RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

cnes CENTRE NATIONAL D'ÉTUDES SPATIALES

SWOT HR
LAKE PRODUCT FEATURES AND ISSUES

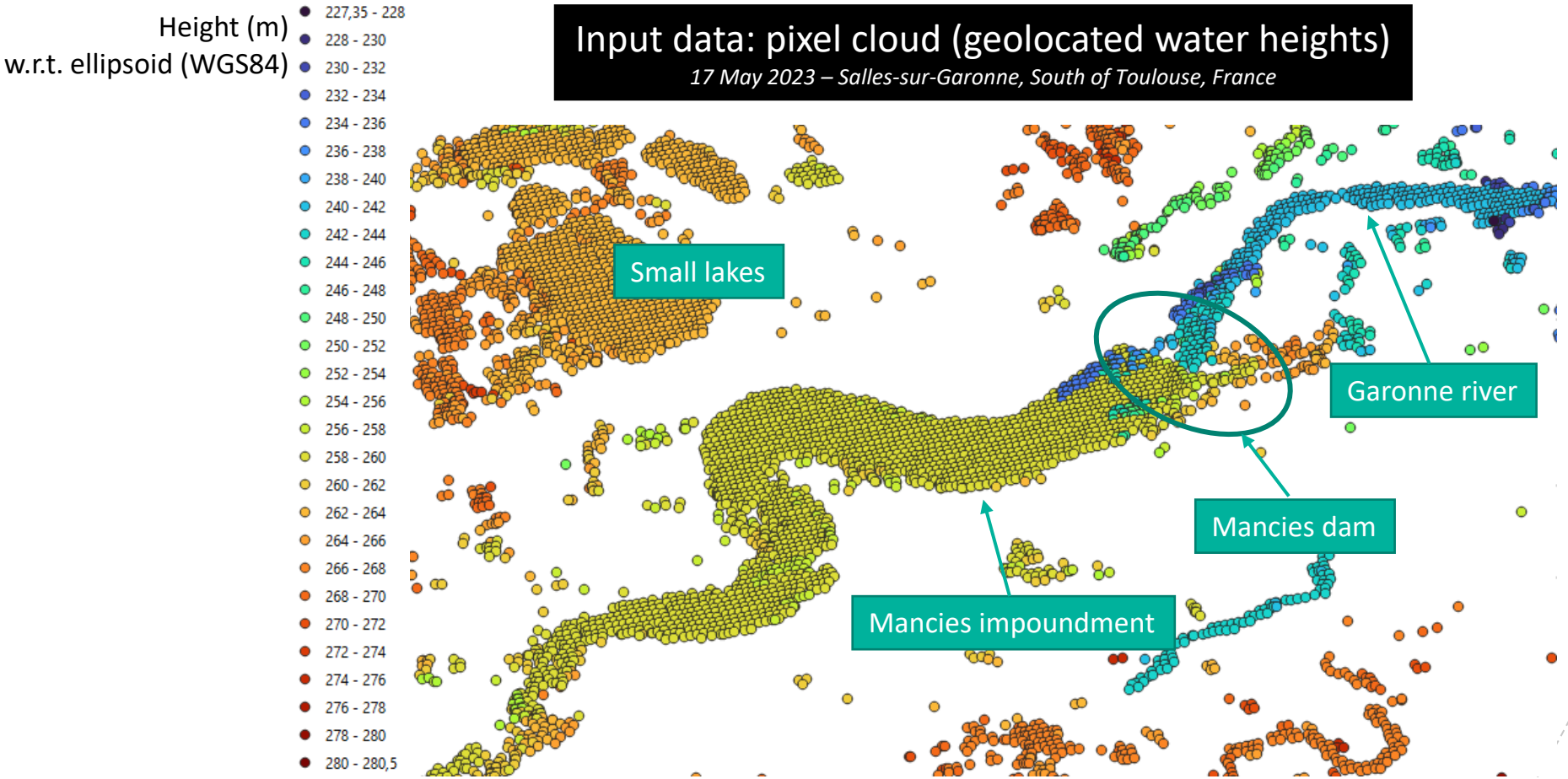
Claire Pottier, Roger Fjørtoft,
on behalf of the ADT and Cal/Val Team

SWOT VALIDATION MEETING, CHAPEL HILL, NC
19 JUNE 2024

OUTLINE

LakeSP PROCESSING

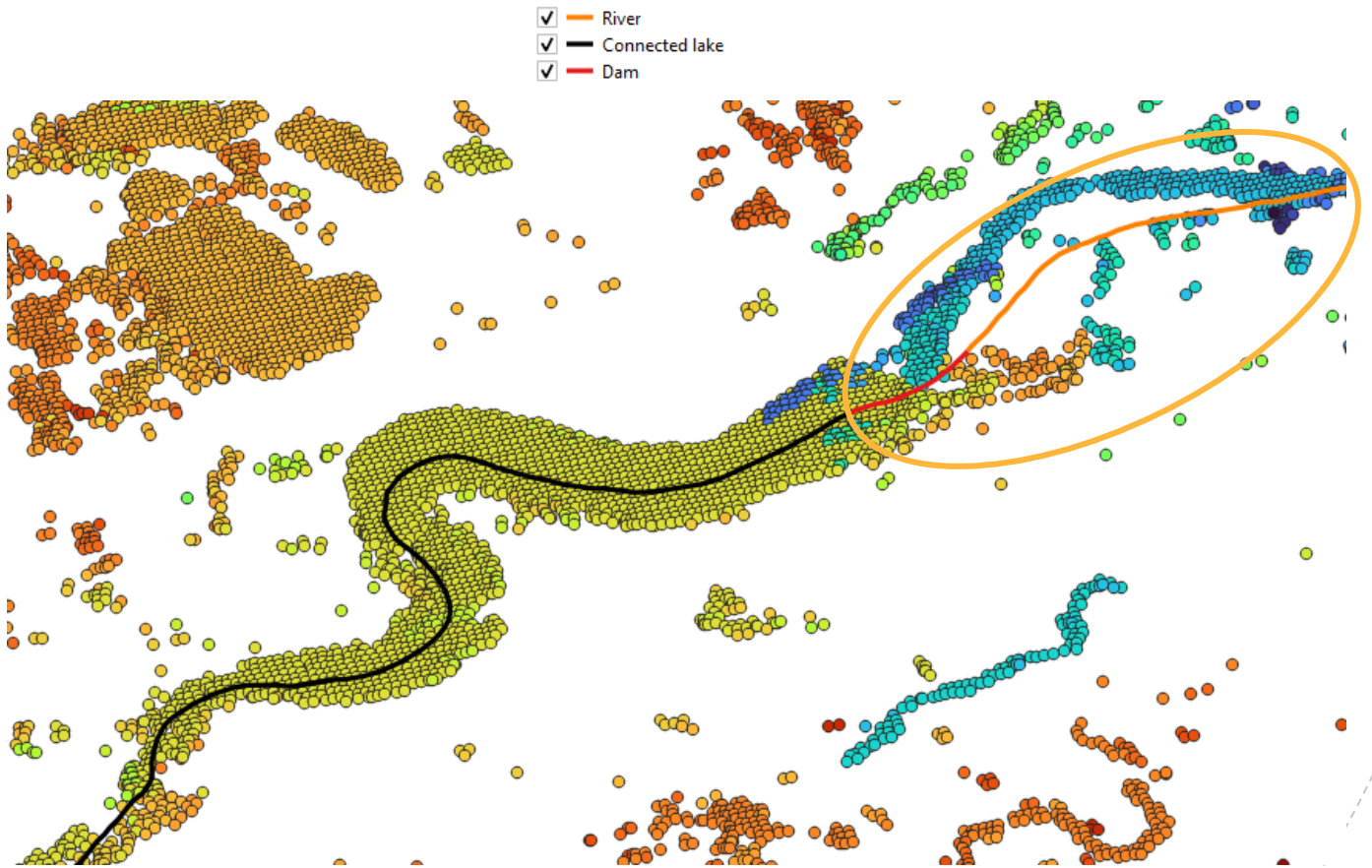
Illustration of the main processing steps (and dependency on river processing, SWORD and PLD)



LakeSP PROCESSING

Illustration of the main processing steps (and dependency on river processing, SWORD and PLD)

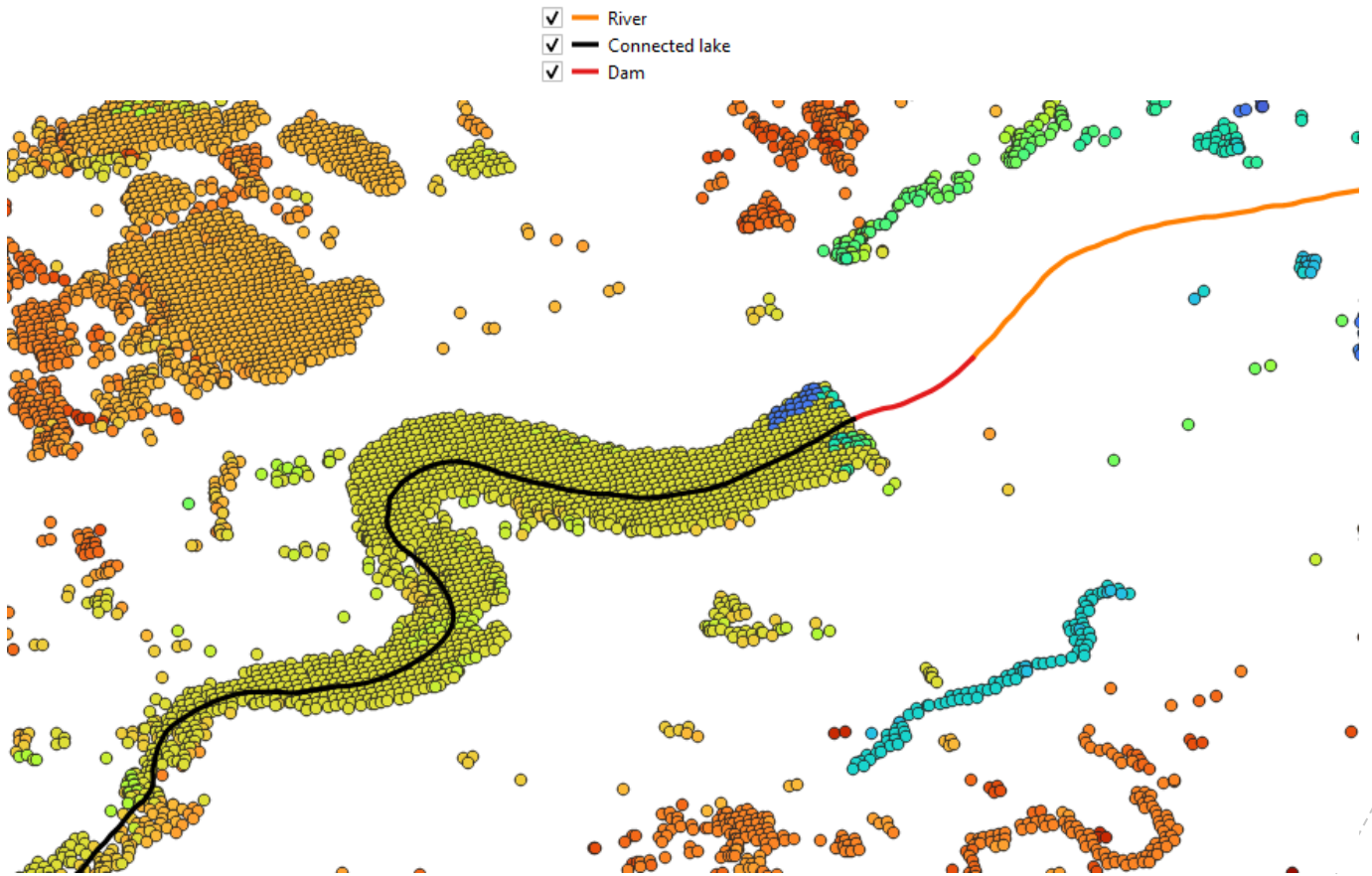
Step 1 = Remove pixels already assigned to a SWORD river reach (except connected lakes)



