Validation of the AirSWOT data Collected during the French campaigns

S. Calmant

SWOT, First Science Definition Team meeting, Pasadena, January 28-30, 2013

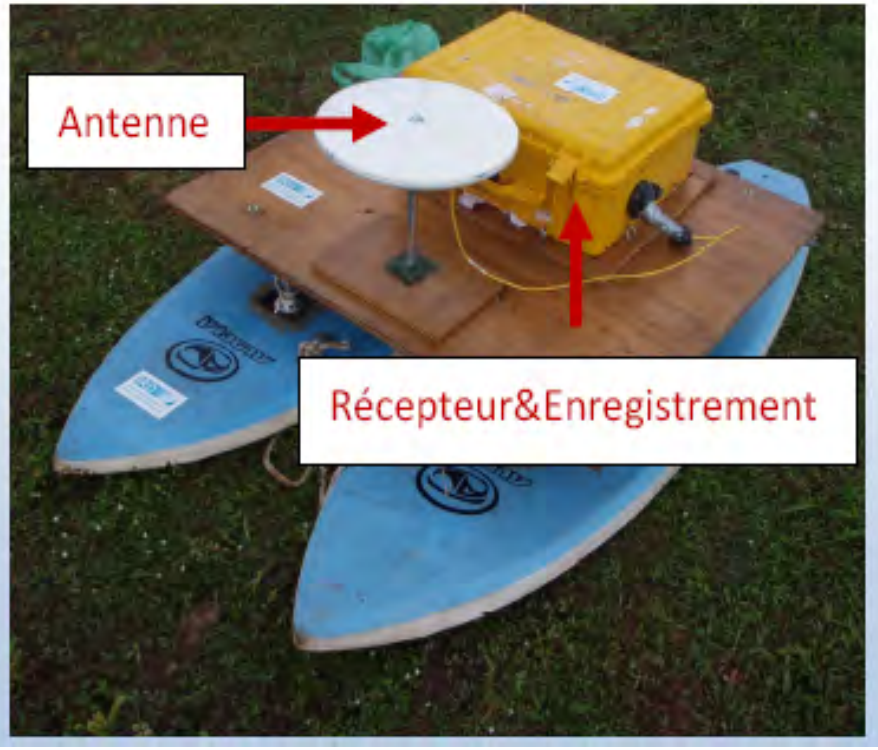
AirSWOT 2014

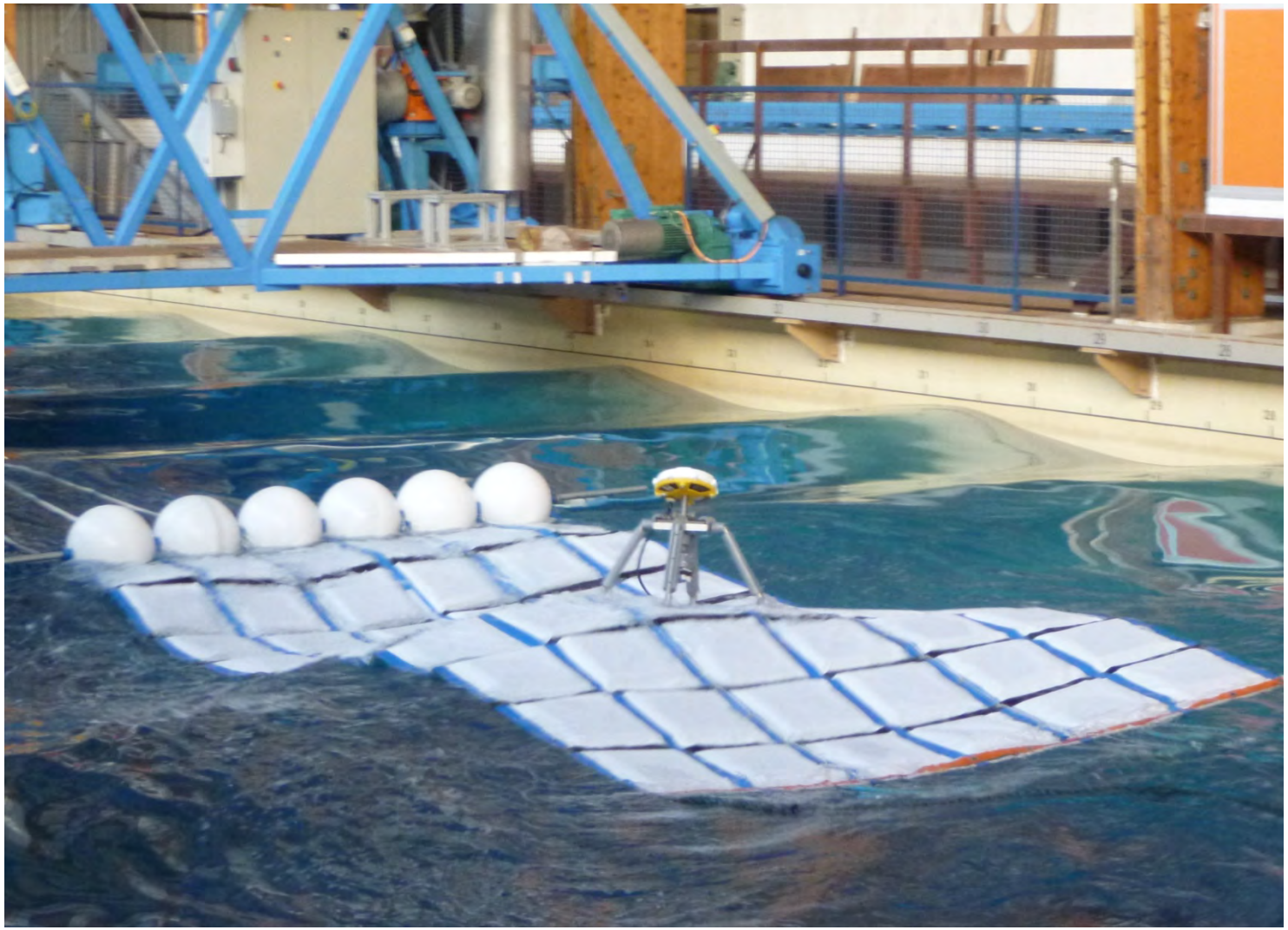
BeechCraft King Air owned by IGN

Ground measurements of heights and slopes

