

TerraSAR-X and TanDEM-X Mission

NRT Ship Detection

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Knowledge for Tomorrow



German Aerospace Center, DLR

Germany's national research center for aeronautics and space.

Space Agency

Project Management Agency

7.000 employees

29 research institutes and scientific/technical facilities at 13 sites

outposts in Brussels, Paris und Washington
(and soon Singapore)



← Security →



A modern, multi-story building with a grey facade and large glass windows. The building is surrounded by a paved area and a grassy lawn. Several flags are flying on poles in the foreground, including the German flag, the Japanese flag, the Chilean flag, and the European Union flag. The sky is blue with some clouds.

DLR Earth Observation Center (EOC), Oberpfaffenhofen, Germany

German Remote Sensing Data Center (DFD)
Remote Sensing Technology Institute (IMF)

Ground Stations:

Neustrelitz (Germany), O'Higgins (Chile),
Inuvik (Canada), Chetumal (Mexico)

TerraSAR-X (Synthetic Aperture Radar – SAR)



Launched June 15, 2007

**Global very high resolution
(1-16m)**

X-Band SAR

Swath width 5-400 km

**Ground segment &
processing by DLR**

**PPP with Astrium / InfoTerra (Astrium
Geoinformation Systems)**

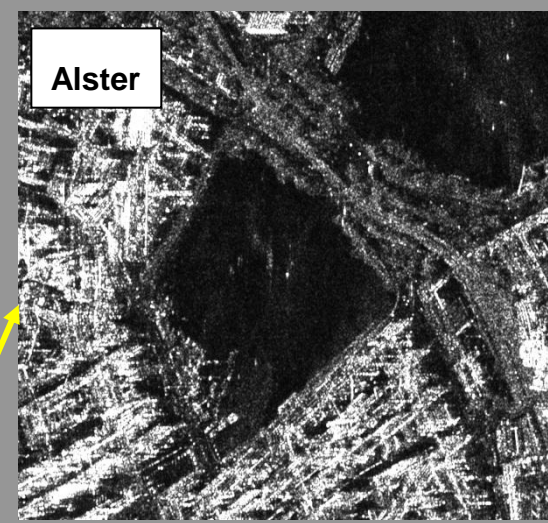


TerraSAR-X Hamburg

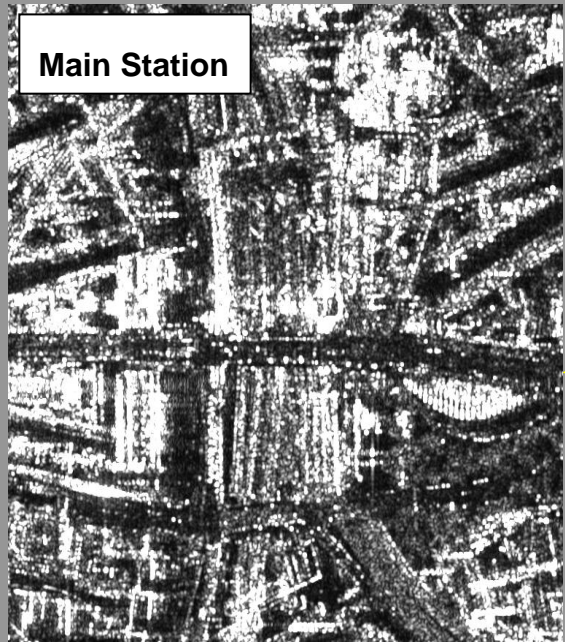
Imtech Arena



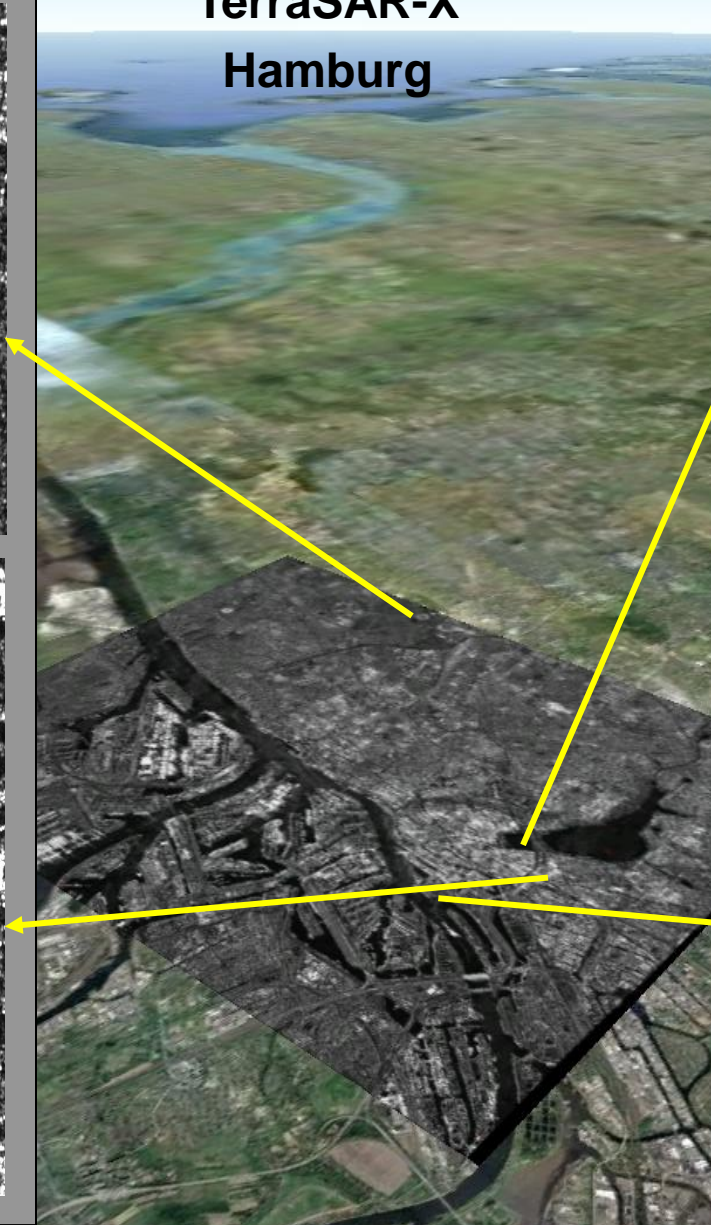
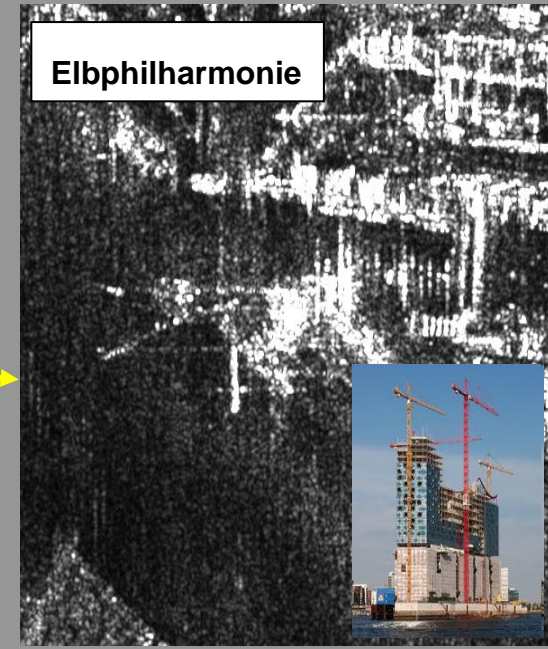
Alster



