DEFENSE METEOROLOGICAL SATELLITE PROGRAM
SPECIAL SENSOR MICROWAVE/IMAGER
ENVIRONMENTAL PRODUCTS

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1. INTRODUCTION

Fleet Numerical Oceanography Center (FNOC) operationally processes global Special Sensor Microwave/Imager (SSM/I) data. From this processing, FNOC provides SSM/I imagery, including sea ice concentration imagery to the Navy Polar Oceanography Center for all-weather global ice analysis. With delivery of upgraded SSM/I algorithms, FNOC began participating in data assimilation studies for numerical models. FNOC also presently provides SSM/I data to NESDIS for archive.

In this paper, we discuss SSM/I sensor characteristics and status, FNOC operational SSM/I processing and data products, SSM/I Calibration/Validation, SSM/I algorithm status and results from preliminary SSM/I data assimilation studies.

2. SSM/I SENSOR OVERVIEW

The SSM/I system consists of a passive, scanning multichannel microwave radiometer sensor and the associated ground processing. The SSM/I sensor is a seven channel, four frequency, linearly polarized system which measures atmospheric, ocean, and terrain microwave brightness temperatures at 19.3, 22.2, 37.0 and 85.5 GHz. The SSM/I system was built by Hughes Aircraft Company under the direction of the United States Air Force Space Division (USAF SD) and the Navy Space Systems Activity (NSSA). The SSM/I system represents a joint Air Force/Navy operational program. The Defense Meteorological Satellite Program (DMSP) F-8 satellite, launched June 1987, with SSM/I sensor is the first of seven SSM/I's scheduled for launch into the 1990's. Figure (1) shows the overall DMSP System Overview.

The sensor is mounted on a DMSP satellite flying in a sun synchronous, nearly polar orbit with orbital period of approximately 100 minutes. The SSM/I sensor rotates in a circular scan with a nominal 1.9 second period, and collects sensor data during approximately 102 degrees of each rotation. During the remainder of each rotation, short bursts of calibration readings from hot and cold calibration sources are taken. The 102 degrees of sensor data provides a nominal 1394 km earth swath width. Figures (2 & 3) show SSM/I sensor characteristics and scan geometry.

DMSP System Overview

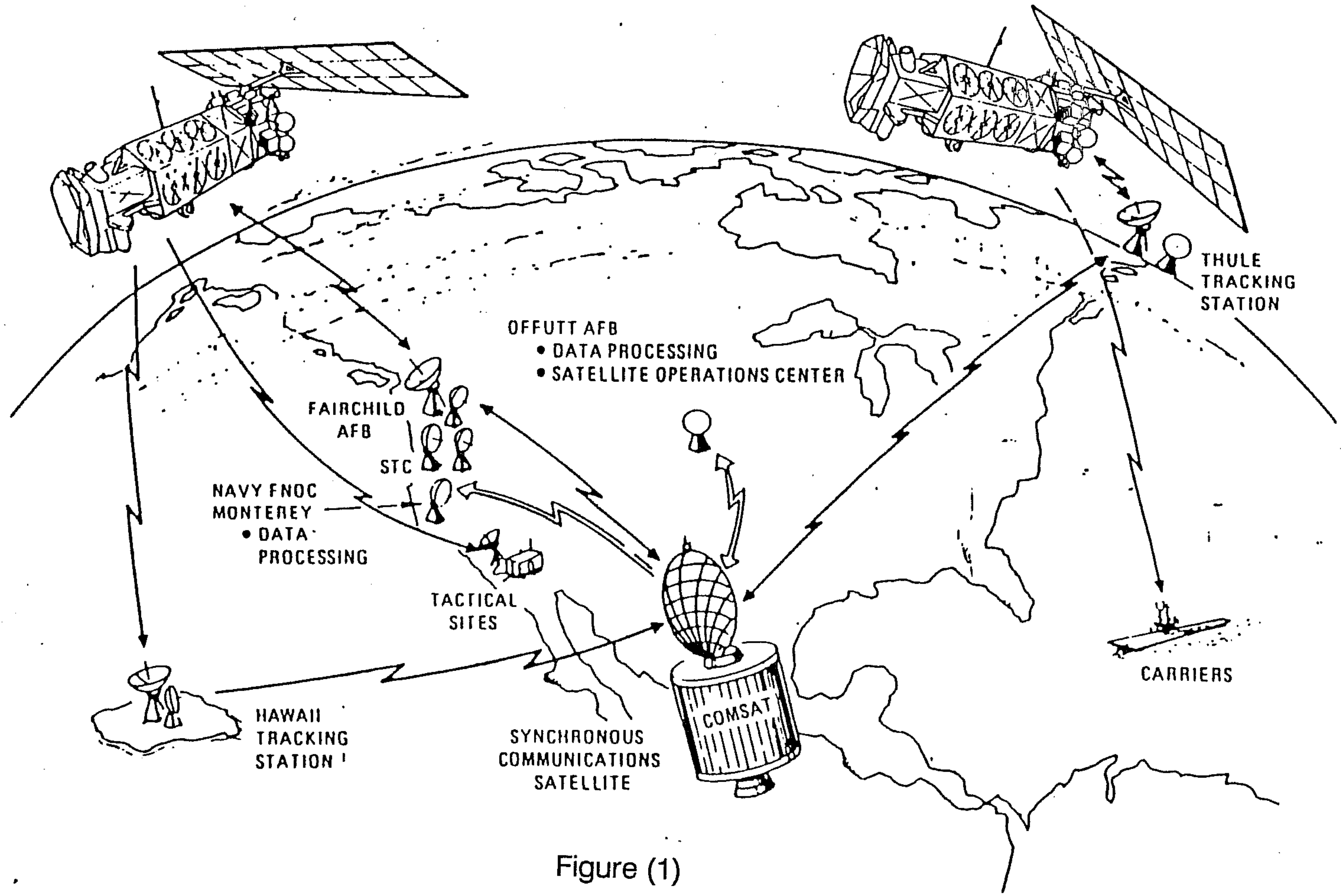
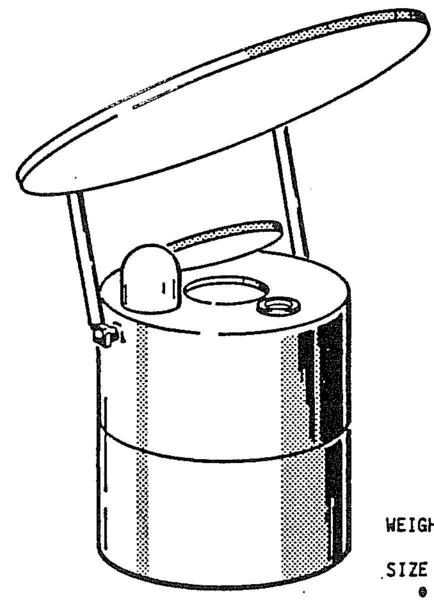


Figure (1)



WEIGHT	74 lb
SIZE	
• ANTENNA	24 x 26 in.
• DRUM	14 in. DIAMETER 16 in. HEIGHT
POWER	45 W
ORBIT	833 km CIRCULAR 101 min PERIOD 98.7° INCLINATION -SUN SYNCHRONOUS
SPACECRAFT	DMSP BLOCK 5D-2

Figure (2) SSM/I Radiometer

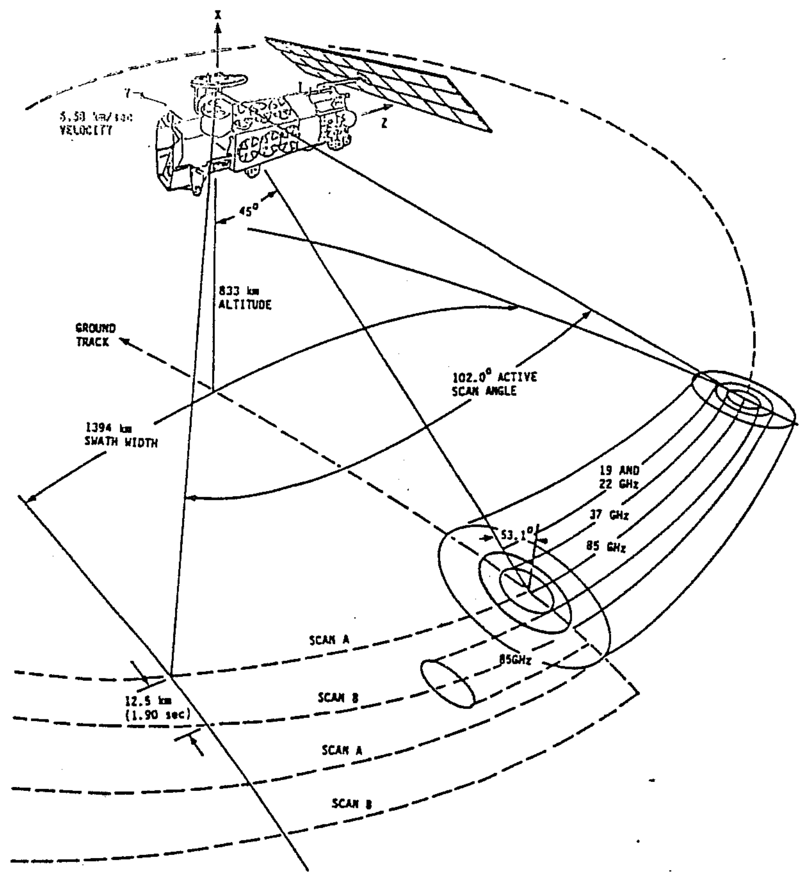


Figure (3) SSM/I Scan Geometry

The SSM/I sensor input data are organized spatially by PIXEL, SCENE STATION and SCAN. A PIXEL is the smallest data element and is a sample of a single footprint of a single frequency and polarization. A SCENE STATION is the center of coaxially located pixels. Finally, a SCAN is one rotation of the sensor in 1.9 seconds during which scene station data, cold load data, hot load data and telemetry data are measured.

