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A Final Report to  
National Aeronautics and Space Administration  
for

Meteorological Satellite Product Support and Research for  
Project GALE

Contract #NAG5-742

For the Period of

1 October 1985 - 14 April 1988

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Virginia Beach, VA, November 1987. "Update on  
satellite products and the UW data assimilation  
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## 1. INTRODUCTION

This report summarizes participation and accomplishments by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) in the Genesis of Atlantic Lows Experiment (GALE), during the two and half year period of support by NASA grant NAG5-742.

The first year of CIMSS involvement in GALE focused on real-time support and collection of satellite data during the field phase of the experiment. Satellite-derived product generation and data set post-processing were also accomplished. Work efforts following the field phase of GALE included: a) distribution of satellite data and products, b) a research effort involving GALE data assimilation studies, and c) satellite-derived rainfall estimates.

Details of these efforts can be found in the Update on Satellite Products and Data Assimilation Effort During IOP#2 (Appendix A), the three 6-month progress reports submitted earlier (Appendix B), or from the proceedings of the GALE workshops.

## 2. SUMMARY OF TASKS ACCOMPLISHED

A partial list of tasks accomplished by CIMSS in support of GALE includes:

1. Real-time support of the GALE field phase, including the installation and manning of a McIDAS workstation in the GALE operations center;
2. Collection, archival and distribution of geostationary and polar-orbiting satellite measurements (VAS, VISSR, TOVS, AVHRR);
3. Generation, post-processing and distribution of special satellite-derived data (VAS and TOVS soundings, VAS-derived sea surface temperature fields, cloud and water vapor tracked winds, etc.).
4. Production of a videotape of animated GOES satellite imagery during the two-month GALE field phase.
5. Production of an atlas of GOES satellite imagery during the two-month GALE field phase.
6. Production of a set of analyses, 12 hour interval, during GALE IOP#2 utilizing the CIMSS data assimilation system and including the special GALE data set.
7. Research into 4-D data assimilation utilizing the special, high-density GALE data set and the CIMSS data analysis and forecast system.
8. Production of a set of satellite-estimated rainfall maps (6 hour interval, and 24 hour interval)

9. Research into the accuracy of the satellite-estimated rainfall maps (#6), focusing on comparisons to special GALE raingauge measurements.

### 3. RESEARCH OVERVIEW

The large volume of data obtained during GALE necessitates a comprehensive 4-D analysis system that can assimilate this data and produce coherent meteorological information. At CIMSS, a 4-D data analysis and forecast system has been implemented on McIDAS. The GALE data set offers a prime opportunity to study the assimilation of mixed data types in numerical analysis and prediction. Analyses at 12 hour intervals were produced for GALE IOP#2. These analyses include most of the special GALE data set. Comparisons of selected analyses to conventional analyses (NMC Global, RAFS, and LFM), along with a description of several experiments performed using the assimilation system are provided in Appendix A.

While the GALE observation network provided high-density measurements of rainfall over the land areas, little information was obtained in the adjacent oceanic regions. Satellite estimates are a means of filling this void. For this purpose, GOES imagery was used to obtain estimates of 24-hour rainfall during the GALE IOP's. A special set of 6-hourly maps were produced for IOP's 1 and 2. Proper calibration of these maps with coastal gauge and radar measurements, along with an assessment of the accuracies of these maps is essential before they can be used by the GALE scientific community. A detailed report on this assessment, and a description of the technique used to estimate rainfall is given in an Atlas of 6 and 24 hour rainfall maps for IOP#1 and IOP#2.

### 4. PUBLICATIONS AND DELIVERABLES

Velden, Christopher and Janet Pyeatt: Genesis of Atlantic Lows GOES Satellite Imagery Atlas (available from the GALE Data Center)

Velden, Christopher and Christopher Scheuer: Genesis of Atlantic Lows GOES Satellite Imagery Videotape (available from the GALE Data Center)

Smith, W.L., L. Leslie, G. Diak, B. Goodman, C. Velden, G. Callan, W. Raymond, and G. Wade: GALE Participation. CIMSS View, Vol.2, No.1 (available from CIMSS)

Martin, D. W., B. Auvine, and B. Hinton: Atlantic Ocean satellite-estimated rainfall maps during GALE (CIMSS Report; also, publication probable)

Velden, C. S., G. Diak, B. Goodman, and G. Callan: Comprehensive analyses for GALE IOP#2 (publication possible)

## 5. CONCLUSIONS

The CIMSS participation in GALE, supported by NASA grant NAG5-742, has focused on three main areas:

1. real-time support of the field phase, centered on a McIDAS workstation,
2. satellite data collection, archive, product generation, and dissemination, and
3. research into satellite rainfall estimation and data assimilation.

It is our belief that the accomplishments cited earlier reveal a successful completion of the tasks set forth by CIMSS in its GALE participation plan. In support of our major task, the GALE community has responded with numerous requests for satellite data and products. CIMSS, in turn, has benefited from GALE by receiving a comprehensive data set in which to study ways that satellite data can contribute to the understanding of the GALE scientific objectives.

## APPENDIX A

### UPDATE ON SATELLITE PRODUCTS AND UNIVERSITY OF WISCONSIN DATA ASSIMILATION EFFORT DURING IOP#2

Christopher Velden and George Diak  
University of Wisconsin/CIMSS

An atlas of selected GOES satellite imagery during GALE is now available from the Gale Data Center (GDC). Included in this atlas are high resolution visible, infrared and water vapor imagery. In addition to the atlas, a videotape version of animated satellite imagery has been delivered to the GDC.

Maps of accumulated precipitation (6 hour interval) over adjacent GALE oceanic areas, derived from GOES satellite imagery, for IOP's 1 and 2 are available. The scheme used to derive these estimates is a modified Arkin (Arkin and Meisner, MWR, 115, pp. 51-74) technique. An example is shown in Fig. 1.

Coastal raingauge data (including PAM II) has been obtained and decoded. These data were used in point-by-point comparisons with the satellite estimates to provide an estimate of satellite bias, on both an individual and aggregate basis.

Several techniques are being investigated using GALE data sets to improve satellite soundings in cloudy regions. Briefly, these include:

1. Inclusion of high resolution visible imagery in the retrieval algorithms (1 km VISSR or AVHRR)
2. Inversion of cloudy TOVS radiances by non-linear optimal estimation. Theoretical work suggests improved soundings just above cloud-top. Preliminary trials of the technique on real data are supportive.
3. Addition of polar-orbiting satellite microwave data to the GOES-VAS infrared retrieval algorithm. Preliminary results suggest increased sounding coverage with improved delineation of dry and moist bands, and an improvement in the temperature bias over VAS soundings alone.

Analysis of standard meteorological parameters at synoptic times for IOP#2 have been produced from the University of Wisconsin Four-dimension Data Assimilation System (UW/4DDA). Diagnostics from these analyses are also available. The analyses were derived from conventional GALE sources (radiosondes, dropsondes, surface reports, ships, buoys) and do not as yet contain any special satellite-derived products (Fig. 2). Current investigations involve methods of inclusion of the various types of satellite data into the analyses to assess compatibility with conventional data, as well as impact in conventional data void areas.

Comparisons between UW/4DDA and available operational analyses for 00 GMT 27 January 1986 for selected fields are shown in Fig. 3(a-e). It should be emphasized that the operational (real time) analyses contain a limited amount (if any) of the special GALE network data, while the UW/4DDA contains the full, quality-controlled version 3 GALE data set. The UW/4DDA analyses are produced with approximately a 60 km horizontal resolution. The assimilation cycle was set up such that the 12-hour forecast from the previous UW/4DDA analysis was used as the first guess field for the subsequent analysis. It should be noted that all of the fields shown represent analyses and not initialized fields.

Fig. 3a depicts MSLP analyses. The UW/4DDA shows slightly more detail and a stronger high pressure system in the northern plains. Fig. 3b shows fairly similar 500 mb height patterns. However, as seen in Fig. 3c, some large differences appear between analyses of the 250 mb wind fields. The large scale patterns are essentially consistent, whereas, features such as jet streaks show significant differences. Comparisons of 500 mb dewpoint fields are shown in Fig. 3d. Note the tightening of the gradient in the GALE region in the UW/4DDA analysis. Finally, Fig. 3e depicts 500 mb relative vorticity fields derived from the respective wind analyses. A close examination of these fields reveals significant differences, especially over the Atlantic coast frontal region. Only

the UW/4DDA depicts two major vorticity maxima, one over North Carolina and a second one over Illinois. Satellite imagery (including animated water vapor imagery) was used to qualitatively verify the positions of the vorticity maxima. These positions were in good agreement with UW/4DDA analyses. The tight gradient and orientation of the vorticity maximum over North Carolina correlated well with the cloud edge and water vapor alignment as depicted in the satellite imagery. Subsequent analyses of the 500 mb vorticity field at 12 GMT 27 January verify the strength of the second vorticity maximum located over Illinois at 00 GMT. It was this feature that was involved in the second "cold air" cyclogenesis occurring late on 27 January that produced 2-4" of snow in New England (when only flurries were forecast).

Experiments with different methods to incorporate satellite data into the analyses are underway. Preliminary results indicate that incorporation of satellite soundings as horizontal gradient information, rather than absolute values (especially for VAS), along with weighting functions based on density and distance from conventional data appear optimal. The weights (based on data density only) for raob and VAS data at 12 GMT 28 January, 1986 are shown in Fig. 4(a-b). Note the weight maximum for raobs is in the GALE special network region, while the VAS maximum exists in the Gulf of Mexico, which was very clear at the time, allowing for optimal satellite sensing. An analysis of 700 mb dewpoints at this time, using conventional data only (first guess), is shown in Fig. 5a. The inclusion of VAS gradient data into the analysis is shown in Fig. 5b. The analysis changes only slightly over the conventionally data rich regions, with larger differences occurring over the data sparse oceanic regions. Note the tight gradient in the combination analysis over the Atlantic. Satellite imagery support this feature in association with a frontal system.

Another experiment was conducted to determine the sensitivity of the VAS retrievals to the first guess field. Soundings were produced in real time using an LFM 12-hour forecast as a first guess. The soundings were then reproduced using a UW/4DDA analysis as a first guess. Examples of the differences are shown in Fig. 6(a-b) for a case on 12 GMT 27 January 1986. The cold anomaly (Fig. 6a) associated with the upper-level trough is significantly stronger with the UW/4DDA guess (this agrees well with raobs which are not shown), and the upper low center (Fig. 6b) is more properly positioned. Our results suggest the need for future work, which would include reprocessing the satellite soundings with the UW/4DDA analyses providing the first guess fields at all IOP#2 synoptic times. The 4DDA would be used to produce three hour fields during IOP#2 (including coincident VAS soundings and special GALE raobs).



The GALE IOP#2 data assimilation effort has provided experience and knowledge in the assimilation of mixed data types in numerical analysis and prediction. Further work is anticipated, pending funding, to produce high quality analyses during GALE IOP's that can be utilized in basic GALE research and numerical modelling studies.

