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

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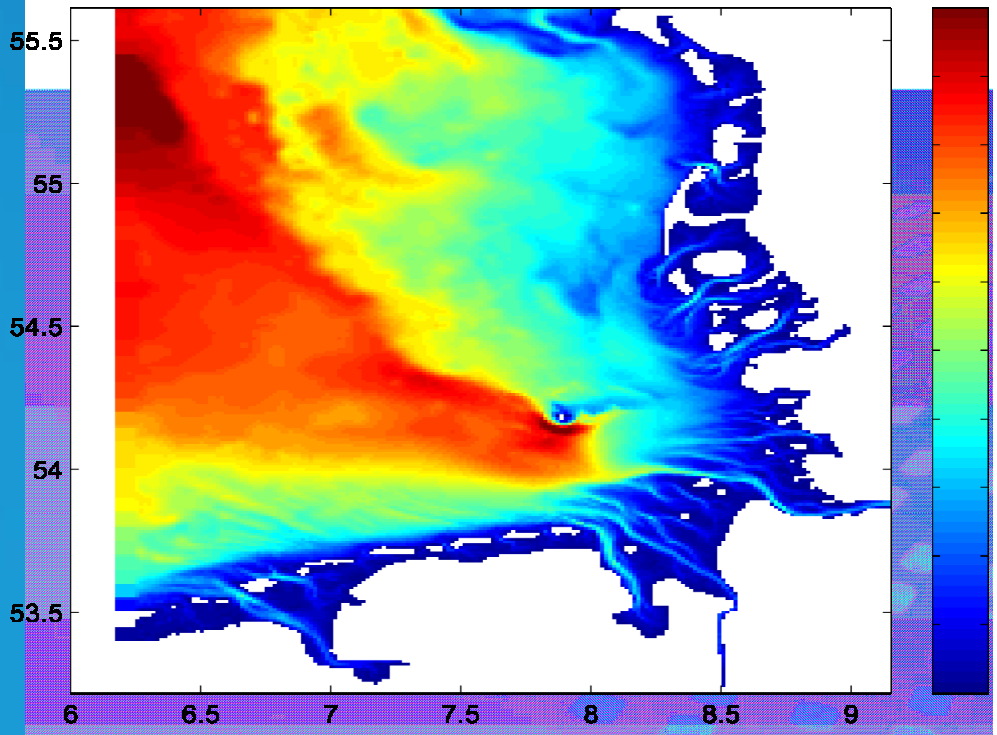
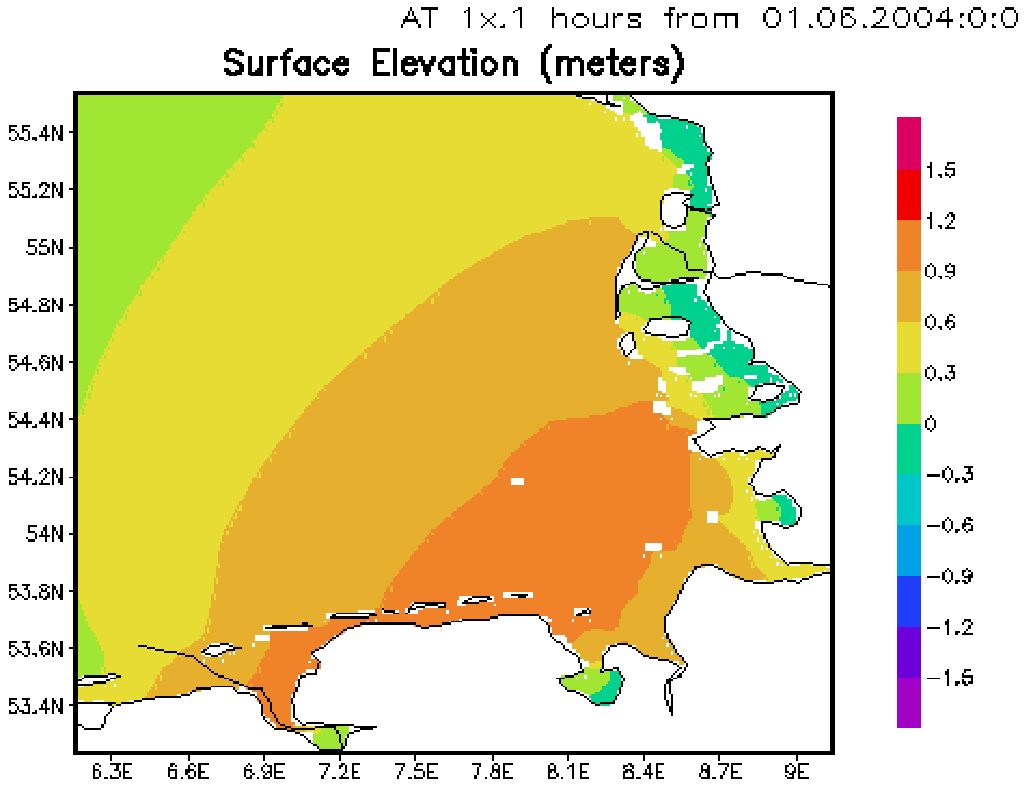
Zentrum für Material- und Küstenforschung

German Bight





---------- 200 km ----------

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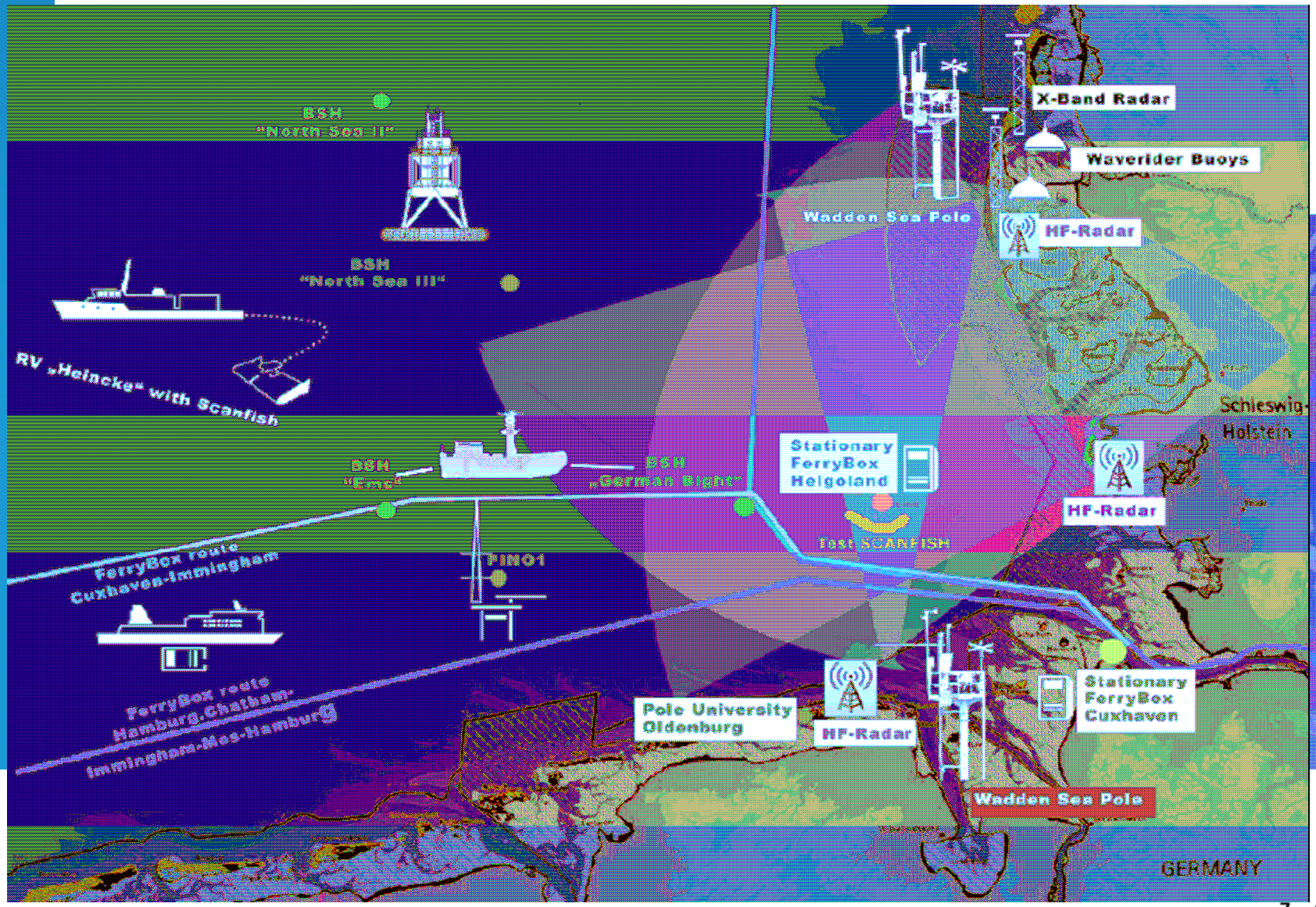
COSYNA



