P. 4.7 RECENT DEVELOPMENTS OF SATELLITE PRODUCTS ON THE FNMOC TC WEB PAGE

Yiping Wang*, Jeff Tesmer, Jeff Lerner and Jim Vermeulen
Fleet Numerical Meteorology and Oceanography Center
Monterey, CA 93943-5501

1. Introduction

The Fleet Numerical Meteorology and Oceanography Center (FNMOC) Tropical Cyclone (TC) Web Page has been running operationally on the Department of Defense (DOD) Non-Secure Internet Protocol Router Network (NIPRNET) and Secret Internet Protocol Router Network (SIPRNET) for more than three years. The site uses observational data from both geostationary and lower earth orbiting satellites to provide the Navy and the rest of the military community a centralized real-time source of data pertaining to tropical cyclones. It plays a critical and efficient role in minimizing the threat and impacts of tropical cyclones to military operations and civilian interests around the world.

Continuous development of new satellite products has been ongoing since its inception. New functions and features are being added to FNMOC TC Web Page to meet users' needs and satisfy emerging Navy Meteorology and Oceanography (METOC) Portal requirements. The latest advancements include the capability of supporting Navy ships with local coverage of geostationary and microwave data, an easier user interface made by a request from the Joint Typhoon Warning Center (JTWC), and an increase in our processing capability that improves product timeliness. New satellite products added to the TC Web Page are from the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager/Sounder (SSMI/S), Coriolis onboard the WindSat satellite, Meteosat Second Generation (MSG) or Meteosat-8, Multi-functional Transport Satellite-1 Replacement (MTSAT-1R), and NOAA-18. Comparisons of new products from each satellite and sensor will be discussed with emphasis on SSMI/S and Coriolis. The integration of satellite data processing systems with FNMOC's operational job monitoring, scheduling, communications, database and configuration management systems will also be presented in this paper.

* Corresponding author address: Yiping Wang, FNMOC, 7 Grace Hopper Ave., Monterey, CA, 93943; e-mail: wangy@fnmoc.navy.mil

2. Data Acquisition, Distribution and Comparisons

As a hub of the Navy's operational satellite data processing for passive microwave sensors, FNMOC is responsible for processing microwave imager data from SSMI/S and Coriolis. There are five SSMI/S sensors scheduled to be launched. The first SSMI/S sensor is onboard DMSP satellite F-16 that was launched on 18 October 2003. The SSMI/S sensor is a passive conically scanning microwave radiometer that combines and extends the current imaging and sounding capabilities of three previously separate DMSP microwave sensors: the SSM/T-1 temperature sounder, the SSMI/T-2 moisture sounder, and the SSM/I. The SSMI/S instrument measures microwave energy at 24 discrete frequencies from 19 to 183 GHz with a swath width of 1700 km. FNMOC's primary SSMI/S data feed is from Air Force Weather Agency (AFWA) via Defense Information Systems Agency Asynchronous Transfer Mode Services – Unclassified (DATMS-U) as SSMI/S Raw Satellite Data Records (RSDRs). As a backup, FNMOC also ingests real-time SSMI/S data and converts them to Simple format and RSDRs. The RSDRs are further processed to Temperature Data Records (TDRs), Sensor Data Records (SDRs) and Environment Data Records (EDRs).

The SSMI/S SDRs and EDRs are distributed to the TC Web data processing system. The system initiates an orbit search and extracts sectors that cover current active storms and Investigation areas. The

whole data process is under control by FNMOC's operational job monitoring and scheduling system (Wang et. al 2002)[1]. To improve storm structure analysis, a total of 11 SSMI/S products are generated and shown on the FNMOC TC Web Page. Figure 1 is one example of an image generated using the horizontally-polarized 91 GHz channel. It shows Hurricane Katrina as it passed near New Orleans, Louisiana as a Category 4 storm. A clearly defined eye is indicated with large rain bands extending from the eye wall to the north that brought heavy rains over the Mississippi area. The wider orbital swath of the SSMI/S increases the global coverage of surface microwave products. This provides forecasters with more overpasses containing relevant information over tropical regions. Combined with the current existing three SSM/I satellites, the temporal and spatial coverage of tropical systems is greatly enhanced.

