Characteristics of diabatically driven high-impact cyclones over Europe.

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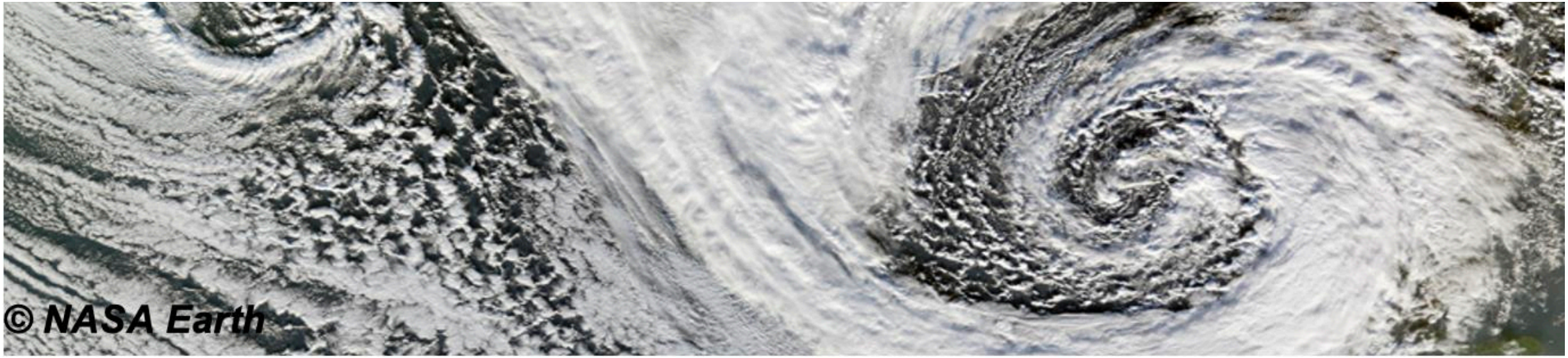
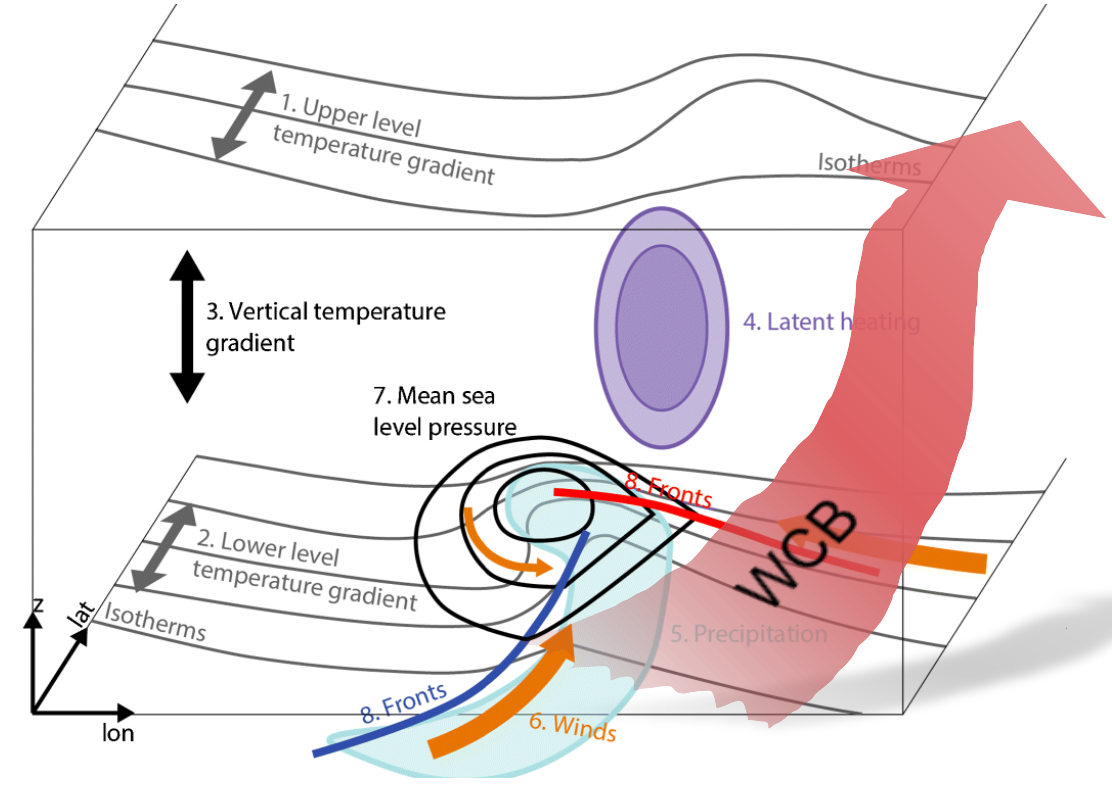


Extratropical Cyclones



Feature	1	2	3	4	5 (intensity)	5 (extent)	6	7	8
Confidence	High	High	High	High	High	Low	Low	Medium	Low

