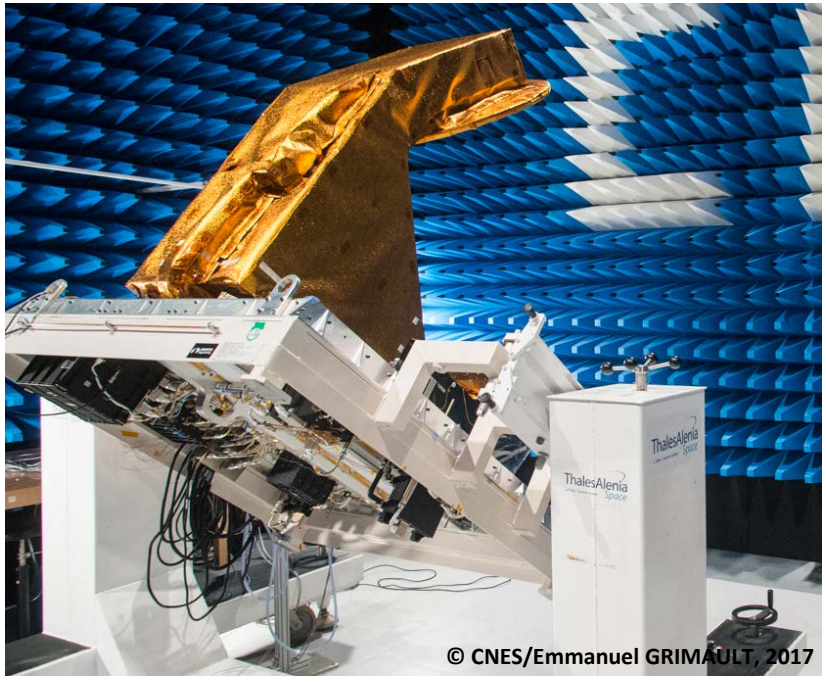
CFOSAT

China **F**rance **O**ceanography **SAT**ellite

A new satellite for the observation of wind and waves



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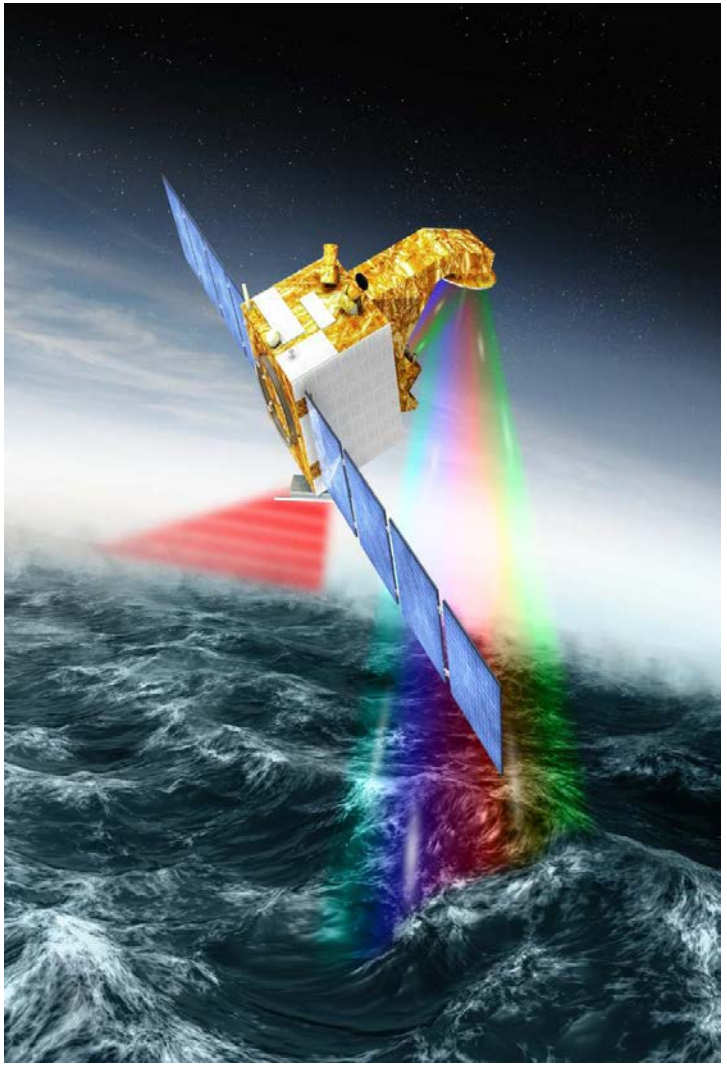
Céline TISON
celine.tison@cnes.fr

Overview of the presentation



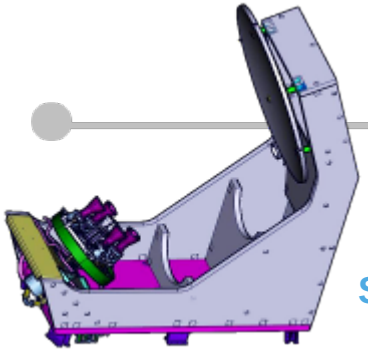
Mission description

- Objectives
- Planning
- Description of the two instruments – focus on SWIM

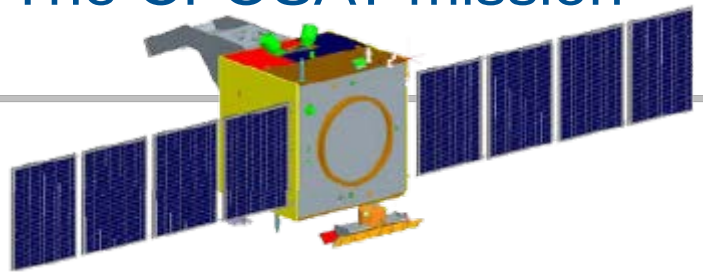
CFOSAT products and accuracies

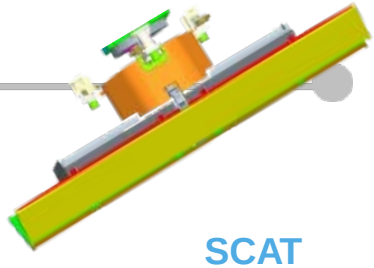
- CFOSAT ground segment
- Processing and products
- Accuracies of wave spectrum

