Study of an anticyclonic eddy in the Algero-Provencal Basin (Mediterranean) in summer 2019 using altimetric satellite data and an eddy tracker

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Context and objectives

Context:

Large anticyclone in the Algero-Provencal Basin (Mediterranean Sea) observed with SST data (Alvera *et al.,* 2020) from April 2019 to December 2019

This eddy was really large (diameter ≈ 100 km) and had a long lifespan (≈ 9 months)

BUT: the eddy was “invisible” from mid-summer until mid-autumn

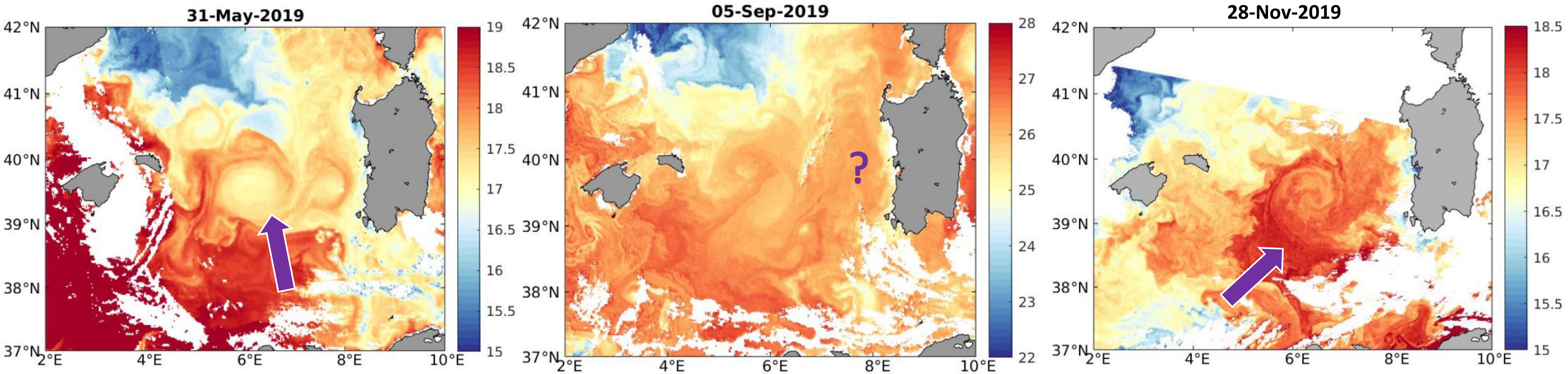


Fig.1. SST maps of the Algero-Provencal Basin (Mediterranean Sea). (A) 31st of May 2019, a large eddy is clearly visible between Balearic Islands and Sardinia. (B) 5th of September 2019, the SST has increase all over the study area and the eddy is not visible anymore. (C) 28th of November 2019, a large eddy is visible between Balearic Islands and Sardinia. (*Alvera-Azcárate et al., 2020)*

Objectives:

To use altimetric satellite data to track the eddy all over its lifespan

To know its characteristics (radius, amplitude, daily position, contours)

Material and methods

Material and Methods

Data:

Sea level anomaly (SLA) data:

The SLA is estimated by Optimal Interpolation, merging the measurement from the different altimeter missions available

It processes data from all altimeter missions (multiplateform, level L4)

Available on the CMEMS website as SEALEVEL_GLO_PHY_L4_NRT_OBSERVATIONS_008_046

Daily 1/4 degree resolution

Sea surface temperature (SST) data:

Mono-Sensor L3 Observations (VIIRS sensor)

Available on the CMEMS website as SST_EUR_SST_L3C_NRT_OBSERVATIONS_010_009_b

Daily 0,02 degree resolution

Data reconstruction: how to reconstruct missing SST data?

DINEOF tool:

Calculates the optimal number of EOF to reconstruct the missing data from cross-validation technique (Aida Alvera-Azcarate *et al.*, 2005)

Material and Methods

Eddy tracker

Free-access Python code (Mason *et al.,* 2014 ; Delepoulle and Mason, 2017)
Eddy detection and tracking using alimetric data

Provides:

- Detection of all the eddies
- Distinction between anticyclone and cyclone
- Temporal and spatial tracking of each eddy
- Daily determination of the radius, center, amplitude, contours for each eddy

How works the eddy tracker?

→ What can we obtain with the eddy tracker?

Speed contours of an anticyclone.
Begining of the tracking: 12-Dec-2019 – End of the tracking: 31-Dec-2019

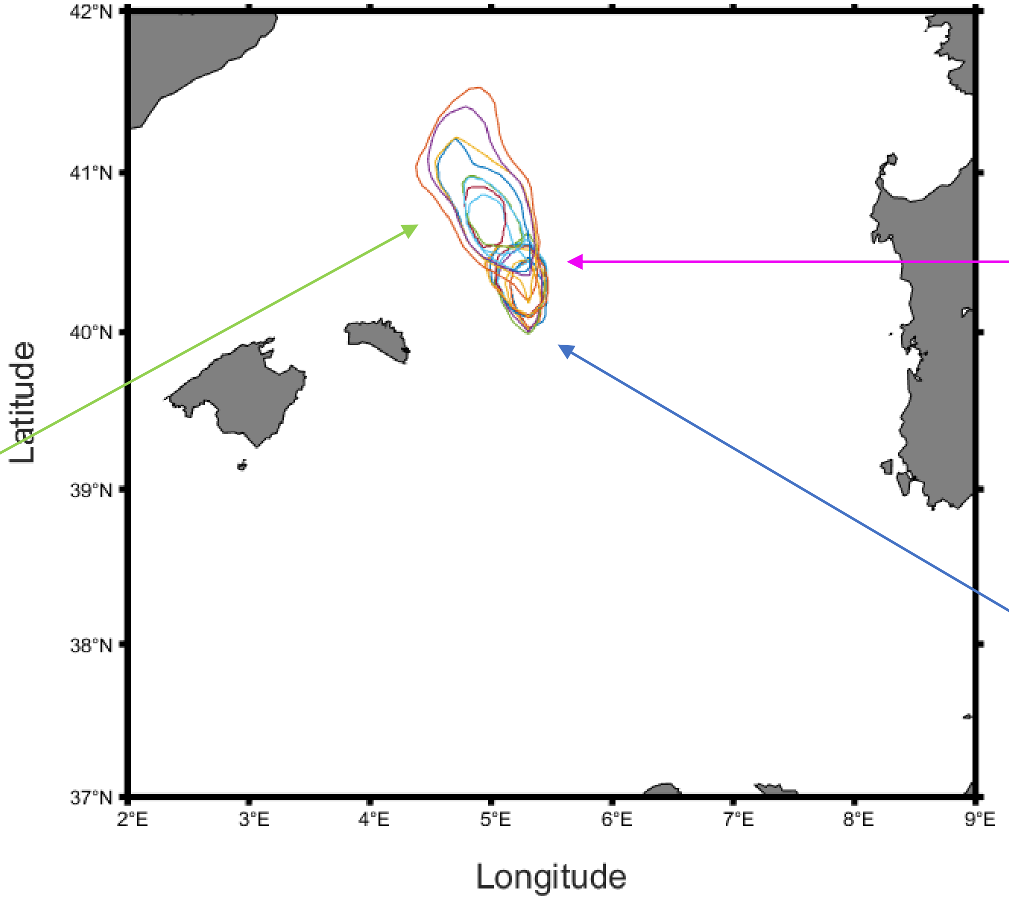


Fig.2. Contours of an anticyclone tracked during 20 days from 12 until 31st of December 2019. Contours are drawn according to currents speed.

