SWOT INLAND WATER

The Lake Single-Pass Data Products:
Format, Content, and Status

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SWOT Science Team meeting
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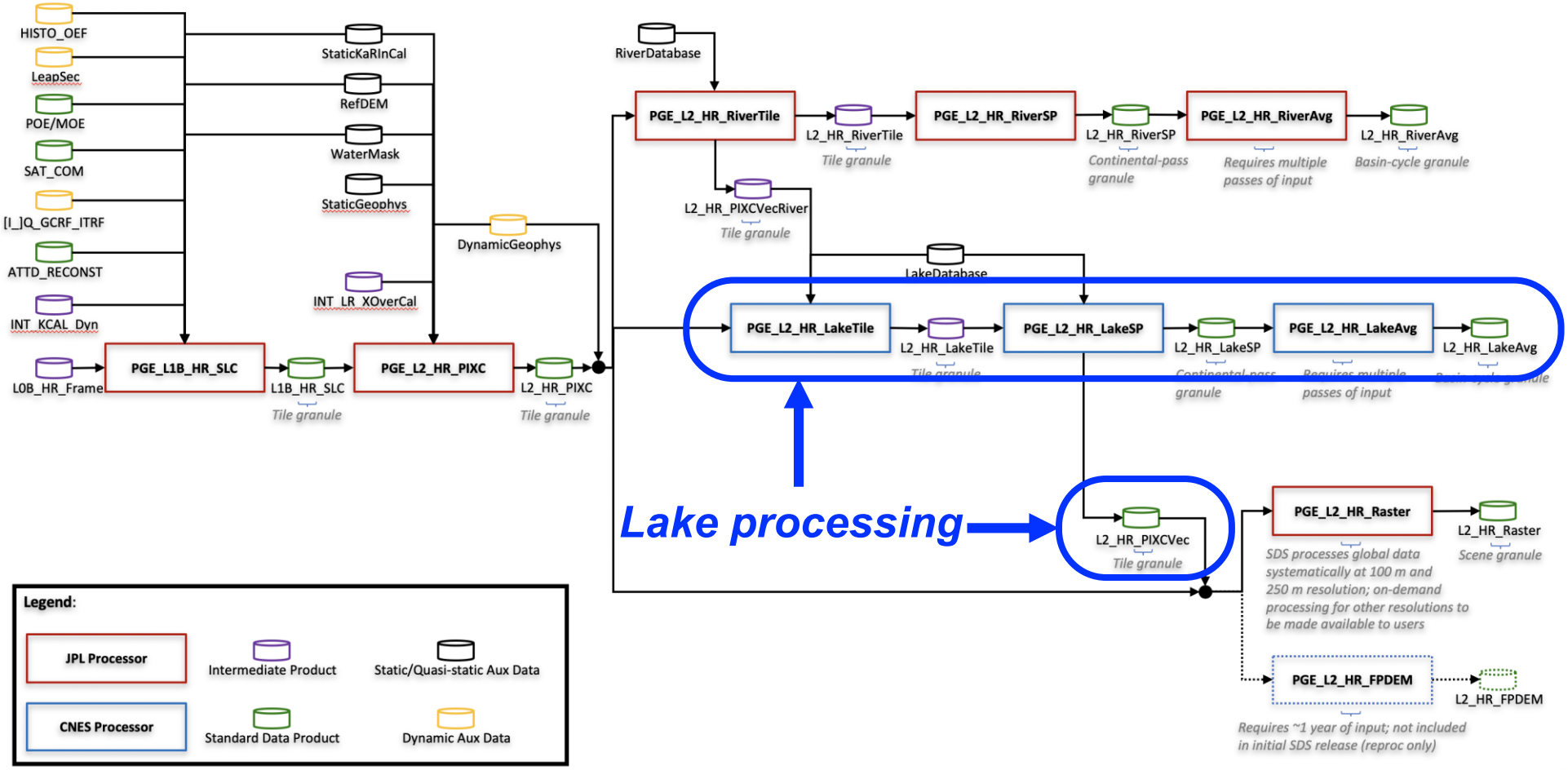
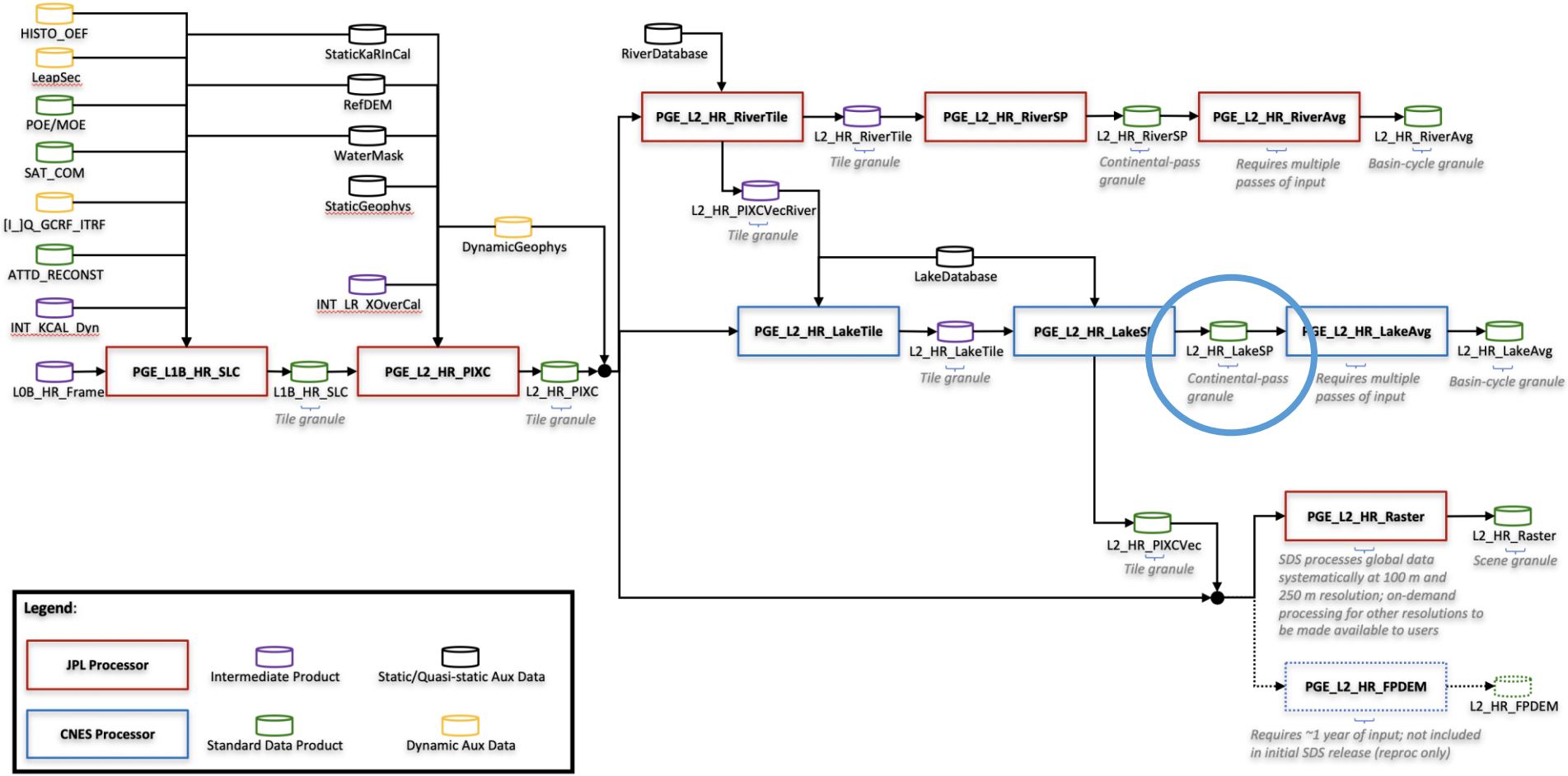
cnes CENTRE NATIONAL D'ÉTUDES SPATIALES

