3D.2 THE NRL TROPICAL CYCLONE R&D WEB PAGE UPGRADES

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1. INTRODUCTION

The Naval Research Laboratory's Marine Meteorology Division in Monterey, CA (NRL-MRY) has successfully demonstrated the utility of passive microwave products for global tropical cyclone (TC) monitoring. Passive microwave frequencies greatly mitigate obscuration frequently hampering visible/Infrared (vis/IR) imagery by upper-level clouds. Intense convection associated with TC rainbands and eyewall features can be readily viewed by the much lower brightness temperatures (T_Bs) resulting from scattering due to frozen hydrometeors at 85 GHz (graupel/hail). Temporal changes from one pass to another then provide short-term structural/intensity updates by recognizing organizational evolution.

The ability to see through non-raining clouds and map rainbands, eyewalls and internal storm structure assists analysts in extracting storm positions and intensity. The passive microwave data can thus play an important role in supplementing the vis/IR data sets that provide the support backbone within the TC satellite reconnaissance mission. Near real-time products are distributed via an Internet web page to users worldwide (Lee, et al., 1999; Hawkins et. al., 2001) and have been transitioned to the Fleet Numerical Meteorology and Oceanography Center's (FNMOC) operational web page.

2. DATA SETS

NRL-MRY ingests data from three operational Special Sensor Microwave/Imager (SSM/I) sensors (F-13, 14 and 15). The conical scanning permits 12-15 km resolution 85 GHz imagery across the entire 1400-km swath, thus permitting good data even along the swath edge.

The Tropical Rainfall Measuring Mission (TRMM) Microwave Imager's (TMI) 750-km swath, 5-km resolution 85 GHz imagery, 35-degree tropical inclination and non-sun synchronous orbit temporally and spatially augment the SSM/I data set. The superior spatial resolution removes some uncertainties in SSM/I data and enables 37 GHz to resolve more TC features. The 37 GHz data responds less to ice scattering and more to emissions from heavy rain, effectively mapping storm characteristics that are lower in the atmosphere than 85 GHz data. The ability to view multiple levels within the TC is highly advantageous.

Advanced Microwave Sounder Unit (AMSU-B) data has been treated as an imager in order to use the 89 GHz channel and it's large 2343-km swath. The 16-km nadir and much coarser resolution near the swath edge limit sensing of smaller TC features, but the added temporal sampling with two (2) AMSU-B sensors significantly enhances the global passive microwave data set.

The Advanced Microwave Scanning Radiometer (AMSR-E) onboard NASA's EOS Aqua spacecraft has been recently added. The 1600-km swath and superb TMI-like horizontal spatial resolution now provide temporal and small feature mapping important for studying eyewall formation and concentric eyewall cycles.

The three SSM/Is, TMI, two AMSU-Bs and AMSR-E create a seven sensor polar orbiting TC constellation with data latencies of 1-3 hours. Although the orbits are not optimized for maximum coverage, temporal sampling has improved several fold since using only SSM/I data during our 1997 start. Active microwave scatterometer data (QuikSCAT) is also included to provide surface wind field values crucial to detecting gale wind radii and the transition from a tropical wave to a depression or tropical storm.

The NRL-MRY TC web page is unique in its combination of storm-centered passive and active microwave products for near real-time tropical cyclone applications. Also included are vis/IR and water vapor from five geostationary satellites GOES-9, 10, and 12 and Meteosat 5 and 7 that provide true worldwide coverage.

Day to day management of the tropical disturbances on the web page is performed by forecasters at the Joint Typhoon Warning Center (JTWC) in Pearl Harbor and the National Hurricane Center (NHC) in Miami. Graphical representations of their forecasts are included on the web page when available.

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The NRL-MRY demonstration web page is located at the following link and the "general" info button in the upper-right corner will assist in understanding the product suite, site navigation and page functionality.

http://www.nrlmry.navy.mil/tc_pages/tc_home.html

2. RECENT TC PAGE UPGRADES

The AMSR-E data began routine addition during the Fall Atlantic hurricane season (Sept., Isabel). A full suite of TC products (89 GHz, 36 GHz, color 89 GHz, color 36 GHz and polarization corrected temperature (PCT) are now created for all active TCs.

The graphical user interface (GUI) has been modified to handle the AMSR-E data and the other passive microwave sensors that will shortly follow. Instead of labeling each product across the rows with alphanumerical headings, buttons indicate if that product is available for each sensor. The buttons are colored according to their timeliness (green < 6 hours, yellow 6-12 hours, red > 12 hours old). This simple rendition helps answer the #1 user request on identifying the most recent data at a glance.

In addition, we have added a "pass_mosaic" function that displays the most recent 24 hours worth of "good" microwave products for any active tropical cyclone. One hyperlink click uses the calculated "closest point of approach" to determine if the overpass adequately sampled the storm environment during the last 24-hours. Users typically select this option upon entering the web page since it quickly determines if valuable new data should be interrogated.

Water vapor (WV) imagery has been added to the standard visible and IR imagery to complete the geostationary product list. The IR and WV domains are large enough (~ 30 degrees on a side) to make mesoscale and synoptic scale evaluations feasible. The vis/IR/WV imagery is produced whenever the GEO imager samples any active storm. Multiple geostationary satellites are used if two sensors view a storm, thus the user should consider which sensor has the best resolution for a given TC's location.

Processing capabilities for the TC web page products has been substantially modified with the creation of a "Linux-cluster" consisting of high-end dual processors. A queuing system now selects the machine with the lightest load and accelerates product generation.

3. SUMMARY AND FUTURE POTENTIAL

The NRL-MRY tropical cyclone web page will evolve as new sensors enable enhanced capabilities. We expect to add two important passive microwave sensors for the upcoming 2004 summer tropical cyclone season. The SSMIS (Special Sensor Microwave Imager and Sounder), that combines the SSM/I with the T1/T2 sounder was launched in Oct 2003 and is undergoing calibration and validation. The SSMIS continues the SSM/I heritage in terms of frequencies and now provides collocated sounding channels, which will assist imager/sounder combined parameter retrievals.

The Navy has launched the Coriolis spacecraft containing the WindSat polarimetric radiometer. The frequencies are similar to the SSM/I and SSMIS, but without the 85 GHz channels. Thus, the 37 GHz data will be the prime data set, especially since the spatial resolution is 11-km, a factor of three increase versus SSM/I or SSMIS. Smaller eyewall-like features will be much better sampled via WindSat's 37 GHz data and will be a prelude to the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project's (NPP) Conical Microwave Imager Sounder (CMIS).

The increased number of passive microwave sensor platforms has addressed the temporal frequency issues that have plagued the tropical cyclone community. The upcoming Global Precipitation Mission (GPM) will expand on these data sets and upgrade temporal sampling as well.

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4. REFERENCES

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