

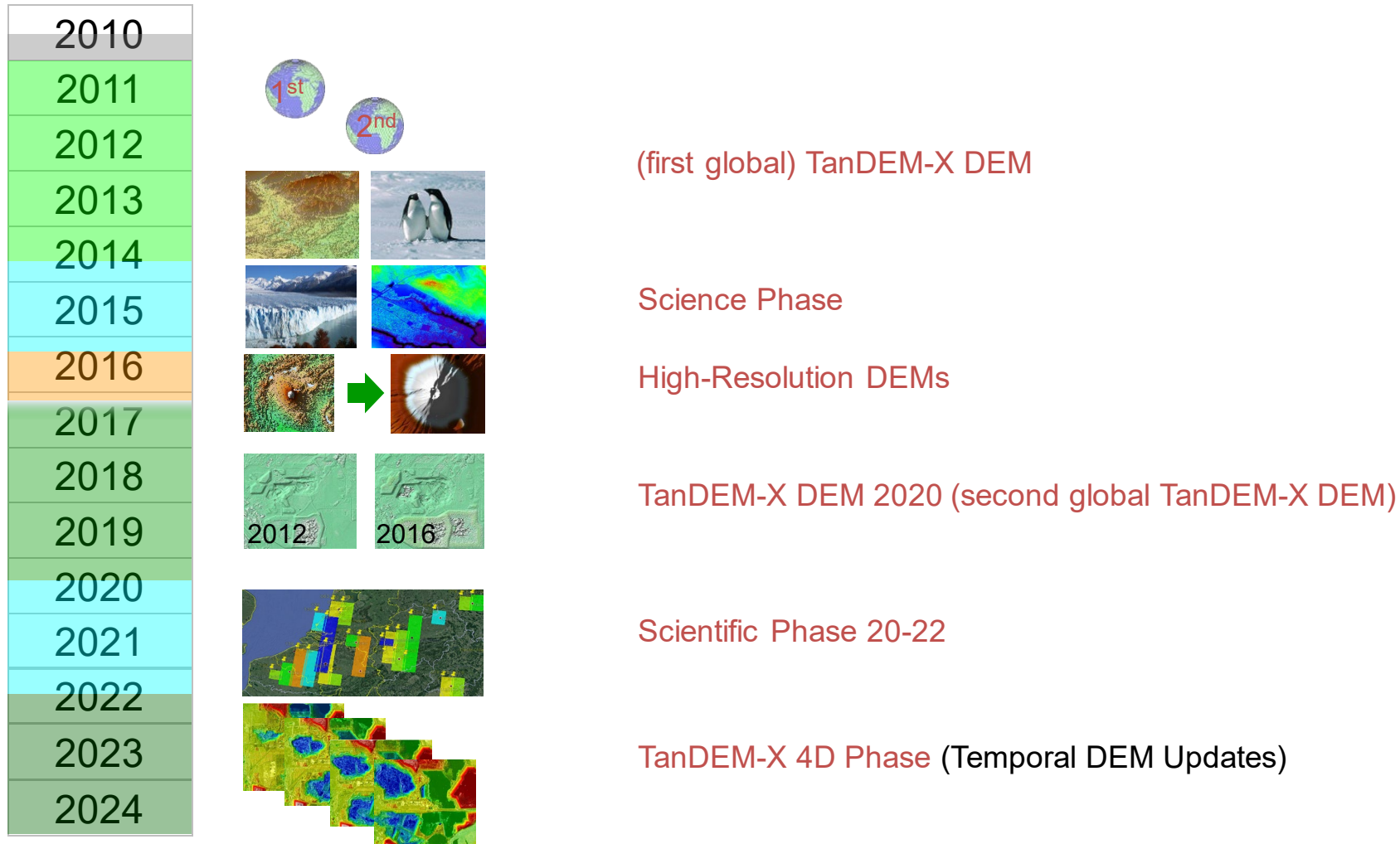
The TanDEM-X DEM Change Maps Product And Their Application

Marie Lachaise, Barbara Schweissheim, Carolina Gonzalez, Paola Rizzoli, Manfred Zink (DLR)

