Combined use of glider, radar and altimetry data
to study a coastal current in the Western Mediterranean Sea

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G-AltiKa: summary

- This multi-platform study is focused on the surface currents in the coastal area of Ibiza (Figure 1).
- **G-AltiKa** mission took place from 1 to 5 August 2014 in the eastern part of the Ibiza Channel (Figure 2).
- Data were acquired through HF radar, satellite altimetry and glider.
- Glider + high-resolution altimetry data showed a 20-30 km width coastal current with velocities above 25 cm s^{-1}.

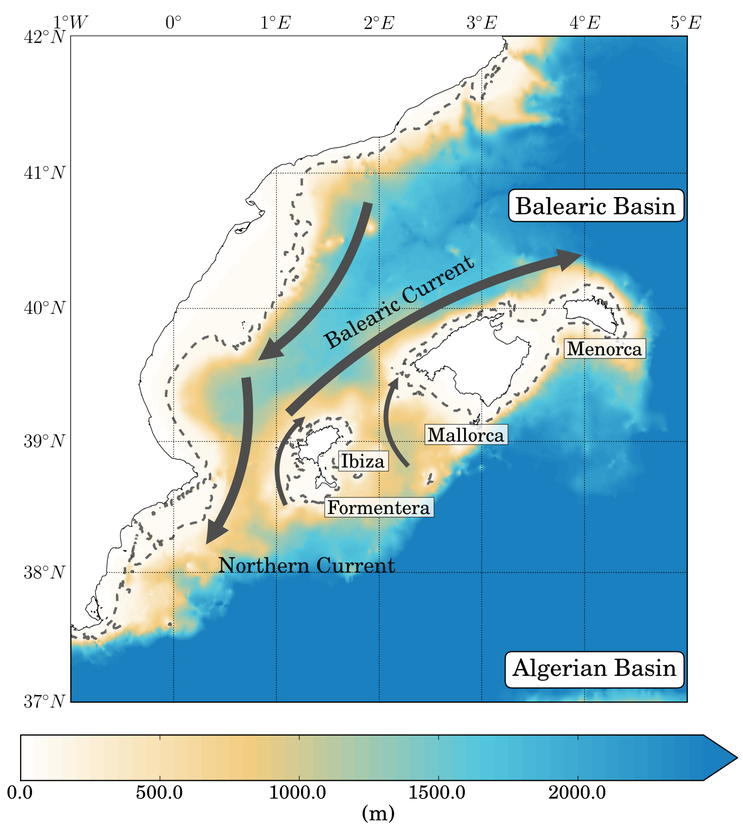

Figure 1 : Bathymetry and main currents of the region of interest.

Data

Satellite altimetry: observation of mesoscale processes
Glider: high-resolution, sub-surface measurements
Altimeter + glider: improved description of the dynamics
High-frequency (HF) radar: time evolution of the surface circulation with approx. 6 km resolution

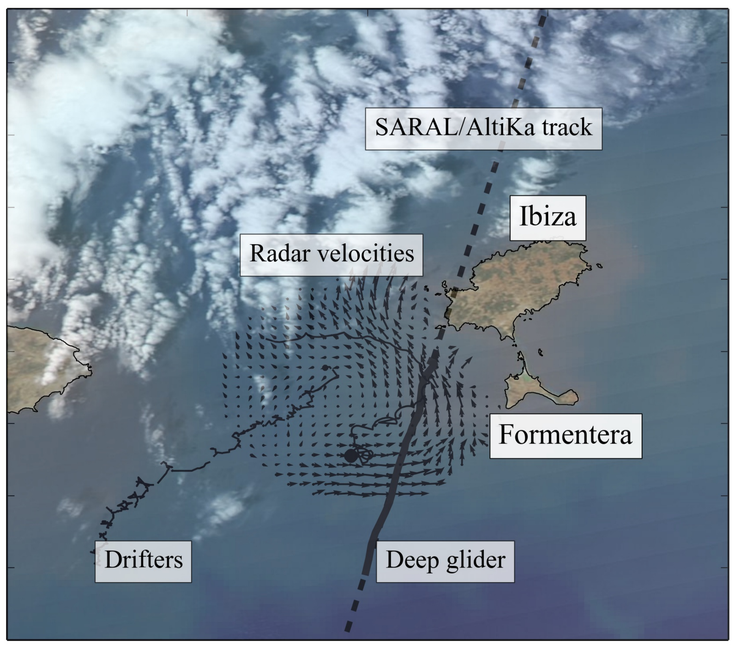

Figure 2 : HF Radar, glider and altimetry data locations in the eastern part of the Ibiza Channel.

