Preliminary assessment of SWOT L2 Lake products over small water bodies in the Alsace and Lorraine regions (France)

Amzil S., Azzoni M., Maxant J., Ledauphin T., Batisse J., Pottier C. and Yésou H.
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s.amzil@unistra.fr, azzoni@unistra.fr, tledauphin@unistra.fr, maxant@unistra.fr, claire.pottier@cnes.fr, herve.yesou@unistra.fr

Context & objectives: CalVal over small lakes

- Daily revisit during the CalVal orbit
- Assess SWOT L2 HR LakeSP products over a set of 20 small lakes:
  - Small to very small lakes : sizes ranging from 7 to 0.03 km²
  - Varied topographic settings: steep-sided reservoirs, lowland lakes near the Rhine River, step-sided lakes surrounded by forest…
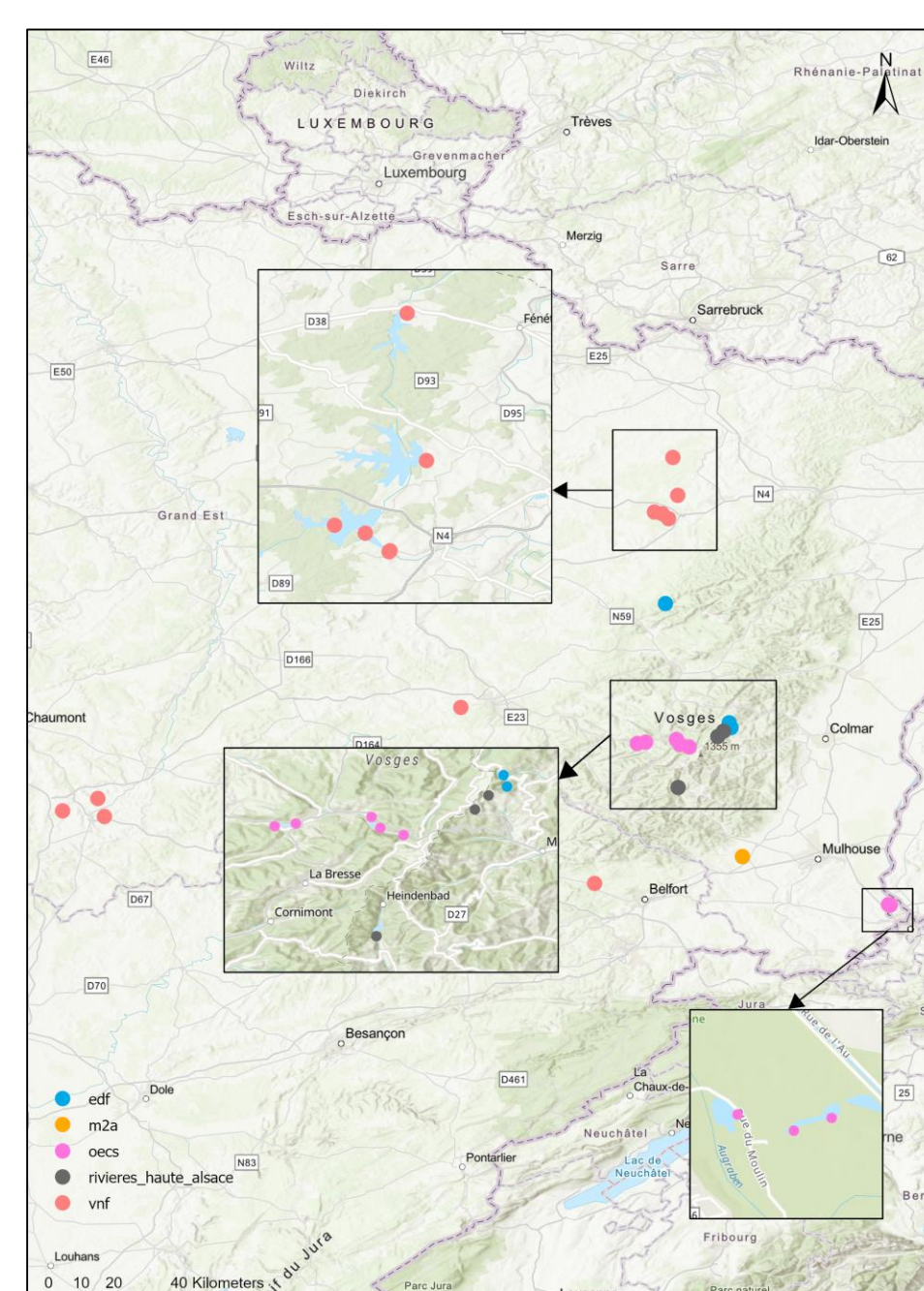