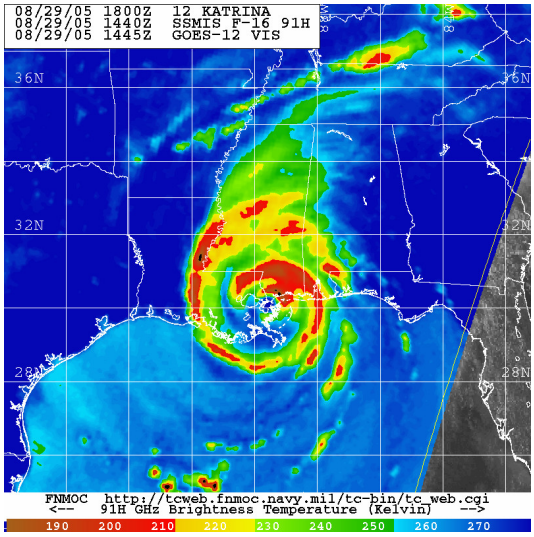

Figure 1. SSMI/S 91GHz horizontal polarization image of Hurricane Katrina as it passed over Louisiana.

Coriolis is a polarimetric microwave radiometer developed by the U. S. Navy and the National Polar-orbiting Operational Environment Satellite System (NPOESS) Integrated Program Office (IPO) to test the feasibility of using a passive microwave instrument for measuring ocean surface wind speed and direction. Coriolis orbits the Earth at an altitude of 830 km in a sun-synchronous orbit that overpasses a point on the Earth's surface roughly twice per day. At this altitude, Coriolis looks at an area 1025 km wide. The Coriolis sensor has five frequencies at 6.8 10.7, 18.7 23.8 and 37.0 GHz. The two lower frequencies, 6.8 and 10.7 GHz, are used to aid in the calculation of sea surface temperature, wind, and rain rate. Wind vectors are also calculated from the 10.7, 18.7 and 37.0 GHz channels. The primary objective of Coriolis is to provide risk reduction for microwave instruments on NPOESS. DOD considers wind speed and direction a high priority since this information affects a wide variety of naval operations including naval deployments and aircraft operations. FNMOC receives Coriolis data in two ways: one is through Domestic Satellite (DOMSAT) from Fairbanks, Alaska and the other route is via optical fiber from Svalberg, Norway. The FNMOC TC Web Page currently hosts four products from the 37 GHz channel including horizontal polarization, vertical polarization, color composite and polarization correction temperature. The wind vectors from Coriolis are also available on the TC Web Page. Figure 2 is one example of the 37 GHz horizontal polarization products that provides information about the lower structure of Hurricane Rita with better resolution than SSM/I.

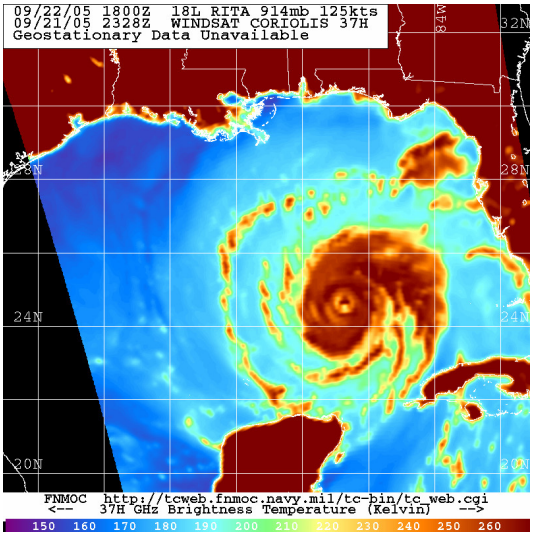

Figure 2. An image of hurricane Rita when it was a category 4 storm in the Gulf of Mexico using data from the 37GHz horizontal channel.

