

# Study of coastal finescale structure : a case study near Toulon using unprecedented high resolution observations

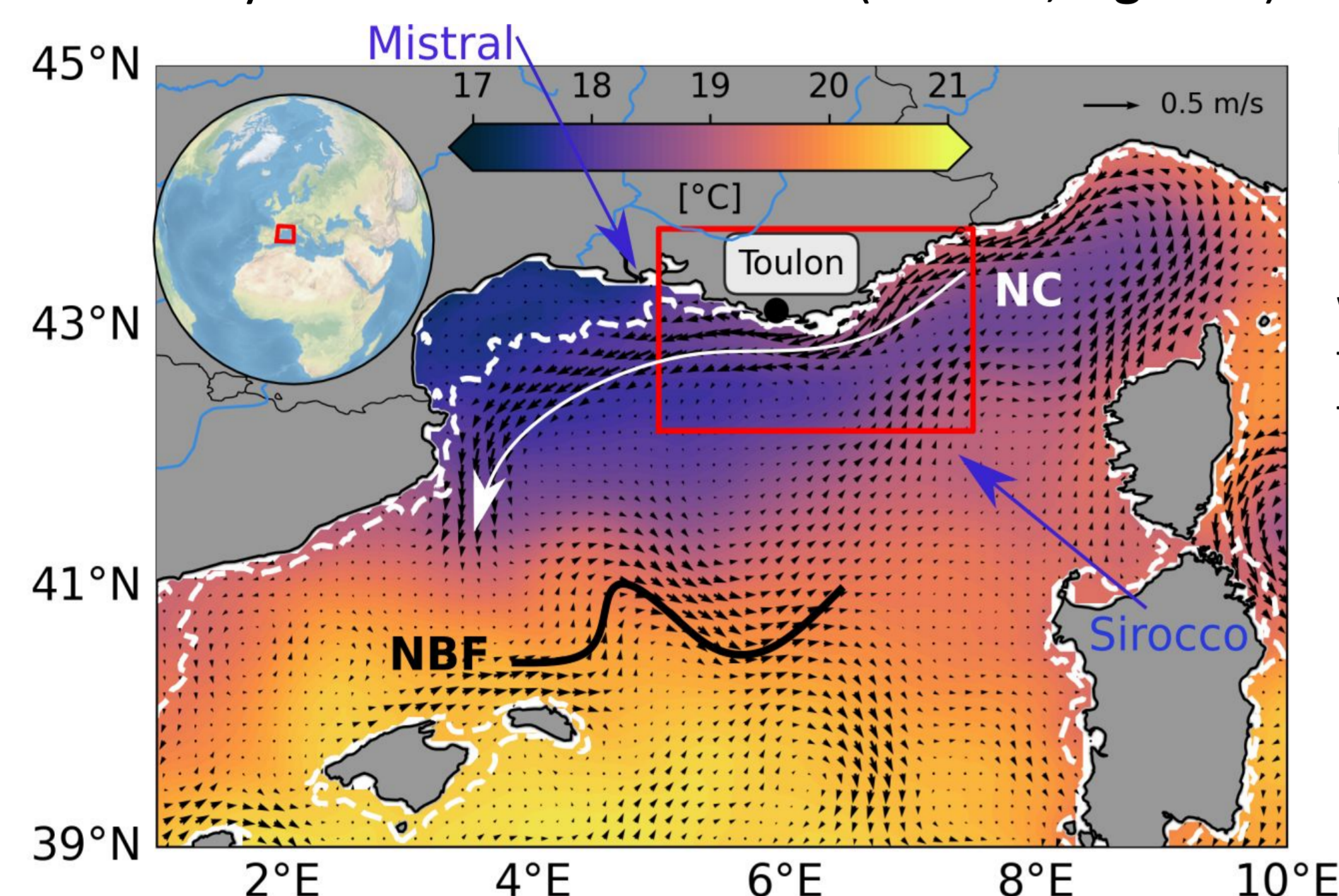
## TAKE HOME MESSAGES

- AIS and SWOT : good agreement with in situ data
- No finescale structure represented in DUACS
- Improved representation of coastal submesoscale structures in AIS and SWOT

- Submesoscale structure (25 km) : signature in SST and Chl
- SWOT very good coherence with Chl data
- Chl filament originating from the coast

