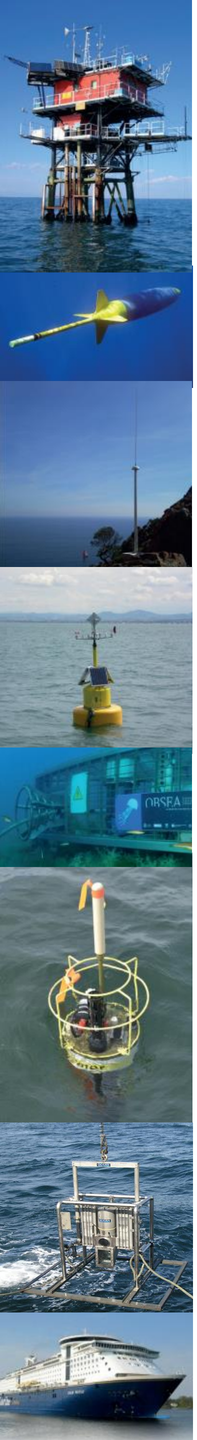


JericoNext HF Radar Workshop

San Sebastian, 9th-11th March 2016

INTRODUCTION

OBJECTIVES

(1) WP2 T2.3 Harmonizing new network systems: HF Radar

To review the state-of-the-art of HF Radar systems in terms of technology, procedures, maintenance, data processing, format, quality and management, identification of limitations and difficulties, applications, dissemination, etc.).

(2) Specific sessions in order to plan and start working on a coordinated way in different tasks involving that technology:

- WP3 T3.2 Developments on current observations from HF radars
- WP4 T4.4 JRAP#4 4D characterization of trans-boundary hydrography and transport
- WP5 T5.6 Definition of Quality Control procedures for HF Radar data
- WP6 Virtual Access (HF Radars)

AGENDA

Wen 9th March 2016

WP2 T2.3 : Harmonizing new network systems, 1. HF Radar

9:00-9:30 **Welcome and introduction (Julien Mader)**

9:30-13:30 **Short presentations (20min) per institute (I)**
Please use the template for focusing the different contributions.

15:00-16:30 **Short presentations (20min) per institute (II)**
Please use the template for focusing the different contributions.

16:30-17:30 **Workshop to organize the work for *D2.1 : Report on the status of HF-radar systems* Sep16 (lead: Jochen Horstmann)**

20:00h All partners dinner.

AGENDA

Thu 10th March 2016

WP5 T5.6 Definition of Quality Control procedures for HF Radar data

9:00-11:30 Synthesis of existing procedures and workshop
To organize D5.13 : *Recommendation Report 1 for HFR data implementation in European marine data infrastructures, including recommended common metadata and data model for HF radar;* v.0 for Sep16 to be shared with wider community before delivering Dic2016

WP6 Virtual Access (HFR)

12:00-13:30 Discussion for coordinated and homogenized solutions from HFR systems

WP3 T3.2 Developments on current observations from HF radars

15:00-17:30 Workshop to organize the work (lead: Annalisa Griffa)

AGENDA

Fri 11th March 2016

WP4 T4.4 JRAP#4 4D characterization of trans-boundary hydrography and transport

9:00-9:30 Overview of JRAP#4 obj. , task and timelines (lead: Anna Rubio)

9:30-11:00 30min - presentations of the background and JRAP#4 scientific strategy main lines & actions per study area

11:30-13:30 Workshop to organize the work for the JRAP4 contribution to the D4.1(Approaches to monitor European coastal seas)

WP2, T2.3 : HARMONIZING NEW NETWORK SYSTEMS

(M1-M48) - AZTI, HZG, OGS, HCMR, CNR, CNRS, IMR, SMHI, DELTARES, NIVA, IFREMER, SOCIB, UPC, EMSO

Julien Mader I AZTI

2.3.1 : HF Radar *Jochen Horstmann I HZG*

2.3.2 : Cabled Observatories *Joaquin del Rio Fernandez I UPC*

Deliverables and milestones

D2.1 : Report on the status of HF-radar systems (lead: HZG) and cabled coastal observatories (lead: UPC) within the JERICO network and, more generally, in the European context. The deliverable will also inform on the outcome and results of the workshop that will be dealing with its topic during the project. **[12 – SEP 2016]**

D2.4 : Report on Best Practice in the implementation and use of HF-radar systems (lead: HZG) and cabled coastal observatories (lead: UPC). The deliverable will also inform on the outcome and results of the workshop that will be dealing with its topic during the project. **[40 – DEC 2018]**
→ Best practice: recommendation

MS9 First Workshop of Task 2.3: Harmonizing new network systems **[Mar/Apr 2016]**
MS13 Second Workshop of Task 2.3: Harmonizing new network systems **[38 –Should be earlier 2017?]**

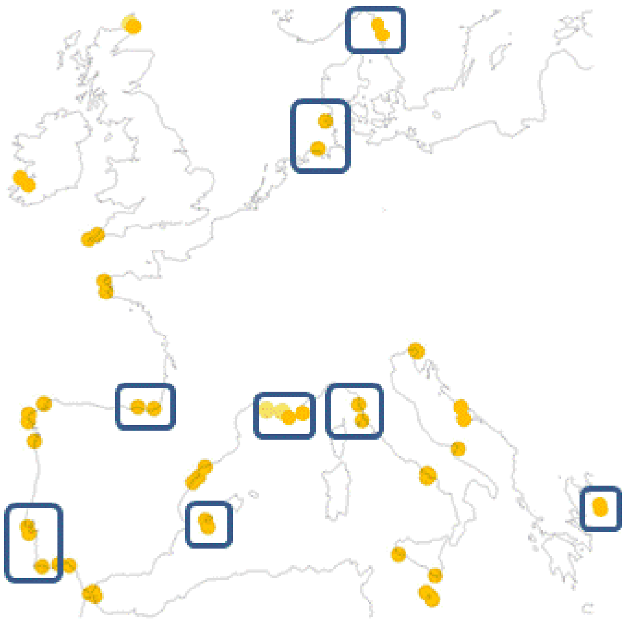
- **MS9-1 HF radar workshop, San Sebastian, 9-11 March 2016**
- **MS9-2 Cabled Observatories workshop, Vilanova i la Geltrú, 19-20 April 2016**

Task 2.3: Harmonizing new network systems

Contents for D2.1

TWO LEVELS OF REVIEWING:

1. EUROPEAN CONTEXT (More general inventory)
2. JERICO NETWORK (More details on operating procedures)



HF Radars

AWI (UNH, UNS)
IFREMER(Molene)
FMI (Utö)
IMR (LoVe)
SBI (CPO in Galway Bay)
UPC (OBSEA)

Cabled observatories

1. EUROPEAN CONTEXT (More general inventory)

Inventory

- Site Name
- Geographical position
- ROOS (IBIROOS, MOON, NOOS, BOOS)
- Manufacturer
- Transmit Frequency; Transmit Bandwidth;
- Data availability (free and open, restricted)
- Start date of use; End date of use or ongoing;
- "Permanent" or temporary installation
- Application area(s) (oil spill, fisheries, search&rescue, etc.)
- Operator
- PI and affiliation
- Website
- …

**Shared with the EuroGOOS Task Team we have an inventory with 61 stations (information should be updated)

2. REVIEW OF JERICO HF Radar Network

→ DRAFT OF INDEX: TEMPLATE FOR INDIVIDUAL PRESENTATIONS

1. Issues during the installation phase?

- Site Selection and Approvals
- Radar choice (Direction Finding, Phased Array, manufacter)
- Environmental Concerns – Electromagnetic
- Environmental Concerns – Impacts (ground, plants, animals, views)
- Power
- Communications

2. Main operational issues

- Power outages and communication failures
- Air-conditioning
- Coastal Erosion
- Calibration
- Mains interference
- Security
- Radar system robustness

3. Site maintenance

- Schedule
- Spares
- ...

4. Quality assessment

- Automatic reporting on changes in status of stations and computer systems.
- Web-based database of incidents and actions…

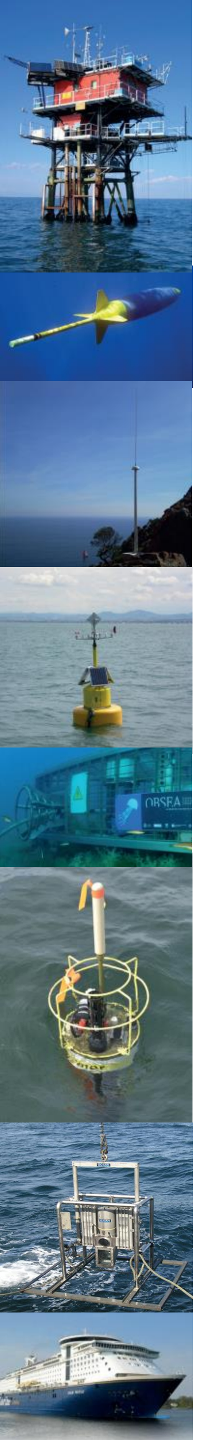
5. Data management

- Format
- Quality control
- Data processing
- Data flow for dissemination

6. Applications

- Users
- Areas (oil spill, fisheries, search&rescue, etc)
- Products
- Lagrangian tools
- …

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.



HF radar on French western Mediterranean sea

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

Presenter: Céline Quentin email : celine.quentin@mio.osupytheas.fr

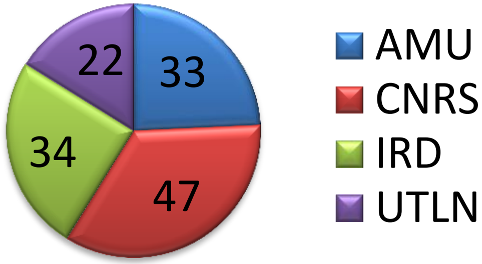
Contributor(s): Bruno Zakardjian, Philippe Forget, Lucio Bellomo, Didier Mallarino, Anne Molcard, Philippe Fraunie, Gilles Rougier

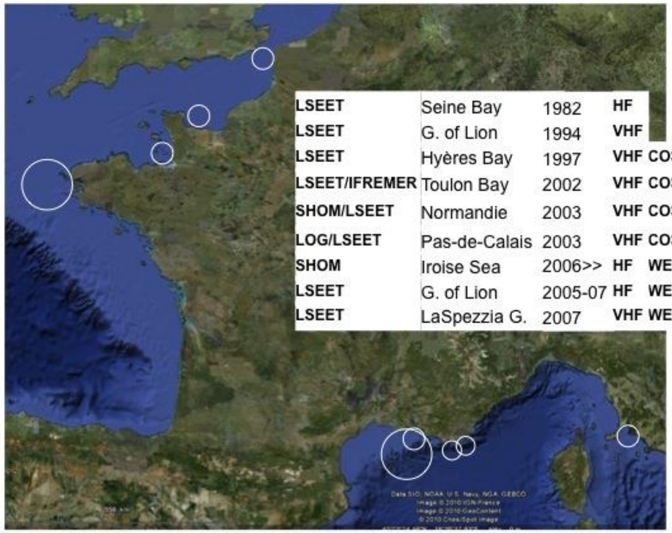
JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

Mediterranean Institute of Oceanography

- MIO is the result of the merging in 2012 of 5 laboratories dealing with oceanography in Marseille and Toulon
- 160 technicians and researchers
- Research fields: Oceanography (biology, ecology, biogeochemistry, geochemistry, physics, remote sensing) and mathematics (modeling and coupling)
- MIO is acting in JERICO NEXT as a CNRS contributor
- participation to the WP2, WP3, WP4 and WP5 for its expertise in flow cytometer (Melilotus Thyssen, Gerald Gregory) and HF radar (as former LSEET – 30 years of development)

Permanent staff





LSEET	Seine Bay	1982	HF	
LSEET	G. of Lion	1994	VHF	
LSEET	Hyères Bay	1997	VHF	COSMER
LSEET/IFREMER	Toulon Bay	2002	VHF	COSMER
SHOM/LSEET	Normandie	2003	VHF	COSMER
LOG/LSEET	Pas-de-Calais	2003	VHF	COSMER
SHOM	Iroise Sea	2006>>	HF	WERA
LSEET	G. of Lion	2005-07	HF	WERA
LSEET	LaSpezzia G.	2007	VHF	WERA

WORKSHOP "HF RADAR Systems for the monitoring surface currents: development and applications" AZTI-Tecnalia 28-29 October 2010.

INDEX

1. **Issues during the installation phase** Site Selection and Approvals; Radar choice (Direction Finding, Phased Array, manufacturer; Environmental Concerns – Electromagnetic; Environmental Concerns – Impacts (ground, plants, animals, views); Power; Communications; …
2. **Main operational issues** Power outages and communication failures; Air-conditioning; Coastal Erosion; Calibration; Mains interference; Security; Radar system robustness..
3. **Site maintenance** Schedule; Spares; ...
4. **Quality assessment** Automatic reporting on changes in status of stations and computer systems; Web-based database of incidents and actions; …
5. **Data management** Format; Quality control; Data processing; Data flow for dissemination
6. **Applications** Users; Areas -search&rescue, oil spill, fisheries, etc-; products; Lagrangian tools; data assimilation…
7. **Other items** you consider interesting in T2.3 context

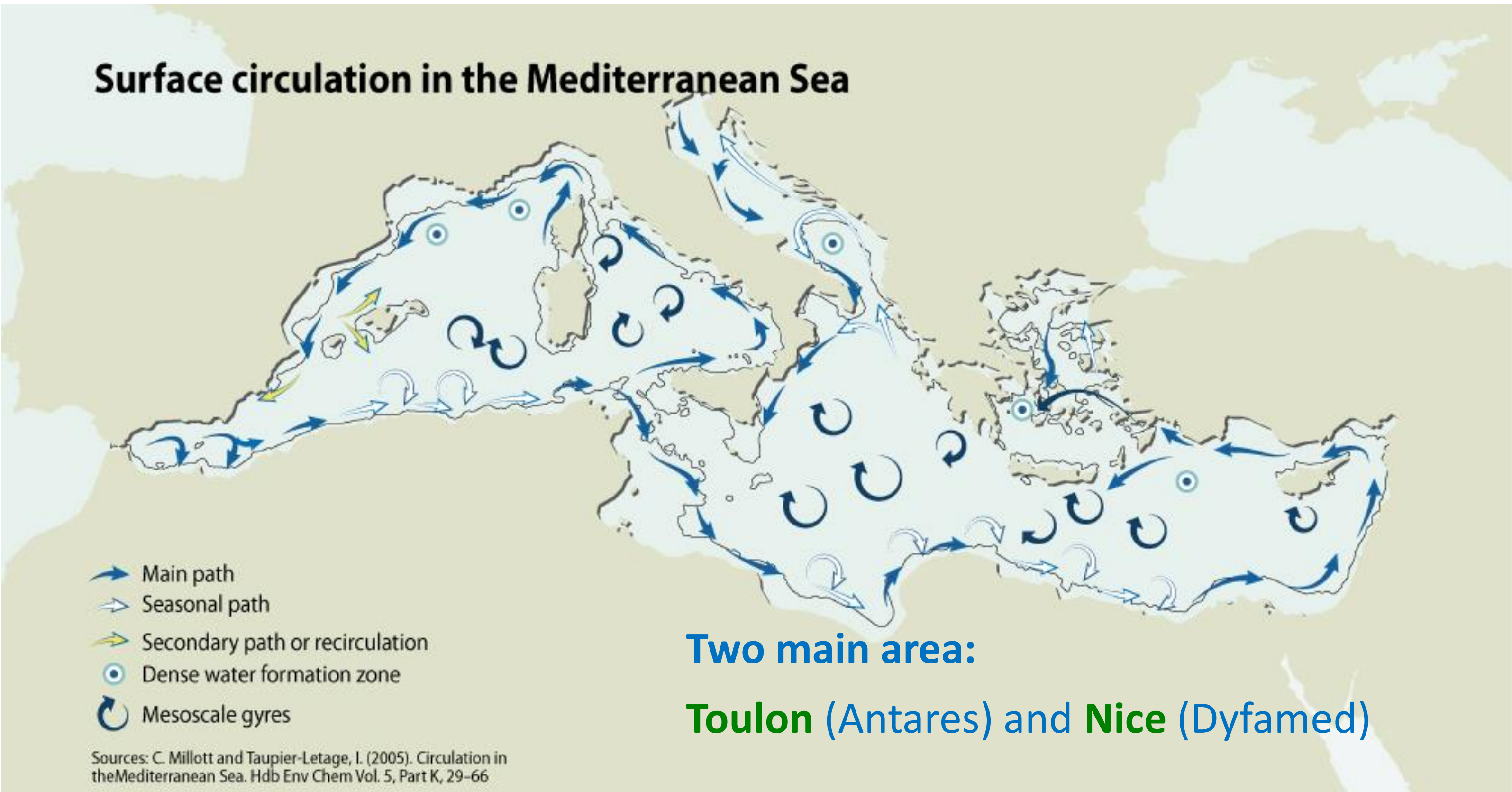
Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

- ## Area of Interest

Survey of the multiscale variability of the Northern current in the West Mediterranean sea.
The NC flows cyclonically along the gulf, bordering the slope over the 1000-2000 m isobaths. The NC's mesoscale activity occurs intense meanders, filaments and eddies.

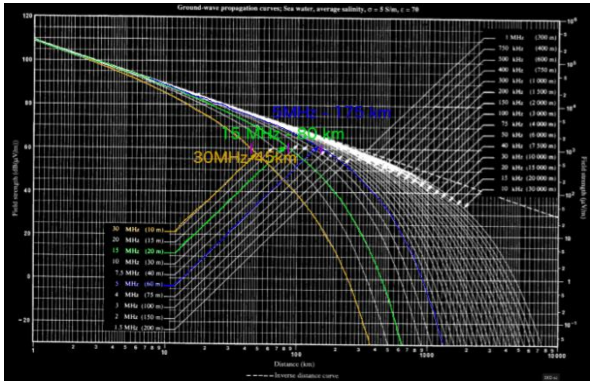
This is not an operational usefulness, no need of the availability of the data 24/24 h and 7/7d, but monthly trending for observing the variability of the Northern Current.



Two main area:

Toulon (Antares) and **Nice** (Dyfamed)

1. Issues during the installation phase

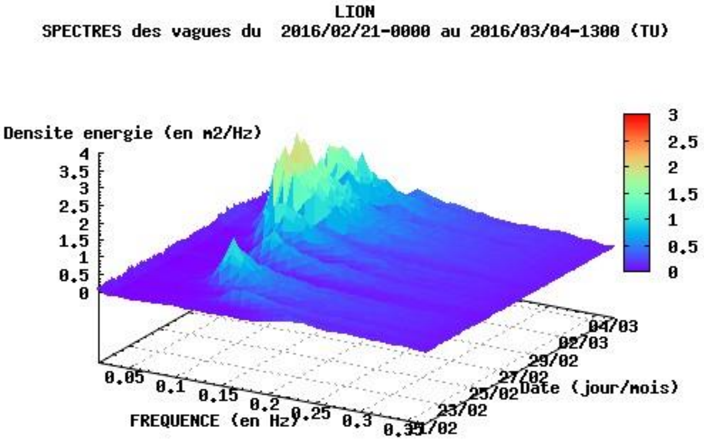


- ## Radar frequency

Ground wave propagation:

attenuation coefficient is growing with the frequency of the electromagnetic wave

max distance > 60 kms -> radar frequency < 20 MHz



Bragg scattering over ocean waves

Mediterranean sea state is characterized by short fetch and young sea

$$\lambda_{em} = 2\, \Lambda_{sea}$$

-> radar frequency > 10 MHz

I.T.U. allocations in region 1:

are not primary, so you can not totally avoid RFI and need to collaborate to share the band.

9.305-9.355 MHz	13.450-13.550 MHz	16.100-16.200 MHz

Other solution : scan free channel…

Space resolution

in radial velocities map of 3 km for FW/CW radar –> bandwidth of 50 kHz

Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

- **Sites selection**

Distance between paired site should be half of the maximum range and good geometry (GDOP)

Compromise with geographical constraints: cliffs, golden islands, touristic area/high density of population/high property value or national park / wild area without facility

Solution: staying close to a lighthouse or navy semaphore (public domain with power supply, strategic location with large sea view)

Antares (WERA)

① Peyras

② Cap Bénat

③ Porquerolles

Dyfamed (CODAR)

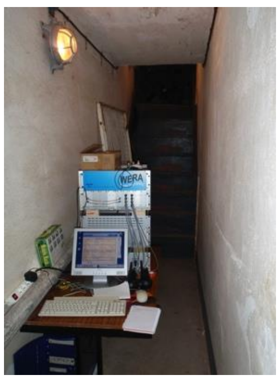
④ Cap Ferrat

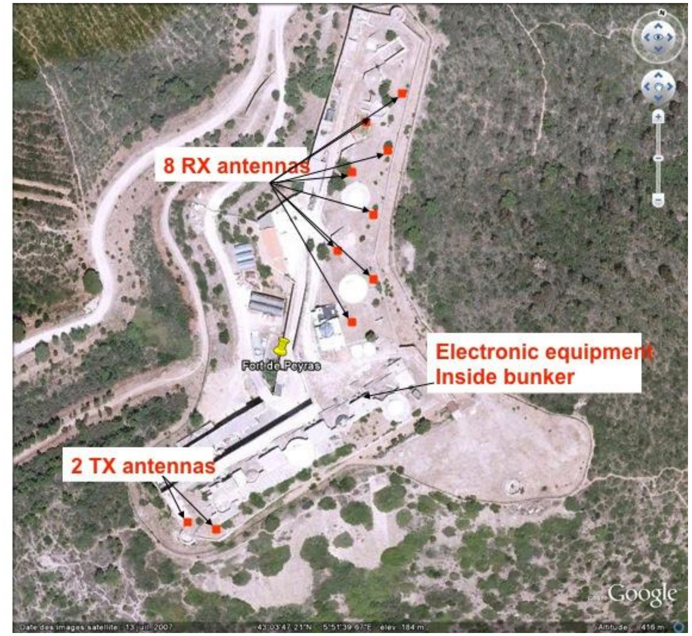
⑤ Dramont

2. Main operational issues

Site 1: Cap Sicié

set up in 2010 in an old military fort, enclosed space to achieve the security of the equipment and the protection of public against non ionizing radiation





Loss of data :

due to power failure following thunderstorm, electrical damage on computer, and antenna broken

- WERA Helzel Messtecknik
- 2 transmit antenna
- 8 receiver antenna in W shape due to minimal space
- GPS synchronization for coordination and sharing of the frequency band
- azimuthal sampling performed using direction finding (MUSIC)
- radial maps send every 20 minutes by GSM to the data center
- remote control of the station by GSM via an auto inverse tunneling based on ssh and http protocols

2. Main operational issues

Site 2: Cap Bénat

receiver site set up in 2011 in an old semaphore,
enclosed private group property in a forest hill (with wild boar)

Material injury:
cable and radial wire cut by brushwood clearing
Recommendation:
underground all the cables

- WERA Helzel Messtecknik
- 8 receiver antenna in line with λ/2 distance separation
- GPS synchronization for coordination with transmitter & sharing frequency band
- azimuthal sampling performed using direction finding (MUSIC)
- radial maps send every 20 minutes by GSM to the data center
- remote control of the station by GSM via an auto inverse tunneling based on ssh and http protocols

2. Main operational issues

Site 3: Porquerolles

Site set up in 2012 after two years of negotiation
Standalone transmitter to scope the effect of shadowing by the golden islands (power 20 W)
Top on the roof of an apartment in the National Parc of Port-Cros (golden islands)

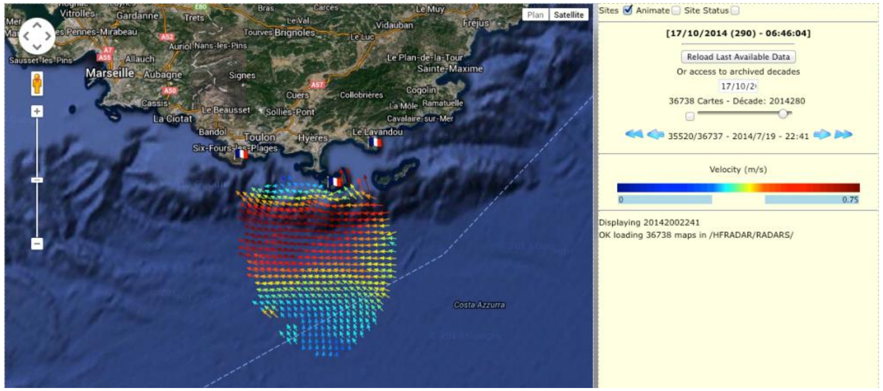
- environmental study on the effect of non ionizing radiation on the pipistrelle (bat)
- analysis of the lightning risk and protection design (2k€)
- low visual impact of the antenna
- public information for restricted access to the roof
- regular measurements of the electromagnetic fields

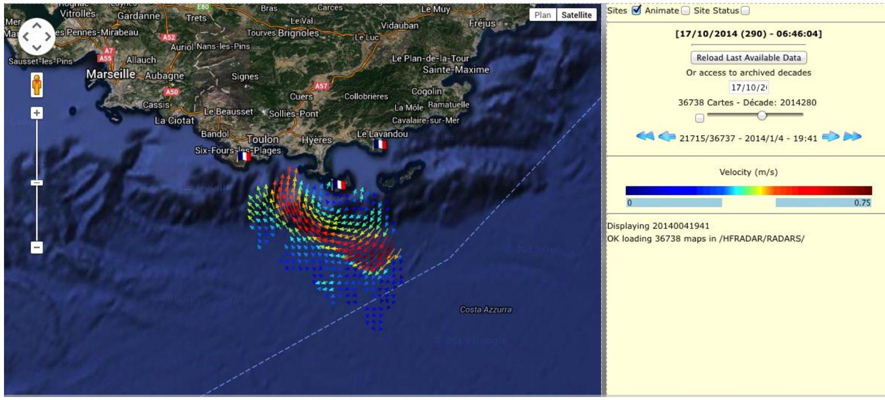
- WERA Helzel Messtecknik
- one transmit antenna
- GPS synchronization for coordination with receiver & sharing frequency band
- no remote control due to bad GSM coverage and no telecom wire on site

2. Main operational issues

Antares - Toulon

fully deployed with WERA systems (Helzel Messtechnik) and operational since 2012





- frequency band 16.1-16.2 MHz [central 16,175 Mhz – bandwidth 50kHz]
- WERA instrument acquired in 2005 and refurbished in 2011
- radial grid resolution 3km x 2deg
- integration time of 20’ to 1 hour
- maximum range of 80 km
- azimuthal sampling performed using Music DF
- pioneering bi-static configuration using GPS synchronization
  with one standalone transmitter on Porquerolles to scope with the islands shadow
- communication link by GSM to control the radar system
  for sending automatic diagnostics and radial files
- near-real time combination every hour on grid 3x3 km^2
- visualization on a dedicated website of current maps and site status: *http://hf-radar.univ-tln.fr*

2. Main operational issues

Site 4: Cap Ferrat

compact antenna CODAR seasonde at 13.5MHz
set up in 2014 in the front of the lighthouse
Obstacle height = 35m , separation distance 30m (<< 3 x height)

Damage to the computer: *following thunderstorm, by the network connection with lost of the hard disk and the network card*

- request of the agreement of the architect of the building of France for a set up in a protected area as the lighthouse is ranked as an historical monument
- grey painting of the antenna to reduce the visual impact
- reinforcement of the roof to withstand the antenna
- no remote control to the station, but network is available behind a firewall

2. Main operational issues

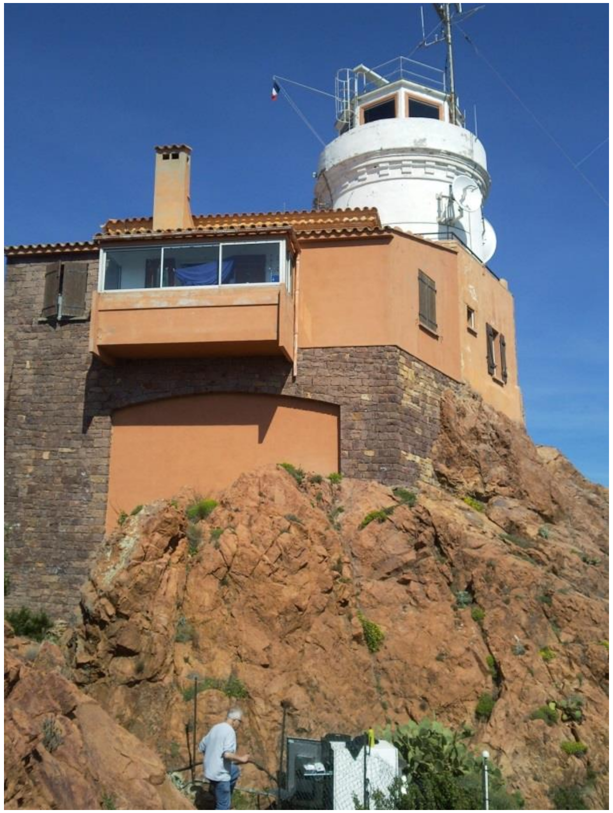
Site 4: Cap Ferrat *skyview from Drone in Nice DN (http://www.drone-in-nice.com)*

2. Main operational issues

Site 5: Dramont

compact antenna CODAR seasonde at 13.5MHz

below an active navy semaphore with spationav radar (X,S) - *source of EM interference ?*



- set up in may 2014, struck by lightning on June
- transmit unit repaired and currently in test on site

Esterel massif specificity is geological red rocks called the rhyolite with more > 65% silica –> **bad electrical grounding**

Natura 2000 protected area with pedestrian walkway, Security guaranteed inside the navy property only

- no remote control, but an autossh inverse tunneling with a GSM connection
- some difficulty to get access to this site following the Paris outrage
- should move in case of work on the semaphore building and bad preliminary results

3. Site maintenance




Main risk and damages:

thunderstorm and lightning activity, rodents, brushwood clearance, brush fire

Prevention:

electrical grounding (ground wire, good earth ground), lightning protection kit, uninterrupted power supply (UPS), mechanical protection on cable and antenna and undergrounding, enclosure with air conditioner, autonomous power supply (solar panel, wind)

Schedule visit:

checking all visible damage on connection (cable) and on antenna, measuring cable continuity, performing auto calibration, antenna pattern measurement, switching external backup disk, register radio interference

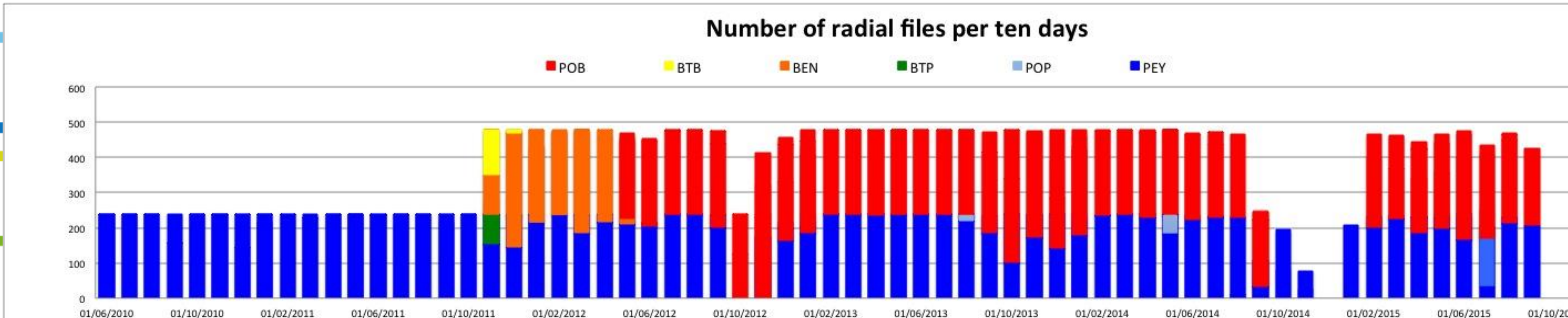
Spare kit: station computer, antenna, cable (RG58, power line), radial wire

Task 2.3: Harmonizing new network systems: HF Radars

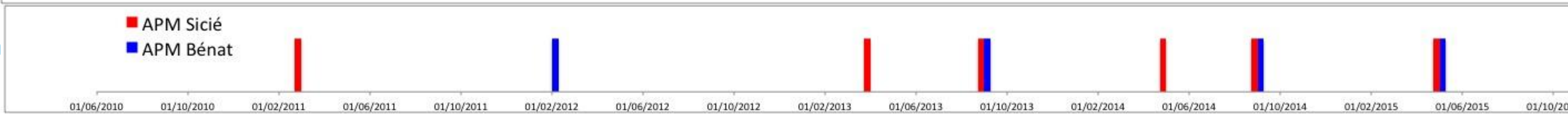
4. Quality assessment

Level 0 - Availability of the instruments (and data)

from june 2010 to october 2015 (in real time since 2012)



Level 1 - Control of the instrument by Antenna Pattern Measurement



Level 2 - Scientific performances on radial velocity

by statistics on radial data, a self-sufficient method

- first outlier removal by using the histogram of the temporal gradient of the current
- Forget, P. (2015), Noise properties of HF radar measurement of ocean surface currents, *Radio Sci., 50,* doi:10.1002/ 2015RS005681

and by comparison with in-situ instrument as:

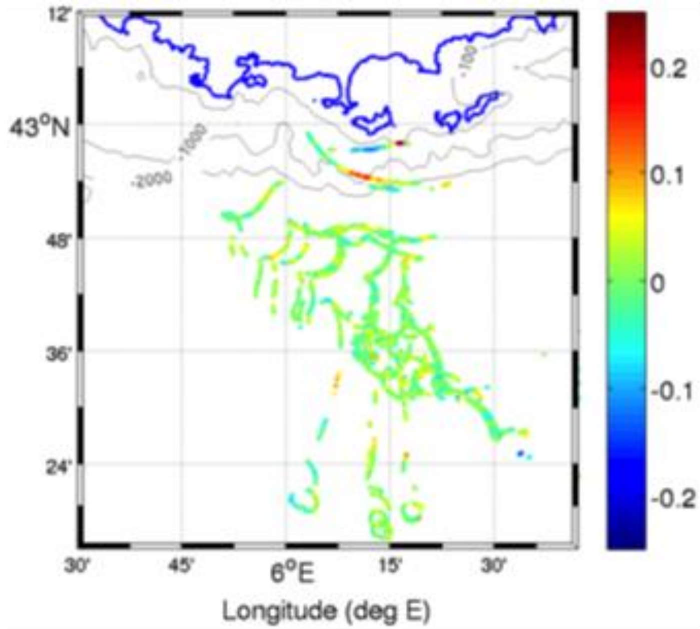
- lagrangian drifters during specific campaigns : TOSCA (dec 2011, aug 2013) , SUBCORAD (sep 2013)
- ADCP (moored or tracked): SUBCORAD (sep 2013), BOMBYX (dec 2013 - mar 2014)

Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment

TOSCA drifters

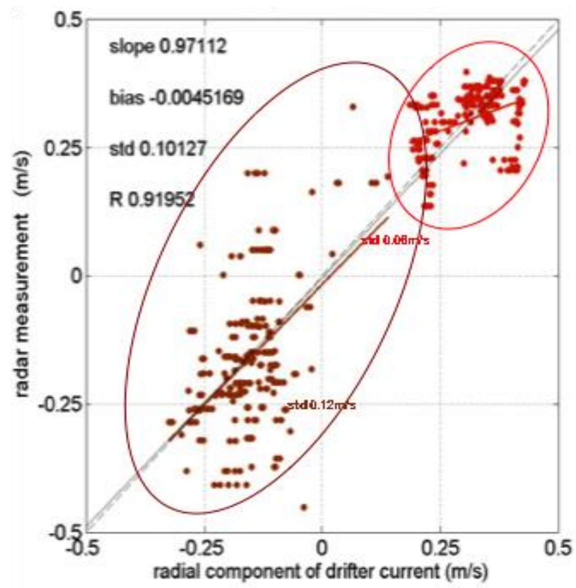
comparison between the radial velocities measured by the radar and the projection of the current in the same direction as it has been deducted by the drifters displacement during the TOSCA experiment



Bellomo, L. et al., Toward an integrated HF radar network in the Mediterranean Sea to improve search and rescue and oil spill response : the TOSCA project experience, accepted *in Journal of Operational Oceanography*.

SUBCORAD drifters

comparison between the radial velocities measured by the radar and the projection of the current in the same direction as it has been deducted by the drifters displacement during the SUBCORAD experiment



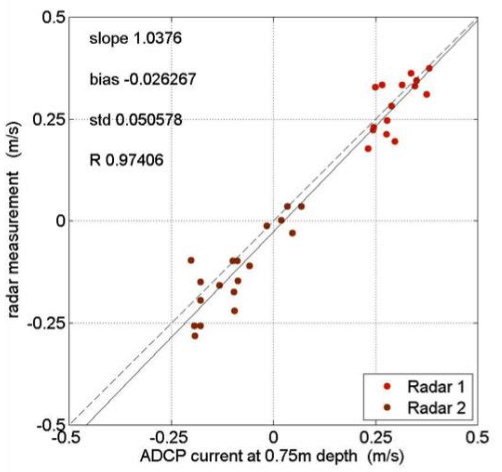
Fraunie, P. et al., Experimental investigation of the relationship between HF radar measurements of currents and the dynamical properties of the upper ocean, *EGU2014-13078*

Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment

SUBCORAD tracked ADCP

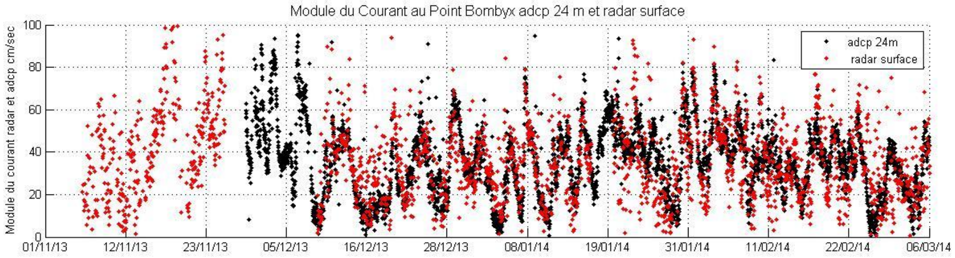
comparison between the radial velocities measured by the radar and the projection of the current in the same direction as it has been measured by a tracked ADCP at the surface level (-0.75 meter) along the radar cell

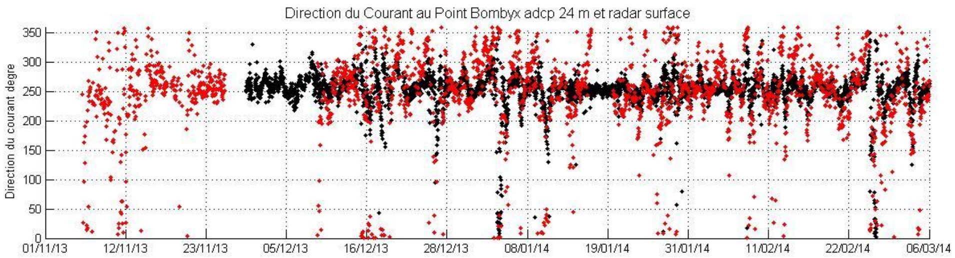


Fraunie, P. et al., Experimental investigation of the relationship between HF radar measurements of currents and the dynamical properties of the upper ocean, EGU2014-13078

BOMBYX moored ADCP (nov. 2013 - mar 2014)

comparison on a local point between the radial velocities measured by the radar and the projection of the current in the same direction as it has been measured by the ADCP at deeper level (-24 meter)





Rougier, G. et al., Wave-current interactions in deep water conditions : field measurements and analyses, EGU2015-4719

Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

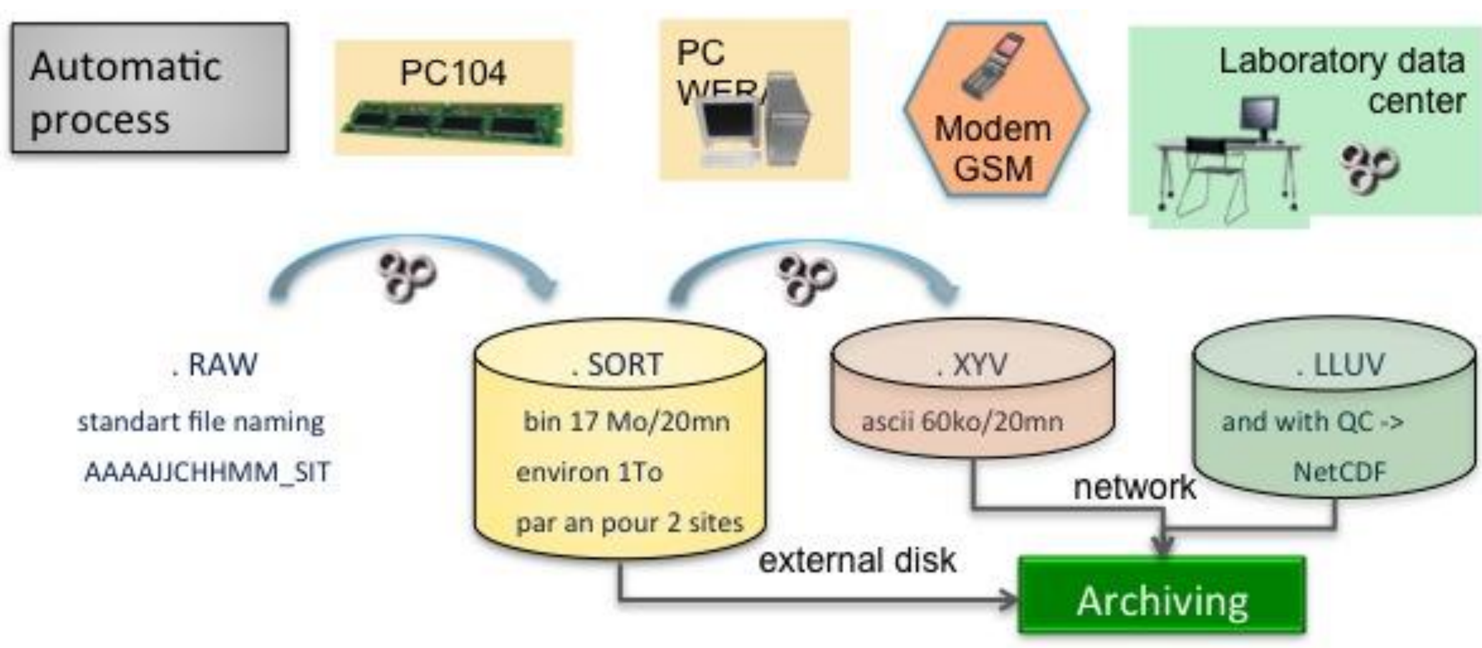
Data Flow

every station performs its diagnostics and send the radial files to the data server

Even if there is not a full link with the radar station to control it, we control

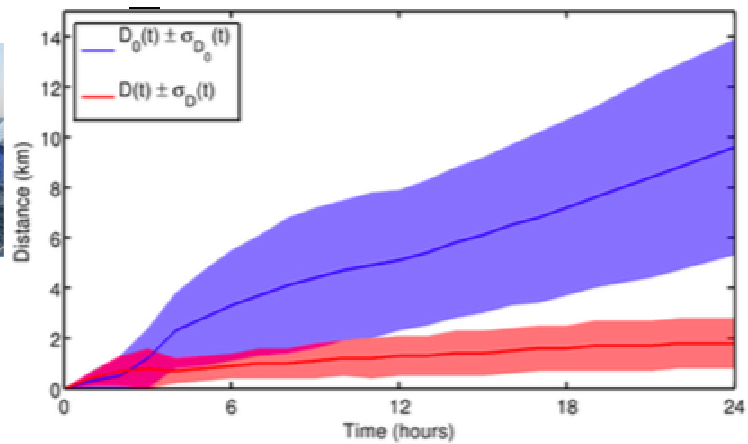
- if no radial file get -> alert
- if radial file is empty -> alert
- if antenna diagnostics failed -> alert

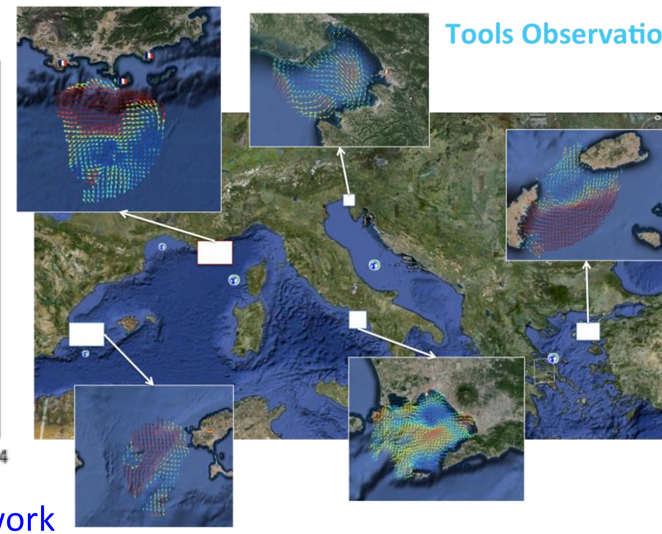
Radial files are then filtering to remove outliers, and a combination is made



6. Applications

During the **TOSCA** (MedProgram) campaign, a comprehensive data set of surface radial currents measured by HFSWR, surface drifter trajectories, and gliders was collected. The data gathered by the project have been combined into a web based decision tool designed for authorities in charge of maritime crisis. The system provide critical data and applications, as the visualization of the surface currents and dispersion of an ***oil spill***.





Tools Observations

Bellomo, L. et al., 2015, Toward an integrated HF radar network in the Mediterranean Sea to improve search and rescue and oil spill response: the TOSCA project experience , JPO

The potential of this real-time observation lies also through the **data assimilation**, as it can correct the baroclinic oceanic forcings and improve the surface currents ([Marmain et al., 2013]).

Task 2.3: Harmonizing new network systems: HF Radars

6. Applications

some technological solutions

- array of 8 antenna and DF MUSIC algorithm for radial velocities with an high azimuthal resolution
- separation of the receiver and transmitter with GPS synchronization (BISTATIC)

data sets

- this is the beginning of long term observation with HF radar in the aim of its integration in operational oceanography
- we have collected more than four years of radial velocities, and two years of total vector at the first area of interest in the neighborhood of Toulon
- we achieved the set up of the second area (Nice)

different applications, different needs

- post-processed radial velocities can be sufficient and are used for modelisation as mesoscale studies and case studies in data assimilation
- total vector in real time are needed for lagrangian purposes as the drift of pollutant

7. Other items

What is the global cost of HF radar infrastructure?

- How many men months for the radar/electronic maintenance?

"2 local field technicians for every 7 direction-finding (DF) HFRs or 2 technicians for every 4 linear phased array (LPA) HFRs. " - Integrated Ocean Observing System A Plan to Meet the Nation's Needs for Surface Current Mapping (updated May 2015)

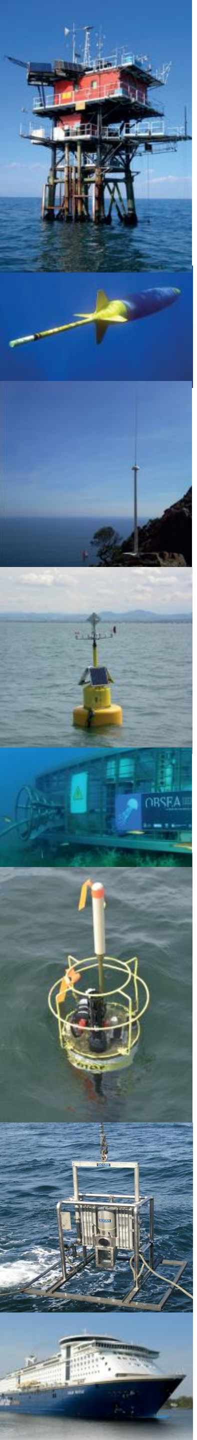
- How many men months for the data management?
- What is the annual cost of the maintenance?
- What is the cost for the ground property, power supply, telecommunication, insurance of the equipment?

What strategy to reduce RFI?

- What can we expect from the ITU regulation?
- How to coordinate the frequency sharing?

  -> next meeting in Toulon at the end of April between
  the national agencies of telecommunication (Spain, France, Italy)
  and HF radar operators

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.



