ETH
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Land surface drivers of droughts: The role of soil moisture persistence

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Motivation

Classical attribution studies investigate role of
human influence vs. natural variability
for extreme events

Heat wave: Stott et al. 2003, *Nature*; Otto et al. 2010, *GRL*
Drought: Hoerling et al. 2012, *J.Clim*
Flooding: Min et al. 2011, *Nature*; Pall et al. 2011, *Nature*

EU-FP7 project *EUCLEIA*

We want to study:

(1) Role of initial conditions vs. atmospheric forcing for soil moisture dynamics (and drought events)
→ Attribution of processes → "Physical attribution"

(2) Classical attribution: Changes in drought risk through long-term soil moisture trends

Model

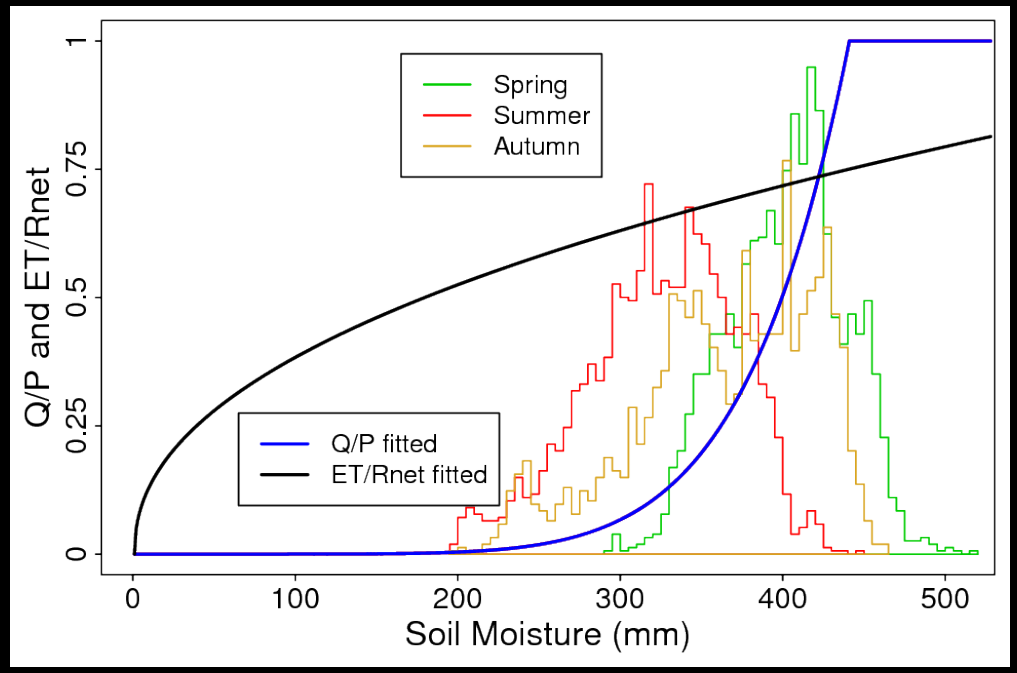
Observation-based simple water balance model:

$SM_{n+1} = SM_n + P_n – Q_n – ET_n$

Assume

$Q_n / P_n = f_1(SM)$

$ET_n / R_n = f_2(SM)$



$SM_{n+1} = SM_n + P_n – f_1(SM) \cdot P_n – f_2(SM) \cdot R_n$

→ f_1 and f_2 are determined by comparing modeled vs. observed streamflow in 400 catchments across Europe

