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AOIPS 3 User's Guide

Volume I : Overview and Software Utilization

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Volume I : Overview and Software Utilization

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List of Acronyms

AIRPAK - Aircraft Data Processing Package
AMMS - Advanced Microwave Moisture Sounder
AOIPS - Atmospheric and Oceanographic Information Processing System
CAPPI - Constant Altitude Plan Position Indicator
CPU - Central Processing Unit
DCL - DEC Command Language
DEC - Digital Equipment Corporation
DMSP - Defense Meteorological Satellite Program
GEMPAK - General Meteorological Data Processing Package
GMS - Japanese Geosynchronous Meteorological Satellite
GSC - General Sciences Corporation
GSFC - Goddard Space Flight Center
GOES - Geostationary Operational Environmental Satellite
IAT - Image Analysis Terminal
IIS - International Imaging System
IR - Infrared
LUT - Look-Up Table
MCD - Modified Cylindrical Equidistant Projection
MCR - Multi-spectral Cloud Radiometer
NCAR - National Center for Atmospheric Research
NRS - Navigational Recording System
NSSL - National Severe Storms Laboratory
PPI - Plan Position Indicator
RADPAK - Radar Data Processing Package

RHI - Range Height Indicator
SSM/I - Special Sensor Microwave/Imager
TAE - Transportable Applications Executive
TOGA - Tropical Oceans and Global Atmosphere
VAS - VISSR Atmospheric Sounder
VISSR - Visible Infrared Spin Scan Radiometer

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CHAPTER 1

DOCUMENT OVERVIEW

This document is Volume I of the Atmospheric and Oceanographic Information Processing System (AOIPS) User's Guide. Volume I is intended to provide the user with an overall guide to the AOIPS system. It introduces the user to AOIPS system concepts, explains how programs are related and the necessary order of program execution, and provides brief descriptions of the function of programs or groups of programs.

Volume II presents detailed program descriptions derived from on-line help for every AOIPS program. It is intended to serve as a reference for information such as: program function, input/output variable descriptions, program limitations, etc. Refer to Volume II for further details.

Chapter 2 provides a brief functional description of AOIPS software and the necessary information on how to get started using AOIPS. Some basic system concepts are also introduced.

Chapters 3 through 5 describe the satellite, radar and aircraft programs, respectively. The necessary program execution sequence is given and brief descriptions of program function are presented. Data flow diagrams are provided to illustrate program execution sequence and data transformations. Standard data flow syntax is used. Circles represent programs or groups of programs. Arrows represent data flows or transformations. Data stores, either disk files or tapes, are represented by two horizontal lines. Rectangles represent entities outside the system, such as user inputs. A glossary defining data stores and other terms is given at the end of each chapter. It should be noted that some program groups are not broken out into individual programs in the data flow diagrams because the programs in these groups do not have to be executed in any particular order. Rather, for brevity, the function of

these groups are just summarized.

Chapter 6 describes the numerous AOIPS utility programs. Utility programs are divided into different categories and listed alphabetically. The function of each utility is discussed briefly.

CHAPTER 2

AOIPS OVERVIEW

2.1 AOIPS Functional Overview

AOIPS is an interactive meteorological processing system with capabilities to ingest and analyze many types of meteorological data. AOIPS 3 is the version of the AOIPS software as of April 1989. The AOIPS software was developed jointly by the Goddard Space Flight Center and General Sciences Corporation. The primary motivation for such a system is to provide an analysis tool in support of the Goddard Space Flight Center (GSFC) Severe Storms Branch. AOIPS operates on hardware based upon Digital Equipment Corporation (DEC) VAX and MicroVAX super mini-computers and International Imaging System (IIS) Model 75 image analysis terminals. For a description of the hardware configuration see Hasler and desJardins (1987).

AOIPS includes several applications areas of relevance to meteorological research. AOIPS may be partitioned into four major applications components:

- 1) satellite data analysis;
- 2) radar data analysis (RADPAK);
- 3) aircraft data analysis (AIRPAK);
- 4) utilities.

It should be noted that GEMPAK, a General Meteorological Software Package (desJardins and Petersen, 1983) is a separate major software system which can be accessed from AOIPS. It is not described in this document. GEMPAK program descriptions are provided in the GEMPAK4 User's Guide (desJardins et al, 1988).

Table 1 summarizes major AOIPS software features. More complete descriptions are contained in later chapters.

Table 1 AOIPS Software Summary

- I. Satellite Data Analysis
 - A) Data Ingest
 - Archive Tapes: (GARS, ODIS, Japanese (GMS), SSM/I)
 - Real-Time: GOES
 - B) Navigation
 - Geosynchronous: (Keplerian and Chebychev navigation, Landmark Extraction)
 - SSM/I : Latitude/Longitude tagged data
 - C) Applications: (Cloud Tracking, Stereo, Hurricane Statistical, VAS Sounding Retrievals, Image Navigation)
 - D) Remapping: (Map projections, Radar Projections)
- II. Radar Data Analysis (RADPAK)
 - A) Data Ingest
 - Archive Tapes: (Universal, NSSL, NCAR, TOGA, etc.)
 - Real-Time: Alden Weather Circuit
 - Fields: (dBz, Velocity, Variance, Correlation, etc.)
 - B) Applications: (BSCAN Display, Velocity Unfolding, Data Deletion, Image Navigation, Rainfall Rate Conversion)
 - C) Remapping: (Radar Coordinates: (PPI, CAPPI, RHI), GOES, GEMPAK Projections)
- III. Aircraft Data Analysis (AIRPAK)
 - A) Data Ingest
 - Archive Tapes: (AMMS, MCR)
 - Fields: (Radiance, Brightness Temp., Reflection Function, Counts, Volts)
 - B) Navigation
 - Archive Tapes: (MMS, NRS)
 - C) Applications: (Image Navigation, Channel ratios)
 - D) Remapping: Remap to equidistant pixels at cloud height
- IV. Utilities
 - A) Image Manipulation: (Zoom, Shift, Noise Removal, Smooth, Stretch, Annotate, etc.)
 - B) Look-Up Table (Color Enhancement): (Create, Edit, Move, Add, Delete)
 - C) Image Arithmetic: (Add, Subtract, Multiply)
 - D) Image Gridding: (Political boundaries, Lat/Lon Grids, Range/Azimuth Grids)
 - E) Data Base Management: (File transfer, Delete, Edit)
 - F) System Utilities: (Device Allocation, Problem Reports, System News, etc.)

2.2 AOIPS User Interface

The Transportable Applications Executive (TAE) serves as the interface between the user and the AOIPS programs. TAE provides a standard and user-friendly set of interfaces, including on-line help. Only a few TAE concepts of relevance to the basic operation of AOIPS will be discussed here. It will be assumed that the user has familiarity with TAE commands. For a complete description of TAE, see the TAE User's Manual (1987).

TAE provides a menu interface for program selection. A more experienced user can invoke an AOIPS program directly by entering the command mode of TAE. When a program is invoked, TAE lists the input parameters in a standard manner and allows the user to edit them by specifying the variable name or by using the cursor to move to the variable line on the screen. If the user wishes to perform DCL operations, he may enter the TAE DCL mode by typing 'DCL <CR>' from the command mode. The TAE DCL mode simulates DCL and provides most, but not all, of the DCL features. To return to TAE command mode properly, the user should type 'TAE <CR>' or <CNTRL-Z> from his home directory. If the user changes his default directory, he should type 'HOME <CR>' before returning to TAE in order to reset the default directory to [USER.AOIPS].

AOIPS on-line help information can be obtained for any menu or program. Help information at the menu level is displayed by typing 'HELP * <CR>'. The menu help discusses how programs in the menu are related and the necessary order of their execution.

The program level on-line help is of two types. General program help is displayed by typing 'HELP * <CR>'. This help provides information on the purpose of the program and any operational notes. Help information on any parameter is obtained by typing 'HELP parameter name <CR>'. This help provides information on the nature of the particular parameter, that is, how it is used, its valid values, etc.

2.3 AOIPS Group

An AOIPS group is the disk and directory location where data to be accessed by AOIPS programs reside. AOIPS groups provide a means of organizing data files in a logical fashion, by allowing data to be located on different disk drives and/or located in different subdirectories. Each group must be a subdirectory of the user's subdirectory AOIPS. Thus, a group must be of form:
DISK:[USERNAME.AOIPS.GROUPNAME]. GROUPNAME is limited to a maximum of nine characters.

A group can be created by either using the DCL command 'CREATE/DIRECTORY [USER.AOIPS.GROUPNAME]' or by using the AOIPS utility program CREATGRP.

The AOIPS file location system provides a capability to set a default AOIPS group. AOIPS programs will then automatically point to the default group to access their data. The default group location can be set by the AOIPS utility programs GETGROUP and SETFLOC. The default group can be overridden by most AOIPS programs.

2.4 Getting Started

To properly enter and exit the AOIPS system, the following files are necessary:

1. The user must have a subdirectory called AOIPS under his main directory ([USER.AOIPS]).
2. The files ULOGON.PDF and ULOGOFF.PDF must reside in the AOIPS subdirectory for proper AOIPS entry and exit. These files may be copied from: AOIPS2\$PARAM:USRLOGON.PDF,USRLOGOFF.PDF.

To invoke AOIPS: type 'AOIPS' and press the carriage return key <CR>.

Upon entering AOIPS, the system will prompt the user for the default AOIPS group name. After the group name is entered, the system presents the top-level (root) menu of AOIPS.

Normally, the following AOIPS utility programs are executed at the beginning of a session:

1. ALLOC allocates the Image Analysis Terminal (IAT).
2. IATINIT initializes the IAT, which clears the refresh and graphic memories.

There are two commands to exit AOIPS:

1. EXIT leaves AOIPS, but the user remains logged onto the host computer.
2. LOG exits AOIPS and logs off the host computer.

CHAPTER 3

SATELLITE DATA PROCESSING

3.1 Geosynchronous Satellite Processing

The Geosynchronous Satellite Processing (Fig. 1) programs provide the capability to ingest, navigate, and analyze geosynchronous satellite data. The system is comprised of two major components: Image And Navigation Generation Programs (3.1.1); and Satellite Application Programs (3.1.2). The Image And Navigation Generation Programs produce the Satellite Image and Navigation Solution files from real-time GOES data or Archive Tapes. These files are the fundamental data stores for geosynchronous satellite data in order to analyze and navigate imagery data. Thus they are required input data to the Satellite Application Programs (3.1.4), as well as other general applications software discussed elsewhere in this document. The Satellite Application Programs (3.1.2) provide cloud tracking, synthetic stereo, stereo height and hurricane statistical analyses.

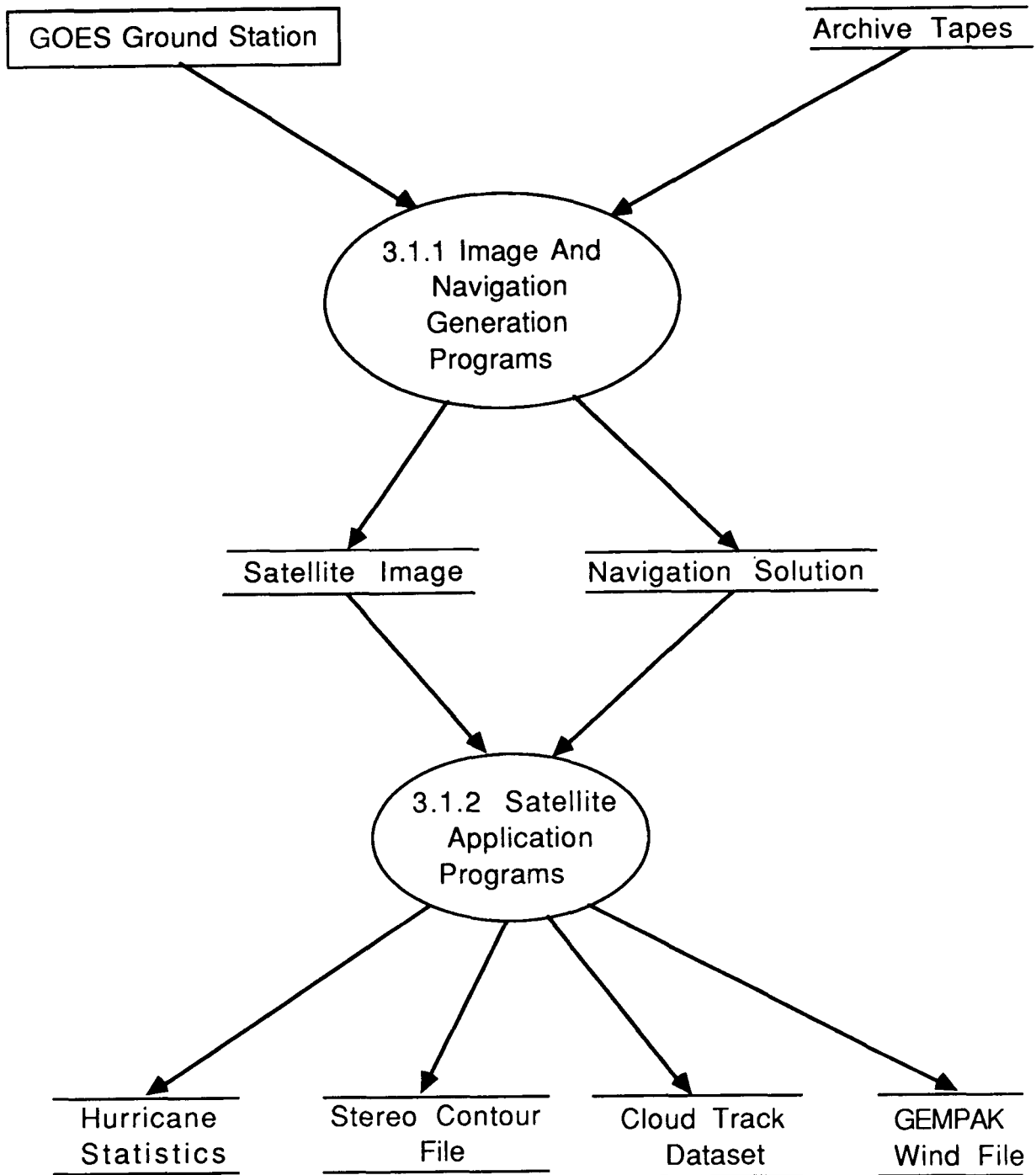


Figure 1. Geosynchronous Satellite Processing (3.1)

3.1.1 Image And Navigation Programs

The Image and Navigation Programs (Fig. 2) generate Satellite Images and Navigation Solutions files from both the AOIPS Tape and real-time data sources. There are a number of intermediate steps to produce these files which are a function of the initial data source. These steps are described in the descriptions of the components of the Image And Navigation Generation Programs that follow.

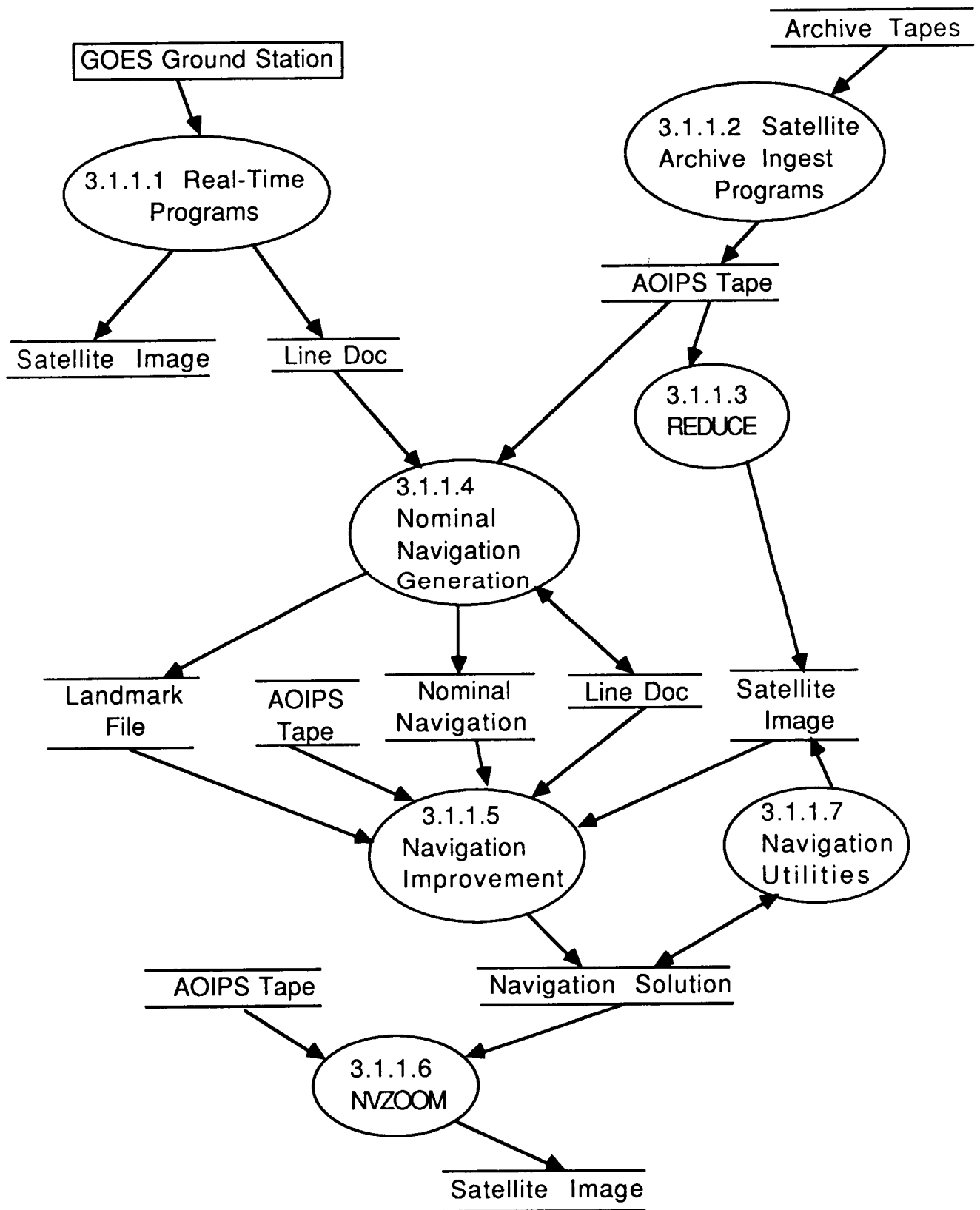


Figure 2. Image And Navigation Generation Programs (3.1.1)

3.1.1.1 Real-Time Programs

The Real-Time Programs (Fig. 3) receive the real-time GOES AAA mode satellite data and generate the AOIPS format Satellite Image and navigation common documentation (Line Doc) files as the end products.

The Real-Time Ingest (3.1.1.1.1) Software receives and sectorizes the data from the GOES satellite and generates the Real-Time Dataset on the Real-Time ingest computer (CPU). The Real-Time Dataset is essentially a disk file copy of all the AAA format data transmitted by the GOES satellite, with the addition of some header information.

SATING (3.1.1.1.2) is a command procedure which invokes the Real-Time Ingest Software (3.1.1.1.1) periodically, before the next scheduled transmit time of GOES data. (Usually, GOES data are transmitted every half hour). SATING passes to the Real-Time Ingest Software appropriate inputs from the Real-Time Schedule file.

The Real-Time Ingest Software and the SATING procedure reside on the Real-Time CPU (currently the MV2 MicroVAX) and are not part of the AOIPS system proper. They do not operate under TAE and are not directly accessible through AOIPS. Instead, these programs run continuously on the Real-Time CPU. Under normal circumstances, they only need to be invoked at system start-up time. To invoke SATING and thus the Real-Time Ingest Software, log on to the Real-Time CPU and enter @SATING.

