VERIFICATION OF THE WIND WAVE FORECASTING SYSTEM FOR THE BALTIC SEA

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1. Introduction

Since 2010 the components of the system designed for operational wind wave forecasting in the World Ocean and Russian seas have been progressively putting into service in the Hydrometcentre of Russia. The forecasting is performed using as input meteorological prognostic information supplied to the spectral wind wave model WAVEWATCH III v. 3.14 (Tolman, 2009). The first results of the system's verification for the Black, Azov and Caspian Seas have been described in (Strukov et al., 2012). In this note the similar results are presented for the Baltic Sea.

2. Model configuration and input data

Bathymetry and the corresponding land-sea mask for the Baltic Sea are constructed using the GEBCO resource (The General Bathymetric Chart of the Oceans), containing the gridded bathymetry data on a global 30 arc-second grid (about 500×900 m in mid-latitudes). The wave forecasts are computed on the 4.8′×2.4′ (~4 km) geographical grid in the main body of the Baltic Sea with nested 2.4′×1.2′ (~2 km) grid in the Gulf of Finland. Atmospheric forcing needed for the model integration is taken from the prognostic meteorological data produced by the Global Forecast System (GFS) of NCEP/NOAA (Environmental Modeling Center, 2003). The wave forecasts are issued on a daily basis up to 5 days ahead starting from 00 UTC. Initial conditions for each forecast session are taken from the previous 1 day forecast. For verification purposes, the model output was written out every 15 minutes of the whole forecast period in order to minimize the time difference between predictions and satellite observations, the latter being arbitrary distributed in time and space.

3. Data for verification

Performance of the forecasting system was evaluated by comparing its product with two sources of observation data over the period from 01.04.2012 to 31.03.2013. The first of them is the satellite altimeter data on Significant Wave Height (SWH) from the Radar Altimeter Database System (RADS) supported by the Delft Institute for Earth-Oriented Space research (DEOS) (Naeije et al., 2008). The RADS is updated with altimeter data from the Earth resources satellites: Jason-2, Envisat-1, and CryoSat-2 (Figure 1).

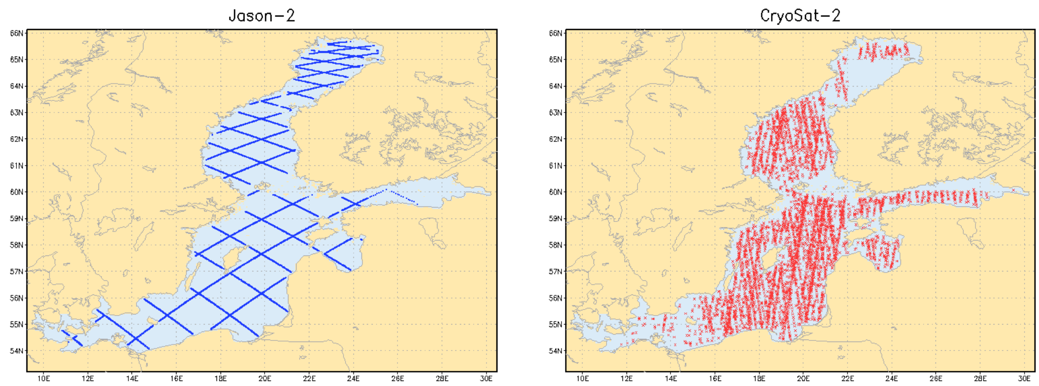

Figure 1. The network of tracks of the Jason-2 (left panel) and CryoSat-2 (right panel) satellites, the data from which were used for the forecasts verification over the Baltic Sea.

The second type of observation data used for verification are in-situ measurements of SWH from wave buoys at two locations: 59,25° N, 21° W (1.04.2012–31.03.2013) and 54,88° N, 13,87°E (1.04.2012–20.06.2012)

4. Forecast performance

Mean error (bias), root mean square error (RMSE) and correlation coefficient (CC) between forecasted and observed SWH values were used as statistical measures of the forecast performance. These statistics are presented in Table 1, and an example of scatter plots, giving an idea of the degree of compliance between forecasted and measured SWHs, are shown in Figure 2.

Table 1. Statistics of the forecast performance relative to RADS data for the verification period from 01.04.2012 to 31.03.2013.

