

On convective enhancement of Vb-events in present and warmer climates

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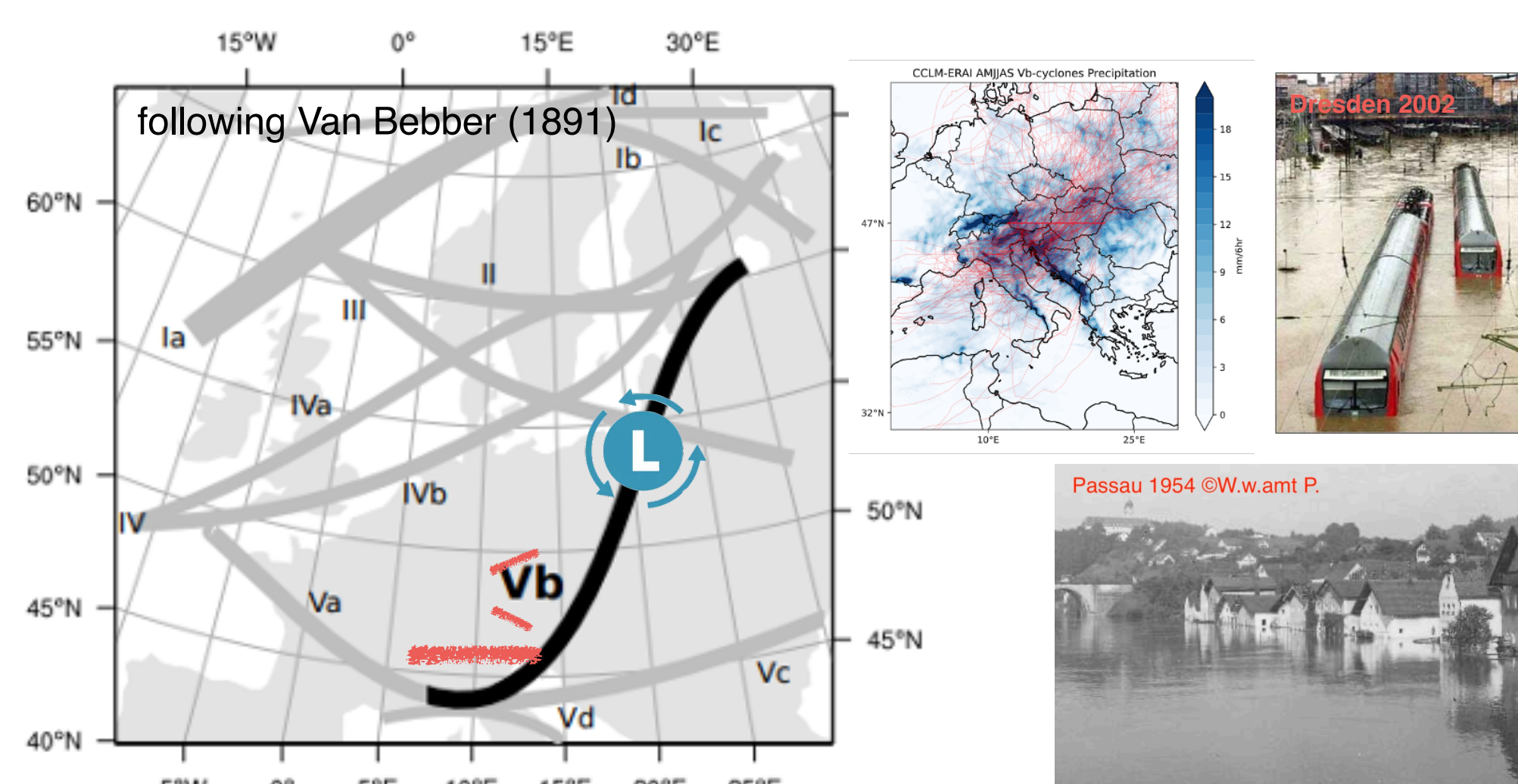
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MOTIVATION

- In summer, important large-scale flood extremes in Central Europe are triggered by slowly moving Vb-cyclones [1]
- Orographic and convective precipitation enhancement intensifies the storm precipitation [5]

Our research questions:

- Fraction of convective precipitation in the historical and a future climate?
- Why change of fraction in a future climate?



