P1.43 Extension of ATL and WPAC best-track tropical cyclone record using gridded reanalyses

Robert E. Hart (rhart@fsu.edu)
Florida State University, Department of Earth, Ocean, and Atmospheric Science

1. INTRODUCTION

The global best-track datasets (e.g. Jarvinen et al. 1984; Chu et al. 2002) and the IBTrACS aggregation of it (Knapp et al. 2010) provide an ensemble archive of track, intensity, and structure of tropical cyclones (TCs) through primarily the tropical component of the TC lifecycle. Some agencies extend the best-track lifecycle through the dissipation stage, whereas some truncate the best-track when extratropical transition has begun or completed. This heterogeneity has led to an incomplete TC historical archive regarding the full TC lifecycle, with the post-tropical stage in particular poorly represented. It has also lead to difficulty in quantifying the post-tropical TC threat to Europe, northeast Asia, Alaska, and the northwestern United States given the often truncated best-track.

To alleviate these deficiencies, various newer higher resolution global reanalyses are utilized to approximately extend the track, intensity, and structural historical Atlantic best-track archive. The gridded reanalyses utilized to this end include ERAI (Dee et al. 2011), CFSR (Saha et al. 2010), and MERRA (Rienecker et al. 2010), with all reanalyses used when possible to produce an ensemble of historical extended tracks. The full track archive will be made available for community use. For brevity, only the CFSR is shown here.

Analyses of the extended dataset include: 1) quantification of the continuity (or lack thereof) in location, intensity, and structure at the transition point between best-track TC and gridded reanalysis TC; 2) quantification of the threat to higher latitude countries based upon these extended tracks, to complement the existing landfall threat at http://moe.met.fsu.edu/tcprob; 3) quantification of the variance among track, intensity.

2. DATA AND METHOD

The locations of all Atlantic and Western Pacific TCs at their best-track end-point were used as starting points for tracking those cyclones within modern gridded reanalyses. The tracking algorithm used largely follows Hart (2003), whereby a predicted location is estimated using prior 6hr motion and the subsequent 6-hr location (as determined by mean sea level pressure minimum [MSLP]) is permitted to be within a threshold distance of that predicted location (else the track was ended). This was repeated until either the distance threshold was no longer satisfied, or 70% of the 700mb maximum wind speed was less than 20kt in the region of the MSLP minimum.

The following analysis provides a quantification of the magnitude of discontinuity that exists at the splice point (between best-track and reanalysis) as well as some examples of notable extended tracks, and concludes with examples of landfall risk maps to higher latitude countries based upon the extended track dataset.

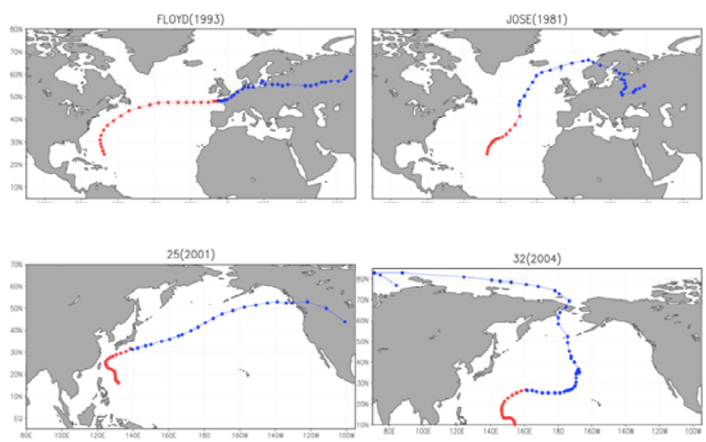

Figure 1: Some examples of the most lengthy track extensions possible using the algorithm when applied to the CFSR reanalysis dataset. The red portion of the track is the best-track dataset while the blue is the CFSR extension.

3. RESULTS

a. Track Extensions and Splice Discontinuity

Some examples of the more lengthy of track extensions are given in Figure 1. These are also four examples of relatively small discontinuity in location at the splice point. For each extended track, the location and subsequent intensity evolution is included (Table 1). The track files include the characteristics of the storm at the splice point for both datasets (best-track and reanalysis); thus, the splice point is the only time for which there are two sets of data in each track file.