KaRIn HR Processing Flow



KaRIn HR Processing Flow



Format

Esri shapefile

- Classic files + .shp.xml file for metadata
- Filename = SWOT_L2_HR_LakeSP_<CycleID>_<PassID>_<ContinentID>_<RangeBeginningDateTime>_<RangeEndingDateTime>_<CRID>_<ProductCounter>.<ext>
- Granule: 1 cycle / 1 pass / full-swath / 1 continent
- Continent from HydroBASINS

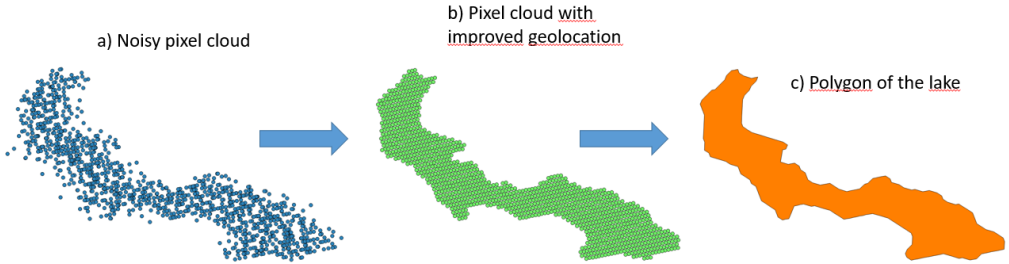
Content

Record

- 1 object = 1 « lake » > 1ha (TBC)
- « lake » = PIXC – pixels already processed by River Processor (except reservoirs)
  - lakes and reservoirs identified in the Prior Lake Database (PLD)
  - lakes not in the PLD
  - small rivers not in Prior River Database (PRD)…

Geometry

- Shape = polygon = concave hull of the pixels after improvement of their geolocation