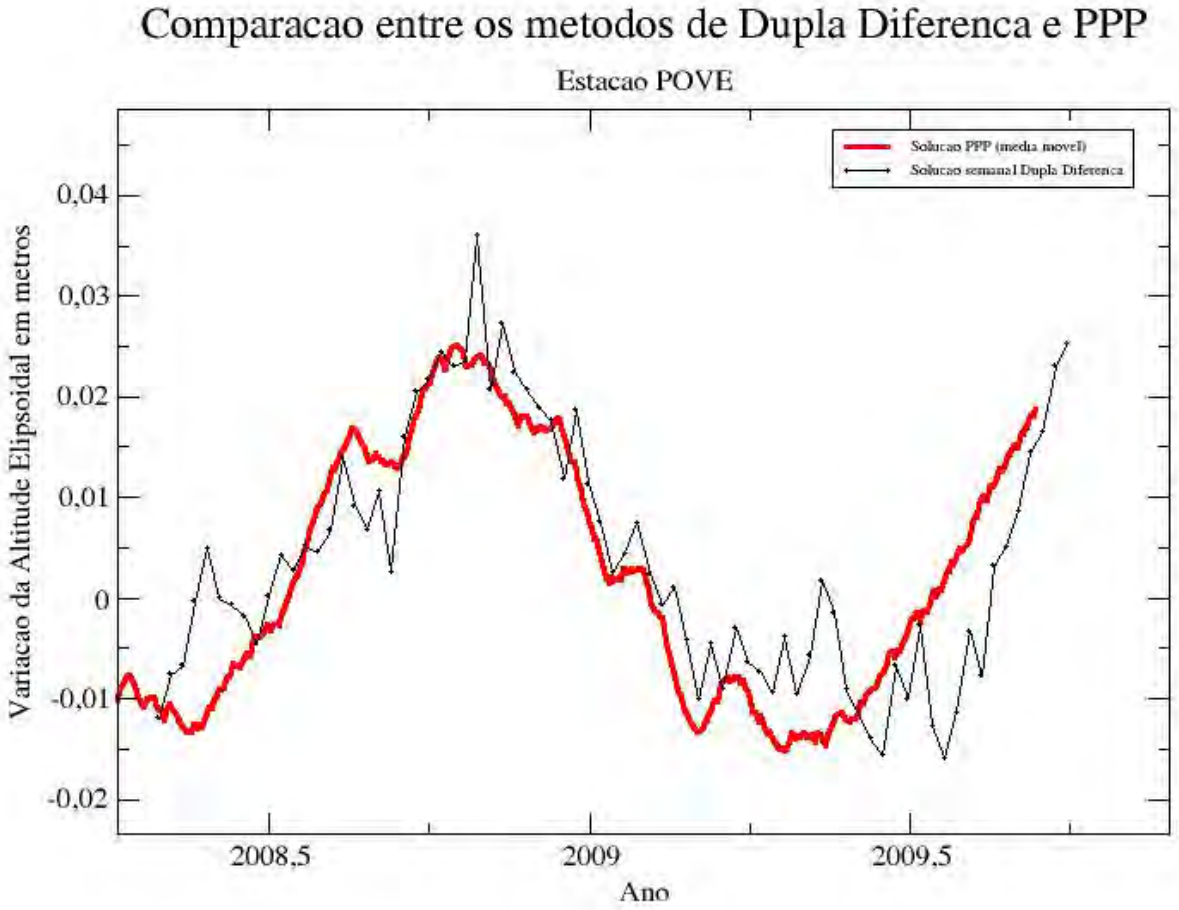
Static GPS stations

Buoys

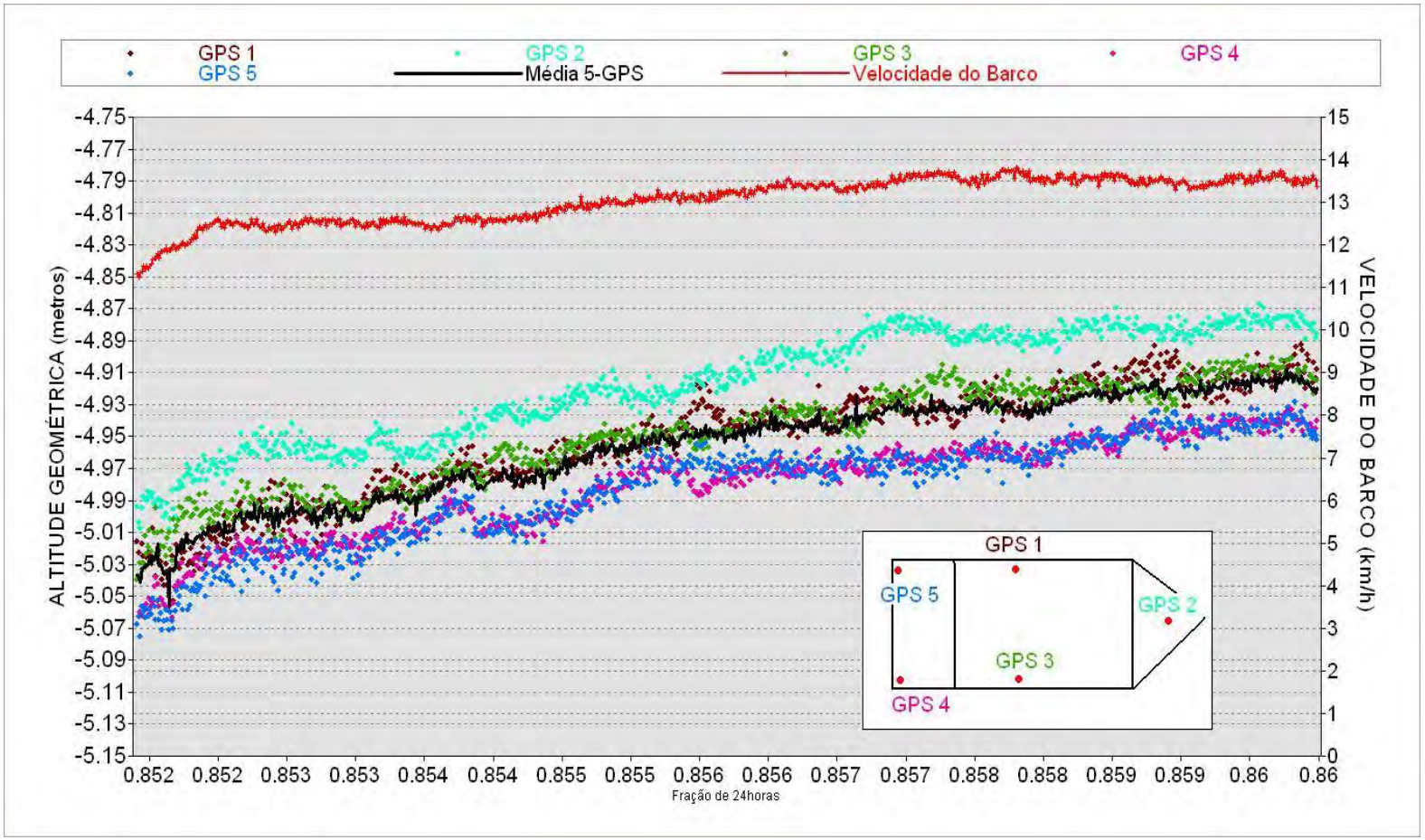

Antenne
Récepteur&Enregistrement



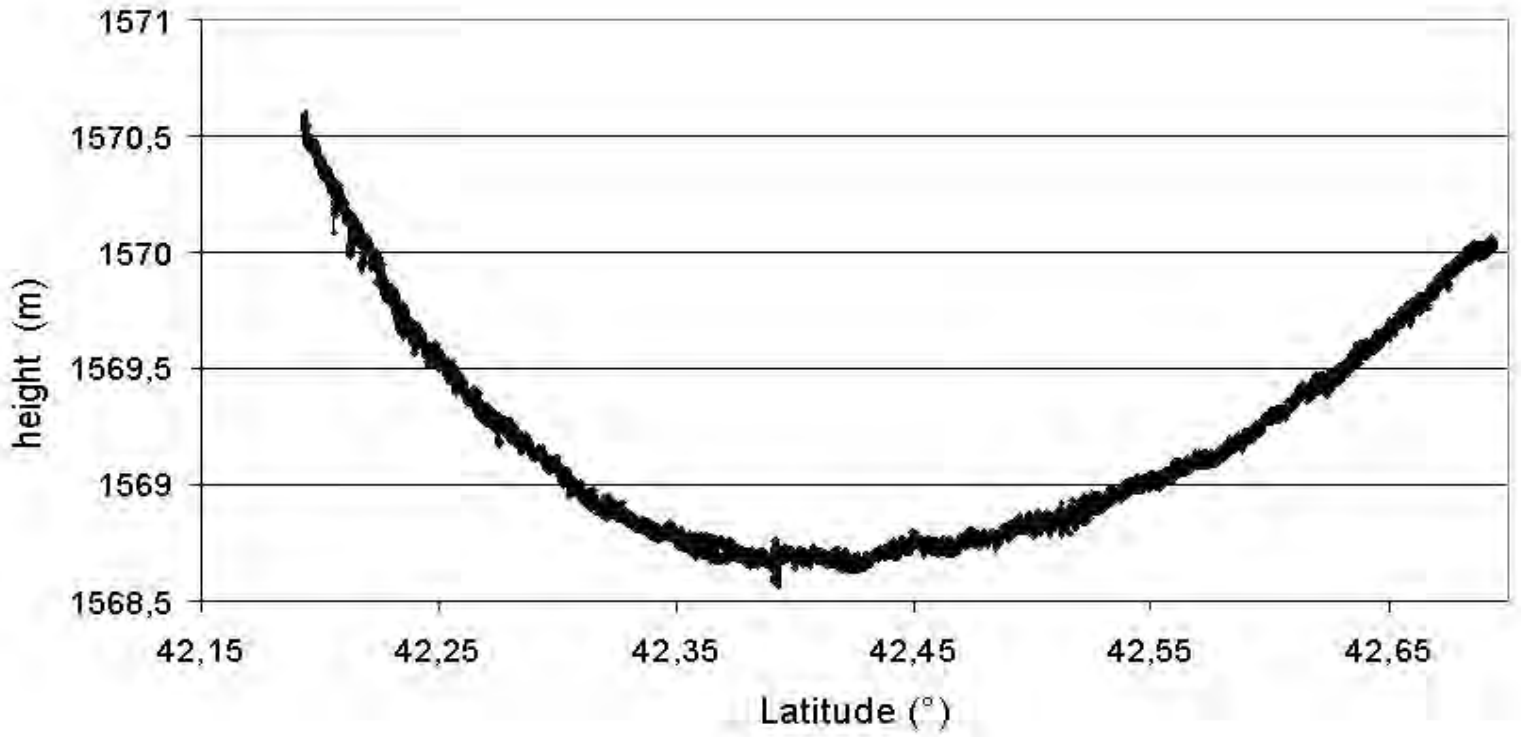
The GPS tool : GINS-PC by CNES



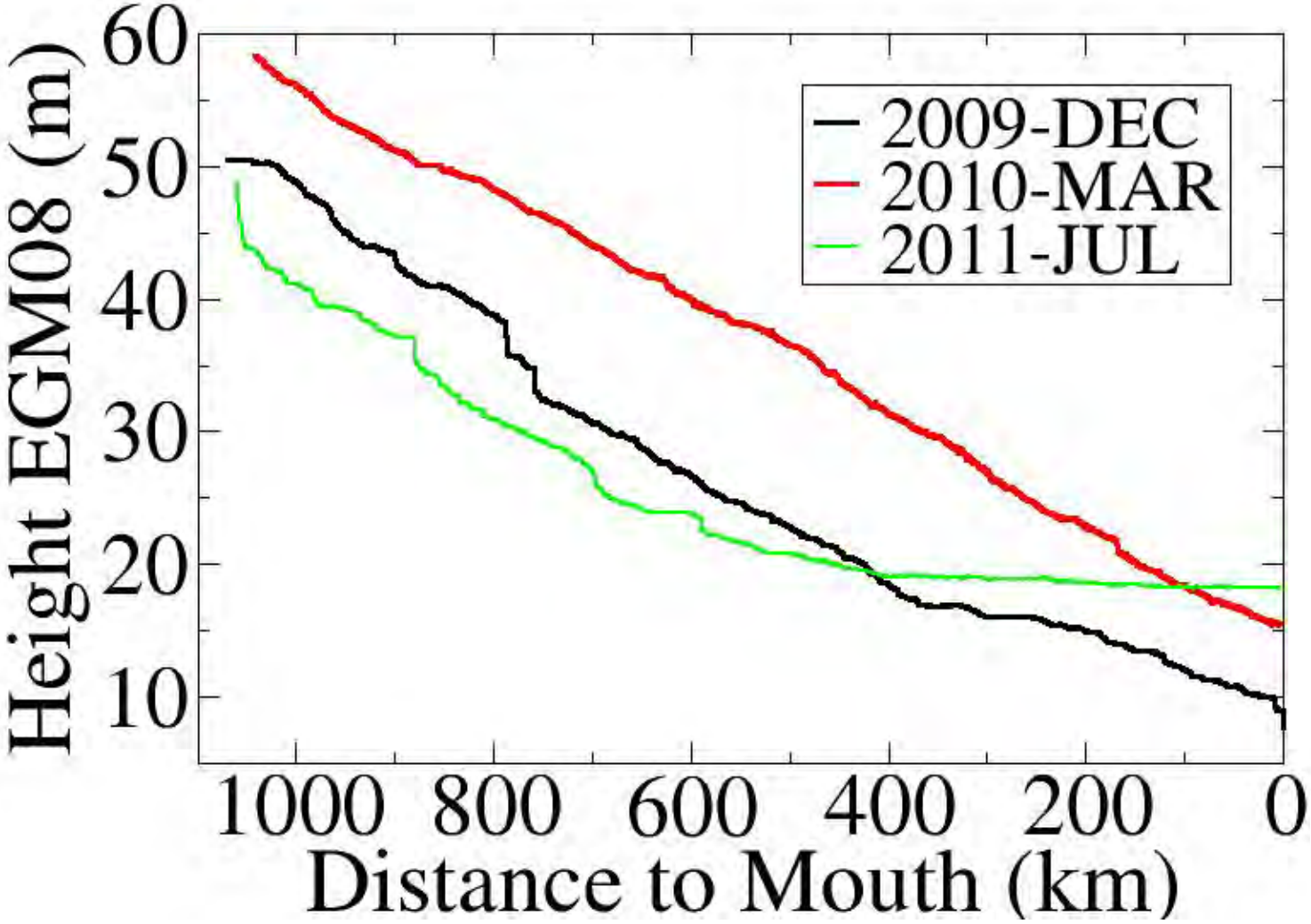
QC with several GPS stations on the same mobile



