

# Three-dimensional characteristics of heat waves in CORDEX RCMs

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INTRODUCTION

- Heat waves (periods of abnormally hot weather in summer) have severe impacts on agriculture, livestock, forestry, infrastructure and human health
- They are regarded as one of the greatest hazards in relation to climate change and thus thoroughly investigated
- Climate change scenarios of heat waves are laden with uncertainties also due to inability of RCMs to simulate their driving mechanisms properly [1, 2]
- In this pioneering study, we aim to advance in understanding of processes governing heat waves in regional climate models (RCMs) by analysing them as *three-dimensional* (3D) phenomena

DATA & METHODS

- 9 CORDEX RCMs driven by the ERA-Interim reanalysis (EUR-11 domain; perfect lateral boundary conditions experiments) were evaluated
- 1989–2008 period (common for all RCMs used)
- Heat waves analysed in the extended Central European region (red polygon in Figure 1)
- Their criteria include temperature anomalies, temporal duration, spatial extent, and vertical structure
- Daily mean temperatures in 2m, 850 hPa, and 500 hPa were used
- For each level, we found sequences of at least three consecutive days during which temperature anomalies are above the 95th percentile of its seasonal (June–August) distribution on at least 25% of the area of Central Europe
- These sequences from all three levels were merged and a heat wave was characterised as a period of consecutive days during which the criteria were fulfilled in any level
- In a final step, if two heat waves were separated by 1 or 2 days only, they were blended in order to prevent heat waves' fragmentation