→ for North America mean values of the derived parameters were applied

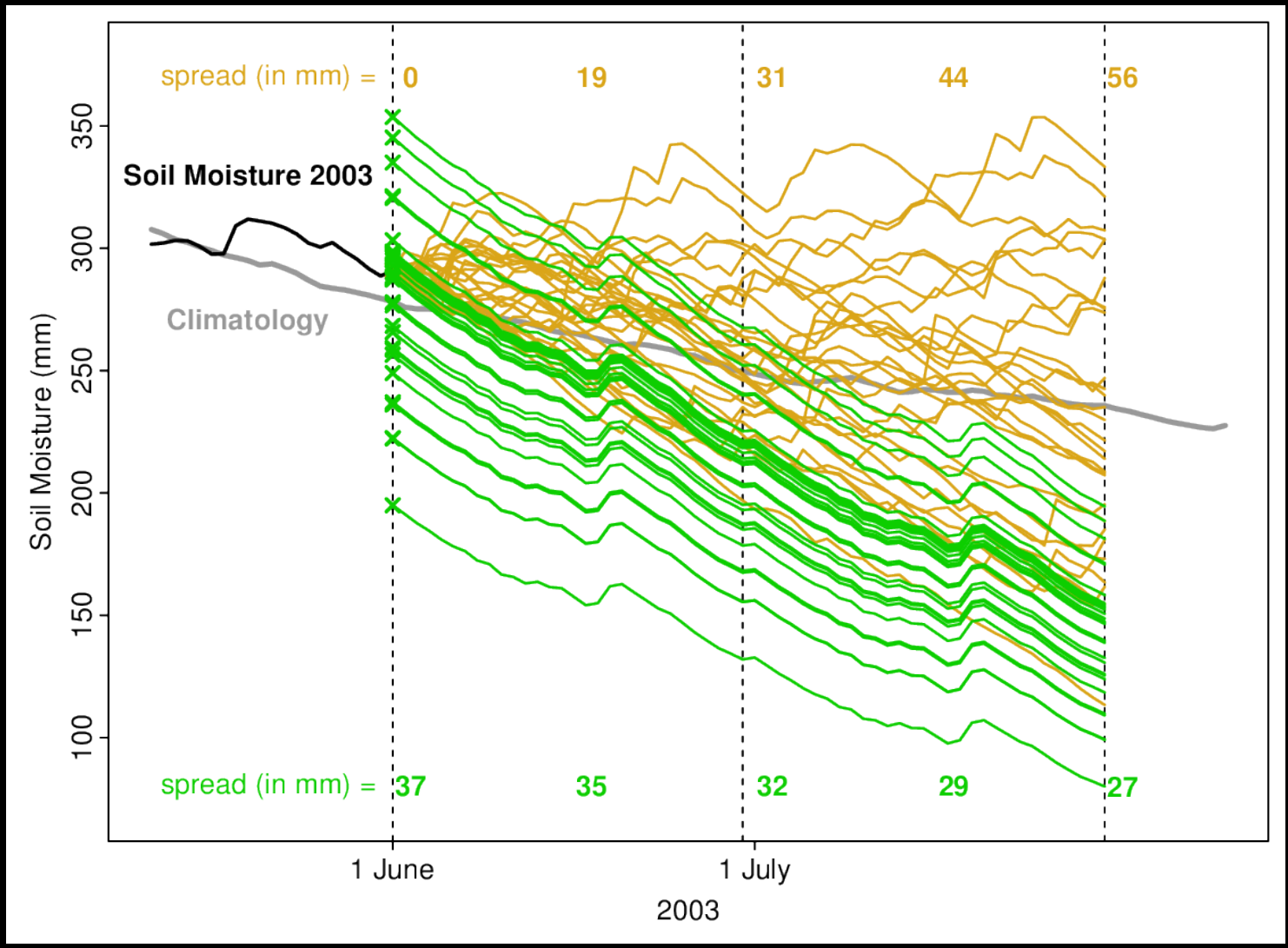
Data

- satellite-derived net radiation from CERES experiment
- observation-based precipitation from GPCP data set
- temperature from ERA-Interim reanalysis

