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REMOTE SENSING OF WATER VAPOR FEATURES

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Recent Accomplishments

Our current research has three major objectives:

1) Describe atmospheric water vapor features as functions of space and time,

2) Evaluate remotely sensed measurements of water vapor content, and

3) Investigate relations between fine-scale water vapor fields and convective activity.

We have been utilizing data from several remote sensors as part of this research. Our investigations utilizing the GOES/VAS, HIS, and MAMS instruments have provided a progressively finer scale view of water vapor features. Recent efforts have been focused in several areas:

1) VAS Evaluations--Error characteristics of VAS soundings have been examined. Olson (1990), Olson and Fuelberg (1990), and Fuelberg and Olson (1991) calculated agreements between VAS operational retrievals and radiosonde soundings, and between both versions of derived thermodynamic variables. Breidenbach (1990) and Breidenbach and Fuelberg (1990) evaluated time tendencies of VAS sounding variables. Each of these studies showed that VAS operational retrievals have serious deficiencies in sensing water vapor. Nonetheless, VAS products still can be used advantageously in some applications if special computational procedures are employed beyond those utilized operationally.

2) Simulated imagery--Muller and Fuelberg (1990) created simulated VAS 6.7 micron imagery by utilizing numerically predicted soundings from the LAMPS model as input to radiative transfer code. By comparing the simulated imagery to LAMPS' mass, moisture, and momentum fields, it was possible to better understand how the atmosphere produced the bands and swirls that were evident in the water vapor imagery. Brad Muller now is applying this methodology to the AMSU instrument. His current work is being sponsored by a NASA Graduate Student Researchers Program which allows him to work closely with Dr. Franklin Robertson and other scientists at NASA/Marshall.

3) VAS Case Studies and Algorithm Development--Fuelberg et al. (1991) used VAS retrievals to understand an event of sudden surface drying over central Tennessee during the summer. The VAS soundings used here were not the operational versions whose limitations were described above, but a special "research quality" data set that was prepared later. Results indicated that surface based mixing

penetrated a narrow dry tongue aloft. Intense thunderstorms formed along the periphery of the surface dry area.

Former graduate student Anthony Guillory has worked with Dr. Gary Jedlovec of MSFC to apply to VAS data Jedlovec's split window technique for calculating precipitable water. This algorithm is simpler and faster than many others, and it has produced very encouraging results (Guillory, 1991). Guillory was sponsored by a NASA Graduate Student Researchers Program--Minority Focus.

4) HIS Studies--Bradshaw and Fuelberg (1990) and Bradshaw (1991) have evaluated HIS interferometer retrievals prepared by scientists at the University of Wisconsin. Our efforts were an independent examination of the Wisconsin products. Specifically, HIS sounding data were compared against those from radiosondes, VAS, and MAMS; and the HIS retrievals were used to examine the causes of mesoscale cloud patterns. Results suggest that HIS will be an improvement over current filter wheel technology. However, since only two cases were investigated, additional studies are needed to fully explore HIS capabilities in diagnosing small scale water vapor features. The CAPE project offers this possibility.

Current Focus

Three research projects currently are in progress. The AMSU efforts of Brad Muller were described above. In addition, graduate student Mike Nichols is exploring a summer case over northern Alabama when MAMS indicated distinctive cumulus cloud patterns that appear to be related to topography and mesoscale circulations along the Tennessee River. To explore causes for the cloud features, precipitable water and skin temperatures are being calculated from MAMS imagery. In addition, a boundary layer model is being used to estimate growth of the mixed layer during the daytime.

A second MAMS study, by graduate student Rick Knabb, is utilizing MAMS data from a Pre-CAPE flight over Florida during October 1990. This case is characterized by strong north-south moisture gradients as well as outflow boundaries from previous thunderstorms. MAMS-derived thermal and moisture products are being used to explain cloud patterns during and after the MAMS flight.

Plans for 1992

The first objective is to complete the AMSU activities and the two ongoing projects involving MAMS. Conference papers and journal manuscripts describing findings will be prepared. As a second objective, we would like to draw on the experience we have gained with MAMS and HIS, by performing CAPE related investigations that utilize these data sources. Florida has an abundance of small scale circulations during the summer that can trigger convective activity (e.g., land/sea breezes, river/swamp/lake breezes, and outflows from previous thunderstorms). Our experience suggests that mesoscale water vapor and stability features also are present. Data collected during CAPE would be ideal for studying the capabilities of MAMS, HIS, and VAS for detecting these features and learning how they relate to thunderstorm formation. We will prepare a proposal for conducting this type of research.

Our second major research activity will investigate the new series of GOES satellites (GOES I-M) that will be launched by Spring 1993. GOES I-M will be superior to the current VAS system, especially in regard to moisture sensing. These new satellites will be the only geostationary platforms for moisture mapping for the remainder of this decade, and possibly for the next 15 years. Since a better understanding of atmospheric water vapor is the goal of a major new NASA research initiative called GVaP, our research will develop, evaluate, and use GOES I-M products in hydrologic studies, thereby permitting immediate progress toward the goals of GVaP.

Our objectives for the GOES I-M research are to:

1) Understand features in GOES I-M water vapor imagery and their relationships to horizontal and vertical humidity distributions and various kinematic/dynamic processes.

2) Quantify the accuracy, representativeness, and information content of GOES I-M imagery and products from that imagery, including temperature/dewpoint profiles, various measures of water vapor content and water vapor tracked winds.

3) Develop new procedures for examining atmospheric water vapor that take advantage of the enhanced capabilities of GOES I-M products over those now available from VAS.

4) As a result of the above, further the goal of improving our understanding of the role of atmospheric water vapor.

The proposed research will conducted jointly with Dr. Gary Jedlovec and other scientists at NASA/Marshall Space Flight Center. Jedlovec and Fuelberg have submitted a joint proposal to NASA Headquarters describing details of the research. Briefly stated, both observed imagery and simulated imagery prepared from a numerical prediction model and radiative transfer code will be employed. The use of simulated imagery will allow considerable research to be conducted prior to the launch of GOES I so that some findings will be available when the new satellite becomes operational.

Publications

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