Regionalization of CMIP3 model simulations and projections of high-impact weather and climate extremes over East Asia

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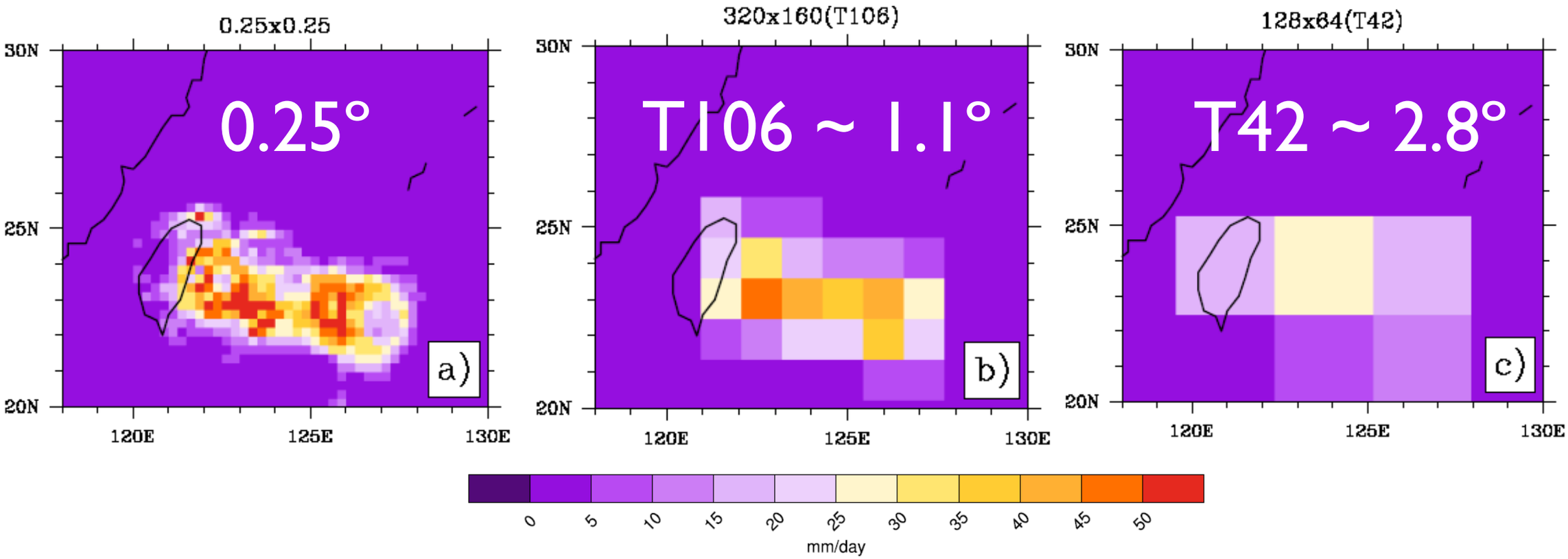


- Extreme Events and Spatial Scale (focus on precipitation)
- Approaches
- Key findings and Limitations

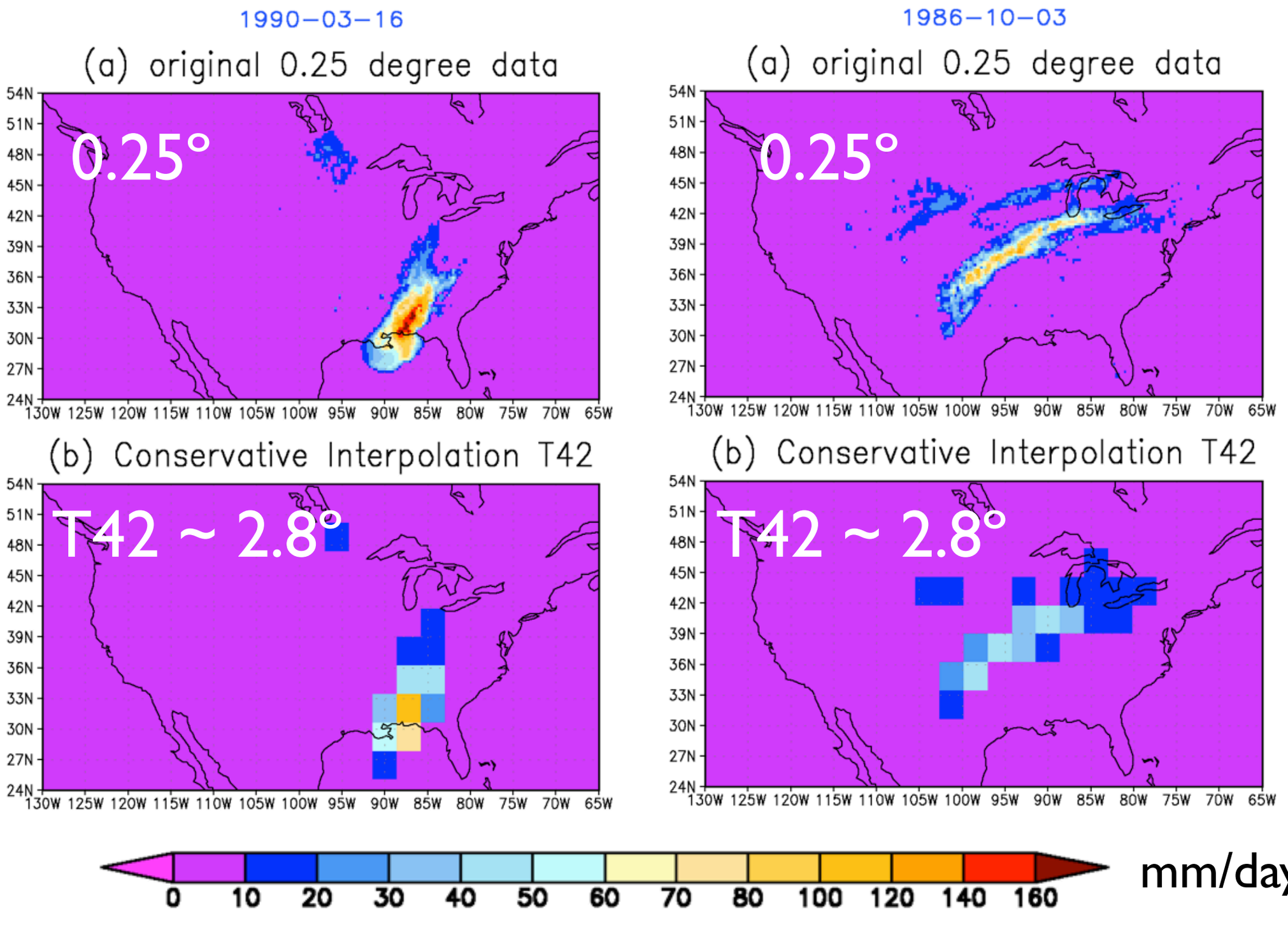
APEC Climate Symposium 2011, Honolulu, Hawaii, USA

- There are increasing interests on projected future regional changes in the frequency or intensity of extreme precipitation since they can have much more significant impact on both human society and natural environment.

- The current CMIP/IPCC climate models are not designed to capture the regional details of large spatial variability of rainfall. Further, they are running at different resolutions that make comparison between models and validation with observation more difficult due to scale mismatch.

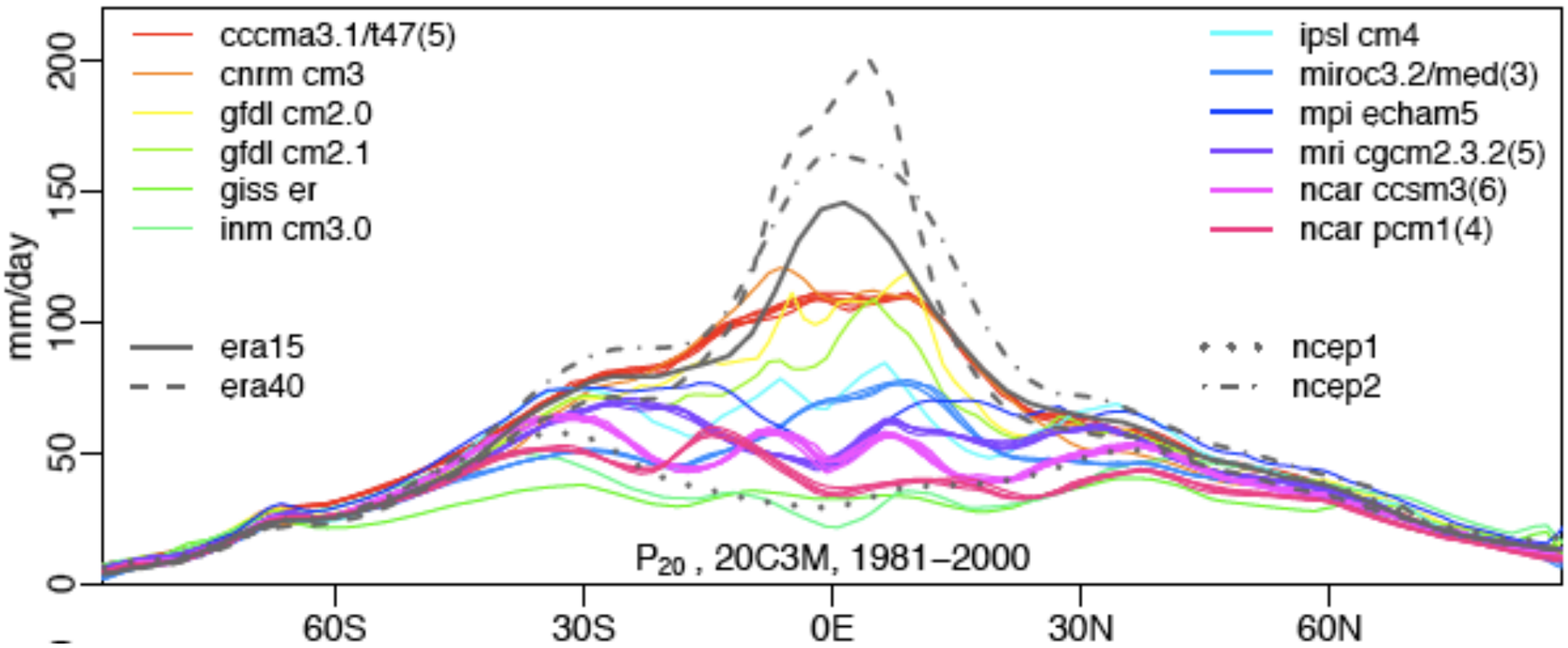
Snapshots of daily precipitation at different resolutions

(Potential problem for model comparison?)



