind speeds and directions in the transport and diffusion equations for the sources in the lower meteorological layers.

It has been suggested by ACTA Inc., that an alternate averaging scheme be developed to include only those wind speeds and directions which actually effect a given line source segment into the Gaussian calculations of downwind concentration, dose and time-weighted average concentration. This suggestion poses several difficulties. First, each line segment source is in a different meteorological layer and thus will pass through a different number of meteorological layers en-route to the ground. Second, reflection from an elevated inversion level must somehow be incorporated to accommodate longer downwind distances where this reflected material will be significant. Thirdly, the number of meteorological layers through which material from a single line segment will pass is dependent upon how far downwind the concentration, dose and time-weighted average concentration must be predicted. Material from a single line source segment may not be expected to diffuse up or down more then one or two meteorological layers in the transport of one or two kilometers downwind. Yet material from that same line source segment may diffuse all the way to the ground and up to the inversion layer after 20 kilometers of downwind transport. The problem then includes trying to determine which meteorological layers to include in the wind speed and direction averaging for a given line source segment effecting the concentration, dose and time-weighted average concentration at a receptor at particular distances downwind. The layers included in the averaging will vary for a given line source segment from one downwind distance to the next, as well as between line source segments. A final twist to the problem is the assumption made by the Gaussian theory that the wind speed and direction are constant throughout the application of the equation. This suggests that a step-wise application of the equation will be required so that the wind speed and distance averages will be held constant over small increments in the equation application. The modified meteorological parameter averaging scheme and stepwise application of the Gaussian equations is illuminated by Figure 6, Modified Source Transport and Diffusion.

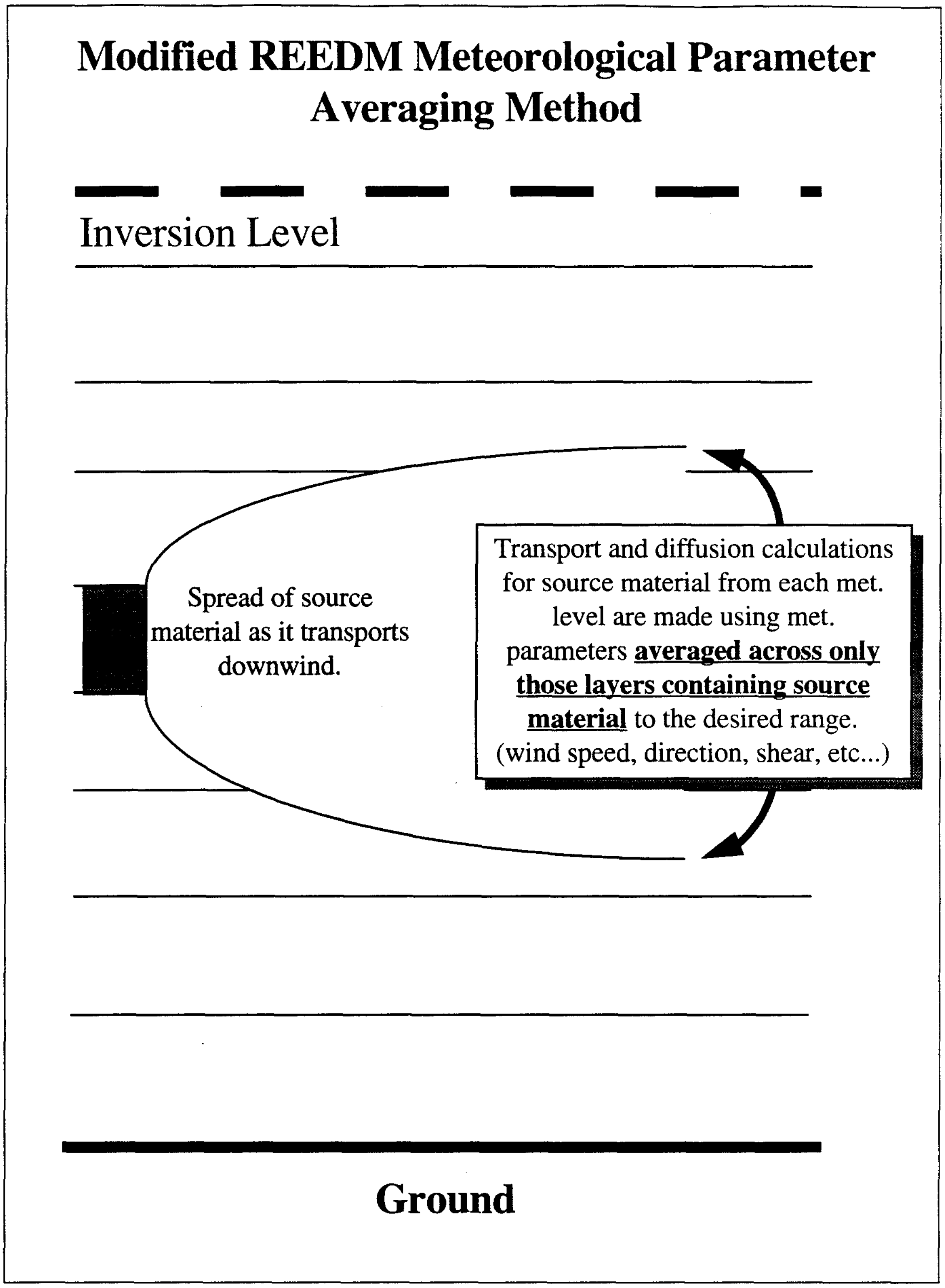


Figure 6: Modified Source Transport and Diffusion

Scope and Thesis Statement

The goal of this thesis is to reduce the uncertainty in the prediction of the concentration isopleths by improving the wind speed and wind direction averaging scheme used in the REEDM (21:88; 32:1-2). Specifically, this thesis will develop and test a method of improving wind speed and direction averaging within the mixing layers so as to more accurately reflect reality. The method will allow line source segments to be transported and diffused under the influence of atmospheric conditions from only those meteorological layers through which source material actually passes en-route to a specified receptor location. The method will update the averaging for each receptor distance and for the line source segment in each meteorological layer. Evaluation of predictions made using the new averaging method versus the old method will be discussed and compared.

It is important to point out that the REEDM depends upon many computational subroutines that will not be addressed in this thesis. These routines include calculations for concentration, dose and time averaged concentration at discrete locations in addition to centerline values, particulate settling, chemical reactions within the exhaust cloud and the rise and stabilization of the exhaust cloud after launch, to name a few. The REEDM uses an elaborate set of subroutines to estimate the rise of the hot exhaust cloud before it cools to neutral buoyancy and stabilizes. The software modifications accomplished herein will not affect the cloud-rise algorithms, but will affect only the transport and diffusion calculations for source material beginning after the exhaust cloud has risen and stabilized.

Approach

The approach to this thesis includes many different efforts. First, the problem was defined through interviews with Air Force Personnel and literature search. Second, the resources required to accomplish the software modification were secured from VAFB sources. Third, in order to properly execute changes in the code, the Gaussian theory upon which the program was based was researched. Fourth, the original REEDM source code was studied to develop an understanding of what was being accomplished within it and how. Fifth, new algorithms were developed from logical routines into FORTRAN code and were integrated into the existing REEDM code. Sixth, the statistical theory required to perform model modification evaluation was identified. Seventh, the modified and original REEDM programs were executed comparatively in an experiment using sample meteorological input data to determine if the software modifications had produced significantly different results. Eighth and finally, the results of the experiment were collected, analyzed, and discussed.

Results

The results of the thesis effort were that the averaging scheme modifications made to the REEDM code caused statistically significant change in the prediction of maximum ground-level instantaneous concentration and maximum ground-level dose. The changes in the calculations due to the modifications included slightly higher (approximately 1 ppm on the average) instantaneous concentration predictions and significantly lower (approximately -50 ppm sec) dose predictions. The 1-minute average concentration predictions did not significantly change as a result of the modifications. Furthermore, it was observed that the model predictions were influenced by a complex relationship of meteorological conditions, such that no single meteorological condition was strongly correlated to the model output.

Document Outline

This thesis is organized into five chapters. The first chapters is the Introduction which both introduces the problems addressed by the thesis. The second chapter is the Literature Review, wherein background information is established. The third chapter is the Approach. It describes the efforts undertaken during the execution of this thesis. The fourth chapter is entitled Results. The Results chapter includes tabulated and graphical results from the experiment undertaken to evaluate the software modifications. The fifth and final chapter is entitled Conclusions. This chapter summarizes the findings, makes the major assertions of the thesis and draws inferences based on the data generated. The Conclusions chapter also suggests possible follow-on research.

LITERATURE REVIEW

Space Launch Issues

Situation Overview

Space launch operations at VAFB and CCAS are seriously impeded by recent decisions of how to interpret toxic exposure limits. The exposure limits are based upon Short Term Public Exposure Guidance Levels (SPEGL's) and Environmental Protection Agency (EPA) Levels of Concern (LOC's) which were previously interpreted as 1-hour time weighted averages. Headquarters Air Force Space Command requested that Armstrong Laboratories (AL) provide technical guidance on how to interpret exposure limits because the issue threatens to impede imminent space launches (11:1-2). Subsequently, AL provided a list of recommended exposure limits which slightly lowered existing limits and pointed out their proper use as ceiling values. AL recognized that CCAS and VAFB would both experience an increased likelihood of launch hold situations as a result of the new limits and the ceiling interpretation (3: 1; 18: 1; 21: 5). The interpretation of exposure limits is recognized as very problematic to launch operations but the limits are based upon the "best available toxicological experimental and epidemiological evidence" (5: 4-5). The reevaluation of these limits as ceiling values began the controversy (13: 1). The interpretation of exposure limits as peak instantaneous concentrations has tremendous adverse impact on launch operations because the predicted instantaneous concentrations can exceed the predicted 1-hour average concentrations by up to an order of magnitude (30: 51). Interpreting exposure limits as peak concentrations immediately increases the predicted effected downwind area known as the toxic hazard corridor (THC) which is expected to experience significant hazardous concentrations (13: 1; 30: 8-9; 5: 4-5).

Commanders use a three-tier system of translating toxic concentration isopleth predictions into appropriate action. The tiers predicted by the model give an indication of the potential health hazard as a result of present meteorological conditions. Each tier level has recommended actions documented in the VAFB regulations, but ultimately, whether to launch or not is a management decision between launch criticality and the hazard to the public (4: 2). The launch of large rockets like Titan, Delta and the Space Shuttle produces rocket exhaust clouds of sufficient magnitude to pose significant health risks. The Rocket Exhaust Effluent Diffusion Model (REEDM) is used to predict the transport and diffusion of the rocket exhaust and to calculate the resultant ground-level concentrations to which people would be exposed (2:3). Exposure limits are based strictly on health risks but the GO / NO GO recommendations are made based upon the model operator's experience with the model (3: 2). Operational model scenarios include normal launches and catastrophic aborts (10: 2). The near instantaneous predictions generated by REEDM for these scenarios are perhaps higher than need be because the model employs conservative assumptions and calculations which may further restrict launch activities (4: 4; 5: 4-5). It has been pointed out that concentrations within the assumed steady state Gaussian plume actually fluctuate considerably over time (30: 8-9). This fluctuation is averaged into a Gaussian distribution over time, but is non-Gaussian when observed instantaneously. Consequently, it is technically difficult to predict ceiling calculations (5: 4-5).

The urgency of this issue is pressing launch directors for a rapid solution to the problem (13: 1). Additionally, the November 1994 abort of a Peace Keeper launch has significantly focused attention on the interpretation the exposure limits (10: 1). Similarly, there is an ever-present pressure to increase launch probabilities because launch delays are extremely expensive. For example, delaying the testing of a solid rocket motor upgrade at Edwards can cost $130,000 per day. Space launch operations are significantly more expensive yet (2: 3). One avenue for the development of a solution to this problem is an information dissemination group known as the Toxic Release Assessment Group (TRAG) which meets regularly to ensure that the Air Force space launch community has the opportunity to discuss current issues of gas dispersion modeling of rocket launch toxic emissions (3: 1) A consideration which has arisen out of the definition of ceiling exposure limits is the inclusion into decision making of the likelihood (or un-likelihood) of the launch failure which would generate the high predicted concentrations. (30: 51). It has been stated that the probability of launch failure is not insignificant (4: 5). Therefore the inclusion of this probability into decision making may or may not increase launch availability. Another concern brought up often in literature and in the TRAG discussions is the need for the REEDM model to be validated (10: 2). In mid 1995, a working group entitled the Range Area Toxic Assessment Team has been formed from many of the members of the TRAG and others in the space launch community. This group is tasked with finding both short and long term solutions to the problem of reduced launch availability.

Rocket Exhaust

In order to predict the health hazards and environmental impact associated with the launch of space vehicles at CCAS and VAFB, there are four launch exhaust scenarios modeled. These include: a normal launch, a conflagration which is an explosion with subsequent scattering and burning of solid rocket propellant, deflagration which is the explosion of the hypergolic liquid fuel and oxidizer resulting in a large fireball, and a solid rocket motor test firing (25: 2-16). The solid fuel is normally PBAN-based ammonium perchlorate with powdered aluminum. The liquid hypergolic fuel is aerozine-50 fuel and the oxidizer is nitrogen tetroxide (3:10). From these fuels, the toxic constituents presently of concern from the conflagration failure, normal launch or test firing are: hydrogen chloride gas (HCl), carbon monoxide (CO), carbon dioxide (CO2) and aluminum oxide particulates (AL2O3). Those presently of concern from the deflagration failure are: hydrazine (N2H4), nitrogen tetroxide (N2O4), unsymmetrical dimethyl hydrazine (UDMH), formaldehyde dimethylhydrazone (FDH) and nitrosodimethylamine (NDMA) which include both products of combustion and un-reacted fuel and oxidizer (25: 2-16, 32: 10). Of these toxic substances, one of the most important is hydrogen chloride (10: 1). During a normal launch, the ground cloud formed is primarily the result of the first 10 seconds of combustion of solid rocket propellant. During this time, a significant amount of fuel is combusted while the rocket is relatively stationary or moving forward at low speed. Combustion products are distributed into a single ground cloud during this time rather than a trail of exhaust. The increasing speed of the rocket vehicle distributes later exhaust into an exhaust trail rather than a cloud, through the troposphere and beyond. The ground cloud is hot and buoyant. It grows in size rapidly by entrainment of ambient air and after about 1.5 minutes, the cloud bottom lifts off the ground as the cloud rises to its stabilized height where it has cooled sufficiently that it is neutrally buoyant (32: 5). The ground cloud from space shuttle launches, for example, usually rises to stabilization height with its top near 2 kilometers above ground-level (27: 1). The deflagration scenario produces a very hot fireball of reacting hypergolic fuels that rises immediately.

Health Risk and Exposure Limits

The National Academy of Science (NAS) - National Research Council's (NRC) Committee on Toxicology (COT) has recommended emergency exposure guidance levels (EEGLs) and continuous exposure guidance levels (CEGLs) for chemicals of concern to the DoD for over 40 years, as requested. The assumption is made by COT that military personnel are relatively healthy and include women of child bearing years. The EEGLs are guidelines for emergency, short term exposure of military personnel as necessary in those circumstances required during some military operation. An EEGL is an airborne concentration based guideline which concedes that personnel so exposed may suffer reversible effects that do not impair judgment or the ability to respond. EEGL exposure times must be limited to 24 hours. CEGLs are recommended for longer exposures of military personnel associated with more normal military operations (15: 89). The recommendations made by COT are not regulatory in nature and should not be applied as such. They are specifically for use by DoD in those situations peculiar to military operations. In addition to the EEGLs and CEGLs requested of COT, the DoD requests a sort-term, public emergency exposure guidance level or SPEGL. This is a peak concentration to which the general public may be exposed to for a single, unpredicted, short-term exposure without significant risk of adverse health effects. It is usually set at .1 to .5 times the EEGL in order to accommodate the wider range of susceptibility found in the general public versus the relatively healthier and more robust military population (15: 89). In 1985 and 1989, the COT published lowered SPEGLs for N2O4 and the hydrazines of concern in rocket exhaust. This lowering of the SPEGLs significantly lengthened the predicted toxic hazard corridors associated with launch to extend beyond base boundaries into civilian populations. This seriously limited the base's capacity to perform rocket launches without risk of causing adverse health effects. This forced commanders to reevaluate how they planned for the toxic hazards space launch (9: 93).

The three tier philosophy of hazard categorization is based upon concern for adverse health effects on exposed populations due to the airborne irritants. It provides operational commanders flexibility and decision criteria for managing hazardous operations with some degree of confidence (9: 94). The tiers correspond to levels of concern, where tier 1 concentrations warrant immediate isolation or evacuation to prevent exposure, tier 2 concentrations present some risk of adverse effects in the general population, and tier 3 concentrations are not expected to induce adverse effects in the general population but may cause such effects in some sensitive subpopulations (4: 3). The tier concentrations for each chemical of concern are based upon National Institute of Occupational Safety and Health (NIOSH) immediately dangerous to life and health values (IDLH), EPA levels of concern (LOC) and the COT recommended SPEGLs. Tier one levels are set at 1/2 the NIOSH IDLH values for each chemical. The IDLH is the maximum concentration at which an average person can be exposed for 30 minutes without being expected to experience escape-impairing adverse health effects. These values are concentration-based, not dose-based and so should be considered ceiling values not to be exceeded. Tier 2 levels are either COT recommended SPEGLs or EPA LOCs. Where the EPA LOC is defined as 1/10 the NIOSH IDLH (9: 93). These values too are considered ceiling values. Tier 3 levels are only specified for HCL and N_2O_4 because they are the only chemicals expected to have potential to effect sensitive-sub populations like asthmatics. These level are set at COT recommended SPEGLs and therefore are also considered ceiling values (4: 3-4, 10: 1). Both VAFB and CCAS should apply consistent health criteria based on this guidance (10: 1).

Instantaneous Calculations

The three tiers used in the three tier hazard evaluation system are defined by concentration contours produced by atmospheric dispersion models. The averaging time used in the concentration predictions should be consistent with the exposure limits used in the three tiered hazard evaluation system (4: 3). Armstrong laboratories has recommended and it is generally agreed that those exposure limits designated as ceiling values for hazard planning in the three-tiered system should not include time averaging (3: 3; 20: 1). AL asserts that reviewed literature supports interpreting the exposure limits as ceiling concentrations, not time-averaged values (3: 2). It is imperative that ceiling values not be predicted by protracted averages because doses received by inhalation even during the first minute will be considerable and may, even in that short time, threaten the health of those exposed. Protracting the interval of averaging has the potential to reduce the average value far below peak instantaneous levels and thereby conceal the dangerous peak exposures (6: 1; 20: 1). As a matter of necessity for modeling purposes however, AL has recommended using 1-minute averaging in the prediction modeling as an approximation of instantaneous predictions (3: 2; 4: 5; 6: 1).

The implementation of instantaneous exposure ceilings presents a serious problem for the models which are not well suited to predicting instantaneous concentrations (21: 5; 30: 15). Specifically, the random and stochastic motion present in the lower turbulent atmosphere makes even 1-minutes averages much more difficult to predict accurately than previously used 60-minute averages (8: 1). Furthermore, model validation will be more difficult when predictions are required to be 1-minute averages or less (8:1). The turbulent atmosphere creates dramatic concentration fluctuations which the models treat as time averaged values (21: 6). These concentration fluctuations have been observed experimentally in the Mountain Iron field story and others (8: 1). ".. some instantaneous concentration measurements were made and the ratios of observed peak instantaneous concentrations to the observed centerline mean concentration ranged from 1.5 to 30 with the tendency for the ratio to increase with down wind distance" (30: 12). It is clear that instantaneous concentrations can greatly exceed time averaged concentrations (30: 15).

Because of the significant impact of the AL recommended ceiling exposure limits on launch operations, the 30 Space Wing Safety office (30 SPW/SEY) at VAFB is seeking alternative limits and or interpretations because prediction the model is designed to calculate average values and works best with time averaging of at least 30 minutes (3: 2).

Meteorological Conditions

Staff meteorologists at both ranges attempt to forecast launch time weather conditions based upon the meteorological conditions identified in the pre-launch activities of rawinsonde release, tower data, etc. (30: 33). At both ranges, rawinsonde measurements are taken to gather meteorological profiles prior to and after launches. These measurements include wind direction, wind speed, air temperature, atmospheric pressure, and relative humidity at frequent elevation intervals from ground-level to about 3048 meters (32: 5). The measurements taken at CCAS are taken approximately 10 miles southeast of the space shuttle launch area (pad 39A). Rawinsonde releases occur at 24, 11, 8 1/2, 5 1/2, 2 1/2, and 1 hour prior to launch with the data being available within 30 to 40 minutes after release. Sonic detection and ranging (SODAR) equipment is employed at VAFB along with tower bivane and cup anemometer measurements to measure wind speed, direction, and turbulence. Thirty minutes prior to the launch at VAFB, real-time tower and a SODAR system known as a Doppler Acoustic Sounding System (DASS) measurements are taken of both the vertical and horizontal wind turbulences (30: 35). At CCAS, DASS is not available, but tower measurements of turbulence conditions are taken prior to launch (21: 45). It is significant that the ground cloud usually rises to a stabilization height that is above the measured tower and or DASS turbulence data. Meteorological inputs for these heights are rawinsonde interpolations or climatological estimates (21: 45).

VAFB typically experiences a mixing depth of 150 to 200 meters. However, low wind conditions permit nocturnal radiation inversions and produce mixing depths of less than or equal to 100 meters (1: 3-10). These nocturnal, stratified inversions conditions reduce vertical wind-speed fluctuations to nearly zero (7: 11). It is not uncommon for VAFB to experience inversion layers at heights between .5 and 1.5 kilometers. This significant mixing layer makes meteorological data within this region of particular importance for transport and diffusion modeling. Meteorological measurements should be tabulated at intervals on the order of a few hundred meters to prevent overlooking influential inversion layers (25: 2-8). This is particularly important for diffusion modeling because inversions tend to act as impenetrable barriers to turbulent mixing. Consequently, gaseous diffusion does not transport significant quantities of materials across inversion boundaries (21: 37). Despite the highly stable nature of these inversions, the high initial velocities and temperatures of the exhaust clouds permit them to rise through surface-based and low elevated inversions with tops less than 200 meters (32: 13). An additional concern at VAFB is an atmospheric transition zone between the opposing afternoon sea breeze and the opposing upper return flow which commonly produces considerable wind direction and speed shears causing turbulent mixing both laterally and vertically within this zone (32: 13). In general, however, vertical wind velocities are usually negligible (21: 45).

The Development of Atmospheric Diffusion Models

Model Development

Development of computer models for the purpose atmospheric dispersion estimation began at least as early as 1963 with a beryllium hazard study for the Pacific Missile Range. In the late 1960's it became clear that volume and point source models were incapable of managing the spatial scales involved with the launch of large space vehicles (28: 1). NASA needed some method of "..assessing the environmental impact of exhaust products from rocket engines with respect to air quality standards, toxicity thresholds and potential bio-ecological effects and in evaluating requirements, if any, for environmental launch constraints" (27: 1; 32: 1). Growing public and governmental concern over exposing people and the natural environment to hazardous substances motivated model development. MSFC began developing dispersion modeling capabilities for NASA at that time. In 1973 NASA began a joint program to monitor and predict rocket exhaust for all Titan launches from the Eastern Test Range (ETR) at Kennedy Space Center (KSC). MFSC had responsibility for delivering atmospheric transport and diffusion capability. Langley Research Center (LaRC) took rocket exhaust concentration measurements from airborne platforms and at ground-level. The ETR was responsible for providing the logistics required for these activities. This joint effort revealed the obvious need for real-time prediction capability and provided a database for model verification. Subsequent work conducted by the H.E. Cramer Company, Inc. under NASA contract number NASA-

34132 resulted in the development of the Rocket Exhaust Effluent Diffusion Model to predict and assess the environmental and health impacts of Space Shuttle operations at the ETR. It provided launch officials real-time dispersion prediction capability (27: 1; 32: 1; 28: 1)

Field Studies

Throughout the development of diffusion model capabilities, several field studies were accomplished to support and validate model development. One such study is known as Mountain Iron. The experiments conducted as part of this study took place at South Vandenberg over an eight month period from December 1965 through July 1966. The experiments were sponsored by the US Air Force and were performed by Pacific Northwest Laboratory of the Battelle Memorial Institute of Richland, Washington. "The objective of the Mountain Iron diffusion program was to collect a comprehensive meteorological and diffusion data base in order to develop an empirical diffusion model specifically for South Vandenberg" (24: 5). During the field study, 102 successful tests were accomplished in which a airborne tracer was released and measured at discrete downwind locations. Plume patterns were determined for each test and a centerline concentration was tabulated for various downwind distances (24: 9).

A more recent field study know as AMADEUS was conducted during the autumn phase of project WIND from 23 September through October of 1987 at a site known as Meadowbrook which is located 15 miles north of Red Bluff, California. The study was conducted by the U.S. Army Atmospheric Sciences Laboratory with support from other Army labs and the Air Force's Geophysics Laboratory. The objective was "..to collect a comprehensive meteorological and diffusion data base for the test and evaluation of complex terrain transport and diffusion models" (24: 4-5). Ten tests were accomplished during the two week period in both stable and unstable conditions. Tracer gas releases occurred during two one-hour periods and two 15-minute releases which were accomplished with one hour separations (24: 4-5). This study provided more downwind concentration data as well as measured meteorological information.

The Rocket Exhaust Effluent Diffusion Model (REEDM)

REEDM Overview

The REEDM calculations are derived from instantaneous Gaussian puff equations (8: 1) and the model has the ability to calculate nearly instantaneous concentrations (4: 4). The Gaussian model upon which the REEDM is based has been proven to be well suited for most applications. The mathematical calculations are not computationally demanding and there is good flexibility in the equations to allow a wide range of application. Furthermore, Gaussian models have proven themselves to be reasonable when compared to available field data (32: 65). The current version of the REEDM can be run at any location for which the needed site input data are available and is therefore referred to as "site-independent" (32: 2). It should be noted however, that there is a significant amount of site specific data required to run the REEDM, ranging from climatological based meteorological profiles, rawinsonde data, digitized topographic information and more. In addition to being site-independent, the program is able to support a variety of large rocket vehicles, including the space shuttle, Titan II, Titan 34D, Titan IV, Delta and Minuteman vehicles (32: 2, 79). Calculations performed by the REEDM can predict downwind concentrations both along the ground-level plume centerline and at discrete receptor locations. This information is available in both a tabulated and graphical contour format (32: 79). The REEDM provides rapid access to reasonable predictions of the diffusion and transport of rocket exhaust on a geographic scale of up to 60 km (32: 58-59)

Within the REEDM code, there exists a balance between accuracy and simplification. Simplification is required because the turbulent and stochastic nature of the atmosphere is too complex to model exactly. Furthermore, the demand for computing resources (including time) and the input data requirement go up significantly with the complexity of the model. Consequently, many assumptions have been made within the algorithms of the code to facilitate its creation and execution (32: 58-59). These simplifying assumptions have optimized the accuracy and minimized computer accuracy to "..permit a rapid assessment of the impact of a launch in the form of tables and plots of centerline values versus distance and isopleth plots while retaining the ability to calculate more precisely the value of interest at a limited set of discrete points" (32: 59). The REEDM supports three modes of use (32: 9). The first is the operational mode which is used for space launch operations. It is designed with built-in defaults to facilitate reasonably accurate operation during pre-launch activities with minimal interactive user input. A second method of operation is the research mode. This allows more specific analysis and modification of those parameters which are used in the calculations. The user has more control of which parameters are used and what values are assigned to those parameters. Finally, the REEDM code can be run in a diagnostic mode which generates an extensive, detailed listing of the variables used in the calculations and the outputs produced (32: 9). All modes of operation of the REEDM are subject to one common and critical factor. The single most important requirement for REEDM code to produce valid predictions of rocket exhaust transport and diffusion is the availability of quality meteorological input data (27: 4).

REEDM Assumptions and Calculations

The REEDM is based upon well established physical concepts including "conservation of mass and energy, Newton's second law of motion, and Gaussian plume dispersion to model rocket exhaust" (25: 2-23, 2-24). The REEDM is designed to calculate dosage, peak concentration, and peak time-mean concentration at downwind locations from the launch site using Gaussian puff dispersion equations (30: 3). The functional upper limit to the applicability of the model is about 3048 meters (32: 11). When the model calculates the stabilized position of the source cloud, its segments rise through and stabilize in meteorological layers with differing wind vectors. Consequently, the discs of source clouds stabilize in different locations and are transported with different trajectories (21: 52). The REEDM represents the stabilized exhaust cloud as adjacent line sources, located within the meteorological layers in a mixing layer. Each line source is located at some slightly different distance from the launch pad than the line sources in the other meteorological layers due to the different wind vectors within each meteorological layer. The calculated downwind concentrations are determined by summing the total contributions of the line sources in each meteorological layer upon the receptor location in question (21: 39; 32: 24). Within discrete meteorological layers, "[i]n the REEDM dispersion model code, the exhaust material is assumed to be uniformly distributed in the vertical and to have a bivariate Gaussian distribution in the horizontal plane at the point of cloud stabilization" (27: 4). This source distribution lends itself to the use of the finite Gaussian line source model, which is the specific model upon which the REEDM is built (27: 4). The dose and concentration formulas are written in rectangular coordinates for clarity. The origin of the coordinate system is located beneath the stabilized ground cloud. The x axis is aligned along the mean wind direction for each mixing layer and the y axis is perpendicular to the mean wind direction. It is aligned along the cross-wind direction (32: 69). The standard deviation of the material distribution is referred to as σ . The standard deviation of the along-wind material distribution is given by σ_x and the deviation of the cross-wind material distribution is given by σ_y (1: 3-10). The sigmas required for the Gaussian-plume model can be determined empirically by observations of the variances of the fluctuations of the wind-speed (7: 2). REEDM uses the standard deviation of the azimuth wind angle and the elevation wind angles (σ_A' and σ_E' respectively) as growth predictors for the exhaust cloud as a function of downwind distance. Ideally these parameters are measured and entered either as turbulence profile input files or interactively, one meteorological layer at a time by the model operator. What data are not provided from measurements or user estimates is calculated from climatological estimates (32: 47). The surface roughness z_0 is assumed to be 10 cm, with the reference values of σ_A' and σ_E' tabulated accordingly (32: 48). Calculations of estimated σ_A' values are not permitted to be less than σ_E' and are set equal to σ_E' if that occurrence arises. Calculated values of σ_E' are set to 1 degree at heights above the mixing layer (32: 54). The σ_y term is the primary parameter in determining the extent of the horizontal diffusion of the toxic cloud associated with the rocket launch scenario. The default value of this term has been adjusted so the REEDM algorithms generate results more closely resembling the Pasquill-Gifford dispersion curves (22: 3-7). Wind direction change with changing altitude is included into the REEDM by a term included in the σ_y . This is relatively uncommon among diffusion models. The Open Burn Open Detonation (OBOD) model is the only other such model to include this changing wind direction. Both models, however, are restricted to using only one directional shear term for the mixing layer so an average is used in both models (22: 3-7).

The REEDM is designed to perform its diffusion calculations within two major mixing layers. The lower of the two begins at the earth's surface and extends up to the base of an elevated inversion layer. The upper layer defaults its base to the top of the lower layer and its top to the highest meteorological sounding level reported (32: 12). For the purposes of the REEDM calculations, the program defines an inversion layer as one or more meteorological layer (identified by rawinsonde sounding levels) with a total thickness of at least 100 meters for which the virtual temperature gradient exceeds $-5 \times 10^{-4}\ K/m$ (32: 58). In order for REEDM to identify and make proper calculations, stable atmospheric layers must be at least 100 meters thick. In the event that no inversion is present, the code will automatically default to an arbitrary 10,000 foot deep mixing level, or the highest meteorological sounding level provided by rawinsonde data, whichever is the lower of the two (21: 37). The depth of the mixing layer is defined as that distance from ground-level up until the turbulent mixing ceases (21: 39-40; 32: 57). A fundamental assumption made by the REEDM code is that the toxic gases do not transport across the inversion layer during the diffusion and transport calculations (1: 3-13). When no inversion layer is present, there is no reflection of contaminate back towards the ground (21: 39). The model assumes that the base of an inversion layer perfectly reflects all gases, vapors and drops back down towards the ground. However, drops with sufficient gravitational settling velocities in the upper mixing layer are allowed to pass down through the inversion layer. No transport of gasses across the inversion layer is allowed (32: 13). One peculiarity of the REEDM model is that the equations used do not permit the possibility of fumigation conditions (26: 1).

The REEDM relies heavily upon rawinsonde observations to provide the requisite meteorological profile used in its calculations.. The rawinsonde soundings are taken from ground-level to at lease 3048 meters. If the interval between soundings is greater than 1000 feet, the model inserts interpolated sounding data in-between the actual observed levels (32: 12). Although the model has algorithms to make estimated calculations of turbulence parameters, it is far preferable to use any measured turbulence parameters which may be available from tower based instruments or Doppler acoustic radar measurements. The tower measurements are least-square fitted using a logarithmic regression. These data are used in lieu of climatological data whenever available for the first 100 meters. Climatological meteorology profiles are used to estimate turbulence parameters above 100 meters in height (32: 56). If measured turbulence parameters in the region below 100 meters are not available, they are calculated using a power law which is a function of the net radiation index. Above about 100 to 200 meters, turbulence parameters are poorly described theoretically and scarcely measured (32: 54). A 10 meter wind speed is calculated by assuming the wind profile to be logarithmic between the lowest two rawinsonde measurements of wind speed (32: 48). REEDM uses a mesoscale wind field trajectory model to accommodate for the varying wind vectors between meteorological layers in the lower turbulent mixing layer. The wind field model uses a numerical technique developed by Tingle and Bjorklund in 1973 to accommodate complex terrain topography. The method was designed for two dimensional shallow-fluid oceanography flow but has been re-applied for atmospheric flows in rough terrain (32: 73).

The REEDM code uses a height-weighted mixing layer average of the meteorological profile for calculating concentrations. This average value is applied to different calculation heights within the mixing layer (22: 3-4). The REEDM averages the wind speed and direction input available from the rawinsonde soundings into mixing layer averages. The rawinsonde observations provide measured values of wind speed and direction at discrete heights above the ground. When an inversion is present, some fall below the inversion into the lower mixing layer and some fall above the inversion into the upper mixing layer. When no inversion is present all sounding levels are within the one mixing layer which extends from the ground to the highest sounding level. The REEDM averages every two adjacent meteorological sounding level measurements of wind speed and direction to generate average values for that meteorological layer which is contained between the two soundings. The model thereby generates average wind speed and direction values for one less meteorological layers than there are sounding levels. Next, the REEDM generates an average wind speed and direction applicable for the entire lower mixing layer. It does this by taking a thickness weighted average of all those wind speed and direction averages for the meteorological layers contained within the mixing layer. The resultant mixing layer average wind speed and direction is applied to the transport and diffusion equations (32: 1).)

REEDM Limitations

The Gaussian equations within the REEDM code require that the atmospheric wind speed and direction be constant. Consequently, there is a significant departure from reality as a gross average wind speed is applied to transport source material in particular meteorological layers where more specific wind vector information is available (21: 37). The assumption of an unvarying and non-divergent wind field is a simplification of reality, as is the assumption that maximum ground-level concentrations lie alone a downwind centerline (8: 1; 30:4, 47). "The dispersing plume is forced to retain the assumed Gaussian material distribution and the model cannot handle conditions of plume lofting by updrafts, fumigation by down drafts, or splitting of the contaminate cloud" (30: 34). The REEDM makes significant limiting assumptions. A statistical approach to the actually varying wind field would be appropriate, but the REEDM solution is deterministic rather than stochastic. There is no provision for error bounds or input variable variances (30: 32). Examination of REEDM predictions has indicated that the predicted centerline value [which should the maximum concentration at that distance] varies from the calculated maximum concentration at that same point but calculated as a discrete point rather than as part of the centerline, by +/- 20%. Because of the uncertainty in the REEDM predicted concentration isopleths, the 30th Space Wing Safety Office has in the past defined the predicted THC as 40 degrees to either side of the predicted plume centerline. The uncertainty faced comes either from input data uncertainty or modeling uncertainty (30: 32). The modeling uncertainty is a result of the simplifying assumptions or empirically derived constants used to adjust the REEDM calculations (30: 32). Another shortcoming within the REEDM program is a lack of a clear way to specify the mixing layer under all practical conditions. Additionally, there is insufficient measured data to support the assumption that an inversion layer is an impermeable boundary to gaseous dispersion (1: 3-13).

For over six years, Geodynamics has been the Independent Verification and Validation (IV&V) contractor working for VAFB. They have studied and critiqued the REEDM extensively. They have over that time identified both minor and significant deficiencies (2: 29). Many of the variables in the REEDM source code have names which are not indicative of their content or use (22: b-3). Furthermore, the Users Manual was deficient in its explanation of the functions and methodology of the subroutines used in the model (1: 3-7). One of the primary subroutines in the REEDM source code is called SIGMA. This subroutine is critical because it calculates the dispersion coefficients σ_x, σ_y and σ_z. The routine, however, is "..extremely convoluted and hard to understand" (22: b-2). Additionally, many local variables are used for multiple disjoint used without clear definition (22: b-2). Reviewed literature has shown that the assumptions made within the REEDM are limiting and the actual program code is

REEDM Sensitivity

It is important to make model calculations using meteorological predictions from the most current observations because changes in the meteorological profile are very significant (27: 4). It is believed that the uncertainties associated with the meteorological input data dominate the uncertainty in the model predictions (30: 32). Because of these uncertainties, "..a THC length increase of 20% is recommended as a compensation factor for uncertainty in the wind speed" (30: 36). Similarly, "..variations in the isopleth lengths represent approximately 30% THC length uncertainty attributable to uncertainty in the turbulence data" (30: 36).

It has been shown through extensive sensitivity studies that wind speed, wind shear, and temperature lapse rate [due to its effect on the depth of the mixing layer] are among the most significant parameters in the prediction of downwind dose, concentration. Variance in these meteorological inputs produces profound changes in the length and width of the predicted toxic hazard corridor (25: 2-46). Under the conflagration failure mode of burning solid rocket propellant, increases in wind speed cause peak concentrations to increase linearly with the wind speed. Under the deflagration failure mode of rapidly combusting hypergolic fuels, the predicted peak concentrations increase gradually with wind speed, but the effect is more pronounced with low cloud stabilization heights (25: 2-47).

The REEDM is very sensitive to the height of the mixing level (1: 3-10). Previous studies of the ground clouds produced from space vehicle launches have shown a relationship between the stabilization height of the exhaust cloud and the ground-level concentrations when the stabilized cloud is completely within the lower mixing layer or there is no inversion present. The ground-level concentrations vary approximately with the inverse cube of the stabilization height (26: 1). The stabilization height of the ground cloud can be expected to vary inversely with the one third power of wind speed (25: 2-29). The direction of the plume centerline even beyond the distance of peak concentration remains critical because it define the end of the THC at the distance where the concentration is less than the SPEGL or other tier criteria (21: 41). Sensitivity studies performed on the REEDM have determined that the peak ground-level concentration is comprised almost exclusively from source material which has dispersed downward from the stabilized exhaust cloud (21: 41). The lower mixing level wind vector as computed by the numerical wind field solution converge to the same result as not using the wind field solution when there is no inversion or it is above 10,000 feet (25: 2-29).

Rates of horizontal and vertical dispersion are greatly effected by atmospheric turbulence and dramatically impact the width and length of the THC (30: 36). Increases in directional wind shear causes increases in the lateral spread of the plume at differing altitudes. Because increasing shear spreads the plume out, the peak centerline concentration declines gradually with increasing shear. This spreading out can enlarge a THC but it reduces the peak concentrations predicted (25: 2-33). Dose, too, is very dependent upon wind speed, direction, shear, mixing height and turbulence. As a first approximation, the dose from an instantaneous cloud source can be expected to be inversely proportional to the mean wind speed. Dose relationships as a function of turbulence and the other meteorological parameters are not so easily described (25: 2-28). The decreasing dose with increasing wind speed is mostly attributable to the decreasing exposure time associated with a faster moving ground cloud (25: 2-29, 2-33).

REEDM Improvement

Of the predictions made by the REEDM, the correct location of the plume centerline is probably the most important. Therefore, any error in wind direction is probably the most significant single error introduced to the model. The averaging scheme used by the model can cause it to use very inaccurate wind direction averages in the dispersion equations applied to source material in each meteorological layer (21: 38). This problem can be described as a mismodeling error. "Mismodeling errors result when the mathematical algorithms selected to model the physical process of exhaust cloud formation, cloud rise, plume dispersion, terrain/wind interactions, etc. are over-simplified, inappropriate or omitted" (25: 2-23;2-24). This averaging scheme is only appropriate if the source material is distributed uniformly vertically throughout the mixing layer, which is not the case. In reality, even the closest scenario to this ideal is the normal launch which itself generates a significant ground cloud that is not uniformly distributed across the mixing layer. The two failure scenarios represent even more radical departures from the assumption of uniform vertical distribution of source material. Additionally, if there is significant wind shear in those meteorological layers within the mixing layer, a serious directional error can occur prediction of the centerline of the toxic plume. This steering error has been observed to occur and is especially problematic when no inversion is present or it is very high and the average wind speed and direction include values from far above the stabilized exhaust cloud (21: 37-38).

ACTA Inc. has recommended that the averaging scheme used for the wind speed, direction and shear be reviewed for improvement (21: 88). The algorithm ACTA Inc. proposed for increasing the accuracy of the averaging scheme should "..should give a more accurate prediction for the plume transport in the first 10 to 15 kilometers with graceful degradation at longer downwind distances" (21: 43). Furthermore, assuming the Gaussian dispersion model to be a reasonably close approximation of reality, it has been asserted by ACTA Inc. that their "..proposed alternative averaging scheme will always provide an equal or better estimate of plume centerline direction to the peak concentration point than the existing REEDM algorithm.." (21: 41). A change in the mixing layer averaging scheme would be expected to produce a change in the isopleth lengths because of the application of different wind speeds, directions and turbulences (21: 42). The IV&V contractor responsible for critiquing the REEDM code has recommended that the subroutine that calculates the turbulence parameters should be restructured and adequately commented, identifying local variables as needed and eliminating meaningless computations (22: b-3). They have since accomplished those changes.

A new method of determining the mean shear, turbulence values, wind direction and wind speed for the mixing layer has been proposed by ACTA, Inc. It is intended to improve the accuracy of the values by excluding from the average those values which have no effect on the on the dispersion out to some given distance downrange. The suggested method is based upon the observations that the overwhelming majority of contaminant that reaches ground-level comes from the source term in the lowest meteorological layer and that the remainder of source material that reaches the ground comes from the source layer down to the ground, not via reflection off an inversion even when one is present. Therefore, the suggested method of determining a mixing layer average is to include only those meteorological layers in the averaging which contain the stabilized cloud and are between the bottom of the stabilized cloud and the ground. This would omit the meteorological layers in the mixing layer which are above the stabilized ground cloud. This method would provide more accurate predictions of plume centerline location to at least the distance of the peak concentration and perhaps beyond. This method would, however, become biased at extreme downwind distances as the ground-level concentration begins to have significant contributions from source material reflected down from an elevated inversion. This bias would occur more quickly with lower inversion layers and higher vertical dispersion coefficients (21: 39-40).

Another solution proposed by ACTA Inc., is a more sophisticated averaging scheme that averages only those meteorological layers which contain source material out to a given distance downrange. A problem with determining which meteorological layers to include in the averaging scheme is that the layers to include are defined by the dispersion of the cloud at that range. Yet, the dispersion of the cloud at the desired range depends upon the meteorological layers included in the averaging (21: 39). A solution to this problem might be to give the vertical dispersion coefficient an initial estimate for the purpose of estimating the downrange vertical dispersion of the exhaust cloud. With an estimate of the vertical dispersion of the cloud at the desired distance downrange, the affected meteorological layers could be determined, a more accurate average wind speed and direction could be calculated and a more realistic vertical dispersion term could also be calculated. The affected meteorological layers could be determined by adding and subtracting 2.15 times the vertical dispersion term from the centerline altitude. This would include 90% of the source material from each source (32: 1-2). This more accurate vertical dispersion term could then be used to predict the downwind concentrations. When the plume growth reached the inversion layer and/or the ground, that becomes the maximum or minimum (respectively) meteorological layer for calculating the average (21: 42).

In addition to the inaccurate averaging scheme, the REEDM has never been adequately validated against a thorough data set. As a result, the possibility of the model predictions being overly conservative or optimistic cannot be dismissed (2: 3). A need for model validation has been expressed by both VAFB and Patrick AFB. The Toxic Release Assessment Group (TRAG) has expressed a need for such a validation effort and is involved with an ongoing effort presently underway at CCAS and scheduled for both ranges. It has been stated by AL that "The exposure limits are only as valid as the model" (4: 4). Visual and infrared imaging of the behavior of the ground cloud formed after a launch is needed to validate certain key subroutines in the REEDM. Specifically, the use of two simultaneously filming cameras with approximately orthogonal viewing angles can generate images for computer reconstruction that will permit the determination of critical dispersion coefficients (26: 1,2). There is a significant need for additional elevated tracer studies to measure turbulence profiles above the 100 meter measurement towers up to the top of the mixing level. This data set is badly needed to validate the climatological model used within the

REEDM (30; 51). As a result of this and other justifications, AL has recommended that a continued program of validation be implemented for the REEDM model and such a program is in place (18: 4; 4: 5). In addition to needed validation, a formal propagation of errors study has not been conducted on the REEDM and should be done (25: 2-24).