Volume

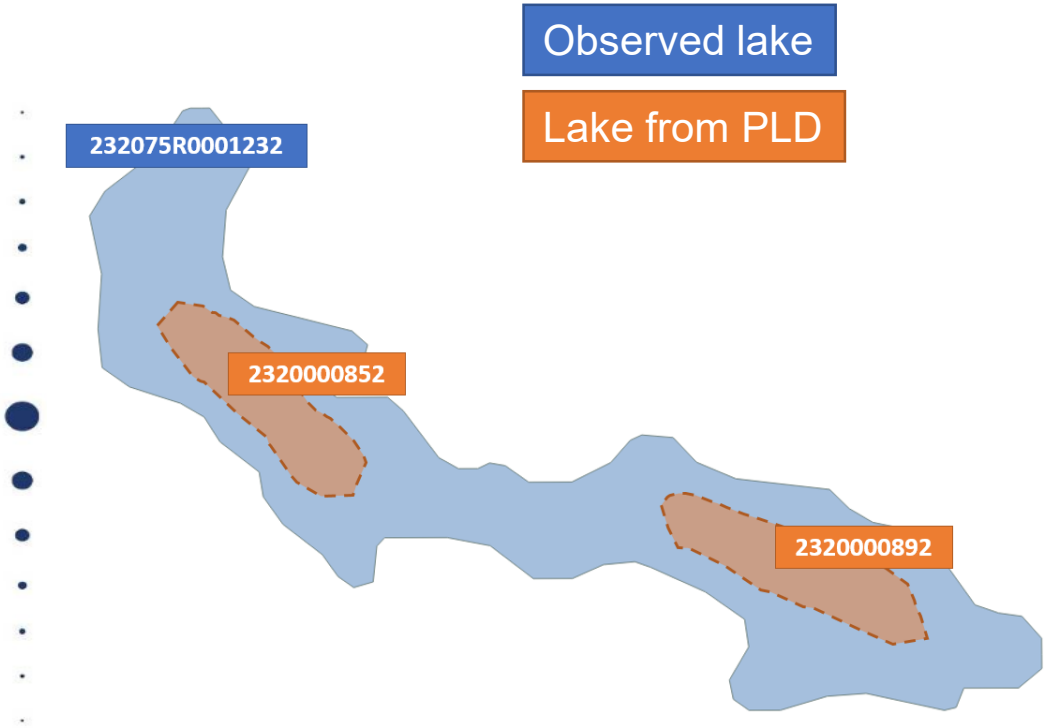
- ~400MB/pass/continent
- ~5GB/day

Content

Basic - *Expert* attributes

Identifiers

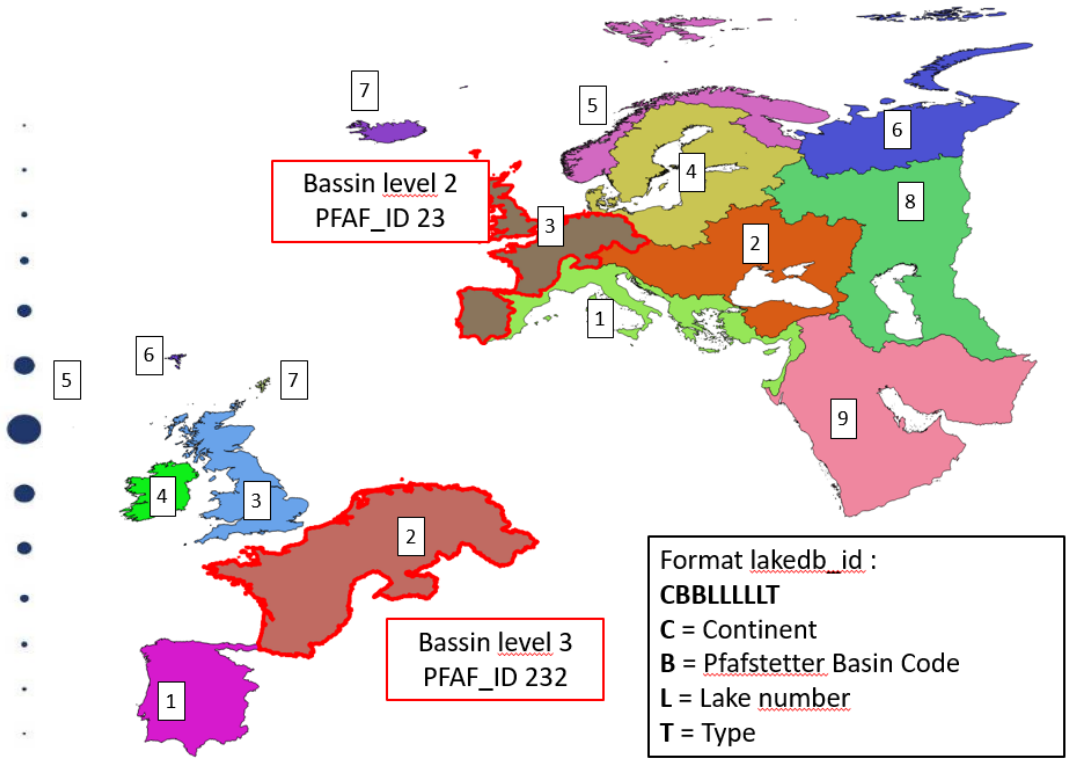
- ***lakeobs_id*** = CBBTTTSLLLLLLT
  - CBB = Pfafstetter basin identifier from HydroBASINS
  - TTT = PIXC tile number
  - S = swath side (right/left)
  - LLLLLL = lake number in the PIXC tile
  - T = type (2=Lake or 3=Lake over river)
- ***lakedb_id*** = list of identifiers of prior lakes intersecting the observed lake
  - Ex: 2320000852;2320000892



