Multiplatform analysis of a large anticyclonic eddy in the Algero-Provençal basin in 2019

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GHER

LIÈGE université

EUMETSAT

IMEDEA

CSIC Consejo Superior de Investigaciones Científicas

UIB Universitat de les Illes Balears

SOCIB Balearic Islands Coastal Observing and Forecasting System

Context

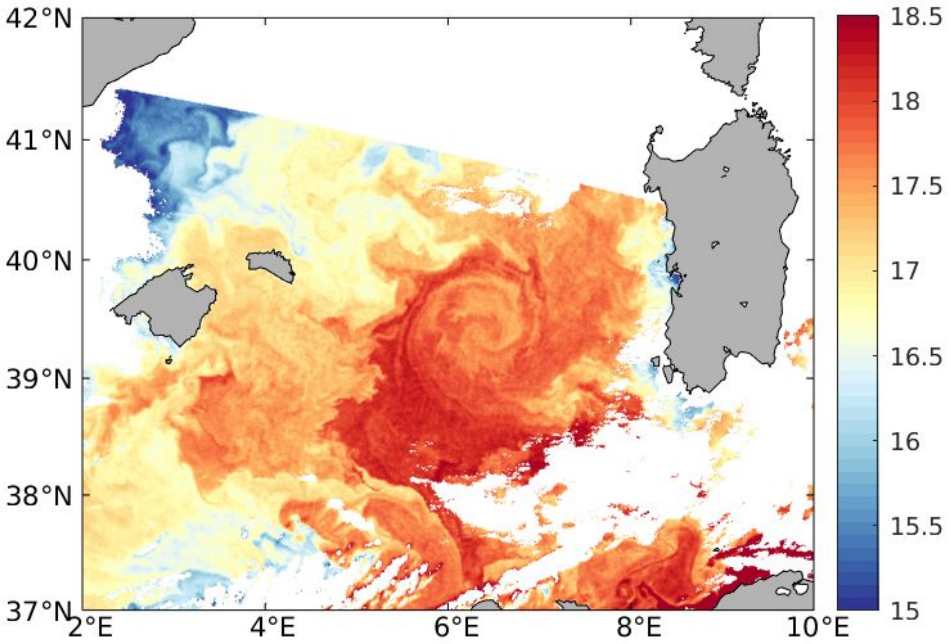
A large anticyclonic eddy formed in April 2019 in the Algero-Provençal basin between Mallorca and Sardinia.

It lasted ~8 months and had a diameter of up to 150 km.

Large eddies influence basin-wide currents, and can have an impact in the ecosystem by influencing nutrients & heat transport across several 10s of km.

During summer it stayed as a subsurface feature, and regained back the surface in Fall.

Several remote sensing data and in situ data, as well as model results, will be used to describe its life cycle.



SST on 28 November 2019 (SLSTR Sentinel-3 data)

Data used

Remote Sensing data:

- Sea Surface Temperature (Sentinel-3 SLSTR)
- Chlorophyll-a concentration (Sentinel-3 OLCI)
- Sea Level Anomaly (merged multi-satellite - AltiKa, Cryosat-2, Jason-3, Sentinel-3A, Sentinel-3B)

In situ data:

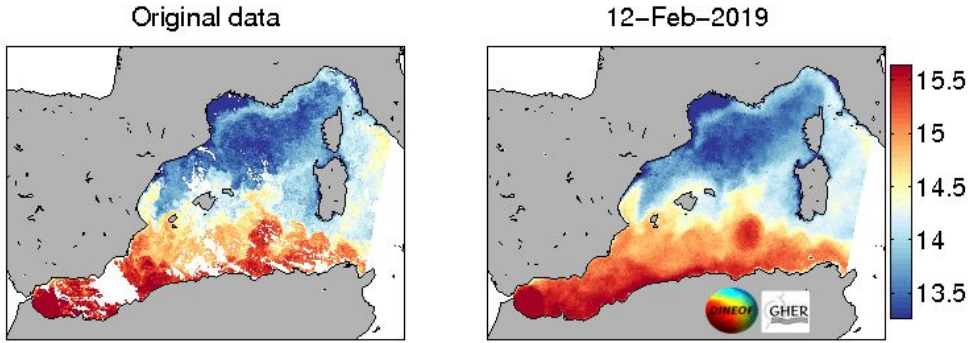
- Drifters (obtained from http://www.coriolis.eu.org/)
- Argo profilers (obtained from http://www.coriolis.eu.org/)

