*Forecasting the weather
- ensemble techniques
in probabilistic weather prediction*

MOS water level forecasts - especially for open tidal harbours

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Model output statistics (MOS) is widely used in many applications. It reduces the error variance of existing numerical models based on physics by about 50% in most applications.

A novel MOS application for use in wind surge forecasting for the German Bight has been developed by Meteo Service at the request of the Federal Maritime and Hydrographic Agency (BSH: Bundesamt für Seeschifffahrt und Hydrographie).

Minimum and maximum tidal water levels are forecast for the important gauge station at Cuxhaven. Forecasts are made every 15 minutes. Water levels at the Cuxhaven gauge are representative of the shipping situation in the 100 km river basin between Hamburg port and the North Sea. Hence, improvements of their forecasts are of high economic value.

The predictand (value to be predicted) of BSH-MOS is not the water level itself but wind surge, which is the difference between the observed water level and astronomical/climatological predictions. The latter are provided by the BSH, the former reflects mainly the meteorological influence dealt with by MOS.

The BSH provided direct model output (DMO) from a 2-dimensional water level forecasting model which is based on the COSMO-EU model of the German National Weather Service (DWD). This DMO is a high-quality reference forecast whose accuracy is comparable to that of oceanographers' final forecasts. The central question of the project was: is MOS capable of improving these forecasts and, if so, to what extent? The BSH's expectations were optimistic but not too high (reduction of error variance RV of MOS, as compared to DMO, between 10 and 20%). Surprisingly, comparative verification has shown improvements of about RV=40%. The main reason for this success was the definition of predictors allowing the correction of systematic errors of DMO which were due to mis-representation of tidal dynamics in the 2D model.

The most important MOS predictors are briefly discussed, and the results of comparative verifications of MOS and DMO as well as of MOS and oceanographers' forecasts are presented.

Extension of the project to the whole German coastal areas of North

Sea and Baltic Sea is in progress.