DEMIX SG3 – “Platforms and processing”

Presentation of studies

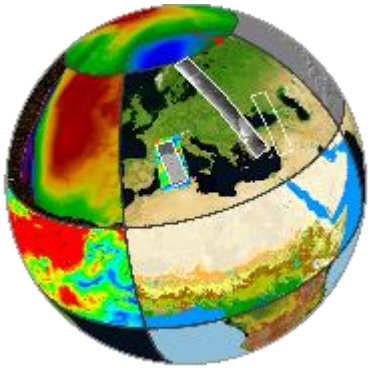

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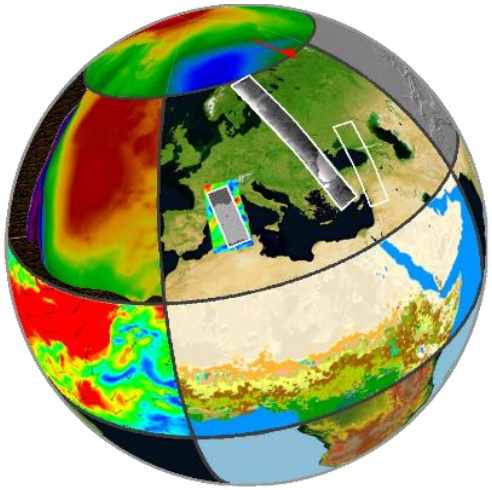
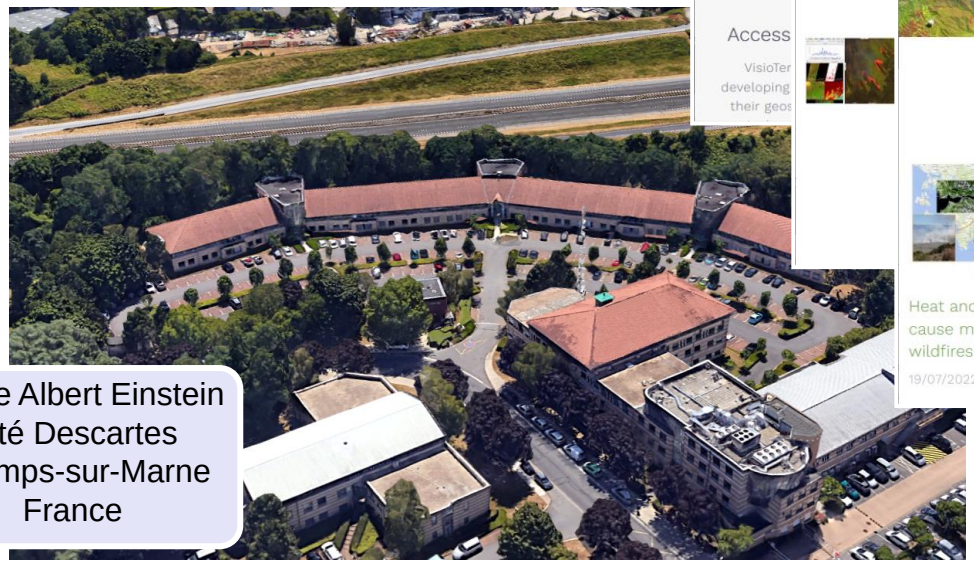
Table of contents



VisioTerra in few numbers

- Founded in May 2004
- 11 engineers
- Projects
  - **ESA** - Studies, Platforms CryoSat / Heritage and TPM missions, Outreach "Sentinel Vision"
  - **In Africa** - EU / NGOs - Platforms / Geoservices / Cartography / Training
- https://visioterra.fr



14 rue Albert Einstein
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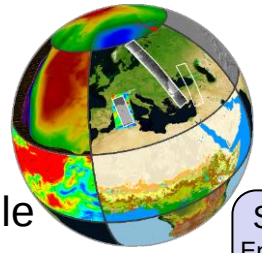
Champs-sur-Marne
France

VtWeb – Data Processing Relay



- VtWeb infrastructure
  - 1 PB (1000 TB) available
    - 50 TB ASAR and ERS
    - 150 TB MERIS
  - 1 Gb/s symmetric fibre
  - 6 powerful servers

meteo., climate ECMWF

VisioTerra collections

Landsat, ASTER… USGS science for a changing world

NASA MODIS

NOAA oceano.

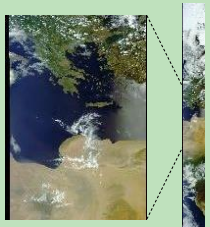
Copernicus services

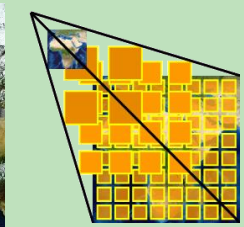
Sentinels, Envisat, ERS… esa

maps UNESCO

…

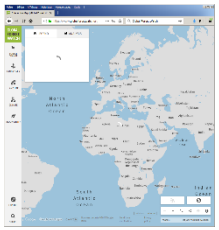
Infrastructure VtWeb



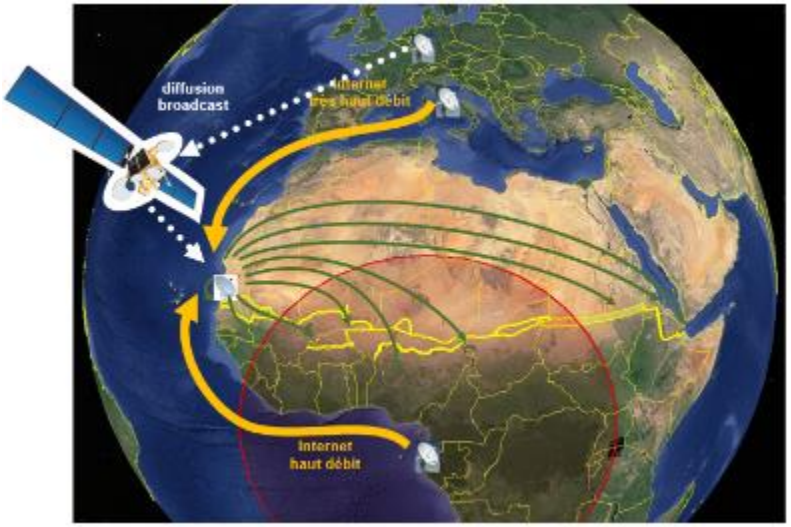


Other drives

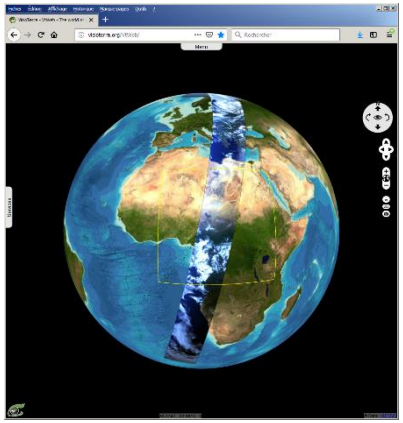
Other infrastructures



- DPR as a solution for Africa



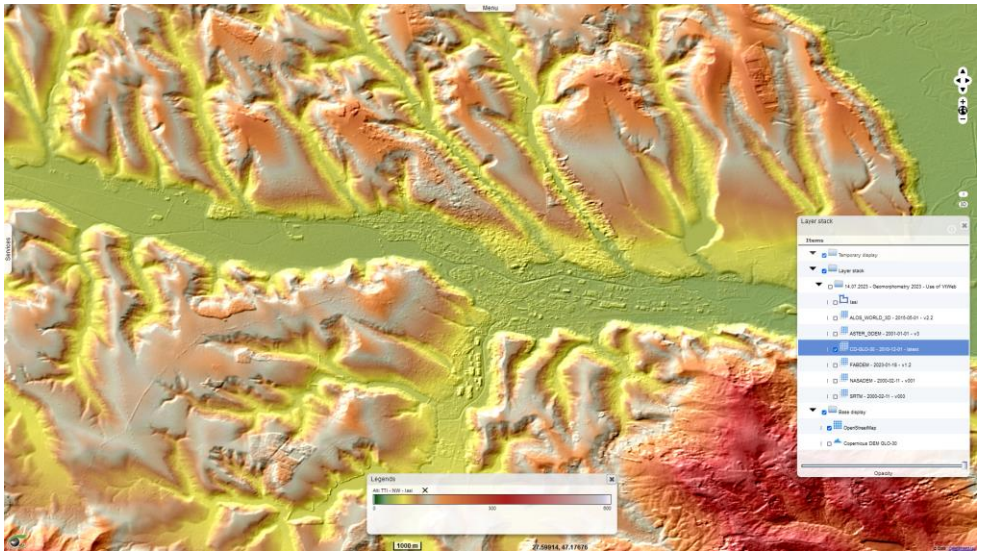
VtWeb client



Google Earth

G.I.S.

