

# Fully coupled TerSysMP EUR-11 evaluation runs

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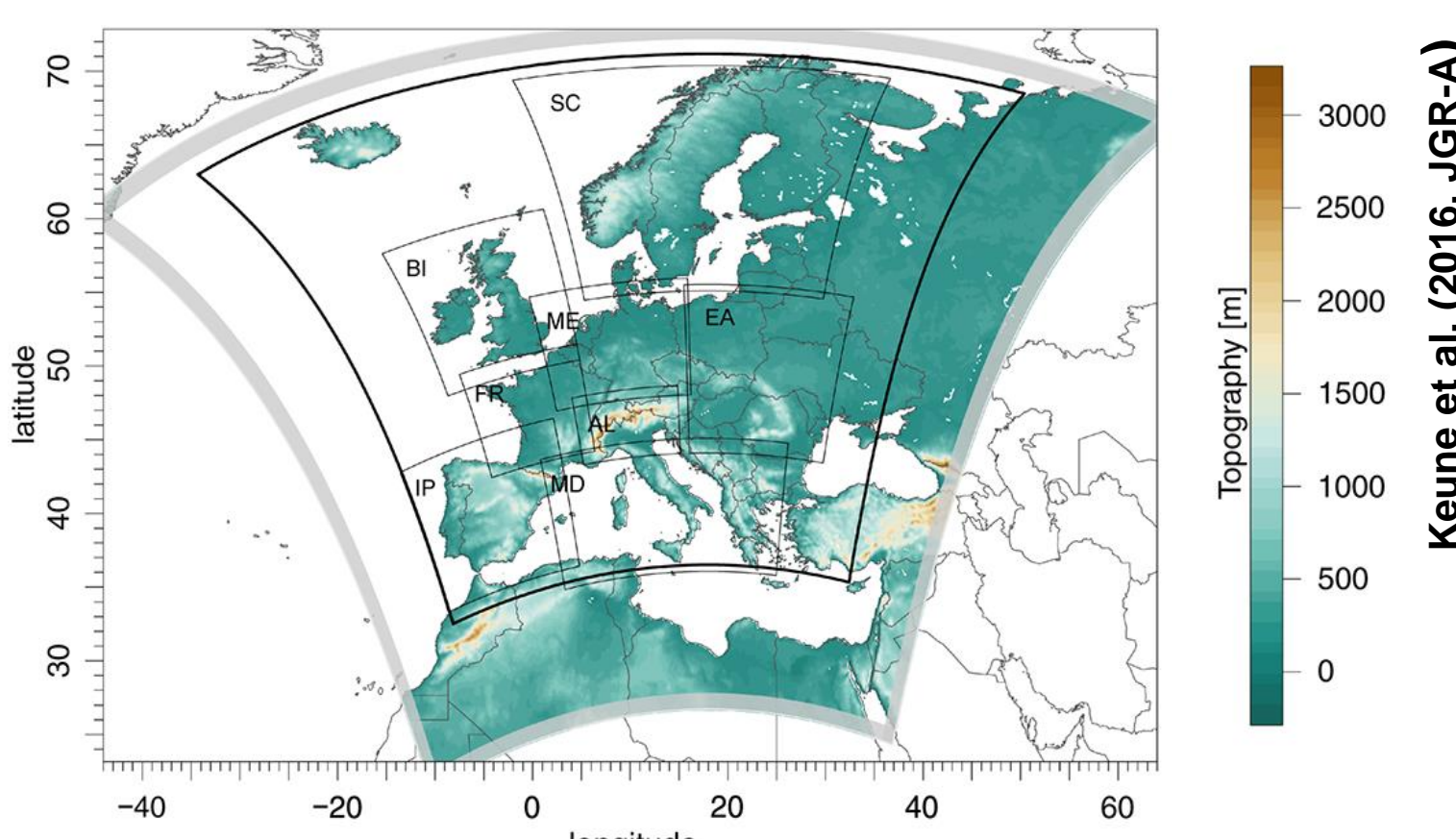
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## Context

Project funded by the **Helmholtz Group**:  
Advanced Earth System Modelling  
Capacity

