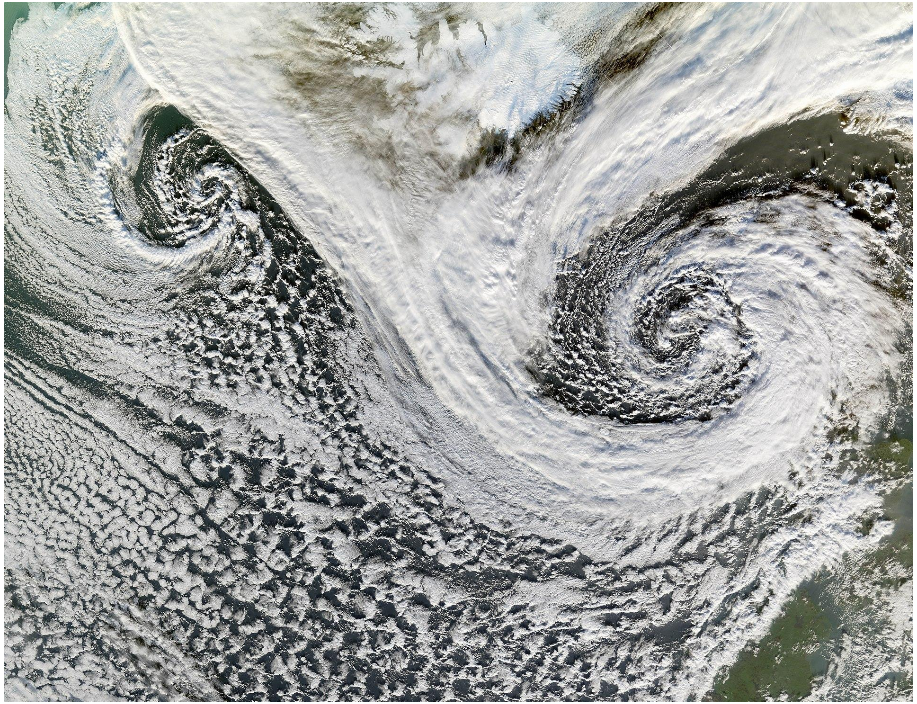
DYNAMICAL SYSTEMS THEORY SHEDS NEW LIGHT ON COMPOUND CLIMATE EXTREMES IN EUROPE AND EASTERN NORTH AMERICA

Pons, F.M.E., De Luca, P., Messori, G., and Faranda, D.



EGU, 2020

Synthesis of the method

Given two atmospheric variables their joint Poincaré recurrences in the phase-space are quantified (Faranda et al. 2020).

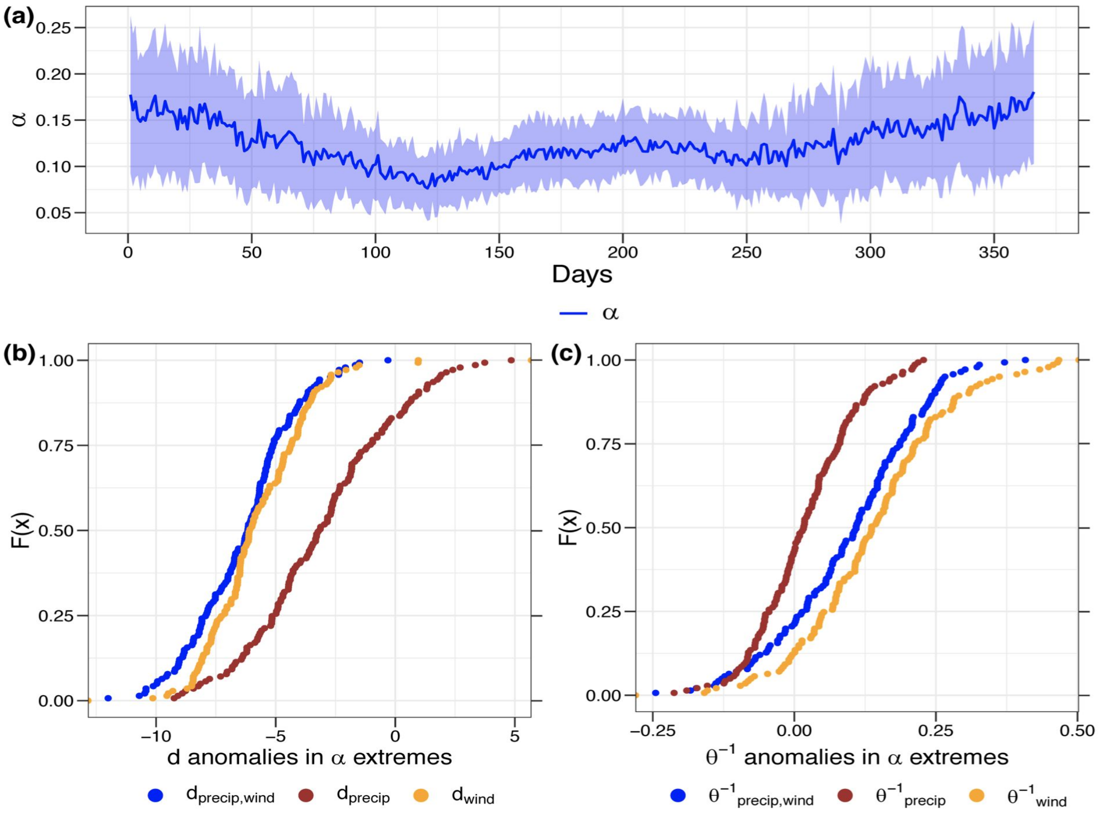
Three joint dynamical systems metrics are computed:

i) the co-recurrence ratio (α);
ii) the local co-persistence ($\theta^{-1}_{x,y}$);
iii) the local co-dimension ($d_{x,y}$).

The α extremes (or compound dynamical extremes) reflect compound events observed within climate data.

$$\alpha(\zeta) = \frac{\nu\left[g\{x(t)\} > s_x(q) | g\{y(t)\} > s_y(q)\right]}{\nu[g\{x(t)\} > s_x(q)]}$$

Europe: daily total precip (mm) and wind gust mean (ms^{-1}) from 1979 to 2018 (ERA-Interim);



α peaks during late autumn SON and winter DJF -> storm season in N-NW Europe;

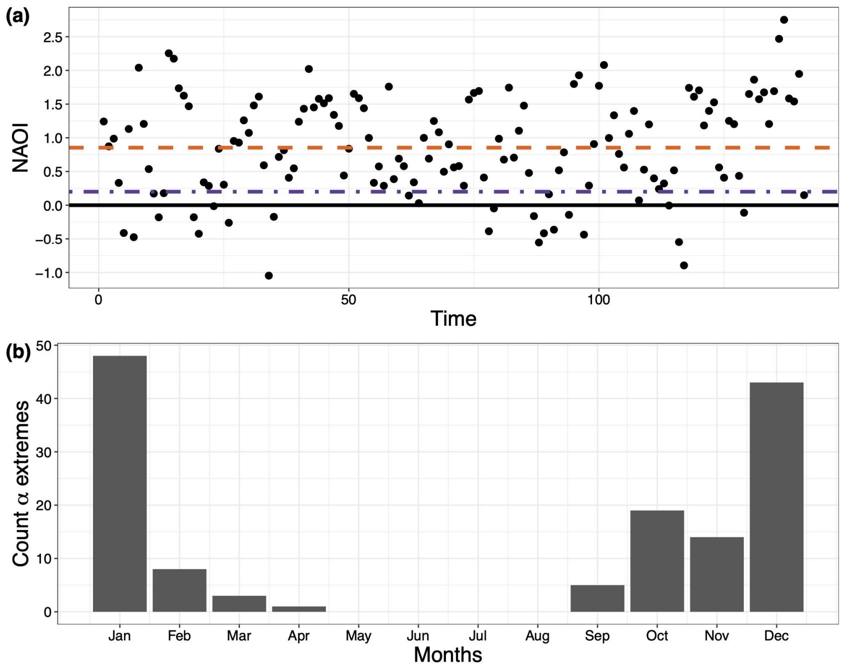
$d_{x,y}$ and $\theta^{-1}_{x,y}$ anomalies during α extremes (>99th quantile) are negative and positive -> predictable configurations;

QJRMS, 2020

α extremes = compound dynamical extremes.

NAOI daily values during α extremes are largely positive (orange dashed line, $p<0.05$) -> a positive NAO brings storms (i.e. ETCs) over N-NW Europe;

α extremes peak during late autumn SON and winter DJF.