LakeSP PROCESSING

Illustration of the main processing steps (and dependency on river processing, SWORD and PLD)

Step 1 = Remove pixels already assigned to a SWORD river reach (except connected lakes)

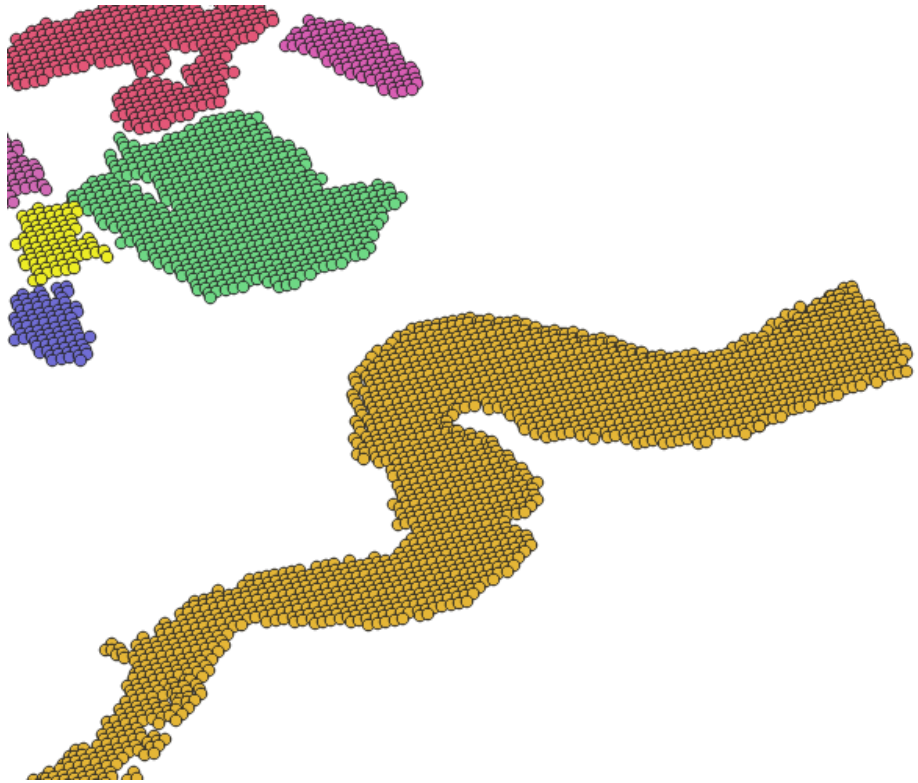


LakeSP PROCESSING

Illustration of the main processing steps (and dependency on river processing, SWORD and PLD)

Step 1 = Remove pixels already assigned to a SWORD river reach (except connected lakes)

Step 2 = Identify separate water regions > 1 ha



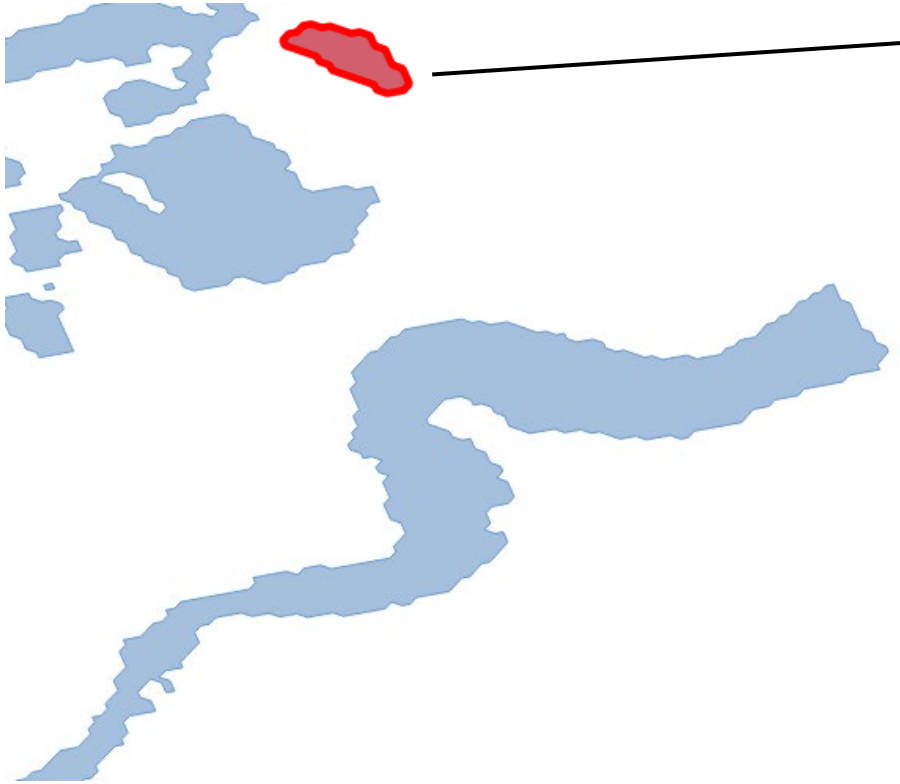
LakeSP PROCESSING

Illustration of the main processing steps (and dependency on river processing, SWORD and PLD)

Step 1 = Remove pixels already assigned to a SWORD river reach (except connected lakes)

Step 2 = Identify separate water regions > 1 ha

Step 3 = Compute lake features
- lake boundary
- intersection with PLD
- attributes (water surface elevation, area, …)



obs_id	232078L067632
time	737608940,430
time_tai	737608977,430
time_str	2023-05-17T03:22:20Z
wse	212,884
wse_u	0,038
wse_r_u	0,038
wse_std	0,101
area_total	0,055101
area_tot_u	0,002303
area_detct	0,055101
area_det_u	0,002303
layovr_val	0,008
xtrk_dist	-22644,586
quality_f	1
dark_frac	0
partial_f	0
xovr_cal_q	0
geoid_hght	49,789543
solid_tide	-0,119218
load_tidef	-0,009028
load_tideg	-0,00973
pole_tide	0,001155
dry_trop_c	-2,253342
wet_trop_c	-0,064866
iono_c	-0,003562
xovr_cal_c	0,531012

LakeSP PROCESSING

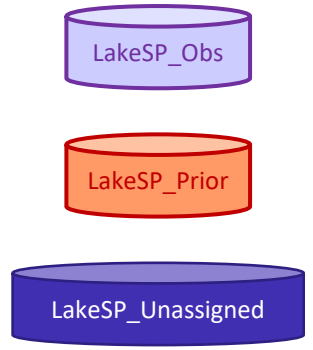
Illustration of the main processing steps (and dependency on river processing, SWORD and PLD)

Step 1 = Remove pixels already assigned to a SWORD river reach (except connected lakes)

Step 2 = Identify separate water regions > 1 ha

Step 3 = Compute lake features
- lake boundary
- intersection with PLD
- attributes (water surface elevation, area, …)

Step 4 = Dispatch into output shapefiles



FEATURES AND ISSUES

Overview

PHENOMENOLOGY

- Dark water
- Specular ringing
- Bright land
- Layover
- Thermal noise
- Coherence time smearing…

ALGORITHMS

- Water detection errors, water fraction inaccuracies
- Inaccuracies and projection issues for dark water flag and other flags
- Errors in phase unwrapping and geolocation
- Xover correction residuals
- Assignment errors
- Bugs…

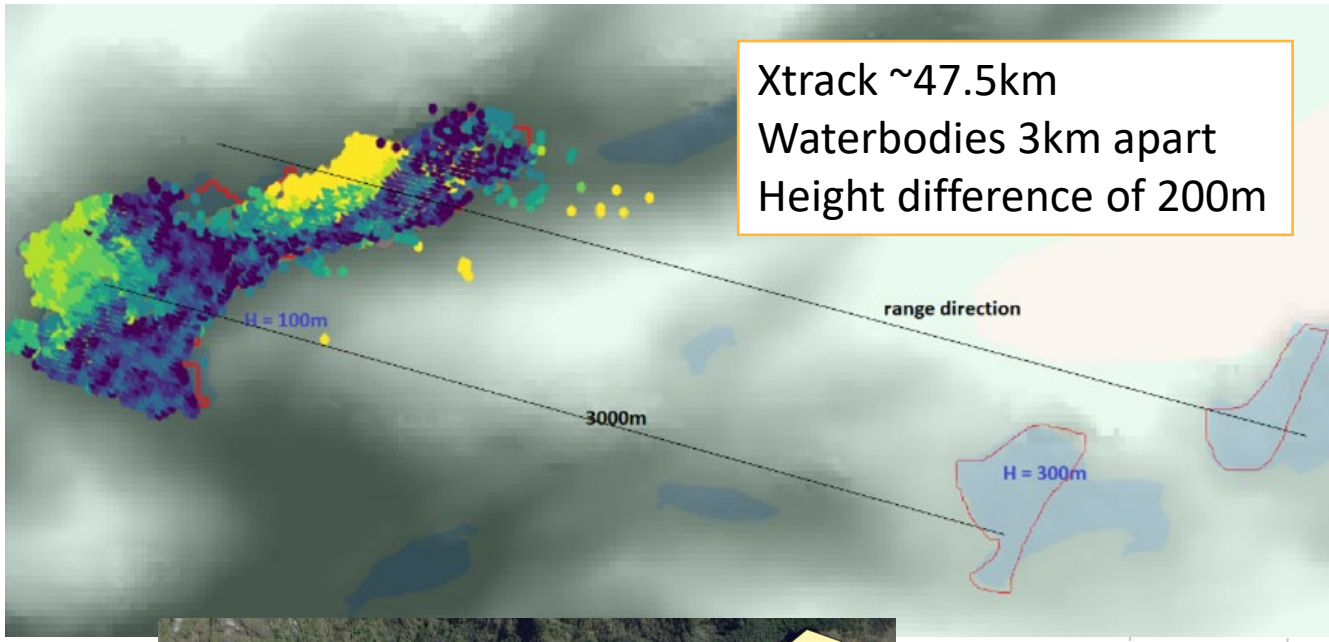
PRIOR DATA

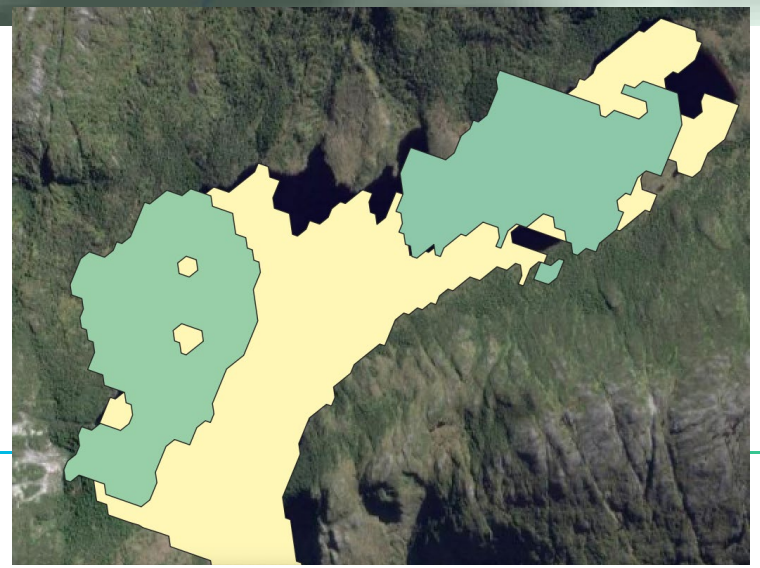
- Imperfect reference DEM
- Imperfect prior masks (water occurrence, bright land…)
- Missing or inaccurate river centerlines/metadata in SWORD
- Missing or inaccurate lake polygons/metadata in PLD…

