Third International SAR Workshop

SAR Activities and Plans
German Aerospace Center

DLR



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DLR Space Agency, Bonn, Germany

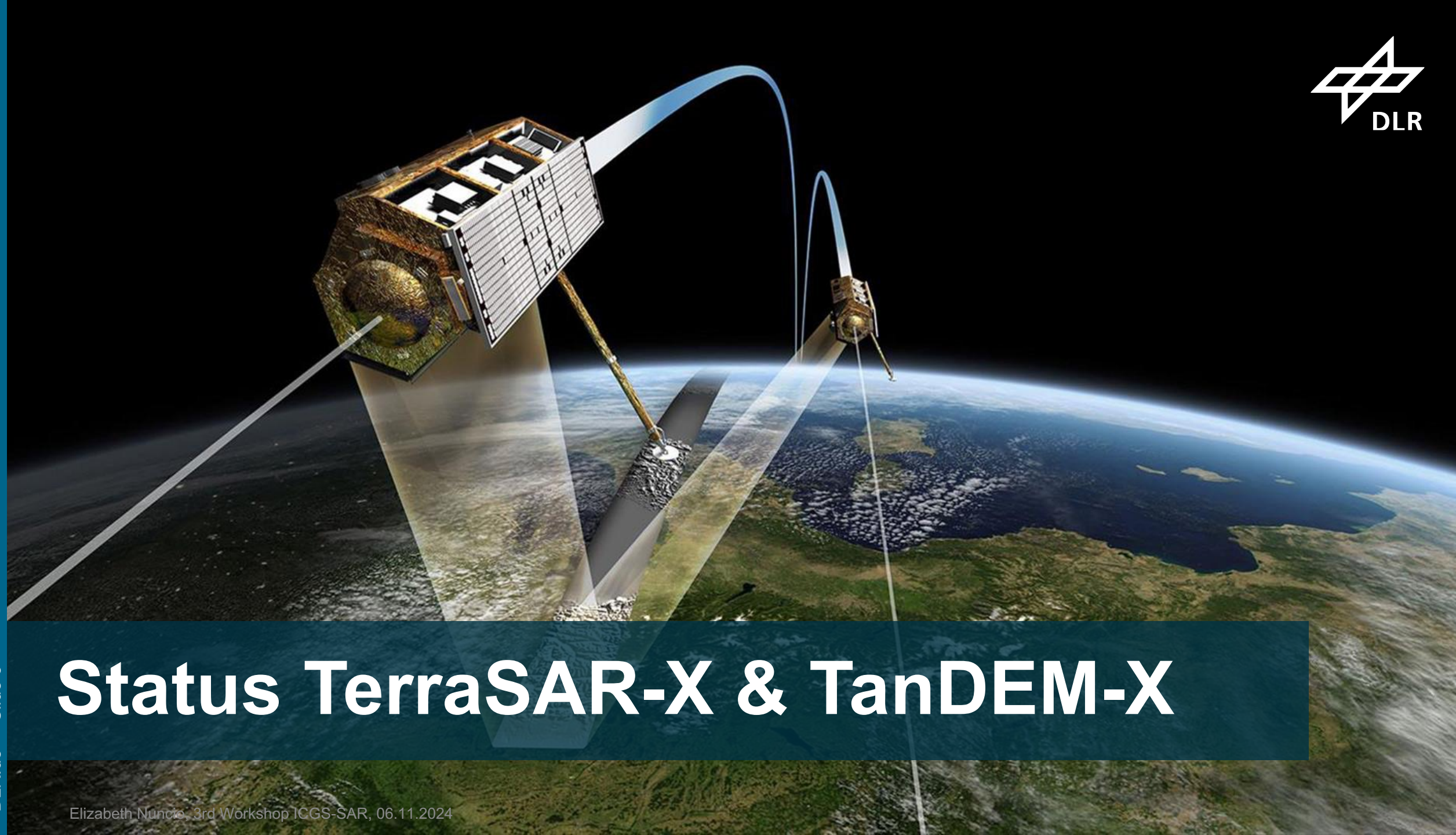
Inputs from the TerraSAR-X / TanDEM-X Team

Saga Prefecture, Japan
6-8 November, 2024

SAR activities and plans

1. Status TerraSAR-X and TanDEM-X
2. International collaboration and fusion with other missions:
   - Fusion with GEDI and Biomass
   - TXS and TDX as contributing missions
   - MOSAIC software patch
3. TerraSAR-FOX Mission

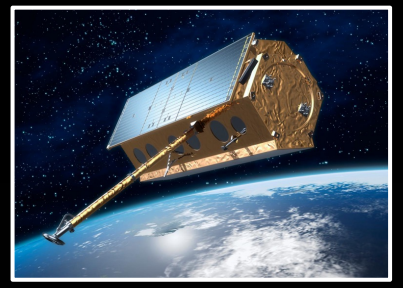




Status TerraSAR-X & TanDEM-X

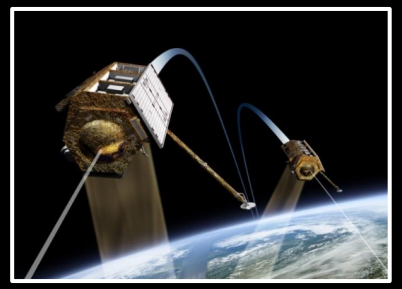
German X-Band SAR Missions

2007



TerraSAR-X

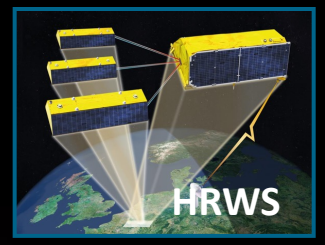
2010



TanDEM-X

Next X-Band Mission

2024
TerraSAR-FOX
Phase 0



2015-2018
Phase 0/A

STOP 2022

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	...	2028	...	2031
CP	17 years of the TerraSAR-X-Mission																				
			CP	14 years of the TanDEM-X-Mission																	

TanDEM-X 4D Mission Phase

- Time as a new information component, in addition to the three spatial dimensions
  → "TanDEM-X 4D“
- Earth's surface is a very dynamic system - repeated images required!
- 3D time series capture these changes
- Accurate trend analyses of local elevation changes are made possible
- Information content and value of time series increases with mission duration

Chuquicamata, the biggest copper mine in the world, located in the north of Chile