Coastal Observing SYstem for Northern and Artic Seas

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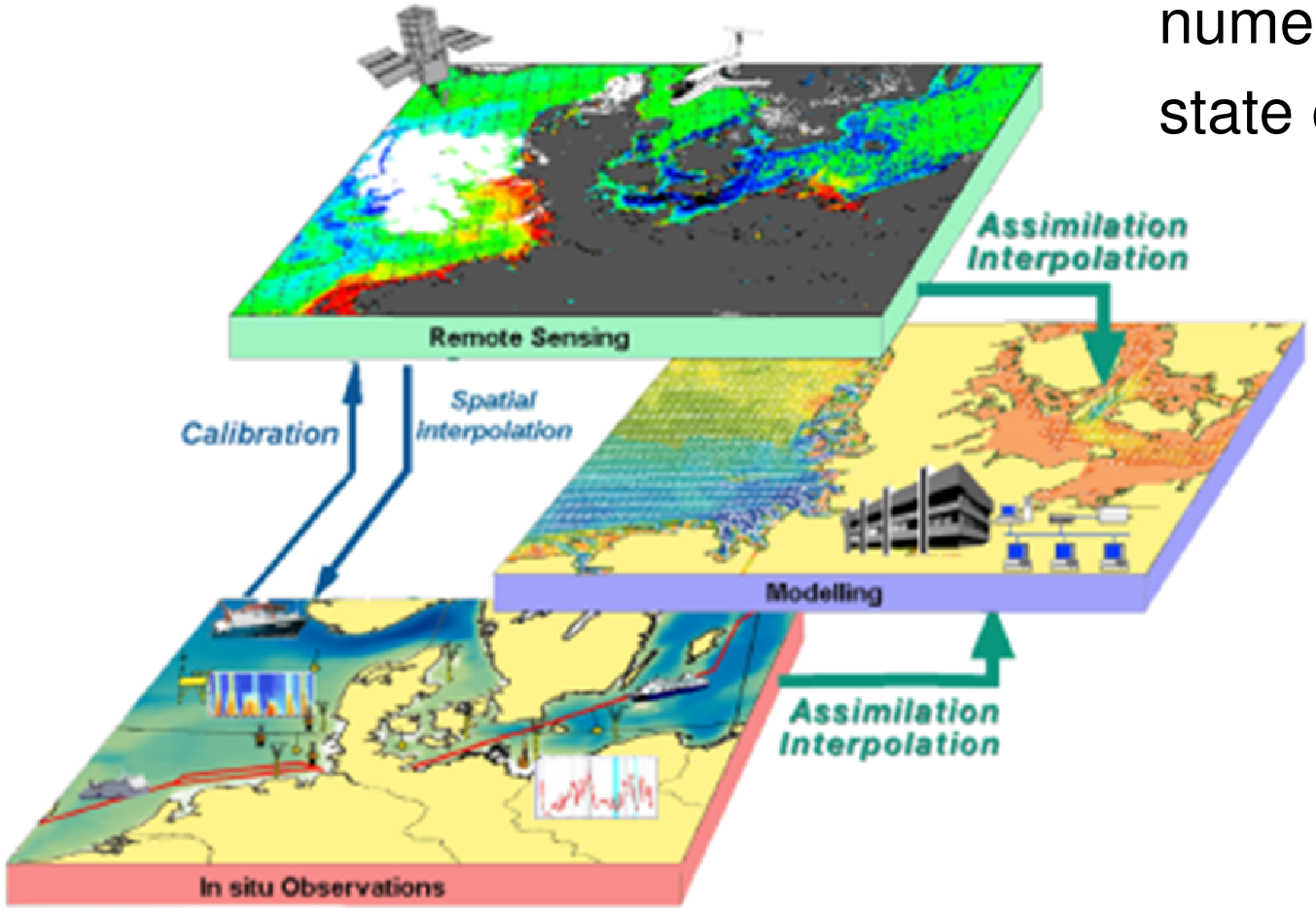
General COSYNA approach

COSYNA - Coastal Observation System for Northern and Arctic Seas



Integration of observations and numerical model data to improve state estimates

Pre-operat ional system to demonstrate usefulnes

www.cosyna.de

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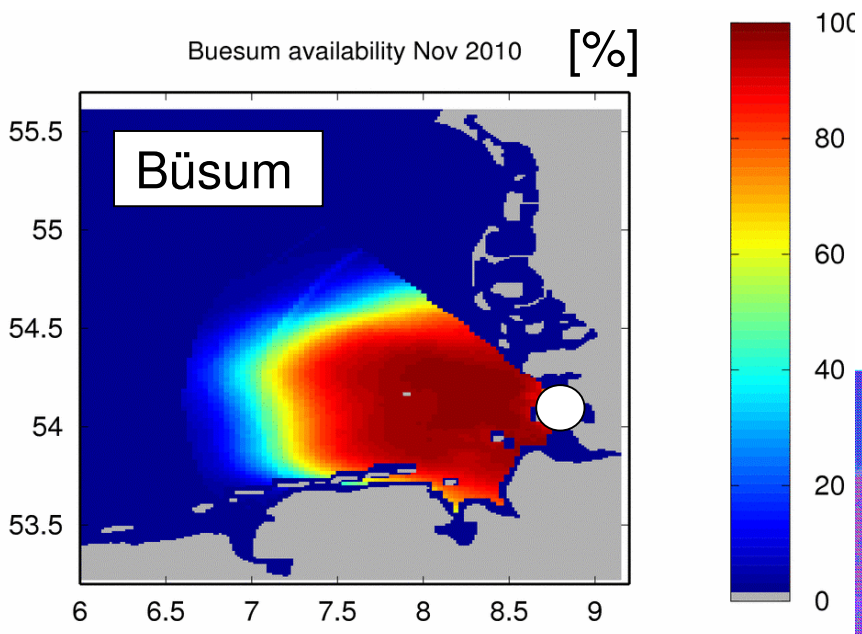
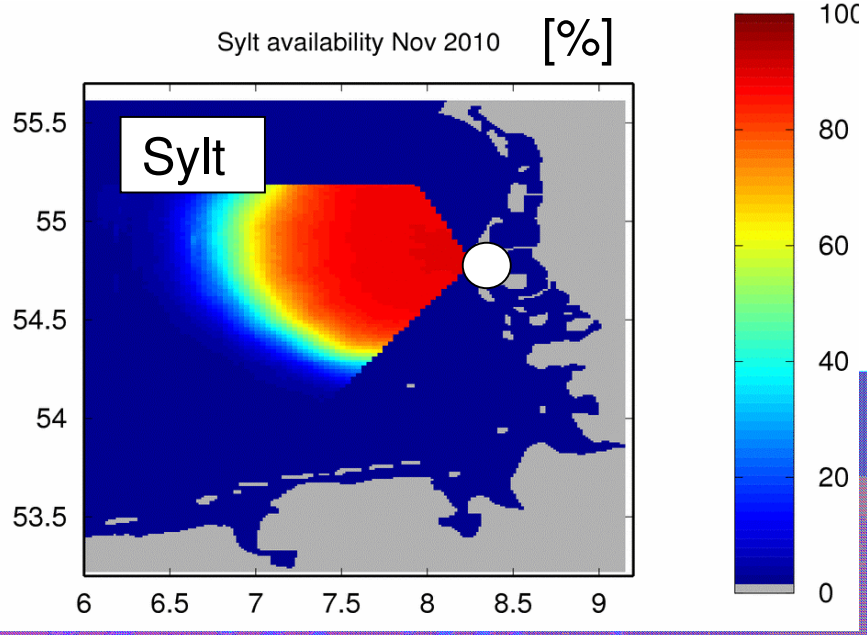
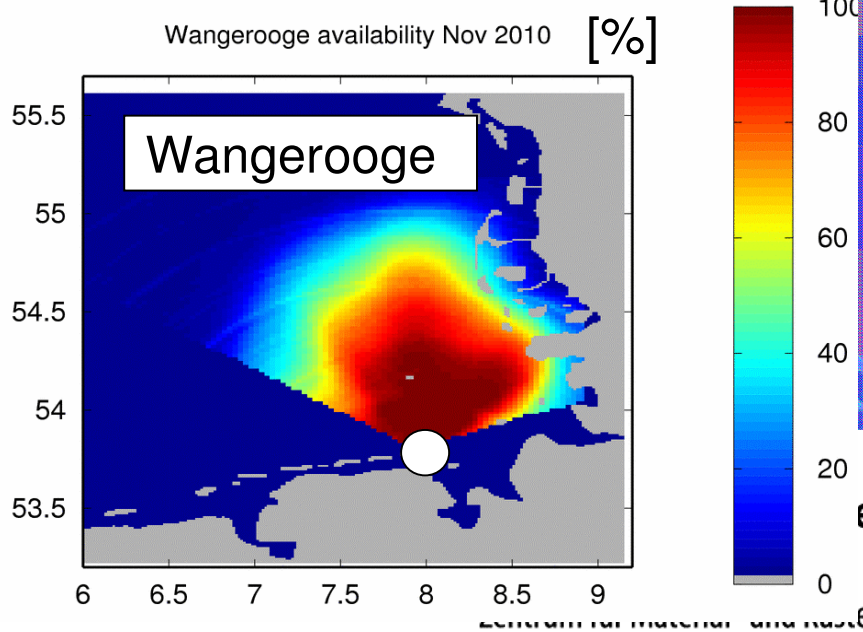
Coverage of the HF Radar-Stations