FEATURES AND ISSUES IN LAKE PRODUCTS

OVERLAPPING POLYGONS = WATER-WATER LAYOVER

- Signs
  - LakeSP has overlapping polygons in ground geometry, with different heights
  - PIXC shows a single feature in slant range, with distinct patches of heights
  - This is a mountain region, with nearby lakes at different altitudes
- Diagnosis
  - This is water/water layover
- Consequences: May cause errors in lake extent (joint LakeSP_Prior polygon, overlapping polygons in LakeSP_Obs), and water surface elevation

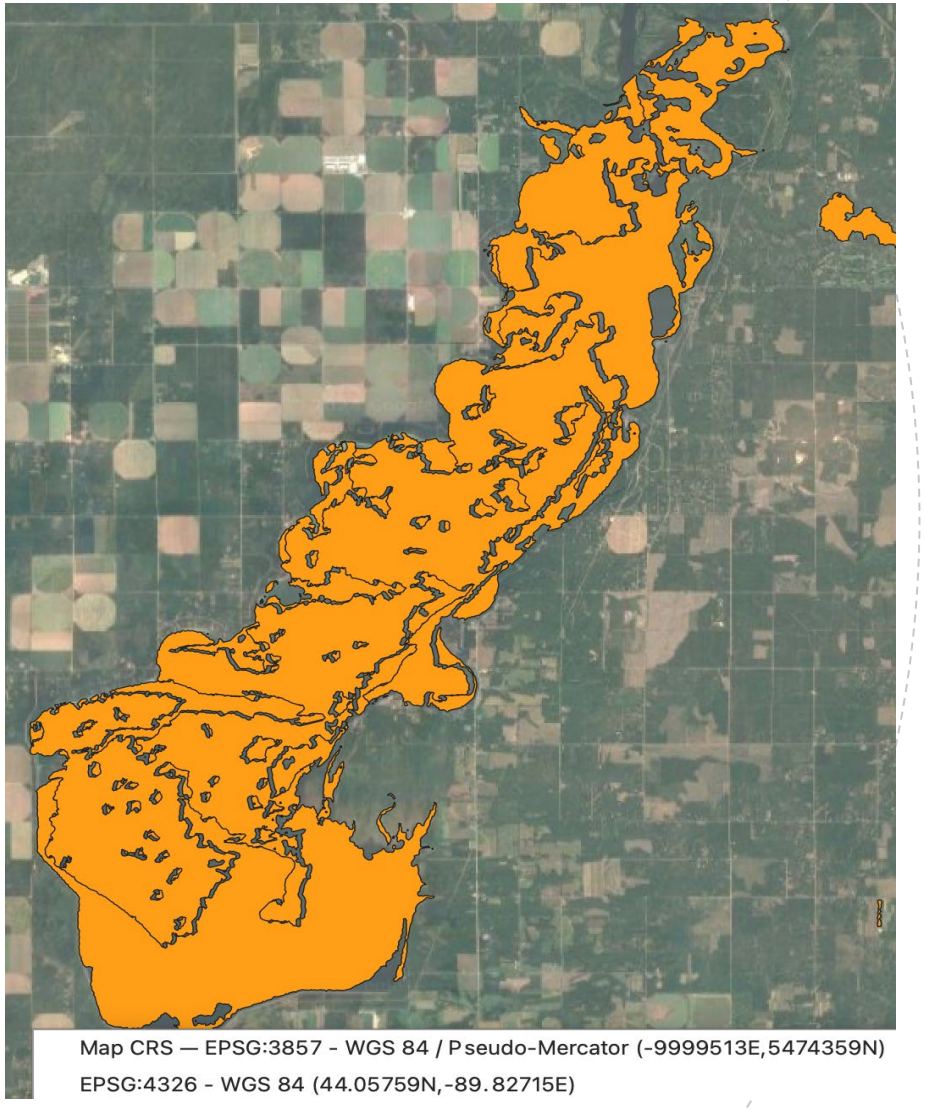




DARK WATER HANDLING BUG

- Lakes divided into several polygons: Some lakes are erroneously divided into several polygons, with small gaps in between, due to a bug in the handling of height-constrained geolocations for dark water patches.

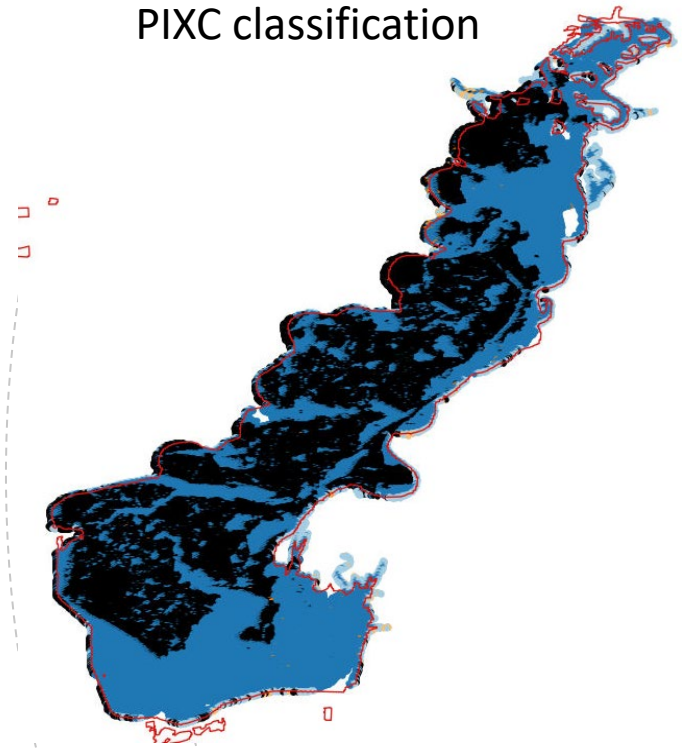
➔ *This will be corrected in next SAS delivery.*



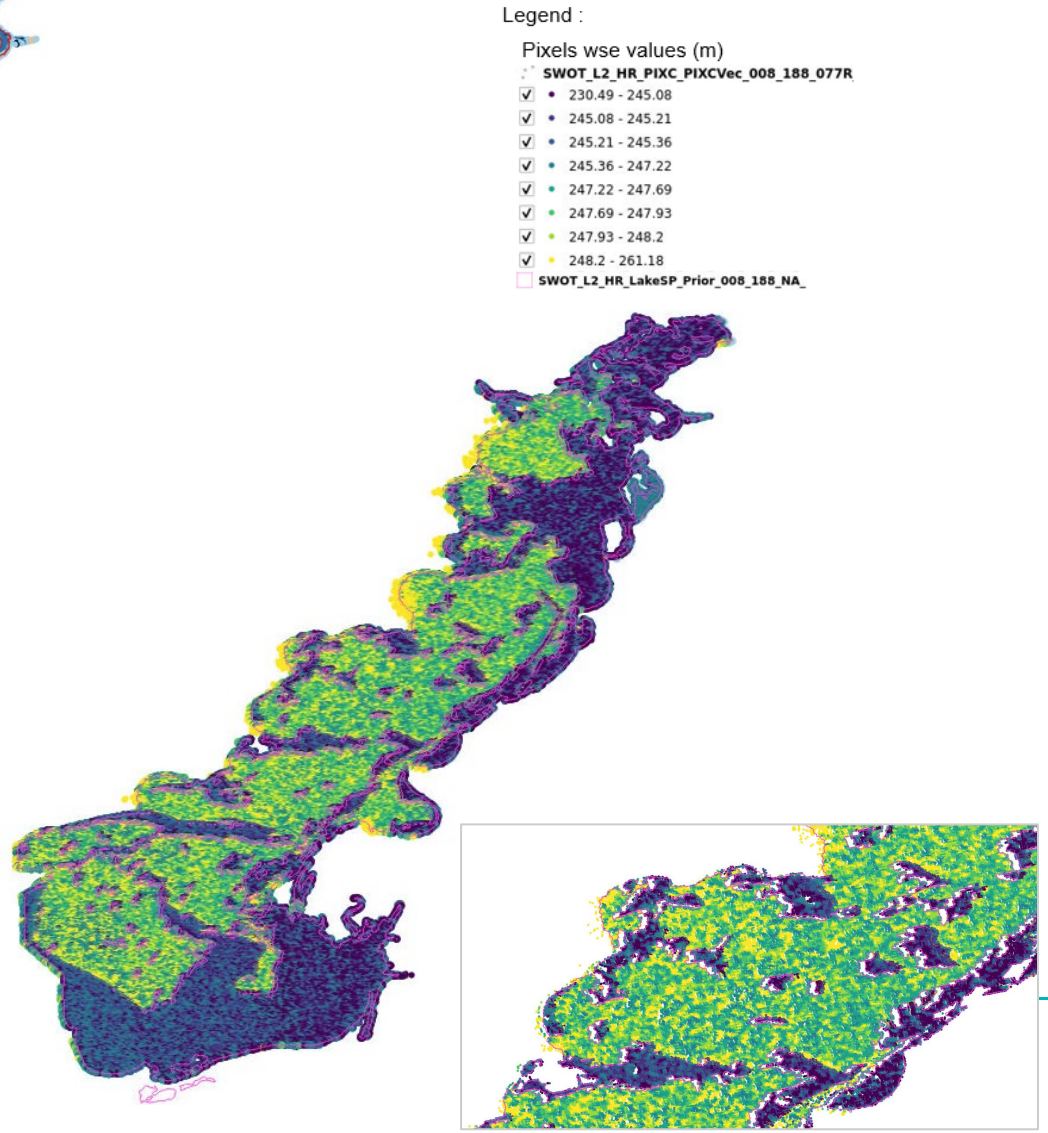
Courtesy: Tamlin Pavelsky and his team (UNC)

