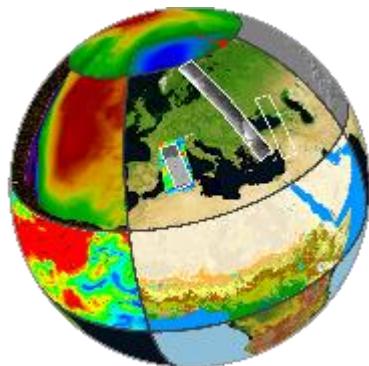




DEMIX SG3 – “Platforms and processing”

Presentation of studies



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- Presentation of VisioTerra
- VtWeb and “Data Processing Relay” (DPR)
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- SRTM, ASTER GDEM, ALOS World 3D
- ICESat-1 / GLAS LiDAR
- Product Quality Evaluation Matrix
- Effects of DEM differences on orthorectification

➤ Study 2 - Quality Assessment for Copernicus DEM

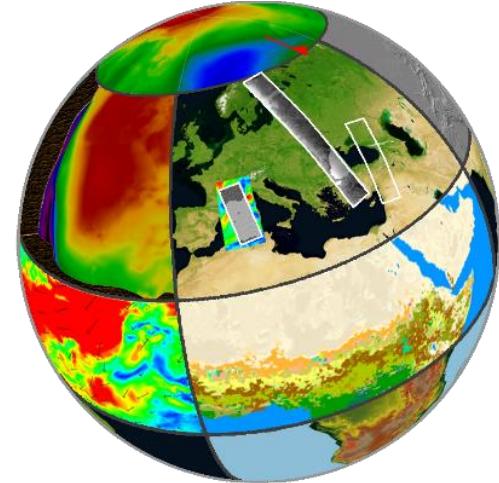
- Copernicus DEMs EEA-10, GLO-30, GLO-90
- 3 LiDAR: ICESat-1 / GLAS, ICESat-2 / ATLAS, GEDI (and 5 returns)
- Analysis of height errors according to LiDAR modes
- Comparison of COP-DEM with SRTM, ASTER GDEM and ALOS Word 3D (study 1)
- Spatial distribution of COP-DEM
- Influence of LULC (C3S-LC) on height errors
- COP-DEM is between the terrain (DTM) and the surface (DSM)

➤ Study 3 - Planimetric Misregistration Assessment

- See [Technical Note on Planimetric Misregistration Assessment](#)

➤ Study 4 - Sentinel-1 ARD from VHR DEM

- See [Technical Note on Sentinel-1 ARD from VHR DEM](#)





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>

The screenshot shows the VisioTerra website homepage. At the top, there's a navigation bar with links for HOME, MISSIONS, SOLUTIONS, REFERENCES, NEWS, VISIOTERRA, and CONTACTS. Below the navigation is a banner with the text "VtWeb The World at your fingertips" over a satellite map. The main content area is divided into several sections: "Missions" (with a map of rivers), "Solutions" (with a satellite image of land), "At th" (partially visible), "Access" (with a small image of a flag), "News" (with a satellite image of a forest fire), and "References" (with a 3D terrain model). A sidebar on the left shows an aerial view of a building complex. At the bottom, there are three featured projects: "Climate change VisioTerra" (with a map of 2085 projections), "10 years of oil in the Gulf of Guinea VisioTerra" (with a map and graphs), and "Estimation of the quality of Copernicus DEMs ESA" (with a map and graphs).

VisioTerra Scientific Consulting for Earth Observation

HOME MISSIONS SOLUTIONS REFERENCES NEWS VISIOTERRA CONTACTS

VtWeb The World at your fingertips

Missions

Solutions

At th

Access

VisioTerra developing their geos

News

References

All Geoservices Software Development Education Communication Studies

Cartographic Production

Heat and di cause multi wildfires in 19/07/2022

Climate change VisioTerra

10 years of oil in the Gulf of Guinea VisioTerra

Estimation of the quality of Copernicus DEMs ESA

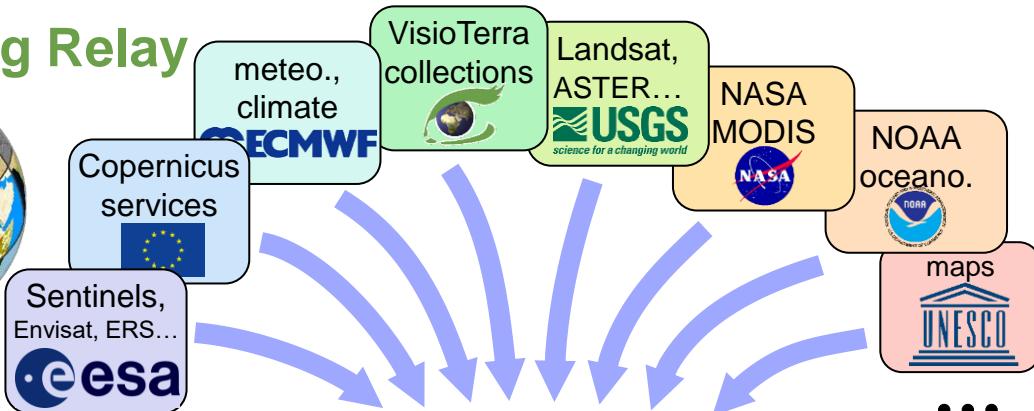
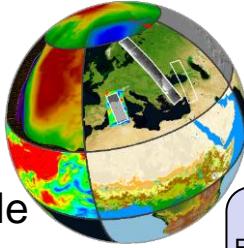
14 rue Albert Einstein
Cité Descartes
Champs-sur-Marne
France