1/19 0-5 GMT

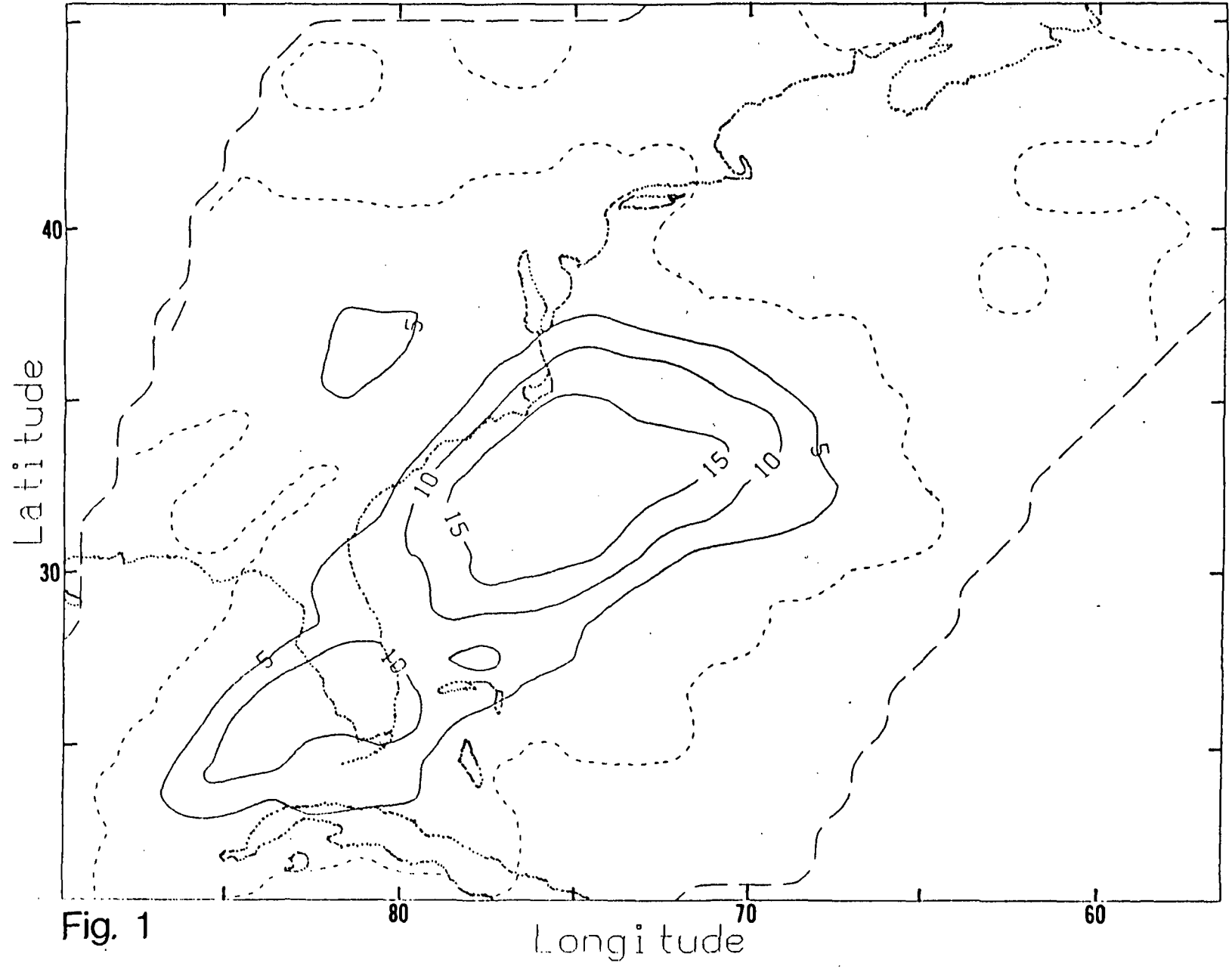
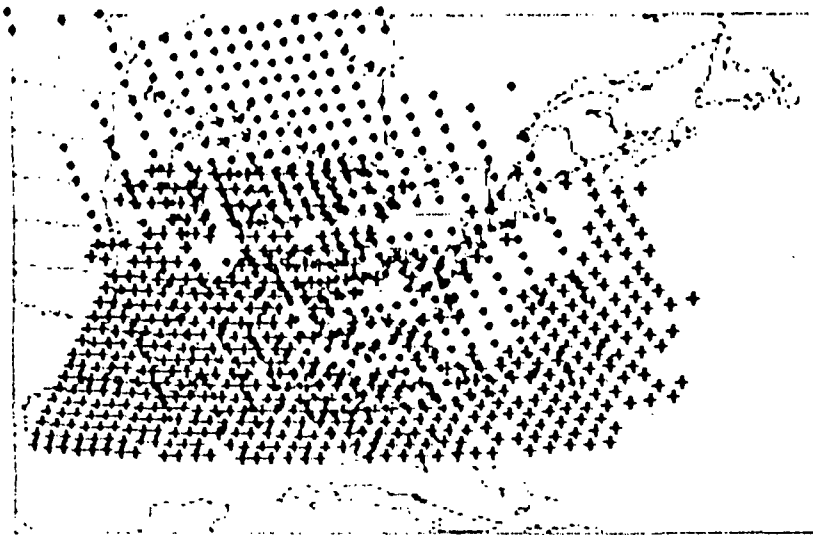
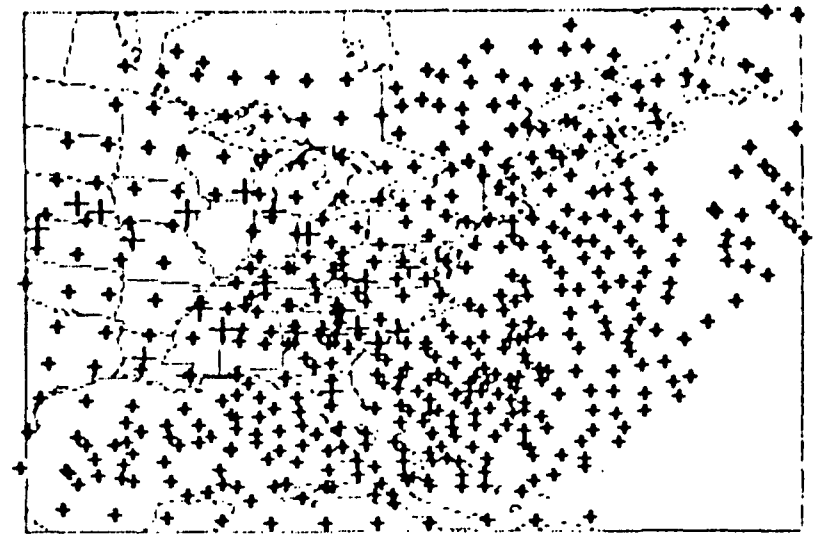