DARK WATER HANDLING BUG

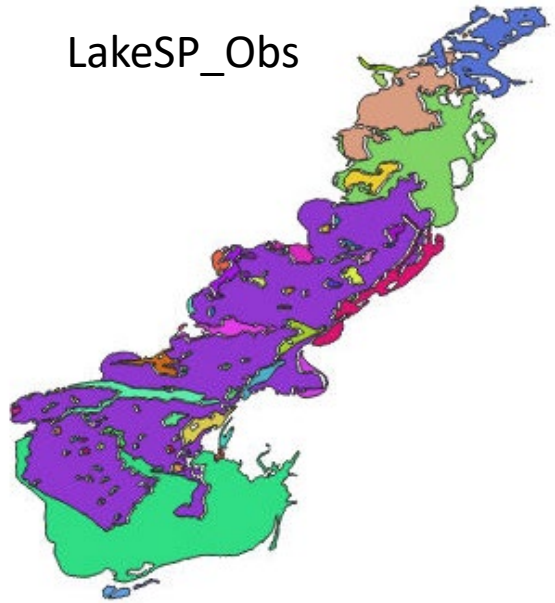
PIXC classification



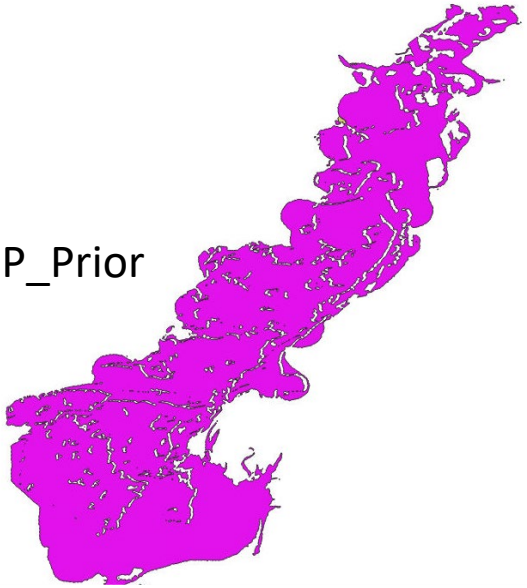
PIXC height



LakeSP_Obs



LakeSP_Prior

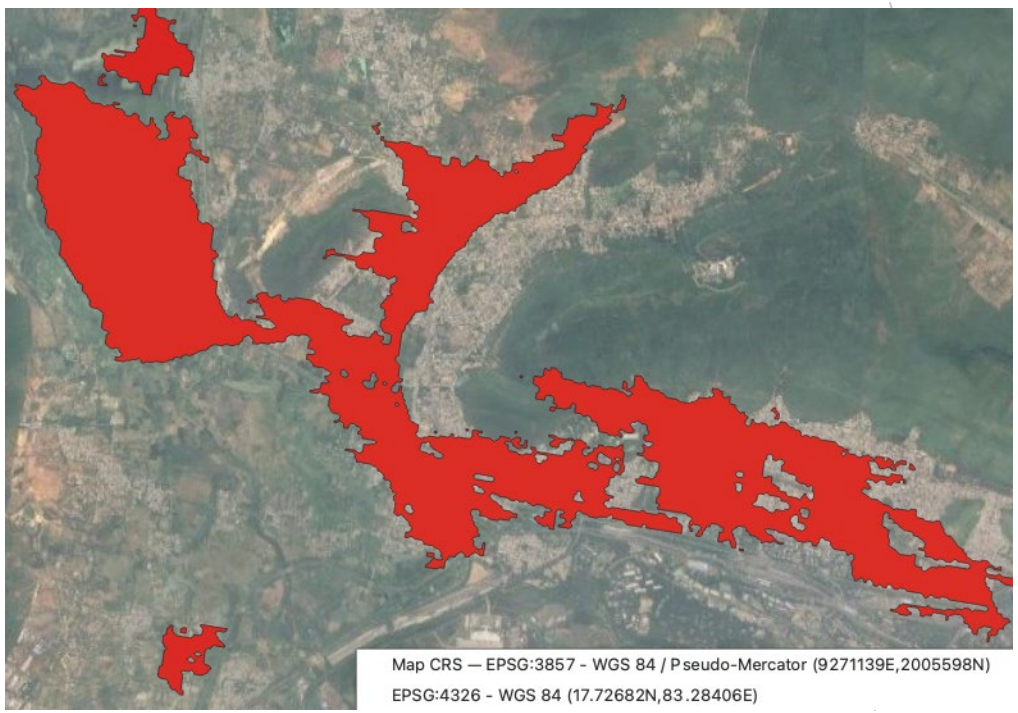


BRIGHT LAND

HUMID SOIL, URBAN AREAS…

- Bright land detected as water adjacent to PLD lakes may cause important overestimation of lake area
- Can be partially mitigated through active use of bright land flag (urban areas)

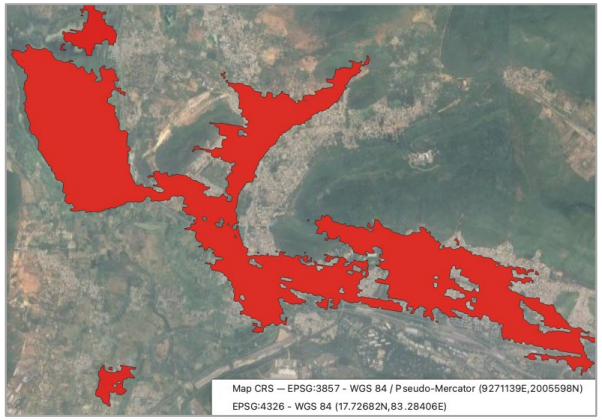
➔ *This will be improved in a future release.*



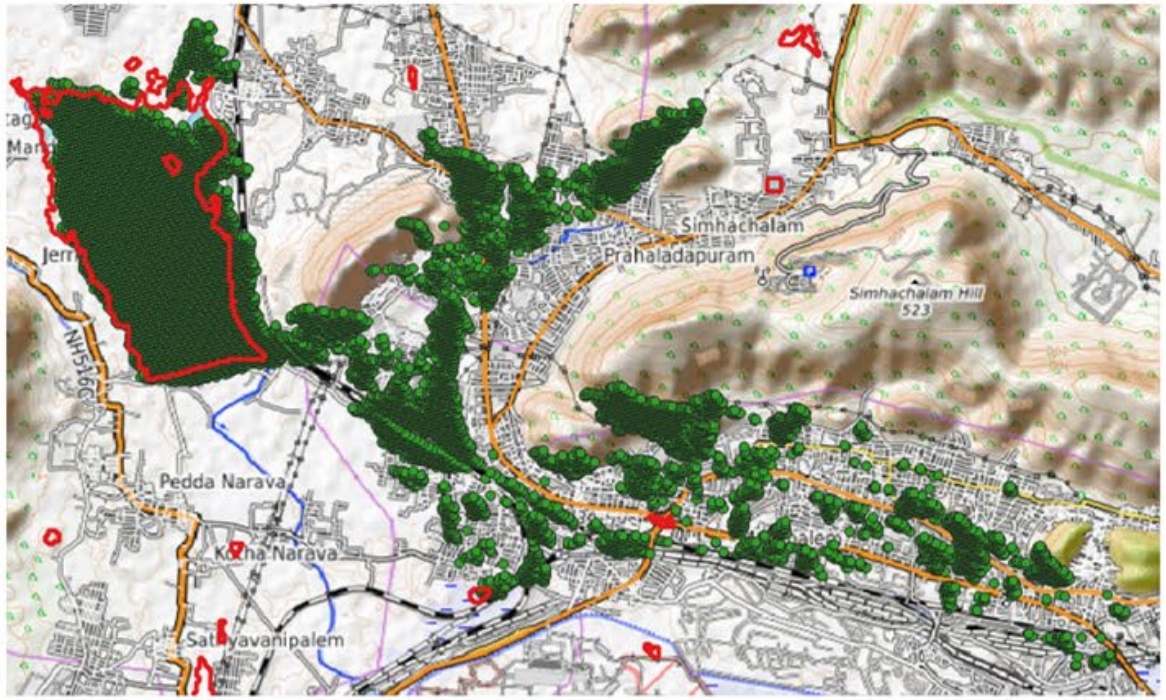
Courtesy: Tamlin Pavelsky and his team (UNC)

BRIGHT LAND

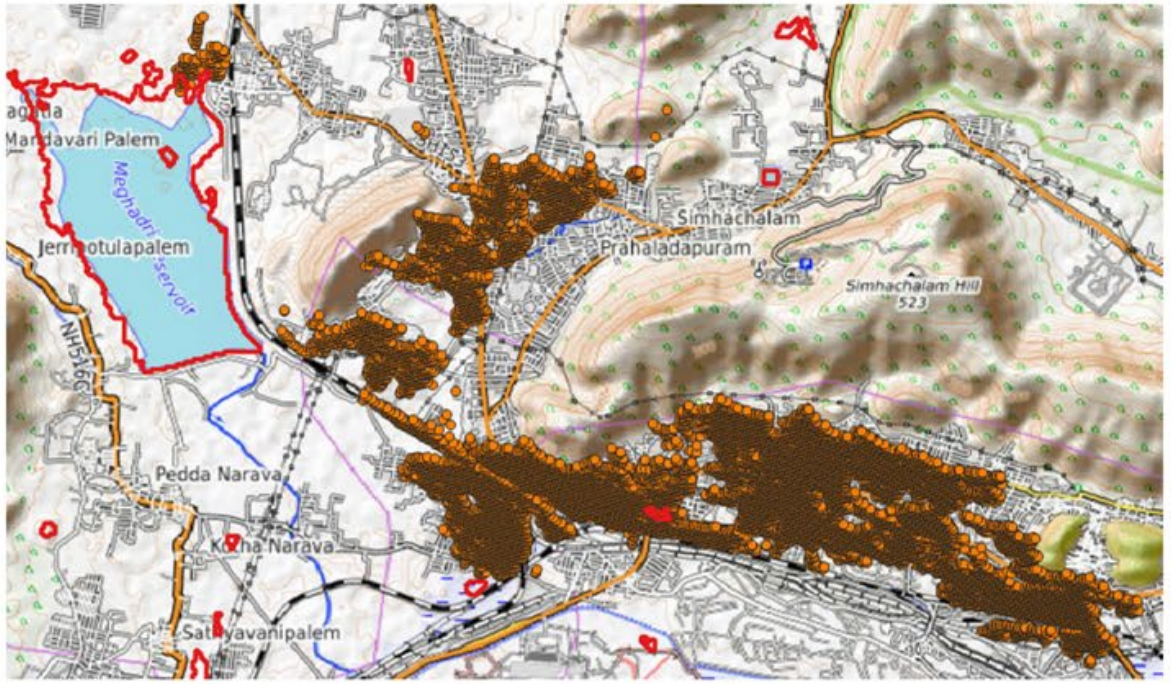
HUMID SOIL, URBAN AREAS...



