Skill assessment of gap filling methodologies for HF-radar currents

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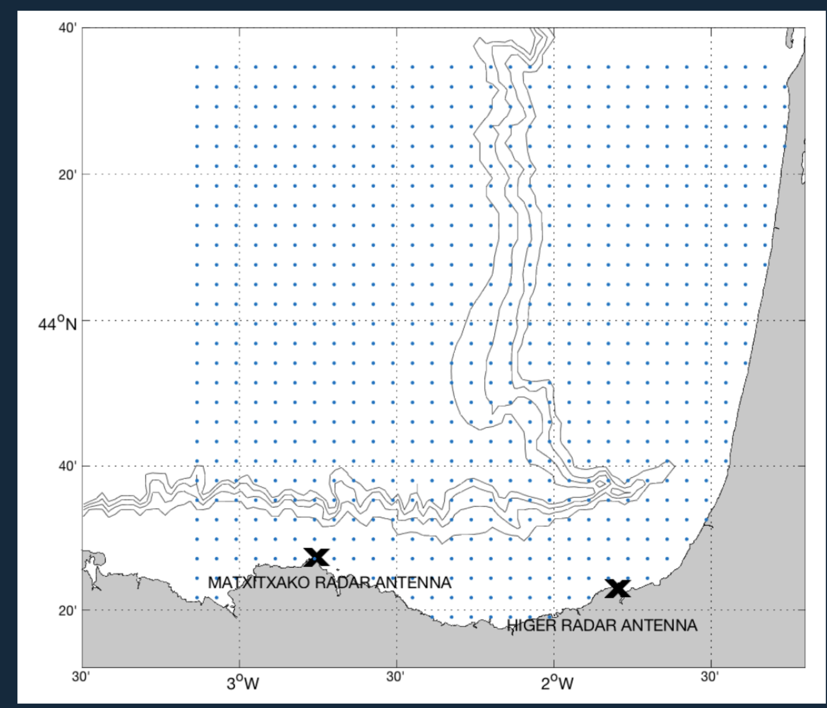
01 Abstract

Three Methods (Open-boundary Modal Analysis -OMA-; Data Interpolating Empirical Orthogonal Functions -DINEOF-, Self Organized Maps -SOM-, etc.) have been proposed to fill spatio-temporal gaps in geophysical time series.

Here we apply those techniques to fill HF-Radar data and then with a systematic experiment we quantify the error introduced by each method in the Eulerian and Lagrangian frames to provide complete sets of HFR derived currents.

02 Data and methodology



Map showing the location of the two antennas (Matxitxako and Higer) of the BoB HFR systems. Blue dots are the grid points of the total HFR velocity field.

HFR system in the SE BoB

2 SeaSonde HF radar stations

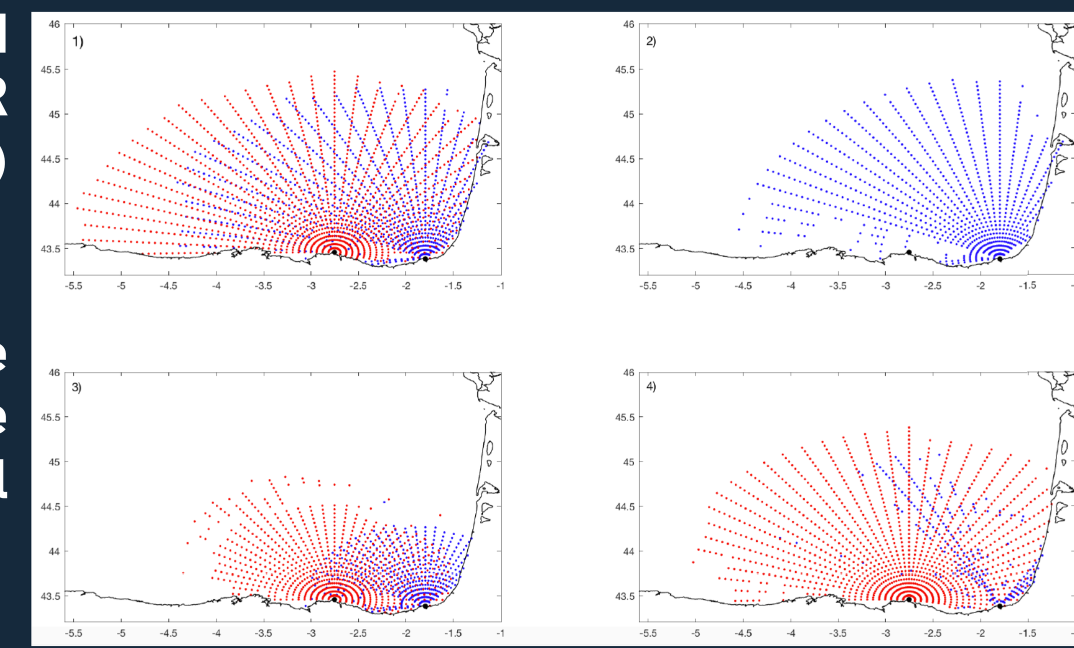
Frequency= 4.5 MHz
Bandwidth= 40 kHz
Operational since 2009
Sites location: Higer and Matxitako Capes