VtWeb - Client-server application

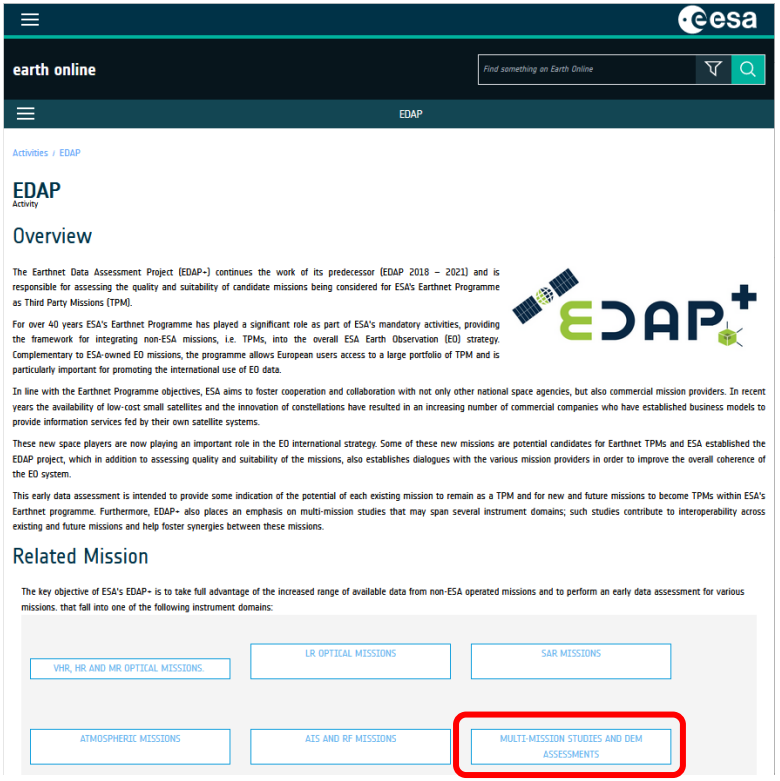


- Main features
  - Open access without registration
  - Many datasets in input (image, LiDAR, altimeter, vector fields…)
  - Processing on-the-fly
  - POF-ML macro-language
  - Sharing with hyperlooks → Iasi 2D layer stack
  - Analysis tools
  - Export
- Demonstration on Friday 14 morning
- Hyperlook documents
  - HYP-080-VtWeb-E_SRTM_ASTER-GDEM_ALOS-World-3D_comparison
  - HYP-082-VtWeb-E_SRTM_ASTER-GDEM_local_statistics_comparison
  - HYP-086-VtWeb-E_DEM_impact_on_orthorectification
  - HYP-087-VtWeb-E_Presentation_of_ICESat-2_ATLAS
  - HYP-089-VtWeb-E_Comparison_of_DEMs_in_Chott_Melghir_Algeria
  - HYP-091-VtWeb-E_MERIT_DEM_first_assessment
  - HYP-094-VtWeb-E_Assessment_of_slopes_in_Alaska_LiDAR_DEM
  - HYP-095-VtWeb-E_Comparison_of_Copernicus_DEM_releases_2020_vs_2019
  - HYP-096-VtWeb-E_Comparison_of_LiDAR_GEDI_vs_ICESat-1_ICESat-2
  - HYP-097-VtWeb-E_NASADEM_SRTMGL1_comparison
  - HYP-098-VtWeb-E_COP-DEM_EU-DEM_comparison
  - HYP-099-VtWeb-E_COP-DEM_GLO-90_vs_GLO-30_for_Sentinel-2_orthorectification
  - HYP-106-VtWeb-E_Comparison_of_FABDEM_releases_1.0_vs_1.2
  - HYP-107-VtWeb-E_Comparison_of_Copernicus_DEM_releases_2022_vs_2021

EDAP / EDAP+ projects

- EDAP - Earthnet Data Assessment Pilot
  - From 29.10.2018 to 04.11.2021 (3 years)
  - Task 5 - Specific studies / Quality assessment of DEMs

- EDAP+
  - KO on 06.07.2022
  - Task 6 – DEM CLUSTER
  - https://earth.esa.int/eogateway/activities/edap/multi-mission-studies



Global DEMs Documentation

- Technical Note on Quality Assessment for Global DEM

Copernicus DEM Documentation

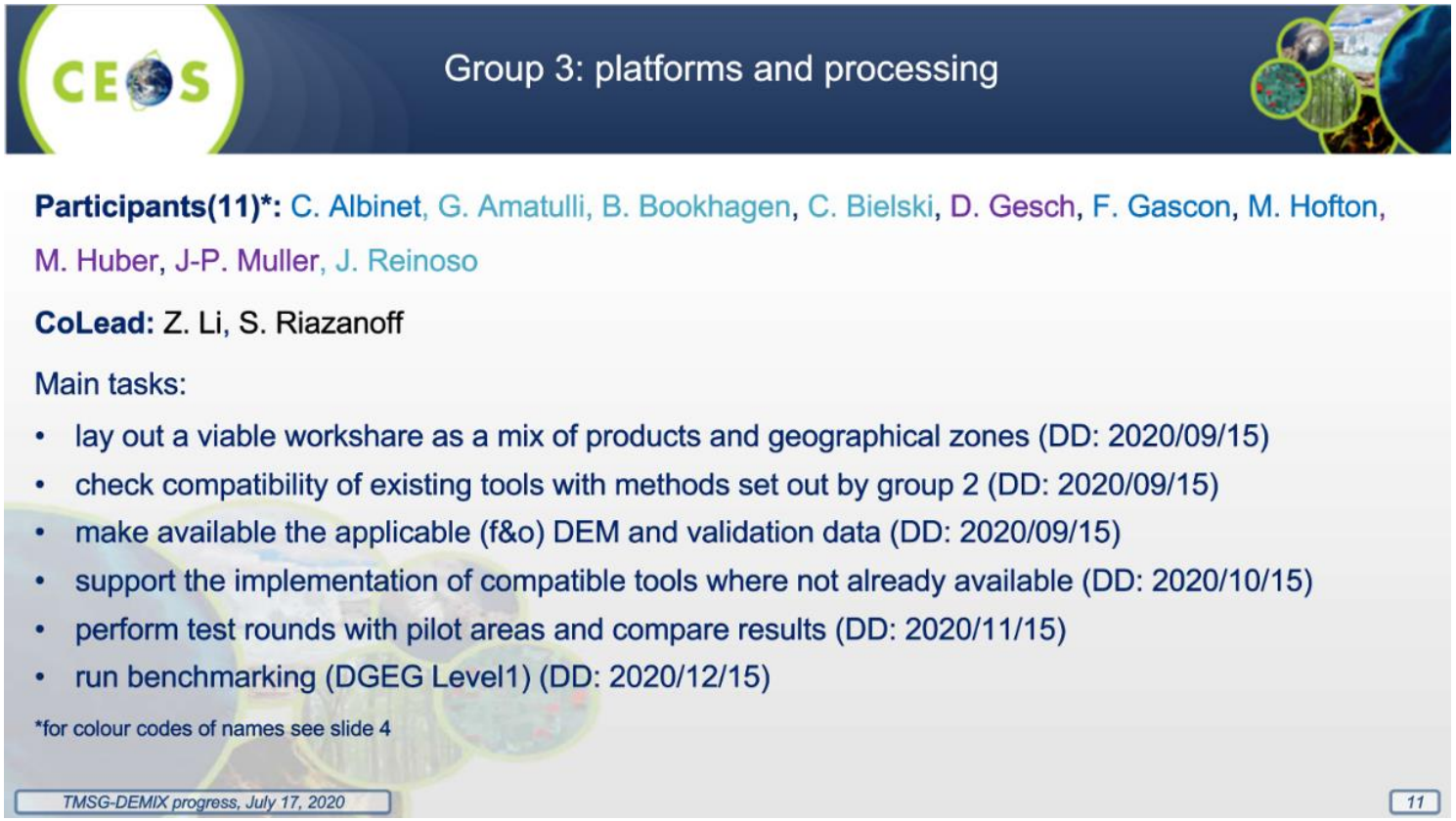
- Technical Note on Quality Assessment for Copernicus DEM
- Technical Note on Planimetric Misregistration Assessment

