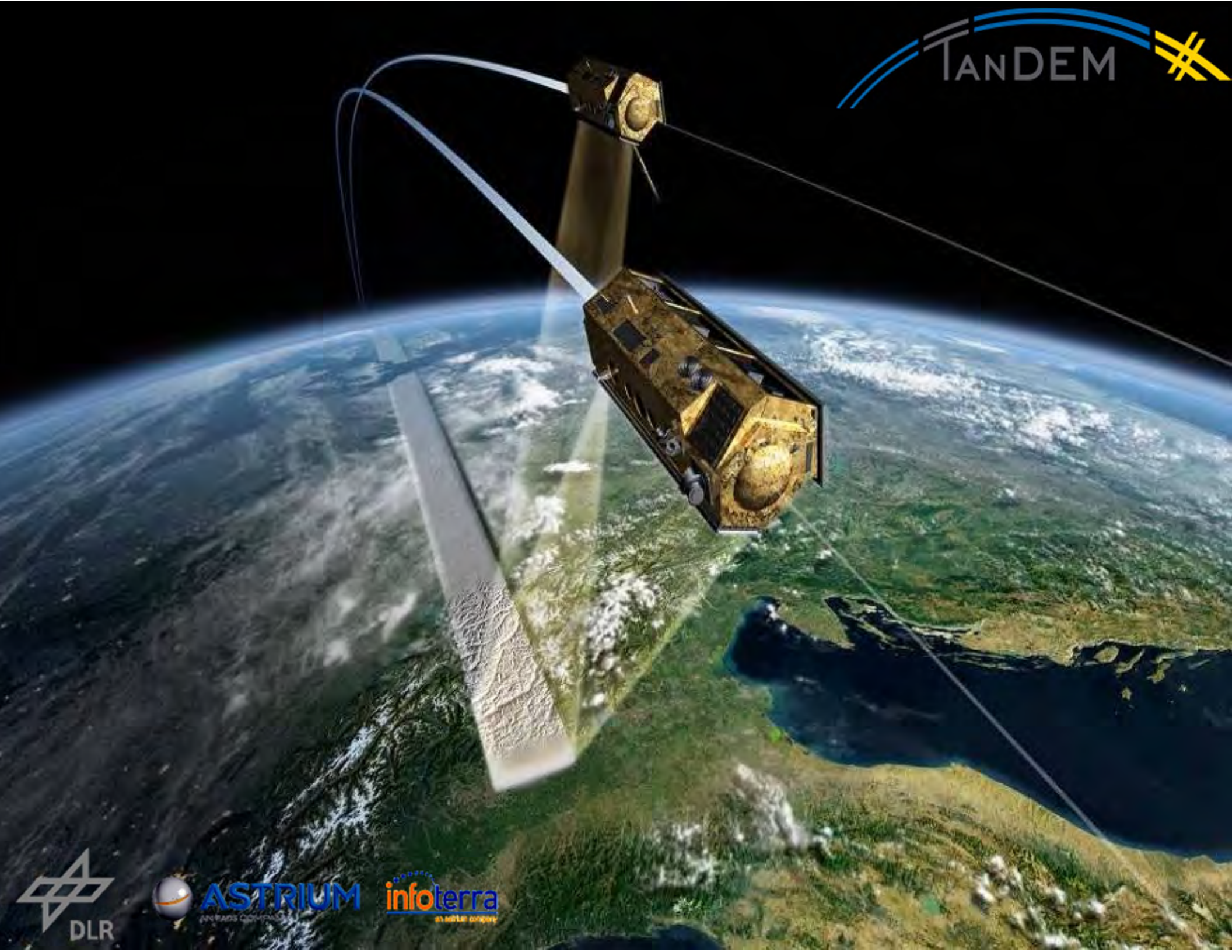
The Earth seen from Space by

Radar Remote Sensing – a Vision for 2025

Alberto Moreira

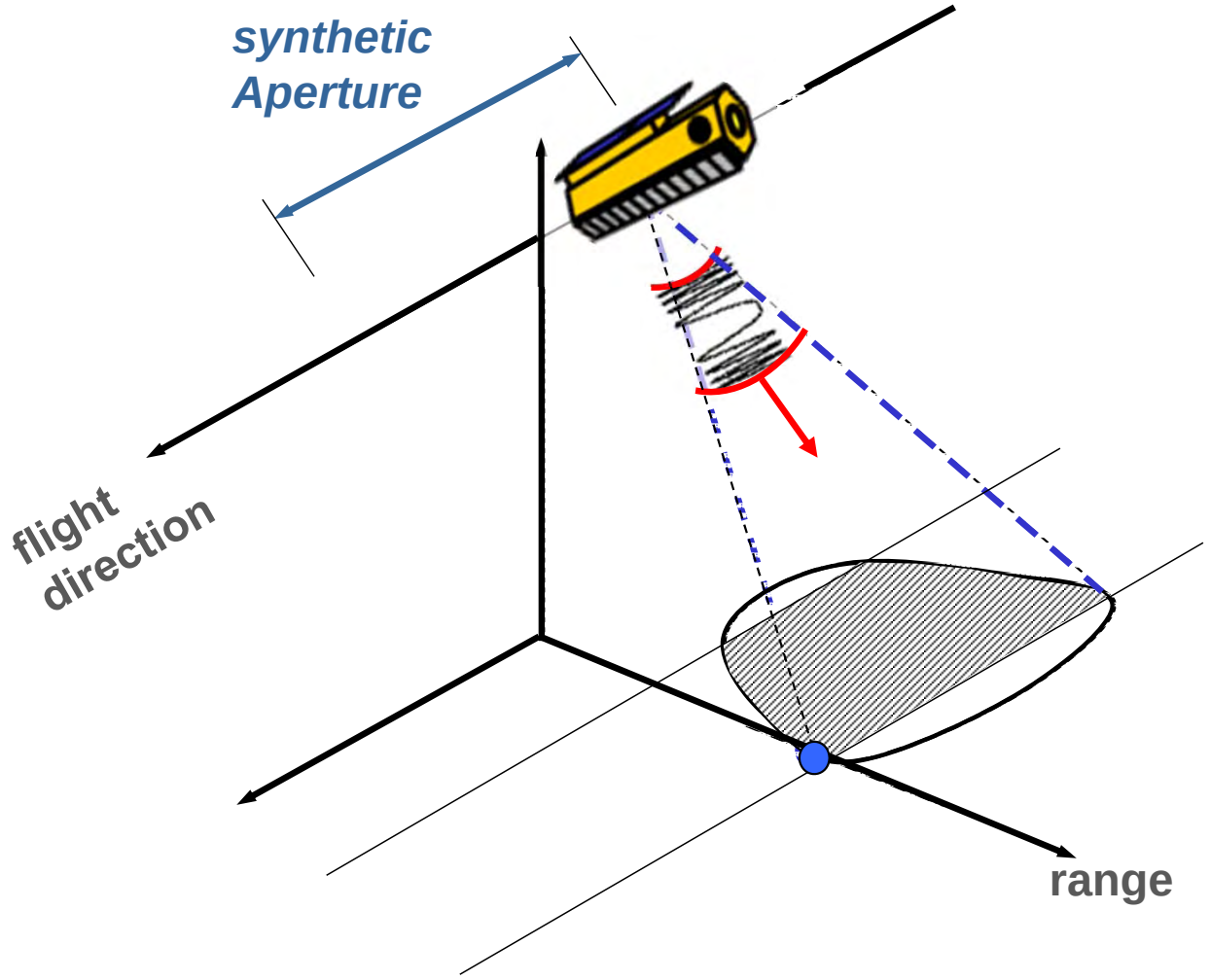
German Aerospace Center – DLR

Microwaves and Radar Institute


TanDEM
DLR
ASTRIUM
infoterra

How spaceborne radar works…

Synthetic Aperture Radar (SAR)



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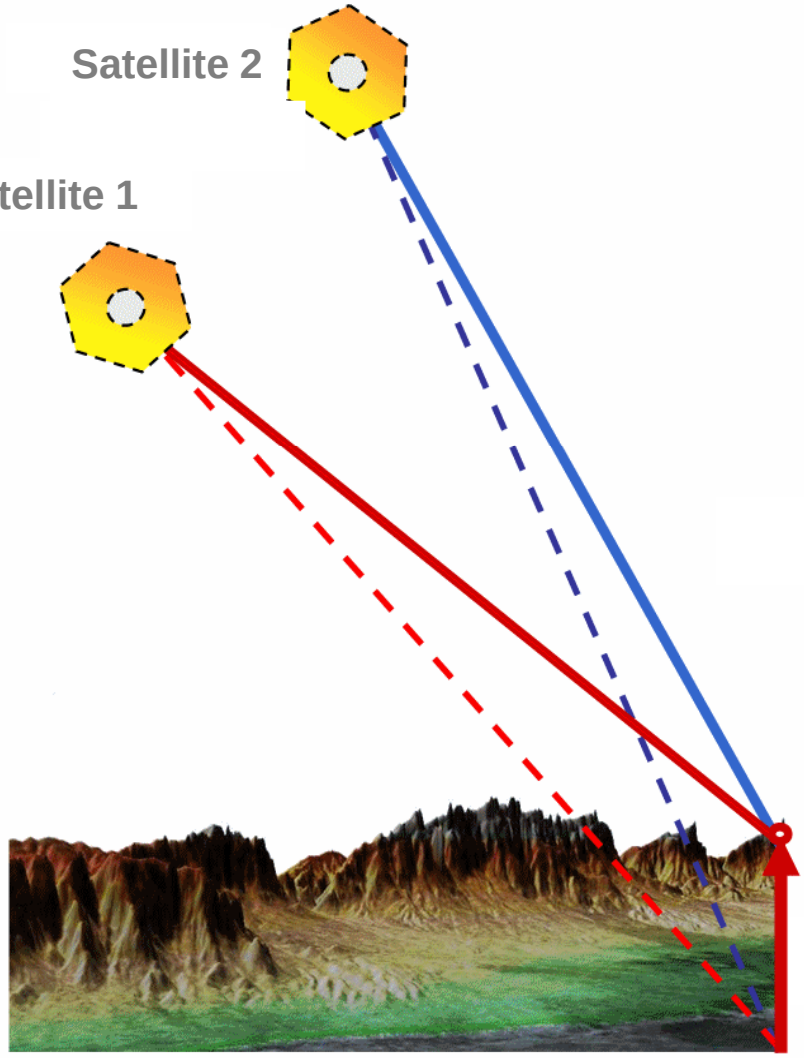
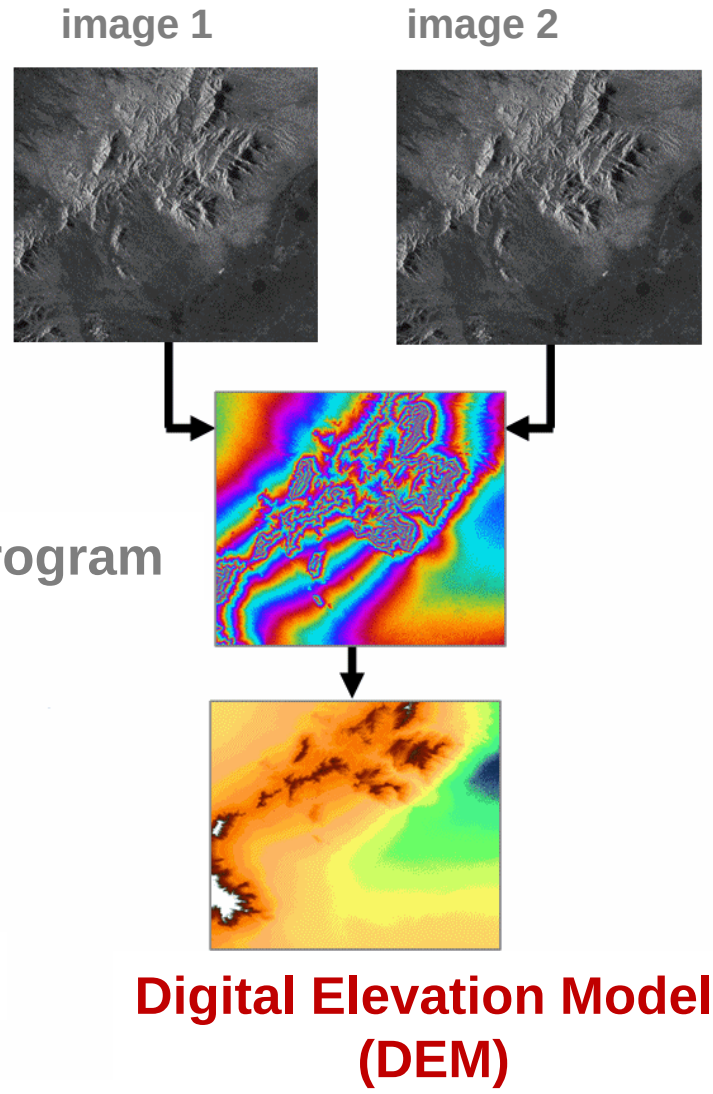
Radar Interferometry

