

Near Real Time Applications for Maritime Situational Awareness

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Maritime Security Lab Neustrelitz

German Remote Sensing Data Center (DFD)

WorldView Global Alliance User Conference
Munich November 2016



Knowledge for Tomorrow



Outline

Background

- Earth Observation Center
 - Maritime Security Lab
 - Mission and Sensors

Application Status and Future Development

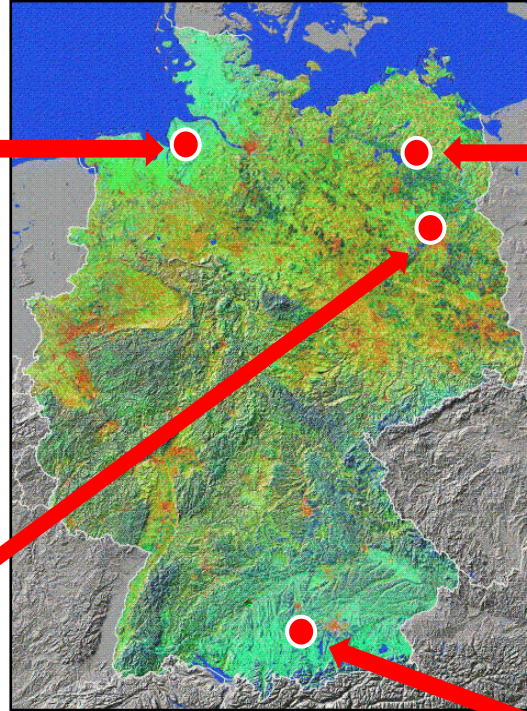
- Ship Detection
- Oil Detection
- Activity and Change Detection
- Wind and Wave
- Icebergs, Ice Classification and Ice Drift



Earth Observation Center – EOC



Bremen
Maritime Security Lab



Neustrelitz
National Ground Segment
Maritime Security Lab



Berlin

- Consists of the Remote Sensing Technology and the German Remote Sensing Data Center
- Appr. 350 employees at 4 sites
- Chairs at 2 university

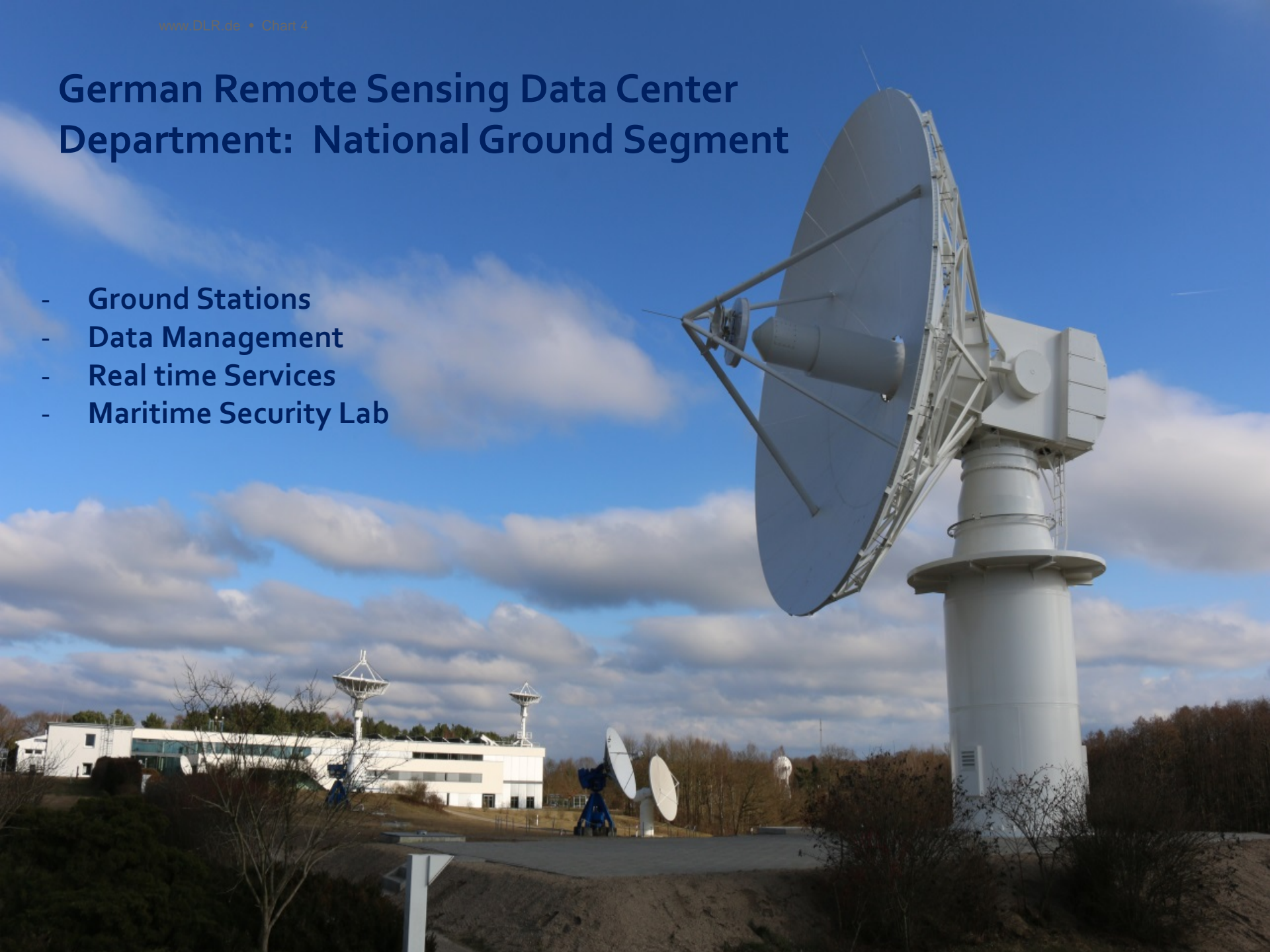


Oberpfaffenhofen



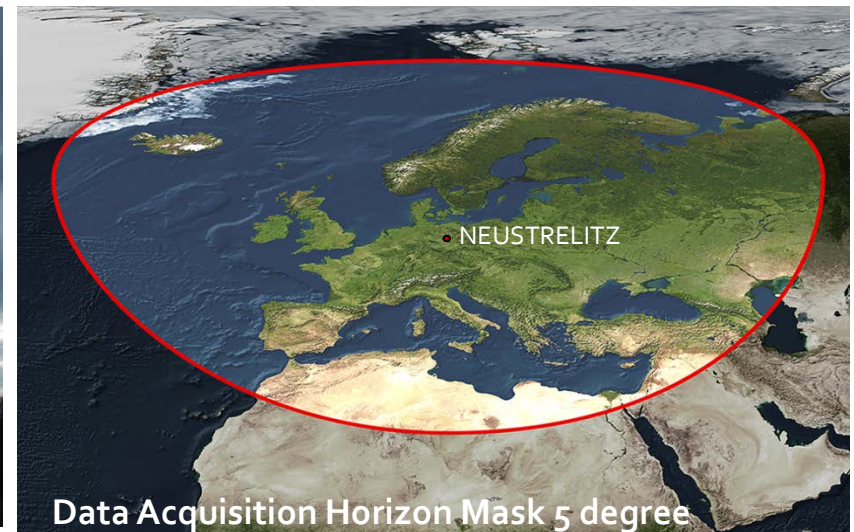
German Remote Sensing Data Center Department: National Ground Segment

- Ground Stations
- Data Management
- Real time Services
- Maritime Security Lab



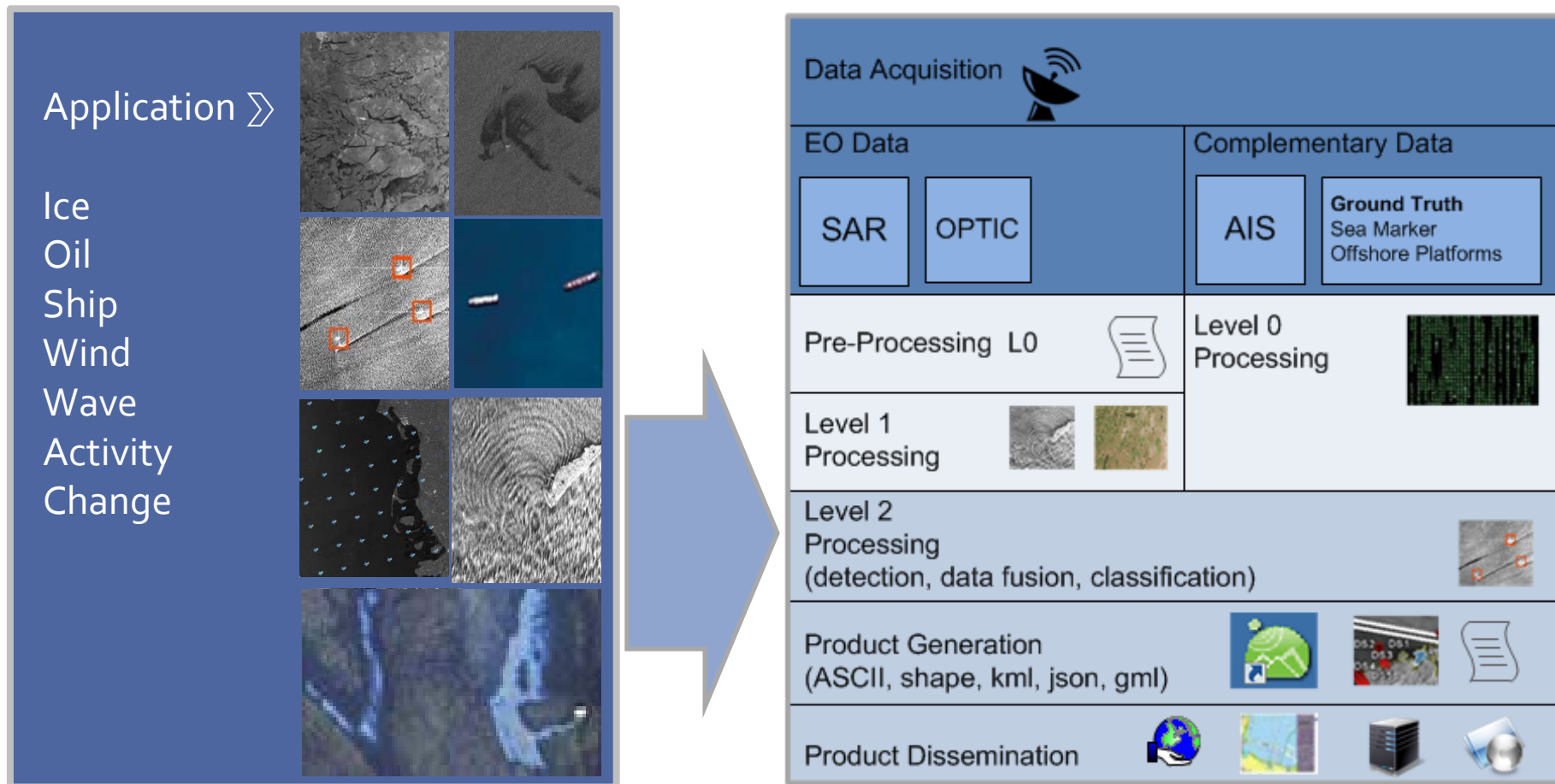
Ground Station and Processing Facility Neustrelitz