The CFOSAT mission



SWIM





SCAT

CFOSAT: an innovative China/France mission for oceanography

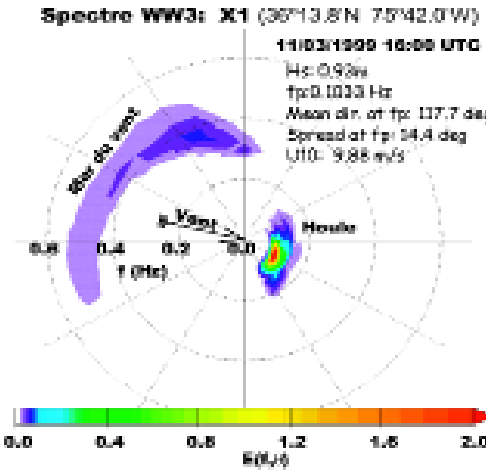
Joint measurements of oceanic wind and waves

- **SWIM**: a wave scatterometer (new instrument)
- **SCAT**: a wind scatterometer (fan beam concept)

Main Objectives

Measure at the global scale surface ocean surface wind and spectral properties ocean waves in order to:

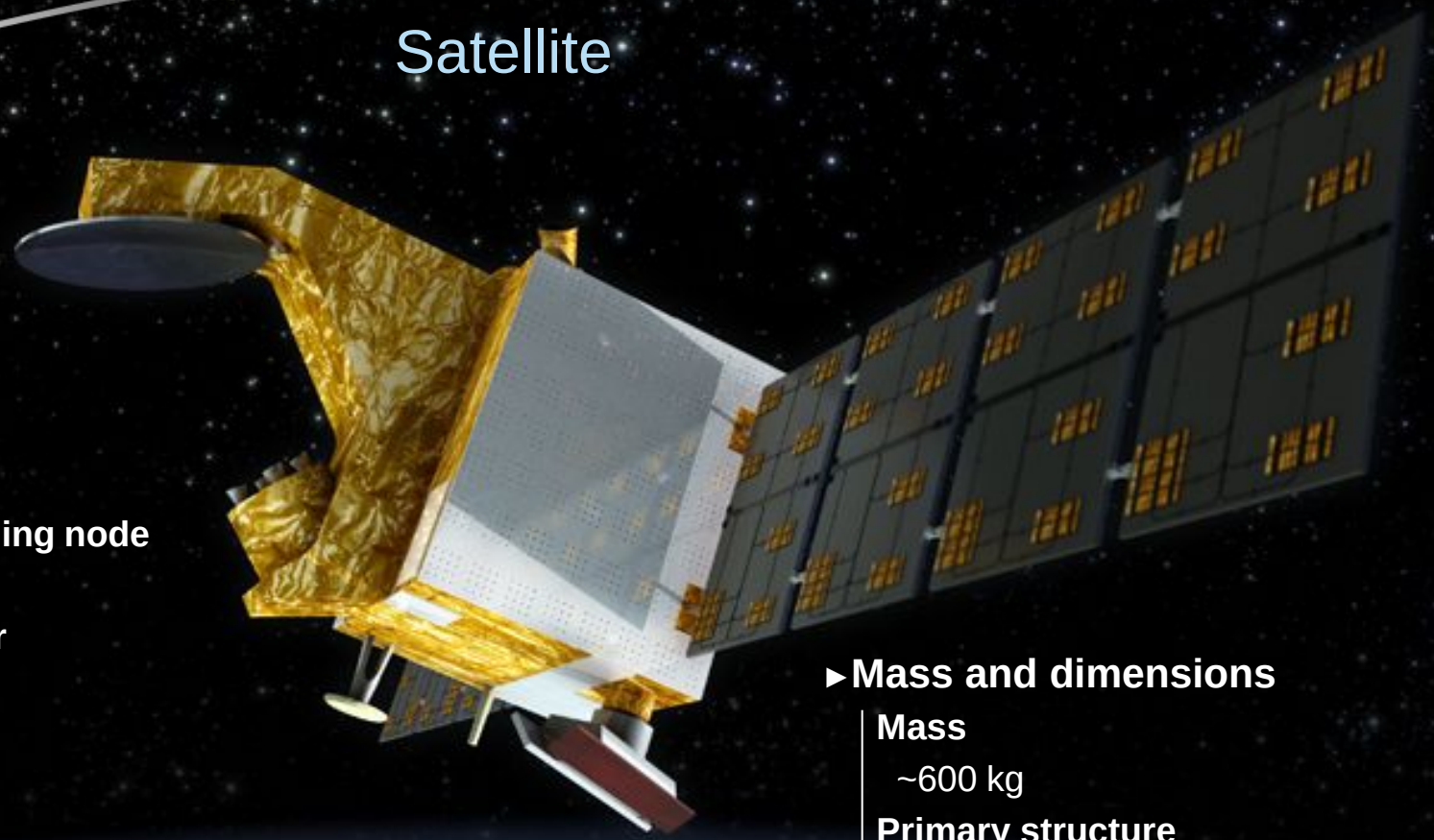
- improve atmospheric, oceanic and wave forecast systems
- monitor sea-surface parameters for wind and wave climatology
- improve knowledge and parameterization of processes affecting surface waves
- improve the characterization and modeling of air/sea exchanges and ocean/atmosphere coupling affecting the climate system



Secondary objectives

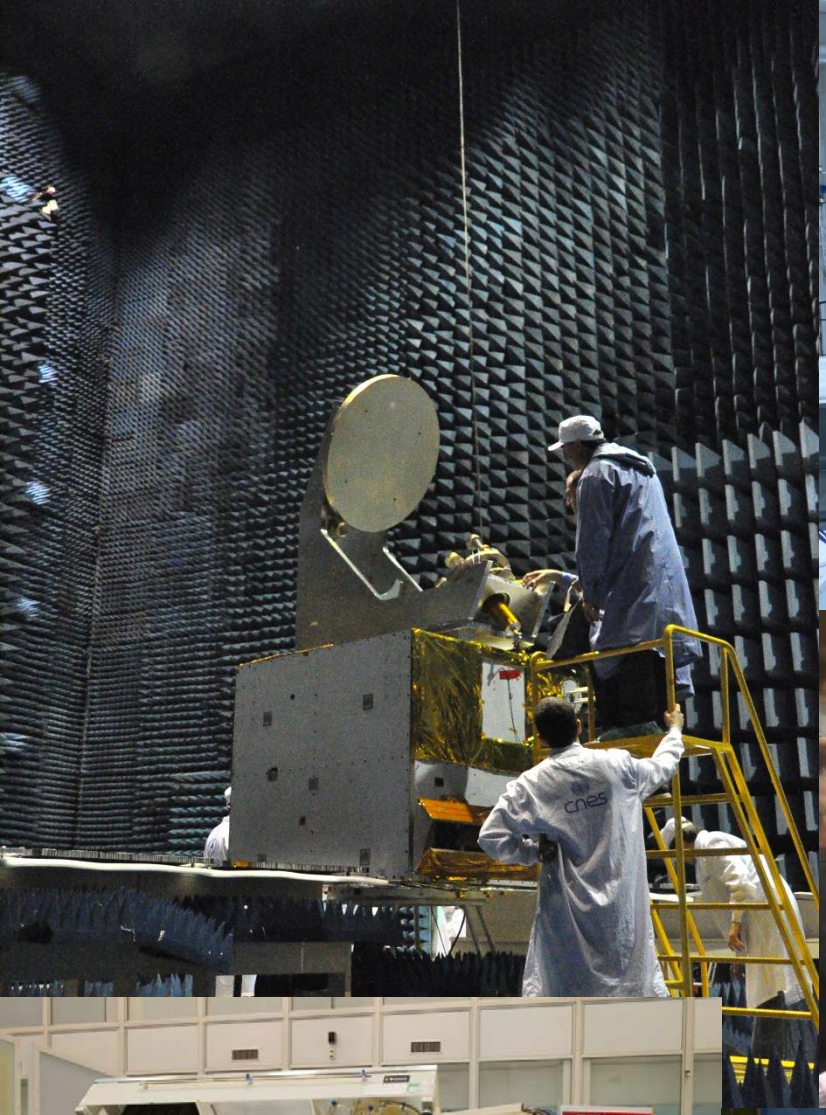
- **Characterize sea ice and ice cover**
- Characterize land surface (variations of humidity and roughness)
- **Improve σ0 models over ice** and land

