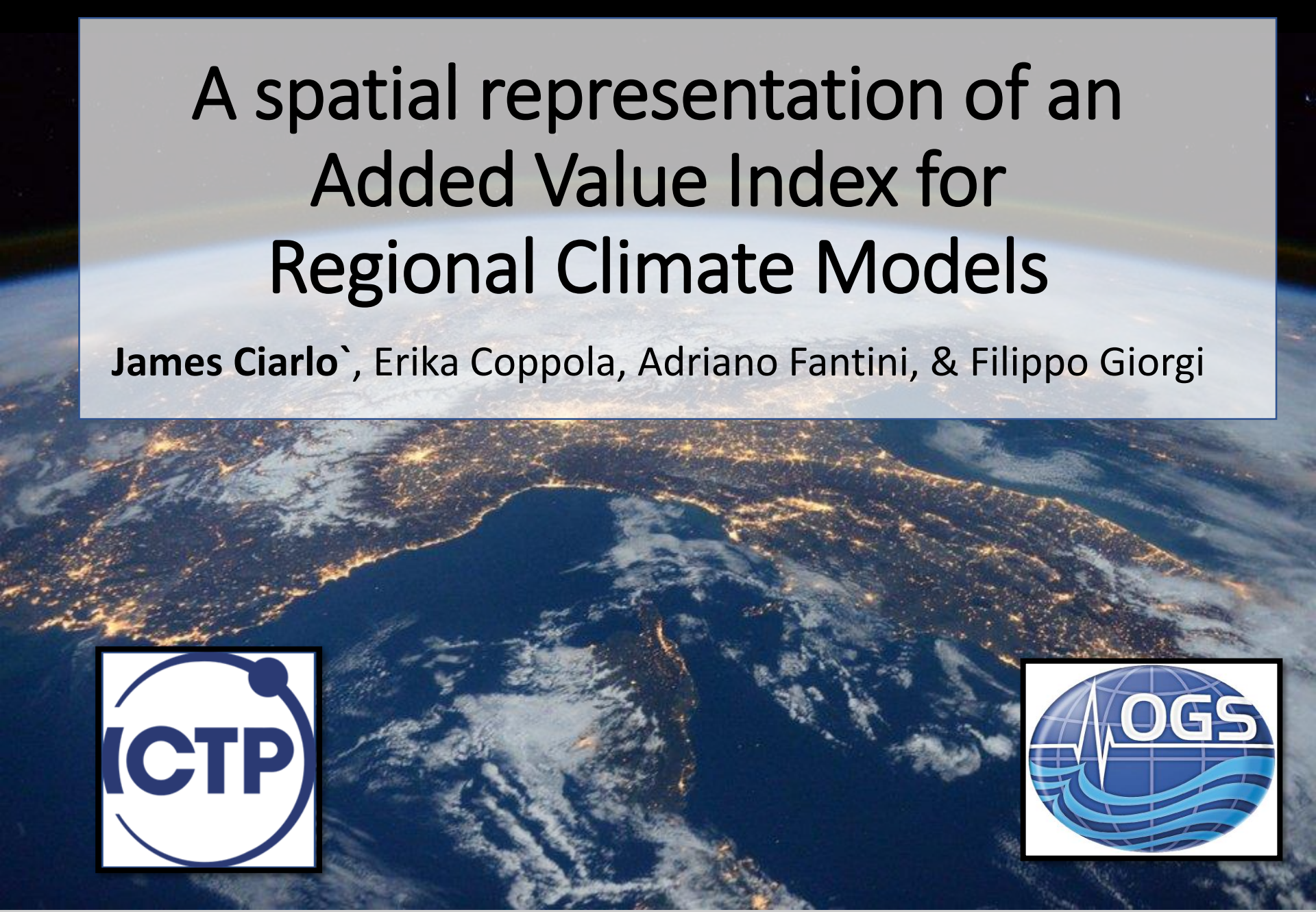
A spatial representation of an Added Value Index for Regional Climate Models

James Ciarlo`, Erika Coppola, Adriano Fantini, & Filippo Giorgi

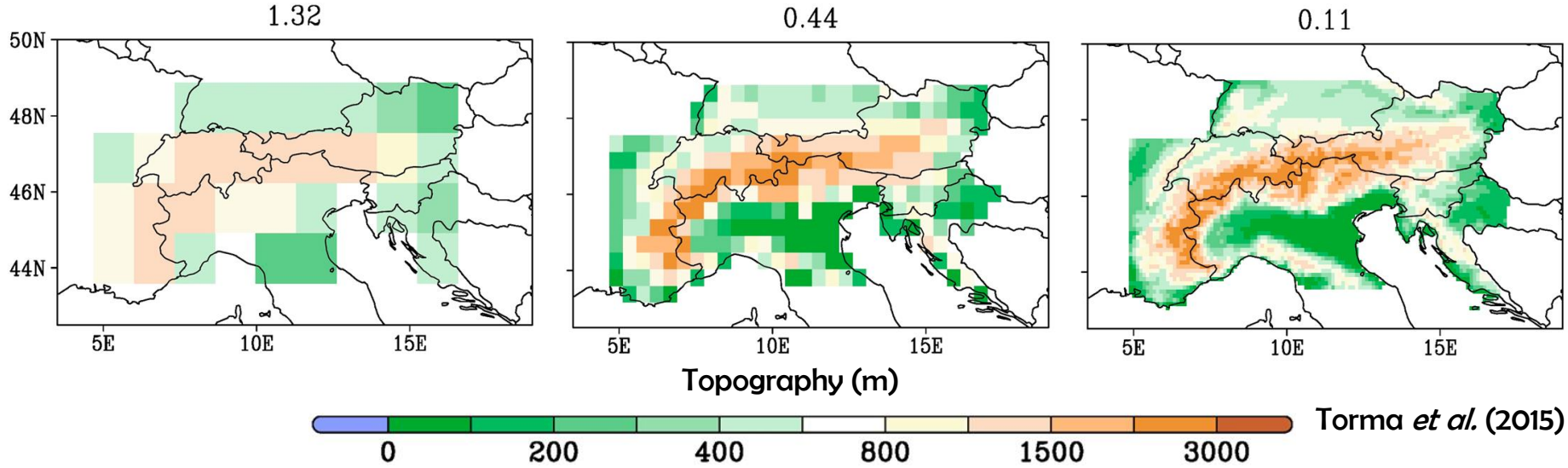


ICRC-CORDEX 2019, Beijing, 14-18 October 2019

Added Value

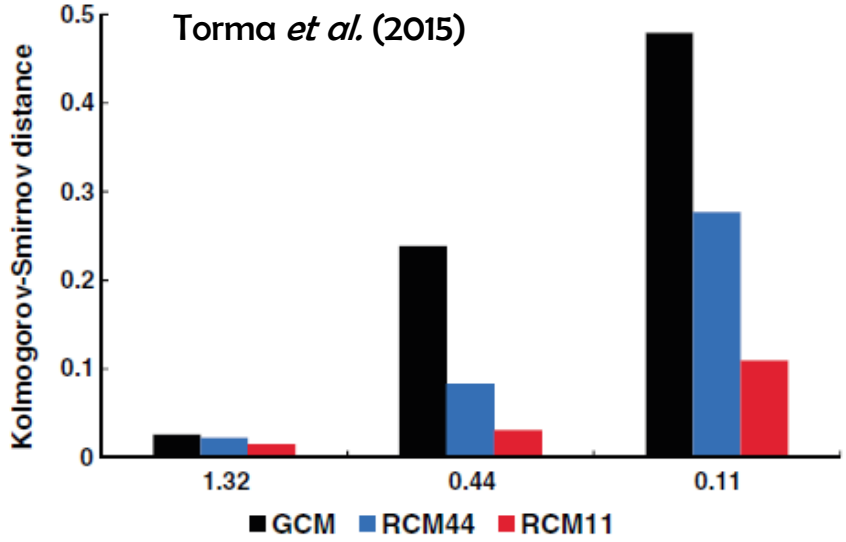
"Nested RCM simulations are indeed useful as climate downscaling tools to the extent that they add valuable information to that produced by GCMs"

