RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

SWOT HR

~ FUTURE ALGORITHM WORK ~

lake extent and reorganization of lake products

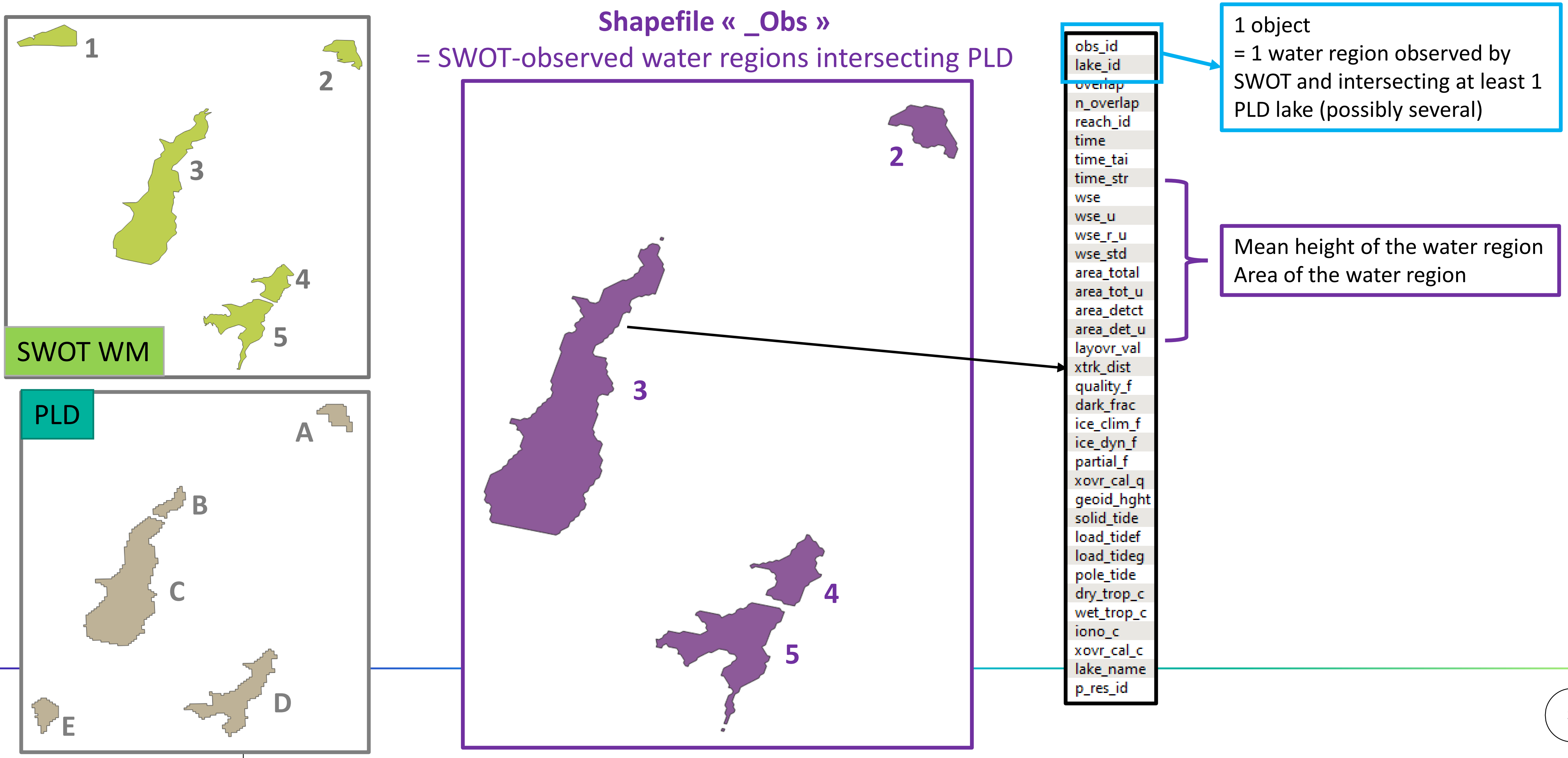
Claire Pottier, Roger Fjørtoft
on behalf of the HR Algorithm Development Team