Interferometric data acquisition



data processing



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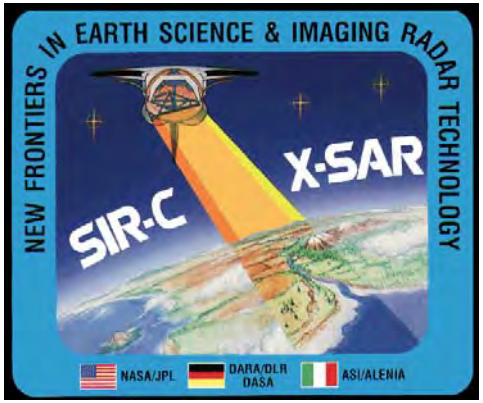
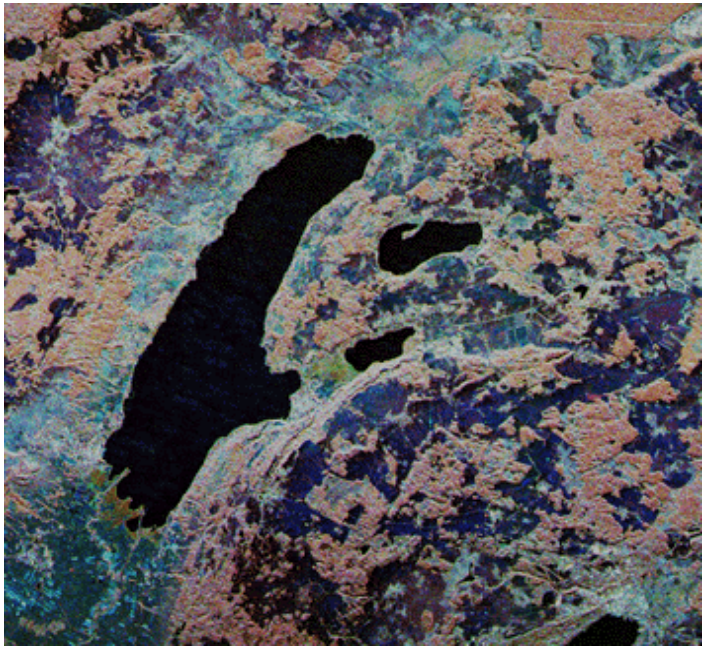
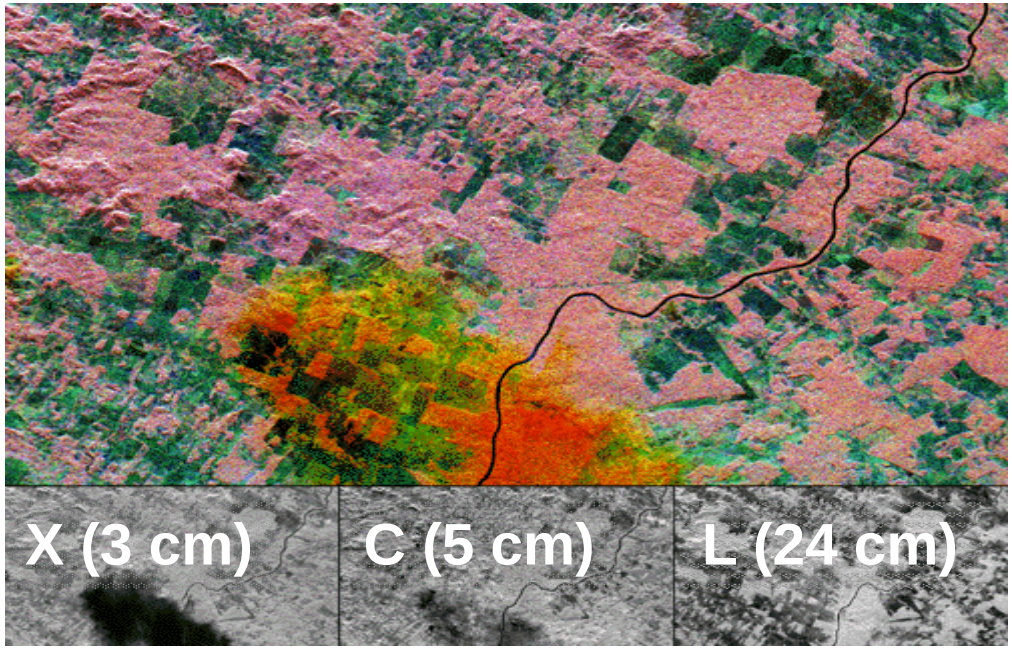
SIR-C/X-SAR - Shuttle Imaging Radar 1 / 2

SIR-C/X-SAR

9. April 1994
30. September 1994







DLR NASA NASA

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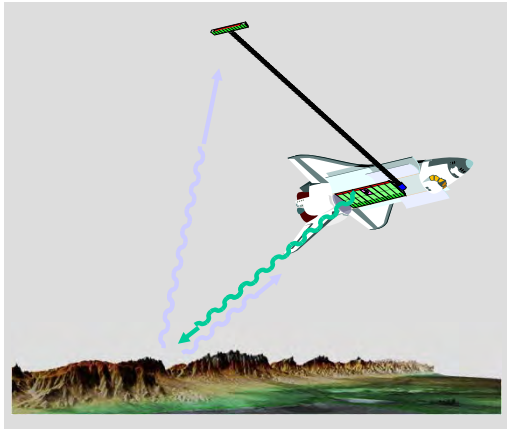
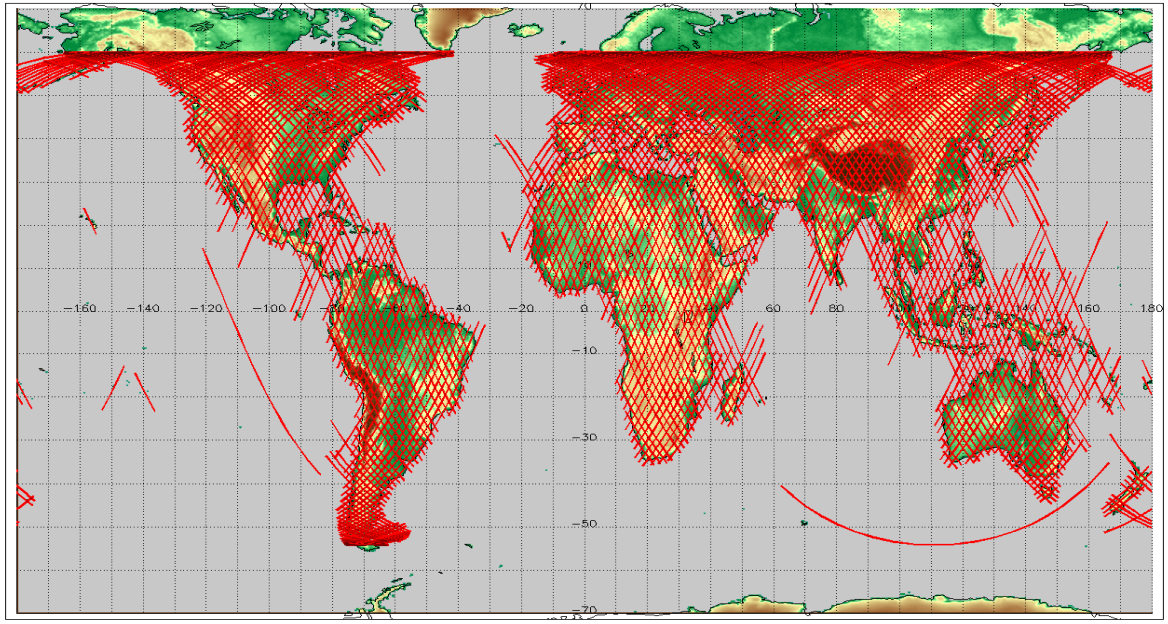
SRTM – Shuttle Radar Topography Mission

SRTM

STS-99
11. Februar 2000

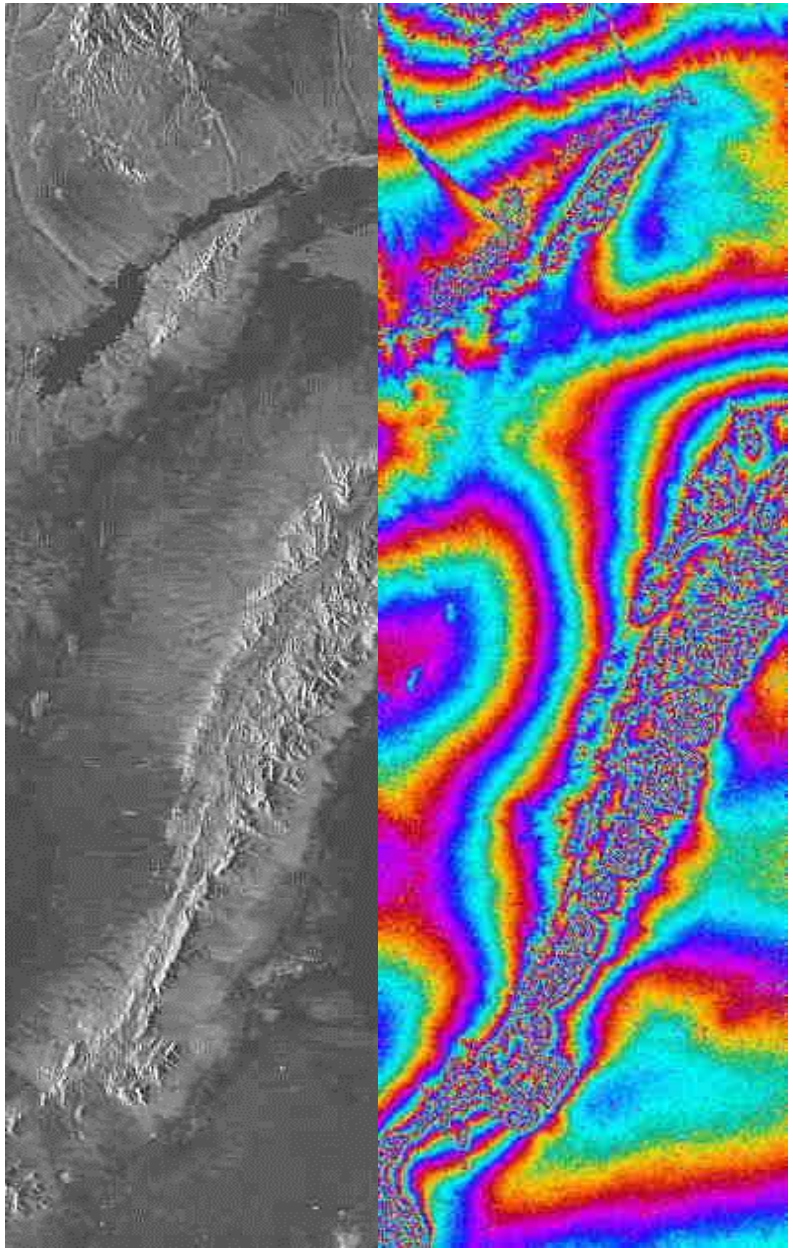


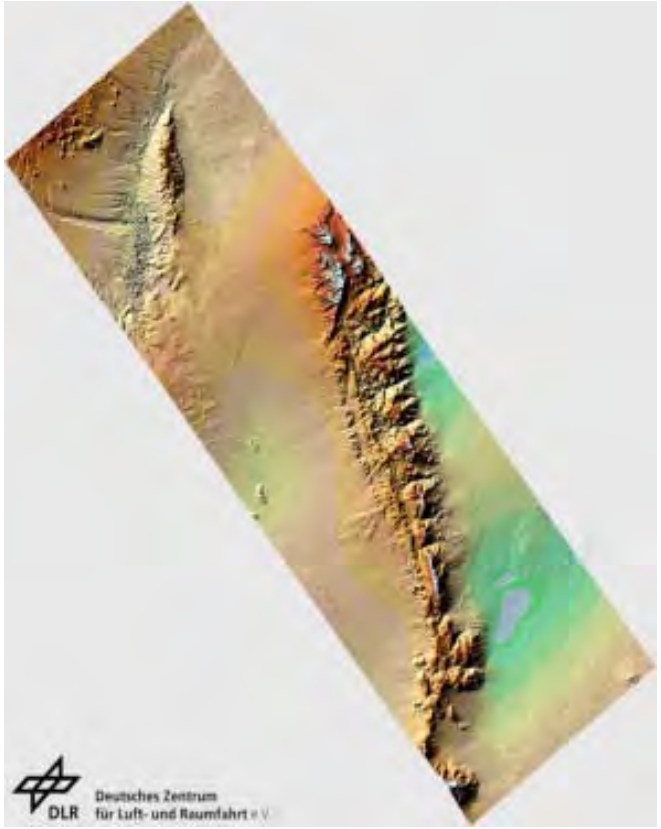


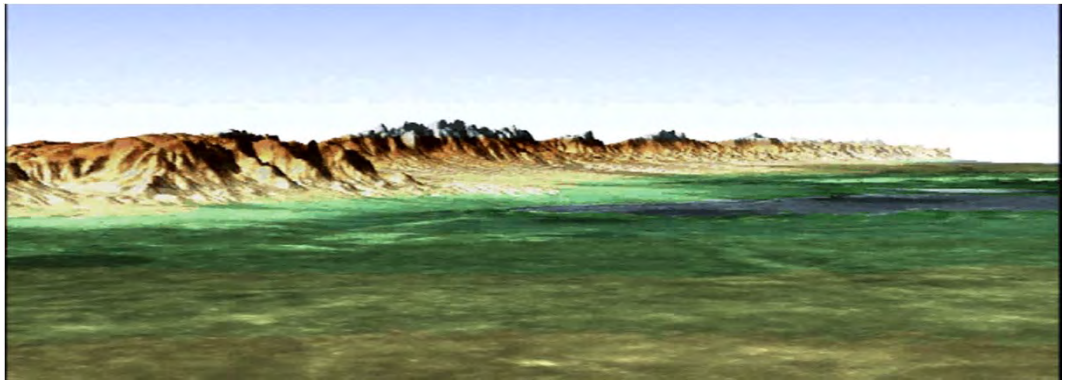
Janice Voss, Kevin Kregel, Dominic Gorie, Janet Kavandi
Mamoru Mohri, Gehard Thiele