Data pre-processing

1. **Dynamic height (DH)** :
   - Integration of density from glider T and S.
   - Reference levels: between 300 and 900 m, weak sensitivity.
2. **Absolute Dynamic Topography (ADT)** :

$$ADT = MDT + SLA$$

3. **Spatial interpolation on the 40 Hz satellite track** :
   - Bilinear interpolation of MDT, glider DH, HF radar velocities.
4. **Signal filtering** :
   - Sinc filter with Blackman window.
   - Cut-off: 30 hours for HF radar,
     14 km for altimetry and glider data.
5. **Geostrophic velocity computation** :
   - Spatial derivative along-track.
   - No additional filtering.
6. **Correction to glider velocities** , using the difference between
   - the relative depth-averaged geostrophic currents (computed from DH)
   - the absolute DAV (computed from glider GPS, Figure 4).

Results

High resolution: $<$ 1 km in coastal area.
Depth-averaged velocity: difference between expected and real surfacing locations (Figure 4).

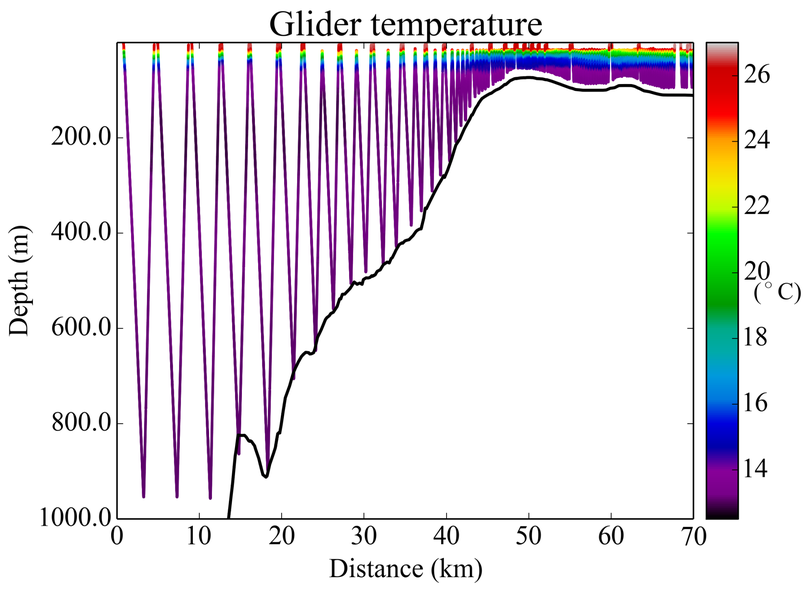

Figure 3 : Temperature measurements along the glider track.

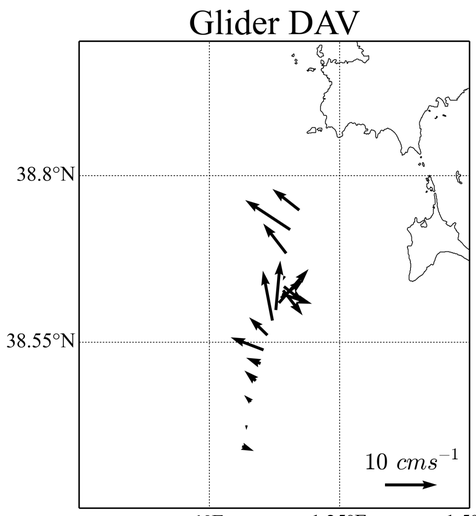

Figure 4 : Depth-averaged velocity (DAV): the glider estimates the current experienced since its last surfacing from the difference between both estimated (dead reckoned position from heading and velocity) and its current actual location from GPS.

Along-track ADT and DH:

1. Raw 40 Hz too noisy to derive velocity.
2. Low gradients along the satellite track.
3. Spatial shift ($\approx$ 5 km) between glider and filtered 40 Hz signals.
4. Agreement in coastal zone.