Distinction between cyclones and anticyclones

Different types of contours can be drawn

Tracking during 20 days

1 contour per day (→ 20 contours overlayed for this example)

→ Anticyclone tracked for 20 days

How works the eddy tracker?

→ 2 types of contours for each eddy

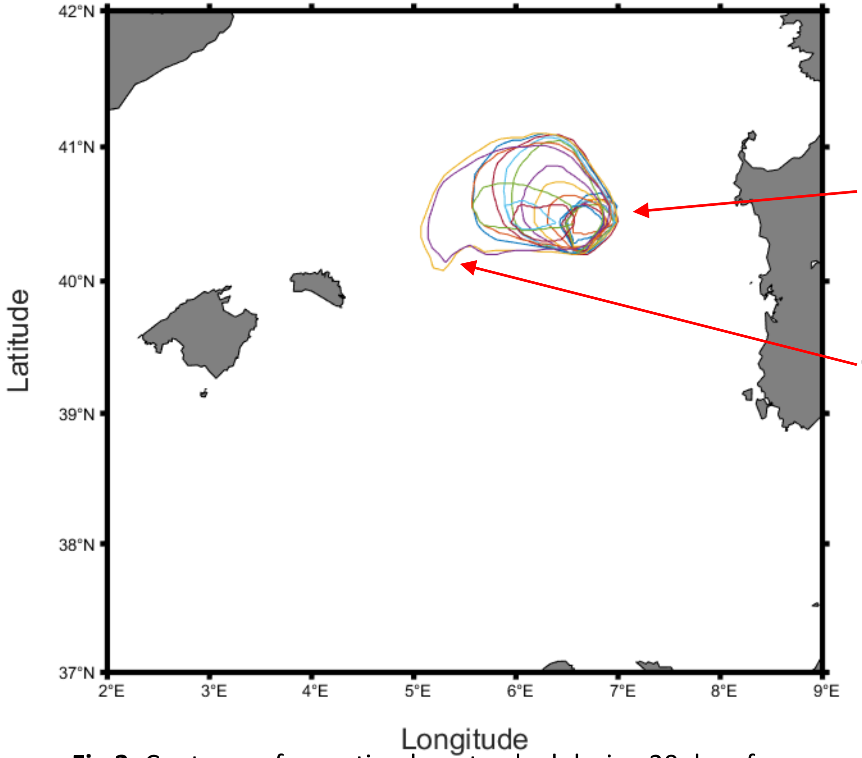
Example with an anticyclone tracked for 20 days

Contours based on sea level anomaly

Contours based on curents speed

→ The contours are drawn where the currents speed is the highest (derived from sea level anomaly)

Altimetric contours of an eddy.
Begining of the observation: 03-Jul-2019 – End of the observation: 23-Jul-2019



Wide contours

Contours with angles

Narrower contours

Fig.3. Contours of an anticyclone tracked during 20 days from 3rd to 23rd of July 2019. Contours are drawn according to the sea level anomaly. As the eddy has been tracked for 20 days, there is 20 contours overlayed.

Speed contours of an eddy.
Begining of the observation: 03-Jul-2019 – End of the observation: 23-Jul-2019

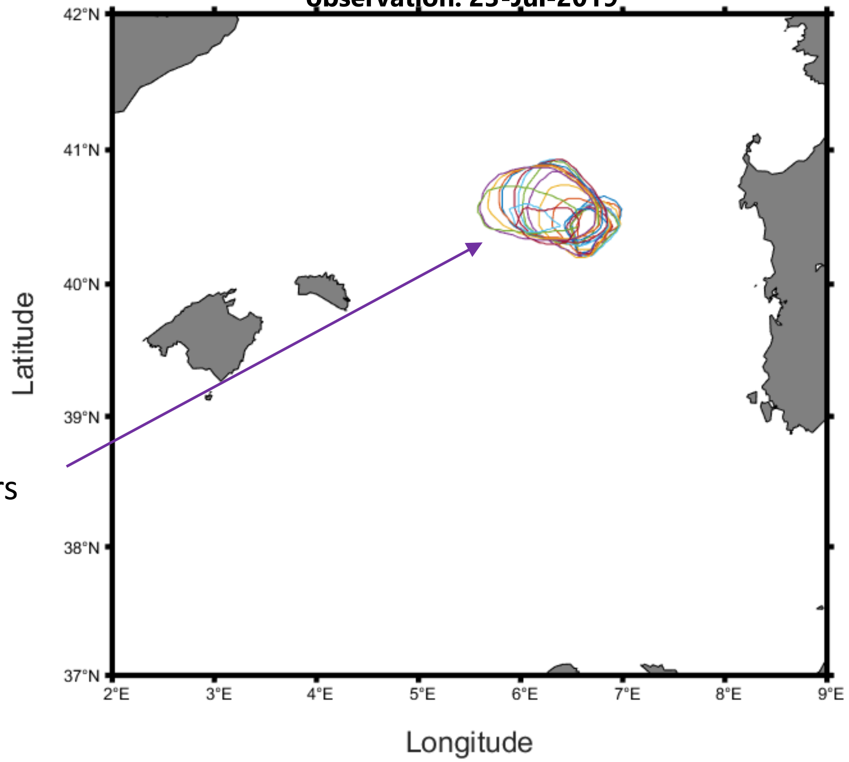
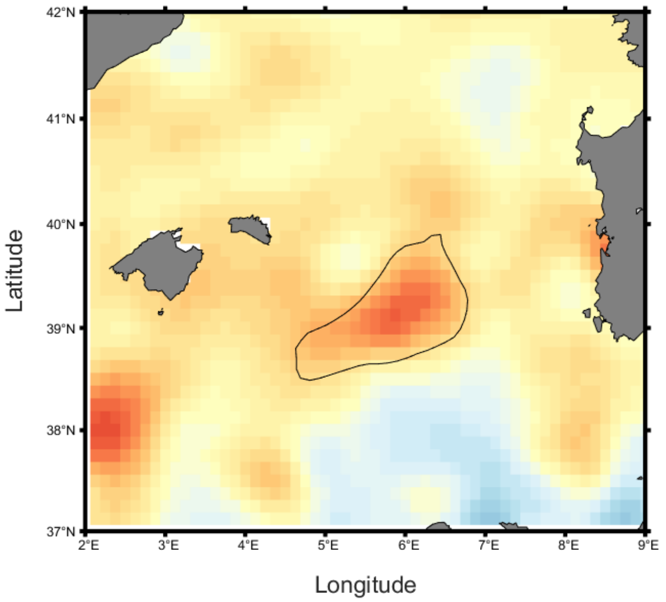


Fig.4. Contours of an anticyclone tracked during 20 days from 3rd to 23rd of July 2019. Contours are drawn where the currents speed is the highest**.** As the eddy has been tracked for 20 days, there is 20 contours overlayed.

