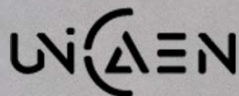


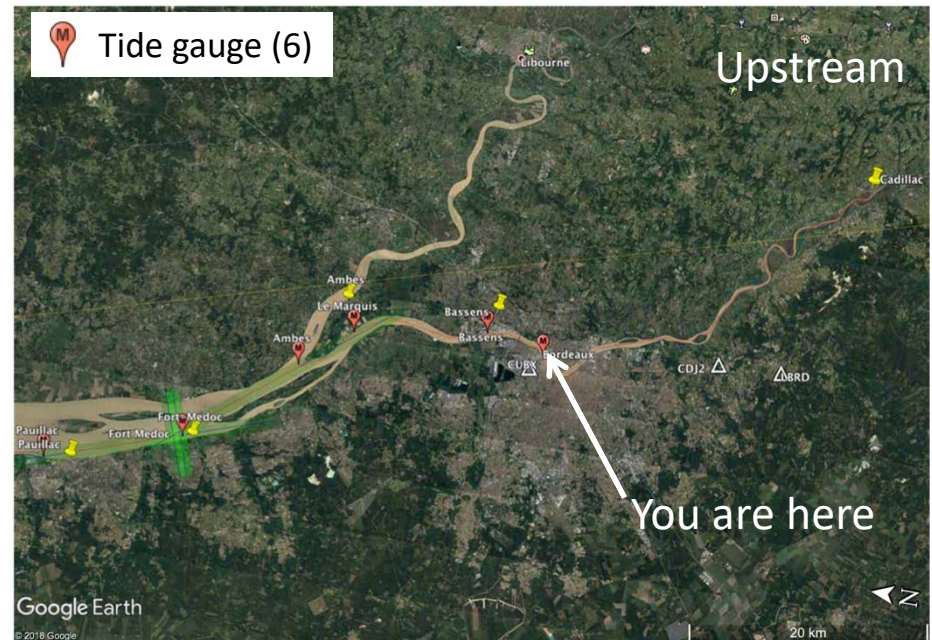
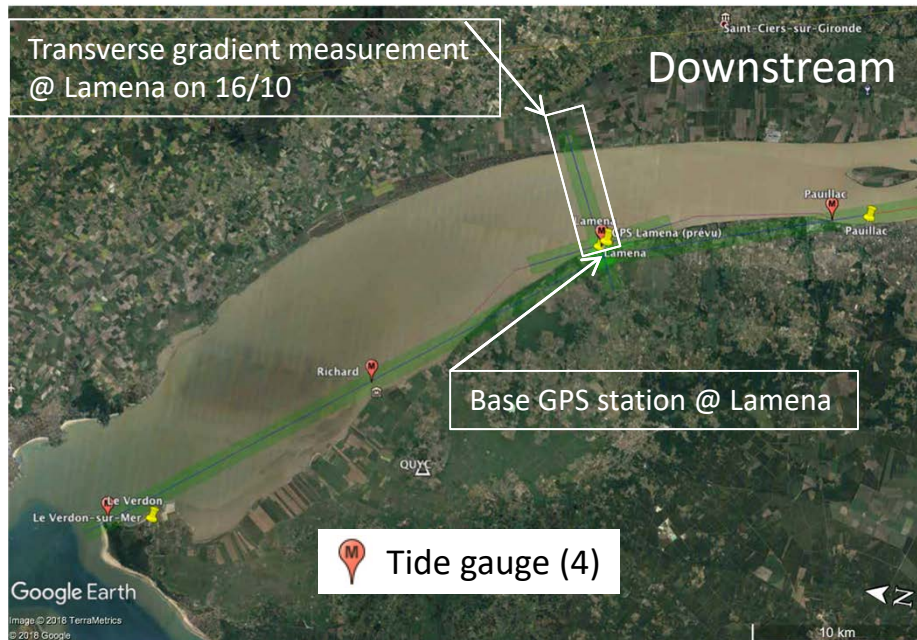
Gironde Campaign, October 2018

Nadia Ayoub, Simon Barbot, Laurent Benoit, Pascal Bonnefond, Cédric Brachet, Michel Calzas, Christophe Conessa, Christine Drezen, Lionel Fichen, Laurent Froideval, Jérémy Garcia, Cyril Giry, Antoine Guillot, Gwénaële Jan, Florent Lyard, Ludovic Magot, Paul TERNON, Guillaume Valladeau



General Description

- 2 measurement zones (outward on 16/10/2018 and return on 17/10/2018):
 - Downstream: Pauillac <-> Verdon + transept to Lamena (CalNaGeo1, Cyclopée, HyDrones) => 133 km round trip
 - Upstream: Pauillac <-> Cadillac (CalNaGeo2) => 172 km round trip
- Airborne LIDAR measurements on downstream zone and part of the upstream zone (done 1 week later because of the weather)
- 2 buoy measurements at Langon and La Réole tide gauges + Airborne LIDAR



Instruments (1/2)

Downstream:

Co-located measurements (time/space) of 3 instruments:

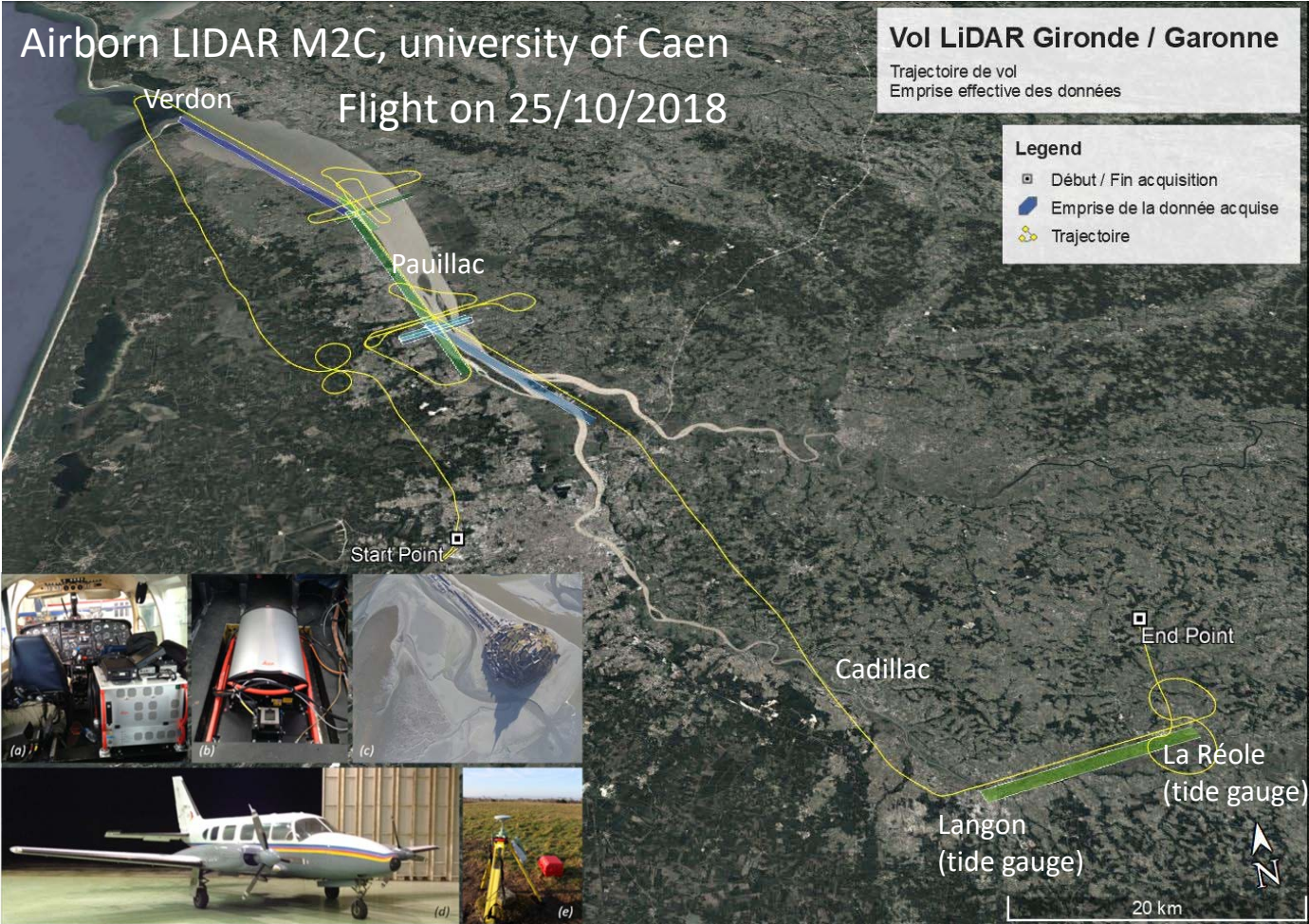
- CalNaGeo
 - Cyclopée (radar+GPS+gyrostabilisation)
 - HyDrones on drone (Azur Drones)
- + comparisons with a buoy at Lamena

Upstream:

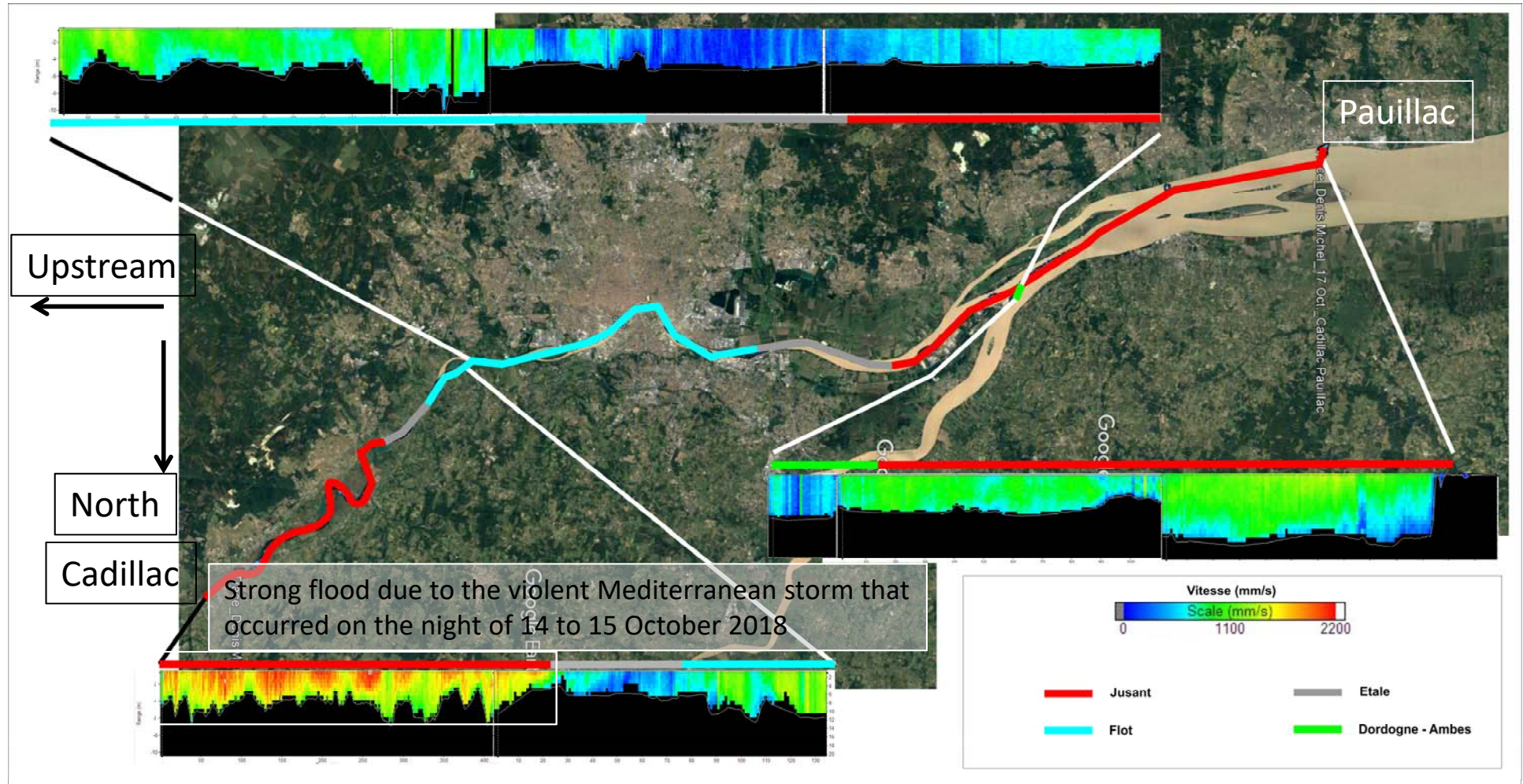
- CalNaGeo (+ADCP)
- Buoy (Langon et La Réole)



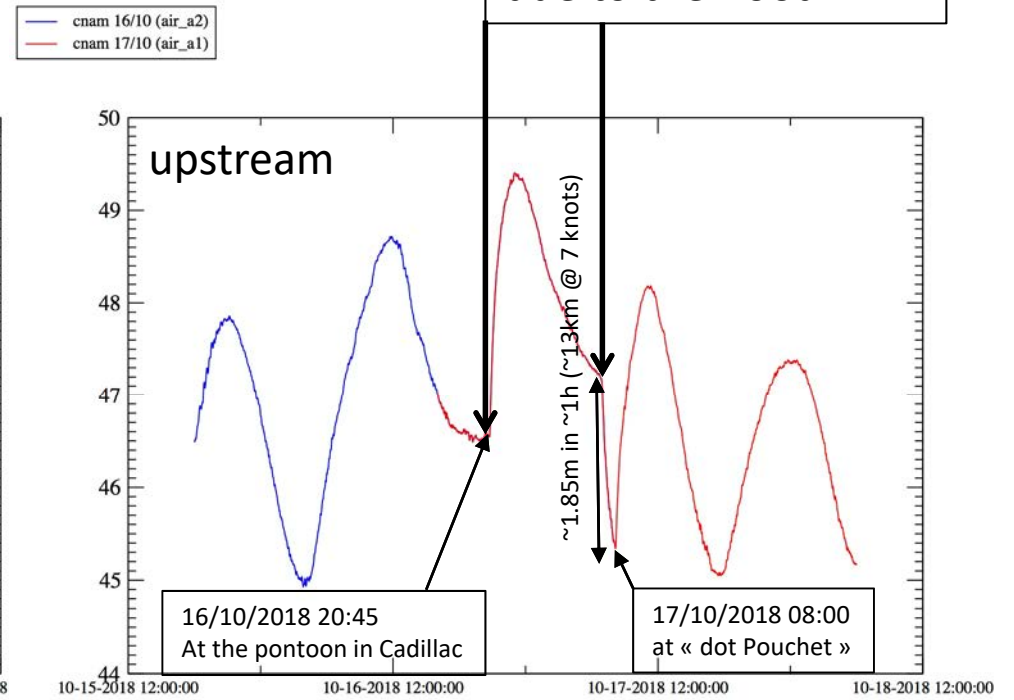
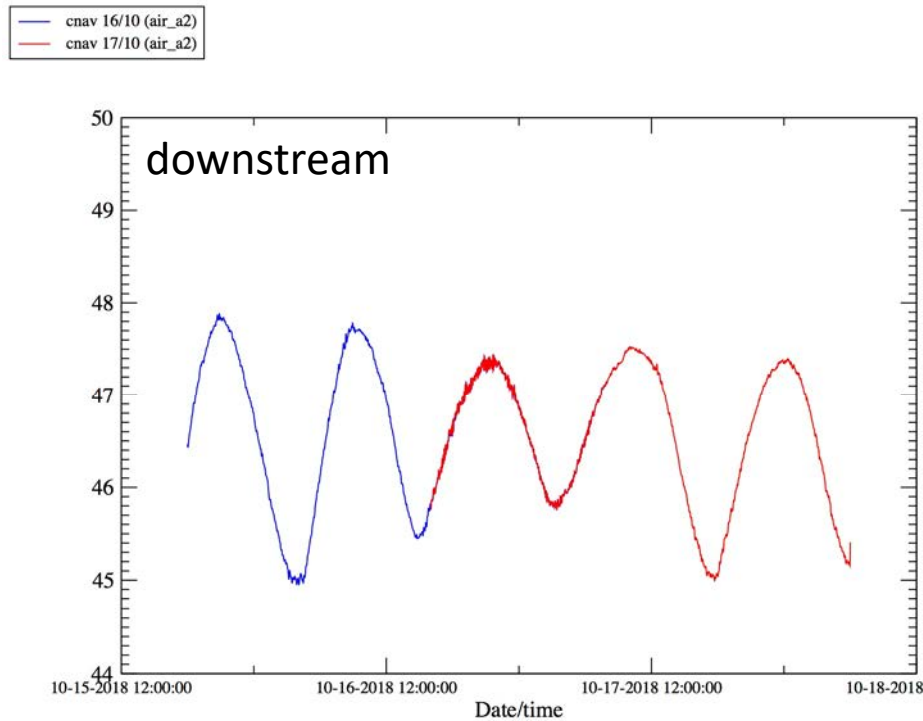
Instruments (2/2)



