

European extreme events simulations with the fully coupled TerrSysMP

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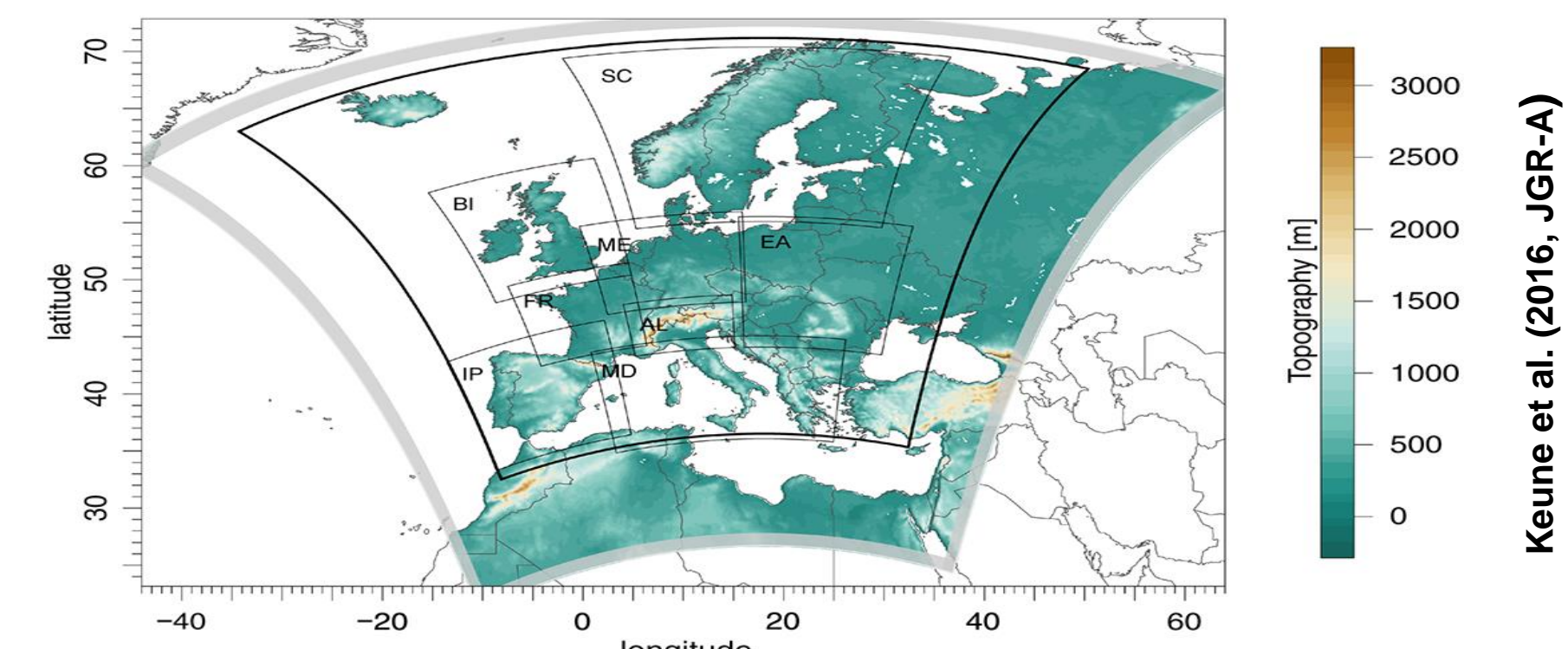