Seven raw sensor data channels, T1 through T7, are provided. They consist of four distinct frequencies with three of the four frequencies employing both vertically and horizontally polarized readings. The relationship between readings from the various channels provides a means to determine environmental conditions. Alternate scans are labeled as "A" and "B" scans. Each A scan contains 64 sets of concentric measurements by all seven channels and 64 sets of T6 and T7 data taken midway between each of the "seven-channel" scene stations. Each B scan contains 128 sets of T6 and T7. The satellite advances approximately 12.5 Km per 1.9 second scan. The combination of this along track motion and the above stated A and B scan sampling technique yields the Scene Station spacing.

The raw data stream is packaged to be compatible with one second SSM/I sampling by the satellite Operational Linescan System (OLS) onboard computer. The OLS will accept a 3276 bit block from the SSM/I sensor each second.

The satellite relays a readout of data to the ground while rewinding its recorded tape so the data is received in reversed order. The global stored data is nominally readout each orbit.

The SSM/I raw sensor stream is ground processed at Fleet Numerical Oceanography Center (FNOC) Monterey, California.

References (5) and (6) include further information on the SSM/I sensor.

3. SSM/I DATA PROCESSING

As shown in Figure (4), the SSM/I ground processing consists of five Computer Program Components (CPC) to produce the required output. The (1) Sensor Data Processing (SSMISDP) CPC reads the SSM/I raw sensor data and ephemeris data to generate Sensor Data Records (SDRs). The Sensor Data Records are earth-located sets of brightness temperatures that have been surface-type tagged, calibrated, antenna pattern corrected, formatted and written to a file for subsequent use by Environmental Parameter Extraction (SMIEPE) CPC.

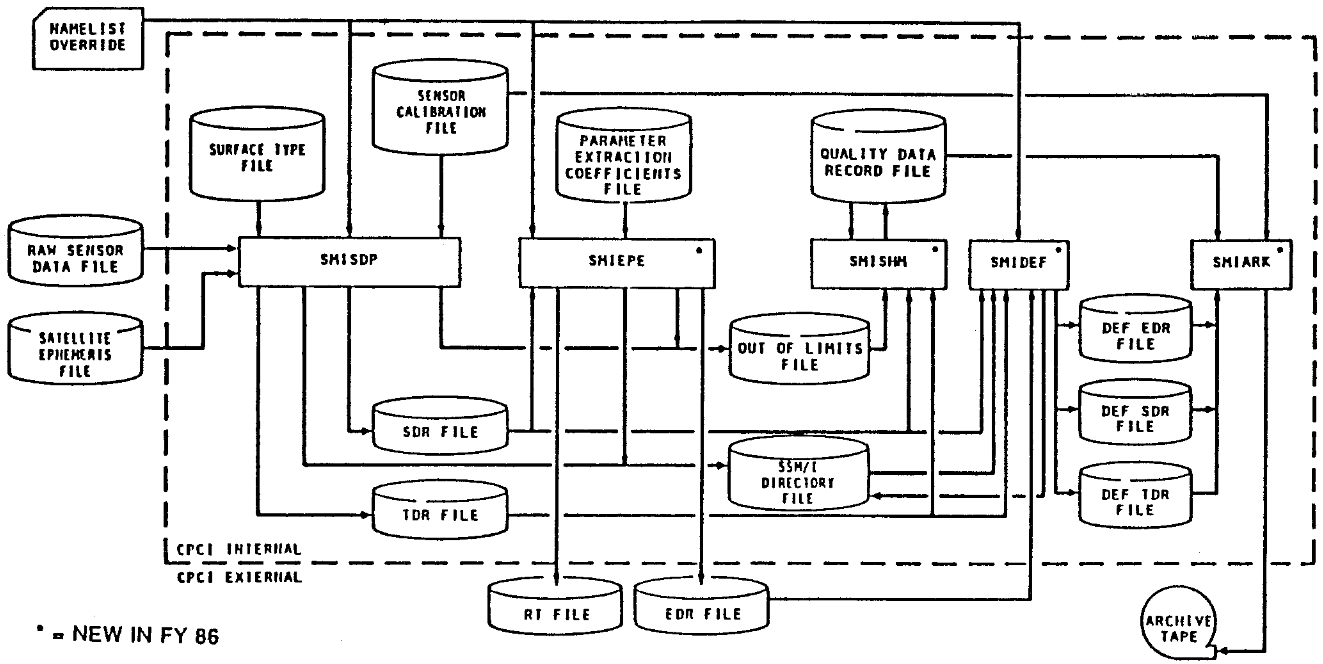


Figure (4) FNOC Processing Software

The (2) Environmental Parameter Extraction (SMIEPE) CPC utilizes the Sensor Data Record File written by the SMISDP CPC to generate Environmental Data Records (EDRs). The Environmental Data Records are earth located measurements for specific environmental parameters depending upon the surface type of the observation.

The specific environmental parameters calculated for each surface type are as follows:

SPECIAL SENSOR MICROWAVE/IMAGER
ENVIRONMENTAL PARAMETERS

Surface Type	Environmental Parameter
ICE	Ice Age
	Ice Edge
	Ice Concentration
	Cloud Water
	Cloud Amount
LAND	Rain Rate
	Soil Moisture
	Cloud Water
	Surface Type
	Surface Temperature
	Cloud Amount
	Snow Water (if snow surface)
OCEAN	Wind Speed
	Rain Rate
	Cloud Water
	Water Vapor

The (3) Sensor Health Monitor (SMISHM) CPC provides statistical information for monitoring SSM/I sensor stability. The Quality Data Record files contain data output from SMISHM.

The (4) Data Exchange Format (SMIDEF) CPC reformats the Sensor Data Records and Temperature Data Records created by SMISDP and the Environmental Data Records created by SMIEPE into Data Exchange Format files. This format is described in references (1) and (5). The DEF files are permanent files stored for subsequent archival.

The (5) Archival (SMIARK) CPC is responsible for the SSM/I DEF file archiving functions. SMIARK generates a file which contains the necessary job control language commands to archive the TDR, SDR, and EDR, plus the ancillary Quality Data Record (QDR), Sensor Calibration, and Parameter Extraction Coefficients DEF files. SMIARK deletes these files from the system once they are successfully archived.

Currently, 6250 bpi SSM/I archive tapes are forwarded to NESDIS. When Shared Processing Network (SPN) reaches Initial Operational Capability in FY90, SSM/I data will be forwarded to NESDIS by SPN.

NOTE: Shared Processing Network uses wideband satellite communications for data exchange between designated Centers of Expertise (COE), namely the (1) Air Force Global Weather Central, (2) Fleet Numerical Oceanography Center, (3) Naval Oceanographic Office and (4) National Environmental Satellite, Data, and Information Service. A dedicated channel on the GE Americom is used. This is the same communications satellite used for the NOAA polar orbiter system. NESDIS is the communications manager. Data rate is 1.3308 million bits per second. Data transmission for shared data is unclassified Shared Processing Data Frames (SPDF) similar to the NESDIS Local Area Coverage/High Resolution Picture Transmission (LAC/HRPT) format.

References (5) and (6) include further information on SSM/I data processing.

4. SPECIAL SENSOR MICROWAVE/IMAGER DATA

SSM/I data include Temperature Data Records (TDR), Sensor Data Records (SDR) and Environmental Data Records (EDR). TDRs are earth-located, calibrated antenna temperatures. One applies irreversible antenna pattern correction (APC) to TDRs to generate brightness temperatures called SDRs. EDRs are the environmental parameters such as wind speed, water vapor and ice concentration.

Except for the deterministic sea ice algorithms, EDRs are generated by a statistical or D-Matrix method which chooses the most probable atmospheric and surface properties which result from the set of brightness temperatures (SDRs). Within regional and seasonal boundaries, the original D-Matrix algorithms assume brightness temperatures are independent variables in linear regression equations. For the linear assumption, algorithm developers assigned 14 climate zones, including transition zones.

5. DMSP SSM/I CALIBRATION/VALIDATION

USAF SD and NSSA directed the Space Sensing Branch of the Naval Research Laboratory to ensure the SSM/I instrument and retrieval algorithms performed within specifications. NRL organized a team of sensor scientists from universities, industry and government to conduct the DMSP SSM/I Calibration/Validation effort. Dr. Jim Hollinger, NRL headed the one year calibration/validation. The objectives of the SSM/I Cal/Val were threefold:

1. Calibrate the SSM/I instrument (T_B)

2. Validate environmental products.

3. Improve environmental products.

NRL is expected to provide the Final DMSP SSM/I Validation Report in FY89. As a result of Cal/Val the DMSP Systems Program Office (SPO) approved TDRs/SDRs for release October 1987. Upon SPO approval, some EDRs may be released during 1989.

5.1 SSM/I Sensor Performance

5.1.1 Radiometric Stability

Cal/Val reports excellent radiometric stability for the SSM/I which is the first satellite microwave radiometer to employ total-power receivers. The total power receivers offer improved stability without loss of sensitivity. The absolute calibration was within $\pm$ 3^{o}K. Except for the 85GHz channel which failed January 1989, stability of gain, noise temperatures and physical temperatures were normal. Due to the excellent radiometric stability, NRL Cal/Val recommends averaging the hot and cold reference counts for more than one SSM/I scan. This will reduce the instrument noise contribution to the antenna temperature calibration and improve the accuracy of the absolute brightness temperatures.

5.1.2 Geolocation Errors

SSM/I data shows geolocation errors of about 25 km. Cal/Val suspects half the error may be due to FNOC predict ephemeris errors. By June 1989, FNOC will implement using DMSP onboard ephemeris data to improve SSM/I geolocation. Accompanying the geolocation error, is a 6 km scan axis alignment error. In that the error appears to be latitude dependent, NRL plans to deliver a scan axis alignment correction algorithm. With both improvements, error should be within 6 km, which is the system geolocation error budget for the SSM/I.

