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Adaptivity and memory-reduced adjoints for optimization problems with parabolic PDE-constraints

Efficient adjoints in Earth system state and parameter estimation

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Abstract:
The sparse, heterogeneous observational sampling of many components of the Earth system mandate the use of formal estimation methods, in which complex climate models may act as dynamical interpolators to reconstruct the full time-evolving state that is consistent with the data ans fullfills known physics and dynamics. For more than a decade the consortium for "Estimating the Circulation and Climate of the Ocean" (ECCO) has conducted such estimation via large-scale gradient based optimization, for which it has relied on algorithmic differentiation (AD) to obtain adjoint representations of its global coupled ocean-ice general circulation model. Ever increasing resolution (i.e. mesh size), extended integration periods (covering years to many decades), and model complexity (new or improved subgrid-scale parameterization schemes) require the development of approaches that keep the computational burden manageable. Promising algorithmic targets that may achieve desired efficiency gain are (1) the development of adaptive checkpointing schemes, and (2) the coupling of high-resolution forward models with low-resolution (or reduced-order) adjoint models. The purpose of this talk is to lay out the problem and invite discussion of solution strategies.