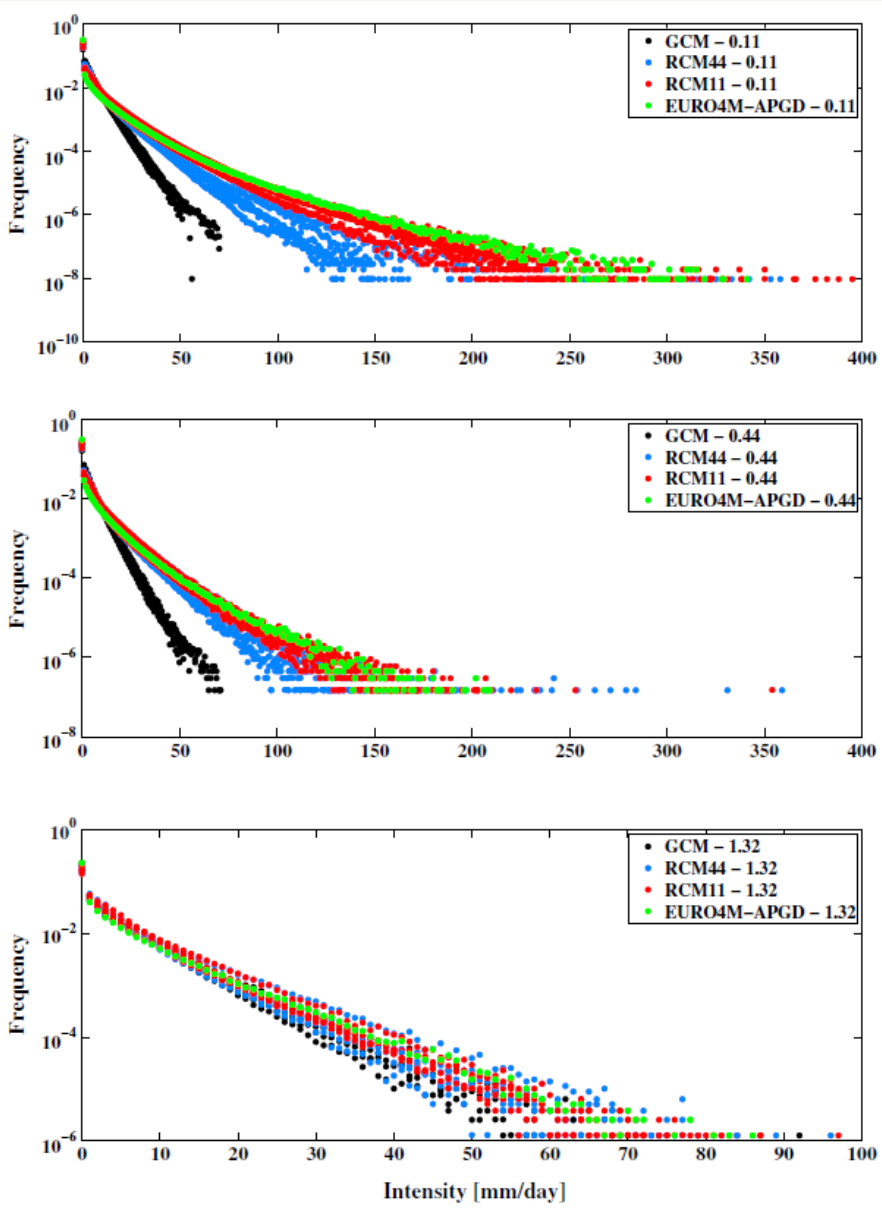
Torma *et al.* (2015)



Kolmogorov-Smirnov Distance

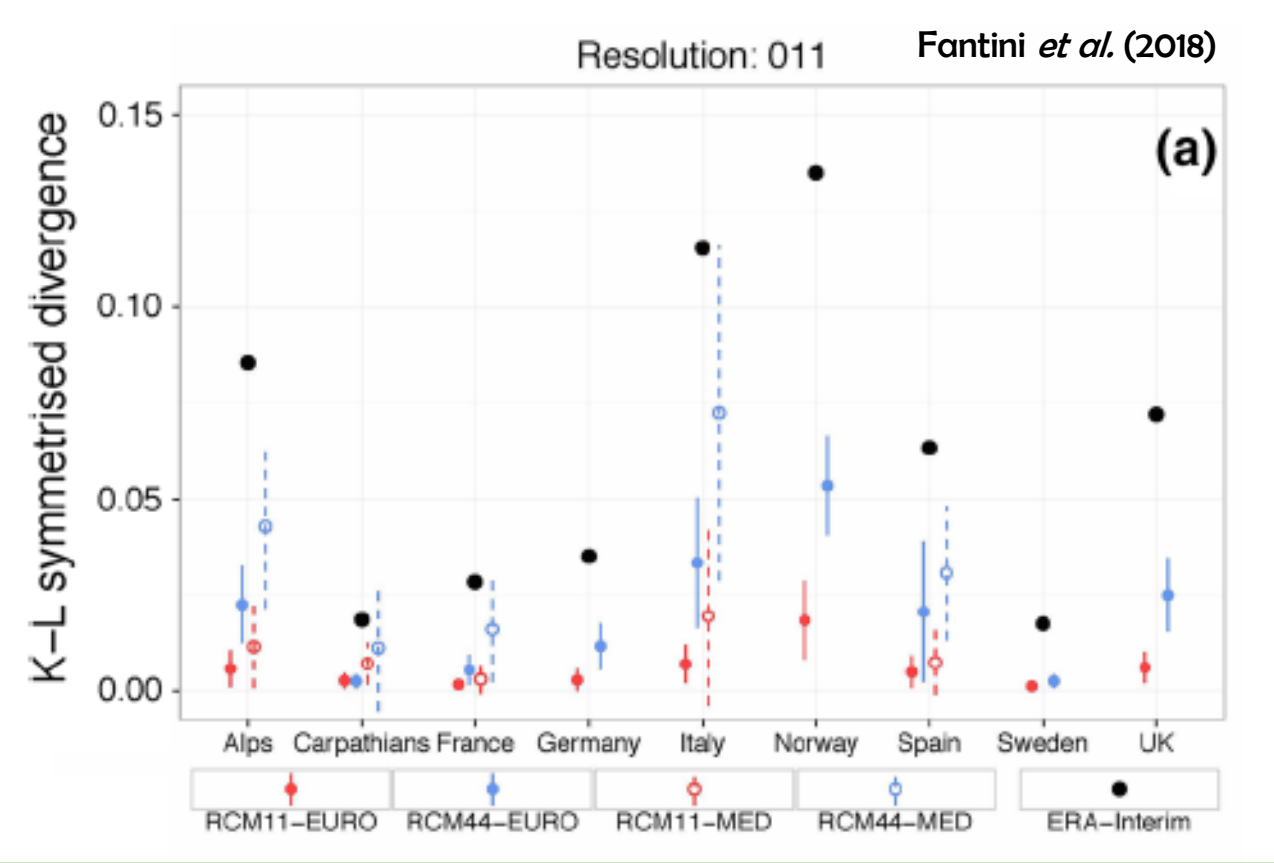
maximum distance between two cumulative distribution functions