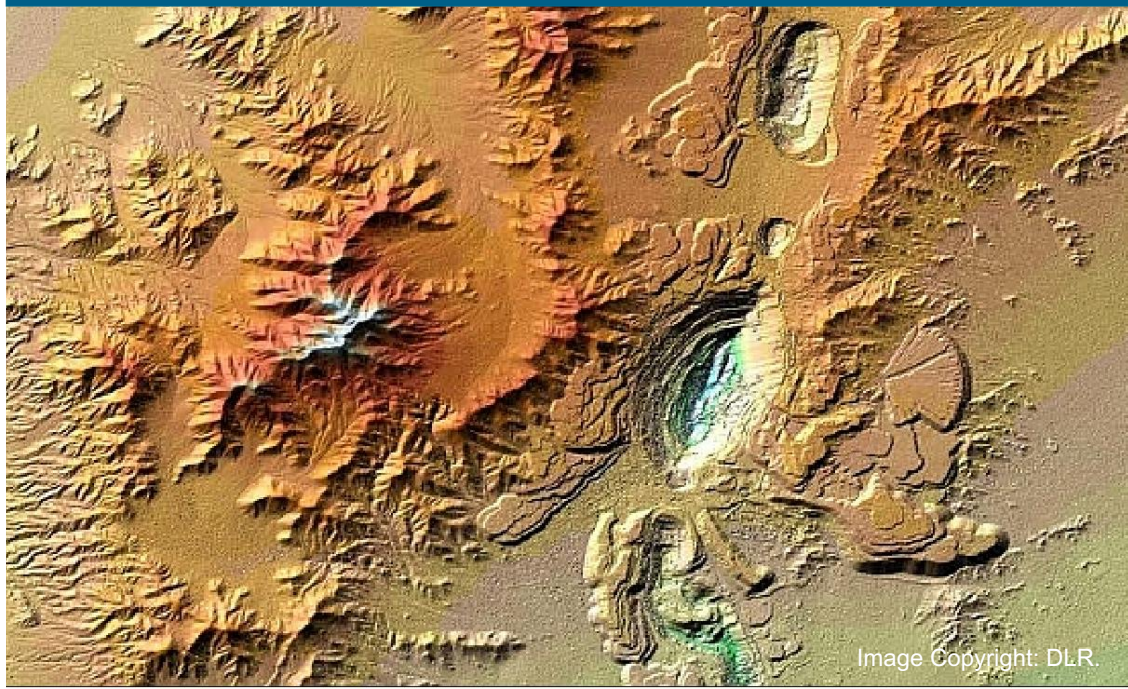


Image Copyright: DLR.

New TanDEM-X Products

Geoservice Maps List of Web Maps Contexts

TanDEM-X 30m Edited Digital Elevation Model (EDEM)

DLR, TDM, HR, TanDEM-X, DEM, EDEM, Digital Elevation Model, TDM30, Edited DEM

Map | Description

TanDEM-X 30m DEM Change Maps (DCM)

DLR, EOC, TanDEM-X, DEM, Digital Elevation Model, TDM 30m DCM, global, InSAR, TSX-1, land, DEM Change Maps, Change, Change Detection, TanDEM-X 4D