bright_land_flag = 0



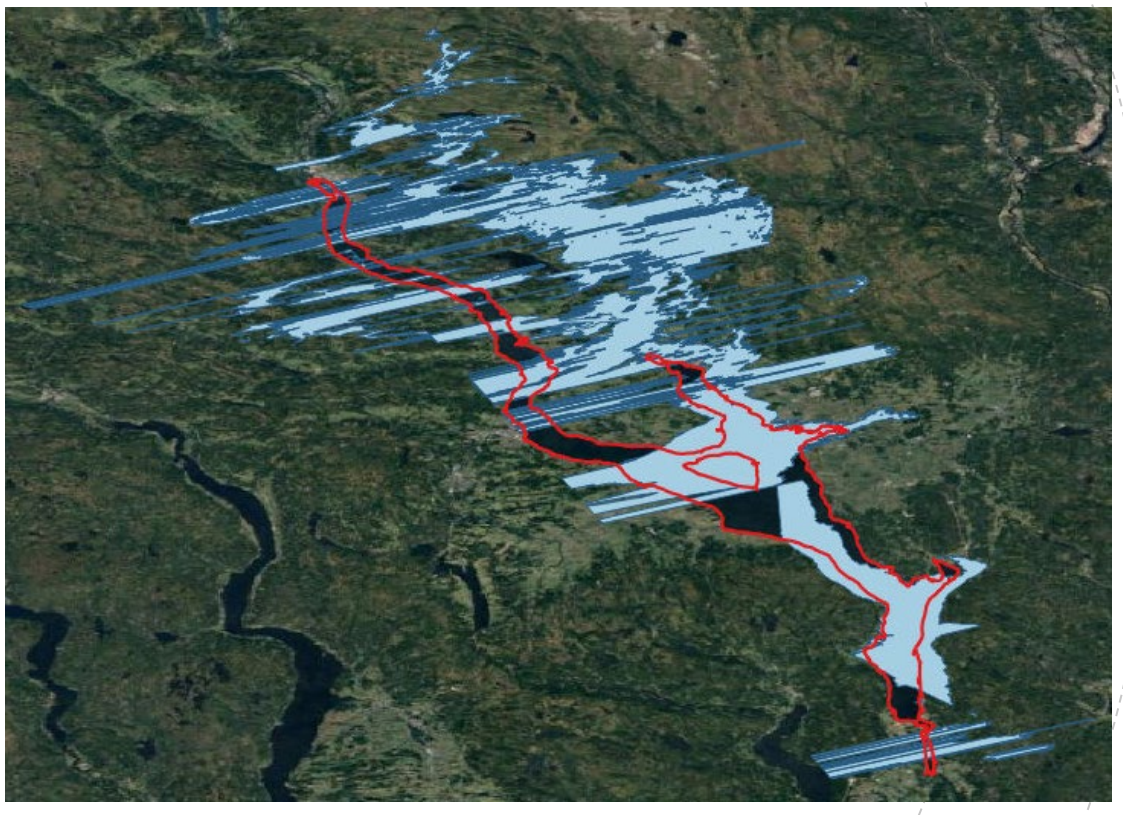
bright_land_flag = 1



SPECULAR RINGING

- Ringing of very bright, specular features near nadir can contaminate the measurements areas far from nadir. This may cause false detection of water and consequent errors in assigning pixels to water features in the river, lake, and raster products. This may also cause missing data that results in “holes” in some water features.

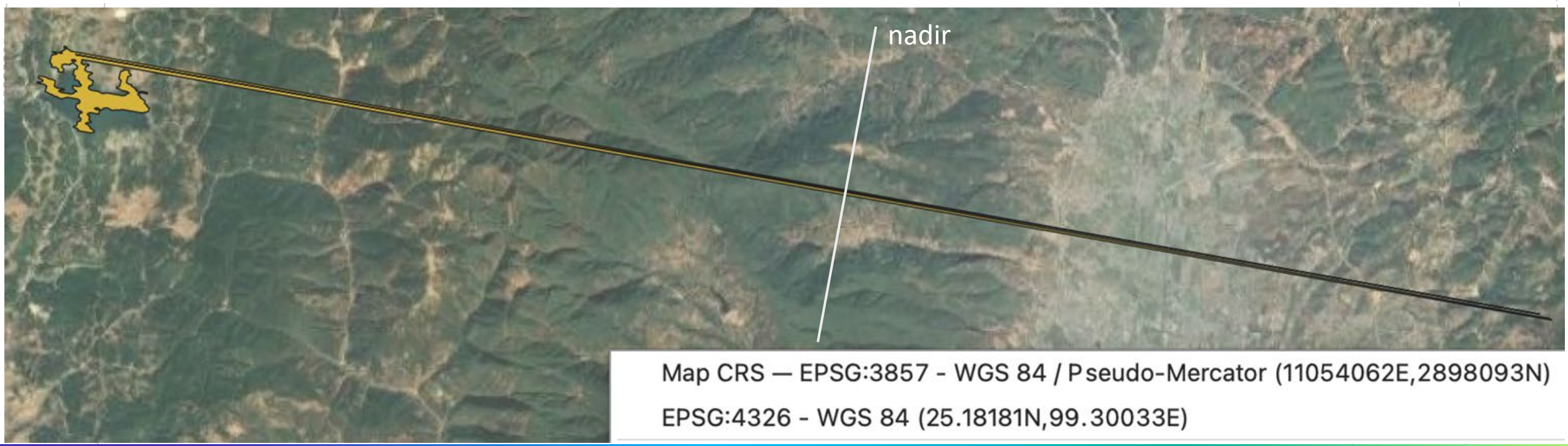
➔ *Handling of this phenomenon will be improved in December SAS delivery.*



HEIGHT-CONSTRAINED GEOLOCATION BUG

- Near nadir pixels geolocated on other side of nadir: near-nadir pixels are in some cases erroneously geolocated on the other side of nadir.

➔ This has been corrected and will be available in forward processing in September.



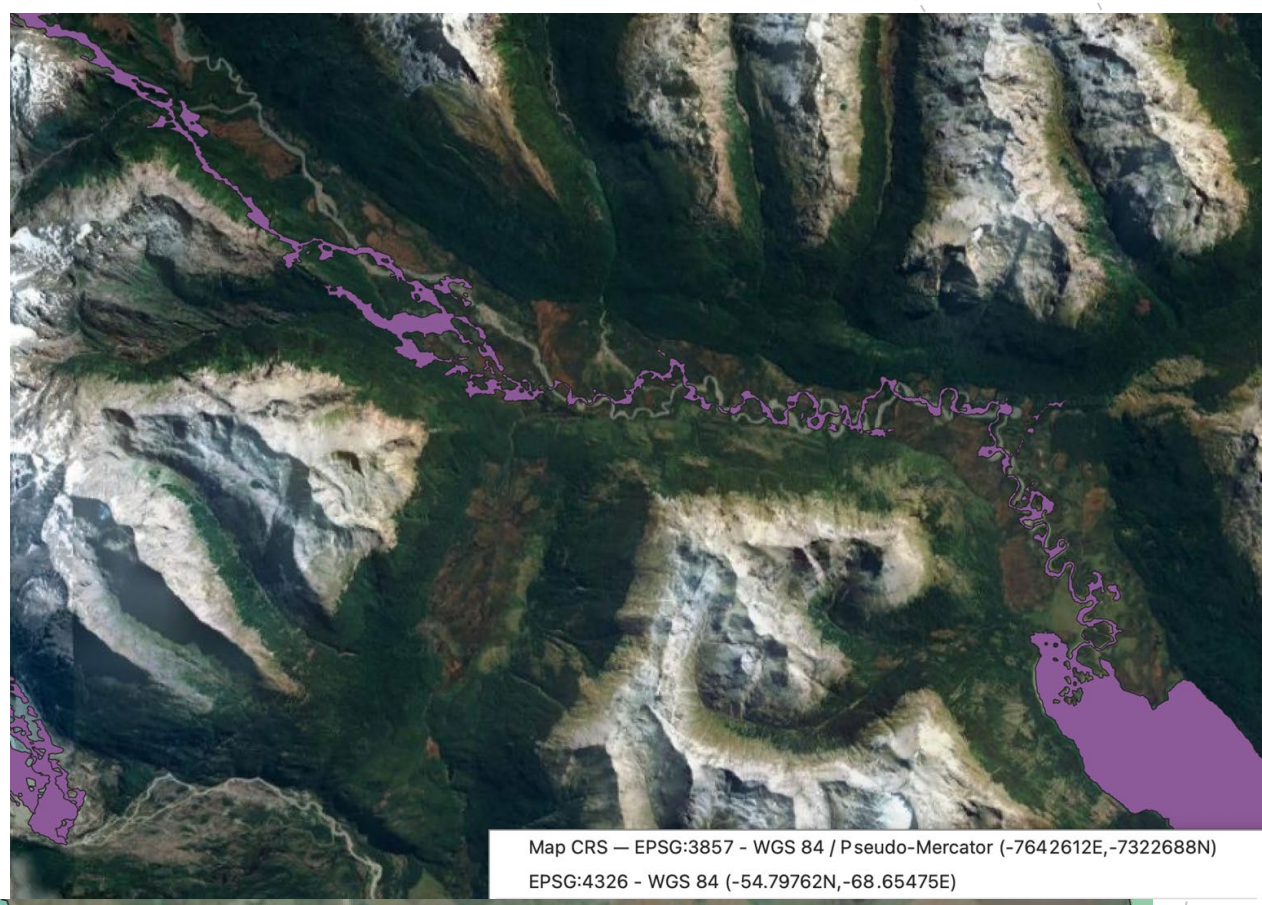
Courtesy: Tamlin Pavelsky and his team (UNC)

ASSIGNMENT ISSUES

- River portions included in lakes: River portions connected to lakes may be erroneously included in the lake object (polygon) if the river reach is not present in SWORD (SWOT Prior River Database). This can propagate to larger areas, e.g. an estuary, if the river reach between the lake and an estuary is missing in SWORD.

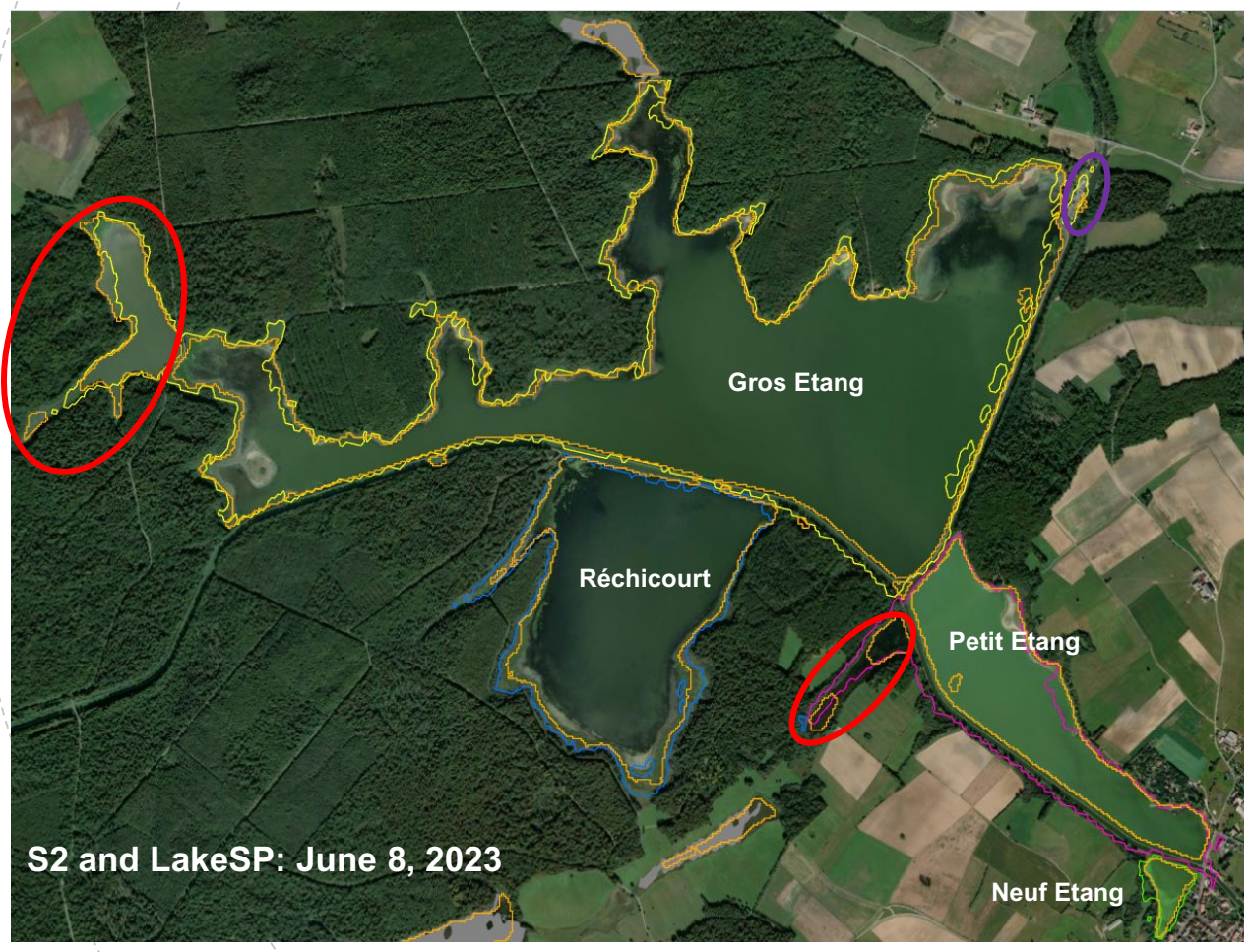
➔ *This may evolve with future versions of SWORD.*

- Likewise missing lakes in the Prior Lake Database (PLD) may cause assignment errors (next slide).



