14A.1 A MULTI-PLATFORM VIEW OF HURRICANE ERIN

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1. INTRODUCTION

Understanding hurricane inner core asymmetries seems critical to accurately forecasting intensification. Polygonal eyewalls and intense low-level swirls in the eyes of hurricanes have been documented (Fletcher et al, 1961; Lewis and Hawkins, 1982; Marks and Black, 1990), experimentally generated (Montgomery and Vladimirov, 2002), and modeled (Kossin and Schubert, 2001; Schubert et al, 1999), yet little skill exists in operationally predicting when these features will form. Barotropic breakdown of the eyewall into several pockets of concentrated convection (mesovortices) can cause rapid pressure falls which in turn lead to a rapid increase in sustained winds in the eyewall.

Hurricane Erin was not only the first hurricane in the Atlantic during 2001, but also the first major (winds >48 m s^{-1}) hurricane and the third strongest storm of the entire season. Between 9 September at 0000 UTC and 10 September at 0000 UTC, maximum sustained winds increased from 34 m s^{-1} to 52 m s^{-1}, corresponding to a pressure fall from 992 hPa to 969 hPa (nearly 1 hPa hr^{-1} drop over 24 hours).

In that same 24-hour period, Hurricane Erin was observed by (at least) six weather satellites, providing spatial resolution as fine as 250 m and temporal resolution as fine as 15 min.

2. INTENSIFICATION

Erin followed a fairly classic track, starting in the far eastern Atlantic basin as Tropical Depression 6 and tracking WNW. Just east of the Greater Antilles, she turned N and was temporarily hindered by strong vertical wind shear. Two days later, the shear subsided and the minimal Tropical Storm was able to get better organized. At about 35N 65W, the storm recurved and headed NE toward Newfoundland. However, as is sometimes the case for these types of storms (Evans and McKinley, 1998), in the 24 hours prior to recurvature, Erin achieved peak strength of 52 m s^{-1} (968 hPa) and in the process, the inner core underwent some fascinating structural changes.

Between 1000-1500 UTC on 9 September, the eyewall took on a distinctly polygonal shape (square in this case). By 2100 UTC, the eyewall was once again nearly circular and the central pressure fell 14 hPa in the preceding 12 hours. Although far from conclusive, this hints that perhaps there are cases when rapid intensification can be anticipated at least six hours in advance.

3. OBSERVATIONS

The suite of instruments used to collect data over Hurricane Erin utilizes a wide range of frequencies and resolutions. While some are better suited for studying the storm environment, others are well-designed for peering into the inner core.

The GOES-8 (Geosynchronous Operational Environmental Satellite) Imager has five channels, including visible, infrared, and water vapor. The visible channel is most useful for studying the inner core because of its 1 km horizontal resolution and 15 min temporal resolution (although 1 min intervals are possible, that type of data was not collected during Erin's intensification).

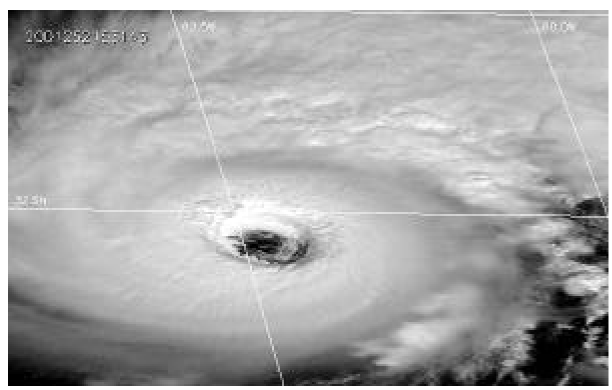

Figure 1 GOES-8 visible image of Hurricane Erin on 9 September at 1531 UTC.

NOAA-15 and NOAA-16 are polar-orbiting satellites that both house the AMSU-B instrument (Advanced Microwave Sounding Unit). Using a microwave retrieval method described in DeMaria et al (2001), it is possible to obtain azimuthally-averaged gradient wind speeds as well as the magnitude and location of the warm core aloft. However, this instrument is not capable of adequately resolving the eye and eyewall.

The MODIS (MODerate-resolution Imaging Spectroradiometer) instrument onboard NASA's Terra spacecraft boasts a visible channel with 250 m resolution. Although the spatial resolution is greater than that of GOES-8, Terra is polar-orbiting, so it only "flies" over a given area perhaps once per day.