**Goal:** Develop, evaluate and apply a  
Earth system modelling infrastructure

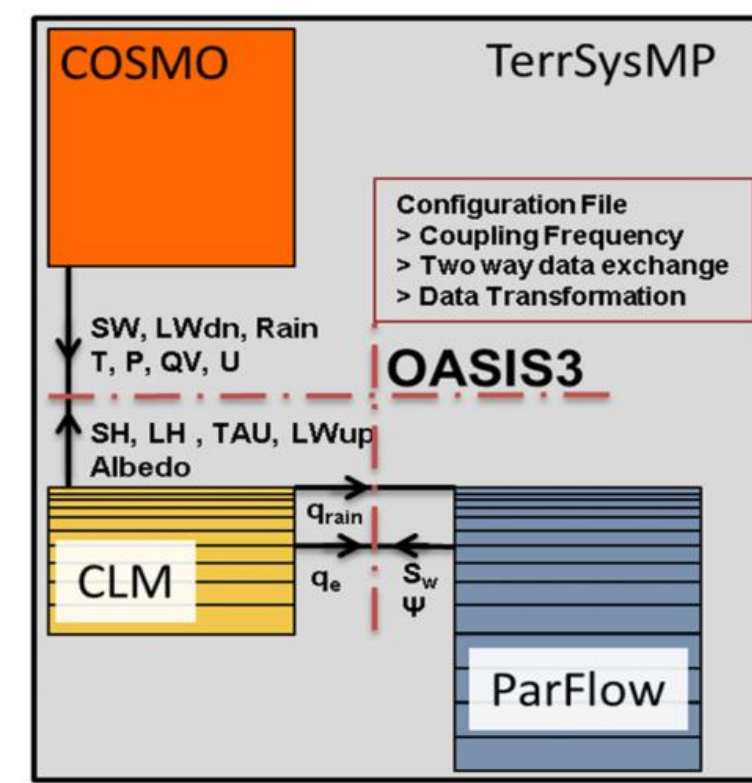
Simulations within the work package 4 :  
Frontier Simulations  
- European hydro-meteorological  
extremes



Topography (m above mean sea level) over the EURO-CORDEX domain at 0.11° resolution. The small inner boxes show the PRUDENCE regions and the respective abbreviation.

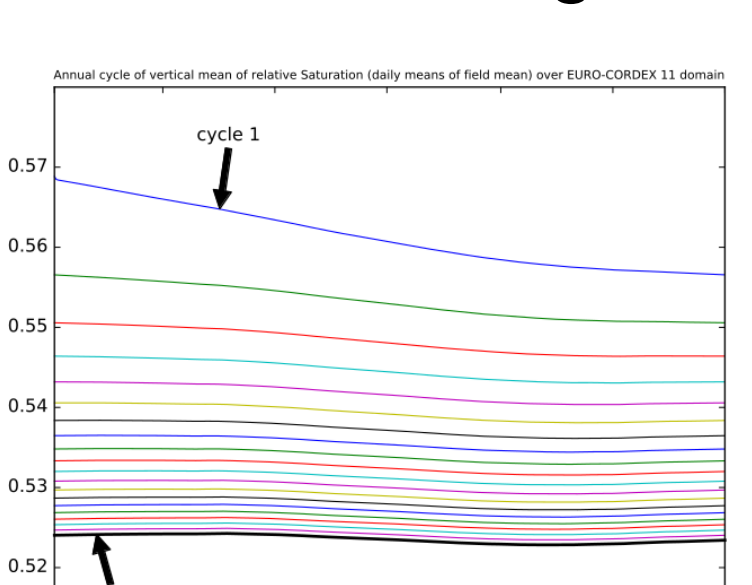
## Terrestrial Systems Modelling Platform (TerrSysMP)

(Shrestha et al., 2014)



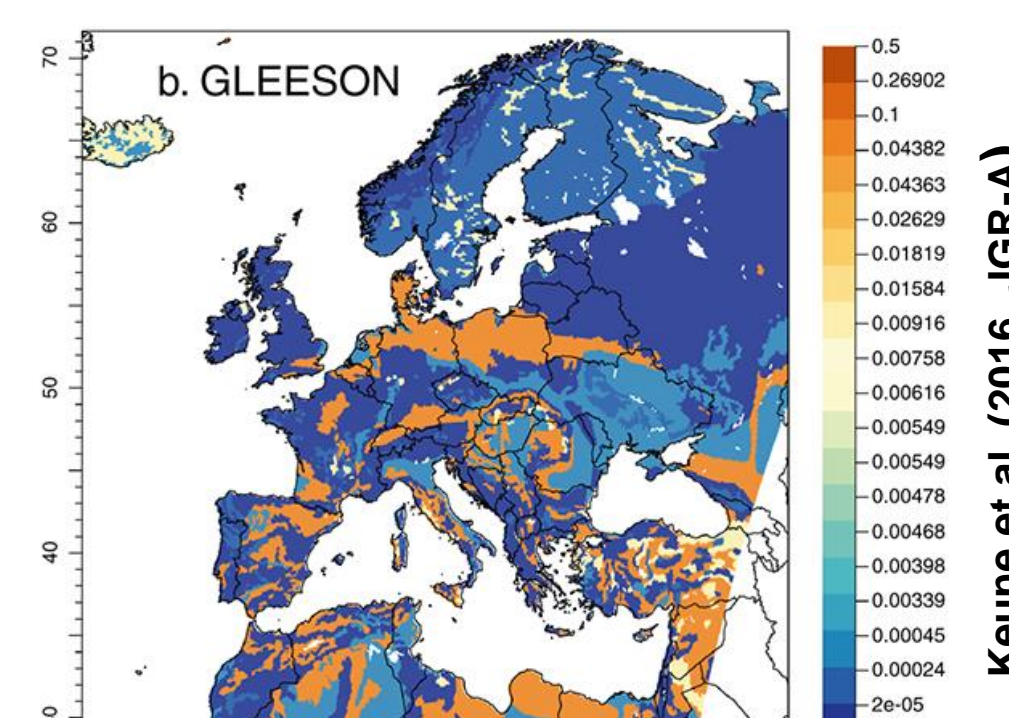
Scale consistent highly modular fully integrated soil – vegetation – atmosphere physically based modelling system  
Component models: **COSMO**; Community Land Model, **CLM** and **ParFlow**; external coupling interface: **OASIS3** and OASIS3-MCT.