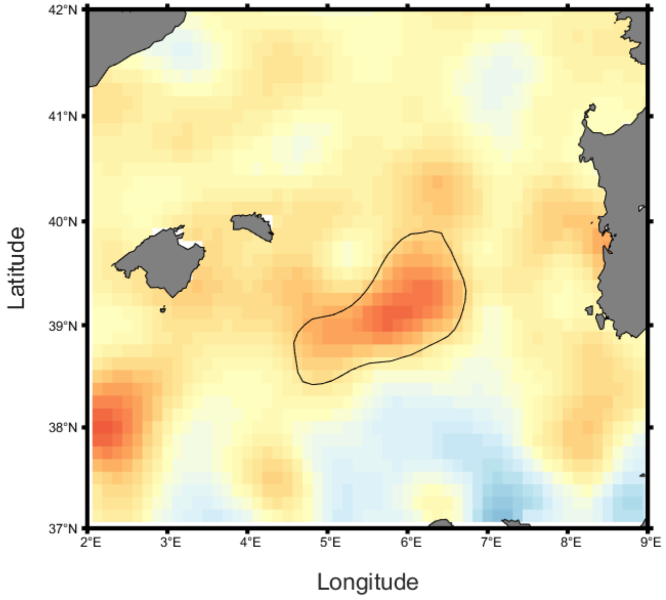
Results:
the anticyclone tracking

Results: some fails in the tracking

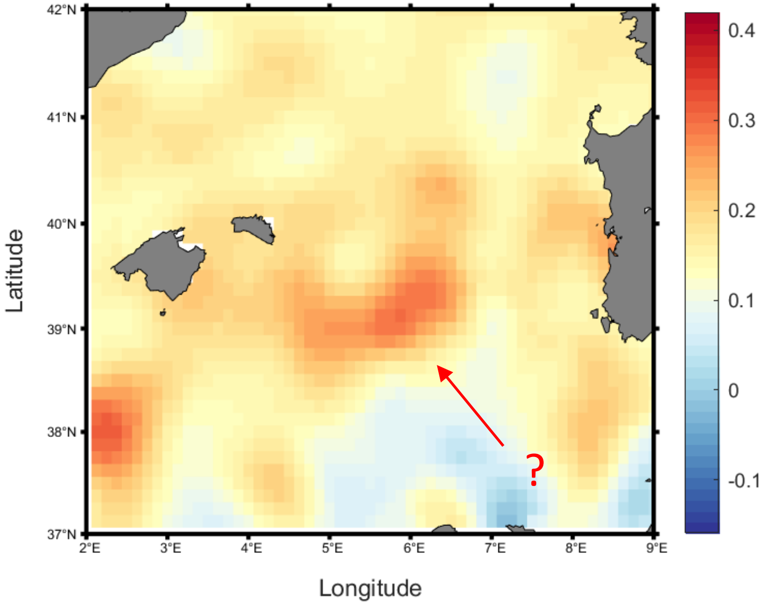
Sea level anomaly (m) and eddy's contours
Date : 29-Aug-2019



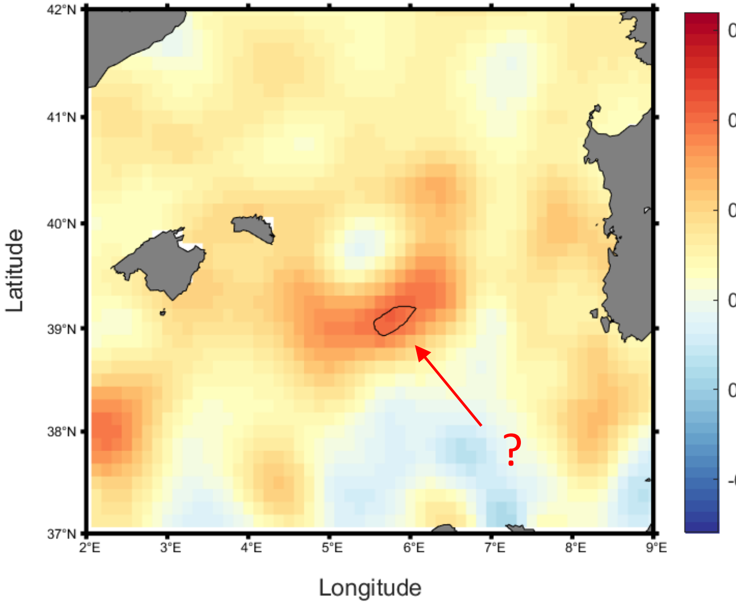
Sea level anomaly (m) and eddy's contours
Date : 30-Aug-2019



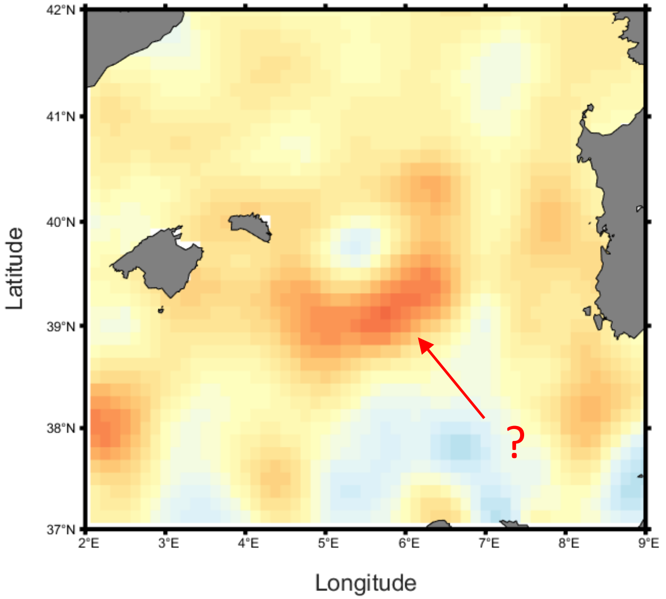
Sea level anomaly (m) and eddy's contours
Date : 31-Aug-2019



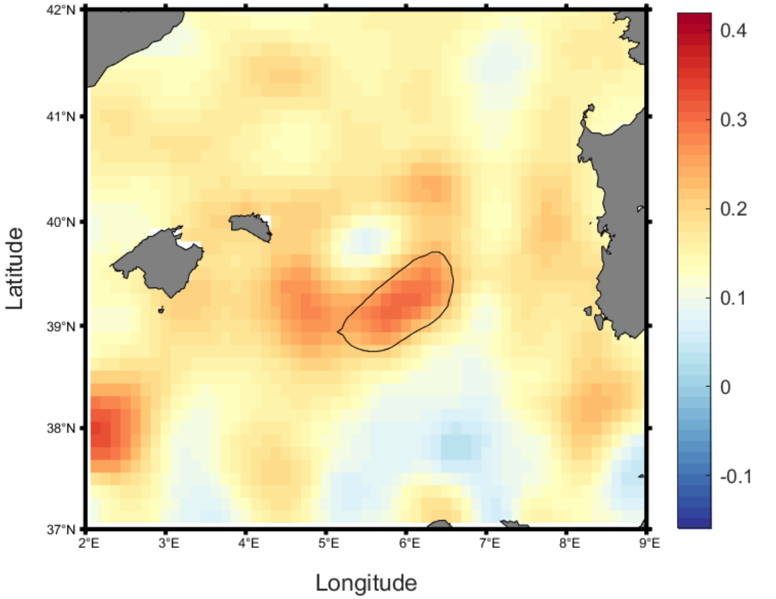
Sea level anomaly (m) and eddy's contours
Date : 01-Sept-2019