Satellite



- **Orbit**
  - **Sun synchronous**
  - **Inclination**
    - **97.5°**
  - **Local time at descending node**
    - AM 7:00
  - **Altitude at the equator**
    - 519 km
  - **Cycle duration**
    - 13 days

- **Mass and dimensions**
  - **Mass**
    - ~600 kg
  - **Primary structure**
    - ~1.5mx1.5mx1.5m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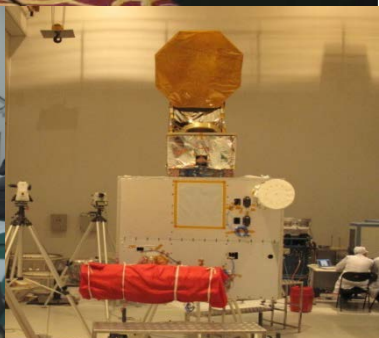
DANGER



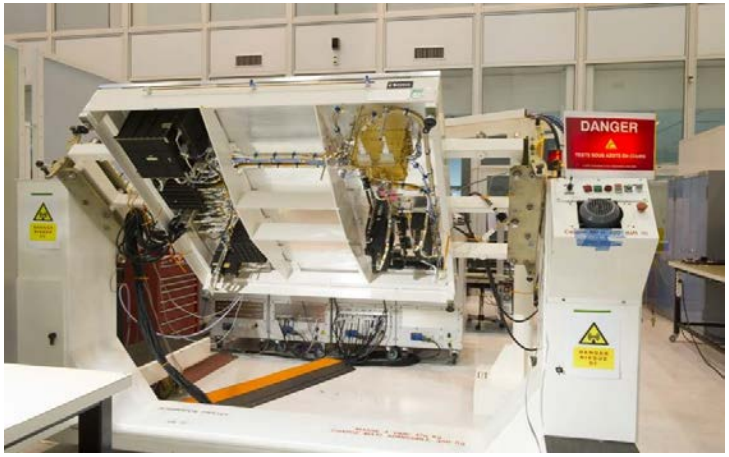
Status of the mission

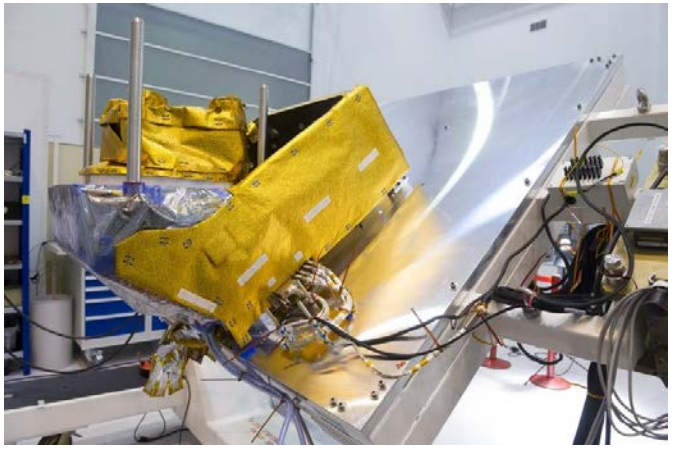
Mid 2017 — 08/2018 — 01/2019 (TBC)

SWIM integration and tests at TAS facilities → Satellite AIT and launch campaign → CAL/VAL phase → Routine phase (> 3 years)

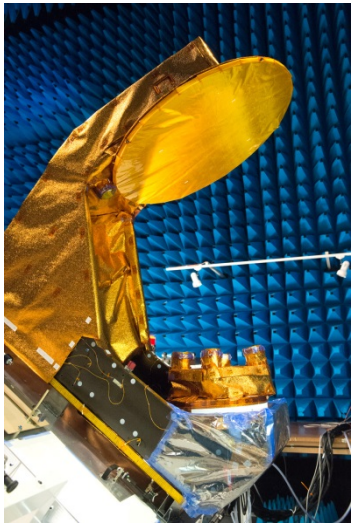
★ End of PFM instrument tests

★ Launch from Jiuquan, China





Qualification model (HYM)



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PFM antenna

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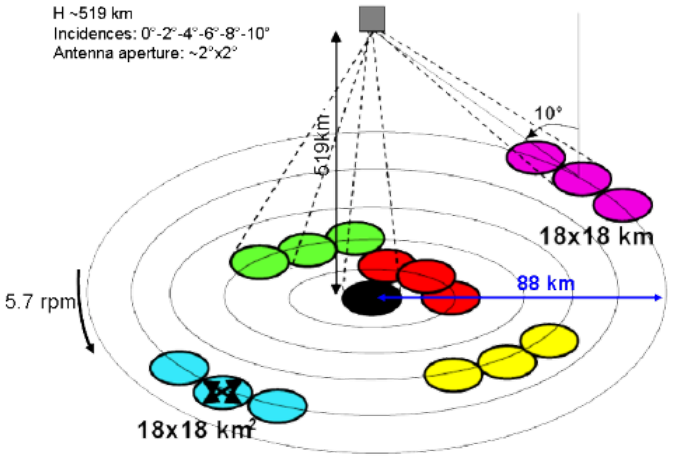
Two radar payloads on CFOSAT