5.1.3 Digital Electronics Heating

Due to increased solar heating, the SSM/I was turned off in July 87 and Dec 87 - Jan 88. The turn off was to prevent damage to the Bearing and Power Transfer Assembly (BAPTA) and digital electronics. Except for the 85GHz Vertical channel, all channels returned to their performances prior to turnoff. For the 85GHz Vertical channel, sudden gain changes and a sensitivity degradation increased til the 85GHz Vertical channel failure, January 1989.

5.2 SSM/I Algorithms

Although processing all SSM/I environmental parameters for NRL CAL/VAL investigations and NESDIS archival, FNOC initial internal SSM/I data investigations focused on sea ice concentration, wind speed and water vapor (ocean) data and products. Algorithm status for these parameters follows:

5.2.1 Sea Ice Algorithms

Since shortly after DMSP F-8 launch, FNOC has provided the Navy Polar Oceanography Center, operational SSM/I ice concentration imagery. The original Hughes SSM/I sea ice algorithm uses only the two 37GHz data channels. As a member of the Cal/Val team, Dr. Rene Ramseier (Atmospheric Environment Service (AES), Canada) is providing an improved deterministic sea ice algorithm. This four channel (19GHz & 37GHz) AES algorithm, includes corrections for wind, cloud cover and precipitation contamination. The AES algorithm was verified using statistical SSM/I data analysis and coincident radar data. The AES algorithm shows improvement in defining ice age and ice concentration. The AES algorithm also identifies thin ice, first year and old ice fractions. FNOC plans to implement the AES algorithm Summer 1989.

5.2.2 Wind Speed Algorithms

The prelaunch developed D-matrix wind speed algorithm didn't meet ± 2m/s root mean square error (RMSE) specifications. Figure (4a) shows scatter plot excessive slope and bias errors resulting from initial validation of the prelaunch algorithm with ocean buoys and climatology. The algorithm's linear regression assumption within each climate zone further resulted in climate zone discontinuities. Also, despite an existing rain flag, rain contamination degraded additional wind retrievals.

A postlaunch refinement of the original D-matrix algorithm resulted from standard linear regression with coincident actual SSM/I-buoy data pairs. Although the refined algorithm shows bias and slope error reduction, figure (5), climate zone discontinuities remained along with underestimates of high wind speed retrievals. Wind speeds from this algorithm were tested in data assimilation studies. See Section 6.1.

The latest algorithm uses global D-matrix coefficients, resulting from weighted linear regression from each climate zone. This scheme meets the SSM/I RMSE specifications of ± 2m/s, figure (6), while removing the high wind bias and climate zone discontinuities. The rain flag was stratified to identify wind retrievals within ± 2, 5, and 10 m/s. The channel selection of the new algorithm differs slightly from the original in that 19GHz V is used instead of 19GHz H. FNOC implemented this algorithm, without rain flags, May 1989. The rain flags, requiring software coding change, will be added later.

Plans are to develop an iterative algorithm for improved wind speed retrievals from 3 - 25 m/s. However, note, as with the other algorithms, wind retrievals above 25 m/s are almost always associated with rain and cloud contamination.

5.2.3 Moisture Algorithms

Moisture algorithms considered here are Water Vapor over ocean or precipitable water and Cloud Water (ocean). Cloud Water (ocean) includes cloud droplets less than 100 micron diameter (i.e., moisture droplets suspended in clouds).

5.2.3.1 Water Vapor (ocean) Algorithms

The prelaunch version of the Water Vapor (ocean) algorithm was inaccurate and also showed climate zone discontinuities. Polar retrievals had low values and tropical retrievals had high values. See figure (7) scatter plot.

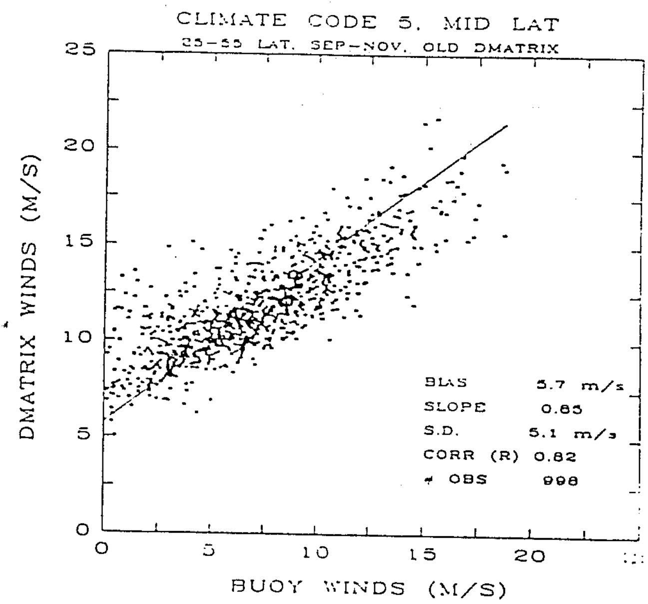


Figure (4a) Original D-Matrix Algorithm

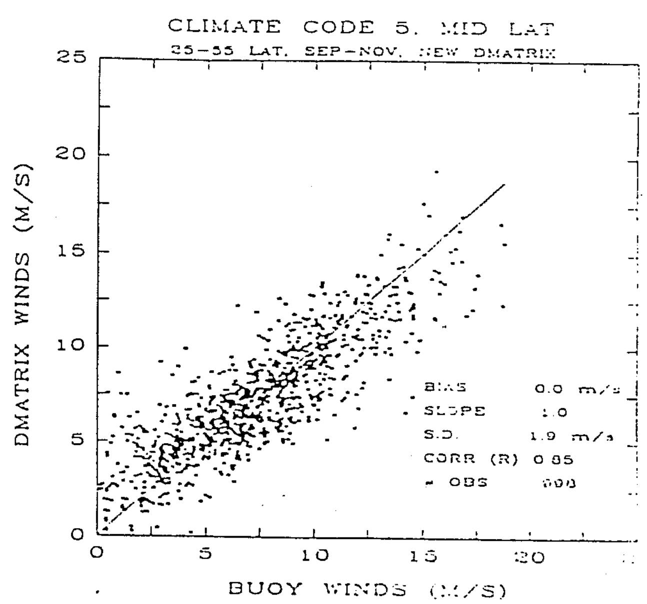


Figure (5) Postlaunch refined D-Matrix

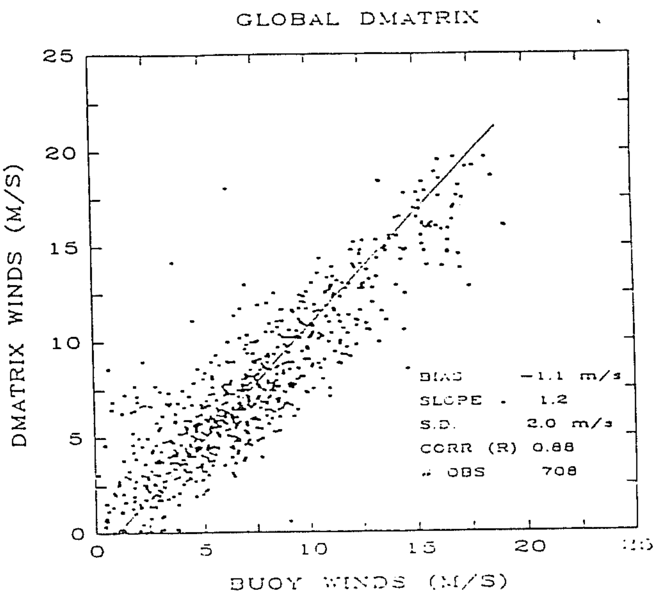


Figure (6) Global D-Matrix Algorithm

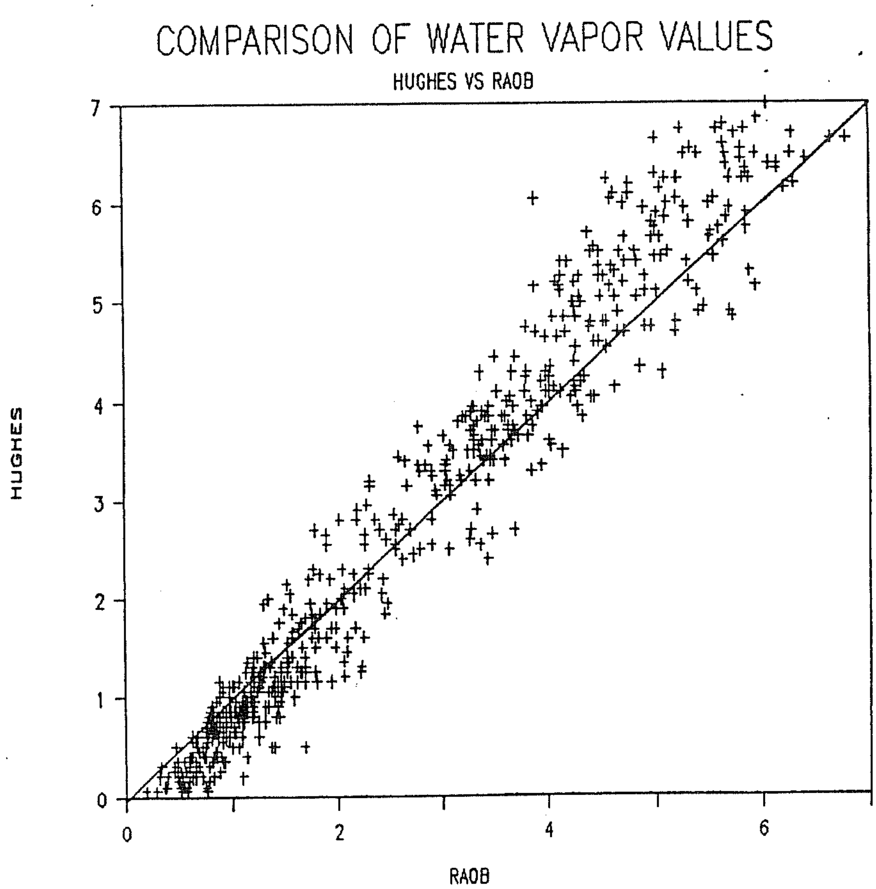


Figure (7)

After launch, Cal/Val presented a global linear algorithm, which removed climate zone discontinuities and reduced RMSE to $\pm$ 3g/cm^2. See figure (8) scatter plot. Water Vapor (ocean) retrievals from this algorithm were used in FNOC Moistanal moisture data assimilation study. See section 6.2.