NASA DLR

SRTM – First Results







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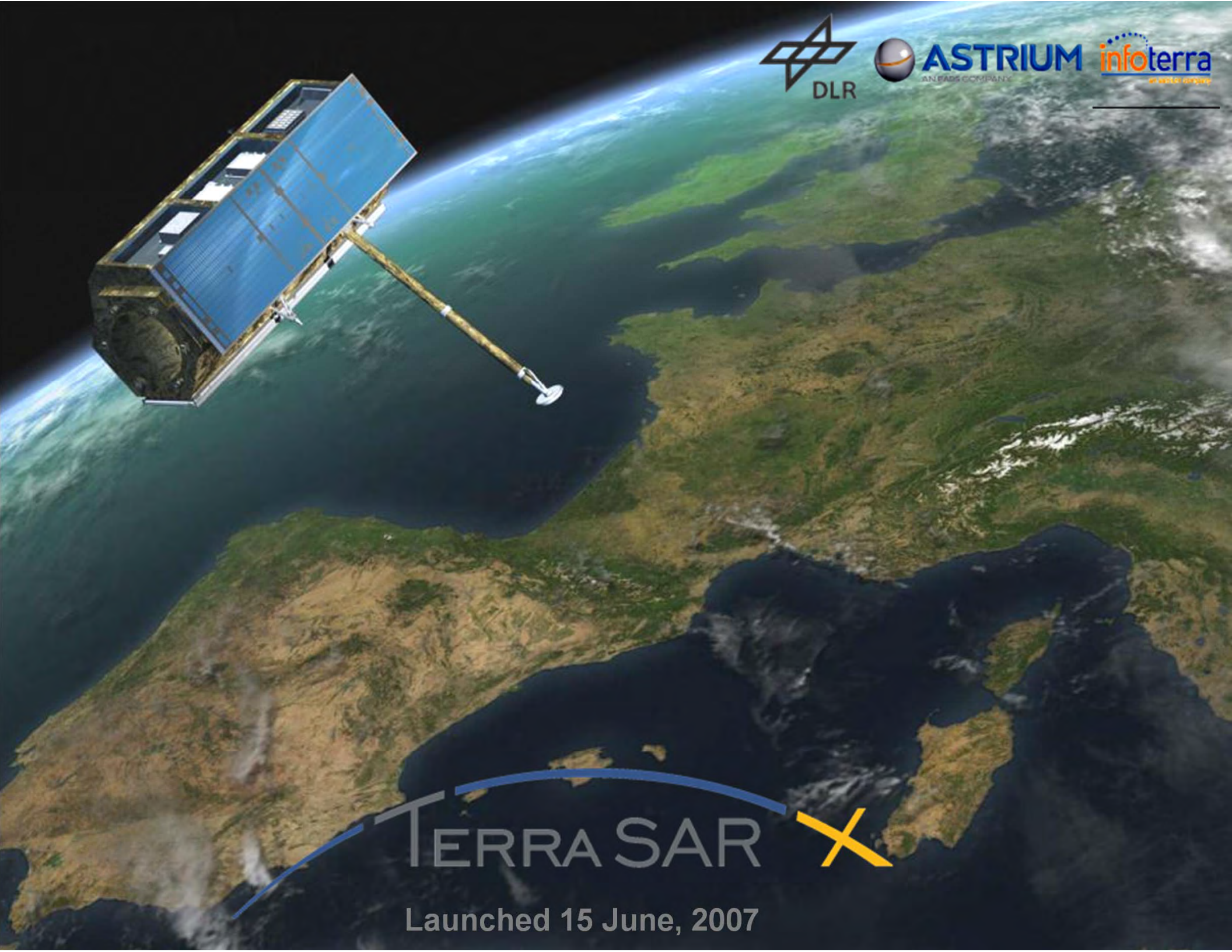
High-Resolution Spaceborne Radars


DLR
ASTRIUM
AN EADS COMPANY
infoterra
TERRA SAR X
Launched 15 June, 2007

TERRASAR X …during the environmental tests

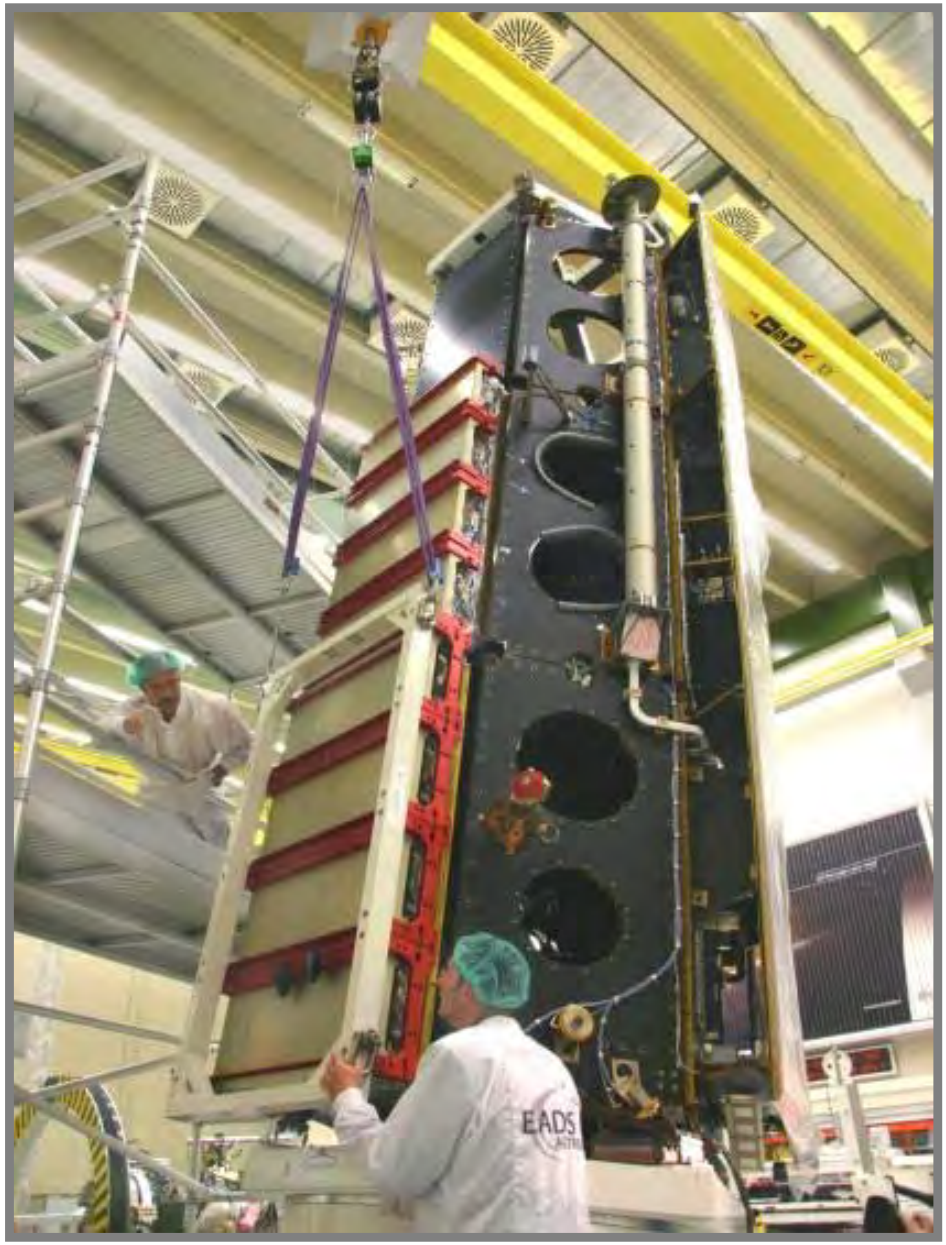


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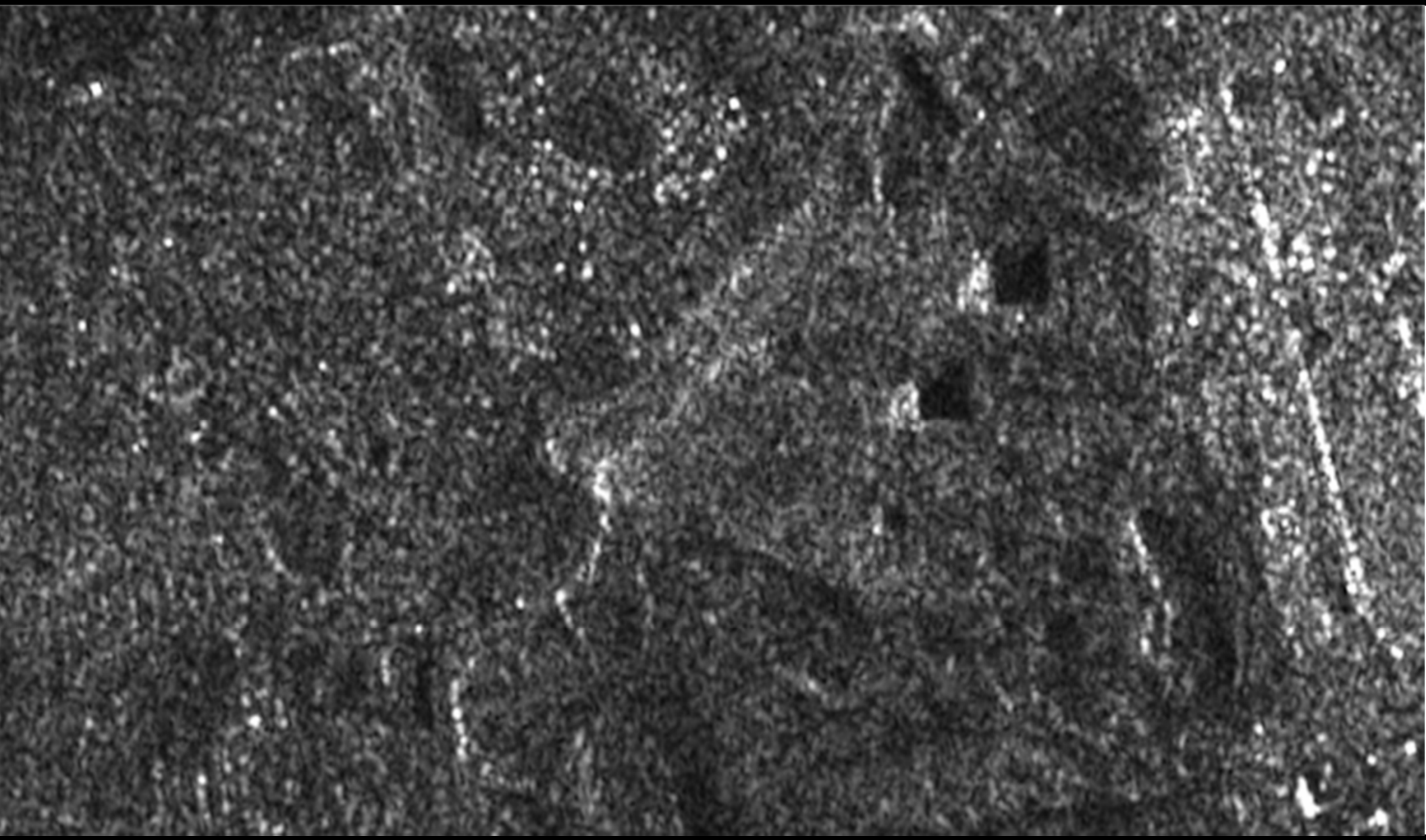
Image quality of spaceborne radar systems (Year 2000)

ca. 10 m × 20 m resolution



Pyramids of Giza, Egypt

TERRASAR X

MEXICO - Tabasco - Flood Situation - Villahermosa - November 10, 2007

1:15.000

Center for Satellite Based Crisis Information
- Emergency Mapping & Disaster Monitoring -

German Remote Sensing Data Center
German Aerospace Center

DLR

Legend

Settlement | Vegetation/Forest | Agriculture

Water surface | Water roads

Normal water level

Interpretation

A week of heavy rains caused rivers to overflow submerging major parts of the state of Tabasco and the neighbouring state of Chiapas. The city of Villahermosa, with a population of more than half a million people, has been most severly hit by the flood event.

This map shows the extent of the flood situation in the region of Villahermosa, Tabasco, Mexico as mapped by the German TerraSAR-X radar satellite on November 10, 2007. TerraSAR-X is jointly operated by the German Aerospace Center (DLR) and Infoterra GmbH, Germany. Please note that the flood extent in urban areas may in some cases not be detected properly due to radar geometry.

For visualising reasons an archived SPOT image (ground resolution of 10 m) was combined with the TerraSAR-X image and used as backdrop.

The map was produced in order to support the Mexican civil protection agency (CENAPRED).

Scale

0 250 500 750 1.000 m

Scale: 1:15.000 for DinA1 printing

Reference coordinate system:

Projection: UTM Zone 15 N
Spheroid: WGS 84
Datum: WGS 84

Data Sources

SPOT5 © CNES/SPOTIMAGE 2007
TerraSAR-X © German Aerospace Center (DLR) 2007
Commercial exploitation rights:

Processing/Analysis

Image processing and map creation by DLR

- Derivation of normal water areas from SPOT
- Derivation of flooded water areas from TerraSAR-X