- **WERA Radar measures Radial-component of surface currents**
- **12.5 MHz WERA HF Radar**
- **Measurement every 20 min**
- **Observation grid with 2 km resolution**

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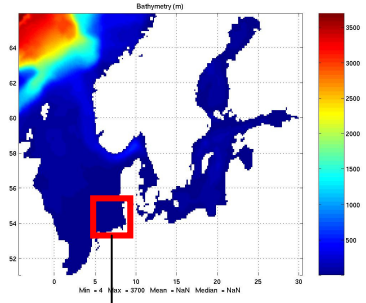
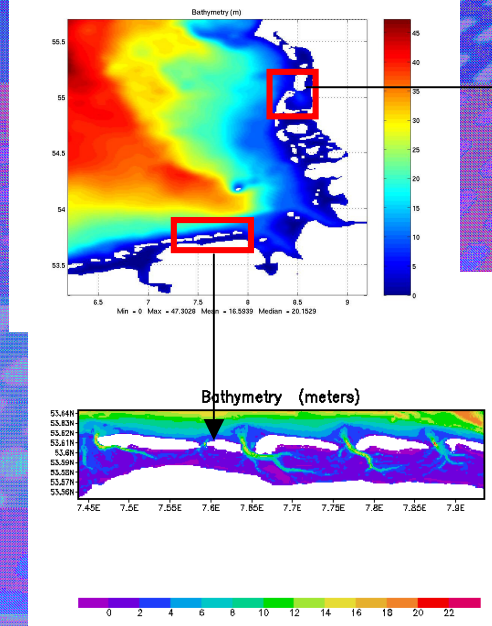
Numerical 3D circulation Model

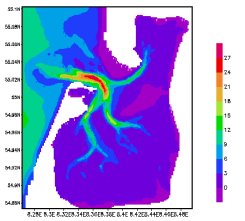
Atmospheric forcing (6–hr ECMWF

river run-offs,

open BC – tides, T and S







+ ocean wave

model (WAM)

+ SPM model

North Sea-Baltic Sea

$\Delta\lambda=\Delta\phi$= 3 min, Time step = 30 s

2 open boundaries (S and N)

German Bight

$\Delta\lambda=\Delta\phi$= 1 km, Time step = 10 s

2 open boundaries (W and N)

- also MYOCEAN BC

Wadden Sea

$\Delta\lambda=\Delta\phi$= 200 m, Time step = 3 s

3 open boundaries (W, N and E)

Sylt-Römö

$\Delta\lambda=\Delta\phi$= 200 m, Time step = 3 s

3 open boundaries (W, N and E)