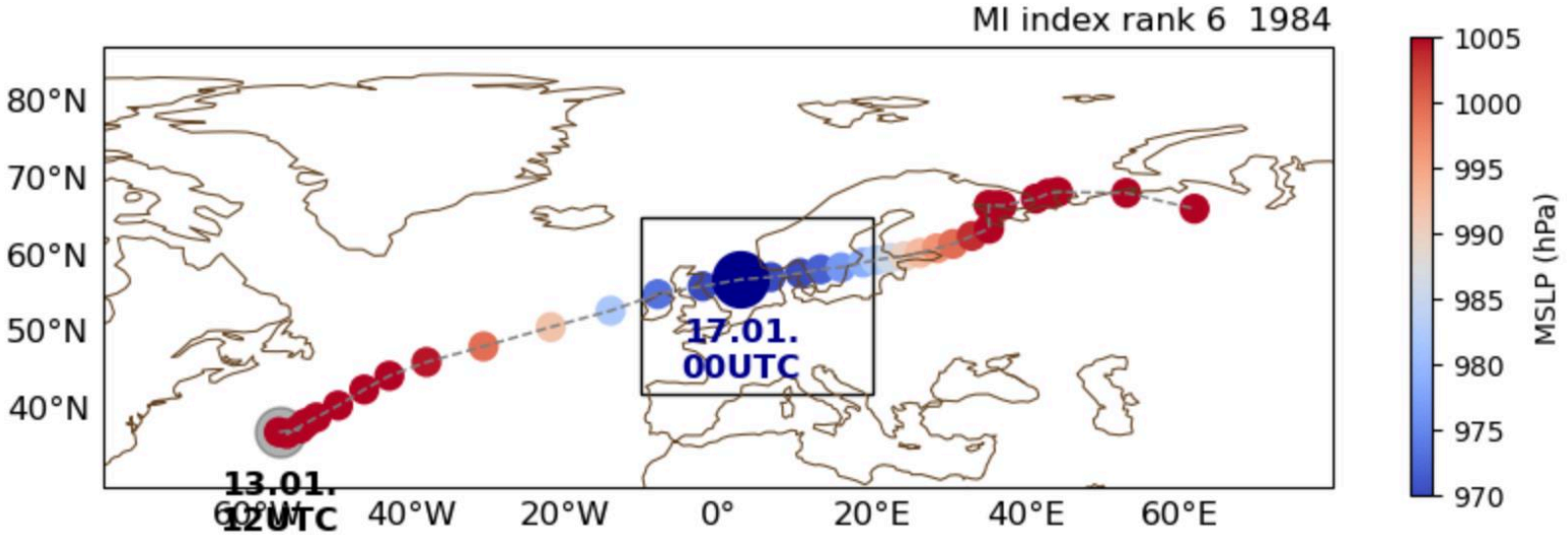
Catto et al. (2019)

- Baroclinicity: Temperature Gradient
- Diabatic heating: Latent heat release

- The rapid development of severe windstorms such as Kyrill (2007) and Xynthia (2010) was linked to diabatic heating.

Recent climate cyclones

1979-2023 ERA5 reanalysis wintertime (Sep-Mar) cyclone tracks, Pinto et al. (2005, 2012) with focus over Europe (40 to 65°N and 10W to 20°E).
Selection of **high-impact cyclones** with the MI36h gust index.



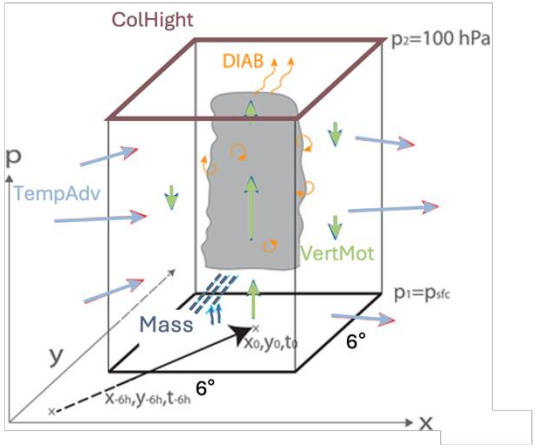
Recent climate cyclones

What is the magnitude of diabatic heating contribution to cyclone intensification in European winterstorms?

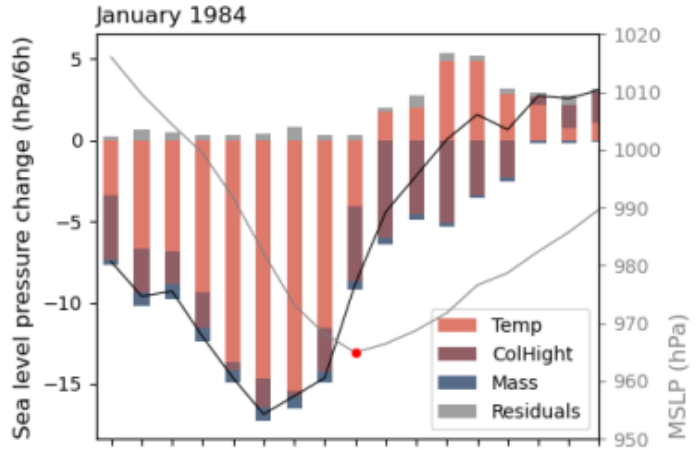
Pressure tendency equation Fink et al. (2012)

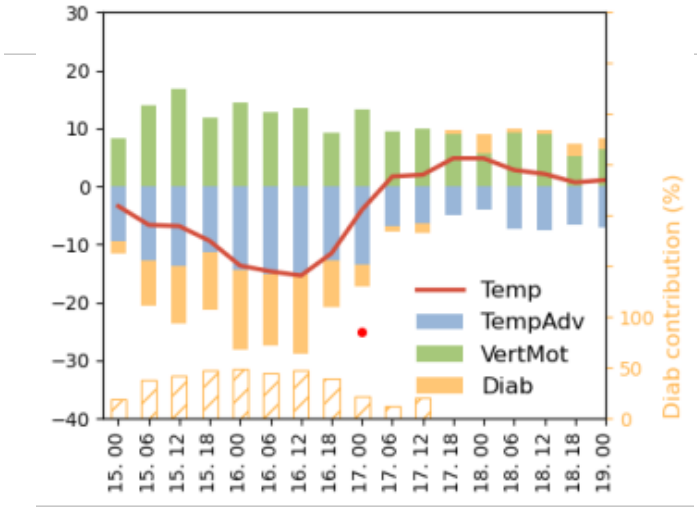
Surface Pressure Tendency
= Column Height + Mass loss (rain) + Warming + Residuals

Warming
= Horizontal Temperature Advection + Vertical Motion + Diabatic Processes



adapted from Fink et al. (2012)