METHODOLOGY

Methodology Summary

The thesis problem was studied and defined. Needed resources were acquired. Gaussian theory consistent with Turner and Seinfeld was studied. The original REEDM algorithm was studied. Then the modifications to the REEDM algorithm were developed. Statistical theory needed for model evaluation was studied. An experiment was conducted to determine if the software modifications produced significantly different results. Finally, the output of the experiment was collected and evaluated.

Problem Definition

Problem Topic

Input from ACTA Inc. and VAFB Safety was solicited to frame the problem. The goal was to increase the accuracy of the REEDM by making the meteorological input averaging scheme more realistic. Acta Inc. and VAFB Safety suggested that the Gaussian calculations should be made using meteorological parameters averaged over only those meteorological layers affecting the source material, not necessarily over the entire mixing layer as was the method in the existing REEDM (32: 1-2). This problem was specifically mentioned in a previous report on the REEDM code provided by ACTA Inc. (21: 39-40).

Problem Scope

The REEDM software has numerous routines to accommodate a variety of natural phenomena including the rise and stabilization of the hot source cloud, particulate settling for AL2O3, acid deposition, chemical decay and others. Furthermore, the model is capable of predicting the transport and diffusion of up to seven different species of airborne chemicals. In addition, the model predicts downwind centerline values, maximum values, values at discrete receptor locations and isopleths of concentration. The extent and complication of the source code and algorithms necessary to support REEDM's diversity required that the scope of this software modification be limited.

Consequently, the software modifications made by this thesis are valid only for gaseous dispersion (no AL2O3) calculation of centerline maximum values. The discrete receptor and isopleth algorithms have not been altered. Furthermore, as HCl was indicated by VAFB safety/Acta Inc. to be a toxicant of primary concern to launch availability. Therefore, model runs were focused on this chemical to the exclusion of other species. Similarly, the ground-level conflagration failure often poses a significant HCl threat to human health and therefore launch availability. Therefore the conflagration failure mode was used to demonstrate model performance. These restrictions of scope permitted progress to be made and conclusions to be drawn. A more extensive modification of the model was judged to be beyond the practical scope of this thesis effort.

Needed Resources

Many resources were required in order to accomplish this thesis effort. See Table 6.

Table 6: Needed Resources

NEEDED RESOURCE	SOURCE
REEDM FORTRAN Source Files	VAFB Safety Office/ACTA Inc.
REEDM Executable File	VAFB Safety Office/ACTA Inc.
REEDM FORTRAN Source Files (Structured)	GEODYNAMICS
REEDM Global & Local Variable Reports	GEODYNAMICS
REEDM Input Database File	VAFB Safety Office/ACTA Inc.
Meteorological Input File For VAFB	VAFB Safety Office/ACTA Inc.
Meteorological Input File For CCAS	VAFB Safety Office/ACTA Inc.
34 Meteorological Input Files For VAFB	GEODYNAMICS
Sample Batch Input File	GEODYNAMICS
Lahey FORTRAN Compiler Software	AFIT/ENG

Gaussian Equations

In order to modify the REEDM, it was first necessary to understand the Gaussian equations upon which the model was based. REEDM uses a finite vertical line source Gaussian puff model to perform the transport and diffusion calculations. The Gaussian equations employed by the REEDM are presented hereafter, along with basic assumptions and the fundamental equations from which the Gaussian equations were derived.

Basic Assumptions

1) The Gaussian derivation is accomplished in rectangular coordinates.
2) The origin of the transport and diffusion calculations was taken to be ground-level, beneath the stabilized ground cloud.
3) The x axis was aligned with the mean wind direction in the lower mixing layer for calculations in that layer and was aligned with the upper mixing layer mean wind direction (if there were two mixing layers) for calculations within that layer. The x axis was the along-wind direction.
4) The y axis was aligned perpendicular to the x axi(s) and was the cross-wind direction

The Conservation of Mass of Mass principal is the starting point for the Gaussian diffusion equations. The variable c is concentration in (g/m^3). It represents mass flux through a differential control volume. The conservation of mass was applied to concentration as shown in Equation 1.

$$\frac{d(cu)}{dx}+\frac{d(cv)}{dy}+\frac{d(cw)}{dz}+\frac{dc}{dt}=0 \quad (1)$$

Equations 1, 3, 4 and 5 as well as the supporting description are here shown as presented in the REEDM Users Manual (32 ,65-69).

Advection - Diffusion

The general differential equation for the advection and diffusion of source material is given hereafter in Equation 2. This is equation was derived from the previous conservation of concentration and is the fundamental equation from which the Gaussian concentration, dose and time-mean concentration equations were derived.

$$\frac{dc}{dt}+u\frac{dc}{dx}+v\frac{dc}{dy}=k_x\frac{d^2c}{dx^2}+k_y\frac{d^2c}{dy^2}+k_z\frac{d^2c}{dz^2} \quad (2)$$

Dosage

The REEDM dosage equation follows from the previous conservation of mass equation with several assumptions and manipulations. Dosage is the time integrated concentration at any point (x,y,z). The total dose received at a receptor position is calculated by summing the dose contribution from all K meteorological layers. Equation 3 presents the final dose equation used within REEDM to calculate the dosage at any point (x,y,z).

$$D_{L,K} = \frac{F\{K\}}{2\sqrt{2}\sigma_{yL}(z_{k+1} - z_z)} \{\exp[-\frac{1}{2}(\frac{y}{\sigma_{yL}})^2]\} \{\sum_{i=0}^{\infty} [\gamma_j^{\,i} [erf(\frac{2i(z_{TL} - z_{BL}) - z_k + z}{\sqrt{2}\sigma_{zL}})$$

$$+erf(\frac{-2i(z_{TL} - z_{BL}) - z_{k+1} - z}{\sqrt{2}\sigma_{zL}}) + \gamma_j^{\,i+1} [erf(\frac{2i(z_{TL} - z_{BL}) - 2z_{BL} + z_{k+1} + z}{\sqrt{2}\sigma_{zL}})$$

$$+erf(\frac{-2i(z_{TL} - z_{BL}) + z_{BL} - z_k - z}{\sqrt{2}\sigma_{zL}}) + \sum_{i=1}^{\infty} [\gamma_j^{\,i} [erf(\frac{2i(z_{TL} - z_{BL}) + z_{k+1} - z}{\sqrt{2}\sigma_{zL}})$$

$$+erf(\frac{-2i(z_{TL} - z_{BL}) - z_k + z}{\sqrt{2}\sigma_{zL}}) + \gamma_j^{\,i+1} [erf(\frac{2i(z_{TL} - z_{BL}) + 2z_{BL} - z_k - z}{\sqrt{2}\sigma_{zL}})$$

$$+erf(\frac{-2i(z_{TL} - z_{BL}) - 2z_{BL} + z_{k+1} + z}{\sqrt{2}\sigma_{zL}})]]\} \quad (3)$$

where...

$F\{K\}$ = fraction of the material in the Kth layer

γ_j = partial reflection coefficient which describes the percent reflection of source material off of the inversion layer. This coefficient can be different for each of j different source material particle size categories.

= 0.0 ; $V_j > 0.3$

= 2.5 (0.3- V_j) ; $0.3 <= V_j <= 0.05$

= 1.0-1.0179066 $V_j^{1/3}$; $V_j <= 0.05$

V_j = Mean settling velocity for source particles of the jth size category.

σ_{zL} = standard deviation of the vertical distribution of source material in the Lth mixing layer due to the source in the kth meteorological layer (m)

= $\sigma_{EL}' \, x_{rz} (\frac{x}{x_{rz}})^{\beta}$

x_{rz} = distance downwind from a vertical point source over which the vertical cloud expansion is linear (REEDM default value equals 100 m)

β = coefficient of vertical cloud expansion (REEDM default equals 1.0) which describes the propensity of the cloud to expand vertically as it is transported. Used in the σ_{zL} definition

σ_{EL}' = effective value of σ_E' in the Lth layer

σ_{yL} = standard deviation of the crosswind distribution of the source material in the Lth mixing layer due to the source in the kth meteorological layer

$$= \{[\sigma_{AL}' x_{ry}(\frac{x + x_v - x_{ry}(1-\alpha)}{\alpha x_{ry}})^{\alpha}]^2 + [\frac{\Delta\theta_L' x}{4.3}]^2\}^{1/2}$$

x_{ry} = distance downwind from a vertical point source over which the crosswind cloud expansion is linear (REEDM default equals 100 m)

x_v = virtual distance (m) which is defined as shown hereafter.

$$= x_{ry}(\frac{\sigma_{yo}\{K\}}{\sigma_{AL}' x_{ry}})^{\frac{1}{\alpha}} + x_{ry}(1-\alpha)$$

α = coefficient of crosswind cloud expansion (REEDM default equals 1) describing the propensity of the cloud to expand cross-wind as it transports.

σ_{AL}' = effective value of σ_A' in the Lth mixing layer (radians) which is the average standard deviation of the wind azimuth angle in the Lth mixing layer

$\sigma_{\theta L}'$ = total directional shear of the wind through the Lth layer (radians)

$$= (\theta_{TL} - \theta_{BL})(\pi / 180)$$

where

θ_{TL} = Wind direction at top of the Lth mixing layer

θ_{BL} = Wind direction at bottom of the Lth mixing layer

$\bar{u}_L$ = mean wind speed in the Lth layer (m / sec)

$$= (\frac{1}{z_{tl} - z_{BL}}) \sum_{K=z_{BL}}^{z_{TL}} (\Delta z_K \bar{u}_K)$$

The sum of the contributions from all sources produces the total concentration at a given receptor distance:

$$D_L = \sum_K D_{L,K}$$

Concentration

The maximum peak concentration to occur as the exhaust cloud passes over a receptor location (x,y,z) is given by Equation 4.

$$\chi_{P,K} = D_L\left(\frac{\bar{u}}{\sqrt{2\pi}\sigma_{xL}}\right) \tag{4}$$

Where:

σ_{xL} = standard deviation of the alongwind distribution of the material in the Lth mixing layer due to the source in the Kth meteorological layer (m)

= $\left[\left(\frac{L\{x\}}{4.3}\right)^2 + \sigma_{xo}^{\ 2}\{K\}\right]^{.5}$

$L\{x\}$ = alongwind cloud length at the distance x (m)

= $\frac{.28\Delta\bar{u}_L x}{\bar{u}_L}$; $\Delta\bar{u}_L \geq 0$

= $\frac{.28|\Delta\bar{u}_L| x}{\bar{u}_L}$; $\Delta\bar{u}_L < 0, \frac{\Delta\phi}{\Delta z} < 0$

= 0 ; $\Delta\bar{u}_L < 0, \frac{\Delta\phi}{\Delta z} \geq 0$

$\Delta\bar{u}_L$ = mean wind speed shear in the Lth layer (m/sec)

= $\frac{\sum_{z_{BL}}^{z_{TL}} (\Delta z_K)(u_{k+1} - u_k)}{z_{TL} - z_{BL}}$

Peak Time Mean Concentration

The peak time-mean concentration, or maximum time-mean concentration that occurs as the exhaust cloud passes the point (x,y,z) is shown in Equation 5.

$$\chi_{P,K}\{t_A\} = \frac{D_L}{t_A}[erf(\frac{\bar{u}_L t_A}{2\sqrt{2}\sigma_{xL}})] \quad (5)$$

where t_A is the time in seconds over which the concentration is averaged

Original REEDM Algorithm

The original REEDM averages meteorological parameters across the entire mixing level, calculates atmospheric turbulence coefficients for the entire mixing layer using those averaged parameters and finally uses these values in the Gaussian equations presented previously. The meteorological parameters of concern in this thesis were wind speed, wind direction, wind speed shear, wind direction shear, azimuth standard deviation of the wind direction and elevation standard deviation of the wind direction. The atmospheric dispersion coefficients are sigmax (along-wind dispersion), sigmay (cross-wind dispersion) and sigmaz (vertical dispersion). The original REEDM uses mixing-level averages of these parameters in the Gaussian equations.

The following equation describes the simple average method used by the original REEDM to calculate the average meteorological parameters for each meteorological layer.

$$\bar{\Theta}_m = \frac{1}{2}(\Theta_k + \Theta_{k+1}) \quad (6)$$

Where:

Θ = Any of the six meteorological parameters measured at meteorological sounding heights

Θ_k = The meteorological parameter measured at the kth sounding height (bottom of mth meteorological layer)

Θ_{k+1} = The meteorological parameter measured at the k+1 sounding height (top of mth meteorological layer)

$\bar{\Theta}_m$ = The meteorological layer average parameter for the mth meteorological layer

Unlike the simple average used to calculate the meteorological layer averages, the mixing layer average calculations in the original REEDM are thickness weighted.

$$\overline{\overline{\Theta}}_L = \frac{1}{n}\left(\sum_{m=mbot}^{mtop} \overline{\Theta}_m Z_m \right) \tag{7}$$

Where:

$\overline{\overline{\Theta}}_L$	=	The mixing layer-wide average of any of the six meteorological parameters
L	=	The present mixing layer
n	=	The number of meteorological layers within the present mixing layer
$mbot$	=	The lowest meteorological layer within this mixing layer
$mtop$	=	The highest meteorological layer within this mixing layer
$\overline{\Theta}_m$	=	The meteorological layer average parameter for the mth meteorological layer
Z_m	=	The thickness of the mth meteorological layer

The first REEDM subroutine of specific concern is RRDRM. RRDRM reads input meteorological data from the rawinsonde data file and assigns meteorological parameter values to each sounding level, linearly interpolating to ensure the distance between sounding levels does not exceed 1000 meters. Then, it averages between every two adjacent sounding levels to produce average meteorological parameters which describe the meteorological layers between each sounding level. Finally, RRDRM performs a mixing-level-wide, thickness-weighted average of the meteorological layers within each mixing layer. If two mixing layers exist, the bottom layer gets a set of average parameters to grossly describe the conditions below the inversion level. Similarly, the upper mixing level gets its own set of parameters averaged from the top of the inversion layer to 3048 meters. When no inversion exist, only one set of average parameters is calculated which describes the atmospheric conditions from the ground up to 3048 meters. RRDRM stores these meteorological parameter averages (both meteorological layer and mixing layer averages) into common variables for use by later routines.

RCONM is another critical subroutine to this thesis effort. RCONM increments the range counter for calculation of maximum centerline calculations and calls BREAK to actually perform the Gaussian calculations. RCONM is the controlling or parent routine for the centerline calculations and is shown along with the other routines critical to the centerline calculations on the following flow chart, Figure 7.

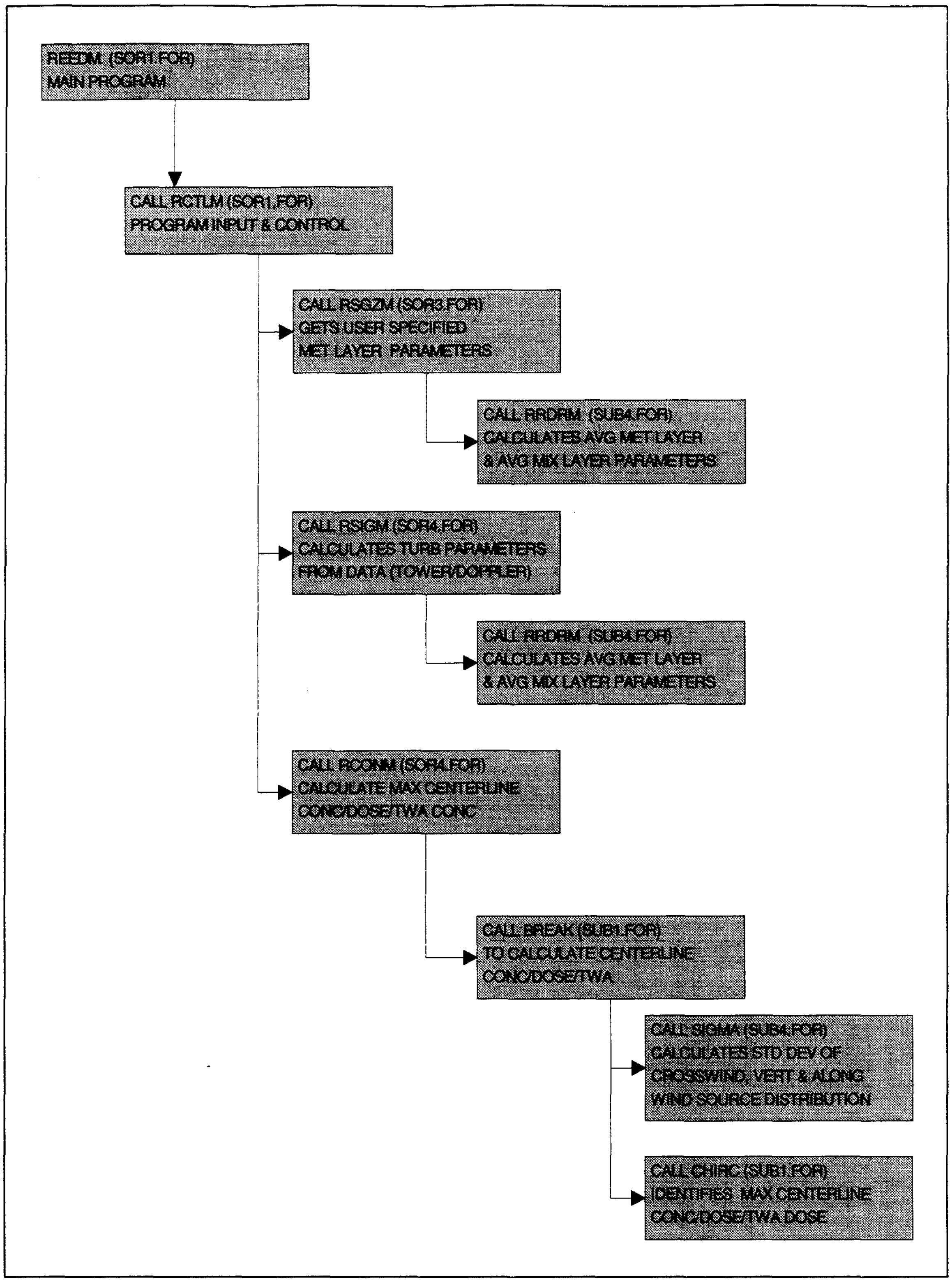


Figure 7: Original REEDM Flow Chart Of Thesis Critical Routines

BREAK is probably the single most important of the original REEDM subroutines to this thesis. BREAK is written to calculate the dose, concentration, and time-mean concentration contributions of source material originating in each of the m meteorological layers to the calculations made at the centerline receptor locations. These calculations are performed using encoded versions of the Gaussian equations listed previously. (Typically these calculations are done for ground-level, centerline receptors. That was the case in all experimental runs included in this thesis) Each meteorological level contribution is summed to produce a total dose, concentration, and time-mean concentration for the centerline receptor. BREAK relies upon the SIGMA subroutine to convert azimuth and elevation wind direction standard deviation values into the diffusion coefficients sigmax, sigmay, and sigmaz as a function of the present downwind distance. BREAK passes SIGMA the mixing-level wide average meteorological parameters to support the calculations. Therefore, the returned sigmax, sigmay, and sigmaz describe the entire mixing level at the specified distance x. BREAK writes the dose, concentration and time-mean concentration values to arrays for printing.

Modified REEDM Algorithm

The concept employed in the modified REEDM attempts to better approximate reality by recognizing that source material from a given meteorological layer is not necessarily affected by all the wind speeds in the mixing layer to the given distance downwind. That is to say that as the source material cloud from the mth meteorological layer travels down wind and expands, it is only effected by meteorological parameters in those meteorological layers into which the cloud has expanded as it translates downwind to the specified distance. This 'intelligent' evaluation of which meteorological layer parameters to include in the average is accomplished through the iterative use of several routines. The equation describing the cloud-wide averaging developed for the modified REEDM is shown hereafter.

$$\overline{\overline{\Theta}}_{m,x} = \frac{1}{ztop - zbot}\left(\sum_{m=botmet}^{topmet} \overline{\Theta}_m Z_m\right) \qquad (8)$$

Where:

$\overline{\overline{\Theta}}_{m,x}$ = The cloud-wide average of any of the six meteorological parameters, specific to source material from the mth meteorological layer, and to a specific range x.

botmet = The lowest meteorological layer containing a significant amount of source material at the range x, from the source in the mth layer.

topmet = The highest meteorological layer containing a significant amount of source material at the range x, from the source in the mth layer.

zbot = The height of the center of the botmet

ztop = The height of the center of the topmet

$\overline{\Theta}_m$ = The meteorological layer average parameter for the mth meteorological layer

Z_m = The thickness of the mth meteorological layer

RRDRM is still relied upon to perform meteorological layer and mixing layer averaging. These values are used as needed throughout the new and modified routines. RCONM was minimally altered to call the new routine CBBREAK in lieu of the original BREAK routine. RCONM is responsible for incrementing the down-range distance and then calling CBBREAK to calculate the concentration, dose and time-weighted concentration at each range distance. In these calculations, however, the average meteorological parameters are recalculated for each meteorological level in which source material originates, and for each range increment. Again, RCONM is the controlling routine for the centerline calculations. Therefore, it and its supporting routines are identified on the following flow chart, Figure 8.

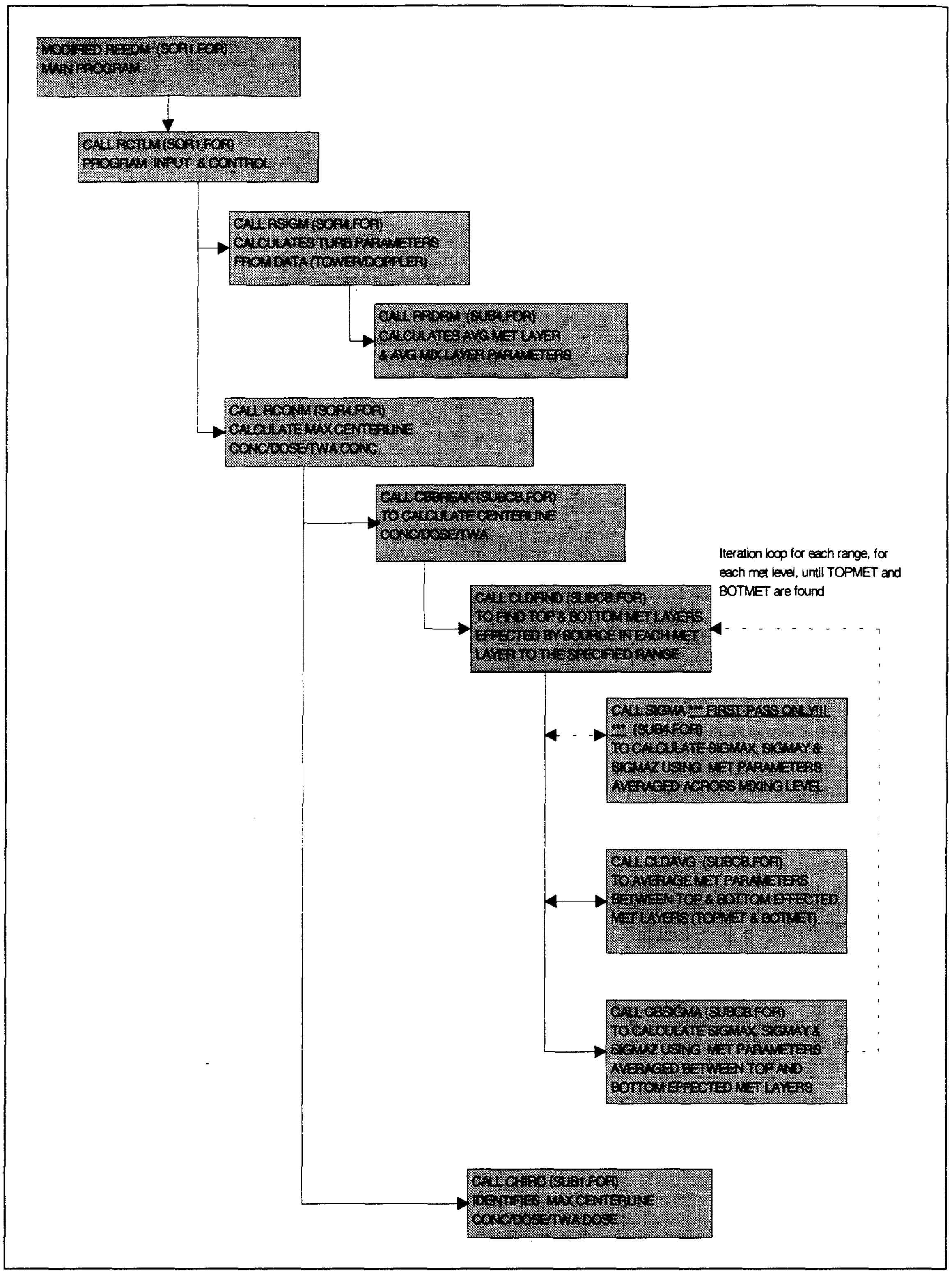


Figure 8: Modified REEDM Flow Chart Of Thesis Critical Routines

CBBREAK is a modified version of the original routine BREAK. The purpose of both is to calculate the maximum downwind centerline concentration, dose and time-weighted average concentration. CBBREAK, however, calls the new and modified subroutines to determine the appropriate average meteorological parameters and atmospheric turbulence coefficients for each range and for source material originating in each meteorological level. It uses those average meteorological parameters and turbulence coefficients in the Gaussian equation for each meteorological level. It sums the contributions from source material in each meteorological level to get the concentration, dose and time-weighted average concentration at each range increment. To accomplish these tasks, CBBREAK calls cldfind to determine the top and bottom meteorological levels effected by source material originating in each m meteorological layers, at the given range. CLDFIND also calculates the average meteorological parameters but uses other subroutines for those specific calculations.

The subroutine CLDFIND is designed to locate the top and bottom meteorological level effected by the expanding source material from each meteorological level at the desired range. The routine first assumes the average meteorological parameters to be the mixing level averages already calculated in the RRDRM routine and as used exclusively in the unmodified version of REEDM. These values are used to calculate first approximations of turbulence coefficients affecting the transport of material from its source in each mth meteorological layer to the specified range. The sigmaz thus determined is used to estimate how much the cloud will spread out vertically in transit from the source to the specified range. The amount of vertical spread is defined to be 2.15 times the sigmaz coefficient (defining the top and bottom of the cloud containing 90% of the source material). The vertical spread distance is split about the center of the mth meteorological layer. The layer which contains the height of the center of the mth layer plus half the spread height is the first iteration top effected meteorological layer. Similarly, that meteorological layer which contains the altitude of the center of the mth layer minus half the vertical spread distance is defined as the first iteration bottom effected meteorological layer. Top and bottom meteorological layers default to the inversion layer and ground-level, respectively, if the cloud expansion encounters these boundaries. Then begins an iterative loop. The meteorological parameters are re-averaged, this time only between the top and bottom effected meteorological layers. The turbulence parameters sigmax, sigmay, and sigmaz are recalculated using these more restricted meteorological parameter averages. The new sigmaz is used to recalculate the top and bottom effected meteorological layers. The recalculated top and bottom meteorological layers are compared to the first iteration top and bottom meteorological layer values. If they have changed, the loop repeats. If they have not changed, the loop ends and the top and bottom effected layers have been determined, the average meteorological parameters have been calculated and the turbulence coefficients have been calculated. CLDFIND uses the new routines CLDAVG and CBSIGMA to perform the previous described tasks. Graphical representations of the functions of CLDFIND and its supporting routines are shown by Figures 9 and 10.

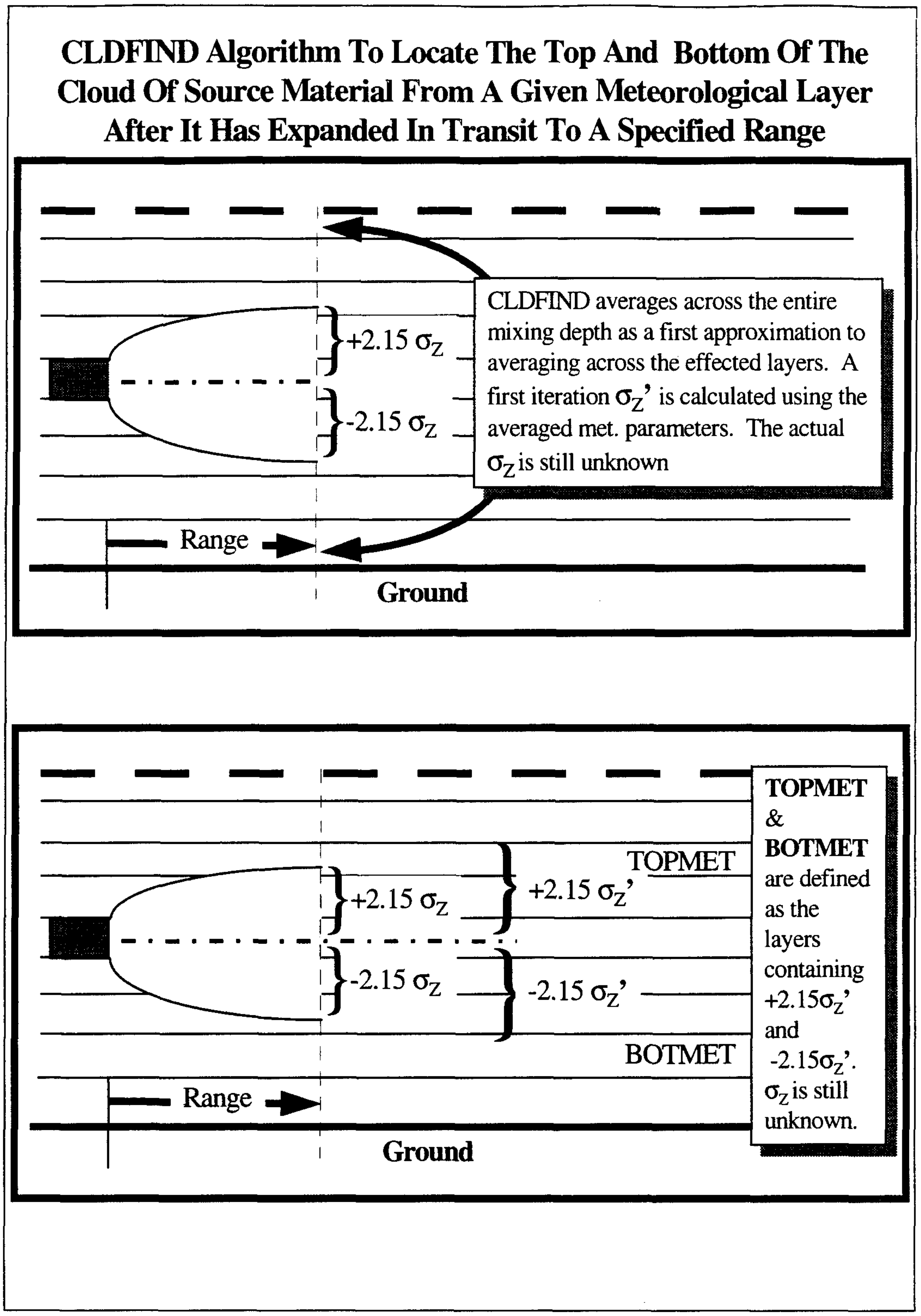
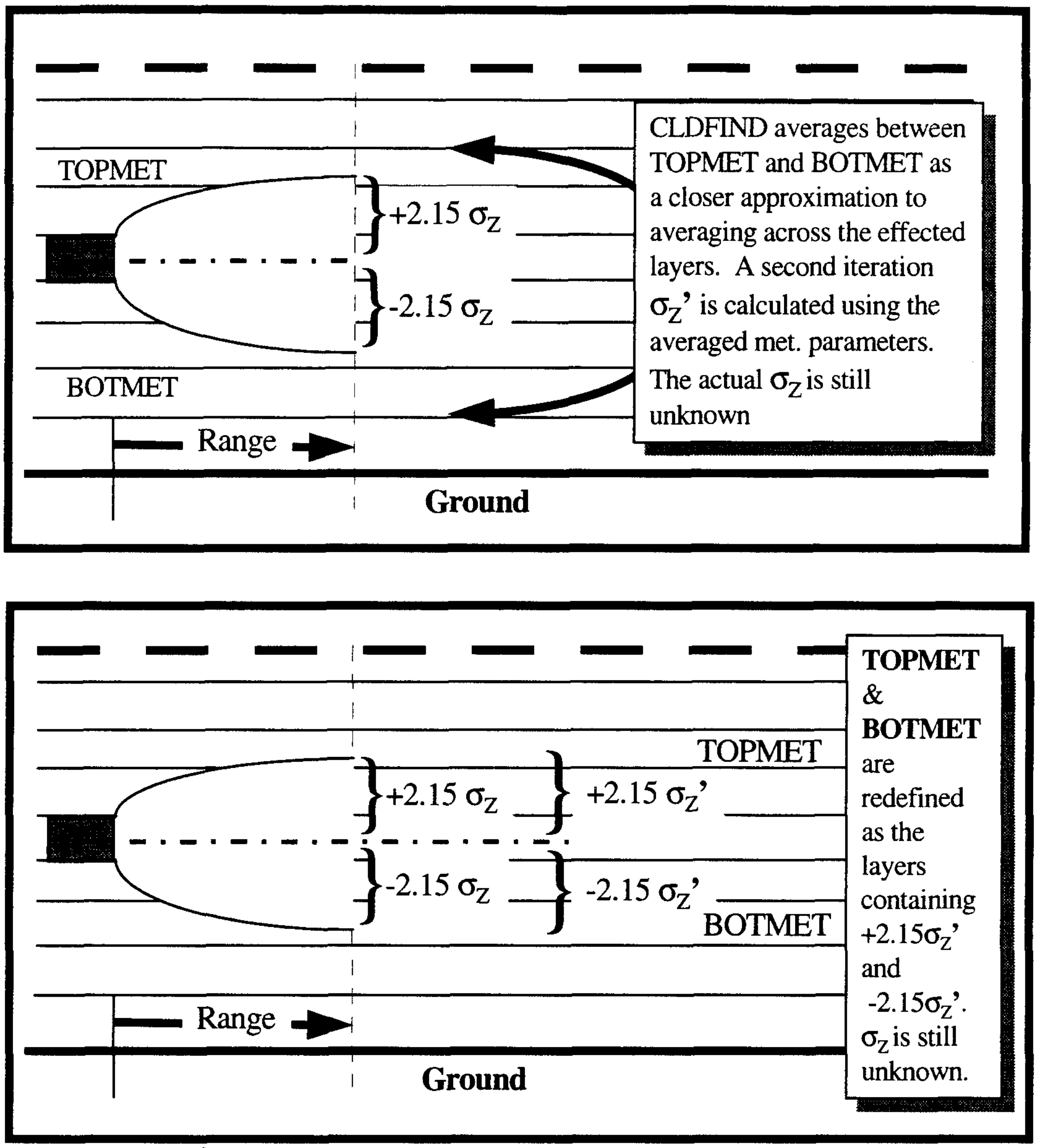


Figure 9: Cloud Finding And Averaging

CLDFIND Algorithm Continued



As the meteorological parameters are averaged between topmet and botmet and subsequent σ_Z' values are calculated, topmet and botmet will stop changing. This indicates that the layers containing the expanded cloud have been located. σ_Z' now approximates σ_Z and the last calculation of the meteorological parameters becomes their final values. They are now averaged across the cloud, not the whole mixing layer.

Figure 10: Cloud Finding And Averaging (Continued)

The CLDAVG routine requires that CLDFIND pass it a top and bottom effected meteorological layer. CLDAVG then averages the meteorological parameters across these meteorological layers. The average parameters are then passed back to CLDFIND.

CBSIGMA is a modified version of the original routine SIGMA. The purpose of both routines is to take average meteorological parameters and return the average dispersion coefficients sigmax, sigmay, and sigmaz at a specified range downwind. CBSIGMA differs from SIGMA by using those average values prepared by CLDAVG across the cloud from the top to the bottom effected meteorological layers, rather than across the entire mixing layer. CBSIGMA therefore returns turbulence coefficients which specifically apply to source material originating in each m meteorological layers as it transports to the specified range distance.

CBBREAK calls CLDFIND (to determine the top and bottom meteorological layers effected by source material in each meteorological layer). CLDFIND calls SIGMA (to determine mixing level parameter averages), CLDAVG (to average the meteorological parameters between the top and bottom effected meteorological levels) and CBSIGMA (to determine the turbulence coefficients using the cloud-wide average meteorological parameters). CLDFIND returns the appropriate average meteorological parameters and dispersion coefficients to CBBREAK. CBBREAK then performs the Gaussian equation calculations and sums the contribution of source material from each meteorological level to the concentration, dose and time-weighted average concentration at each of the down-range, centerline receptor distances.

In this way, the modified REEDM is able to use only those meteorological parameters actually affecting the transport of source material to a centerline receptor distance. The Gaussian equation calculations in the modified REEDM are made with more realistic cloud-wide average meteorological parameters than those same calculations made in the original REEDM using gross mixing-level-wide averages.

Statistical Theory

Populations and Samples

It was assumed that the 34 meteorological scenarios available in the form of rawinsonde input files represented a random sample from the population of all possible launch meteorological scenarios. Furthermore, it was assumed that one meteorological scenario was independent of any other. The model outputs recorded (max concentration, dose and time-weighted max concentration) were assumed to be measured values of random variables. Therefore, the sets of 34 outcomes for each random variable generated by the 34 input data files were assumed to be samples from the entire set of possible values of each random variable from all possible launch meteorological conditions. The sample size of $n = 34$ permitted the invocation of the Central Limit Theorem (33, 223) and the subsequent assertion that the mean of each sample was normally distributed (33,220). These assumptions are shown graphically by Figure 11.

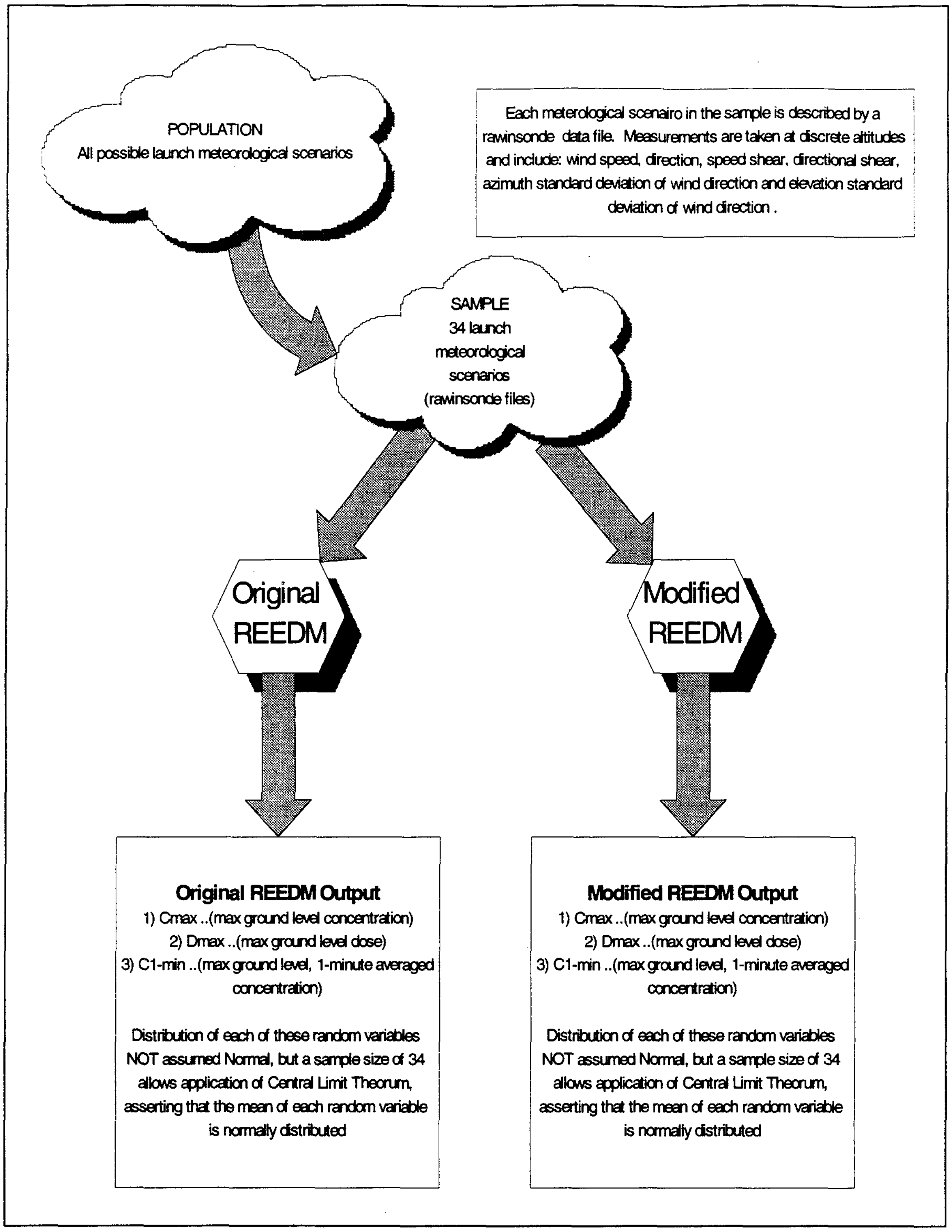


Figure 11: Statistical Assumptions

Paired Sample T-test

The paired sample T test is useful in determining whether two data samples were taken from the same population (33,347-350). In this thesis, the question was whether or not the REEDM modifications significantly altered the output. If the output was not significantly altered the sample data sets would then have come from the same population of possible outputs. If, however, the modifications made a significant difference in the output, the two output data sets would have come from two different populations of possible outputs. The null hypothesis for the experiment was that the two output samples came from the same population (the REEDM modifications did not significantly alter the REEDM output). The alternate hypothesis was that the output samples came from different populations (the modifications significantly altered REEDM output).

The assertion that the mean of each sample was normally distributed is critical to the applicability of the paired T-test. This test requires either that the sample means be normally distributed or that the sample sizes are sufficiently large that the Central Limit Theorem applies. Furthermore, the paired sample T-test requires that the sample data be in pairs, as would be the case when observing the same random variable both before and after a treatment. This is the case in this thesis. The 'treatment' is the modification of the REEDM. Therefore, the values of the random variables of interest are indeed paired. With these conditions met, the paired T-test is a valuable tool for determining whether the REEDM modifications significantly altered the means of the model output for each random variable of interest.

The paired T-test calculates the difference in the model outputs for each of the meteorological scenarios. It then tests the null hypothesis that the mean of the differences is zero. The null hypothesis was tested to a 95% confidence level. In the paired sample test, the value of the calculated T-statistic was compared to the calculated critical values of t. When -tcritical < T-statistic < tcritical, the null hypothesis was accepted. According to Devore (33; 349), the paired T-statistic is defined as:

$$t_{paired} = \frac{\bar{d} - \Delta_o}{\frac{S_D}{\sqrt{n}}} \tag{9}$$

Where:

t_{paired}	=	The paired T-test statistic
$\bar{d}$	=	The mean of the set of differences
Δ_o	=	The null hypothesized mean of the differences = 0 ppm
S_D	=	The standard deviation of the set of differences
n	=	The size of the set of differences

The paired-T critical values were determined based on the two-tail confidence level of 95%. When the T-statistic fell outside of the previously described range of t values, the null hypothesis was rejected in favor the alternate hypothesis. Whether the T-statistics fell below or above the acceptance ranges was indicative of whether the modified REEDM caused the means of the samples to be less than or greater than the unmodified sample means.

Percent Differences

Percent differences were calculated for the change in each random variable from the original REEDM to the modified REEDM. These percent differences provided insight into how the modified REEDM predictions varied from the original REEDM predictions. Similarly, the percent differences were calculated to indicate the change in output relative to the magnitude of the original REEDM output for each random variable.

Correlation

Finally, the differences in the before and after modification random variables were correlated to key meteorological conditions. The conditions examined were mixing level depth, mixing level average wind speed, mixing level average wind speed shear, mixing level average wind directional shear, mixing level average azimuth standard deviation of wind direction and mixing level average elevation standard deviation of wind direction. This correlation was done to give indication of which conditions caused the modified REEDM to predict lower values than the original model, higher values, or generate the same predictions.

Experiment

Experiment Summary

The goal of the experiment was four-fold. First, it was necessary to determine whether the modified REEDM produced output that was significantly different from that of the original REEDM. Second, It was desired to know whether the modified code under or over predicted the original for each output variable. Third, it was desired that the amount of over or under prediction should be quantified. Fourth, it was desired that the performance of the modified REEDM be correlated to key atmospheric conditions. Therefore, the data generated and collated was for the specific purpose of satisfying these four experiment objectives. Batch input files were prepared for both the existing and modified REEDM codes. The batch files executed the two versions of REEDM, 34 times each. The repeated executions ran each model using the 34 different meteorological input data files in the same order, in each version of REEDM. Each execution produced an output file which supported the final data collection. A sample output file is shown in Appendix D.

Experiment Input Data

For this thesis, REEDM and the modified REEDM programs utilized batch input files. A database file of launch input data and rawinsonde database were specified during the program execution. In order to execute the programs many times, with the 34 different input rawinsonde input files, batch files have been prepared to execute the programs, specify the appropriate input data files and provide additional input for each execution. The input database file is in Appendix B, the input batch files are Appendix C and the rawinsonde input data files are in Appendix A.

