Model velocities assesment and HF radar data assimilation in the Ibiza Channel

Jaime Hernandez Lasheras[1] (jhernandez@socib.es) , Baptiste Mourre[1], Emma Reyes[1], Julien Marmain[3], Alejandro Orfila[2], Joaquín Tintoré[1,2]

[1]SOCIB, Balearic Islands Coastal Observing and Forecasting System, Palma de Mallorca, Spain. [2]IMEDEA (CSIC-UIB), Esporles, Spain. [3]Degreane Horizon company, Toulon, France

1 Motivation

High Frequency radars (HFR) provide continuous and high-resolution surface current measurements in coastal areas, allowing to better understand surface ocean dynamics and providing valuable data to improve numerical model predictions through data assimilation. Since 2012, **SOCIB** operates two coastal HFR antennas with the purpose of monitoring the surface currents in the **Ibiza Channel** (Western Mediterranean Sea).

In this work, we perform the first steps to evaluate the potential of Ibiza Channel HF radar data to improve the WMOP model circulation after data assimilation. The realism of model velocities in terms of mean field and EOF modes is first evaluated to verify the capacity of the model to represent the processes of interest in the area. Then, a single experiment of HF radar data assimilation is presented.

2 Model and data assimilation system

1 WMOP model

- Regional configuration of the ROMS model, hindcast 2009-2015
- Horizontal resolution: ~2km (1/50º), 32 σ-levels
- Initial & Boundary conditions: CMEMS MED-MFC (1/16º)
- Atmospheric forcing: AEMET Hirlam (1/3h,5km)
- Rivers: Var, Rhône,Aude,Hérault, Ebro, Jucar

2 Ensemble Optimal Interpolation

- Ensemble anomalies sampled from three WMOP hindcast simulations (2009-2015) with different initial/boundary forcing and mixing parameters
- Anomalies selected within the same season as the analysis date after having removed the seasonal cycle

  → Multivariate, inhomogeneous and anisotropic 3-dimensional model error covariances characteristic of the mesoscale variability
- Domain localization with a 250-km radius
- 80 ensemble members

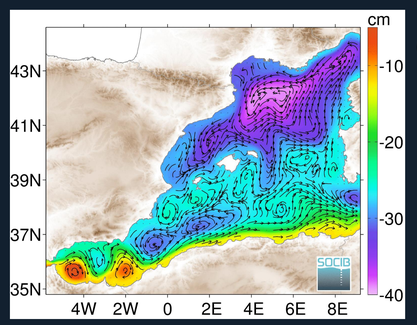


Figure: WMOP mean SSH over the period 2009-2015 and associated surface geostrophic currents

3 Observations

- **SLA:** AVISO products, mapped (1/8º) and along-track
- **SST**: 10km resolution, degraded from MUR-JPL
- **Argo:** TS profiles
- **HFR:** Ibiza Channel (3km, daily total velocities)

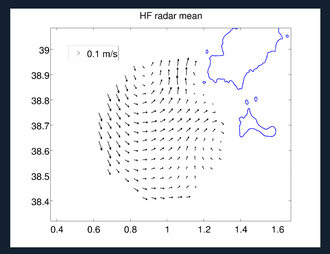
3 Assessment of model velocities

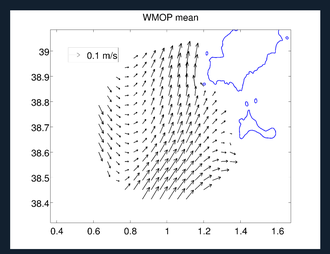
An EOF analysis of surface currents has been performed over the HFR coverage area, with the objective to evaluate the capacity of the model to capture the dominant processes, which is a prerequisite to perform a successful HFR data assimilation.

The mean current and the first two EOF modes show good agreement between HFR and WMOP in terms of spatial pattern, explained variance and seasonal cycle.

Data used: daily mean surface currents between 2012-06-01 and 2014-08-31 (HF radar reconstructed fields through Open-Boundary Modal Analysis)

Mean currents: similar overall circulation pattern. WMOP overestimates velocities in the eastern part of the HFR coverage area.





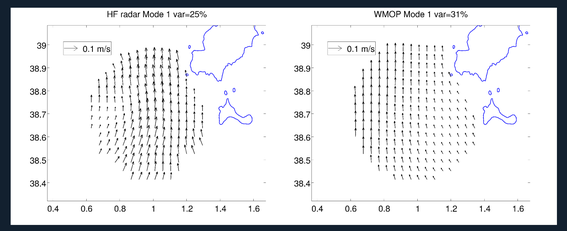
EOF Mode1:

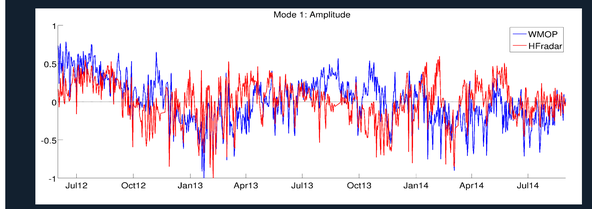
Accounts for 25% and 31% of total variance for HFR and WMOP respectively.

Represents an overall meridional flow in both cases.