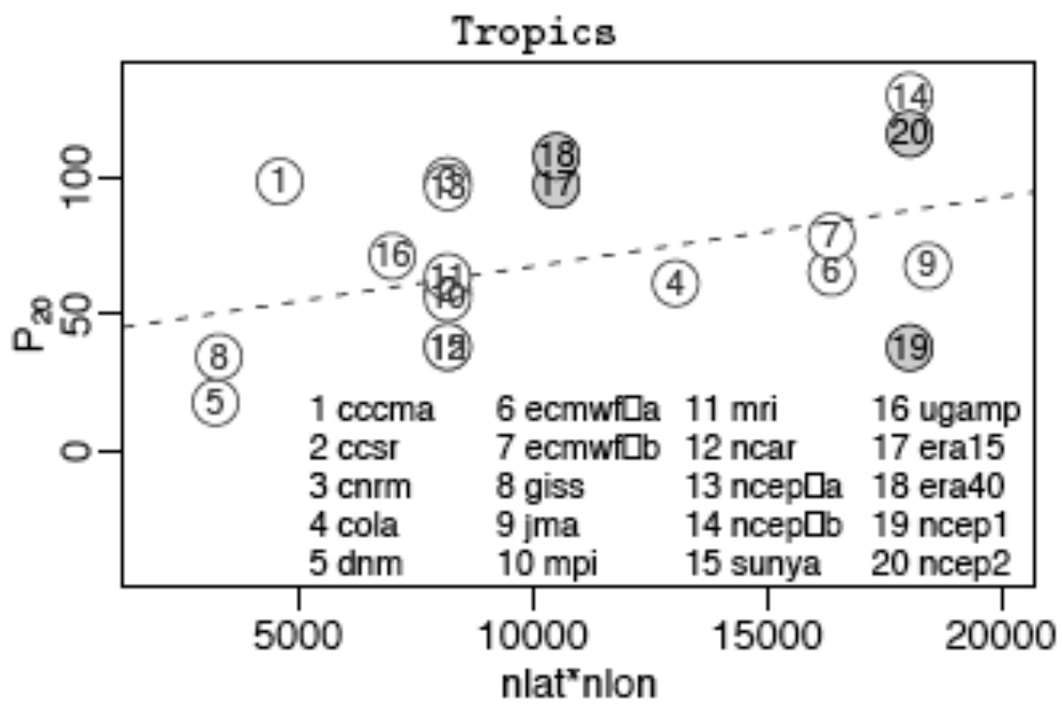
20 year return-level of daily precipitation

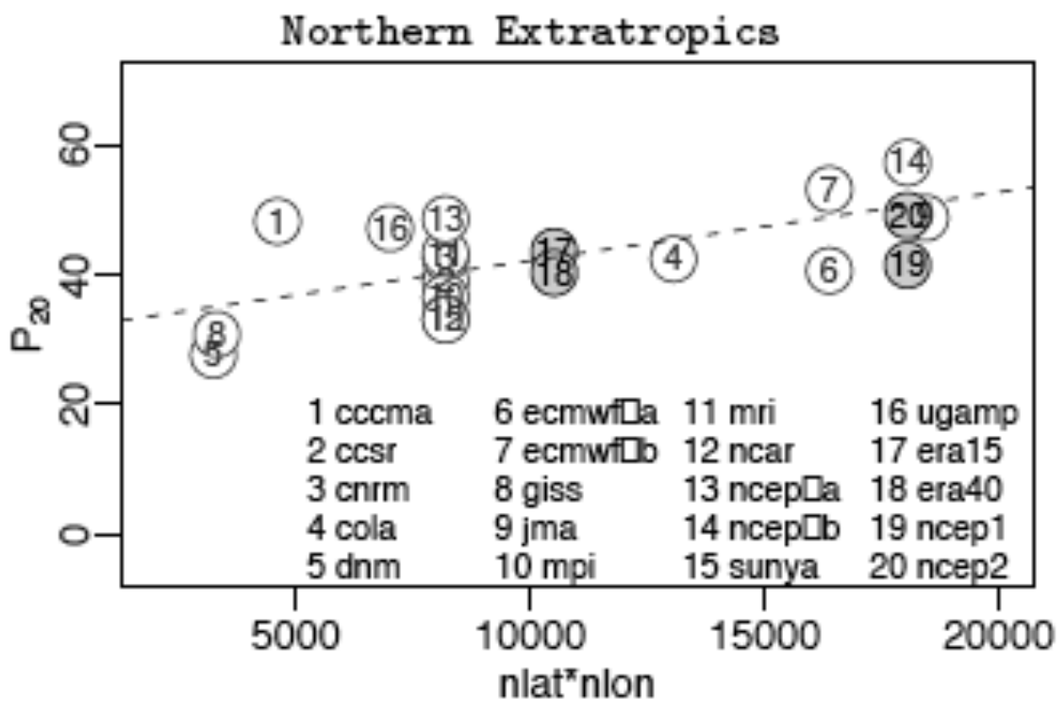
Kharin et al.(2007)



Is there a scale dependence?

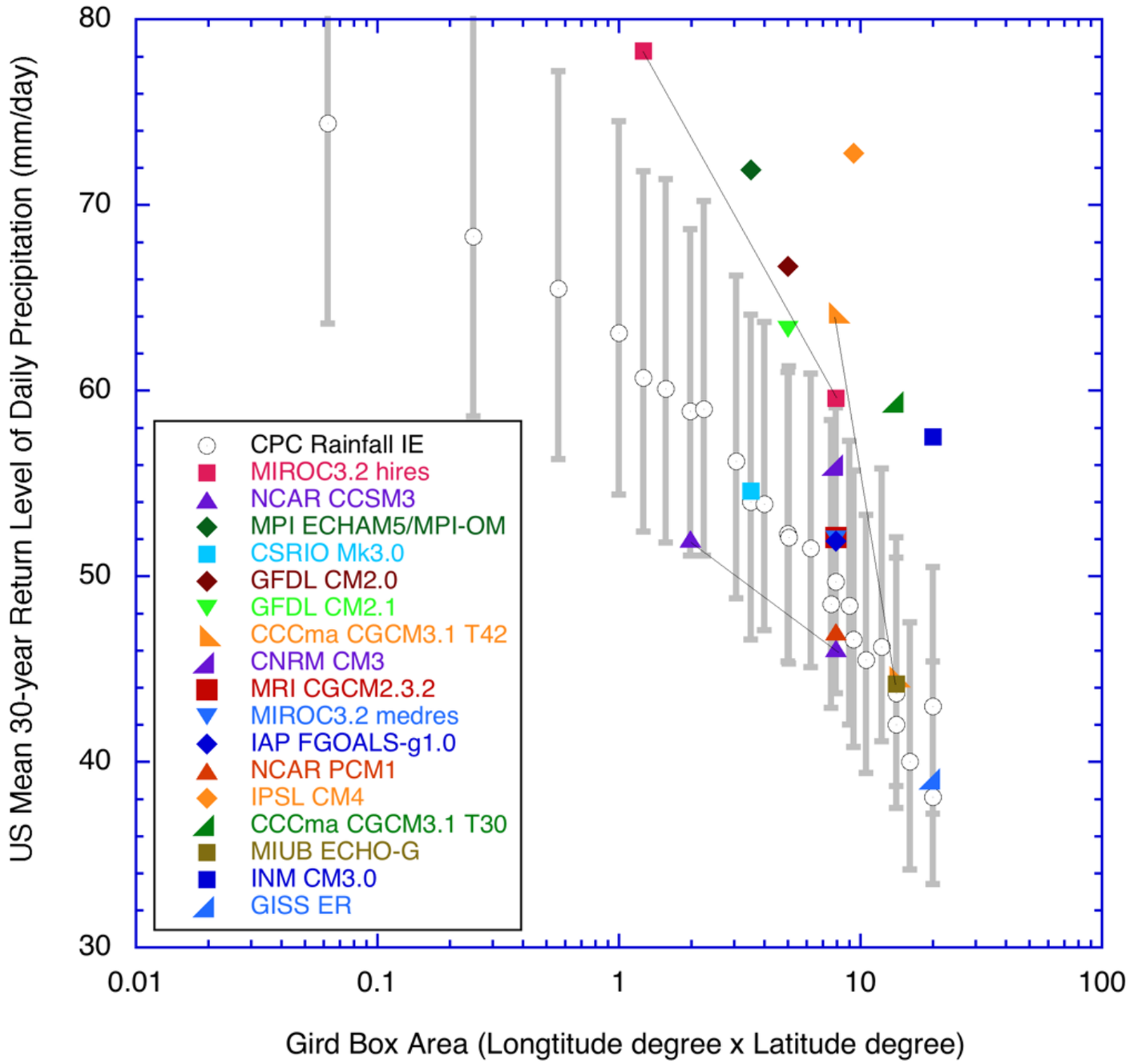
Kharin et al.(2005)





