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UW-CIMSS SATELLITE PRODUCTS: RECENT RESEARCH AND DEVELOPMENTS

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1. Introduction

This poster will highlight some of the new satellite-based research and development at the Cooperative Institute for Meteorological Satellite Studies (UW-CIMSS) over the past couple of years as applied to tropical cyclones (TC). The topics will include the latest in satellite-derived wind applications and derived products, advances in the Objective Dvorak Technique (ODT), development of Advanced Microwave Sounding Unit (AMSU techniques for estimating TC intensity, use of diagnostic fields derived from the satellite winds, and satellite data assimilation studies. Each topic will be briefly summarized with examples, and the relevance to TC issues will be highlighted along with a status report on operational transition.

2. New satellite-derived winds products and applications

Recent collaborative efforts between NOAA's Hurricane Research Division (HRD) and UW-CIMSS have resulted in the development of several new satellite-derived products designed for TC applications. These products utilize advanced geostationary satellite winds derived at UW-CIMSS and are made available in real-time on the UW-CIMSS TC web site. For example:

Low-level (600-925 hPa) cloud-drift winds are generated in the TC environment using the visible channels on the GOES-8, GOES-10, and GMS-5 satellites. These wind data are "surface adjusted" using a planetary boundary layer program developed at HRD, and are made available to forecasters during real-time storm events. Recent efforts have also resulted in the development of a technique for generating low-level cloud-drift winds using the 3.9 µm shortwave infrared (SWIR) channel available on the GOES satellites. These SWIR winds show promise for providing substantial nighttime low-level wind information in TC environments in the northwest Atlantic and northeast Pacific TC basins. This technique results in a 40-50% increase in the number of low-level cloud-drift winds tracked around TCs by the UW-CIMSS wind tracking algorithms.

A new product that uses the 10.7 and 12 µm channels on GOES –8 is being developed to track the advance of the Saharan Air Layer (SAL) across the north Atlantic basin. The SAL can be associated with TC development, but can also negatively impact tropical systems (see Dunion and Velden, this volume).

Analyses derived from the multispectral satellite winds are being used to create deep-layer-mean wind fields of selected tropospheric depths. The analyses approximate the steering flow of TCs with the depth of the steering flow being correlated with TC intensity. These fields are being made available in real time on the CIMSS TC web site (see Dunion and Velden, this volume).

Collaborative efforts between NHC/TPC and UW-CIMSS are underway in order to evaluate the potential application of newly advanced satellite-derived products and algorithms in an operational environment (See Rhome and Velden, this volume). These new products and tools have shown skill in locating features such as fronts, easterly waves, and shear zones as well as the associated wind field and their interactions with other environmental features such as TCs. For example:

Given the lack of observed data over the open oceans, low-level (600-925 hPa) cloud-drift winds are a valuable data source for tropical analysis and have shown skill in aiding the detection and tracking of tropical easterly waves. Using these winds, a color-enhanced analysis of 850-hPa relative vorticity is created every 3 hours. This product has been demonstrated as a useful tool for tracking tropical waves across basins and inter-basin.

A new product was recently made available for TPC evaluation. This product consists of a 4-panel plot of vorticity at 200, 500, 700, and 850 hPa covering the entire TPC area of interest. The 4-panel product is currently being evaluated as a diagnostic tool for locating synoptic features (i.e. fronts, troughs, shear axis etc) and analyzing their vertical structure.

The effects of vertical wind shear on TC structure and intensity change are qualitatively well known. For low (high) values of vertical shear, a storm will generally intensify (weaken) provided other parameters that affect TC intensity remain constant. However, quantitative relationships have remained elusive, mainly due to the lack of temporal and spatial continuity in measurements of the three-dimensional wind field structure over data sparse regions such as the tropical oceans. UW-CIMSS has automated a process to derive vertical wind shear fields using satellite wind information. Gallina and Velden (this volume) have used these fields to quantitatively investigate the relationship between vertical wind shear and TC intensity change. The goal of this study is to examine a large number of TC cases and provide more insight on critical shear magnitudes, time lags, and vertical shear's effect on TCs with different strengths and thermodynamic potentials. Preliminary results from their study suggest the presence of shear thresholds and time lags between the onset of detrimental shear and subsequent TC weakening.

The lack of in-situ data in the tropics makes it difficult to properly initialize TCs in Numerical Weather Prediction (NWP) models. To account for this data void, synthetic data has traditionally been used to initialize hurricanes within NWP models. An alternative solution to this initialization problem involves using remotely sensed data from satellites instead of synthetic data. To examine this solution, experiments have been performed that are designed to optimize the assimilation of winds derived from GOES rapid-scan data into the National Centers for Environmental Prediction's (NCEP) Eta model. The wind data are assimilated into the Eta model through the Eta Data Assimilation System (EDAS). The preliminary case study evaluated is Atlantic Hurricane Keith, (Sept/Oct 2000) although additional cases, such as hurricane Humberto (Sept 2001), are presented in Berger (this volume). The satellite-derived winds will more accurately describe the initial upper-level environment over these storms. Various assimilation strategies designed to optimize the influence of these wind data on the model initialization and resulting analyses are examined.

Further applications of the satellite-enhanced analyses in diagnostic TC studies can be found in Mecikalski and Velden (this volume), Bosart et al. (this volume), and Evans et al. (this volume).

3. The Advanced Dvorak Technique (AODT)

The Objective Dvorak Technique (ODT) is an automated algorithm developed at UW-CIMSS based on satellite IR data to estimate TC intensity. It now has a wide usage at various global forecast centers. User feedback has identified situations when the ODT has trouble identifying scene characteristics that can cause intensity analysis errors. This has led to the development of the AODT, discussed in Olander et al. (this volume). The AODT extends the application of the method to weaker storms, adds new scene typing features, and attempts to address some of the shortcomings of the ODT. The AODT will be tested in the 2002 TC season.

4. Advanced Microwave Sounding Unit (AMSU) applications

Satellite-based passive microwave data applications to TC intensity estimation have shown tremendous promise over the past few years (Brueske et al.; DeMuth et al., this volume). Based on upper-level AMSU channel observed brightness temperature warm anomalies in the TC core and hydrostatic assumptions, algorithms have been developed to calculate TC minimum sea-level pressure (MSLP). These algorithms are currently being transitioned into NHC/TPC for operational testing. During the 2001 TC season, a new multi-channel AMSU method was tested and is showing promise (Kabat et al. this volume). Results of intercomparisons between AMSU TC temperature profiles and ER-2 dropsonde measurements during CAMEX-4 are presented in Halverson et al. (this volume).

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References: Numerous citations in the text appear in this volume.