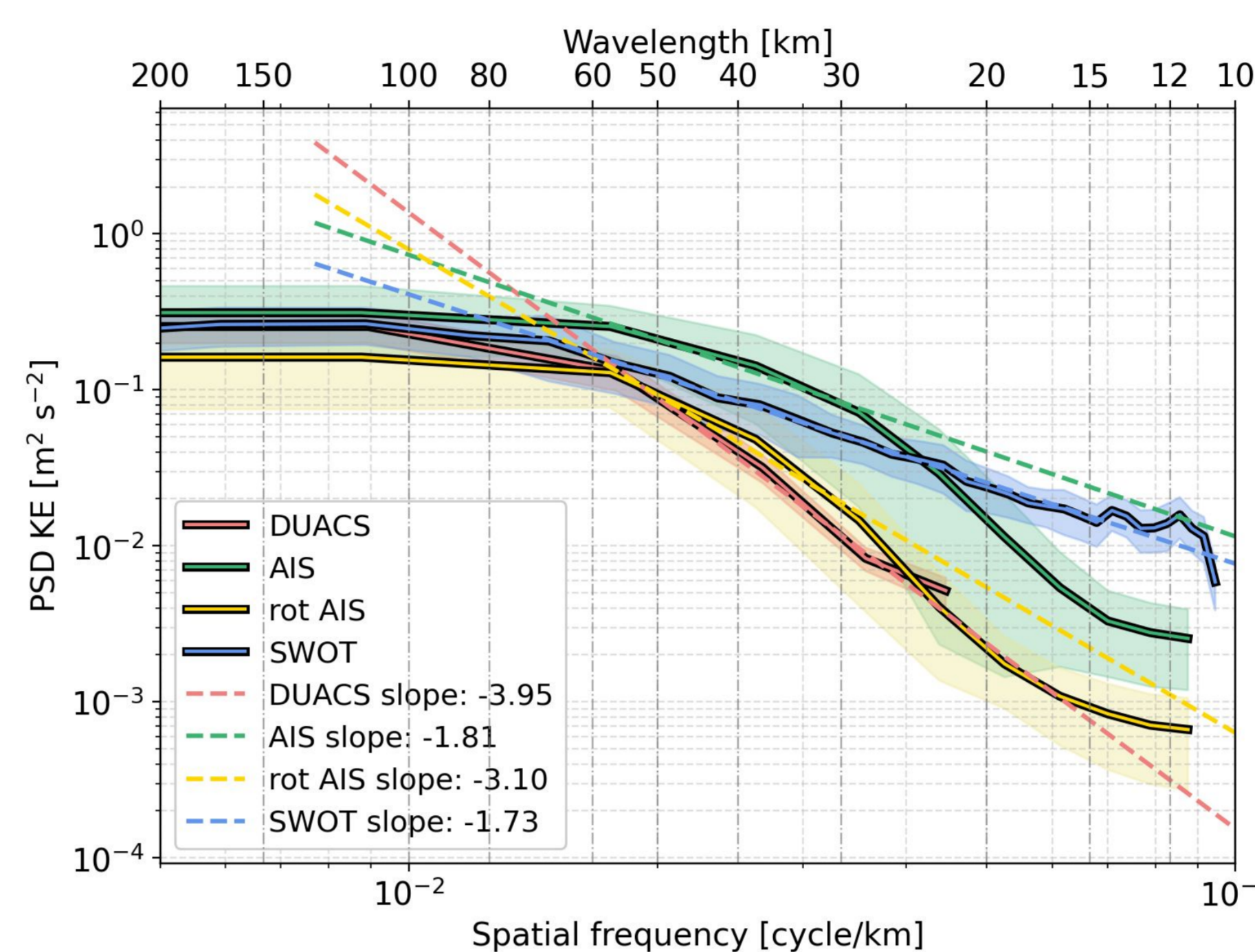
## I- Introduction : Study Area

- Gulf of Lion (Figure 1):
  - Small Rossby radius ( $R_o$ )  $\approx$  10 km
  - Current : Northern Current (NC), North Balearic Front (NBF)
  - Wind : Mistral & Sirocco
  - Limits of conventional altimetry : close to the coast and finescale structures
  - Study area : Focus near Toulon (red box, Figure 1)



**Figure 1:** Mean circulation in the Gulf of Lion from mid-May to mid-July 2023, with mean sea surface temperature (SST) from MUR in the background. Keys : NC-Northern Current, NBF-North Balearic Front. Red box  $\rightarrow$  the study area

## IV- Observability of finescale structures



- Observability of finescale structures (<20 km) by AIS and SWOT
- Similar slope for geostrophic part of AIS (rot) and DUACS
- SWOT can detect structures down to 15 km.

