

Funded by the EU



# The Copernicus DEM from WorldDEM data



DEFENCE AND SPACE

Vera Leister-Taylor  
November 2015



# Outline

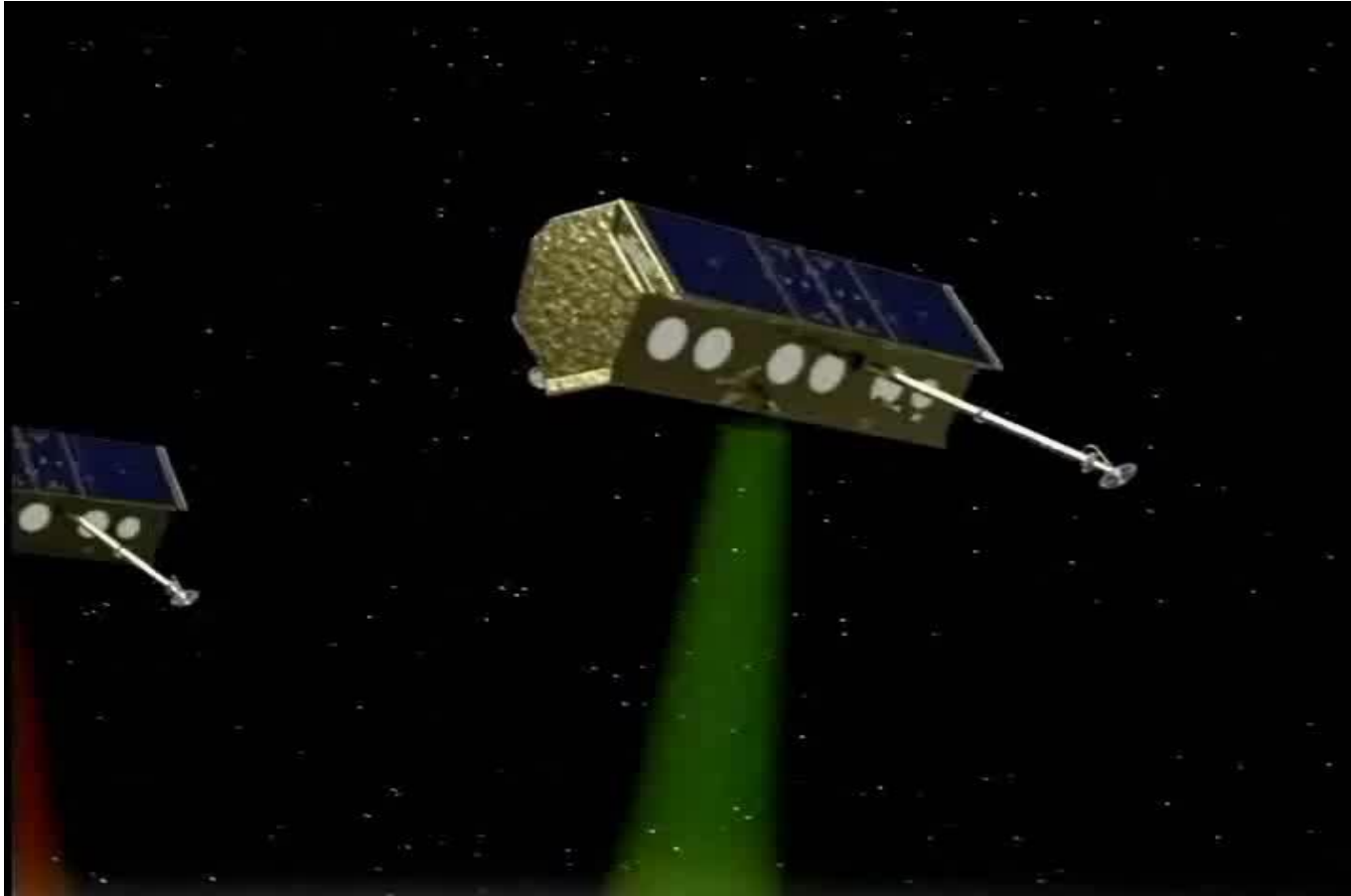
## I. From TanDEM-X to Copernicus DEM

- I. TerraSAR-X and TanDEM-X Mission
- II. WorldDEM™ Editing
- III. Generation of Copernicus DEM

## II. Copernicus DEM

- I. DEM instances
- II. Specification

## I.I TerraSAR-X and TanDEM-X



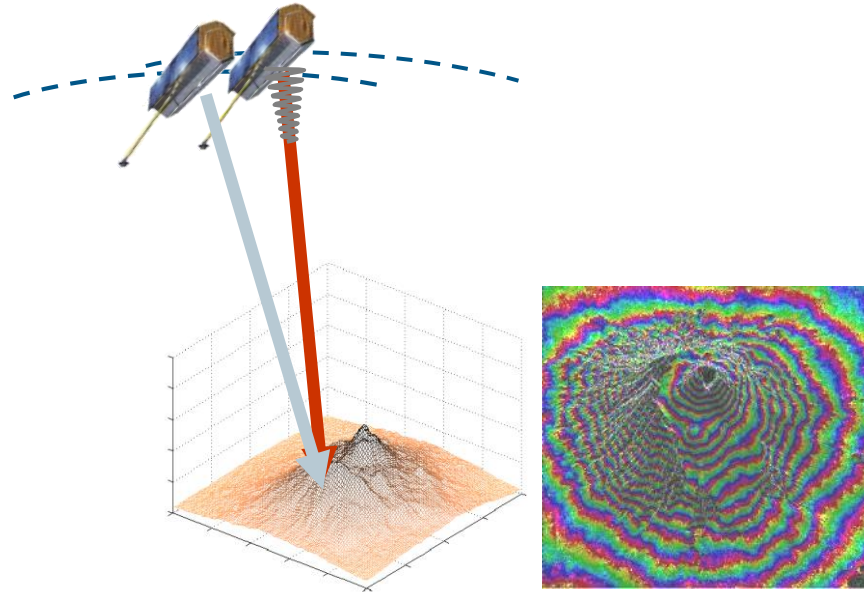
- Private Public Partnership between DLR and Airbus Defence and Space
- Bistatic mission
- Primary mission goal: Generation of global Digital Elevation Model
- Launch TerraSAR-X June 2007
- Launch TanDEM-X June 2010