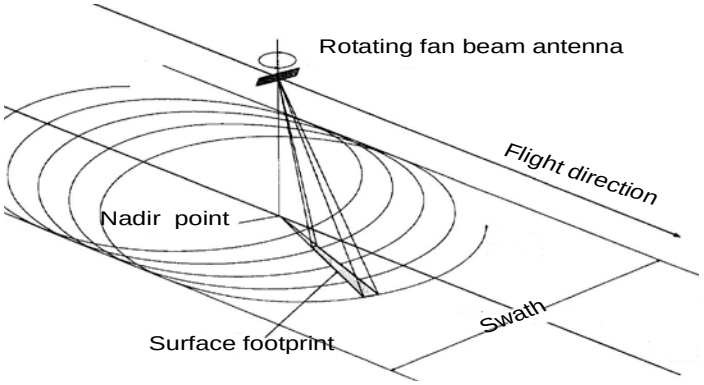
SWIM: a wave scatterometer

- 6 incidence angles: 0°, 2°, 4°, 6°, 8°, 10°
- Rotating antenna: 5,6 rpm
- Ku band



SCAT: a wind scatterometer

- Fan beam concept
  - ✦ Large swath
  - ✦ Rotating antenna: 3 rpm
- Incidences between 26° and ~50°
- Ku band

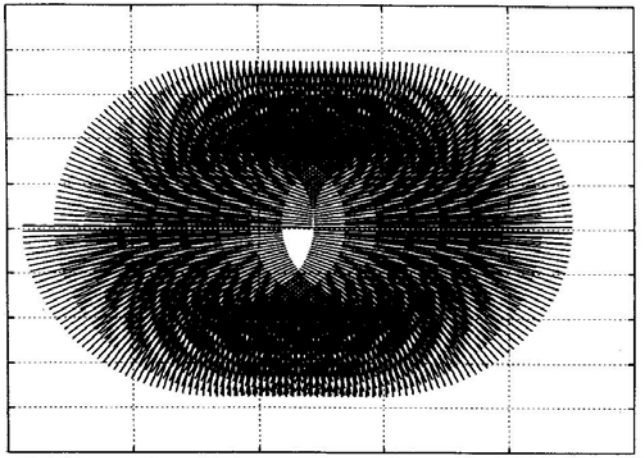


SCAT – Scientific requirements

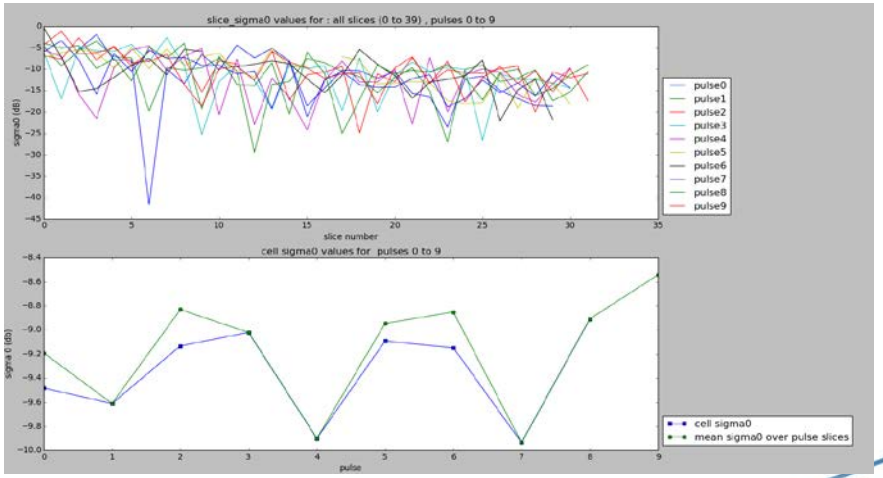
- Global coverage within 3 days
- NRT access to the data
- Geolocalization better than 5km

- Parameters to be measured:
  - ✦σ_0:
    - » ± 1.0 dB for WS ∈ [4-6 m/s]
    - » ± 0.5 dB for WS ∈ [6-24 m/s]

  - ✦Ocean wind vector
    - » Wind speed: 2 m/s or 10% (the largest) for WS ∈ [4-24 m/s]
    - » Wind direction: ± 20°



On-ground footprint

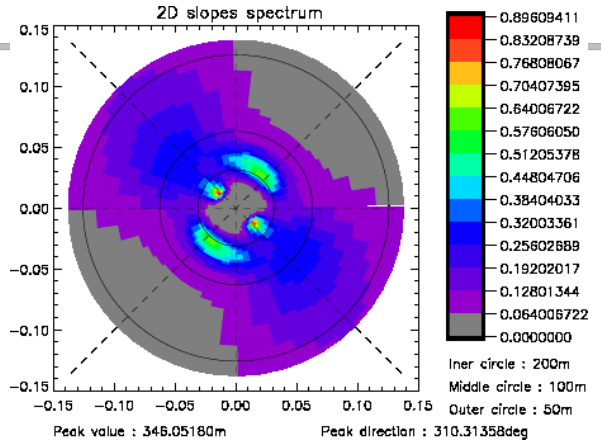


Simulation with random wind fields

SWIM - Scientific requirements

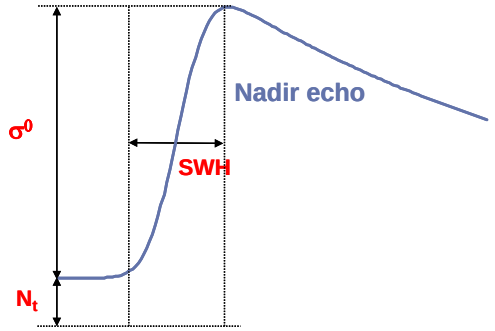
Directional wave spectra from incidences 6º / 8º /10º

λ	$\frac{\delta\lambda}{\lambda}$	ϕ	*Spectral peak power*	*Resolution cell*
70 – 500 m	10%	15°	20%	70x90 km^2



