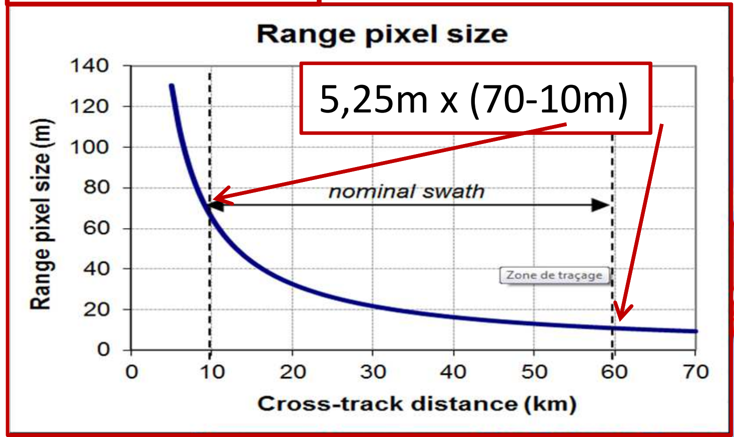
SWOT LAKE PRODUCT

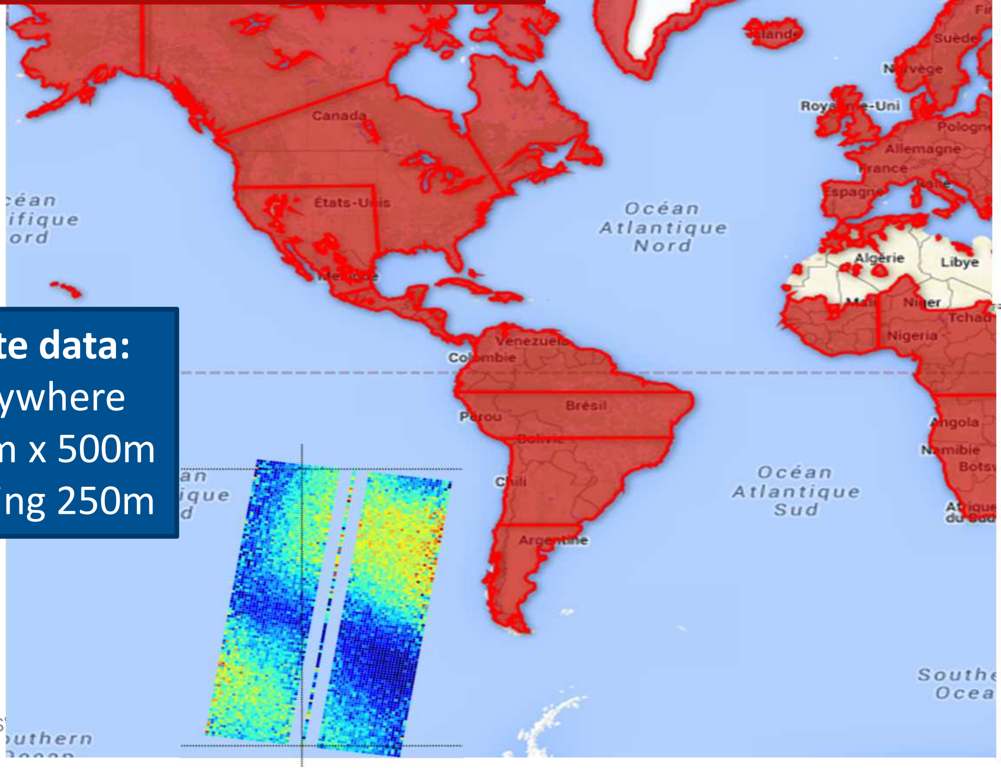
Claire POTTIER(CNES) and P. Callahan (JPL) SWOT ADT project team
J.F. Cretaux, T. Pavelsky SWOT ST Hydro leads

Lake, Climate and Remote Sensing Workshop
Toulouse – June 1&2 2017

HR MASK

High Rate data:





Low Rate data:

- everywhere
- 500m x 500m
- Posting 250m

Hydrology Error Component	Height Error [cm]	Slope Error [μrad]	Comments
Ionosphere signal	0.8	0.1	RMS of the full signal for maximum solar activity (100 TECU), using IONEX model
Dry Troposphere Signal	0.7	0.1	RMS after correction with weather models, based on Jason heritage
Wet Troposphere Signal	4.0	1.5	Model-based correction
Radial Component	1.62	0.5	Radial error RMS
KaRIn Random and Systematic Errors after Cross-Over Correction	8.9	15.5	Includes cross-over correction residual
Motion errors	0.8	1.6	Based on 1-sigma surface velocities of up to 2.6 m/s
Total Allocation (RSS)	**9.98**	**15.7**	**Total error, as allocated**
Unallocated margin RSS/SUM	0.65 / 0.02	6.6 / 1.3	
Total (RSS) Error	**10**	**17**	**Requirement**

