Third Workshop on Remote Ocean Sensing
ROS 2011
11 – 13 October 2011
at NATO Undersea Research Center, La Spezia, Italy

HF RADAR BASED CURRENT OBSERVATION SYSTEM IN THE GERMAN BIGHT

Helmholtz-Zentrum Geesthacht
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Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

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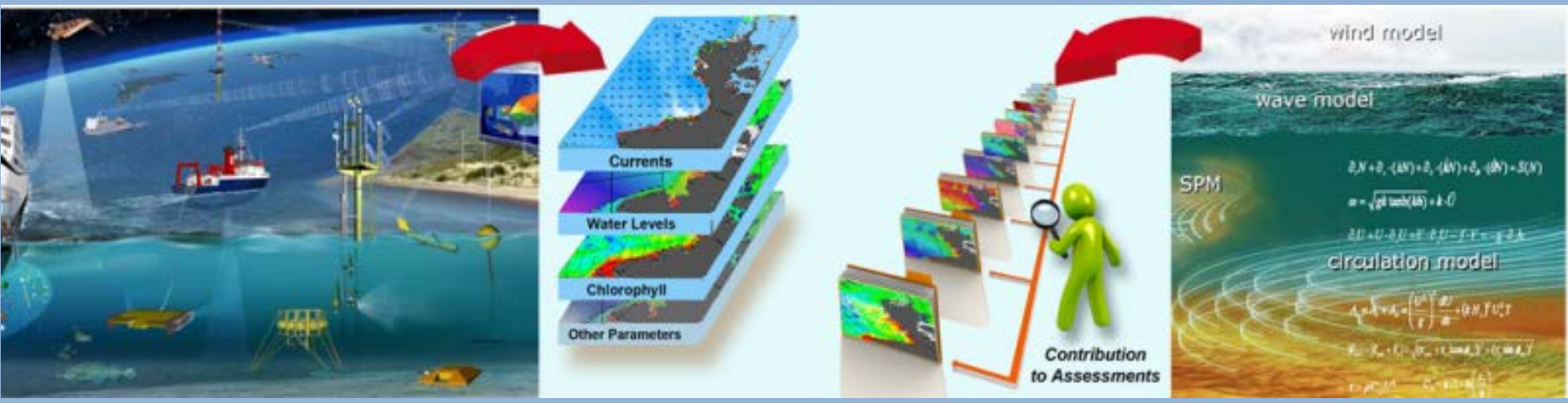
Overview

- COSYNA HF Radar Network in the German Bight
- Radio Frequency Interference (RFI) & other Disturbances
- Quality Control (QC)
- Cross-Validation with Ship-mounted ADCP

Coastal Observation System for Northern and Arctic Seas (COSYNA)

Operational COSYNA Products



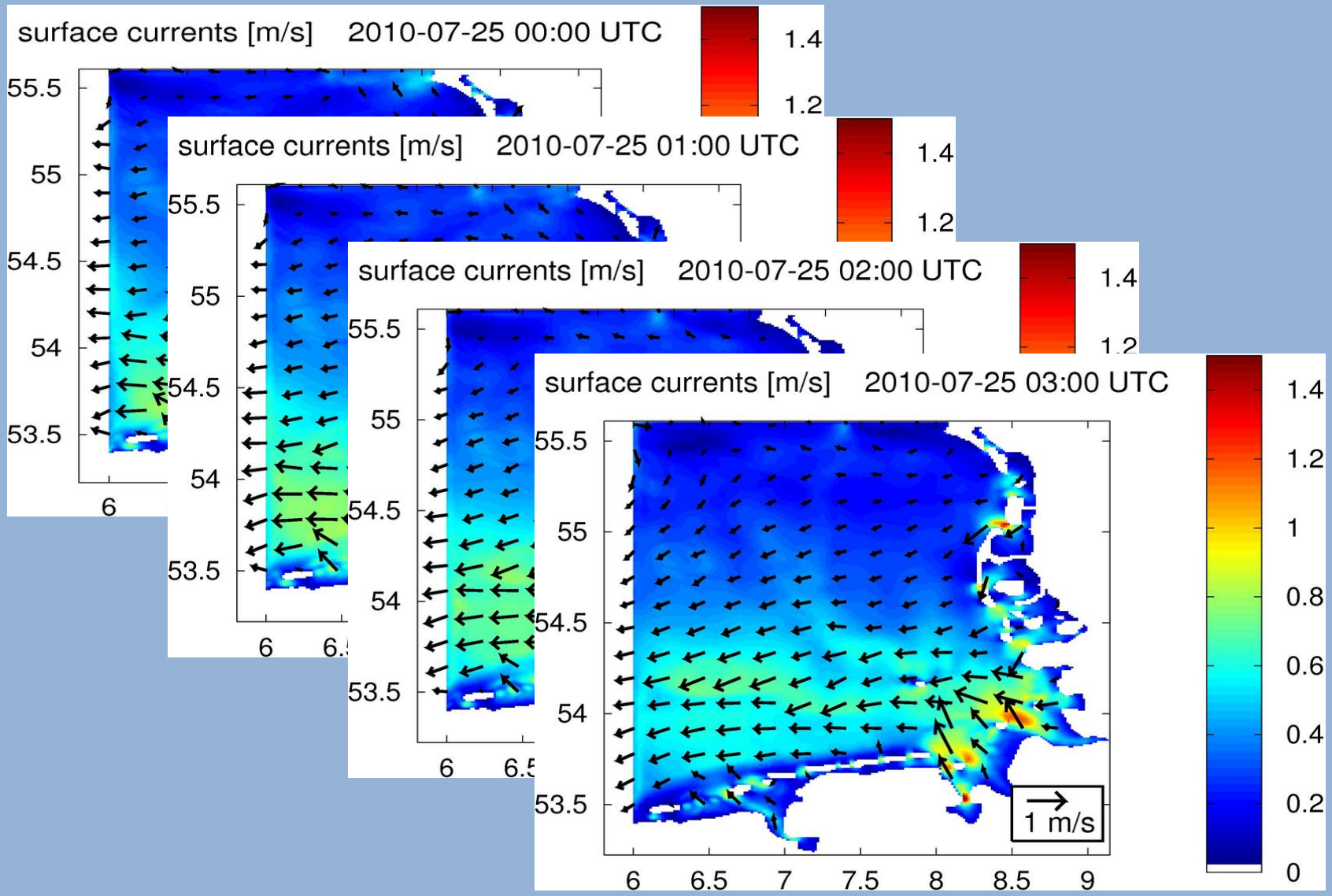
Realtime Maps

Analyses, Prognoses & Scenarios

- Pre-Operational Forecasting by combining Observations & Models

www.cosyna.org

Combination of HF Data & Model



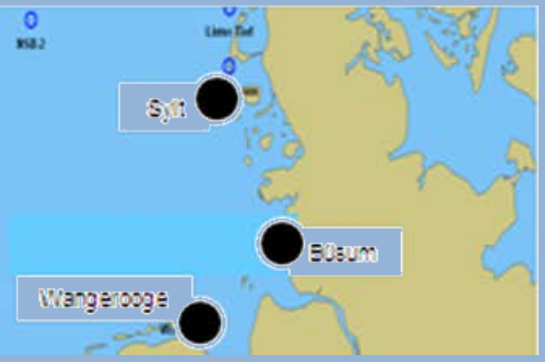
source: Johannes Schulz-Stellenfleth

HF Radar Stations

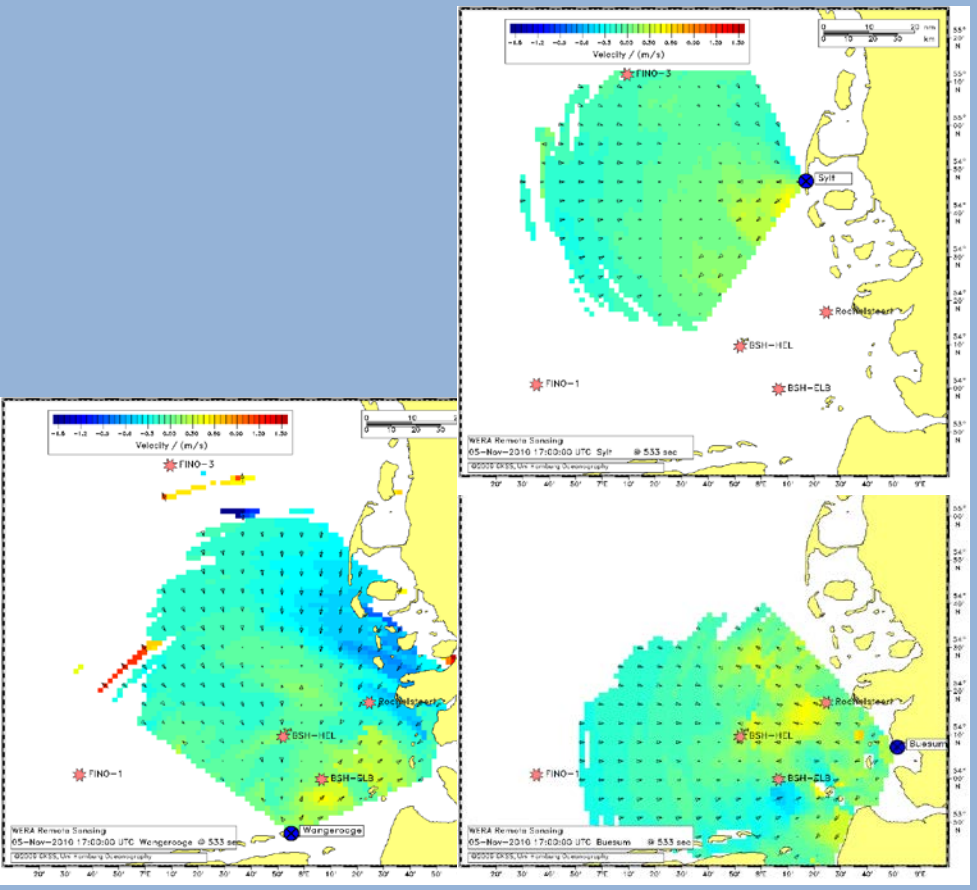
Wangerooge

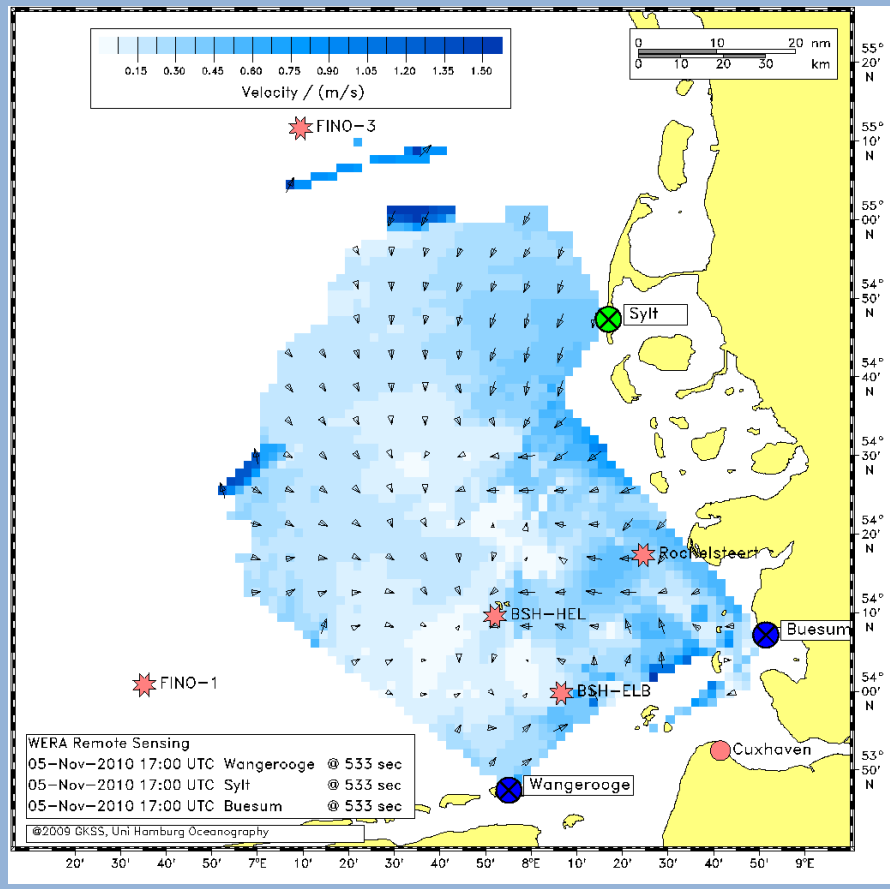
Büsum

Sylt



Current Vector Field from Radial Components





HF Radar Stations

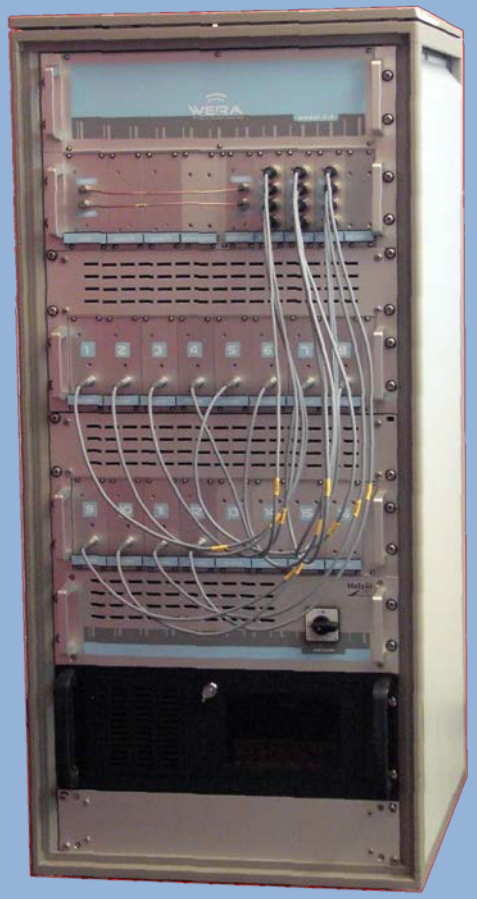
- Operating Frequencies: 10.8 MHz (Sylt and Büsum) 12.2/13.5 MHz (Wangerooge)

- Bragg Wave Penetration Depth for a Frequency of 12 MHz: 1 m

- A linear frequency chirp is transmitted, transmitter and receiver are operated simultaneously (FMCW).

