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On the Use of Adaptive Wavelet-based Methods for Ocean Modeling and Data Assimilation Problems

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Latest advancements in parallel wavelet-based numerical methodologies for the solution of partial differential equations, combined with the unique properties of wavelet analysis to unambiguously identify and isolate localized dynamically dominant flow structures, make it feasible to start developing integrated approaches for ocean modeling and data assimilation problems that take advantage of temporally and spatially varying meshes. In this talk the Parallel Adaptive Wavelet Collocation Method with spatially and temporarily varying thresholding is presented and the feasibility/potential advantages of its use for ocean modeling are discussed. The second half of the talk focuses on the recently developed Simultaneous Space-time Adaptive approach that addresses one of the main challenges of variational data assimilation, namely the requirement to have a forward solution available when solving the adjoint problem. The issue is addressed by concurrently solving forward and adjoint problems in the entire space-time domain on a near optimal adaptive computational mesh that automatically adapts to spatio-temporal structures of the solution. The compressed space-time form of the solution eliminates the need to save or recompute forward solution for every time slice, as it is typically done in traditional time marching variational data assimilation approaches. The simultaneous spacio-temporal discretization of both the forward and the adjoint problems makes it possible to solve both of them concurrently on the same space-time adaptive computational mesh reducing the amount of saved data to the strict minimum for a given a priori controlled accuracy of the solution. The simultaneous space-time adaptive approach of variational data assimilation is demonstrated for the advection diffusion problem in 1D-t and 2D-t dimensions.