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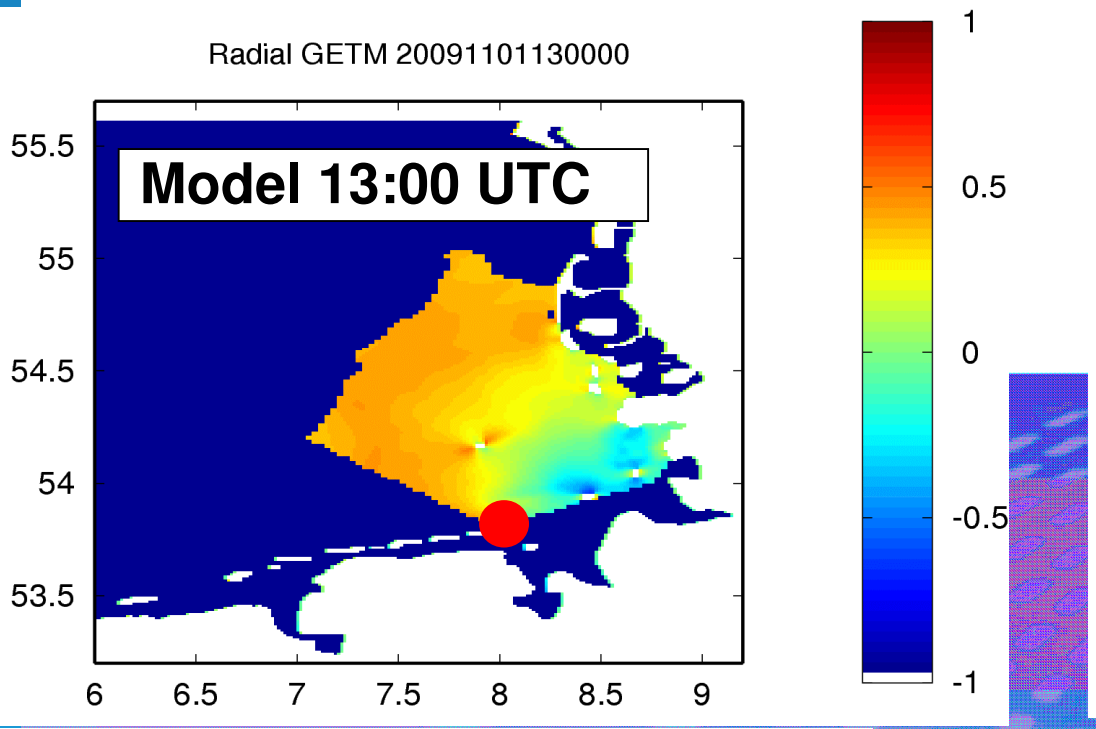
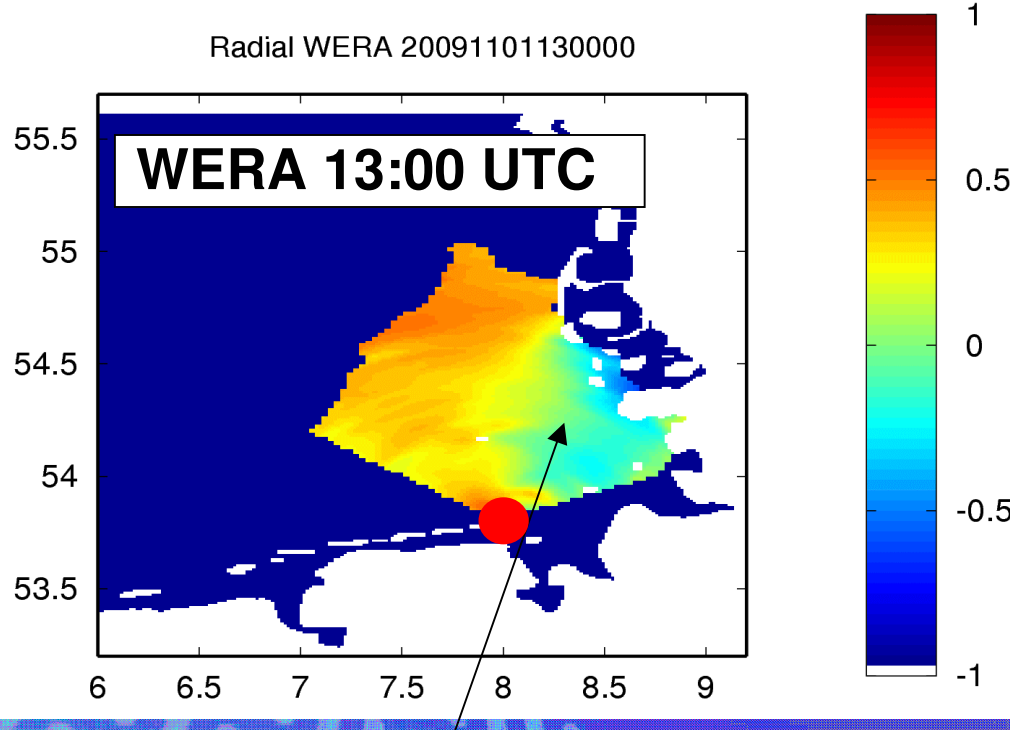
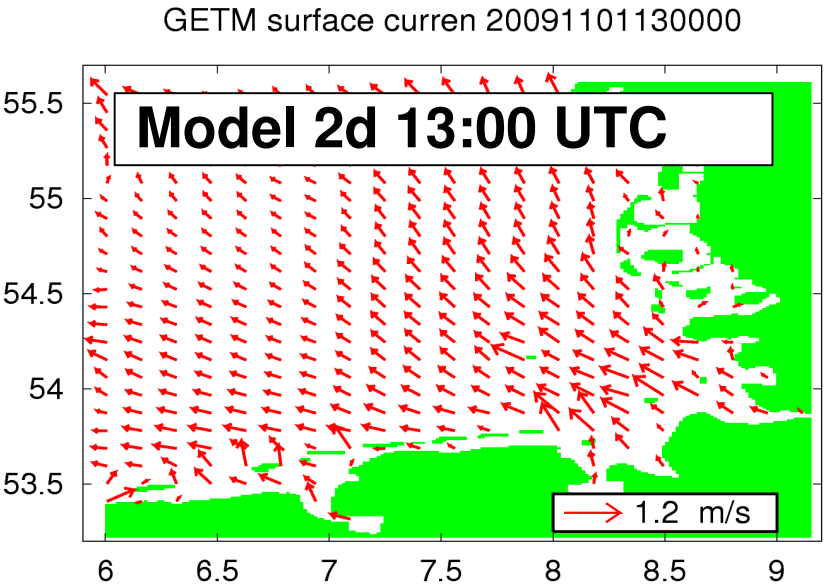
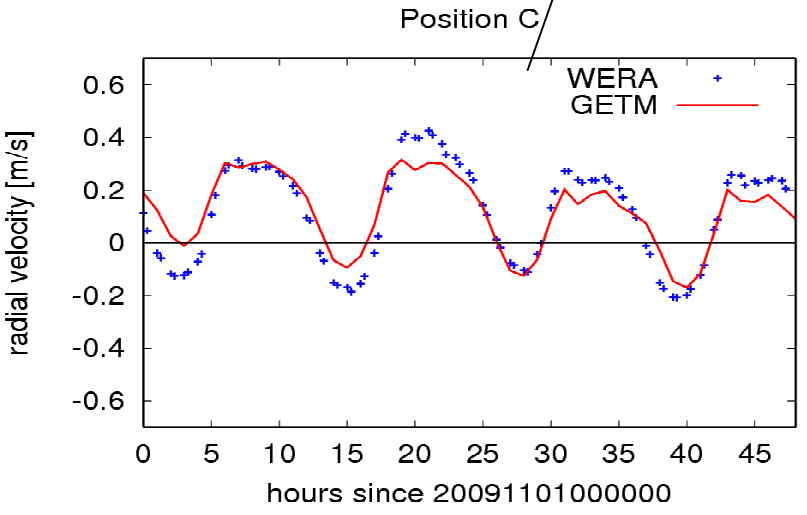
Model (GETM) vs. WERA
(Radialcomponent Wangerooge)









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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

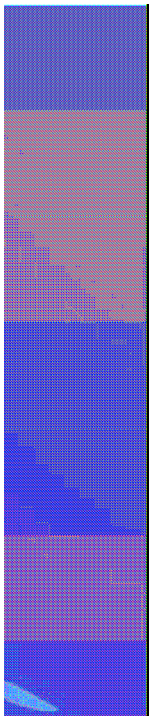
Challenges

- **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

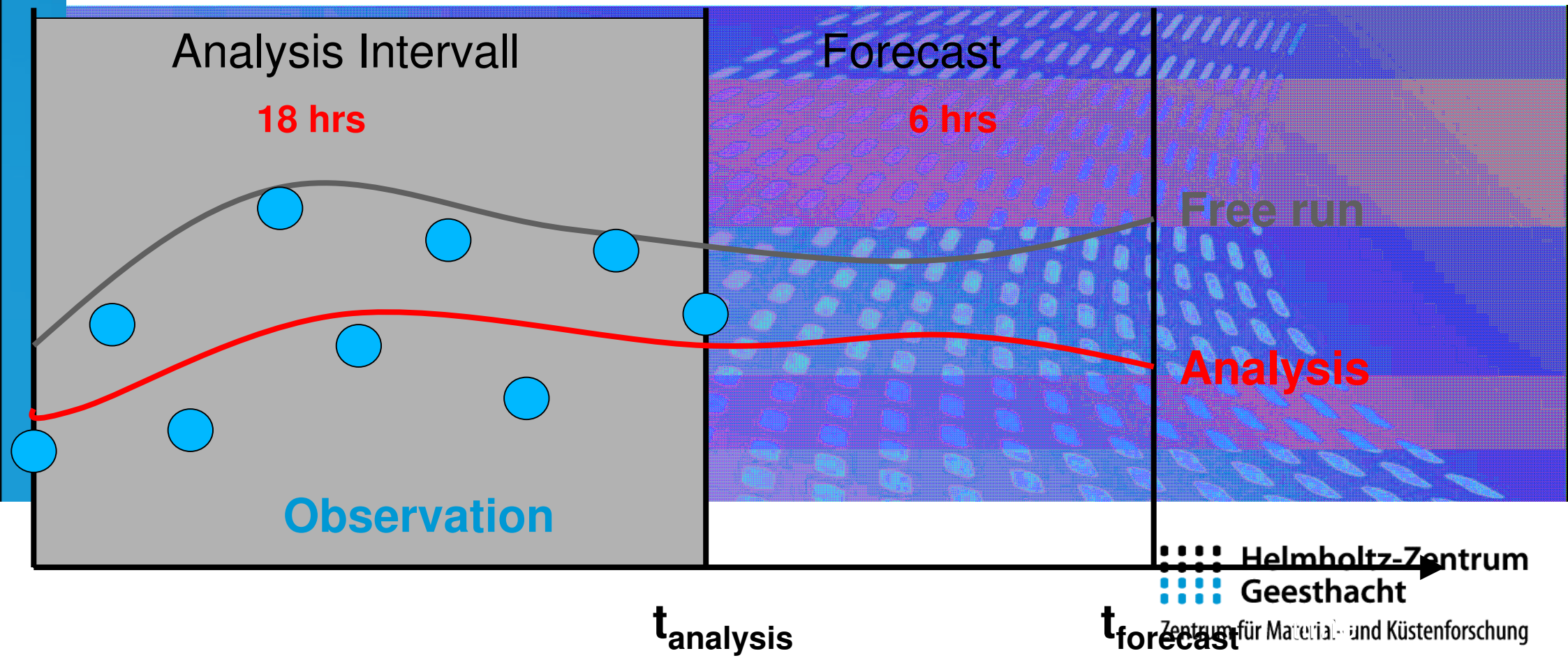
- **HF radar measurements are very frequent**

