A fine scale topographical modulation of summer precipitation change over the European Alps challenging current GCM projections

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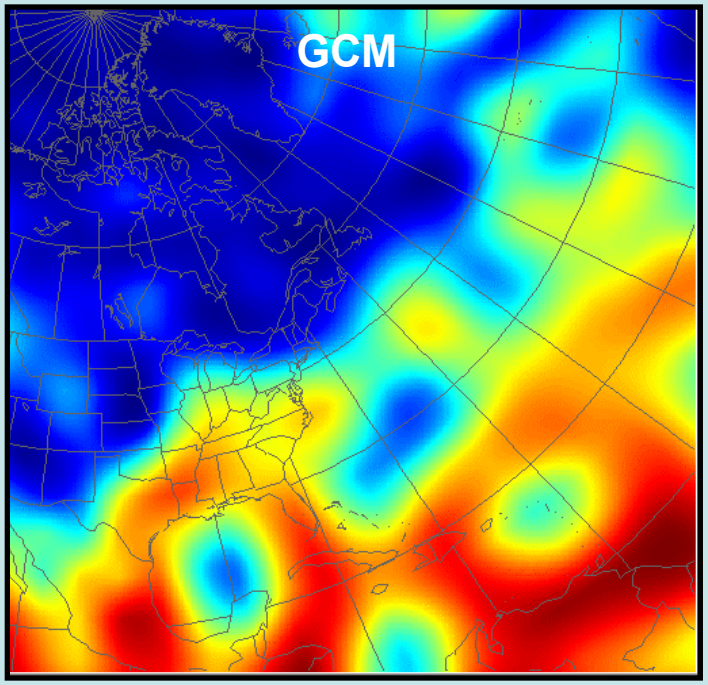
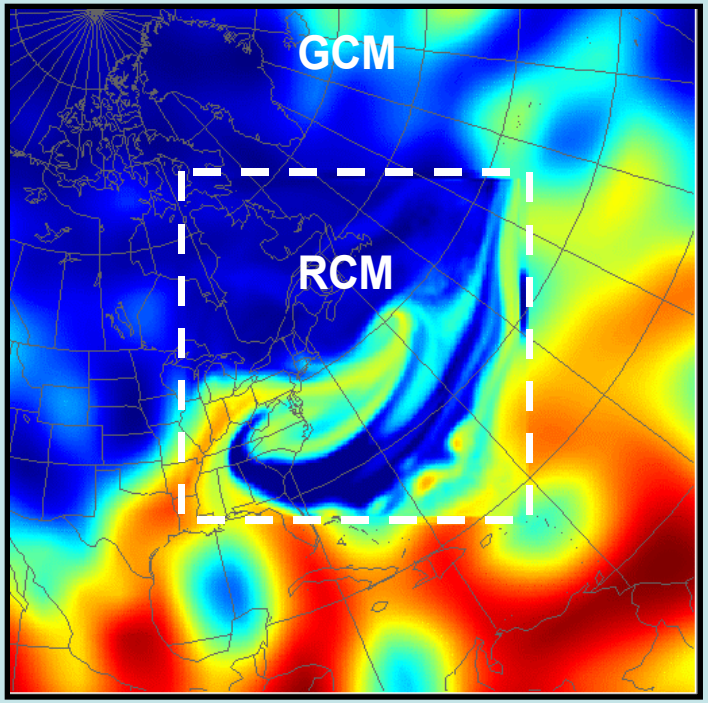
ICRC-CORDEX 2016, 17-20 May 2016, Stocholm

The issue of Added Value (AV)

- The issue of AV is one of the most important within the context of regional climate modeling
  - The question is always asked “why use an RCM?”
- Often there are misconceptions about the AV
  - The RCMs cannot be expected to be better than the GCMs in everything (e.g. some large scale fields)
  - Some RCMs can be “worse” (then GCMs) because they are worse not because “downscaling does not work”.
- The AV needs to be searched for in a targeted way
  - Topography and complex land surface
  - Extreme events
  - Regional circulations
- Need of quantitative measures of AV
  - Need of fine scale observations
- Does AV in present day climate necessarily imply AV in climate change projections?



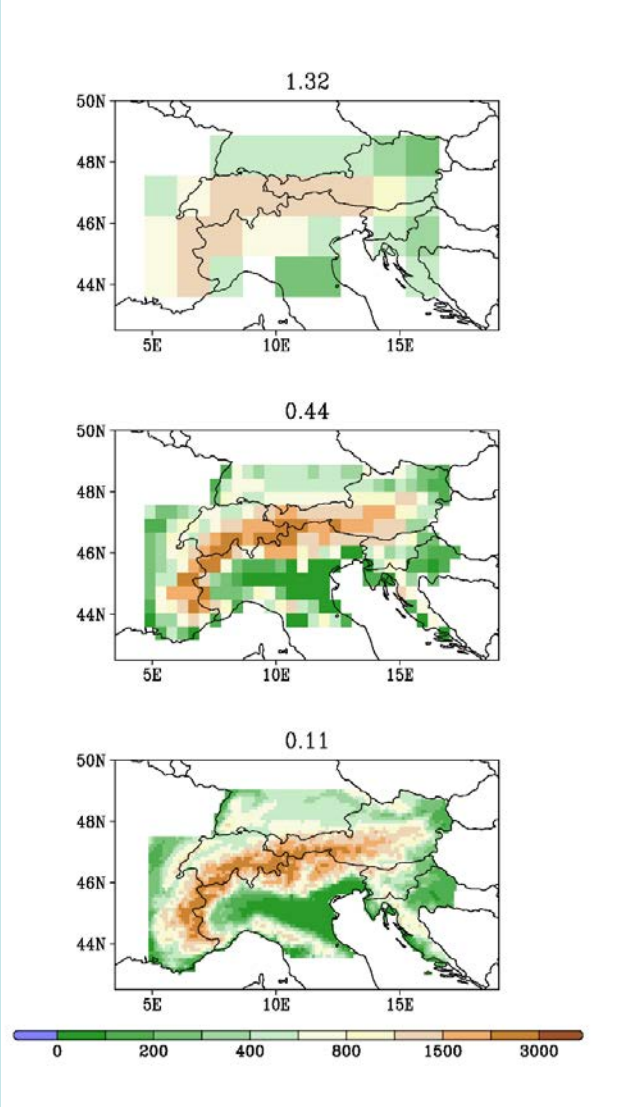


Added Value

Added value consists of the generation of small (spatial and temporal) scales by a high-resolution RCM driven by low-resolution GCM data, for example in response to local forcings (topography, coastlines, land use)