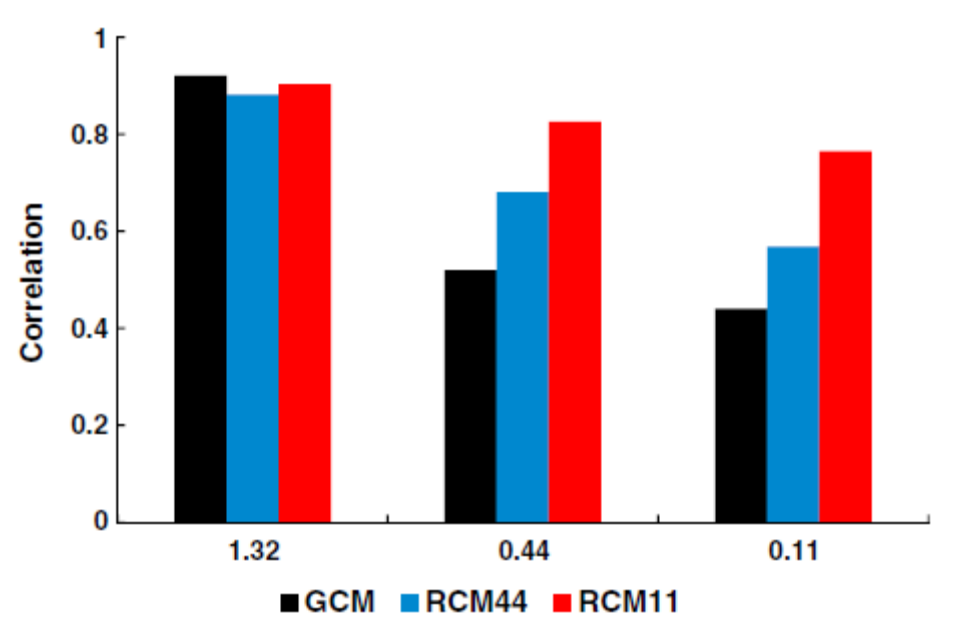


Kullback-Leibler Divergence

mean difference between PDFs



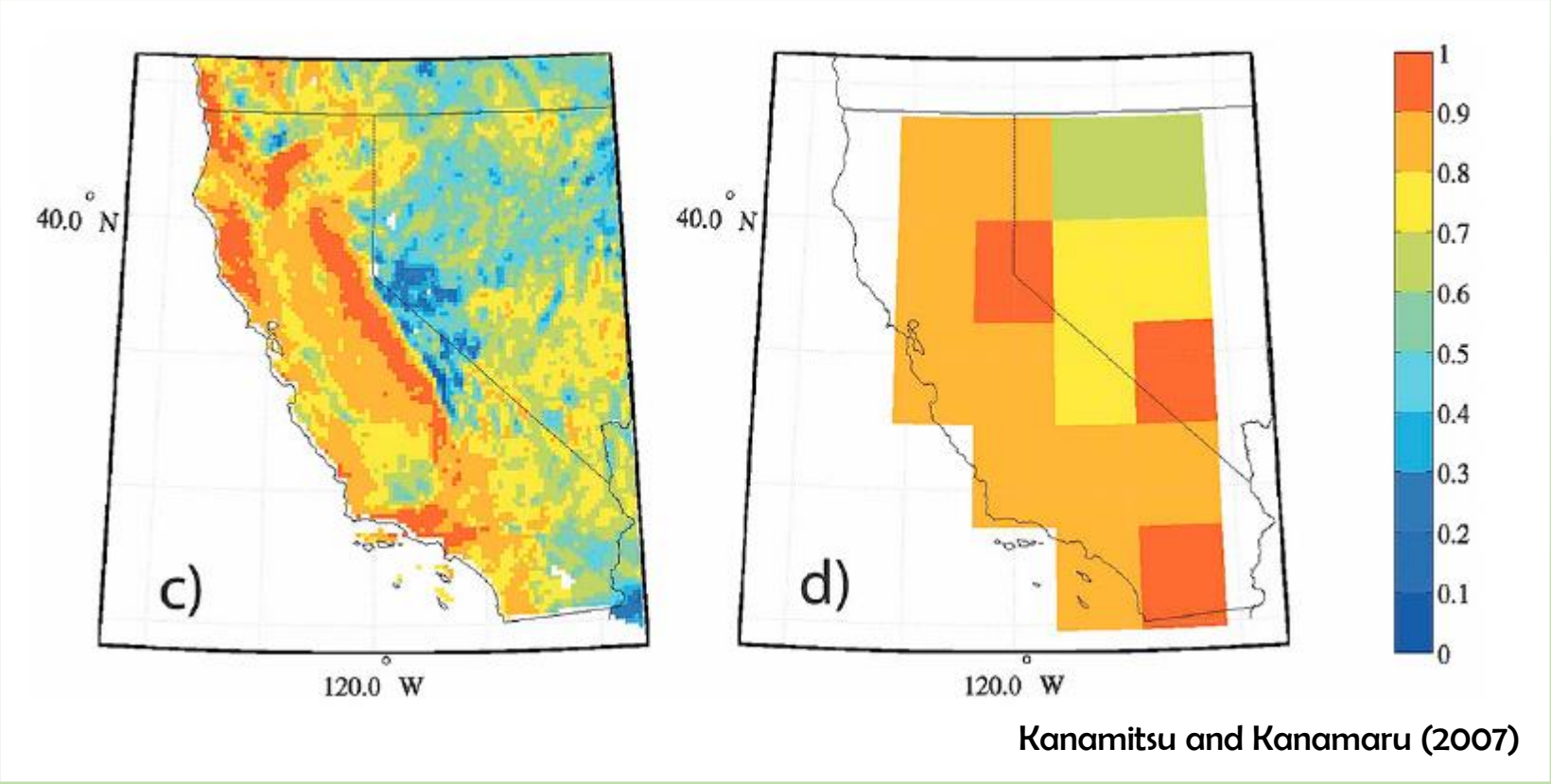
Spatial Correlation Coefficient



daily precipitation R95 ensemble averages, compared to EURO4M-APGD observations (Torma *et al.*, 2015)

Where is the Added Value?

Correlation Skill



Kanamitsu and Kanamaru (2007)