Content

Identifier in the PLD

- *lakedb_id* = CBBLLLLLLT
  - CBB = Pfafstetter basin identifier from HydroBASINS *(same as for rivers)*
  - LLLLLL = lake number
  - T = type (2=Lake or 3=Lake over river)



Content

Basic - *Expert* attributes

Time

- ***time***: Time in UTC time scale (seconds since January 1, 2000 00:00:00 UTC which is equivalent to January 1, 2000 00:00:32 TAI),
- ***time_tai***: Time in TAI time scale (seconds since January 1, 2000 00:00:00 TAI, which is equivalent to December 31, 1999 23:59:28 UTC).
- The attribute *time* has a metadata field named *tai_utc_difference*, which represents the difference between TAI and UTC (i.e., total number of leap seconds) at the time of the first measurement record in the products granule.
  - time_tai[0] = time[0] + tai_utc_difference

Content

Basic - *Expert* attributes

Measured hydrological parameters (1/2)

- ***wse***: Average water surface elevation of the lake, relative to the geoid, with all corr. for media delays (wet and dry troposphere, and ionosphere) and tidal effects applied
- ***wse_u***: Total uncertainty (random and systematic) in ***wse***
- ***wse_r_u***: Random-only component of ***wse_u***
- ***height_std***: Standard deviation of the height of all the pixels composing the lake (computed only for large lakes > 5000ha TBC)
- ***area_detct***: Area of pixels detected as water by the SWOT observations

Content

Basic - *Expert* attributes

Measured hydrological parameters (2/2)

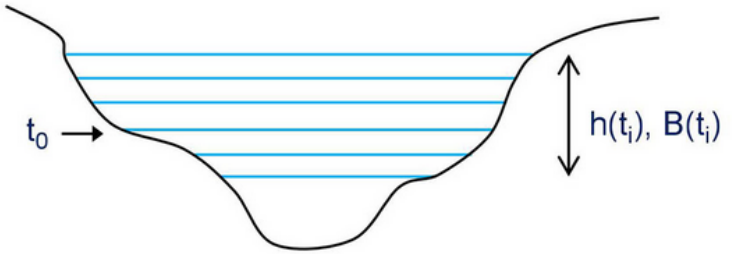
- ***area_det_u***: Total uncertainty (random and systematic) in ***area_detct***,
- ***area_total***: Total estimated water surface area = ***area_detct*** + dark water area (identified through the use of a prior water likelihood map)
- ***area_tot_u***: Total uncertainty (random and systematic) in ***area_total***
- ***layovr_val***: Placeholder for WSE error due to layover (TBD)
- ***xtrk_dist***: Distance from of the lake polygon centroid from the spacecraft nadir track (negative = left swath; positive = right swath)

Content

Basic - *Expert* attributes

Storage change, computed with 2 different methods [M. Quellec and JF. Crétaux]

- With respect to reference area and height in the PLD → only for observed lakes associated to 1 or more lake(s) or reservoir(s) in the PLD
- ***delta_s_Q*** and ***ds_u_Q***: storage change, and associated uncertainty, computed by the **quadratic** method (1)
- ***delta_s_L*** and ***ds_u_L***: storage change, and associated uncertainty computed by the **linear** method (2)



$$\Delta V\left(\frac{t_j}{t_0}\right) = \Delta V\left(\frac{t_{j-1}}{t_0}\right) + \frac{[B(t_j)+B(t_{j-1})+\sqrt{B(t_j)*B(t_{j-1})}]}{3} \cdot [h(t_i) - h(t_{i-1})] \quad (1)$$

$$\Delta V\left(\frac{t_j}{t_0}\right) = \Delta V\left(\frac{t_{j-1}}{t_0}\right) + \frac{[B(t_j) + B(t_{j-1})]}{2} \cdot [h(t_j) - h(t_{j-1})] \quad (2)$$

