Toward a Coupled Adjoint Assimilation Environment for Climate Model Initialization

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Initialization of coupled climate models for decadal predictions often relies on initial conditions generated by assimilating ocean data in a stand-alone ocean general circulation model. The incompatibility of these initial conditions, often generated by a different ocean model than used in the coupled system, usually leads to initialization shocks in the coupled system. Ideally the initial conditions therefore should be created by the same system used for the forecast, which calls for data assimilation into a coupled system.

Our objective is to introduce the new coupled atmospheric-ocean model PLETHORA and its adjoint that ultimately will allow for calculating initial conditions in the coupled system, and subsequently to use these conditions for decadal climate predictions with the same modeling framework. The ocean model is based on the MIT General Circulation Model (MITgcm) on a global domain with 1° resolution. The atmospheric model is based on Planet Simulator (PLASIM): an Earth System Model that comprises a spectral atmospheric component (PUMA), a thermodynamic sea ice module, and a terrestrial biosphere component (SIMBA). Previously both model components possessed an adjoint. We now created the adjoint of the coupled system. The main goal here is exploring the limits of the adjoint method of data assimilation with a coupled climate model. The automatic differentiation tool (TAF) is used for the generation of the adjoint of the coupled model. Because both ocean- and atmosphere components are nonlinear, modifications to the original model had to be done in order to increase the assimilation window. Preliminary work for tuning and optimization is presented. These efforts will finally lead to a climate model assimilation system that allows for model improvements through parameter optimization and for the generation of initial conditions by incorporating real ocean and atmosphere observations and predictions with the same system.

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