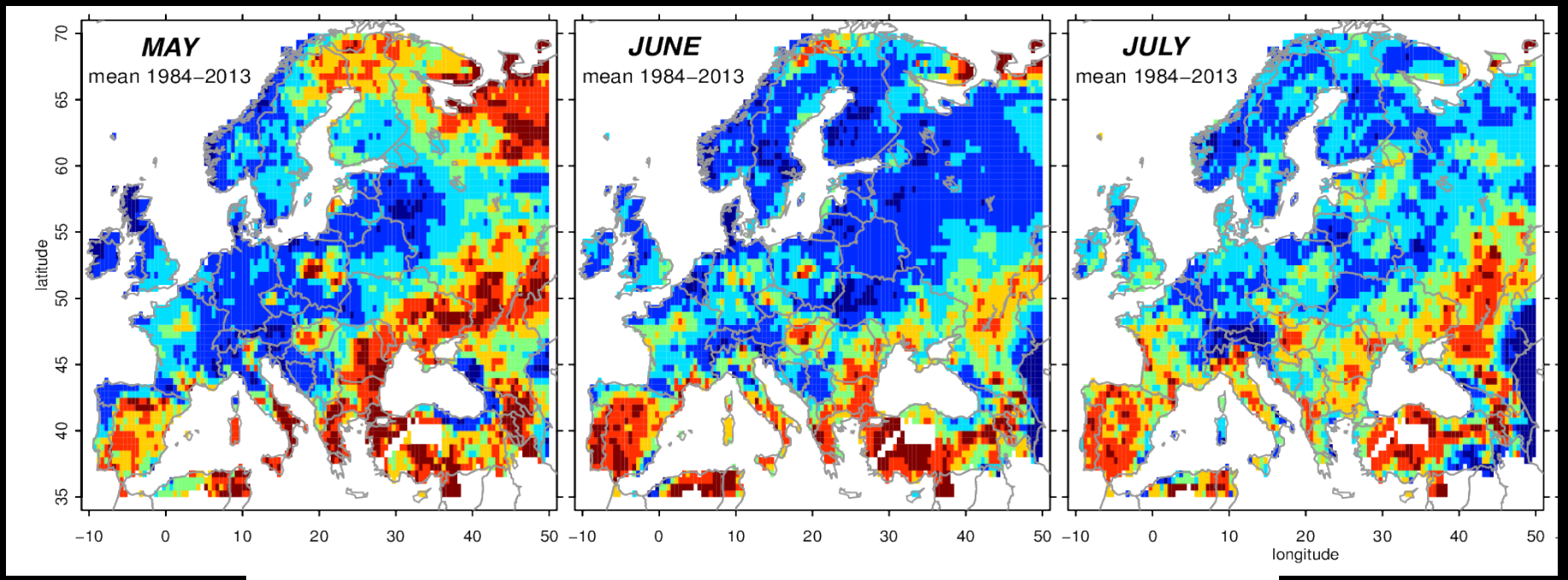
→ deriving soil moisture, ET and runoff with conceptual model

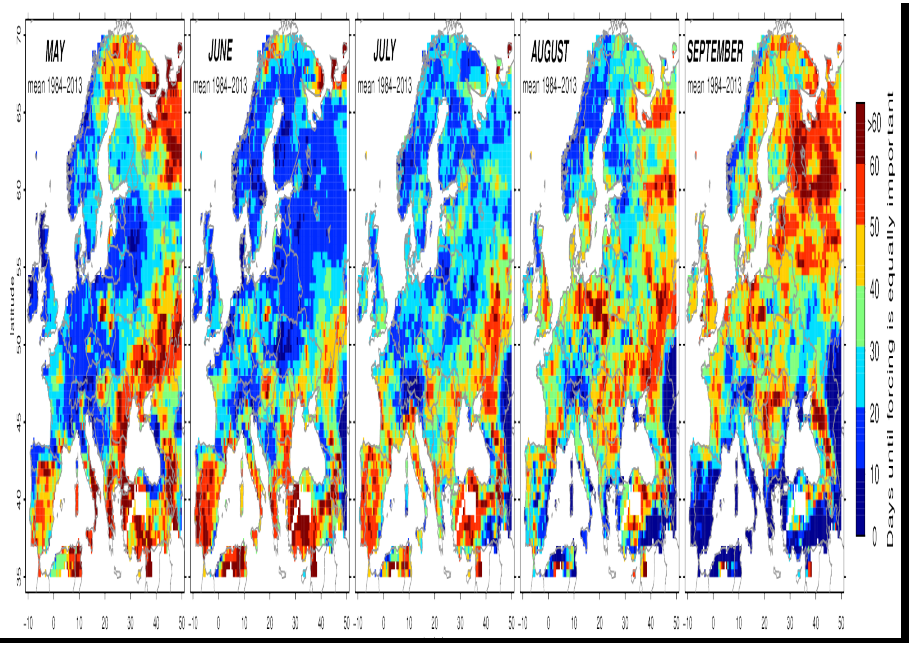
- considered time period 1998-2012
- focus on North America