ASSIGNMENT ISSUES

Gondrexange

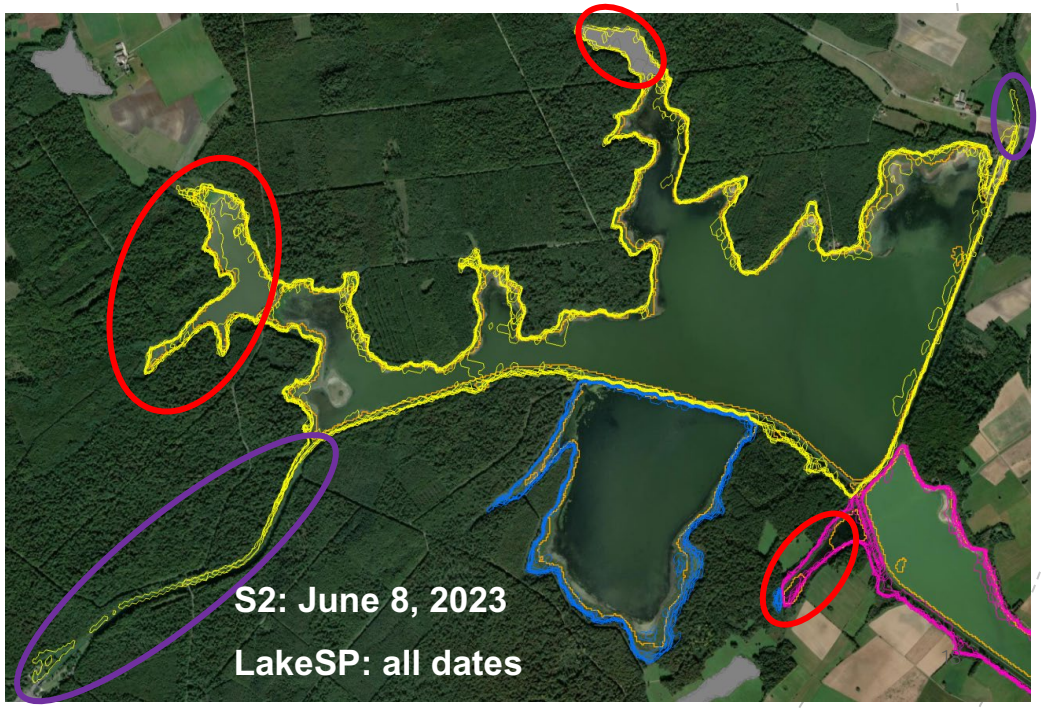


S2

lake_id
- 2320162172 Neuf Etang
- 2320166602 Gros Etang
- 2320166622 Réchicourt
- 2320166632 Petit Etang

LakeSP

- Separate water body, not in PLD, erroneously included in PLD lake of LakeSP_Prior product.
- Small river, not in SWORD, erroneously included in PLD lake of LakeSP_Prior product.

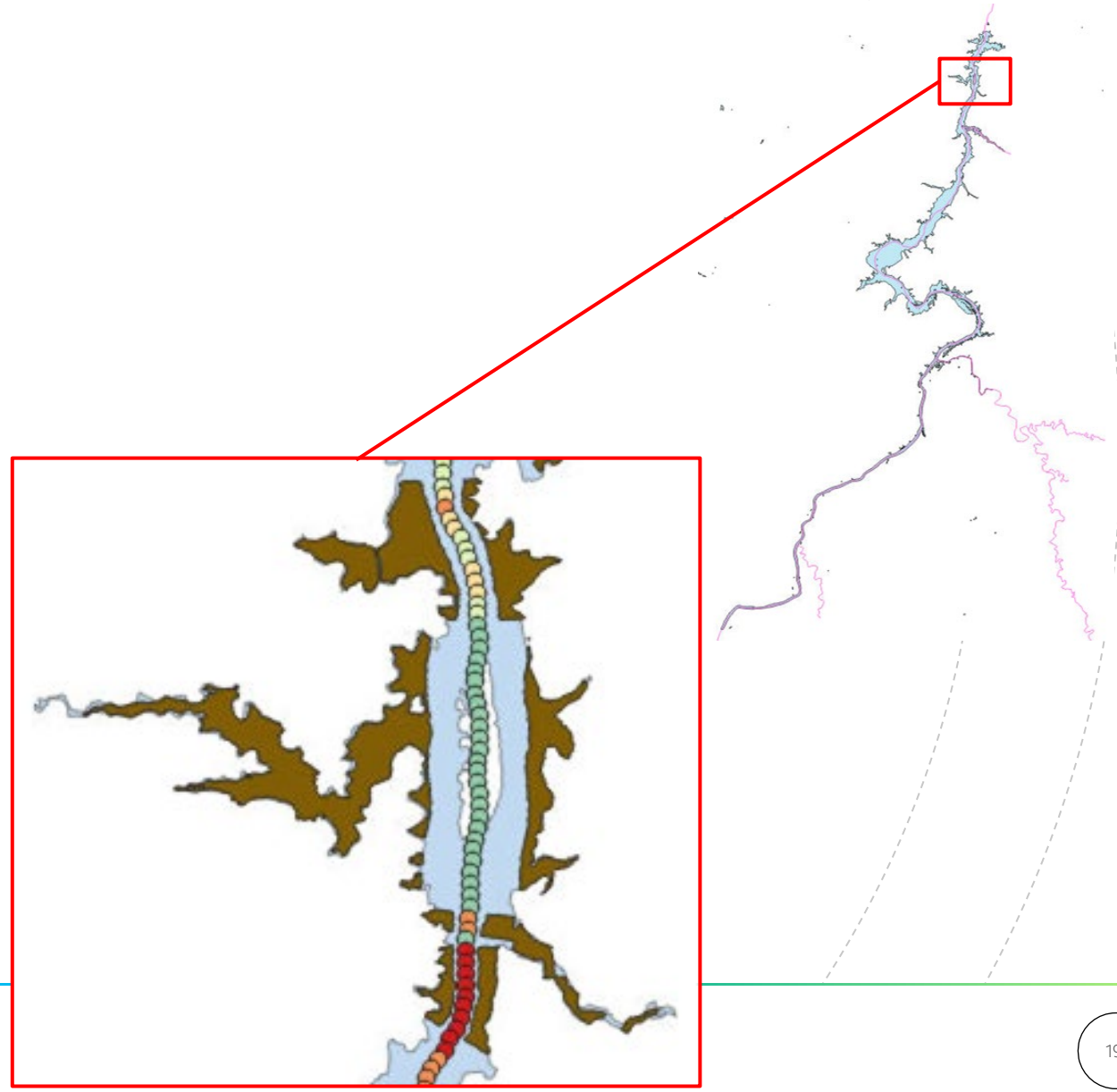


Courtesy: Sabrine Amzil, Thomas Ledauphin, Jérôme Maxant, Hervé Yésou

ASSIGNMENT ISSUES

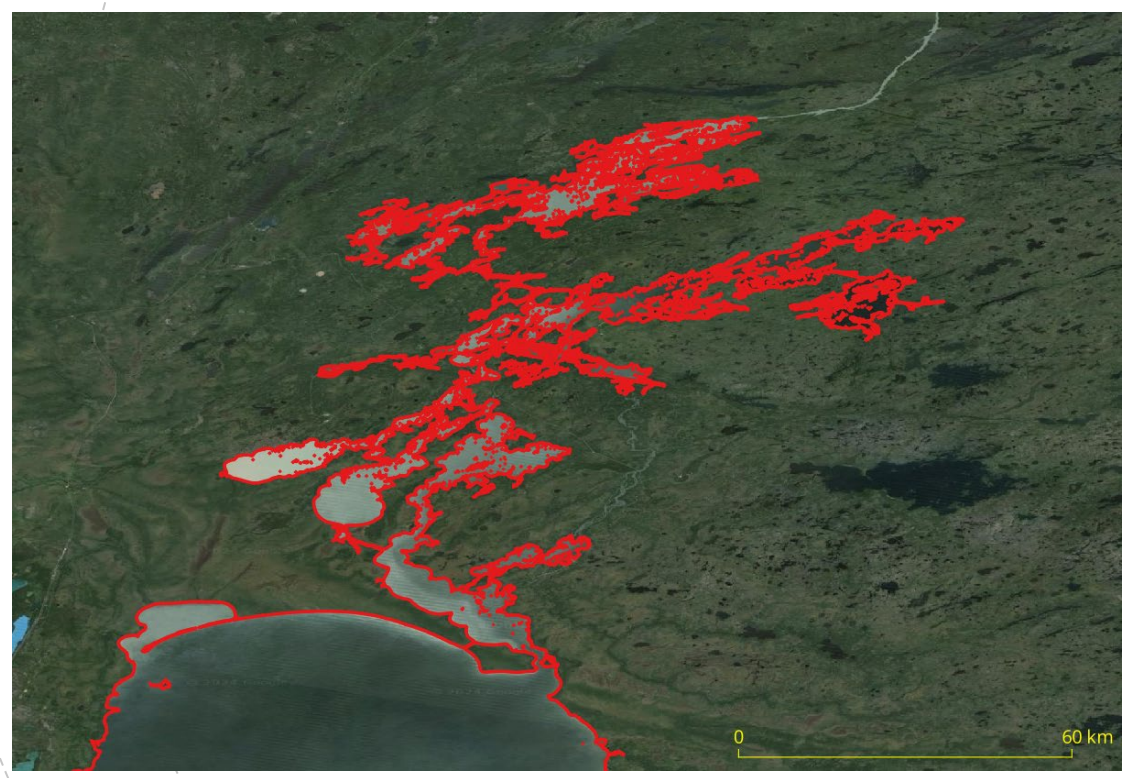
- Missing water surfaces in the middle of reservoirs: Water surfaces in the middle of reservoirs may be missing if SWORD identifies it as a regular river reach rather than a reservoir (connected lake).

