Data assimilation of ocean wind waves using Neural Networks

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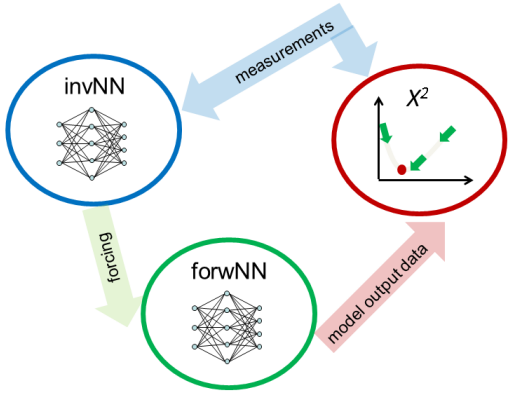
Wahle, K., J. Staneva, H. Günther (2015): Data assimilation of ocean wind waves using Neural Networks. A case study for the German Bight, Ocean Modelling, 96, pp 117-125

Motivation: Variational data assimilation systems using adjoint models often suffer from oversimplification of the adjoint. We present a novel assimilation technique based on Neural Networks (NNs) which combines the computational efficiency of sequential methods with non-locality of Kalman and adjoint methods.

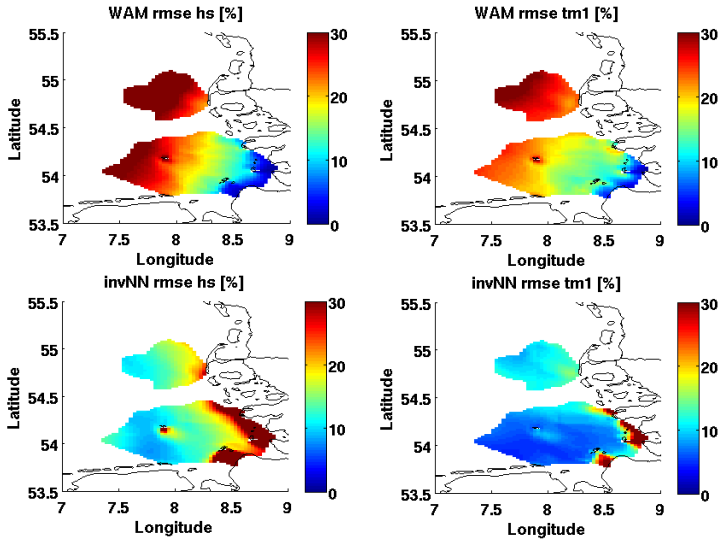


Sketch of assimilation scheme: The combination of forward and backward NN is used to minimize error between measurement and model output.

Method: NNs are trained to emulate a physical model and its adjoint. Given some measurements a first (statistical) estimate of model forcings are derived by NN emulating the adjoint model. Subsequent application of forward NN gives an emulated model output error which can be subsequently minimized using the Levenberg–Marquardt algorithm. The method can thus be summarized as a statistical adjoint method.

Application: The technique was applied to improve boundary values and/or forcing wind fields in a regional (German Bight) wave model (WAM) using synthesized HF-radar wave data (wave height, period and direction) for assimilation:

- ✓ errors of the innovated wave parameters (in particular wave period) is reduced significantly throughout most of the measurement area, except for the shallow water regions along East coast, probably due to wave breaking not accounted for by NN



Time averaged relative errors of integrated wave parameters: first guess WAM and innovations as emulated by NN using improved wind fields from assimilation scheme.

Summary: We developed a new data assimilation method for ocean wind waves using Neural Networks. The novel technique shows very promising first results. Advantages are:

- ✓ easy to implement for other models and regions (requires only model output and areal measurements of model observations)
- ✓ can be adapted to specific problems (any model parameter(s) of interest)
- ✓ computational very efficient
- ✓ NN software is freely accessible to any interested user

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