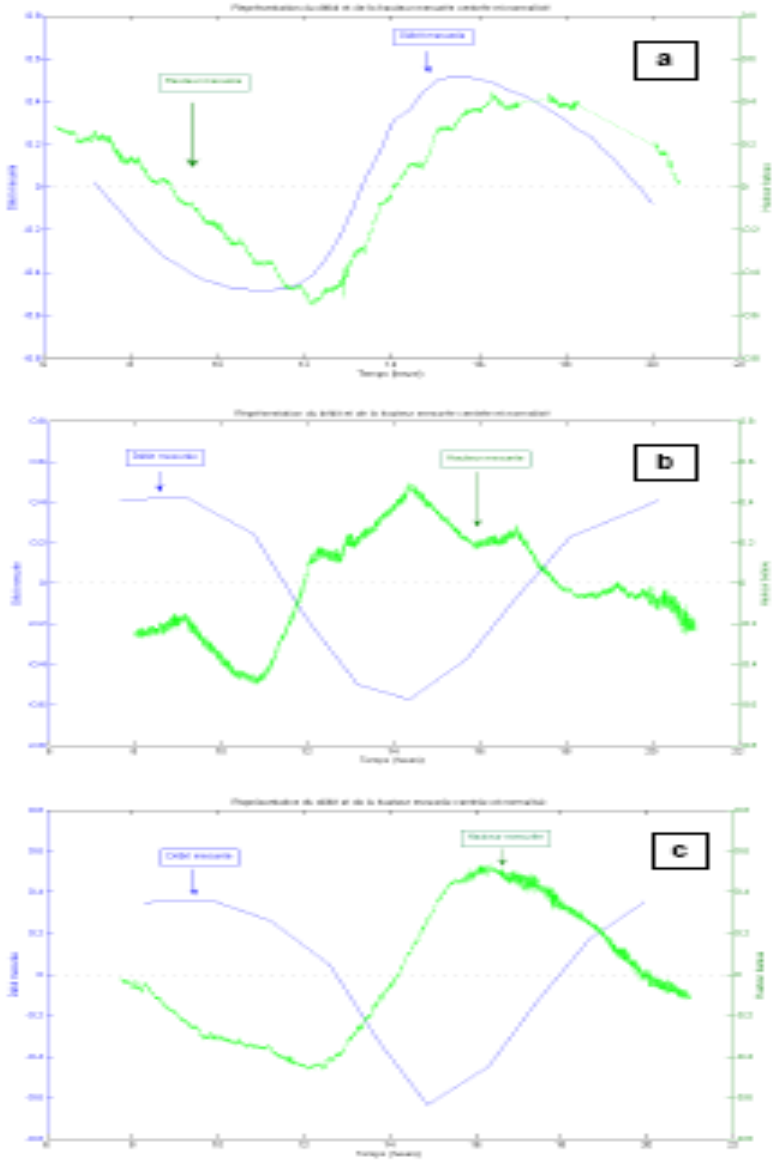
South Coast <-- Lake Issyk-kul → North Coast



(raw) GPS profiles on the MADEIRA river



Tide vs discharge in the mouth of the Amazon river



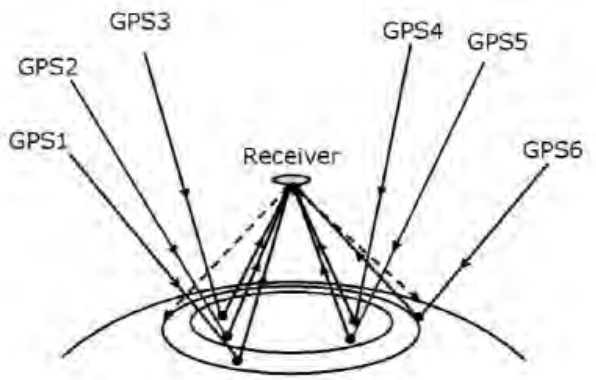
successfully applied for the ground measurements during the preliminary studies with Busard

successfully tested for plane trajectory

Ground measurements of heights and slopes

Static GPS stations

Buoys



Reflectometry in test

Tropospheric corrections

Application to the Air SWOT projects

Exact deployment of ground geodesy devices will be discussed with PIs during year 2013

Estuaries (B. Laignel, Univ. Rouen)

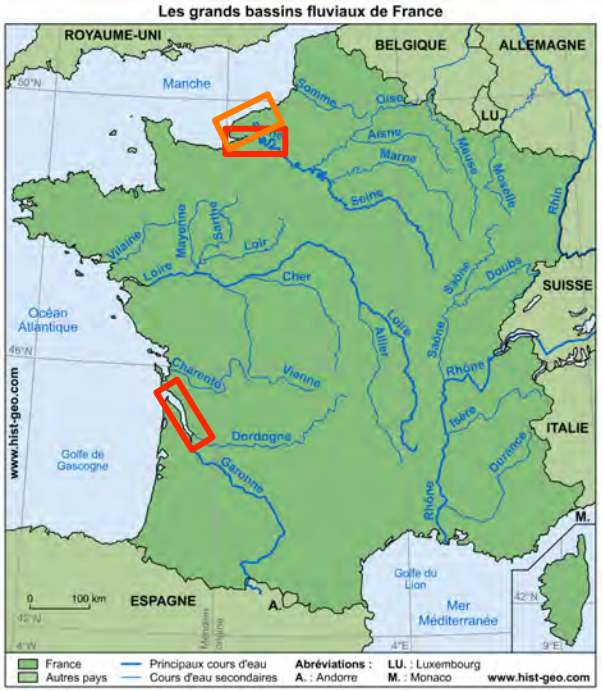
Hydrological variability of estuaries

- Seine estuary

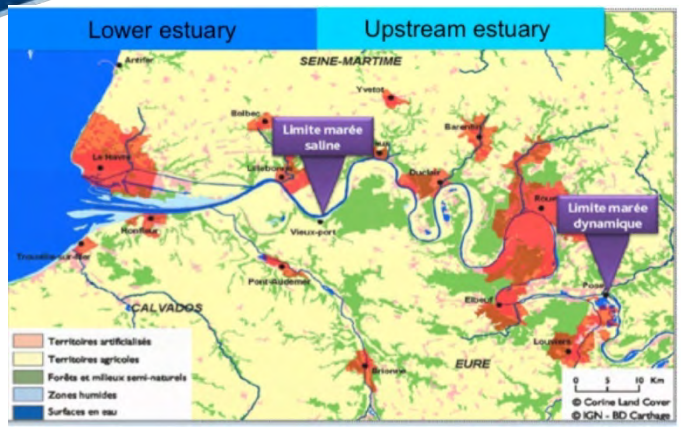
Length 160 km, width 150m to 8 km (at mouth)
max tidal range 8m (at mouth)

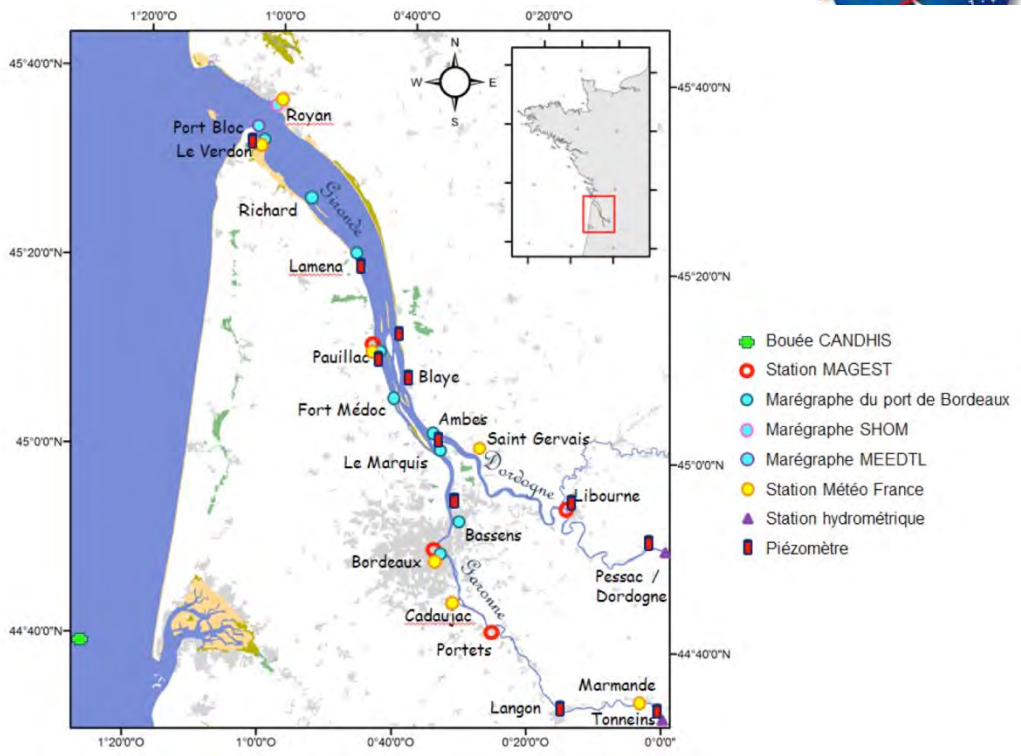
- Gironde estuary

the largest estuary in Europe (635 km²)
length 75 km, width up to 12 km at the mouth
max tidal range 6m



Available data





Important data base: many gauging stations on the river & tributaries, bathymetric surveys, piezometric data, 10 tide-gauges on the Gironde & 17 tide-gauges & LIDAR survey on the Seine

Needs: High resolution & Vector SWOT data
Measurements on the field: need to discuss

Conditions for AirSWOT campaign

Preferred measurement period: period with high hydrological variability

Winter: during the highest flows & highest tidal range and eventualy floods & storm surge

Plane numbers : 2 per day (1 high tide & 1 low tide) & 4 times (1 per weak) in february (or in january, february & march)

Preferred study areas

all estuaries and coastal zone (longitudinal plane) or key sectors: mouth, island areas, some beaches (transversal plane)