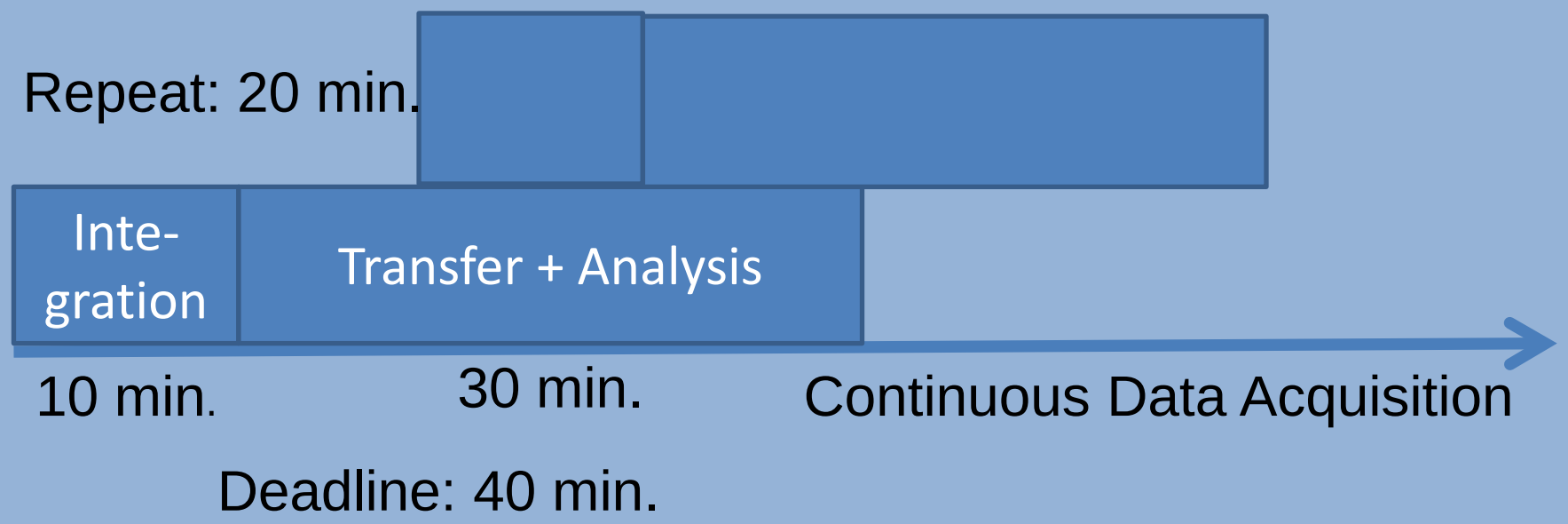
- Azimuthal and range resolutions: ±3 and 1.5 km, respectively

- Maximum Range: 120 km

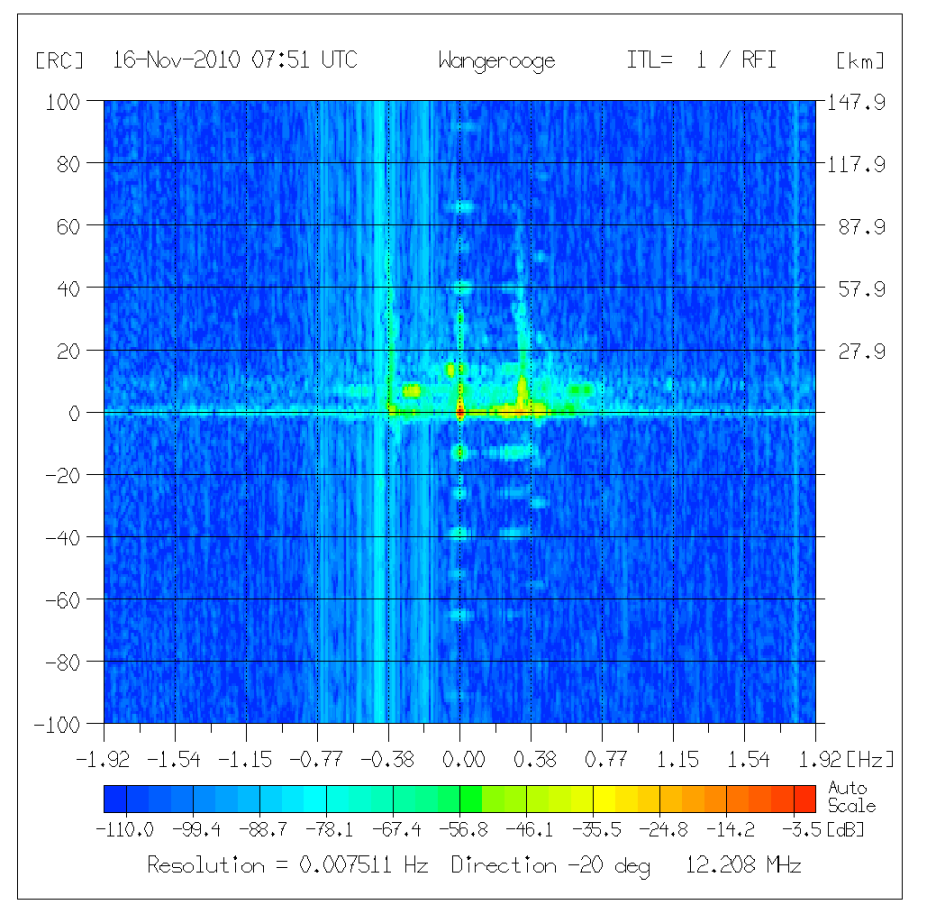


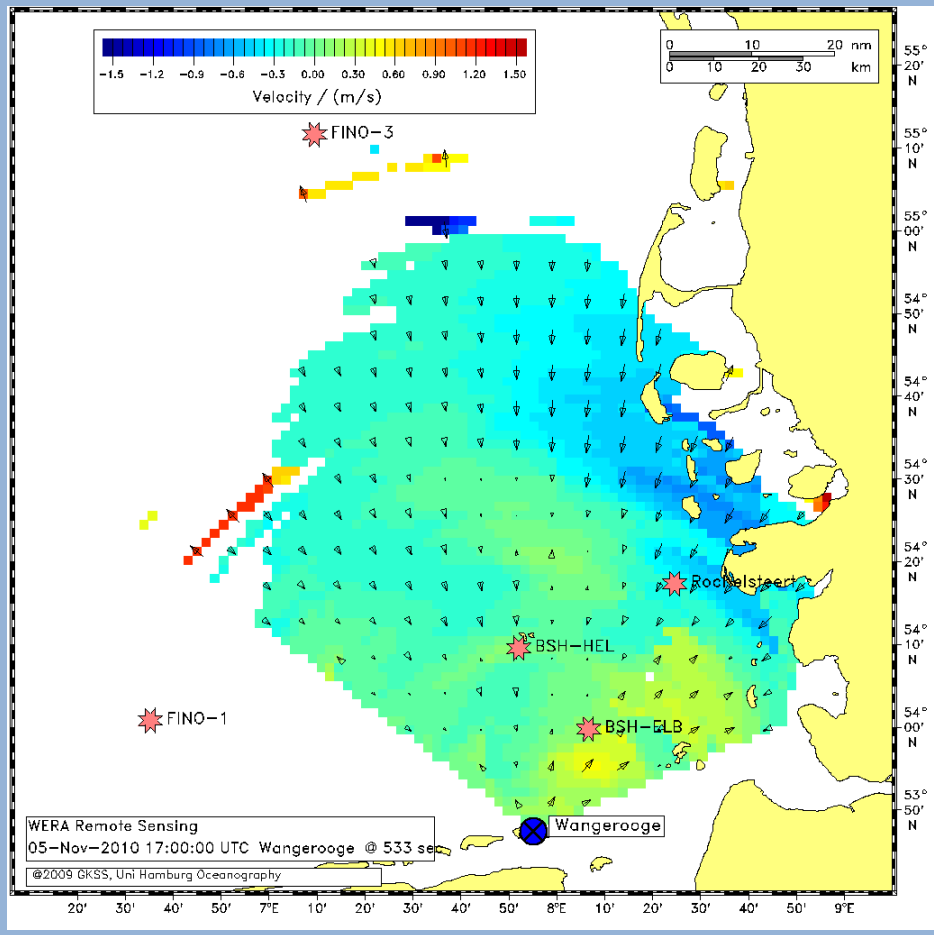
source: Helzel Messtechnik GmbH

HF-System Time Constraints



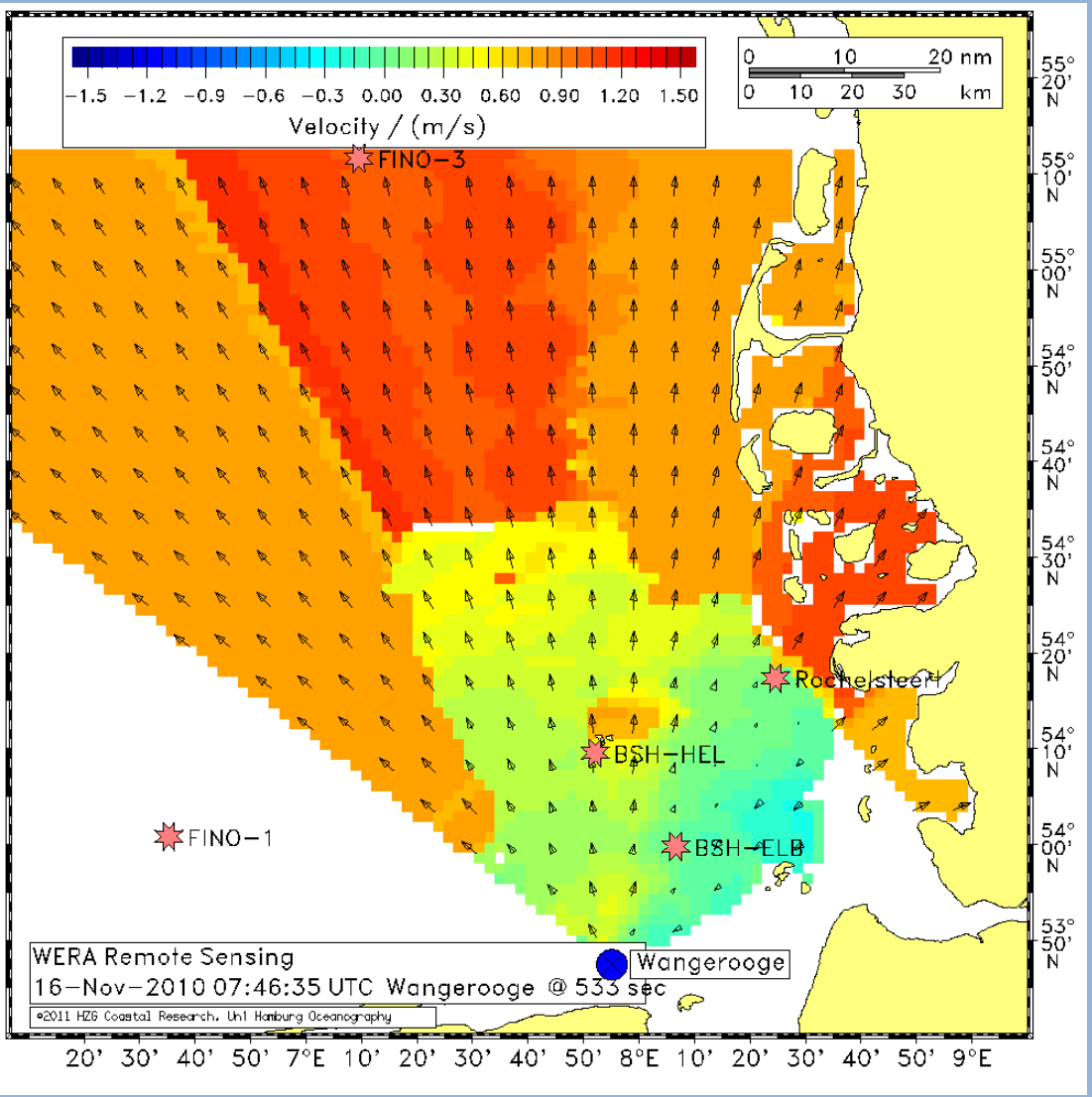
Reduction of Disturbances & QC in Range-Doppler & Spatio-Temoral Domain





RFI Reduction

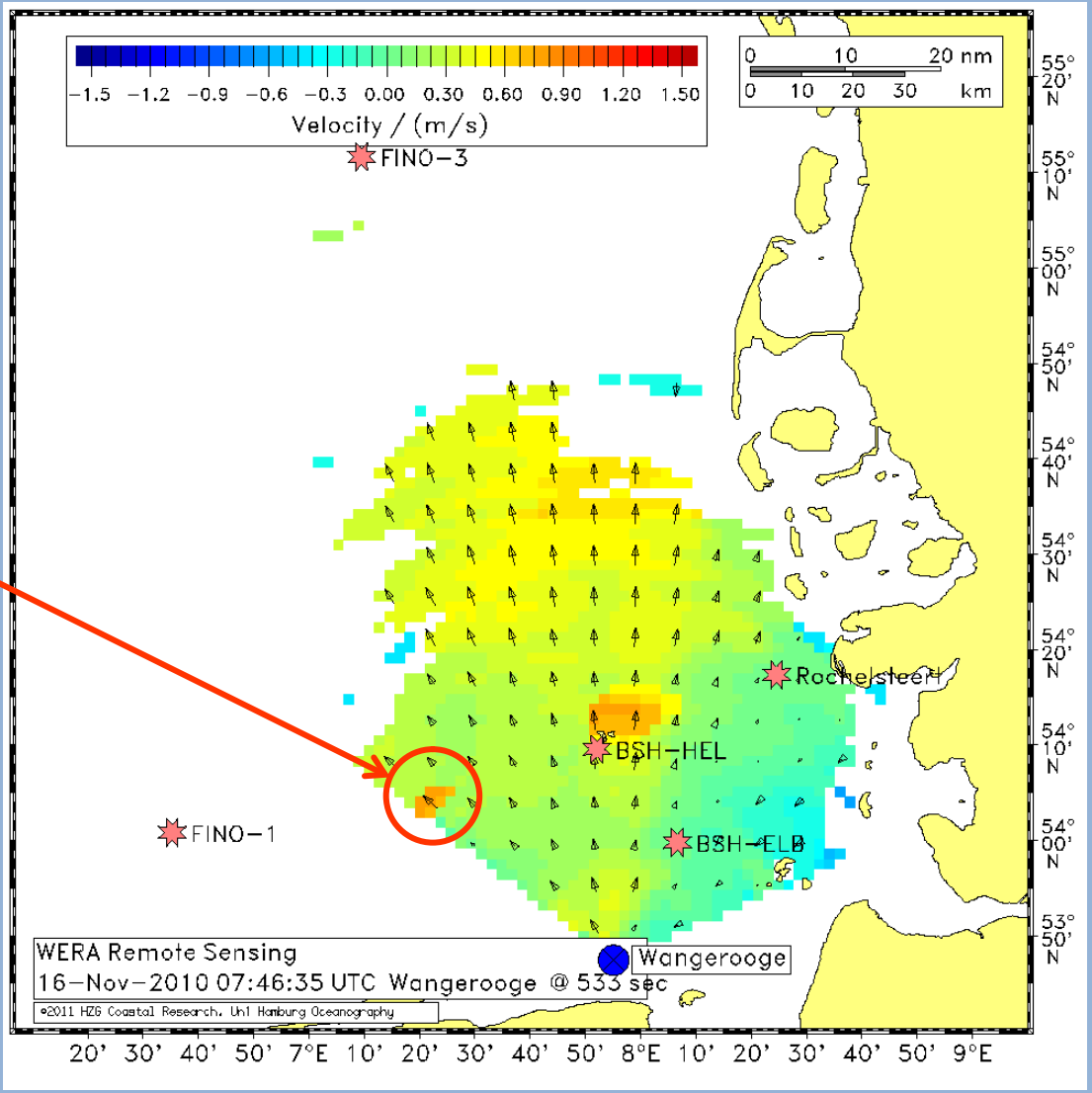
- Radial ocean current components measured at Wangerooge.
- Where RFI is stronger than the Bragg echoes, wrong values are calculated.



