

The climatological Lagrangian Coherent Structures in the Black Sea: the first look.

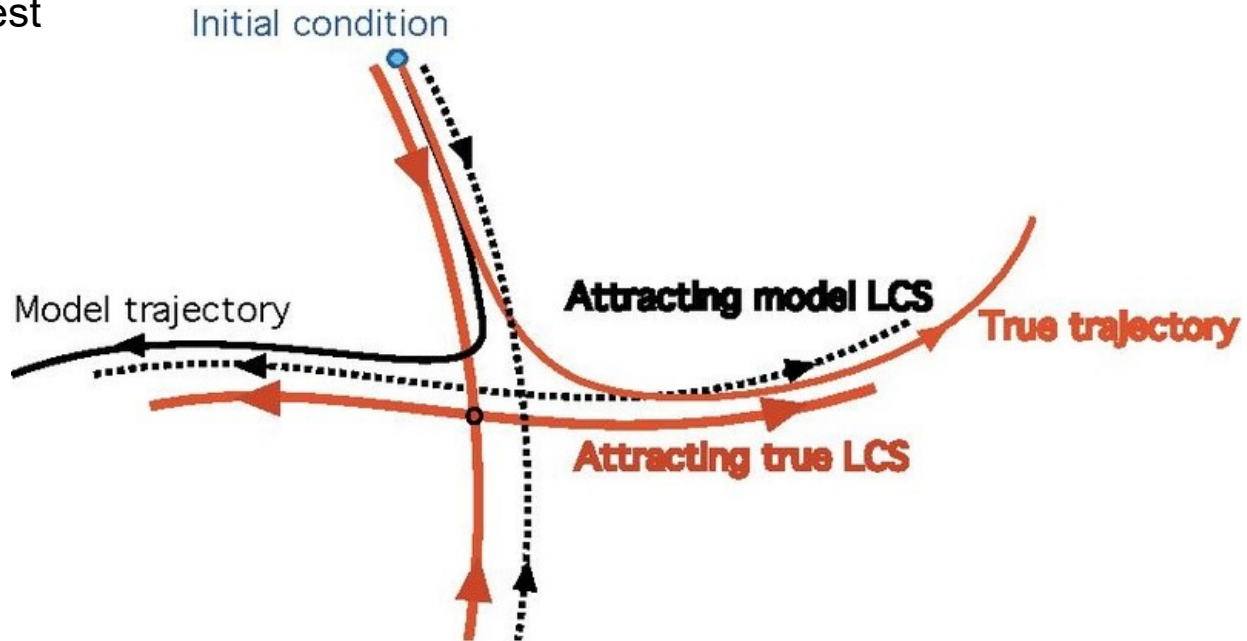


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Lagrangian coherent structures (LCSs)

- Lagrangian coherent structures (LCSs) are distinguished surfaces of trajectories in a dynamical system that exert a major influence on nearby trajectories over a time interval of interest



Why use the cLCS method?

Duran, R., Beron-Vera, F. J., & Olascoaga, M. J. (2018). Extracting quasi-steady Lagrangian transport patterns from the ocean circulation: An application to the Gulf of Mexico. *Scientific reports*, 8(1), 1-10.

Gouveia, M. B., Duran, R., Lorenzetti, J. A., Assireu, A. T., Toste, R., de F. Assad, L. P., & Gherardi, D. F. M. (2021). Persistent meanders and eddies lead to quasi-steady Lagrangian transport patterns in a weak western boundary current. *Scientific reports*, 11(1), 497.

- To identify persistent and recurring transport pathways of passive tracers, particles (like phytoplankton, oil spills, or marine debris), eddies, jet structures, and natural barriers.
- To quantify and identify isolated or low-attraction regions.
- To create a climatology that serves beyond the computed period.



Credit: Nasa Earth Observatory



Sea pollution concept with plastic bottles in a dirty water in romania, black sea coast

<https://www.dreamstime.com/royalty-free-stock-image-pollution-black-sea-coast-romania-image23311766>

60 migrants rescued off Romania's Black Sea coast

Experts warn the crossing is far more dangerous than the Mediterranean Sea because of fierce thunderstorms

Alp | November 28, 2017

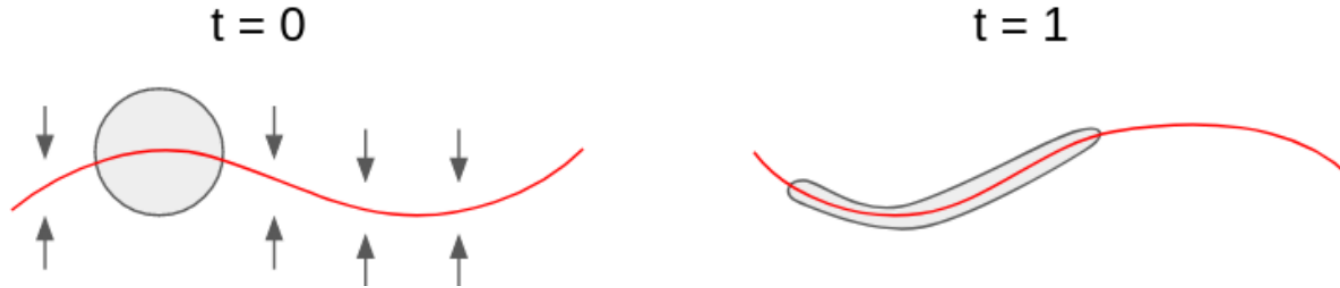


File Photo: Migrants are seen on a capsizing boat before a rescue operation by Italian navy ships 'Delfino' and 'Bergamini' off the coast of Libya in this handout picture released by the Italian Marina Militare on May 25, 2016. PHOTO: REUTERS

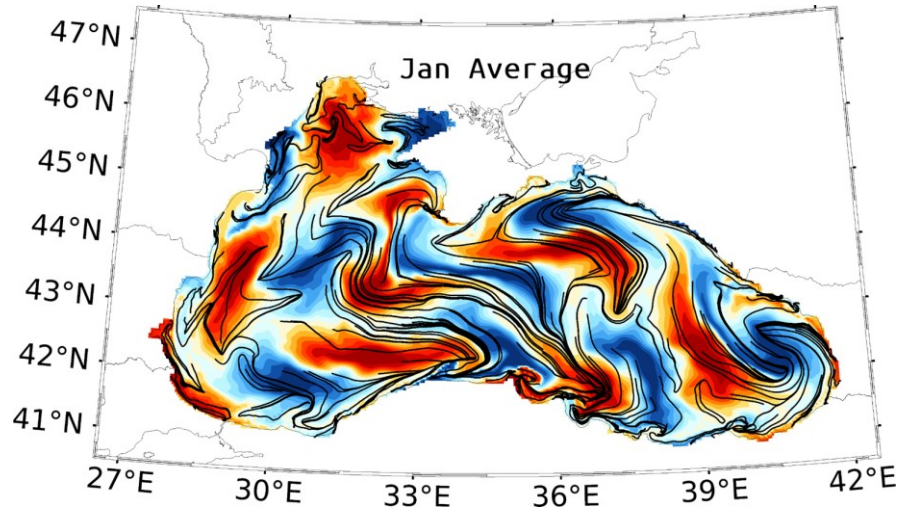
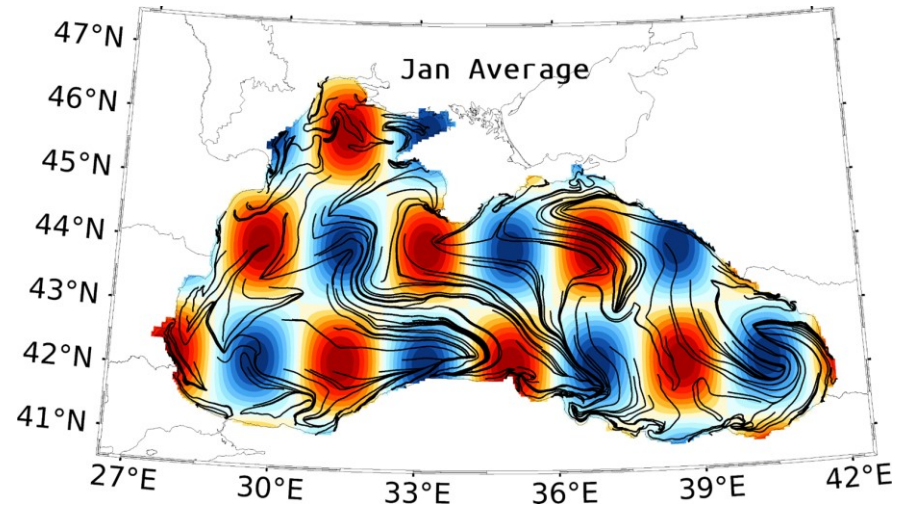
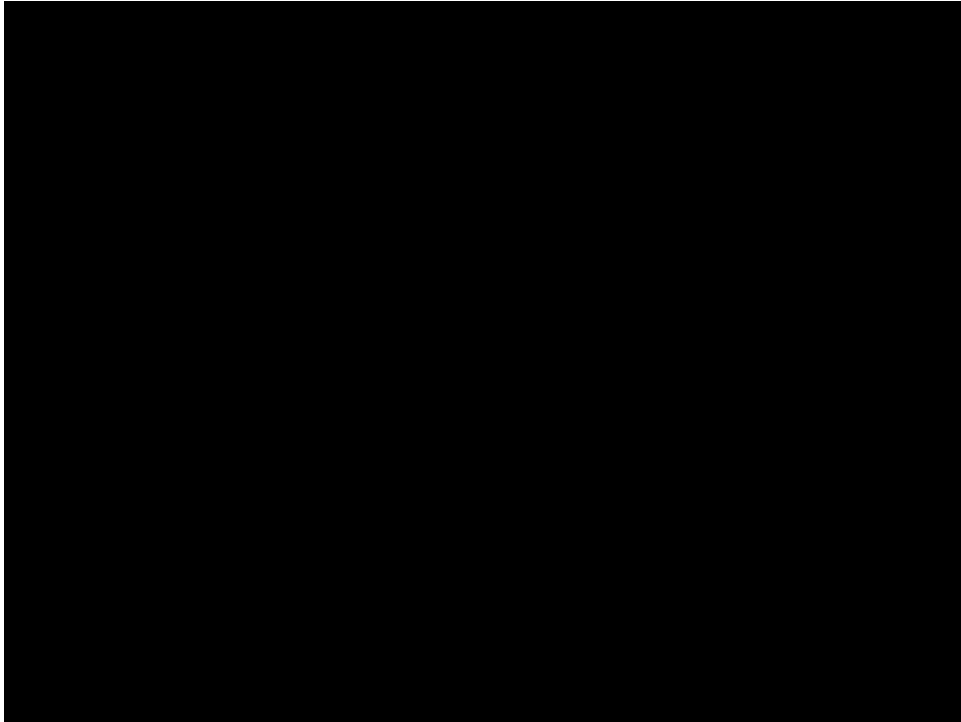
<https://tribune.com.pk/story/1570749/3-60-migrants-rescued-off-romaniias-black-sea-coast/>