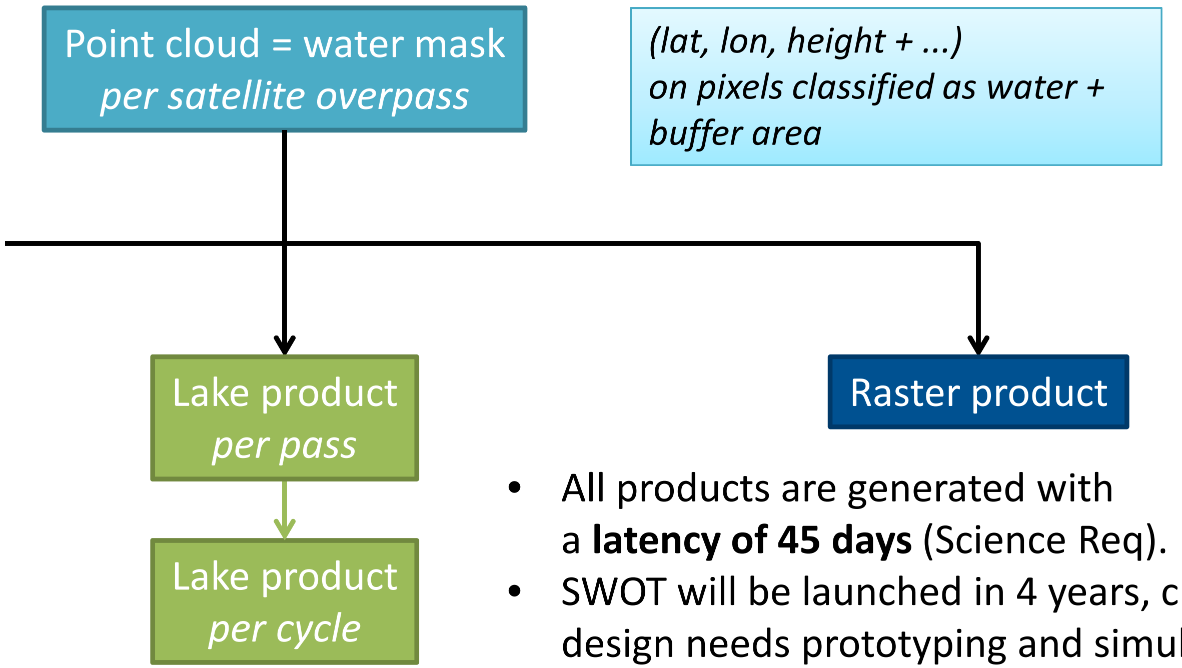
KaRIn Hydrology Error Component	Height Error [cm]	Slope Error [μrad]	Comment
KaRIn Random	4.4	15.3	Height based on a 1km^2 averaging area of water-only pixels; slope based on a 10 km downstream averaging of a 100 m ideal river.
KaRIn Systematic cross-track errors after cross-over correction	7.4	1.7	Residual after cross-over correction; these are the RMS cross-track slopes (and associated height) for the entire along-track land pass.
KaRIn Systematic along-track height bias error	1.5	0.08	This is the RMS timing and dilation along-track height errors accumulated down to 0 Hz.
High Frequency errors	1.15	0.5	RMS of systematic errors > 6.5 Hz
(Unallocated margin, RSS)	1.23	1.75	
Total (RSS) Error Requirement[1]	**8.9**	**15.5**	**Requirement**

SWOT HYDRO PRODUCTS (HR MODE)

The « rawest » one is the pixel cloud computed for each satellite overpass. For each pixel classified as water + a buffer area, we will have longitude / latitude / height info.

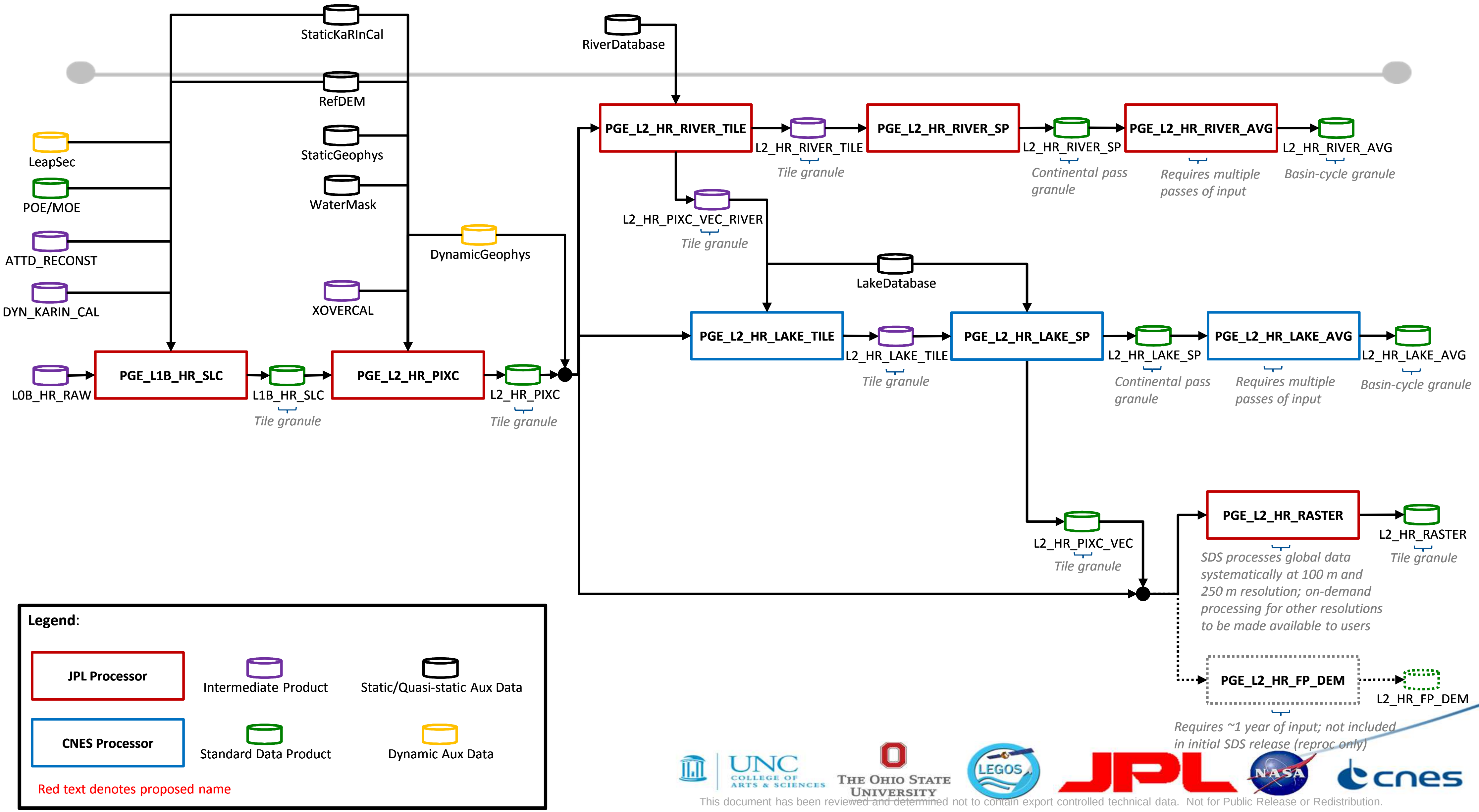
From this pixel cloud, we will have :

- products specific to rivers, per pass and averaged per cycle. It will be computed for each river referenced in an a priori DB currently computed by Tamlin team. We will have information per 10km reaches and points every 200m along the centerline.
- lake products (per pass and per cycle) and a raster product.