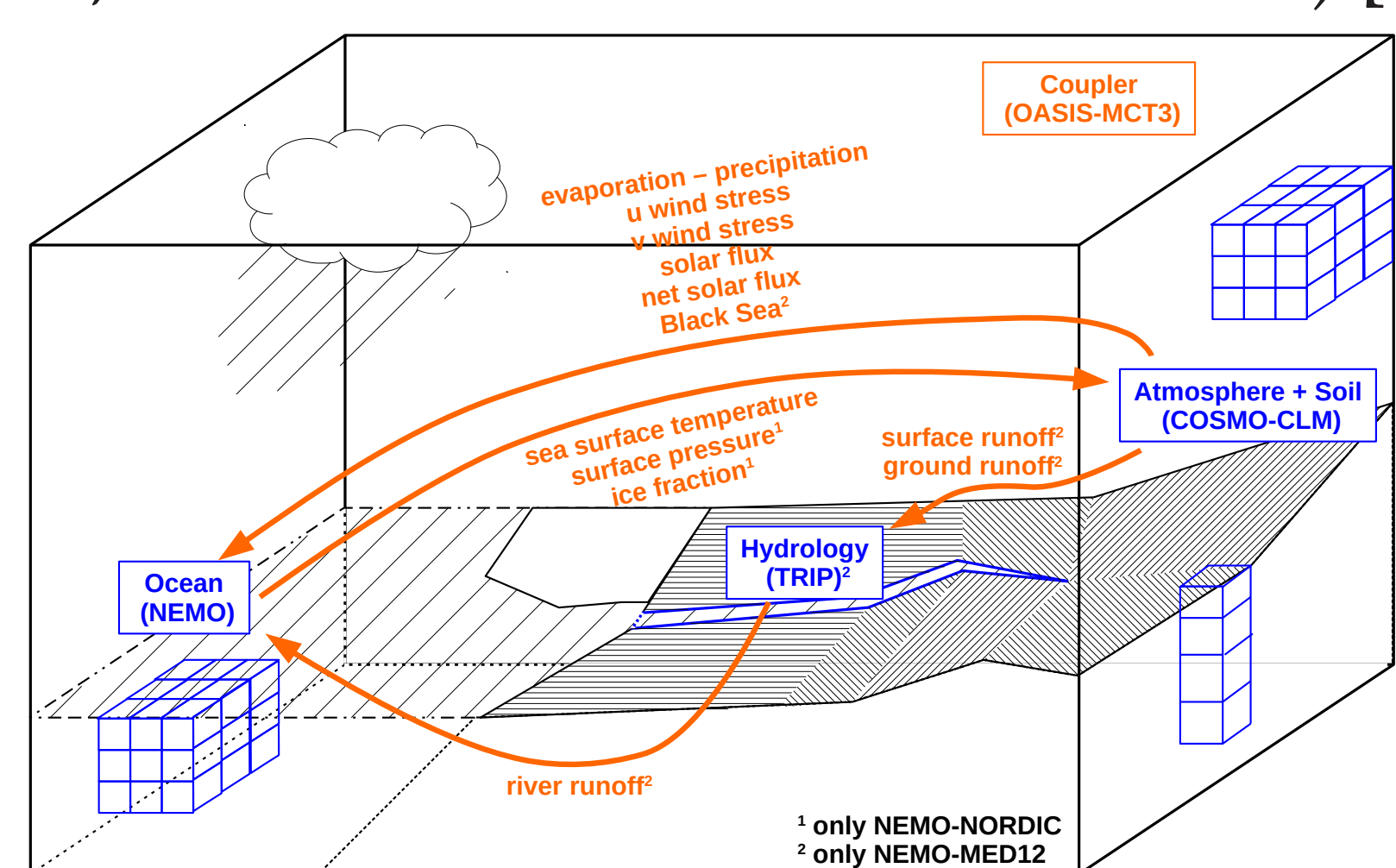
REF.S & ACKN.