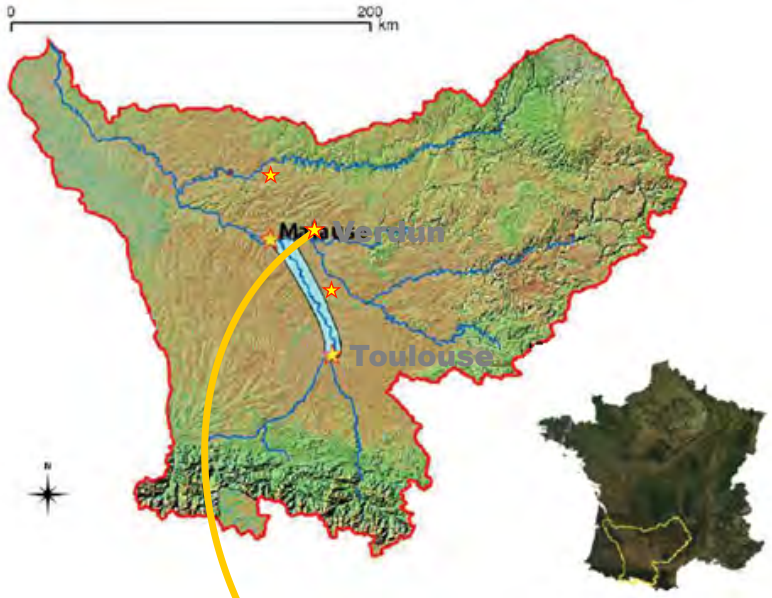
Processes studied in the key sectors

Tide wave propagation & their impact on the spatial water level in mouth

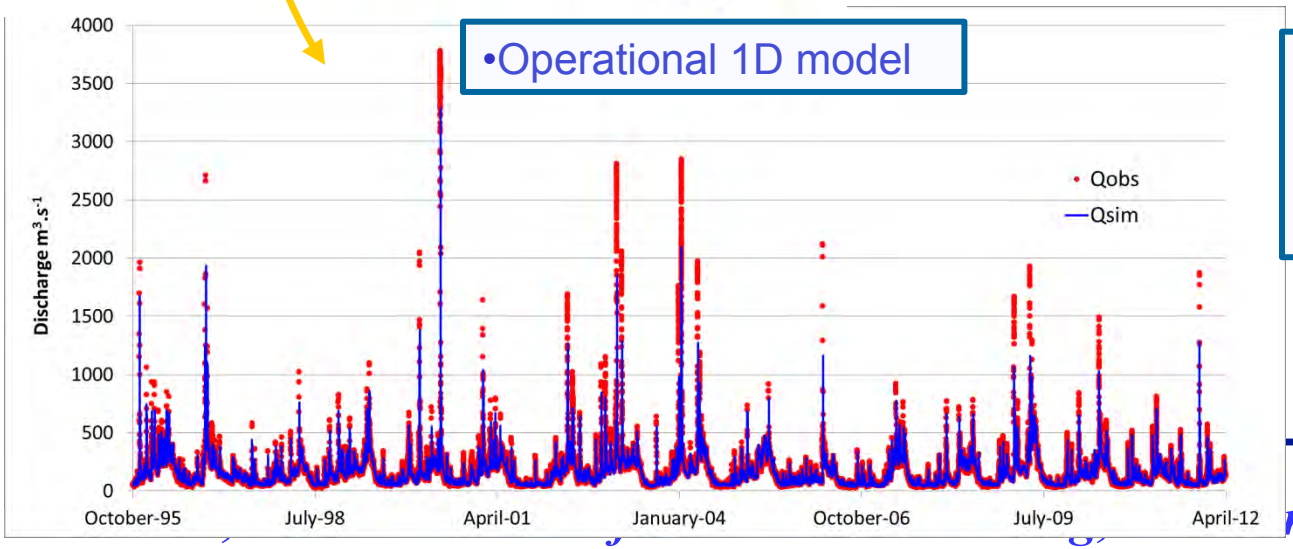
Water propagation in the channels in the island areas

Wave propagation on the beaches

(Air)SWOT variational Data Assimilation : identification, sensitivities, hierarchical models. Test Case on the Garonne river (France)



Width	~150 m
Length	~ 100 km
Low-Water Target Flow	40 $m^3.s^{-1}$
10 yr flood	2000 $m^3.s^{-1}$
Operational gauges + rating curves	3
Cross sections	203



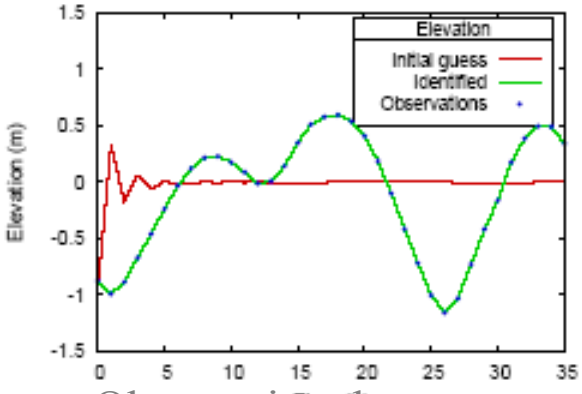
•Operational 1D model

•In preparation:
•- JPL simulator input data
•- 2D meshes

Identification of discharge and parameters

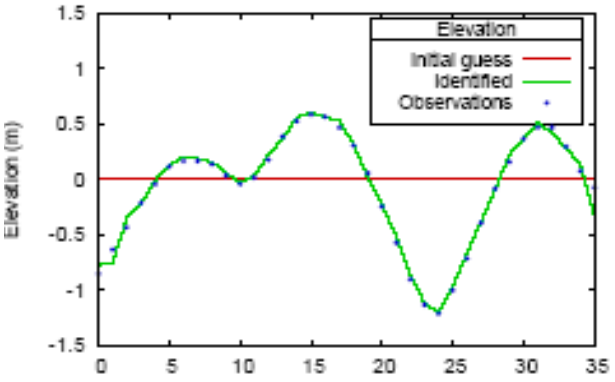
[Monnier et al. 2006] Assimilation of in-situ elevation data (DassFlow software)

- **Observations:**
  h at 3 stations
  + at two b.c. (3,4)



Observation: h at gauges

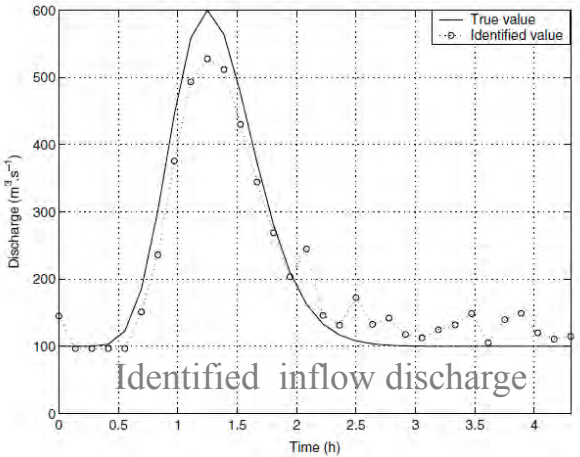
Identification of elevation h at
- BC1, BC2, BC6 (tides)
- Initial state



Identified elevation at BC6

[Roux - Dartus 2006, 2008] Assimilation of flow width and in situ elevation data

Identification of
- Q_{in}, Q_{out}, q_L, H_{out}, n_1, n_2
- cross geometry



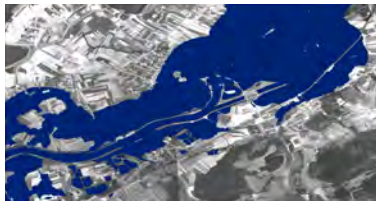
Identified inflow discharge

Identification in presence of floodplain flow

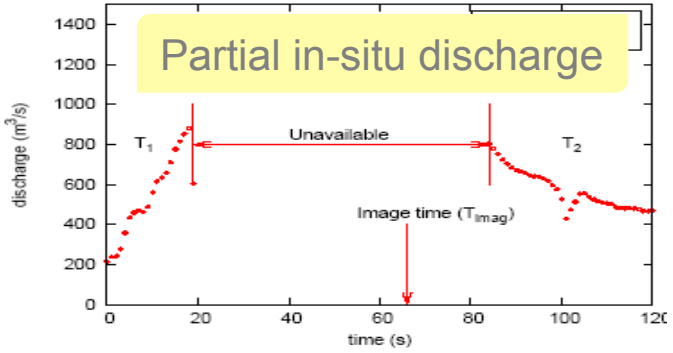
Assimilation of in situ elevation and SAR image (DassFlow)

➢ **Observations:**

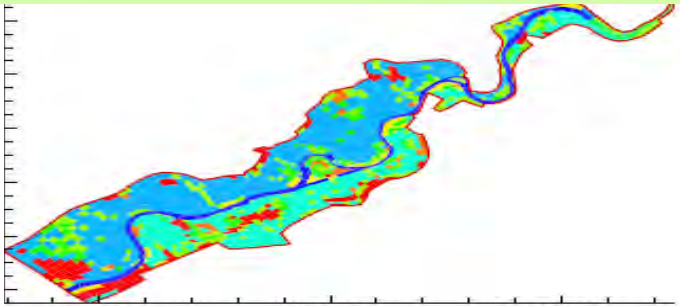
Partial water elevation extracted



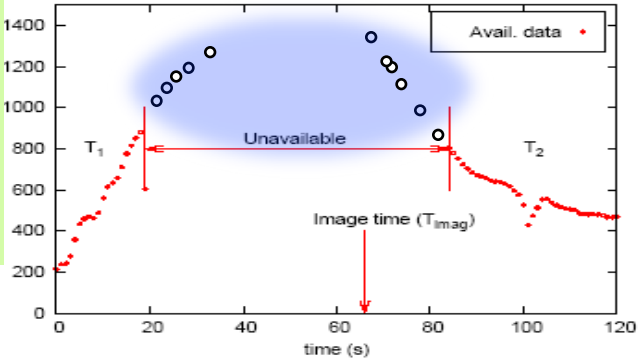
Partial in-situ discharge

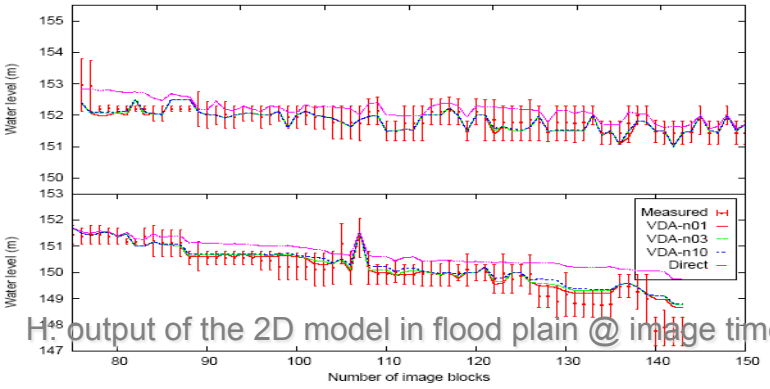


Method and results :
1) Sensitivity analysis wrt Manning roughness
2) Identification of Manning coef