Use observed high resolution rainfall estimates to study scale dependence

US domain mean 30-year return-level of daily rainfall

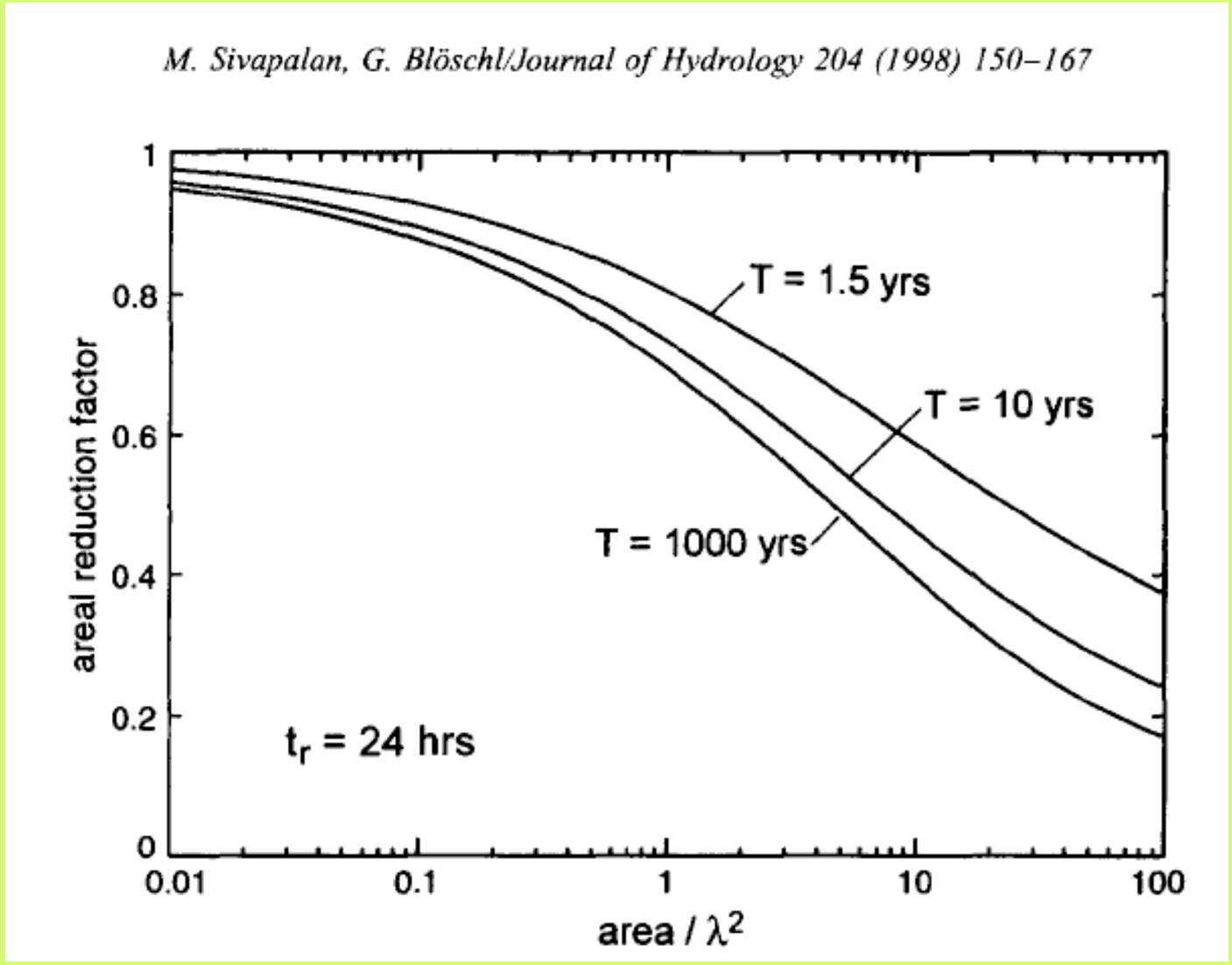


Chen and Knutson (2008)

Grid box Area (log scale)

Use observed high resolution rainfall estimates

If model rainfall represents grid-box mean, there is an areal reduction factor to consider. (Hydrology)



US domain

30-year retur

of daily rai

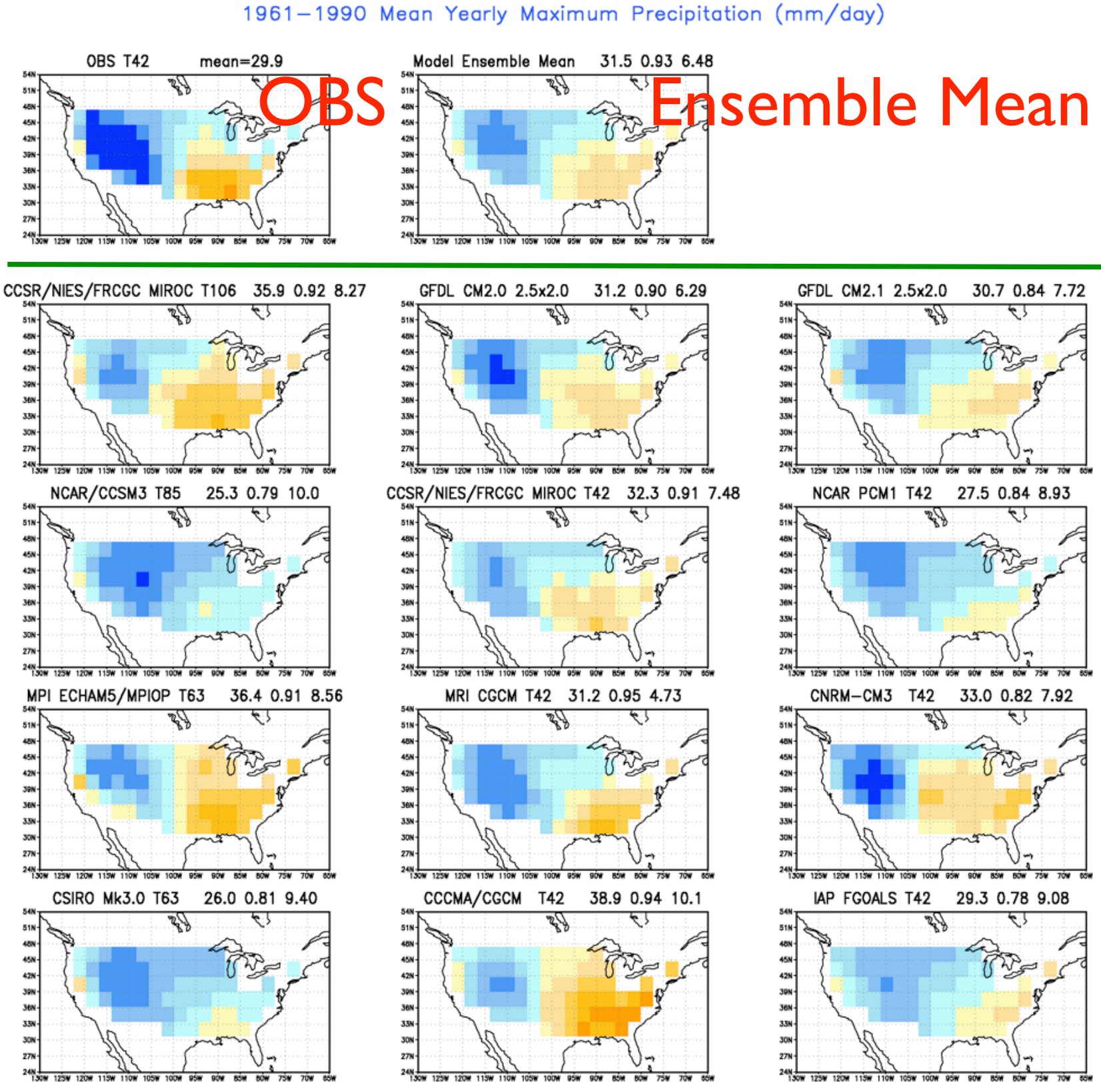
00

Chen and Knu

Validation (Climatology, 1961-1990 mean Rx1day)

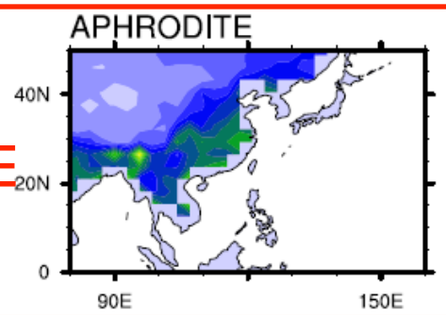
Interpolate to T42 before identify yearly maximum