VHR DEMs Documentation

- Technical Note on VHR DEMs
- Technical Note on Sentinel-1 ARD from VHR DEM

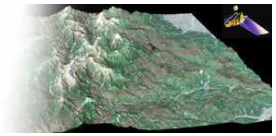
DEMIX SG3 “Platforms and processing”

- DEMIX
  - KO on 17 July 2020
  - Duties of SG3 “Platforms and processing”



Study 1 - Quality Assessment for Global DEM

- Global DEMs



AW3D

- Product Quality Evaluation Matrix

Product Information	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Details	Sensor Calibration & Characterisation Pre-Flight	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch	Ancillary Data	Uncertainty Sources Included	Reference Data Quality
Product Format	Retrieval Algorithm Method		Uncertainty Values Provided	Validation Method
User Documentation	Retrieval Algorithm Tuning		Geolocation Uncertainty	Validation Results
Metrological Traceability Documentation	Additional Processing			

SRTM

Product Information	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Details	Sensor Calibration & Characterisation Pre-Flight	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch	Ancillary Data	Uncertainty Sources Included	Reference Data Quality
Product Format	Retrieval Algorithm Method		Uncertainty Values Provided	Validation Method
User Documentation	Retrieval Algorithm Tuning		Geolocation Uncertainty	Validation Results
Metrological Traceability Documentation	Additional Processing			

ASTER GDEM

Product Information	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Details	Sensor Calibration & Characterisation Pre-Flight	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch	Ancillary Data	Uncertainty Sources Included	Reference Data Quality
Product Format	Retrieval Algorithm Method		Uncertainty Values Provided	Validation Method
User Documentation	Retrieval Algorithm Tuning		Geolocation Uncertainty	Validation Results
Metrological Traceability Documentation	Additional Processing			

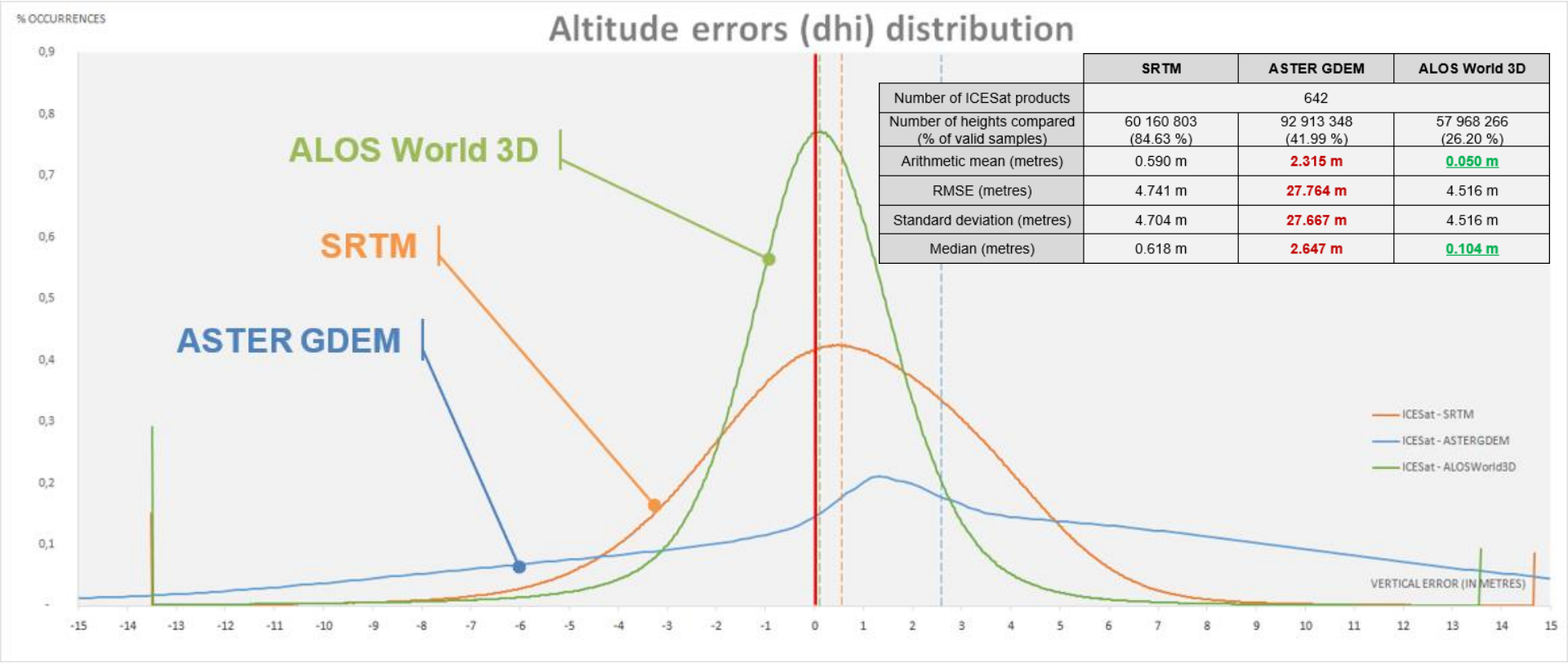
ALOS World 3D

Key
Not Assessed
Not Assessable
Basic
Intermediate
Good
Excellent

Information Not Public

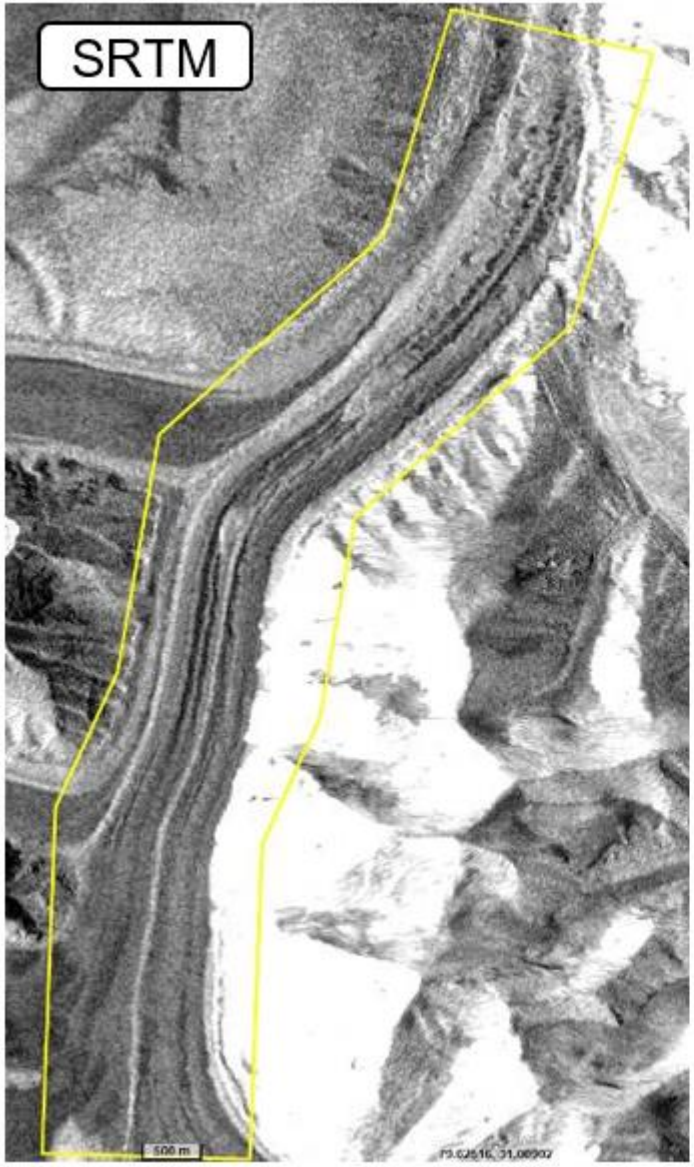
Study 1 - Computation of height differences

