Eddies in the Western Mediterranean

Preliminary study of altimetry tracked eddies: characterization and tracking

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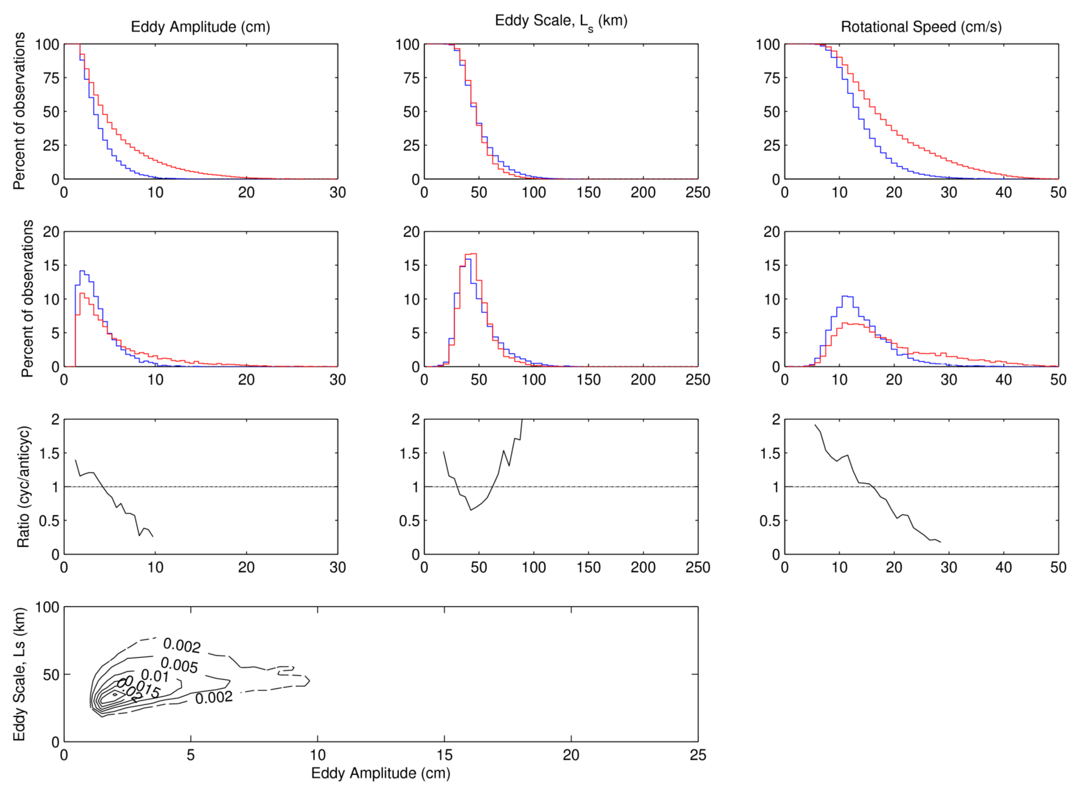
Introduction

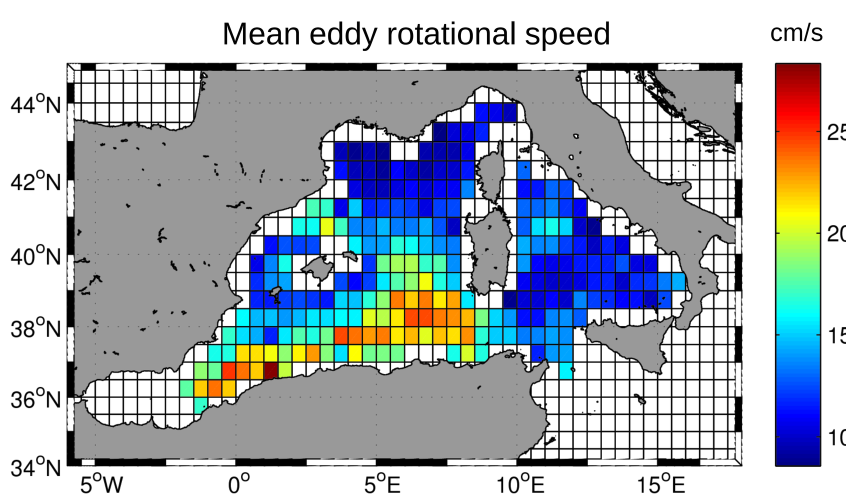
Eighteen years of weekly SLA merged maps in the Western Mediterranean are analyzed using the new method proposed by Chelton et al. (2011) to identify and track mesoscale eddies. Preliminary results confirm that eddies are smaller in radius and weaker in amplitude than in the global Ocean. The propagation speeds and direction show a wide range of values without a clear preferred direction, although there is a certain west-east dominance. The temporal evolution of the weekly number of eddies which presents a significant semi-annual periodicity, is examined.