Model:

- CMEMS Mediterranean Sea Physics Analysis and Forecast product (MEDSEA_ANALYSIS_FORECAST_PHY_006_013)

SST missing data (due to clouds for example) have been filled using **DINEOF**

- Technique to **fill in missing data** in geophysical data sets, based on a EOF decomposition
- Truncated EOF basis to calculate missing data (iterative method)
    - EOFs extract main patterns of variability
    - Reduced noise
- Optimal number of EOFs?: reconstruction error by cross-validation
- Uses EOF basis to infer missing data: non-parametric
- No need of a priori information (correlation length, covariance function...)
- Spatio-temporal coherence exploited to calculate missing values



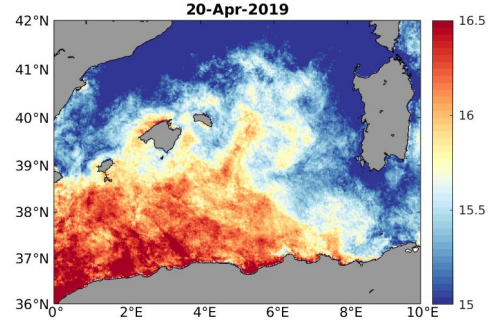
Near real time infrared Sea Surface Temperature over the Mediterranean Sea; http://www.dineof.net/DINEOF

Formation of the eddy

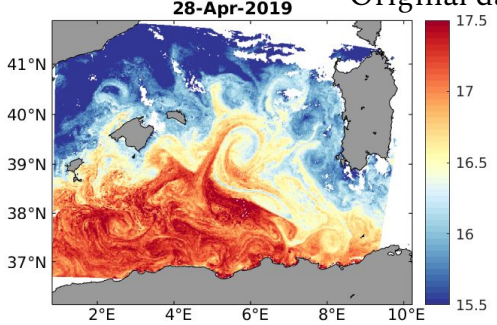
The eddy appears to have formed from an instability originated in the Algerian current

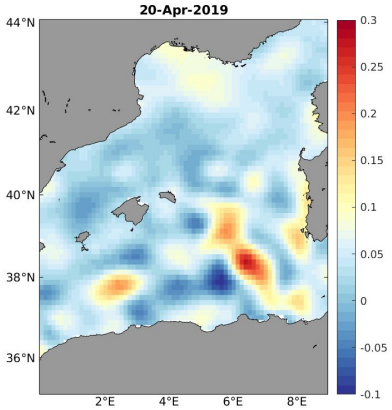
Anticyclonic activity was observed in SST on April 2019