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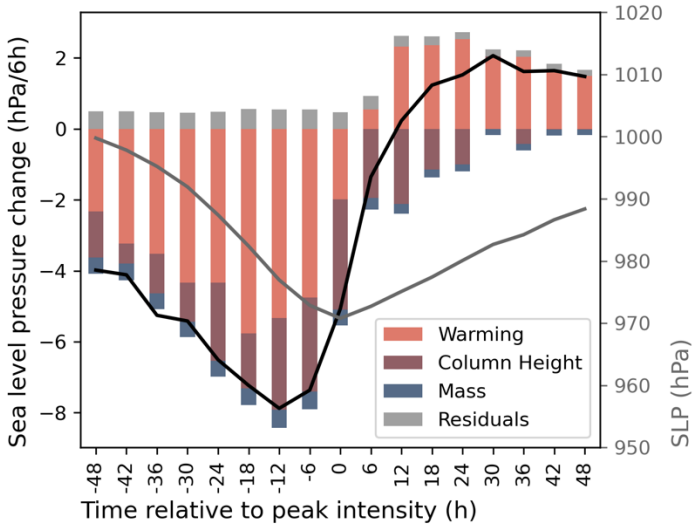
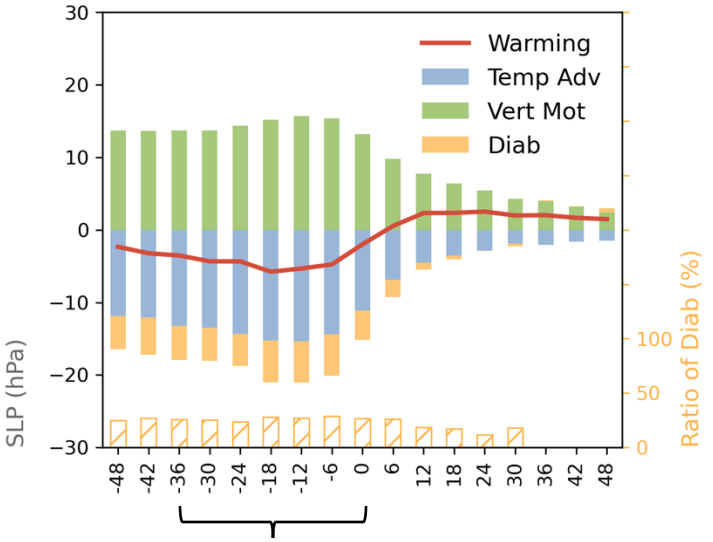
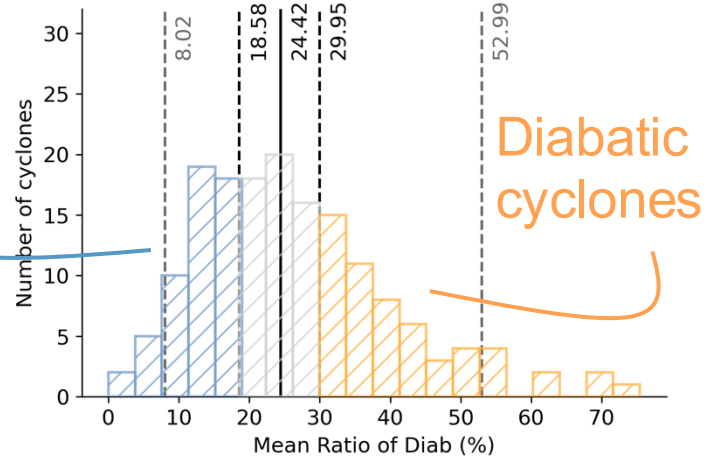