➔ *This should evolve with better harmonization between SWORD and PLD (Safat Sikder & Jida Wange)*

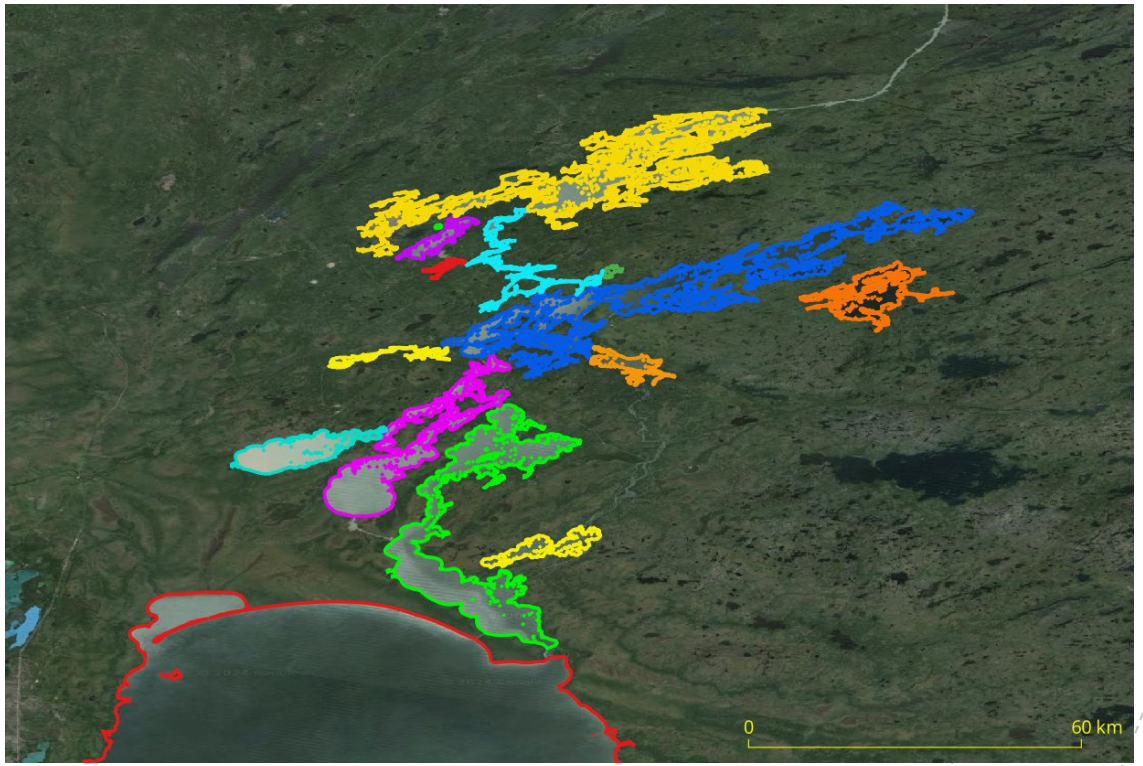


ASSIGNMENT ISSUES

Example north of Lake Winnipeg: various smaller lakes linked by small rivers

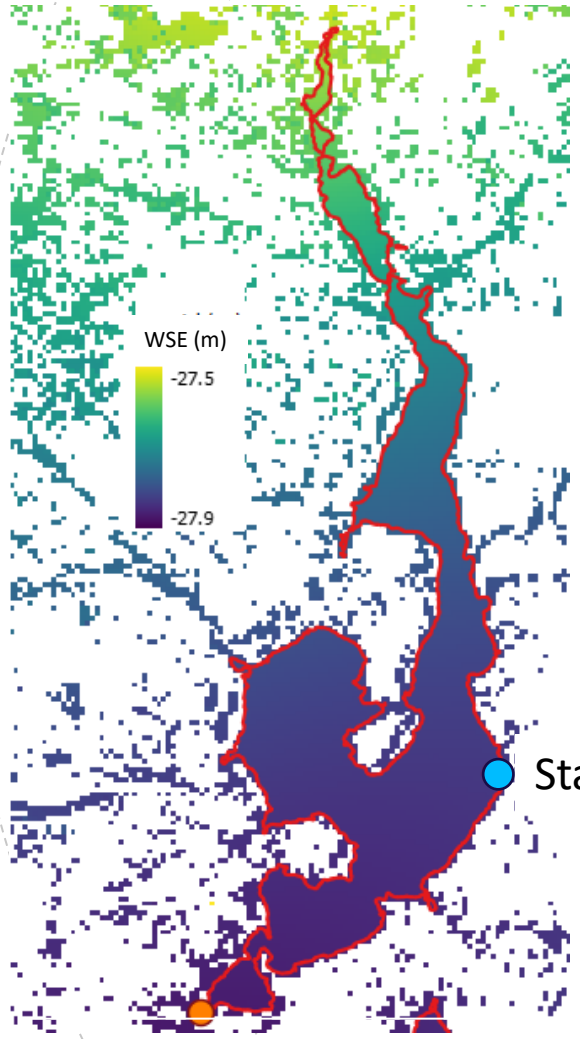


Current PLD



Better PLD

GEOID VARIATIONS



North : -27.6054

Raster product WSE
PLD lake polygon

Station 030296 : -27.8346

South : -27.8709

Station 030202 : -27.8705

Example of Lake Aylmer (Canada)

- Water surface (true geoid) varies significantly from North to South w.r.t. EGM2008 (~27cm).
- If the observation is partial (dark water), the resulting WSE in the LakeSP product will not be representative of the actual lake average.
- geoid_hght value in the LakeSP product is computed from the pixels used to compute the WSE.
- Also impacts the comparison with in situ data.
- Better handling is under investigation.

MAIN LAKE ERROR SOURCES (1/2)

- Azimuth smearing
  - Lake extent systematically over-estimated
    - Larger impact on relative area error of small lakes
    - Can be improved through algorithm modifications (better handling of edge pixels, water fraction estimates…)
- Dark water
  - Area errors because of imperfect dark water flagging (estimation of extent or projection)
    - Can be improved through improved prior water occurrence masks , reference DEM and projection algorithm
- Bright land (humid soil, urban areas…)
  - Bright land detected as water adjacent to PLD lakes may cause important overestimation of lake area.
    - Can be partially mitigated through active use of bright land flag

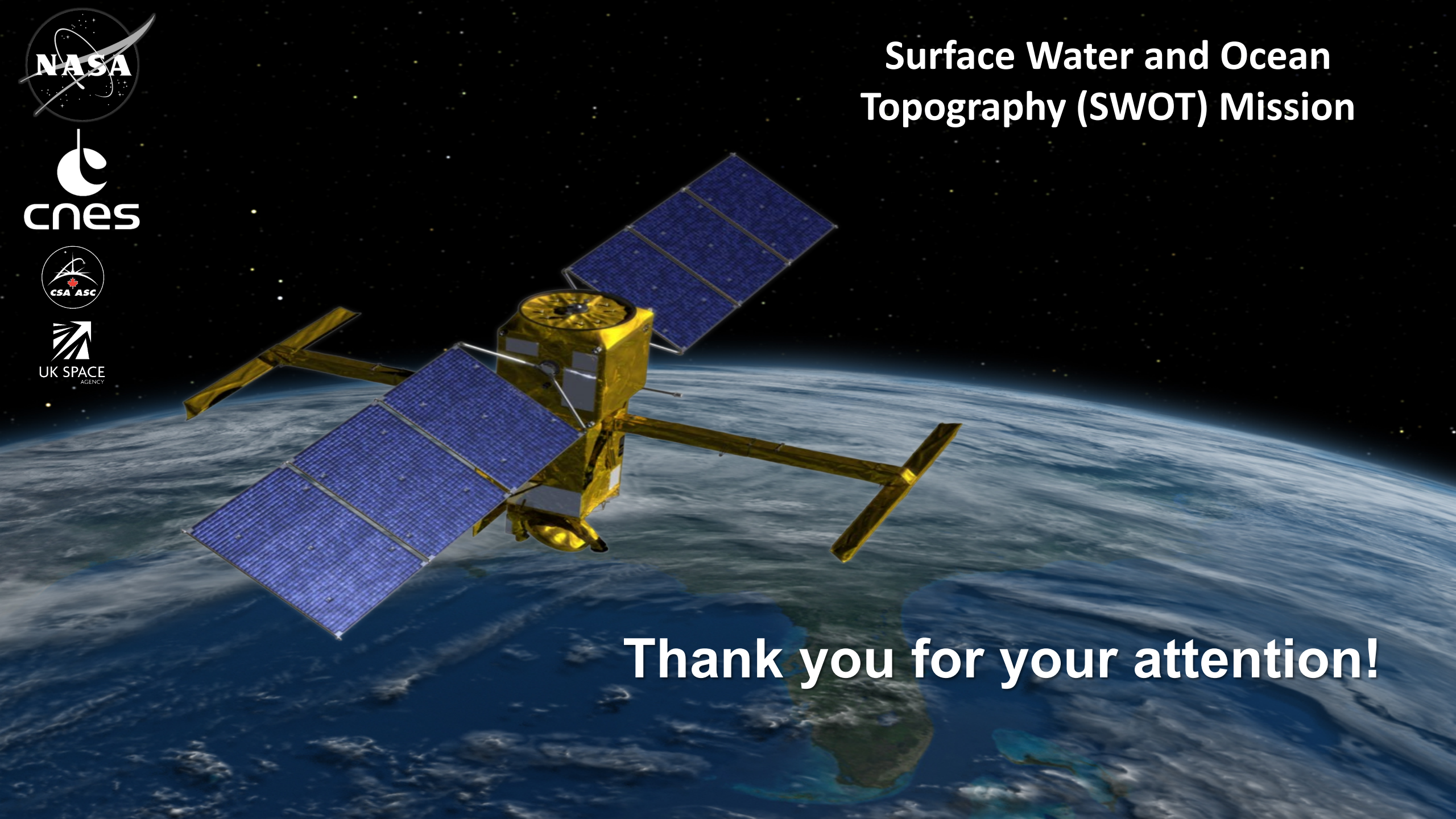
MAIN LAKE ERROR SOURCES (2/2)

- Specular ringing
  - Specular ringing may seriously deteriorate lake polygon and degrade lake area and wse.
    - Handling of specular ringing will be improved in future versions
- Geoid errors
  - Significant differences between the EGM2008 geoid and the actual lake water surface topography may lead to errors average lake WSE, especially for large lakes and partial observations.
    - Ongoing investigations to handle this better in future versions
- Assignment errors
  - Missing connected rivers in SWORD and missing nearby lakes in PLD may cause assignment and area errors.
    - Improved versions of SWORD and PLD will reduce the assignments errors, likewise improved assignment algorithms.