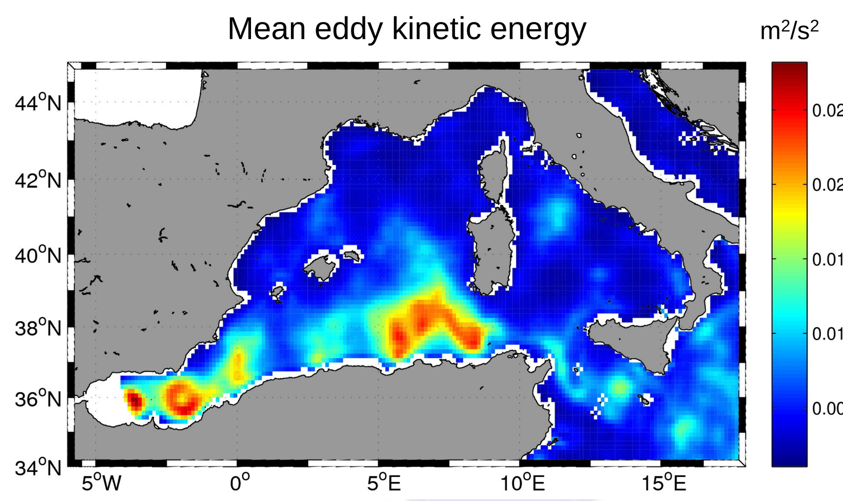
Kinematic properties

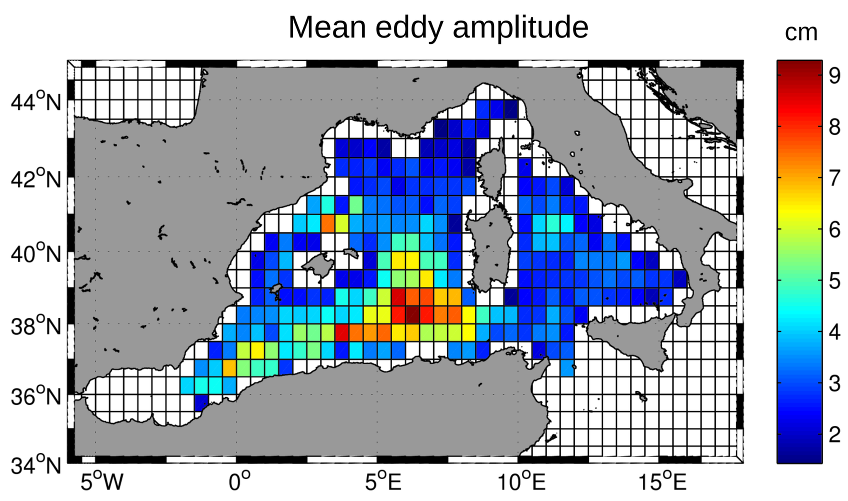


Histograms of the distribution of amplitude, scale and rotational speed of the eddies (cyclonic, blue and anticyclonic, red) found in WMED.