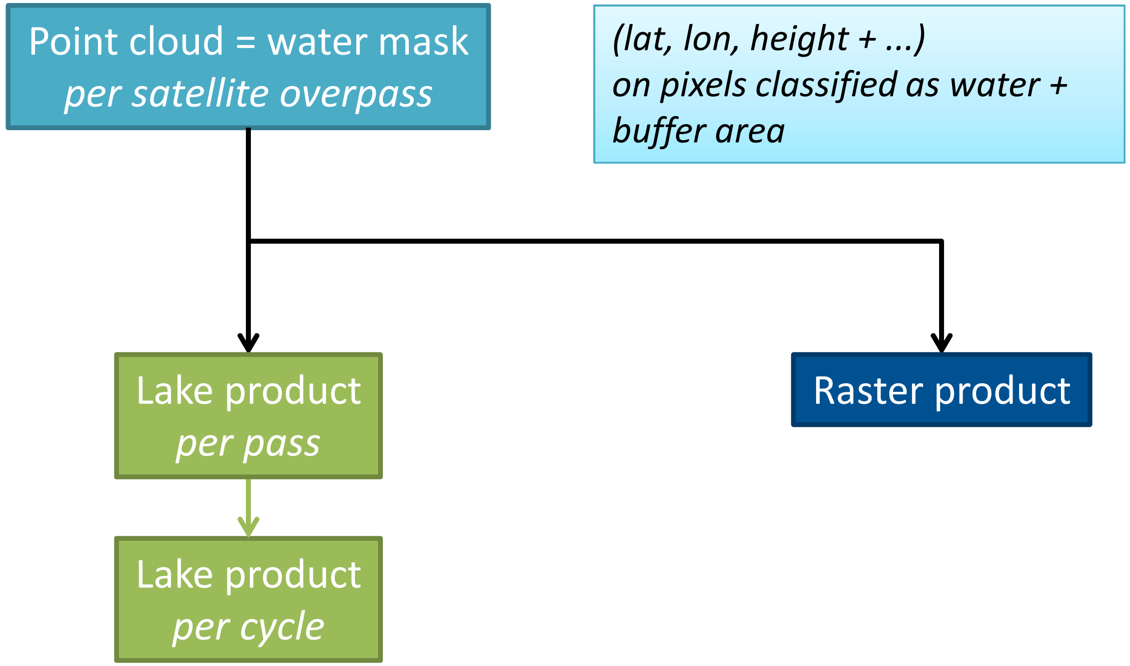


- All products are generated with a **latency of 45 days** (Science Req).
- SWOT will be launched in 4 years, current design needs prototyping and simulations : so we expect adjustments in coming months
- SWOT is a pathfinder mission so current baseline is likely to be modifed with flight data in 2022