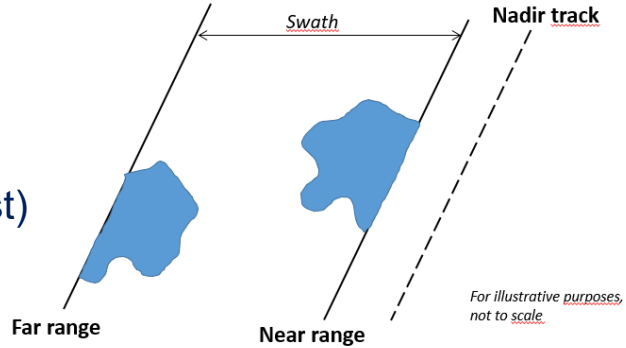
(Credits: M. Quellec and JF. Cretaux)

Content

Basic - *Expert* attributes

Quality indicators

- ***quality_f***: Summary quality indicator. 0=valid, 1=invalid.
- ***dark_frac***: Fraction of the lake total area (***area_total***) covered by dark water. Ranges bet. 0 and 1.
- ***ice_clim_f***: Climatological ice cover flag indicating. Indicates if the lake is ice-covered on the day of the observation based on climatological ice coverage (not the SWOT measurement). 1=partially ice covered, 2=fully ice covered
- ***ice_dyn_f***: Dynamic ice cover flag. Indicates if the lake is ice-covered on the day of the observation based on dynamic ice coverage, determined from analysis of optical satellite data (not the SWOT measurement). Only after reprocessing.
  1=partially ice covered, 2=fully ice covered
- ***partial_f***: Flag that indicates partial lake coverage flag.
  0=lake is fully covered by a half-swath,
  1=lake hits the right or left edge of the half-swath (a part of it may be lost)
- ***xovr_cal_q***: Quality of the cross-over calibration (TBD)



Content

Basic - *Expert* attributes

Geophysical references

- ***geoid_hght***: Lake-averaged geoid model height above the reference ellipsoid (EGM2008)
- ***earth_tide***: Lake-averaged solid-Earth tide height (Cartwright/Taylor model)
- ***pole_tide***: Geocentric pole tide height
- ***load_tide1***: Geocentric load tide height (FES2014); use to compute ***wse***
- ***load_tide2***: Geocentric load tide height (GOT4.10c)

Content

Basic - *Expert* attributes

Geophysical range corrections

- ***dry_trop_c***: Equivalent vertical correction due to dry troposphere delay (from ECMWF model)
- ***wet_trop_c***: Equivalent vertical correction due to wet troposphere delay (from ECMWF model)
- ***iono_c***: Equivalent vertical correction due to ionosphere delay (GIM)

Instrument correction

- ***xover_cal_c***: Equivalent height correction estimated from KaRIn crossover calibration

Content

Basic - *Expert* attributes

Prior Lake Database (PLD) information

- ***p_name***: Name(s) of the lake, retrieved from Open Street Map, IGN Carthage, GLWD and vMap0 databases
- ***grand_id***: Reservoir identifier from the Global Reservoir and Dam (GRanD) database
- ***p_height***: Reference height, used to compute the storage change
- ***p_area***: Reference area, used to compute the storage change

Content

Basic - *Expert* attributes

Basics

- In HR products (from PIXC), longitudes range between -180° and +180° (contrary to ocean products)
- _FillValues:

Data Type	Description	fill value
int4	integer (4 character storage)	-999
int9	integer (9 character storage)	-99999999
float	floating point (13 character storage)	-999999999999
text	maximum 254 character storage	“no_data”

