Improving current forecasts for the German Bight using HFR measurements

J. Schulz-Stellenfleth, E.V. Stanev, J. Staneva

Introduction

The Coastal Observing System for Northern and Arctic Seas (COSYNA) aims at the construction of a long-term observatory for the German part of the North Sea. At present a coastal prediction system deployed in the area of the German Bight integrates near real-time measurements with numerical models in a pre-operational way and provides continuously state estimates and forecasts of the coastal ocean state. The measurement suite contributing to the pre-operational set up includes insitu time series from stationary stations, a High-Frequency (HF) radar system measuring surface currents, a Ferrybox system and remote sensing data from satellites. The forecasting suite includes nested 3-D hydrodynamic models running in a data-assimilation mode. This study describes the development and implementation of a pre-operational surface current forecast system, which is based on a combination of HF observations and numercial model data.

Observation System

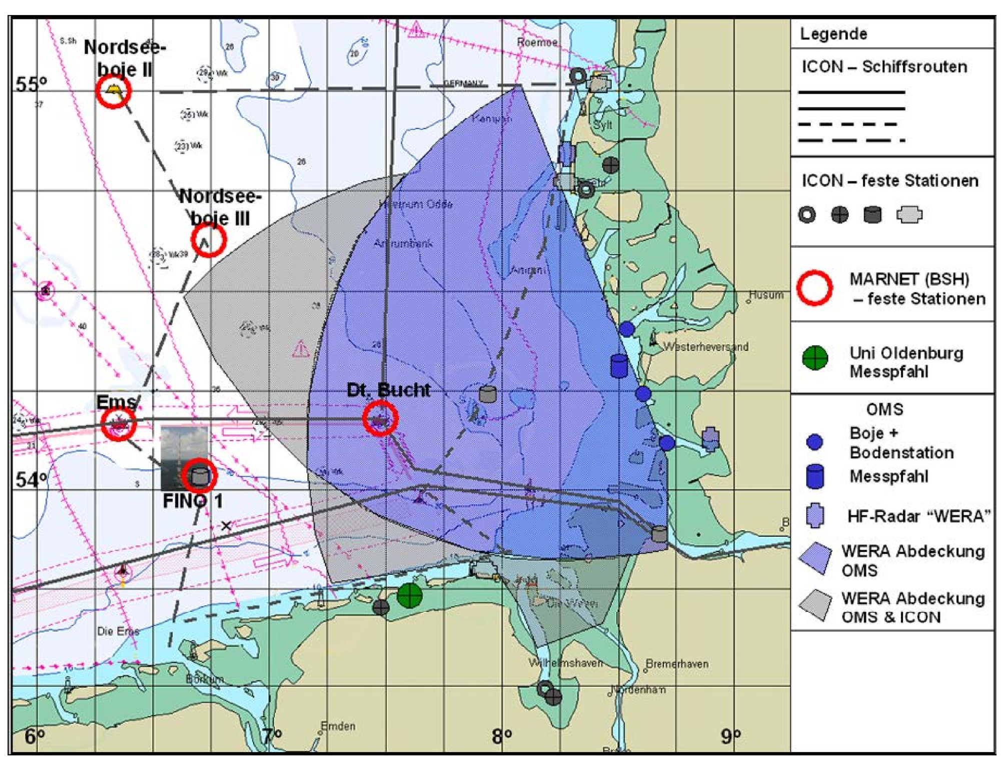


Figure 1: Positions of some of the COSYNA observations systems including the three HF radar stations

Surface current measurements are taken by three radar stations located at Wangerooge, Büsum and Sylt. The key characteristics of the system are as follows

- Operating Frequency 12.1-13.5 MHz
- Measurements are taken every 20 min
- The measurement grid has 2 km resolution

In areas with an overlap of two or more radar stations the zonal and meridional components of the surface currents are derived from the radial current components measured by each station. For the assimilation the radial current components are used directly.

Numerical Model System

The 3D primitive equation model GETM is used for hindcast and forecast of barotropic and baroclinic parameters in the COSYNA area. A nested model setup with a 5 km North Sea/Baltic Sea model, a 1 km German Bight model and 200 m setups for the Wadden Sea areas is used.