Main Station



Elbphilharmonie





TanDEM-X

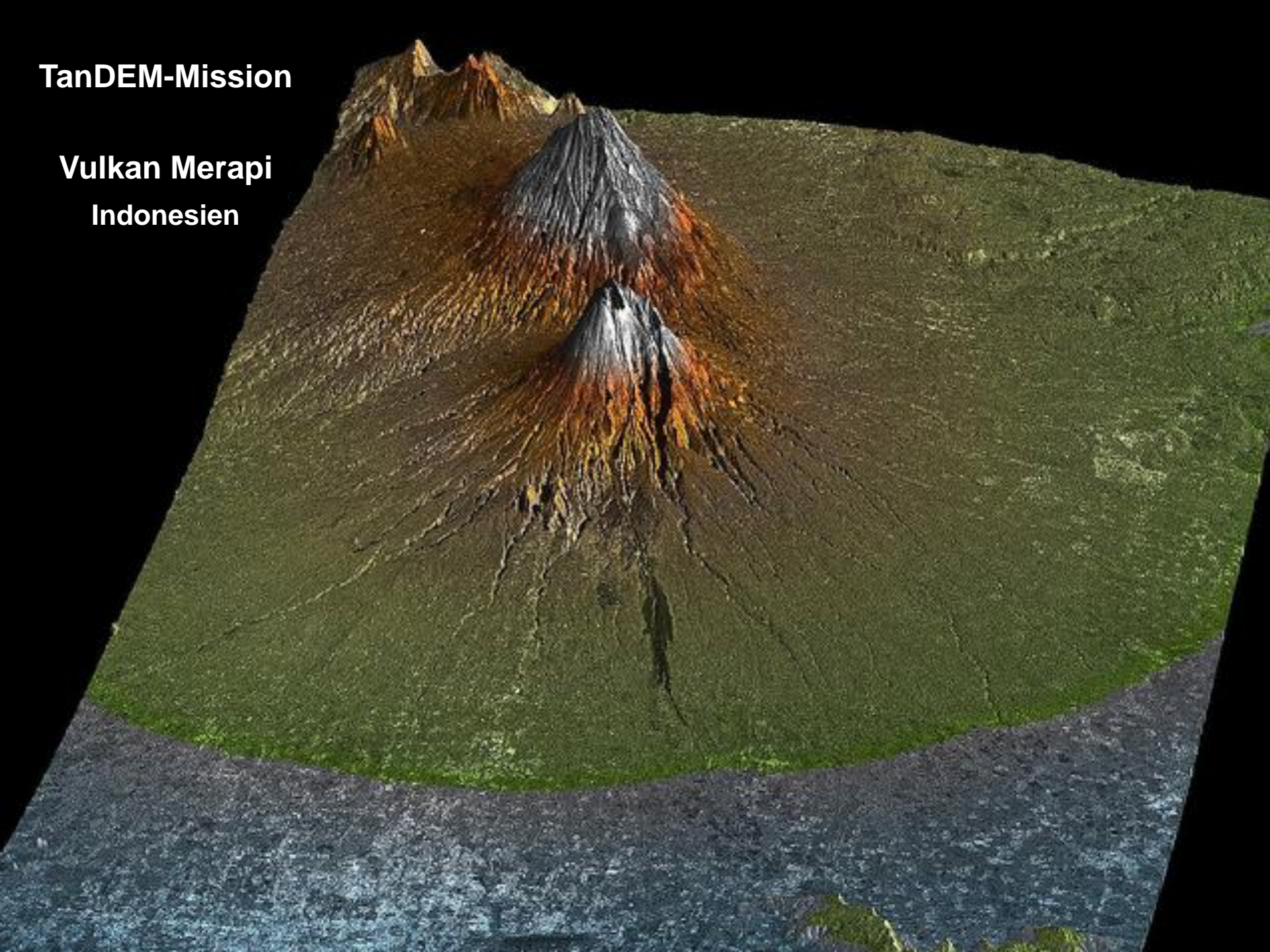
TanDEM Mission

TanDEM-X Start: Juni 2010

TerraSAR-X

TanDEM-Mission

**Vulkan Merapi
Indonesien**



TerraSAR-X



TanDEM-X

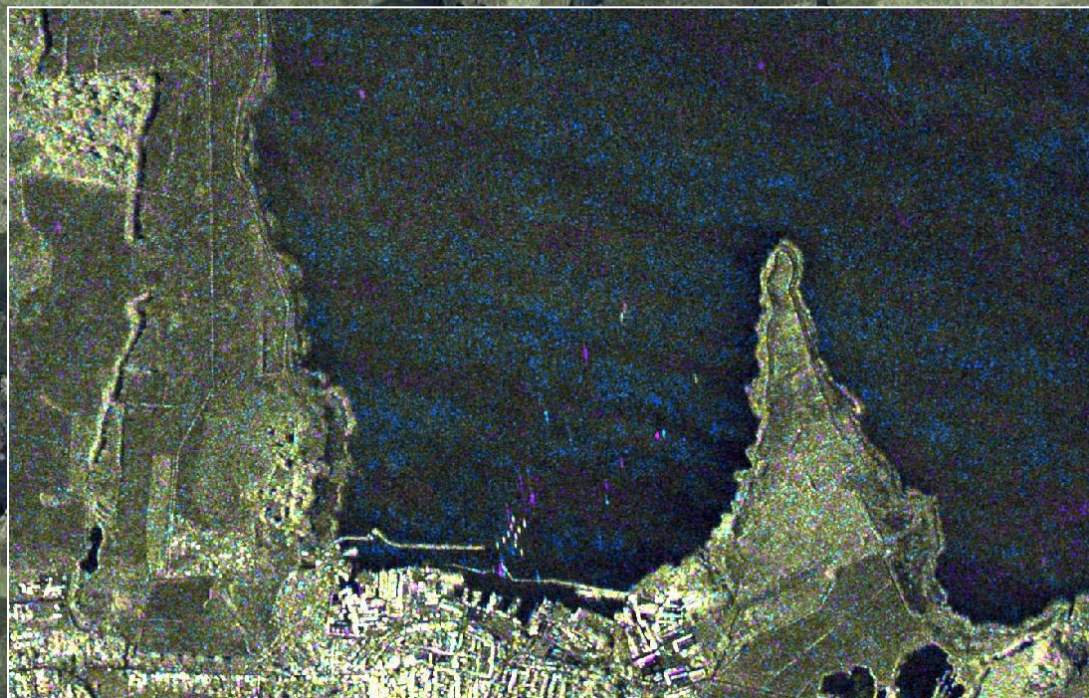
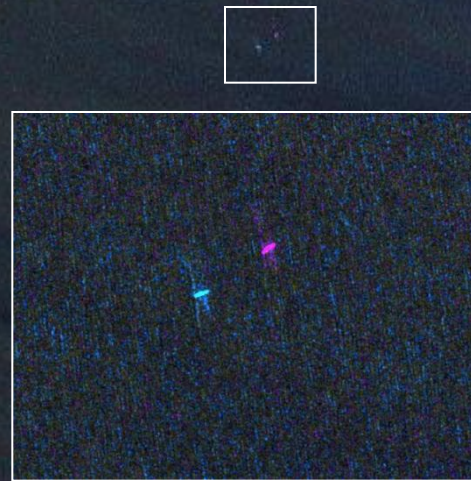