Fringe 2023

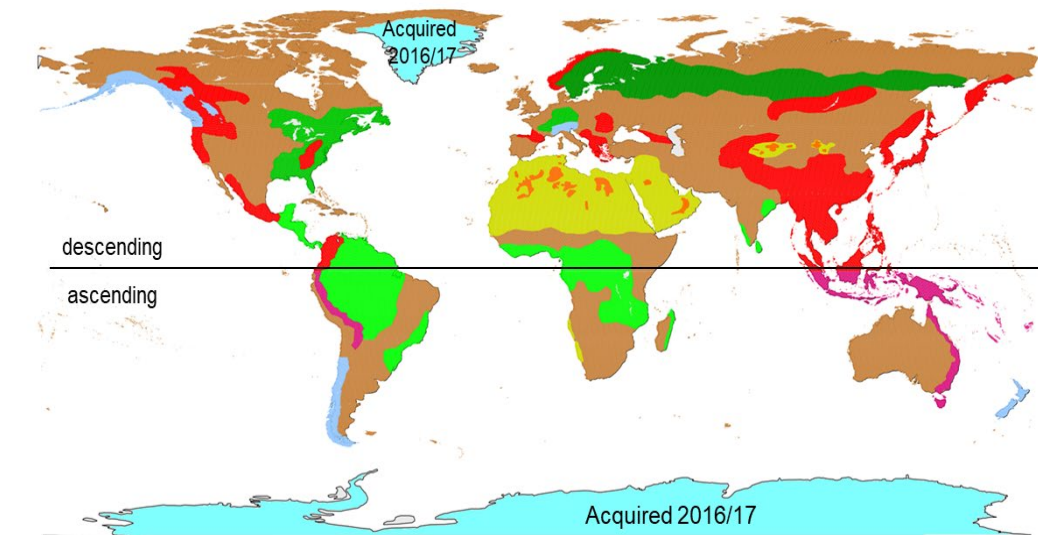


TanDEM-X Acquisitions and Products



Third global TanDEM-X DEM acquisition phase

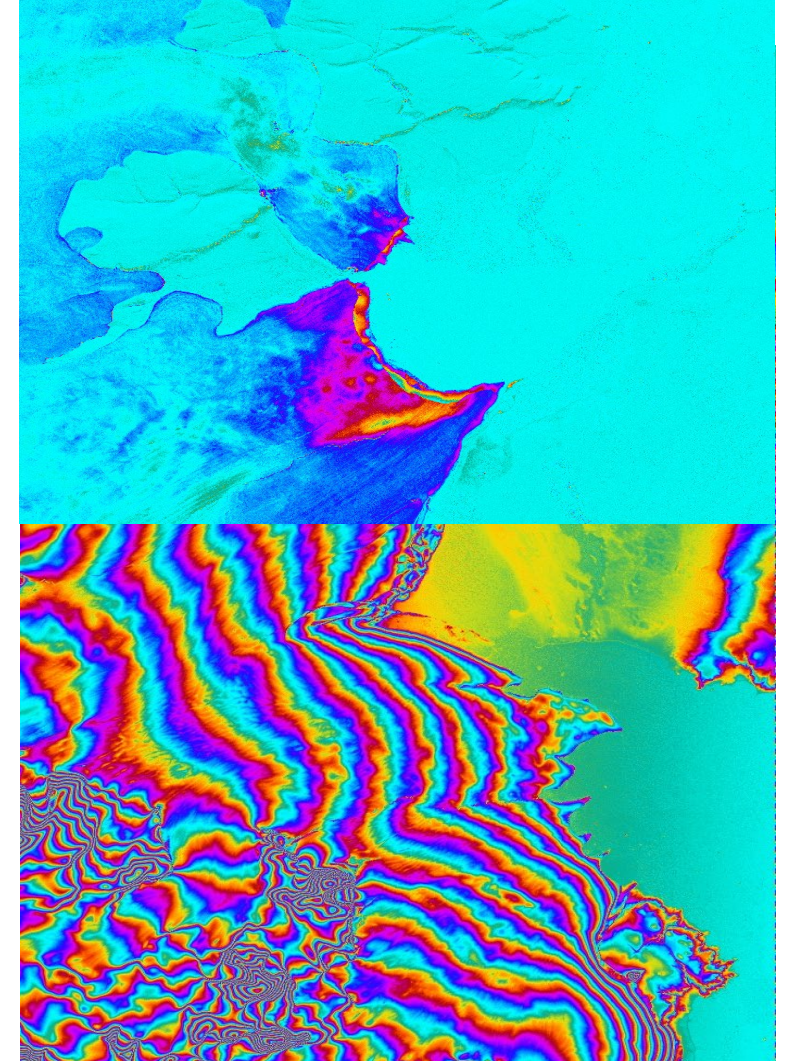
- **only one global coverage for most of the landmass**
 - From late 2016 until mid 2020 (+gaps filling till 2022)
 - Acquisition parameters depend on dominant land classes / types
- **Goal:** new independent global DEM TanDEM-X DEM 2020 with similar absolute and relative accuracies to first TanDEM-X DEM.



Region	Coverages	Season	Height of Ambiguity	Incidence Angle Range	Expected Relative Height Error
Mountains with forest	2	Local summer	55 m – 75 m (1 st) 45 m – 53 m (2 nd)	27 – 49 deg	2 m – 4 m
Glaciers	2	Local winter	55 m – 75 m (1 st) 45 m – 53 m (2 nd)	29 – 47 deg	2 m – 3 m
Tropical forest	1	Year round	50 m – 60 m	27 – 49 deg	2.5 m – 4.5 m
Temperate and boreal forest	1	Local summer	50 m – 55 m	27 – 49 deg	2.5 m – 4 m
Deserts with mountains	2	Year round	55 m – 75 m (1 st) 45 m – 55 m (2 nd)	27 – 49 deg	3 m – 7 m
Deserts	1	Year round	23 m – 45 m	14 – 38 deg	2.5 m – 5 m
Rest of the world	1	Year round	35 m – 45 m	27 – 49 deg	1 m – 2.5 m

InSAR processing strategy: Change Raw DEMs generation

- Usage of **reference DEM** to ease phase unwrapping:
 - TanDEM30_EDIT
 - TanDEMPolar12 (ATA, GRL)
- Delta-phase (also called differential phase e.g. in PSI)
- Better filtering (depending on the scene content)
- Pre-calibration



TanDEM-X DEM Change Maps: Motivation

lava field

Austurland

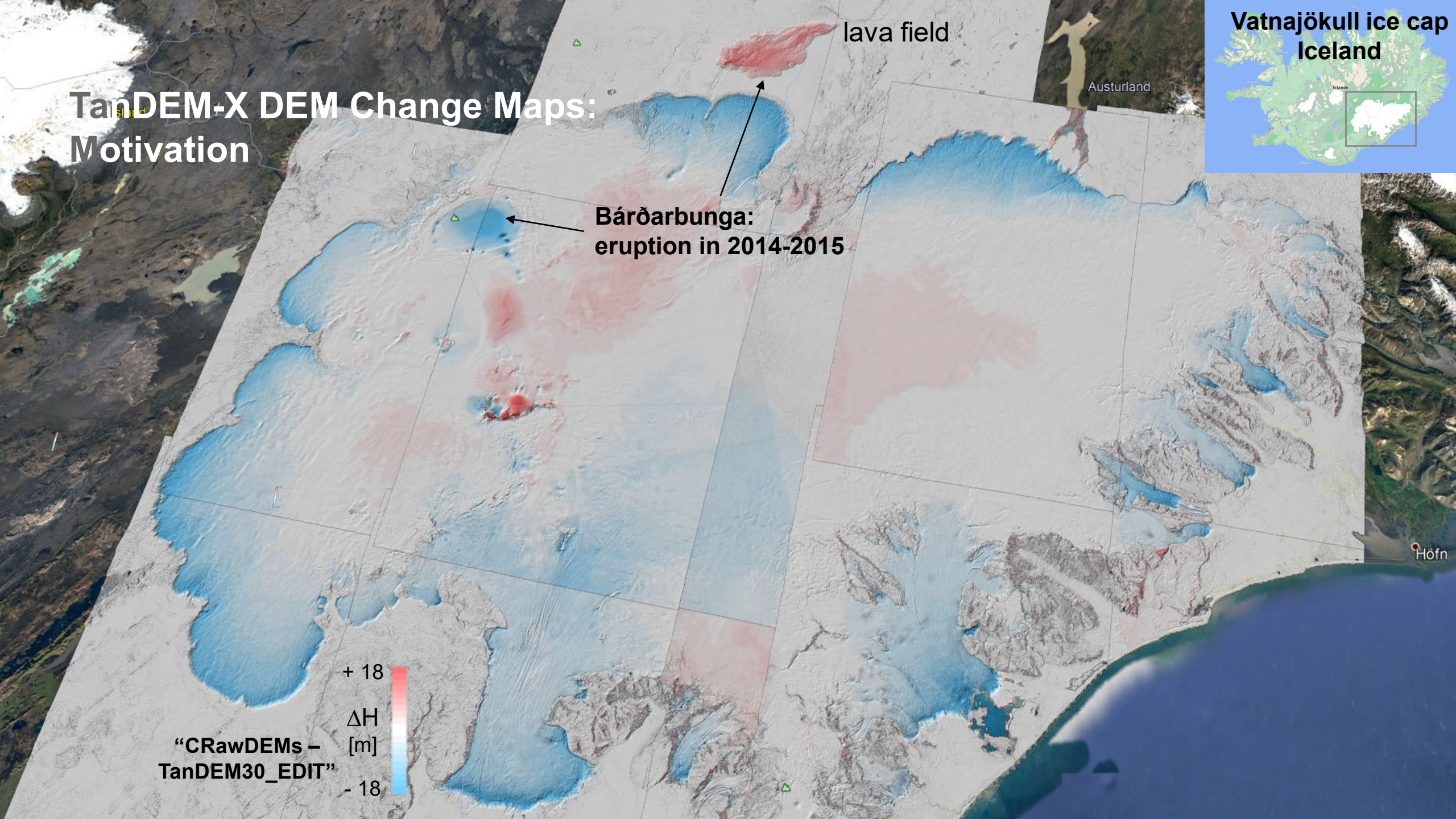
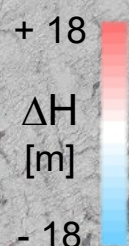
Bárðarbunga:
eruption in 2014-2015

Vatnajökull ice cap
Iceland

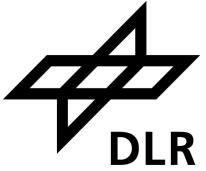


+ 18
 ΔH
[m]
- 18

“CRawDEMs –
TanDEM30_EDIT”