Experiment Execution

The original REEDM and the modified REEDM were executed using the 34 different meteorological scenarios. Each run produced an output file containing the predicted downwind maximum concentrations, maximum dose and time-weighted concentrations. In addition, the output files contain the range and bearing to the maximum points described previously and the meteorological data used as program input.

Experiment Output Data

After the runs were complete and the output files were generated, the data were collated. Each of the output files from both the original and modified REEDM runs were opened and the data was tabulated. Table 7 lists those variables collected from the output files.

Table 7: Data Variables

DATA VARIABLES COLLATED FROM OUTPUT FILES
Meteorological Scenario File Name
Maximum Instantaneous Ground-Level Concentration (Cmax)
Maximum Ground-Level Dose (Dmax)
Maximum 1-Minute Time-Weighted-Average Ground-Level Concentration (C1-Min)
Range To Cmax
Bearing to Cmax
Range To Dmax
Bearing To Dmax
Range To C1-Min
Bearing To C1-Min
Ground-Based Mixing Level Height
Ground-Based Mixing Level Average Wind Speed
Ground-Based Mixing Level Average Wind Speed Shear
Ground-Based Mixing Level Average Wind Direction Shear
Ground-Based Mixing Level Average Azimuth Standard Deviation Of Wind Direction
Ground-Based Mixing Level Average Elevation Standard Deviation Of Wind Direction

RESULTS

The results from this thesis are organized into sections presenting four major categories of data. Both the original REEDM and the modified REEDM were run on the same 34 input rawinsonde data files. The calculated maximum ground-level instantaneous concentrations are shown in the first section below. The calculated maximum ground-level dose output from both models is shown in the second section. The maximum ground-level 1-minute average concentration values are shown in the third section. Each section is organized similarly The sections include: 1) a table of predicted concentrations and differences between the original and modified calculations is included , 2) descriptive statistics on the output data samples, 3) bar graphs showing the output of the two models, 4) bar graphs showing the difference between the output of the two models, 5) bar graphs showing the percent difference between the predictions of the two models and 6) T-test statistics for the output of each model. The instantaneous concentration section also includes one sample T-test results from the differences between the two model predictions. Finally, a fourth section is presented summarizing correlation among the difference in model predictions and several summary meteorological parameters. This correlation section includes: 1) output data from each model , along with the summary meteorological conditions which generated the data, 2) statistical correlation among the differences between model outputs and the summary meteorological conditions and 3) a bar graph graphically illustrating the correlation. This correlation data is presented for the maximum ground-level instantaneous concentration predictions, the maximum ground-level dose predictions and the maximum ground-level 1-minute average concentration predictions. The numbers reported hereafter are presented to various precision, but due to input data limitations, these numbers should be considered accurate only to 2 significant figures.

Maximum Ground-level Instantaneous Concentrations

For one of the meteorological input files, the modified REEDM predicted maximum ground-level instantaneous concentration values exceeded the original REEDM predictions by 7.870 ppm or 155.41% difference. For another meteorological input file the modified version predicted less than the original version by -.146 ppm or -8.10% difference. In general, as indicated by table 8, the modified version of REEDM predicted higher maximum ground-level instantaneous concentration values than did the original version of REEDM.

Table 8: Maximum Ground-level Instantaneous Concentration Data

	Cmax		DIFFERENCES	
RAWINSONDE INPUT DATA FILE	ORIGINAL REEDM MAX GROUND LEVEL INSTANTANEOUS CONCENTRATION (ppm)	MODIFIED REEDM MAX GROUND LEVEL INSTANTANEOUS CONCENTRATION (ppm)	DIFFERENCE (ppm)	PERCENT DIFFERENCE (%)
P1A_0SHR	33.770	33.779	0.009	0.03%
P1B_0SHR	8.229	8.233	0.004	0.05%
P1C_0SHR	1.735	2.467	0.732	42.19%
P2A_0SHR	5.601	5.735	0.134	2.39%
P2B_0SHR	7.466	7.481	0.015	0.20%
P3A_0SHR	21.351	21.786	0.435	2.04%
P3B_0SHR	4.250	4.256	0.006	0.14%
P4A_0SHR	2.250	2.340	0.090	4.00%
P5A_0SHR	4.604	5.702	1.098	23.85%
P5B_0SHR	3.301	7.286	3.985	120.72%
P5C_0SHR	5.717	5.726	0.009	0.16%
P6A_0SHR	1.986	2.122	0.136	6.85%
P6BB_0SH	6.866	7.000	0.134	1.95%
P6B_0SHR	0.392	0.468	0.076	19.39%
P6C_0SHR	1.803	1.657	-0.146	-8.10%
P7A_0SHR	18.589	18.823	0.234	1.26%
P7B_0SHR	6.541	6.643	0.102	1.56%
P7C_0SHR	10.172	10.332	0.160	1.57%
P7D_0SHR	5.658	5.655	-0.003	-0.05%
P7E_0SHR	6.106	8.099	1.993	32.64%
P8A_0SHR	8.914	10.670	1.756	19.70%
P8BB_0SH	0.602	0.637	0.035	5.81%
P8B_0SHR	10.416	12.566	2.150	20.64%
P8C_OSHR	22.374	25.035	2.661	11.89%
P9A_0SHR	8.613	11.336	2.723	31.62%
P9B_0SHR	15.376	15.548	0.172	1.12%
P9C_0SHR	5.064	12.934	7.870	155.41%
P9D_0SHR	11.406	14.328	2.922	25.62%
P9E_0SHR	7.979	9.051	1.072	13.44%
P9F_0SHR	8.943	9.403	0.460	5.14%
P9G_0SHR	10.013	10.385	0.372	3.72%
P9H_0SHR	5.606	6.411	0.805	14.36%
P9I_0SHR	7.045	7.537	0.492	6.98%
P9J_0SHR	2.125	2.226	0.101	4.75%

The descriptive statistics in Table 9 show that the mean of the instantaneous concentration predictions from the modified REEDM was slightly larger than the mean concentration from the original REEDM. The sample mean for the maximum ground-level instantaneous concentration was 8.261 ppm for the original REEDM and 9.225 ppm for the modified REEDM.

The mean of the differences was .956 ppm. According to Devore, the standard deviation of the mean is defined as the standard deviation of the sample set divided by the square root of the size of the sample set (33; 213).

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} \tag{10}$$

Where:

$\sigma_{\bar{X}}$	=	The standard deviation of the mean of the differences
σ	=	The standard deviation of the set of differences
n	=	The size of the set of differences

Table 9 reports the standard deviation of the set of differences to be 1.609 ppm and the sample size of 34. Therefore, the standard deviation of the mean was shown as the standard error of .276 ppm. The mean of the differences (.956 ppm) was greater than 3 standard deviations of the mean (.276 ppm) above zero.

Table 9: Maximum Ground-level Instantaneous Concentration Data Descriptive Statistics

ORIGINAL REEDM MAX GROUND LEVEL INSTANTANEOUS CONCENTRATION (ppm)		MODIFIED REEDM MAX GROUND LEVEL INSTANTANEOUS CONCENTRATION (ppm)		DIFFERENCE (ppm)	
Mean	8.260676471	Mean	9.225206	Mean	0.964529
Standard Error	1.202428773	Standard Error	1.234099	Standard Error	0.275952
Median	6.7035	Median	7.509	Median	0.203
Mode	#N/A	Mode	#N/A	Mode	0.009
Standard Deviation	7.011304334	Standard Deviation	7.195974	Standard Deviation	1.609064
Sample Variance	49.15838847	Sample Variance	51.78204	Sample Variance	2.589088
Kurtosis	4.574553086	Kurtosis	3.311843	Kurtosis	9.752054
Skewness	1.927289697	Skewness	1.612994	Skewness	2.813859
Range	33.378	Range	33.311	Range	8.016
Minimum	0.392	Minimum	0.468	Minimum	-0.146
Maximum	33.77	Maximum	33.779	Maximum	7.87
Sum	280.863	Sum	313.657	Sum	32.794
Count	34	Count	34	Count	34
Confidence Level(95.000%)	2.3567136	Confidence Level(95.000%)	2.418787	Confidence Level(95.000%)	0.540856

In Figure 12, the graph of maximum ground-level instantaneous concentration shows that the predictions of the two models were similar for that output parameter. Also evident in Figure 12 is the trend of the modified REEDM routine to predict higher values of instantaneous concentration than the original model.

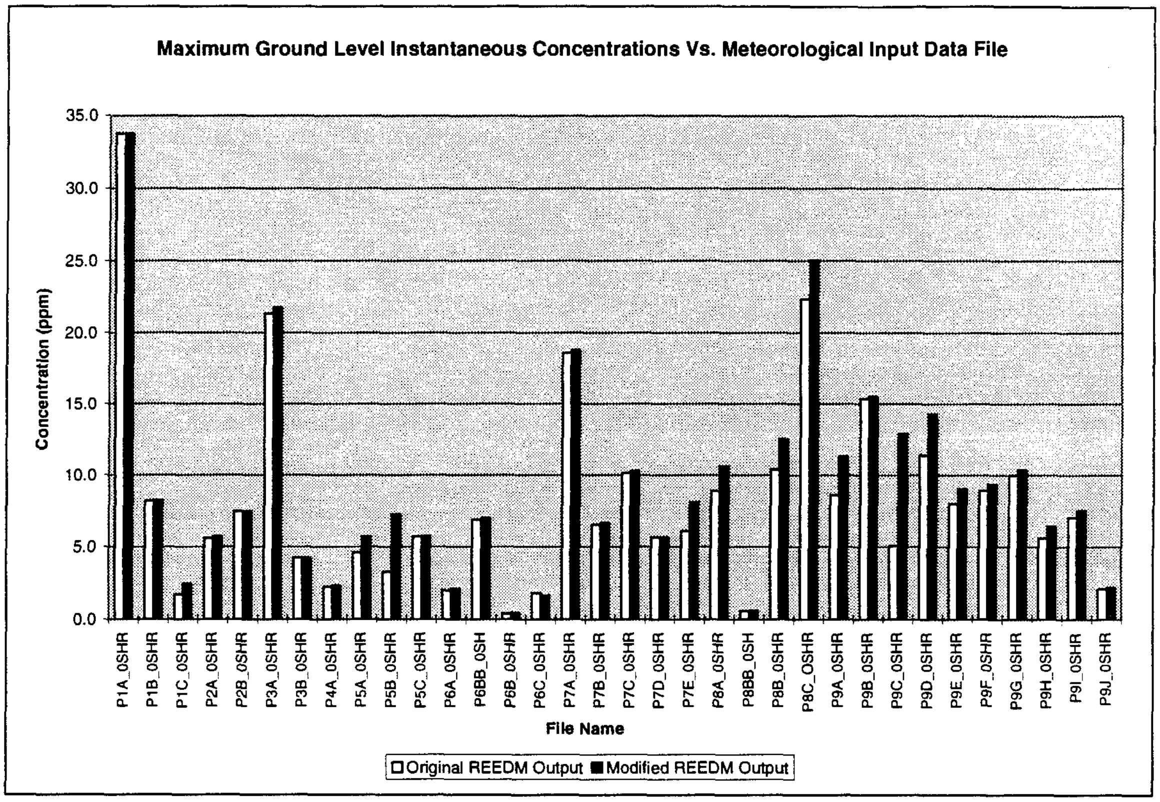


Figure 12: Maximum Ground-level Instantaneous Concentration Graph

Figure 13, the graph of differences between the ground-level instantaneous concentration predictions from the two models, displays the difference between the two model predictions for instantaneous concentration..

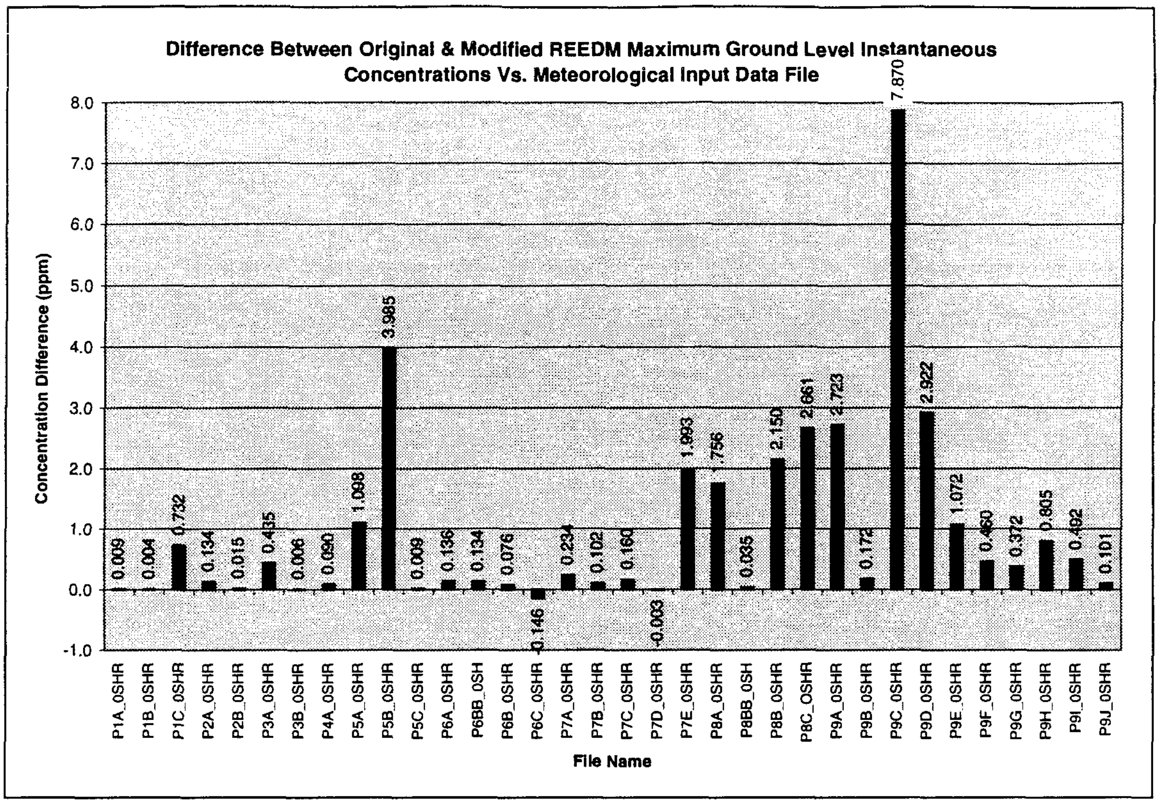


Figure 13: Maximum Ground-level Instantaneous Concentration Difference Graph

Figure 14, the graph of percent differences between the two model predictions for this output parameter, scales the differences by the magnitude of the original prediction. This relative scaling, however, does not obscure the trend of the modified REEDM predicting higher instantaneous concentrations than the original.

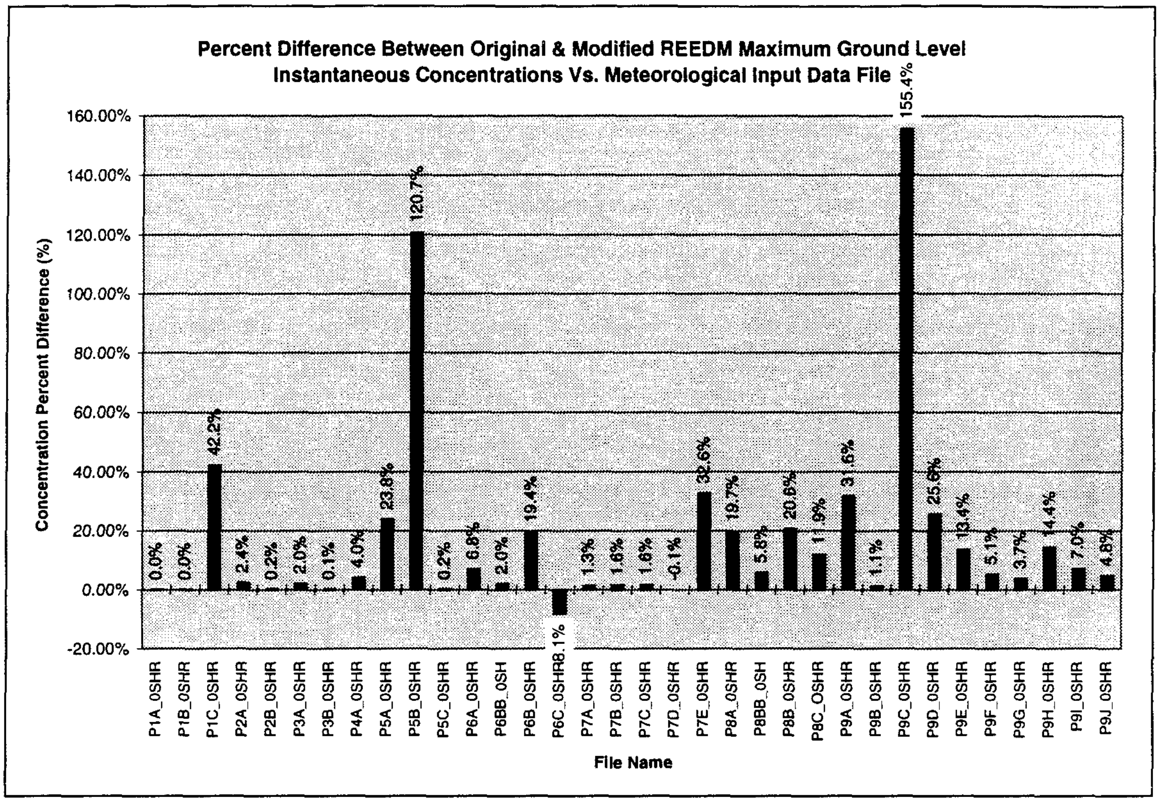


Figure 14: Maximum Ground-level Instantaneous Concentration Percent Difference Graph

The paired sample T-test indicated that the modified REEDM predicted larger values than the original REEDM for maximum ground-level instantaneous concentration. The confidence level for this two-tail test was set at 95%. The t-statistic of -3.495 fell below the acceptance range of the t-critical value of +/- 2.035. Therefore the null hypothesis was rejected in favor of the alternate. Table 10 therefore indicates, to a 95% confidence, that the means of the two sample output data sets were significantly different.

Table 10: Maximum Ground-level Instantaneous Concentration Data T-Statistics

t-Test: Paired Two Sample for Means	ORIGINAL REEDM MAX GROUND LEVEL INSTANTANEOUS CONCENTRATION (ppm)	MODIFIED REEDM MAX GROUND LEVEL INSTANTANEOUS CONCENTRATION (ppm)
Mean	8.260676471	9.225205882
Variance	49.15838847	51.78204205
Observations	34	34
Pearson Correlation	0.974679637	
Hypothesized Mean Difference	0	
df	33	
t Stat	-3.495276621	
P(T<=t) one-tail	0.00068651	
t Critical one-tail	1.692360456	
P(T<=t) two-tail	0.001373019	
t Critical two-tail	2.03451691	

Maximum Ground-level Dose

For one of the meteorological input files, the modified REEDM predicted maximum ground-level dose values which exceeded the original REEDM predictions by 37.926 ppm sec or 35.06% difference. For another meteorological input file, the modified version predicted a maximum ground-level dose that was less than the original version by -573.839 ppm sec or -43.47% difference. In general, as indicated by table 11, the modified version of REEDM predicted lower maximum ground-level dose values than did the original version of REEDM.

Table 11: Maximum Ground-level Dose Data

	Dmax		DIFFERENCES	
RAWINSONDE INPUT DATA FILE	ORIGINAL REEDM MAX GROUND LEVEL DOSE (ppm sec)	MODIFIED REEDM MAX GROUND LEVEL DOSE (ppm sec)	DIFFERENCE (ppm sec)	PERCENT DIFFERENCE (%)
P1A_0SHR	1652.987	1653.732	0.745	0.05%
P1B_0SHR	103.713	103.756	0.043	0.04%
P1C_0SHR	517.589	526.084	8.495	1.64%
P2A_0SHR	488.105	490.832	2.727	0.56%
P2B_0SHR	391.641	391.678	0.037	0.01%
P3A_0SHR	492.475	495.417	2.942	0.60%
P3B_0SHR	93.733	93.919	0.186	0.20%
P4A_0SHR	68.626	66.475	-2.151	-3.13%
P5A_0SHR	228.789	235.338	6.549	2.86%
P5B_0SHR	472.738	441.623	-31.115	-6.58%
P5C_0SHR	432.565	434.812	2.247	0.52%
P6A_0SHR	55.408	54.530	-0.878	-1.58%
P6BB_0SH	448.633	344.165	-104.468	-23.29%
P6B_0SHR	18.132	14.381	-3.751	-20.69%
P6C_0SHR	63.765	58.420	-5.345	-8.38%
P7A_0SHR	980.913	1003.290	22.377	2.28%
P7B_0SHR	84.378	87.496	3.118	3.70%
P7C_0SHR	234.891	236.237	1.346	0.57%
P7D_0SHR	154.253	155.458	1.205	0.78%
P7E_0SHR	156.436	156.282	-0.154	-0.10%
P8A_0SHR	762.025	443.495	-318.530	-41.80%
P8BB_0SH	11.547	11.827	0.280	2.42%
P8B_0SHR	1178.807	871.641	-307.166	-26.06%
P8C_OSHR	475.567	436.056	-39.511	-8.31%
P9A_0SHR	581.353	383.044	-198.309	-34.11%
P9B_0SHR	108.170	146.096	37.926	35.06%
P9C_0SHR	391.537	376.809	-14.728	-3.76%
P9D_0SHR	504.919	473.665	-31.254	-6.19%
P9E_0SHR	1320.038	746.199	-573.839	-43.47%
P9F_0SHR	160.443	151.843	-8.600	-5.36%
P9G_0SHR	86.168	112.103	25.935	30.10%
P9H_0SHR	107.856	62.440	-45.416	-42.11%
P9I_0SHR	334.146	199.520	-134.626	-40.29%
P9J_0SHR	25.329	24.804	-0.525	-2.07%

The descriptive statistics in Table 12 show that the mean of the dose predictions from the modified REEDM was less than the mean concentration from the original REEDM. The sample mean for the maximum ground-level dose was 387.873 ppm sec for the original REEDM and 337.749 ppm sec for the modified REEDM. The mean of the differences (-50.12 ppm sec) was greater than 2 standard deviations of the mean (21.46 ppm sec) less than zero.

Table 12: Maximum Ground-level Dose Data Descriptive Statistics

ORIGINAL REEDM MAX GROUND LEVEL DOSE (ppm sec)		MODIFIED REEDM MAX GROUND LEVEL DOSE (ppm sec)		DIFFERENCE (ppm sec)	
Mean	387.8727941	Mean	337.749	Mean	-50.1238
Standard Error	67.69727949	Standard Error	58.18021	Standard Error	21.45999
Median	284.5185	Median	235.7875	Median	-0.3395
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	394.7395801	Standard Deviation	339.246	Standard Deviation	125.1322
Sample Variance	155819.3361	Sample Variance	115087.8	Sample Variance	15658.06
Kurtosis	2.689400359	Kurtosis	5.987185	Kurtosis	9.395854
Skewness	1.653185044	Skewness	2.09971	Skewness	-2.95449
Range	1641.44	Range	1641.905	Range	611.765
Minimum	11.547	Minimum	11.827	Minimum	-573.839
Maximum	1652.987	Maximum	1653.732	Maximum	37.926
Sum	13187.675	Sum	11483.47	Sum	-1704.21
Count	34	Count	34	Count	34
Confidence Level(95.000%)	132.6840332	Confidence Level(95.000%)	114.0309	Confidence Level(95.000%)	42.06074

The graph of maximum ground-level dose shown in Figure 15 indicates that the prediction of the two models was similar for that output parameter also, though not as close as the instantaneous concentration predictions for the two models. Figure 15 also shows that the modified REEDM routine predicted slightly smaller values than the original model.

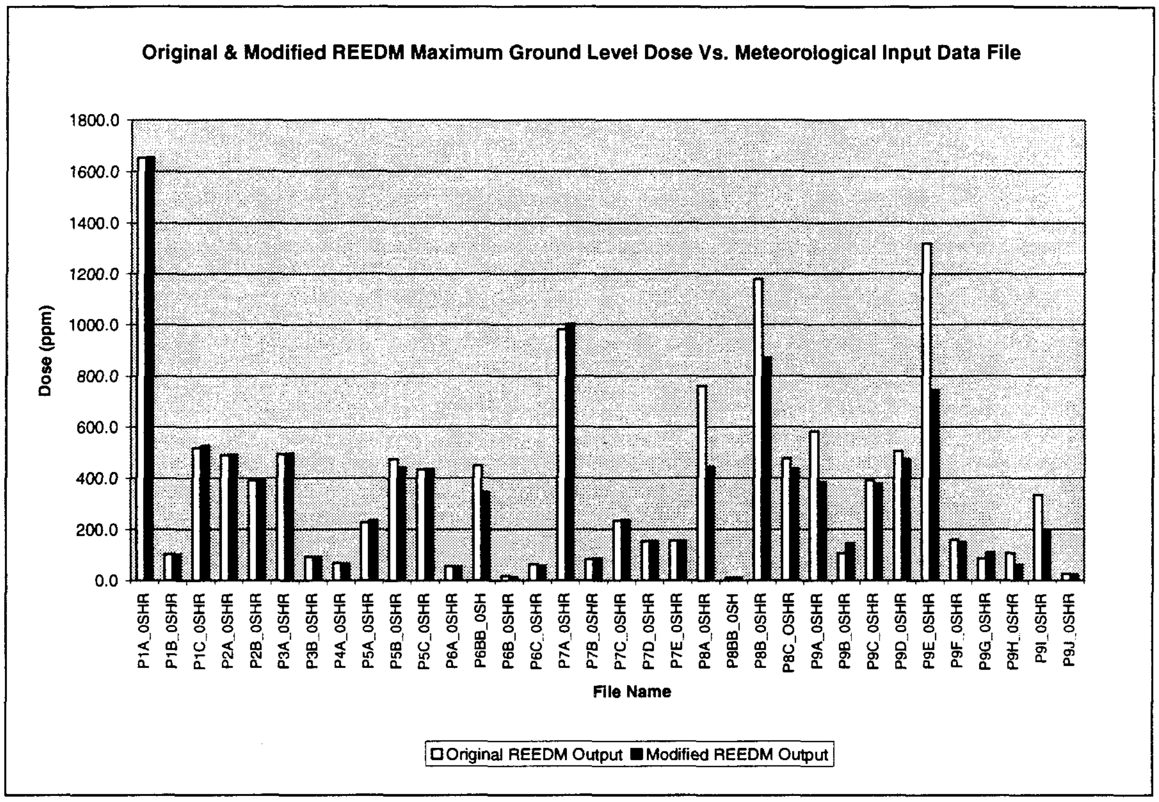
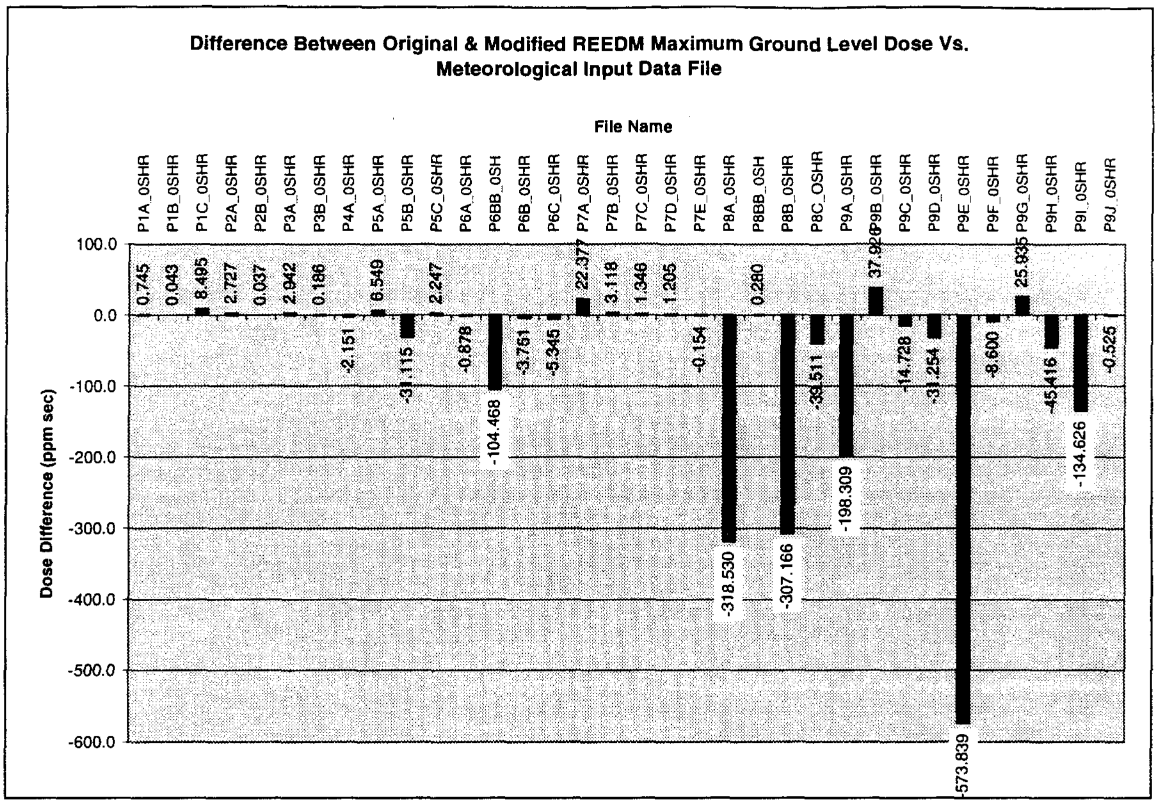


Figure 15: Maximum Ground-level Dose Graph

Figure 16, the graph of differences between the ground-level dose predictions from the two models shows that the modified REEDM predicted smaller values than the original for this output parameter.



<u>Figure 16: Maximum Ground-level Dose Difference Graph</u>

Figure 17, the graph of percent differences between the two model predictions indicates the trend for the modified REEDM to predict lower maximum ground-level dose values than the original REEDM.

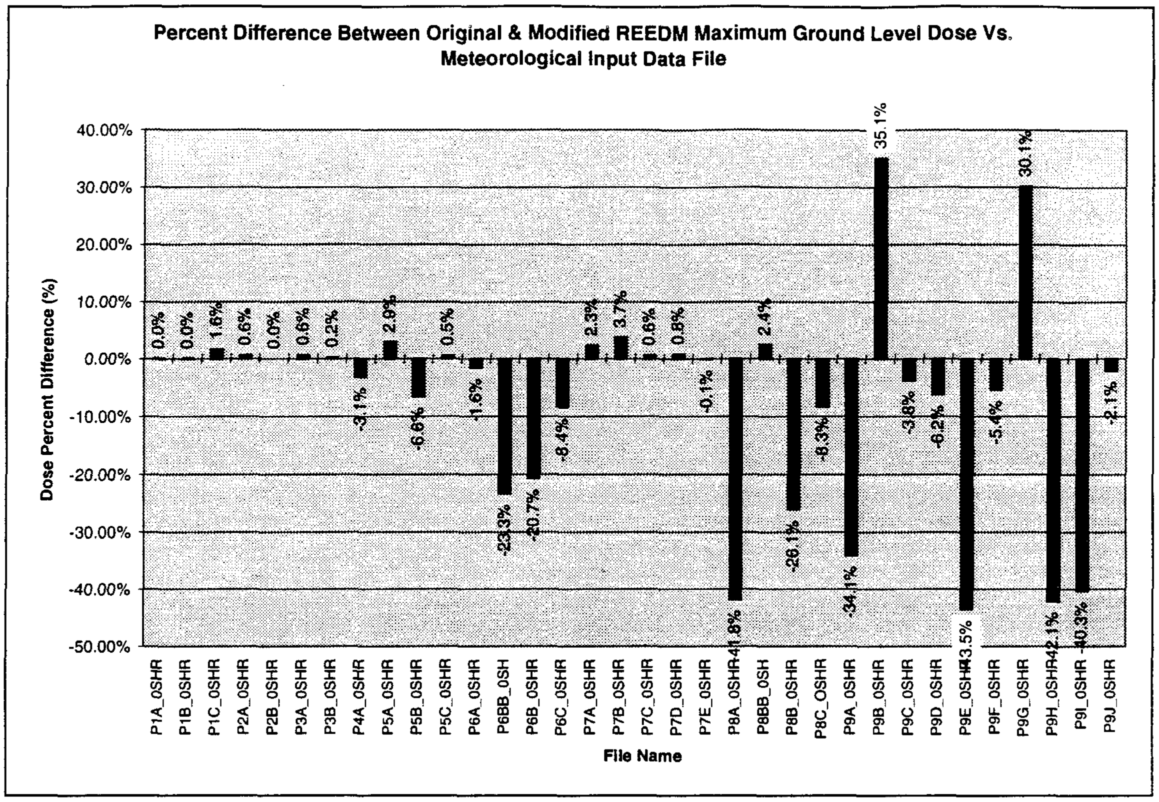


Figure 17: Maximum Ground-level Dose Percent Difference Graph

The paired sample T-test indicated that the modified REEDM predicted lower values than the original REEDM for maximum ground-level dose. The confidence level for this two-tail test was set at 95%. The t-statistic of 2.336 fell above the acceptance range of the t-critical value of +/- 2.035. Therefore the null hypothesis was rejected in favor of the alternate. Table 13 indicates, to a 95% confidence, that the means of the two sample output data sets were significantly different.

Table 13: Maximum Ground-level Dose Data T-Statistics

t-Test: Paired Two Sample for Means	ORIGINAL REEDM MAX GROUND LEVEL DOSE (ppm sec)	MODIFIED REEDM MAX GROUND LEVEL DOSE (ppm sec)
Mean	387.8727941	337.7490294
Variance	155819.3361	115087.8441
Observations	34	34
Pearson Correlation	0.953035026	
Hypothesized Mean Difference	0	
df	33	
t Stat	2.335684701	
P(T<=t) one-tail	0.012866966	
t Critical one-tail	1.692360456	
P(T<=t) two-tail	0.025733932	
t Critical two-tail	2.03451691	

Maximum Ground-level 1-Minute Average Concentrations

For one of the meteorological input files, the modified REEDM predicted maximum ground-level 1-minute average concentration values which were larger than the original REEDM predictions by 2.625 ppm or 83.20% difference. For another of the meteorological input files the modified version predicted a maximum ground-level 1-minute average concentration smaller than the original version by a maximum of -1.207 ppm or -27.51% difference. This data set is presented in Table 14, but it is not clear from that table whether the modified version of REEDM generally predicted higher or lower values than the original version of REEDM for maximum ground-level 1-minute average concentration.

Table 14: Maximum Ground-level 1-Minute Average Concentration Data

RAWINSONDE INPUT DATA FILE	ORIGINAL REEDM MAX GROUND LEVEL 1-MINUTE AVERAGE CONCENTRATION (ppm)	MODIFIED REEDM MAX GROUND LEVEL 1-MINUTE AVERAGE CONCENTRATION (ppm)	DIFFERENCE (ppm)	PERCENT DIFFERENCE (%)
P1A_0SHR	22.754	22.761	0.007	0.03%
P1B_0SHR	1.729	1.729	0.000	0.00%
P1C_0SHR	1.711	1.997	0.286	16.72%
P2A_0SHR	4.977	5.075	0.098	1.97%
P2B_0SHR	5.537	5.543	0.006	0.11%
P3A_0SHR	7.979	8.029	0.050	0.63%
P3B_0SHR	1.561	1.564	0.003	0.19%
P4A_0SHR	1.128	1.106	-0.022	-1.95%
P5A_0SHR	3.317	3.654	0.337	10.16%
P5B_0SHR	3.155	5.780	2.625	83.20%
P5C_0SHR	4.900	4.913	0.013	0.27%
P6A_0SHR	0.917	0.906	-0.011	-1.20%
P6BB_0SH	5.371	4.880	-0.491	-9.14%
P6B_0SHR	0.271	0.231	-0.040	-14.76%
P6C_0SHR	1.027	0.941	-0.086	-8.37%
P7A_0SHR	12.705	12.875	0.170	1.34%
P7B_0SHR	1.406	1.458	0.052	3.70%
P7C_0SHR	3.910	3.933	0.023	0.59%
P7D_0SHR	2.556	2.575	0.019	0.74%
P7E_0SHR	2.599	2.604	0.005	0.19%
P8A_0SHR	7.754	6.712	-1.042	-13.44%
P8BB_0SH	0.192	0.197	0.005	2.60%
P8B_0SHR	9.463	9.462	-0.001	-0.01%
P8C_OSHR	7.910	7.263	-0.647	-8.18%
P9A_0SHR	6.840	5.949	-0.891	-13.03%
P9B_0SHR	1.803	2.435	0.632	35.05%
P9C_0SHR	4.297	6.090	1.793	41.73%
P9D_0SHR	7.536	7.535	-0.001	-0.01%
P9E_0SHR	7.323	7.201	-0.122	-1.67%
P9F_0SHR	2.674	2.531	-0.143	-5.35%
P9G_0SHR	1.436	1.868	0.432	30.08%
P9H_0SHR	1.797	1.041	-0.756	-42.07%
P9I_0SHR	4.388	3.181	-1.207	-27.51%
P9J_0SHR	0.422	0.413	-0.009	-2.13%

The sample statistics shown in Table 15 demonstrate that on the average, the modified REEDM version predicts very slightly larger values than the original. The sample mean for the maximum ground-level 1-minute average concentration was 4.510 ppm for the original REEDM and 4.542 ppm for the modified REEDM. The mean of the differences (.032 ppm) was well within one standard deviation of the mean (.118 ppm) from zero.

Table 15: Maximum Ground-level 1-Minute Average Concentration Data Descriptive Statistics

ORIGINAL REEDM MAX GROUND LEVEL 1-MINUTE AVERAGE CONCENTRATION (ppm)		MODIFIED REEDM MAX GROUND LEVEL 1-MINUTE AVERAGE CONCENTRATION (ppm)		DIFFERENCE (ppm)	
Mean	4.510147059	Mean	4.542118	Mean	0.031971
Standard Error	0.758598268	Standard Error	0.753558	Standard Error	0.117573
Median	3.236	Median	3.4175	Median	0.004
Mode	#N/A	Mode	#N/A	Mode	-0.001
Standard Deviation	4.423350007	Standard Deviation	4.39396	Standard Deviation	0.685561
Sample Variance	19.56602528	Sample Variance	19.30689	Sample Variance	0.469993
Kurtosis	7.947955996	Kurtosis	8.211259	Kurtosis	6.594143
Skewness	2.372888174	Skewness	2.395889	Skewness	1.83268
Range	22.562	Range	22.564	Range	3.832
Minimum	0.192	Minimum	0.197	Minimum	-1.207
Maximum	22.754	Maximum	22.761	Maximum	2.625
Sum	153.345	Sum	154.432	Sum	1.087
Count	34	Count	34	Count	34
Confidence Level(95.000%)	1.486823082	Confidence Level(95.000%)	1.476944	Confidence Level(95.000%)	0.230438

Figure 18, the graph of maximum ground-level 1-minute average concentration shows that the prediction of the two models was very similar for that output parameter.

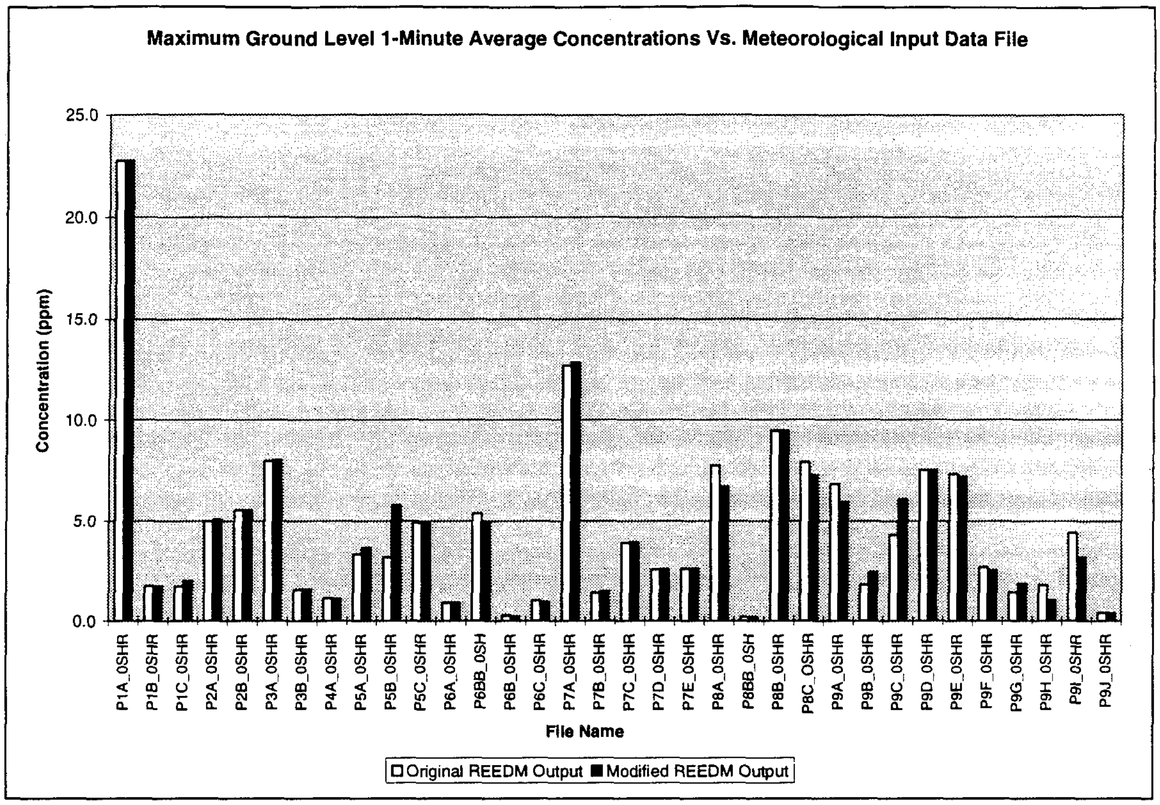


Figure 18: Maximum Ground-level 1-Minute Average Concentration Graph

Figure 19, the graph of differences in the maximum ground-level 1-minute average concentration values between the two models shows that the modified REEDM predicted both higher and lower values than the original model.

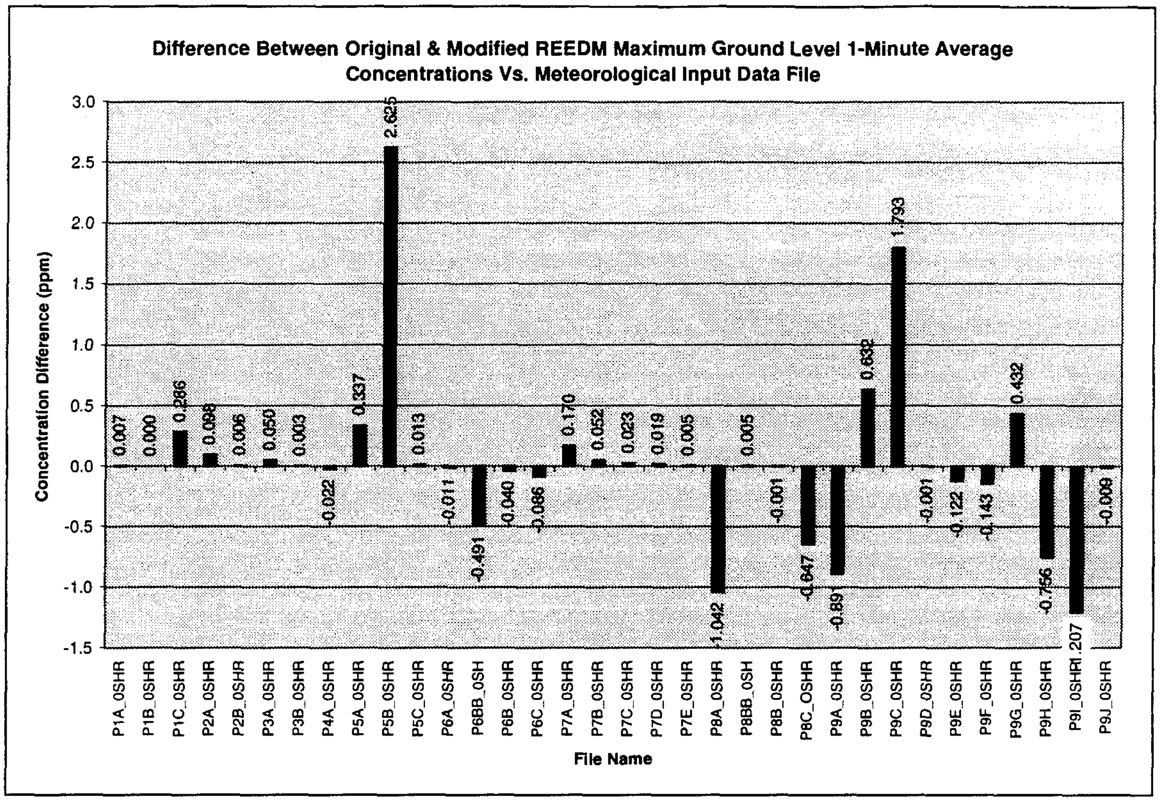


Figure 19: Maximum Ground-level 1-Minute Average Concentration Difference Graph

Figure 20, the graph of percent differences between the two model predictions for 1-minute average concentration scales the differences by the magnitude of the original prediction, but it is not evident from this graph whether the models produce significantly different output.