Spin-up  
1979-1989 Era  
Interim forcing



ParFlow annual cycle of relative saturation over various spin-up cycles

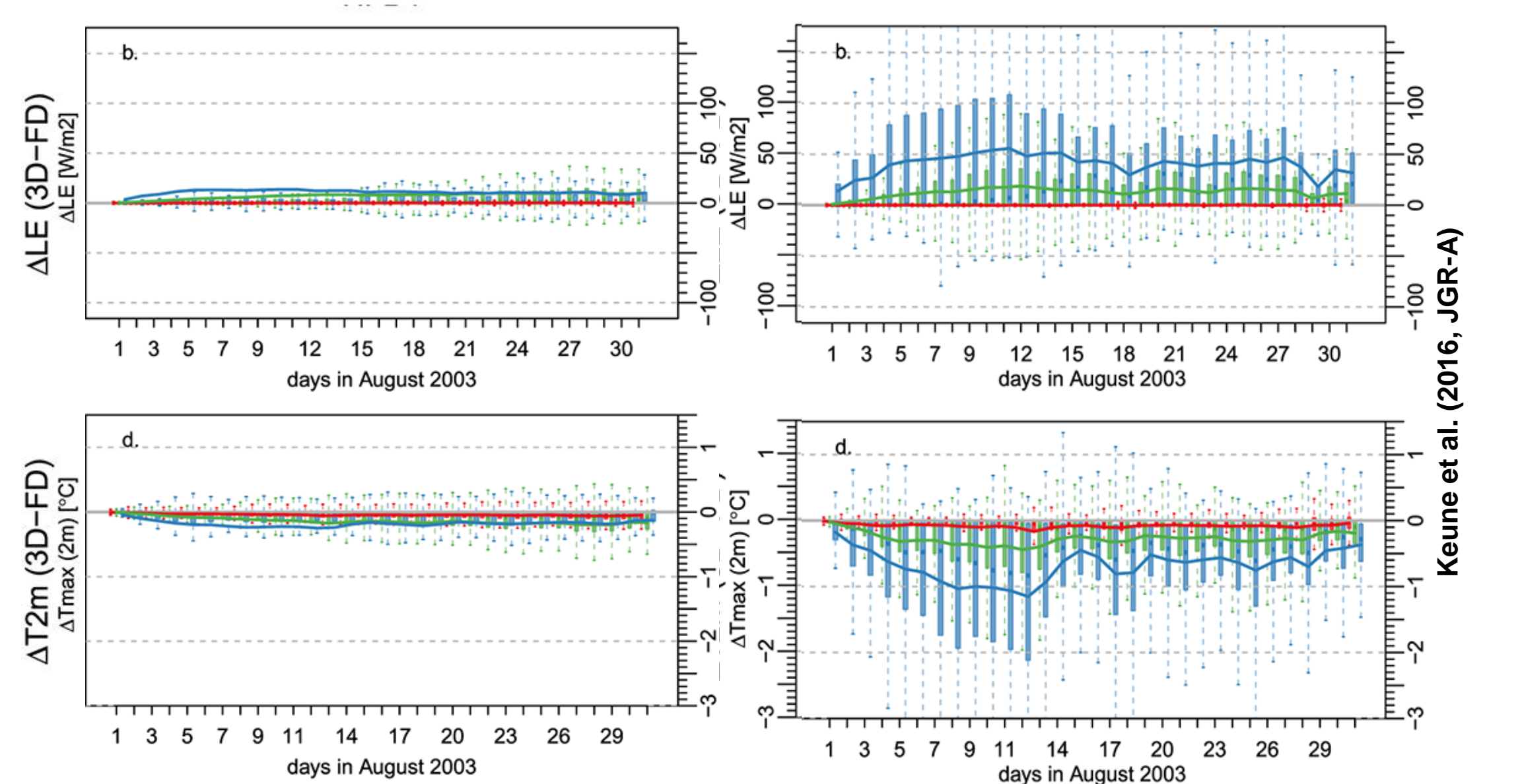
Hydraulic conductivities



Spatial distributions of the hydraulic conductivity k(x) (m/h) prescribed by the Gleeson data base.