  Applying standard assimilation filters will cause permant shocks at model restarts

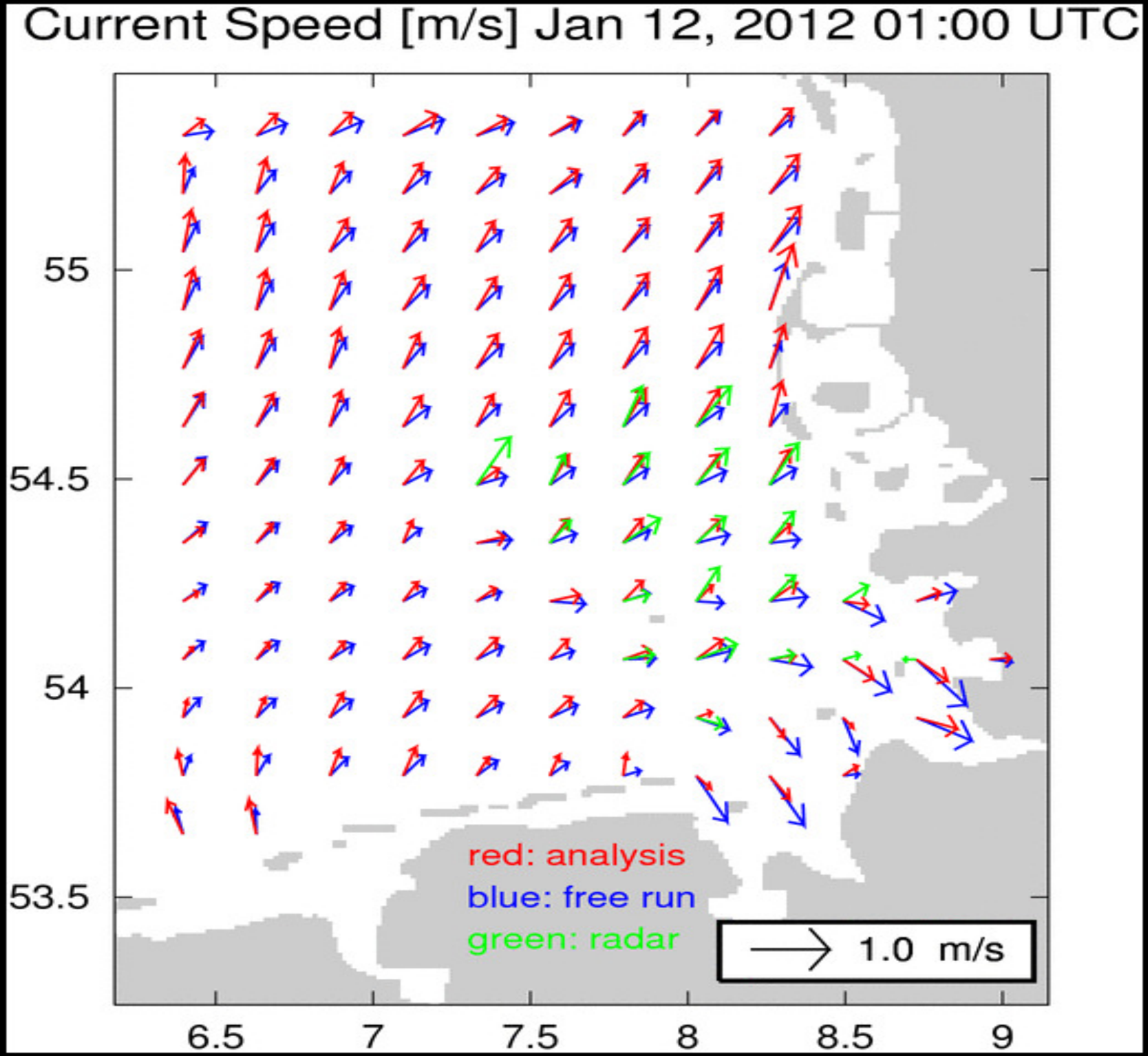


→HF radar data from previous 18 hours

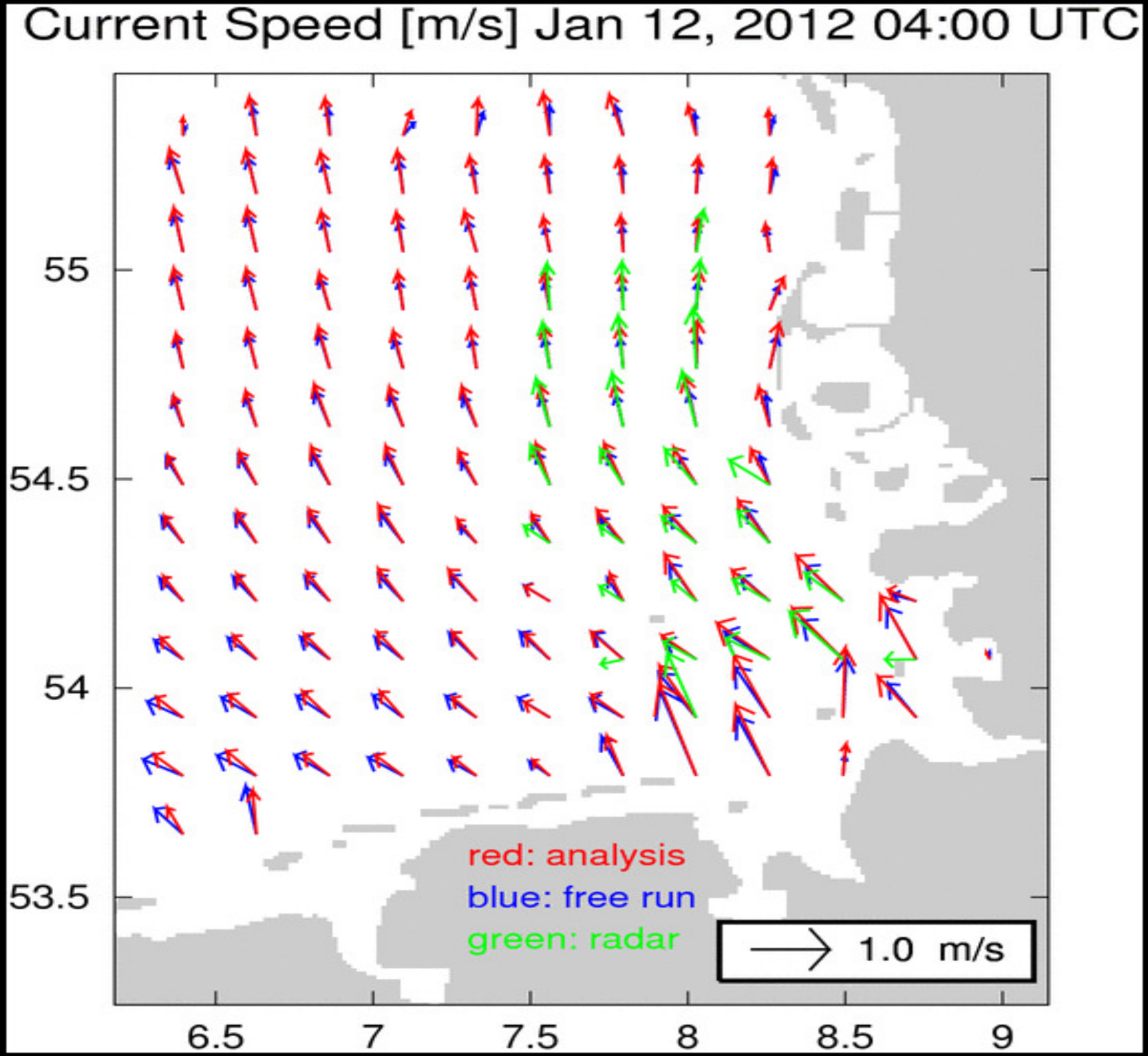
→Free run forecast for next 6 hrs



COSYNA


Current Speed [m/s] Jan 12, 2012 01:00 UTC
55
54.5
54
53.5
6.5
7
7.5
8
8.5
9
red: analysis
blue: free run
green: radar
1.0 m/s