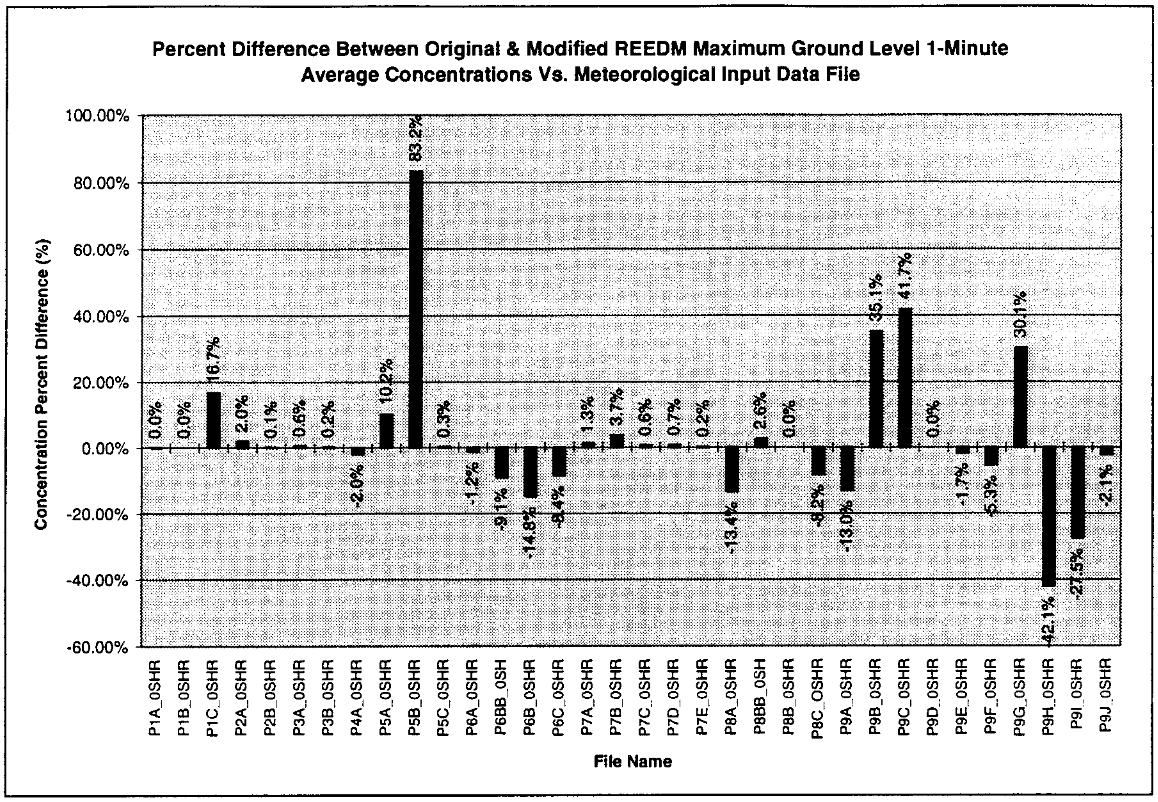


Figure 20: Maximum Ground-level 1-Minute Average Concentration Percent Difference Graph

Unlike the two previous paired sample T-tests, Table 16 shows that the modified REEDM output was not significantly different from the original REEDM output for 1-minute average concentrations. The confidence level for this two-tail test was set at 95%. As indicated in Table 16, the t-statistic of -.272 was well within the acceptance range of the t-critical value +/- 2.035 so the null hypothesis was accepted asserting that for 1-minute average concentration, the REEDM modifications made no significant difference in the output data sets.

Table 16: Maximum Ground-level 1-Minute Average Concentration Data T-Statistics

t-Test: Paired Two Sample for Means	ORIGINAL REEDM MAX GROUND LEVEL 1-MINUTE AVERAGE CONCENTRATION (ppm)	MODIFIED REEDM MAX GROUND LEVEL 1-MINUTE AVERAGE CONCENTRATION (ppm)
Mean	4.510147059	4.542117647
Variance	19.56602528	19.30688793
Observations	34	34
Pearson Correlation	0.98793144	
Hypothesized Mean Difference	0	
df	33	
t Stat	-0.271921906	
P(T<=t) one-tail	0.393688073	
t Critical one-tail	1.692360456	
P(T<=t) two-tail	0.787376145	
t Critical two-tail	2.03451691	

Correlation

The previous graphs and data demonstrated that the instantaneous concentration calculations and dose calculations varied considerably between the original and modified REEDM predictions. The following correlation data was developed to help explain the behavior of the models. The key indicator for the correlation was the difference in model predictions. Therefore, the difference in model predictions, for the instantaneous concentration, dose and 1-minute average concentration was correlated against summary atmospheric conditions. Those atmospheric conditions were: the height of the ground-based mixing layer (Mix Hgt), the mixing layer average wind speed (Ubar), the average wind speed shear for the mixing layer

(SShear), the average wind direction shear for the mixing layer (DShear), the azimuth standard deviation of wind direction for the mixing layer (SigA) and the elevation standard deviation of wind direction for the mixing layer (SigE).

Maximum Ground-level Instantaneous Concentration

Table 17 contains the meteorological data included in the correlation studies. Each file name represents one of the 34 meteorological input files (rawinsonde data) use to generate REEDM output

Table 17: Summary Meteorological Data For Correlation

Meteorological Parameters						
FILE	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
P1A_0SHR	430.99	5.51	0.28	4.29	5.7873	5.7223
P1B_0SHR	149.62	6.67	0.03	1.46	3.8489	4.2359
P1C_0SHR	311.81	1.91	0.98	22.89	1.7943	1.5595
P2A_0SHR	313.61	1.34	0.35	15.68	15.6139	8.0995
P2B_0SHR	210.31	1.61	0.10	11.67	15.3208	10.1671
P3A_0SHR	351.74	6.21	0.69	9.87	7.9973	6.5959
P3B_0SHR	175.87	3.85	0.52	6.00	12.7755	9.2671
P4A_0SHR	197.18	3.66	0.65	3.10	8.2795	2.7449
P5A_0SHR	313.61	2.06	0.26	8.33	10.3057	4.3980
P5B_0SHR	313.61	1.11	0.49	23.96	7.9064	6.6513
P5C_0SHR	313.61	1.14	0.15	3.36	20.5378	9.3864
P6A_0SHR	163.64	3.25	0.45	3.02	5.0750	4.0831
P6BB_0SH	3003.80	10.39	3.06	3.76	19.4548	8.2045
P6B_0SHR	150.72	2.18	0.56	20.99	12.6740	12.4979
P6C_0SHR	149.96	2.42	0.41	4.26	4.4235	2.8095
P7A_0SHR	392.89	3.36	0.13	1.51	6.6293	6.1412
P7B_0SHR	180.31	6.62	0.43	1.08	3.6378	3.1340
P7C_0SHR	260.60	3.73	0.12	2.46	2.9995	2.7542
P7D_0SHR	146.30	3.08	0.00	1.56	3.8356	3.3098
P7E_0SHR	173.13	4.62	0.68	2.82	1.9641	1.6773
P8A_0SHR	2736.19	9.84	2.19	5.28	3.8701	3.7796
P8BB_0SH	170.08	4.61	0.48	5.28	6.2874	5.0249
P8B_0SHR	1982.11	6.60	0.82	4.84	3.9838	3.7998
P8C_OSHR	505.64	17.29	2.29	3.37	4.3272	2.5254
P9A_0SHR	2847.62	11.13	1.76	14.40	5.0063	4.9216
P9B_0SHR	172.49	12.32	0.63	2.50	4.5671	2.5648
P9C_0SHR	2836.14	9.83	1.20	23.64	2.4920	1.7222
P9D_0SHR	2858.45	17.83	2.77	3.15	2.4964	2.4803
P9E_0SHR	3036.87	4.42	0.65	28.97	12.4055	12.1808
P9F_0SHR	165.51	5.06	0.78	3.63	7.4116	4.5235
P9G_0SHR	159.91	11.90	1.56	1.73	2.7395	1.5161
P9H_0SHR	150.24	5.51	1.88	14.06	9.4858	4.3515
P9I_0SHR	898.25	9.42	0.41	7.58	8.2204	3.6095
P9J_0SHR	150.24	7.14	0.71	4.99	3.6838	2.0895

Table 18 shows the maximum ground-level instantaneous concentration difference between model predictions along with the respective summary meteorological input data.

Table 18: Maximum Ground-level Instantaneous Concentration Correlation Data

FILE	Cmax Difference	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
P1A_0SHR	0.009	430.99	5.51	0.28	4.29	5.7873	5.7223
P1B_0SHR	0.004	149.62	6.67	0.03	1.46	3.8489	4.2359
P1C_0SHR	0.732	311.81	1.91	0.98	22.89	1.7943	1.5595
P2A_0SHR	0.134	313.61	1.34	0.35	15.68	15.6139	8.0995
P2B_0SHR	0.015	210.31	1.61	0.10	11.67	15.3208	10.1671
P3A_0SHR	0.435	351.74	6.21	0.69	9.87	7.9973	6.5959
P3B_0SHR	0.006	175.87	3.85	0.52	6.00	12.7755	9.2671
P4A_0SHR	0.090	197.18	3.66	0.65	3.10	8.2795	2.7449
P5A_0SHR	1.098	313.61	2.06	0.26	8.33	10.3057	4.3980
P5B_0SHR	3.985	313.61	1.11	0.49	23.96	7.9064	6.6513
P5C_0SHR	0.009	313.61	1.14	0.15	3.36	20.5378	9.3864
P6A_0SHR	0.136	163.64	3.25	0.45	3.02	5.0750	4.0831
P6BB_0SH	0.134	3003.80	10.39	3.06	3.76	19.4548	8.2045
P6B_0SHR	0.076	150.72	2.18	0.56	20.99	12.6740	12.4979
P6C_0SHR	-0.146	149.96	2.42	0.41	4.26	4.4235	2.8095
P7A_0SHR	0.234	392.89	3.36	0.13	1.51	6.6293	6.1412
P7B_0SHR	0.102	180.31	6.62	0.43	1.08	3.6378	3.1340
P7C_0SHR	0.160	260.60	3.73	0.12	2.46	2.9995	2.7542
P7D_0SHR	-0.003	146.30	3.08	0.00	1.56	3.8356	3.3098
P7E_0SHR	1.993	173.13	4.62	0.68	2.82	1.9641	1.6773
P8A_0SHR	1.756	2736.19	9.84	2.19	5.28	3.8701	3.7796
P8BB_0SH	0.035	170.08	4.61	0.48	5.28	6.2874	5.0249
P8B_0SHR	2.150	1982.11	6.60	0.82	4.84	3.9838	3.7998
P8C_OSHR	2.661	505.64	17.29	2.29	3.37	4.3272	2.5254
P9A_0SHR	2.723	2847.62	11.13	1.76	14.40	5.0063	4.9216
P9B_0SHR	0.172	172.49	12.32	0.63	2.50	4.5671	2.5648
P9C_0SHR	7.870	2836.14	9.83	1.20	23.64	2.4920	1.7222
P9D_0SHR	2.922	2858.45	17.83	2.77	3.15	2.4964	2.4803
P9E_0SHR	1.072	3036.87	4.42	0.65	28.97	12.4055	12.1808
P9F_0SHR	0.460	165.51	5.06	0.78	3.63	7.4116	4.5235
P9G_0SHR	0.372	159.91	11.90	1.56	1.73	2.7395	1.5161
P9H_0SHR	0.805	150.24	5.51	1.88	14.06	9.4858	4.3515
P9I_0SHR	0.492	898.25	9.42	0.41	7.58	8.2204	3.6095
P9J_0SHR	0.101	150.24	7.14	0.71	4.99	3.6838	2.0895

Table 19 shows that the summary meteorological parameter most strongly correlated to the difference in the instantaneous concentration calculations. Mixing height was the most strongly correlated summary input parameter with a correlation coefficient of .547. This was still a weak correlation compared to the maximum correlation coefficient of 1.000.

Table 19: Maximum Ground-level Instantaneous Concentration Correlation Results

	Cmax Difference	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
Cmax Difference	1						
Mix Hgt	0.5470171	1					
DShear	0.4439483	0.296208	-0.25046	0.012182	1		
Ubar	0.3672765	0.496212	1				
SShear	0.3653141	0.632717	0.74249	1			
SigE	-0.251381	0.088036	-0.41294	-0.18458	0.413094	0.818836	1
SigA	-0.303068	0.028183	-0.36276	-0.05237	0.204926	1	

Figure 21 gives a graphical presentation of the correlation data in Table 19. The correlation between the difference in model predictions for maximum ground-level instantaneous concentration and the summary meteorological parameters is demonstrated.

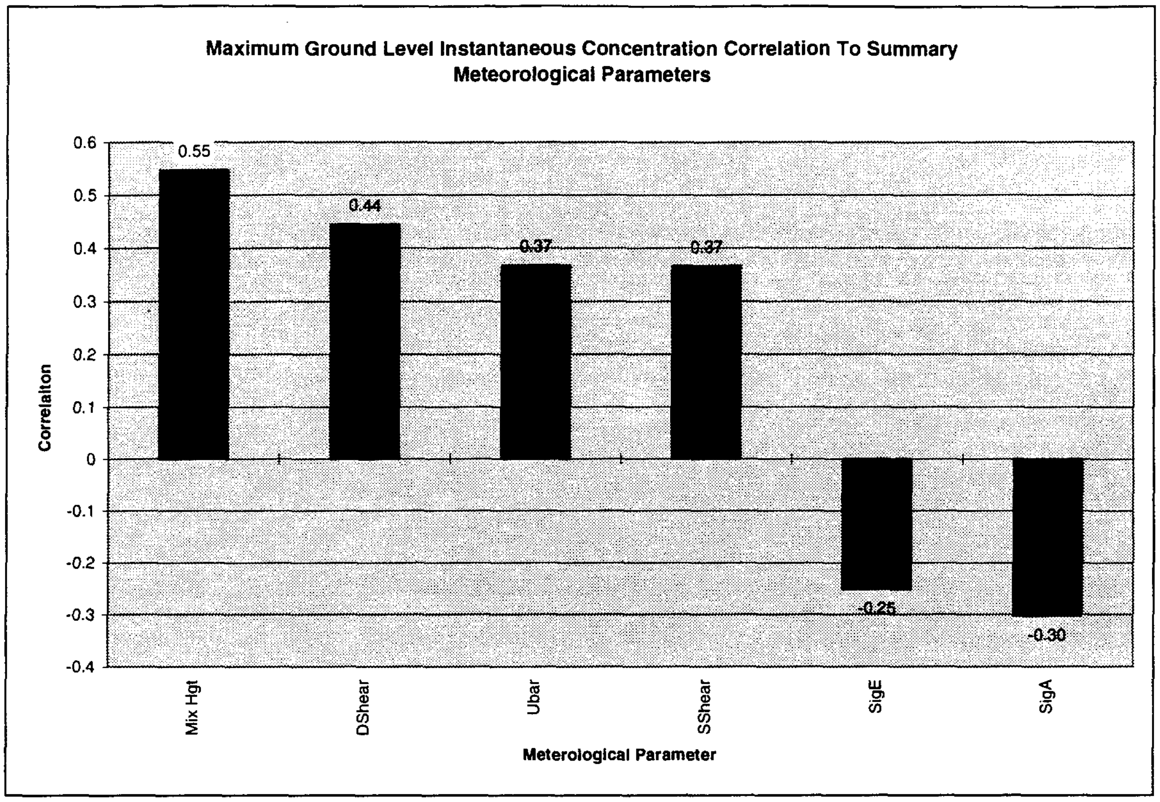


Figure 21: Maximum Ground-level Instantaneous Concentration Correlation Graph

Maximum Ground-level Dose

Table 20 shows the maximum ground-level dose difference between model predictions along with the respective summary meteorological input data

Table 20: Maximum Ground-level Dose Correlation Data

FILE	Dmax Difference	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
P1A_0SHR	0.745	430.99	5.51	0.28	4.29	5.7873	5.7223
P1B_0SHR	0.043	149.62	6.67	0.03	1.46	3.8489	4.2359
P1C_0SHR	8.495	311.81	1.91	0.98	22.89	1.7943	1.5595
P2A_0SHR	2.727	313.61	1.34	0.35	15.68	15.6139	8.0995
P2B_0SHR	0.037	210.31	1.61	0.10	11.67	15.3208	10.1671
P3A_0SHR	2.942	351.74	6.21	0.69	9.87	7.9973	6.5959
P3B_0SHR	0.186	175.87	3.85	0.52	6.00	12.7755	9.2671
P4A_0SHR	-2.151	197.18	3.66	0.65	3.10	8.2795	2.7449
P5A_0SHR	6.549	313.61	2.06	0.26	8.33	10.3057	4.3980
P5B_0SHR	-31.115	313.61	1.11	0.49	23.96	7.9064	6.6513
P5C_0SHR	2.247	313.61	1.14	0.15	3.36	20.5378	9.3864
P6A_0SHR	-0.878	163.64	3.25	0.45	3.02	5.0750	4.0831
P6BB_0SH	-104.468	3003.80	10.39	3.06	3.76	19.4548	8.2045
P6B_0SHR	-3.751	150.72	2.18	0.56	20.99	12.6740	12.4979
P6C_0SHR	-5.345	149.96	2.42	0.41	4.26	4.4235	2.8095
P7A_0SHR	22.377	392.89	3.36	0.13	1.51	6.6293	6.1412
P7B_0SHR	3.118	180.31	6.62	0.43	1.08	3.6378	3.1340
P7C_0SHR	1.346	260.60	3.73	0.12	2.46	2.9995	2.7542
P7D_0SHR	1.205	146.30	3.08	0.00	1.56	3.8356	3.3098
P7E_0SHR	-0.154	173.13	4.62	0.68	2.82	1.9641	1.6773
P8A_0SHR	-318.53	2736.19	9.84	2.19	5.28	3.8701	3.7796
P8BB_0SH	0.28	170.08	4.61	0.48	5.28	6.2874	5.0249
P8B_0SHR	-307.166	1982.11	6.60	0.82	4.84	3.9838	3.7998
P8C_OSHR	-39.511	505.64	17.29	2.29	3.37	4.3272	2.5254
P9A_0SHR	-198.309	2847.62	11.13	1.76	14.40	5.0063	4.9216
P9B_0SHR	37.926	172.49	12.32	0.63	2.50	4.5671	2.5648
P9C_0SHR	-14.728	2836.14	9.83	1.20	23.64	2.4920	1.7222
P9D_0SHR	-31.254	2858.45	17.83	2.77	3.15	2.4964	2.4803
P9E_0SHR	-573.839	3036.87	4.42	0.65	28.97	12.4055	12.1808
P9F_0SHR	-8.6	165.51	5.06	0.78	3.63	7.4116	4.5235
P9G_0SHR	25.935	159.91	11.90	1.56	1.73	2.7395	1.5161
P9H_0SHR	-45.416	150.24	5.51	1.88	14.06	9.4858	4.3515
P9I_0SHR	-134.626	898.25	9.42	0.41	7.58	8.2204	3.6095
P9J_0SHR	-0.525	150.24	7.14	0.71	4.99	3.6838	2.0895

Table 21 shows the summary meteorological parameter most strongly correlated to the difference in the dose calculations. Mixing height was again the most strongly correlated summary input parameter with a negative correlation coefficient of -.705, which was a reasonably strong correlation compared to the maximum of -1.000.

Table 21: Maximum Ground-level Dose Correlation Results

	Dmax Difference	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
Mix Hgt	-0.705047	1					
DShear	-0.36825	0.296208	-0.25046	0.012182	1		
SigE	-0.284905	0.088036	-0.41294	-0.18458	0.413094	0.818836	1
SShear	-0.257994	0.632717	0.74249	1			
Ubar	-0.148037	0.496212	1				
SigA	-0.087273	0.028183	-0.36276	-0.05237	0.204926	1	
Dmax Difference	1						

Figure 22 gives a graphical presentation of the correlation data in Table 21. The correlation between the difference in model predictions for maximum ground-level dose and the summary meteorological parameters is demonstrated

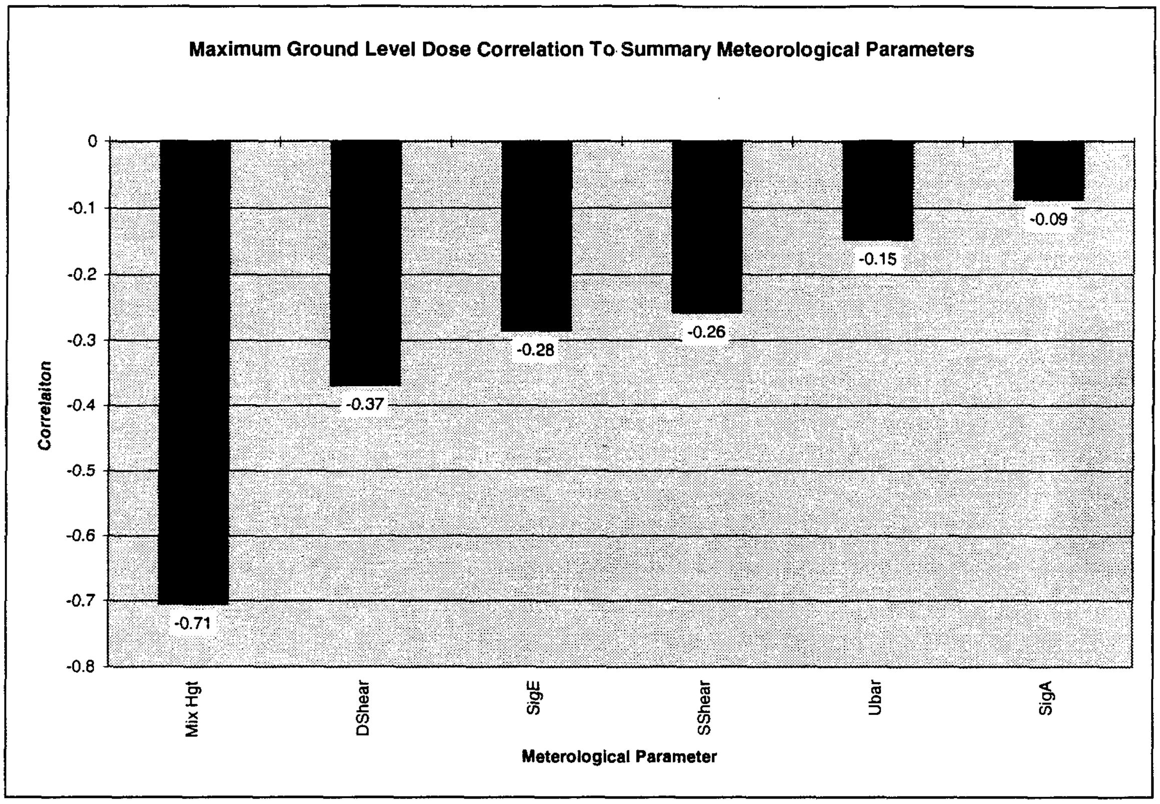


Figure 22: Maximum Ground-level Dose Correlation Graph

Maximum Ground-level 1-Minute Average Concentration

Table 22 shows the maximum ground-level 1-minute average concentration difference between model predictions along with the respective summary meteorological input data.

Table 22: Maximum Ground-level 1-Minute Average Concentration Correlation Data

FILE	C1min Difference	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
P1A_0SHR	0.007	430.99	5.51	0.28	4.29	5.7873	5.7223
P1B_0SHR	0	149.62	6.67	0.03	1.46	3.8489	4.2359
P1C_0SHR	0.286	311.81	1.91	0.98	22.89	1.7943	1.5595
P2A_0SHR	0.098	313.61	1.34	0.35	15.68	15.6139	8.0995
P2B_0SHR	0.006	210.31	1.61	0.10	11.67	15.3208	10.1671
P3A_0SHR	0.05	351.74	6.21	0.69	9.87	7.9973	6.5959
P3B_0SHR	0.003	175.87	3.85	0.52	6.00	12.7755	9.2671
P4A_0SHR	-0.022	197.18	3.66	0.65	3.10	8.2795	2.7449
P5A_0SHR	0.337	313.61	2.06	0.26	8.33	10.3057	4.3980
P5B_0SHR	2.625	313.61	1.11	0.49	23.96	7.9064	6.6513
P5C_0SHR	0.013	313.61	1.14	0.15	3.36	20.5378	9.3864
P6A_0SHR	-0.011	163.64	3.25	0.45	3.02	5.0750	4.0831
P6BB_0SH	-0.491	3003.80	10.39	3.06	3.76	19.4548	8.2045
P6B_0SHR	-0.04	150.72	2.18	0.56	20.99	12.6740	12.4979
P6C_0SHR	-0.086	149.96	2.42	0.41	4.26	4.4235	2.8095
P7A_0SHR	0.17	392.89	3.36	0.13	1.51	6.6293	6.1412
P7B_0SHR	0.052	180.31	6.62	0.43	1.08	3.6378	3.1340
P7C_0SHR	0.023	260.60	3.73	0.12	2.46	2.9995	2.7542
P7D_0SHR	0.019	146.30	3.08	0.00	1.56	3.8356	3.3098
P7E_0SHR	0.005	173.13	4.62	0.68	2.82	1.9641	1.6773
P8A_0SHR	-1.042	2736.19	9.84	2.19	5.28	3.8701	3.7796
P8BB_0SH	0.005	170.08	4.61	0.48	5.28	6.2874	5.0249
P8B_0SHR	-0.001	1982.11	6.60	0.82	4.84	3.9838	3.7998
P8C_OSHR	-0.647	505.64	17.29	2.29	3.37	4.3272	2.5254
P9A_0SHR	-0.891	2847.62	11.13	1.76	14.40	5.0063	4.9216
P9B_0SHR	0.632	172.49	12.32	0.63	2.50	4.5671	2.5648
P9C_0SHR	1.793	2836.14	9.83	1.20	23.64	2.4920	1.7222
P9D_0SHR	-0.001	2858.45	17.83	2.77	3.15	2.4964	2.4803
P9E_0SHR	-0.122	3036.87	4.42	0.65	28.97	12.4055	12.1808
P9F_0SHR	-0.143	165.51	5.06	0.78	3.63	7.4116	4.5235
P9G_0SHR	0.432	159.91	11.90	1.56	1.73	2.7395	1.5161
P9H_0SHR	-0.756	150.24	5.51	1.88	14.06	9.4858	4.3515
P9I_0SHR	-1.207	898.25	9.42	0.41	7.58	8.2204	3.6095
P9J_0SHR	-0.009	150.24	7.14	0.71	4.99	3.6838	2.0895

Table 23 shows the summary meteorological parameter most strongly correlated to the difference in the 1-minute average concentration calculations. Directional shear was the most strongly correlated summary input parameter with a correlation coefficient of .359, which was a very weak correlation compared to the maximum of 1.000.

Table 23: Maximum Ground-level 1-Minute Average Concentration Correlation Results

	C1min Difference	Mix Hgt	Ubar	SShear	DShear	SigA	SigE
C1min Difference	1						
DShear	0.3588268	0.296208	-0.25046	0.012182	1		
SigE	-0.037121	0.088036	-0.41294	-0.18458	0.413094	0.818836	1
SigA	-0.110858	0.028183	-0.36276	-0.05237	0.204926	1	
Mix Hgt	-0.136639	1					
Ubar	-0.244392	0.496212	1				
SShear	-0.274758	0.632717	0.74249	1			

Figure 23 gives a graphical presentation of the correlation data in Table 23. The correlation between the difference in model predictions for maximum ground-level 1-minute average concentration and the summary meteorological parameters is demonstrated It is obvious that only directional shear had a positive correlation to the output difference, and that all were weak correlations.

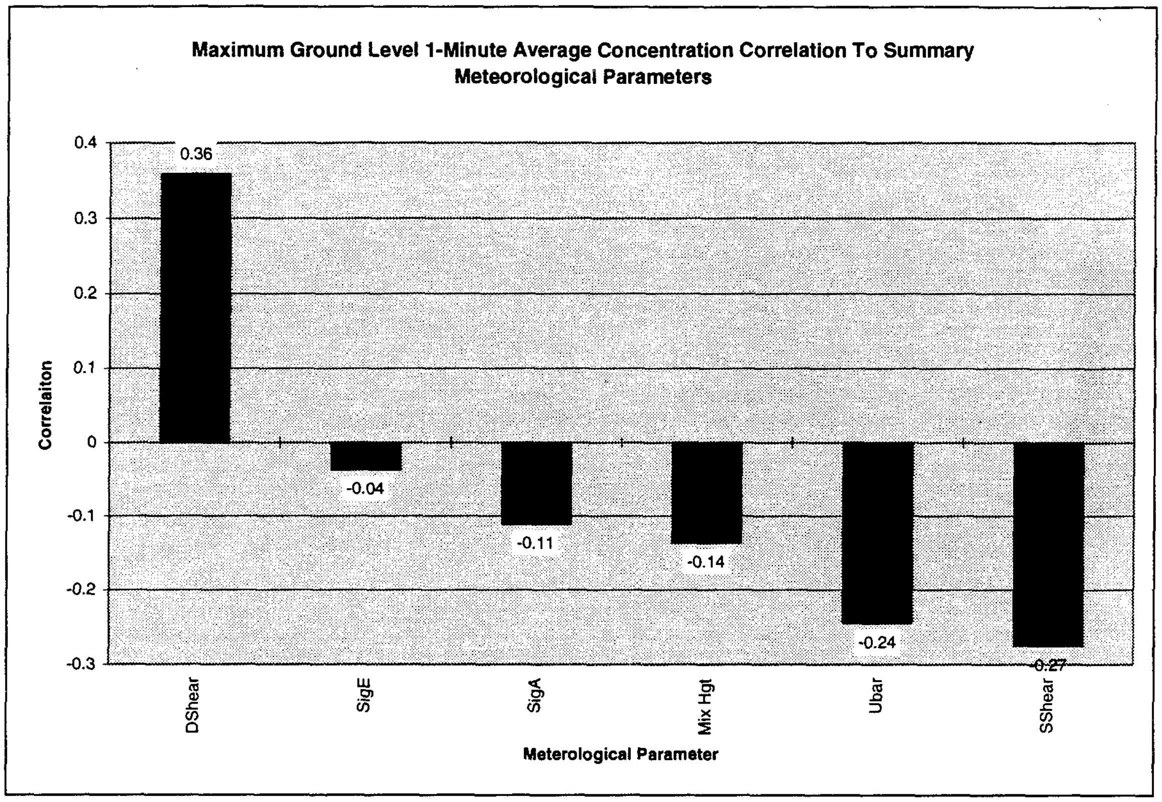


Figure 23: Maximum Ground-level 1-Minute Average Concentration Correlation Graph

CONCLUSIONS

Conclusions Introduction

The modified version of REEDM produced results that were similar to the original version. Of the three output categories studied, maximum ground-level instantaneous concentration and maximum ground-level dose were statistically different from those predictions made by the original REEDM. However, the maximum ground-level 1-minute average concentrations were not significantly altered by the REEDM modifications. It was seen that the models are influenced by a complex relationship among the input meteorological parameters, such that there was no strong correlation between the difference in model predictions and the summary input meteorological conditions. This section will present the conclusions for all three categories of output from the models, from the correlation studies of meteorological sensitivity and finally, will suggest follow-on research topics.

Maximum Ground-level Instantaneous Concentration

The maximum ground-level instantaneous concentration predictions made by the modified REEDM were an average .965 ppm greater than the original REEDM predictions. The modified version predicted values less than the original version by as much as -.146 ppm and greater than the original version by as much as 7.87 ppm. Although the two models produced statistically different output, the magnitude of that difference is small on the relative scale of the numbers being calculated. It was observed that the strongest correlation for maximum ground-level centerline instantaneous concentration was with mixing height with a correlation coefficient of .547. A strong correlation would be indicated by a correlation coefficient with magnitude greater than or equal to .8. A weak correlation would be indicated by a correlation coefficient magnitude less than or equal to .5 (33, 205). Therefore, this .574 correlation coefficient magnitude indicates moderate-to-weak correlation. This moderate-to-weak correlation supports the assertion that the models are influenced by a complex relationship among the input meteorological parameters rather than being driven primarily by one or two. It is noted that instantaneous concentration is, at least weakly, positively correlated to mixing height.

The modified REEDM predictions of higher instantaneous concentrations would be consistent with the model using lower wind speeds in the Gaussian equations. According to the instantaneous concentration equation, concentration is inversely proportional to wind speed. Most of the source material effecting the ground is transported only through the lower meteorological layers. Input meteorological data files indicate slower speeds near the surface and higher speeds at greater altitudes. The original REEDM averaged the high altitude wind speeds with the low altitude wind speeds to determine the mixing layer average wind speed. This average is larger than a more restricted average taken across only the lower mixing layers which have the lower speeds and which most dramatically affect ground-level concentration. Therefore, the modified REEDM applies slower wind speed averages to the transport and diffusion of the critical source material near the ground and produced higher concentrations as a result. A more detailed meteorological correlation study could illuminate this issue as well as similar influences of wind shear and directional perturbations.

Maximum Ground-level Dose

The maximum ground-level dose predictions made by the modified REEDM were less than those made by the original REEDM by an average -50.124 ppm sec. The modified version predicted lower dose values by as much as -.573.839 ppm sec and higher dose values by as much as 37.926 ppm sec. Although the two models produced similar outputs, the modified REEDM produced significantly lower maximum ground-level dose predictions. The strongest correlation for maximum ground-level centerline dose was with mixing height with a correlation coefficient of -.705. While this moderate correlation is stronger than was seen with instantaneous concentration, it is on the weak end of the moderate range for correlation and as such, supports the assertion that the models are influenced by a complex relationship among the input meteorological parameters rather than being driven primarily by one or two. It is further noted that dose is negatively correlated to mixing height.

In order for the dose to decrease with decreasing wind speed, the exhaust cloud would have to be less spread out in the along wind direction so that a receptor would be exposed to the source material for less time, despite the lower wind speeds. Less along wind dispersion would be consistent with the higher concentrations predicted. Again, a more detailed study of the meteorological conditions generating these output could possibly illuminate the dose performance of the modified REEDM.

Maximum Ground-level 1-Minute Average Concentration

The maximum ground-level 1-minute average concentration predictions made by the modified REEDM differed by an average .032 ppm from the original REEDM. The modified REEDM predicted lower values by as much as -1.207 ppm and higher values by as much as 2.625 ppm. Not only do the models appear to respond nearly identically with regard to their 1-minute average calculations, but the two sample paired T-test asserts to a 95% confidence level that the means of the model output are the same. It was observed that the strongest correlation for maximum ground-level centerline 1-minute average concentration was with directional shear with a correlation coefficient of .359. This is a weak correlation which again supports the assertion that the models are influenced by a complex relationship among the input meteorological parameters rather than being driven primarily by one or two. This correlation is too weak to positively assert a relationship between 1-minute average concentration and directional shear.

A 1-minute average concentration is equivalent to a time-extended instantaneous calculation or a short time dose calculation. It is reasonable to assume that a counterbalance exists between higher concentration and shorter exposure time because of a less disperse cloud passing over a receptor. This would explain the increased concentration and decreased dose predicted by the modified REEDM. As mentioned previously, further study of the wind speed and other meteorological parameter profiles along with the model predictions could possibly answer this question empirically.

The results from the thesis data analysis are summarized in Table 24.

Table 24: Findings Summary

Output Category	Average Difference Between Model Predictions	Minimum Difference Between Model Predictions	Maximum Difference Between Model Predictions	Statistically Different Sample Means?	Strongest Meteorological Parameter Correlation
Max Ground-level Instantaneous Concentration	.965 ppm	-.146 ppm	7.87 ppm	Yes	Mixing Height Correlation = .547
Max Ground-level Dose	-50.124 ppm sec	-573.839 ppm sec	37.926 ppm sec	Yes	Mixing Height Correlation = -.705
Max Ground-level 1-Minute Average Concentration	.032 ppm	-1.207 ppm	2.625 ppm	No	Directional Wind Shear Correlation = .359

Conclusions Summary

In conclusion, the goal of this thesis to develop and implement a more specific meteorological averaging scheme to improve the accuracy of the model has been accomplished. Furthermore, it has been shown that the original REEDM predictions do not suffer badly from present meteorological averaging scheme assumptions. The data presented indicate that as the modified REEDM applied more specific meteorological parameters to the transport and diffusion of source material, it made different predictions of maximum instantaneous ground-level concentration, maximum ground-level dose and maximum 1-minute time weighted average concentration. The modified REEDM predicted slightly larger instantaneous ground-level concentrations than did the original. The modified version predicted lower maximum ground-level doses. The two models performed nearly identically for maximum ground-level 1-minute average concentration predictions. The predictions were reasonable given the previously explained response of concentration and dose predictions to wind speeds. The small magnitude of the mean difference in the predictions between the two models indicated that the averaging scheme presently used in the original REEDM does not suffer extensively from its more gross averaging assumptions. It may be suggested that the differing meteorological conditions which caused the modified REEDM to have slightly different predictions balance out when calculating short time averaged concentrations. Finally, there are some areas of additional research which could further the accomplishments of this thesis as well as make strides in related areas.

Recommended Follow-On Research

1) The results of the meteorological averaging scheme modifications to REEDM could be further analyzed with in-depth correlations drawn among model output differences and specific meteorological input from the discrete sounding layers.

2) The chemical reaction and decay models presently in use in REEDM are under review and improvement. Because source strength is one of the strongest determinants of downwind concentration, this area of research could have significant operational impact.

3) REEDM is a Gaussian based model which is limited by many assumptions like constant coefficients and time averaging. Another method of modeling atmospheric transport and diffusion which is gathering popularity with increasing computing capability is numerical modeling. There are several numerical models under review and development which have the potential to predict down wind concentrations from space launches.

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APPENDIX A: Rawinsonde Data Files

R1A
$
UNINTERPOLATED DATA
***** T-24 FORECAST ******

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 420
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1115Z 1 AUG 1993 968.
ASCENT NBR 420

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	280.	9.	24.3	10.7	1000.00	999.	.1250	1203.55	342.	663.
600.	270.	10.	23.0	8.0	990.00	999.	.1260	1203.55	342.	663.
1782.	290.	12.	22.8	7.2	968.25	999.	.1267	1132.07	328.	673.
1871.	15.	16.	30.9	8.9	940.98	26.	.0812	1073.22	286.	681.
2975.	15.	17.	30.9	4.1	913.71	18.	.0583	1043.38	266.	681.
3886.	19.	16.	28.6	5.4	885.70	23.	.0644	1018.64	265.	678.
4733.	28.	14.	27.2	.4	860.26	17.	.0453	995.06	248.	676.
5511.	37.	11.	25.4	.3	837.40	19.	.0455	974.39	244.	674.
6361.	41.	8.	23.1	2.0	812.98	25.	.0517	952.89	243.	672.
7315.	55.	4.	20.5	2.4	786.21	30.	.0538	929.47	239.	669.
8152.	120.	4.	18.3	.2	763.26	29.	.0460	909.54	230.	666.
8925.	142.	8.	18.1	-8.5	742.55	16.	.0240	886.74	212.	666.
9668.	145.	10.	16.3	-9.4	723.11	16.	.0225	868.96	207.	664.
10389.	145.	10.	13.9	-10.3	704.59	18.	.0211	853.85	203.	661.

$ 06/10/93 20:17:45
1710Z 10 06 93 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA	
300	012	397.0	6.0	43.0	13.9	999.0	999.0	659.9	999.0	9999.0	4.5	1.0
300	054	439.0	7.0	29.0	12.8	999.0	999.0	658.7	999.0	9999.0	4.1	4.0
300	102	487.0	8.0	9.0	13.1	999.0	999.0	658.9	999.0	9999.0	3.5	6.3
300	108	493.0	8.0	28.0	999.0	999.0	999.0	999.0	999.0	9999.0	3.0	7.0
300	204	589.0	8.0	21.0	12.7	999.0	999.0	658.6	999.0	9999.0	3.0	8.0
300	300	685.0	9.0	16.0	12.6	999.0	999.0	658.4	999.0	9999.0	3.0	8.5
300	490	875.0	12.0	4.0	16.7	85.4	13.9	663.1	665.4	1001.6	2.8	8.5
300	660	1045.0	12.0	4.0	16.7	85.4	13.9	663.1	665.4	1001.6	2.5	8.0
300	820	1205.0	12.0	4.0	16.7	85.4	13.9	663.1	665.4	1001.6	2.5	6.0

R1B
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8047 ASC NO: 198
900
BLDG 900, VANDENBERG AFB, CALIF.
FORECAST MSS/SYN
0407Z 8 NOV 1991 983.5
ASCENT NBR 0198

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368	180	13	15.6	14.1	1000.80	91				
762	185	13	18.7	14.4	986.88	76				
1223	195	12	18.5	12.0	970.90	66				
1288	175	11	21.5	11.8	968.69	54				
1446	156	15	22.1	9.5	963.31	45				
2068	156	16	24.3	2.5	942.63	24				
2542	155	19	24.1	2.3	927.20	24				
3525	154	20	22.1	1.8	895.87	26				
4529	146	20	21.2	1.8	864.82	28				
5678	150	20	19.1	-0.1	830.44	28				
6807	154	18	16.1	-1.5	797.68	30				
7930	161	17	12.6	-3.2	766.07	33				
9098	166	16	10.1	-4.6	734.17	35				
10196	165	16	7.8	-5.7	705.16	38				

R1C
UNINTERPOLATED DATA

TEST NBR SITE: 900   OP NO: W8047   ASC NO: 202
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
0652Z 8 NOV 1991 967.
ASCENT NBR 0202

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	330.	2.	13.1	12.2	1003.70	94.	.1073	1215.01	337.	661.
1166.	201.	5.	11.6	10.8	975.12	95.	.0988	1187.00	325.	659.
1189.	223.	12.	11.6	10.8	974.30	95.	.0989	1185.99	325.	659.
1391.	222.	11.	11.6	10.8	967.19	95.	.0988	1177.30	323.	659.
1437.	170.	7.	12.5	11.7	965.56	95.	.1045	1171.23	325.	661.
1483.	133.	10.	15.5	13.5	963.98	88.	.1164	1156.37	329.	664.
1555.	148.	12.	17.0	6.8	961.51	51.	.0738	1149.97	301.	665.
1679.	170.	14.	18.3	.9	957.27	31.	.0485	1141.30	284.	666.
2213.	175.	15.	20.9	-4.7	939.33	17.	.0317	1110.95	266.	669.
2423.	181.	17.	21.0	-4.2	932.40	18.	.0330	1102.28	265.	669.
3070.	180.	18.	20.3	-5.2	911.36	17.	.0306	1080.08	259.	668.
3894.	179.	21.	18.9	-5.8	885.14	18.	.0295	1054.07	253.	667.
4796.	179.	23.	17.4	-6.2	857.17	19.	.0288	1026.03	246.	665.
5763.	177.	24.	15.5	-7.5	827.99	20.	.0262	997.73	238.	663.
6705.	174.	23.	13.6	-7.5	800.36	22.	.0263	970.78	232.	661.
7730.	171.	22.	11.0	-6.6	771.12	28.	.0284	943.69	228.	658.
8708.	168.	23.	8.7	-7.3	743.98	31.	.0272	917.94	221.	655.
9814.	166.	23.	7.0	-9.4	714.24	30.	.0232	886.78	212.	653.
10683.	164.	22.	5.3	-10.8	691.56	30.	.0209	863.97	206.	651.
11633.	168.	21.	4.0	-14.0	667.48	26.	.0162	838.04	197.	649.