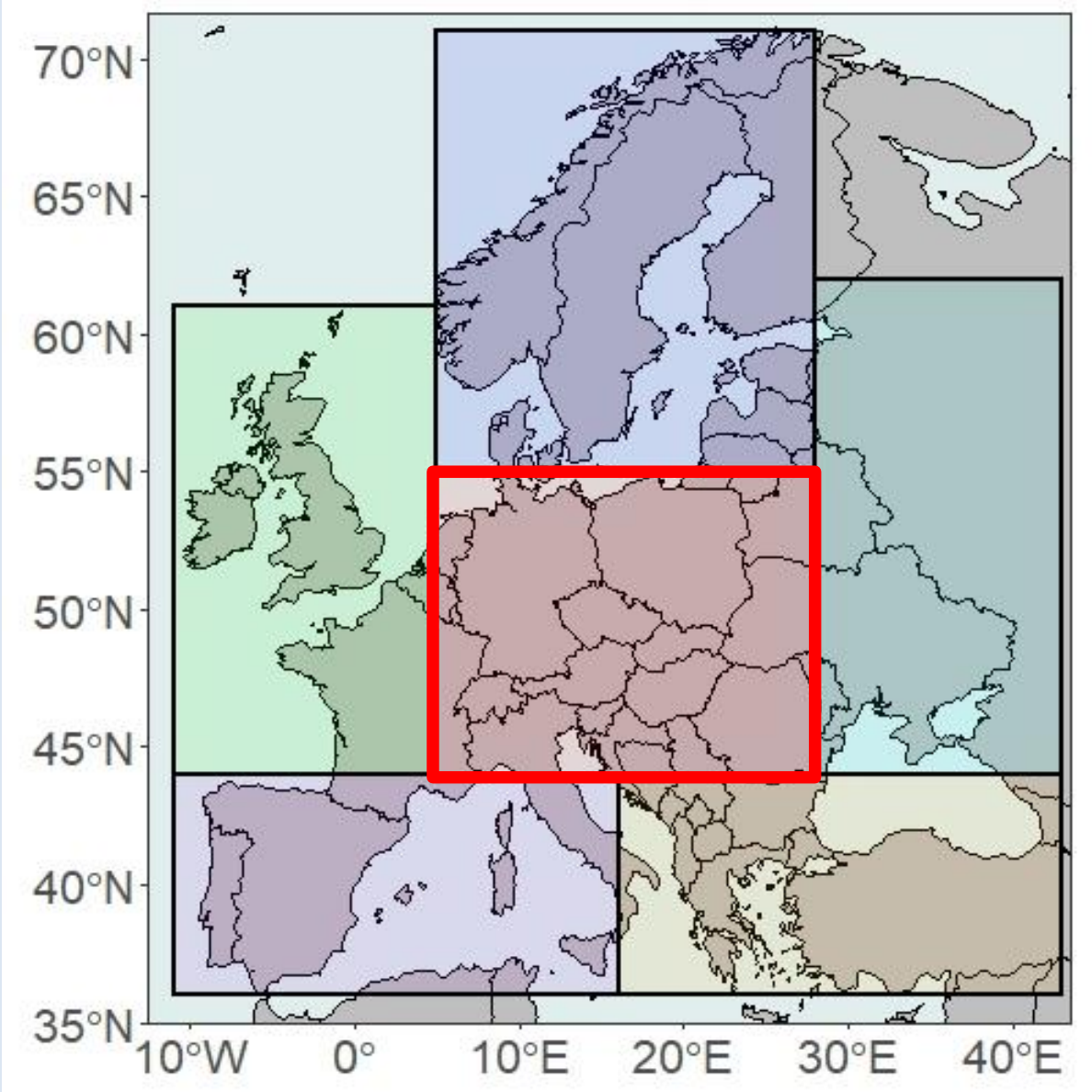


Figure 1: Definition of European regions; only Central Europe (red shading) was used in this study

REFERENCE DATA

- Firstly, reference data were created using the ERA5 reanalysis
- Selected summer seasons with major heat waves in Central Europe were plotted in a high vertical resolution (50 hPa step), using the same heat wave definition as in RCMs
- During the July–August 1994 heat wave, high temperature anomalies were limited from near-surface to 850 hPa only (Figure 2)

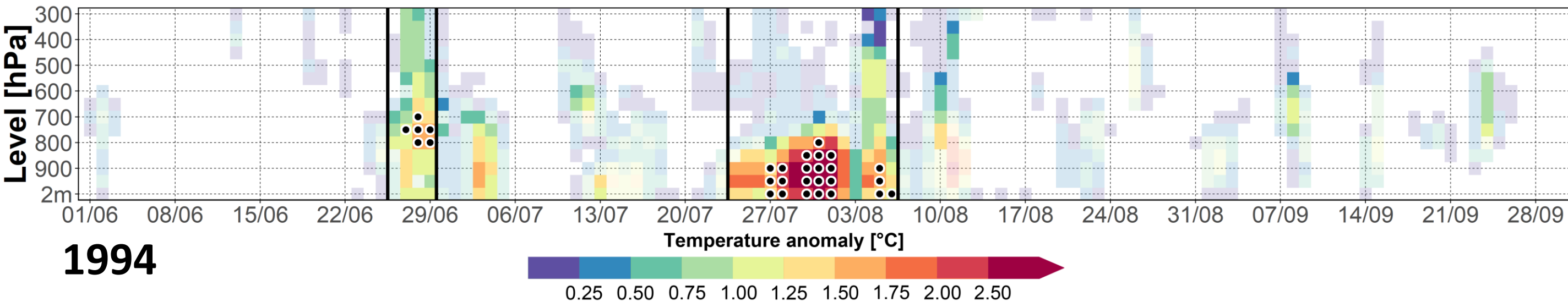


Figure 2: Temperature anomalies during the summer of 1994 in individual levels according to ERA5; black vertical bars delimit individual heat waves, circles indicate spatially widespread (>50% of Central Europe) positive anomalies

- For July 2007 heat wave, by contrast, large and spatially widespread positive temperature anomalies were found through the troposphere (Figure 3)
- Other two heat waves in the beginning and middle of August were located in upper levels only, while the last heat wave of 2007 was found in lower troposphere again

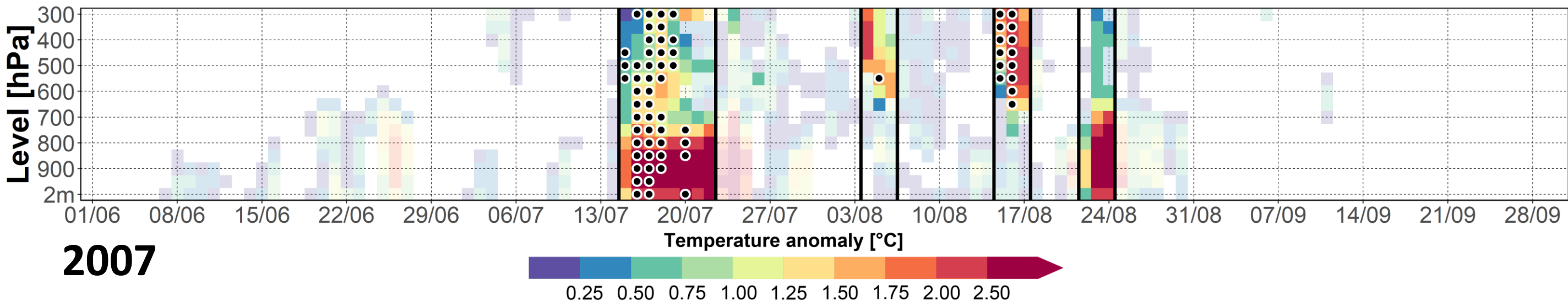


Figure 3: Same as Figure 2 but for the summer of 2007

SUMMERS 1994 AND 2007 IN RCM

- The reference data from the 1994 and 2007 summers were transformed into a low vertical resolution to match the RCM outputs (Figures 4 and 5)