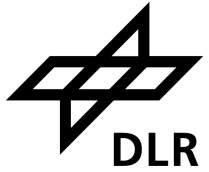


TanDEM-X DEM Change Maps: Product Characteristics



- DEM changes between the Change Raw DEMs and TanDEM30_EDIT (edited first global TanDEM-X DEM)
- Available layers:
 - 2 DEM Change Maps with date layers:
 - first and last DEM changes
 - 2 Change Indication Masks
 - 2 Height Accuracy Indicators
- Also available:
 - Edited TanDEM-X DEM: edited version of the first global DEM
 - DEM Editing Mask
 - HEM (Height Error Map)
 - Land Cover Map
- **Freely available from mid October on in 30m posting** on geoservice.dlr.de

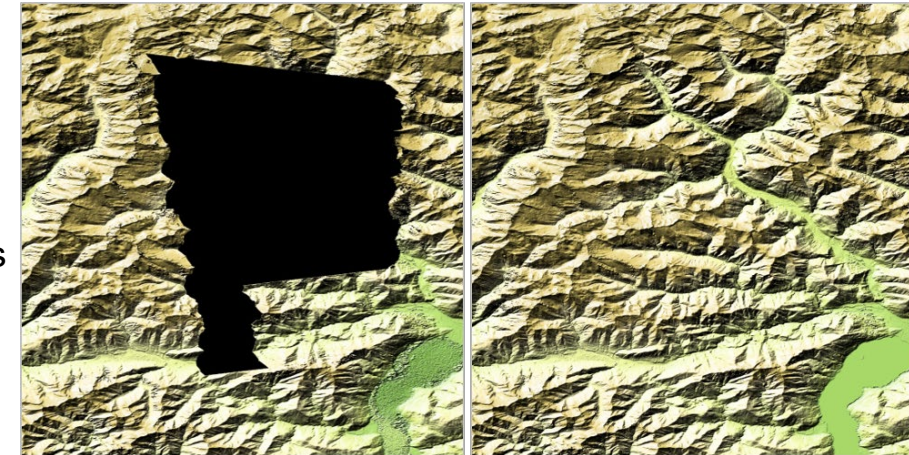
Edited TanDEM-X DEM 30m



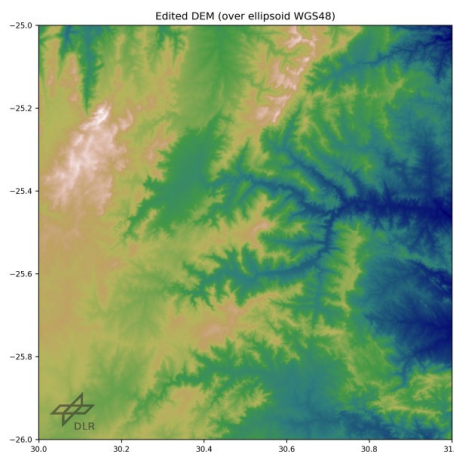
- Holes are filled by means of external reference and water is flattened by a fully automatic process
- Available layers:
 - Edited DEMs (EDEM) in WGS84 (TanDEM-X DEM like) & EGM (Copernicus)
 - Height Error Map
 - Editing Mask
 - Land Cover Map indicating water and forest

original
TanDEM-X DEM

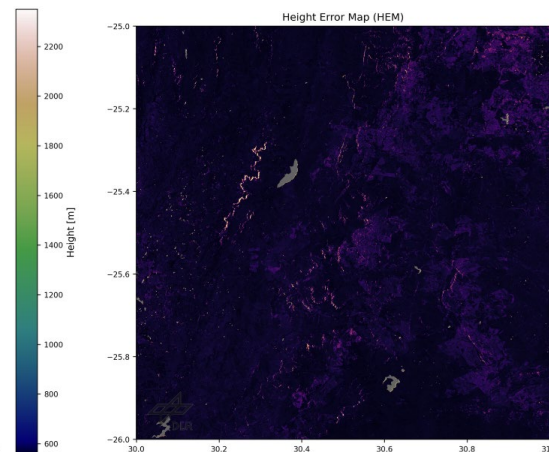
edited
TanDEM-X DEM



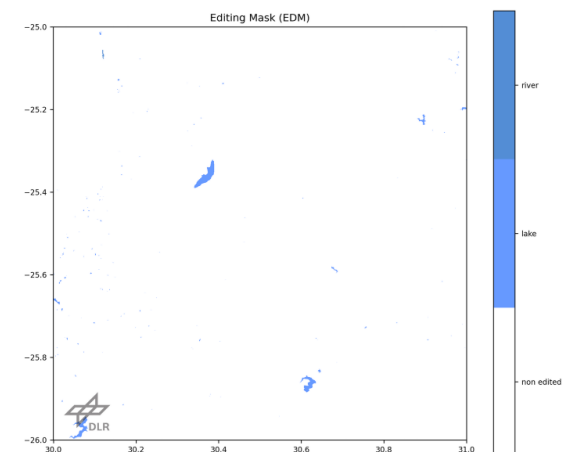
EDEM (WGS84 & EGM)



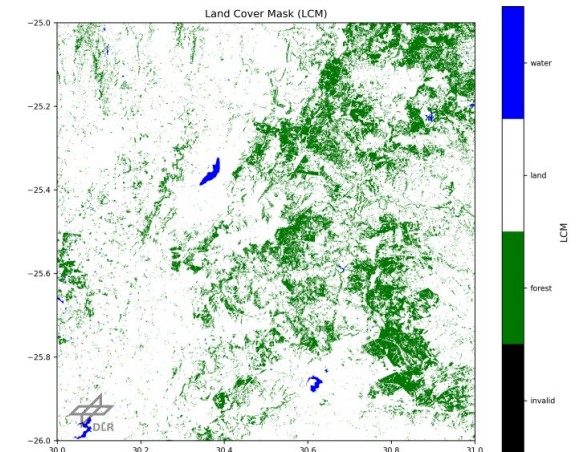
Height Error Map



Editing Mask



Land Cover Map



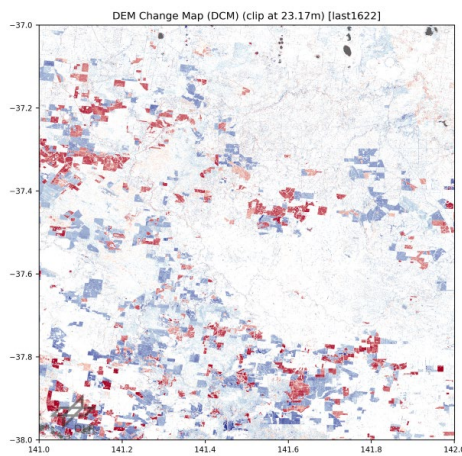
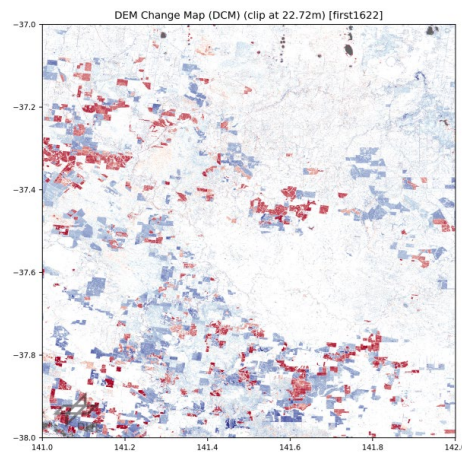
TanDEM-X DEM Change Maps: Available Layers