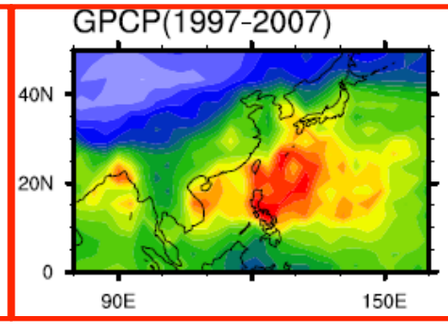
- Overall patten are reasonable (ρ=0.78~0.95)
- Overestimate in the Mountain states
- Underestimate in the South



Validation (Climatology, 1981-2000 mean Rx1day)

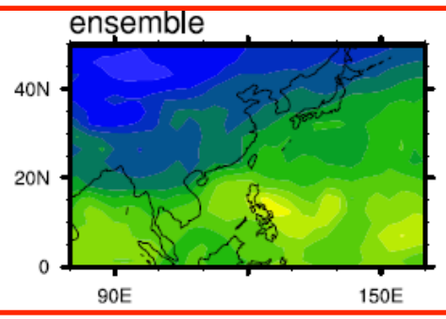
APHRODITE

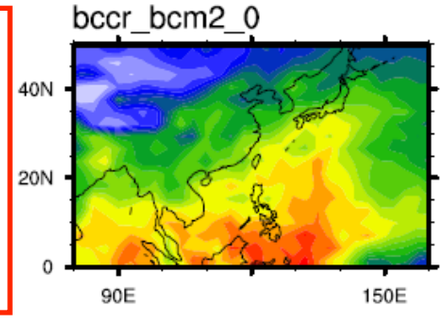


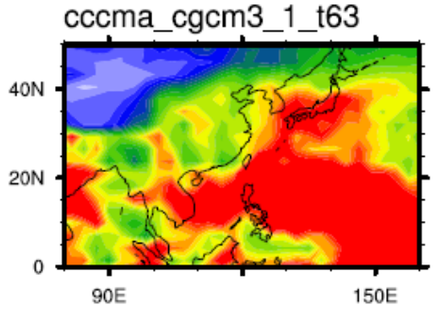


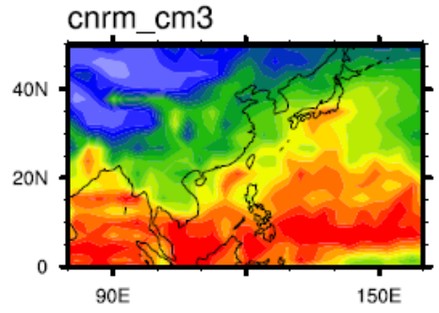
GPCP

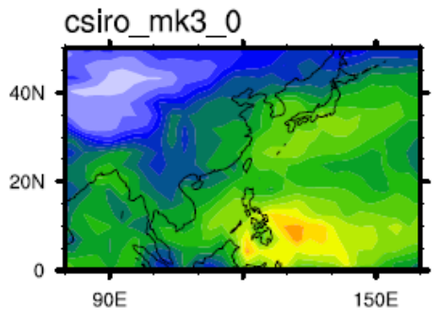
Ensemble Mean

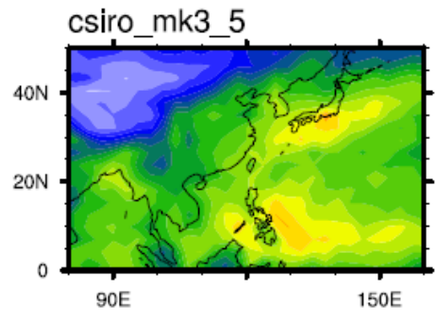


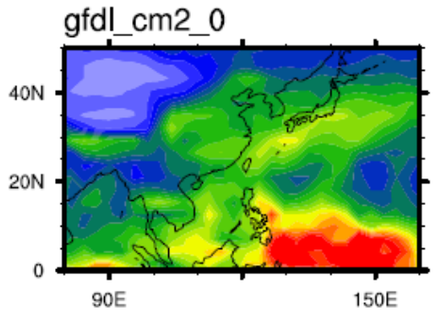


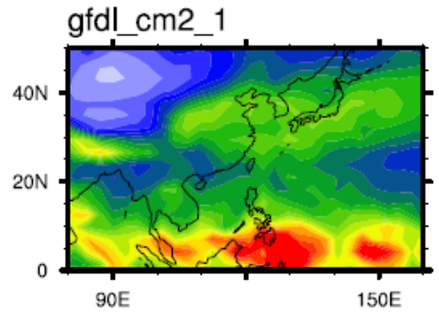


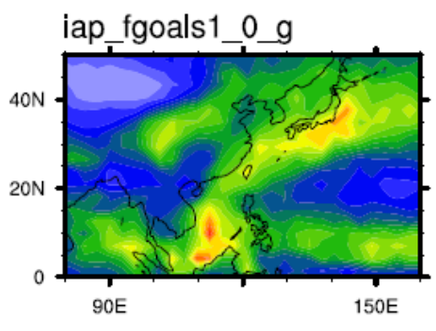


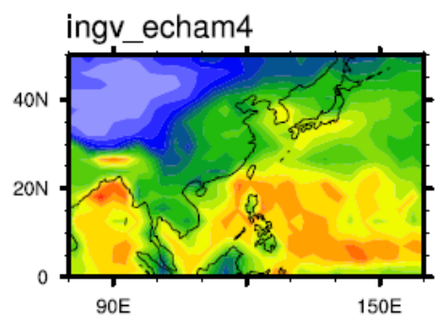


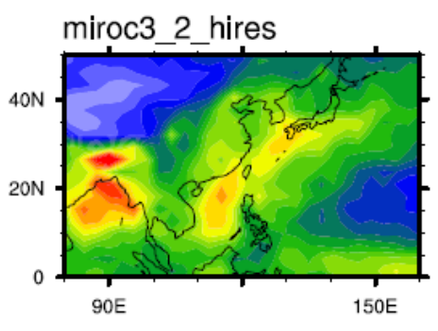


