Synergies between Sentinel-3A altimetry and in-situ multi-platform observations in the western Mediterranean

Antonio Sánchez-Román[1], Ananda Pascual[1], Emma Heslop[2], Krissy Reeve[2], Daniel Rodríguez[2], Yannice Faugère[3], Sophie Coustance[3], Marc Torner[2] and Joaquín Tintoré[1,2]

(1) IMEDEA (CSIC-UIB), Balearic Islands. Spain
(2) SOCIB, Balearic Islands. Spain
(3) CLS, Toulouse. France

Corresponding author: asanchez@imedea.uib-csic.es

ABSTRACT

In the frame of the Copernicus Marine Environment Monitoring Service (CMEMS) Sea Level Thematic Assembly Center (SL-TAC), a glider mission was undertaken between May and June 2016 contemporaneous with and along the same track as the overpass of the Sentinel-3A satellite in the Southern Mallorca region. In addition a one-day ship mission on May 30, synchronous with the overpass of the satellite, captured two transects of moving vessel ADCP.

The aim was to compare the along track altimeter products and multi-platform in-situ observations, and in particular to explore the potential of the Synthetic Aperture Radar Mode (SARM) instrumentation of Sentinel-3. The ultimate goal is to contribute to a more complete understanding of physical ocean processes and biogeochemical impacts.

MULTI-PLATFORM EXPERIMENT

SENTINEL-3A satellite mission

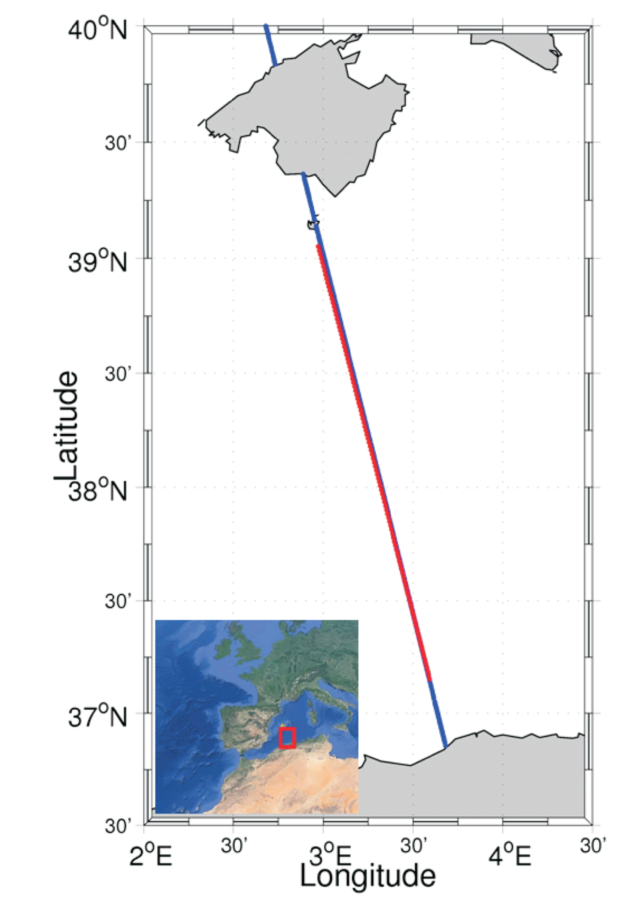
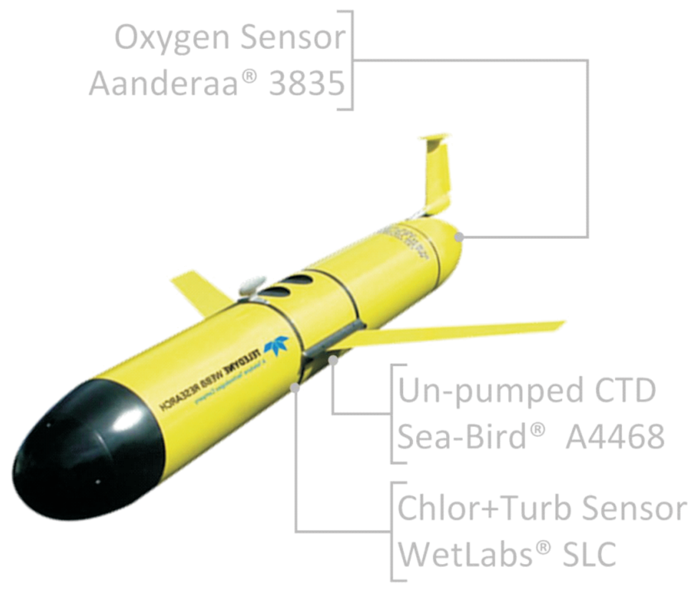


Figure 1.Sentinel-3A #713 track (blue line) overpassing Mallorca Island and the Algerian coast. Red line shows the glider track along the same path.