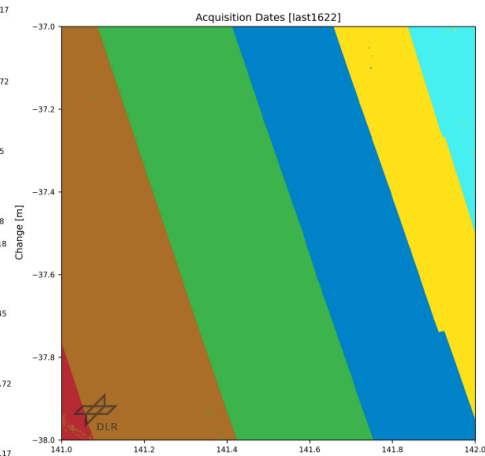
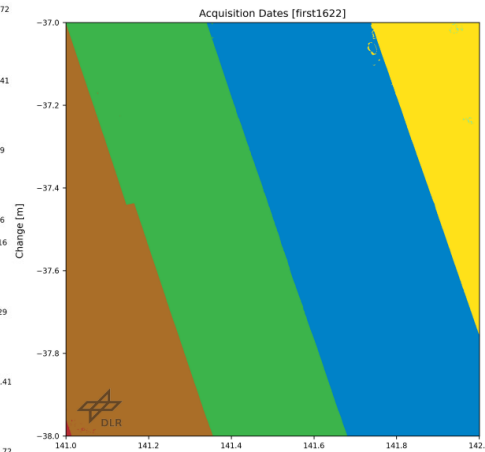
1st DCM:
oldest
changes
within
2016-
2022

2nd DCM:
newest
changes
within
2016-
2022

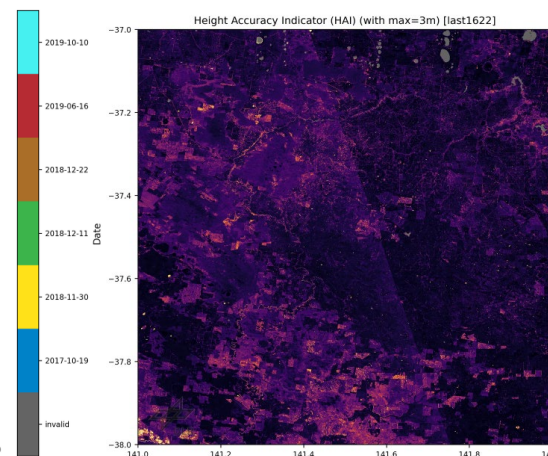
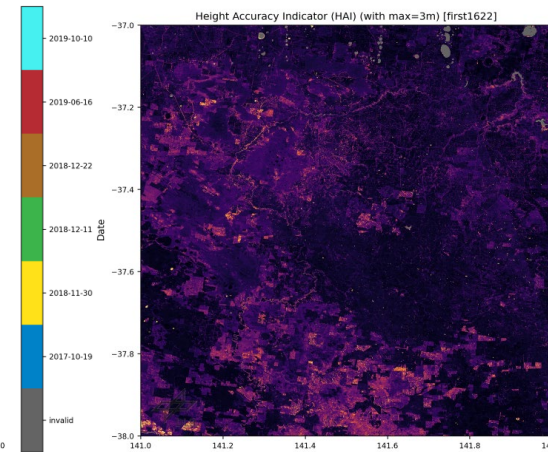
DEM Change Maps



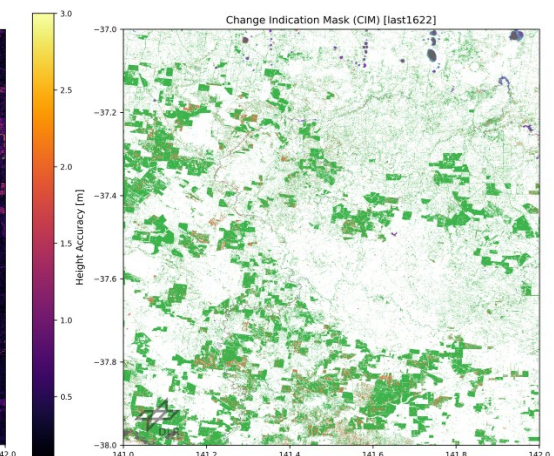
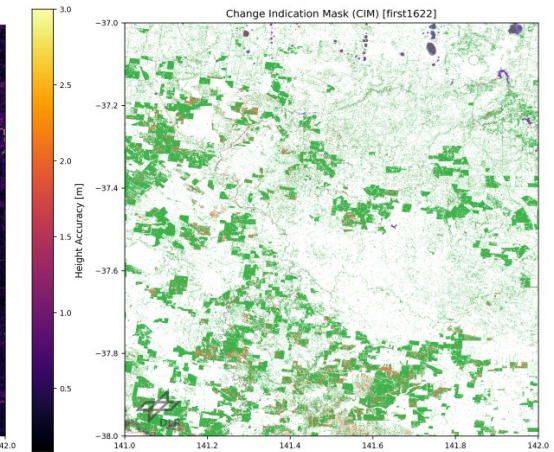
DATES



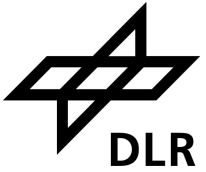
Height Accuracy Indicator



Change Indication Mask

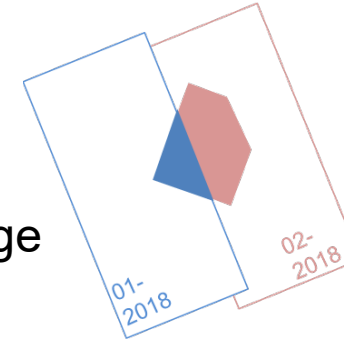


TanDEM-X DEM Change Maps: First and Last Change Maps

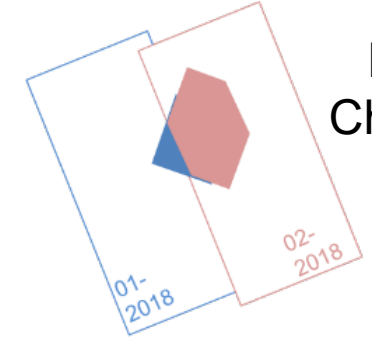


- 2 Change Maps generated:
 - first DEM change: change from the oldest pixel within the new dataset
 - last DEM change: change from the newest pixel used