SWOT SCIENCE TEAM MEETING, ARCACHON, FRANCE
15 OCTOBER 2025

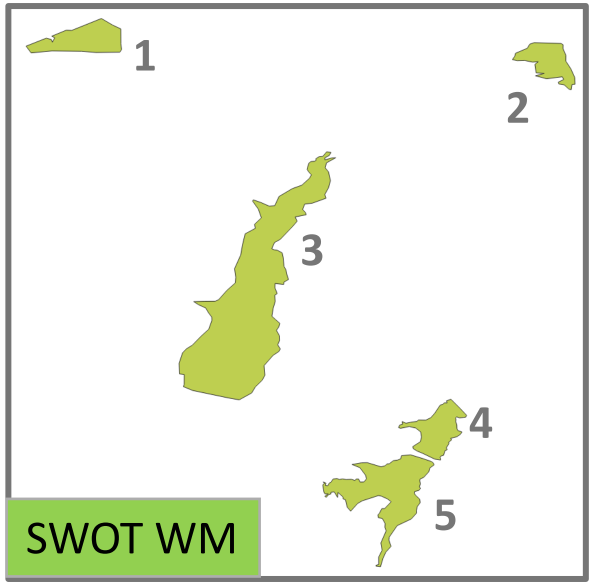
1

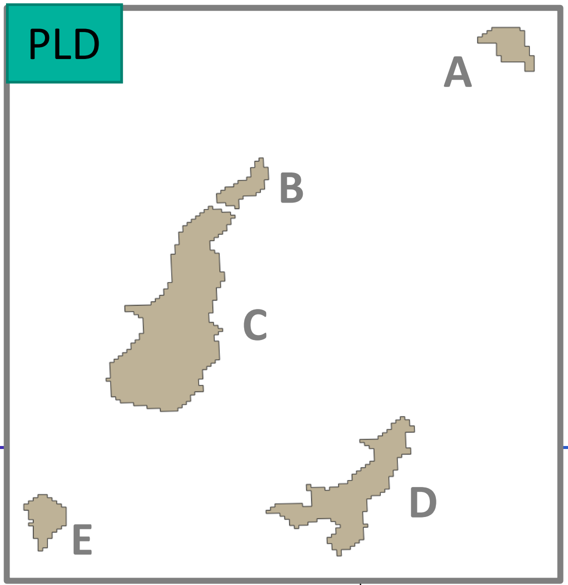
CURRENT LAKESP PRODUCTS

LAKESP PRODUCT = 3 POLYGON SHAPEFILES



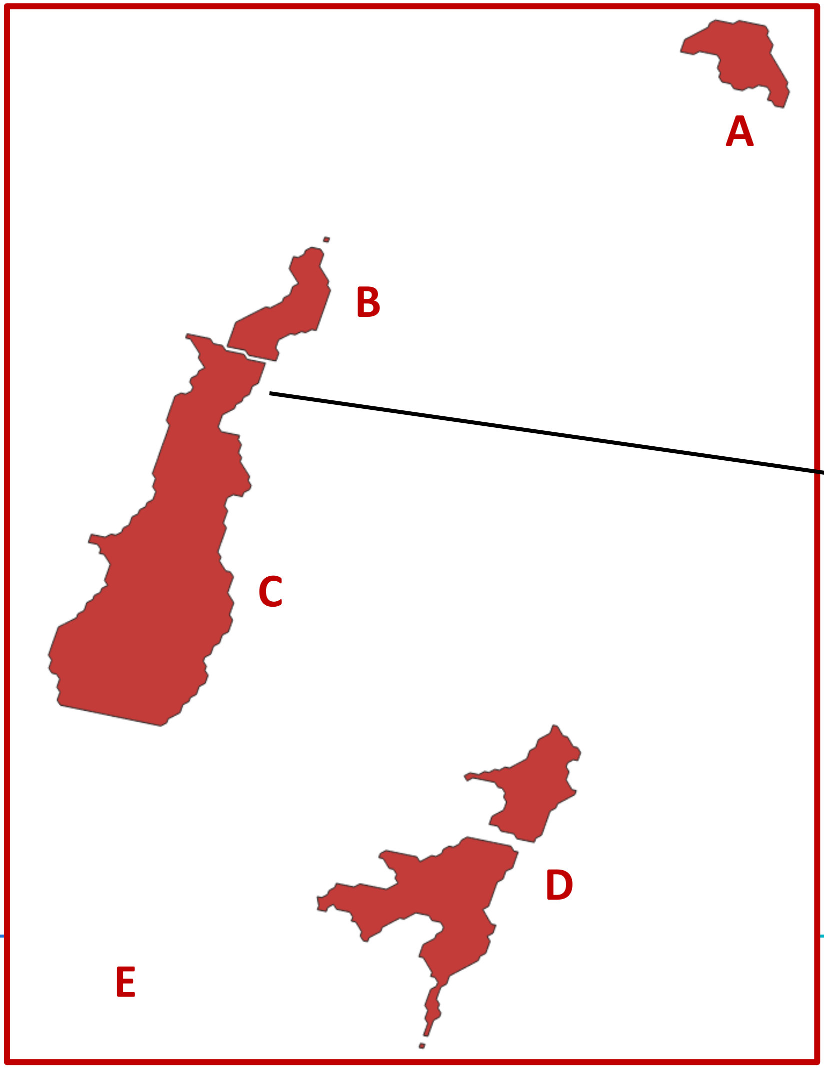
LAKESP PRODUCT = 3 POLYGON SHAPEFILES





Shapefile « _Prior »

= SWOT-observed (and unobserved) PLD lakes



- lake_id
- reach_id
- obs_id
- overlap
- n_overlap
- time
- time_tai
- time_str