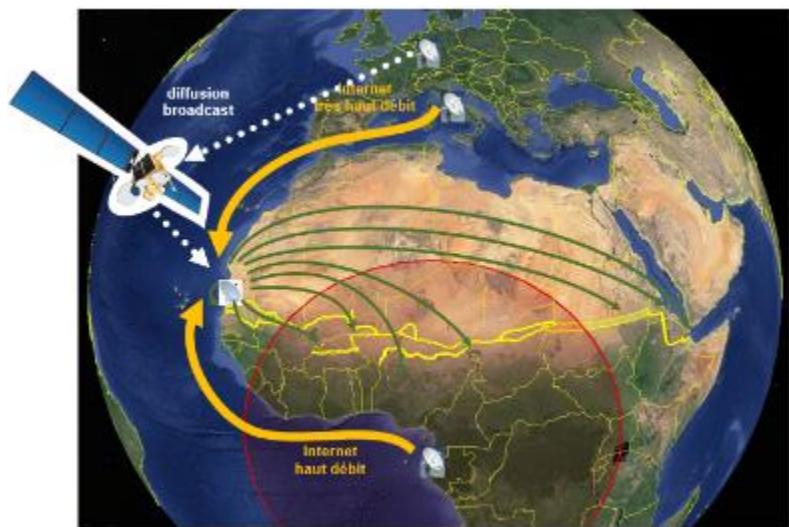
VtWeb – Data Processing Relay

➤ VtWeb infrastructure

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



➤ DPR as a solution for Africa



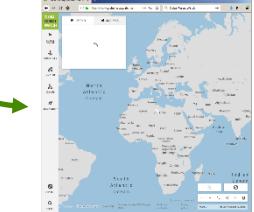
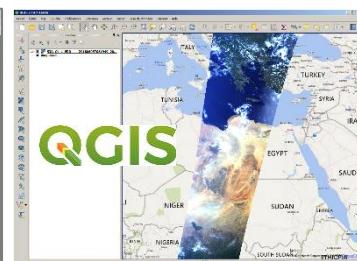
VtWeb client



Google Earth



G.I.S.





VtWeb - Client-server application

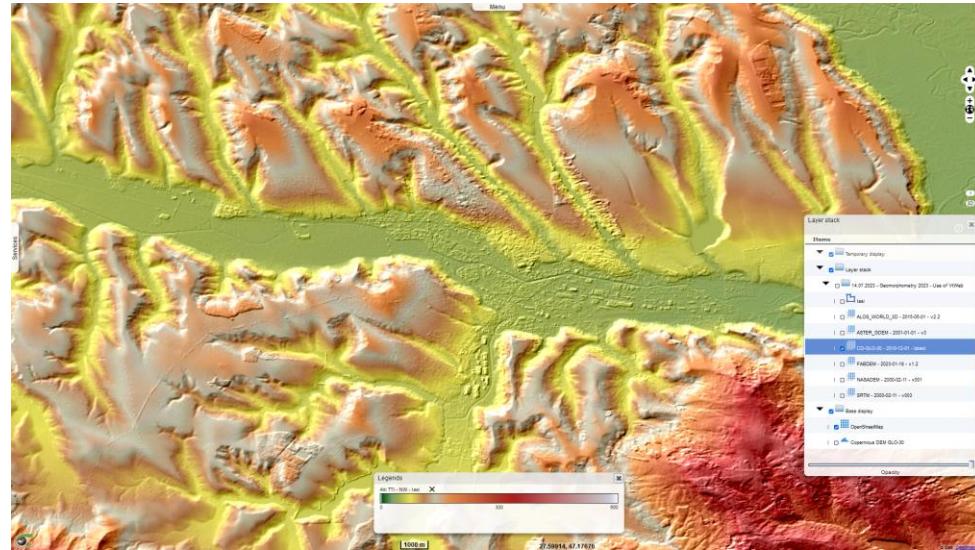
➤ Main features

- Open access without registration
- Many datasets in input
(image, LiDAR, altimeter, vector fields...)
- Processing on-the-fly
- POF-ML macro-language
- Sharing with hyperlooks → [lasi 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>

Activities / EDAP

EDAP

Activity

Overview

The Earthnet Data Assessment Project (EDAP+) continues the work of its predecessor (EDAP 2018 – 2021) and is responsible for assessing the quality and suitability of candidate missions being considered for ESA's Earthnet Programme as Third Party Missions (TPMs).

For over 40 years ESA's Earthnet Programme has played a significant role as part of ESA's mandatory activities, providing the framework for integrating non-ESA missions, i.e. TPMs, into the overall ESA Earth Observation (EO) strategy. Complementary to ESA-owned EO missions, the programme allows European users access to a large portfolio of TPM and is particularly important for promoting the international use of EO data.

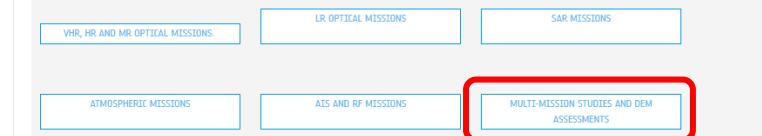
In line with the Earthnet Programme objectives, ESA aims to foster cooperation and collaboration with not only other national space agencies, but also commercial mission providers. In recent years the availability of low-cost small satellites and the innovation of constellations have resulted in an increasing number of commercial companies who have established business models to provide information services fed by their own satellite systems.

These new space players are now playing an important role in the EO International strategy. Some of these new missions are potential candidates for Earthnet TPMs and ESA established the EDAP project, which in addition to assessing quality and suitability of the missions, also establishes dialogues with the various mission providers in order to improve the overall coherence of the EO system.

This early data assessment is intended to provide some indication of the potential of each existing mission to remain as a TPM and for new and future missions to become TPMs within ESA's Earthnet programme. Furthermore, EDAP+ also places an emphasis on multi-mission studies that may span several instrument domains; such studies contribute to interoperability across existing and future missions and help foster synergies between these missions.

Related Mission

The key objective of ESA's EDAP+ is to take full advantage of the increased range of available data from non-ESA operated missions and to perform an early data assessment for various missions, that fall into one of the following instrument domains:



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”

Group 3: platforms and processing

Participants(11)*: C. Albinet, G. Amatulli, B. Bookhagen, C. Bielski, D. Gesch, F. Gascon, M. Hofton, M. Huber, J-P. Muller, J. Reinoso

CoLead: Z. Li, S. Riazanoff

Main tasks:

- lay out a viable workshare as a mix of products and geographical zones (DD: 2020/09/15)
- check compatibility of existing tools with methods set out by group 2 (DD: 2020/09/15)
- make available the applicable (f&o) DEM and validation data (DD: 2020/09/15)
- support the implementation of compatible tools where not already available (DD: 2020/10/15)
- perform test rounds with pilot areas and compare results (DD: 2020/11/15)
- run benchmarking (DGEG Level1) (DD: 2020/12/15)