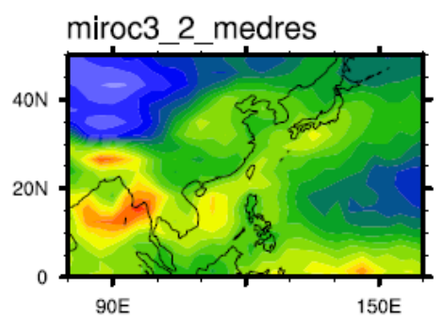


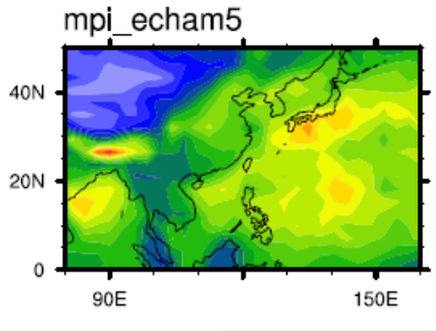


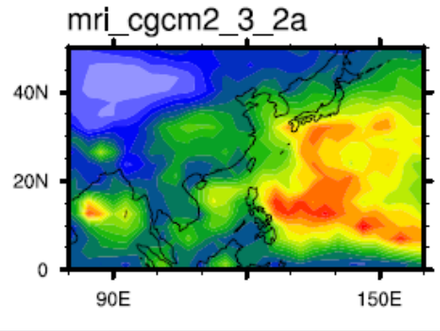


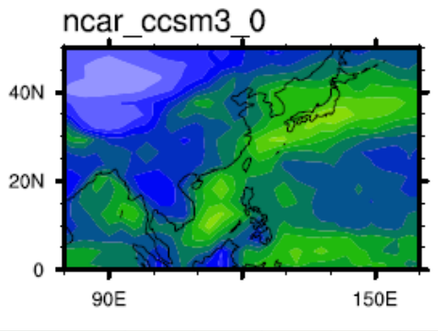


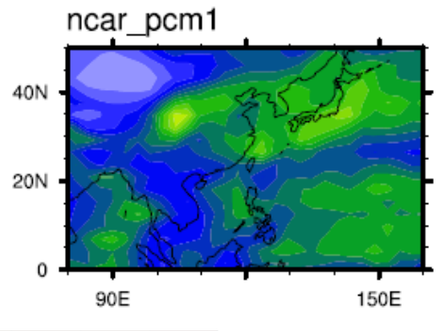


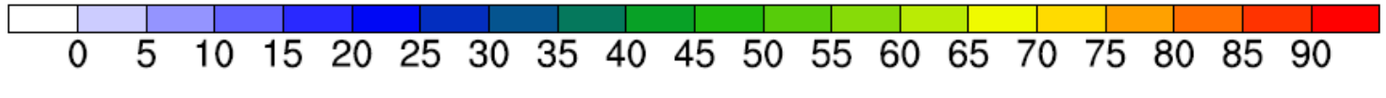












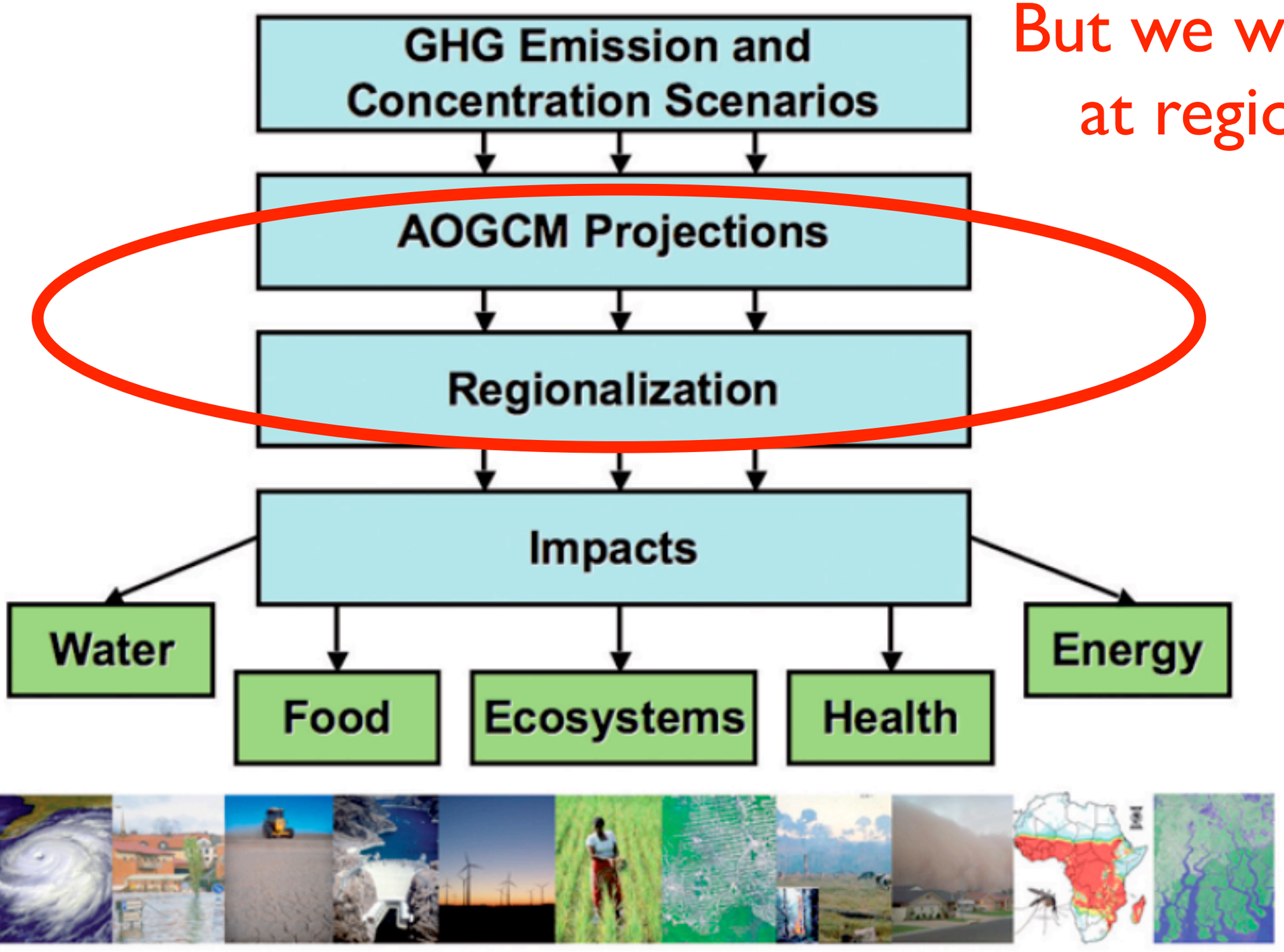


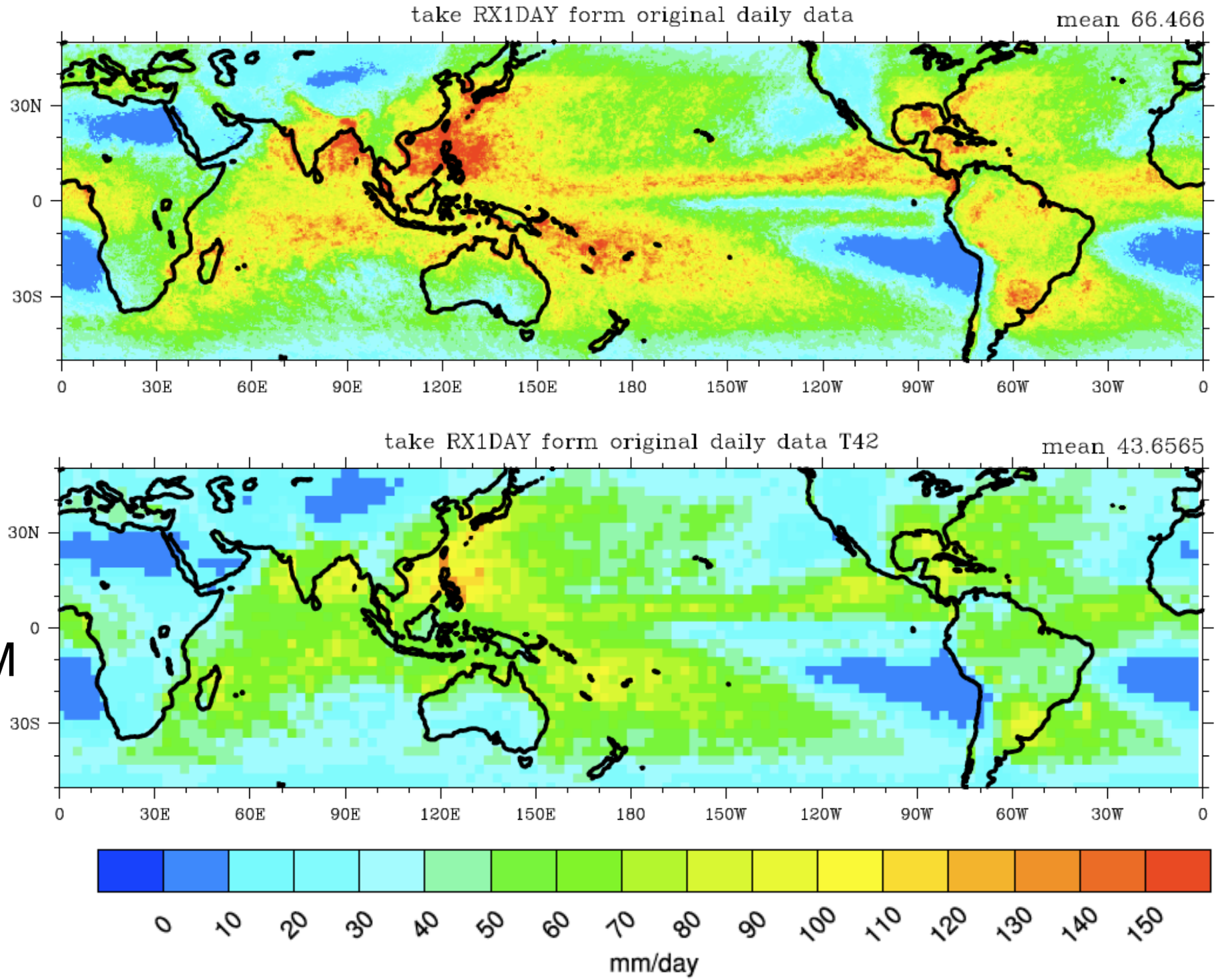
Figure 3 — Schematic depiction of the steps involved in the production of climate change information usable for impact assessment work via regionalization methods

But we want extremes at regional scale!!!

Source: Giorgi (2008)

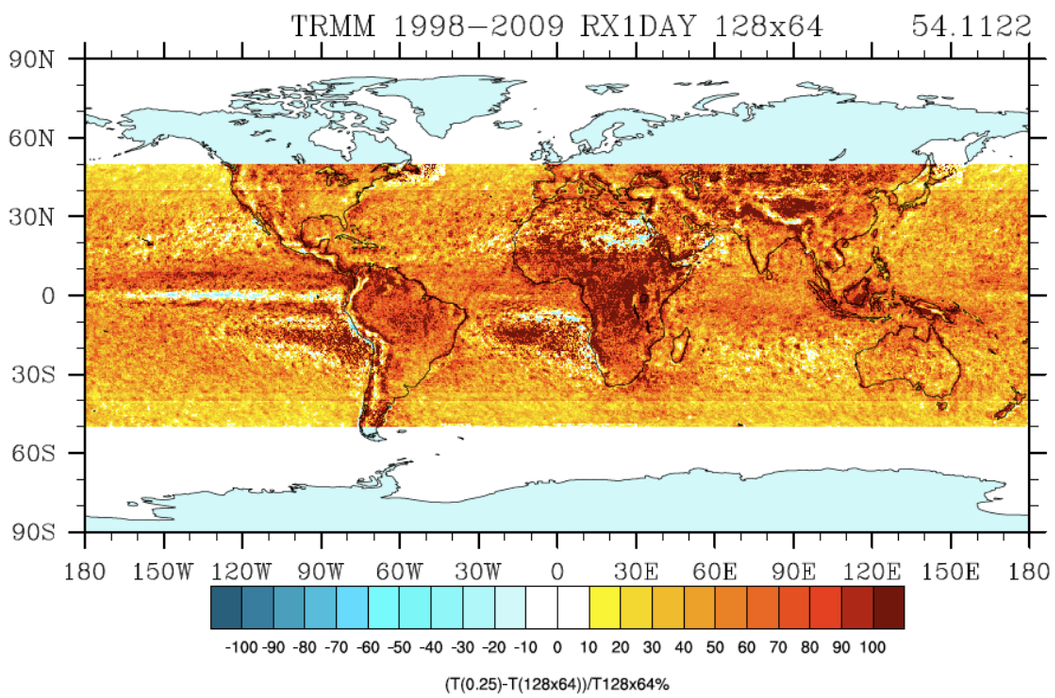
Deriving high-impact weather extremes at different spatial resolutions using observational estimates