Methodology



Results for Europe (part 1)





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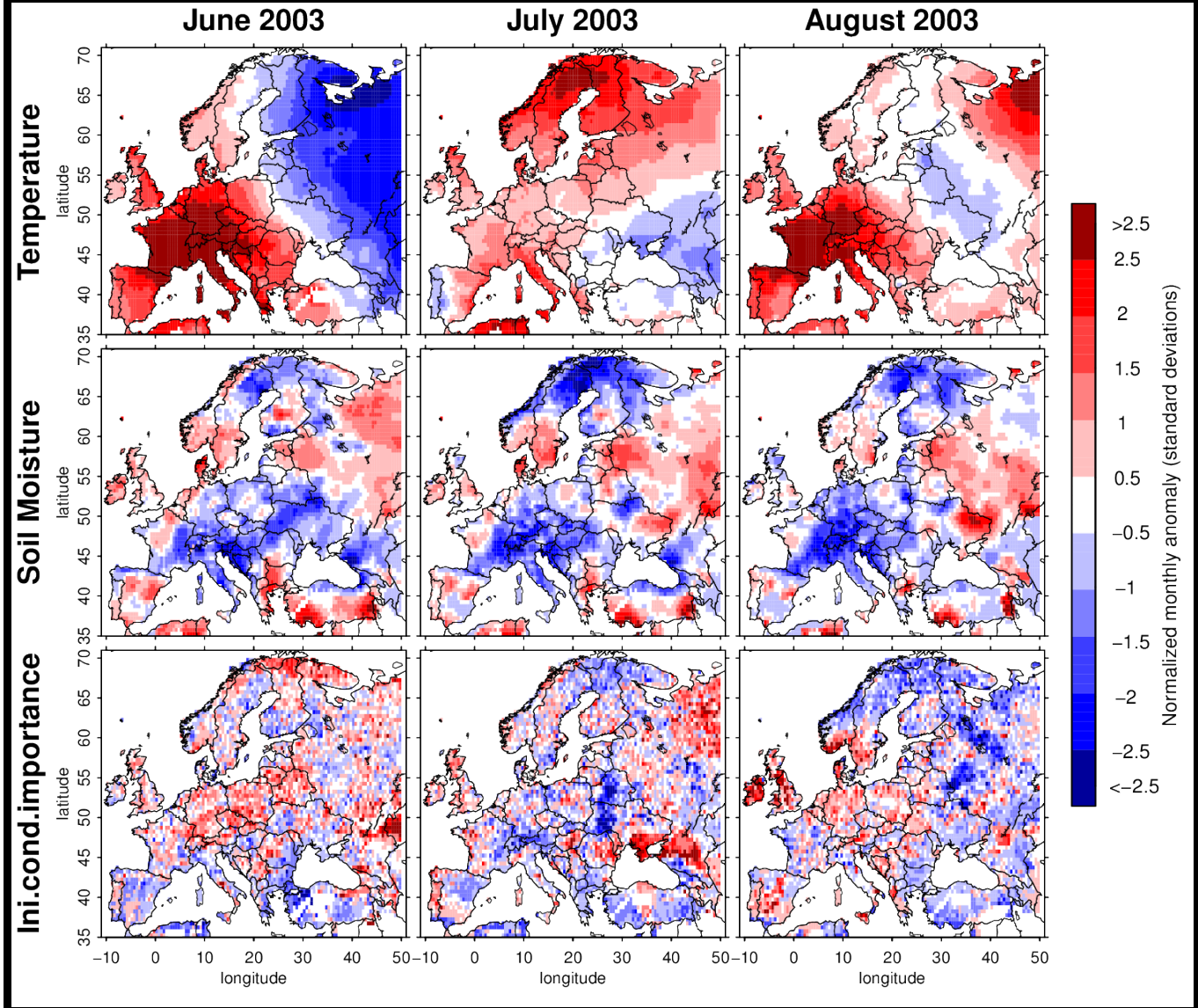