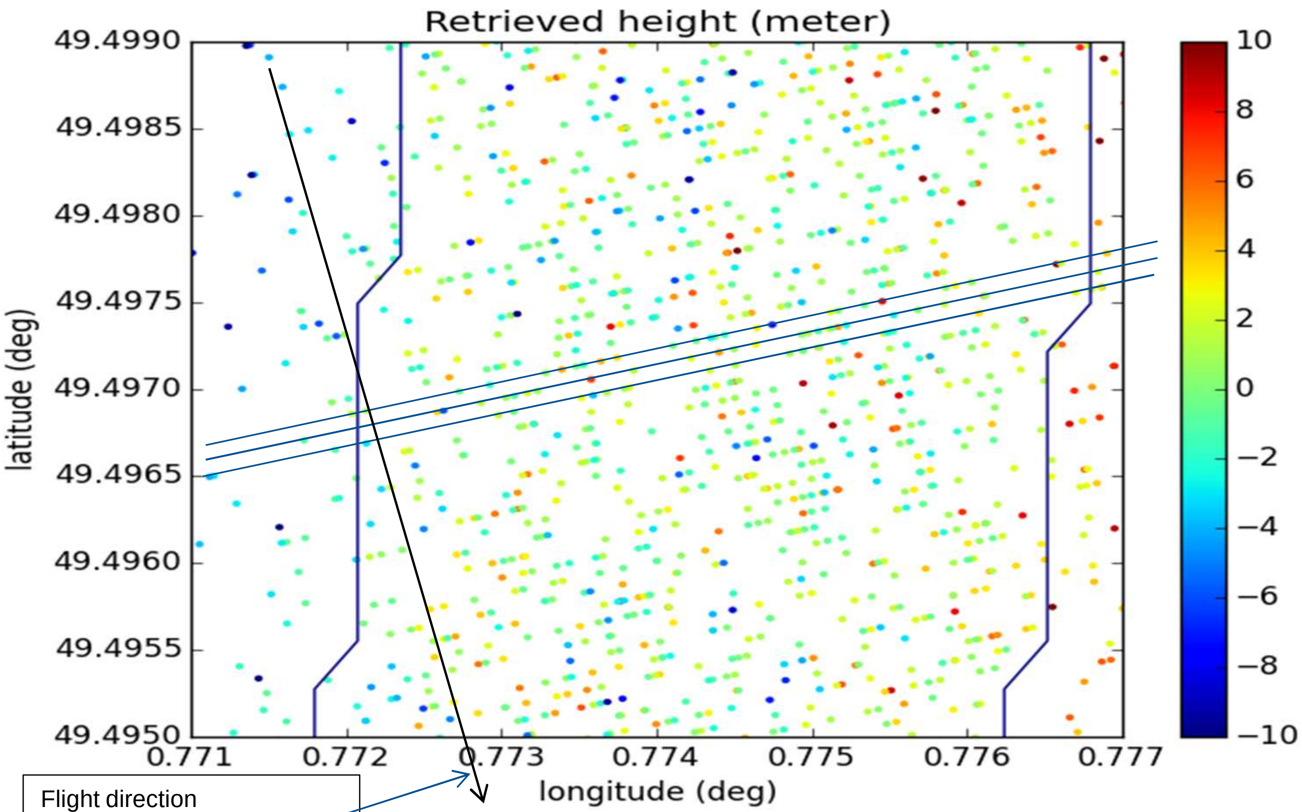
KaRIn HR Flow



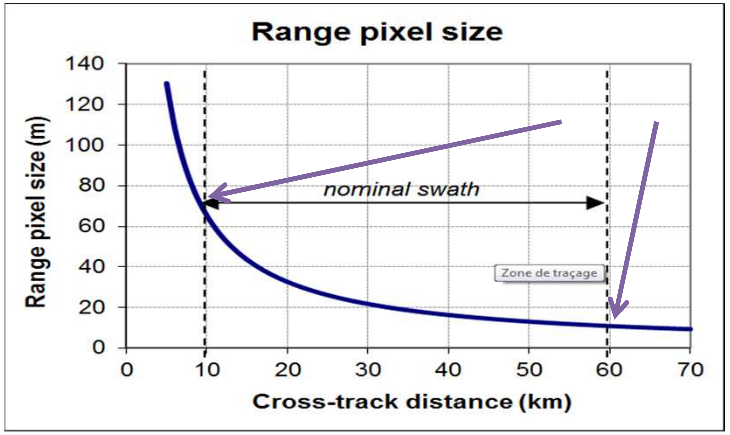
4 MAIN PRODUCTS OVER LAKES



PIXEL CLOUD



Flight direction



NETCDF – Tile per swath over 60 kms

→ lon / lat / Height
with 2 smoothing values
Pixel size

Meta data (date, orbit number, ...)
+ geophysical correction, quality flags, …

PASS-BASED PRODUCT (1/2)

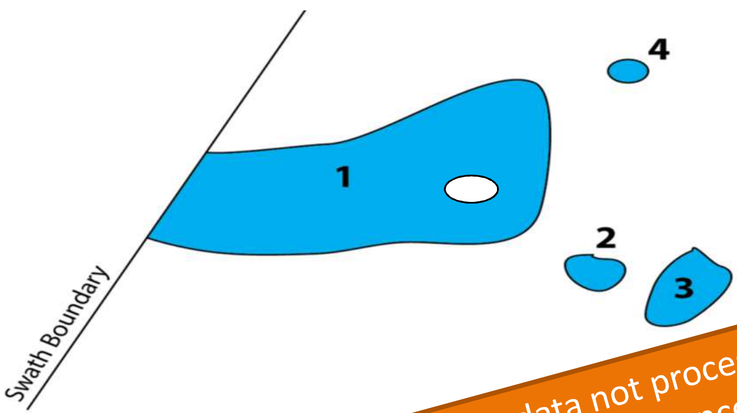
Format

OGRPolygon shapefile (WGS_84)

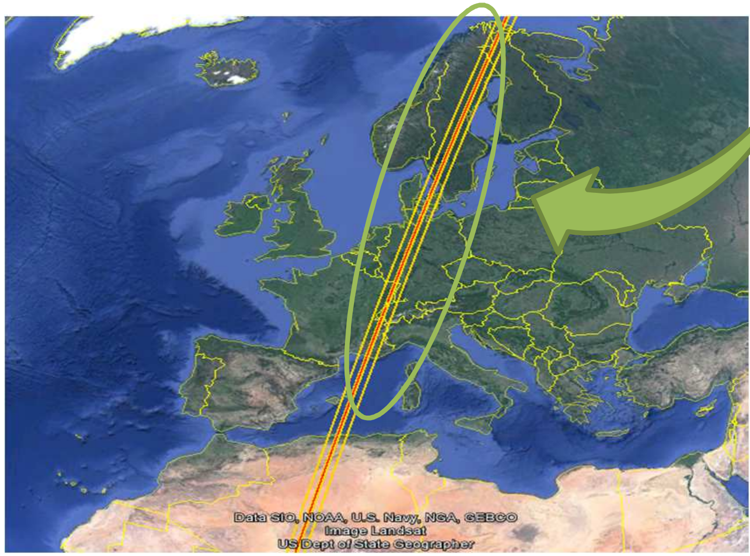
- 1 object = part of a lake or reservoir observed by SWOT
- polygons:
  - lake boundary
  - inner islands boundary

Coverage

- Intersection pole-to-pole pass & continent
- Both swaths



All HR data not processed as river, i.e.:
Lakes + not referenced rivers
+ shorelines/estuaries + ocean parts in HR



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PASS-BASED PRODUCT (2/2)

Lake product = average information from pixels of the pixel cloud associated to the lake

Content:

- Identifiers
  - Reference ID from an a priori lake database
- Space time info
  - Date of measurement, distance from nadir, number of pixels
- Height **(one single value)** + uncertainty
- Area + uncertainty
- Storage change + uncertainty
- Flags
  - Partial observation, ice, measurement issue

CYCLE-BASED PRODUCT (1/2)