A nonlinear global algorithm is ready to implement. The nonlinear algorithm uses 22GHz V squared SSM/I data channel. This nonlinearity requires changes to SSM/I software. Although still underestimating high moisture retrievals, RMSE, with this algorithm, is reduced to $\pm$ 0.24g/cm^2. See figure (9).

Again, an iterative algorithm meeting SSM/I specifications is planned for the future.

5.2.3.2 Cloud Water (ocean) Algorithms

The original algorithm was 90% out of limits. However, from studies of SSM/I brightness temperatures (SDRs) vs. upward looking radiometers, Cal/Val recommended and FNOC implemented a new algorithm. The RMSE error for the new algorithm, over a limited range (0 - 0.028 g/cm^2), is $\pm$ 0.004 g/cm^2. See Figure (10).

5.3 NRL Calibration/Validation Recommendations

DMSP Calibration/Validation recommendations included the following:

1. For reduced instrument noise and improved calibration, average hot and cold reference counts.

2. For better geolocation, use satellite on-board ephemeris.

3. For better geolocation, implement scan axis alignment correction.

4. With improved geolocation, compute incidence angles for each pixel.

5. Use computed incidence angles to correct SDRs and improve EDRs.

6. Implement global linear wind speed algorithm.
(with quality flags & 0.1 m/s significance)

7. Implement global non-linear Water Vapor (ocean) algorithm.

8. Implement Cloud Water (ocean) algorithm.

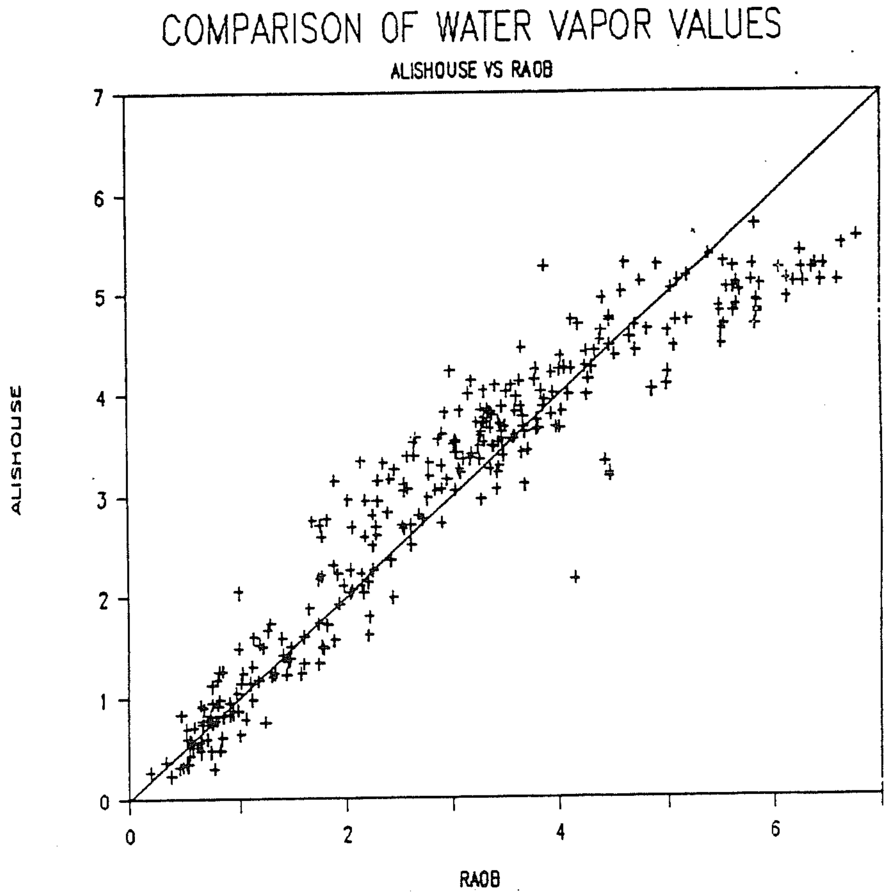


Figure (8)

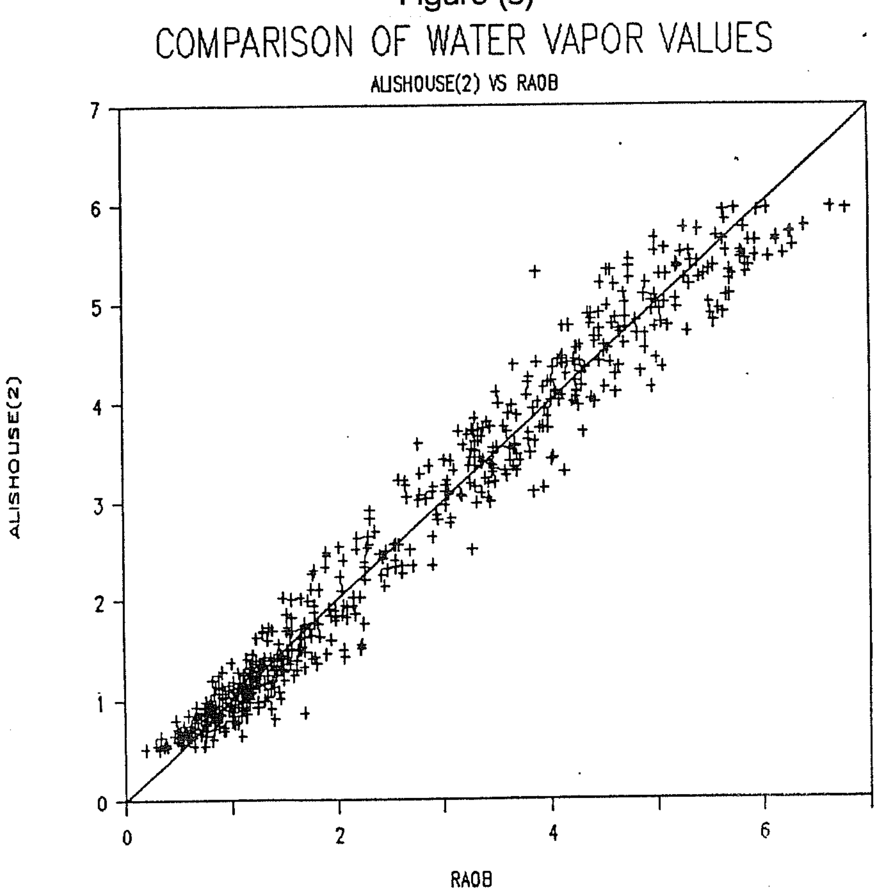


Figure (9)

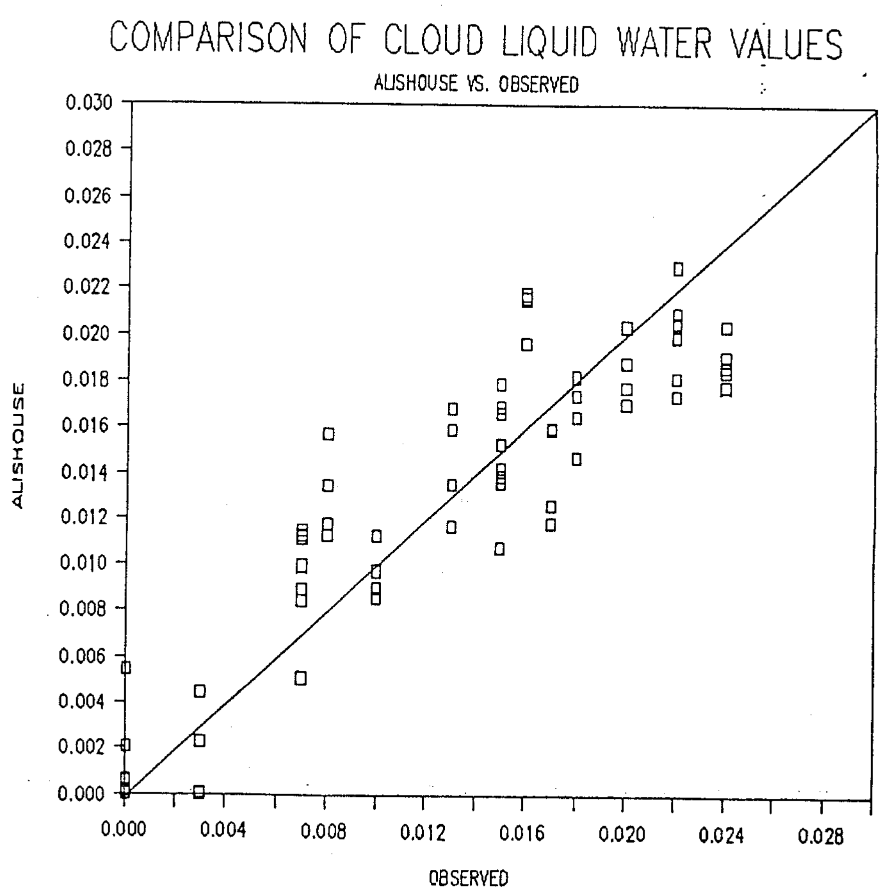

COMPARISON OF CLOUD LIQUID WATER VALUES
ALISHOUSE VS. OBSERVED
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
ALISHOUSE
0.000
0.004
0.008
0.012
0.016
0.020
0.024
0.028
OBSERVED

Figure (10)