HF radar covering the approach to the Port of Rotterdam

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

Presenter: Rinus Schroevers, Deltares

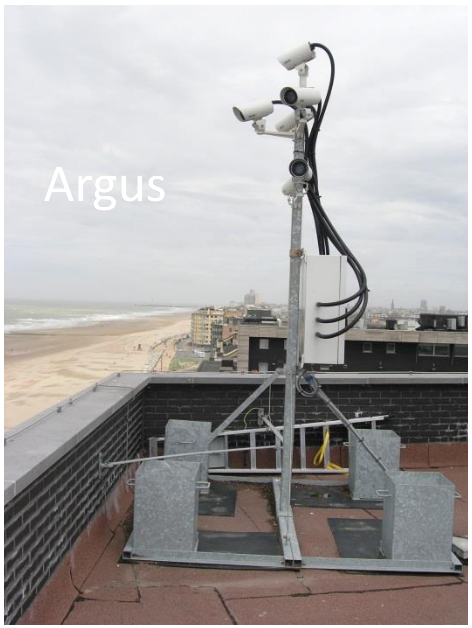
email: Rinus.Schroevers@ Deltares.nl

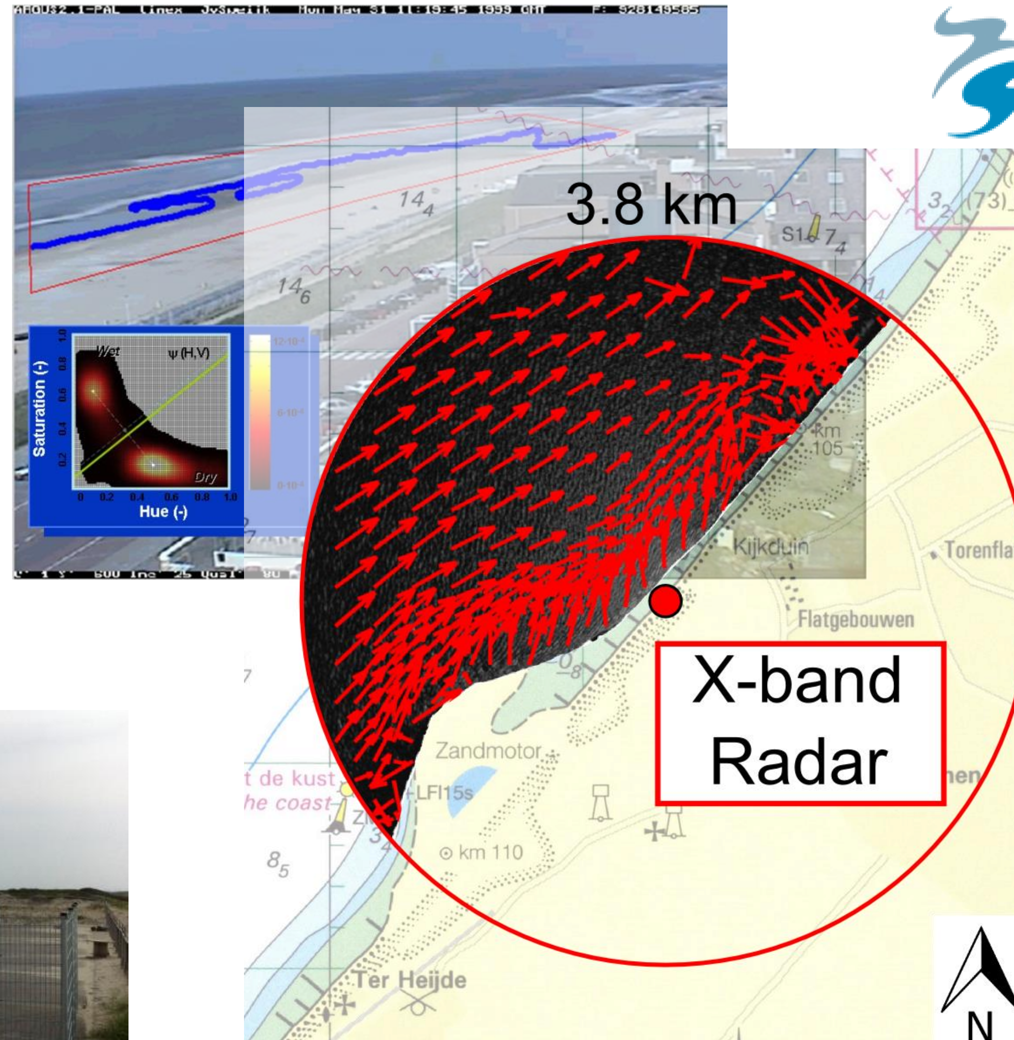
Contributor(s): P. Verburgh, H. Peters, M. de Jong, G. Hof, Helzel Technologies, RADAC,

JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

Remote sensing of coastal areas

Argus Video and X-band radar





Task 2.3: Harmonizing new network systems: HF Radars

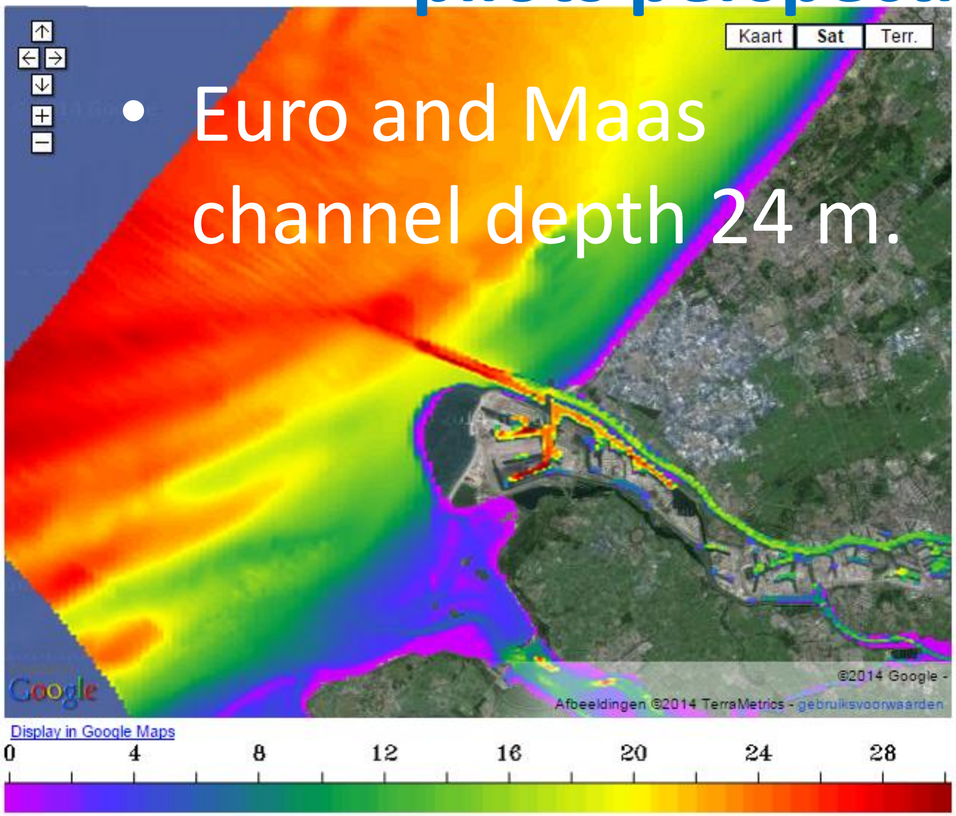
1. Issues during the installation phase

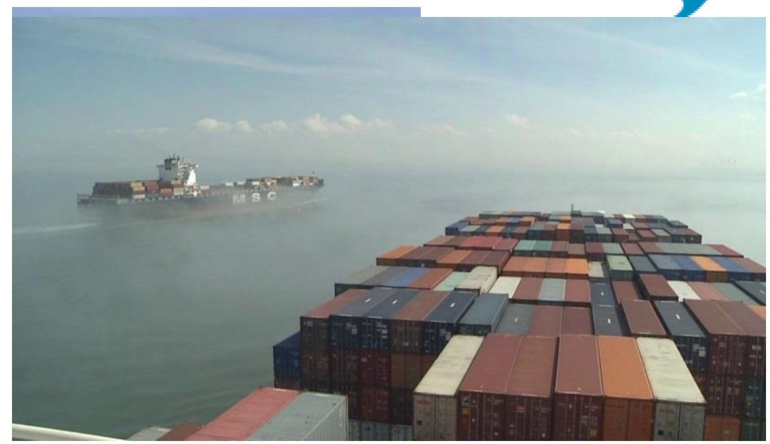
The port of Rotterdam

95.000 movements of sea going vessels p/y
400.000 movements of inland freighters p/y

Access to the port Rotterdam: pilots perspective

- Euro and Maas channel depth 24 m.





Tide

Swell

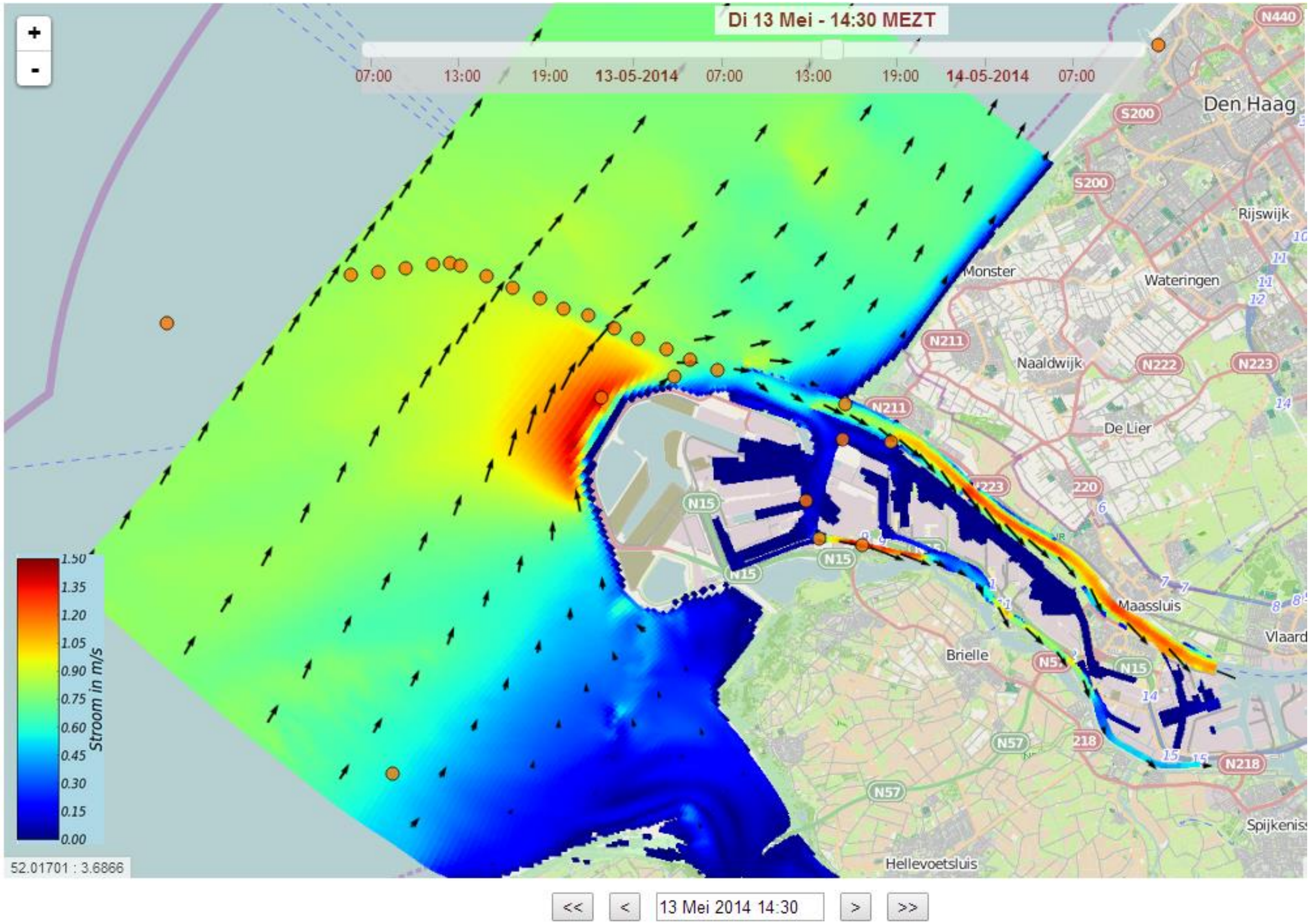
Cross currents < 1.7 m/s

Ship specifications

} time window for entrance

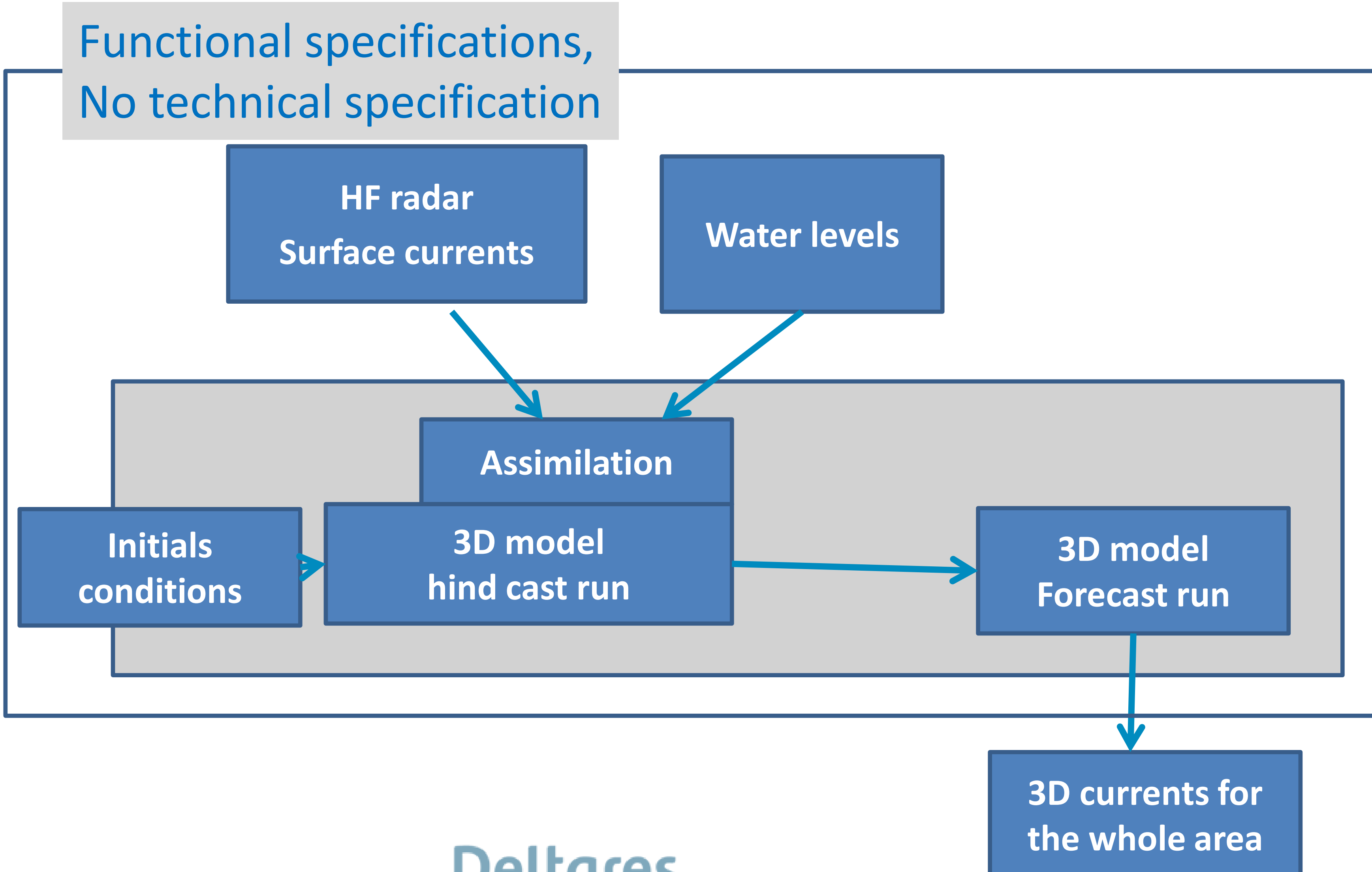
Rijkswaterstaat
Ministry of Infrastructure and the Environment

Present current forecast



2D hydrodynamic forecast model → depth averaged currents

Future 3D currents forecast



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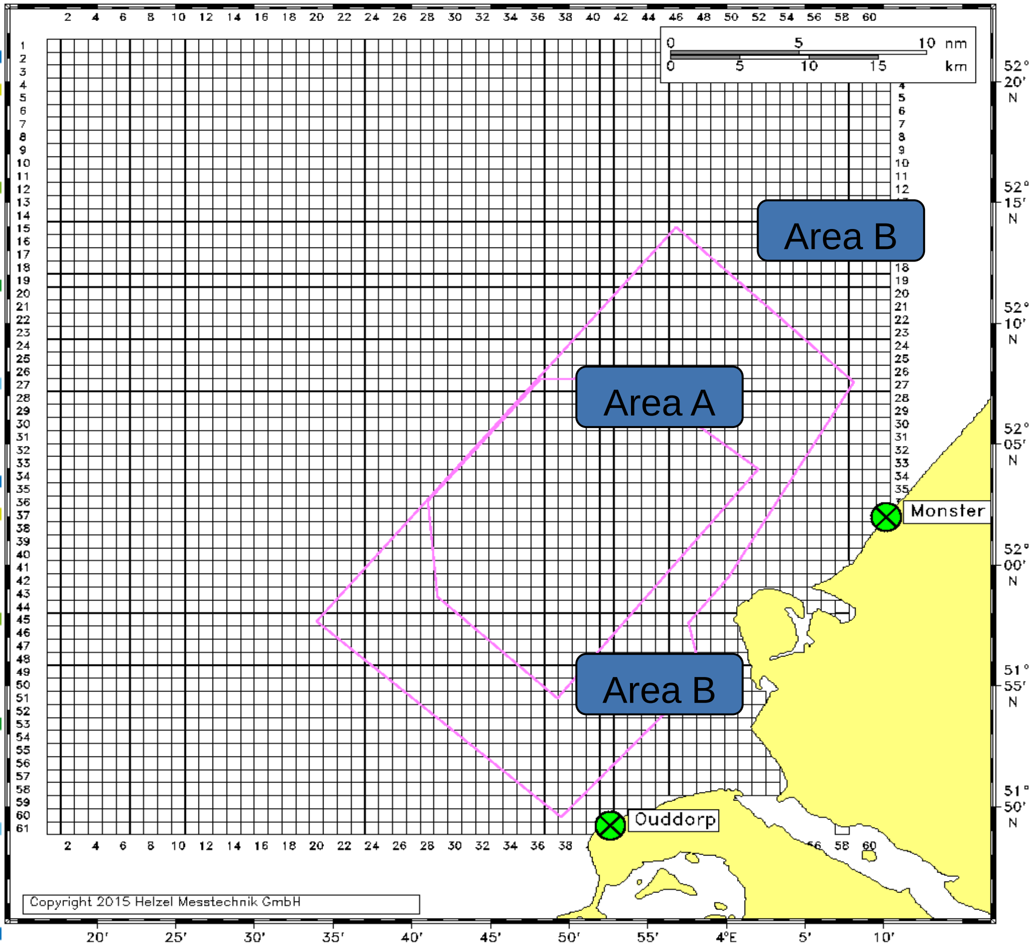
Deltares

1.1 Definition of Requirements

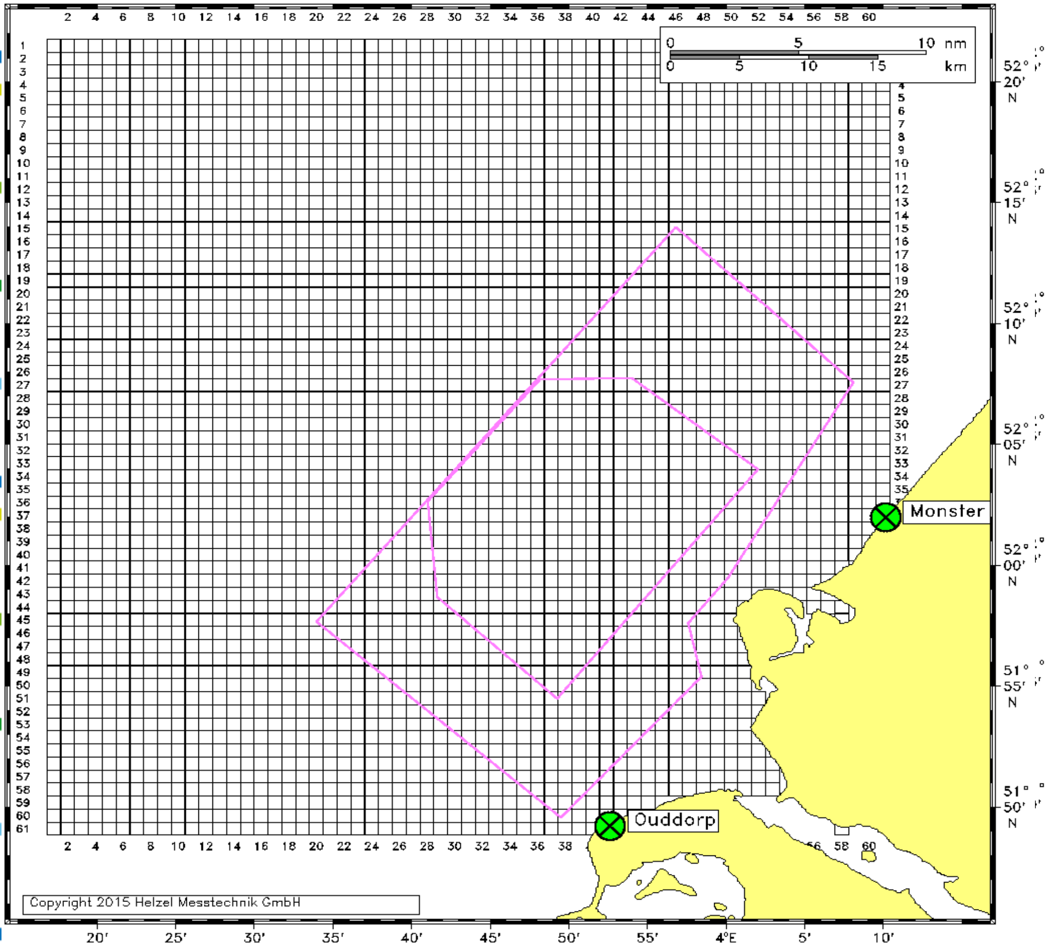


Grid Size: 1 x 1 km

In Area A are 354 Grid Cells:
In Average for 95% of theses gird cells Surface Current Velocity Vectors should be available, 90% as minimum.

In Area B are 841 Grid Cells:
In Average for 90% of theses gird cells Radial Current Velocity values should be available, 80% as minimum.

1.2 Definition of Requirements

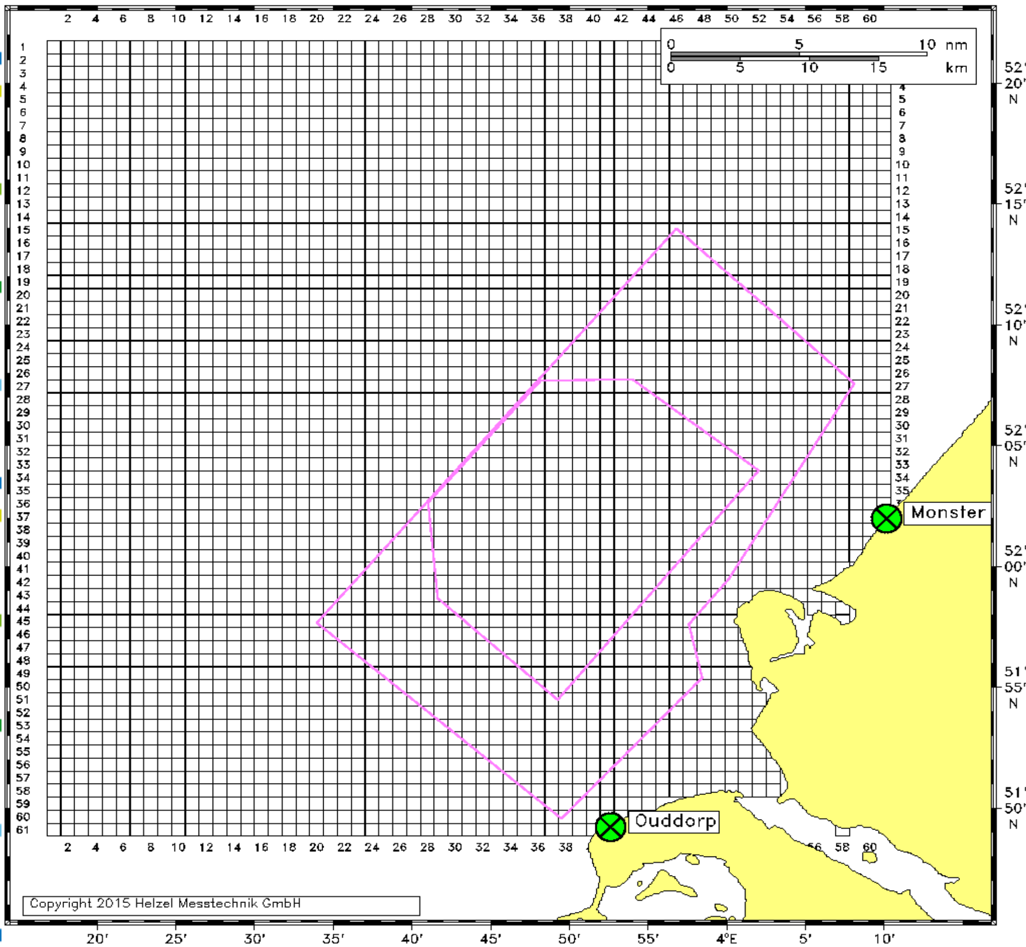


Time Gaps of Data for individual Grid Cells

There should be no grid cell without data for a period of more than 3 hours.

The total data loss per data should be less than 6 hours for any individual grid cell.

1.3 Definition of Requirements

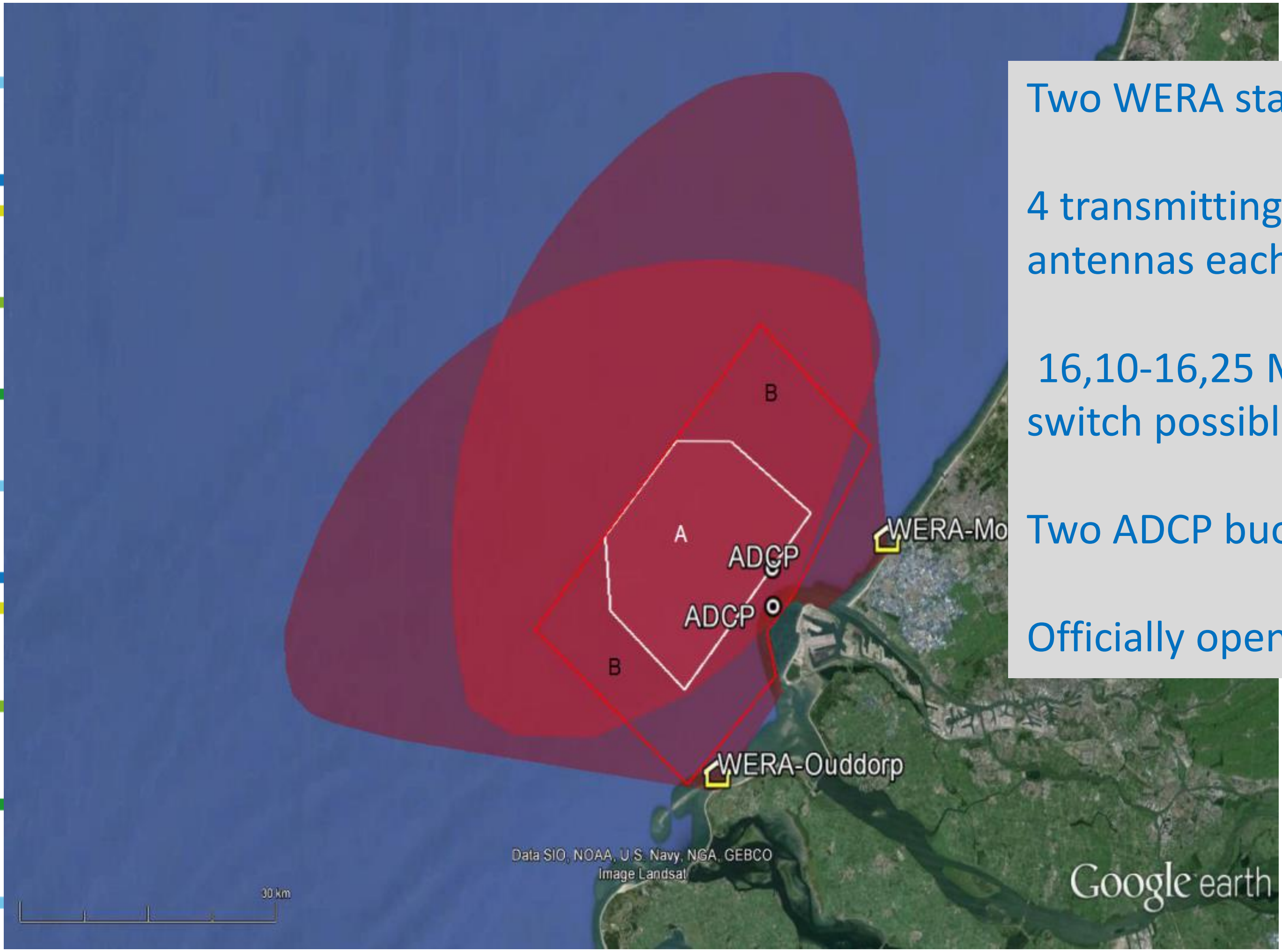


Latency from end of Data Acquisition to Accessible Data on Server

There should be a Data up-date twice per hour.

The new data set should be available not later than 10 min after end of acquisition period.

Coverage Map



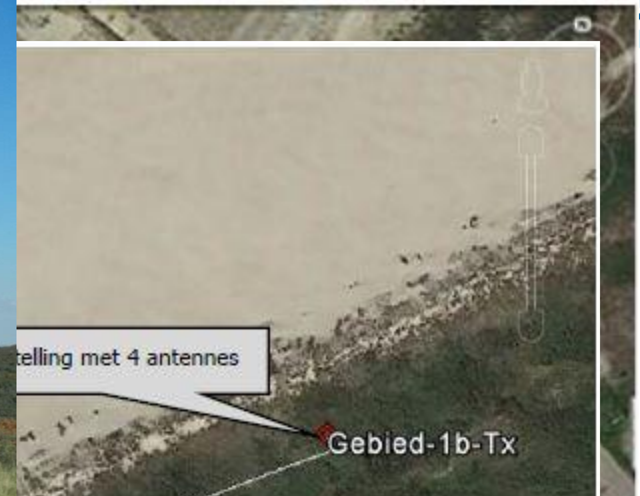
Two WERA stations

4 transmitting and 12 receiving antennas each.

16,10-16,25 MHz → Frequency switch possible

Two ADCP buoys within range

Officially opened on 30 nov 2015


telling met 4 antennes
Gebied-1b-Tx


Gebied-1b-WERA
100 m
2005

Power and infra
structure

Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

Site Selection and Approvals;
Possibilities given by Rijkswaterstaat, contractors choice and responsibility.

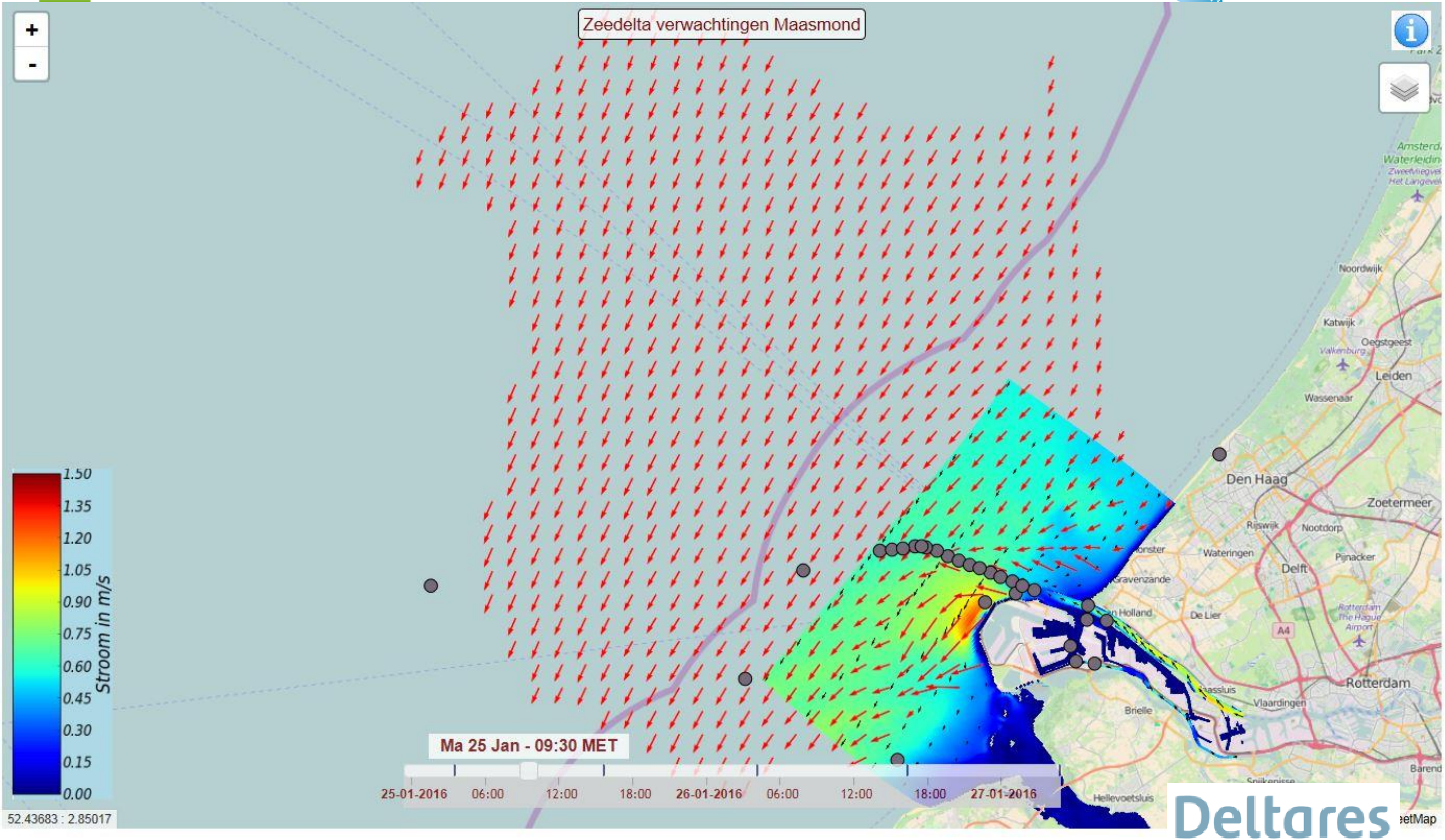
Radar:
WERA 16,10-16,25 MHz 4 transmitting and 12 receiving antennas each.

Environmental Concerns:
Breading season of toads and relocation of sea thisle

Power and infrastructure:
Location one: Power and hardware at local restaurant
Location two: Separate power connection and housing for hardware.

Electromagnetic:
Low power (7 w transmit), maximum energy towards sea

Public awareness:
Brochures and billboards at locations



http://waterberichtgeving.rws.nl

Task 2.3: Harmonizing new network systems: HF Radars

2. Main operational issues

Power outages and communication failures; Air-conditioning; Coastal Erosion; Calibration; Mains interference; Security; Radar system robustness..

No evaluation available. Maintenance plan not open to public.

Electromagnetic:

Disturbance by activities at Port of Rotterdam during day

Task 2.3: Harmonizing new network systems: HF Radars

3. Site maintenance

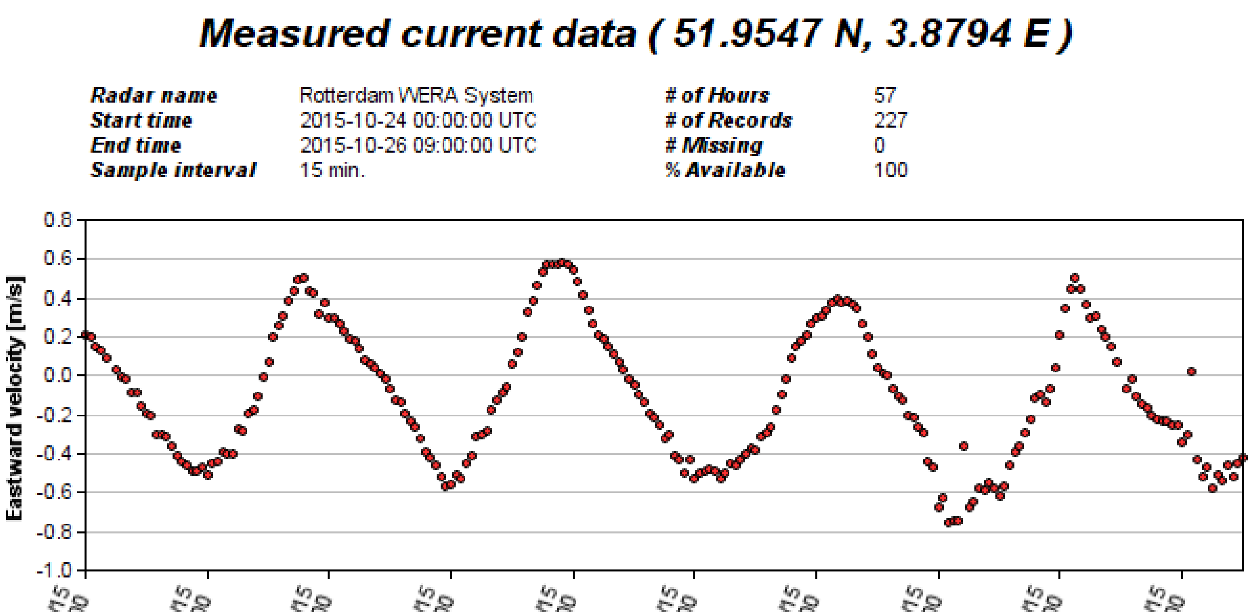
In the hands of contractor for 5 years who has to maintain the data availability set by the contract.

4. Quality assessment

Contractor has to maintain the data availability for 5 years (Automated quality checks in place)

Quality checked at start-up period (contract) using ADCP data.
- Tidal components analysis
- Correlation with wind
- consistency

Some artifacts are artifacts, but some are physics!
- currents near shore (6m)cut off

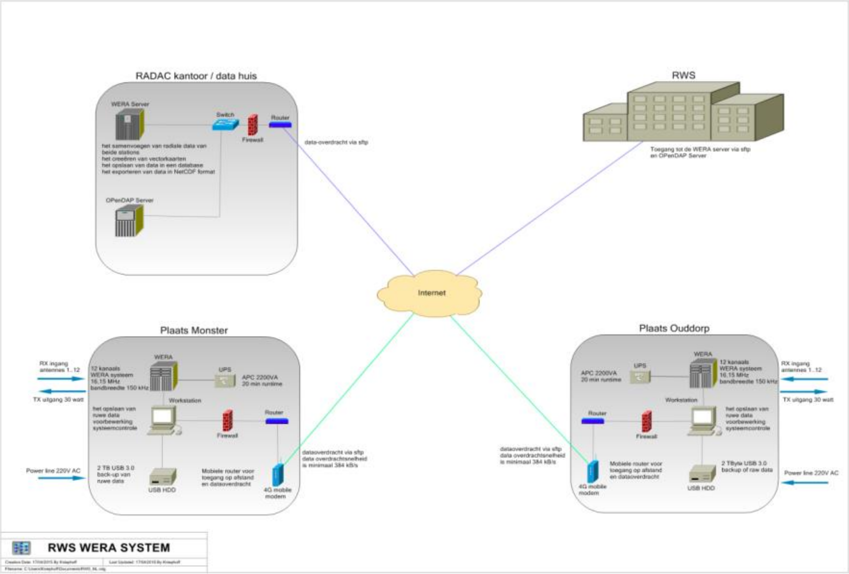


Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

Format: NetCDF
Quality control: Standard by WERA software module by contractor
Data processing:
Both radials of separate stations and combined vectors available.

Data flow for dissemination: data on OpenDAP server. Access and products under discussion.



Task 2.3: Harmonizing new network systems: HF Radars

6. Applications

Primary Use:
Navigation to/from Port of Rotterdam, Data products under consideration

Secundary use:
Search & rescue, oil spill

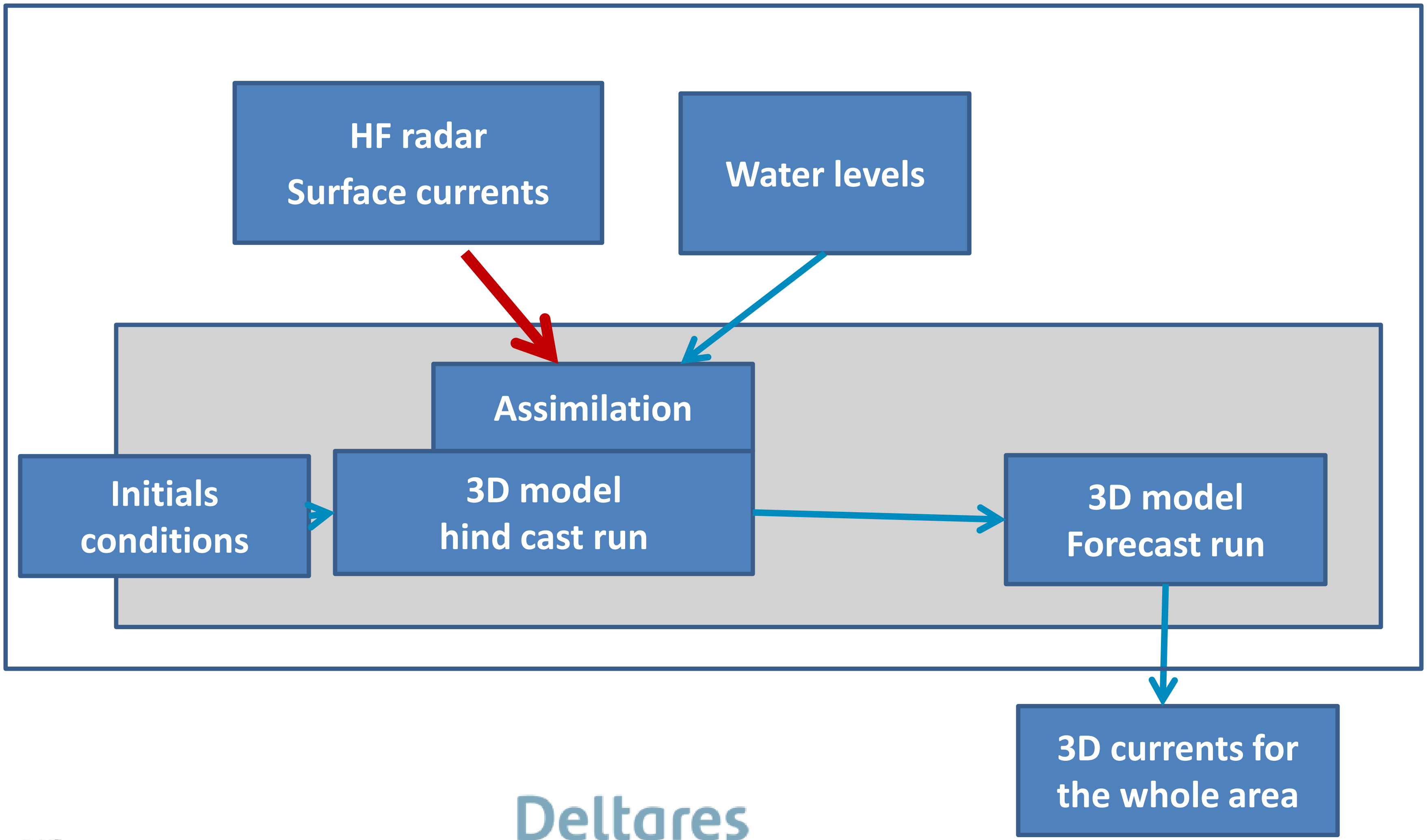
Tertian use:
Research of River outflow and coastal dynamics

Under consideration
Wave heights for validation and data assimilation into operational wave model (primary use: navigation)

Deltares

6. Applications

Next step

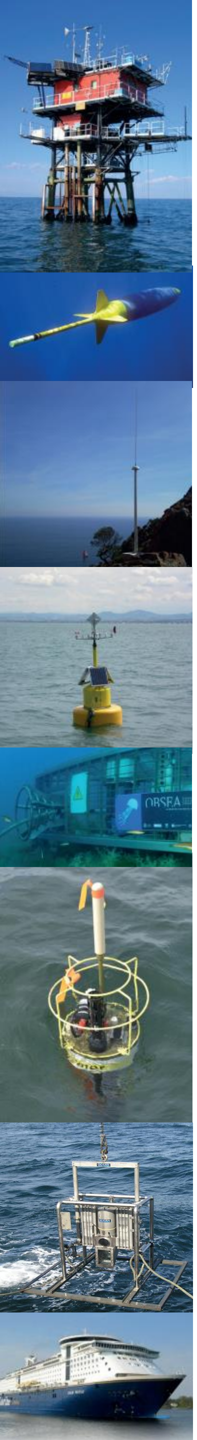


Rijkswaterstaat
Ministry of Infrastructure and the Environment

Deltares

Thank You

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.



Test of HF-radar on the west coast of Sweden
SMHI

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

Presenter: Magnus Wenzer email: magnus.wenzer@smhi.se

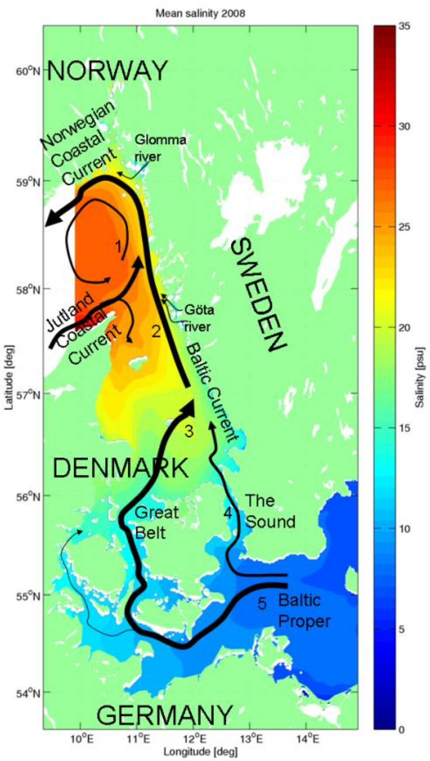
Contributor(s): Pia Andersson, Johan Kronsell

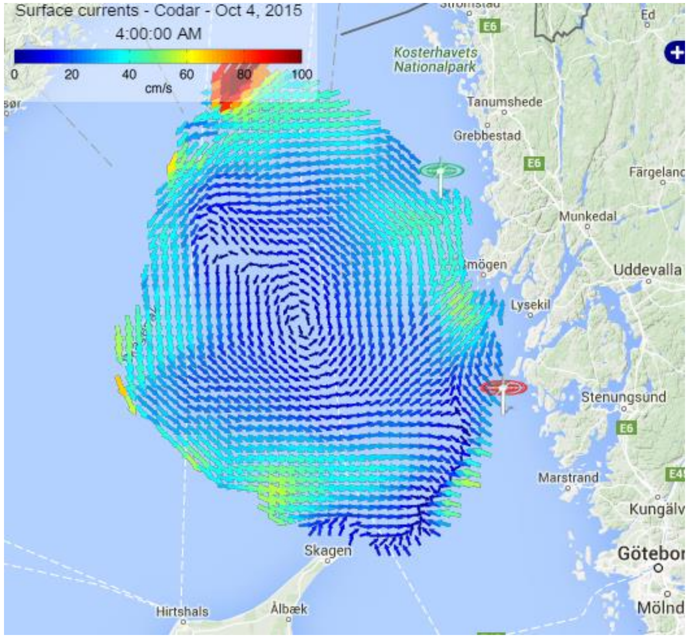
JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

Task 2.3: Harmonizing new network systems: HF Radars

Introduction

- Project lead by SMHI in cooperation with Chalmers, FOI, Meteorologisk institutt and DMI.
- Test period: October 2014 – December 2015
- Two CODAR systems
- 9.33 and 13.5 MHz





Interreg IVA · Europeiska Unionen Europeiska regionala utvecklingsfonden · Meteorologisk institutt · DMI · SMHI · Rymdstyrelsen · Chalmers · FOI

INDEX

1. **Issues during the installation phase** Site Selection and Approvals; Radar choice (Direction Finding, Phased Array, manufacturer; Environmental Concerns – Electromagnetic; Environmental Concerns – Impacts (ground, plants, animals, views); Power; Communications; …
2. **Main operational issues** Power outages and communication failures; Air-conditioning; Coastal Erosion; Calibration; Mains interference; Security; Radar system robustness..
3. **Site maintenance** Schedule; Spares; ...
4. **Quality assessment** Automatic reporting on changes in status of stations and computer systems; Web-based database of incidents and actions; …
5. **Data management** Format; Quality control; Data processing; Data flow for dissemination
6. **Applications** Users; Areas -search&rescue, oil spill, fisheries, etc-; products; Lagrangian tools; data assimilation…
7. **Other items** you consider interesting in T2.3 context

1. Issues during the installation phase

- Systems on island – weather limitations - rough terrain
- Approvals: Took long time - project delayed.
- Radar choice: CODAR. All requirements were met and CODAR won the bid.
- Impact: Environmental protected area.
  Minor drilling were allowed.
  Very little impact.
- Power: Weather station (owned by SMHI) and in cooperation with the Swedish Maritime Administration.
- Communications: Some troubles at one of the sites.
  Tests with different mobile operators.

Task 2.3: Harmonizing new network systems: HF Radars

2. Main operational issues

- Disturbance on initial frequency (9 MHz)
- Air- conditioning: Well insulated shelter at one of the sites.
  A couple of hot days during summer might have had some interference with the equipment.
- Sites on islands – time consuming and additional expenses

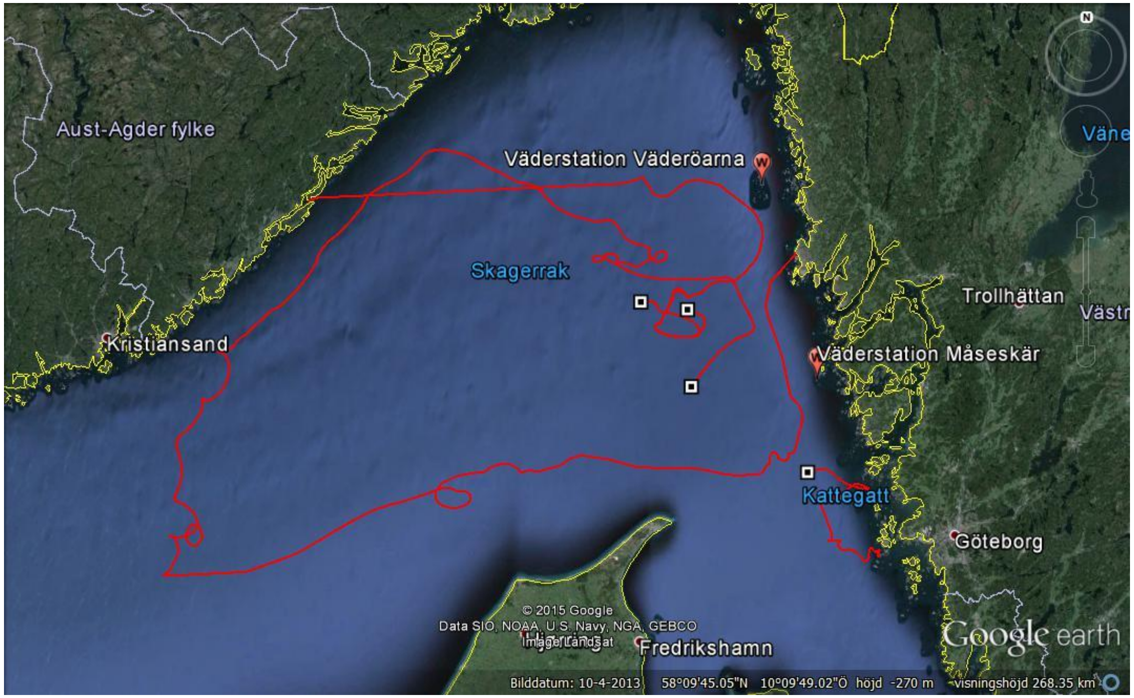
3. Site maintenance

- One planed visit to both sites to change frequency.
- Two visits to change communication system on one of the sites.
- One visit to change the GPS-module at one of the sites.
- All minor work made by our own personnel.