900 hPa specific humidity
From R. Laprise

Search of AV over the Alps in the EURO/MED-CORDEX experiments



Horizontal resolutions: 1.32°, 0.44° and 0.11°

GCMs :
- MPI-ES-MR
- EC-EARTH
- CNRM-CM5
- HadGEM-ES

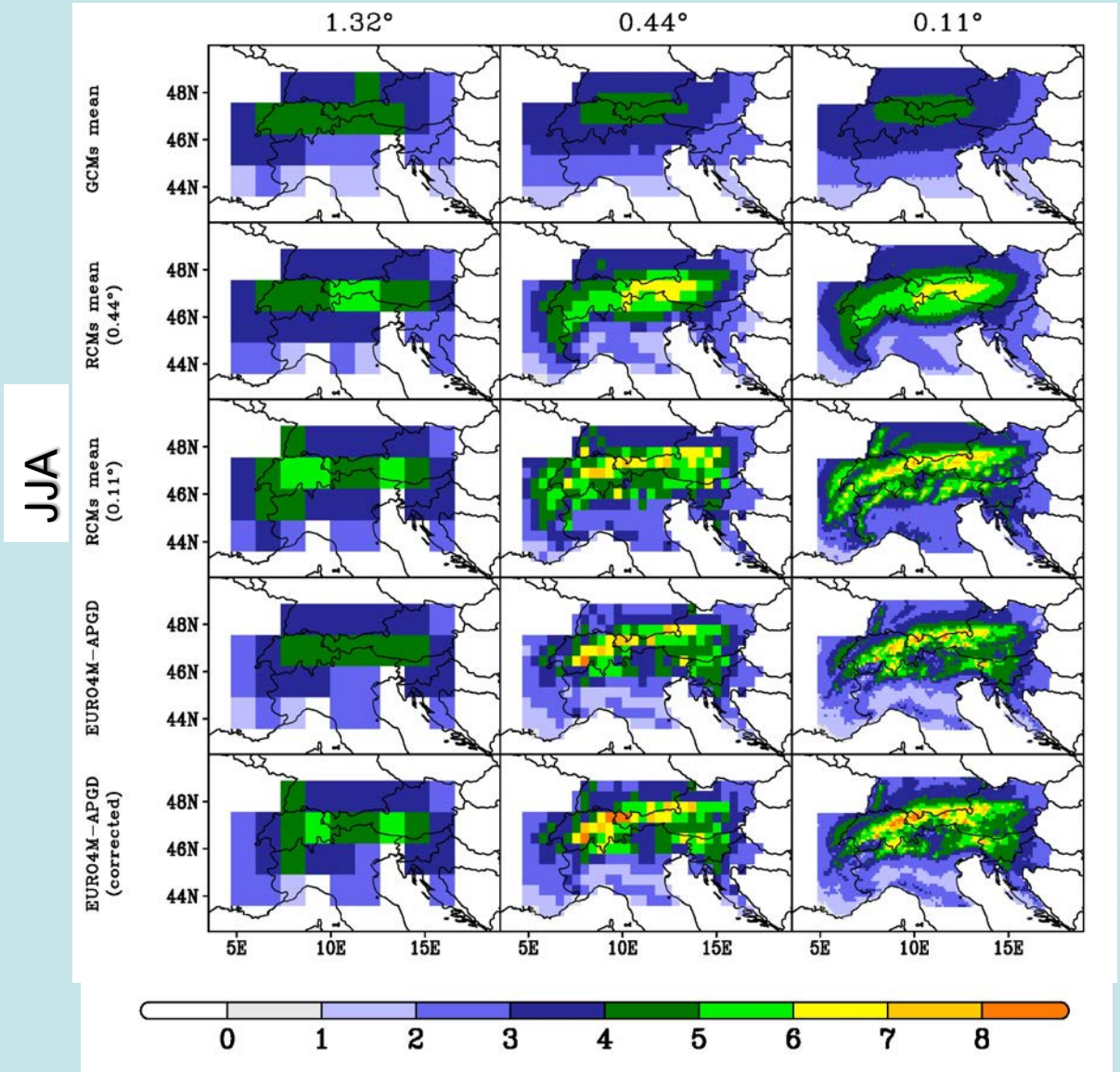
RCMs:
- CCLM
- RACMO
- ALADIN
- RegCM4.3
- RCA4

Reference period: 1975-2004
Future period: 2070-2099

Observational data: EURO4M-APGD (Isotta et al., 2014)

Torma et al. JGR (2015)

