P1.16 HURRICANE REANALYSIS USING HURRICANE SATELLITE (HURSAT) DATA

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1. INTRODUCTION

Given the recent hypotheses relating long-term trends in tropical cyclone (TC) activity and global warming, there is a growing need for consistent reanalyses of the historical TC data. The hurricane satellite (HURSAT) data set provides a basis for consistent analysis.

The initial version of HURSAT-B1 data provided 3-hourly observations centered on global tropical cyclones with ~8km spatial resolution (Knapp and Kossin, 2007). This data was used to perform a re-analysis of tropical cyclone intensities during 1983-2005 (Kossin et al., 2007). However, more information on tropical storms is available from other satellite instruments. In particular, the Advanced Very High Resolution Radiometer (AVHRR) provides finer spatial resolution and the Special Sensing Microwave Imager (SSMI) provides information on atmospheric structure below the cloud top. The characteristics of each data set are summarized in Table 1.

All HURSAT data are provided in NetCDF format. This allows users with experience in nearly any programming language to work with the data. The data are stored according to the Climate and Forecasting (CF) netCDF convention, which means that many software (e.g., IDV and GrADS) can read and process the data directly. Additionally, all HURSAT imagery is also provided via Keyhole Markup Language (KML) for viewing with Google Earth[1].

2.REVIEW

Kossin et al (2007) (hereafter, K07) used azimuthally averaged brightness temperatures (AAT_b) to objectively estimate cyclone intensity. The first 6 principal components of the AAT_b along with cyclone age, latitude and local solar time were used as predictors. Using multiple linear regression, K07 correlated the predictors with the logarithm of the cyclone maximum sustained winds (MSW). (The logarithm of MSW is more normally distributed than the MSW). The result was an explained variance of 64% and an RMS of 16.7 knots (8.6 m/s) when compared to North Atlantic best track intensities that were within 12 hours of aircraft reconnaissance.

While the RMS is large compared to the Automated Dvorak Technique (ADT) (Velden et al., 1998), it is without temporal bias since the same algorithm can be applied to the HURSAT period of record. Additionally, the ADT requires coincident microwave imagery to attain intensity estimates with low RMS and thus cannot be applied to the HURSAT period of record (C. Velden, personal communication, 2010).

The following is an expansion of K07 to current. The analysis of K07 is replicated here as a baseline for further improvements.

3. UPDATING KOSSIN ET AL (2007)

The K07 analysis is updated using the latest HURSAT data, which extends the period of record through 2008. The results are provided in Figure 1. Global values of Power Dissipation Index [PDI] (Emanuel, 2005) are accumulated annually from IBTrACS (Knapp et al., 2010) [red lines] and from the satellite-derived intensity [blue lines]. The PDI values are also accumulated by basin: the North Atlantic (NA), Eastern North Pacific (EP), Western north Pacific (WP), North Indian (NI), Southern Indian (SI) and Southern Pacific (SP) oceans. Following K07, the PDI values are normalized to facilitate intercomparing the best track and satellite-derived PDI values. The annual values are smoothed using a binomial filter (1-4-6-4-1) (thick solid lines). Additionally, the regression line through the period of record is provided in thin lines, which are solid if the trends are statistically significant.

In short, the results are consistent with the work of K07. For the globe, neither the best track nor satellite-derived linear trends are significant.

The results are also similar to K07 for the individual basins. The NA and EP are the only basins with significant trends: increasing and decreasing (respectively).

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[1] http://www.ncdc.noaa.gov/oa/rsad/hursat/index.php?name=kml

5. SUMMARY

The analysis of Kossin et al (2007) is updated here. Results are consistent with the previous work. Efforts are now underway to decrease the RMS of the intensity derivation as well as to compare the performance in the West Pacific by matching intensities with aircraft reconnaissance in that basin during the 1980s.

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Table 1 - Summary of various HURSAT products.

Product	**HURSAT-B1**	**HURSAT-AVHRR**	**HURSAT-MW**	**GriSat**
Temporal span	1978-present	1978-present	1988-present	1979-present
Spatial span	Storm-centric: 10.5° from center for all global TCs	Storm-centric: 10.5° from storm for all global TCs	Storm-centric: 10.5° from center for all global TCs	Global
Temporal resolution	3 hourly	Varying (6-12 hourly)	Varying (6-12 hourly)	3 hourly
Gridding resolution	8km	4km	8km[ii]	8km
Data source	ISCCP B1	AVHRR GAC	DMSP SSM/I	ISCCP B1
Channels available[iii]	IRWIN (11μm) IRWVP (6.7μm) VIS (0.65μm)	All AVHRR channels	All SSM/I channels	IRWIN (11μm) IRWVP (6.7μm) VIS (0.65μm)
Calibration	Clim.[iv] – IRWIN, ISCCP – IRWVP, VIS	Climate calibrated.	Operational calibration.	Clim. – IRWIN, ISCCP – IRWVP, VIS
Yearly Size (GB)	<6.5	40-60	4	200
Format	NetCDF	NetCDF	NetCDF	NetCDF
Current Version	4.0	Beta	Beta	Beta
Imagery	Movies[v]	BD Imagery	Imagery[vi]	Planned

[ii] While the original SSMI data have a coarse resolution (ranging from 25-70km), the SSM/I gridded data are remapped to a resolution identical to the B1 for ease of display and analysis. However, the original SSM/I swaths are provided for further quantitative analysis. The swath data have various footprint sizes and two native sampling resolutions (referred to as the A and B scans).