COSYNA


Current Speed [m/s] Jan 12, 2012 04:00 UTC
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54.5
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53.5
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8.5
9
red: analysis
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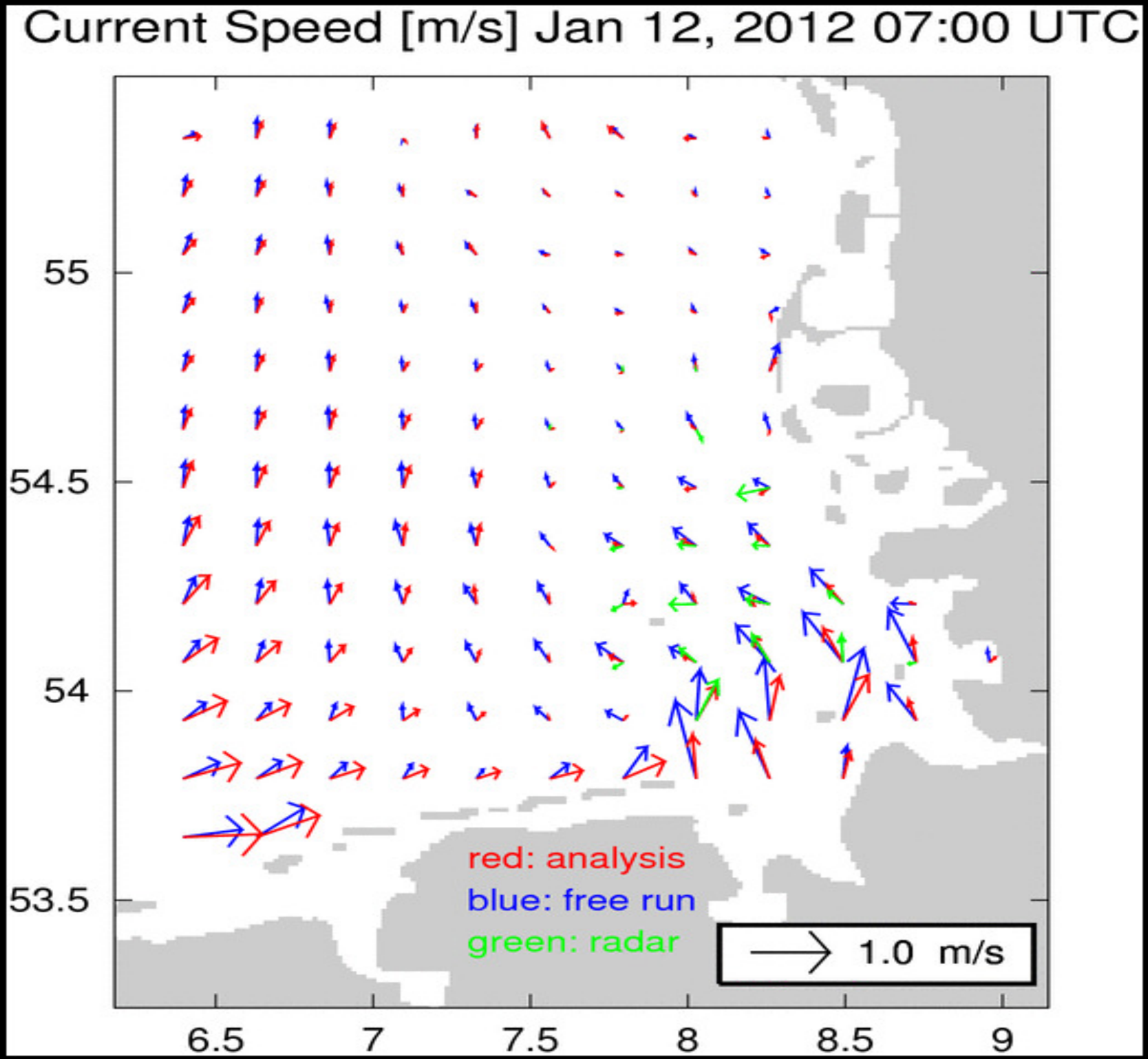
1.0 m/s

COSYNA


Current Speed [m/s] Jan 12, 2012 07:00 UTC
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54.5
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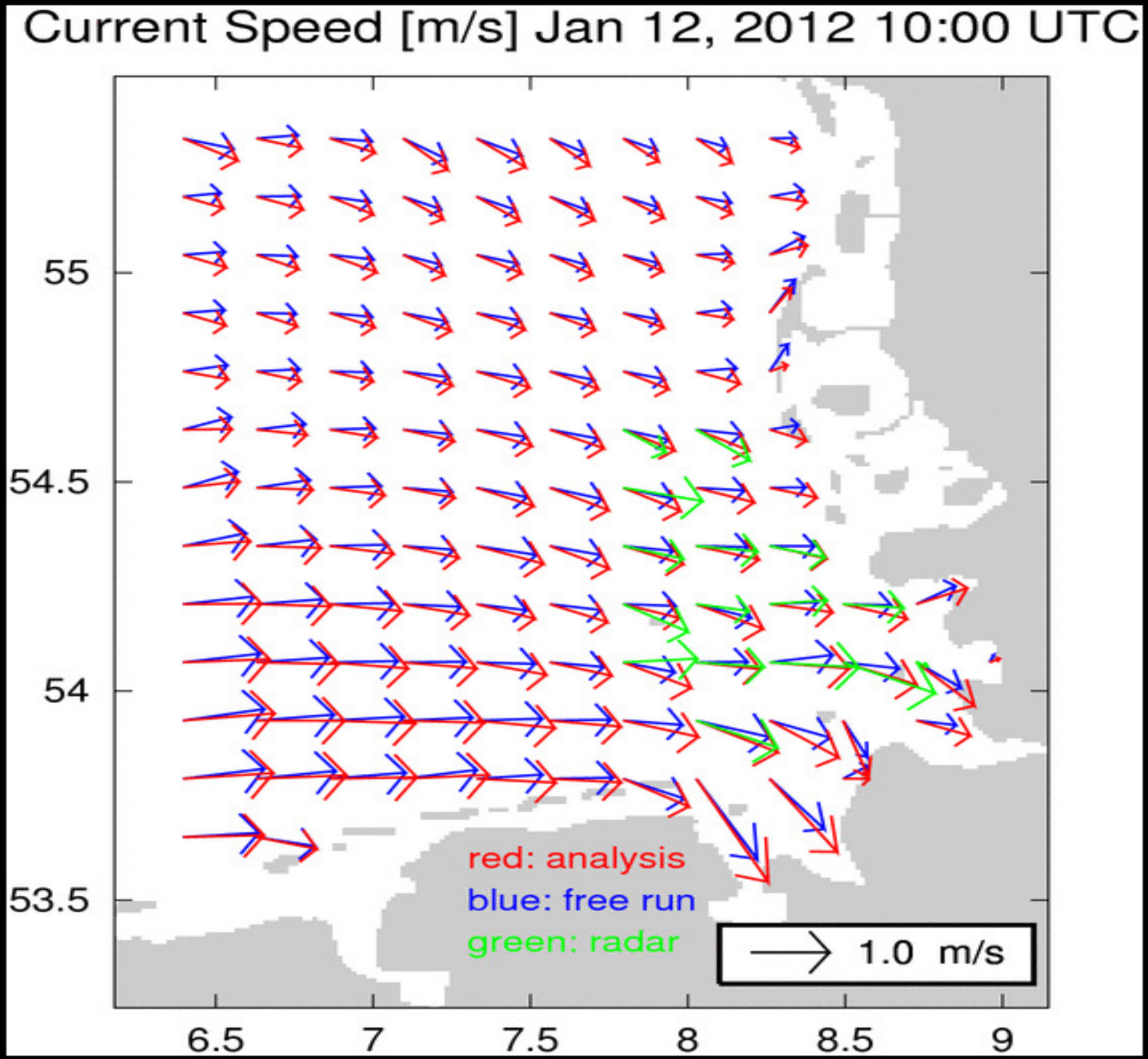
red: analysis
blue: free run
green: radar
1.0 m/s