source: Gurgel et al., CWTM 2011

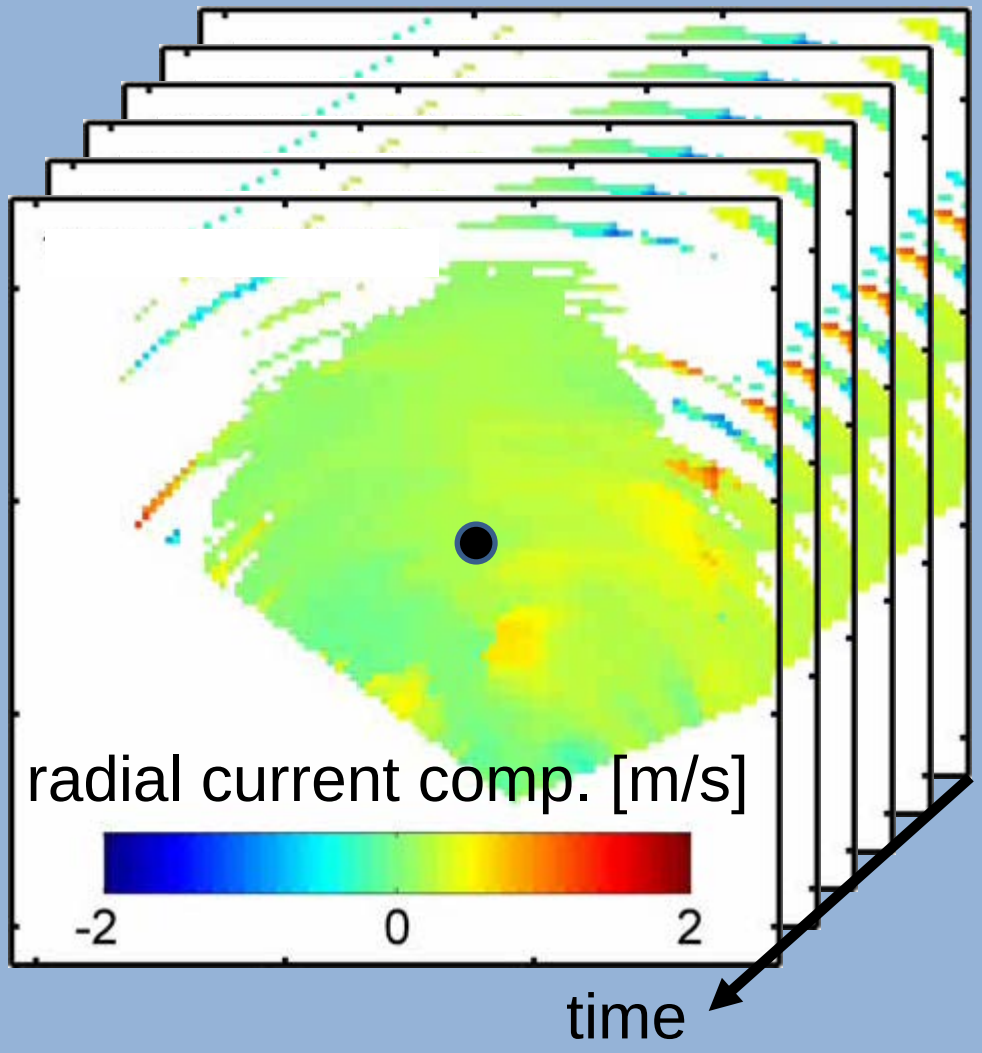
RFI Reduction

- Same as the previous map but with RFI reduction applied.
- Not all distrorted values due to RFI and line power frequency are removed.
- Implement an additional layer: Quality Control



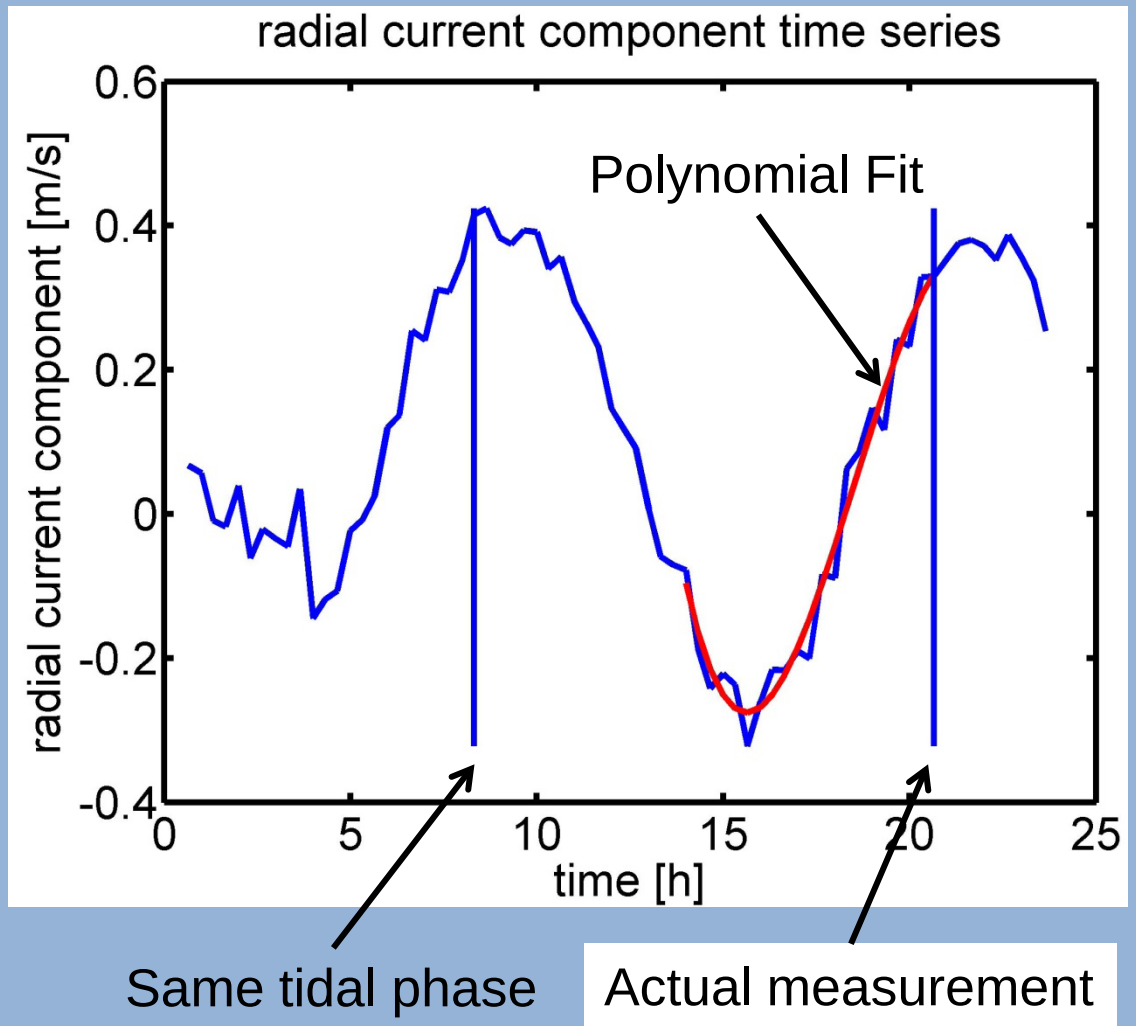
source: Gurgel et al., CWTM 2011

QC Scheme applied to Radial Current Component Sequence



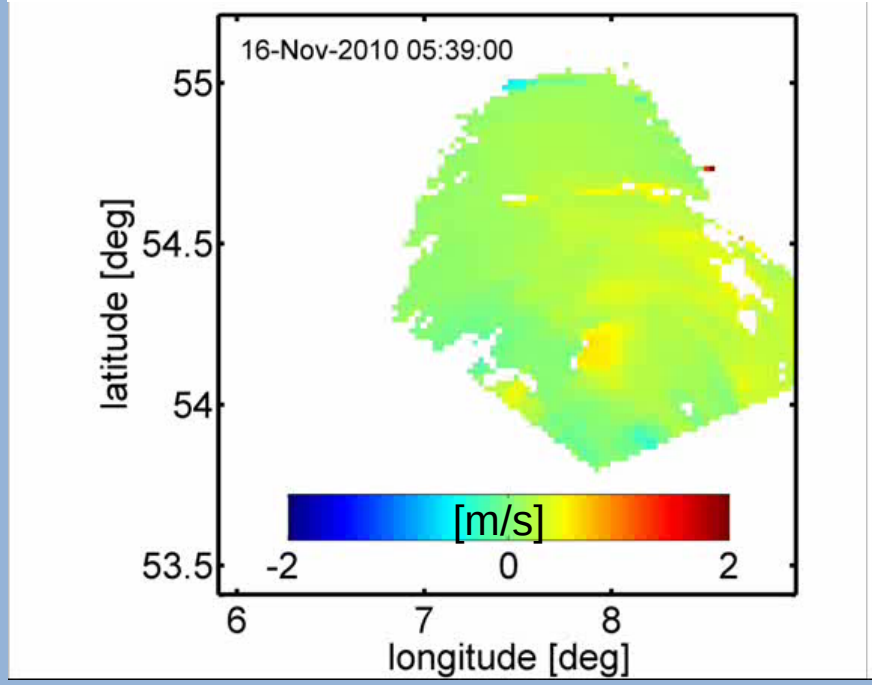
QC Scheme

- For each grid point look at the values during the last 6 hours.
- Fit a 3rd order polynomial to the data .
- Use polynomial to calculate the actual data.
- Check difference between measured and fitted actual data and the RMS error of the fit.

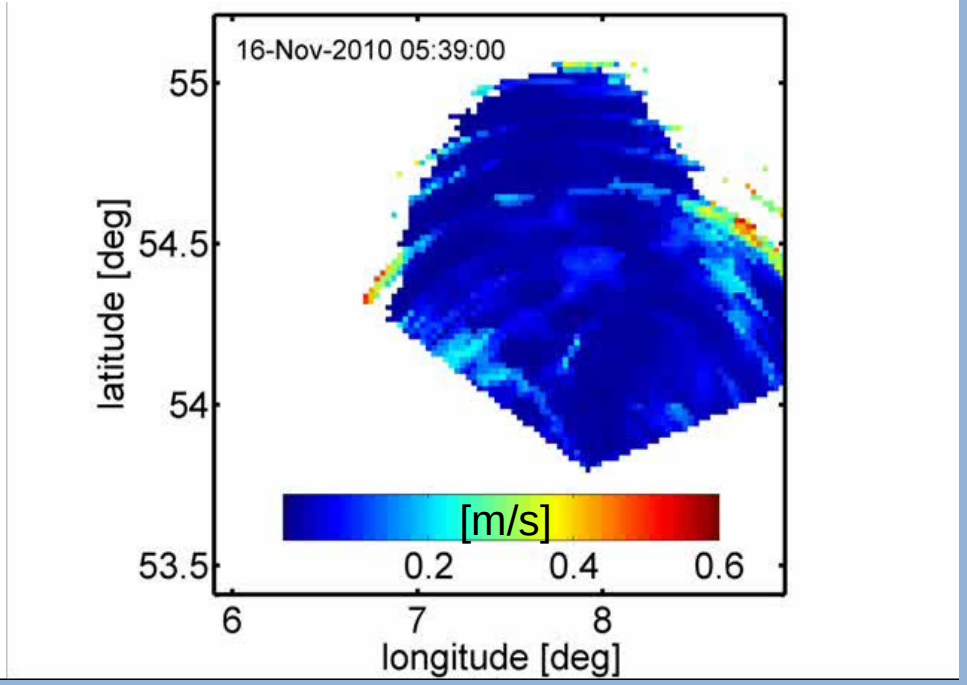


QC Scheme

Fitted Radial Current Component



RMS Fit Error

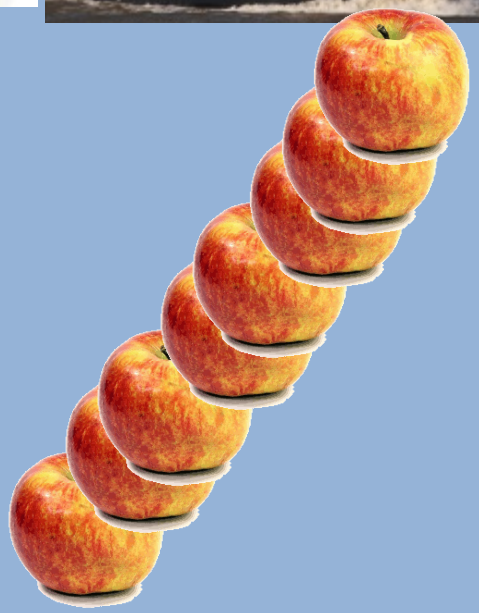


Quality Control

- Distortions identified by Polynomial Fit
- Transient (Short-Time) Distortions can be replaced by Fitted Values
- Stationary (Long-Lasting) Distortions identified by RMS Error
- Values flagged as ‚Probably Bad Data‘

ADCP-HF Cross-Validation:Is it possible to Compare Apples with Oranges?