They are part of the Basque in situ operational oceanography observational network owned by the Directorate of Emergency Attention and Meteorology of the Basque government's Security Department.

In order to characterize the most typical and realistic gap types observed in the Basque HFR system, K-means classification algorithm (KMA) is applied to the real radial data for 2014.

Previous to applying the KMA, the radial data are converted to 1 or 0 values, depending on the availability or absence of data for each radial position, respectively.

Then KMA are used to classify the dataset into a specified number of groups according to the similarity in the distribution of gaps exhibited in the HFR data set. The selection of the number of groups was done qualitatively. In our case we choose to keep 16 groups

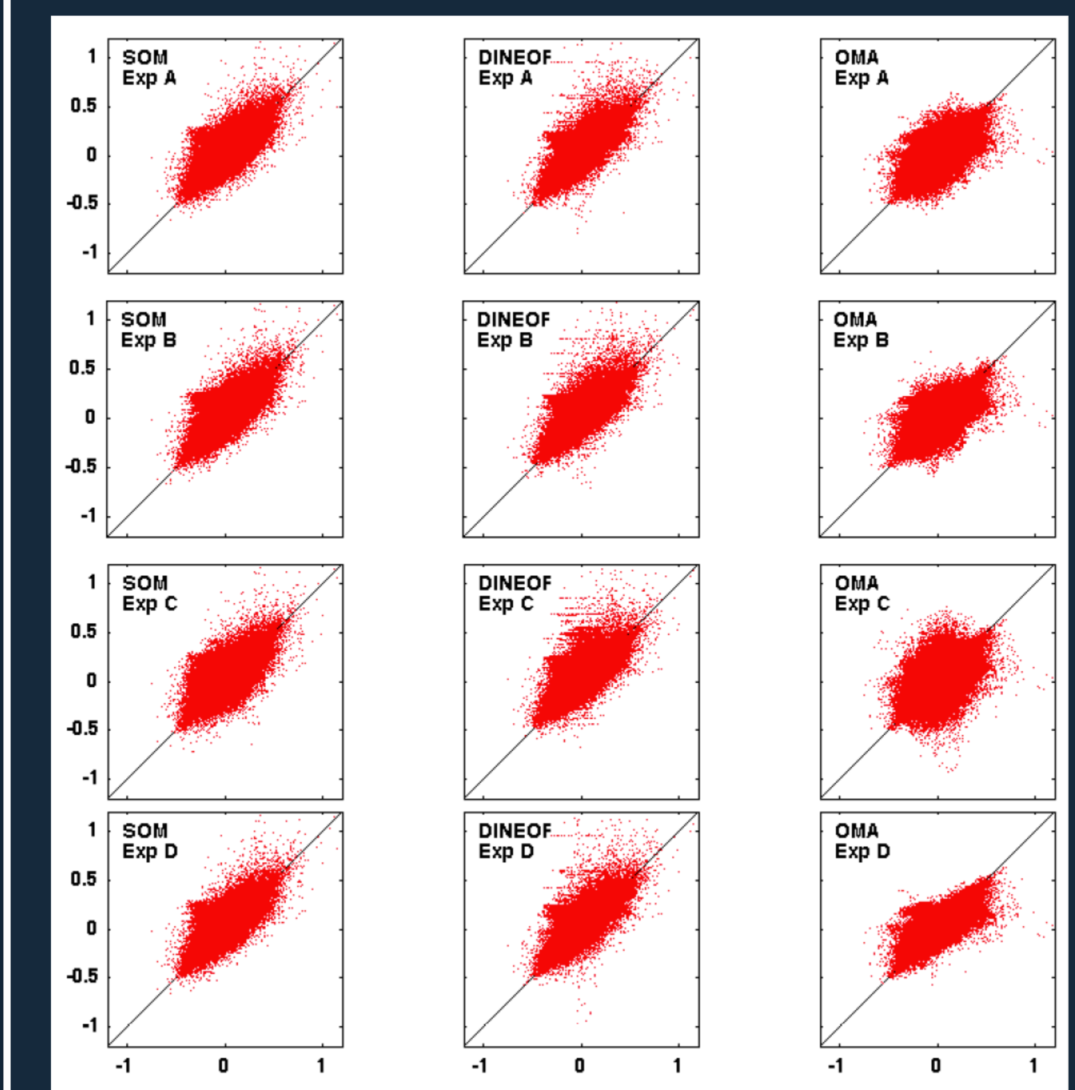


Example of the four prototypes of KMA groups of gap distribution scenarios obtained by the KMA analysis applied to HFR availability-absence matrix for 2014. (1) representing a good data coverage scenario; (2) accounting of the failure of one of the two antennas; (3) characterizing a range decrease in both antennas; (4) representing bearing coverage decreasing in one of the antennas. Matxitxako radials (red dots) and Higer radials (blue dots).