The entire track extension database for the CFSR (1979-2010) is graphically displayed in Figure 2. As in Figure 1, the red subset of the tracks are the best-track and the blue are the reanalysis extension. In each case, the full red component of the record is plotted followed by the full blue component, to better illustrate the differences between the two basins. Finally, Figure 3 presents quantification of the discontinuity at the splice point in terms of intensity and location.

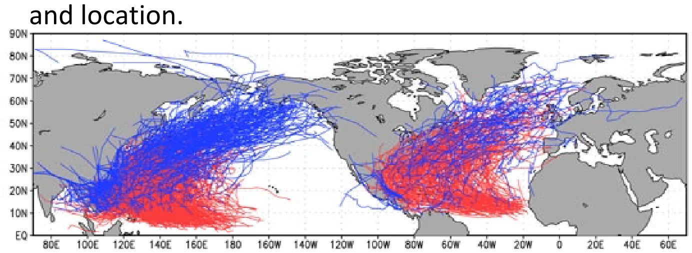

Figure 2: 1979-2010 CFSR extension dataset with coloring as in Fig 1

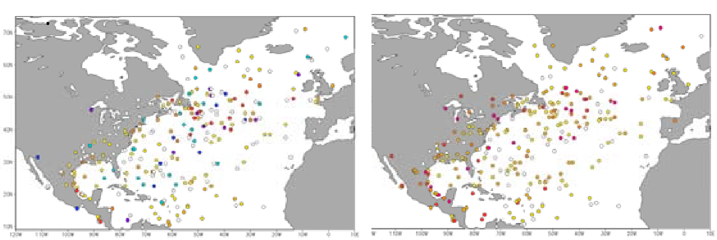

Figure 3: Measurement of splice discontinuity between Atlantic best-track database and CFSR estimate for left) intensity by MSLP and right) location by km. Yellow to red (cyan to blue) on the left figure indicates a CFSR intensity that is 2 to 8mb higher (lower) than the best-track estimate at the same time. On the right image, yellow to orange to red indicates a position difference at splice that is 50 to 200 to 400km different between the best-track and CFSR location at splice. Schenkel and Hart (2012) provides an exhaustive comparison of these differences for the entire best-track lifecycle.

b. Landfall Threat Maps using Extended Tracks

The extended track dataset permits the calculation of landfall risk to higher latitude regions. Such maps were generally not reliable prior to this extended dataset, as the policy on best-track track cessation varied from agency to agency and sometimes from year to year. Fig. 4 illustrates examples of landfall risk to the entire north Atlantic basin (including Europe) utilizing the extended track datasets in a simplified version of Brettschneider (2008).