Lead time (days)	Region	Number of observations	Bias (m)	RMSE (m)	CC
1	Baltic Sea	27156	–0.02	0.36	0.88
	Gulf of Finland	1411	–0.12	0.30	0.86
2	Baltic Sea	27156	0.04	0.42	0.85
	Gulf of Finland	1411	–0.13	0.31	0.84
3	Baltic Sea	27156	–0.04	0.51	0.77
	Gulf of Finland	1411	–0.27	0.35	0.72
4	Baltic Sea	27156	–0.07	0.62	0.60
	Gulf of Finland	1411	–0.36	0.52	0.23
5	Baltic Sea	27156	–0.14	0.59	0.57
	Gulf of Finland	1411	–0.34	0.41	0.59

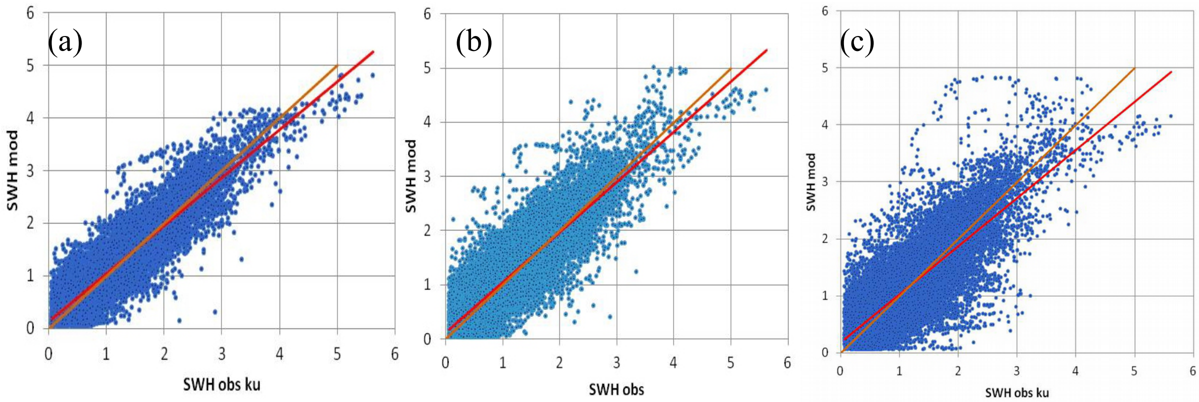

Figure 2. Scatter plots of forecasted (ordinate) and satellite measured (abscissa) SWHs for the first (a), second (b) and third (c) forecast days in the Baltic Sea. Red lines show the linear regression, yellow lines – the perfect agreement.

The absolute values of mean errors were relatively small, slightly increasing with an increase of lead time from 0.02–0.12 m to 0.14–0.34 m. In most cases the bias remained negative, indicating some underestimation of wave heights prediction in comparison with RADS estimates. The correlation coefficient varied from 0.86–0.88 for a one day lead time to 0.57–0.59 for 5 days lead time. In the comparisons with buoy measurements, the correlation coefficient was slightly higher: 0.91–0.92 for a one day lead time and 0.64–0.73 for 4 days lead time.

Deterioration of the forecast performance with increase of lead time was caused to a large extent by the increase of uncertainty of wind speed data used as input in the wave model. This is indicated by an increase of the correlation coefficient between the errors of forecasted SWH and the uncertainties of wind speed data from 0.42 for a one day lead time to 0.75 for five days lead time.

Thus, there are grounds to expect that the performance of the wind waves forecasting system will improve with improvement of weather forecasting.

References

Environmental Modeling Center, 2003: The GFS Atmospheric Model. NCEP Office Note 442. Global Climate and Weather Modeling Branch, EMC, Camp Springs, Maryland, 14 pp.

Naeije, M., R. Scharroo, E. Doornbos, and E.. Schrama, 2008: Global Altimetry Sea-level Service: GLASS. NIVR/SRON GO project: GO 52320 DEO, 107 pp.

Strukov, B.S., A.A. Zelenko, Yu.D. Resnyansky, and S.L. Martynov, 2012: Verification of the Wind Wave Forecasting System for the Black, Azov and Caspian Seas.// Research Activities in Atmospheric and Oceanic Modelling. Ed. by A. Zadra. WCRP Rpt No. 5/2012. p. 08-05–08-06.

Tolman, H.L., 2009: User manual and system documentation of WAVEWATCH III version 3.14. NOAA/NWS/NCEP/MMAB Technical Note 276, 194 pp + Appendices [Available at http://polar.ncep.noaa.gov/waves/wavewatch/].