Annual maximum daily rainfall (Rx1day) at 0.25° resolution derived from TRMM (1998-2009)

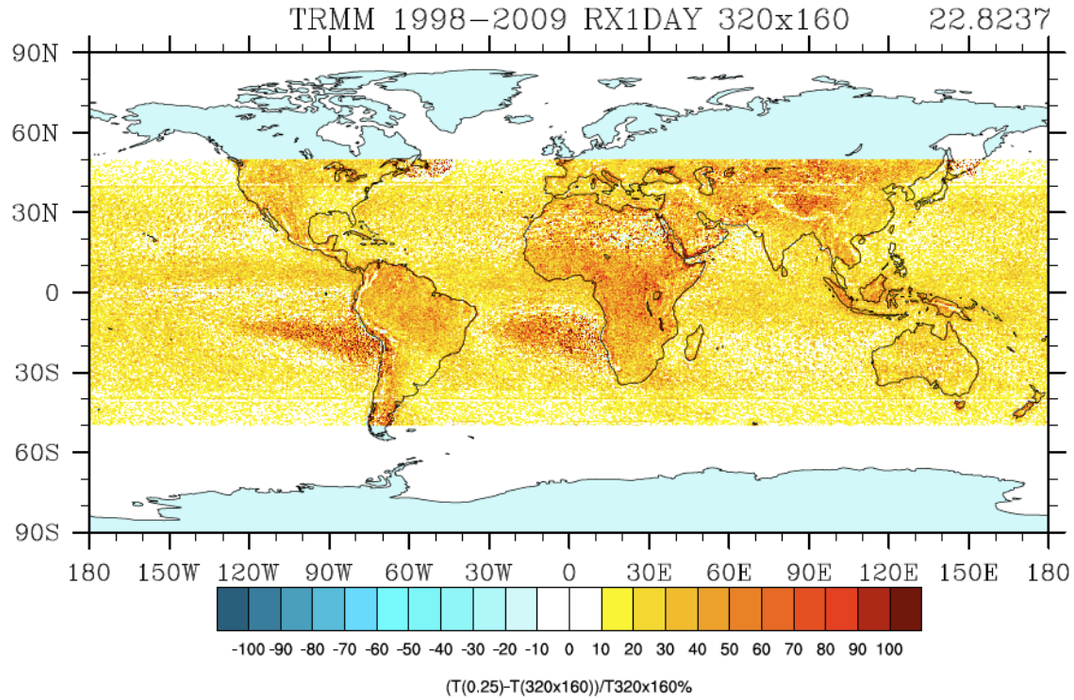


Annual maximum daily rainfall (Rx1day) at T42 derived from TRMM

Enhancing factor (%) from T42 to 0.25° resolution [P(0.25°)-P(T42)]/P(T42)

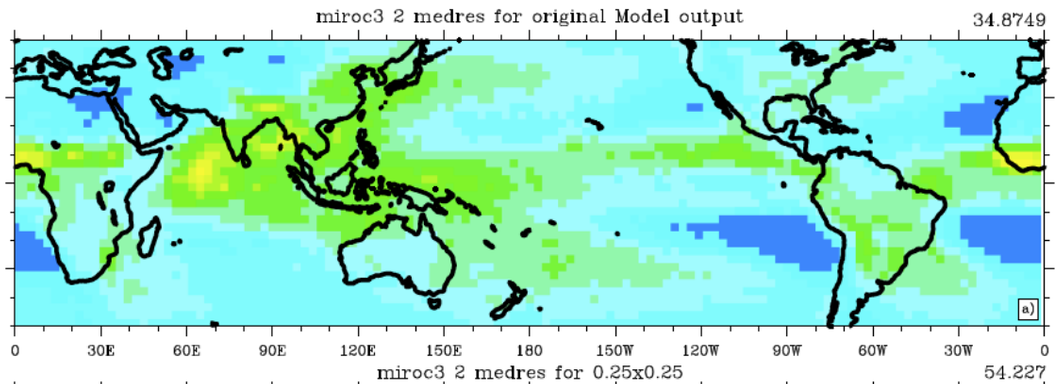


Enhancing factor (%) from T106 to 0.25° resolution [P(0.25°)-P(T106)]/P(T106)

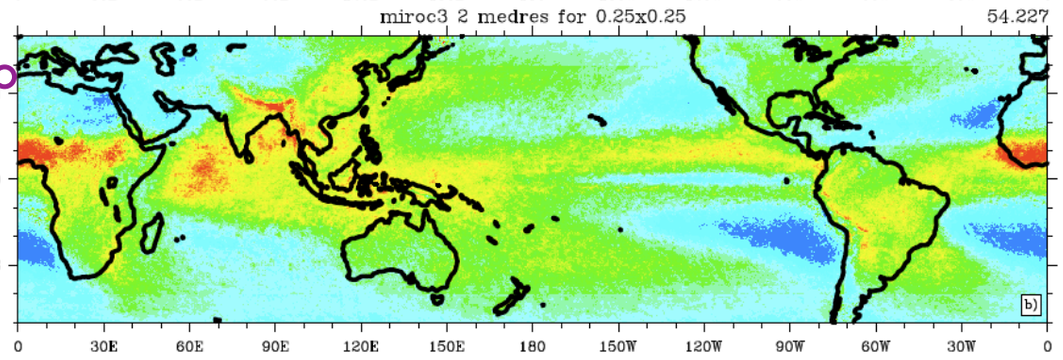


Projecting MIROC3.2 T42 medium resolution run to 0.25° resolution

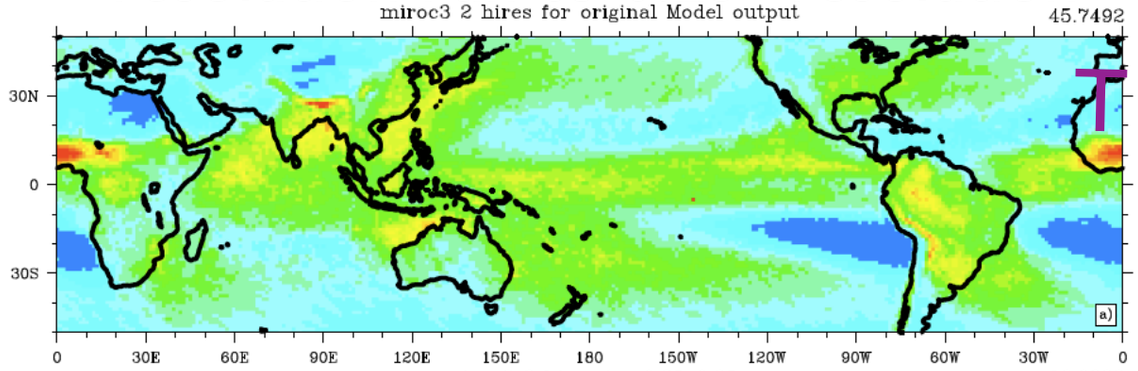
T42



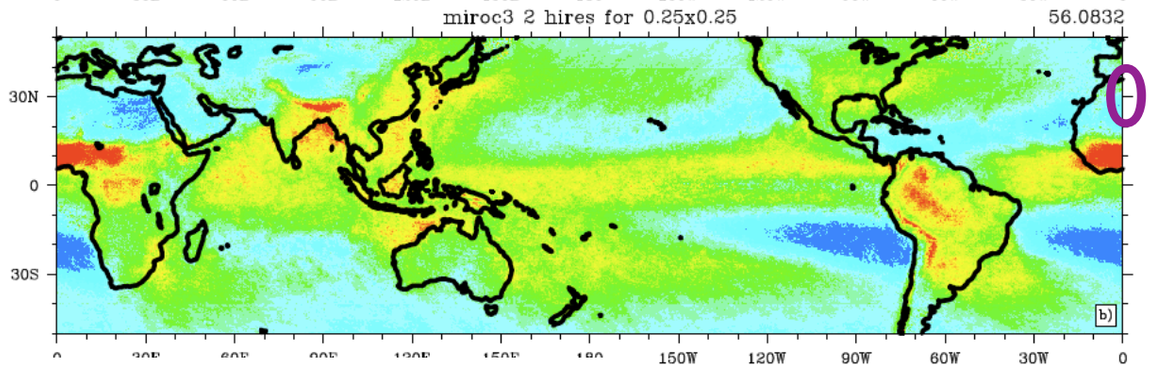
0.25°



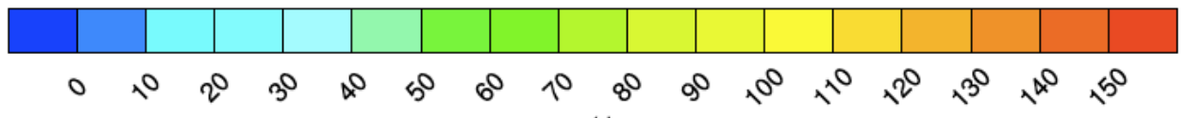
Projecting MIROC3.2 T106 high resolution run to 0.25° resolution