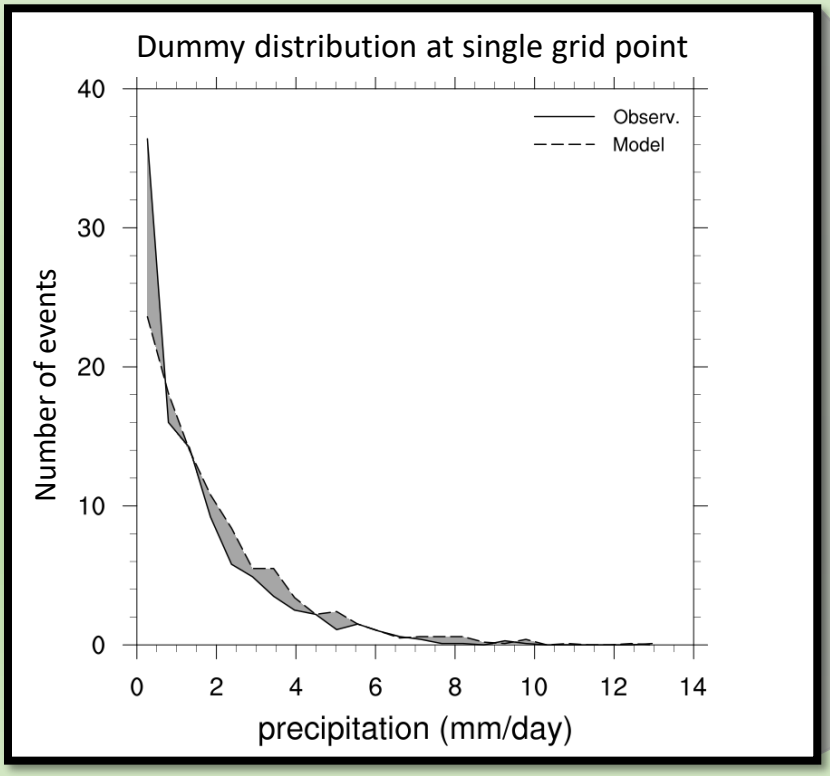
Proposed Method

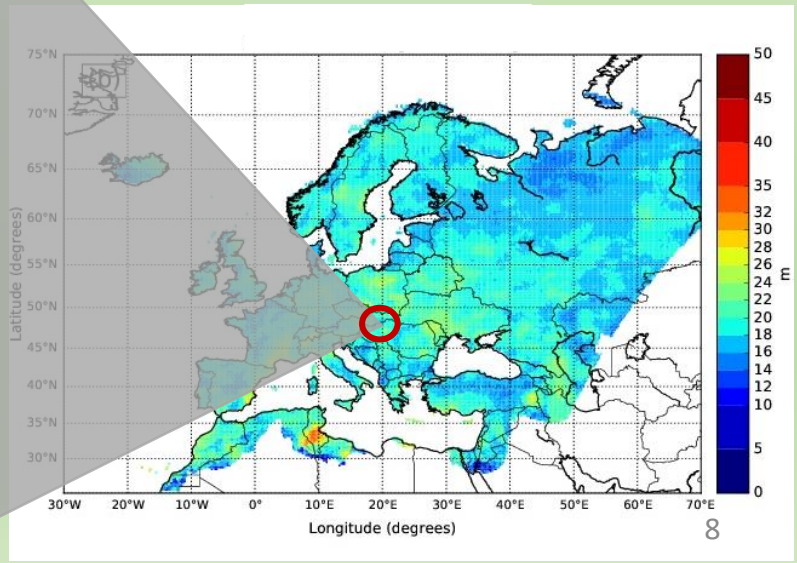
1. Interpolate to common grid [ex. RCM]
2. **Calculate distribution for each cell**
   - Independent number of bins
   - Identical bin size [1 mm/day]
3. **Calculate sum of differences**

for EACH grid-cell!

