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Double-scale diffusive wave model dedicated to spatial river observation and associated covariance kernel for variational data assimilation

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The spatial altimetry provides an important amount of water surface height data from multi-missions satellites (especially Jason-3, Sentinel-3A/B and the forthcoming NASA-CNES SWOT mission). To exploit at best the potential of spatial altimetry, the present study proposes on the derivation of a model adapted to spatial observations scale; a diffusive-wave type model but adapted to a double scale [1].

Moreover, Green-like kernel can be employed to derived covariance operators, therefore they may provide an approximation of the covariance kernel of the background error in Variational Data Assimilation processes. Following the derivation of the aforementioned original flow model, we present the derivation of a Green kernel which provides an approximation of the covariance kernel of the background error for the bathymetry (i.e. the control variable) [2].

This approximation of the covariance kernel is used to infer the bathymetry in the classical Saint-Venant's (Shallow-Water) equations with better accuracy and faster convergence than if not introducing an adequate covariance operator [3].

Moreover, this Green kernel helps to analyze the sensitivity of the double-scale diffusive waves (or even the Saint-Venant's equations) with respect to the bathymetry.

Numerical results are analyzed on real like datasets (derived from measurements of the Rio Negro, Amazonia basin).

The double-scale diffusive wave provide more accurate results than the classical version. Next, in terms of inversions, the derived physically-based covariance operators enable to improve the inferences, compared to the usual exponential one.

[1] T. Malou, J. Monnier "Double-scale diffusive wave equations dedicated to spatial river observations". In prep.

[2] T. Malou, J. Monnier "Physically-based covariance kernel for variational data assimilation in spatial hydrology". In prep.

[3] K. Larnier, J. Monnier, P.-A. Garambois, J. Verley. "River discharge and bathymetry estimations from SWOT altimetry measurements". Inv. Pb. Sc. Eng (2020).