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- [3] B. Poujol, S.P. Sobolowski, P.A. Mooney, S. Berthou (2020) A physically based precipitation separation algorithm for convection-permitting models over complex topography. QJRM, 46, 727, 748-761
- [4] Purr, C., E. Brisson, H. Schlünzen, B. Ahrens (2022) Convective rain cell properties and the resulting precipitation scaling in a warm temperate climate. Quarterly J. of Royal Met. Soc., 148(745), 1768-1781. doi: 10.1002/qj.4277
- [5] Ulbrich, U., T. Brücher, A.H. Fink, G.C. Leckebusch, A. Krüger, J.G. Pinto (2003) The Central European Floods in August 2002, Part II: Synoptic causes and considerations with respect to climatic change. – Weather 58, 434–441.

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METHODS & EVALUATION

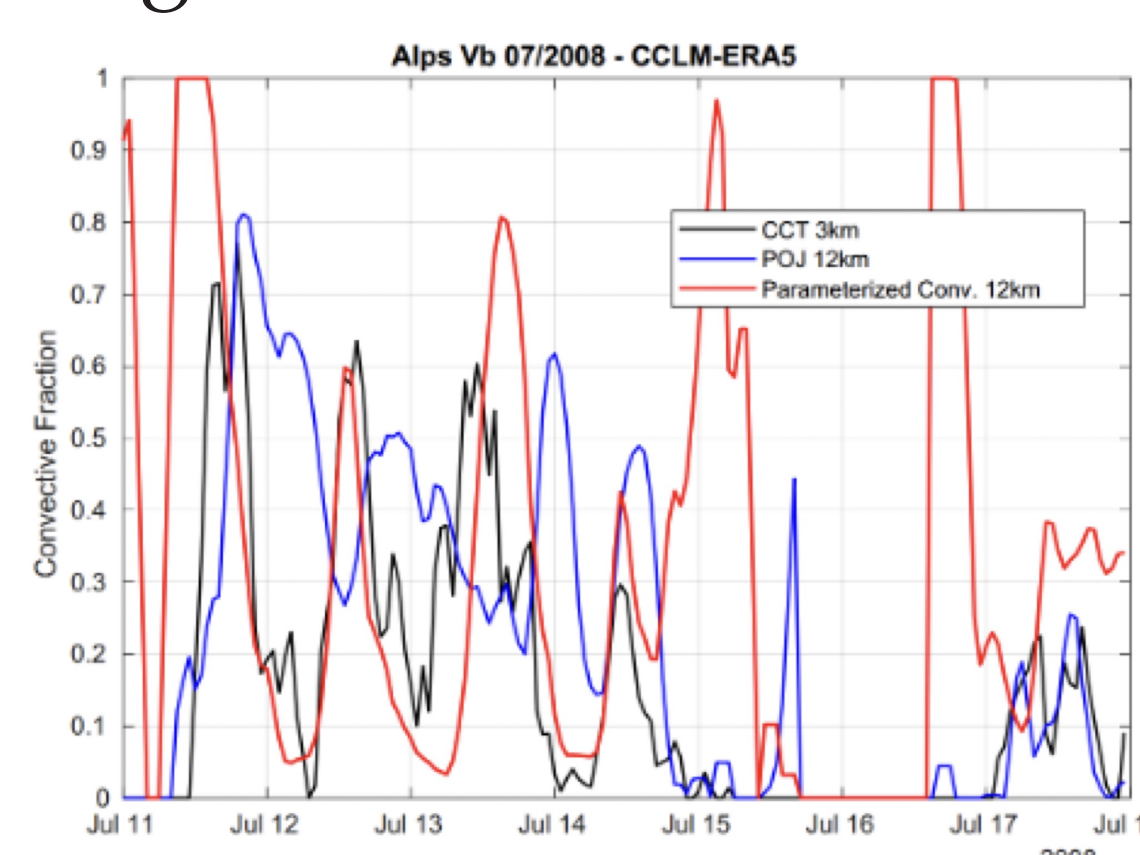
- COSMO-CLM/NEMO climate simulations (Dx = 12km, extended MedCORDEX domain) [2]