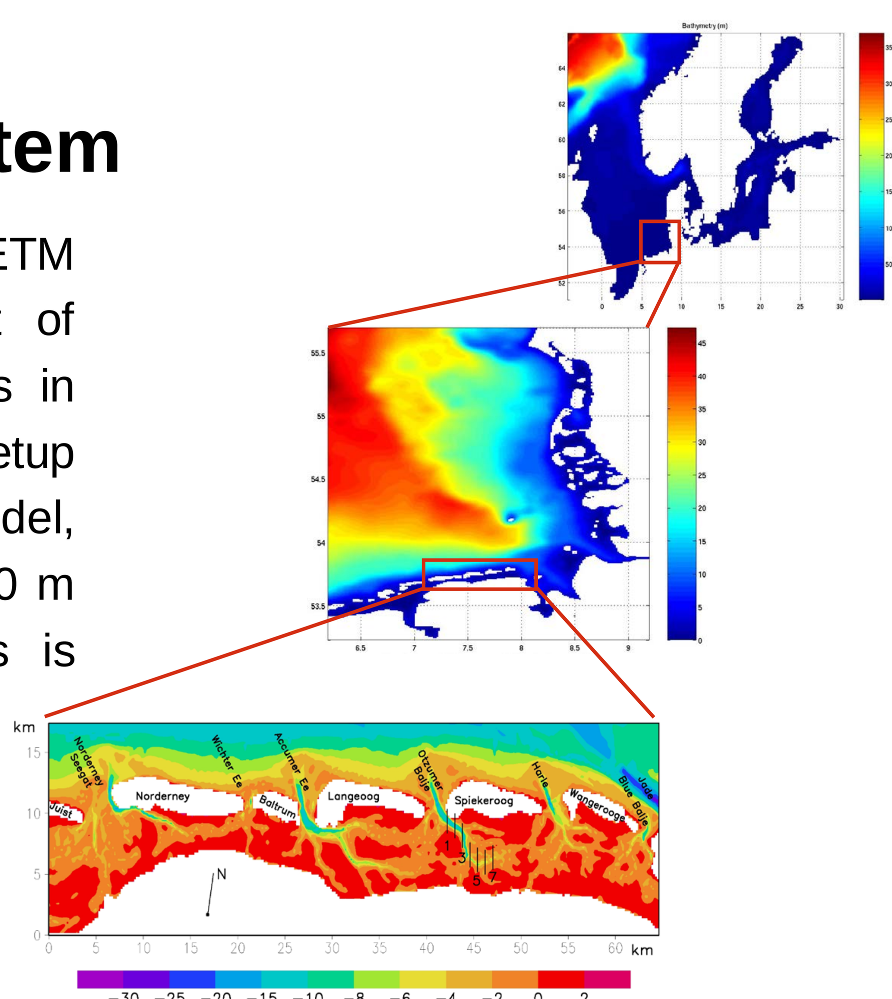
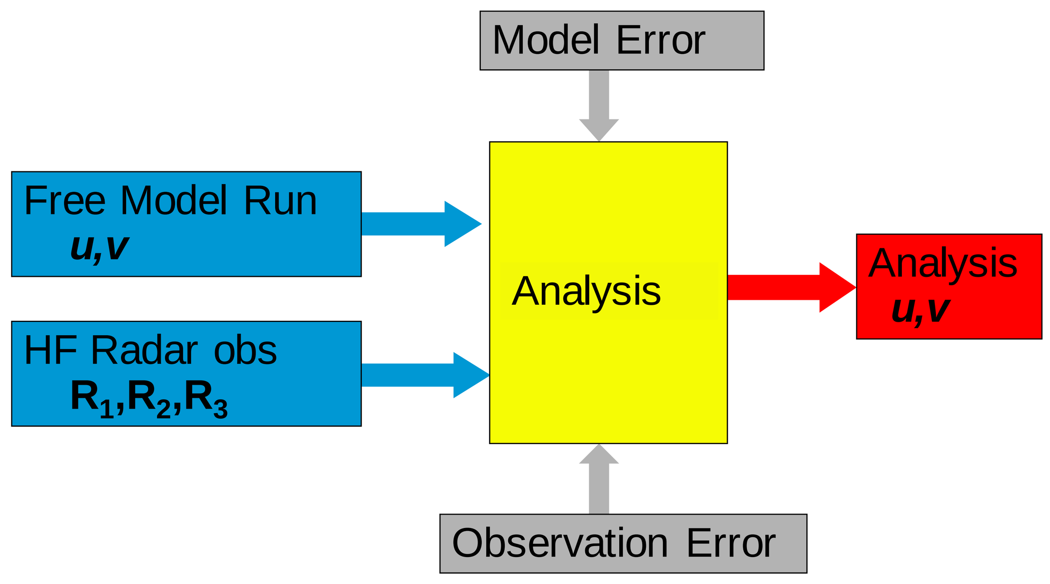


Figure 2: Nested modelling system used in COSYNA

GALATON analysis scheme



The general objective of data assimilation is to blend observation data and numerical model results in a dynamically consistent way. This usually requires to have some a priori knowledge about the measurement errors and the model errors.