Ship-Mounted ADCP

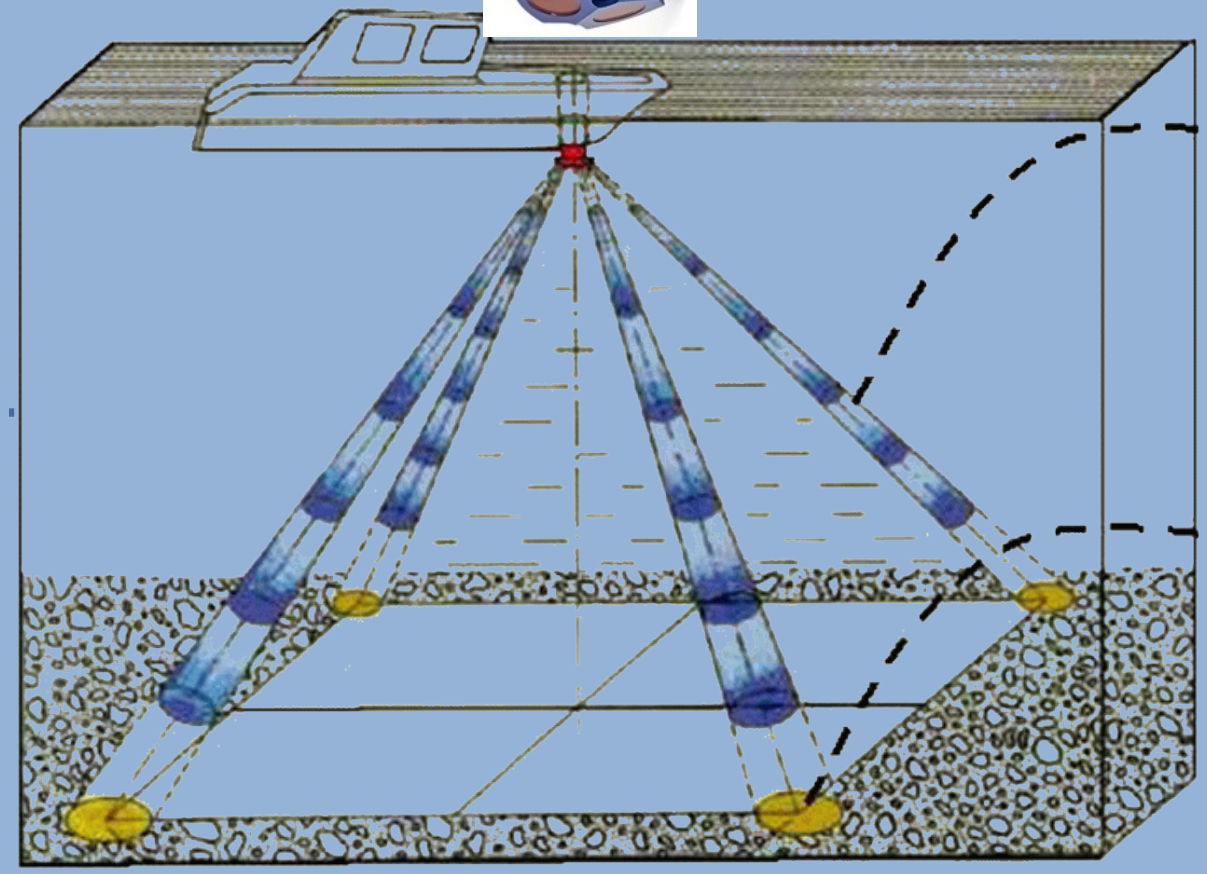


Many High-Resolution Samples ui(x,y,t)

HF Sytem (WERA)

One Low-Resolution Averaged Sample <u(x,y,t)>

ADCP Measurement Principle

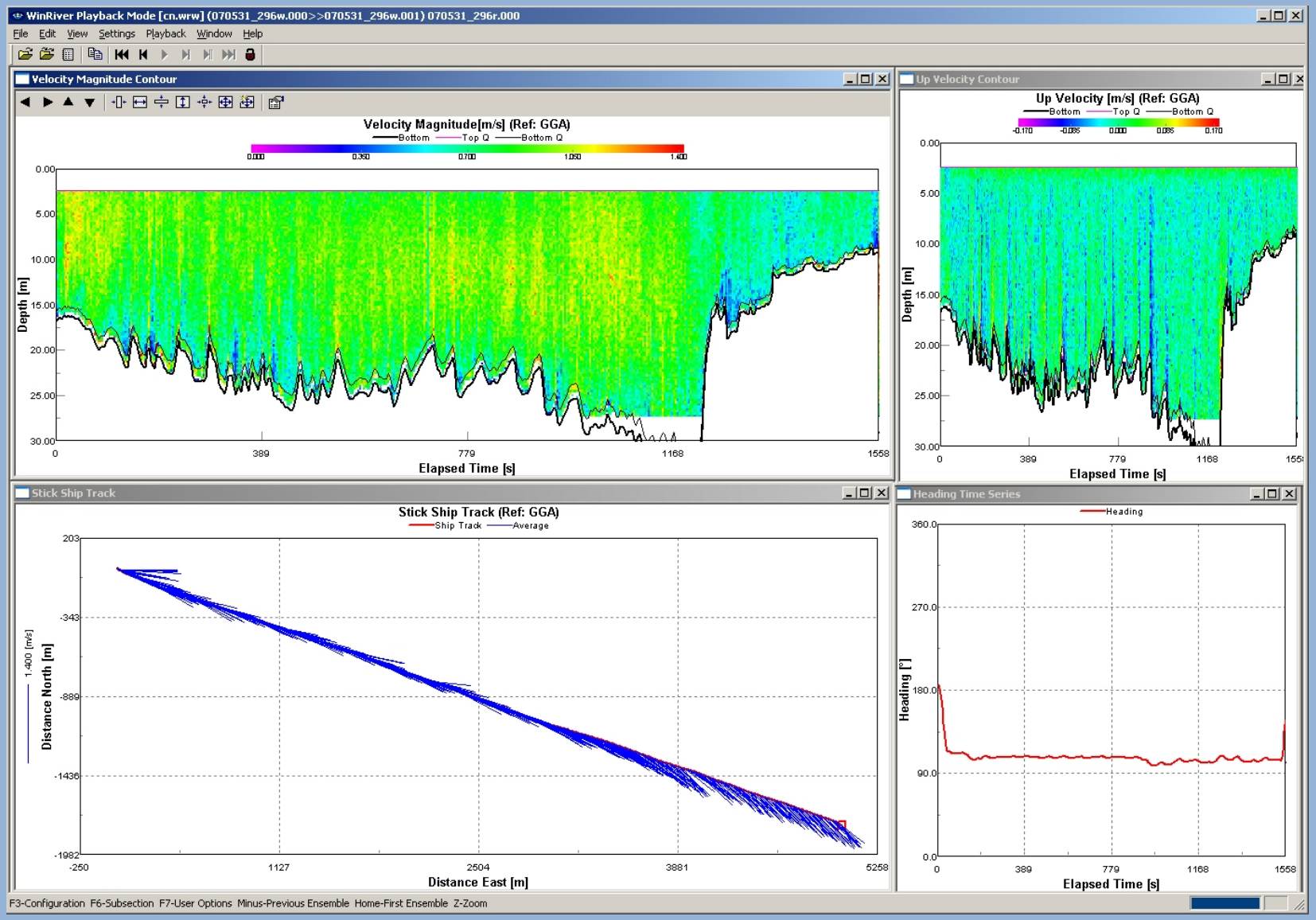


Measurement Cell

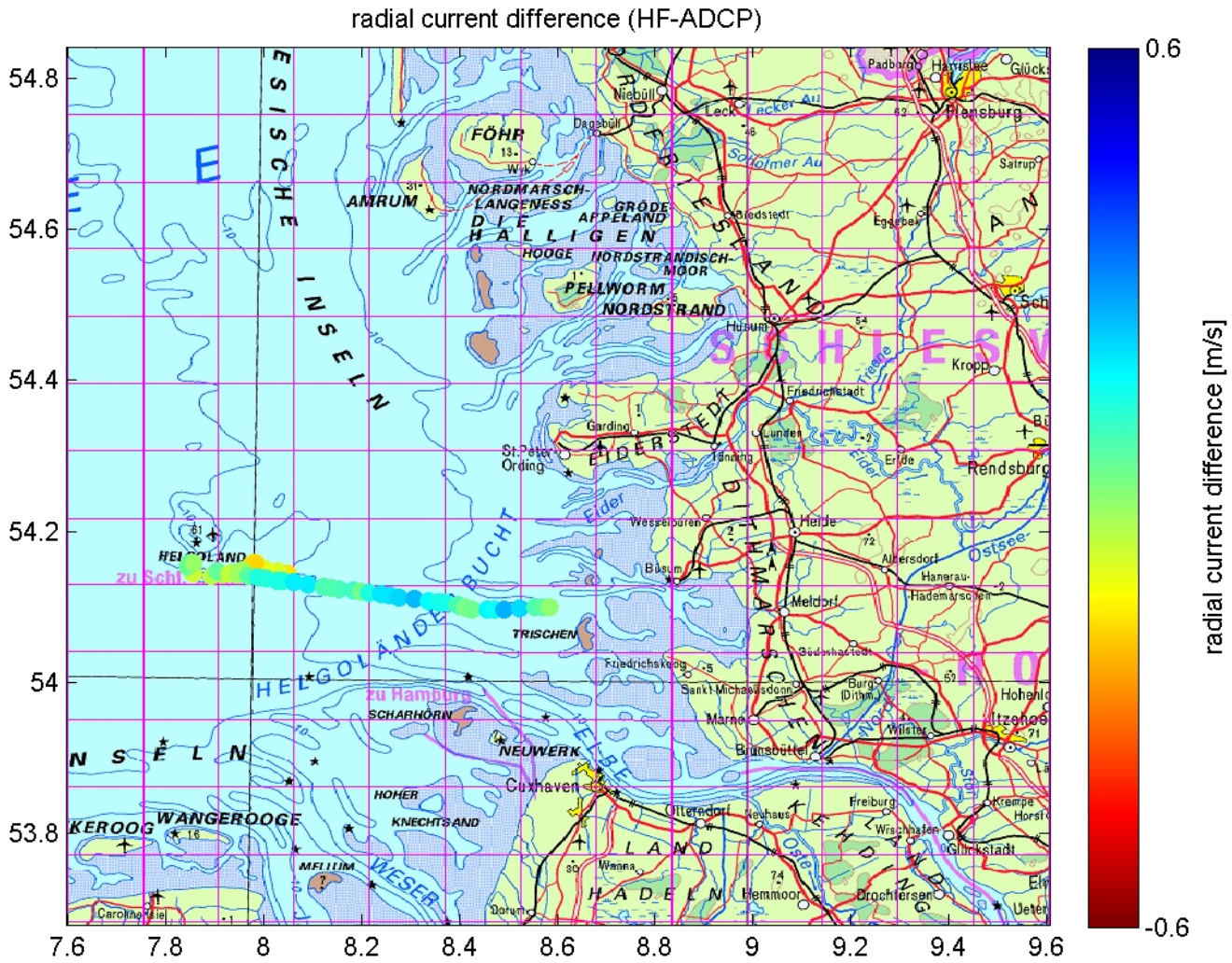
ADCP Settings

- Acoustic Frequency: 1200 kHz
- Ping Rate: 1 HZ
- AVG over 3 Pings => 1 vertical Profile each 3 sec.
- Transducer Depth: 170 cm
- Dead Range: 50 cm
- Layer Width: 50 cm
- Max. Depth: 30 m
- Single-Ping Accuracy: 0,12 m/s