*for colour codes of names see slide 4

TMSG-DEMIX progress, July 17, 2020

11



Study 1 - Quality Assessment for Global DEM

➤ Global DEMs



➤ 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

Key	
	Not Assessed
	Not Assessable
	Basic
	Intermediate
	Good
	Excellent

Information Not Public

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			

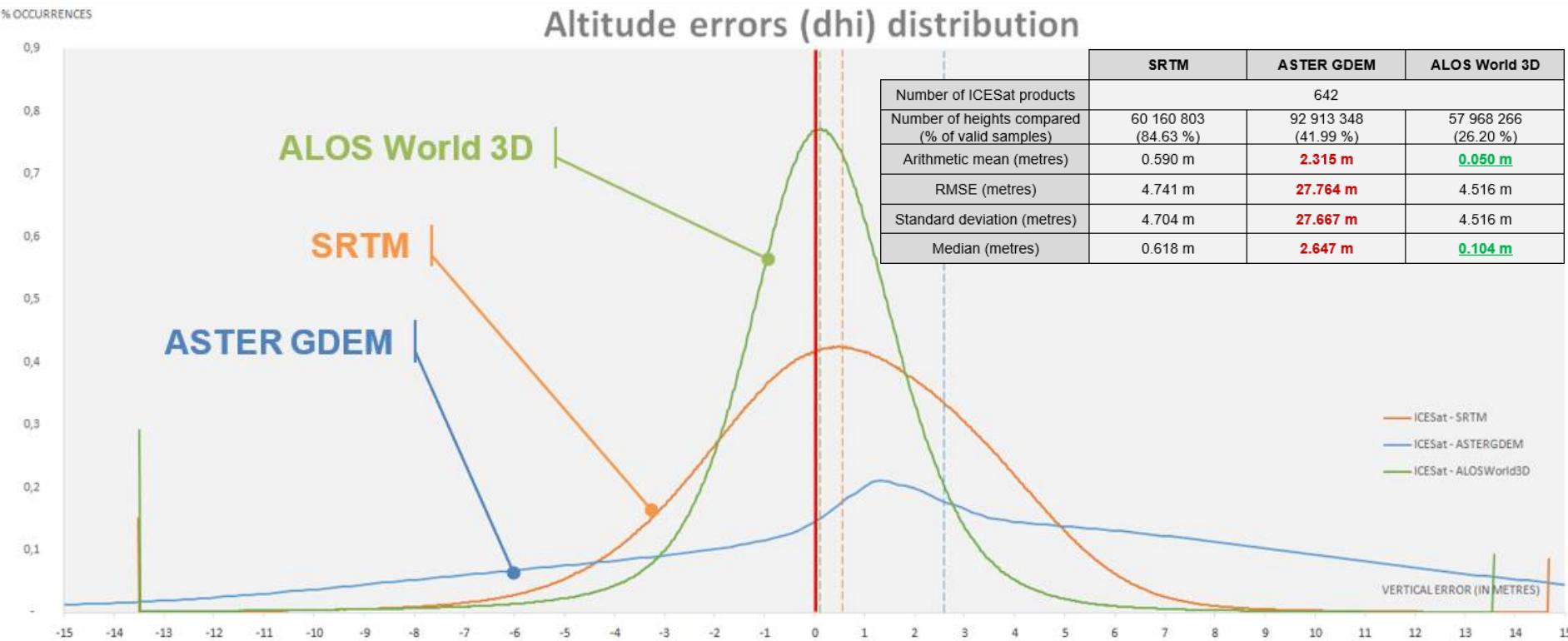
ALOS World 3D



Study 1 - Computation of height differences

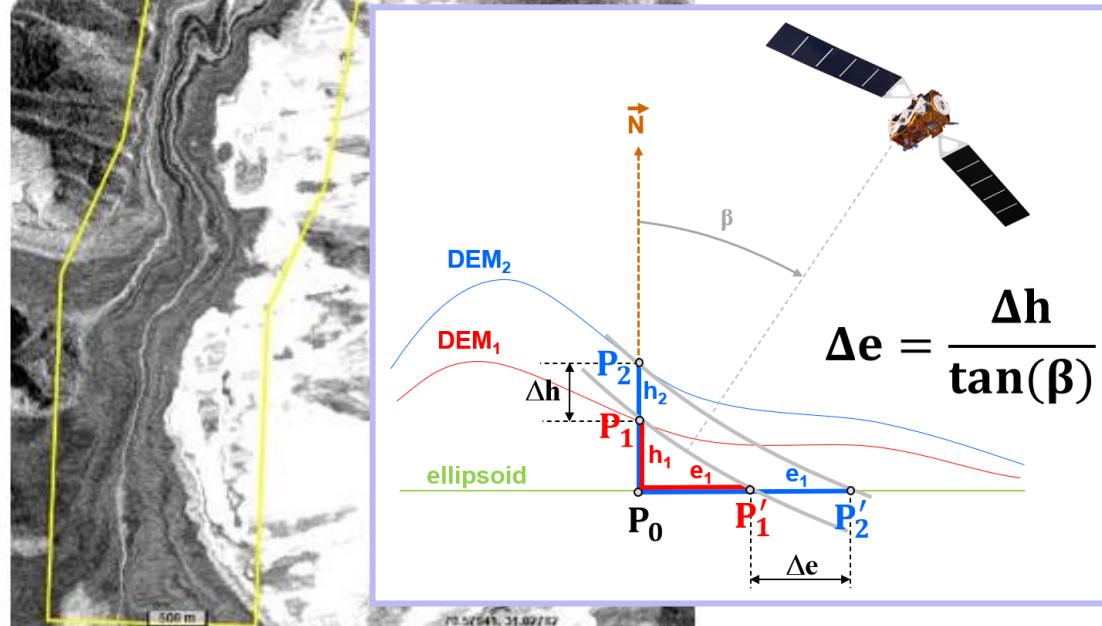
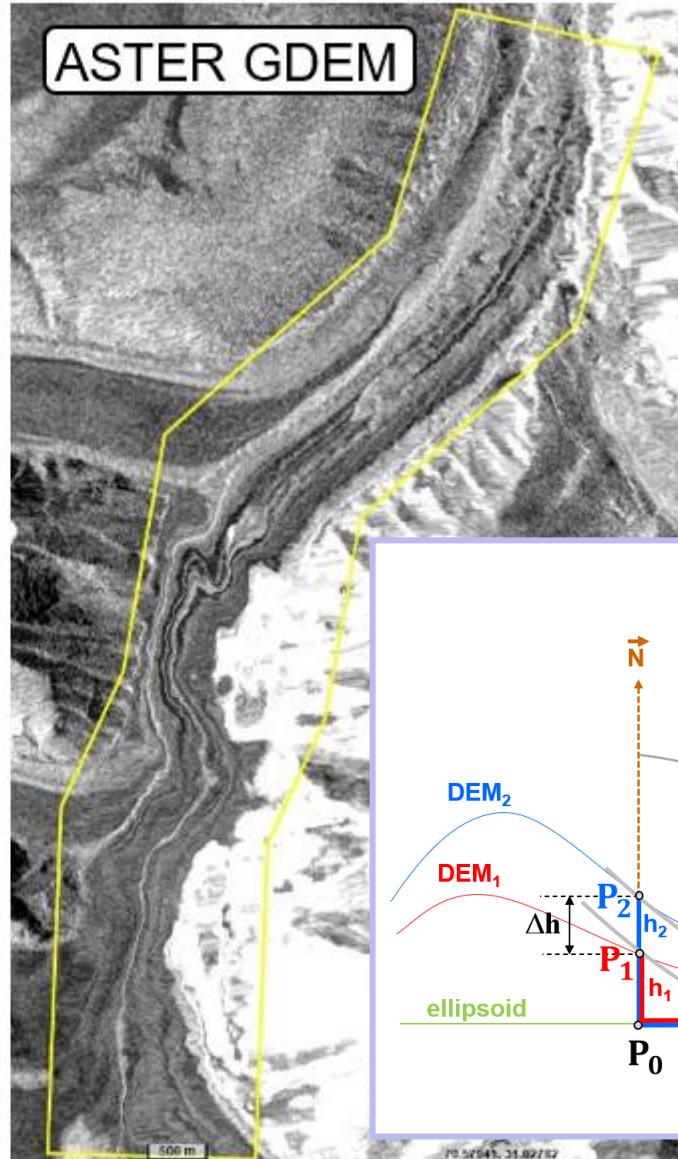


