Verifications of Week-1 to Week-4 Tropical Cyclone Forecasts in the Western North Pacific from the ECMWF 46-Day Ensemble

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This study uses the ECMWF 46-day ensemble to evaluate the subseasonal forecasts of tropical cyclones (TCs) in the western North Pacific, including TC formations, tracks, intensity, and precipitation forecasts. TC formations and the subsequent tracks are objectively detected in both real-time forecasts and also the 20-year ECMWF reforecasts. Additionally, a spatial-temporal track clustering technique is utilized to group similar vortex tracks in the 101-member real-time forecasts for operational application. The forecast verification focuses on evaluating the influence of large-scale environmental factors on TC forecast skills during weeks 1-4, such as the Western North Pacific Summer Monsoon (WNPSM), Madden Julian Oscillation (MJO), and Boreal Summer Intraseasonal Oscillation (BSISO). The Precision-Recall (PR) curve is used to represent the imbalanced TC data instead of the Receiver Operating Characteristic (ROC) curve. Better TC forecast skills are observed if model initialized on MJO Phases 6 and 7 for the week-1 forecasts, and on MJO Phases 4 and 5 for the weeks 2 and 3 forecasts. Also, TC forecast skills are better if the cumulative percentage of the WNPSM index (Wang et al. 2001) is larger than 60%. This study also investigats the TC precipitation forecast skill around Taiwan area.

The evaluation results obtained from this study has been integrated into the TC Tracker 2.0 system developed by Central Weather Administration (CWA). The system can generate a "Subseasonal TC Threat Potential Forecast" product to assist in disaster mitigation and water resources management for the Water Resources Agency. More details about the subseasonal TC forecast verifications and applications will be presented in the meeting.

Subseasonal Typhoon Precipitation Forecast in Taiwan Area Using the ECMWF Reforecasts: Forecast Verification and Application

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The main objective of this study is to assess typhoon precipitation forecast skill on the subseasonal timescale. The 20-year reforecasts from the ECMWF 46-day ensemble (ENS) are utilized to compare with gridded surface observations in Taiwan. The analysis focuses on the dates when typhoons affect Taiwan (117-129°E and 19-28°N). 15 ENS grids around Taiwan area are used with the grid size of 0.8 x 0.8 degree. Historical rainfall observations are provided by the Central Weather Administration (CWA), which the observations from the surface stations are interpolated into a resolution of 1km x 1km grid box. A comparison between the ENS forecast data and gridded CWA rainfall observations is performed by searching the optimal percentile rank (PR) of gridded CWA rainfall that has the smallest mean difference against the ENS data. The result reveals that the ENS can somewhat capture the rainfall contrast between the mountainous area and plain area, despite its relatively lower horizontal resolution. However, the difference between ENS rainfall forecasts and surface observations significantly increases for the forecasts beyond 72 hours, due to the model's coarser resolution and typhoon track forecast errors.

The ENS typhoon track forecast errors in weeks 1-4 are analyzed by comparing the ensemble vortex tracks with the JTWC best tracks. The track forecast error is decomposed into the along-track (AT) and cross-track (CT) components. The analysis result shows negative mean AT errors, indicating slower translation speed biases in the model. The mean AT errors could reach up to 400 km for the 168 h forecasts after TC formations.

Given the significant typhoon track forecast errors, using the raw ENS rainfall forecasts for the operational TC forecasting/outlook become challenging. In response, we have developed a statistical Quantitative Precipitation Forecast (QPF) model to predict typhoon rainfall, considering the track biases in the ENS forecasts. The forecast tools developed in this study will be integrated into CWA’s subseasonal typhoon forecast system to support water resources management and disaster risk reduction.