On the statistical analysis of explosive-cyclogenesis over the Mediterranean Sea using ERA5 dataset

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Overview

- Explosive Cyclogenesis (**EC**) **definition**
- **Classification** of cyclogenesis events in the Mediterranean for minimum pressure and deepening rate (**Bergeron**) in the period 1979-2020 using ERA5 dataset
- **Synoptical analysis**: triggering factors, formation site, development and trackings
- **Statistical analysis**: frequency of occurrence and return time of EC in the Mediterranean (period 1979-2020)
- **Correlation** with synoptic indexes (NAO, AO) and phenomena

What is an Explosive – Cyclogenesis (EC)?

- Baroclinic instability
- Extremely fast deepening
- Cut-off from Atlantic Circulation
- PV variations
- Dry air intrusions from the stratosphere
- Influence of air–sea interaction, latent heat release, SST anomalies

Definition by Sanders and Gyakum 1980

Low pressure area with a critical deepening rate exceeding 1 Bergeron:

$$1\ Bergeron = \left(\frac{sin\phi}{\sin 60°}\right) \times 24mb$$

"The resulting critical rate varies from 28 mb $(24\ h)^{-1}$ at the pole to 12 mb $(24\ h)^{-1}$ at latitude 25°N" *

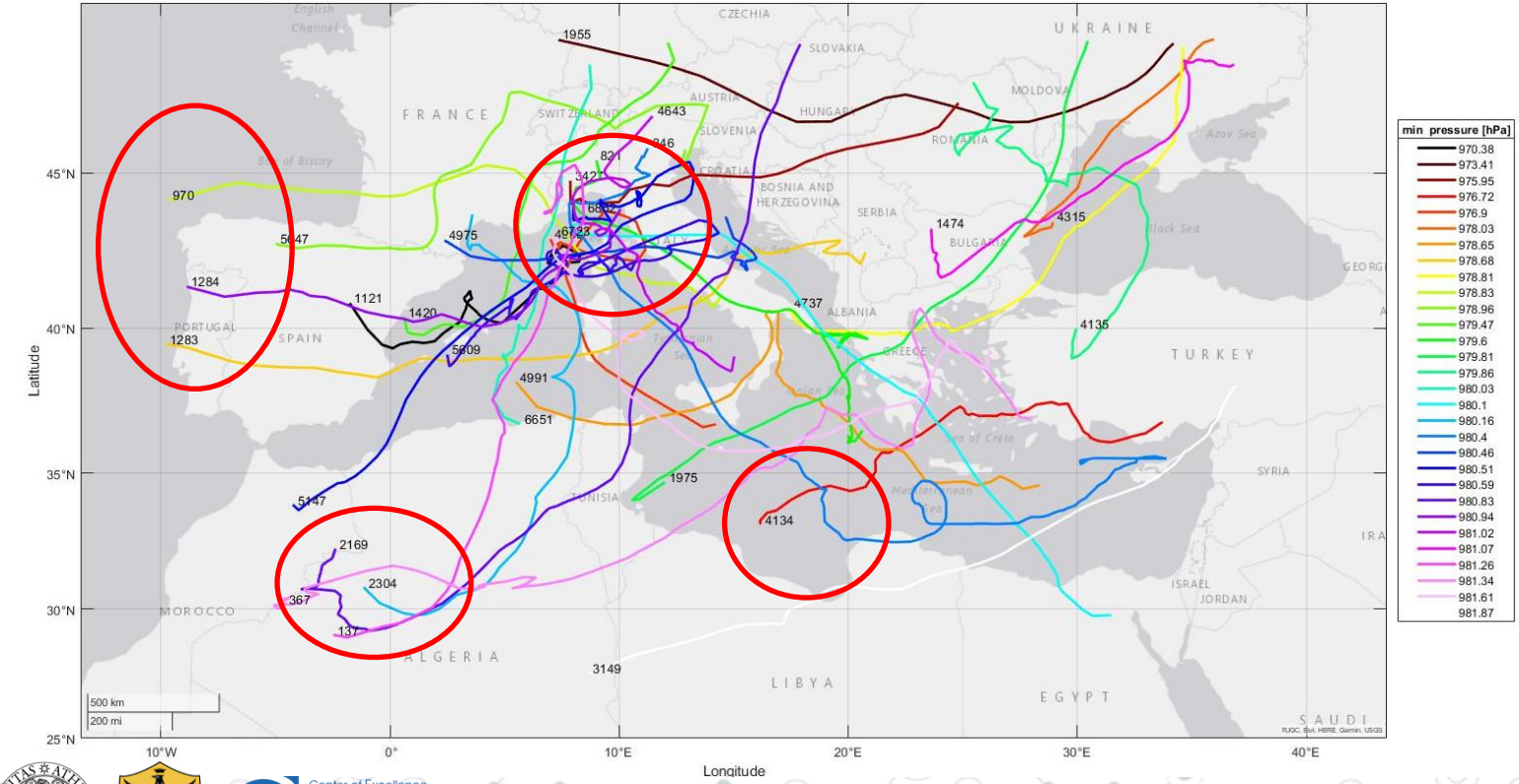
Definition by Zhang et al. ** (12 hours) 2021