Fig.1: Lakes' locations

Method:

- Evaluation of the accuracy of the 2024 LakeSP PIC0 product.
- Evaluation of the accuracy of the PIXC classes (water only, land and water, dark water, etc.).
- Exploitation of Bright Land and Dark Water flags.
- Comparison of the in situ water elevations and the ones provided by the L2 SWOT HR LakeSP Prior products.
- Comparison of water area provided by the SWOT product and the ones derived either from quasi-synchronous VHR Pleiades and HR Sentinel-2 data

In situ and reference data

- Water extent based on 6 years of Sentinel-2 images, plus quasi simultaneous Sentinel-2 and Pleiades images
- Water elevation from historical data from institutes, municipalities, state agencies (VNF, DREAL, EDF, RHA …), and Citizen Science networks (OECS initiative)
- Leveling of these stations through ICESat-2 data and field campaigns

Fig.2: OECS scale and leveling activity

Lake water surface assessment

- SWOT expect: relative error smaller than 15% for water bodies exceeding 250*250m² (i.e. 6,25 Ha)
- Results: a slight overestimation with a relative area error (1sigma) between 4 and 20%

SWOT L2 Lake Prior – Simplified extent
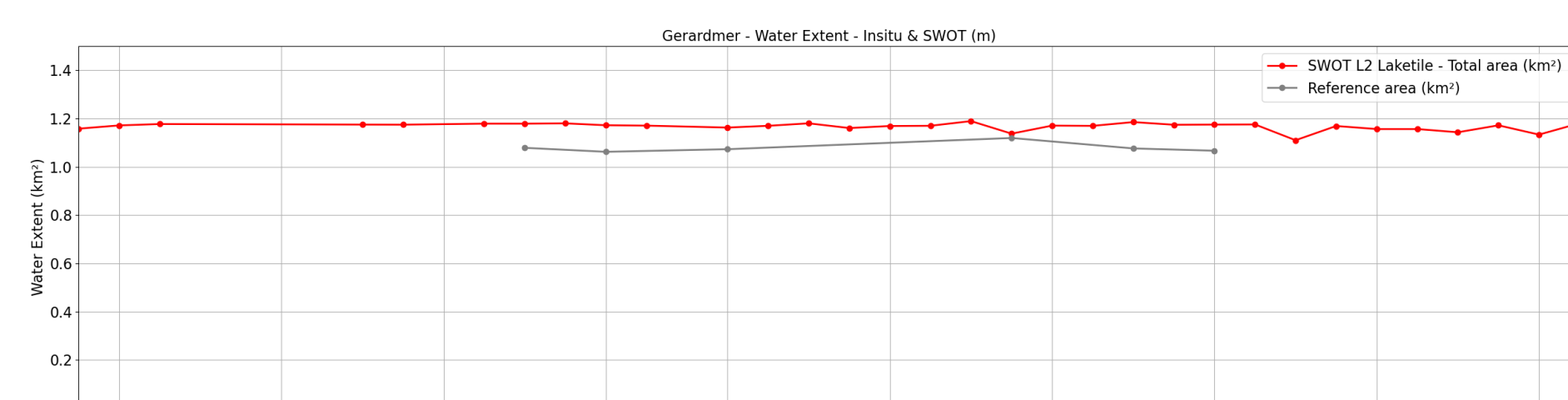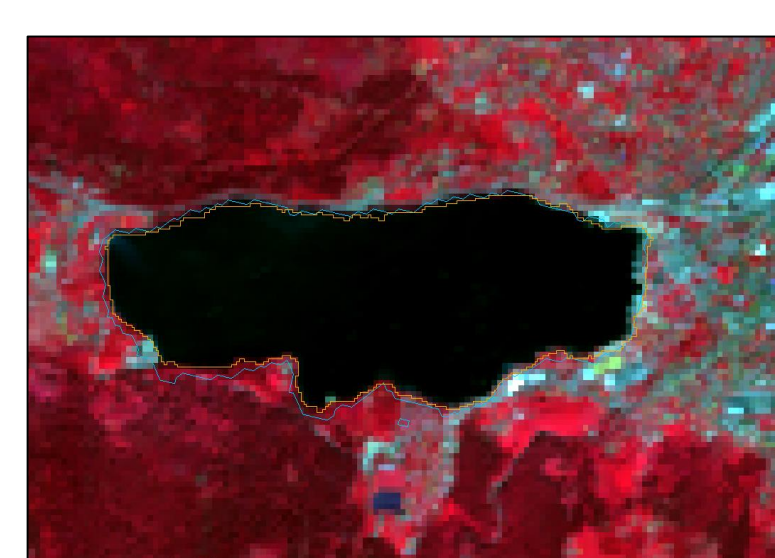Reference mask – Sentinel-2 HR EEO (10 m)