R2A
$ 06/20/95 21:37:22
1020Z 06 14 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
017	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	1.0
017	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	5.2
017	229	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	5.5
017	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	6.0
017	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	14.0	7.2
017	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	18.8	9.5
017	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	36.1	19.1
017	1028	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1063	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1168	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1311	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1350	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1385	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1419	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1456	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1982	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3030	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3941	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	4855	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	5813	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	6776	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	7767	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	8697	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	10666	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	11635	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	12520	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	13545	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	14560	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	15609	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	16562	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:37:24
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W9193 ASC NO: 084
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 2.3 3.7 30
1001Z 14 JUN 1995 965.13
ASCENT NBR 084

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	176.0	2.0	9.6	6.5	1002.30	81.0	0.0	1234.90	0.0	0.0	1	9
493.0	331.0	4.3	9.1	7.6	996.31	91.0	0.0	1226.09	0.0	0.0	2	0
558.0	317.9	4.1	8.9	8.1	993.94	95.0	0.0	1222.61	0.0	0.0	2	9
657.0	298.0	3.7	8.7	8.0	990.32	95.1	0.0	1218.95	0.0	0.0	2	0
821.0	279.0	3.1	8.4	7.7	984.36	95.3	0.0	1212.91	0.0	0.0	2	0
985.0	302.0	2.3	8.2	7.5	978.44	95.5	0.0	1206.90	0.0	0.0	2	0
1149.0	301.0	1.2	7.9	7.2	972.55	95.7	0.0	1200.91	0.0	0.0	2	0
1357.0	315.5	1.3	7.5	6.9	965.13	96.0	0.0	1193.37	0.0	0.0	2	9
1392.0	316.0	1.5	8.7	8.1	963.89	95.7	0.0	1186.37	0.0	0.0	2	9
1497.0	318.5	2.3	8.3	6.6	960.15	89.0	0.0	1183.91	0.0	0.0	2	9
1640.0	329.0	3.9	8.6	-4.9	955.13	38.0	0.0	1179.01	0.0	0.0	2	9
1679.0	332.9	4.8	9.3	-7.4	953.75	30.0	0.0	1174.73	0.0	0.0	2	9
1714.0	336.6	5.6	11.2	-7.6	952.51	26.0	0.0	1165.39	0.0	0.0	2	9
1748.0	340.1	6.4	14.8	-5.0	951.35	25.0	0.0	1149.07	0.0	0.0	2	9
1785.0	343.9	7.3	16.7	-3.9	950.10	24.0	0.0	1139.87	0.0	0.0	2	9
2311.0	1.2	11.1	20.2	-6.4	932.48	16.0	0.0	1105.70	0.0	0.0	2	9

3359.0	296.4	10.5	19.3	-6.3	898.46	17.1	0.0	1068.56	0.0	0.0	4	9
4270.0	274.8	9.6	19.5	-6.8	869.90	16.2	0.0	1033.90	0.0	0.0	4	9
5184.0	264.1	10.5	18.3	-7.8	842.11	16.2	0.0	1005.05	0.0	0.0	4	9
6142.0	254.1	12.4	15.3	-8.0	813.73	19.2	0.0	981.26	0.0	0.0	4	9
7105.0	245.2	16.0	14.1	-10.9	785.97	16.6	0.0	952.00	0.0	0.0	4	0
8096.0	239.5	21.2	13.3	-12.2	758.28	15.7	0.0	921.11	0.0	0.0	4	9
9026.0	235.3	25.6	12.3	-12.3	733.13	16.6	0.0	893.66	0.0	0.0	4	9
10995.0	237.1	29.2	9.1	-13.8	682.23	18.2	0.0	841.09	0.0	0.0	4	0
11964.0	237.3	31.4	7.0	-15.4	658.28	18.4	0.0	817.74	0.0	0.0	4	0
12849.0	233.9	33.3	5.0	-16.5	636.98	19.2	0.0	797.02	0.0	0.0	4	9
13874.0	233.5	33.4	2.5	-18.1	612.97	20.0	0.0	774.00	0.0	0.0	4	0
14889.0	236.8	33.1	-.2	-18.9	589.89	22.8	0.0	752.24	0.0	0.0	4	0
15938.0	238.6	33.9	-3.2	-20.2	566.73	25.3	0.0	730.79	0.0	0.0	4	0
16891.0	237.1	35.9	-6.1	-21.4	546.23	28.4	0.0	712.04	0.0	0.0	4	9

R2B
$ 08/02/93 19:20:08
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8260 ASC NO: 101
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/WIN
1729Z 2 AUG 1993 974.9 2 7000
ASCENT NBR 101

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	270.	5.	21.2	13.6	999.00	62.	.1150	1182.33	331.	669.
522.	319.	3.	18.4	13.5	993.60	73.	.1149	1180.27	332.	668.
1058.	325.	3.	17.7	16.6	974.86	93.	.1404	1159.14	343.	667.
1122.	339.	5.	18.0	16.9	972.66	93.	.1429	1155.14	344.	668.
1230.	341.	6.	20.4	15.6	968.98	74.	.1310	1141.99	333.	670.
1307.	337.	9.	23.3	13.5	966.35	54.	.1130	1128.74	319.	673.
1380.	328.	12.	23.8	12.2	963.91	48.	.1037	1124.54	312.	674.
1680.	325.	12.	25.1	9.4	953.91	37.	.0857	1109.03	298.	675.
1834.	322.	12.	27.4	7.8	948.84	29.	.0763	1095.19	289.	677.
2493.	322.	11.	28.8	11.6	927.63	35.	.0983	1064.28	294.	679.
2684.	323.	6.	29.8	12.7	921.58	35.	.1050	1053.37	296.	681.
3620.	324.	6.	28.7	11.5	892.57	35.	.0975	1024.21	285.	679.
4783.	328.	5.	27.0	9.1	857.64	32.	.0832	990.38	269.	677.
5908.	347.	4.	24.5	7.6	824.89	34.	.0759	960.85	259.	674.
7019.	36.	2.	22.4	5.4	793.54	33.	.0658	931.38	247.	672.
8161.	92.	2.	20.1	4.8	762.33	36.	.0635	901.78	239.	669.
9290.	109.	3.	17.4	-.3	732.41	30.	.0446	875.47	222.	665.
10356.	112.	2.	14.4	1.1	704.99	40.	.0497	851.10	220.	662.

$ 08/02/93 19:20:32
1840Z 02 08 93 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
300	012	397.0	5.0	332.0	21.1	999.0	999.0	668.1	999.0	9999.0	16.7
300	054	439.0	5.0	322.0	21.4	999.0	999.0	668.5	999.0	9999.0	13.1
300	102	487.0	6.0	301.0	20.0	999.0	999.0	666.9	999.0	9999.0	12.4
300	108	493.0	5.0	314.0	999.0	999.0	999.0	999.0	999.0	9999.0	14.3
300	204	589.0	5.0	303.0	20.2	999.0	999.0	667.1	999.0	9999.0	12.0
300	300	685.0	5.0	304.0	20.2	999.0	999.0	667.1	999.0	9999.0	13.2

$ 08/02/93 00:00:00 note - DASS borrowed from T-0, 100 min later
DASS DATA FROM BLDG. DAS2 UNEDITED

02/08/93 20:00 10-MIN. AVE.

ALT M	DIR DEG	V KNOTS	VZ KNOTS	SD DEG	SV KNOTS	SZ KNOTS
GND	279	9.7	1.2	12.0	1.7	.4
50	278	9.5	.8	23.6	4.1	2.1
100	268	8.2	.6	28.0	3.3	1.9
150	271	9.9	-.8	20.5	2.7	1.7
200	268	8.7	-.6	15.6	1.9	1.4
250	294	7.6	-2.5	--	--	1.6

R3A
$ 08/02/93 14:54:57
******* T-5 FORECAST ********
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8260 ASC NO: 099
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/WIN
1329Z 2 AUG 1993 958. 2 7000
ASCENT NBR 099

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	330.	10.	22.0	12.9	998.10	999.	.1347	1198.37	347.	664.
1211.	340.	12.	21.1	11.8	968.52	999.	.1265	1162.85	336.	664.
1243.	348.	13.	20.4	9.1	967.38	999.	.1212	1164.64	334.	663.
1280.	349.	16.	19.8	8.0	966.09	999.	.0989	1166.88	321.	662.
1322.	345.	18.	18.4	6.7	964.64	999.	.0742	1164.18	305.	662.
1402.	350.	17.	17.8	1.3	961.86	999.	.0506	1160.64	289.	662.
1441.	356.	15.	17.0	.6	960.52	999.	.0477	1154.36	286.	664.
1522.	010.	13.	16.8	3.6	957.80	999.	.0573	1110.44	281.	676.
2497.	015	13.	29.2	3.0	926.17	19.	.0543	1063.86	269.	679.
3037.	010.	11.	29.7	2.1	909.19	17.	.0507	1042.79	262.	679.
3536.	005.	8.	29.2	1.8	893.79	17.	.0500	1026.82	258.	679.
4584.	010.	6.	27.1	1.0	862.14	18.	.0474	997.46	250.	676.
5663.	17.	4.	24.8	.4	830.53	20.	.0458	968.32	243.	674.
6750.	55.	3.	22.8	-1.6	799.62	20.	.0398	938.85	233.	671.
7872.	138.	3.	20.4	-3.2	768.68	20.	.0356	910.09	224.	669.
8981.	172.	2.	17.9	-7.7	739.04	17.	.0255	883.05	212.	666.
10095.	173.	3.	14.7	-4.0	710.13	27.	.0343	857.37	212.	662.

$ 08/02/93 14:56:07
1950Z 26 07 93 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA	
300	012	397.0	5.0	252.0	16.7	999.0	999.0	663.1	999.0	9999.0	12.1	2.0
300	054	439.0	6.0	244.0	16.2	999.0	999.0	662.5	999.0	9999.0	14.4	6.0
300	102	487.0	7.0	226.0	16.6	999.0	999.0	663.0	999.0	9999.0	15.3	8.0
300	108	493.0	6.0	251.0	999.0	999.0	999.0	999.0	999.0	9999.0	14.3	8.0
300	204	589.0	6.0	238.0	16.4	999.0	999.0	662.8	999.0	9999.0	12.3	10.
300	300	685.0	6.0	239.0	15.9	999.0	999.0	662.3	999.0	9999.0	10.8	10.
300	490	875.0	4.0	238.0	17.2	96.9	16.7	663.7	666.3	1000.4	9.0	11.
300	660	1045.0	4.0	238.0	17.2	96.9	16.7	663.7	666.3	1000.4	7.0	9.0
300	820	1205.0	4.0	238.0	17.2	96.9	16.7	663.7	666.3	1000.4	5.0	3.0

R3B
$ Created by upwind version 1.0
T-0 sounding, tower, & DASS2
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8260 ASC NO: 103
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/WIN
1944Z 2 AUG 1993 978.22 4 150
ASCENT NBR 103

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	308.	6.	21.8	15.4	998.90	67.	0.000	1179.81	0.0	0.0
422.	298.	6.	21.1	15.4	997.00	70.	0.000	1179.37	0.0	0.0
470.	276.	7.	20.5	15.4	995.31	73.	0.000	1178.98	0.0	0.0
572.	282.	6.	19.2	15.4	991.72	80.	0.000	1178.14	0.0	0.0
668.	278.	7.	17.9	15.3	988.37	86.	0.000	1177.36	0.0	0.0
795.	270.	9.	16.3	15.3	983.94	94.	0.000	1176.32	0.0	0.0
860.	271.	10.	16.6	15.4	981.66	93.	0.000	1172.46	0.0	0.0
945.	269.	9.	16.9	15.6	978.69	92.	0.000	1167.45	0.0	0.0
1015.	268.	9.	21.5	15.4	976.26	68.	0.000	1146.47	0.0	0.0
1188.	294.	8.	22.1	13.6	970.37	59.	0.000	1138.04	0.0	0.0
1368.	316.	10.	22.7	11.7	964.29	50.	0.000	1129.36	0.0	0.0
1878.	316.	10.	26.6	8.6	947.34	32.	0.000	1096.13	0.0	0.0
2539.	316.	10.	27.9	11.4	926.06	36.	0.000	1065.71	0.0	0.0
3201.	316.	9.	29.4	12.8	905.29	36.	0.000	1035.98	0.0	0.0
3726.	323.	8.	28.0	12.9	889.18	39.	0.000	1022.11	0.0	0.0
4956.	329.	7.	26.6	9.1	852.35	33.	0.000	985.54	0.0	0.0
6139.	348.	4.	24.4	8.4	818.14	36.	0.000	952.99	0.0	0.0
7484.	37.	2.	22.0	8.0	780.66	41.	0.000	916.63	0.0	0.0
8762.	103.	2.	19.1	1.3	746.30	30.	0.000	886.60	0.0	0.0
10210.	137.	2.	15.2	2.4	708.75	42.	0.000	852.96	0.0	0.0

$ 08/02/93 00:00:00
DASS DATA FROM BLDG. DAS2 UNEDITED

02/08/93 20:00 10-MIN. AVE.

ALT	DIR	V	VZ	SD	SV	SZ
M	DEG	KNOTS	KNOTS	DEG	KNOTS	KNOTS
GND	279	9.7	1.2	12.0	1.7	.4
50	278	9.5	.8	23.6	4.1	2.1
100	268	8.2	.6	28.0	3.3	1.9
150	271	9.9	-.8	20.5	2.7	1.7
200	268	8.7	-.6	15.6	1.9	1.4
250	294	7.6	-2.5	--	--	1.6

$ 08/02/93 00:00:00
2000Z 02 08 93 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
300	012	397.0	6.0	308.0	19.4	999.0	999.0	659.9	999.0	9999.0	14.1
300	054	439.0	6.0	298.0	18.8	999.0	999.0	660.2	999.0	9999.0	9.5
300	102	487.0	7.0	276.0	17.4	999.0	999.0	659.6	999.0	9999.0	9.7
300	108	493.0	6.0	297.0	999.0	999.0	999.0	999.0	999.0	9999.0	13.4
300	204	589.0	6.0	282.0	16.4	999.0	999.0	659.5	999.0	9999.0	9.9
300	300	685.0	7.0	278.0	15.7	999.0	999.0	659.3	999.0	9999.0	11.7

R4A
$ 06/20/95 21:32:25
0500Z 06 14 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
017	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.7	1.0
017	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.7	4.1
017	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.7	3.4
017	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.6	2.4
017	646	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	992	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1177	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1342	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1476	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1620	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	2440	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	2962	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3618	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	4666	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	5586	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	6575	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	8559	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	10430	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	11475	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	12442	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	13333	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	14294	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	15227	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:32:38
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W9193 ASC NO: 081
1764
"BLDG 1764, VANDENBERG AFB, CALIF."
RAWINSONDE MSS/SYN 5.1 6.6 24
0501Z 14 JUN 1995 979.76
ASCENT NBR 081

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	327.0	5.0	10.2	7.6	1003.20	84.0	0.0	1233.40	0.0	0.0	1	9
493.0	312.0	5.4	10.0	7.8	997.20	86.5	0.0	1225.69	0.0	0.0	2	0
657.0	309.0	6.6	9.7	8.0	991.23	89.1	0.0	1218.03	0.0	0.0	2	0
821.0	308.0	9.3	9.5	8.2	985.30	91.6	0.0	1210.42	0.0	0.0	2	0
975.0	306.1	9.7	9.3	8.4	979.76	94.0	0.0	1203.31	0.0	0.0	2	9
1149.0	301.0	7.0	9.6	8.7	973.54	94.0	0.0	1194.25	0.0	0.0	2	0
1321.0	301.0	4.3	9.9	9.0	967.43	94.0	0.0	1185.37	0.0	0.0	2	9
1506.0	355.8	2.8	11.0	9.9	960.92	93.0	0.0	1172.46	0.0	0.0	2	9
1671.0	3.3	5.5	15.6	8.8	955.20	64.0	0.0	1147.27	0.0	0.0	2	9
1805.0	360.0	7.4	15.9	4.3	950.64	48.6	0.0	1141.83	0.0	0.0	2	0
1949.0	348.6	9.9	16.2	-.5	945.76	32.0	0.0	1136.01	0.0	0.0	2	9
2769.0	305.8	14.5	21.2	-3.3	918.57	19.0	0.0	1085.04	0.0	0.0	2	9
3291.0	311.0	8.7	21.0	-3.8	901.80	18.5	0.0	1066.00	0.0	0.0	4	0
3947.0	307.3	7.4	21.5	-4.6	881.20	17.0	0.0	1039.94	0.0	0.0	4	9
4995.0	259.9	5.5	19.6	-5.8	849.17	17.4	0.0	1008.74	0.0	0.0	4	9
5915.0	246.3	9.2	17.0	-2.5	821.83	26.2	0.0	984.45	0.0	0.0	4	9
6904.0	239.8	13.1	16.9	-8.1	793.29	17.3	0.0	951.31	0.0	0.0	4	9
8888.0	238.0	17.5	14.0	-9.7	738.70	18.3	0.0	894.87	0.0	0.0	4	9
10759.0	250.1	23.1	9.8	-13.1	690.05	18.4	0.0	848.58	0.0	0.0	4	0
11804.0	250.7	25.4	7.7	-13.7	664.03	20.1	0.0	822.70	0.0	0.0	4	0
12771.0	251.9	27.3	5.6	-14.5	640.64	21.8	0.0	799.73	0.0	0.0	4	0
13662.0	253.9	29.0	3.2	-15.8	619.67	23.1	0.0	780.34	0.0	0.0	4	0

14623.0	252.4	29.6	0.3	-17.4	597.59	25.0	0.0	760.59	0.0	0.0	4	0
15556.0	248.1	31.7	-2.0	-20.8	576.72	22.1	0.0	740.42	0.0	0.0	4	9

R5A
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0950Z 06 14 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
017	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	1.0
017	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	5.0
017	229	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	5.0
017	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.7	5.0
017	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.3	4.4
017	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	12.2	5.2
017	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	14.2	6.0
017	1028	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1063	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1168	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1311	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1350	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1385	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1419	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1456	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1982	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3030	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3941	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	4855	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	5813	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	6776	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	7767	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	8697	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	10666	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	11635	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	12520	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	13545	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	14560	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	15609	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	16562	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

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UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W9193 ASC NO: 084
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 2.3 4.5 30
1001Z 14 JUN 1995 965.13
ASCENT NBR 084

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	49.0	2.0	9.6	6.5	1002.30	81.0	0.0	1234.90	0.0	0.0	1	9
493.0	12.0	4.5	9.1	7.6	996.31	91.0	0.0	1226.09	0.0	0.0	2	0
558.0	23.1	4.5	8.9	8.1	993.94	95.0	0.0	1222.61	0.0	0.0	2	9
657.0	40.0	4.5	8.7	8.0	990.32	95.1	0.0	1218.95	0.0	0.0	2	0
821.0	45.0	5.1	8.4	7.7	984.36	95.3	0.0	1212.91	0.0	0.0	2	0
985.0	55.0	4.3	8.2	7.5	978.44	95.5	0.0	1206.90	0.0	0.0	2	0
1149.0	48.0	3.7	7.9	7.2	972.55	95.7	0.0	1200.91	0.0	0.0	2	0
1357.0	27.4	3.0	7.5	6.9	965.13	96.0	0.0	1193.37	0.0	0.0	2	9
1392.0	22.9	2.9	8.7	8.1	963.89	95.7	0.0	1186.37	0.0	0.0	2	9
1497.0	10.2	2.7	8.3	6.6	960.15	89.0	0.0	1183.91	0.0	0.0	2	9
1640.0	357.0	3.1	8.6	-4.9	955.13	38.0	0.0	1179.01	0.0	0.0	2	9
1679.0	355.1	4.3	9.3	-7.4	953.75	30.0	0.0	1174.73	0.0	0.0	2	9
1714.0	353.4	5.5	11.2	-7.6	952.51	26.0	0.0	1165.39	0.0	0.0	2	9
1748.0	351.8	6.6	14.8	-5.0	951.35	25.0	0.0	1149.07	0.0	0.0	2	9
1785.0	350.0	7.8	16.7	-3.9	950.10	24.0	0.0	1139.87	0.0	0.0	2	9
2311.0	344.2	5.6	20.2	-6.4	932.48	16.0	0.0	1105.70	0.0	0.0	2	9

3359.0	296.4	10.5	19.3	-6.3	898.46	17.1	0.0	1068.56	0.0	0.0	4	9
4270.0	274.8	9.6	19.5	-6.8	869.90	16.2	0.0	1033.90	0.0	0.0	4	9
5184.0	264.1	10.5	18.3	-7.8	842.11	16.2	0.0	1005.05	0.0	0.0	4	9
6142.0	254.1	12.4	15.3	-8.0	813.73	19.2	0.0	981.26	0.0	0.0	4	9
7105.0	245.2	16.0	14.1	-10.9	785.97	16.6	0.0	952.00	0.0	0.0	4	0
8096.0	239.5	21.2	13.3	-12.2	758.28	15.7	0.0	921.11	0.0	0.0	4	9
9026.0	235.3	25.6	12.3	-12.3	733.13	16.6	0.0	893.66	0.0	0.0	4	9
10995.0	237.1	29.2	9.1	-13.8	682.23	18.2	0.0	841.09	0.0	0.0	4	0
11964.0	237.3	31.4	7.0	-15.4	658.28	18.4	0.0	817.74	0.0	0.0	4	0
12849.0	233.9	33.3	5.0	-16.5	636.98	19.2	0.0	797.02	0.0	0.0	4	9
13874.0	233.5	33.4	2.5	-18.1	612.97	20.0	0.0	774.00	0.0	0.0	4	0
14889.0	236.8	33.1	-.2	-18.9	589.89	22.8	0.0	752.24	0.0	0.0	4	0
15938.0	238.6	33.9	-3.2	-20.2	566.73	25.3	0.0	730.79	0.0	0.0	4	0
16891.0	237.1	35.9	-6.1	-21.4	546.23	28.4	0.0	712.04	0.0	0.0	4	9

R5B
$ 06/20/95 21:35:36
1000Z 06 14 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
017	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.6	1.0
017	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.6	5.0
017	229	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.6	5.7
017	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.6	6.7
017	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.6	7.6
017	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.9	10.4
017	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.9	9.5
017	1028	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1063	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1168	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1311	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1350	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1385	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1419	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1456	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1982	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3030	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3941	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	4855	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	5813	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	6776	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	7767	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	8697	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	10666	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	11635	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	12520	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	13545	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	14560	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	15609	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	16562	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:35:40
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W9193 ASC NO: 084
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 2.3 3.3 30
1001Z 14 JUN 1995 965.13
ASCENT NBR 084

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	180.0	2.0	9.6	6.5	1002.30	81.0	0.0	1234.90	0.0	0.0	1	9
493.0	331.0	4.5	9.1	7.6	996.31	91.0	0.0	1226.09	0.0	0.0	2	0
558.0	332.6	4.0	8.9	8.1	993.94	95.0	0.0	1222.61	0.0	0.0	2	9
657.0	335.0	3.3	8.7	8.0	990.32	95.1	0.0	1218.95	0.0	0.0	2	0
821.0	327.0	2.9	8.4	7.7	984.36	95.3	0.0	1212.91	0.0	0.0	2	0
985.0	1.0	2.1	8.2	7.5	978.44	95.5	0.0	1206.90	0.0	0.0	2	0
1149.0	42.0	2.3	7.9	7.2	972.55	95.7	0.0	1200.91	0.0	0.0	2	0
1357.0	34.8	1.8	7.5	6.9	965.13	96.0	0.0	1193.37	0.0	0.0	2	9
1392.0	32.2	1.7	8.7	8.1	963.89	95.7	0.0	1186.37	0.0	0.0	2	9
1497.0	19.7	1.8	8.3	6.6	960.15	89.0	0.0	1183.91	0.0	0.0	2	9
1640.0	334.0	4.3	8.6	-4.9	955.13	38.0	0.0	1179.01	0.0	0.0	2	9
1679.0	335.4	4.9	9.3	-7.4	953.75	30.0	0.0	1174.73	0.0	0.0	2	9
1714.0	336.7	5.5	11.2	-7.6	952.51	26.0	0.0	1165.39	0.0	0.0	2	9
1748.0	337.9	6.1	14.8	-5.0	951.35	25.0	0.0	1149.07	0.0	0.0	2	9
1785.0	339.3	6.7	16.7	-3.9	950.10	24.0	0.0	1139.87	0.0	0.0	2	9
2311.0	327.6	4.6	20.2	-6.4	932.48	16.0	0.0	1105.70	0.0	0.0	2	9

3359.0	296.4	10.5	19.3	-6.3	898.46	17.1	0.0	1068.56	0.0	0.0	4	9
4270.0	274.8	9.6	19.5	-6.8	869.90	16.2	0.0	1033.90	0.0	0.0	4	9
5184.0	264.1	10.5	18.3	-7.8	842.11	16.2	0.0	1005.05	0.0	0.0	4	9
6142.0	254.1	12.4	15.3	-8.0	813.73	19.2	0.0	981.26	0.0	0.0	4	9
7105.0	245.2	16.0	14.1	-10.9	785.97	16.6	0.0	952.00	0.0	0.0	4	0
8096.0	239.5	21.2	13.3	-12.2	758.28	15.7	0.0	921.11	0.0	0.0	4	9
9026.0	235.3	25.6	12.3	-12.3	733.13	16.6	0.0	893.66	0.0	0.0	4	9
10995.0	237.1	29.2	9.1	-13.8	682.23	18.2	0.0	841.09	0.0	0.0	4	0
11964.0	237.3	31.4	7.0	-15.4	658.28	18.4	0.0	817.74	0.0	0.0	4	0
12849.0	233.9	33.3	5.0	-16.5	636.98	19.2	0.0	797.02	0.0	0.0	4	9
13874.0	233.5	33.4	2.5	-18.1	612.97	20.0	0.0	774.00	0.0	0.0	4	0
14889.0	236.8	33.1	-.2	-18.9	589.89	22.8	0.0	752.24	0.0	0.0	4	0
15938.0	238.6	33.9	-3.2	-20.2	566.73	25.3	0.0	730.79	0.0	0.0	4	0
16891.0	237.1	35.9	-6.1	-21.4	546.23	28.4	0.0	712.04	0.0	0.0	4	9

R5C
$ 06/20/95 21:38:02
1030Z 06 14 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
017	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	19.9	1.0
017	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	19.9	6.7
017	229	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	19.9	7.8
017	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	19.9	9.5
017	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	28.6	14.3
017	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	26.9	12.7
017	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	26.9	12.7
017	1028	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1063	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1168	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1311	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1350	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1385	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1419	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1456	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	1982	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3030	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	3941	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	4855	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	5813	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	6776	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	7767	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	8697	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	10666	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	11635	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	12520	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	13545	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	14560	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	15609	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
017	16562	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:38:04
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W9193 ASC NO: 084
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 1.3 2.3 30
1001Z 14 JUN 1995 965.13
ASCENT NBR 084

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	214.0	1.0	9.6	6.5	1002.30	81.0	0.0	1234.90	0.0	0.0	1	9
493.0	326.0	3.3	9.1	7.6	996.31	91.0	0.0	1226.09	0.0	0.0	2	0
558.0	328.0	2.9	8.9	8.1	993.94	95.0	0.0	1222.61	0.0	0.0	2	9
657.0	331.0	2.3	8.7	8.0	990.32	95.1	0.0	1218.95	0.0	0.0	2	0
821.0	329.0	1.6	8.4	7.7	984.36	95.3	0.0	1212.91	0.0	0.0	2	0
985.0	331.0	1.7	8.2	7.5	978.44	95.5	0.0	1206.90	0.0	0.0	2	0
1149.0	294.0	1.7	7.9	7.2	972.55	95.7	0.0	1200.91	0.0	0.0	2	0
1357.0	287.4	1.7	7.5	6.9	965.13	96.0	0.0	1193.37	0.0	0.0	2	9
1392.0	289.3	1.7	8.7	8.1	963.89	95.7	0.0	1186.37	0.0	0.0	2	9
1497.0	300.1	1.8	8.3	6.6	960.15	89.0	0.0	1183.91	0.0	0.0	2	9
1640.0	344.0	2.9	8.6	-4.9	955.13	38.0	0.0	1179.01	0.0	0.0	2	9
1679.0	344.9	3.8	9.3	-7.4	953.75	30.0	0.0	1174.73	0.0	0.0	2	9
1714.0	345.8	4.7	11.2	-7.6	952.51	26.0	0.0	1165.39	0.0	0.0	2	9
1748.0	346.6	5.6	14.8	-5.0	951.35	25.0	0.0	1149.07	0.0	0.0	2	9
1785.0	347.5	6.5	16.7	-3.9	950.10	24.0	0.0	1139.87	0.0	0.0	2	9
2311.0	345.2	10.8	20.2	-6.4	932.48	16.0	0.0	1105.70	0.0	0.0	2	9

3359.0	296.4	10.5	19.3	-6.3	898.46	17.1	0.0	1068.56	0.0	0.0	4	9
4270.0	274.8	9.6	19.5	-6.8	869.90	16.2	0.0	1033.90	0.0	0.0	4	9
5184.0	264.1	10.5	18.3	-7.8	842.11	16.2	0.0	1005.05	0.0	0.0	4	9
6142.0	254.1	12.4	15.3	-8.0	813.73	19.2	0.0	981.26	0.0	0.0	4	9
7105.0	245.2	16.0	14.1	-10.9	785.97	16.6	0.0	952.00	0.0	0.0	4	0
8096.0	239.5	21.2	13.3	-12.2	758.28	15.7	0.0	921.11	0.0	0.0	4	9
9026.0	235.3	25.6	12.3	-12.3	733.13	16.6	0.0	893.66	0.0	0.0	4	9
10995.0	237.1	29.2	9.1	-13.8	682.23	18.2	0.0	841.09	0.0	0.0	4	0
11964.0	237.3	31.4	7.0	-15.4	658.28	18.4	0.0	817.74	0.0	0.0	4	0
12849.0	233.9	33.3	5.0	-16.5	636.98	19.2	0.0	797.02	0.0	0.0	4	9
13874.0	233.5	33.4	2.5	-18.1	612.97	20.0	0.0	774.00	0.0	0.0	4	0
14889.0	236.8	33.1	-.2	-18.9	589.89	22.8	0.0	752.24	0.0	0.0	4	0
15938.0	238.6	33.9	-3.2	-20.2	566.73	25.3	0.0	730.79	0.0	0.0	4	0
16891.0	237.1	35.9	-6.1	-21.4	546.23	28.4	0.0	712.04	0.0	0.0	4	9

R6A
3) 11/14 reconstruction of 0001 sounding

UNINTERPOLATED DATA
TEST NBR SITE: 1764 OP NO: 12345 ASC NO: 634
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1155Z 14 NOV 1994 990.
ASCENT NBR 634

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
329.	100.	2.	4.5	3.3	1009.60	92.	.0605	1266.75	320.	650.
460.	122.	7.	7.8	6.7	1004.72	93.	.0759	1241.23	324.	655.
649.	125.	7.	11.8	6.3	997.79	69.	.0727	1215.47	316.	659.
1250.	133.	6.	13.3	2.6	976.26	48.	.0558	1183.93	298.	661.
1315.	190.	10.	13.5	1.8	973.98	45.	.0527	1180.52	295.	661.
2208.	190.	10.	12.2	.4	942.96	44.	.0478	1148.34	285.	659.
3143.	186.	8.	10.0	-1.6	911.31	44.	.0417	1118.71	275.	657.
4087.	173.	6.	9.7	-8.1	880.32	28.	.0255	1082.71	257.	656.
5027.	151.	2.	8.4	-9.2	850.41	28.	.0234	1050.84	249.	655.
6077.	357.	2.	6.9	-10.8	818.05	27.	.0207	1016.38	239.	653.
7037.	332.	5.	4.8	-10.7	789.36	31.	.0211	988.09	233.	650.
8059.	324.	9.	2.6	-13.6	759.68	29.	.0168	958.75	224.	648.
9029.	322.	14.	1.4	-13.6	732.40	32.	.0169	928.31	218.	646.
10072.	319.	17.	-1.1	-15.4	703.95	33.	.0147	900.57	210.	643.

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0801Z 15 11 94 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA	
004	012	407.0	6.0	281.0	999.0	999.0	999.0	999.0	999.0	9999.0	8.8	
005	012	342.0	6.0	243.0	999.0	999.0	999.0	999.0	999.0	9999.0	7.9	
007	012	456.0	4.0	266.0	999.0	999.0	999.0	999.0	999.0	9999.0	17.3	
008	012	932.0	5.0	216.0	16.7	999.0	999.0	663.1	999.0	9999.0	18.2	
014	012	1458.0	5.0	204.0	999.0	999.0	999.0	999.0	999.0	9999.0	3.7	
015	012	584.0	5.0	262.0	16.7	999.0	999.0	663.1	999.0	9999.0	11.6	
017	012	137.0	4.0	238.0	999.0	999.0	999.0	999.0	999.0	9999.0	8.4	
018	012	340.0	4.0	100.0	999.0	999.0	999.0	999.0	999.0	9999.0	13.3	1.0
018	054	394.0	4.0	78.0	999.0	999.0	999.0	999.	9999.0	9999.0	6.5	5.4
018	102	496.0	5.0	60.0	999.0	999.0	999.0	999.	9999.0	9999.0	6.0	4.6
018	204	700.0	4.0	55.0	999.2	999.0	999.0	999.	9999.0	9999.0	5.9	5.7
018	300	796.0	4.0	40.0	999.0	999.0	999.0	999.	9999.0	9999.0	5.8	5.0

R6B$
DASS DATA FROM BLDG. DAS2, UNEDITED

25/01/94 16:30 10-MIN. AVE.

ALT M	DIR DEG	V KNOTS	VZ KNOTS	SD DEG	SV KNOTS	SZ KNOTS
GND	183	2.3	.8	19.0	.8	.6
50	--	--	.0	--	--	.6
100	--	--	.2	--	--	--
150	--	--	1.6	--	--	--
200	--	--	-.4	--	--	--
250	--	--	4.3	--	--	5.2
300	--	--	4.7	--	--	7.0
350	--	--	--	--	--	--
400	--	--	16.3	--	--	--
450	--	--	16.5	--	--	--
500	--	--	17.1	--	--	--
550	129	47.6	16.9	--	--	--
600	126	46.5	17.9	--	--	--
650	127	48.4	18.9	--	--	--
700	141	62.6	--	--	--	--
750	122	33.4	19.4	34.2	22.7	--
800	112	43.9	--	--	--	--
850	--	--	--	--	--	--
900	213	57.3	--	--	--	--
950	242	36.0	--	--	--	--
1000	299	35.0	--	--	--	--

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1630Z 25 01 94 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
300	012	397.0	4.0	76.0	8.9	999.0	999.0	654.1	999.0	9999.0	6.5
300	054	439.0	5.0	79.0	9.4	999.0	999.0	654.8	999.0	9999.0	7.6
300	102	487.0	5.0	60.0	9.8	999.0	999.0	655.2	999.0	9999.0	7.8
300	108	493.0	5.0	75.0	999.0	999.0	999.0	999.0	999.0	9999.0	12.1
300	204	589.0	5.0	38.0	10.1	999.0	999.0	655.5	999.0	9999.0	7.1
300	300	685.0	6.0	21.0	9.7	999.0	999.0	655.0	999.0	9999.0	4.7

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UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W7149 ASC NO: 009
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1556Z 25 JAN 1994 985.
ASCENT NBR 009

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	76.	3.	4.7	3.7	1003.20	93.	.0620	1257.81	319.	650.
512.	85.	3.	7.9	7.1	997.85	95.	.0781	1232.14	323.	655.
690.	21.	6.	8.7	7.6	991.36	93.	.0805	1220.46	322.	656.
1380.	322.	10.	7.7	5.2	966.48	84.	.0685	1194.70	309.	654.
2350.	316.	13.	5.2	3.9	932.37	91.	.0629	1163.11	299.	651.
3323.	311.	17.	3.0	2.0	899.05	93.	.0554	1130.84	287.	649.
4280.	308.	19.	.8	-.2	867.22	93.	.0475	1099.94	276.	646.
5290.	307.	20.	-.5	-4.4	834.62	75.	.0352	1064.30	260.	644.
5603.	306.	22.	-1.4	-5.2	824.73	75.	.0330	1055.29	256.	643.
6009.	304.	23.	-1.6	-10.1	812.05	52.	.0225	1040.43	246.	643.
6195.	304.	25.	-2.0	-8.6	806.30	60.	.0254	1034.41	247.	642.
6374.	305.	24.	-2.4	-4.9	800.79	83.	.0340	1028.32	251.	642.
6940.	306.	24.	-2.9	-14.6	783.59	40.	.0158	1009.16	235.	641.

7177.	308.	24.	-3.3	-15.4	776.47	38.	.0148	1001.54	233.	641.
7921.	309.	25.	-5.1	-12.9	754.50	54.	.0183	979.50	230.	639.
8130.	311.	29.	-5.2	-18.8	748.41	33.	.0111	972.38	224.	638.
8304.	310.	31.	-5.5	-26.6	743.39	17.	.0056	967.27	219.	638.
9110.	309.	31.	-7.3	-25.5	720.44	22.	.0062	943.71	214.	636.
9949.	309.	32.	-9.2	-29.7	697.12	17.	.0042	919.85	208.	633.
10088.	309.	31.	-9.7	-24.9	693.32	28.	.0066	916.43	209.	633.
10223.	309.	31.	-10.1	-20.8	689.64	41.	.0096	912.77	210.	632.
10423.	306.	32.	-10.0	-28.6	684.22	20.	.0047	905.55	205.	632.
11118.	999.	999.	-10.8	-33.1	665.67	14.	.0031	883.77	199.	631.

R6BB
$
DASS DATA FROM BLDG. DAS2, UNEDITED

25/01/94 16:30 10-MIN. AVE.

ALT M	DIR DEG	V KNOTS	VZ KNOTS	SD DEG	SV KNOTS	SZ KNOTS
GND	183	2.3	.8	19.0	.8	.6
50	--	--	.0	--	--	.6
100	--	--	.2	--	--	--
150	--	--	1.6	--	--	--
200	--	--	-.4	--	--	--
250	--	--	4.3	--	--	5.2
300	--	--	4.7	--	--	7.0
350	--	--	--	--	--	--
400	--	--	16.3	--	--	--
450	--	--	16.5	--	--	--
500	--	--	17.1	--	--	--
550	129	47.6	16.9	--	--	--
600	126	46.5	17.9	--	--	--
650	127	48.4	18.9	--	--	--
700	141	62.6	--	--	--	--
750	122	33.4	19.4	34.2	22.7	--
800	112	43.9	--	--	--	--
850	--	--	--	--	--	--
900	213	57.3	--	--	--	--
950	242	36.0	--	--	--	--
1000	299	35.0	--	--	--	--

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1630Z 25 01 94 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
300	012	397.0	4.0	76.0	8.9	999.0	999.0	654.1	999.0	9999.0	6.5
300	054	439.0	5.0	79.0	9.4	999.0	999.0	654.8	999.0	9999.0	7.6
300	102	487.0	5.0	60.0	9.8	999.0	999.0	655.2	999.0	9999.0	7.8
300	108	493.0	5.0	75.0	999.0	999.0	999.0	999.0	999.0	9999.0	12.1
300	204	589.0	5.0	38.0	10.1	999.0	999.0	655.5	999.0	9999.0	7.1
300	300	685.0	6.0	21.0	9.7	999.0	999.0	655.0	999.0	9999.0	4.7

$
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W7149 ASC NO: 009
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1556Z 25 JAN 1994 690.
ASCENT NBR 009

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	76.	3.	4.7	3.7	1003.20	93.	.0620	1257.81	319.	650.
512.	85.	3.	7.9	7.1	997.85	95.	.0781	1232.14	323.	655.
690.	21.	6.	8.7	7.6	991.36	93.	.0805	1220.46	322.	656.
1380.	322.	10.	7.7	5.2	966.48	84.	.0685	1194.70	309.	654.
2350.	316.	13.	5.2	3.9	932.37	91.	.0629	1163.11	299.	651.
3323.	311.	17.	3.0	2.0	899.05	93.	.0554	1130.84	287.	649.
4280.	308.	19.	.8	-.2	867.22	93.	.0475	1099.94	276.	646.
5290.	307.	20.	-.5	-4.4	834.62	75.	.0352	1064.30	260.	644.
5603.	306.	22.	-1.4	-5.2	824.73	75.	.0330	1055.29	256.	643.
6009.	304.	23.	-1.6	-10.1	812.05	52.	.0225	1040.43	246.	643.
6195.	304.	25.	-2.0	-8.6	806.30	60.	.0254	1034.41	247.	642.
6374.	305.	24.	-2.4	-4.9	800.79	83.	.0340	1028.32	251.	642.

6940.	306.	24.	-2.9	-14.6	783.59	40.	.0158	1009.16	235.	641.
7177.	308.	24.	-3.3	-15.4	776.47	38.	.0148	1001.54	233.	641.
7921.	309.	25.	-5.1	-12.9	754.50	54.	.0183	979.50	230.	639.
8130.	311.	29.	-5.2	-18.8	748.41	33.	.0111	972.38	224.	638.
8304.	310.	31.	-5.5	-26.6	743.39	17.	.0056	967.27	219.	638.
9110.	309.	31.	-7.3	-25.5	720.44	22.	.0062	943.71	214.	636.
9949.	309.	32.	-9.2	-29.7	697.12	17.	.0042	919.85	208.	633.
10088.	309.	31.	-9.7	-24.9	693.32	28.	.0066	916.43	209.	633.
10223.	309.	31.	-10.1	-20.8	689.64	41.	.0096	912.77	210.	632.
10423.	306.	32.	-10.0	-28.6	684.22	20.	.0047	905.55	205.	632.
11118.	999.	999.	-10.8	-33.1	665.67	14.	.0031	883.77	199.	631.