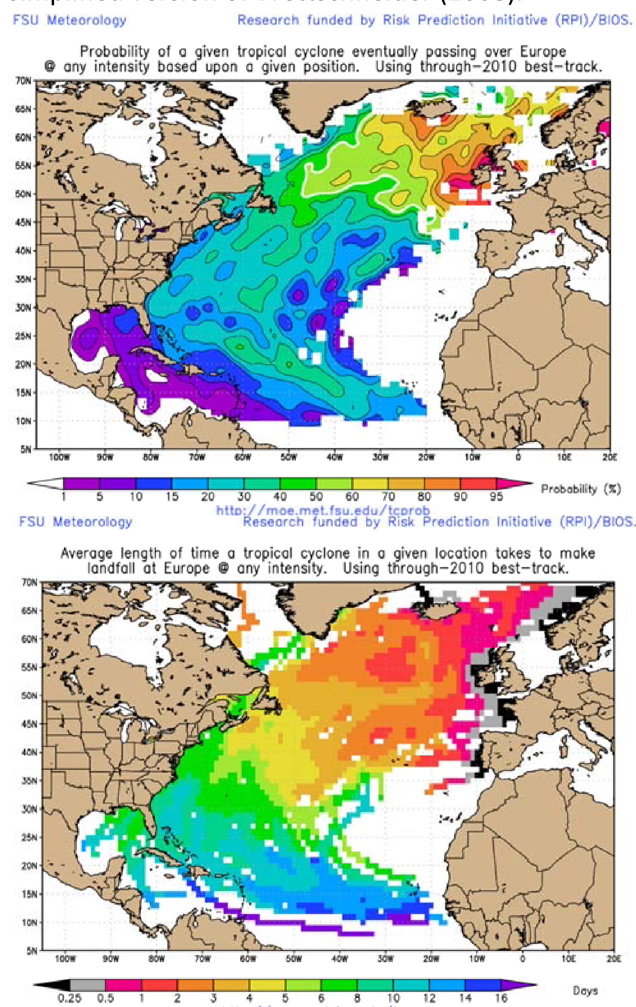

Figure 4: Using the extended tracks shown in Figure 2, estimates of landfall risk from post-tropical cyclones to higher latitude regions can be produced. The top figure quantifies the probability of a TC (either as a TC or post-tropical) eventually making landfall at any intensity in Europe for a given starting position. The bottom figure provides a similar estimate using the same database, expect for quantifying the average length of time until that landfall. Real-time maps of climatological threat estimates based on current TC locations are provided at http://moe.met.fsu.edu/tcprob.

Variable	Level
Mean Sea Level Pressure	N/A
Latitude and Longitude	Surface
Maximum Wind Speed	10 meters
Maximum Wind Speed	925 mb
Maximum Wind Speed	850 mb
Maximum Wind Speed	700 mb

Table 1: Reanalysis variables recorded in the extended best-track dataset for the splice point onward.

4. DISCUSSION

The differing percentage of blue vs. red in Figure 2 illustrates well the earlier truncation of cyclone tracks in the WPAC. Whether this difference is due to structural differences (including the timing of extratropical transition; Evans and Hart 2003) or procedural differences (e.g. Jones et al. 2003) is unclear. Regardless, the extended track dataset now permits a more homogeneous comparison between the basins for the full track lifecycle among TCs. Comparisons among intensity lifecycles, however, should be done with caution given the splice intensity discontinuity shown in Figure 3. A replication of this work to other gridded datasets, including the ERAI and the MERRA, is ongoing. When completed for all basins and datasets, these extended datasets will be made available at a public URL.

5. ACKNOWLEDGMENTS

This work was sponsored in part by the Risk Prediction Initiative (RPI) of the Bermuda Institute for Oceanic Sciences (BIOS), as well as in part by National Science Foundation Grant #ATM-0848742. The author is grateful to all agencies for making their datasets readily available for their use here. All graphics produced here were done using the GrADS software package, provided by COLA/IGES.

6. REFERENCES

Brettschneider, B., 2008: Climatological Hurricane Landfall Probability for the United States. *J. Applied Meteor. and Climatology.* **47**, 704-716.

Chu, J., C. Sampson, A. Levine, and E. Fukada, 2002: The Joint Typhoon Warning Center tropical cyclone Best-Tracks, Naval Research Laboratory Reference NRL/MR/7540-02-16, 22 pp.

Dee, D., and Coauthors, 2011: The ERA-Interim reanalysis: Configuration and performance of the data assimilation system. *Quart. J. Roy. Meteor. Soc.*, **137**, 553–597.

Evans, J.L. and R. Hart, 2003: Objective indicators of the extratropical transition lifecycle of Atlantic tropical cyclones. *Mon. Wea. Rev.*, **131**, 909-925.

Hart, R., 2003: A cyclone phase space derived from thermal wind and thermal asymmetry. *Mon. Wea. Rev.*, **131**, 585-616.

Jarvinen, B., C. Neumann, and M. Davis, 1984: Tropical cyclone data tape for the North Atlantic basin, 1886–1983: Contents, limitations and uses. NOAA Tech. Memo. NWS NHC 22, 24 pp.

Jones, S. C. and Coauthors, 2003: The extratropical transition of tropical cyclones: Forecast challenges, current understanding, and future directions. *Wea. Forecasting*, **18**, 1052-1092.

Knapp, K. R., M. C. Kruk, D. H. Levinson, H. J. Diamond, and C. J. Neumann, 2010: The International Best Track Archive for Climate Stewardship (IBTrACS): Unifying tropical cyclone best track data. *Bull. Amer. Meteor. Soc.*, **91**, 363-376.

Rienecker, M., and Coauthors, 2011: MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications. *J. Climate*, **24**, 3624–3648.

Saha, S., and Coauthors, 2010: The NCEP climate forecast system reanalysis. *Bull. Amer. Meteor. Soc.*, **91**, 1015–1057.

Schenkel, B. and R. E. Hart, 2012: An examination of tropical cyclone position and intensity differences within reanalysis datasets. *J. Climate*, MERRA Special Collection, **25**, 3453-3475.