Strong improvements have been made in our knowledge of the surface ocean geostrophic circulation thanks to satellite observations. However, the synergy of different sources of observation (satellite and in-situ) is mandatory in order to go toward higher resolution. In this study, we combined altimetric along track Sea Level Anomalies (SLA) with geostrophic velocity estimated from surface drifters in order to map SLA and associated geostrophic current anomalies in the Gulf of Mexico.

First, an important work is done to pre-process drifter data to extract the geostrophic component of the signal in order to be consistent with physical content of altimetry. This step include estimate and remove of Ekman current, Stokes drift and wind slippage. Two kind of drifters are used:

- Drifters from the HMI Company are processed from 2014 to 2016 (this company, part of CLS group, launches their own drifter in the Gulf of Mexico for their downstream services).

- The drifters launched in the framework of the Lagrangian Submesoscale Experiment (LASER) campaign (January-April 2015) are also processed and used for independent validation.

Second, drifters and along track SLA from Jason2, HY2, SARal and C2 are combined through multivariate objective analysis to map a time series of SLA and associated geostrophic current anomalies. Finally, comparisons with independent data set show the better agreement of maps merging both altitude and drifters especially for the meridional component of geostrophic current.

### Method: Merging altimetry and drifters to compute SLA and associated geostrophic current maps

We use a Multivariate objective analysis (Rio et al., 2014) to map SLA and associated anomalies of geostrophic current in the Gulf of Mexico from observation of:

- Along track SLA
- Anomalies of geostrophic current (u', v') estimated from drifters

The differences with the classical monovariate objective analysis using altimetric data only can reach locally 10 cm (Figure 6).

### Validation of a long time series (h2,j2,al + drifters)

To have independent dataset to validate the long time series, we first compute daily maps without using c2 from 01/09/2015 to 30/04/2016. We have 2 time series of maps:

- Merged maps using 3 altimetric dataset (h2,j2) and al and drifters from HMI
- Reference maps from altimetry only (h2,j2) and al

Validation results (Table 1), Validation Table 2 and Table 3 show:

- Merged and reference maps have similar performances in comparison with zonal geostrophic velocities estimated from LASER drifters (Table 1);
- Merged maps improved significantly meridional component (Table 1) because the zonal component is already well resolved using altimetric tracks mainly oriented north/south;
- Statistical results are relevant since statistics of along track velocities from c2 and zonal velocities from LASER drifters are similar (Table 1 and Table 3);
- Merged maps (alti-drifters) and reference maps (alti only) have similar performances in comparison with Table 2 and Table 3;

### Computation of the best estimate (h2,j2,al,C2 + drifters): demonstration dataset

- Description of the dataset:
  - Time period: daily maps from 01/09/2015 to 30/04/2016
  - Area: Gulf of Mexico
  - Upstream: drifters from HMI (processed to extract anomalies of geostrophic current)
  - Altimetric along track SLA from Jason2, AltiKA, HY2 and Cryosat 2

Output variables: SLA, zonal and meridional anomalies of geostrophic current

### Quality of the dataset:

Table 4 shows that:

- Statistics are improved compared with Table 1 (without C2)
- The estimate from alti-drifters gives better results than alti only mainly for the meridional component.

Table 4: statistics of comparison against LASER drifters over 1/1/2016 to 31/4/2016 (U = zonal component, V = meridional component)

<table>
<thead>
<tr>
<th></th>
<th>Alt only</th>
<th>Alti + Drifters</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSD U (cm/s)</td>
<td>14.69/14.57</td>
<td>14.67/14.68</td>
</tr>
<tr>
<td>RMSD U/V (RMS SLA-C2)</td>
<td>75/77</td>
<td>75/77</td>
</tr>
<tr>
<td>Corr U/Cov</td>
<td>0.62/0.77</td>
<td>0.61/0.80</td>
</tr>
</tbody>
</table>

### References:


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Available in November 2017 as demonstration dataset on AVISO (www.aviso.altimetry.fr)