REALSCH (3.1.1.1.3) allows the scheduling of ingest inputs by editing the Real-Time Schedule file. Parameters such as dataset geographic location, size, and resolution can be scheduled. In addition, REALSCH features a navigated box option which allows the location of the Real-Time Dataset to be selected by overlaying a box on a Master Satellite Image (a reduced navigated Satellite Image).

Satellite Images and Line Doc files are extracted from the Real-Time Dataset by REAL2IM (3.1.1.1.4). REAL2IM allows interactive extraction of the Satellite Image and Line Doc files. REXTRACT (3.1.1.1.5) automatically extracts Satellite Image files in batch mode from the Real-Time Datasets as they are updated on the Real-Time CPU by invoking REAL2IM at the proper time and passing it the appropriate input parameters.

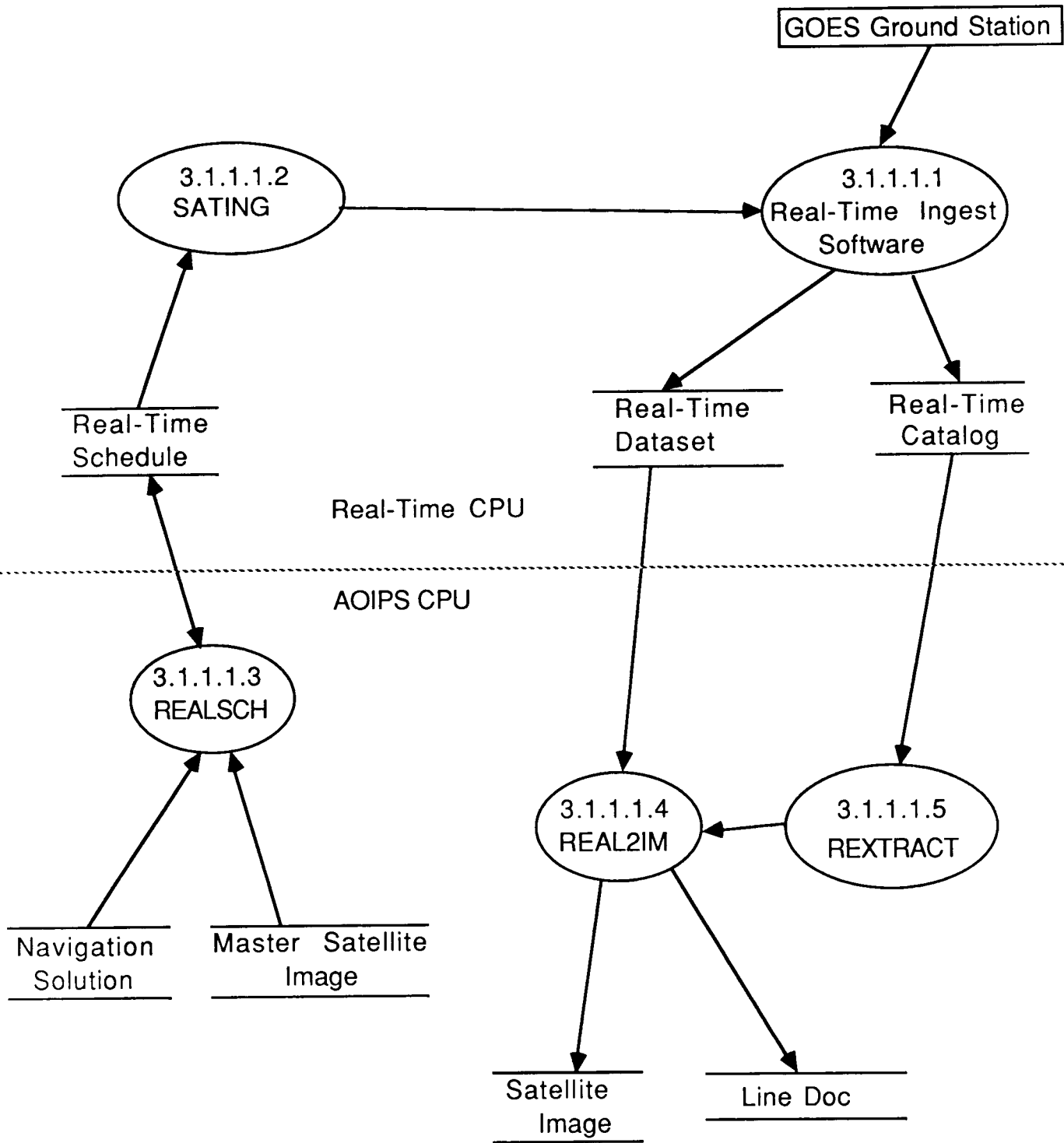


Figure 3. Real-Time Programs (3.1.1.1)

3.1.2 Satellite Archive Ingest Programs

The Satellite Archive Ingest Programs (Fig. 4) convert archive satellite data tapes to the common format AOIPS Tape. The AOIPS Tape is the data source for several subsequent programs that produce the Satellite Image and Navigation Solution. The archive data tapes include: GARS (the standard NOAA format for GOES data), ODIS (the previous format for GOES data), and GMS (Japanese Geosynchronous Meteorological Satellite) data.

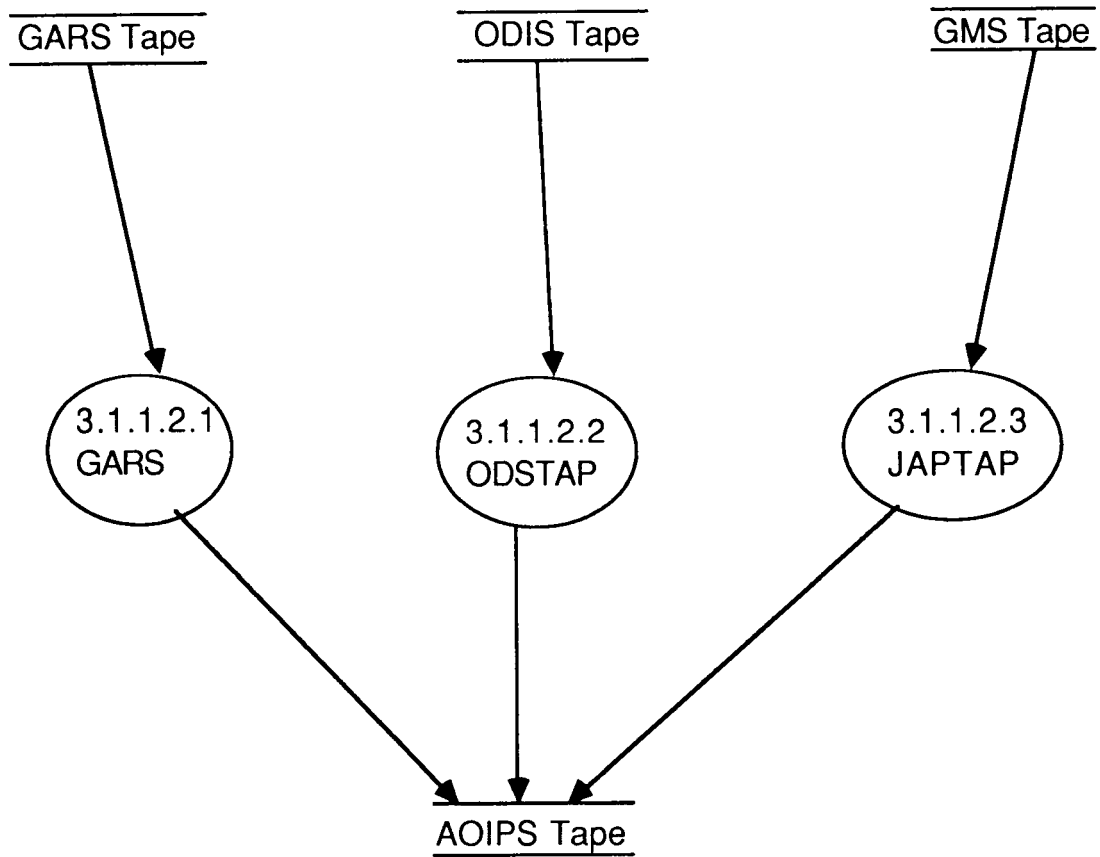


Figure 4. Satellite Archive Ingest Programs (3.1.1.2)

3.1.1.3 REDUCE

If the data source is the AOIPS Tape, REDUCE (3.1.1.3, see Fig. 2) is executed to generate a reduced resolution Satellite Image file from the AOIPS Tape. The reduced image allows the user to survey all the data covered by the scene stored on the AOIPS Tape, and provides a first-cut image to evaluate the quality of the Nominal Navigation Solution. It also is used to determine what landmarks are available to improve the nominal navigation if necessary (see below).

It should be noted that there are three programs that generate the Satellite Image from the AOIPS Tape: REDUCE (3.1.1.3), NVZOOM (3.1.1.6), and LMZOOM (3.1.1.5.4). These programs are used for different purposes to generate a Satellite Image from the AOIPS Tape. They are shown in the data flow diagrams each time they are necessary to execute. In the case of real-time data, only one program, REAL2IM (3.1.1.1.4), is necessary to extract the Satellite Image. For simplicity, this program is not repeated in the diagrams but is referenced in the text when necessary.

3.1.1.4 Nominal Navigation Generation

The Nominal Navigation Generation (Fig. 5) programs are executed to generate the nominal navigation solution. This solution, which is based solely upon the orbit and attitude parameters provided by the GOES data, is generally a good first approximation. In fact, for many applications, the nominal navigation solution is adequate. Both Keplerian and Chebychev navigation techniques are available.

In order to generate the nominal solution, the following sequence of steps is necessary:

1. If the data source is an AOIPS Tape, run NVLDOC (3.1.1.4.1) to store the formatted navigation parameters in the Line Doc file. If the source is the Real-Time Dataset, the Line Doc file is already generated by REAL2IM (3.1.1.1.4).
2. Run NVCFIL (3.1.1.4.2) to create empty Navigation Solution and Landmark Files.
3. Run NVGEN (3.1.1.4.3) to generate the nominal solution by selecting the nominal solution option of the program.
4. Run the Navigation Utilities (3.1.1.7) program NVLINK to link associated Satellite Image(s) to the navigation solution.

The quality of the nominal navigation solution can be evaluated by using the utility program NAV to check the accuracy of features in the Satellite Image against known landmarks. Alternatively, a geopolitical grid can be generated by the utility program MAPGRID, and the alignment between the grid and landmarks such as coastlines can be checked. If the navigation quality is acceptable, then full-resolution Satellite Images should be generated and linked to the navigation with NVLINK. If the data source is the AOIPS Tape, run NVZOOM (3.1.1.6). If the data source is the Real-Time Dataset, run REAL2IM (3.1.1.1.4). The quality of the navigation should then be rechecked using the full-resolution Satellite Images.

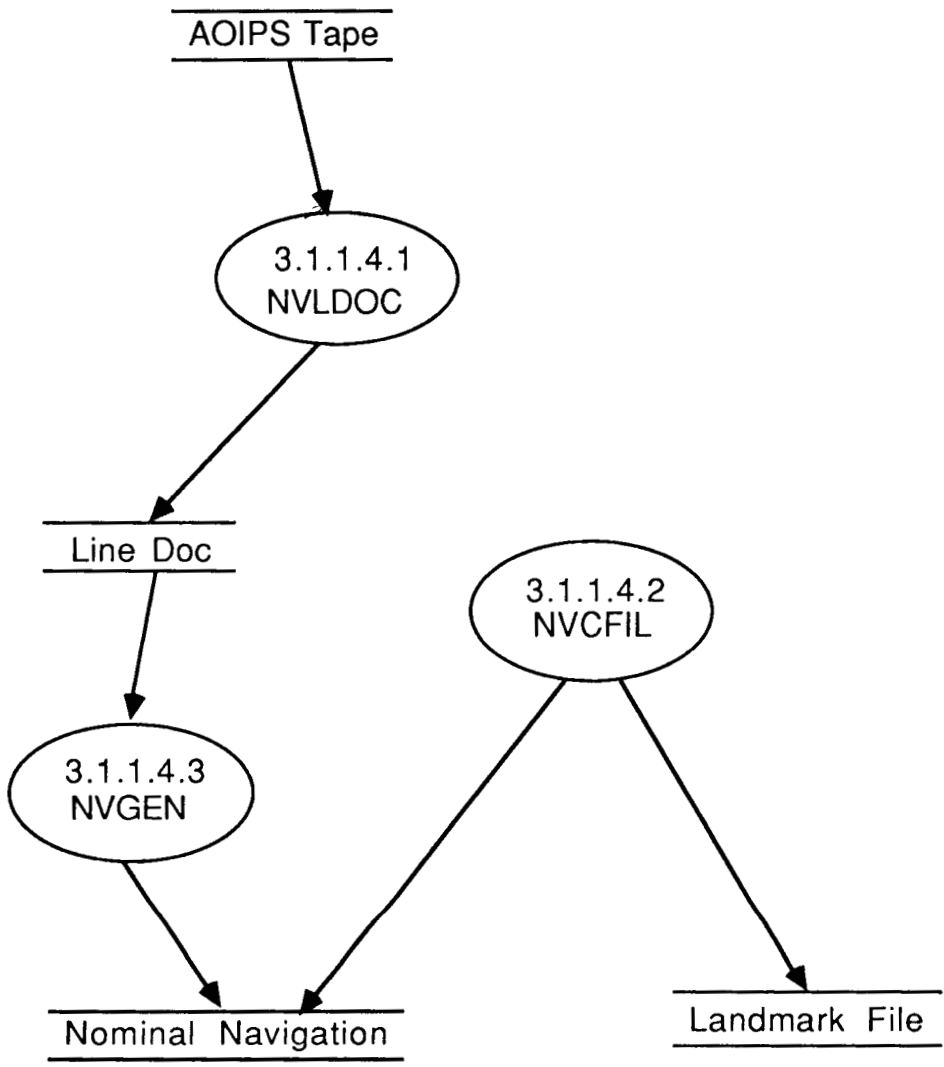


Figure 5. Nominal Navigation Generation (3.1.1.4)

3.1.1.5 Navigation Improvement

The Navigation Improvement software (Fig. 6) provides two techniques for improving the nominal navigation solution.

The first technique involves applying linear shifts to the navigation solution based upon the correspondence between a geopolitical map and visible landmarks (e.g., coastlines) in an image. This technique has the advantage of being relatively simple and fast. The following sequence of programs should be executed:

1. Run the utility MAPGRID (3.1.1.5.1) to generate the geopolitical grid on an image associated with the nominal navigation.
2. Determine the offset between the MAPGRID-generated grid and visible landmarks (e.g., coastlines). The amount of line-and-pixel shift can be found by using the Button Board utility program to shift the graphics plane which has the grid.
3. Enter these shift values into NVGEN (3.1.1.5.2) to adjust the navigation solution in a linear manner.

The second technique improves the nominal solution by using landmarks as known reference points. This technique can adjust the navigation solution for non-linear as well as linear errors. In addition, it provides a time-dependent solution to remove temporal satellite navigation errors. Thus, a sequence of images spanning several hours can be linked to one precise navigation solution, providing overall navigation consistency among the image set. To perform the best landmarking, landmarks should be chosen from widely separated points on the Earth in both the line and pixel directions. At least three locations should be used to surround the area of interest. The times of the landmark image series should be separated over many hours to encompass the time of interest. Ideally, a series of landmarks a few hours before and after the period of interest taken at half-hour intervals should be used for landmarking.

The following sequence of steps is necessary in order to improve the navigation with landmarking:

1. Create a zoomed set of visible Satellite Images (Landmark Images) about each landmark of interest for a landmark time series. A zoom factor of four will assure pixel accuracy during landmark definition. If the area coverage is too small, a zoom of two can be used with good results. If the data source is the AOIPS Tape, run NVZOOM (3.1.1.6) or LMZOOM (3.1.1.5.4).

NVZOOM is run if the nominal navigation solution is accurate enough to be able to zoom about the landmark of interest. Otherwise, run LMZOOM using a reduced Satellite Image as a guide. If the data source is the Real-Time Dataset, run REAL2IM (3.1.1.1.4).

2. Run the utility program ALIGN (3.1.1.5.6) to align the time series of Landmark Images for each landmark.
3. Run LMREG (3.1.1.5.7) to register the landmark on the image series. This program matches the known latitude, longitude, and height of the landmark with master coordinates on each image. The selected landmark point will be defined on all images in the aligned series.
4. Run NVGEN (3.1.1.5.2) to improve the nominal navigation solution with landmarks. Use all the landmarks to create the solution.
5. Run LMLIST (3.1.1.5.8) to list each landmark and how well it is fit by the current solution. The overall quality of the solution can be examined, and poorly fitting landmarks can be marked for deletion.
6. Run LMEDIT (3.1.1.5.9) to eliminate the landmarks which were marked for deletion by LMLIST.
7. Run NVGEN (3.1.1.5.2) to create the improved Navigation Solution. Steps 5, 6 and 7 can be repeated to further improve the solution.

Once the navigation has been improved to the required accuracy, the final set of Satellite Images can be generated by NVZOOM and REAL2IM for the AOIPS and Real-Time Dataset data sources, respectively.

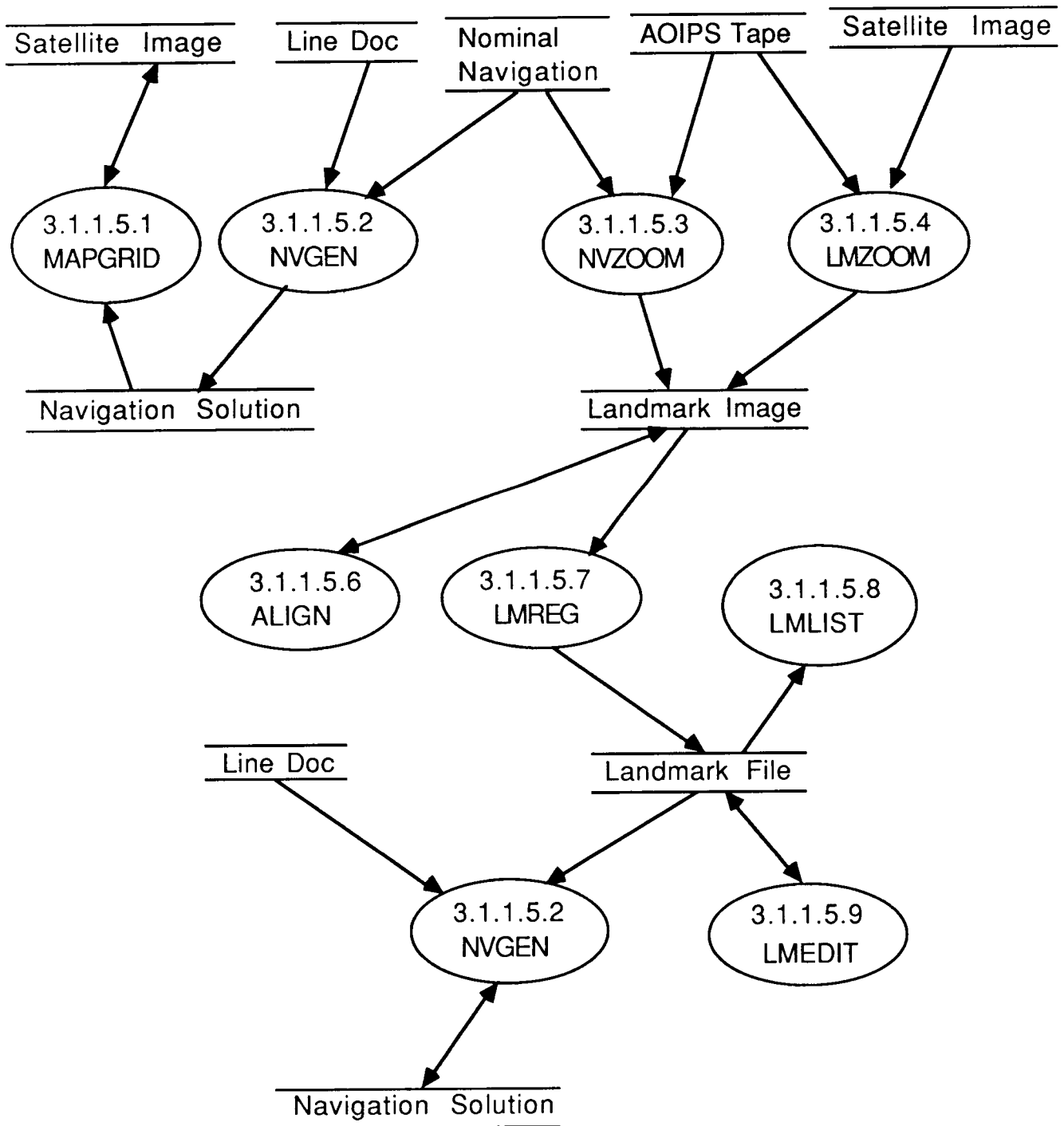


Figure 6. Navigation Improvement (3.1.1.5)

3.1.1.7 Navigation Utilites

The Navigation Utilities (3.1.1.7, see Fig. 2) perform several data management functions on the Navigation Solution files, including the selection of the navigation file and solution number, the listing of the current navigation solution, the deletion of the navigation file and/or solution(s), and the linking of Satellite Images to the Navigation Solution files.