Barocline cyclones

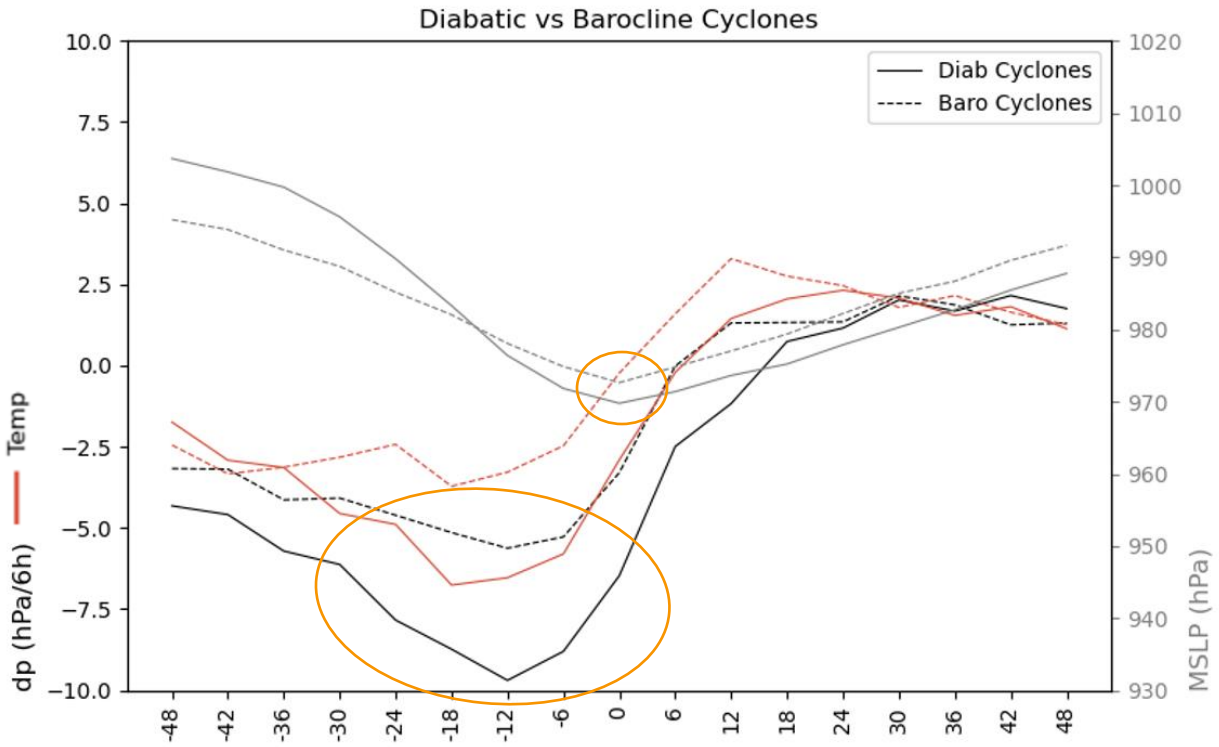
Diabatic cyclones



Diabatic vs Barocline Cyclones

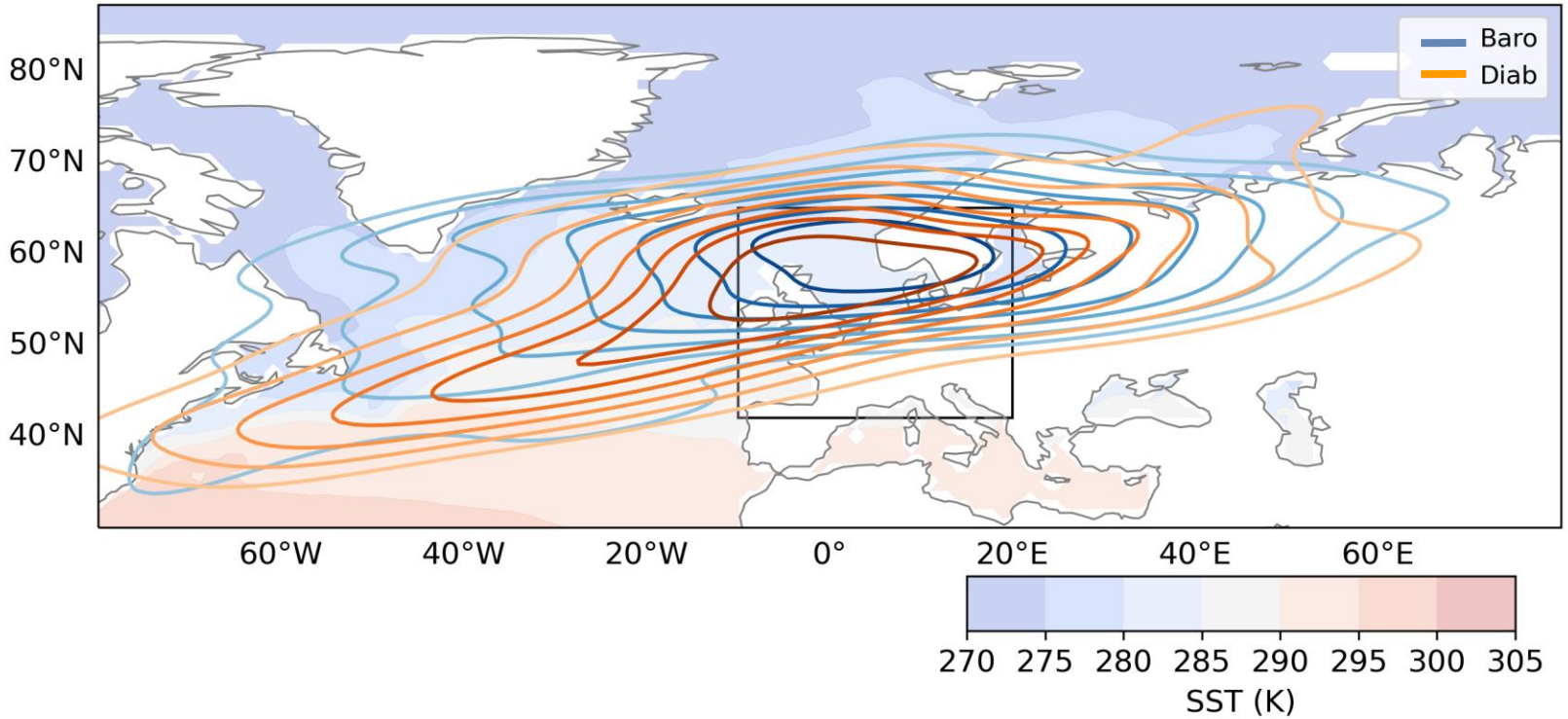
What distinguishes diabatic cyclones from barocline cyclones?

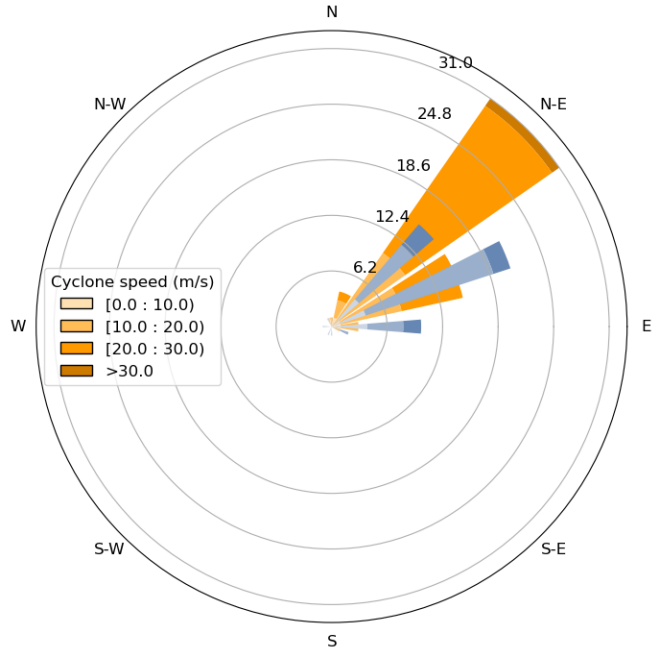
Diabatic vs Barocline Cyclones



-> Diabatic and Barocline cyclones same intensity, but diabatic cyclones stronger deepening rates.