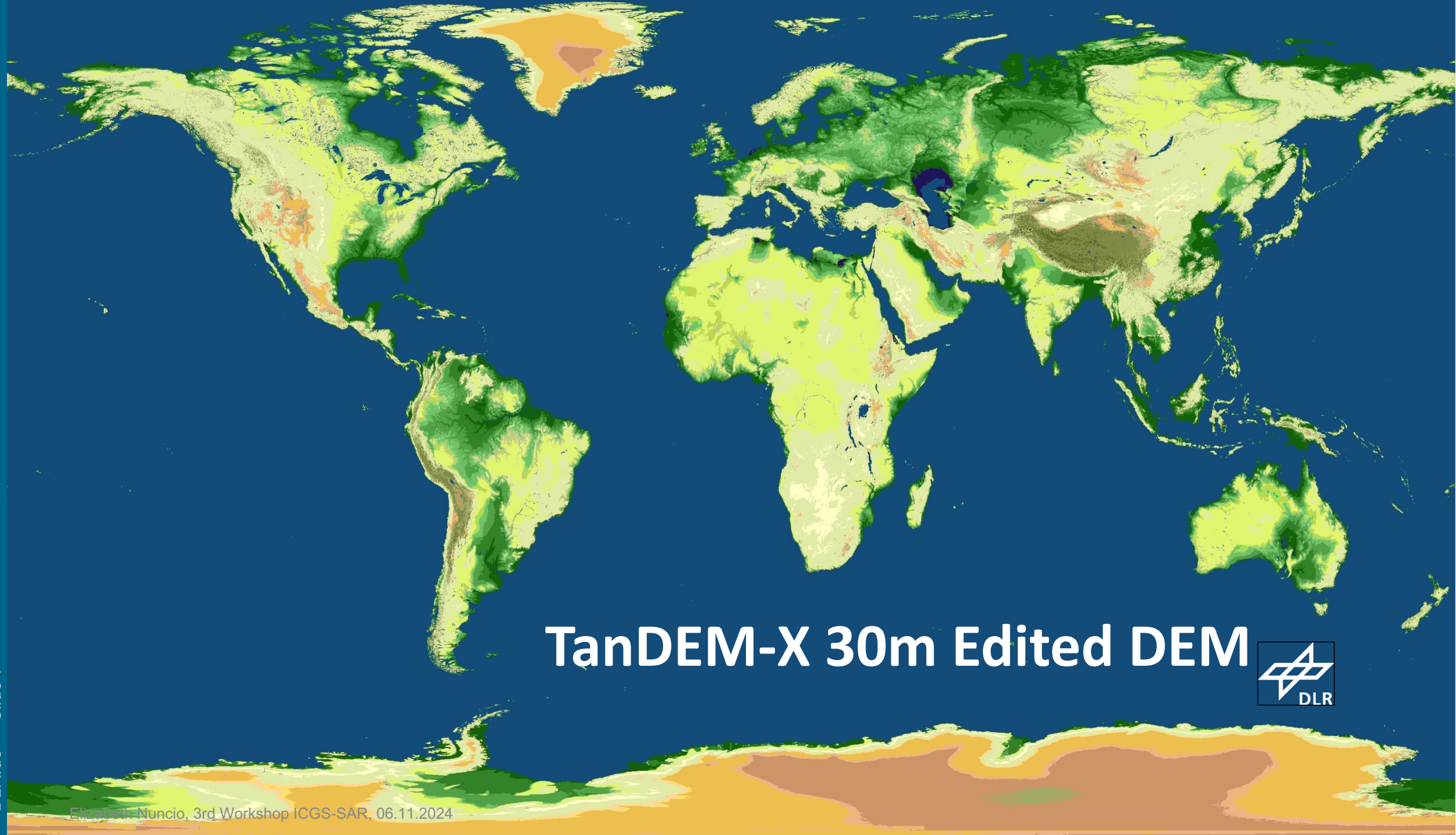
Map | Description

TanDEM-X 90m DEM

DLR, TDM, TanDEM-X, DEM, Digital Elevation Model, TDM-DEM-90m

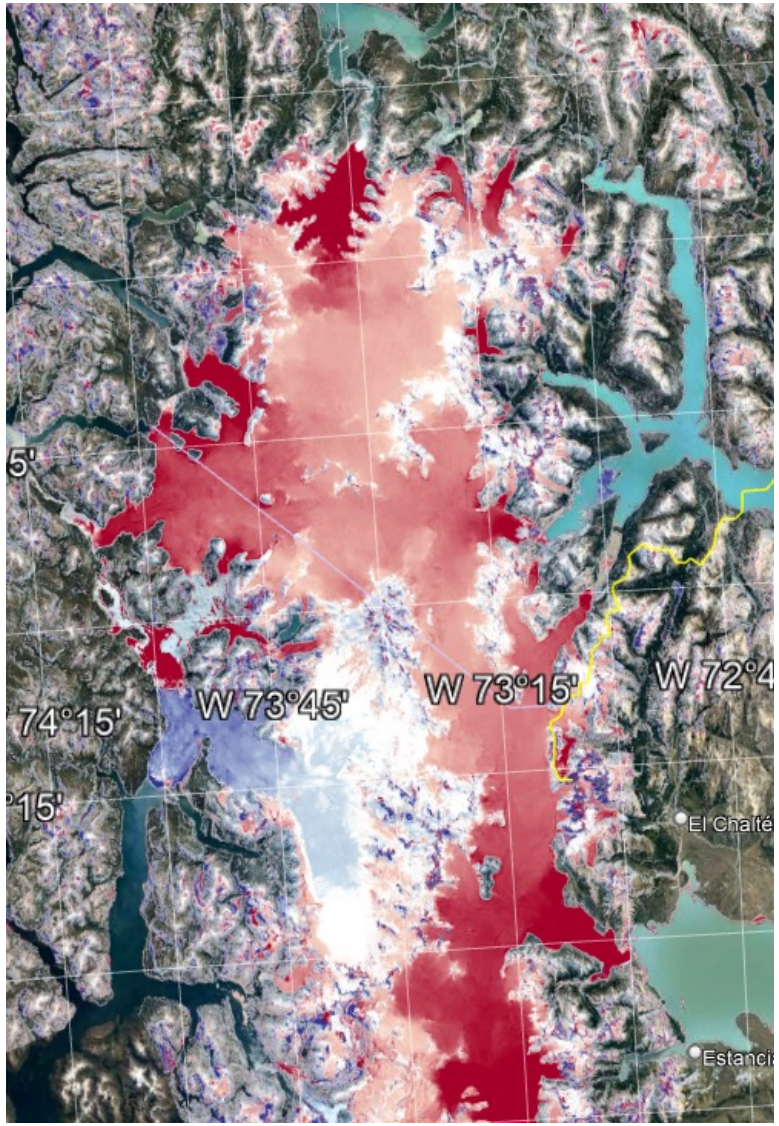
Map | Description

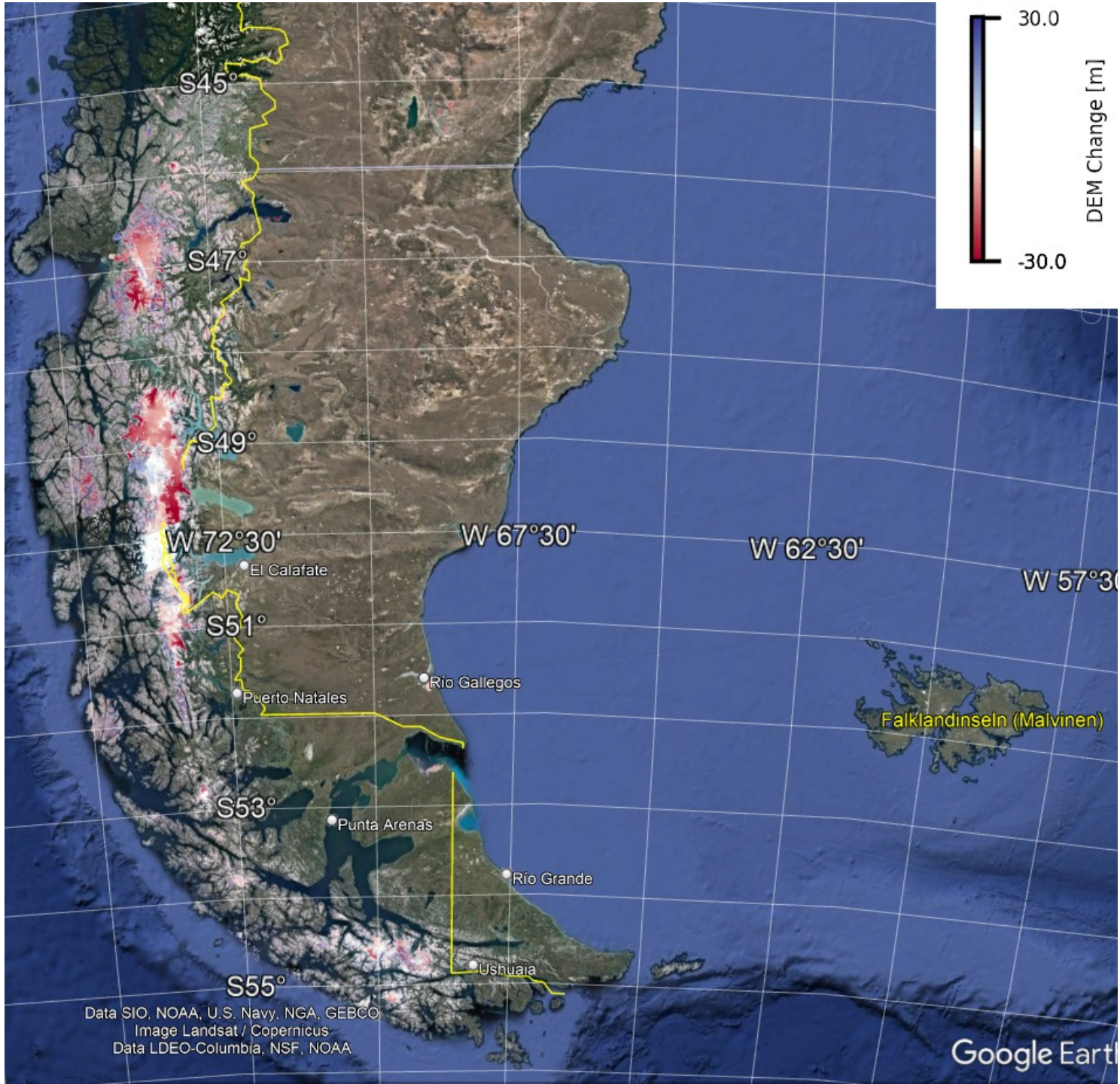
https://geoservice.dlr.de/web/maps


TanDEM-X 30m Edited DEM
DLR

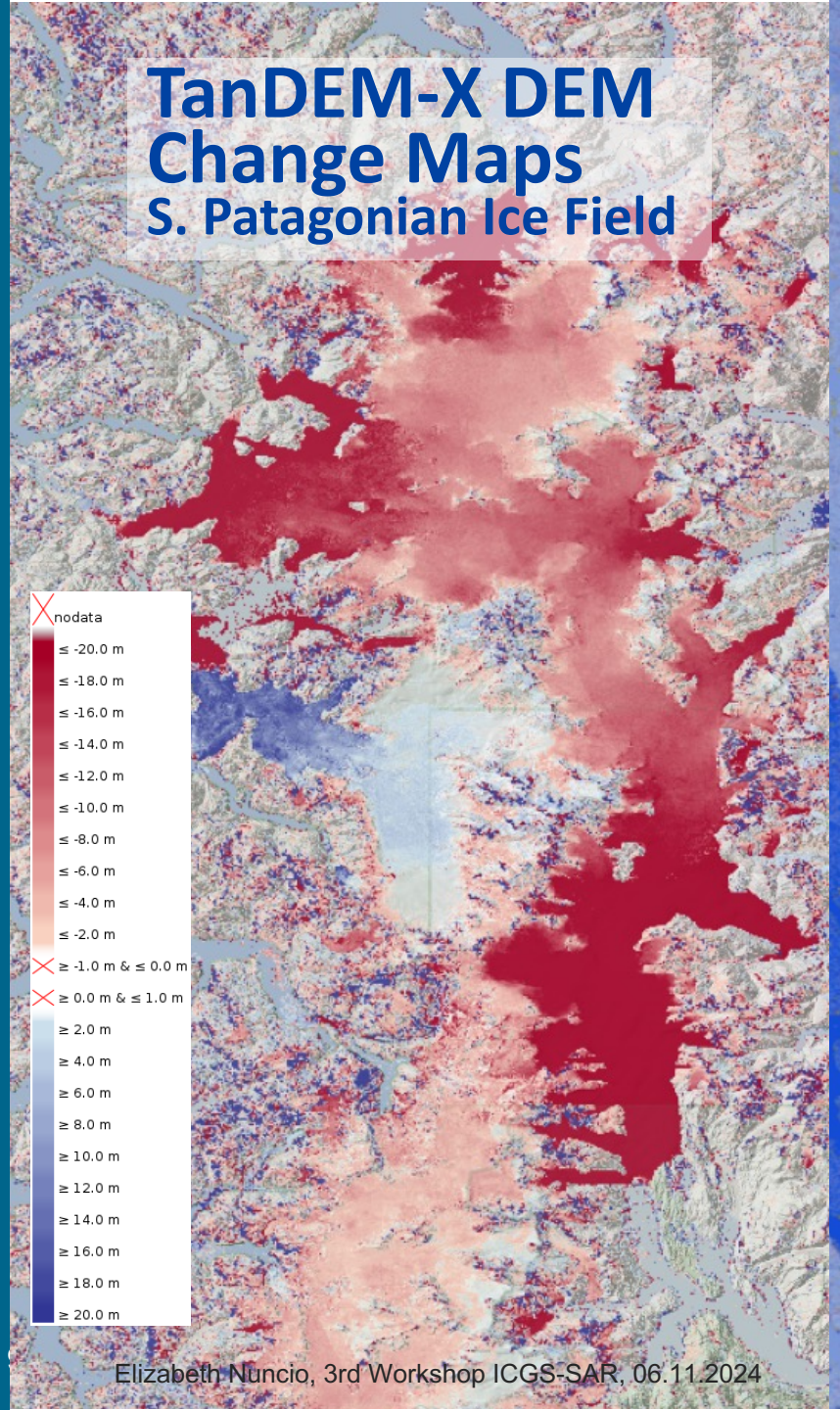
TanDEM-X DEM Change Maps:

Southern Patagonian Ice Field

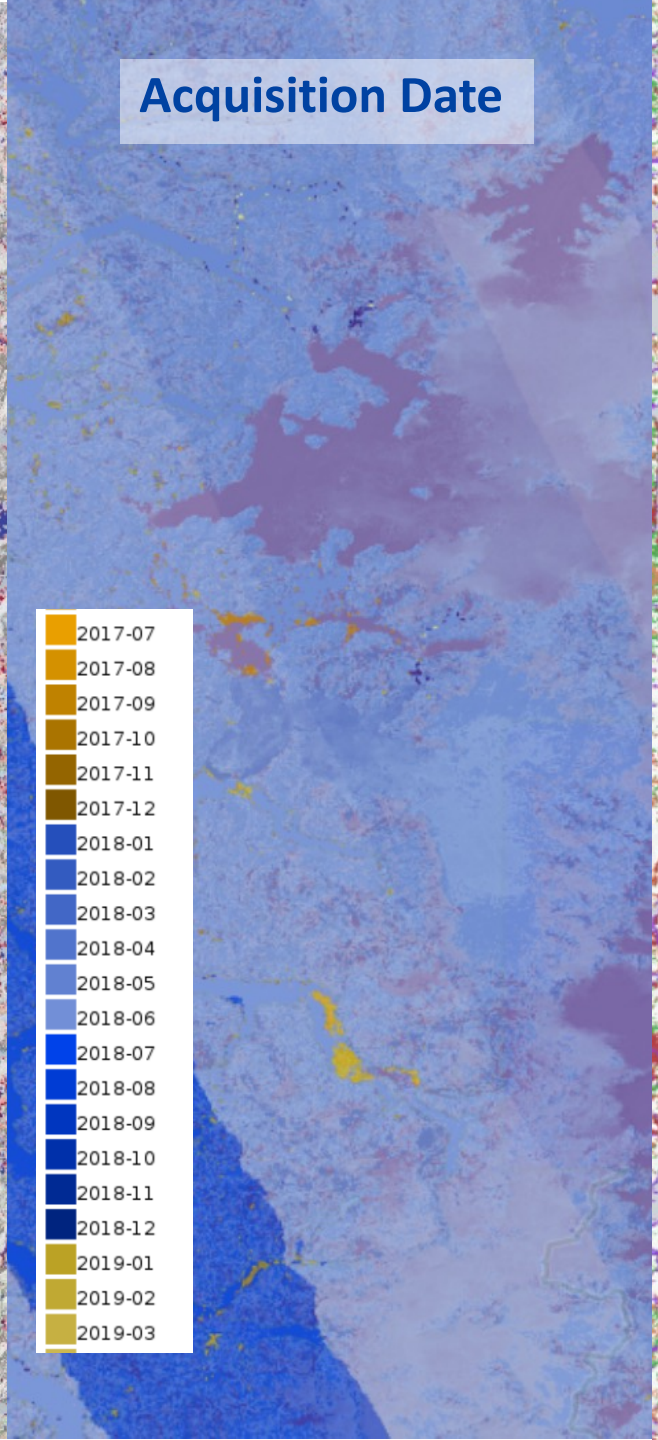




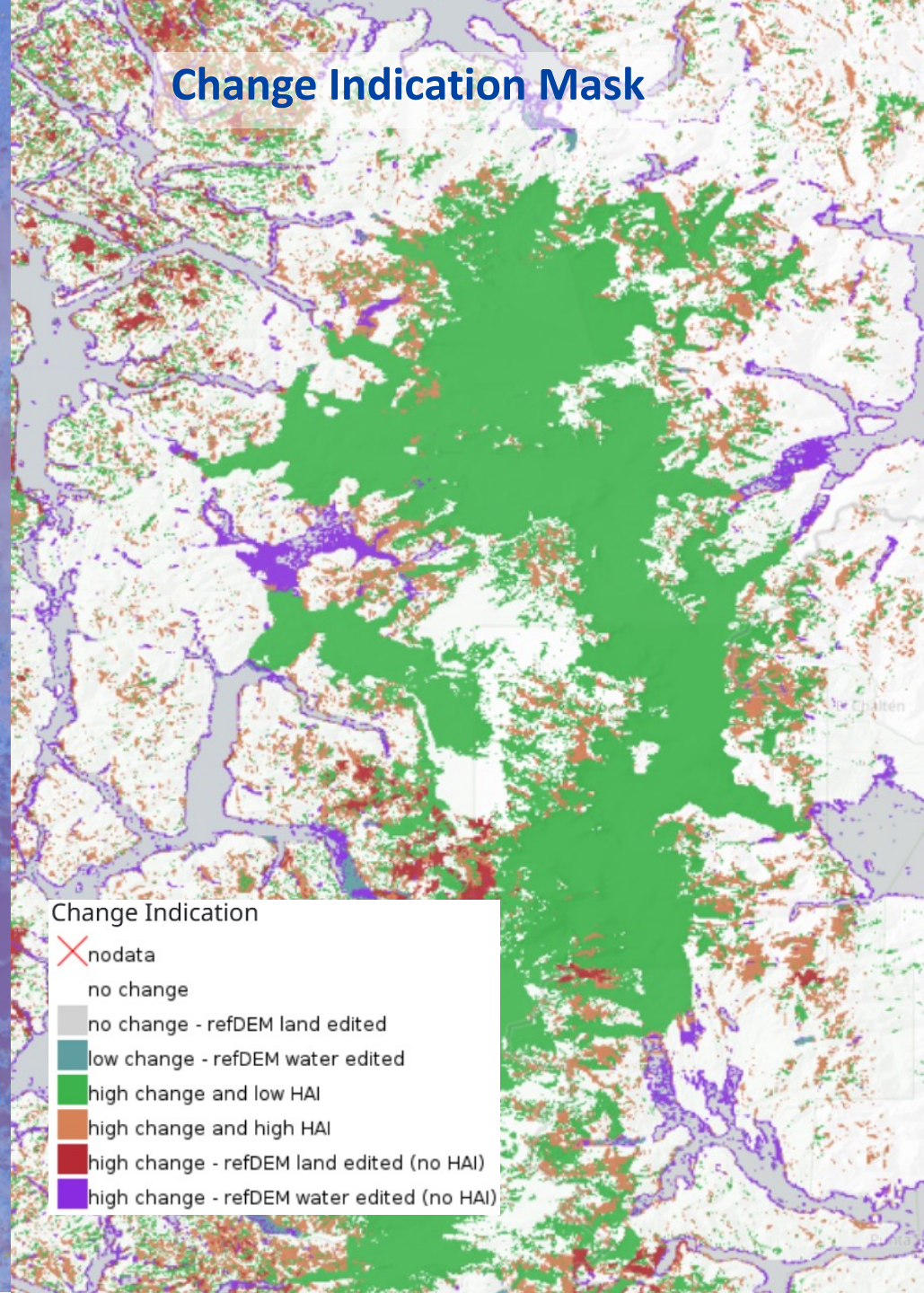
TanDEM-X DEM Change Maps
S. Patagonian Ice Field



