Final Report

The Application of VAS Satellite Imagery to Thunderstorm Forecasting at Cape Canaveral

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The objective of this research was to investigate whether satellite-derived imagery and derived products could be used advantageously in forecasting thunderstorms in the Cape Canaveral area. Specifically, we used data from the VISSR Atmospheric Sounder that is housed on the current series of GOES geostationary meteorological satellites. These satellite data have been used extensively in the middle latitudes, but their utility over central Florida where the climate is more tropical had not been examined.

One facet of the research examined the use of VAS temperature/dew point retrievals over Florida. Initial work focussed on a case study of 10-11 July 1989 when intense and rapidly changing humidity gradients occurred in the lower troposphere. Several modifications were made to the operational retrieval methodology that is used by NESDIS so that smaller scale humidity features could be detected. Individual retrievals, horizontal fields of data, and cross sections from the VAS retrievals were examined. Results showed a well defined mesoscale dry feature on 10 July. It exhibited good space and time continuity, moving west and dissipating during the 24 h period. The size and timing of this feature prohibited its detection by the standard operational network of radiosondes.

It is well known that a deep layer of humid air is required for thunderstorm development over Florida. Thus, thunderstorm activity was non-existent in the dry zone over central Florida on 10 July, but with the increased humidity on 11 July, a large area of intense thunderstorms covered the area.

The new methodology also was utilized during the Convection and Precipitation/Electrification (CaPE) Experiment conducted over central Florida in the Summer of 1991. The objective was to determine the frequency of mesoscale humidity features such as observed during the 1989 case study. Another aim was to demonstrate that the "man in the loop" methodology could be run in real time. VAS-derived products were sent to the CaPE project office each morning during the experiment as well as examined locally at Florida State. The methodology worked well operationally; however, Summer 1991 was atypical in that there was greater than usual early morning cloudiness. VAS retrievals cannot be made in cloudy areas since infrared imagery is utilized.

As part of this research, graduate student Wayne Hoepner spent much of summer 1989 in residence at NASA KSC. He and Prof. Fuelberg presented seminars on their findings during the summer of 1991 at both NASA KSC and Patrick AFB.

A second facet of the overall research was to explore the use of "split window" algorithms for calculating total column precipitable water from VAS data. There are several such techniques, but none has been examined over Florida where humidity gradients are traditionally thought to be more uniform than over the Midwest. Our research focussed on the algorithm developed by Dr. Dennis Chesters. Split window procedures do not give a

vertical profile of humidity as does the full retrieval procedure that was described above. However, the split window scheme is much easier and quicker to use, and the data needed for it are available many more times per day than are the data needed for making full retrievals.

Results from this procedure showed that significant variations in water vapor content exist in Florida during the summer, even though the atmosphere there is semi-tropical. Mesoscale moisture features were observed to evolve consistently and related well with areas of convective development and suppression. Case studies suggested that the split window derived precipitable water fields could be used in thunderstorm forecasting across central Florida. Comparison of the split window derived precipitable water to that obtained from complete VAS retrievals indicated that both methods detected similar features.

This part of the research was conducted by graduate student Mike Baker. He and Prof. Fuelberg presented seminars on this part of the research during the summer of 1992 at both NASA KSC and Patrick AFB. In addition, copies of the computer code were given to NASA scientists for further research.

Grant funds were used to help purchase a direct readout GOES ground station whose products were used during the research described above. In addition, that imagery was used to prepare a videotape of conditions during the CaPE project. That tape has received wide dissemination.

In summary, our research has shown that intense mesoscale gradients of water vapor do occur over central Florida during the summer and that these features are closely related to the presence or absence of convective activity. Satellite remote sensing currently is the only way by which such mesoscale features can be detected. The algorithms needed for that purpose can be used by local forecasters.

Patents

No patents were awarded as part of this research, and no products subject to patent were developed.

Publications

Baker, M.N., 1992: Precipitable water variations over central Florida as derived from the VAS split-window channels. M.S. thesis, Florida State University, Tallahassee, 84 pp.

Hoepner, W.A., 1993: The use of VAS retrievals for meteorological forecasting at the Kennedy Space Center, M.S. thesis, Florida State University, Tallahassee, 61 pp.

Hoepner, W.A., and H.E. Fuelberg, 1992: The use of VAS retrievals for thunderstorm forecasting at the Kennedy Space Center. Preprints Sixth Conf. Satellite Meteor. and Ocean., Atlanta, Amer. Meteor Soc., J31-J35.

Baker, M.N., H.E. Fuelberg, and J.E. Ahlquist, 1993: Satellite-derived precipitable water over central Florida and its relation to thunderstorm development. Preprints Seventeenth Conf. Severe Local Storms, in press.