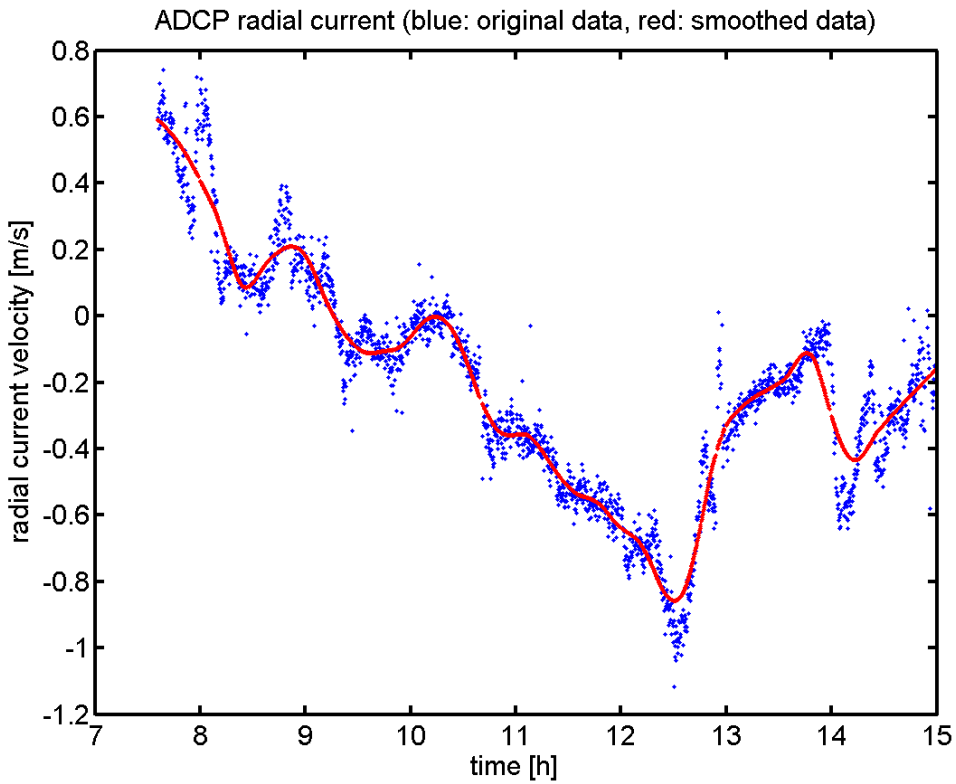
ADCP: RDI Playback Software WinRiver

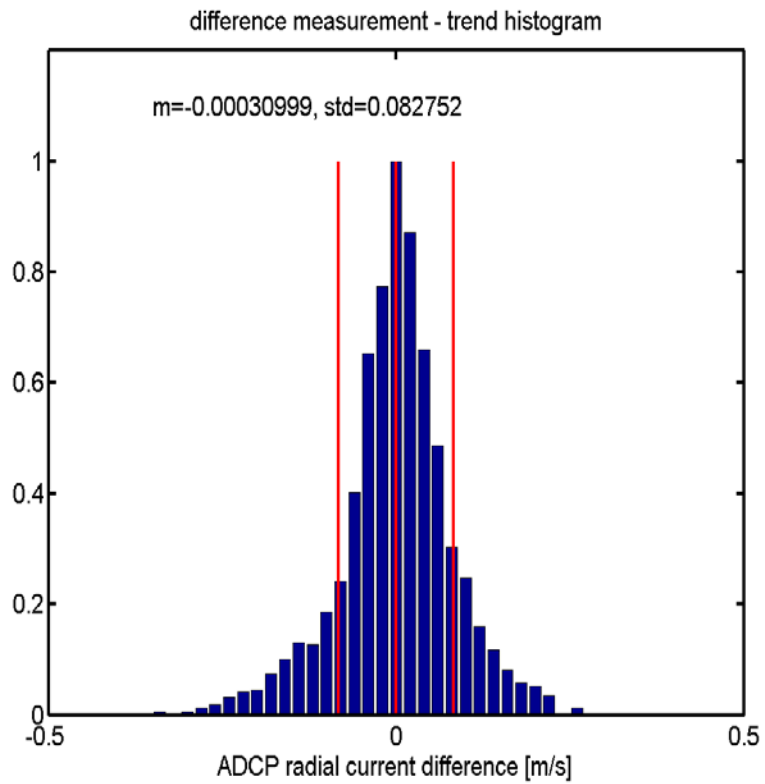


Validation Ship Track



ADCP Accuracy

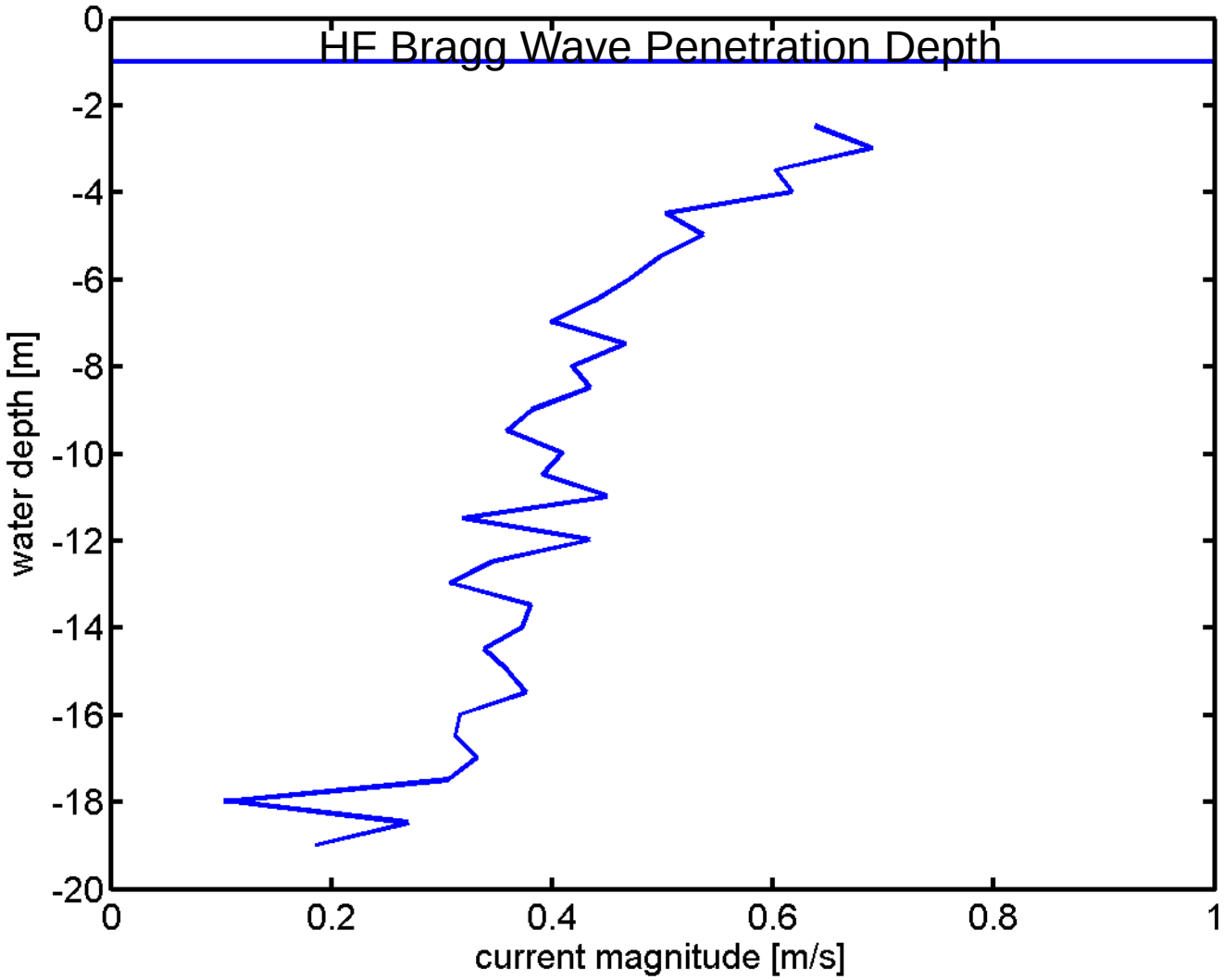




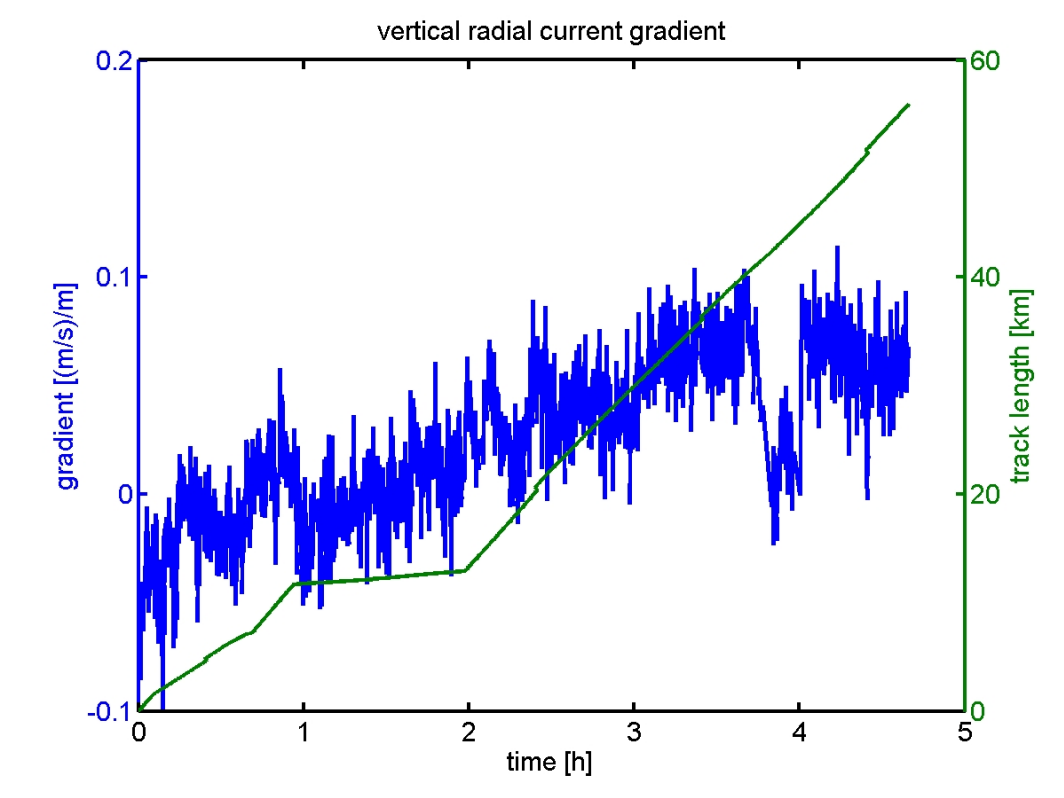
m = 0,0 (m/s)/m

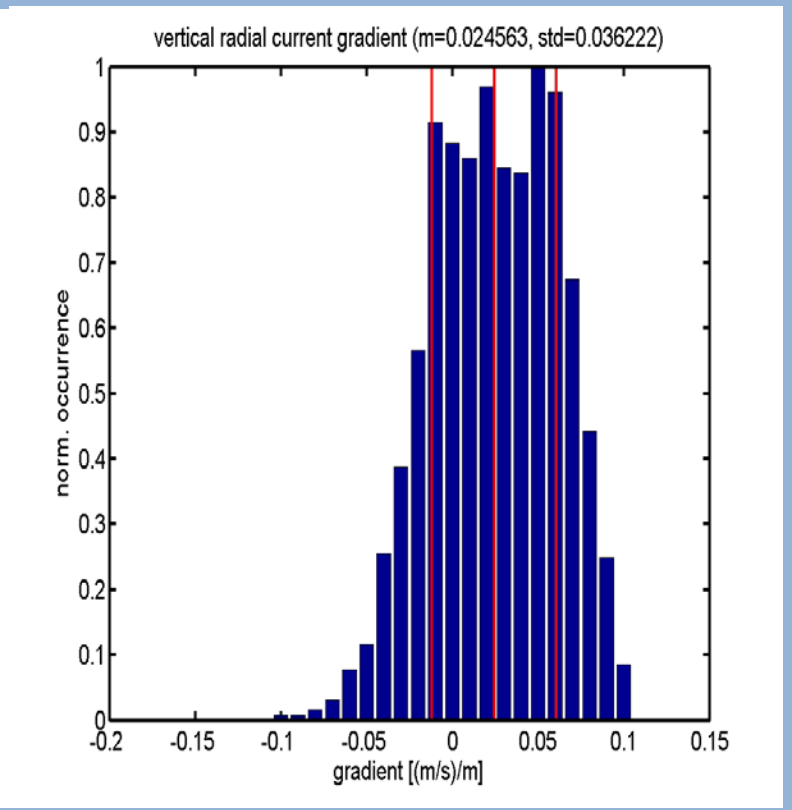
std = 0,083 (m/s)/m

ADCP: Vertical Current Profile



ADCP: Vertical Current Gradient

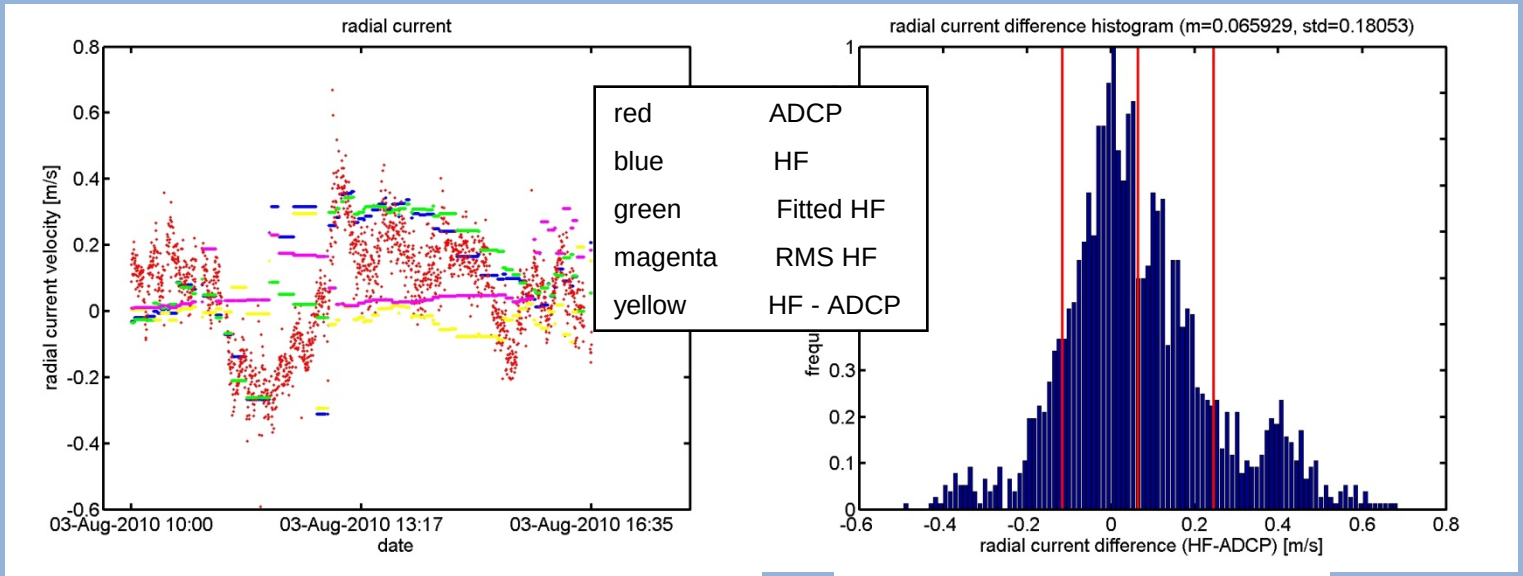




m = 0,025 (m/s)/m

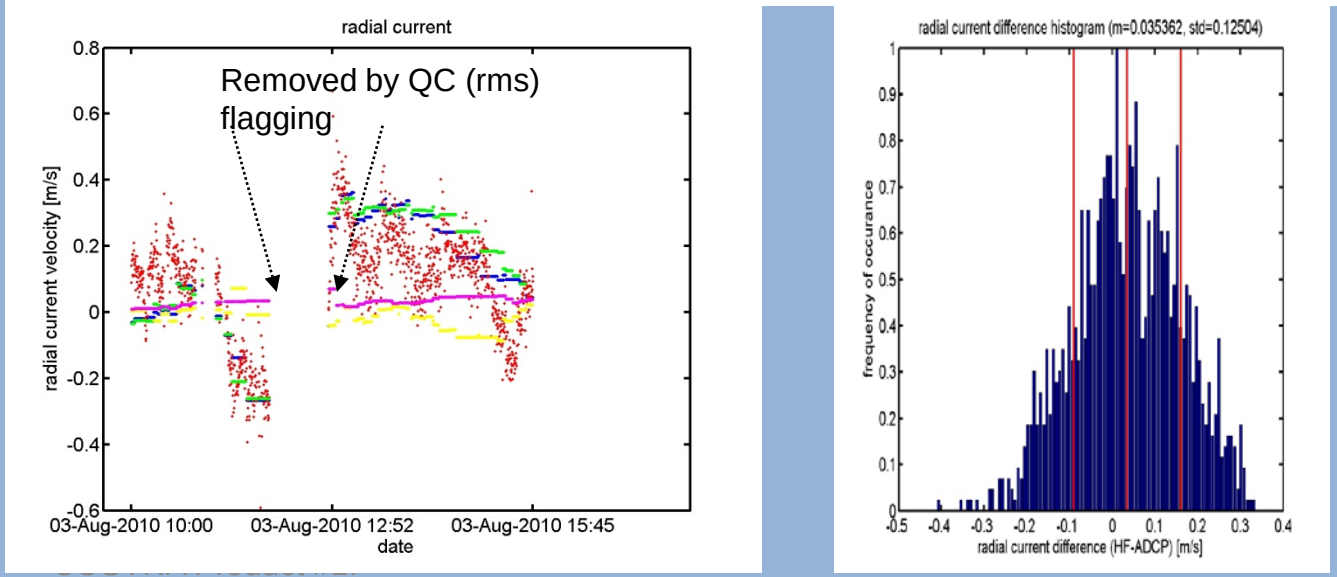
std = 0,036 (m/s)/m

Application of QC Scheme



m = 0,066 m/s

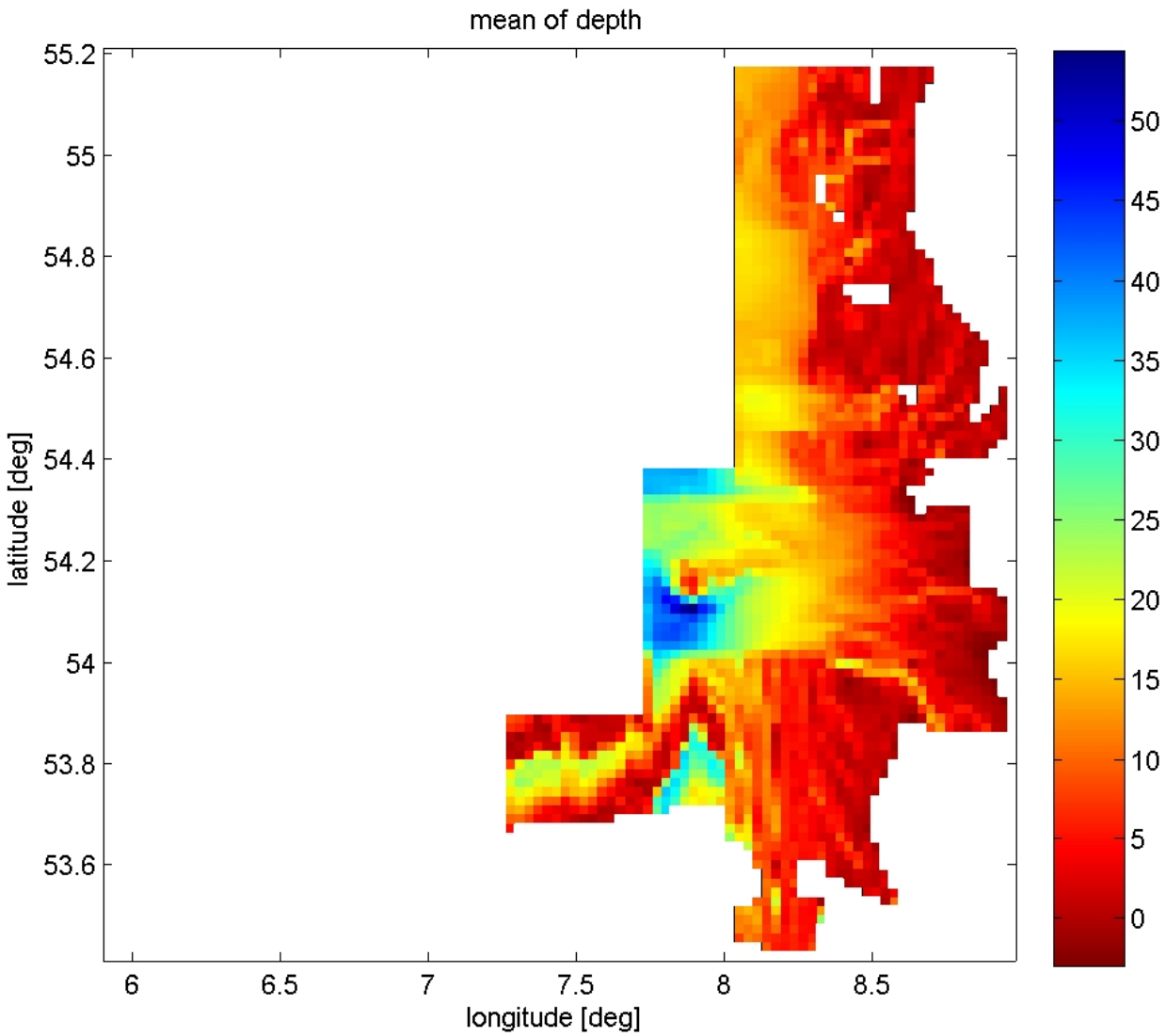