Results

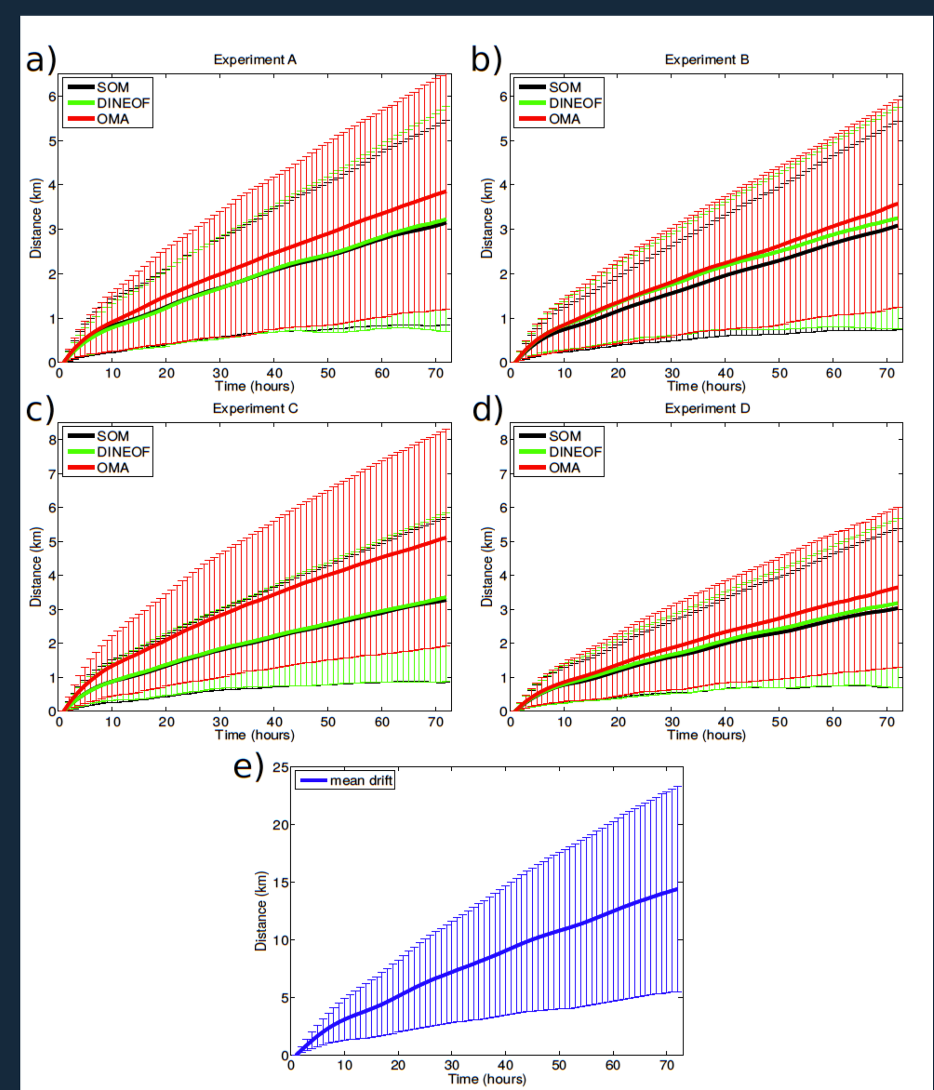
03

3.1 Eulerian Comparison



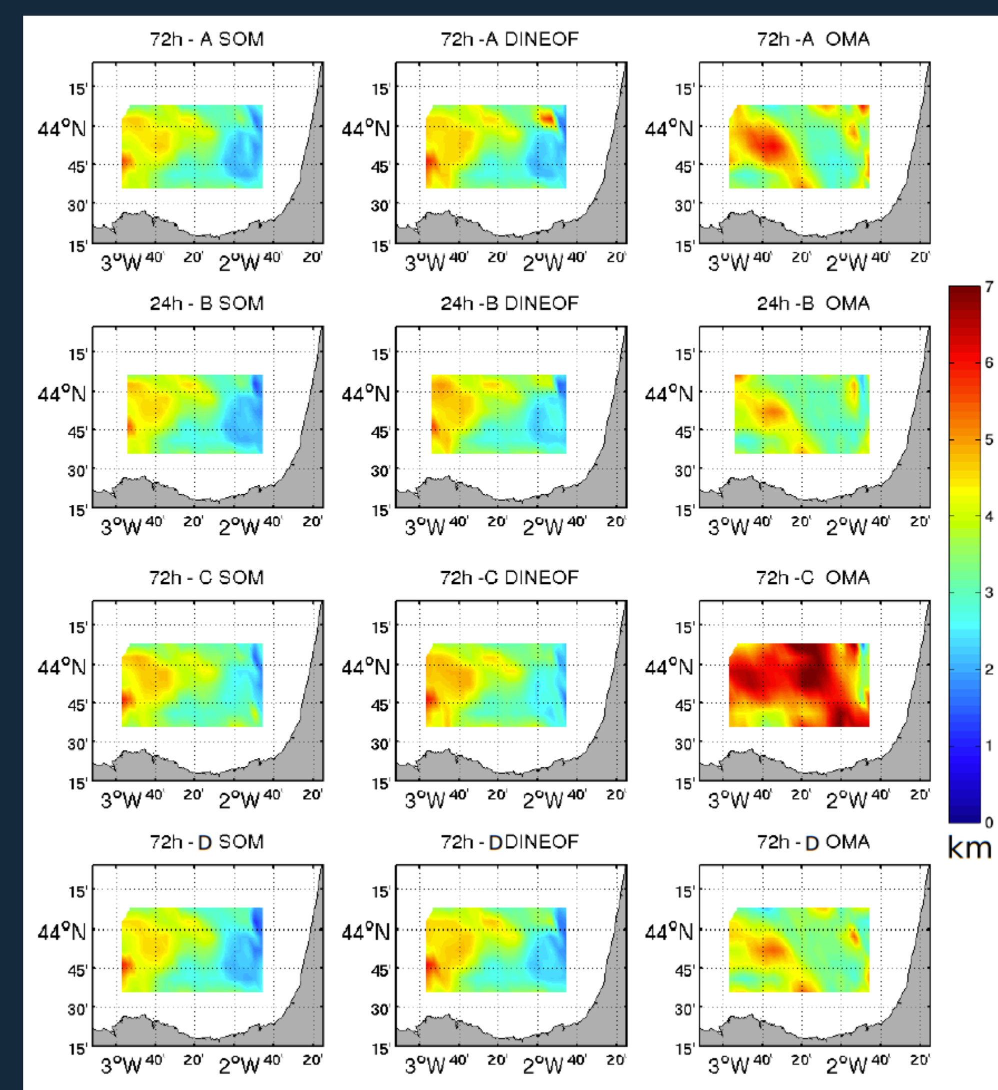
Scatter plot of the SOM model (first column), DINEOF (second column) and OMA (third column) models *vs.* observations for the 4 experiments (rows) for the meridional velocities.