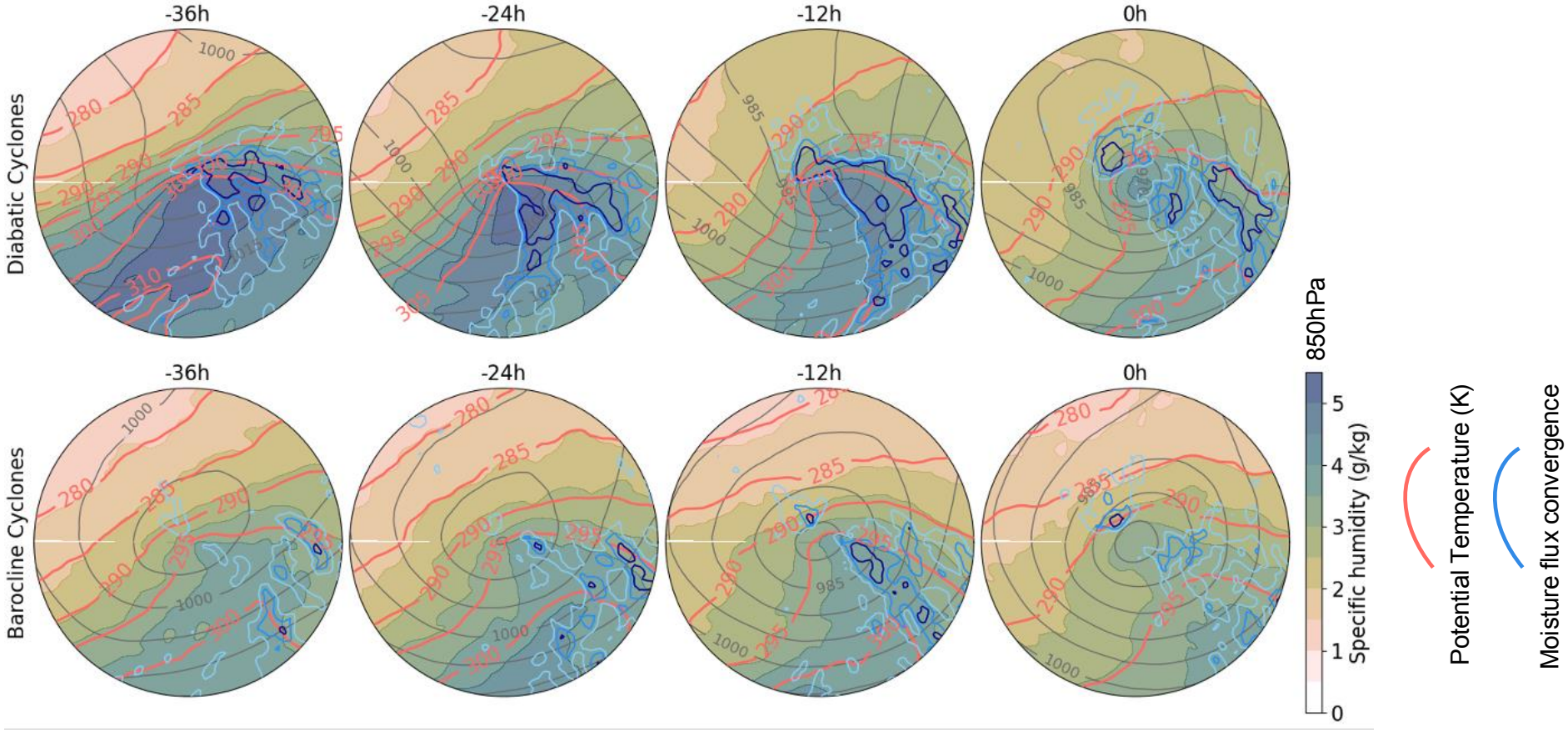
Diabatic vs Barocline Cyclones





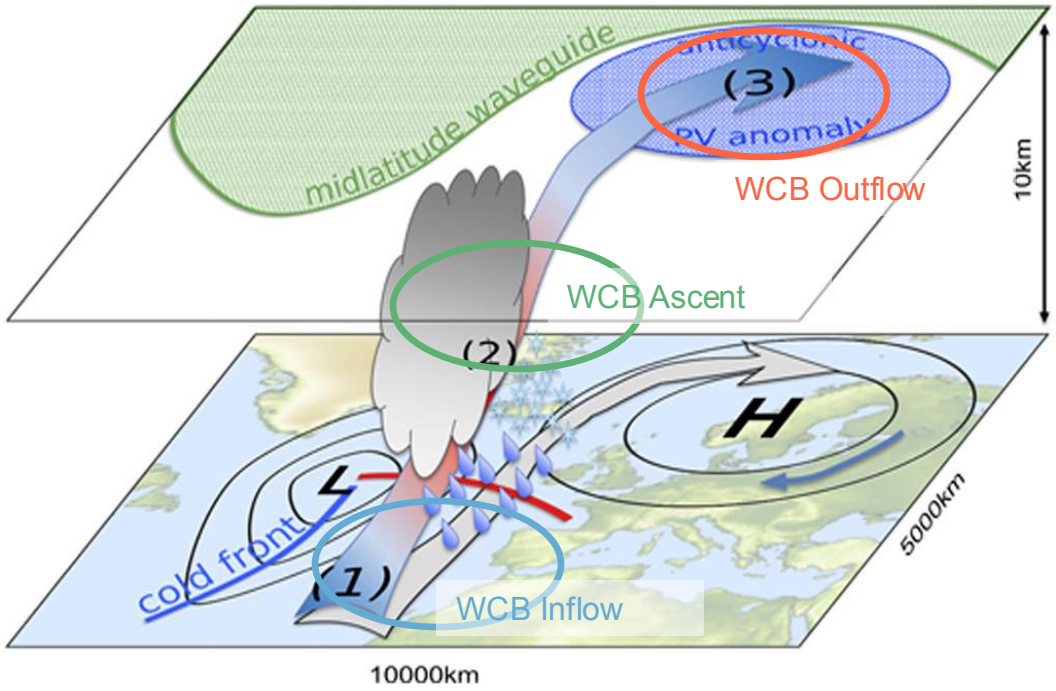
-> Diabatic develop further south,
propagate faster, and experience a further northward displacement.