ADCP measurements on 17/10/2018 between Cadillac and Pauillac



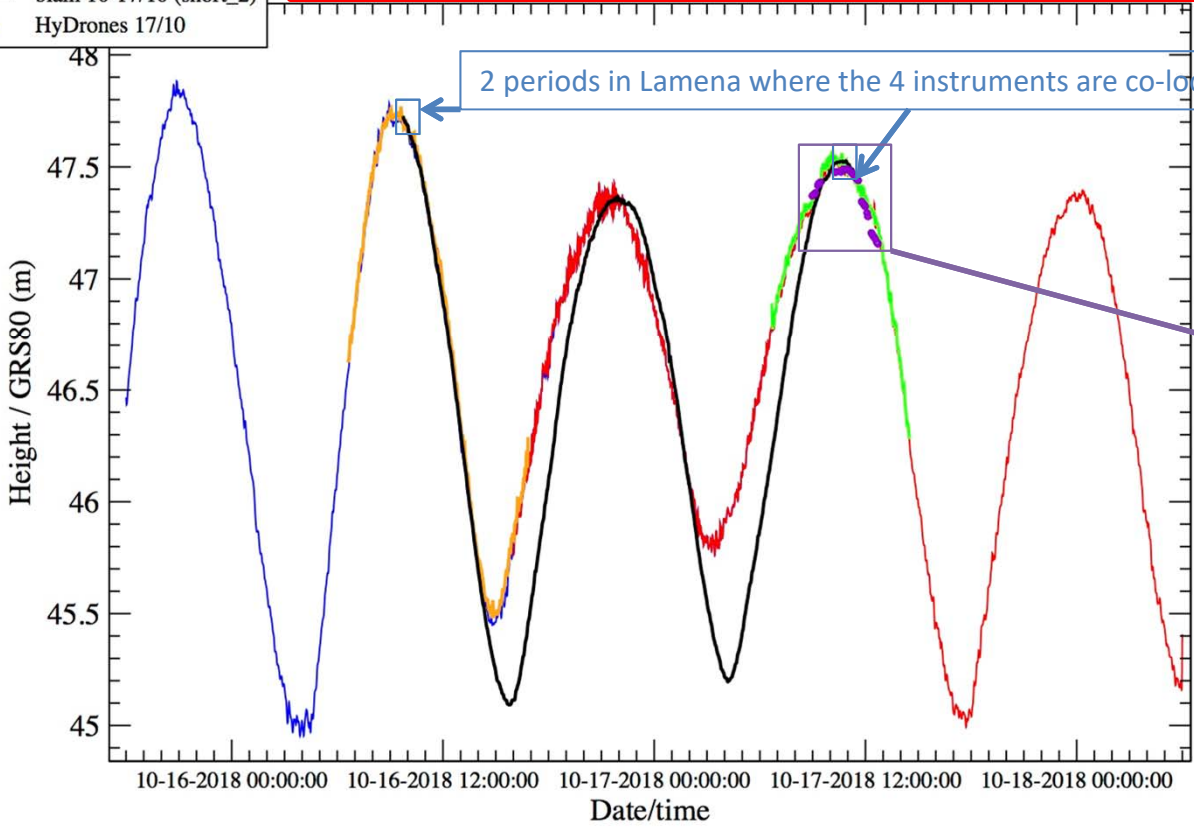
GPS Solutions 15-17 (blue) & 16-18 October (red) for CalNaGeo downstream and upstream



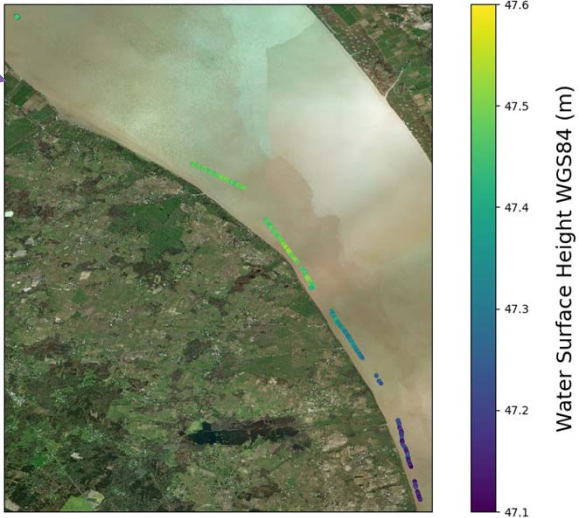
Downstream: CalNaGeo (blue/red), Cyclopée (orange/green), Buoy (black) and HyDrones (purple)

- cnav 16/10 (air_a2)
- cnav 17/10 (air_a2)
- cycl 16/10 (air_a1)
- cycl 17/10 (air_a1)
- blam 16-17/10 (short_2)
- HyDrones 17/10

Raw measurements (1 Hz) are smoothed with a low-pass filter at 300 seconds (~ 1 km @ 6 knots)

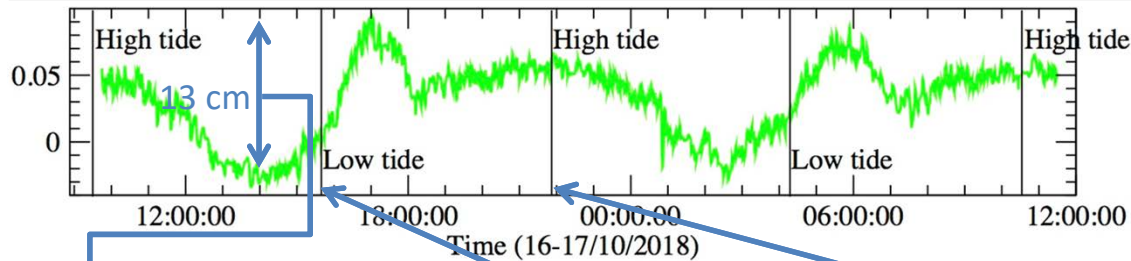


HyDrones WSH in the Gironde estuary Lamena 17/10/2018



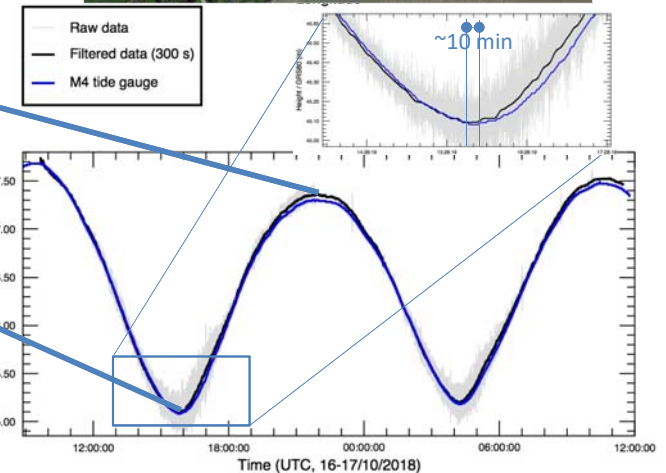
Common measurements buoy (**black**) and M4 tide gauge (**blue**) over 2 days at Lamena (16-17/10)

Differences Buoy – Tide Gauge: mean = + 33 mm / rms = 28 mm

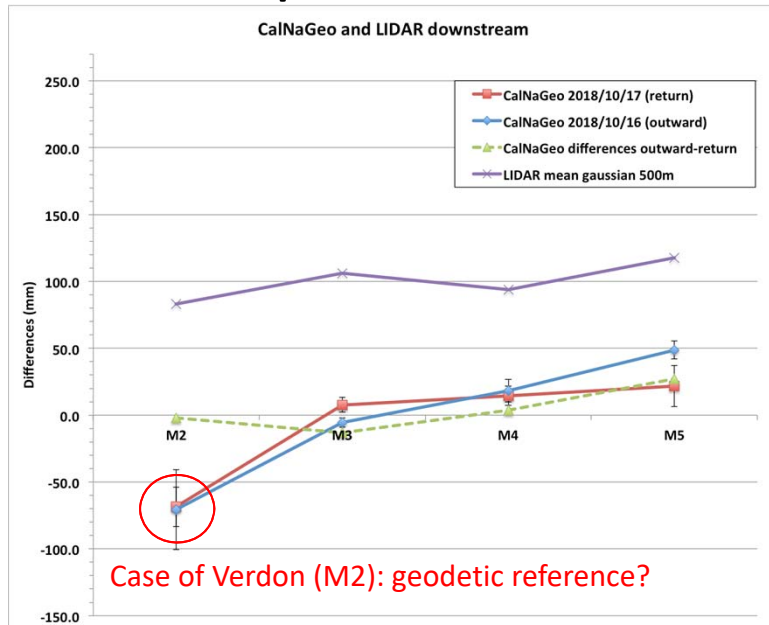


Unexpected signal !
Differences up to 13 cm peak to peak
@ less than 150 m:

- Higher waves during low tides?
- Sinkage effect of the buoy due to current (strength on the cable)?
- **Problem in datation (during high gradient up to 10 cm in 10 min)?**



Comparisons with tide gauges for CalNaGeo and LIDAR



CalNaGeo: without Verdon (M2)

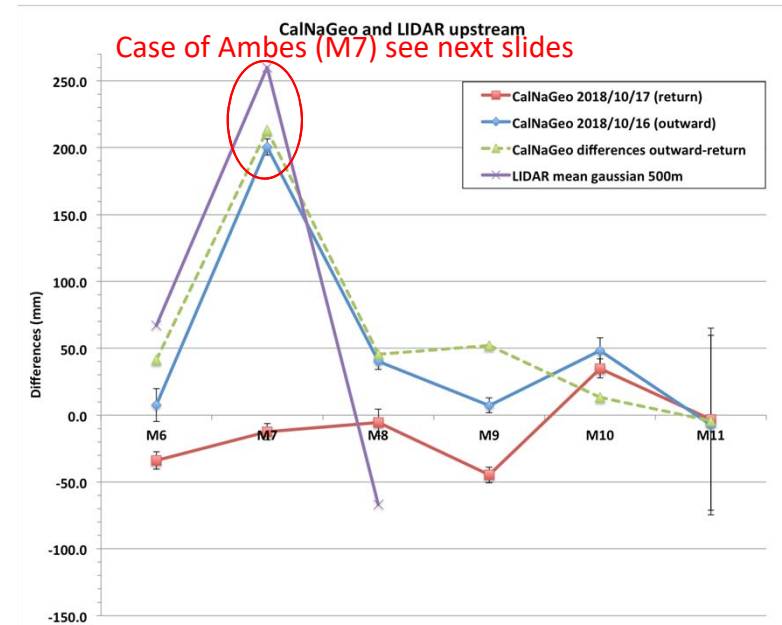
Outward: mean = +21 mm / rms = 27 mm

Return: mean = +15 mm / rms = 7 mm

Outward-Return differences: mean = +6 mm / rms = 20 mm

LIDAR: without Verdon (M2)