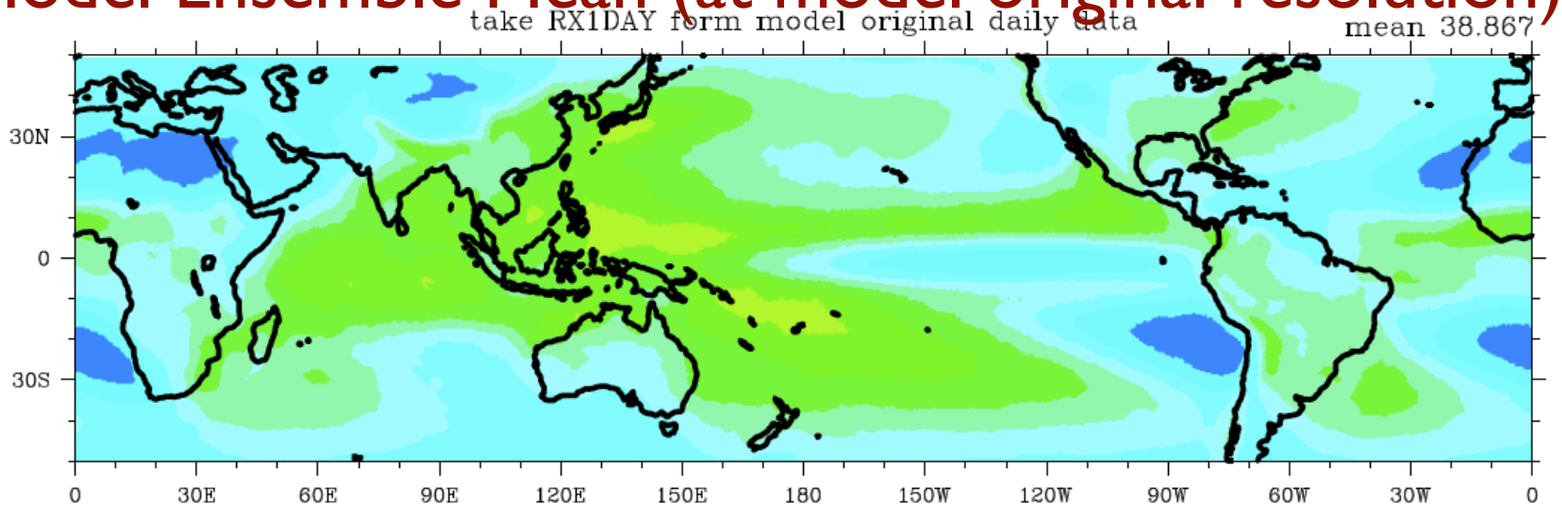
T106



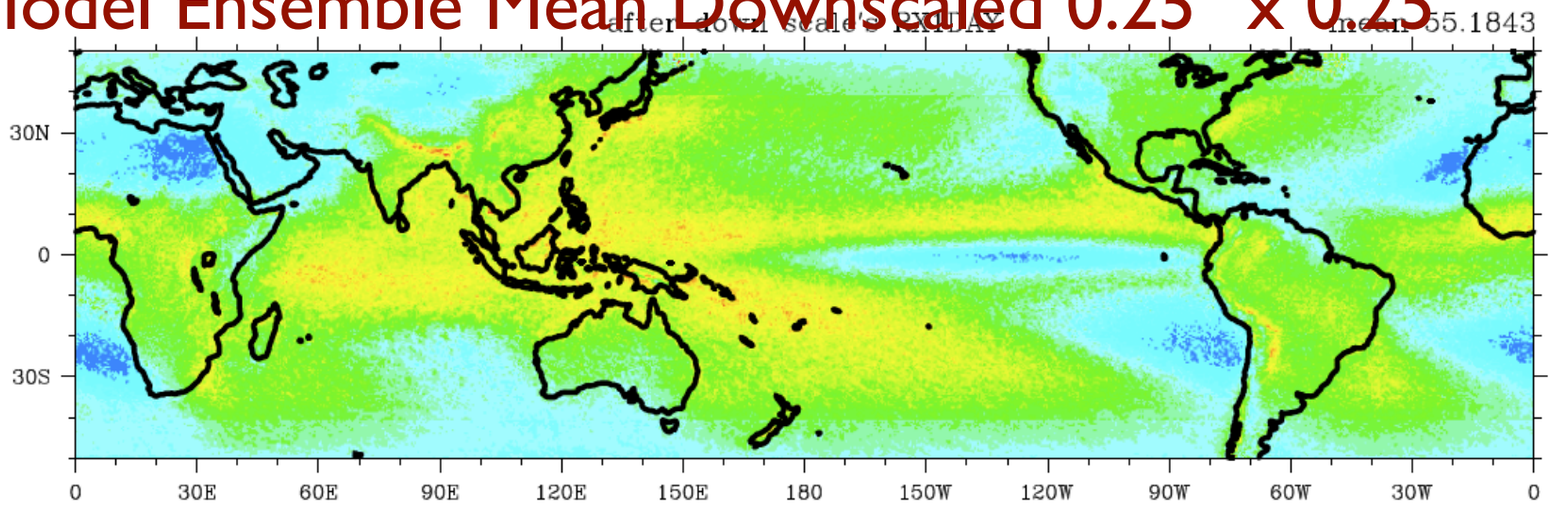
0.25°



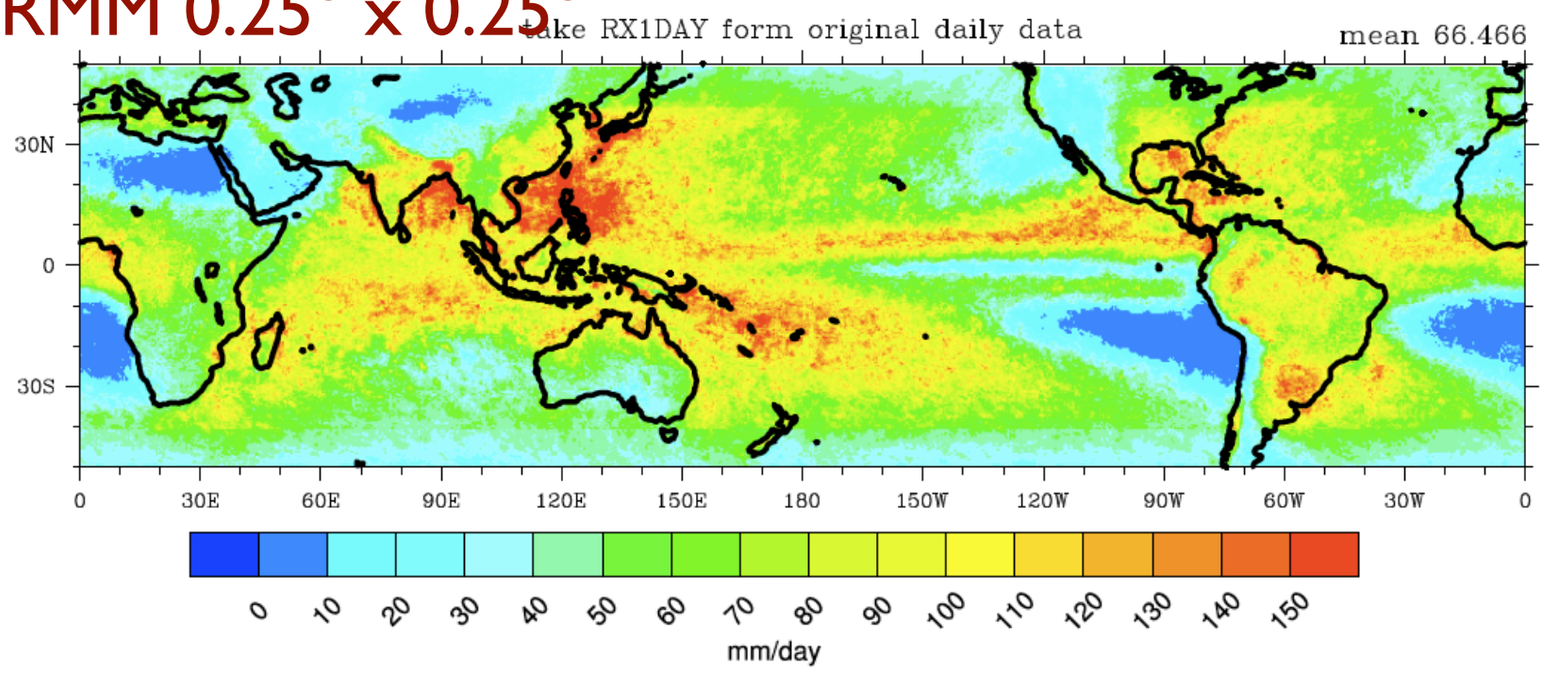
Model Ensemble Mean (at model original resolution)