Task 2.3: Harmonizing new network systems: HF Radars

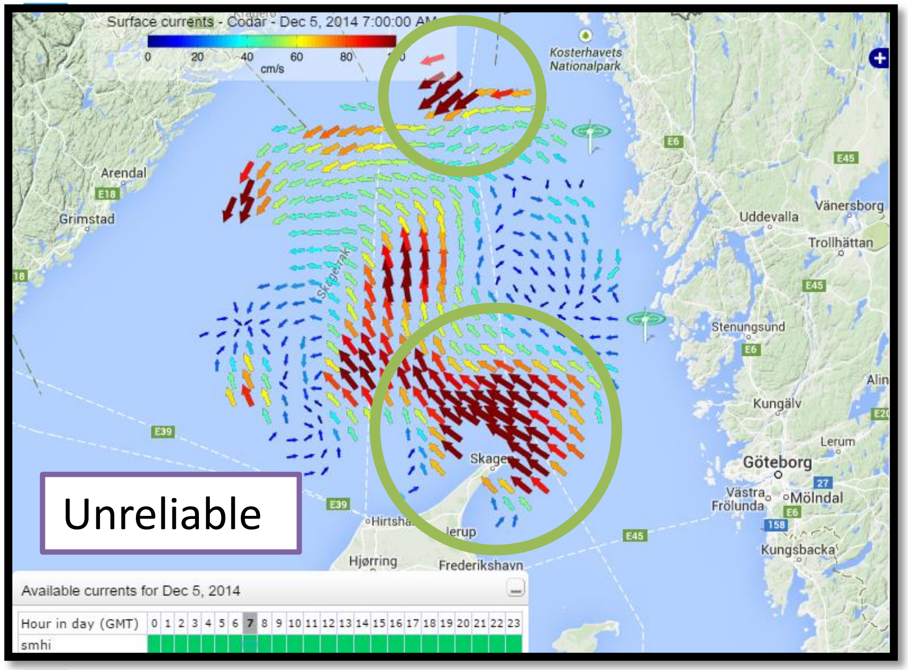
4. Quality assessment

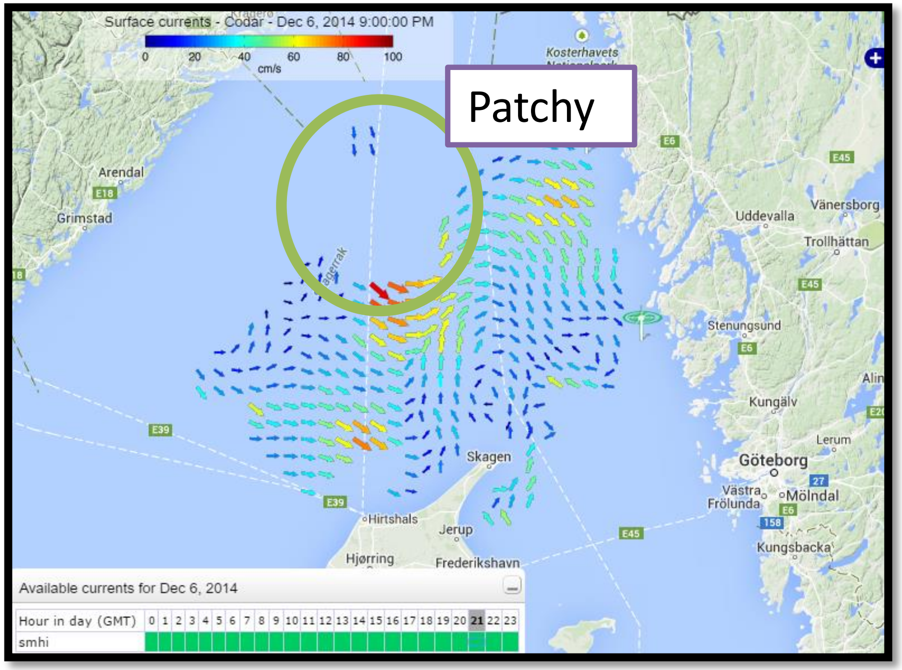
- Close contact with Qualitas
- Minor quality control made by SMHI
- Some visual comparisons with drifters



Data coverage, 9 MHz

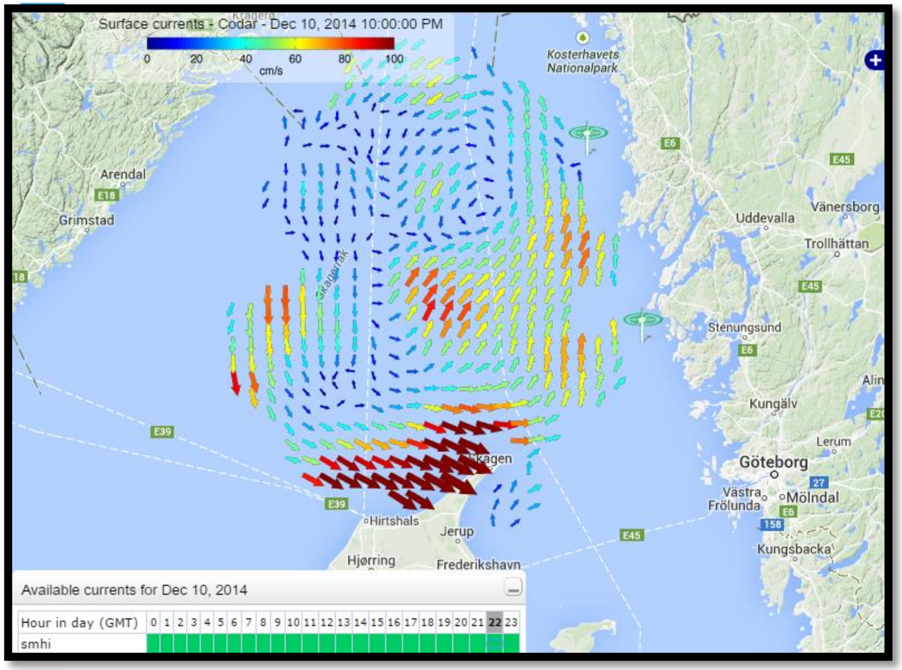
Unsatisfying

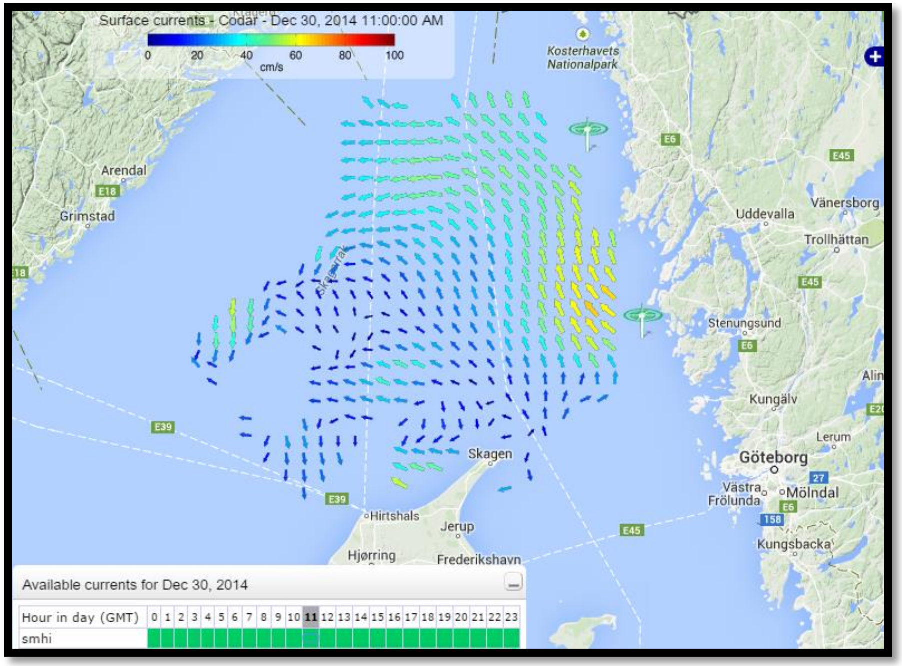




Data coverage, 9 MHz

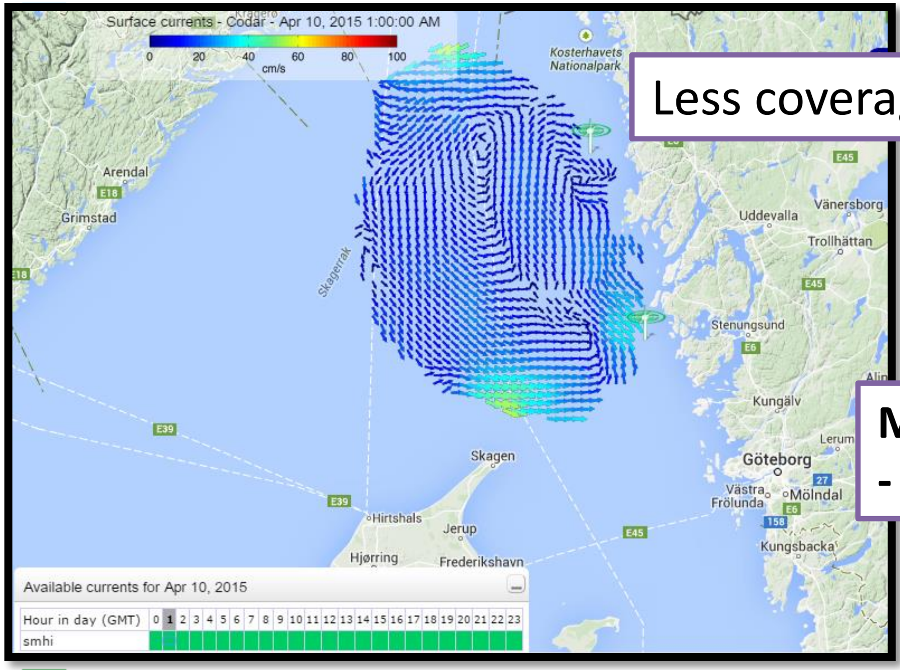
Unsatisfying



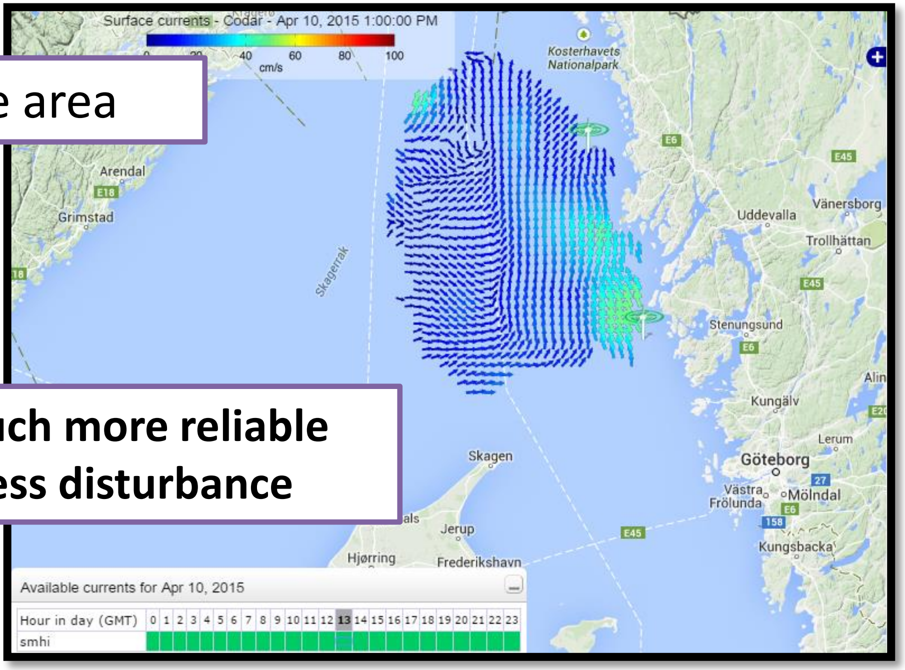


Data coverage, 13 MHz

high resolution



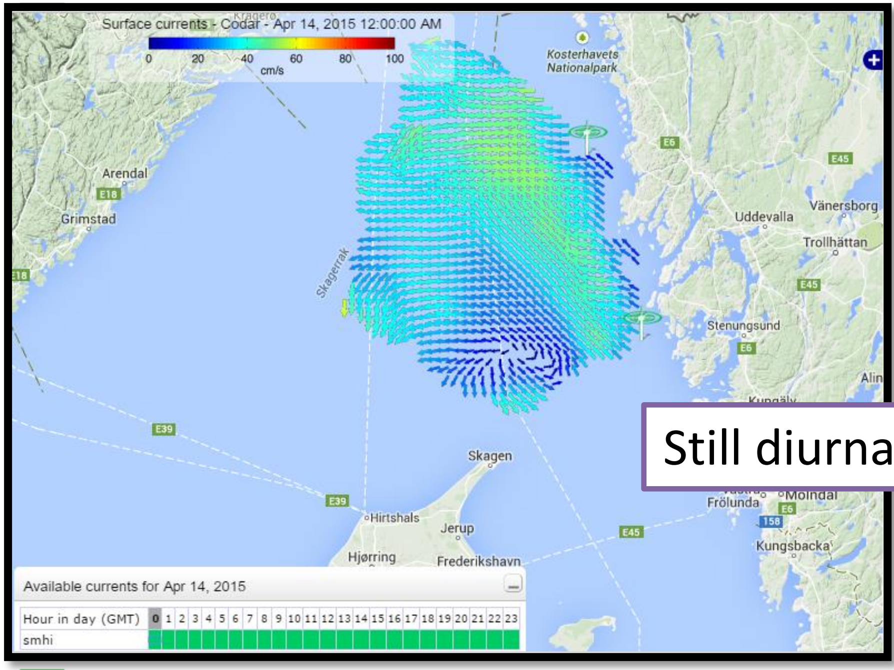
Less coverage area

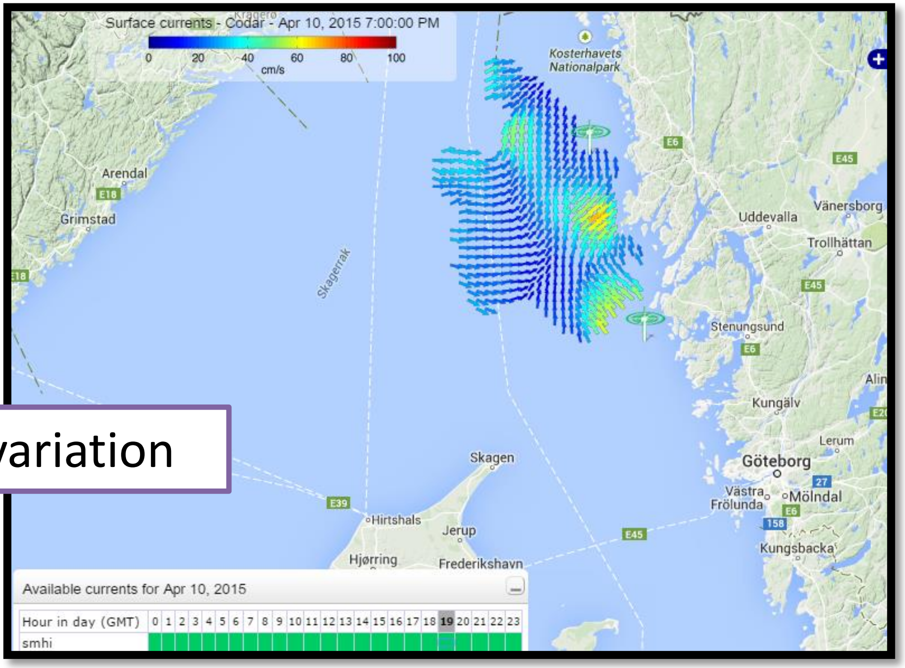


Much more reliable
- Less disturbance

Data coverage, 13 MHz

high resolution





Still diurnal variation

5. Data management

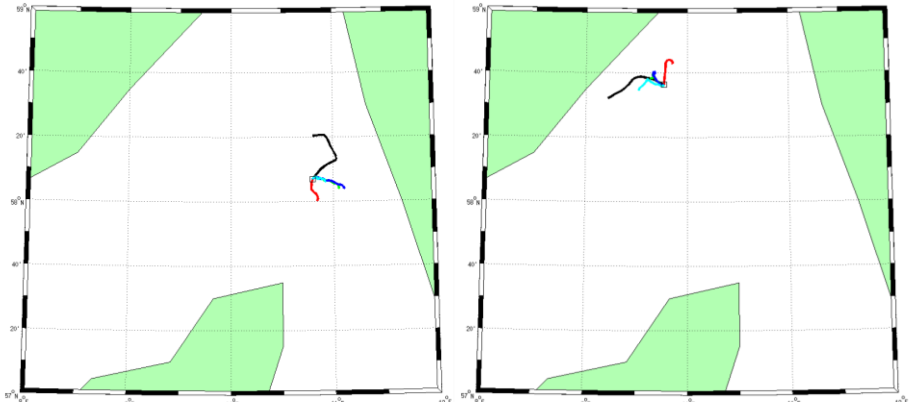
- Historical HF radar data stored at SMHI:
  - 9 MHz: Nov 2014 – Jan 2015 (bad quality).
  - 13.5 MHz: Feb 2015 – Dec 2015.

- Drifter data stored at SMHI

Task 2.3: Harmonizing new network systems: HF Radars

6. Applications

- Data access by partners during the test period
  - Data assimilation into HIROMB (SMHI). Some conclusions:
    - Simulation of buoy trajectories show improvements compared to the case of ”No Data Assimilation ”
    - Performing Data Assimilation every 3 hours gave improved results compared to every 6 hours.
  - Comparison to satellite data (Chalmers Technical University)
  - Ship detection (FOI, Swedish defense research agency)
  - Visual usage (via Portus web page) on monitoring cruises to orientate ship during water sampling.

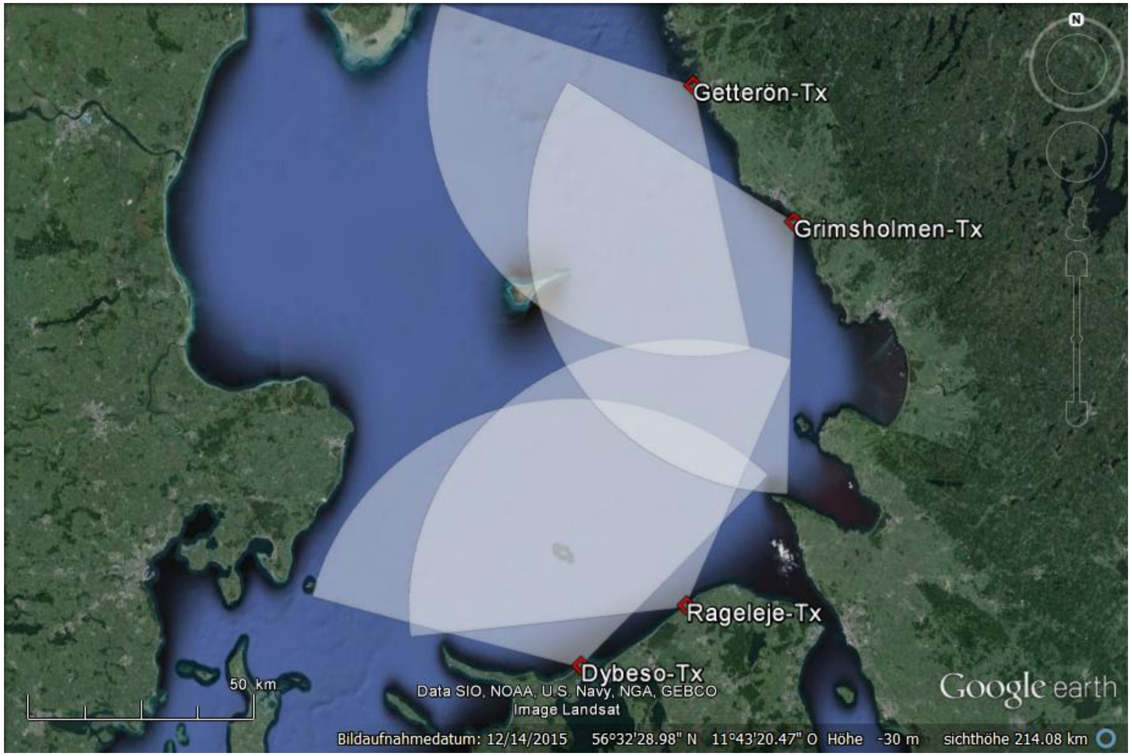


Black: Drifter bouy, **Red: No assimilation**, **2* Blue: Assimilated model**

Task 2.3: Harmonizing new network systems: HF Radars

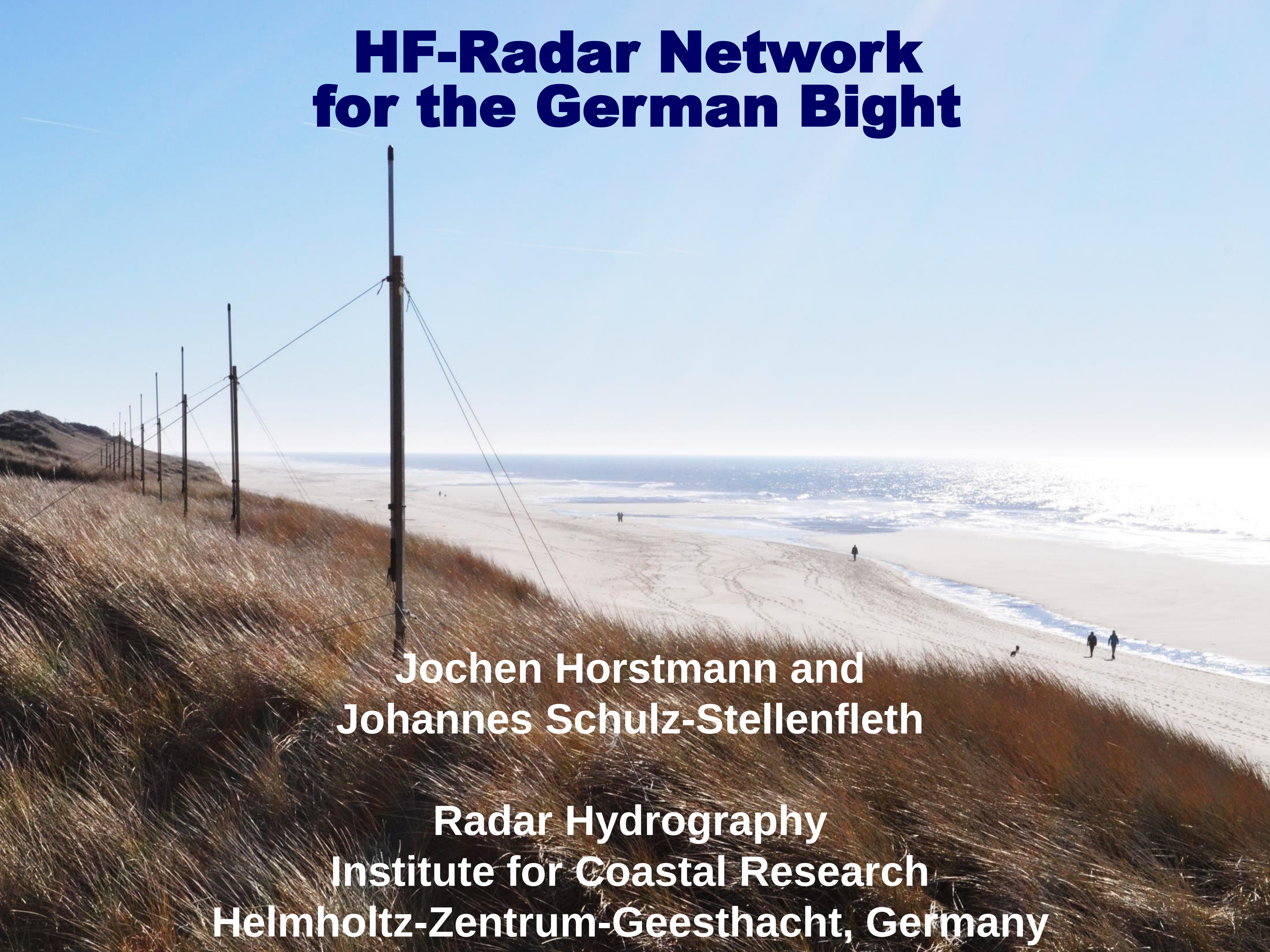
7. Other items

- Communicating on national level and with neighboring countries, to create conditions for a HF radar network.
- Ongoing BONUS proposal 2017-2019



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.

HF-Radar Network for the German Bight



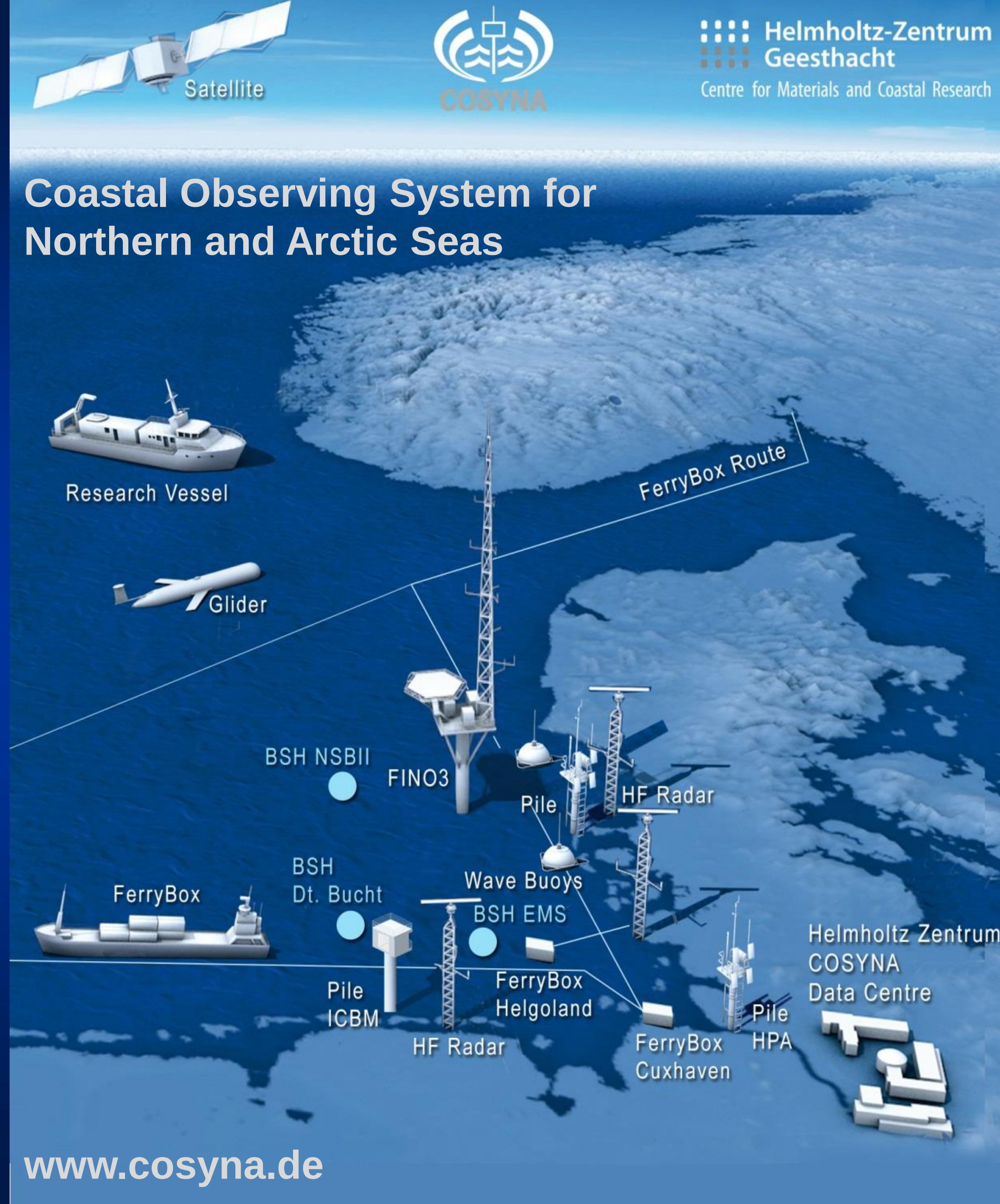
Jochen Horstmann and
Johannes Schulz-Stellenfleth

Radar Hydrography
Institute for Coastal Research
Helmholtz-Zentrum-Geesthacht, Germany

COSYNA

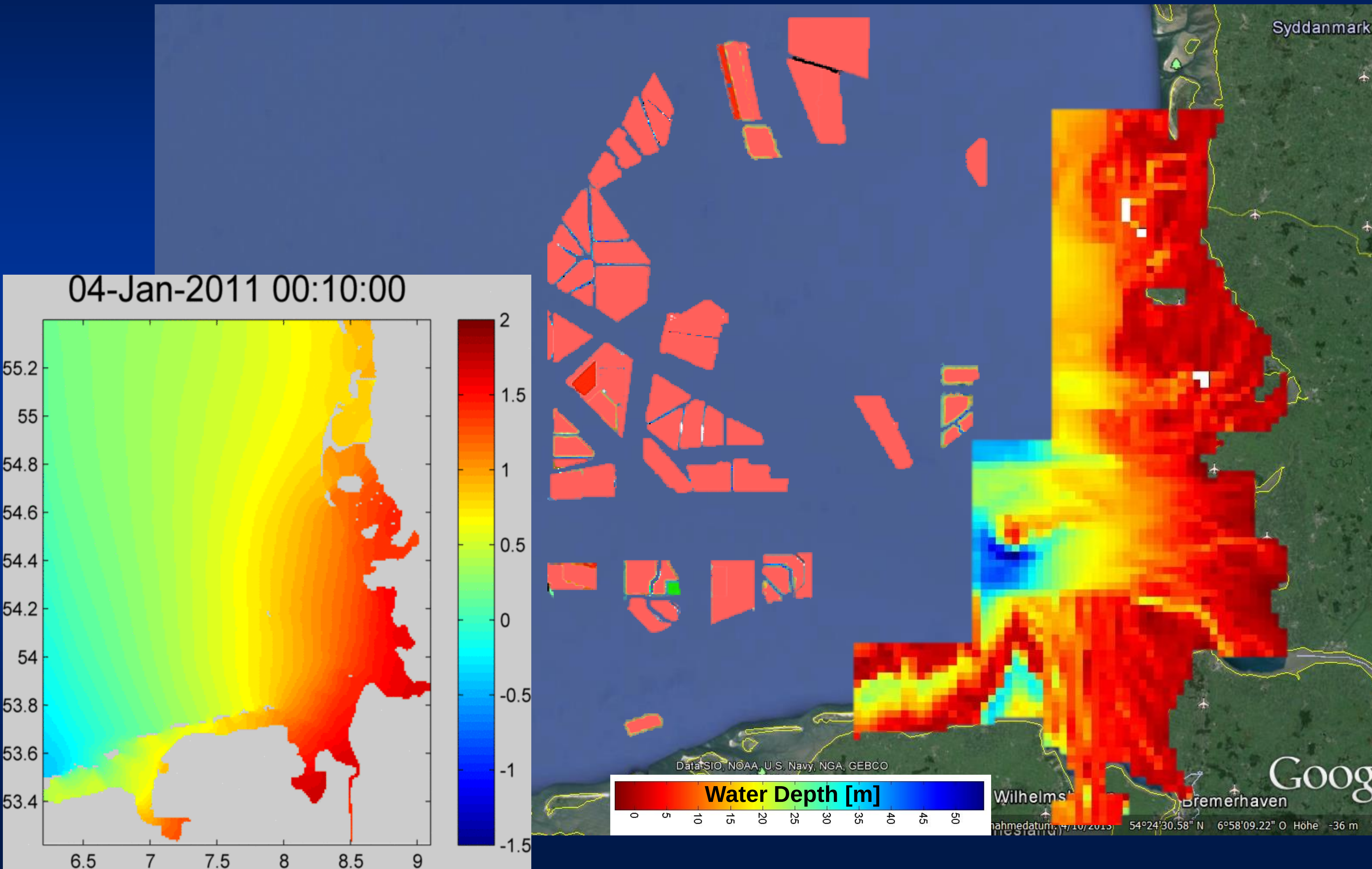
Pre-Operational Products:

- Wind
- Waves
- Currents
- Salinity
- Temperature
- Turbidity
- Chlorophyll
- Primary Production
-



The German Bight (Southern North Sea)

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung



Radar Network for Monitoring the German Bight

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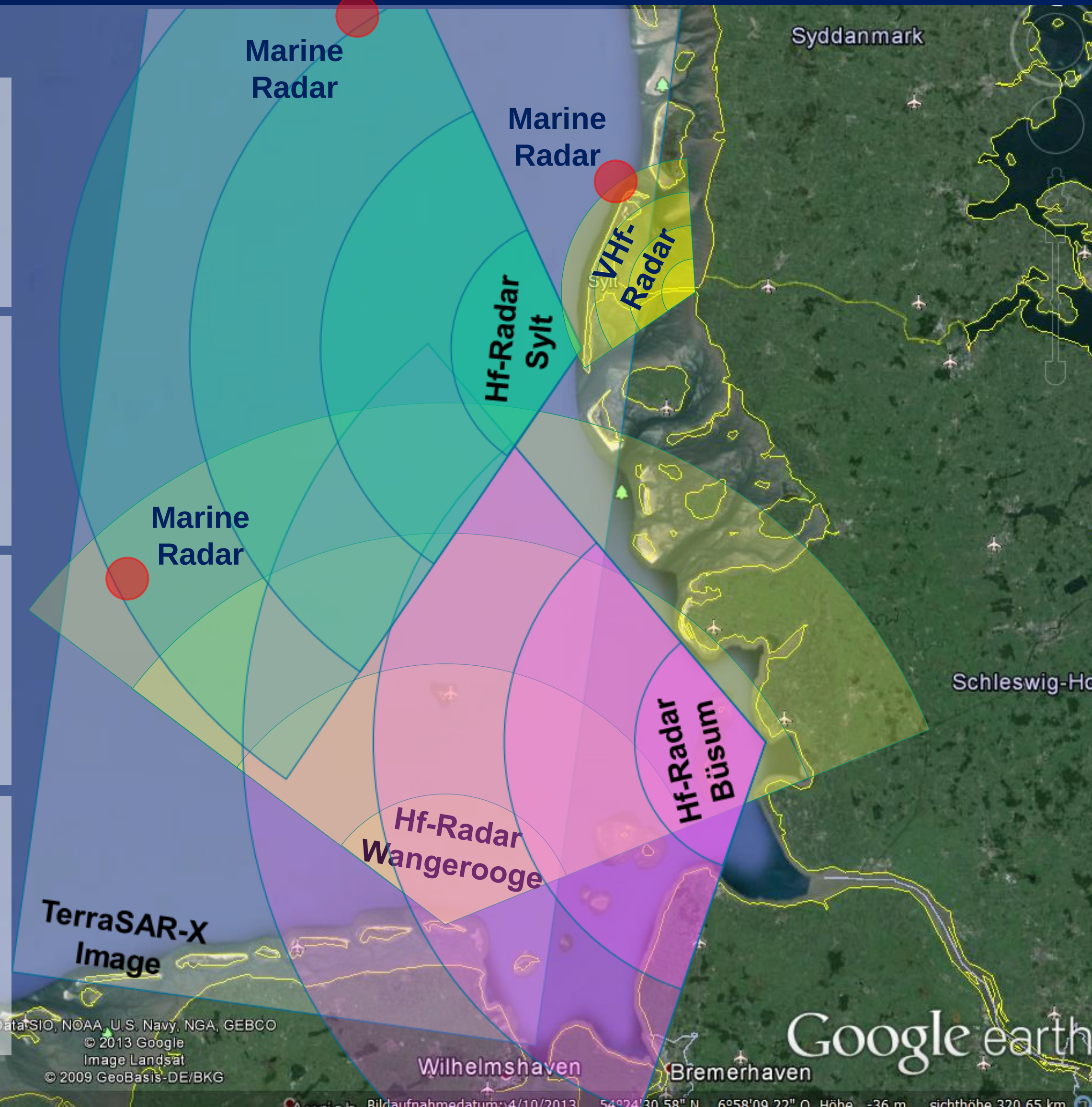
Zentrum für Material- und Küstenforschung

Satellite borne SAR
- up to 500 km swaths
- resolution up to 1 m
- wind fields (300 m)

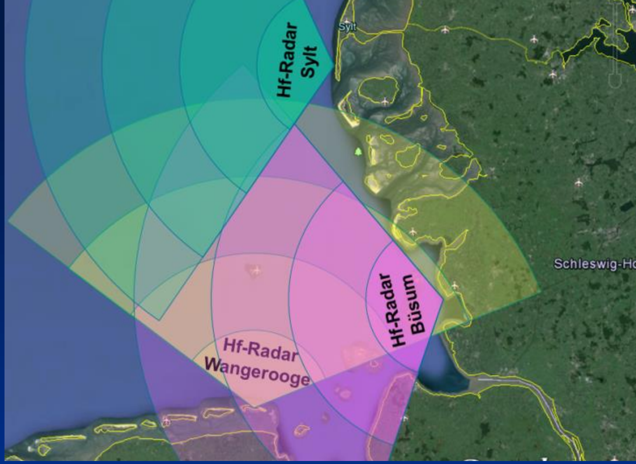
HF-Radar
- 120 km range
- resolution 1,5 km
- currents, ship tracking (waves)

(VHF-Radar)
- 25 km range
- resolution of 50 m
- currents (wind)

Marine Radar
- range of 4 km
- resolution up to 1.5 m
- wind, waves, currents and bathymetry



HF-Radar Network in the German Bight



HF-Radar System in the German Bight

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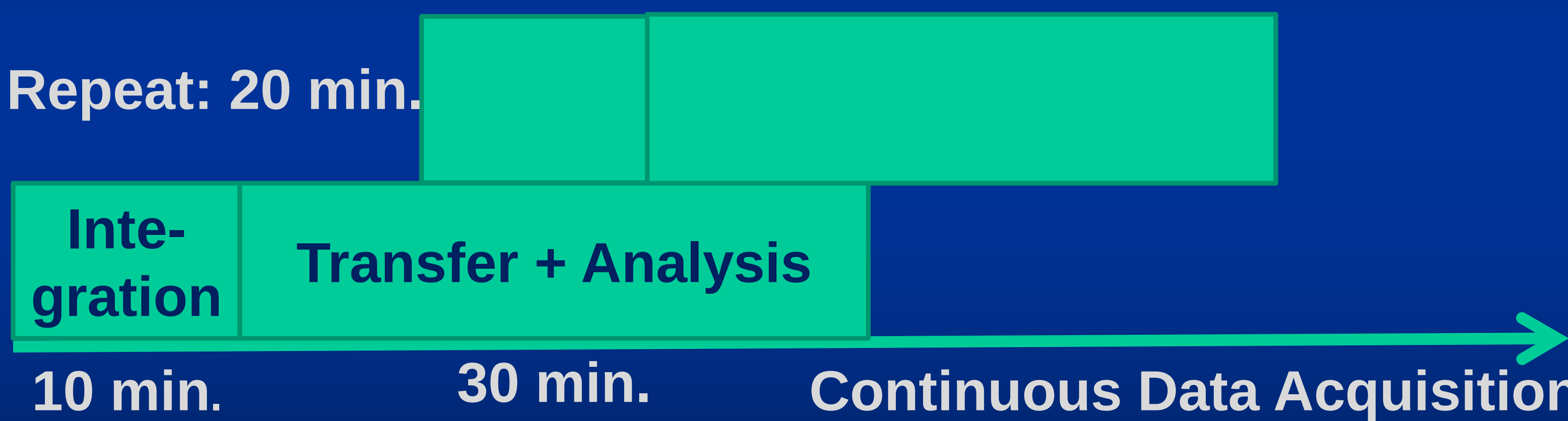
Zentrum für Material- und Küstenforschung

Azimuthal and range resolutions: ±3 and 1.5 km
Maximum Range: 120 km



Deadline: 40 min.

HF-Radar Acquisition and Production Scheme for Currents

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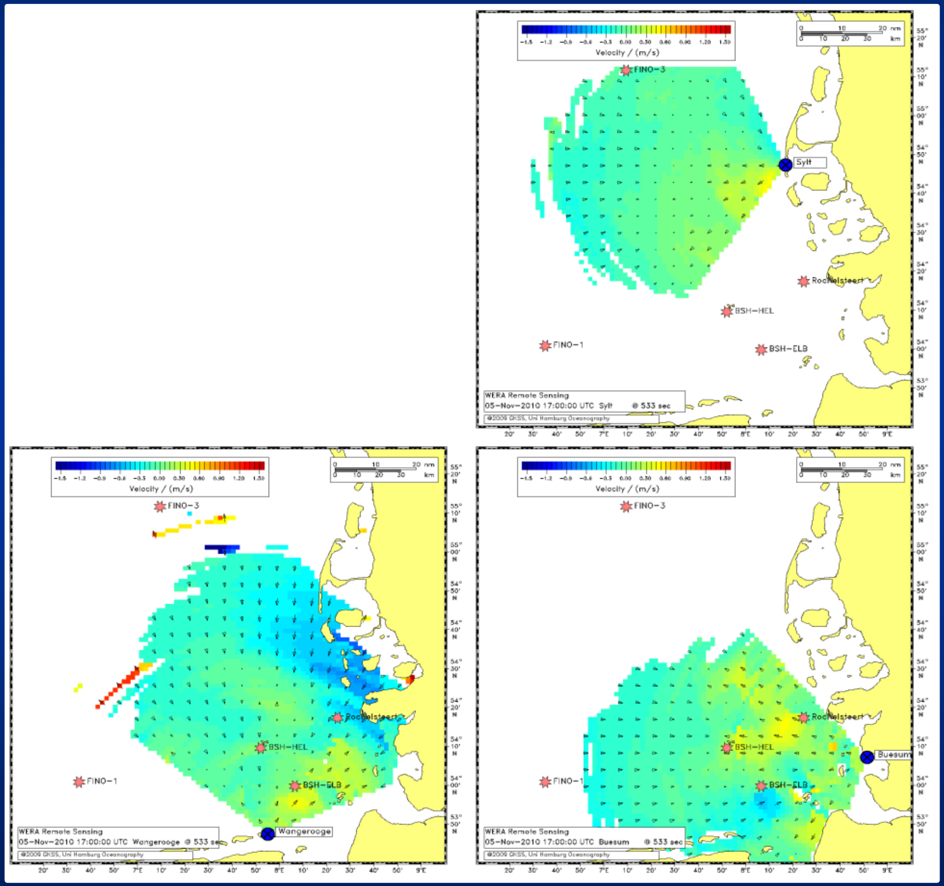
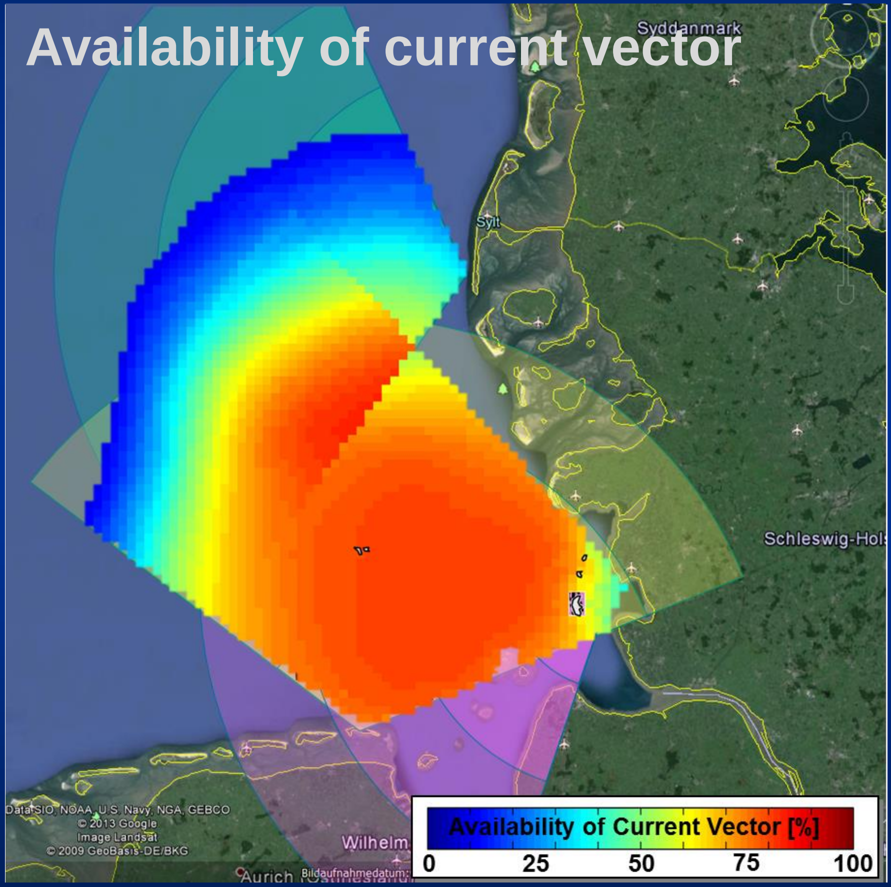
Zentrum für Material- und Küstenforschung





Assimilation of HF-Radar Currents into a 3D Circulation Model

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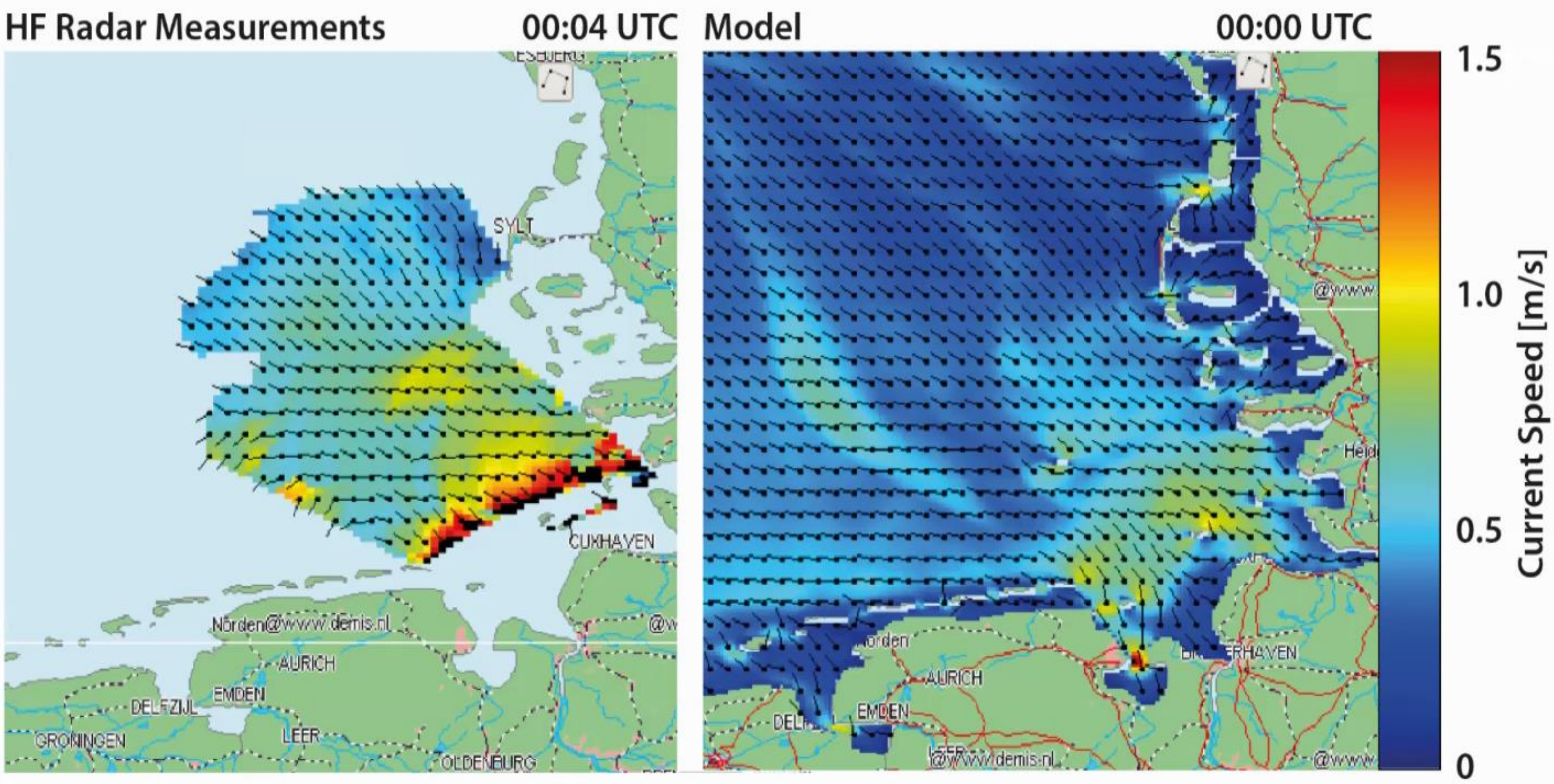

Support for Save and Rescue Operations

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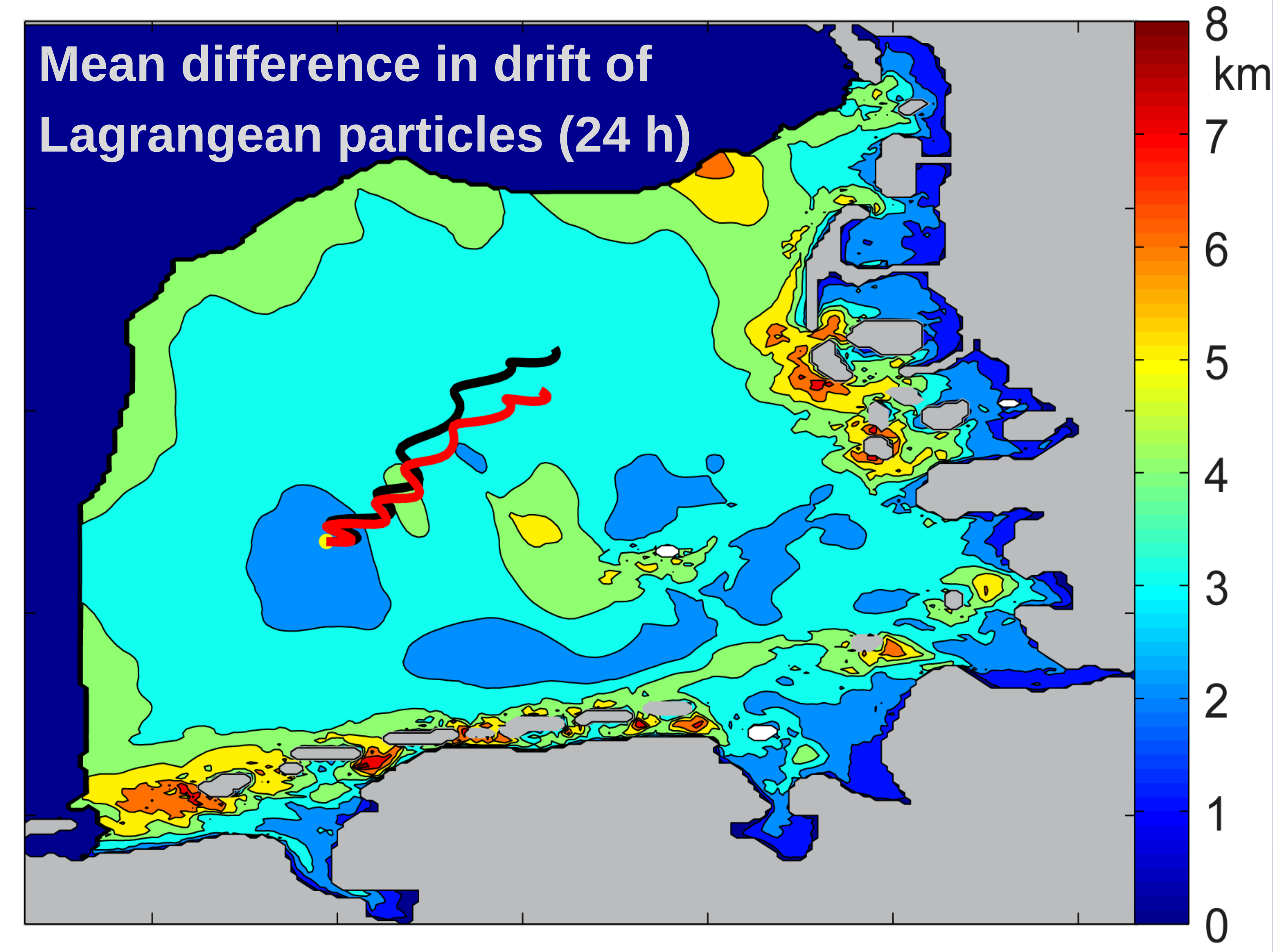

Drifters in the German Bight

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HF-Radar Ship Detection and Tracking

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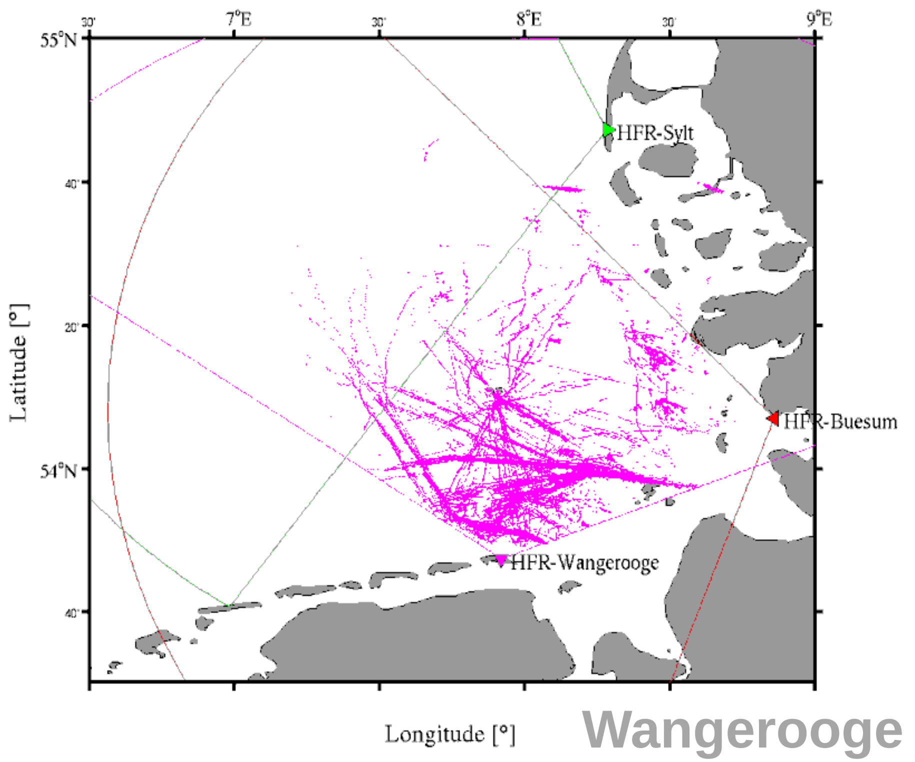
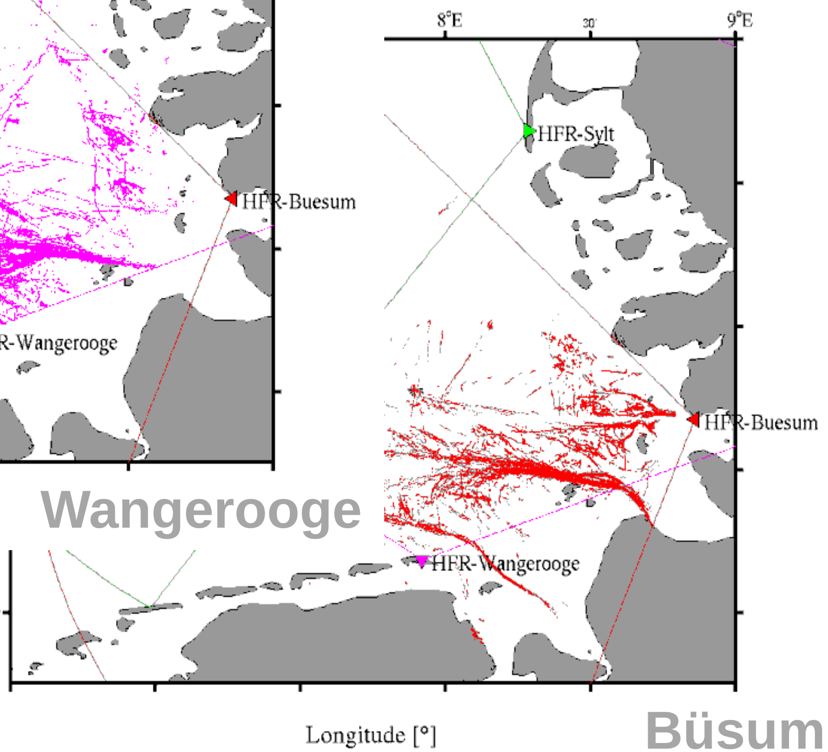
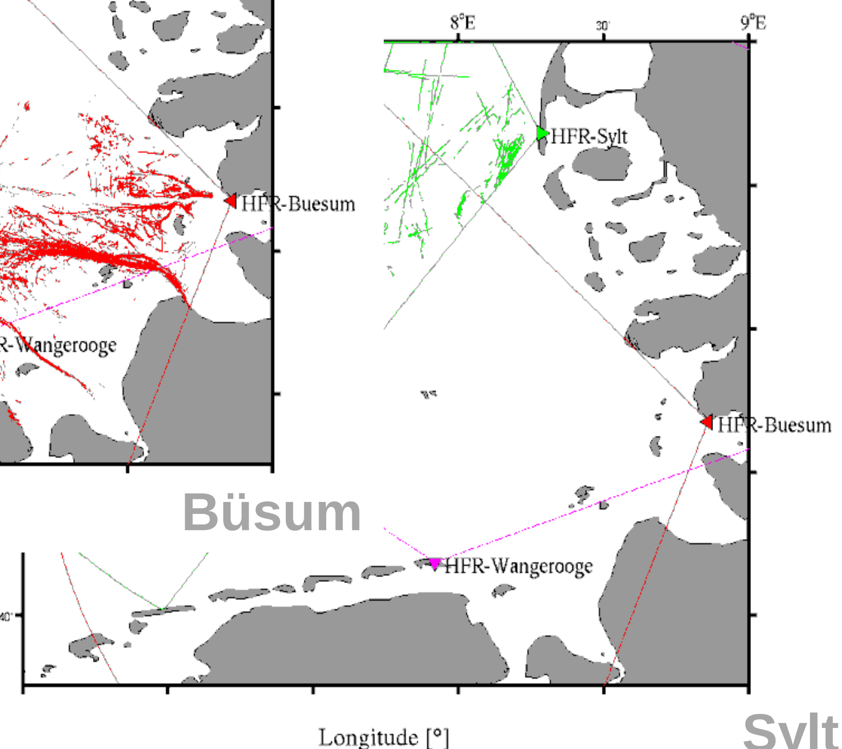
Ship detection via 3D Ordered Statistics Constant False Alarm Rate algorithm (Dzvonkovskaya et al., 2009).



