Experimental Regional Reanalysis with the WRF-based Local Ensemble Transform Kalman Filter (LETKF) Using Two-Way-Nested Heterogeneous Grids

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It would be ideal if we could perform global high-resolution reanalysis, but it may not be a wise approach if we consider an effective use of computational resources with the available observing coverage. Studies have suggested that without having a sufficient observing coverage for the model resolution, it is sometimes difficult to obtain accurate analysis at the scales that are hardly resolved by the observations. Moreover, we may focus on specific high-impact events, which are local both in space and time. Global data assimilation allows resolving the entire globe uniformly, but instead, having temporally and spatially heterogeneous reanalysis may be a reasonable choice.

In view of the above discussion, regional reanalysis has been sought by previous efforts such as NCEP North American Regional Reanalysis (NARR). Regional reanalysis is considered to be downscaled products of global reanalysis. Here, a regional data assimilation system is applied, with the boundary conditions provided by a parent global reanalysis. In this study, we apply the Local Ensemble Transform Kalman Filter (LETKF) with the Weather Research and Forecasting (WRF) model, with particular focus on Tropical Cyclones (TC) in the Northwestern Pacific.

A unique aspect of this study is the newly-developed LETKF with heterogeneous grids. The LETKF treats each grid point independently, without restrictions to the choice of the model grid system. In a two-way nested model configuration, a smaller domain model with finer grids is embedded within a larger domain model with coarser grids. Since the two-way nested time integration makes these two models consistent, the two models can be regarded as a single model with a heterogeneous grid system. In this study, a single LETKF system is applied to such a heterogeneous grid system. This allows having even a higher resolution only when and where high-impact events exist.

In this study, about 2-month experimental reanalysis is computed using the 2-way-nested WRF-LETKF system. Only when high-impact events exist, appropriate high-resolution inner domains are activated. In this first trial, Typhoon Sinlaku (2008) is chosen as our focus. Sinlaku (2008) is a famous event due to internationally collaborated T-PARC (THORPEX Pacific Asian Regional Campaign) observations including dropwinsondes from reconnaissance flights. With the 60/20-km two-way-nested WRF setting, the central pressure as low as 935 hPa of matured Sinlaku was well resolved. Forecasts from the high-resolution analysis show improvement over the parent NCEP final analysis (FNL).

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