Application of the NMME for the Intraseasonal Prediction of Tropical Cyclones over the Atlantic and North Pacific Basins

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1. Background

Tropical storm activity is modulated by the MJO and exhibits large sub-seasonal variations. This project was motivated by (a) success in forecasting seasonal hurricane activity with a dynamical–statistical model, (b) improved MJO prediction in climate models, and (c) the availability of NMME hindcast and forecast datasets.

Objective: To develop dynamical–statistical prediction systems for Atlantic and North Pacific basin *monthly mean* tropical storm activity and assess forecast skill.

2. Data and methodology

Data:

- NMME hindcasts (1982–2010) and real-time forecasts
- Best Track Data: Atlantic Hurricane Database, NE/NC Pacific Hurricane Database, RSMC Tokyo-Typhoon Best Track Data

Methodology:

- The forecast model is based on the statistical relationships between observed tropical storm activity and model predicted large-scale circulation anomalies and linear regressions.
- Predictors: vertical wind shear (VWS; $U_{200} - U_{850}$), sea level pressure (SLP), and sea surface temperature (SST).
- The forecast skill is cross-validated over the 1982–2010 period.

3. Results

3.1 Tropical cyclone climatology and variability

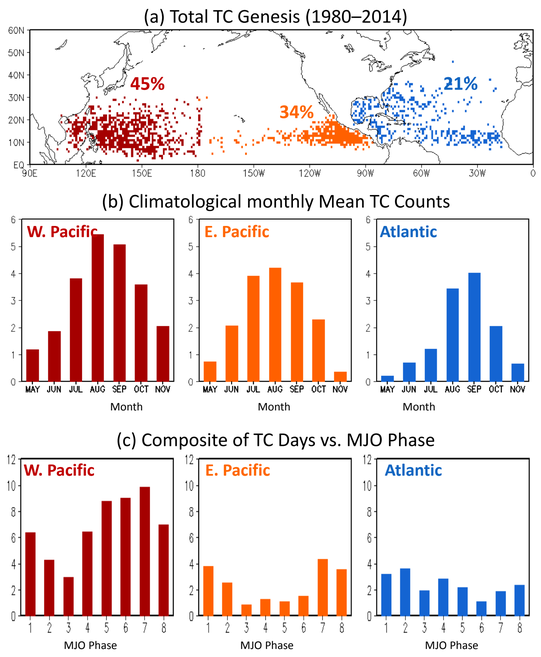

Fig. 1. (a) Total tropical cyclone (TC) genesis during 1980–2014 in the western Pacific (red), eastern Pacific (orange), and Atlantic (blue) basins, (b) seasonal distribution of long-term monthly mean TC counts, and (c) composite of weekly TC days associated with difference phases of the MJO.

Fig. 1

3.2 Relationship between monthly TC activity and large-scale circulation/SST

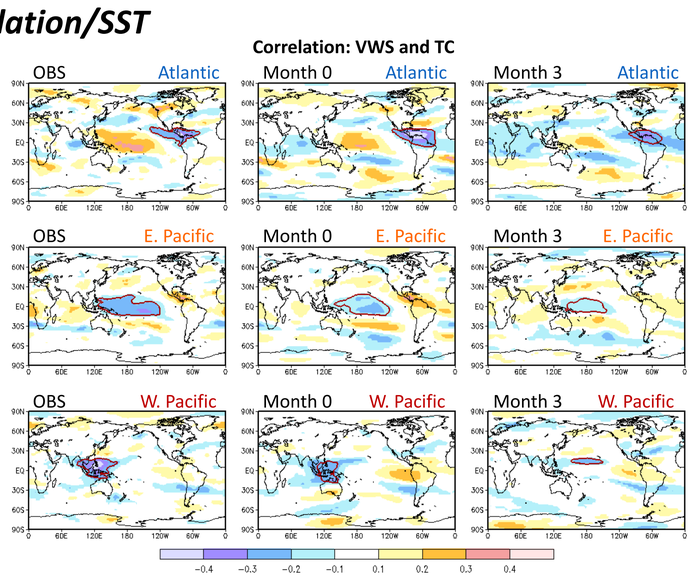

Fig. 2

Fig. 2. Correlation between observed monthly TC counts and VWS in observations (left), 0- (central) and 3-month (right) forecasts from CFSv2 hindcasts for the Atlantic (top), E. Pacific (middle), and W. Pacific (bottom), respectively, over May–November, 1982–2010.

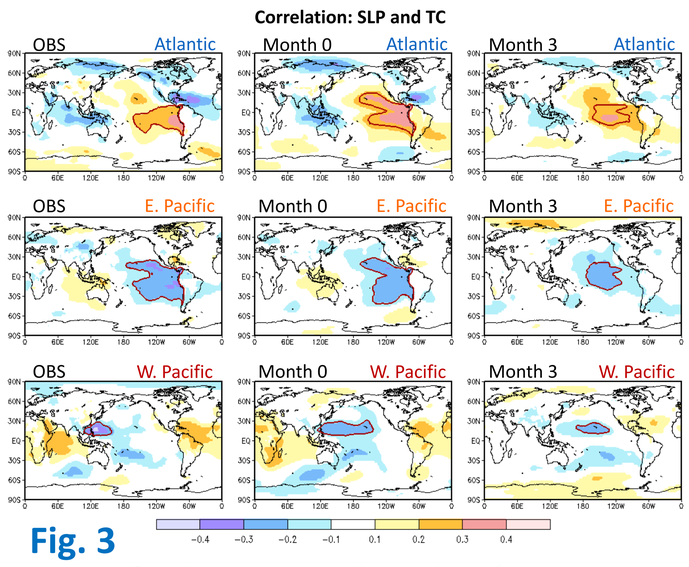

Fig. 3

Fig. 3. Same as Fig. 2, but for SLP.