- Computation of differences (DEM height - ICESat-1 height)
 - ICESat-1 / GLAS / GLAH14 product - Filtering using quality flags (elev_use_flg, sat_corr_flg, elv_cloud_flg) - Conversion from TOPEX / Poseidon to WGS84 - Verification of collocation in flat areas
 - Candidate DEMs - Change of VRS (Vertical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





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

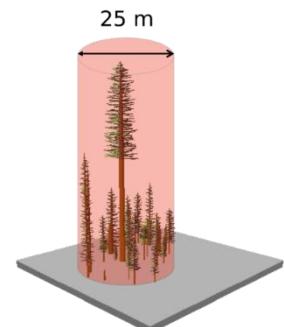
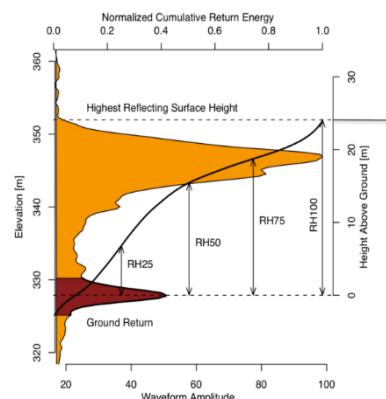
Return / mode

ATL08

terrain only
terrain with
canopy

GEDI02_A

lowest mode
highest return





Study 2 - Height errors depending on LiDAR mission / mode EEA-10

Copernicus DEM EEA-10 - Comparison with ICESat-1, ICESat-2 and GEDI (LE95)

1,4 %

1,2 %

1,0 %

0,8 %

0,6 %

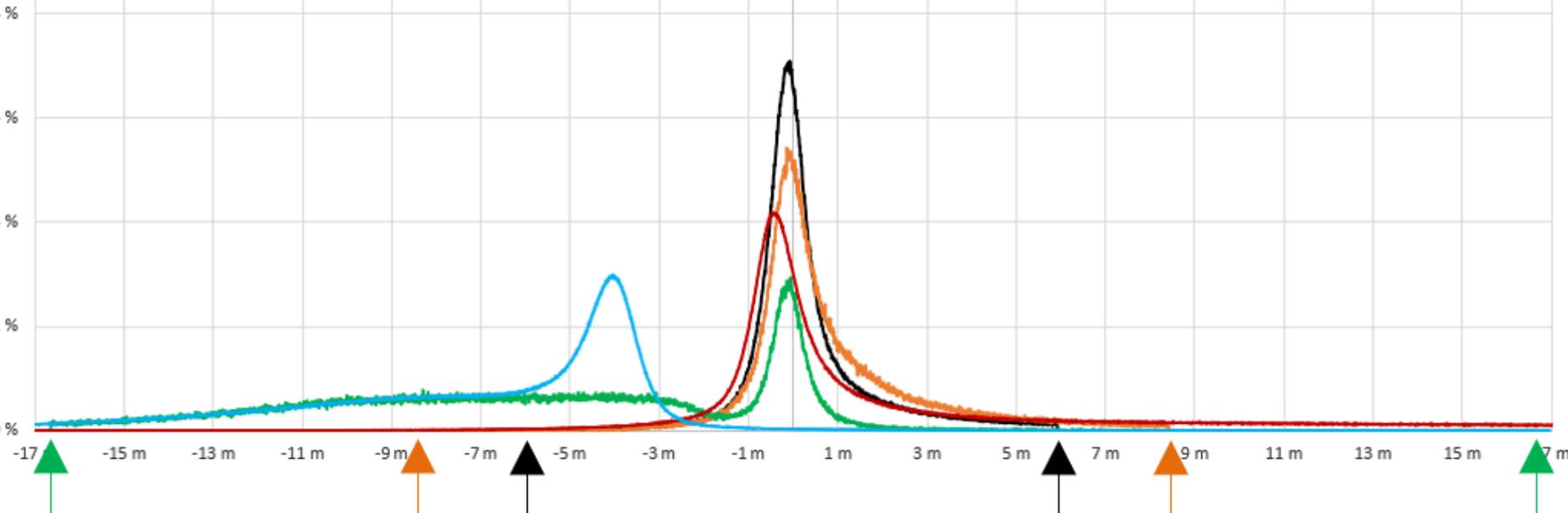
0,4 %

0,2 %

0,0 %

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

- ICESat-1 (%)
- ICESat-2 terrain only (%)
- ICESat-2 terrain with canopy (%)
- GEDI lowest mode (%)
- GEDI highest return (%)