Acquisition Date



Change Indication Mask



TanDEM-X DEM Change Maps

Rondonia, Brazil (first, 2017-2018)



-64.9644, -9.4017

Humaitá
Porto Velho
Machadinho d'Oeste
Alto Paraíso
Ariquemes
Acrelândia
Campo Novo de Rondônia
Ji-Paraná
Riberalta

nodata
≤ -20.0 m
≤ -18.0 m
≤ -16.0 m
≤ -14.0 m
≤ -12.0 m
≤ -10.0 m
≤ -8.0 m
≤ -6.0 m
≤ -4.0 m
≤ -2.0 m
≥ -1.0 m & ≤ 0.0 m
≥ 0.0 m & ≤ 1.0 m
≥ 2.0 m
≥ 4.0 m
≥ 6.0 m
≥ 8.0 m
≥ 10.0 m
≥ 12.0 m
≥ 14.0 m
≥ 16.0 m
≥ 18.0 m
≥ 20.0 m



TanDEM-X DEM Change Maps

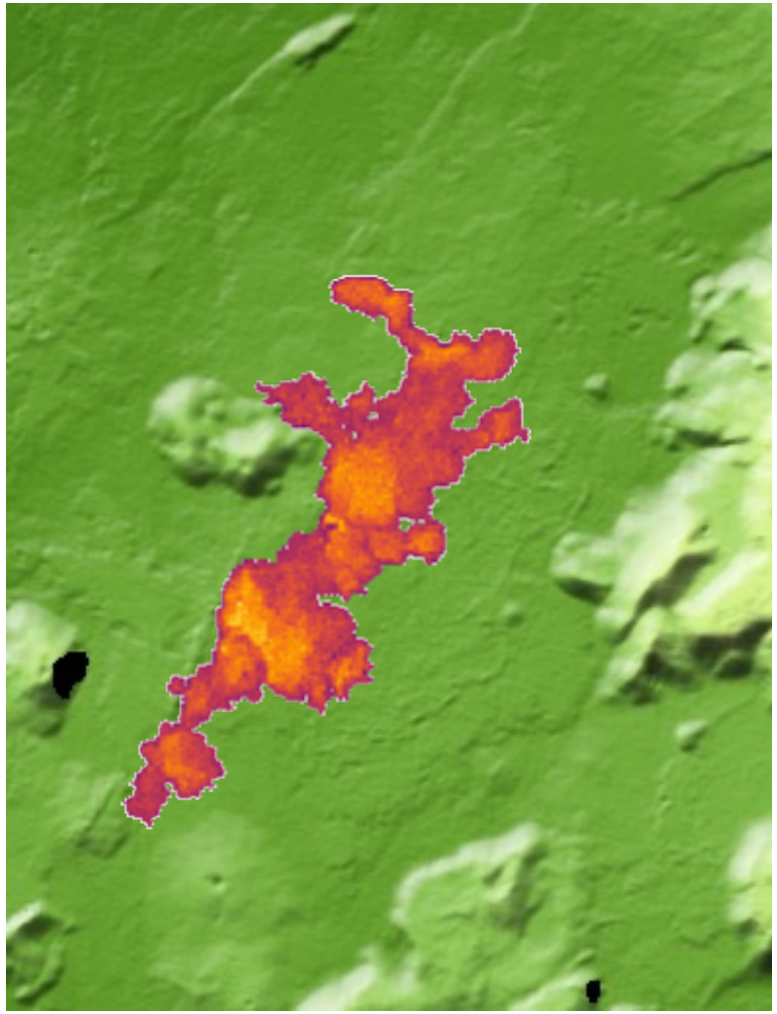
Rondonia, Brazil (last, 2019-2020)

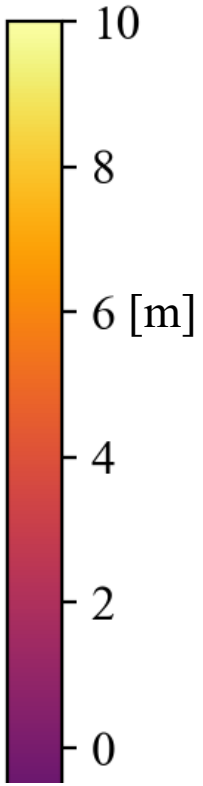
-63.8626, -9.5891

Humaita
Porto Velho
Machadinho d'Oeste
Alto Paraiso
Ariquemes
Acrelândia
Campo Novo de Rondônia
Ji-Paraná
Riberalta

nodata
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≥ -1.0 m & ≤ 0.0 m
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≥ 20.0 m

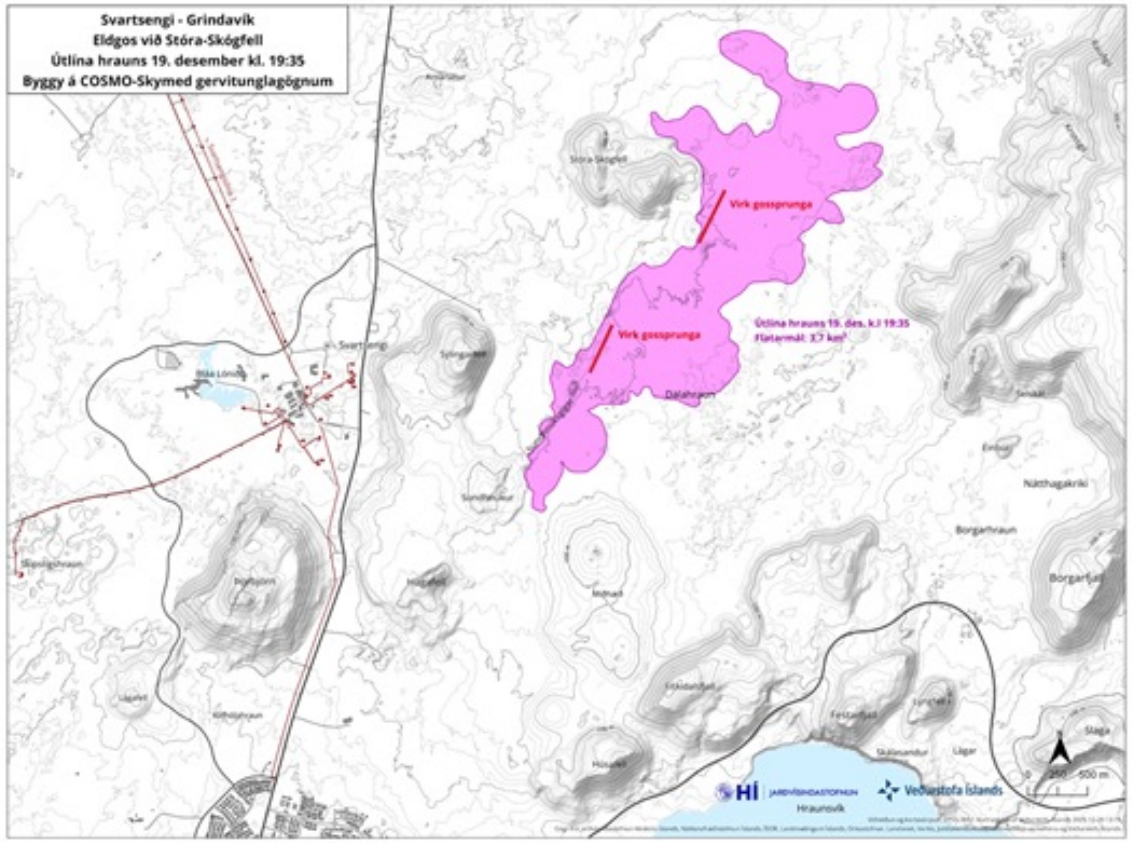
Lava Volume (Grindavik, Iceland)