Wangerooge



Büsum



Sylt

Ship tracking via the Joint Probabilistic Data Association rule in combination with an Unscented Kalman Filter (Maresca et al., 2014)

Near Real time HF-Radar Ship Tracking in the German Bight

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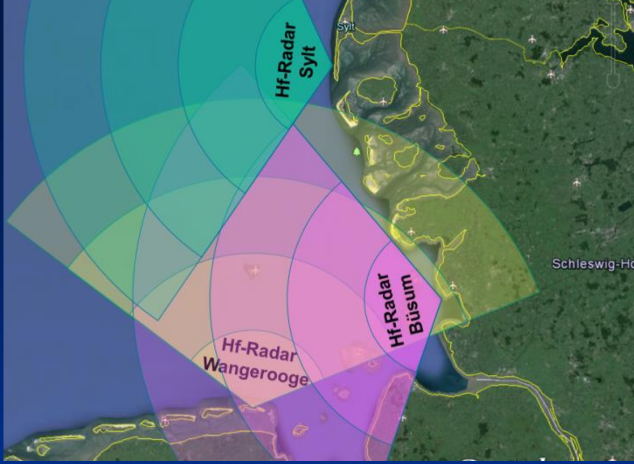
Zentrum für Material- und Küstenforschung

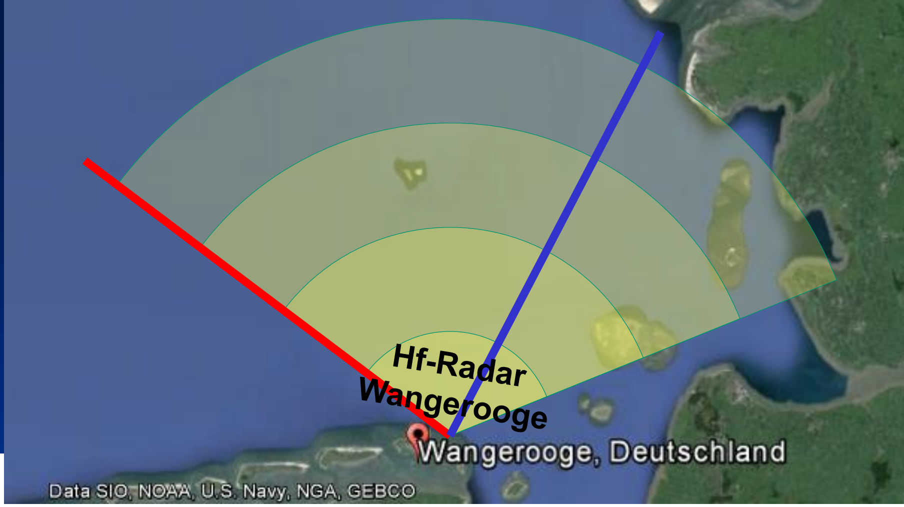
AIS reports

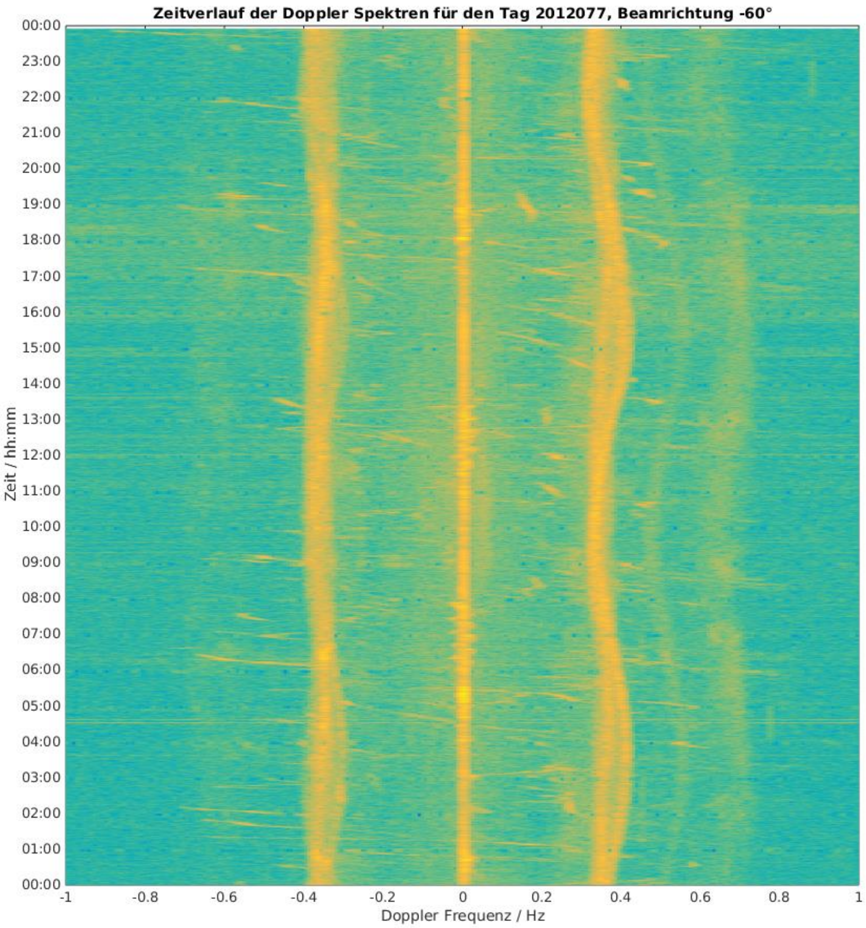
HF tracks

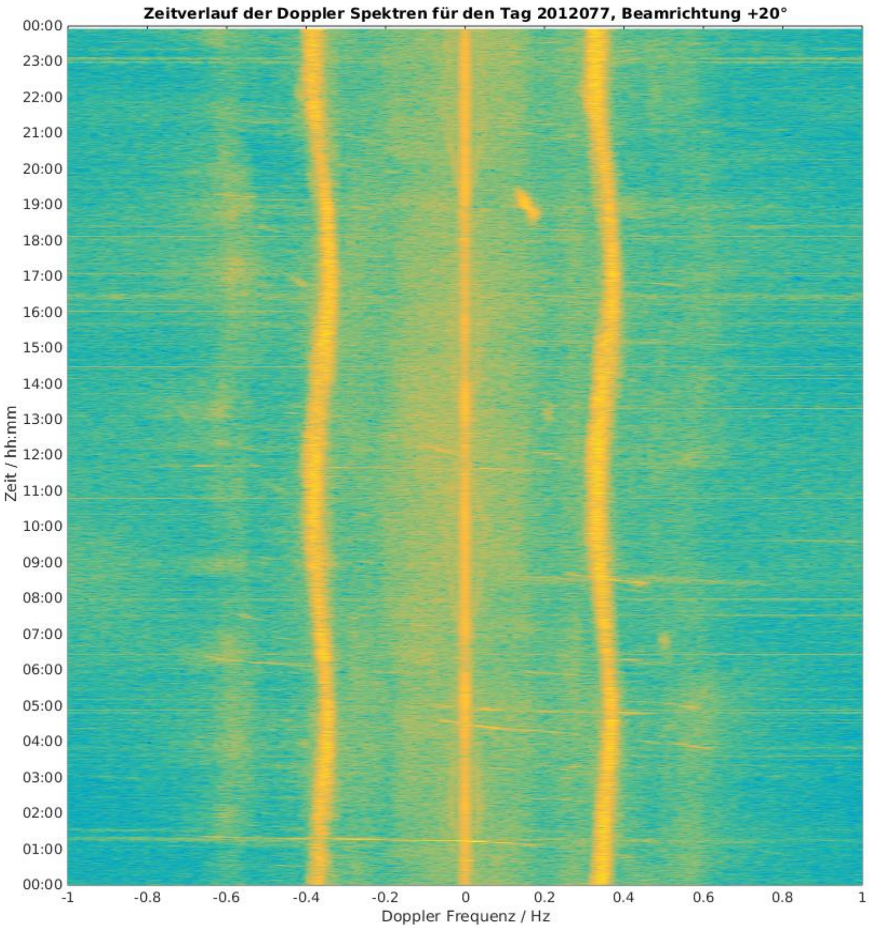
Testing of New Systems and Concepts



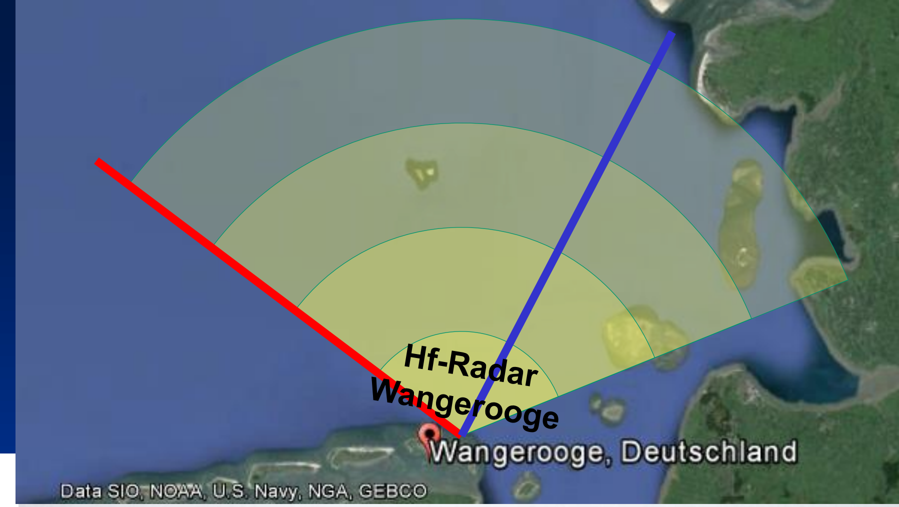
HF-Radar Retrieved Time- Doppler Power Spectra

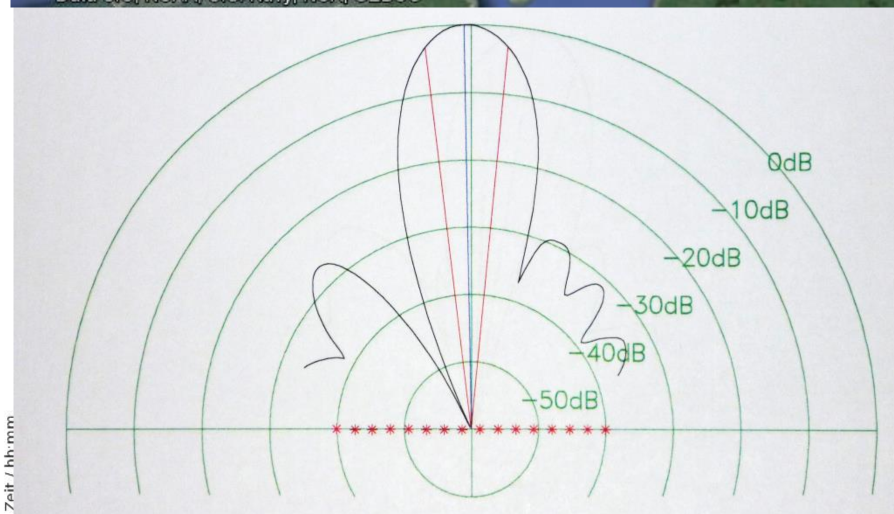


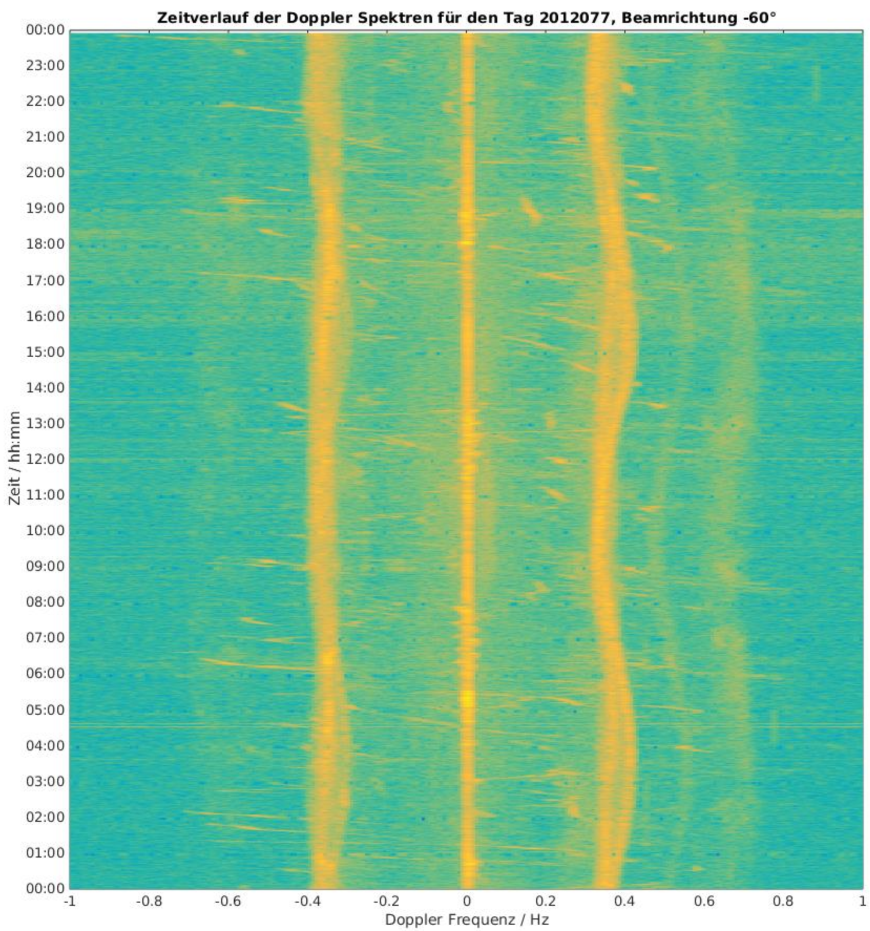


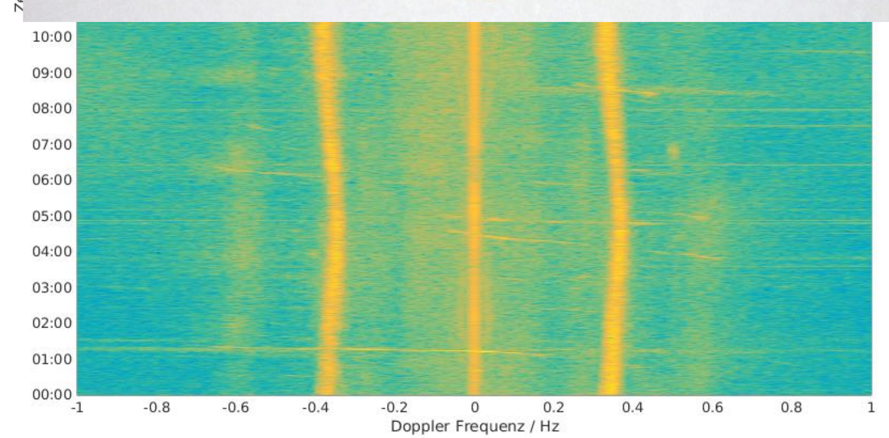


HF-Radar Retrieved Time- Doppler Power Spectra





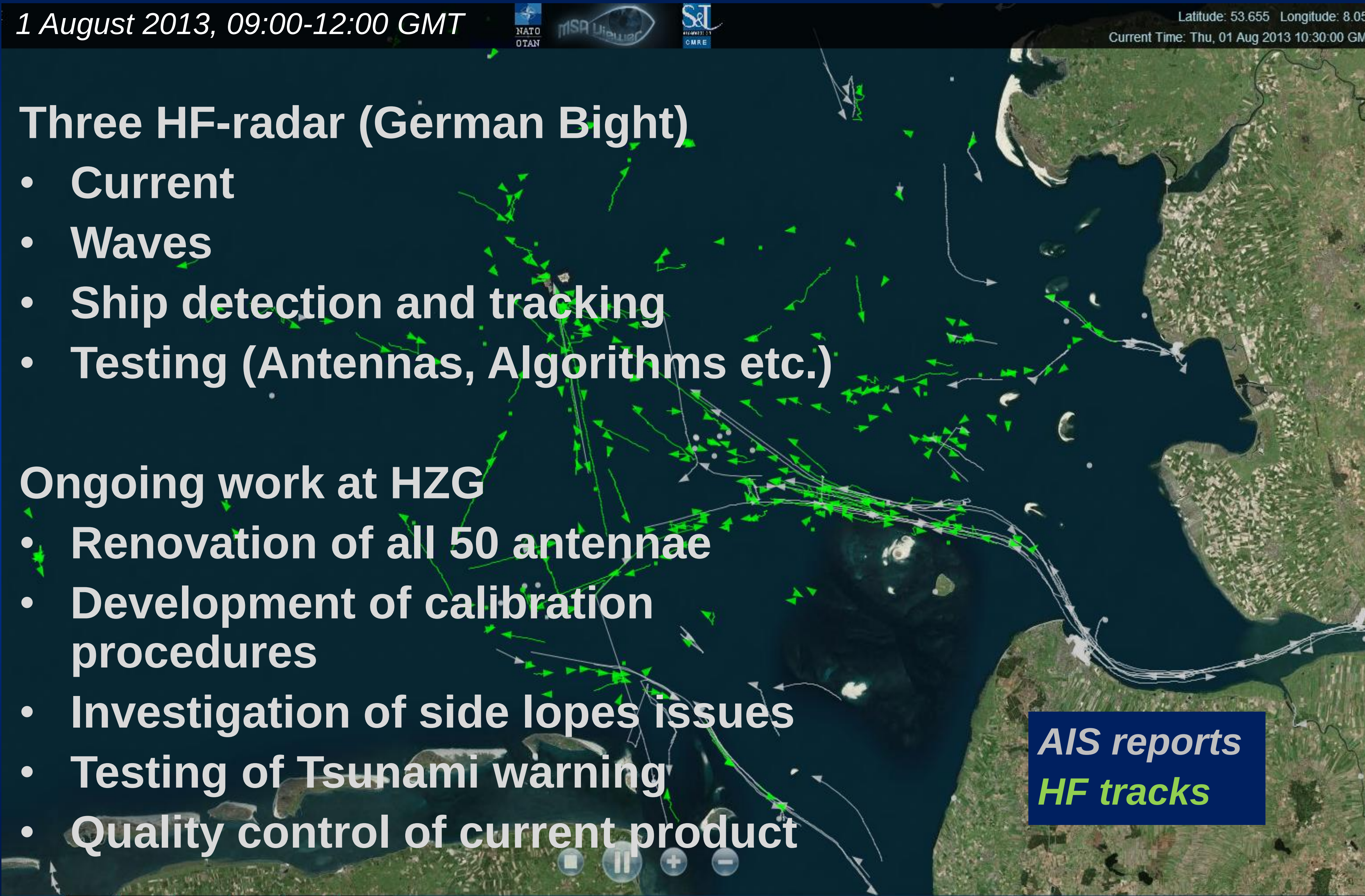




Summary

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

1 August 2013, 09:00-12:00 GMT



Three HF-radar (German Bight)

- **Current**
- **Waves**
- **Ship detection and tracking**
- **Testing (Antennas, Algorithms etc.)**

Ongoing work at HZG

- **Renovation of all 50 antennae**
- **Development of calibration procedures**
- **Investigation of side lopes issues**
- **Testing of Tsunami warning**
- **Quality control of current product**

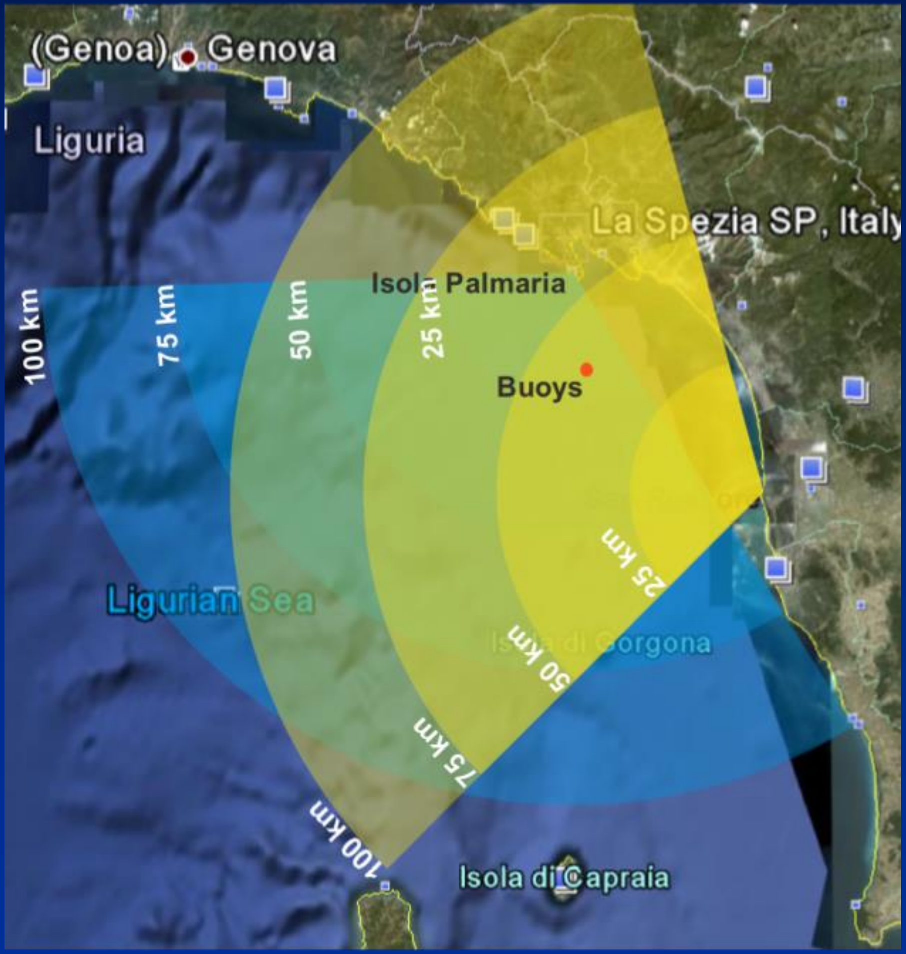
Setup, Operation and Maintenance of Phased Array HF-Radars

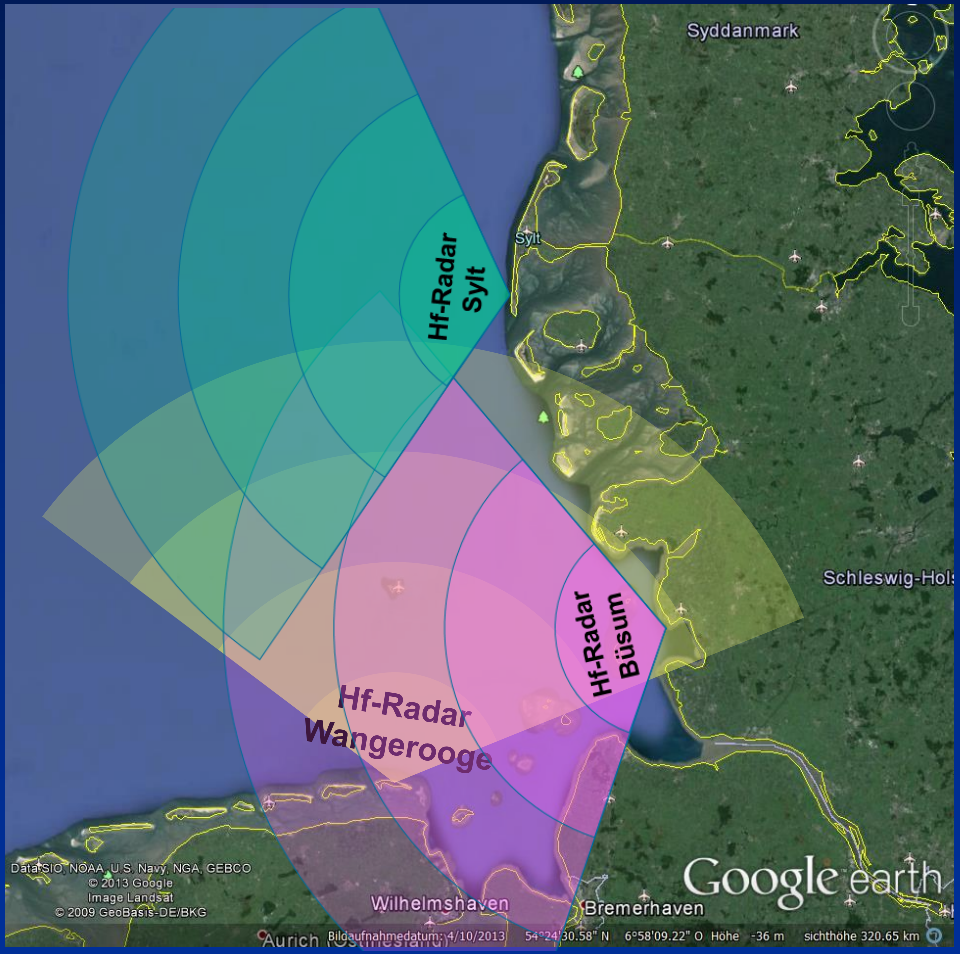
Jochen Horstmann

Radar Hydrography
Institute for Coastal Research
Helmholtz-Zentrum-Geesthacht, Germany

Radar Network in the Ligurian Sea and the German Bight

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

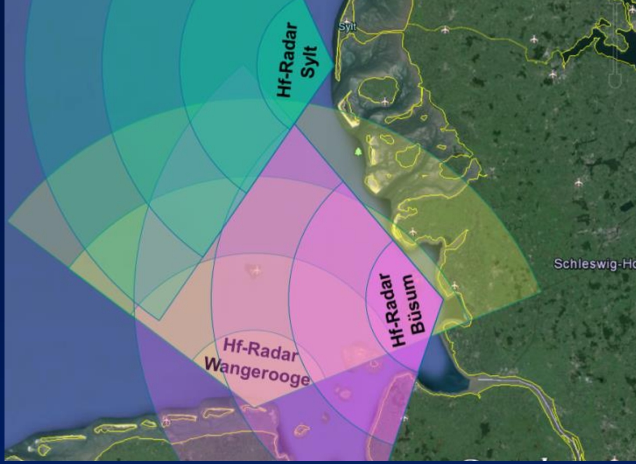




HF-Radar Network in the Ligurian Sea

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

HF-Radar Network in the German Bight



Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

- Site selection and approvals : coverage, application, accessibility, power, security
- Radar choice: application, space, coverage, price
- Environment on radar: noise, interference (watch out for metal)
- Radar on environment: impact during installation/maintenance, view
- Power: from network (up to 300 m cable)
- Communication: via DSL or satellite, all stations have mobile backup

Task 2.3: Harmonizing new network systems: HF Radars

2. Main operational issues

- Communication failures
- Power outages (lightning)
- Antennae and cabling (corrosion, animals)
- Coastal Erosion (minor problem)
- Air-conditioning (no problems)
- Calibration (less important, depends on application)
- Interference (automated selection of frequency band)
- Security (no problems)
- Radar system robustness (no problems)

Task 2.3: Harmonizing new network systems: HF Radars

3. Site maintenance

- regular checks of voltage on antennae, check of maximum range, check of output power of amplifier
- every 3 months visit of stations, pickup of raw data, visual inspection of station and antenna arrays (approx. 2 h)
- every year greasing of antennae shafts and readjustment of antennae lengths (approx. 2 d)
- every two years: visual inspection of all connectors (approx. 1 d)

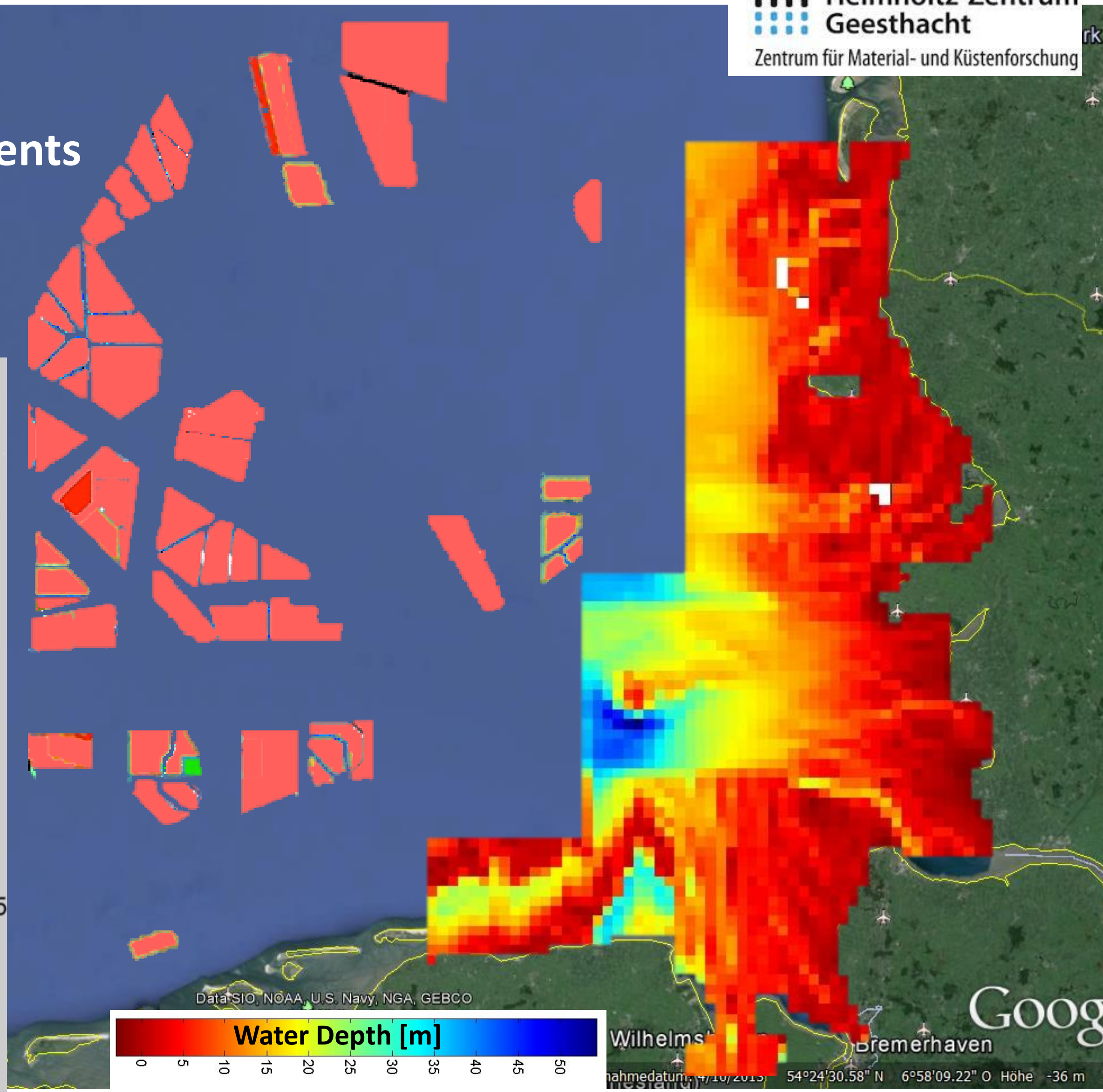
Task 2.3: Harmonizing new network systems: HF Radars

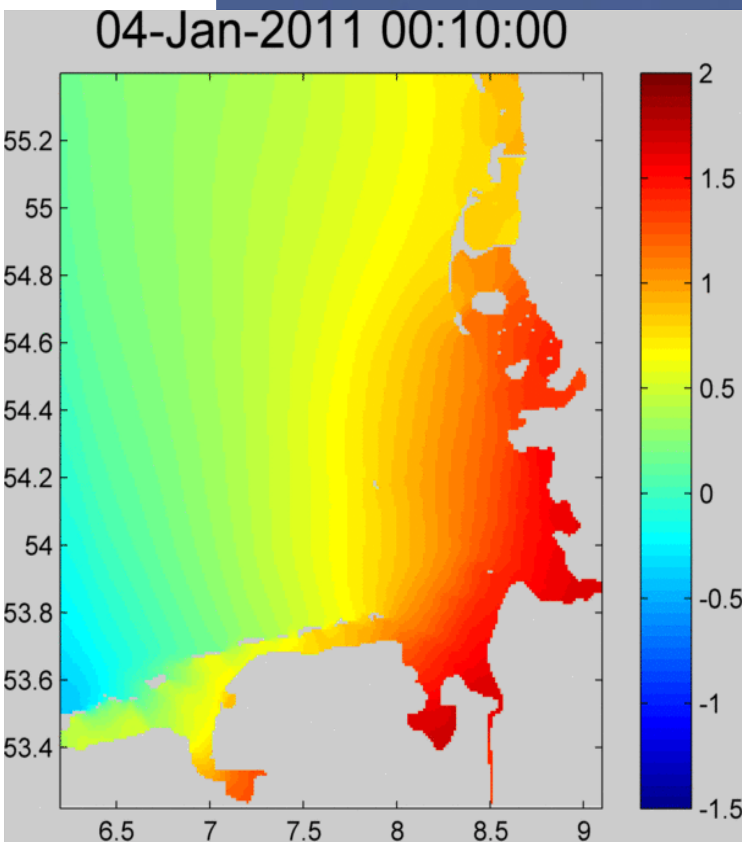
4. Quality assessment

JERICO next

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

- Ongoing developments

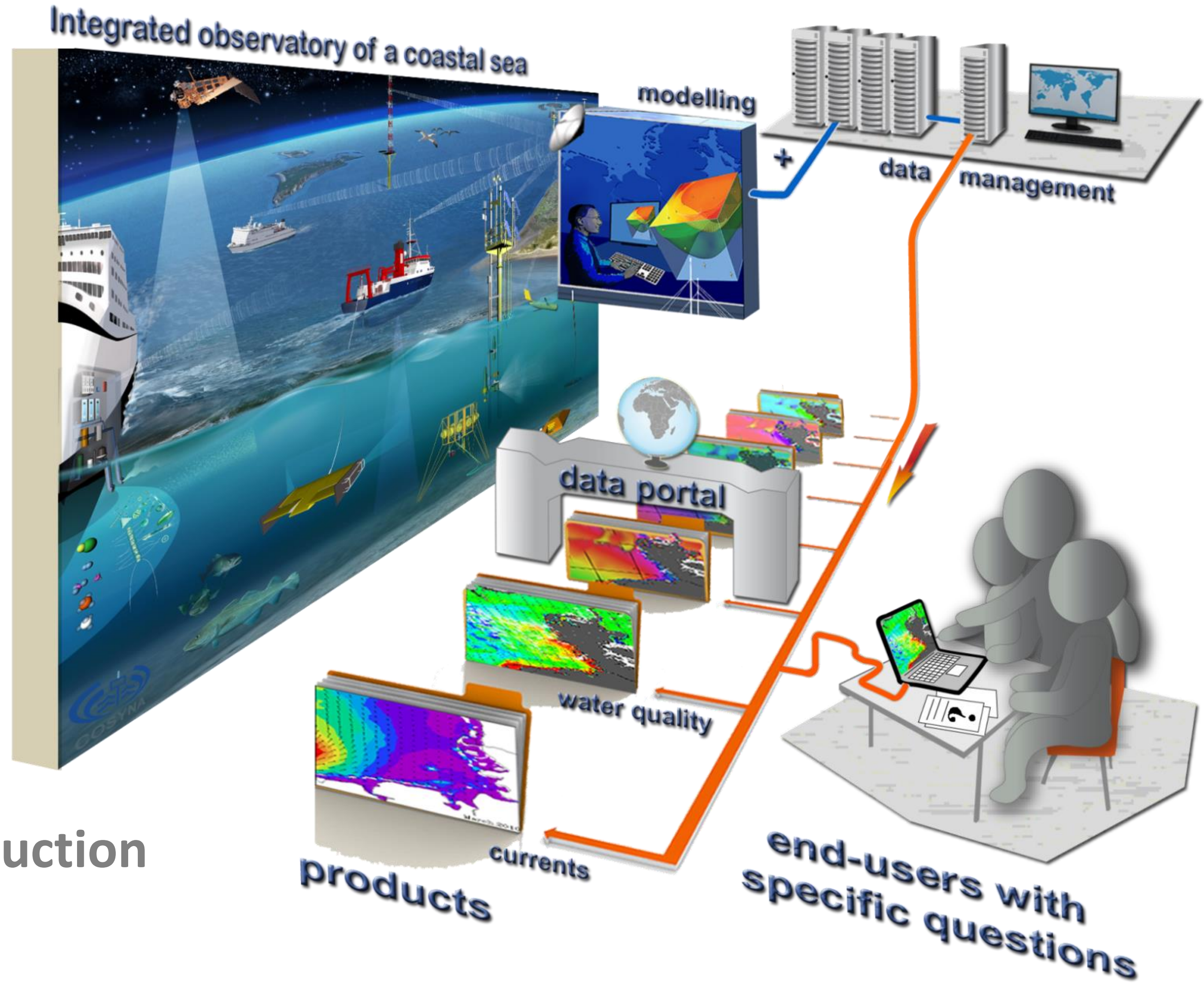




Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

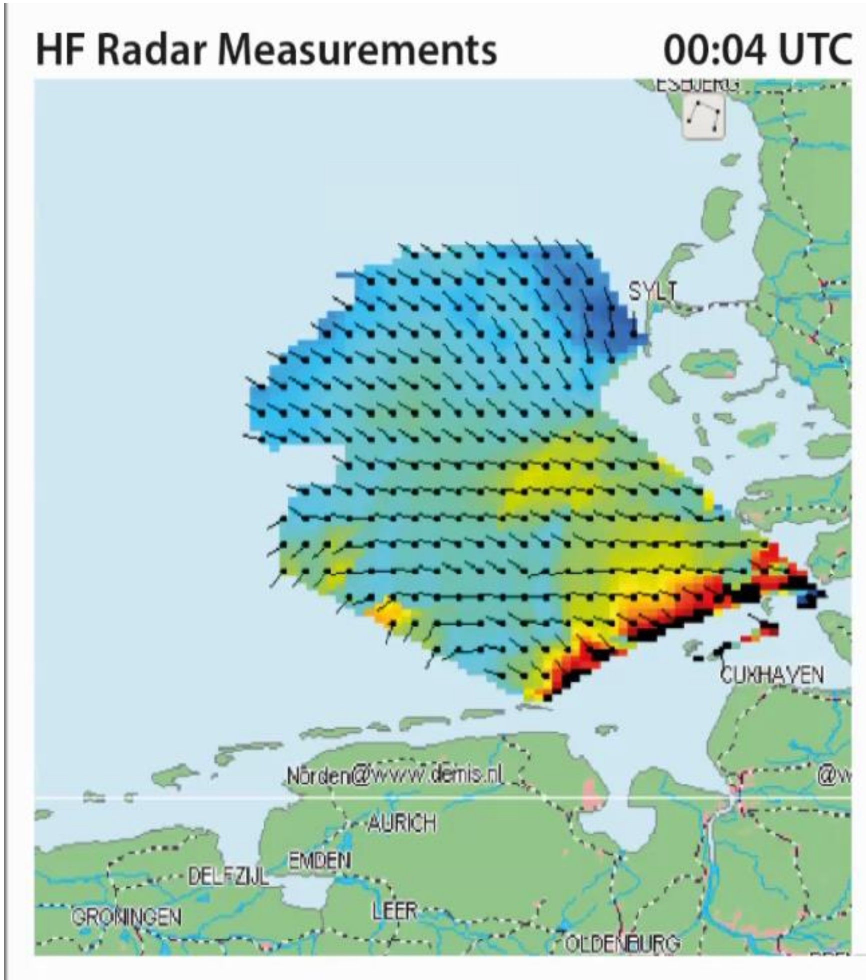
- Wind
- Waves
- Currents
- Salinity
- Temperature
- Turbidity
- Chlorophyl
- Primary Production



Task 2.3: Harmonizing new network systems: HF Radars

6. Applications

- surface currents scientific (open access)
- ship detection, tracking and fusion scientific (demonstration)
- data assimilation scientific (open access)
- test site for techniques: new HF-systems (antenna design etc.), calibration etc.
- test site for parameter retrieval : waves, tsunami, quality control



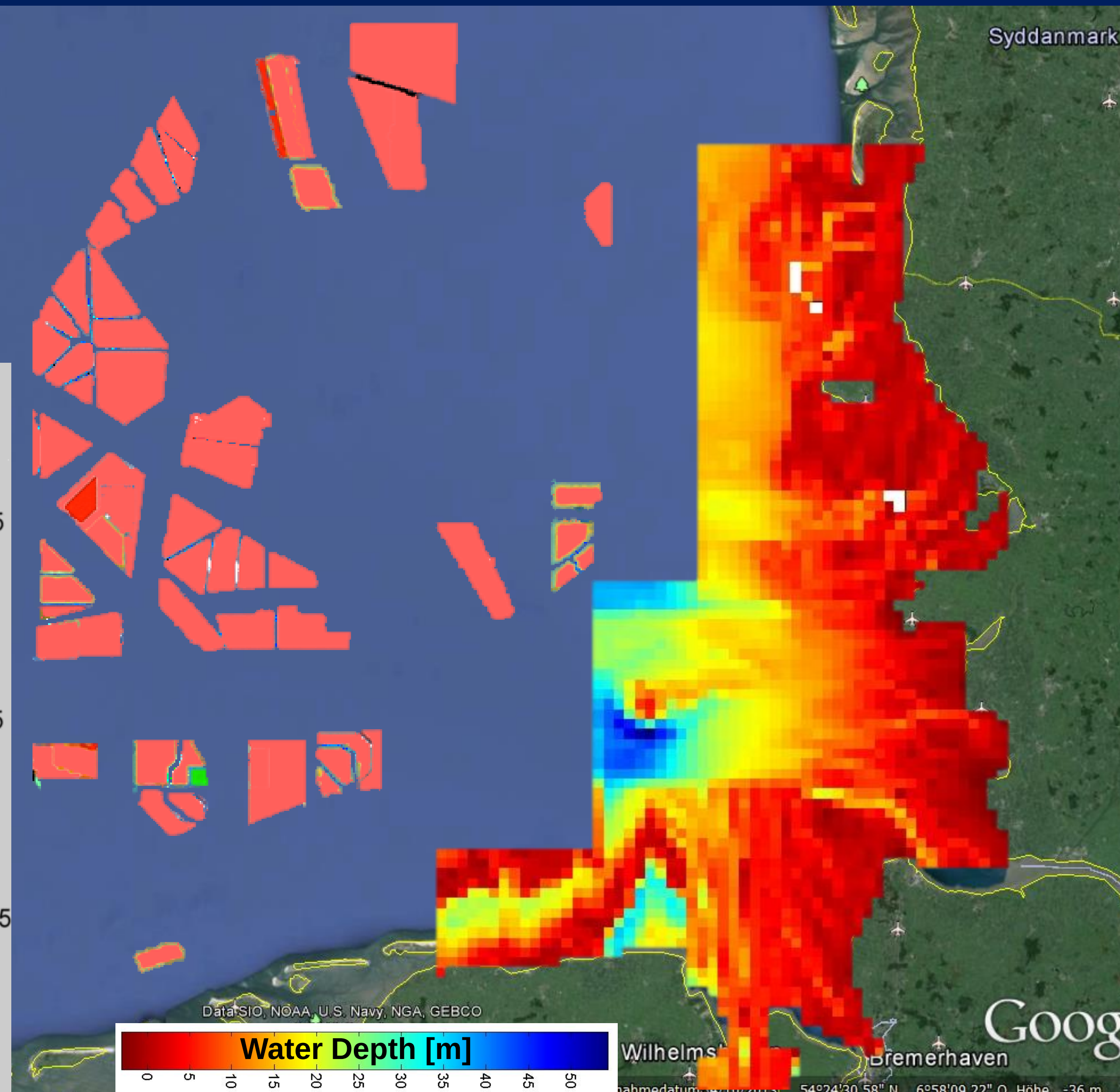
Quality Control of HF-Radar Data

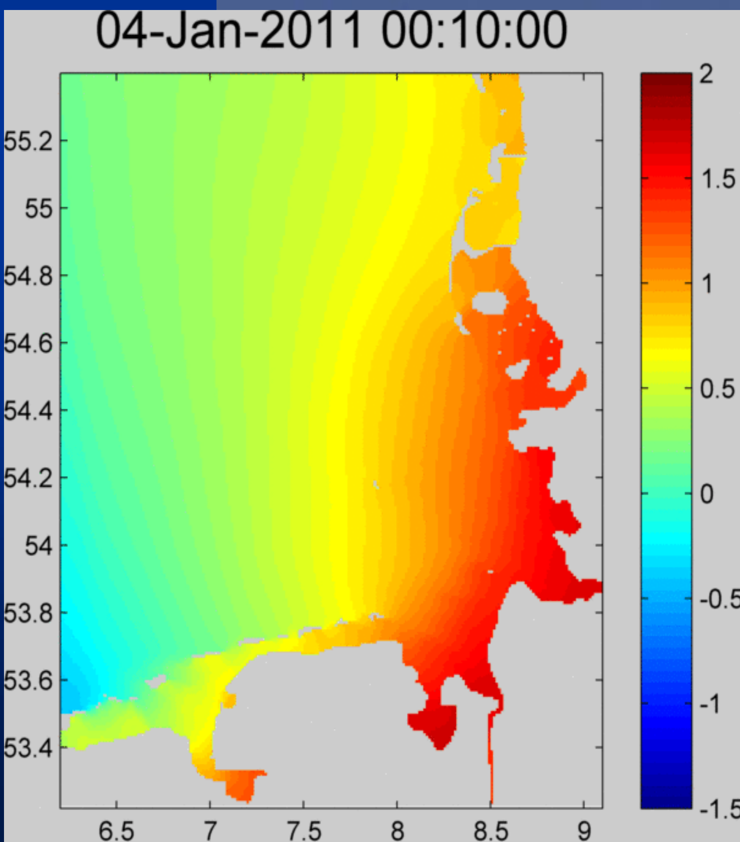
J. Horstmann, J. Seemann
and L. Merckelbach