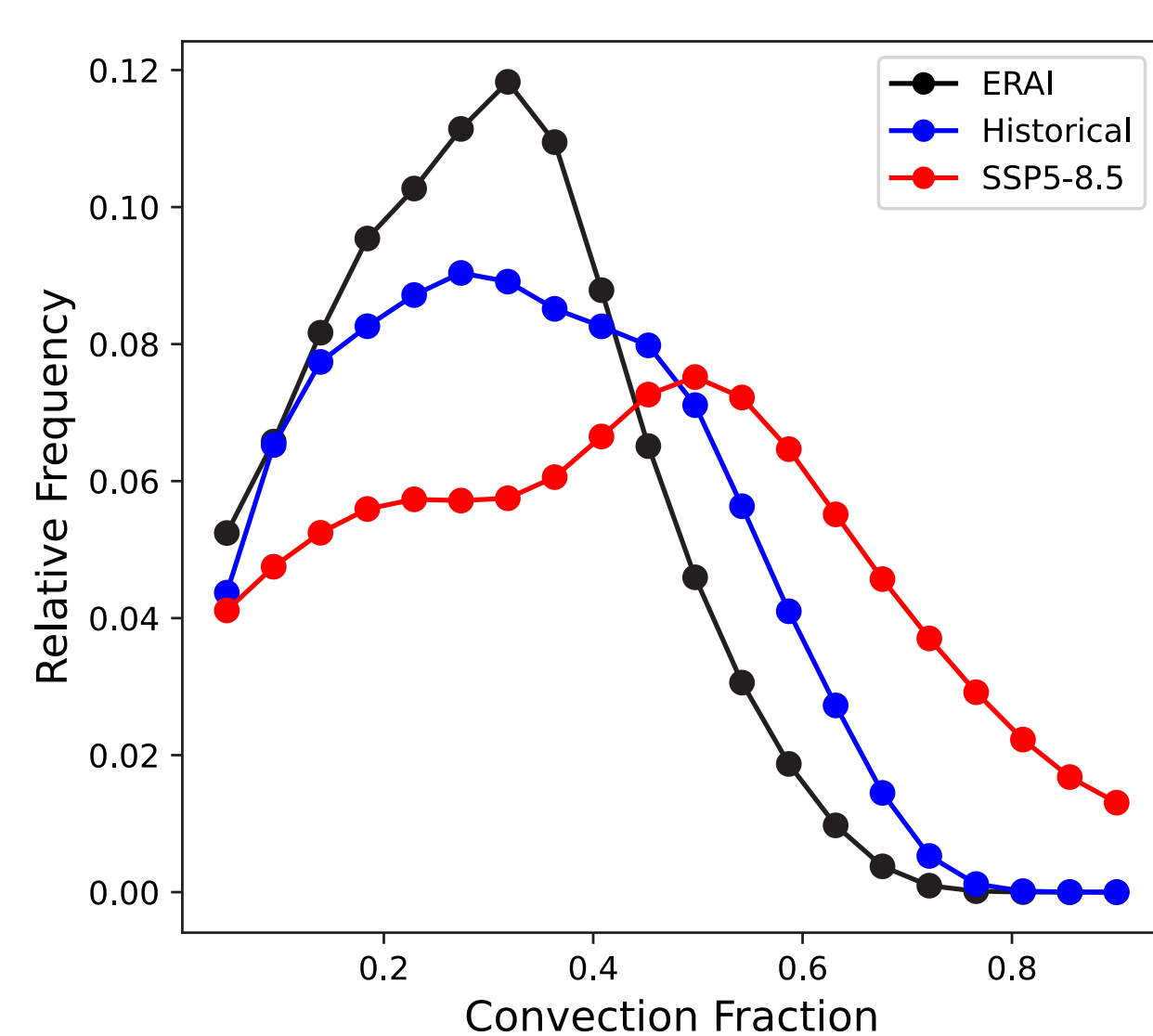
- Vb cyclone tracks climatology [2]