Sea level anomaly (m) and eddy's contours
Date : 02-Sept-2019

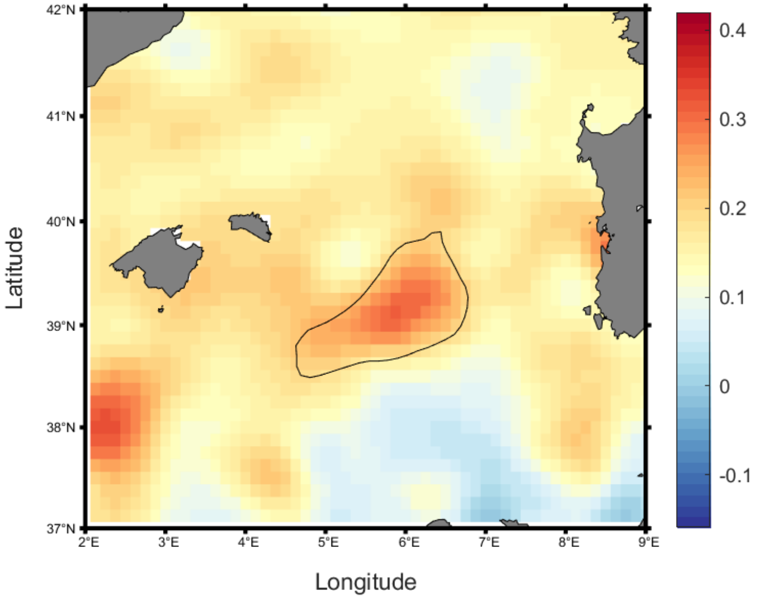


Sea level anomaly (m) and eddy's contours
Date : 03-Sept-2019

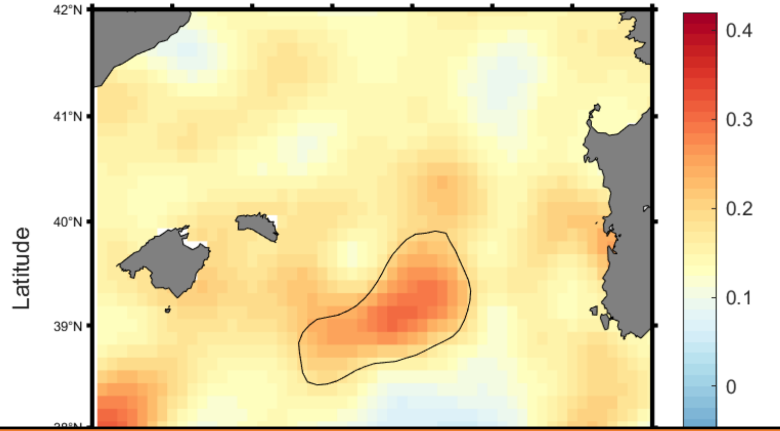


Results: some fails in the tracking

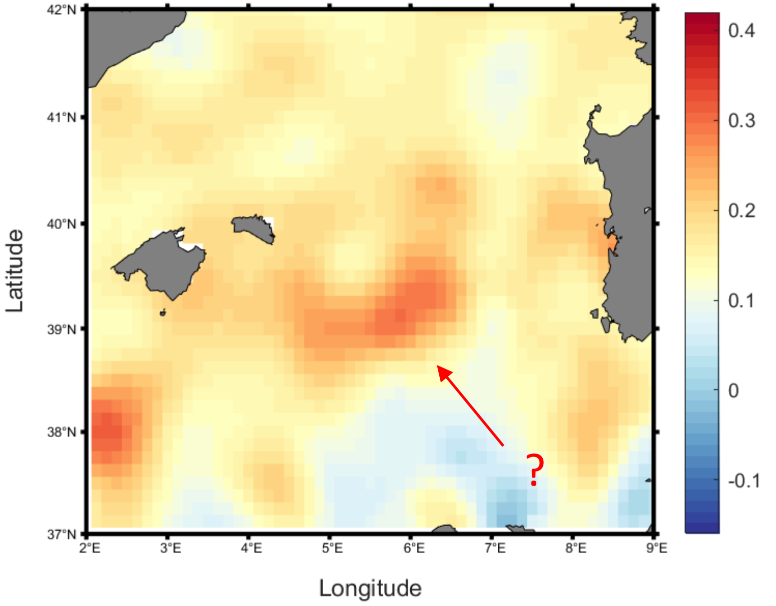
Sea level anomaly (m) and eddy's contours
Date : 29-Aug-2019



Sea level anomaly (m) and eddy's contours
Date : 30-Aug-2019



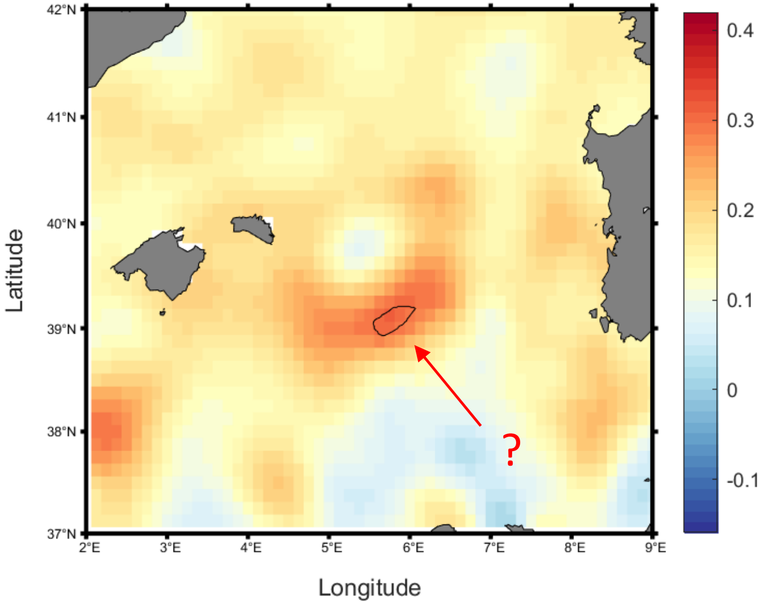
Sea level anomaly (m) and eddy's contours
Date : 31-Aug-2019

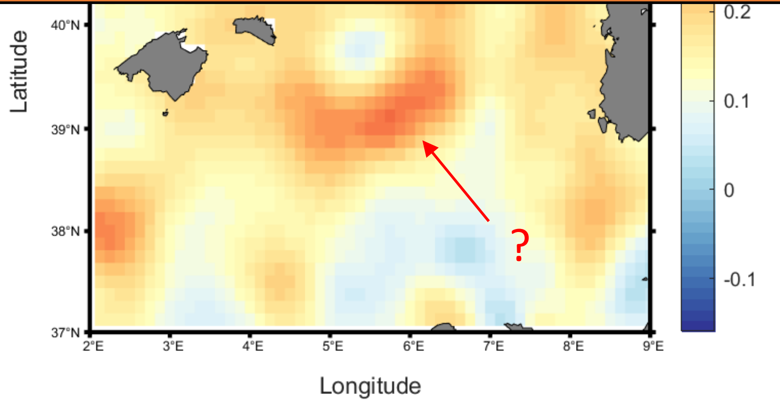


Maybe the anticyclone's shape was too complex to be identified as an eddy by the eddy tracker?