R6C
1) 3/13 T-36 HR RUN FOR 3/15 00:01 use SLC 2 for MM

$ 03/13/95 17:00:19
0800Z 03 12 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
060	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.0	1.0
060	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.8	2.3
060	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.0	3.4
060	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.0	4.9
060	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.0	2.5
060	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.0	3.4
060	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.0	3.0
060	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.0	2.5
060	974	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1148	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1908	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	2862	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	2999	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	3857	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	4786	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	5680	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	6557	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	7506	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	8428	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	9422	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	10442	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 03/13/95 17:00:24
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 141
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 4.0 4.3 21
1115Z 12 MAR 1995 983.57 3 3048
ASCENT NBR 141

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
368.0	100.0	2.0	8.0	7.0	1001.40	93.4	0.0	1229.45	0.0	0.0	1	9
422.0	100.0	6.0	8.1	7.1	999.43	93.1	0.0	1226.94	0.0	0.0	1	0
470.0	100.0	8.0	8.3	7.2	997.68	92.8	0.0	1224.72	0.0	0.0	1	0
532.0	100.0	3.7	8.5	7.3	995.42	92.4	0.0	1221.86	0.0	0.0	2	0
696.0	110.0	4.3	8.9	7.6	989.47	91.4	0.0	1214.31	0.0	0.0	2	0
860.0	115.0	4.6	9.4	7.9	983.57	90.4	0.0	1206.82	0.0	0.0	2	0
1024.0	117.0	4.9	9.8	8.1	977.69	89.4	0.0	1199.37	0.0	0.0	2	0
1188.0	122.0	5.0	10.3	8.4	971.85	88.4	0.0	1191.96	0.0	0.0	2	0
1342.0	126.7	5.2	10.7	8.7	966.40	87.5	0.0	1185.05	0.0	0.0	2	9
1516.0	134.0	5.3	10.7	8.4	960.25	85.9	0.0	1178.50	0.0	0.0	2	0
2276.0	135.9	7.7	10.5	7.0	933.85	79.0	0.0	1150.31	0.0	0.0	4	9
3230.0	144.2	11.1	7.4	2.6	901.57	71.8	0.0	1118.91	0.0	0.0	4	9
3367.0	157.9	12.4	6.0	2.5	868.83	78.5	0.0	1087.08	0.0	0.0	4	9
4225.0	157.9	12.4	8.0	2.5	868.83	68.5	0.0	1087.08	0.0	0.0	4	9
5154.0	182.7	12.7	5.0	0.2	839.15	71.5	0.0	1054.90	0.0	0.0	4	9
6048.0	205.4	14.4	4.0	-1.1	811.40	69.8	0.0	1025.39	0.0	0.0	4	0
6925.0	215.5	15.8	2.0	-2.2	784.95	74.2	0.0	997.17	0.0	0.0	4	9
7874.0	233.8	16.7	1.3	-3.3	757.16	72.0	0.0	967.99	0.0	0.0	4	9
8796.0	237.1	17.2	-1.3	-4.9	730.92	77.1	0.0	941.54	0.0	0.0	4	9
9790.0	240.4	18.2	-1.4	-7.1	703.47	66.0	0.0	910.15	0.0	0.0	4	9
10810.0	245.6	20.7	-2.5	-11.5	676.28	51.2	0.0	879.01	0.0	0.0	4	0

R7A
$ 06/20/95 21:38:57
1110Z 05 19 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
300	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.2	1.0
300	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.9	3.0
300	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.6	4.9
300	844	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.6	10.4
300	1289	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1476	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1624	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1721	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1864	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	2446	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	3508	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	4408	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	5383	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	5783	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	5876	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	7187	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	9939	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	10876	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11828	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	12754	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	13624	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	14480	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	15471	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	16240	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:39:02
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 277
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 5.5 6.8 24
1115Z 19 MAY 1995 954.98
ASCENT NBR 277

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
368.0	18.0	5.0	10.9	9.2	1001.20	89.0	0.0	1227.90	0.0	0.0	1	9
422.0	29.0	6.0	10.8	9.1	999.23	89.4	0.0	1225.73	0.0	0.0	1	0
470.0	19.0	7.0	10.6	9.1	997.47	89.7	0.0	1223.81	0.0	0.0	1	0
1212.0	25.5	6.5	8.8	8.0	970.77	94.9	0.0	1194.46	0.0	0.0	1	9
1657.0	21.6	6.1	7.6	6.9	954.98	95.0	0.0	1180.37	0.0	0.0	1	9
1844.0	20.0	6.0	10.1	9.3	948.49	95.0	0.0	1161.10	0.0	0.0	2	0
1992.0	29.9	9.0	10.1	9.3	943.36	95.0	0.0	1154.79	0.0	0.0	2	9
2089.0	34.0	9.7	12.4	11.6	940.06	94.8	0.0	1140.58	0.0	0.0	2	9
2232.0	43.6	10.1	17.8	13.7	935.20	77.0	0.0	1112.67	0.0	0.0	2	9
2814.0	111.0	10.1	19.1	8.7	916.09	51.0	0.0	1086.94	0.0	0.0	2	9
3876.0	136.1	6.0	17.4	5.3	882.18	44.7	0.0	1053.73	0.0	0.0	4	0
4776.0	124.4	5.2	15.6	0.8	854.27	36.6	0.0	1027.71	0.0	0.0	4	0
5751.0	129.8	6.0	13.5	-3.1	824.78	31.4	0.0	1000.16	0.0	0.0	4	9
6151.0	146.2	8.3	13.0	-2.1	812.91	35.0	0.0	987.28	0.0	0.0	4	9
6244.0	167.4	11.8	13.5	-11.0	810.19	17.0	0.0	983.46	0.0	0.0	4	9
7555.0	170.3	12.1	10.7	-15.0	772.43	14.8	0.0	947.14	0.0	0.0	4	0
10307.0	173.8	5.1	5.3	-20.7	697.78	13.2	0.0	872.46	0.0	0.0	4	0
11244.0	193.3	3.5	4.1	-21.9	673.78	12.9	0.0	846.14	0.0	0.0	4	0
12196.0	210.9	3.9	2.1	-23.6	650.10	12.8	0.0	822.38	0.0	0.0	4	9
13122.0	203.1	5.3	0.5	-24.6	627.73	13.1	0.0	798.75	0.0	0.0	4	0
13992.0	203.3	6.6	-1.5	-26.1	607.28	13.2	0.0	778.46	0.0	0.0	4	0
14848.0	213.7	7.5	-3.3	-27.6	587.68	13.1	0.0	758.40	0.0	0.0	4	9

15839.0	227.4	7.8	-4.5	-28.7	565.65	13.0	0.0	733.24	0.0	0.0	4	0
16608.0	244.1	8.3	-5.7	-29.6	549.06	13.0	0.0	714.95	0.0	0.0	4	9

R7B
UNINTERPOLATED DATA

TEST NBR SITE: 900   OP NO: W8047   ASC NO: 198
900
BLDG 900, VANDENBERG AFB, CALIF.
FORECAST MSS/SYN
0207Z   8 NOV 1991   980.
ASCENT NBR   0198

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368	50	15	15.0	14.1	1000.80	999				
762	51	12	18.7	14.4	986.88	76				
1223	60	10	18.5	12.0	970.90	66				
1288	139	10	21.5	11.8	968.69	54				
1446	146	9	22.1	9.5	963.31	45				
2068	146	9	24.3	2.5	942.63	24				
2542	145	8	24.1	2.3	927.20	24				
3525	144	7	22.1	1.8	895.87	26				
4529	146	8	21.2	1.8	864.82	28				
5678	150	8	19.1	-0.1	830.44	28				
6807	154	9	16.1	-1.5	797.68	30				
7930	161	10	12.6	-3.2	766.07	33				
9098	166	15	10.1	-4.6	734.17	35				
10196	165	16	7.8	-5.7	705.16	38				

UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8047 ASC NO: 198
900
BLDG 900, VANDENBERG AFB, CALIF.
FORECAST MSS/SYN
0207Z 8 NOV 1991 970.
ASCENT NBR 0198

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368	50	7	15.0	14.1	1000.80	999				
762	51	7	18.7	14.4	986.88	76				
1223	60	8	18.5	12.0	970.90	66				
1288	139	9	21.5	11.8	968.69	54				
1446	146	9	22.1	9.5	963.31	45				
2068	146	9	24.3	2.5	942.63	24				
2542	145	8	24.1	2.3	927.20	24				
3525	144	7	22.1	1.8	895.87	26				
4529	146	8	21.2	1.8	864.82	28				
5678	150	8	19.1	-0.1	830.44	28				
6807	154	9	16.1	-1.5	797.68	30				
7930	161	10	12.6	-3.2	766.07	33				
9098	166	15	10.1	-4.6	734.17	35				
10196	165	16	7.8	-5.7	705.16	38				

R7C
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8047 ASC NO: 198
900
BLDG 900, VANDENBERG AFB, CALIF.
FORECAST MSS/SYN
0207Z 8 NOV 1991 970.
ASCENT NBR 0198

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368	50	7	15.0	14.1	1000.80	999				
762	51	7	18.7	14.4	986.88	76				
1223	60	8	18.5	12.0	970.90	66				
1288	139	9	21.5	11.8	968.69	54				
1446	146	9	22.1	9.5	963.31	45				
2068	146	9	24.3	2.5	942.63	24				
2542	145	8	24.1	2.3	927.20	24				
3525	144	7	22.1	1.8	895.87	26				
4529	146	8	21.2	1.8	864.82	28				
5678	150	8	19.1	-0.1	830.44	28				
6807	154	9	16.1	-1.5	797.68	30				
7930	161	10	12.6	-3.2	766.07	33				
9098	166	15	10.1	-4.6	734.17	35				
10196	165	16	7.8	-5.7	705.16	38				

R7D
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8047 ASC NO: 200
900
BLDG 900, VANDENBERG AFB, CALIF.
FORECAST MSS/SYN
0600Z 8 NOV 1991 985.
ASCENT NBR 0200

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368	55	6	13.6	12.3	1002.80	92				
1040	65	6	14.1	12.1	978.82	88				
1364	75	8	16.0	10.6	967.50	70				
1534	100	10	18.4	8.7	961.77	53				
1708	140	12	18.4	7.2	955.75	48				
1774	140	16	20.1	5.7	953.54	39				
2297	150	17	21.4	4.9	936.13	34				
2412	150	17	21.2	4.6	932.33	34				
3525	156	18	20.2	1.7	896.48	29				
4581	152	20	19.0	2.4	863.61	33				
5680	157	22	16.8	-0.1	830.50	32				
6747	152	23	15.0	-0.1	799.35	36				
7780	149	24	12.8	-2.1	770.09	35				
8796	152	22	10.4	-3.9	742.16	36				
9917	156	20	8.3	-6.1	712.29	36				
10979	158	19	6.3	-8.4	684.87	34				

R7E
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W8047 ASC NO: 201
900
BLDG 900, VANDENBERG AFB, CALIF.
FORECAST MSS/SYN
0637Z 8 NOV 1991 983.
ASCENT NBR 0201

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368	60	3	13.2	12.3	1003.10	94				
535	82	10	12.9	12.0	997.07	94				
936	85	10	13.3	12.4	982.74	94				
1023	98	9	15.9	13.9	979.66	88				
1073	135	7	17.1	12.8	977.92	76				
1120	173	10	19.0	8.6	976.30	51				
1378	179	12	21.4	-2.5	967.43	20				
1669	184	15	20.2	-4.0	957.57	19				
2936	179	16	20.0	-3.5	915.62	20				
4208	170	18	18.9	-4.2	875.26	21				
5422	164	21	16.7	-3.8	838.22	24				
6564	160	23	14.8	-5.1	804.56	25				
7631	159	23	12.6	-6.5	774.13	26				
8735	159	23	9.9	-8.5	743.59	26				
9885	161	22	7.8	-10.0	712.84	27				
11074	164	21	5.4	-12.4	682.09	26				

R8A
$ 06/20/95 21:42:46
1110Z 06 16 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
300	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.8	1.0
300	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	20.2	9.6
300	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.2	17.2
300	204	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.6	23.1
300	300	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.0	13.8
300	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.3	9.3
300	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.7	6.9
300	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.6	6.9
300	1027	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.8	4.8
300	1148	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.6	3.3
300	1312	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.4	3.7
300	1476	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.7	9.3
300	1640	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.6	5.6
300	1960	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.4	3.9
300	2898	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.7	2.7
300	3938	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.0	3.0
300	5024	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.8	2.7
300	6147	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.7	2.5
300	7215	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.6	2.4
300	7934	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.4	2.2
300	8618	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.3	1.8
300	8977	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.2	1.6
300	10382	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11405	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	12380	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	13505	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	14653	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	15833	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:42:49
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 332
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 3.5 6.0 28
1115Z 16 JUN 1995 683.03
ASCENT NBR 332

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
368.0	223.0	3.0	11.6	10.0	996.10	90.0	0.0	1218.65	0.0	0.0	1	9
422.0	298.0	4.0	11.5	9.9	994.14	90.4	0.0	1216.43	0.0	0.0	1	0
470.0	235.0	5.0	11.4	9.9	992.40	90.7	0.0	1214.47	0.0	0.0	1	0
572.0	249.0	7.0	11.2	9.8	988.71	91.3	0.0	1210.30	0.0	0.0	1	0
668.0	248.0	8.0	11.0	9.7	985.26	92.0	0.0	1206.40	0.0	0.0	1	0
860.0	265.0	8.4	10.6	9.5	978.38	93.2	0.0	1198.62	0.0	0.0	2	0
1024.0	267.0	9.7	10.3	9.4	972.54	94.3	0.0	1192.02	0.0	0.0	2	0
1188.0	234.0	6.4	9.9	9.2	966.74	95.3	0.0	1185.46	0.0	0.0	2	0
1395.0	290.8	12.7	9.5	9.0	959.47	96.7	0.0	1177.22	0.0	0.0	2	9
1516.0	293.0	13.6	9.2	8.7	955.21	96.6	0.0	1173.38	0.0	0.0	2	0
1680.0	294.0	15.0	8.8	8.3	949.47	96.6	0.0	1168.20	0.0	0.0	2	0
1844.0	296.0	13.2	8.3	7.8	943.77	96.5	0.0	1163.04	0.0	0.0	2	0
2008.0	290.0	13.8	7.9	7.4	938.10	96.4	0.0	1157.90	0.0	0.0	2	0
2328.0	289.0	14.8	7.1	6.6	927.13	96.3	0.0	1147.94	0.0	0.0	2	9
3266.0	288.7	20.9	6.0	5.4	895.47	95.7	0.0	1113.31	0.0	0.0	2	9
4306.0	294.7	18.3	3.6	3.0	861.45	95.9	0.0	1080.80	0.0	0.0	4	9
5392.0	297.9	20.4	1.5	0.3	827.00	91.5	0.0	1046.02	0.0	0.0	4	9
6515.0	298.6	21.8	-.8	-4.5	792.54	75.7	0.0	1011.68	0.0	0.0	4	9

7583.0	299.1	23.1	-2.7	-11.9	760.85	49.1	0.0	978.89	0.0	0.0	4	9
8302.0	299.9	25.1	-3.6	-18.6	740.10	30.0	0.0	955.85	0.0	0.0	4	9
8986.0	303.1	28.4	-5.2	-13.3	720.82	53.0	0.0	936.10	0.0	0.0	4	9
9345.0	305.7	30.2	-6.1	-8.5	710.84	83.0	0.0	925.73	0.0	0.0	4	9
10750.0	308.7	32.7	-8.6	-10.5	672.93	86.1	0.0	884.79	0.0	0.0	4	0
11773.0	310.8	33.4	-10.0	-10.9	646.41	93.1	0.0	854.44	0.0	0.0	4	9
12748.0	310.1	34.3	-11.7	-12.6	621.98	93.0	0.0	827.61	0.0	0.0	4	9
13873.0	307.8	36.0	-14.2	-16.6	594.69	82.1	0.0	799.22	0.0	0.0	4	0
15021.0	309.4	39.9	-16.5	-19.7	567.85	76.2	0.0	770.15	0.0	0.0	4	0
16201.0	314.1	44.5	-19.0	-22.9	541.29	71.1	0.0	741.48	0.0	0.0	4	9

R8B
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1120Z 02 08 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
300	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.8	1.0
300	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.2	2.2
300	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.9	3.2
300	204	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.4	5.3
300	300	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.3	6.8
300	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.1	5.8
300	558	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.9	4.6
300	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.6	3.1
300	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.0	5.7
300	900	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.8	4.7
300	984	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.1	4.4
300	1792	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.8	3.9
300	2722	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.7	3.8
300	3612	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.6	3.7
300	4531	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.9	4.2
300	5460	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.7	3.7
300	6342	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.3	1.4
300	6503	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	6563	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	6911	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	7237	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	9232	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	10114	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11014	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11946	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	12794	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	13686	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	14573	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	15396	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

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UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 077
900
"BLDG 900, VANDENBERG AFB, CALIF."
RAWINSONDE MSS/SYN 7.0 9.1 29
1115Z 8 FEB 1995 786.39
ASCENT NBR 077

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
368.0	178.0	6.0	10.5	8.6	1001.70	88.0	0.0	1230.25	0.0	0.0	1	9
422.0	187.0	8.0	10.6	8.8	999.73	88.4	0.0	1226.75	0.0	0.0	1	0
470.0	183.0	8.0	10.7	8.9	997.98	88.7	0.0	1223.65	0.0	0.0	1	0
572.0	194.0	7.0	10.9	9.3	994.28	89.5	0.0	1217.09	0.0	0.0	1	0
668.0	180.0	11.0	11.1	9.6	990.81	90.2	0.0	1210.95	0.0	0.0	1	0
860.0	203.0	9.5	11.6	10.2	983.90	91.5	0.0	1198.75	0.0	0.0	2	0
926.0	197.4	10.1	11.7	10.4	981.54	92.0	0.0	1194.59	0.0	0.0	2	9
1024.0	189.0	10.9	11.3	10.0	978.05	91.9	0.0	1192.28	0.0	0.0	2	0
1188.0	217.0	3.9	10.6	9.3	972.23	91.6	0.0	1188.44	0.0	0.0	2	0
1268.0	212.1	8.1	10.2	8.9	969.40	91.5	0.0	1186.57	0.0	0.0	2	9
1352.0	207.0	12.6	10.0	8.7	966.42	91.7	0.0	1183.84	0.0	0.0	2	0
2160.0	209.0	14.1	8.0	7.0	938.21	93.2	0.0	1157.86	0.0	0.0	4	9
3090.0	214.2	14.7	6.2	5.1	906.52	92.6	0.0	1126.38	0.0	0.0	4	9
3980.0	218.6	14.9	4.7	3.6	877.03	92.5	0.0	1095.90	0.0	0.0	4	9
4899.0	217.6	13.3	3.0	1.9	847.39	92.1	0.0	1065.69	0.0	0.0	4	9
5828.0	215.0	12.5	0.4	-2.4	818.23	81.5	0.0	1039.58	0.0	0.0	4	9
6710.0	215.2	12.6	-1.4	-7.5	791.23	62.9	0.0	1012.66	0.0	0.0	4	9

6871.0	224.1	13.1	-1.5	-7.8	786.39	62.0	0.0	1006.87	0.0	0.0	4	9
6931.0	246.5	15.0	0.3	-5.9	784.59	63.0	0.0	997.68	0.0	0.0	4	9
7279.0	255.2	14.7	0.5	-16.3	774.31	27.0	0.0	984.94	0.0	0.0	4	9
7605.0	277.1	14.6	1.0	-19.6	764.78	19.7	0.0	971.23	0.0	0.0	4	9
9600.0	303.7	22.2	-1.1	-24.8	708.95	14.4	0.0	907.46	0.0	0.0	4	9
10482.0	307.1	29.0	-2.8	-26.2	685.42	14.4	0.0	882.90	0.0	0.0	4	0
11382.0	306.3	34.5	-4.7	-26.0	662.06	16.9	0.0	858.83	0.0	0.0	4	0
12314.0	303.1	37.3	-6.9	-24.8	638.53	22.3	0.0	835.10	0.0	0.0	4	0
13162.0	298.3	39.6	-8.6	-26.5	617.71	21.8	0.0	813.09	0.0	0.0	4	0
14054.0	295.7	43.6	-10.1	-30.9	596.39	16.3	0.0	789.62	0.0	0.0	4	0
14941.0	296.6	47.8	-12.0	-33.1	575.81	15.2	0.0	767.96	0.0	0.0	4	0
15764.0	298.3	50.5	-13.9	-35.7	557.22	13.7	0.0	748.65	0.0	0.0	4	0

R8BB
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1120Z 02 08 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
300	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.8	1.0
300	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.2	2.2
300	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.9	3.2
300	204	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.4	5.3
300	300	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.3	6.8
300	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.1	5.8
300	558	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.9	4.6
300	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.6	3.1
300	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.0	5.7
300	900	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.8	4.7
300	984	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.1	4.4
300	1792	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.8	3.9
300	2722	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.7	3.8
300	3612	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.6	3.7
300	4531	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.9	4.2
300	5460	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	2.7	3.7
300	6342	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.3	1.4
300	6503	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	6563	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	6911	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	7237	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	9232	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	10114	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11014	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11946	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	12794	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	13686	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	14573	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	15396	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/21/95 17:40:53
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 077
900
"BLDG 900, VANDENBERG AFB, CALIF."
RAWINSONDE MSS/SYN 7.0 9.1 29
1115Z 8 FEB 1995 981.54
ASCENT NBR 077

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
368.0	178.0	6.0	10.5	8.6	1001.70	88.0	0.0	1230.25	0.0	0.0	1	9
422.0	187.0	8.0	10.6	8.8	999.73	88.4	0.0	1226.75	0.0	0.0	1	0
470.0	183.0	8.0	10.7	8.9	997.98	88.7	0.0	1223.65	0.0	0.0	1	0
572.0	194.0	7.0	10.9	9.3	994.28	89.5	0.0	1217.09	0.0	0.0	1	0
668.0	180.0	11.0	11.1	9.6	990.81	90.2	0.0	1210.95	0.0	0.0	1	0
860.0	203.0	9.5	11.6	10.2	983.90	91.5	0.0	1198.75	0.0	0.0	2	0
926.0	197.4	10.1	11.7	10.4	981.54	92.0	0.0	1194.59	0.0	0.0	2	9
1024.0	189.0	10.9	11.3	10.0	978.05	91.9	0.0	1192.28	0.0	0.0	2	0
1188.0	217.0	3.9	10.6	9.3	972.23	91.6	0.0	1188.44	0.0	0.0	2	0
1268.0	212.1	8.1	10.2	8.9	969.40	91.5	0.0	1186.57	0.0	0.0	2	9
1352.0	207.0	12.6	10.0	8.7	966.42	91.7	0.0	1183.84	0.0	0.0	2	0
2160.0	209.0	14.1	8.0	7.0	938.21	93.2	0.0	1157.86	0.0	0.0	4	9
3090.0	214.2	14.7	6.2	5.1	906.52	92.6	0.0	1126.38	0.0	0.0	4	9
3980.0	218.6	14.9	4.7	3.6	877.03	92.5	0.0	1095.90	0.0	0.0	4	9
4899.0	217.6	13.3	3.0	1.9	847.39	92.1	0.0	1065.69	0.0	0.0	4	9
5828.0	215.0	12.5	0.4	-2.4	818.23	81.5	0.0	1039.58	0.0	0.0	4	9
6710.0	215.2	12.6	-1.4	-7.5	791.23	62.9	0.0	1012.66	0.0	0.0	4	9

6871.0	224.1	13.1	-1.5	-7.8	786.39	62.0	0.0	1006.87	0.0	0.0	4	9
6931.0	246.5	15.0	0.3	-5.9	784.59	63.0	0.0	997.68	0.0	0.0	4	9
7279.0	255.2	14.7	0.5	-16.3	774.31	27.0	0.0	984.94	0.0	0.0	4	9
7605.0	277.1	14.6	1.0	-19.6	764.78	19.7	0.0	971.23	0.0	0.0	4	9
9600.0	303.7	22.2	-1.1	-24.8	708.95	14.4	0.0	907.46	0.0	0.0	4	9
10482.0	307.1	29.0	-2.8	-26.2	685.42	14.4	0.0	882.90	0.0	0.0	4	0
11382.0	306.3	34.5	-4.7	-26.0	662.06	16.9	0.0	858.83	0.0	0.0	4	0
12314.0	303.1	37.3	-6.9	-24.8	638.53	22.3	0.0	835.10	0.0	0.0	4	0
13162.0	298.3	39.6	-8.6	-26.5	617.71	21.8	0.0	813.09	0.0	0.0	4	0
14054.0	295.7	43.6	-10.1	-30.9	596.39	16.3	0.0	789.62	0.0	0.0	4	0
14941.0	296.6	47.8	-12.0	-33.1	575.81	15.2	0.0	767.96	0.0	0.0	4	0
15764.0	298.3	50.5	-13.9	-35.7	557.22	13.7	0.0	748.65	0.0	0.0	4	0

R8C
$ 06/21/95 17:42:54
2310Z 03 09 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
060	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.0	1.0
060	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.0	1.8
060	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.0	3.5
060	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.0	3.8
060	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.5	2.7
060	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.2	2.9
060	816	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.4	2.5
060	984	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.6	2.6
060	1658	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.2	1.9
060	2150	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	3566	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	4677	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	5709	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	6700	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	8569	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	9648	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	10656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	10888	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	11654	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	12636	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	13564	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	14299	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	15132	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/21/95 17:42:56
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: 12345 ASC NO: 137
1764
"BLDG 1764, VANDENBERG AFB, CALIF."
RAWINSONDE MSS/SYN 26.5 26.4 23
1115Z 10 MAR 1995 937.06
ASCENT NBR 137

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	136.0	24.0	13.5	12.6	995.30	94.0	0.0	1209.60	0.0	0.0	1	9
383.0	137.0	29.0	13.3	12.4	993.35	93.9	0.0	1207.52	0.0	0.0	1	0
493.0	145.0	25.5	13.0	12.1	989.40	93.8	0.0	1203.31	0.0	0.0	2	0
657.0	141.0	26.4	12.5	11.6	983.54	93.6	0.0	1197.05	0.0	0.0	2	0
821.0	146.0	28.8	12.1	11.0	977.72	93.4	0.0	1190.82	0.0	0.0	2	0
985.0	152.0	30.5	11.6	10.5	971.93	93.2	0.0	1184.62	0.0	0.0	2	0
1145.0	154.0	35.8	11.1	10.0	966.31	93.0	0.0	1178.61	0.0	0.0	2	9
1313.0	157.0	34.8	10.8	9.7	960.40	93.0	0.0	1172.81	0.0	0.0	2	0
1987.0	146.6	44.0	9.5	8.4	937.06	93.1	0.0	1149.81	0.0	0.0	4	9
2479.0	160.1	46.2	12.0	10.7	920.42	92.0	0.0	1118.54	0.0	0.0	4	9
3895.0	184.1	48.1	10.7	8.2	874.19	84.5	0.0	1067.87	0.0	0.0	4	9
5006.0	195.5	46.4	8.6	7.0	839.38	89.5	0.0	1033.19	0.0	0.0	4	0
6038.0	206.6	43.2	6.8	5.8	808.07	93.0	0.0	1001.25	0.0	0.0	4	9
7029.0	217.1	41.1	5.5	4.6	778.95	94.0	0.0	969.85	0.0	0.0	4	0
8898.0	228.2	46.6	2.6	1.6	726.41	93.1	0.0	914.46	0.0	0.0	4	9
9977.0	228.6	49.5	0.4	-.6	697.44	92.7	0.0	885.41	0.0	0.0	4	0
10985.0	228.1	51.3	-1.3	-2.4	671.26	92.3	0.0	857.74	0.0	0.0	4	9
11217.0	225.6	54.9	-.2	-1.2	665.36	93.0	0.0	846.52	0.0	0.0	4	9
11983.0	226.8	56.3	-2.5	-3.6	646.23	92.0	0.0	829.54	0.0	0.0	4	0
12965.0	228.9	58.8	-4.2	-5.4	622.33	91.6	0.0	804.11	0.0	0.0	4	0
13893.0	229.8	61.8	-6.3	-7.5	600.38	91.0	0.0	782.09	0.0	0.0	4	9
14628.0	230.1	64.6	-8.1	-9.4	583.45	90.1	0.0	765.39	0.0	0.0	4	0
15461.0	230.4	66.6	-9.9	-12.4	564.68	82.0	0.0	746.10	0.0	0.0	4	9

R9A
$ 06/20/95 21:34:00
2310Z 06 15 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
300	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	11.2	1.0
300	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	12.2	4.6
300	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	9.6	7.8
300	187	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.7	11.9
300	300	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	9.9	11.9
300	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	9.2	12.0
300	694	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.6	8.0
300	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	6.9	6.1
300	957	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.3	4.4
300	1148	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.7	4.7
300	1881	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.2	5.2
300	2931	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.1	5.1
300	4013	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.9	4.8
300	4284	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.1	4.1
300	5002	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.2	4.2
300	5506	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.4	4.4
300	5894	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.5	4.5
300	6492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.5	4.5
300	6921	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.8	4.7
300	7995	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.7	4.7
300	10015	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11088	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	12227	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	13269	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	14408	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	15424	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	16343	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	17250	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:34:03
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: 12345 ASC NO: 331
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 6.5 11.3 28
2315Z 15 JUN 1995 687.33
ASCENT NBR 331

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	309.0	6.0	15.6	12.0	999.10	79.0	0.0	1205.38	0.0	0.0	1	9
383.0	337.0	7.0	14.7	11.1	997.16	78.7	0.0	1205.17	0.0	0.0	1	0
431.0	312.0	7.0	14.0	10.3	995.44	78.5	0.0	1204.98	0.0	0.0	1	0
516.0	318.2	7.8	12.6	8.9	992.39	78.0	0.0	1204.64	0.0	0.0	1	9
629.0	310.0	8.0	12.3	9.1	988.33	81.3	0.0	1201.00	0.0	0.0	1	0
821.0	308.0	12.1	11.7	9.6	981.47	87.0	0.0	1194.85	0.0	0.0	2	0
1023.0	313.7	14.7	11.1	10.0	974.30	93.0	0.0	1188.40	0.0	0.0	2	9
1149.0	316.0	16.3	10.8	8.8	969.83	87.9	0.0	1184.74	0.0	0.0	2	0
1286.0	314.3	21.1	10.4	7.5	964.99	82.4	0.0	1180.78	0.0	0.0	2	9
1477.0	310.0	23.7	10.0	6.6	958.25	80.0	0.0	1174.57	0.0	0.0	2	0
2210.0	314.0	21.4	8.3	3.3	932.84	70.7	0.0	1151.04	0.0	0.0	4	9
3260.0	307.7	21.8	6.4	2.0	897.35	73.2	0.0	1114.97	0.0	0.0	4	9
4342.0	301.0	23.0	4.4	-1.6	861.93	65.1	0.0	1079.30	0.0	0.0	4	9
4613.0	281.9	27.0	4.8	-3.0	853.27	57.0	0.0	1067.15	0.0	0.0	4	9
5331.0	275.7	26.6	3.4	-1.0	830.68	72.8	0.0	1043.73	0.0	0.0	4	9
5835.0	268.3	25.2	2.9	2.3	815.11	96.0	0.0	1025.23	0.0	0.0	4	9
6223.0	262.7	24.8	2.4	0.6	803.31	88.1	0.0	1012.57	0.0	0.0	4	9
6821.0	260.7	24.6	1.4	-1.2	785.44	83.0	0.0	993.95	0.0	0.0	4	9

7250.0	262.9	23.5	1.7	-14.5	772.82	28.7	0.0	978.62	0.0	0.0	4	9
8324.0	268.6	23.7	0.8	-18.0	742.03	22.9	0.0	942.92	0.0	0.0	4	9
10344.0	269.3	34.9	-3.1	-22.2	686.94	21.1	0.0	885.69	0.0	0.0	4	9
11417.0	262.8	39.4	-3.5	-20.4	659.17	25.4	0.0	851.04	0.0	0.0	4	9
12556.0	258.8	40.7	-5.5	-23.0	630.78	23.6	0.0	820.57	0.0	0.0	4	0
13598.0	260.7	40.7	-8.2	-25.4	605.69	23.3	0.0	796.03	0.0	0.0	4	0
14737.0	267.9	42.3	-10.5	-27.8	579.15	22.5	0.0	767.88	0.0	0.0	4	9
15753.0	274.4	45.7	-12.3	-28.8	556.27	23.7	0.0	742.65	0.0	0.0	4	0
16672.0	277.9	48.4	-14.6	-30.2	536.23	24.9	0.0	722.29	0.0	0.0	4	0
17579.0	279.1	50.5	-17.2	-32.5	516.96	24.8	0.0	703.44	0.0	0.0	4	9

R9B
$ 06/20/95 21:40:46
0100Z 06 20 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
060	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.8	1.0
060	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.4	1.8
060	145	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.4	3.0
060	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.4	2.8
060	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.6	3.0
060	565	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	656	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	815	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	940	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1116	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1312	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1476	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1640	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1939	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	2266	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	3395	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	4247	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	5095	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	6053	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	6845	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	7655	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	8557	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	10319	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	11199	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	11996	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	12764	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	13570	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	14448	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	15314	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	16120	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:40:49
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: 12345 ASC NO: 339
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 20.0 24.3 30
0054Z 20 JUN 1995 982.27
ASCENT NBR 339

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	308.0	18.0	14.3	8.5	1002.60	68.0	0.0	1215.08	0.0	0.0	1	9
383.0	311.0	22.0	13.6	8.5	1000.65	71.0	0.0	1213.68	0.0	0.0	1	0
474.0	301.9	23.1	12.5	8.4	997.37	76.0	0.0	1211.31	0.0	0.0	1	9
657.0	302.0	24.3	12.0	8.9	990.76	81.7	0.0	1205.27	0.0	0.0	2	0
821.0	309.0	26.2	11.5	9.4	984.88	86.7	0.0	1199.89	0.0	0.0	2	0
894.0	310.8	25.5	11.3	9.6	982.27	89.0	0.0	1197.50	0.0	0.0	2	9
985.0	313.0	24.7	11.6	9.3	979.03	85.7	0.0	1192.42	0.0	0.0	2	0
1144.0	316.0	23.7	12.1	8.8	973.39	80.0	0.0	1183.58	0.0	0.0	2	9
1269.0	314.5	24.9	15.8	8.1	969.00	60.0	0.0	1163.38	0.0	0.0	2	9
1445.0	310.0	24.0	16.6	5.3	962.91	47.0	0.0	1153.71	0.0	0.0	2	9
1641.0	310.0	24.1	17.0	5.7	956.21	47.3	0.0	1144.01	0.0	0.0	2	0
1805.0	316.0	23.9	17.3	6.1	950.64	47.6	0.0	1135.96	0.0	0.0	2	0
1969.0	322.0	21.0	17.6	6.4	945.10	47.9	0.0	1127.97	0.0	0.0	2	0
2268.0	340.7	13.5	18.2	7.1	935.09	48.4	0.0	1113.54	0.0	0.0	2	9
2595.0	31.3	13.5	19.2	6.7	924.30	44.0	0.0	1097.02	0.0	0.0	2	9
3724.0	11.4	15.0	17.9	5.1	887.98	42.9	0.0	1058.90	0.0	0.0	4	9

4576.0	16.7	14.6	15.6	4.1	861.39	46.1	0.0	1035.54	0.0	0.0	4	9
5424.0	9.4	14.4	13.6	1.1	835.49	42.4	0.0	1012.02	0.0	0.0	4	9
6382.0	355.0	15.0	11.6	-7.2	806.95	26.0	0.0	985.62	0.0	0.0	4	9
7174.0	340.1	15.2	11.5	-10.0	783.99	21.0	0.0	958.19	0.0	0.0	4	9
7984.0	321.4	14.7	11.6	-11.3	761.20	18.8	0.0	930.11	0.0	0.0	4	9
8886.0	303.6	16.3	10.6	-12.4	736.53	18.4	0.0	903.20	0.0	0.0	4	9
10648.0	284.3	20.0	7.1	-14.1	690.33	20.3	0.0	857.18	0.0	0.0	4	0
11528.0	276.5	20.8	6.0	-14.8	668.15	20.8	0.0	832.94	0.0	0.0	4	0
12325.0	270.3	21.0	4.3	-15.4	648.60	22.1	0.0	813.54	0.0	0.0	4	0
13093.0	265.5	21.1	2.9	-17.5	630.19	20.6	0.0	794.57	0.0	0.0	4	9
13899.0	263.7	22.0	1.3	-18.8	611.33	20.6	0.0	775.34	0.0	0.0	4	9
14777.0	265.6	23.8	-.4	-20.1	591.31	20.8	0.0	754.67	0.0	0.0	4	0
15643.0	267.2	26.0	-2.3	-19.8	572.09	24.5	0.0	735.23	0.0	0.0	4	0
16449.0	268.9	27.7	-4.2	-18.3	554.65	32.2	0.0	717.75	0.0	0.0	4	9

R9C
7) 11/16 0001 reconstructed sounding

MIDNIGHT SOUNDING
$ CREATED BY UPWIND VERSION 1.1

UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W3733 ASC NO: 638
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1115Z 16 NOV 1994 700.00 8 900
ASCENT NBR 638

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
329.	315.	9.	8.2	6.3	1004.80	88.	.000	1244.14	.0	.0
383.	332.	10.	8.3	6.1	1002.80	86.	.000	1240.66	.0	.0
431.	347.	14.	8.4	5.9	1001.03	85.	.000	1237.57	.0	.0
493.	349.	18.	8.5	5.7	998.75	83.	.000	1233.60	.0	.0
657.	343.	21.	8.9	5.1	992.74	77.	.000	1223.14	.0	.0
756.	342.	21.	9.1	4.7	989.13	74.	.000	1216.88	.0	.0
821.	341.	22.	9.0	4.5	986.76	74.	.000	1214.51	.0	.0
985.	340.	23.	8.7	4.0	980.83	73.	.000	1208.55	.0	.0
1149.	333.	22.	8.4	3.5	974.93	71.	.000	1202.61	.0	.0
1313.	331.	19.	8.1	3.0	969.07	70.	.000	1196.71	.0	.0
1385.	331.	19.	8.0	2.8	966.52	70.	.000	1194.14	.0	.0
1477.	330.	20.	7.7	3.2	963.23	73.	.000	1191.06	.0	.0
1778.	329.	15.	6.9	4.4	952.58	84.	.000	1181.06	.0	.0
2439.	330.	17.	5.7	1.5	929.55	74.	.000	1158.10	.0	.0
3492.	330.	20.	3.0	-.7	893.68	77.	.000	1124.65	.0	.0
4507.	328.	23.	.5	-.1	860.11	96.	.000	1092.07	.0	.0
5544.	330.	25.	-2.0	-2.9	826.85	94.	.000	1059.95	.0	.0
6531.	325.	25.	-4.6	-5.2	796.05	95.	.000	1030.65	.0	.0
6821.	315.	25.	-4.5	-8.1	787.19	76.	.000	1019.17	.0	.0
6888.	305.	22.	-3.2	-9.2	785.17	63.	.000	1011.80	.0	.0
6922.	290.	20.	-2.9	-19.2	784.14	27.	.000	1010.18	.0	.0
7584.	275.	17.	-3.9	-24.2	764.42	19.	.000	988.65	.0	.0
8614.	264.	28.	-6.7	-25.6	734.48	21.	.000	959.95	.0	.0
9633.	250.	35.	-8.8	-25.4	705.79	25.	.000	929.75	.0	.0
10709.	240.	22.	-11.2	-28.1	676.46	23.	.000	899.35	.0	.0

$
1950Z 26 07 93 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
018	012	312.0	9.0	315.0	999.0	999.0	999.0	999.0	999.0	9999.0	10.8
018	054	354.0	10.0	332.0	999.0	999.0	999.0	999.0	999.0	9999.0	6.4
018	102	402.0	14.0	347.0	999.0	999.0	999.0	999.0	999.0	9999.0	4.1

$
DASS DATA FROM BLDG. DAS4, UNEDITED
16/11/94 11:30 10-MIN. AVE.

ALT M	DIR DEG	V KNOTS	VZ KNOTS	SD DEG	SV KNOTS	SZ KNOTS
GND	72	9.5	--	86.3	999	.4
50	349	18.3	-1.0	3.0	999	.8
100	343	20.8	-1.0	3.1	999	.8
150	341	21.8	-1.2	2.7	999	.6
200	340	22.9	-1.2	2.8	999	.8
250	333	21.8	-1.2	3.4	999	.8
300	331	19.0	-1.2	4.1	999	.6
350	330	19.6	-1.4	3.0	999	.8
400	--	--	--	--	999	--

450	--	--	--	--	999	--
500	--	--	--	--	999	--
550	--	--	--	--	999	--
600	--	--	--	--	999	--
650	--	--	--	--	999	--
700	--	--	--	--	999	--
750	--	--	--	--	999	--
800	--	--	--	--	999	--
850	--	--	--	--	999	--
900	--	--	--	--	999	--
950	--	--	--	--	999	--
1000	--	--	--	--	999	--

R9D
13) 11/18 0001 SOUNDING (RECONSTRUCTION)
$ CREATED BY UPWIND VERSION 1.1

UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: 12345 ASC NO: 642
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1140Z 18 NOV 1994 700. 6 1200
ASCENT NBR 642

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
329.	321.	13.	6.8	3.2	1004.30	78.	.000	1249.74	.0	.0
383.	324.	16.	6.7	3.1	1002.29	78.	.000	1247.39	.0	.0
431.	323.	23.	6.7	3.0	1000.51	77.	.000	1245.30	.0	.0
1305.	328.	28.	5.5	.9	968.58	72.	.000	1207.89	.0	.0
2350.	322.	30.	2.7	-.1	931.43	82.	.000	1173.44	.0	.0
3444.	317.	31.	-.3	-2.3	893.71	87.	.000	1138.60	.0	.0
4419.	314.	33.	-2.9	-4.6	861.06	88.	.000	1107.88	.0	.0
5331.	315.	34.	-5.3	-6.0	831.31	95.	.000	1079.32	.0	.0
6393.	320.	35.	-7.0	-16.4	797.68	47.	.000	1043.29	.0	.0
7426.	325.	37.	-8.9	-20.9	766.08	37.	.000	1009.40	.0	.0
8403.	327.	43.	-10.6	-23.5	737.12	34.	.000	977.62	.0	.0
9262.	325.	51.	-11.6	-25.1	712.46	32.	.000	948.58	.0	.0
10158.	322.	56.	-12.0	-25.8	687.55	30.	.000	916.84	.0	.0

$
0700Z 18 11 94 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
018	012	312.0	13.0	321.0	999.0	999.0	999.0	999.0	999.0	9999.0	7.7
018	054	354.0	16.0	324.0	999.0	999.0	999.0	999.0	999.0	9999.0	5.6
018	102	402.0	23.0	323.0	999.0	999.0	999.0	999.0	999.0	9999.0	3.6

R9E
T-0 HOUR SOUNDING
$
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W3810 ASC NO: 136
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
1726Z 5 OCT 1993 693.
ASCENT NBR 136

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	330.	6.	15.3	9.9	1003.90	70.	.0915	1212.43	325.	662.
1513.	334.	10.	10.9	9.9	963.21	93.	.0929	1175.69	320.	659.
2643.	332.	11.	8.7	7.9	924.20	95.	.0819	1137.36	305.	656.
2892.	317.	12.	7.8	6.9	915.78	94.	.0767	1130.89	300.	655.
3511.	314.	11.	8.9	7.8	895.19	93.	.0815	1100.75	296.	656.
3867.	311.	8.	8.0	4.1	883.56	76.	.0630	1091.00	282.	655.
5051.	306.	8.	6.3	.4	845.70	66.	.0487	1051.33	265.	653.
6467.	300.	8.	4.1	-1.5	802.28	67.	.0429	1005.49	251.	650.
6598.	288.	10.	6.2	.9	798.37	69.	.0508	992.56	253.	653.
7313.	284.	10.	4.6	.1	777.43	73.	.0481	972.19	247.	651.
7576.	256.	11.	3.9	.9	769.84	81.	.0512	964.92	247.	650.
8577.	250.	11.	2.2	-3.5	741.48	66.	.0372	935.88	232.	648.
9016.	245.	13.	1.6	-3.9	729.31	67.	.0362	922.54	229.	647.
9087.	243.	16.	1.9	-8.2	727.35	47.	.0260	919.68	221.	647.
9737.	238.	18.	.9	-9.1	709.71	47.	.0242	900.73	216.	646.
10926.	236.	20.	-.8	-15.1	678.40	33.	.0150	866.87	203.	644.
12215.	999.	999.	-2.6	-23.7	645.76	18.	.0072	831.09	190.	641.

$
1750Z 05 10 93 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
300	012	397.0	8.0	32.0	16.1	999.0	999.0	662.4	999.0	9999.0	8.1
300	054	439.0	9.0	15.0	15.2	999.0	999.0	661.4	999.0	9999.0	6.6
300	102	487.0	8.0	3.0	15.2	999.0	999.0	661.4	999.0	9999.0	6.2
300	108	493.0	8.0	28.0	999.0	999.0	999.0	999.0	999.0	9999.0	15.5
300	204	589.0	999.0	13.0	15.0	999.0	999.0	661.2	999.0	9999.0	7.1
300	300	685.0	9.0	14.0	14.7	999.0	999.0	660.9	999.0	9999.0	5.6

$
DASS DATA FROM BLDG. DAS2, UNEDITED

05/10/93 17:50 10-MIN. AVE.

ALT M	DIR DEG	V KNOTS	VZ KNOTS	SD DEG	SV KNOTS	SZ KNOTS
GND	337	6.8	1.4	12.8	1.6	.4
50	339	8.4	1.0	23.6	2.7	1.2
100	340	9.5	.8	15.1	1.9	1.9
150	353	8.6	1.2	--	--	2.5
200	--	--	-.2	--	--	3.1
250	--	--	-1.2	--	--	2.9
300	--	--	-1.7	--	--	1.2
350	--	--	.4	--	--	.2
400	--	--	--	--	--	--
450	--	--	-.6	--	--	1.0
500	--	--	.6	--	--	2.1
550	--	--	-5.2	--	--	--
600	--	--	-2.7	--	--	--
650	--	--	.6	--	--	--
700	--	--	-2.3	--	--	.0

750	--	--	.0	--	--	--
800	--	--	-2.1	--	--	--
850	--	--	-3.1	--	--	--
900	--	--	.4	--	--	--
950	--	--	--	--	--	--
1000	--	--	.8	--	--	--

EOF

R9F
$ 06/20/95 21:41:59
1110Z 06 20 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
300	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.5	1.0
300	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	13.0	2.8
300	102	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	10.3	4.4
300	204	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	9.2	6.5
300	300	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	8.6	6.7
300	543	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	631	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	687	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1004	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1148	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1312	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1476	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	1640	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	2083	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	2244	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	3174	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	4222	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	5186	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	6008	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	8687	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	10581	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	11645	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	12625	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	13647	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	14679	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	15622	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	16615	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	17638	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	18670	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	19667	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	20711	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
300	21813	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 06/20/95 21:42:01
UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W1135 ASC NO: 340
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 6.5 11.2 32
1115Z 20 JUN 1995 979.64
ASCENT NBR 340

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
368.0	14.0	6.0	10.2	9.0	999.30	92.0	0.0	1228.60	0.0	0.0	1	9
422.0	360.0	7.0	10.1	8.9	997.33	92.4	0.0	1226.17	0.0	0.0	1	0
470.0	10.0	7.0	10.0	8.9	995.58	92.8	0.0	1224.02	0.0	0.0	1	0
572.0	12.0	9.0	9.7	8.8	991.87	93.5	0.0	1219.46	0.0	0.0	1	0
668.0	357.0	11.0	9.5	8.7	988.39	94.2	0.0	1215.19	0.0	0.0	1	0
911.0	359.6	12.7	9.0	8.4	979.64	96.0	0.0	1204.43	0.0	0.0	1	9
999.0	0.5	13.3	10.0	9.4	976.48	96.0	0.0	1195.93	0.0	0.0	1	9
1055.0	1.1	13.7	12.8	11.7	974.51	93.0	0.0	1180.91	0.0	0.0	1	9
1372.0	4.5	15.9	13.9	7.3	963.39	64.3	0.0	1164.52	0.0	0.0	1	9
1516.0	6.0	16.9	14.3	6.4	958.42	60.1	0.0	1157.24	0.0	0.0	2	0
1680.0	11.0	21.0	14.7	5.3	952.79	55.3	0.0	1149.00	0.0	0.0	2	0
1844.0	23.0	22.5	15.1	4.2	947.20	50.6	0.0	1140.83	0.0	0.0	2	0
2008.0	27.0	26.8	15.6	3.2	941.63	45.8	0.0	1132.71	0.0	0.0	2	0
2451.0	36.0	22.7	16.7	0.3	926.77	32.9	0.0	1111.07	0.0	0.0	2	9

2612.0	31.9	23.8	17.5	-.3	921.46	30.0	0.0	1101.76	0.0	0.0	2	9
3542.0	1.4	21.9	15.0	-.8	891.28	33.7	0.0	1074.94	0.0	0.0	4	9
4590.0	356.8	22.6	12.3	-4.3	858.14	31.0	0.0	1045.27	0.0	0.0	4	9
5554.0	338.9	26.2	13.6	-11.7	828.64	16.0	0.0	1005.59	0.0	0.0	4	9
6376.0	337.7	25.2	13.2	-12.4	804.33	15.6	0.0	977.47	0.0	0.0	4	9
9055.0	306.9	22.0	10.0	-14.5	729.46	16.2	0.0	896.57	0.0	0.0	4	9
10949.0	297.4	20.9	6.4	-16.5	680.25	17.5	0.0	846.94	0.0	0.0	4	0
12013.0	291.9	21.7	4.2	-17.2	653.82	19.2	0.0	820.51	0.0	0.0	4	0
12993.0	286.3	22.9	2.5	-19.5	630.20	17.8	0.0	795.85	0.0	0.0	4	0
14015.0	284.6	23.6	1.5	-21.1	606.37	16.7	0.0	768.60	0.0	0.0	4	9
15047.0	286.5	24.2	-.8	-23.0	583.09	16.6	0.0	745.40	0.0	0.0	4	0
15990.0	284.5	24.7	-2.9	-24.5	562.44	16.9	0.0	724.64	0.0	0.0	4	0
16983.0	279.5	25.5	-5.4	-26.6	541.32	16.9	0.0	703.99	0.0	0.0	4	0
18006.0	276.0	26.9	-7.5	-28.4	520.19	16.8	0.0	681.90	0.0	0.0	4	0
19038.0	273.8	28.4	-9.7	-30.2	499.56	16.9	0.0	660.36	0.0	0.0	4	0
20035.0	273.2	29.2	-12.5	-32.4	480.23	17.0	0.0	641.67	0.0	0.0	4	0
21079.0	272.3	30.2	-14.9	-34.4	460.59	17.0	0.0	621.17	0.0	0.0	4	0
22181.0	268.7	32.4	-17.3	-36.2	440.57	17.3	0.0	599.77	0.0	0.0	4	9

R9G
$ Created by upwind version 1.1

UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W7760 ASC NO: 018
1764
"BLDG 1764, VANDENBERG AFB, CALIF."
RAWINSONDE MSS/SYN
0810Z 1 FEB 1995 990.
ASCENT NBR 018

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
329.	21.	14.	17.7	11.1	1008.50	65.	0.000	1207.94	0.0	0.0
506.	22.	22.	20.2	12.7	1002.21	62.	0.000	1183.61	0.0	0.0
657.	16.	25.	19.9	12.1	996.87	61.	0.000	1178.61	0.0	0.0
821.	23.	29.	19.6	11.5	991.11	59.	0.000	1173.21	0.0	0.0
1000.	24.	30.	19.3	10.8	984.86	58.	0.000	1167.35	0.0	0.0
1065.	25.	31.	21.1	12.2	982.62	57.	0.000	1156.98	0.0	0.0
1149.	27.	32.	20.5	11.5	979.71	56.	0.000	1156.33	0.0	0.0
1198.	26.	31.	20.1	11.1	978.03	56.	0.000	1155.96	0.0	0.0
1304.	23.	29.	20.2	11.0	974.37	56.	0.000	1151.22	0.0	0.0
1477.	21.	29.	21.4	11.6	968.47	54.	0.000	1139.16	0.0	0.0
1679.	22.	23.	22.9	12.2	961.65	51.	0.000	1125.28	0.0	0.0
2287.	24.	23.	23.6	4.9	941.44	30.	0.000	1101.39	0.0	0.0
2474.	31.	24.	24.6	3.3	935.33	25.	0.000	1090.94	0.0	0.0
3205.	30.	23.	23.0	2.3	911.78	26.	0.000	1069.38	0.0	0.0
4118.	28.	22.	20.7	2.5	883.00	30.	0.000	1043.57	0.0	0.0
5036.	23.	21.	18.3	0.8	854.78	31.	0.000	1018.81	0.0	0.0
6027.	19.	22.	15.7	-1.4	825.04	31.	0.000	992.56	0.0	0.0
7002.	20.	22.	12.7	-3.6	796.51	32.	0.000	968.59	0.0	0.0
8019.	23.	23.	10.3	-8.1	767.56	26.	0.000	941.84	0.0	0.0
9046.	21.	22.	7.6	-7.5	739.11	33.	0.000	915.52	0.0	0.0
10044.	14.	20.	5.3	-7.0	712.26	41.	0.000	889.42	0.0	0.0
10959.	4.	17.	3.8	-7.6	688.33	43.	0.000	864.23	0.0	0.0

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0810Z 01 02 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
017	012	137.0	14.0	21.0	999.0	999.0	999.0	999.0	999.0	9999.0	10.2

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DASS DATA FROM BLDG. DAS4, UNEDITED

01/02/95 08:10 10-MIN. AVE.