3) Identification of inflow discharge.
In present case: more dense in-situ hydrograph required





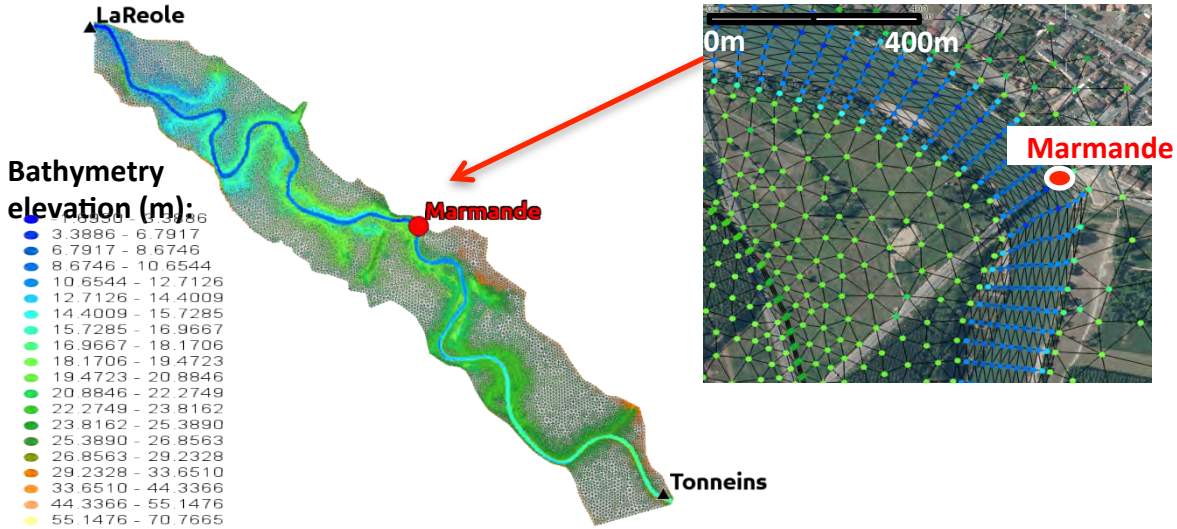
H: output of the 2D model in flood plain @ image time

- Combination of heterogeneous data (spatially distributed – partial time series)
- Combination of hierarchical models

Garonne River S. Biancamaria (LEGOS)

Tonneins-La Réole downstream reach

4th longest River in France.
drainage area = 55,930 km²



Bathymetry used in the TELEMAC-2D modelling

- 1D (MASCARET) and 2D (TELEMAC) hydraulic models are available (developed by EDF/LNHE) for the 50 km reach
- cross-section profiles made *DDE* + field measurements made by LNHE
- **Benchmarking test-case for the hydraulic community**

Garonne River
Tonneins-La Réole downstream reach

Work plan:

•Run 1D and 2D models to provide outputs for the JPL AirSWOT/SWOT data simulator

• Validate discharge algorithms : $(H,Q)_{sim}$ vs $(H,Q)_{AirSWOT/SWOT}$

•Assimilate pseudo-AirSWOT data to retrieve corrected friction coefficients, upstream forcing, bathymetry, hydraulic state…

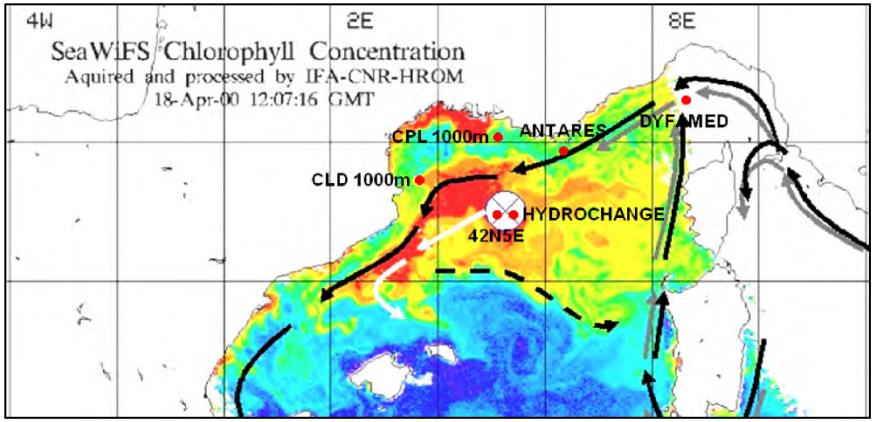
•Assimilate pseudo-SWOT data to correct the hydraulic state

•Arguments on the orbit and revisit cycle for SWOT

French AirSWOT proposed sites – WHY?

1) NW Mediterranean Sea

– Spring 2014 – 2 weeks?

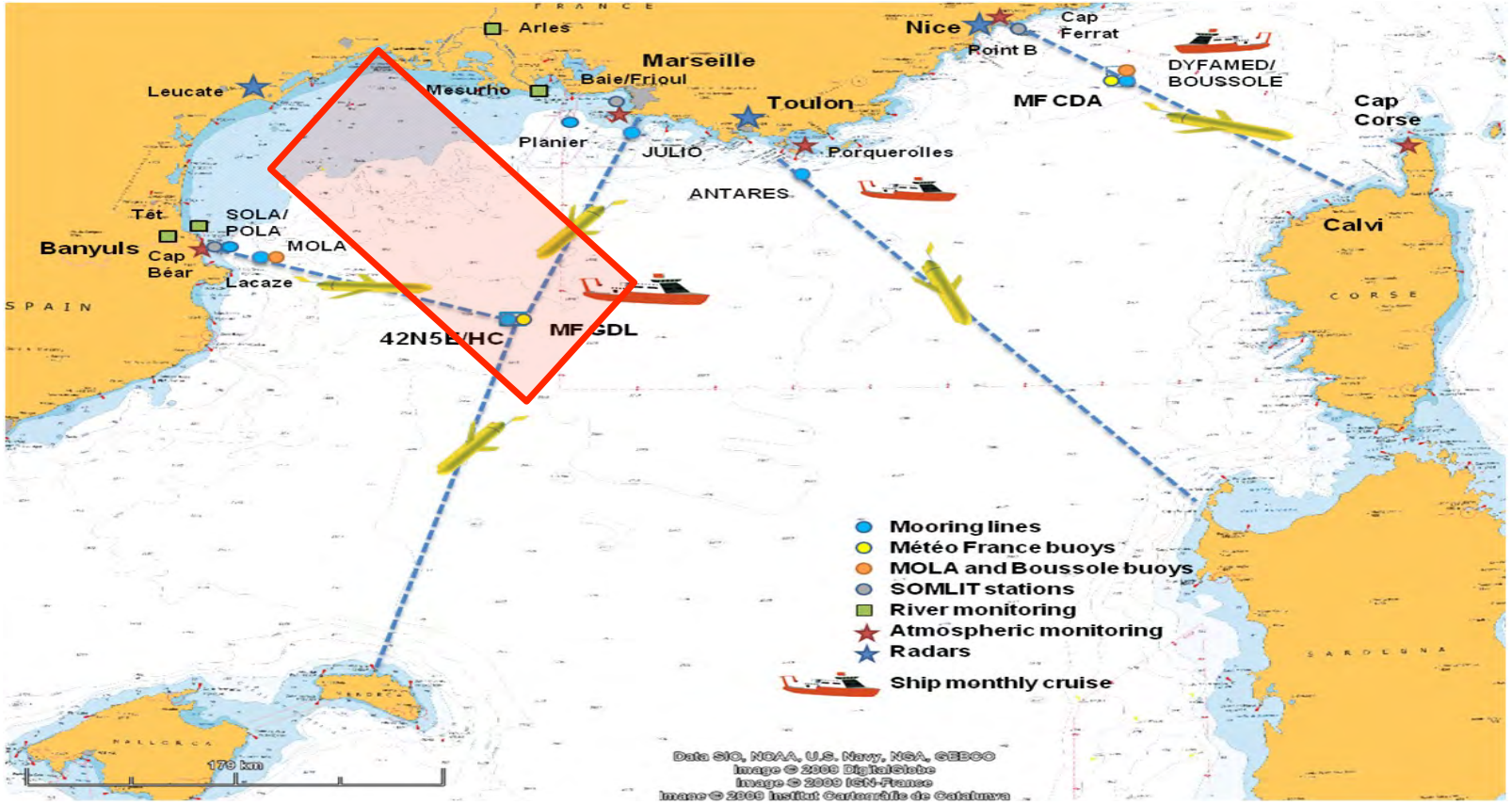


- No tides;
- Intensive spring blooms of ChL;
- Dynamics : coastal currents generating eddies and filaments; river inputs
- Mid-latitude deepwater formation in late winter;
- In-situ obs : regular monitoring, extensive field program HyMex in 2012 / 2013, HR ocean models in operational mode

Joint experiment MOOSE :