Map created November 13, 2007 by zki@dlr.de

For more information visit: http://www.zki.dlr.de

TERRA SAR

Disaster Monitoring

Deepwater Horizon
Gulf of Mexico
30 April 2010

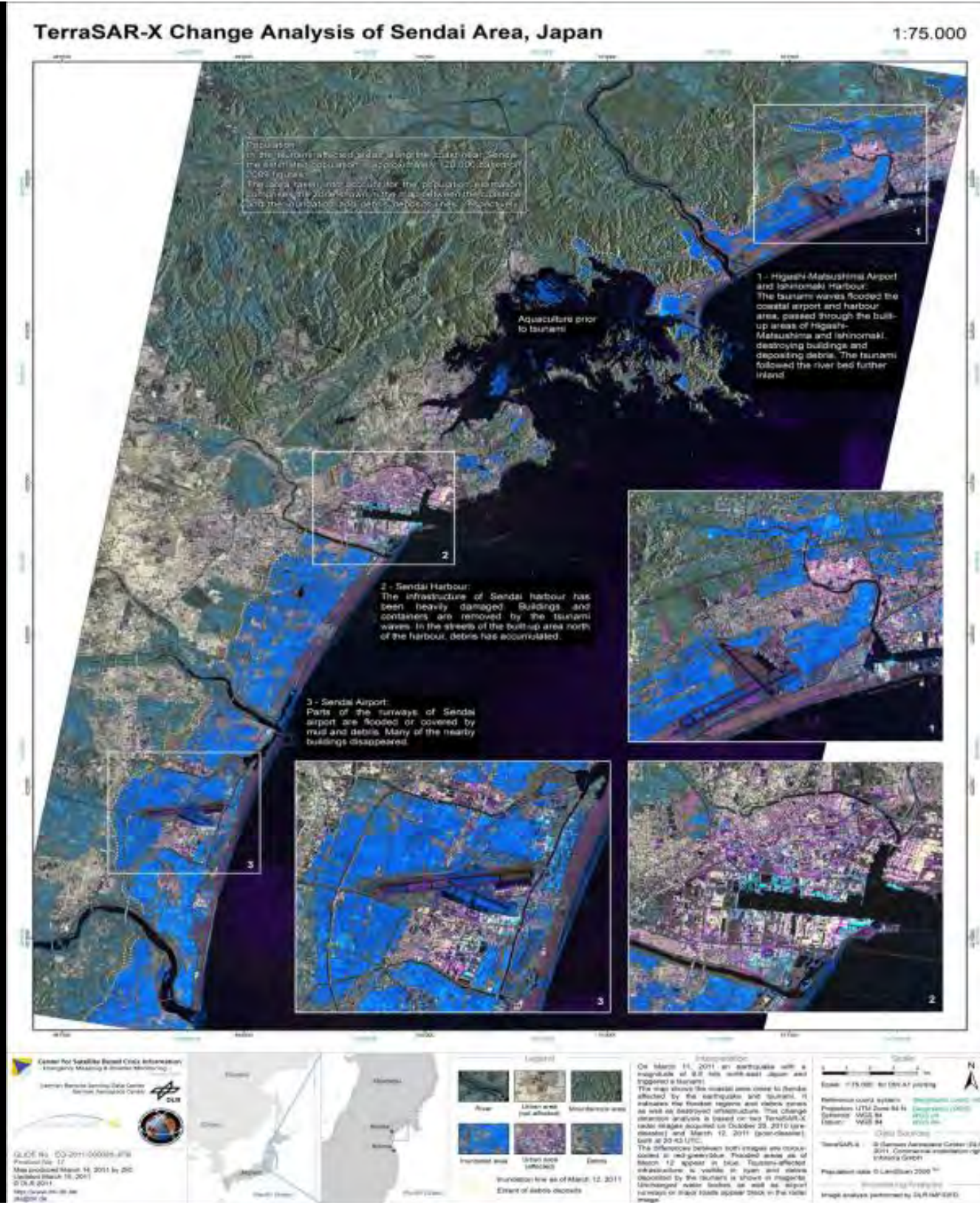
Oil Platform

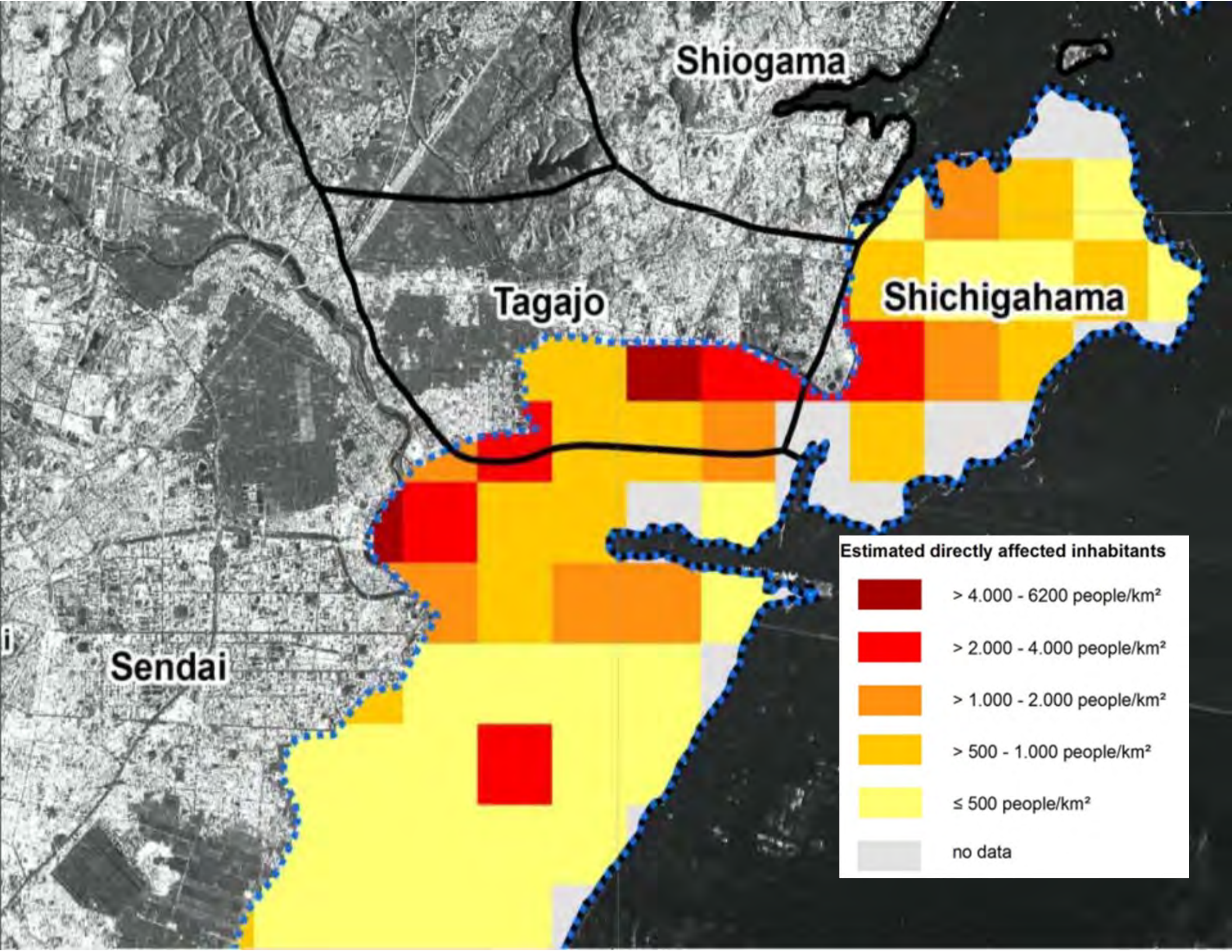
100 km (54 nmi)

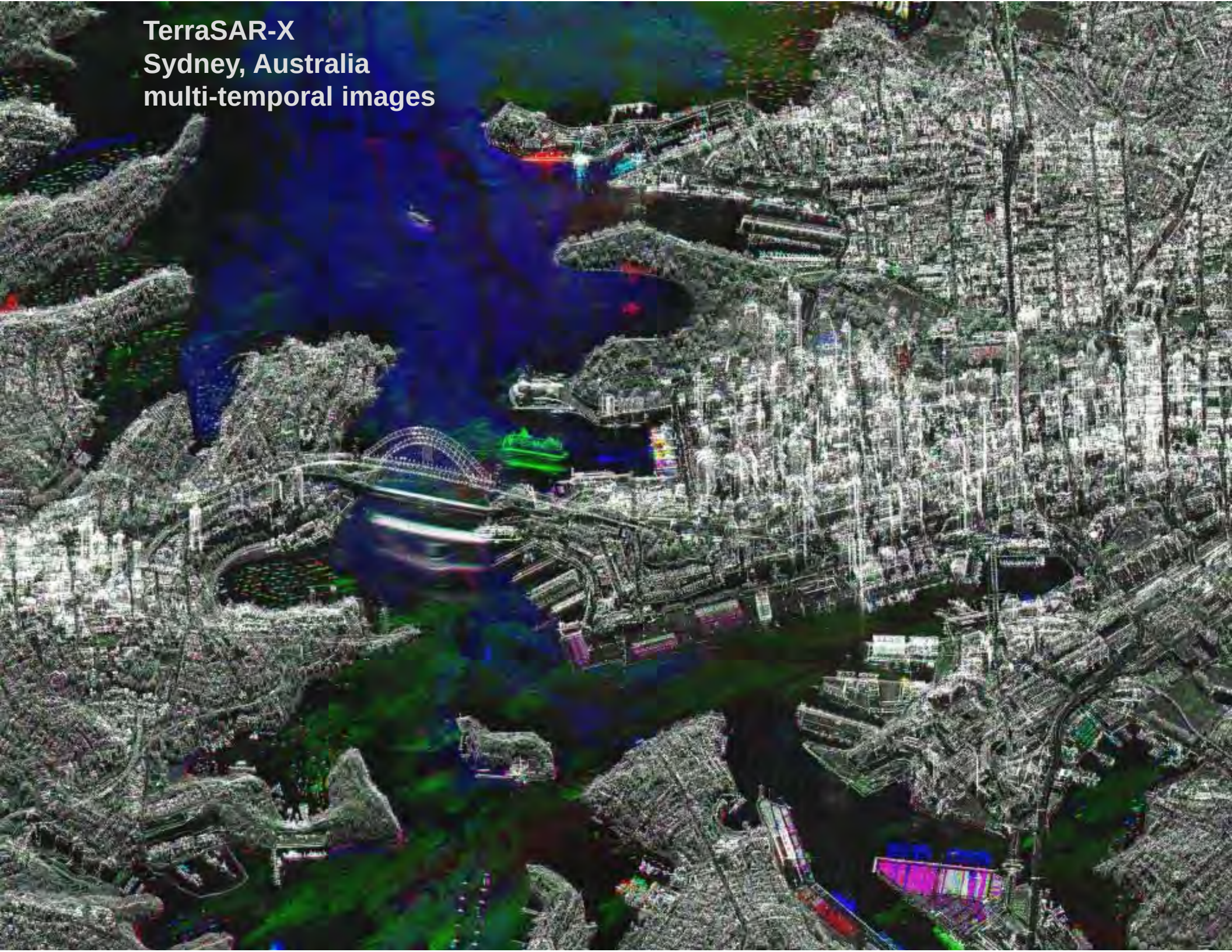
DLR

TERRASAR X

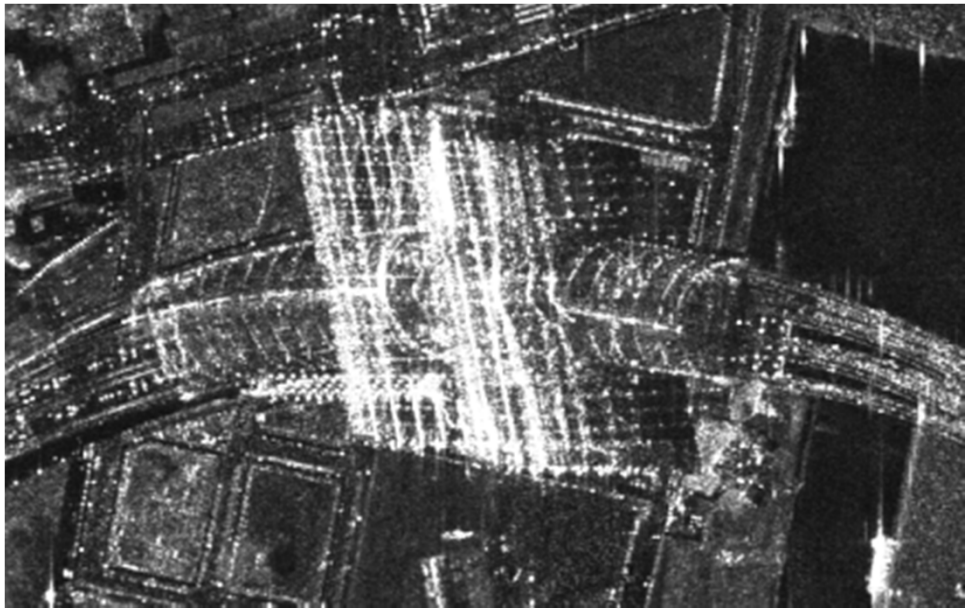
DLR Center for Satellite based Crisis Information - ZKI




Shiogama
Tagajo
Shichigahama
Sendai
Estimated directly affected inhabitants
> 4.000 - 6200 people/km²
> 2.000 - 4.000 people/km²
> 1.000 - 2.000 people/km²
> 500 - 1.000 people/km²
≤ 500 people/km²
no data