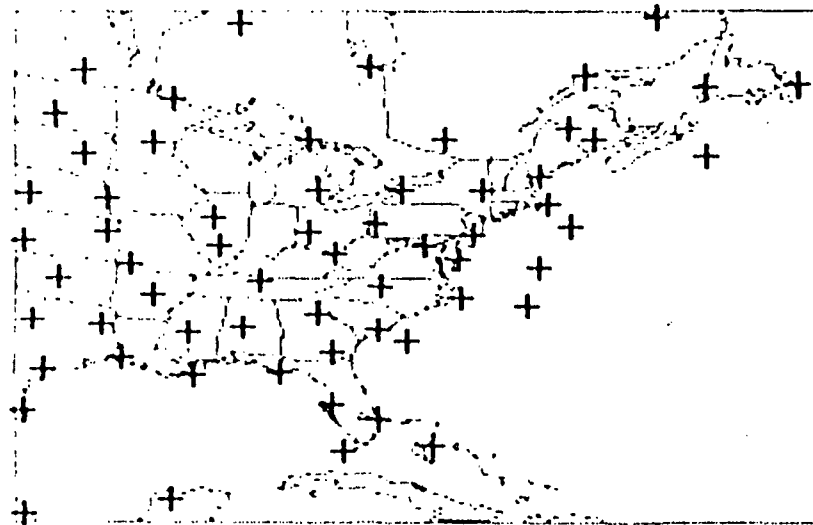
Fig. 1



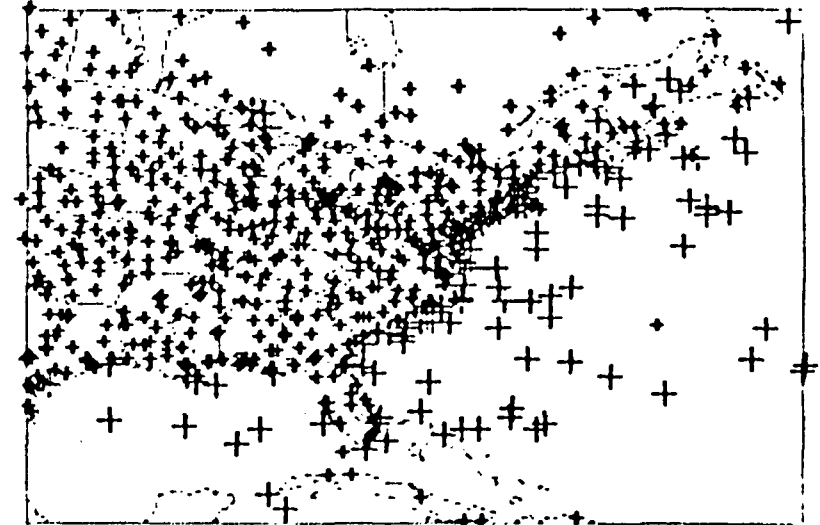
VAS & TOVS      SATELLITE RETRIEVALS



CD+NV DRIFT & ASDAR      WINDS

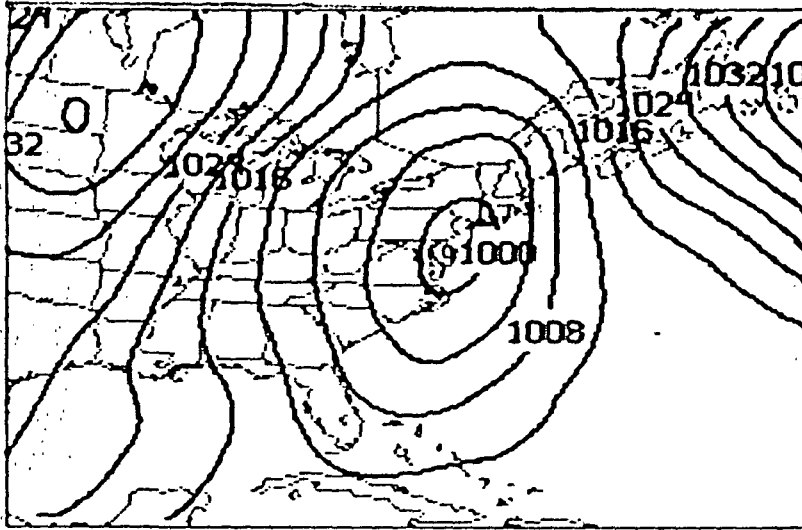


RAOBS & DROPS      UPPER AIR



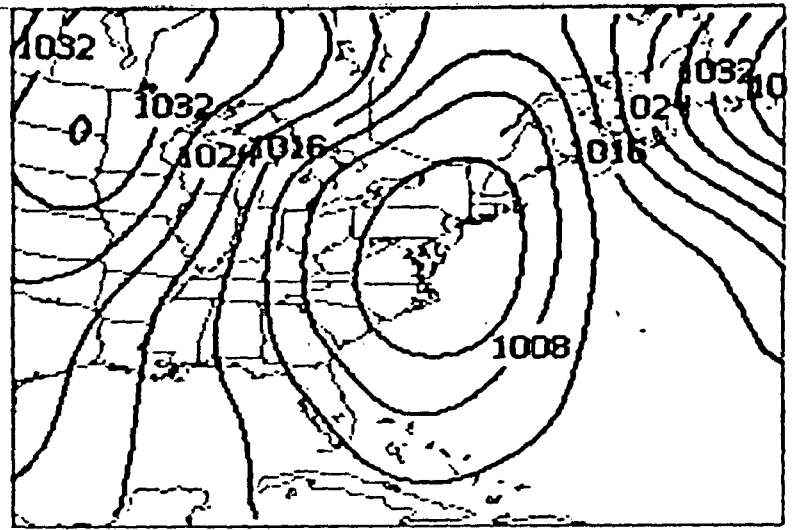
SVCA & SHIP & BUOY      SURFACE

Fig. 2

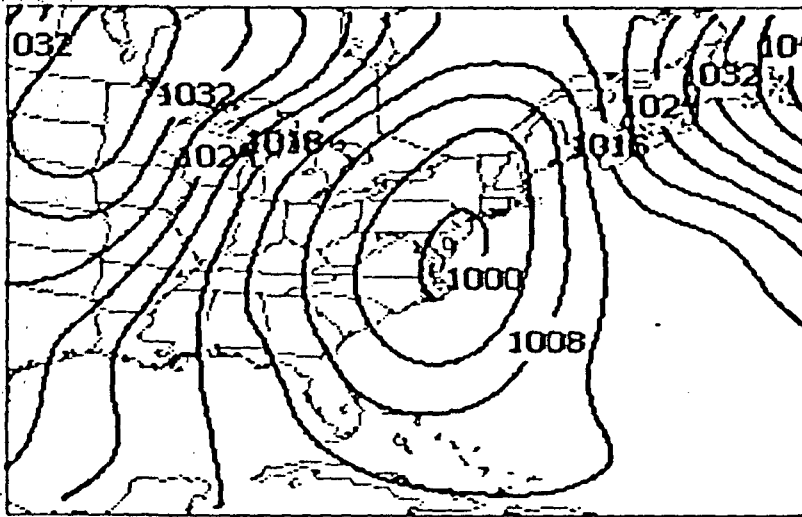


GBL

00 GMT 27 JAN 86

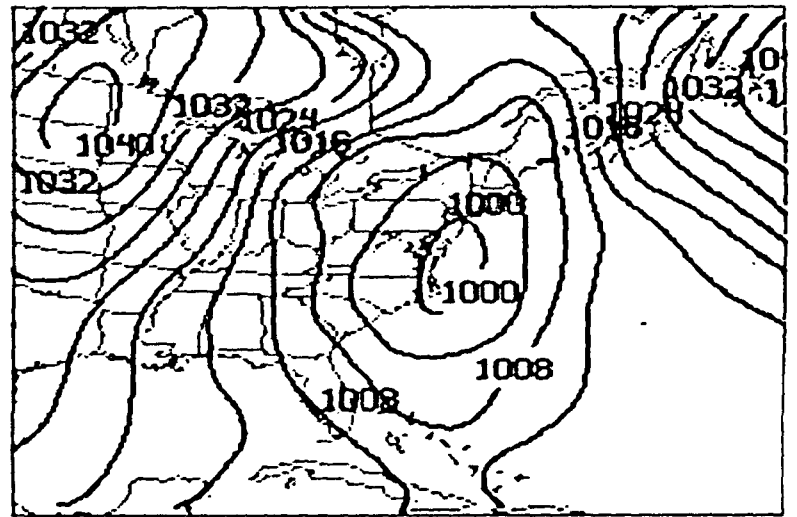


LFM



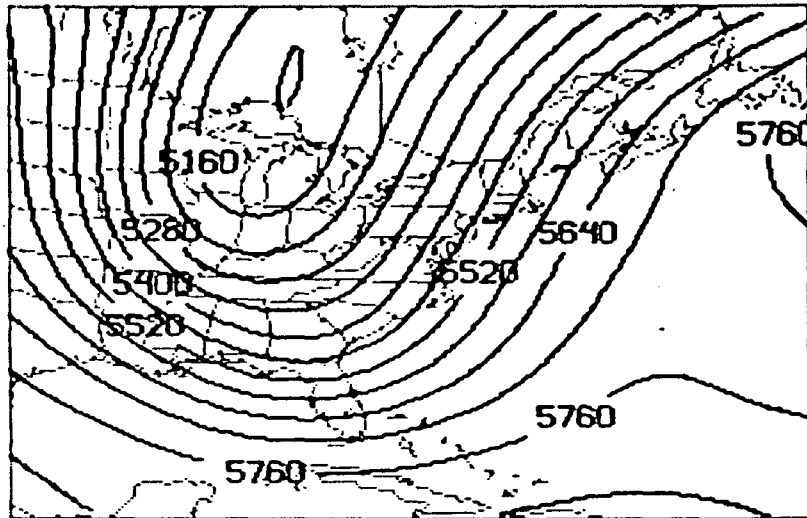
RAFS

Fig. 3a



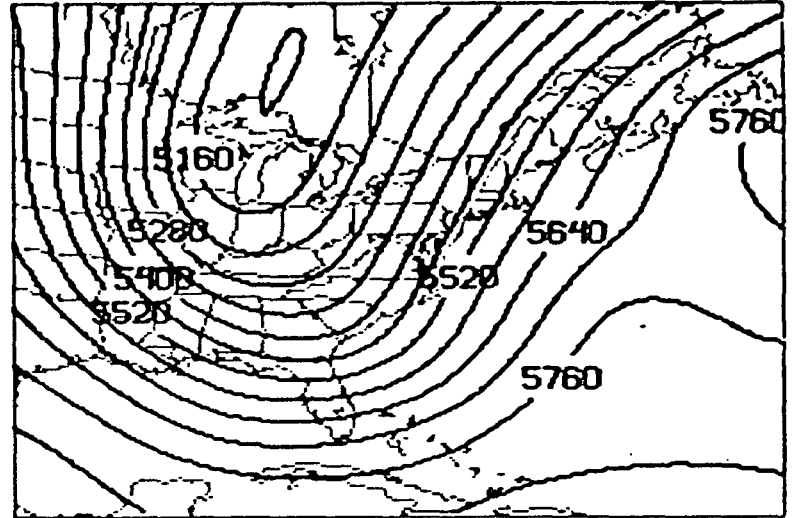
UH/DAS

MEAN SEA LEVEL PRESSURE

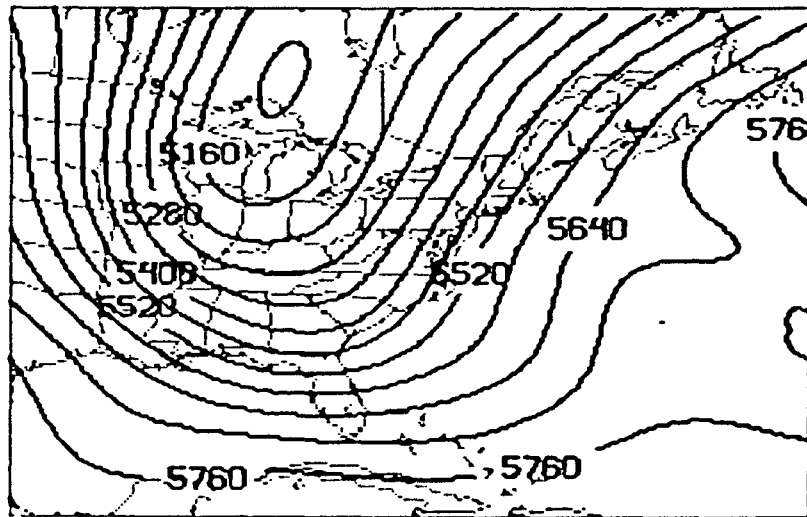