$$DR = \left(\frac{P_{t-6} - P_{t+6}}{12}\right) \times \left(\frac{\sin 45°}{sin\frac{\phi_{t-6} + \phi_{t+6}}{2}}\right)$$

*(Sanders, F., and J. R. Gyakum, 1980: Synoptic-dynamic climatology of the bomb.)

**(Zhang S. et al., 2021: Physical Process Contributions to the Development of a Super Explosive Cyclone Over the Gulf Stream)

30 most intense cyclogeneses for pressure minimum



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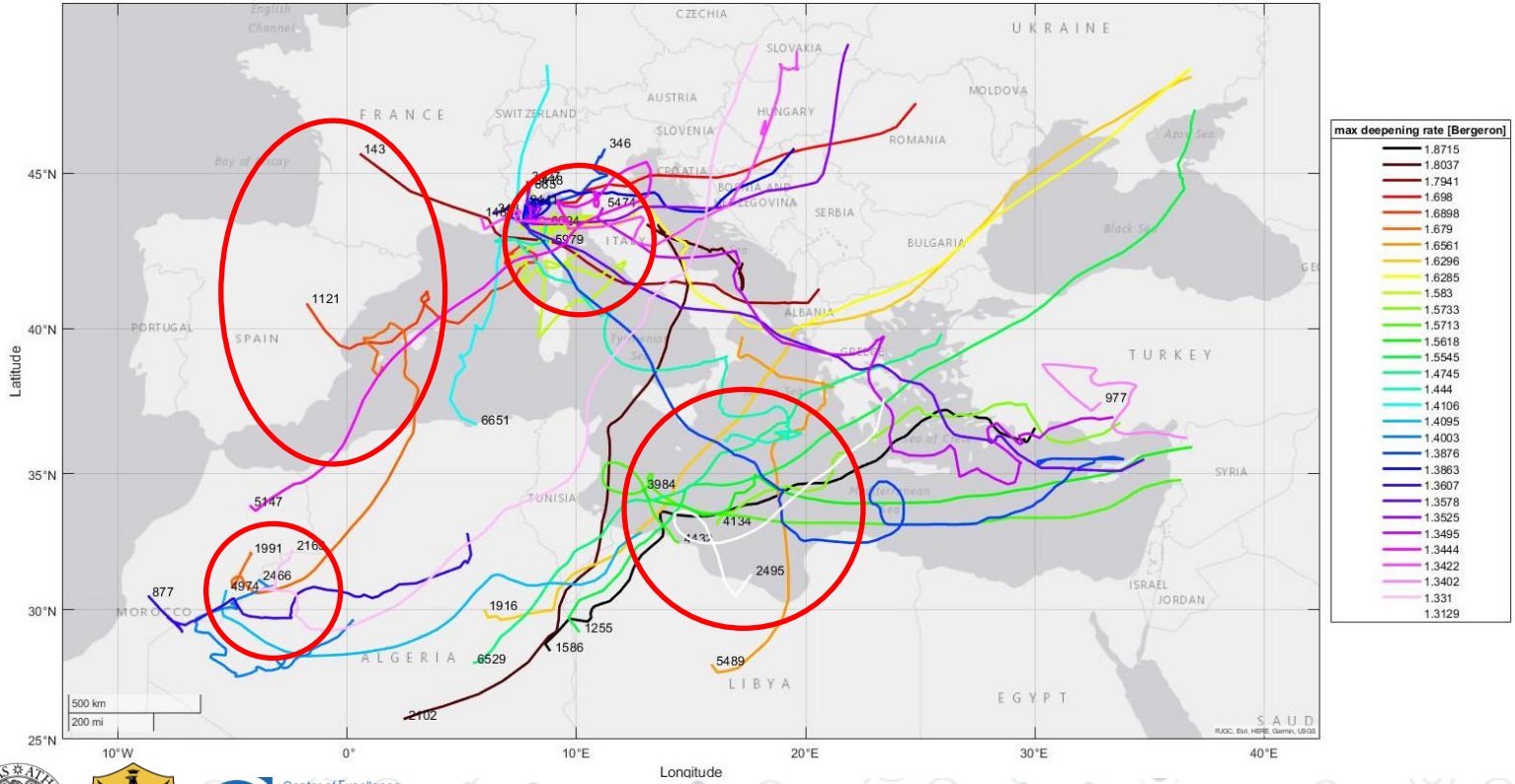
30 most intense cyclogenesis for deepening rate



