MAMS - High Resolution Atmospheric Moisture / Surface Properties (460-21-30-90)

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PAST WORK AND CURRENT RESEARCH ACTIVITIES. Multispectral Atmospheric Mapping Sensor (MAMS) data collected from a number of U2/ER2 aircraft flights have been used to investigate atmospheric and surface (land) components of the hydrologic cycle. Algorithms have been developed to retrieve surface and atmospheric geophysical parameters which describe the variability of atmospheric moisture, its role in cloud and storm development, and the influence of surface moisture and heat sources on convective activity. Techniques derived with MAMS data are being applied to existing satellite measurements to show their applicability to regional and large process studies and their impact on operational forecasting.

Currently data from the Cooperative Huntsville Meteorological Experiment (COHMEX) and follow-on flight data are under investigation. Data from the CaPE experiment in summer of 1991 over Florida will provide additional collaborative measurements to further refine the techniques and to study the development of convection over Florida. Beginning in 1992, data from both the MAMS and Wildfire spectrometers flown during STORMFEST will come under investigation.

Currents efforts have been focused in in seven areas.

1. Refinement of MAMS precipitable water retrieval algorithms. Development has continued on the Split Window Variance Ratio (SWVR) technique to derive integrated water content (precipitable water) in the column from MAMS data. Improvements to the technique include better cloud detection/elimination schemes and the use of various template sizes for variance computations. The SWVR technique is being applied to other (more recent) data sets for further evaluation. The new data sets present higher quality MAMS data (than past applications) which include better calibration and 10-bit digitization of the split window channels. This new data is improving the retrieval quality for precipitable water. A second technique developed for MAMS precipitable water estimation, the physical split window (PSW) technique, has had limited application to MAMS in the past because of poor absolute sensor calibration. The new data sets are providing opportunity to re-evaluate this technique, however. The application of both of these techniques to the retrieval of other atmospheric parameters (e.g., ozone) is being studied to investigate the structure and dynamics of mid-latitude storm systems.
2. Application of SWVR and PSW techniques to satellite data. Both the SWVR and PSW techniques are being tested on satellite data to show their application to regional and global scale moisture mapping. Results of using the SWVR technique on AVHRR data have been inconclusive thus far. The SWVR technique requires fairly high spatial resolution data over a region under which the atmosphere is invariant (homogeneous). Preliminary results seem to indicate that the SWVR technique can only be applied to AVHRR data in regions with relatively high moisture content because of the reduced sensitivity of the 12 micrometer channel to low amounts of water vapor. The PSW technique on the other-hand has been successfully applied to VAS data for a COHMEX case study. The results compare favorably with those of other VAS PW retrieval techniques. The PSW technique has the capability to produce finer scale moisture products than some other techniques because of its use of only the two split window channels on VAS rather than all 12 sounding sounding channels. This work has been performed in conjunction with scientists at Florida State University and has lead to the M.S. thesis of Mr. Anthony Guillory this year.
3. Variability of surface thermal measurements. The variability of land surface temperature (LST) and normalized difference vegetation index (NDVI) has been evaluated using

multi-temporal MAMS measurements over the Konza prairie during FIFE (1987). FIFE offers a unique opportunity to study surface processes because of the extensive ground truth and other ancillary conventional and remotely sensed data. The MAMS work shows that significant thermal variability exists at small scales (less than a few kilometers) and varies a over short period of time. The differential changes with time are due to different underlying land use in the region. Sun-sensor viewing geometries also had significant impact on both the LST and NDVI calculations indicating that caution must be used when combining different data sets. This has considerable impact on future Eos and geostationary observations and those made at different times or large and changing view angles from polar orbiting satellites.

4. Relationship between moisture distributions and convective development. The COHMEX case studies are being used to investigate the relationship between convective activity and atmospheric and surface features in the region. MAMS data is being used to describe the mesoscale moisture environment and surface thermal forcing. Additional information about the surface (land, water, vegetation, terrain slope/elevation, etc.) is obtained from MAMS visible channels and from ancillary GIS information. These derived parameters are also being utilized in one and two dimensional modeling at Florida State University (Fuelberg) and at the University of Alabama-Huntsville (McNider) to further this diagnostic investigation.

