Future mission SWOT :

vers l'altimétrie à haute résolution

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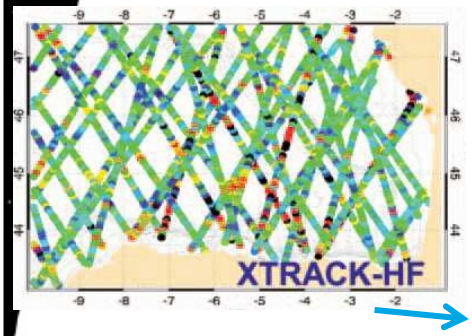
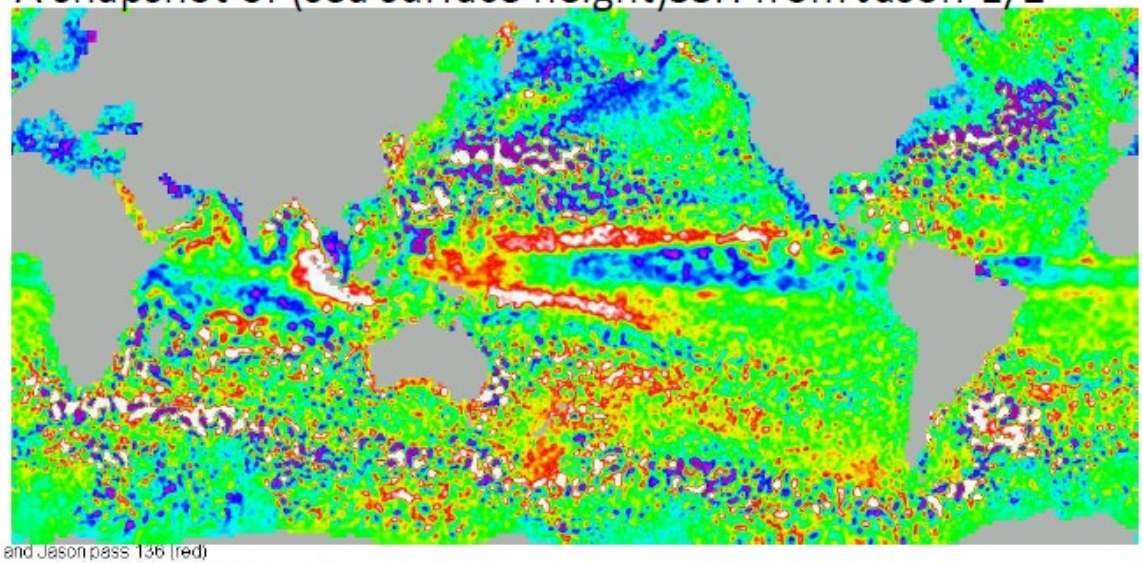
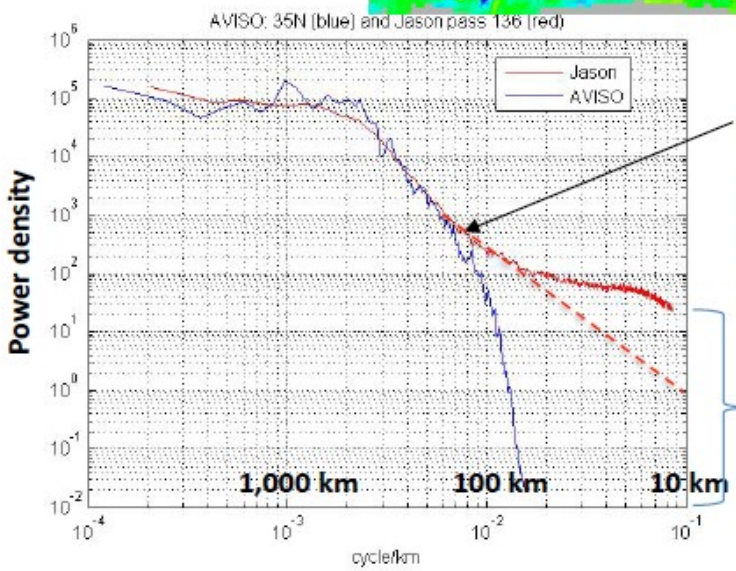
CNES SWOT Oceanography Lead

The limit of resolution of Jason-1/2

A snapshot of (sea surface height)SSH from Jason-1/2







Drop in energy of 2-D gridded SSH spectrum (blue) vs alongtrack spectrum (red) at 200 km Indicates the mapping resolution with nadir altimeter constellations.