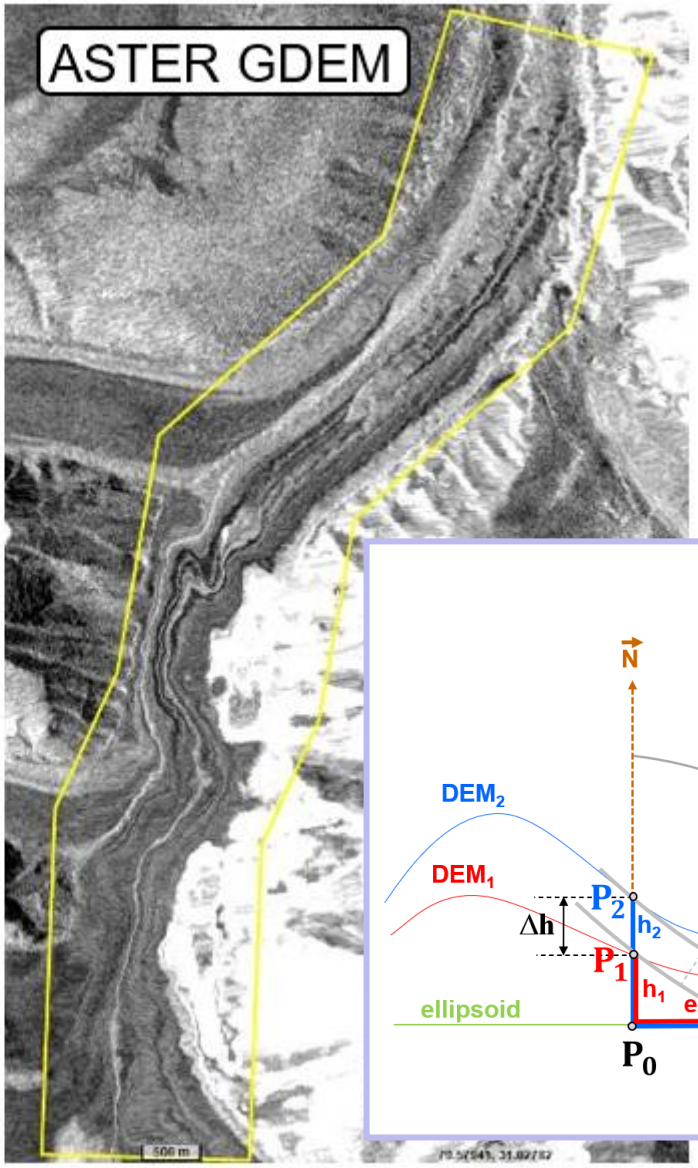
- Computation of differences (DEM height - ICESat-1 height)
  - ICESat-1 / GLAS / GLAH14 product - Filtering using quality flags (elev_use_flg, sat_corr_flg, elv_cloud_flg) - Conversion from TOPEX / Poseidon to WGS84 - Verification of collocation in flat areas
  - Candidate DEMs - Change of VRS (Vertical Reference System) from EGM96 to WGS84
- Results of height differences

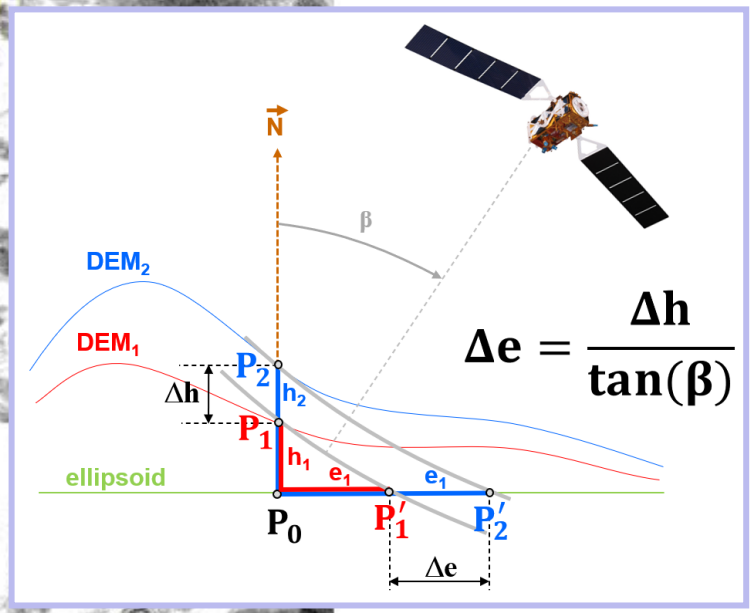


	SRTM	ASTER GDEM	ALOS World 3D
Number of ICESat products	642		
Number of heights compared (% of valid samples)	60 160 803 (84.63 %)	92 913 348 (41.99 %)	57 968 266 (26.20 %)
Arithmetic mean (metres)	0.590 m	**2.315 m**	**0.050 m**
RMSE (metres)	4.741 m	**27.764 m**	4.516 m
Standard deviation (metres)	4.704 m	**27.667 m**	4.516 m
Median (metres)	0.618 m	**2.647 m**	**0.104 m**

Study 1 - Effects of DEM differences on orthorectification

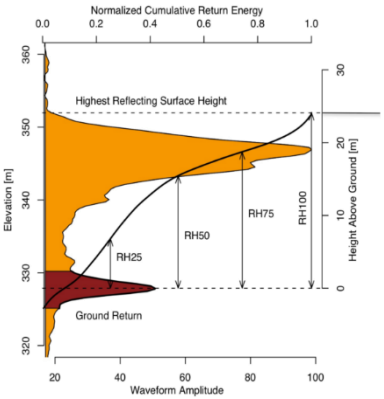


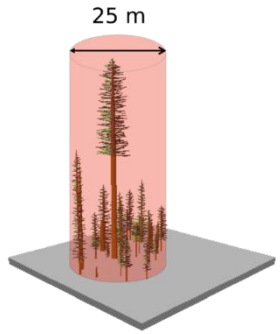




Study 2 - Copernicus DEMs EEA-10, GLO-30, GLO-90

Technical specification	ICESat-1	ICESat-2	GEDI
Instrument name	Geoscience Laser Altimeter System (GLAS)	Advanced Topographic Laser Altimeter System (ATLAS)	Global Ecosystem Dynamics Investigation (GEDI)
First acquisition date	02.20.2003	13.10.2018	25.03.2019
Last acquisition date	11.10.2009	Ongoing	Ongoing
Acquisition frequency	40 Hz	10 KHz / 70 Hz[1]	242 Hz
Ground sampling distance	~170 m	~0.7 m / 100 m^2	~60 m
Central wavelength	532 nm (green) / 1064 nm (near infrared)	532 nm (green)	1064 nm (near infrared)
Number of beams	1	6	8
Repeat cycle	Phase 1 – 8 days – [20/02/2003; 04/10/2003] Phase 2 – 91 days – [04/10/2003; 11/10/2009]	91 days	No repeat cycle
Footprint diameter	~70 m	~13 m / 100 m^3	~25 m
Product	GLAH14	ATL08	GEDI02_A
Return / mode		terrain only terrain with canopy	lowest mode highest return