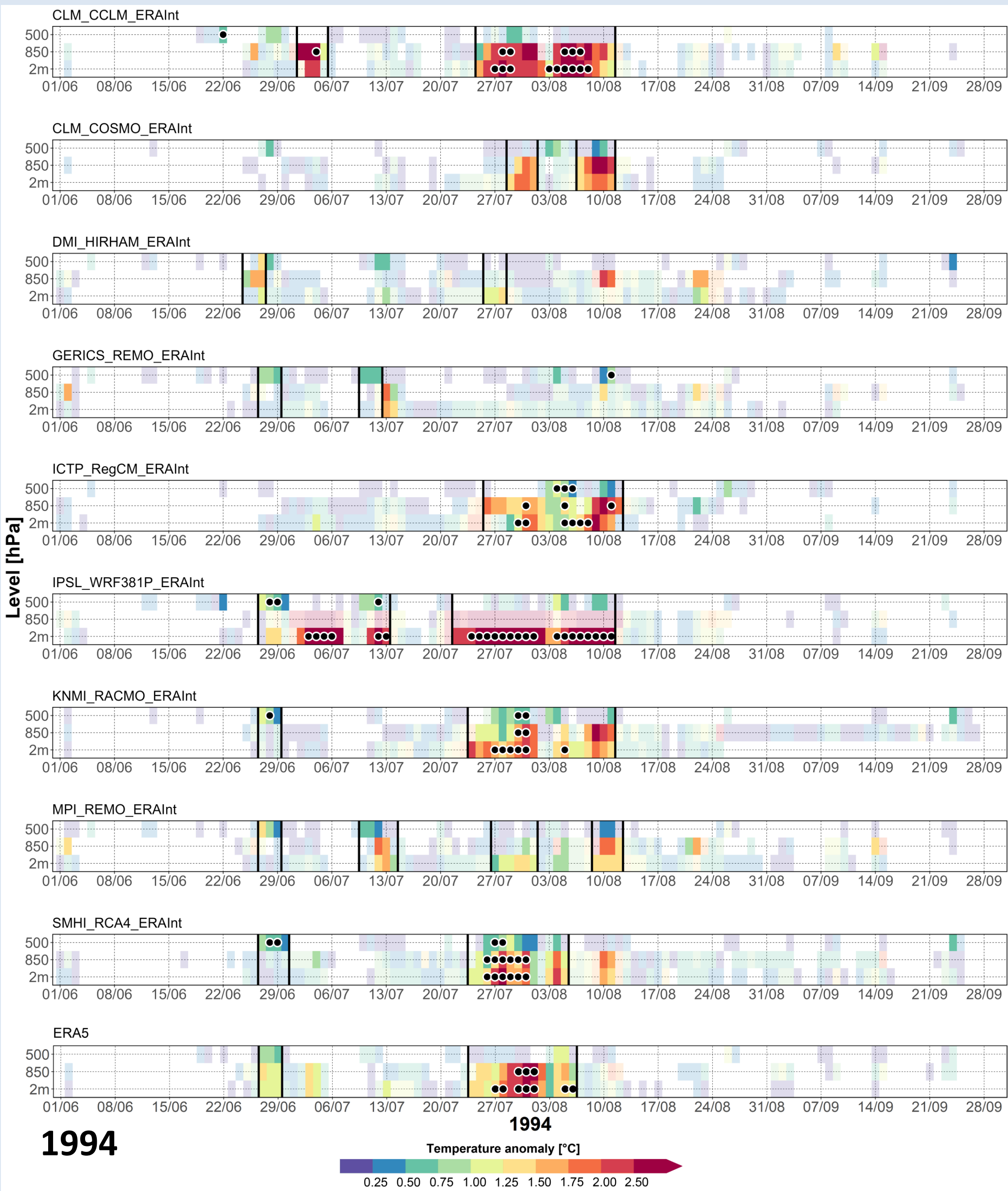


Figure 4: Temperature anomalies during the summer of 1994 in 2m, 850 hPa, and 500 hPa levels according to RCMs and ERA5; black vertical bars delimit individual heat waves, circles indicate spatially widespread (>50% of Central Europe) positive anomalies