std = 0,181 m/s



m = 0,035 m/s

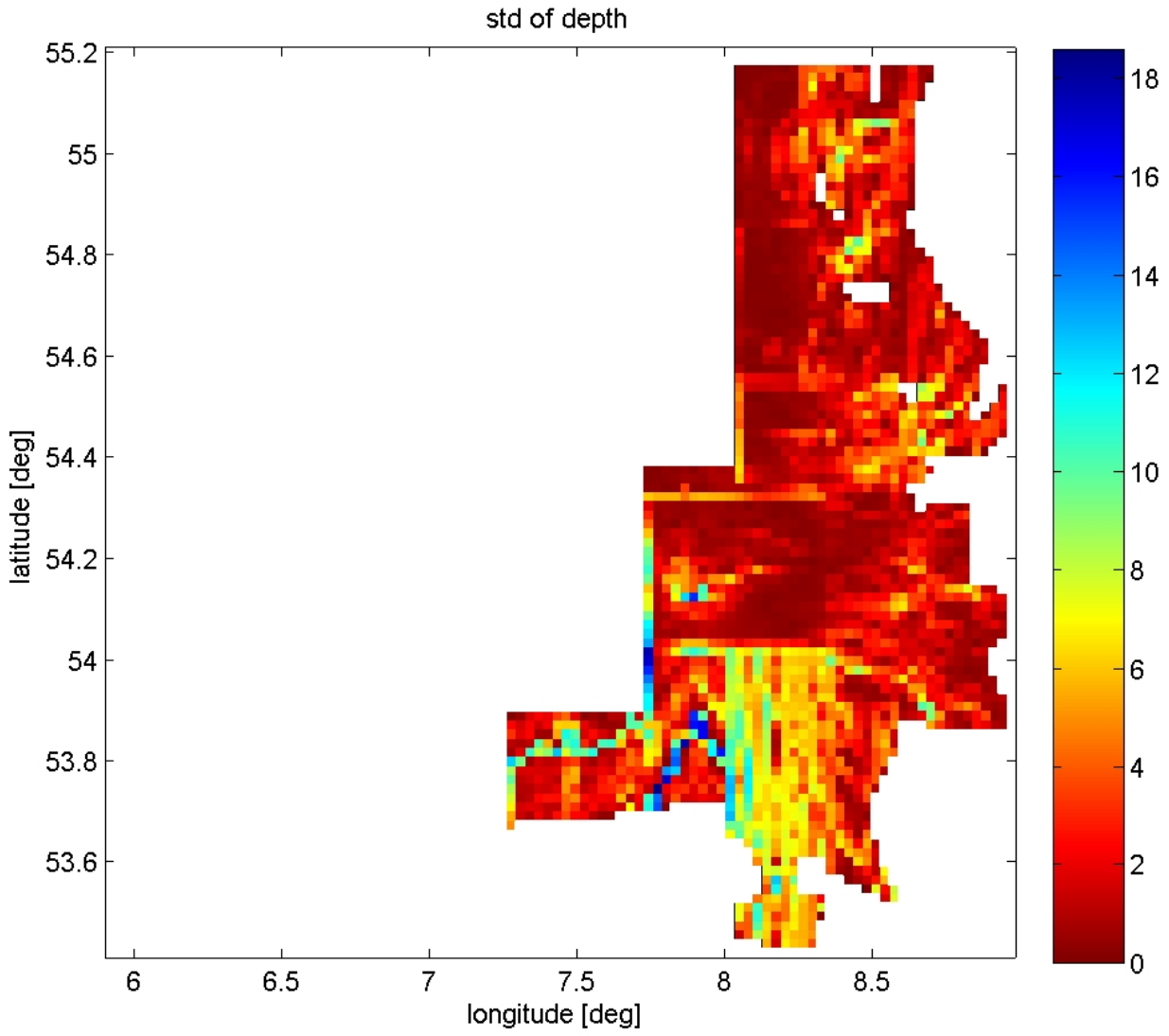
std = 0,125 m/s

Bottom Topography

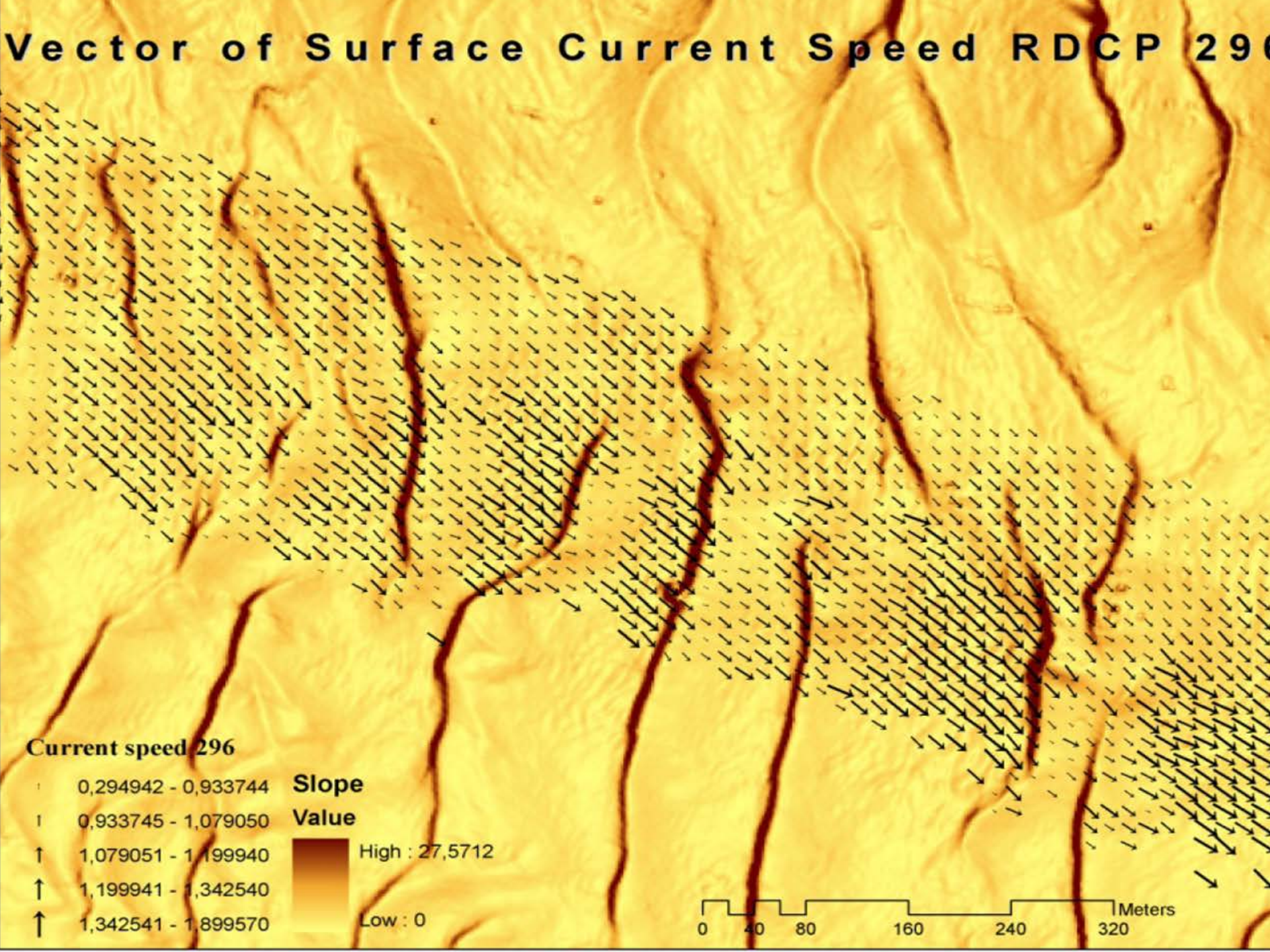


Source: BSH, LKN Husum, Portal Tideelbe

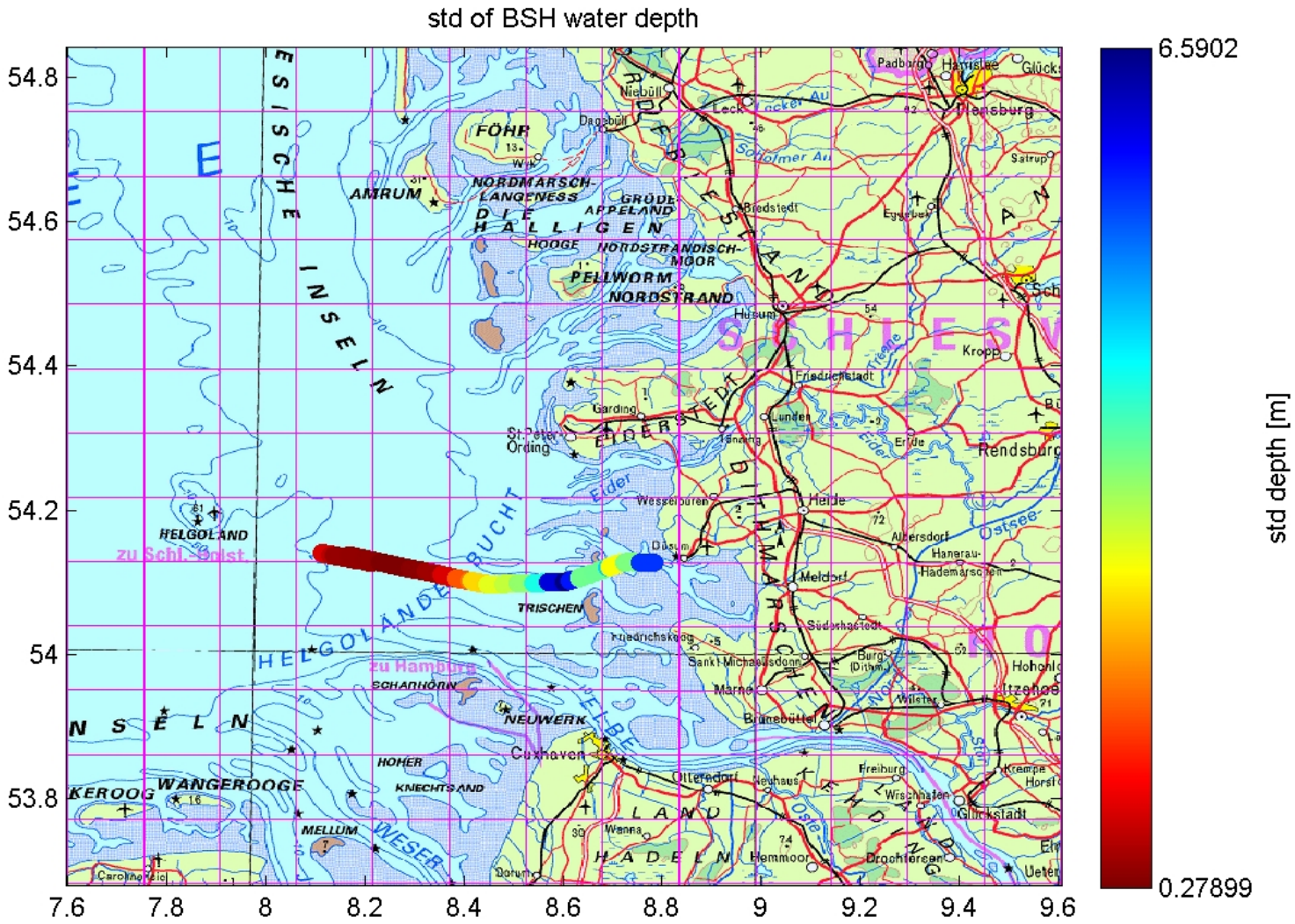
Spatial Inhomogeneity



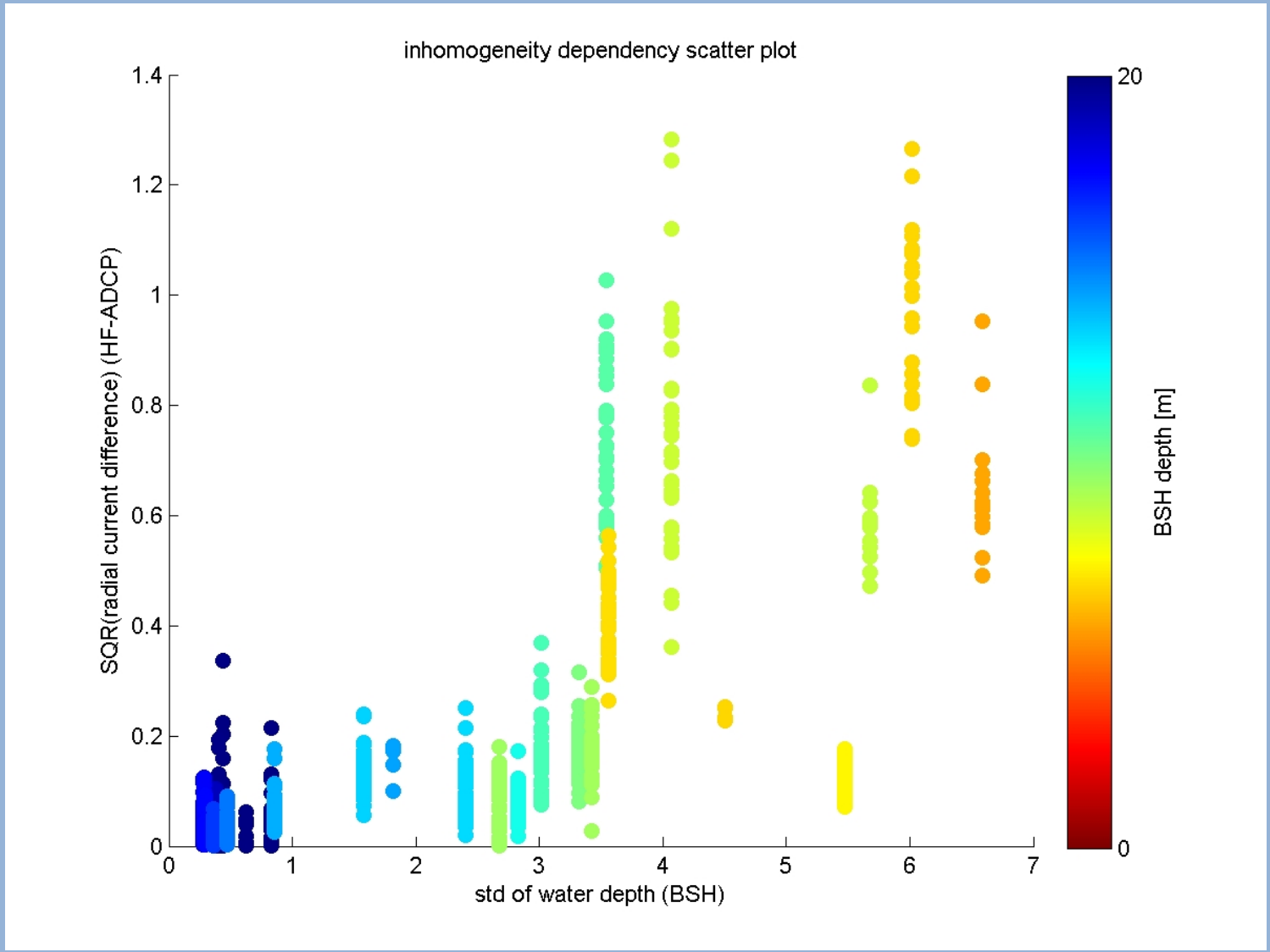
Source: BSH, LKN Husum, Portal Tideelbe


Vector of Surface Current Speed RDCP 29
Current speed 296
0,294942 - 0,933744
0,933745 - 1,079050
1,079051 - 1,199940
1,199941 - 1,342540
1,342541 - 1,899570
Slope
Value
High : 27,5712
Low : 0
0
40
80
160
240
320
Meters