# I.I Generation of a Digital Elevation Model from SAR

## SAR Interferometry

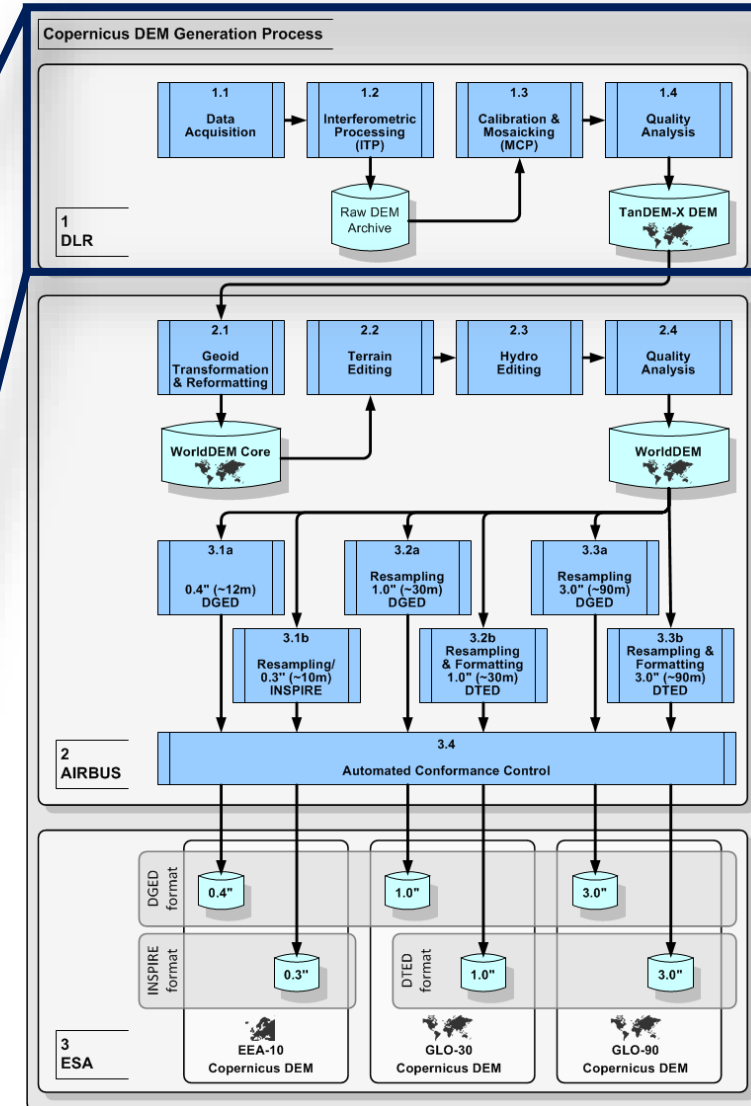
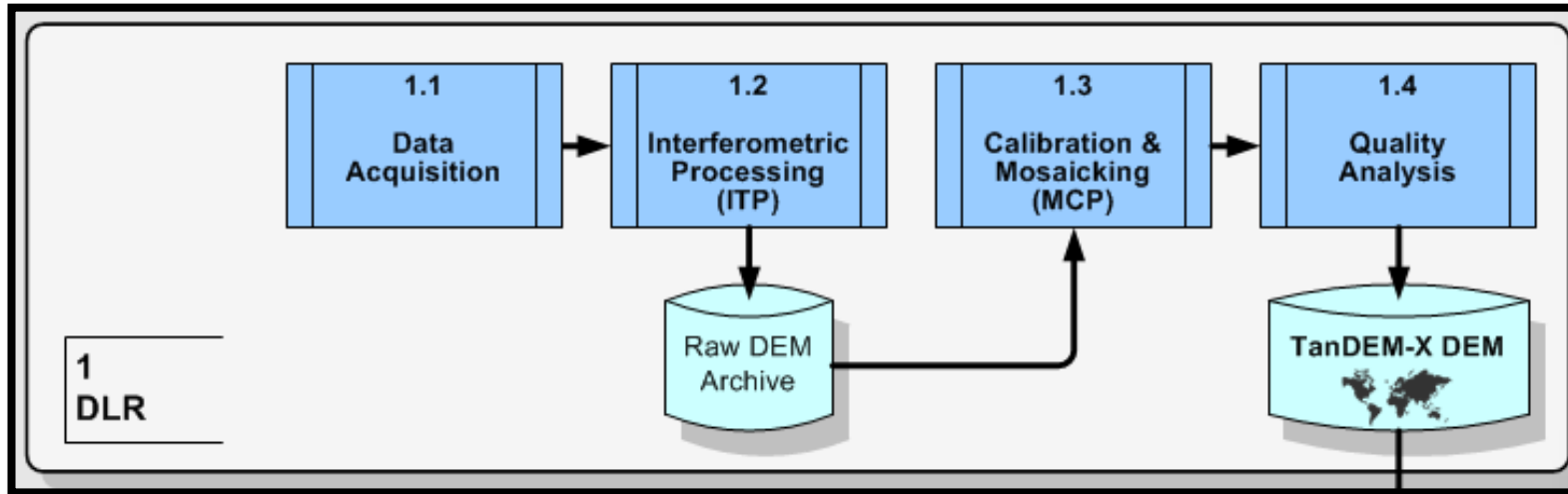
TerraSAR-X: repeat pass InSAR, 11 days

TanDEM-X: single pass InSAR, simultaneous



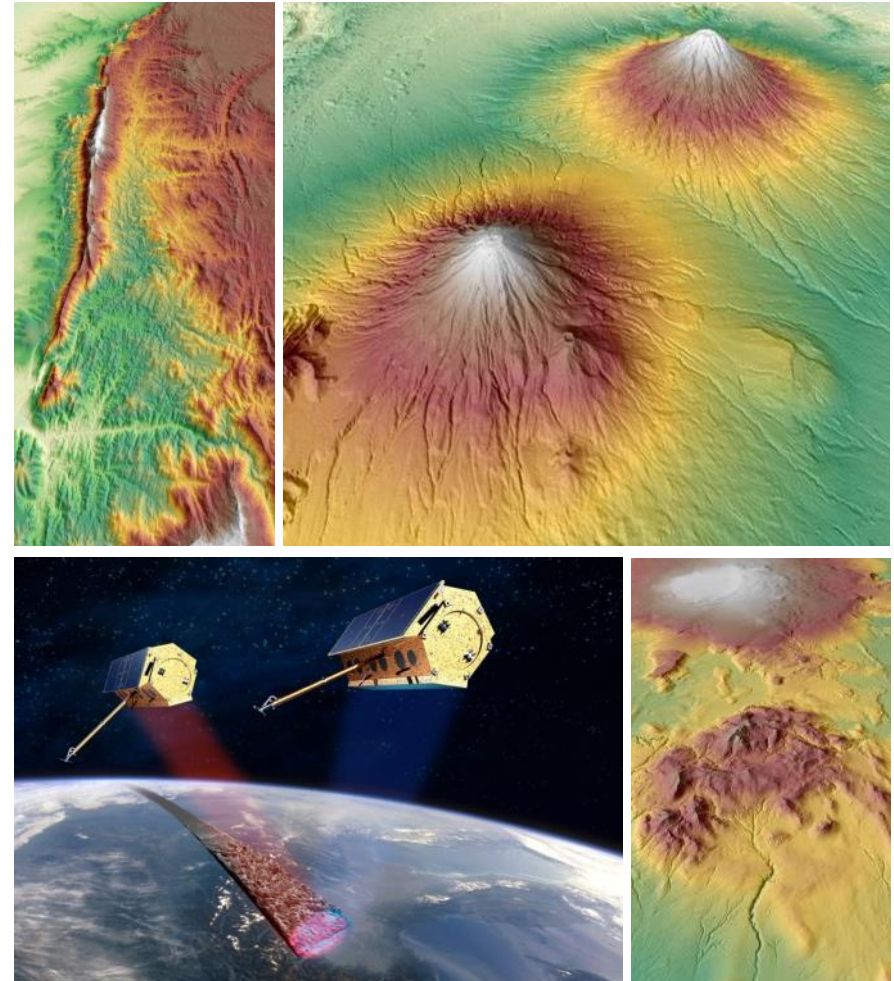
Processing of *phase difference* between  
2 acquisitions with comparable  
*viewing geometry*

# I.I Generation of a Digital Elevation Model from SAR

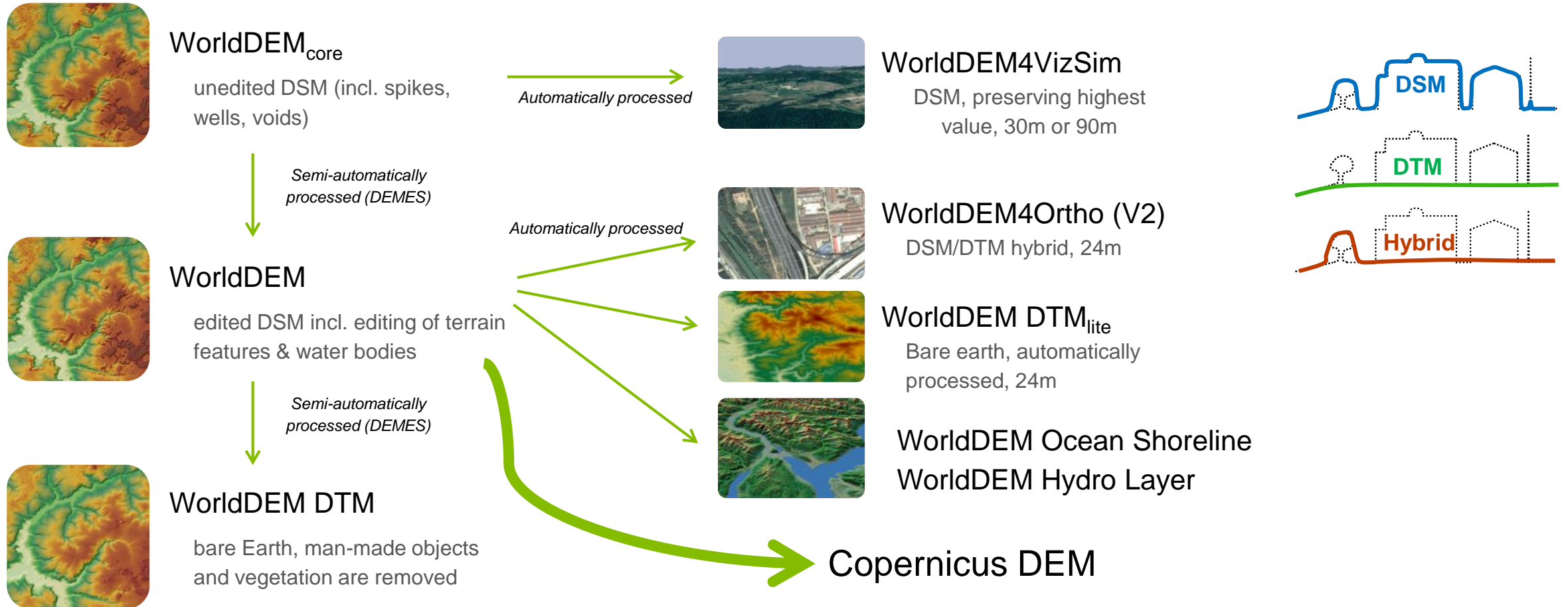


## I.II WorldDEM™ – Digital Elevation Model

- Worldwide, consistent and seamless DEM product
- Covering the entire Earth's land mass (pole-to-pole)
- Single Source
- Resolution: 12m
- Acquisition time: 2010-2015
- Global Accuracy Values:
  - Absolute Vertical Accuracy < 4m (90% linear error)
  - Relative Vertical Accuracy < 2m (slope ≤ 20%)  
< 4m (slope > 20%) (90% linear point-to-point error within an area of 1° x 1°)
  - Absolute Horizontal Accuracy < 6m (90% circular error)