- Support of currently 12 different Satellite missions
- Main reception and processing facility for SAR Mission TerraSAR-X
- Collaborative Station for European Sentinel-1 mission
- Radarsat-2 Regional Ground System
- Landsat-8 Global Network Station
- CartoSAT, ResourceSat, Oceansat (GAFAG)



Objective

Research and development of integrated applications enabling specific value added **Maritime Information Products for the Maritime Situational Awareness** in Near Real Time



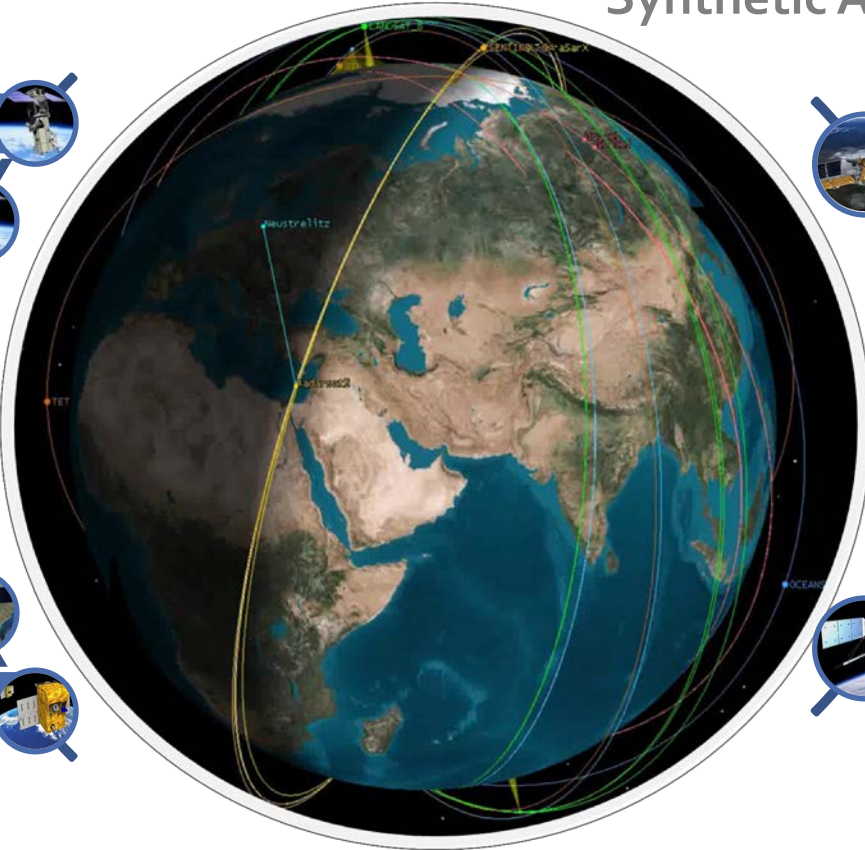
Sensors and Modes

Optical

- Worldview-1
- Worldview-2
- Worldview-3
- GeoEye-1
- Deimos
- Landsat-8
- Firebird

Synthetic Aperture Radar (SAR)