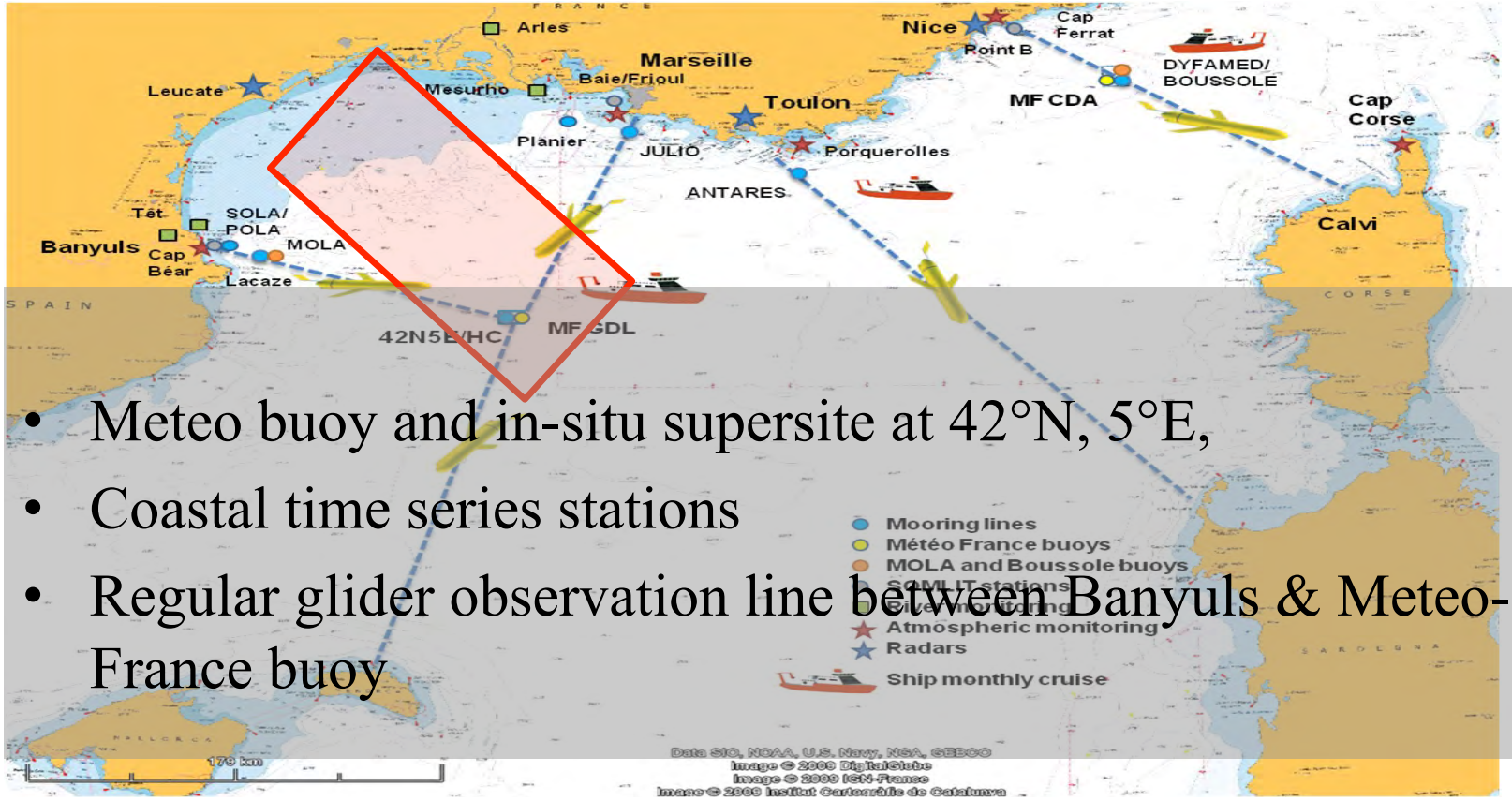
monthly glider lines, HF Radar at Leucate (currents & waves),

coastal buoy time series T,S, chl; meteo-buoy & super-site



Joint experiment MOOSE :

monthly glider lines, HF Radar at Leucate (currents & waves), coastal buoy time series T,S, chl; meteo-buoy & super-site



- Meteo buoy and in-situ supersite at 42°N, 5°E,
- Coastal time series stations
- Regular glider observation line between Banyuls & Meteo-France buoy

Air SWOT is not alone !