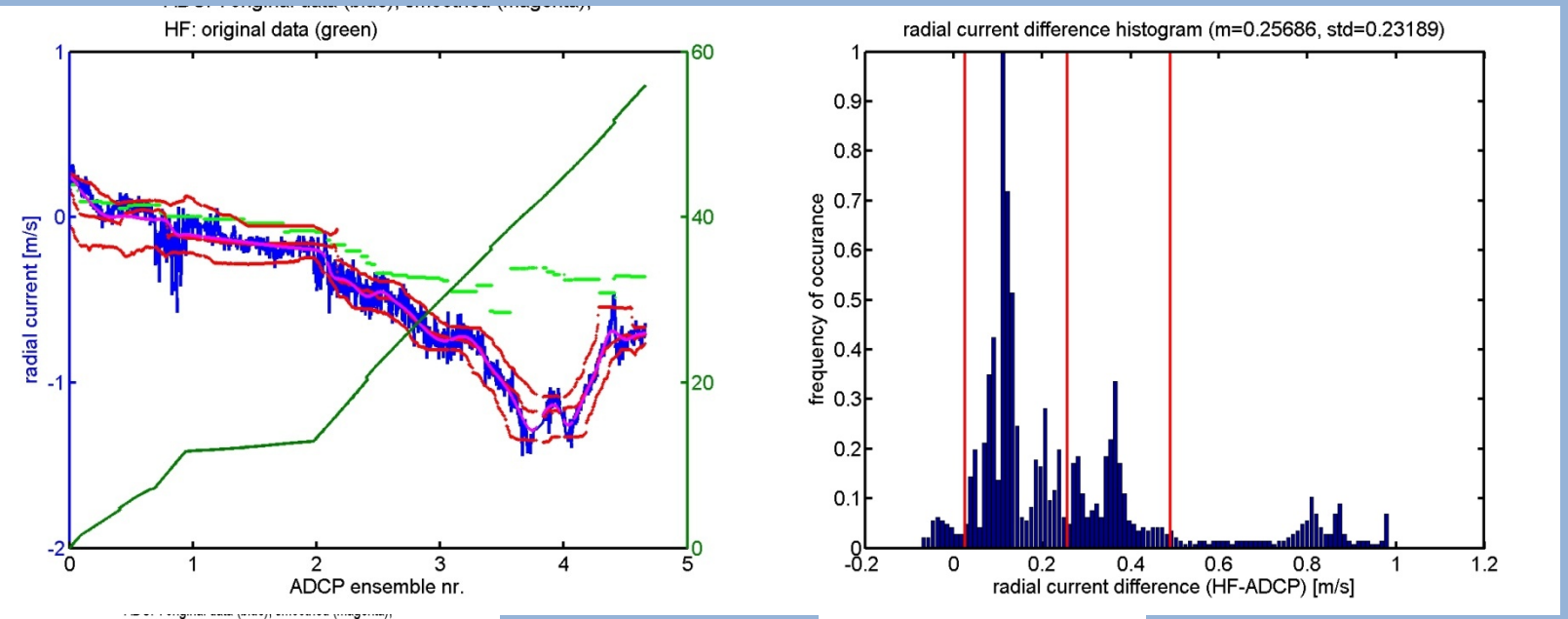
Inhomogeneity on Ship Track



Inhomogeneity Dependency of Radial Current Deviation

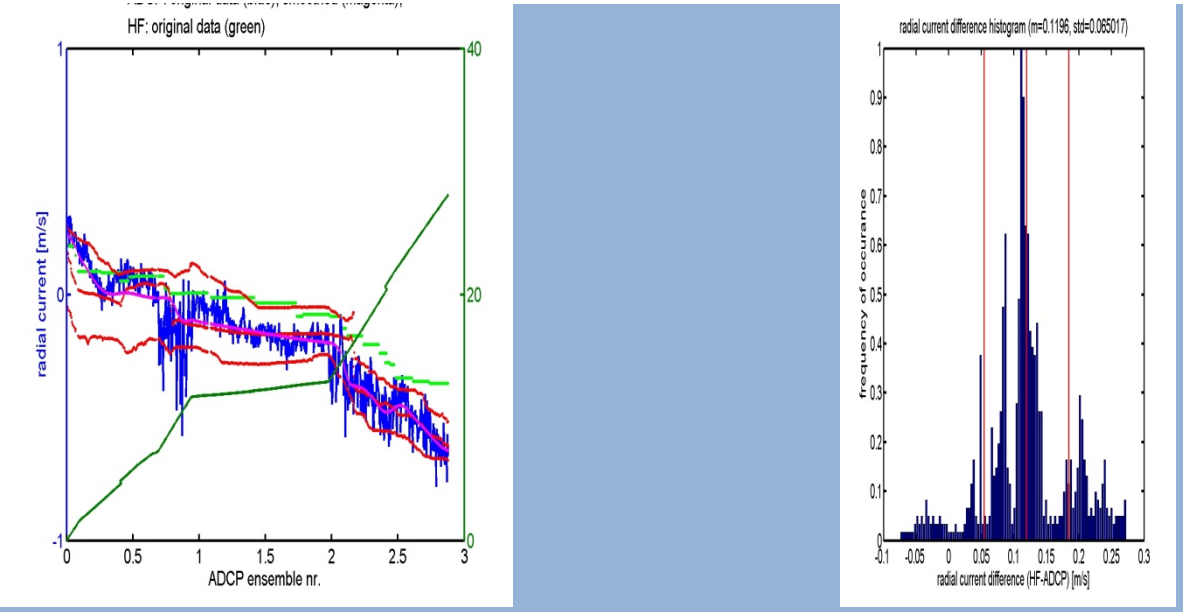


Removal of Inhomogeneous Areas



m = 0,26 m/s

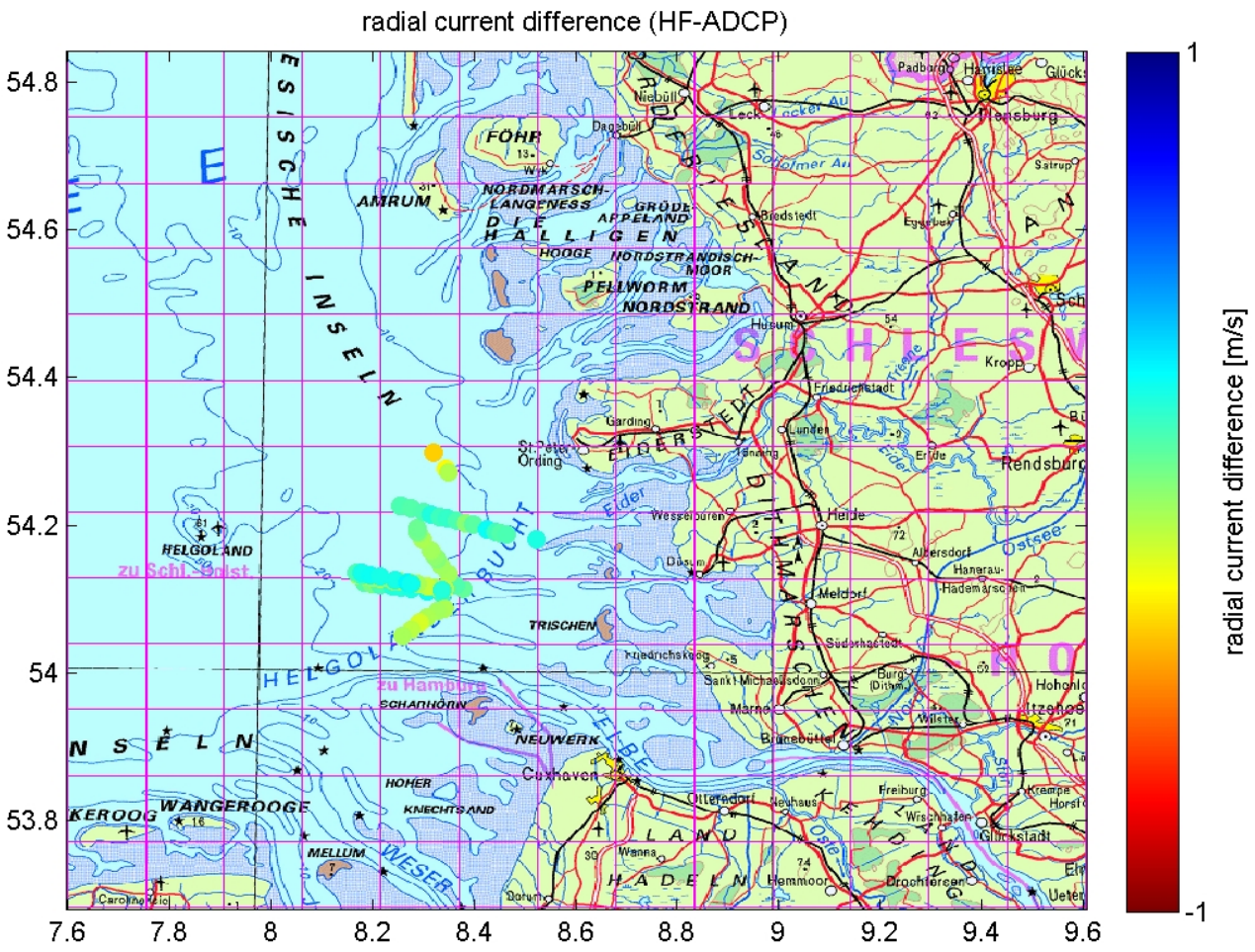
std = 0,23 m/s



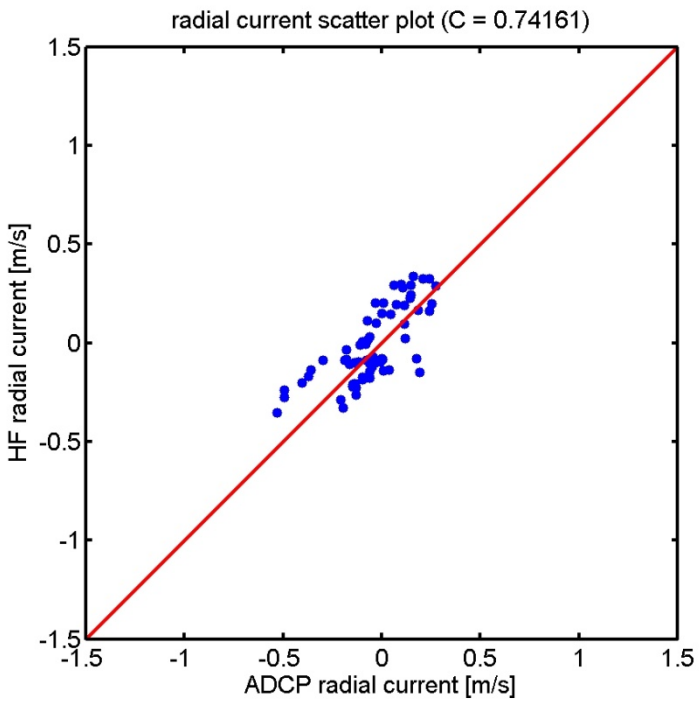
m = 0,12 m/s

std = 0,065 m/s

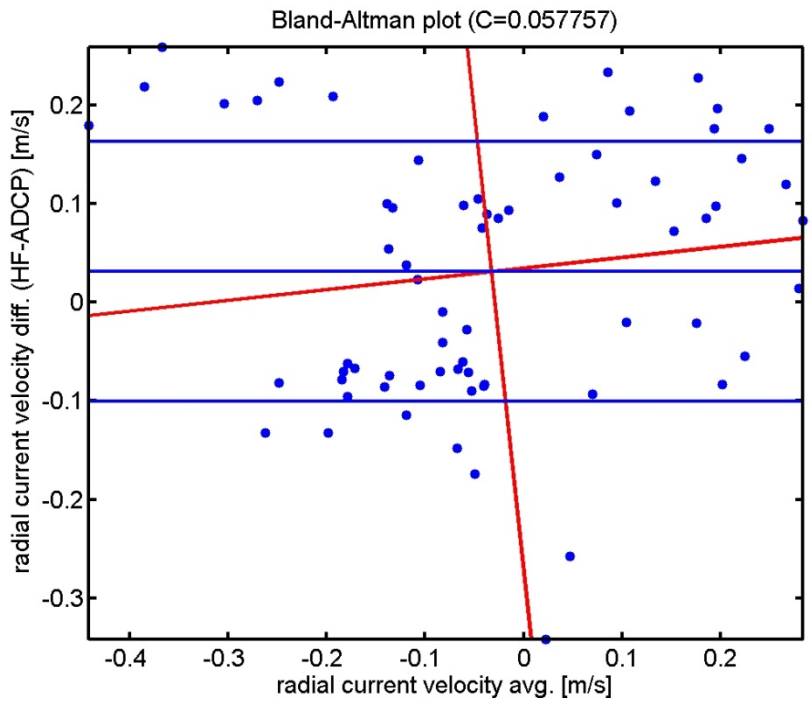
Ship Tracks in Homogeneous Areas



Scatter- & Bland-Altman Plot between Radial Current of ADCP & HF

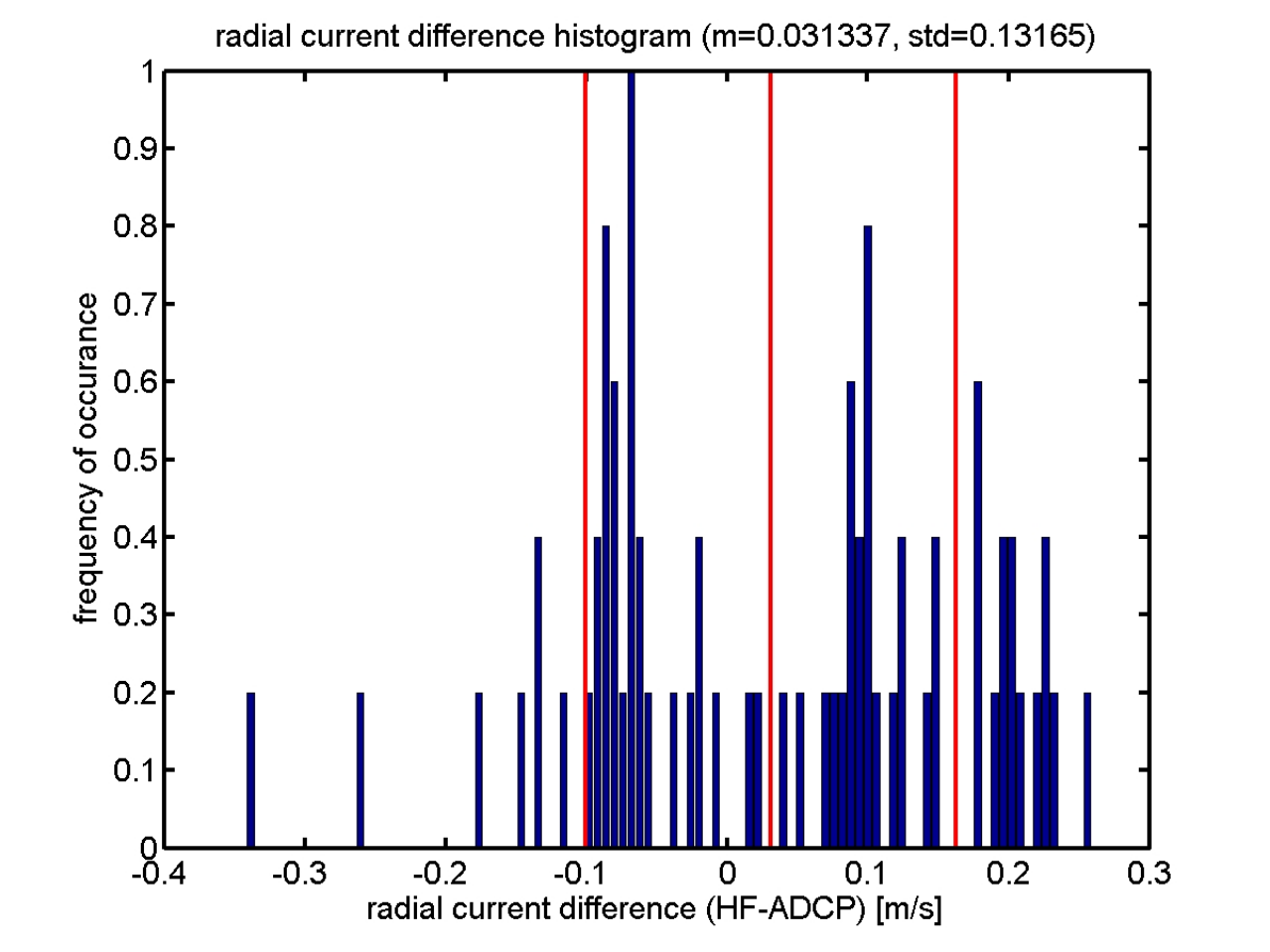


C = 0,74



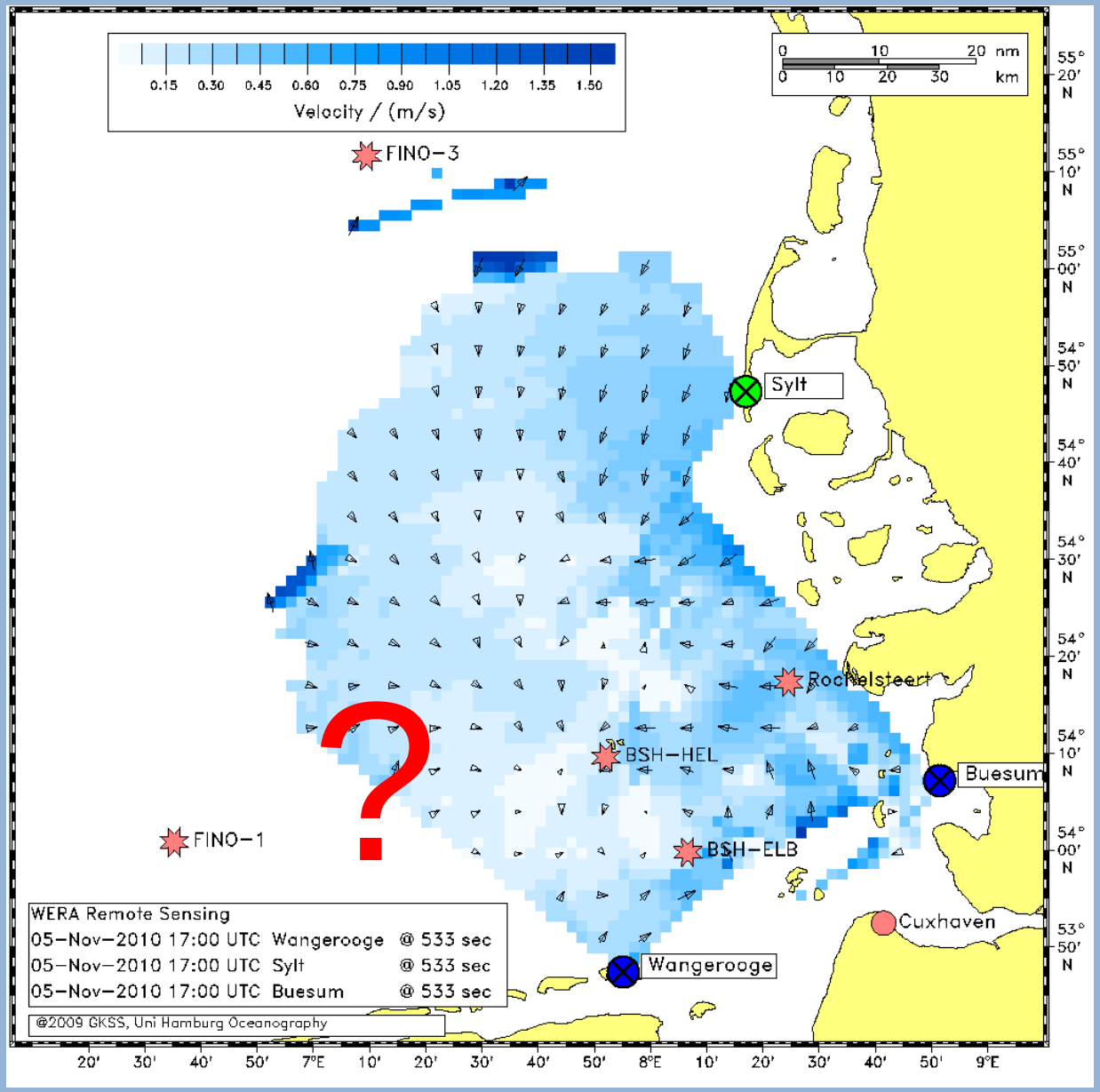
C = 0,056

Hist. of Radial Current Diff. (HF-ADCP, filt.)



m = 0,031 m/s

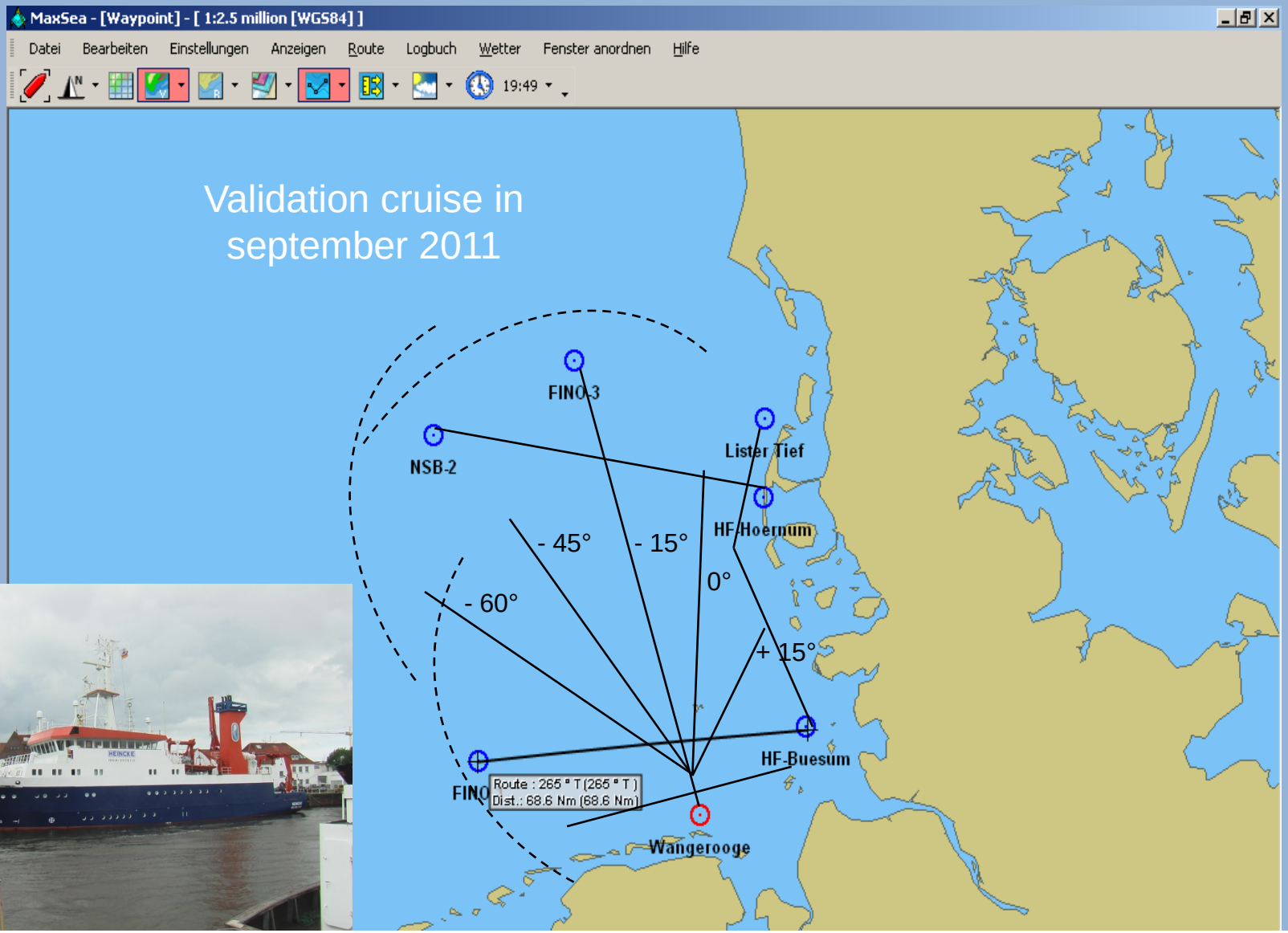
std = 0,13 m/s


0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20 1.35 1.50
Velocity / (m/s)
0 10 20 nm
0 10 20 30 km
FINO-3
Sylt
Rochelsteert
BSH-HEL
Buesum
FINO-1
BSH-ELB
Cuxhaven
Wangerooge
WERA Remote Sensing
05-Nov-2010 17:00 UTC Wangerooge @ 533 sec
05-Nov-2010 17:00 UTC Sylt @ 533 sec