Study 2 - Height errors depending on LiDAR mission / mode GLO-30

Copernicus DEM GLO-30 - Comparison with ICESat-1, ICESat-2 and GEDI (LE95)

1,4 %

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

— ICESat-1 (%)
— ICESat-2 terrain only (%)
— ICESat-2 terrain with canopy (%)
— GEDI lowest mode (%)
— GEDI highest return (%)

1,2 %

1,0 %

0,8 %

0,6 %

0,4 %

0,2 %

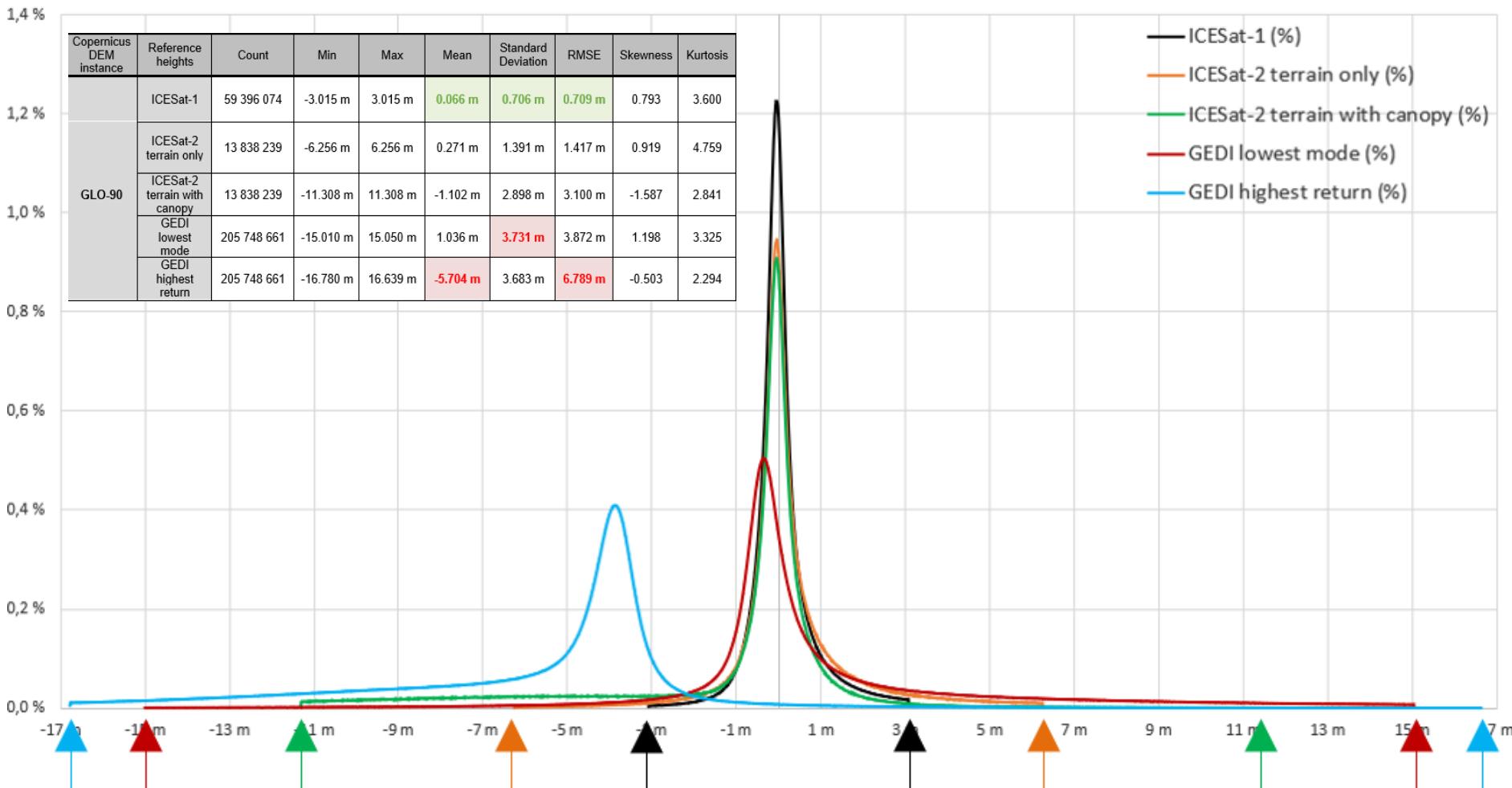
0,0 %





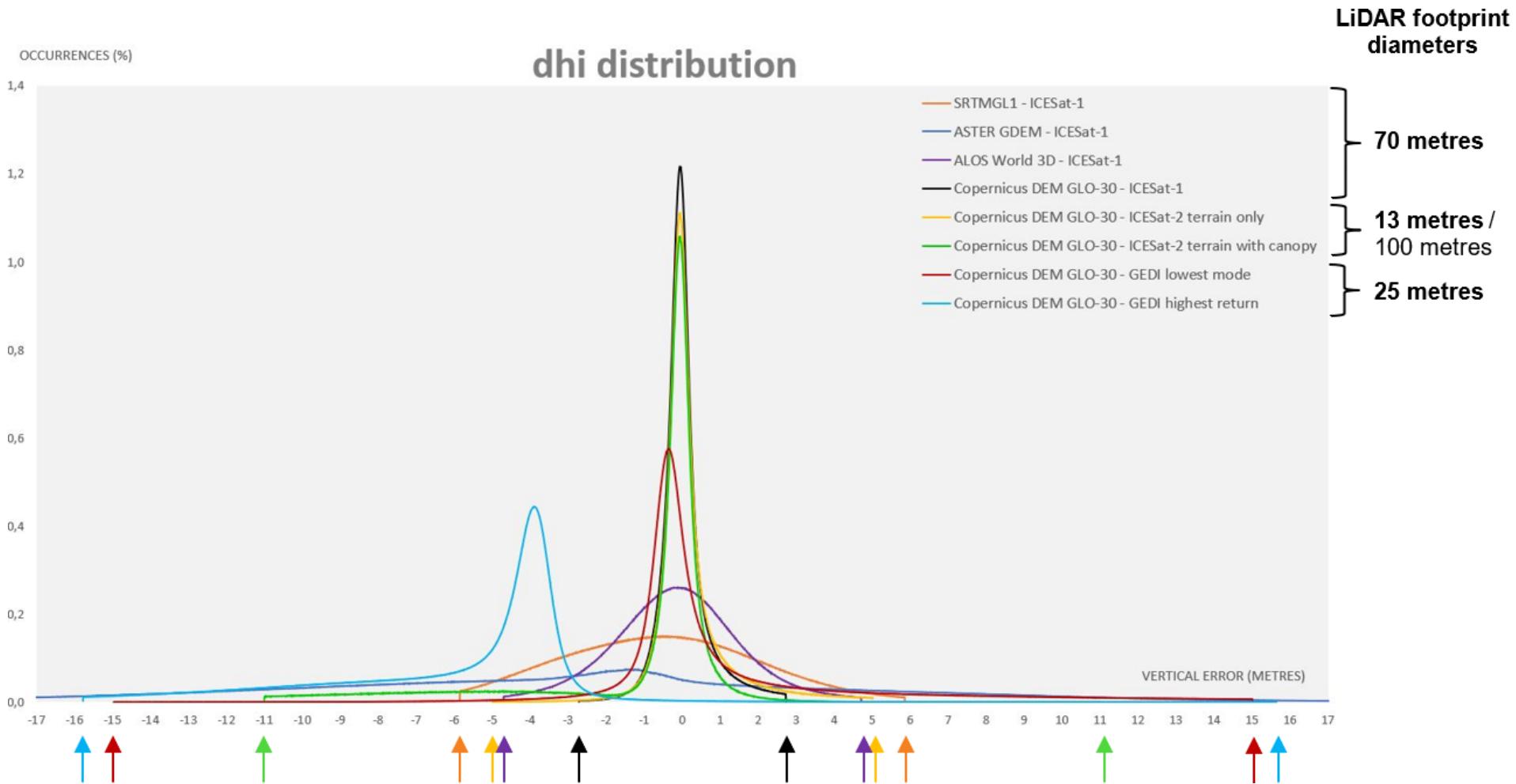
Study 2 - Height errors depending on LiDAR mission / mode GLO-90

Copernicus DEM GLO-90 - Comparison with ICESat-1, ICESat-2 and GEDI (LE95)



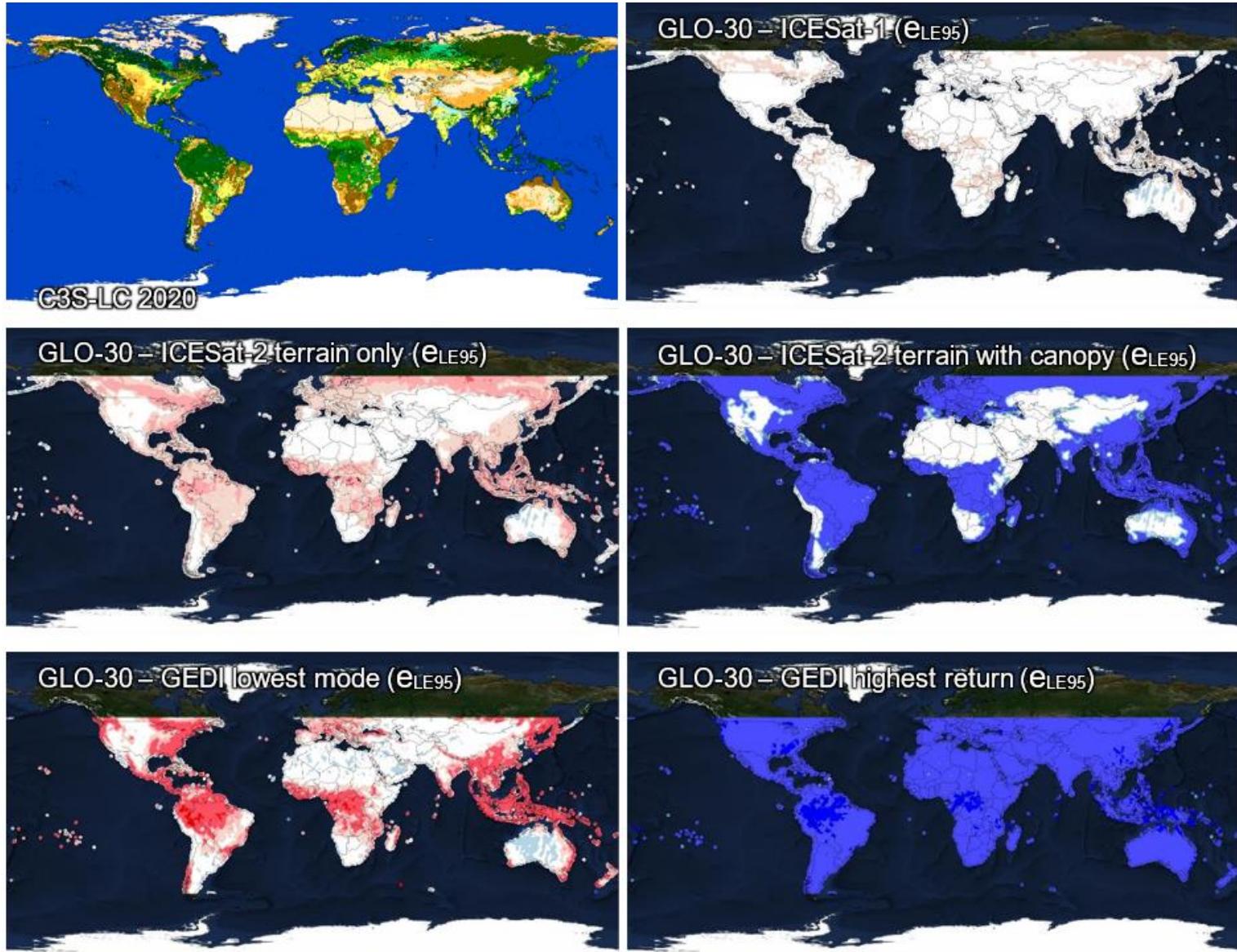
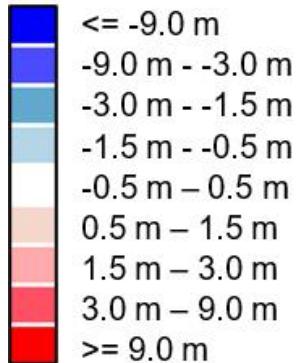