3.1.2 Satellite Application Programs

The Satellite Application Programs (Fig. 7) include: Cloud Track Programs (3.1.2.1), Stereo Image Analysis (3.1.2.2) software, Synthetic Stereo (3.1.2.3) software, and the hurricane statistical analysis program HRANAL (3.1.2.4). These programs, with the exception of the Synthetic Stereo (3.1.2.3) software, require navigated geosynchronous Satellite Images as their data source. In principle, Synthetic Stereo can be generated from any two AOIPS images, but Satellite Images are most often used.

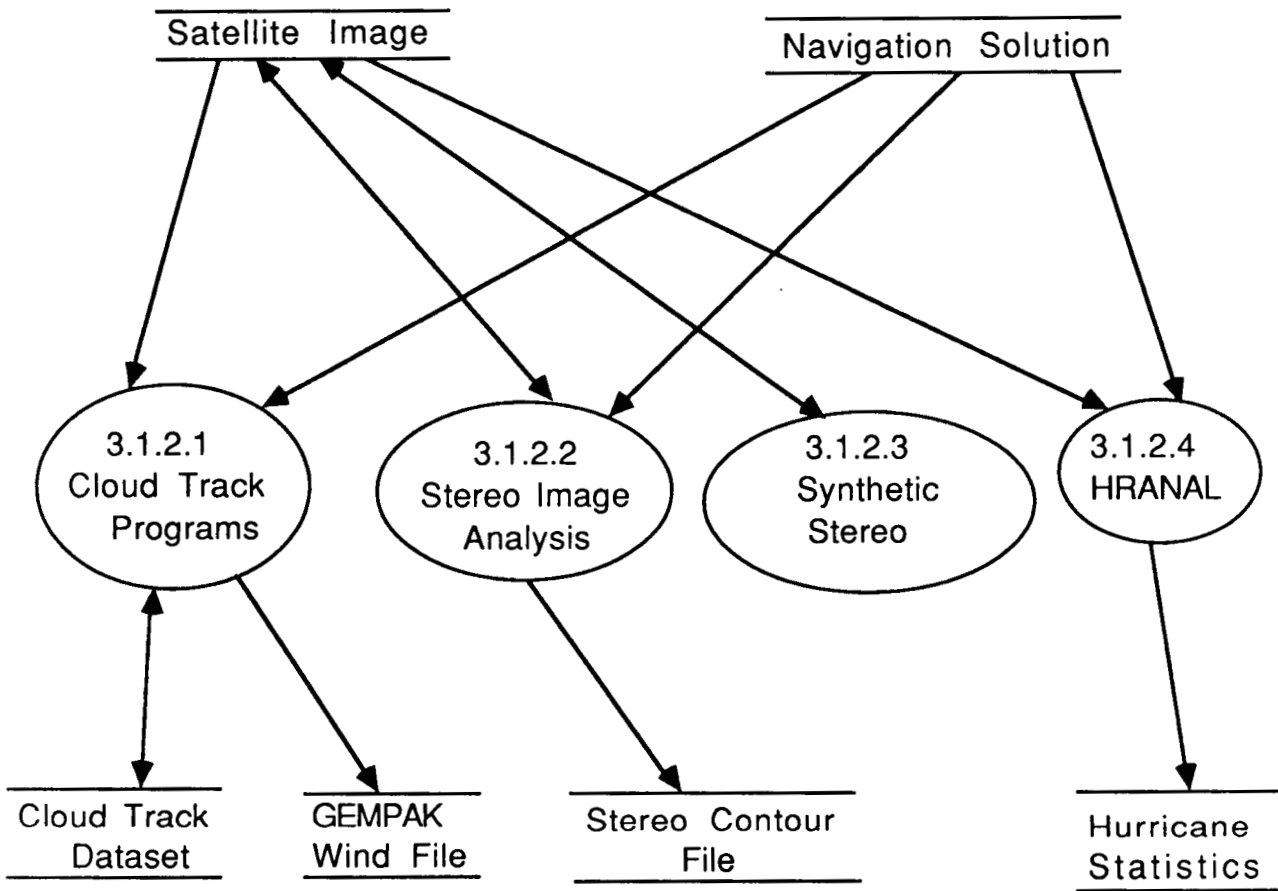


Figure 7. Satellite Application Programs (3.1.2)

3.1.2.1 Cloud Track Programs

The Cloud Track Programs (Fig. 8) generate both cloud motion and cloud height estimates. Cloud heights can be computed using stereo or IR image techniques.

The following steps are necessary to perform cloud tracking analysis:

1. Run TKSET (3.1.2.1.1) to define a new Cloud Track Dataset and the associated Satellite Images. A maximum of four Satellite images can be associated with a Cloud Track Dataset.
2. Run the utility program IMGLNK(3.1.2.1.2) to logically link the Satellite Images in the Cloud Track Dataset to their Stereo Remap and IR image counterparts for the IR and stereo estimation techniques, respectively.
3. Once the Cloud Track Dataset is defined, execute the programs TKMOVE (3.1.2.1.3), TKMOVEHT (3.1.2.1.4), and TKHGT (3.1.2.1.5) to measure the cloud motion and height with the results being stored in the Cloud Track Dataset. Note that steps 1 and 2 need only be done once for a given Cloud Track Dataset.

The other cloud tracking programs can be executed after a Cloud Track Dataset is successfully stored. TKOVERLAY (3.1.2.1.6) overlays cloud vectors, heights and other information on the Satellite Image. TKCONVERT (3.1.2.1.7) creates a GEMPAK Wind File from the Cloud Track Dataset to allow GEMPAK analyses, such as objective and streamline analysis. The Cloud Track Utilities (3.1.2.1.8) perform database management functions such as listing, deleting, undeleting and editing of the Cloud Track Dataset.

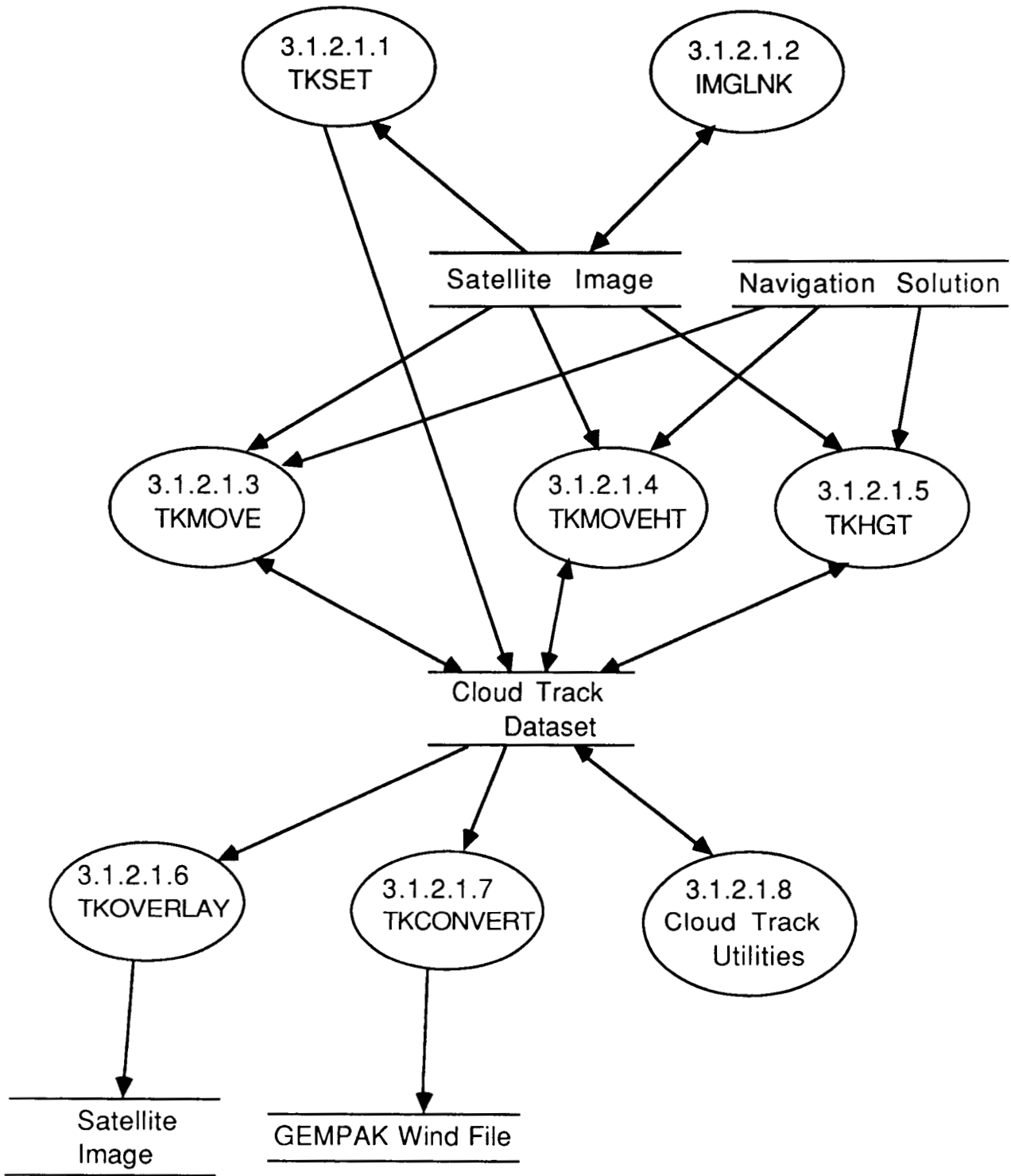


Figure 8. Cloud Track Programs (3.1.2.1)

3.1.2.2 Stereo Image Analysis

The Stereo Image Analysis software (Fig. 9) creates a stereo image from two geostationary satellites. Estimates of cloud heights can be computed, and cloud height contours can be stored and displayed. In addition, the software presents a three-dimensional view of clouds by generating a configuration on the IAT which is viewed with anaglyph glasses that provide the three-dimensional effect.

The following sequence of programs is necessary to successfully perform stereo analysis:

1. Run SRREMAP (3.1.2.2.1) to remap Source Satellite Image (e.g., a GOES-West image) into the coordinates of the Base Satellite Image (e.g., a GOES-East image) to produce a remapped Satellite Image. The remapped Satellite Image is combined with the Base Satellite Image to produce a Stereo Image Pair, which is an image configuration in the IAT. That is, the Base Satellite Image is displayed through the red gun and the Remapped Satellite Image is displayed through the blue and green guns. SRREMAP also calibrates the Stereo Image Pair by determining the shift amount for a feature of known height.
2. Run the utility program IMGLNK (3.1.2.2.2) to logically link the Base Satellite Image and the Remapped Satellite Image. This step is necessary for redisplaying the Stereo Image Pair by subsequent programs.
3. Run SRCALIB (3.1.2.2.3) if recalibration of the Stereo Image Pair is desired.
4. Run SRESTHT (3.1.2.2.4) to estimate stereo cloud heights at selected points using the Stereo Image Pair.
5. Run the Contour Programs (3.1.2.2.5) to draw contours at selected heights on the Stereo Image Pair and store these contours in the Stereo Contour File. These programs also provide interactive editing, smoothing, and deletion of derived contours.

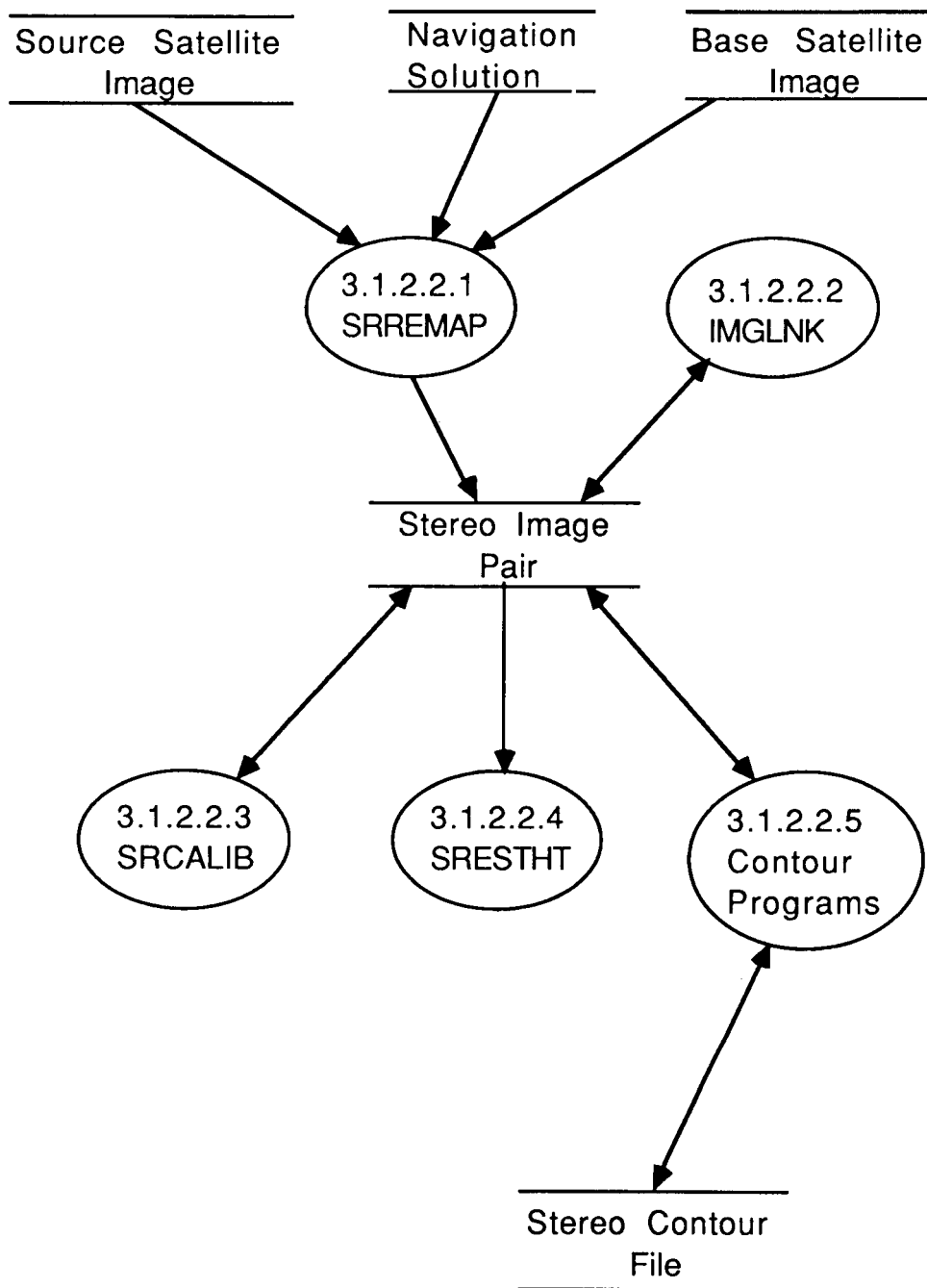


Figure 9. Stereo Image Analysis (3.1.2.2)

3.1.2.3 Synthetic Stereo

The Synthetic Stereo software (Fig. 10) provides the capability to view an AOIPS image (Base AOIPS Image) in a three-dimensional manner where the "height" of features is a function of the grey values from another AOIPS image (Source AOIPS Image). Typically, the Base AOIPS Image is a visible Satellite Image and the Source AOIPS image is the corresponding IR Satellite Image. Thus, a three-dimensional view of clouds is presented based upon the relationship between IR temperature (grey values) and cloud height.

SRSYNTH (3.1.2.3.1) generates a shifted Base AOIPS Image, where the shift amount is a function of the the grey values in the Source AOIPS Image. The shifted Base AOIPS Image is combined with the Base AOIPS Image to produce the Synthetic Stereo Image Pair, which is a configuration displayed on the IAT. The Synthetic Stereo Image Pair is viewed with anaglyph glasses to illustrate the three-dimensional effect.

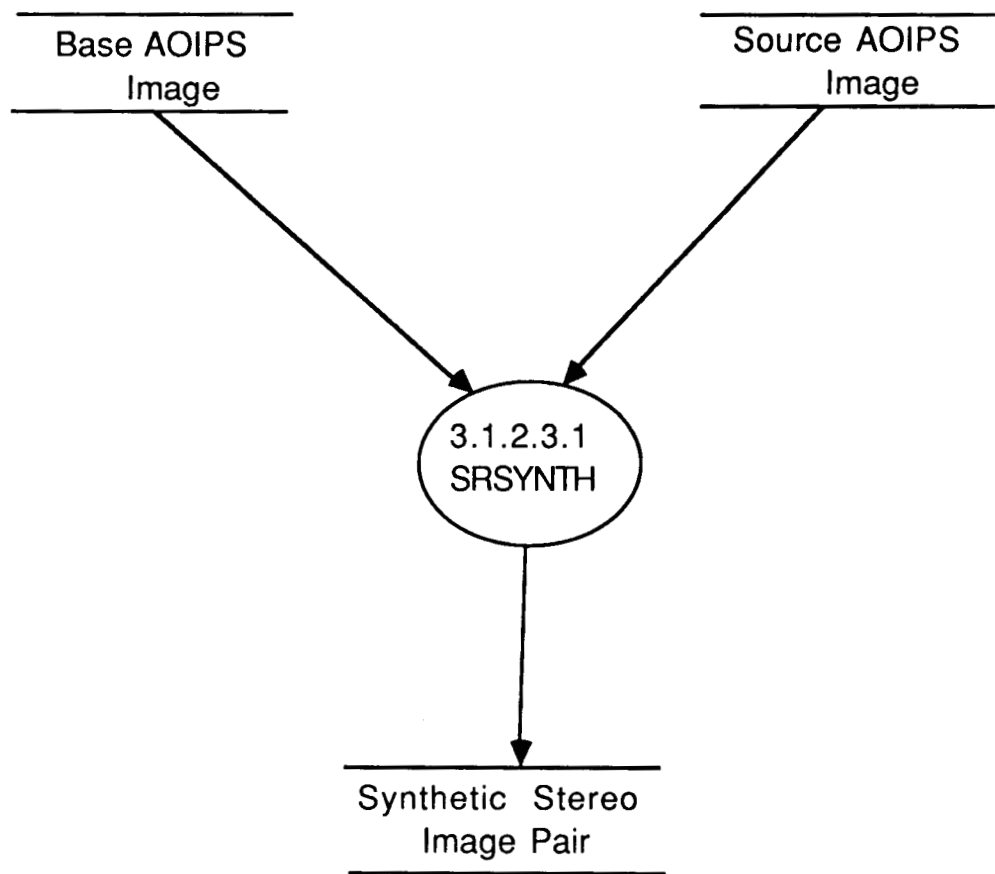


Figure 10. Synthetic Stereo (3.1.2.3)

3.1.2.4 HRANAL

HRANAL (3.1.2.4, see Fig. 7) plots a polar grid on a satellite image and performs a statistical analysis. The statistical analysis includes the display of parameters such as the mean, standard deviation, minimum and maximum grey value and/or black body temperature, and histogram for a selected area of the grid. The results of the statistical analyses are stored in the Hurricane Statistics file.