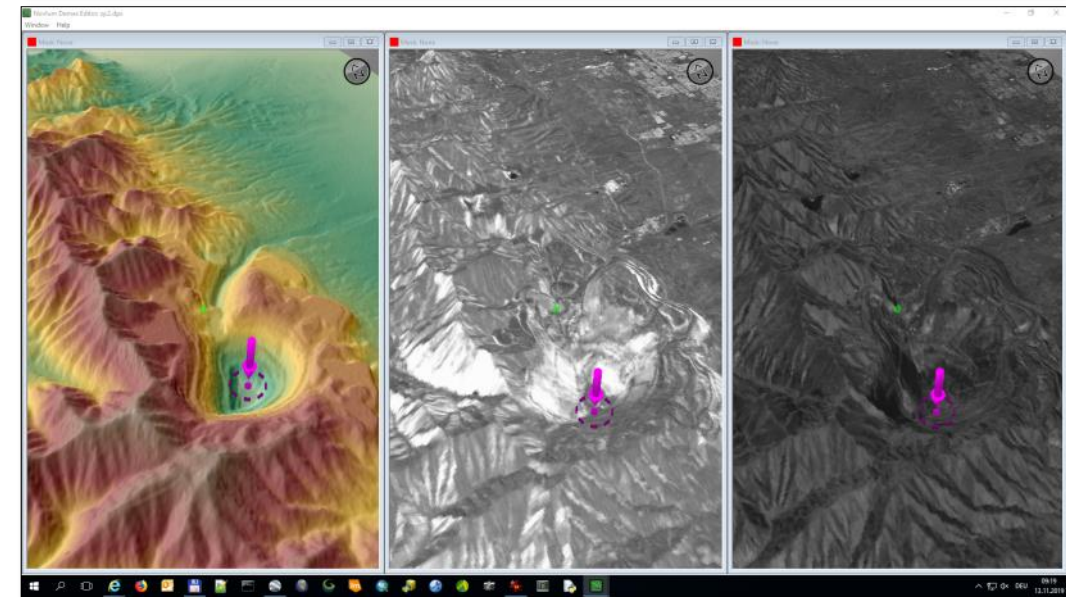
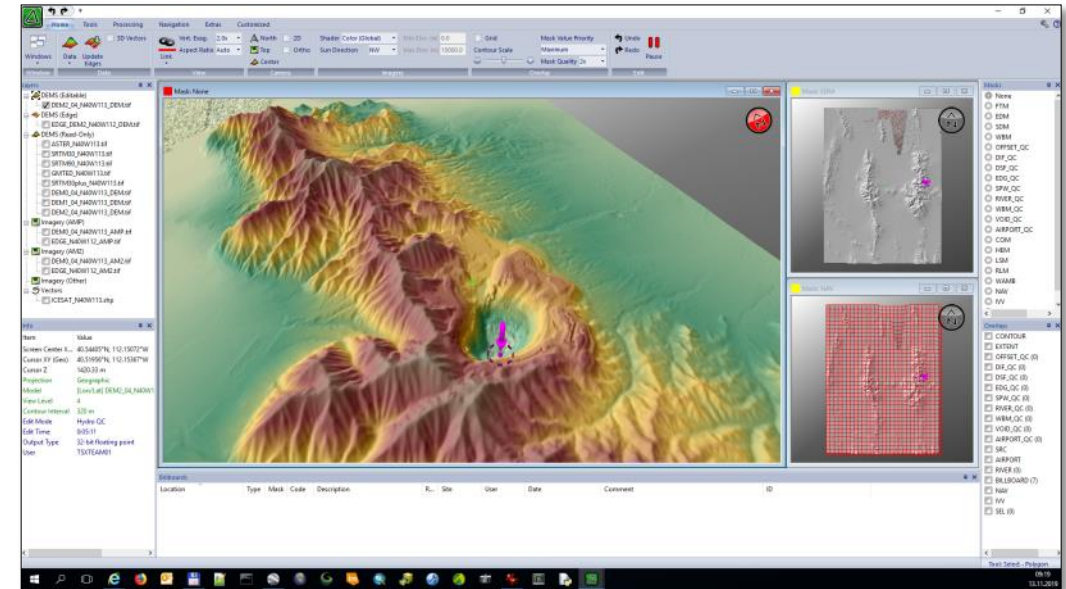


# I.II WorldDEM™ / TanDEM-X Heritage



## I.II World DEM™ Editing

- **Data manipulation instance**, tailored for
  - Display
  - Editing
  - Plausibility Control
- Key functionalities
  - **Selection** tools
  - **Processing** tools
  - File reading/writing
- **Direct connection to DEMES Viewer**
  - Simplified process management and internal data distribution
  - Additional on-the-fly overview of **up-to-date neighboring data** easing the management of production teams and edge related editing issues