Study 2 - Comparison of COP-DEM GLO-30 with the other DEMs



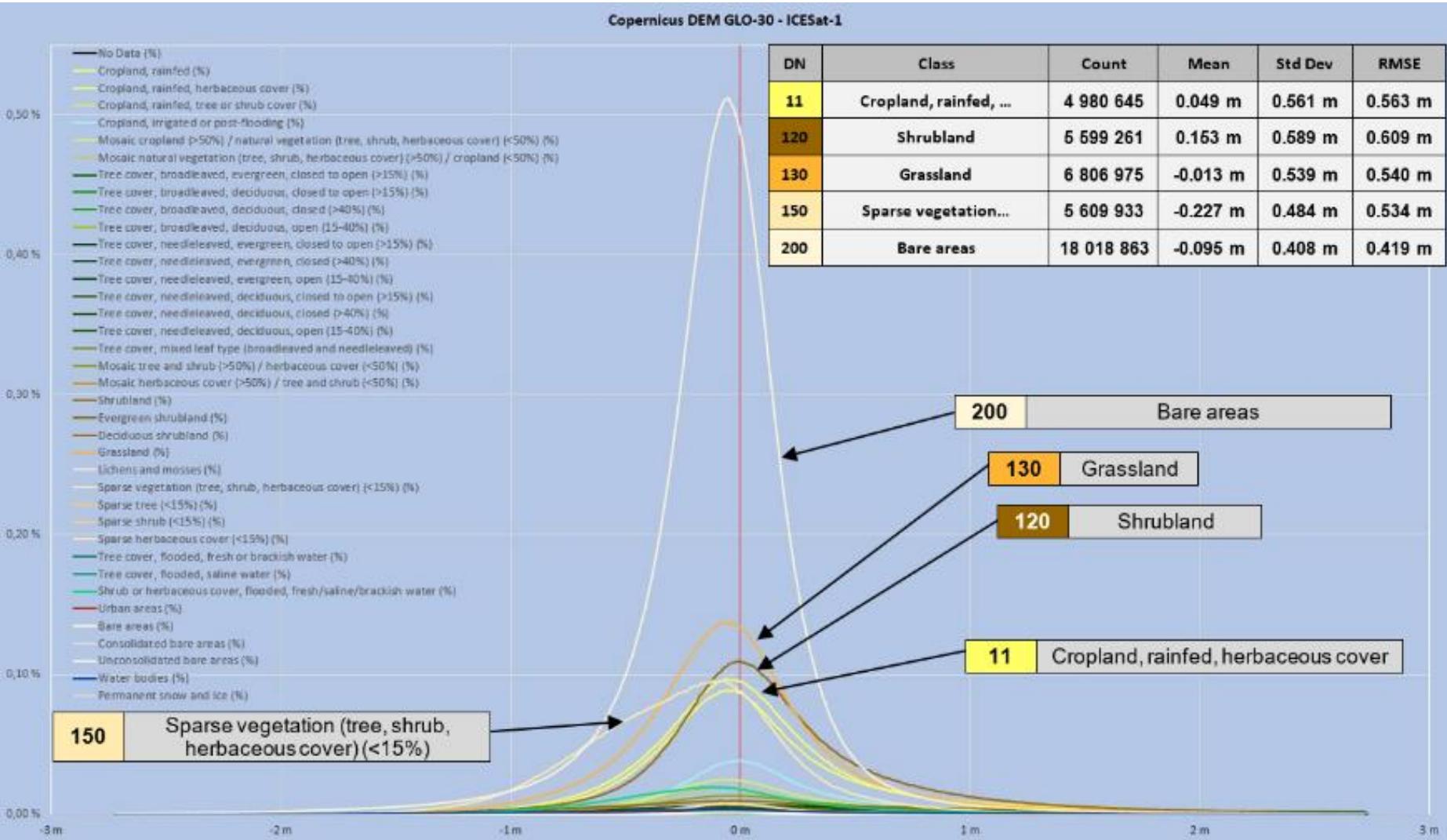


Study 2 - Spatial distribution of COP-DEM GLO-30 errors (LE95)