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The “Vaia” Storm

- High pressure block from East, West and North
- Inverted Ω configuration

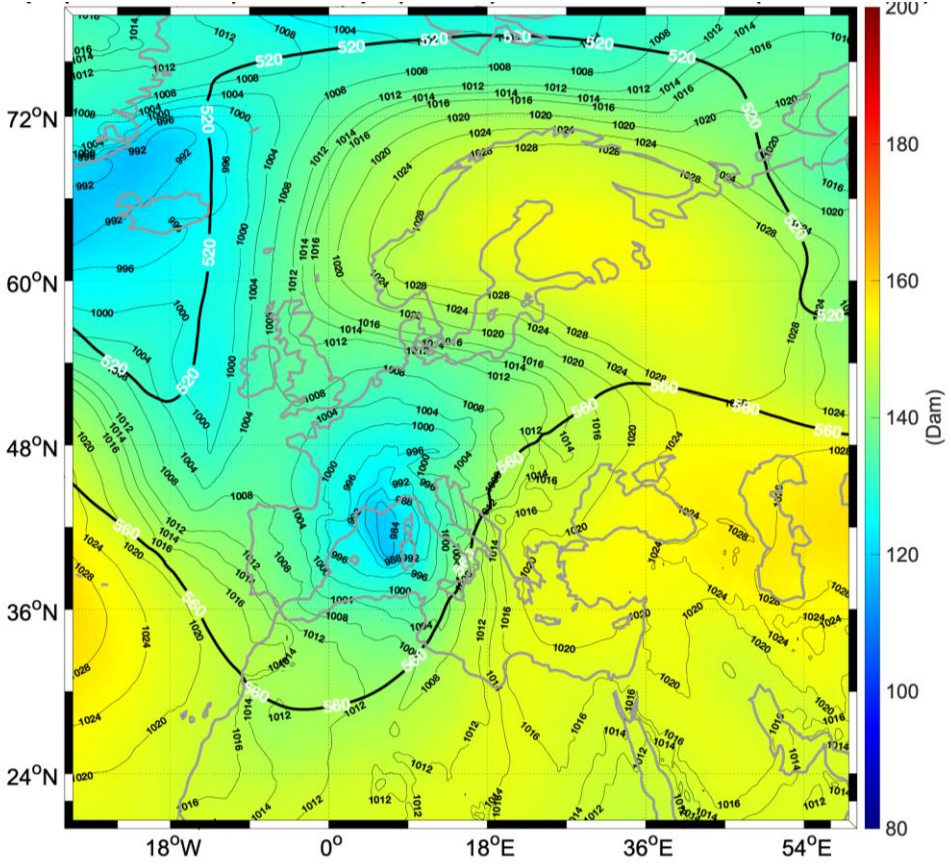


Figure: Geopotential height 500 hPa (white contour) and 850 hPa (shaded) - Sea Level pressure (black contour) 29/Oct/2018 12:00:00

- Azores at higher latitudes, high NAO
- Intense polar vortex

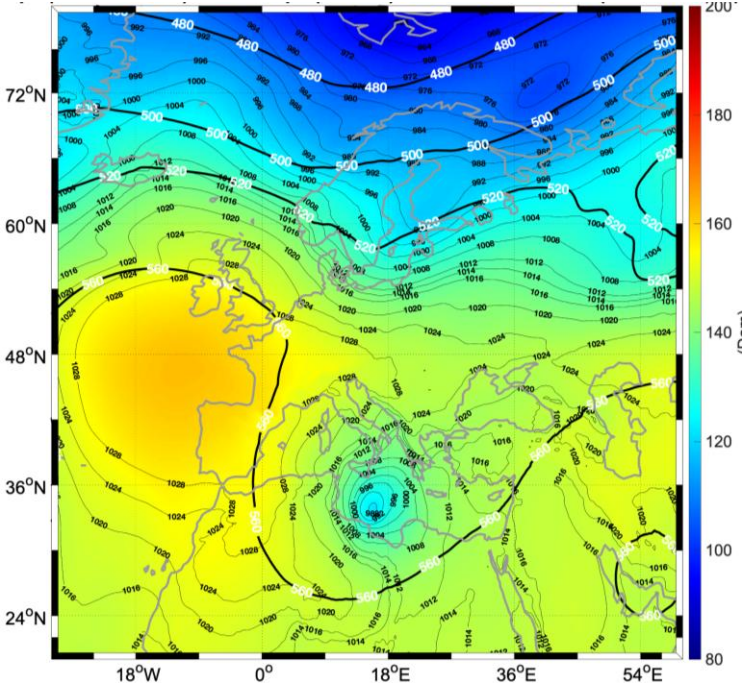


Figure: Geopotential height 500 hPa (white contour) and 850 hPa (shaded) - Sea Level pressure (black contour) – 08/Dec/1988 23:00:00