Context

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

Goal: Develop, evaluate and apply a Earth system modeling infrastructure

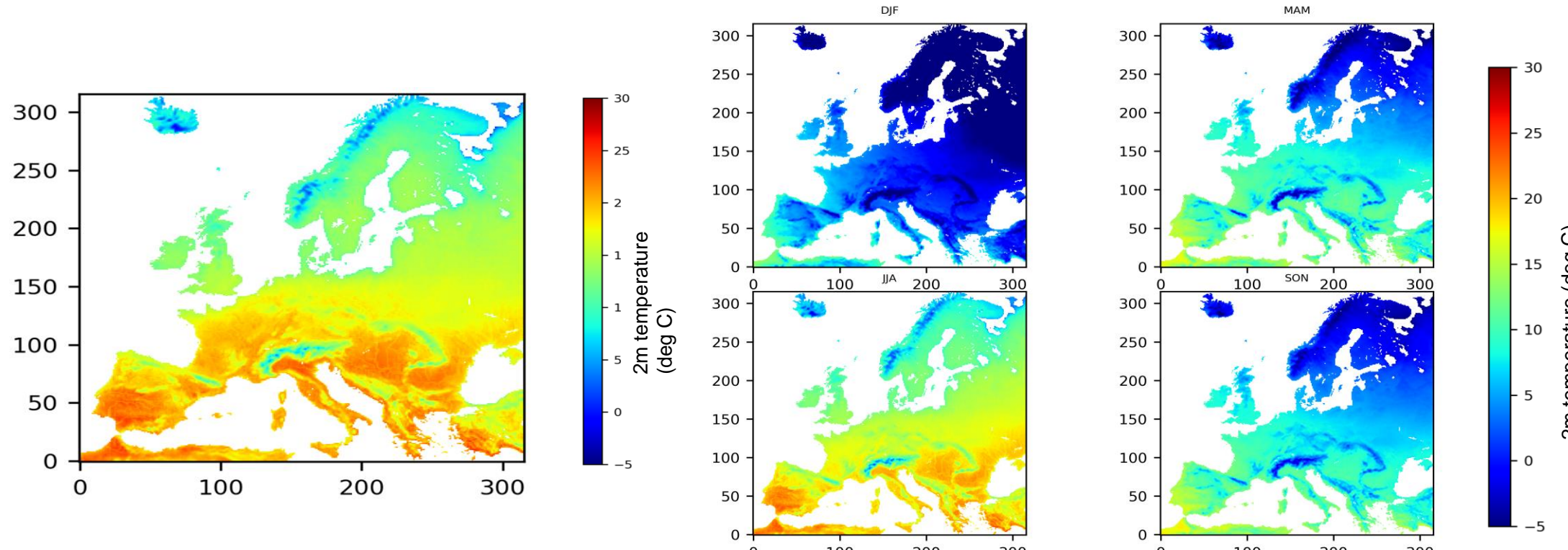
Frontier Simulations within the work package 4:
European hydro-meteorological extremes



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.