- wse
- wse_u
- wse_r_u
- wse_std
- area_total
- area_tot_u
- area_detct
- area_det_u
- layovr_val
- xtrk_dist
- ds1_l
- ds1_l_u
- ds1_q
- ds1_q_u
- ds2_l
- ds2_l_u
- ds2_q
- ds2_q_u
- quality_f
- dark_frac
- ice_clim_f
- ice_dyn_f
- partial_f
- xovr_cal_q
- geoid_hght
- solid_tide
- load_tidef
- load_tideg
- pole_tide
- dry_trop_c
- wet_trop_c

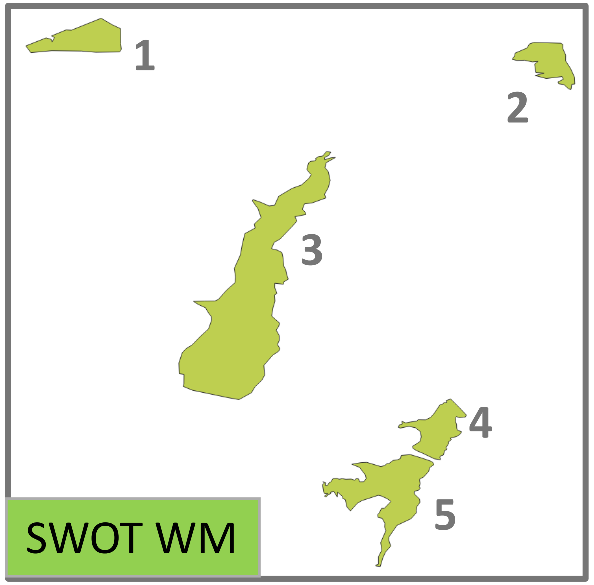
1 object
= 1 PLD lake, overflown by SWOT during the pass