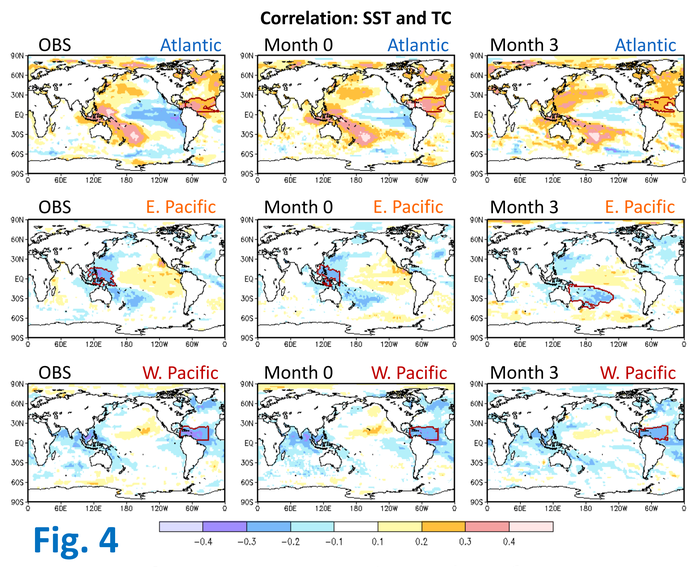

Fig. 4

Fig. 4. Same as Fig. 2, but for SST.

The regions with relatively high correlations (outlined in red) are selected for averaging vertical wind shear (VWS), sea level pressure (SLP) and sea surface temperature (SST) as a potential predictor. The regions used to average the three variables for the predictors are also the regions where CFSv2 has relatively high forecast skills for these fields (not shown).

3.3 Forecast skill for monthly TC activity

Fig. 5. Forecast skill for monthly TC activity using different predictors assessed based on cross-validations over the period of May to November, 1982–2010. The SST and VWS are selected as two predictors for the real-time forecasts for the 2017 hurricane season because of their high forecast skills for the monthly TCs in all three tropical ocean basins.

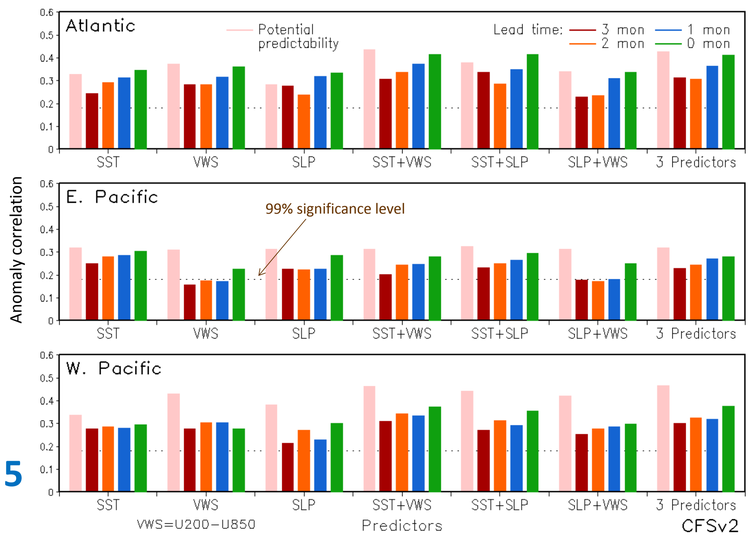

Fig. 5

3.4 NMME-based real-time forecast for the 2017 hurricane season

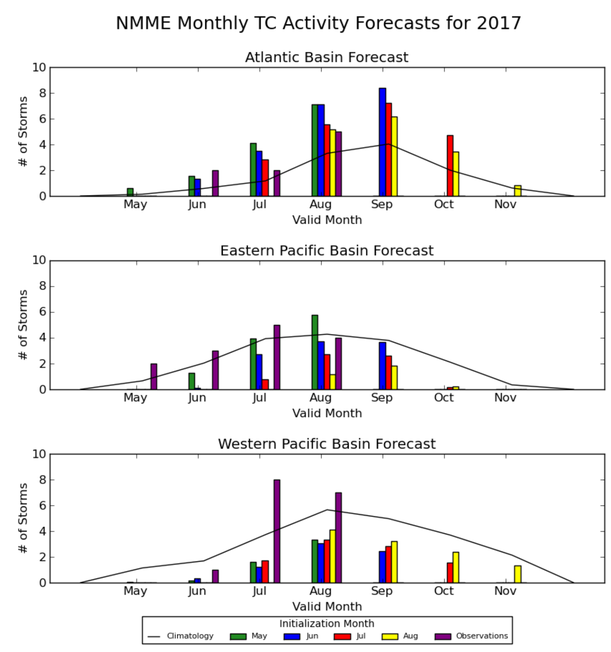

Fig. 6. Real-time forecasts of monthly TC counts (bars) at different leads for the 2017 hurricane season using VWS and SST as predictors, which are derived from the NMME seasonal forecasts, for the Atlantic (top), eastern Pacific (middle), and western Pacific (bottom) basins, respectively. Observed monthly numbers of TCs (purple bars) are also plotted for validation. Black curves are the observed climatology of monthly TCs.

Fig. 6

4. Summary and conclusions

- A statistical–dynamical model was developed for forecasting monthly TC activity over the North Atlantic and North Pacific basins using predictors derived from the NMME forecasts.
- Vertical wind shear, sea level pressure, and sea surface temperature from the NMME dynamical seasonal forecasts were identified as predictors.
- Cross-validations indicate certain forecast skills for monthly TC activity.
- The model is being tested for real-time forecasts for the 2017 hurricane season.