ALT	DIR	V	VZ	SD	SV	SZ
M	DEG	KNOTS	KNOTS	DEG	KNOTS	KNOTS
GND	30	9.5	.6	1.8	.6	.2
50	23	22.0	-.4	2.5	1.2	.6
100	16	24.5	-.2	3.1	1.2	.8
150	23	28.6	-.2	2.5	1.2	.6
200	24	30.3	.2	2.2	1.0	.6
250	27	31.7	.2	2.1	1.0	.6
300	23	29.0	.2	1.9	.6	.4
350	21	29.4	.2	2.1	.8	.4
400	21	28.0	-.2	2.8	1.4	.6

R9H
8) 2/1/95 01:47 T-ZERO VERIFICATION DATA

$ Created by upwind version 1.1

UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W7760 ASC NO: 019
1764
"BLDG 1764, VANDENBERG AFB, CALIF."
RAWINSONDE MSS/SYN
0947Z 1 FEB 1995 990.
ASCENT NBR 019

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
329.	323.	4.	12.5	7.0	1008.10	69.	0.000	1229.44	0.0	0.0
443.	325.	8.	18.0	12.7	1003.97	71.	0.000	1194.67	0.0	0.0
493.	326.	9.	19.1	12.9	1002.21	67.	0.000	1187.94	0.0	0.0
551.	341.	10.	20.4	13.1	1000.17	63.	0.000	1180.19	0.0	0.0
657.	8.	12.	20.2	12.6	996.43	62.	0.000	1176.71	0.0	0.0
821.	11.	21.	19.9	11.8	990.68	60.	0.000	1171.35	0.0	0.0
985.	20.	23.	19.6	11.1	984.95	58.	0.000	1166.02	0.0	0.0
1149.	24.	24.	19.3	10.3	979.27	56.	0.000	1160.70	0.0	0.0
1229.	24.	26.	19.2	9.9	976.51	55.	0.000	1158.13	0.0	0.0
1301.	25.	27.	19.3	9.9	974.01	55.	0.000	1154.77	0.0	0.0
1505.	24.	30.	21.7	8.9	967.04	44.	0.000	1137.49	0.0	0.0
1641.	23.	30.	22.2	7.1	962.43	39.	0.000	1130.63	0.0	0.0
1805.	24.	28.	22.8	5.0	956.92	32.	0.000	1122.42	0.0	0.0
1906.	22.	26.	23.2	3.7	953.55	28.	0.000	1117.42	0.0	0.0
1969.	21.	25.	23.1	3.4	951.44	28.	0.000	1115.45	0.0	0.0
2338.	36.	20.	22.4	1.8	939.25	26.	0.000	1104.04	0.0	0.0
3262.	38.	20.	22.3	2.8	909.30	28.	0.000	1068.86	0.0	0.0
4142.	38.	19.	20.3	2.0	881.57	30.	0.000	1043.41	0.0	0.0
5022.	37.	17.	18.1	0.2	854.49	30.	0.000	1019.30	0.0	0.0
6048.	32.	16.	15.2	-0.3	823.72	35.	0.000	992.47	0.0	0.0
7083.	23.	19.	13.3	-5.4	793.54	27.	0.000	963.22	0.0	0.0
8106.	16.	21.	10.6	-7.0	764.54	28.	0.000	937.00	0.0	0.0
9070.	12.	21.	7.9	-8.1	737.95	31.	0.000	913.17	0.0	0.0
9882.	8.	19.	5.9	-9.5	716.09	32.	0.000	892.59	0.0	0.0
10728.	5.	15.	3.8	-9.9	693.86	36.	0.000	871.44	0.0	0.0

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DASS DATA FROM BLDG. DAS4, UNEDITED

01/02/95 09:50 10-MIN. AVE.

ALT	DIR	V	VZ	SD	SV	SZ
M	DEG	KNOTS	KNOTS	DEG	KNOTS	KNOTS
GND	281	5.1	--	61.1	1.7	--
50	326	9.3	--	4.5	1.6	.8
100	8	11.7	.2	7.8	1.9	1.0
150	11	21.4	1.6	3.8	1.6	.8
200	20	23.1	1.9	3.2	1.2	.8
250	24	24.1	2.5	3.2	1.4	.6
300	25	27.0	2.9	2.7	1.2	1.0
350	24	30.3	3.1	2.2	1.0	.6
400	23	29.5	2.9	2.2	1.0	.6
450	24	27.8	2.5	2.2	.8	.6
500	21	24.9	2.1	2.2	.6	.4
550	19	25.3	2.1	2.8	1.2	.4
600	18	27.8	1.6	3.4	1.9	1.2
650	13	27.6	1.9	3.1	1.6	.4
700	11	32.3	1.7	3.1	2.1	.4

0950Z 01 02 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
017	012	137.0	4.0	323.0	999.0	999.0	999.0	999.0	999.0	9999.0	29.2

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2130Z 28 11 92 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIGMA
300	012	397.0	15.0	357.0	16.7	999.0	999.0	663.1	999.0	9999.0	7.0
300	054	439.0	16.0	360.0	14.4	999.0	999.0	660.5	999.0	9999.0	5.2
300	102	487.0	18.0	348.0	14.8	999.0	999.0	661.0	999.0	9999.0	4.8
300	108	493.0	18.0	26.0	999.0	999.0	999.0	999.0	999.0	9999.0	7.1
300	204	589.0	19.0	336.0	14.3	999.0	999.0	660.3	999.0	9999.0	4.3
300	300	685.0	19.0	317.0	14.9	999.0	999.0	661.0	999.0	9999.0	2.5

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DASS DATA FROM BLDG. DAS2, UNEDITED

28/11/92 21:30 10-MIN. AVE.

ALT M	DIR DEG	V KNOTS	VZ KNOTS	SD DEG	SV KNOTS	SZ KNOTS
GND	347	11.1	.6	9.5	1.9	.8
50	335	18.9	1.0	11.6	3.5	1.6
100	334	19.0	-.2	11.7	3.5	1.6
150	348	17.1	.4	10.8	3.3	1.9
200	356	18.7	.2	10.3	3.5	1.9
250	10	20.6	1.2	8.7	4.5	2.1
300	15	23.1	1.0	11.7	3.5	1.9
350	20	23.5	2.3	8.9	6.2	1.7
400	--	--	4.3	--	--	--
450	--	--	--	--	--	--
500	--	--	--	--	--	--
550	--	--	2.1	--	--	--
600	--	--	--	--	--	--
650	--	--	--	--	--	--
700	--	--	--	--	--	--
750	--	--	--	--	--	--
800	--	--	--	--	--	--
850	--	--	--	--	--	--
900	--	--	--	--	--	--
950	--	--	--	--	--	--
1000	--	--	--	--	--	--

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UNINTERPOLATED DATA

TEST NBR SITE: 900 OP NO: W4119 ASC NO: 252
900
BLDG 900, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN
2105Z 28 NOV 1992 900.
ASCENT NBR 0252

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABSHUM	DEN	IR	SOS
368.	360.	15.	17.3	3.6	1001.20	40.	.0590	1197.30	302.	665.
508.	355.	19.	15.9	2.0	996.21	39.	.0528	1197.47	299.	664.
1279.	9.	18.	14.9	2.0	968.98	42.	.0529	1168.70	293.	662.
2250.	25.	19.	12.6	-1.9	935.59	36.	.0403	1138.20	278.	660.
3243.	30.	19.	9.9	-2.4	902.33	42.	.0393	1108.20	271.	657.
3315.	16.	22.	9.6	-2.3	899.96	43.	.0394	1106.45	271.	656.
3675.	10.	23.	10.6	-11.4	888.17	20.	.0195	1089.28	255.	657.
4236.	7.	24.	12.5	-13.4	870.20	15.	.0165	1060.30	246.	659.
4271.	359.	24.	12.3	-13.3	869.11	15.	.0166	1059.70	246.	659.
5007.	359.	24.	10.4	-15.1	846.07	15.	.0145	1038.64	240.	657.
5314.	2.	26.	11.0	-14.4	836.63	15.	.0153	1024.81	238.	657.
6493.	1.	27.	9.2	-15.7	801.25	15.	.0138	987.80	229.	655.

7751.	358.	27.	8.0	-16.7	765.00	15.	.0127	947.16	219.	654.
8793.	356.	25.	8.0	-16.8	736.14	15.	.0127	911.40	211.	654.
9764.	354.	24.	6.8	-17.7	710.16	15.	.0118	883.03	204.	652.
10623.	347.	23.	4.9	-19.1	687.84	16.	.0105	861.19	198.	650.
11538.	999.	999.	2.7	-20.7	664.68	16.	.0092	838.88	193.	648.

R9J
$ 03/15/95 09:45:45
0930Z 03 15 95 10

TWR	LVL	HMSL	SPD	DIR	TEMP	RH	TD	SOSD	SOSM	PRESS	SIG-A	SIG-E
060	1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	7.3	1.0
060	54	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.9	1.4
060	164	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.9	2.1
060	328	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.9	2.6
060	492	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.7	3.1
060	630	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	5.8	3.8
060	820	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	4.4	2.9
060	964	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	3.7	1.7
060	1148	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.9	2.0
060	1237	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1312	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1476	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	1640	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	2296	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	2959	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	3878	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	4746	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	5697	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	5954	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	6781	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	8632	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	9613	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0
060	10641	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	999.0	1.0	1.0

$ 03/15/95 09:45:52
UNINTERPOLATED DATA

TEST NBR SITE: 1764 OP NO: W3406 ASC NO: 028
1764
BLDG 1764, VANDENBERG AFB, CALIF.
RAWINSONDE MSS/SYN 14.0 13.0 23
0546Z 15 MAR 1995 990.00 7 305
ASCENT NBR 028

ALT	DIR	SPD	TEMP	DEWPT	PRESS	RH	ABH	DENSITY	IR	SOS	S	I
329.0	315.0	12.0	13.0	11.4	1008.70	90.0	0.0	1228.02	0.0	0.0	1	9
383.0	315.0	16.0	13.1	11.3	1006.74	89.1	0.0	1224.84	0.0	0.0	1	0
493.0	317.0	15.9	13.2	11.1	1002.75	87.1	0.0	1218.37	0.0	0.0	2	0
657.0	324.0	13.0	13.4	10.8	996.83	84.3	0.0	1208.80	0.0	0.0	2	0
821.0	339.0	10.9	13.6	10.5	990.95	81.4	0.0	1199.31	0.0	0.0	2	0
959.0	1.7	8.8	13.8	10.2	986.03	79.0	0.0	1191.38	0.0	0.0	2	9
1149.0	18.0	11.5	14.7	6.6	979.30	60.1	0.0	1180.64	0.0	0.0	2	0
1293.0	15.4	13.7	15.4	3.8	974.23	45.8	0.0	1172.56	0.0	0.0	2	9
1477.0	11.0	16.5	15.7	2.8	967.82	41.9	0.0	1163.71	0.0	0.0	2	0
1566.0	9.4	17.3	15.9	2.3	964.74	40.0	0.0	1159.46	0.0	0.0	2	9
1641.0	8.0	17.9	15.8	2.2	962.15	40.0	0.0	1156.78	0.0	0.0	2	0
1805.0	18.0	15.2	15.6	2.0	956.50	40.1	0.0	1150.94	0.0	0.0	2	0
1969.0	77.0	15.9	15.3	1.8	950.88	40.2	0.0	1145.14	0.0	0.0	2	0
2625.0	10.0	11.9	14.5	1.4	928.70	40.7	0.0	1121.48	0.0	0.0	2	0
3288.0	354.5	15.2	13.9	1.1	906.77	41.5	0.0	1097.47	0.0	0.0	4	0
4207.0	1.7	15.7	12.5	-.2	877.08	41.4	0.0	1066.91	0.0	0.0	4	9
5075.0	359.2	17.2	11.2	-2.8	849.84	37.3	0.0	1038.90	0.0	0.0	4	9
6026.0	350.9	17.6	10.3	-5.1	820.80	33.4	0.0	1006.87	0.0	0.0	4	9
6283.0	315.2	17.7	9.5	0.7	813.11	54.0	0.0	999.21	0.0	0.0	4	9
7110.0	302.9	18.4	8.6	-5.7	788.79	35.8	0.0	973.45	0.0	0.0	4	9
8961.0	287.2	21.5	4.6	-5.3	736.51	48.7	0.0	921.84	0.0	0.0	4	9
9942.0	284.9	23.9	2.1	-7.9	709.90	47.3	0.0	896.89	0.0	0.0	4	9
10970.0	284.7	26.1	-.7	-4.9	682.80	73.3	0.0	871.03	0.0	0.0	4	9

APPENDIX B: Input Database File

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                  REEDM VERSION 07.01 DATA BASE 'RDMBASE' 04/10/90

#00.01                   THESE DATA ARE CLASSIFIED= N, (MUST HAVE Y OR N)

#01.00 LOCATION ID=VAFB, SYSTEM= 5, UTM ZONE= 10, AVG ROUGHNESS=  5,
#01.01 TIME ZONE DIFF= 8,
#01.04 CRASH GRID DATA                            xxxxxxxxxx yyyyyyyyyy
  reference point utm coordinates (m) =       714025.0   3820135
  grid cell dimensions (m) =                     304.8      304.8
  minimum cell number =                              1          0
  maximum cell number =                             78        167
  print format (digits,<0=character data) =         2         -2
  grid orientation (deg. cw rotation) =  -2.05

#01.05 concentration/dosage model centerline data print control flags
  print conc = y       print dose = y       print time mean conc = y

#09.00 default isopleth level data, level type = tier

#09.01 lowest level designator =  3
  conc/dosage model              conc        dose   time mean conc
       HCL (ppm)                  0.0         0.0         0.0
       CO2 (ppm)                  0.0         0.0         0.0
       CO (ppm)                   0.0         0.0         0.0
       Al2O3 (mg/m^3)             0.0         0.0         0.0
       N2H4 (ppm)                 0.0         0.0         0.0
       UDMH (ppm)                 0.0         0.0         0.0
       N2O4 (ppm)                 0.0         0.0         1.0
       NDMA (ppb)                 0.0         0.0         0.0
       FDH (ppb)                  0.0         0.0         0.0
  precipitation deposition
       HCL (ph)                   0.0
       Al2O3 (mg/m^2)             0.0
  gravitational deposition
       HCL (mg/m^2)               0.0
       Al2O3 (mg/m^2)             0.0
       Al2O3 (part/m^2)           0.0

#09.02 mid level designator =      2
  conc/dosage model              conc        dose   time mean conc
       HCL (ppm)                  0.0         0.0         0.0
       CO2 (ppm)                  0.0         0.0         0.0
       CO (ppm)                   0.0         0.0         0.0
       Al2O3 (mg/m^3)             0.0         0.0         0.0
       N2H4 (ppm)                 0.0         0.0         0.0
       UDMH (ppm)                 0.0         0.0         0.0
       N2O4 (ppm)                 0.0         0.0         5.0
       NDMA (ppb)                 0.0         0.0         0.0
       FDH (ppb)                  0.0         0.0         0.0
  precipitation deposition
       HCL (ph)                   0.0
       Al2O3 (mg/m^2)             0.0
  gravitational deposition
       HCL (mg/m^2)               0.0
       Al2O3 (mg/m^2)             0.0
       Al2O3 (part/m^2)           0.0

#09.03 highest level designator = 1
  conc/dosage model              conc        dose   time mean conc
       HCL (ppm)                  0.0         0.0         0.0
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        CO2 (ppm)                 0.0         0.0         0.0
        CO (ppm)                  0.0         0.0         0.0
        Al2O3 (mg/m^3)            0.0         0.0         0.0
        N2H4 (ppm)                0.0         0.0         0.0
        UDMH (ppm)                0.0         0.0         0.0
        N2O4 (ppm)                0.0         0.0        25.0
        NDMA (ppb)                0.0         0.0         0.0
        FDH (ppb)                 0.0         0.0         0.0
   precipitation deposition
        HCL (ph)                  0.0
        Al2O3 (mg/m^2)            0.0
   gravitational deposition
        HCL (mg/m^2)              0.0
        Al2O3 (mg/m^2)            0.0
        Al2O3 (part/m^2)          0.0

#02.00           AVERAGE MONTHLY TEMPERATURES IN DEGREES CELSIUS
  12.5 12.22 12.67 11.67 12.56 13.06 13.67 14.17 15.22 14.67 13.78 13.00

#03.00           NAME IDENTIFIERS OF LAUNCH SITES
 6   2W  3W  3E  4W  4E  5   10W
#03.01           UTM X COORDINATES OF LAUNCH SITES IN METERS
  717681.0 717594.75  720617.0 720856.75 718542.25 718861.62 717821.25 717371.88
      0.0       0.0       0.0       0.0
#03.02           UTM Y COORDINATES OF LAUNCH SITES IN METERS
 3828974.5 3848285.5 3835962.5 3835598.5 3834744.5 3834642.0 3831948.5 3849167.5
      0.0       0.0       0.0       0.0
#03.03           ELEVATION OF LAUNCH SITES IN METERS
     129.0      52.0     129.0     143.0     113.0     154.0     101.0      50.0
      0.0       0.0       0.0       0.0

#04.00    NAMES OF SPECIAL DISCRETE POINTS OF INTEREST (MAX=21, 20 CHAR EACH)
 VAFB CANTONMENT      JALAMA BEACH         JALAMA RANCH
 MIGUELITO PARK       FED CORRECTIONAL INSWEST LOMPOC
 LOMPOC               SURF TRAIN STATION   LASALLE CANYON
 VANDENBERG VILLAGE   1.5 NM OFFSHORE #1   1.5 NM OFFSHORE #2
 1.5 NM OFFSHORE #3   1.5 NM OFFSHORE #4   1.5 NM OFFSHORE #5
 1.5 NM OFFSHORE #6   1.5 NM OFFSHORE #7   1.5 NM OFFSHORE #8
 1.5 NM OFFSHORE #9 1.5 NM OFFSHORE #10   1.5NM S PT CNCEPTION
#04.01        UTM X COORDINATES OF SPECIAL DISCRETE POINTS IN METERS
  725877.0   729509.5   730961.9   731674.8   729044.8   729154.9   733725.1   719593.4
  726696.2   732654.3   713113.6   714350.4   716505.6   723984.0   725374.7   726784.6
  727565.0   729079.1   729493.3   730091.1   732508.3
#04.02        UTM Y COORDINATES OF SPECIAL DISCRETE POINTS IN METERS
 3846009.5 3821459.3 3822160.8 3830392.3 3840205.0 3835768.0 3836437.5 3840530.3
 3835041.3 3842515.3 3827282.5 3825424.3 3823588.0 3821989.5 3821468.5 3820171.0
 3818303.5 3816564.5 3814688.0 3812816.0 3811766.3

#05.00                       VEHICLE DATA SECTION
   VEHICLE TYPE = 1, NAME = SPACE SHUTTLE,
   TIME HEIGHT COEFFICIENTS A,B,C = 0.6522129891,    0.4680846,        0.375,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 2,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =    1.251174E9,
   FUEL BURN RATE (G/S) =    1.521923E7,
   HEAT CONTENT (CAL/G) =     1479.7,
   FRACTION HCL,CO2,CO,AL2O3 = 0.0379,0.25029,0.00042,    0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =  15.0,
   INITIAL RADIUS OF CLOUD (M) =     72.0,
   INITIAL HEIGHT OF CLOUD (M) =      0.0,
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   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =   1.015095E9,
   FUEL BURN RATE (G/S) =9.887260711E5,
   HEAT CONTENT (CAL/G) =    1000.0,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1146,0.25029,0.00042,0.18279,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) =    6.25587E8,
   FUEL BURN RATE (G/S) =   7.609615E6,
   HEAT CONTENT (CAL/G) =    1479.7,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1146,0.25029,0.00042,0.18279,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) =          0.0,
   TOTAL LIQUID OXIDIZER (G) =          0.0,
   FUEL FLOW RATE (G/S) =          0.0,
   OXIDIZER FLOW RATE (G/S) =          0.0,
   TIME OF IGNITION (S) =       0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =  15.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                       VEHICLE DATA SECTION
   VEHICLE TYPE = 2, NAME =       TITAN II,
   TIME HEIGHT COEFFICIENTS A,B,C =      1.47973,         0.42,            0.0,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 0,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =          0.0,
   FUEL BURN RATE (G/S) =          0.0,
   HEAT CONTENT (CAL/G) =        0.0,
   FRACTION HCL,CO2,CO,AL2O3 =    0.0,    0.0,    0.0,    0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =     0.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =          0.0,
   FUEL BURN RATE (G/S) =          0.0,
   HEAT CONTENT (CAL/G) =       0.0,
   FRACTION HCL,CO2,CO,AL2O3 =    0.0,    0.0,    0.0,    0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =     0.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
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   TOTAL FUEL (G) =          0.0,
   FUEL BURN RATE (G/S) =          0.0,
   HEAT CONTENT (CAL/G) =       0.0,
   FRACTION HCL,CO2,CO,AL2O3 =    0.0,     0.0,     0.0,     0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =     0.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) = 5.05342646E7,
   TOTAL LIQUID OXIDIZER (G) = 9.44528854E7,
   FUEL FLOW RATE (G/S) =  2.5295436E5,
   OXIDIZER FLOW RATE (G/S) = 4.72793769E5,
   TIME OF IGNITION (S) =       0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                       VEHICLE DATA SECTION
   VEHICLE TYPE = 2, NAME =     TITAN 34D,
   TIME HEIGHT COEFFICIENTS A,B,C =     0.699602,     0.459375,          0.0,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 2,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =  4.2124935E8,
   FUEL BURN RATE (G/S) =   3.510411E6,
   HEAT CONTENT (CAL/G) =    1555.58,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1978, 0.2665, 0.0222, 0.2819,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =  4.2124935E8,
   FUEL BURN RATE (G/S) =   9.361097E5,
   HEAT CONTENT (CAL/G) =    2137.00,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1978, 0.2665, 0.0222, 0.2819,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) = 2.10624675E8,
   FUEL BURN RATE (G/S) =  1.7552055E6,
   HEAT CONTENT (CAL/G) =   1555.58,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1978, 0.2665, 0.0222, 0.2819,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) = 5.79518594E7,
   TOTAL LIQUID OXIDIZER (G) =1.083541286E8,
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   FUEL FLOW RATE (G/S) =  2.5295436E5,
   OXIDIZER FLOW RATE (G/S) = 4.72793769E5,
   TIME OF IGNITION (S) =     120.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                      VEHICLE DATA SECTION
   VEHICLE TYPE = 2, NAME =      TITAN IV,
   TIME HEIGHT COEFFICIENTS A,B,C =     0.867784,   0.44996009,          0.0,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 2,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =5.361460986E8,
   FUEL BURN RATE (G/S) =   4.188641E6,
   HEAT CONTENT (CAL/G) =   1555.58,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1978, 0.2665, 0.0222, 0.2819,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =5.361460986E8,
   FUEL BURN RATE (G/S) =  1.1914358E6,
   HEAT CONTENT (CAL/G) =   2137.00,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1978, 0.2665, 0.0222, 0.2819,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) =2.680730493E8,
   FUEL BURN RATE (G/S) =  2.0943205E6,
   HEAT CONTENT (CAL/G) =   1555.58,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1978, 0.2665, 0.0222, 0.2819,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) =6.671662345E7,
   TOTAL LIQUID OXIDIZER (G) =1.252740286E8,
   FUEL FLOW RATE (G/S) =2.529543643E5,
   OXIDIZER FLOW RATE (G/S) =4.727937692E5,
   TIME OF IGNITION (S) =     120.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    72.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                      VEHICLE DATA SECTION
   VEHICLE TYPE = 2, NAME =    DELTA 7925,
   TIME HEIGHT COEFFICIENTS A,B,C =       0.69646     0.46291,          0.0,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 6,
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 A-NORMAL LAUNCH
   TOTAL FUEL (G) =   9.404388E7,
   FUEL BURN RATE (G/S) =   1.481006E6,
   HEAT CONTENT (CAL/G) =   1510.0,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1603, 0.1223, 0.2404, 0.2546,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =   36.0,
   INITIAL HEIGHT OF CLOUD (M) =    0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =  5.2838220E8,
   FUEL BURN RATE (G/S) =    6.30528E6,
   HEAT CONTENT (CAL/G) =    587.00,
   FRACTION HCL,CO2,CO,AL2O3 = 0.0395, 0.0884, 0.0000, 0.0683,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =   50.0,
   INITIAL HEIGHT OF CLOUD (M) =    0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) =   1.174183E7,
   FUEL BURN RATE (G/S) =   1.849107E5,
   HEAT CONTENT (CAL/G) =    1449.9,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1589, 0.2783, 0.0331, 0.1936,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    6.0,
   INITIAL HEIGHT OF CLOUD (M) =    0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) =      2.104E6,
   TOTAL LIQUID OXIDIZER (G) =      3.972E6,
   FUEL FLOW RATE (G/S) =     5.944E3,
   OXIDIZER FLOW RATE (G/S) =    1.1221E4,
   TIME OF IGNITION (S) =    260.3,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =   36.0,
   INITIAL HEIGHT OF CLOUD (M) =    0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                          VEHICLE DATA SECTION
   VEHICLE TYPE = 3, NAME =    DELTA 2914,
   TIME HEIGHT COEFFICIENTS A,B,C =     0.922156,     0.432703,        0.54,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 6,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =   2.887598E7,
   FUEL BURN RATE (G/S) =   8.360685E5,
   HEAT CONTENT (CAL/G) =   1766.0,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1218, 0.2055, 0.0156, 0.2214,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =   36.0,
   INITIAL HEIGHT OF CLOUD (M) =    0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =   1.885373E7,
   FUEL BURN RATE (G/S) =   2.729434E5,
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   HEAT CONTENT (CAL/G) =     690.0,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1218, 0.2055, 0.0156, 0.2214,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) =   4.812663E6,
   FUEL BURN RATE (G/S) =   1.393447E5,
   HEAT CONTENT (CAL/G) =    1766.0,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1218, 0.2055, 0.0156, 0.2214,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =     6.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) =          0.0,
   TOTAL LIQUID OXIDIZER (G) =          0.0,
   FUEL FLOW RATE (G/S) =          0.0,
   OXIDIZER FLOW RATE (G/S) =          0.0,
   TIME OF IGNITION (S) =        0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                       VEHICLE DATA SECTION
   VEHICLE TYPE = 3, NAME =    DELTA 3914,
   TIME HEIGHT COEFFICIENTS A,B,C =     1.245756,    0.4180947,          0.0,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 6,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =    6.70269E7,
   FUEL BURN RATE (G/S) =   1.057557E6,
   HEAT CONTENT (CAL/G) =    1449.9,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1589, 0.2783, 0.0331, 0.1936,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =   4.699308E7,
   FUEL BURN RATE (G/S) =    3.70731E5,
   HEAT CONTENT (CAL/G) =    411.18,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1589, 0.2783, 0.0331, 0.1936,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) =   1.117115E7,
   FUEL BURN RATE (G/S) =   1.762595E5,
   HEAT CONTENT (CAL/G) =    1449.9,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1589, 0.2783, 0.0331, 0.1936,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
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   INITIAL RADIUS OF CLOUD (M) =     6.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) =          0.0,
   TOTAL LIQUID OXIDIZER (G) =          0.0,
   FUEL FLOW RATE (G/S) =          0.0,
   OXIDIZER FLOW RATE (G/S) =          0.0,
   TIME OF IGNITION (S) =        0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =     0.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,

#05.00                  VEHICLE DATA SECTION
   VEHICLE TYPE = 4, NAME =  MINUTEMAN II,
   TIME HEIGHT COEFFICIENTS A,B,C =     0.469982,     0.463333,          0.0,
#05.01 SOLID ROCKET BOOSTER (SRB) ENGINE DATA, NUMBER OF SRB'S = 0,
 A-NORMAL LAUNCH
   TOTAL FUEL (G) =  2.8106856E7,
   FUEL BURN RATE (G/S) =   4.684476E5,
   HEAT CONTENT (CAL/G) =    2055.9,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1866, 0.2055, 0.0156, 0.3391,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 B-CONFLAGRATION
   TOTAL FUEL (G) =  2.8106856E7,
   FUEL BURN RATE (G/S) =   1.171119E5,
   HEAT CONTENT (CAL/G) =    1000.0,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1866, 0.2055, 0.0156, 0.3391,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
 C-SINGLE ENGINE TEST BURN
   TOTAL FUEL (G) =  2.8106856E7,
   FUEL BURN RATE (G/S) =   4.684476E5,
   HEAT CONTENT (CAL/G) =    2055.9,
   FRACTION HCL,CO2,CO,AL2O3 = 0.1866, 0.2055, 0.0156, 0.3391,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
   INITIAL HEIGHT OF CLOUD (M) =     0.0,
   INITIAL X DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
   INITIAL Y DISPLACEMENT OF CLOUD FROM PAD (M) =     0.0,
#05.02 LIQUID HYPERGOLIC ENGINE DATA
 A-NORMAL LAUNCH/DEFLAGRATION
   TOTAL LIQUID FUEL (G) =          0.0,
   TOTAL LIQUID OXIDIZER (G) =          0.0,
   FUEL FLOW RATE (G/S) =          0.0,
   OXIDIZER FLOW RATE (G/S) =          0.0,
   TIME OF IGNITION (S) =        0.0,
   INITIAL VERTICAL VELOCITY OF CLOUD (M/S) =   0.0,
   INITIAL RADIUS OF CLOUD (M) =    36.0,
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586.	427.	365.	423.	426.	376.	225.	126.	154.	170.	310.	365.	182.	262.	244.	245.
322.	408.	400.	369.	426.	363.	365.	360.	282.	259.	303.	243.	182.	232.	304.	285.
0.	0.	0.	74.	179.	189.	288.	198.	157.	180.	218.	365.	451.	451.	388.	548.
492.	445.	482.	429.	277.	231.	287.	125.	121.	184.	311.	304.	182.	304.	365.	398.
396.	369.	436.	486.	456.	357.	184.	286.	383.	512.	438.	318.	182.	226.	272.	305.
0.	0.	0.	76.	133.	304.	303.	344.	384.	426.	533.	401.	361.	328.	355.	422.
367.	482.	412.	312.	243.	191.	144.	121.	121.	121.	224.	182.	244.	249.	304.	365.
461.	486.	487.	487.	214.	205.	214.	281.	345.	448.	384.	290.	182.	243.	325.	393.
0.	0.	0.	32.	121.	299.	353.	300.	274.	302.	352.	265.	299.	243.	321.	487.
304.	243.	182.	216.	230.	243.	182.	130.	115.	121.	184.	258.	304.	322.	365.	255.
377.	457.	487.	381.	164.	131.	204.	161.	241.	392.	484.	266.	182.	304.	303.	208.
0.	0.	0.	38.	112.	95.	152.	123.	187.	190.	217.	196.	242.	262.	363.	426.
316.	337.	216.	121.	156.	232.	183.	120.	104.	161.	254.	249.	239.	182.	165.	182.
272.	373.	269.	247.	147.	120.	121.	128.	315.	351.	327.	258.	121.	285.	157.	121.
0.	0.	0.	0.	87.	235.	231.	265.	299.	283.	286.	271.	292.	383.	286.	217.
369.	304.	183.	122.	126.	194.	182.	77.	121.	178.	224.	170.	118.	97.	113.	116.
127.	272.	104.	69.	69.	161.	121.	121.	366.	233.	212.	122.	121.	121.	121.	121.
0.	0.	0.	0.	66.	183.	182.	303.	182.	243.	276.	318.	304.	340.	301.	131.
296.	239.	169.	92.	130.	243.	121.	85.	111.	243.	153.	90.	60.	61.	60.	64.
61.	60.	88.	75.	84.	218.	177.	121.	224.	121.	121.	121.	121.	121.	121.	153.
0.	0.	0.	0.	60.	122.	185.	204.	181.	186.	195.	207.	152.	170.	208.	118.
177.	126.	181.	143.	170.	148.	75.	60.	60.	60.	62.	121.	106.	137.	116.	126.
213.	129.	182.	121.	121.	182.	121.	121.	121.	121.	121.	121.	121.	142.	160.	180.
0.	0.	0.	0.	0.	109.	181.	112.	123.	130.	161.	190.	127.	105.	89.	77.
60.	57.	53.	59.	59.	60.	60.	60.	60.	60.	60.	120.	216.	233.	240.	191.
243.	248.	180.	121.	121.	179.	121.	121.	133.	124.	147.	161.	158.	168.	182.	190.
0.	0.	0.	0.	0.	60.	73.	121.	125.	121.	120.	117.	103.	60.	60.	60.
58.	46.	40.	59.	59.	59.	60.	60.	82.	68.	241.	121.	242.	243.	243.	245.
292.	198.	153.	122.	121.	225.	185.	129.	184.	170.	182.	199.	178.	179.	215.	246.
0.	0.	0.	0.	0.	24.	58.	88.	82.	61.	81.	60.	60.	60.	60.	60.
58.	45.	32.	59.	59.	59.	59.	60.	122.	121.	182.	177.	121.	155.	182.	182.
186.	182.	180.	175.	195.	182.	182.	236.	244.	185.	254.	261.	182.	183.	292.	244.
0.	0.	0.	0.	0.	0.	55.	71.	64.	60.	60.	60.	60.	60.	60.	60.
59.	50.	42.	60.	60.	59.	59.	59.	84.	114.	123.	182.	121.	132.	179.	182.
182.	186.	237.	182.	244.	241.	182.	266.	249.	303.	304.	243.	246.	183.	245.	258.
0.	0.	0.	0.	0.	0.	33.	62.	58.	60.	60.	60.	60.	60.	60.	60.
59.	53.	51.	60.	60.	60.	60.	60.	68.	120.	121.	139.	141.	156.	177.	182.
244.	292.	401.	182.	308.	297.	297.	339.	305.	326.	246.	304.	300.	201.	243.	249.
0.	0.	0.	0.	0.	0.	21.	60.	16.	60.	60.	60.	60.	60.	60.	60.
60.	57.	60.	60.	60.	61.	60.	60.	121.	121.	121.	179.	179.	182.	209.	261.
243.	309.	310.	243.	358.	418.	398.	367.	338.	374.	365.	395.	245.	267.	246.	242.
0.	0.	0.	0.	0.	0.	0.	0.	22.	60.	60.	60.	75.	60.	60.	60.
60.	60.	60.	60.	79.	83.	97.	116.	128.	153.	154.	179.	240.	258.	243.	342.
271.	327.	431.	245.	410.	502.	417.	483.	486.	455.	340.	262.	244.	284.	304.	232.
0.	0.	0.	0.	0.	0.	0.	39.	67.	119.	121.	60.	121.	60.	60.	60.
89.	74.	68.	63.	101.	117.	121.	146.	172.	182.	225.	182.	227.	243.	349.	326.
317.	338.	397.	255.	304.	523.	447.	370.	419.	369.	367.	308.	304.	304.	313.	243.
0.	0.	0.	0.	0.	0.	0.	46.	72.	120.	121.	121.	112.	73.	84.	60.
92.	98.	93.	102.	120.	121.	121.	121.	182.	226.	242.	234.	243.	297.	321.	426.
426.	426.	425.	369.	424.	486.	305.	304.	426.	306.	403.	365.	304.	353.	316.	285.
0.	0.	0.	0.	0.	0.	38.	60.	72.	108.	121.	121.	121.	121.	121.	60.
83.	115.	120.	121.	147.	160.	148.	179.	210.	276.	303.	301.	333.	359.	425.	304.
398.	428.	361.	408.	424.	354.	288.	343.	395.	304.	359.	372.	365.	304.	304.	304.
0.	0.	0.	0.	0.	5.	60.	61.	77.	99.	121.	121.	121.	121.	108.	121.
108.	121.	126.	166.	182.	208.	207.	242.	270.	304.	306.	300.	301.	359.	359.	337.
394.	387.	448.	399.	306.	296.	273.	306.	296.	304.	280.	280.	304.	304.	304.	330.
0.	0.	0.	0.	1.	38.	60.	60.	72.	92.	112.	121.	121.	121.	121.	121.
121.	121.	152.	237.	287.	280.	304.	303.	293.	273.	243.	229.	244.	337.	305.	243.
269.	243.	306.	270.	246.	231.	231.	243.	243.	243.	243.	271.	304.	304.	304.	357.
0.	0.	0.	0.	44.	60.	60.	60.	68.	90.	116.	121.	121.	121.	134.	140.

#08.00 DIGITIZED MAP DATA

1 LOCAL VANDENBERG COAST LINE

716122.5	3886604.5	716122.0	3886191.8	716146.4	3885966.0	716150.4	3885696.3
716182.9	3885294.5	716185.7	3885046.8	716180.0	3884721.5	716193.9	3884402.3
716197.4	3884153.8	716200.7	3883884.3	716220.4	3883587.0	716213.8	3883299.3
716200.0	3882980.5	716226.9	3882749.3	716202.6	3882373.5	716228.6	3882076.5
716205.3	3881762.0	716210.2	3881386.8	716185.8	3881144.5	716129.6	3880675.8
716101.6	3880322.5	716077.3	3880079.5	716036.8	3879847.8	716027.6	3879599.0
716002.4	3879395.5	715963.4	3879135.8	715910.4	3878864.8	715879.7	3878654.5
715901.3	3878412.0	715831.3	3878085.8	715764.8	3877749.5	715729.4	3877434.5
715695.9	3877114.0	715635.8	3876904.0	715578.8	3876703.8	715538.1	3876444.3
715481.2	3876167.8	715435.3	3875831.5	715355.8	3875570.8	715331.4	3875327.3
715286.6	3875111.0	715243.2	3874800.0	715149.8	3874460.5	715053.4	3874209.5
715009.9	3873901.3	714964.3	3873684.0	714920.1	3873437.3	714873.7	3873219.8
714804.3	3872970.8	714745.9	3872723.0	714674.8	3872475.0	714618.8	3872227.3
714572.2	3871979.8	714501.3	3871792.5	714455.6	3871545.3	714384.6	3871358.0
714340.4	3871112.0	714270.1	3870861.8	714225.2	3870614.5	714154.8	3870366.3
714082.3	3870179.3	714023.9	3869931.5	713941.6	3869683.0	713922.0	3869436.3
713849.4	3869249.0	713793.3	3869002.5	713735.6	3868723.8	713667.5	3868413.8
713560.6	3868101.8	713464.1	3867883.8	713328.8	3867696.8	713206.3	3867507.0
713462.5	3867406.8	713518.7	3867176.0	713525.9	3866867.8	713482.4	3866558.0
713388.0	3866248.3	713292.9	3865937.8	713200.1	3865627.3	713143.1	3865317.0
713036.0	3865007.3	712916.3	3864696.0	712922.0	3864448.8	713151.1	3864392.5
713483.4	3864338.8	713787.3	3864377.8	714216.6	3864448.8	714398.1	3864360.0
714675.0	3864398.8	714979.6	3864405.8	715236.4	3864287.3	715396.8	3863983.8
715556.4	3863679.0	715536.1	3863462.3	715642.0	3863279.3	715821.8	3863160.3
715827.6	3862915.0	715863.9	3862452.0	715843.6	3862236.0	716051.1	3862024.8
716283.9	3861847.0	716648.3	3861547.3	716904.4	3861430.0	717134.4	3861342.5
717343.5	3861162.0	717577.1	3860921.0	717757.1	3860832.3	717989.4	3860715.8
718043.8	3860499.3	718251.4	3860351.0	718383.5	3860138.8	718517.1	3859864.8
718600.0	3859619.0	718661.8	3859128.0	718682.6	3858820.0	718676.5	3858511.0
718683.8	3858203.8	718615.0	3857893.8	718571.5	3857583.8	718528.8	3857275.5
718459.1	3856965.3	718416.5	3856654.8	718372.2	3856346.3	718304.1	3856037.3
718285.3	3855728.3	718217.1	3855417.0	718172.1	3855109.5	718077.7	3854798.5
718010.4	3854487.5	717915.3	3854176.5	717846.4	3853866.3	717778.2	3853556.5
717734.7	3853248.0	717665.8	3852937.8	717572.8	3852535.8	717527.8	3852318.5
717433.4	3852007.8	717338.3	3851696.8	717244.6	3851387.3	717124.0	3851075.8
716978.8	3850764.0	716884.3	3850453.0	716815.3	3850144.0	716721.7	3849833.3
716651.9	3849523.0	716558.2	3849213.5	716514.6	3848903.8	716444.8	3848592.8
716349.7	3848344.0	716632.3	3848196.5	716890.9	3848049.5	716972.3	3847835.8
717077.7	3847652.0	717108.2	3847437.3	717107.8	3847220.8	717118.4	3847006.0
717249.9	3846825.0	717343.3	3846641.8	717408.0	3846427.0	717695.5	3846310.5
717900.3	3846193.0	718078.1	3846042.0	718288.4	3845925.0	718408.1	3845741.3
718450.6	3845527.3	718600.4	3845346.5	718705.8	3845162.3	718752.3	3844948.3
718782.9	3844732.8	718982.3	3844645.0	719062.2	3844461.5	719100.7	3844247.3
719198.9	3844064.5	719204.0	3843850.3	719322.9	3843666.8	719496.0	3843548.5
719646.0	3843396.8	719759.3	3843216.5	719822.6	3843000.5	719858.7	3842787.0
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3 ROADS
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3 ROADS
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3 ROADS
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722839.9	3836500.3	722830.7	3836752.0	722811.8	3836975.5	722731.5	3837166.8
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725504.8	3843214.5	725501.7	3843437.5	725468.5	3843687.3	725340.1	3843928.5
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723590.9	3846566.3	723454.1	3846796.0	723306.6	3847009.8	723170.8	3847196.3
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722560.5	3851149.5	722660.7	3851376.0	722774.8	3851590.8	722873.3	3851787.5
722931.8	3851997.8	722947.8	3852221.0	722921.8	3852445.8	723061.6	3852707.5
723273.1	3852869.3	723432.3	3852992.0	723615.4	3853106.3	723796.7	3853202.8
724054.8	3853279.0	724268.3	3853324.3	724462.6	3853372.0	724680.1	3853445.0
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725163.1	3854202.8	725029.9	3854412.8	724915.8	3854628.8	724805.0	3854869.0
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723960.8	3855790.5	723749.3	3855929.8	723519.6	3856063.0	723293.4	3856182.8
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718253.3	3860638.8	718026.6	3860719.5	717797.5	3860869.5		

3 ROADS

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730066.1	3844059.8	730007.7	3844326.0	729934.9	3844531.5	729782.1	3844756.3
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729002.8	3845669.3	728843.4	3845871.5	728683.3	3846076.3	728504.6	3846256.0
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727880.4	3850352.0	728087.3	3850569.0	728345.4	3850614.5	728592.4	3850625.0
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-5 SMX
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5 RNWY
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3 SOUTH VAN. ROADS
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3 SOUTH VAN ROADS CONT.
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3 SOUTH VAND. ROADS CONT.
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3 SOUTH VAND. ROADS CONT.
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3 SOUTH VAND. ROADS CONT.
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3 ROADS CONT.