The scales in the Western Mediterranean Sea (hereafter called WMED) are much smaller than in the global ocean due to the correlation scales applied in the optimal interpolation performed to obtain the 2D fields. Between WMED and all Mediterranean few differences are found but they are very similar (not shown): anticyclonic eddies not only have a tendency to last longer but also to have larger amplitude and speed than in the global ocean.



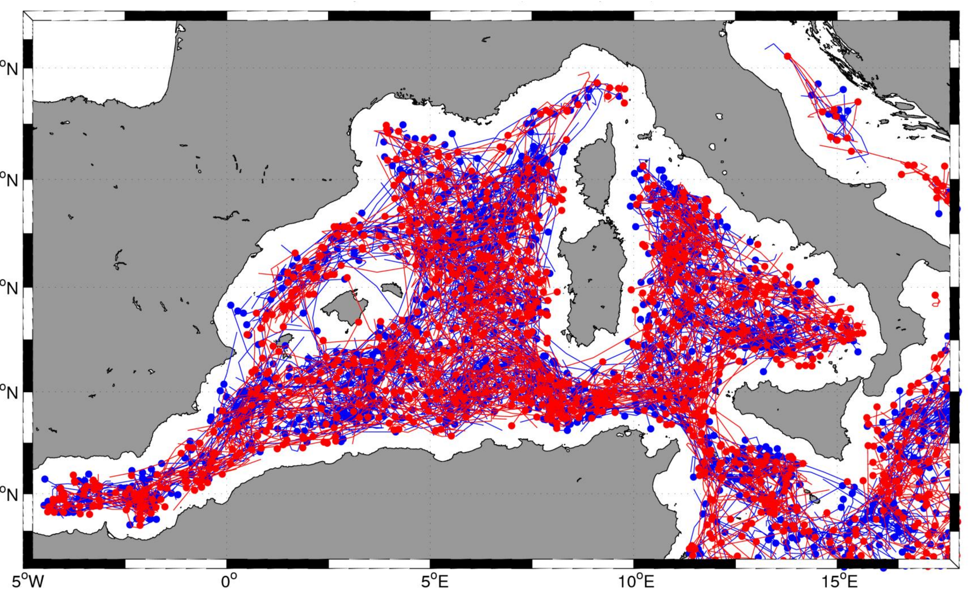




The mean eddy amplitude and speed have, as expected, similar pattern as EKE computed from the same altimetry fields, with strong energy in the Algerian current, and moderated levels in the northern Tyrrhenian Sea and Balearic Sea. This follows the structures detailed by Millot (1999).

Data and Methods

Data used :
SLA fields of the AVISO MED REF series for the 1992-2010 period. Pixels are 1/8° x1/8° .