COSYNA


Current Speed [m/s] Jan 12, 2012 10:00 UTC
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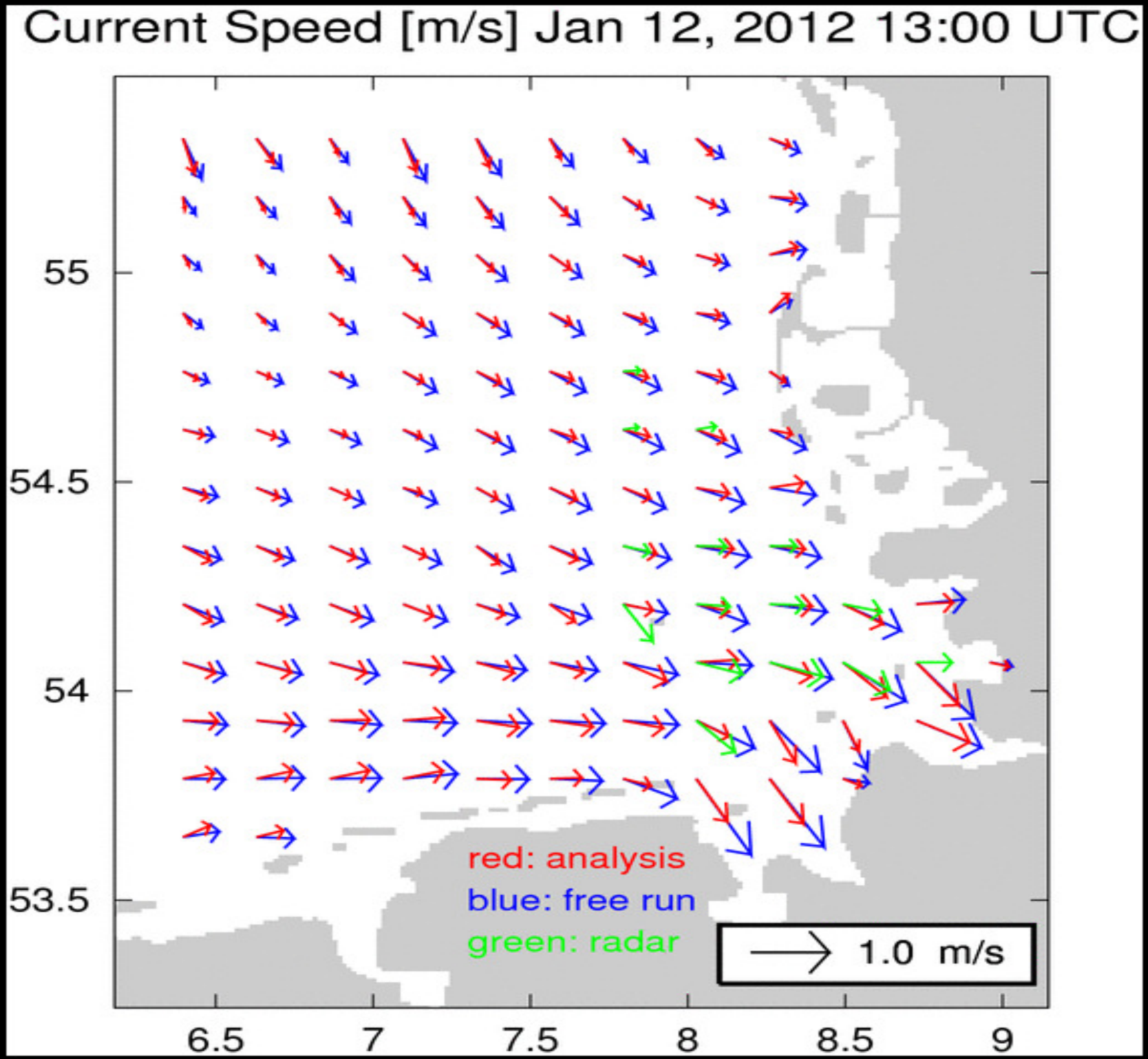
red: analysis
blue: free run
green: radar
1.0 m/s

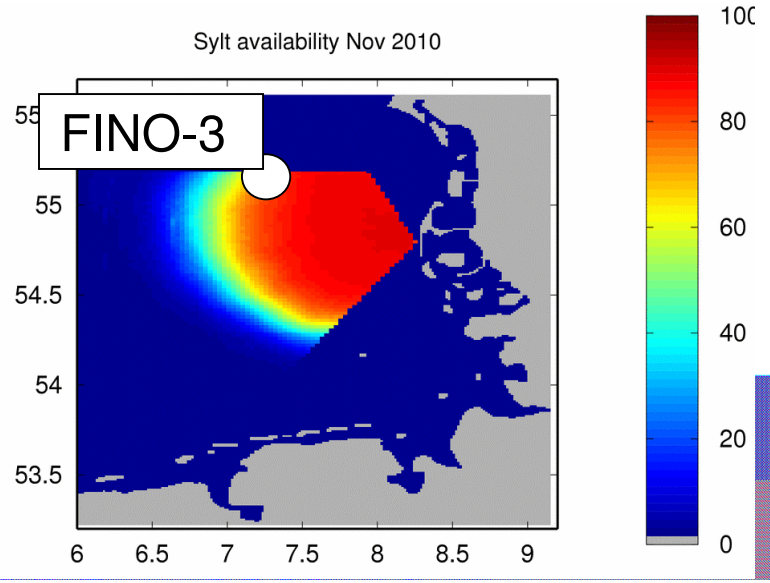
COSYNA

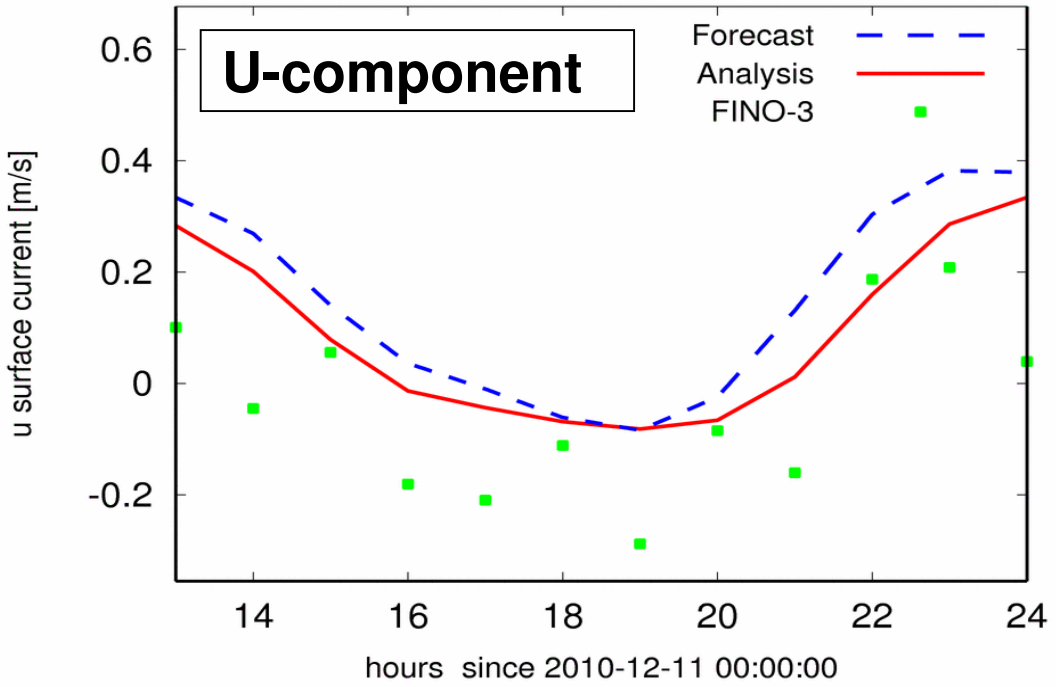

Current Speed [m/s] Jan 12, 2012 13:00 UTC
55
54.5
54
53.5
6.5
7
7.5
8
8.5
9
red: analysis
blue: free run
green: radar
1.0 m/s