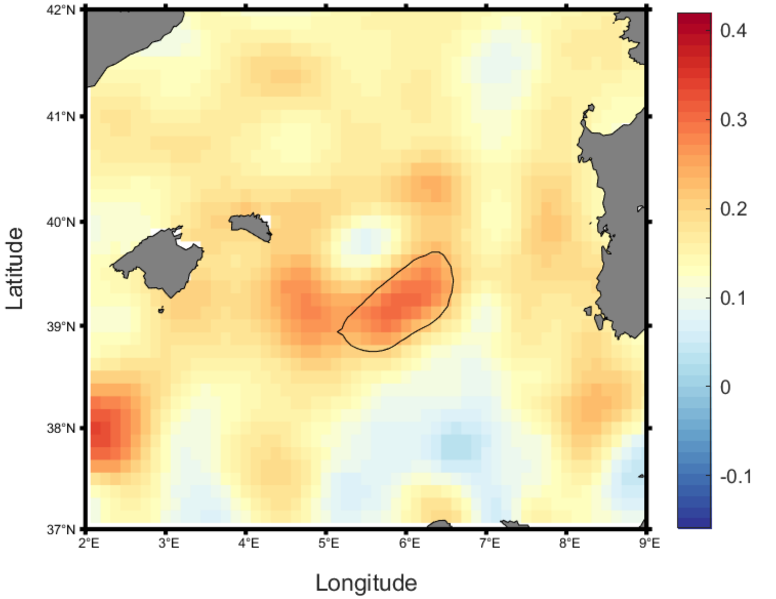
However, the tracking hasn't been stopped because the eddy tracker allows to lost the eddy's track during a few days

Sea level anomaly (m) and eddy's contours
Date : 01-Sept-2019





Sea level anomaly (m) and eddy's contours
Date : 03-Sept-2019



Results: SLA vs SST

Anticyclone tracking: the eddy has been tracked during its entire lifespan thanks to SLA data
We are now able to know its characteristics and its position

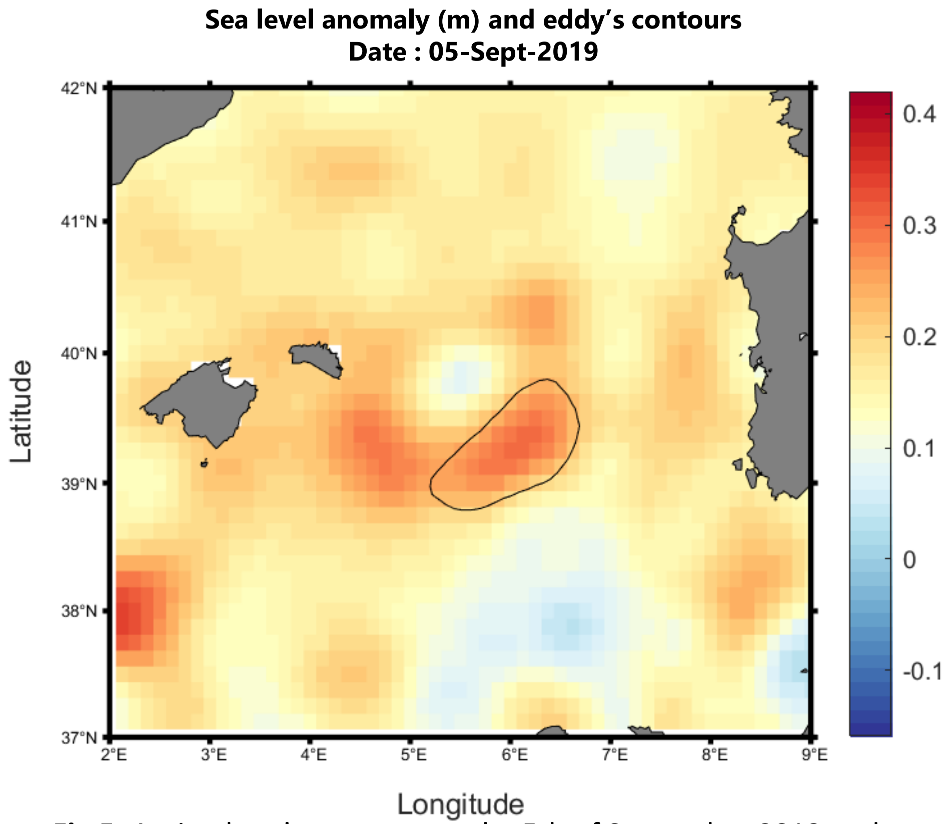


Fig.5. Anticyclone's contours on the 5th of September 2019 and sea level anomaly (m). Contours drawn according to currents speed.

The eddy's track has been lost with SST data from August to September

But with altimetric data and the eddy tracker we are able to see it

→ The anticyclone has been tracked during 9 month

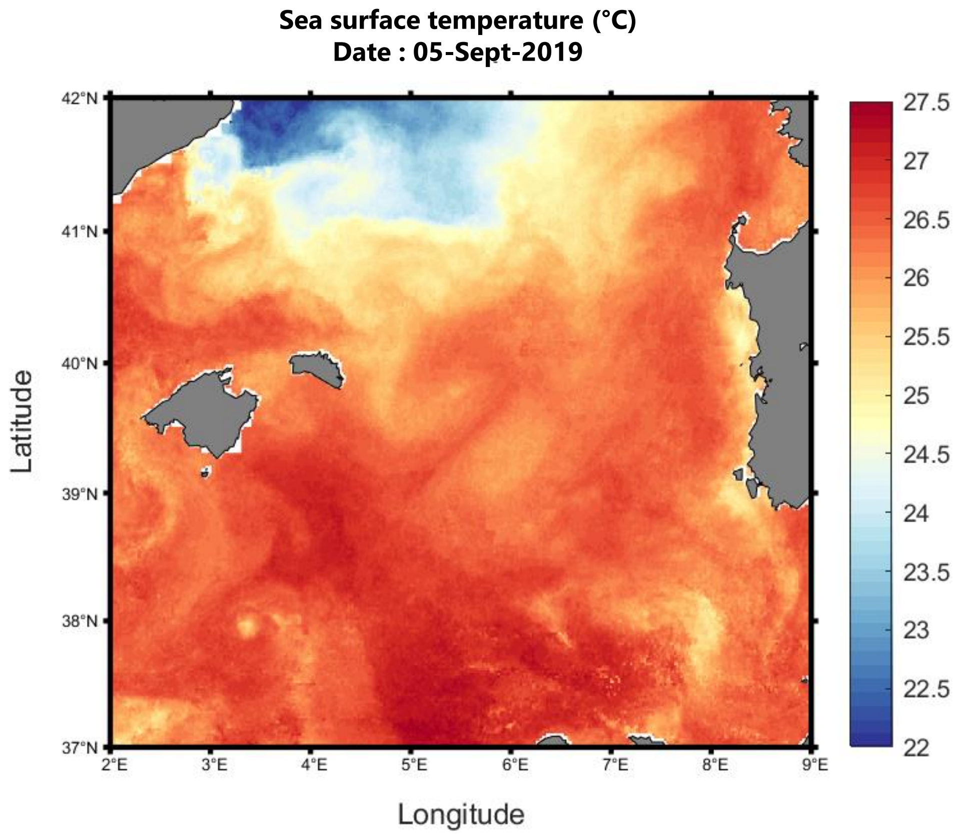


Fig.6. Sea surface temperature (°C) on the 5th of September 2019. The anticyclone is not observable because the sea surface temperature is high all over the study area.