Metadata

Attribute	Format	Description
conventions	string	Esri shapefile: http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf
title	string	Level 2 KaRIn high rate lake single pass vector product
institution	string	Name of producing agency.
source	string	SWOT/KaRIn
history	string	UTC time when file generated. Format is: "YYYY-MM-DD hh:mm:ss : Creation"
mission_name	string	SWOT
references	string	Provides version number of software generating product.
reference_document	string	SWOT-TN-CMD-0673-CNES
contact	string	Contact information for producer of product. (e.g., "ops@jpl.nasa.gov").
cycle_number	short	Cycle number of the product.
pass_number	short	Pass number of the product.
continent	string	Continent the product belongs to
equator_time	double	UTC time of the first equator crossing in product. Format is YYYY-MM-DDThh:mm:ss.ssssssZ
equator_longitude	double	Longitude of the first equator crossing in product (degrees_east)
start_time	string	UTC time of first measurement. Format is: YYYY-MM-DDThh:mm:ss.ssssssZ
stop_time	string	UTC time of last measurement. Format is: YYYY-MM-DDThh:mm:ss.ssssssZ
xref_input_l2_hr_pixc_files	string	List of water mask pixel cloud files used to generate data in product.
xref_input_l2_hr_lake_tile_files	string	List of LakeTile products used to generate data in product.
xref_static_lake_db_file	string	Name of static lake a priori database file used to generate data in product.
xref_l2_hr_lake_sp_param_file	string	Name of PGE_L2_HR_LakeSP parameter file used to generate data in product.
ellipsoid_semi_major_axis	double	Semi-major axis of reference ellipsoid in meters.
ellipsoid_flattening	double	Flattening of reference ellipsoid

(+ per attribute as in NetCDF files)

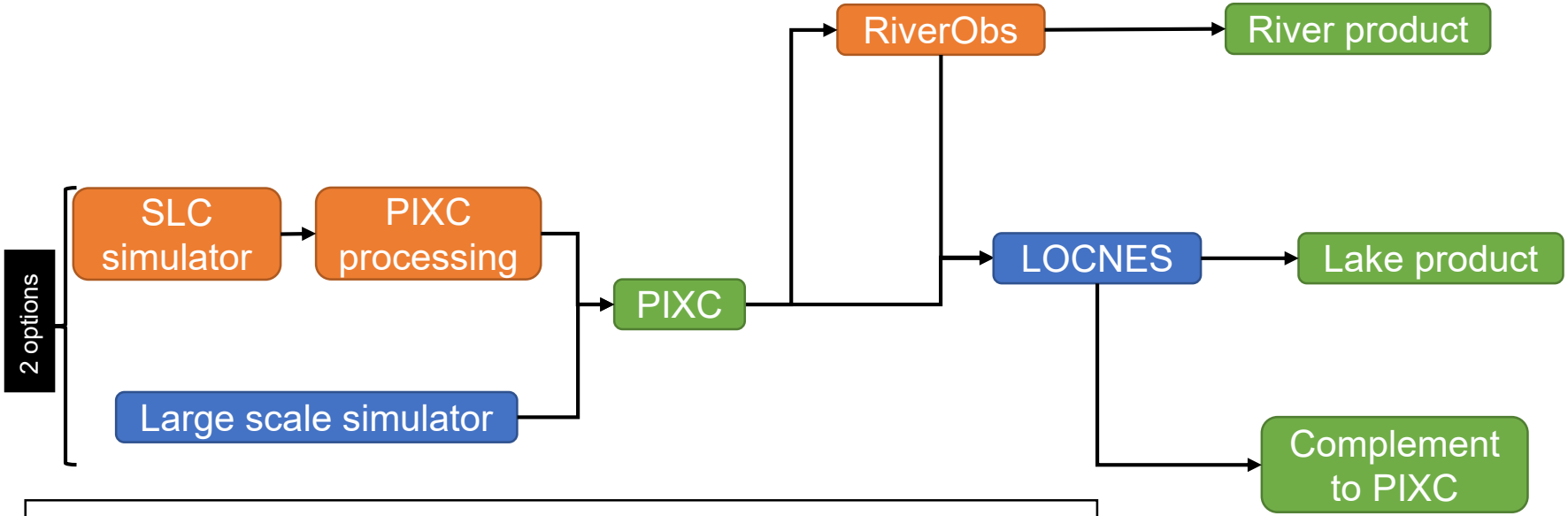
Status

- LakeSP PDD written and under review at JPL and CNES
- Already implemented:
  - 2 ways to compute the lake boundary (one preferred)
  - UTC time
  - Basic Water Surface Elevation, standard deviation, detected area, crosstrack distance
  - Storage change for basic case (1 observed lake ↔ 1 prior lake)
  - Dark water fraction and partial flag
  - Prior Lake Database information

