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Application of a soft rule-based model to storm surge and sea level variability

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A rule-based model, founded in Bayesian statistics, is applied to sea level prediction with two aims. The data-driven model uses information theory metrics to prioritise model inputs to create a tree structure of IF-THEN rules. One aim of this method, therefore, is to interpret these rules linguistically, to identify dominant relationships between input data and the data of interest in the physical system and to identify key mechanisms for individual events. Secondly, the model makes probabilistic predictions, and so we aim to utilise the natural error estimates made by the method.

Application of the model to sea level problems has been proven on the problem of short-term forecasting of storm surge in the North Sea. The model is comparatively accurate to alternative data-driven methods and is compared against the operational hydrodynamic storm surge forecast model. The rules of the model are found to be consistent with our understanding of the physics of the North Sea tide-surge system, and for individual large storm surge events, the importance of external and internal components of storm surge is identified.

The same probabilistic and transparent approach is then applied to the prediction of local and regional annual mean sea level from atmospheric and analogue tide gauge data. The algorithm identifies the data fields providing most information about the system and the rules can be interpreted to identify key drivers of sea level variability. The probabilistic nature of the model allows for a natural data-driven error estimation in the predictions, which bounds the variability.