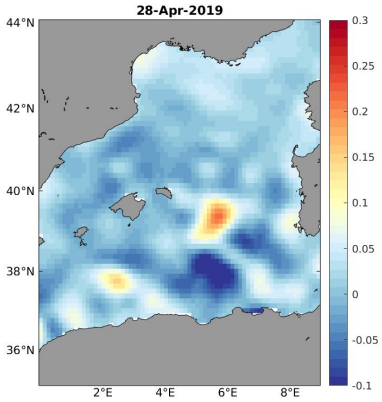
DINEOF reconstruction



Original data



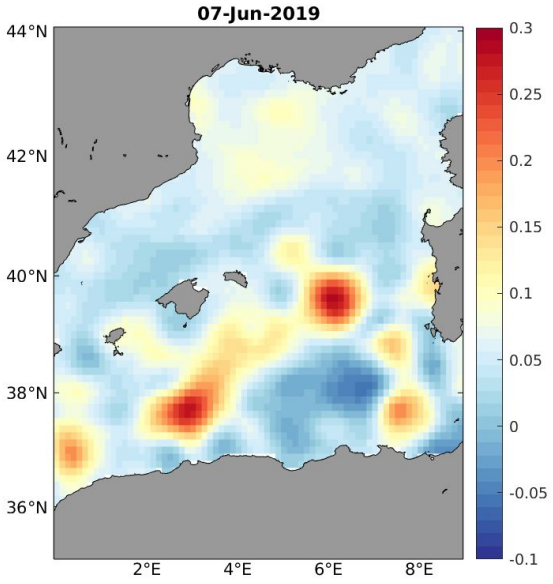




The SST shows a spiraling feature on 20 April that is clearly associated with a signal in the SLA data

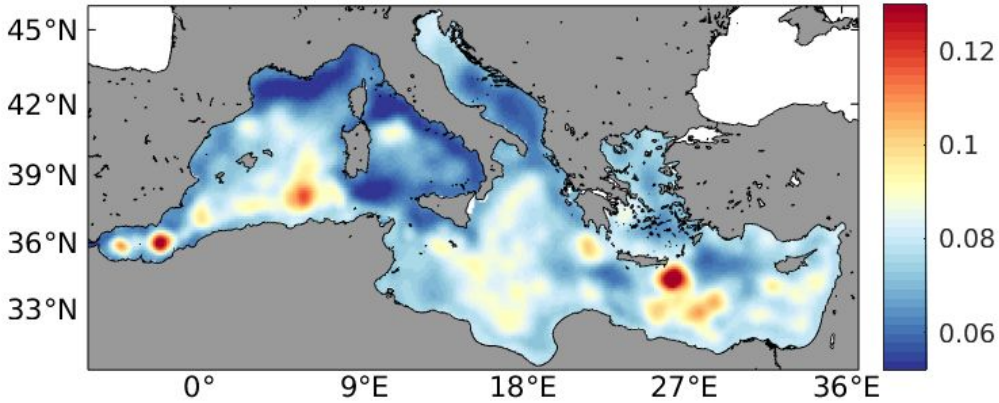
As soon as 28 April, the SLA signal shows a circular anomaly associated with the eddy.

Maximum diameter of the eddy: 150-160 km (from SST and SLA)

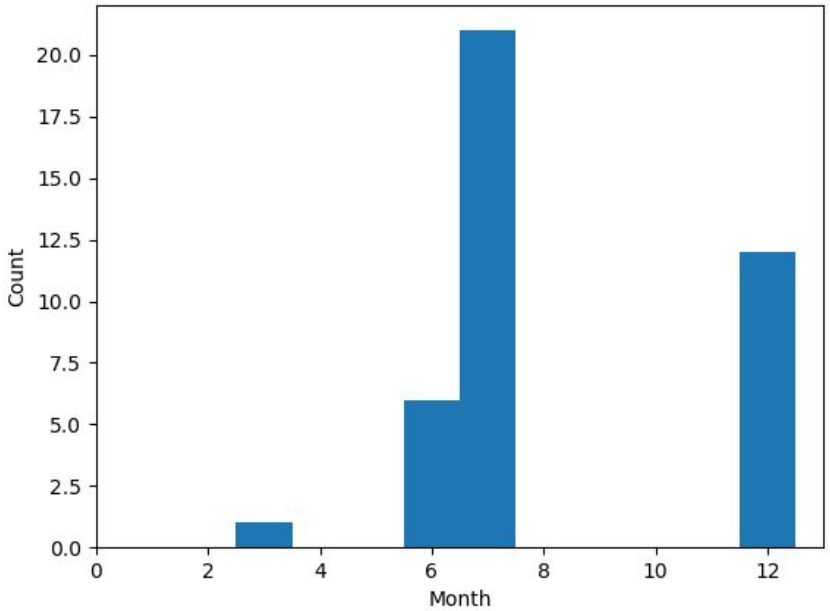


The SLA standard deviation in the Liguro-Provençal basin shows that variability is relatively high in this zone