**GBL**

**00 GMT 27 JAN 86**

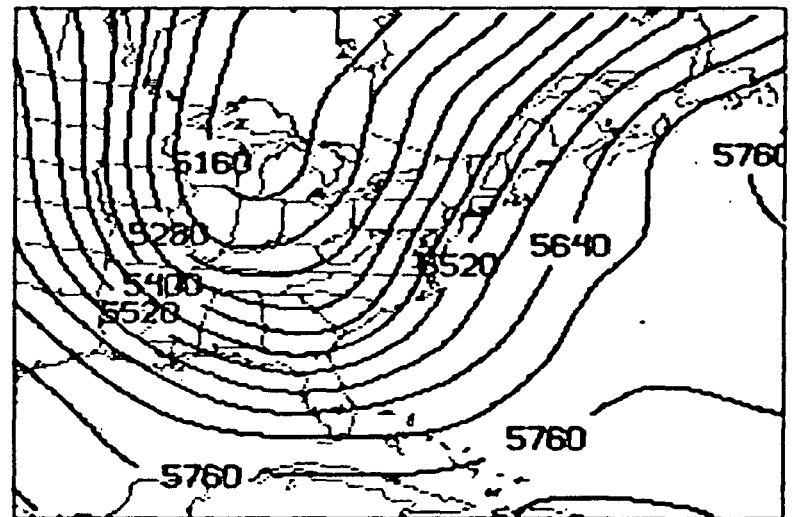


**LFM**



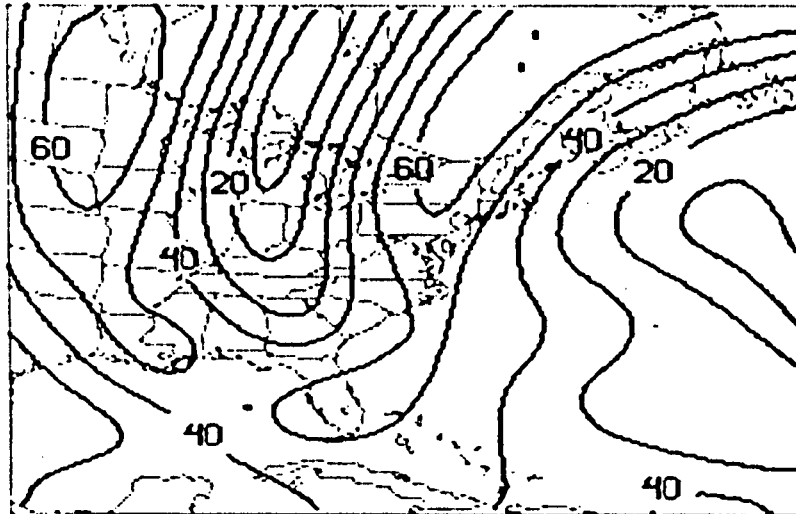
**RFS**  
**Fig. 3b**

**500 MB**



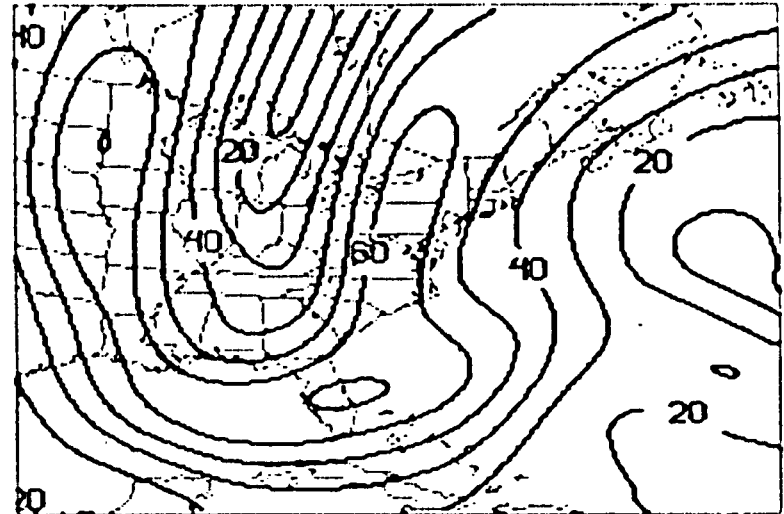
**UW/DRS**

**HEIGHT**

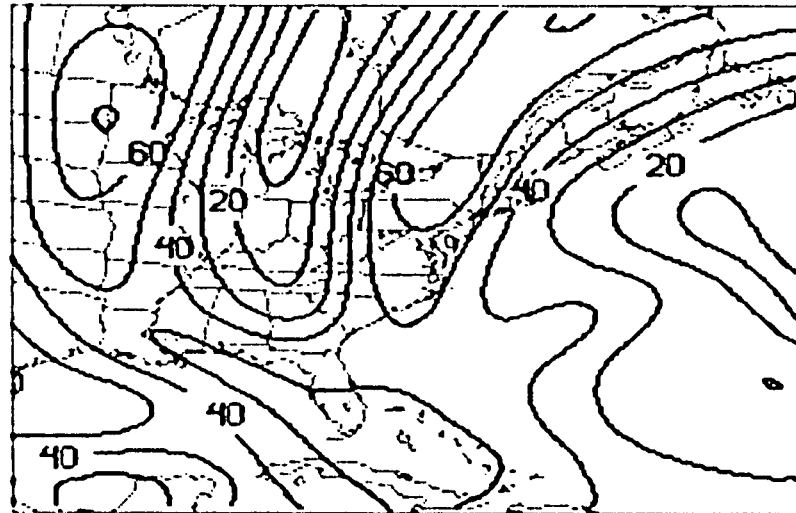


**GBL**

**00 GMT 27 JAN 86**

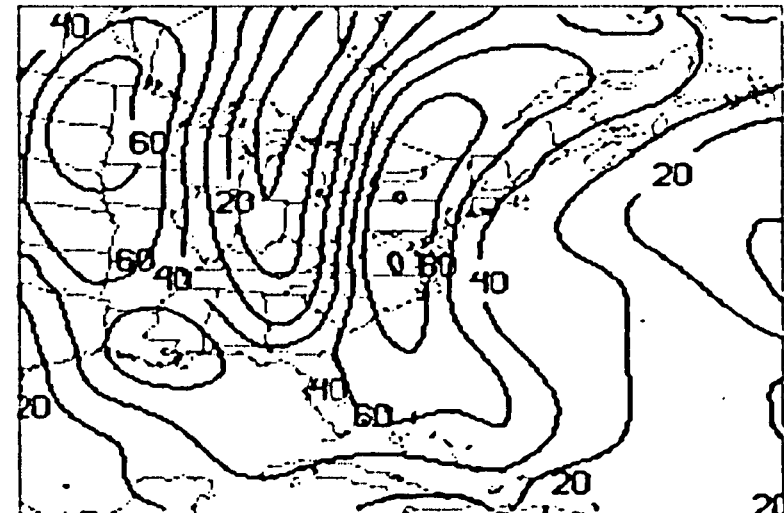


**LFM**

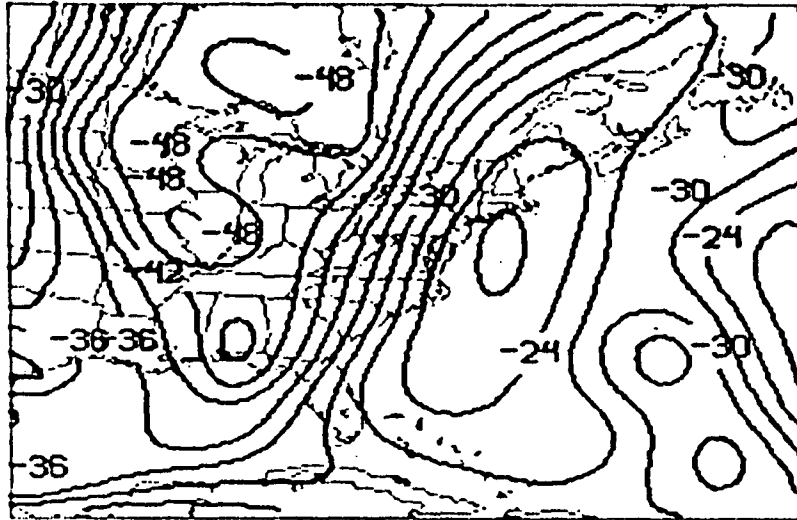


**RFS**  
**Fig. 3c**

**250 MB ISOTACHS (M/S)**



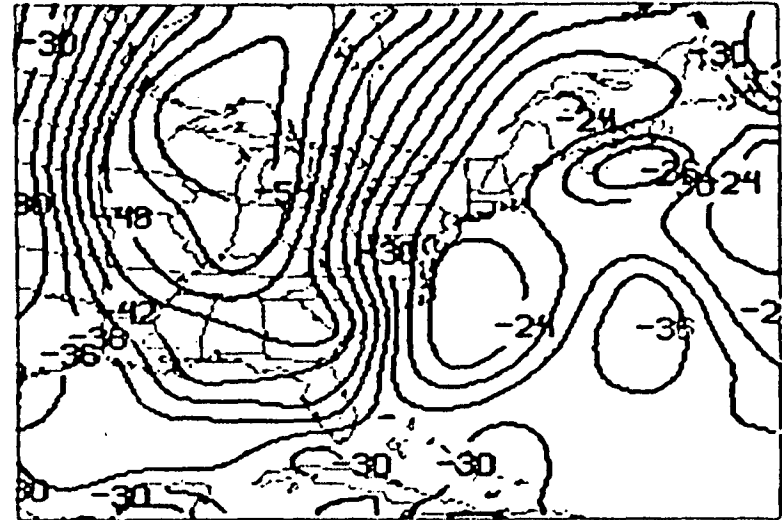
**UW/DAS**



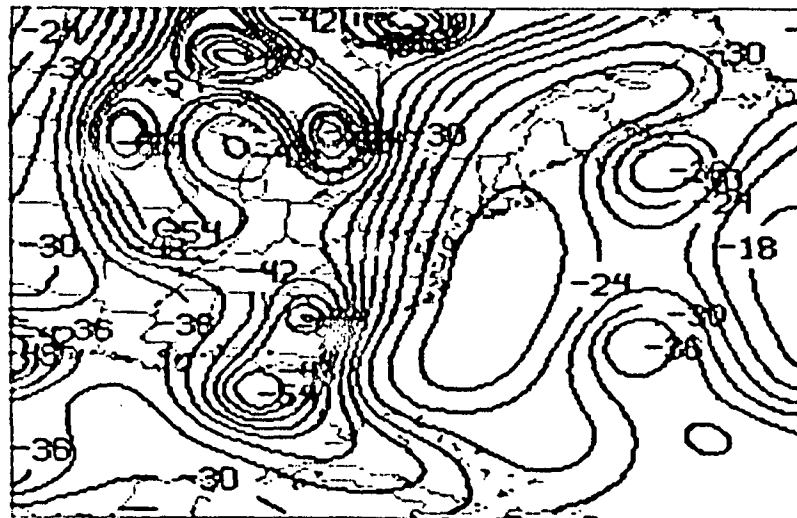