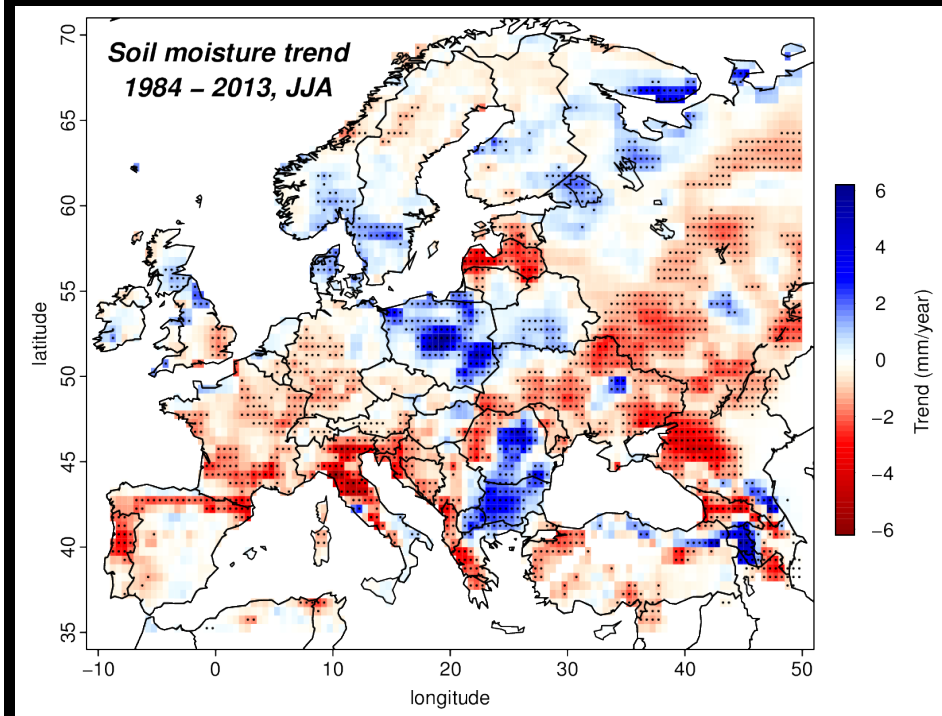
Questions:

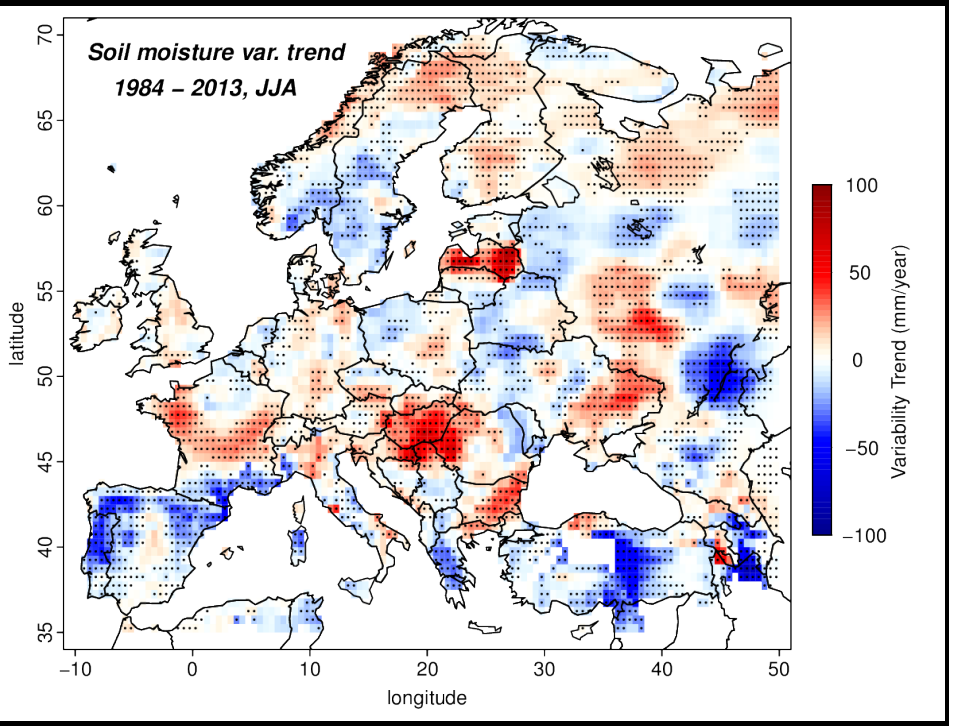
What is the role of the initial soil moisture conditions in North America?

What are the controls of initial condition importance?

How and why does initial condition importance change during drought?

Results for Europe (part 2)





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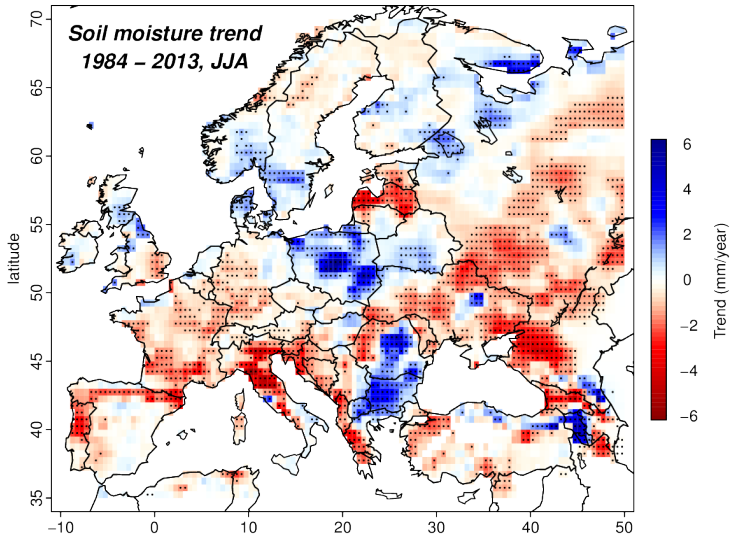
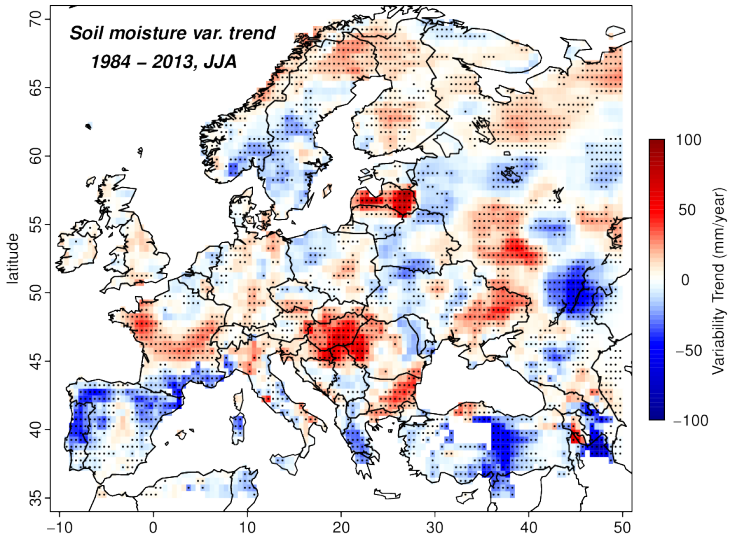
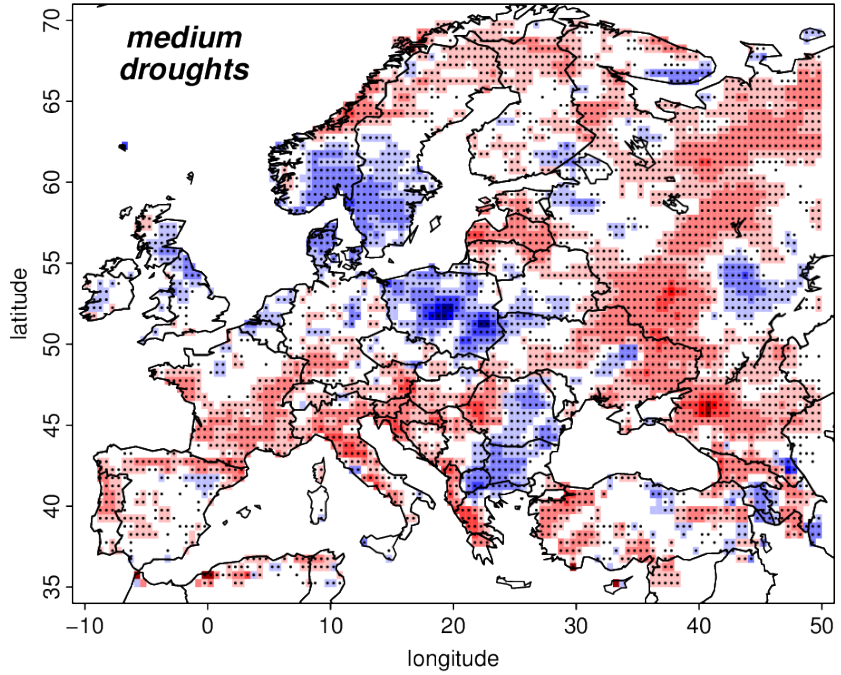