3.2 VAS Data Processing

The GOES VISSR Atmospheric Sounder (VAS) Data Processing Programs (Fig. 11) use the radiances from the VAS sounder instrument and consist of four main functions. The Radiance Dataset Creation Programs (3.2.1) convert the external VAS data source radiances into a radiance dataset format which is central to all the downstream VAS processing. Program RDSIMP (3.2.2) creates imagery of the VAS data contained in the radiance dataset. RDSIMP can make images of individual VAS channels, linear combinations of the channels or the complex combination of channels which result in imagery of meteorological retrievals. The satellite imagery created via RDSIMP is the same as imagery created via the Geosynchronous Satellite Processing (3.1) and thus may be processed with many of the same programs. The Sounding Retrieval Programs (3.2.3) prepare retrieval coefficients from radiance and ground truth meteorological data and create meteorological retrieval products from the radiances. The VAS Utilities (3.2.4) perform various data utility functions on the Radiance Dataset.

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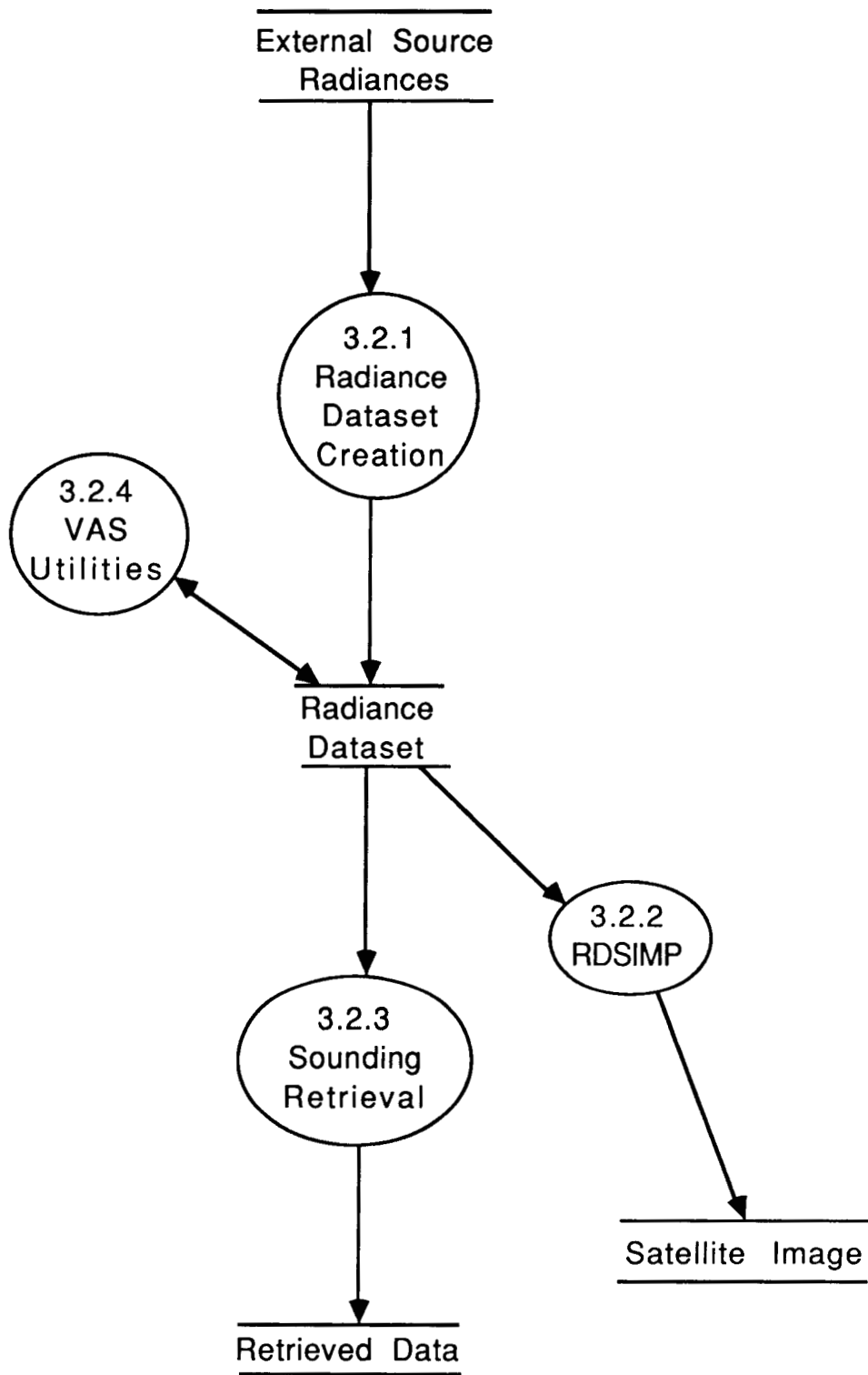


Figure 11. VAS Data Processing (3.2)

3.2.1 Radiance Dataset Creation Programs

The Radiance Dataset Creation programs (Fig. 12) convert VAS radiance data from external sources into a radiance dataset which has a common and easy-to-use format. Program AO2RDS (3.2.1.1) is run to create a radiance dataset from GARS format VAS data. Program GARS (3.1.1.2.1) must be run on the GARS tape to create an AOIPS tape in the proper format (REAL*4) before it can be read by AO2RDS. Program CCTRDS (3.2.1.2) is run to create radiance datasets from GSFC VAS data archived in the CCT format. Program GRDRDS (3.2.1.3) is run to create a radiance dataset from a GEMPAK grid of meteorological data. Program CNVRAD (3.2.1.4) is run to convert radiances in the old VAS format into a radiance dataset.

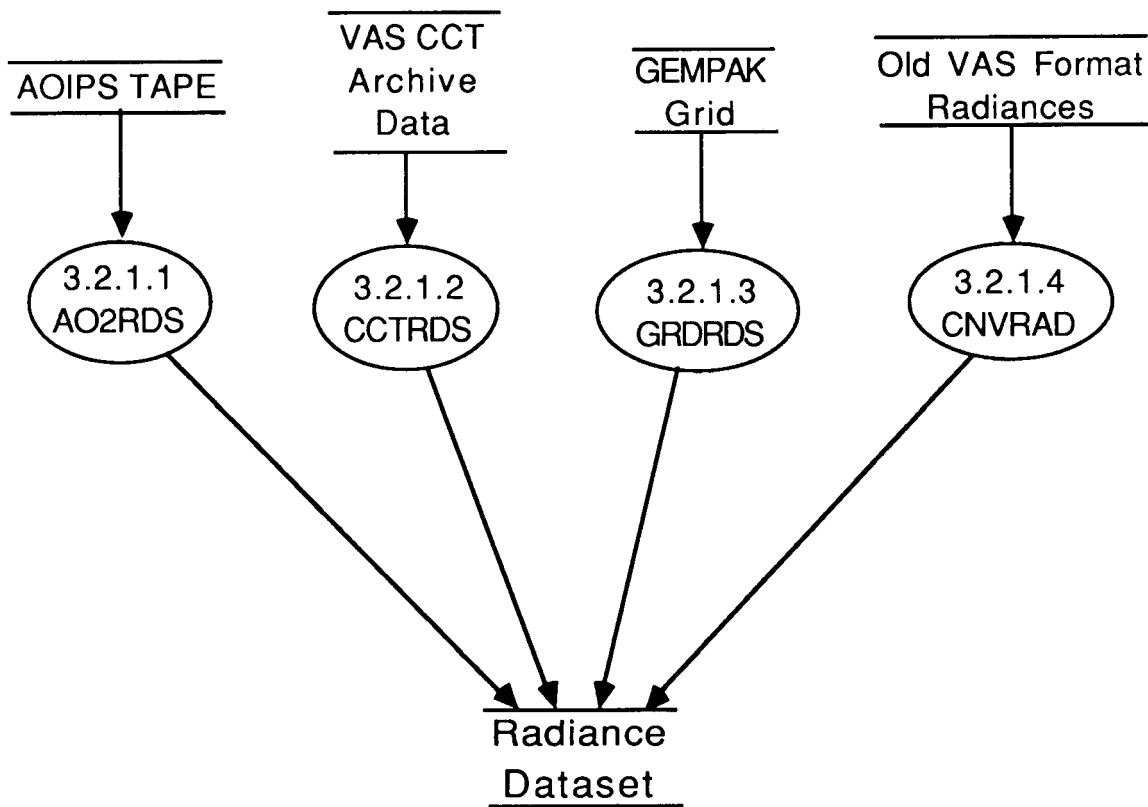


Figure 12. Radiance Dataset Creation (3.2.1)

3.2.3 Sounding Retrieval Programs

The Sounding Retrieval Programs (Fig. 13) generate retrieval coefficients (training path) for use in the retrieval process and also use these coefficients to produce meteorological retrievals (retrieval path). Program CRSLIS (3.2.3.1) may be run to create a list of sounding sites from which to choose radiances. CRSLIS has the option of creating the list at equal intervals in latitude and longitude or at a set of sites matching those in a GEMPAK upper-air dataset. Program RDSPIK (3.2.3.2) is then run to use the sounding site list or a set of sites entered by the user to pick a set of radiances from a VAS Radiance Dataset. A Radiance List dataset is created which is then used in either the training or retrieval paths of the retrieval programs. Two retrieval methods are available: the Matrix Retrieval Programs (3.2.3.3), which use linear regression to retrieve any meteorological parameter; and the Split-Window Retrieval Programs (3.2.3.4), which use a simple physical model to retrieve low-level precipitable water information.

The Matrix Retrieval Programs (Fig. 14) have a training path which builds the relation between the VAS radiances and selected meteorological parameters, and a retrieval path which uses the relationship with VAS radiances to determine the meteorological parameters.

In the training path, program CPPACC (3.2.3.3.1) is run to create an empty Accumulation File which allows specification of those meteorological parameters to be related to VAS radiances. Program APPACC (3.2.3.3.2) is then run to fill the Accumulation File with co-located Radiance List and meteorological data (Upper-Air and/or Surface Data). When all the desired data are accumulated, program CRGMTX (3.2.3.3.3) is run to create the regression matrix which relates the data. The matrix may then be used in the retrieval path to create meteorological retrievals.

In the retrieval path, program RGRETR (3.2.3.3.4) takes radiances from the Radiance List and creates Sounding Retrievals of meteorological parameters. Program RDSIMP (3.2.2) may also be used to retrieve a meteorological parameter and display it in the form of a Sounding Image.

The Split Window Retrieval Programs (Fig. 15) are structured in a similar way to the Matrix Retrieval Programs in that they have a training path and a retrieval path. Instead of generating a regression matrix, an average air temperature is generated.

In the training path, program PWACC (3.2.3.4.1) is run to accumulate precipitable water and co-located VAS radiances. Program SWTRN (3.2.3.4.2) is then run to generate the

Average Air Temperature. This value is then used in the Retrieval Path.

In the retrieval path, program SWRTR (3.2.3.4.3) is run to generate a file of point retrievals of precipitable water. Program RDSIMP (3.2.2) is run to retrieve the precipitable water in image form.

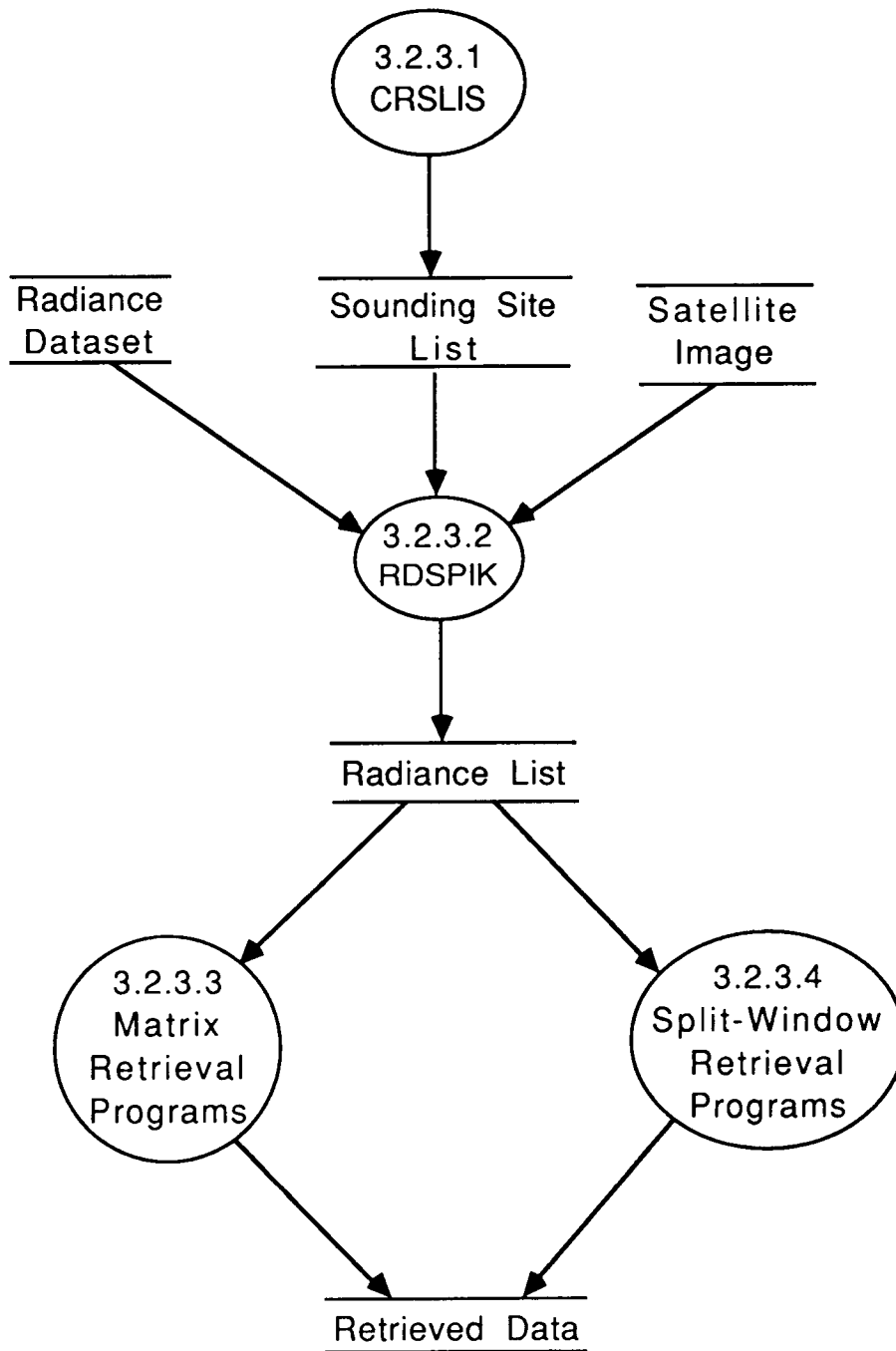


Figure 13. Sounding Retrieval Programs (3.2.3)

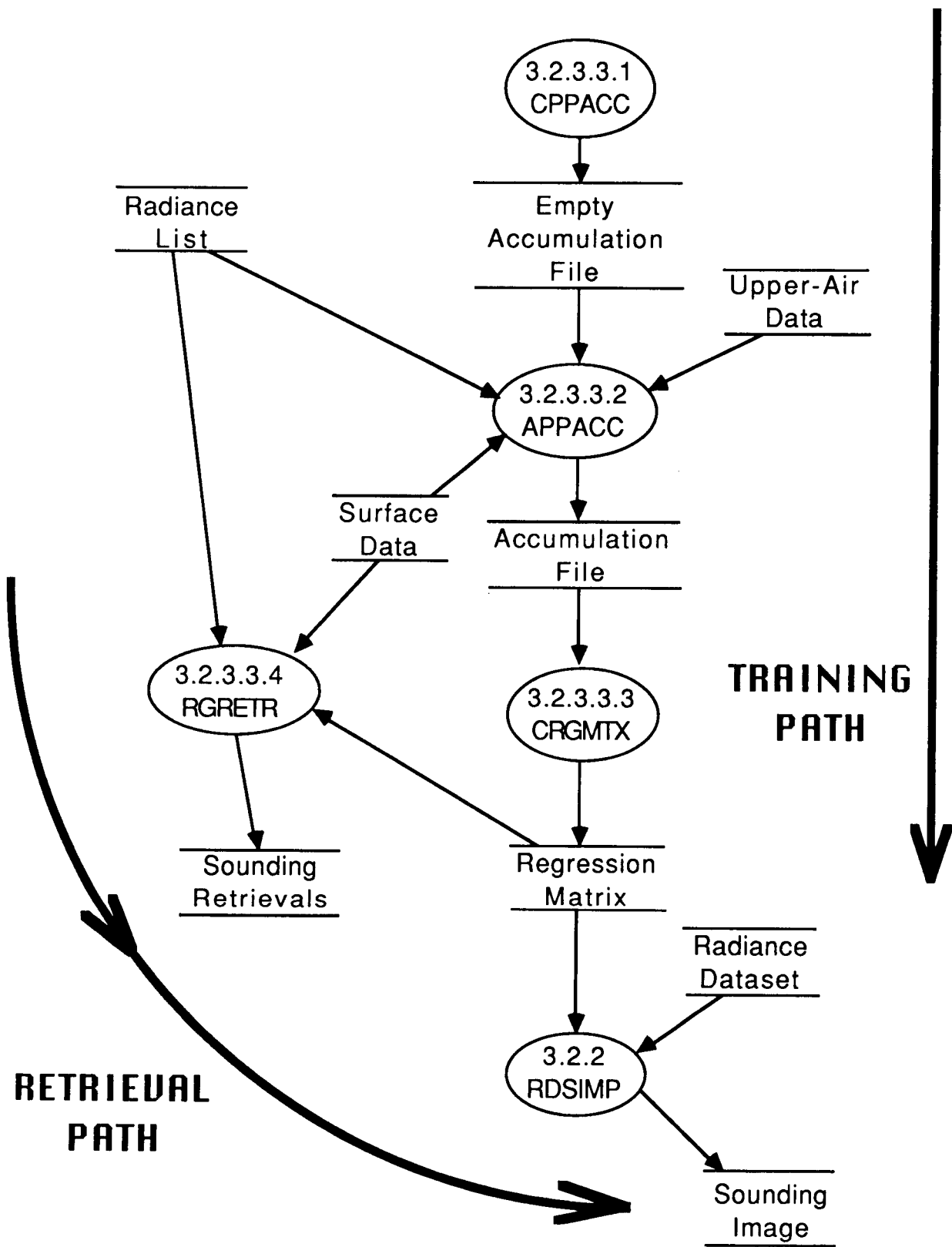


Figure 14. Matrix Retrieval Programs (3.2.3.3)