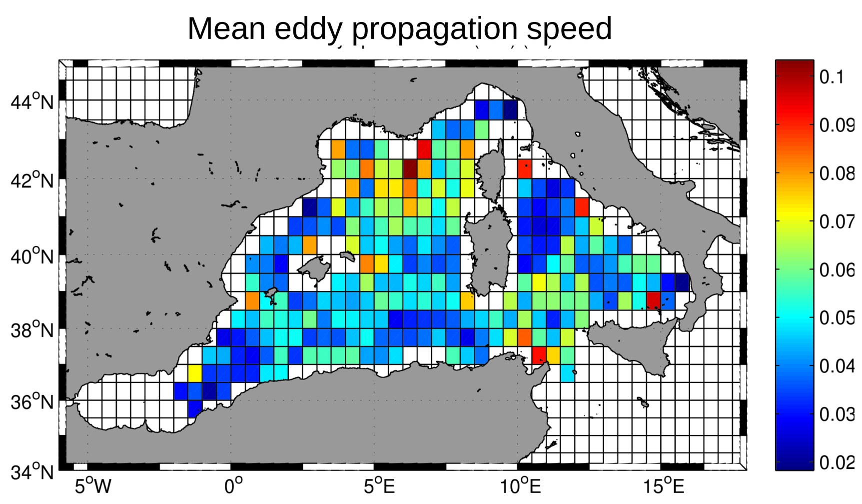


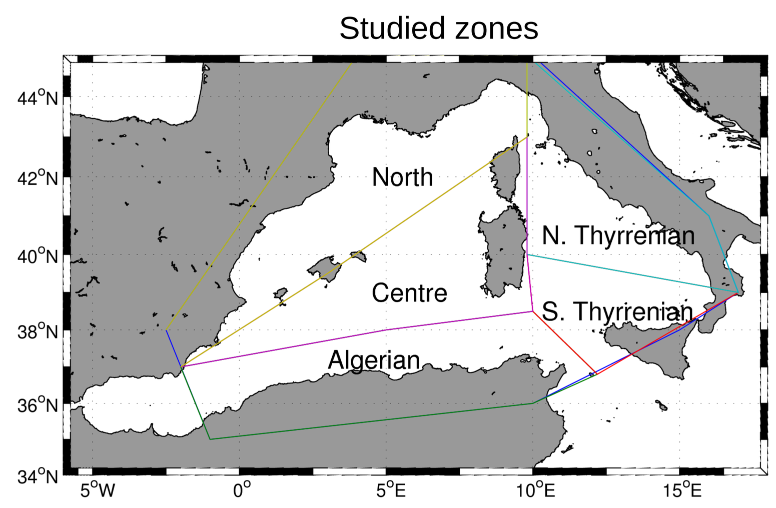
Starting point and trajectories for cyclonic (blue) and anticyclonic (red) eddies.

Method : Eddies are defined as connected set of pixels satisfying the following criteria (Chelton, 2011) :

1. The SSH values of all of the pixels in the region (eddy) are above (below) a given SSH threshold for anticyclonic (cyclonic) eddies.
2. Connected region pixels number >8 and <1000
3. There is at least one local extremum of SSH for eddies in the region.
4. Eddy amplitude is at least 1 cm.
5. The distance between any pair of points within the connected region must be less than a specified maximum.