Significant wave height and wind speed from nadir

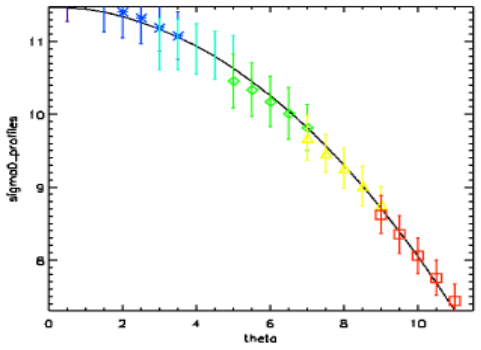
SWH	*WS*
10% or 50 cm	2 m/s



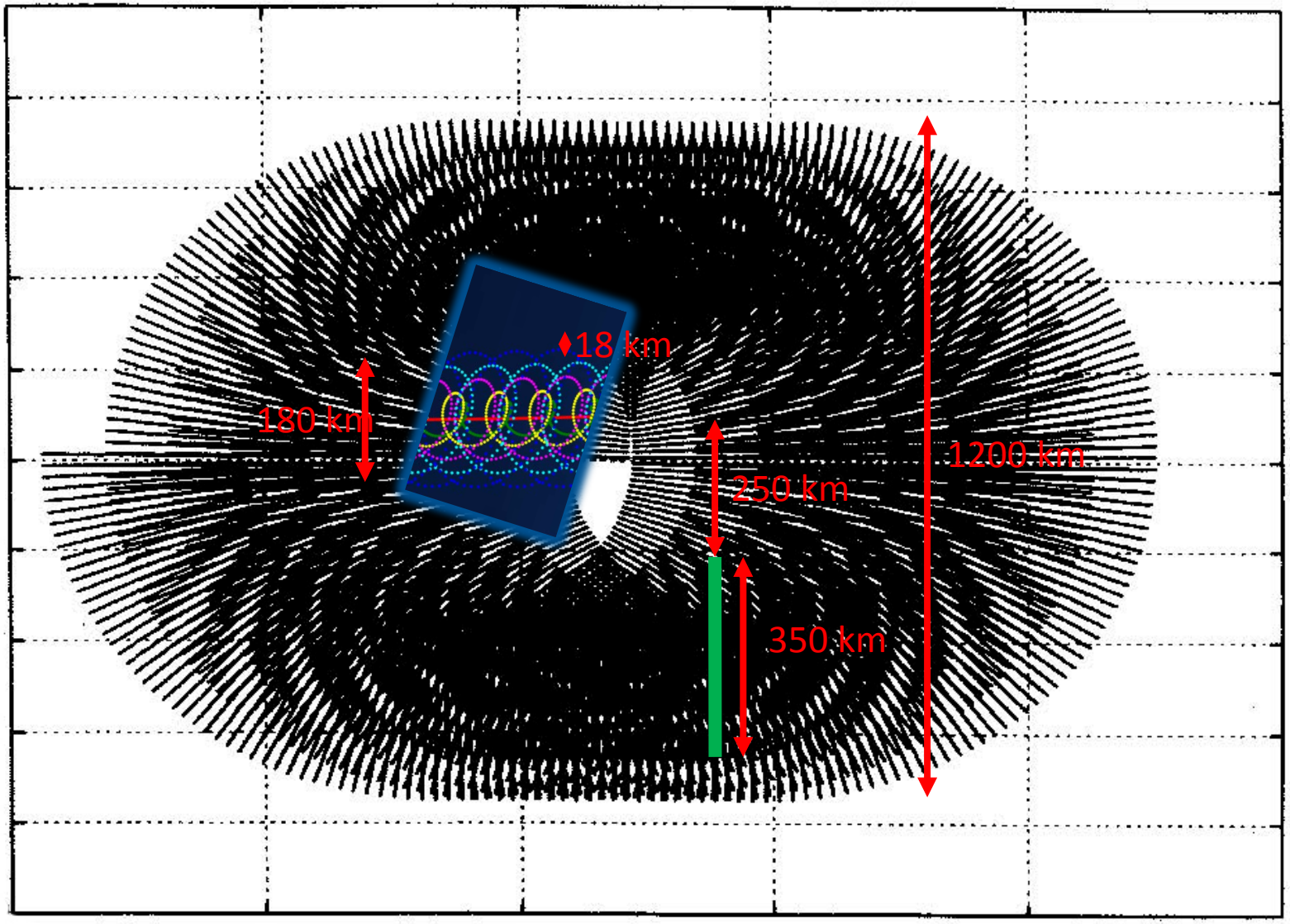
Normalized radar cross-section from 0 to 10º

σ_0	$\Delta\sigma_0^{i,j}$
1 dB	0.1 dB

Normalized radar cross-section

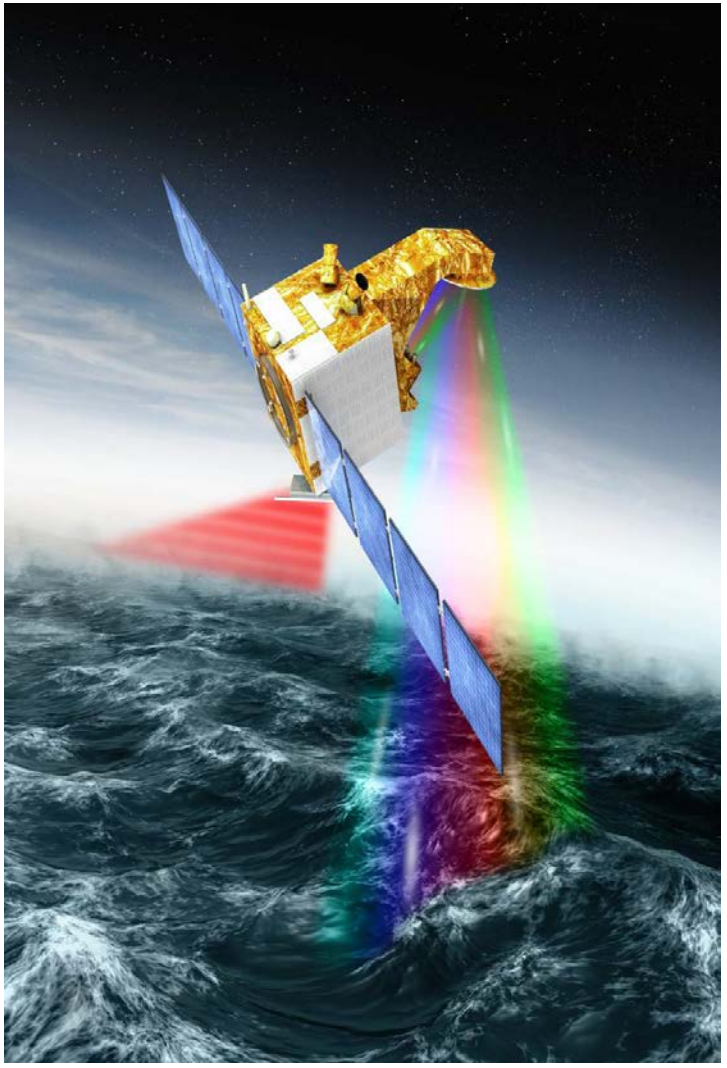


Combined observation



➔ Co-localized SWIM & SCAT data over ±90 km from the nadir track (<20s)

