

Adjoint-based deep learning for efficient pointwise residence time estimation in coastal environments

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Residence time is an essential measure for evaluating water renewal and pollutant retention in coastal environments. However, its computation remains challenging due to spatial and temporal variability and complex time-dependent flows. Traditional techniques used to compute residence time are usually based on simplified hypotheses, such as applying a one-cycle tide and considering it for the entire computing time to simplify the hydrodynamics in the region of interest. Yet, these approaches fail to capture the dynamic conditions accurately. In this study, we introduce a new deep learning framework that uses a convolutional Long Short-Term Memory network (ConvLSTM) to solve the adjoint advection-diffusion problem. Our approach enables the derivation of spatially and temporally resolved residence time without the need to store extensive hydrodynamic histories. It relies on high-resolution data generated by solving the shallow water equations using a non-homogeneous Riemann solver (SRNH). To address the substantial computing difficulties posed by full-resolution data, we employ a data reduction strategy. Initially, the ConvLSTM is trained using full data for the first day of simulation to establish a robust recognition of hydrodynamic models. After that, temporal and spatial resolutions are progressively reduced to preserve the essential characteristics of the model.

References

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