2018/10/25: mean = +106 mm / rms = 12 mm



CalNaGeo: without Ambes (M7)

Outward: mean = +19 mm / rms = 24 mm

Return: mean = -11 mm / rms = 31 mm

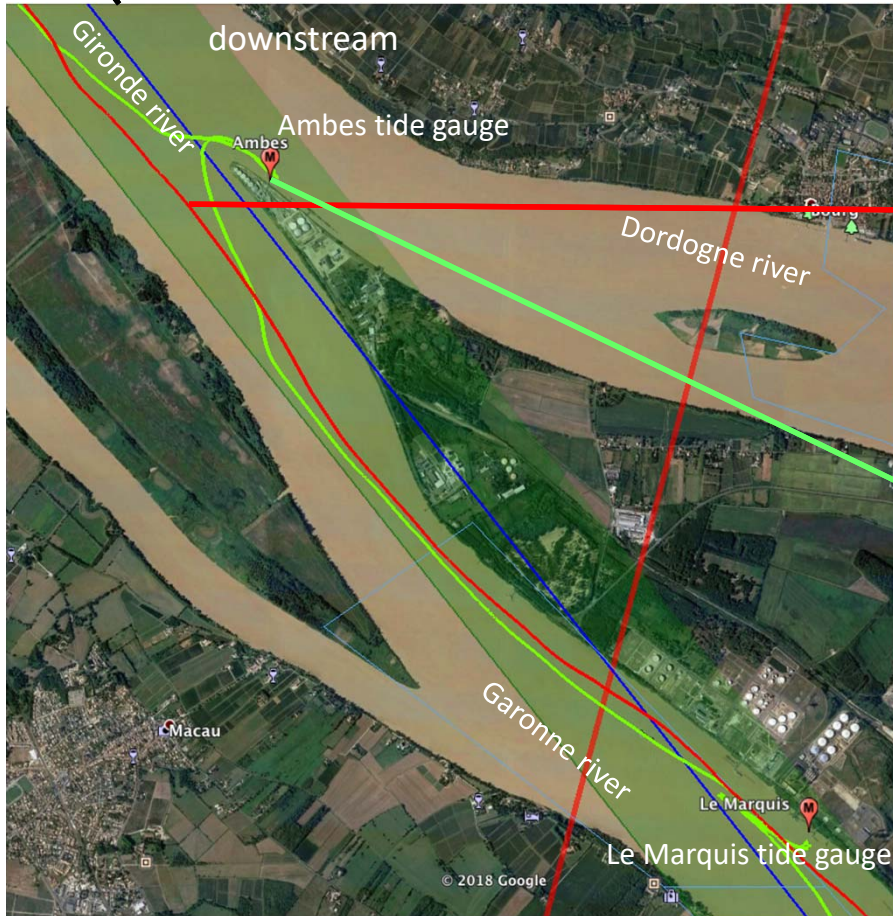
Outward-Return differences: mean = +30 mm / rms = 24 mm

LIDAR: without Verdon (M2)

2018/10/25: mean = +0 mm / rms = 95 mm

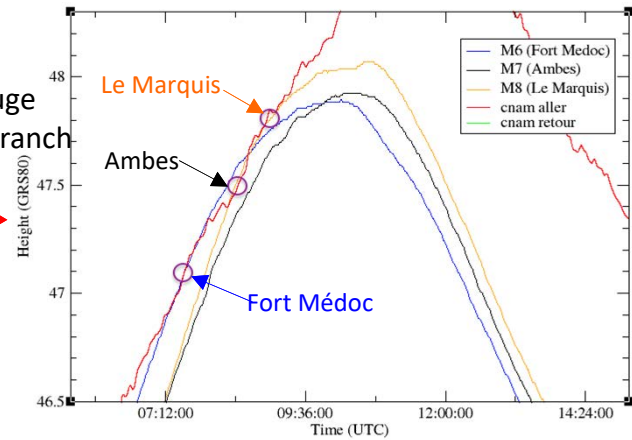
Impact of non co-located measurements: CalNaGeo

Fort Médoc
tide gauge



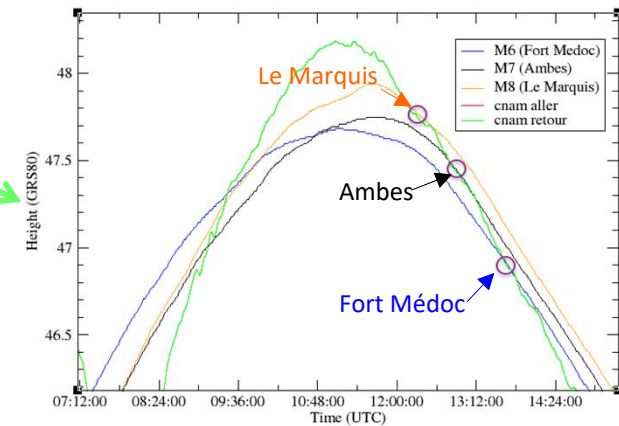
Outward journey:

Far (500 m) from the tide gauge
And NOT on the same river branch
=> Difference = 200 mm

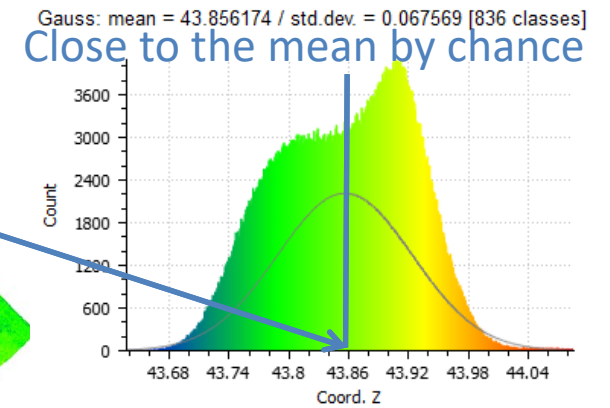
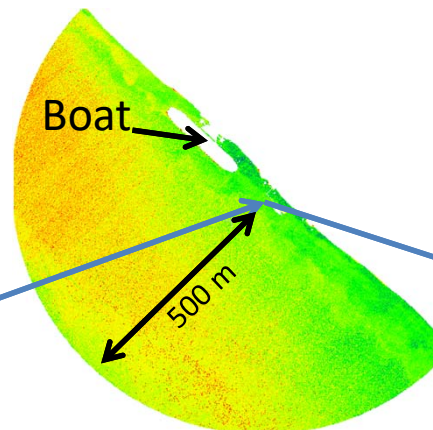
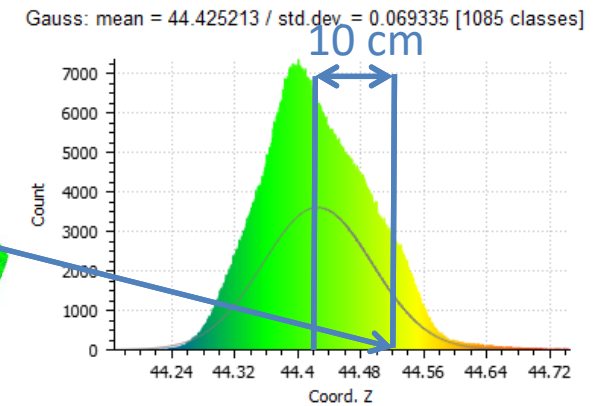
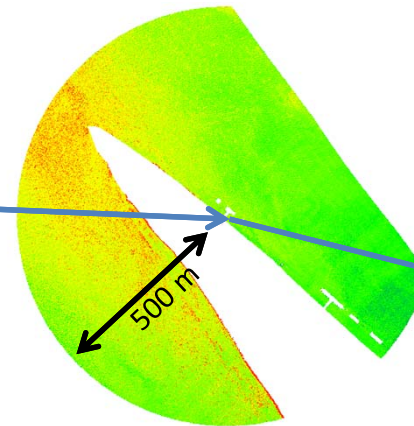
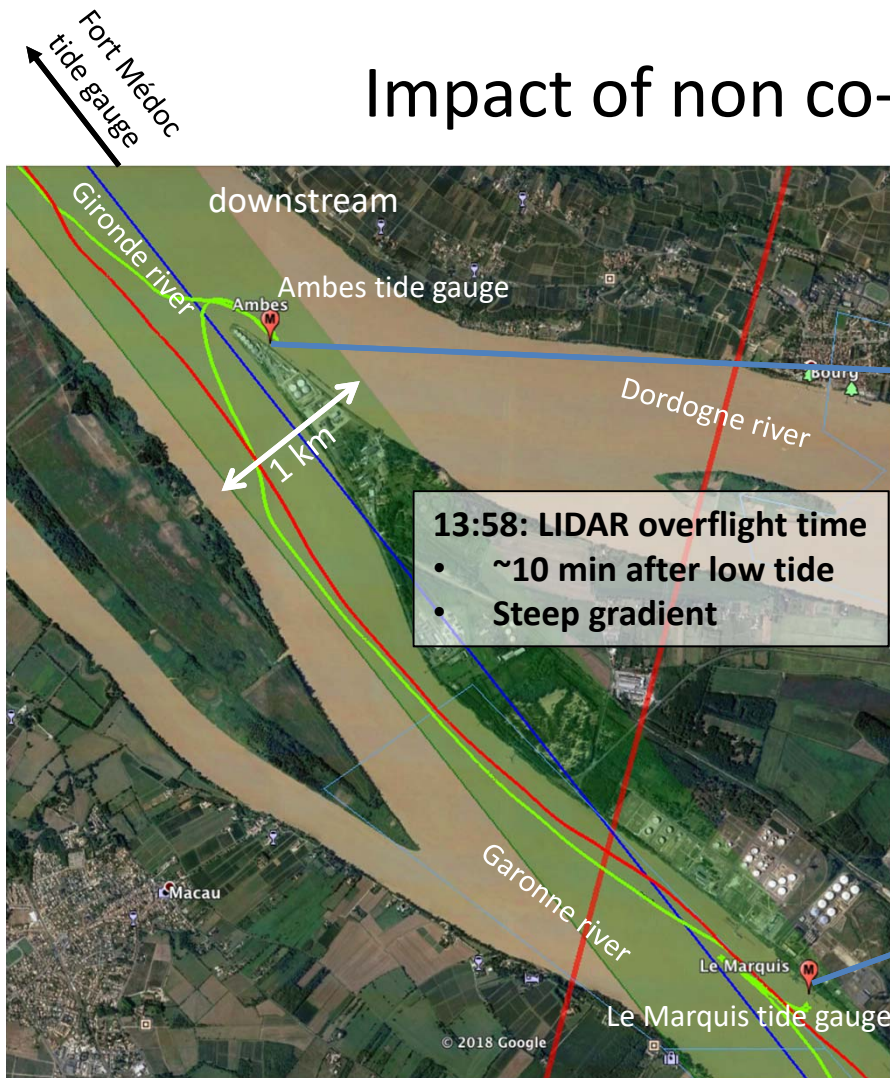