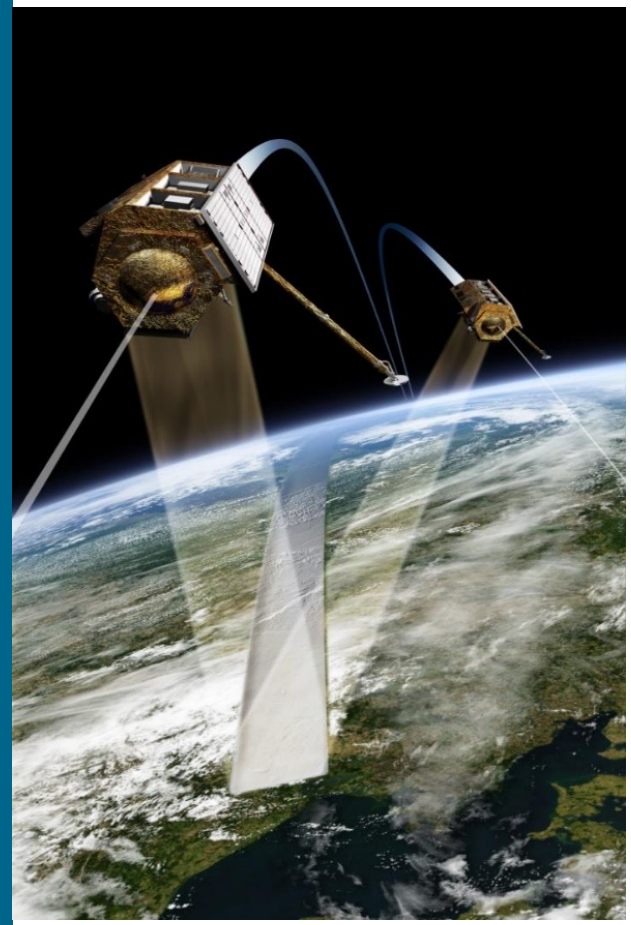
Lava volume ~ 11.2 million m³

$DEM_{23\ Dez\ 2023} - DEM_{01\ Dez\ 2023}$



Geodetic modelling results indicate that over 10 million m³ of magma were sourced from beneath Svartsengi to feed the intrusion that formed on 18 December.
https://en.vedur.is/about-imo/news/volcanic-unrest-grindavik

Summary TerraSAR-X & TanDEM-X



- With more than 17 and 14 years in orbit, both satellites have considerably exceeded their design lifetime
- Redundant systems are in place at various points, but both satellites are fully operational and continue to provide data of excellent quality
- Hydrazine is currently projected to last until 2028 for TDX and until 2031 for TSX, battery degradation is our main concern
  → keep satellites functional by all means!
- Continue 4D Mission Phase as long as possible

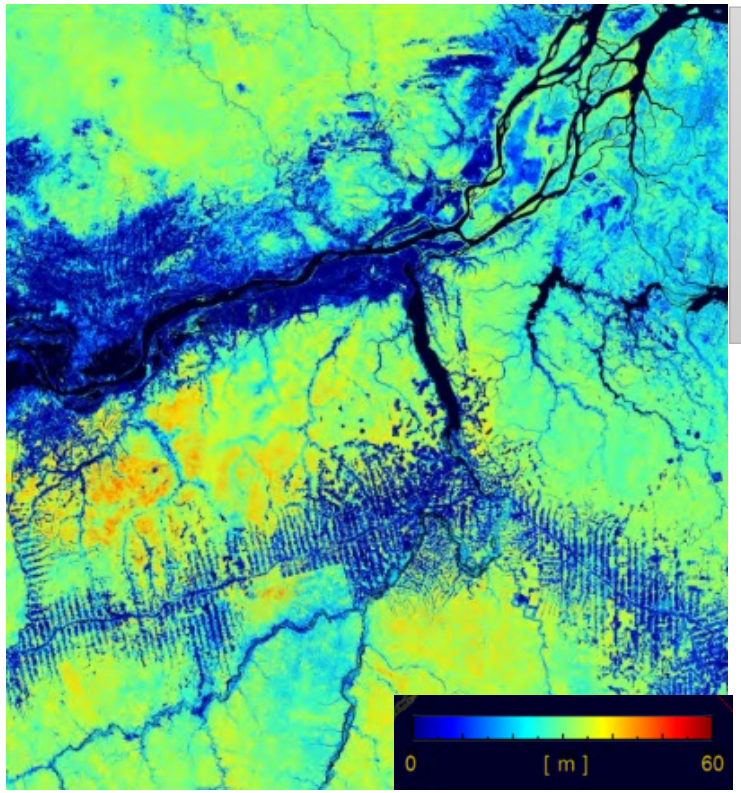


INTERNATIONAL COLLABORATION AND FUSION WITH OTHER MISSIONS

Fusion with other Missions

TanDEM-X & GEDI Fusion: Forest Height

Develop methods for mapping 3D forest structures by fusing multispectral LiDAR and SAR data from TanDEM-X, GEDI, and BIOMASS to assess changes in forest height and biomass.



Amazon Forest Height Map @ 25 m

- 12,000 TanDEM-X CoSSC Scenes
- 60 M GEDI Waveforms

TanDEM-X & BIOMASS Fusion

Joint operations between TanDEM-X and BIOMASS aim to develop a global prototype algorithm for hectare-scale forest biomass estimation, conduct large-area assessments of forest biomass, and integrate the algorithm into ESA's Algorithm and Analysis Platform (MAAP)

TerraSAR-X and TanDEM-X as Contributing Missions



DLR is contributing TerraSAR-X data to the International Charter: Space and Major Disasters to support disaster management and response efforts globally.

Committee on Earth Observation Satellites

CEOS and Geohazard Supersites

DLR provides TerraSAR-X and TanDEM-X data to support the GEO Geohazard Supersites and Natural Laboratory (GSNL) initiative, a voluntary international partnership aimed at enhancing geophysical research and geohazard assessment for Disaster Risk Reduction, supported by the CEOS Working Group on Disasters.