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





Study 2 - COP-DEM is above the terrain

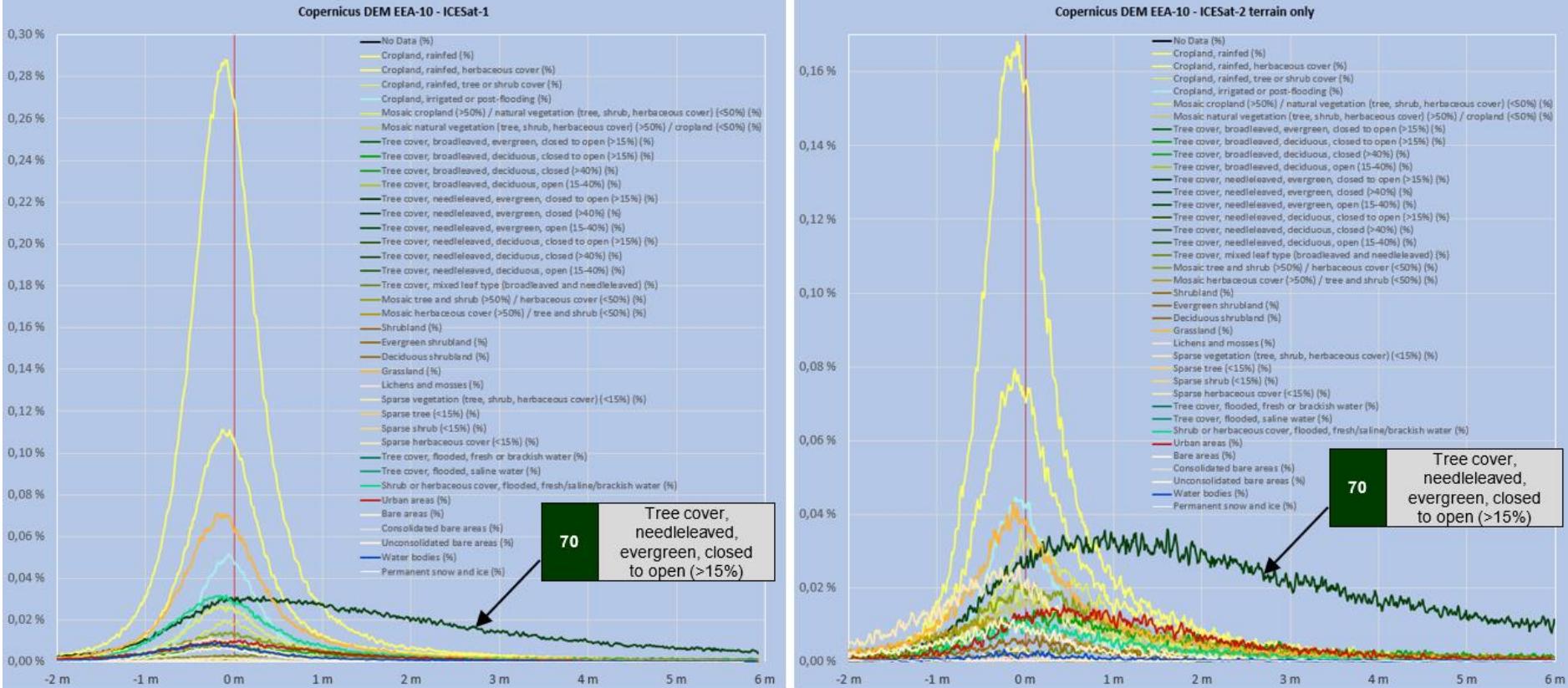


Figure 152– Comparison of errors histograms (Copernicus DEM EEA-10 – ICESat-1 LE95) on the left and (Copernicus DEM EEA-10 – ICESat-2 terrain only LE95) on the right - classified with C3S-LC 2013.



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

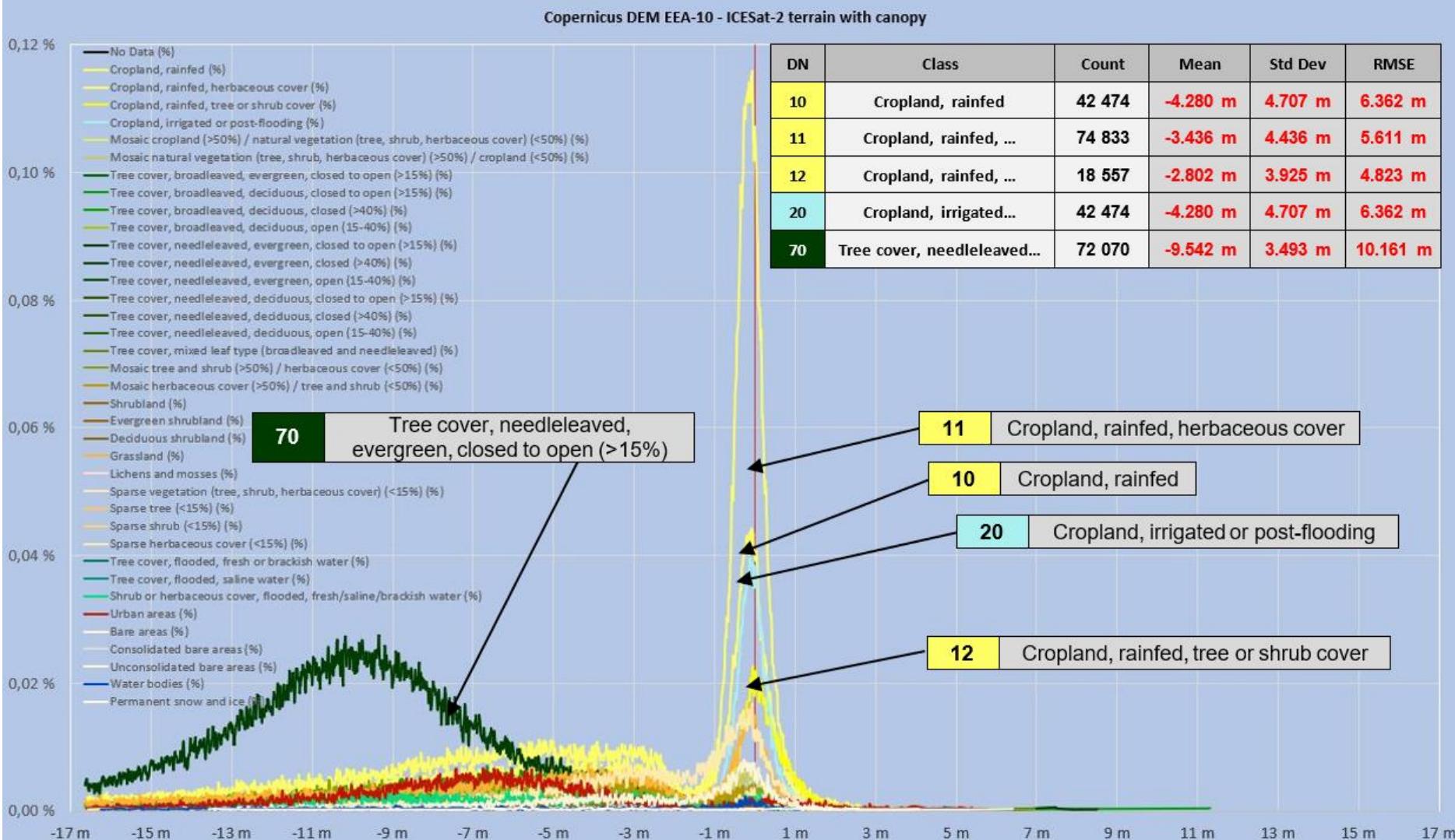


Figure 153 – Error histograms of (Copernicus DEM EEA-10 – ICESat-2 terrain with canopy LE95) classified with C3S-LC 2013.



Merci de votre attention
Thank you for your attention

Questions ?



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www.visioterra.fr

serge.riazanoff@visioterra.fr