9. Implement AES sea ice algorithm.

6.0 SSM/I DATA ASSIMILATION STUDIES

6.1 Surface Winds

The Naval Environmental Prediction Research Facility (NEPRF), with FNOC, conducted preliminary data assimilation tests of SSM/I surface wind speed data. NEPRF used a Multivariate Optimum Interpolation (MVOI) analysis scheme with the Navy Operational Global Atmospheric Prediction System (NOGAPS). The NOGAPS system has the following characteristics:

Nonlinear normal mode initialization
15 levels, 1000 - 10 mb
T47 spectral forecast model
2.5 x 2.5 degree spherical grid
Volume method (Lorenc, 1981)
6 hr update cycle

Data:
- Surface observations
- Conventional heights & winds
- Aircraft & satellite winds
- Satellite-derived thicknesses

NEPRF case studies (Goerss, 1989), evaluate impact of assimilating SSM/I data in the MVOI analysis. (Note: the SSM/I algorithm used in the study, is the initial postlaunch algorithm refinement. See section 5.2.2. NEPRF plans more detailed studies when improved algorithms are in place.) Results are summarized as follows:

For a general evaluation of SSM/I wind speed data, Table (1) shows RMSE errors of 15,000 SSM/I report sets, at six hour intervals for 14 - 15 September 1988. MVOI background wind speeds were interpolated to the nearest SSM/I data location and differenced with the SSM/I data. As shown below, wind speed ranges are stratified into three wind speed categories (i.e., < 5 m/s, 5 - 10 m/s and > 15 m/s). Upon investigation, 40% of the > 15 m/s wind retrievals were judged to be contaminated by high levels of liquid water or rainfall. Therefore, SSM/I observations with greater than 8 m/s difference from MVOI were rejected from further study.

TABLE 1

SSM/I - MVOI

14 - 15 September 1988

CLASS	< 5.0 m/s	5 - 10.0 m/s	> 15.0 m/s
RMSE	2.1 m/s	3.3 m/s	8.1 m/s

After rejecting the rain contaminated SSM/I observations, Ship observations and SSM/I data were each differenced from the MVOI background. Each selected six hour interval included approximately 1000 ship reports. Difference statistics were calculated globally and for six ocean basins. Table (2) shows global RMSE differences. In both global and ocean basin cases, for a total five day period, SSM/I differences were less than ship report differences. Therefore, Table (2) data infers SSM/I winds are as usable as ship wind speeds in MVOI analyses.

TABLE 2

SSM/I Observations vs MVOI (global)

14 - 15 September 1988

SSM/I vs MVOI - RMSE = 3.1 m/s

Ship vs MVOI - RMSE = 3.3 m/s (1000 obs)

The MVOI Analysis procedure was conducted as follows:

1. Run MVOI without SSM/I (1000, 850, 700 mb).

2. Interpolate 1000 mb MVOI wind direction to SSM/I reports.

3. Use SSM/I wind speeds at 1000 mb and set SSM/I data error variance equal to ship reports error variance.

4. Reduce SSM/I observations to 4,000 reports per 6 hours.

5. Perform MVOI analysis with SSM/I data.

Figures (11 - 17) show comparisons without and with SSM/I data for 1200 GMT 15 September 1988:

Figure (11).
MVOI 1000 mb isotach analysis without SSM/I (5 kt intervals) and SSM/I plotted observations (kt).
Note: (SSM/I data doesn't support 25 kts isotach east of Bahamas.)

Figure (12).
MVOI 1000 mb analysis (with SSM/I) and SSM/I plotted observations.
Note: (Including SSM/I data removes 25 kt isotach east of Bahamas.)

Figure (13).
MVOI D-value analysis (with SSM/I), and plotted ship reports.
Note: (No support for high winds east of Bahamas. Ship reports support analysis in the Gulf of Mexico.)

Figures (14 & 15).
MVOI analysis error estimates (2m/s intervals).
MVOI u-wind (Fig. 14, conventional), (Fig. 15, with SSM/I)
Note: (See error reduction in SSM/I areas. V-wind error analyses were similar.)

Figures (16 & 17).
MVOI analysis error estimates (5m intervals).
MVOI 1000 mb height (Fig. 16, conventional), (Fig. 17, with SSM/I)
Note: (Error reduction in SSM/I areas is more subtle. Analysis error estimate near hurricane Gilbert center is reduced 2.5m due to multivariate nature of analysis and geostrophic coupling.)

Plans:

Because the NEPRF (Goerss, 1989) study shows only preliminary results, plans are to conduct further assimilation studies using the improved global linear weighted SSM/I wind algorithm (with quality flags).

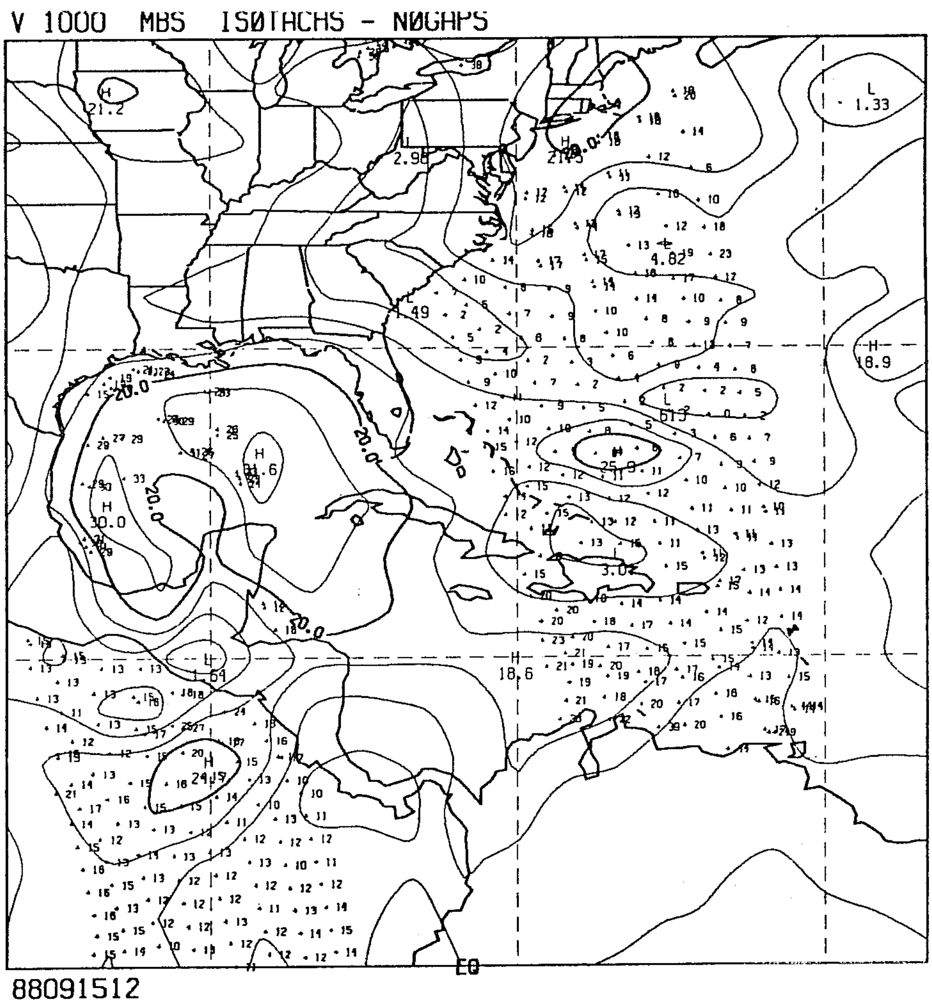


Figure (11) MVOI 1000 mb isotach analysis without SSM/I and SSM/I plotted observations

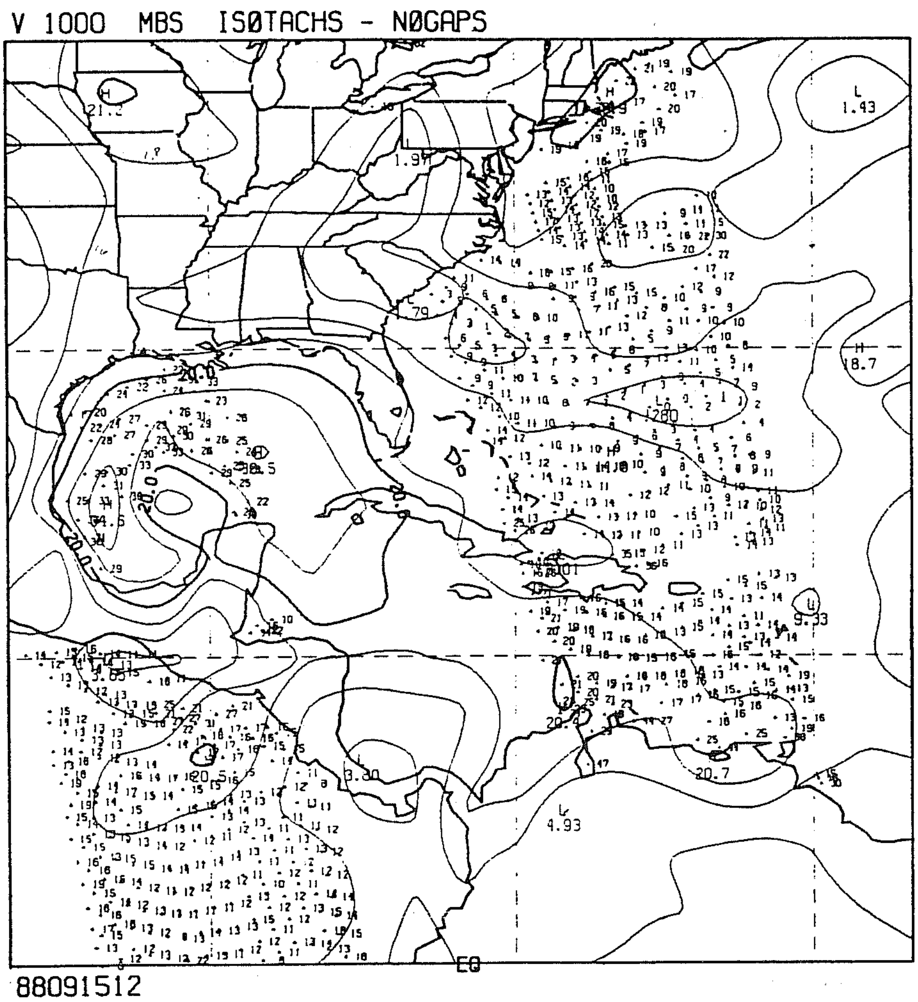


Figure (12) MVOI 1000 mb analysis (with SSM/I) and SSM/I plotted observations.