- While the majority of the RCMs have difficulties to reproduce the 1994 heat wave, temperature anomalies were simulated reasonably well for 2007

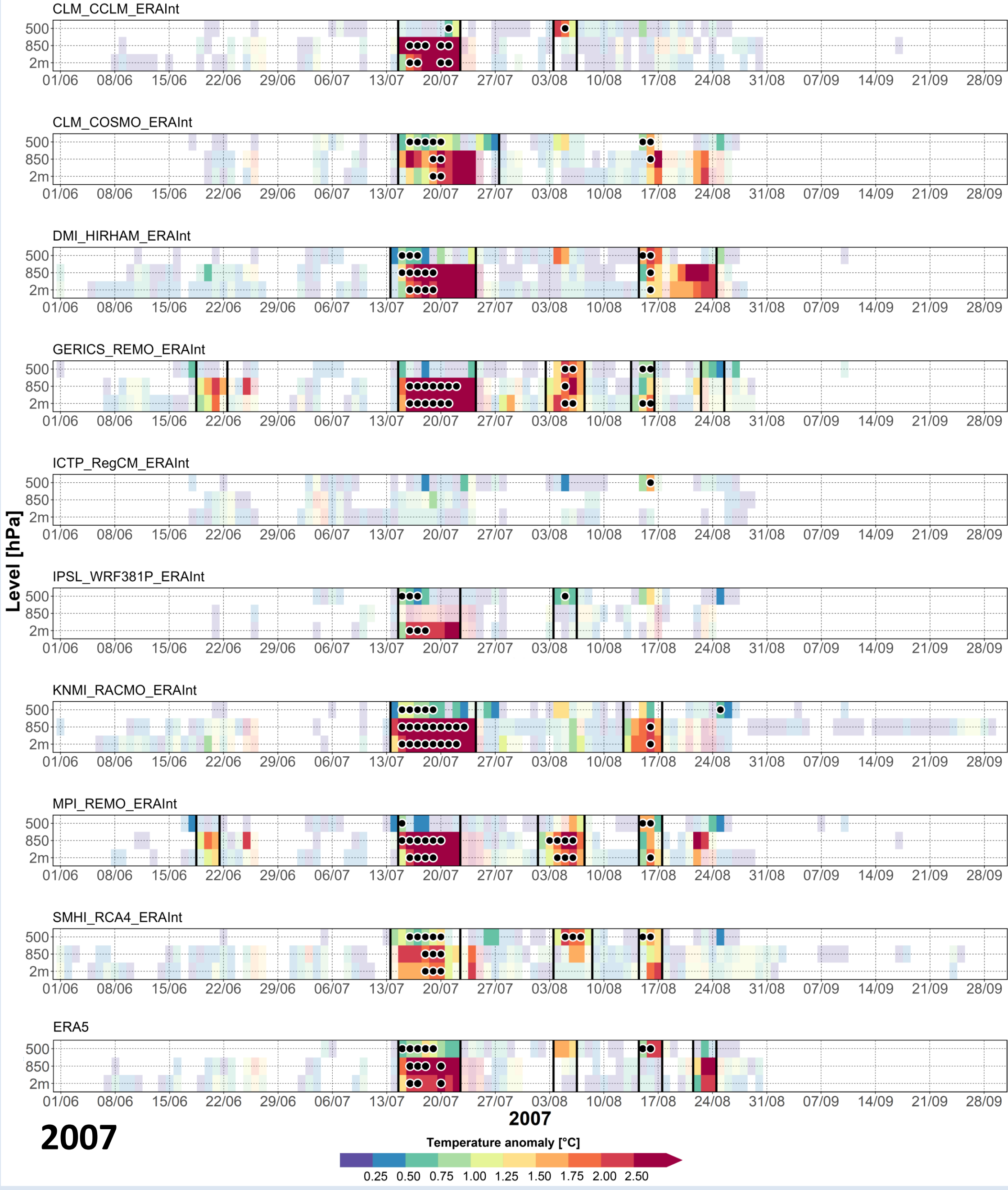


Figure 5: Same as Figure 4 but for the summer of 2007

NEXT TASKS

- Analyse more summer seasons / European regions
- Identification of physical mechanisms beyond the differences

## References

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- [2] Lhotka O, Kyselý J & Plavcová E (2018) Evaluation of major heat waves' mechanisms in EURO-CORDEX RCMs over Central Europe. *Climate Dynamics*, 50. <https://doi.org/10.1007/s00382-017-3873-9>

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