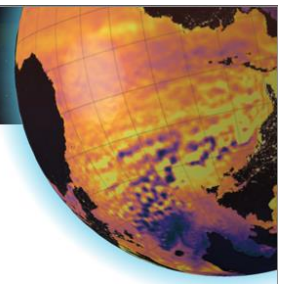
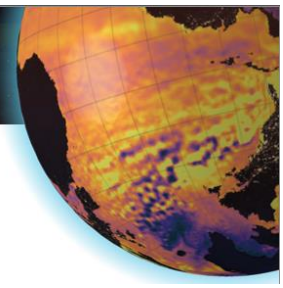


How uncertain is the Sea Level forecast?

Dealing with storm surges forecast always means dealing with modelling. However, models are intrinsically imperfect and have to take into account the uncertainty. The key question is: what uncertainty means? The model accuracy, the forecasting error, the spread of models' ensemble? We mean here the probability of a threshold to be overtopped at a certain time in the future, conditional on the information provided by the forecasting models, available up to present. This concept of uncertainty as 'predictive probability' has radically changed the 'deterministic threshold paradigm'. The decision will not be based on deterministic sea level thresholds (warning level), but rather on different probabilities of a threshold to be overtopped. We used the Model Conditional Processor (MCP) that integrates different predictive models, allowing for the quantification of uncertainty and providing probabilistic estimates. This processor has been applied to storm surges in the Venice Lagoon and the North Adriatic Sea and implemented in ISPRA operational chain. The theoretical derivation of the predictive distribution is based on the Bayes theorem and the joint predictand-prediction distribution in the Gaussian space is derived by models' historical time series. To satisfy Bayes statistical requirements (marginal Gaussian distributions) a Normal Quantile Transform is applied, the multivariate distribution calculated in the Normal space and counter transformed in the real space. So far, the MCP was directly applied to the total sea level, while in a new development with Separated Components, the MCP discriminates the tidal component with a very low associated uncertainty as it can be described accurately by the astronomical laws governing it, and the meteorological component that has a rather wide associated uncertainty. The calibration (01/01/2018 - 31/12/2021) and the validation (01/01/2022 30/06/2022) of MCP was performed using the sea level at Lido Diga Sud and 96 hours of prediction coming from the SHYFEM model, in eight different configurations. The MCP provides a 96 hours predictive distribution with thresholds fixed as 110 cm, 130 cm and 140 cm. MCP performance has been evaluated through many statistical tests as in the standard configuration as in the Separated Components one and through the application to many storm surge events. The comparative analysis between the two configurations highlights how the results improve using Separated Components and how the MCP accurately predicts the exceeding probability, pointing definitely out the importance of handling with such an operative tool for real time prediction and decision making during extreme events.



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