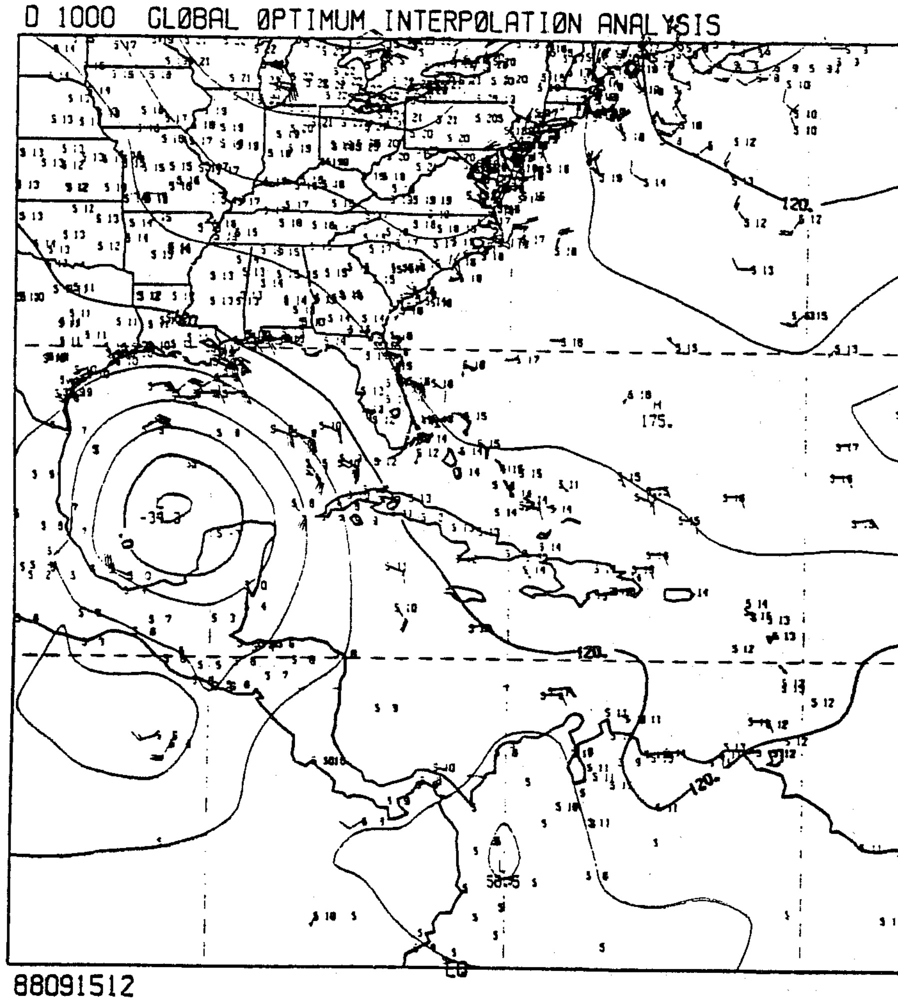


Figure (13) MVOI D-value analysis (with SSM/I), and plotted ship reports.

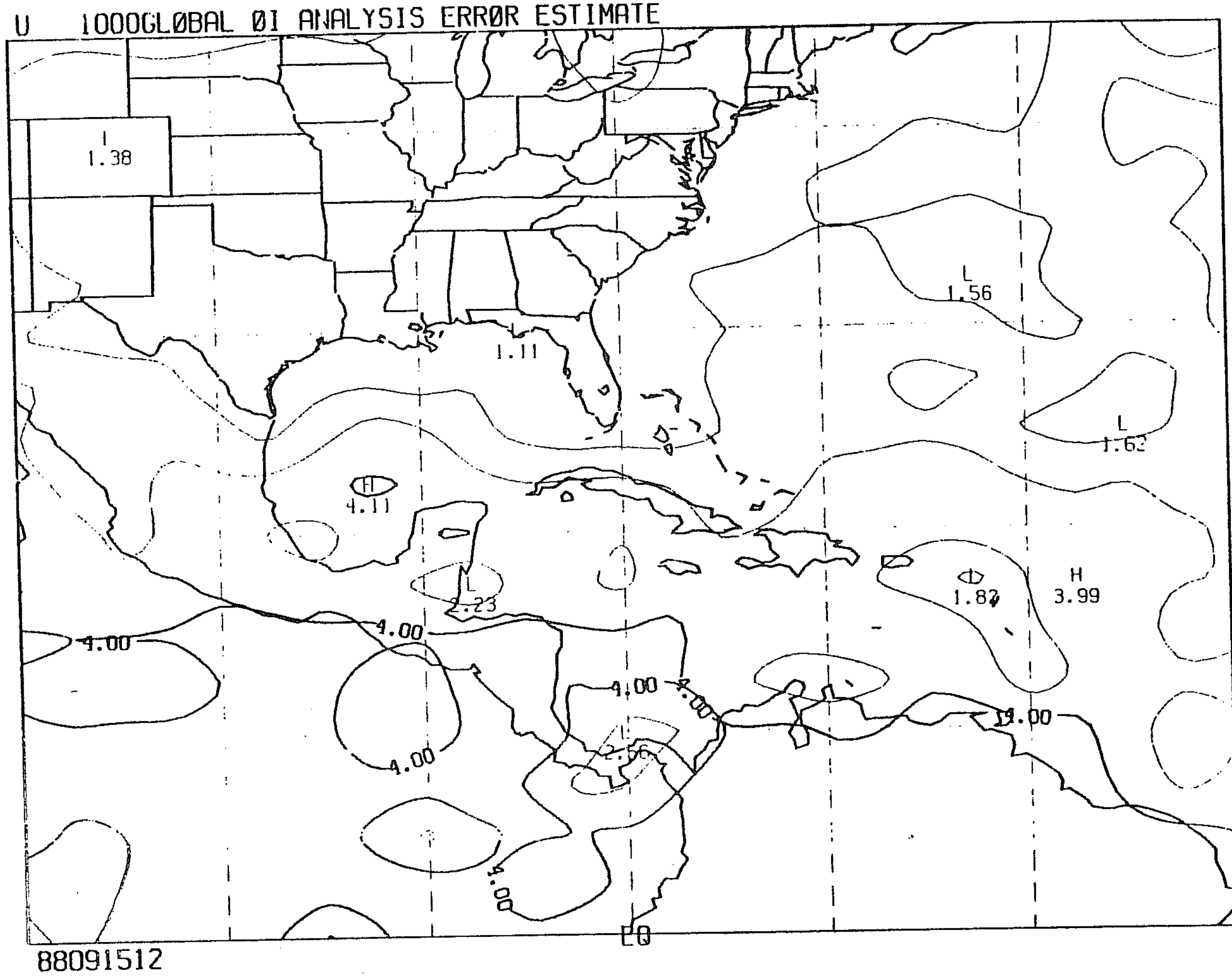


Figure (14) MVOI analysis error estimates (2m/s intervals). MVOI u-wind (conventional).