TerraSAR-X
Sydney, Australia
multi-temporal images

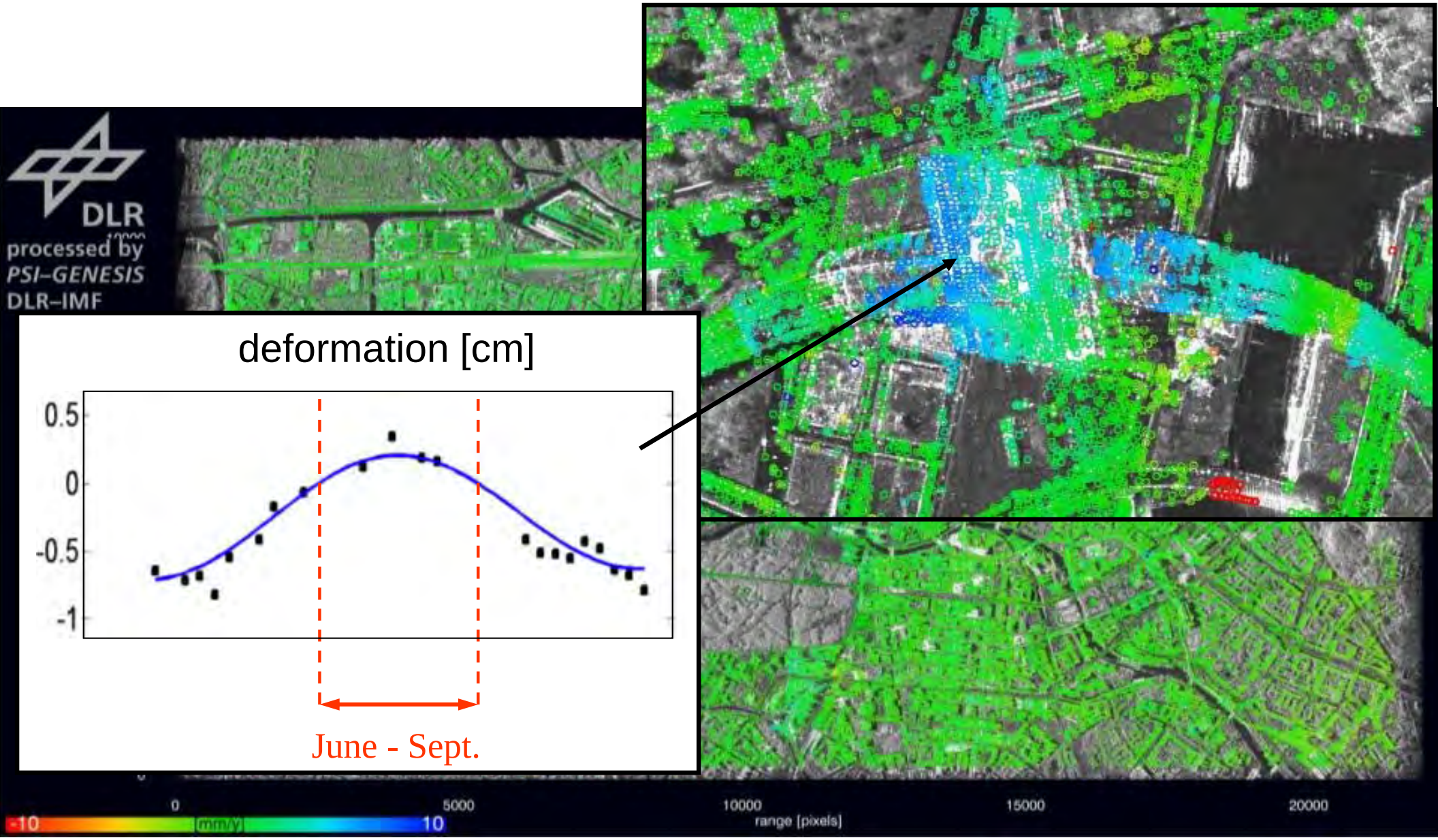
Deformation: Train Station Berlin



TerraSAR-X

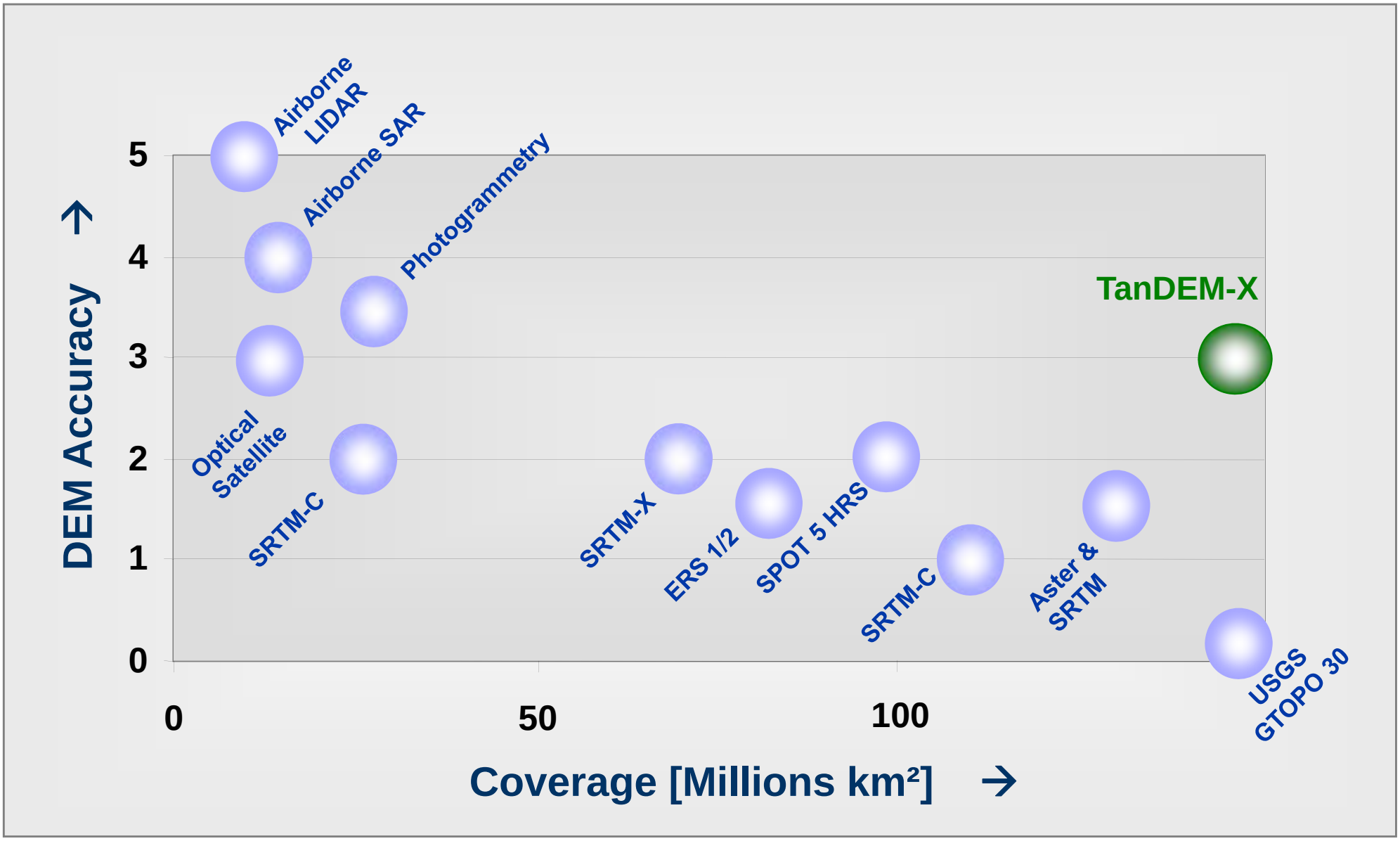
Google Earth

Deformation: Train Station Berlin



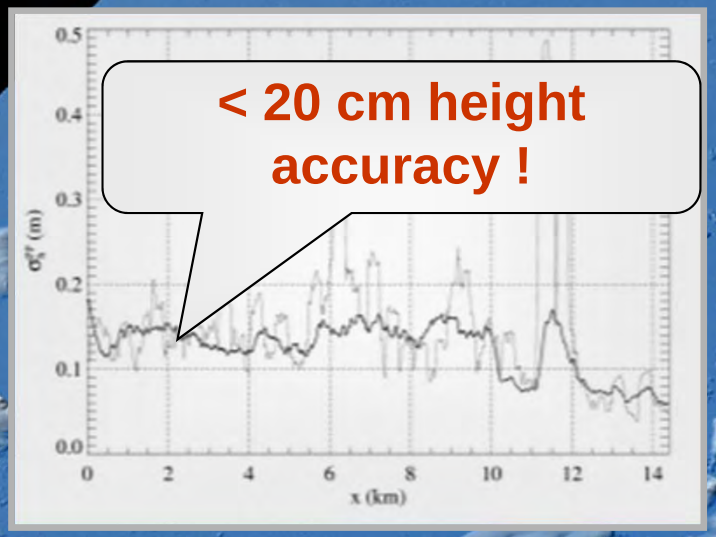

TanDEM
Launched 21 June, 2010
DLR
ASTRIUM
infoterra

Standards for Digital Elevation Models (DEM)



DLR

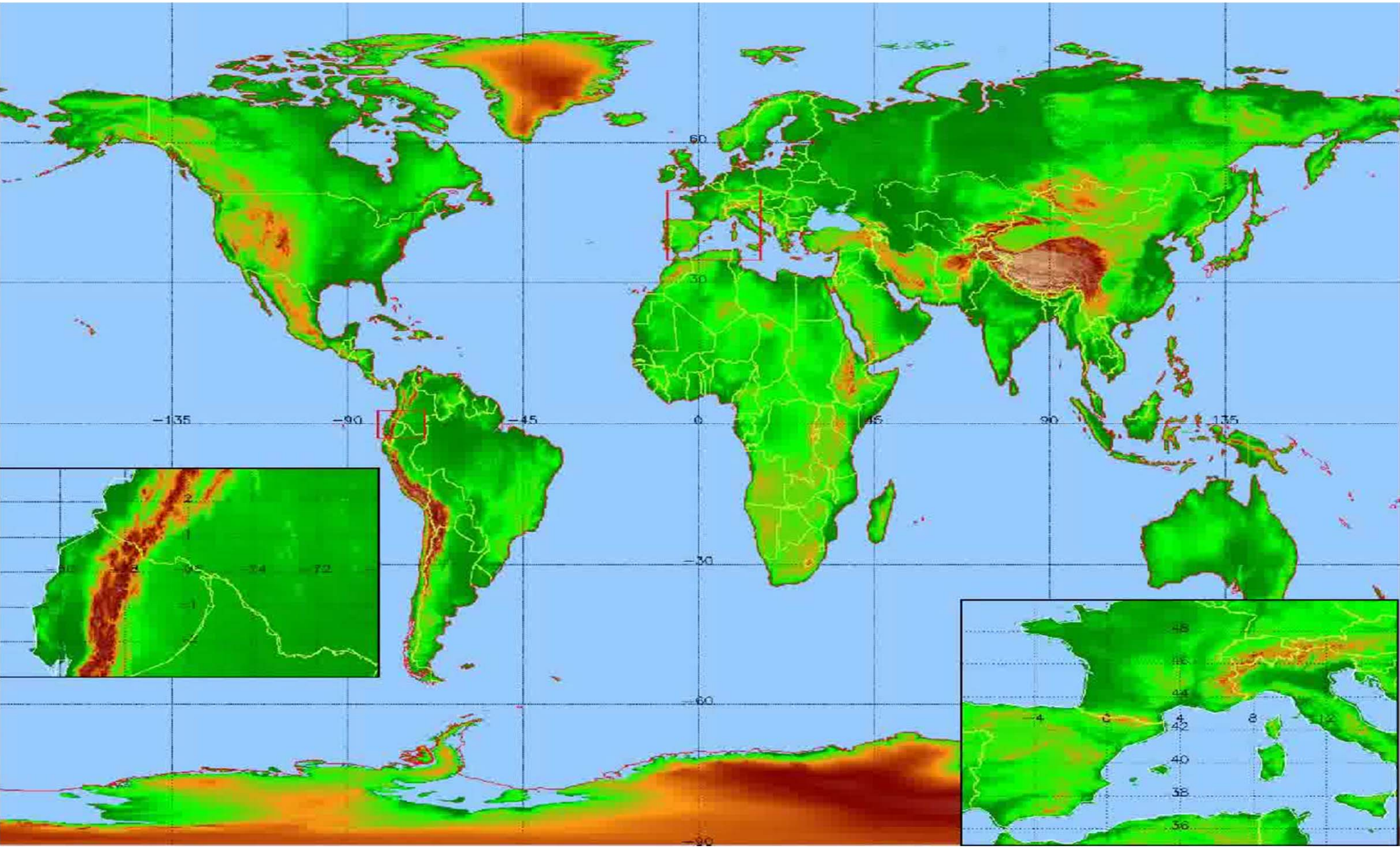
TanDEM-X:
First Digital Elevation Model



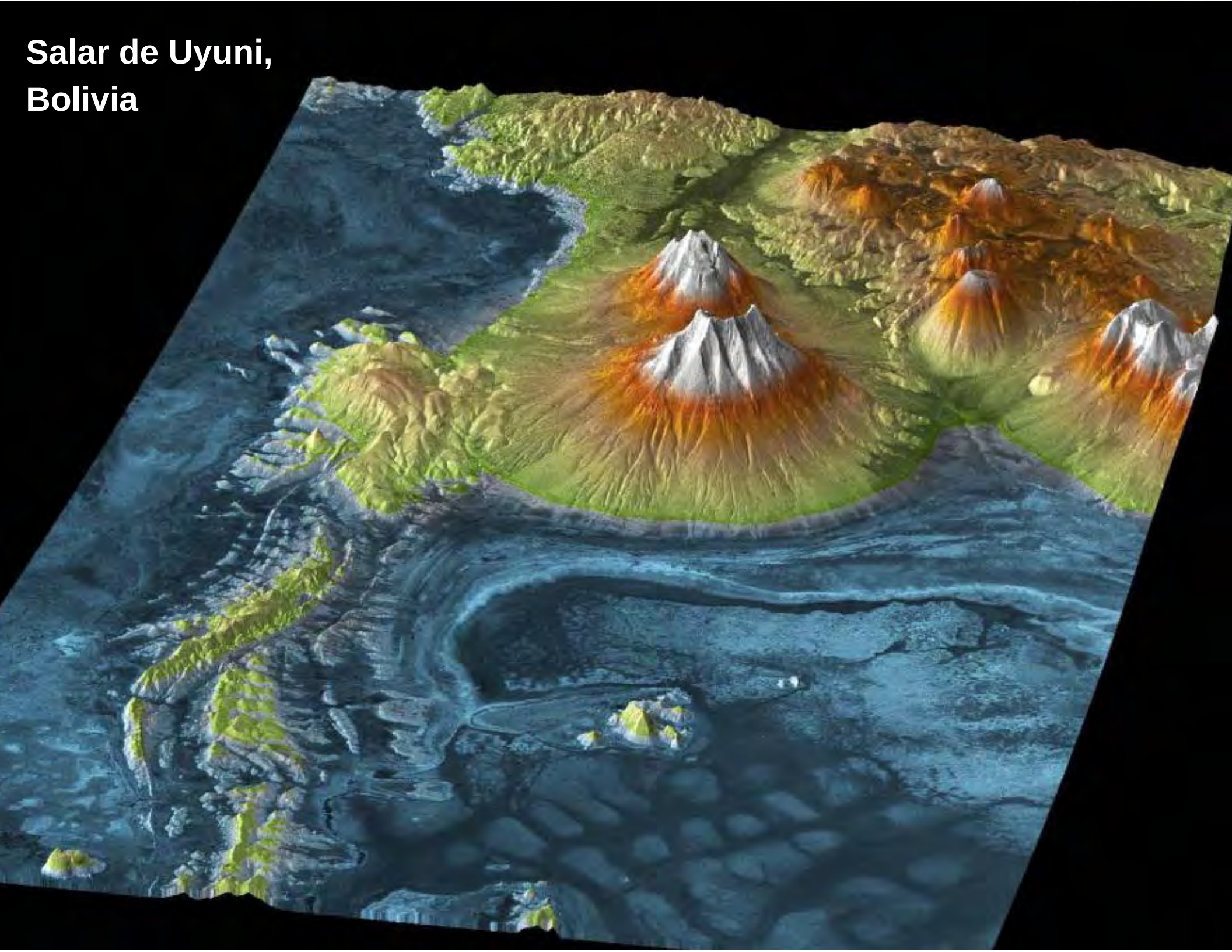
DLR

TanDEM

Data Acquisition – Timeline over 3 Months



DLR

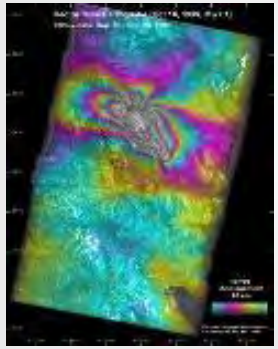

Salar de Uyuni,
Bolivia

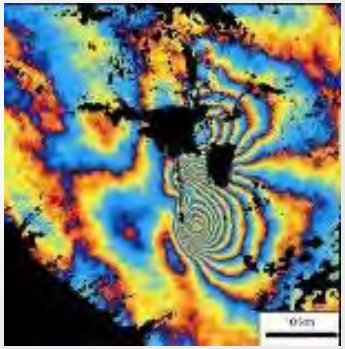
Iceland

Terra Sar X & Tandem X, 28 Nov 2010; 17:01:22.30 - 17:01:32.35 UTC
Canon EOS 450D + EF 50/2.5 Macro @ F2.8, 800 ISO, 10.05s
Marco Langbroek, SatTrackCam Leiden (Cospar 4353)