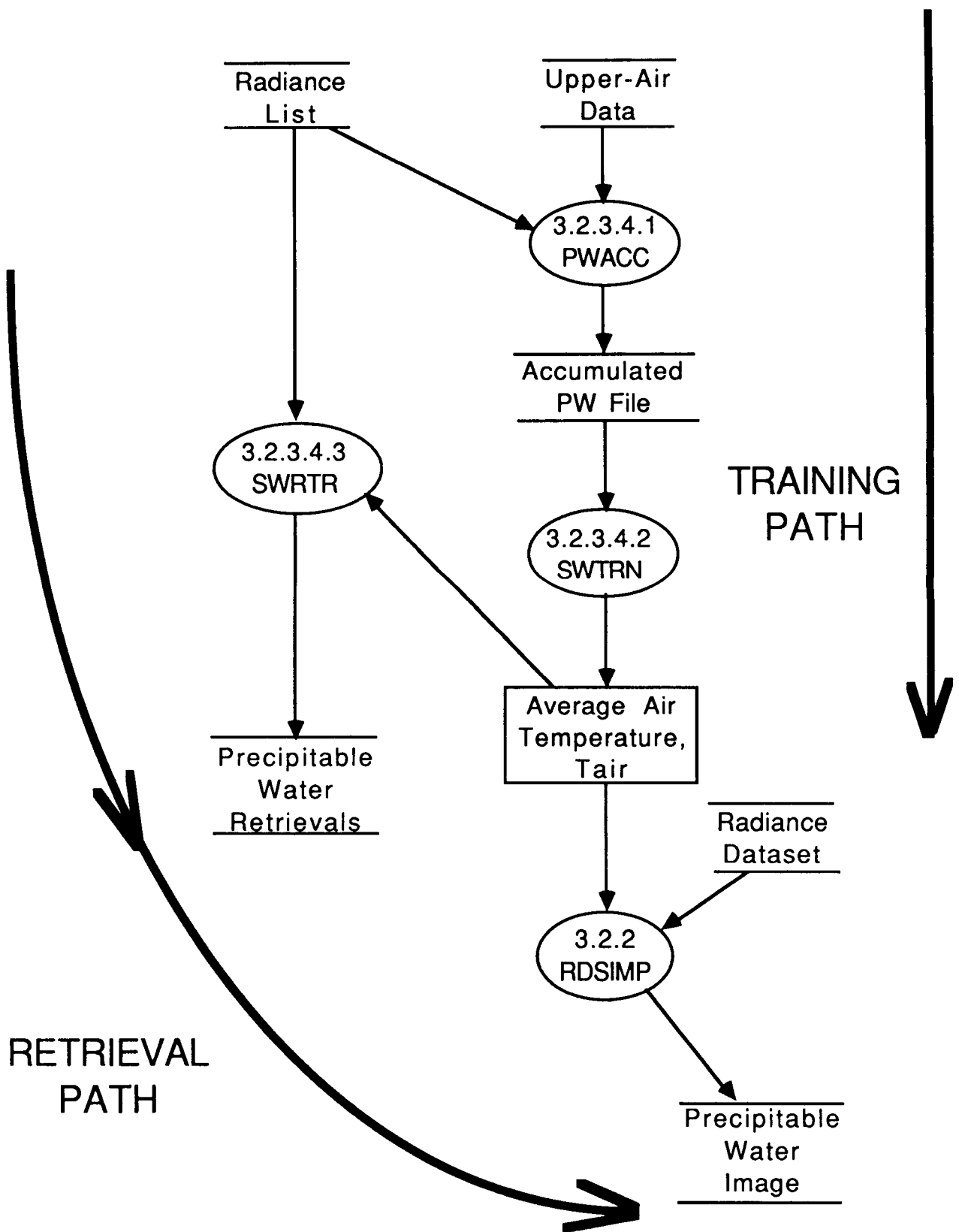


Figure 15. Split-Window Retrieval Programs (3.2.3.4)

3.2.4 VAS Utilities

The VAS Utilities (3.2.4) perform various data utility functions with the Radiance Dataset. Program RDSAVG (3.2.4.1) performs a running average on the VAS data channels. Averaging of the radiance data reduces the noise to a point where better retrieval images may be made with program RDSIMP (3.2.2). Program SATLIS (3.2.4.2) produces a list of radiance datasets available in the current directory location.

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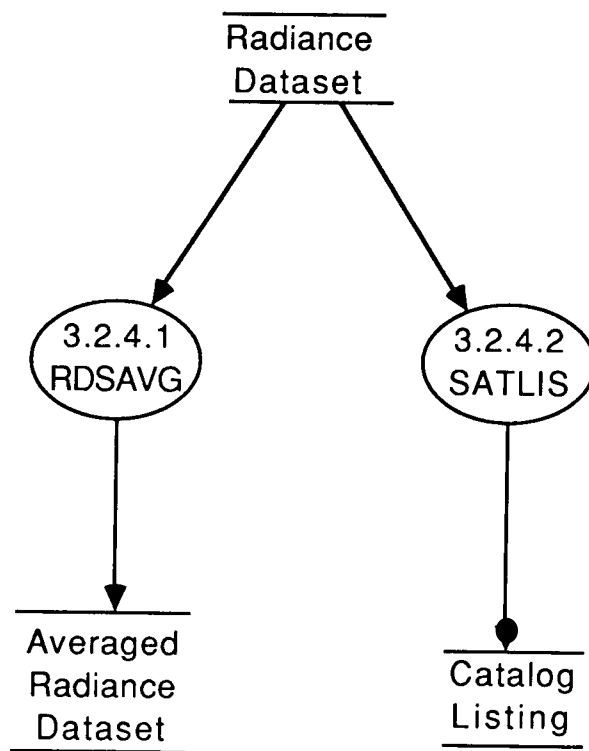


Figure 16. VAS Utilities (3.2.4)

3.3 SSM/I Data Processing

The AOIPS2 SSM/I Data Processing package (Fig. 17) processes SSM/I data from special format tapes produced by Dr. Frederic Wentz of Remote Sensing Systems of Santa Rosa, CA. The Special Sensor Microwave/Imager was launched on a polar-orbiting DMSP satellite in June 1987. Data consist of 7 channels (4 frequencies) of microwave temperature (Tb) at wavelengths from 19 to 86 GHz. See the SSM/I User's Guide (Hollinger et al., 1987) for further details.

The highly compressed data tapes are read into the AOIPS system by program SWENTZ (3.3.1). This produces a Location Tagged Dataset (LTD), which includes both radiometric and navigational information.

The LTD is used as input to three programs which remap and display the data. Output from each of the three programs consists of counts (C) related to Tb by: $C = 305 - Tb$. Program SSMING (3.3.2) displays the conical scans of the SSM/I as horizontal image scan lines, i.e., no remapping is done. Program SSMIMAP (3.3.3) remaps the data into any GEMPAK standard projection, or to GOES coordinates if a corresponding navigation solution and GOES image exist. Program SSMIRAD (3.3.4) remaps the data into the coordinate system of a radar PPI image (Modified Cylindrical Equidistant Projection), with the corner points specified by the corners of the input radar image.

A utility program to delete LTD's is also provided.

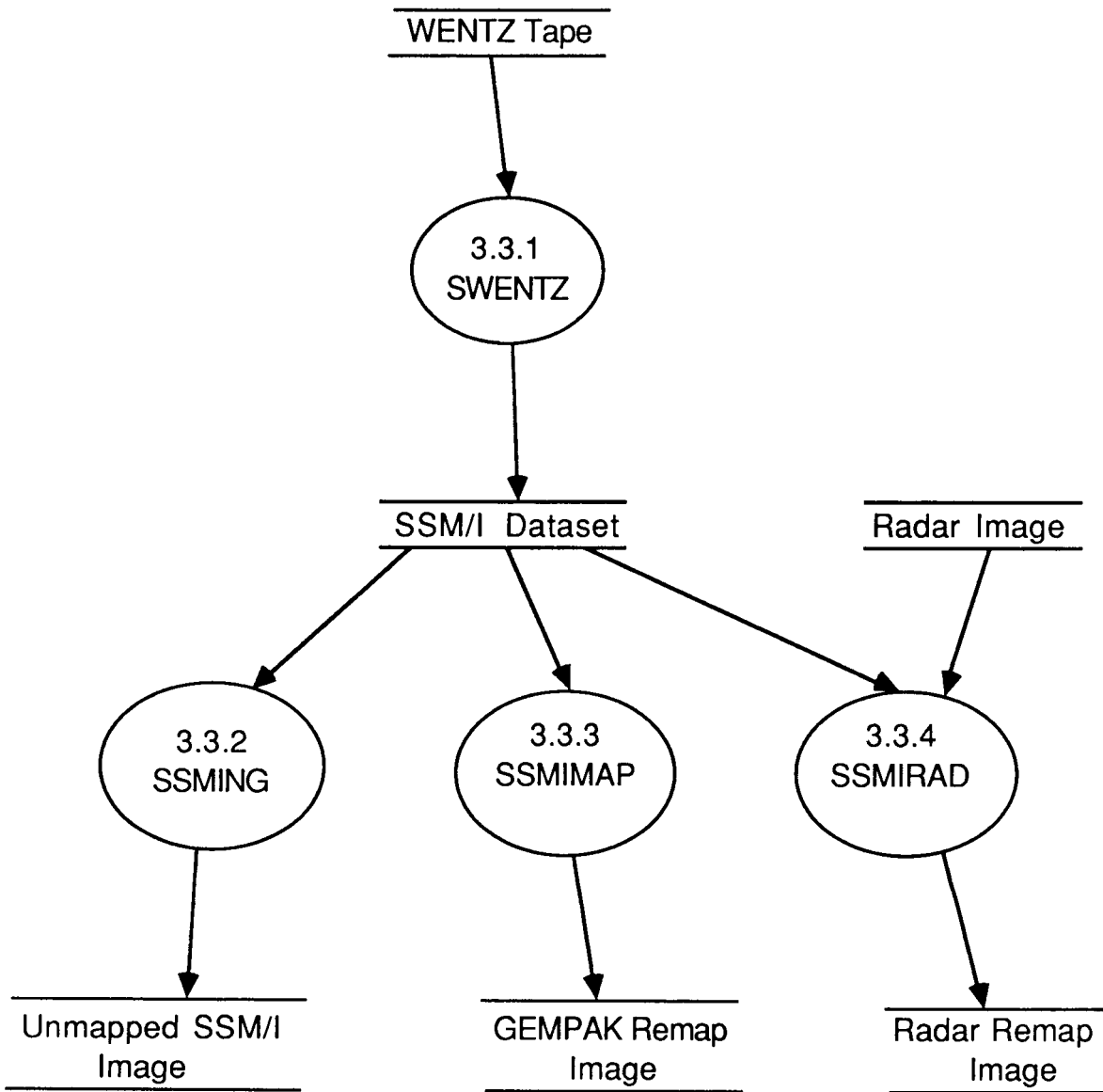


Figure 17. SSM/I Data Processing (3.3)

3.4 Satellite Glossary

Accumulated PW File

The Accumulated PW File is a dataset which is used to accumulate precipitable water derived from a GEMPAK Upper-Air Dataset and co-located 11 and 12 micrometer radiances from a Radiance List File.

Accumulation File

The Accumulation File is a dataset which is used to accumulate selected meteorological parameters available in GEMPAK Upper-Air and Surface Datasets and co-located VAS radiances from a Radiance List File.

AOIPS Image

The AOIPS Image is the fundamental mode of data storage in the AOIPS system. The image data which are displayed on the IAT are stored as packed byte data to represent the grey values (0-255) in a line-and-pixel format. The size of the image is variable with a maximum of 512 lines and pixels. The file also includes labels which contain information pertaining to the type of AOIPS Image (e.g., satellite, radar, etc).

Average Air Temperature

The Average Air Temperature is a single-valued retrieval coefficient used in the Split-Window Retrieval Processing.

Averaged Radiance Dataset

The Averaged Radiance Dataset is a Radiance Dataset in which the VAS radiances have been averaged to reduce the effects of noise.

Base AOIPS Image

The Base AOIPS Image is an AOIPS image which can be displayed in a three-dimensional manner by the Synthetic Stereo software. Typically, this image is a visible-band Satellite Image.

Base Satellite Image

The Base Satellite Image is a visible-band Satellite Image from a particular GOES satellite (e.g., GOES East) that is used by the Stereo Image Analysis software. The Source Satellite Image from the other GOES satellite (e.g. GOES West), is remapped into the Base Satellite Image coordinates.

Catalog

The Catalog file contains the name and storage time of ingested Real-Time Datasets.

Cloud Track Dataset

The Cloud Track Dataset contains the cloud height and velocity data for the tracked clouds and a logical link to the images that compose the Cloud Track Dataset.

GEMPAK Remap Image

The GEMPAK Remap Image is an AOIPS image remapped to a GEMPAK map projection. Map projections include: Mercator, North Polar Projection, and Lambert, among several others.

GEMPAK Wind File

The GEMPAK Wind File contains cloud estimated wind position, height and velocity data in the GEMPAK sounding file format.

Hurricane Statistics

The Hurricane Statistics file contains grey value and black body temperature statistics generated by the HRANAL software. Statistics include grid mean, standard deviation and histogram summaries.

Landmark File

The Landmark File contains the geographic location and corresponding satellite master coordinates of registered landmarks. This file is used to improve the nominal navigation solution.

Line Doc

The Line Doc file contains the navigation orbit and attitude parameters extracted from the IR common documentation generated from the geosynchronous satellite data stream. This file is used to generate the navigation solution.

Navigation Solution

The Navigation Solution file contains the necessary parameters for software to transform between satellite master coordinates and Earth (latitude, longitude) coordinates. The file can contain multiple solutions of the Keplerian or Chebychev type.

Real-Time Dataset

The Real-Time Dataset contains all the AAA format data generated by the GOES satellite. These include: visible data, infrared data for all available channels, calibration data and navigation data. The Real-Time Dataset can cover a much larger area than a Satellite Image file, conceivably the entire Earth disk.

Real-Time Schedule

The Real-Time Schedule file contains schedule inputs, such as, real-time dataset resolution, and geographic location as a function of date and time. This file provides a means to schedule the Real-Time Ingest Software inputs.

Remapped Satellite Image

The Remapped Satellite Image is a visible Satellite Image that has been remapped to the other GOES satellite coordinate system for stereo analysis.

Satellite Image

The Satellite Image file contains grey values scaled to represent radiances in the visible, infrared, or microwave wavelengths. It is in the AOIPS Image format. The pixel and line directions in the image data correspond to the off-nadir and satellite scan lines, respectively.

Source AOIPS Image

The Source AOIPS Image is an AOIPS image which has image data that are related to some variable of meteorological interest, usually cloud height. Thus, this image is usually an IR-band Satellite Image.

SSM/I Dataset

The SSM/I dataset is a disk file that contains the SSM/I channel brightness temperature data and navigation data. It can cover a larger area than an AOIPS image.

Stereo Contour File

The Stereo Contour File contains the height contours generated by the Stereo Image Analysis software. These contours can be superimposed on the stereo image.

Stereo Image Pair

The Stereo Image Pair is a configuration on the IAT that combines a Base Satellite Image with a Remapped Satellite

Image to produce the three-dimensional effect when viewed with anaglyph glasses. The Base Satellite Image is displayed through the red gun, and the Remapped Satellite Image is seen through the green and blue guns of the IAT. The Stereo Image Pair is used for stereo height and contour analysis.

Precipitable Water Image

The Precipitable Water Image is a Satellite Image in which the grey values represent the precipitable water at each image point. It is in AOIPS Image format.

Precipitable Water Retrievals

Precipitable Water Retrievals are values of retrieved precipitable water stored in a GEMPAK Upper-Air Dataset.

Radiance Dataset

The Radiance Dataset is a file containing VAS radiance data in REAL*4 format (not in limited-accuracy byte format, as in a Satellite Image). Up to 32 VAS radiance channels may be stored in the radiance dataset. The dataset can cover any number of pixels and lines up to the coverage of the VAS instrument (1821 lines, 3822 pixels). The dataset points to a navigation solution of the same form used by the GOES Satellite Images (see section 3.1).

Radiance List

The Radiance List is a file containing a list of radiances extracted from a Radiance Dataset at selected sites. Data may be the average of the radiance data around each site in order to help reduce noise effects.

Regression Matrix

The Regression Matrix is a file containing the relation between VAS radiances (and possibly hourly GEMPAK surface data) and GEMPAK upper-air data in the form of a linear regression matrix.

Sounding Image

The Sounding Image is a Satellite Image in which the grey values represent a meteorological parameter at each image point. It is in AOIPS Image format.

Sounding Retrievals

Sounding Retrievals are a set of meteorological parameters retrieved in the matrix retrieval process. They are in the form of a GEMPAK Upper-Air Dataset.

Surface Data

Surface Data is surface meteorological data in GEMPAK format.

Synthetic Stereo Image Pair

The Synthetic Stereo Image Pair is a configuration displayed on the IAT that combines the Base AOIPS Image with a shifted Base AOIPS Image, where the shifts are a function of the grey values in the Source AOIPS Image. The Base AOIPS Image is displayed through the red gun, and its shifted counterpart is seen through the blue and green guns. This configuration produces a three-dimensional effect when viewed with anaglyph glasses.

Unmapped SSM/I Image

The Unmapped SSM/I Image is a scan line versus off-nadir scan element display of the SSM/I Dataset. It is in AOIPS Image format.

Upper-Air Data

Upper-Air Data is upper-air meteorological data in GEMPAK format.

CHAPTER 4

RADAR DATA PROCESSING

The AOIPS2 Radar Data Processing package (Fig. 18) displays, processes, and analyzes digital radar data.

Radar tapes of various formats may be ingested by the AOIPS system via the Radar Archive Ingest Programs (Fig. 19) to produce a common format disk Radar Dataset. Radar Datasets are used to produce and display radar data in various coordinate systems. Multiple radar fields, such as reflectivity, velocity, or standard deviation may be present on the radar input tapes. Radar data is either in PPI Scan Mode (range vs. azimuth) or in RHI Scan Mode (range vs. elevation). PPI Scan Mode data is the norm for most input tapes.

Real-time PPI images from the ALDEN radar system can be converted to AOIPS Radar PPI images by the program REALR (4.2).

The Radar Remap Programs (Fig. 20) remap the radar dataset PPI or RHI scan data to more useful projections for analysis. The RADMAP (4.3.1) and RDREMAP (4.3.2) remapping programs produce radar images in either a Cartesian coordinate system or an Earth latitude/longitude coordinate system. The Earth latitude/longitude coordinate system is equivalent to the GEMPAK Modified Cylindrical Equidistant projection (MCD). Images may be remapped to either a Plan Position Indicator (PPI) format, a Constant Altitude Plan Position Indicator (CAPPI) format, or a Vertical Section (VERT) format. The VERT image may be constructed from a series of PPI scans or a RHI scan. Program RADSAT (4.3.3) remaps a radar image from an Earth coordinate system into a GOES satellite coordinate system.

The Radar Analysis Programs (Fig. 21) operate on the Radar Dataset and Radar Remap Image files. Program RDEDIT (4.4.1) provides a means of analyzing and editing the data values within a radar dataset. Data values may be flagged as

"deleted" or, conversely, a deleted value may be "undeleted". Also, velocity data may be "unfolded". BSCAN (4.4.2) displays radar sweep data in a range versus azimuth radial coordinate system for PPI Scan Mode data or in a range versus elevation coordinate system for RHI Scan Mode data. RADGRID (4.4.3) generates navigated range, distance, or height rings and azimuth lines on Radar Remapped Images. Program RDRAIN (4.4.4) creates a rainfall-rate image from a remapped reflectivity image.

Several Radar Utility Programs (4.5) are available to list and edit the contents of the radar dataset and to maintain the radar directory. Radar datasets may be appended to, compressed and deleted, and the header information and data values may be examined and edited. Utility Programs also list the contents of the Remap Command File.