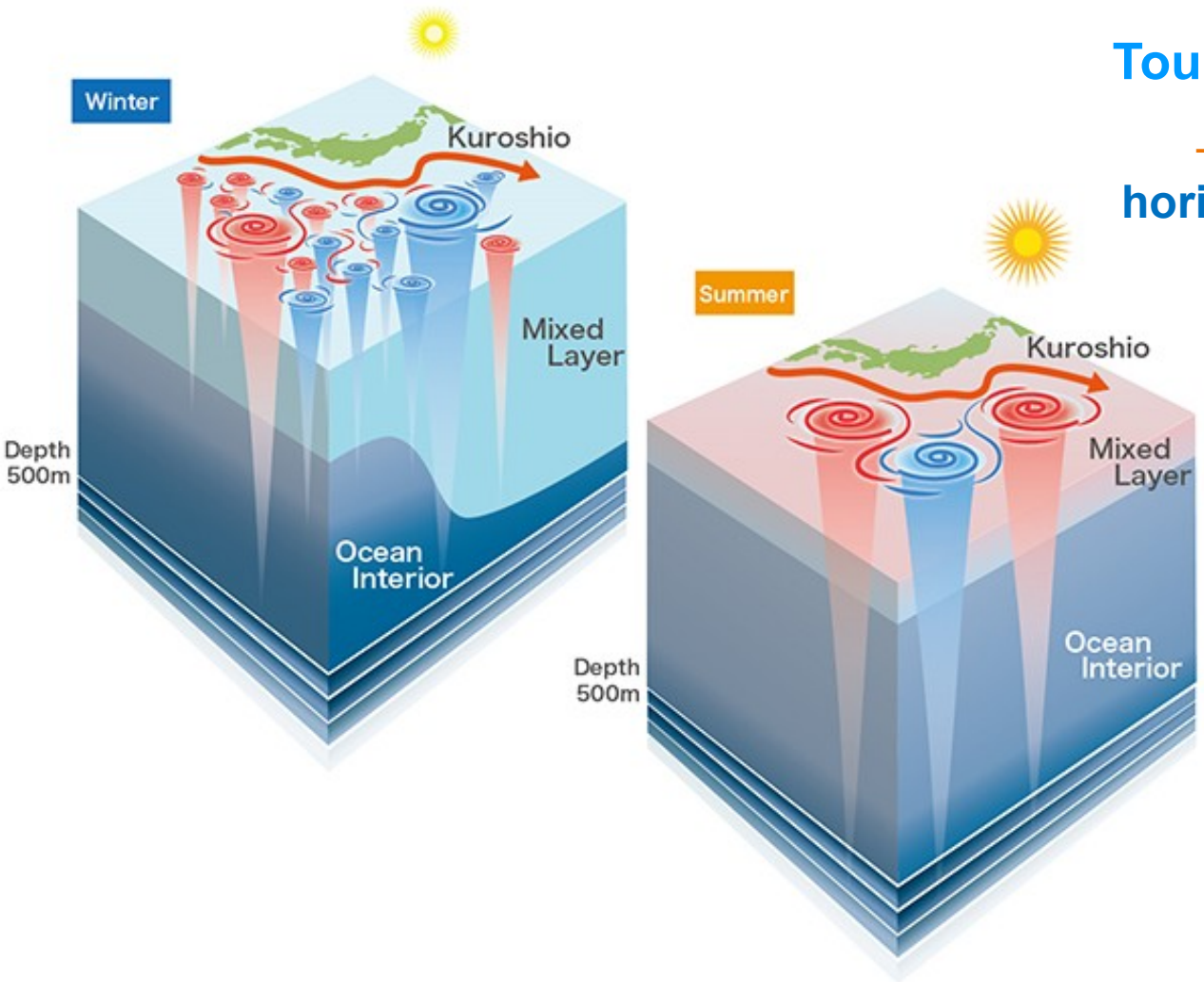
SWOT will extend the measurement down to 15 km

Oceanographic Objectives of SWOT

•The **primary oceanographic objectives of the SWOT mission** are to **observe the ocean mesoscale and submesoscale circulation at spatial resolutions of 15 km and larger**, providing the missing link between 15 and 200 km for ocean climate studies.

• The mission is also designed to **observe coastal and high-latitude tides and internal tides**, important in the ocean's energy budget, and for ocean mixing & dissipation

Pourquoi altimétrie 2D à haute résolution ?



Tourbillons à Méso-échelle

- Transport & mélange horizontal (Chaleur, carbone, nutritifs)

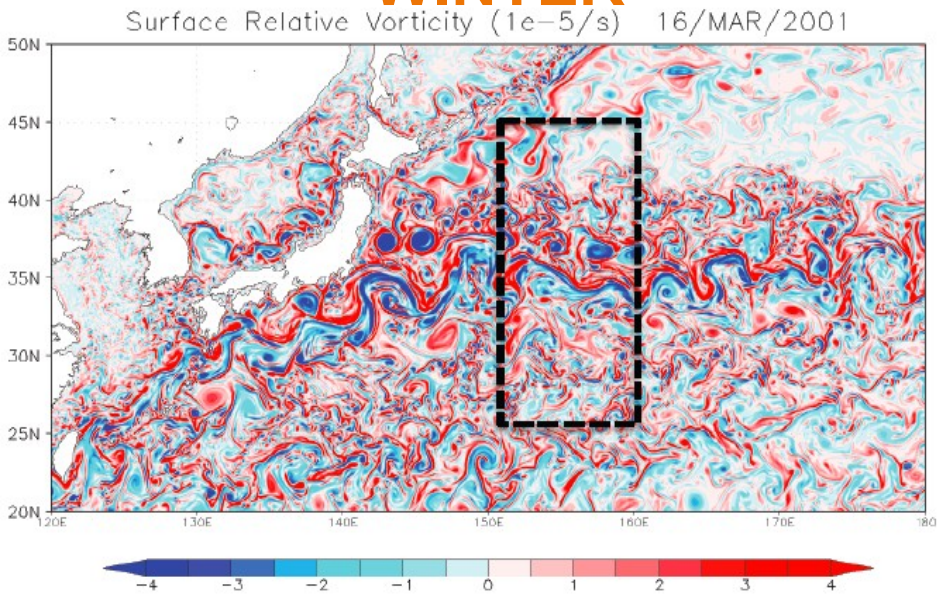
Fronts & tourbillons à Subméso-échelle

- 50 % de vitesses verticales !