Helmholtz-Zentrum Geesthacht, Germany

The German Bight (Southern North Sea)

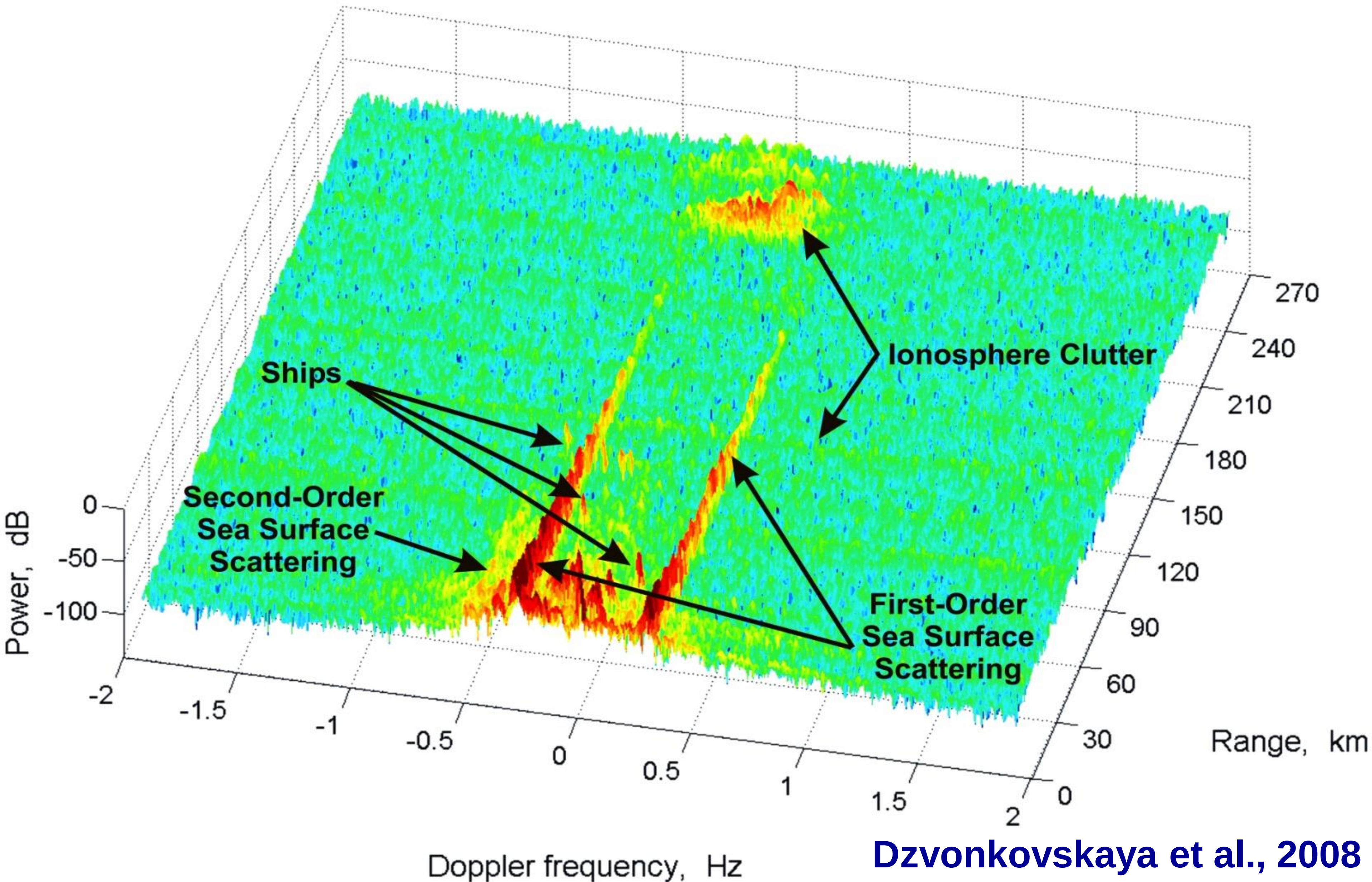
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung





Range- Doppler Power Spectra
HF-Radar Ship Detection

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung



Dzvonkovskaya et al., 2008

Current Errors due to Spatial Inhomogeneity of Bathymetry

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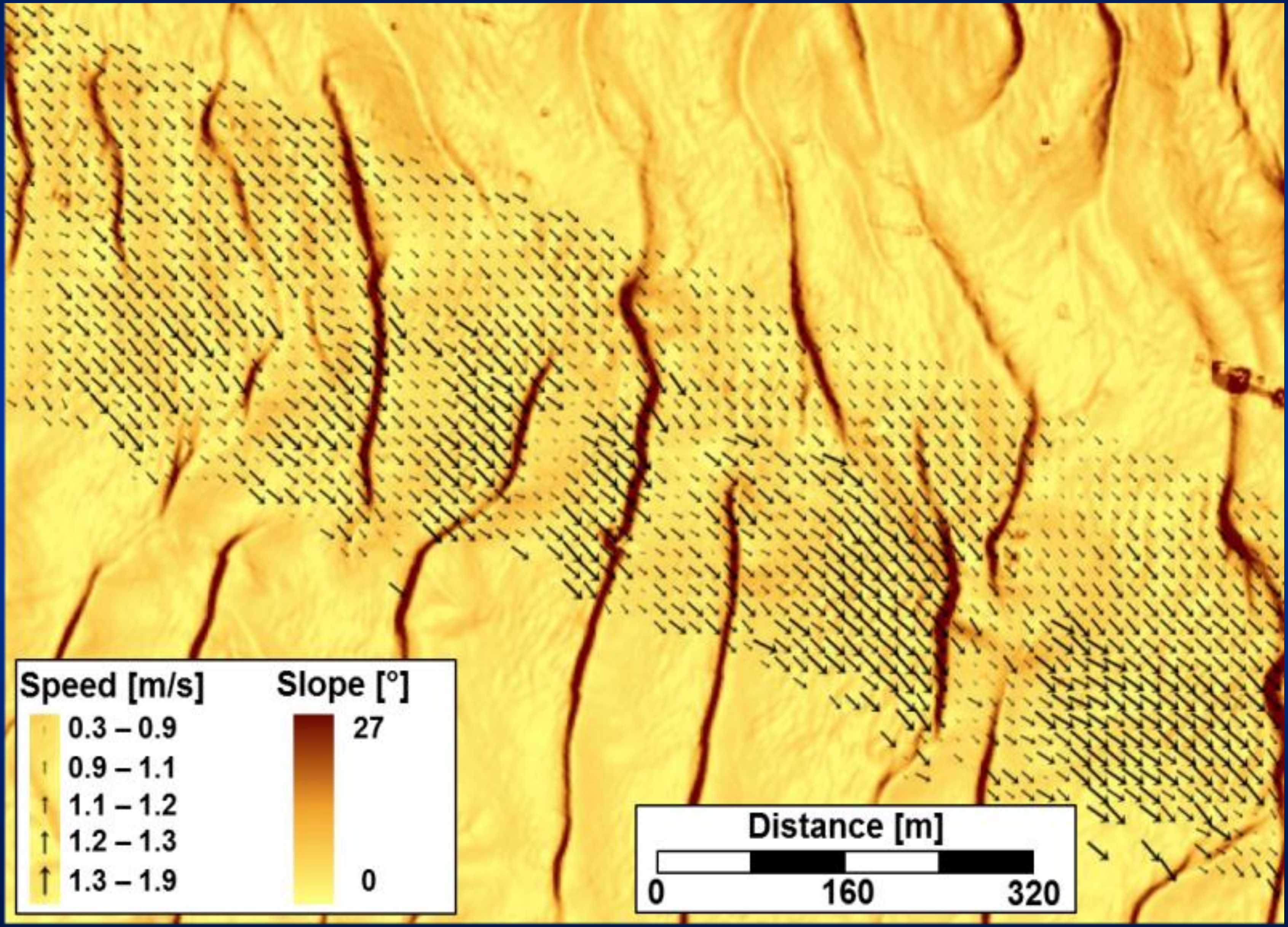
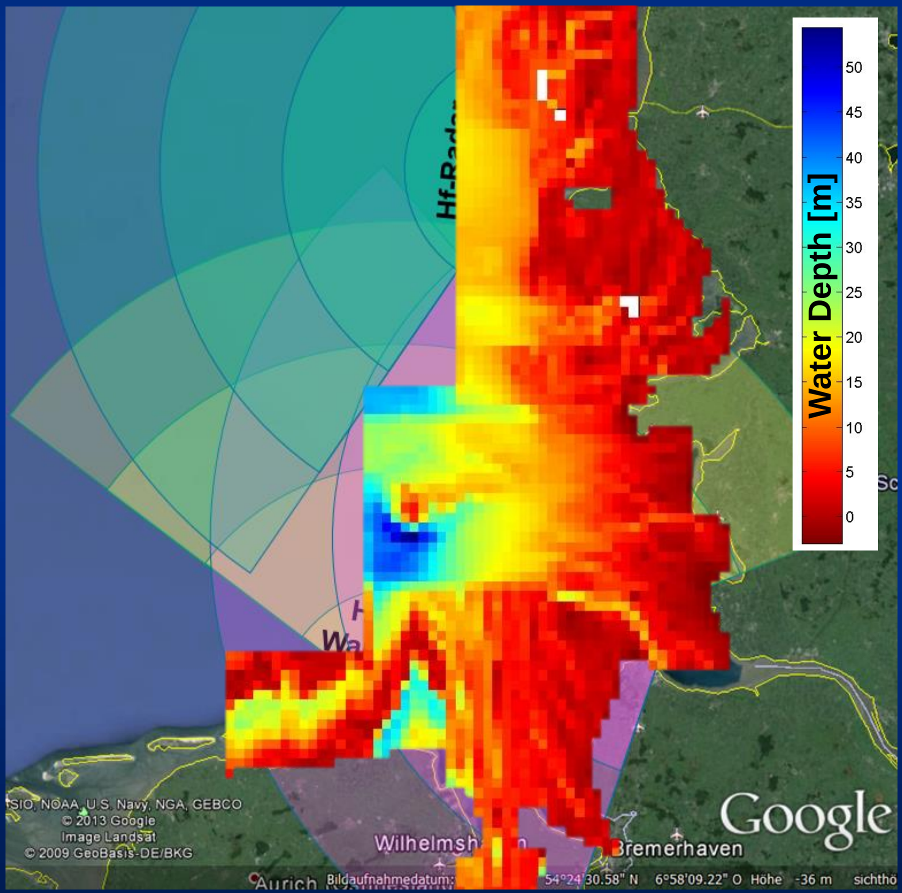
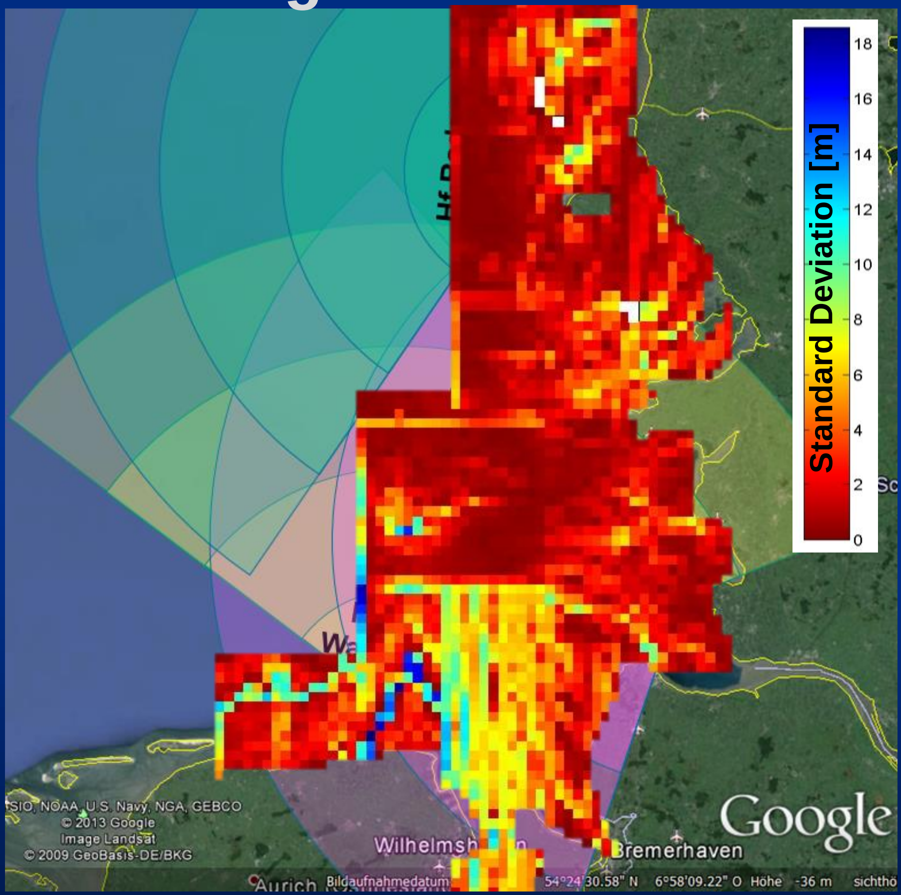


Current Errors due to Spatial Inhomogeneity of Bathymetry

Bathymetry



Standard Deviation on 2 km grid



Source: BSH, LKN Husum, Portal Tideelbe

Current Errors due to Spatial Inhomogeneity of Bathymetry

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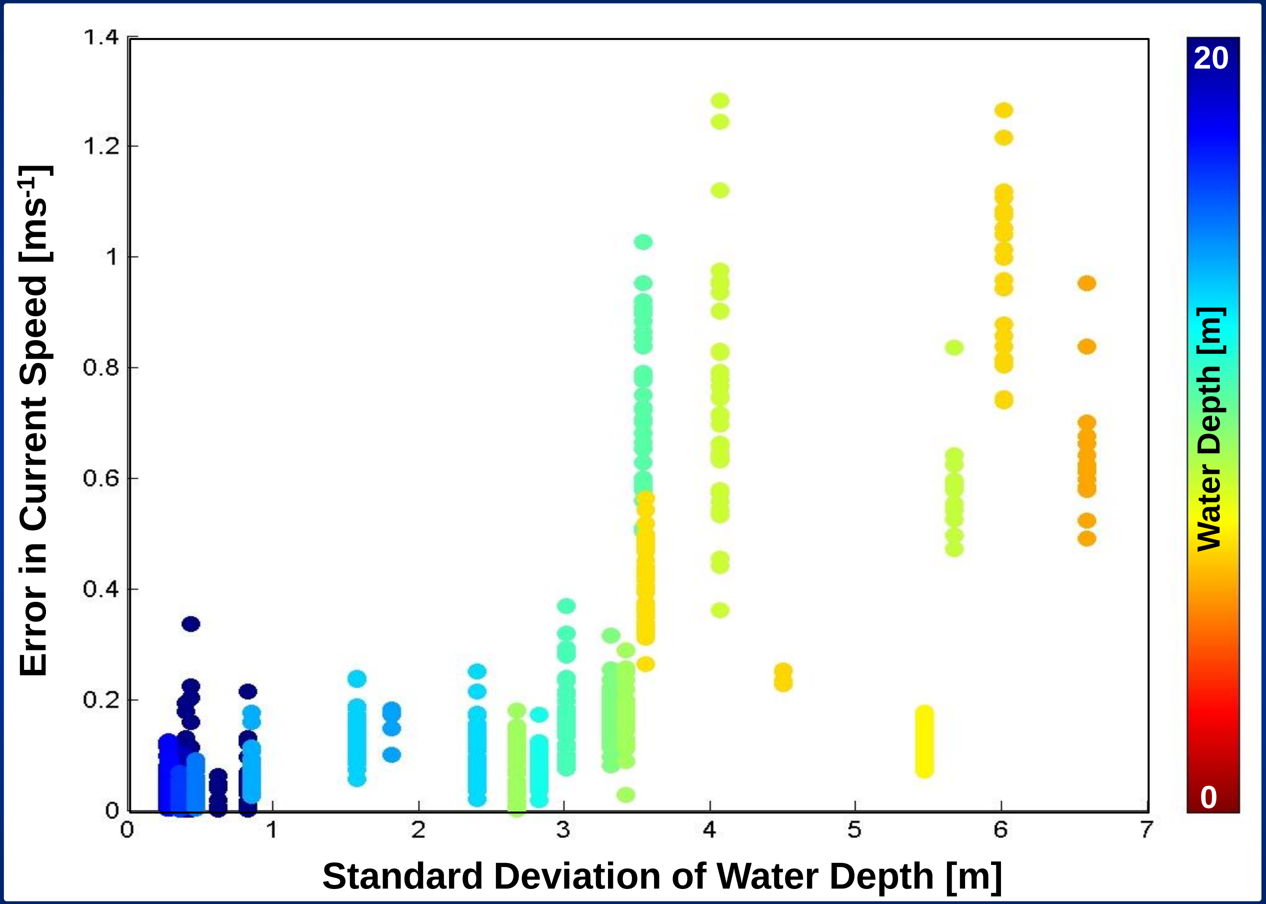
Zentrum für Material- und Küstenforschung



all data

bias 0.26 m/s

stdev 0.23 m/s

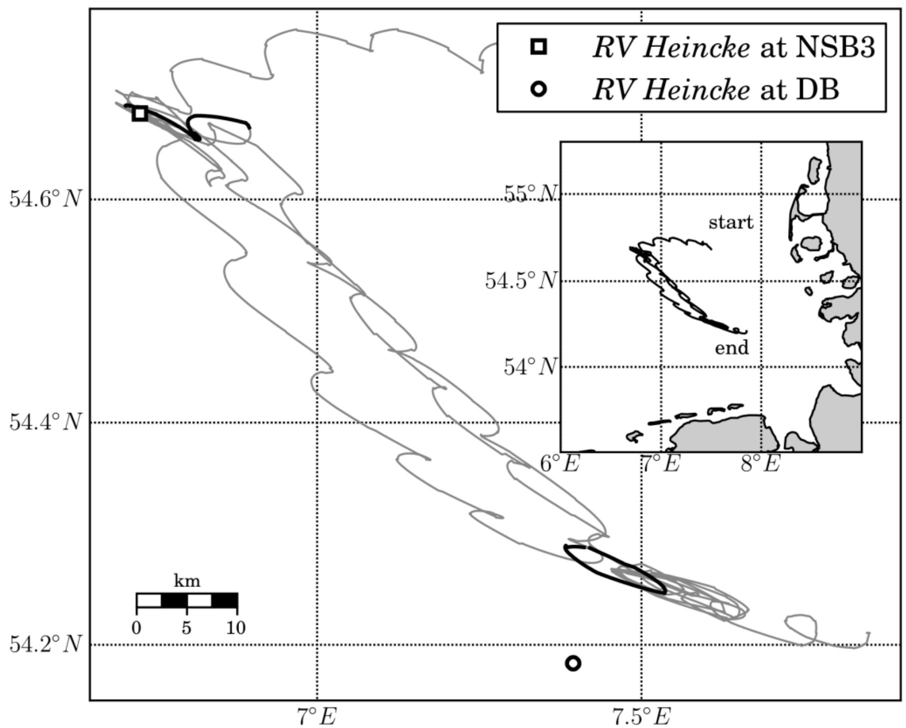
excl. inhom. data

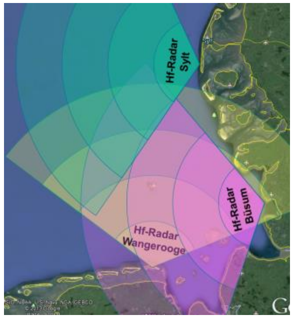
bias 0.12 m/s

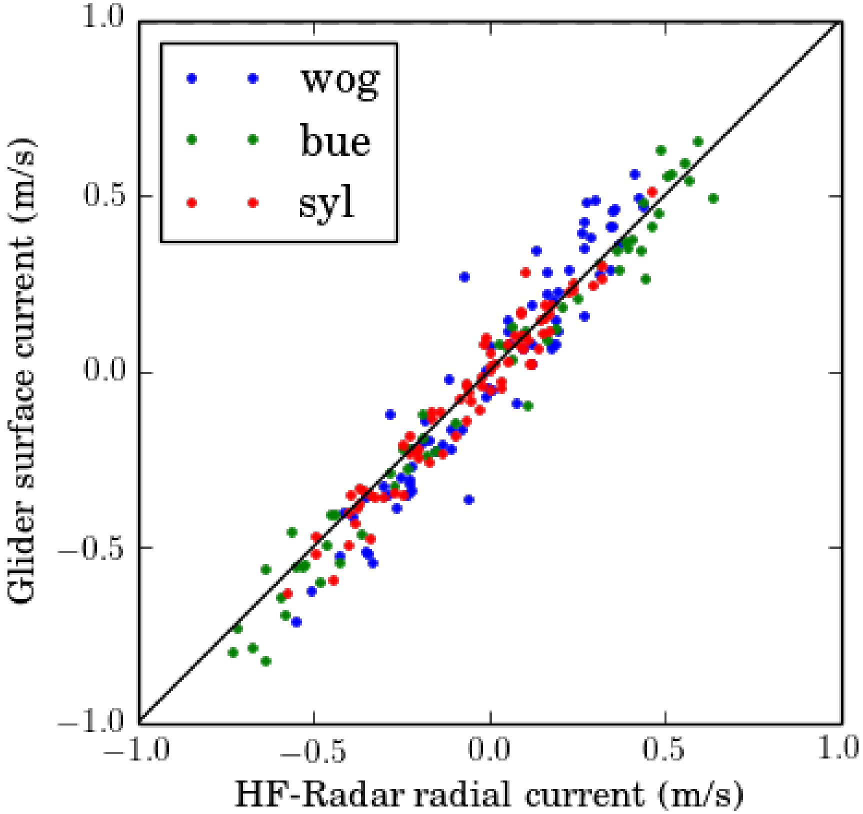
stdev 0.07 m/s

Comparison of HF-Radar Currents to Glider Results

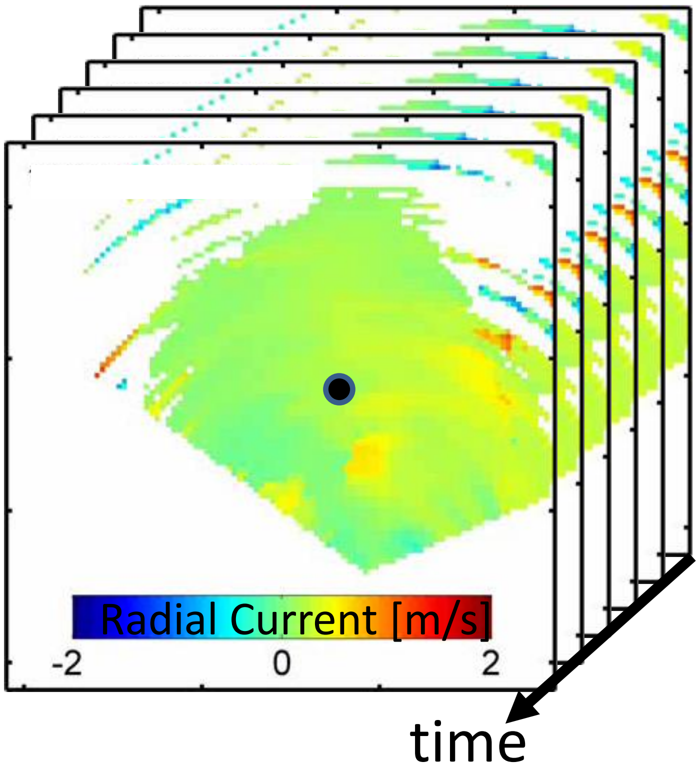
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

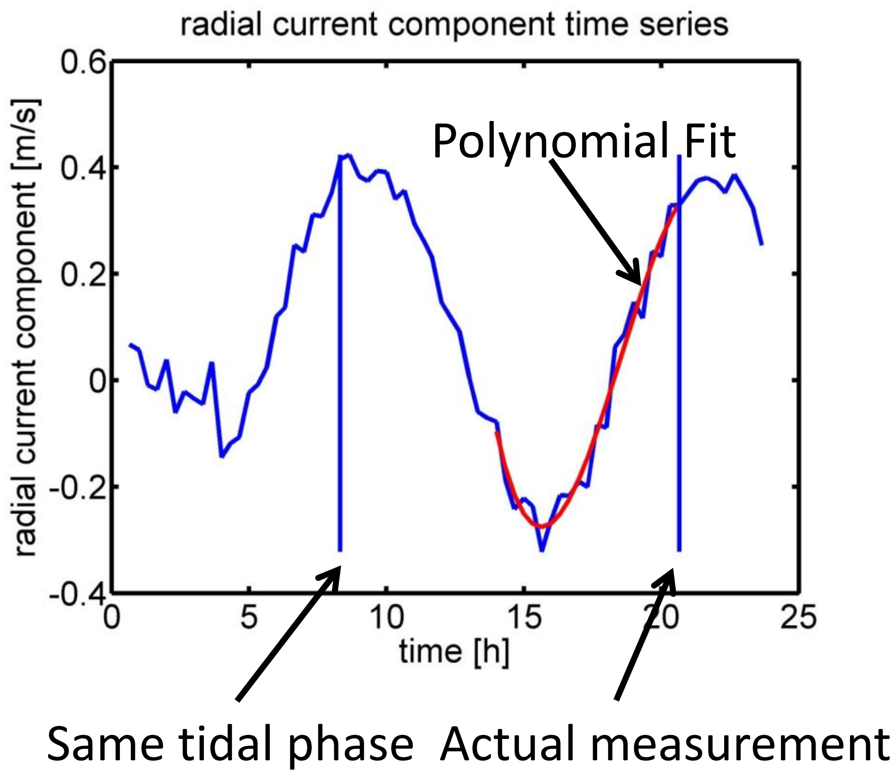






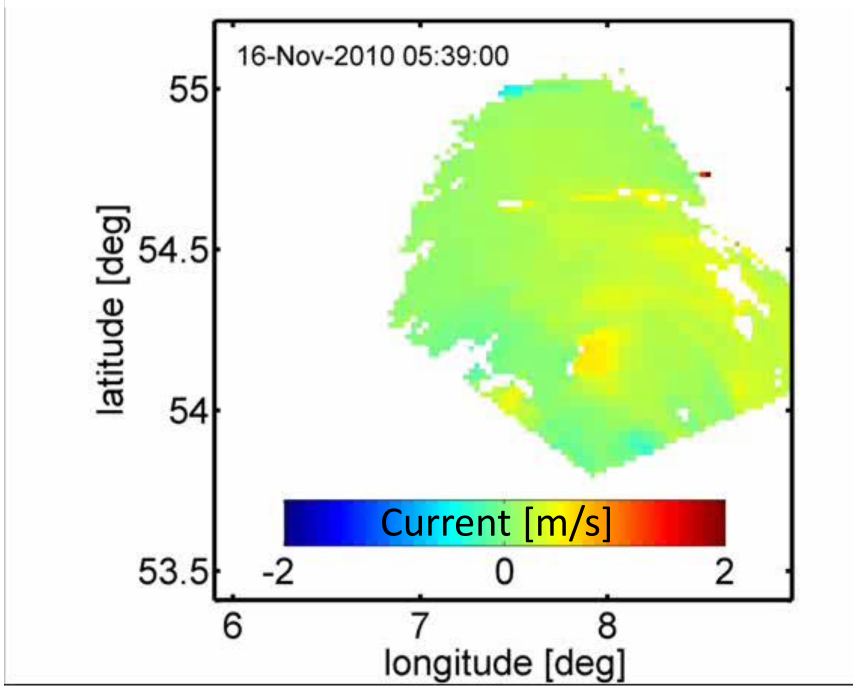
QC Scheme applied to Radial Current Component Sequence



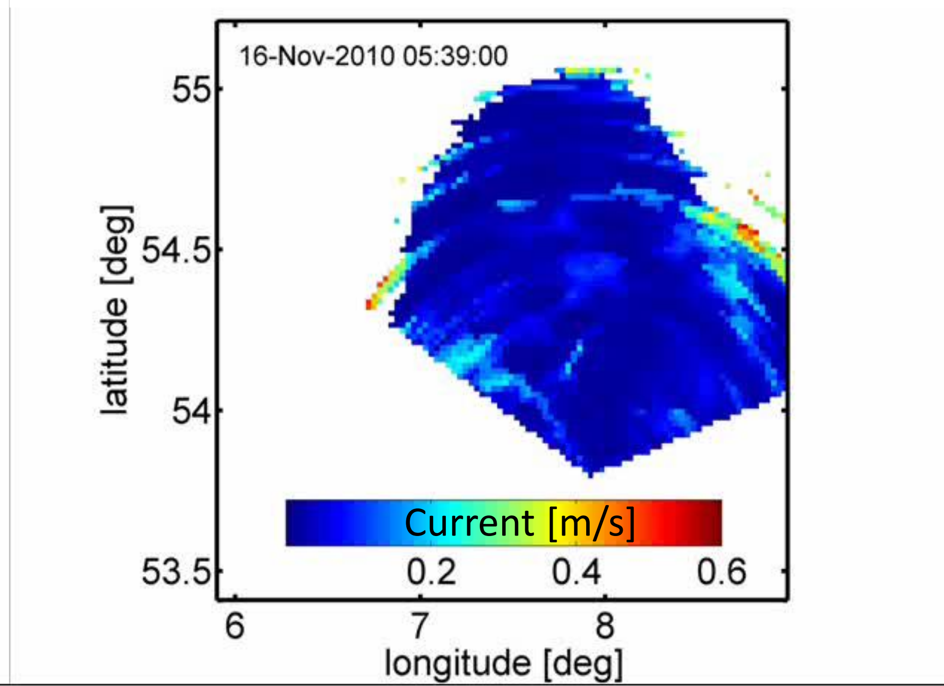


QC Scheme applied to Radial Current Component Sequence

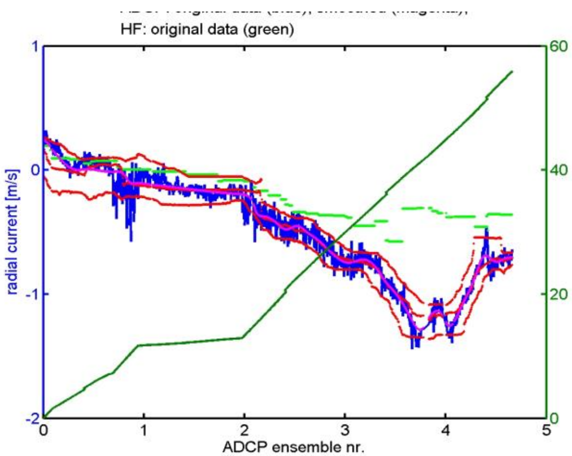
Fitted Radial Current Component

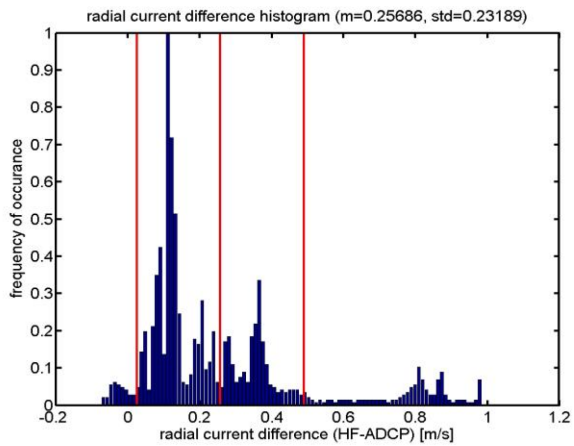


RMS Fit Error



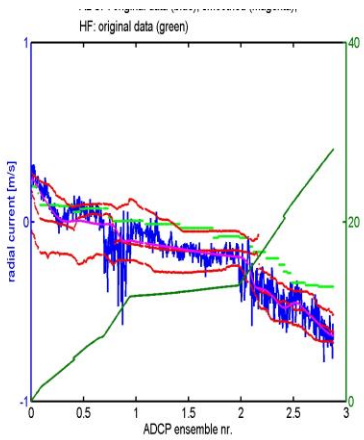
Removal of Inhomogeneous Areas

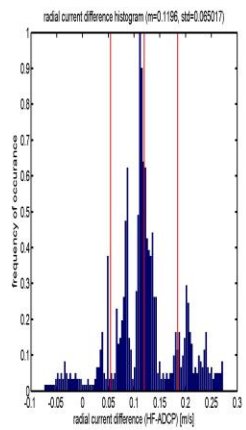




m = 0,26 m/s

std = 0,23 m/s





m = 0,12 m/s

std = 0,065 m/s

SOCIB HF RADAR: A KEY CONTRIBUTION TO MULTI-PLATFORM OCEAN OBSERVATION

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

Presenter: Charles TROUPIN ctroupin@socib.es

Contributor(s): **J. Marmain, E. Reyers**, A. Lana, V. Fernández, B. Mourre, M. Juza, A. Orfila, J. Tintoré

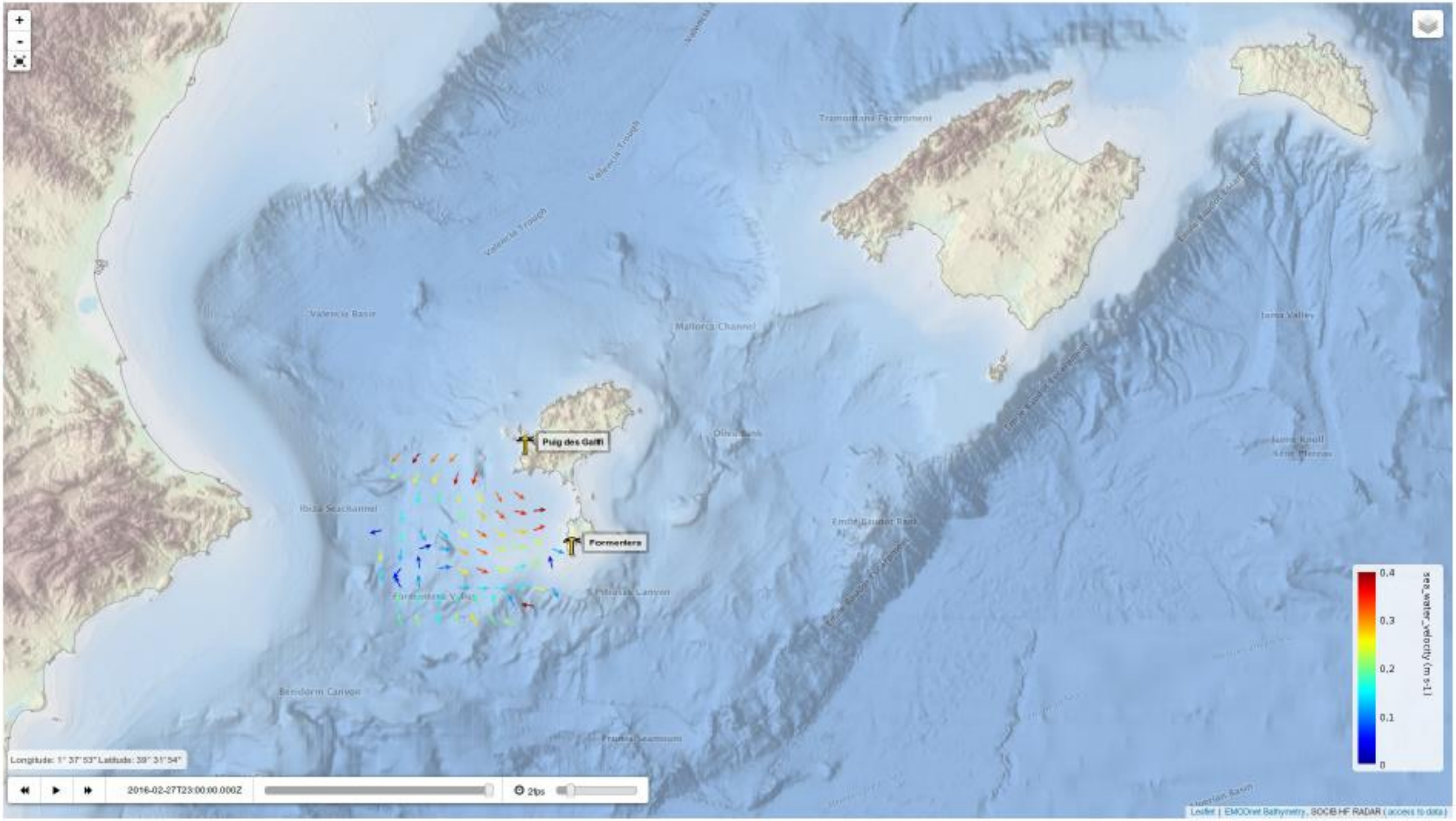
JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

INDEX

1. **Issues during the installation phase**
   Site Selection and Approvals; Radar choice (Direction Finding, Phased Array, manufacturer; Environmental Concerns – Electromagnetic; Environmental Concerns – Impacts (ground, plants, animals, views); Power; Communications; ...
2. **Main operational issues** Power outages and communication failures; Air-conditioning; Coastal Erosion; Calibration; Mains interference; Security; Radar system robustness..
3. **Site maintenance** Schedule; Spares; ...
4. **Quality assessment** Automatic reporting on changes in status of stations and computer systems; Web-based database of incidents and actions; ...
5. **Data management** Format; Quality control; Data processing; Data flow for dissemination
6. **Applications** Users; Areas -search&rescue, oil spill, fisheries, etc-; products; Lagrangian tools; data assimilation...
7. **Other items** you consider interesting in T2.3 context

Task 2.3: Harmonizing new network systems: HF Radars

0. Context: where we are



Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

Main features

Combined TX-RX antennas
TX- frequency: 13.5 MHz (standard-range)
Grid resolution: 3 km
Averaging radius (radials): 6 km
Time sampling: hourly (75 min moving average)
Effective measurement depth: ~0.9 m
Deployed: 1 June 2012 - ongoing

Site selection and approvals

Remote coastal areas
Top of a cliff
Clear area

Task 2.3: Harmonizing new network systems: HF Radars

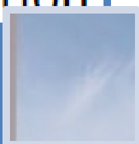
1. Issues during the installation phase

Communications (between Radial-Sites and Combine)

...a great challenge...in the Balearic Islands

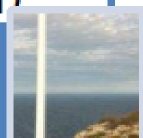
- 3G connection

GALF



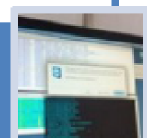
- WIMAX (IB-Red)

FORM



- SOCIB LAN

COMBINE



1. Issues during the installation phase

Impacts

Visual impact of HF radar and GPS antennas: construction of 7Pines Resort Ibiza

CODAR SeaSonde: Compliance Certification Services

Security

No Liability Insurance Policy → thinking about that...

Task 2.3: Harmonizing new network systems: HF Radars

2. Main operational issues

Main incidences occurred since June 2012

Power cut at the waste treatment plant (FORM)
Humidity in the cables and antenna connectors (GALF)
MiniMac problems (does not start up automatically)
Anomalous antenna impedance values (90 units) in GALF
 bad adjustment of the antenna top whip
 antenna connectors
Router blocked outgoing TCP packet (FORM)
Low S/N < 20 dB → problems in antenna or cable
Radial-site HD space > 90 %

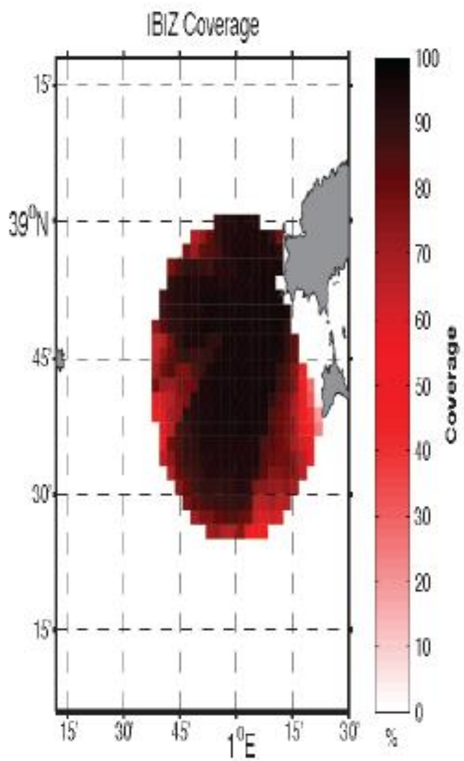
Consequences

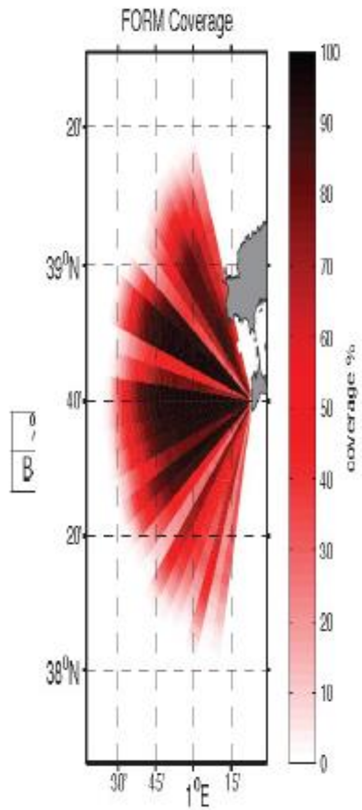
Radial low coverage
Lack of radial vectors in one radial-station → lack of total vectors
Communications failure between Radial Site-Combine
(data is reprocessed)
Anomalous velocity values

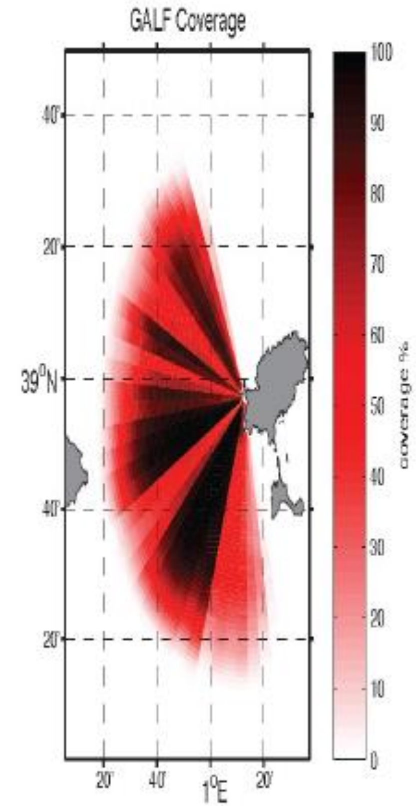
Task 2.3: Harmonizing new network systems: HF Radars

2. Main operational issues

Data Coverage and Availability
(last 3 months)







Data Availabil

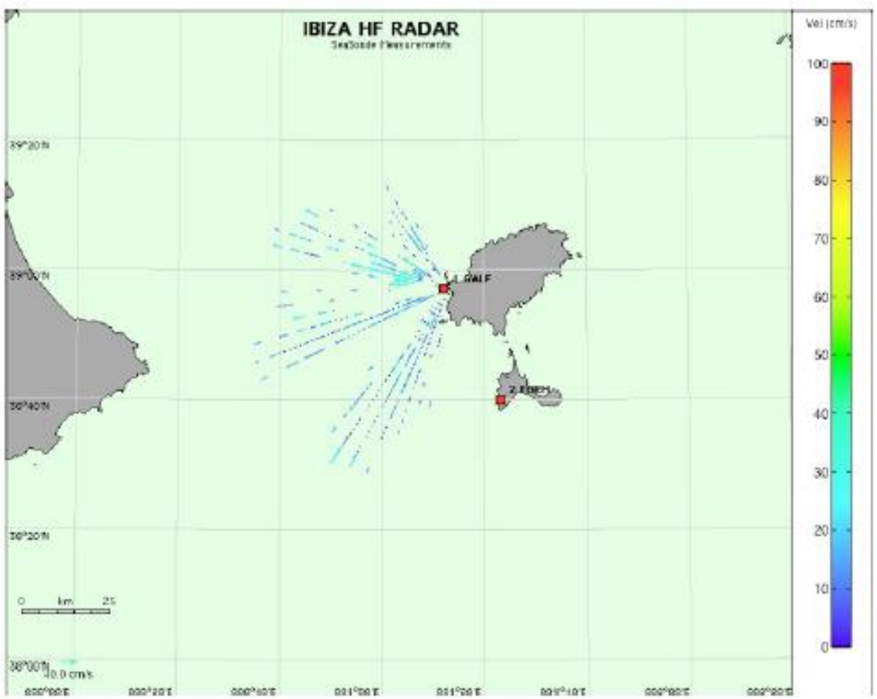
% Availability	
Biggest Gap [h]	

Task 2.3: Harmonizing new network systems: HF Radars

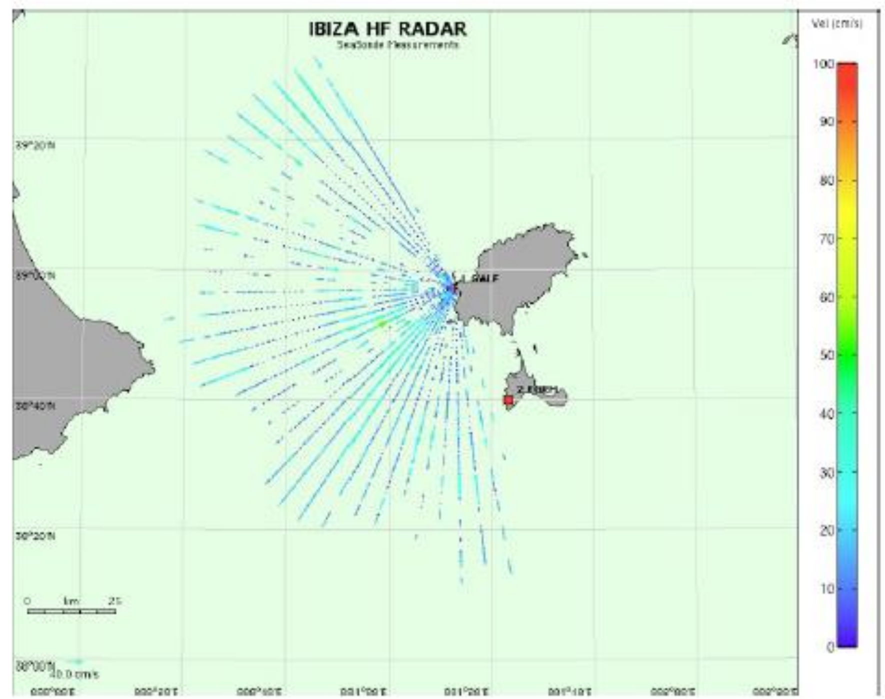
2. Main operational issues

GALF : Radial data before and after the top-whip adjustment

24.FEB.2016 11.00 GMT



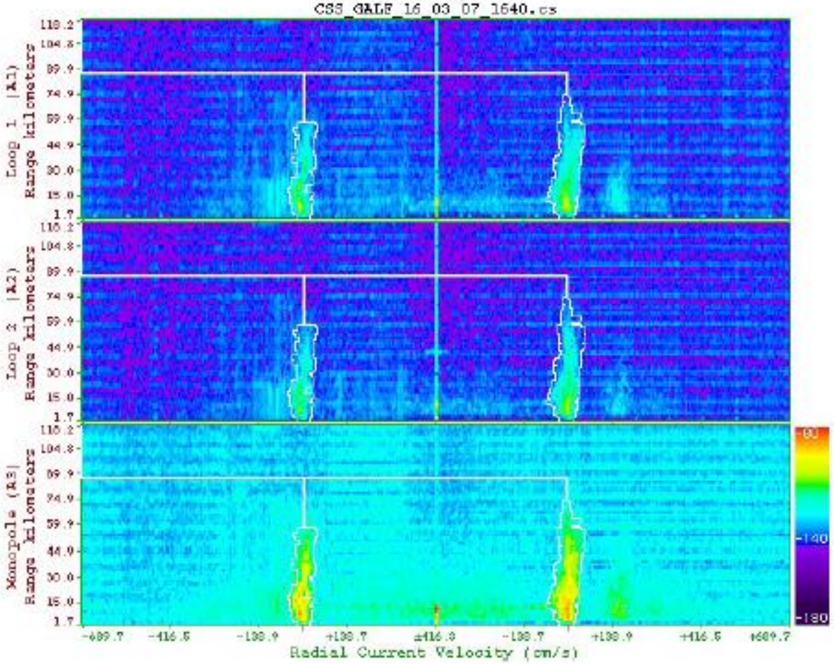
24.FEB.2016 20.00 GMT



Task 2.3: Harmonizing new network systems: HF Radars

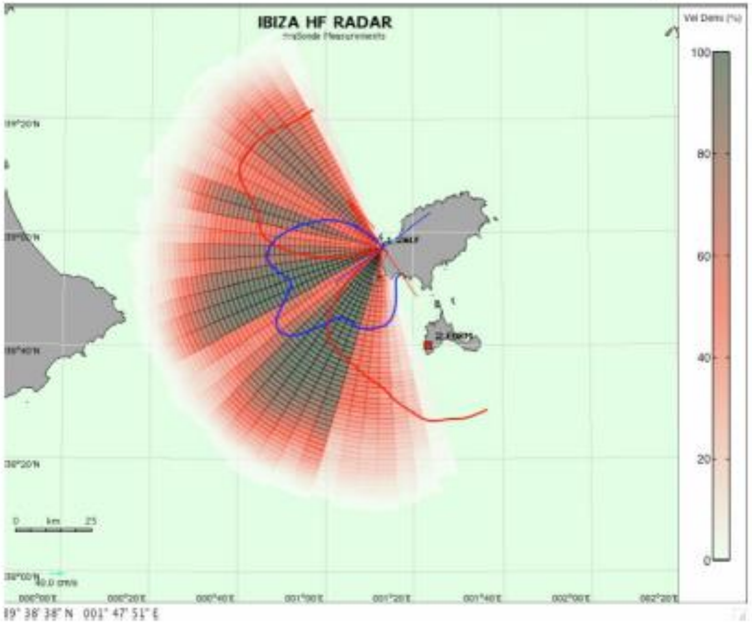
2. Main operational issues

Interference: 13.5 Mhz is a secondary band of frequency with daily oscillations



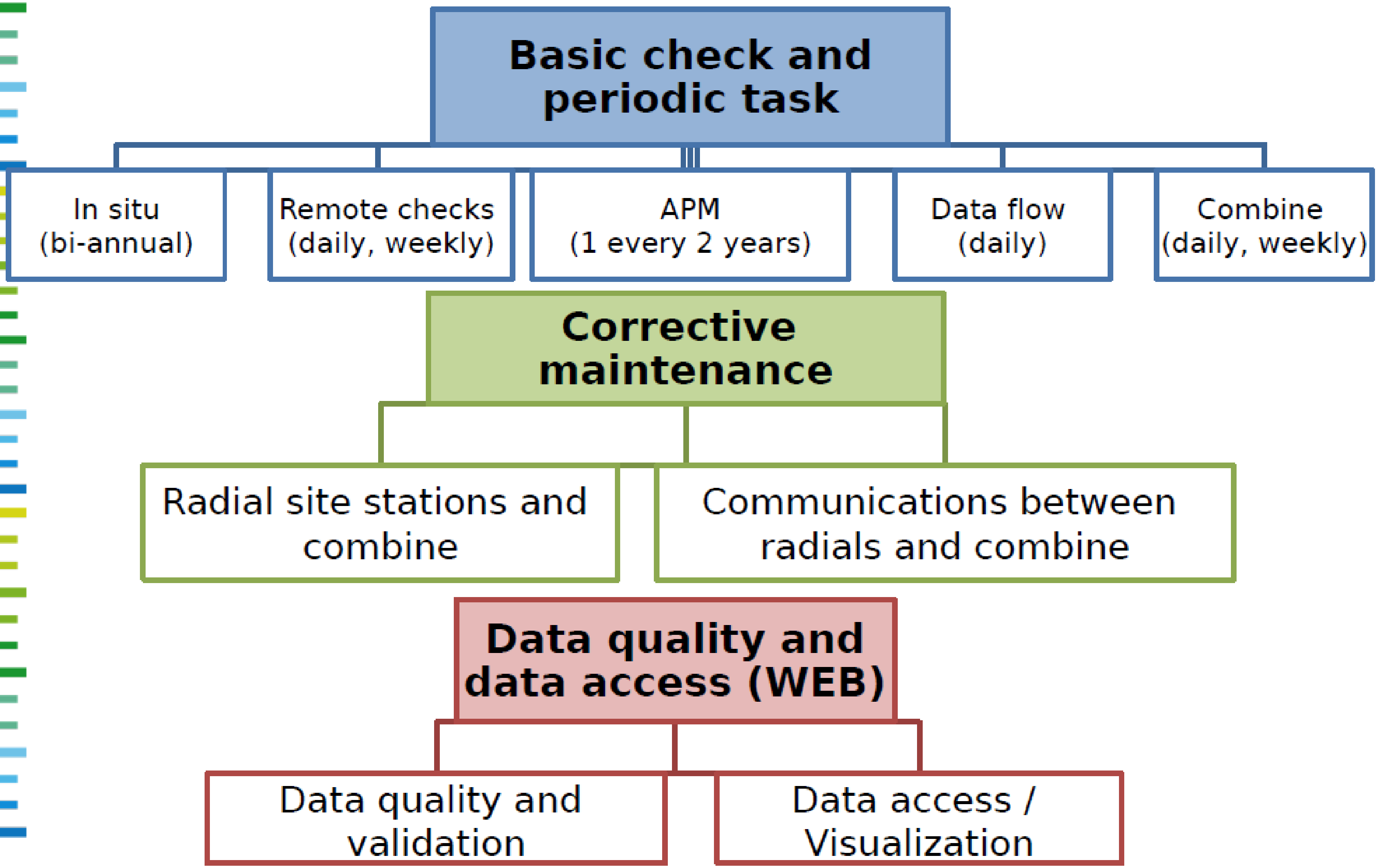
Interference: antenna pattern distortion of Loop 2

(low radial coverage in sector 220-250° in GALF)



Task 2.3: Harmonizing new network systems: HF Radars

3. Site maintenance



Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment

CODAR QC procedures **[L0]**

- Threshold for radial (80 cm/s), total vectors (70 cm/s)
- Angle between radial in the range 30°-150°
- First Order Limit settings
- (prevent interferences and errant high radial velocities)
- Antenna pattern calibration → Last APM in July 2015.