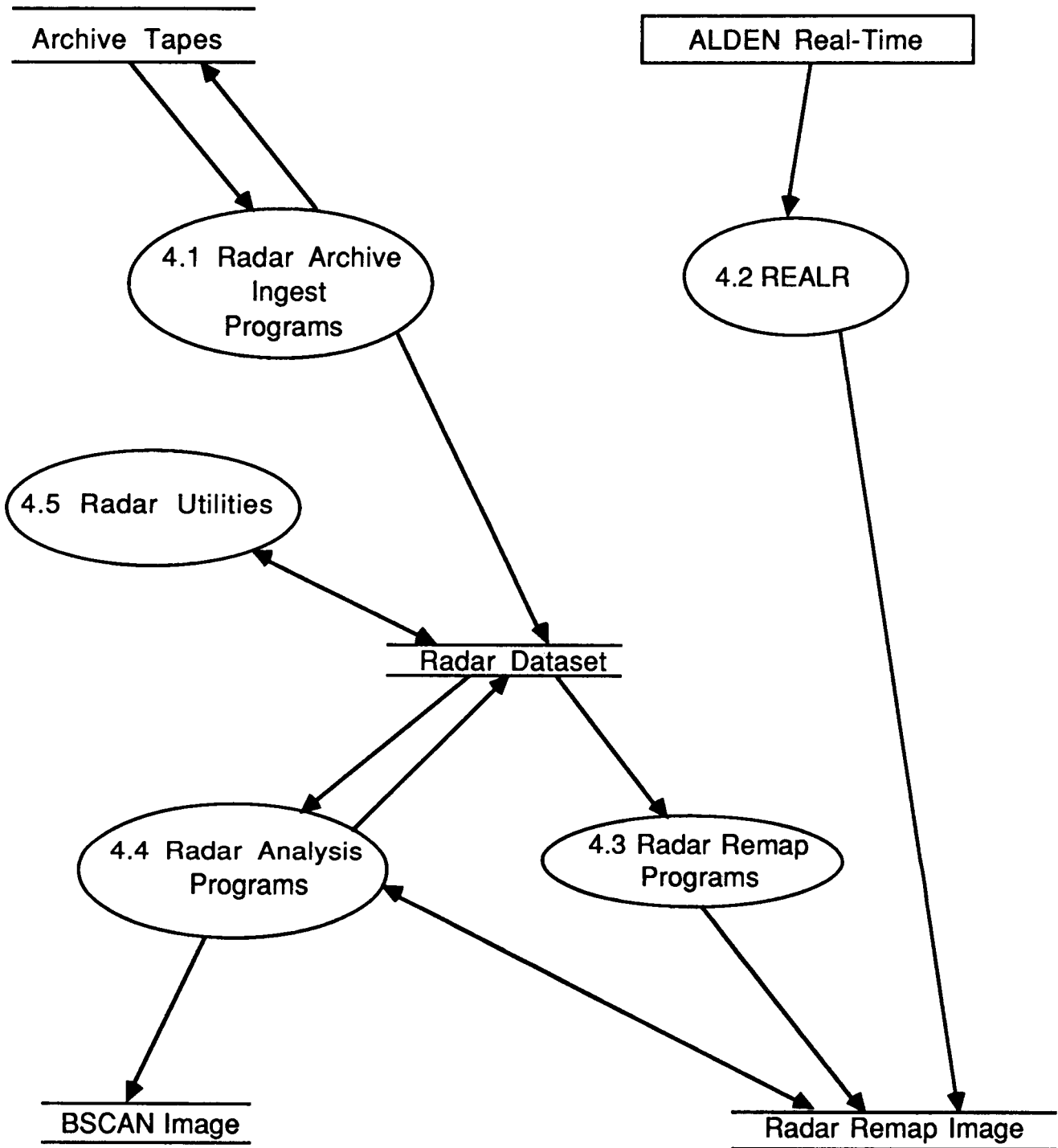


Figure 18. Radar Data Processing (4.0)

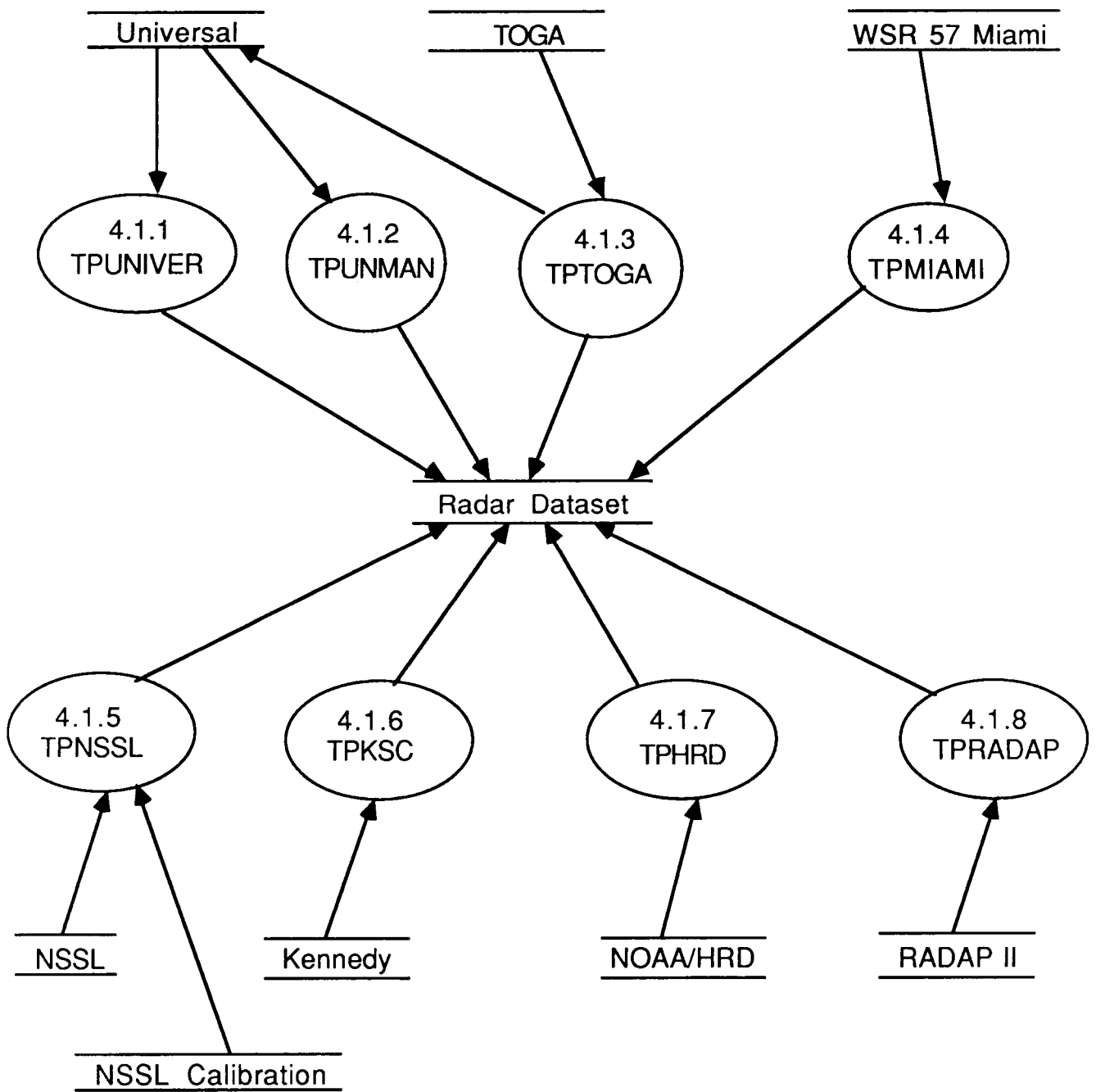


Figure 19. Radar Archive Ingest Programs (4.1)

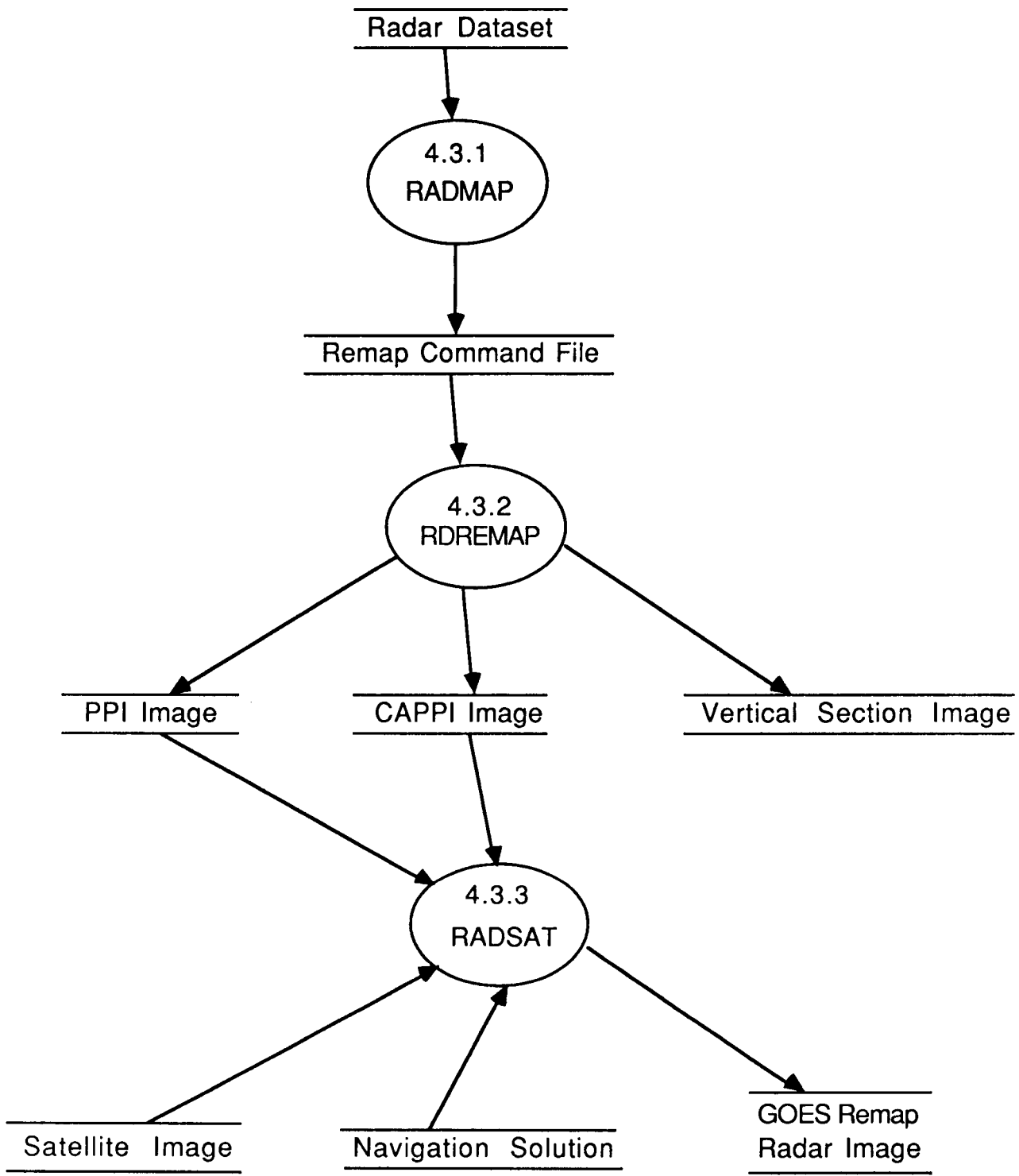


Figure 20. Radar Remap Programs (4.3)

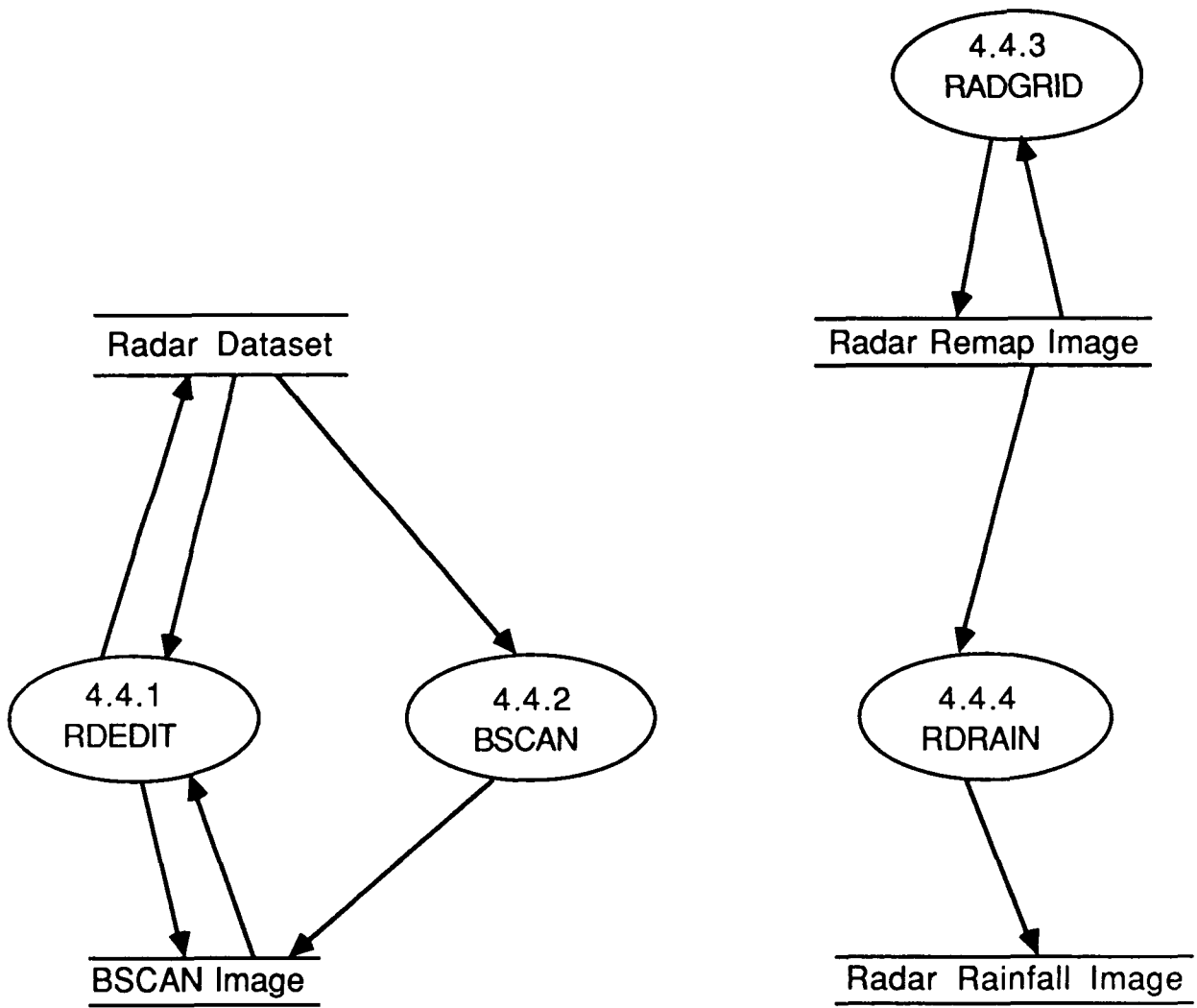


Figure 21. Radar Analysis Programs (4.4)

4.6 Radar Glossary

BSCAN Image

A BSCAN Image is obtained directly from the radar measurements. Each BSCAN Image typically represents one sweep of radar data with the y-axis corresponding to the beam number (azimuth) and the x-axis proportional to the range for the PPI scan mode. The coordinate system of BSCAN Images is referred to as the radial coordinate system. BSCAN Images are created in refresh memory as Dynamic AOIPS Images.

CAPPI Image

The CAPPI Image contains radar data at a constant height, and hence, multiple BSCAN sweeps are required for interpolation. It is in the AOIPS Image format.

FIELDTYP is the radar data field. Specify a field by its two-character name. Valid field names grouped by category are:

Category	Fields
-----	-----
Reflectivity (dBZ) XX, ZD, ZH, ZR, ZV	CZ, DZ, RE, SM, SZ, XH,
Velocity	VE, VF, VL, VR, VT, VU
Variance	SD, SW, VA
Power (dBM)	DM, PR, XM
Correlation	CF, CO, CR, NC
Rainfall	RR

GOES Remap Radar Image

The GOES Remap Radar Image is a remap of the PPI or CAPPI images to the GOES projection. It is in the AOIPS Image format.

PPI Image

The PPI image is defined as a complete 360-degree or a limited (less than 360-degree) scan where the elevation is constant. Thus, a PPI requires as its source only one BSCAN sweep from the Radar Dataset. It is in the AOIPS Image format.

Radar Dataset

The AOIPS Radar Dataset is a standard format disk file in which radar sweep data are stored. Raw radar data tapes do not share a common tape format. In order for such data to be accessed by the AOIPS system, the raw radar data must be

calibrated and transformed into a standardized disk file structure known as the Radar Dataset. These datasets are created using the Radar Archive Ingest programs. The radar dataset is the input for other radar functions such as: BSCAN generation, editing/unfolding, radar remapping command file generation, and radar remapping. The file naming convention for a radar dataset is setname.RAD, where setname is a user-defined descriptive name of up to 9 characters. A dataset contains multiple sweeps of multiple beams of multiple gates, and may possibly contain multiple fields. Individual sweeps are packed within the dataset in either an 8-bit/gate format or a 16-bit/gate format, depending upon the fields to be stored in the dataset and the user's preference at the time of ingest. Each sweep has a corresponding sweep header containing pertinent information for that particular sweep and a list of azimuth or elevation angles contained in the sweep. Each beam within the sweep is preceded by a delta time from the sweep start time, the elevation angle, and the azimuth angle, followed by the gate data for the first field, the gate data for the second field, etc. The maximum number of sweeps in a dataset is 255 and the maximum number of fields is five.

Radar Remap Image

A Radar Remap Image is an AOIPS Image which has been generated either directly from the radar dataset via program RDREMAP or from another remapped radar image in the Earth coordinate system via program RADSAT. Thus it can be either a PPI Image, CAPPI Image, Vertical Section Image or a GOES Remap Radar Image.

Remap Command File

The Remap Command File, "RDREMAP.CMD," contains control parameters necessary to perform radar remappings. It is generated by invoking program RADMAP as a preliminary step to creating radar remapping images. There exists at most one remapping command file per AOIPS group. Unless deleted, new remapping commands are appended to the file.

Vertical Section Image

The Vertical Section Image is a vertical slice through a sweep volume. Its coordinates are height above the ground versus distance along the ground. It is in the AOIPS Image format.

CHAPTER 5

AIRCRAFT DATA PROCESSING

The AOIPS Aircraft Data Processing package (Fig. 22) is used to ingest, remap, navigate and analyze imagery data from scanning instruments flown on NASA high-altitude research aircraft. Data from the Advanced Microwave Moisture Sounder (AMMS) and the Multi-spectral Cloud Radiometer (MCR) can be ingested and analyzed with the various programs available.

The Aircraft Ingest Programs (Fig. 23) ingest aircraft sensor data (AMMS or MCR), and various formats of navigation data (MMS, NRS, or Universal) to create common format Aircraft Dataset and Aircraft Navigation disk files. The sensor data should be ingested first, followed by the navigation data. The navigation will be automatically linked to the appropriate sensor dataset. Navigation data from the NASA high-altitude aircraft (providing the Earth location, altitude, speed, heading, and yaw, roll, and pitch of the aircraft) are ingested separately for linkage with the corresponding sensor data. The formats for the navigation data vary as a function of field experiment, and users are advised to check the experiment documentation for more details. The AMMS is a four-channel scanning passive microwave radiometer observing at 92 and 183 GHz (approximately 0.32 and 0.18 cm wavelengths). The MCR is a seven-channel scanning visible/near-IR/thermal-IR radiometer with detectors at wavelengths of 0.754, 0.761, 0.763, 1.362, 1.645, 2.160, and 10.842 micrometers. (The exact wavelengths may vary with each field experiment. Users should check the documentation provided by Code 617 for details.) MCR datasets are voluminous. Because of virtual memory limitations of the MicroVAX computer system, it is advisable to ingest MCR data in increments of 3 to 4 "channels" for a given flight track if the track is more than 10 minutes in length.