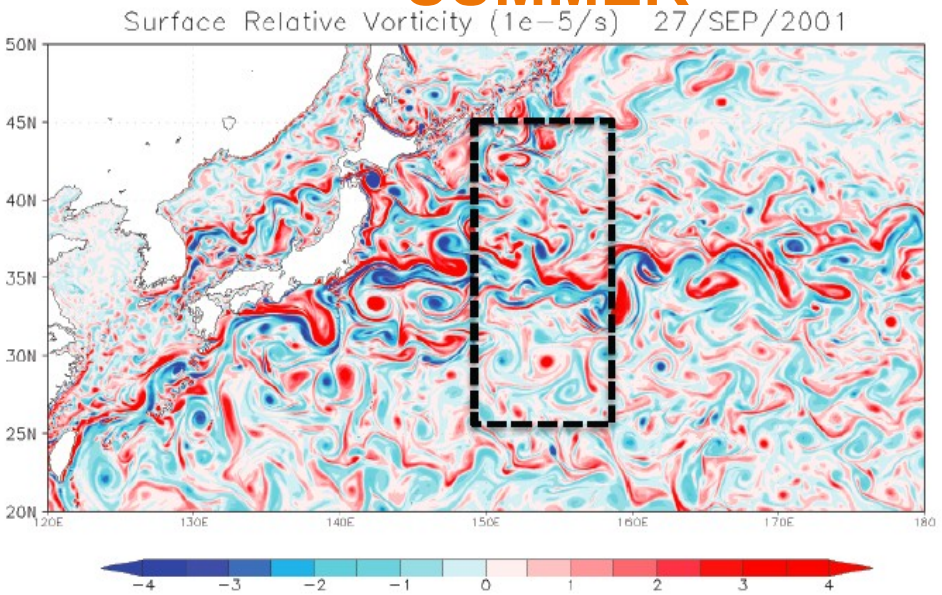
North Pacific simulation (1/36th 100 vertical levels) (Sasaki et al.,'13.) :

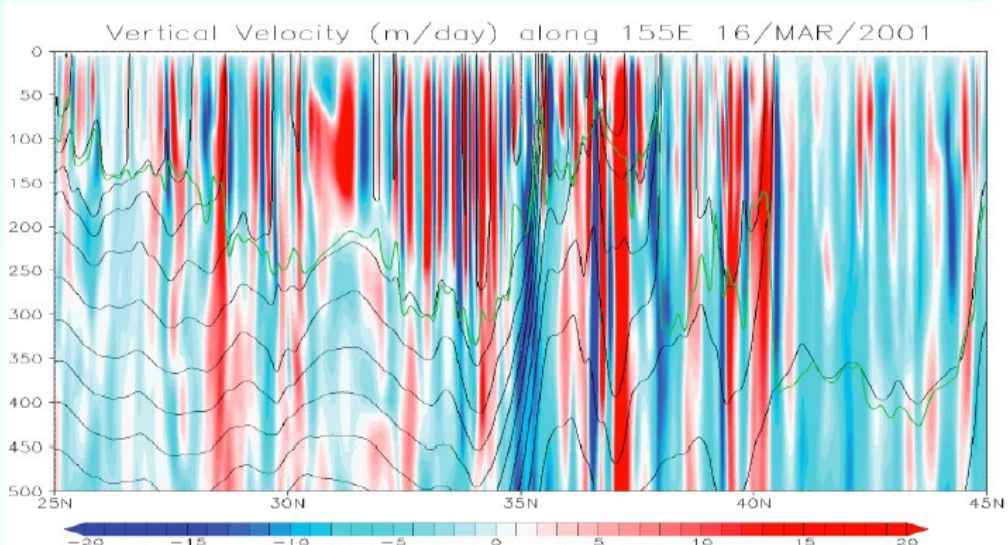
Impact of submesoscale mixed-layer instabilities on larger scales