PLAN FOR NEXT DELIVERIES

- End of August (in forward processing in October 2024)
  - Lake processing :
    - Correction of bugs identified by the SDS
    - Bug fix in height-constrained geolocation
    - Refine quality_f flag
  - PLD : update with missing or inaccurate lakes, identified by ST and us

- End of November (in forward processing in January 2025)
  - Lake processing:
    - Bug in handling height of dark water pixels during segmentation step
    - Better handling of specular ringing in LakeSP product
    - Better assignment of pixels to PLD lakes with TopoCat (Jida Wang & Safat Sikder)
    - Take PIXC evolutions into account (after analysis of forward processing of October 2024)
    - Bug fixes
  - PLD:
    - Analysis of storage change values computed for the 26 lakes that currently have bathymetry
    - Addition of other external bathymetries
    - Extension to other lakes with p_ref_height computed from SWOT

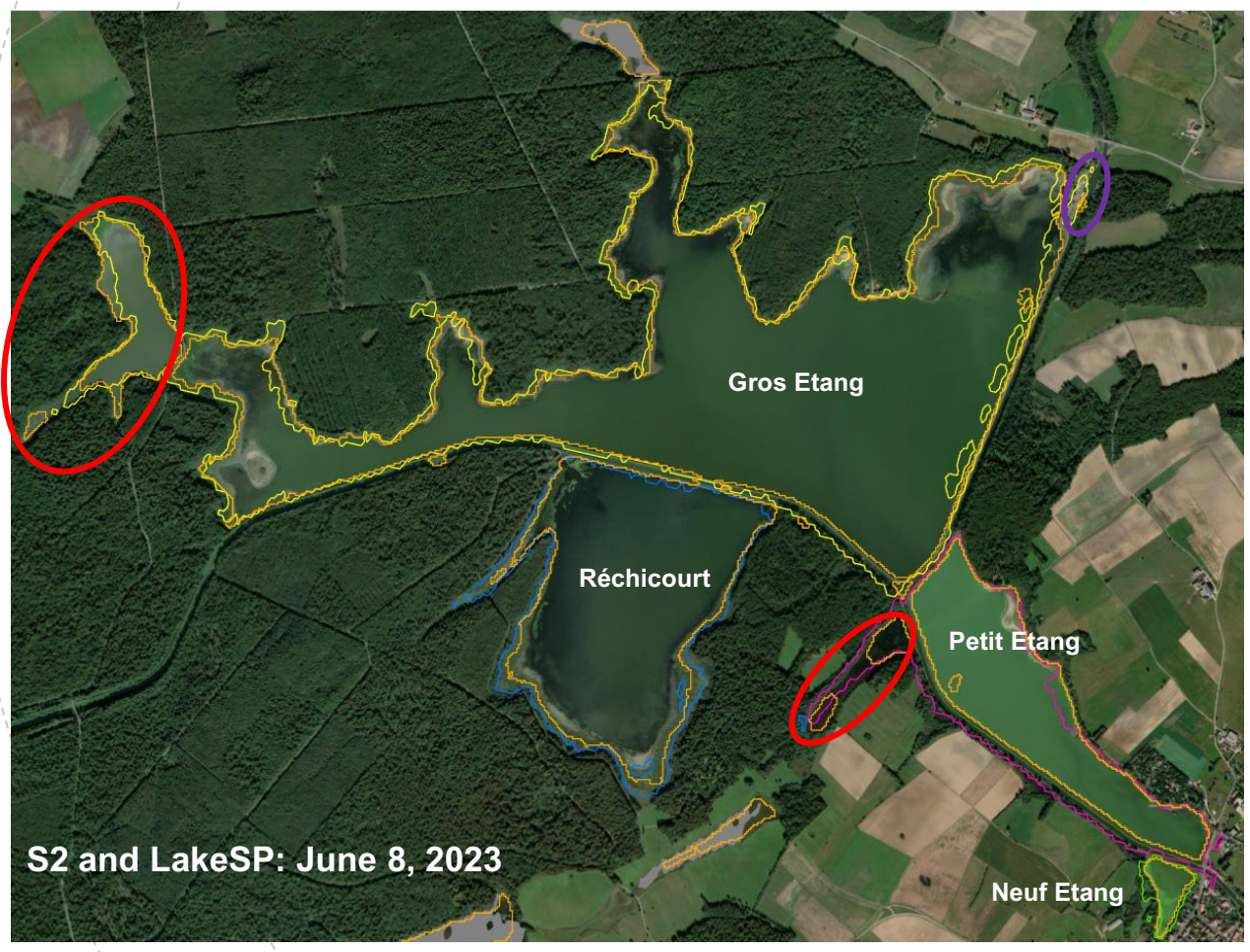

NASA
cnes
CSA ASC
UK SPACE AGENCY
Surface Water and Ocean Topography (SWOT) Mission
Thank you for your attention!

BACK-UP

© CNES/DERAMECOURT Arnaud, 2007

ASSIGNMENT ISSUES

Gondrexange

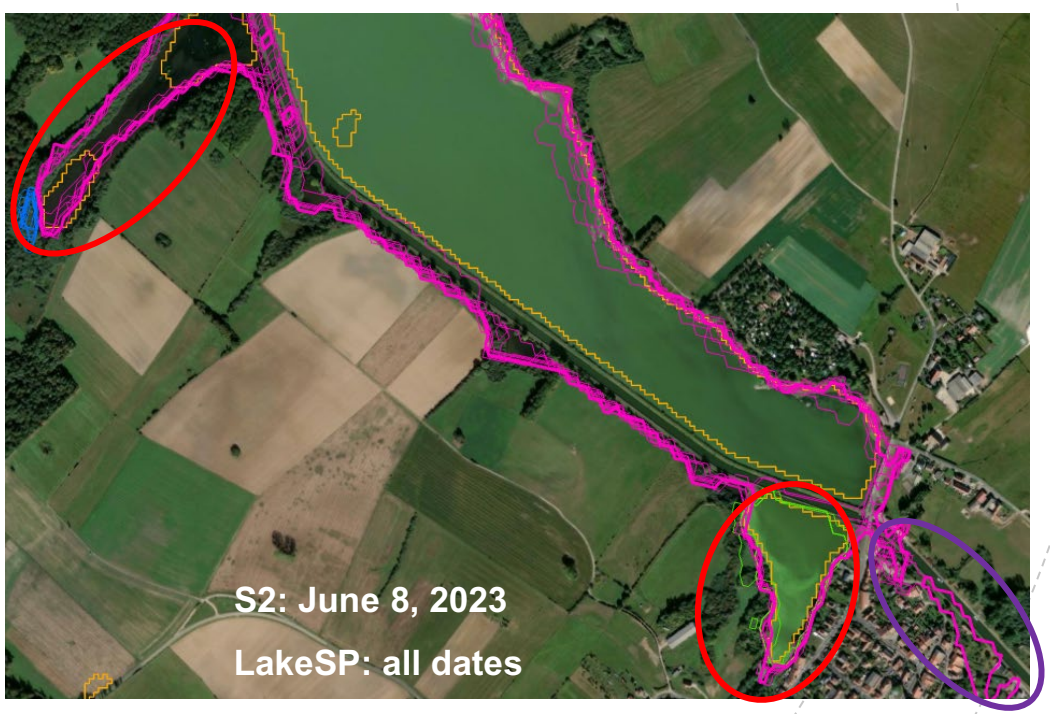


S2

lake_id
- 2320162172 Neuf Etang
- 2320166602 Gros Etang
- 2320166622 Réchicourt
- 2320166632 Petit Etang

LakeSP

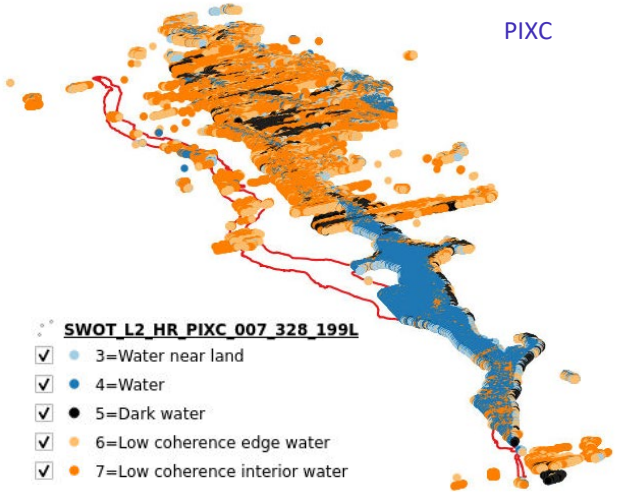
- Separate water body, not in PLD, erroneously included in PLD lake of LakeSP_Prior product.
- Small river, not in SWORD, erroneously included in PLD lake of LakeSP_Prior product.

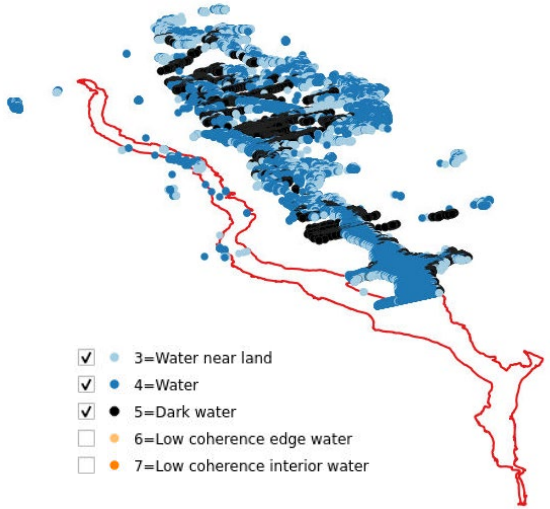


Courtesy: Sabrine Amzil, Thomas Ledauphin, Jérôme Maxant, Hervé Yésou

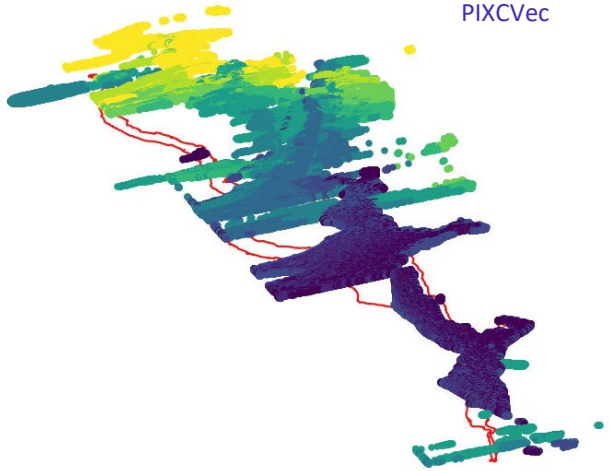
SPECULAR RINGING

PIXC

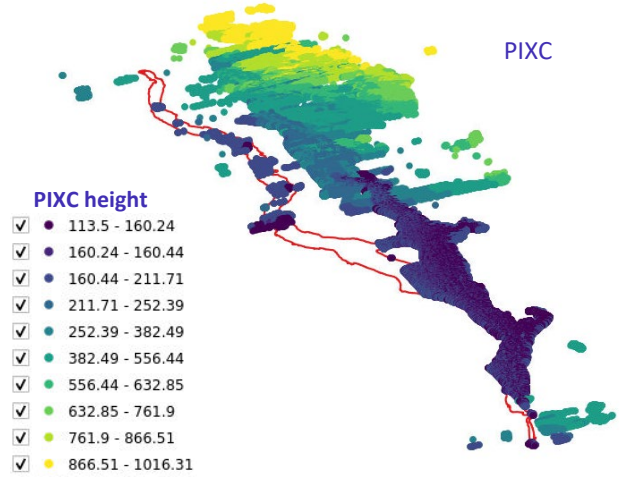


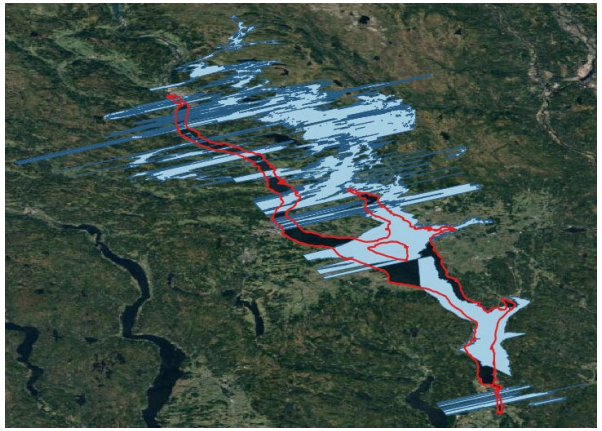


PIXCVec



PIXC





PIXC/PIXCVec