SOCIB Data Centre procedures and flags **[L1]**

Battery of tests for individual total vector

- (range, gradient, spike for module and direction).
- System functioning diagnostic parameters at each radial station:
- signal-to-noise ratio
- radial vector count,
- average radial bearing
- comparison of averaged radial bearing for the measured and ideal patterns

4. Quality assessment : validation

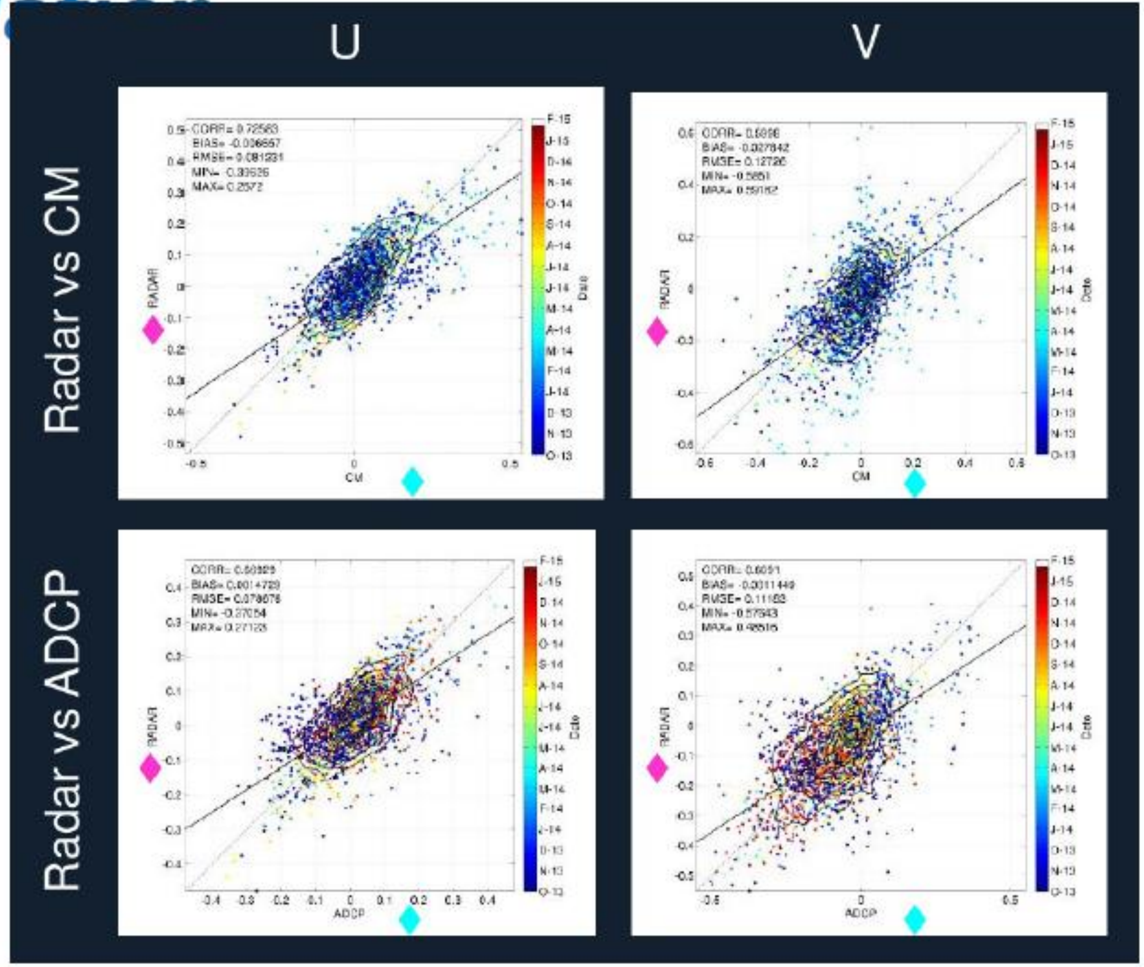
Comparison exercise in the Ibiza Channel:

3h averaged U, V velocities from
- HF radar (0.9m),
- Currentmeter (1.5m)
- ADCP (5m)

Period: 2013/09/27 to 2015/01/22
QC flags: 1, 2 (good and probably good data)

Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment : validation



Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment : validation

Results:

- 7cm/s < RMSE < 13cm/s
- 0.6 < correlation < 0.73
- Good agreements with previous studies
- (recently Lorente et al., 2014, Cosoli et al., 2010 or Rubio et al, 2011)
- Good agreement in reproducing the strongest velocities events
- Better agreement for the U component
- (geometric effect + higher variability for V)
- Improvement due to APM (July 2015)
-

Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

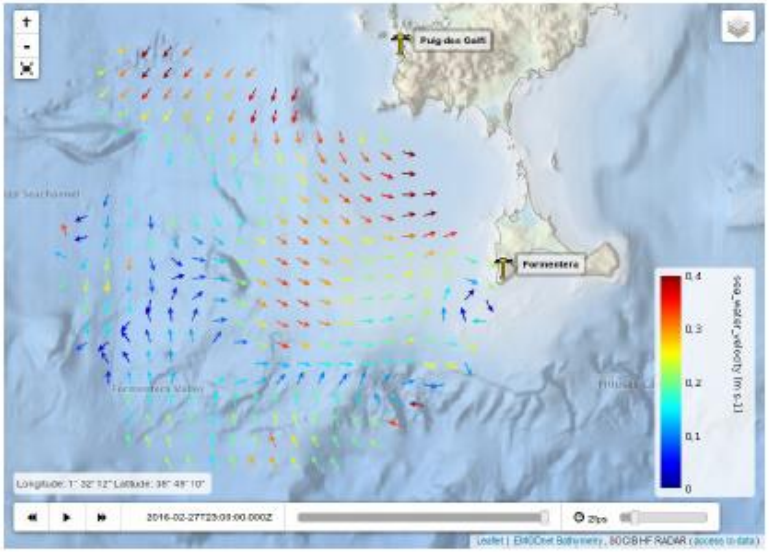
Thredds data server:

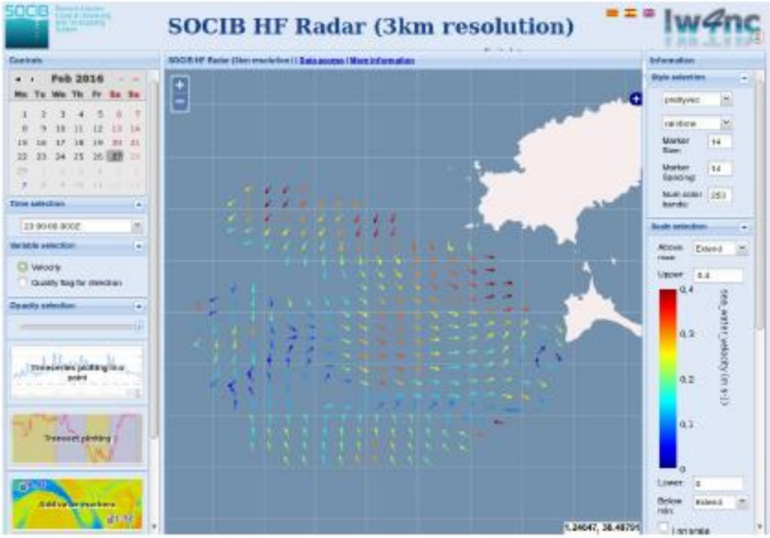
http://thredds.socib.es/thredds/catalog/hf_radar/hf_radar_ibiza-scb_codarssproc001/catalog.html

- One file per month
- L0 and L1
-

Visualisation:

- ✓ Leaflet TimeDimension: https://github.com/socib/Leaflet.TimeDimension
- ✓ Lightweight for NetCDF: http://thredds.socib.es/lw4nc2/?m=radar
- ✓
- ✓

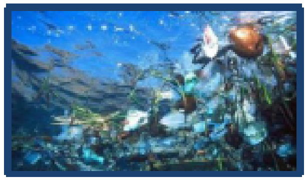




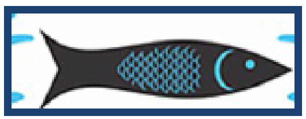
Task 2.3: Harmonizing new network systems: HF Radars

6. Applications

Maritime search and rescue
- Ship tracking
- Body rescue

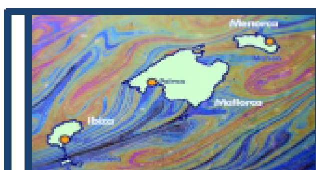


Water quality
- Jellyfish tracking
- Floating waste tracking
- Harmfull algal bloom warnings



Sustainable fishing
- larval transport and distribution (bluefin tuna)

Technical/Scientific knowledge of marine environment
- Risk assessment; validation of WMOP surface currents
- Support decission-makers
- Navigational assistance; off-shore energy
- Circulation characterization and variability



Pollution of the marine environment
- Oil spill pollution

Emerging uses of HF Radar

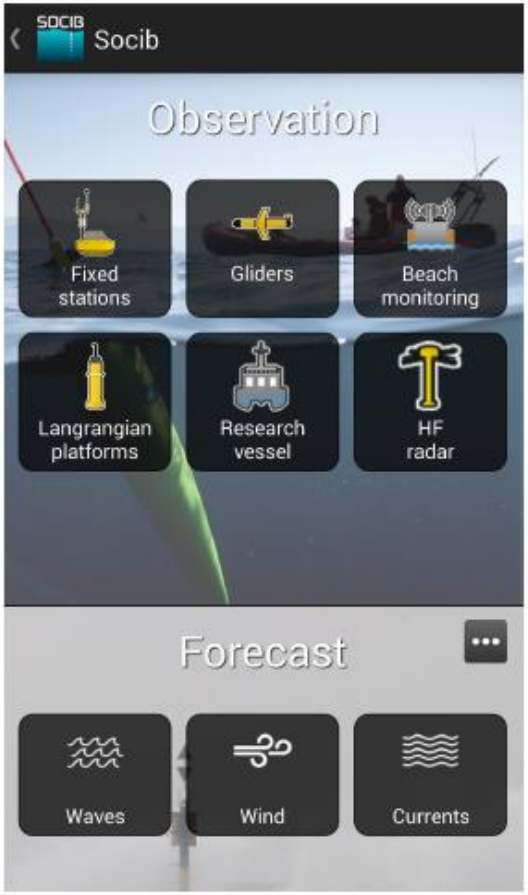
Task 2.3: Harmonizing new network systems: HF Radars

6. Applications

Data to be included for

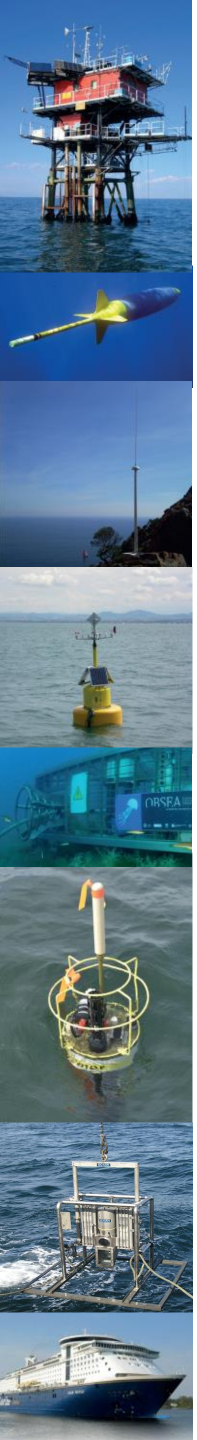
- Search and Rescue applications
- Oil spill trajectory forecast

App for Android and iOS



7. Other items

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.



CNR-ISMAR HF radar network

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

Presenter: Carlo Mantovani – Lorenzo Corgnati email: carlo.mantovani@cnr.it

Contributor(s): Carlo Mantovani – Lorenzo Corgnati – Annalisa Griffa (CNR-ISMAR)

JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

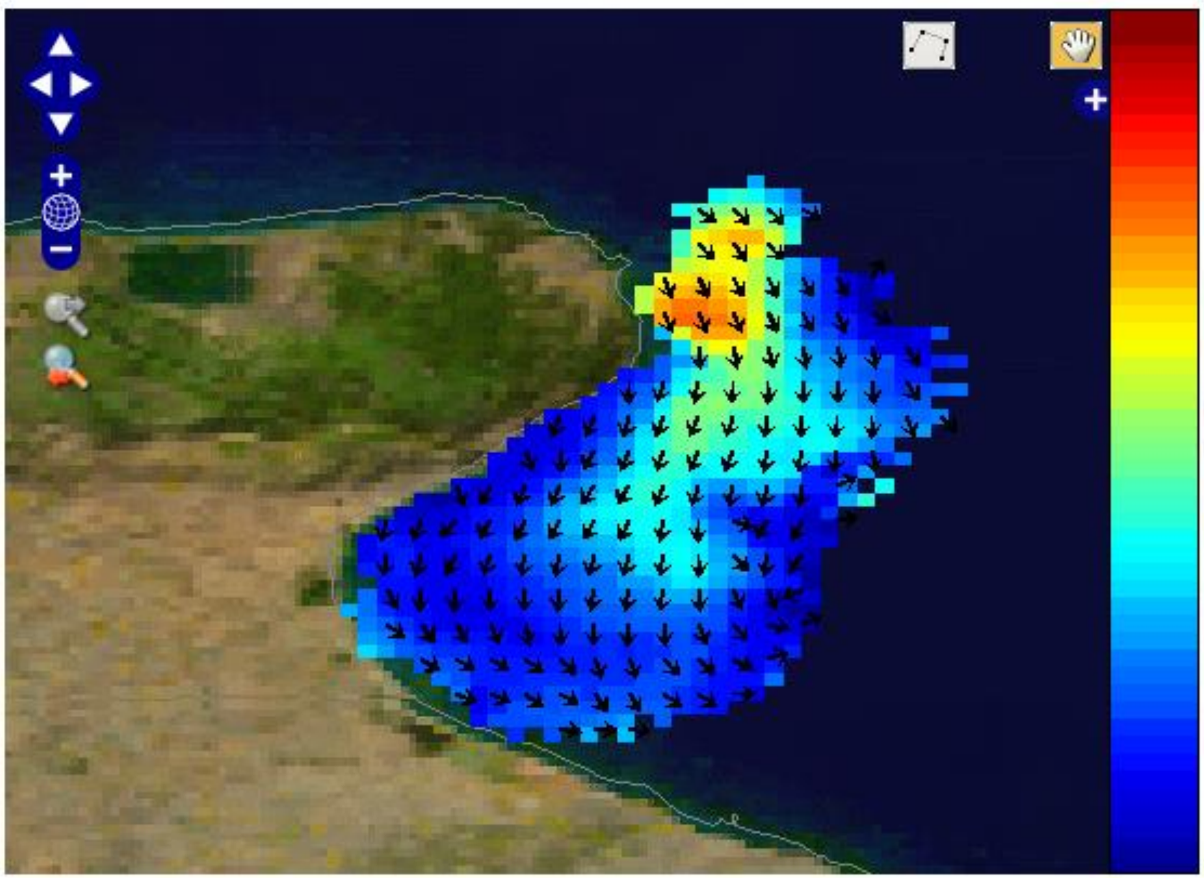
ISMAR HF radar network

ISMAR HF radar infrastructure consists of 4 Codar SeaSonde compact direction finding systems operating at 25MHz

Historical Hf radar data archive – Gulf of Manfredonia (2013-2015)

Available at

http://ritmare.artov.isac.cnr.it/thredds/ritmare/CoastalRadarOS/RADAR_HF/Gulf_of_Manfredonia/catalog.html



ISMAR HF radar network

Upcoming Deployment in East Ligurian Sea, from upper left:

Selected sites: Monterosso; Isola Tino

Sites under evaluation for a third HF radar station: Marina di Carrara

INDEX

1. **Issues during the installation phase** Site Selection and Approvals; Radar choice (Direction Finding, Phased Array, manufacturer; Environmental Concerns – Electromagnetic; Environmental Concerns – Impacts (ground, plants, animals, views); Power; Communications; …
2. **Main operational issues** Power outages and communication failures; Air-conditioning; Coastal Erosion; Calibration; Mains interference; Security; Radar system robustness..
3. **Site maintenance** Schedule; Spares; ...
4. **Quality assessment** Automatic reporting on changes in status of stations and computer systems; Web-based database of incidents and actions; …
5. **Data management** Format; Quality control; Data processing; Data flow for dissemination
6. **Applications** Users; Areas -search&rescue, oil spill, fisheries, etc-; products; Lagrangian tools; data assimilation…
7. **Other items** you consider interesting in T2.3 context

Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

- Site selection: even with compact antenna, possible limitations in villages or coastal areas inside regional or national protected areas, either from environmental or architectural point of view (historical town centres).
  - **Possible solutions**: change design of the antenna.

- Site selection: usually private or public subjects are asked for installing the radar system inside their property.
  - **Issues:** agreement between public research centres and private citizens is always difficult. Agreement between public bodies (e.g. the Navy) could take months.
  - **Possible solutions** ??? (start much earlier…)

- Site selection: best sites are often wild sites out of urban areas and with no infrastructures. **Need of guidelines for implementing a self powered HF radar station.**

Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

- Radio frequency usage authorization: normally 2-3 months to get a temporary permission. Much more for a long term permission.
    - **Possible issue:** need agreement with another country if close to the borders.
    - **Possible solutions:** pre-agreement between eu countries on HF radar frequency bands.

- Electromagnetic hazard: in Italy a specific authorization is provided by Agenzia Regionale per la Protezione dell'Ambiente (ARPA).
    - **Possible issue:** depending on the region, you may need to provide a deep study on radiation pattern and its impact on the selected site.
    - **Possible solutions:** shared document with pre-study on e.m. impact for different kind of antennas/frequencies, to be easily applied in specific sites.

Task 2.3: Harmonizing new network systems: HF Radars

2. Main operational issues

Communication: provided that the site is covered by some communication services (cable, mobile network, satellite), delay in data transfer due to software/hardware failures can occurr.

Possible solutions: guidelines for better integration of hardware components (router, computer) and development of advanced tools for network and file transfer management.
Need to define benchmarks for "near real time" data transfer, in order to evaluate the good/bad status of each remote system.

Datacenter: for operational use, need of a robust datacenter.
Issues: hardware failures (HDD, boards…), communication failures.
Solutions: redundancy

Task 2.3: Harmonizing new network systems: HF Radars

3. Site maintenance

Remote monitoring (every 2 weeks)
- Check of diagnostic report (web site) for hardware and software parameters

Site inspection (every 4 months):
- Visual inspection of the outdoor components
- Full data backup
- HF radar hardware and other electronic devices visual inspection and basic checks
- Site cleaning

Deep check of the radar system (every 1 year)
- Antenna Pattern Measurement
- Maintenance of outdoor components
- Full data backup
- Consumable replacement (UPS batteries, fans, fuses)

Special maintenance (in case of hardware failures)
- main spare parts: one computer ready for acquisition; one antenna; one power supply, control boards.

Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment

Check of initial operational parameters vs ideal values: Antenna pattern; transmitted and reflected power; absolute and relative SNR between antenna elements; radial coverage;

Comparison with velocities from ADCP and drifters for measurments validation.

Monitoring of site diagnostics: Codar SaSonde software provides web tools for real time monitoring of system diagnostics, and output data preview and averages and cross spectra visualization

Failure automatic report: alerts and warnings are sent in case of most common issues (e.g. high noise, temperature anomalies, available storage space, empty data etc…)

Log of activities: web based tool for activity logging on a txt file – manual entry by operator

Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

- **Formats**:

  Activities:

  - Definition of an interoperable netCDF architecture to be adopted as European standard for surface current radial and total velocity data and metadata.
  - Implementation of software tools for conversion of native HF radar formats into the netCDF standard for surface current radial and total velocity data and metadata.

  Issues:

  - Presence of different international data and metadata conventions, not always compatible.
  - Presence of different metadata standards sub-definition depending on the measurement type.
  - Different data formats from different HF radar manufacturers.
  - Resistance of data providers to share data and change their data management habits.

  Possible solutions:

  - Follow the US example as the US coastal radar network has well-defined data and metadata standards operating within a national unified network.
  - Define a minimal set of metadata fields for each of the recommended international data and metadata conventions.

Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

- **Quality Control**:

  Activities:

  - Experimental study on GDOP control on radial velocity combination.
  - Ongoing discussion on the definition of QC procedures to be adopted as European standard for HF radar providers.

  Issues:

  - Presence of substantial differences in data generation from different manufacturers.
  - High level of subjectivity among data providers about QC procedures.
  - Resistance of data provider to share achievements.

  Possible solutions:

  - Define indicators able to compare data generated by different manufacturers.
  - Define a minimal set of mandatory procedures and let the data providers free to apply their own procedures.

5. Data management

- **Data Processing**:

  Activities:

  - Design and implementation of an automated system for data gathering, data cleaning, QC, radial combination, interoperable data production and data dissemination.
  - Use of the HFR Progs Matlab library for data management in order to be independent from manufacturers software tools.

  Issues:

  - Need for Matlab license or for being dependent on manufacturers software tools: no open source approach.
  - Possible troubles in occasion of manufacturer software upgrades.

  Possible solutions:

  - Establishment of a centralized Thematic Assembly Center responsible for data collection, cleaning, combination and dissemination.
  - Development of open source tools for HF radar data management.

Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

- **Data Flow for Dissemination**:

  Activities:

  - Implementation of specific THREDDS catalogs for interoperable HF radar data.
  - Design and implementation of an automated system for data attachment to a THREDDS catalog.

  Issues:

  - Need for THREDDS server and related services.
  - Resistance of data provider to share data.
  - Presence of different data policies governing data potentially attachable to the dissemination catalogs.

  Possible solutions:

  - Establishment of a centralized Thematic Assembly Center responsible for data collection, cleaning, combination and dissemination.

6. Applications

(potential) Users:

- Coast Guard and maritime authorities for oil spill and search & rescue operations (Med project TOSCA)
- Decision makers and fishermen for studies on larvae dispersion and marine protected areas connectivity (eu project CoCoNet and italian SSD Pesca project)

Products and tools:

- LAVA (LAgrangian Variational Analysis) software for fusion of HF radar and drifter information to improve transport analysis
- Software to estimate residence time in HF radar areas

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.

High Frequency radar activities at the University of Hawaii

Pierre Flament

http://www.satlab.hawaii.edu/

DESIGN AND PRODUCTION OF A LOW-POWER LOW-COST HIGH FREQUENCY DOPPLER RADIO SCATTEROMETER (HFDRS) FOR COASTAL ZONE OCEANOGRAPHY

Mael Flament[1], Dave Harris[1], Tyson Hilmer[1], Pierre Flament[1], Louis Marie[2], Lindsey Benjamin[1], Alma Castillo[1], Charina Repollo[1], Yu-Wei Chang[1], Jean-Philippe Derout[1], Benedicte Dousset[1]

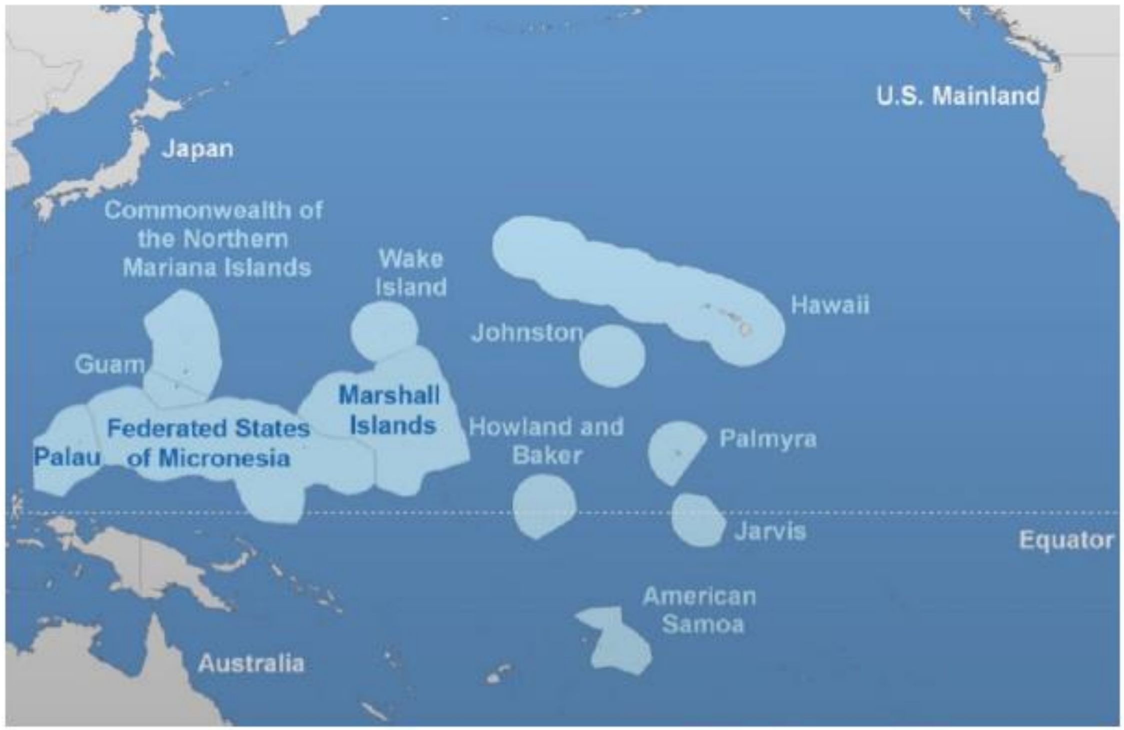
[1]University of Hawaii, Manoa, Honolulu, Hawai'i, USA
[2]Institut Français pour l'Exploitation de la Mer, Plouzané, France

Abstract

A new beam-forming HFDRS a.k.a. Doppler Radar has been designed, maximizing commercial-off-the-shelf (COTS) components thus minimizing overall cost, minimizing power consumption thus enabling solar/wind operation in remote areas. For 8 channels, components cost less than k$30 and six man-weeks suffice for assembly, testing and calibration. Power consumption is 300W full duty. It uses frequency-ramped continuous wave signals, and phased-array transmissions to decouple direct path to receivers. Fan-less operation of critical components avoids 60Hz inter-modulation. Five sub-assemblies are controlled by a Linux server: (i) COTS direct digital synthesis of transmit and orthogonal local oscillator signals, derived from a ultra-low phase noise oven-controlled crystal; (ii) COTS 50-W MOSFET power amplifier; (iii) lambda/20 compact active antenna monopoles with embedded out-of-band rejection filters; (iv) analog homodyne receivers based on complex demodulation by double-balanced mixers; (v) COTS 24-bit analog-to-digital sigma-delta conversion with 512 oversampling and digital low-pass filter. At 16 MHz, 20 W transmit, 10 min averaging, range of 120 km is achieved. Twenty units were built, and are being deployed in Hawai'i, Mexico and the Philippines; one will be on display at the meeting.

Motivations:

Coverage of the Pacific Island Ocean Observing System (PACIOOS):



Needed: ~ 60 HFR, population ~ 2M, \$3.6/head

Compare: US West Coast: ~ 80 HFR, population ~40M, \$0.25/head

Motivations:

Notion: commodity pricing of oceanographic instrumentation (Mark Abbott, 2001); *cost of instrument << cost of staff*

Year	150 kHz ADCP	1 year MSc tech	4-channel HFR	HFR/ tech	ADCP/ tech
1990	150	135	200	1.50	1.10
2000	50	135	155	1.15	0.37
2010	20	135	115	0.85	0.15
1990/2010	**7.5**	**1**	**1.8**		

(inflation corrected using http://www.bls.gov/data/inflation_calculator.htm)

Objectives:

- maximize commercial-off-the-shelf components (COTS)
- minimize overall cost (non-profit non-subsidized)

  $64,000 16-channels 50 W RF (beam-forming)

  $48,000 8-channels 50 W RF (beam-forming)

  $32,000 4-channels 5 W RF (direction finding)

  about 50% hardware 50% labor assembly&testing
- readily scalable to arbitrary number of channels (∞!)

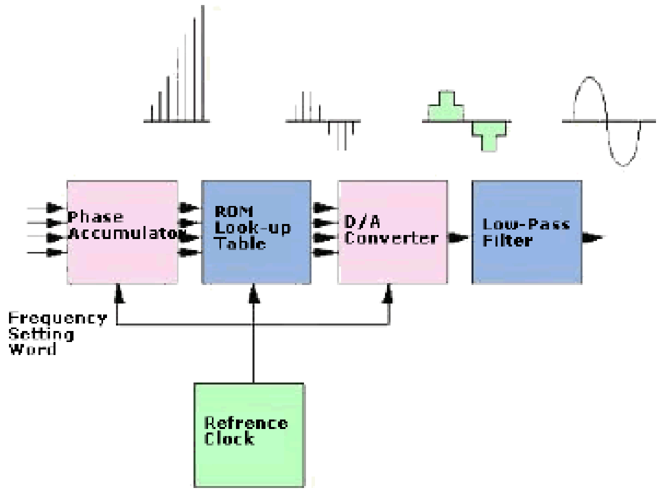
  $2,000/channel
- minimize power consumption

  320 W AC for 16-channel 50 W RF (continuous)

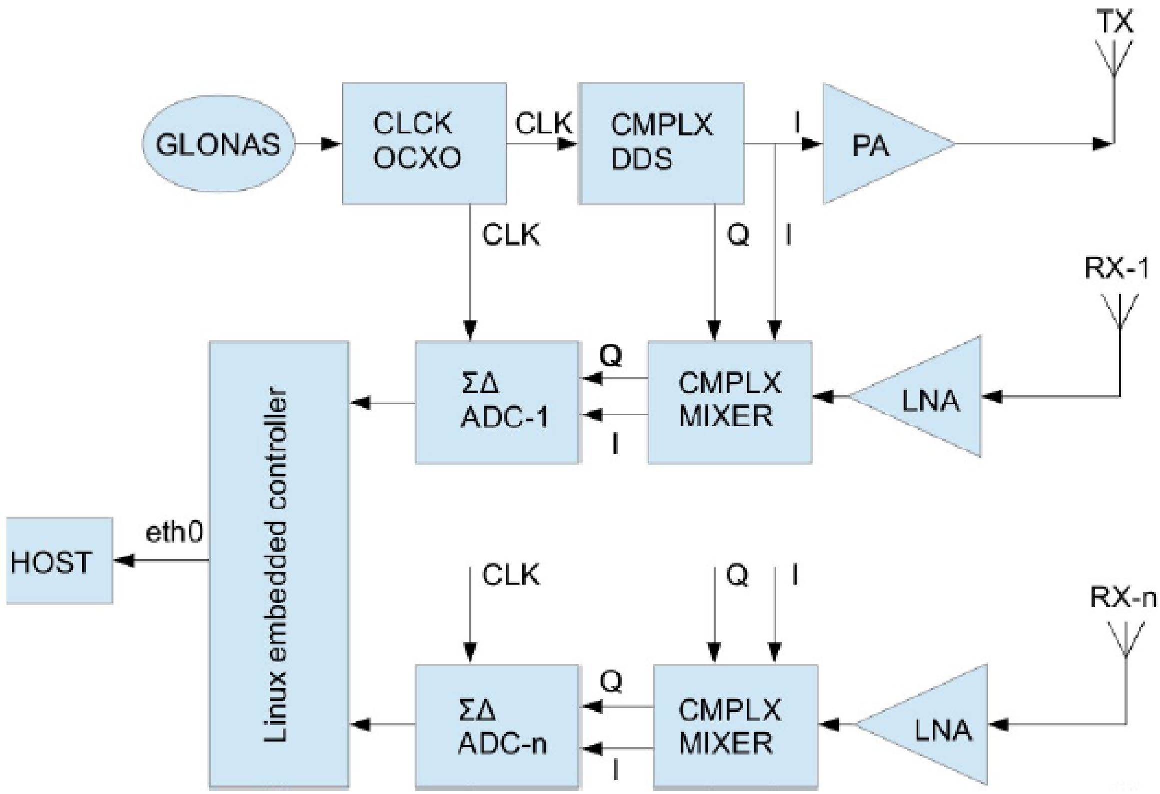
  90 W AC for 4-channel 5 W RF (continuous)
- solar/wind operation enabled
- open-source open-design under GPL-like license

System specifications:

Modulation	FMCW frequency-ramped linear chirp
Operating Frequency	3 MHz to 150 MHz
Transmitted RF-Power	5-50 Watts, beam-formed
Range	typ. 100 km/ 60 NM @ 16 MHz
Range Resolution	depends on bandwidth c/2B 1.5 km @ 100 kHz, 150 m @1 MHz
Azimuthal Resolution	- beam-forming arbitrary array (8 to ∞ antennas)
	- direction-finding triangle/square array
Systems built	22
Deployed	Hawaii (7), Mexico (5), France (1)



Direct Digital Synthesizer/sweep generator



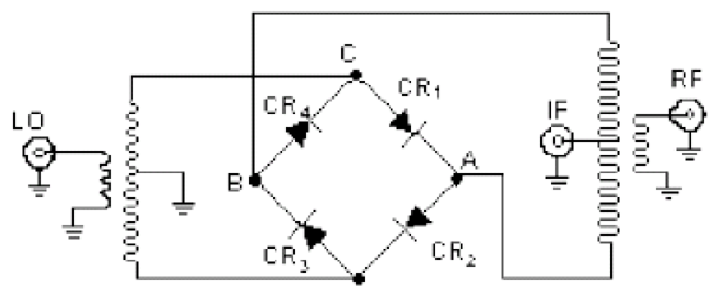
Principle of operation

Double-Balanced Mixer/quadrature detector:

I: $2 \sin x \sin y = \cos (x-y) - \cos (x+y)$

Q: $2 \sin x \cos y = \sin (x-y) + \sin (x+y)$

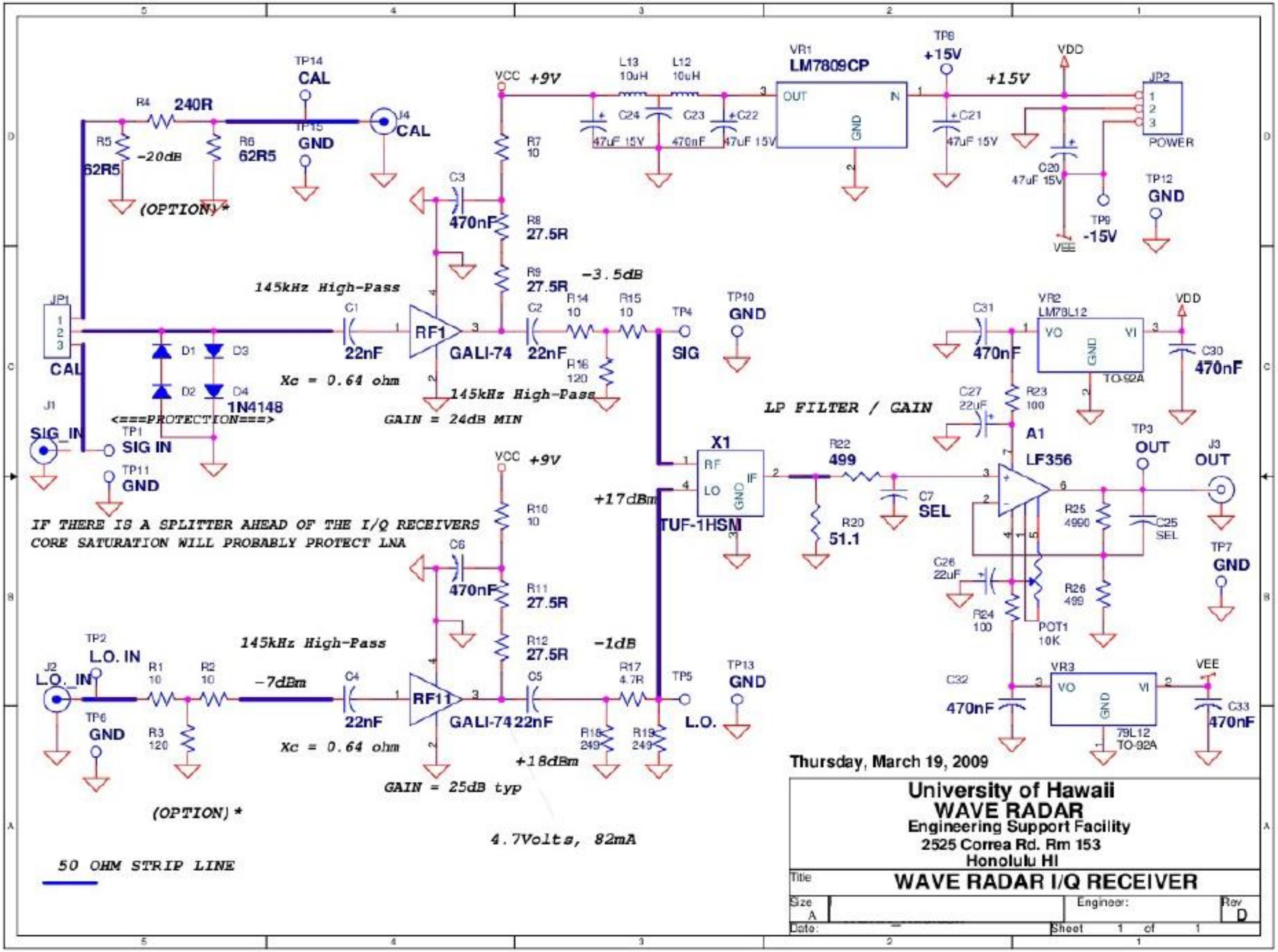
if $x = (\omega + \Delta \omega)\, t$ **and** $y = \omega\, t$ **then** $x-y = \Delta \omega\, t$



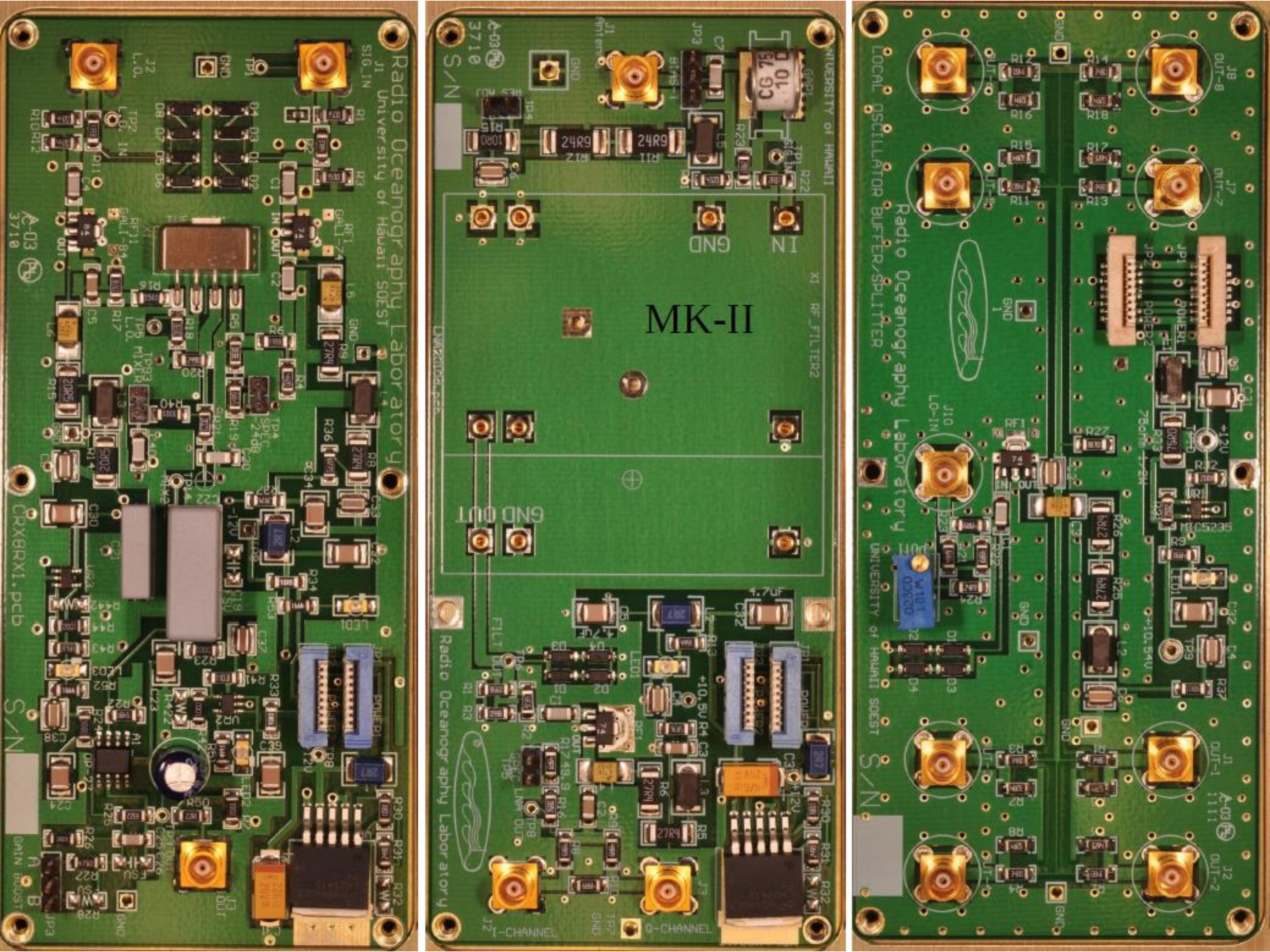
Double

System overview:

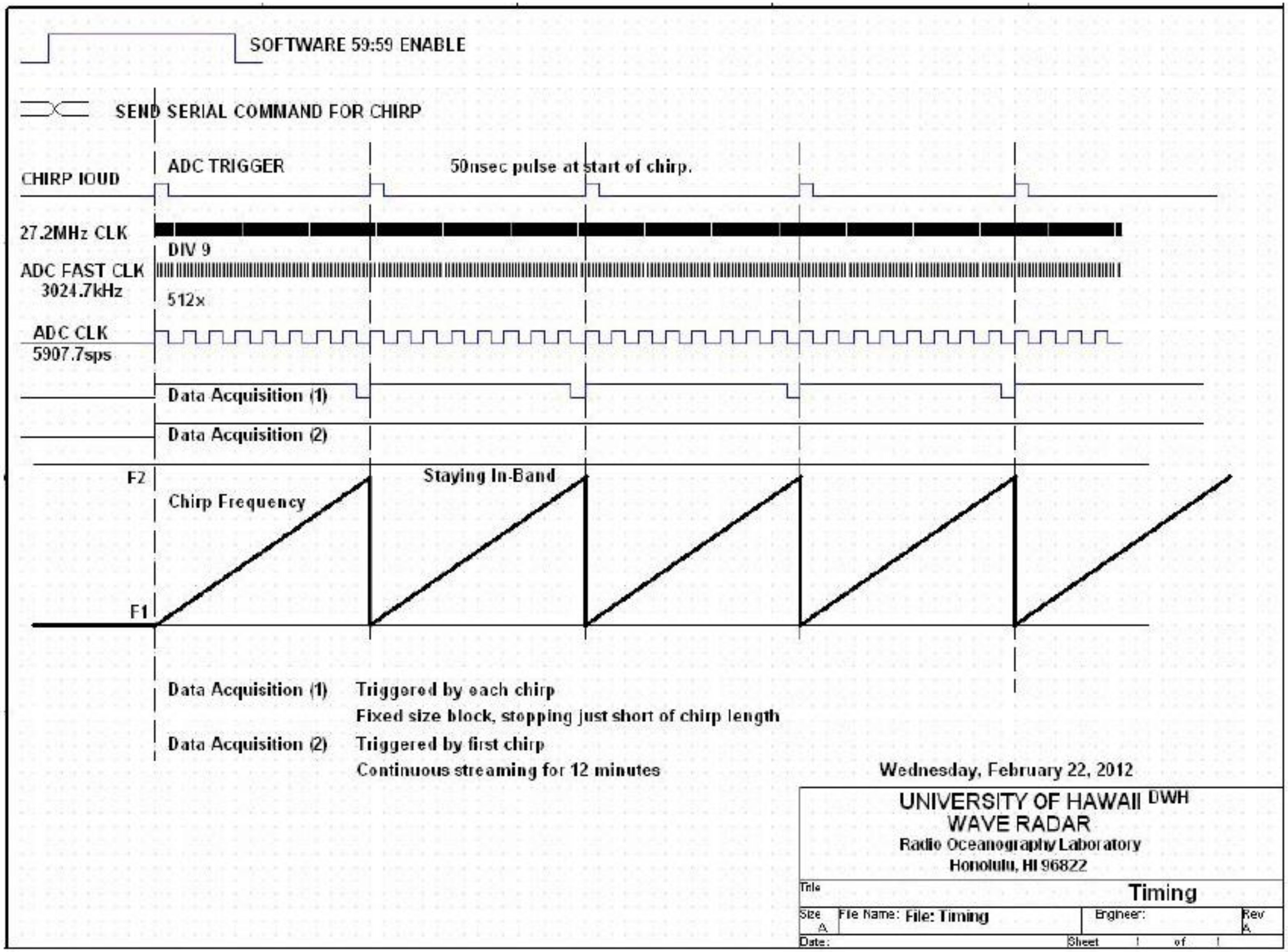
- sub-assemblies controlled by Linux embedded SBC
- ultra-low phase noise oven-controlled crystal for synchronous signal synthesis and A/D conversion (VECTRON)
- direct digital synthesis of transmit and orthogonal local oscillator signals (ANALOG DEVICES/NOVATECH)
- 50 W RF amplifier (TOMCO) or 4x1.5W in-line amplifiers (UH)
- $\lambda/8$ passive transmit monopoles
- $\lambda/16$ active receive antenna monopoles with out-of-band rejection filters (UH)
- complex demodulation by double-balanced mixers, homodyne translation of HF spectrum to audio band (UH)
- 24-bit analog-to-digital sigma-delta conversion with 1024-oversampling and digital low-pass filter (DTACQ)