SLA standard deviation (1993 to 2020)



Lagged correlation of the SLA eddy feature on 7 June 2019 with the full 1993-2020 SLA series on the same location shows a correlation larger than 0.75 for July and December

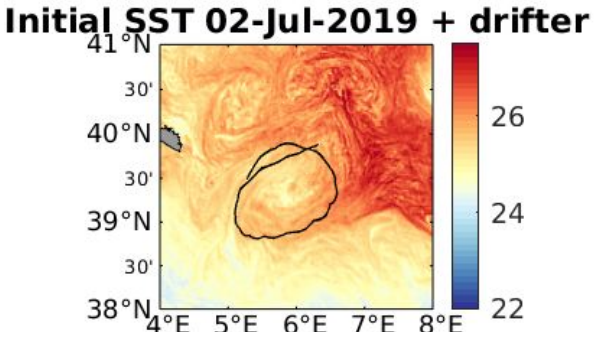


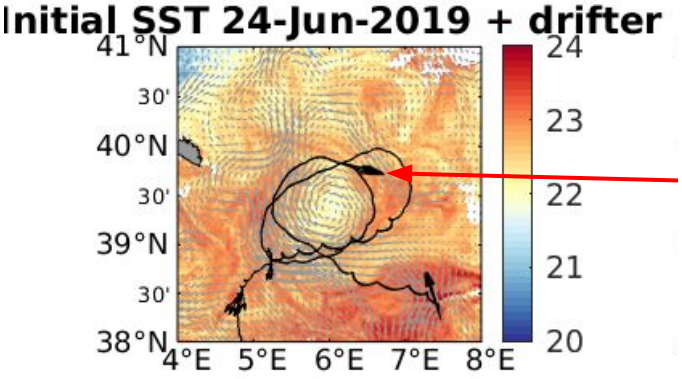
Similar SLA situations have happened, with a preference in June and December

In situ data

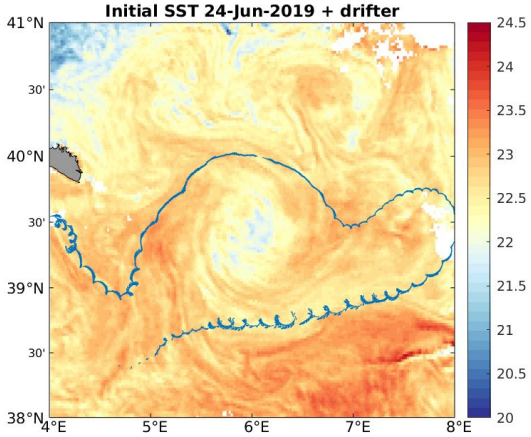
2 surface drifters and 1 argo profiler were trapped in the eddy, showing extended evidence of its size and speed