Propagation

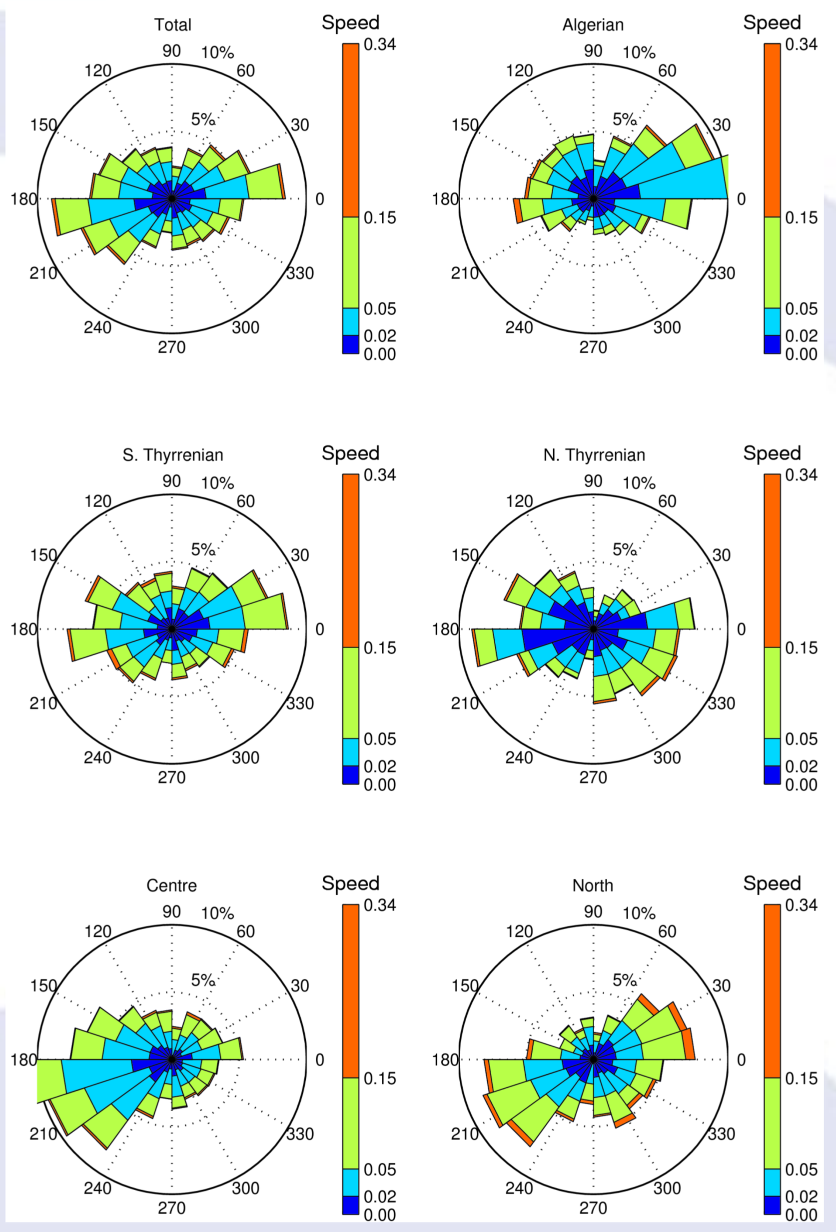




Relatively high propagation velocities are found in the northern part of the basin where eddies are characterized by smaller scale and amplitude. On the contrary, the southern eddies which have larger radius and amplitude propagate at a slower pace.