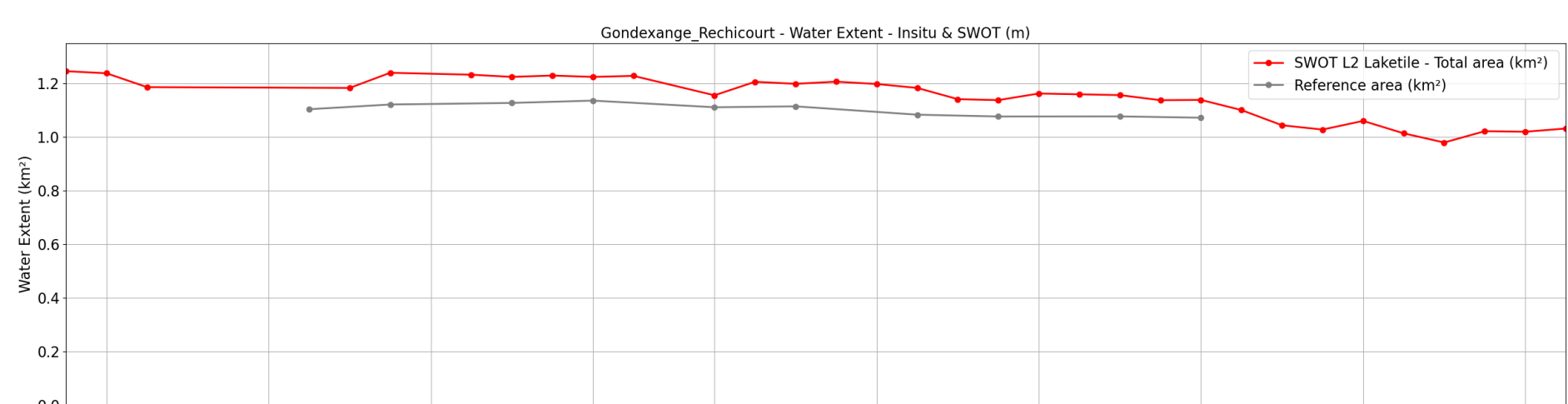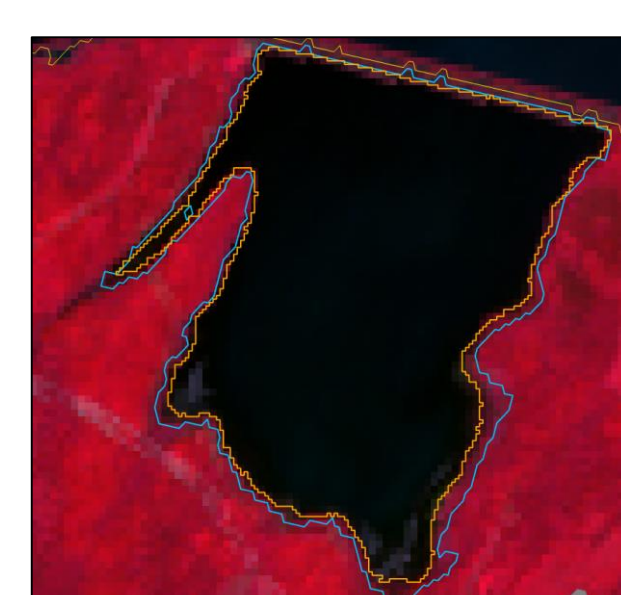Fig. 3: Comparison of SWOT LW surface and Sentinel-2 derived extents over Gerardmer Lake