TSX + TDX

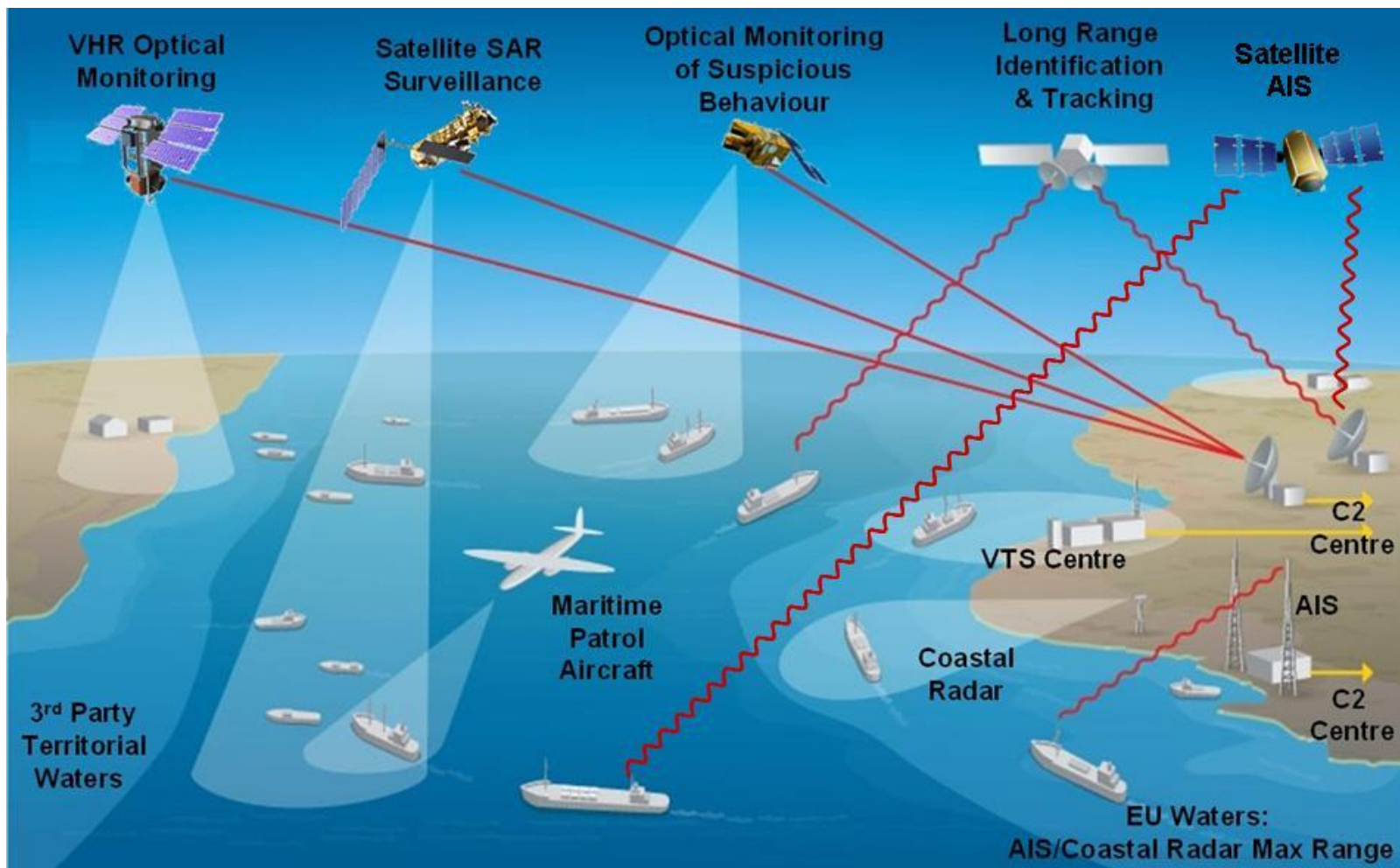


TerraSAR-X, TanDEM-X Overlay
Tandem Start 21.6.2010

Fischland Darß



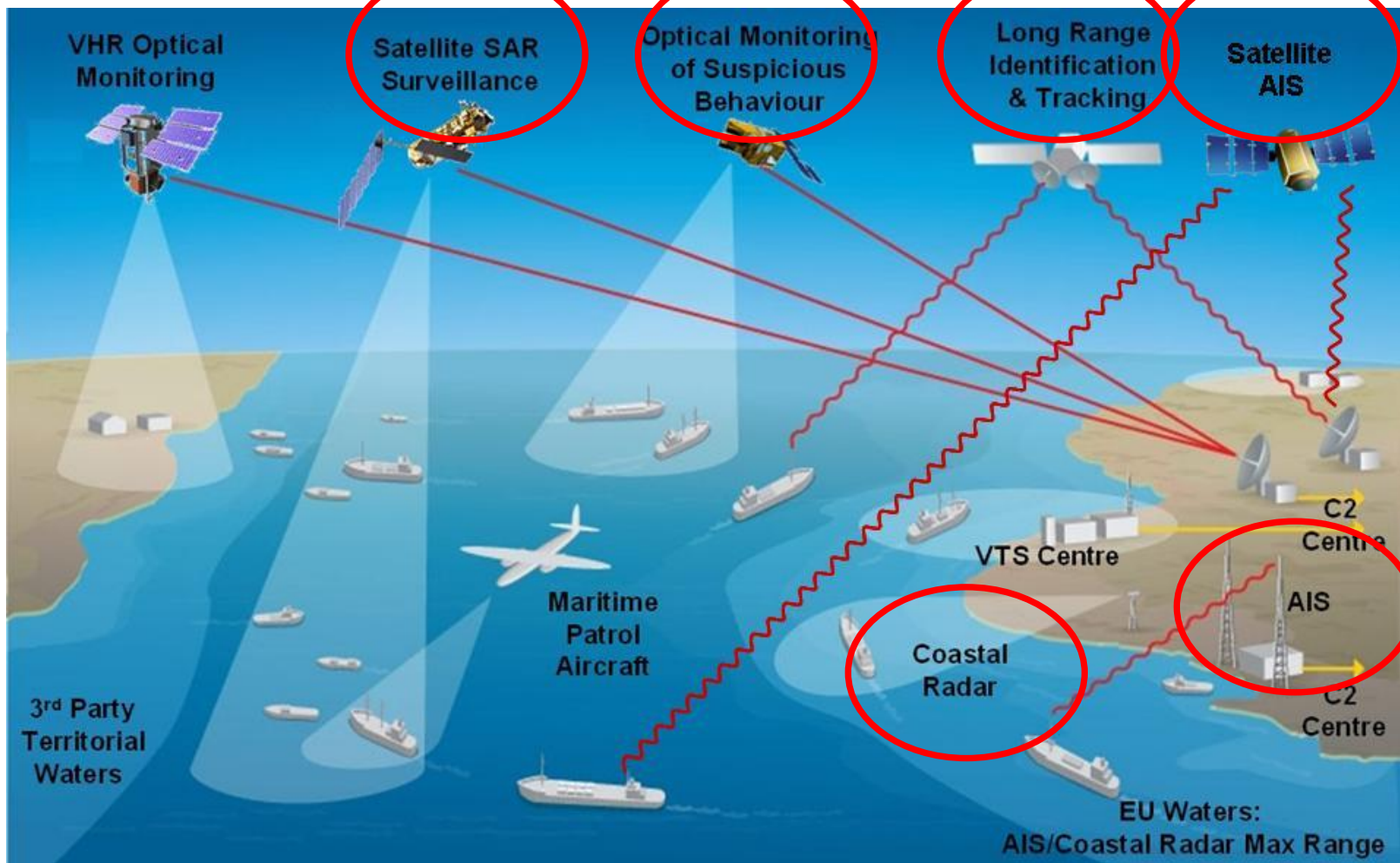
Ship Detection in Near Real Time (DLR)



source: ESA - MARISS



Ship Detection in Near Real Time (DLR)



source: ESA - MARISS



Ship Detection in Near Real Time (DLR)

SAR satellite images

- resolution (1-150 m)
- area (up to 400 x 400 km)
- indep't of clouds, time
- >use for **DETECTION**

Optical satellite images

- high resolution (<1-10 m)
- small area (10-60 km)
- daytime, clear skies
- >use for **RECOGNITION**



Ship Detection in Near Real Time (DLR)

- **NRT: product available in less than 20 min (FRONTEX, EMSA, GERMAN NAVY, German Federal Police Requirements)**

- 1. Downlink**

- 2. L1B Data Processing**

- 3. Preprocessing:**

... applying calibration factors and performing some image wide enhancement algorithms

- 4. Landmasking**

- 5. Prescreening / Discrimination**

... CFAR (Constant False Alarm Rate), image order statistic approaches, ...

