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A Predictive Data-Driven Approach Based on Reduced Order Models for the Morphodynamic Study of a Coastal Water Intake

Authors

Authors and affiliations

Rem-Sophia Mouradi, Cédric Goeury, Olivier Thual, Fabrice Zaoui, Pablo Tassi

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Abstract

For many environmental applications, field measurement techniques are increasingly evolving, resulting in more complex and complete datasets. The statistical analysis of these datasets is challenging, and requires the use of relevant mathematical tools. Furthermore, the access to a richer collection of data offers a new optimistic perspective on data-driven modeling, to complement, or even replace, process-based modeling. The presented work is within the context of a power plant water intake monitoring. The intake channel is subject to massive sediment arrivals, which represents a clogging risk. One of the challenges is therefore to better understand the sediment dynamics observed in the channel, and to characterize their correlation to environmental forcing. The final goal is to proceed to the forecasting of the dynamics using the knowledge of forcing parameters. Luckily, due to monitoring needs, bathymetric measurements of the channel are realized on a regular basis, along with meteorological and hydrodynamic survey. A statistical study is hereby proposed on the basis of this data. Firstly, a Proper Orthogonal Decomposition (POD) is applied to the two-dimensional bathymetric data set, in order to reduce it to a low-dimensional set of time dependent scalar coefficients. The latter are linked to the physical forcings via an adapted statistical model. In this study, a Polynomial Chaos Expansion (PCE) is used for this purpose. Consequently, a data-driven model is proposed, on the basis of a POD-PCE coupling. The proposed step-by-step methodology could also be transposed to other applications.

Keywords

Data-Driven Model (DDM) Proper Orthogonal Decomposition (POD) Polynomial Chaos Expansion (PCE) Dimensionality reduction Sediment transport Coastal dynamics

Notes

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