Simulation of spatial patterns of summer precipitation



Higher resolution

↓

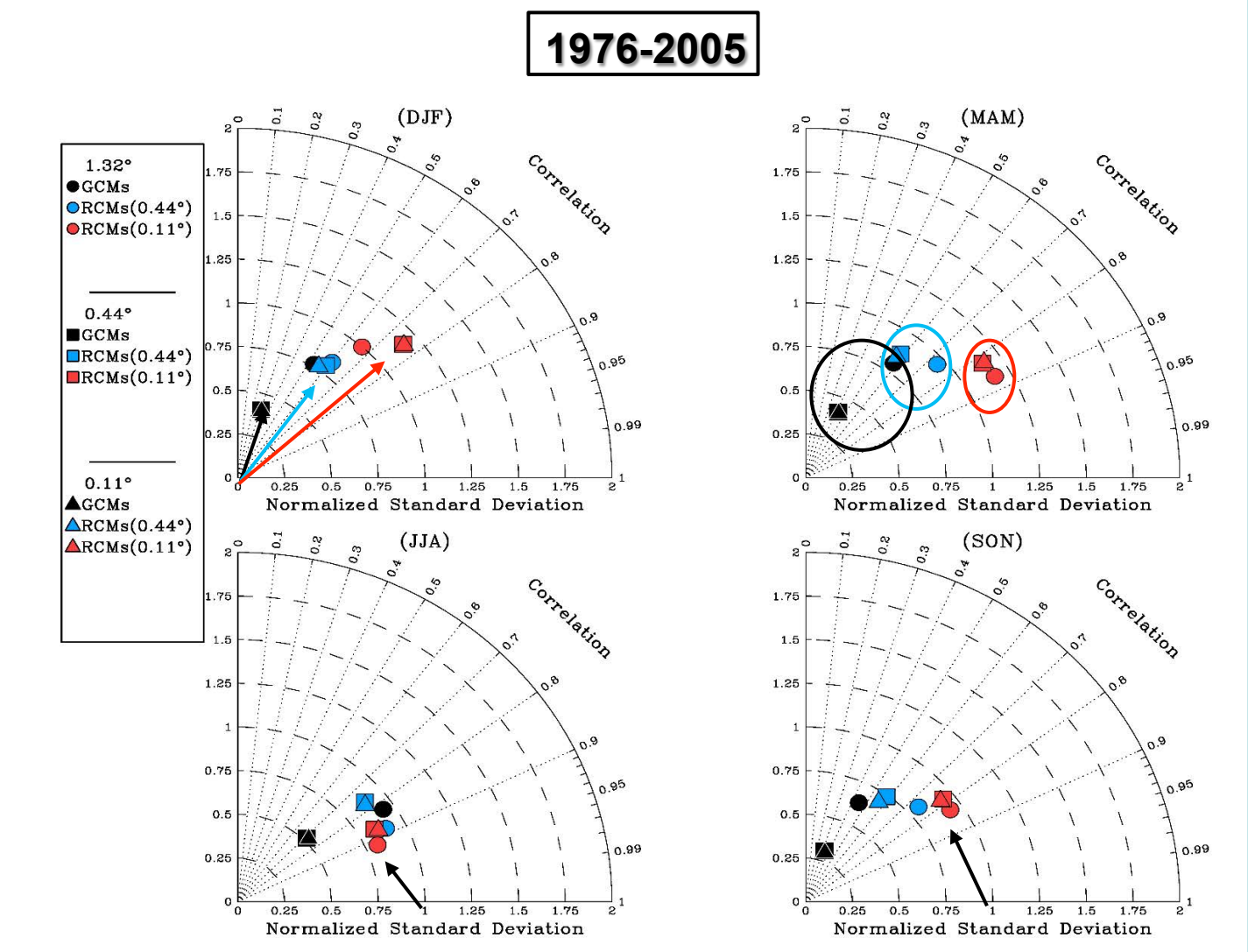
Increasing details in precipitation spatial distribution

↓

Fine scale AV

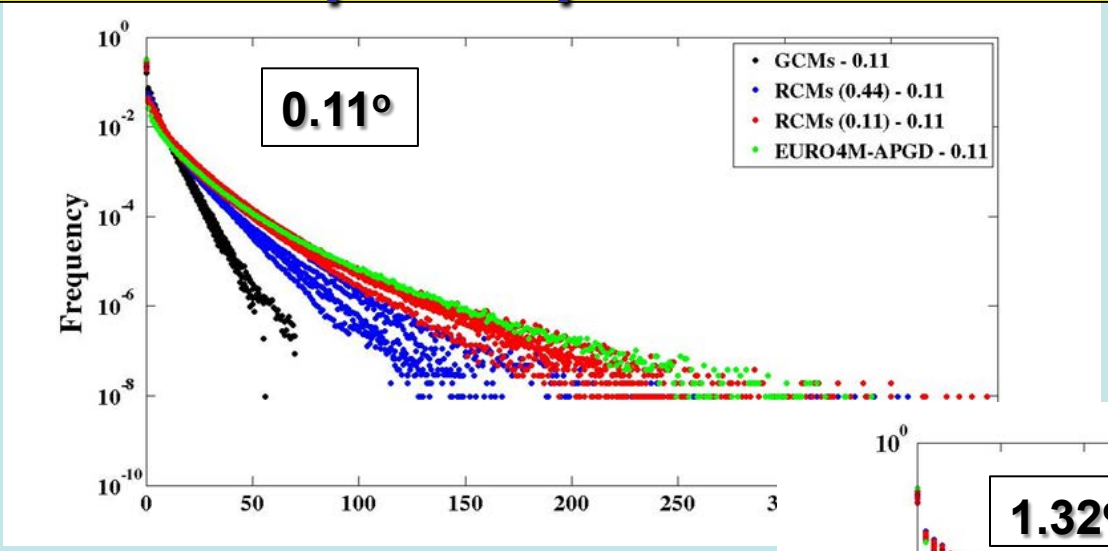
Torma et al., JGR, (2015)

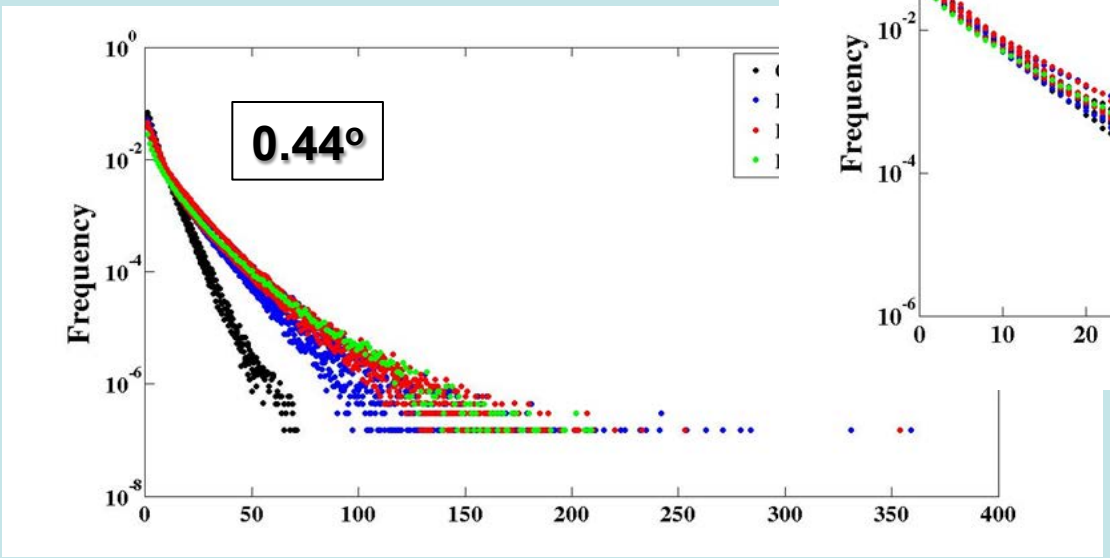
Taylor diagrams for mean seasonal precipitation