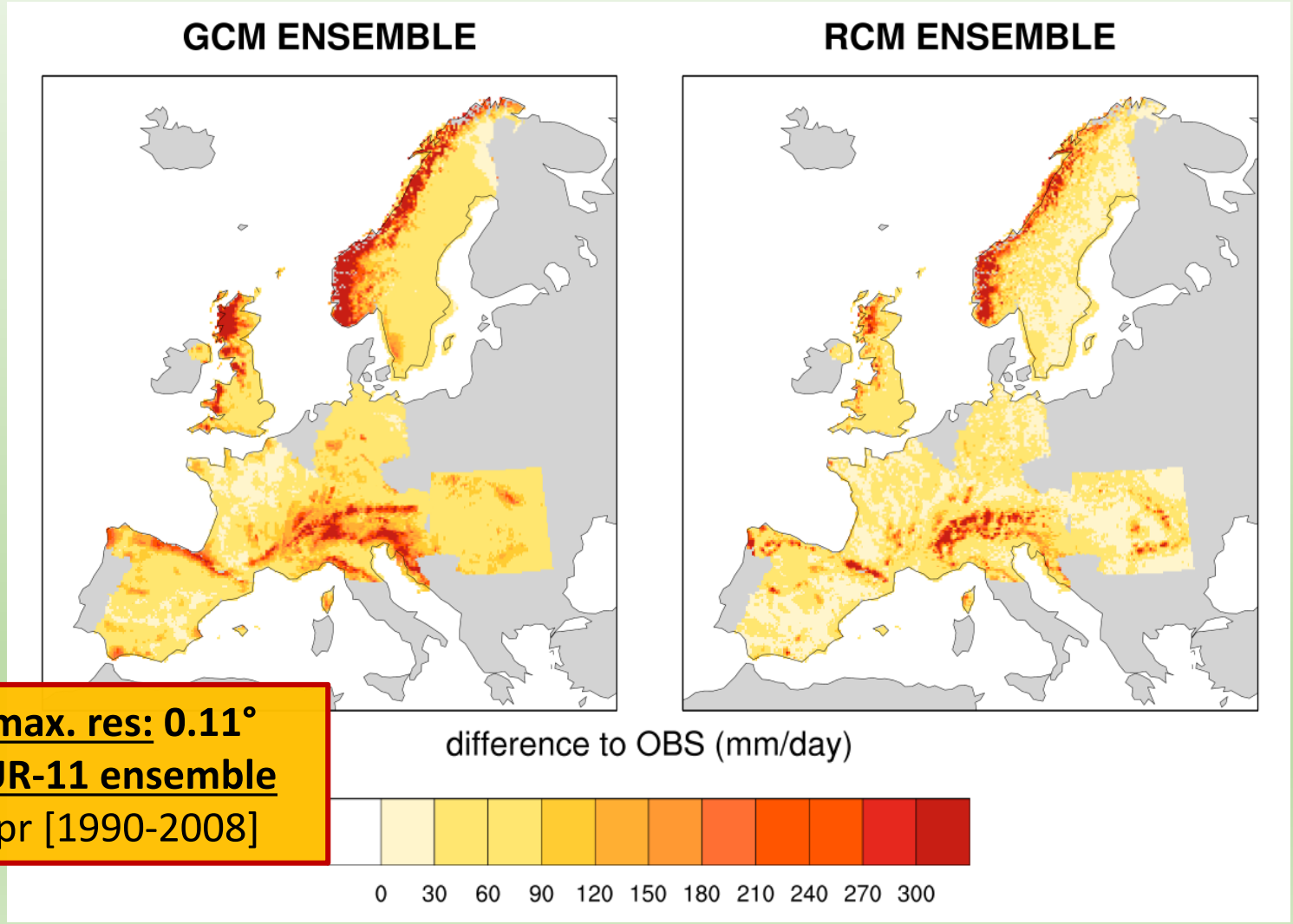
Relative Distribution Difference

$$D_{MOD} = \frac{\sum |N_M - N_O| \Delta v}{\sum P_O \Delta v}$$





Distribution Difference



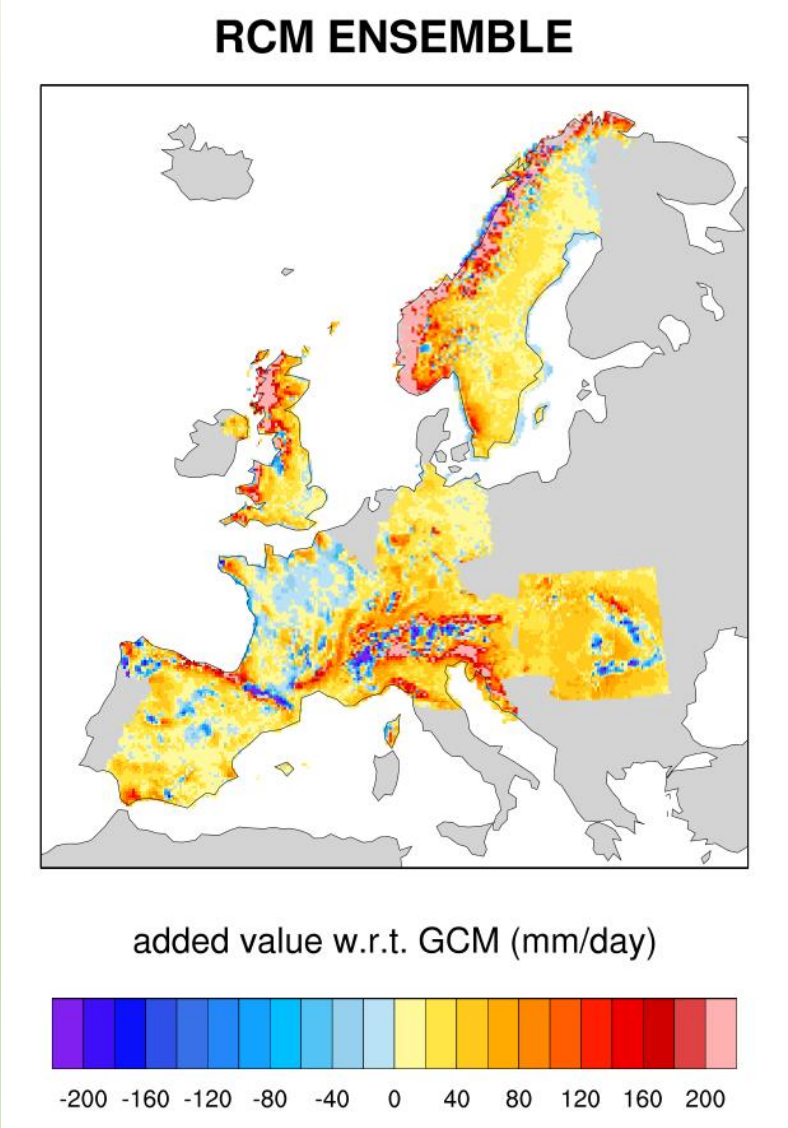
OBS max. res: 0.11°
34x EUR-11 ensemble
daily pr [1990-2008]

Added value

1. Interpolate to common grid [RCM]
2. Calculate distribution for each cell
3. Calculate sum of differences
4. **Compare the differences**
   - **Empty GCM bin → AV +1**

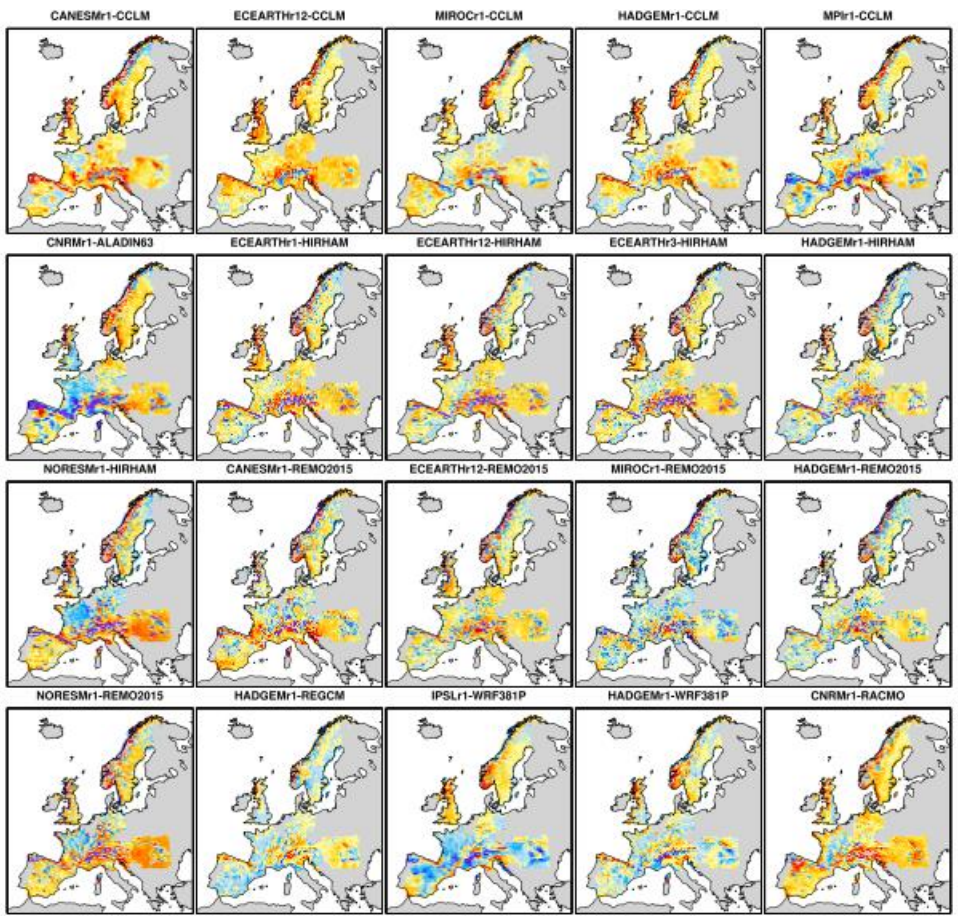
$$AV = D_{GCM} - D_{RCM}$$

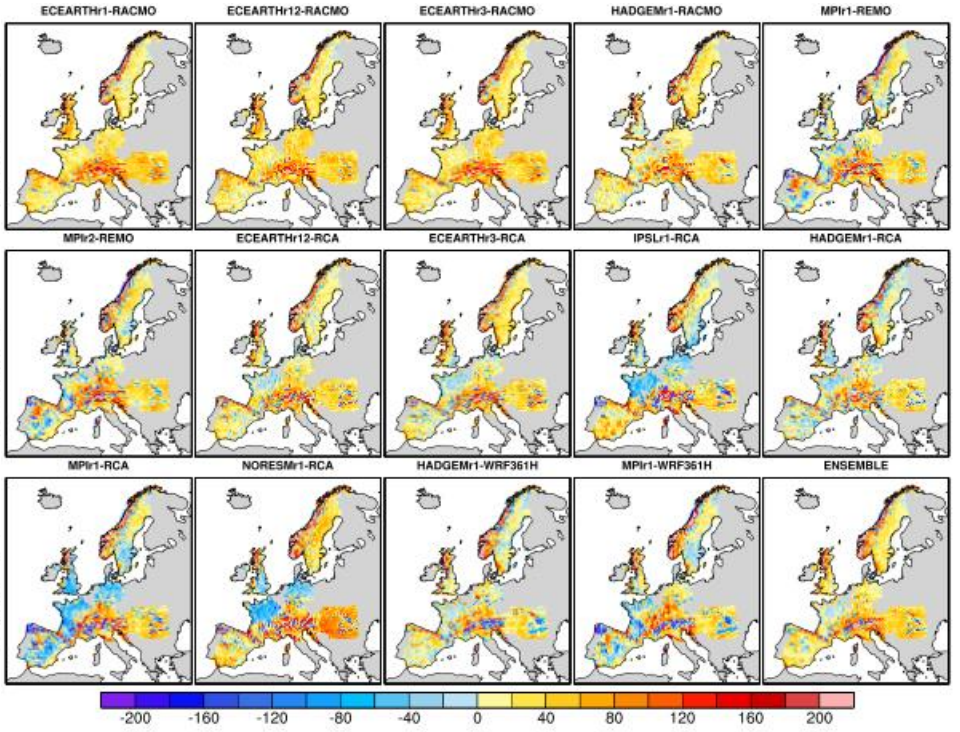
Units depend on [Relative] Distribution Difference



