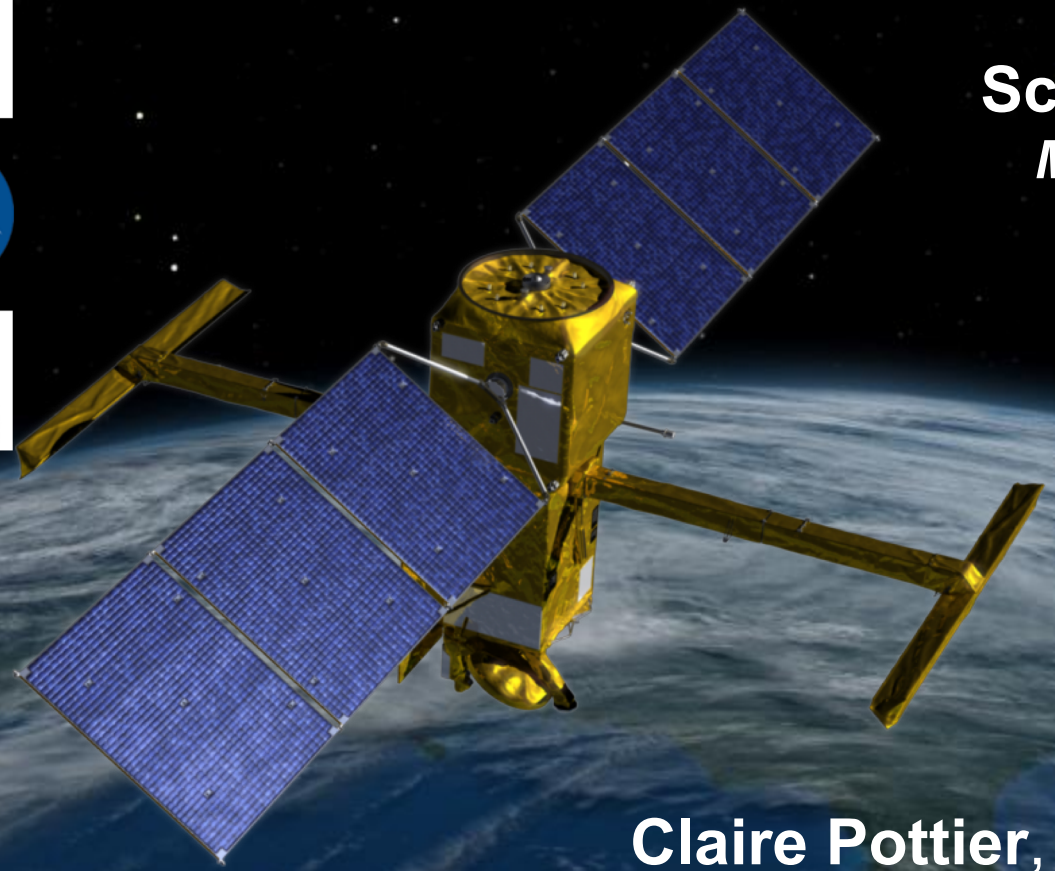
National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Surface Water and Ocean Topography (SWOT) Mission