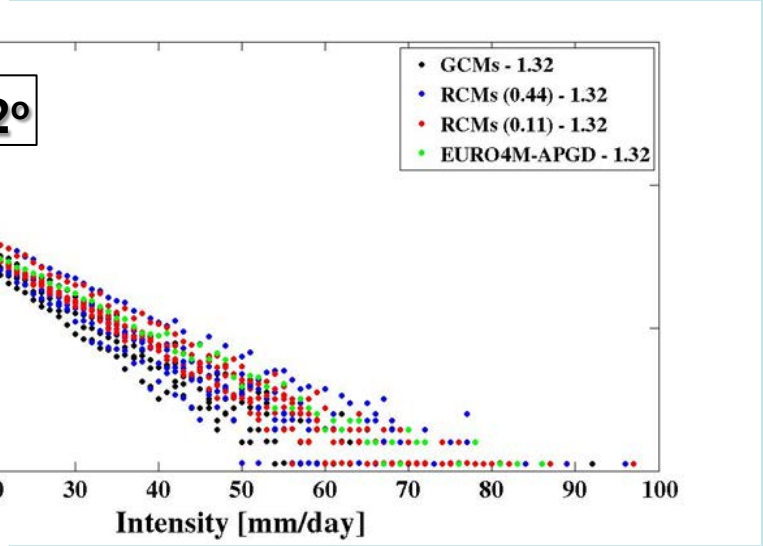


AV is found also when the data are upscaled at the GCM resolution

Added value: Simulation of daily precipitation intensity PDF





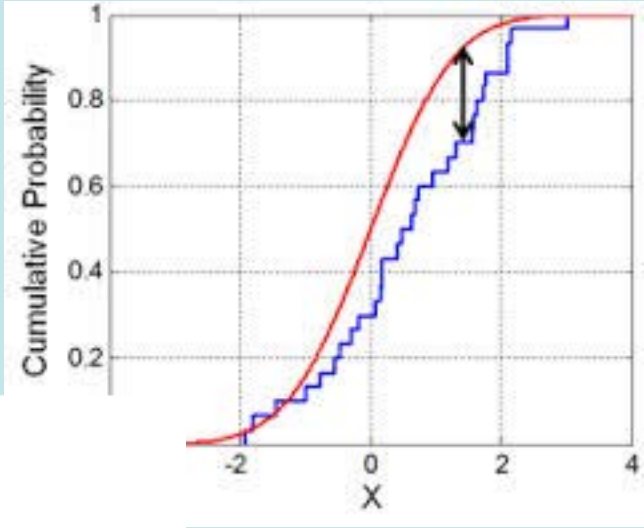


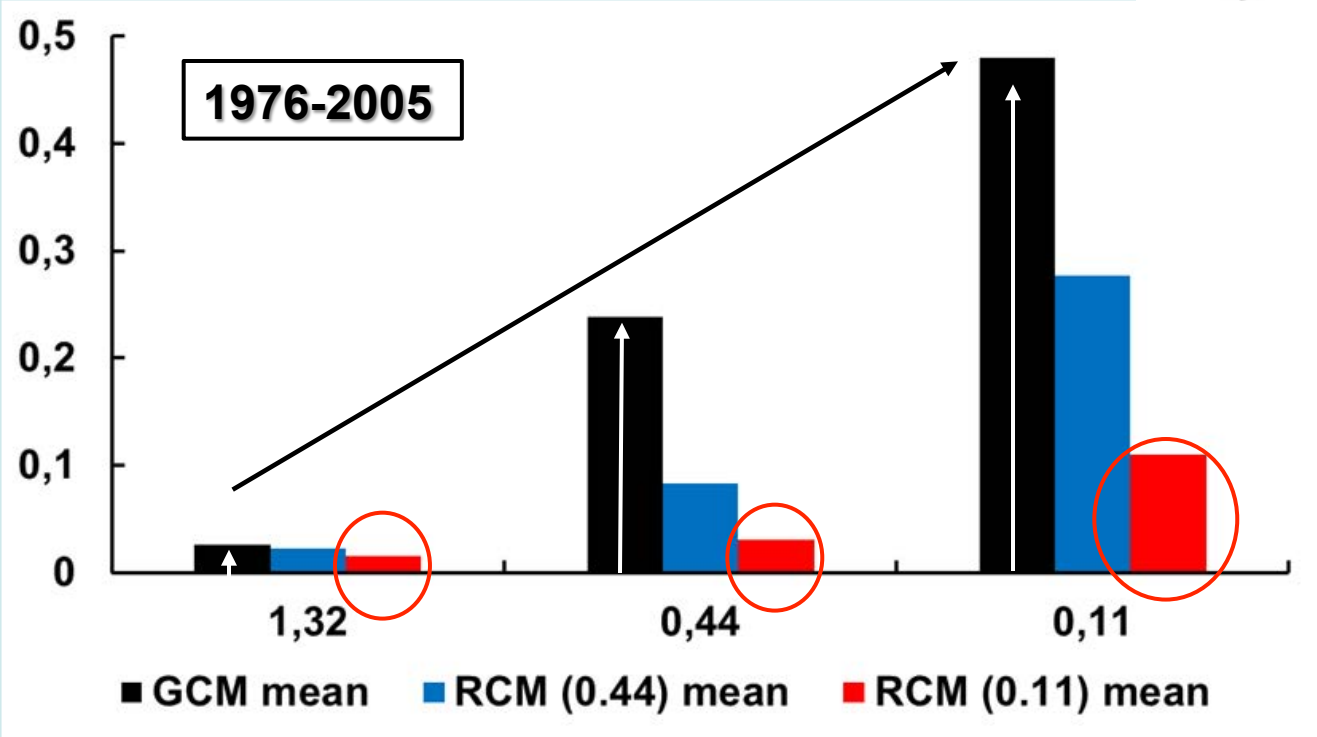
RCMs are always closer to OBS (also when upscaled)