- **Satellite Over-flight Date: 30 May 2016 at 21:00, utc.**
- **Orbital Context: Cycle 0004 – Trace 0713**
- **Exact Over-flight Glider Location :**

  [38.6695°N, 3.1075°E] 30 May 2016 at 20:10utc

GLIDER mission



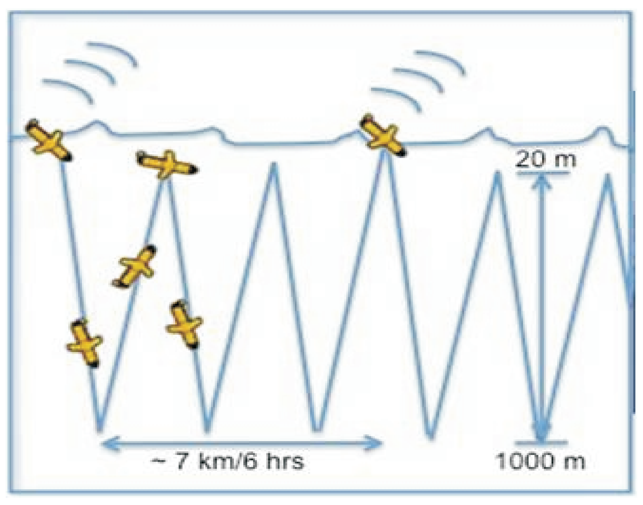


Figure 2.Glider SLOCUM-G1 used in the experiment (left panel) and operating scheme (right panel).

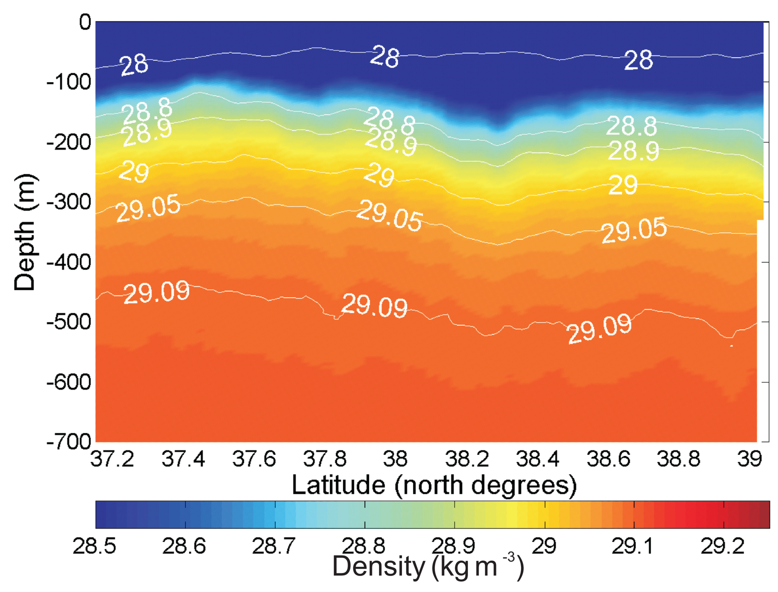


Figure 3. Density field computed from the glider data.

- **2 transects in the Algerian Basin along S-3A track #713**
- **Time Period: 25 May 2016 to 17 June 2016**
- **Navigated Km/NM: 600/324**
- **Profiles: 876 (CTD), 439 (OXY), 439 (CHL-TURB)**
- **Free Public Data available at www.socib.es**

<u>TECHNICAL SPECIFICATIONS</u>

- **AUV (Autonomous Underwater Vehicle):Electric Glider**
- **Manufacturer/Model: SLOCUM-G1**
- **Max. Operative Depth : 1000 meters**
- **Scientific Sensors: CTD, Oxygen, Chlor/Turb**