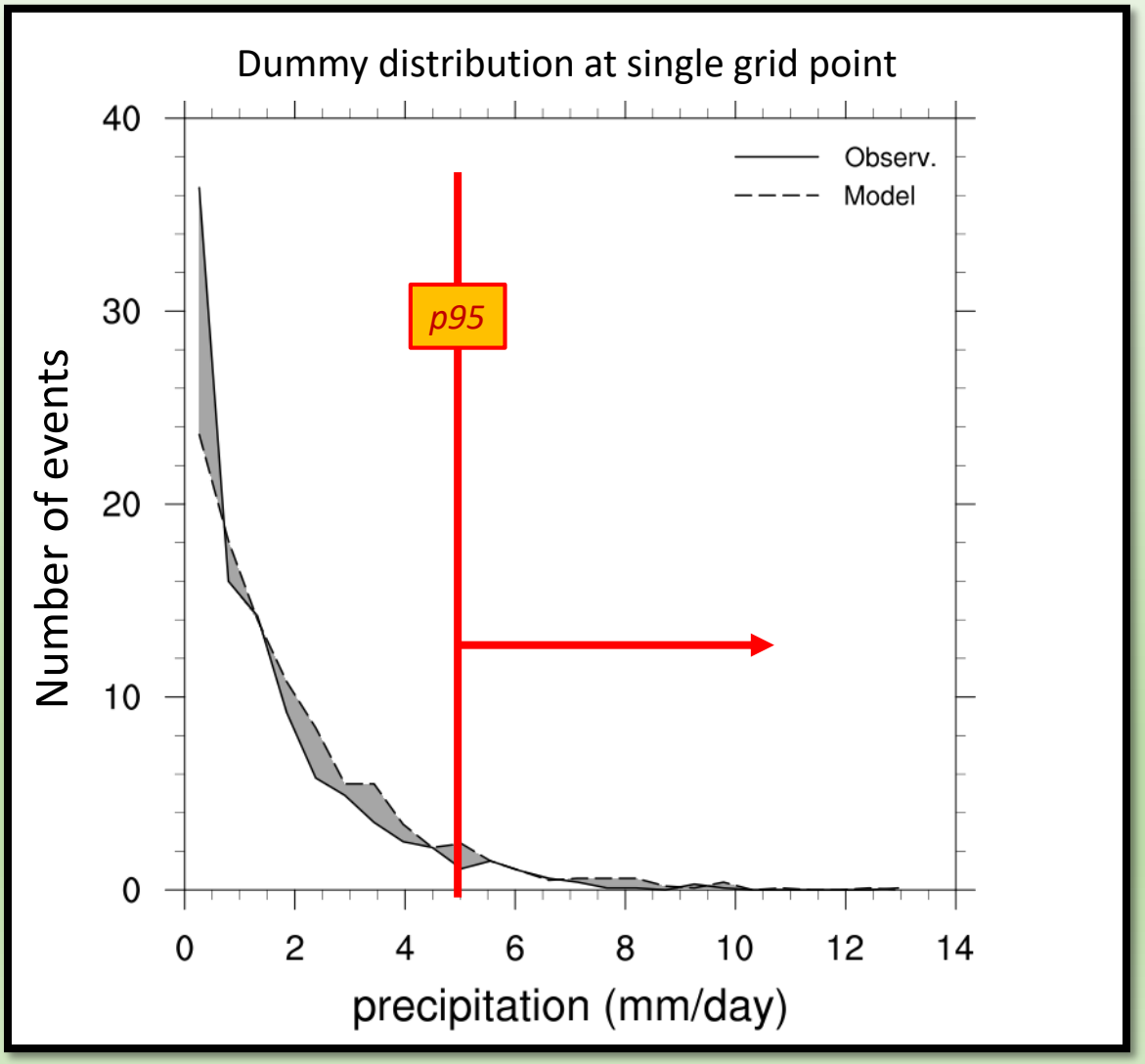
Added Value:
EURO-CORDEX
12km

To be updated:
Currently at 53+ models

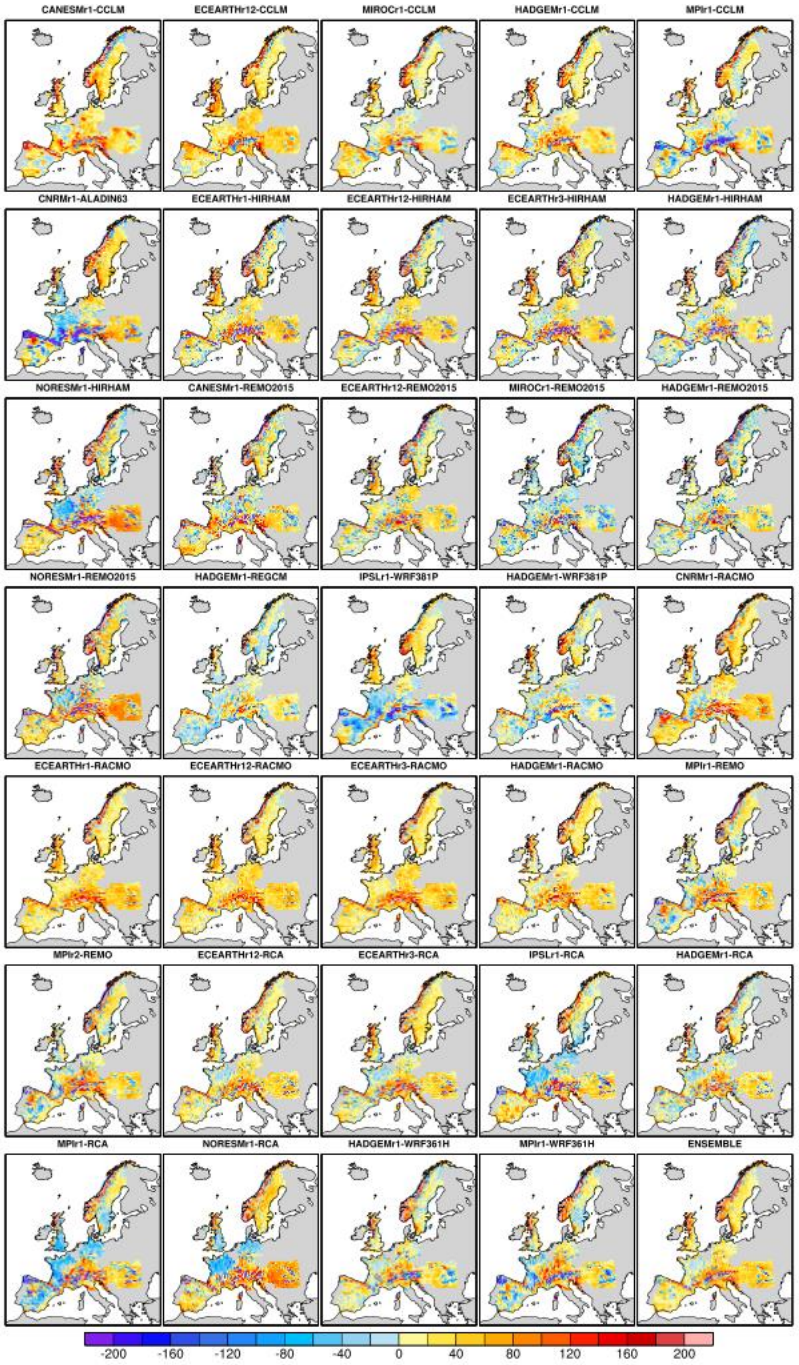




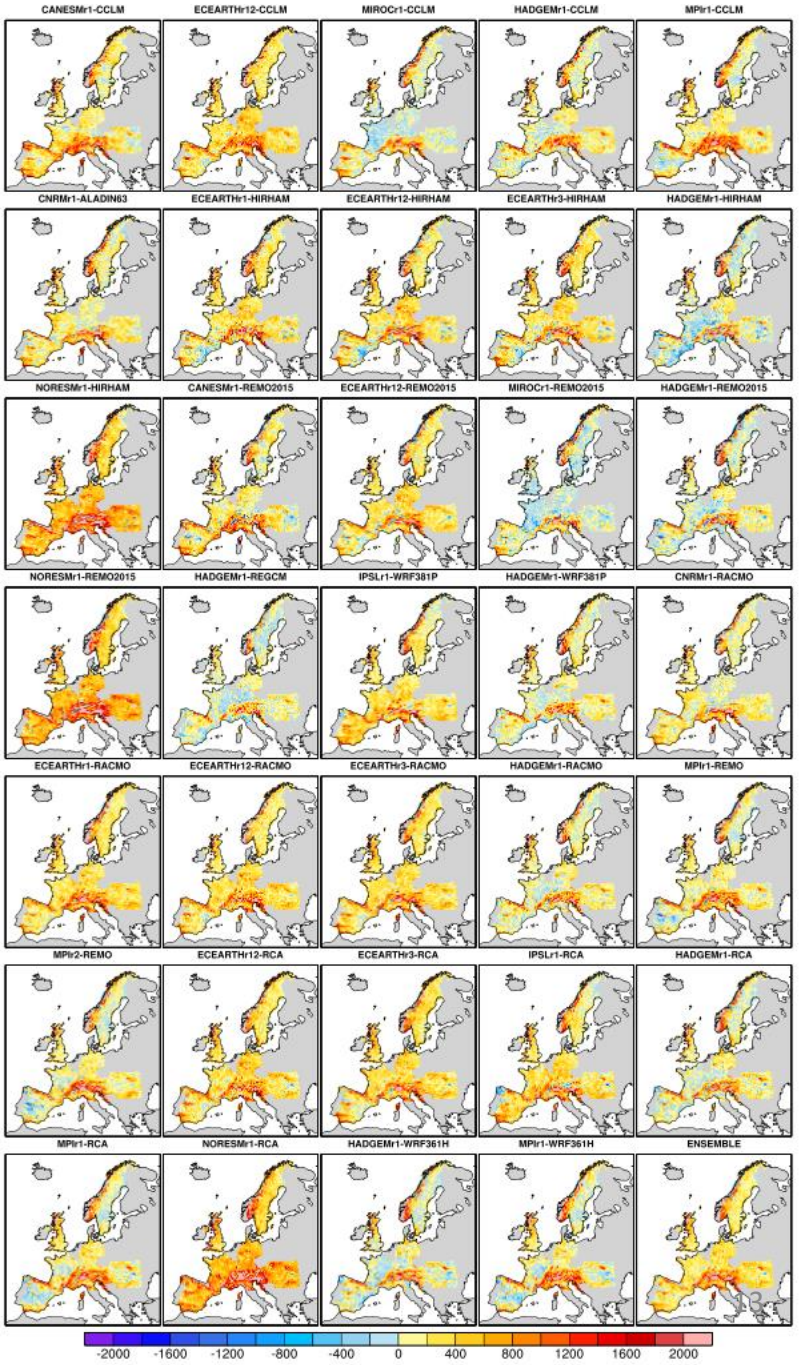
Extreme q95-100 fraction



full PDF



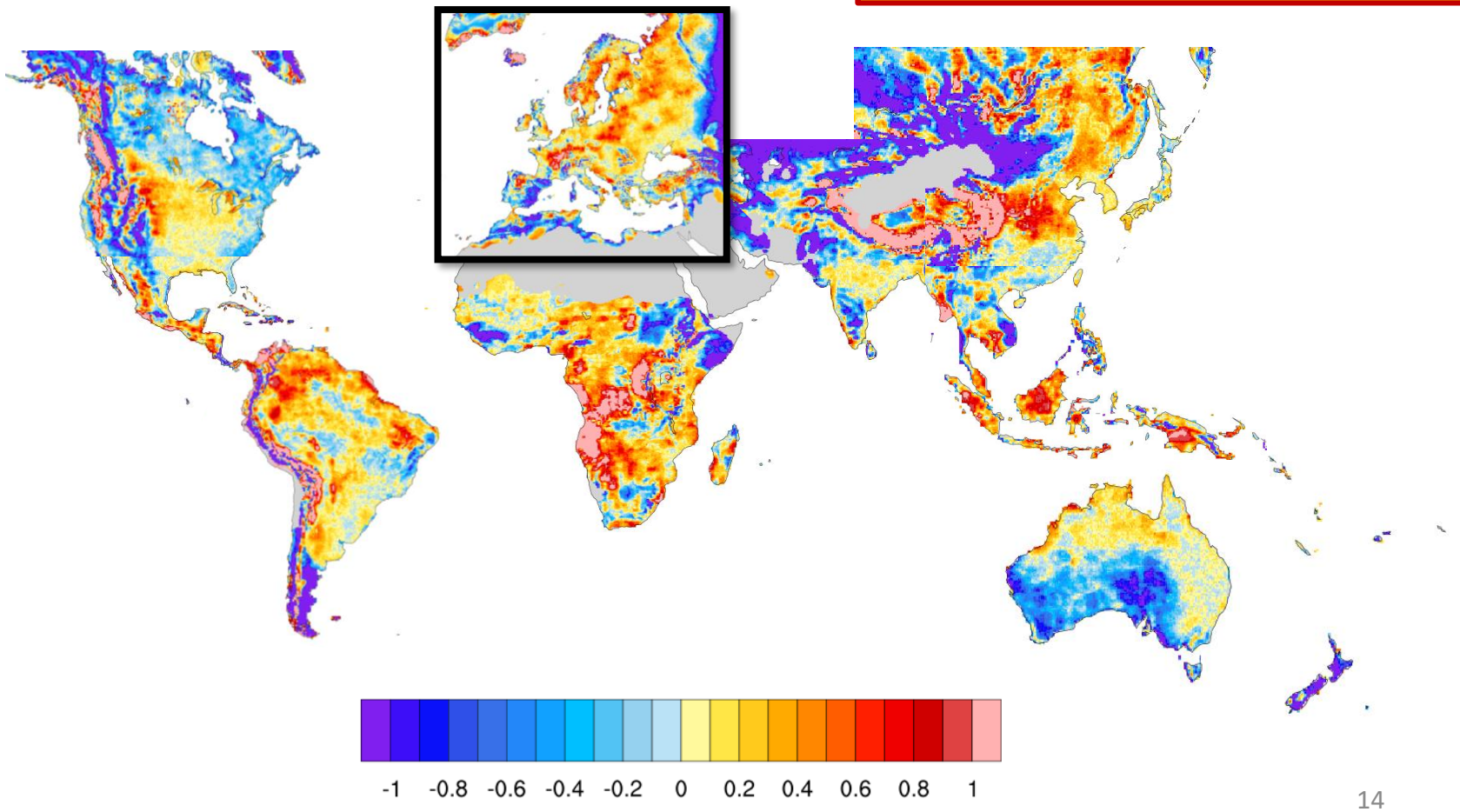
p95-100 fraction



CORDEX-ATLAS

+ Moetasim Ashfaq, Melissa Bukovsky, Sushant Das, Xuejie Gao, Russell Glazer, Eun-Soon Im, Francesca Raffaele, Taleena Sines, Jose Abraham Torres Alavez + Avengers cast and many others…

OBS: CPC 0.50°
GCM: MPI-M-MPI-ESM-{MR,LR}
daily p95-100 pr [1995-2014]