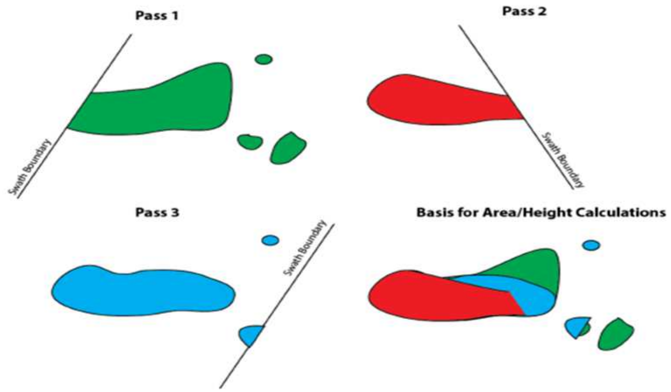
Format

OGRPolygon shapefile (WGS_84)

- 1 object = lake or reservoir observed by SWOT during cycle
- polygons:
  - lake boundary
  - inner islands boundary

Extent for polygons:

- Status = max extent during cycle (idem for islands)



Coverage

Time aspect

- Cycle average

Geographic aspect:

- Stored per “major” river basin

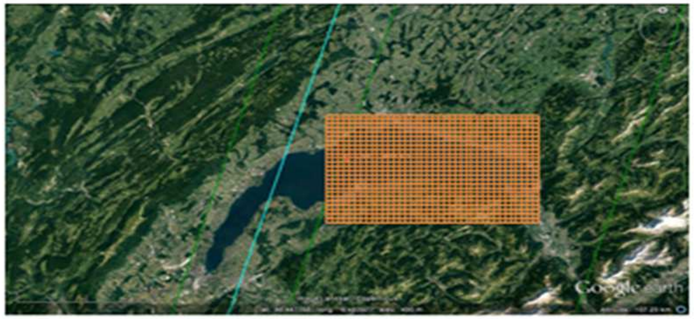
Only for lakes in the *a priori* database

CYCLE-BASED PRODUCT (2/2)

	Parameter name	Definition	Type
IDENTIFIER	prior_id	ID of the lake of the *a priori* database	INT
SPACE-TIME INFO	l_time	List of observation times during the cycle	STRING
	l_pass	Overpasses during the cycle, as list of pass numbers	STRING
	ct_dist	List of cross-track distances with regard to the lake center, corresponding to each overpass	STRING
HYDRO VAR AND UNCERTAINTIES	h_min	Min height over the cycle	FLOAT
	h_max	Max height over the cycle	FLOAT
	height	Cycle-averaged height	FLOAT
	h_std	Associated uncertainty	FLOAT
	area	Maximum water area observed during the cycle	FLOAT
	area_std	Associated uncertainty	FLOAT
	area_est	Estimated water area, computed from rating curves	FLOAT
	delta_s	Storage change	FLOAT
	ds_std	Associated uncertainty	FLOAT

RASTER

→ To capture internal variability in river reaches and lakes not captured by the vector products (ex: Léman lake)



Computed from pixel cloud (water pixels only)

- Systematic production:
  - 1 NetCDF tile covering both swaths and 120km along-track
  - fixed grid
  - 100m & 250m resolution
- On-demand production: bounding box / resolution / variables / format specified by user

ALGORITHM (1/2)

Pass-based product

- 1°) per pixel cloud tile (1 swath * ~60km):
  - Identify all separate entities in the water mask
  - Retrieve pixels corresponding to lakes and new objects entirely inside the tile
  - For pixels entirely inside the tile:
    - Refine pixel geolocation
    - Compute lake product
    - Link to the a priori DB

- 2°) combination of all tiles corresponding to one pass:
  - Gather pixels of objects at tiles edges
  - For each object:
    - Refine pixels geolocation
    - Compute lake product
    - Link to the *a priori* database
  - Gather polygons in a single shapefile

ALGORITHM (2/2)

Cycle-based product

FOR EACH a priori lake in specific river basin:

- Identify all lake products linked to the current lake
- Compute lake averaged product for the current lake

ON-GOING WORK

Prototyping

- within a CNES-JPL simulator
- as close as possible from the operational aspects
- to support ground system tests and to generate lake product test files to the SWOT science team

Defining lake a priori database

- Comparing existing lake databases (Sheng, Pekel, OpenStreetmap, …) regarding the lake processing constraints:
  - Surface area of lakes: goal = 1ha ; requirement = 6.25ha
  - Format: polygon shapefile for the a priori DB
  - Global coverage
  - Lake database and not a water body database (need to separate rivers from lakes)
  - Availability: free and easy to retrieve
- Statistical comparison under work

ON-GOING WORK

Prototyping requires a priori knowledge of :

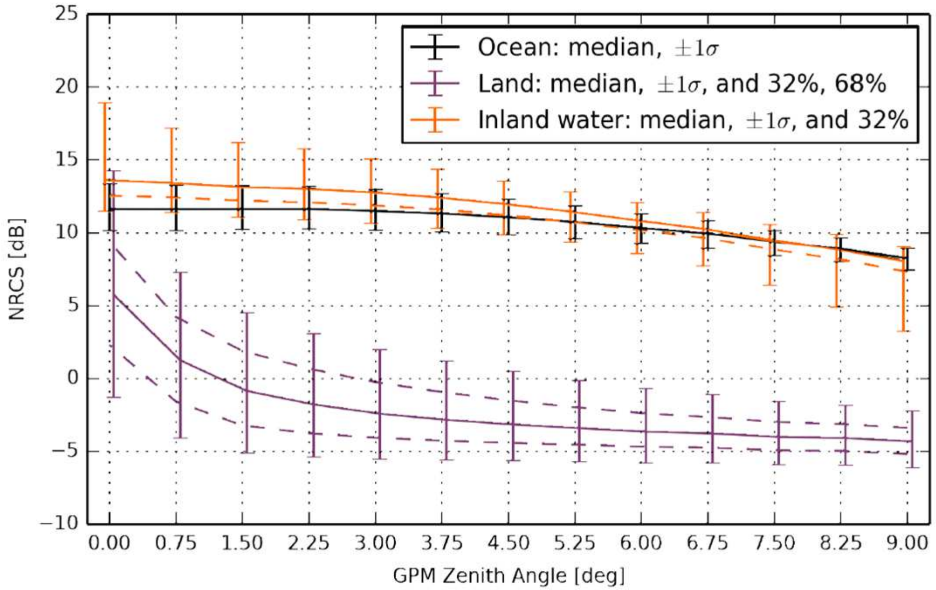
- MNT:
  - quite easy with Lidar DEM over US, Europe but over tropical and mountains regions is becoming more challenging.
  - Looking at Tandem-X DEM but also optical one's (Pleiades, S2A, …)

