Applications for Maritime Situational Awareness

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German Aerospace Center (DLR)

Earth Observation Center (EOC)
Maritime Security Lab Bremen | Neustrelitz

C-SIGMA VII
19-20 APRIL 2017

Presentation Outline

Introduction

- Earth Observation Center
- Ground Station Neustrelitz

Project Support

- Real Time Service for Maritime Security (**E**chtzeitdienste für die **M**aritime Sicherheit – **Sec**urity; EMSec)
- Optical Satellite Services for EMSA
- ANTARCTIC CIRCUMNAVIGATION EXPEDITION (ACE) - Swiss Polar Institute

German Aerospace Center, DLR

Germany's national research center for aeronautics, space, energy, transport & security.

Space Agency

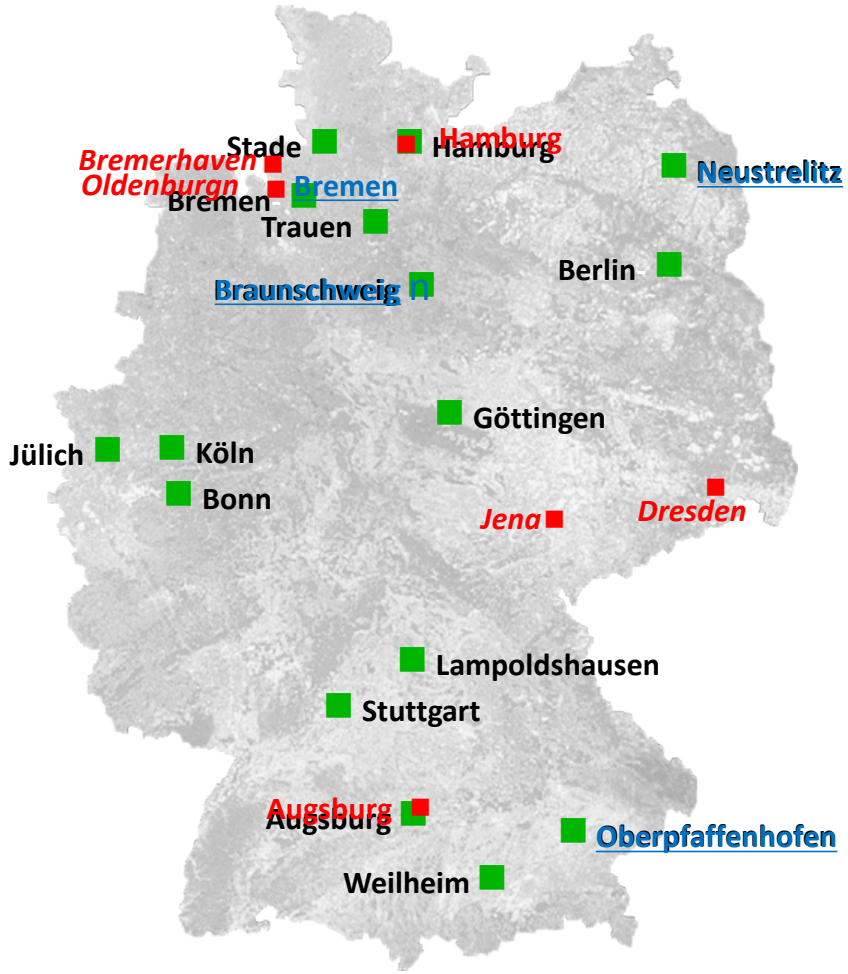
Project Management Agency

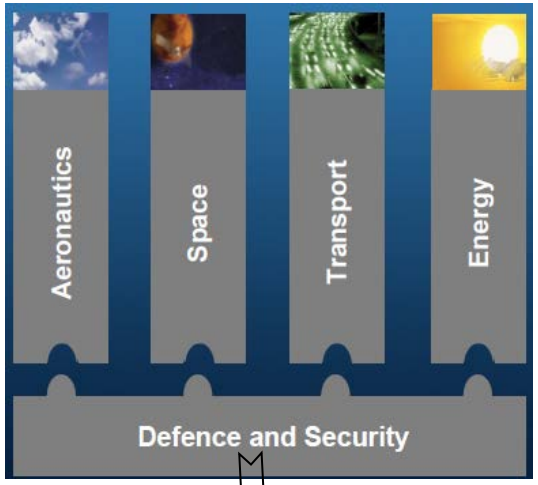
~ 8.000 Employees

39 Research Institutes and large test facilities at 20 Sites across Germany

3 Field stations in O'Higgins (AQ), Inuvik (CA) & Almería (ES)

outposts in Brussels, Paris, Washington DC, *Tokyo*





Maritime Safety and Security

Maritime Security_Lab's

- **Bremen**
- **Neustrelitz**
- **Braunschweig**
- **Oberpfaffenhofen**

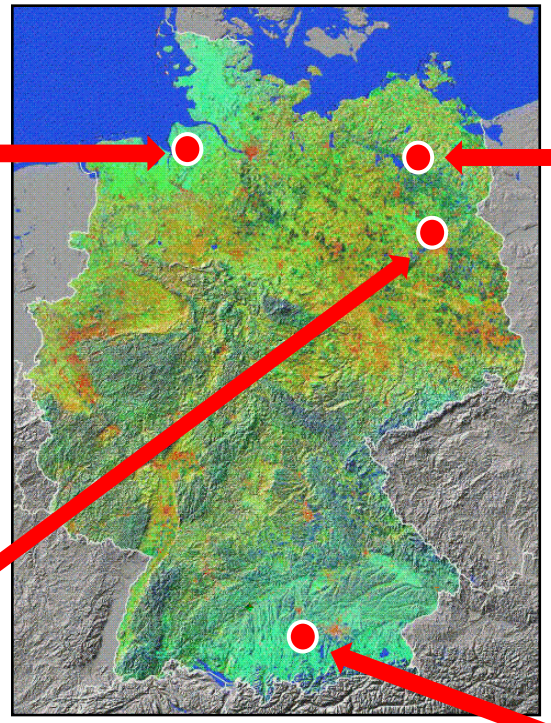
Earth Observation Center – EOC

2 Institutes

German Remote Sensing Data Center (DFD)

Remote Sensing Technology Institute (IMF)

Bremen
Maritime Security Lab



Neustrelitz
National Ground Segment
Maritime Security Lab

Berlin

- Appr. 350 empl. at 4 sites
- Chairs at 2 univercities

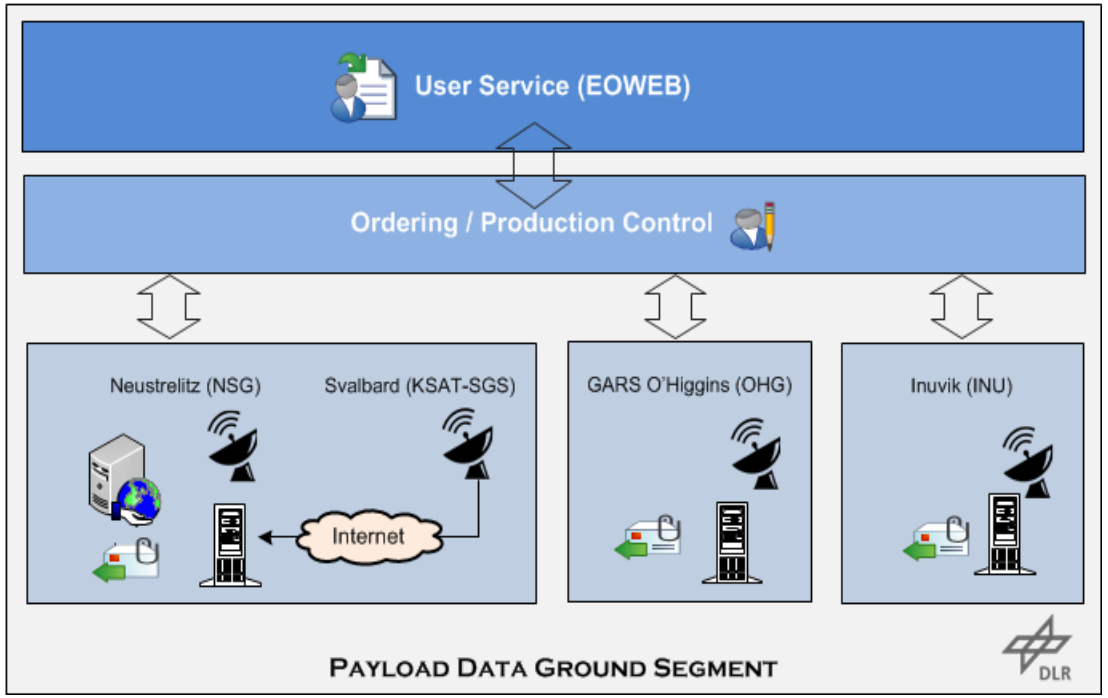
Oberpfaffenhofen

Neustrelitz Ground Station

- Ground Station and Processing Facility Neustrelitz support of currently 21 different Satellite missions
- Main reception and processing facility for SAR Mission TerraSAR-X (TerraSAR-X/ TanDEM-X)
- Collaborative Station for European Copernicus mission Sentinel-1 (Sentinel-1A/ Sentinel-1B)
- Radarsat-2 Regional Ground System
- Landsat-8 Global Network Station, United States Geological Survey (USGS)
- CartoSAT, ResourceSat, Oceansat supporting Gesellschaft für Angewandte Fernerkundung (GAFAG)
- Kompsat 3, 3A, 5 supporting Korea Aerospace Research Institute (KARI)

TerraSAR-X NRT System Capabilities

- Morning and evening timeline upload for a 12 h desirable / 12 h critical timeline with order deadline a few hours before
  - ➢ for data take at end of timeline: allow about 17 hours for tasking
  - ➢ based on satellite TSX **or** TDX acquisition
- **Product latency after downlink: about 10 – 15 minutes**
- No orbit information available in X-band downlink
  - ➢ usage of predicted orbit information only
- NRT ground station pool (Neustrelitz, Svalbard)
  - ➢ online raw data transfer to Neustrelitz
- Mission planning uses next possible pool contact for NRT downlink