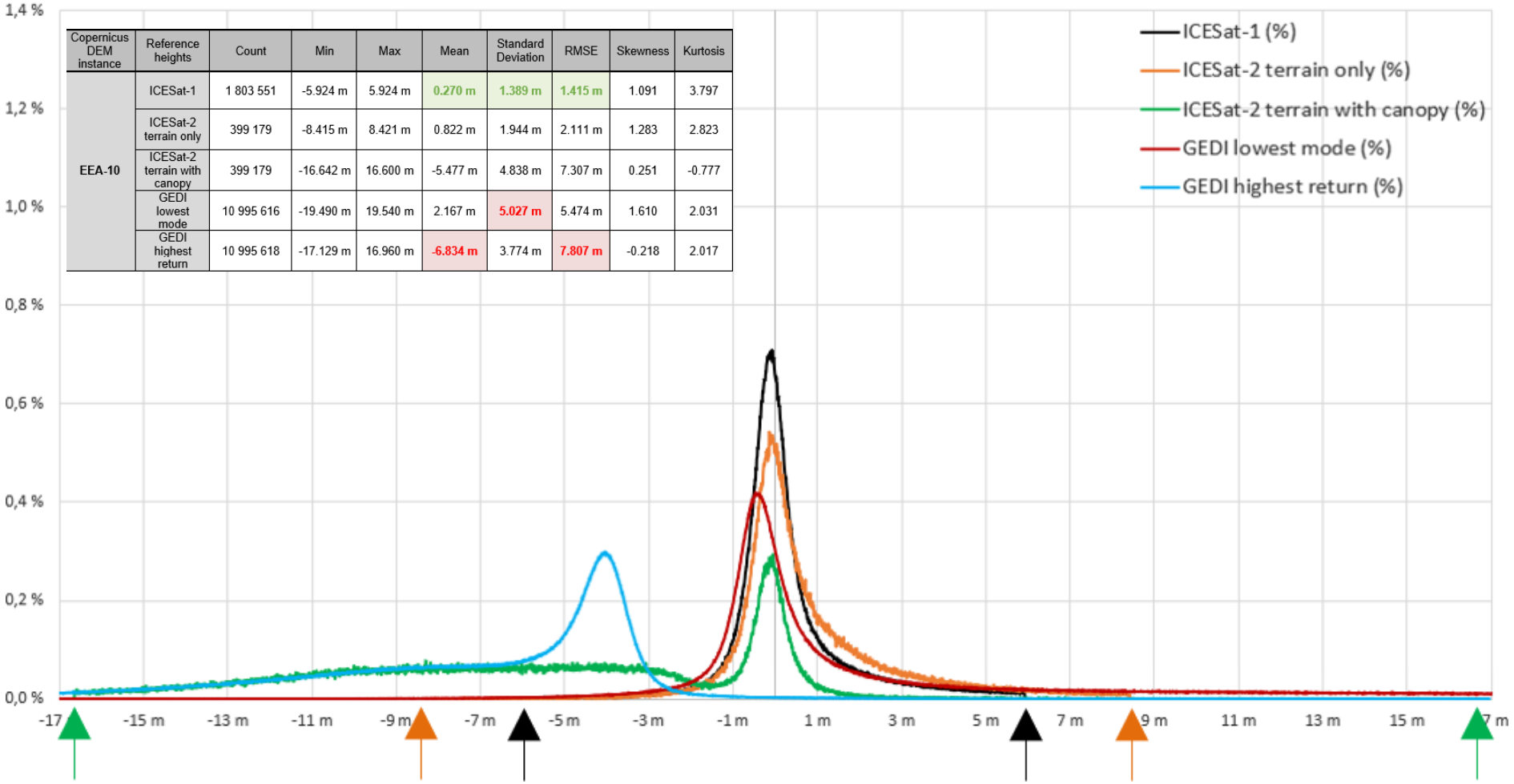




Study 2 - Height errors depending on LiDAR mission / mode

EEA-10

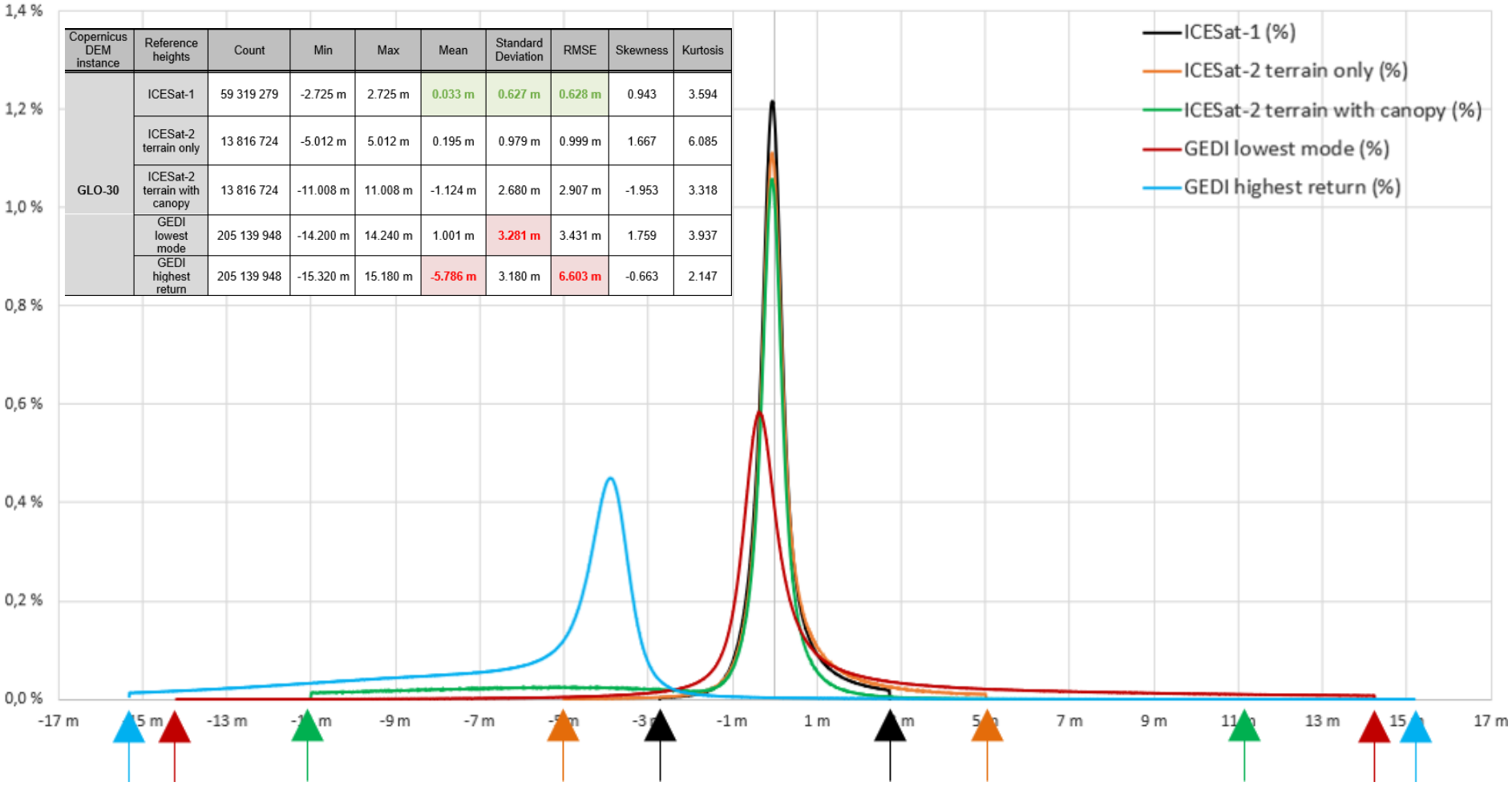
Copernicus DEM instance	Reference heights	Count	Min	Max	Mean	Standard Deviation	RMSE	Skewness	Kurtosis
EEA-10	ICESat-1	1 803 551	-5.924 m	5.924 m	0.270 m	1.389 m	1.415 m	1.091	3.797
	ICESat-2 terrain only	399 179	-8.415 m	8.421 m	0.822 m	1.944 m	2.111 m	1.283	2.823
	ICESat-2 terrain with canopy	399 179	-16.642 m	16.600 m	-5.477 m	4.838 m	7.307 m	0.251	-0.777
	GEDI lowest mode	10 995 616	-19.490 m	19.540 m	2.167 m	5.027 m	5.474 m	1.610	2.031
	GEDI highest return	10 995 618	-17.129 m	16.960 m	-6.834 m	3.774 m	7.807 m	-0.218	2.017