**Figure 5 :** Spatial spectral analysis of Kinetic Energy

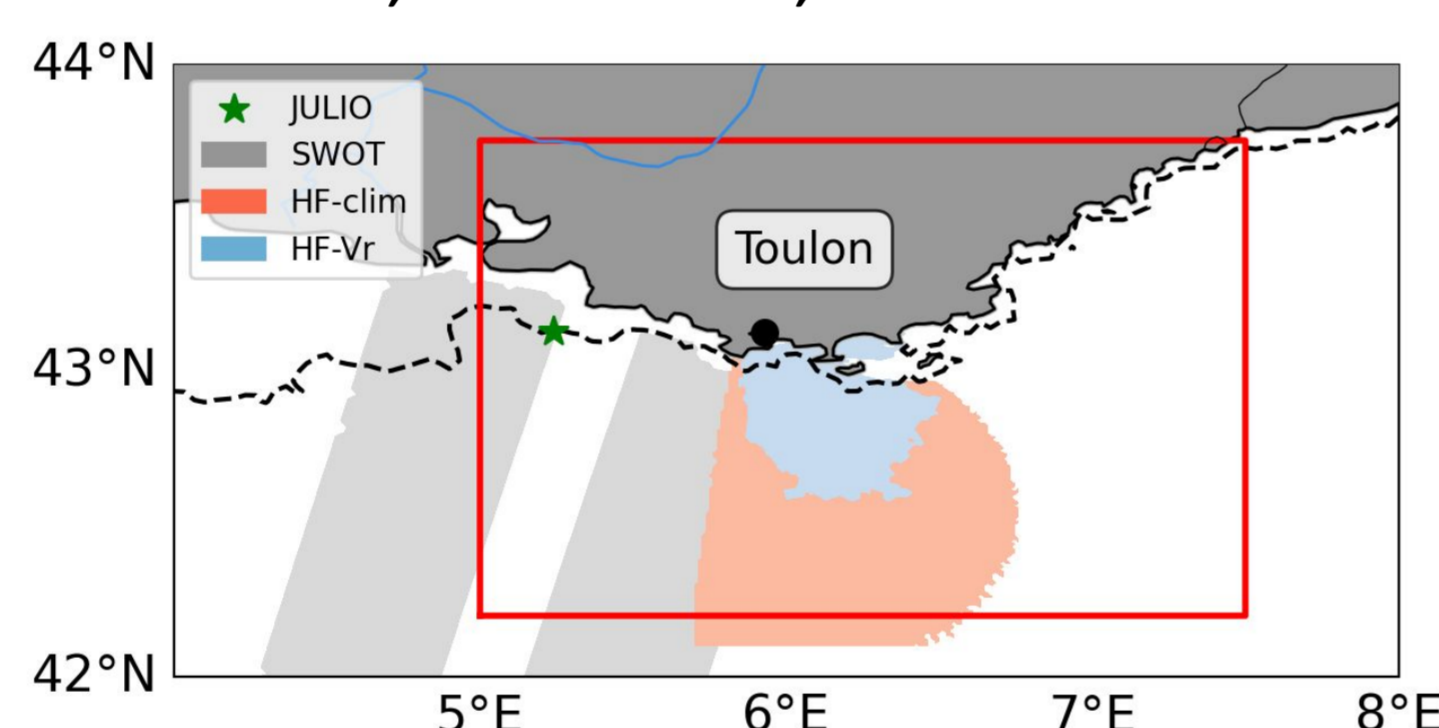
## II- Data used

### Several velocities dataset (Figure 2):

- SWOT (Dibarboure et al 2024), 1 day (track 003), 2 km
- DUACS, 1 day, 12 km
- AIS (Le Goff et al 2021), 1 day, 6 km
- HF-radar (Guérin et al 2019), Monthly climatology (2012-2022), 1 km
- JULIO mooring (Petrenko et al 2023) ( $\sim$ 43.2°N-5.3°E), resampling 1 day, at a depth of 11 m  $\rightarrow$  Utilisation of data from mid-May to mid-July (fast sampling phase)