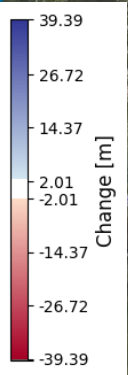
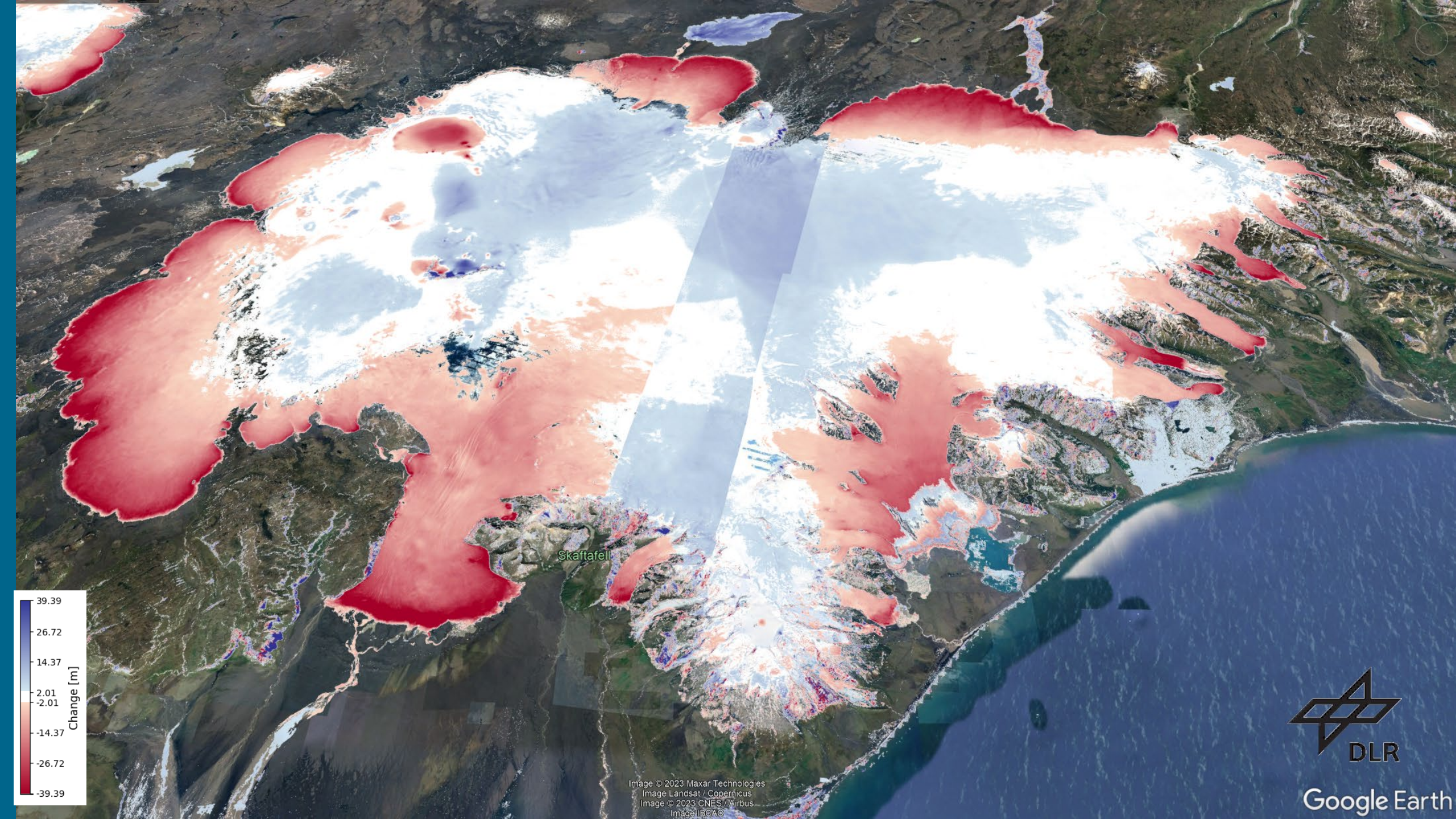
First
Change



Last
Change



- Jumps between datatakes separated by several months are possible when large scale terrain changes occurred
- **WARNING:**
 - the elevation change measured in the DEM change maps corresponds to a topographic change with respect to the global TanDEM-X DEM
 - **but** it does not correspond to a physical height change of the same magnitude.
 - the reference TanDEM-X DEM is an average of different images, possibly acquired over a period of several years.
 - ➔ Especially important over vegetated and snow-covered regions.

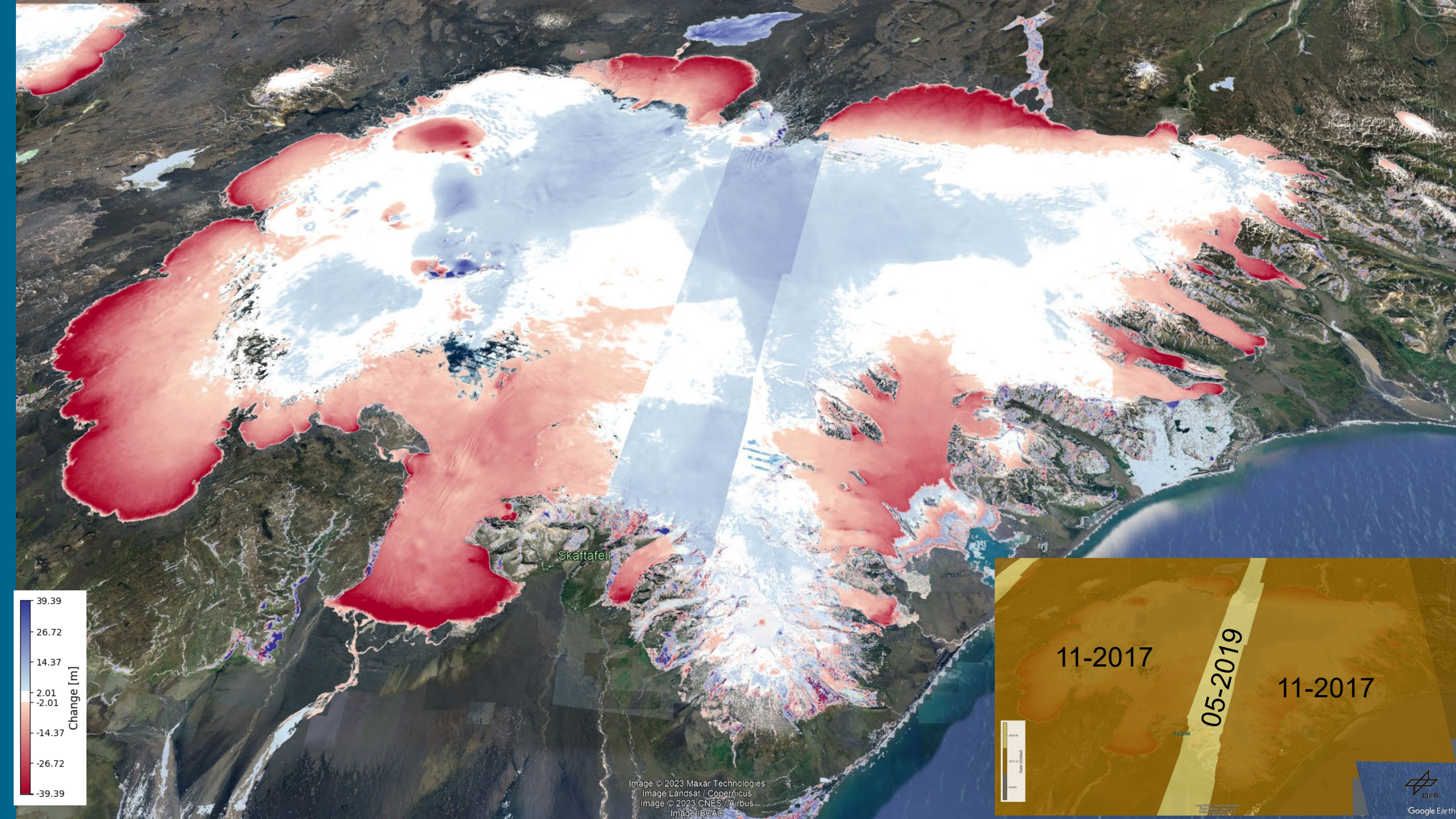


Skaffafell

Image © 2023 Maxar Technologies
Image Landsat / Copernicus
Image © 2023 CNES / Airbus
Image IBCAO