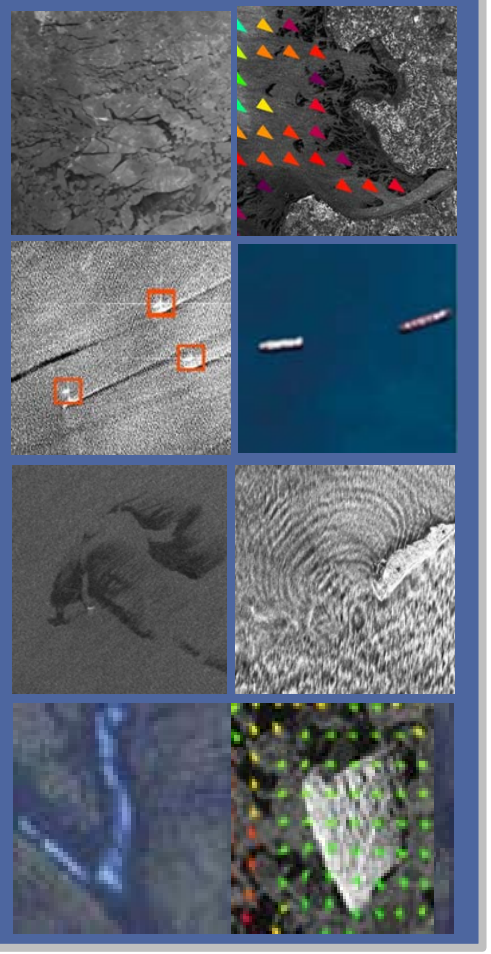


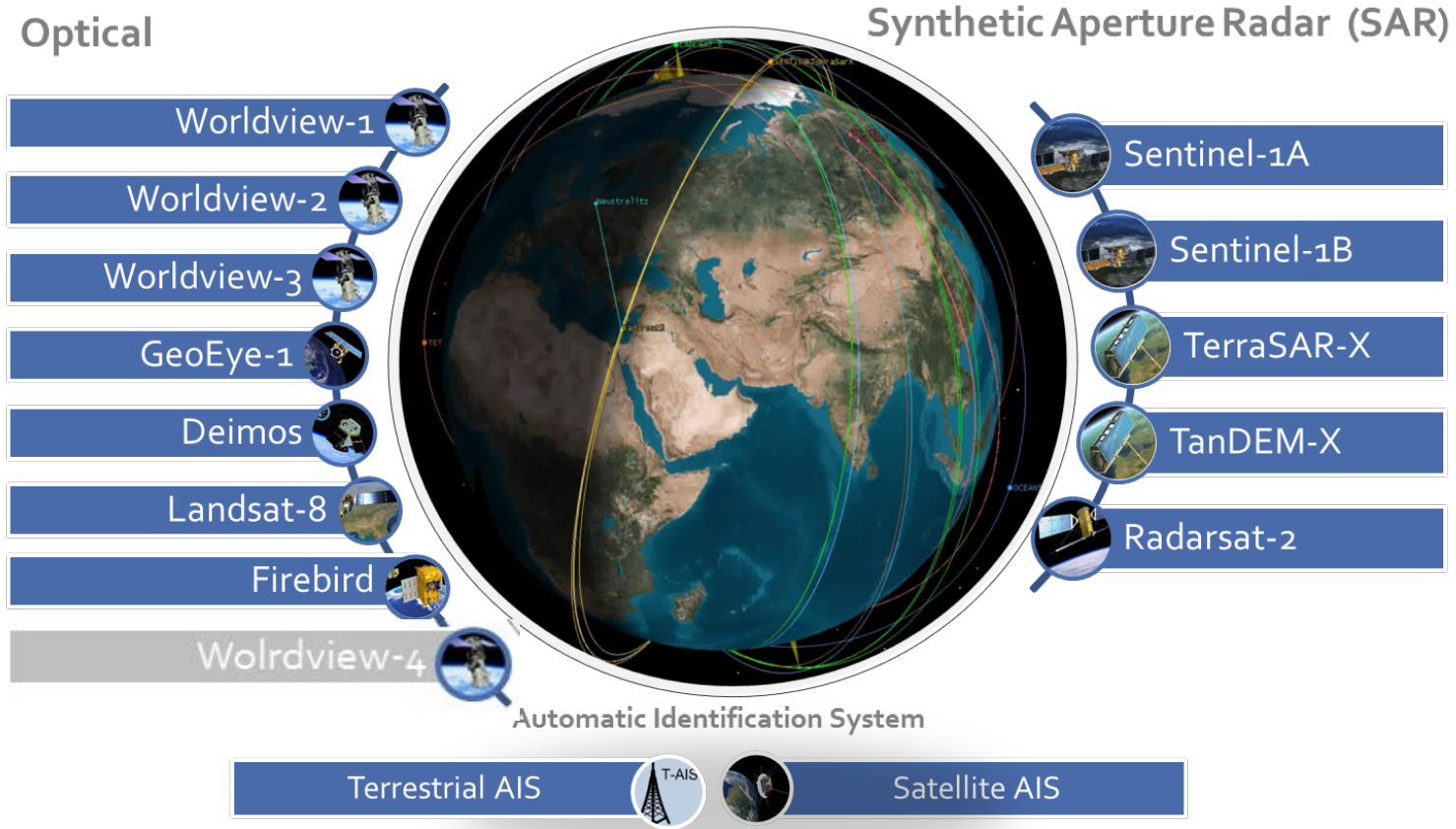
DLR TerraSAR-X Payload Data Ground Segment

Application for Maritime Domain Awareness

Application

Oil
Ship detection
Ship classification
Wind detection
Wave State
Ice Classification
Ice drift



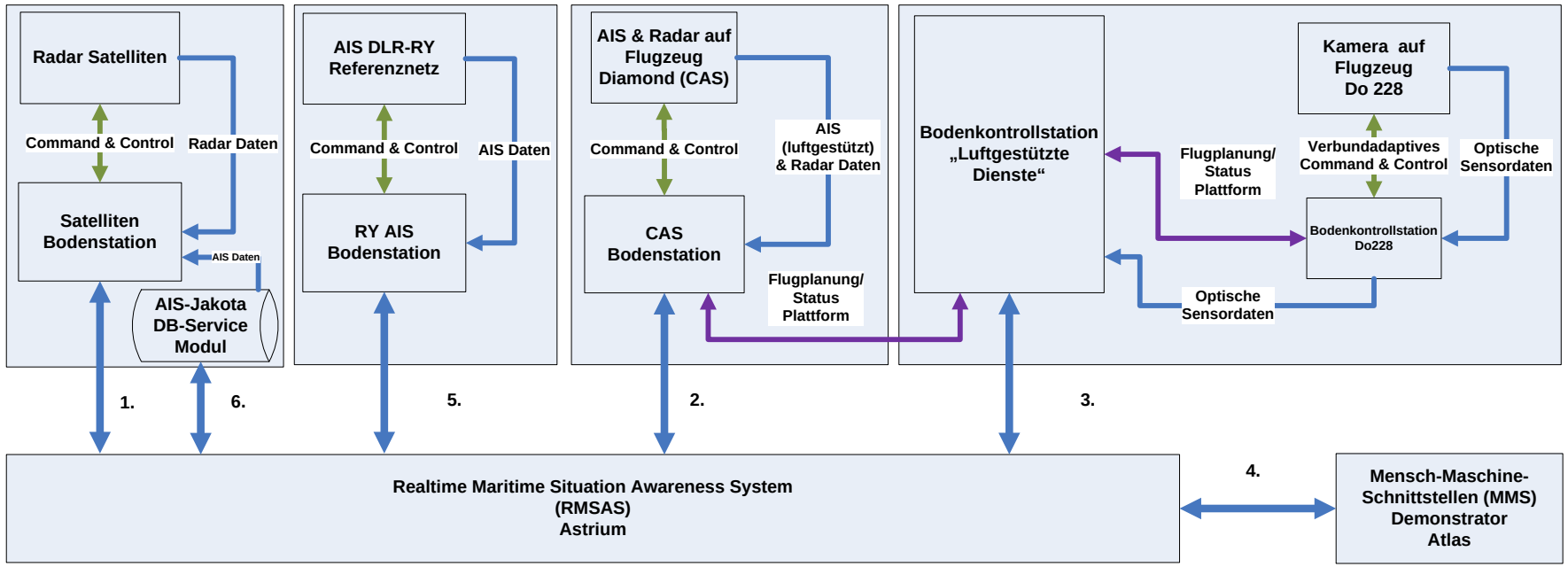


EMSec (Echtzeitdienste für die Maritime Sicherheit – Security; Real Time Service for Maritime Security)

Objectiv

Situational Awareness
- improve revisit time and near real time capabilities
- deliver SAR/ Optic derived target detection information
- deliver SAR derived wind and wave information
- improve data fusion methods and anomaly detection
- improve detection quality of hazardous materials and classification
- development of HMI interfaces

Navigation
- improve secure navigation
- protection of navigation systems (spoofing, jamming)



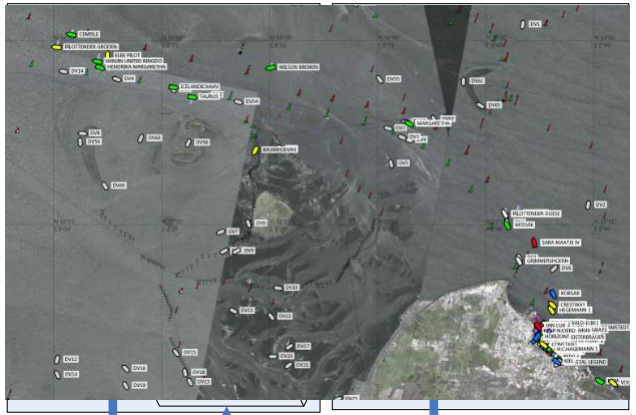
AIRBUS DEFENCE & SPACE · ATLAS ELEKTRONIK A joint company of ThyssenKrupp and EADS · Technisches Hilfswerk · Universität Rostock Traditio et Innovatio · DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft · VDI · Bundesministerium für Bildung und Forschung

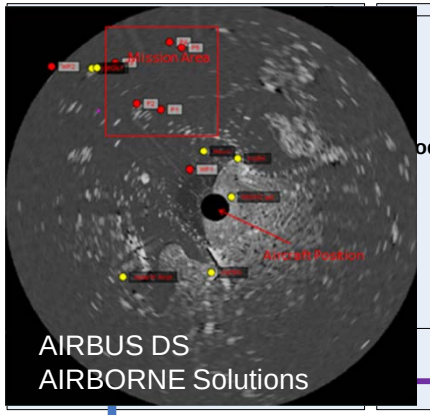
DLR

EMSec (Echtzeitdienste für die Maritime Sicherheit – Security; Real Time Service for Maritime Security)

Test Scenarios

- vessel monitoring and detection of anomaly behavior, simulation of hijacked ferry
- detection of people who have gone overboard based on AIS-Search And Rescue Transmitter (SART)
- observing pollution of hazardous substances
- jamming and spoofing – suppression of interference and decoy signals at sea





1. 6. 5. 2. 3.

Realtime Maritime Situational Awareness System (RMSAS)
AIRBUS DS

4.

Mensch-Maschine-Schnittstellen (MMS) Demonstrator Atlas

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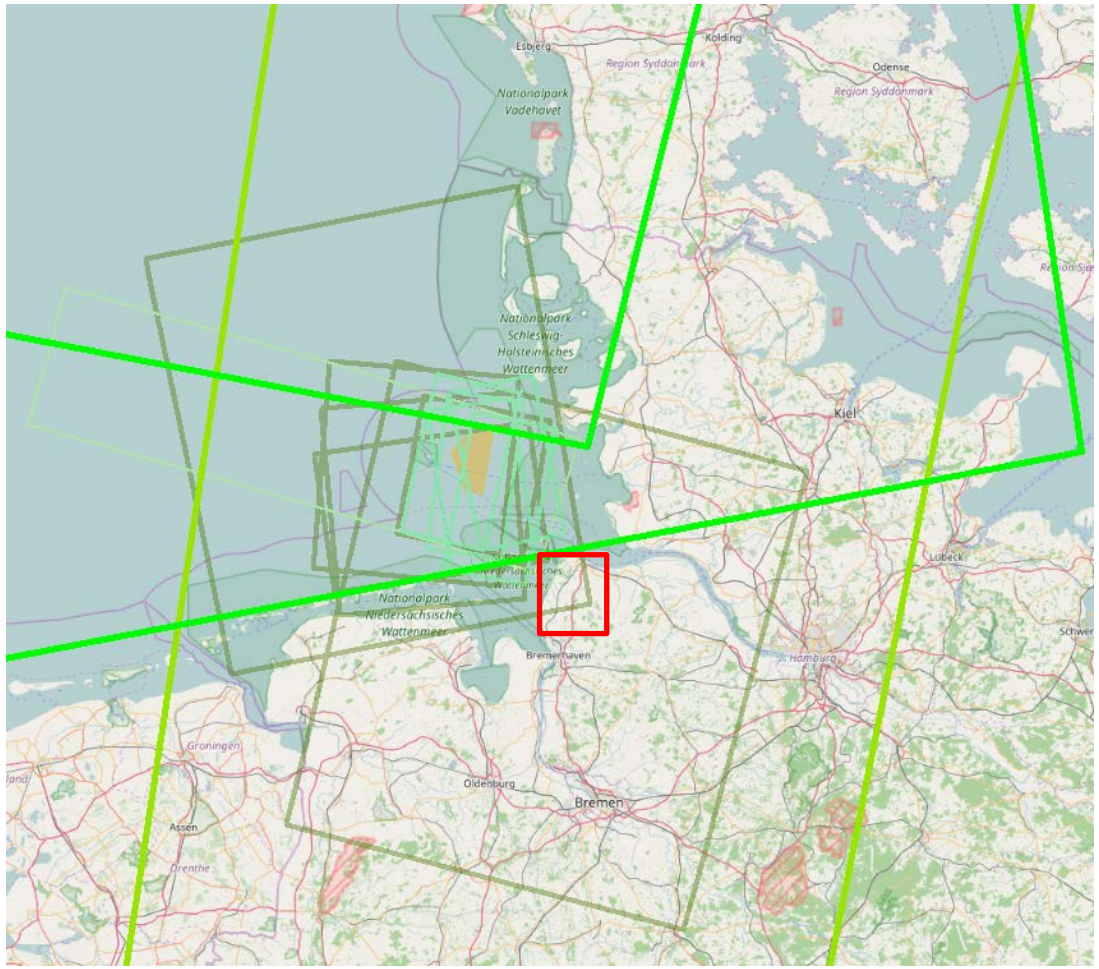
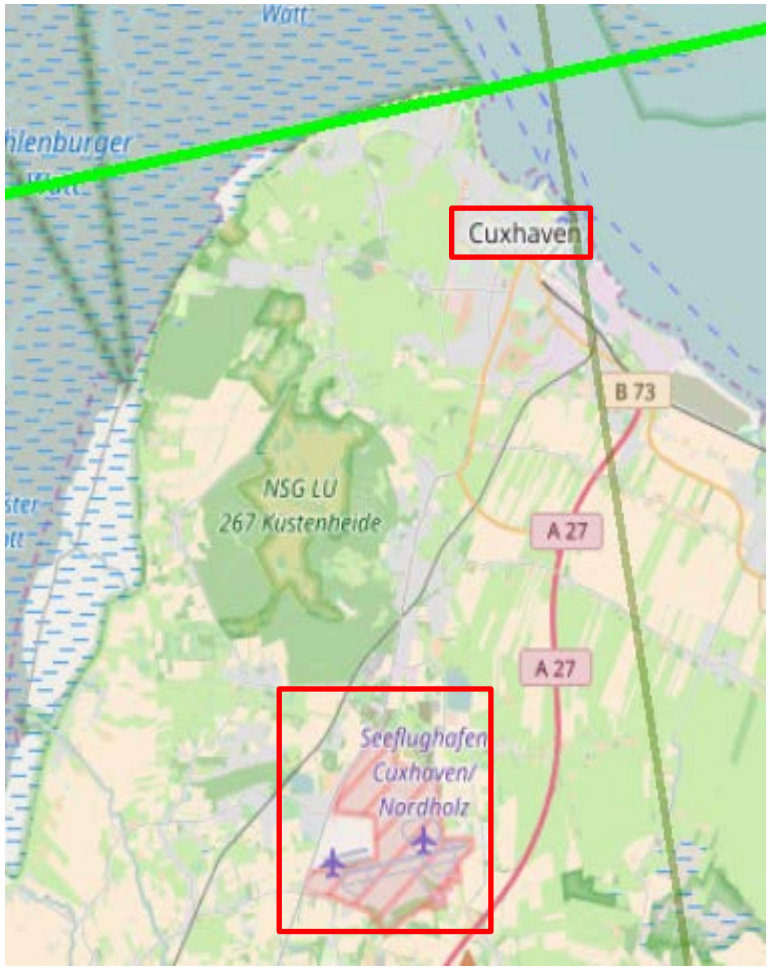
EMSec (Echtzeitdienste für die Maritime Sicherheit – Security; Real Time Service for Maritime Security) Demonstration second week of September 2016