**GBL**

**00 GMT**

**27 JAN 86**



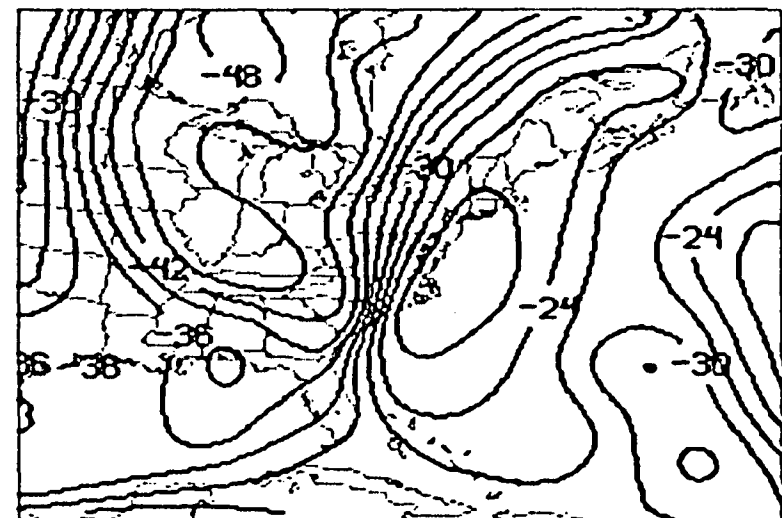
**LFM**



**RAFS**

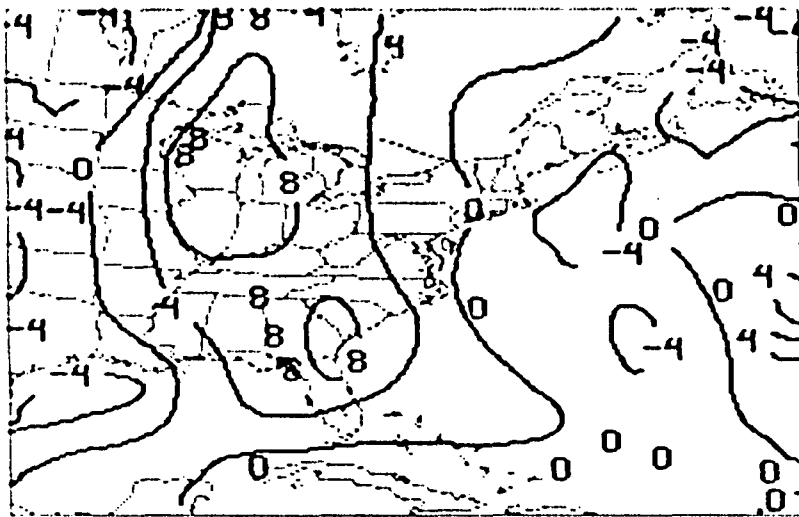
**500 MB**

**DEWPOINT TEMP**



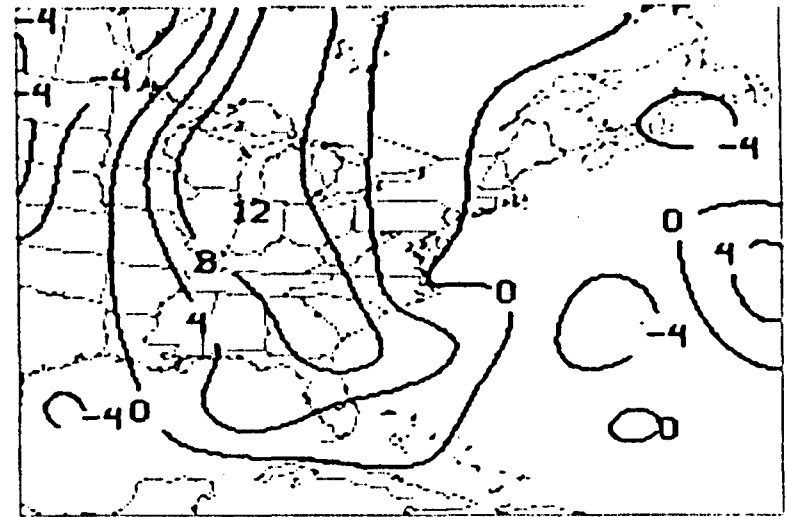
**UW/DAS**

Fig. 3d

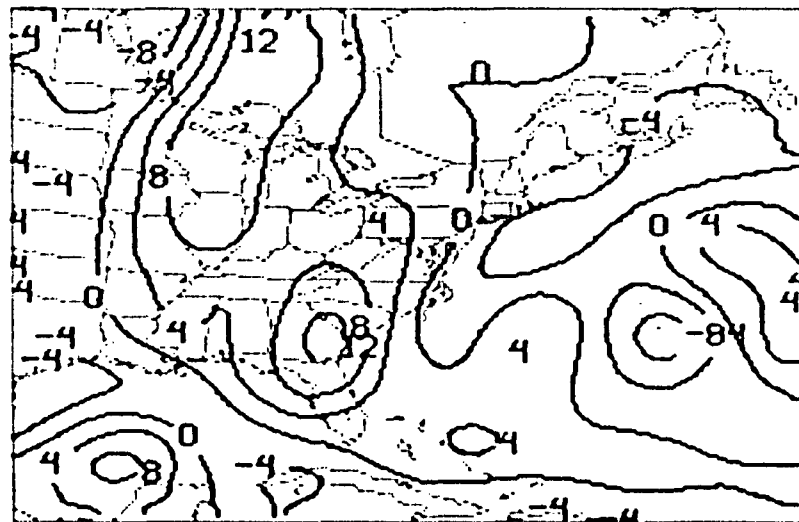


GBL

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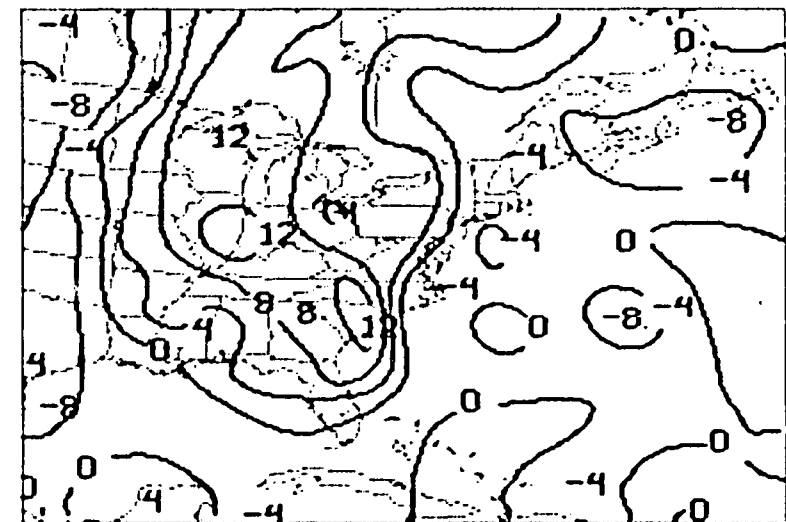


LFM



RAFS

500 MB REL VORT

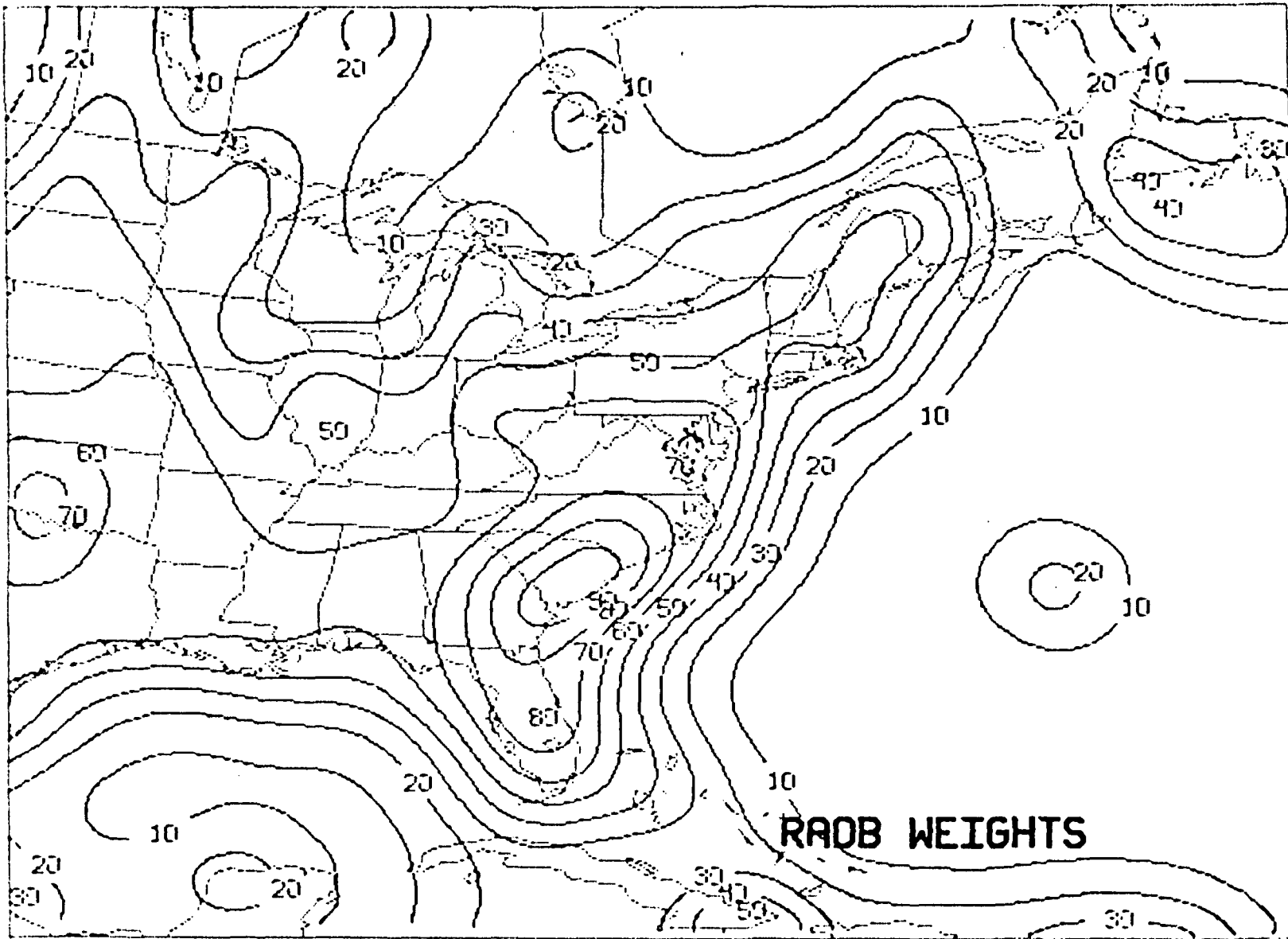


UN/DAS

Fig. 3e

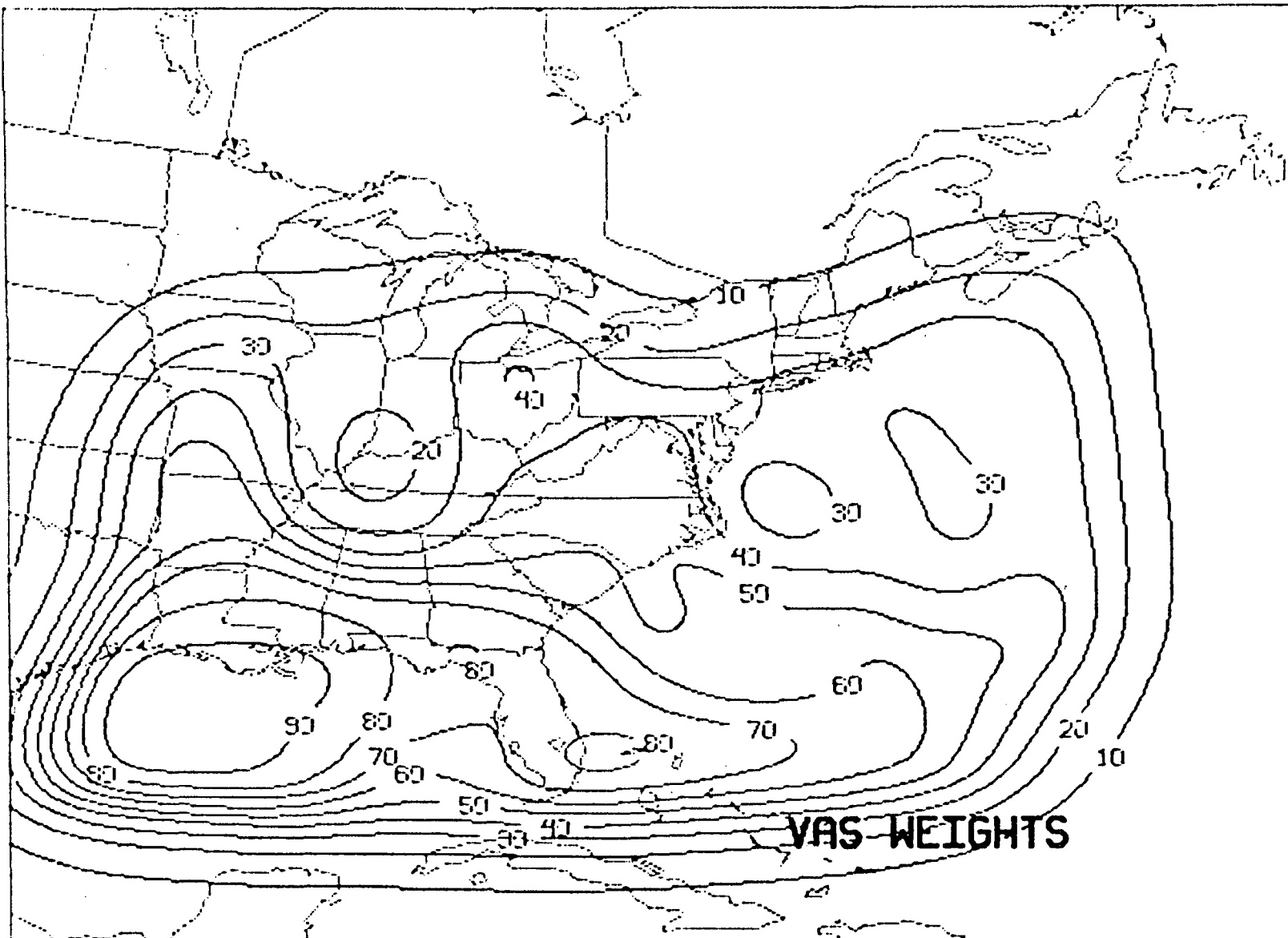


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WGT1 TIME 12. DRY 86028. 700. WWT + 120000.  
WWW

