IMPACT OF UNCERTAINTIES IN MODEL FREE PARAMETERS AND SEA LEVEL RISE ON SHORELINE CHANGES: A 20-YEAR HINDCAST AT TRUC VERT BEACH, SW FRANCE

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INTRODUCTION

Chronic erosion of sandy coasts is a continuous potential threat for the growing coastal communities worldwide. The prediction of shoreline evolution is therefore key issue for robust decision making worldwide, especially in the context of climate change. Shorelines respond to various complex processes interacting at several temporal and spatial scales, making shoreline reconstructions and predictions challenging and uncertain, especially on long time scales (e.g. decades or century). Despite the increasing progresses in addressing uncertainties related to the physics of Sea Level Rise (SLR), very little effort is made towards understanding and reducing the uncertainties related to wave driven coastal response. To fill this gap, we analyse the uncertainties associated with long-term (2 decades) modelling of the cross-shore transport dominated high-energy sandy coast around Truc Vert beach, SW France, which has been surveyed semi-monthly over the last 12 years (Castelle et al., 2017).

METHODS

We use the state-of-the-art LX-Shore model (Robinet et al., 2018), a reduced complexity shoreline change model coupling longshore (switched off here) and cross-shore processes able to account for presence of non-erodible structures (e.g., headland, groynes). A probabilistic shoreline reconstruction over the past 20 years is produced at Truc Vert beach, SW France, where SLR rate, depth of closure and the 3 model free parameters of the wave-driven change model are considered uncertain variables. We assign probability density functions to each uncertain input variable. For the 3 model free parameters, a simulating annealing algorithm is used to search for all the combinations of coefficients leading to a skilful hindcast against 7 years of shoreline field data (Figure 1a,b) when measurements are the more accurate (2011-2017). We further address the relative impact of each source of uncertainty on the model results performing a Global Sensitivity Analysis (GSA) (Sobol', 2001; Saltelli et al., 2008).

PRIMARY RESULTS AND IMPLICATIONS

The GSA shows that, on these time scales of a couple of decades, results are mostly insensitive to uncertainties in SLR, which is in line with Le Cozannet et al. (2016) who showed that shoreline change is sensitive to uncertainties in SLR rates on longer time scales. Results show that shoreline response is mainly sensitive to the uncertainties associated with the free parameters of the wave-driven model, and that the sensitivity to each one of them is strongly modulated on seasonal and interannual time scales (Figure 1c). These results have strong implications from the perspective of sensitivity of model skill to the calibration period (source of the free parameters uncertainty), as well as for the predictive skill of shoreline change models in the frame of climate change potentially implying changes in overall wave regimes.

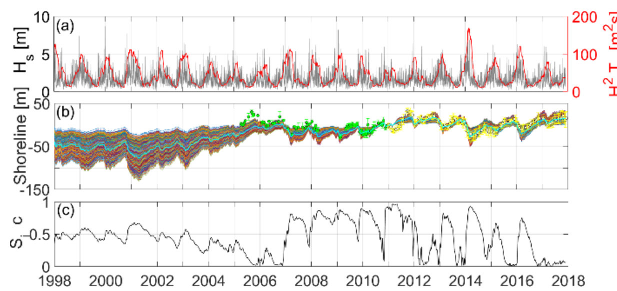

Figure 1 - (a) Simulated offshore wave conditions synthetized in the average value H^2_{so}/T_p; (b) Envelop of 3000 (coloured lines) simulated shoreline evolutions over the period 1998-2018, and observed shoreline positions between 2005 and 2017 (green and yellow dots) with associated longshore standard deviation; (c) Example of sensitivity index time series of a model free parameters.

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