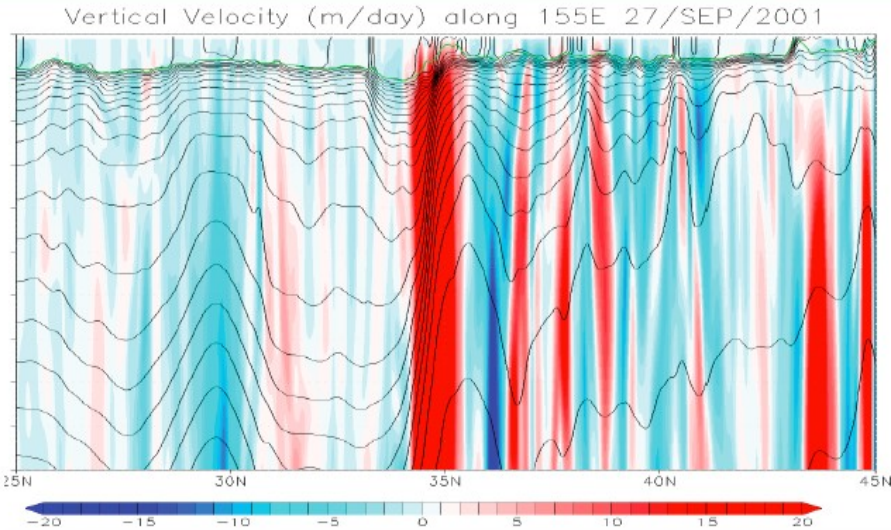
WINTER



SUMMER

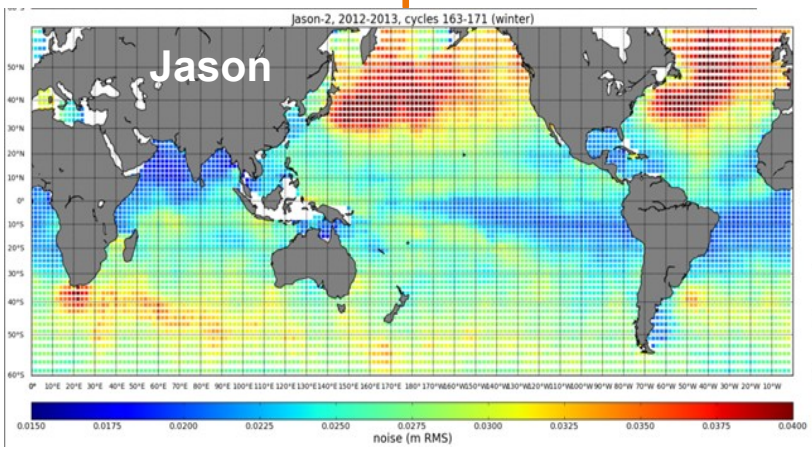






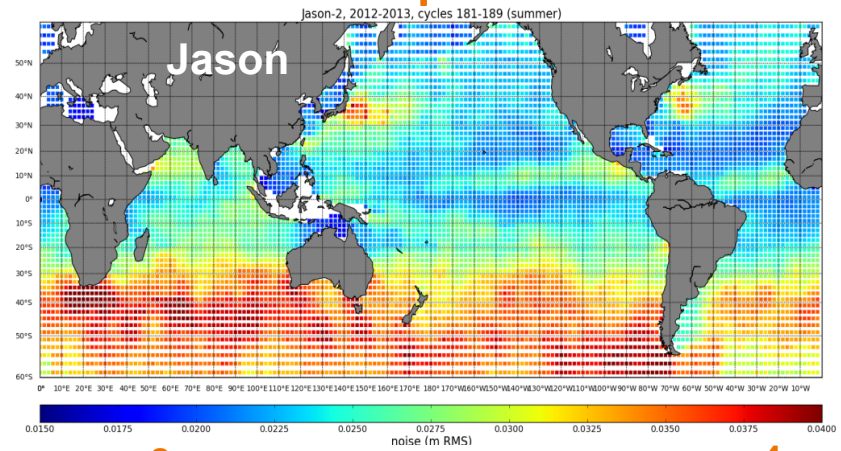
Seasonal variations in Error Level in … conventional altimetry missions

