Prepared for
FY-84 Atmospheric Processes Research Program Review
May 2 and 3, 1984

Title: VAS Sounding Data Evaluation

Principal Investigator: Dr. James R. Scoggins
Department of Meteorology
Texas A&M University
College Station, TX 77843
409/845-7671

Significant Accomplishments to Date in FY-84:

A contract report has just been finalized which presents a comparison between the VAS soundings derived by NOAA personnel at the University of Wisconsin (UW) and NASA personnel at the Goddard Space Flight Center (GSFC), and rawinsonde soundings.

Three different types of comparisons between VAS and rawinsonde soundings were made. The first was a direct comparison between satellite and rawinsonde soundings plotted on Skew T-log p diagrams. The satellite sounding represents a highly smoothed version of the rawinsonde sounding; the satellite smoothing is both in the vertical and horizontal, but the vertical smoothing seems to be the more dominant feature.

Rawinsonde soundings were paired with the closest satellite soundings and the mean and standard deviations of differences between the two data sets were calculated. The profiles of temperature and dewpoint show mean differences of about 1.5°C and 3.0°C, respectively, with the standard deviations roughly constant with height. The differences are related to atmospheric structure and are dependent on synoptic and subsynoptic scale features that affect the variability of the rawinsonde (ground truth) profiles of temperature and moisture.

Satellite-rawinsonde differences for other parameters showed a strong dependence on the satellite profiles of temperature and moisture and can be explained by satellite vertical smoothing. The temperature differences show similar characteristics for both the UW and GSFC soundings, but statistical tests showed the two retrieval methods are producing statistically significantly different temperature profiles. The dewpoint differences between GSFC and UW show greater differences than the temperature profiles although the GSFC profiles were found to give a better representation of the ground truth. Statistical tests between satellite-rawinsonde differences show that at times corresponding to the greatest number of pairs, there is a statistically significant difference between the two data sets.

Synoptic and subsynoptic scale analyses were constructed with both rawinsonde and satellite data. Large scale systems are represented reasonably well by the satellite data with best analyses at higher levels. Small scale systems were poorly represented by the satellite data. The constant pressure charts show height and temperature fields that are highly smoothed compared to the rawinsonde. All but large scale features are lost in mesoscale vertical cross sections.

An analysis of temperature and height gradients showed that they would be poorly represented by the satellite data at low levels, but would improve with height and for this case it was not possible to accurately measure gradients over small distances (<200 km) with the satellite data.

The results given here pertain to one synoptic situation in which there was a high degree of vertical structure in the temperature profile. The limitations of the satellite soundings for prescribing small scale horizontal features are directly related to the limited vertical resolution of the satellite sensor. This study demonstrates the need for a geostationary satellite sounder with higher vertical resolution.

Focus of Current Research Activities:

Now that we have achieved a reasonable understanding of the accuracy and representativeness of the VAS data, we have turned our attention to the utilization of the data. Our approach is to develop a method for combining the VAS and rawinsonde soundings into a unified data set that will preserve the large-scale features of the rawinsonde data and utilize the VAS data to add horizontal resolution. We hope this can be done for areas with and without rawinsonde soundings. If rawinsonde soundings do not exist as over the ocean, constant pressure charts will be utilized to determine characteristics large-scale features of the rawinsonde soundings. Once the unified data set is derived, geopotential heights will be recomputed, a method developed for deriving wind from the geopotential heights, and analyses conducted to determine the utility of the new data set in diagnostic analysis, specification of initial conditions, and in forecasting.

The initial approach in developing a unified data set, although barely begun before the present contract expires at the end of May 1984, is to combine the zeroth and first harmonics from rawinsonde data with the second and third harmonics from satellite data. Gridding procedures are used to match the two fields. Initial results are extremely promising. Over the VAS regional network, the one case analyzed so far shows improved horizontal resolution compared with rawinsonde data alone, and the measured winds appear to agree better with the height fields computed from the unified data than with the rawinsonde height fields. These are very preliminary results; much additonal research is required before conclusions are reached.

Plans for FY-85:

A proposal has been submitted to NASA for the continuation of this research. Our hope is to continue the research on the utilization of the VAS soundings. If funded, the research will concentrate on the development of a unified data set and its validation, and on utilization of the data.

Recommendations for New Research:

Our research on the accuracy and representativeness of the VAS soundings shows that additional vertical resolution in the VAS data is desirable. A study is needed to determine whether or not additional vertical resolution can be achieved by increasing the number of channels in the radiometer. Also, additional research is needed on the utilization of the VAS soundings. Research on this subject has barely begun.

Publications Prepared Since June 1983:

Townsend, Tamara L. and James R. Scoggins, 1983: The Influence of Convective Activity on the Vorticity Budget. NASA CR 3752, 105 pp.

Rhodes, Robert C. and James R. Scoggins, 1984: An Analysis of the Properties of VAS Satellite Soundings. NASA Contractor Report (In Publication), 104 pp.