Another new data set that will be added to TC Web is from MTSAT-1R, the

Japanese Meteorological Agency's (JMA) newly operational geostationary satellite. It replaces GOES-9 that NOAA has been operating over the western Pacific since the failure of JMA's GM-5 satellite. GOES-9 is scheduled to be decommissioned at the end of October 2005. The MTSAT-1R data FNMOC receives from AFWA contains Visible (VIS), Infrared (IR) 1, IR2, and water vapor channels with hourly full disk and 30 minute northern and southern hemisphere regional coverage. The TC Web page only processes visible and infrared channel data currently.

3. New Features and METOC Portal

A. U.S. Navy ship support

FNMOC expanded the capability of the TC Web Page in July 2005 when it provided round-the-clock satellite coverage for individual U. S. Navy ships. This effort was initiated after the USS Kitty Hawk SMQ-11 satellite receiver went down. To ensure that the system was successful, additional processors and improved processing speed were added and this reduced the latency on both SIPRNET and NIPRNET TC Web Pages. With this ship capability, the TC Web Page provided support for Joint Task Force Katrina by starting an area devoted to 24/7 satellite coverage over the affected region.

To meet other customer needs, new enhancements were applied to the TC Web Page. For example, FNMOC added product color-coding to indicate the age of imagery, expanded the Closest Point of Approach (CPA) table to include +/- 24 hour satellite overpasses, and posted the current CPA to the TC Web Page. FNMOC also improved the automated storm starting, renaming, renumbering and deleting system to make sure primary customers such as JTWC were able to monitor dissipating Tropical Storms during peak web server usage periods.

B. METOC Portal

Task Force Web (TFWeb) is the Navy's ongoing groundbreaking information technology initiative. TFWeb is leading the Navy to a Service Oriented Environment (SOE) through a standard enterprise Navy Portal. FNMOC's TC Web Page is being integrated into the METOC component of the Navy Portal. To meet Navy METOC Portal standards, the TC Web Page interface will have to be redesigned by removing the frame structure, adding drop-down product menus, and removing hyperlinks. The implementation of the TC Web Page under the METOC Portal will be completed in two steps. Step 1 is reference integration. A Cascading Style Sheet (CSS) will be employed at this step. A protocol at the portal level will be developed to send the CSS parameters and user requests to the TC Web Page. At the other end, a TC Web Page server interface will also be constructed to receive these parameters and send the products back to the METOC Portal. Step 2 will be a content integration. In addition to e-mail driven messages in the current TC Web, a web server driven method might be added where forecasters or ships can set up areas themselves. This new feature requires the development of a User Facing Service (UFS) and the implementation of a Satellite Data Oriented Service (SatDOS) database.

4. Summary

The FNMOC TC Web Page is providing reliable 24/7 tropical cyclone coverage for forecasters, military forces, and research communities who want a one-stop shopping place for microwave and geostationary imagery. It displays a wide range of satellite products that cover current active tropical storms using six passive microwave sensors: SSM/I, TRMM, AMSU, AMSR-E, SSMI/S, and Coriolis, one active microwave SeaWinds scatterometer onboard the QuikScat spacecraft, and five geostationary satellites: GOES-10, GOES-12, Meteosat-5, Meteosat-7 and MTSAT-1R. The new satellite products recently added to the TC Web Page offer tropical cyclone satellite analysts more capability to track tropical cyclone positions and their structure. More new geostationary satellite data and low-earth orbit satellite data products (e.g., Meteosat-8, NOAA-18, METOP, and AMSR-E EDRs) will be developed in the near future. The transition of NIPRNET and SIPRNET TC Web pages to the new FNMOC ATOS2 Linux cluster system

utilizing the Navy Web Portal design will provide customers a more user-friendly, concise, and accessible TC Web Page in the future.

To view current active and past tropical storms, visit the FNMOC TC Web Page at http://tcweb.fnmoc.navy.mil/tc-bin/tc_home.cgi. Send any suggestions and questions to fnmoc.satteam@fnmoc.navy.mil.

5. Reference

Wang, Y., J. Tesmer, C. Skupniewicz, J. Vermeulen, J. Conelius, and J. Haferman, 2002: Operational Implementation of the NRL Tropical Cyclone Web Page at FNMOC. 18th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, J317-319, 13-17 January 2002, Orlando, Florida.