Diabatic vs Barocline Cyclones
Moisture availability



-> In diabatic cyclones more moisture in the warm sector.

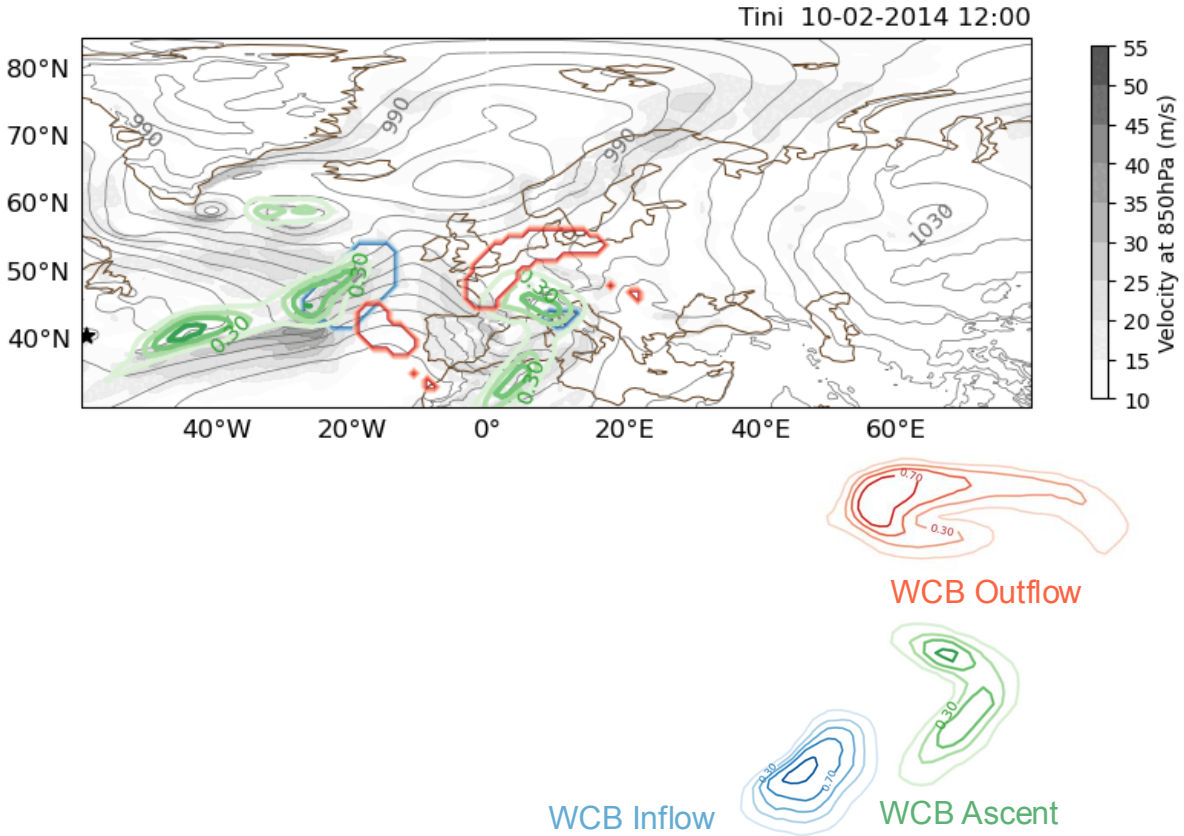
Warm Conveyor Belts



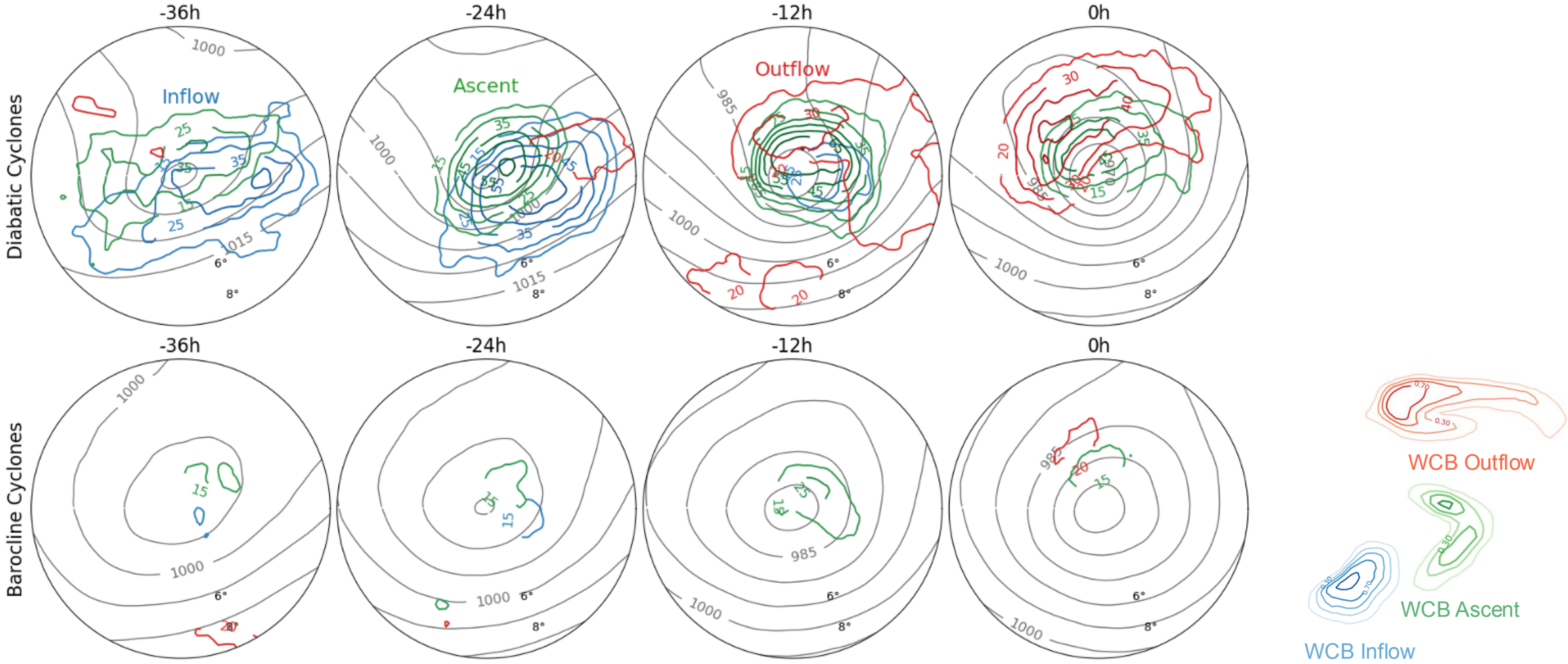
(Quinting and Grams, 2021)