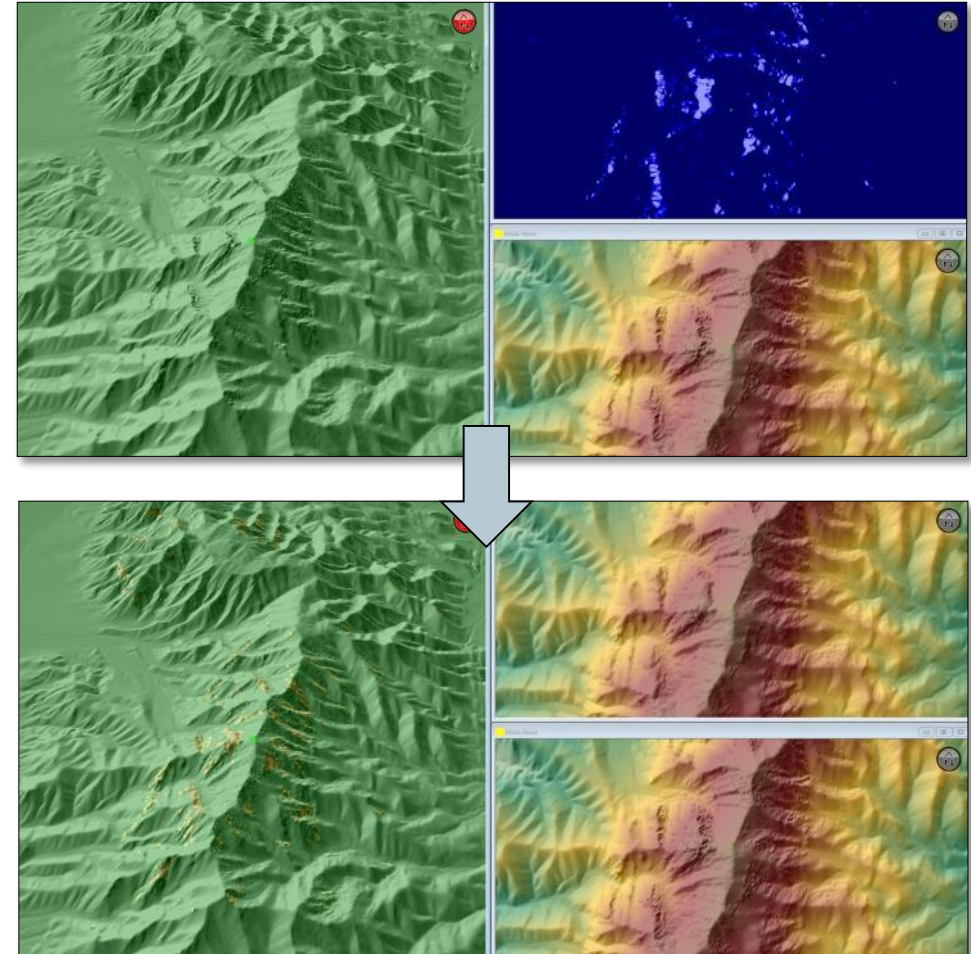




## I.II WorldDEM™ Editing

### 1. Terrain Editing

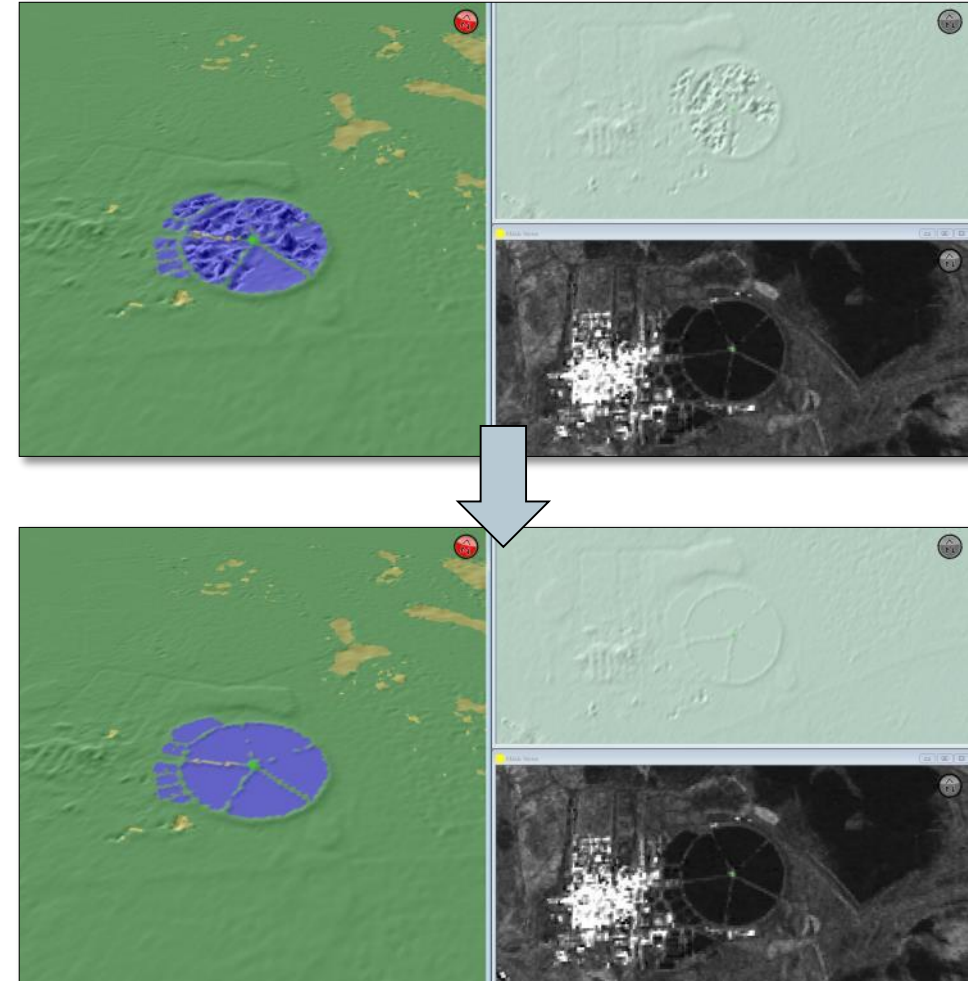
- **Spike and Well Removal**
  - Single pixels with height difference of 20m removed and interpolated
- **Void Filling**
  - Small voids (up to 16 pixel) interpolated
  - Larger void areas filled
- **Editing of Noise**
  - E.g. shadow areas smoothed
- **Raising of Implausible Negative Elevation**
  - Ocean shoreling pixel raised above 0m



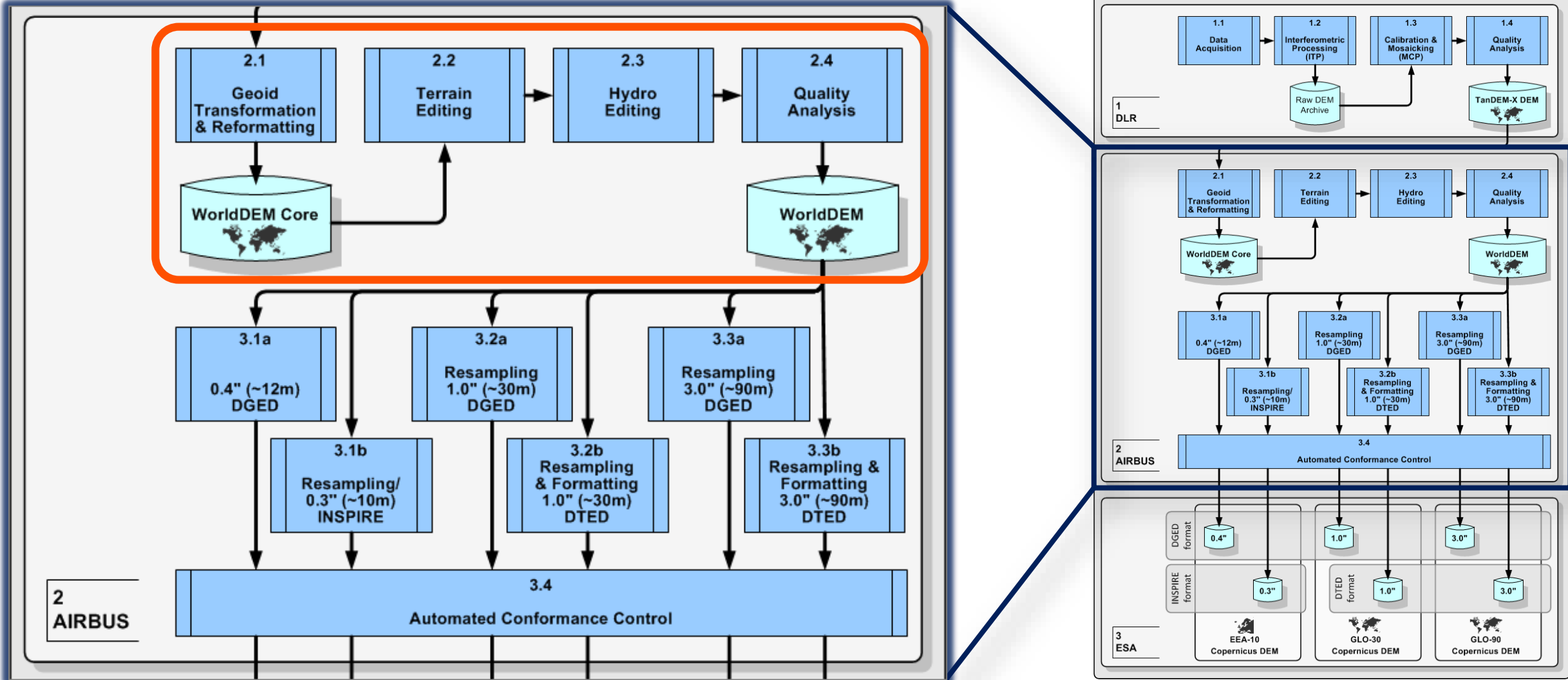
# I.II WorldDEM™ Editing

## 2. Hydrology Editing

- **Ocean:** ocean incl. all seas, inlets, fjords set to 0m
- **Lake:** all inland water bodies present in the Amplitude Mosaic image set to a single elevation
- **River:** Double line feature with monotonic changing elevation



# I.II WorldDEM™ Editing Process – Overview



The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.