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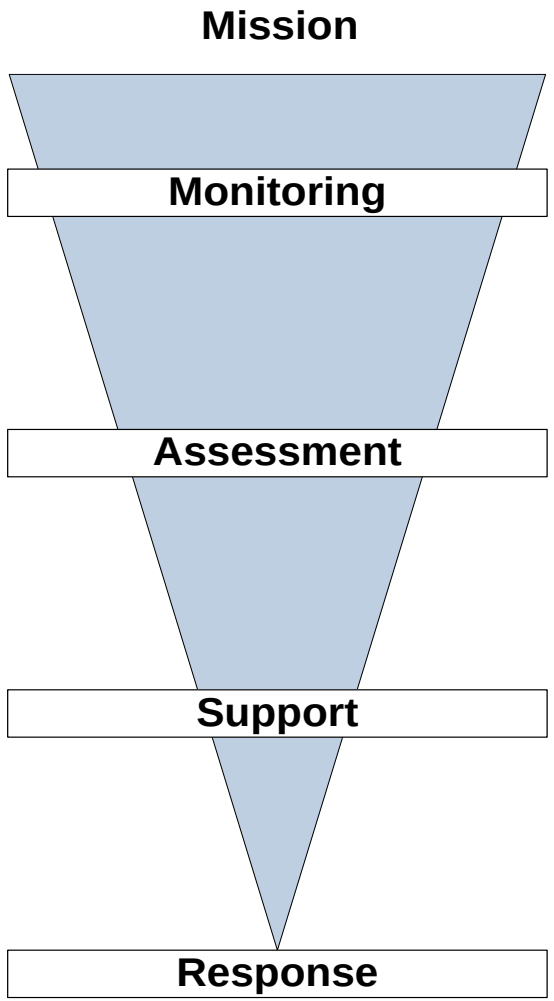
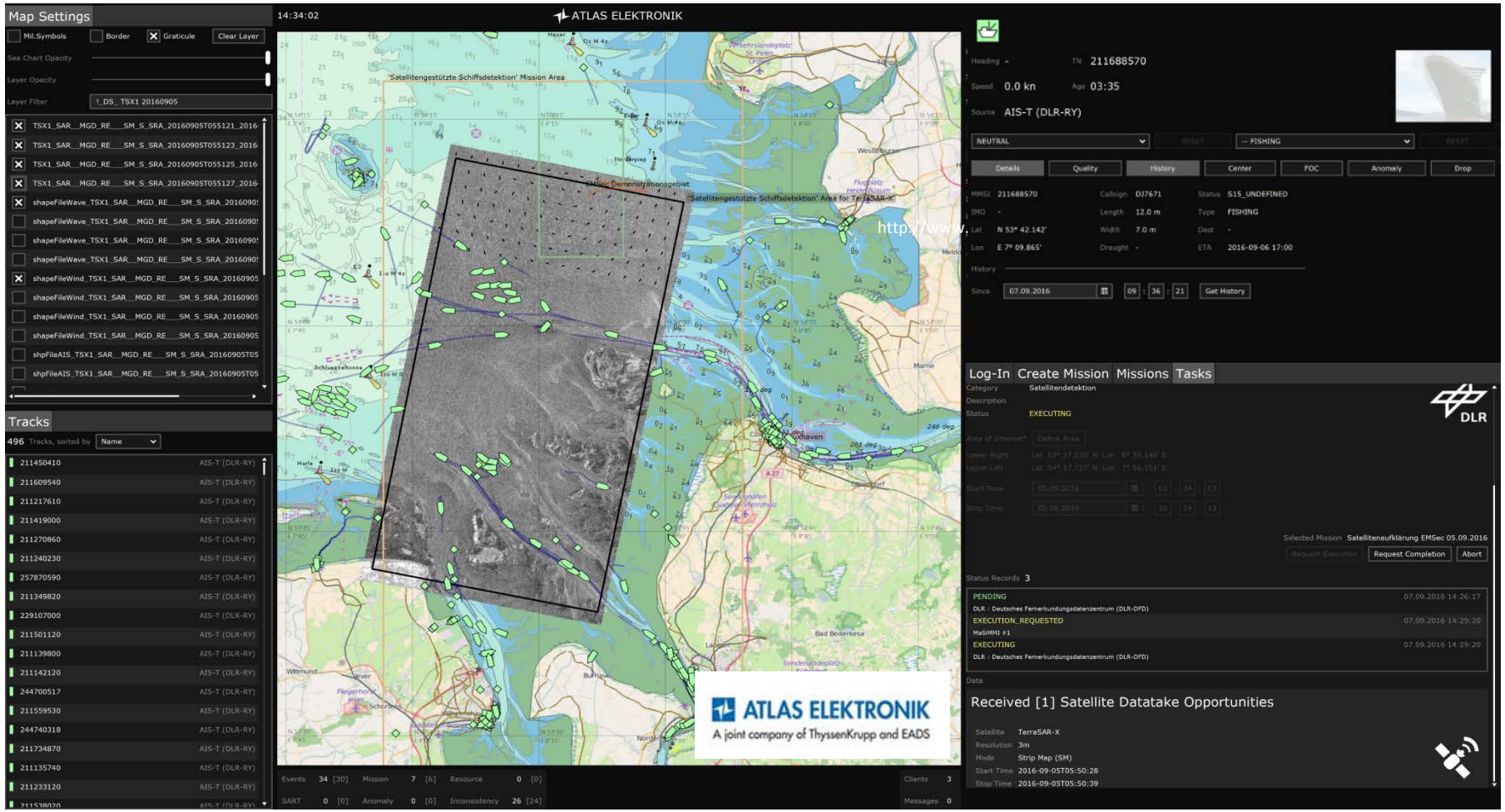
VDI
Bundesministerium für Bildung und Forschung
DLR

EMSec (Echtzeitdienste für die Maritime Sicherheit – Security; Real Time Service for Maritime Security)



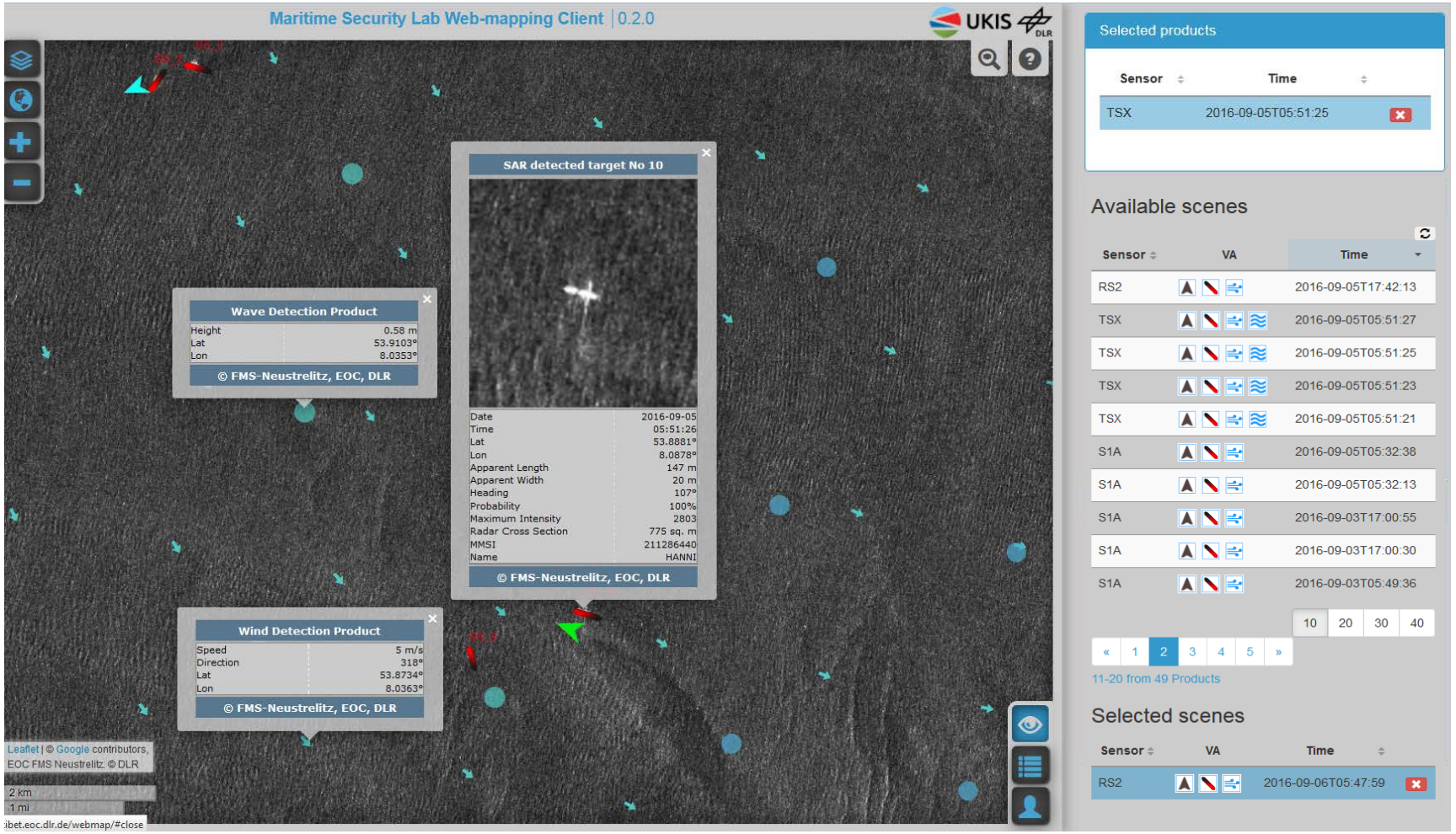


HMI interface (ATLAS ELEKTRONIK)

EMSec (Echtzeitdienste für die Maritime Sicherheit – Security; Real Time Service for Maritime Security)

Main Requirements EO-Data project:

- Share of hardware resources to support multiple mission and archive near real time performance.
- Extension of processing framework in the way that additional processing rules can called and executed in parallel if requested (TerraSAR-X, Sentinel-1, Radarsat-2)
- Support both, single and parallel value add processing of ship-, wind-, and wave detection
  - Support product slicing and parallel scene processing
  - Support scene based AIS (Automated Identification System) data fusion in real time via Web-Interface connected to the AIS provider



TerraSAR-X Level 1 quicklook product in the background is overlaid by the DLR SAR SAR-AIS Vessel layer, wind and wave product derived from the TerraSAR-X image.