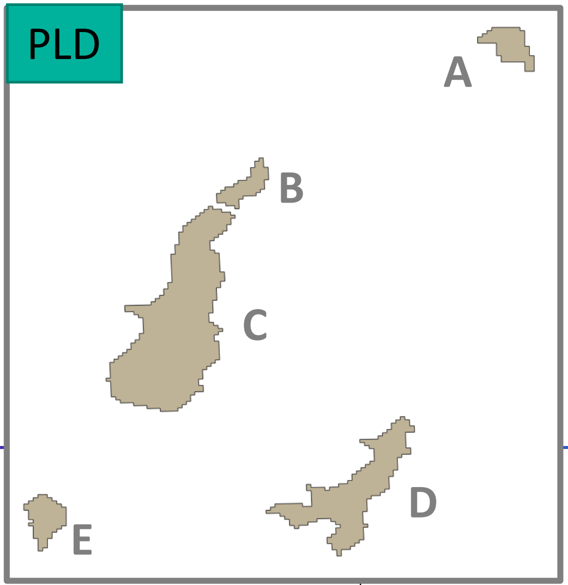
(obtained by splitting or merging _Obs objects to have one-to-one relationship with PLD lakes)

Mean height of the PLD lake
Area of the PLD lake

Storage change
(2 algorithms [Crétaux et al.])