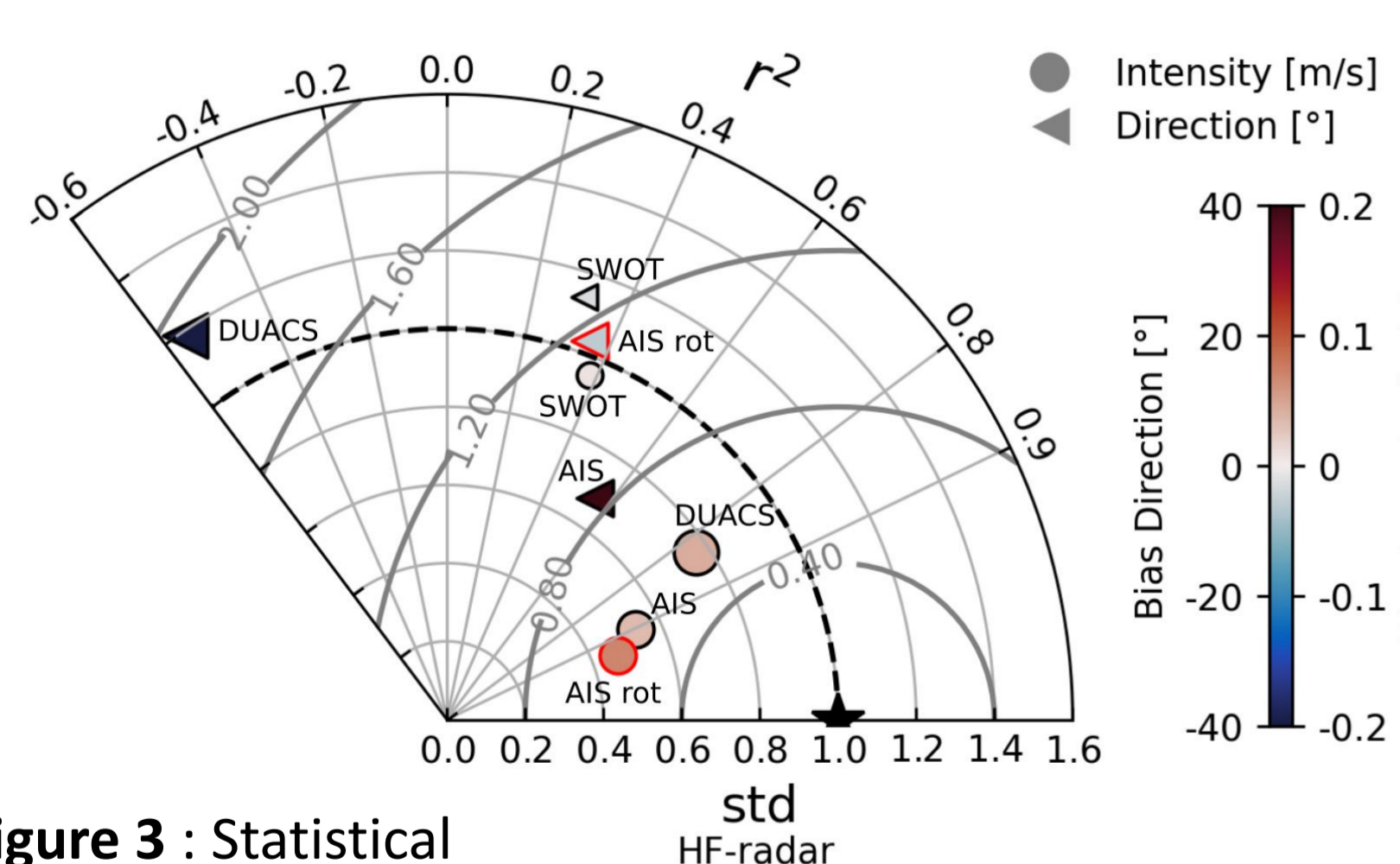
### Other satellite data :