Metric of added value: Kolmogorv-Smirnov (KS) distance

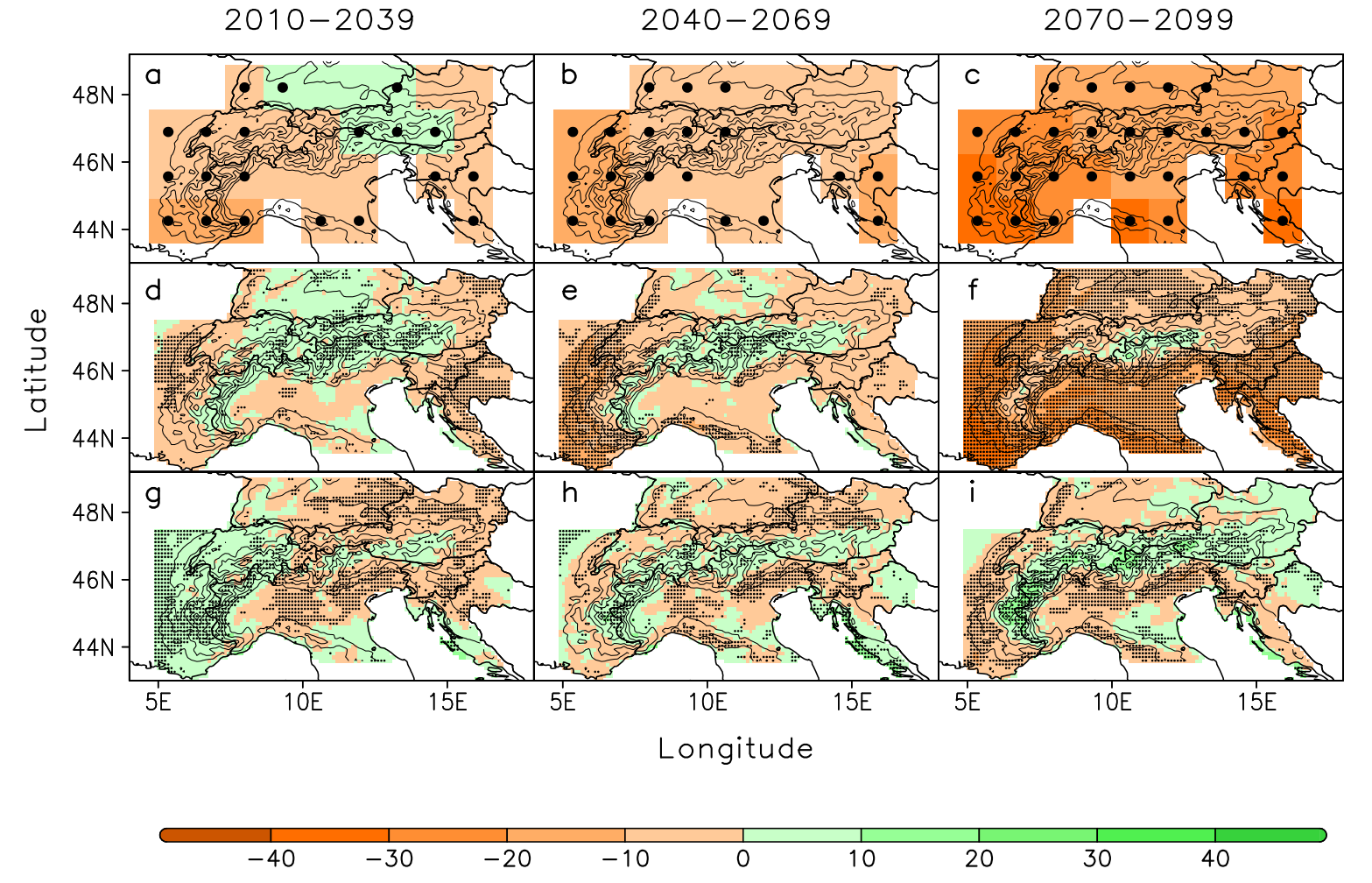
Kolgomorov-Smirnov distance

$$d_{KS}(F,G) = sup_{t\in\mathbb{R}}|F(t) - G(t)|$$





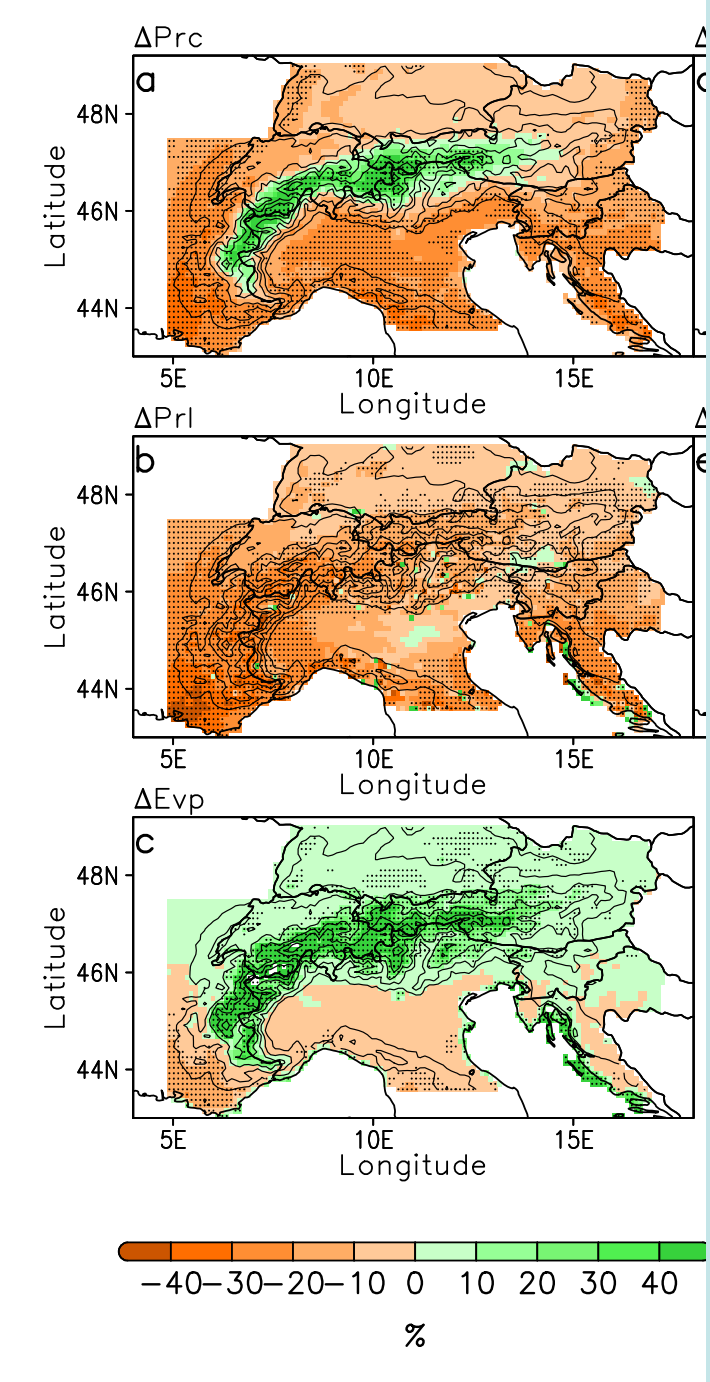
Summer precipitation change (%)