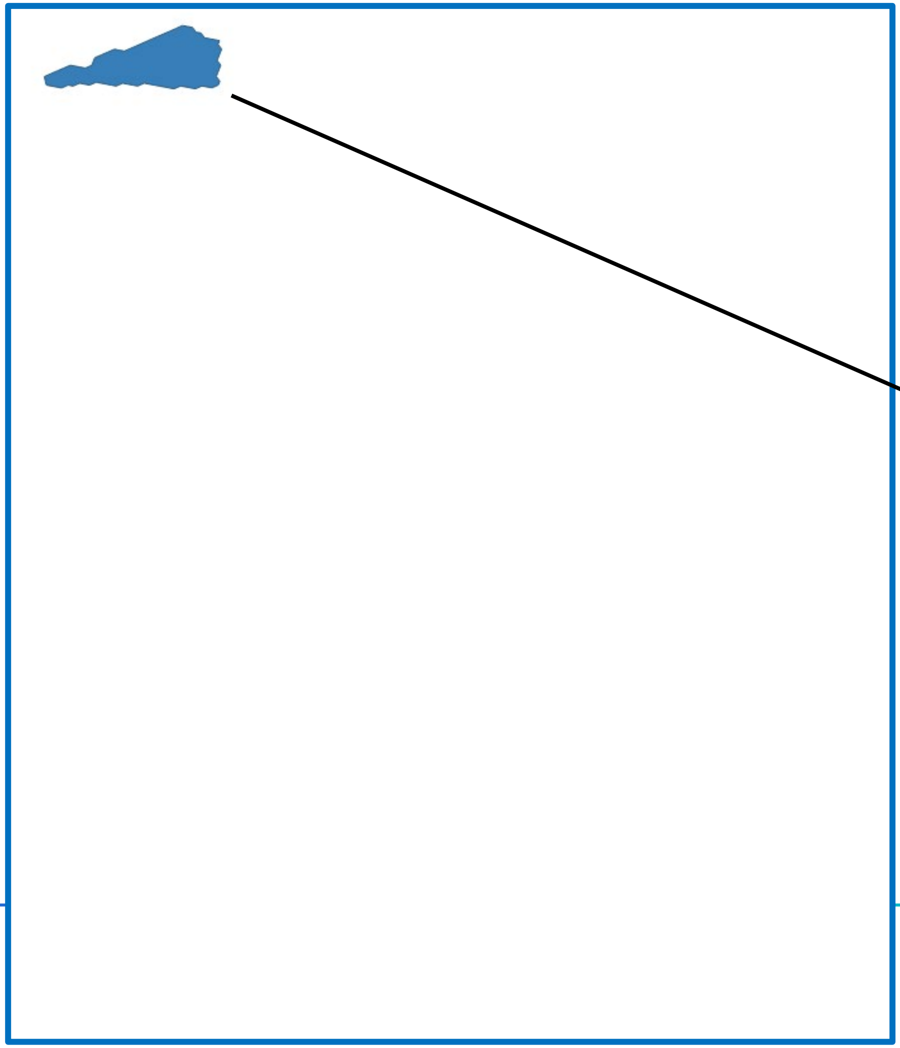
LAKESP PRODUCT = 3 POLYGON SHAPEFILES





Shapefile « _Unassigned »

= water regions not linked to PLD (nor PRD)



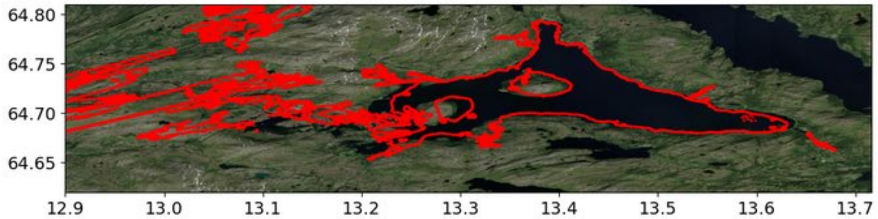
obs_id
time
time_tai
time_str
wse
wse_u
wse_r_u
wse_std
area_total
area_tot_u
area_detct
area_det_u
layovr_val
xtrk_dist
quality_f
dark_frac
ice_clim_f
ice_dyn_f
partial_f
xovr_cal_q
geoid_hght
solid_tide
load_tidef
load_tideg
pole_tide
dry_trop_c
wet_trop_c
iono_c
xovr_cal_c