3.2 Lagrangian Comparison



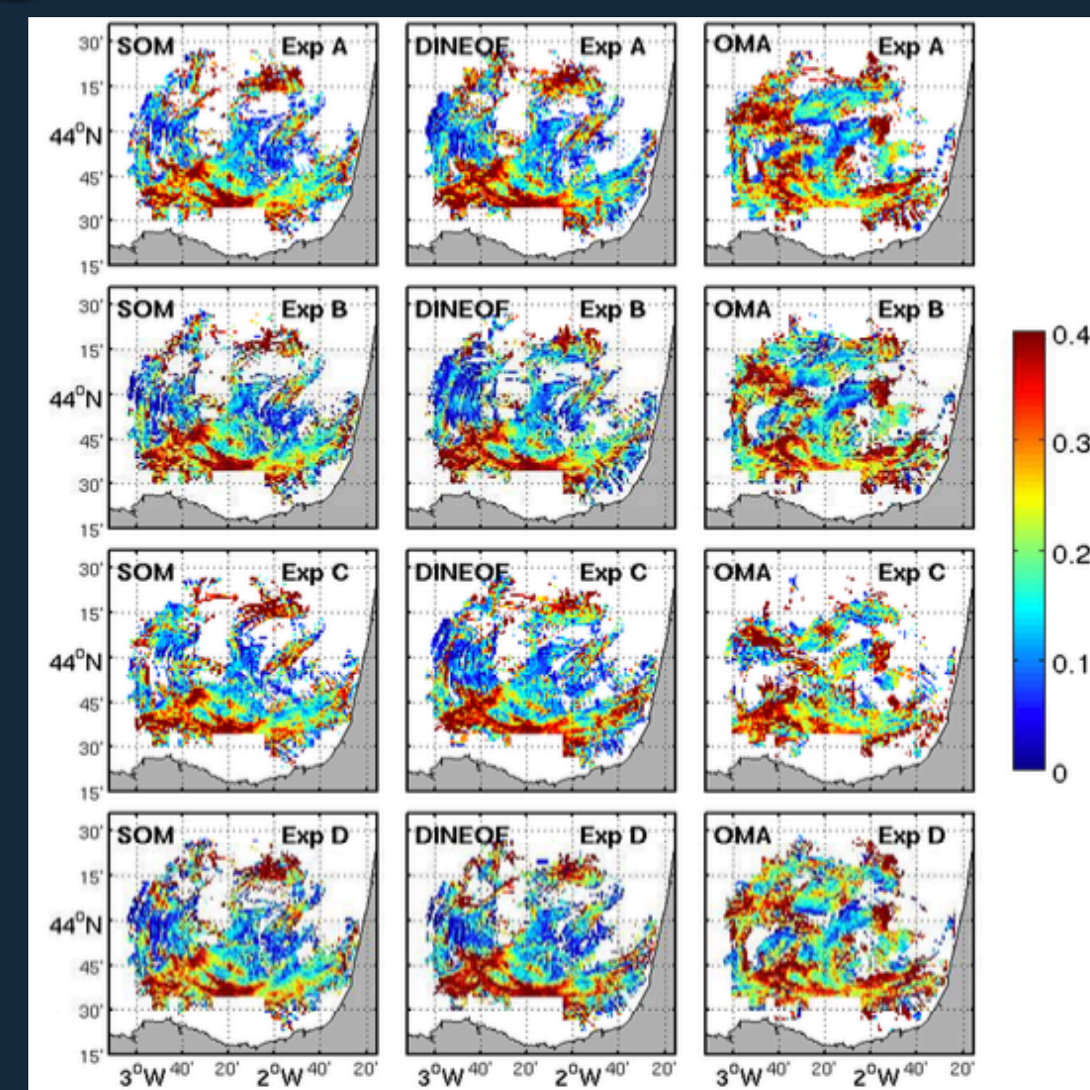
Average of the separation distance between trajectories computed from the filled HFR using the three methodologies and reference HFR velocities as a function of time.