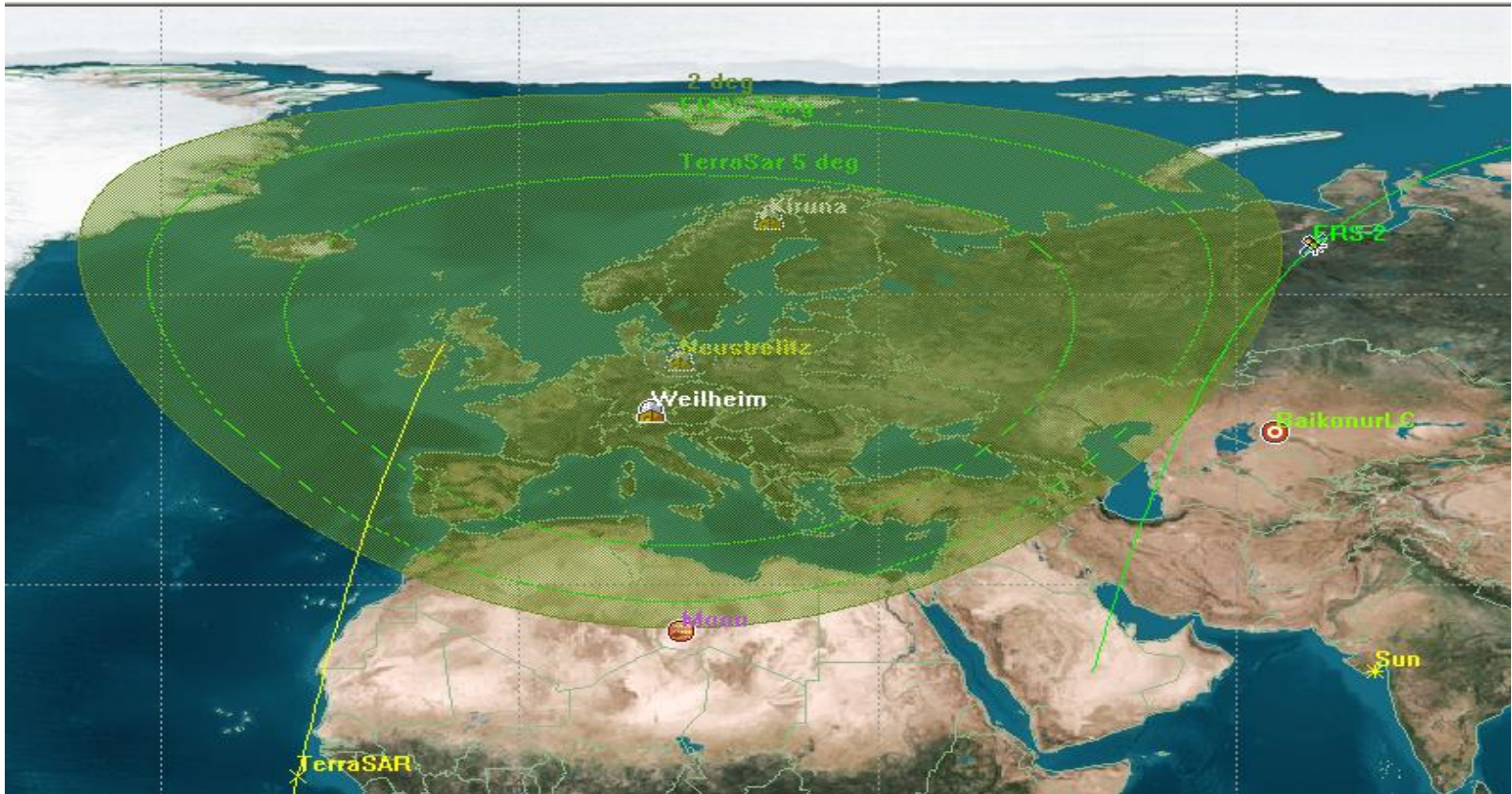
- **Partner of MARISS (ESA Project)**

- **EU FP 7 DOLPHIN / SAGRES**

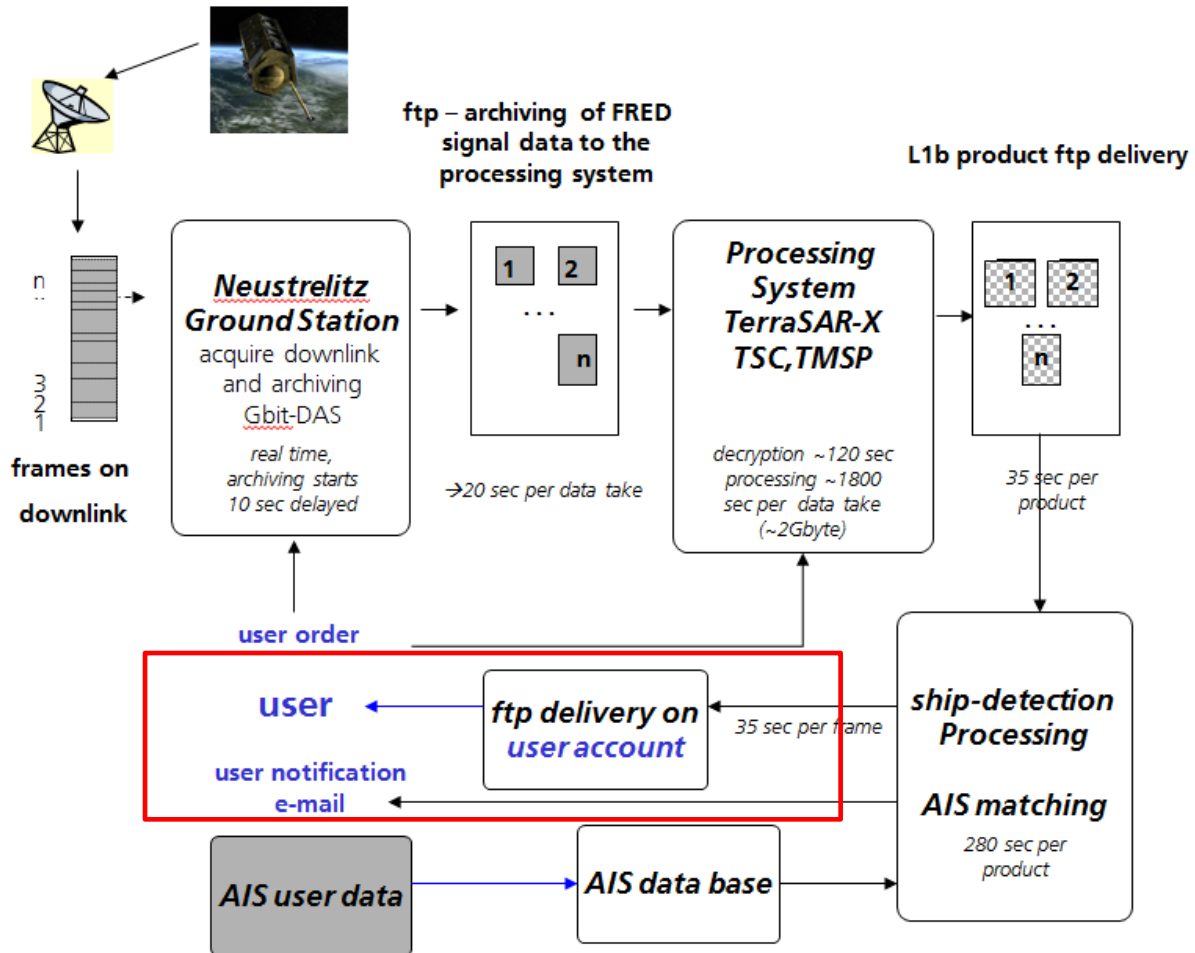


Ship Detection in Near Real Time (DLR)

1. Downlink



Ship Detection in Near Real Time (DLR)



DLR – Google Earth Solution

The screenshot displays the Google Earth interface with a SAR (Synthetic Aperture Radar) image overlaid on a satellite view of the ocean. The SAR image is a dark, textured area with a white border, containing several red arrows labeled DS1 through DS21, representing detected ships. A blue arrow labeled KOL-120 represents a ship with known AIS information. The map includes a coordinate grid with latitude (N54.85° to N55.15°) and longitude (E15.25° to E16.25°) labels. A scale bar indicates 2 km. The interface includes a search bar, a list of layers on the left, and a map legend at the bottom right.

MAP LEGEND

view of extrapolated movement at time of acquisition + 1 hour		calc. relations	
	SAR based detection		SAR to AIS not
	AIS ship information		AIS to SAR not
	AIS heading unknown		most probable
	AIS speed unknown		
	AIS speed 0		

Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft 14.2 km

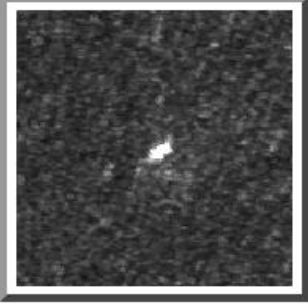
Breite 54.928903° Länge 15.736058° Höhe -78 m

Sichthöhe 60.90 km



DLR – Google Earth Solution

Radar Satellite Detection 7



Date	2012 05 07
Time	05:16:16
Lat	55.01499107 °
Lon	15.72185427 °
Length	56.85 m
Width	9.69 m
Heading	41.17 °
Probability	73.60 %

Satellite Based Information



KOL-120

DESCRIPTION

Length	000 m
Width	00 m
Type	Not available (default)

POSITION

Lat	55.015730 °
Lon	15.726450 °

IDENTIFICATION

Name	KOL-120
Mmsi	261275000
Callsign	000000
Imo	0000000

DESTINATION

Destination	mtN.A.
Eta	mtN.A.

STATE

Status	Not defined (default)
Speed	003.0 kn
Course	234.0 °
Heading	234 °
Draft	00.0 m

TIMESTAMP

Mtime	n.a.
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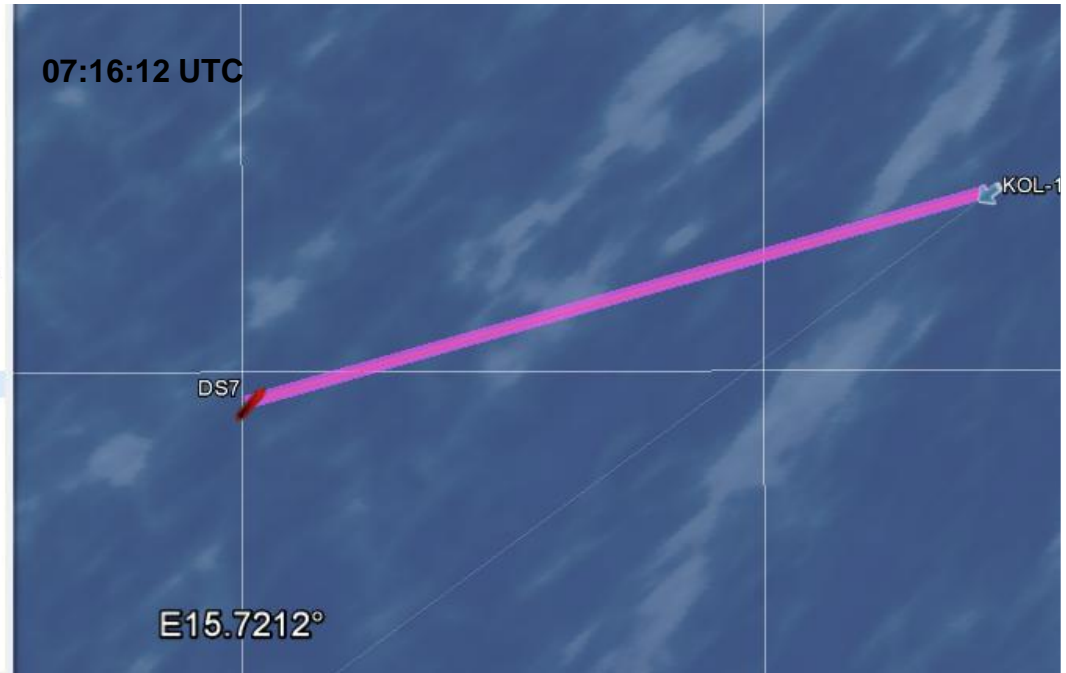
AIS or other Systems