ADCP mission

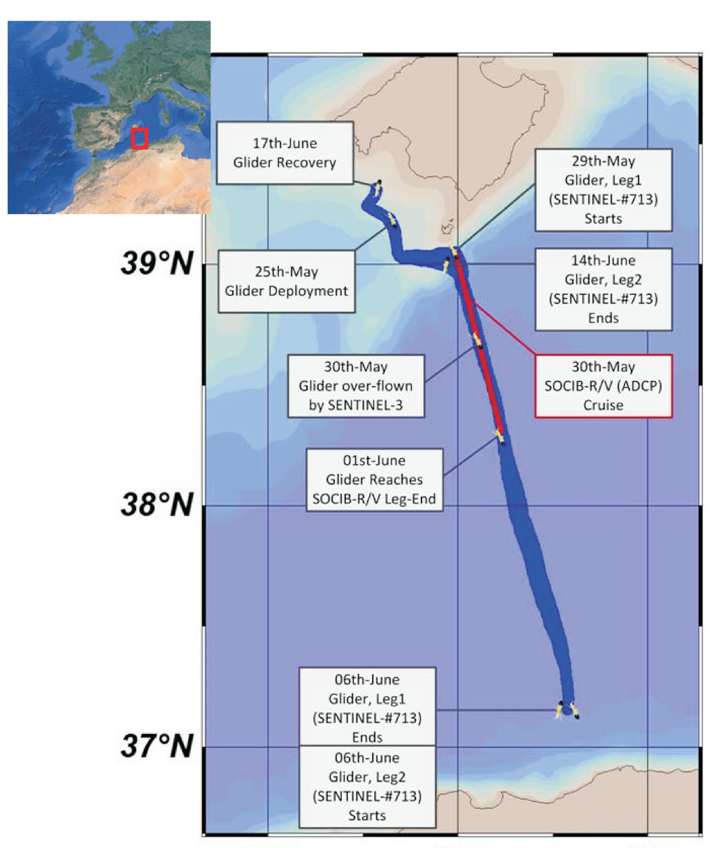


Figure 5.Glider path (blue line) between Mallorca Island and the Algerian coast. Red line shows the ADCP track contemporaneous with the overpass of the satellite.

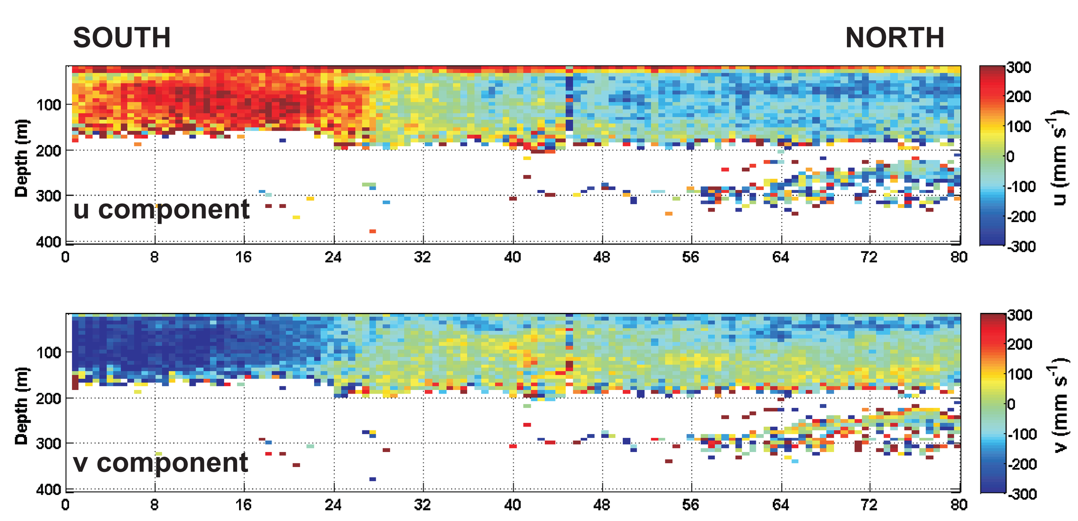


Figure 4. ADCP velocity field along the Sentinel-3A path.