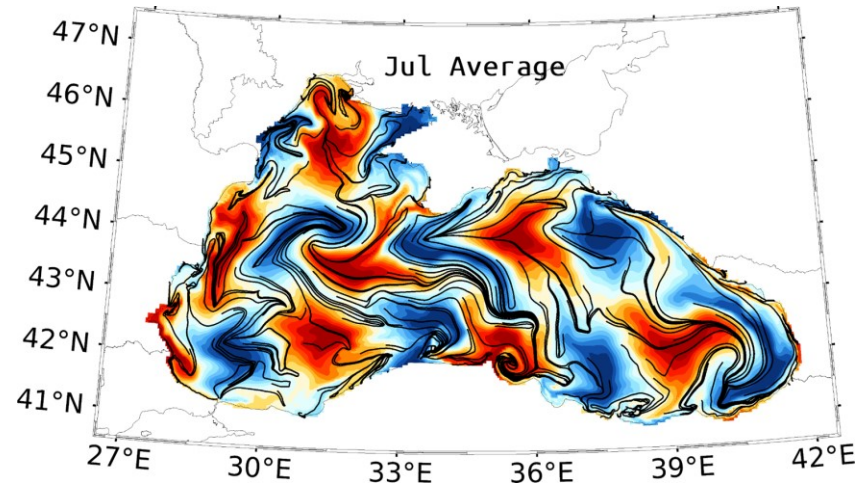
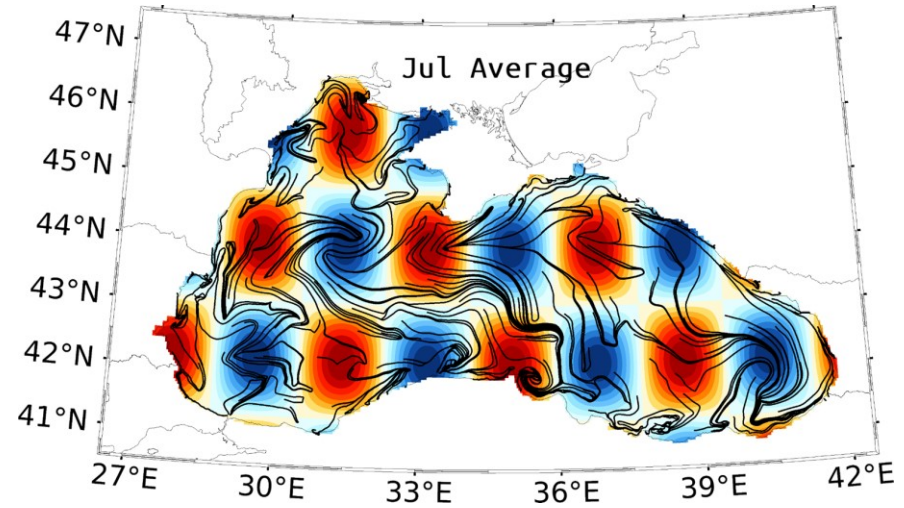
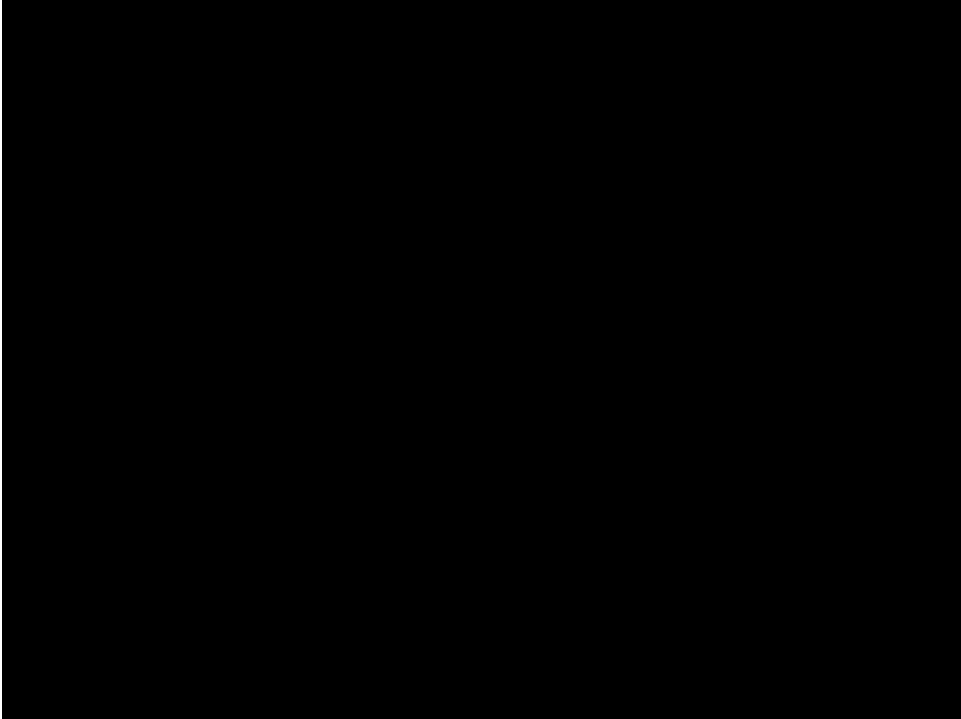
How does the tool work?

- The climatological LCS identifies and quantifies the persistent and recurrent attracting material line (squeezelines) that plays the dominant role in attracting neighboring fluid elements onto itself.

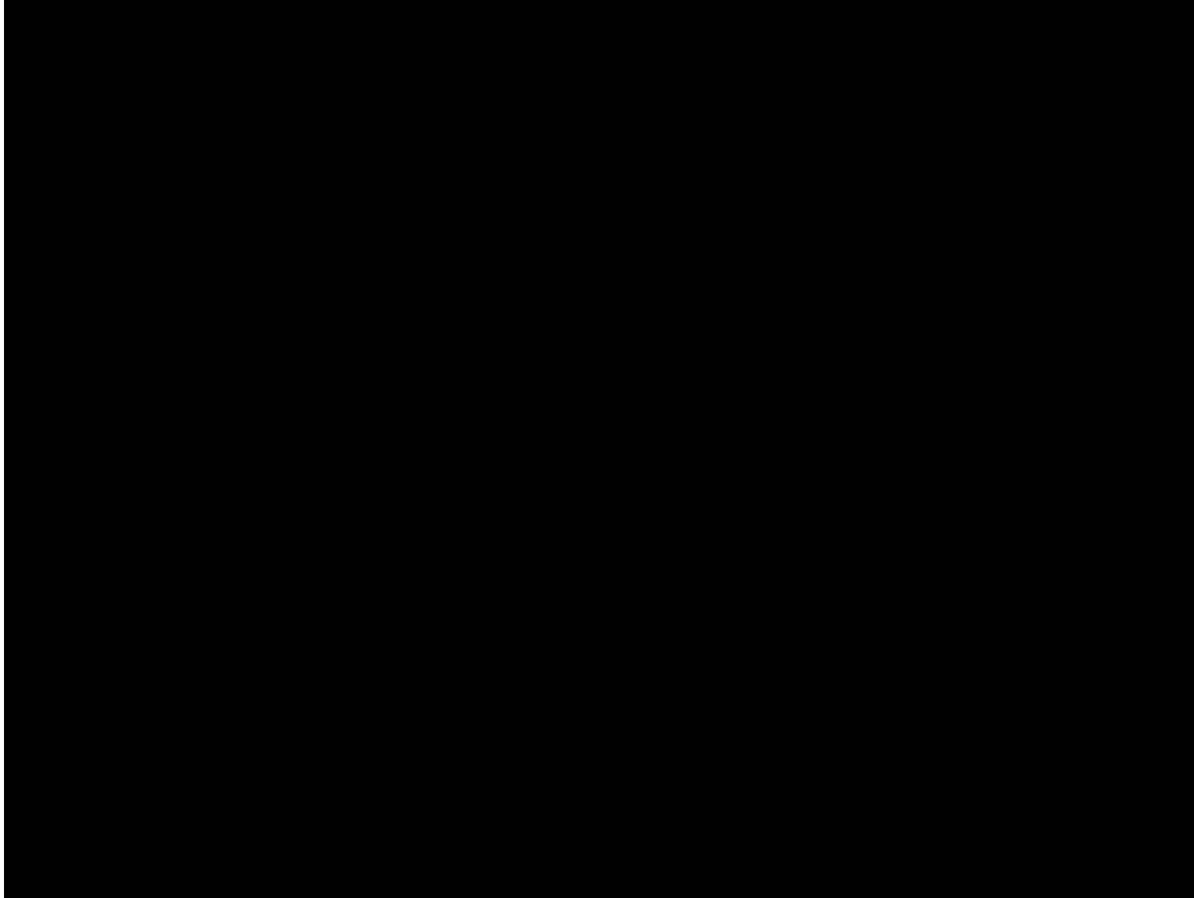


- This squeezelines are objective (frame-independent), robust to sparse and noisy data.
- The geometric approach of cLCS can identify and quantify the flow transport pathway without contemplating the forecasting of the individual trajectories of passive tracers and particles.



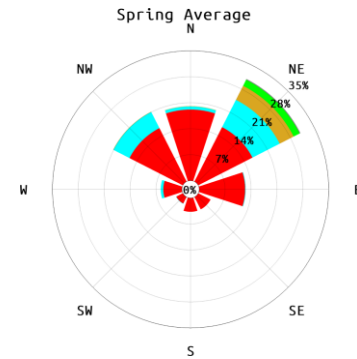
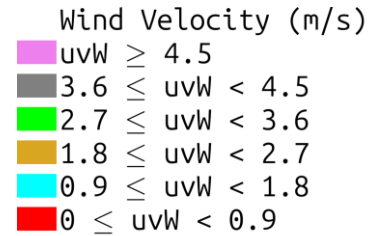
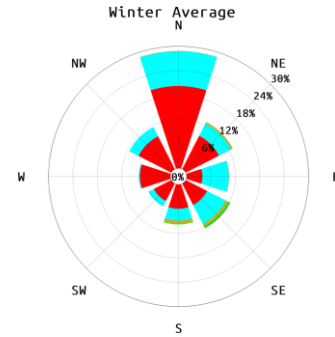
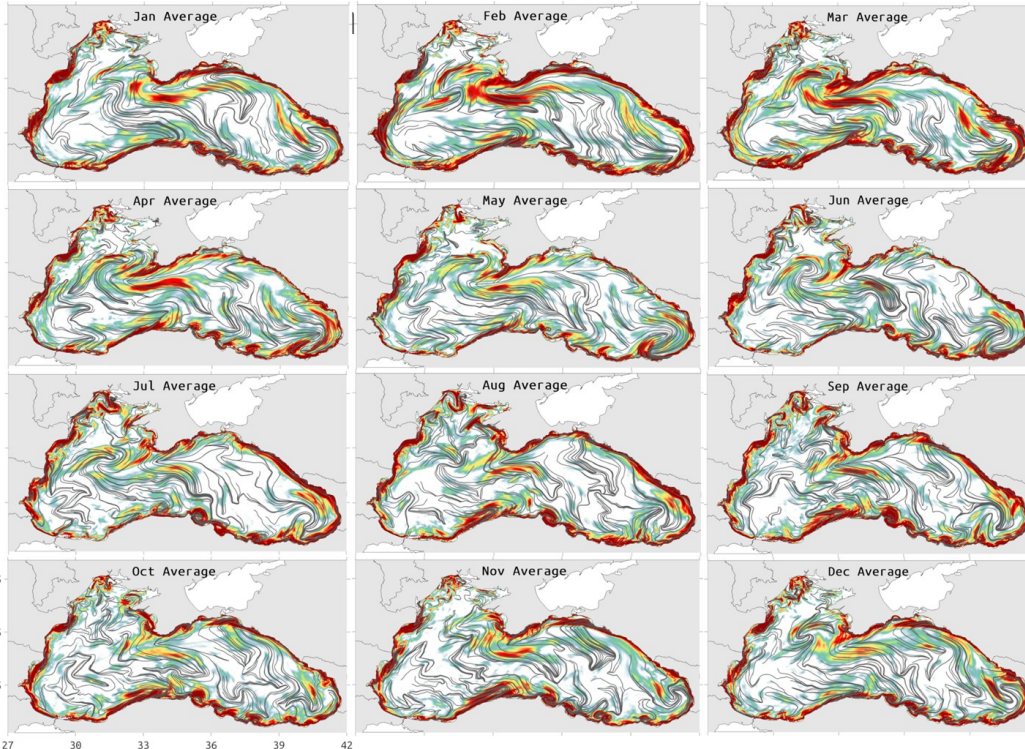


