Coastal Ocean Surface Currents: melding HF Radar Observations with numerical Model Data

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COSYNA

Coastal Observing SYstem for Northern and Artic Seas

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General COSYNA approach

COSYNA - Coastal Observation System for Northern and Arctic Seas

Integration of observations and numerical model data to improve state estimates

Pre-operational system to demonstrate usefulness

www.cosyna.de
Coverage of the HF Radar-Stations

- WERA Radar measures Radial-component of surface currents
- 12.5 MHz WERA HF Radar
- Measurement every 20 min
- Observation grid with 2 km resolution
Atmospheric forcing (6-hr ECMWF data analyses),
river run-offs, open BC – tides, T and S

North Sea-Baltic Sea
\(\Delta \lambda = \Delta \phi = 3 \text{ min, Time step } = 30 \text{ s}\)
2 open boundaries (S and N)

German Bight
\(\Delta \lambda = \Delta \phi = 1 \text{ km, Time step } = 10 \text{ s}\)
2 open boundaries (W and N)
- also MYOCEAN BC

Wadden Sea
\(\Delta \lambda = \Delta \phi = 200 \text{ m, Time step } = 3 \text{ s}\)
3 open boundaries (W, N and E)

Sylt-Römö
\(\Delta \lambda = \Delta \phi = 200 \text{ m, Time step } = 3 \text{ s}\)
3 open boundaries (W, N and E)

+ ocean wave model (WAM)
+ SPM model
Model (GETM) vs. WERA
(Radial component Wangerooge)
Circulation Modell Errors

Systematic errors

• Bathymetry errors
• Bottom roughness
• Turbulence parameterisation
• ..........

Non-systematic errors

• Meteo forcing errors
• Boundary forcing errors
• Numerical scheme / physical model approximations
• river run off
Challenges

• **Currents in the German Bight are strongly dominated by tides**
  Applying standard assimilation methods the information provided by observations in the GB is lost very rapidly.

• **HF radar measurements are very frequent**
  Applying standard assimilation filters will cause permanent shocks at model restarts.
→ HF radar data from previous 18 hours
→ Free run forecast for next 6 hrs
Comparison mit FINO-3 Daten

Statistics for Nov 25-Dec 15, 2010

<table>
<thead>
<tr>
<th></th>
<th>Free run</th>
<th>Analysis</th>
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</thead>
<tbody>
<tr>
<td>bias u (sim-FINO3) [m/s]</td>
<td>0.1232</td>
<td>0.0944</td>
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<tr>
<td>bias v (sim-FINO3) [m/s]</td>
<td>0.0071</td>
<td>0.0182</td>
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<td>stdv u (sim-FINO3) [m/s]</td>
<td>0.1523</td>
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<tr>
<td>stdv v (sim-FINO3) [m/s]</td>
<td>0.1908</td>
<td>0.1171</td>
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<tr>
<td>rms u (sim-FINO3) [m/s]</td>
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<td>0.1645</td>
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<tr>
<td>rms v (sim-FINO3) [m/s]</td>
<td>0.1909</td>
<td>0.1186</td>
</tr>
</tbody>
</table>

U-component

V-component
Forecast Skill

u current component

Statistics refers to domain where 2D information from radar is available for Feb 1 – Apr 1, 2011
- Use COSYNA as a test laboratory (Hf radar, glider, fixed stations, ...)
- Impact studies (OSSE experiments)
- Use of spaceborne data to correct systematic errors in numerical models (use currents and elevation info + wind (?) + waves (?))  
  
  $1 \text{ km scale and below}$
  $< 0.1 \text{ m/s accuracy}$
- Improve error models for circulation models (spatial error correlations) required for assimilation

- Use satellite data in an operational assimilation framework? (e.g. through boundary forcing)
  \[ \text{km scale and below,} \]
  \[ < 0.1 \text{ m/s accuracy} \]

- Revisit time of < 6 hrs required to resolve dominant tidal M2 constituent?

- Directional information important (e.g., "WaveMill")