Return journey:

At the tide gauge
And on the same river branch
=> Difference = -13 mm



Impact of non co-located measurements: **LIDAR**



Conclusions (1/2)

- Comparisons between **CalNaGeo, Cyclopée, HyDrones and buoy**:

Differences / buoy (@Lamena, static)	16/10/2018	17/10/2018
CalNaGeo - buoy	~-33 mm for the 2 days ($\sigma \sim 6$ mm)	
Cyclopée - buoy	~-24 mm for the 2 days ($\sigma \sim 14$ mm)	
HyDrones - buoy		~-19 mm ($\sigma \sim 5$ mm)

⇒ **Offset of ~2-3 cm compare to the buoy**

Differences on all the data	@Lamena
Cyclopée – CalNaGeo	~+10 mm ($\sigma \sim 10$ mm)
Cyclopée – HyDrones	~-15 mm ($\sigma \sim 13$ mm)
CalNaGeo – HyDrones	~-22 mm ($\sigma \sim 5$ mm)

⇒ **Offsets of ~1-2 cm between the 3 instruments**

⇒ **Very good coherence with the different instruments at 1-2 cm rms**

- Comparisons of **CalNaGeo and LIDAR with tide gauges**:
 - **CalNaGeo**: 24 mm rms globally
same level for Outward-Return differences
 - **LIDAR**: 75 mm rms globally
clear ~100 mm offset probably due to too large averaging (500 m)
but only 12 mm rms for downstream

Conclusions (2/2)

- **Is in situ giving the truth?**

As shown, local effects can impact the comparisons with tide gauges:

- Distance: strong effects (tens of cm) increased in particular conditions (river branches)
- Datation: up to 10 cm for time tagging error of several minutes depending water level time gradient (strong tides in estuaries)
- Geodetic referencing uncertainty: several cm (often only based on geoid grid instead of accurate leveling)

- **Using existing networks of instruments is a good opportunity**

- **But they were not all designed to achieve our level of accuracy**

- **If we want to meet our requirements we must end-to-end design, install and monitor our in situ instruments**