MOSAIC Instrument Software Patch

Problem

- The MOSAIC receiver on-board of the German TSX and TDX and the Spanish PAZ experienced interference issues.
- Without GPS measurements, the receiver is in propagation mode, using its orbital filter, and relies on its internal clock and last estimate for timing propagation.
- The internal MOSAIC clock is quite poor and directly impact timing accuracy (and PPS stability).

International coordination

- DLR and HISDESAT coordinate to do a SW update to improve the clock modeling, and thus directly the timing performance. This will allow the receiver to stay valid for longer period of time in the area.
- Airbus is developing the Patch. This evolution is of interest for several satellites carrying the MOSAIC instrument.

01.01.-15.03.2024 – Affected Areas (viewing angle 20 to 45 degrees)

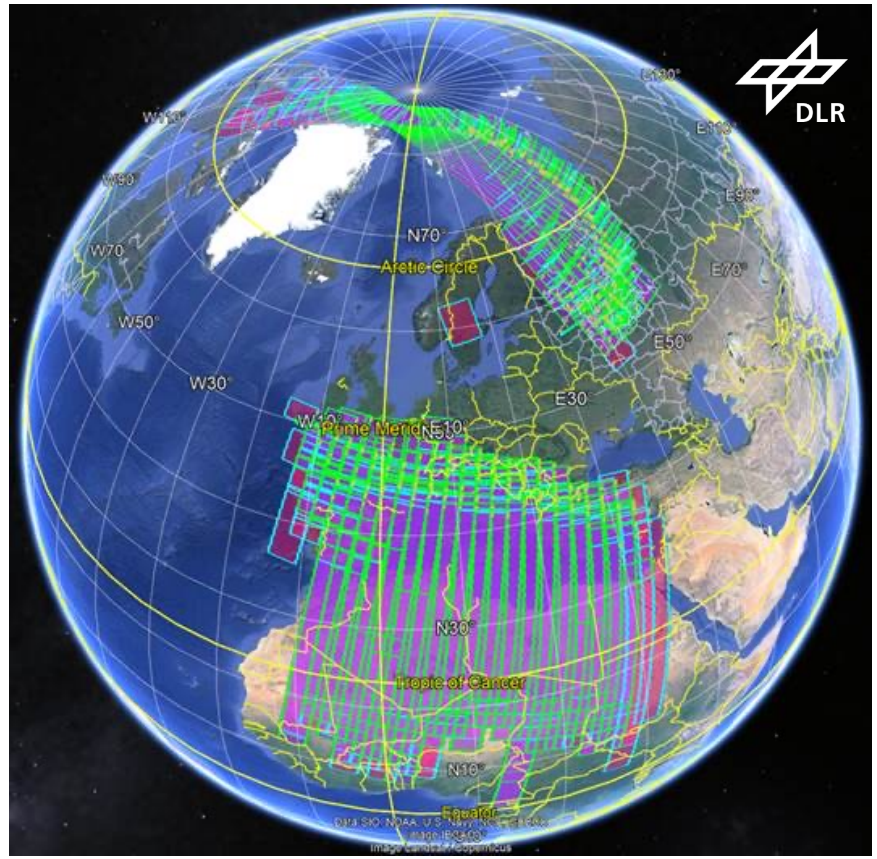


Image: DLR HR-STL OP

MOSAIC Instrument Software Patch

Shift of the TerraSAR-X image by approx. 140 m in the direction of flight (compared to Google Earth). In this case, no GPS satellites were tracked for more than 8 minutes.



Solution

- The overall solution is to save the clock bias and drift values on previous orbits, for which clock drift estimation has been done by the navigation solution, and to use this data to predict current behavior.
- Management of clock drift estimation during outages is also necessary.

The Patch will be uploaded to the satellites ca. Jan/Feb 2025.



TerraSAR-FOX MISSION

TerraSAR-FOX Mission
(TerraSAR Follow-On X-Band)

The Federal Ministry for Economic Affairs and Climate Action (BMWK) appointed the DLR Space Agency to explore alternatives for a new X-band SAR mission

Bundesministerium für Wirtschaft und Klimaschutz

1. Internal analysis on strengths/weaknesses/interests & situation around international missions and NewSpace
2. Interaction with the German Ministries
3. Dialog with Scientific and Users groups
4. Workshops with experts in Hardware & Technology
5. Approval of Phase 0 — 2023



Requirements for a new SAR Mission in X-Band

TerraSAR-FOX Mission

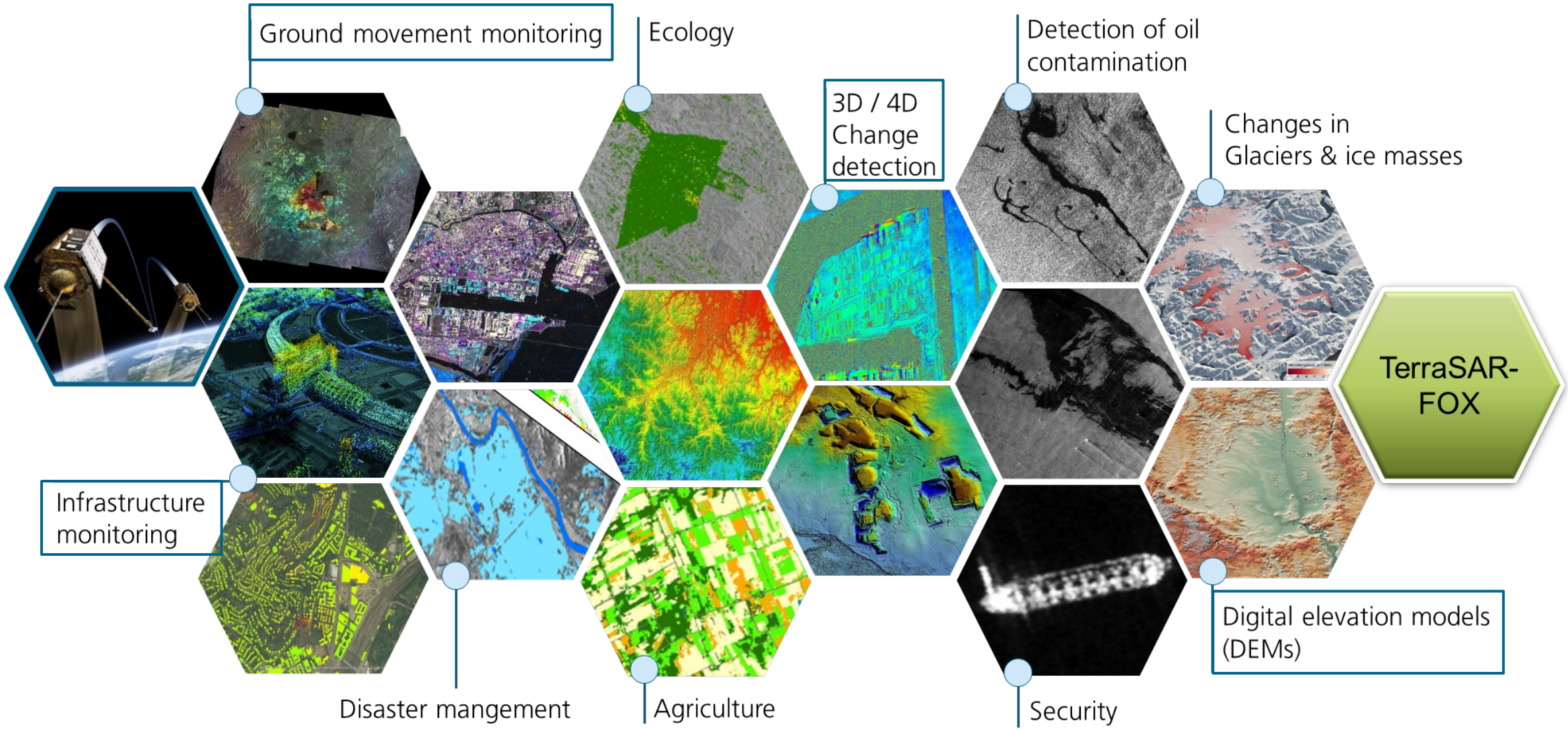
The new mission targets civil sovereign needs. Reliable data supply over years would increase the user base in Germany.