DJF : N hemisphere Winter



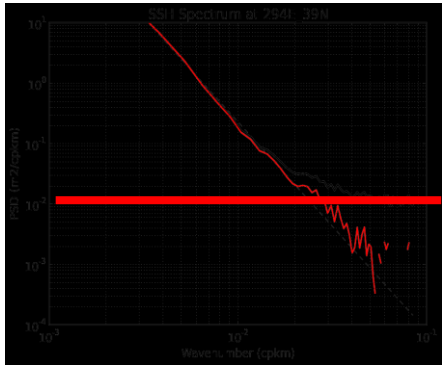
2 cm 4 cm

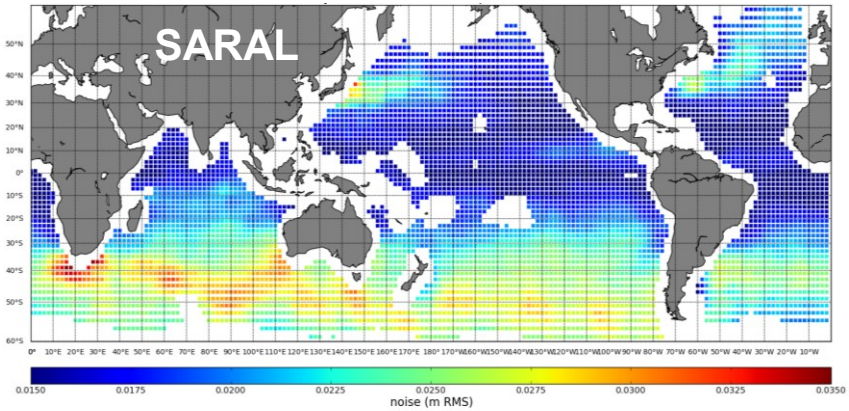
JJA : S hemisphere Winter



2 cm 4 cm

1hz error level for each Season

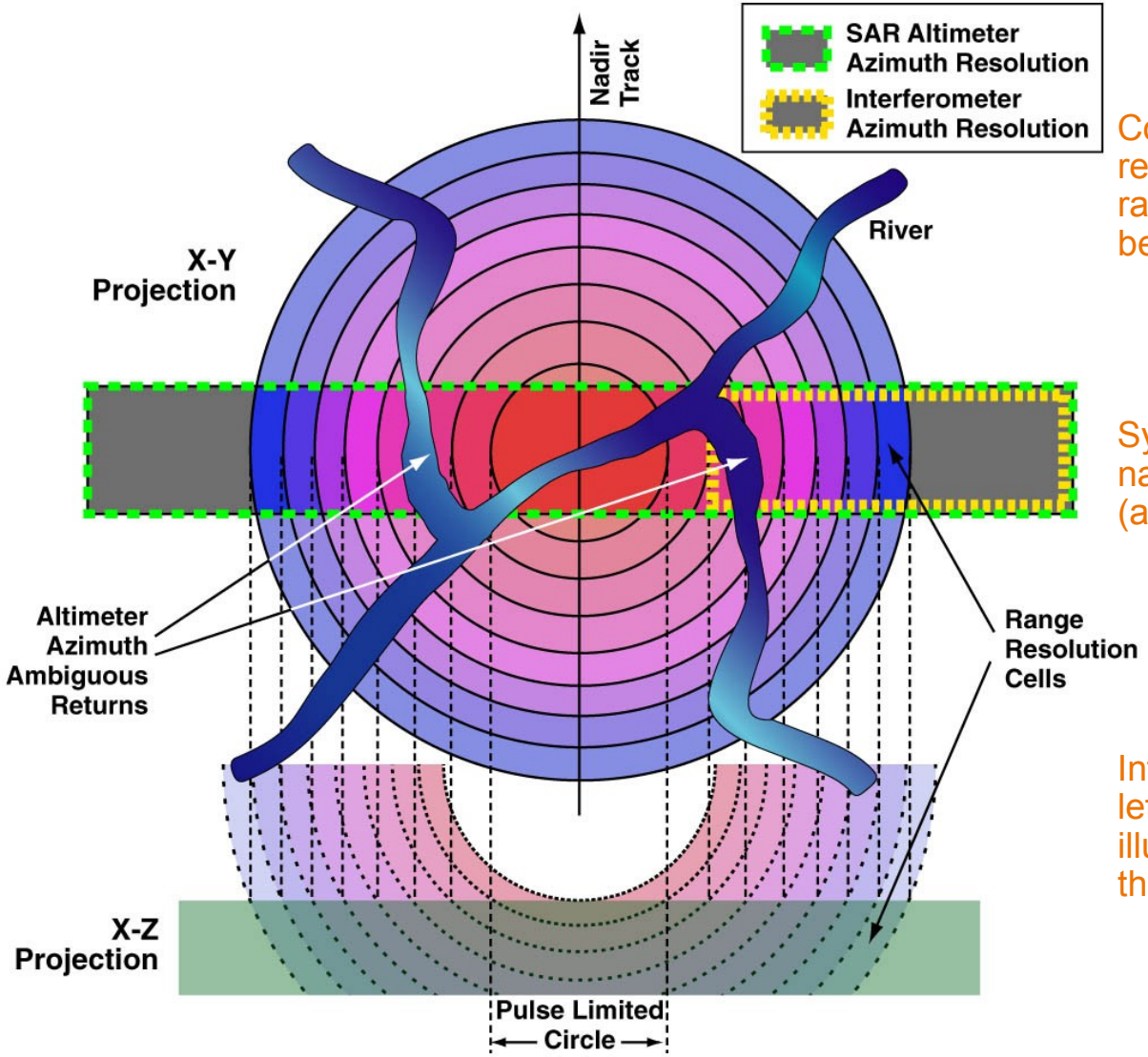




2 cm 4 cm

Dufau, et al, 2014

Altimetric error levels linked to Spatial resolution



Conventional altimeter spatial resolution determined by iso-range annuli and antenna beamwidth

T/P & Jason

SARAL

Synthetic aperture processing narrows the along-track (azimuth) cell size

CR2-SAR

Sentinel-3

J-CS

Interferometry resolves left/right ambiguity by illuminating only one side of the swath

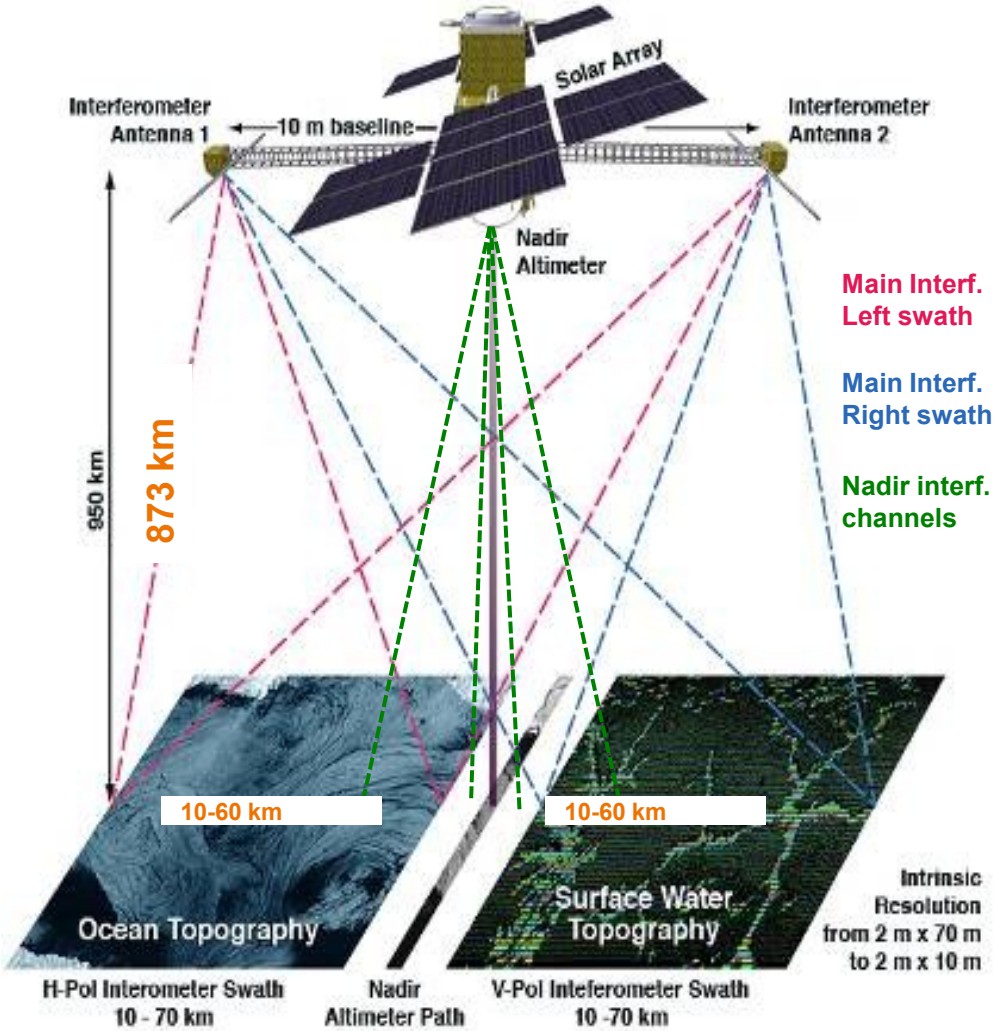
SWOT

Compira

SWOT Mission description

Mission Architecture

- Ka-band SAR interferometric (KaRIn) system with 2 swaths, 60 km wide
- Produces heights and co-registered all-weather SAR imagery
- Intrinsic resolution 2 m x 10-70 m grid
- Averaged to detect 100 m wide rivers, 250 m^2 lakes and **onboard processor gives 1 km^2 grid over oceans**
- **Interferometry will reduce noise by 1 order of magnitude : 2.4 cm^2/cycle/km^2**
- Use conventional Jason-class altimeter for nadir coverage, radiometer for wet-tropospheric delay, and GPS/Doris/LRA for POD.