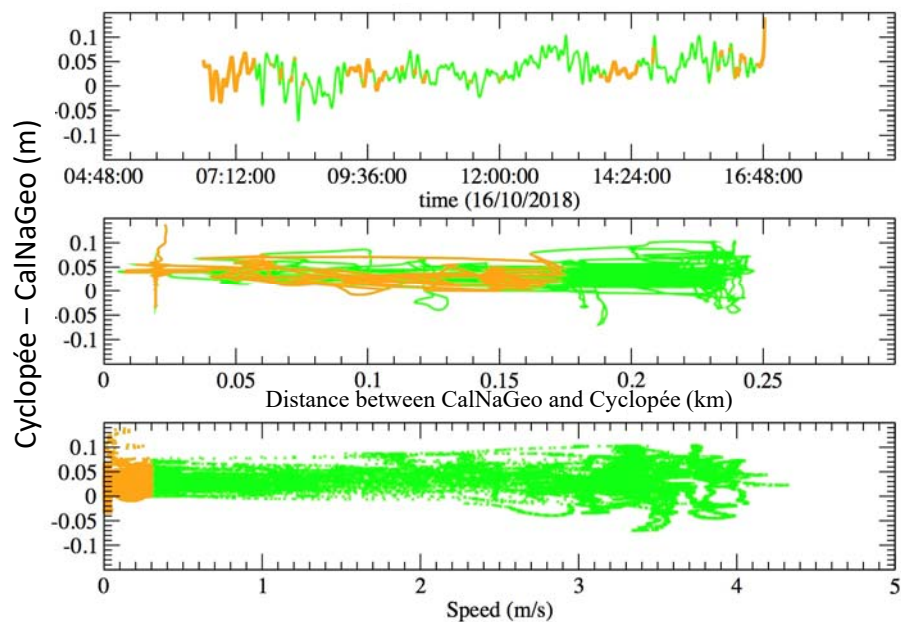
Backup slides

Comparisons over the whole downstream path

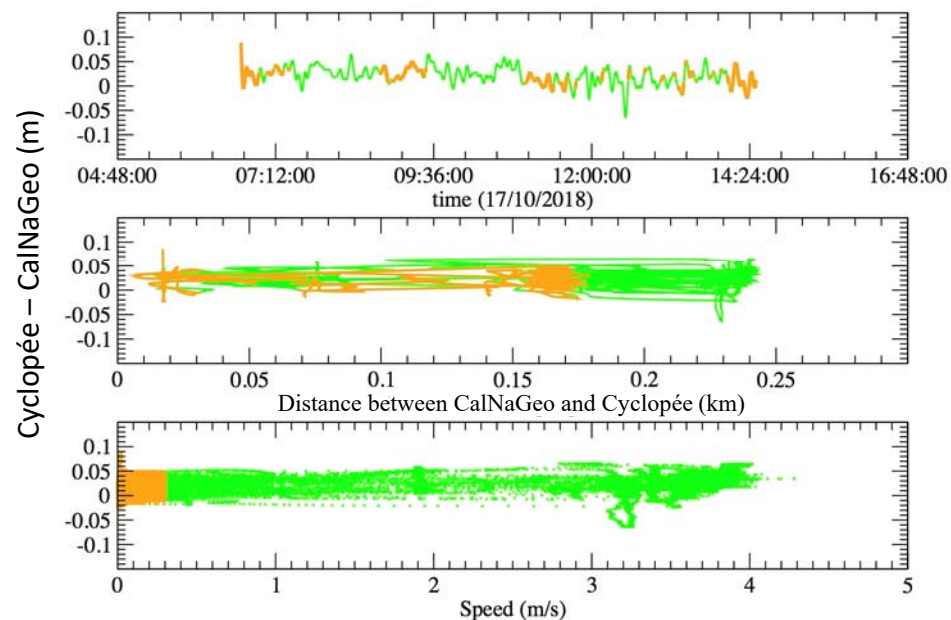


Comparisons Cyclopée — CalNaGeo

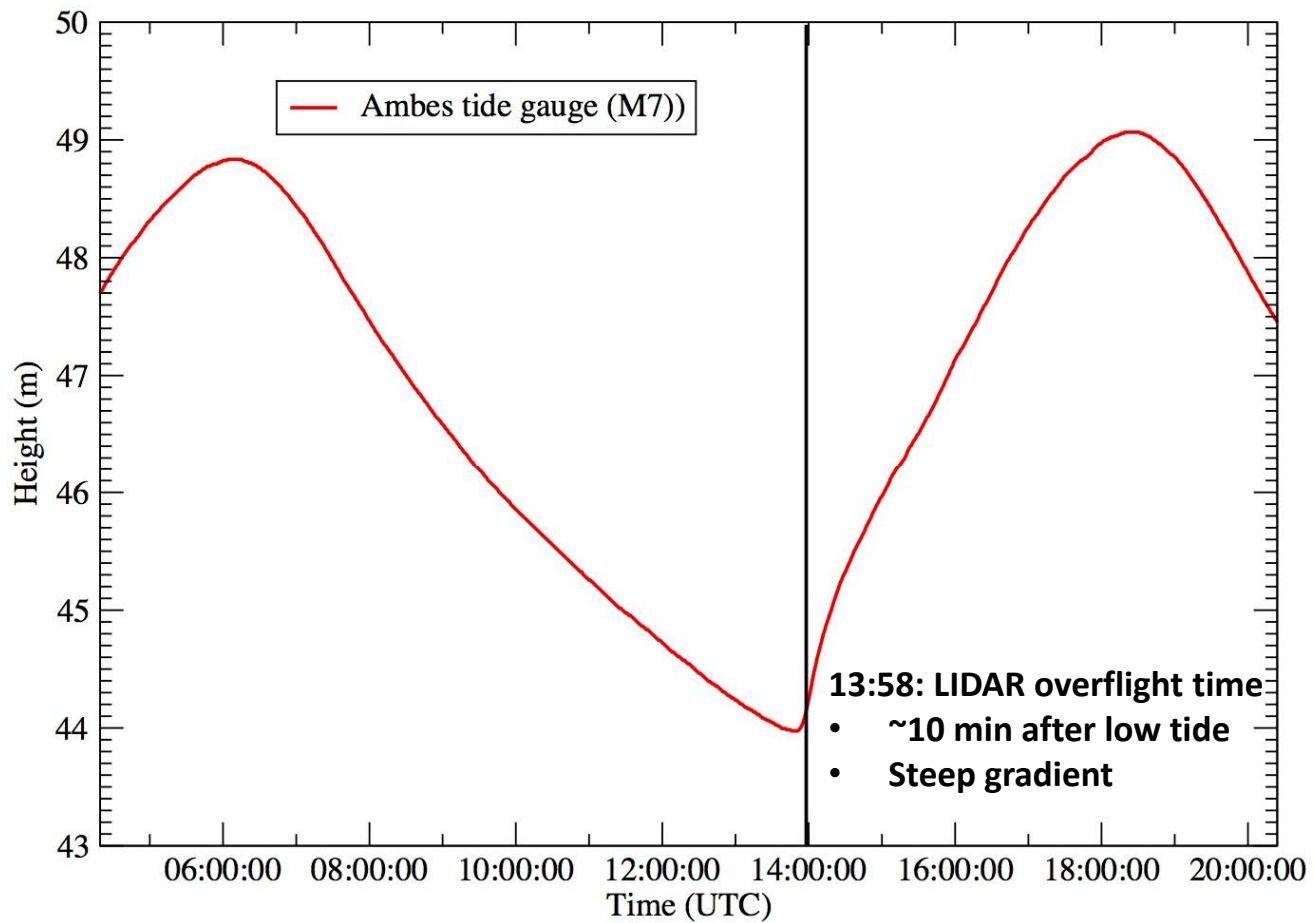
Cyclopee Experiment @ GIRONDE (Track mode air)



Cyclopee Experiment @ GIRONDE (Track mode air)



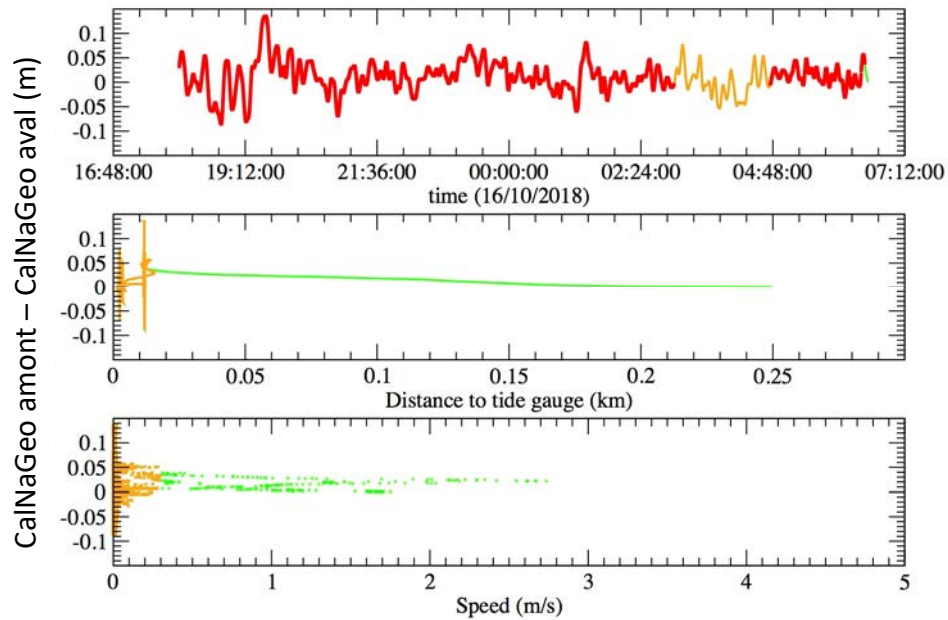
Date	Type	Mean (mm)	σ (mm)	N
16/10/18	D<250m	31.2	26.3	36596
16/10/18	D<250m + V<0.3m/s	27.2	20.7	8373
17/10/18	D<250m	21.3	17.3	28047
17/10/18	D<250m + V<0.3m/s	18.1	16.1	6907



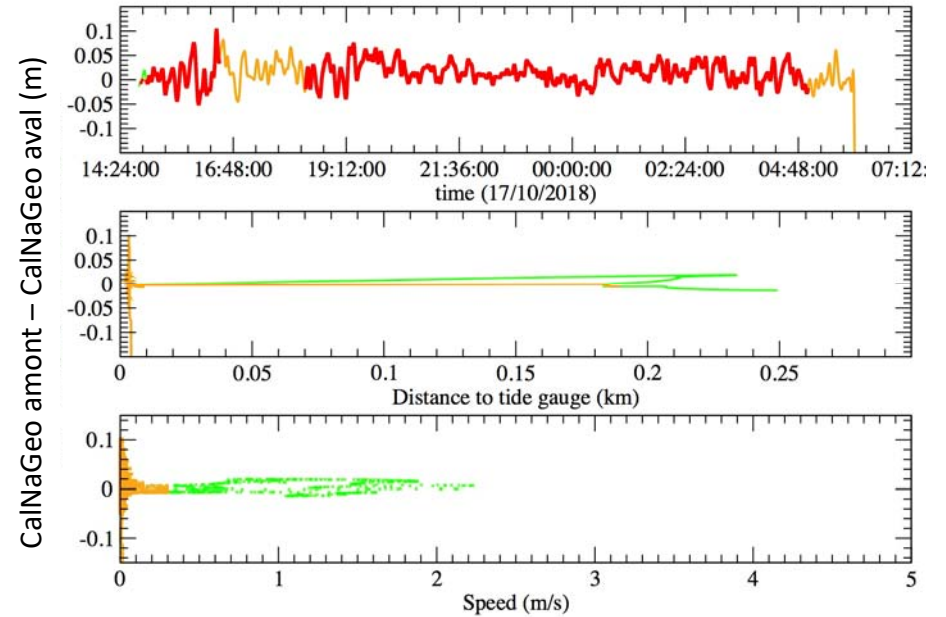
CalNaGeo Comparisons upstream – CalNaGeo downstream @ Pauillac

RED= apart from the low tide at Pauillac

CalNaGeo upstream Experiment @ GIRONDE (Track mode air)

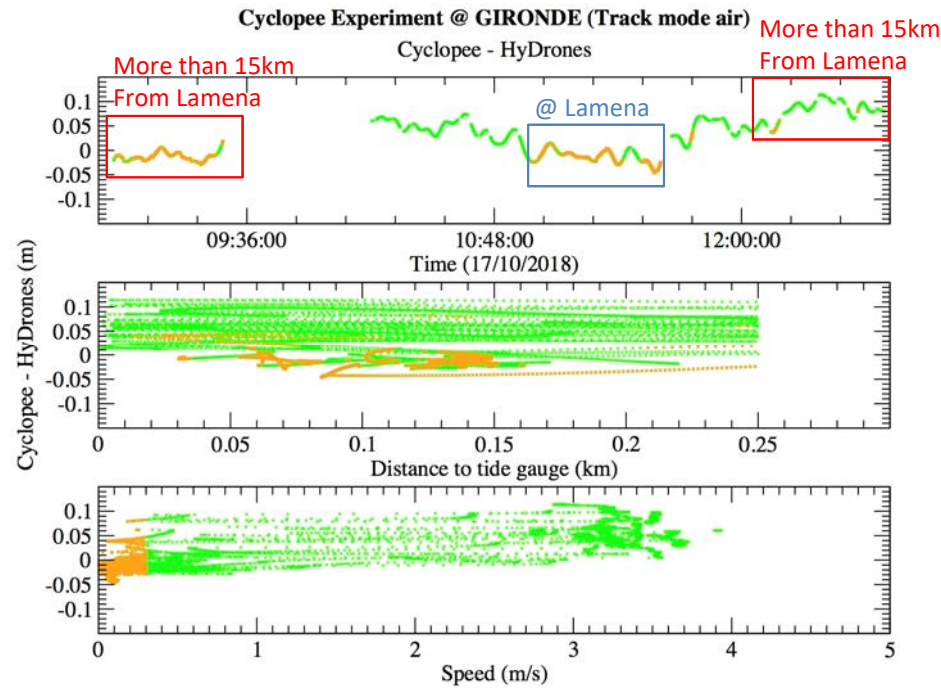


CalNaGeo upstream Experiment @ GIRONDE (Track mode air)