- Sentinel-1A
- Sentinel-1B
- TerraSAR-X
- TanDEM-X
- Radarsat-2

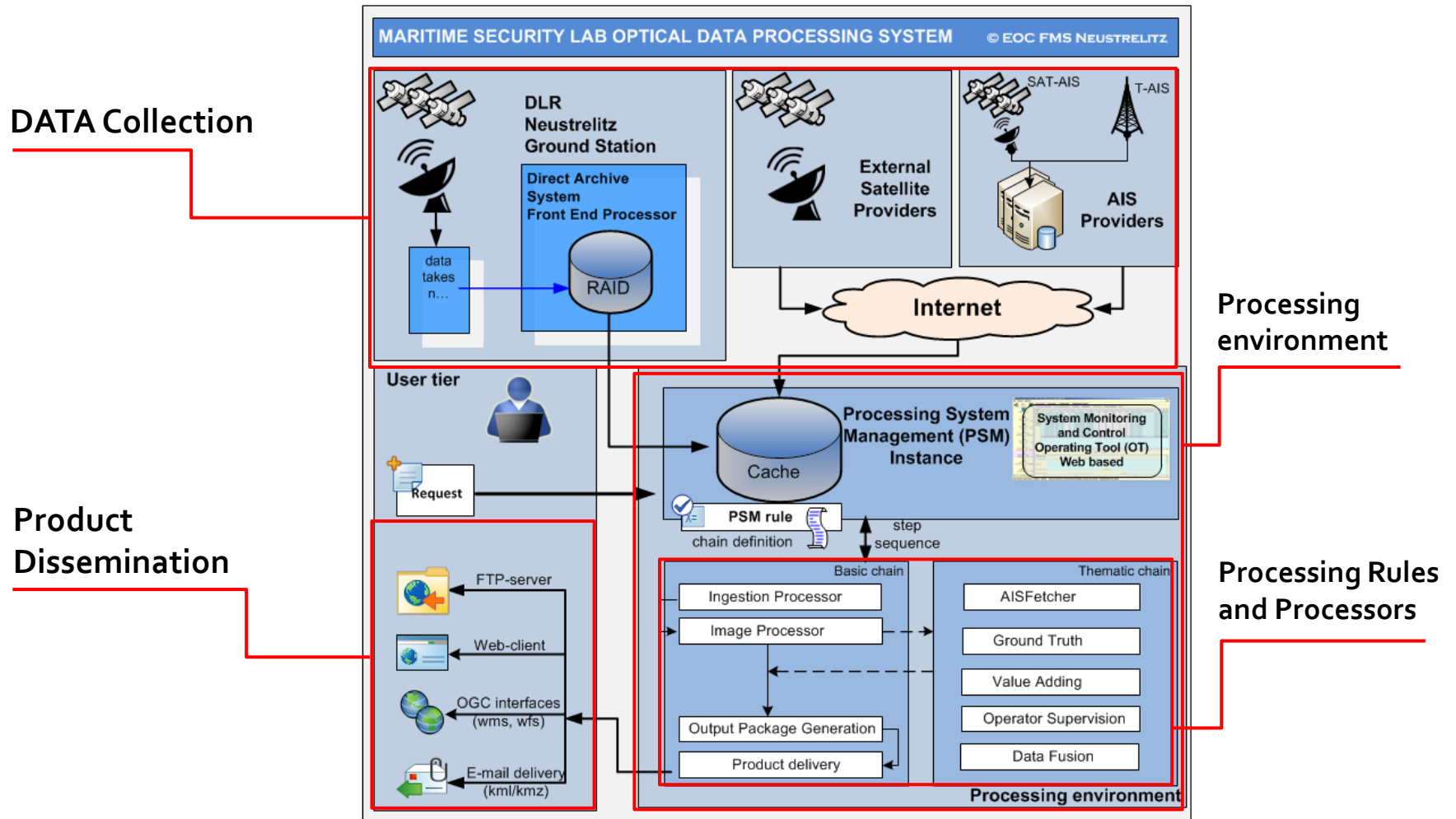


Automatic Identification System

- Terrestrial AIS
- T-AIS
- Satellite AIS



Architecture of Processing Chain



Processing System Management - Workflows and Plug-Ins

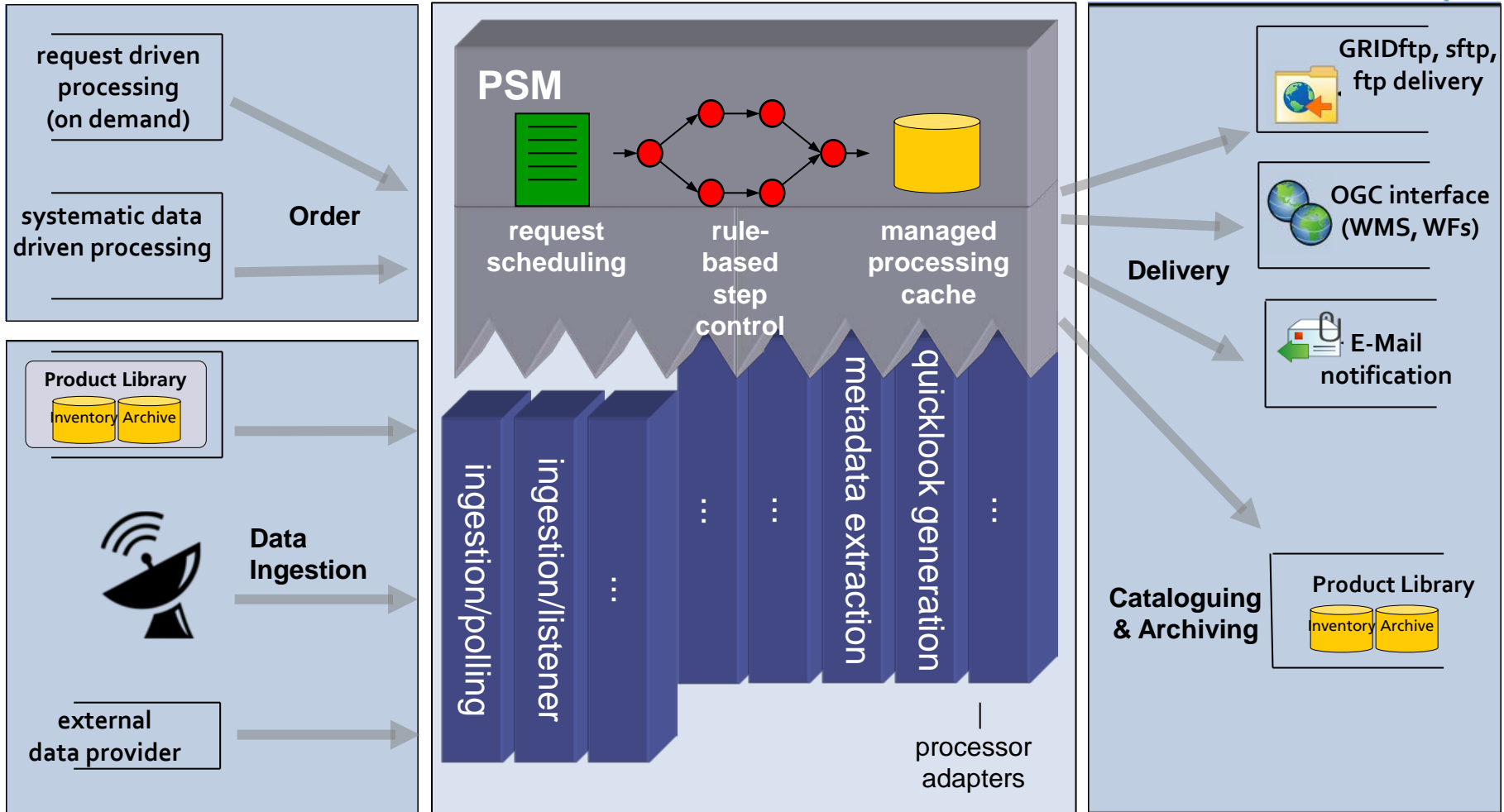


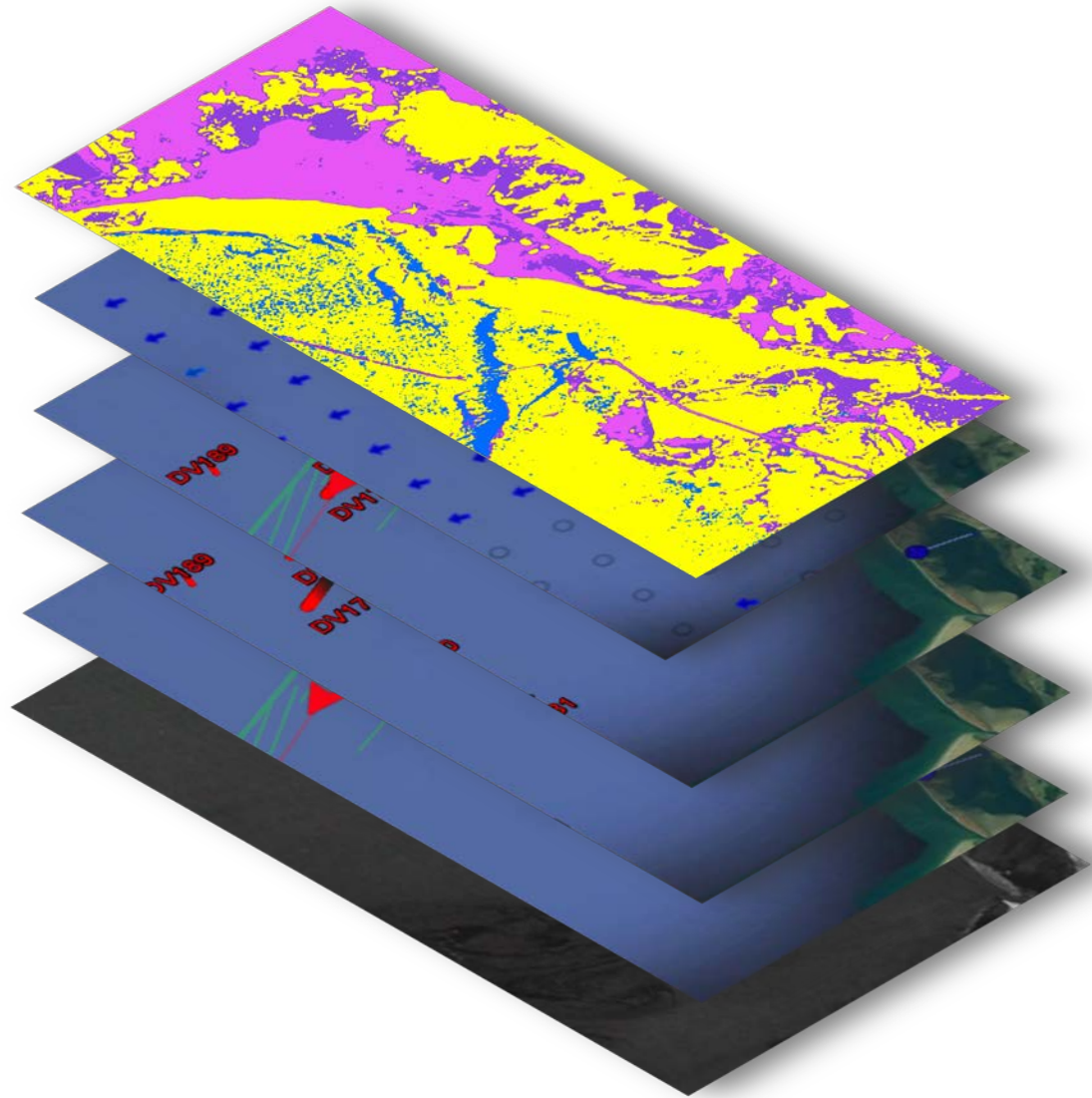
Image Processing

- Pre-processing
 - Lo, L1b
- Scene Slicing
- image mosaicking
- Image projection
- Product Format
 - GeoTIFF
 - JPEG 2000



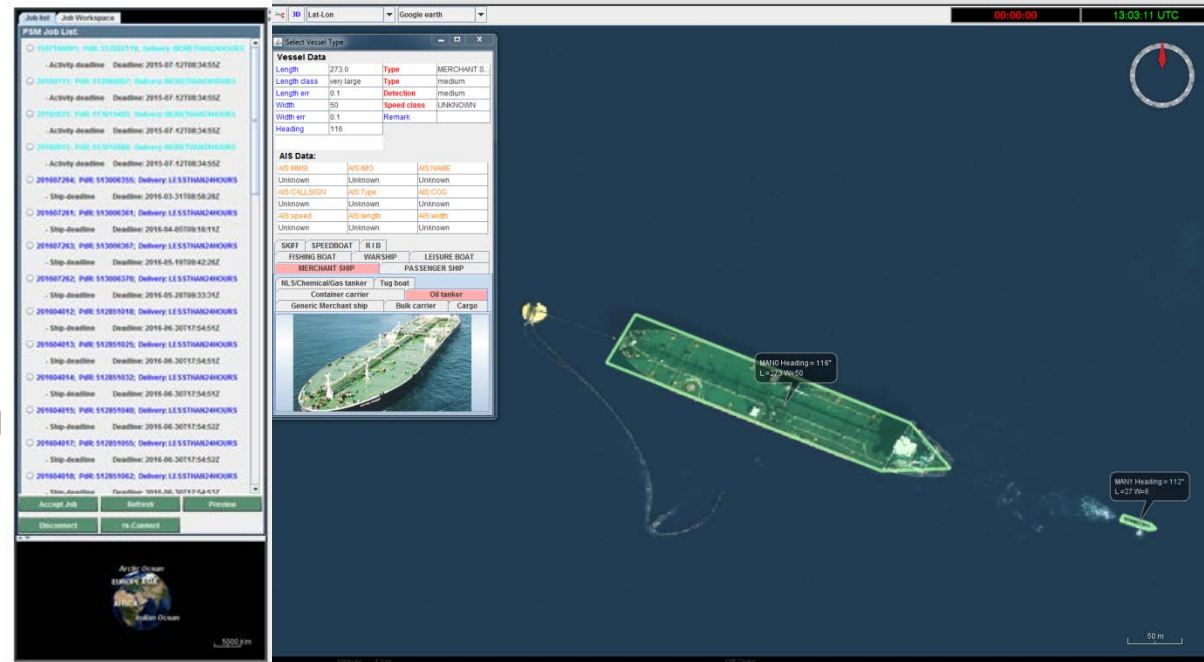
Thematic Processing Chain

- Automated processing
 - Target detection
 - Data fusion
 - Wind
 - Wave
- Semi automated algorithms
 - Target detection
 - Activity detection
 - Change detection
 - Data fusion
- Operator Interface
 - GUI with 3D viewer



Thematic Processing Chain

- Automated algorithm
 - Target detection
 - Data fusion
 - Wind
 - Wave
- Semi automated processing
 - Target detection
 - Activity detection
 - Change detection
 - Data fusion
- Operator Interface
 - GUI with 3D viewer



Operator GUI of Analysis Framework (client side)

WorldView 3
 © 2016 DigitalGlobe, Inc.
 provided by European Space Imaging

Product Dissemination

Product Delivery Services



UKIS
<http://dlr.de/>



Leaflet
<http://leafletjs.com/>




ANGULARJS
by Google
<http://angularjs.org/>




node
<https://nodejs.org>


Powered by:



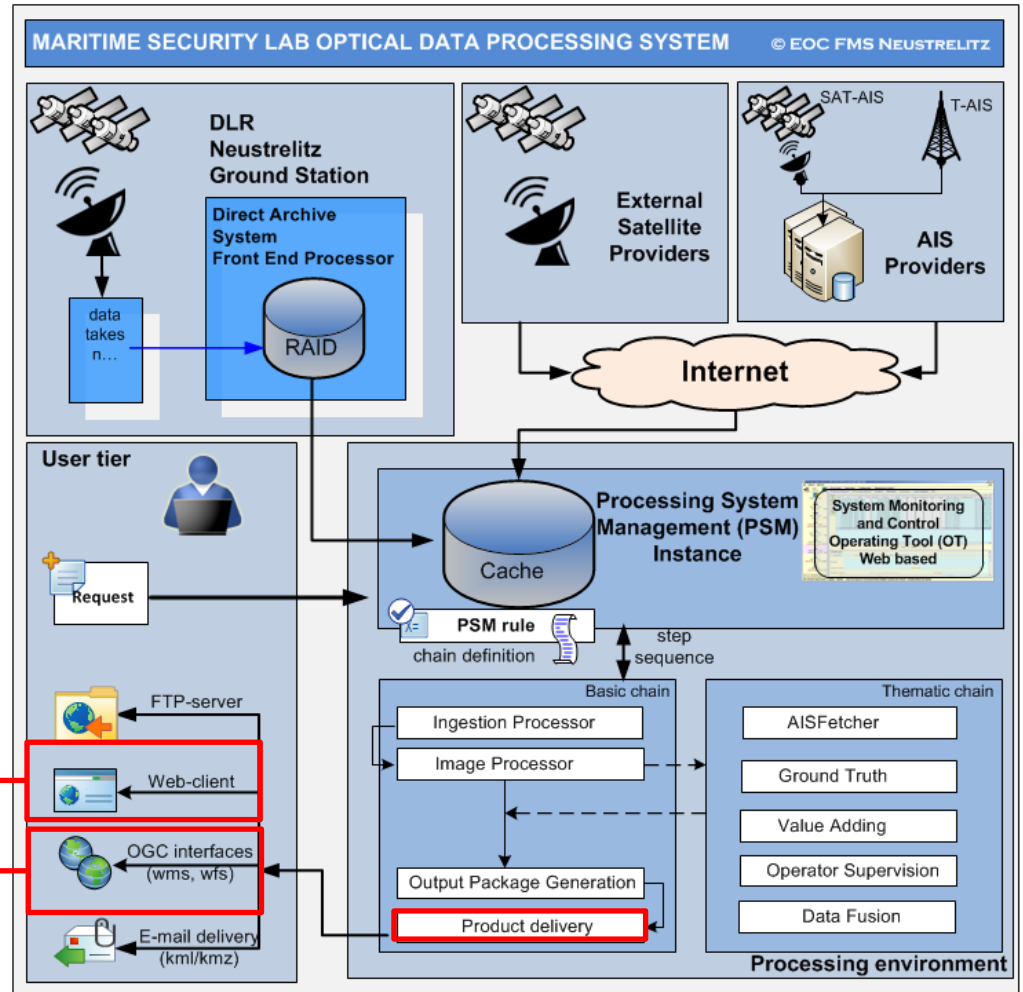
Tomcat
<http://tomcat.apache.org/>



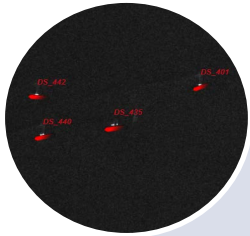
GeoServer
<http://geoserver.org/>



PostgreSQL
<https://www.postgresql.org/>



Ship- Detection Application (SAR)



Near real time ship
detection application
based on SAR images

currently developed for:

TerraSAR-X,

TanDEM-X

Radarsat-2,

Sentinel-1A,

Sentinel-1B

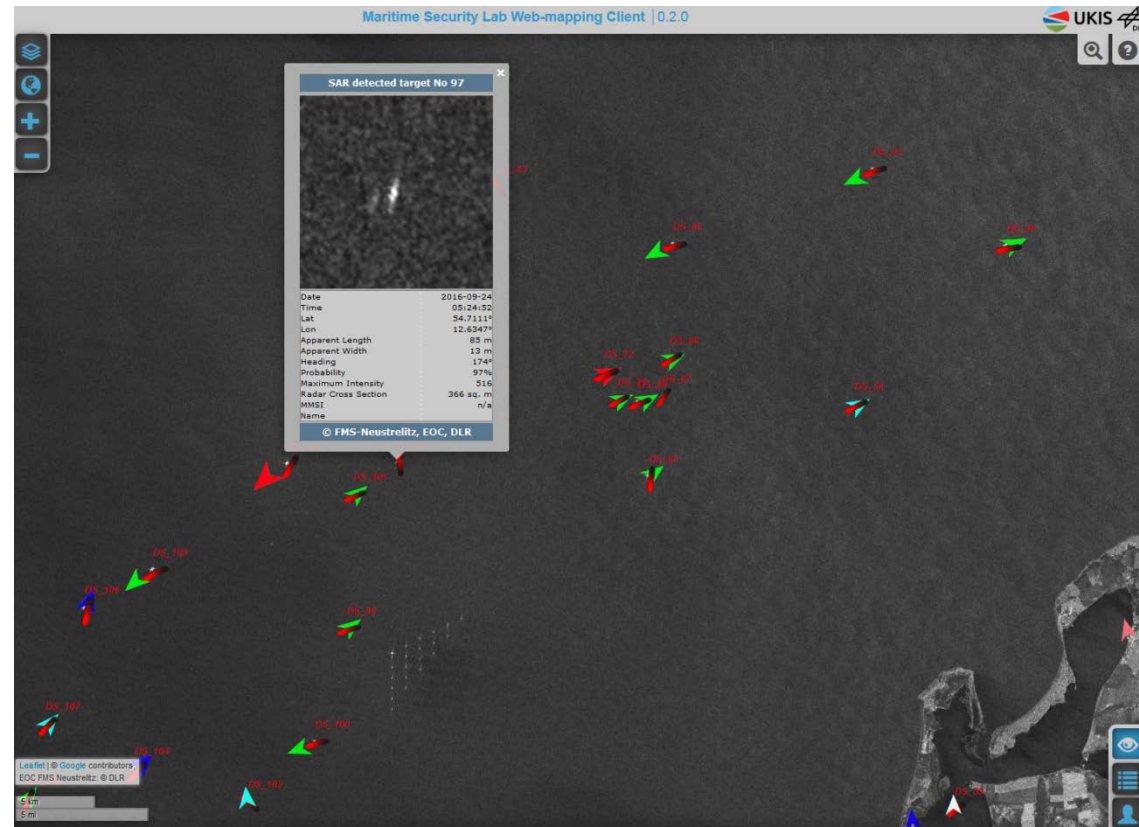


Image: S1A_IW_GRDH_1SDV_20160924T0524

Value added products

- **SAR/ AIS merged products** (in case of available AIS Data)
- ASCII ; KMZ, GML; DER (EMSA); ESRI shape; json;
- GeoTIFF (MRES_L1b; HRES_L1B)

Ship- Detection Application (Optic)



Near real time ship detection application based on optical data

Core processor currently being developed by the Maritime Security_Lab Neustrelitz

value added products in near real time based on very high resolution images (Worldview 1-3, GeoEye,)

Maritime Security Lab Web-mapping Client | 0.2.0

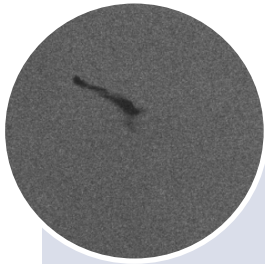
BAYREUTH	
DESCRIPTION	
Length	66 m
Width	10 m
POSITION	
Lat	54.1627°
Lon	8.3582°
IDENTIFICATION	
MMSI	211386450
Callsign	DBGY
Ship Type	Law Enforcement
Imo	9252632
DESTINATION	
Destination	
ETA	
STATE	
Status	Under way using engine
Speed	0.6
Course(COG)	334.85°
True Heading	334°
Draft	0 m
Timestamp	
Message type	predictedAtCollectionTime
© FMS-Neustrelitz, EOC, DLR	

Optical detected target No 2	
Date	2016-09-07
Time	11:06:18
Lat	54.1628°
Lon	8.3582°
Length	66 m
Width	10 m
Heading	246°
Probability	100%
MMSI	211386450
Name	BAYREUTH
© FMS-Neustrelitz, EOC, DLR	

WorldView-2, pansharp, 2016-09-07, 11:06 UTC

- Value added products
 - **OPT/AIS merged products** (in case of available AIS Data)
 - ASCII ; KMZ, GML; VDS (EMSA); ESRI shape; json; GeoTIFF

Oil Spill Detection (SAR)

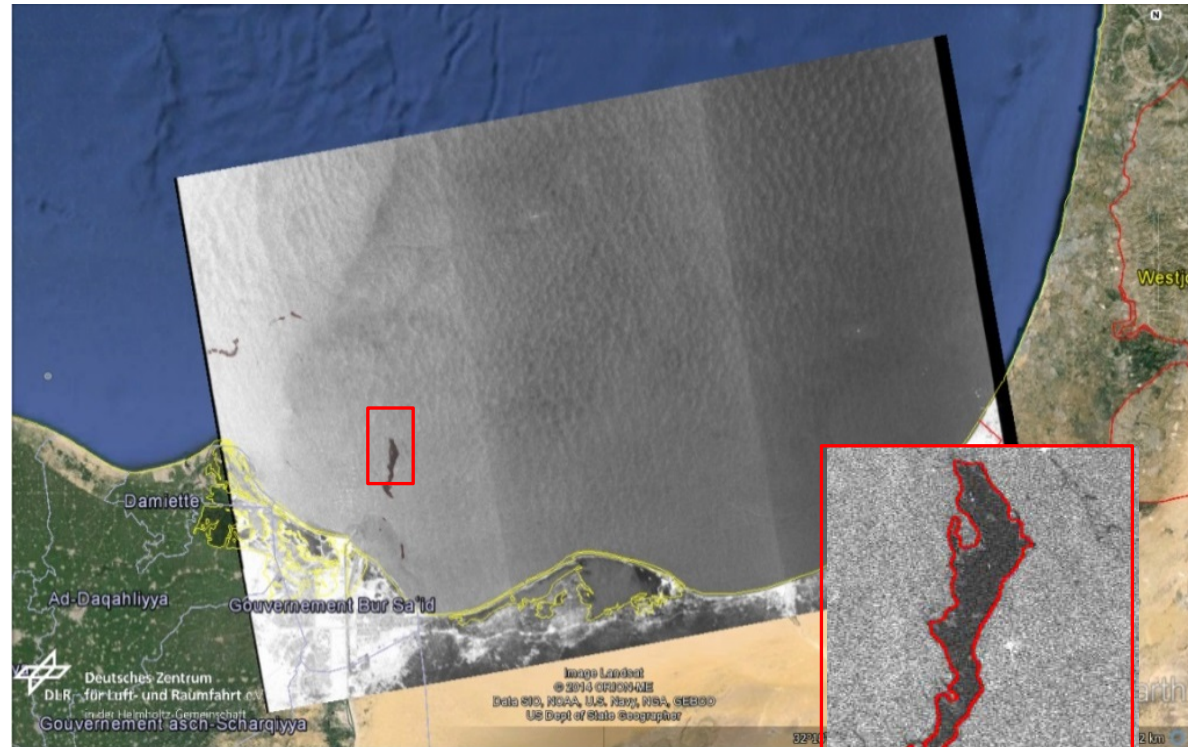


Near real time oil spill detection application based on SAR images

core function is the qualification algorithm developed by the Maritime Security Lab Bremen based on Neural Network

currently developed for:
TerraSAR-X, TanDEM-X
Radarsat-2, Sentinel-1A,
Sentinel-1B