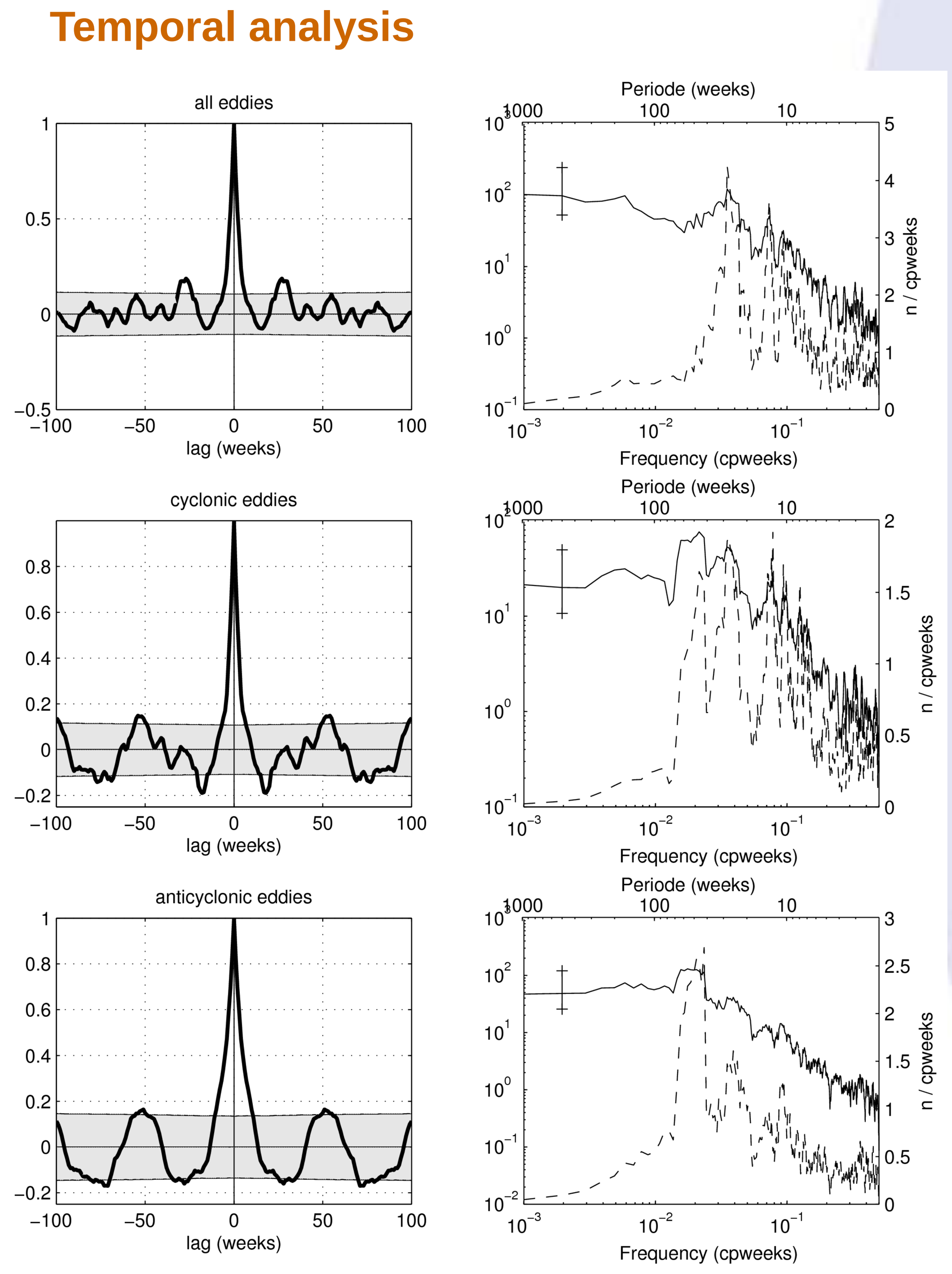
For the direction of propagation, there is a general preference for East-West propagation so that the resulting northward or southward propagation takes place when the eastward and westward propagation compensate. Several zones of study have been studied (cf above figure).

