A101

Detection and Analysis of Tropical Cyclones Within the D4PDF Mega-Ensemble Projection

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Introduction

Tropical cyclones (TCs) play an important role in the climate system and are a major source of natural coastal hazards worldwide, such as those due to river flooding, storm surges, and extreme waves. TC-related hazards are sensitive to properties of the storm path and while climate models can provide data to accurately model these events, samples are inadequate for analysis of extreme events on climatological time scales. The climate dataset d4PDF (Database for Policy Decision Making for Future Climate Change) was created to overcome this low-occurrence frequency limitation and spans more than 17,000 years under present, +1.5 K, +2 K, and +4 K warming conditions, making it possible to directly estimate 100 year or longer return values.

Here, a new TC track dataset (Version 2) has been created for the d4PDF dataset. It is a follow up to Webb et al. (2019) and includes a sea surface temperature (SST) threshold parameter to overcome shortcomings of the first version (Version 1). The detection method also uses pressure difference and wind speed threshold parameters and is tuned to optimize annual TC count and cyclogenesis locations. Tuning of the updated method has been conducted using 30-year IBTrACS observation, JRA-55 reanalysis, and COBE SST data and *O*(6) tracks have been extracted for the different future warming conditions (+1.5 K, +2 K, and +4 K). We will present an overview of the detection method (including validation and performance), and analyze changes in the TC tracks (such as occurrence frequency and cyclogenesis location).

Methodology

In the first TC track dataset (Version 1), the detection method used two threshold parameters —pressure differences and wind speeds—and was tuned to optimize annual TC count and cyclogenesis locations; see Webb et al. (2019) for a full overview of the method. Since wind speeds tend to be higher nearer the subtropical ridges (between 30° and 35° north and south), the cyclogenesis domain was restricted to [S25°, N25°] to minimize the number of falsely detected TCs at higher poleward latitudes. This excluded many TCs, particularly in the North Atlantic where approximately half of the storms are formed outside this region during the 30-year period analyzed in IBTrACS.

To fix this deficiency, the cyclogenesis domain was extended to [S30°, N35°] and an SST threshold parameter was added to remove false positives at the higher poleward latitudes. COBE SST data was also used for tuning and was time-averaged (monthly) to match the available data within the d4PDF dataset. Based on previous studies and analysis of IBTrACS data, 27° was chosen as an appropriate minimum threshold limit for the maximum along-track monthly SST. In Figure 1, sample tuning results are shown for cyclogenesis location between the observational and reanalysis data. While studies on the relationship between SST and TC formation under future climate conditions may be limited, we would like to emphasize that we are using the TC track dataset to primarily analyze extreme TCs and are less focused on weaker TCs, whose detection may be sensitive to the threshold parameters chosen and results less robust.

Results and Discussion

A sample map of the extracted TC tracks for one d4PDF historic ensemble (60 years; HPB m001) is shown in Figure 2. While, the number of tracks detected in the North Atlantic is still deficient, the method has been improved overall, particularly in the Southern Hemisphere.

The Japan Meteorological Association classifies a typhoon as a TC with a 10-minute averaged wind speed greater than 64 kn. Similar with other studies, we find that the number of typhoon category storms decrease under the +4K warming condition (comparison of 190 ensembles; 11,400 years) but that the intensities increase (approximately 8 hPa decrease for 100-year return storms). In Figure 3, the relationship between SST is examined for extreme TCs (very strong and violent TCs as classified by JMA) are examined; interestingly, the median SST (along-track maximum of monthly means) associated for the detected TCs increases by approximately +3K between historic and +4K warming conditions.

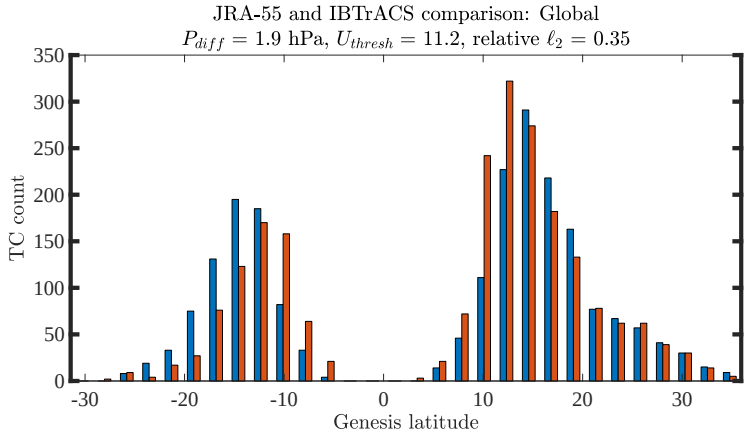

Figure 1. Histogram comparison of reanalysis (blue) and observational (red) genesis latitudes for tuned parameters.

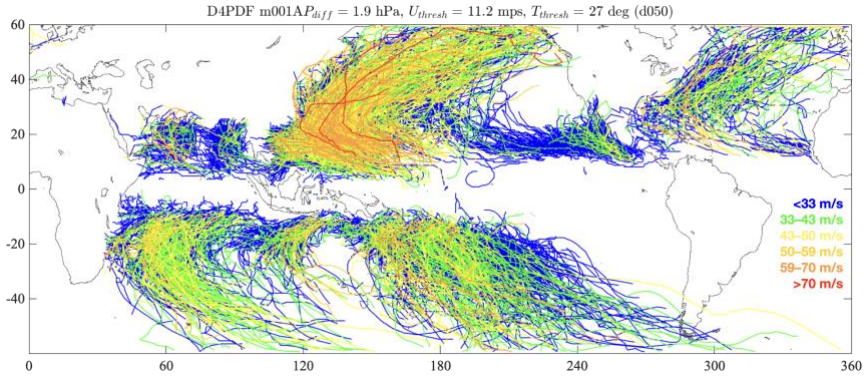

Figure 2. Sample map of detected tracks for one ensemble from the historic conditions.

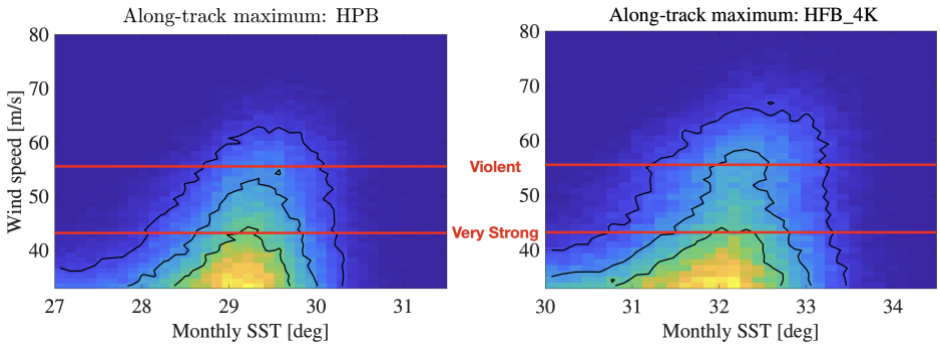

Figure 3. Comparison of SST and wind speed between (a) historic and (b) future +4K warming for extreme TCs.