Science Team Meeting

Montréal – June 26, 2018



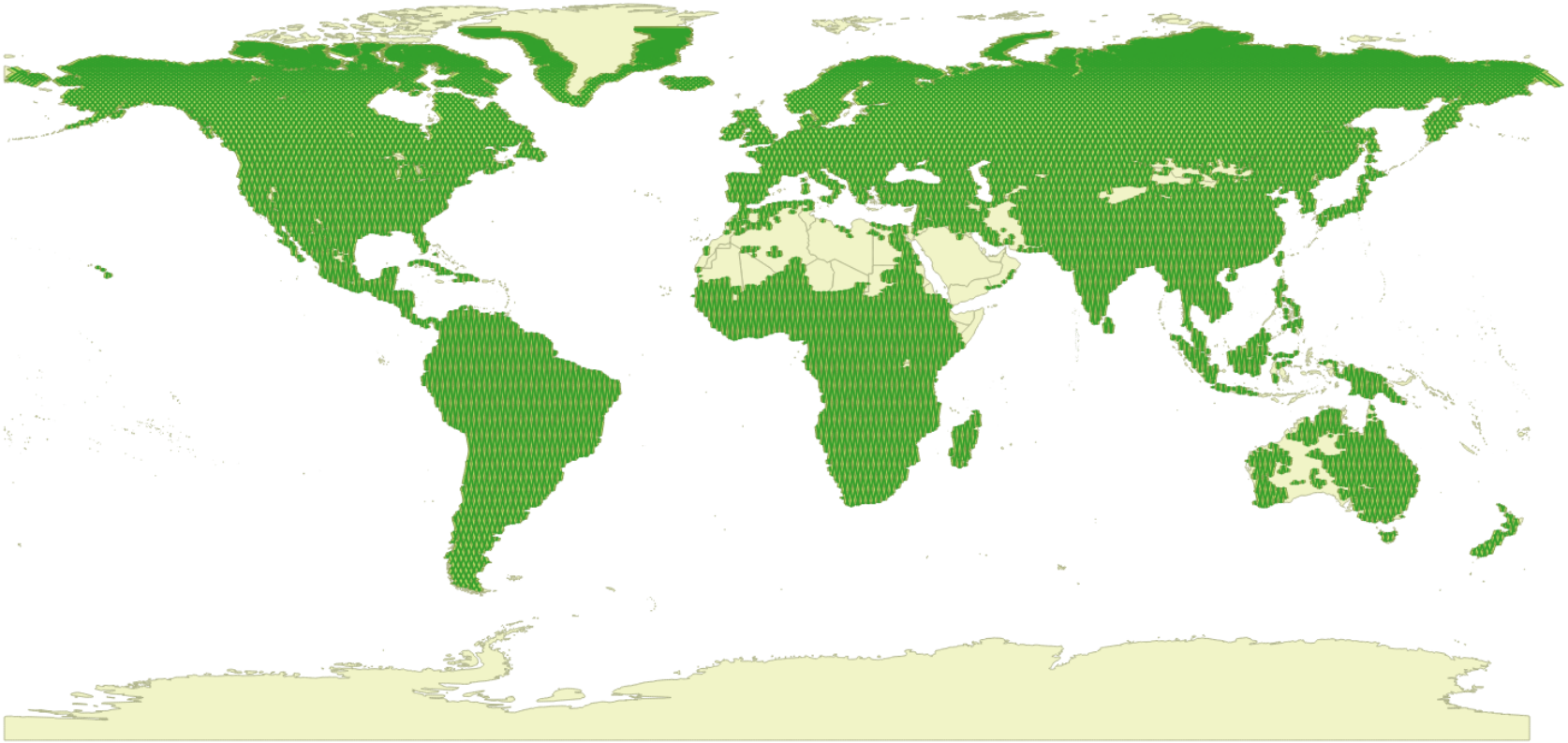
Hydrology Products Status

Claire Pottier, CNES – Lake Product

Joe Turk, JPL – River Product

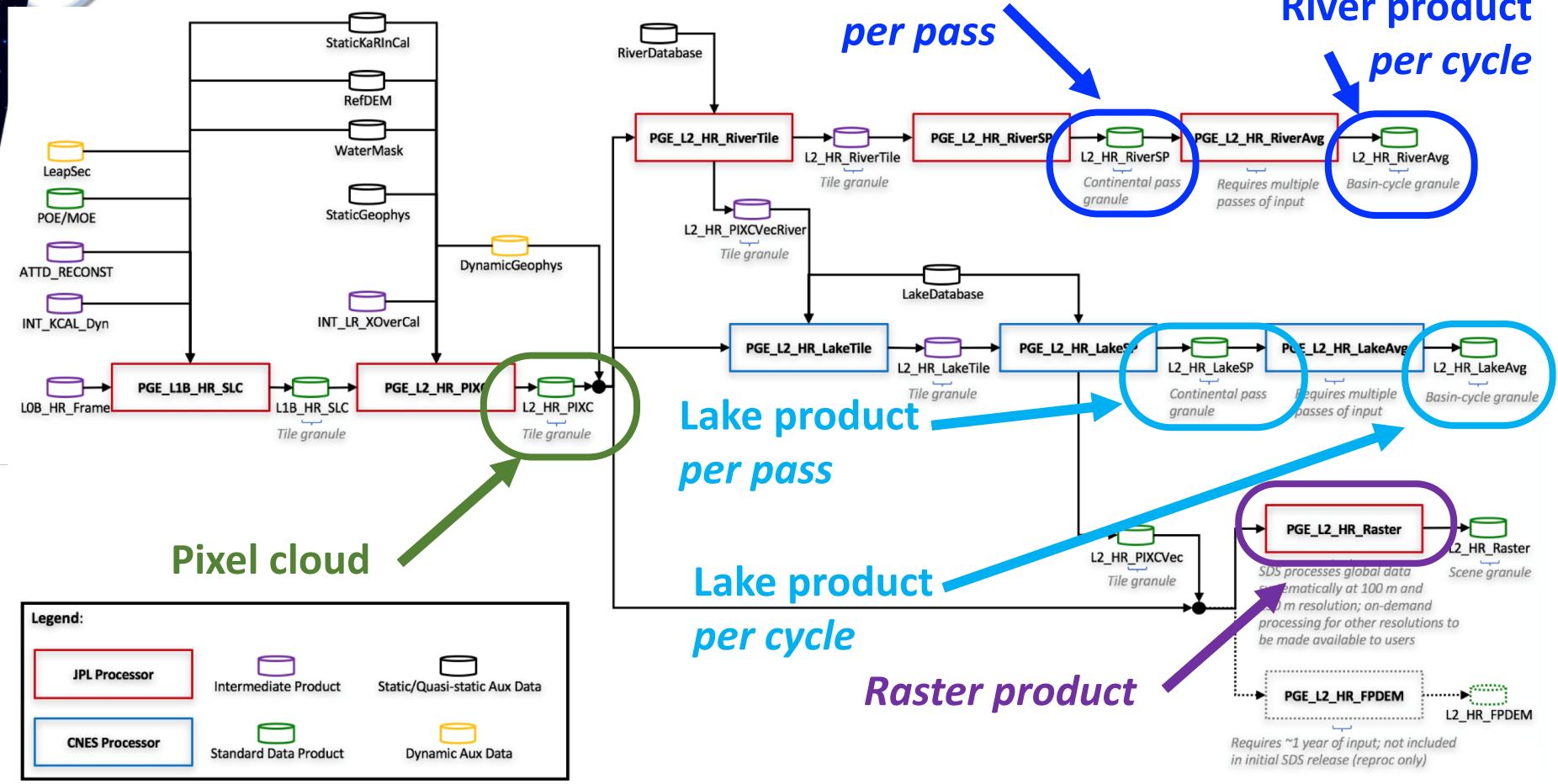
CL#18-3637