Overview of the presentation



Mission description

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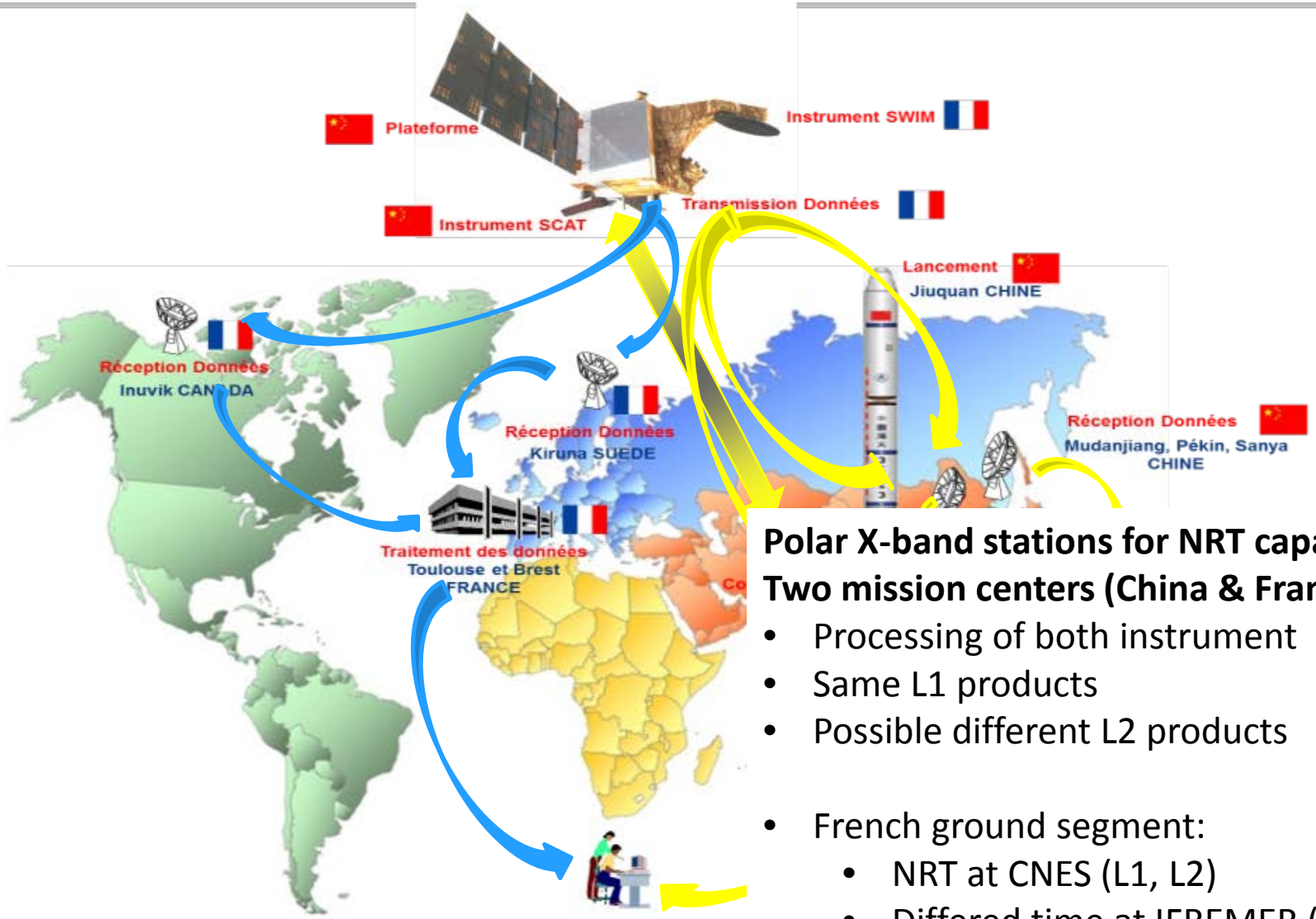
CFOSAT products and accuracies

