Development and initial performance evaluation of the KIAPS weakly-coupled atmosphere-ocean-sea ice data assimilation system

It has long been known that coupling between different Earth system components such as ocean, atmosphere, sea ice, and land produces improved forecasts on seasonal and longer time scales. The Korea Institute of Atmospheric Prediction Systems (KIAPS) has been developing a coupled atmosphere-land-ocean-sea ice model, that is composed of the Korean Integrated Model (KIM) for atmospheric modeling, the Nucleus for European Modelling of the Ocean (NEMO) for ocean modeling, and the Sea Ice Modelling Integrated Initiative (SI3) sea ice modeling, aimed at extended-range forecasts. When atmospheric and ocean initial conditions are produced by independent (uncoupled) data assimilation (DA) systems, inconsistencies at the ocean surface can lead to imbalances in the coupled model. It has been reported that applying a coupled DA approach can mitigate this initialization shock. In this regard, we develop a weakly-coupled atmosphere-ocean-sea ice DA (WCDA) system to provide more balanced initial conditions to the KIM coupled model. The current WCDA system is based on the KIM v4.0, and the atmospheric DA uses the KIM VARiational DA (KVAR) software to run 3DVAR-FGAT analyses within a 6-hour DA cycle. The ocean system is based on KMA (Korea Meteorological Administration)'s "GODAPS" system (Global Ocean Data Assimilation and Prediction System), which uses the NEMO ocean model. The ocean DA system employs the NEMOVAR software to run 3DVAR-FGAT analyses driven by the KIM atmospheric forcing. To obtain consistency between the atmospheric and ocean DA cycles, we adopt a 6-hour based ocean DA cycle instead of the typical 24-hour cycle. And we upgraded the NEMO version and sea ice model (SI3) used by the KIM coupled model. The major recent progress in our ocean and atmospheric DA system includes: 1. Instead of the offline NEMO, the coupled KIM-NEMO is used as an observation operator for NEMOVAR, and Incremental Analysis Update (IAU) is also applied to the coupled NEMO. 2. The IAU procedure for NEMO is matched to that for KIM. That is, the coupled model runs IAU from -03 to 03 UTC and forecast with both processes integrated. Here, we will introduce our progress for the new KIM-NEMO based WCDA system and present initial performance.

Jiyoun Kim, Hyeyeong Jang, Eunbyeol Ko, Yonghwan Kwon, Adam Clayton, In-Hyuk Kwon (Korea Institute of Atmospheric Prediction Systems)