HR mask



HR mask: 2013 version under revision by PIs

4 main products

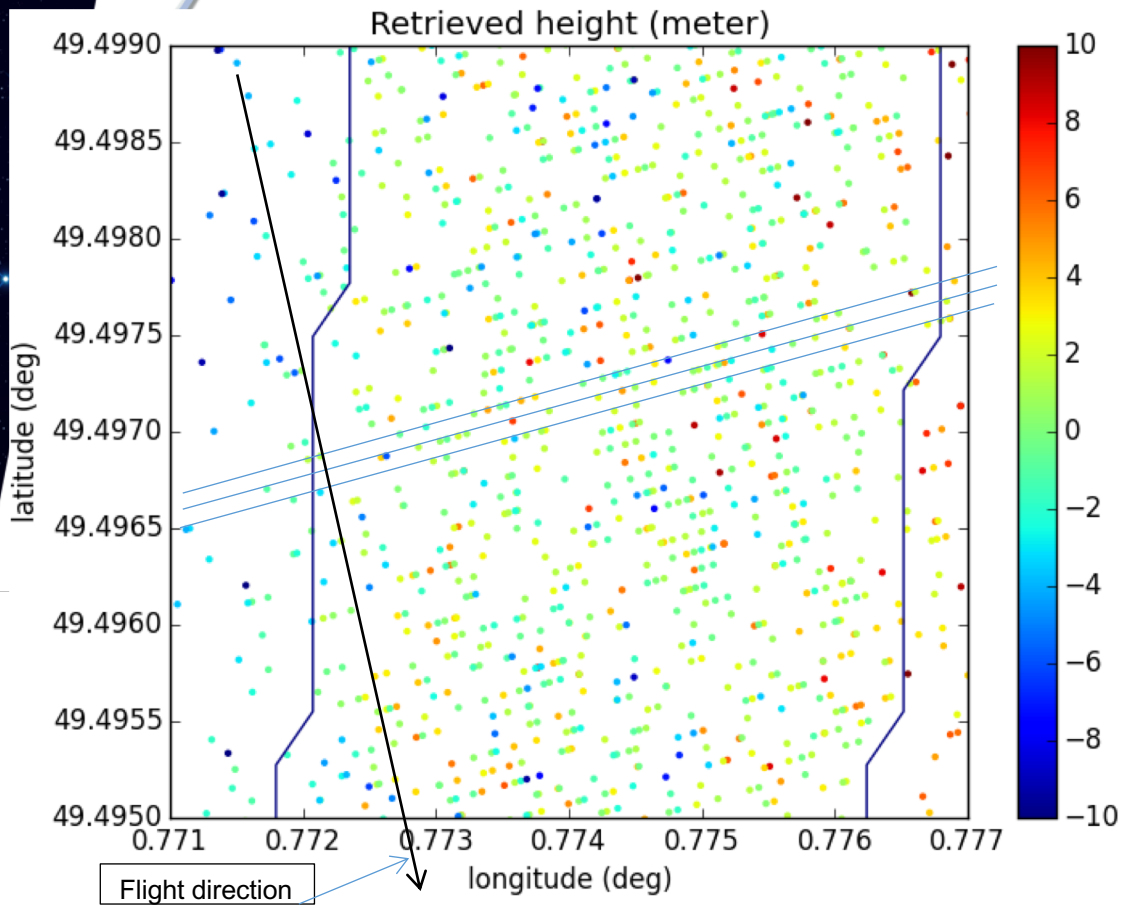


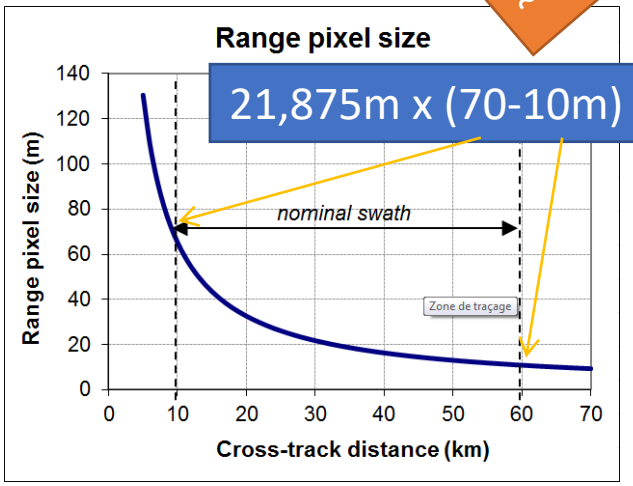
See detailed descriptions of products in hydro splinter tomorrow afternoon

