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Multi-model Statistical-Dynamical Seasonal Forecast of Landfalling Tropical Cyclones in the United States
登陸美國熱帶氣旋的多模式統計動力季節預報

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Abstract

In past studies, seasonal prediction of tropical cyclones (TCs) has been made by statistically relating historical observations and the TC activities. In statistical relationship between past data and future condition, it is implicitly assumed the future would behave in the same way as in the past, which is not necessarily correct. To solve such an inherent problem, the statistical-dynamical technique is used in this study. Instead of relating the TC activities with historical data such as El Niño-Southern Oscillation (ENSO), stratospheric Quasi-Biennial Oscillation (QBO), North Atlantic Oscillation (NAO) and other atmospheric indices, the predictors are derived from dynamical-model-predicted fields. Dynamical and thermodynamical fields related to the formation and movement of TCs, such as sea-surface temperature, environmental steering flow patterns and geopotential fields are chosen as predictors.

In this study, forecasts of seven coupled global atmospheric general circulation models (GCMs) from the DEMETER (Development of a European multimodel ensemble system for seasonal to interannual prediction) project are related to the number of landfalling TCs over a particular coastal region of the United States of America. As a result, seven individual prediction equations are formulated from predictors of one of the seven models. A multi-model prediction equation is then formulated as a linear combination of the individual equations.

To analyze the relationships between the number of landfalling TCs and model-predicted fields, the model-predicted fields are represented by the empirical orthogonal functions (EOFs) as potential predictors. To predict the

number of future landfalling TCs, an equation relating the each of the predictors and the TC number is needed. The Poisson regression is used for the purpose, as the normality assumption failed in small number of landfalling TCs. Replacing the simple linear prediction equation, a non-linear prediction equation is used with the Poisson regression. Multivariate stepwise procedures are used to select the "best" sets of predictors in the forecast equation. With the U.S. Atlantic coast divided into three regions (East Coast, Florida and Gulf Coast) according to the geophysical location, the predictions for the regional number of landfalling TCs are skillful. The prediction for the Florida region gives about 17% skills over the climatology, which is defined as the ratio between the root-mean-square errors of the prediction scheme and that of the climatological mean, while the predictions for the East Coast and Gulf Coast regions give skills of about 30% and 40%, respectively. It is therefore shown that the statistical-dynamical technique is feasible in seasonal forecast of TC activities. It is hoped that a more accurate seasonal forecast will be made using the technique in the near future.

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