Study 2 - Height errors depending on LiDAR mission / mode

GLO-30

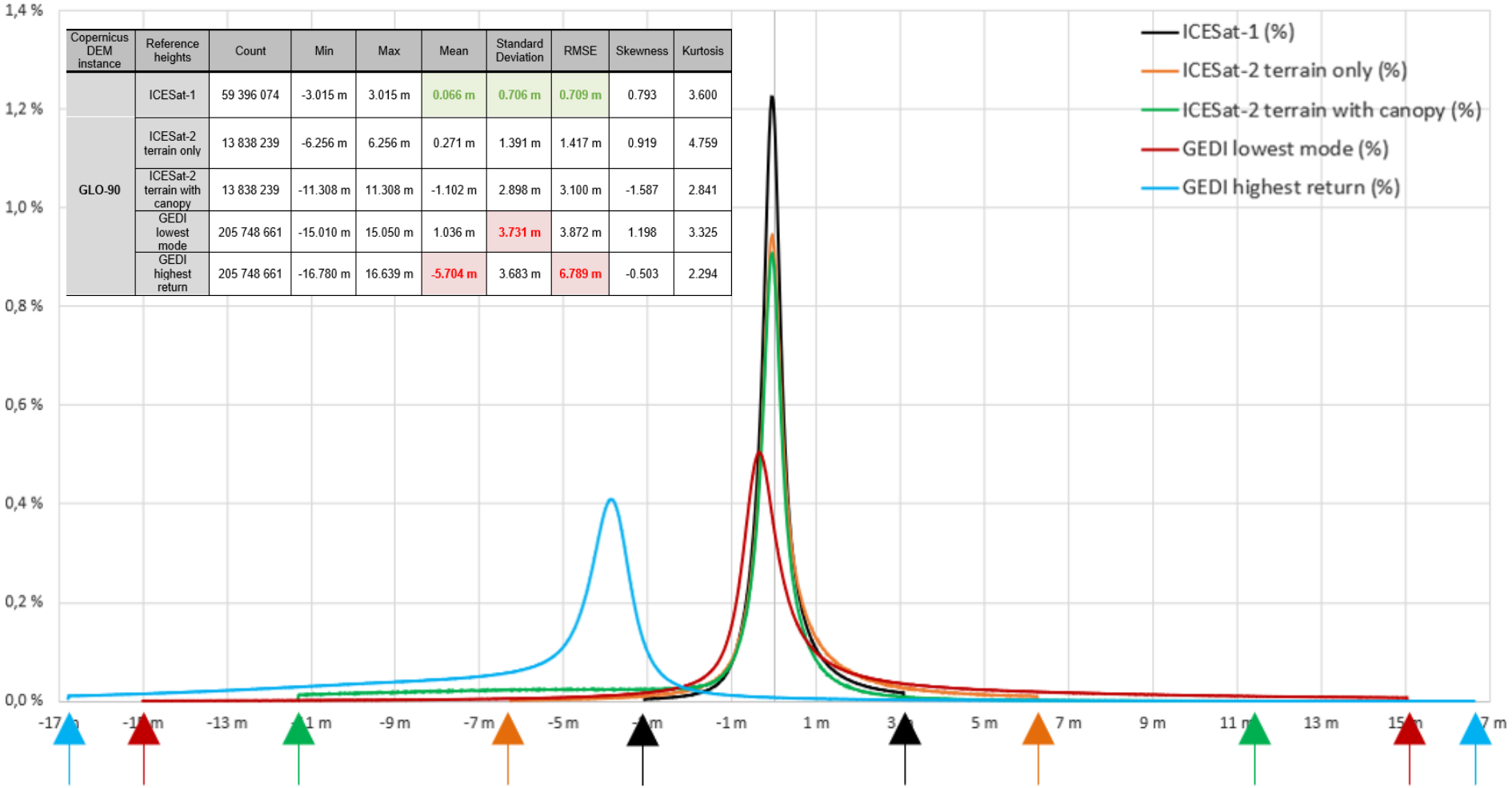
Copernicus DEM instance	Reference heights	Count	Min	Max	Mean	Standard Deviation	RMSE	Skewness	Kurtosis
GLO-30	ICESat-1	59 319 279	-2.725 m	2.725 m	0.033 m	0.627 m	0.628 m	0.943	3.594
	ICESat-2 terrain only	13 816 724	-5.012 m	5.012 m	0.195 m	0.979 m	0.999 m	1.667	6.085
	ICESat-2 terrain with canopy	13 816 724	-11.008 m	11.008 m	-1.124 m	2.680 m	2.907 m	-1.953	3.318
	GEDI lowest mode	205 139 948	-14.200 m	14.240 m	1.001 m	3.281 m	3.431 m	1.759	3.937
	GEDI highest return	205 139 948	-15.320 m	15.180 m	-5.786 m	3.180 m	6.603 m	-0.663	2.147



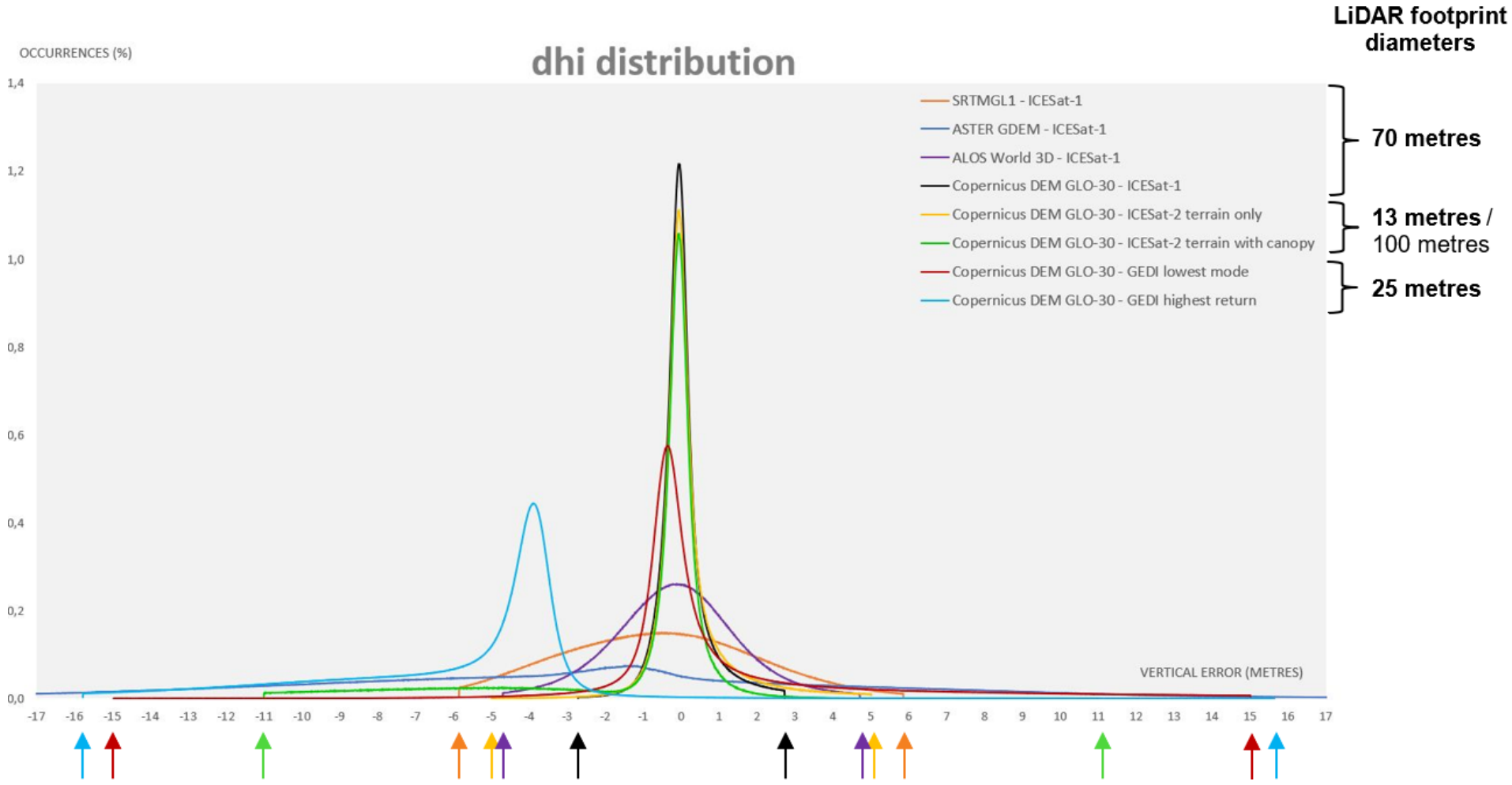
Study 2 - Height errors depending on LiDAR mission / mode