Google Earth



Changes due to the
2014-2015 Bárðarbunga eruption

Volume change
of $1,47 \pm 0,03 \text{ km}^3$

lava field

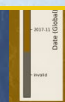
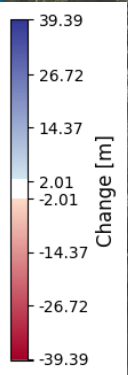
graben

cauldrons

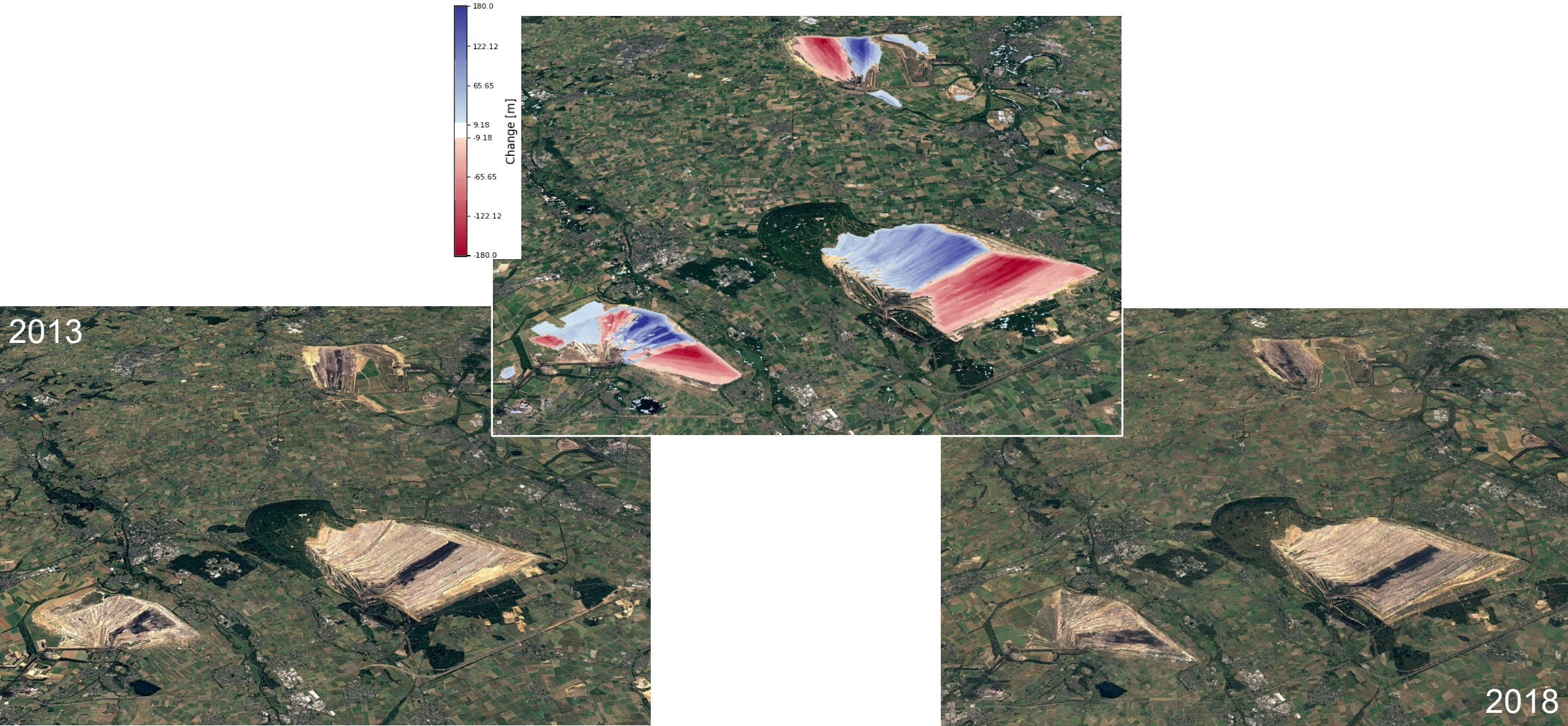
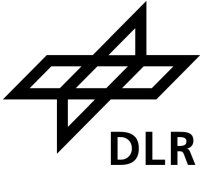
caldera

05-2019

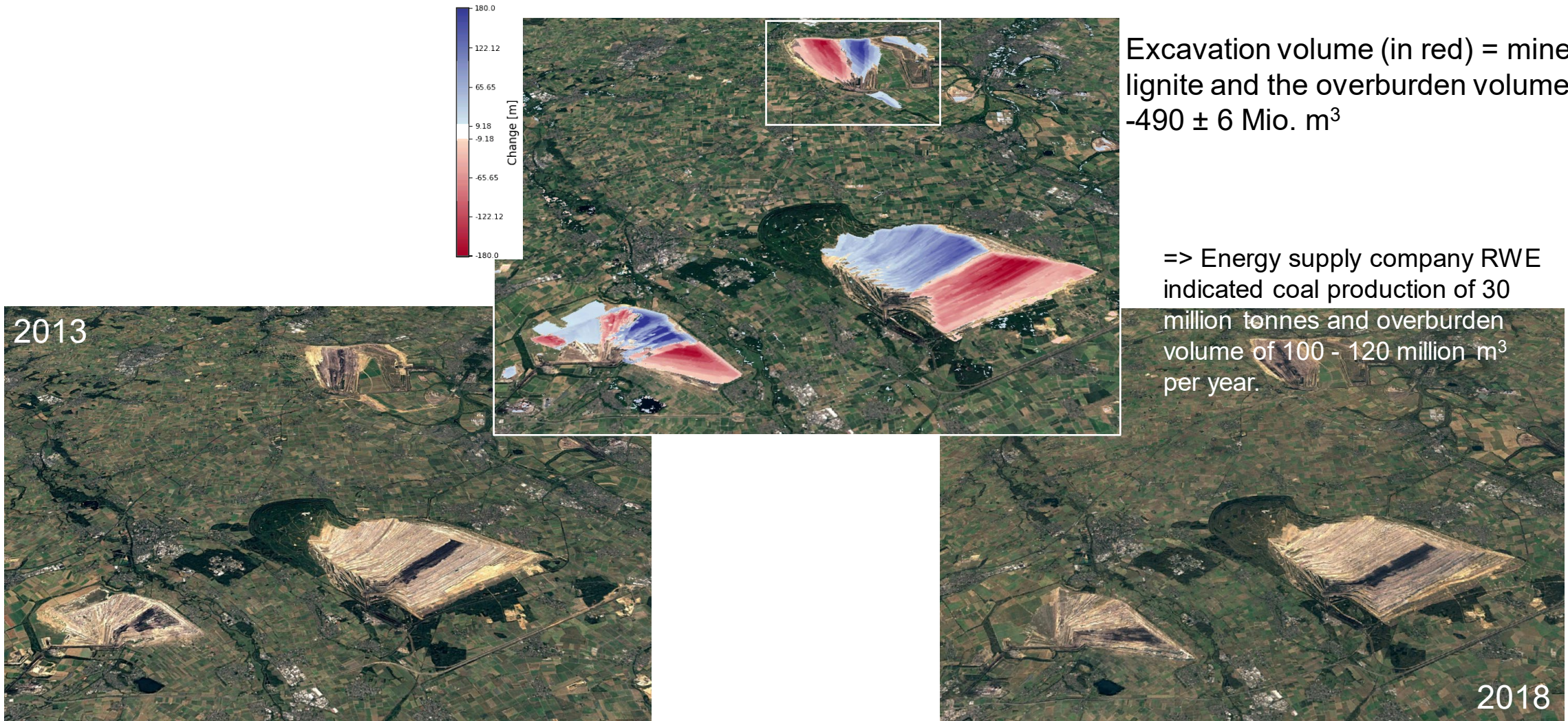
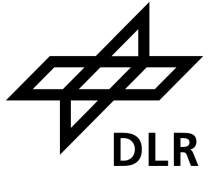
11-2017