Pixel Cloud = « rawest » L2 product

For each pixel classified as « water » + buffer area + systematic areas

~ 1TB/day



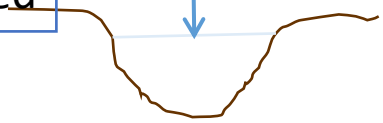


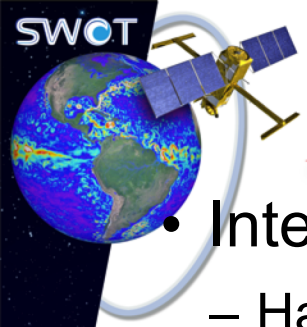
NETCDF – Tile = 1 swath*60km

→ lon / lat / height
with 2 smoothing values

+ pixel size
+ metadata (date, pass number, …)
+ other variables (corrections, …)

With respect to reference ellipsoid
+ media corrections applied



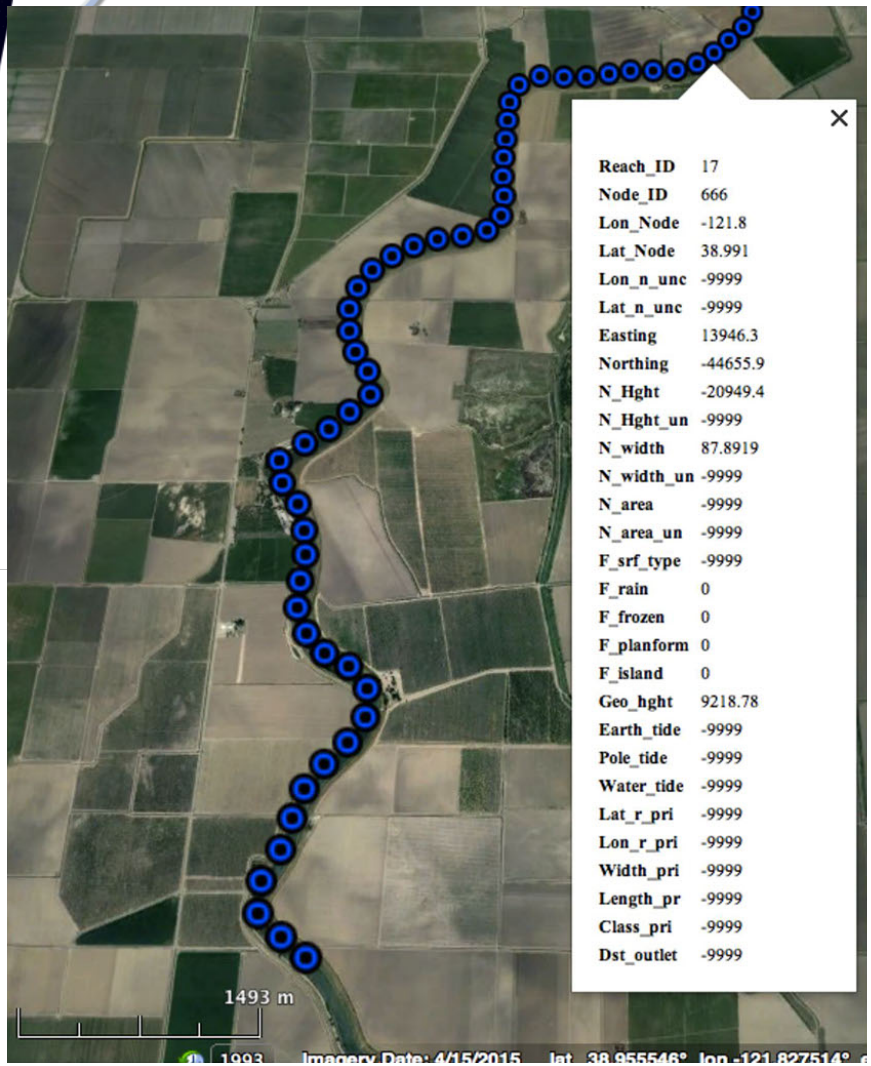


River Vector Products

- Interacted with ST to define key attributes
  - Harmonized River and Lake products. For Rivers, corresponding Reach and Node attributes.
  - Basic and expert tags for attributes
- Output shapefiles with spatial aggregation:
  - Nodes: nodes approx every 200m. Shape = Point
  - Reaches: Collection of nodes ~ 10km long. Shape = Polyline (centerline with 30m points)
  - Nodes and reaches come from the prior river database (ST defined)
- Temporal representation:
  - Single pass: Nodes and reaches observed in either side of the swath for a single pass. Distributed as one shapefile file per continent.
  - Cycle average: aggregation of all passes in a cycle. Possibly distributed as one shapefile per basin (definition TBD by ST).