Sentinel-1 Capabilities

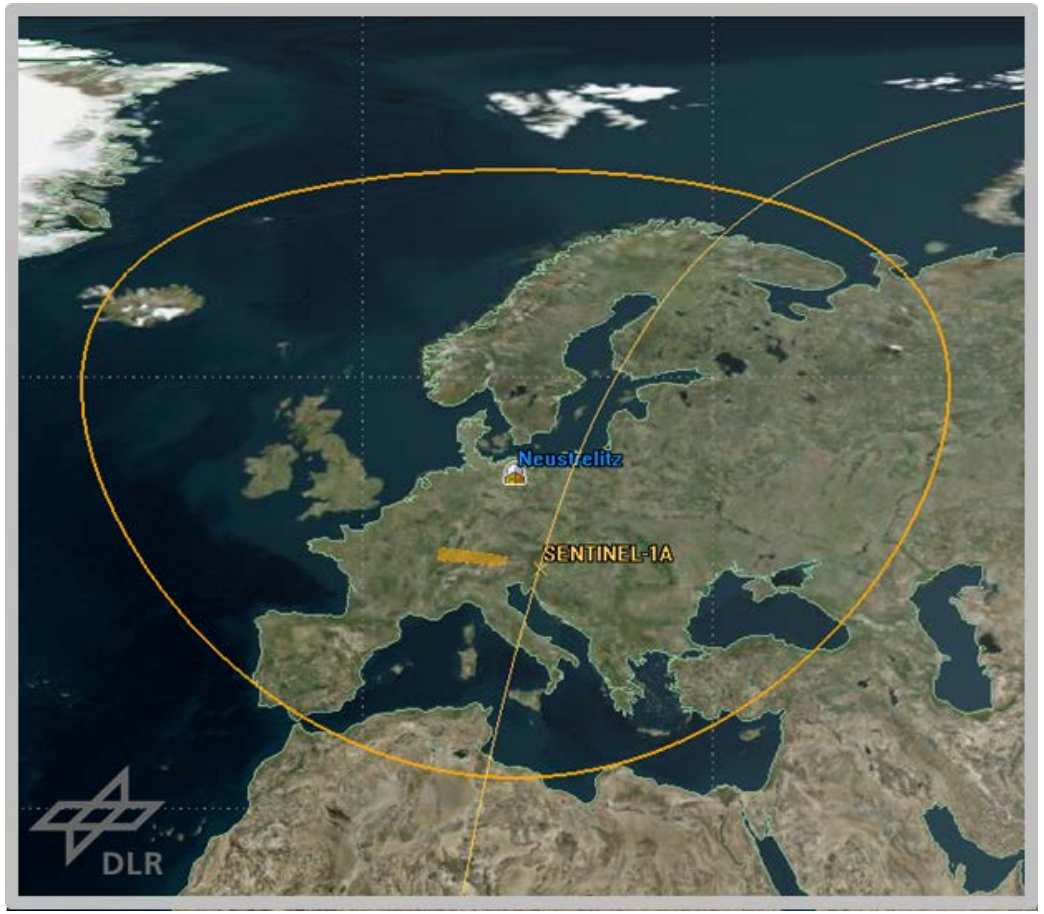
NRT reception and processing for Sentinel-1A and Sentinel-1B data,available in direct downlink mode

Processing Chain

- VM Cluster
- Processing System Management (PSM)
- Original ESA PDGS Instrument Processing Facility (IPF) used for Level 1 processing

- DLR Level 2 processing
  - Ship Detection
  - Wind
  - Wave
  - Oil (development ongoing)

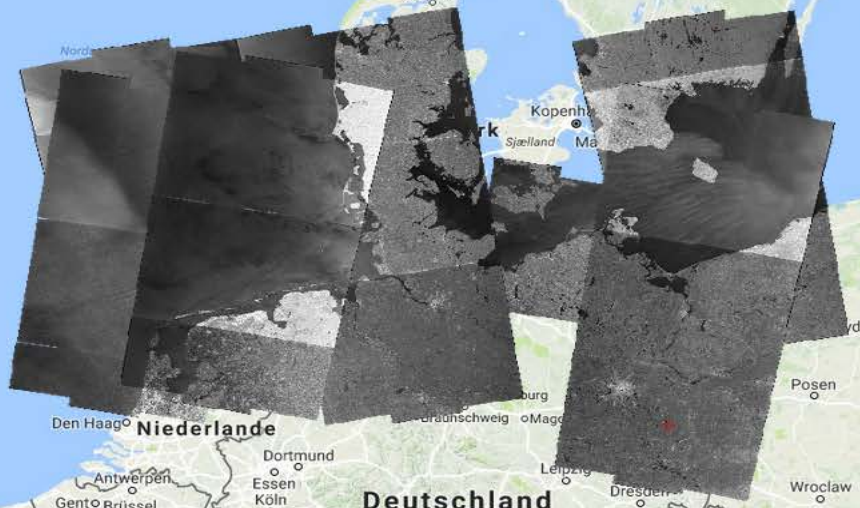
- **Product latency from acquisition: about 15 – 20 minutes**



Ground Station Neustrelitz, elevation mask for Sentinel-1, 5 degree elevation

Maritime Security Lab Web-mapping Client

UKIS DLR



Available scenes

Sensor	Type	VA	Time
S1B	IW,GRDH		2017-03-20T05:48:38
S1B	IW,GRDH		2017-03-20T05:48:10
S1B	IW,GRDH		2017-03-20T04:13:40
S1A	IW,GRDH		2017-03-19T17:09:25
S1A	IW,GRDH		2017-03-19T17:09:00
S1A	IW,GRDH		2017-03-19T17:08:31
S1B	IW,GRDH		2017-03-19T16:15:11
S1A	IW,GRDH		2017-03-19T05:58:04
S1A	IW,GRDH		2017-03-19T05:57:39
S1A	IW,GRDH		2017-03-19T05:57:10
S1A	IW,GRDH		2017-03-19T04:22:33
S1A	IW,GRDH		2017-03-18T05:16:57
S1A	IW,GRDH		2017-03-18T05:16:32
S1A	IW,GRDH		2017-03-18T05:16:04
S1A	IW,GRDH		2017-03-17T17:25:59
S1A	IW,GRDH		2017-03-17T17:25:34
S1A	IW,GRDH		2017-03-17T17:25:04
S1A	IW,GRDH		2017-03-17T06:14:43
S1B	IW,GRDH		2017-03-17T05:24:20
S1B	IW,GRDH		2017-03-17T05:23:50

10 20 30 40

« 1 … 5 6 7 8 9 … 22 »

121-140 from 426 Products

Selected scenes

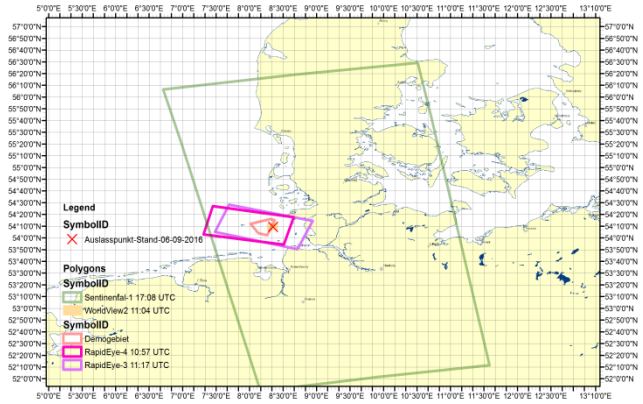
300 km
100 mi

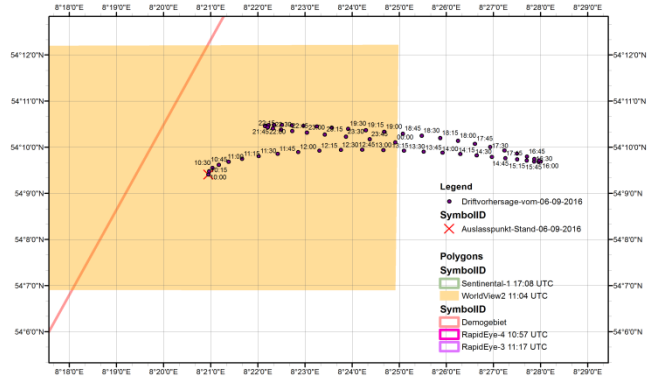
Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection

EMSec
ECHTZEITDIENSTE FÜR DIE MARITIME SICHERHEIT security

Demonstration Event for the EMSec Project Cuxhaven (North Sea), 8th of September 2016

- Real-Time data exchange
- Data fusion capabilities
- Detection of liquid hazardous materials
- Tracking of detected materials
- Validation of drift models provided by BSH (Federal Maritime and Hydrographic Agency

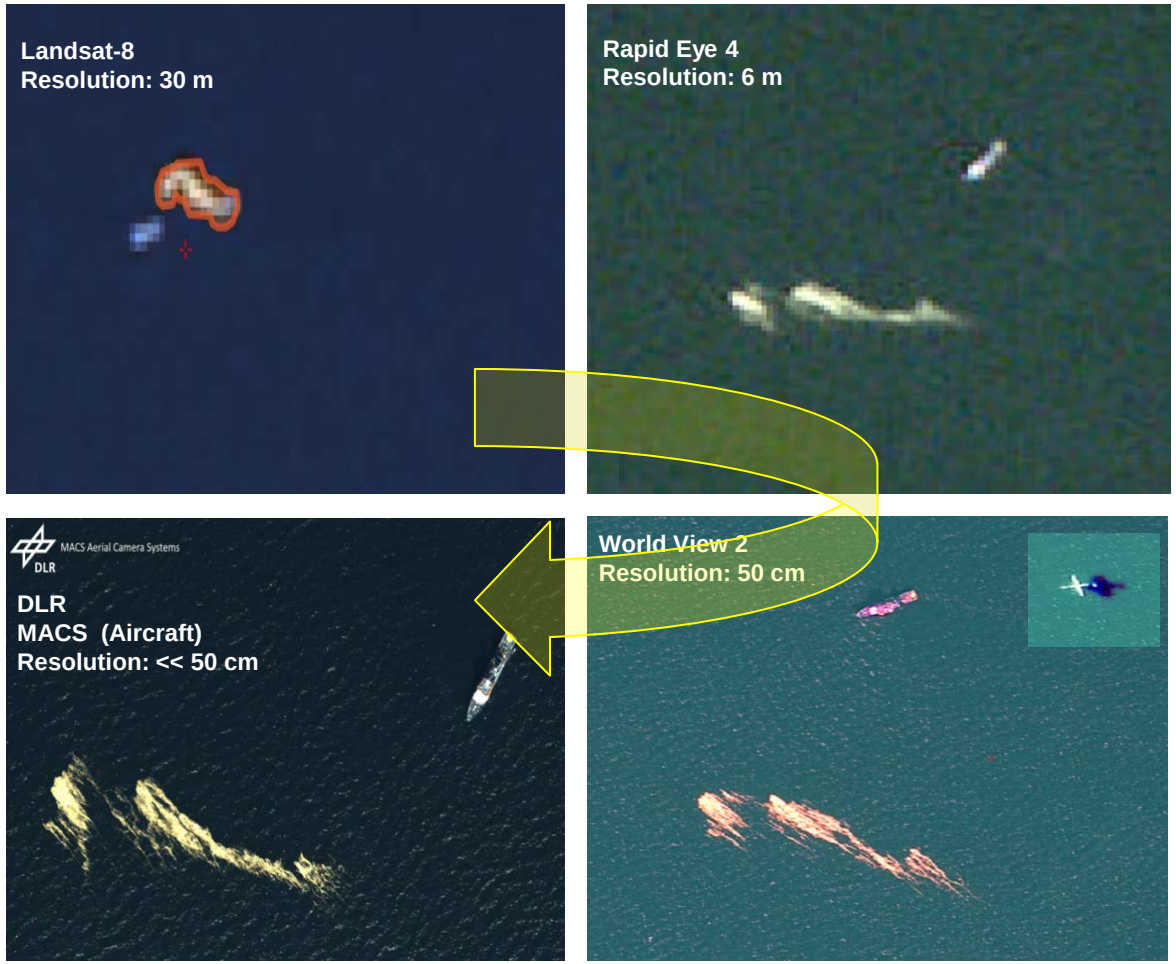


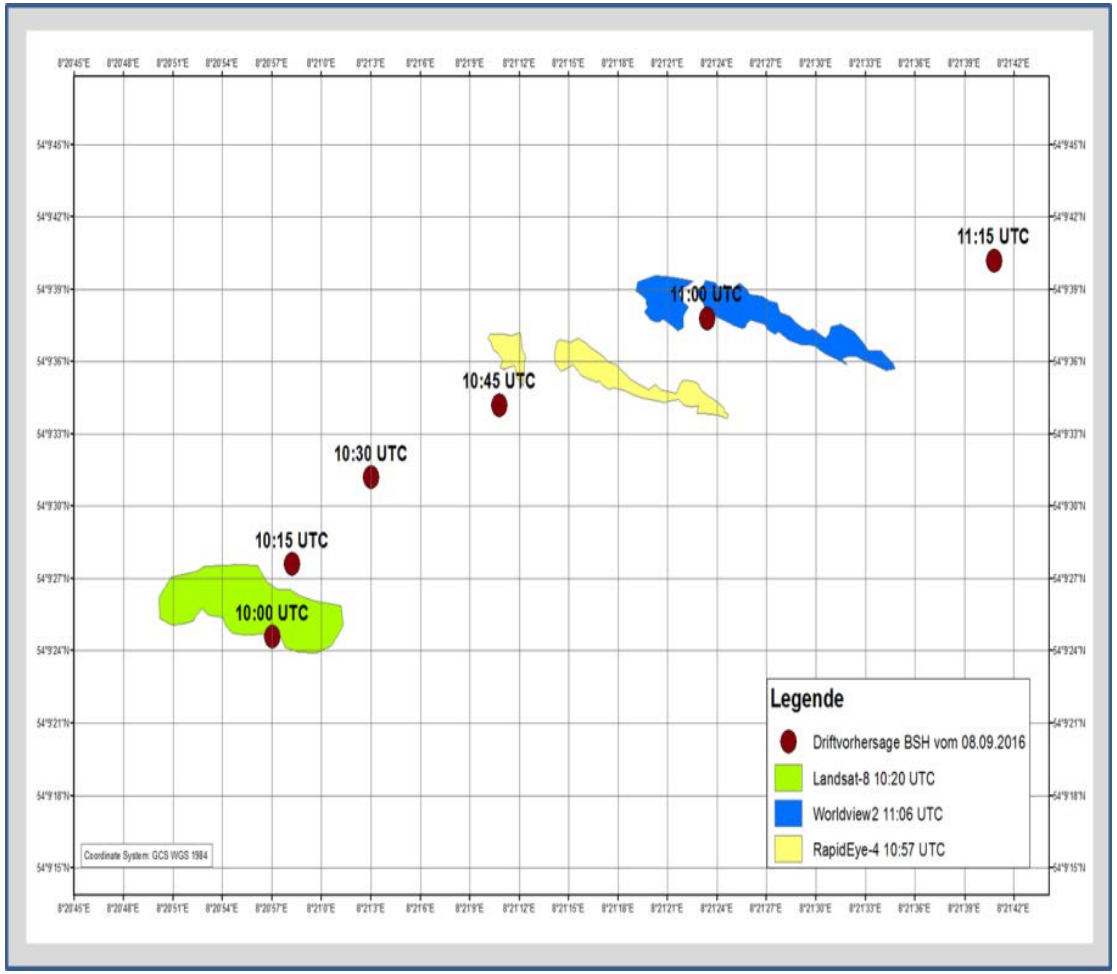


http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10081/151_read-19273/

DLR

Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection





Optical Satellite Services for the European Maritime Safety Agency EMSA (OpSSERVE)

partner: EUSI (contractor) and DLR (subcontractor)