GCMs

RCMs
0.11°

Downscal.
Signal

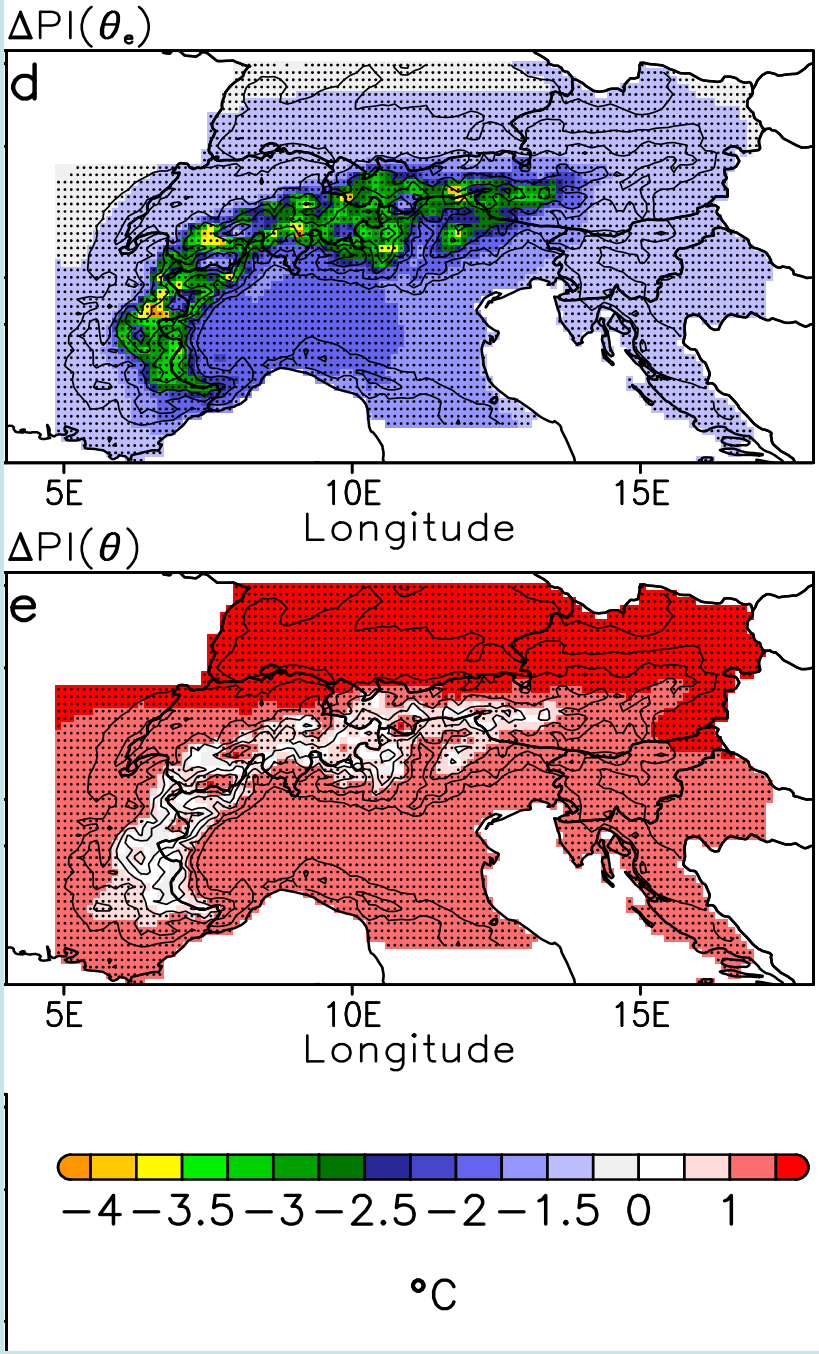


Convective

Non Convective

Evaporation

Summer precipitation change

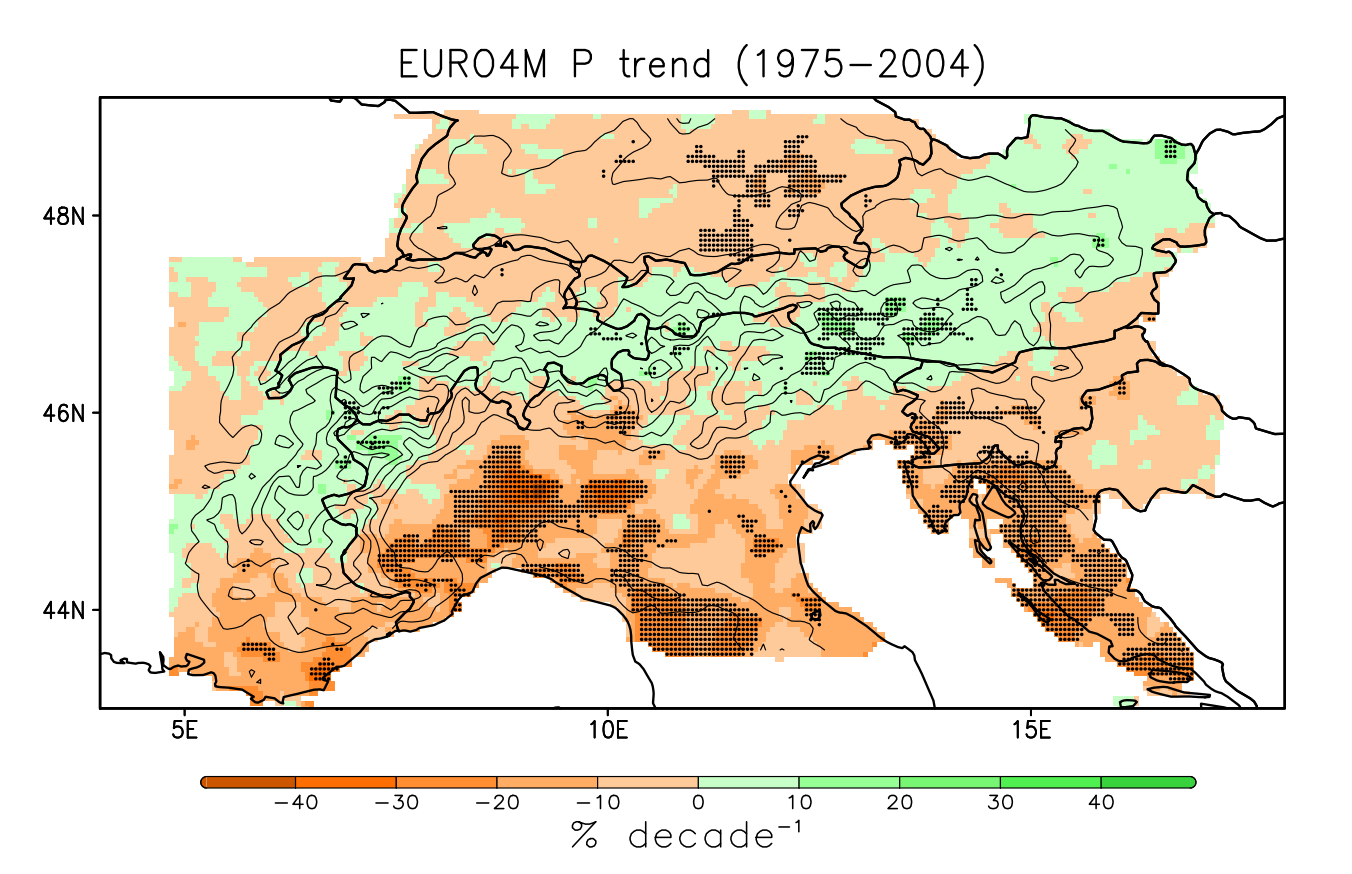


Including moisture

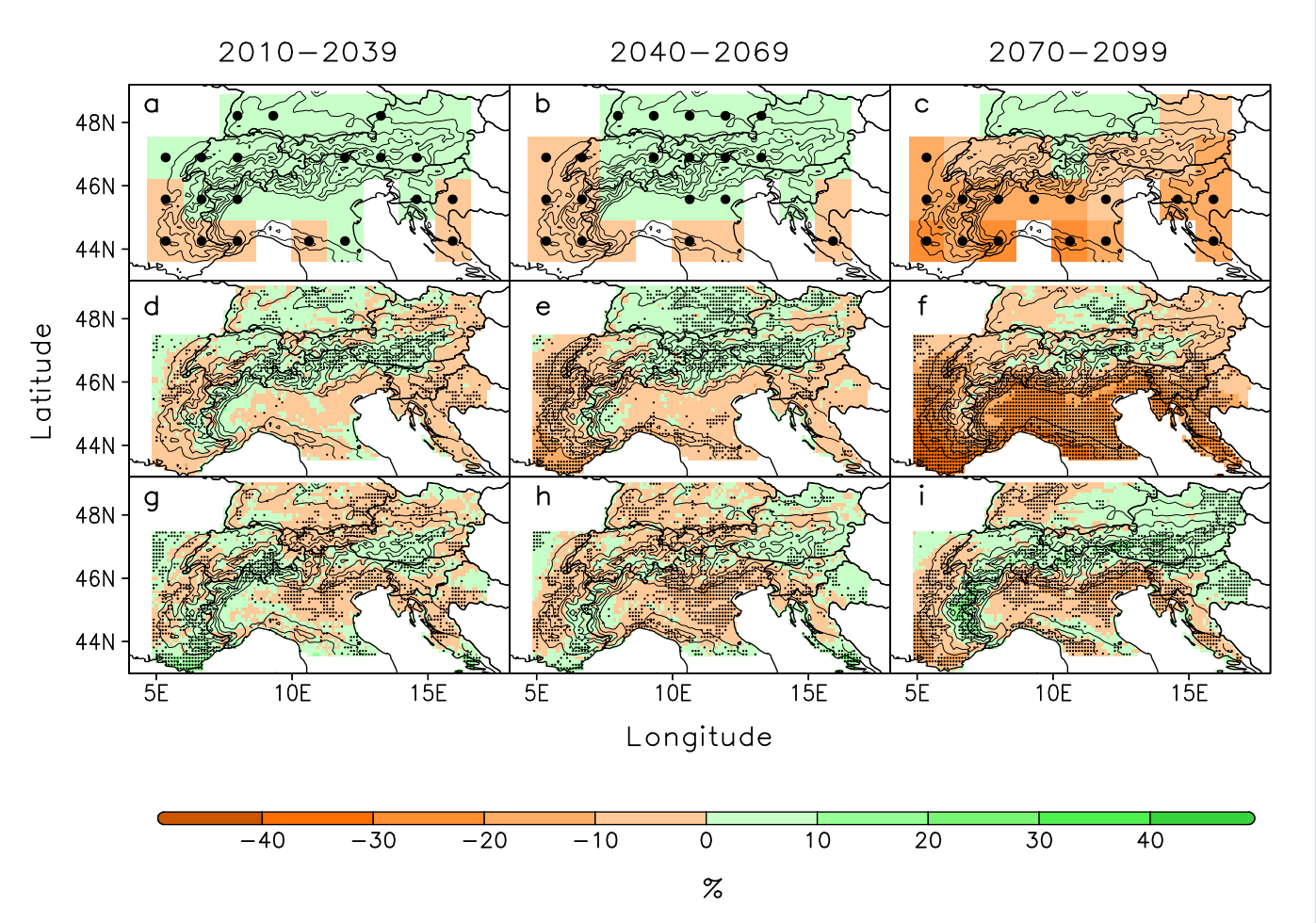
Not including moisture

Change in potential instability index

Observed summer precipitation trend during 1975-2004