AirSWOT & the nadir altimetry missions

2008 2010 2012 2014 2016 2018 2020 2022 2024 2026 2028 2030 2032

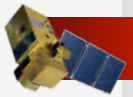
SWOT

Jason 1

Jason 2

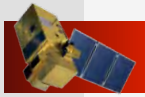
CryoSat

Altika



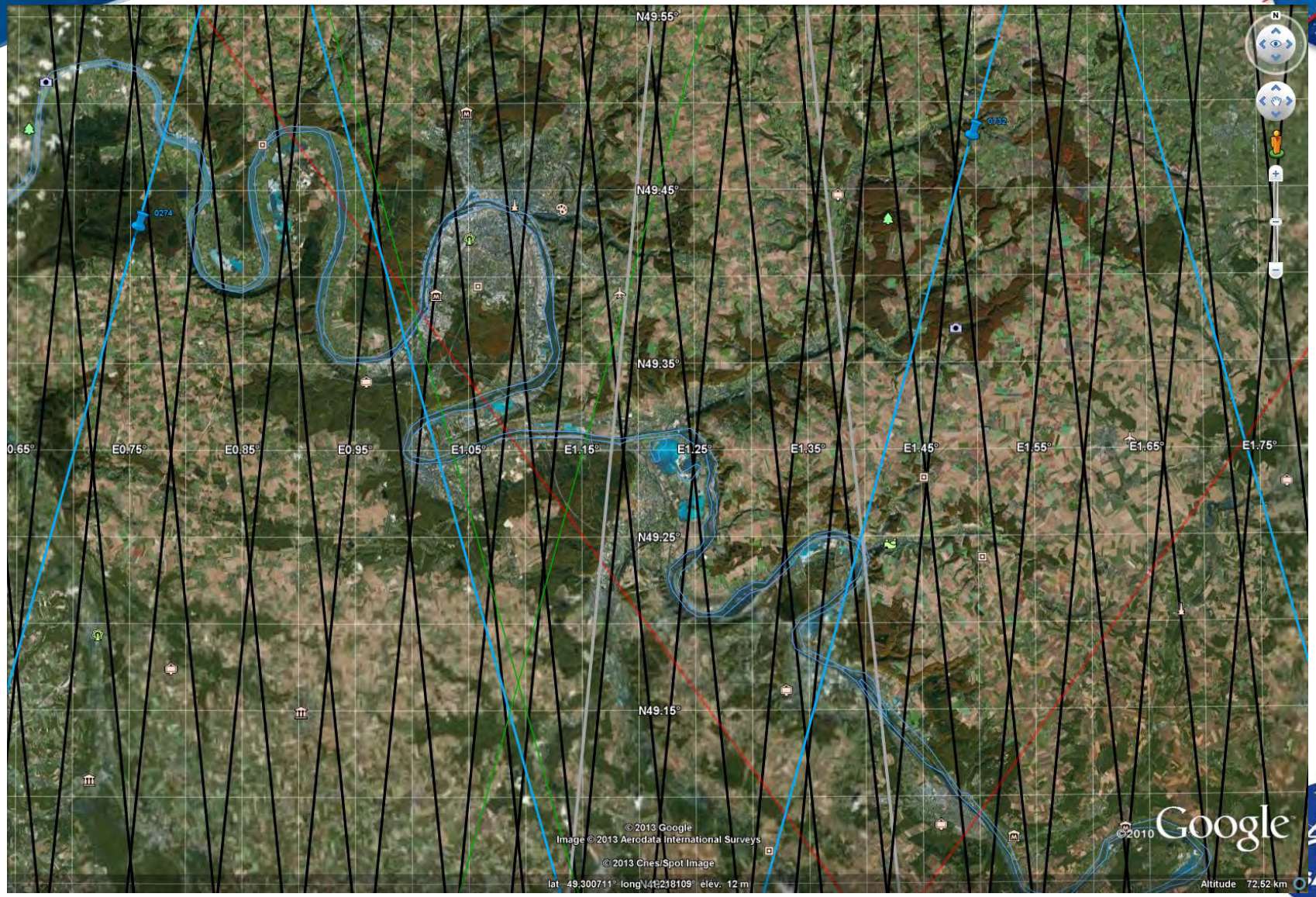
SENTINEL 3-A

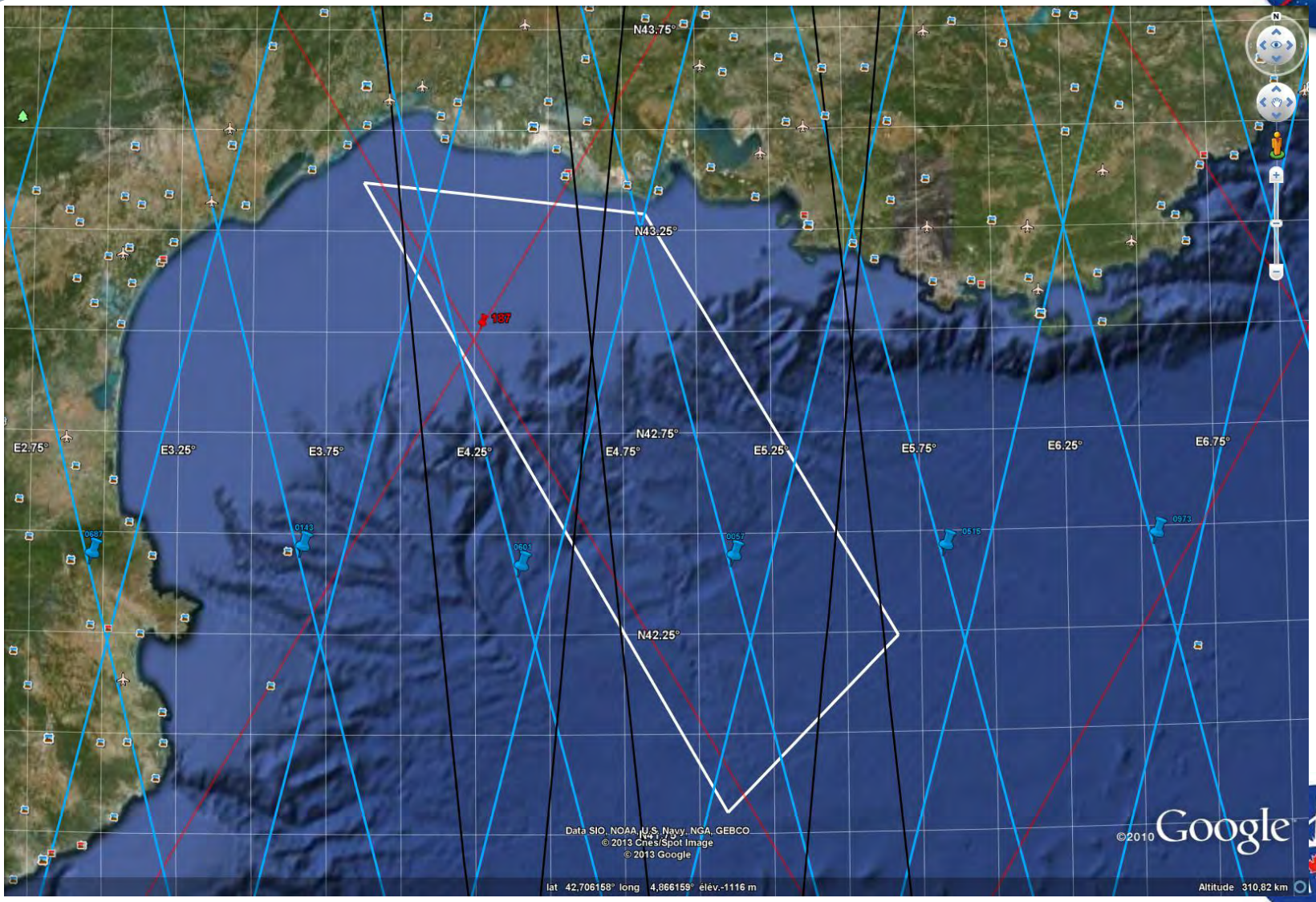
Jason 3

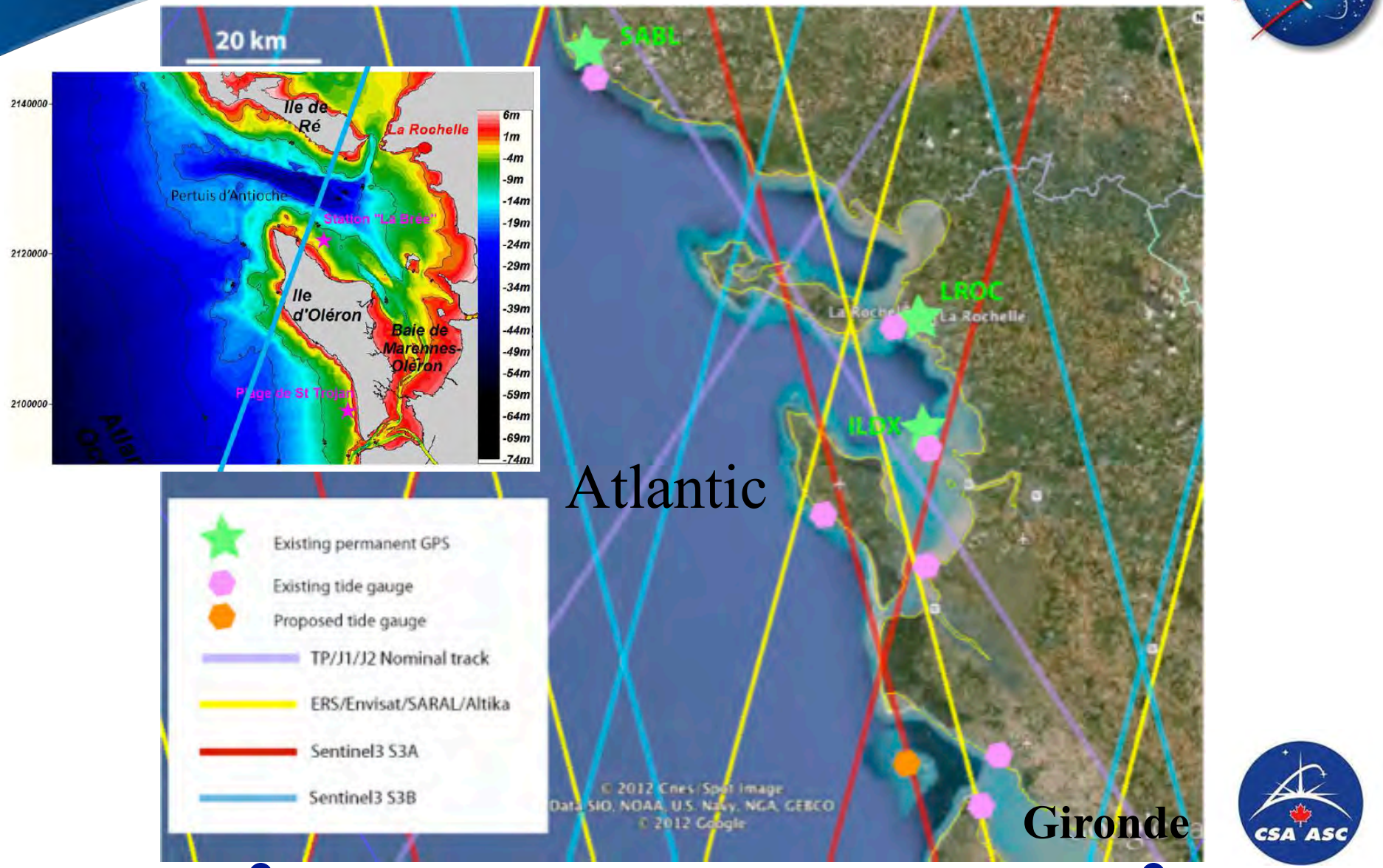


SENTINEL 3-B

JASON CS


N49.55°
N49.45°
N49.35°
N49.25°
N49.15°
E0.65°
E0.75°
E0.85°
E0.95°
E1.05°
E1.15°
E1.25°
E1.35°
E1.45°
E1.55°
E1.65°
E1.75°
0274
0732
© 2013 Google
Image © 2013 Aerodata International Surveys
© 2013 Cnes/Spot Image
lat 49.300711° long 1.218109° elev: 12 m
Google
2010
Altitude 72,52 km


N43.75°
N43.25°
187
E2.75°
E3.25°
E3.75°
E4.25°
N42.75°
E4.75°
E5.25°
E5.75°
E6.25°
E6.75°
0687
0143
0601
0057
0515
0873
N42.25°
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2013 Cnes/Spot Image
© 2013 Google
©2010 Google
lat 42,706158° long 4,866159° élév.-1116 m
Altitude 310,82 km


20 km
SABL
LROC
ILDX
La Rochelle
Atlantic
Gironde
Ile de Ré
La Rochelle
Pertuis d'Antioche
Station "La Brée"
Ile d'Oléron
Baie de Marennes-Oléron
Plage de St Trojan
2140000
2120000
2100000
6m
1m
-4m
-9m
-14m
-19m
-24m
-29m
-34m
-39m
-44m
-49m
-54m
-59m
-64m
-69m
-74m
Existing permanent GPS
Existing tide gauge
Proposed tide gauge
TP/J1/J2 Nominal track
ERS/Envisat/SARAL/Altika
Sentinel3 S3A
Sentinel3 S3B
© 2012 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Google

Flight demand - 1
(hydrology)

place	dim of the polygon	length * # of passes	linear	
Rhone	44 x 5	44*2	88	
Garonne Amont	75 x 10	75*3	225	
Garonne avale	43 x 8	43*3	129	
Gironde	157 x 19	157*6	942	
Perthuis	64 x 39	64*10	640	
Cote Manche	36 x 7	36*2	72	
estuaire	81 x 23	81*6	486	
basse Seine (long)	170 x 14	170*4	680	
Basse seine (small)	55 x 19	55*6	330	
Haute Seine	143 x 17	143*5	715	
			4307	TOTAL

Flight schedule - 2

Synthesis (2014):

Oceanography : 2 to 4 weeks in spring
Hydrology : 4 passes over 2 weeks in spring (catch events)
2 passes in summer (low waters)

-> need that instrument be available late 2013

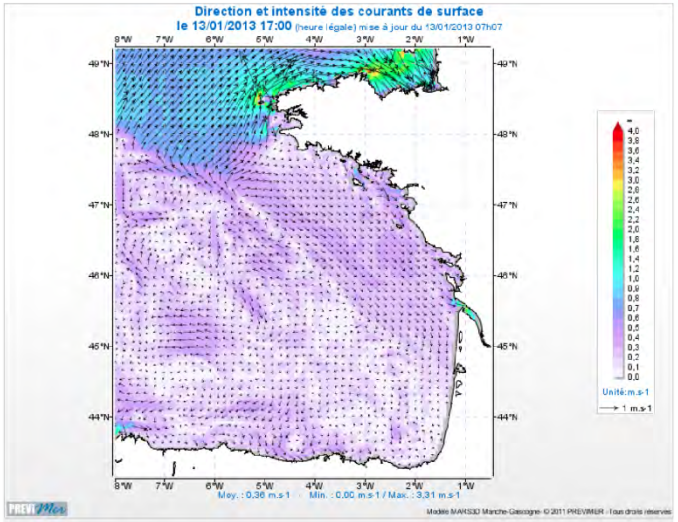
What's next ???

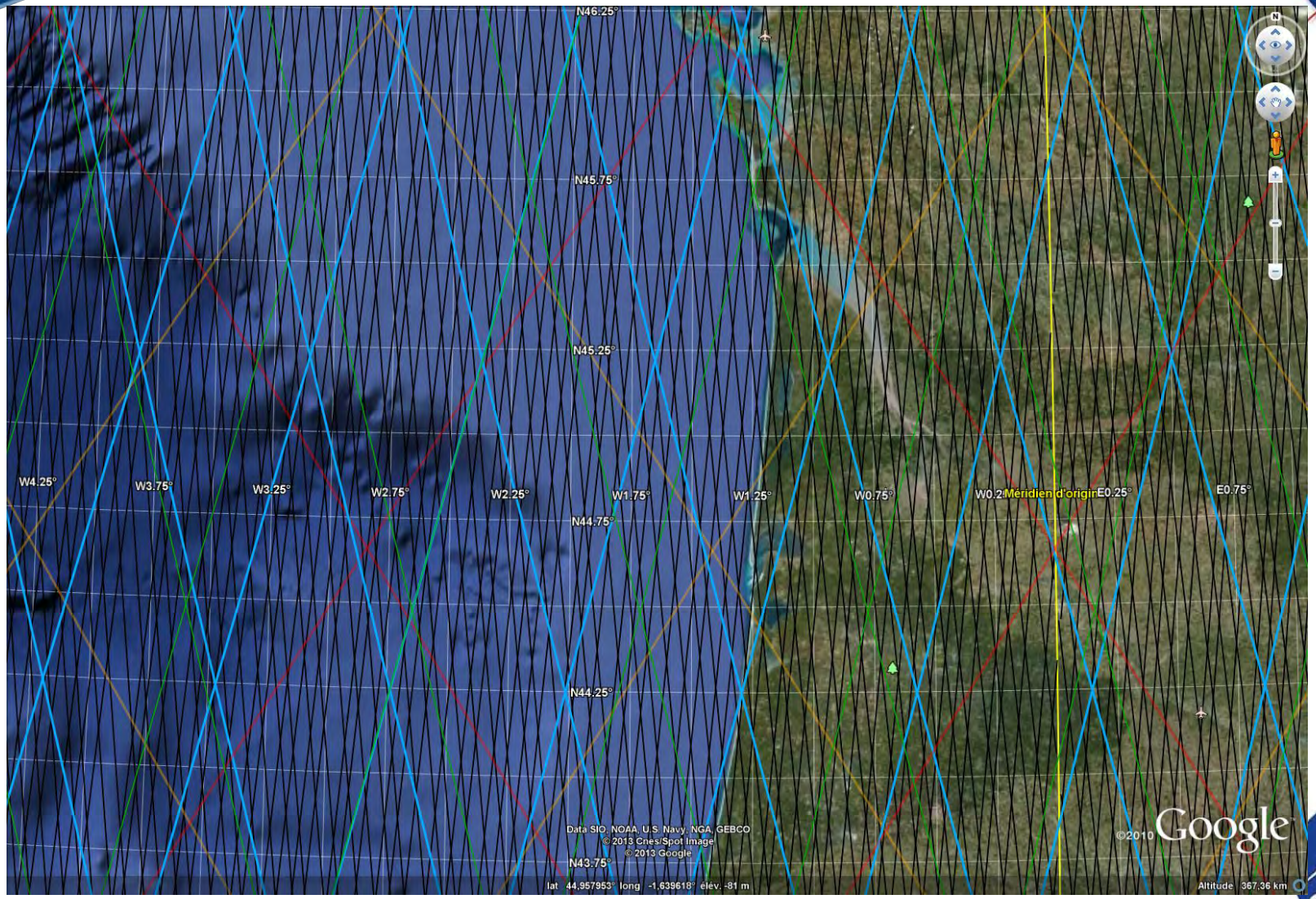
AirSWOT France 2016?