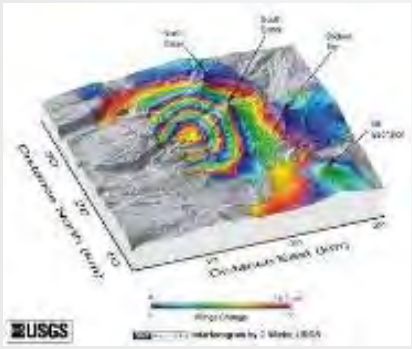
Future Spaceborne Radar Systems

Earthquakes

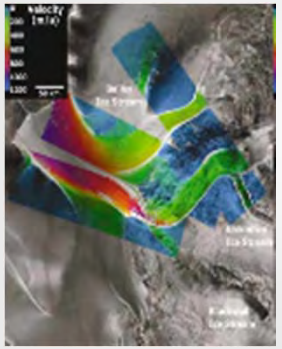


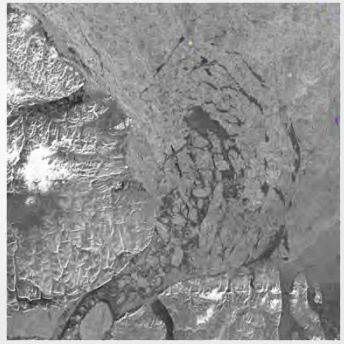


Volcanoes

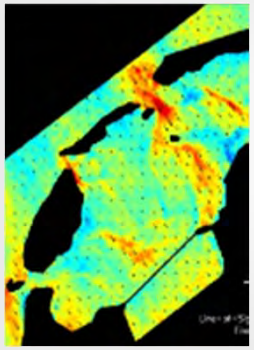


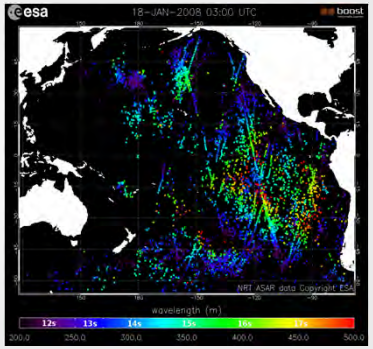
Land & Sea Ice



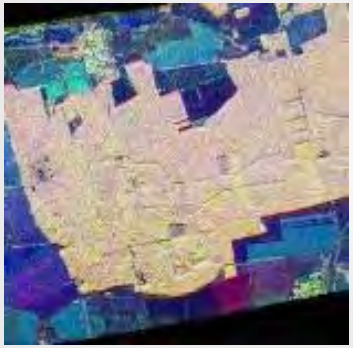


Ocean

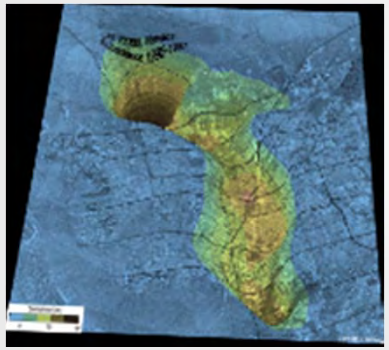


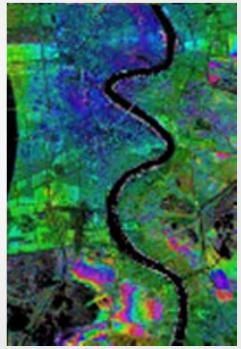


Land Environment

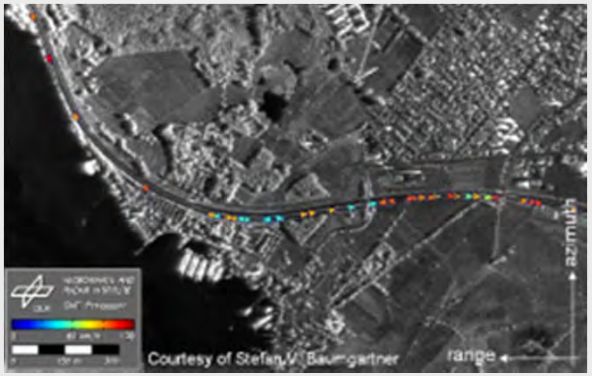


Subsidence

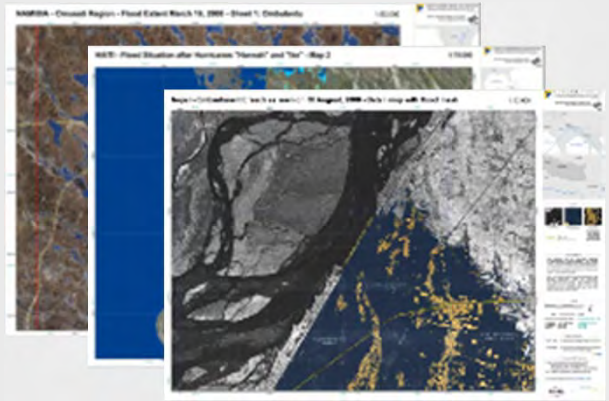




Traffic



Disaster



Reconnaissance

Dynamic Processes on the Earth Surface

*) Essential Climate Variables

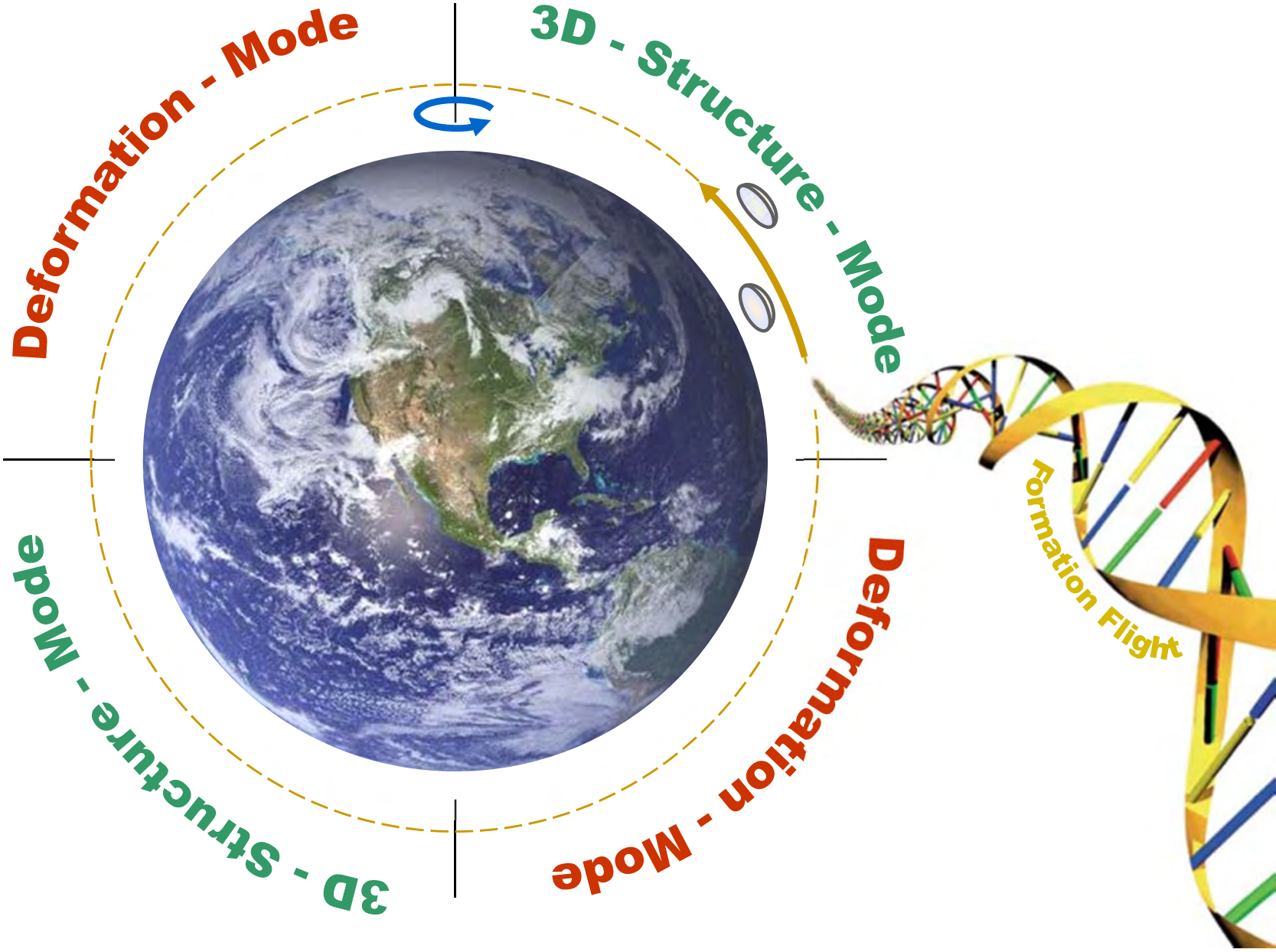
Days Weeks Months Years Observation Interval

DLR

Tandem-L

DLR

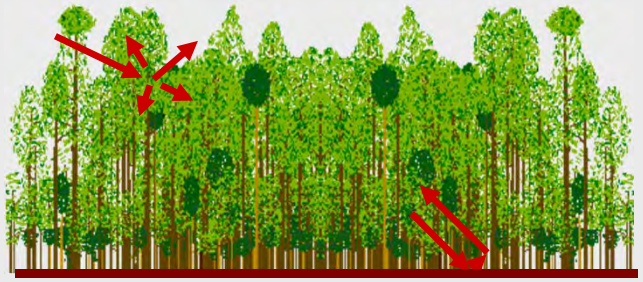
Tandem-L Mission Concept



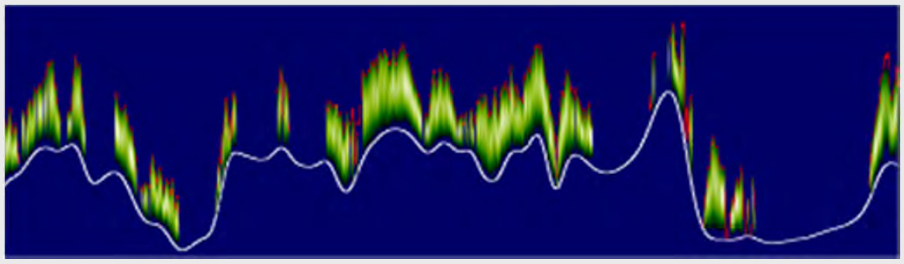
DLR

3-D Structure Mode

Polarimetric Backscattering

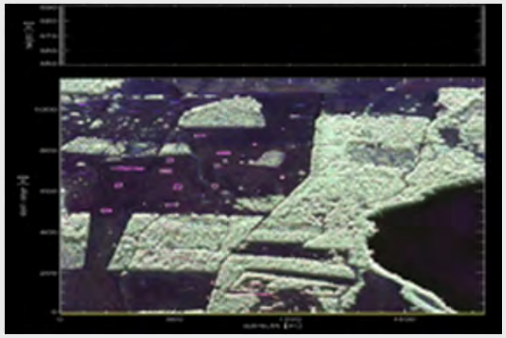


3-D Forest Structure



Forest height and Biomass

Tomography

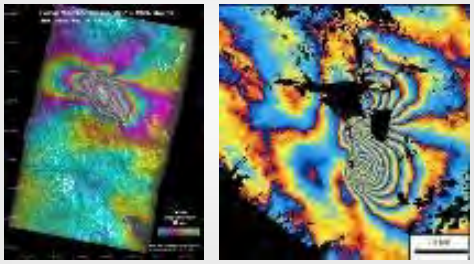


Polarimetric SAR Interferometry (Pol-InSAR)