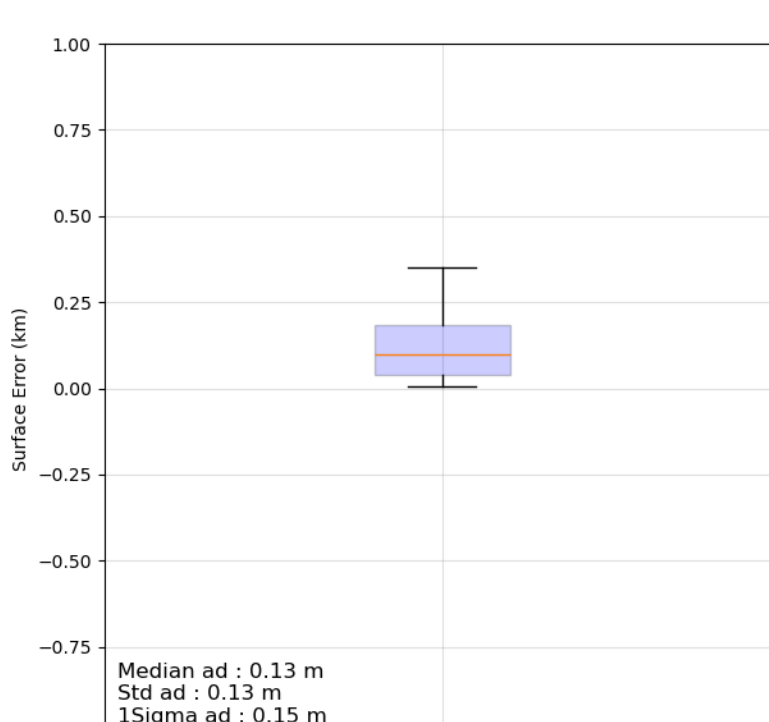Fig. 4: Comparison of SWOT LW surface and Sentinel-2 derived extents over Gondrexange Lake
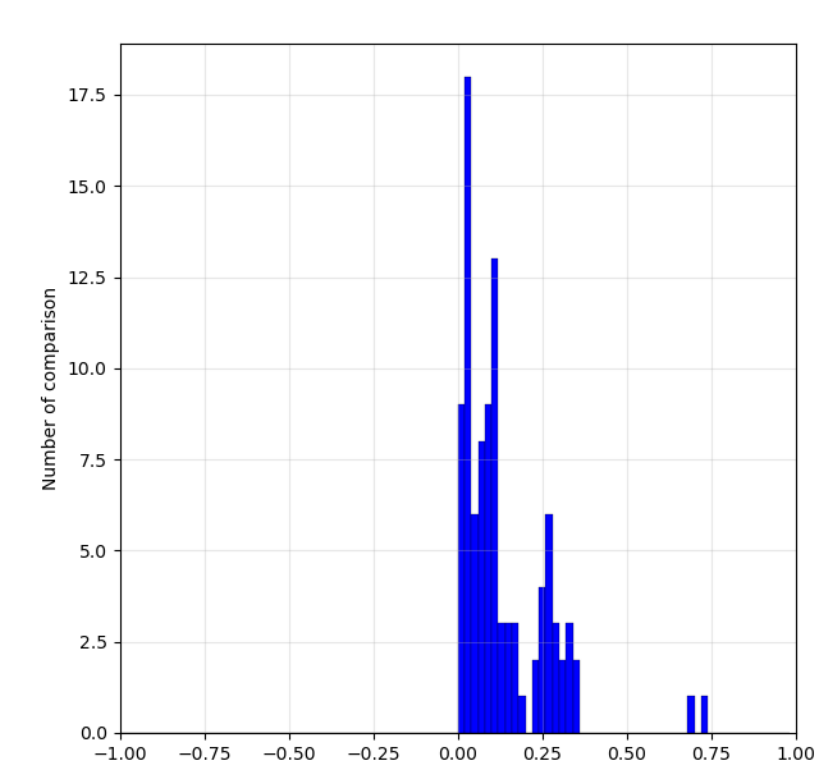