Change in summer precipitation R95 (%)

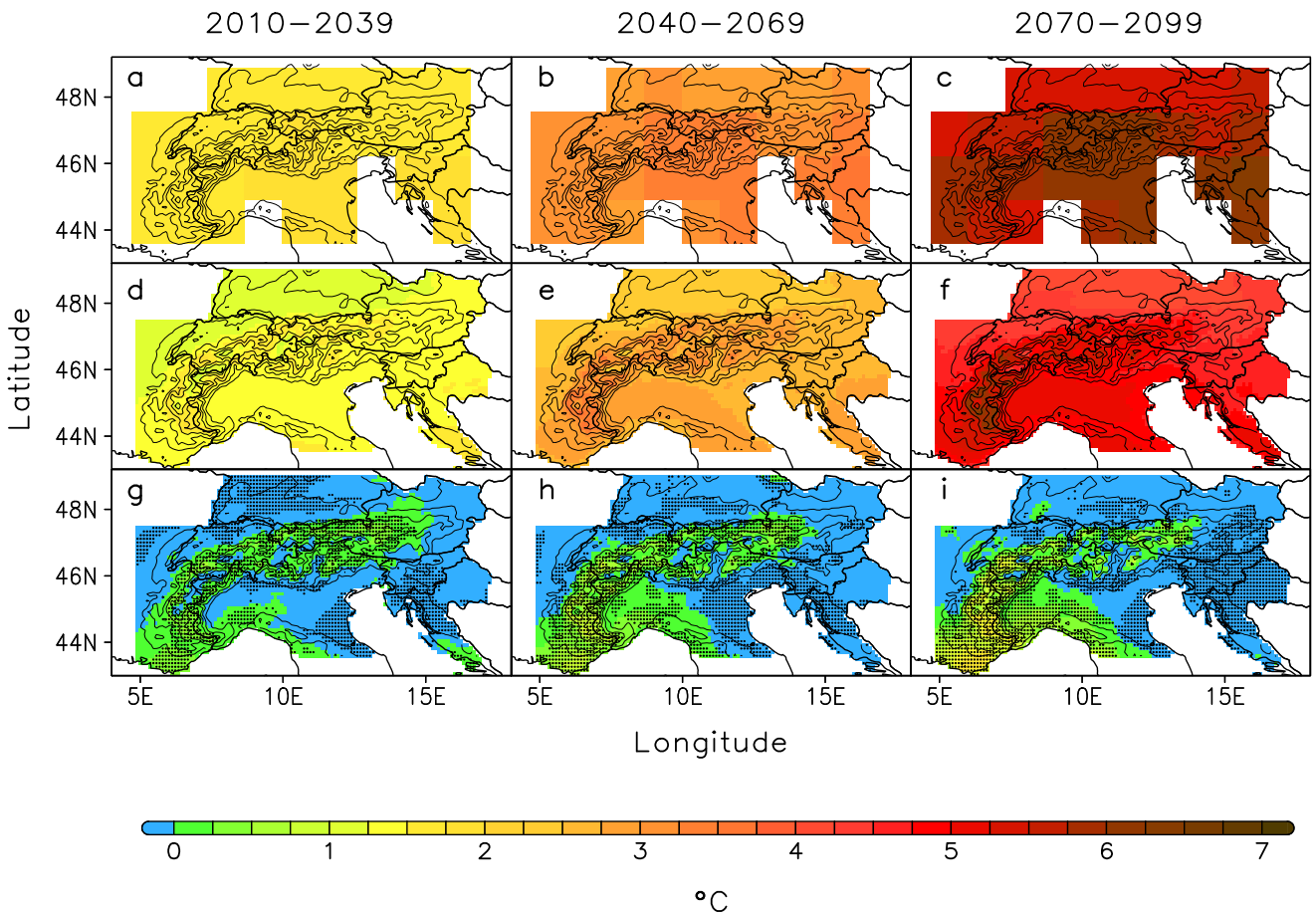


GCMs

RCMs 0.11°

Downscal. Signal

Change in summer temperature



GCMs

RCMs
0.11°

Downscal.
Signal

Conclusions

- RCM-based multiple lines of evidence point to an increase of summer precipitation over the mountainous regions of the European Alps under global warming (even with general drying of the region projected by GCMs)
  - Good performance of the RCMs in the reference period (and AV compared to the GCMs)
  - Model agreement in the mesoscale signal (RCMs)
  - Plausible driving underlying process (increased instability and convection)
  - Consistency with observed trends
- Example of the AV of RCMs in the simulation of climate change signals (one of the few)


THANK YOU