## Scientific rationale

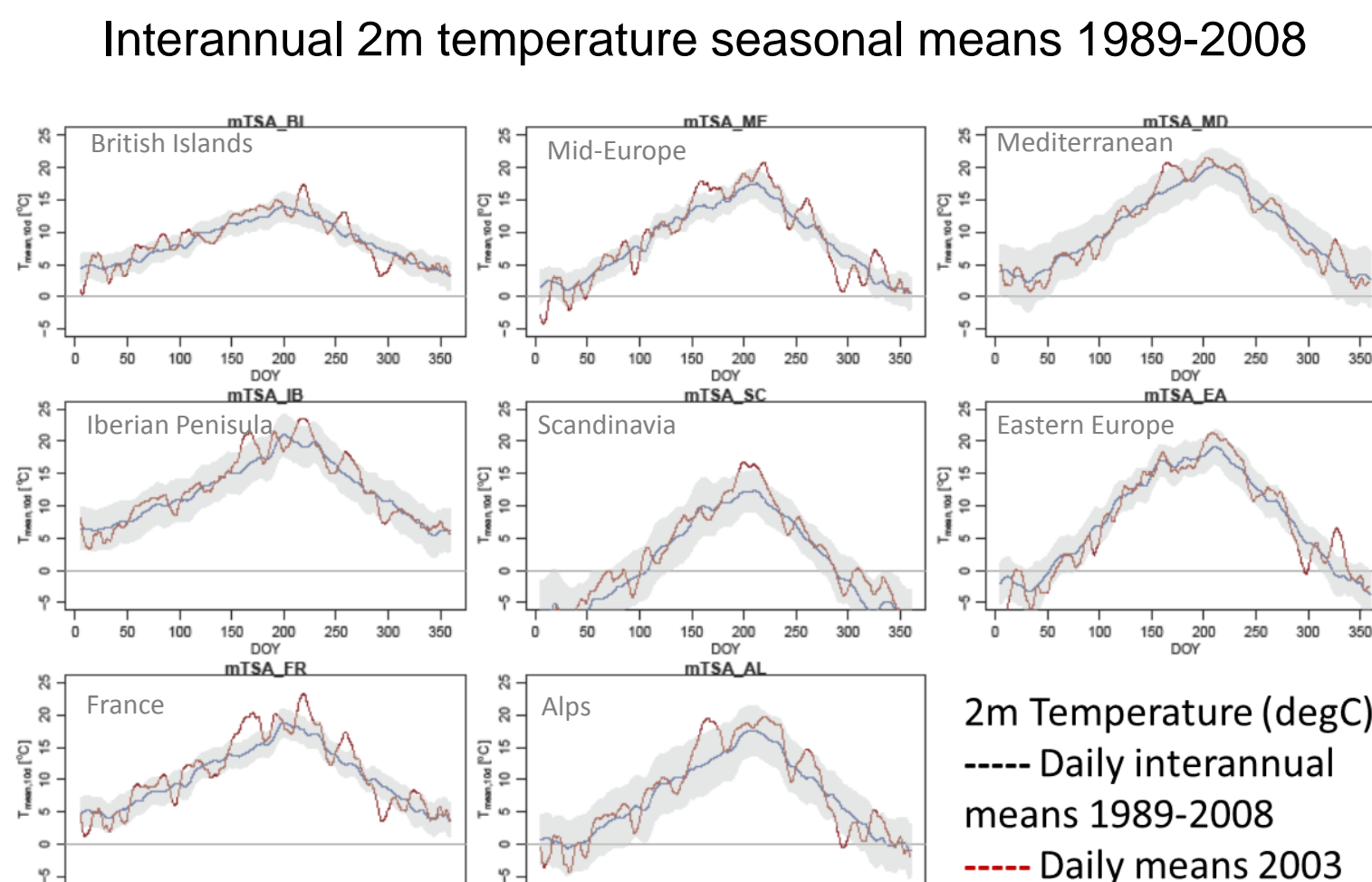
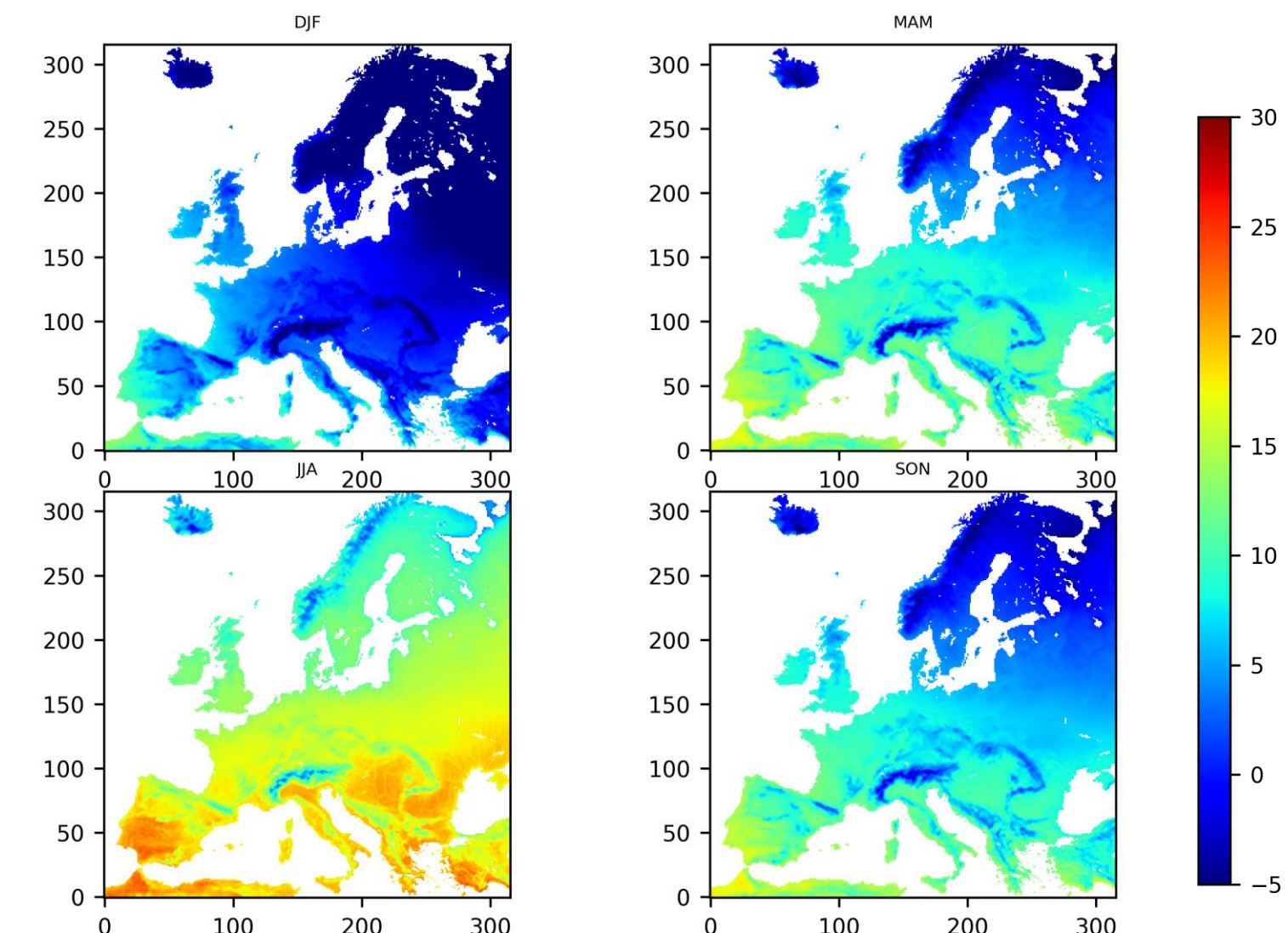
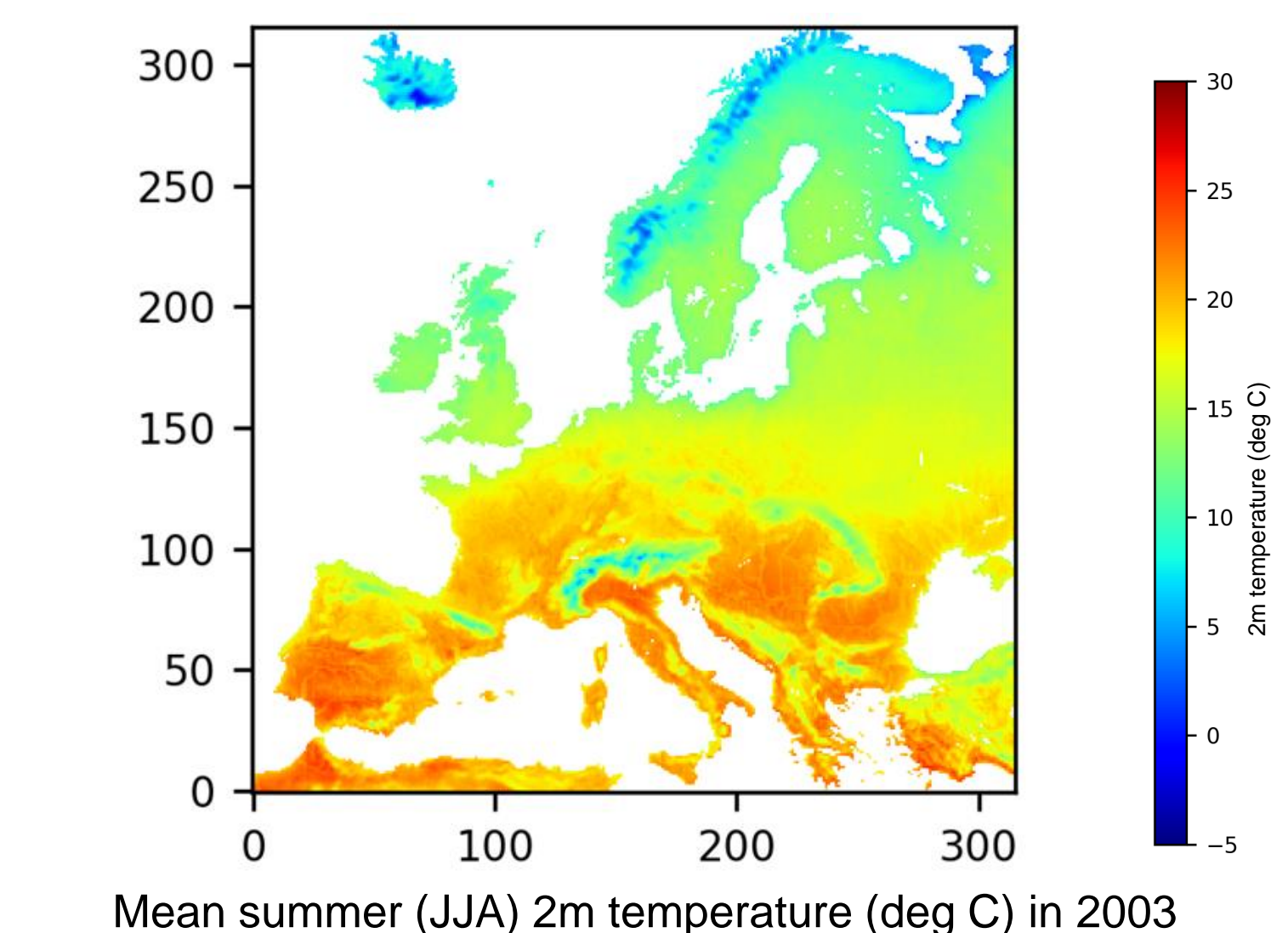
- What is the impact of groundwater representation in regional climate simulations, e.g. on heat waves, extreme precipitation, etc.? (e.g., Keune et al., 2016)
- Introducing interactions and feedbacks between the subsurface and the land surface and atmosphere to the ensemble of EURO-CORDEX RCM simulations