The Aircraft Analysis Programs (Fig. 24) append additional

channels onto existing datasets and generate images for analysis from the Aircraft Dataset and Aircraft Navigation files. MCRAPP (5.2.1) creates datasets of the ratio of two "channels" of MCR data and appends these data to the existing dataset. AIRIMG (5.2.2) creates reduced or subscene aircraft images from an Aircraft Dataset. AIRMAP (5.2.3) remaps a reduced or subscene aircraft image to a user-specified spatial resolution Remap Aircraft Image. The remapped image will contain evenly-spaced pixels, with the center of the remapping at the image center.

The Aircraft Utilities Programs (5.3) allow editing of selected fields in the aircraft dataset header and addition or deletion of datasets from the aircraft dataset directory.

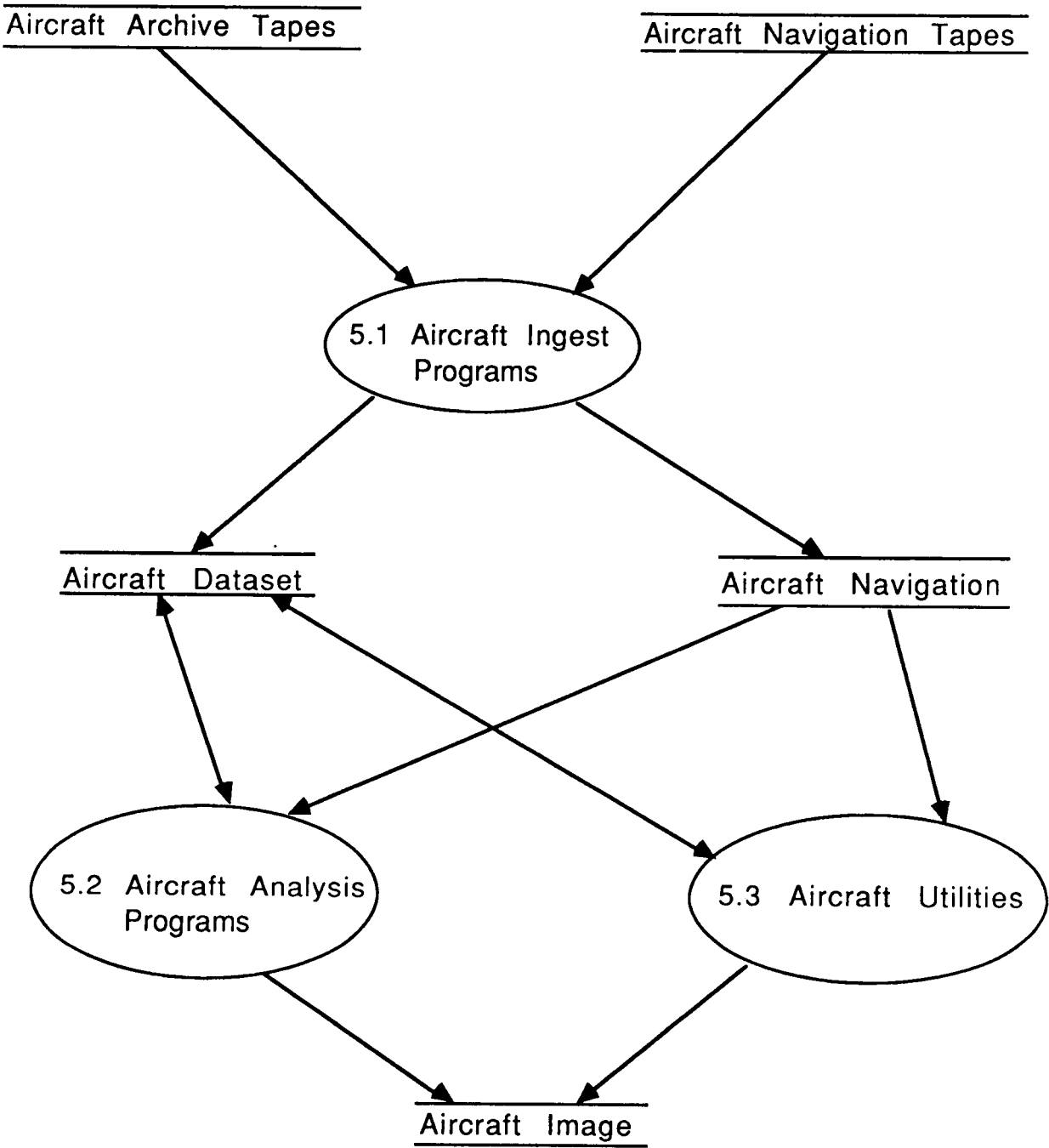


Figure 22. Aircraft Data Processing (5.0)

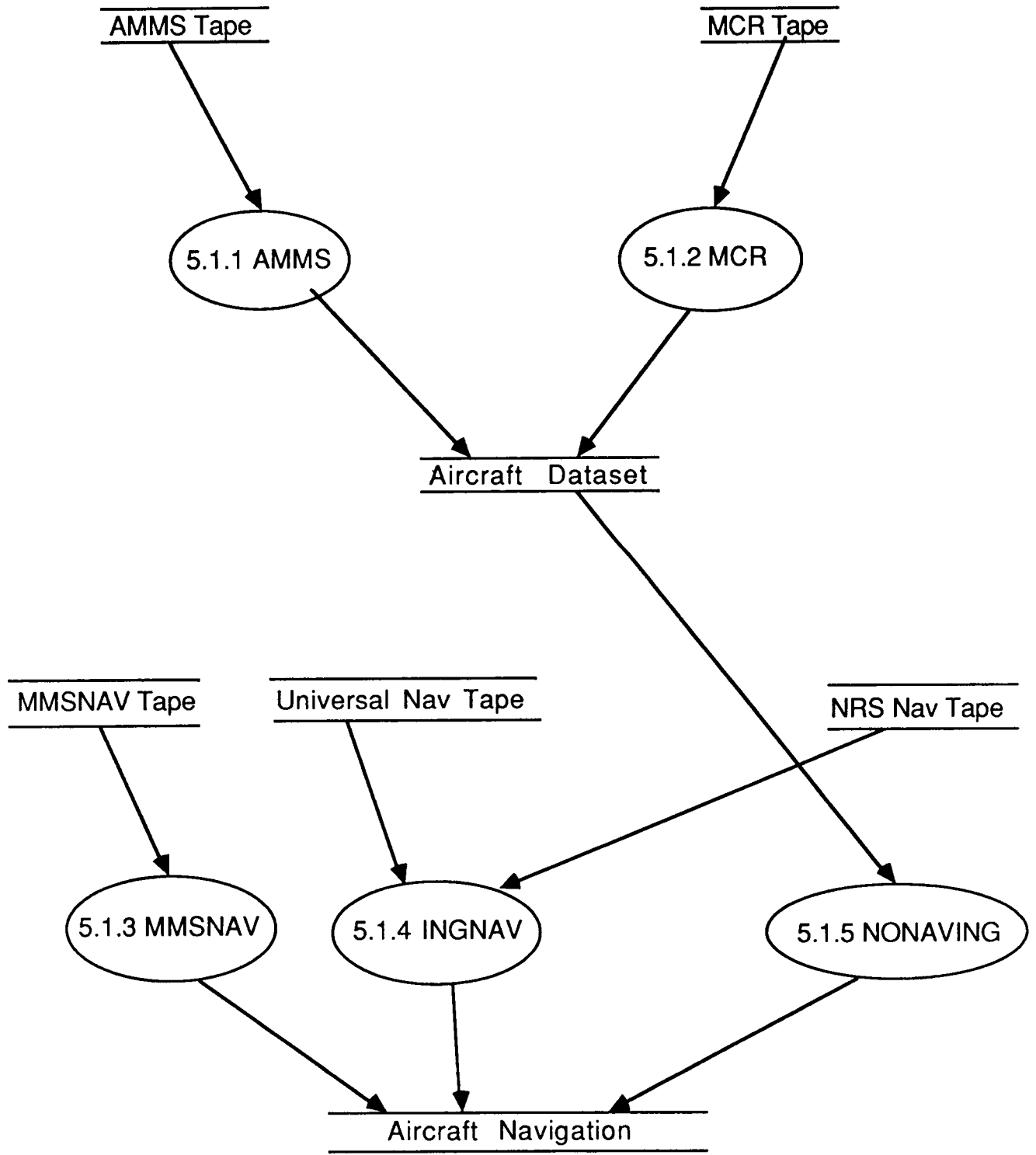


Figure 23. Aircraft Ingest Programs (5.1)

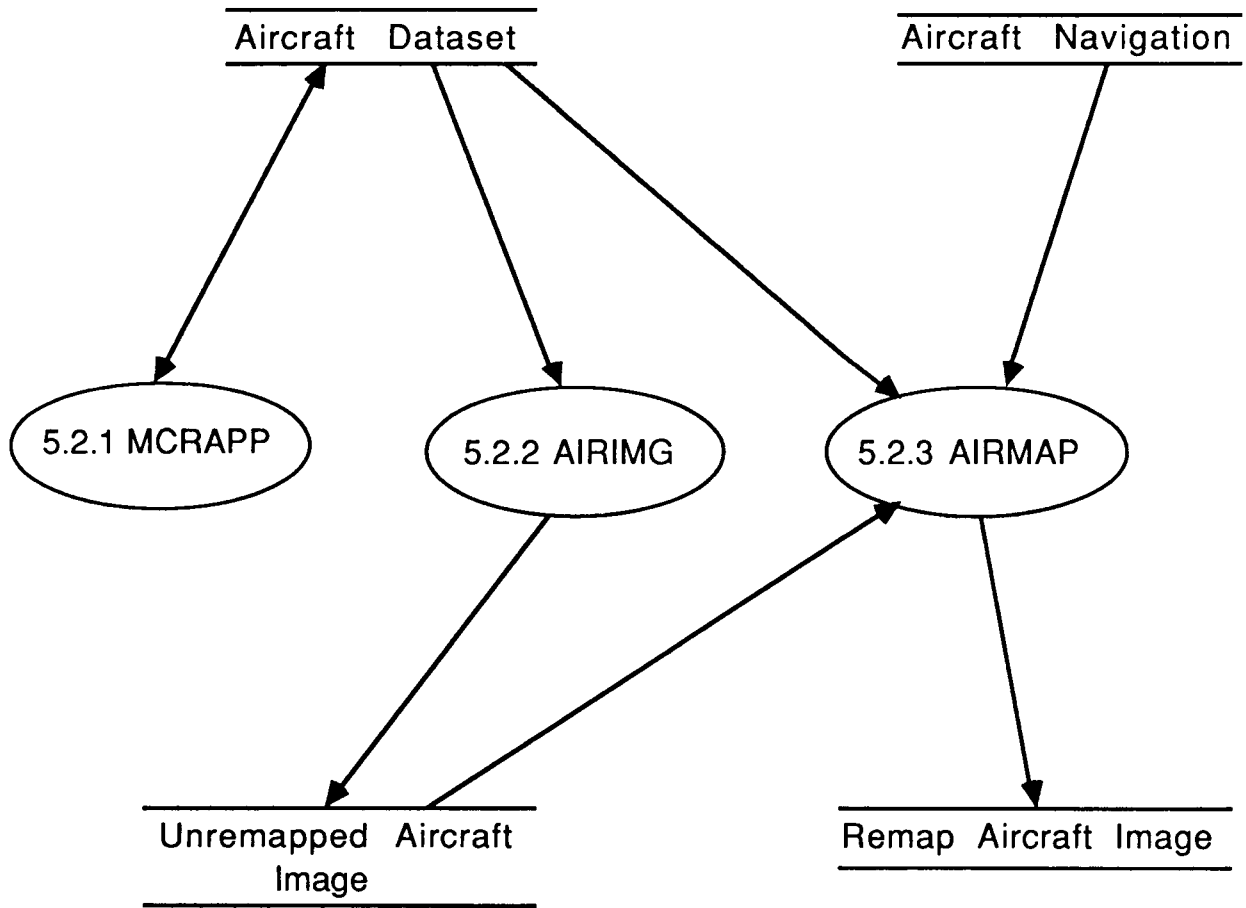


Figure 24. Aircraft Analysis Programs (5.2)

5.4 Aircraft Glossary

Aircraft Dataset

The Aircraft Dataset is a standard format disk file in which aircraft flight line data are stored. The file contains data for each scan and channel of the source aircraft instrument. The scan data types includes: raw counts, volts, radiance, temperature, reflection function or derived quantity field data. The file also contains date and time information for navigation purposes, as well as header information to describe the characteristics of the source instrument and data.

Aircraft Image

An Aircraft Image is either an Unremapped Aircraft Image or a Remap Aircraft Image. This file contains grey values which are scaled to represent aircraft field data. The Aircraft Image is in the AOIPS Image format.

Aircraft Navigation Dataset

The Aircraft Navigation Dataset is a standard format disk file in which aircraft navigation flight line data are stored. This file contains time, location, and aircraft attitude data for each scan line. The Aircraft Navigation Dataset is associated with an Aircraft Dataset and is thus linked to it logically.

Remap Aircraft Image

A Remap Aircraft Image contains grey value scaled aircraft data remapped to a constant cloud height with evenly-spaced pixels. It is in the AOIPS Image format.

Unremapped Aircraft Image

An Unremapped Aircraft Image contains grey value scaled aircraft data. The image can be a reduce (sub-sample) of the dataset or a subscene (selected area at full resolution) of the dataset. This file is in the AOIPS Image format.

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CHAPTER 6

UTILITIES

The AOIPS Utilities provide a wide range of functions for data manipulation, enhancement, and management. These programs include such capabilities as: image zooming, shifting, looping, and the application of color look-up tables (LUTs). In addition, functions to edit image labels, organize data directories, and set system parameters are available.

The utilities are grouped into categories and are described in the sections that follow. The categories and programs within them are listed alphabetically.

6.1 AOIPS File Location Utilities

The AOIPS File Location Utilities identify and modify the AOIPS file location global parameter F\$FILLOC. The F\$FILLOC parameter has the following format:
NODE::DISK:[USER.AOIPS.GROUPNAME]. This parameter is the fully qualified host directory location that is used as the default location for AOIPS data files in AOIPS programs. The AOIPS Group Name is the subdirectory component of the file location parameter.

CREATGRP creates a new AOIPS data group. The new group will be located on the user-selected node and disk on the user account: NODE::DISK:[USER.AOIPS.GROUPNAME]. GROUPNAME may be a maximum of 9 characters.

GETGROUP selects an AOIPS group from those available from the user executing the program.

SETFLOC sets the AOIPS file location global parameter F\$FILLOC. Thus, the default data location can be set to any user's AOIPS group.

WHEREAMI displays the current AOIPS file location (F\$FILLOC) and the user's default directory for DCL operations.

6.2 AOIPS Conversion Utilities

The AOIPS Conversion Utilities convert AOIPS1 files (pre-1984) into the proper AOIPS file format for use with the current system.

CNVNAV converts AOIPS1 landmark and navigation files to the current AOIPS format.

CNVLDC converts AOIPS1 line documentation files to the current AOIPS format.

CNVUIC converts an AOIPS1 'UIC' into an AOIPS group and makes the proper image, navigation and directory file conversions so that the data may be used with the current AOIPS system.

6.3 Button Board Utility

The Button Board utilizes the keyboard of the CRT to implement a variety of image manipulation functions. Each key represents an executable AOIPS utility program or function. Thus, the Button Board allows the user to have interactive control of image manipulation functions. These functions include image loop, zoom, shift, statistics, and graphics plane control. The description of each key is displayed upon entering the Button Board (see Table 2). The Button Board also displays the current status of refresh memories, i.e., which image is currently being viewed, which graphics planes are enabled, zoom factors, etc.

The Button Board also features a Configuration (or Secondary) Button Board (see Table 3) which is invoked by pressing the "C" key. The Configuration Button Board allows combinations of refresh memories (configurations) to be displayed through the red, green, or blue guns of the IAT using either primary or secondary LUT for each refresh memory. This capability is used to display different channel combinations or to create stereo images from the appropriate stereo image pair. Configurations can be saved and recalled.

The Button Board is invoked by either entering it directly from the TAE (known as the stand-alone version) or by selecting it as an option in the Image Selection List (known as the callable version). The stand-alone Button Board has all the features available and is the most often used version. To execute this version, enter BB from TAE command mode or select the Button Board through the menus. The callable version of the Button Board is a convenient way to invoke the Button Board from inside AOIPS programs, since the Image Selection List is presented in most AOIPS programs. However, it should be noted that the callable version does not contain all of the features of the stand-alone version. Look-up table editing is not available through the callable version of the Button Board.

BBDEMO is a version of the Button Board that can be executed for demonstration purposes. This program reads an ASCII script file to receive a sequence of keystrokes. Thus, Button Board functions can be set up to run automatically.

The following gives a brief description of each Button Board key. Note that the key is enclosed by angle brackets.

Table 2 AOIPS Button Board Screen

```

Function Key: Z
Active Memory: 5
Refresh Memories:
Protection, Active LUT:
Active Graphic Planes:
Loop Seq: 1 7 9
Message:
Mode: Trackball Current Display:5P5P5P
Previous Active Memory: 1 X,Y Zoom: 2 2
1 2 3 4 5 6 7 8 9
NS LP NP NP NP NP NP NP NP
1 3 5 Loop Delay:0.10 -->

```

HELP: List Of Function Keys:

```

A andgate(engrave) P edit PDF parms > or ./< or, slice high / slice low
B zero memory Q sequential lut / reset cursor / box
C configure R statistics ; or :/'or" act. memory dir. input
D drop image S shift memory <linefeed> edit cursor parameters
E exit T toggle protection <backspace> toggle active lut
F fade U unshift memory 1-9,0,-,= activate memory 1-12
G grey display V view memory <shift>1-0,-,+ view config. 1-12
H histogram W write cursor PF1 / PF2 LUT edit / zoom planes
I set loop sequence X shape box PF3 / KP9 shift / unshift planes
J profile Y polygon KP- / KP, clear all/active planes
K mosaic loop Z zoom / unzoom KP0 / KP. annotation/ select color
L loop control l copy memory PF4 / ENTER stop loop / keypad help
M move box j copy lut ? or <cr> help cursor control
N manual loop O cursor on/off <sp> restore screen tab key

```

Table 3 Configuration Button Board Screen

HELP: Image Configuration Button Board

```

      refresh memories
      1 2 3 4 5 6 7 8 9 10
+-----+-----+
L   red gun | Q W E R T Y U I O P
U   green gun | A S D F G H J K L ;
T   blue gun | Z X C V B N M , . /

```

```

<lf>  back to primary BB
<cr>  configuration help
ENTER keypad help
<sp>  restore screen
<bksp> toggle active LUT
PF1   edit LUT
PF4   stop looping

      [ or { save current configuration
      \ or | delete images/configurations
      ] or } enter configuration name
      , or ~ enter refresh memory
      ' or " set to null configuration
      1-9,0,-,= activate memory 1-12
      <shift>1-0,_,+ view configuration 1-12

```

<UP> : Cursor Control
This key moves the IAT cursor upward.

<DOWN> : Cursor Control
This key moves the IAT cursor downward.

<RGHT> : Cursor Control
This key moves the IAT cursor to the right.

<LEFT> : Cursor Control
This key moves the IAT cursor to the left.

<BKSP> : Toggle Active LUT
This key toggles the active look-up table (LUT) for the active refresh memory. (Primary LUT to Secondary LUT or vice-versa)

<TAB> : Cursor Speed
This key adjusts the cursor speed for each interrupt from the arrow keys. The initial speed is 10 pixels per interrupt. Each time the TAB key is pressed, the speed toggles between 1 pixel per interrupt and 10 pixels per interrupt.

<LINEFEED> : Edit Cursor Parameters
This key invokes a dynamic tutor that allows the user to change the global cursor and box parameters. These parameters define cursor characteristics (shape, color, blink rate, size, and position) and box characteristics (size, position, color).