Fig. 5: Histogram of surface differences (SWOT-S2) for all Vosges and Lorraine lakes by date

Lake water elevation assessment

- SWOT Expects: height accuracy shall be 10 cm or better for water bodies exceeding 1km² and 25 cm or better for water bodies between 250*250m2 and 1km².
- Results confirm the quality SWOT's measurements in terms of absolute water level with a wse error (1sigma) of 5 to 11 cm
- Obtain water's height values even over very small reservoirs such as Vert and Forlet Lake
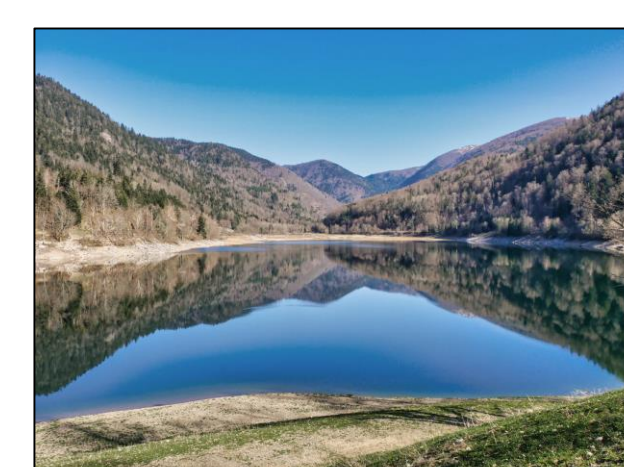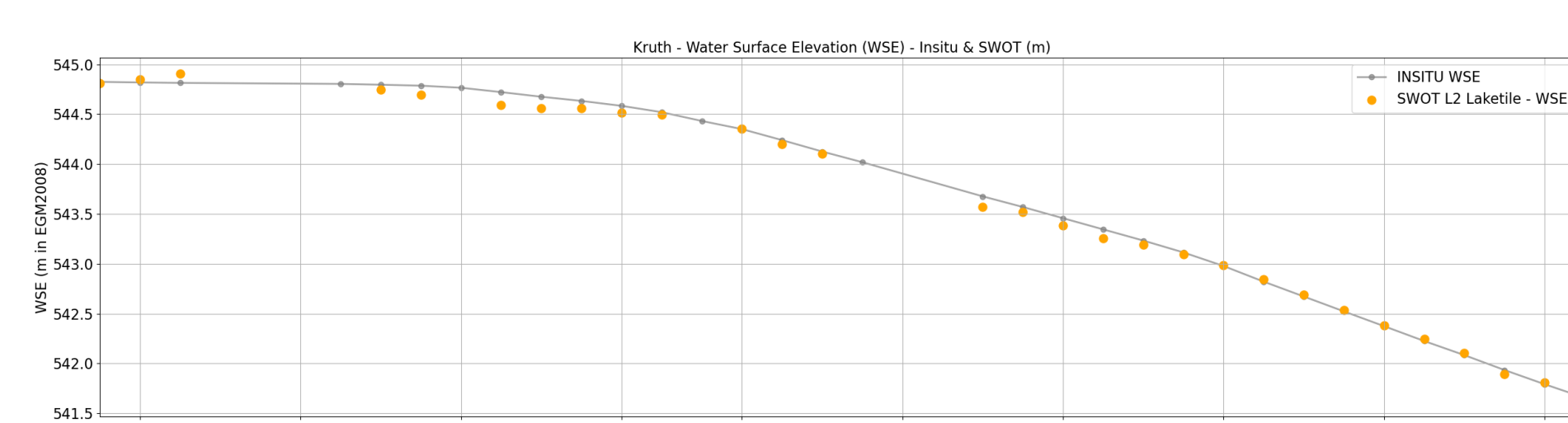