Box-whisker plots of daily maximum LE (W/m<sup>2</sup>) daily maximum T2M (°C) differences between TerrSysMP(3D) and TerrSysMP(FD) over the entire focus domain (left) and PRUDENCE region mid-Europe (right), conditioned on the water table depth in TerrSysMP(3D): WTD < 1 m (blue), 1 m <= WTD < 5 m (green), and WTD > 5 m (red)

## 2003 heat wave

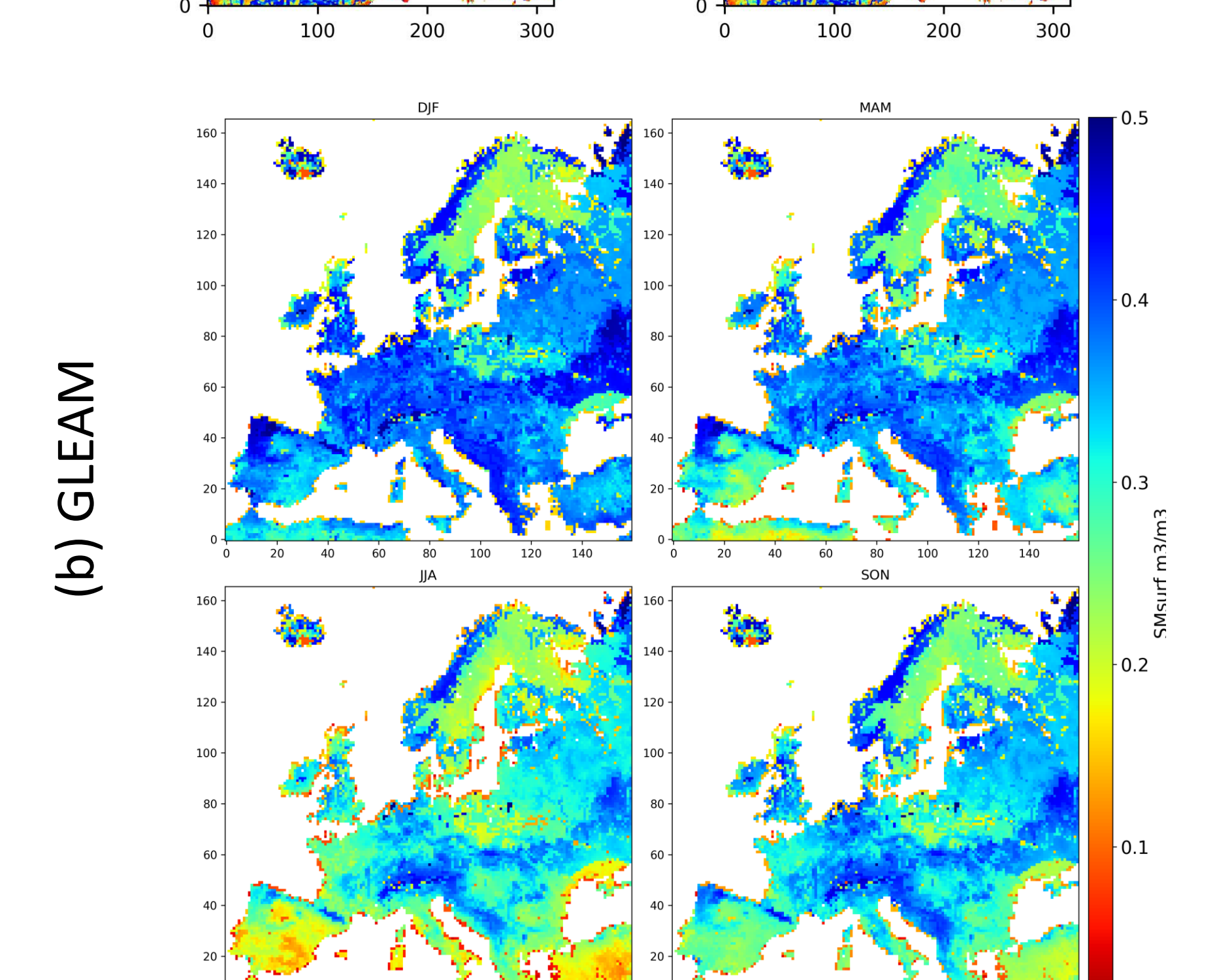
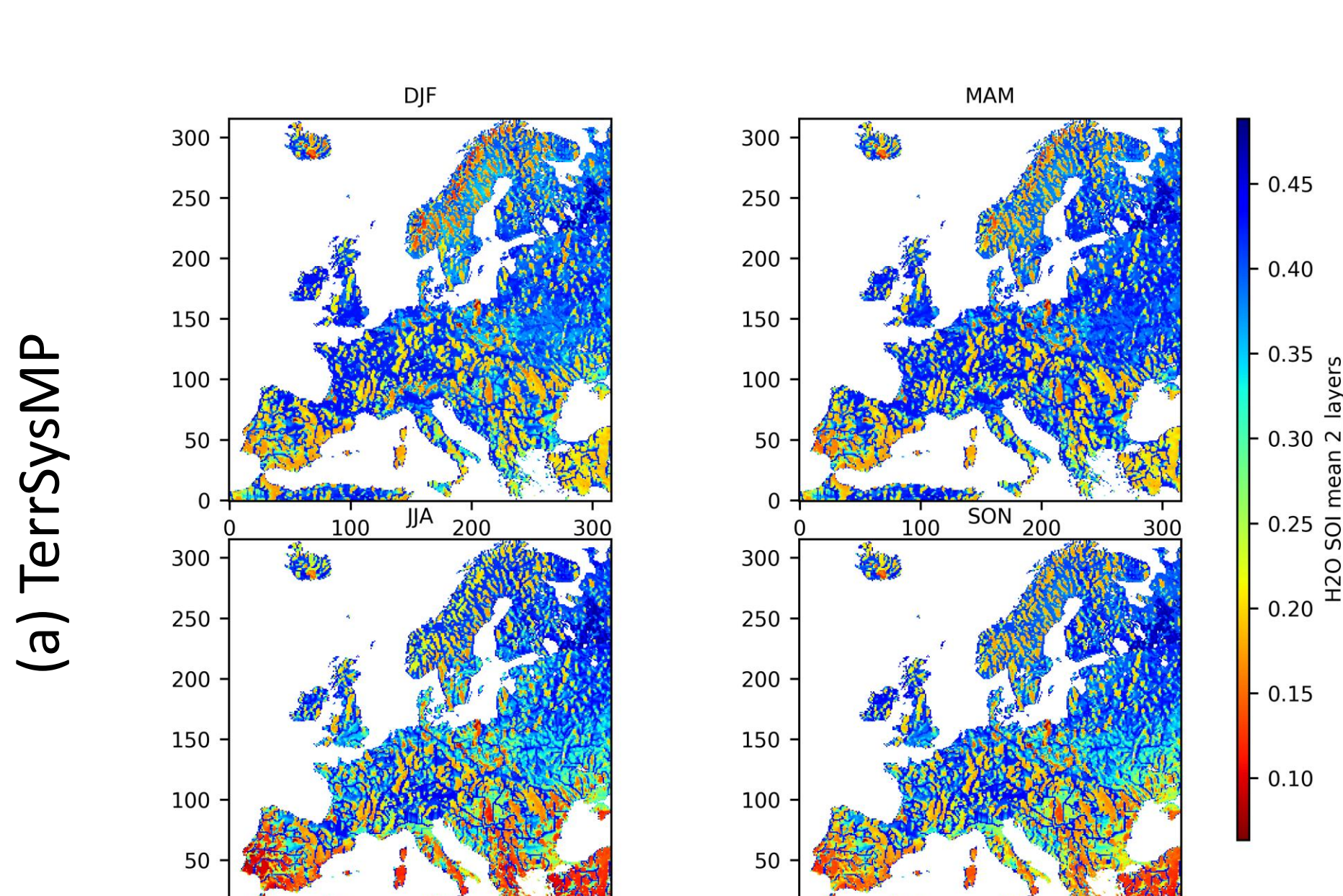
TerrSysMP simulation on 2003 compared to 1989-2008



Interannual 2m temperature in 2003 compared to interannual daily means 1989-2008 in each PRUDENCE region