<CR> :
This key displays the primary Button Board information when the user is in the primary Button Board, and the configuration information when the user is in the secondary (configuration) Button Board.

<KP ,> :
This key clears all active bit planes. Inactive bit planes are not affected. It is used in both the primary and configuration Button Boards.

<KP -> :
This key clears and resets all bit planes (whether active or not). It is used in both the primary and configuration Button Boards.

<KP .> :
This key sets the active bit planes to a user-specified color. Select the color by entering the one-letter code for the desired color. This key is used in both the primary and configuration Button Boards.

<KP 0> :

This key invokes a dynamic tutor for annotating a character string onto the active bit planes. Characters may be as large as 512 pixels in height, providing that the proper combination of aspect ratio and string length are used. The start location of the string will be the upper-left portion of the first character. This key is used in both the primary and configuration Button Boards.

<KP 1> - <KP 7> :

These keys toggle bit planes 1 - 7 on/off. Bit planes turned on are added to the list of active planes used for graphics operations (e.g., andgate). These keys are used in both the primary and configuration Button Boards.

<KP 8> :

This key toggles all bit planes on/off. Bit planes turned on are added to the list of active planes used for graphics operations (e.g., andgate). This key is used in both the primary and configuration Button Boards.

<KP 9> :

This key unshifts all the bit planes. The use of the graphics box unshifts and unzooms all bit planes. Only one shift amount is possible for all bit planes. This key is used in both the primary and configuration Button Boards.

<PF 1> : Look-up Table Edit

This key allows the user to edit/create a look-up table (LUT). The new look-up table cannot be catalogued unless the file location directory (F\$FILLLOC) is owned by the user. This function is only available in the "stand-alone" Button Board. If the Button Board is entered from another program, this function is not available.

<PF 2> : Zoom Bit Planes

This key zooms the bit planes, using either the trackball or arrow keys, depending upon the operational mode. The zoom method (replication, bilinear, or cubic) is defined using the "Edit PDF Parameters" function (P key). This key is used in both the primary and configuration Button Boards.

<PF 3> : Shift Bit Planes

This key shifts the bit planes, using either the trackball or arrow keys, depending upon the operational mode. This key is used in both the primary and configuration Button Boards.

<PF 4> : Stop Loop

This key stops the current loop sequence. The image or configuration currently viewed will be indicated by the 'current display' on the status display.

<SP> :

This key refreshes the Button Board status displays.

<">, <'> : Reset Graphics Box Size

This key resets the size of the graphics box to its default size of 16 lines by 16 pixels. The location of the upper-left-hand corner of the box does not change.

<,>, <<> : Slice Low

This key enables the grey level slice function. The active LUT will be replaced by a sequential LUT. The slice is controlled by the trackball or arrow keys, depending upon the operational mode. The low slice edits the sequential LUT from the low end, (i.e., the range of values zeroed is (0,n) where n ranges from 0 to 255). After the low slice is completed, the new (sliced) LUT becomes the active LUT.

<>>, <.> : Slice High

This key enables the grey level slice function. The active LUT will be replaced by a sequential LUT. The slice is controlled by the trackball or arrow keys, depending upon the operational mode. The high slice edits the sequential LUT from the high end, (i.e., the range of values zeroed is (n,255) where n ranges from 255 to 0). After the high slice is completed, the new (sliced) LUT becomes the active LUT.

</> : Slice Single

This key enables the grey level slice function. The active LUT will be replaced by a sequential LUT. The slice is controlled by the trackball or arrow keys, depending upon the operational mode. The slice edits the sequential LUT by replacing the grey value n with 0. The value n can range from 0 to 255. The default width of delta-n is set to 0, meaning that the slice is for a single grey level. Use the "Edit PDF Parameters" function key (P) to change the delta value, enabling the slice to be over a constant "delta width" of grey values. After the low slice is completed, the new (sliced) LUT becomes the active LUT.

<1> - <=>:

These keys activate refresh memory #1 - # 12. Refresh memories must be activated before they can be used in other Button Board functions. These keys are used in both the primary and configuration Button Boards.

<!> : shift <1> - shift <=>

These keys cause saved configurations #1 - 12 to be viewed. The active refresh memory is not changed by these functions. These keys are used in both the primary and the configuration Button Boards.

<:;>, <:> Reset Cursor Coordinates

This key resets the cursor to the center of the screen (i.e., 256,256).

<?> :

This key prompts the user for the function key for which

detailed help is to be displayed.

<[>, <{> : Copy Memory

This key copies the image in the previous active refresh memory and its associated label to the active refresh memory.

<]>, <}> : Copy Look-Up Table

This key copies the Primary and Secondary LUTs in the previous active refresh memory to the active refresh memory.

<'>, <~> : Input Active Refresh Memory Number

This key prompts the user for the number of the refresh memory to be activated. This provides a way to set refresh memories greater than twelve (12) as the active refresh memory.

<A>, <a> : Andgate (Engrave)

This key engraves the graphics on the active bit planes onto the active refresh memory using the current value of the input parameter ANDVALUE. Any shifts of images or graphics will be taken into account. ANDVALUE may be changed by using the "Edit PDF Parameters" function (P key).

, : Zero Image

This key clears the image and graphics data in the active refresh memory. The refresh memory must be unlocked in order for it to be cleared. The image label will remain in the image selection list.

<C>, <c> : Configure

This key invokes the secondary Button Board for dynamic configuration of images. Active memory keys, view keys, and keypad keys for graphics plane control are all valid in the configuration keyboard. This configuration Button Board allows refresh memories to be viewed through the selected gun (red, green, blue) with the appropriate segment of the selected look-up table. The LUT of the active refresh memory can be toggled.

<D>, <d> : Drop Image

This key displays the image selection list (using the current group location) for the selection of disk image files to drop to specified refresh memories.

<E>, <e> : Exit

This key exits the Button Board utility and returns control to TAE.

<F>, <f> : Fade

This key enables the fade function between two images. The two images to fade between are the last two memories specified, i.e., the active memory and the previous active memory. Control of the fade function is done by the x

direction of motion of the trackball. If the cursor is at the left of the screen, 100 % of the active memory is displayed on the IAT and 0 % of the previous active memory is displayed. As the cursor is moved toward the right, an increasing amount of the previous active memory fades into view and a proportional amount of the active memory fades from view. When the cursor is all the way to the right, the active memory is completely faded out and replaced by the previous active memory. Exiting from the fade function is accomplished by pressing any trackball button. The current display is restored upon exiting.

<G>, <g> : Grey

This key displays grey values for the image in active refresh memory. The user moves the graphics box with the trackball or arrow keys, depending upon the operational mode. The maximum size of the graphics box for grey-level display is 16 lines by 16 pixels.

<H>, <h> : Histogram

This key computes and displays a histogram of the grey values of the image in active refresh memory. (If the bi-dimensional histogram option is used, grey values on two images will be calculated and displayed, along with the regression line of best fit.) The area for computation is defined by a box or polygon. The user must first use the "Move/Shape Box" (M or X keys) or "Polygon" (Y key) keys to define the area before invoking the histogram calculation. Histograms can be displayed at the CRT (default) or directed to the line printer. The histogram type is defined by the parameter TYPEHST in the "Edit PDF Parameters" function (P key). The upper and lower bounds and bin size for the histogram are also defined by this function.

<I>, <i> : Set Loop Sequence

This key displays the image/configuration selection list for the selection of refresh memories/configurations to be defined for a loop sequence. Additionally, memories or configurations can be viewed, deleted or have their protection toggled (LOCK/UNLOCK). Detailed information for each image is also available.

<J>, <j> : Profile

This key allows the user to determine grey values along a specified line. Field values (i.e., temperature, reflectivity, etc.) are also displayed for aircraft, radar, and satellite images. Results can be printed to a print file and/or plotted to a graphics device.

<K>, <k> : Perform Four-image Mosaic Loop

This key loops selected images one quadrant at a time in a mosaic loop. Loop direction and speed can be modified by the "Edit PDF Parameters" function (P key).

<L>, <l> : Loop

This key loops refresh memories/configurations defined by the "Set Loop Sequence" function (I key). Four speeds are defined for this asynchronous loop, and can be toggled by successively depressing the loop key. The loop is stopped by pressing the <PF4> key. During the loop, the 'current display' value on the status display will not be updated, but when the loop is stopped, this value will be set to what is currently being viewed. The loop direction and speed parameters are modified by the "Edit PDF Parameters" function (P key). These parameters cannot be modified when a loop is in progress.

<M>, <m> : Move Cursor / Box

This key moves the graphics box using the trackball or arrow keys, depending upon the operational mode. The box cannot wrap around the edge of the screen.

<N>, <n> : Manual Loop

This key steps through the loop defined by the "Set Loop Sequence" (I key) one image at a time. The next image is displayed each time this key is depressed.

<O>, <o> : Cursor On/Off

This key toggles the cursor on/off.

<P>, <p> : Edit Control Parameters

This key displays the TAE dynamic tutor for editing Button Board control parameters. After the dynamic tutor is executed, the Button Board status display will reappear.

<Q>, <q> : Load Sequential Look-Up Table (LUT)

This key loads the active refresh memory with a sequential LUT (0-255). The replaced LUT cannot be recovered.

<R>, <r> : Statistics

This key generates the following image statistics for a defined region: mean, mode, standard deviation, minimum value, and maximum value. The statistics are given in terms of both grey value and field value (temperature, reflectivity, etc.). The area for computation is defined by a box or polygon. The user must first use the "Move/Shape Box" (M or X keys) or "Polygon" (Y key) keys to define the area before invoking the statistics calculation. Statistics can be displayed at the CRT (default) or directed to the line printer.

<S>, <s> : Shift Image

This key shifts the image in the active refresh memory using the trackball or arrow keys, depending upon the operational mode. Movement of the cursor reflecting the movement of the image will be viewed if the cursor is active. The cursor is restored to its original position after shifting is complete.

<T>, <t> : Toggle Protection

This key toggles the protection of the active refresh memory. Refresh memories that are "LOCKED" cannot be zeroed (B Key).

<U>, <u> : Unshift Image

This key resets the shift of the image in active refresh memory to zero. If the image has been zoomed, the zoom shift will remain.

<V>, <v> : View

This key causes the active refresh memory to be viewed on the IAT device.

<W>, <w> : Write Cursor

This key writes a cursor onto the image in the active refresh memory. The size and form of the cursor are defined by the "Edit Cursor Parameters" function (<linefeed> key). The grey value at which the cursor is written is defined by the parameter VALUECUR in the "Edit PDF Parameters" function (P key).

<X>, <x> : Shape Box

This key shapes the graphics box using the trackball or arrow keys, depending upon the operational mode. The size of the box increases as the trackball (arrow keys) is moved to the right (up) and decreases when the trackball is moved to the left (down). The box size does not change when the box reaches the edge of the screen.

<Y>, <y> : Polygon

This key draws a polygon to be used to define a region for histogram (H key) or statistics (R key) computations. The user must close and fill the region in order for the histogram and statistics functions to work properly.

<Z>, <z> : Zoom (Unzoom)

This key zooms the image in the active refresh memory by a factor of 2, 4, 8, or 1, respectively. The cursor position defines the center around which the image will be zoomed.

6.4 Database Management Utilities

The Database Management Utilities provide a variety of data management features for AOIPS Image files.

CRCATLG creates an AOIPS catalog file (DIR.IMG) and catalogs images in the current AOIPS group.

IDDELETE deletes selected AOIPS images from the current AOIPS group.

IDLIST lists the set of AOIPS images which reside in the current AOIPS group.

IMGLNK logically links images together for stereo, synthetic stereo, and cloud tracking analysis.

UICCOPY copies a group of AOIPS images and their associated catalog from one AOIPS group to another.

6.5 File Edit Utilities

The File Edit Utilities perform editing of image labels or files. All of the programs, except LBLEDT, invoke the Structured Variable Editor software which is not strictly part of the AOIPS system. For further information, refer to the on-line documentation for this editor.

DIREDT invokes the Structured Variable File Editor program to edit the AOIPS image directory file.

LBLEDT enables editing of selected image label information. A non-TAE image menu will be presented that allows selection of the image label to be edited. Fields that can be edited are then displayed with their current values.

IMGEDT invokes the Structured Variable File Editor program to edit AOIPS Image Files.

STVEDT invokes the Structured Variable File Editor program. The types of files that may be edited and the TYPE name keyword values for these types of file organizations are: AOIPS Image Directory Files (DIRORG) and AOIPS Image Data Files (IMGORG).

6.6 Graphics Utilities

The Graphics Utilities manipulate the graphics planes of the image analysis terminal device (IAT).

ANNOT writes user-specified text strings to selected graphics plane(s). This program uses the Display Management System (DMS) software to perform the annotation, which is faster, but of lower quality, than programs using the GEMPLT software.

ASCCHG modifies the cursor definition in terms of its form color, size screen position and blink rate. The graphics box definition can also be changed in terms of its color, screen position, and size.

BPCOLOR sets the color of a specified graphics plane.

BPONOFF toggles the specified graphics planes on or off.

PUTGRP writes a string onto all the graphics planes.

SHIFTGR performs a relative or absolute shift on all graphics planes.

TXTQRY lists the current GEMPLT annotation defaults used by TXTWRT.

TXTSET sets the GEMPLT annotation parameters. It should be called before executing TXTWRT.

TXTWRT writes an annotation string onto the graphics plane using the GEMPLT software.

ZOOMGR zooms (and shifts) all graphics planes by a specified zoom factor.

6.7 Image Hard Copy Utilities

The Image Hard Copy Utilities generate various hard copy products from AOIPS images.

GREY produces a character map of image grey values.

IMGPRT creates a disk file for printing on the QMS laser printer that is a grey shade reproduction of an AOIPS image.

VCOPY produces a grey shade reproduction of an AOIPS image on the Versatec plotter.

6.8 IAT Utilities

The IAT Utilities perform operations related to the image analysis terminal (IAT).

ALLOC allocates the IAT to the current process. A user must have the IAT allocated to his/her process in order to display images.

DEALLOC de-allocates the IAT, freeing it for use by other processes.

IATINIT initializes the user's allocated IAT display. Options are available to initialize images or graphics planes, or both. Image initialization clears all refresh memories, loads linear look-up tables, resets display registers (zoom, shift, etc.), and resets the display management tables. Graphic initialization clears all bit plane overlays, and resets the graphics planes to default colors. Both initializations turn off the cursor.

IATSTAT displays a summary status listing of IAT display devices. This function is useful for determining whether a given device is available for allocation.

IMGLST displays on the user's CRT the currently defined image configurations of the IAT device. The image name, associated refresh memory numbers, memory protection, image date, and source file name are displayed in tabular form.

VIEW displays a specified image from refresh memory in the IAT.

6.9 Image Transfer Utilities

The Image Transfer Utilities move image data from one data storage device to another.

DCO2TP is used to create a Dicomed format tape from a Dicomed format disk file created by DICO.

DICO creates a Dicomed format file to either disk or tape.

DROP displays and configures images from the disk to the IAT display device. If the defaults are taken, a list of images for selection is presented.

DSK2IIS transfers images from disk to the IAT. This function is used to transfer images that do not have a valid AOIPS label and to create mosaic images.

FROMTV copies one or more images in the IAT refresh memory to a specified location on disk.

TAP2IIS transfers images from tape to the IAT.

6.10 Image Manipulation Utilities

The Image Manipulation Utilities perform a variety of image enhancements.

ADD adds (subtracts) two images.

ALIGN aligns a series of images and updates the image labels so that the alignment shifts are saved.

BORDER writes a constant grey-valued border around an image.

CNTOUR contours specified grey level values of an image onto selected graphics planes which may be written into the image data.

DESTRIPE performs destriping of an image.

INVERT inverts the grey values of an image.

MULTIPLY multiplies (divides) two images.

NONOISE removes selected noise spikes, blank lines, or bad lines from images.

SMOOTH smooths image data by convolution.

STRETCH performs a grey level contrast stretch on an image.

WEDGE writes a grey scale wedge onto the image data in refresh memory.

6.11 Look-Up Table Utilities

The Look-Up Table Utilities create, edit and manage Look Up Tables (LUTs) which are used primarily to color enhance displayed images.

CPIMAG copies an image through a LUT, thus altering the image data grey values.

LUTCOPY copies one or more LUTs from another catalog to the current default catalog. The source catalog may be another user's catalog or another catalog of the user.

LUTDELETE deletes one or more LUTs from the specified LUT catalog.

LUTEDIT allows the creation of a new LUT or the capability to edit an existing LUT and cataloging it in a LUT catalog. A LUT for a currently displayed image can be edited with the changes occurring interactively on the image LUT.

LUTLINK links a LUT to one or more image files on disk.

LUTLIST lists the names of the LUTs contained in the specified catalog and optionally lists any of the LUTs. The listing can be directed to either the terminal or to a printer.

LUTLOAD loads a LUT to one or more images residing in the refresh memory of the IAT.

LUTMOVE moves the PRIMARY, SECONDARY, or BOTH LUTs of an image in refresh memory of the IAT display device to one or more images in another refresh memory.

LUTSAVE catalogs a LUT that is currently applied to an image residing in the refresh memory of the IAT. The saved LUT will be of LUT type "NUMBERS".

LUTUNLNK unlinks LUTs from one or more image files on disk.

6.12 Navigated Image Utilities

The Navigated Image Utilities are programs that have the capability to operate on a number of navigated image types (e.g., satellite, aircraft, and radar). Graphics created by any of these programs may be engraved onto the image using the Button Board Utility.

MAPGRID plots latitude/longitude grids and political boundaries on GOES satellite images, GEMPAK projection images, and radar CAPPI or PPI images.

MAPIMG remaps radar or GOES satellite images to any of the map projections supported by GEMPAK. The output image (GEMPAK projection image) is created on either the disk or the image terminal.

NAV provides navigation information, via the IAT cursor, for satellite (GOES and SSM/I), radar, aircraft or GEMPAK projection images. The program displays the corresponding coordinates values for the IAT screen, master dataset and latitude, longitude coordinate systems.

PLOTRK plots the aircraft nadir flight track and sensor scan limits associated with an aircraft image on a radar CAPPI/PPI, GOES satellite or a GEMPAK projection image.

RADGRID plots distance/range (height on PPI) circles and azimuth lines on CAPPI or PPI radar images.

6.13 System Utilities

The System Utilities perform a variety of functions relating to the AOIPS system including: editing software global parameters, listing current system information, and reporting system errors.

ASNEWS displays the AOIPS news file containing the latest system software news and information.

ASWHAT displays the current AOIPS software system global variable values.

DISKS displays a tabular listing of available disks on the system.

MENUTREE produces a Warnier-Orr diagram (a menu tree) of the available programs and procedures in the AOIPS software system.

PRINTER sets the default printer device for all AOIPS programs that have a print option.

REPORT is used to report problems and/or enhancement requests concerning the AOIPS system. The report is sent to the proper accounts via DEC MAIL by the system.

CHAPTER 7

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16. Abstract <p>This document is Volume I of the Atmospheric and Oceanographic Information Processing System (AOIPS) User's Guide. AOIPS 3 is the version of the AOIPS software as of April 1989. The AOIPS software was developed jointly by the Goddard Space Flight Center and General Sciences Corporation. Volume I is intended to provide the user with an overall guide to the AOIPS system. It introduces the user to AOIPS system concepts, explains how programs are related and the necessary order of program execution, and provides brief descriptions derived from on-line help for every AOIPS program. It is intended to serve as a reference for information such as: program function, input/output variable descriptions, program limitations, etc.</p> <p>AOIPS is an interactive meteorological processing system with capabilities to ingest and analyze the many types of meteorological data. AOIPS includes several applications in areas of relevance to meteorological research. AOIPS is partitioned into four major applications components: satellite data analysis, radar data analysis, aircraft data analysis, and utilities.</p>					
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