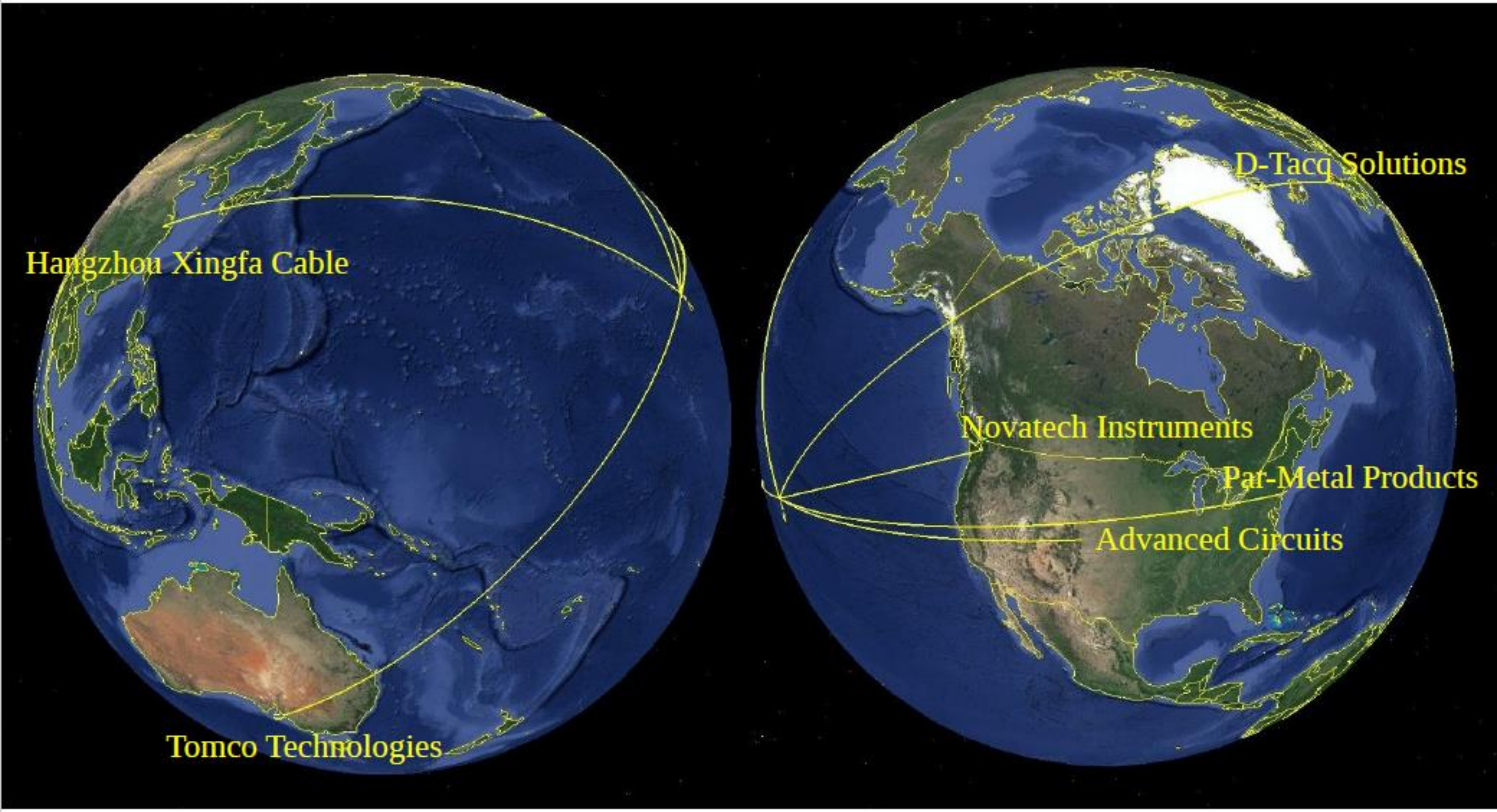
Critical UH-designed circuit: complex demodulator (600 built)


MK-II

Timing:



SOFTWARE 59:59 ENABLE
SEND SERIAL COMMAND FOR CHIRP
CHIRP IOUD
ADC TRIGGER
50nsec pulse at start of chirp.
27.2MHz CLK
DIV 9
ADC FAST CLK
3024.7kHz
512x
ADC CLK
5907.7sps
Data Acquisition (1)
Data Acquisition (2)
F2
Staying In-Band
Chirp Frequency
F1
Data Acquisition (1)
Triggered by each chirp
Fixed size block, stopping just short of chirp length
Data Acquisition (2)
Triggered by first chirp
Continuous streaming for 12 minutes
Wednesday, February 22, 2012
UNIVERSITY OF HAWAII DWH
WAVE RADAR
Radio Oceanography Laboratory
Honolulu, HI 96822
Title
Timing
Size
A
File Name: File: Timing
Engineer:
Rev
A
Date:
Sheet 1 of 1



The supply chain... and our industrial partners

HF radars produced by UH cost center (4/1/16)

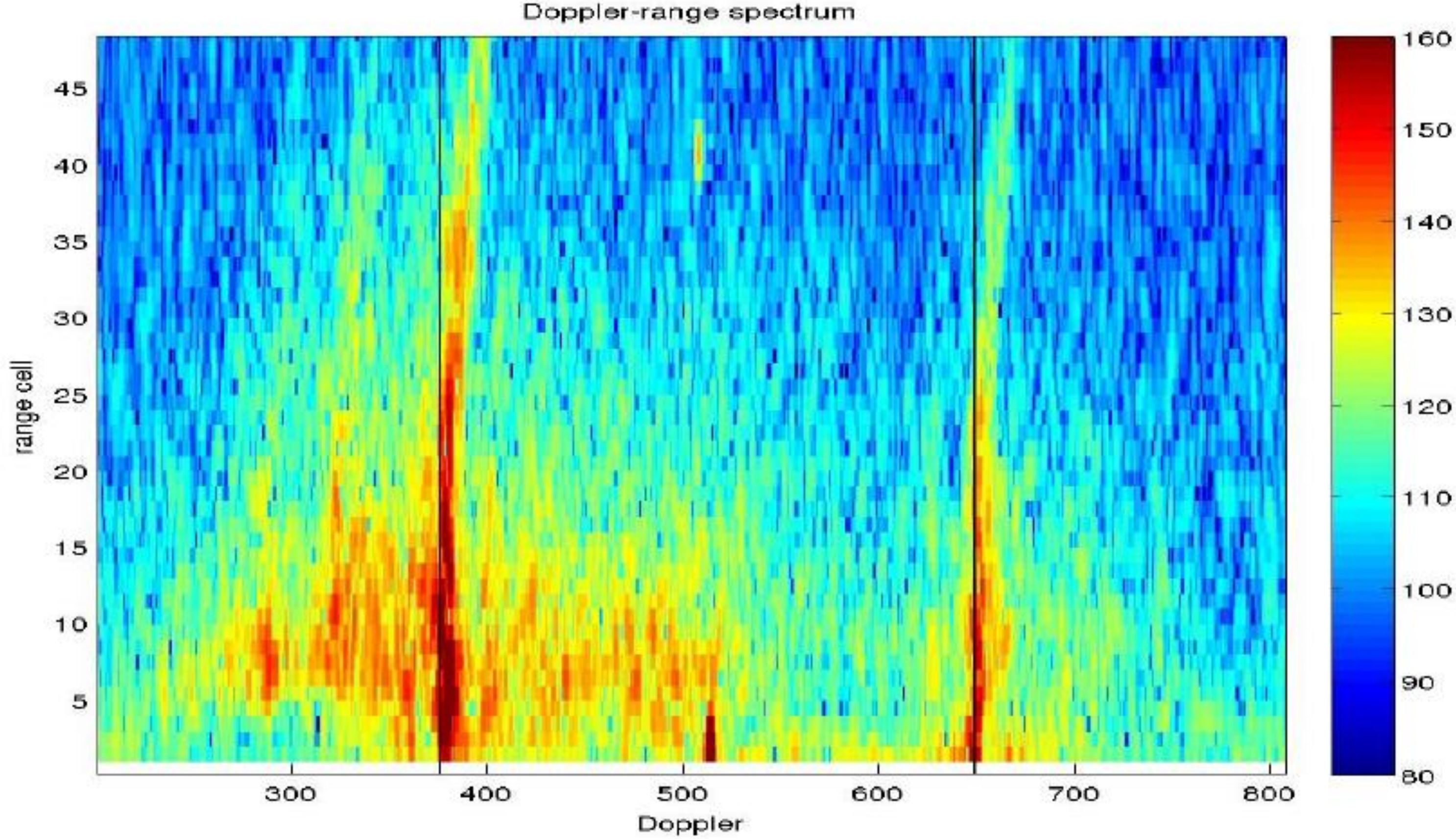
Who	# radars	# CRX 8 channels	Freq. (MHz)	Status
WHOI	**1**	**2 MK-II**	**12**	to be deployed in Nantucket
UABC	**10**	**10 MK-II**	**8, 12, 26, 45**	4 operational, 6 being deployed
UHHilo/DHS	**2**	**3 MK-II**	**16, 26**	2 operational
UH/Navy	**5**	**10 MK-II**	**8, 12, 27**	awaiting installation in Philippines (1 loaner to Ifremer)
UH/NOAA/IOOS	**4**	**9 MK-II**	**13.5, 16, 27**	5 operational
total	**22**	**35**	-	

Rapid-deployment ruggerized systems

MK-II version

Software solutions:

- Output simple binary files of A/D converter antenna signals
- Simple to process directly in matlab and python
- Python scripts for spectra and Bragg-line tracking (UH)
- Import radial currents into Paduan&Cook HFR toolboxes
- Simple import of raw data to all common processing packages:
    - Neptune/Seaview Sensing currents/wave/wind
    - Gurgel WERA currents/wave/wind
    - LSET/Broche/Barbin currents



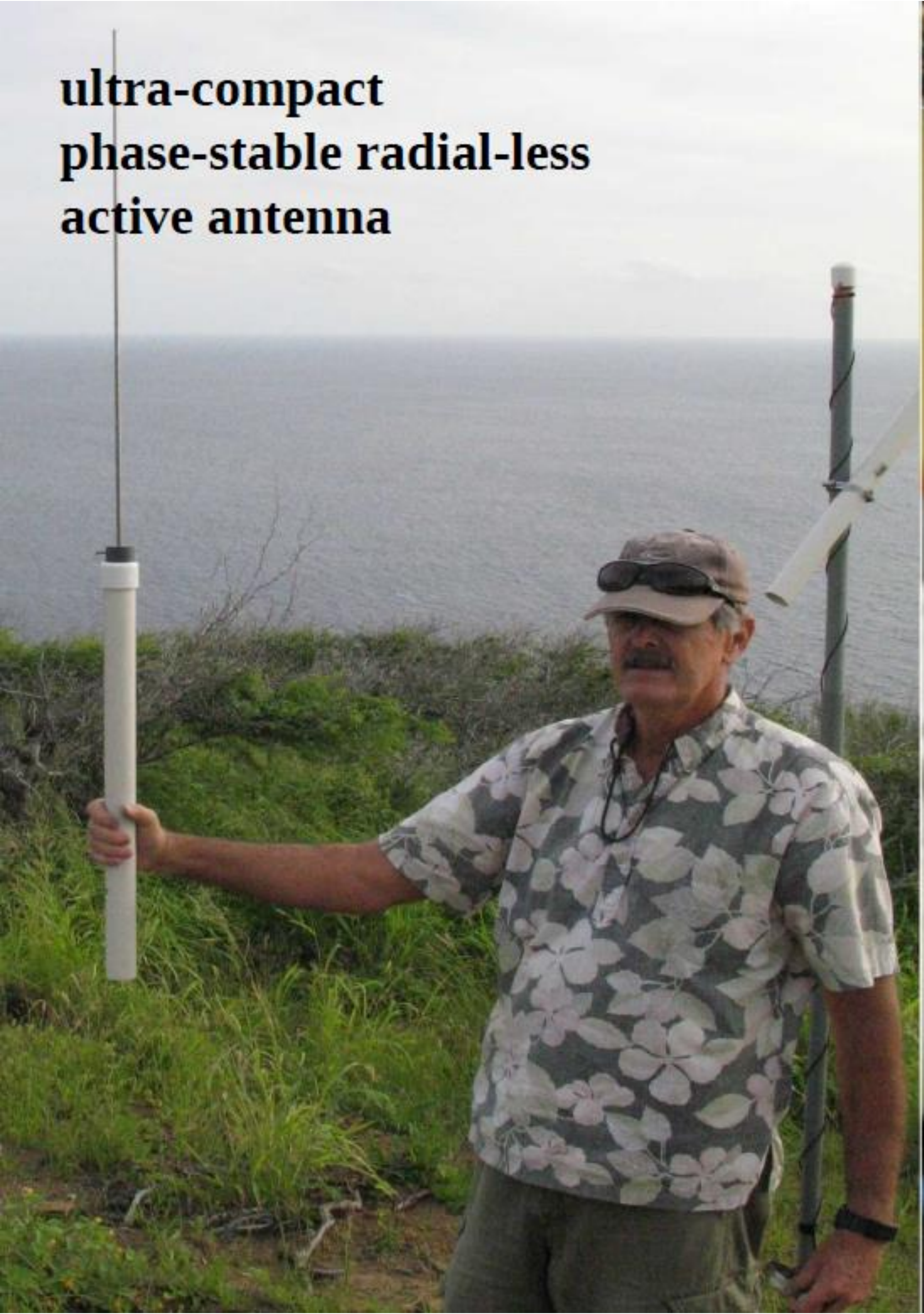

```
% make range-resolving Fourier transform
w=blackmanharris(OVER*MT);
for i=1:NCHIRP
   wraw(:,i)=mraw(:,i).*w;
end
sp=fft(wraw,OVER*MT);

% make Doppler-resolving Fourier transform
w1=blackmanharris(NCHIRP);
for i=1:OVER*MT
   wsp(:,i)=sp(i,:)'.*w1;
end
sp1=fft(wsp,NCHIRP)';
```

```
% fold back negative part of spectrum
sp2=sp1(:,NCHIRP/2+1:NCHIRP);
sp2(:,NCHIRP/2+1:NCHIRP)=sp1(:,1:NCHIRP/2);

%plot range-Doppler spectrum
figure(1)
pcolor(20*log10(abs(sp2)))
shading flat
```

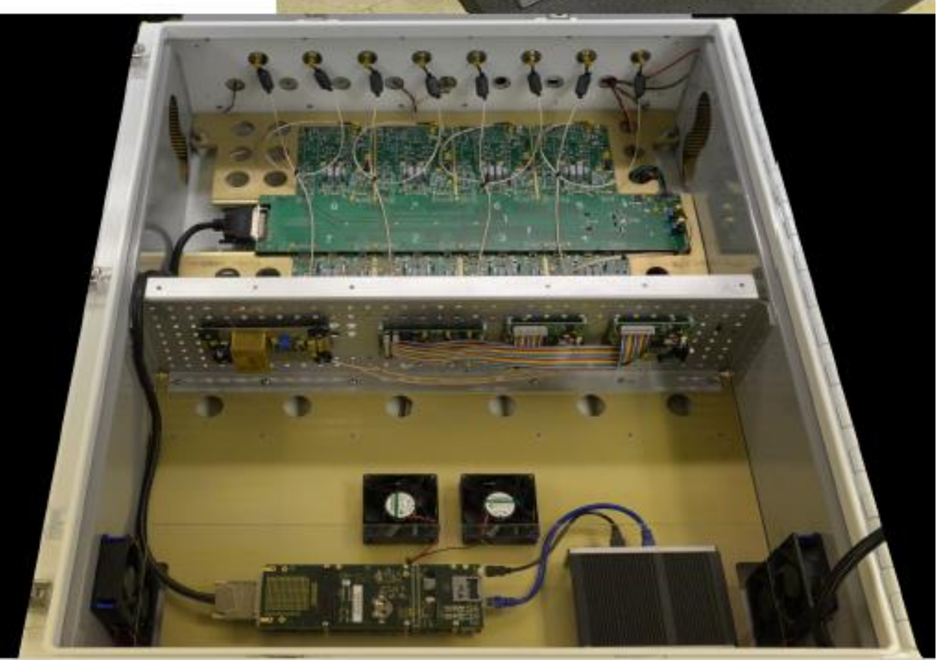
ultra-compact
phase-stable radial-less
active antenna



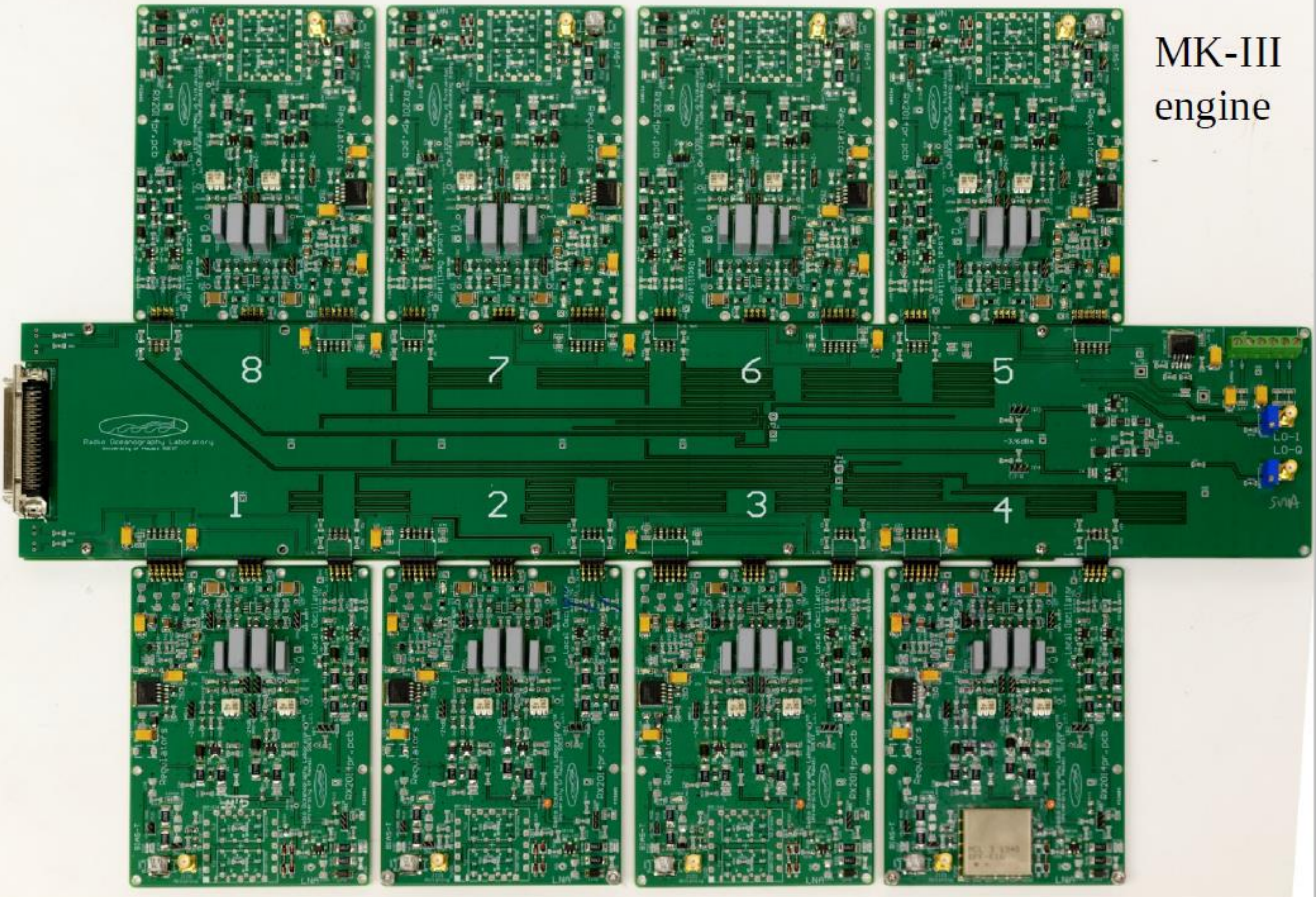
Active antenna array:
13.5 MHz range 120 km
(Chevron Kapolei)

Design of the MK-III UH-HFDR

- all-in-one implementation
- directly field deployable, no container
- low-power (120 W) 24 V
- solar/wind ready (4 panels, 2 turbines)
- passively cooled, no A/C
- active RX antennas
- distributed PA 4x1W
- 8-antenna standard
- Cost ~ $36,000 unsubsidized



MK-III engine



Commercialization structure:

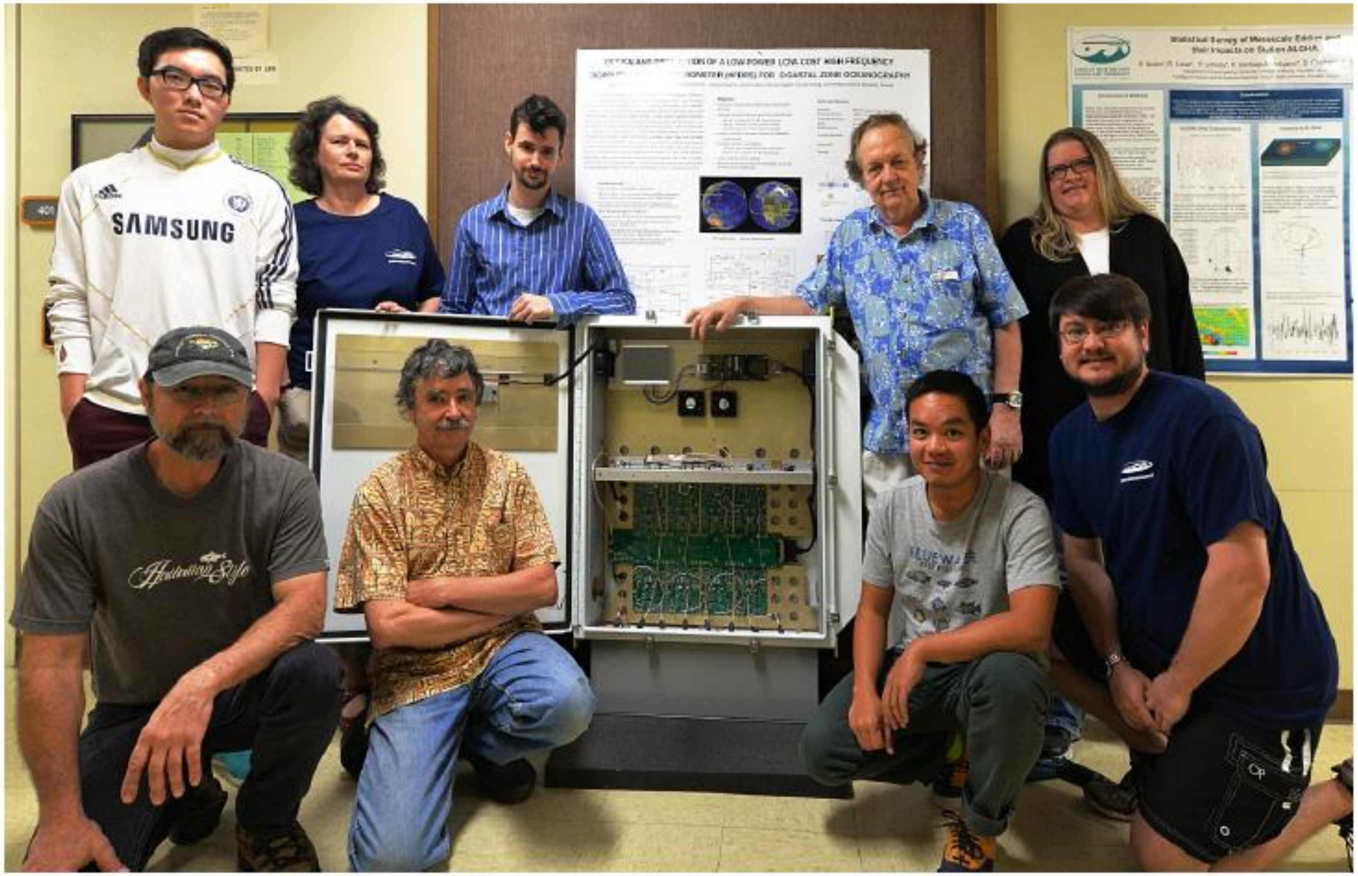
- overall design: University of Hawaii, open design, GPL-like license
- software: University of Hawaii, open source, GPL license

- coordination: Ocean Physics Inc/SAS (San Diego/Brest)
- A/D and DDS: D-Tacq solutions, East Kilbridge, Scotland
- receiver and 1-W amplifiers: AODE, Plouzane, France
- 50-W amplifiers: Tomco, Adelaide, Australia
- metal work: Iltom/Bresto, Plouzane, France

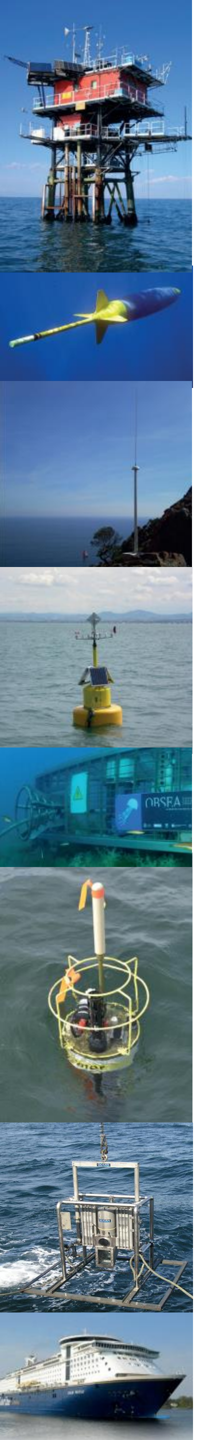
Availability, pending funding:

- production launch July 2016
- delivery January 2017
- assume >30 units, $36,000/unit
- credit cards accepted

Thank you!



The radlab design team in front of the prototype of the MKIII all-in-one HFDR, February 2016, School of Ocean and Earth Science and Technology, University of Hawaii at Manoa



EuroGOOS HFR TT and EMODnet Physics experience

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

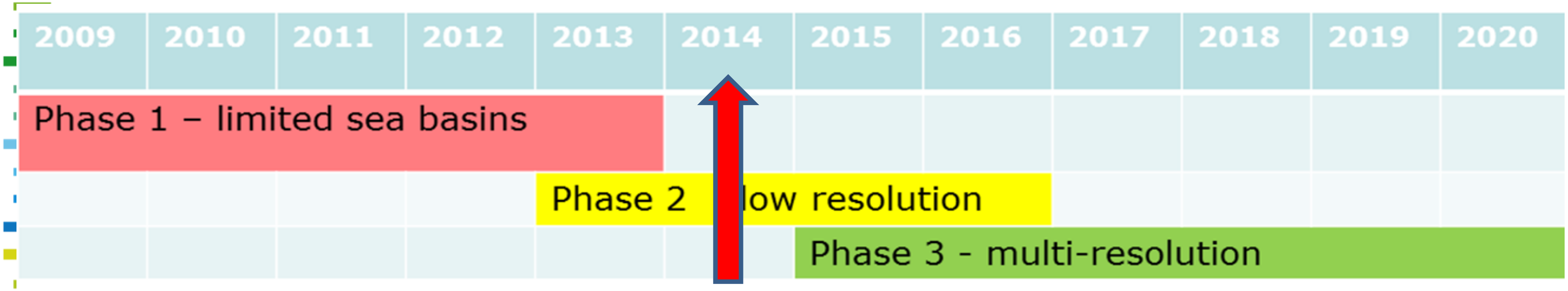
Presenter: email

Contributor(s):

JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

EMODnet Physics

- Provides a single point of **free and open** access to marine **real-time and archived data on physical** conditions of all European Seas as monitored by fixed platforms, ferry boxes, ARGOs, gliders, ***HF Radar***
- …



We were asked, within EMODnet Physics to:

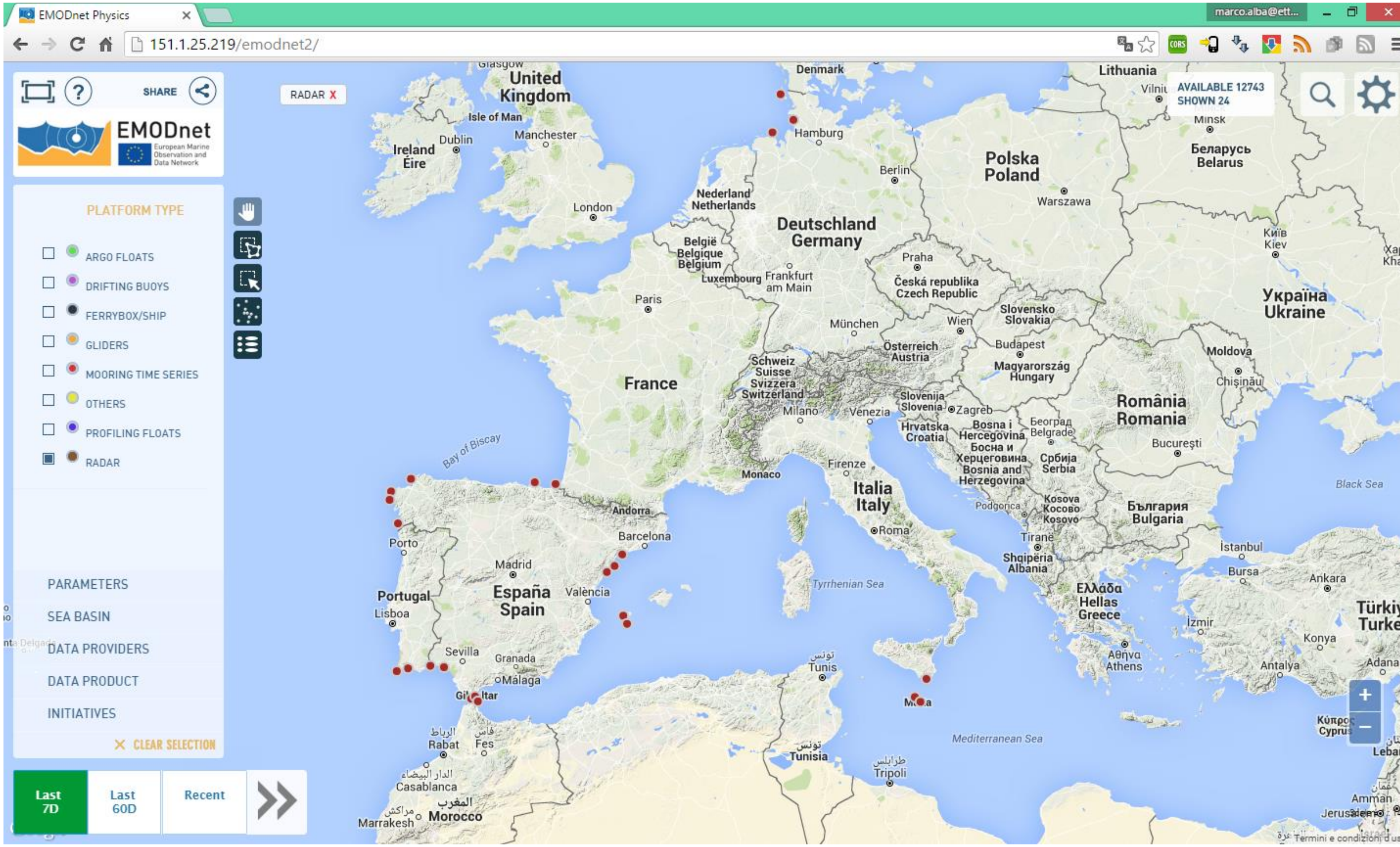
”Initiate a coordinated approach to HF radar data in Europe”

With EuroGOOS …

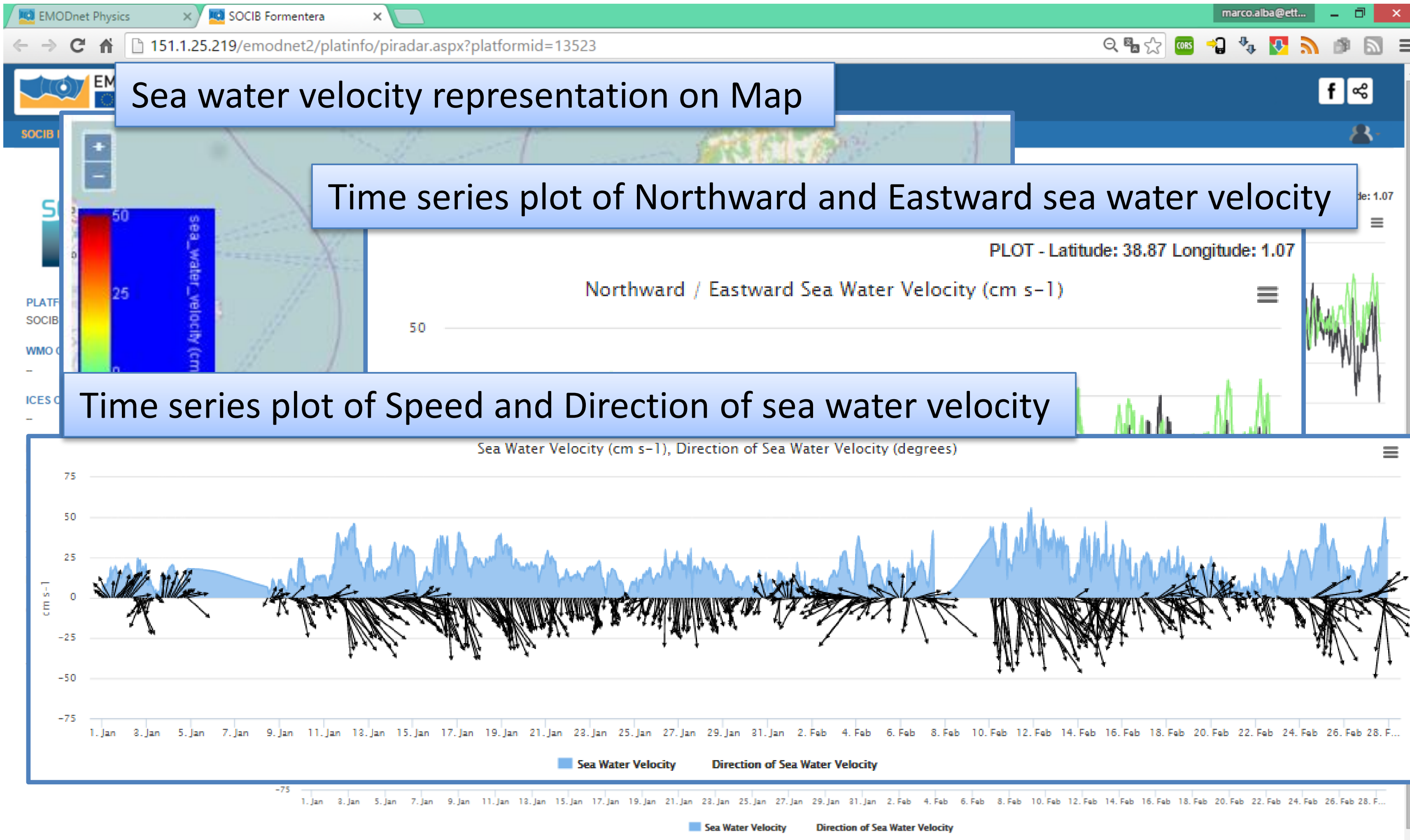
- *yO Annual Meeting in*

- *we started a pilot action to proof the concept/method*
  AZTI, INTECMAR, and CNR
- *set up the scene for JERICO NEXT with the group (here we are!)*
- *EMODnet Phase III is in the pre-tendering*
  - *we know HFRadar topic is in!*

EMODnet Physics



EMODnet Physics



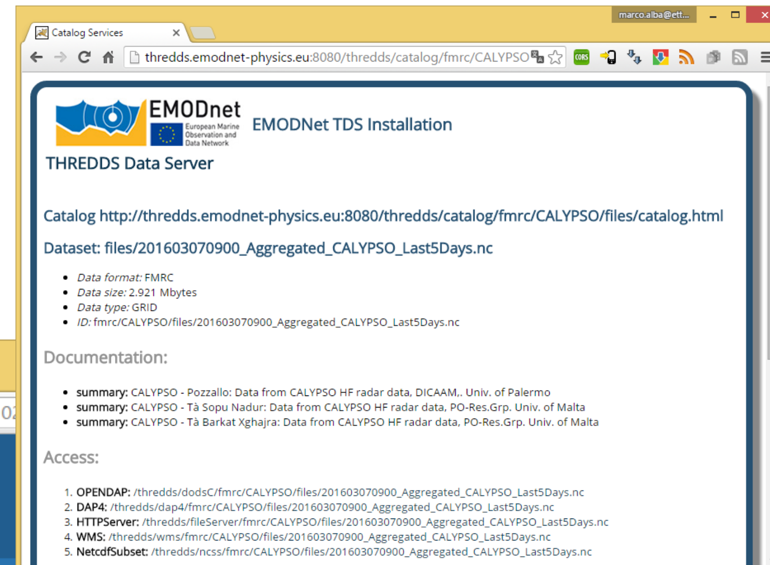
Backoffice infrastructure

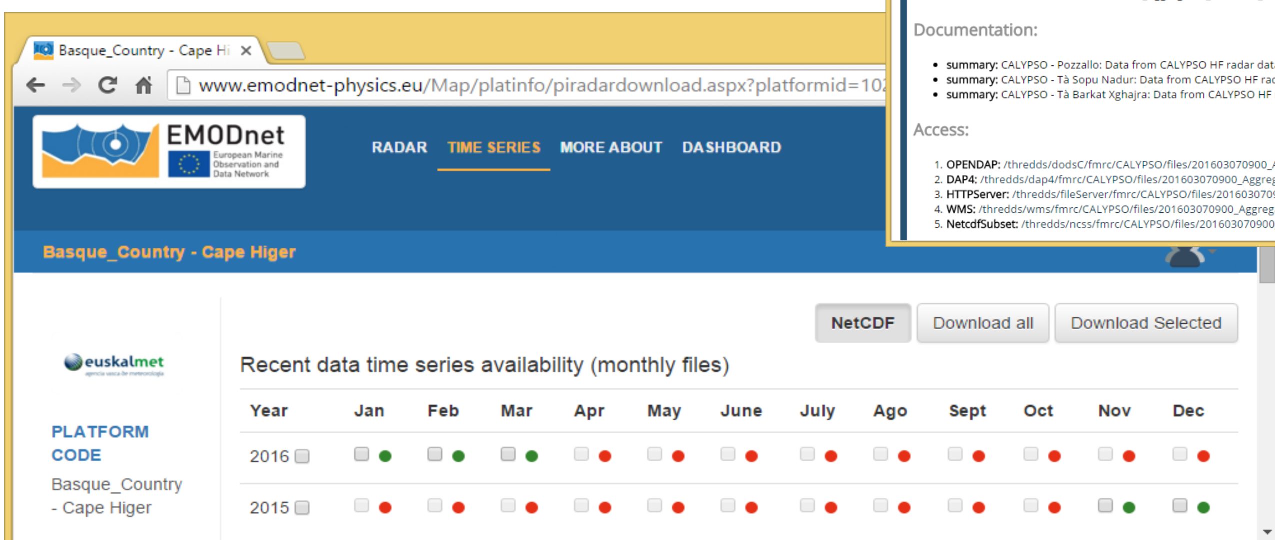
NetCDF files stored in a THREDDS server:

1. WMS
2. NetcdfSubset
3. OPENDAP
4. HTTP download of single NetCDF file

Other services:

1. HTTP download of zip files





Problems…

1. NON standard data format:
   - Variable name
   - Units

Example: **eastward_velocity(m s-1):**
- BASQUE: **eastward_velocity (m s-1)**
- CALYPSO: **water_u (m s-1)**
- PUERTOS: **u (m s-1)**
- SOCIB: **U_ORG (cm s-1)**

2. NON standard time coverage of NetCDF File:
   2. Hourly
   3. Daily
   4. Monthly

We need to scan the full file to find the standard name and link it to the variable name

3. NON standard data time step:
   - 1 hour time step
   - 20 minutes time step (COSYNA)

4. NON standard filename for NetCDF file

5. NON standard metadata in NetCDF file

Let's make some steps…

Definition of a COMMON STANDARD:

1. **Data format**

   variable name and units from **CF Standard Name Table** :
   - eastward_sea_water_velocity (m s -1)
   - northward_sea_water_velocity (m s -1)
   - sea_water_speed (m s -1) *OPTIONAL*[1]
   - direction_of_sea_water_velocity (degree) *OPTIONAL*[1]

(http://cfconventions.org/Data/cf-standard-names/30/build/cf-standard-name-table.html)

2. **NetCDF file time coverage**

   use e.g. a daily time coverage for NetCDF file

3. **Data time step**

   all NetCDF file using the same time step, starting at the same hour (i.e. 1 hour time step starting at 00.00)

[1] computed run time

4. **NetCDF filename**

use a standard file name coding like
<RR_HFR_Code_TimeStep_YYYYMMDD.nc>
Example:
IR_HRF_Basque_Hourly _20160307.nc

- RR: region bigram
- Code: platform code
- TimeStep: time step of data
- YYYYMMDD: year month day of data

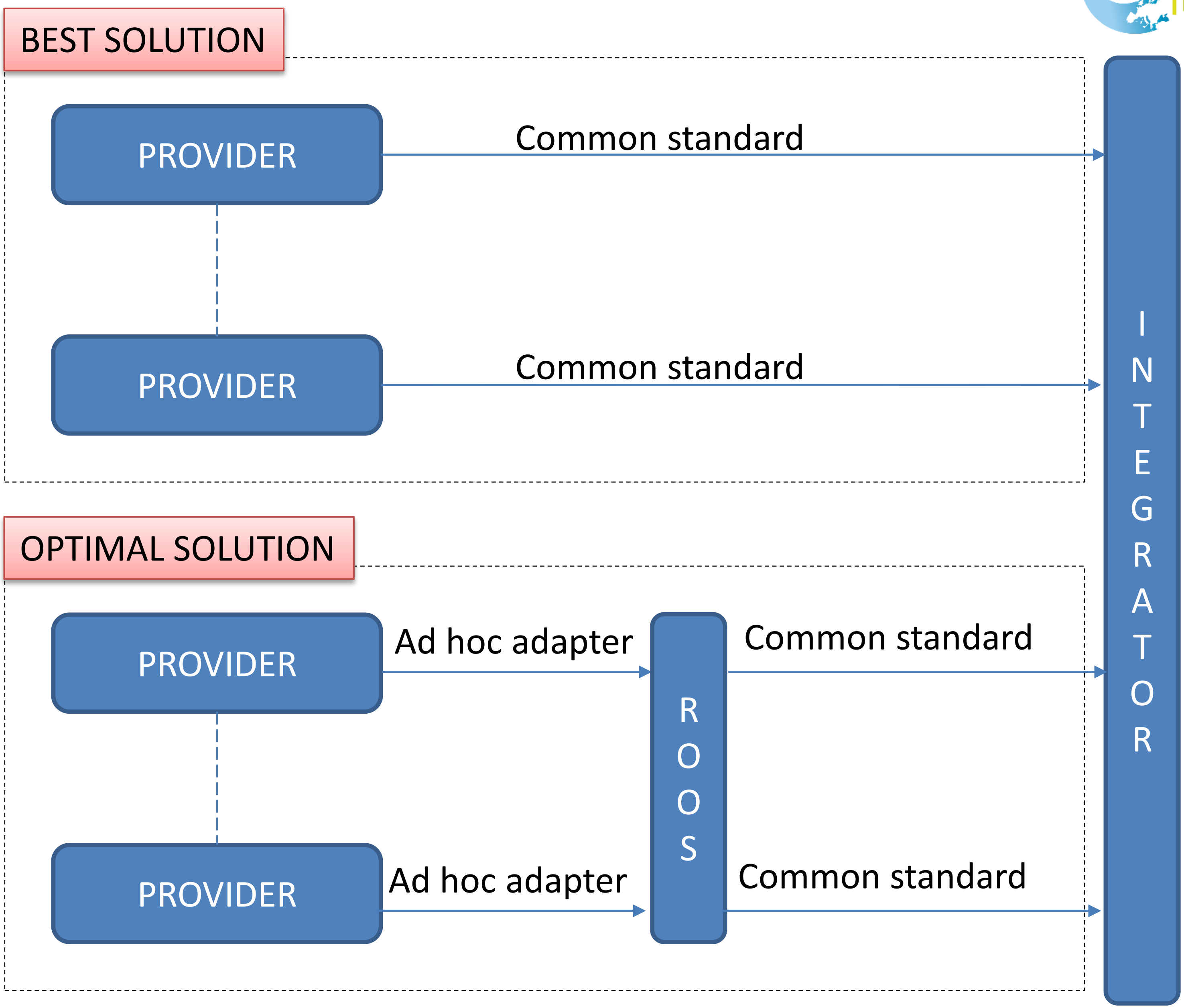
5. **NetCDF Metadata**

use a minimum set of common metadata fields

- acknowledgement
- creator
- creator_email
- description
- institution
- institution_references
- license

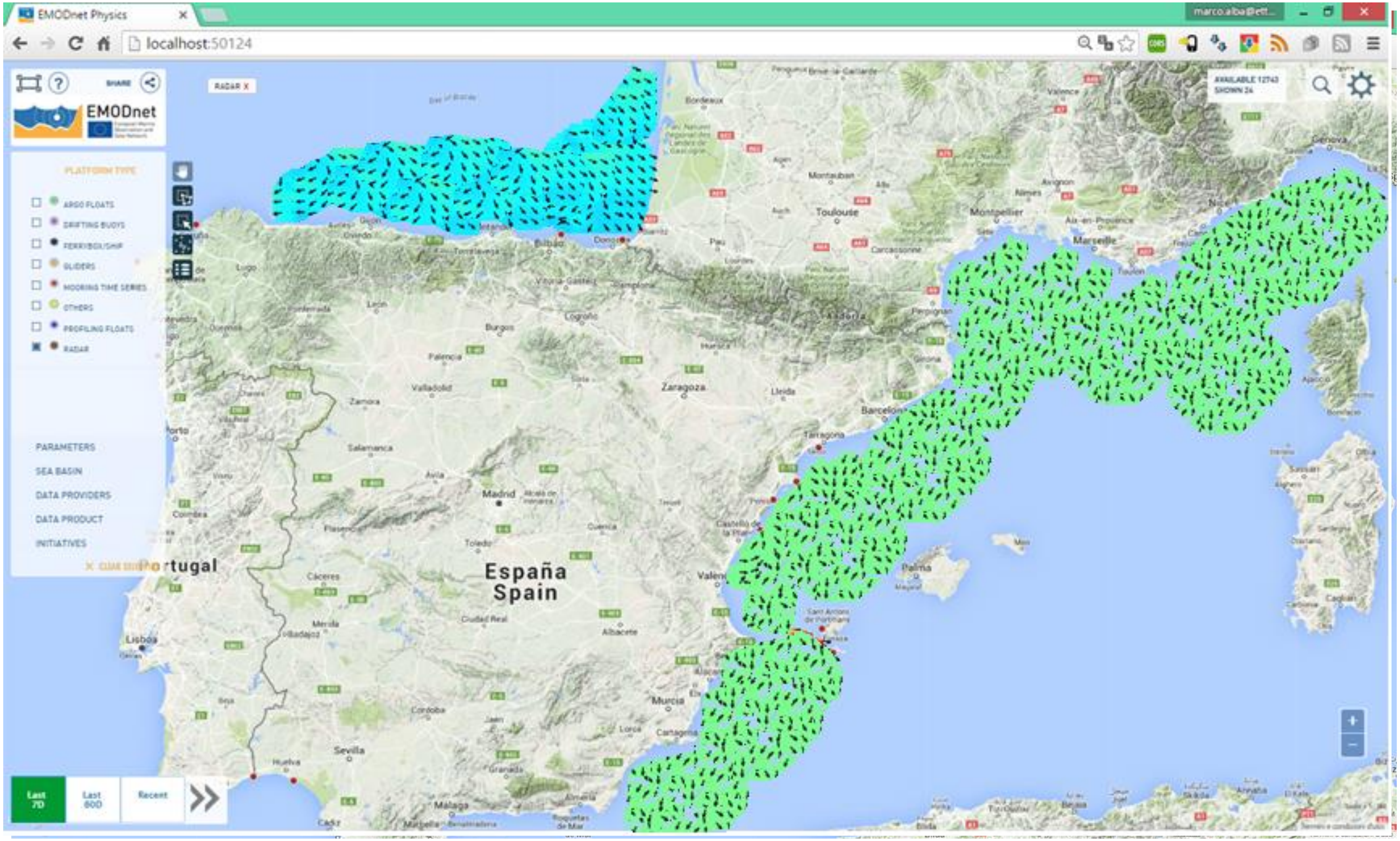
<u>Example from Basque NetCDF file</u>

acknowledgement: These data have been generated …
creator: Yolanda Sagarminaga; Anna Rubio
creator_mail: ysagarminaga@azti.es, arubio@azti.es
description: The data set consists of maps of …
institution: Euskalmet, Basque Government
institution_reference: http://www.euskalmet.euskadi.net/; http://www.azti.es
license: Currently data, products and services are provided "as is", without any warranty.

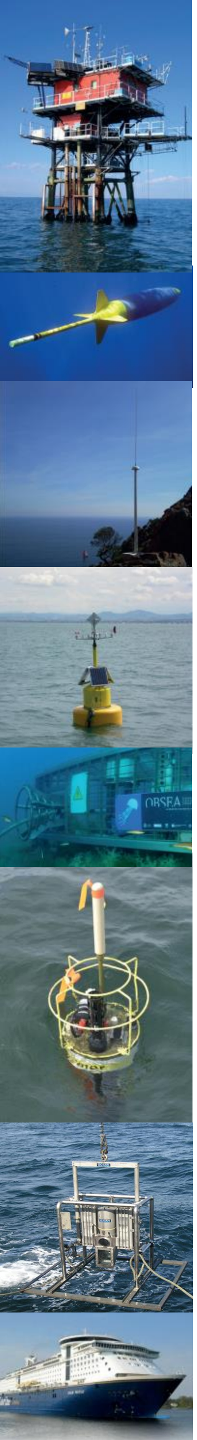


BEST SOLUTION
PROVIDER
Common standard
PROVIDER
Common standard
INTEGRATOR
OPTIMAL SOLUTION
PROVIDER
Ad hoc adapter
ROOS
Common standard
PROVIDER
Ad hoc adapter
Common standard

The goal …


EMODnet Physics
localhost:50124
EMODnet
PLATFORM TYPE
ARGO FLOATS
DRIFTING BUOYS
FERRYBOX/SHIP
GLIDERS
MOORING TIME SERIES
OTHERS
PROFILING FLOATS
RADAR
PARAMETERS
SEA BASIN
DATA PROVIDERS
DATA PRODUCT
INITIATIVES
Last 7D
Last 60D
Recent
España
Spain
Portugal
Madrid
Lisboa
Sevilla
Zaragoza
Barcelona
Toulouse
Marseille
Montpellier
Bilbao
Murcia
Valladolid
Palma
Málaga

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.