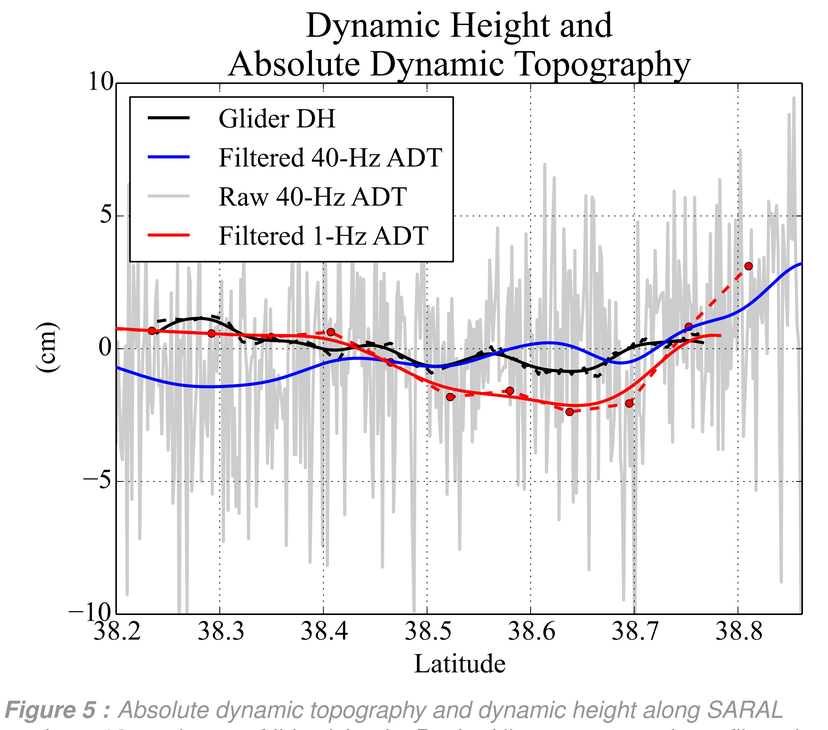

Figure 5 : Absolute dynamic topography and dynamic height along SARAL track no. 16 southwest of Ibiza islands. Dashed lines represent the unfiltered glider DH and 1 Hz ADT signals.

Time variability shown by HF radar:
5-km shift: different times of measurement
Plausible assumption considering HF radar

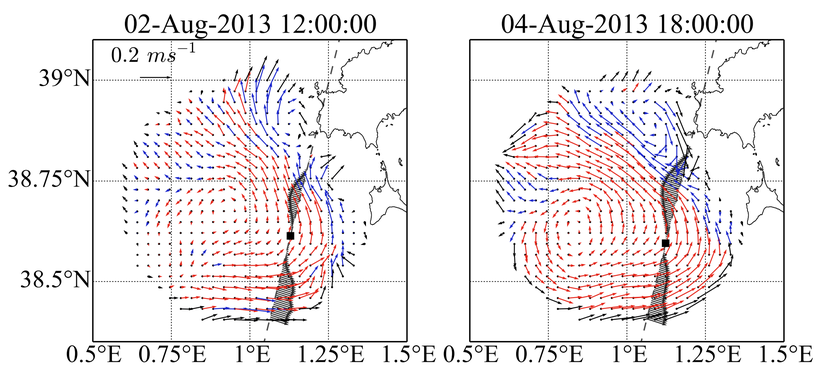

Figure 6 : HF Radar velocities on August 2, 12:00 and August 4, 18:00. Red (blue) indicates positive (negative) vorticity. Black arrows represent the velocity component perpendicular to SARAL/AltiKa track (dashed line). Black squares indicate the location where the velocity changes its direction with respect to the satellite track.

Comparison

HF radar and the 1 Hz data:
→ cyclonic circulation,
→ maximal velocity: 1 Hz data: 32 cm s^{-1}, HF radar: 21 cm s^{-1}.
40 Hz and glider data:
→ dominant westward current,
→ width of the coastal jet $\approx$ 30 km,
→ maximal velocity $>$ 30 cm s^{-1}.

