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A hybrid-model-based probabilistic forecast procedure of the seasonal number of tropical cyclones

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Tropical cyclones (TCs) are severe natural disasters that cause significant global loss of life and economic damage each year. This study aims to improve the operational forecasting of seasonal TC occurrences using a hybrid model that integrates a dynamical module (GloSea6) and a statistical module employing Poisson regression. The statistical module considers internal variability and external forcing, represented by El Niño-Southern Oscillation (ENSO) and global ocean warmth, respectively. ENSO is indicated by the Southern Oscillation Index (SOI), while global ocean warmth is measured by global mean sea surface temperature (GMSST). Observational data for SOI and GMSST are sourced from NOAA. The model targets the peak TC season in the Northern Hemisphere, from June to November (JJASON), using historical Best-track data from the US Joint Typhoon Warning Center (JTWC) to validate the forecast procedure.

Statistically, the model shifts from an ordinary least squares (OLS) method to a Poisson regression model using generalized linear modeling (GLM) for more realistic TC count by avoiding negative values. The model's forecasts are expressed as probability distributions, which more accurately reflect forecast uncertainty. Based on climatological data from 1991 to 2020, the forecasts are categorized into five levels: "Below Normal (B)", "Normal or Below Normal (NB)", "Normal (N)", "Normal or Above Normal (NA)", and "Above Normal (A)". Final forecast decisions are based on the category that surpasses a predefined threshold percentage, offering a more nuanced and probabilistic approach to predicting TC activity.

This approach enhances the accuracy of TC forecasts, supporting better disaster management and preparedness. It is expected to be highly beneficial for the public by enhancing preparedness and response to tropical cyclone-related disasters.

Key words: Hybrid model, Tropical cyclone, Probabilistic forecast procedure