BASQUE HFR OPERATION & DATA MANAGEMENT

WP2: Harmonisation of technologies and methodologies: technical strategy (NA)

Task 2.3: Harmonizing new network systems: HF Radars

Presenter: Anna Rubio, Julien Mader arubio@azti.es

Contributor(s): AZTI team

JERICO-NEXT HF Radar workshop / San Sebastian / SPAIN / 9th – 11th March 2016

Presentation: azti tecnalia — Transforming Science into Business

1875 publications

13 Untransferred patents in force

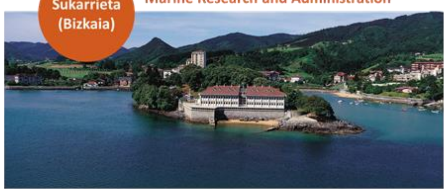
30 books

Pasaia (Gipuzkoa)

Marine Research Unit

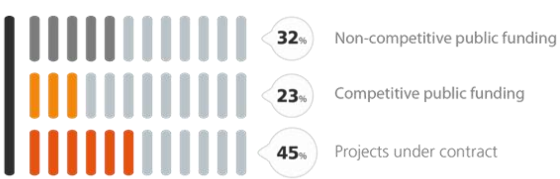
Sukarrieta (Bizkaia)

Marine Research and Administration



Food Research Unit

Derio (Bizkaia)



Marine Research

Food Research

400 clients

28,1M€ Invested in 2006-2015

17,1M€ Turnover annuel

1,2M€ Cash-flow 2015

29 FP7 UE projects

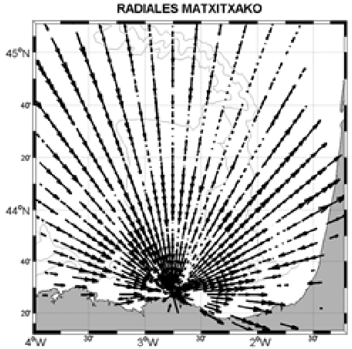
8 H2020 projects

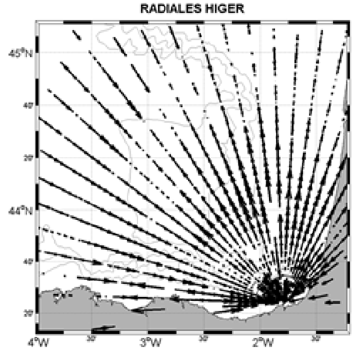
2 ERA-NET 2015 projects

Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

- System owned by the Meteorology and Emergency Department of the Basque Government (DAEM). Operated and maintained by DAEM and QUALITAS with the assistance of AZTI.
- TWO SEASONDE HFR STATIONS: Higer (~Donostia) and Matxitxako (~Bilbao)
- Central COMBINE STATION at Vitoria (Euskalmet)





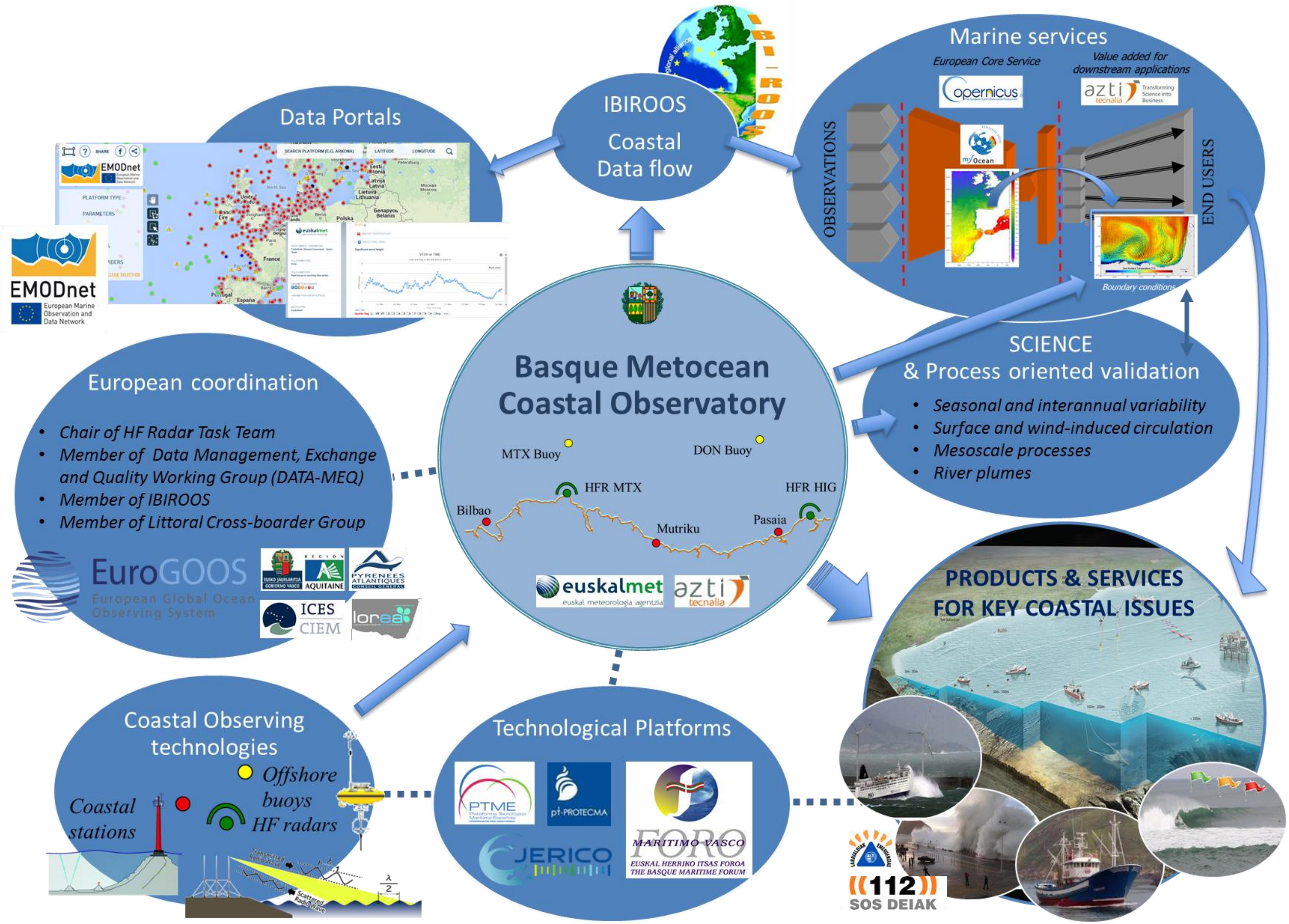
- Choice of the TECHNOLOGY strongly determined by the coast orography
- Practical choice for a turnkey system
- Choice of the frequency – higher offshore coverage
- Power and communications from light house and waste water plant)

MAIN CHARACTERISTICS of the BASQUE SYSTEM

Radar Frequency (MHz)	Radar Wavelength (m)	Ocean Wavelength (m)	Depth of Current[1] (m)	Typical Range[2] (km)	Typical Resolution[3] (km)	Typical Bandwidth (kHz)	Upper $H_{1/3}$ Limit[4] (m)
4.86	60	30	2-3	~150	~ 5	30	25

Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

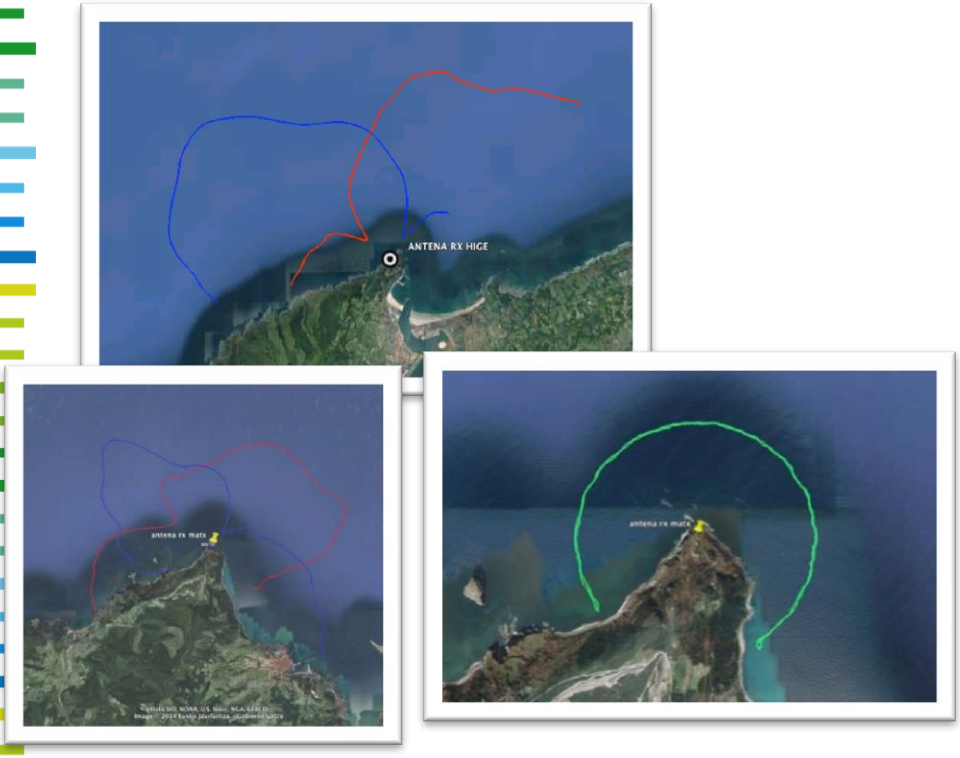


Task 2.3: Harmonizing new network systems: HF Radars

1. Issues during the installation phase

Task 2.3: Harmonizing new network systems: HF Radars

3. Site maintenance



APM campaigns (collaboration with AZTI)

21 JULY 2009

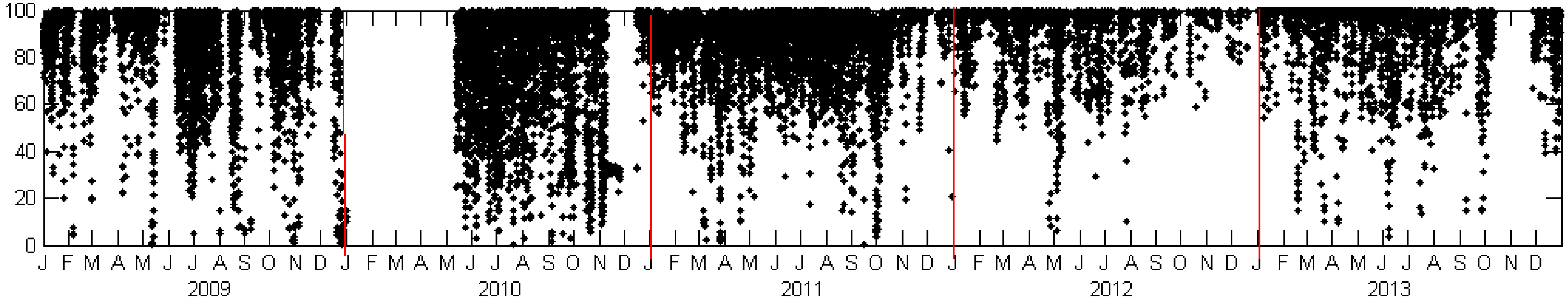
10 OCT 2011

30 SEPT 2014 (Only at MATXITXAKO)

5 JUNE 2015

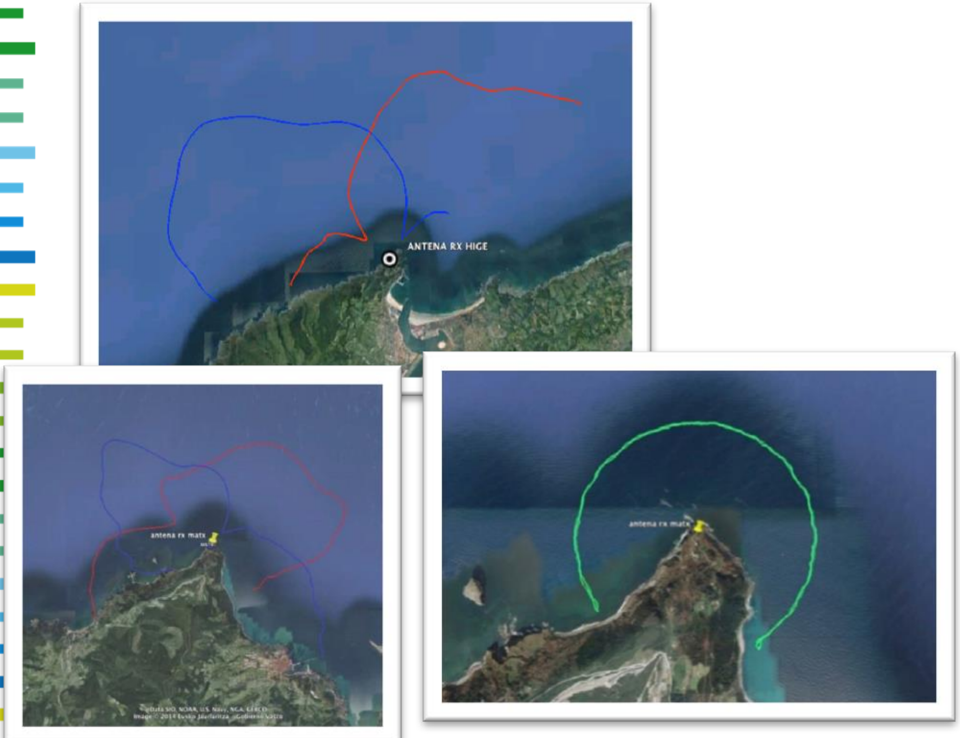
IN-SITU OPERATIONS: Miss-functioning of the antennae, hard disc capacity, electric power or transmission problems, bad weather conditions (2010)

REMOTE operations: periodic checking of the signal emitted/received signal, nts parameters, etc…



Task 2.3: Harmonizing new network systems: HF Radars

3. Site maintenance



Source: Macu Ferrer, QUALITAS

<u>APM campaigns</u> (collaboration with AZTI)

- **21 JULY 2009**
- **10 OCT 2011**
- **30 SEPT 2014 (Only at MATXITXAKO)**
- **5 JUNE 2015**

<u>IN-SITU OPERATIONS</u>: Miss-functioning of the antennae, hard disc capacity, electric power or transmission problems, bad weather conditions (2010)

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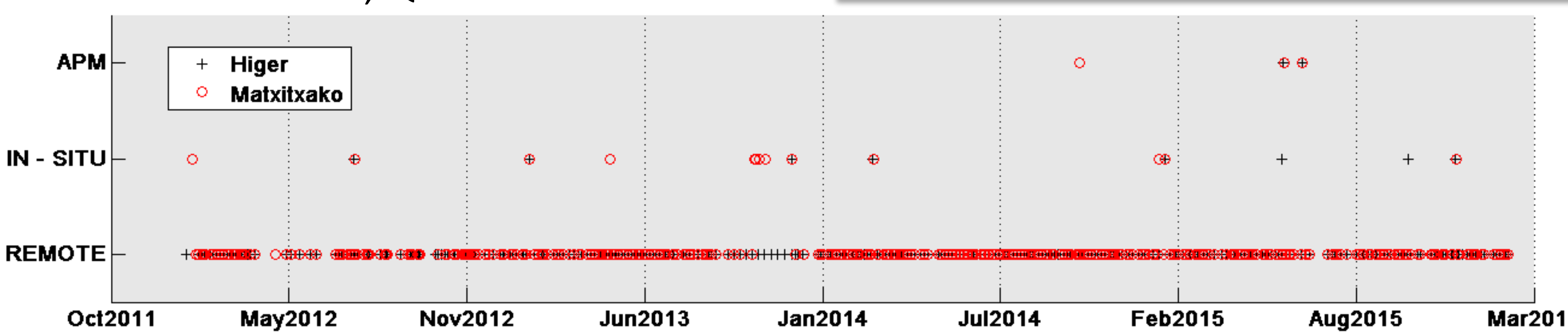
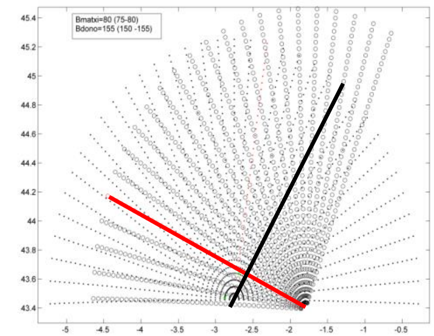


Task 2.3: Harmonizing new network systems: HF Radars

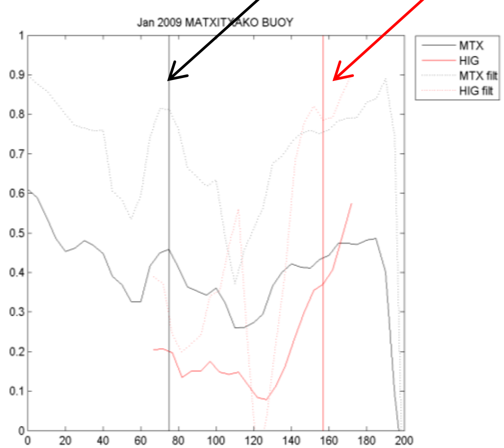
4. Quality assessment

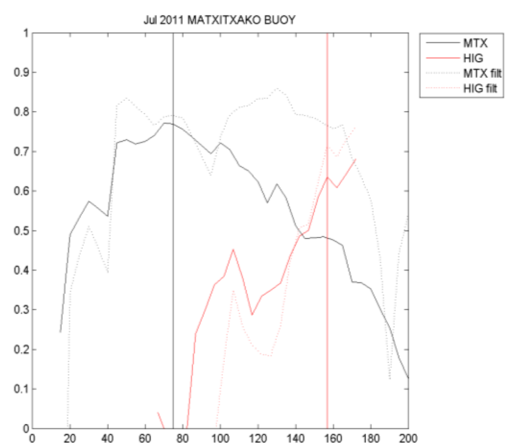
RADIALS R	BIMEP 11 m 2009 -2011		MATX 12 m 2009 -2011		HIGER 12 m 2009 -2011	
vs.	**NON FILT**	**FILT (48h)**	**NON FILT**	**FILT (48h)**	**NON FILT**	**FILT (48h)**
MATX SITE	**0,72**	**0,91**	**0,46**	**0.60**	**0,14**	**0,24**
HIGE SITE	**0,48**	**0,77**	**0,35**	**0.54**	**0,29**	**0,48**

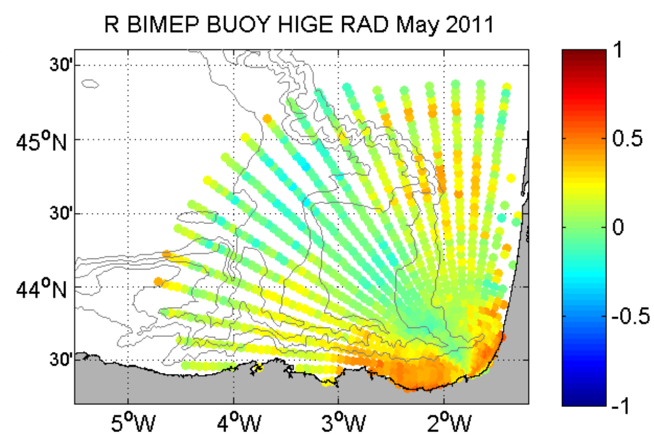


Bearing angle nearest MATXI RADIAL

Bearing angle nearest HIGE RADIAL

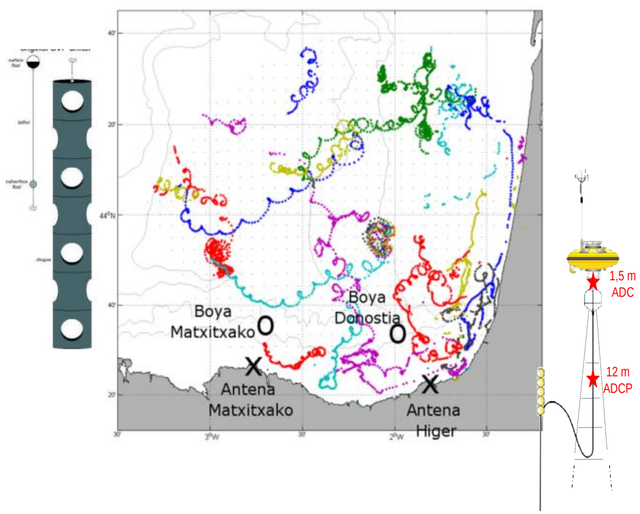






4. Quality assessment

Eulerian comparisons



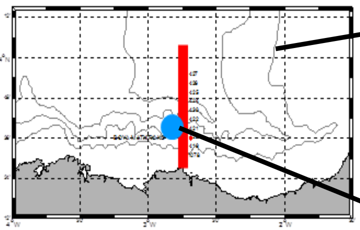
- RMS and R between HF radar and insitu data: slope buoys (from EUSKALMET) and drifters (Charria et al. 2013).

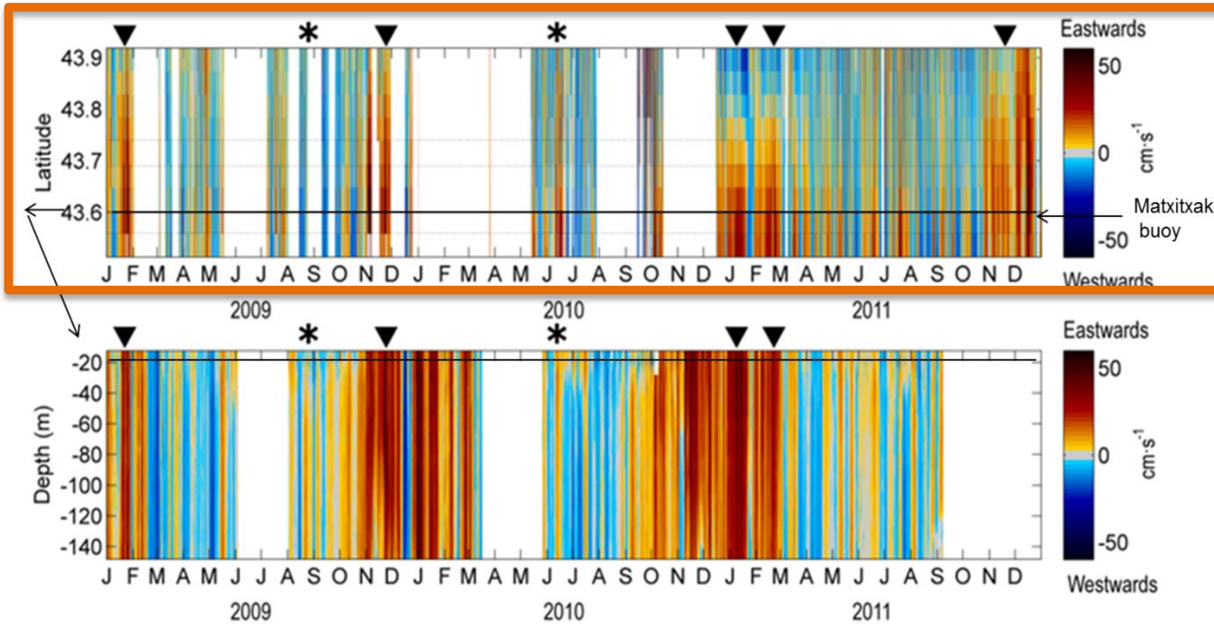
- RMS ~ 8-14cm/s depending on in-situ measurements depth, stratification conditions, current regime.

- *Rubio et al. 2011 GRL; Solabarrieta et al. 2013, CSR

In-Situ Data	Measurement depth (m)	Time period	RMS ($cm\ s^{-1}$) In-Situ data u	RMS In-Situ data v	RMS Radar node u	RMS Radar node v	Mean Speed In-Situ data u	Mean Speed In-Situ data v	Mean Speed Radar node u	Mean Speed Radar node V	Corr-u In-situ-Radar data	Corr-v In-situ-Radar data	RMSd-u ($cm\ s^{-1}$) In-situ-Radar data	RMSd-v ($cm\ s^{-1}$) In-situ-Radar data
Matxitxako	1.5	2009	16	10	13	8	-	-	-	-	0.86	0.64	8.09	8.12
Donostia	1.5	2009	12	11	11	12	-	-	-	-	0.53	0.34	10.38	12.88
Matxitxako	12	01-Jan-2009 /07-Sep-2011	13.88	8.20	14.3	9.21	5.30	-2.28	4.09	0.22	0.66	0.50	11.12	8.97
Donostia	12	01-Jan-2009 /15-Oct-2010	9.72	6.84	12.4	13.0	2.75	-0.01	3.84	4.20	0.49	0.27	10.95	13.09
Matxitxako	12	Well mixed months	20.03	8.98	18.5	8.69	13.3	2.05	11.1	0.62	0.67	0.46	12.38	9.46
Donostia	12	Well mixed months	13.23	7.79	14.7	16.4	5.84	1.03	6.06	9.27	0.59	0.20	11.49	16.41
Matxitxako	12	Stratified months	9.03	8.58	11.8	9.73	1.14	2.57	0.31	0.31	0.51	0.57	10.70	8.89
Donostia	12	Stratified months	8.77	6.76	11.9	11.6	1.67	0.28	2.66	2.51	0.44	0.32	11.07	11.52
Drifters	15	May-Sep-2009	13.99	13.6	13.7	13.8	-0.88	-0.33	-1.49	-1.14	0.42	0.46	14.85	14.30

4. Quality assessment –process oriented

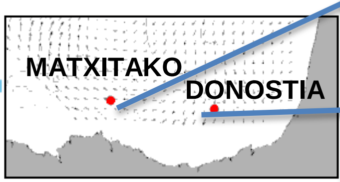


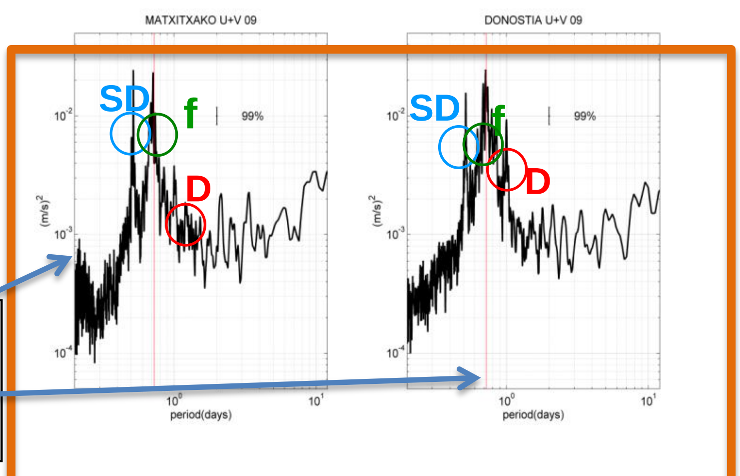


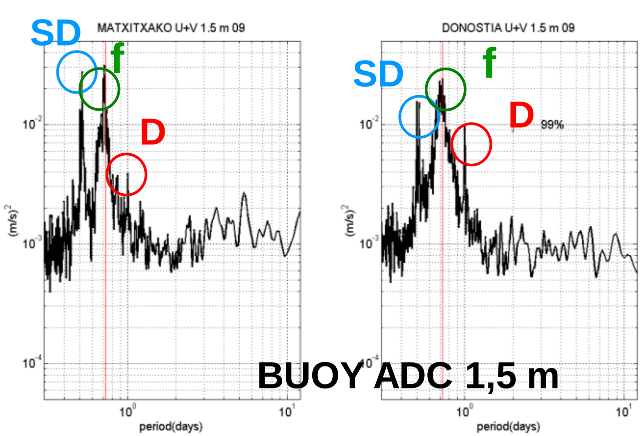
BUOY ADCP
15-200 m

MAIN LOCAL PEAKS

- **D**: diurnal
- **SD**: semidiurnal
- **f**: inertial



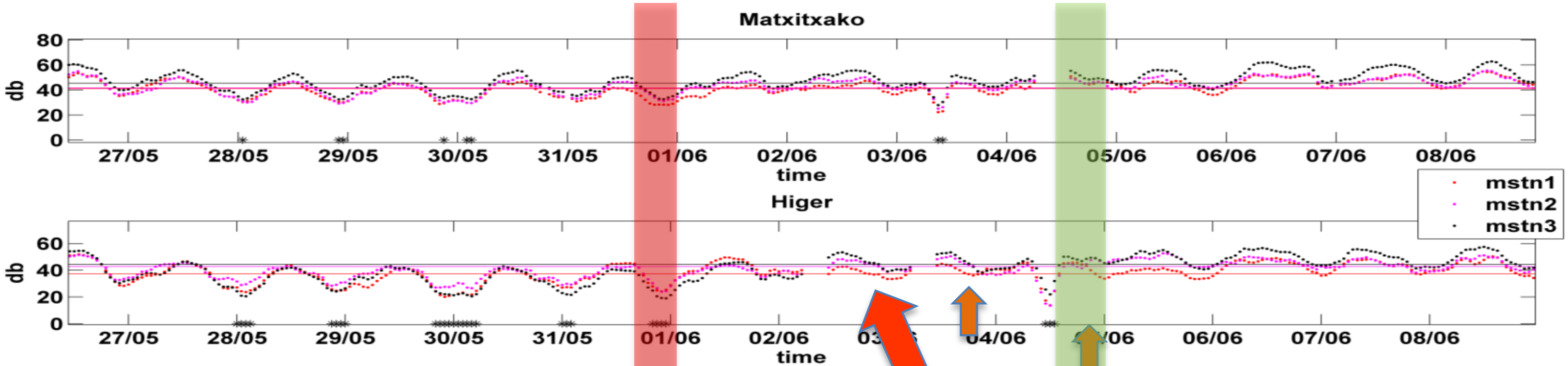




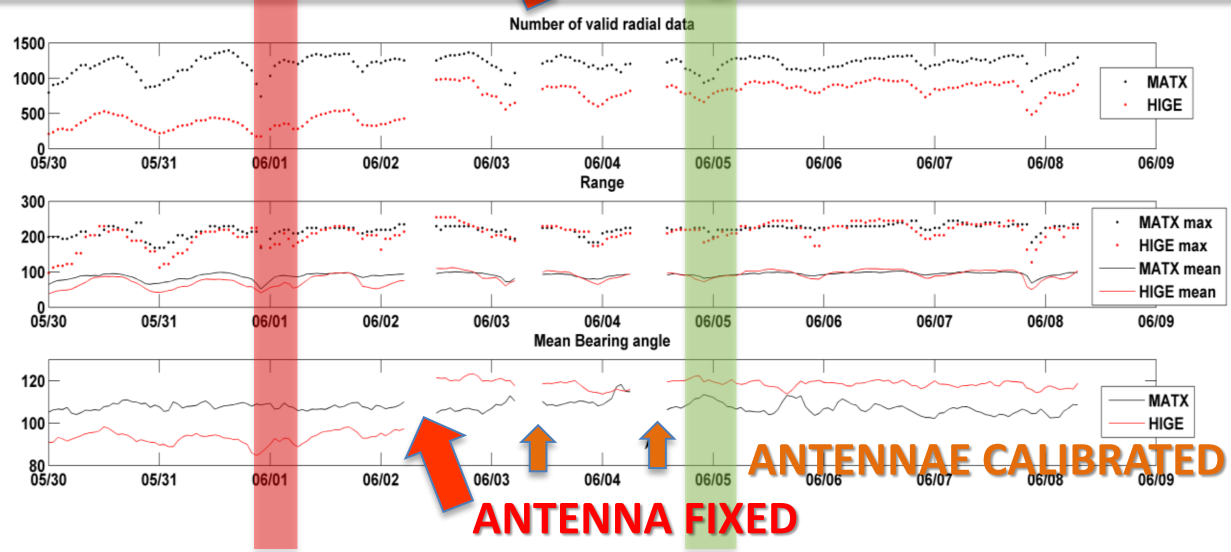
Task 2.3: Harmonizing new network systems: HF Radars

4. Quality assessment –towards operational indices

SPECTA



RADIALS

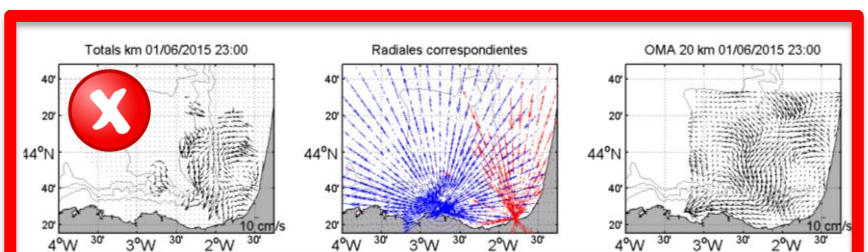


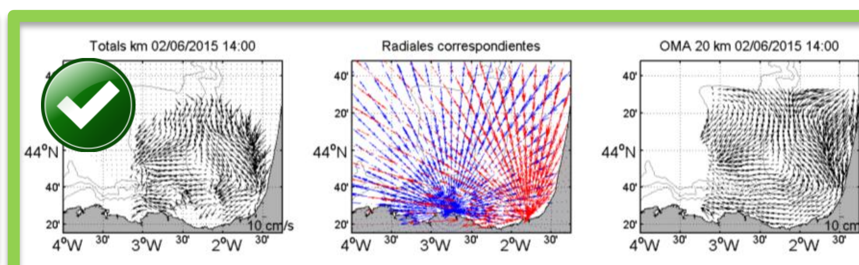
EXAMPLE of 3 LEVEL QA/QC procedure

1) Signal 2 noise ratios
2) Radial coverage
3) Total field coherence

All parameters contained in hourly total fields

TOTALS





Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

Vitoria COMBINE STATION- Euskalmet (waves, radials & totals)

OPERATIONAL

Hard disc

FTP

At AZTI vía ftp (radials and totals)

CODAR Software processing (operational QA/QC)

Converted to NETCDF (CDF-1) – EMODNET STANDARD

Published (last 5 days) at AZTI thredds :

(http://oceandata.azti.es/thredds/RADAR_OO.html)

HISTORICAL

Every 3 months data are updated (spectra, waves radials and totals)

Historical CURRENT data reprocessed for research applications using HFR Progs. (different processing, OMA)

(https://cencalarchive.org/~cocmpmb/COCMP-wiki/index.php/Main_Page)

Task 2.3: Harmonizing new network systems: HF Radars

5. Data management

oceandata.azti.es/thredds/RADAR_OO.html?dataset=/RADAR/HFRadar_BasqueCountry_6km_hourly.nc

Aplicaciones | Chrome | THREDDS | https://www.azti.es/... | INTRANET 2.0 .:. Ko...

NETCDF DATA STANDARIZATION (EMODNET):
- Metadata
- Thredds cahtalog structure
- Netcdf :variables & atributes

Catalog http://oceandata.azti.es/thredds/RADAR_OO.html

Dataset: RADAR Data/HFRadar_BasqueCountry_6km_hourly.nc

- *Data type:* GRID
- *Naming Authority:* Euskalmet, Basque Government
- *ID:* /RADAR/HFRadar_BasqueCountry_6km_hourly.nc

Documentation:

- **Summary:** Surface ocean velocities estimated from HF-Radar are representative of the upper 0.3 - 2.5 meters of the ocean. The main objective of the near-real time processing is to produce the best product from available data at the time of processing. Radial velocity measurements are obtained from the individual radar sites of the Basque Country HF-Radar Network. Hourly radial data are processed by unweighted least-squares on a 5km resolution grid of the Basque Country Coast to produce near real-time surface currents maps.
- **Rights:** These data may contain inaccuracies or errors, thus we decline every responsibility for their use. These data have been generated from the Basque Country in-situ Operational Oceanography observational network; Their use have to be informed at resp-meteo@ej-gv.es and appropriate acknowledgment to Euskalmet, Basque Governement, given in any publications arising therefrom

Access:

1. **OPENDAP:** /thredds/dodsC/RADAR/HFRadar_BasqueCountry_6km_hourly.nc
2. **HTTPServer:** /thredds/fileServer/RADAR/HFRadar_BasqueCountry_6km_hourly.nc
3. **WCS:** /thredds/wcs/RADAR/HFRadar_BasqueCountry_6km_hourly.nc
4. **WMS:** /thredds/wms/RADAR/HFRadar_BasqueCountry_6km_hourly.nc
5. **NetcdfSubset:** /thredds/ncss/grid/RADAR/HFRadar_BasqueCountry_6km_hourly.nc
6. **ISO:** /thredds/iso/RADAR/HFRadar_BasqueCountry_6km_hourly.nc

Keywords:

- HF Radar, Basque Country,SPAIN,Cantabrian coast,surface sea water velocity, near-real time

Creators:

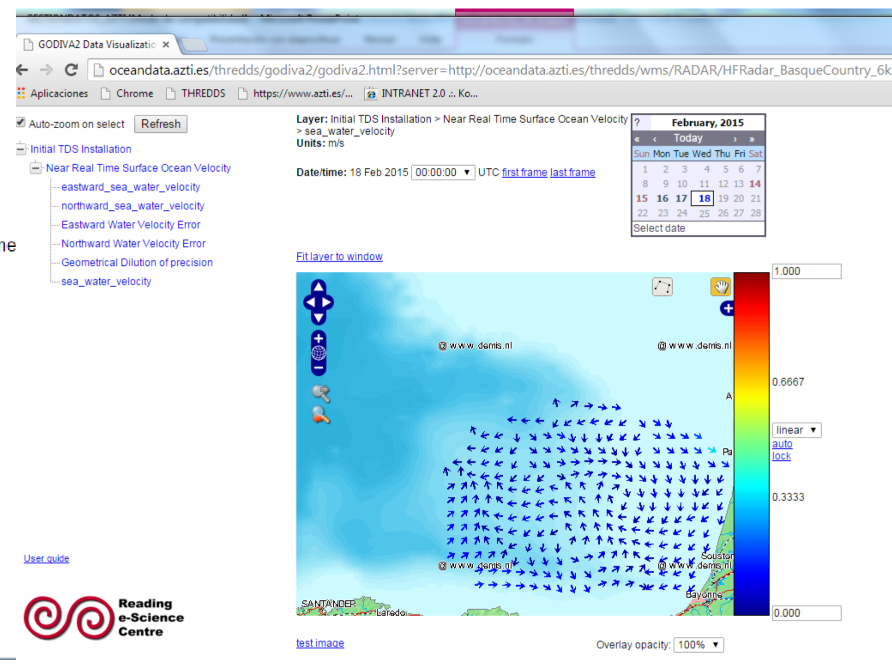
- **Euskalmet, Basque Government,AZTI**
  - *email:* arubio@azti.es
  - *http://www.euskalmet.euskadi.net/,http://www.azti.es/*

Publishers:

- **Euskalmet, Basque Government, AZTI**
  - *email:* ysagarminaga@azti.es
  - *http://www.euskalmet.euskadi.net/,http://www.azti.es/*

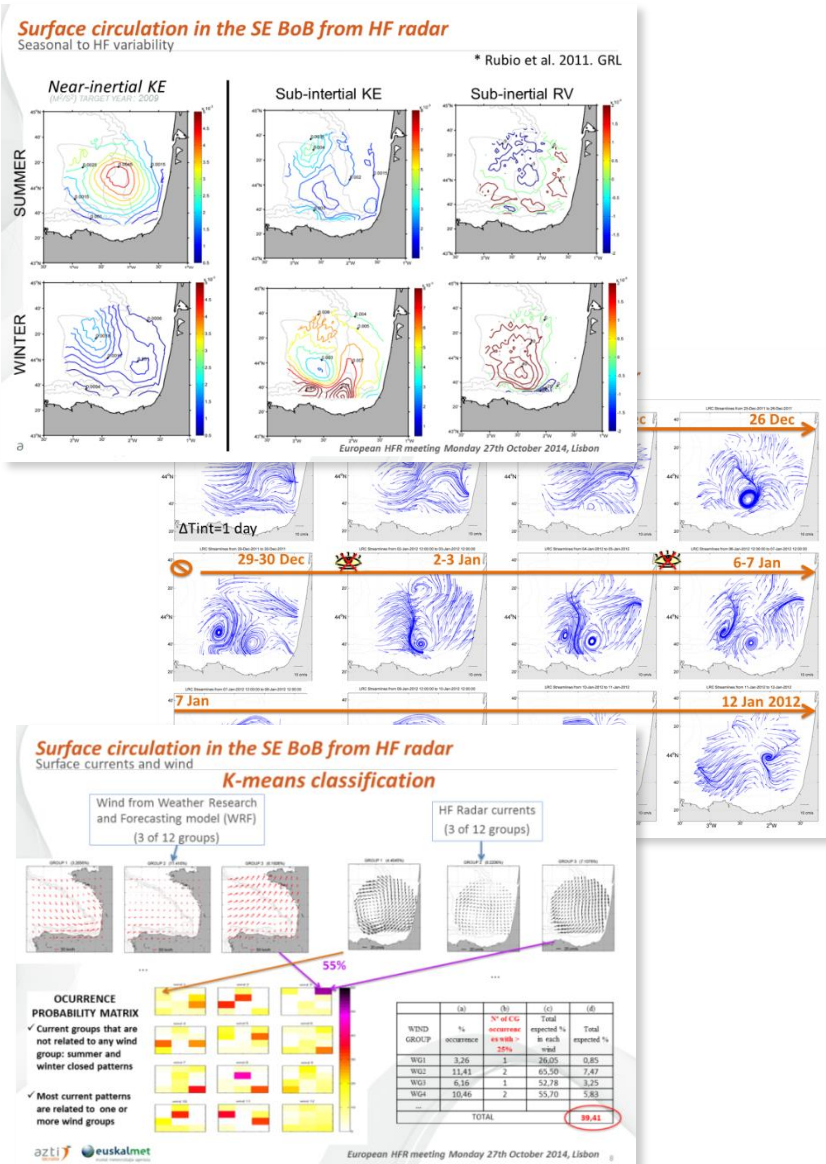
GeospatialCoverage:

- *Longitude:* -4.0 to -5.3 degrees_east
- *Latitude:* 45.4 to 88.9 degrees_north



Task 2.3: Harmonizing new network systems: HF Radars

6. Applications



<u>PUBLICATIONS:</u>

- Mapping near-inertial variability in the SE Bay of Biscay from HF radar data and two offshore moored buoys. Rubio et al., Geophys. Res. Lett., 38, L19607, doi:10.1029/2011GL048783. (2011)
- Surface circulation and transport in the SE BoB from HF radar Rubio et al. OCEANS 13 MTS/IEEE Bergen, June 2013
- Surface water circulation patterns in the south-eastern Bay of Biscay: new evidences from HFR data.Solabarrieta, et al. CSR, 2014, 74, 60-76
- FISHING LITTER EFFICIENTLY: IS IT VIABLE? Basurko et al. *Marine Policy*
- Surface water circulation and wind interaction using k-means classification in the SE Bay of Biscay. L. Solabarrieta et al. Ocean dynamics

<u>PHD THESIS (JULY</u> 2015): L. Solabarrieta: **"Study of the Surface Ocean Dynamics in the Bay of Biscay, Using HF Radar Technology"**

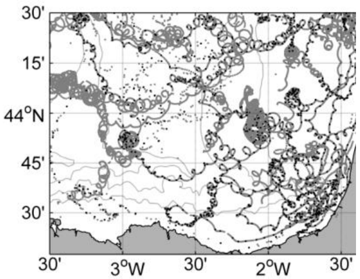
<u>FUNDING ACTIVITIES on HF radar:</u>

Iñaki Goenaga TCF oundation; Basque Government ITSASEUS , EMODIS, PREVIM projects; PN: ESTIBB 2009 y **MESOANCHOA 2014** ; French EPIGRAM and **ENIGME** projects; EU: LOREA , **JERICO_NEXT**

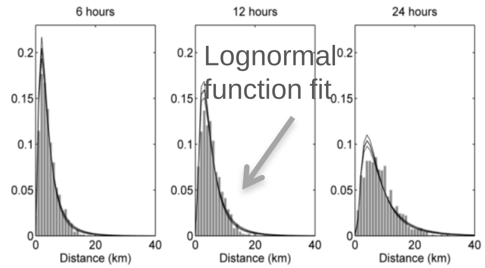
6. Applications

LAGRANGIAN PARTICLE-TRACKING MODEL

(every 5 h at the position of the real drifters and advected 48 h).



Drifters (Charria et al. 2013) May - Sep 2009 (gray) and starting points for simulations (black)

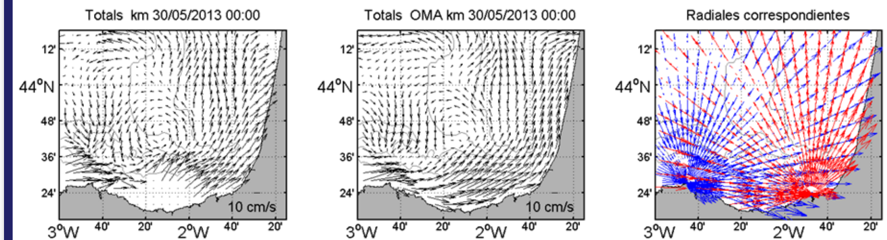


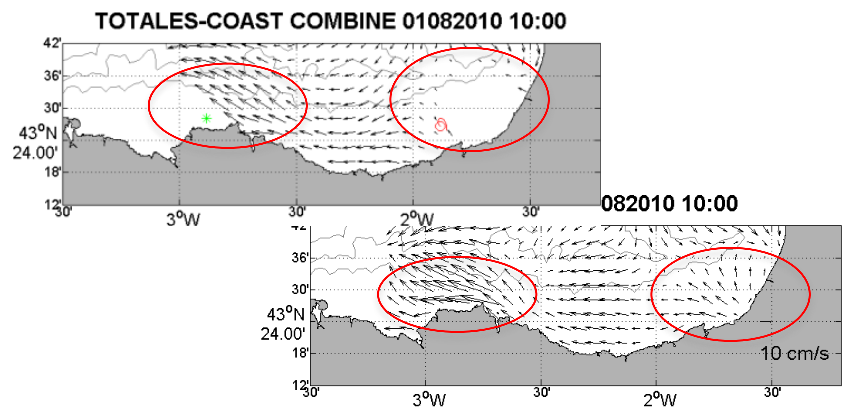
Probability density distributions of the distances between real and simulated trajectories

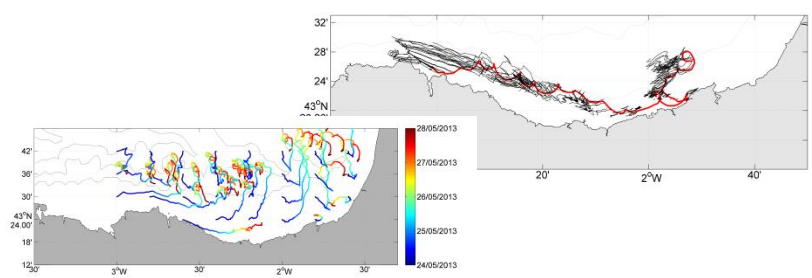
Statistical Parameters For The Log-normally Distributed Distances Between Real And Simulated Trajectories

Time (hours)	Main statistical parameters (in km)		
	Mode	*Mean*	*Standard deviation*
6	2.30 [2.30, 2.30]	4.61 [4.35, 4.89]	3.60 [3.24, 4.02]
12	3.07 [3.07, 3.07]	5.73 [5.42, 6.08]	4.38 [3.95, 4.89]
24	5.14 [5.14,5.14]	8.93 [8.43,9.48]	6.96 [6.25,7.79]

OMA CURRENTS – COASTAL COVERAGE







Short term prediction exercise in the SEBoB

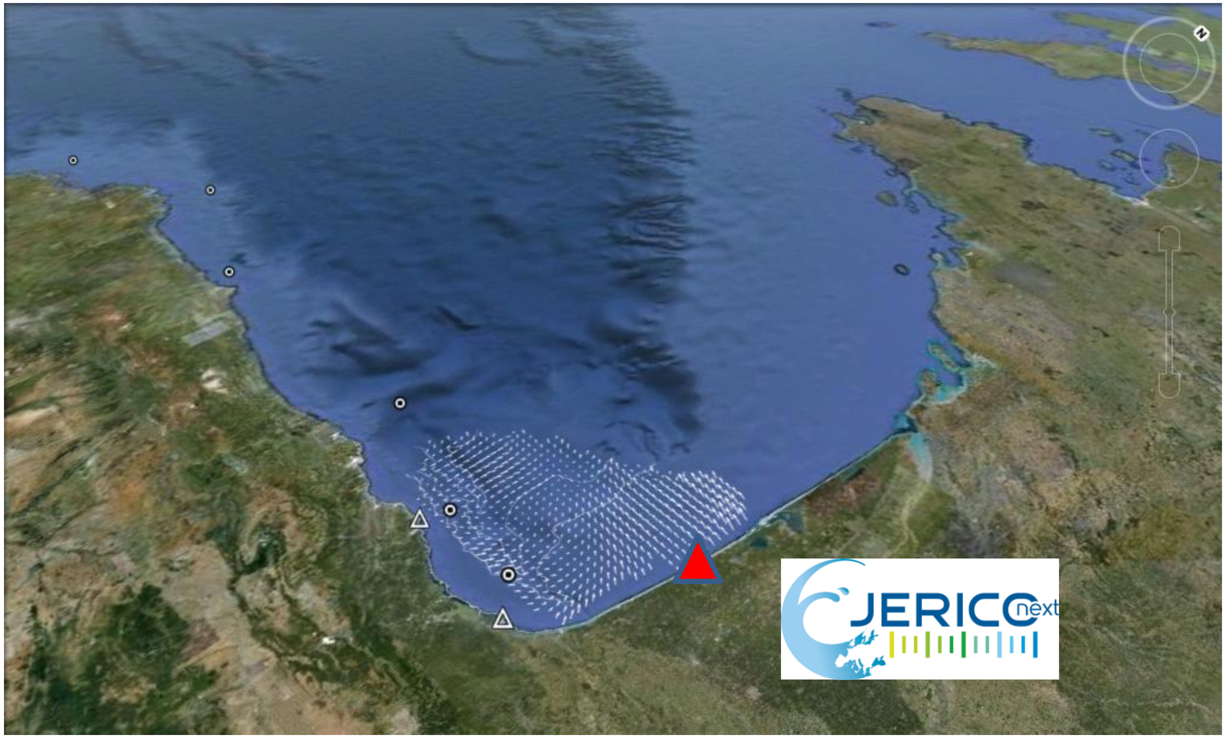
Skill assessment of HF radar–derived products for lagrangian simulations in the Bay of Biscay

L. Solabarrieta, S. Frolov, M. Cook, J. Paduan, A. Rubio, M. González, G. Charria, J. Mader· Submitted to JAOT

Task 2.3: Harmonizing new network systems: HF Radars

7. Other items

From 2009



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