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Learning dominant physical processes in complex flows with data-driven balance models[1] JARED CALLAHAM, J. NATHAN KUTZ, BINGNI BRUNTON, STEVEN BRUNTON, University of Washington — Theoretical analysis in fluid mechanics has long relied on judiciously approximating the full flow physics as a balance between a few dominant processes. However, this traditional approach typically only applies in asymptotic regimes where there is a strict separation of scales. We automate and generalize this approach to non-asymptotic regimes by introducing the idea of an equation space, in which different local balances appear as distinct subspace clusters. Unsupervised learning can then automatically identify regions where groups of terms may be neglected. We show that our data-driven balance models successfully delineate dominant balance physics in a broad range of fluid flows, including a laminar bluff body wake, a boundary layer in transition to turbulence, and surface currents in the Gulf of Mexico.

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