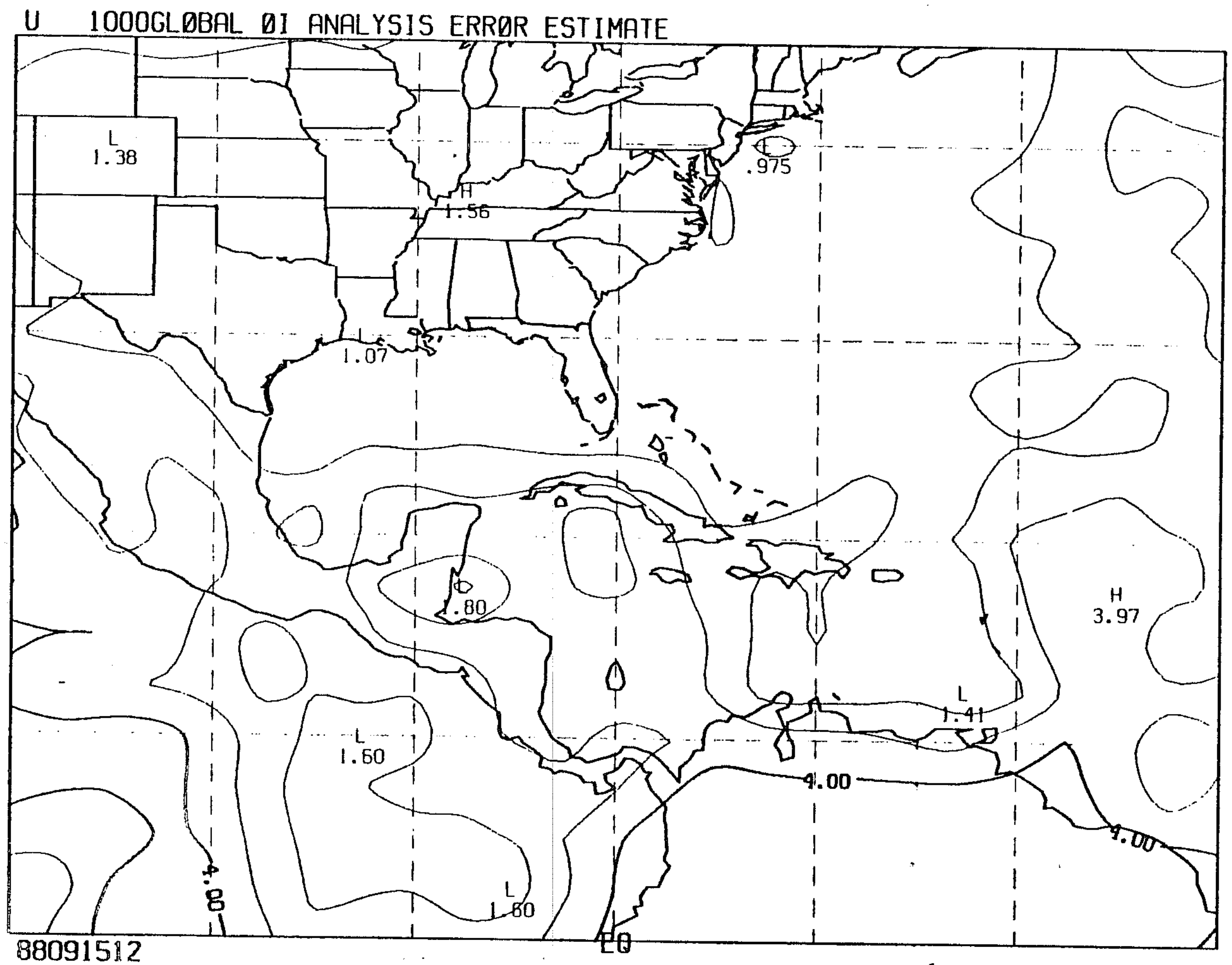


Figure (15) MVOI analysis error estimates (2m/s intervals). MVOI u-wind (with SSM/I).

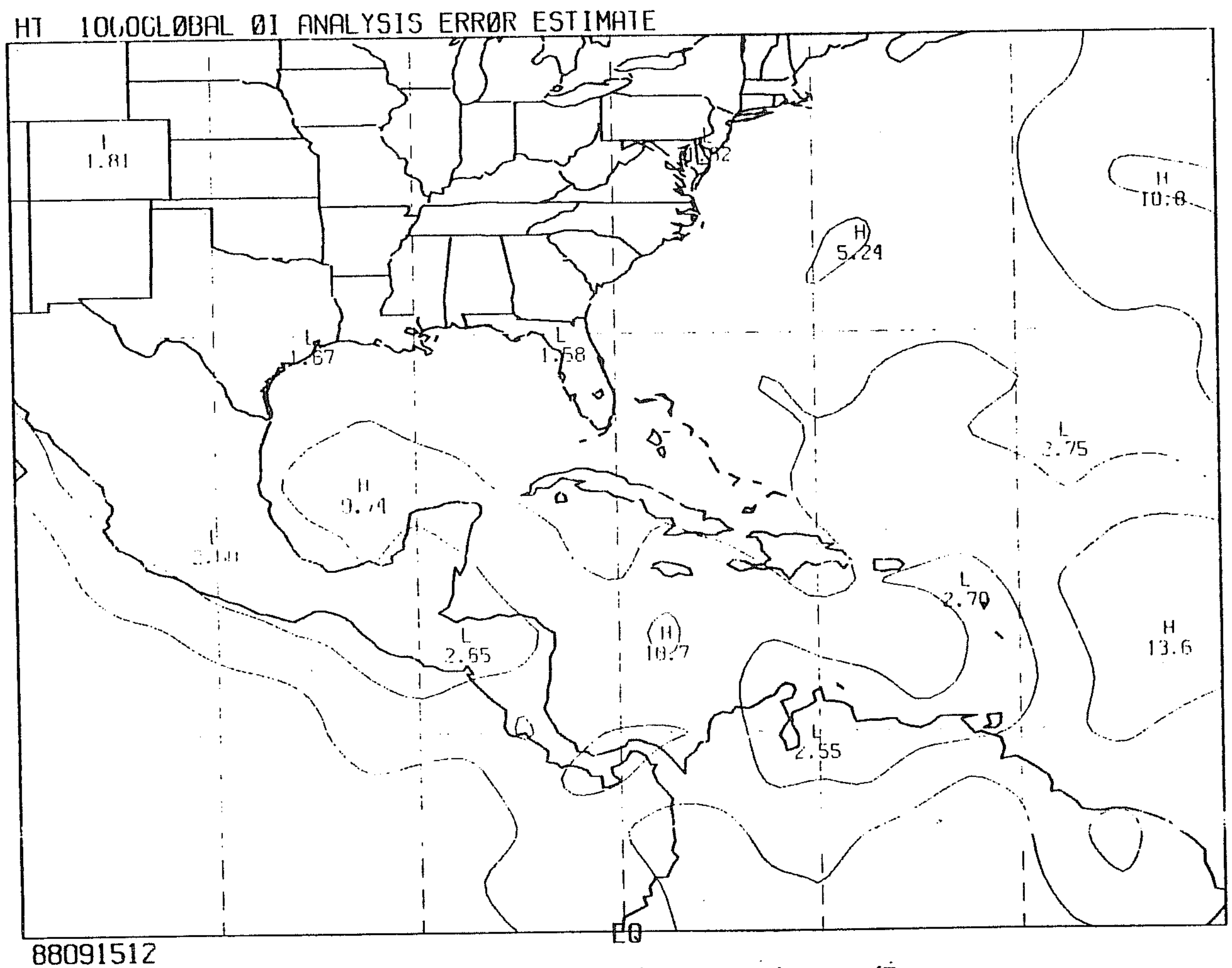


Figure (16) MVOI analysis error estimates (5m intervals). MVOI 1000 mb height (conventional)

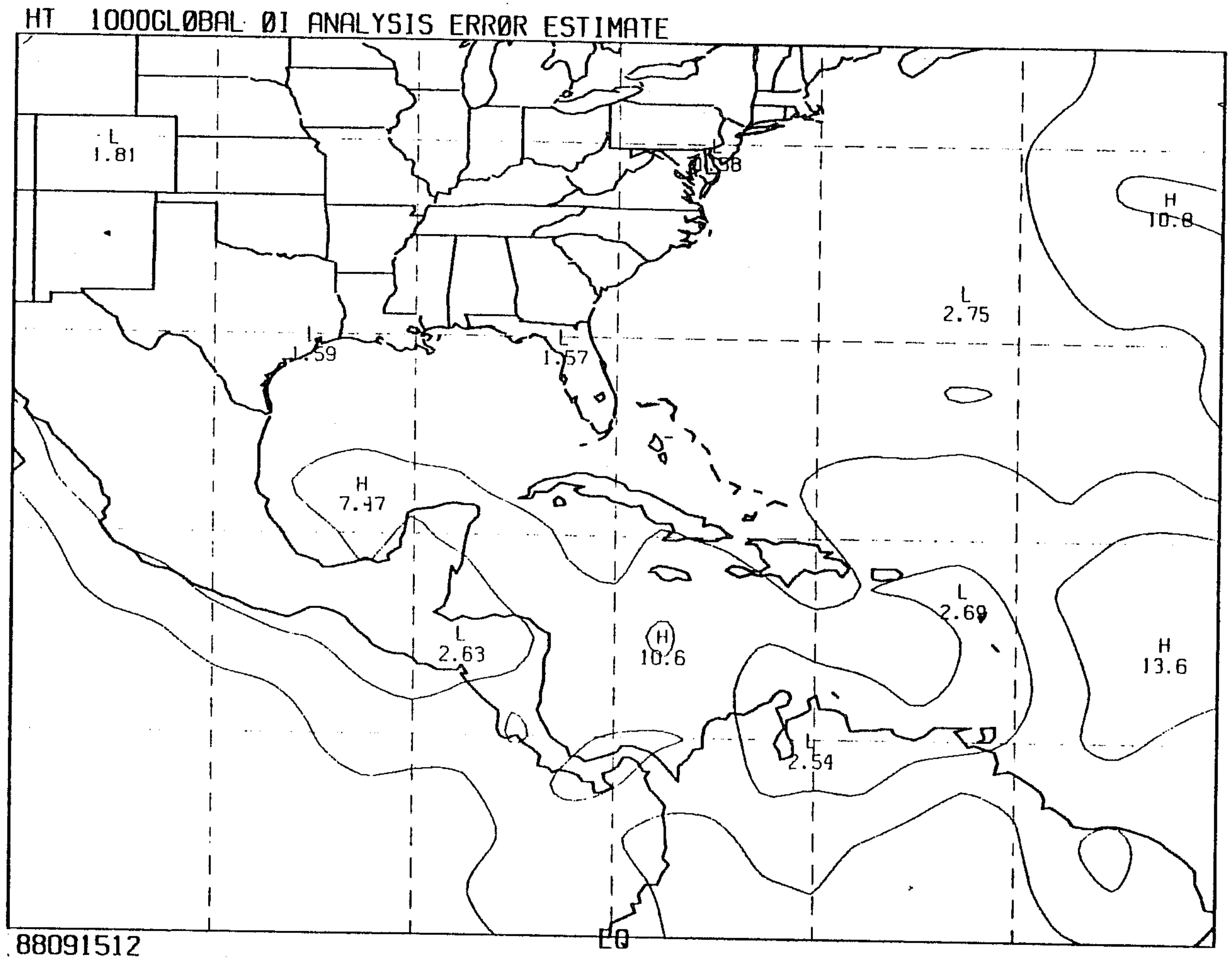


Figure (17) MVOI analysis error estimates (5m intervals).
MVOI 1000 mb height (with SSM/I).

6.2 Water Vapor (ocean)

Under contract, FNOC conducted preliminary data assimilation studies for SSM/I water vapor (ocean) or precipitable water measurements. An interim report (Rennick, 1988) discusses impact of SSM/I data on FNOC's moisture analysis system, MOISTANAL. MOISTANAL has the following characteristics:

Modified Barnes Successive Corrections Scheme
Surface, 1000, 925, 850, 700, 500, 400, 300 mb
Parameter: $(1\text{-RH})^{.5}$
NOGAPS 3.0 initialization
Data:
- Surface land & ship reports
- Rawinsondes
- TOVS precipitable water soundings
- SSM/I Water Vapor (ocean)

The SSM/I Water Vapor (ocean) or precipitable water measurements used include 120,000 WVO reports within $\pm$ 3 hr of MOISTANAL analysis time. MOISTANAL used SSM/I data from the post launch refined global linear WVO algorithm, section 5.2.3.1. Due to SSM/I data density, the 120,000 reports were averaged within 2.5 X 2.5 degree grid boxes.