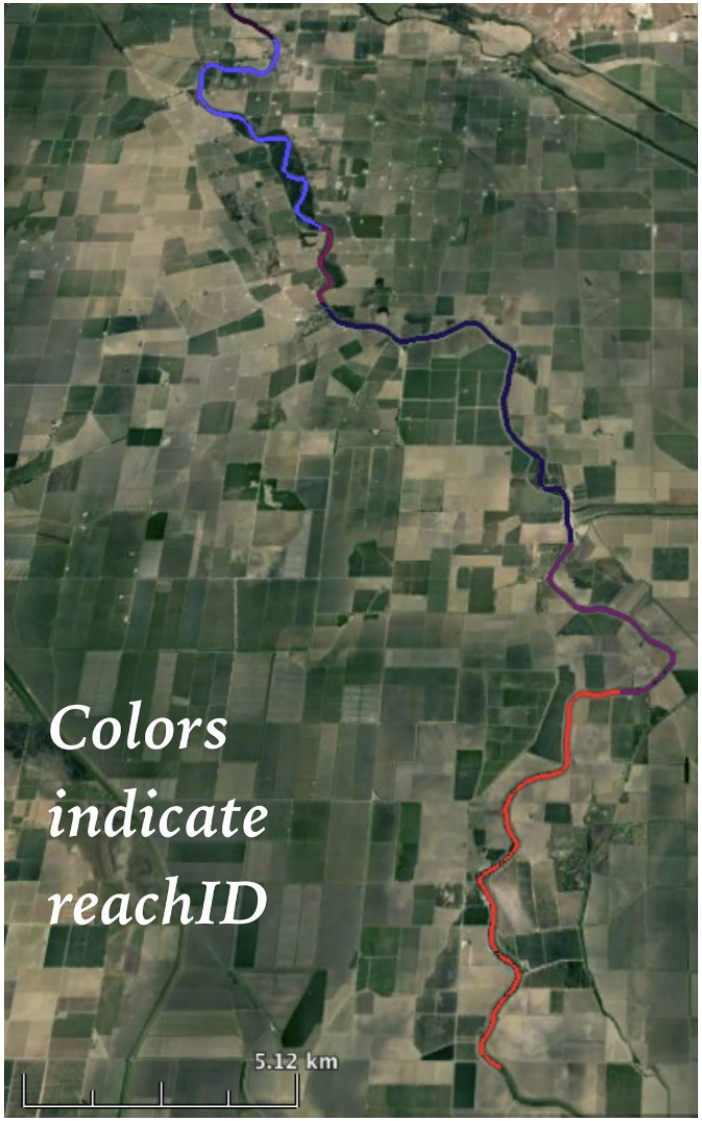
River Vector Products

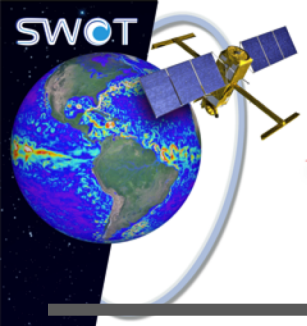
Nodes – points every ~200m



Courtesy R. Frasson, OSU

Reaches – polyline, ~10km





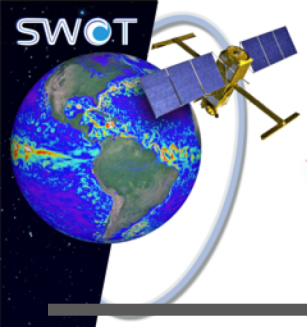
Node - Basic vs Expert

Attributes are divided into 8 categories:

1. Time and location:
   - Node id, reach id, time stamp, centroid of detected pixels (latitude and longitude) and associated uncertainties.
2. Hydro parameters:
   - Water surface height with respect to geoid and ellipsoid and associated uncertainties,
   - Width and estimated uncertainty,
   - Planform area (more to come) of water and uncertainties,
   - Cross-track distance, node distance, node length,
   - Metric of layover effect.
3. Geophysical flags:
   - Number of pixels per node,
   - Flags: dark water, layover, frozen surface, measurement quality, partial/fully observed, quality of cross-over calibrations.

Node - Basic vs Expert (cont'd)

4. KaRin σ_0 information:
   - Radar σ_0 and uncertainty, Radar σ_0 calibration, Radar σ_0 atmospheric correction from model data.
5. Geophysical references:
   - Geoid model height,
   - Tides: earth, pole, water, and load.
6. Geophysical range corrections:
   - Dry and wet tropospheric and ionospheric correction to heights.
7. Instrument corrections:
   - Cross-over calibration, KaRin orientation (attitude), Overall instrument height bias, internal calibration.
8. Items from the prior river database:
   - Prior height and historical variability,
   - Width and historical variability, distance from outlet, planform type, dam id.



River reaches – Basic vs Expert

Attributes are divided into 7 categories:

1. Time and location:
   - Reach id, time stamp, coordinates of the center of the reach (latitude and longitude).
2. Hydro parameters:
   - Water surface height and slope and their uncertainties
   - Width and uncertainty,
   - “Enhanced” slope: water surface slope computed from smoothed node heights,
   - Cross-sectional area change and uncertainty,
   - Planform total area (+ other areas) of water pixels and uncertainty,
   - Layover metric,
   - Average deviation from a priori and detected node locations,
   - Cross-track distance,
   - Consensus discharge and uncertainty,
   - Discharge from individual algorithms.