Results: Eddy's radius and amplitude

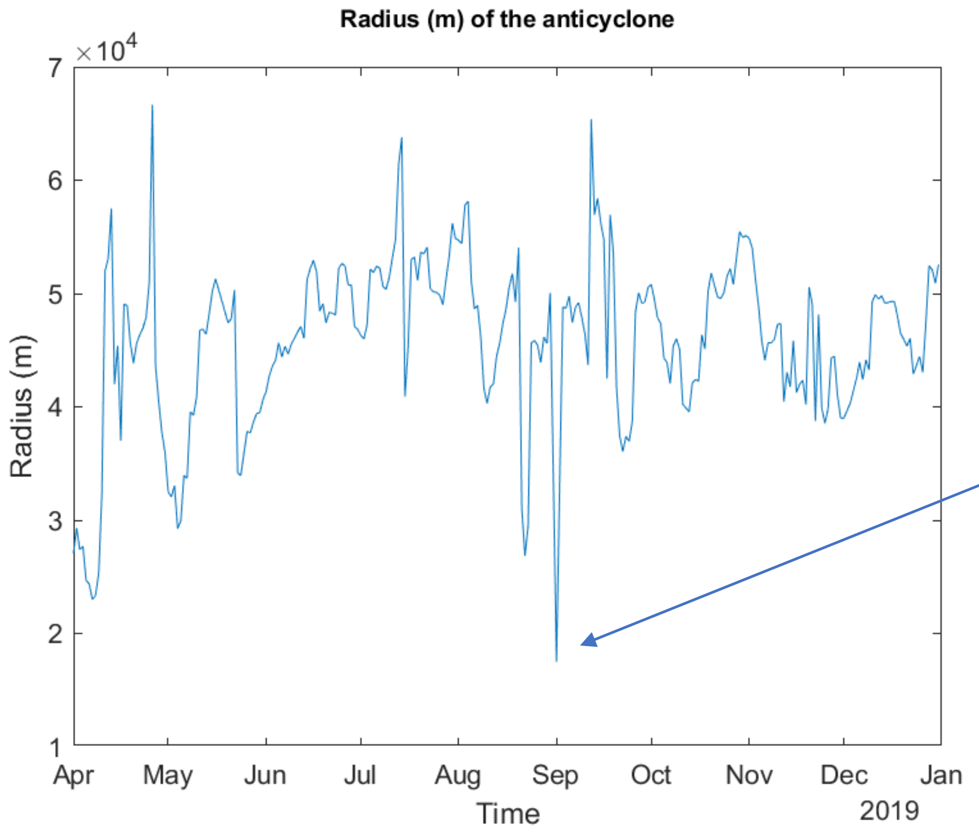


Fig.7. Radius (m) of the anticyclone we are interested in from 01-April-2019 to 31-Dec-2019.

Note that there is some days where the tracking has failed

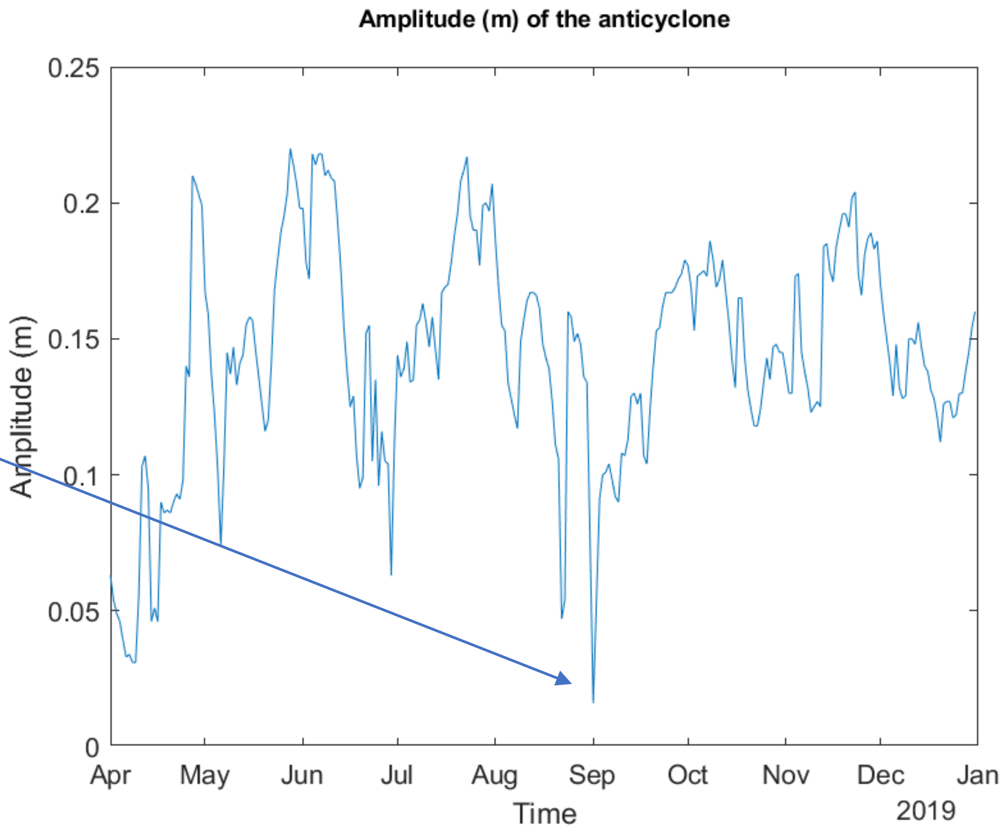
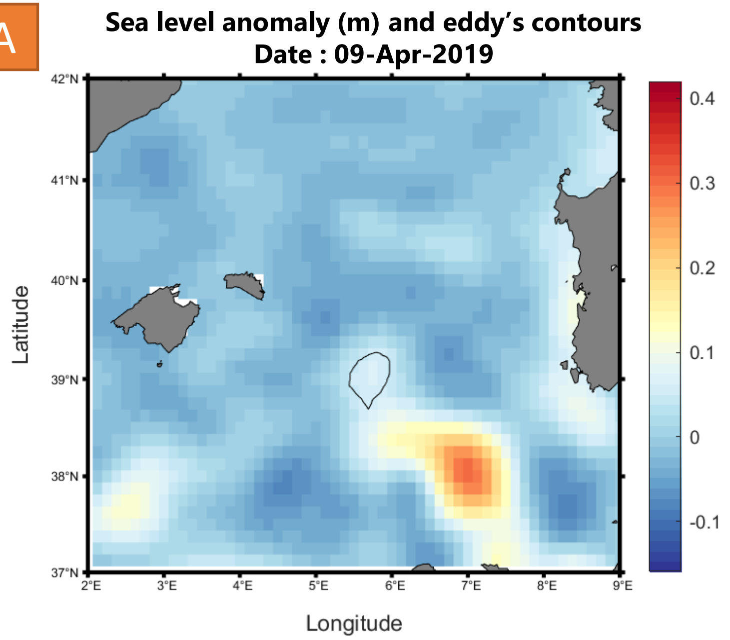


Fig.8. Amplitude (m) of the anticyclone we are insterested in from 01-April-2019 to 31-Dec-2019.

Results: Anticyclone tracking: contours overlayed with SLA → different life stages