A real case similar as before

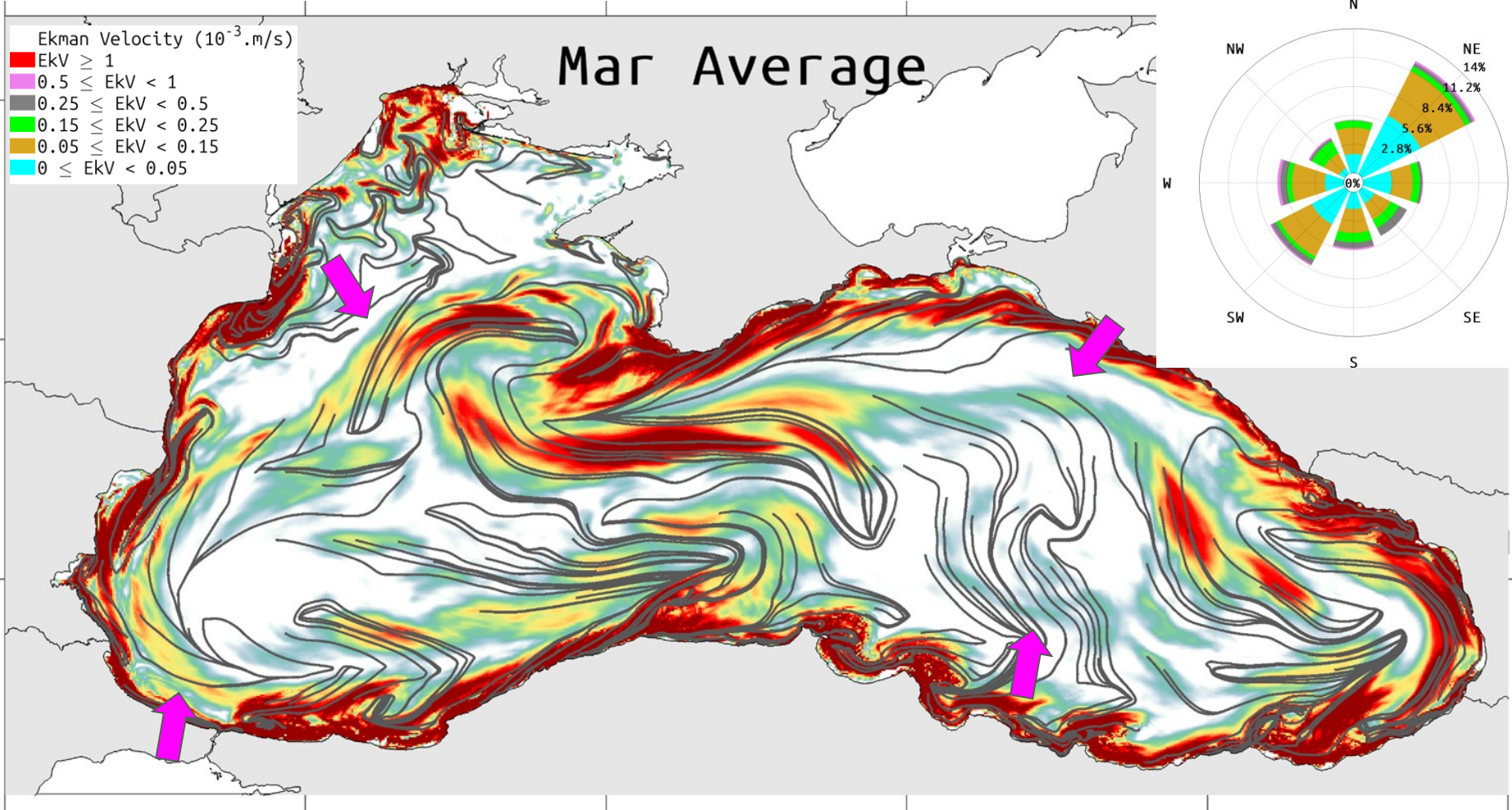


Lagrangian characterization of surface transport in the Black Sea

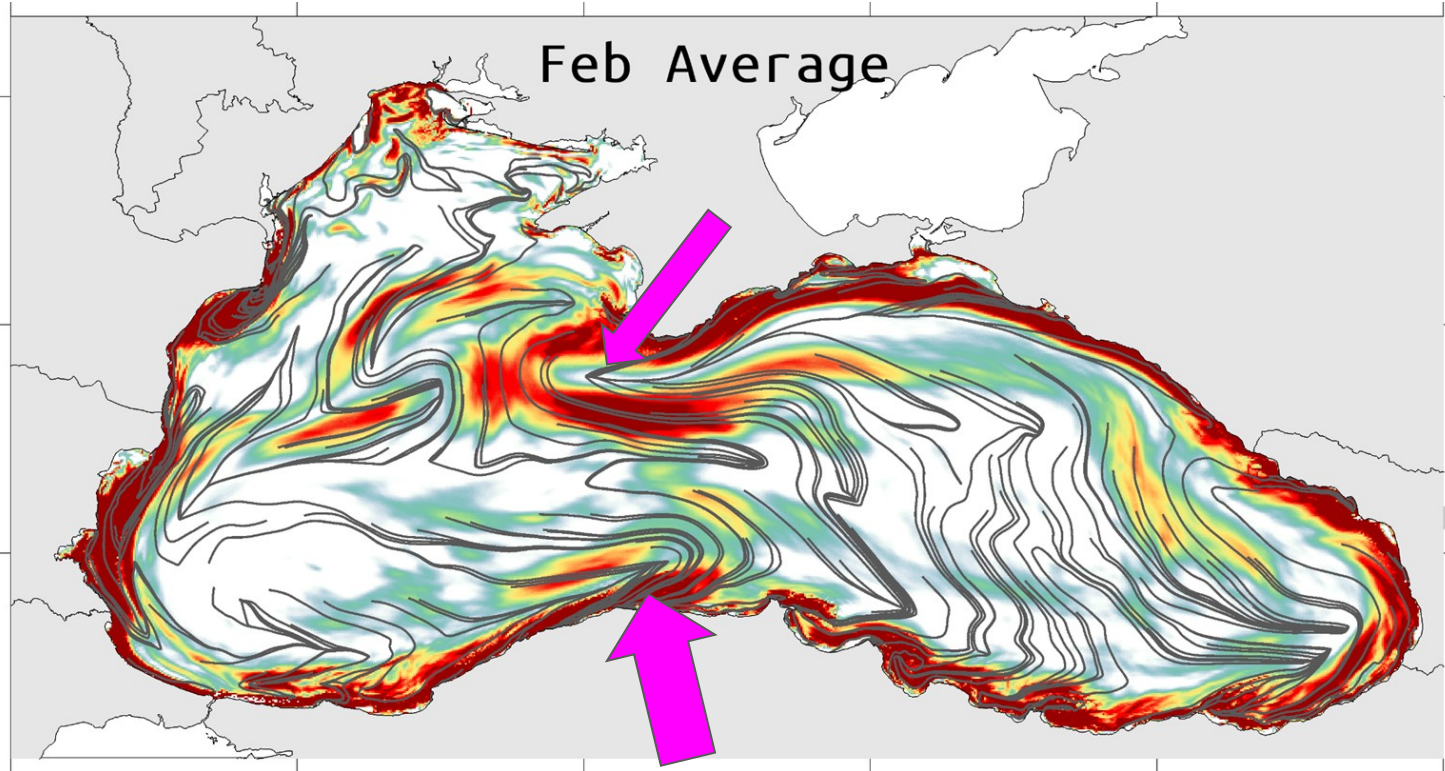
The seasonal variability of the Rim Current has a high climatological attraction strength from

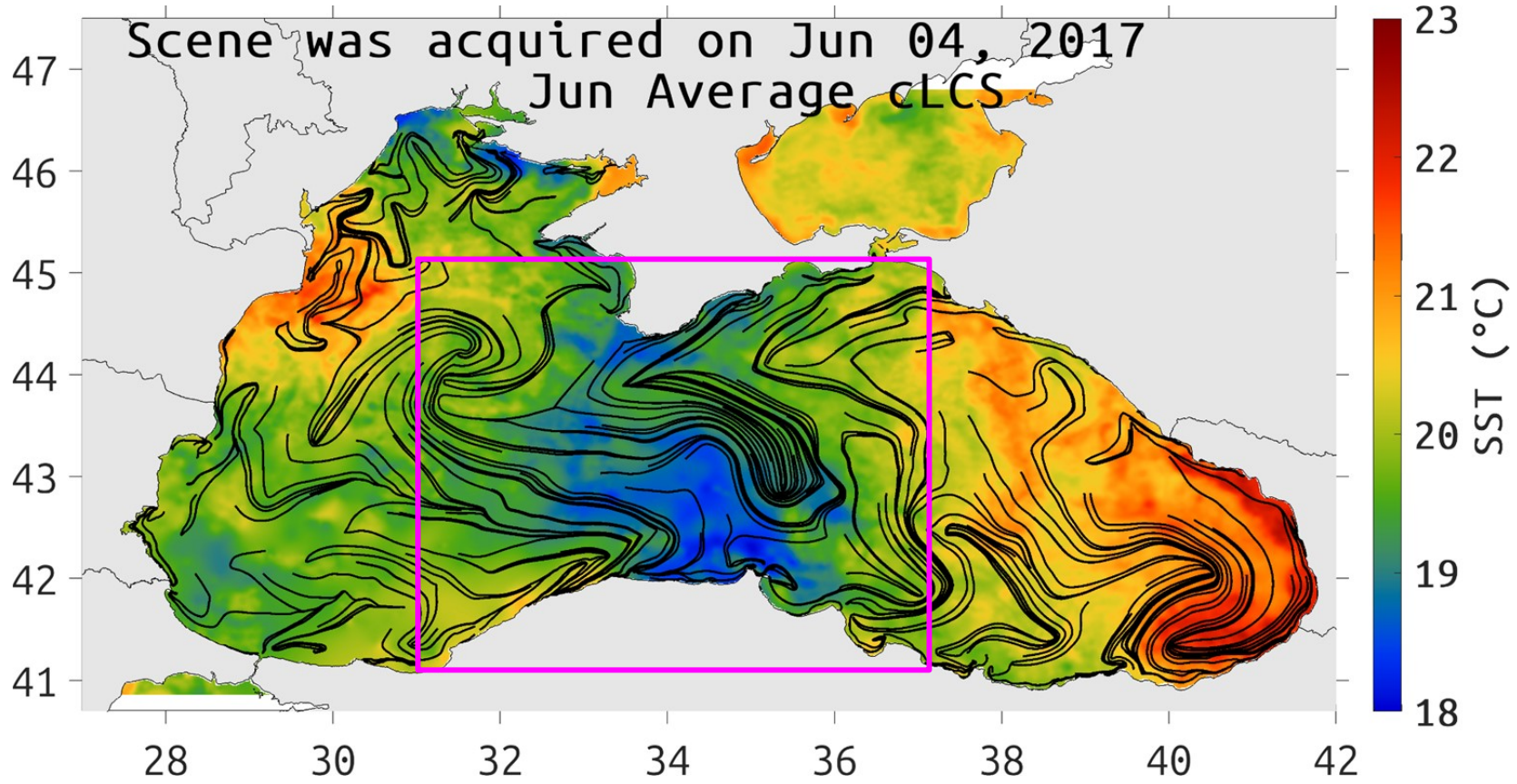


Mar Average

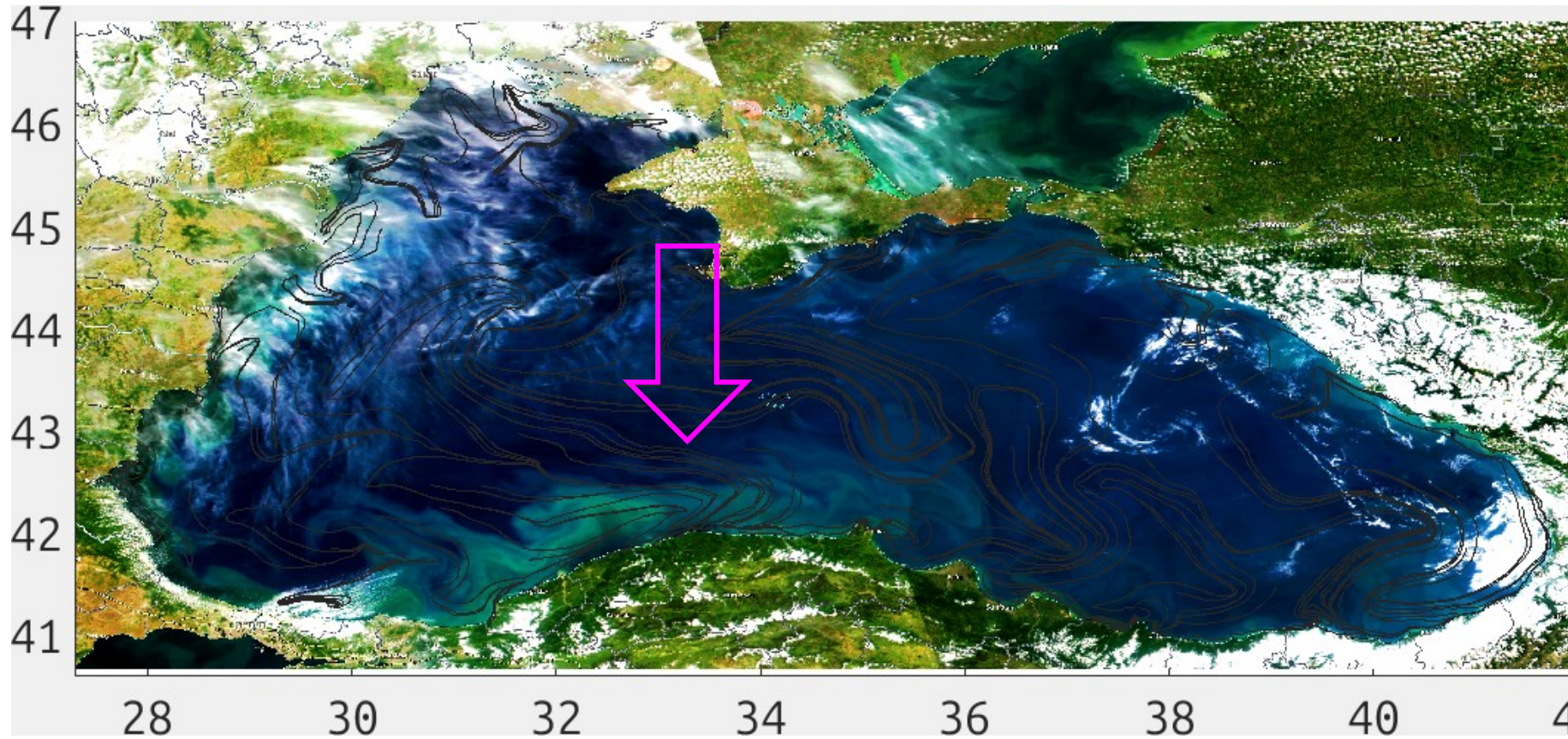


With two well-defined and highly attractive strength jet structures. The jet structure in the center-north (near Sevastopol) is well-defined and highly attractive throughout the year. In contrast, the jet structure located in the center-south (near Baltasi) has high attraction from August to November and February.

