Title: Statistical Analysis and Use of VAS Radiance Data

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Significant Accomplishments to Date in FY-84:

A. Several tasks were completed as part of the contract that expired in March 1984. The focus of that effort was to better understand causes for intense convection along with its impact on the surrounding environment.

1) Our investigation of the AVE-SESAME V period (20-21 May 1979) was very successful. Special radiosonde soundings at 75 km spacings and 3 h intervals provided a unique opportunity to learn more about mesoscale data and storm-environment interactions. Results proved that relatively small areas of intense convection produce major changes in surrounding fields of thermodynamic, kinematic, and energy variables. Three publications describing these efforts were prepared.

2) We continued to study the Red River Valley tornado outbreak (10-11 April 1979, AVE-SESAME I). Generation of available potential energy (APE) by five diabatic components was computed as an extension of our earlier investigation of kinetic energy during the same period. A unique aspect to the research was that satellite imagery and surface data were used to specify cloud information needed in the radiative heating/cooling calculations. Also, the radiative transfer models were more sophisticated than those used in previous APE investigations. Results showed that convective latent heat release was the major diabatic component and generator of APE. Infrared cooling was the second greatest contributor. The findings suggest that radiative processes may have a greater influence on the atmosphere's APE generation than was previously realized.

3) We completed a feasibility study for computing boundary layer winds from satellite-derived thermal data, and results were very encouraging. Winds in the lowest 1600 m AGL were diagnosed via Ekman relations similar to those contained in the Air Force's Boundary Layer Model. Winds obtained from TIROS-N retrievals compared very favorably with corresponding values from concurrent rawinsonde thermal data, and both sets of thermally-derived winds showed good agreements with the observed values. Fields of various kinematic parameters (e.g., moisture convergence, vertical motion, vorticity) derived from the satellite data were very similar to those from the rawinsonde thermal data (Fig. 1). In addition, the patterns agreed with the locations of convection that developed later in the day. Thus, this procedure for estimating low-level winds may have useful forecasting applications.

B. Our new contract began in September 1983, and its focus is to provide better understanding and utilization of VAS radiances and retrieved soundings. Although this effort is still quite new, we are making substantial progress.

1) Fuelberg spent his Fall 1983 sabbatical leave in residence at NASA/Marshall. A one week period at the University of Wisconsin also was included. The sabbatical was very fruitful since it provided time to read and plan for the new efforts. By having access to Marshall's McIDAS terminal, "hands-on" experience with VAS imagery was available in a timely manner. Finally, the visits provided opportunities to discuss our ideas with other scientists.

2) We are well into the investigation of data from the 6.7 μm water vapor

channel of VAS. By considering the 6-7 March day of the 1982 AVE-VAS Field Experiment, we are able to evaluate mesoscale radiance features with those from the special mesoscale radiosonde network in central Texas. Thus far, we have emphasized comparisons between the two data sources, but we are about to seek explanations for the observed radiance patterns. The 6.7 μm radiances are affected by humidity and temperature, and the level of the vapor features also is a key factor. Thus, this effort promises to be challenging, but with the potential for important applications.

3) We are conducting a case study of a convective outbreak during July 1982. VAS retrievals were available at mesoscale spacings for six times over a 12 h period. The soundings were carefully evaluated, edited, and then objectively analyzed to provide meso α- scale resolution. The resulting patterns demonstrate that VAS soundings can yield good continuity of features. From the gridded data, we have computed thermodynamic parameters including thickness, stability indices, and precipitable water. All results are being compared with those from the routine 12 h NWS radiosonde releases. Our goals are 1) to evaluate the usefulness of VAS data in describing conditions after 1200 GMT that lead to the convection, and 2) to investigate new applications for the retrievals.

Focus of Current Research Activities:

Explanations for patterns in the 6.7 μm data are being sought. The special mesoscale radiosonde data are being objectively analyzed so that kinematic parameters such as deformation, vertical motion, and vorticity can be calculated. Prior studies have shown that these quantities relate to the water vapor image features.

Concerning our case study, a report on the results to date is being prepared. It will document procedures and describe findings relating the thermodynamic variables to the thunderstorm activity. We are beginning to compute geostrophic winds from the VAS thermal data. Our ultimate goal here is to investigate whether VAS retrievals can be used to estimate vertical motions via the adiabatic method or the omega equation.