Occurrence probability in 1999–2013 climate vs. 1984–1998 climate



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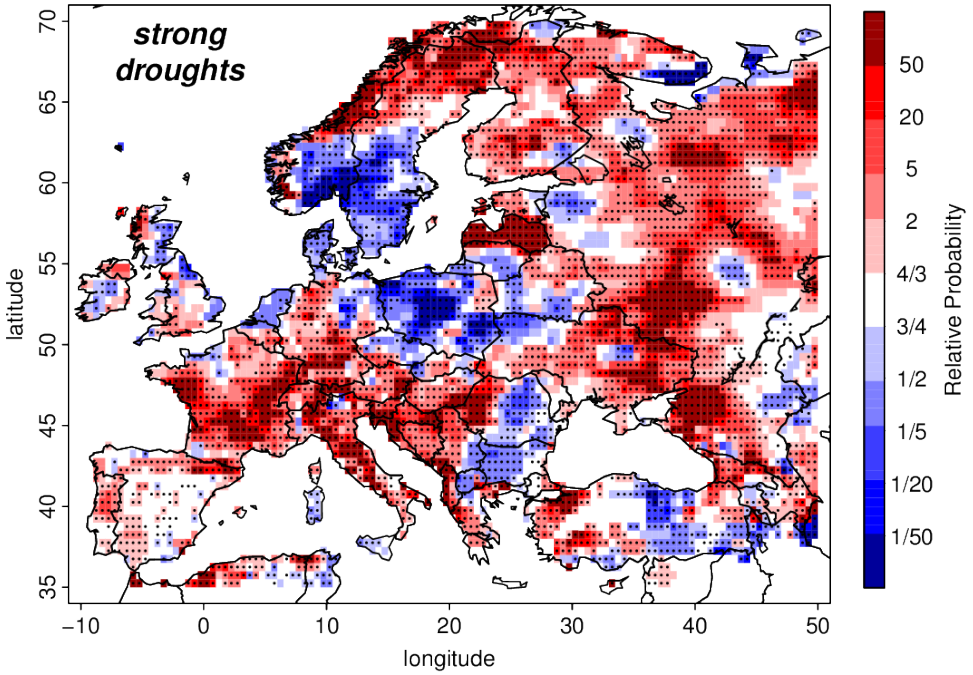