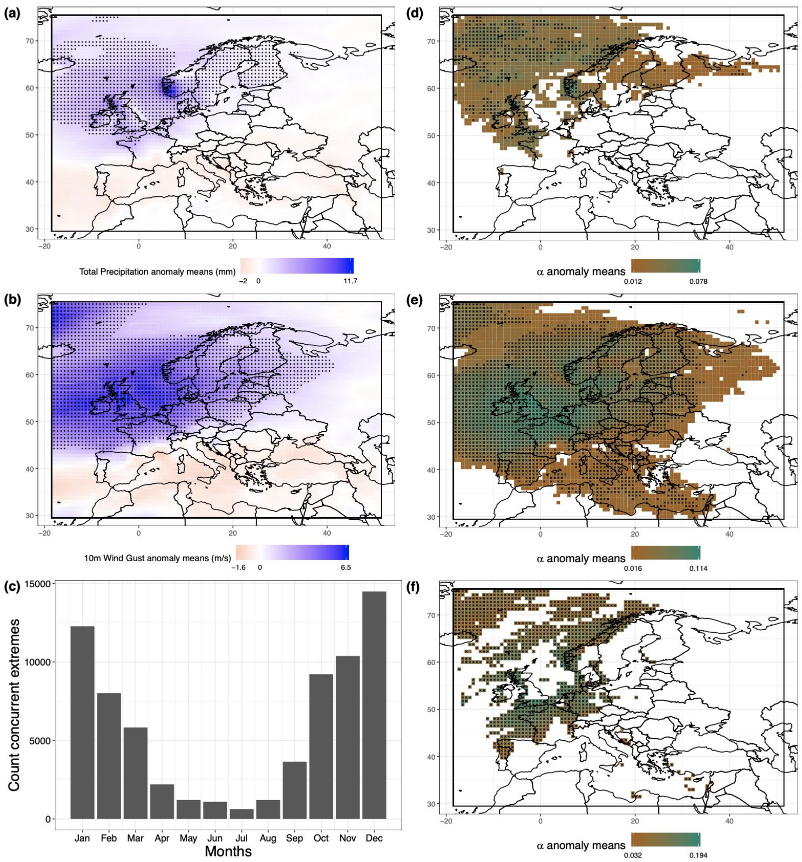


QJRMS, 2020

Precip and wind anomalies during α extremes are positive ($p<0.05$) over N-NW Europe -> ETCs;

concurrent (i.e same-day) precip and wind extremes (>99th quantile) peak during late autumn SON and winter DJF
-> as for α extremes;

α anomalies during concurrent precip-wind extremes are significant ($p<0.05$) over W Europe (panel f) ->
α extremes reflect ETCs patterns.



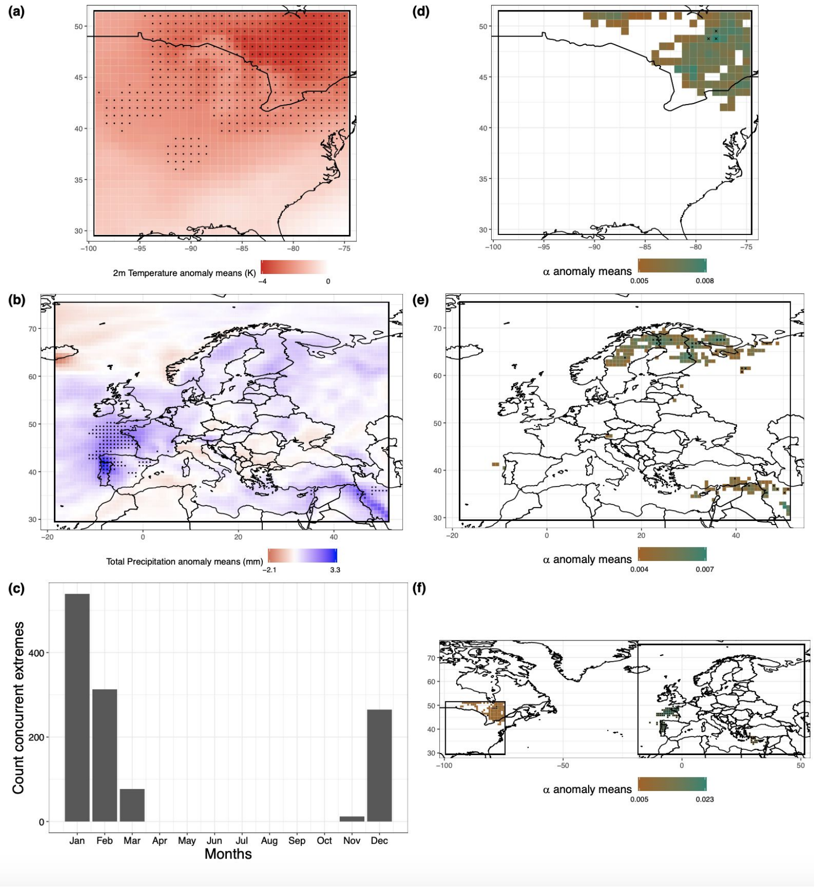
QJRMS, 2020

Eastern North America (ENA) and Europe: daily temperature (K) and total precipitation (mm) from 1979 to 2018 (ERA-Interim);

temp and precip anomalies during α extremes are negative and positive ($p<0.05$) over N-NE ENA and W Europe;

concurrent temp and precip extremes ($>99^{th}$ quantile) peak during winter DJF;

α anomalies during concurrent temp-precip extremes are significant ($p<0.05$) over N-NE ENA and W Europe (panel f).



QJRMS, 2020

Thank you

Any questions?

References

Faranda, D., Messori, G. & Yiou, P. Diagnosing concurrent drivers of weather extremes: application to warm and cold days in North America. *Clim Dyn* **54,** 2187–2201 (2020), https://doi.org/10.1007/s00382-019-05106-3

De Luca, P, Messori, G, Pons, FME, Faranda, D. Dynamical systems theory sheds new light on compound climate extremes in Europe and Eastern North America. *QJR Meteorol Soc,* 1– 15 (2020a), https://doi.org/10.1002/qj.3757