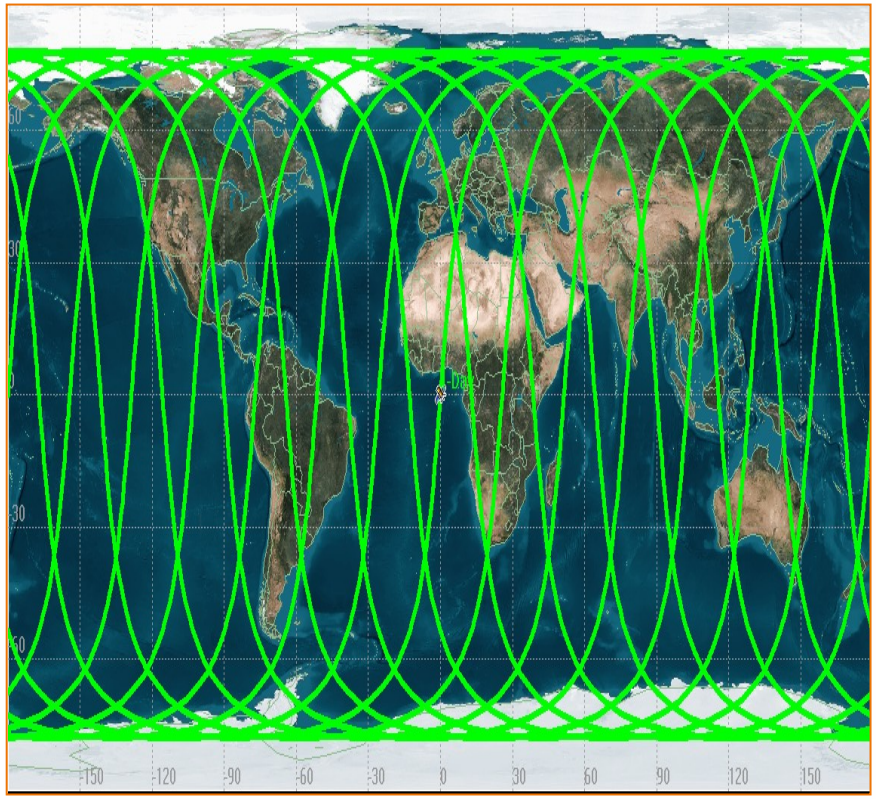


- Partnered mission NASA, CNES & CSA & UKSA
- Mission life of 3.5 years
- 890 km Orbit, 78º Inclination, 21 day repeat
- Launch: 2020

SWOT orbits

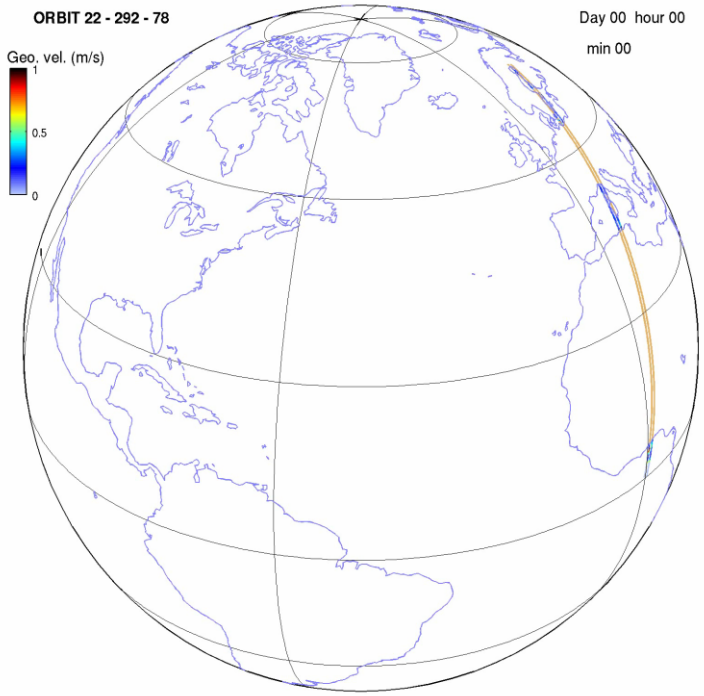
1-day fast sampling orbit

Duration 180 days (60 days for science studies). Limited coverage CalVal & fast ocean processes