- SST, Sentinel 3, 1km
- Chl, Sentinel 3, 300 m



**Figure 2 :** Spatial coverage of SWOT (grey), HF radar (blue and pink), AIS (red square) and JULIO (green star)

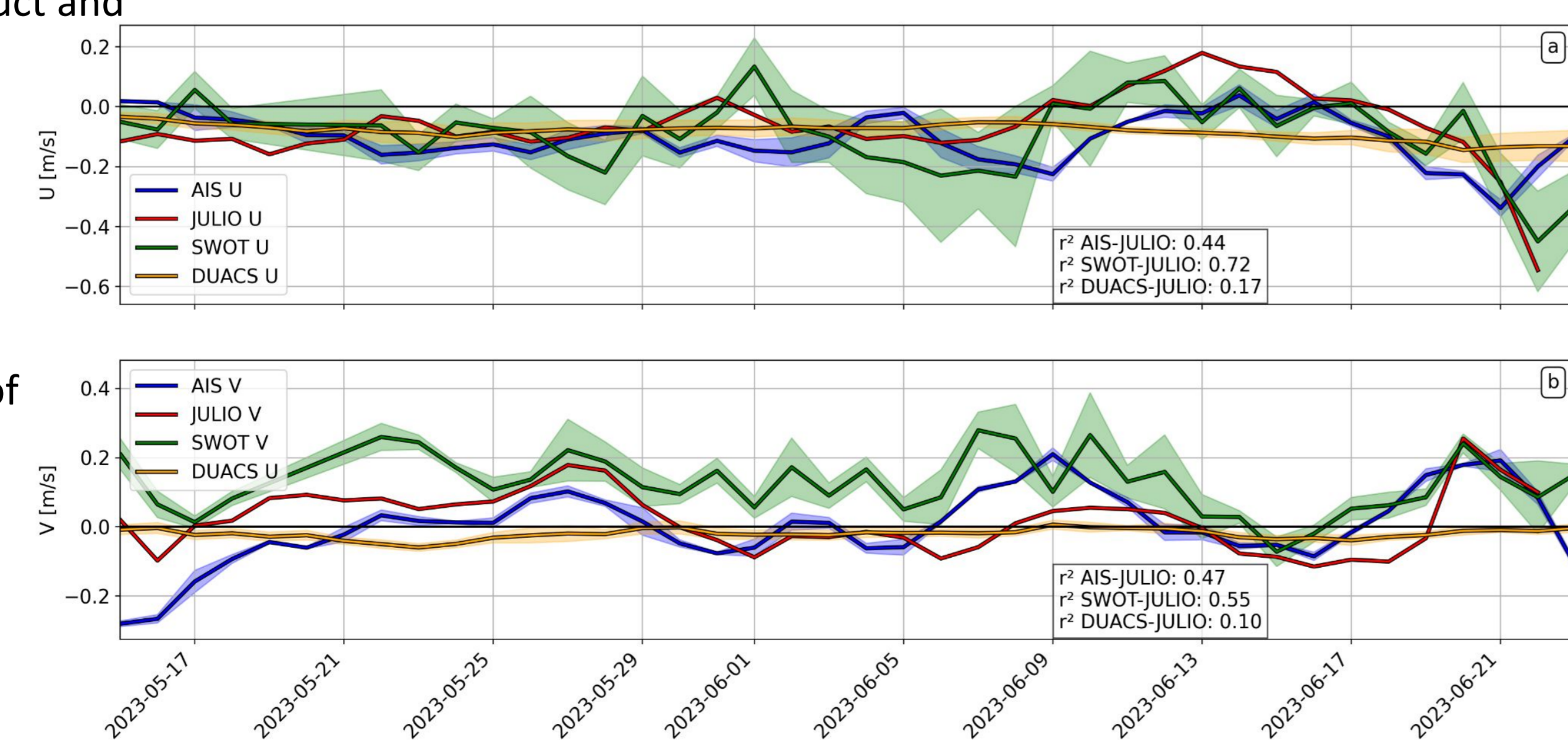