Ackn: S. Singha; DLR- IMF



S1A_IW_GRDH_1SDV_20141004T154824

Value added products

- ASCII ; KMZ, GML; OSN (EMSA); ESRI shape; pdf;
- GeoTIFF (MRES_L1b; HRES_L1B)

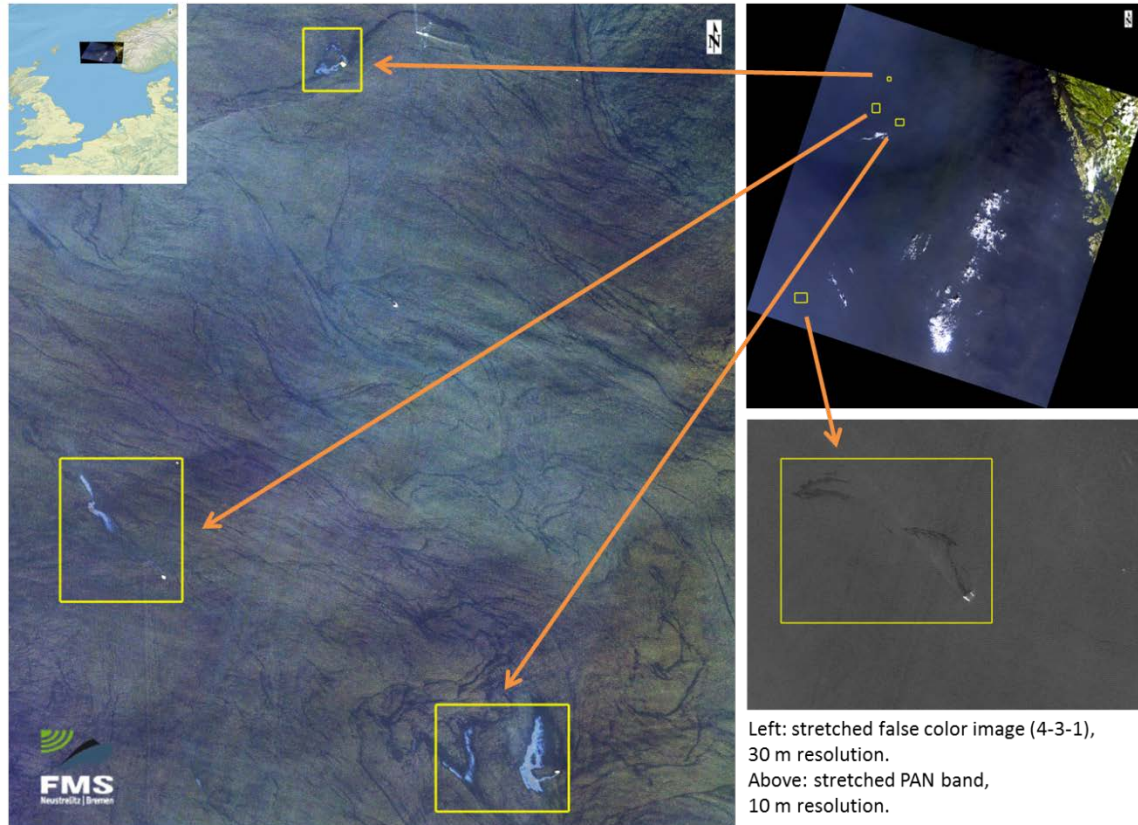
Oil Spill Detection (Optic)



Near real time oil spill detection application based on optical data

Core processor currently being developed by the Maritime Security_Lab Neustrelitz

planned value added products in near real time based on Landsat-8



Left: stretched false color image (4-3-1), 30 m resolution.
Above: stretched PAN band, 10 m resolution.

Potential oil spills nearby platforms in the North Sea,

Landsat 8 OLI, 2014-07-11, 10:56 UTC



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

Maritime Security Lab Web-mapping Client | 0.2.0

Selected products

Sensor	Time	
LA8	2016-09-08T10:20:38	<input type="checkbox"/>
WV02	2016-09-08T11:06:18	<input checked="" type="checkbox"/>

Layers

- SDP layer off
- AIS layer off
- Popcorn detection on
- SAT image on

SAT image opacity: 0% to 100%

Legend

Vessel Type

- Passenger
- Cargo
- Highspeed
- Tug/service
- Yacht
- Fishing
- Military
- Wing
- Tanker
- Other

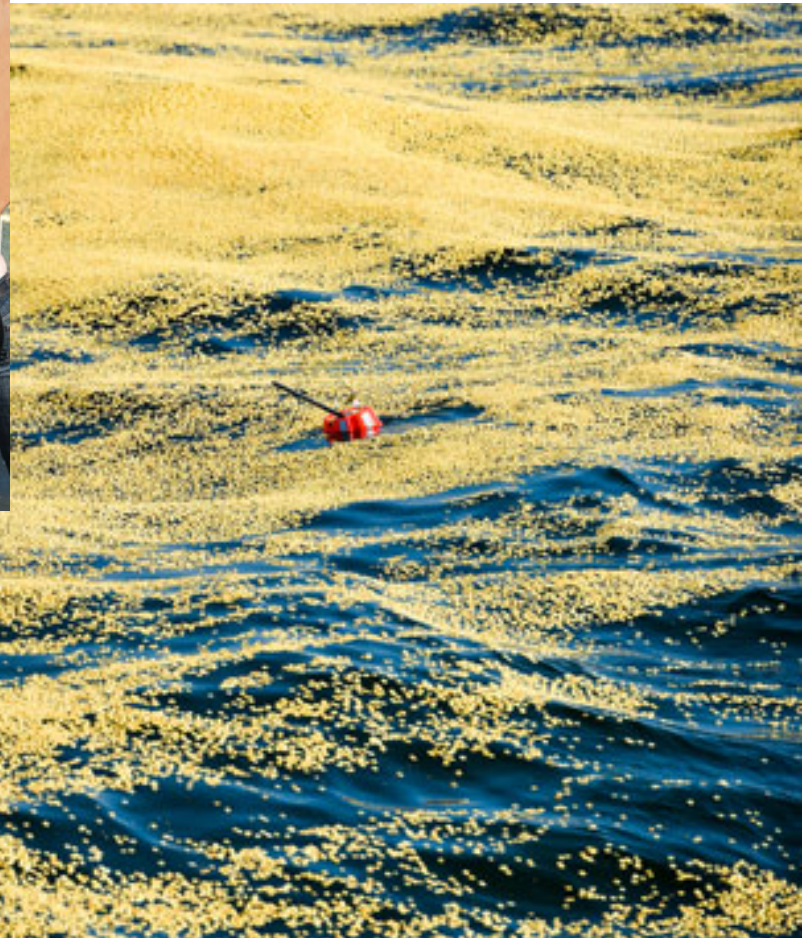
Leaflet | © Google contributors, EOC FMS Neustrelitz © DLR

5 km
5 mi



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

Project EMSec, Sep. 2016, Hazard (Popcorn) detection



Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection – Landsat-8

Maritime Security Lab Web-mapping Client | 0.2.0

UKIS DLR

Selected products

Sensor	Time
LA8	2016-09-08T10:20:38

Layers

- SDP layer
- AIS layer
- Popcorn detection
- SAT image

SAT image opacity: 0% to 100%

Legend

Vessel Type

- Passenger
- Cargo
- Highspeed
- Tug/service
- Yacht
- Fishing
- Military
- Wing
- Tanker
- Other

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Leaflet | © Google contributors, EOC FMS Neustrelitz, © DLR

100 m
300 ft

Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection – WorldView-2

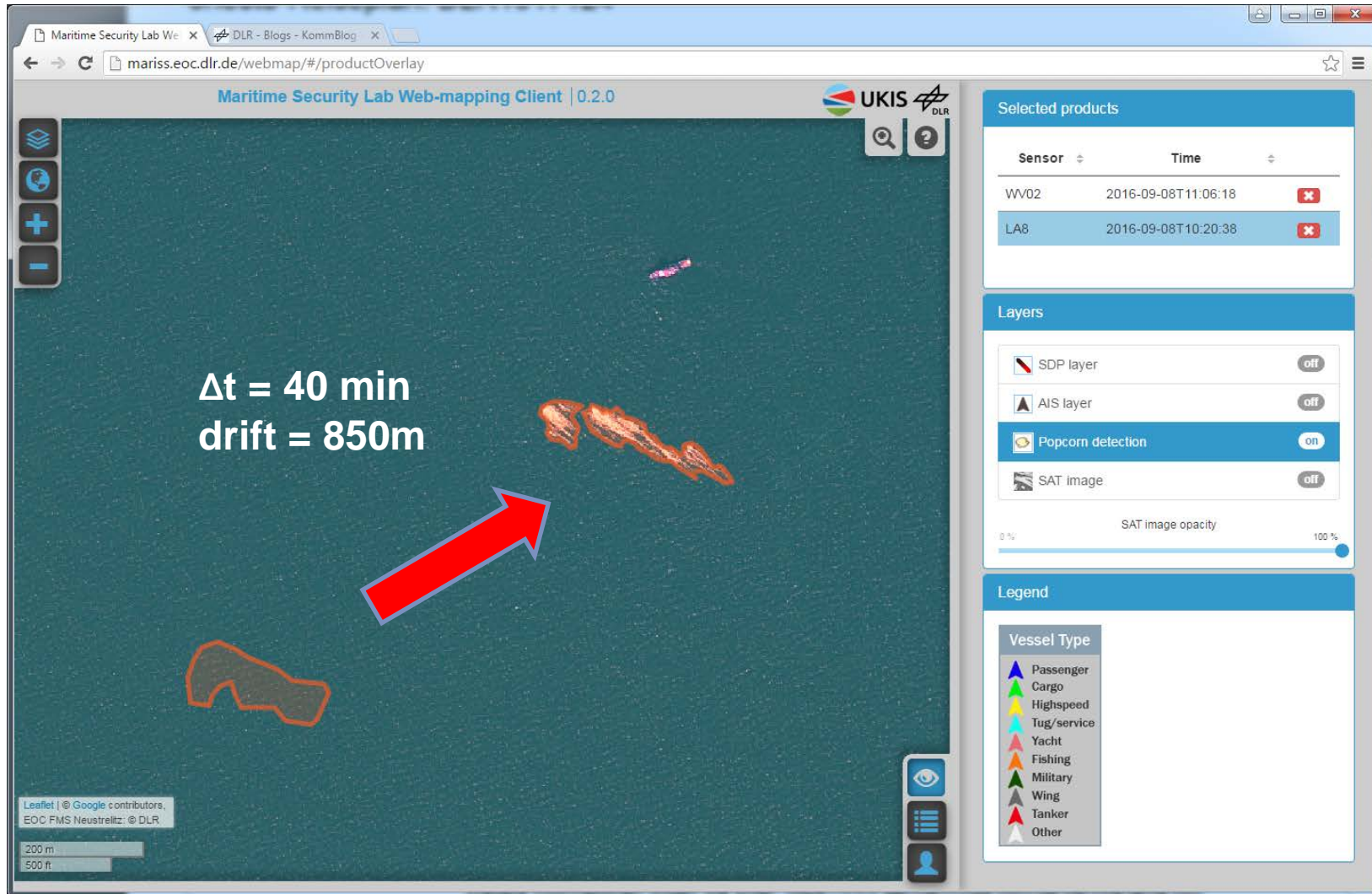
The screenshot displays the Maritime Security Lab Web-mapping Client interface. The main map area shows a satellite image of a ship (labeled 'WV02') with a red hazard detection overlay. The interface includes a sidebar with navigation controls, a top navigation bar with the URL 'mariss.eoc.dlr.de/webmap/#/productOverlay', and a right-hand panel with the following sections:

- Selected products:** A table showing the selected product 'WV02' with a sensor of 'WV02' and a time of '2016-09-08T11:06:18'.
- Layers:** A list of layers with their status:
 - SDP layer: on
 - AIS layer: off
 - Popcorn detection: on
 - SAT image: on
- Legend:** A legend for Vessel Type with the following categories:
 - Passenger (blue triangle)
 - Cargo (green triangle)
 - Highspeed (yellow triangle)
 - Tug/service (cyan triangle)
 - Yacht (magenta triangle)
 - Fishing (orange triangle)
 - Military (green triangle)
 - Wing (grey triangle)
 - Tanker (red triangle)
 - Other (white triangle)

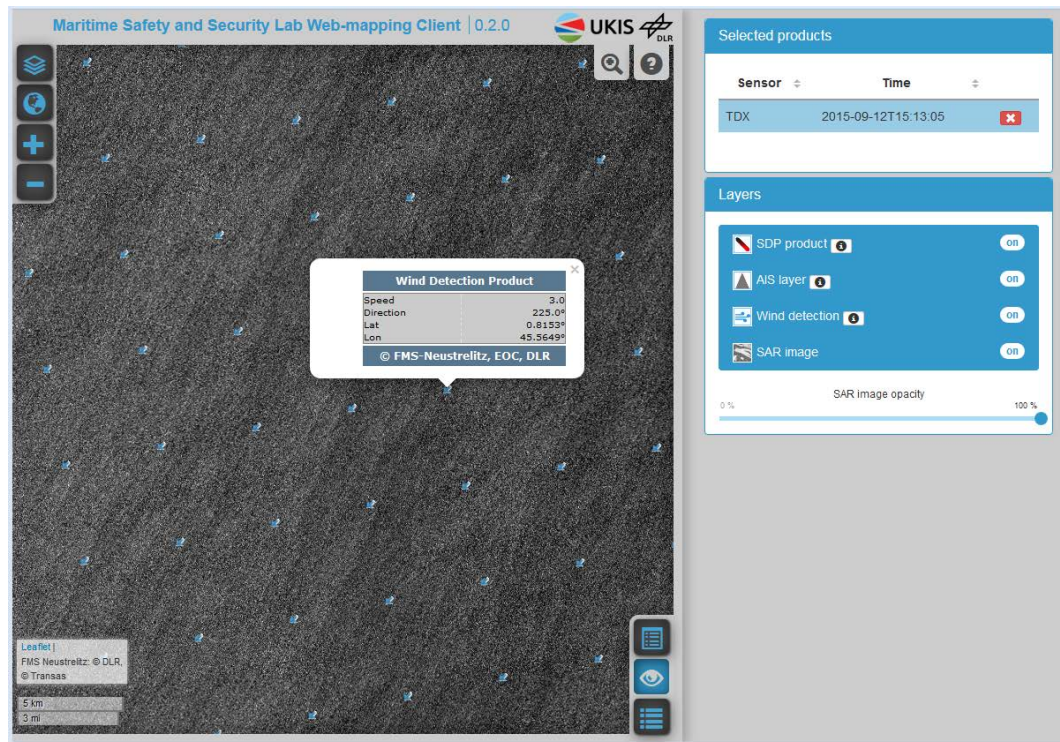
The interface also features a scale bar (100 m / 300 ft) and a DLR logo in the bottom left corner.



Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection – Landsat-8



Application for Wind field products



- Core function is the XMOD-2 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, (Jacobsen et al., 2013)

- Forecast model is implemented to provide wind direction, the netCDF output is generated, containing the wind direction and intensity (WD10)

- Level 2 Produktformate

- ASCII

- netCDF

- Google (KMZ)

- png, wld, png.aux.xml

- ESRI Shape Layer Files (shape)

Image:

TDX1_SAR_MGD_RE__SC_S_SRA_20150912T151305_20150912T151310

The wind forecast and the Level 1 quicklook product in the background is overlaid by the DLR SAR WIND product (rectangle) derived from the Sentinel image.

Example for Wind field products based on Sentinel-1

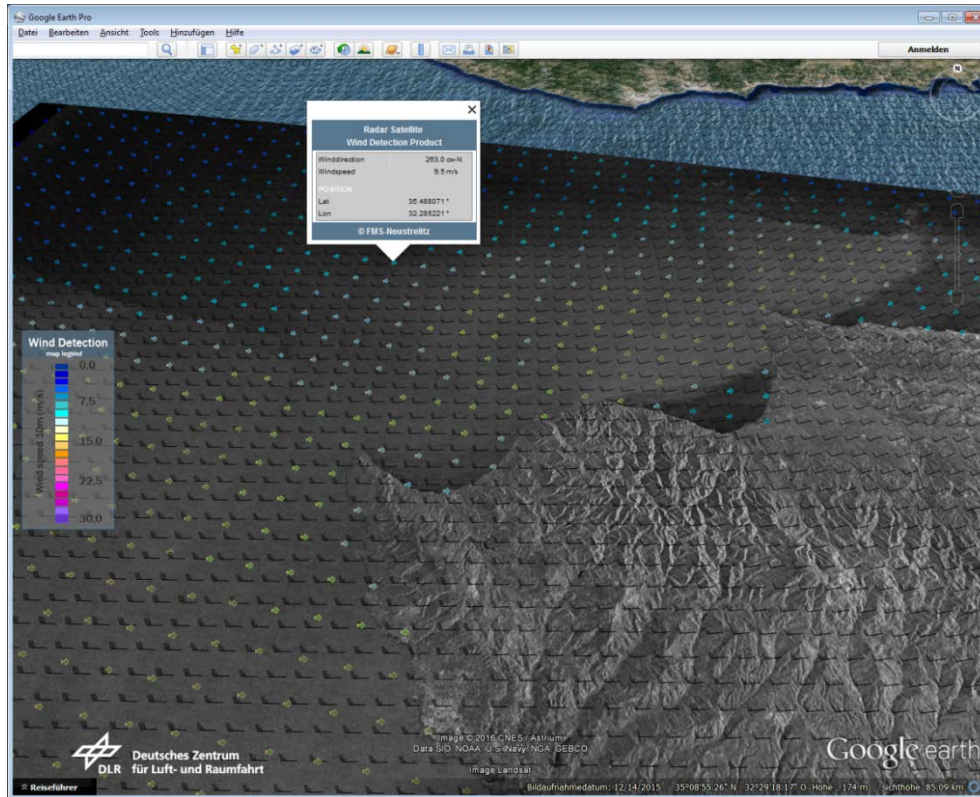
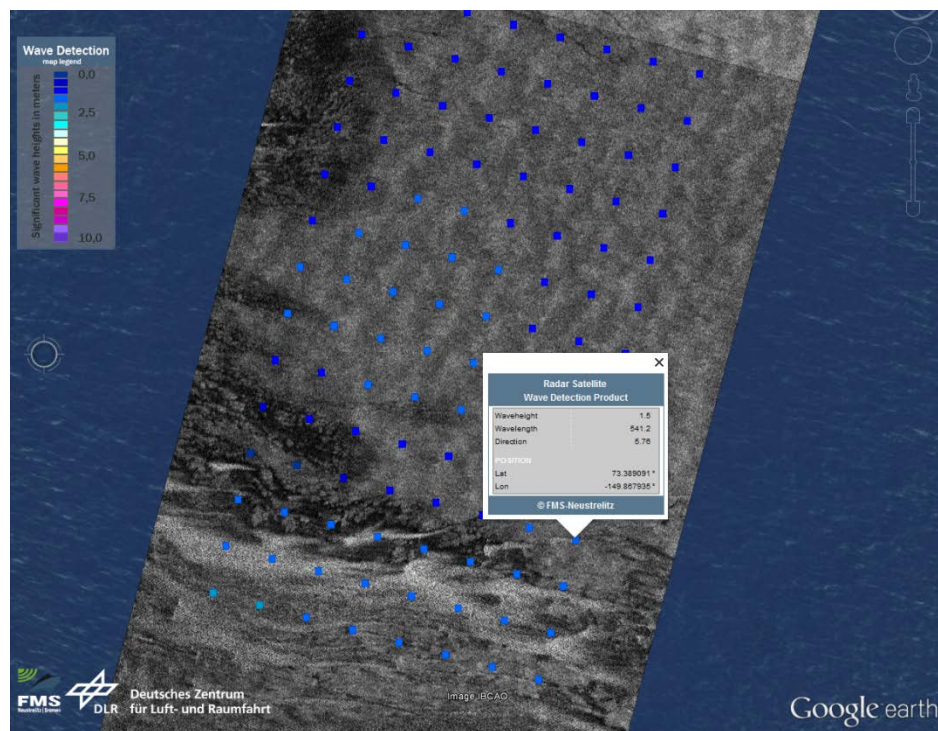


Image: S1A_IW_GRDH_1SDV_20160316T035101_20160316T035125

DLR SAR WIND product (rectangles) derived from the Sentinel image, wind forecast and Level 1 quicklook product as background.