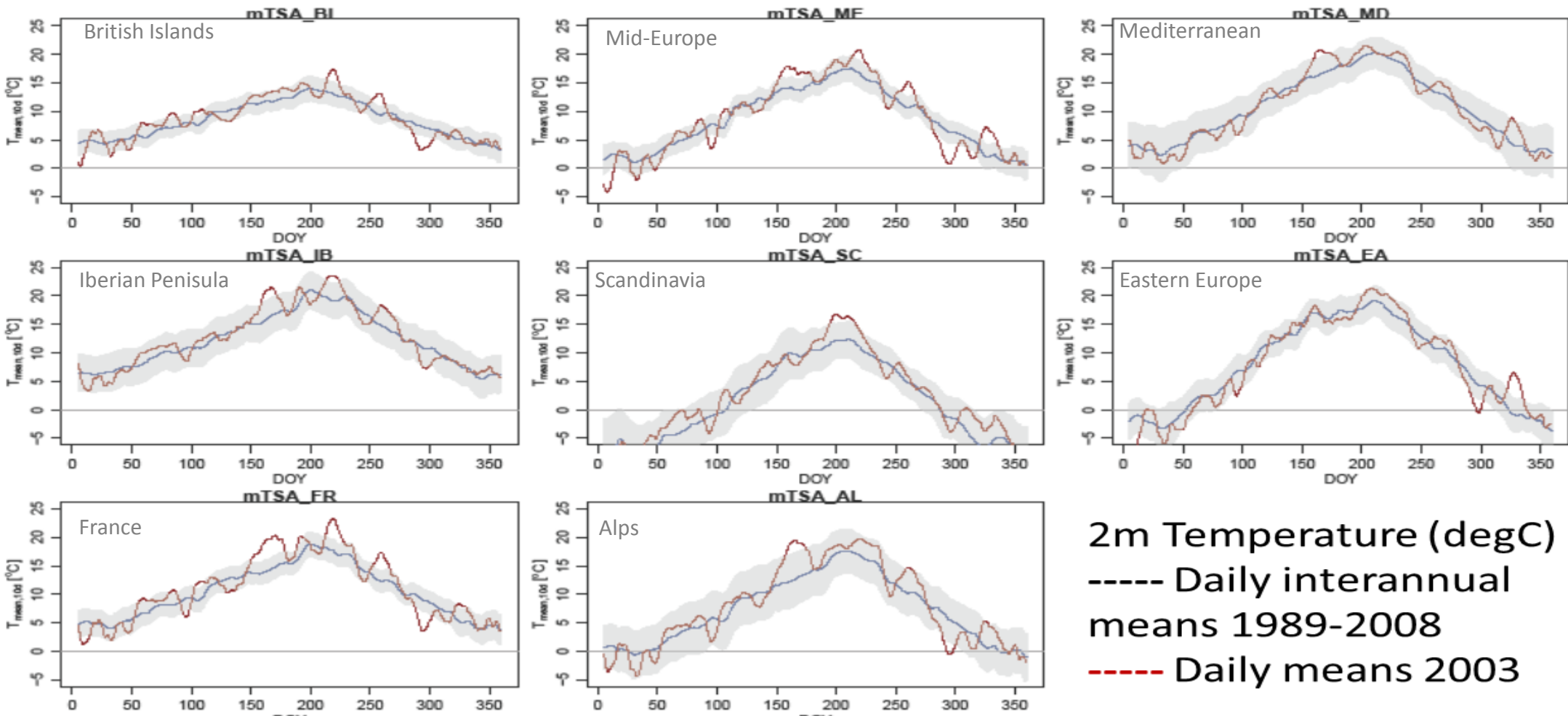
2003 heat wave

TerrSysMP simulation on 2003 compared to 1989-2008



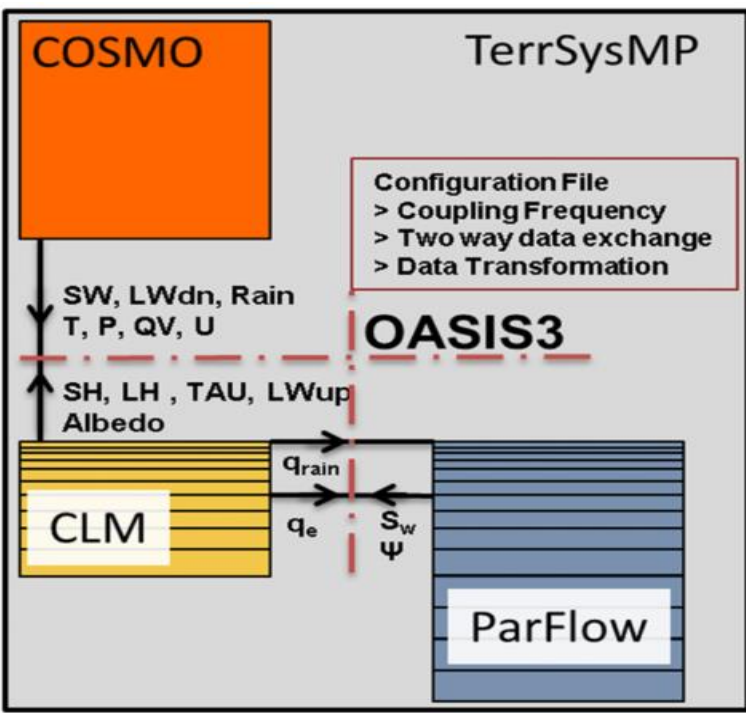
Mean summer (JJA) 2m temperature (deg C) in 2003