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3 ROADS CONT.

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3 ROADS CONT.

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721318.2 3840423.5

3 ROADS CONT.

722873.8 3837868.3 722614.9 3837874.3 722414.6 3837865.3 722175.5 3837872.5
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719694.1 3839141.5

3 ROADS CONT.

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3 ROADS CONT.

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3 ROADS CONT.

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4 SLC 2
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4 S3E
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4 S4E
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4 SLC 10
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-4 GERTS
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4 MPS 36
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4 OAK MTN
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-4 PT SAL
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-4 PT ARGUELLO
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-4 PT CNCPTN
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4 HERMOSA
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4 HONDO
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4 HONDO SALM
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4 JULIUS (1988)
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4 HAYLEY (1990)
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3 Central Ave
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3 Bailey Ave
730652.7 3838103.0 730725.6 3835185.0
3 Floridale Ave
729873.4 3835823.0 729784.2 3839408.0 728915.1 3840745.0 728873.5 3842421.0
3 Leege Ave
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3 Douglas Ave
728170.8 3839402.0 728251.0 3836158.0 727797.7 3835619.0
3 DeWolff Ave
727371.3 3839476.0 727455.9 3836044.0
3 Artesia Ave
726583.6 3839853.0 726663.8 3836590.0
3 Union Sugar Ave
725767.4 3839833.0 725828.8 3837324.0
3 La Salle Canyon Rd
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4 HOUSING
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4 1 houses
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4 1 houses
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4 1 houses
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4 1 houses
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4 1 houses

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4 1 houses
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4 1 houses
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4 1 houses
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4 1 houses
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4 1 houses
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727339.9 3828828.0
4 1 houses
737881.1 3828471.0 737881.1 3828551.0 737961.1 3828551.0 737961.1 3828471.0
737881.1 3828471.0
4 1 houses

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  737858.1 3827847.0  737858.1 3827927.0  737938.1 3827927.0  737938.1 3827847.0
  737858.1 3827847.0
4                                              1 houses
  738310.3 3827651.0  738310.3 3827731.0  738390.3 3827731.0  738390.3 3827651.0
  738310.3 3827651.0
4                                              1 houses
  738671.0 3827264.0  738671.0 3827344.0  738751.0 3827344.0  738751.0 3827264.0
  738671.0 3827264.0
4                                              1 houses
  738926.1 3826458.0  738926.1 3826538.0  739006.1 3826538.0  739006.1 3826458.0
  738926.1 3826458.0
4                                              1 houses
  739248.1 3826033.0  739248.1 3826113.0  739328.1 3826113.0  739328.1 3826033.0
  739248.1 3826033.0
4                                              1 houses
  739264.6 3825392.0  739264.6 3825472.0  739344.6 3825472.0  739344.6 3825392.0
  739264.6 3825392.0
4                                              1 houses
  738723.0 3825246.0  738723.0 3825326.0  738803.0 3825326.0  738803.0 3825246.0
  738723.0 3825246.0
4                                              1 houses
  741572.8 3827263.0  741572.8 3827343.0  741652.8 3827343.0  741652.8 3827263.0
  741572.8 3827263.0
4                                              1 houses
  743908.8 3822889.0  743908.8 3822969.0  743988.8 3822969.0  743988.8 3822889.0
  743908.8 3822889.0
4                                              1 houses
  748765.9 3823376.0  748765.9 3823456.0  748845.9 3823456.0  748845.9 3823376.0
  748765.9 3823376.0
4                                              1 houses
  752356.1 3818149.0  752356.1 3818229.0  752436.1 3818229.0  752436.1 3818149.0
  752356.1 3818149.0
4                                              1 houses
  751258.3 3819819.0  751258.3 3819899.0  751338.3 3819899.0  751338.3 3819819.0
  751258.3 3819819.0
4                                              1 houses
  748347.3 3817890.0  748347.3 3817970.0  748427.3 3817970.0  748427.3 3817890.0
  748347.3 3817890.0
4                                              1 houses
  747008.3 3819893.0  747008.3 3819973.0  747088.3 3819973.0  747088.3 3819893.0
  747008.3 3819893.0
4                                              1 houses
  746996.8 3820327.0  746996.8 3820407.0  747076.8 3820407.0  747076.8 3820327.0
  746996.8 3820327.0
4                                              1 houses
  746214.5 3818928.0  746214.5 3819008.0  746294.5 3819008.0  746294.5 3818928.0
  746214.5 3818928.0
4                                              1 houses
  746486.4 3817520.0  746486.4 3817600.0  746566.4 3817600.0  746566.4 3817520.0
  746486.4 3817520.0
4                                              1 houses
  746317.5 3817270.0  746317.5 3817350.0  746397.5 3817350.0  746397.5 3817270.0
  746317.5 3817270.0
4                                              1 houses
  746148.8 3816982.0  746148.8 3817062.0  746228.8 3817062.0  746228.8 3816982.0
  746148.8 3816982.0
4                                              1 houses
  745087.1 3818804.0  745087.1 3818884.0  745167.1 3818884.0  745167.1 3818804.0
  745087.1 3818804.0
4                                              1 houses
```

745959.9 3816789.0 745959.9 3816869.0 746039.9 3816869.0 746039.9 3816789.0
745959.9 3816789.0
4 1 houses
745477.8 3817304.0 745477.8 3817384.0 745557.8 3817384.0 745557.8 3817304.0
745477.8 3817304.0
4 1 houses
744619.8 3816582.0 744619.8 3816662.0 744699.8 3816662.0 744699.8 3816582.0
744619.8 3816582.0
4 1 houses
744385.4 3818087.0 744385.4 3818167.0 744465.4 3818167.0 744465.4 3818087.0
744385.4 3818087.0
4 1 houses
744105.1 3819098.0 744105.1 3819178.0 744185.1 3819178.0 744185.1 3819098.0
744105.1 3819098.0
4 1 houses
743613.4 3816273.0 743613.4 3816353.0 743693.4 3816353.0 743693.4 3816273.0
743613.4 3816273.0
4 1 houses
742197.7 3818256.0 742197.7 3818336.0 742277.7 3818336.0 742277.7 3818256.0
742197.7 3818256.0
4 1 houses
743210.4 3818283.0 743210.4 3818363.0 743290.4 3818363.0 743290.4 3818283.0
743210.4 3818283.0
4 1 houses
743023.3 3819486.0 743023.3 3819566.0 743103.3 3819566.0 743103.3 3819486.0
743023.3 3819486.0
4 1 houses
741299.1 3816817.0 741299.1 3816897.0 741379.1 3816897.0 741379.1 3816817.0
741299.1 3816817.0
4 1 houses
740519.4 3816816.0 740519.4 3816896.0 740599.4 3816896.0 740599.4 3816816.0
740519.4 3816816.0
4 1 houses
740523.8 3819667.0 740523.8 3819747.0 740603.8 3819747.0 740603.8 3819667.0
740523.8 3819667.0
4 1 houses
739460.8 3818562.0 739460.8 3818642.0 739540.8 3818642.0 739540.8 3818562.0
739460.8 3818562.0
4 1 houses
739349.3 3817597.0 739349.3 3817677.0 739429.3 3817677.0 739429.3 3817597.0
739349.3 3817597.0
4 1 houses
738161.0 3817566.0 738161.0 3817646.0 738241.0 3817646.0 738241.0 3817566.0
738161.0 3817566.0
4 1 houses
737558.4 3817476.0 737558.4 3817556.0 737638.4 3817556.0 737638.4 3817476.0
737558.4 3817476.0
4 1 houses
737621.5 3818100.0 737621.5 3818180.0 737701.5 3818180.0 737701.5 3818100.0
737621.5 3818100.0
4 1 houses
738013.4 3819525.0 738013.4 3819605.0 738093.4 3819605.0 738093.4 3819525.0
738013.4 3819525.0
4 2 houses
728825.8 3838098.0 728825.8 3838211.0 728938.9 3838211.0 728938.9 3838098.0
728825.8 3838098.0
4 2 houses
729076.4 3836599.0 729076.4 3836712.0 729189.5 3836712.0 729189.5 3836599.0
729076.4 3836599.0
4 2 houses

729536.4 3836097.0 729536.4 3836210.0 729649.5 3836210.0 729649.5 3836097.0
729536.4 3836097.0
4 2 houses
728925.8 3836025.0 728925.8 3836138.0 729038.9 3836138.0 729038.9 3836025.0
728925.8 3836025.0
4 2 houses
726663.0 3839800.0 726663.0 3839913.0 726776.1 3839913.0 726776.1 3839800.0
726663.0 3839800.0
4 2 houses
726498.1 3838608.0 726498.1 3838721.0 726611.3 3838721.0 726611.3 3838608.0
726498.1 3838608.0
4 2 houses
726740.4 3835876.0 726740.4 3835989.0 726853.5 3835989.0 726853.5 3835876.0
726740.4 3835876.0
4 2 houses
726579.2 3835305.0 726579.2 3835418.0 726692.3 3835418.0 726692.3 3835305.0
726579.2 3835305.0
4 2 houses
727014.1 3829465.0 727014.1 3829578.0 727127.2 3829578.0 727127.2 3829465.0
727014.1 3829465.0
4 2 houses
732459.1 3832827.0 732459.1 3832940.0 732572.3 3832940.0 732572.3 3832827.0
732459.1 3832827.0
4 2 houses
732086.7 3830592.0 732086.7 3830705.0 732199.8 3830705.0 732199.8 3830592.0
732086.7 3830592.0
4 2 houses
730941.0 3829694.0 730941.0 3829807.0 731054.1 3829807.0 731054.1 3829694.0
730941.0 3829694.0
4 2 houses
726159.1 3824631.0 726159.1 3824744.0 726272.3 3824744.0 726272.3 3824631.0
726159.1 3824631.0
4 2 houses
737707.3 3830016.0 737707.3 3830129.0 737820.4 3830129.0 737820.4 3830016.0
737707.3 3830016.0
4 2 houses
737436.8 3829160.0 737436.8 3829273.0 737549.9 3829273.0 737549.9 3829160.0
737436.8 3829160.0
4 2 houses
736465.1 3829135.0 736465.1 3829248.0 736578.2 3829248.0 736578.2 3829135.0
736465.1 3829135.0
4 2 houses
736513.3 3826437.0 736513.3 3826550.0 736626.4 3826550.0 736626.4 3826437.0
736513.3 3826437.0
4 2 houses
738150.3 3826422.0 738150.3 3826535.0 738263.4 3826535.0 738263.4 3826422.0
738150.3 3826422.0
4 2 houses
746663.6 3822436.0 746663.6 3822549.0 746776.7 3822549.0 746776.7 3822436.0
746663.6 3822436.0
4 2 houses
749533.4 3823154.0 749533.4 3823267.0 749646.5 3823267.0 749646.5 3823154.0
749533.4 3823154.0
4 2 houses
750149.9 3819130.0 750149.9 3819243.0 750263.1 3819243.0 750263.1 3819130.0
750149.9 3819130.0
4 2 houses
747012.9 3817612.0 747012.9 3817725.0 747126.0 3817725.0 747126.0 3817612.0
747012.9 3817612.0
4 2 houses

745710.6 3818181.0 745710.6 3818294.0 745823.7 3818294.0 745823.7 3818181.0
745710.6 3818181.0
4 2 houses
744546.0 3820190.0 744546.0 3820303.0 744659.1 3820303.0 744659.1 3820190.0
744546.0 3820190.0
4 2 houses
742695.8 3818668.0 742695.8 3818781.0 742808.9 3818781.0 742808.9 3818668.0
742695.8 3818668.0
4 2 houses
743172.6 3819077.0 743172.6 3819190.0 743285.8 3819190.0 743285.8 3819077.0
743172.6 3819077.0
4 2 houses
741350.4 3817199.0 741350.4 3817312.0 741463.5 3817312.0 741463.5 3817199.0
741350.4 3817199.0
4 3 houses
728774.1 3834932.0 728774.1 3835070.0 728912.8 3835070.0 728912.8 3834932.0
728774.1 3834932.0
4 3 houses
728207.2 3837410.0 728207.2 3837548.0 728345.8 3837548.0 728345.8 3837410.0
728207.2 3837410.0
4 3 houses
727895.3 3835855.0 727895.3 3835993.0 728033.9 3835993.0 728033.9 3835855.0
727895.3 3835855.0
4 3 houses
727879.1 3835703.0 727879.1 3835842.0 728017.7 3835842.0 728017.7 3835703.0
727879.1 3835703.0
4 3 houses
727264.9 3839331.0 727264.9 3839469.0 727403.5 3839469.0 727403.5 3839331.0
727264.9 3839331.0
4 3 houses
727344.8 3837672.0 727344.8 3837810.0 727483.4 3837810.0 727483.4 3837672.0
727344.8 3837672.0
4 3 houses
726462.2 3839538.0 726462.2 3839676.0 726600.8 3839676.0 726600.8 3839538.0
726462.2 3839538.0
4 3 houses
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727369.3 3839068.0
4 3 houses
726475.5 3835007.0 726475.5 3835146.0 726614.1 3835146.0 726614.1 3835007.0
726475.5 3835007.0
4 3 houses
725602.7 3838100.0 725602.7 3838239.0 725741.3 3838239.0 725741.3 3838100.0
725602.7 3838100.0
4 3 houses
729290.6 3827433.0 729290.6 3827571.0 729429.2 3827571.0 729429.2 3827433.0
729290.6 3827433.0
4 3 houses
737157.3 3828952.0 737157.3 3829090.0 737295.9 3829090.0 737295.9 3828952.0
737157.3 3828952.0
4 3 houses
737567.7 3828113.0 737567.7 3828252.0 737706.3 3828252.0 737706.3 3828113.0
737567.7 3828113.0
4 3 houses
747786.6 3819527.0 747786.6 3819666.0 747925.3 3819666.0 747925.3 3819527.0
747786.6 3819527.0
4 3 houses
745339.9 3818423.0 745339.9 3818562.0 745478.6 3818562.0 745478.6 3818423.0
745339.9 3818423.0
4 3 houses

```
745158.1 3817211.0  745158.1 3817349.0  745296.8 3817349.0  745296.8 3817211.0
745158.1 3817211.0
4                                                 3 houses
740211.9 3816987.0  740211.9 3817126.0  740350.6 3817126.0  740350.6 3816987.0
740211.9 3816987.0
4                                                 3 houses
739404.7 3819572.0  739404.7 3819710.0  739543.3 3819710.0  739543.3 3819572.0
739404.7 3819572.0
4                                                 4 houses
727257.6 3836017.0  727257.6 3836177.0  727417.6 3836177.0  727417.6 3836017.0
727257.6 3836017.0
4                                                 4 houses
726335.3 3836315.0  726335.3 3836475.0  726495.3 3836475.0  726495.3 3836315.0
726335.3 3836315.0
4                                                 4 houses
725295.8 3836724.0  725295.8 3836884.0  725455.8 3836884.0  725455.8 3836724.0
725295.8 3836724.0
4                                                 4 houses
734795.8 3815667.0  734795.8 3815827.0  734955.8 3815827.0  734955.8 3815667.0
734795.8 3815667.0
4                                                 4 houses
752117.6 3818953.0  752117.6 3819113.0  752277.6 3819113.0  752277.6 3818953.0
752117.6 3818953.0
4                                                 4 houses
746923.0 3818587.0  746923.0 3818747.0  747083.0 3818747.0  747083.0 3818587.0
746923.0 3818587.0
4                                                 4 houses
741564.0 3816313.0  741564.0 3816473.0  741724.0 3816473.0  741724.0 3816313.0
741564.0 3816313.0
4                                                 5 houses
744397.1 3823834.0  744397.1 3824013.0  744575.9 3824013.0  744575.9 3823834.0
744397.1 3823834.0
4                                                 5 houses
747619.0 3817709.0  747619.0 3817888.0  747797.9 3817888.0  747797.9 3817709.0
747619.0 3817709.0
4                                                 6 houses
744414.4 3816937.0  744414.4 3817133.0  744610.4 3817133.0  744610.4 3816937.0
744414.4 3816937.0
4                                                 7 houses
729676.8 3837033.0  729676.8 3837245.0  729888.4 3837245.0  729888.4 3837033.0
729676.8 3837033.0
4                                                 7 houses
742513.6 3816313.0  742513.6 3816525.0  742725.3 3816525.0  742725.3 3816313.0
742513.6 3816313.0
```

APPENDIX C: Input Batch Files

RUN_ROLD.BAT

```
reedm < in_1a
reedm < in_1b
reedm < in_1c
reedm < in_2a
reedm < in_2b
reedm < in_3a
reedm < in_3b
reedm < in_4a
reedm < in_5a
reedm < in_5b
reedm < in_5c
reedm < in_6a
reedm < in_6b
reedm < in_6bb
reedm < in_6c
reedm < in_7a
reedm < in_7b
reedm < in_7c
reedm < in_7d
reedm < in_7e
reedm < in_8a
reedm < in_8b
reedm < in_8bb
reedm < in_8c
reedm < in_9a
reedm < in_9b
reedm < in_9c
reedm < in_9d
reedm < in_9e
reedm < in_9f
reedm < in_9g
reedm < in_9h
reedm < in_9i
reedm < in_9j
```

RUN_RNEW.BAT

```
newreedm < in_1a
newreedm < in_1b
newreedm < in_1c
newreedm < in_2a
```

```
newreedm < in_2b
newreedm < in_3a
newreedm < in_3b
newreedm < in_4a
newreedm < in_5a
newreedm < in_5b
newreedm < in_5c
newreedm < in_6a
newreedm < in_6b
newreedm < in_6bb
newreedm < in_6c
newreedm < in_7a
newreedm < in_7b
newreedm < in_7c
newreedm < in_7d
newreedm < in_7e
newreedm < in_8a
newreedm < in_8b
newreedm < in_8bb
newreedm < in_8c
newreedm < in_9a
newreedm < in_9b
newreedm < in_9c
newreedm < in_9d
newreedm < in_9e
newreedm < in_9f
newreedm < in_9g
newreedm < in_9h
newreedm < in_9i
newreedm < in_9j
```

IN_1A (All other 'IN_ ' input files are identical to this one except for differing rawinsonde file names on line 5. eg. r1a, r1b, r1c, r2a)

```
 ! conflag, no plots, research, no cloud heights specified, zero shear
(706s)
n! classified
b,f! files
r1a! rawin name
p1a_0shr! print
b! research
 ! dosage model
d! T-IV
```

```
 ! op #
b! sounding time
b! conflagration
 ! SRB parameters
 ! a,b,c
 ! species fractions
 ! SRB cloud parameters
 ! abort at surface
 ! HCl
 ! gamma (0.5)
f! SLC 4e
 ! calc hgt (gnd)
 ! shape (sphere)
 ! absorption coeff for gases (0.0)
 ! decay coeff for gases (0.0)
 ! diffusion coeffs (x-wnd = 1, vert = 1)
 ! downwind expansion distances (x-wnd = 100, vert = 100)
60! tmc
 ! SRB temp
 ! tower, Doppler
 ! cloud cover
 ! ceiling
 ! T- hrs
 ! print detailed
y! allow sigma-a to be raised
n! change reflection
y! max centerline calcs
 ! distances
 ! discrete pts (n)
 ! another (n)
```

APPENDIX D: Sample Output File

----- PROGRAM OPTIONS -----

MODEL		CONCENTRATION
RUN TYPE		RESEARCH
WIND-FIELD TERRAIN EFFECTS MODEL		NONE
LAUNCH VEHICLE		TITAN IV
LAUNCH TYPE		CONFLAGRATION
LAUNCH COMPLEX NUMBER		4E
TURBULENCE PARAMETERS ARE DETERMINED FROM		DOPPLER & TOWER DATA
SPECIES		HCL
CLOUD SHAPE		SPHERICAL
CALCULATION HEIGHT		SURFACE
PROPELLANT TEMPERATURE (DEG. C)		14.17
TIME AFTER LAUNCH OF ABORT (SECONDS)		0.00
HEIGHT OF ABORT (METERS)		0.00
CONCENTRATION AVERAGING TIME (SEC.)		60.00
DECAY COEFFICIENT		0.0000
ABSORPTION COEFFICIENT (RNG- 0 TO 1,NO ABSORPTION=0)		0.0000
DIFFUSION COEFFICIENTS	LATERAL	1.0000
	VERTICAL	1.0000
VEHICLE AIR ENTRAINMENT PARAMETER	GAMMAE	0.5000
DOWNWIND EXPANSION DISTANCE (METERS)	LATERAL	100.00
	VERTICAL	100.00

----- DATA FILES -----

INPUT FILES

RAWINSONDE FILE	r1a
DATA BASE FILE	RDMBASE

OUTPUT FILES

PRINT FILE	p1a_0shr

----- METEOROLOGICAL RAWINSONDE DATA -----

TEST NBR SITE: 900 OP NO: 12345 ASC NO: 420
RAWINSONDE MSS/SYN
TIME- 1115 Z DATE- 01 AUG 1993
ASCENT NUMBER 420

----- T +0.0 HR SOUNDING -----

MET. LEV. NO.	ALTITUDE MSL (FT)	GND (FT)	GND (M)	WIND DIR (DEG)	WIND SPEED (M/S)	(KTS)	TEMP	AIR PTEMP (DEG C)	DPTEMP	AIR PRESS (MB)	AIR RH (%)	H M	INT-ERP
1	368	0.0	0.0	280	4.6	9.0	24.3	25.8	10.7	1000.0	42.4		
2	414	46.4	14.1	278	4.7	9.2	24.0	25.6	10.2	998.0	41.5		**
3	461	92.8	28.3	276	4.8	9.4	23.8	25.5	9.6	996.0	40.7		**
4	507	139.2	42.4	274	4.9	9.6	23.5	25.4	9.1	994.0	39.8		**
5	554	185.6	56.6	272	5.0	9.8	23.3	25.2	8.5	992.0	39.0		**
6	600	232.0	70.7	270	5.1	10.0	23.0	25.1	8.0	990.0	38.2		
7	836	468.4	142.8	274	5.4	10.4	23.0	25.4	7.8	985.6	37.9		**
8	1073	704.8	214.8	278	5.6	10.8	22.9	25.8	7.7	981.2	37.6		**
9	1309	941.2	286.9	282	5.8	11.2	22.9	26.1	7.5	976.9	37.3		**
10	1546	1177.6	358.9	286	6.0	11.6	22.8	26.4	7.4	972.6	37.0		**
11	1782	1414.0	431.0	290	6.2	12.0	22.8	26.8	7.2	968.3	36.7	*	
12	1800	1431.8	436.4	307	6.6	12.8	24.4	28.9	7.5	962.7	34.1		**
13	1818	1449.6	441.8	324	7.0	13.6	26.0	31.1	7.9	957.2	31.7		**
14	1835	1467.4	447.3	341	7.4	14.4	27.7	33.3	8.2	951.8	29.6		**
15	1853	1485.2	452.7	358	7.8	15.2	29.3	35.5	8.6	946.4	27.6		**
16	1871	1503.0	458.1	15	8.2	16.0	30.9	37.7	8.9	941.0	26.0		
17	2423	2055.0	626.4	15	8.5	16.5	30.9	38.8	6.5	927.2	21.9		**
18	2975	2607.0	794.6	15	8.7	17.0	30.9	40.0	4.1	913.7	18.0		
19	3886	3518.0	1072.3	19	8.2	16.0	28.6	40.5	5.4	885.7	23.0		
20	4733	4365.0	1330.5	28	7.2	14.0	27.2	41.4	0.4	860.3	17.0		
21	5511	5143.0	1567.6	37	5.7	11.0	25.4	41.9	0.3	837.4	19.0		
22	6361	5993.0	1826.7	41	4.1	8.0	23.1	42.3	2.0	813.0	25.0		
23	7315	6947.0	2117.4	55	2.1	4.0	20.5	42.7	2.4	786.2	30.0		
24	7524	7156.3	2181.2	71	2.1	4.0	20.0	42.7	1.9	780.4	30.8		**
25	7734	7365.5	2245.0	88	2.1	4.0	19.4	42.8	1.3	774.7	30.7		**
26	7943	7574.7	2308.8	104	2.1	4.0	18.9	42.8	0.8	768.9	30.5		**
27	8152	7784.0	2372.6	120	2.1	4.0	18.3	42.8	0.2	763.3	29.0		
28	8539	8170.5	2490.4	131	3.1	6.0	18.2	43.8	-4.2	752.8	22.4		**
29	8925	8557.0	2608.2	142	4.1	8.0	18.1	44.7	-8.5	742.5	16.0		
30	9668	9300.0	2834.6	145	5.1	10.0	16.3	45.1	-9.4	723.1	16.0		

* - INDICATES THE CALCULATED TOP OF THE SURFACE MIXING LAYER
** - INDICATES THAT DATA IS LINEARLY INTERPOLATED FROM INPUT METEOROLOGY

SURFACE AIR DENSITY (GM/M**3) 1203.55
MIXING LAYER HEIGHT 430.99 (M) SPECIFIED BY PRESSURE LEVEL (MB) 968.00
CLOUD COVER IN TENTHS OF CELESTIAL DOME 0.0
CLOUD CEILING (M) 9999.0

VERSION 7.05 AT VAFB
1359 PDT 28 SEP 1995
launch time: 0415 PDT 01 AUG 1993
RAWINSONDE ASCENT NUMBER 420, 1115 Z 1 AUG 1993 T +0.0 HR
****

```
***REEDM  WARNING 09, END OF FILE READ, DATA MAY BE TRUNCATED, FILE =
                  rla
                   THE ERROR OCCURRED AT RECORD   40.00

***REEDM  ERROR 09, INCOMPLETE DATA - DOPPLER
                   THE ERROR OCCURRED AT RECORD   40.00

***REEDM  ERROR 01, INPUT ERROR AT CHARACTER  6, INPUT BUFFER=
   1 AUG 1993  968.
```

----- PLUME RISE DATA -----

EXHAUST RATE OF MATERIAL-	(GRAMS/SEC)		1.17655E+06
TOTAL MATERIAL OUTPUT-	(GRAMS)		5.36146E+08
HEAT OUTPUT PER GRAM-	(CALORIES)		2137.0000
VEHICLE RISE TIME PARAMETERS-	(TK=(A*Z**B)+C)	A=	0.8678
		B=	0.4500
		C=	0.0000

VERSION 7.05 AT VAFB
1359 PDT 28 SEP 1995
launch time: 0415 PDT 01 AUG 1993
RAWINSONDE ASCENT NUMBER 420, 1115 Z 1 AUG 1993 T +0.0 HR
****

----- EXHAUST CLOUD -----

MET. LAYER NO.	TOP OF LAYER (METERS)	CLOUD RISE TIME (SECONDS)	CLOUD RISE RANGE (METERS)	CLOUD RISE BEARING (DEGREES)	STABILIZED CLOUD RANGE (METERS)	STABILIZED CLOUD BEARING (DEGREES)
1	14.1	2.8	12.9	99.0	574.2	99.0
2	28.3	4.2	19.7	98.3	586.4	97.0
3	42.4	5.4	25.7	97.5	598.5	95.1
4	56.6	6.6	31.3	96.7	610.3	93.2
5	70.7	7.8	37.0	95.8	621.9	91.3
6	142.8	13.7	67.1	94.1	638.6	92.2
7	214.8	20.2	100.6	94.7	659.4	95.8
8	286.9	27.3	138.3	96.2	677.7	99.2
9	358.9	35.1	180.5	98.0	693.2	102.4
10	431.0	43.7	227.3	100.1	705.3	105.5
11	436.4	44.6	232.3	100.5	722.3	112.8
12	441.8	45.7	237.2	101.3	731.1	125.0
13	447.3	46.9	241.3	102.5	725.0	137.7
14	452.7	48.1	244.2	104.1	704.8	151.1
15	458.1	49.6	245.4	105.9	671.9	165.4
16	626.4	89.9	357.9	151.7	588.3	170.3
17	794.6	122.6 *	532.7	167.6	532.7	167.6
18	1072.3	122.6 *	532.7	167.6	532.7	167.6
19	1330.5	0.0	0.0	0.0	0.0	0.0
20	1567.6	0.0	0.0	0.0	0.0	0.0
21	1826.7	0.0	0.0	0.0	0.0	0.0
22	2117.4	0.0	0.0	0.0	0.0	0.0
23	2181.2	0.0	0.0	0.0	0.0	0.0
24	2245.0	0.0	0.0	0.0	0.0	0.0
25	2308.8	0.0	0.0	0.0	0.0	0.0
26	2372.6	0.0	0.0	0.0	0.0	0.0
27	2490.4	0.0	0.0	0.0	0.0	0.0
28	2608.2	0.0	0.0	0.0	0.0	0.0
29	2834.6	0.0	0.0	0.0	0.0	0.0

* - INDICATES CLOUD STABILIZATION TIME WAS USED

----- EXHAUST CLOUD -----

MET. LAYER NO.	TOP OF LAYER (METERS)		LAYER SOURCE STRENGTH (GRAMS)	CLOUD UPDRAFT VELOCITY (M/S)	CLOUD RADIUS (METERS)	STD. DEVIATION MATERIAL DIST. ALONGWIND (METERS)	CROSSWIND (METERS)
1	14.1		7.03328E+03	4.8	72.0	33.6	33.6
2	28.3		3.48180E+03	9.9	72.0	33.6	33.6
3	42.4		5.08348E+03	11.4	72.0	33.6	33.6
4	56.6		7.36062E+03	12.0	72.0	33.6	33.6
5	70.7		1.05693E+04	12.2	72.0	33.6	33.6
6	142.8		1.70629E+05	12.1	72.0	33.6	33.6
7	214.8		8.07770E+05	11.2	72.0	33.6	33.6
8	286.9		3.07751E+06	10.1	149.3	69.6	69.6
9	358.9		9.43562E+06	9.2	218.7	101.9	101.9
10	431.0		2.32859E+07	8.4	301.8	140.6	140.6
11	436.4		2.57827E+06	5.8	331.7	154.6	154.6
12	441.8		2.71420E+06	5.1	335.3	156.3	156.3
13	447.3		2.85375E+06	4.6	338.8	157.9	157.9
14	452.7		2.99670E+06	4.2	342.2	159.5	159.5
15	458.1		3.14287E+06	3.8	345.5	161.0	161.0
16	626.4		1.72449E+08	4.2	383.6	178.8	178.8
17	794.6	*	2.13132E+08	0.0	397.7	185.3	185.3
18	1072.3	*	9.94685E+07	0.0	292.5	136.3	136.3
19	1330.5		0.00000E+00	0.0	0.0	0.0	0.0
20	1567.6		0.00000E+00	0.0	0.0	0.0	0.0
21	1826.7		0.00000E+00	0.0	0.0	0.0	0.0
22	2117.4		0.00000E+00	0.0	0.0	0.0	0.0
23	2181.2		0.00000E+00	0.0	0.0	0.0	0.0
24	2245.0		0.00000E+00	0.0	0.0	0.0	0.0
25	2308.8		0.00000E+00	0.0	0.0	0.0	0.0
26	2372.6		0.00000E+00	0.0	0.0	0.0	0.0
27	2490.4		0.00000E+00	0.0	0.0	0.0	0.0
28	2608.2		0.00000E+00	0.0	0.0	0.0	0.0
29	2834.6		0.00000E+00	0.0	0.0	0.0	0.0

* - INDICATES CLOUD STABILIZATION TIME WAS USED

----- CLOUD STABILIZATION -----

CALCULATION HEIGHT	(METERS)		0.00
STABILIZATION HEIGHT	(METERS)		659.09
STABILIZATION TIME	(SECS)		122.65
BURN TIME	(SECS)		450.00
FIRST MIXING LAYER HEIGHT-	(METERS)	TOP =	430.99
		BASE=	0.00
SECOND SELECTED LAYER HEIGHT-	(METERS)	TOP =	2834.64
		BASE=	430.99
SIGMAR(AZ) AT THE SURFACE	(DEGREES)		4.2484
SIGMER(EL) AT THE SURFACE	(DEGREES)		1.0000

MET. LAYER NO.	WIND SPEED (M/SEC)	WIND SPEED SHEAR (M/SEC)	WIND DIRECTION (DEG)	WIND DIRECTION SHEAR (DEG)	SIGMA OF AZI ANG (DEG)	SIGMA OF ELE ANG (DEG)
1	4.70	0.10	279.00	-2.00	4.0937	2.2286
2	4.78	0.10	277.00	-2.00	4.8991	4.6582
3	4.89	0.10	275.00	-2.00	6.5921	6.5921
4	4.99	0.10	273.00	-2.00	7.5667	7.5667
5	5.09	0.10	271.00	-2.00	7.9771	7.9771
6	5.25	0.21	272.00	4.00	8.3229	8.3229
7	5.45	0.21	276.00	4.00	7.9700	7.9700
8	5.66	0.21	280.00	4.00	6.2099	6.2099
9	5.86	0.21	284.00	4.00	3.9848	3.9848
10	6.07	0.21	288.00	4.00	1.9949	1.9949
11	6.38	0.41	298.50	17.00	1.0000	1.0000
12	6.79	0.41	315.50	17.00	1.0000	1.0000
13	7.20	0.41	332.50	17.00	1.0000	1.0000
14	7.61	0.41	349.50	17.00	1.0000	1.0000
15	8.03	0.41	6.50	17.00	1.0000	1.0000
16	8.36	0.26	15.00	0.00	1.0000	1.0000
17	8.62	0.26	15.00	0.00	1.0000	1.0000
18	8.49	-0.51	17.00	4.00	1.0000	1.0000
19	7.72	-1.03	23.50	9.00	1.0000	1.0000
20	6.43	-1.54	32.50	9.00	1.0000	1.0000
21	4.89	-1.54	39.00	4.00	1.0000	1.0000
22	3.09	-2.06	48.00	14.00	1.0000	1.0000
23	2.06	0.00	63.13	16.25	1.0000	1.0000
24	2.06	0.00	79.38	16.25	1.0000	1.0000
25	2.06	0.00	95.63	16.25	1.0000	1.0000
26	2.06	0.00	111.88	16.25	1.0000	1.0000
27	2.57	1.03	125.50	11.00	1.0000	1.0000
28	3.60	1.03	136.50	11.00	1.0000	1.0000
29	4.63	1.03	143.50	3.00	1.0000	1.0000

----- CALCULATED TRANSITION LAYER PARAMETERS -----

TRANSITION LAYER NUMBER- 1

VALUE AT	HEIGHT (METERS)	TEMP. (DEG K)	WIND SPEED (M/SEC)	WIND SPEED SHEAR (M/SEC)	WIND DIR. (DEG)	WIND DIR. SHEAR (DEG)	SIGMA AZI. (DEG)	SIGMA ELE. (DEG)
TOP-	430.99	299.91	6.17		290.00		1.0000	1.0000
LAYER-			5.51	0.28	279.51	4.29	5.7873	5.7223
BOTTOM-	0.00	298.91	4.63		280.00		4.2484	1.0000

TRANSITION LAYER NUMBER- 2

VALUE AT	HEIGHT (METERS)	TEMP. (DEG K)	WIND SPEED (M/SEC)	WIND SPEED SHEAR (M/SEC)	WIND DIR. (DEG)	WIND DIR. SHEAR (DEG)	SIGMA AZI. (DEG)	SIGMA ELE. (DEG)
TOP-	2834.64	318.27	5.14		145.00		1.0000	1.0000
LAYER-			4.37	2.47	35.41	22.06	1.0000	1.0000
BOTTOM-	430.99	299.91	6.17		290.00		1.0000	1.0000

DIAGNOSTICS FOR MODEL CALCULATIONS

----- MAXIMUM CENTERLINE CALCULATIONS -----

CONCENTRATION OF HCL AT A HEIGHT OF 0.0 METERS
DOWNWIND FROM A TITAN IV CONFLAGRATION LAUNCH
CALCULATIONS APPLY TO THE LAYER BETWEEN 0.0 AND 431.0 METERS

RANGE FROM PAD (METERS)	BEARING FROM PAD (DEGREES)	PEAK CONCEN-TRATION (PPM)	CLOUD ARRIVAL TIME (MIN)	CLOUD DEPARTURE TIME (MIN)
1000.000	96.500	3.975	0.959	1.840
2000.328	98.475	18.643	3.463	5.359
3000.009	99.655	32.680	6.207	8.908
4000.231	100.127	33.770	8.952	12.460
5000.121	99.910	29.163	11.695	16.014
6000.059	99.766	24.621	14.439	19.570
7000.024	99.662	21.111	17.182	23.127
8000.006	99.585	18.411	19.924	26.687
9000.297	99.977	16.280	22.666	30.247
10000.267	99.930	14.556	25.408	33.809
11000.242	99.892	13.128	28.149	37.371
12000.223	99.860	11.928	30.889	40.934
13000.205	99.833	10.904	33.630	44.499
14000.190	99.811	10.020	36.370	48.063
15000.178	99.791	9.250	39.109	51.629
16000.167	99.773	8.573	41.848	55.194
17000.156	99.758	7.973	44.587	58.761
18000.148	99.744	7.438	47.325	62.327
19000.141	99.732	6.959	50.063	65.894
20000.133	99.721	6.526	52.801	69.461
21000.127	99.711	6.135	55.538	73.028
22000.121	99.702	5.778	58.275	76.596
23000.115	99.694	5.453	61.012	80.164
24000.111	99.686	5.155	63.748	83.732
25000.107	99.679	4.882	66.484	87.300
26000.104	99.673	4.629	69.219	90.868
27000.100	99.667	4.396	71.955	94.437
28000.096	99.661	4.180	74.690	98.005
29000.092	99.656	3.980	77.425	101.574
30000.090	99.651	3.793	80.159	105.142

	RANGE	BEARING
33.770 IS THE MAXIMUM PEAK CONCENTRATION	4000.2	100.1

----- MAXIMUM CENTERLINE CALCULATIONS -----

CONCENTRATION OF HCL AT A HEIGHT OF 0.0 METERS
DOWNWIND FROM A TITAN IV CONFLAGRATION LAUNCH
CALCULATIONS APPLY TO THE LAYER BETWEEN 0.0 AND 431.0 METERS

RANGE FROM PAD (METERS)	BEARING FROM PAD (DEGREES)	TOTAL DOSAGE (PPM SEC)	CLOUD ARRIVAL TIME (MIN)	CLOUD DEPARTURE TIME (MIN)
1000.000	96.500	60.746	0.959	1.840
2000.020	99.257	487.739	3.463	5.359
3000.144	100.072	1450.550	6.207	8.908
4000.231	100.127	1652.987	8.952	12.460
5000.121	99.910	1462.006	11.695	16.014
6000.059	99.766	1249.305	14.439	19.570
7000.381	100.109	1083.336	17.182	23.127
8000.333	100.035	955.671	19.924	26.687
9000.297	99.977	854.884	22.666	30.247
10000.267	99.930	773.312	25.408	33.809
11000.242	99.892	705.958	28.149	37.371
12000.223	99.860	649.386	30.889	40.934
13000.205	99.833	601.212	33.630	44.499
14000.190	99.811	559.686	36.370	48.063
15000.178	99.791	523.529	39.109	51.629
16000.167	99.773	491.757	41.848	55.194
17000.156	99.758	463.622	44.587	58.761
18000.148	99.744	438.530	47.325	62.327
19000.141	99.732	416.017	50.063	65.894
20000.133	99.721	395.694	52.801	69.461
21000.127	99.711	377.277	55.538	73.028
22000.121	99.702	360.486	58.275	76.596
23000.115	99.694	345.137	61.012	80.164
24000.111	99.686	331.032	63.748	83.732
25000.107	99.679	318.043	66.484	87.300
26000.104	99.673	306.027	69.219	90.868
27000.100	99.667	294.893	71.955	94.437
28000.096	99.661	284.534	74.690	98.005
29000.092	99.656	274.884	77.425	101.574
30000.090	99.651	265.862	80.159	105.142

	RANGE	BEARING
1652.987 IS THE MAXIMUM TOTAL DOSAGE	4000.2	100.1

launch time: 0415 PDT 01 AUG 1993
RAWINSONDE ASCENT NUMBER 420, 1115 Z 1 AUG 1993 T +0.0 HR
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----- MAXIMUM CENTERLINE CALCULATIONS -----

CONCENTRATION OF HCL AT A HEIGHT OF 0.0 METERS
DOWNWIND FROM A TITAN IV CONFLAGRATION LAUNCH
CALCULATIONS APPLY TO THE LAYER BETWEEN 0.0 AND 431.0 METERS

RANGE FROM PAD (METERS)	BEARING FROM PAD (DEGREES)	1.0 MIN. MEAN CONCEN-TRATION (PPM)	CLOUD ARRIVAL TIME (MIN)	CLOUD DEPARTURE TIME (MIN)
1000.000	96.500	1.012	0.959	1.840
2000.127	98.866	7.634	3.463	5.359
3000.144	100.072	20.393	6.207	8.908
4000.231	100.127	22.754	8.952	12.460
5000.121	99.910	20.019	11.695	16.014
6000.059	99.766	17.059	14.439	19.570
7000.381	100.109	14.751	17.182	23.127
8000.333	100.035	12.977	19.924	26.687
9000.297	99.977	11.574	22.666	30.247
10000.267	99.930	10.435	25.408	33.809
11000.242	99.892	9.492	28.149	37.371
12000.223	99.860	8.698	30.889	40.934
13000.205	99.833	8.018	33.630	44.499
14000.190	99.811	7.431	36.370	48.063
15000.178	99.791	6.917	39.109	51.629
16000.167	99.773	6.463	41.848	55.194
17000.156	99.758	6.060	44.587	58.761
18000.148	99.744	5.698	47.325	62.327
19000.141	99.732	5.372	50.063	65.894
20000.133	99.721	5.077	52.801	69.461
21000.127	99.711	4.807	55.538	73.028
22000.121	99.702	4.561	58.275	76.596
23000.115	99.694	4.335	61.012	80.164
24000.111	99.686	4.126	63.748	83.732
25000.107	99.679	3.932	66.484	87.300
26000.104	99.673	3.753	69.219	90.868
27000.100	99.667	3.586	71.955	94.437
28000.096	99.661	3.431	74.690	98.005
29000.092	99.656	3.285	77.425	101.574
30000.090	99.651	3.149	80.159	105.142

	RANGE	BEARING
22.754 IS THE MAXIMUM 1.0 MIN. MEAN CONCENTRATION	4000.2	100.1

VITA

Captain Chad A. Burel [redacted] He was an Eagle Scout in Boy Scout Troop 822 and the Vice President of a local Explorer Scout Post. He graduated Orange High School in May 1986.

He was admitted to North Carolina State University on an Air Force Reserve Officer Training Corp. (ROTC) scholarship. In May of 1991 he graduated with a BS degree in Mechanical Engineering, received the Distinguished Graduate award from his ROTC detachment and was commissioned as a 2nd Lieutenant in the US Air Force.

He was married to Shannon Michelle Smith [redacted]. In May of that same year, he reported to Ellsworth AFB in Rapid City South Dakota for his first active duty assignment. At his first assignment, he worked in the 28th Civil Engineering Squadron, Environmental Compliance Element. He was the base Environmental Coordinator for emergency response and clean up of hazardous materials. He was also active in readiness activities, deploying twice with the squadron, leading aggressor teams and directing a sensitive operation to remove a downed weather balloon from the nearby Badlands National Park. On 13 November 1993 he was promoted to the rank of 1st Lieutenant.

In May of 1994, he was assigned to the Air Force Institute of Technology to pursue a MS Degree in Engineering and Environmental Management. His area of study focused on environmental sciences and atmospheric modeling in particular. [redacted] On 13 Nov 1995 he was promoted to the rank of Captain. Upon completion of this thesis, he graduated in December of 1995.

He was then assigned to the Air Force Institute of Technology professional continuing education school to teach environmental managers in the Civil Engineering career field.

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13. ABSTRACT *(Maximum 200 words)*

Space launches at Vandenberg Air Force Base (VAFB) and the Cape Canaveral Air Station (CCAS) produce exhaust from the solid rocket boosters and liquid hypergolic fuels containing several toxic substances including hydrogen chloride and hydrazine. In order to estimate the health risk that would be imposed upon the public by proposed launches, range safety officials rely on the Rocket Exhaust Effluent Diffusion Model to predict where the exhaust chemicals will go after the launch and how strong the concentrations will be. The original REEDM program averaged the meteorological parameters (wind speed, wind direction, shear, etc.) across the entire mixing level and used these averages in its Gaussian calculations to predict instantaneous concentration, dose and time weighted average concentration. This thesis modified the model program to perform its meteorological parameter averaging using only those parameters which affected source material transport in diffusion, excluding from the averaging, those parameters which did not affect the calculation. The difference in before and after modification REEDM output was statistically, significantly different for maximum centerline instantaneous concentrations and maximum centerline doses . However, the magnitude of the difference may not be considered practically significant by launch safety officials.

14. SUBJECT TERMS
Rocket exhaust, REEDM, Toxic dispersion programs, Meteorological data
Exhaust cloud, Dispersion model, Gaussian dispersion, Gas dispersion

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