- CFOSAT ground segment
- Processing and products
- Accuracies of wave spectrum

Overview of the ground segment

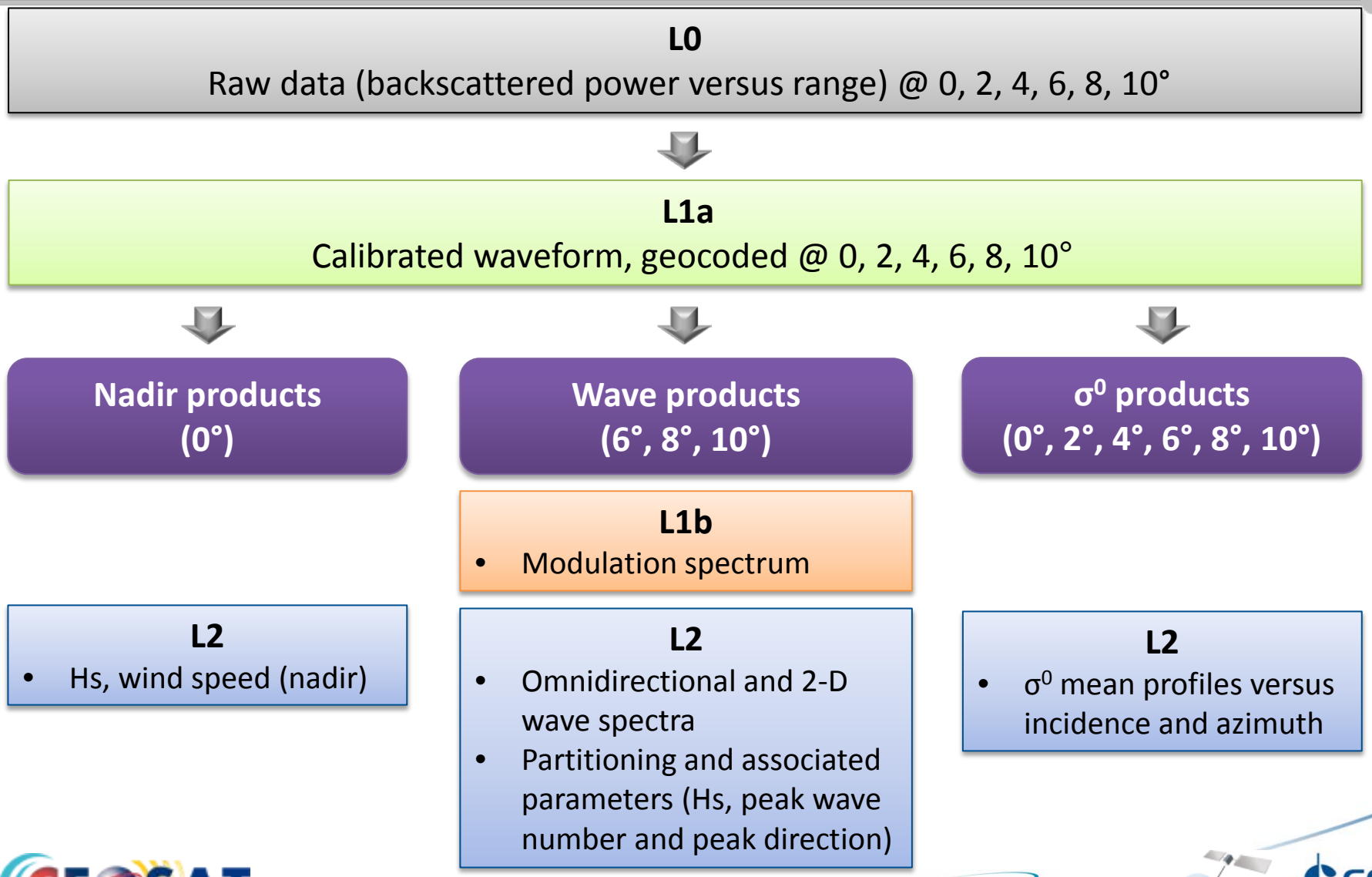


Polar X-band stations for NRT capability
Two mission centers (China & France):

- Processing of both instrument
- Same L1 products
- Possible different L2 products

- French ground segment:
  - NRT at CNES (L1, L2)
  - Differed time at IFREMER (L2S, L3, L4)

SWIM NRT products



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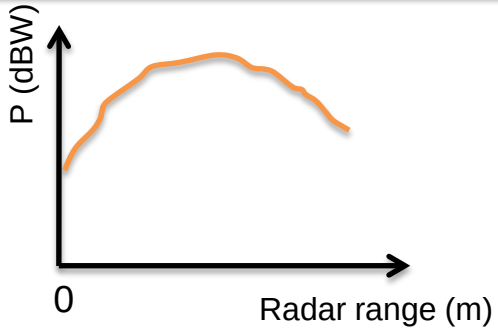
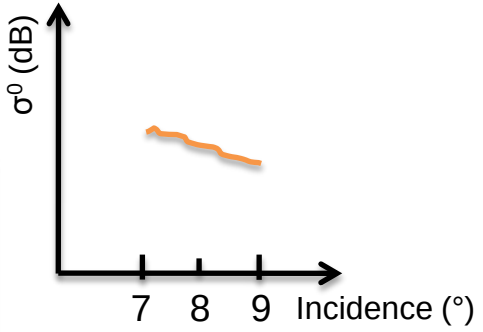
SWIM NRT products (nadir and σ^0 profile)

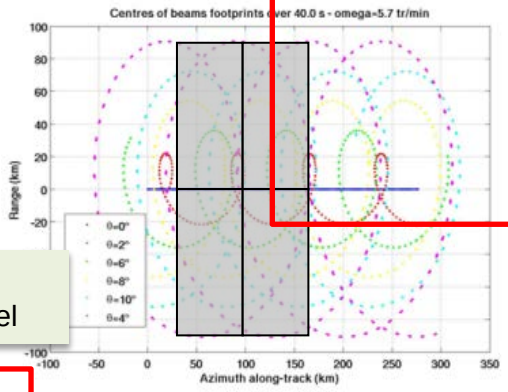
L0: non calibrated wave form (per cycle, incidence, azimuth)



- ***σ^0 estimate from radar equation***
- ***Geocoding***

L1a: Calibrated wave form, geocoded (per cycle, incidence, azimuth)



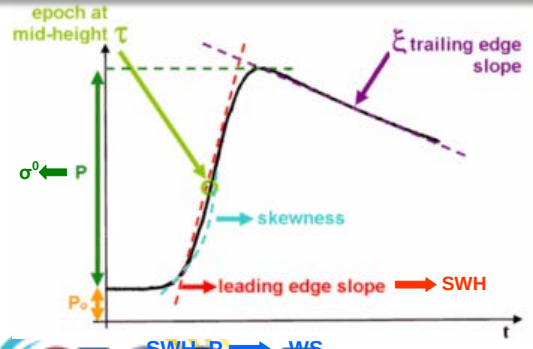


- ***Nadir waveform retracking***

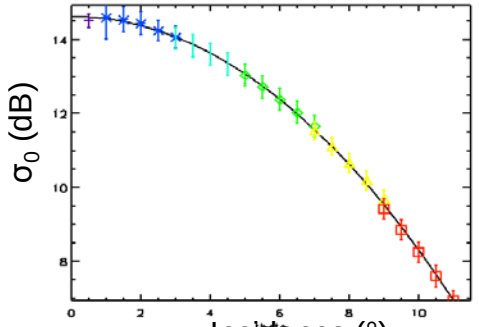
Numerical retracking with adaptive model

- ***Combining incidences within boxes***

L2 Nadir : SWH, WS, σ^0 (nadir)
Ice and land properties

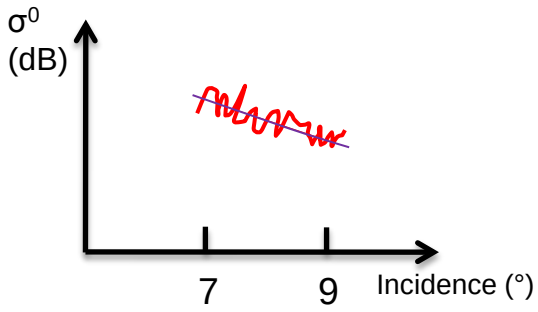


L2: Normalized radar cross-section profiles
From 0° to 11° (per 15°-azimuth range) at a scale of 70 x 90 km and associated radiometric accuracy

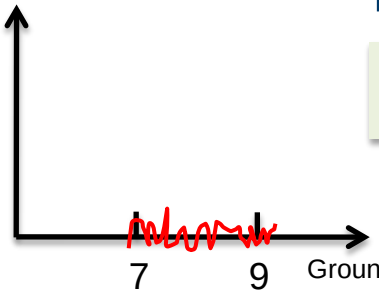


SWIM NRT products (wave slope spectrum)

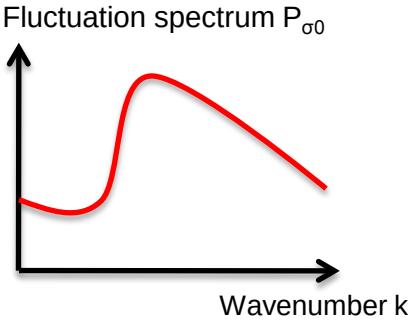
L1a: Calibrated wave form, geocoded
(per cycle, per azimuth, incidence = 6, 8 or 10°)