DLR – Google Earth Solution

Correlations, Distances, Behaviour

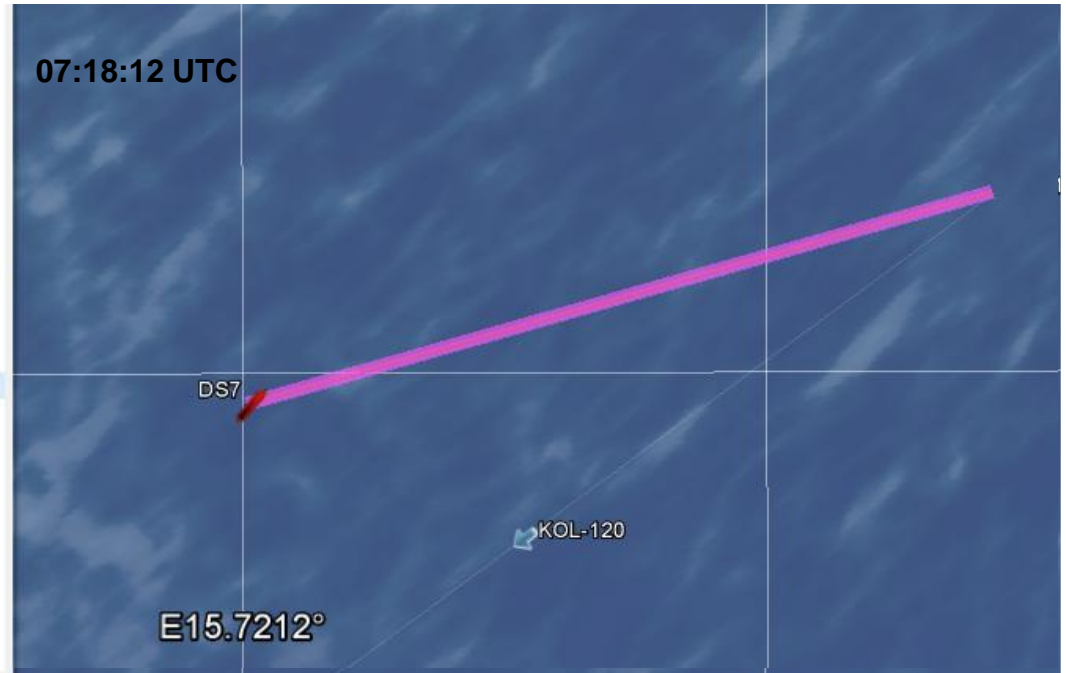
- Meine Orte
 - Bild-Overlay ohne Namen
 - Bild-Overlay ohne Namen
 - Ortsmarkierung ohne Namen
- Temporäre Orte
 - TSX1_SAR_MGD_RE__SM_S_SRA_20120507T051612_20120507T051616
 - DLR logo
 - Legend
 - Scene overlay (SAR-image)
 - Scene frame TSX1_SAR_MGD_RE__SM_S_SRA_20120507T051612_20120507T...
 - Layer AIS to SAR RELATIONS (AIS-contact to the nearest SAR-Detection)
 - Layer SAR to AIS RELATIONS (SAR-contact to the nearest AIS-Detection)
 - SAR2AIS distance 304 m
 - 304 m away from nearest AIS
 - Layer MOST PROBABLE RELATIONS
 - most probable relation
 - Layer SAR - satellite detected ship positions
 - Layer AIS - transponders based informations
 - [most probable relations \(lat lon text\)](#)
 - [unrelated SAR detections text \(lat lon text\)](#)
 - [AIS informations \(text\)](#)
 - [readme](#)