- Water body location :
  - Several database existe (Sheng, Glowabo, Pekel, …) but needs to be inline with the DEM (in other words surface water needs to be flat)

- Roughness information :
  - Very challenging as SWOT is a pathfinder mission
  - Currently using simple approach with a constant contrast of 10 dB between water and surrounding terrain
  - Ongoing analysis with GPM data (see next slide), complemented by AirSwot (Tamlin presentation) and tentatively SWALIS
  - Needs to account for the impact of vegetation

ROUGHNESS FROM GPM

GPM has clear limitations due to its footprint size (~5 km square) but provides Ku&Ka band sigma0 values worldwide

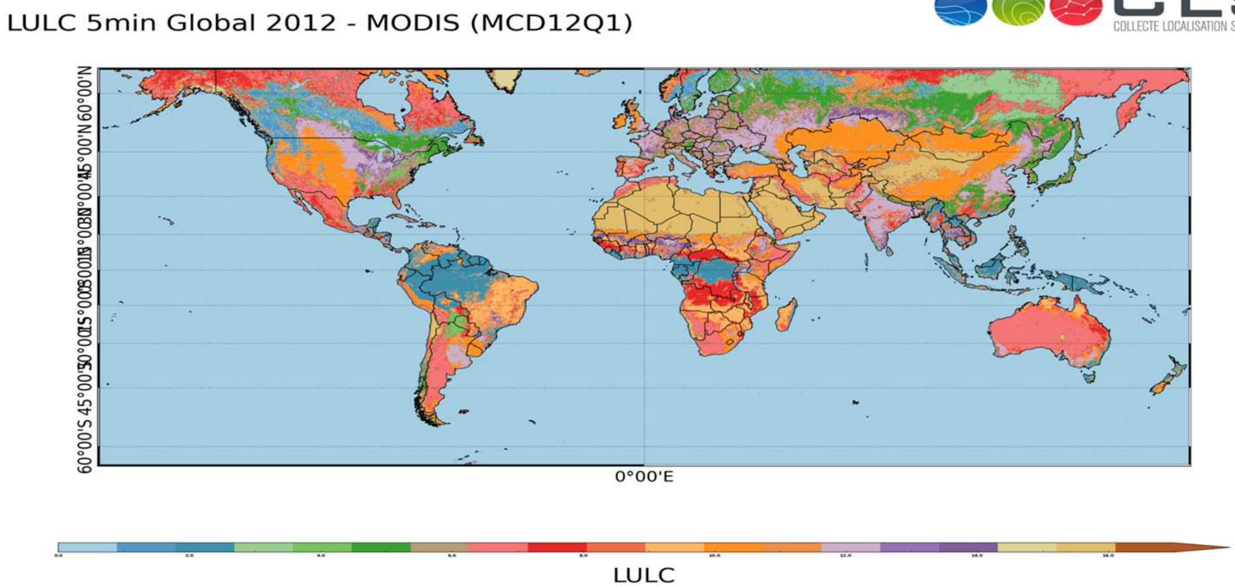


ROUGHNESS FROM GPM

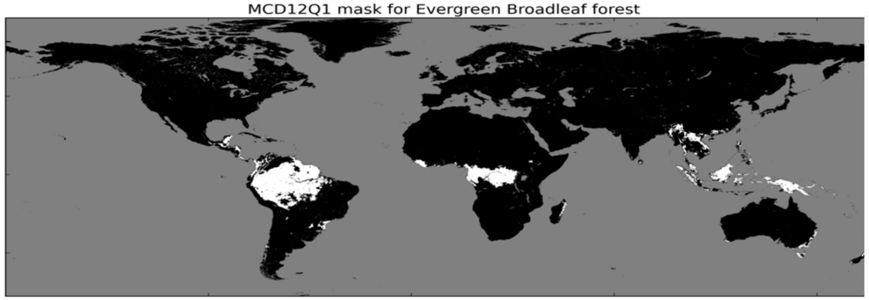
LULC map from MODIS Land Cover available here http://glcf.umd.edu/data/lc/
17 classes defined with 1/12° resolution

- All Ka-band & Ku-band GPM PR data acquired in May 2015
  - with rain flag at 0
  - quality flag OK

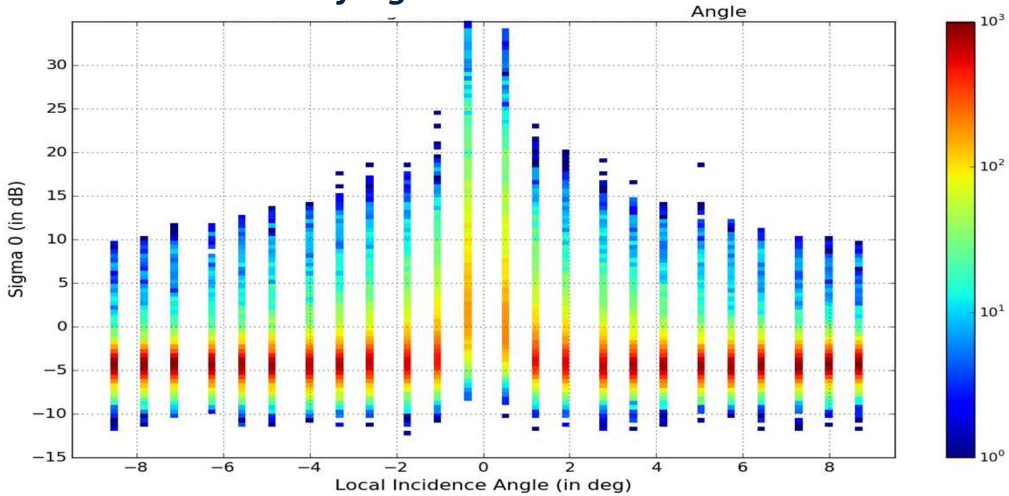
Colocated with all LULC classes, No D



Evergreen Broadleaf forest



Distribution of Sigma0 at Ka-band



Flat fall-off
-> mainly volume contribution with isotropic angular behavior

No significant difference between Ku and Ka-band:
below centimetric wavelength (responding to leafs elements of the top of the canopy)