- **A 16 hour mission on 30 May 2016**
- **2 ADCP transects along the same track and contemporaneous with the overpass of the satellite**
- **At the same time as a glider mission**

<u>TECHNICAL SPECIFICATIONS</u>

- **150 kHz, RDI Ocean Surveyor, VM-ADCP**
- **Transducer depth = 2 m / Blank distance = 8 m**
- **Bin thickness = 8 m / Number of Bins = 50**
- **Max range for bottom tracking = 400 m**

RESULTS

Dynamic Height and Absolute Dynamic Topography

Temperature and salinity fields from glider data are used to estimate the Dynamic Hight (DH) at 20 m depth with respect to a reference level of 900 m. This data is compared with the Absolute Dynamic topography (ADT) computed from altimetry. A Loess filter was previously applied to remove the measurement noise. This filter performs a local regression using weighted linear least squares and a second degree polynomial model. A sensitivity test was performed to choice the more suitable filter cut-off window used to construct the smoothed ADT and DH. Results showed that a reasonable smoothing can be obtained by using a filtering scale of 55 km (see Figure 6). Moreover, since the reference level used to compute DH does not match with the reference used in the altimetry data (geoid), ADT and DH datasets have been normalized before the comparison by subtracting the mean value of each transect.

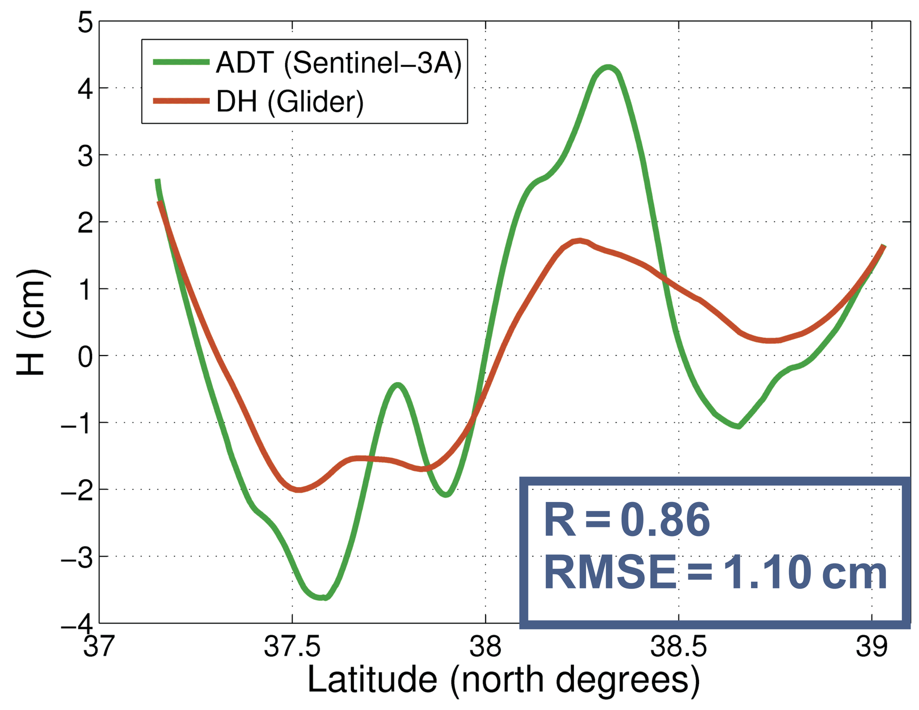


Figure 6. ADT (geen line) from Altimetry and DH (brown line) derived from glider data. Notice that the mean value of the DH and ADT has been removed for comparison purposes.

Surface geostrophic velocity

The smoothed ADT was subsequently used to compute absolute geostrophic velocities along the satellite track. We computed the component of the geostrophic current perpendicular to the track by applying central finite differences in the interior and first differences at the boundaries of the smoothed ADT data. This geostrophic velocity was compared with velocites recovered from the glider and ADCP.

Glider velocity collected along the transect 1 (30 May to 6 June 2016) was used to compute geostrophic currents at 20 m depth perpendicular to the glider track. The glider geostrophic velocity uses a reference velocity for the geostrophic calculation derived from the Depth Average Velocity (DAV) variable, which is calculated by the glider for each dive segment (see Bouffard et al., 2010). DAV is an estimation of the average current speed for each segment of the glider trajectory and is corrected post mission for errors in the internal compass heading. Then, a Loess filter with a filtering scale of 55 km was applied.

ADCP velocity at 16 m depth recovered along the ADCP transects (conducted on 30 May between 08:55h - 12:58h and 13:16h - 17:37h) were also used to compare with geostrophic velocities from altimetry (Figure 7). Here, however, the Loess filter was not applied due to the high quality of this dataset.