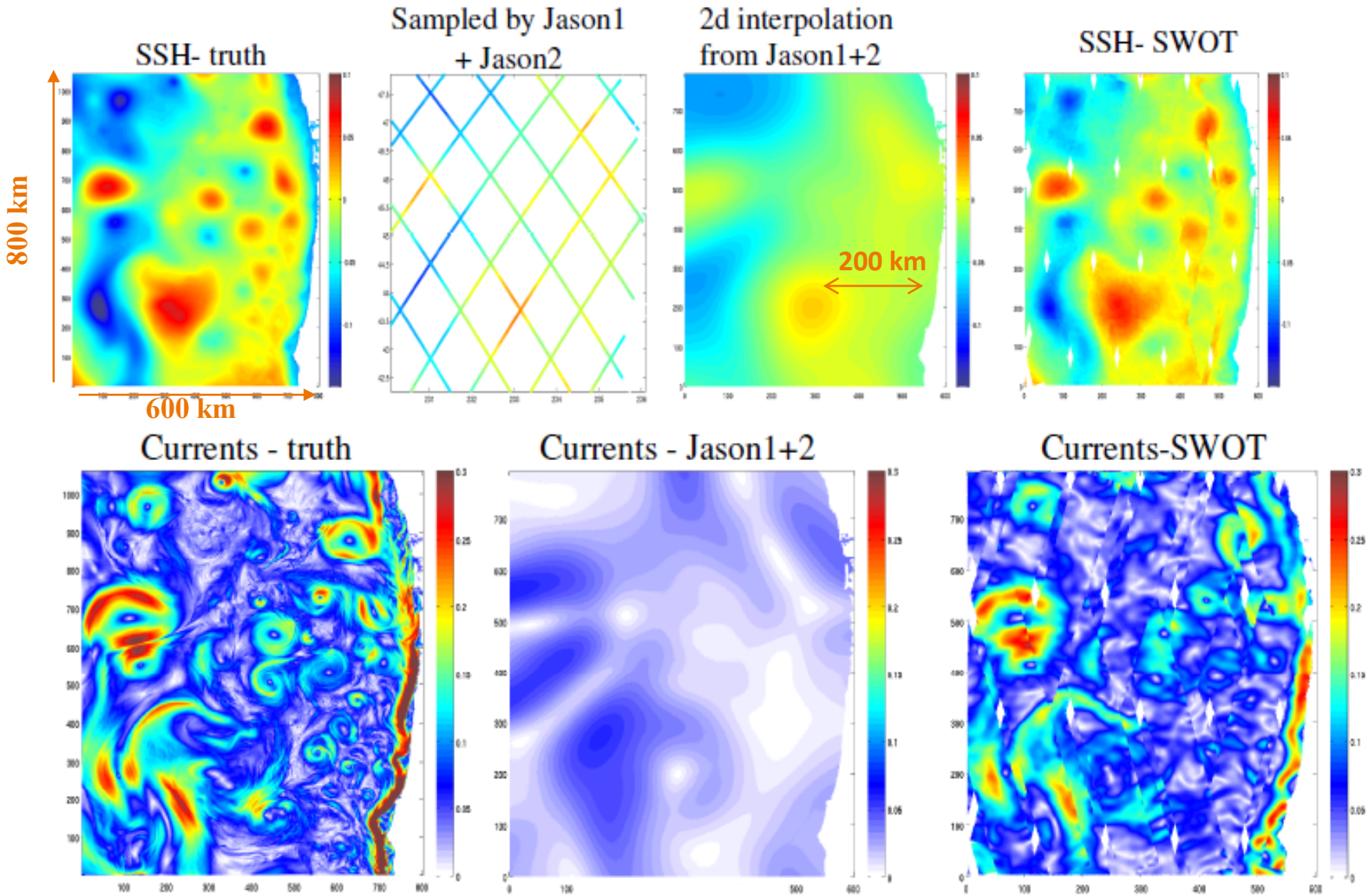


Nominal orbit : 21-day sampling

Duration : 3-years. Global coverage



SIMULATION OF OCEAN DYNAMICS BY SWOT



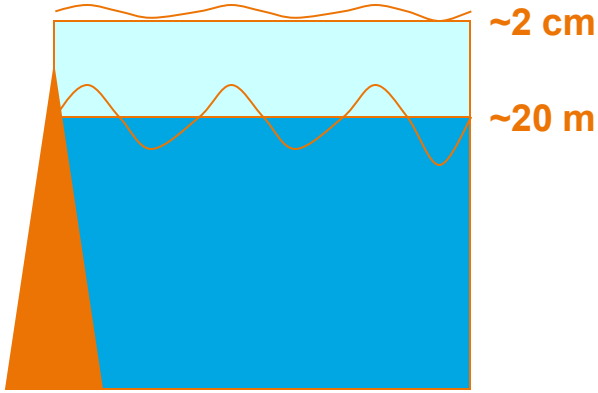
$$v = \frac{g}{f}\frac{dh}{dx}$$

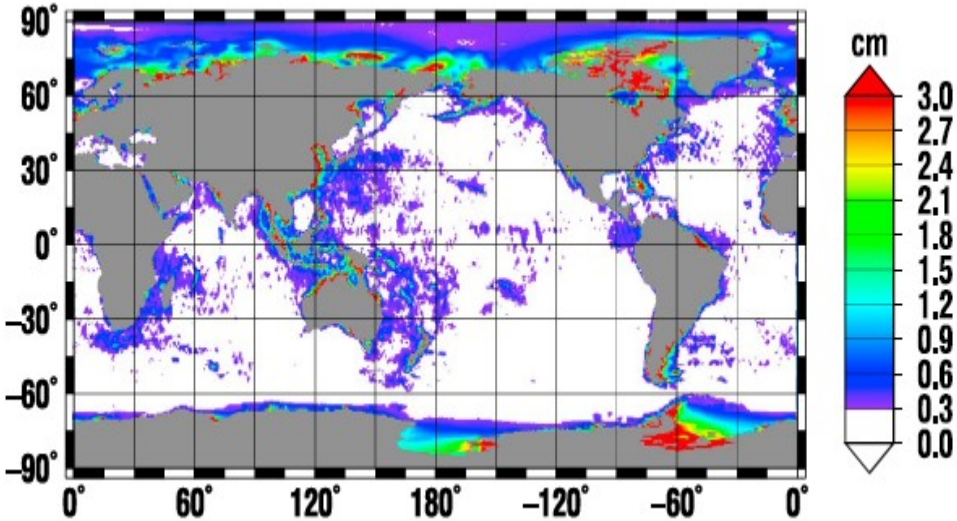
C. Ubelmann

Orbit chosen to better observe coastal and internal tides

Coastal tides are observed today by tide gauges or alongtrack data – 3 years of SWOT data will provide finer-scale 2D data