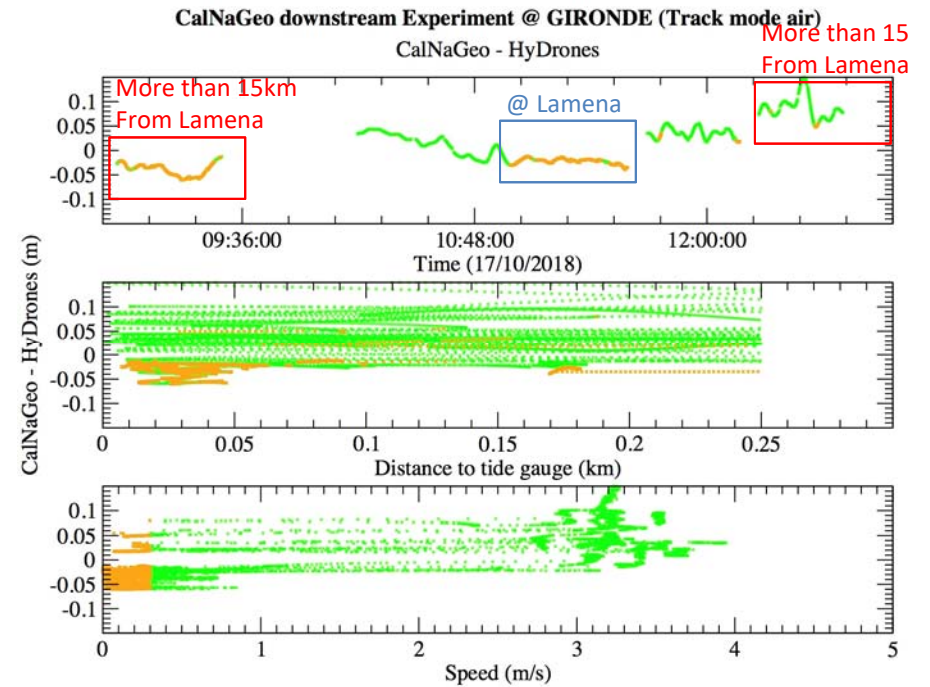
Date	Type	Mean (mm)	σ (mm)	N
15-16/10/18	D<250m	10.3	31.0	45156
15-16/10/18	D<250m + V<0.3m/s	10.2	31.0	44904
16-17/10/18	D<250m	13.9	22.6	54745
16-17/10/18	D<250m + V<0.3m/s	14.0	22.7	54127

Comparisons Cyclopée & CalNaGeo — Hydrones



Cyclopée – Hydrones (17/10)

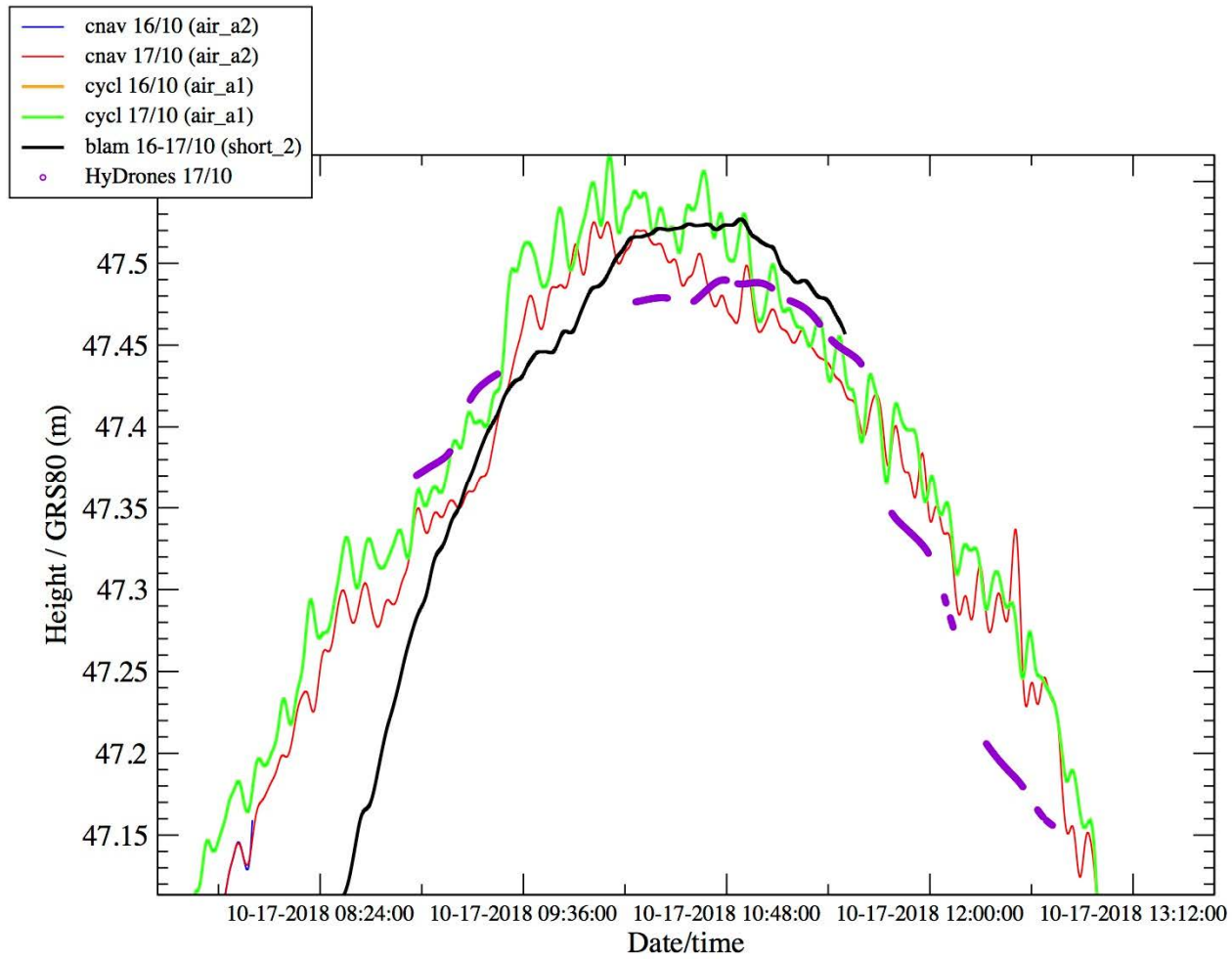
Date	Type	Mean (mm)	σ (mm)	N
17/10/18	D<250m	+25.5	40.3	9432
17/10/18	D<250m + V<0.3m/s	-11.6	15.0	6907



CalNaGeo- Hydrones (17/10)

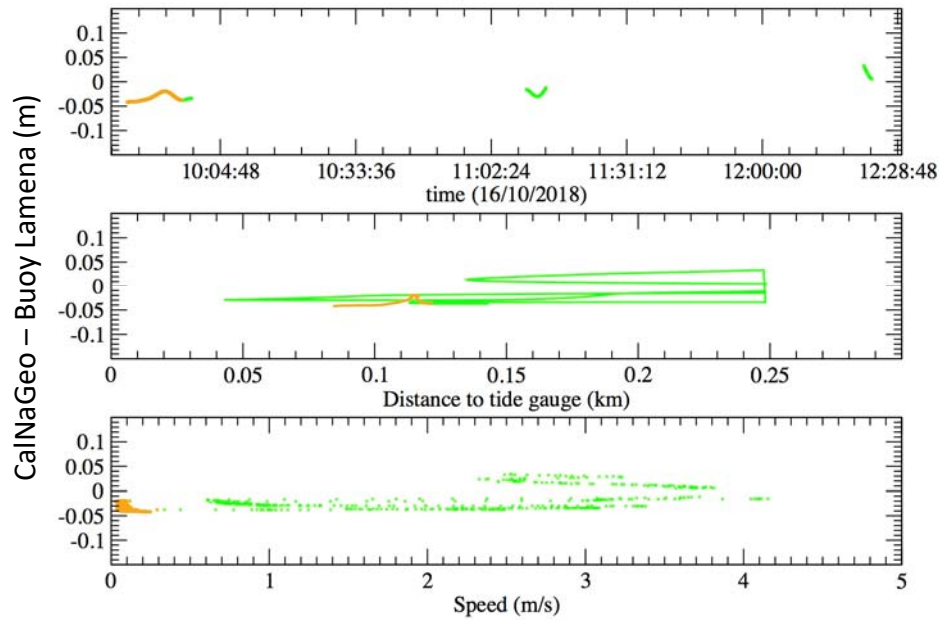
Date	Type	Mean (mm)	σ (mm)	N
17/10/18	D<250m	+9.8	44.3	9939
17/10/18	D<250m + V<0.3m/s	-26.9	17.5	3324

Mesures communes le 17/10: série CalNaGeo (rouge), Cyclopée (vert), bouée (noir) et HyDrones (violet)