Near-Term Plans

- Release LakeSP PDD along with sample dataset
- Prepare ATBD
- Further improvements:
  - Modify identifiers wrt the new format
  - Selection of pixels to keep for lake processing
  - Modify height computation similarly to RiverObs
  - Integrate random uncertainties attached to hydrological attributes and systematic uncertainty components
  - Storage change: integrate complex case
  - Calculating time (long for very big lakes)
- Set up a complete validation plan with large scale simulations and finer simulations using JPL SLC simulator

Simulations



SWOT hydrology toolbox *(in constant evolution)*
= Large scale simulator
+ Script permitting to run RiverObs
+ LOCNES
Available on GitHub: https://github.com/CNES/swot-hydrology-toolbox

Simulation over France with SWOT Hydrology Toolbox

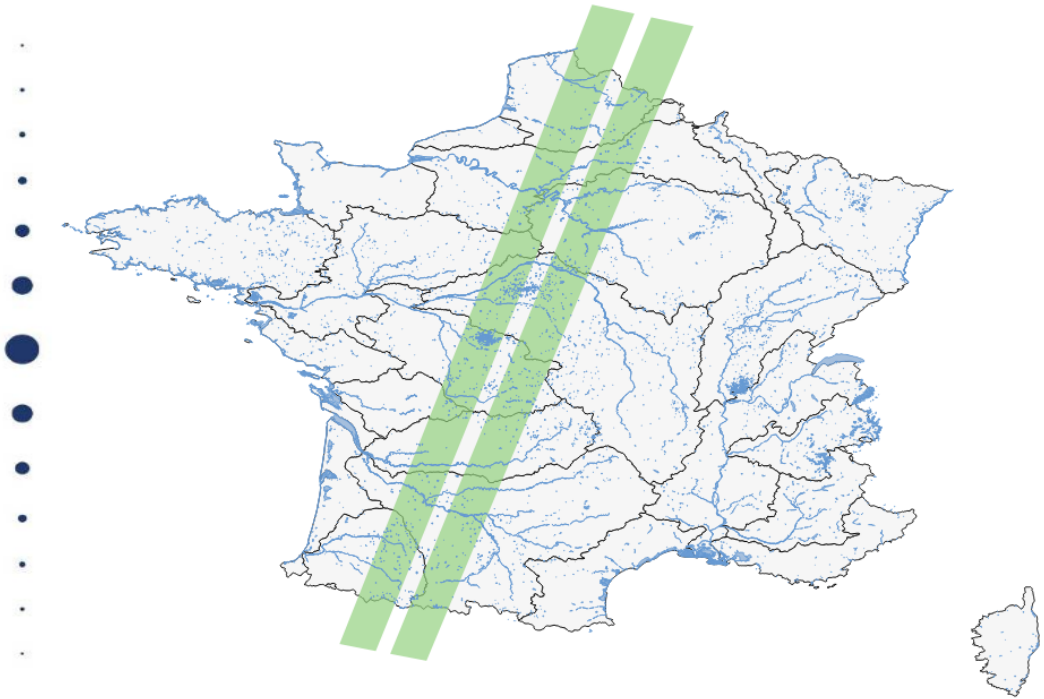
IGN Carthage DB

Selection of water bodies corresponding to:

- Lakes > 6.25ha
- Rivers > 50m

Track number 391

- ~2400 water bodies observed



Demo (if time for it ;-))

Questions?

Backup slide

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Simulation over France with SWOT Hydrology Toolbox

Output of large scale simulator:

- 30 PIXC tiles