from ELIAS2.0

(Quinting and Grams, 2022)



Diabatic vs Barocline Cyclones
WCBs



Diabatic vs Barocline Cyclones
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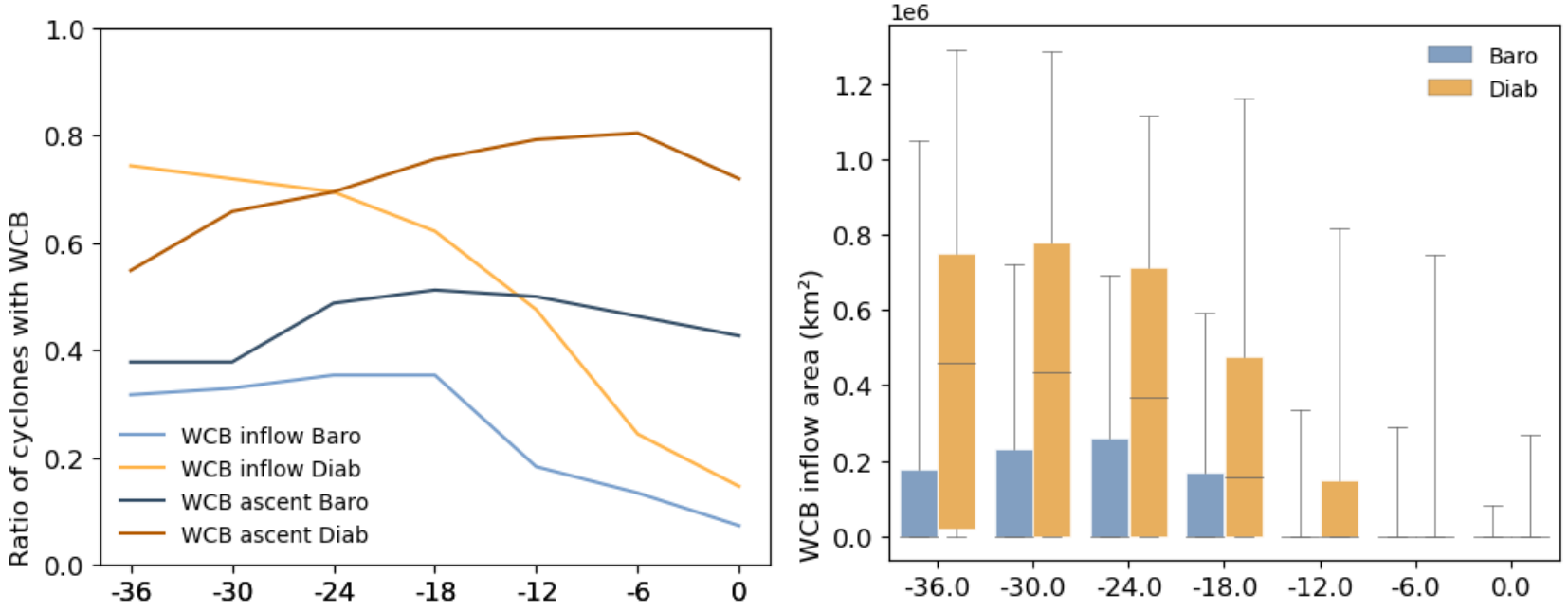
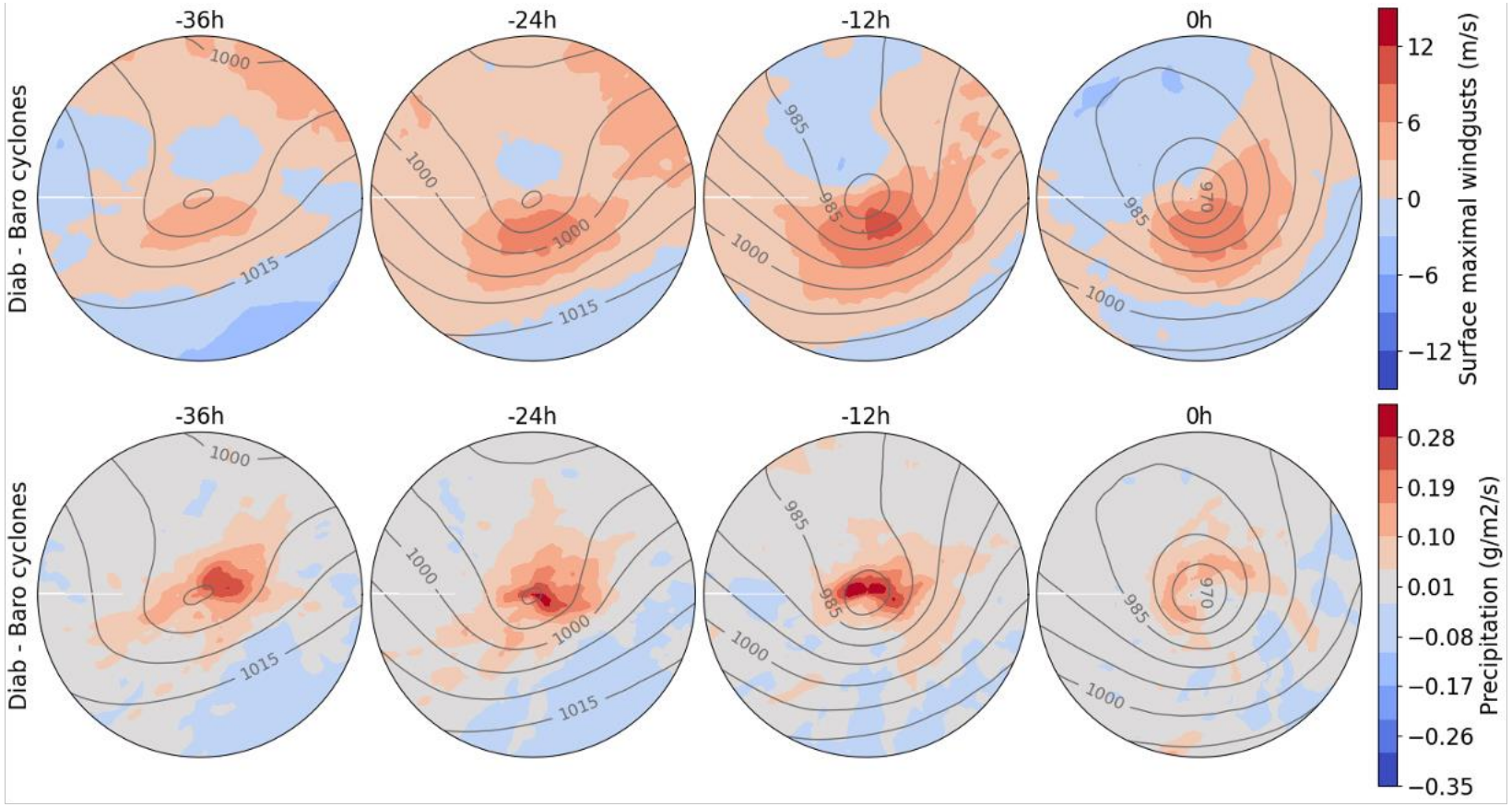