Related to strong winds from storms (Lana et al 2016) and Atlantic water inflows.

Time series correlation (HFR vs WMOP) = 0.53





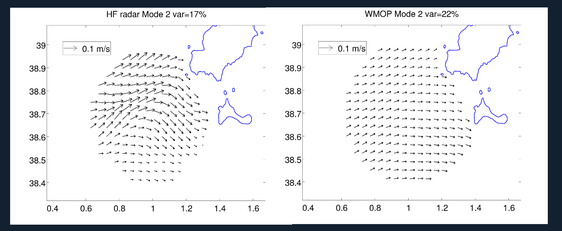
EOF Mode2:

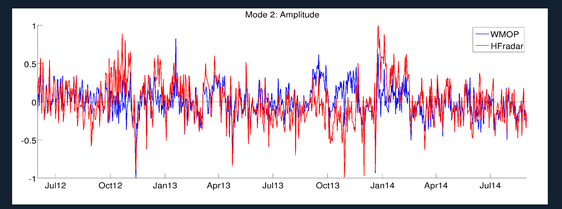
Accounts for 17% and 22% of total variance for HFR and WMOP respectively.

Represents an overall zonal flow in both cases.

Related to zonal wind events.

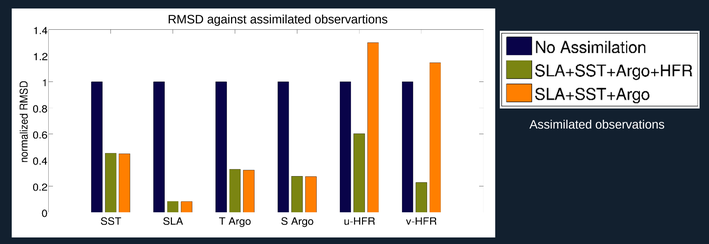
Time series correlation (HFR vs WMOP) = 0.61



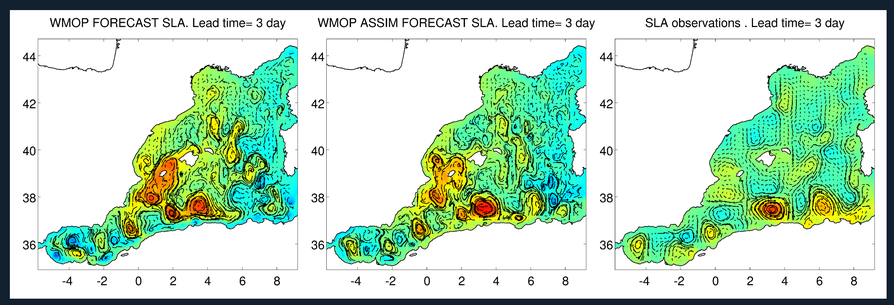


4 Data assimilation results

- Several data assimilation experiments have been performed for a given date (24 February 2016), including or not HFR data in addition to SLA, SST and Argo profiles.
- The RMSD against all type of assimilated data is systematically reduced with the assimilation.
- Radar data are properly ingested in the model, without degrading the improvement in terms of SLA, SST and TS profiles provided by the rest of the observations.



The improvement in SLA (normalized RMSD = 0.83) persists after a 3-day forecast starting from the analysis after SLA+SST+Argo+HFR assimilation.



- Improvement of model velocities in the area of the radar after data assimilation
- Improvement of temperature and salinity profiles
- Smooth transition between HFR observed area and the rest of the domain

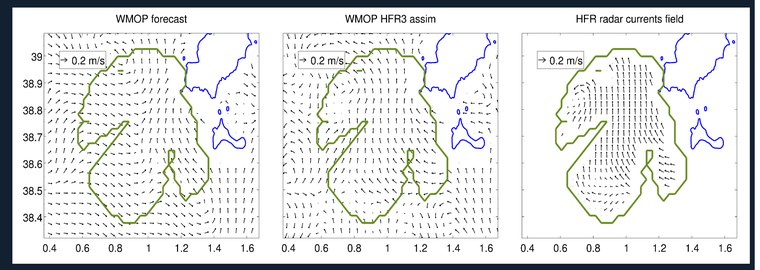


Figure: Surface currents in the HFR covearge area. WMOP Forecast (Left), WMOP ASSIM forecast from SLA+SST+Argo+HFR assimilation (center) and HFR daily mean observation (right)

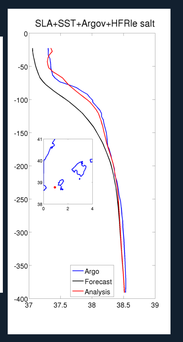


Figure: Salinity profiles in HFR coverage area

5 Conclusions and perspectives

- The main modes of surface current variability in the area covered by the radar are realistically reproduced in the model, however with a rather time series correspondence.
- The WMOP data assimilation system sucessfully ingests HFR observations.
- Further validation to be performed using independent measurements from gliders and surface drifters.

Reference: Lana, A., Marmain. J., Fernández, V., Tintoré, J., & Orfila, A. (2016). Wind influence on surface current variability in the Ibiza Channel from HF Radar. Ocean Dynamics, 66(4), 483-497….