A



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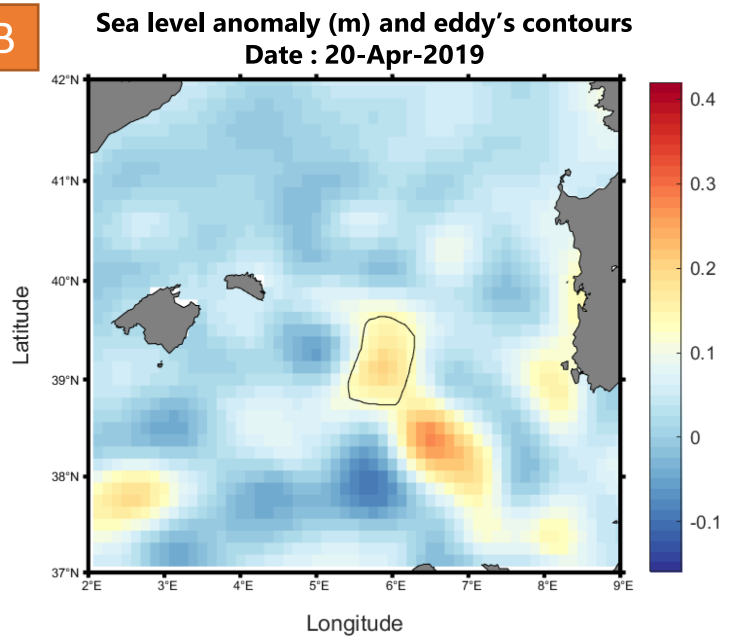
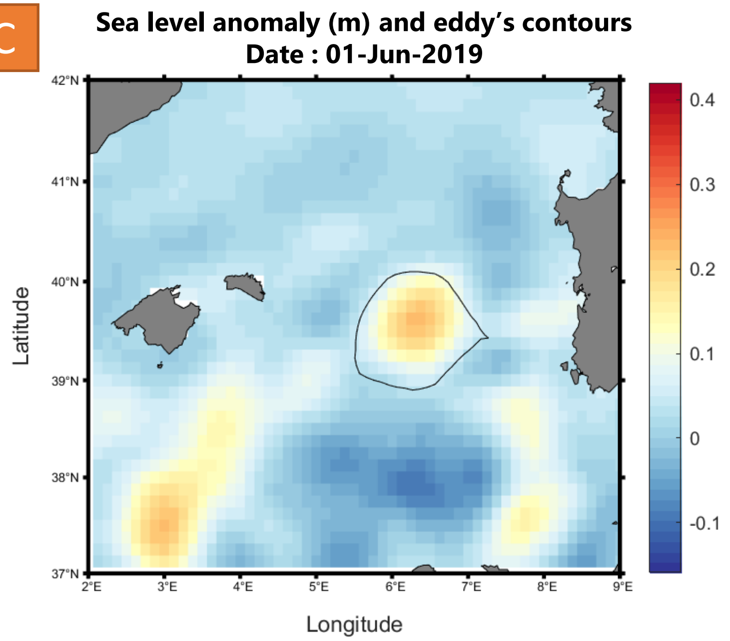
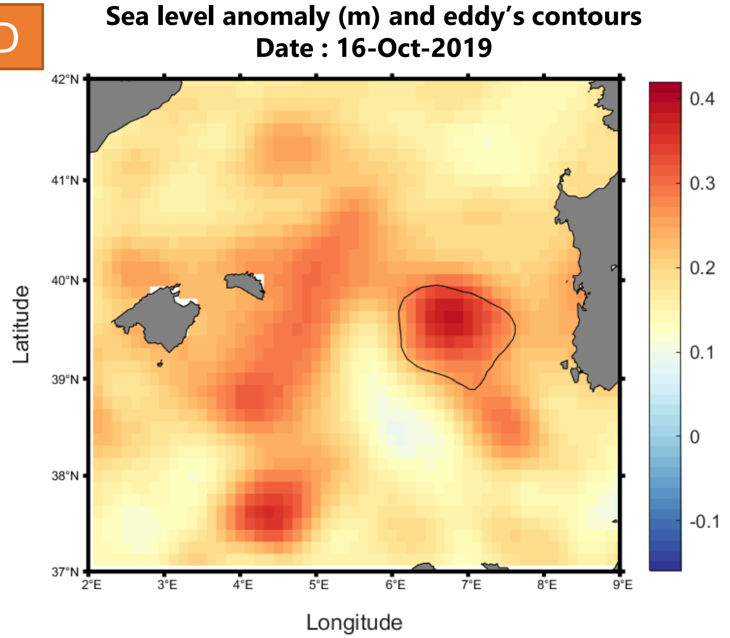


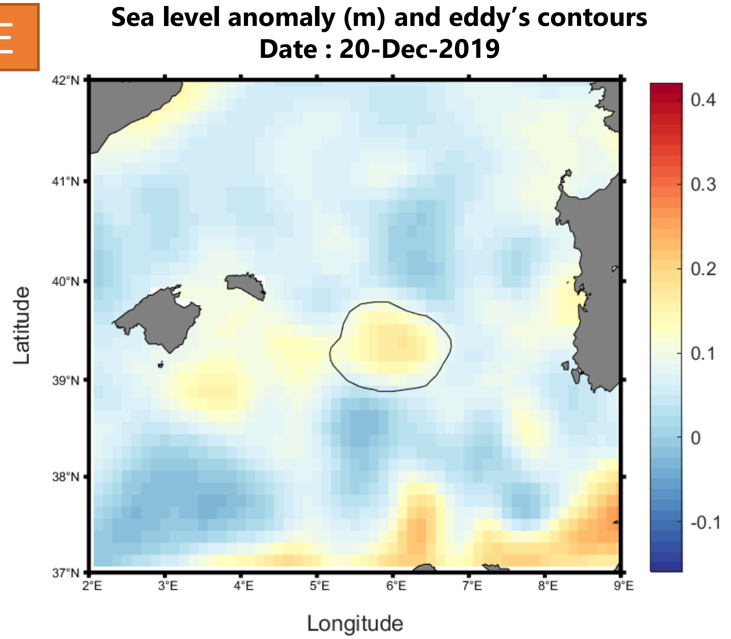
C



D



E



A = First half of April: the eddy is forming and low SLA

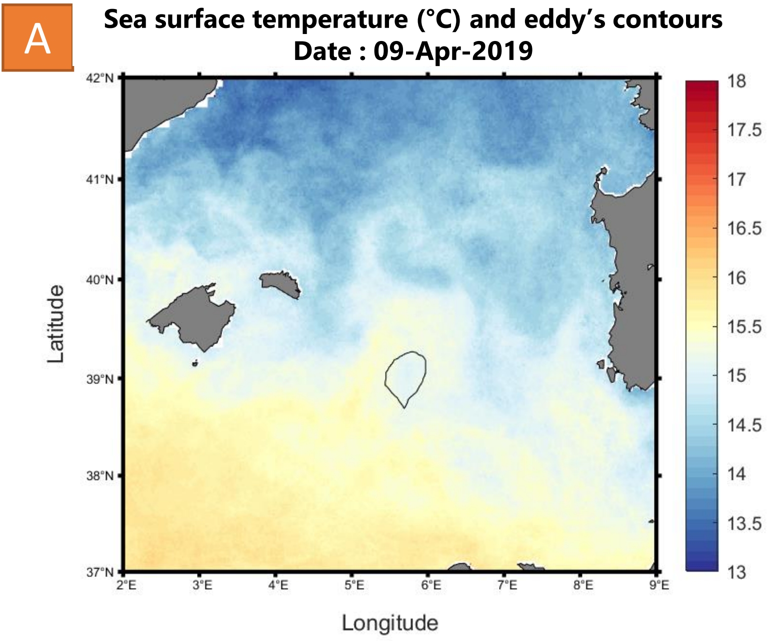
B = Second half of April: Eddy's radius and amplitude are increasing