12 hour re-analysis

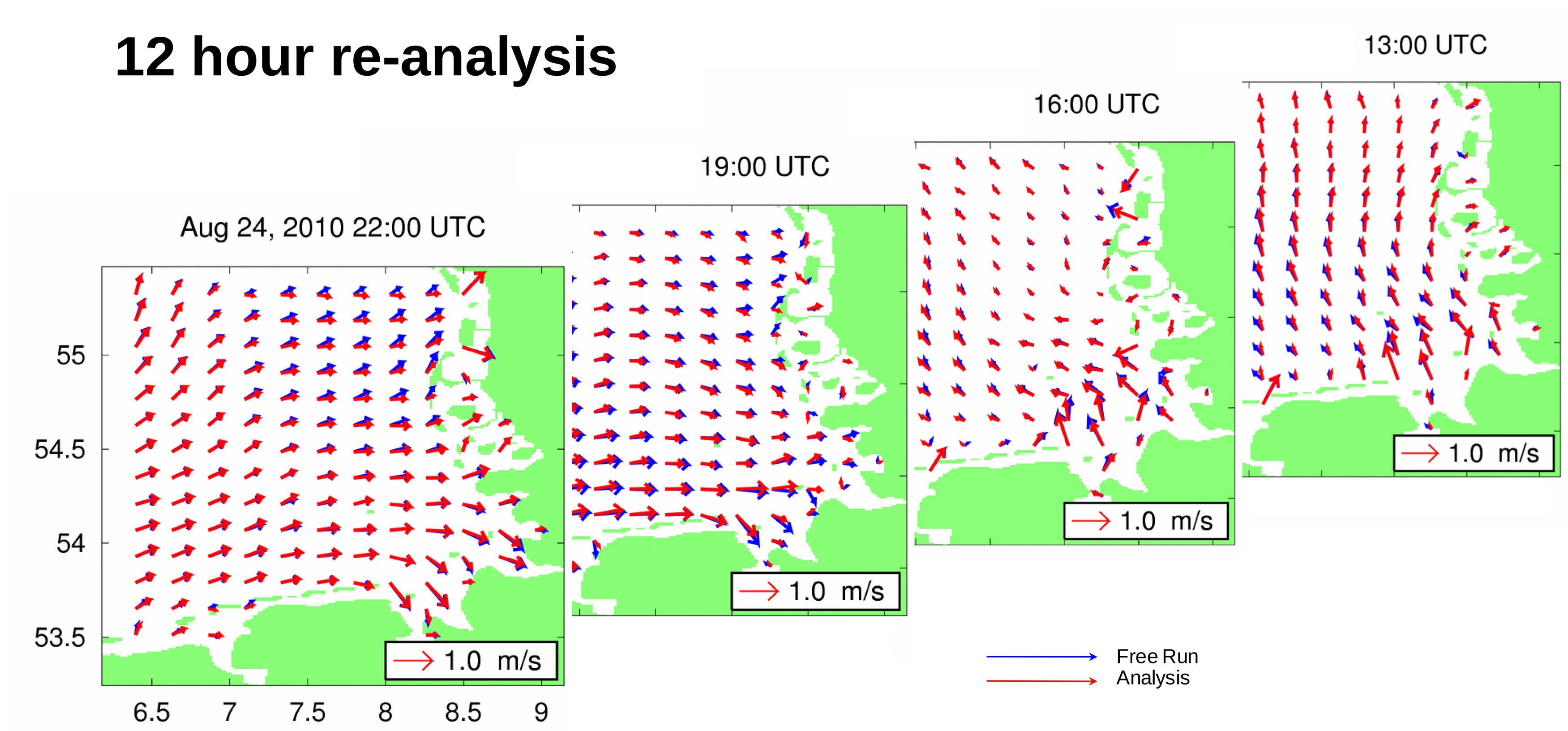


Figure 3: Sequence of surface current fields from the free run (blue) and the analysis (red) over a period of 12 hours

A spatio temporal optimal imterpolation method was developed to blend HF radar surface current measurements acquired by three antenna stations with numerical model data. The technique uses an analysis window of 12 hours and is efficient in correcting errors of both phase and magnitude of the coastal wave. The method also improves the consistency with independent ADCP data. The method was implemented as part of the pre-operational **G**eesthacht **a**ssimi**lation** system (**GALATON**) .