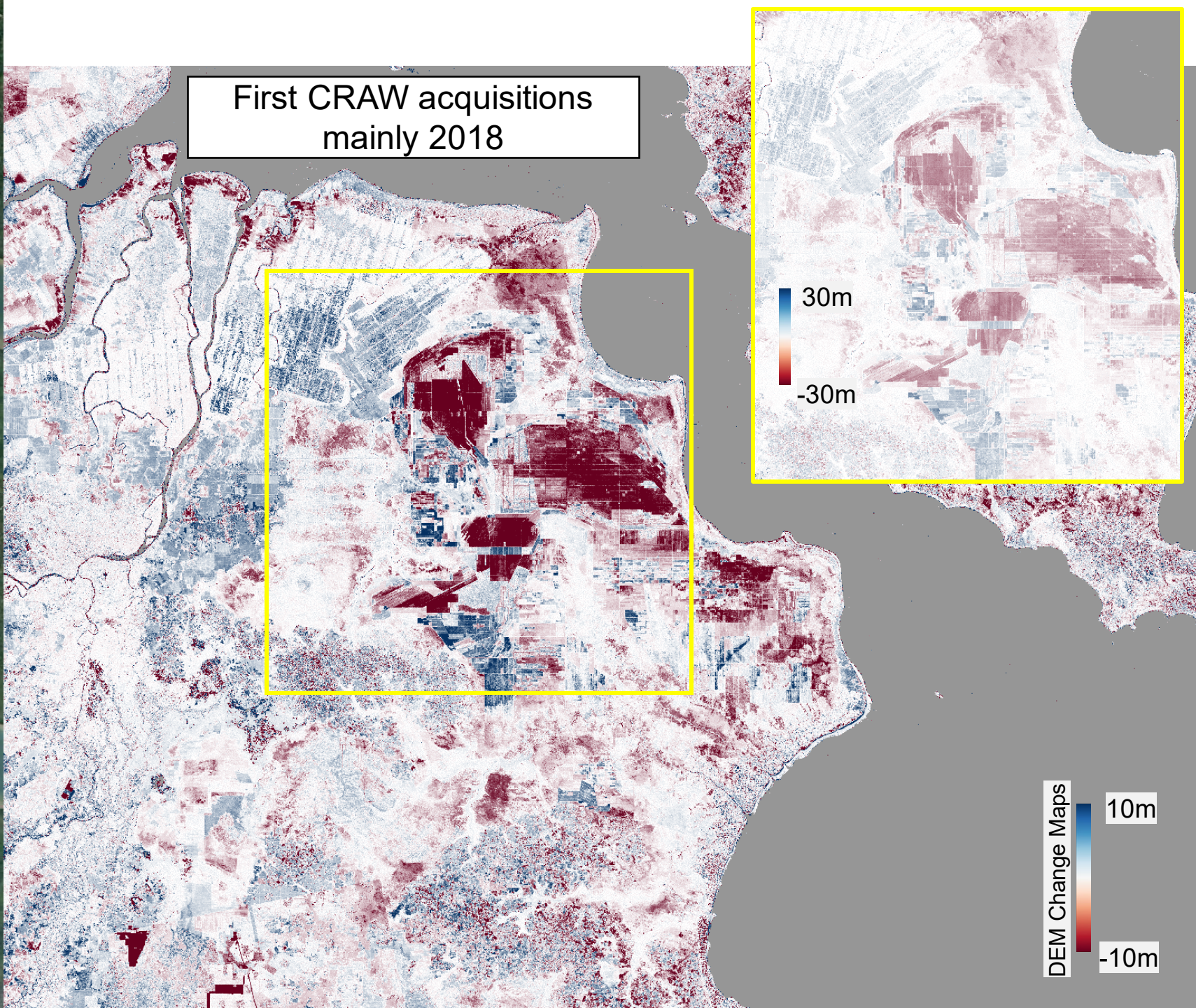


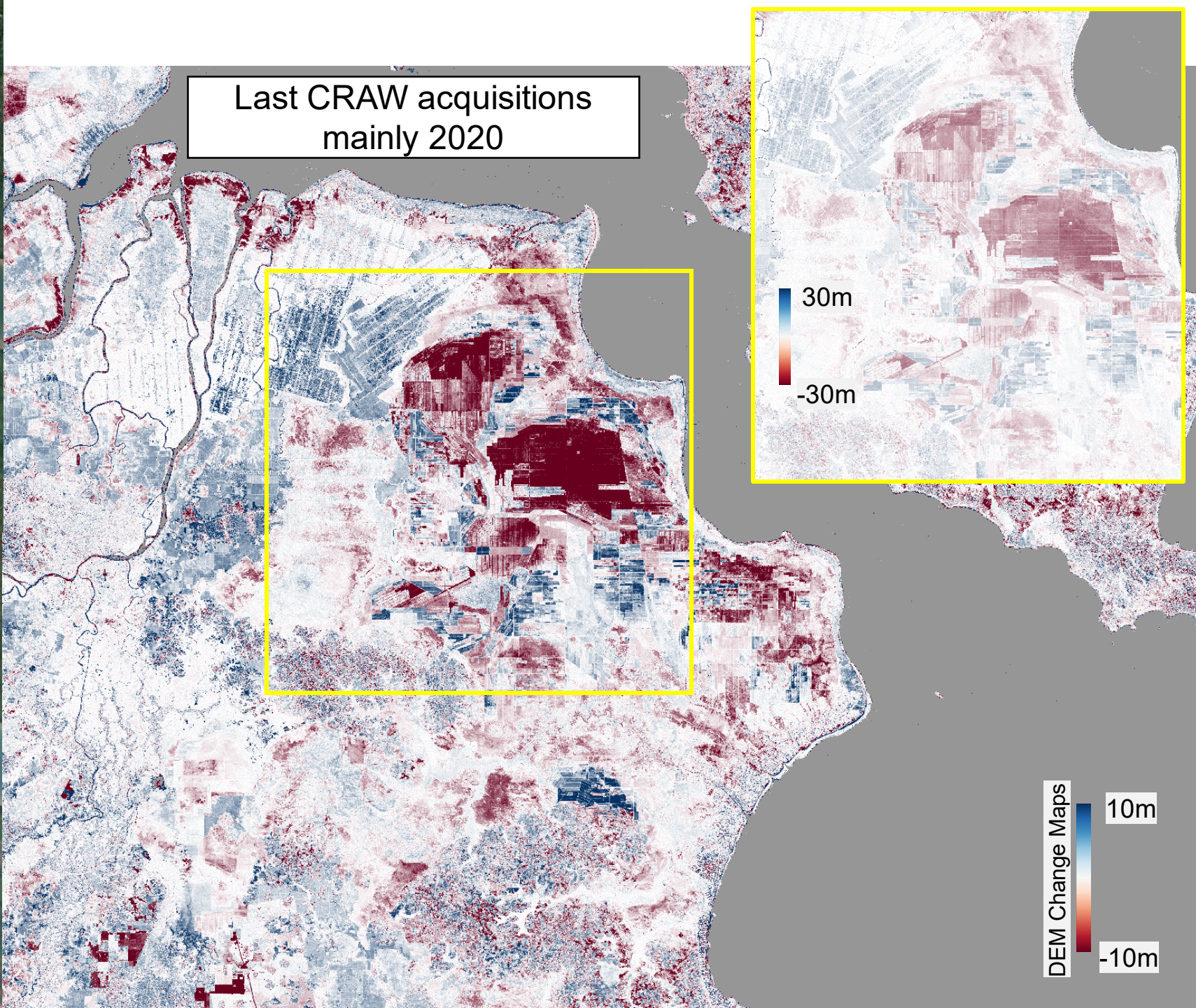
Hambach and Garzweiler Mines in Germany,