[iii] IRWIN = Infrared Window, IRWVP = Infrared Water Vapor and VIS = visible channels.

[iv] "Clim." and "climate" refers to a climate quality re-calibration. In the case of B1 data, a reanalysis of the ISCCP calibration using an independent instrument as a reference. For AVHRR, it relies on the work performed at NOAA/STAR. "ISCCP" refers to the absolute calibration provided by ISCCP.

[v] http://www.ncdc.noaa.gov/oa/rsad/hursat/movie.php

[vi] http://www.ncdc.noaa.gov/oa/rsad/hursat/index.php?name=mw-imagery

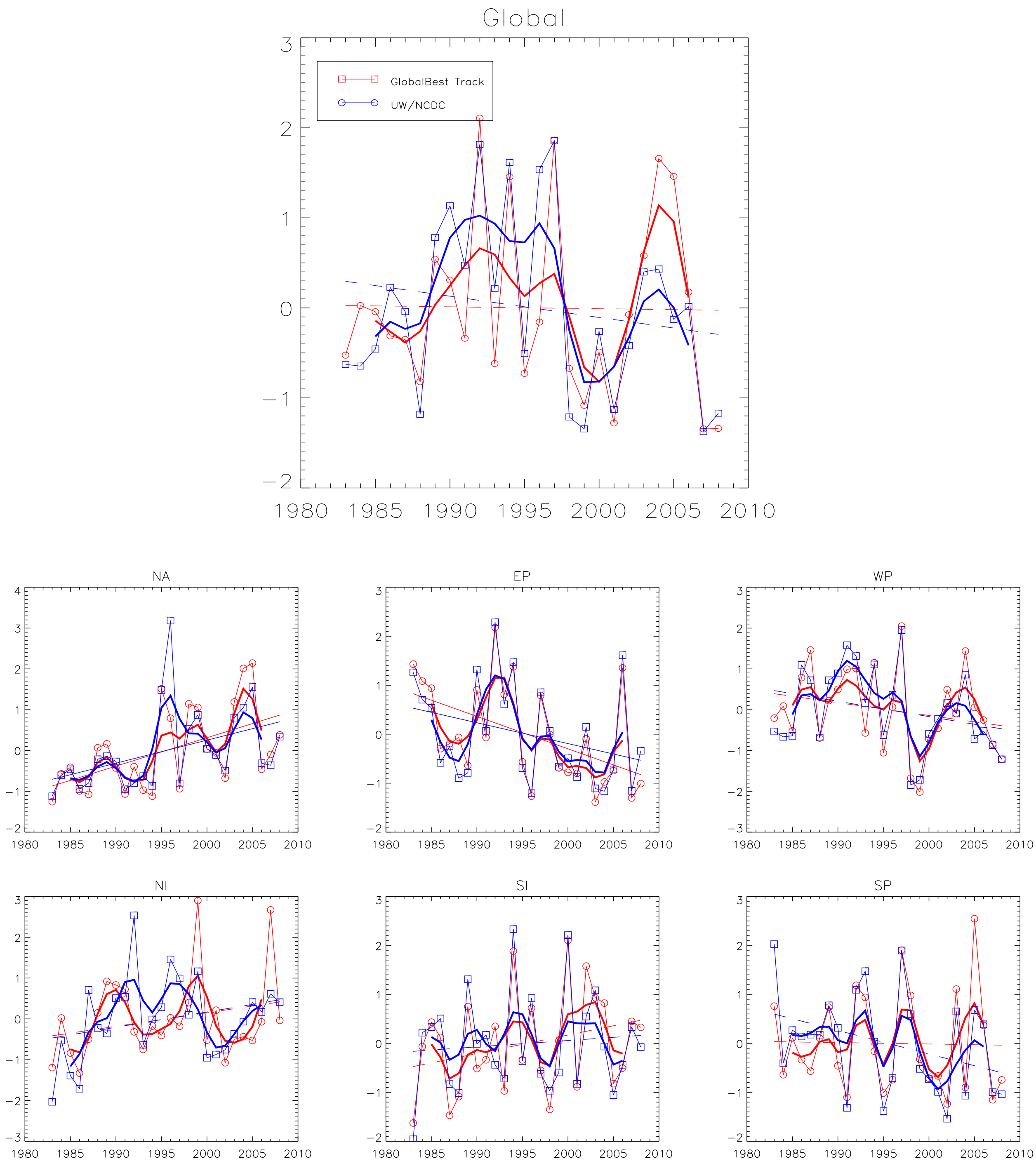

Figure 1 - Normalized PDI for Global (top) and by basin (bottom) for global best track data (red, from IBTrACS) and for the HURSAT reanalysis (blue, following the UW/NCDC approach). Thin lines are the annual PDI anomaly, thick lines are the binomial smoothing of the annual values (1-4-6-4-1) and straight lines are linear regressions (which are statistically significant when solid)