Fig. 4a

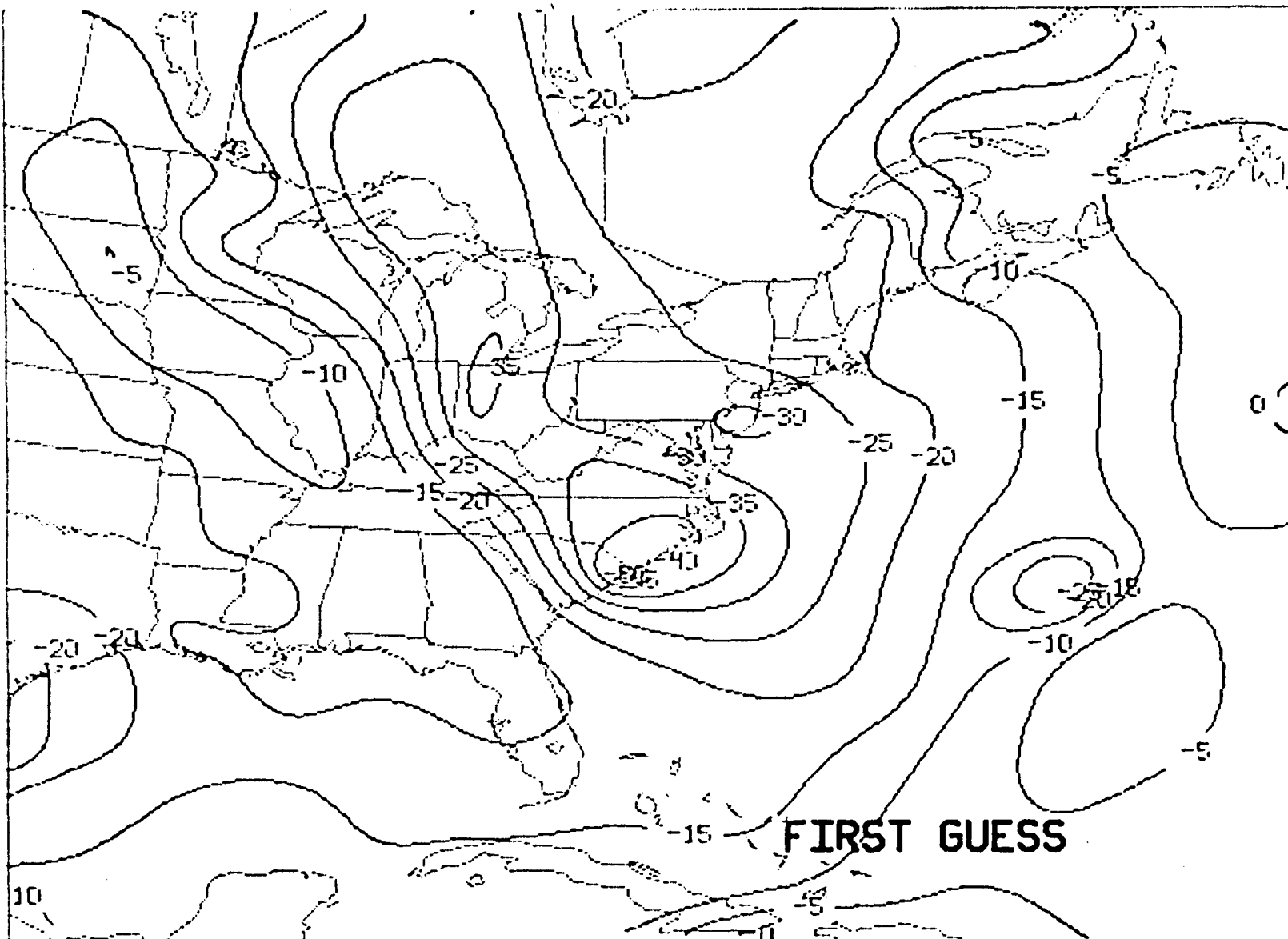


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NGT1 TIME 10.30 DAY 86028. 700.  $\Delta T + 101800.$

Fig. 4b

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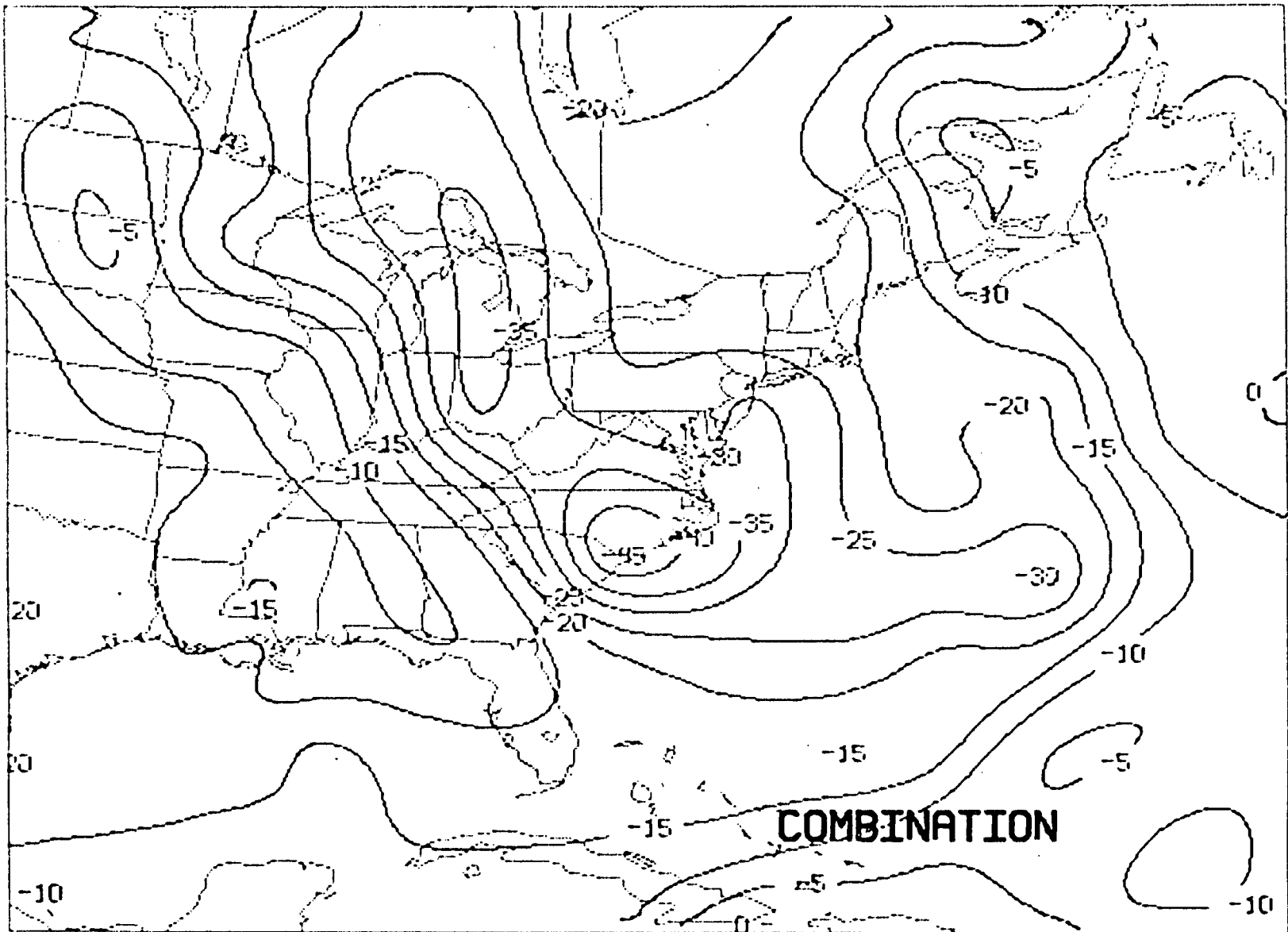