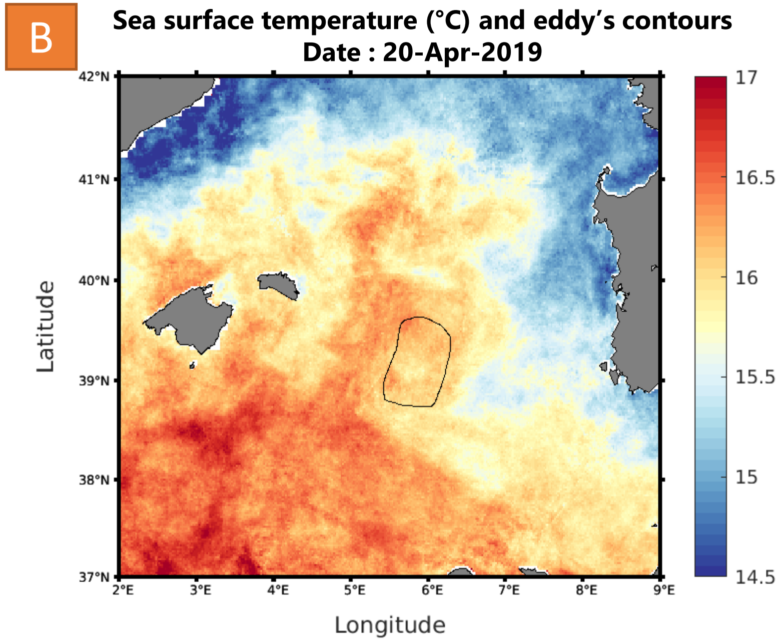
C = May to mid-June: Eddy's position is quite stable and its amplitude is still incresing. Cold period → low SLA all over the area

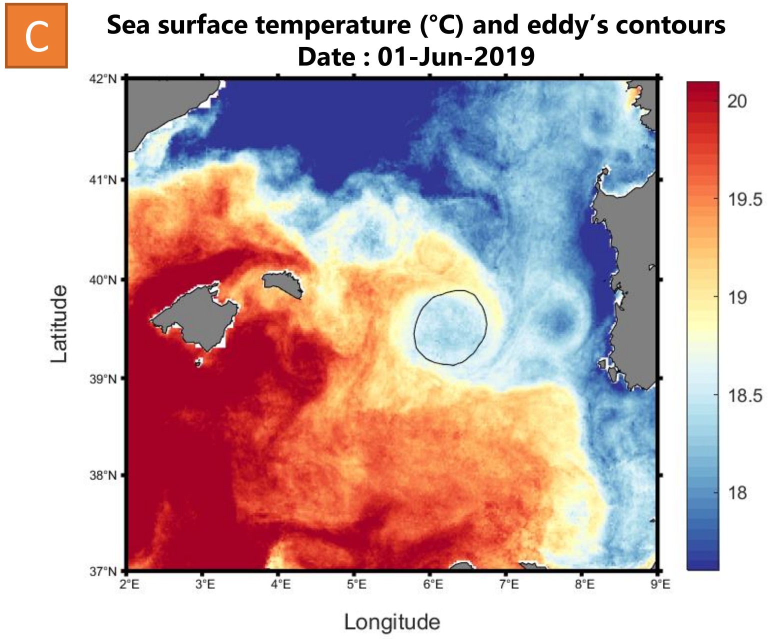
D = July to November: the eddy is relativly stable. Warm period → highSLA all over the area

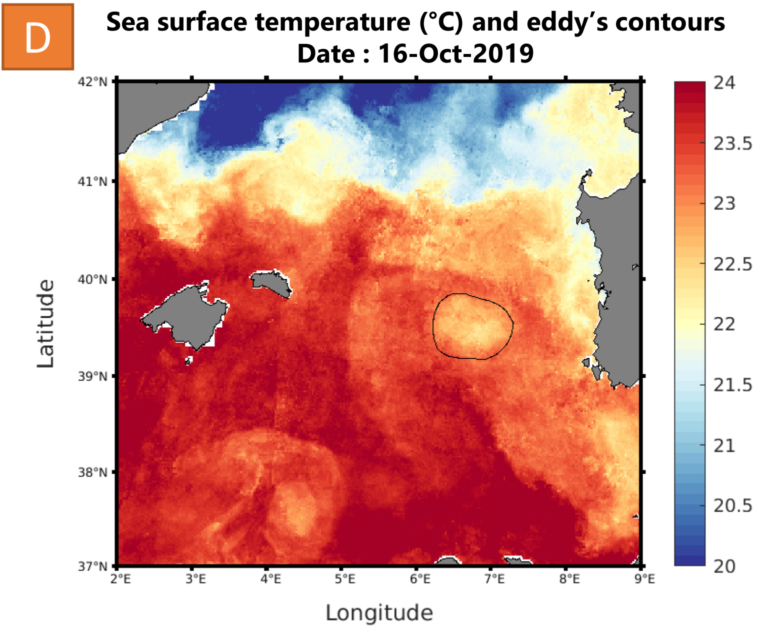
E = December: Eddy's amplitude is decreasing

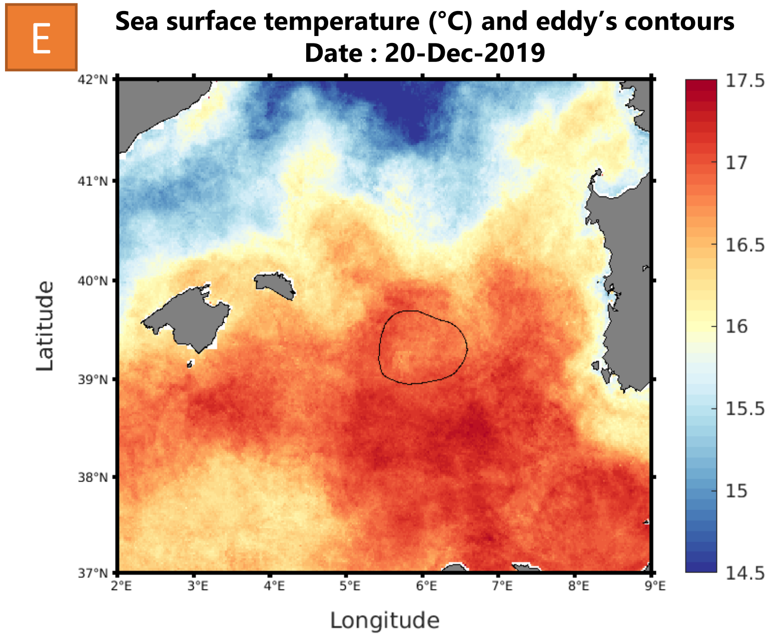
Results: Anticyclone tracking: contours overlayed with SST











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E = December: Eddy's amplitude is decreasing

Conclusion:

Large anticyclone observed with SST data from April to December 2019 but its trace has been lost in August-September

Use of sea level anomaly and an Eddy Tracker
→ Daily position known
→ Maximum amplitude = 0,22 m (2019-Jun-02)
→ Maximum radius = 66,6 km (2019-Apr-28)

References:

Alvera-Azcárate, A., Barth, A., Troupin, C., Beckers, J.-M., Evers-King, H., Pascual, A., Aguiar, E., Tintoré, J., 2020. Multiplatform analysis of a large anticyclonic eddy in the Algero-Provencal basin in 2019 (other). display. https://doi.org/10.5194/egusphere-egu2020-13744

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Mason, E., Pascual, A., McWilliams, J.C., 2014. A New Sea Surface Height–Based Code for Oceanic Mesoscale Eddy Tracking. J. Atmospheric Ocean. Technol. 31, 1181–1188. https://doi.org/10.1175/JTECH-D-14-00019.1

Mason, E., Pascual, A., Gaube, P., Ruiz, S., Pelegrí, J.L., Delepoulle, A., 2017. Subregional characterization of mesoscale eddies across the Brazil-Malvinas Confluence. J. Geophys. Res. Oceans 122, 3329–3357. https://doi.org/10.1002/2016JC012611

Datasets:

SLA: available on the CMEMS website
https://resources.marine.copernicus.eu/?option=com_csw&view=details&product_id=SEALEVEL_GLO_PHY_L4_NRT_OBSERVATIONS_008_046

SST: available on the CMEMS website
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