- Core function is the CMOD-5 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, **validation ongoing**,
- Forecast model is implemented to provide wind direction, the netCDF output is generated, containing the wind direction and intensity (WD10)
- Level 2 Produktformate
 - ASCII
 - netCDF
 - Google (KMZ)
 - png, wld, png.aux.xml
 - ESRI Shape Layer Files (shape)

Application for Wave products based on Mission TerraSAR-X




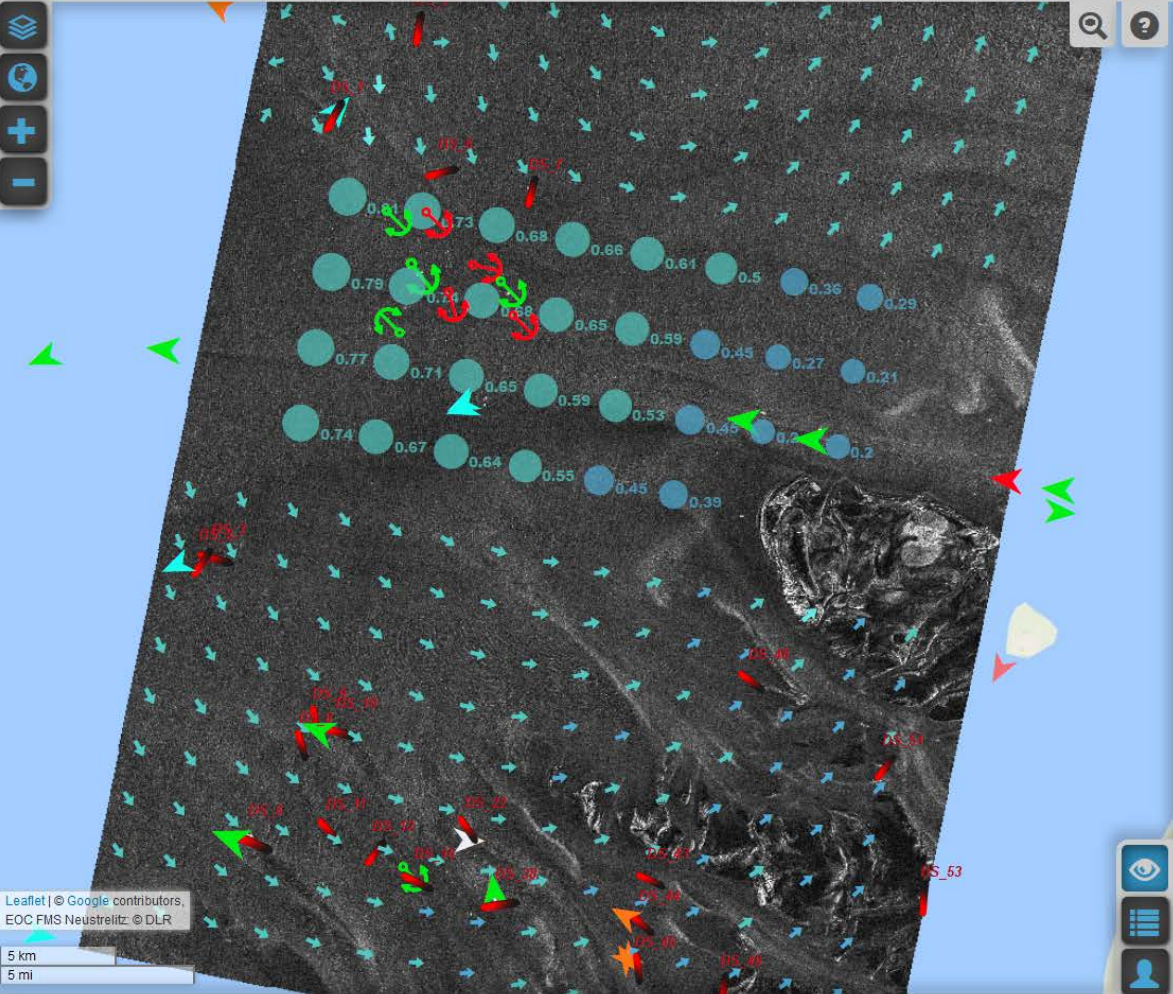
DLR SAR WAVE product (rectangles) derived from the TerraSAR-X StripMap image, L1 quicklook product as background.

Pleskachevsky, A., Rosenthal, W., Lehner, S. (2016) Meteo-Marine Parameters for Highly Variable Environment in Coastal Regions from Satellite Radar Images. ISPRS Journal of Photogrammetry and Remote Sensing, Seiten 1-25. ELSEVIER. DOI: 10.1016/j.isprsjprs.2016.02.001. (in print)

- new XWAVE-2 algorithm developed by the Maritime Security Lab Bremen to derive wave height and wave length (Pleskachevsky et al., 2016)
- Level 2 Produktformate
 - ASCII
 - netCDF
 - Google (KMZ)
 - GIS, png, wld, png.aux.xml
 - ESRI Shape Layer Files (shape)

Example of Product delivery on GeoServer and connected via Web-mapping Client

Maritime Security Lab Web-mapping Client | 0.2.0




Selected products

Sensor	Time	
TSX	2016-09-05T05:51:21	✕
TSX	2016-09-05T05:51:23	✕
TSX	2016-09-05T05:51:25	✕

Layers

- SDP layer on
- AIS layer on
- Wind detection on
- Wave detection off
- SAT image on

SAT image opacity 0% 100%

Legend

Vessel Type	Wind Detection <small>map legend</small>	Wave Detection <small>map legend</small>
▲ Passenger	0,0	0,0
▲ Cargo	7,5	2,5
▲ Highspeed	15,0	5,0
▲ Tug/service	22,5	7,5
▲ Yacht	30,0	10,0
▲ Fishing		
▲ Military		
▲ Wing		
▲ Tanker		
▲ Other		

Leaflet | © Google contributors, EOC FMS Neustrelitz © DLR

5 km
5 mi

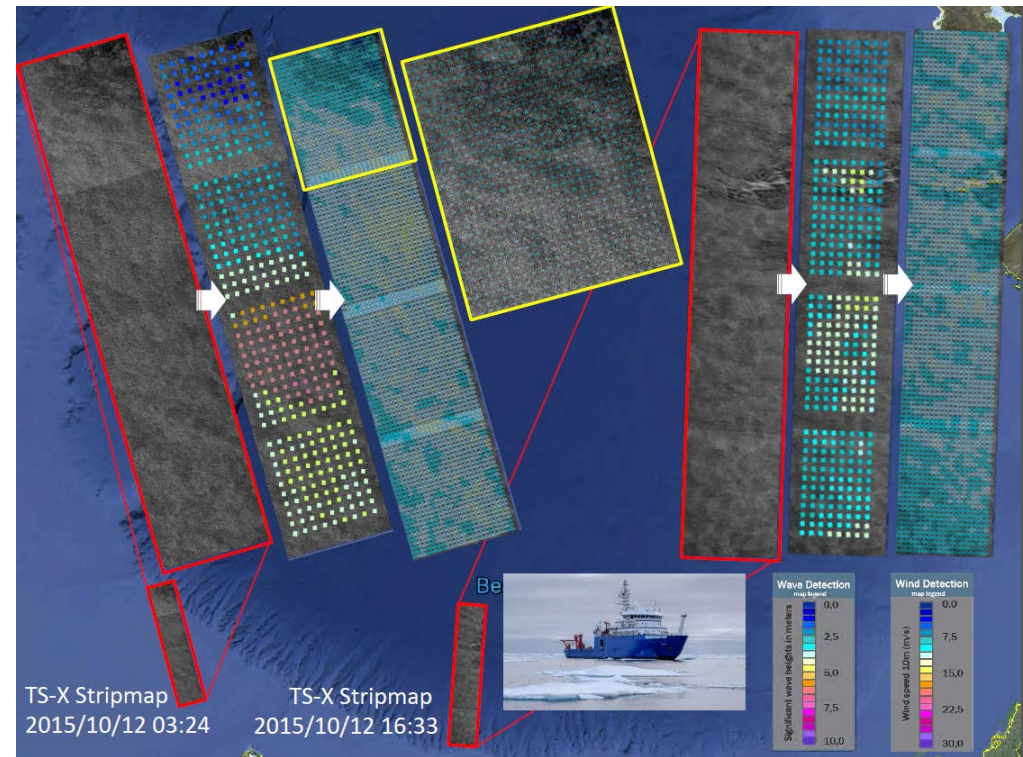


Example of NRT Support for Office of Naval Research (ONR) Arctic Sea State Campaign 2015

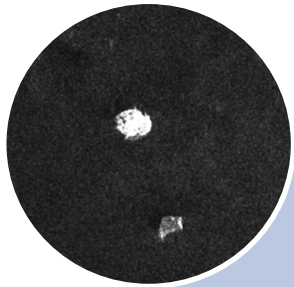
Research Vessel Sikuliaq
Beaufort Sea

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

- TerraSAR-X support comprises
- additional SGS contacts used for D/L
- NRT L1b product delivery
- products deliveries for usage at ship
- Quicklook products in addition with wind and wave charts