Figure (18) shows the SSM/I data distribution or coverage within three hours of 22 December 1988 1200Z analysis. Typically 40 - 150 SSM/I reports are averaged from within each 2.5 X 2.5 degree grid box. Figure (18) contour interval is 10 reports. Tiros Operational Vertical Sounder (TOVS) and rawinsonde report positions are shown by plus (+).

Figure (19) shows Moistanal total water vapor content computed from analyzed fields of moisture data excepting SSM/I. Since the NOGAPS 3.0 initialization is known to be generally dry, areas of TOVS and Rawinsonde reports shown in figure (18) reflect higher moisture levels in figure (19).

Figure (20) compares averaged SSM/I data minus MOISTANAL analyzed total water vapor. Regions of large difference between the SSM/I observations and the analysis (e.g., off the west coast of South America) correspond to regions of little or no rawinsonde/TOVS data. See Figure (18). Similar to rawinsonde/TOVS data, SSM/I data adds moisture to the generally dry NOGAPS 3.0 initialization. In other regions (e.g., 120E near Australia) where rawinsonde/TOVS data is collocated with SSM/I, small differences predictably show consist-

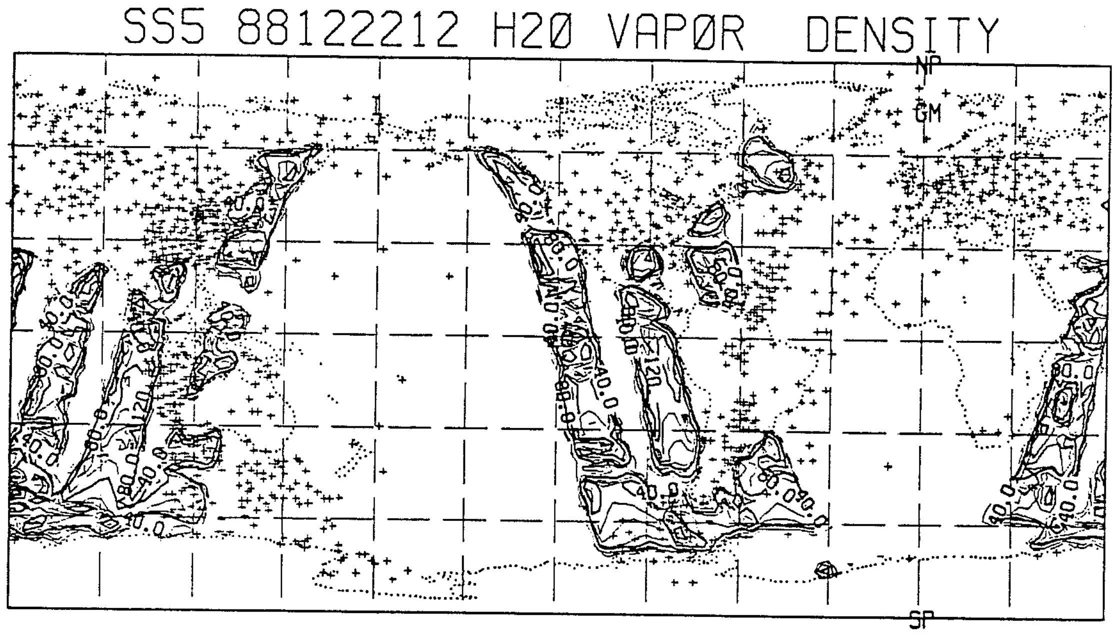


Figure (18) Number of SSM/I water vapor observations in 2.5 X 2.5 degree grid boxes. contour interval is 10. locations of Rawinsonde and TOVS reports are shown by +.

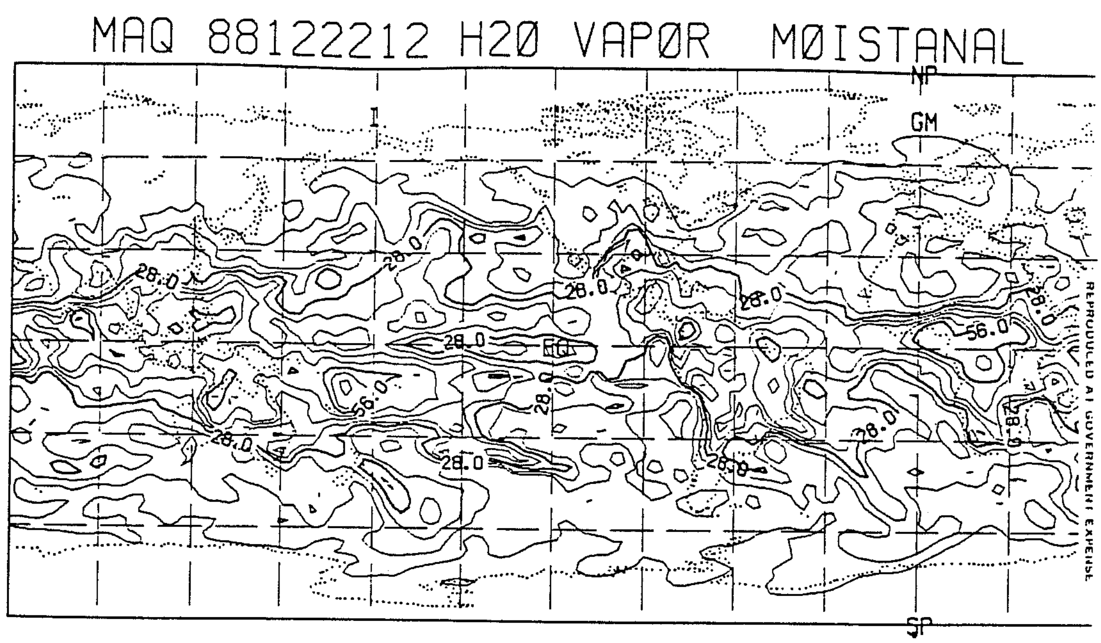


Figure (19) Total water vapor content computed from analyzed (MOISTANAL) moisture fields. Contour interval is 7 mm.

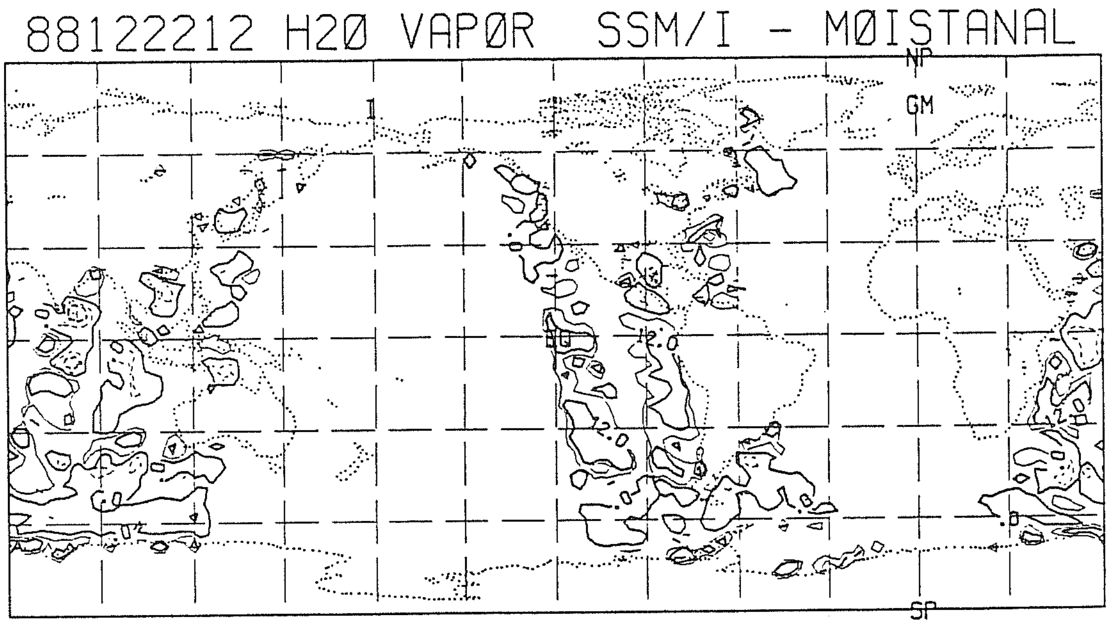


Figure (20) SSM/I analyzed total water vapor field. Contour interval is 6 mm. Difference is set to zero where no SSM/I observations were available.

ency between the two data types. Since the rawinsonde/TOVS data is already in the total moisture analysis, SSM/I data adds little new information in these areas. The results shown here are for a single observation period, but are typical of patterns observed on a daily basis.

Plans:

Plans include further MOISTANAL data assimilation studies using NOGAPS 3.1 initialization and the global nonlinear WVO algorithm (RMSE = $\pm$ 0.24 g/cm^2). (NOGAPS 3.1, with improved moisture physics, should further improve the analysis.)

7. CONCLUSION

The SSM/I data has extended operational utility. Six remaining SSM/I sensors plus the follow-on Special Sensor Microwave Imager/Sounder (SSMIS) instrument are scheduled for launch on future DMSP satellites through the year 2000. Therefore, algorithm improvements can be implemented in time for data assimilation in operational models over several years. Data assimilation studies for surface wind speeds and water vapor (ocean), presented here, though preliminary, are encouraging. Improved sea ice concentration, surface wind speed and water vapor (ocean) algorithms show earliest promise for Navy use. Shared Processing Network wideband communications will enhance NESDIS archival of SSM/I data for the scientific community.

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