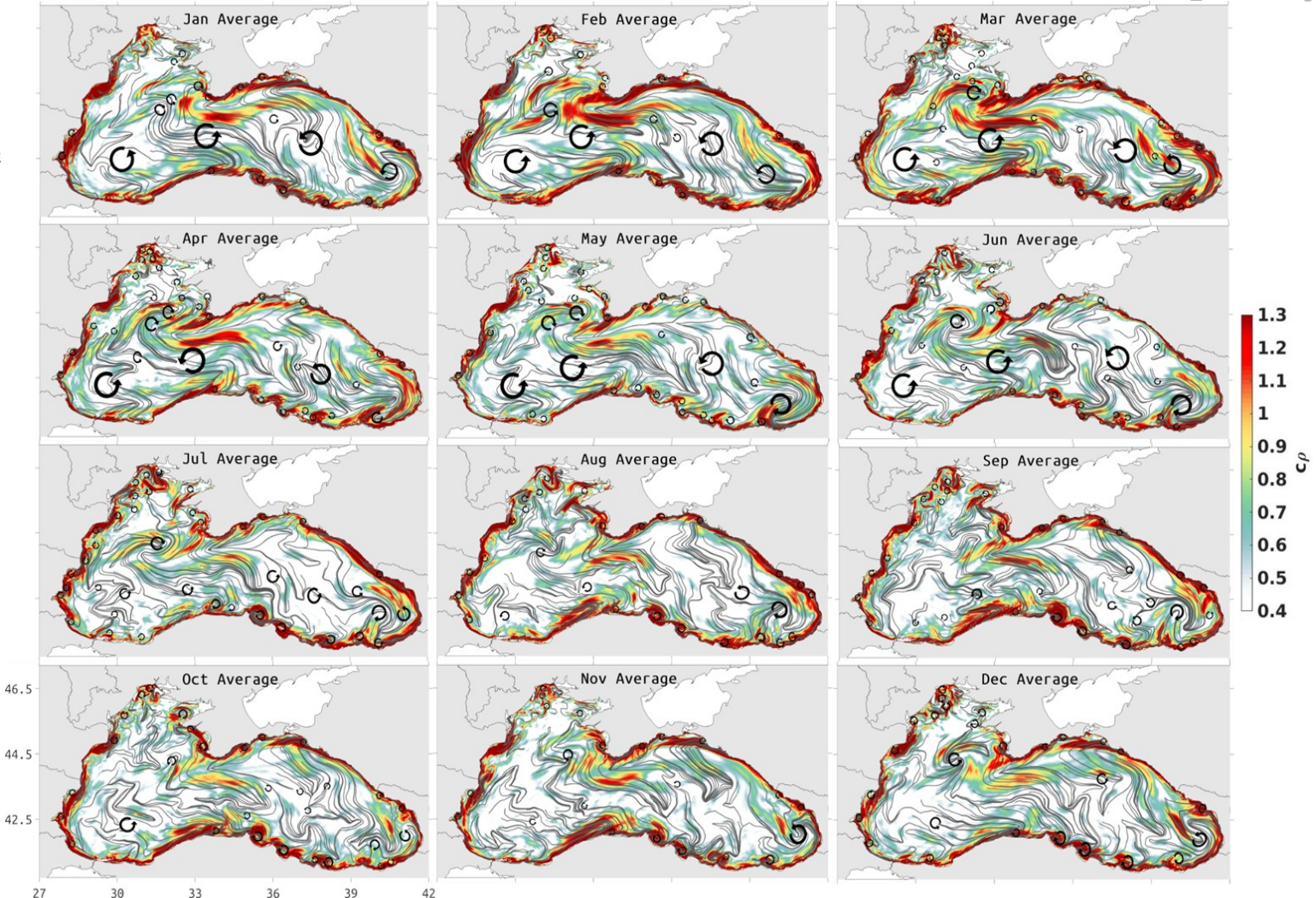




Scene was acquired on Jun 07, 2023

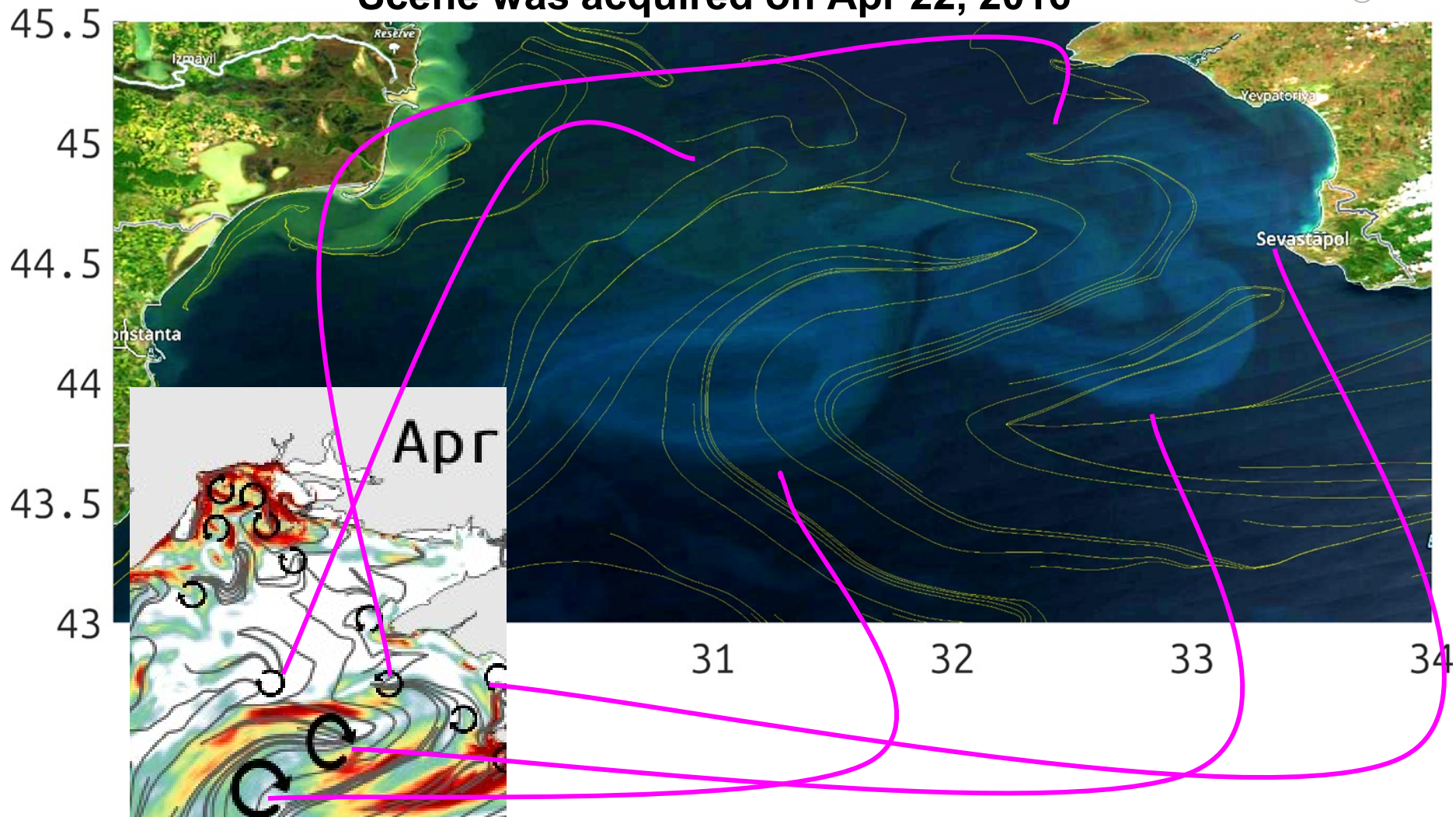


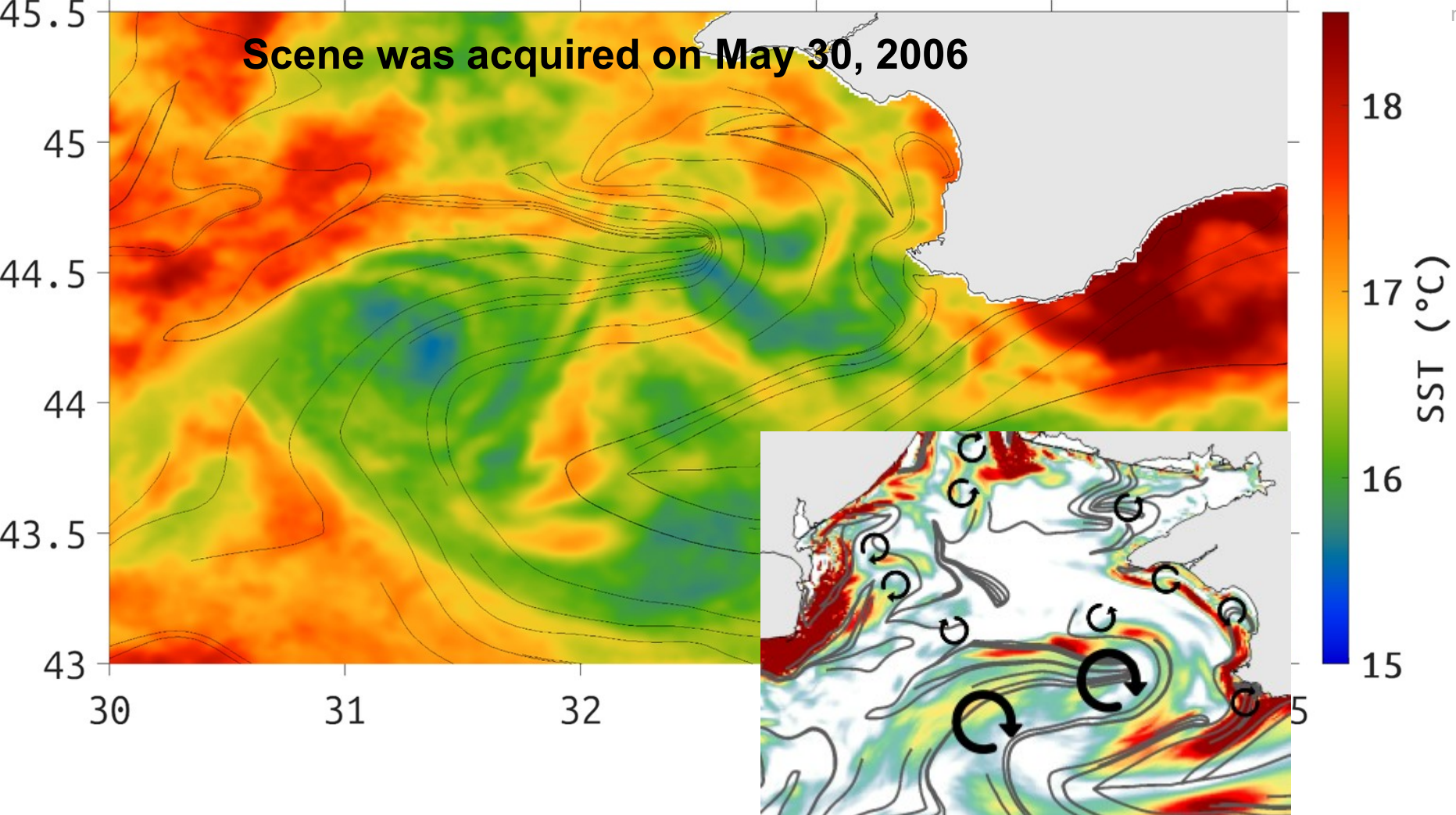
The Basin comprises numerous cyclonic and anticyclonic structures, meanders, and eddies all year round.