Diameter in SST is smaller than drifter due to surface warming

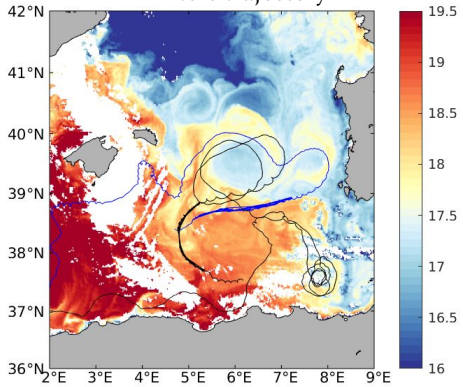




Highest speed recorded by drifter: 0.71 m/s



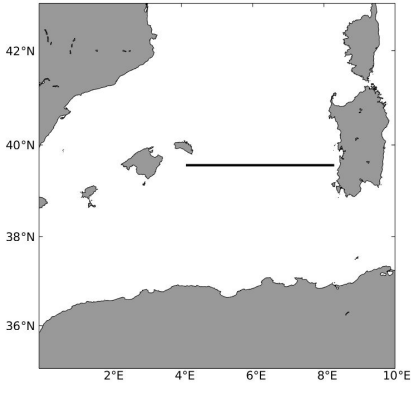
Drifters trajectory



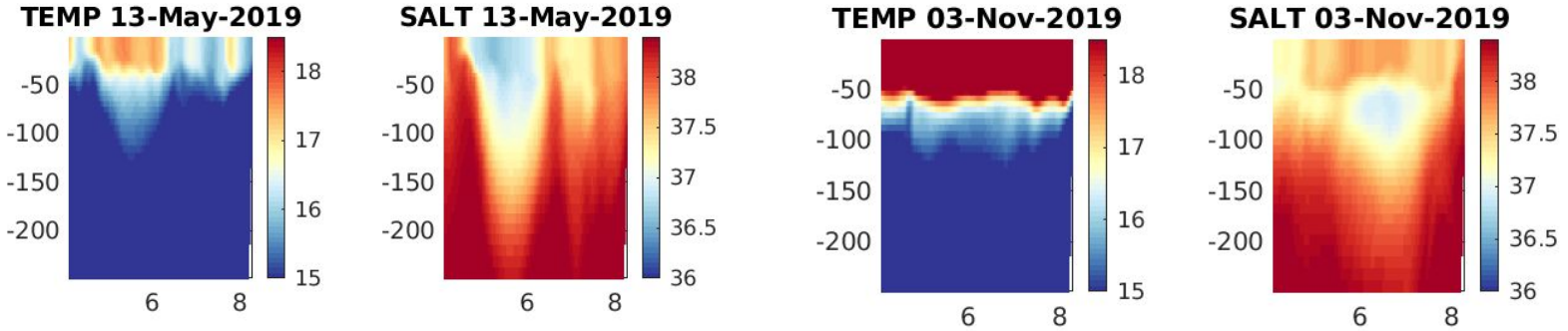
During summer time (from June 2019), the eddy was no longer visible in SST (surface warming)

The eddy remains during this period as a **subsurface feature**, with a strong SLA signal

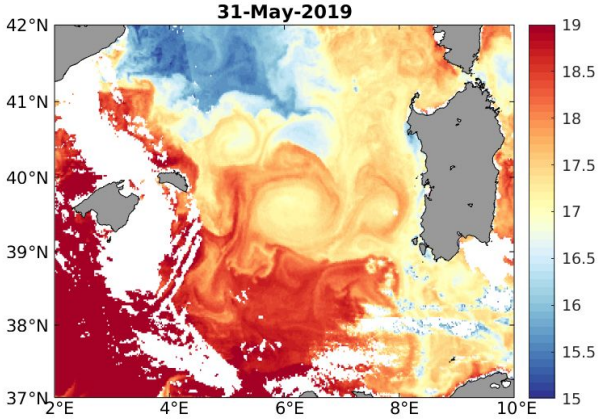
Model temperature and salinity transects show it remained as a subsurface feature during the warm months.



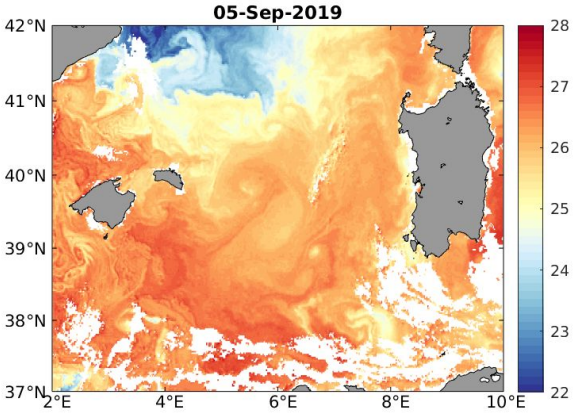
Vertical transects showing the eddy in T&S (May) and in S as a sub-surface feature (November)