## Surface soil moisture

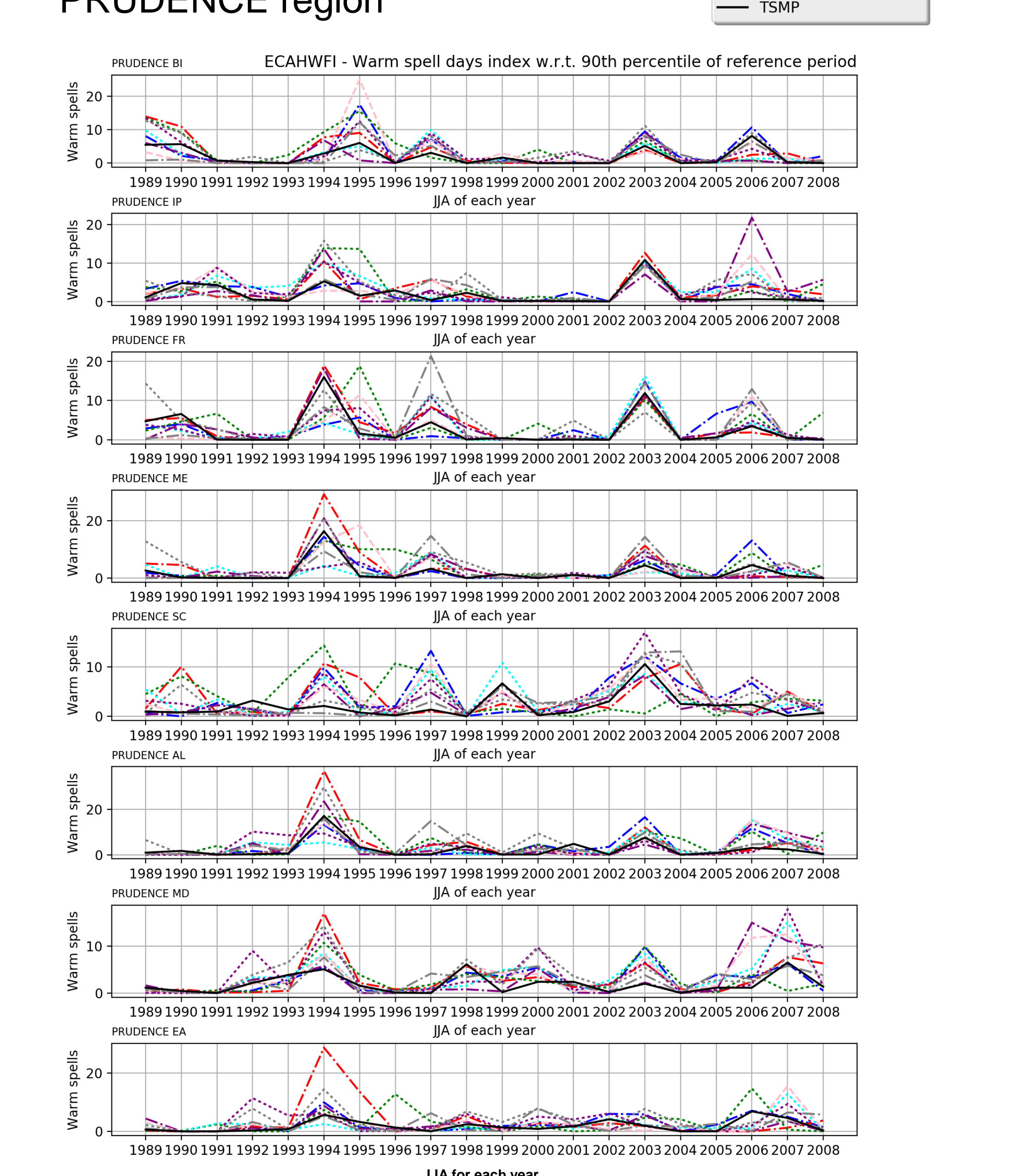
TerrSysMP compared to GLEAM dataset  
Seasonal data 1989-2008



Volumetric surface soil moisture seasonal means in 1989-2008, for TerrSysMP simulations (a) and GLEAM database (b)

## Warm Spells

TerrSysMP compared to other EUR-11 models (Vautard, 2013) in each PRUDENCE region



Warm spells with regard to each model 90<sup>th</sup> percentile summer (JJA) daily maximum 2m temperatures. TerrSysMP (TSM) is represented by the continuous black line and the other models acronyms listed in the legend are described by Vautard (2013).

### Next steps

- Alternative groundwater treatment, 3D vs free drainage
- Inclusion of human water use, towards water management application, derivation of climatology

## Acknowledgements

The authors gratefully acknowledge the computing time granted by the JARA-HPC Vergabegremium on the supercomputer JURECA at Forschungszentrum Jülich.

## References

Keune, J., F. Gasper, K. Goergen, A. Hense, P. Shrestha, M. Sulis, and S. Kollet (2016), Studying the influence of groundwater representations on land surface-atmosphere feedbacks during the European heat wave in 2003, *J. Geophys. Res. Atmos.*, 121(22), 13,301-13,325.  
Knut, S. et al. (2017), Land-atmosphere coupling in EURO-CORDEX evaluation experiments, *J. Geophys. Res. Atmos.*, 122(1), 79-103.  
Shrestha, P., M. Sulis, M. Masbou, S. Kollet, and C. Simmer (2014), A scale-consistent Terrestrial Systems Modeling Platform based on COSMO, CLM and ParFlow, *Mon. Weather Rev.*, 142(9), 3466-3483.  
Jülich Supercomputing Centre. (2016), JURECA: General-purpose supercomputer at Jülich Supercomputing Centre. Journal of large-scale research facilities, 2, A62. doi:10.17815/jlsrf-2-121  
Vautard, R., et al. (2013), The simulation of European heat waves from an ensemble of regional climate models within the EURO-CORDEX project, *Clim. Dyn.*, 41(9-10), 2555-2575, doi:10.1007/s00382-013-1714-z.

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