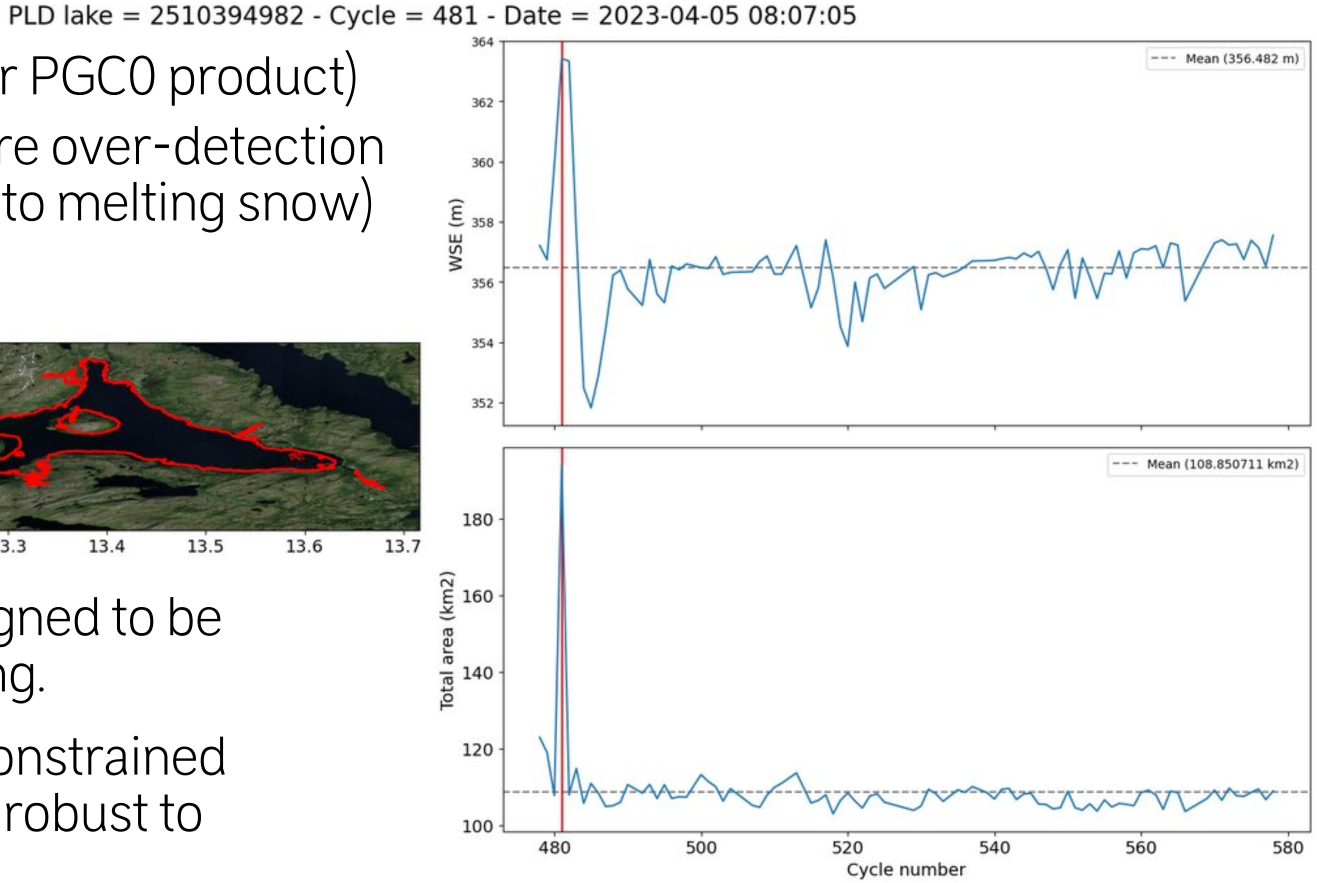
1 object
= 1 SWOT-observed water region

Mean height over the water region
Area of the water region

LIMITATIONS: BIG LAKE WSE ERRORS ARE OFTEN LINKED TO OVER-DETECTION OF WATER

- Example: Tunnsjø lake, Norway (LakeSP_Prior PGC0 product)
  - Huge area and WSE outlier caused by severe over-detection of water on April 5th 2023 (probably linked to melting snow)





- LakeSP_Prior (and _Obs) products were designed to be able to capture extreme events such as flooding.
- Their lake extents are therefore not strongly constrained by prior knowledge of water surfaces, and not robust to over-detection of water (wet soil, snow…)

LIMITATIONS

- To be able to detect unusual events such as inundations, the LakeSP_ ... Prior products contain **everything** that has been detected as water by SWOT ... ygons:
  - Even in version D, it often incorporates regions that ... soil, layover…)
  - This leads to erroneous water surface elev... egions are connected to lakes
- LakeSP_Obs and LakeSP_Prior shar...
  - The water surfaces are th... split into objects is different: per observation in the _Obs file, and per P...
- Filenames are...
  - A lot of peop... _Obs file because they believe that it contains the ***Obs***ervations and that the LakeSP_Prio... ontains ***Prior*** data

It’s time to change!

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes

2

PROPOSITION FOR NEW LAKESP PRODUCT

LIMITATIONS

- To be able to detect unusual events such as inunda[…] _Prior products contain everything th[…] polygons:
  - Even in versio[…] water (wet soil, layover…)
  - This leads to er[…] surface elevation and area when these regions are connected to lakes
- LakeSP_Obs and LakeSP_Prior shapefiles are redundant:
  - The water surfaces are […] objects is different: per observation in the _Obs file, and per PLD […] _Prior file
- Filenames are confusing:
  - A lot of people use the […] believe that it contains the *Obs*ervations and that the LakeSP_Prior file only contains *Prior* data

Add a new shapefile, similar to LakeSP_Prior but more strongly constrained by prior data