Interannual 2m temperature seasonal means 1989-2008



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

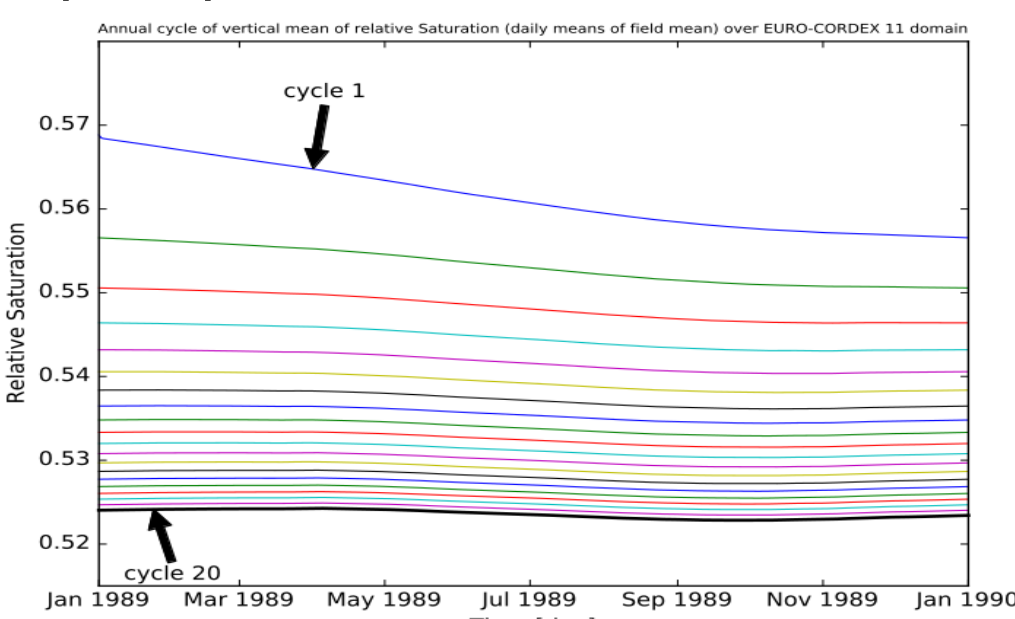
Terrestrial Systems Modelling Platform (TerrSysMP)



Scale consistent highly modular fully integrated soil – vegetation – atmosphere physically based modeling system

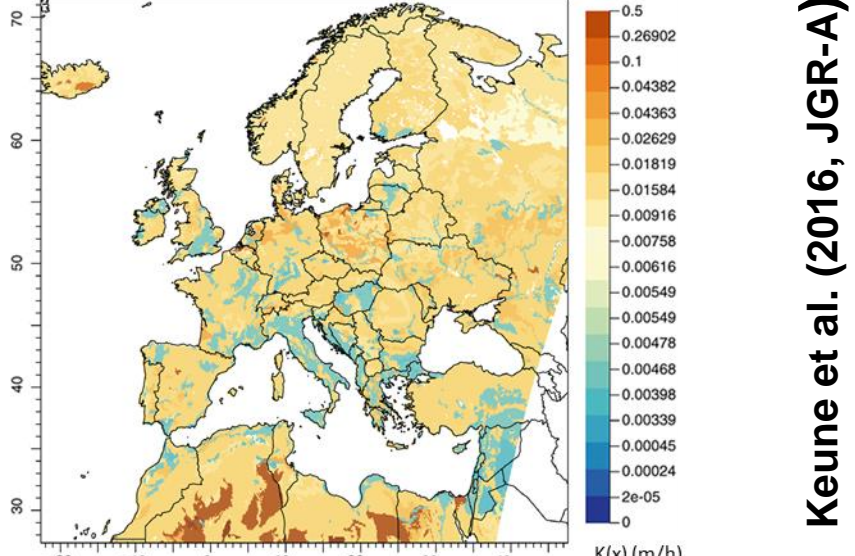
Component models: **COSMO**; Community Land Model, **CLM** and **ParFlow**; external coupling interface: **OASIS3** and OASIS3-MCT.