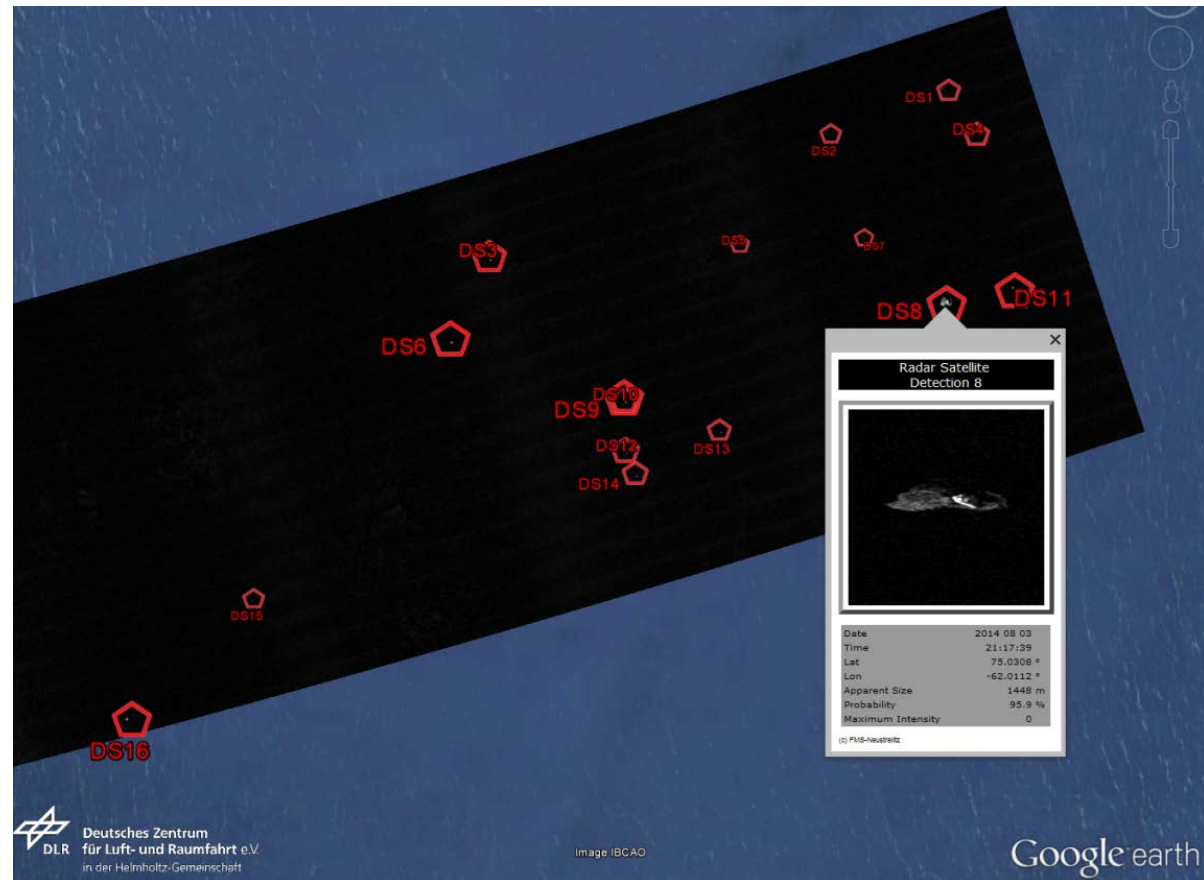
Outlook - Iceberg- detection



Near real time
iceberg detection
application
to Support Maritime
Situation Awareness

- Ice Service Center
- Support Exploration
Management and
Resource planning
- Route management

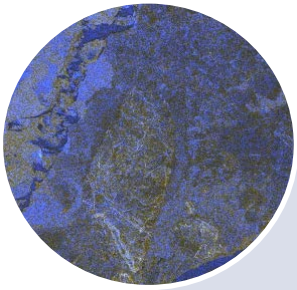
Ackn: A. Frost; DLR- IMF



TerraSAR-X ScanSAR Mode, Polarisation: HH, 150 km range,

Frost, Anja und Ressel, Rudolf und Lehner, Susanne (2015) Iceberg Detection over Northern Latitudes Using High Resolution TerraSAR-X Images. In: 36th Canadian Symposium of Remote Sensing - Abstracts. 36th Canadian Symposium of Remote Sensing, 8.-11. June 2015, ST. JOHN'S, NEWFOUNDLAND AND LABRADOR, CANADA.

Outlook - Ice Classification

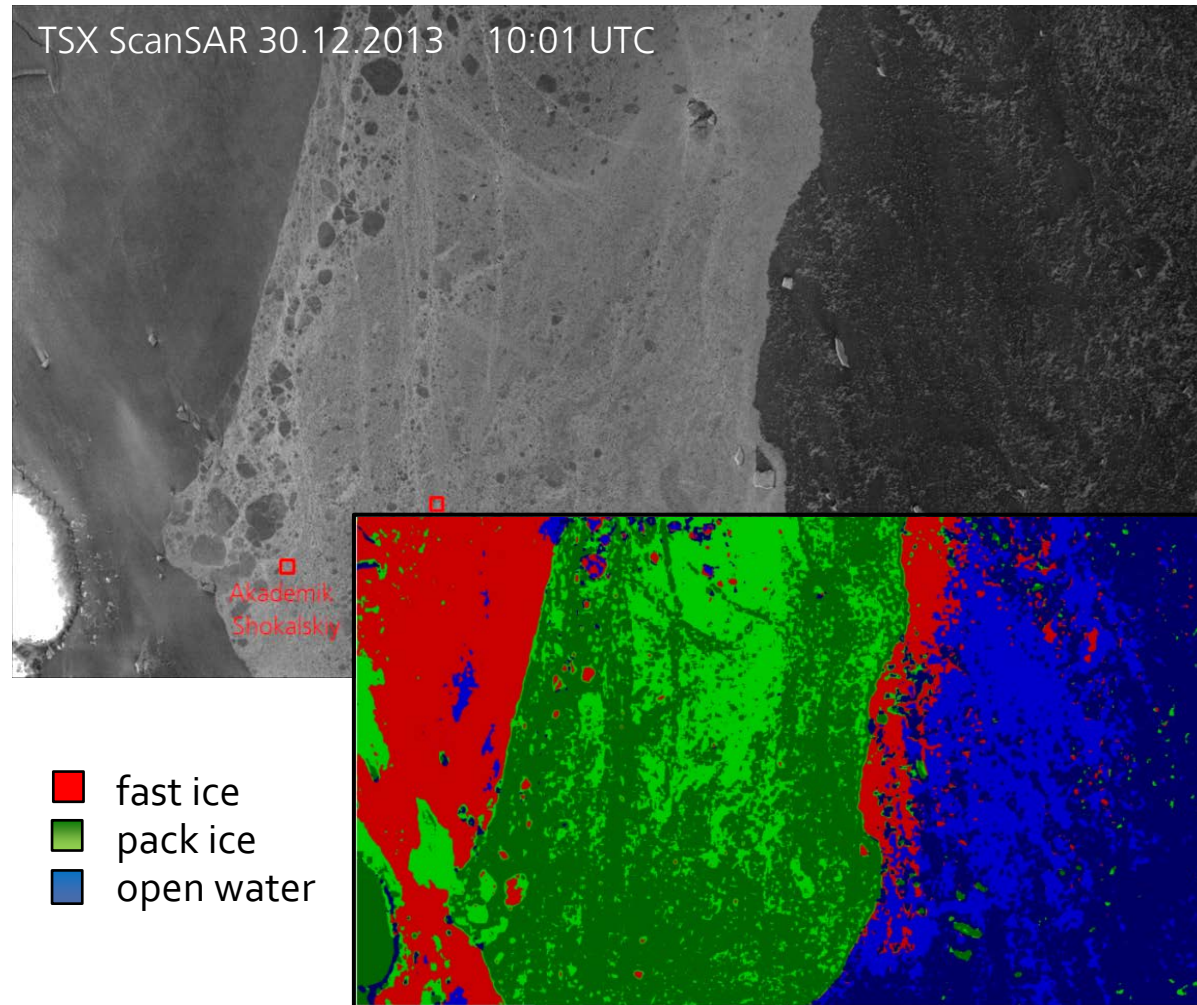


Near real time Ice drift application to Support Maritime Situation Awareness

Core processor currently being developed by the Maritime Security_Lab Bremen

Planned value added products based on TerraSAR-X (DualPol)

Ackn: S. Singha; DLR-IMF



Outlook - Ice Drift

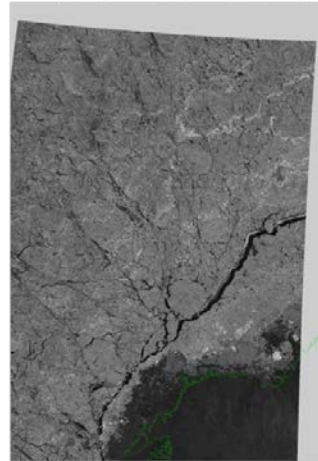


Near real time Ice drift application to Support Maritime Situation Awareness

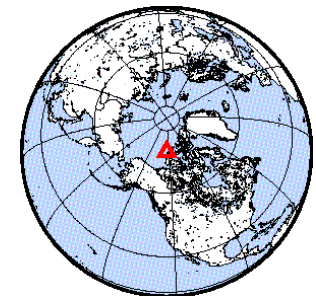
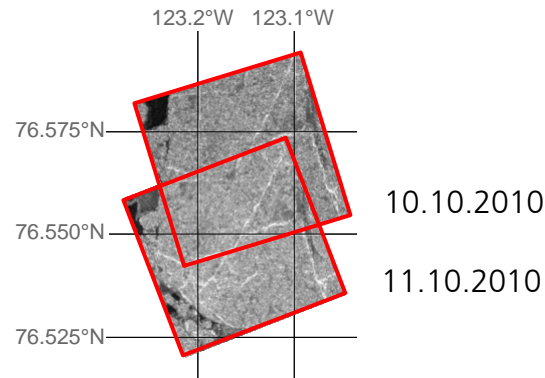
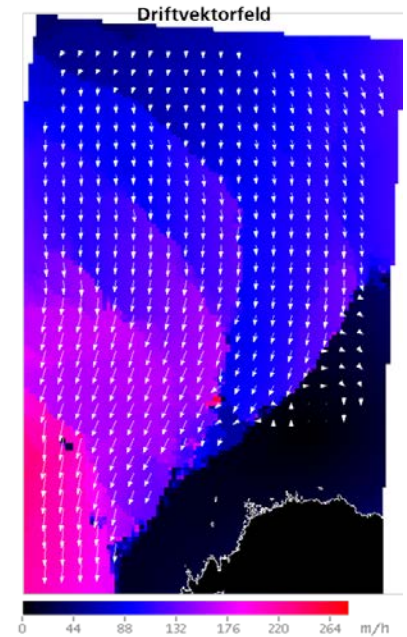
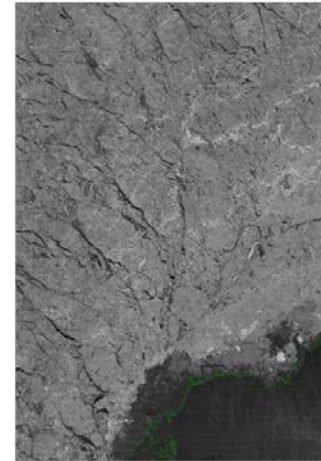
Core processor currently being developed by the Maritime Security_Lab Bremen

planned value added products in near real time based on TerraSAR-X, Sentinel-1 and Radarsat-2

TS-X ScanSAR • 10.10.2010 01:10 UTC



TS-X ScanSAR • 11.10.2010 00:53 UTC



An aerial photograph of a river delta, likely the Rhine delta, with a semi-transparent topographic map overlaid. The topographic map shows elevation contours in shades of purple, blue, and green, highlighting the river's path and surrounding terrain. The river branches out into a complex network of channels and distributaries. The background is a lush green landscape with some urban areas visible.

Egbert Schwarz

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E-mail: egbert.schwarz@dlr.de

Thank you
for your attention !

Landsat-8- 08. September 2016