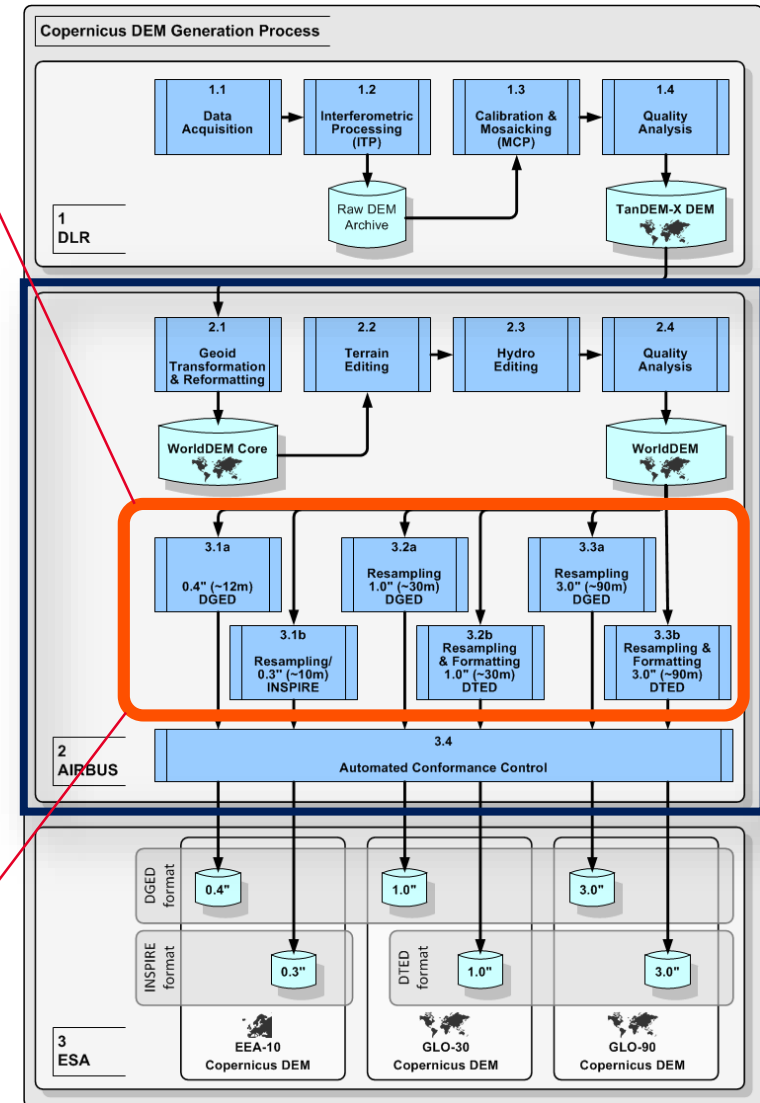
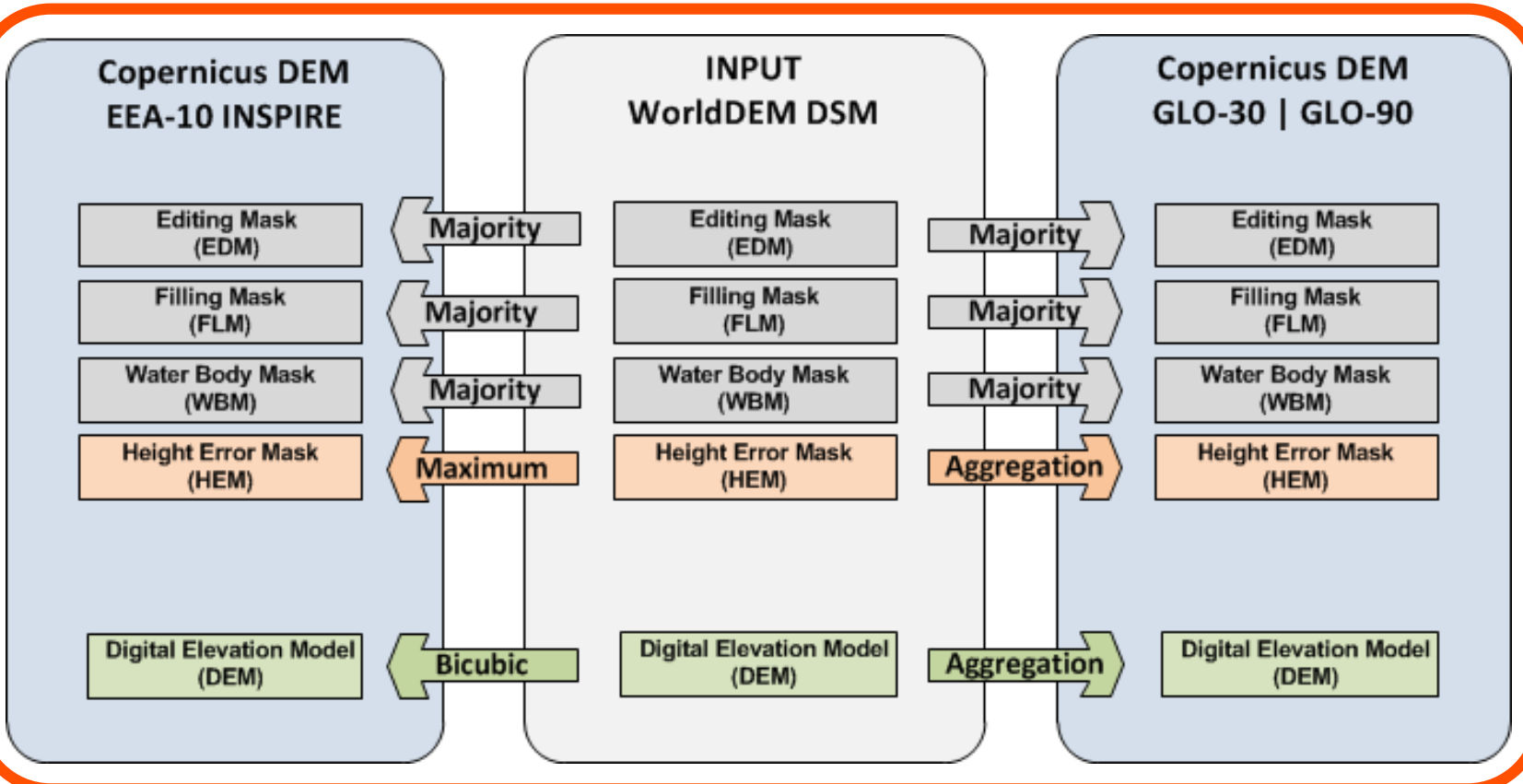


## I.III From WorldDEM™ to Copernicus DEM - Timeline

- Objective: To procure a **global** and **consistent** high-resolution Digital Elevation Model (DEM) for usage within the Copernicus Programme
- Following an open tender, ESA selected WorldDEM™ as suitable DEM
- Negotiation with Airbus Defence and Space concluded successfully in July 2019
- “Copernicus DEM” project kicked-off on 5<sup>th</sup> August 2019
- The delivery of all Copernicus DEM instances to users will start **before end 2019** through the following website:

**<https://spacedata.copernicus.eu/>**

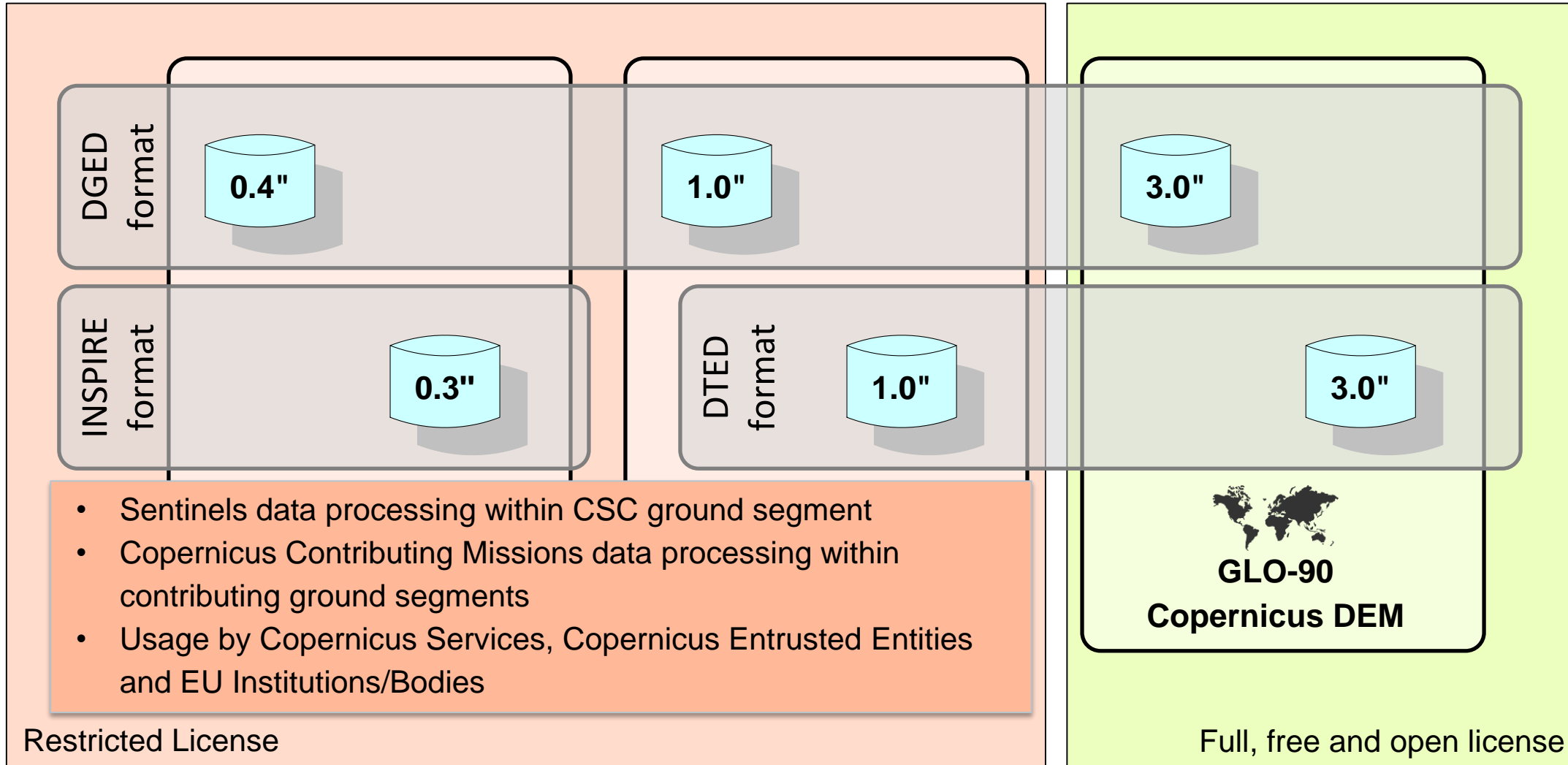
# I.III From WorldDEM™ to Copernicus DEM



The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.