Spin-up 1979-1989 Era-Interim forcing



Soil annual relative saturation over 20 spin-up cycles

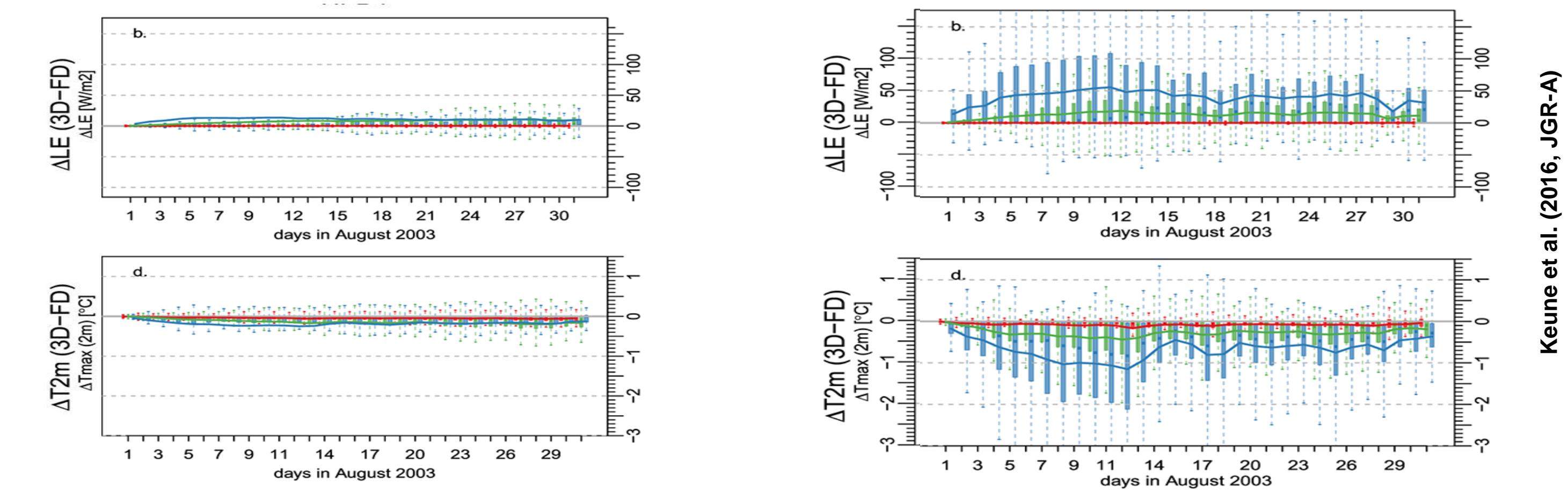
Hydraulic conductivities



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

Scientific rationale

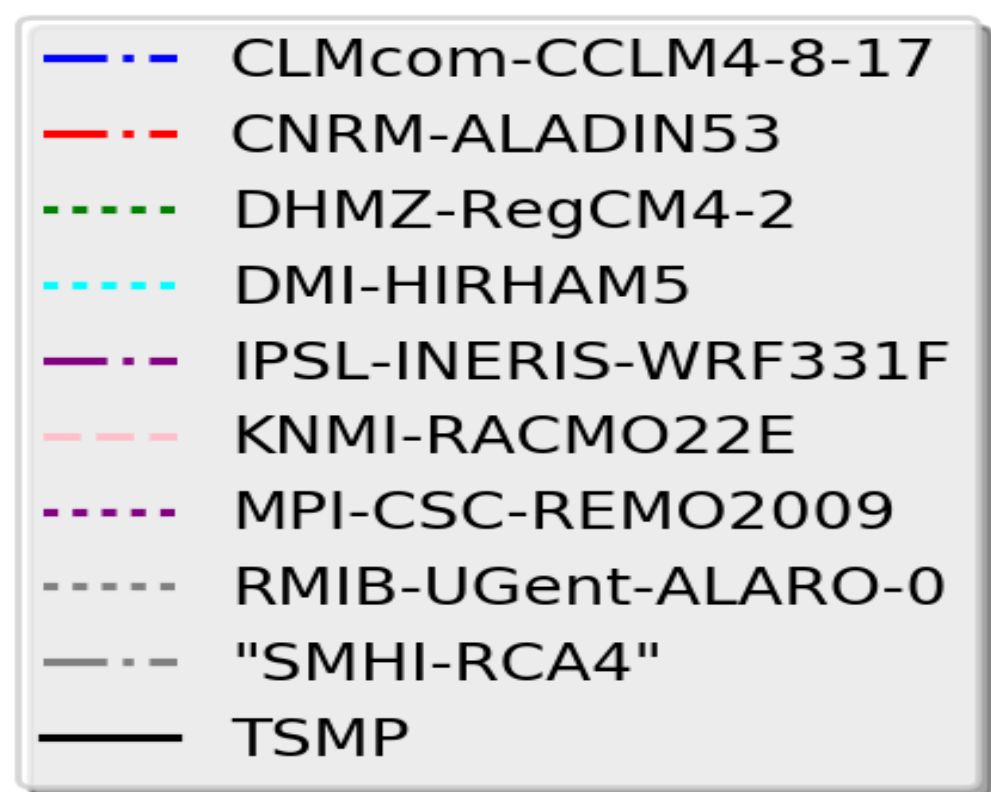
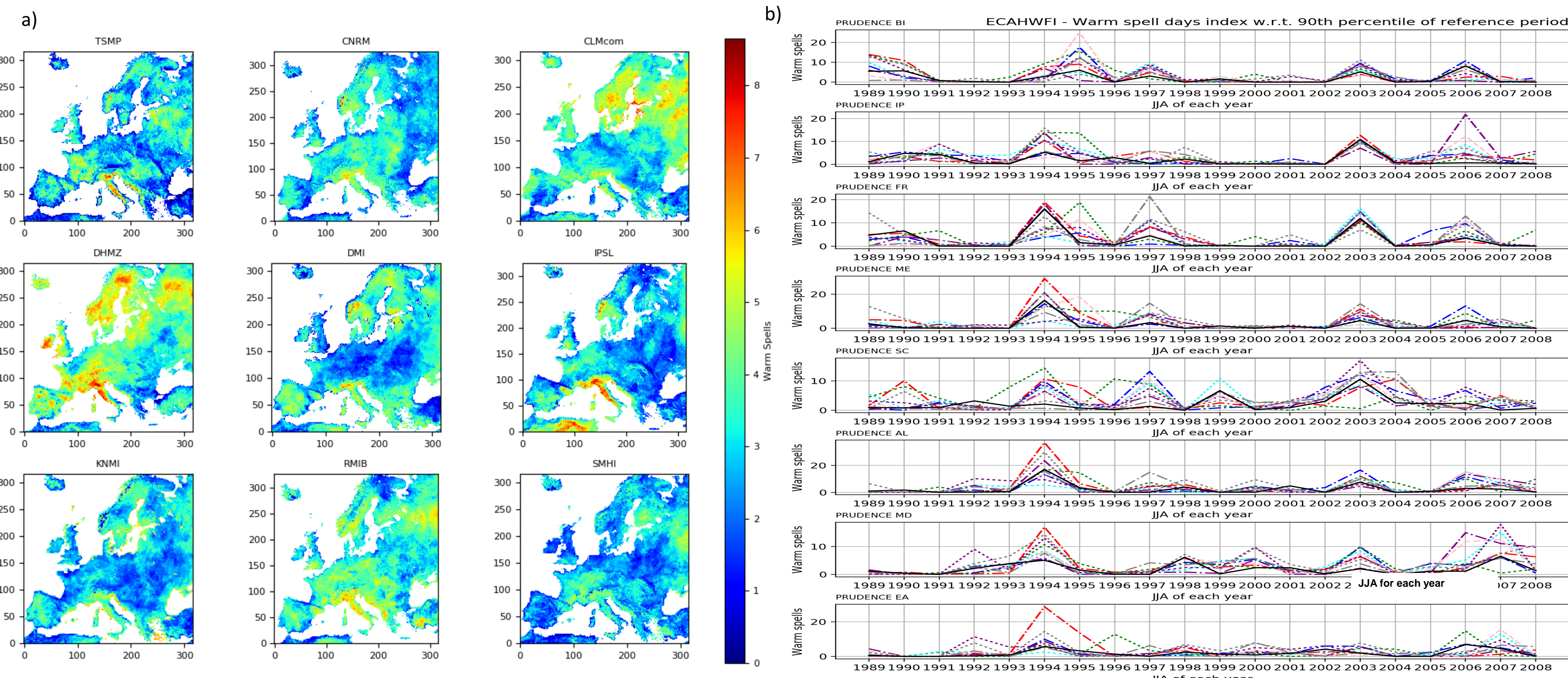
- What is the impact of groundwater representation in regional climate simulations, e.g. on heat waves, extreme precipitation, etc.? (e.g., Keune et al., 2016)
- Introducing interactions and feedbacks between the subsurface and the land surface and atmosphere to the ensemble of EURO-CORDEX RCM simulations



Box-whisker plots of daily maximum LE (W/m²) 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)

Warm Spells (1989 - 2008)

TerrSysMP warm spells (with regard to each model 90th percentile summer (JJA) daily maximum 2m temperatures) compared to other EUR-11 regional climate models (Vautard, 2013), spatial variation in the EUR-11 domain (a) and time-series of the mean values in each PRUDENCE region (b).



TerSysMP (TSMP) 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

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