-> Diabatic cyclones enhanced WCB activity.

Impacts



Diabatic cyclones
stronger gusts

more precipitation

Conclusion

What is the magnitude of diabatic heating contribution to cyclone intensification in European winterstorms?

The median **ratio of diabatic heating** contribution to cyclone intensification is around **25%**, for certain cases it exceeds 70%.

What distinguishes diabatic cyclones from barocline cyclones?

Diabatic cyclones are **more impactful**, with stronger winds, more precipitation, and higher and faster northward displacement.

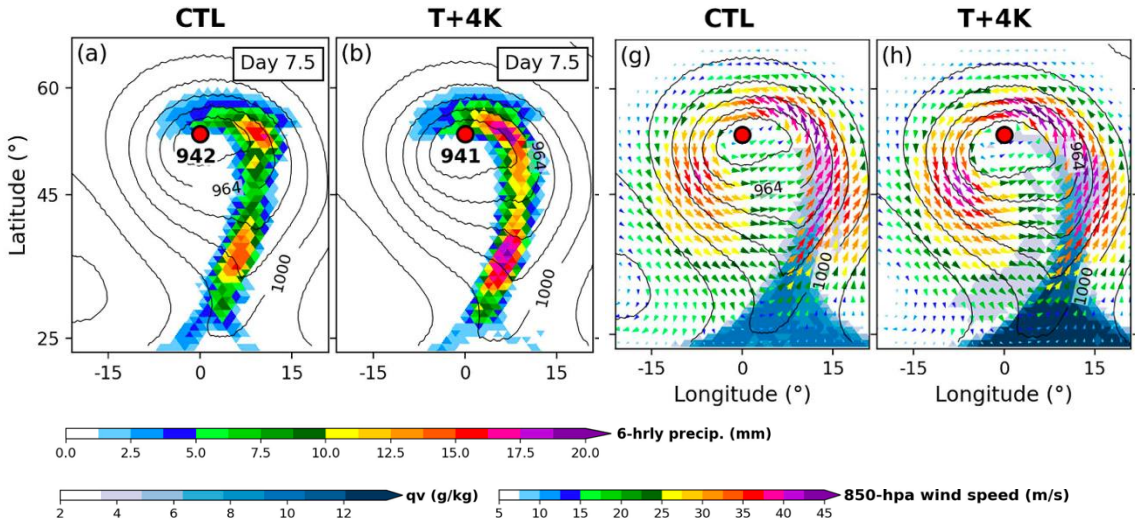
They **originate further south** and are therefore characterized by **increased moisture** and warmer temperatures in the WCB inflow, as well as more frequent **WCB activity**, leading to **stronger deepening rates** driven by enhanced diabatic heating.

Outlook

- How are diabatic processes relevant for cyclone intensification changing?
- Assess future changes of windstorms and their associated impacts.

In a storyline approach, simulate recent storms using ICON with a convection permitting resolution, for +2K, +3K and +4K.

Quantify impacts in terms of wind gusts and heavy precipitation.



(Chen et al. 2024)