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BEST TRACK DETERMINATION AT NHC

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1. INTRODUCTION

The National Hurricane Center (NHC) tracks all tropical cyclones in the Atlantic and eastern Pacific basins. For each cyclone, a report is prepared which includes the "best track", a subjectively-smoothed representation of the tropical cyclone's location and intensity at 6-h interval over its lifetime. The life cycle of the cyclone is defined to include the tropical (or subtropical) depression stage, but does not include the extratropical stage. These best track positions and intensities (maximum1-min sustained surface wind speed and minimum sea-level pressure) are based on a post-storm assessment of all available data and may differ from values contained in real-time storm advisories. In general, they will not reflect the erratic motion implied by connecting individual center fix positions. The best track is the official U.S. National Weather Service historical record of the tropical cyclone. It is used as the basis to verify all NHC forecasts as well as all numerical models.

2. DATA SOURCES

Surface observations in a tropical cyclone over the ocean are rarely available. In fact, one of the purposes of issuing advisories and forecasts is to prevent ships from getting close to a tropical cyclone. There are a number of data buoys stationed near the U.S. coastline and these provide very useful data when a tropical cyclone is near. Several drifting buoys have been deployed in the Atlantic Ocean to the east of the Lesser Antilles in recent years. When a tropical cyclone is well inland, conventional surface reports are a primary data source.

For storms east of 55W longitude, or those not threatening land, the primary (and often sole) source of information is Geostationary Operational Environmental Satellite and polar-orbiting weather satellite imagery, interpreted using the Dvorak (1984) technique. For systems posing a threat to land, in situ observations are also generally available from aircraft reconnaissance flights conducted by the 53rd Weather Reconnaissance Squadron ("Hurricane Hunters") of the Air Force Reserve Command and by the National Oceanic and Atmospheric Administration (NOAA) Aircraft Operations Center. During reconnaissance flights, minimum sea-level pressures are either measured by dropsondes released at the circulation center or extrapolated hydrostatically from flight-level. Surface or near-surface winds in the eyewall or maximum wind band are often measured directly using Global Positioning System (GPS) dropwindsondes (Hock and Franklin 1999), but more frequently are estimated from flight-level winds using empirical relationships derived from a three-year sample of GPS dropwindsonde data (Franklin et al. 2000). When available, satellite and reconnaissance data are supplemented by conventional land-based surface and upper-air observations, ship and buoy reports, and weather radars. In key forecast situations, the vertical kinematic and thermodynamic structure of the storm environment is obtained from dropsondes released during operational "synoptic surveillance" flights of NOAA's Gulfstream-IV jet aircraft.

Several satellite-based remote sensors are playing an increasingly important part in the analysis of tropical weather systems. Foremost of these is multi-channel passive microwave imagery, which over the past decade has provided radar-like depictions of systems' convective structure (Hawkins et al. 2001), and is of great help in assessing system location and organization. Available for a full season for the first time in 2000, the SeaWinds scatterometer onboard the QuikSCAT satellite (Tsai et al. 2000) provides surface winds over large oceanic swaths. While the QuikSCAT does not have the horizontal resolution to determine a cyclone's maximum winds, it can be used to estimate the extent of tropical storm force winds, and is often helpful in determining whether an incipient tropical cyclone has acquired a closed surface circulation. Finally, information on the thermal structure of cyclone cores is provided by the Advanced Microwave Sounder Unit (Velden and Brueske 1999).

Although reconnaissance observations are considered to be more accurate than satellite estimates, a recent study by Brown and Franklin (2002) indicates that nearly half of Dvorak satellite-based intensity fall within 7 kt of reconnaissance-based best track values, and only in 10% of the cases are differences of 20 kt or more.

3. METHODOLOGY

A starting point for determining the post-analysis at NHC is to the use the Automated Tropical Cyclone Forecast (ATCF) software or system to obtain a 'first guess" of the best track center positions and maximum wind speeds. All fix data are entered into an ATCF file. The ATCF system has a program which objectively determines best track positions and wind speeds. This objective best track is then examined and compared with the fixes to see if it is acceptable.

Thereafter, the norm is to adjust the track subjectively by giving more weight to a particular fix. For example, an aircraft fix is given much more weight than to a remote satellite fix. Surface wind observations

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are usually given more weight than satellite or aircraft. Night-time infrared satellite position estimates are considered to be not as reliable and should not be given as much weight as daylight satellite fixes.

Figure 1 is an example that includes all fixes and the best track during a portion of Michelle's track. Fig. 2 is a final best track wind speed graphic which is included in the post storm reports. Note in the figure that there are wind values measured by aircraft under the best track curve. Most of the time, these wind speeds correspond to observations from the weaker side of the tropical cyclone circulation or measured away from maximum wind band and do not represent the maximum intensity of the tropical cyclone.

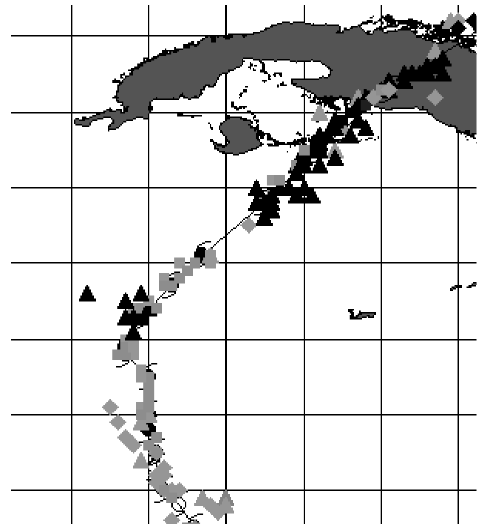

Fig.1. Best track and fixes from all available data sources for Hurricane Michelle, 2001.

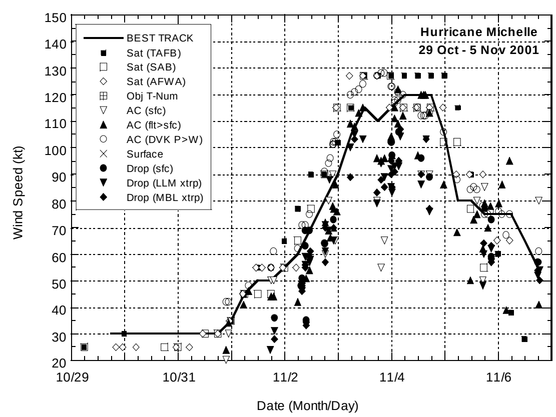

Fig. 2. Best track maximum sustained surface wind speed curve for Hurricane Michelle, 29 October - 5 November 2001, and the observations on which the best track curve is based. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include 10 m winds, as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding and from the sounding boundary layer mean.

4. REFERENCES

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