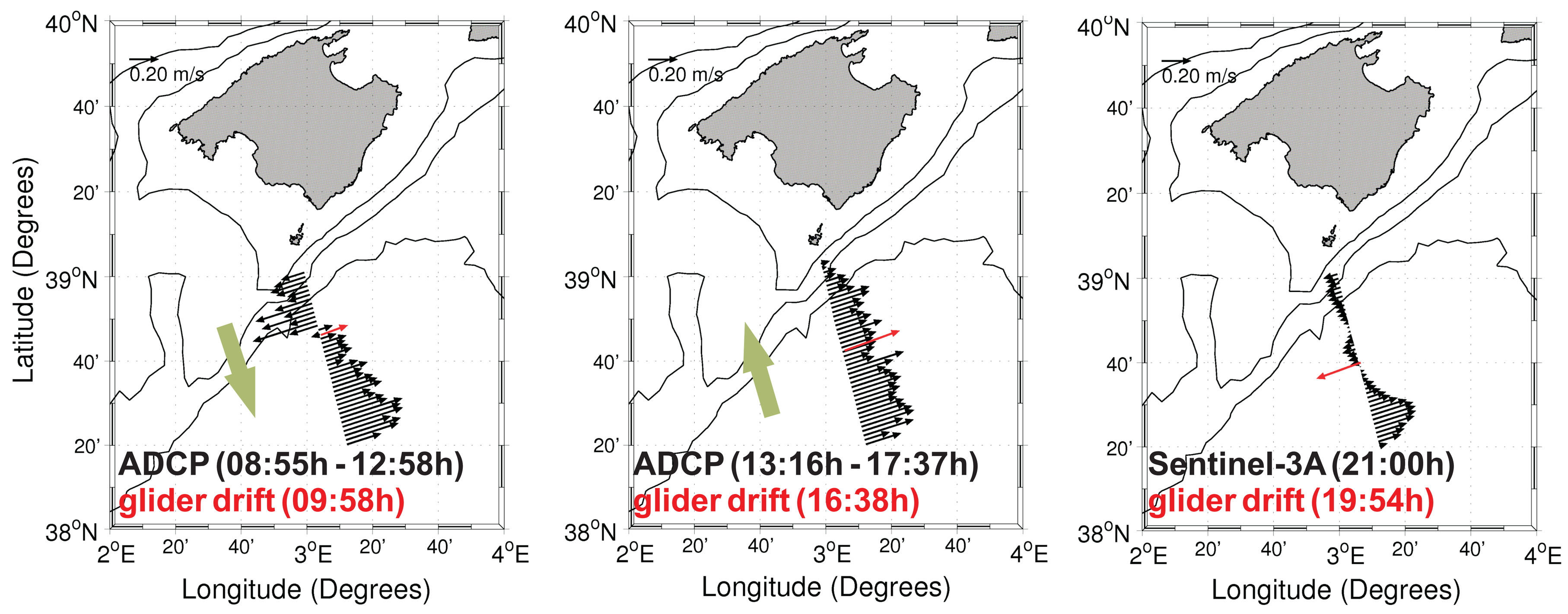


Figure 7. Left panel: ADCP velocity at 16 m depth perpendicular to the ADCP transect 1. Panel in the middle: the same than panel on the left but for transect 2. Right panel: geostrophic velocity from Altimetry perpendicular to the satellite track derived from the smoothed ADT. Red arrows denote surface drift velocities derived from glider data.

SUMMARY AND CONCLUSIONS

1- A multi-platform experiment has been successfully conducted in summer 2016 in the Western Mediterranean Sea to compare the along-track Sentinel-3A altimeter product and in-situ Glider and ADCP observations. Preliminary results are presented here.

2- ADT from Altimetry and DH derived from glider data exhibit a quite similar spatial pattern with a correlation coeficient of 0.86 and a RMSE of 1.10 cm.

3- This fact promotes a good agreement between the geostrophic velocities computed from Altimetry and glider velocities with a correlation coeficient between both datasets of 0.67 and a RMSE of 11 cm/s (see Pascual et al, 2015 and Troupin et al., 2015).

4- Surface velocities from ADCP data exhibit an opposite pattern than geostrophic velocities computed from Altimetry in the northern part of the transect. This fact might be related to the presence of surface inertial currents nearby the Mallorca Island which are not captured by Altimetry. The change of direction in the gliders' drift velocity seems to be associated with the change in the wind direction.

ACKNOWLEDGMENTS

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