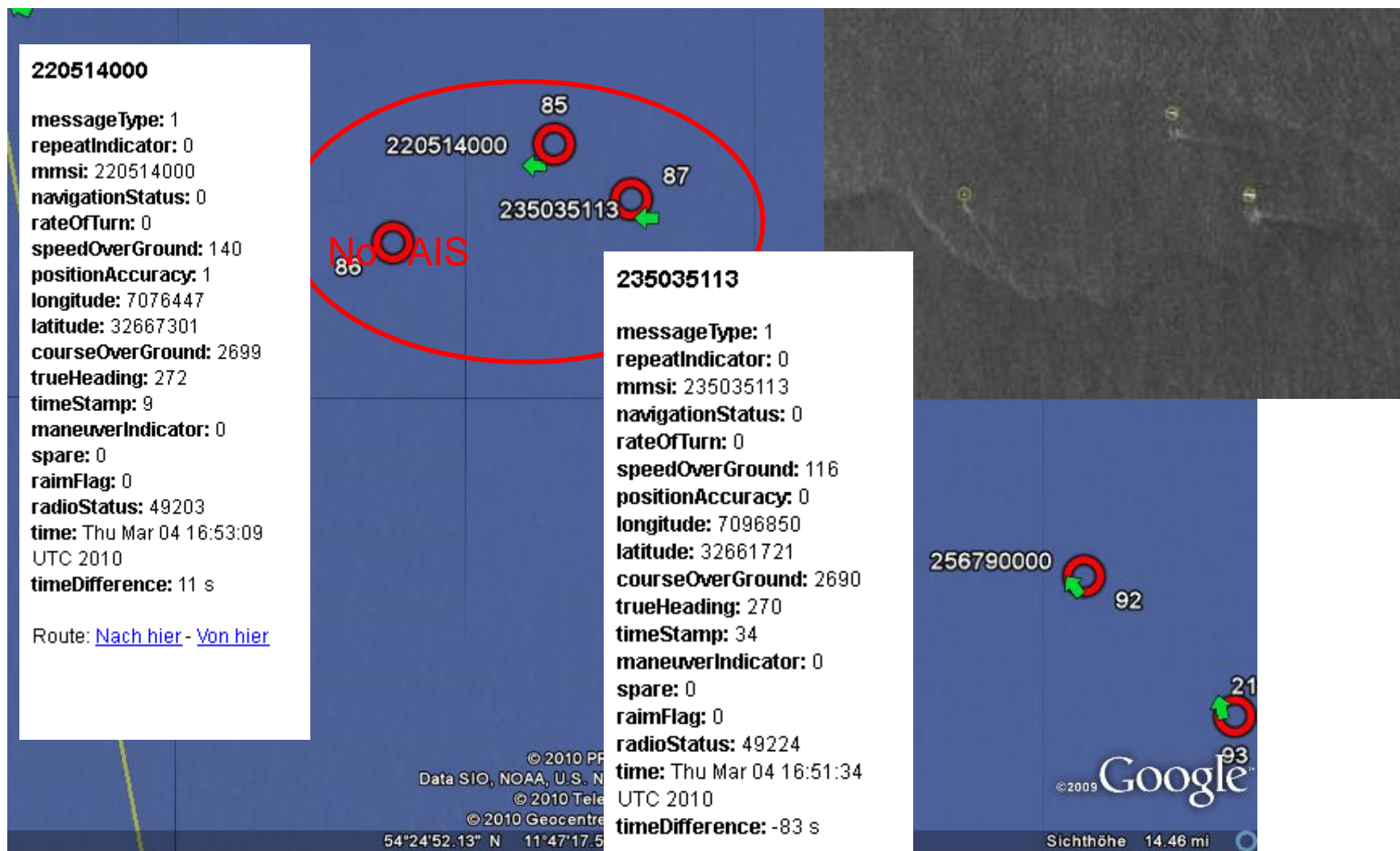
DLR – Google Earth Solution

Correlations, Distances, Behaviour

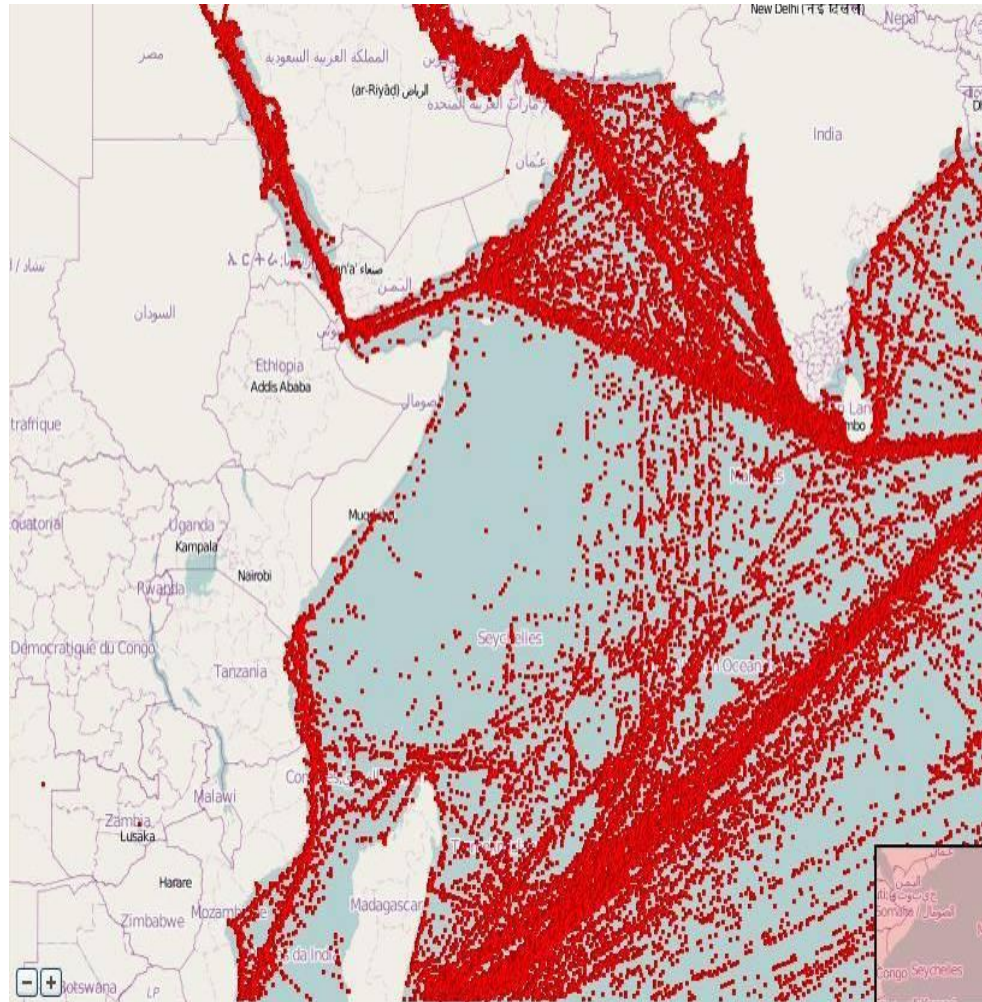
- Meine Orte
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 - [unrelated SAR detections text \(lat lon text\)](#)
 - [AIS informations \(text\)](#)
 - [readme](#)



Warning System (co-operative yes / no)



Ship Detection and Satellite AIS



-Satelliten

-AIS

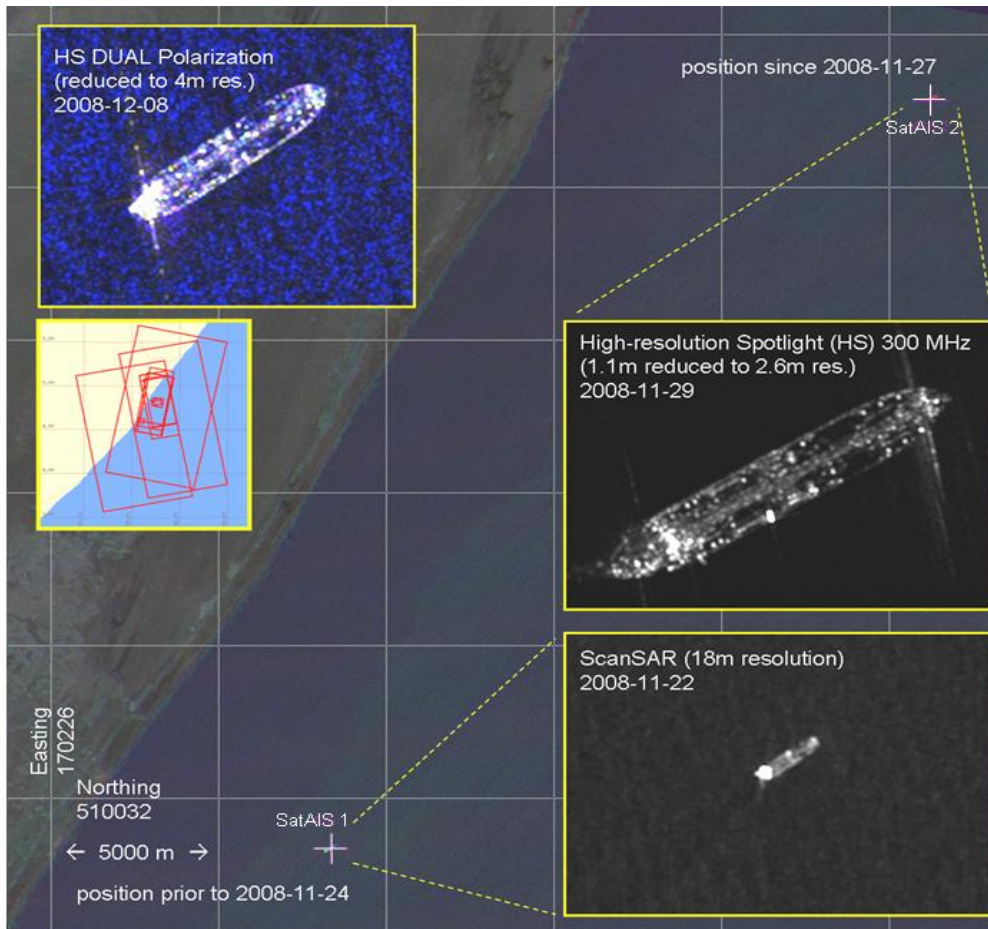
-© Luxspace



Examples - Piracy



Ship Detection in Near Real Time (DLR)



Abduction of Sirius Star by pirates (2008)



24-JAN-2011 S.P.D.F AIR WING



(Courtesy Bundespolizei)

AF
RATE

002.49.79.S
055.30.74.E

027

131

SCENE

N 4°51'

N 4°45'

N 4°39'

E 48°03'

E 48°09'

E 48°15'

E 48°21'

N 4°33'