- Estimation of convective precipitation fraction with

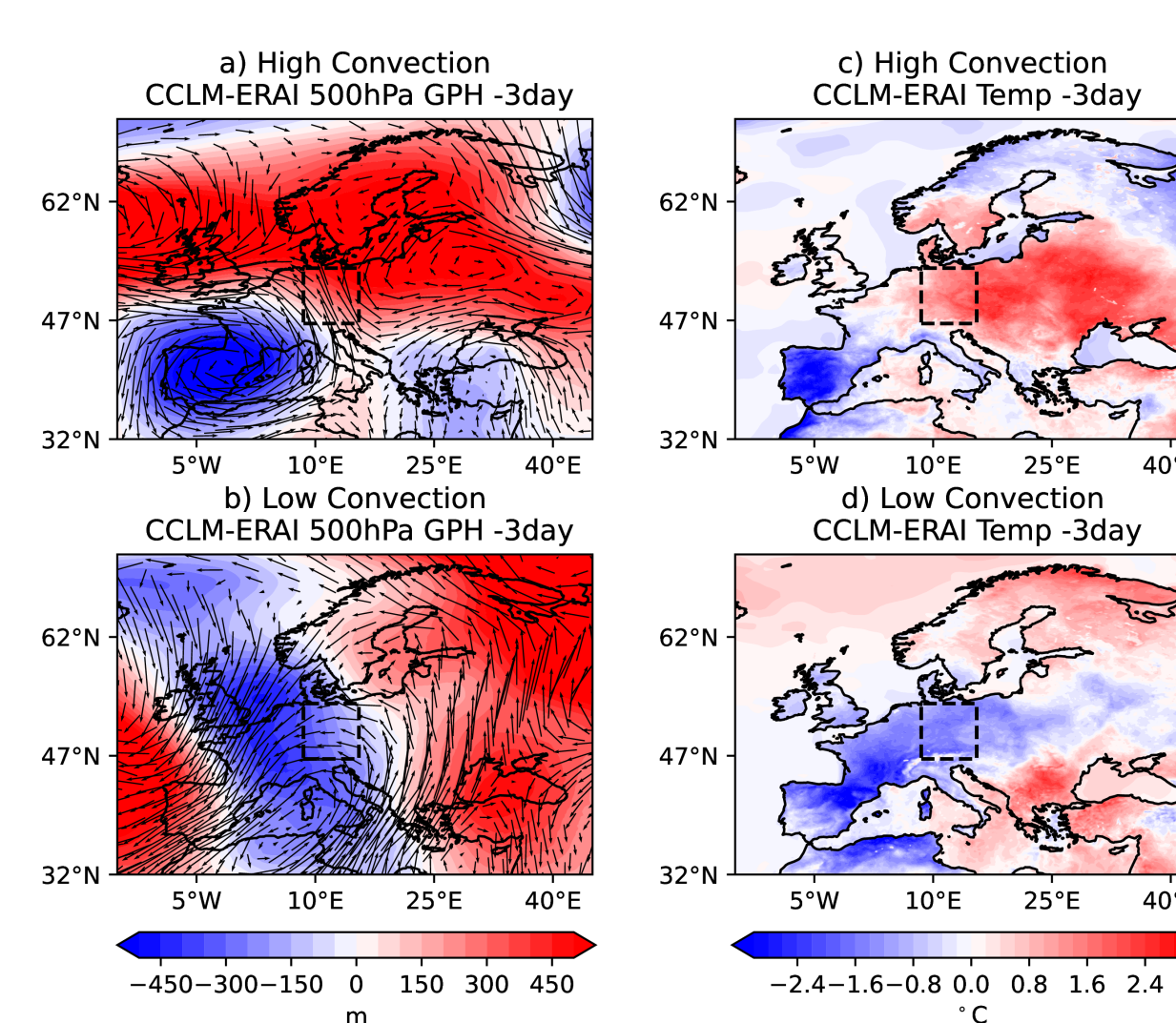
- (a) Convection-permitting event simulations (CPS, Dx=3.3km) and tracking of convective cells [4]
- (b) Diagnostic method following Poujol et al. [3]