TD (K) TIME 12. DAY 86028. 700. MB

Fig. 5a

1

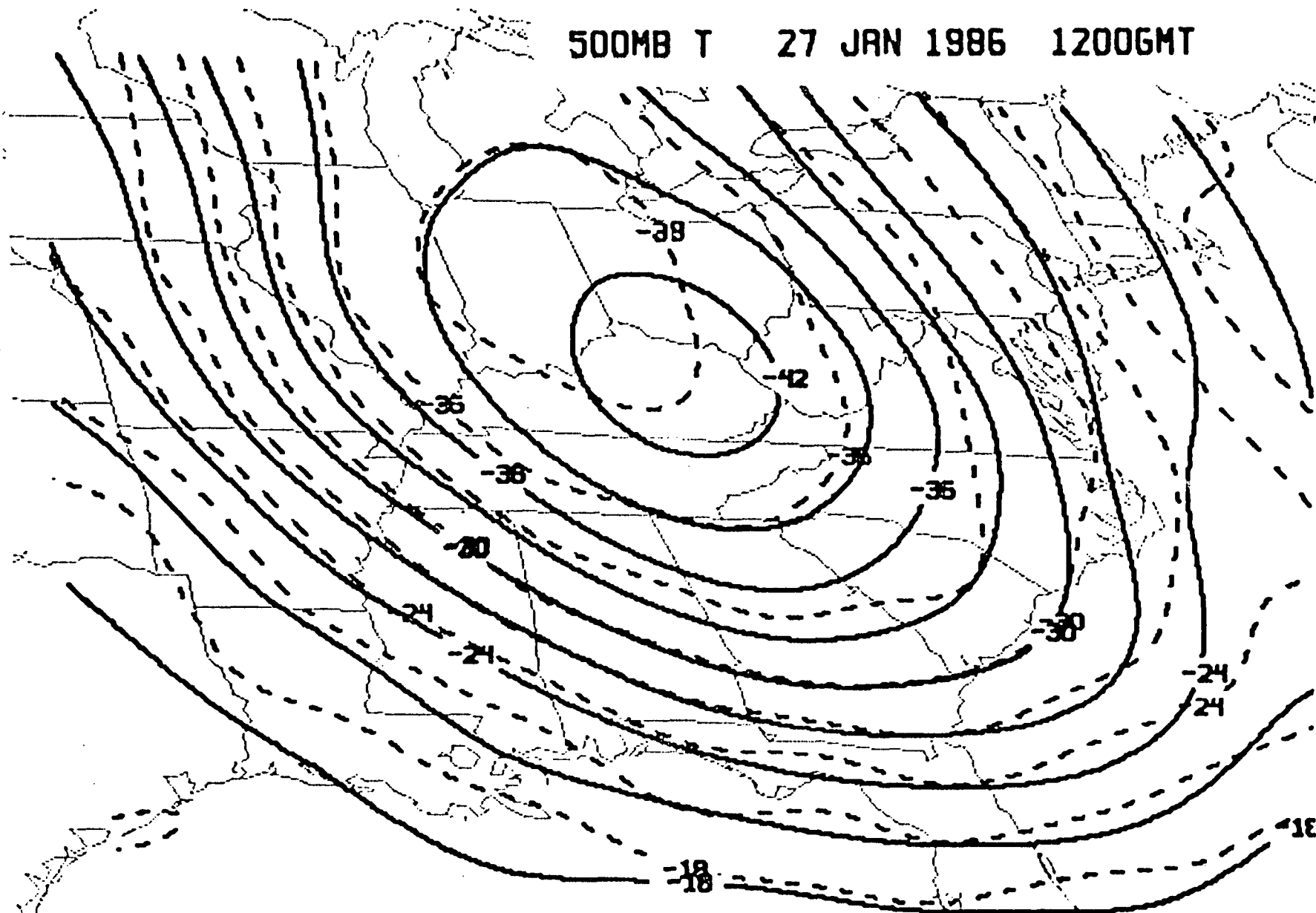
W MCIDRS



TD (K) TIME 12. DAY 86023. 700. MB

Fig. 5b

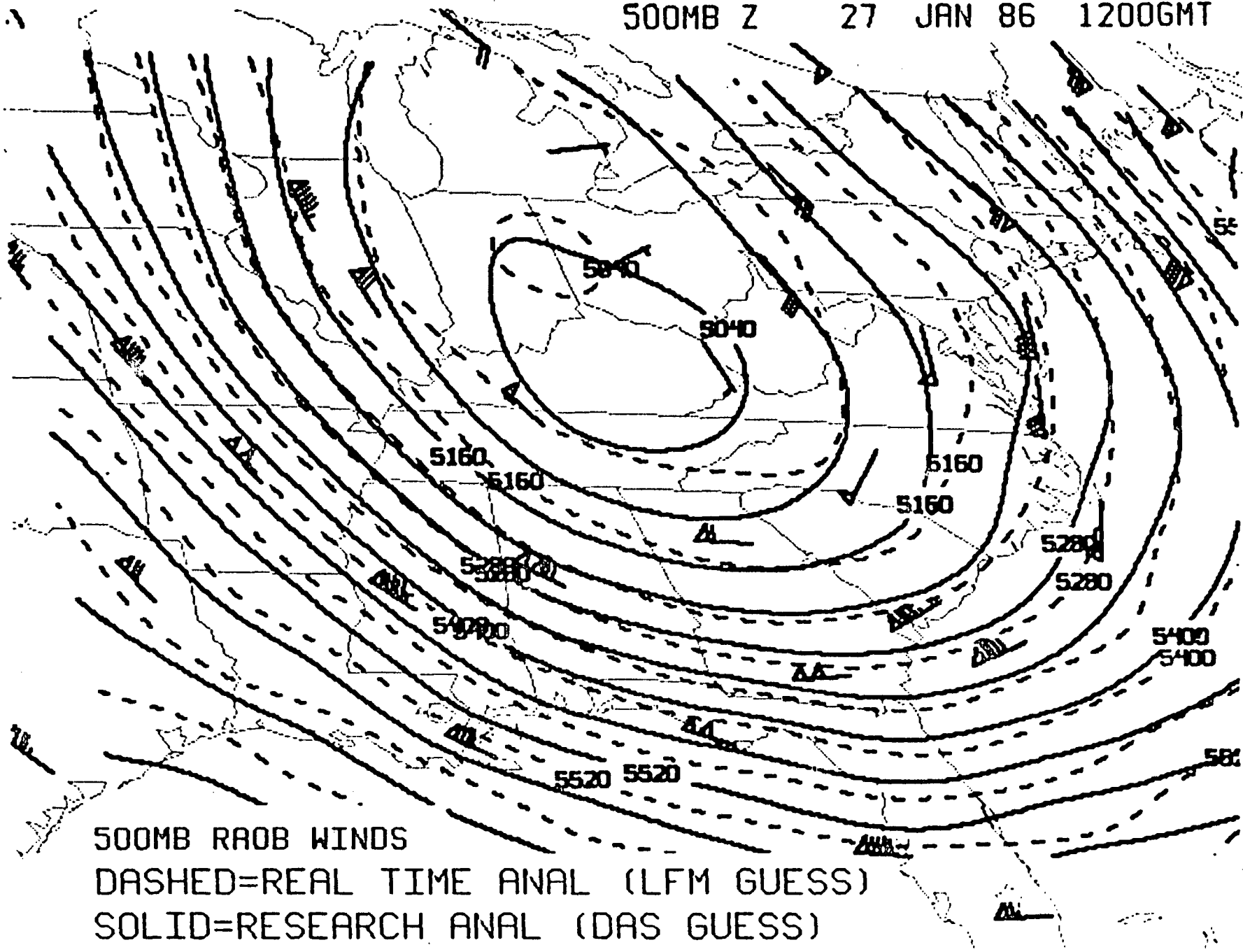
500MB T 27 JAN 1986 1200GMT



DASHED=REAL TIME ANAL (LFM GUESS)  
SOLID=RESEARCH ANAL (DAS GUESS)

Fig. 6a

500MB Z 27 JAN 86 1200GMT



500MB RAOB WINDS  
DASHED=REAL TIME ANAL (LFM GUESS)  
SOLID=RESEARCH ANAL (DAS GUESS)

Fig. 6b

APPENDIX B:

1. 3 September 1986
2. 28 April 1987
3. 8 November 1987

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265452 UOFWISC MDS

TO: Dr. James C. Dodge/NASA Headquarters  
Dr. Louis W. Uccellini/NASA/GSFC

FROM: Christopher S. Velden/CIMSS *Chas Velden*  
Dr. Paul Menzel/ASPP/NESDIS *Paul Menzel*

DATE: September 3, 1986

SUBJECT: Summary of Satellite Data Collected and Processed by CIMSS During  
the GALE Field Phase

We thought it would be appropriate to prepare a preliminary list of all satellite data collected and processed in real time by CIMSS during GALE. This effort is being supported by NASA grant NAG5-742. There are still some data being post-processed (i.e. cloud drift winds and VAS SST fields during IOPs that were not done in real time), but most of the level IIA data sets are complete.

As discussed with Dr. Uccellini, a standard package of GOES satellite imagery has been prepared, including daily visible, infrared window, and 6.7 $\mu$ m water vapor data. This package consists of the raw digital data on standard nine-track magnetic tapes. Requests from the GALE community for other data (i.e. VAS dwell sound or MSI data) will have to be extracted from the SSEC cassette library. We have also included a list of any unusual events (i.e. RISOP, Wallops ground station problems) that occurred that may have interrupted the regular T-VAS schedule in effect during GALE. Only major data losses (i.e. not an image here or there) are included in this list.

A videotape of satellite imagery in motion during the two month GALE period is being prepared. This will include the regular visible, IR, and water vapor imagery that exists in the standard package. It should be about a 20 minute tape and will consist of large scale views, as well as color enhancements and high resolution views during IOPs. This will be a standard U-MATIC tape, with conversion to other tape formats left to the user. We hope this tape will be available for presentation at the GALE meetings in Monterey in February.

We are also exploring the possibility of preparing an atlas of GOES satellite imagery during GALE. This will obviously involve much more time and effort, but would definitely be a worthwhile venture. Completion of such a document would not be expected for at least a year.

As it stands now, UW will serve as the distribution center for the satellite data collected during GALE. Since the data volumes are so large, and we possess all the proper documentation, this seems appropriate. Our only concern is that large data requests may come to us when funding from the current grant has terminated. The user will have to reimburse CIMSS for data copying costs.



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A brief explanation of the data list follows:

- The numbers in the table represent GMT times nearest the data set.
- This represents IIA data processed in real time, with quality control underway. Some additional data sets (mostly winds and SSTs are currently being processed).
- The VAS soundings are derived from two-piece dwell sounds. The sounding method was a physical solution using a one-step simultaneous temperature and moisture retrieval technique.
- The VAS derived imagery consists of precipitable water and Lifted Index data retrieved from VAS radiances at a single FOV resolution and presented in image format.
- VAS gridded analyses (level IIIA) include selected mandatory level temperature, moisture and height fields analyzed from the VAS soundings. A recursive filter analysis scheme was utilized.
- Cloudiness estimates pertain to cloud top heights and amounts as determined from the VAS CO<sub>2</sub> method. Resolution of observations is about 65 km.
- The daily VAS SST observations are derived from VAS multispectral data and also can be presented in image (digital) format with IR-window data substituted in cloudy regions. Resolution is about 7 km.
- The composite VAS SST imagery consists of data from the last six days with the latest data possible in any single FOV.
- Height assignment of the cloud drift winds was done by IR-window and 6.7 $\mu$ m water vapor brightness relationships. Low level vectors were assigned 850 mb.
- Water vapor motion winds utilized the 6.7 $\mu$ m VAS water vapor channel.
- NOAA-9 passes consist of HIRS and MSU data.
- NOAA-9 soundings utilized the same retrieval method as the VAS data.
- NOAA-6 passes include MSU data only.

AVHRR data from NOAA-9 is being accessed from NESDIS for all GALE IOPs. This is a fairly expensive acquisition, due to the high data density. This data set will consist mainly of the GAC (4 km) observations, with an occasional LAC (1 km) pass when available.

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This list of level IIA processed data as well as the list of unusual events is being sent to Drexel as part of the GALE archive documentation. An updated table which may include level IIB data sets will be prepared next year. This table might be included with the atlas.

Future plans through the grant period include completing the level IIA data set library as a top priority. In addition, maps of rainfall (six hourly) using satellite estimation techniques are being prepared during GALE IOPs. Level IIB and IIIB data sets will be produced during selected IOPs utilizing the CIMSS four-dimensional data assimilation system.

Any further questions or comments, please feel free to contact Chris or Paul.

Attachments

cc: Kit Hayden  
Bill Smith  
Bob Fox  
Carl Kreitzberg/Drexel GALE Archive

02/CSV5/08.1

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DATE	STATUS	EXPLANATION	DATE	STATUS	EXPLANATION
1/15/85			2/14	IOP	Some data loss-equipment problems
1/16		RISOP 9-14Z -- no VAS	2/15	IOP	
1/17		RISOP 8-14Z -- no VAS	2/16		Some data loss-equipment problems
1/18	IOP		2/17		Some data loss-equipment problems
1/19	IOP		2/18		
1/20	IOP		2/19		
1/21			2/20		
1/22			2/21	IOP	Some data loss-equipment problems
1/23	IOP		2/22	IOP	
1/24	IOP		2/23	IOP	
1/25	IOP		2/24	IOP	
1/26	IOP		2/25	IOP	Wallops SDB testing--17-00Z no VAS
1/27	IOP	RISOP 11-18Z	2/26	IOP	Wallops SDB testing-no VAS
1/28	IOP		2/27	IOP	Data loss (9-16Z)-equipment probs
1/29			2/28	IOP	Some data loss-equipment problems
1/30			3/1	IOP	
1/31			3/2	IOP	
2/1			3/3		Data loss (17-00Z) no VAS-equip pro
2/2	IOP		3/4		Some data loss-equipment problems
2/3	IOP	Some data loss-equipment problems	3/5		No VAS-equipment problems
2/4	IOP		3/6	IOP	No VAS (18-00Z)-equipment testing
2/5			3/7	IOP	
2/6	IOP		3/8	IOP	Some data loss-equipment problems
2/7	IOP		3/9	IOP	RISOP 18-00Z
2/8			3/10		RISOP 0-10Z--no VAS
2/9	IOP		3/11	IOP	RISOP 16-00Z
2/10	IOP		3/12	IOP	RISOP
2/11	IOP		3/13	IOP	RISOP
2/12	IOP		3/14	IOP	RISOP 0-14Z--no VAS
2/13	IOP	data loss due to satellite maneuver	3/15		No VAS-equipment problems

STATUS	VAS SOUNDINGS	VAS DERIVED IMAGERY	VAS GRIDDED ANALYSES	CLOUDINESS ESTIMATES	VAS DAILY SST	VAS COMPOSITE SST	CLOUD DRIFT WINDS	WATER VAPOR WINDS	NOAA-9 PASSES	NOAA-9 SOUNDINGS	NOAA-6 PASSES
	11,23	11,23	11	01,09,12,19	15	15			18,19	19	
	11,23	11,23	11	01,09,12,20	15	15	11	11	8,19	8,19	
	11,23	11,23	11	01,09,12,20	15	15	11	11	7,19	7,19	
IOP	11,23	11,23	11	01,09,12,20	15	15	11	11	7,19	7,19	12
IOP	11	11	11	01,09			11				
IOP	11	11	11	09,12	15,20	15			7,9,18		
IOP	11,14,17,20,23	11,14,17,20,23	11,14,17,20	01			17	17	7,18		11,13
IOP	11,14,17	11,14,17	11,14,17	09,12,19	15	15	11,17	11,17	18	18	
IOP	14,17,20,23	14,17,20,23	14,17,20	01,09,12,17	15	15	11	11	6,18	6,18	12
IOP	14,17,20,23	14,17,20,23	14,17,20	14,19	17		11,17	17	8,18,19	8,18	11,13
IOP	11,14,17,20,23	11,14,17,20	11	14,19	17		11,17	17	8,19	8,19	11,13
IOP	11,14,17,20,23	11,14,17,20,23	11,14,17	01,20	15	15	11		7,19	7,19	
IOP	11	11	11	0,9,19	15	15	11,17	11,17	7,19	7,19	
	11,23	11,23	11	0,12,19	15	15	11	11			
	11,23	11,23	11	01,09,12,17	15	15	11	11	7,18	7,18	
	11,23	11,23	11	09,12,19	15	15	11	11	7,18	7,18	12
IOP	11	11	11	01,14,17	15	15	11		7,18	7,18	
IOP	11,23	11,23	11	09,12,17	15	15	11	11	6	6	
IOP	14,17,20,23	14,17,20	01,09,12,19	09,12,19	15	15	11	11	18,19	18	
IOP	11,14	11,14	11,14	01,09,12,17	15	15	11,17	11,17	8,9,19	8,19	11,12
IOP	11	11	11	01,09,12,17	15	15	11,17	11,17	8,9,19	8	
IOP	11	11	11	09,12,14	15	15	11	11	7	7	
IOP							17		7,19,20	7,20	
IOP							11,17		7,9,18,20	7,18,20	
IOP							17		7,18	7,18	
IOP									8,18,20	8,18	