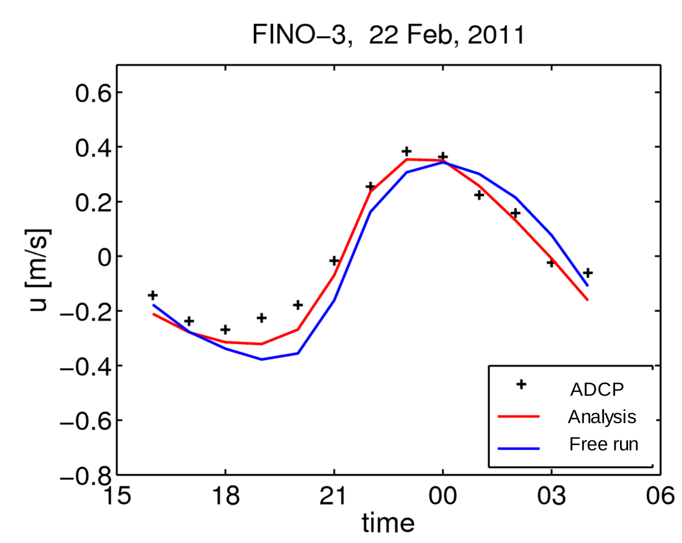


Figure 4: Meridional surface current component at the loaction of the FINO-3 platform from the free run (blue), the ADCP (green) and the analysis (red)

6 hour forecast

The method is also applicable for short term forecasts. In this case an analysis window of 24 hours is used and data are only available within the first 18 hours resulting in a 6 hour forecast.

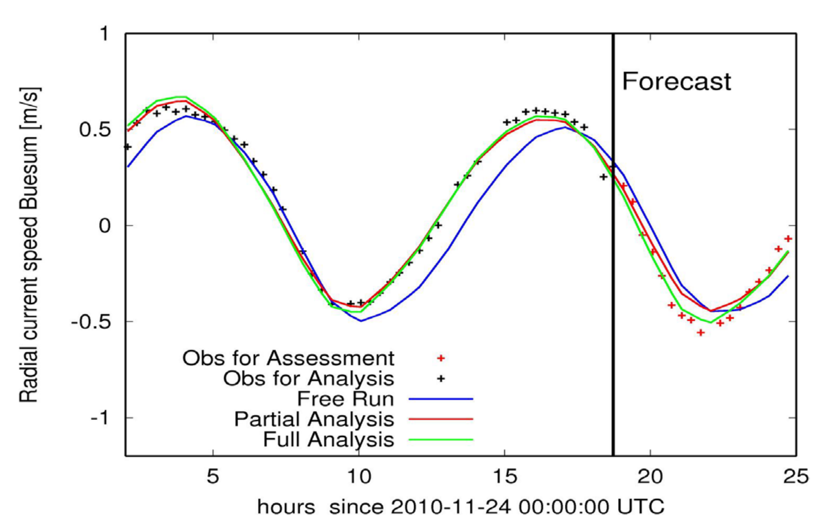


Figure 4: Illustration of the 6 hrs forecast analysis windows

Conclusions

The analysed HF radar surface current fields are generated on a pre-operational basis. The forecasts are updated hourly and can be downloaded freely on www.cosyna.de as netcdf files. There are ongoing activities concerning validation and optimisation of the existing products as well as development of new assimilation procedures, e.g. for glider profile data. A 12 hrs forecast was implemented in an offline setup. Details can be found in the publication below.

Reference: *Blending surface currents from HF radar observations and numerical modelling: Tidal hindcasts and forecasts*, Stanev, E.V., Ziemer, F., Schulz-Stellenfleth, J., Seemann, J., Staneva, J.,Gurgel, K.W., Accepted by J. Atmos. Ocean Techn., 2014

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research