Extreme cyclones in the central Mediterranean in a regional climate model.

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01 Introduction

The **central Mediterranean** basin is an important area of enhanced cyclone activity and is a hotspot of climate change (Lionello et al., 2016). Cyclones have a big impact in this region, as they are often related to extreme wind speed and precipitation (Raveh-Rubin and Wernli, 2015).
In previous work, we used the Community Earth System Model (**CESM**) to detect Mediterranean cyclones over the last 3500 years. However, the coarse resolution of CESM of 2°x2.5° is not well-suited for representing Mediterranean cyclone features, since they are of smaller scale, and due to the presence of complex topography in the region (Flaounas et al., 2013).
In this study we downscaled 280 years of the CESM run to 20km resollution using the Weather Research & Forecasting Model (**WRF**). This should yield a much better representation of cyclones in the central Mediterranean and their accompanying features and will help us in understanding changes in the future and the past better.

02 Research Questions

- How do extreme cyclone-related precipitation and wind speed change in the future compared to pre-industrial times in the central Mediterranean?
- What are the characteristics of the composites of the most extreme cyclones in the Central Mediterranean?

03 Methods and Data

- Cyclone Tracking algorithm provided by Blender et al. (1999)
- Downscaling CESM data between 1821-2100 from 2°x2.5° to **20 km resolution** using WRF (**RCP8.5** scenario for the future)
- Output: cyclone depth, radius, gradient, precipitation - wind speed.
- All analyses for **DJF** and for central Mediterranean (Fig. 1).

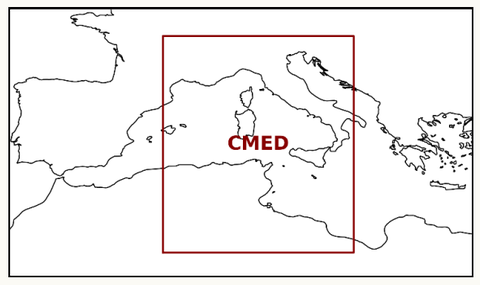

Fig. 1: Analysis region defined as the central Mediterranean in the study.

04 Past and Future Extreme Wind Speed Cyclones

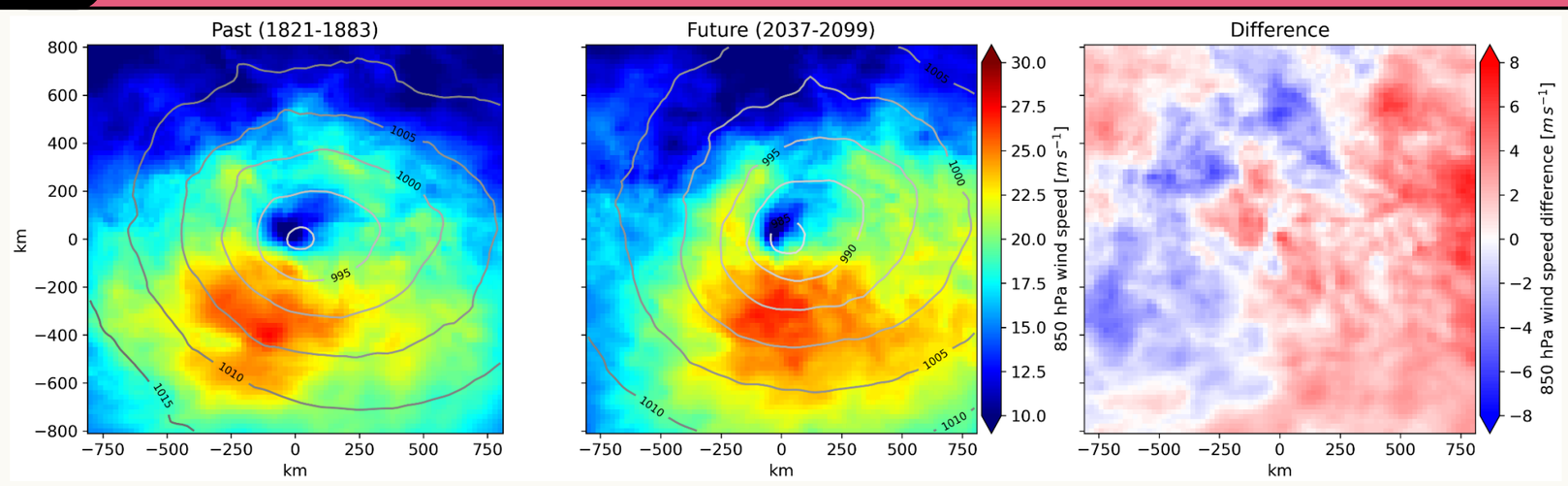

Fig 2: Composites of the 20 most extreme cyclones with respect to mean cyclone-related wind speed, for the period between 1821-1853 (left), 2037-2099 based on the RCP8.5 scenario (middle) and the difference between them (right). The contours indicate wind speed, the contour lines indicate sea level pressure.

- **20 most extreme cyclones** in past and future with respect to **wind speed** (**Fig. 2**).
- Highest wind speeds located south of cyclone core.
- Slight increase in cyclone wind speed, most likely not significant.
- Increase in wind speed east of cyclone core, decrease west of cyclone core. Most likely due to different rotation of cyclones.
- Future cyclones slightly deeper in terms of pressure.