Project summary: **rapid access to satellite data and derived information** for use in maritime situational awareness based on WorldView - (1, 2, 3, and 4), GeoEYE-1, Deimos-2, Landsat-8

Direct delivery of information to EMSA Earth Observation Data Centre (EO-DC)

–Derive Value Adding Information

- –**Vessel detection**
- –**Vessel activity detection**
- –**Change detection**

DLR

EUROPEAN SPACE IMAGING

EMSA European Maritime Safety Agency

Optical Satellite Services for EMSA OpSSERVE

Service tasks of European Space Imaging EUSI

Project and contractual management

- Handling and management of all EMSA service requests
  - Feasibility analysis for acquisitions of WorldView - (1 & 2 & 3, 4) and GeoEYE-1, Deimos-2
  - Data acquisition planning
  - Near-real time reception, cloud screening
  - Quality assurance
  - Routine native Level 1 (L1) processing for WorldView - (1 & 2 & 3)
  - L1 data delivery

Optical Satellite Services for EMSA OpSSERVE

Service tasks of DLR Maritime Security Lab Neustrelitz

Image Processing

- Pre-processing, L0, L1b (Landsat-8 only)
- Scene Slicing, Image mosaicking
- Orthorectification (@DLR SRTM DEM, 25 m resolution)
- Image projection

Value adding and analysis

- Ship detection
- Activity detection
- Change detection

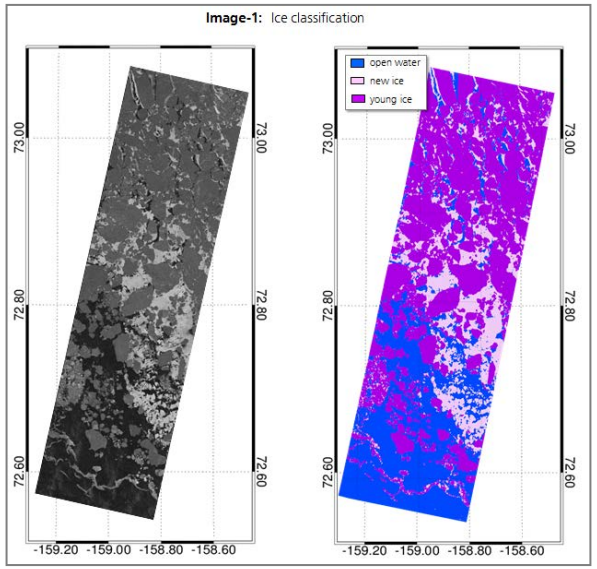
Product generation and secure transmission to EMSA (EO-DC)

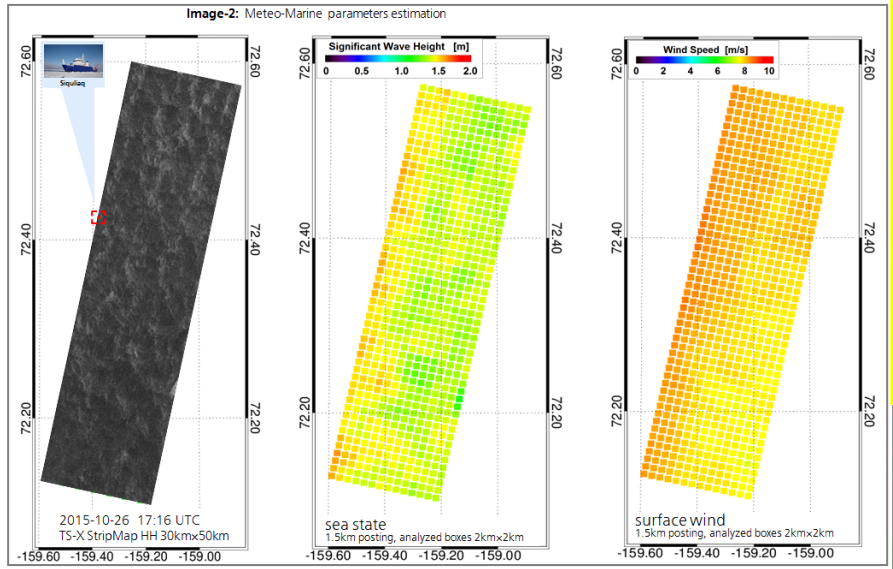
NRT Support for Office of Naval Research (ONR) Arctic Sea State Campaign

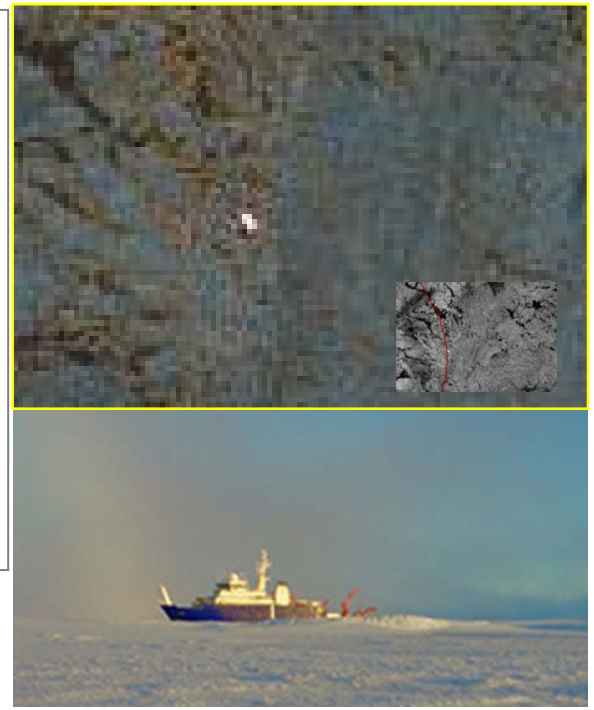
Research Vessel Sikuliaq; Beaufort Sea

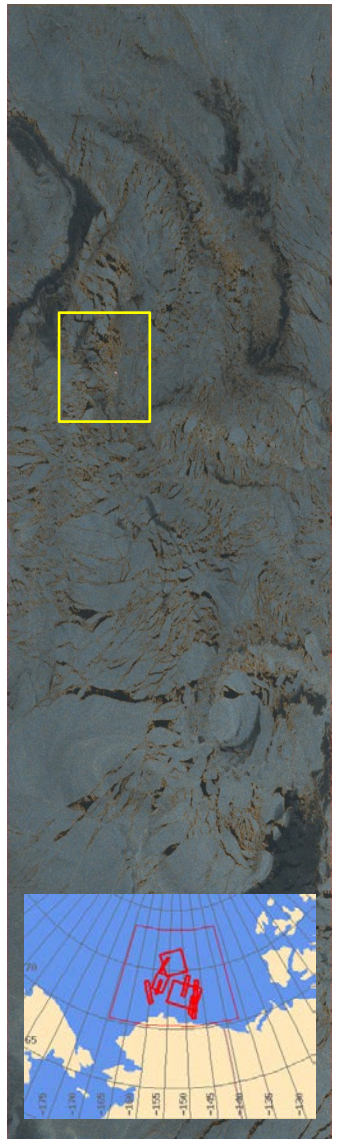
http://www.apl.washington.edu/project/project.php?id=arctic_sea_state

The cruise goal was to observe the fall ice advance and the interactions with wind and waves









TerraSAR-X Data Sea Ice Classification and Wind and Wave Field Measurements

25 acquisitions (SM, SC, SC wide)

Antarctic Circumnavigation Expedition (ACE)

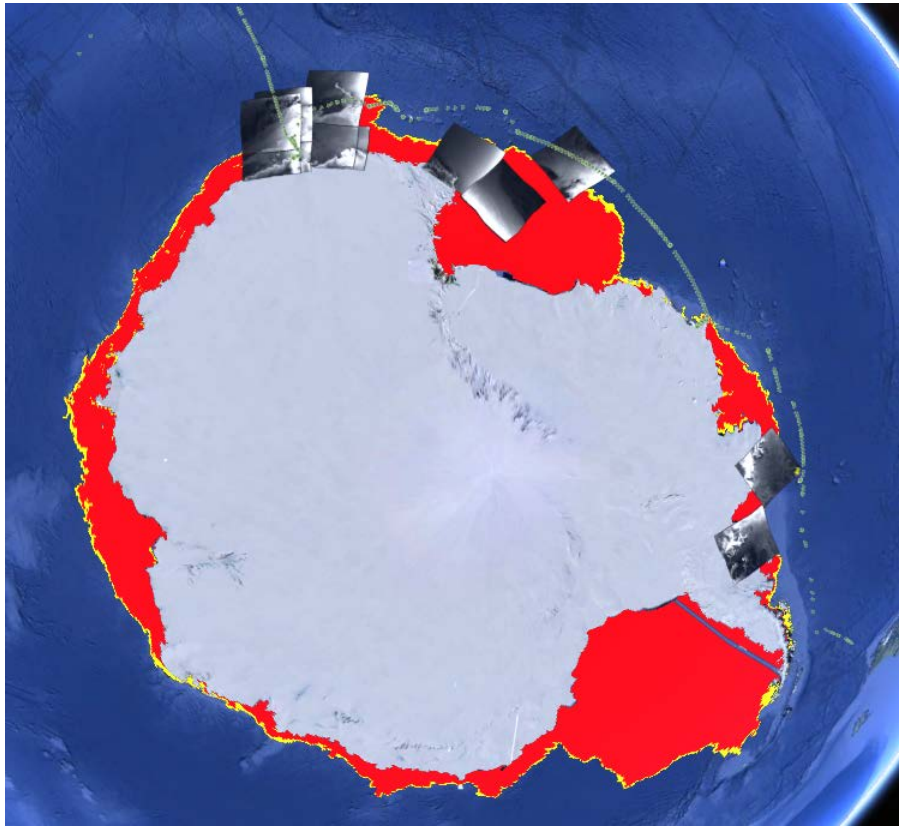
http://spi-ace-expedition.ch/science-has-no-borders/

First project of the Swiss Polar Institute, a newly created entity founded by EPFL, the Swiss Institute of Forest, Snow and Landscape research WSL, ETHZ, the University of Bern and Editions Paulsen. It aims to enhance international relations and collaboration between countries, as well as to spark the interest of a new generation of young scientists and explorers in polar research.

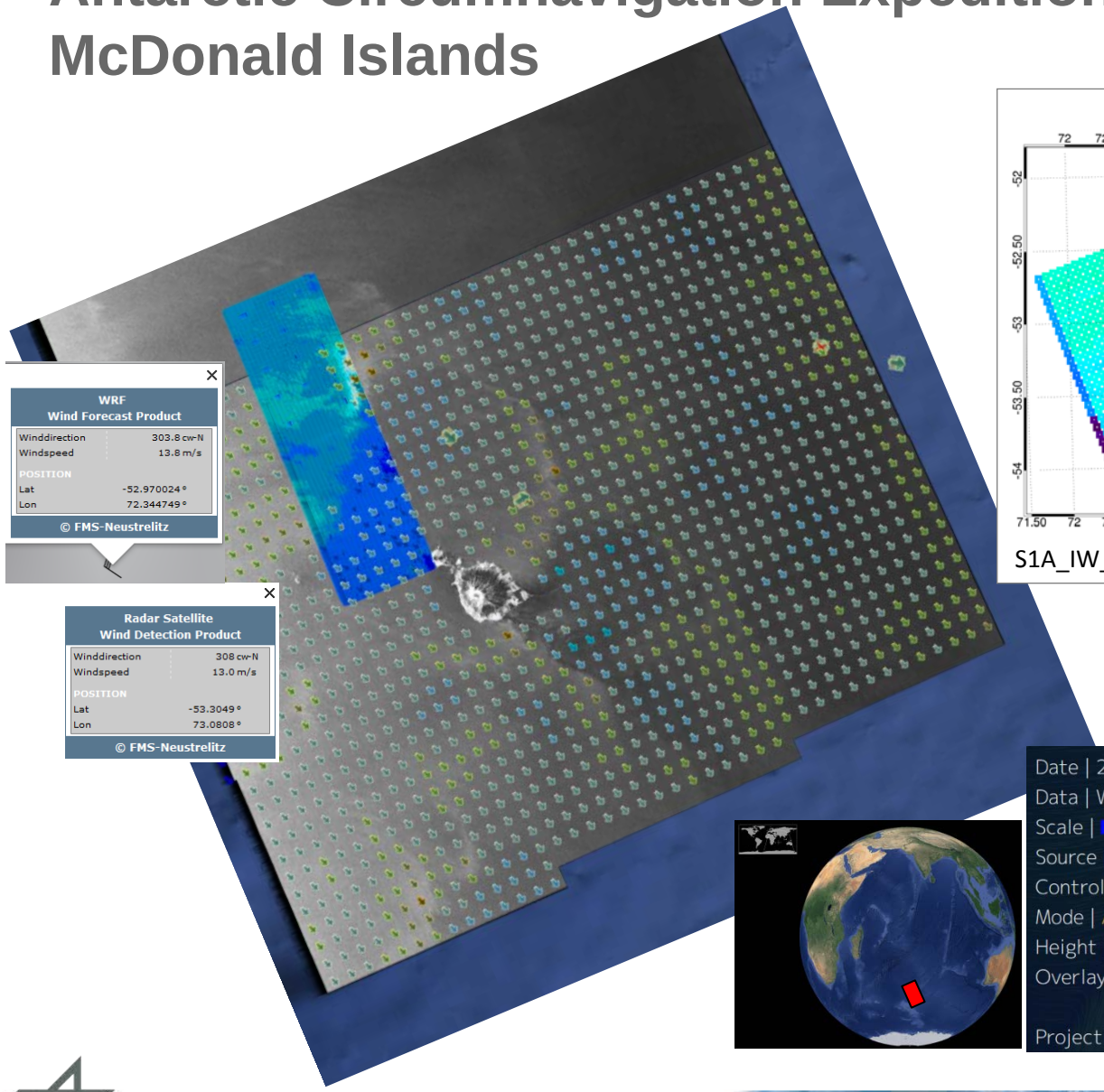
From December 2016 to March 2017, scientific teams from all over the world will board the Russian research vessel Akademik Treshnikov for an unprecedented expedition around Antarctica. From **biology** to **climatology** to **oceanography**, researchers will work on a number of interrelated fields for the future of this continent.