Fig.6: comparison of in situ water altitude and SWOT measurements, Kruth Reservoir- ~ 0.52 km², 1 sigma = 0.052 m
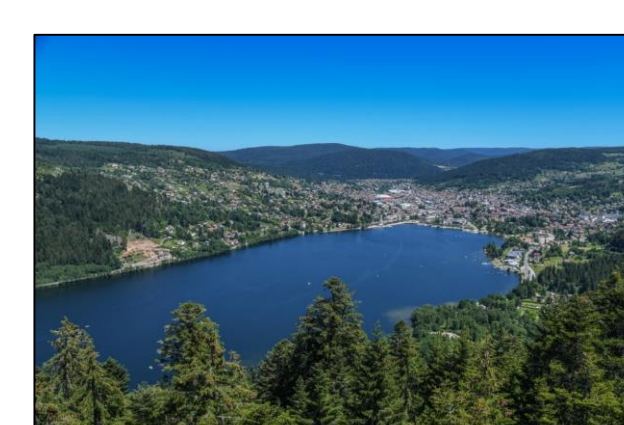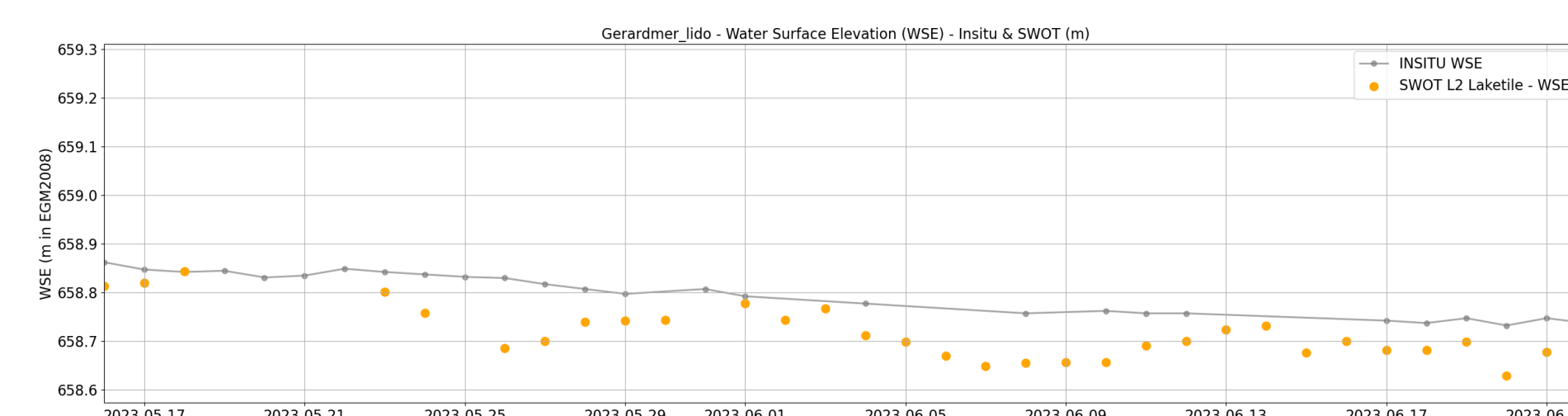