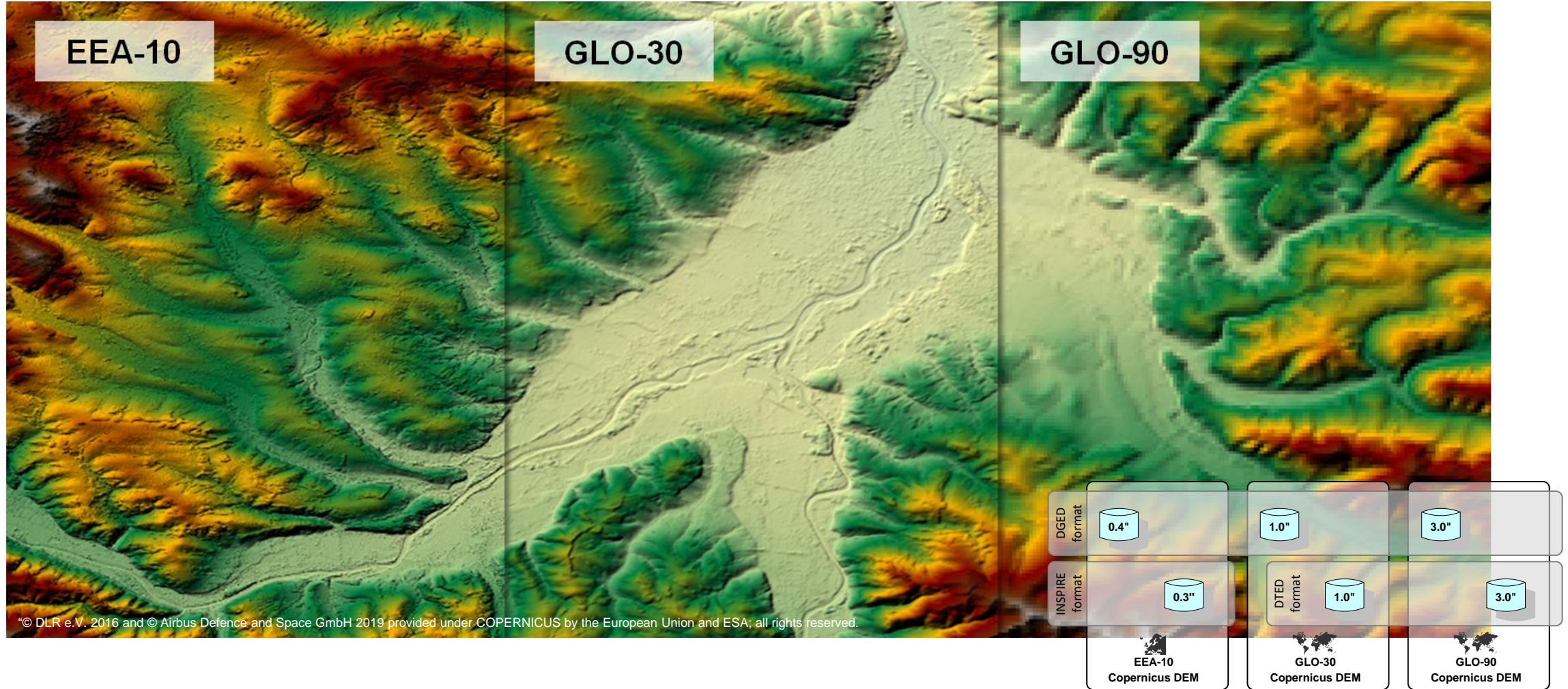


## II.I Copernicus DEM – 6 DEM Instances



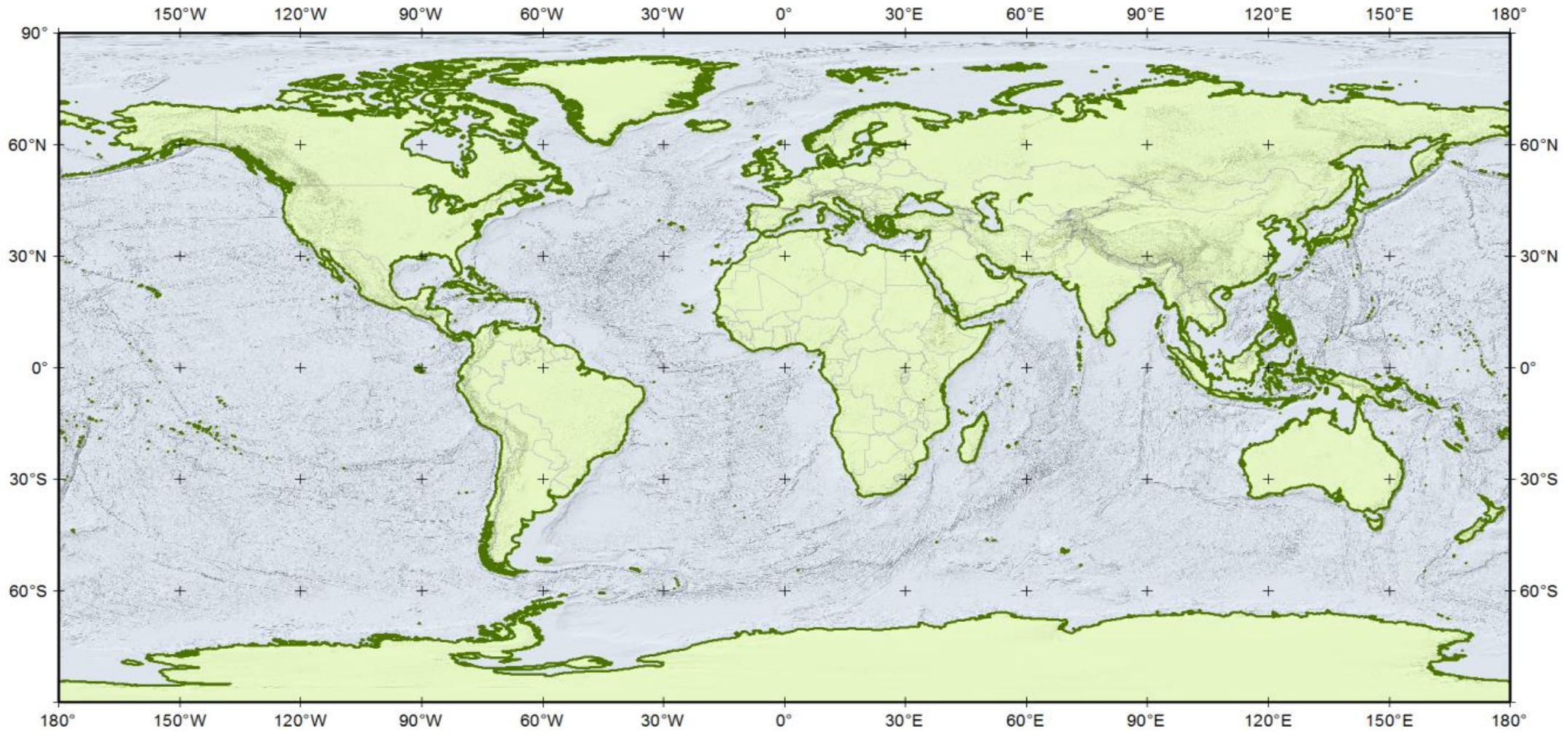
The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.

## II.I Copernicus DEM – DEM Instances



The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.