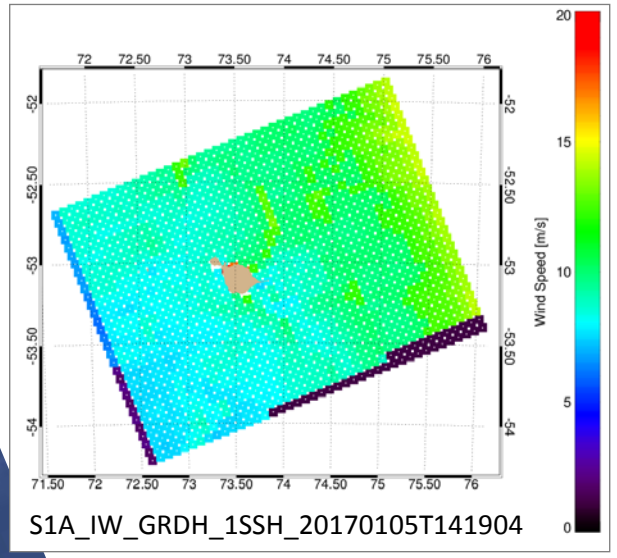
A better understanding of Antarctica is critical, not just for its preservation, but for the whole planet. The poles are affected by climate change more than any other region on Earth. Moreover, they play a central role in providing oceans with strong underwater streams that regulate the world's climate from the poles to the equator.

ACE_FINAL_Brochure

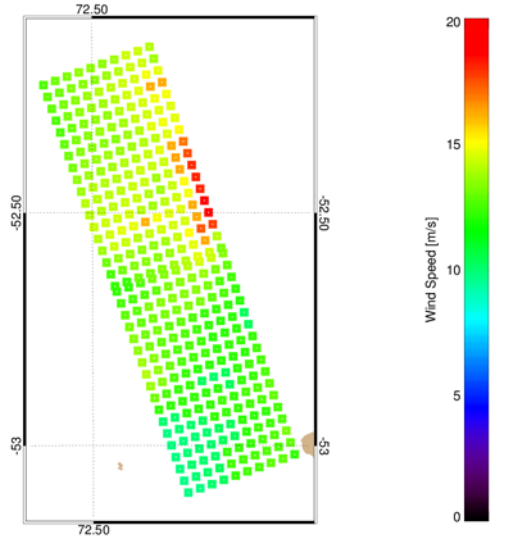


Antarctic Circumnavigation Expedition (ACE) – WIND McDonald Islands





S1A_IW_GRDH_1SSH_20170105T141904



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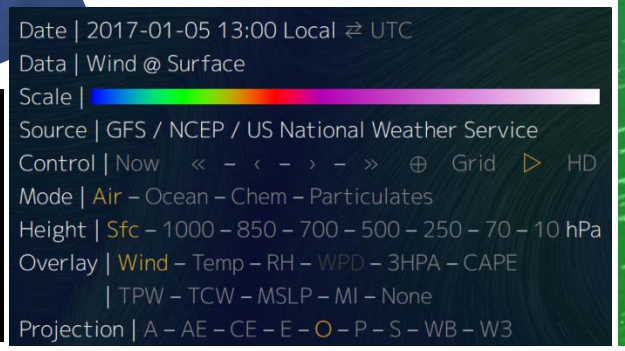
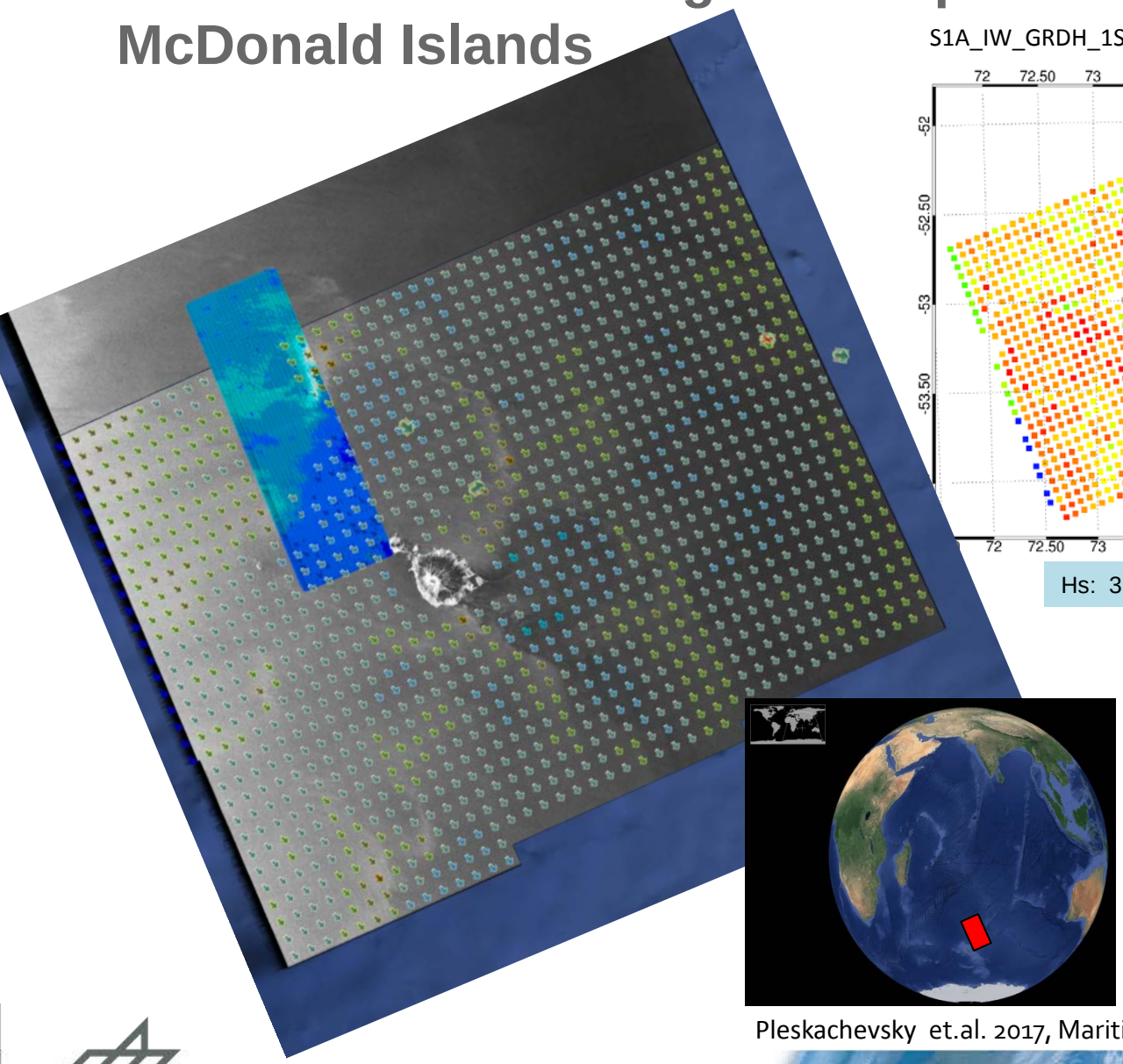
Jacobsen et.al., Maritime Security Lab Bremen



https://earth.nullschool.net/#2017/01/05/1200Z/ocean

Antarctic Circumnavigation Expedition (ACE) – WAVE

McDonald Islands



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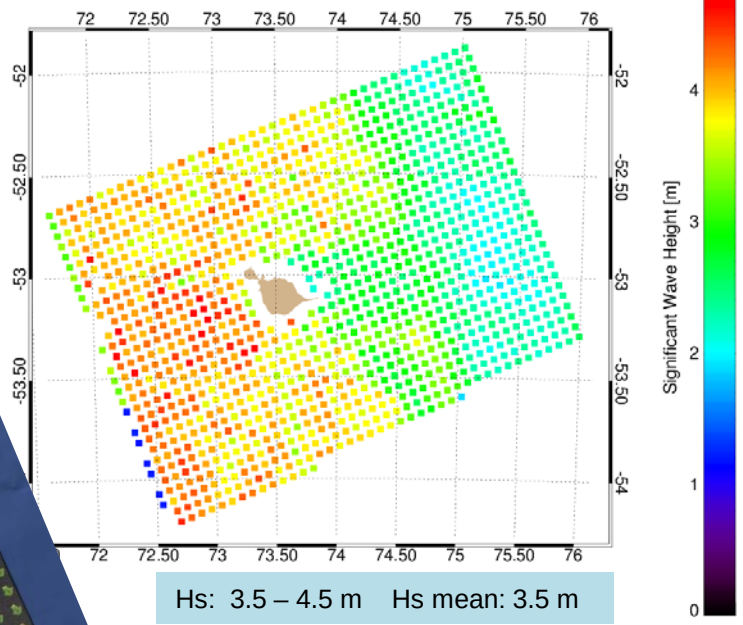
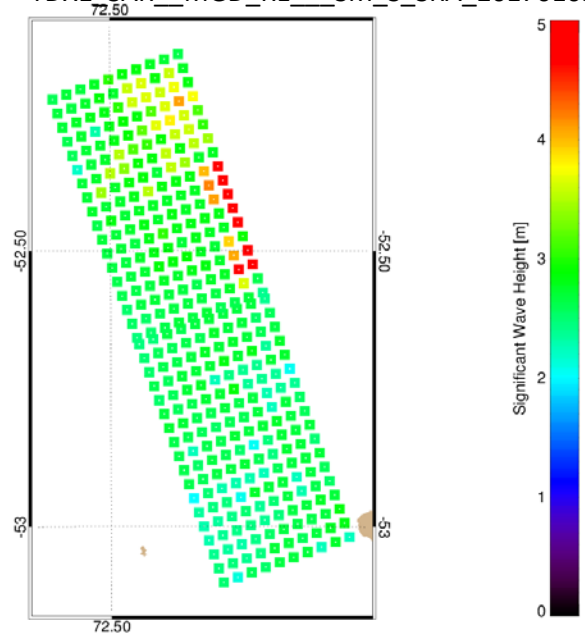
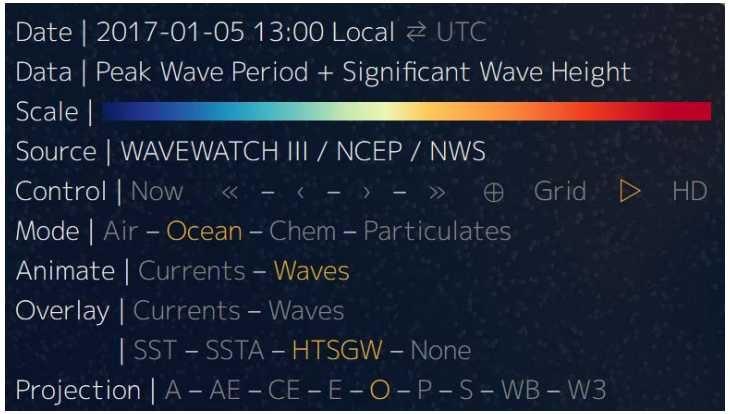