• ***Mean trend suppression***
• ***Ground projection***



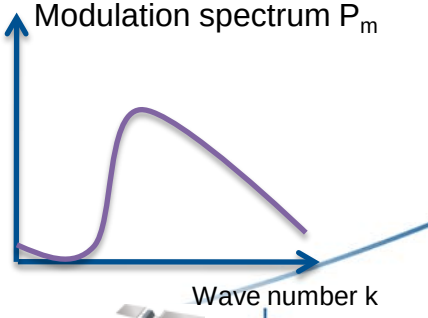
• ***Spectral density***



$P_{\sigma 0} = P_{IR}.P_m + P_{sp}$

• ***Speckle + IR correction***

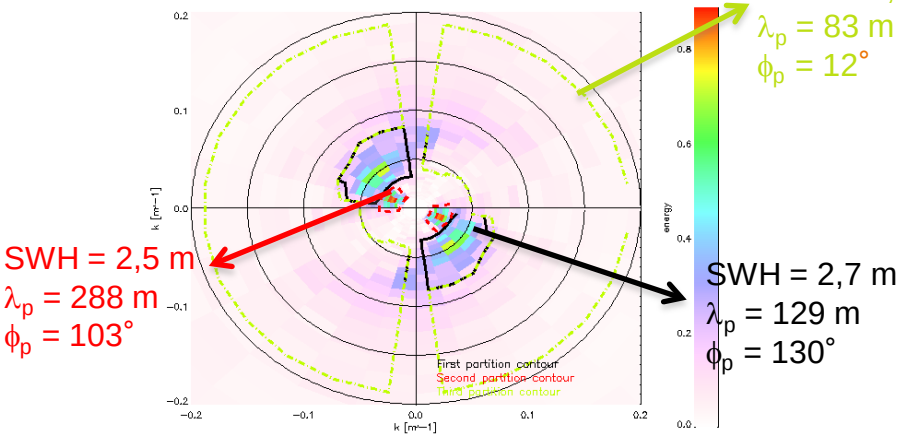
L1b: modulation spectrum
(per cycle, per azimuth, incidence=6, 8 or 10°)



$P_w = P_m/MTF$

- ***Transfer function estimation and wave slope spectrum computation***
- ***15°-azimuth averaging***
- ***Partitioning and physical parameter computation***

L2: wave slope spectrum and partitions
(per box, per beam or merged)



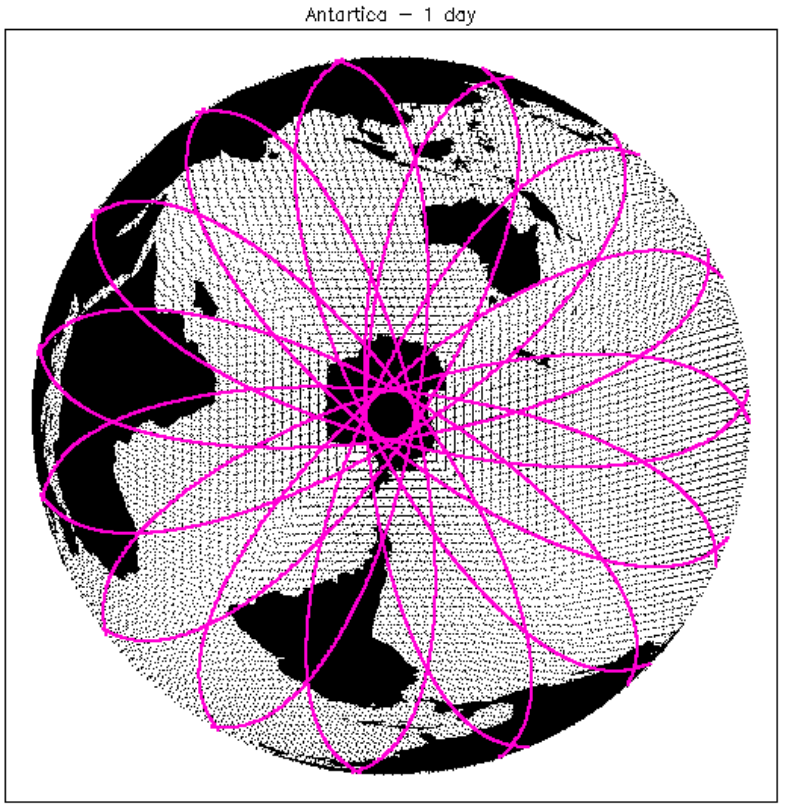
SCAT NRT products

Level		Definition	Associated processing
Level 0	**0**	Time order **raw data**	Transmission to mission centres
Level 1	**1a**	**Backscattered power** (about 1 km range resolution)	Internal calibration
	1b	**Normalized radar cross section over 40 slices** **(~8 km ground resolution)** (Time-Ordered Earth-Located Sigma0s)	- Apply time difference correction - Assignment of ephemeris and attitude information to each frame - Do DN-EU conversion for engineering data
Level 2	**2a**	**Sigma0** (Surface Flagged Sigma0s and Attenuations in 25 and 50 km Swath Grid) **Kp** (asked by French scientists) Sigma0 over land and ice (asked by French scientists)	- Calculate cell location& geometry - Calculate surface flags - Calculate sigma0 and associated - Quantities (Calibrated data for wind retrieval)
	2b	**Wind Vector** (Ocean Wind Vectors in 25 and 50 km Swath Grid)	- Perform sigma – 0 Grouping - Calculate wind vectors - Perform ambiguity removal

CFOSAT assets for ice studies

- Polar orbit
  - Daily revisit of polar areas
- Available data:
  - Large scale of incidence angles (0° to 50° with small gap)
  - Full azimuth scanning
  - Calibrated radar waveforms
- Applications
  - Improvement of σ_0 models and physics understanding
  - Better characterization of ice/snow properties
  - Synergy with altimeters (Sentinel-3, Cryosat-2 and AltiKa)
  - Impact of waves on the ice sheet

1 day of CFOSAT orbits over Antarctica



Conclusion

CFOSAT

- New space-borne scatterometers for joint wind and wave observations
- Full characterization of wave spectra
- Launch August 2018

Focus on ice:

- Polar orbit
- Acquisition on land/ice
- Possible scientific exchanges with **PolarPod expedition**

- **! Today, no scientific proposition at TOSCA on CFOSAT / ice** (only on-going study with LOPS and CLS) **!**

Simulation data open to scientists on AVISO+ (**ONLY ON OCEAN**):
http://www.aviso.altimetry.fr/fr/missions/missions-futures/cfosat.html

(please contact celine.tison@cnes.fr for more information)