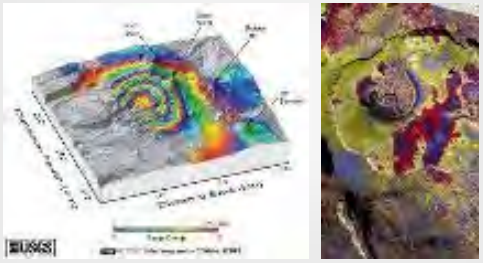
DLR

Deformation Mode

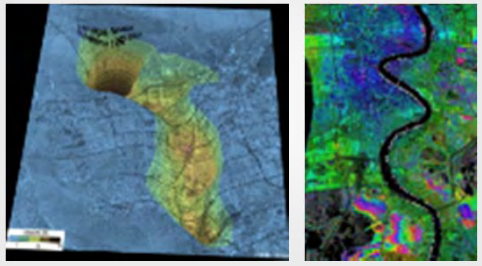
Earthquakes



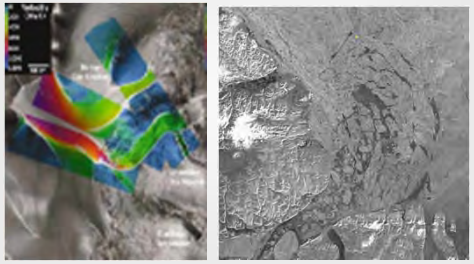
Volcanoes

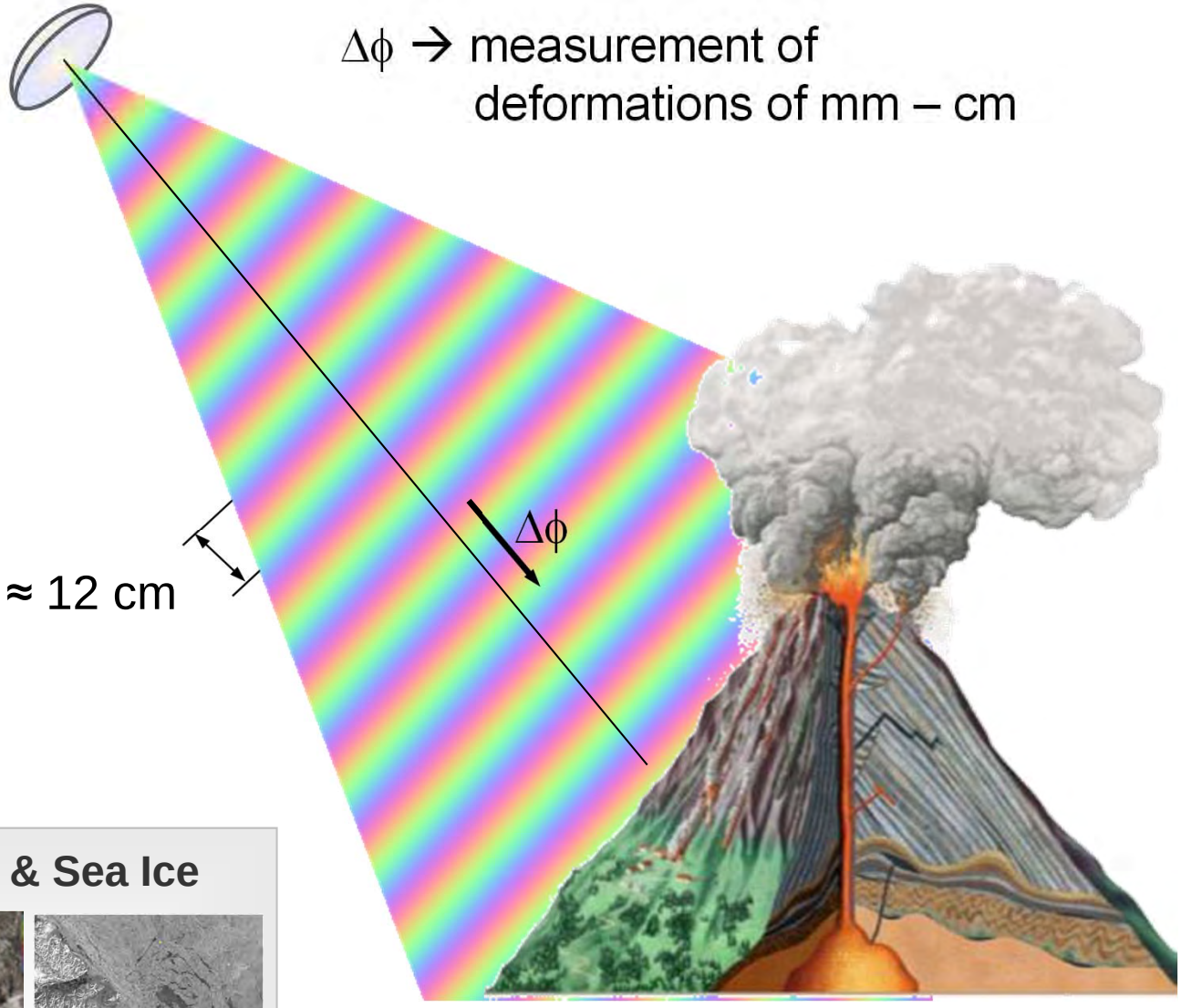


Subsidence



Land & Sea Ice

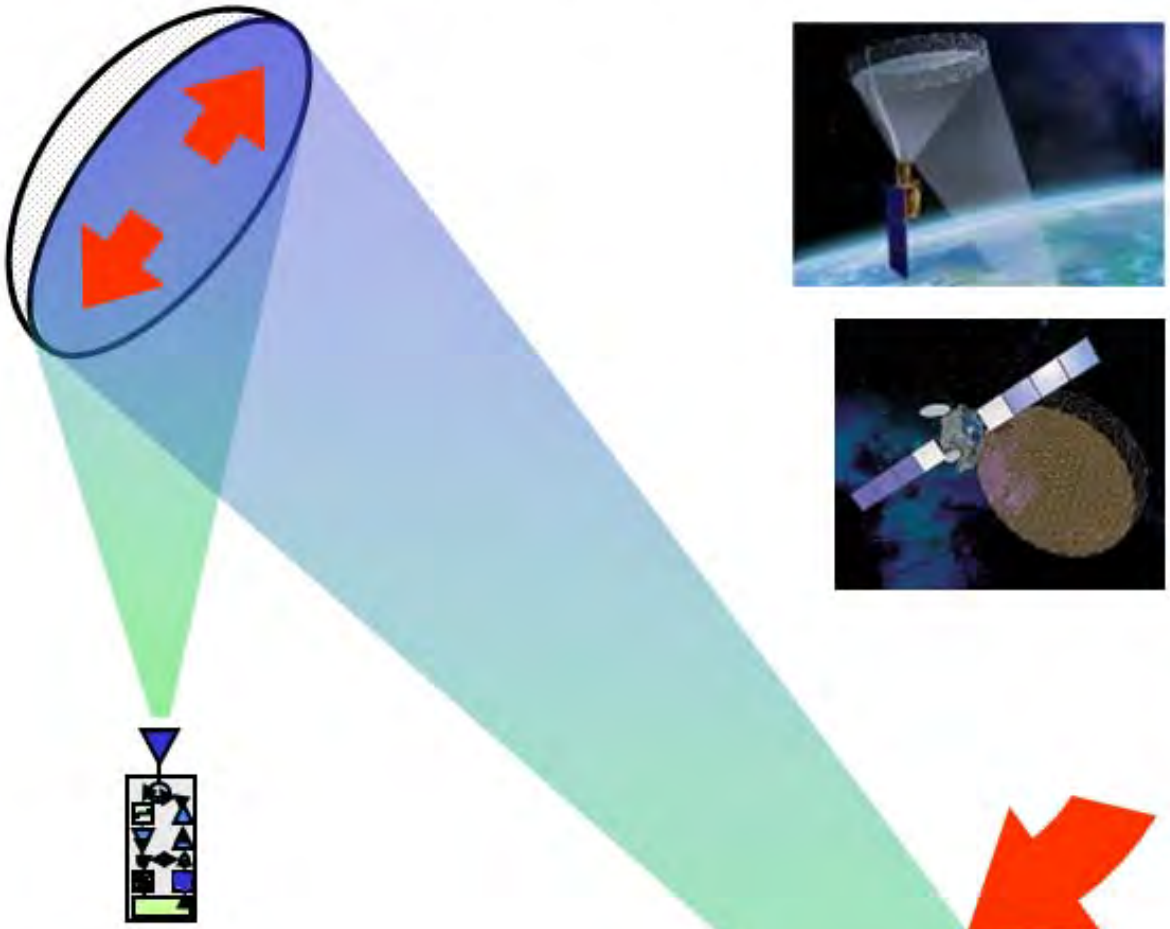


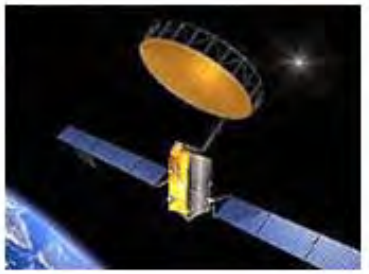


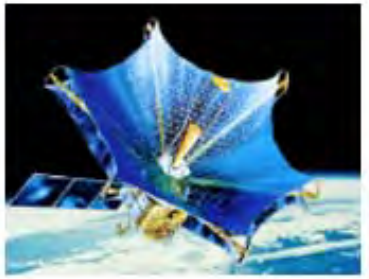
systematic multi-temporal
acquisitions (image stacks)

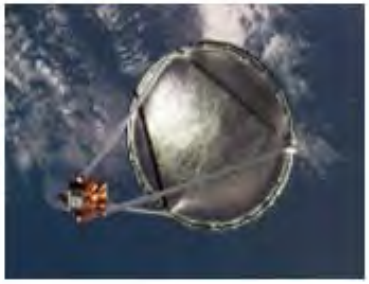
DLR

Deployable Reflector Antennas







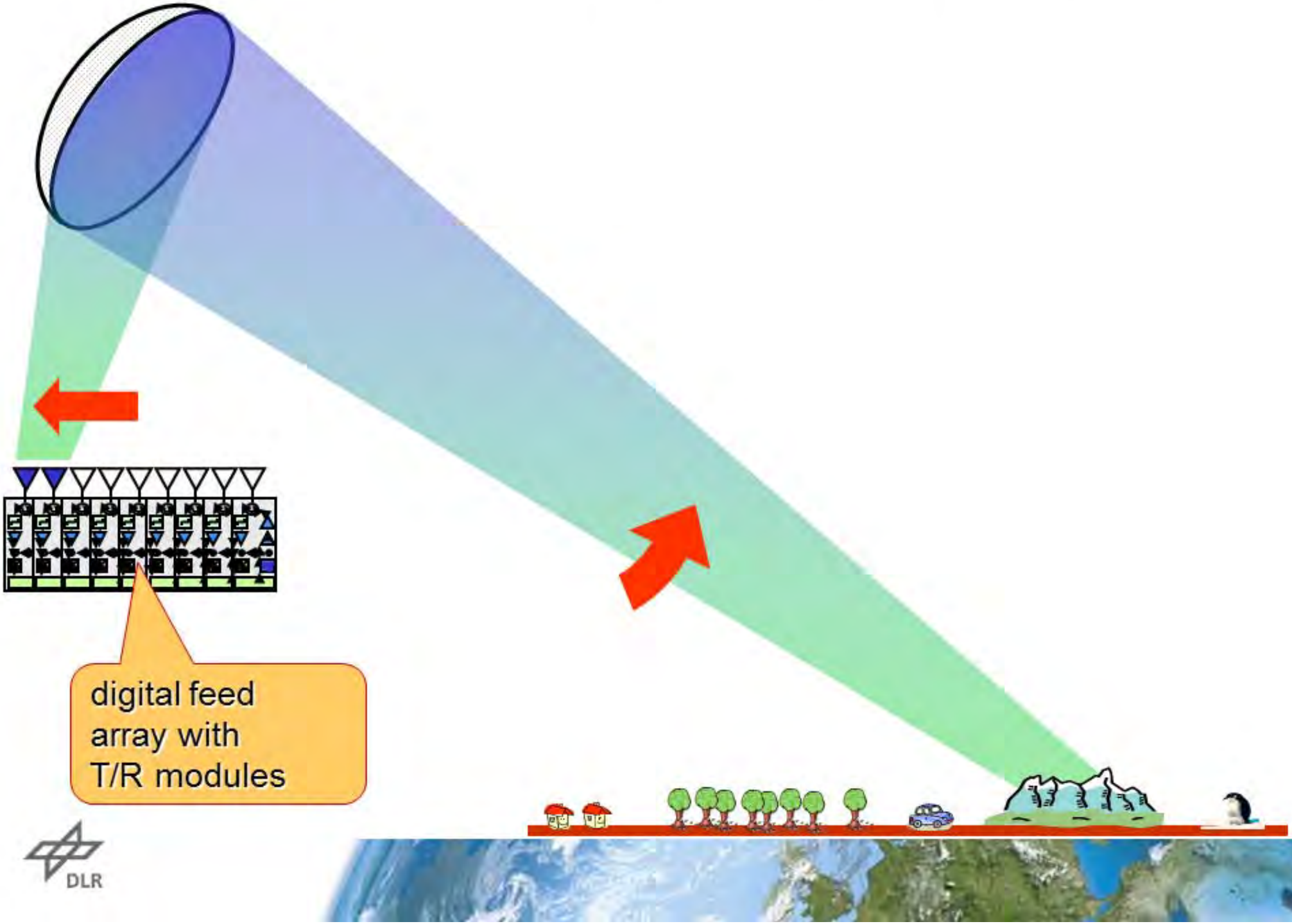


DLR

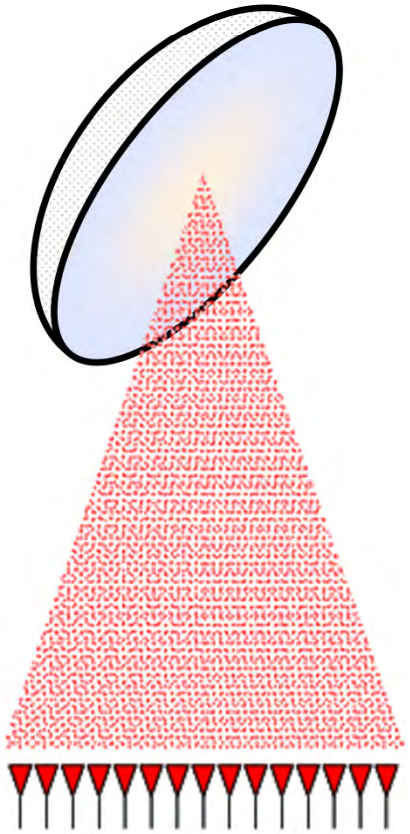
Digital Beamforming with Reflector Antennas