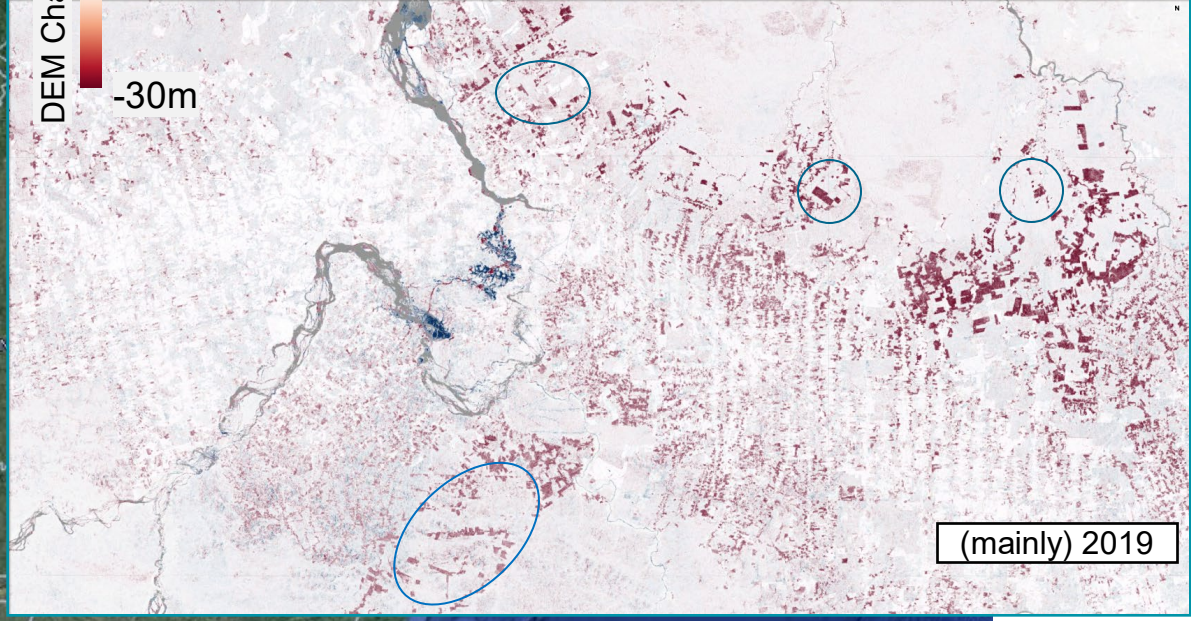
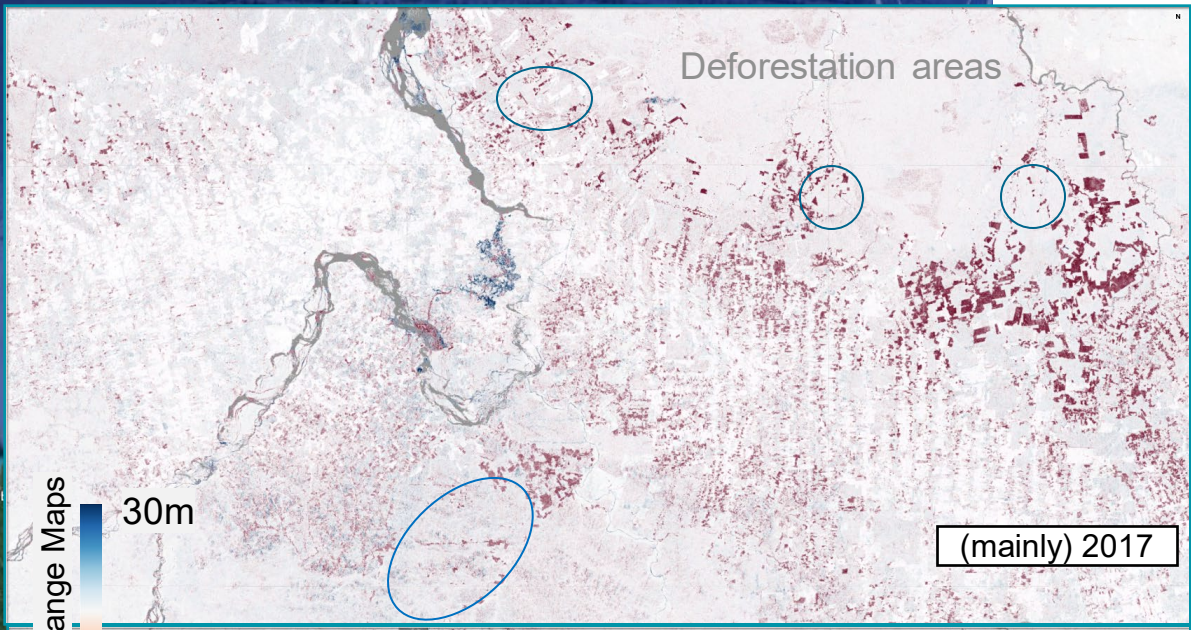


Hambach and Garzweiler Mines in Germany,







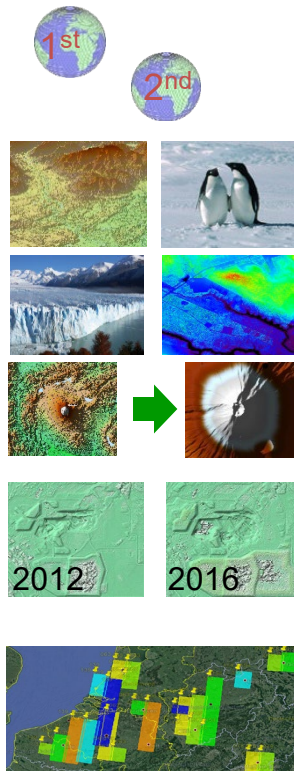


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Image Landsat / Copernicus

Google Earth

Further developments: DEM Change Map stacks

2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024



(first global) TanDEM-X DEM

Science Phase

High-Resolution DEMs

TanDEM-X DEM 2020 (second global TanDEM-X DEM)

Scientific Phase 20-22

TanDEM-X 4D Phase (Temporal DEM Updates)

Changes between temporal DEMs, number of maps and coverage completeness in stacks will depend on data availability for that location