Plans are underway to investigate the physical retrieval procedure. We will compare the information content of the first guess and radiance data with that of the final VAS soundings. Our goal is to better understand the algorithms and assess the utility of using radiances directly as a supplement to the retrieved soundings. Data for this task are being collected, and computational procedures are being planned.

Plans for FY-85:

We will continue the efforts of the first year. Specifically, we will perform trajectory analyses to better understand the patterns in 6.7 μm imagery during 6-7 March 1982. Satellite-derived vertical motions will be obtained from several procedures for our case study. Finally, the information contents of VAS radiances and first guess data will be evaluated against those of the retrieved soundings. At least two journal manuscripts will be submitted on results from the recently expired contract.

Recommendations for New Research:

First, based on one set of TIROS-N retrievals, it seems feasible to calculate boundary layer winds from satellite thermal data. Now that VAS soundings are available at relatively short time intervals, the utility of this technique should be tested in a pre-convective environment to determine if there is potential for severe storm forecasting. Second, most applications of satellite data have been patterned after those using radiosonde information. Since satellite data are fundamentally different, however, we should focus on the development of new techniques that make use of the satellite's particular strengths, but are not overly dependent on its limitations.

Publications Since June 1983:

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Fuelberg, H. E., and M. F. Printy, 1983: Meso β- scale thunderstorm/environment interactions during AVE-SESAME V (20-21 May 1979). Bull. Amer. Meteor. Soc., 64, 1144-1156.

Fuelberg, H. E., and M. F. Printy, 1984a: A kinetic energy study of the meso β-scale storm environment during AVE-SESAME V (20-21 May 1979). NASA Contractor Report, in press.

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Ruminski, M. G., and H. E. Fuelberg, 1983: A subsynoptic scale analysis of available potential energy generation during a tornado outbreak. Preprints Thirteenth Conf. Severe Local Storms, Tulsa, Amer. Meteor. Soc., 358-361.

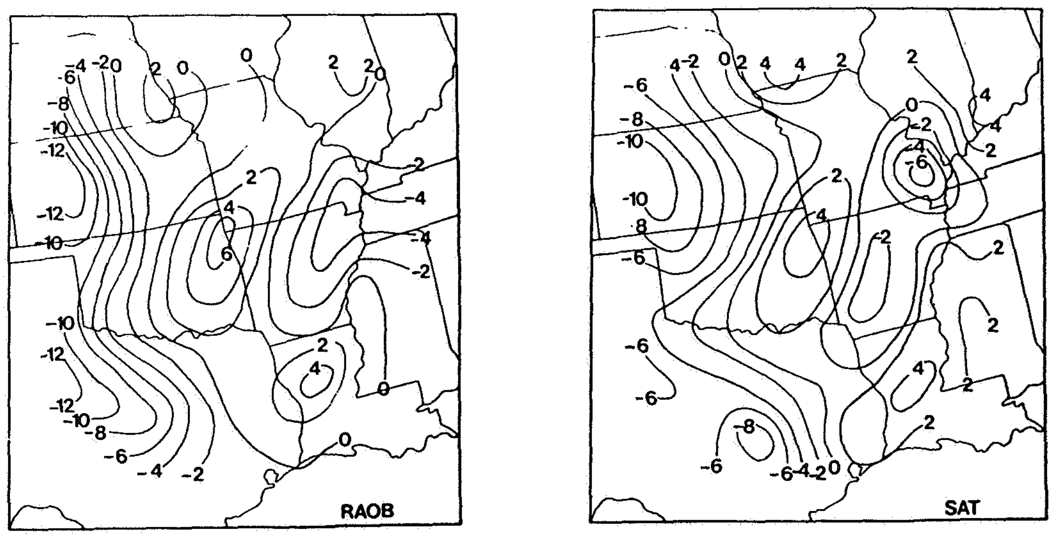

Fig. 1. Moisture divergence (10^{-4} g kg^{-1} s^{-1}) from RAOB- and satellite-derived Ekman winds at 300 m AGL for 0921 GMT 19 April 1979.