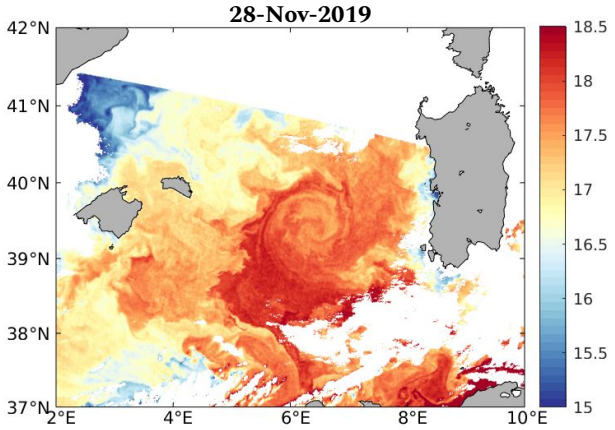
Eddy life as shown in SST & SLA



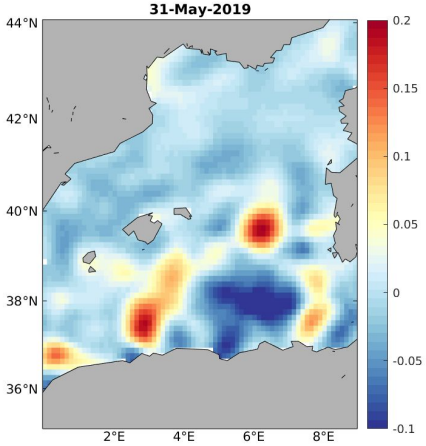
First evidence of presence
Clear SLA signal

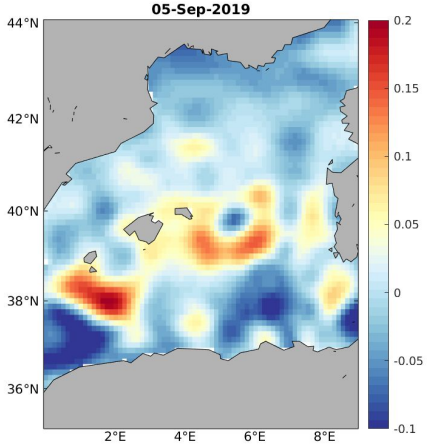


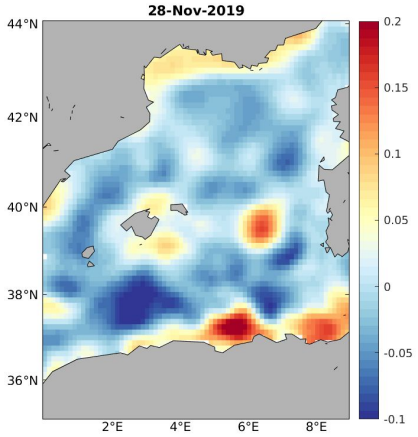
Surface warming period
SLA shows structure remains



Surface reached again in November
Clear SLA signal again





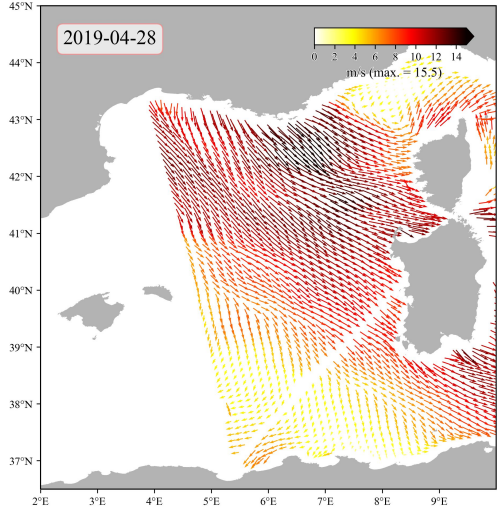


Conclusions / items for discussion:

Mesoscale eddies form regularly in the Mediterranean. We have studied a large eddy that formed in the Liguro-Provençal basin and remained strong for about 8 months.

It was a strong eddy, with speeds of up to 0.7m/s as measured by drifters

- How / why did the Algerian current instability form an eddy, why it got stronger and remain for months?
- What is the role of e.g. wind in the formation of the eddy?
- Is the "resurface" phase a different eddy? If the same, how did it resurfaced?



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