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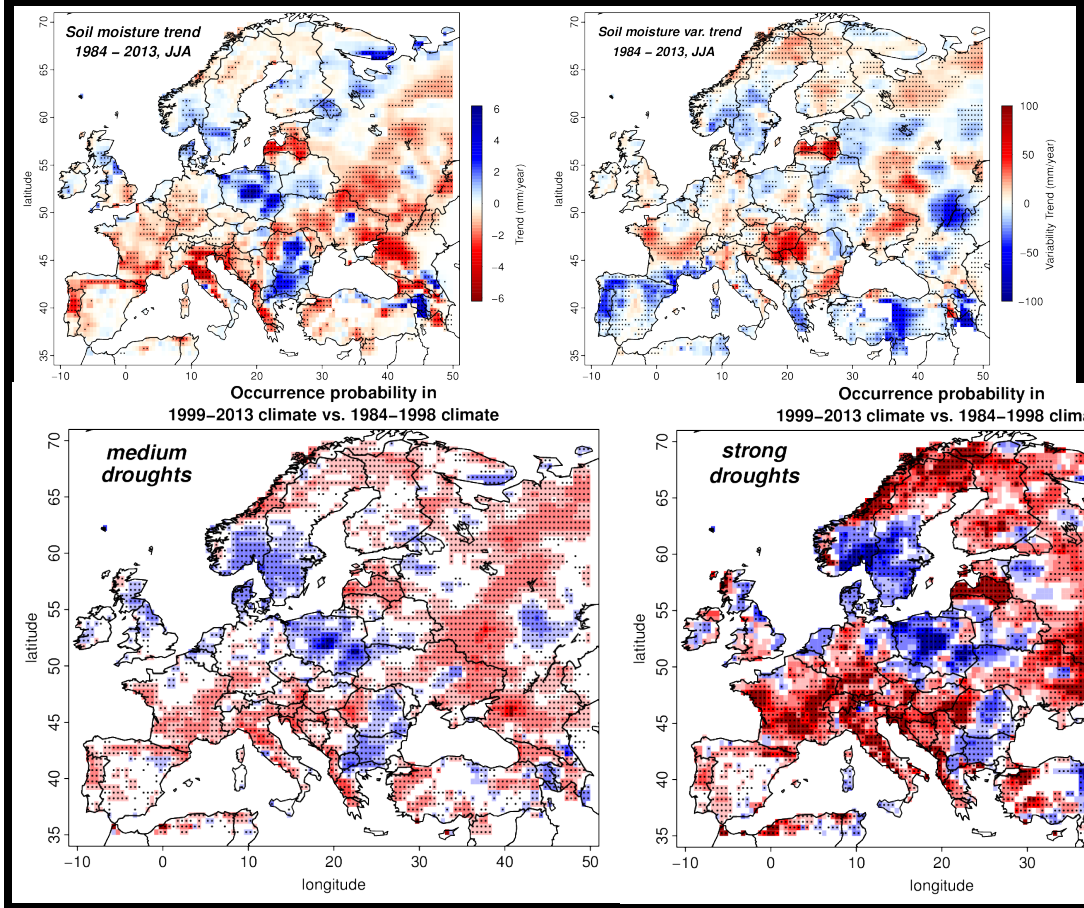

Questions:

Are the trends in soil moisture and its variability in North America?

If yes, how can we translate these trends into changes in occurrence probability?