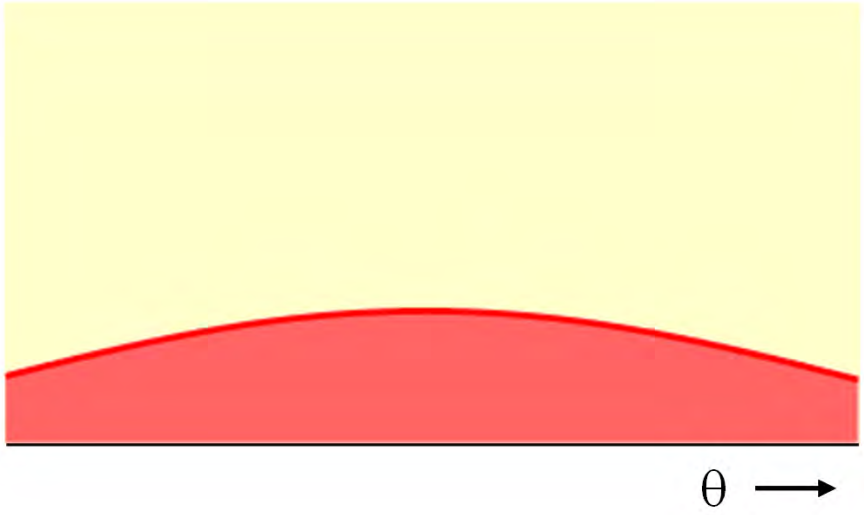
DLR

Digital Beamforming with Reflector Antennas



Digital Beamforming with Reflector Antennas





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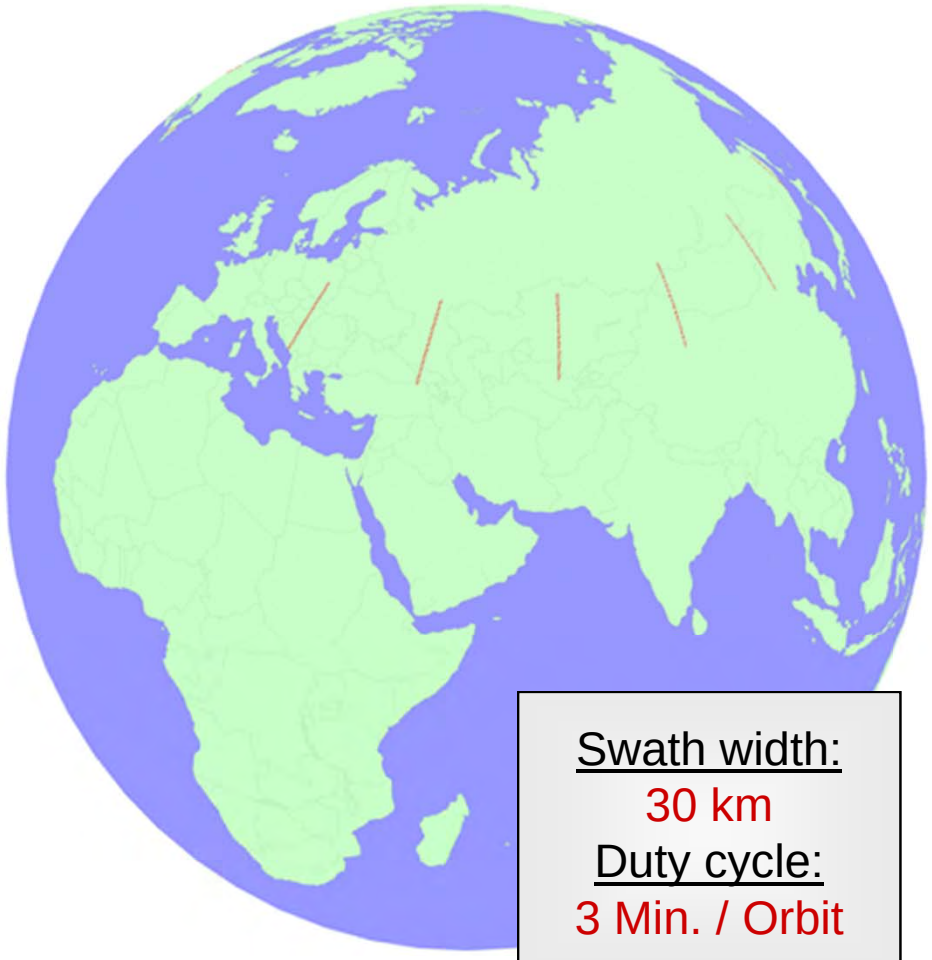
Comparison of Imaging Capacity

TanDEM-X

1 global coverage / year



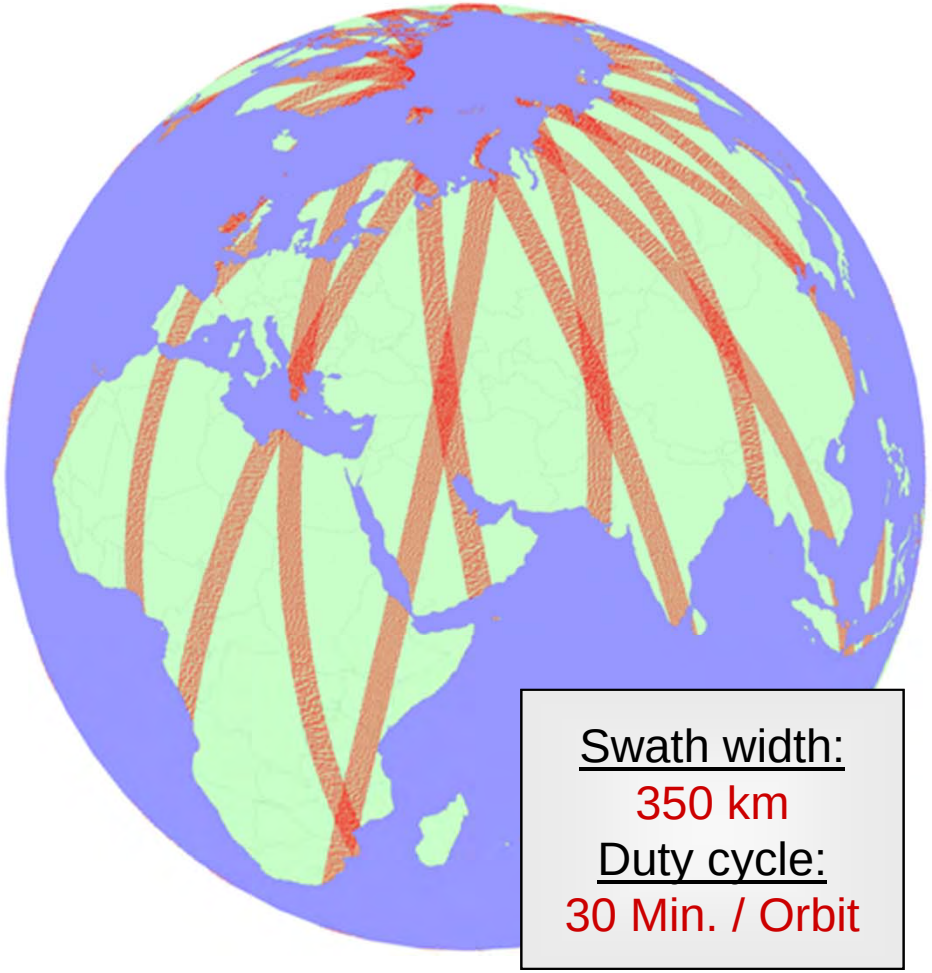
Swath width:
30 km
Duty cycle:
3 Min. / Orbit

Day

1

Tandem-L

2 global coverages / week



Swath width:
350 km
Duty cycle:
30 Min. / Orbit

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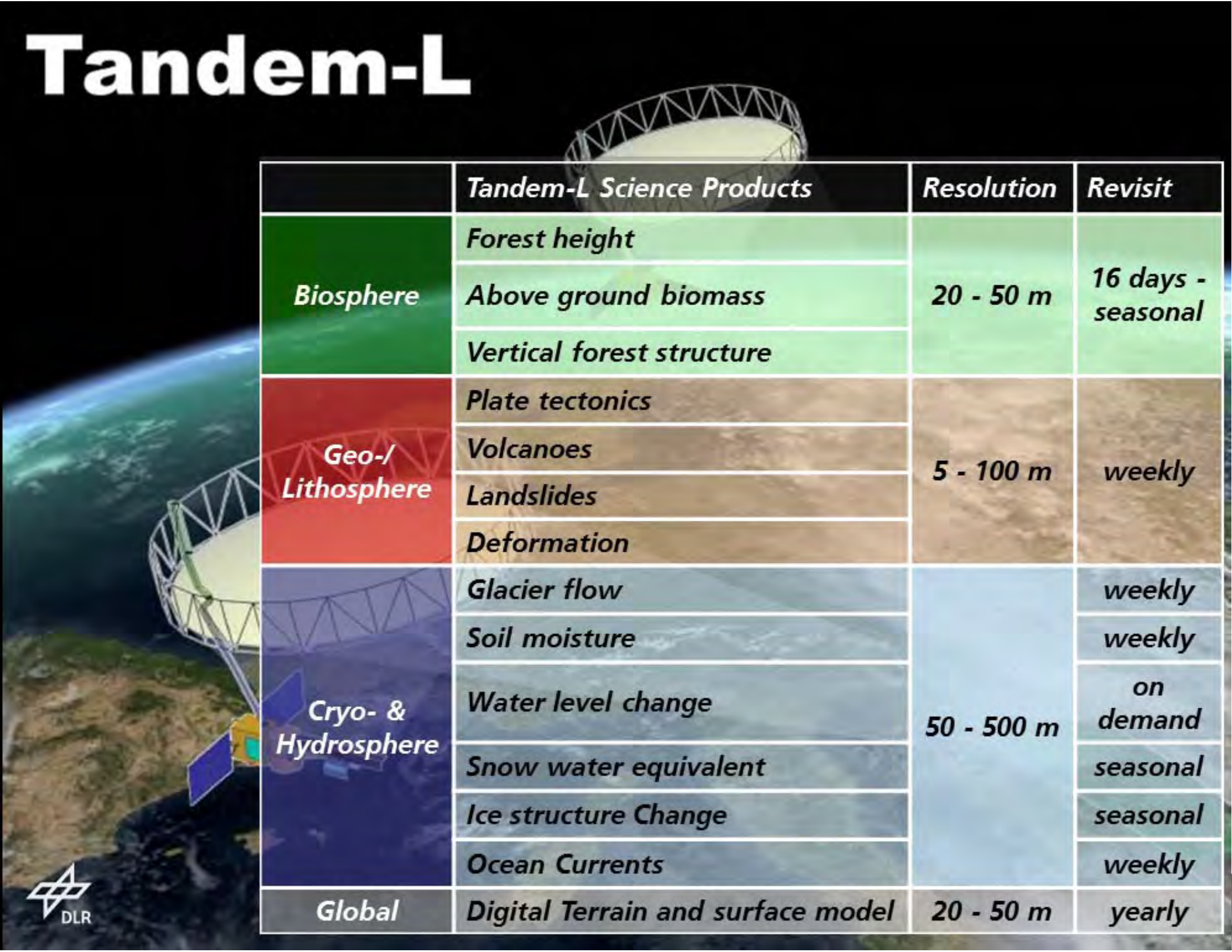
Tandem-L



	Tandem-L Science Products	Resolution	Revisit
Biosphere	Forest height	20 - 50 m	16 days - seasonal
	Above ground biomass		
	Vertical forest structure		
Geo-/ Lithosphere	Plate tectonics	5 - 100 m	weekly
	Volcanoes		
	Landslides		
	Deformation		
Cryo- & Hydrosphere	Glacier flow	50 - 500 m	weekly
	Soil moisture		weekly
	Water level change		on demand
	Snow water equivalent		seasonal
	Ice structure Change		seasonal
	Ocean Currents		weekly
Global	Digital Terrain and surface model	20 - 50 m	yearly

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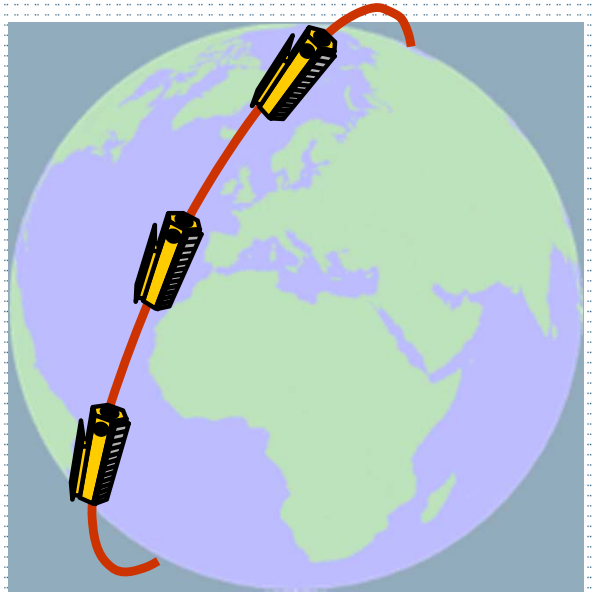
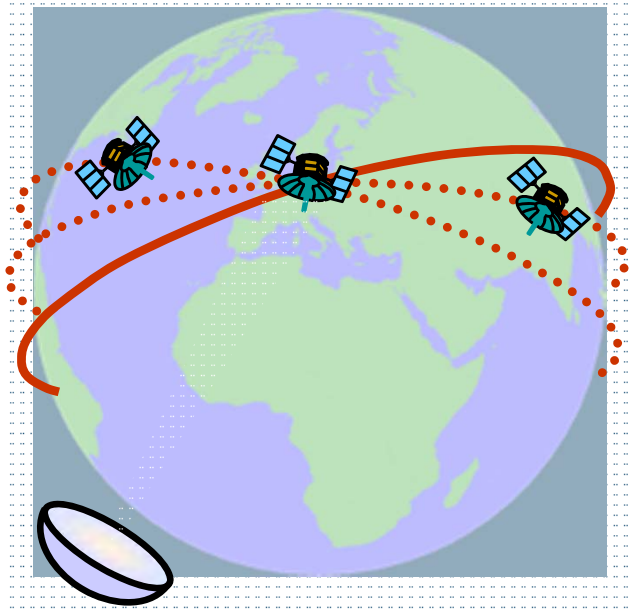
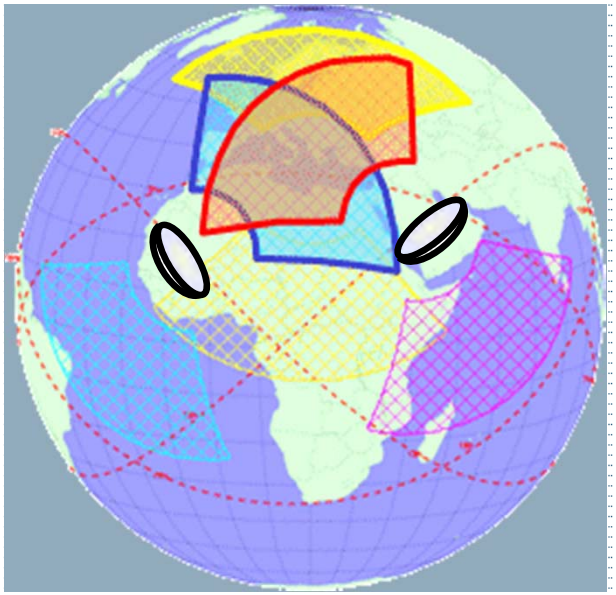
Vision for Radar Remote Sensing

Low Earth Orbit (LEO) Satellites	Geostationary illuminator + small receivers	Medium Earth Orbit (MEO) Satellites
		
• Short revisit times by multiple SAR satellites • Conventional technique with low risk	• Constant illumination with geostationary transmitter • Signal reception by passive low-cost micro-satellites	• Huge simultaneous access area • Multiple revisits per day with one satellite

DLR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SR 520
124TH AVE NE
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Continuous
Monitoring of a
Dynamic Earth