TSX1 SAR MGD RE Spotlight

2011-02-14 at 14:56 UTC

MV York

-Length (SAR): ~95m

Beluga Nomination

-Length (SAR): ~137m

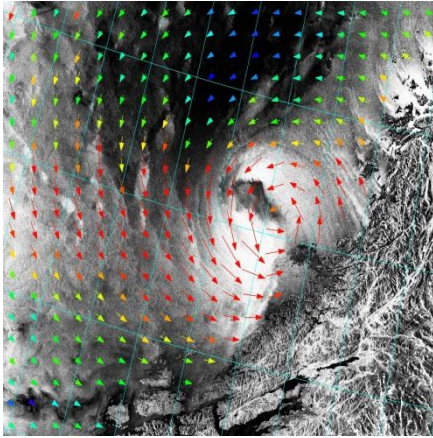
Beluga Nomination

Length: 132 m

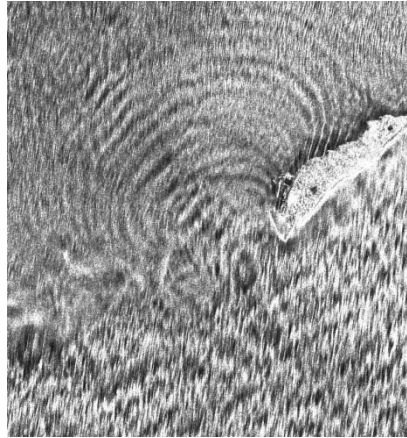


Piracy Somalia – Support German Federal Police

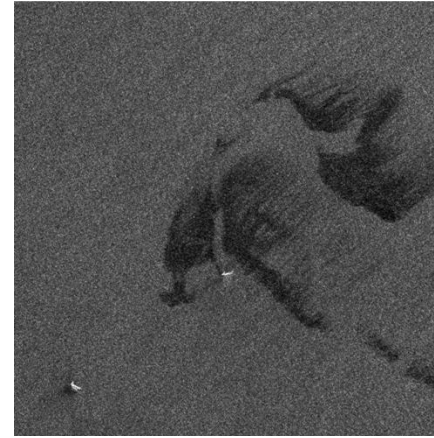
Planned or existing NRT Products



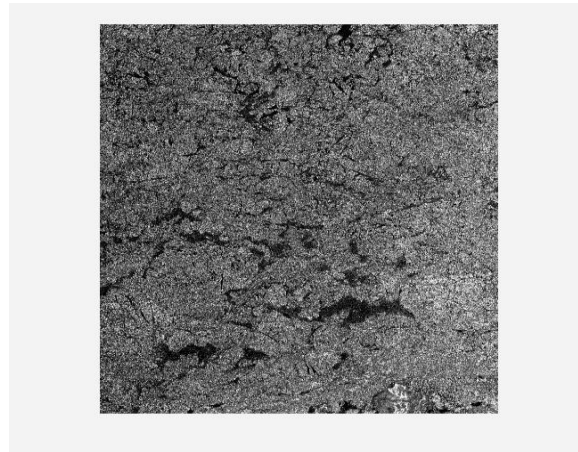
Wind



Sea State



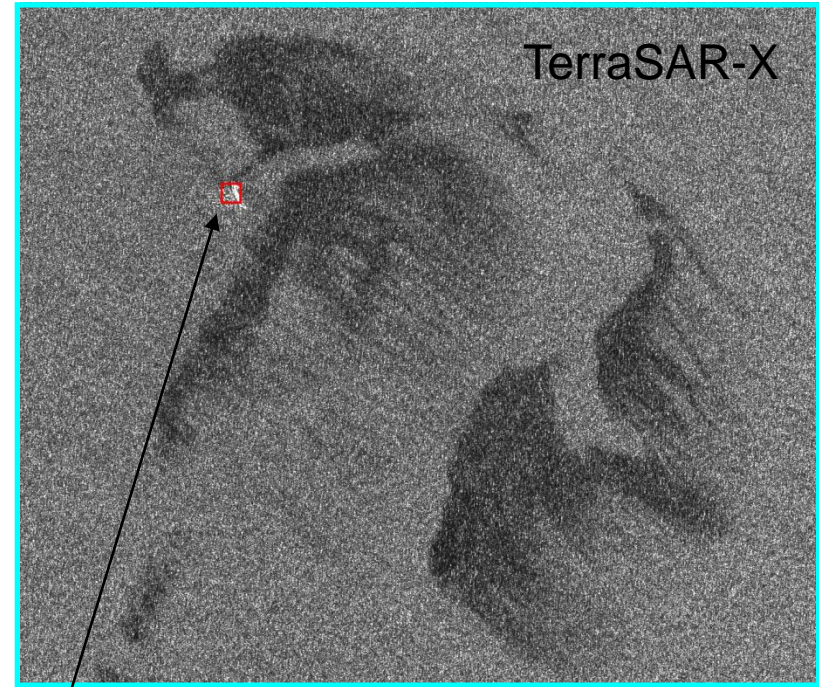
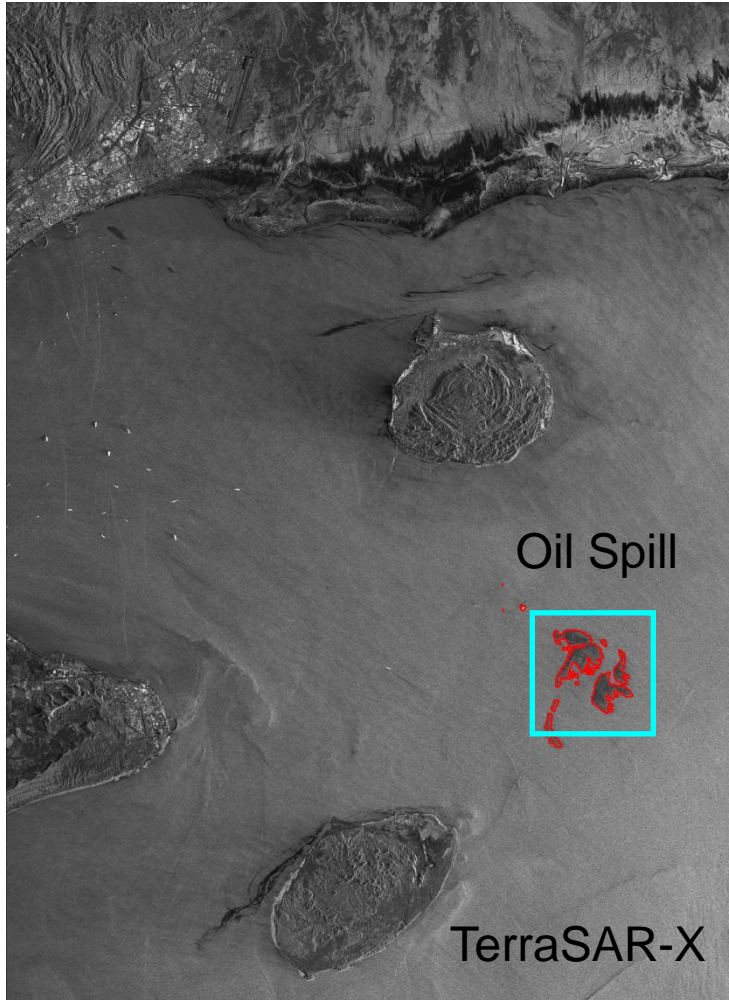
Oil



Sea Ice



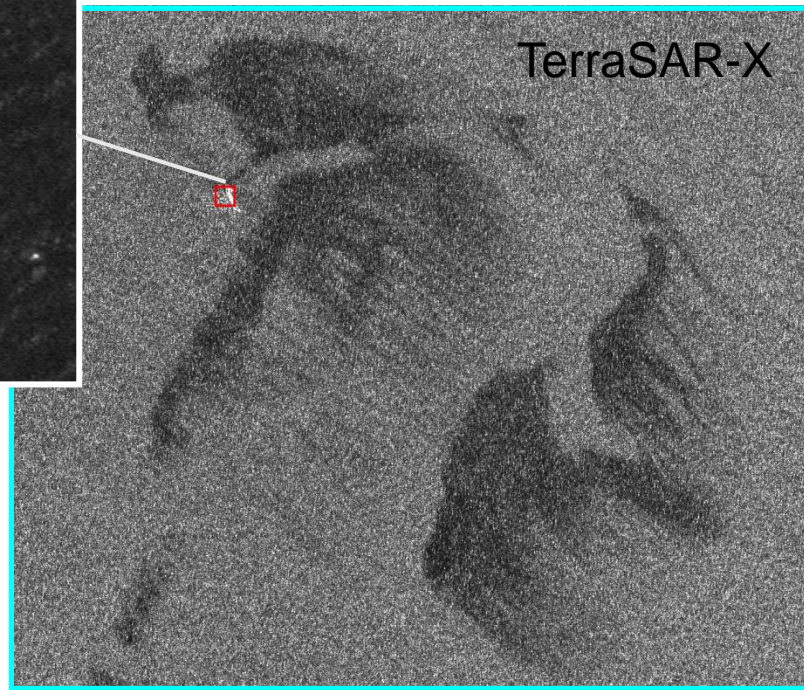
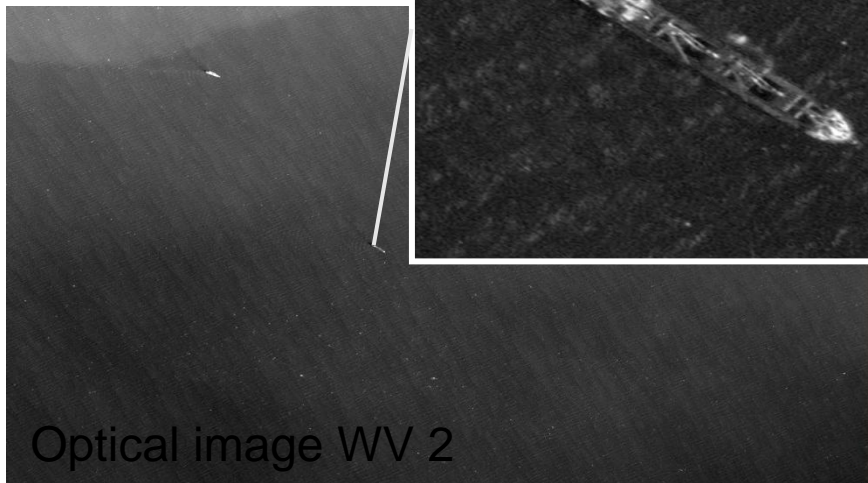
Semi-Operational Oil Spill Detection Bandar Abbas Jun 27, 2009



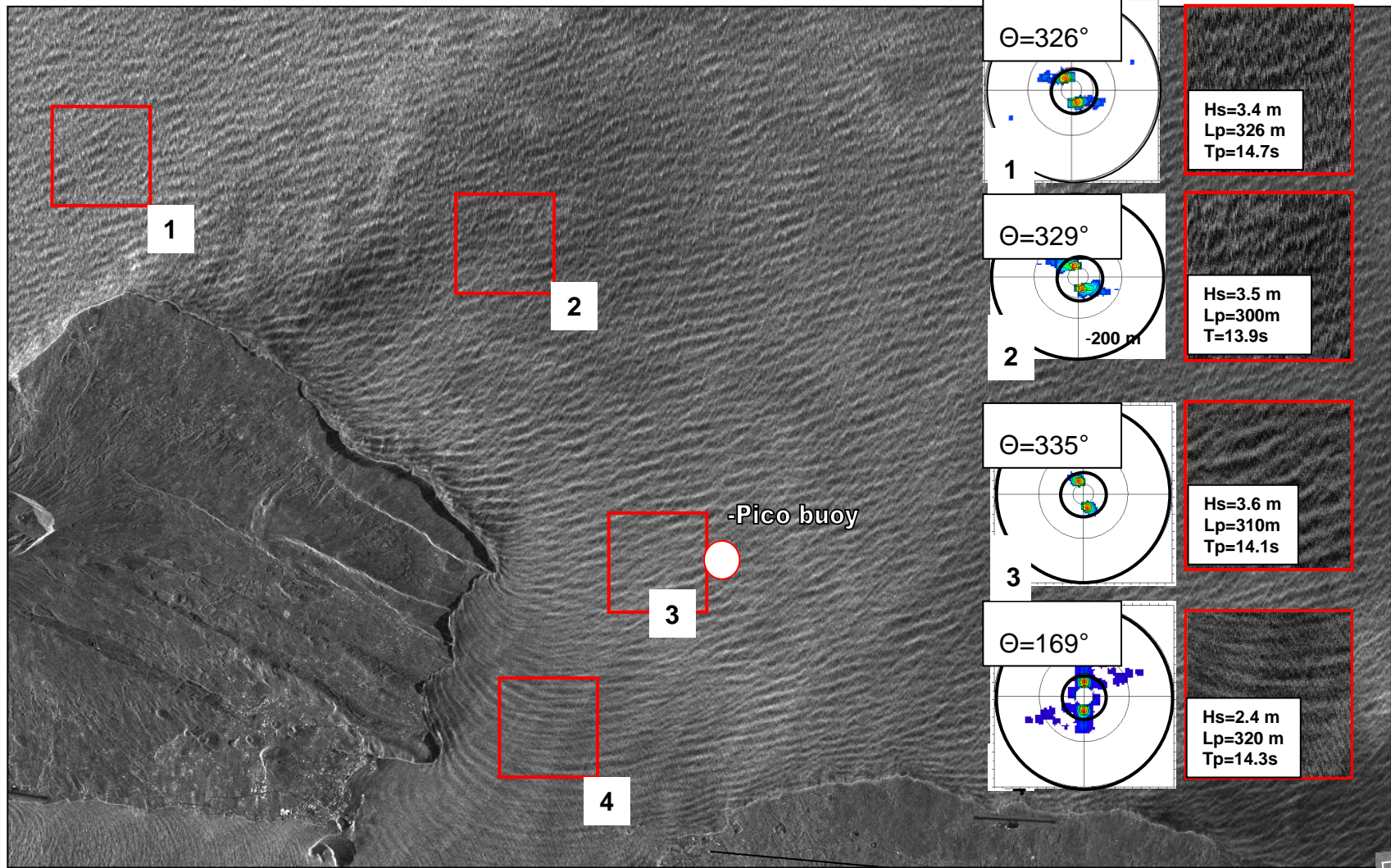
Source: Ship (automatic detection)



