

기후 분과 [P-027]

Development of Physical–Biogeochemical Reanalysis Based on an Earth System Model

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Earth System Models (ESMs) are sophisticated tools for simulating and understanding the global climate system, integrating both physical and biogeochemical (BGC) processes. A key factor in improving ESM predictive skill is data assimilation, which incorporates observations to refine reanalysis data as initial conditions. Despite its crucial role, data assimilation faces challenges, including limited BGC observations and physically unrealistic diapycnal mixing, which hinder progress in ESM-based prediction. In this study, we develop a data assimilation system using the Parallel Data Assimilation Framework (PDAF) within GFDL-ESM4, aiming to produce a reanalysis of the ocean and the atmosphere for the initialization of coupled physical-biogeochemical predictions. The developed system addresses challenges associated with data assimilation and produces a 7-year reanalysis (2015–2021) by assimilating only physical observations. Comparisons with observed and other reconstructed datasets indicate that our reanalysis similarly represents the physical mean state and climate variability. Notably, the reanalyzed biogeochemical variables show consistency with observations—such as air–sea carbon flux exhibiting similar spatial patterns, and chlorophyll anomaly showing significant correlations (~ 0.73) across several oceanic regions—even without assimilating BGC data. These findings highlight the potential of our developed data assimilation system to initialize coupled physical-biogeochemical predictions.

Keywords: Earth System Models, Physical-Biogeochemical Reanalysis, Data Assimilation