Discard the LakeSP_Obs shapefile

Make filenames more meaningful

NEW LAKESP SHAPEFILE
→ PIXC SELECTION FOR AREA

CURRENT _PRIOR (* will be renamed)

- classification =
  - 3 = water near land
  - 4 = open water
  - 5 = dark water
  - 6 = low-coherence water near land
  - 7 = low-coherence open water
- classification_qual AND geolocation_qual NOT "bad"
  + variable bright_land_flag NOT 1 = bright_land
  + exclude pixels having classification_qual.
  detected_water_but_no_prior_water=1 AND
  classification_qual.specular_ringing_degraded=1
- pixels gathered in slant (range, azimuth) plane (radar geometry)

NEW SHAPEFILE

- SAME CRITERIA
  + constraints from prior data to limit the extent
- classification_qual.detected_water_but_no_prior_water = 0 *(=1 when water is detected but the prior water probability is low, based on thresholded GSWO also used for dark water flagging)*
- Other options to investigate:
  - prior_water_prob > 0? *(probability of water occurring from a prior water mask, currently GSWO)*
  - OR PLD polygon? *(too strict?)*
  - OR segmentation, to keep only the “flat” water and exclude the wet shorelines? *(feasibility TBC and possibly too time consuming?)*
  - OR broader bright_land_flag? *(beyond urban areas)*

NEW LAKESP SHAPEFILE
→ PIXC SELECTION FOR WATER SURFACE ELEVATION

CURRENT _PRIOR (* will be renamed)

- PIXC inside the detected water region
- IF nb of PIXC of classification 4 > 5:
  - Keep only these PIXC
- ELSE:
  - Keep also PIXC of classification 3

NEW SHAPEFILE

- SAME criteria = PIXC inside the detected water region *(better results now that the PIXC pixels selected for the water region are more strongly filtered?)*
- 2 other options under test:
  - PIXC inside the PLD polygon
  - PIXC such as prior_water_prob > 95% (TBC)

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes

NEW LAKESP SHAPEFILE
→ METHOD TO COMPUTE WATER SURFACE ELEVATION

CURRENT _PRIOR (* will be renamed)

- Same as in RiverSP products = uncertainty-weighted average of the wse_p of each selected PIXC [B. Williams, JPL]:
  - $wse_p = height_p - geoid_p - solid\_tide_p - load\_tide\_fes_p - pole\_tide_p$
  - Weights: $w_p = 1 / height\_std_p^2$ where $height\_std_p = phase\_noise\_std_p * dheight\_dphase_p$
    - $phase\_noise\_std_p$ = the phase noise standard deviation
    - $dheight\_dphase_p$ = sensitivity of height estimate to interferogram phase

NEW SHAPEFILE

- SAME method *(better results now the PIXC pixels selected for the water region are more strongly filtered?)*
- 3 other options under test:
  - Median of wse_p
  - Filter the « height » outliers out of mean +/- 1*std before computing the mean of wse_p
  - Filter the « sig0 » outliers out of mean +/- 1*std before computing the mean of wse_p

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cnes

ON-GOING WORK

- Prototype already implemented (covering all the options)

- Will soon be tested on a large dataset
  - Quantify the improvement w.r.t current version PxD0
  - Estimate the best options (end of year)

- Provide a time series over a tile of this new product to the science community (~early 2026)

- Other evolutions (for all shapefiles):
  - Improve the quality bitflag (and thereby also the general quality flag)
  - Populate the dynamic ice flag based on SWOT data
  - Add new attributes (TBC):
    - Bring the new PIXC variables related to the previous and next xovers down to the lake product level
    - Add a « big lake » flag by computing the standard deviation of the geoid in the PLD lake
  - …


SWOT
SURFACE WATER & OCEAN TOPOGRAPHY
Contacts:
claire.pottier@cnes.fr
roger.fjortoft@cnes.fr
Thank you for your attention!