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DATE	S T A T U S	VAS SOUNDINGS	VAS DERIVED IMAGERY	VAS GRIDDED ANALYSES	CLOUDINESS ESTIMATES	VAS DAILY SST	VAS COM- POS- ITE SST	CLOUD DRIFT WINDS	WATER VAPOR WINDS	NOAA-9 PASSES	NOAA-9 SOUNDINGS	NOAA-9 PASSES
1/15		11	11,23	11	9,12,17			11	11	7,18	7,18	
1/16					01			11		8,20	8,20	
1/17								11		8,20	8,20	
1/18	IOP	11,14,17,20,23	11,14,17,20,23	11	12,19					8,19	19	12
1/19	IOP	11,14,17,20,23	11,17,20,23	11	01,12					8,19	8,19	
1/20	IOP	11,14,17,20,23	11,14,17,20,23	11,14	01,12,19	15				7,20	7	11
1/21		11,23	11,23	11	01,12,19	15		11	11			
1/22		11,23	11,23	11	01,09,12,19	15		11	11	7,19	7,19	
1/23	IOP	11,23		11	12,19	15	15	11	11	7,19	7,19	
1/24	IOP	11,14,17,20,23	11,14,17,20,23	11,14	01,09,12,19	15	15	11		7,9,18	7,18	11,13
1/25	IOP	11,14,17,20,23	11,14,17,20,23	14	01,09,12,19	15				8,18,20	8,20	11,13
1/26	IOP	11,14,17,20,23	11,14,17,20,23	11	01,12,19	15	15			7,8,10,18,20	8,20	12
1/27	IOP	11,20,23	11,20,23	11,20	01,09,11,19			11,17	11,17	6,8,10,18,20	8,20	12
1/28	IOP	11,17,20,23	11,17,20,23	11	01,09,11,19			11,17	11	6,8,10,18,19	8,19	11,13
1/29		11	11	11	01,09,12,17	15	15	11	11	8,19	8,19	13
1/30		11,23	11,23	11	01,09,12	15	15	11	11	8,19	8,19	
1/31		11,23	11,23	11	01,09,12,19	15	15	11	11	7,19	7,19	12
2/1		11,23			01,09,12	15						
2/2	IOP				12							
2/3	IOP	11,23	11,23	11	01,09,12,19	15	15	11		7,18	7,18	
2/4	IOP	11,23	11,23	11	01,09,12,19	15	15	11	11	7,20	7,20	12
2/5		11,23	11,23	11	01,09,12,17	15,17,20	15	11	11	7,18	7,18	11
2/6	IOP	11,23	11,23	11	01,09,12,19	15,20	15	11	11	6,18	6,18	11,13
2/7	IOP	11,23	11,23	11	01,09,12,19	15,17,20	15	11	11	8,18	8,18	
2/8					01,09,12,19	15				8,17	8,17	
2/9	IOP	11,23			01,09,12,19					8,19	8,19	
2/10	IOP	11,14,17,20,23	11,14,17,20,23	11,14,17,20	01	15	15	11,17	11,17	7,19	7,19	11,13
2/11	IOP	11,14,17,20,23	11,14,17,20,23	11,14,17,20	01,09,12,19	15	15	11,17	11,17	7,9,19,20	19,20	11,12
2/12	IOP	11,14,17,20,23	11,14,17,20,23	11,14,20		15	15	11	11	7,18	7,18	12
2/13	IOP	14,23	14,23	14	01,14,19	15	15	11		7,18	7,18	
2/14	IOP	11,14,17,20,23	11,14,17,20,23	11,14,17	01,09,19			11,17	11,17	6,8,18,20	6,18,20	11,13
2/15	IOP				00,09,12,19	15						
2/16					01,09	15						

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Progress Report

through

March 1987

Meteorological Satellite Products Support

for Project GALE

Contract No. NAG5-742

Prepared by

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Washington, D.C. 20546



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265452 UOFWISC MDS

TO: Dr. James C. Dodge  
NASA Headquarters

FROM: Christopher S. Velden *CSV*  
CIMSS

DATE: April 28, 1987

SUBJECT: Update on Meteorological Satellite Support for Project GALE

Two presentations were given recently at the GALE Workshop in Monterey, summarizing the CIMSS effort in the project. I have enclosed the abstracts for the proceedings of the Workshop. I also gave a brief presentation on the CIMSS/GALE effort at the recent VAS Assessment Meeting in Washington, D.C. A set of slides used in the presentation, along with a complete list of all satellite data available from CIMSS, was sent to Drexel and is included in the GALE Data Users Guide. Some of the slides were color-enhanced depictions of satellite image products which the GALE Data Center can use as examples for interested users. (There were several inquiries about these enhanced products at the Workshop.)

Numerous requests for satellite imagery and products have been processed. Dr. Uccellini is being provided with a complete set of tapes containing the "quick look" standard satellite image package for all of the IOPs.

The AVHRR data tapes for GALE IOPs have been received and are stored here at CIMSS. This 80 tape volume consists of the five channel, 1 km resolution LAC data. Drexel and the GALE community have been informed about the availability of this data set.

Sea surface temperature fields over the Gulf Stream area were a high priority item at the Workshop. We are currently producing additional VAS derived SST fields for IOP2, utilizing temporal capabilities of the VAS (up to three times a day) to retrieve as complete SST fields as possible given cloud conditions. If time permits, we will process additional sets for IOP1 also.

The GALE satellite videotape has been converted to 1/2" VHS format and delivered to Drexel. They will handle the distribution.

Work on the GALE satellite image atlas is proceeding well. All the photographs have been taken and now the technical aspects are being addressed. We are still aiming for a July distribution.

A "quick look" set of satellite estimated rainfall maps have been completed for IOPs and made available to Drexel for distribution. I have enclosed a copy of an SSEC report on this authored by Dave Martin and Brian Auvine. This first

Dr. James C. Dodge

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set of maps contain 24-hour accumulated rainfall estimates. We plan on producing six-hour estimate maps for IOP2, and IOP1 if time permits, along with validation studies using GALE gauge and radar measurements.

We are conducting data assimilation studies using the CIMSS analysis/forecast system. Emphasis is on producing high quality analyses of IOP2 using conventional as well as special GALE observations. Impact of satellite data on the analyses will be assessed. Much has already been learned from preliminary experiments with these data. This work is summarized in the enclosures and will be discussed in more detail and updated with further results at the GALE Workshop next fall.

Enclosures

02/GALE/14



**Progress Report**  
**through**  
**September 1987**  
**Meteorological Satellite Products Support**  
**for Project GALE**  
**Contract No. NAG5-742**

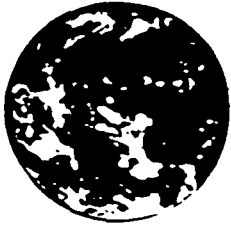
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**for**

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265452 UOFWISC MDS

November 9, 1987

TO: Dr. James C. Dodge  
NASA Headquarters

FROM: Christopher S. Velden *CSV/lb*  
CIMSS

SUBJECT: Update on CIMSS Support for Project GALE

A presentation was recently given at the GALE workshop in Virginia Beach which briefly summarizes CIMSS accomplishments involving the GALE project. I have included the abstract for the proceedings of that workshop. There was a great deal of interest in CIMSS products generated at the workshop.

One of the main accomplishments in this reporting period was the distribution of the GALE satellite atlas in September. Approximately 175 copies were produced, of which 100 were initially distributed to the GALE community, with the remainder residing at GDC. This atlas was not explicitly defined in our original proposed effort, but was a high priority request for the GALE community. The production costs of this atlas were approximately \$25,000. Since this was not budgeted, some of our other proposed work (e.g., enhanced SST fields, surface flux estimates, 4-d assimilation satellite analyses) had to be curtailed. The good news is that the atlas has been well received by the GALE community and deemed an extremely useful product.

In the past six months, many additional requests for satellite data and products have been processed. These requests included conventional imagery, VAS multispectral imagery, TOVS and VAS soundings, satellite estimated rainfall total maps, AVHRR data, and cloud and water vapor motion winds.

Interest at the workshop was high in obtaining the six hourly maps of satellite estimates of accumulated rainfall. Dave Martin and Brian Arvine of CIMSS are currently working on validation of these maps with coastal gauge and radar data. A final set of maps for IOP's 1 and 2 will be produced with algorithms that are calibrated to the gauge and radar data. These maps will then provide valuable quantitative oceanic estimates of precipitation for both diagnostic and modelling studies by the GALE scientific community.

Several institutions (Drexel, NMC, AES-Canada, NEPRF, and others) are interested in the TOVS soundings produced with the physical retrieval algorithm by CIMSS during GALE. Comparisons of these soundings to NMC and Canadian operational soundings will be conducted, along with general assessment of the data in GALE applications.

Much of our effort during this period were focused on data assimilation studies during GALE IOP #2. The latest available special GALE network data was

Mr. James Dodge  
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provided by GDC and merged with the standard conventional data. Analyses were performed on a 60 km grid for synoptic time periods during a five day period (January 23-28, 1986). Comparisons of several fields with operational model fields (global, LFM, RAFS) indicated improved delineations of gradients and features by the CIMSS analyses. Satellite imagery was helpful in this assessment. These analyses will be provided to GDC for use in diagnostic and modelling experiments by the GALE community. In addition to these conventional analyses, experiments were performed in determining optimal incorporation of satellite data into the analysis cycle. Only limited experiments were performed due to funding limitations. It was found in one case that TOVS data had a positive impact on a model forecast of a secondary surface low during IOP #2 when incorporated into the assimilation cycle. In another study, the VAS data were found to be quite sensitive to a first guess field used in generating the retrievals in a case from IOP #2. The poor forecast (first guess field) of a strong upper-level trough was reflected in the VAS data. When the CIMSS analysis was used as the first guess field, this error disappeared. Another experiment determined that VAS data is probably more useful if incorporated as gradient information, rather than vertical profiles, due to bias problems.

A videotape was produced depicting selected CIMSS model forecast fields in 4-d. These special graphical techniques give an interesting perspective to the evolution of various features and provide a unique way to evaluate model performance.

A final comment on the funding situation. As can be seen, allocated funds for the proposed work are nearly depleted. The remaining funds will mostly be used to complete the rainfall maps and validation. As a result of many factors, including the reduction of original funding by \$45,000 and the expense involved in the GALE GOES atlas (~\$25,000), we were not able to investigate or complete all of the originally proposed work. Also, we have received additional data and product requests from the GALE community. We also feel the incorporation of satellite data and products into the 4-d assimilation cycle for IOP #2 is an important investigation. For all of these reasons, we plan to submit a request for additional funding to support this work.

Enclosure

02/GALE/10