(NASA-CR-199770) APPLICATIONS OF
GOES-8/9 DATA TO HURRICANE ANALYSIS
(Wisconsin Univ.) 2 p

N96-15864

Unclas

G3/47 0083951

NASA-CR-199770

from the 21st AMS Conf. on Hurricanes and Tropical Meteorology, Miami, FL, April 1995, pp.639-641.

NDB NAG 8-974

3.5 APPLICATIONS OF GOES-8/9 DATA TO HURRICANE ANALYSIS

IN-47-CR REPRINT 6429 P. 2

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1. INTRODUCTION

GOES-8 was successfully launched in 1994, and has performed up to expectations and in some cases has actually exceeded pre-launch specifications. A similar geostationary satellite, GOES-9, was launched in May of 1995. This new generation of NOAA's geostationary satellites carry a superior design and instrumentation package that allow for greater detection of meteorological features and parameters. The new GOES imager has a 5 band multispectral capability with high spatial resolution, while the sounder contains 18 thermal infrared (IR) bands plus a low-resolution visible band. The imager carries a visible channel with 10-bit quantization and increased sampling frequency, a short-wave and long-wave window channel, and a water vapor band with a twofold increase in spatial resolution and a factor of 3 improvement in signal-to-noise over that obtained from previous GOES sensors.

The advances in observing the earth's atmospheric system anticipated from these improvements are outlined in Menzel and Purdom (1994). The specific impact of this improved remote sensing capability on the analysis of tropical cyclones is discussed here.

2. HURRICANE ANALYSIS

The detector improvements summarized above have lead to superior qualitative image presentations of hurricane structure and development. In the visible spectrum, sharper images are resulting in improved cloud top and cloud edge feature detection. This helps in the subjective interpretation of the imagery in regards to eye and eyewall characteristics, but also enhances the ability of automated cloud tracking algorithms. In addition, with proper image display and enhancement techniques, the 10-bit imagery allows extended use in low light situations to aid in eye location.

In the IR spectrum, the improved spatial resolution and signal-to-noise again benefits the ability to detect trackable cloud features, and is resulting in higher quantity and quality wind vectors. Velden et al. (1992) have shown that high-density satellite-derived wind information in the hurricane near-environment can lead to important forecast improvements. Rainfall estimation techniques should also benefit from the higher quality data. Determination of sea surface temperatures (important to hurricane energetics and potential intensity) by split window techniques should become more accurate, especially with the availability of the short wave window channel.

Water vapor observations from geostationary satellites have been shown to be useful in delineating features in the hurricane environment that can affect intensity and motion (Dvorak 1984; Weldon and Holmes 1991, Velden et al., 1993). Upper-level wind data sets derived utilizing water vapor image sequences from previous geostationary satellites have resulted in modest positive impact on numerical weather prediction (Velden 1995a). The water vapor images from GOES-8 are of unprecedented quality, and indications (Velden 1995b) are that image sequences are providing substantially improved wind vectors in cloud-free regimes (more on this below).

The importance of the sounder information is to provide multivariate vertical profile observations in cloud-free regions in the hurricane environment, especially valuable in regions void of conventional data (i.e. subtropical ridge in the North Atlantic). Thermal gradient winds derived from these profiles have been shown to benefit hurricane track forecasts

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(Velden et al. 1992). Preliminary indications are that the improvements in the GOES-8/9 sounder detection capabilities are resulting in superior gradient wind information.

As mentioned above, quantitative wind information derived from sequences of water vapor imagery has the potential to impact hurricane analysis by improving the depiction of the upper-level environmental flow fields. During hurricanes Florence and Gordon (1994), data sets were produced at 12-hour intervals and delivered to numerical modeling centers for their evaluation on track forecast impacts. First results obtained from the Hurricane Research Division's barotropic hurricane forecast model (VICBAR) were encouraging. The wind sets were shown to yield positive impact on 72-hour track forecasts (nearly 2/3 of the forecasts were improvements over the control runs). However, the improvements were quite modest, which might be partially explained by the characteristics of the VICBAR model, which initializes on a deep layer mean wind analysis that gives little weight to the upper-levels, and contains no vertical blending of data above 350mb (most of the water vapor vectors are assigned heights above 350mb).

For this reason, the data sets are being tested in more sophisticated hurricane track assimilation and forecast systems (FSU, GFDL) which employ physical initialization schemes and use the full primitive equations. The results of these trials will be presented at the conference.

3. SUMMARY

GOES-8 has performed up to expectations, and in some cases is exceeding pre-launch specifications. Applications of this new and improved satellite data to the analysis of hurricanes commenced in 1994 during the spacecraft and instrumentation check-out, and continued during the active 1995 Atlantic hurricane season. Findings are revealing that the data being provided by GOES-8 are superior to observations from previous geostationary satellites, and have the potential to positively impact both the subjective and objective analysis of hurricane situations. Development and testing of algorithms to optimally extract useful information from the observations is underway.

GOES-9 was launched in May of 1995, and positioned at 90W during the 4-6 month checkout phase. This allowed dual-satellite coverage and inter-satellite data comparisons. Preliminary indications are that the GOES-9 observations are as good as GOES-8, and in some channels are slightly superior in quality. As of the time of this writing, the plan is to move GOES-9 to 135W after a successful check-out, where it will provide coverage of eastern and central Pacific hurricanes on par with the quality of GOES-8.

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