Semi-Operational Oil Spill Detection Bandar Abbas Jun 27, 2009



Sea State Retrieval (going to be operational)

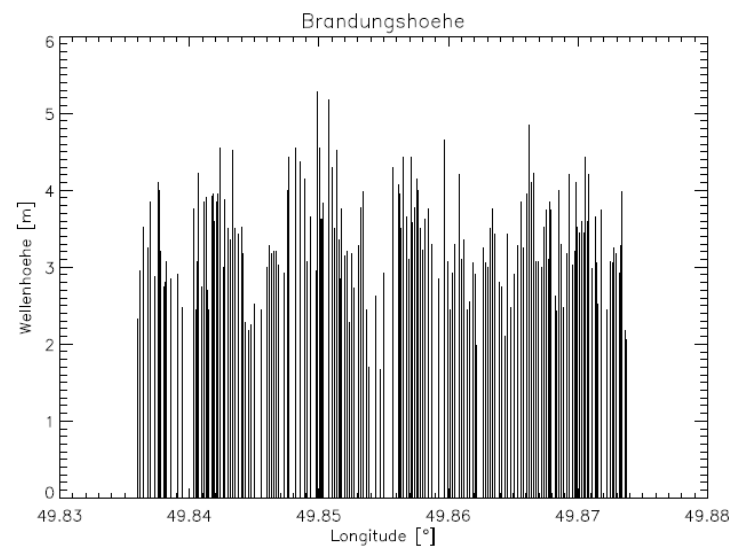
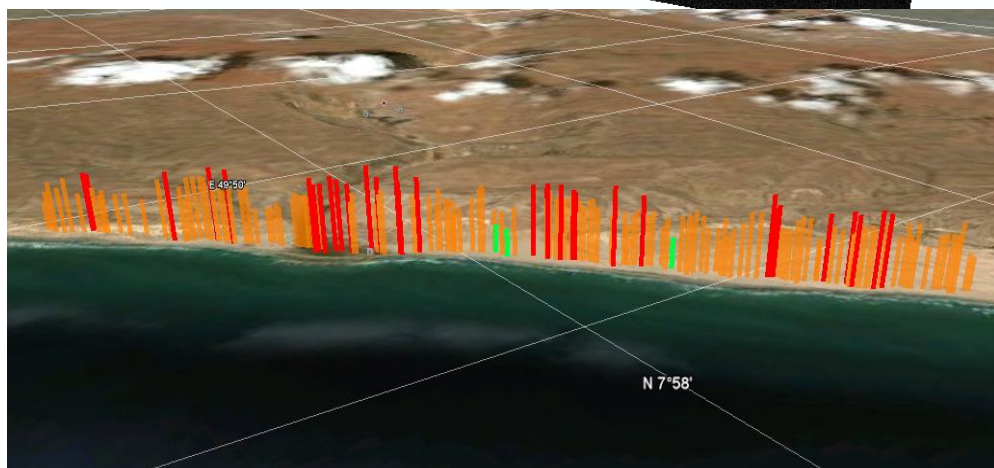
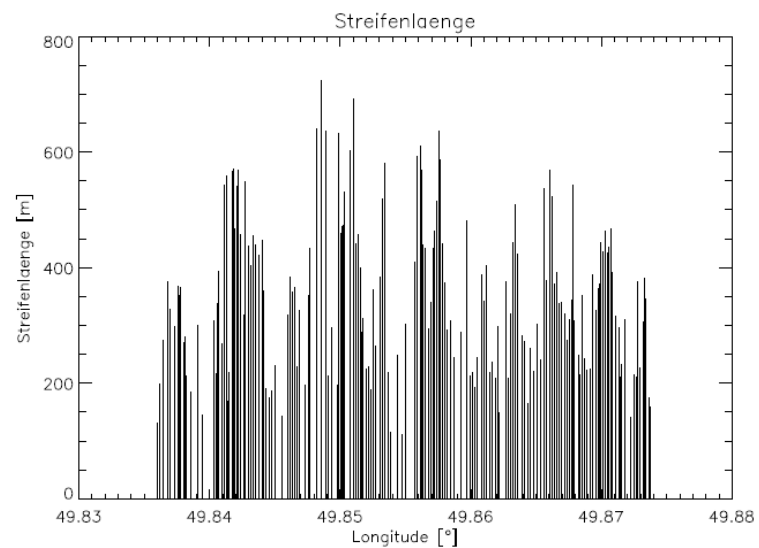
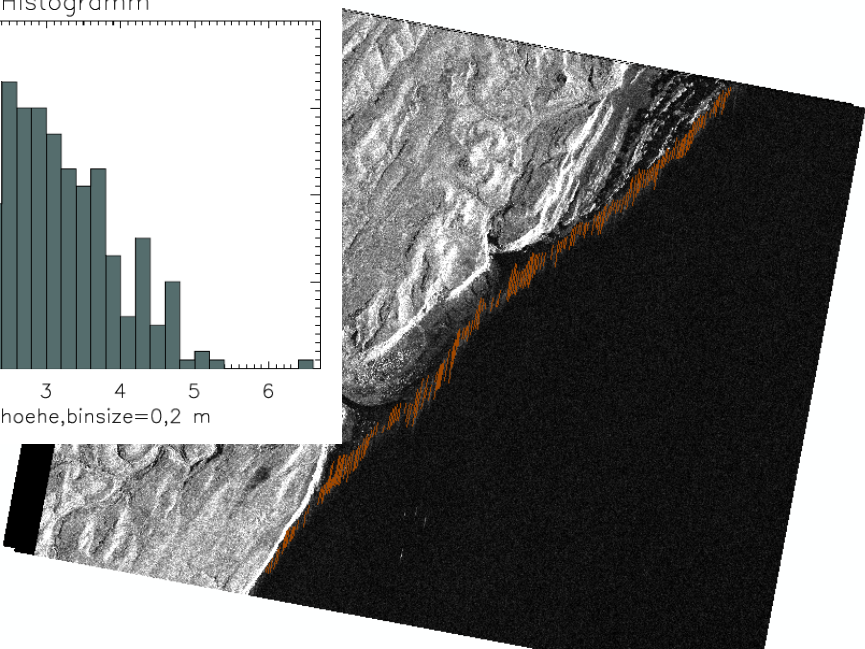
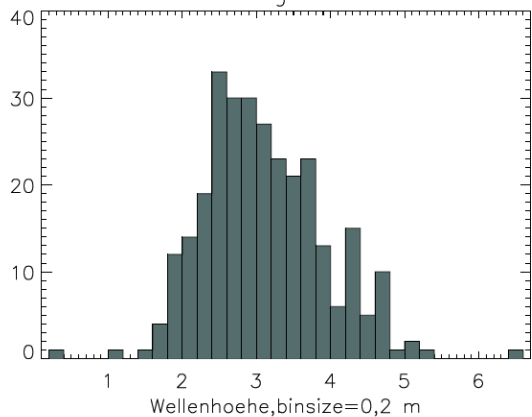


TS-X high resolution data allows to observe spatial variability of sea state.



Surf

Histogramm





www.dhl.de Chart: Marine Navigation Service GmbH, Berlin www.mn-service.de www.san-marine.com www.san-marine.com

Thank You