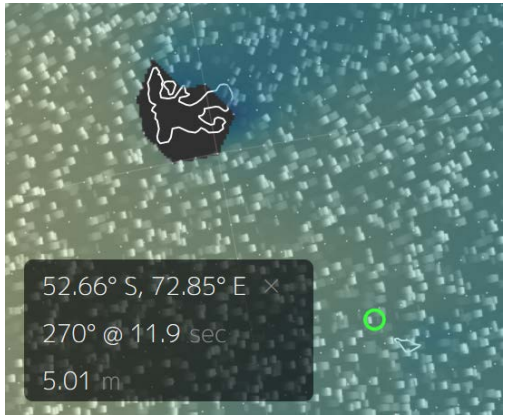
Hs: 3.5 – 4.5 m Hs mean: 3.5 m

TDX1_SAR__MGD_RE___SM_S_SRA_20170105T141547



Hs: 2.5 – 4.5 m Hs mean: 3m





Pleskachevsky et.al. 2017, Maritime Security Lab Bremen

https://earth.nullschool.net/#2017/01/05/1200Z/ocean

Antarctic Circumnavigation Expedition (ACE)

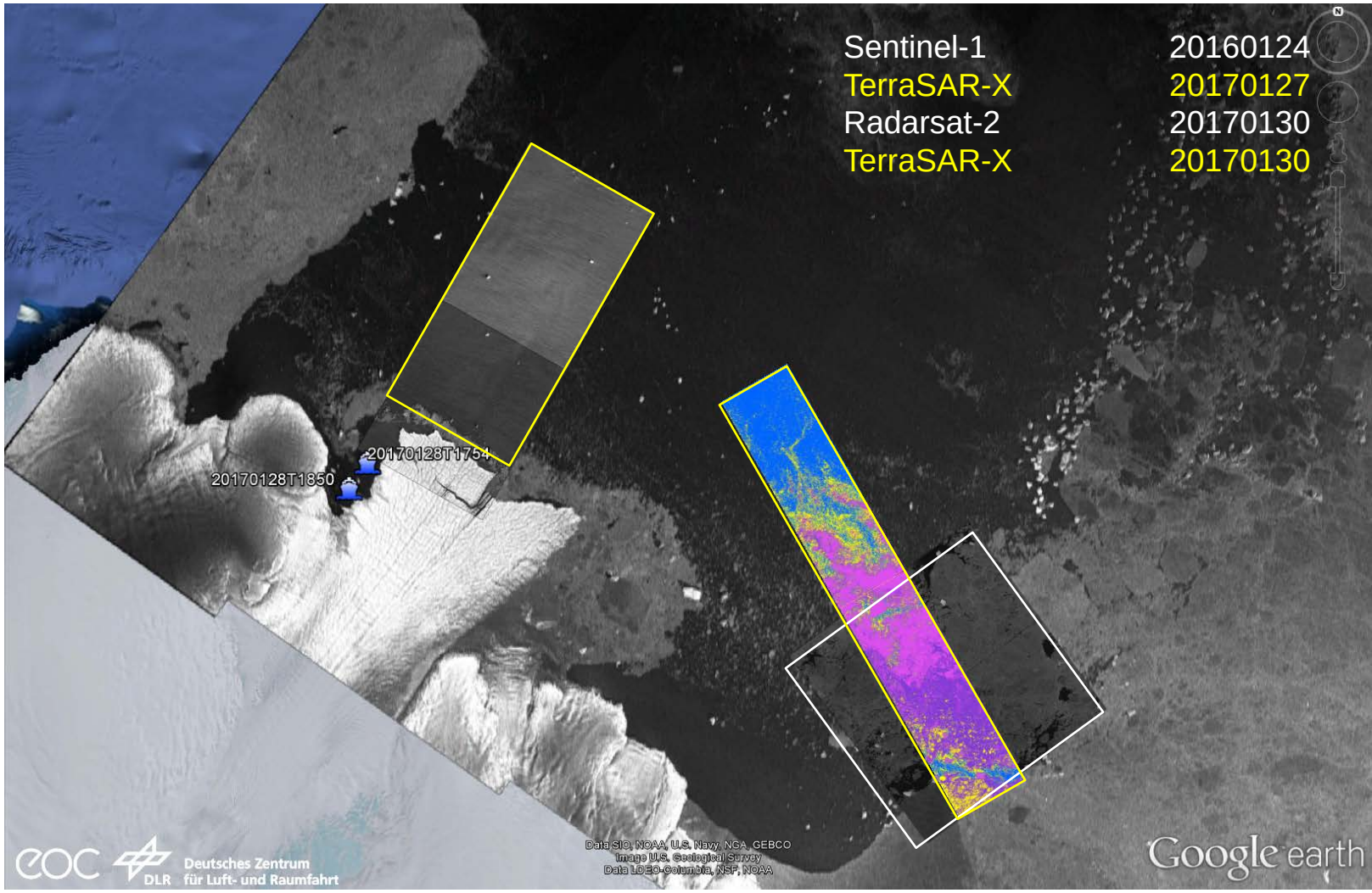
Research Vessel Akademik Treshnikov

DLR support comprises

TerraSAR-X and Sentinel-1

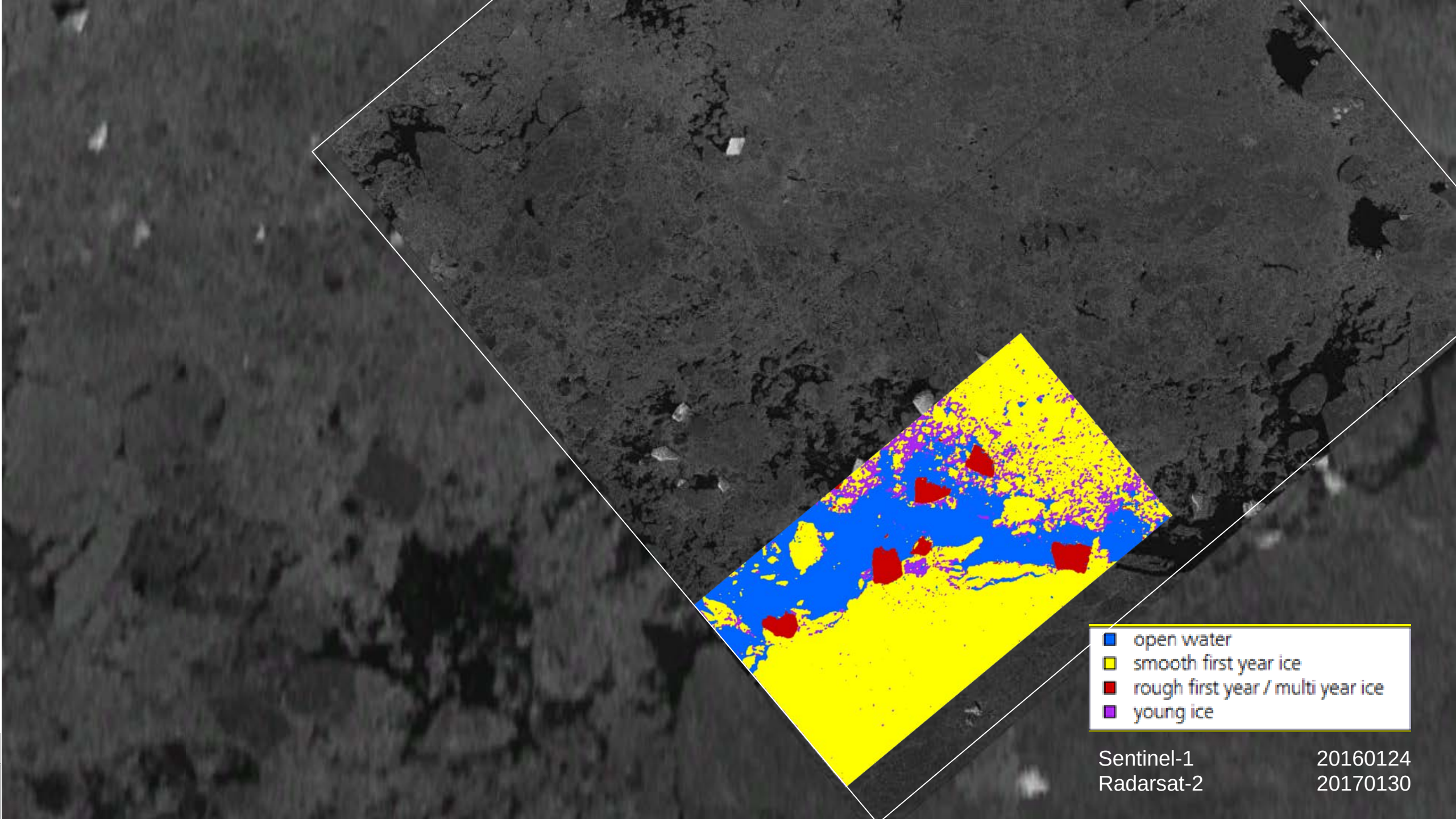
- Georefereced quicklooks delivered for usage at ship
- Validation of wind and wave charts derived from TerraSAR and Sentinel-1
- delivery of ice charts derived from TerraSAR-X dualpol,

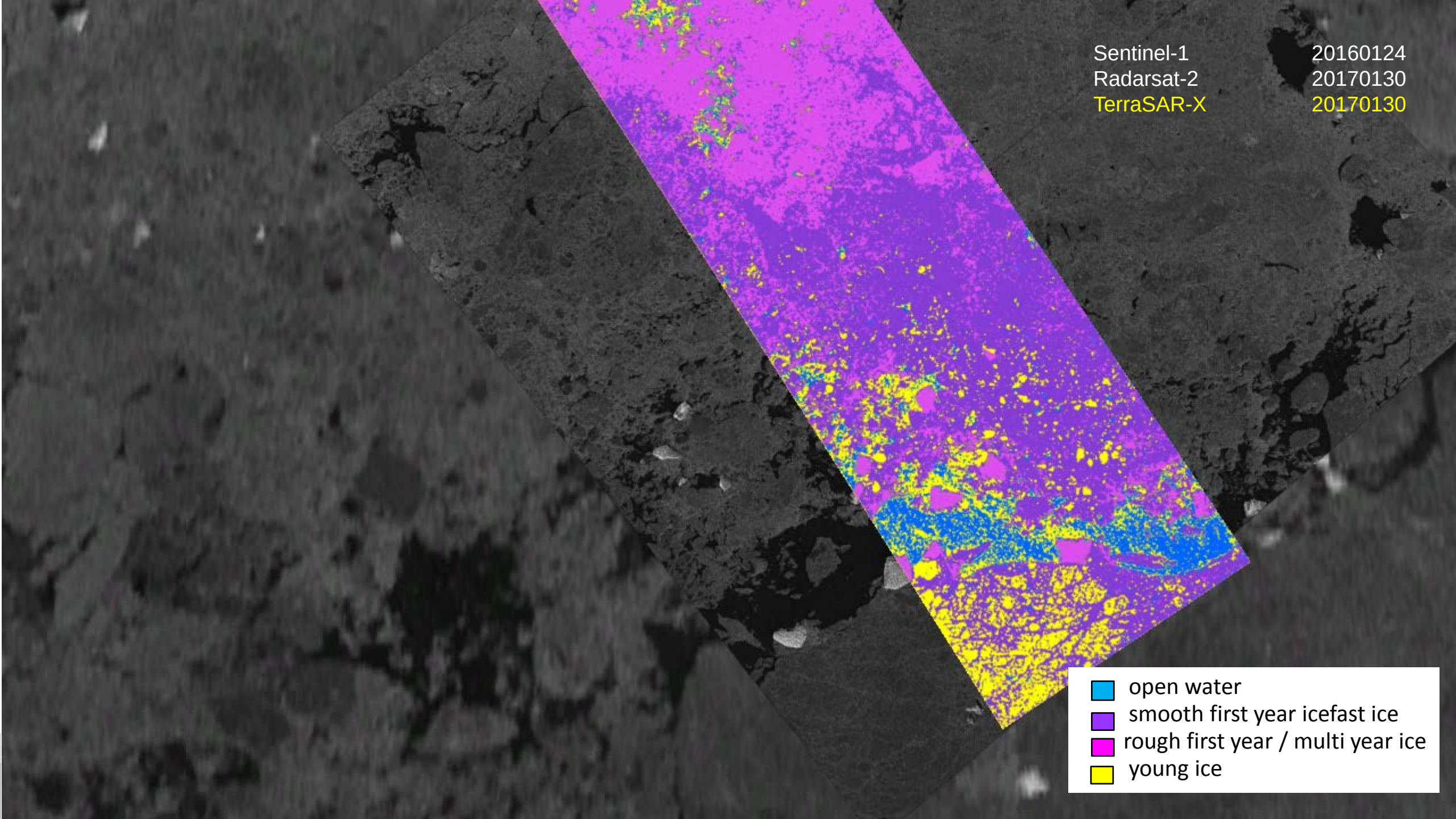
Singha et.al. 2017, Maritime Security Lab Bremen