Fig.7: comparison of in situ water altitude and SWOT measurements Gerardmer reservoir, ~ 1.07 km², 1 sigma = 0.076 m
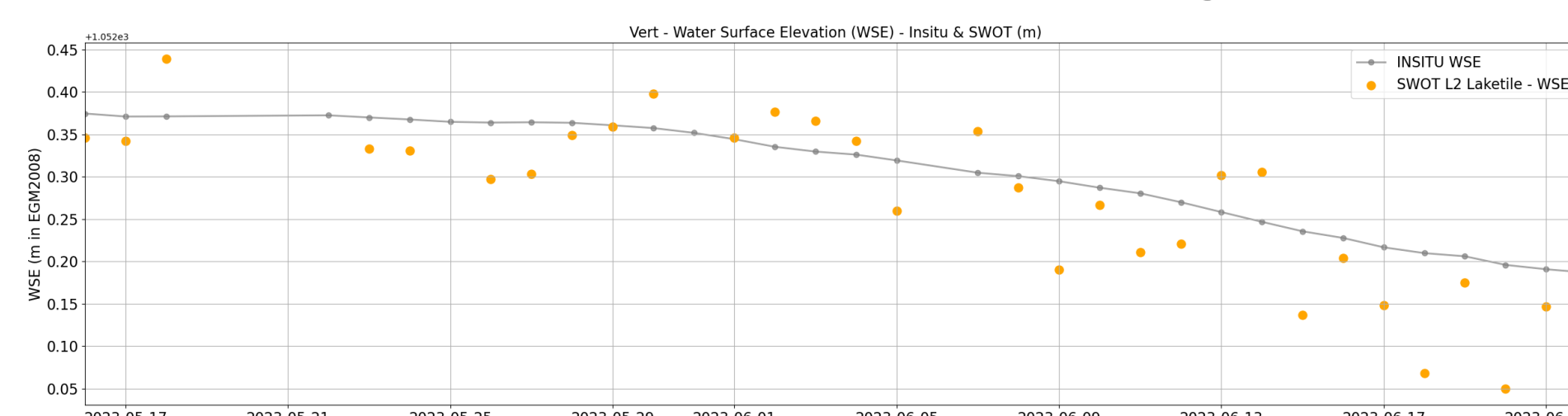

Fig.8: comparison of in situ water altitude and SWOT measurements for the Lac Vert, ~0,05 km² , 1 sigma = 0.06 m

Lake name (& PLD ID)	Size in PLD (km2)	Abs(SWOT- In situ) 1 sigma, in m
Gérardmer (2320165822)	1.07	0.076
Longemer (2320167252)	0.67	0.059
Stock [main] (2320165452)	3.88	0.053
Stock [Etang des femmes] (2320165422)	0.75	0.057
Gondrexange [gros étang] (2320166602)	2.93	0.102
Gondrexange [Réchicourt] (2320166622)	0.93	0.066
Gondrexange [cornée Gondrexange] (2320166632)	0.53	0.153
Mittersheim2 (2320165272)	0.6	0.064
Mittersheim1 (2320163222)	0.65	0.059
Kruth-wildenstein (2320167333)	0.52	0.052
Forlet (2320165812)	0.02	0.109
Vert (2320167122)	0.05	0.060