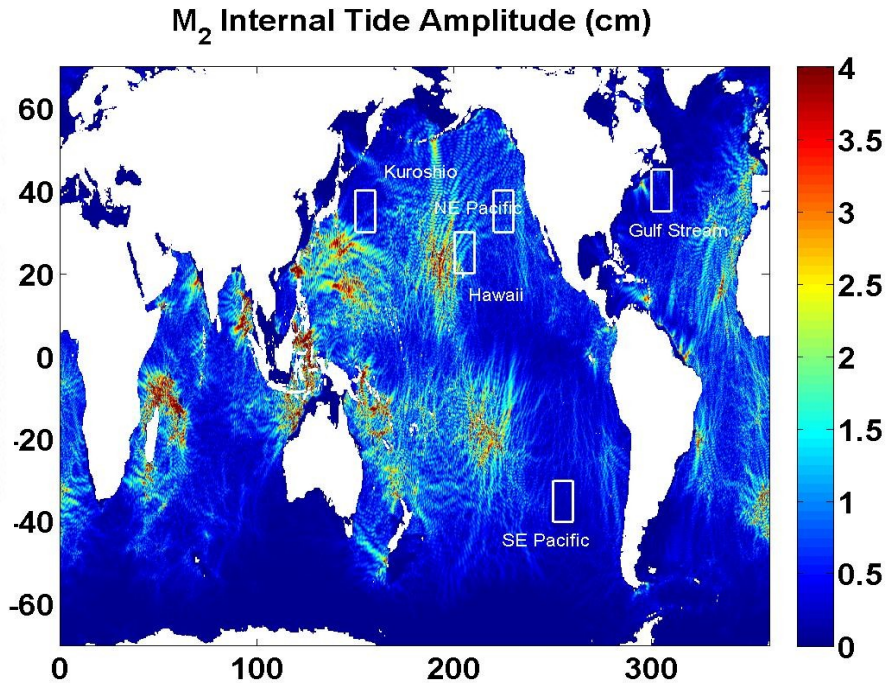
2D propagation of Internal tides observed by SWOT – important for ocean mixing & energy dissipation





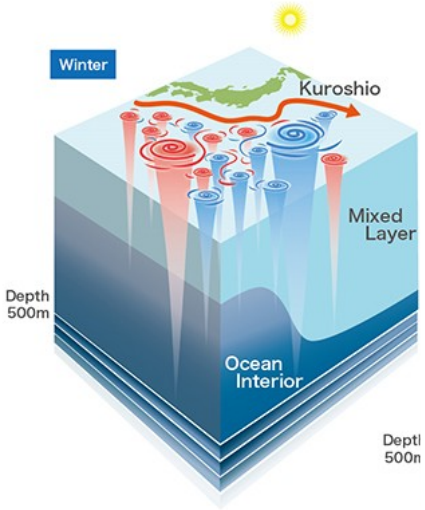
St. Dev of 7 global tide models, M2

Stammer et al., 2014



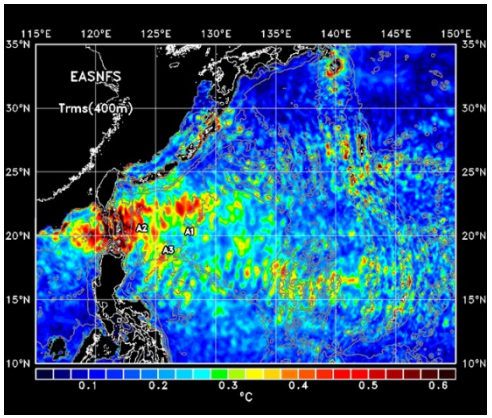
Model : HYCOM 1/12° *Arbic et al., 2012*

Rupture scientifique avec SWOT



Meso & sub-mesoscale ocean dynamics

2D surface height images for …

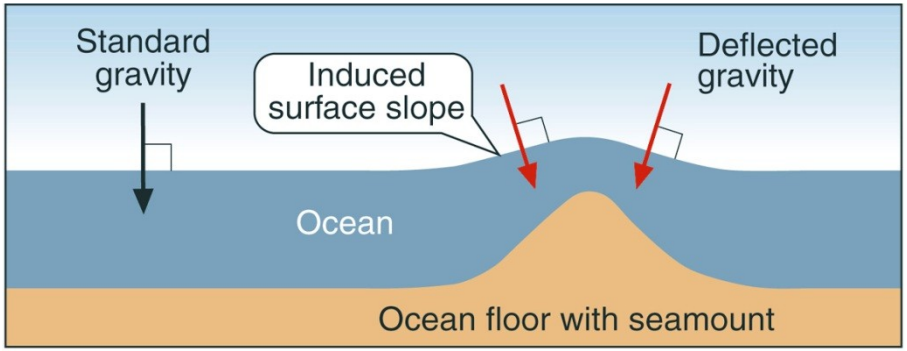


Coastal, high latitude and Internal Tides

Sea Ice Freeboard

Coastal dynamics

Ocean Bathymetry



SWOT Conclusions

For ocean studies, SWOT will provide a **revolution** in **global, 2-D SSH** observations with an **order of magnitude less noise** than traditional nadir altimetry

SWOT will allow us to improve our observations & understanding of **mesoscale & sub-mesoscale dynamics in all weather conditions** – 2D energy fluxes, generation & dissipation mechanisms, etc

Vertical velocities can be obtained from sQG theory or models, improving our knowledge of heat, carbon & nutrient exchange between the surface mixed layer & deeper layers

Need to understand radar interaction with surface – **simulations of wave / wind / surface current interactions**

In preparation for SWOT : we established a **Science Definition Team** of 40 scientists for 2013-2015 – observationalists, modellers, assimilators in ocean physics and biogeochemistry.

A new team is being selected by NASA-ROSES and CNES-TOSCA for 2016-2019

For more information – see http://swot.jpl.nasa.gov

Workshop :
Towards High-Resolution of Ocean Dynamics and Terrestrial Surface Waters from Space

21 – 22 October 2010, Lisbon, Portugal

Carl Wunsch :

Key point 1 : new oceanographic instruments working on previously unmeasured time or spatial scales, have led to surprising, sometimes **startling, discoveries that were not predicted**.

Key point 2 : experience strongly suggests that **models must be tested against observations on all time and space scales**. One of the major issues facing oceanography is that high resolution models become fundamentally untestable, so we need more repeated observations at finer space and time scales.