RESULT 1

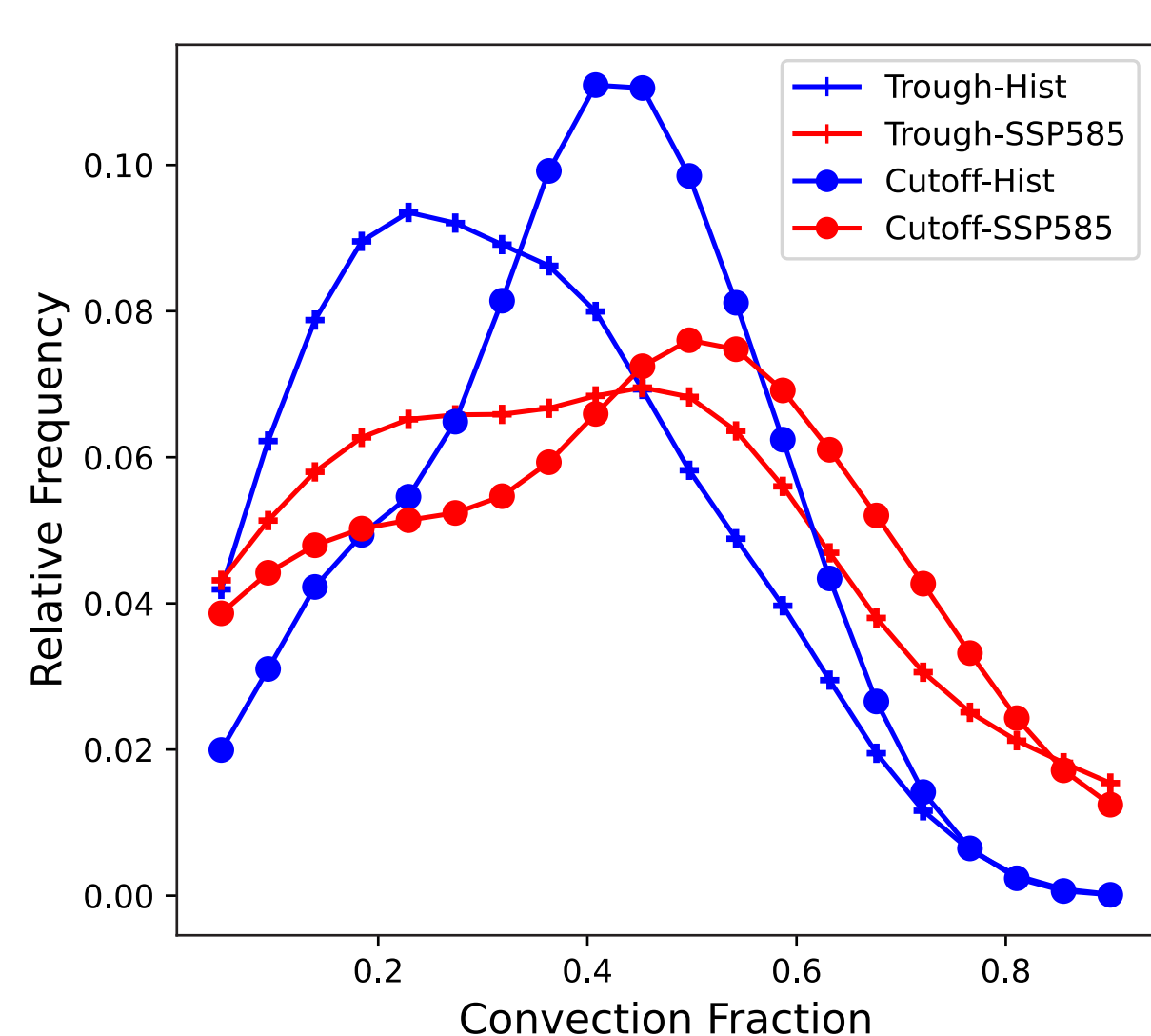


Relative frequency as a function of convection fraction during Vb-cyclones in current climate and a warmer climate scenario under SSP5-8.5 in the Central European box (COSMO-CLM-NEMO driven by ERA-Interim reanalysis in 1979 to 2014 and by CMIP6 EC-Earth3: Historical, 1950-2014, and future SSP5-8.5, 2015-2099)