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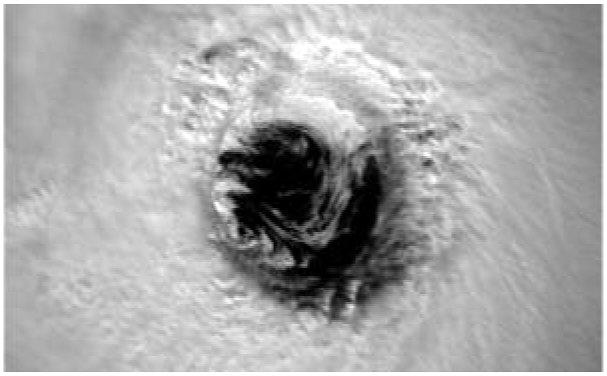

Figure 2. MODIS visible image of Hurricane Erin on 9 September at 1527 UTC. This image is taken shortly after the polygonal eyewall phase and just prior to an intensification phase.

Another satellite with several useful instruments onboard is TRMM (Tropical Rainfall Measuring Mission), also operated by NASA. Of particular interest here is the Precipitation Radar (PR). The PR senses at 13.8 GHz and has a ground resolution of 4.3 km. It is capable of "looking" through the icy cloud tops and into the heavily-precipitating inner core, unveiling the shape and intensity of the eyewall.

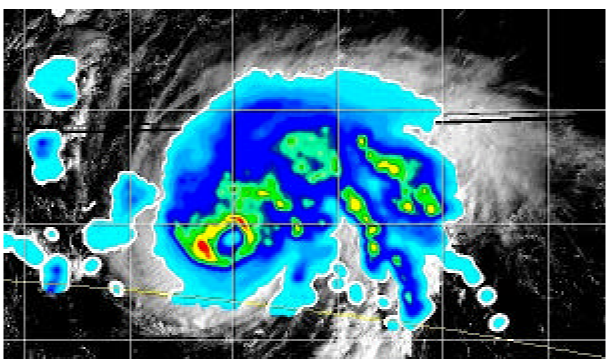

Figure 3. TRMM Precipitation Radar data overlaid on GOES-8 visible image on 9 September at 1326 UTC. Note the square eyewall in the "reflectivity" pattern. Image courtesy of NRLMRY.

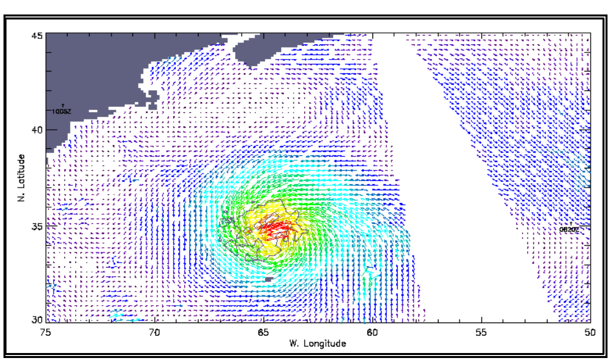

Figure 4. QuikSCAT SeaWinds data plotted over Hurricane Erin on 10 September at 1002 UTC. Peak measured winds are near 30 m s^{-1}.

The last instrument to be described here is SeaWinds on NASA's QuikSCAT satellite. It is a microwave scatterometer, sensing at 13.4 GHz, and has 25 km resolution. Since it is in a sun-synchronous orbit (98.6° inclination), it views the same place on Earth twice per day, although thin swath gaps can prevent the *exact* same location to be covered twice daily. SeaWinds is an active microwave sensor, so it not only retrieves the wind speed, but also the direction. There are limits to the accuracy of the measurements, especially in heavily-precipitating regions.

4. DISCUSSION AND CONCLUSIONS

An impressive array of satellites armed with instruments viewing at a wide range of frequencies provides us with a detailed view of the intensification of Hurricane Erin on 9-10 September 2001. Three NOAA satellites (NOAA-15, NOAA-16, and GOES-8) along with three NASA satellites (TRMM, QuikSCAT, and Terra) provided over 100 observations of the storm in one day alone.

In this case, a nearly symmetric eyewall had broken down into a ring of four mesovortices, leading to a polygonal eyewall. Just hours later, in a process likely caused by vorticity redistribution, the eyewall had re-symmetrized and a 15% jump in intensity resulted.

5. ACKNOWLEDGEMENTS

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