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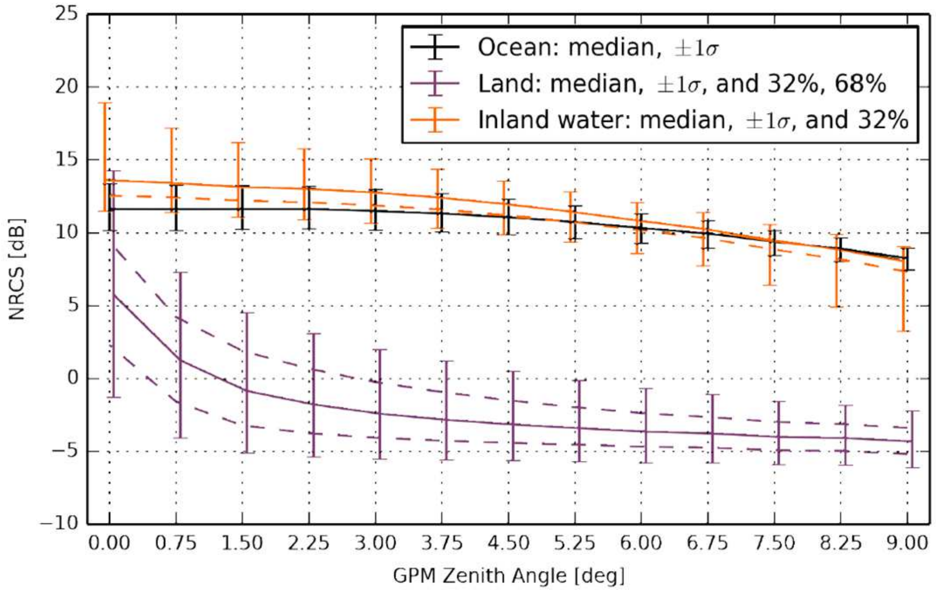
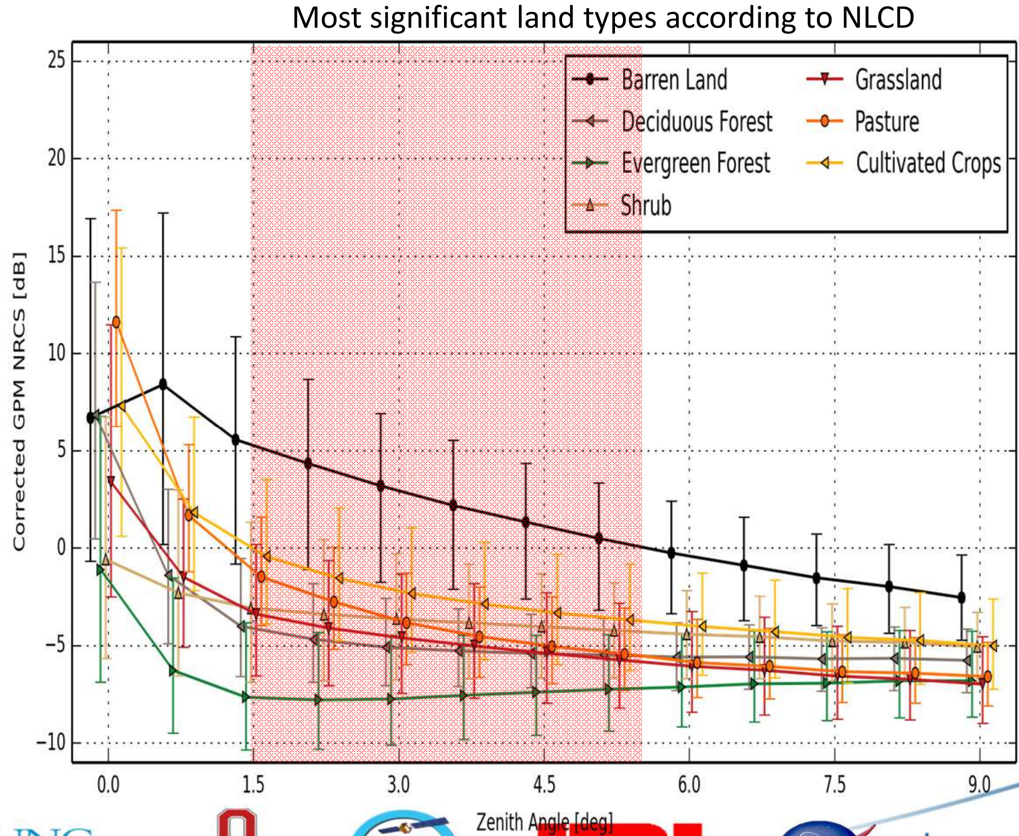
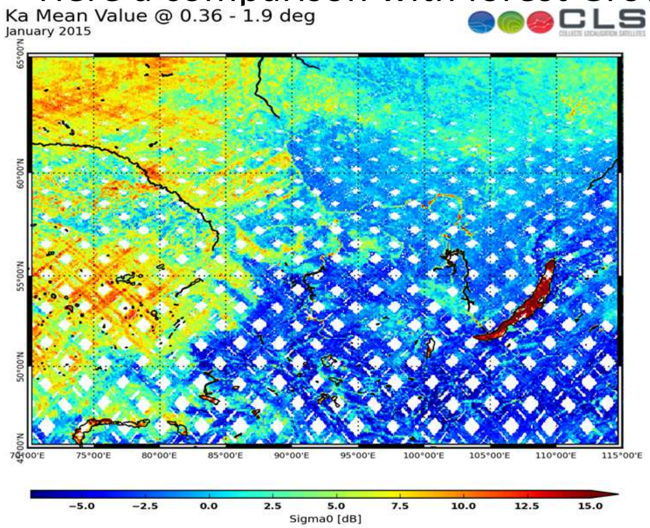