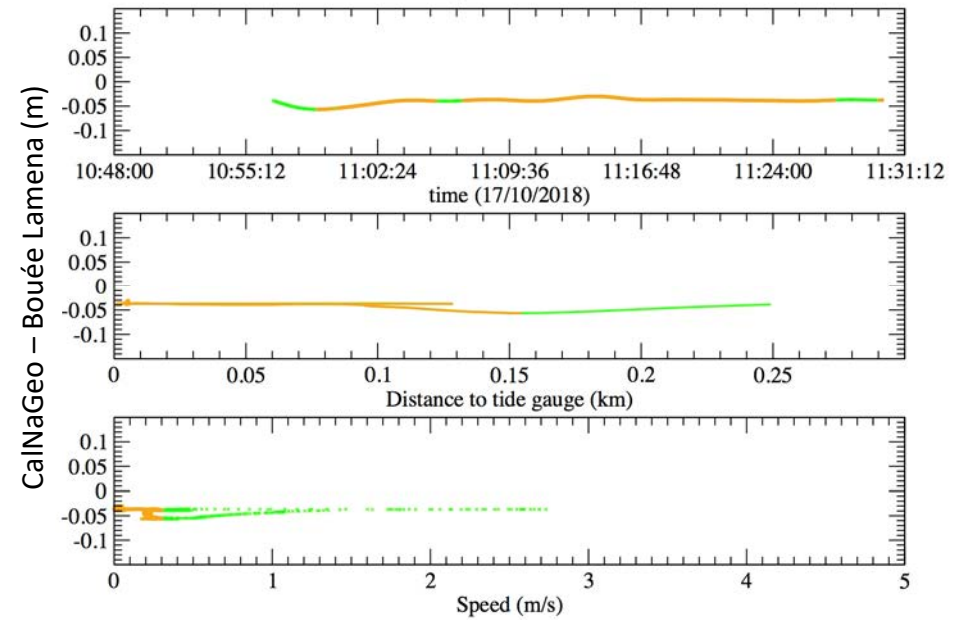


Comparisons CalNaGeo — Buoy @ Lamena

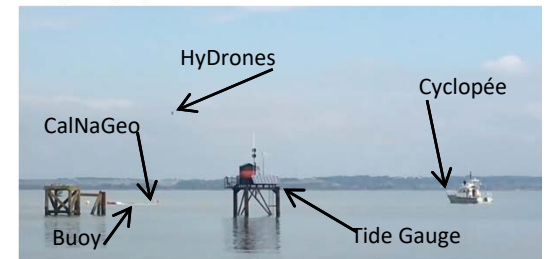
CalNaGeo downstream Experiment @ GIRONDE (Track mode air)



CalNaGeo downstream Experiment @ GIRONDE (Track mode air)

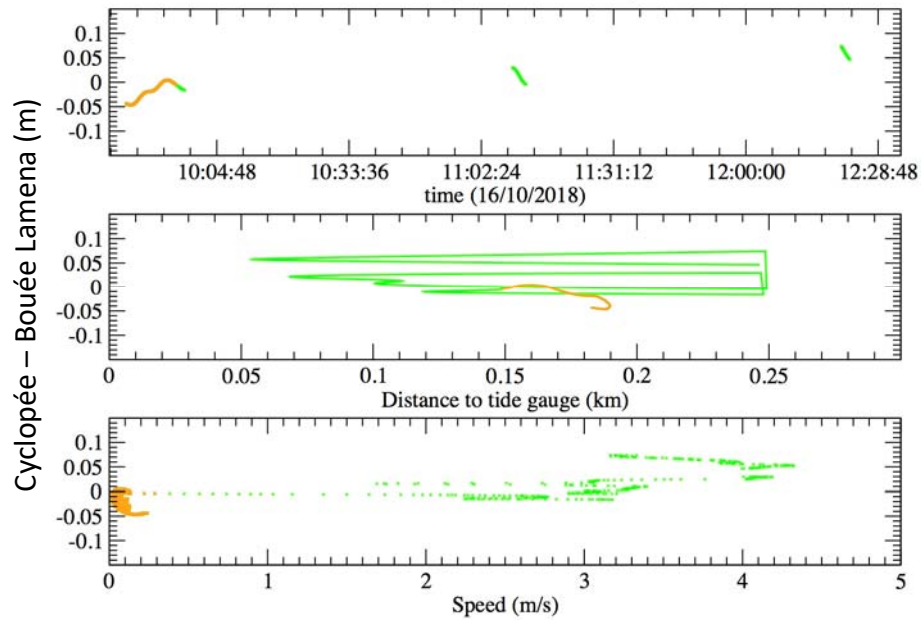


Date	Type	Mean (mm)	σ (mm)	N
16/10/18	D<250m	-26.1	15.8	2872
16/10/18	D<250m + V<0.3m/s	-32.0	7.4	1995
17/10/18	D<250m	-39.5	6.0	2566
17/10/18	D<250m + V<0.3m/s	-38.6	5.3	2055

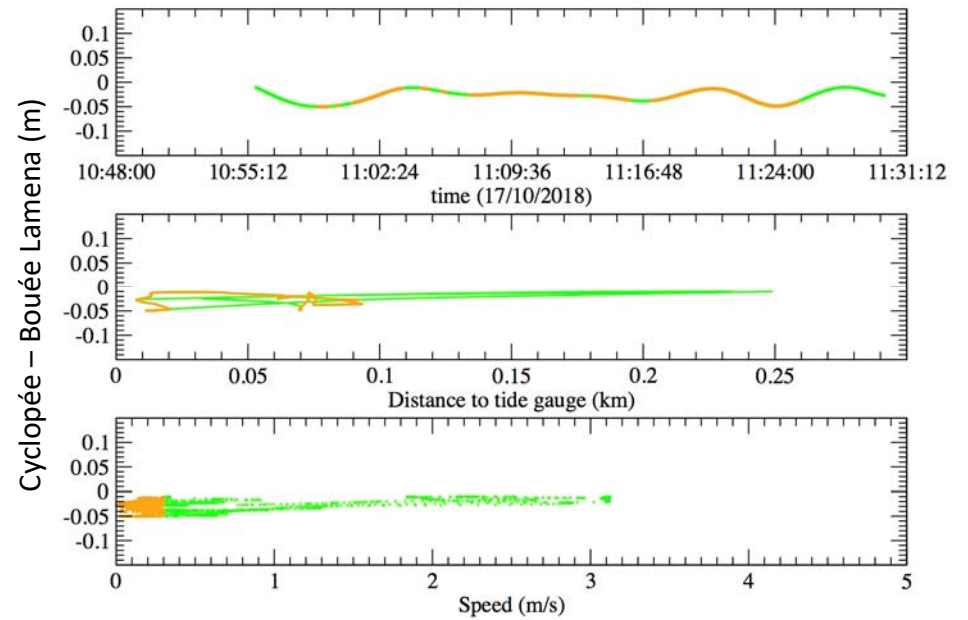


Comparaisons Cyclopée – Bouée Lamena

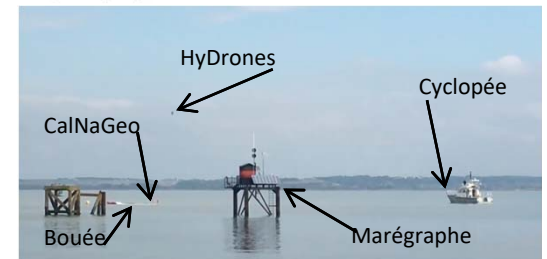
Cyclopee Experiment @ GIRONDE (Track mode air)



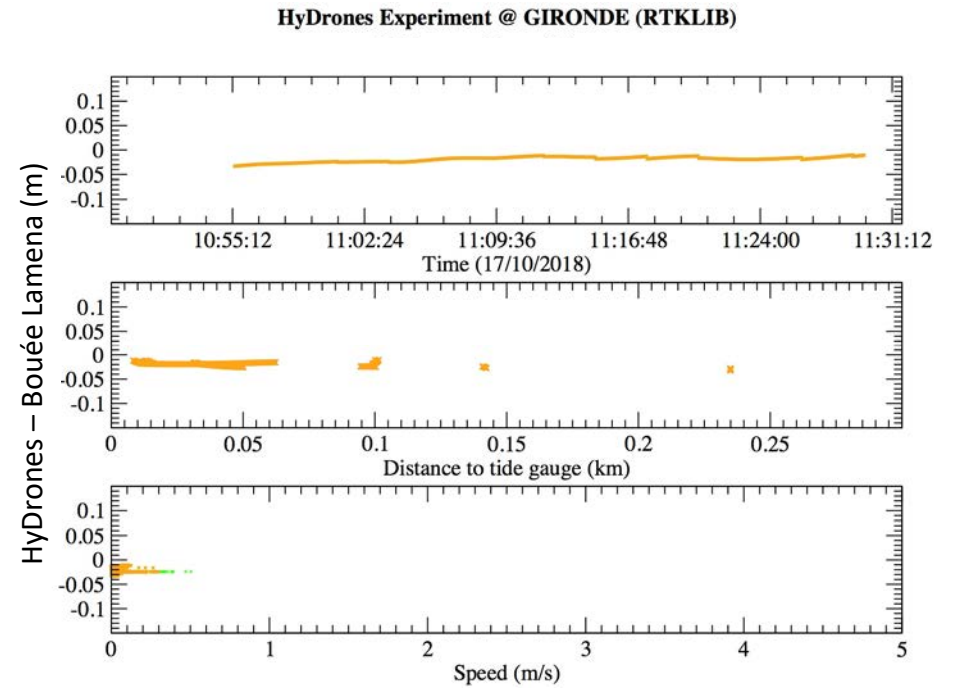
Cyclopee Experiment @ GIRONDE (Track mode air)



Date	Type	Mean (mm)	σ (mm)	N
16/10/18	D<250m	-3.9	29.3	3062
16/10/18	D<250m + V<0.3m/s	-19.0	17.5	1940
17/10/18	D<250m	-27.8	11.3	2577
17/10/18	D<250m + V<0.3m/s	-28.4	10.0	1556



Comparaisons HyDrones – Bouée Lamena



Date	Type	Mean (mm)	σ (mm)	N
16/10/18				
16/10/18				
17/10/18	D<250m	-19.0	5.2	2062
17/10/18	D<250m + V<0.3m/s	-19.0	5.2	2062