2) Bay of Biscay

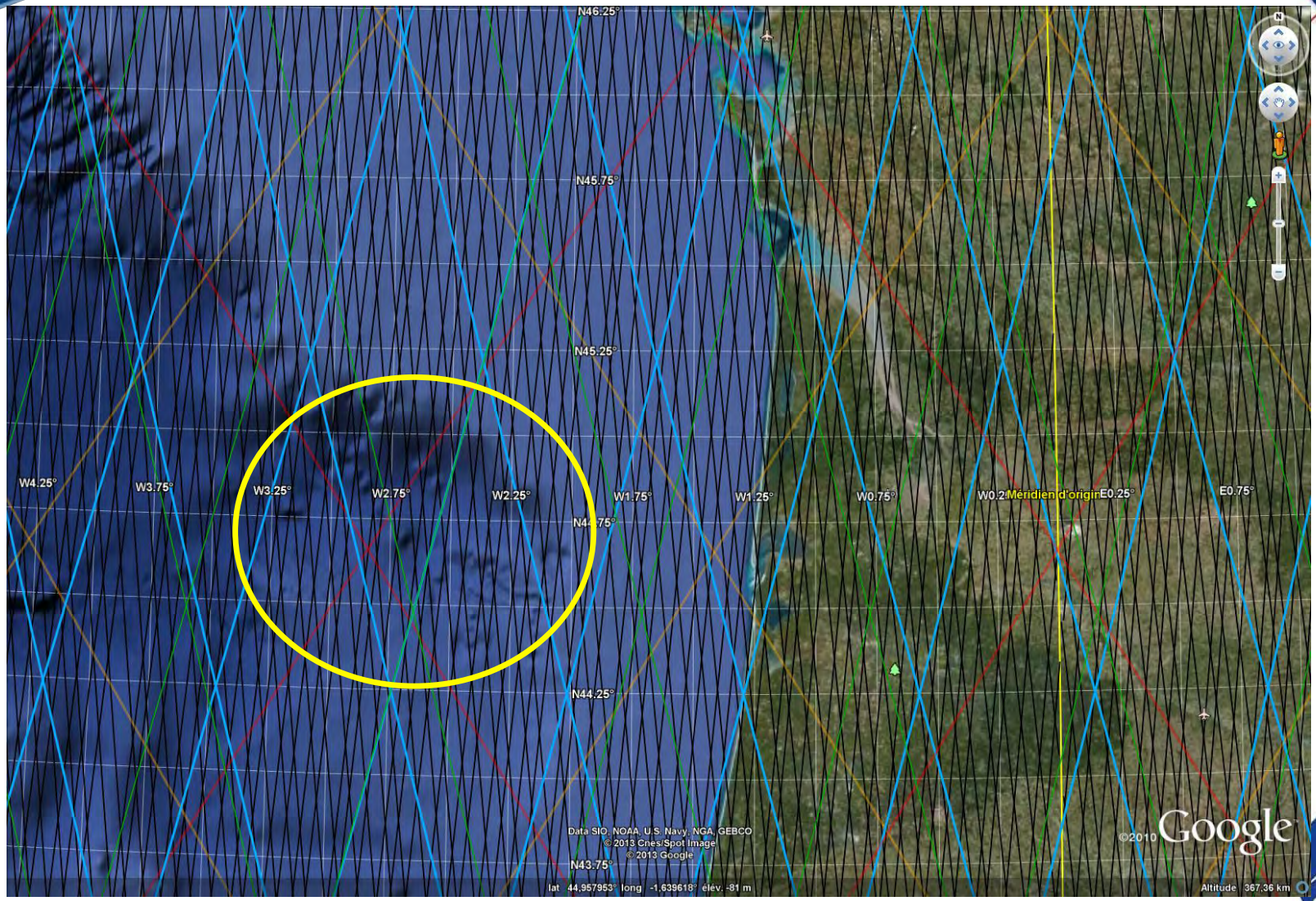
2016-2017– 1 month

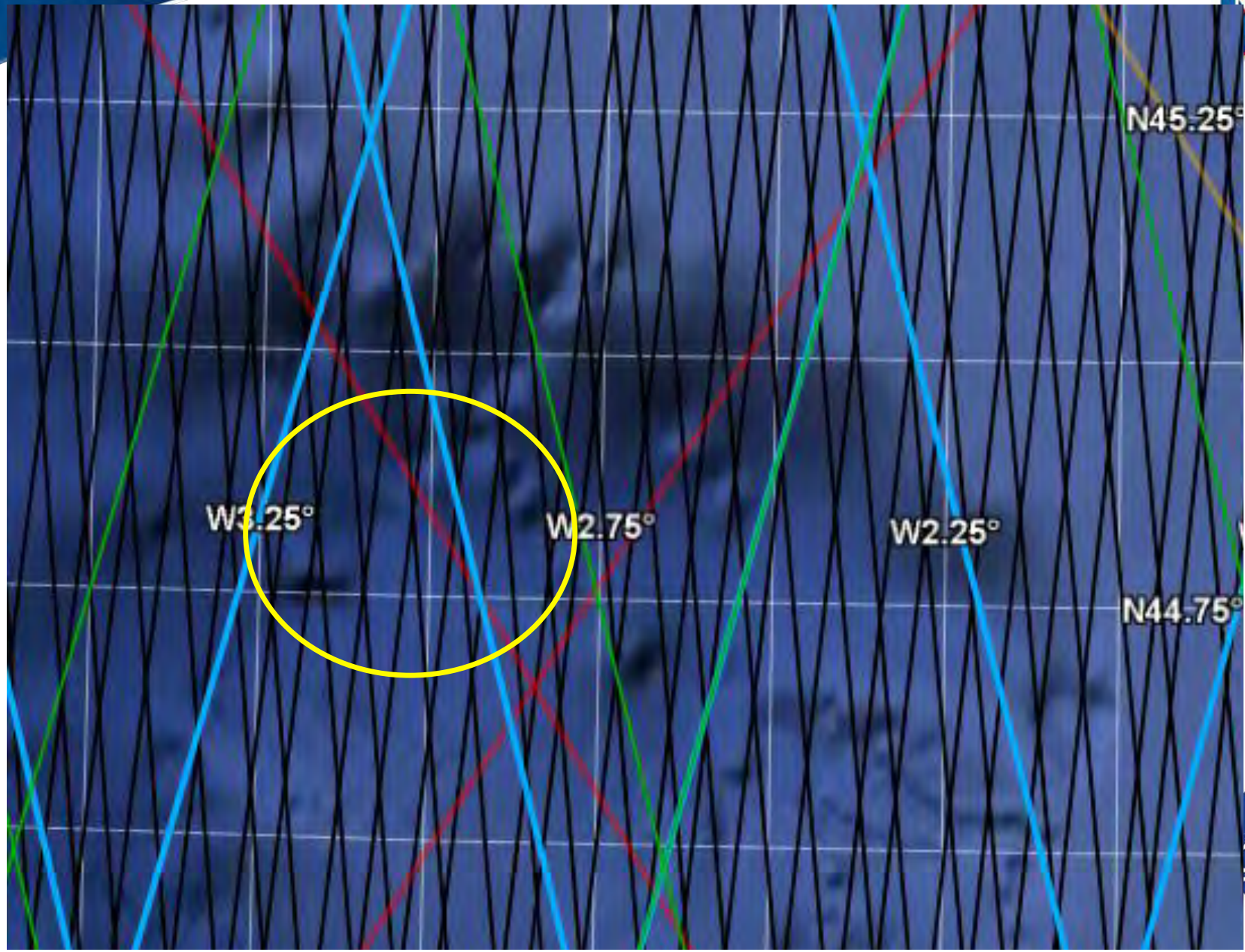
- Strong tides and atmospheric forcing
- Dynamics : coastal currents, river inputs, tidal mixing, Swoddies
- HR operational ocean models, w & w/o tides & assim & waves





SWOT, First Science Definition Team meeting, Pasadena, January 28-30, 2013


N46.25°
N45.75°
N45.25°
W4.25°
W3.75°
W3.25°
W2.75°
W2.25°
W1.75°
W1.25°
W0.75°
W0.2
Méridien d'origir
E0.25°
E0.75°
N44.25°
N43.75°
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2013 Cnes/Spot Image
© 2013 Google
©2010 Google
lat 44.957953° long -1.639618° élév. -81 m
Altitude 367.36 km


N45.25°
W3.25°
W2.75°
W2.25°
N44.75°

Is that all ???

No, what about sampling
a tropical forest environment
In 2017+?

Maroni

Kaw SWAMP

Oyapock

unsolved question:
Surface roughness for rivers

(ongoing discussion with IMFT to devellop –cheap- sensors)

Let's go!