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CONSERVATIVE AND STABLE ASYNCHRONOUS FLUID-FLUID COUPLING METHODS

Jeffrey M. Connors[1,*] and Robert Dolan[2]

[1] University of Connecticut, 341 Mansfield Rd. U-1009, Storrs, CT 06269-3009,
jeffrey.connors@uconn.edu, http://www.math.uconn.edu/ connors
[2] University of Connecticut, 341 Mansfield Rd. U-1009, Storrs, CT 06269-3009,
robert.dolan@uconn.edu

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The distribution of energy across space and time scales is quite different between the atmosphere and ocean. Therefore, codes for air-sea interaction are constructed by coupling together atmosphere and ocean components, each highly optimized using different numerical methods, by passing fluxes of conserved quantities between the components in the form of boundary conditions at the air-sea interface. For efficiency, the fluxes are usually asynchronous, meaning they are calculated using data extrapolated from previous times for at least one component. Moreover, these extrapolations are low-order accurate in terms of the time step size associated with the coupling interval. The accuracy may be improved via iteration, which has been explored in [3, 4], but iteration is expensive. In some cases, higher-order extrapolation in time may suffice to improve accuracy and circumvent or reduce iteration costs, but then stability and conservation considerations arise; see [1, 2, 3]. For a simplified, model problem of fluid-fluid interaction, a rigorous stability analysis is performed for higher-order extrapolation of fluxes satisfying a discrete conservation property. A scaling analysis provides some intuition regarding the use of high-order extrapolation methods for climate or regional forecasting applications. Some computations are provided to illustrate different coupling configurations; that is, using low- versus high-order extrapolations and with or without iterations to tighten the coupling.

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