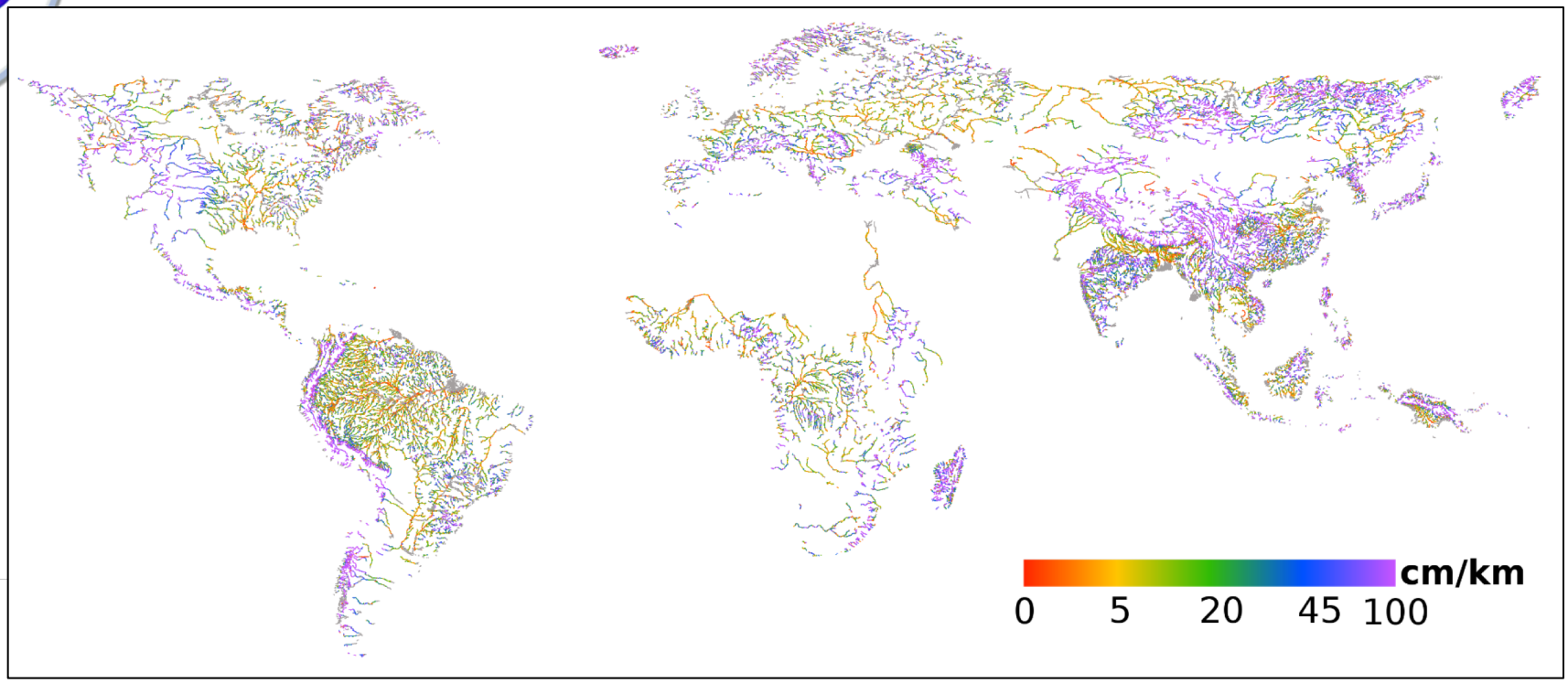
River reaches – Basic vs Expert (cont'd)

3. Flags:
   - Number of good nodes,
   - Dark water, frozen surface, layover effect, quality summary, partial observation, quality of cross-over calibrations.
4. Geophysical references:
   - Geoid height and slope with respect to the ellipsoid,
   - Tides: Earth, pole, water, and load.
5. Geophysical range corrections:
   - Dry and wet troposphere and ionospheric corrections to surface height.

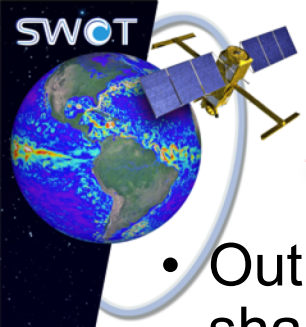
River reaches – Basic vs Expert (cont'd)

6. Instrument corrections:
   - Cross-over calibration,
   - KaRin orientation (attitude),
   - Overall instrument height bias,
   - Internal calibration.
7. Copy of Prior river database:
   - Number or up and downstream reaches and their ids,
   - Prior height and width and their historic variability,
   - Planform class,
   - Number of nodes per reach, distance from outlet, reach length,
   - Mean annual flow, dam id, discharge parameters.

Current River Database



- Current *a-priori* River Database centerlines are extracted from Landsat water masks.
- Elevations, flow accumulations, and network topology are extracted from SRTM.
- Contains data at ~60 M points along rivers, which aggregate to ~6.39M nodes.
- Ongoing work:
  - Complete north of 60N (working with Multi-Error-Removed-Terrain (MERIT) DEM)
  - Provide discharge coefficients
  - Improve delineation of river reaches using sinuosity, multitemporal widths