5. MAMS Quick View System Development. The MAMS Quick View System (QVS) is a personal computer (PC) based image analysis and display system designed to provide an enhanced capability to evaluate MAMS data during an aircraft deployment. This need arises from the limited post-flight evaluation capabilities provided by Ames for the Daedalus scanner systems. The QVS offers the portability of a personal computer with the advanced analysis and display features of a mainframe image analysis system. The QVS is currently based on an AST Premium 486 personal computer with 10 megabytes of RAM and 1000 megabytes of disk space. An IBM OS2 operating system (version 1.3) is used along with a the PC version of McIDAS (5.0). With the addition of a few specialized software and hardware modules, the QVS provides locally many of the MAMS processing capabilities currently available on the Engineering Analysis and Data System's (EADS) McIDAS. Many of the system components have been integrated and will be fully tested during the CaPE experiment. The MAMS QVS will soon have the capability to display real-time MAMS data (telemetered from the ER2) during a flight. This capability should be available in FY92 and may provide a valuable resource to future ER2 flights.

6. ER2 Coordination for CaPE. The NASA ER2 activities for CaPE are being coordinated by MSFC. Five NASA or NASA supported instruments will be flown on the ER2 during a four and a half week period beginning on 16 July and running through 17 August. The deployment will be based out of Wallops Flight Facility at Wallops Island, Virginia were extensive support facilities exist for a program of this nature. The ER2 activities have become an integral part of the CaPE experiment because of the unique measurements being made from this platform. The ER2 will also require special interactions with other aircraft, the Doppler radars, and other ground based measurement systems. This activity is currently being coordinated with the ER2/CaPE personnel.

7. MAMS data set production for earth system science investigations. A number of MAMS data sets have been collected and provided to outside investigators for use in their own NASA funded (and other) research activities. The MAMS measurements provide unique multispectral-multitemporal measurements of surface and atmospheric parameters at high spatial resolutions. These data sets include thunderstorm imagery (sent to GSFC and used extensively at MSFC), SST measurements for ocean motion calculations (sent to B. Emery at U. of Colorado), many data sets for moisture and cloud mapping (sent to H. Fuelberg, Florida State University, and D. McNider, UAH), Konza prairie surface scenes (FIFE Information System, GSFC), and surface scenes (Smith, Florida State University).

Other Activities, Much planning work was done in preparation for MAMS and Wildfire for STORMFEST (February and March, 1991), and for ER2/DC8 involvement in TOGA/COARE.

PLANS: See technical plan/proposal sent to NASA Headquarters by Principal Investigator for analysis of MAMS data from CaPE and for use of MAMS and Wildfire in STORMFEST. The analysis plans include the following goals and objectives. The involvement in STORMFEST will require 15hours of ER2 flight time during February/March 1992. Deployment is likely out of

Kelly AFB in San Antonio, Texas.

CaPE:

1) Use data from several good cases of sea-breeze front development to quantify the moisture associated with the front, its time and space variability, and its importance to developing clouds and thunderstorms. Either the SWVR technique or the PSW technique will be used to derive integrate water content from MAMS. Similar moisture products will be derived from VAS (and AVHRR if available) to show the strengths and weaknesses of moisture mapping from satellite platforms. In situ measurements from the King Air aircraft along with CLASS soundings and PAM surface stations will be used to verify the remotely sensed water vapor products.
2) Local sources of heat and moisture which may be important for convective development will be evaluated with MAMS data by monitoring the land surface temperature (LST) and atmospheric moisture patterns over the central Florida area. These parameters will be compared to surface features to investigate cause and effect relationships between the measurements.
3) Along with AMPR data, the utility of combined passive visible, infrared, and microwave measurements will be evaluated to assess land use, vegetation mapping, and soil moisture estimation. Data from several clear surface flights will be used. The high resolution aircraft data will provide a unique opportunity to inter-retate visible, infrared, and passive microwave measurements. The results of the comparison will show the limits and expectations of similar analyses from coarser resolution satellite data.
4) MAMS data from various thunderstorm flights will be processes in support of the precipitation and lightning investigations with ER2 data. MAMS imagery will be remapped into common projections with other ER2 data and that of GOES to provide a comprehensive analysis of the structure of the convective storms.

STORMFEST:

The newly developed Wildfire spectrometer (Daedalus Enterprises, Inc. under a NASA Ames Research Center SBIR) will be used to map high resolution ozone and water vapor fields for STORMFEST. This proposed work is a demonstration effort to show the feasibility of mapping high resolution ozone fields (with passive IR techniques) and the importance of tropospheric/lower stratospheric ozone variations to the study of jet streaks and mid-latitude storm systems. The goals are:

1) to collect high quality Wildfire data in conjunction with other in situ and remote measurements available during the STORMFEST field phase (1 February - 15 March 1992),
2) to develop algorithms to retrieve total ozone content and compare with those from TOMS and HIRS (IR), and
3) along with water vapor imagery, use the ozone data to better understand the 3-dimensional structure and dynamics of jet streaks and frontal systems in a case study investigation.

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