The Africa coastal area with eastward propagation due to the Algerian current and the center region with westward propagation (as predicted by the theory for isolated eddies) are the clearest zones. The others where northern or southern propagation is expected are clouded by the East-West dominancy.



Angle histogram of eddies trajectory direction (in %) with distribution of speed (in color).

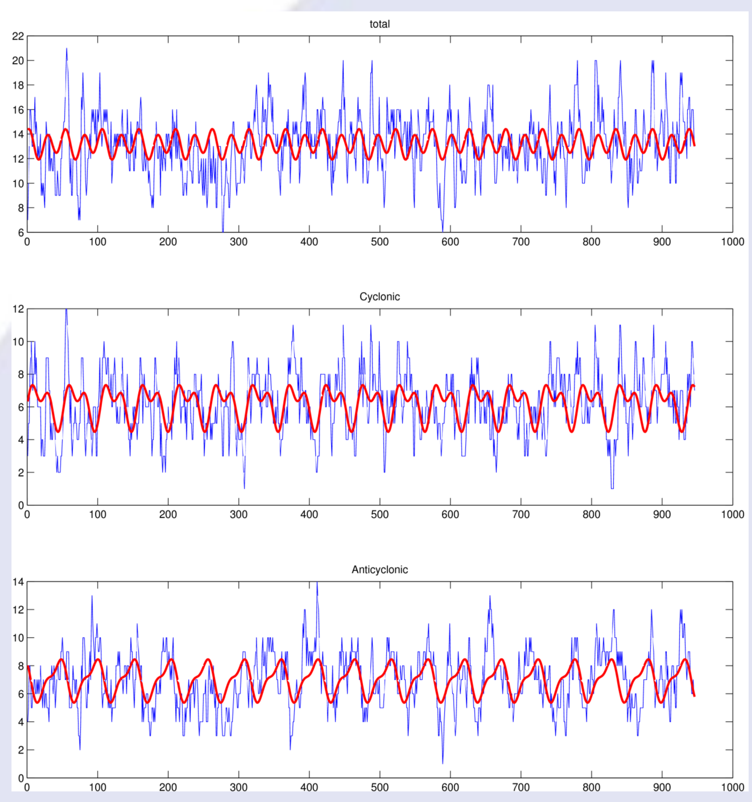
Temporal analysis



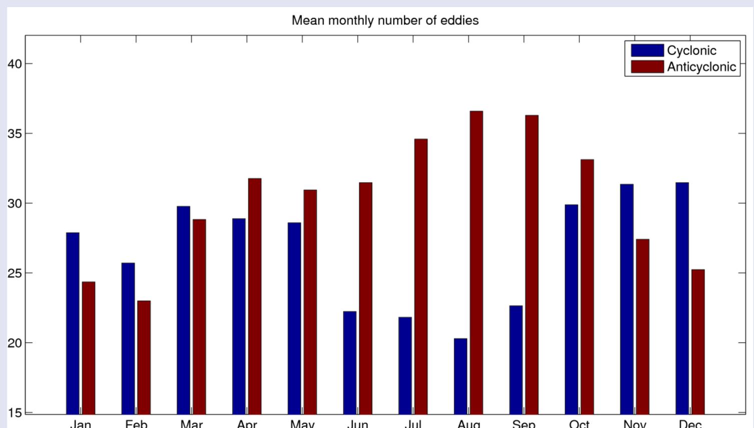
- (left) Autocorrelation of weekly number of eddies for all (top), cyclonic (center) and anticyclonic (bottom) eddies.
- (right) Spectrum of the same time-series (in dashed line variance preserving spectrum).

There is quite a strong temporal variability of the weekly number of eddies (standard deviation of 2.5 for a mean of 14, top right figure) with a statistically significant semi-annual periodicity (top panels of left figure).

Nonetheless, the dominant periodicity for cyclonic and anticyclonic eddies appears to be annual (other panels of left and right figures). This is explained by the anticorrelation of the annual cycles of the two time-series that damps the total annual cycle (with cyclones and anticyclones) whereas the semi-annual signal that was present (although not significant) in both series adds coherently.
The number of anticyclones is maximum in summer whereas the cyclones peak in autumn-winter (figure on the bottom right).



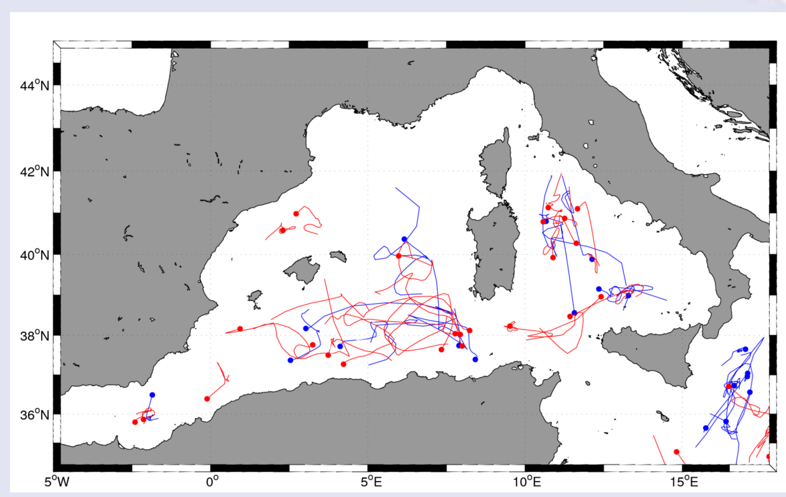
Weekly number of eddies for all (top), cyclonic (center) and anticyclonic (bottom) eddies. In red is the fitted harmonic with annual and semi-annual periodicity



Climatology of the monthly number of eddies for cyclonic (blue) and anticyclonic (red) eddies

Future work

- Sensitivity analysis on the parameters of the method and improving eddy identification close to the coast
- Models to understand physical mechanism of the annual variability and cyclonic differences
- Long lasting eddies study
- Comparison with other eddy tracking method result (e.g. Isern-Fontanet, 2006)



Trajectories for long lasting (20-30 weeks) eddies

References

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Millot, C. (1999). Circulation in the western mediterranean sea. Journal of Marine Systems, 20(1-4):423–442.
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Isern-Fontanet, J., García-Ladona, E. & Font, J., 2006. Vortices of the Mediterranean Sea: An Altimetric Perspective. J. Phys. Oceanogr., 36(1), p.87-103.