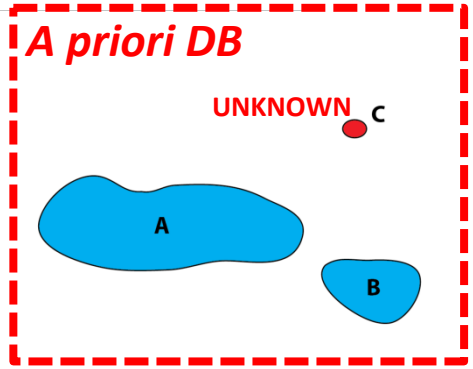
River Processing Status

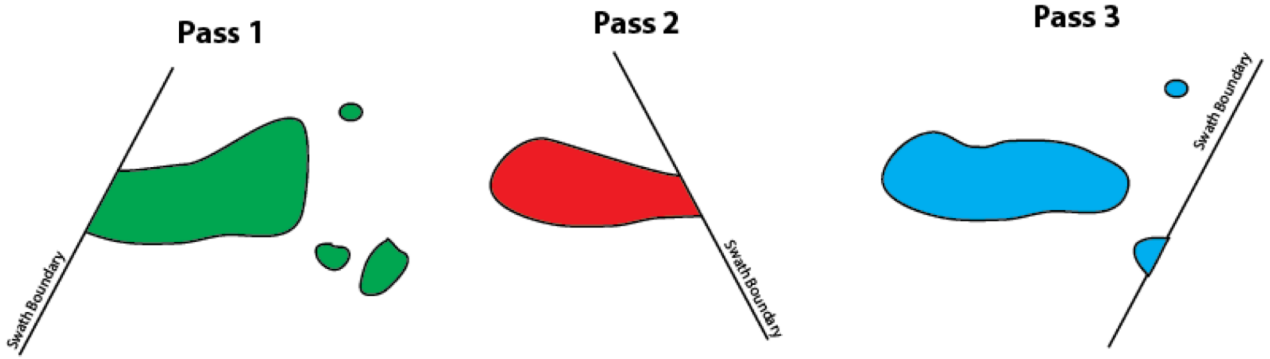
- Output file format are reach (≈10-km) and node (200-m) shapefiles. ADT and ST have made substantial progress in product variables and definitions.
- Ongoing validation of River Processor to examine uncertainties introduced by pixel aggregation, and methods to aggregate products from the node level to reaches
- Work in progress by the ST to finalize the node, reach (centerline) databases and deliver updated versions
- Ongoing ST effort to address partially-observed reaches, and special cases such as reservoirs
- Climatological ice flag shown to meet requirements. Optical-based ice flag being investigated.

Pass-based lake product

~ 1.7GB/day

- Polygon shapefile (WGS_84)
  - 1 object = part of a lake/reservoir or "other" observed by SWOT
  - polygons:
    - lake boundary
    - inner islands boundary
  - Lake averaged values = height, area, water storage, ...
    + Link to *a priori* DB (see Sheng & Pottier' talk tomorrow)



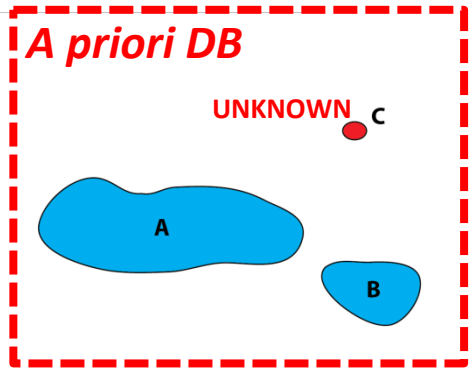


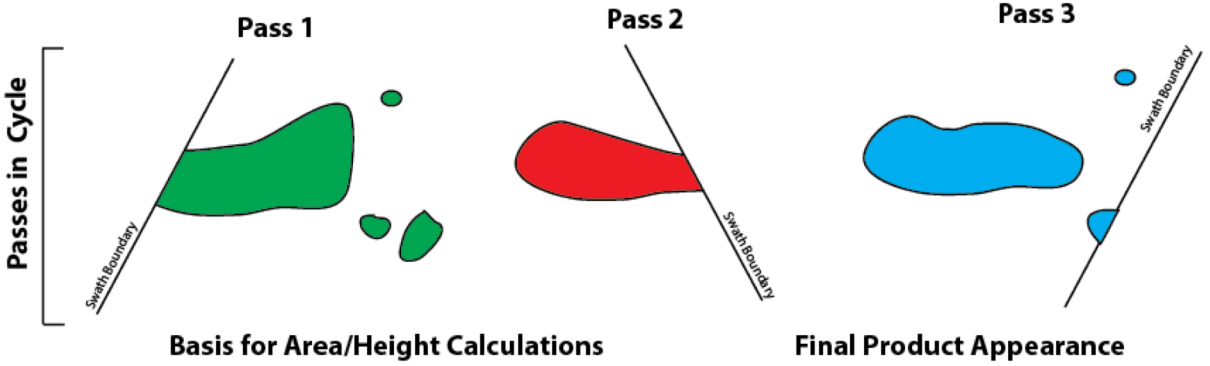
Cycle-based lake product

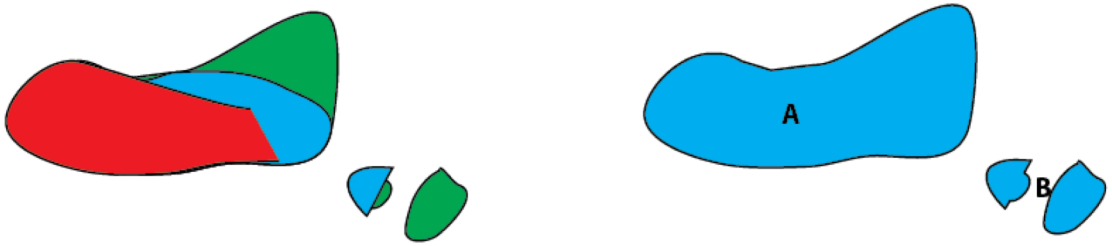
~ 12GB/cycle

- Polygon shapefile (WGS_84)
  - 1 object = lake/reservoir **from DB** observed by SWOT during cycle
  - polygons:
    - lake boundary
    - inner islands boundary

    } Method to compute extent TBD (max or better: see Sheng's talk on Thursday)
  - Cycle averaged values