Scene was acquired on Apr 22, 2016

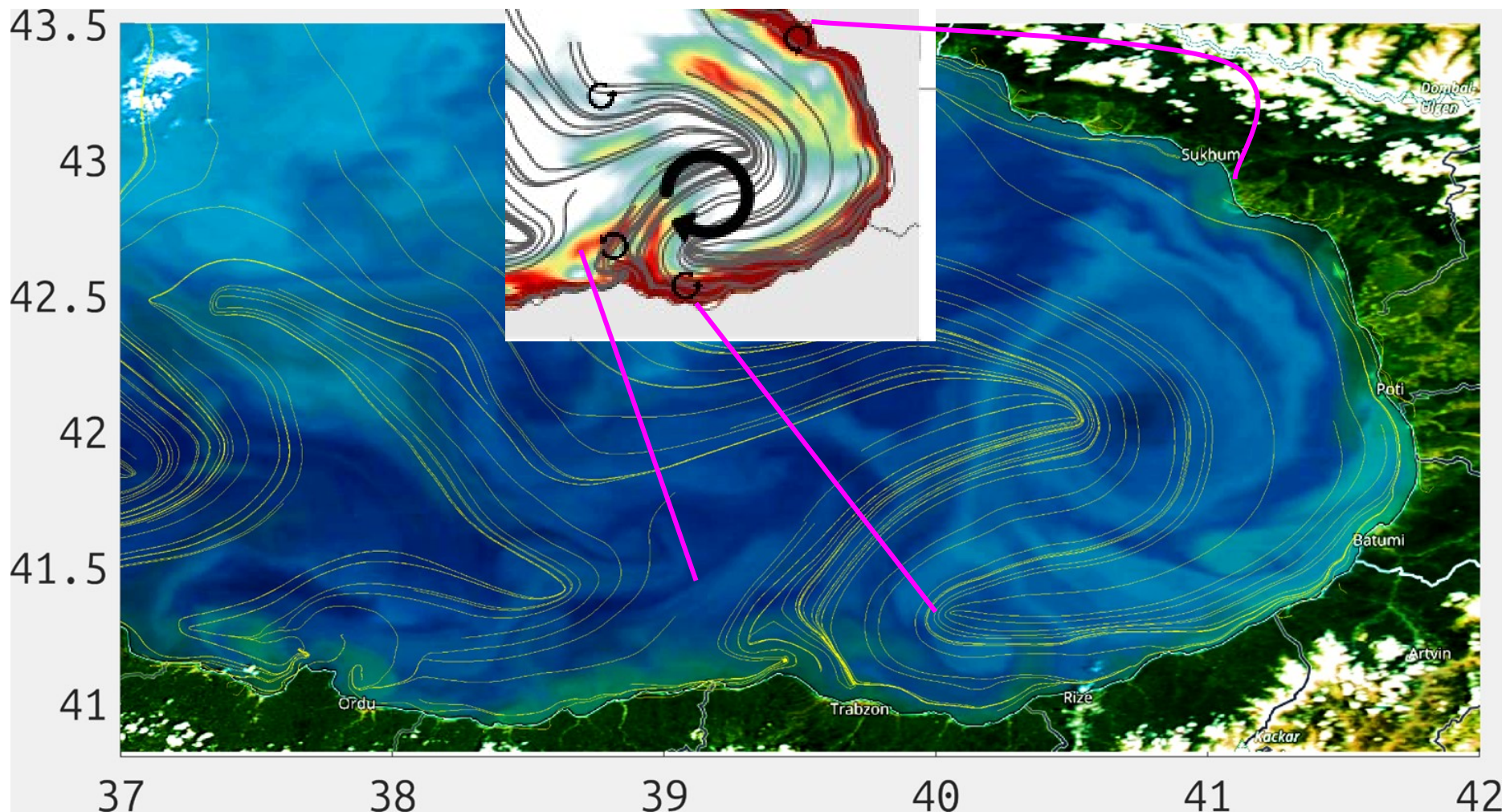
@mainarabg



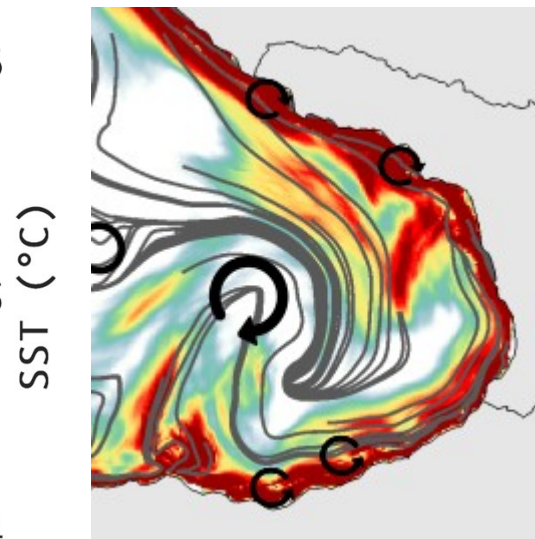
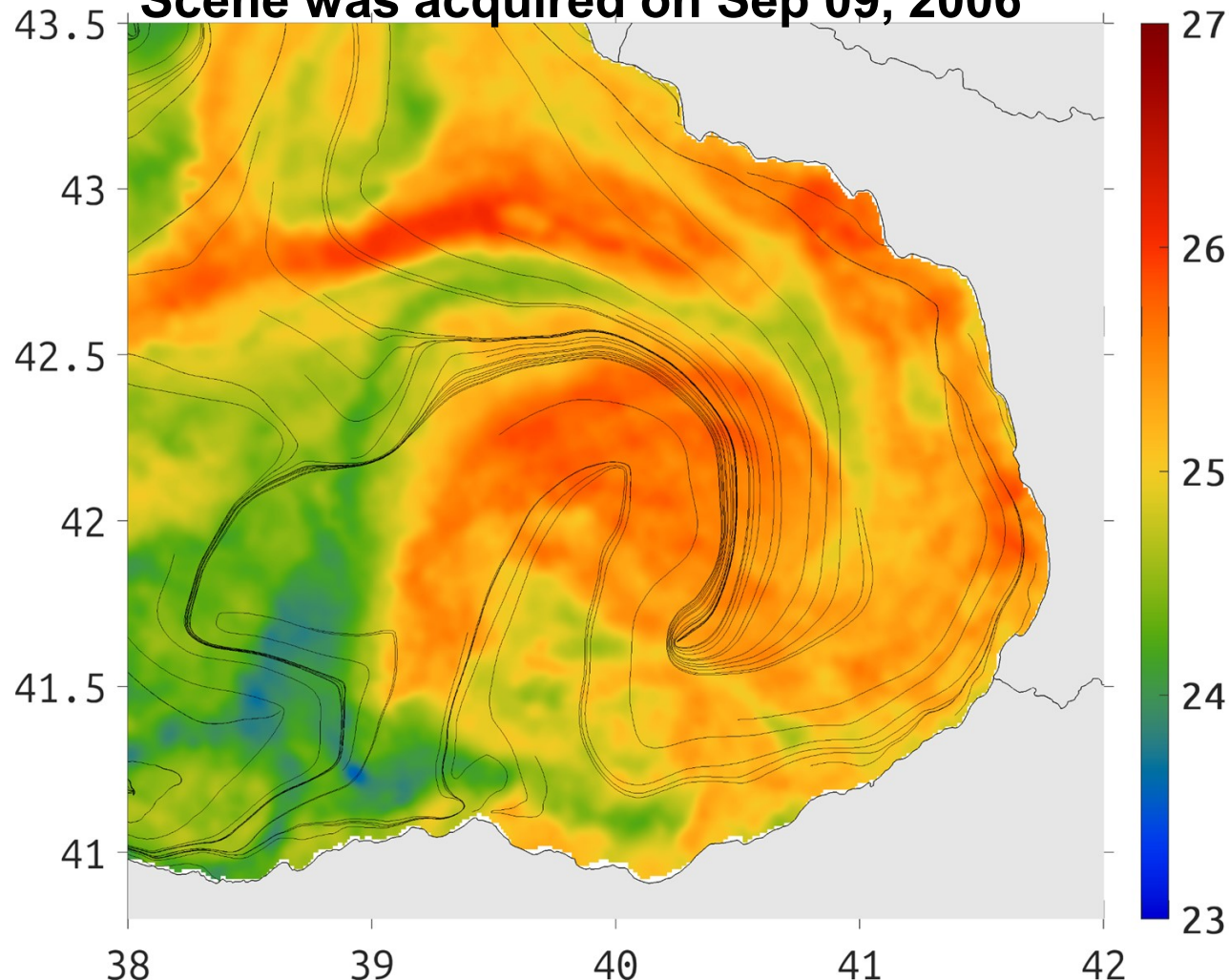


Scene was acquired on Jun 02, 2006

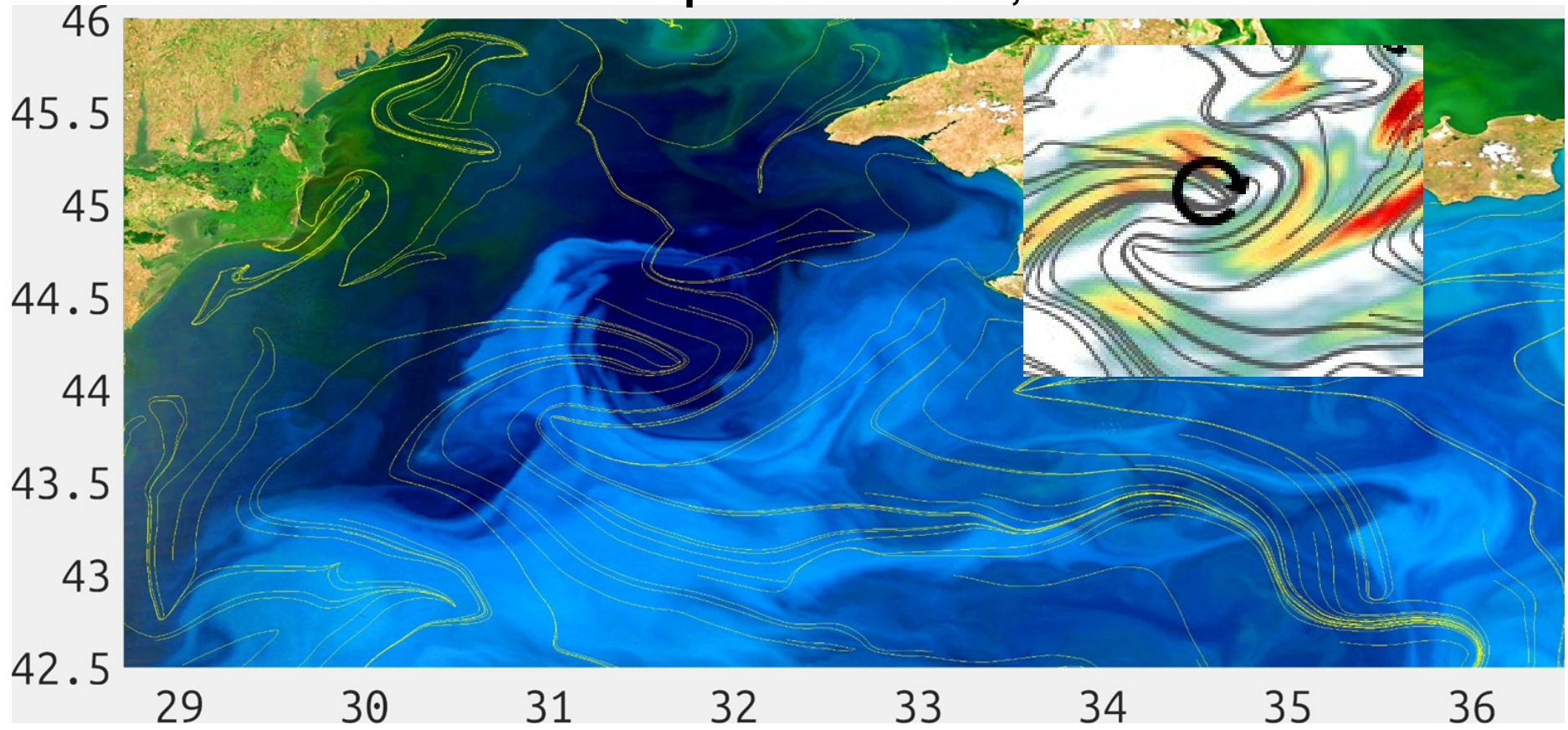
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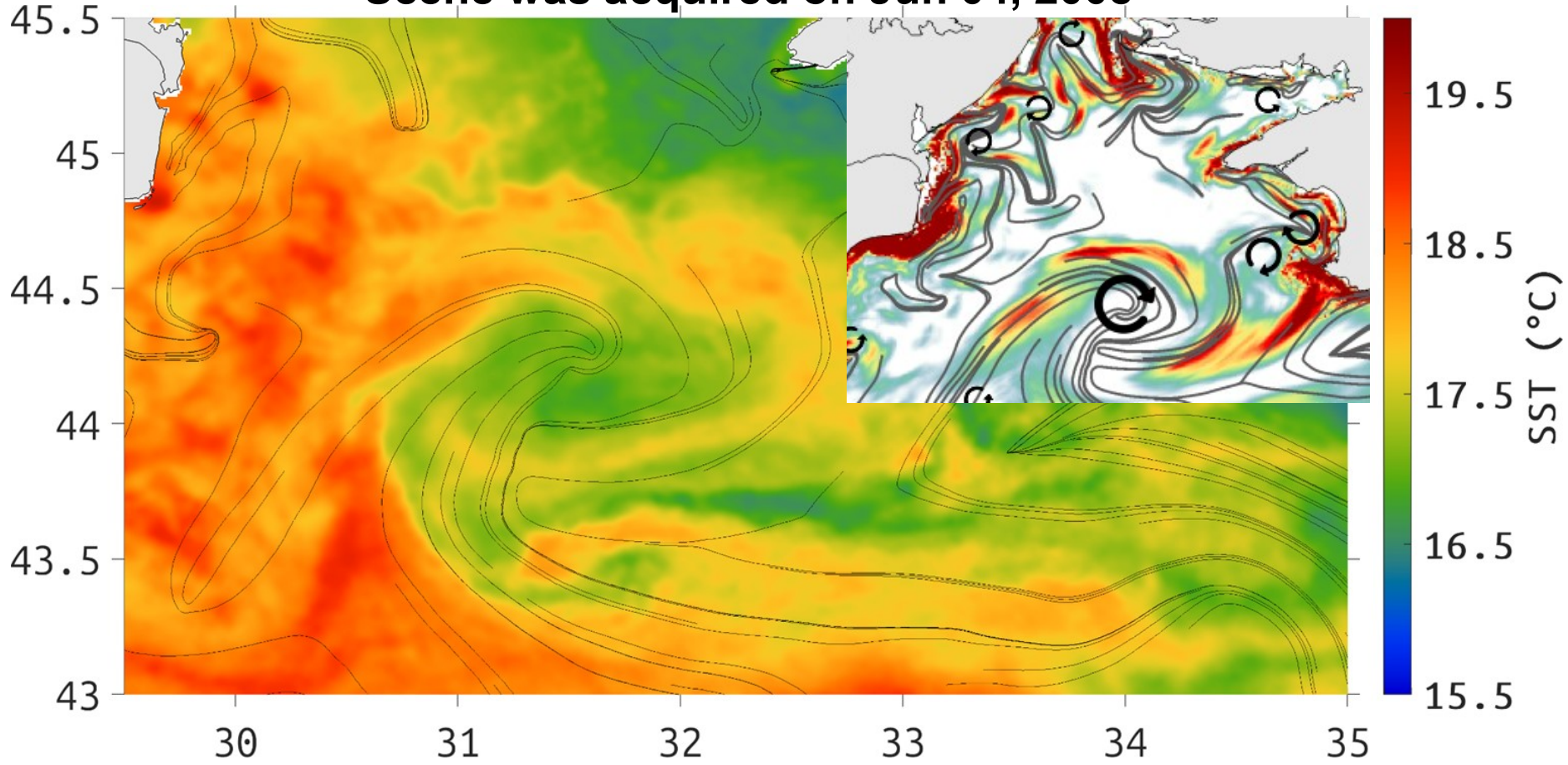
Scene was acquired on Sep 09, 2006