GLO-90

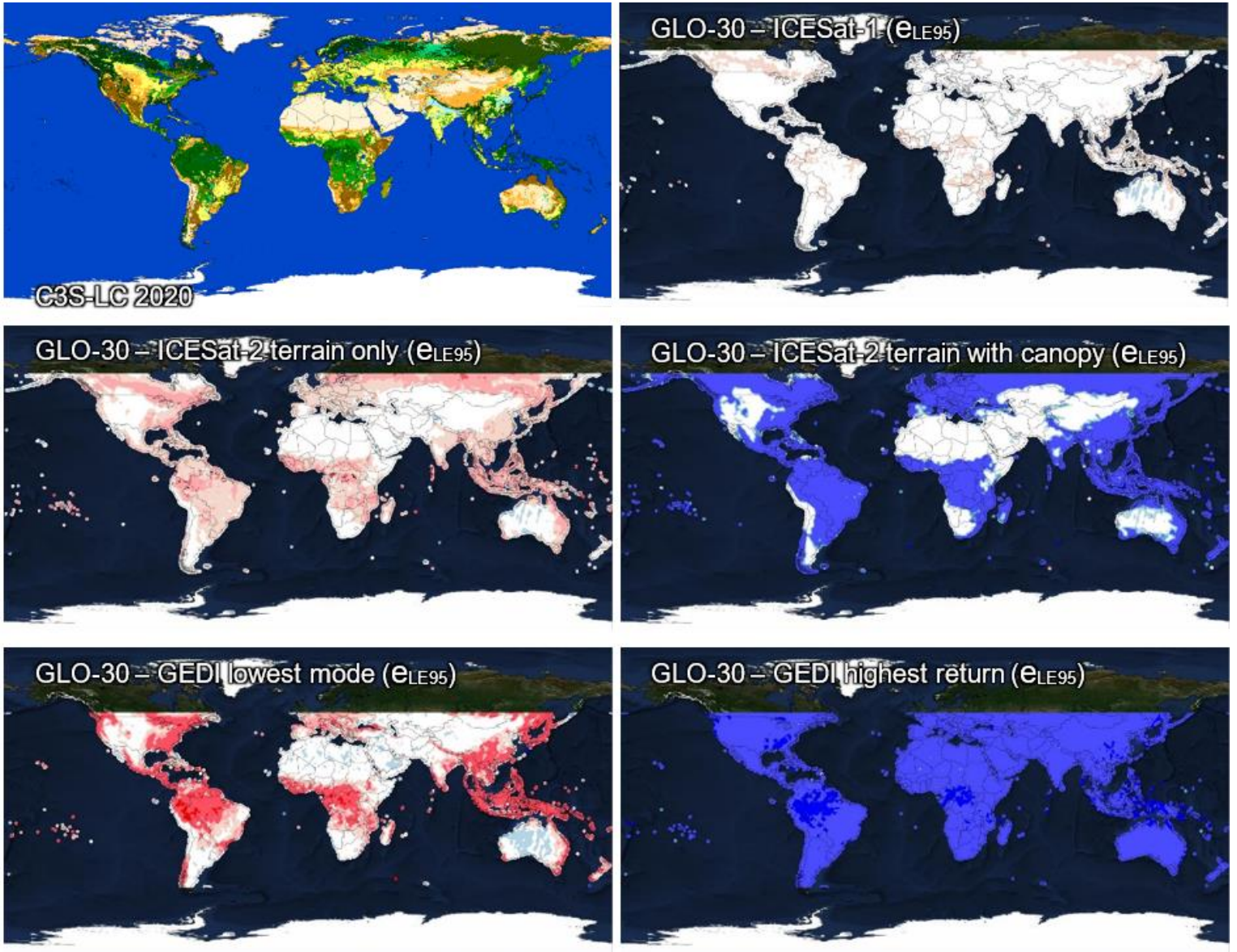
Copernicus DEM instance	Reference heights	Count	Min	Max	Mean	Standard Deviation	RMSE	Skewness	Kurtosis
GLO-90	ICESat-1	59 396 074	-3.015 m	3.015 m	0.066 m	0.706 m	0.709 m	0.793	3.600
	ICESat-2 terrain only	13 838 239	-6.256 m	6.256 m	0.271 m	1.391 m	1.417 m	0.919	4.759
	ICESat-2 terrain with canopy	13 838 239	-11.308 m	11.308 m	-1.102 m	2.898 m	3.100 m	-1.587	2.841
	GEDI lowest mode	205 748 661	-15.010 m	15.050 m	1.036 m	3.731 m	3.872 m	1.198	3.325
	GEDI highest return	205 748 661	-16.780 m	16.639 m	-5.704 m	3.683 m	6.789 m	-0.503	2.294



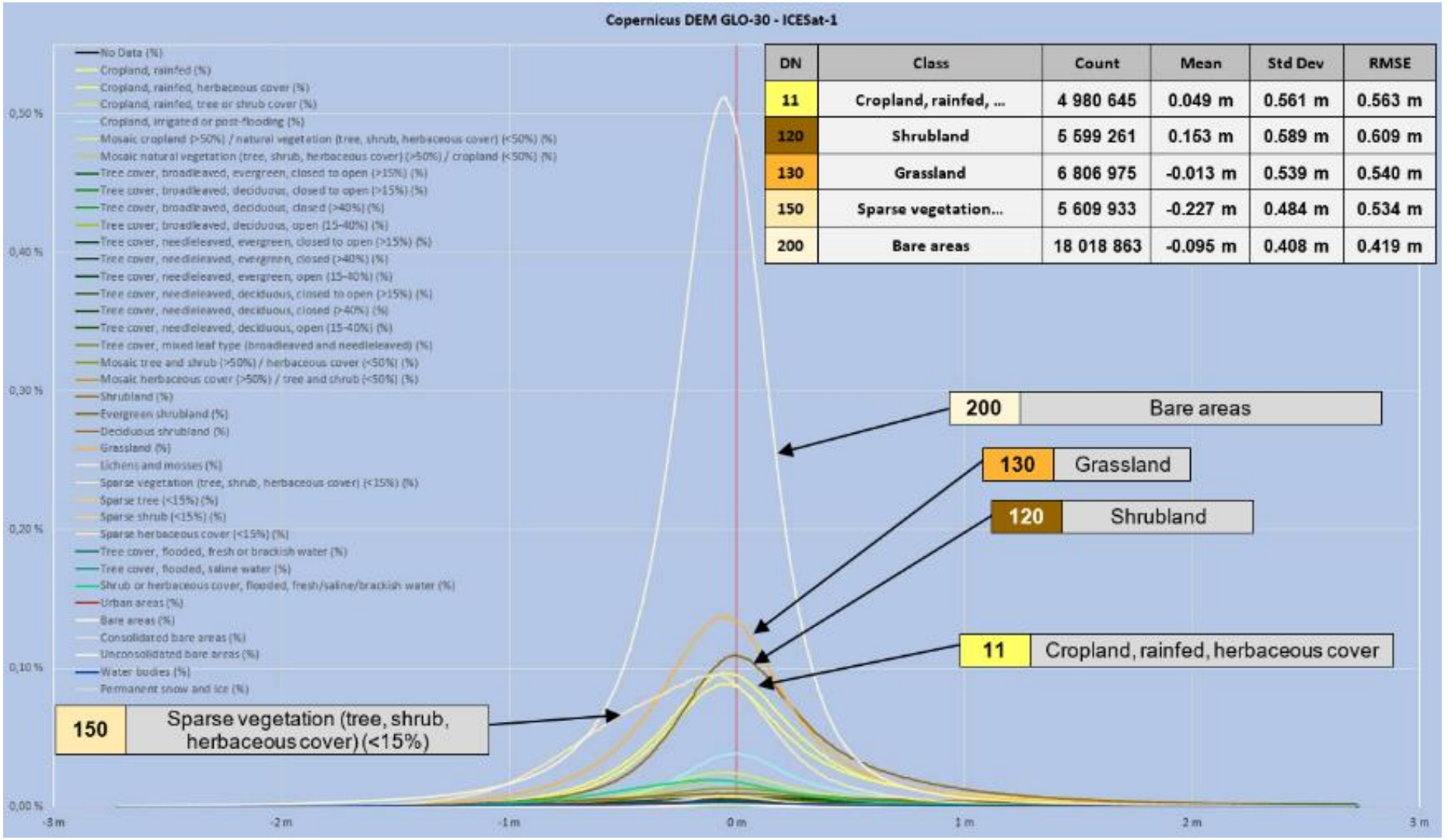
Study 2 - Comparison of COP-DEM GLO-30 with the other DEMs



Study 2 - Spatial distribution of COP-DEM GLO-30 errors (LE95)

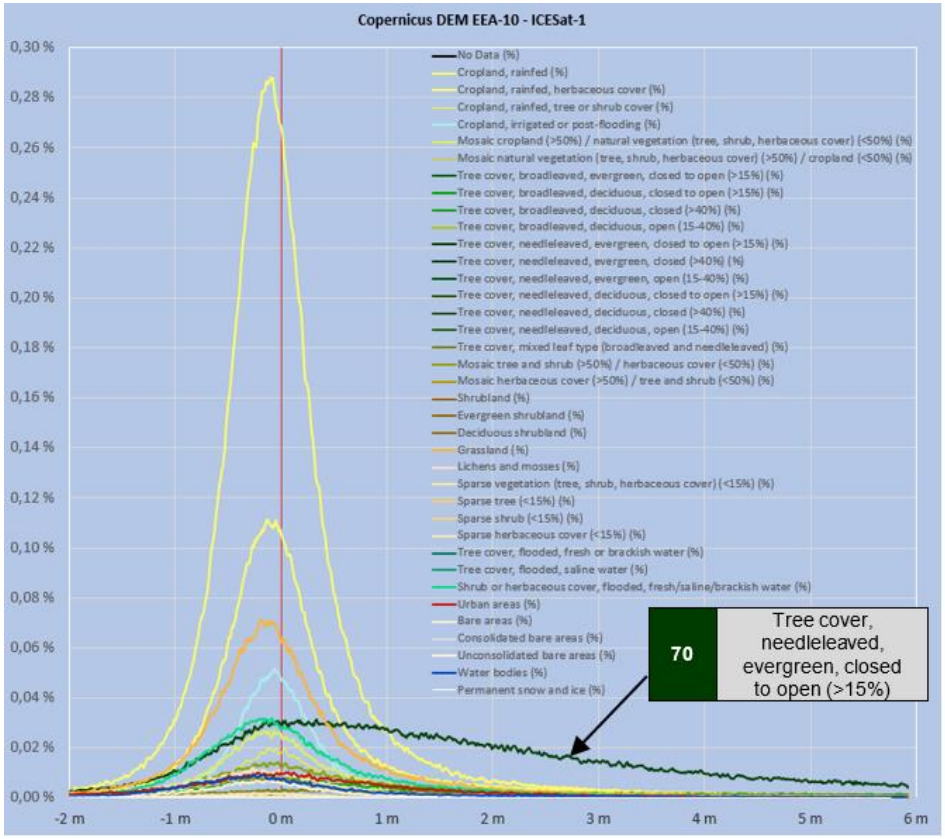


Study 2 - Influence of LULC (C3S-LC) on height errors



DN	Class	Count	Mean	Std Dev	RMSE
11	Cropland, rainfed, ...	4 980 645	0.049 m	0.561 m	0.563 m
120	Shrubland	5 599 261	0.153 m	0.589 m	0.609 m
130	Grassland	6 806 975	-0.013 m	0.539 m	0.540 m
150	Sparse vegetation...	5 609 933	-0.227 m	0.484 m	0.534 m
200	Bare areas	18 018 863	-0.095 m	0.408 m	0.419 m

