

New weather prediction model produces more accurate typhoon intensity forecasts

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Storm surge caused by the landfall of Typhoon Ma-on near Zhuhai, a coastal city in Guangdong, China. Credit: Si Gao

As one of the most disastrous weather systems, typhoons heavily impact human life, property, and socioeconomic development. To mitigate these

challenges, meteorologists and modeling experts have steadily improved typhoon track forecasts through the last few decades. However, typhoon intensity forecasts have seen marginal progress, especially for short forecast lead times.

One essential component of numerical weather prediction, or model forecasting for typhoons is the [initial conditions](#), which need to accurately represent a typhoon's intensity, structure, and the large-scale environment. Data assimilation seeks the storm's optimal initial conditions by combining information from observations and short-term model forecasts.

Prof. Zhe-Min Tan at Nanjing University, alongside a group of modeling researchers, conducted a study focused on improving typhoon intensity forecasts through ensemble data assimilation. They used the Weather Research and Forecasting model (WRF) with an 80-member ensemble Kalman filter to conduct the regional ensemble cycling assimilations and forecasts for the western North Pacific typhoons that occurred during the 2016 tropical cyclone season. *Advances in Atmospheric Sciences* just published their full research report.

Several advanced data assimilation methods have shown great promise toward improving typhoon forecasts. The ensemble Kalman filter, which is a Monte Carlo approach, integrates observations into the model based on flow-dependent error statistics, while also providing ensemble analyses. Launched from these analyses, ensemble forecasts can provide probabilistic distributions that paint a more accurate picture of possible typhoon tracks and intensities. Thus, the ensemble Kalman filter could be particularly beneficial for both typhoon track and intensity analyses and forecasts.

That said, short-term (six-hourly) ensemble forecasts from these cycling processes have an appropriate amount of variance for typhoon tracks but

still produce insufficient variance for typhoon intensity. The 6-hourly ensemble forecasts tend to overestimate the intensity for weak storms and underestimate the intensity for strong storms. This indicates that a 6-km horizontal grid spacing is still unable to resolve the large gradients of wind and mass fields within typhoon's core-region.

To continue their investigation, the team compared the regional forecasts using WRF model with the cycling ensemble Kalman filter to global forecasts from the European Center for Medium-Range Weather Forecasts (ECMWF) and National Centers for Environmental Prediction (NCEP) models. They found that the 5-day deterministic regional forecasts have less errors and biases for typhoon intensity than the ECMWF and NCEP global forecasts. However, due to an inferior representation of the large-scale environment surrounding typhoons, the 5-day deterministic regional forecasts produce greater track error than ECMWF and NCEP global forecasts.

Overall, the 5-day ensemble forecasts from the cycling ensemble assimilation provided improvements toward better ensemble forecasts for typhoon track and intensity, especially for short [forecast](#) lead times. These regional typhoon ensemble forecasts with a higher spatial resolution are superior to the global ensemble forecasts, regarding the typhoon [intensity](#) predictability.

Looking ahead, the research group will develop more advanced [data assimilation](#) algorithms that can better capture multiscale features of [typhoons](#) with dynamic constrained and balanced vortex initial conditions.

More information: Lili Lei et al, Evaluation of a Regional Ensemble Data Assimilation System for Typhoon Prediction, *Advances in Atmospheric Sciences* (2022). [DOI: 10.1007/s00376-022-1444-4](https://doi.org/10.1007/s00376-022-1444-4)

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