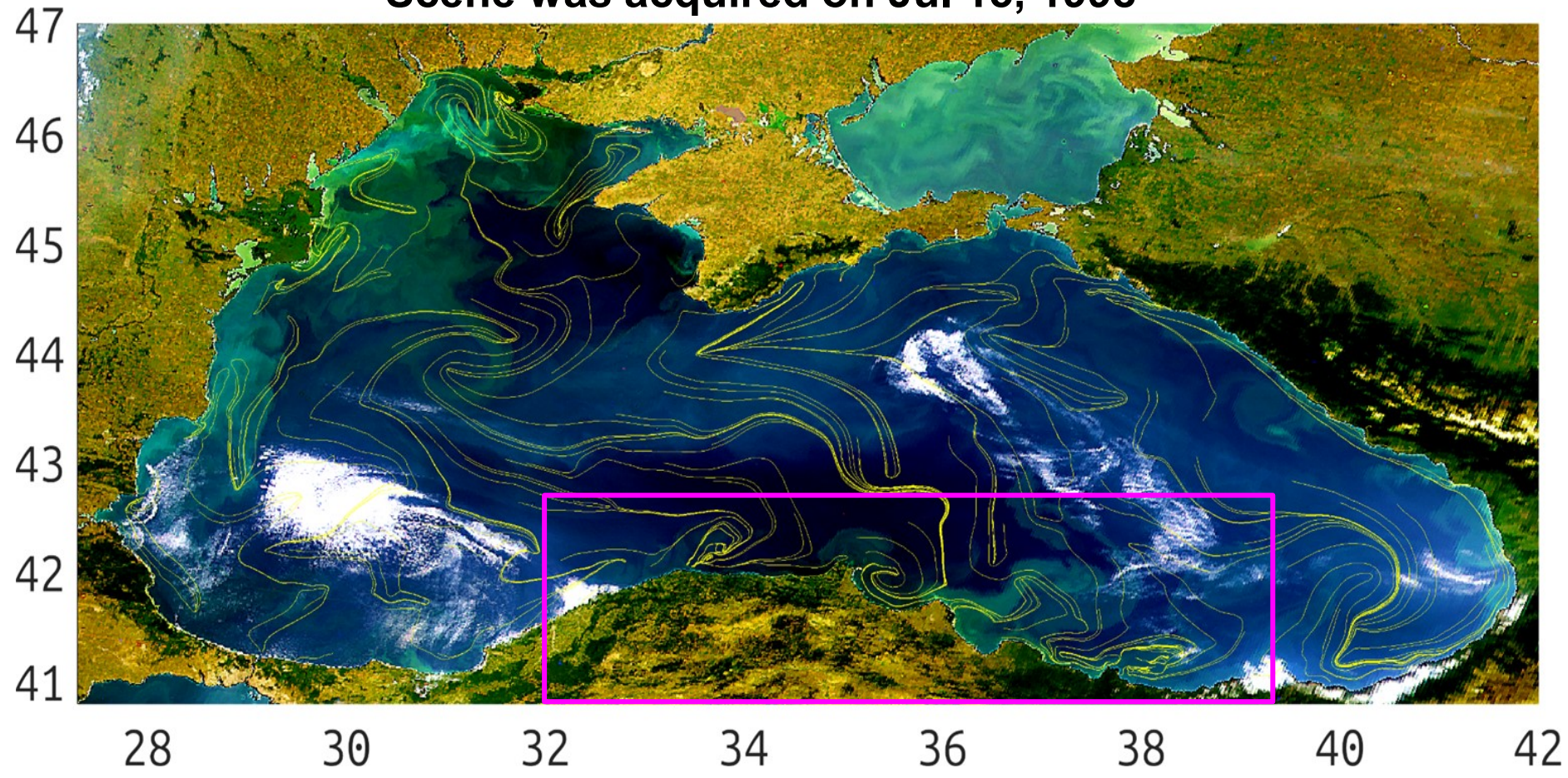
Scene was acquired on Jul 31, 2012



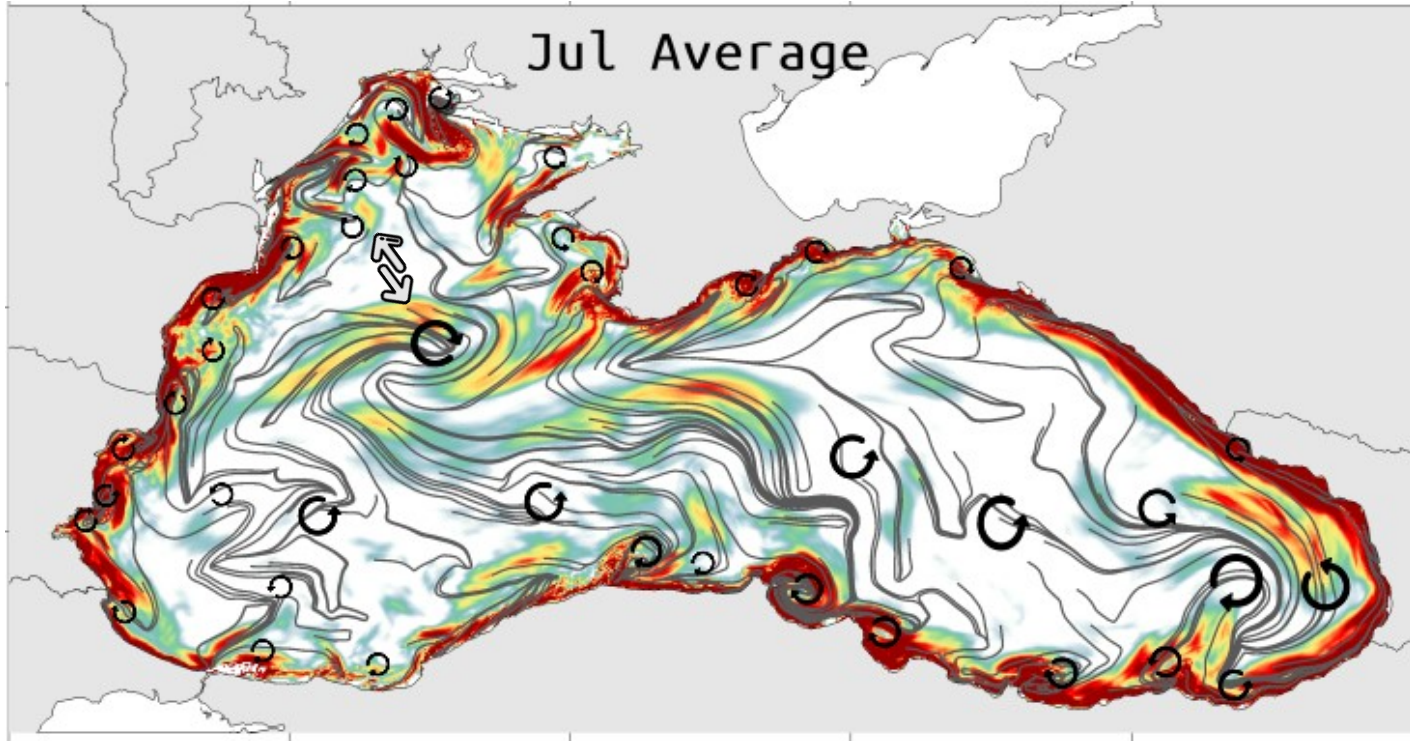
Scene was acquired on Jun 04, 2008



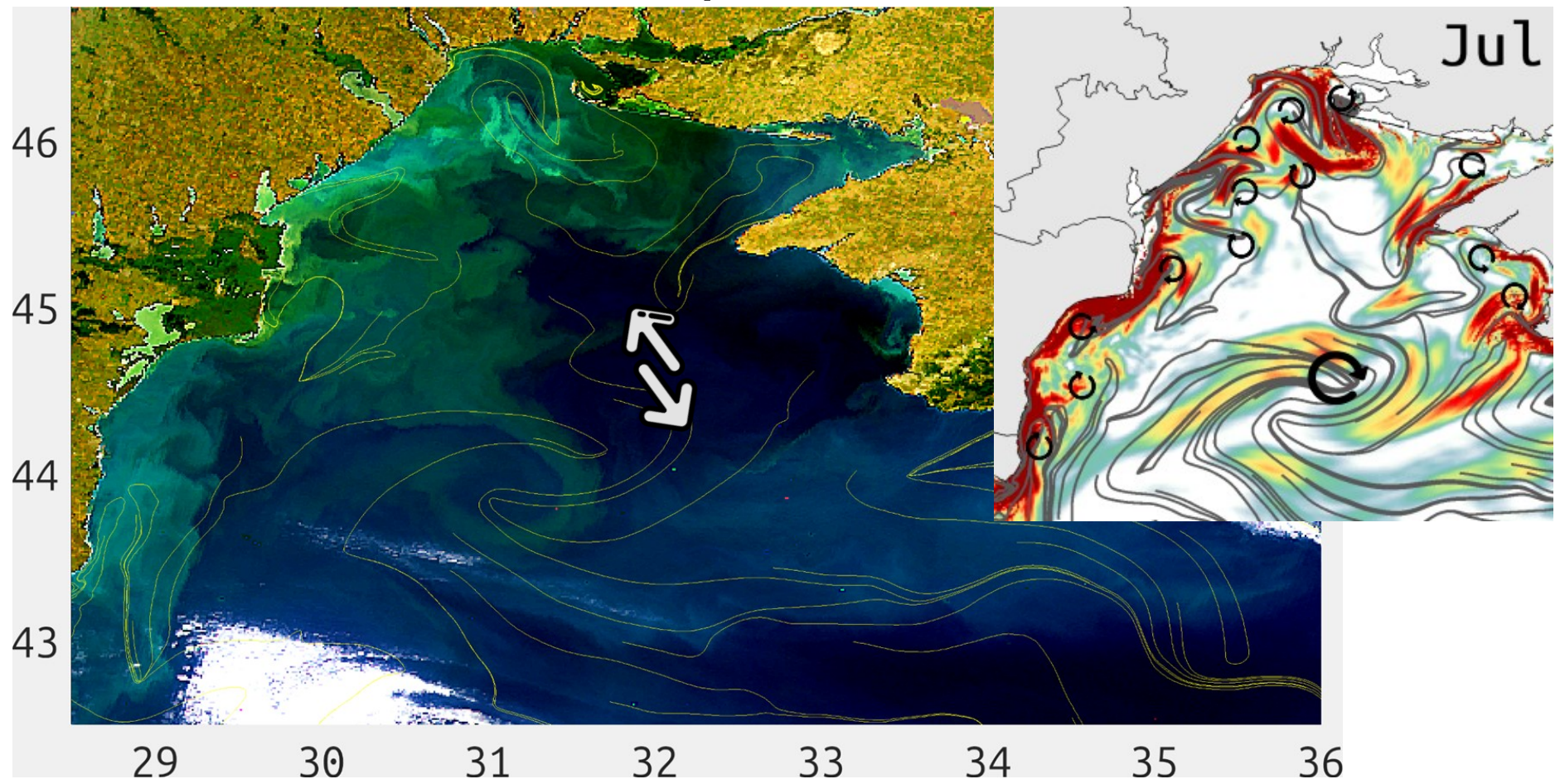
Scene was acquired on Jul 15, 1998



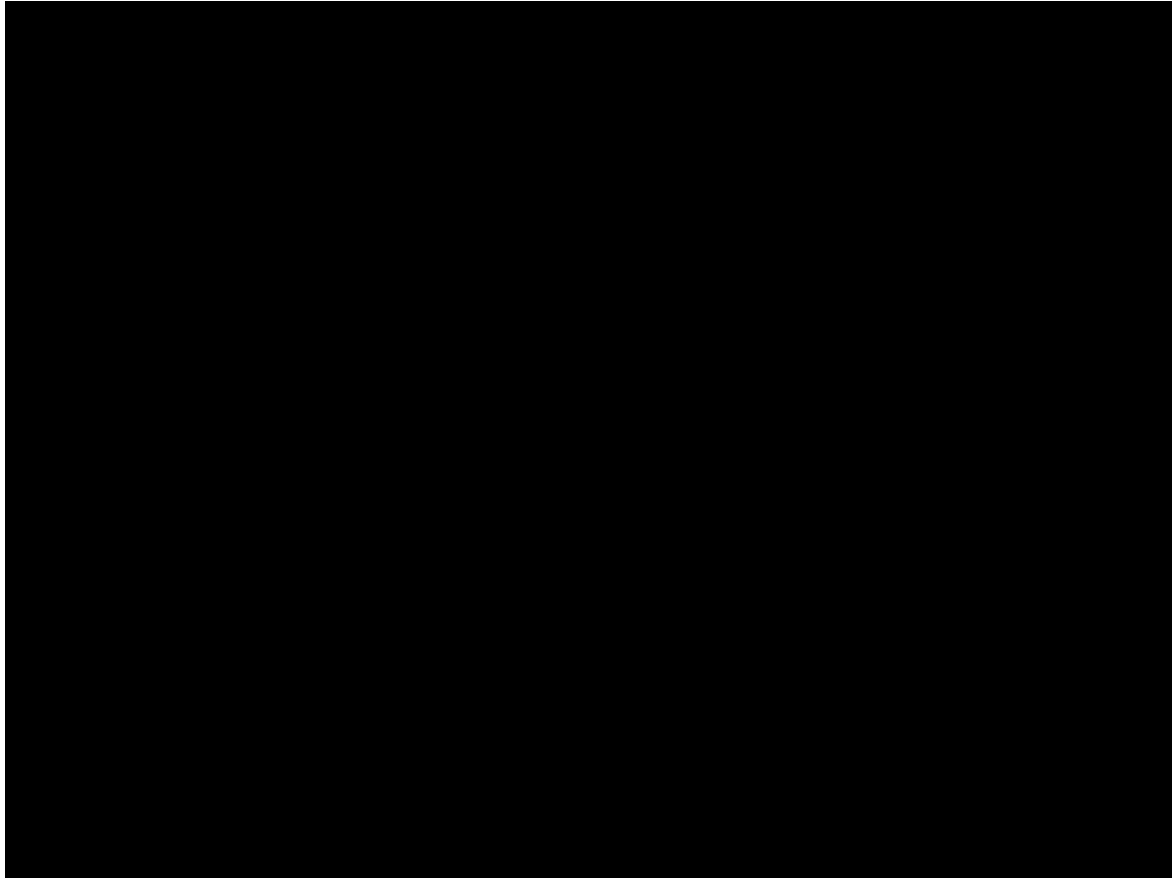
A cross-shelf transport in the northwest throughout the year, whose dance of the eddies (with high attraction strength) to the Rim Current is well-identified by the squeezelines.