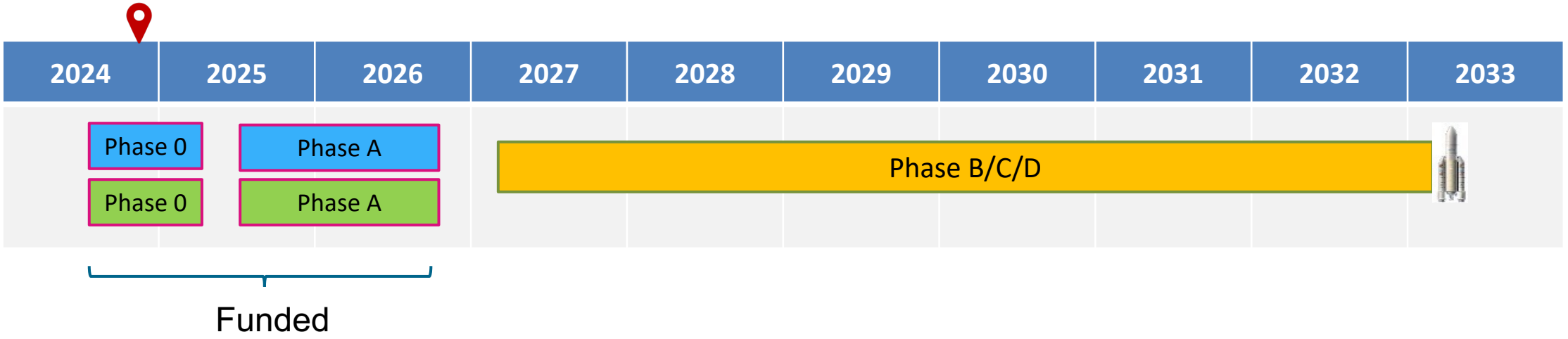
As the successor mission to TerraSAR-X and TanDEM-X, the new mission will use novel technology to continue providing X-Band data to users.

Many X-band SAR applications performed today with TerraSAR-X and TanDEM-X cannot be met with the same quality by data from other sources because the bi-static system design of TerraSAR-X and TanDEM-X is so far unique in the world.

Analysis and prioritization of user needs



TerraSAR-FOX | Timeline



- Parallel studies for Phase 0 were granted to:
  - Airbus Defence and Space
  - OHB Systems
- Phase A funding is covered within DLR Budget
- The main industrial contractor for phase B/C/D will be selected after phase A

Opportunities for international collaboration

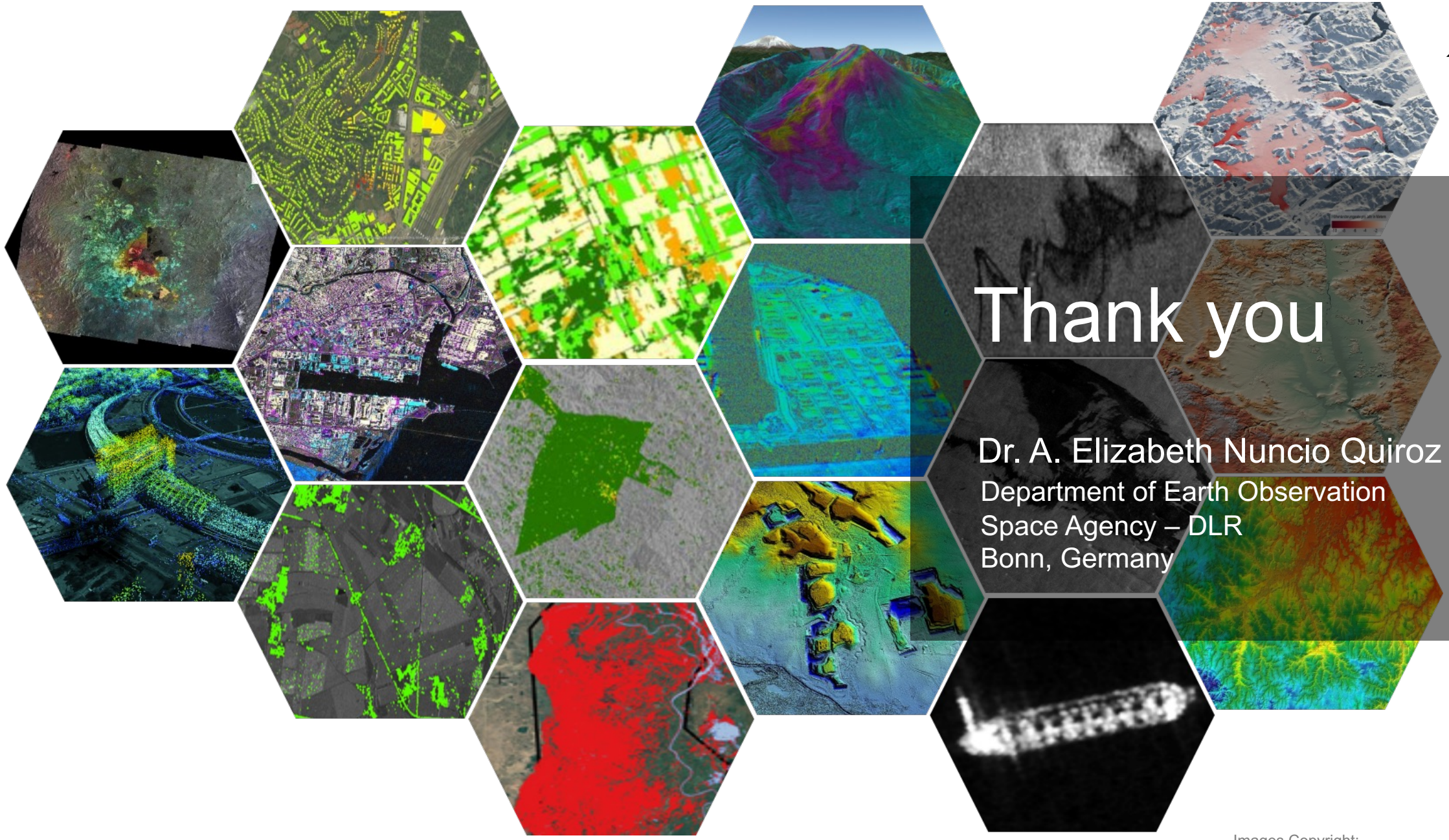
TerraSAR-X/TanDEM-X

- Join call TSX/TDX, PAZ, RCM
- Coordination on calibration sites
- CEOS Working Group disasters
- Synergies with other Missions: Radar & Optical
- …

TerraSAR-FOX (Plan)

- Data exchange / share Data
- Reduce redundancy of observations
- Coordination data takes with other missions
- Share observational goals
- Multifrequency Data takes
- …





Thank you

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