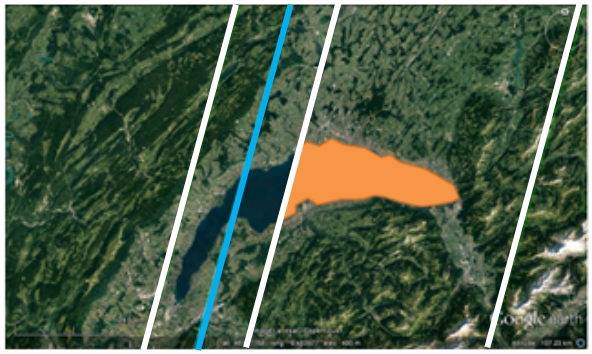
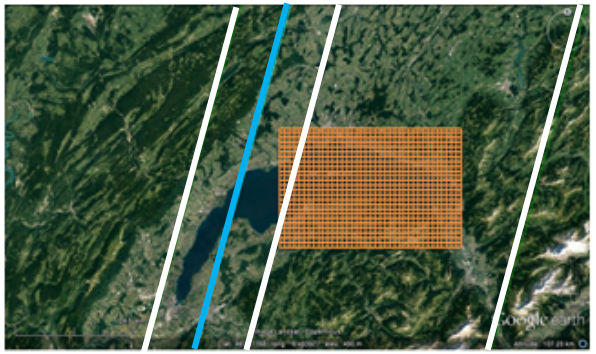




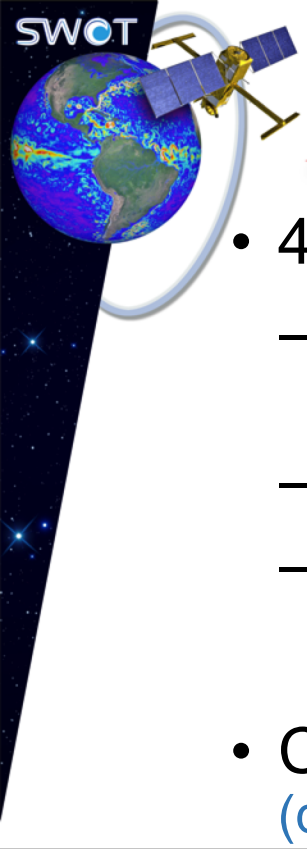


Raster product

- → To capture internal variability in river reaches and lakes / wetlands / … not captured by the vector products

- Computed from pixel cloud (water pixels only)
  - Systematic production:
    - 1 NetCDF tile covering 4 PixC tiles (both swaths and 120km along-track)
    - fixed grid
    - 100m & 250m resolution
  - On-demand production: bounding box / resolution / variables / format specified by user



Conclusion and on-going work

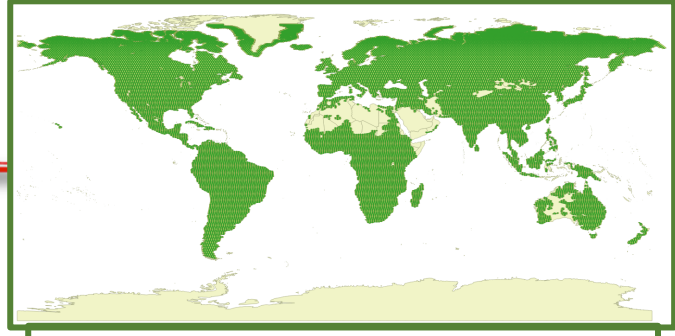
- 4 main products:
  - Pixel cloud = water mask [longitude / latitude / height for water pixel + buffer + systematic areas]
  - River/lake products: pass-based and cycle-based
  - Raster products: systematic & on-demand

- Current homogenization between river and lakes (detailed tomorrow afternoon)
  - Basic and expert attributes
  - Spring 2019: Product Description Document release.

- Prototyping activities in progress (today last session)
  - Bef. summer 2019: first stable version

Backup

4 main products



HR mask: 2013 version under revision by PIs

Point cloud
per satellite overpass

River product
per pass

River product
per cycle

Lake product
per pass

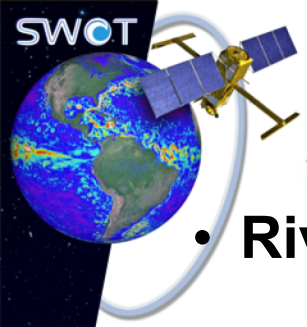
Lake product
per cycle

Raster product

See detailed descriptions of products in hydro splinter tomorrow afternoon

River Tile Processor

- **Main Functions**
  - Aggregate pixels to Nodes in River Database based on distance (within threshold), classification, flags
  - Compute Node quantities
  - Compute Reach quantities from Nodes
  - Produce PIXC_VEC_RIVER intermediate product to mark pixels used for rivers. All detected water pixels not used for river vector processing are handled by Lake processing.



River Processing

- **River Processing Chain**: Three main processors

  – **River Tile Processor**: Operates on single tile of Pixel Cloud (PIXC) at a time, using the prior river database to define output. Produces tiles of river vector data as an intermediate product.

  – **River Single Pass Processor**: Concatenates tile processor outputs into continent-pass granules.

  – **River Average Processor**: Averages data temporally over an orbit cycle and spatially over predefined river basins.