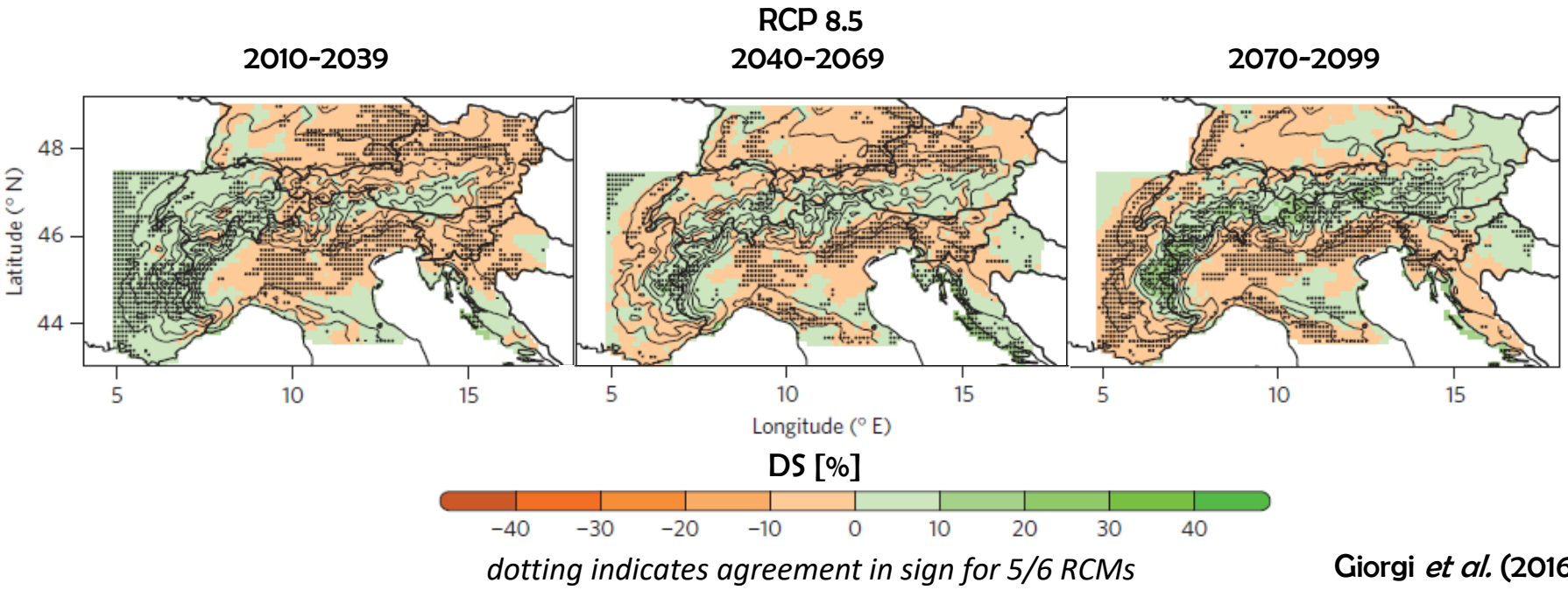


Downscaling Signal

Difference between RCM and GCM anomalies,

compared with the corresponding region-average change in each model.

$$DS(\Delta P) = \left(\Delta P_{RCM_i} - \Delta \bar{P}_{RCM_i}\right) - \left(\Delta P_{GCM_j} - \Delta \bar{P}_{GCM_j}\right)$$



Giorgi *et al.* (2016)

Adapting for Downscaling Signal

Difference between RCM and GCM anomalies,

compared with the corresponding region-average change in each model.

$$DS(\Delta P) = \left(\Delta P_{RCM_i} - \Delta \bar{P}_{RCM_i}\right) - \left(\Delta P_{GCM_j} - \Delta \bar{P}_{GCM_j}\right)$$

Giorgi *et al.* (2016)

for EACH grid-cell!

Historical Data:

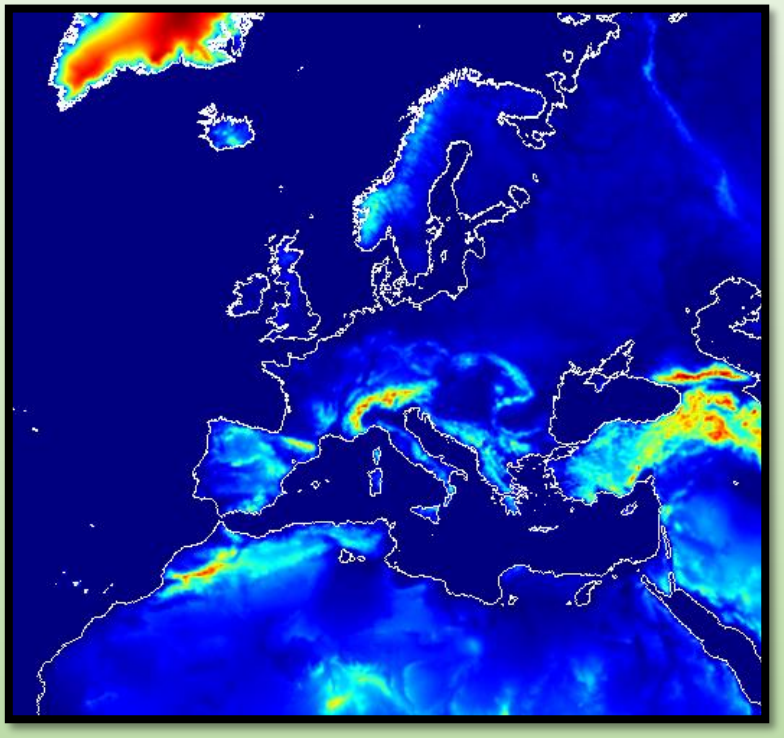
$$D_{MOD} = \frac{\left|\sum P_M \Delta v - \sum P_O \Delta v\right|}{\sum P_O \Delta v}$$

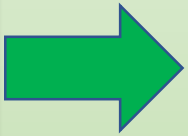
Future Data:

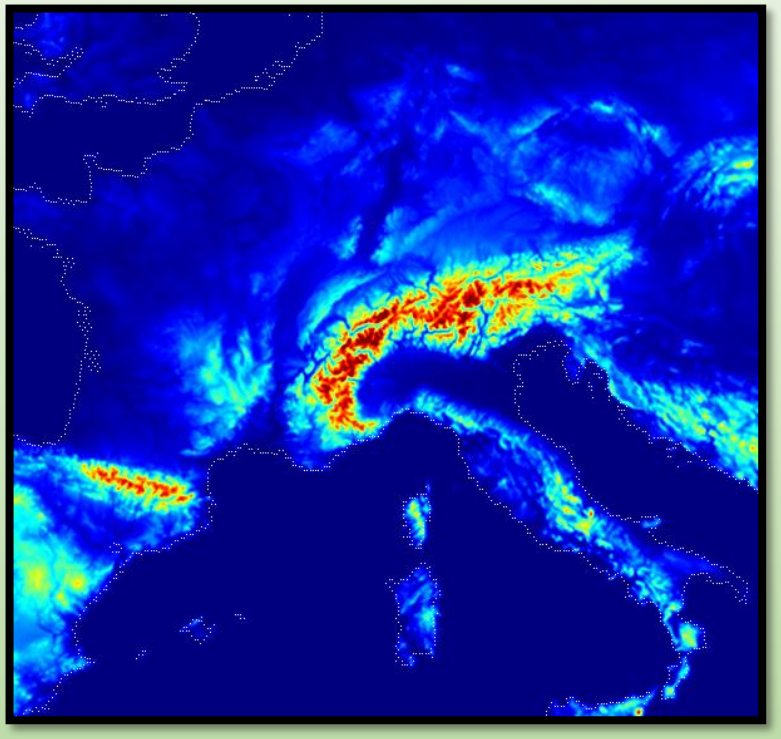
$$D_{MOD} = \frac{\left|\sum P_f \Delta v - \sum P_h \Delta v\right|}{\sum P_h \Delta v}$$

$$AV = D_{GCM} - D_{RCM}$$

Convective Permitting (3 km)







- **12 KM hydrostatic**
- **23 v-levels**

- **3 KM non-hydrostatic**
- **41 v-levels**

Thank You for your attention!

Email: jciarlo@ictp.it

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