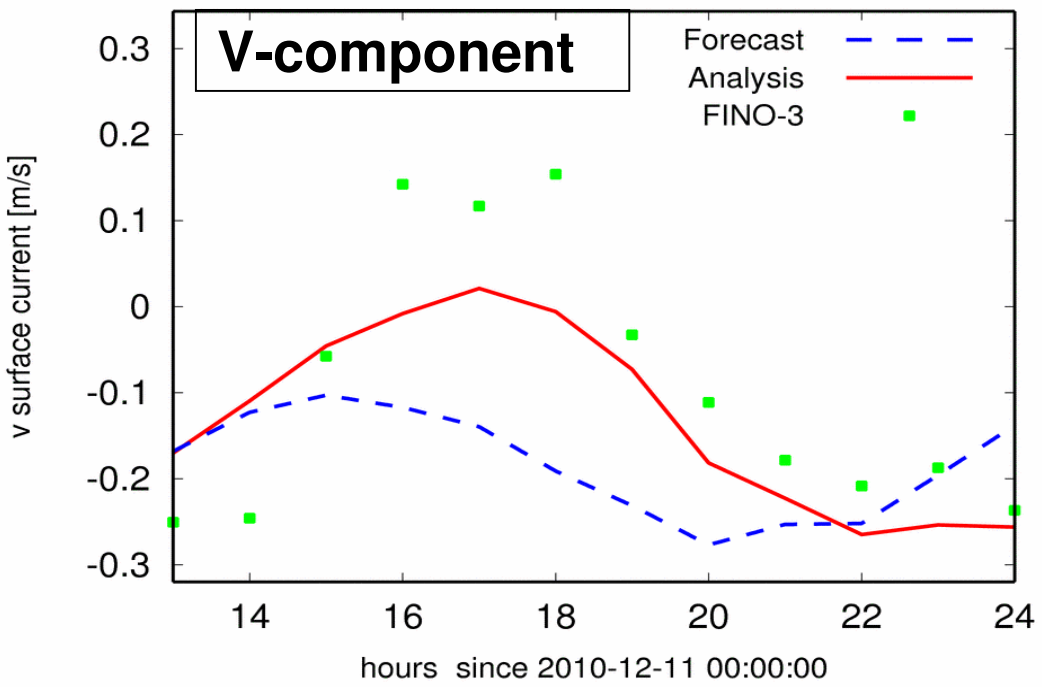
Comparison mit FINO-3 Daten

Statistics for Nov 25-Dec 15, 2010

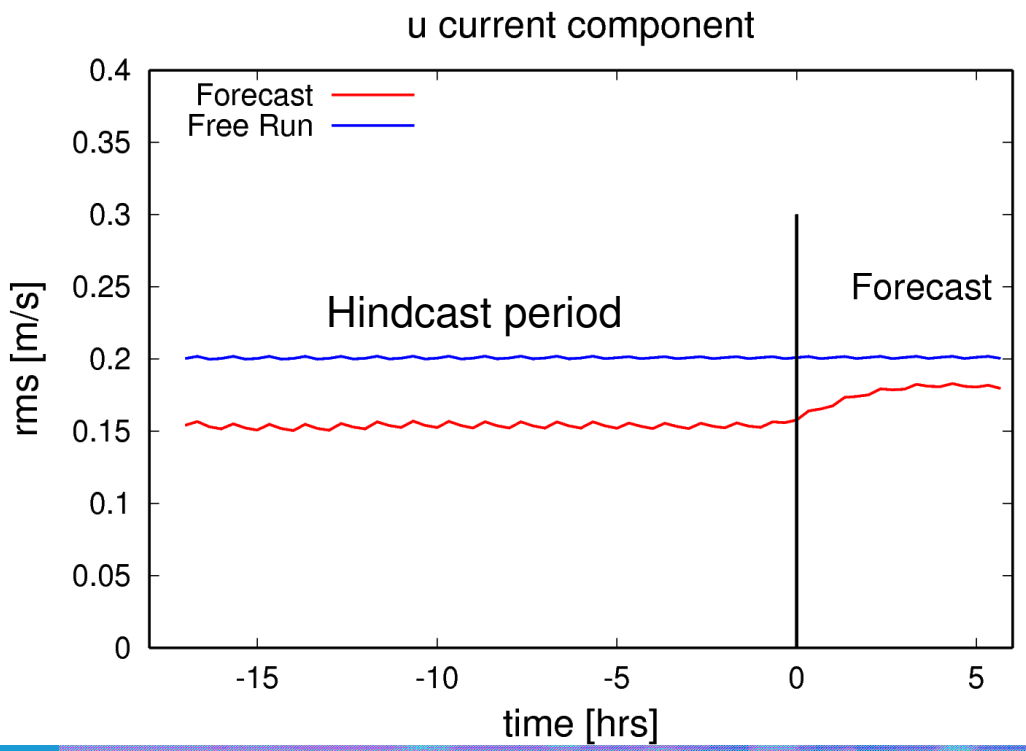
	Free run	Analysis
bias u (sim-FINO3) [m/s]	0.1232	0.0944
bias v (sim-FINO3) [m/s]	0.0071	0.0182
stdv u (sim-FINO3) [m/s]	0.1523	0.1348
stdv v (sim-FINO3) [m/s]	0.1908	0.1171
rms u (sim-FINO3) [m/s]	0.1958	0.1645
rms v (sim-FINO3) [m/s]	0.1909	0.1186

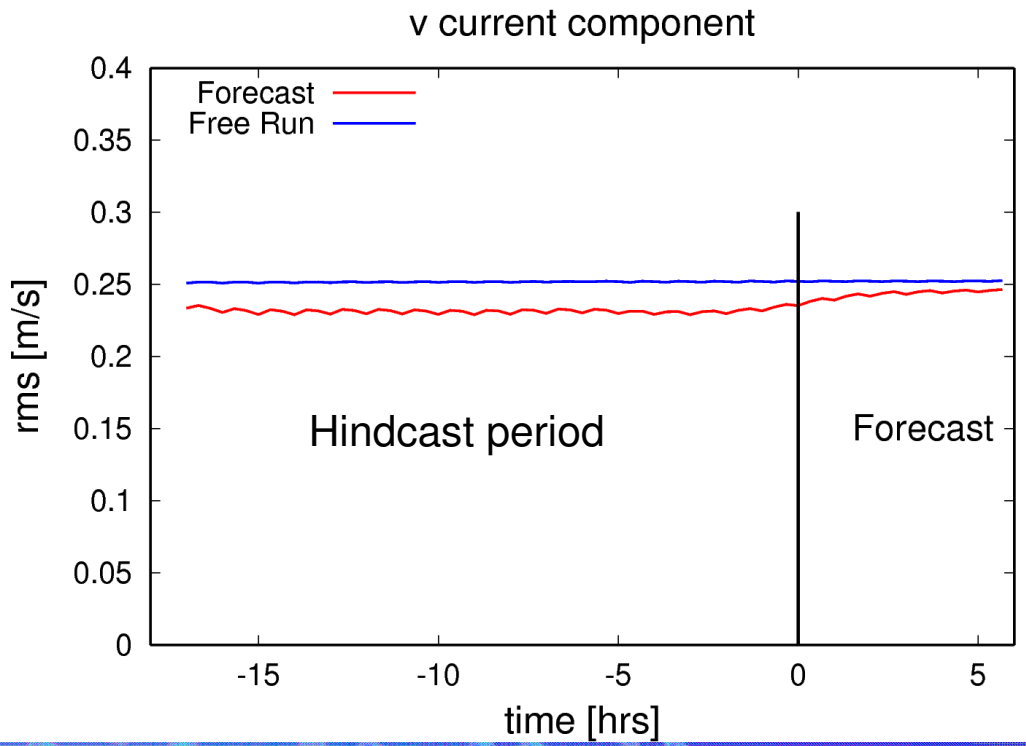






Forecast Skill





Statistics refers to domain where 2D information from radar is available for Feb 1 – Apr 1, 2011

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Link to spaceborne systems 1/2

- 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 km scale and below

< 0.1 m/s accuracy

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Link to spaceborne systems 2/2

- 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)

  ← km scale and below,

  < 0.1 m/s accuracy

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

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