Scene was acquired on Jul 15, 1998

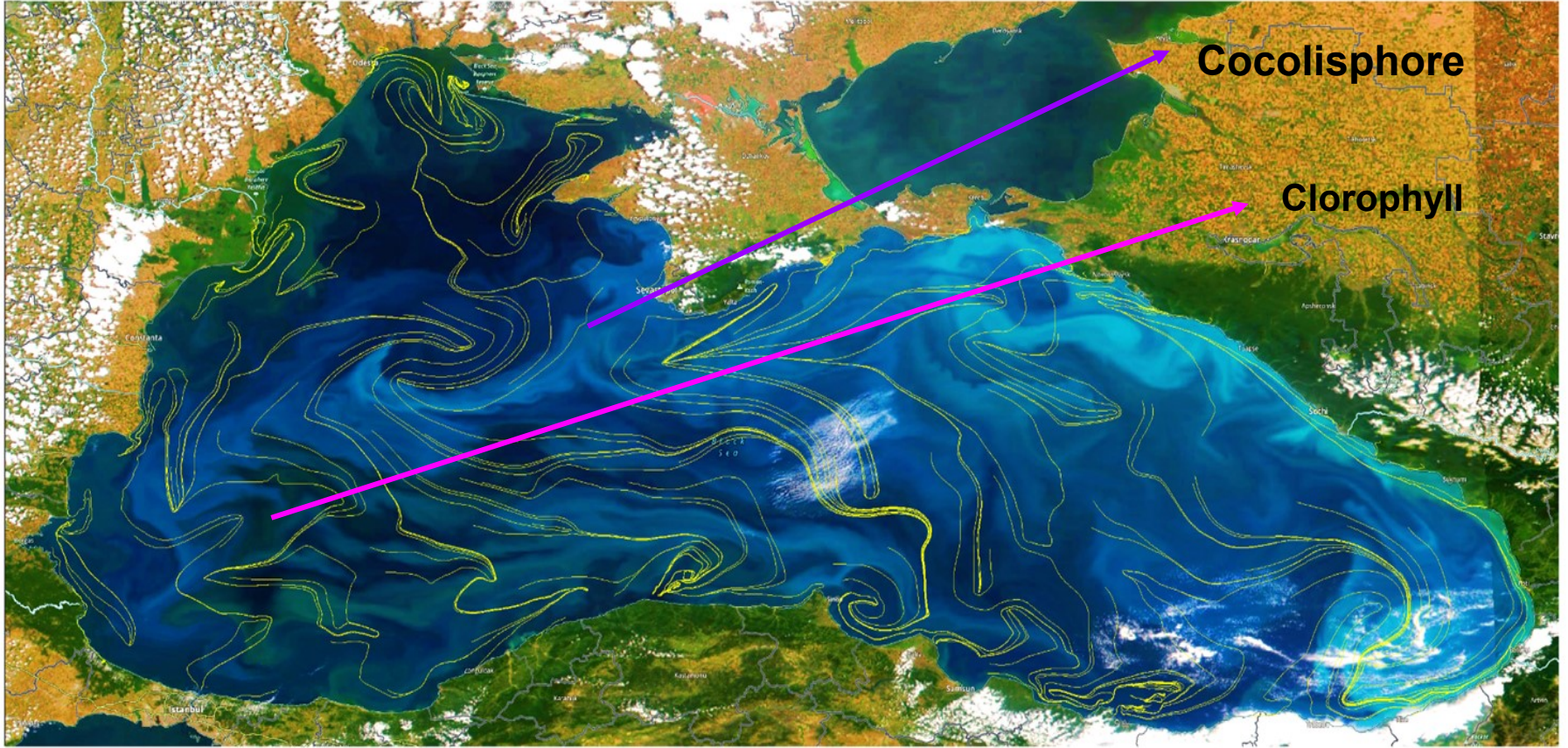


Point cocolisphores routes



Scene was acquired on Jul 06, 2022

47
46
45
44
43
42
41

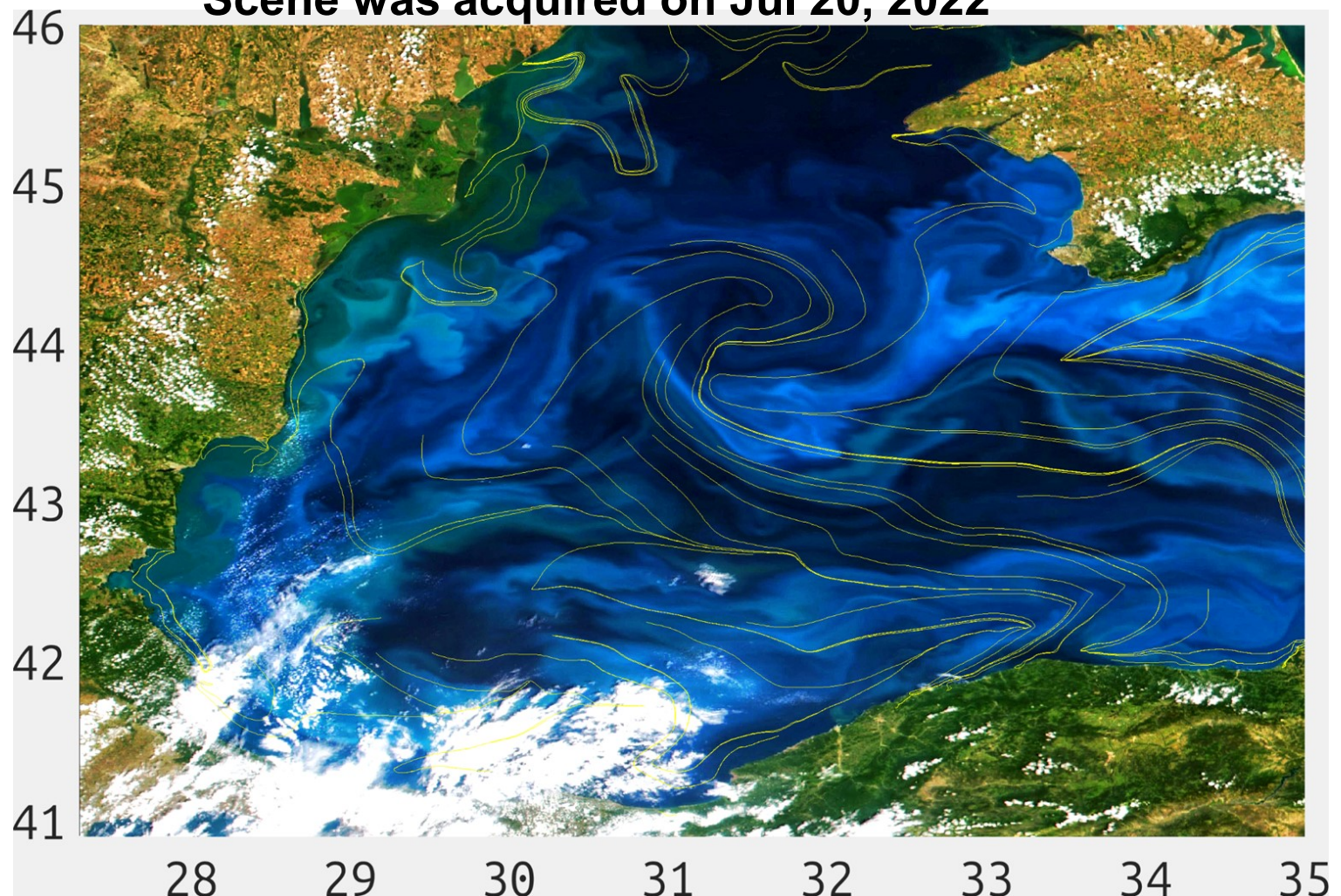


Cocolisphore

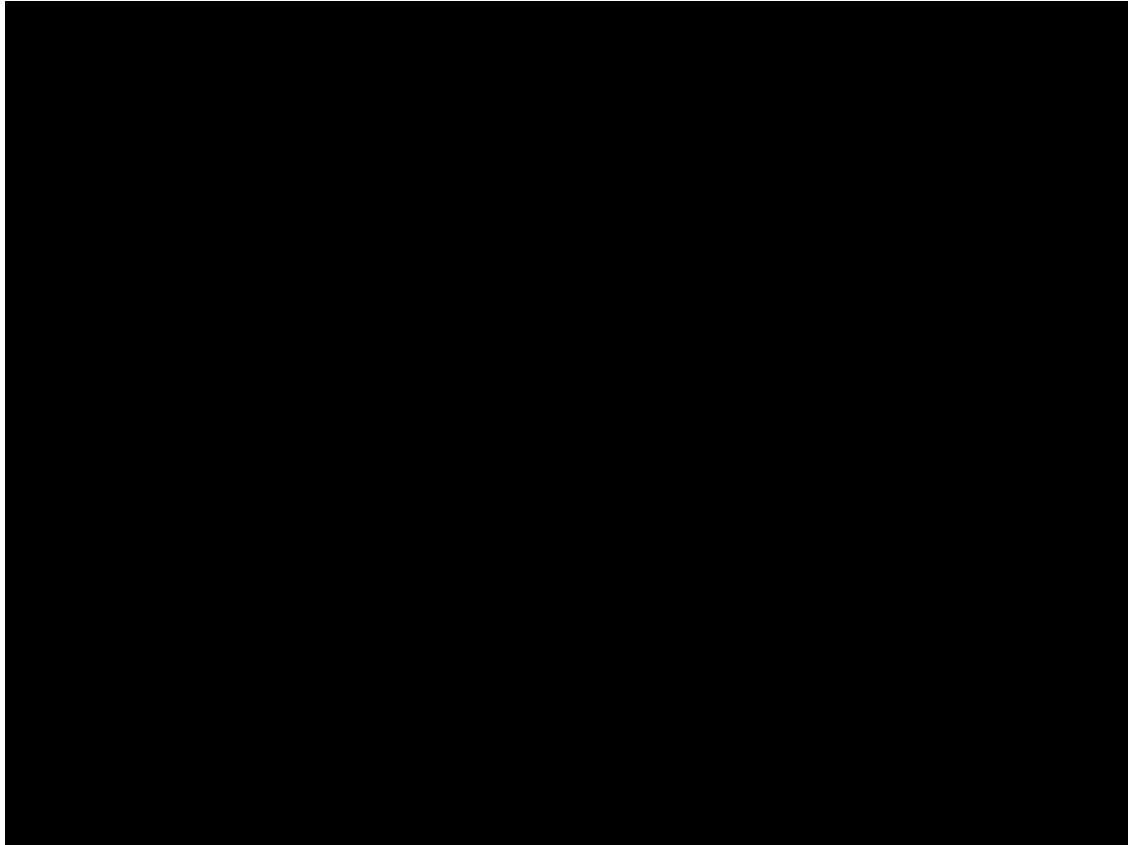
Chlorophyll

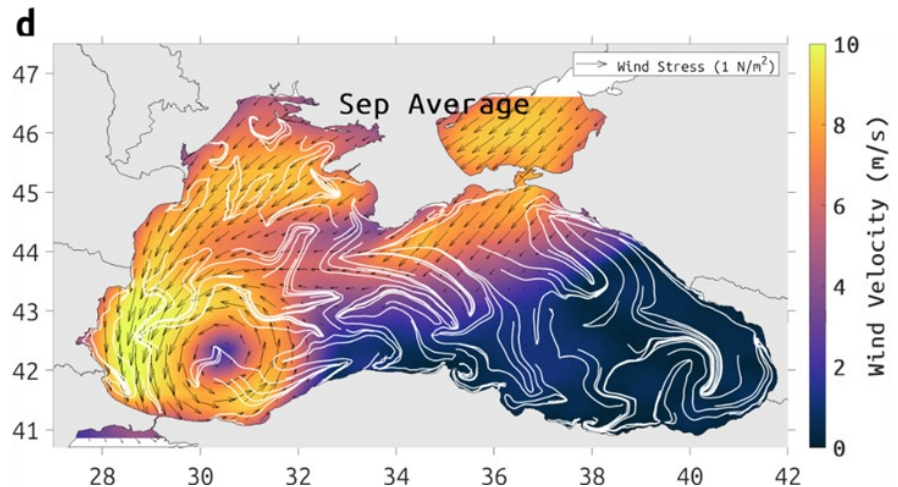
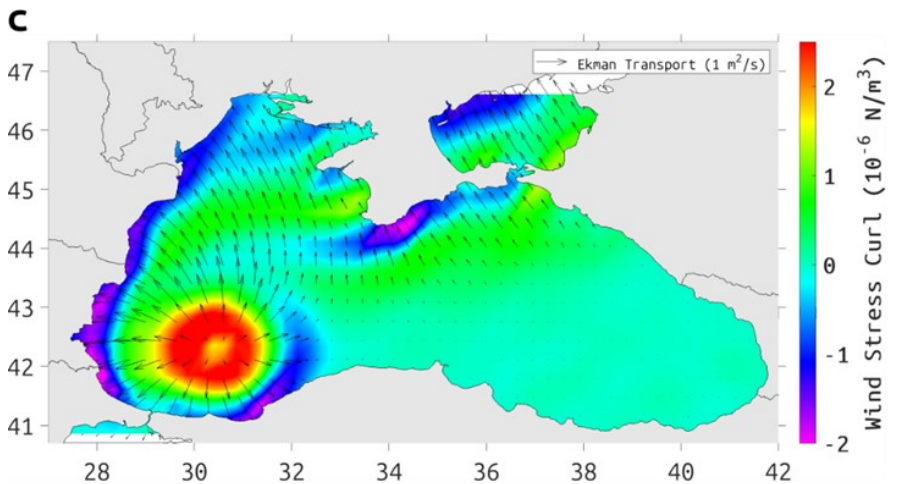
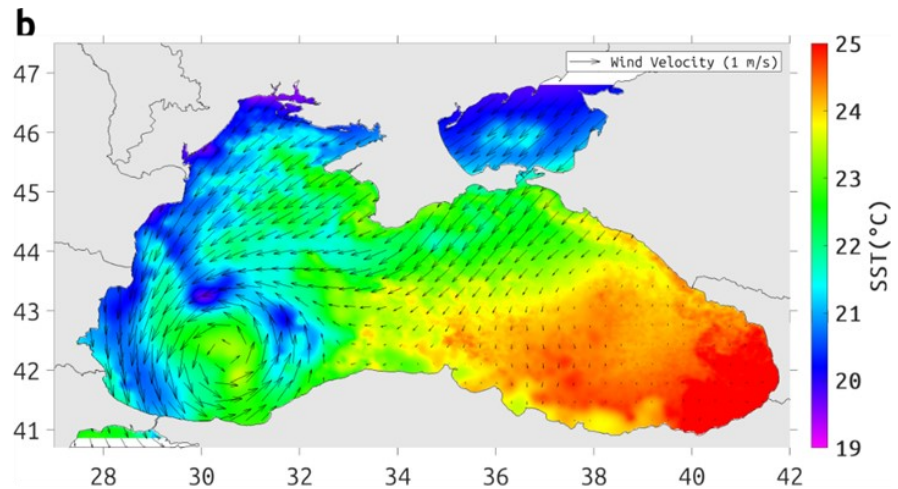
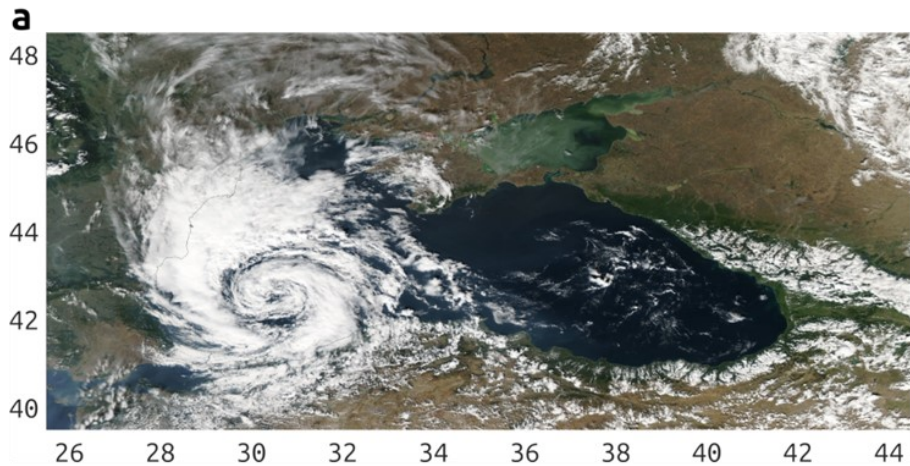
28 30 32 34 36 38 40 42

Scene was acquired on Jul 20, 2022

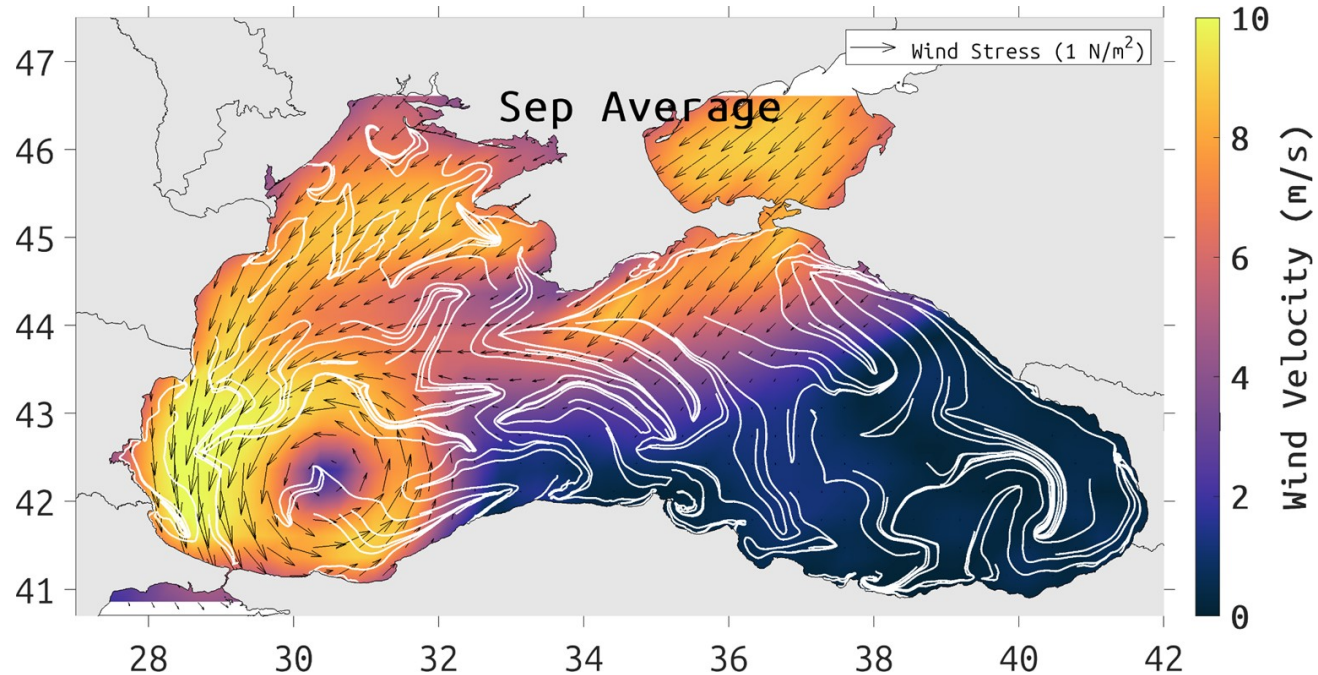


Quasi-tropical Cyclone Sept 25 -29, 2005





The most significant incidence of cyclones occurs in the southwest, northeast, and southeast of the Black Sea during the summer, with its maximum occurring in September (Romero & Emanuel, 2017; Nastos et al., 2018). Due to strong winds, a smaller number of persistent squeezelines are formed. However, it is possible to observe the transport of tracers and particles in their surroundings and centers.



Thanks for your attention and time.

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