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Assimilation of Multiscale Data into Multifidelity Biogeochemical Models

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Vast disparity of spatiotemporal scales on which data are collected and models are used remains one of the key challenges in accurate and reliable predictions of watershed dynamics. We generate multi-resolution data by developing novel regression- and neural network-based closures for averaged (watershed-scale) equations of flow and transport. Then, we introduce an information-theoretic approach that allows for seamless integration of multi-resolution data into multi-scale simulations to upscale/downscale hydraulic conductivity of heterogeneous porous formations. Available data (at either the fine- or the coarse-scale) are used to inform models at the opposite scale by setting a probabilistic equivalence between the fine and the coarse scale, with closures (parameters and/or constitutive laws) that are learnt via minimization of observables error and mutual information across scales. We investigate how this can guide us to formulate scaling laws and we explore means to accelerate scaling of dynamic processes and to reduce data requirements.