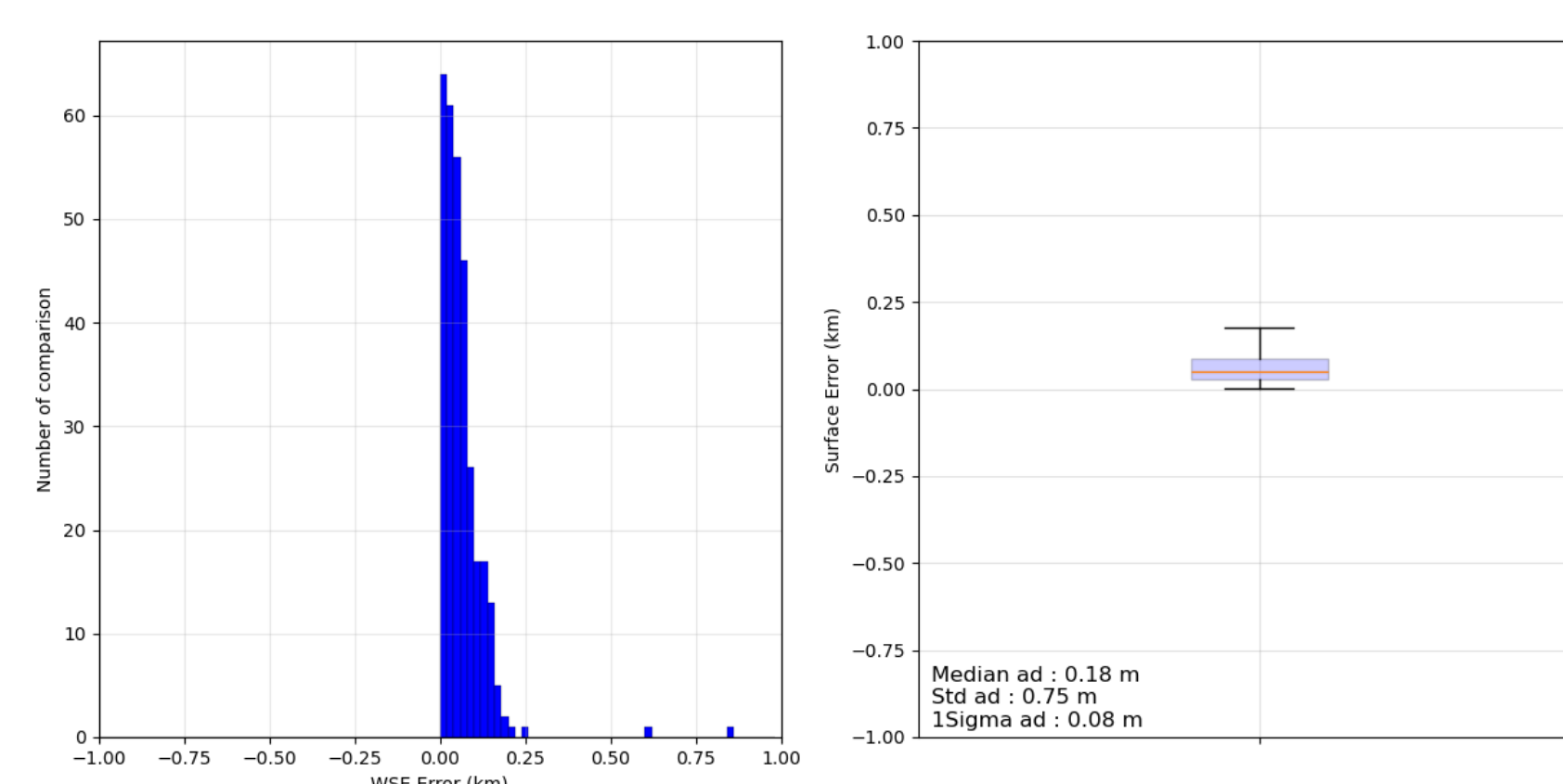Fig.9. Synthesis of water level error at 1 sigma

Fig. 10: Histogram of water elevation differences (SWOT-In situ) for all Vosges and Lorraine lakes by date (Global 1sigma = 8 cm)

Conclusion-perspectives

- Water extent and water elevation errors lower than the SWOT requirements, wse error (1sigma) of 5 to 11 cm
- Able to follow the reservoirs' behaviors (drainage or stability)
- Next steps:
  - Consolidating and extending to more other lakes exploiting the science orbit data
  - Leveling campaign to insure the best accuracy for reference in situ data set

Université de Strasbourg