Study 2 - COP-DEM is above the terrain



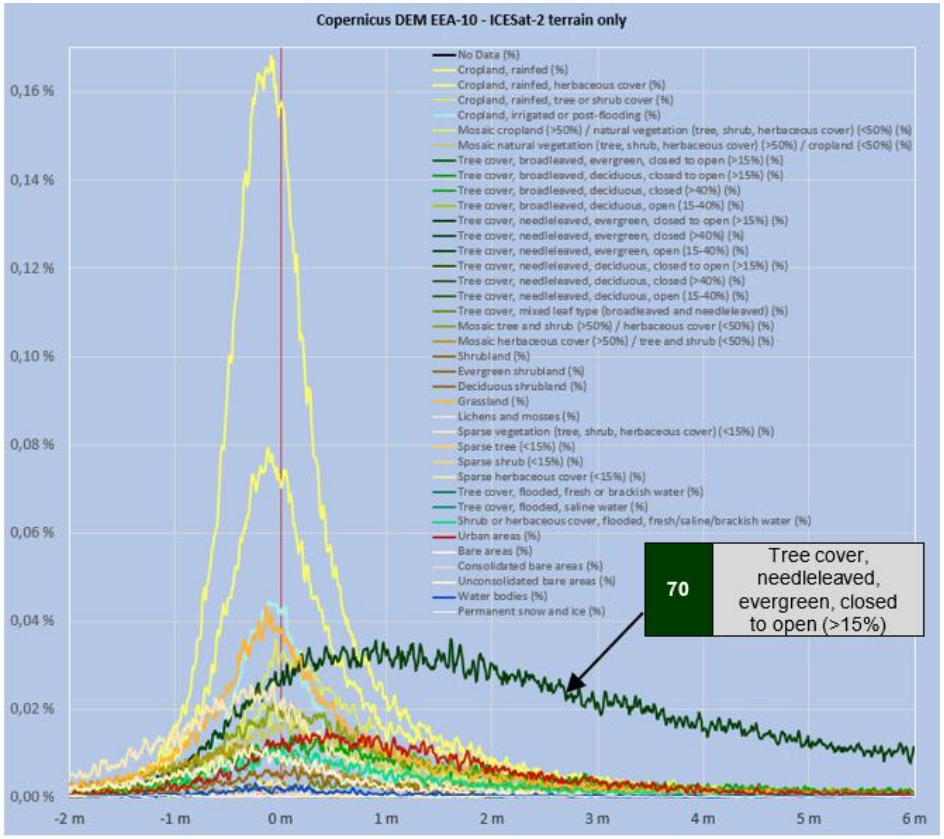
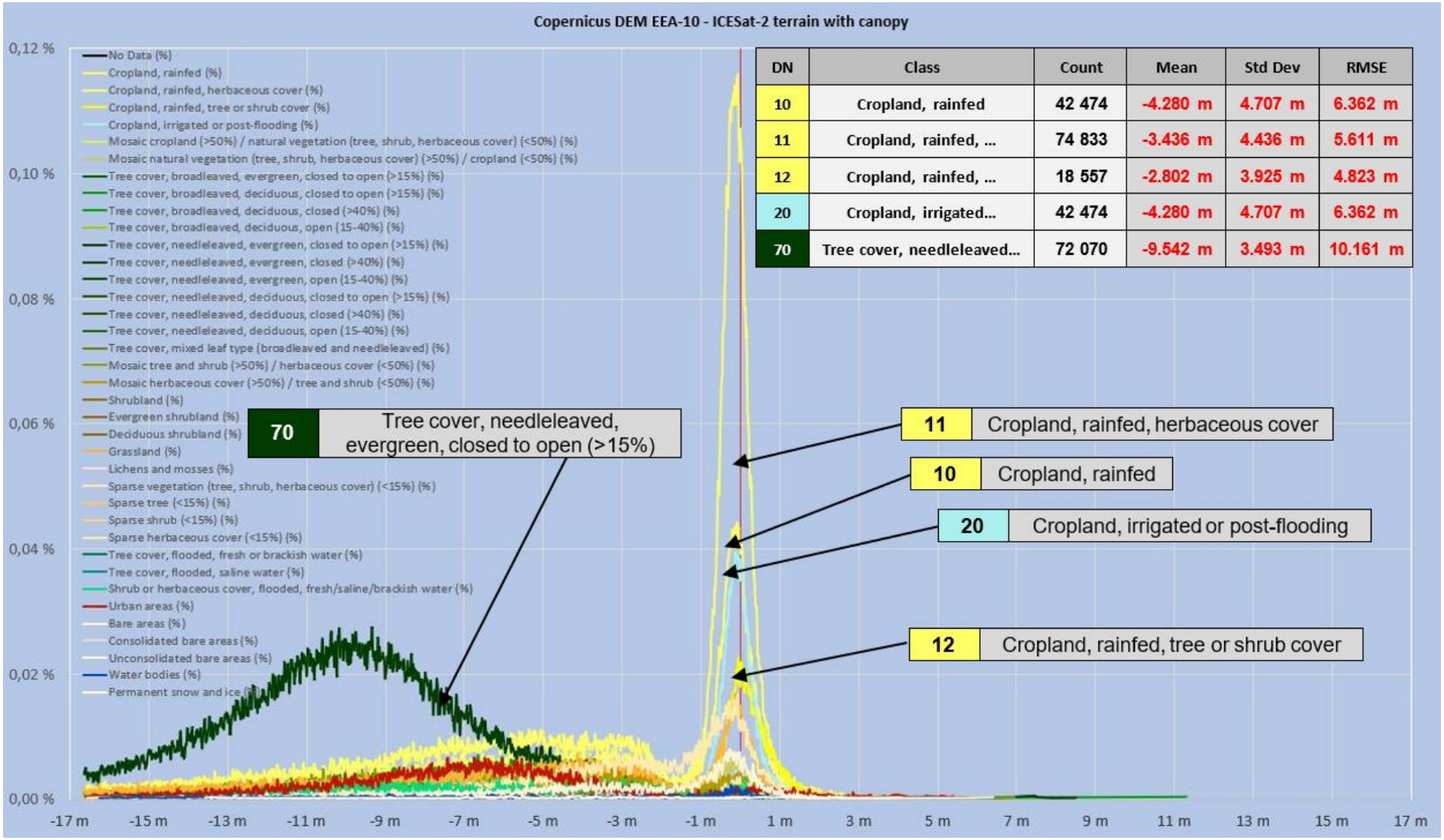


Figure 152– **Comparison of errors histograms (Copernicus DEM EEA-10 – ICESat-1 LE95) on the left and (Copernicus DEM EEA-10 – ICESat-2 terrain only LE95) on the right - classified with C3S-LC 2013.**

Study 2 - But COP-DEM is also below the surface !



DN	Class	Count	Mean	Std Dev	RMSE
10	Cropland, rainfed	42 474	-4.280 m	4.707 m	6.362 m
11	Cropland, rainfed, ...	74 833	-3.436 m	4.436 m	5.611 m
12	Cropland, rainfed, ...	18 557	-2.802 m	3.925 m	4.823 m
20	Cropland, irrigated...	42 474	-4.280 m	4.707 m	6.362 m
70	Tree cover, needleleaved...	72 070	-9.542 m	3.493 m	10.161 m

Figure 153 – **Error histograms of (Copernicus DEM EEA-10 – ICESat-2 terrain with canopy LE95) classified with C3S-LC 2013.**

Merci de votre attention

Thank you for your attention

Questions ?

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www.visioterra.fr