05 Past and Future Extreme Precipitation Cyclones

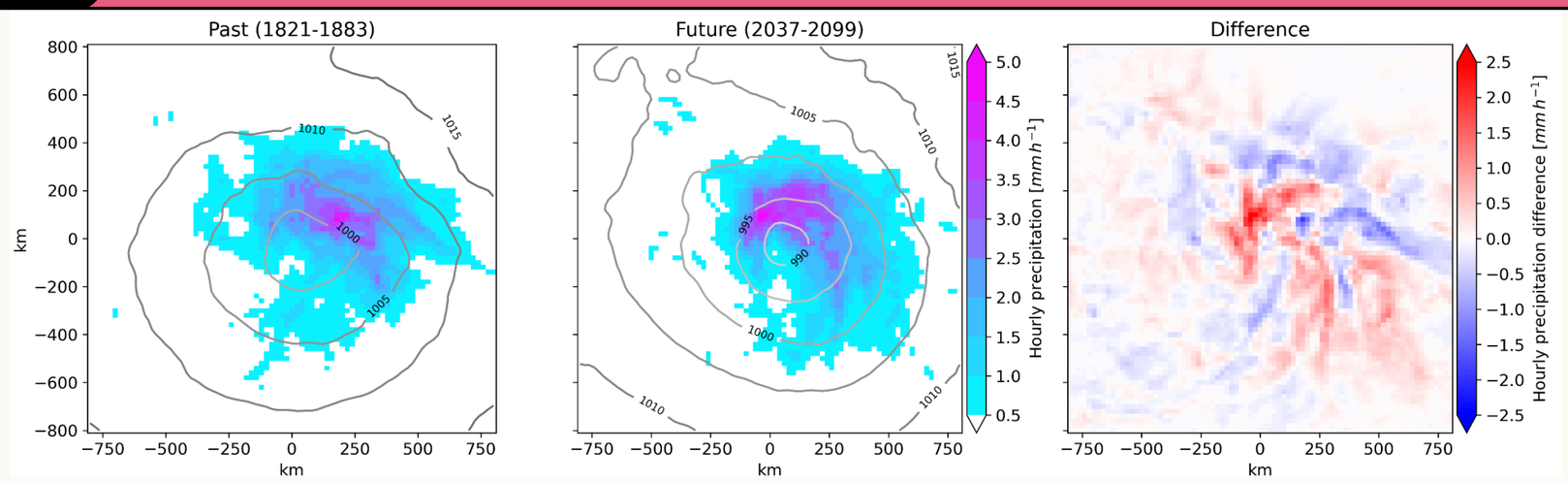

Fig 3: Same a Fig. 2, but now the 20 most extreme cyclones with recspect to 95th-percentile cyclone-related precipitation.

- **20 most extreme cyclones** with respect to **95th-percentile cyclone-related precipitation** (**Fig. 3**).
- Highest precipitaion north of cyclone core.
- **Big increase in cyclone precipitation** in the future. Largest icnrease north and east of core (up to 50%).
- Strong deepening of cyclone core.

06 Future Cyclone Frequency

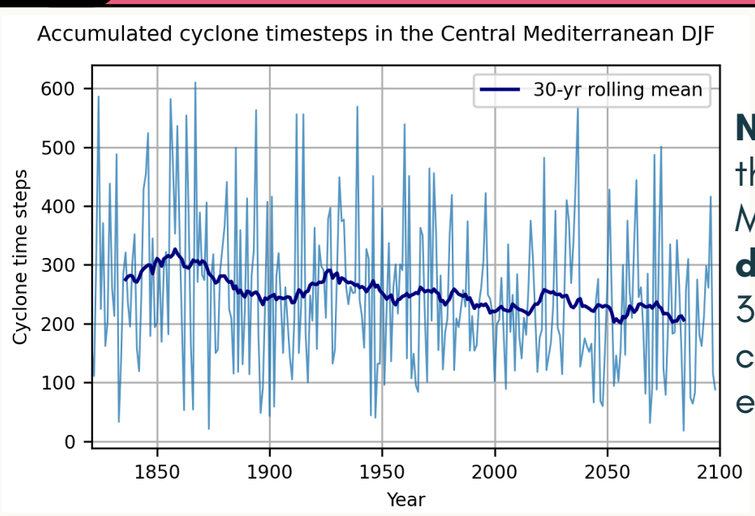

Fig 4: Number of cyclones per winter (1821-2100) in WRF. Thick blue line denotes 30-year running average.

Number of cyclones in the central Mediterranean is set to **decrease** in WRF up to 33%, despite extreme cyclones getting more extreme (**Fig. 4**).

07 Conclusion and Outlook

- WRF enables us to look at Mediterranean cyclones in more detail.
- The most extreme cyclones are set to get **more extreme**, especially with respect to precipitation (Fig. 2). For Wind Speed, the signal is less clear (Fig. 3).
- Still, the **total number of cyclones is set to decrease**, potentially leading to drier conditions in the central Mediterranean in winter (Fig. 4).
- Despite the fact that fewer cyclones will appear, **impact on society may increase** due to cyclones getting more extreme.
- Future goals: Finding out when extreme cyclones in the low-resolution CESM model are also extreme in WRF, and looking at reasons to find out when this is not the case.

References: Raveh-Rubin and Wernli, QJRMS, 141, 2404-2417 (2015) - Lionello et al., Tellus A: Dynamic Meteorology and Oceanography, 68:1, 29391 (2016) - Blender et al., QJRMS, 123, 727-741 (1997)