## III- Validation



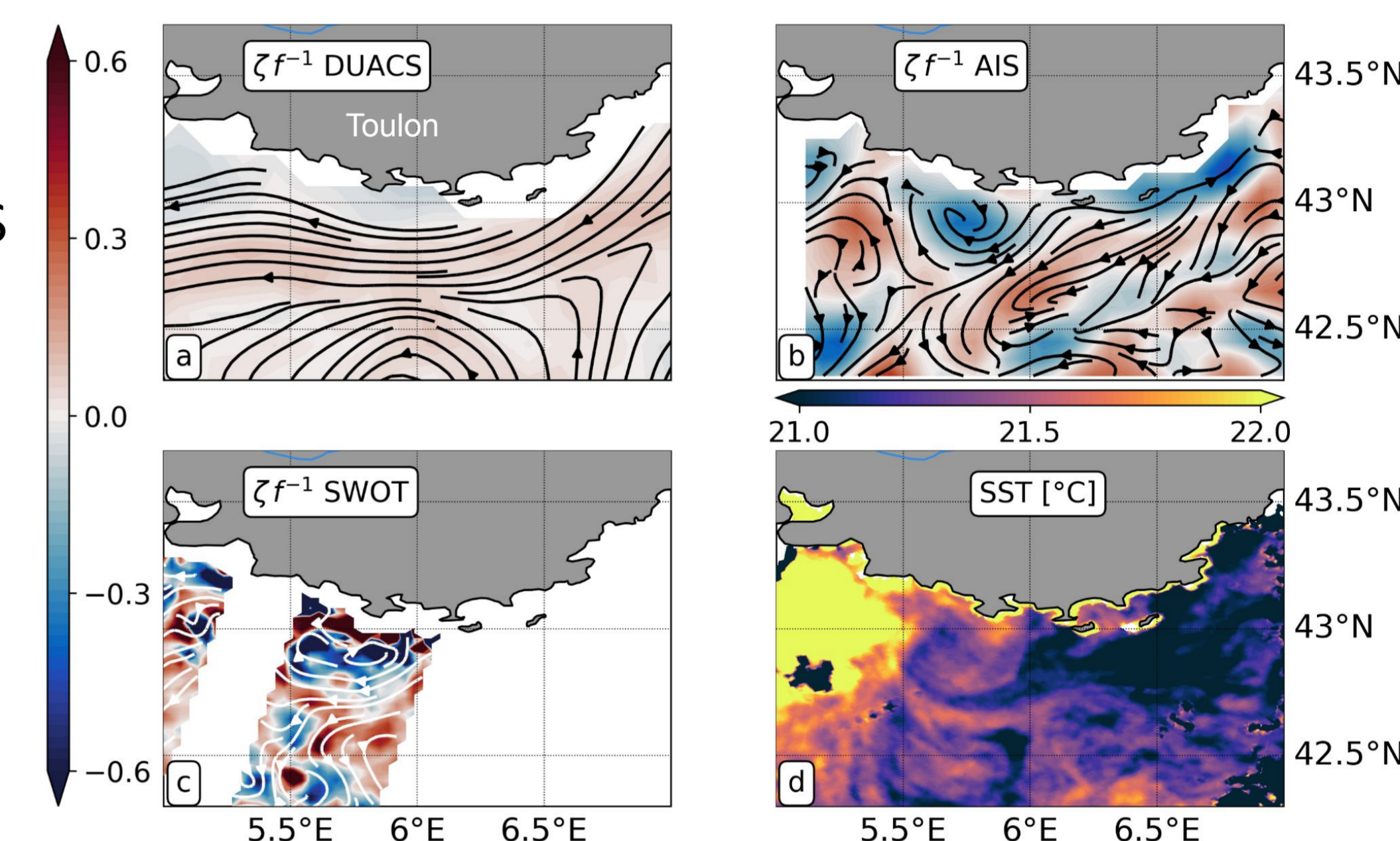
- Best correlation : AIS and HF radar
- AIS and DUACS better for intensity
- Velocity direction better for AIS
- SWOT low correlation with HF radar explained by a small overlap