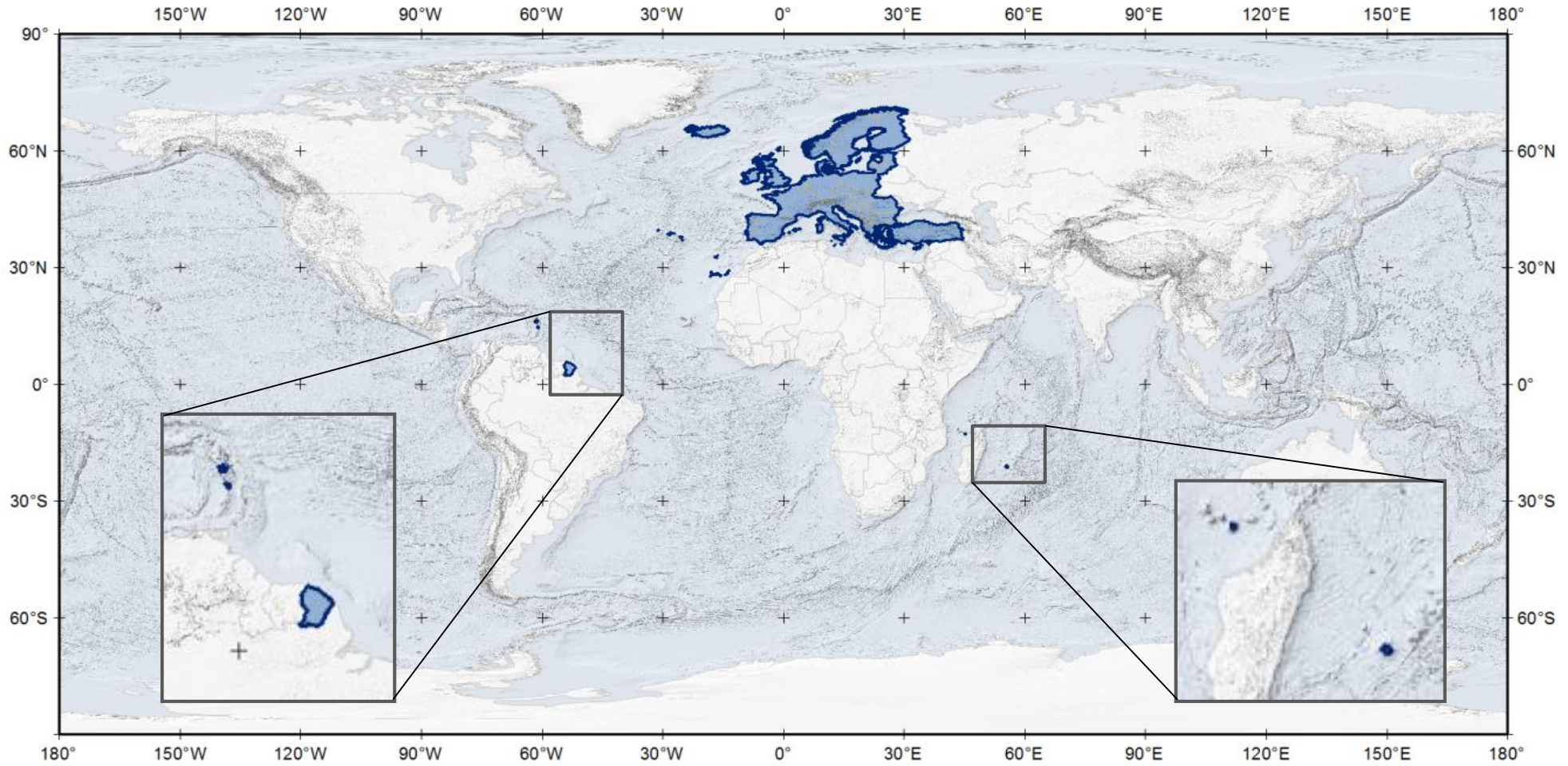
## II.II Copernicus DEM Coverage – Global



The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.



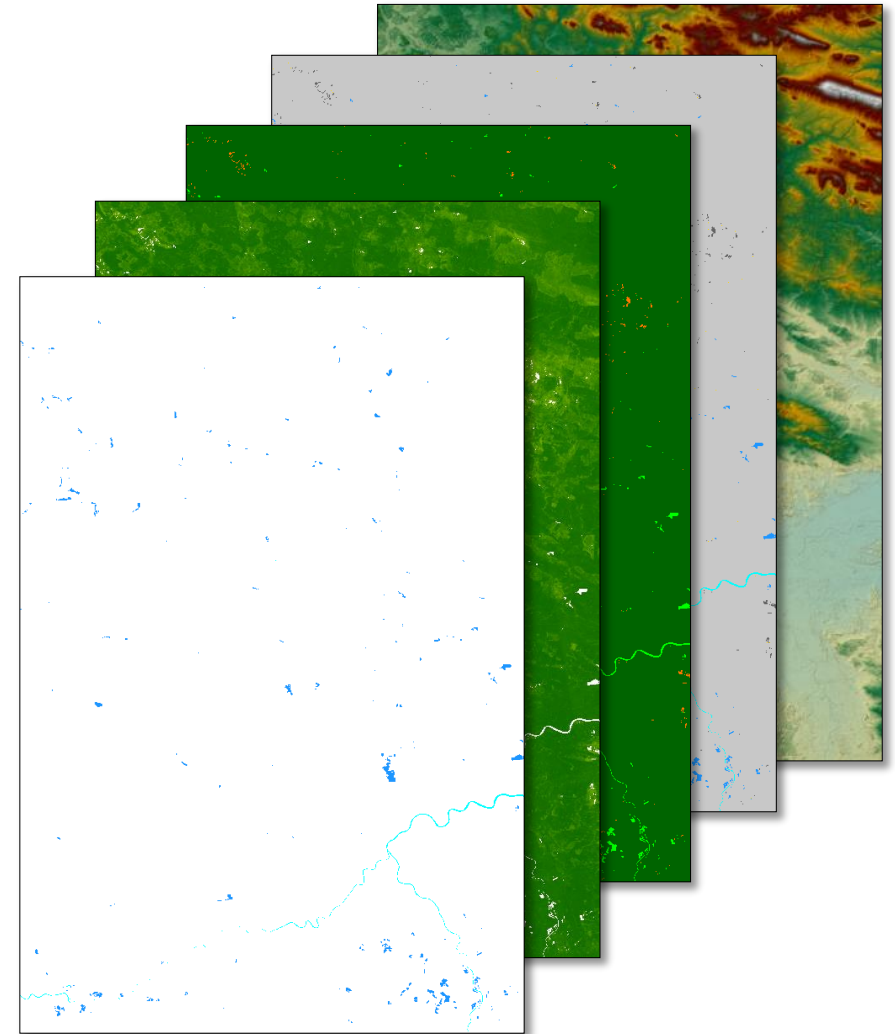
## II.II Copernicus DEM Coverage – EEA39



The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.

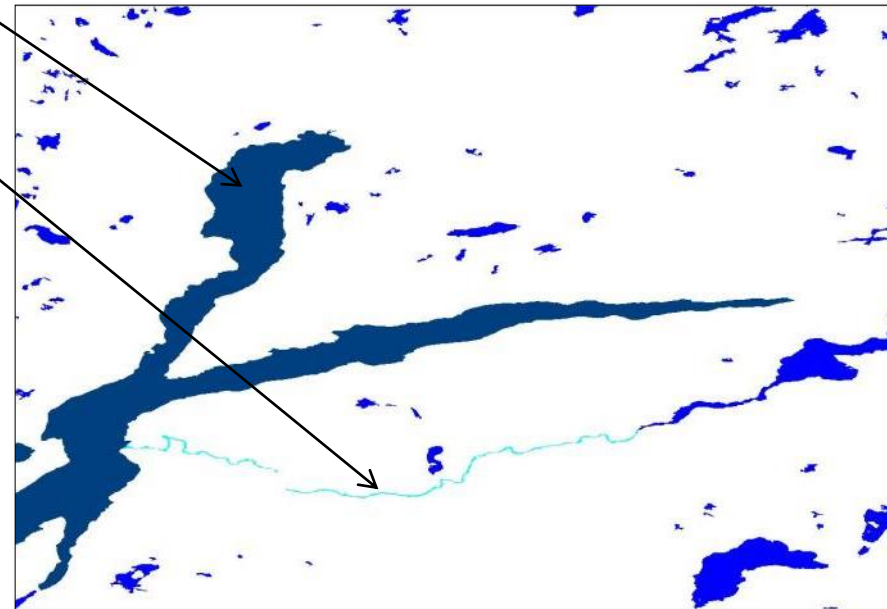
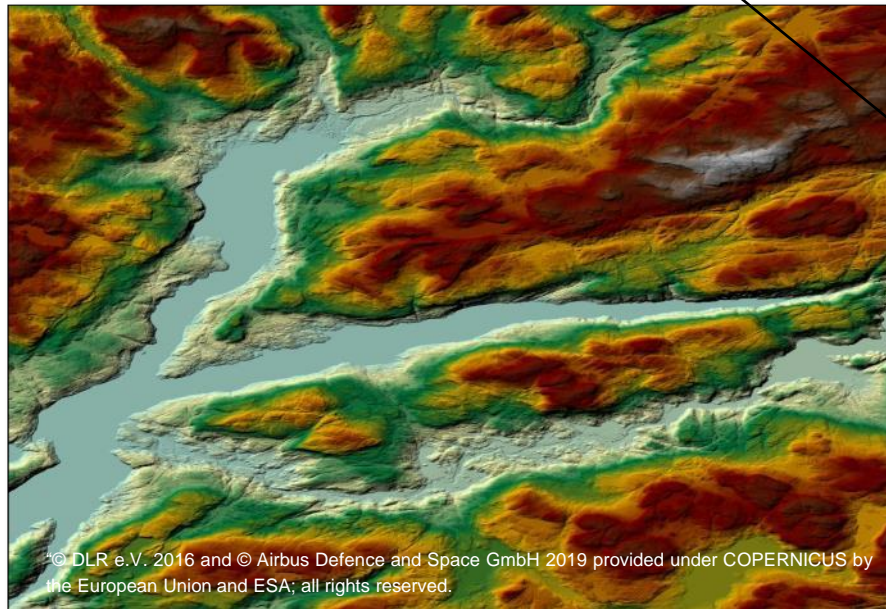
## II.II Copernicus DEM – Quality Layer