- Cold Air Outbreak
- Voejkov bridge (Ricchi et al., 2016)

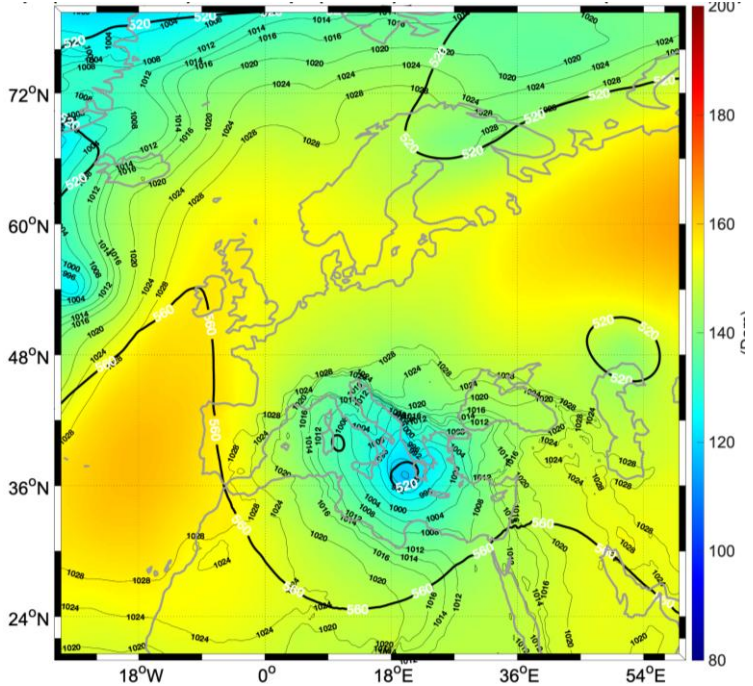
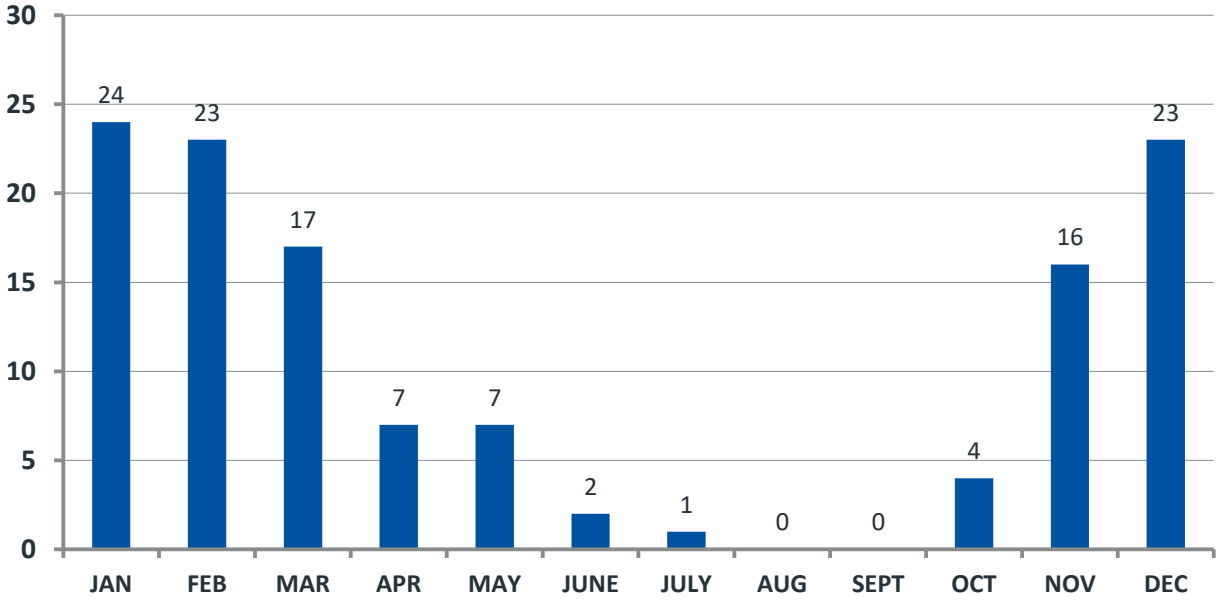
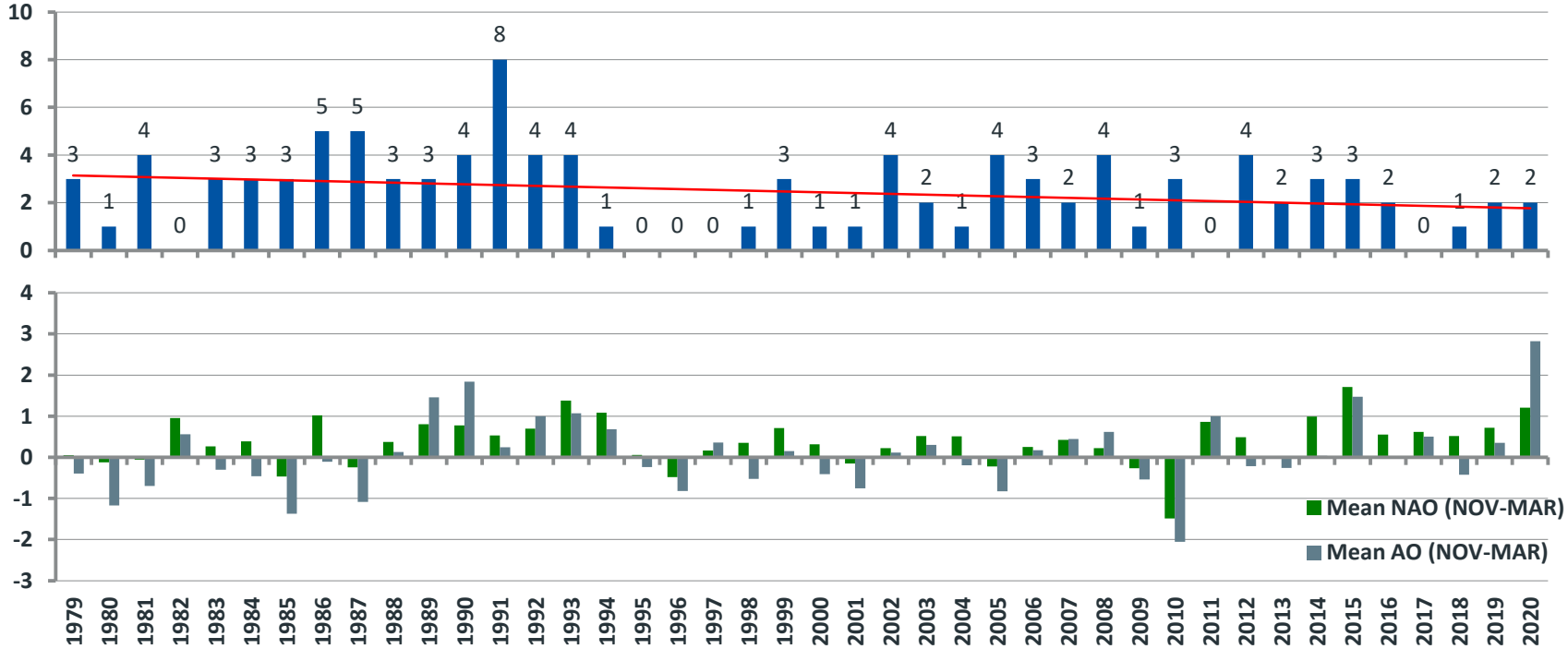


Figure: Geopotential height 500 hPa (white contour) and 850 hPa (shaded) - Sea Level pressure (black contour) – 06/Feb/2012 20:00:00

Total Number of EC per month (1979-2020)



Total Number of NOV-MAR EC per year (1979-2020)



Conclusions and possible future work

First preliminary study undertaken using ERA5 high resolution reanalysis dataset
Analyzing the 30 most intense cyclogeneses:

- Their formation locates in primarily in four geographical areas
- The Ligurian Sea presents the highest density of explosive cyclogeneses, not only developed in situ, but also coming from other regions with genesis not typical of the Genova low
- Highest frequency winter and autumn

Future work

- Further statistical analysis to explore correlation between frequency and climate indexes (NAO, AO, EA, SCAND)
- Intensification's physical factors, decoupling highest atmospheric levels processes and the ocean's role

https://meetingorganizer.copernicus.org/Plinius17/Plinius17-20.html

Thanks for your attention

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