05-Nov-2010 17:00 UTC Buesum @ 533 sec
@2009 GKSS, Uni Hamburg Oceanography
55° 20' N
55° 10' N
55° 00' N
54° 50' N
54° 40' N
54° 30' N
54° 20' N
54° 10' N
54° 00' N
53° 50' N
20' 30' 40' 50' 7°E 10' 20' 30' 40' 50' 8°E 10' 20' 30' 40' 50' 9°E

Summary

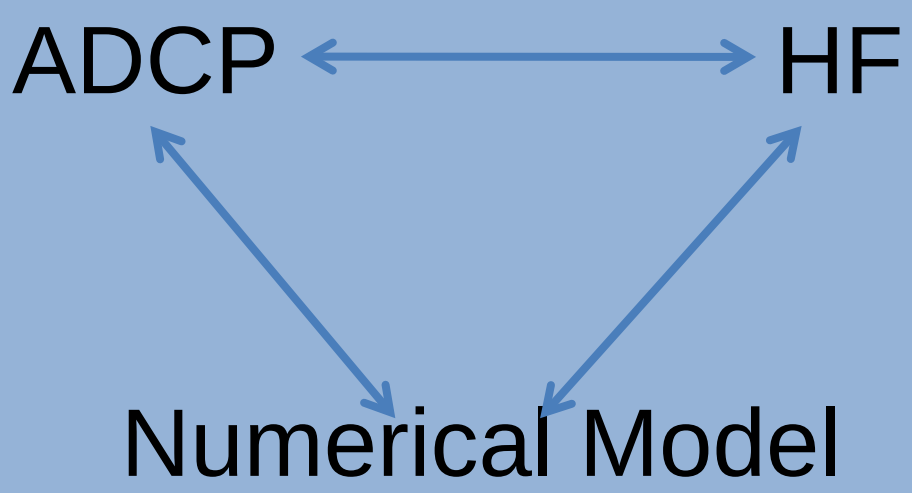
- Three WERA HF Radars sucessfully installed in the German Bight.
- System in Preoperational Mode, Current Maps each 20 min., max. Time Delay 40 min.
- A New Technique to determine and mitigate RFI is implemented.
- Remaining distorted Data identified by a QC Procedure.
- These Data are flagged before Assimilation in the Model.
- HF Radial Current Component & QC Procedure validated with Ship-based ADCP.

RDCP Profiles during HE #365 in 2011



Qutlook

- Implementation of QC Scheme in Prä-Operational Workflow.
- Cross-Validation with all available ADCP Ship Tracks.
- Cross-Validation Triangle ADCP – HF – Numerical Model.



THANK YOU, ANY QUESTIONS?

joerg.seemann@hzg.de

see for more information: www.hzg.de/radarhydrographie