**Figure 3 :** Statistical comparison between the different velocity product and the HF radar monthly climatology.

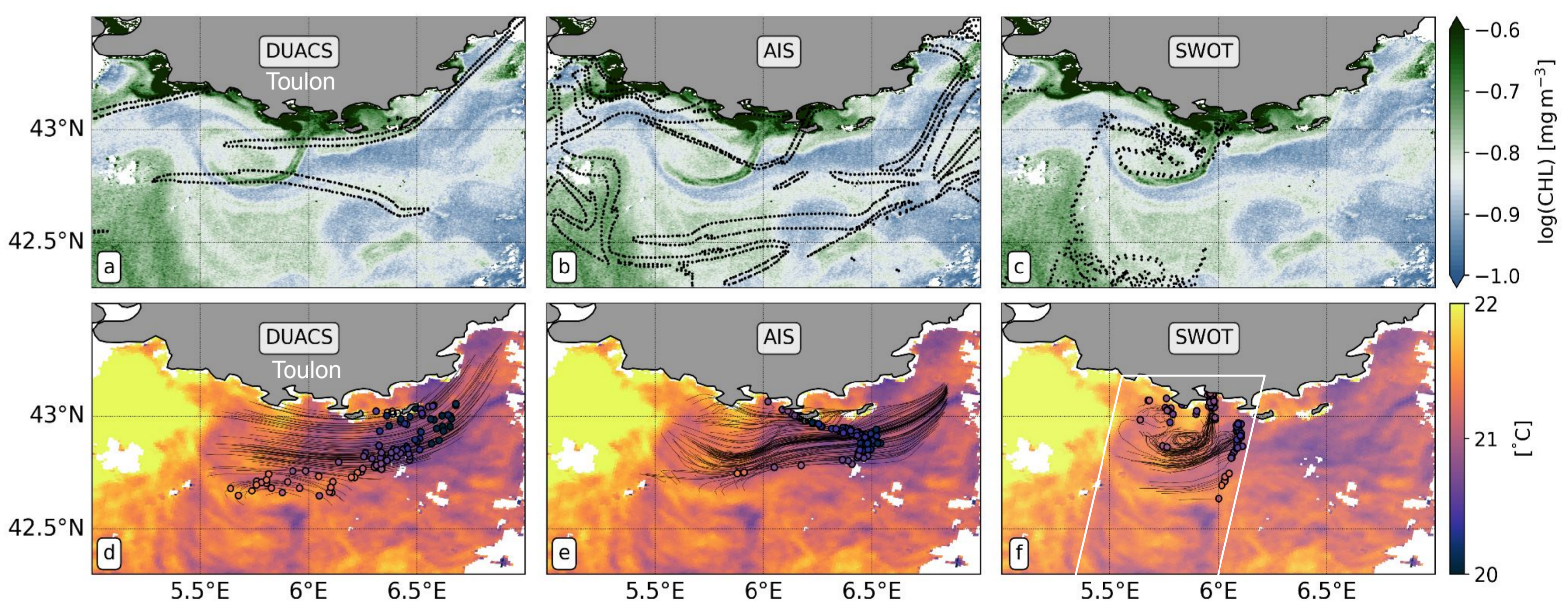
**Figure 4 :** Time series of velocity at JULIO mooring



- Best correlation between JULIO and SWOT
- More detailed structures represented in AIS and SWOT
- Difference between AIS and JULIO linked to relative depth difference (5 m vs 11 m) : Ekman Spirale



**Figure 6 :** Snapshots of vorticity and SST for 5 June 2023



**Figure 7 :** Upper panels : Chlorophyll for 5 June 2023, in background colors. One FTLE contour in dashed line for : DUACS (a) (15 days- 0.22/day), AIS (b) (7 days, 0.22/day) and SWOT (c) (5 days, 0.50/day) . Lower panels : SST for 5 June 2023 in background. Backward trajectories of particles randomly set in the eddy core and the associated SST for 2 June 2023.

- Finescale structure visible in AIS, SWOT and Chl : not in DUACS
- Excellent agreement between SWOT and Chl (4 hours of lag between SWOT and Sentinel 3)
- Backtracking SST showing the origin of the colder (20°C) water masses
- Chl enriched filament stirred from the coast
- AIS and SWOT able to capture submesoscale coastal dynamics

## V- Conclusion and Perspectives

- Good agreement between AIS and HF radar
- SWOT is able to reproduce small variations visible in the in situ data (JULIO)
- Spectral analysis highlight the capacity of AIS and SWOT to reconstruct small structures (<20 km)
- A case study of a finescale event visible in AIS and SWOT but not in DUACS
- Signature of this submesoscale anticyclone (25 km of radius) in SST and Chl
- SWOT allows us to study the origin of this coastal finescale event

**To go further :** Studying the recurrence of this kind of events thanks to AIS one year time series