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LESbrary: A library of large eddy simulation data for the calibration and uncertainty quantification of ocean surface boundary layer turbulence parameterizations

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Parameterizations of turbulent mixing in the ocean surface boundary layer (OSBL) are key Earth System Model (ESM) components that modulate the communication of heat and carbon between the atmosphere and ocean interior. OSBL turbulence parameterizations are formulated in terms of unknown free parameters estimated from observational or synthetic data. In this work we describe the development and use of a synthetic dataset called the "LESbrary" generated by a large number of idealized, high-fidelity, limited-area large eddy simulations (LES) of OSBL turbulent mixing. We describe how the LESbrary design leverages a detailed understanding of OSBL conditions derived from observations and large scale models to span the range of realistically diverse physical scenarios. The result is a diverse library of well-characterized "synthetic observations" that can be readily assimilated for the calibration of realistic OSBL parameterizations in isolation from other ESM model components. We apply LESbrary data to calibrate free parameters, develop prior estimates of parameter uncertainty, and evaluate model errors in two OSBL parameterizations for use in predictive ESMs.