3.3 Trajectories Separation



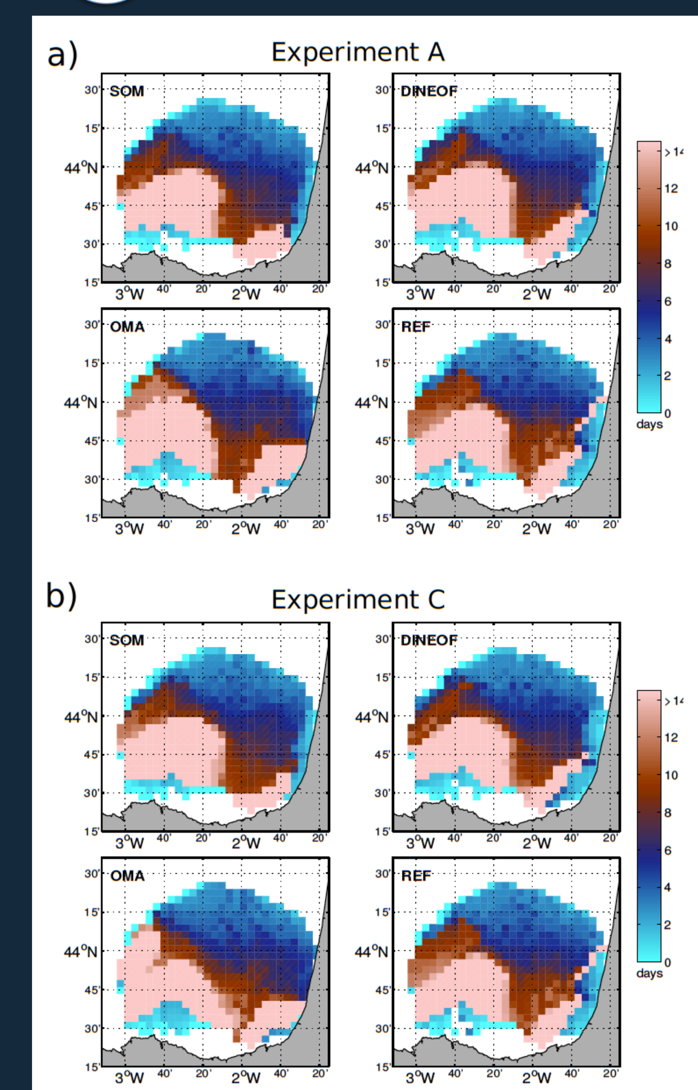
Time average of the separation distance between trajectories computed from the filled HFR using the three methodologies and reference HFR velocities initiated in the same pixel.

3.4 Time average absolute LCS error



Maps of the time average of the pixel by pixel absolute relative error of the LCS computed from the three filled with respect to LCS obtained from the reference velocity field. White color indicates points where LCS have nor been identified.

3.5 Residence Time



Snapshots of Residence Time computed from the three filled and the reference HFR for the experiment A and C at April 04, 2013 18:00.

04 Conclusions

We observed that the relative errors found for the filled velocity field with respect to the original HFR field, (up to 43%, 38% and 57% in the case of SOM, DINEOF and OMA, respectively, for the worst gap-scenario corresponding to one antenna failure) are reduced in the Lagrangian diagnosis.

The largest errors found between the four experiments and for the LCS computations are up to 22% 22% and 27% and up to 13% 13% and 16% for RT, when using SOM, DINEO and OMA reconstructed data, respectively. While DINEOF presents the lowest errors in the Eulerian comparison of the velocity field, SOM is the method with lowest errors in the trajectories, LCS and residence times computations. The four experiments based on different grouping of missing values demonstrate that even for spatially severe and persistent gaps, the LCS diagnostics obtained from the FSLE fields and the residence times applied to gap-filled high-resolution HFR surface currents are robust representations of surface dynamics in coastal basins. Our results show that even when a large number of pixels is missing the FSLEs computations still give an accurate picture of the oceanic transport properties and the velocity field filled by the three methods analyzed here are not introducing artifacts in the Lagrangian computations.).

SOCIB Balearic Islands Coastal Observing and Forecasting System

05 Acknowledgements / Contact**

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