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Assimilation of HF radar data into a 3D primitive equation model to improve forecasts of the circulation in the German Bight

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Within the German Project COSYNA "Coastal Observing System for Northern and Arctic Seas" HF radar data are acquired by three antenna stations located at the islands of Wangerooge and Sylt as well as in Buesum. The system provides three surface current maps per hour together with information on the measurement accuracy. The data are used in an assimilation system to improve forecasts of the circulation in the German Bight.

The method makes use of a 3-D primitive equation model with 1 km resolution, which is driven by meteo forcing from the German Weather Service (DWD) and boundary forcing from the North West Shelf modelling system of the MYOCEAN project. The model is able to simulate flooding and drying processes in the shallow wadden sea areas of the German Bight.

The assimilation problem for the German Bight is characterised by the fact that the system is strongly dominated by the boundary forcing in general and the tides in particular. A spatio-temporal optimal interpolation method was developed to deal with these conditions in an efficient way. The technique is based on an EOF analysis of the 3-D current field, water levels and the wind field. In total a period of 36 hrs is analysed before a 12 hrs forecast is launched. This includes an analysis of the previous 24 hrs before the new forecast is started and an analysis of the boundary and meteo forcing within the forecast period. In particular this approach makes sure that the boundary forcing used in the forecast is consistent with the restart field. Furthermore the approach makes sure that the information provided by the measurements has an impact over a longer period compared to a sole adjustment of the restart field, where the signal is lost after 4 hours maximum.

A statistical analysis of the method is presented using data acquired in summer and autumn 2010. This in particular includes a storm event in August 2010. Maps of innovation and analysis residuals are discussed and related to errors in the numerical model and the radar measurements. The forecast skill of the assimilation system is analysed for different forecast periods up to 12 hrs. Furthermore validations are performed using ADCP data from the FINO-1 station located about 50 km off the island of Borkum. This station is outside the area covered by the HF radars and can thus be used to demonstrate the ability of the assimilation scheme to propagate the observation information in time and space. Possible extensions of the system, e.g., by assimilation of ADCP or tide gauge measurements are discussed.