Quality Layers		Data Format
<b>Editing Mask</b>	EDM	8 Bit unsigned integer, GeoTIFF
<b>Filling Mask</b>	FLM	8 Bit unsigned integer, GeoTIFF
<b>Height Error Mask</b>	HEM	32 Bit floating point, GeoTIFF
<b>Water Body Mask</b>	WBM	8 Bit unsigned integer, GeoTIFF
<b>Source Data Layer</b>	SRC	KML vector file
<b>Accuracy Layer</b>	ACM	KML vector file

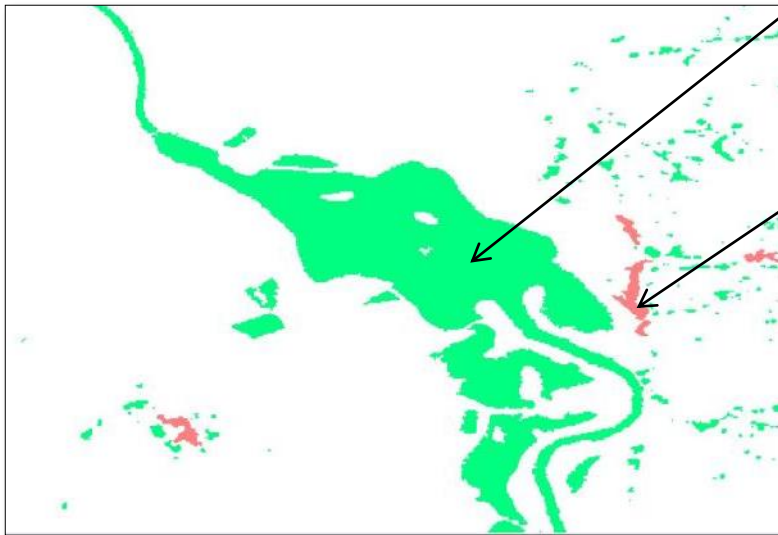
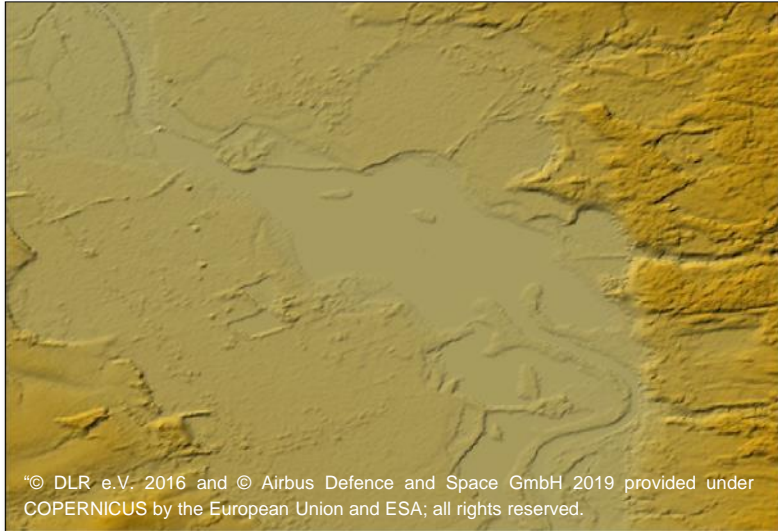


# Example for Quality Masks – Water Body Mask

Pixel Value	Meaning
0	No water
1	Ocean
2	Lake
3	River

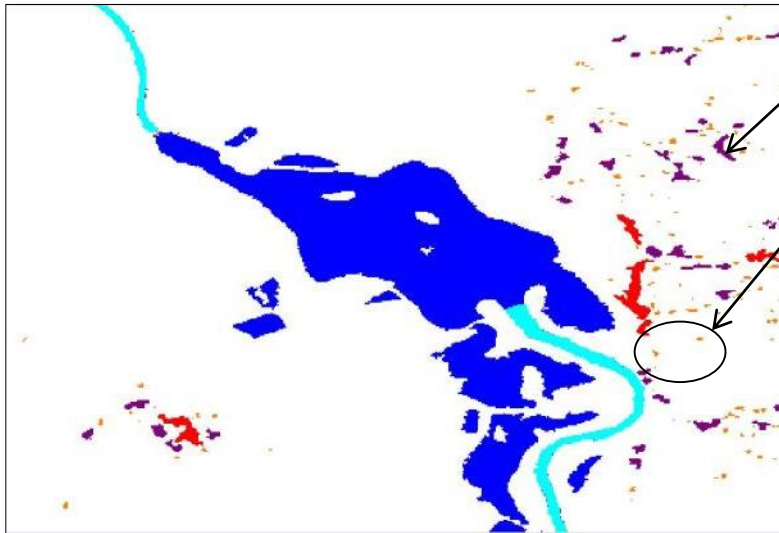
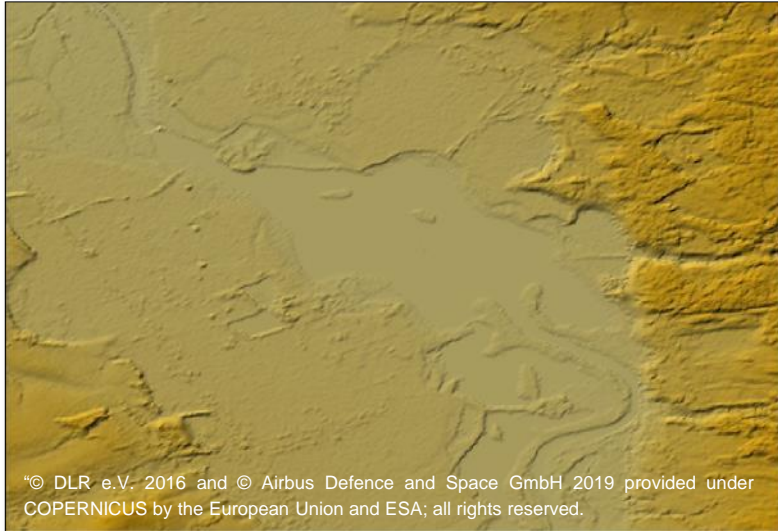


# Example for Quality Masks – Filling Mask



Pixel Value	Meaning
0	Void (no data)
1	Edited (except filled pixels)
2	Not edited / not filled
3	ASTER
4	SRTM90
5	SRTM30
6	GMTED2010
7	SRTM30plus
8	TerraSAR-X Radargrammetric DEM
9	AW3D30

# Example for Quality Masks – Editing Mask



Pixel Value	Meaning
0	Void (no data)
1	Not edited
2	Infill of external elevation data
3	Interpolated pixels
4	Smoothed pixels
5	Airport editing
6	Raised negative elevation pixels
7	Flattened pixels
8	Ocean pixels
9	Lake pixels
10	River pixels
11	Shoreline pixels
12	Morphed pixels (series of pixels manually set)
13	Shifted pixels

## II.II Copernicus DEM - Specification

Specification Parameter		Value			
<b>File Format</b>		<b>GeoTIFF   DTED</b>			
<b>File Data Type</b>		<b>32 Bit, floating (DGED &amp; INSPIRE format) or 16 Bit, signed (DTED format)</b>			
<b>Delivery Unit / Tiling</b>		<b>1°x1° latitude/longitude</b>			
<b>NoData Value</b>		<b>-32,767 (EEA-10 only)</b>			
<b>Projection</b>		<b>Geographic Coordinates</b>			
<b>Coordinate Reference System</b>	Horizontal	<b>WGS84-G1150 (EPSG 4326)</b>			
	Vertical	<b>EGM2008 (EPSG 3855)</b>			
<b>Grid Spacing</b>	Latitude direction	<b>Format</b>	INSPIRE	DGED	DTED
		<b>EEA-10</b>	0.3"	0.4"	
		<b>GLO-30</b>		1.0"	1.0"
	<b>GLO-90</b>		3.0"	3.0"	
	Longitude direction	<b>variable (dep. on latitude)</b>			
<b>Vertical Unit</b>		<b>meters</b>			

---

Thank you