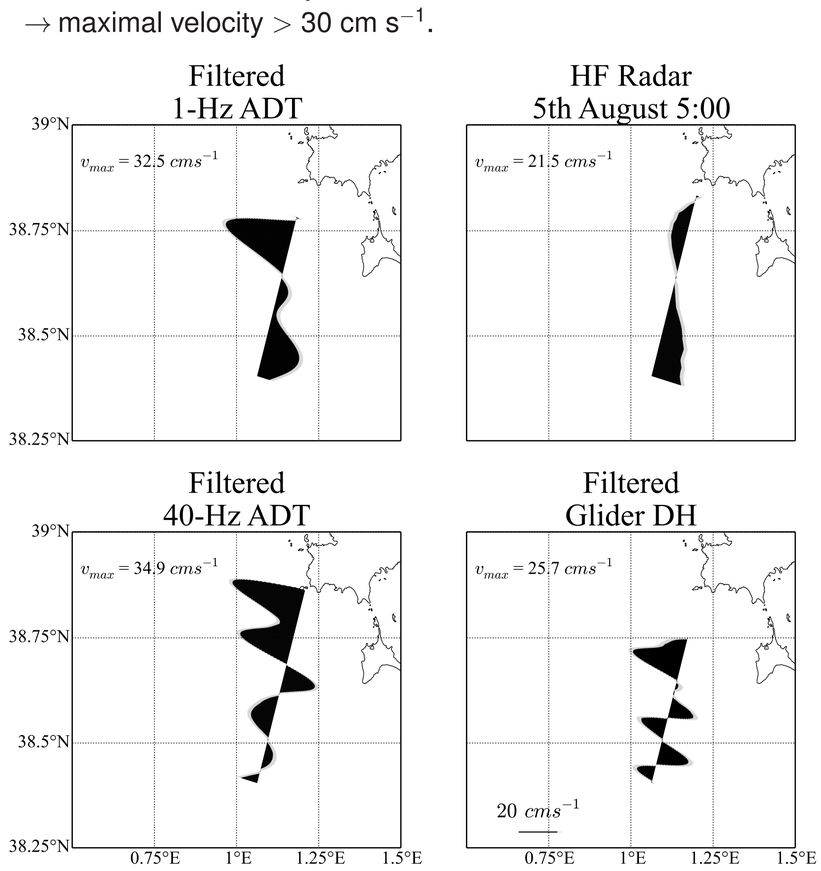

Figure 7 : Cross-track velocities obtained by HF radar and by geostrophy for filtered 1 Hz, 40 Hz and glider data.

Statistics on the section of the track covered by the HF radar, the glider and SARAL/AltiKa altimeter (41.3 km)

Table 1 : RMS difference and correlation between the glider and the 40 Hz velocities.

	RMS (cm s^{-1})	Correlation (%)
Without shift	15.21	3.68
With km shift	9.72	63.67

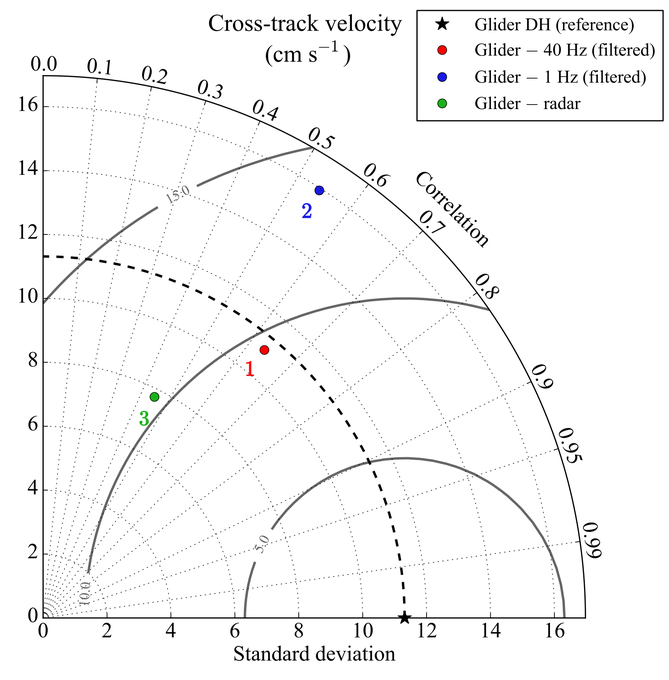

Figure 8 : Taylor diagram for cross-track velocities obtained with the different platforms.

Best agreement between the glider and the 40 Hz data.

Conclusions

- Multi-platform approach to respond to new challenges in the coastal oceanography (Figure 2),
- Processing of glider, HF radar and altimetry data in order to compare them (Figure 6).
- North-westward coastal current $<$20 km off Ibiza; intensity $>$20 cm s^{-1} (Figure 7).
- 5 km shift due to lack of sinopticity, confirmed by HF radar (Figure 6).

Acknowledgements

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