Sentinel-1
20160124

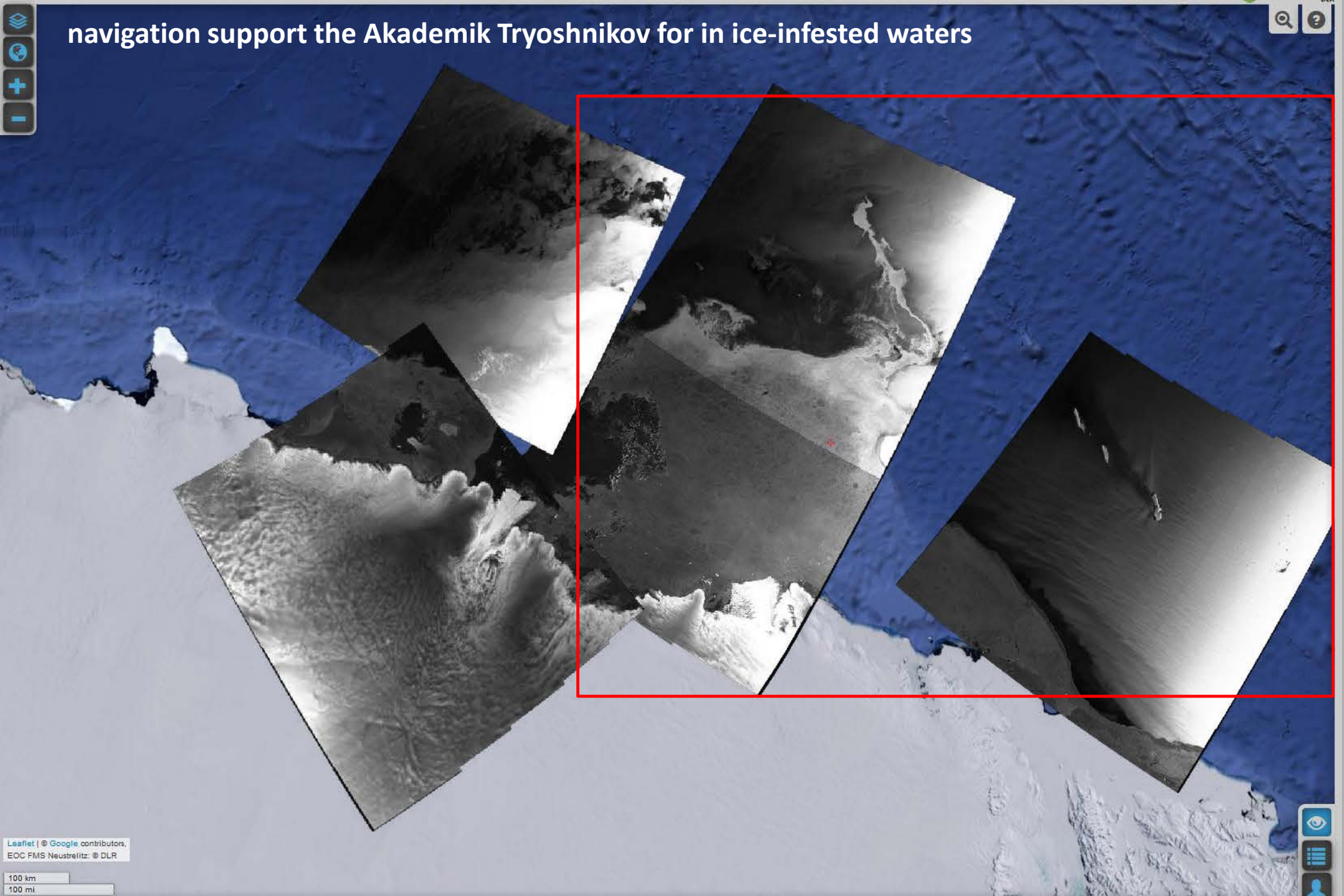

Sentinel-1 20160124
Radarsat-2 20170130


open water
smooth first year ice
rough first year / multi year ice
young ice
Sentinel-1 20160124
Radarsat-2 20170130


Sentinel-1 20160124
Radarsat-2 20170130
TerraSAR-X 20170130
open water
smooth first year icefast ice
rough first year / multi year ice
young ice

UKIS DLR

navigation support the Akademik Tryoshnikov for in ice-infested waters



Selected products

Sensor	Time	
S1B	2017-01-31T17:53:42	
S1B	2017-01-31T17:52:38	
S1B	2017-02-05T14:45:09	
S1B	2017-02-05T14:46:14	
S1B	2017-02-05T14:47:14	
S1B	2017-02-01T18:33:41	
S1A	2017-01-31T10:40:17	
S1B	2017-02-01T16:56:06	

Layers

Legend

Coordinates

Latitude: -66,6486231449303

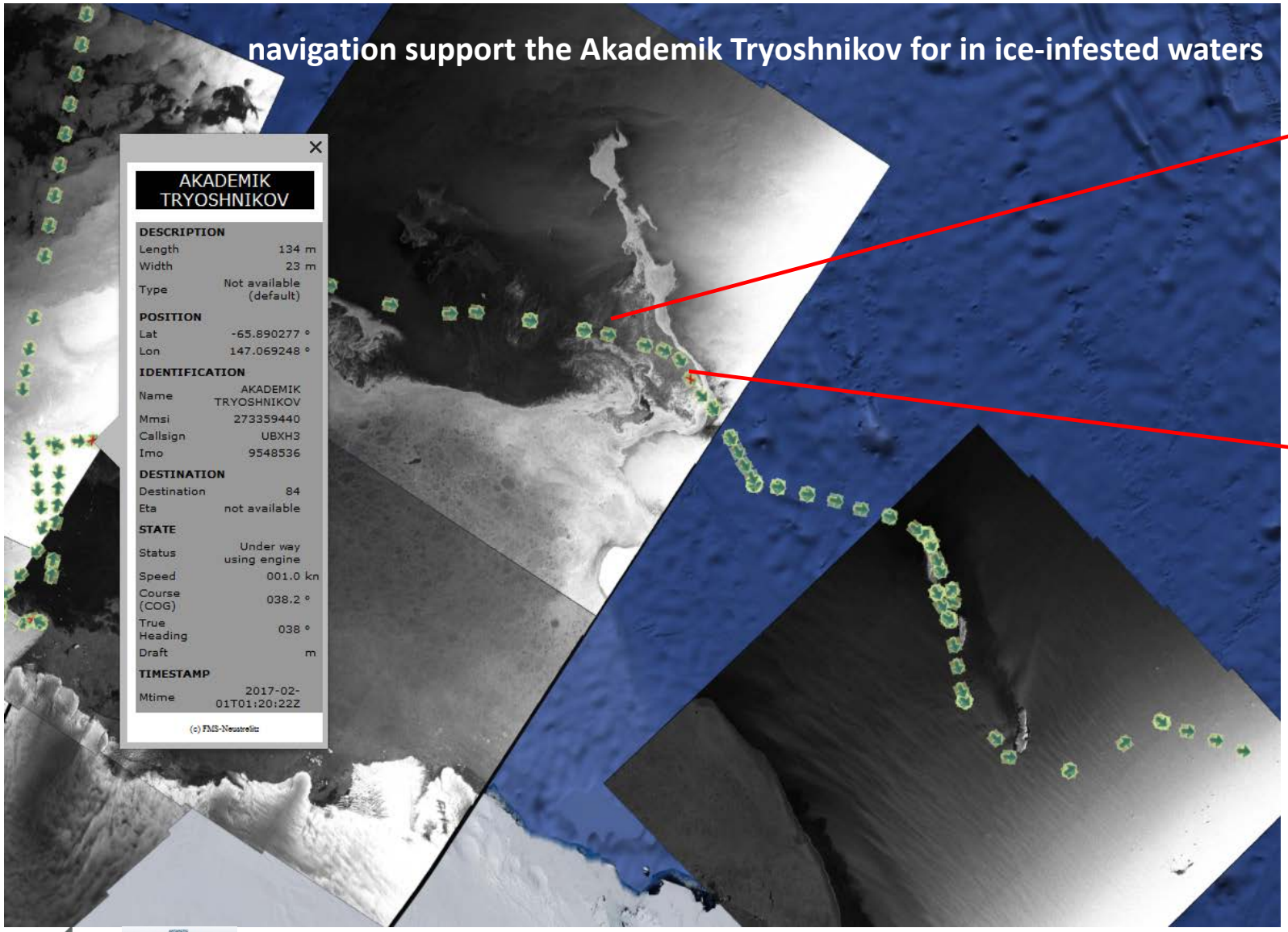
Longitude: 154,918212890625

Zoom: 6

100 km
100 mi

Antarctic Circumnavigation Expedition (ACE)

navigation support the Akademik Tryoshnikov for in ice-infested waters



Picture: Alessandro Toffoli, University of Melbourne

Ice drift application

Maritime Security Lab Bremen

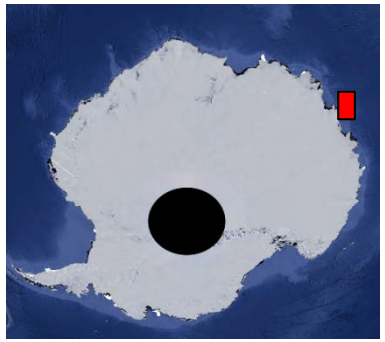
Ice drift application to Support Maritime Situation Awareness

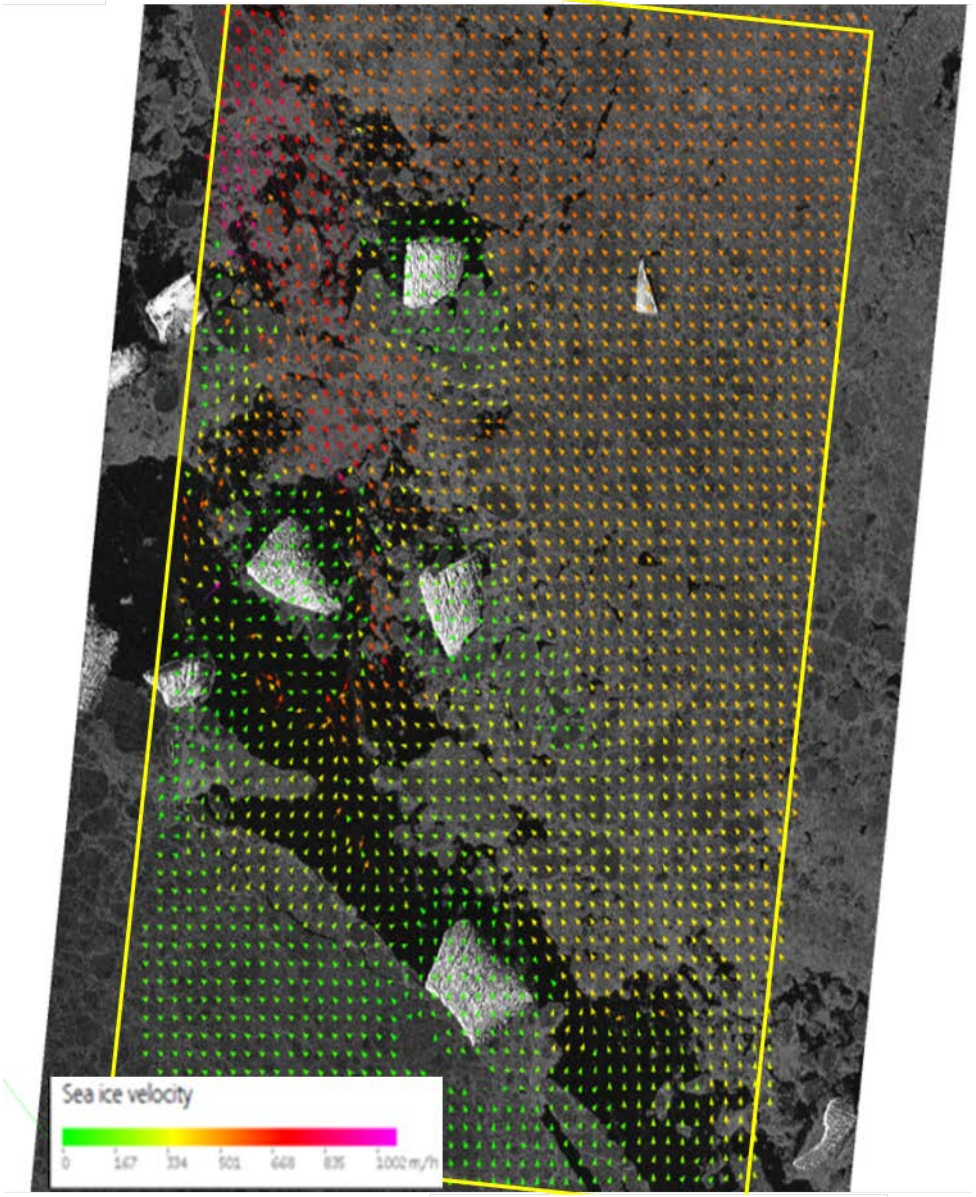
planned value added based on TerraSAR-X, Sentinel-1 and Radarsat-2

Frost et.al. 2017,

with TerraSAR-X image at 10:09 UTC (SM-DP yellow rectangle, drift values only) overlaid with Radarsat-2 image (WFQ) at 10:36 UTC in the background to derive Ice drift information

TDX1_SAR__MGD_RE___SM_D_SRA_20170130T100956
RS2-20170130-103635-WFQ-47663-_FIN_I004465_4162





Thank you for attention!

Egbert Schwarz
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17235 Neustrelitz
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E-mail: **Egbert.Schwarz@dlr.de**

Rostock: TerraSAR-X, Spotligth 19.10.2012