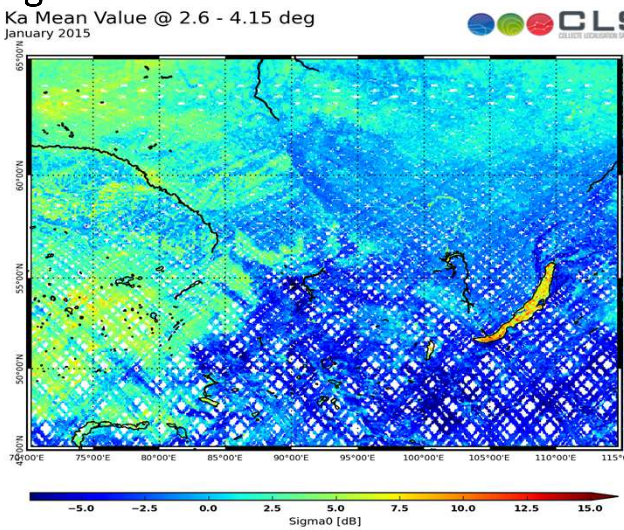


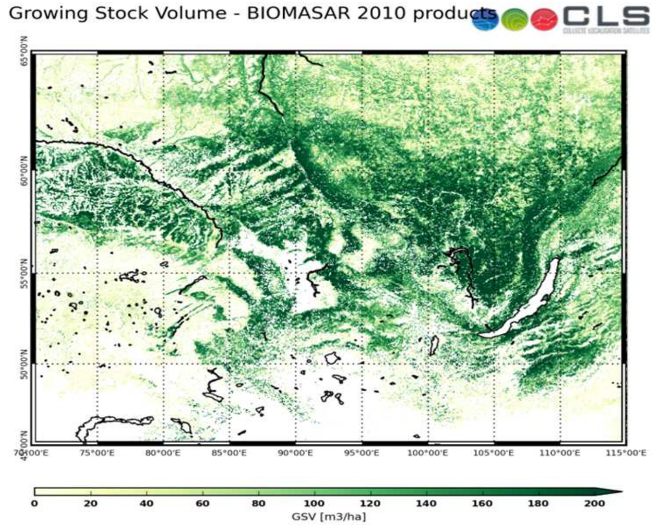
Roughness from GPM

Comparison with ancillary information for investigating new potential of upcoming SWOT data
Integration into the SWOT simulator for algorithm refinement over specific study sites

Here a comparison with forest Growing Stock Volume – BIOMASAR data in Central Siberia

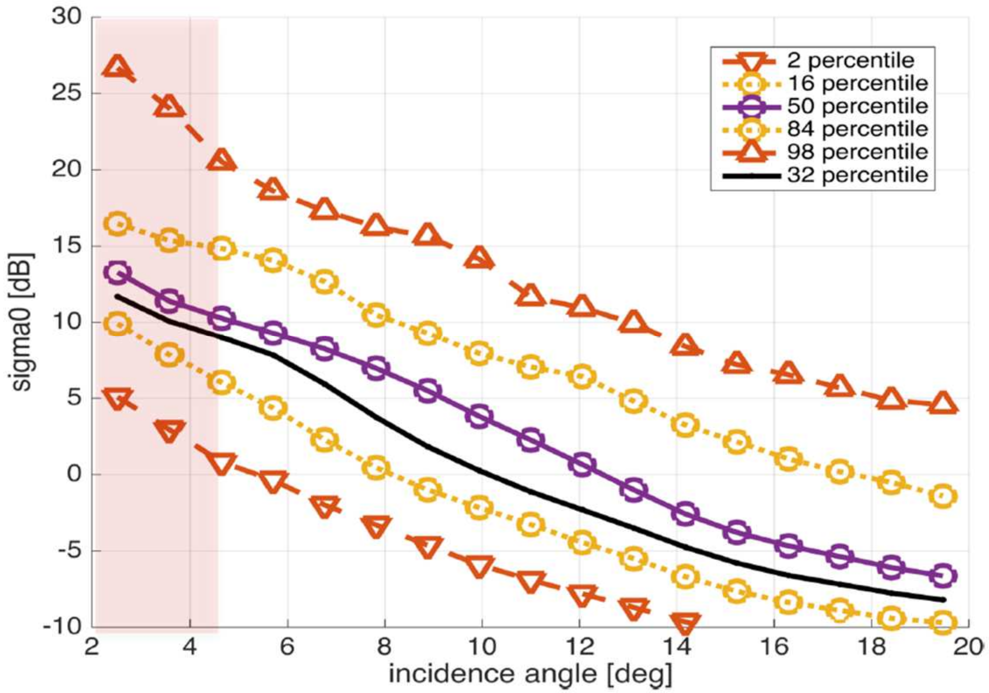






ROUGHNESS FROM AIRSWOT

Refer to Tamlin presentation – using available data JPL was able to derive the sigma0 measured by the AirSWOT instrument over smaller water bodies (includes about 9,000 water bodies, rivers, and lakes obtained from flights in Alaska, Sacramento, New Orleans, and Tahoe).



ROUGHNESS FROM SWALISS

New airplane experiment – simple design to measure roughness between 0 and 4° in low wind conditions (dark water) - no interferometry

Successful design review held in CNES end April 2017 – expected to acquire first data in Sept-Oct 17'

Test sites located in France close to Rennes