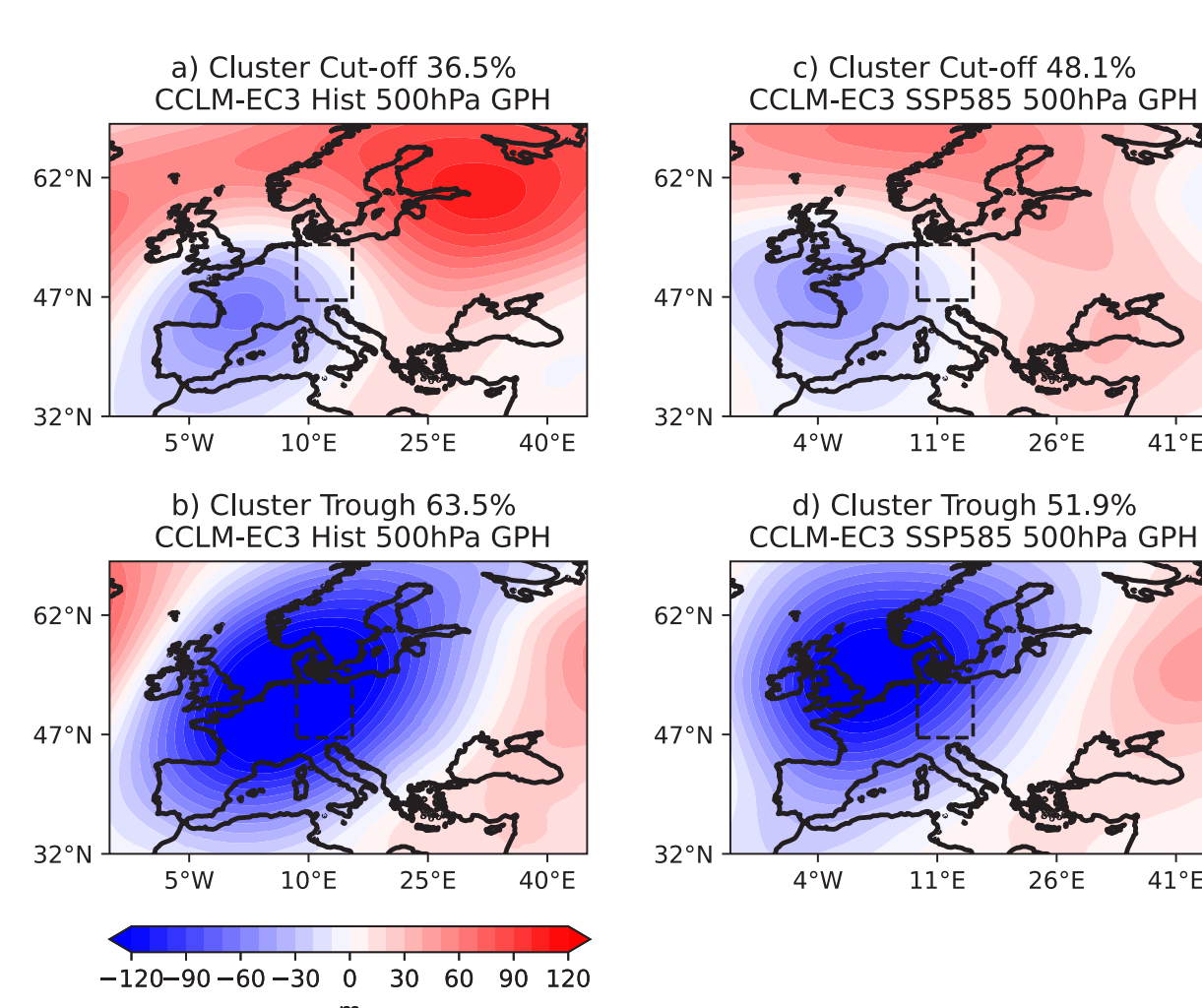


Composites of 500 hPa geopotential height anomalies for historical and a future climate 3 days before the Vb onsets. Composites are averaged over events with the highest and lowest 10% of convection fraction in CCLM-ERA5 as detected within the Central Europe box.

RESULT 2



Relative frequency as above for historical and SSP5-8.5 however after clustering into trough and cutoff-low events



Two-cluster compositing of 500 hPa geopotential height into trough and cutoff-low events and frequencies for historical and future SSP5-8.5 climate

CONCLUSION AND OUTLOOK

- Simple diagnostic of Poujol et al. [3] is applied as indicator for convective precipitation fraction (after evaluation against CPS)
- Historical climate Vb events: Convection contribution about 30% (troughs: 25%, cutoff lows: 45%)
- Future Vb events: larger convective contribution 55% (very likely, esp. because of more convective troughs) -> > Vb floods intensity (+ paths more eastward (uncertain) -> smaller orographic contribution -> dampening effect on Vb floods, not shown)
- Change in large scale dynamics and small scale thermo-/dynamics

Outlook: 10y (hist) + 10y (SSP5-8.5) CPS with ICON-CLM in the MedCORDEX domain done and available for direct convective contribution diagnostics