Model Ensemble Mean Downscaled 0.25° x 0.25°



TRMM 0.25° x 0.25°

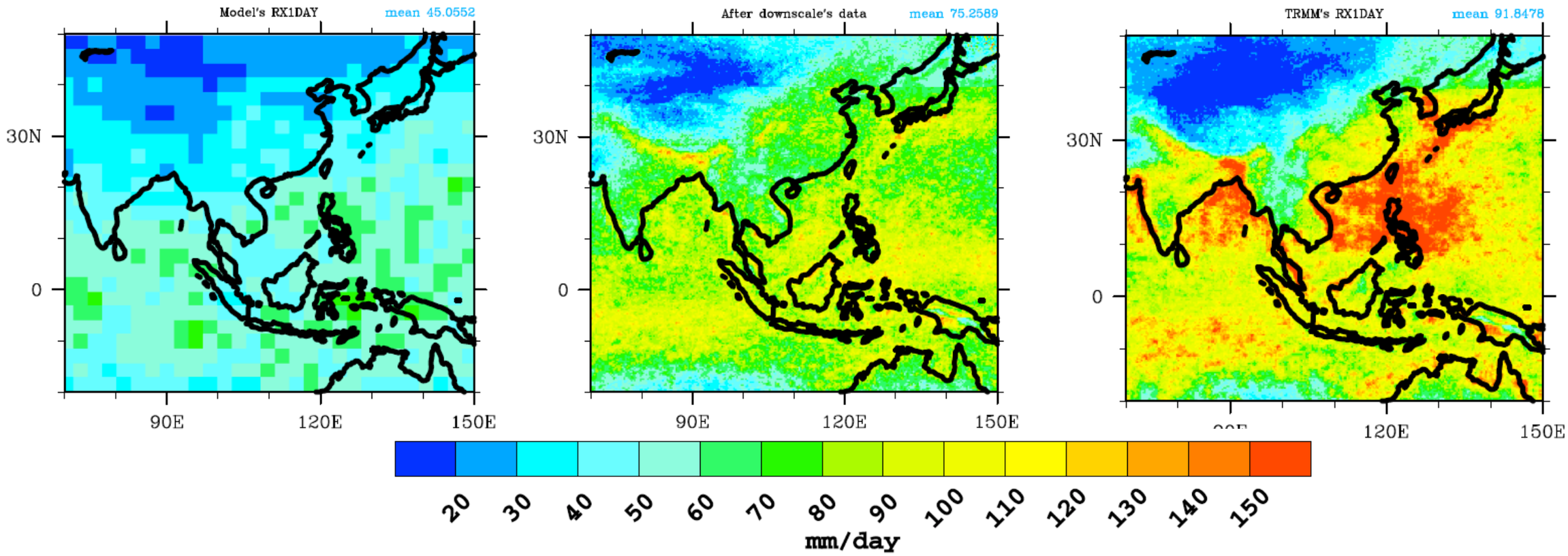


Regionalization significantly improve the model simulated extreme rainfall events at comparable spatial scale to the high resolution TRMM observation.

Model Ensemble Mean
(at model original resolution)

Model Ensemble Mean
Downscaled 0.25° x 0.25°

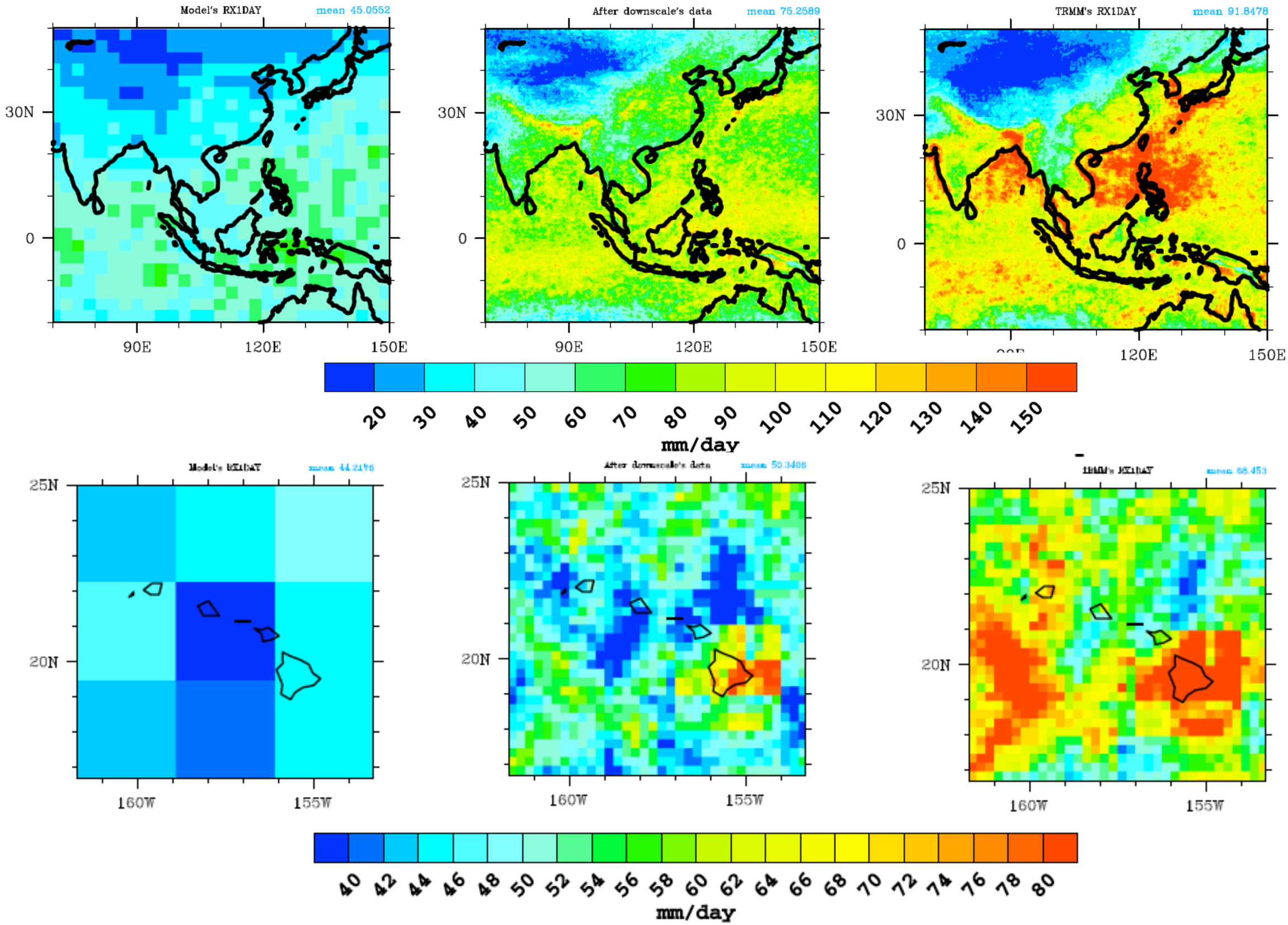
TRMM 0.25° x 0.25°



Model Ensemble Mean
(at model original resolution)

Model Ensemble Mean
Downscaled 0.25° x 0.25°

TRMM 0.25° x 0.25°

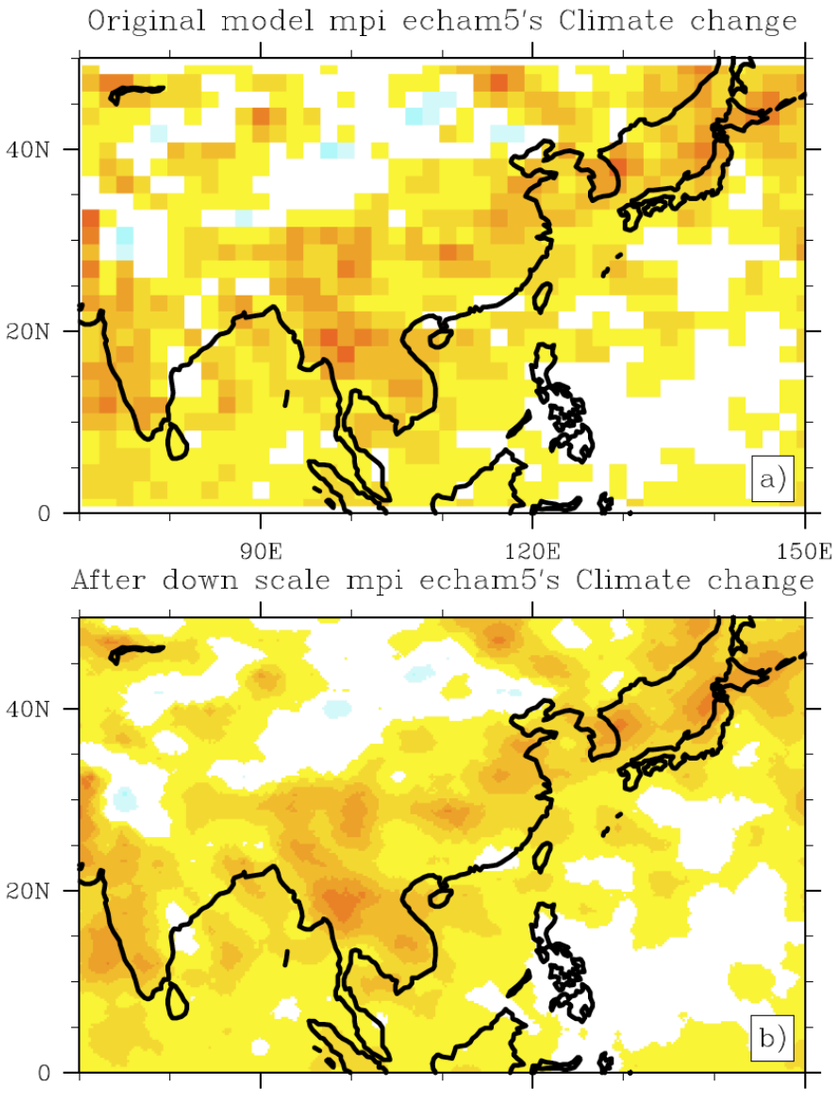


Regionalization of projected future changes in high impact weather and extreme climate indices can be derived while keeping the original spatial pattern.

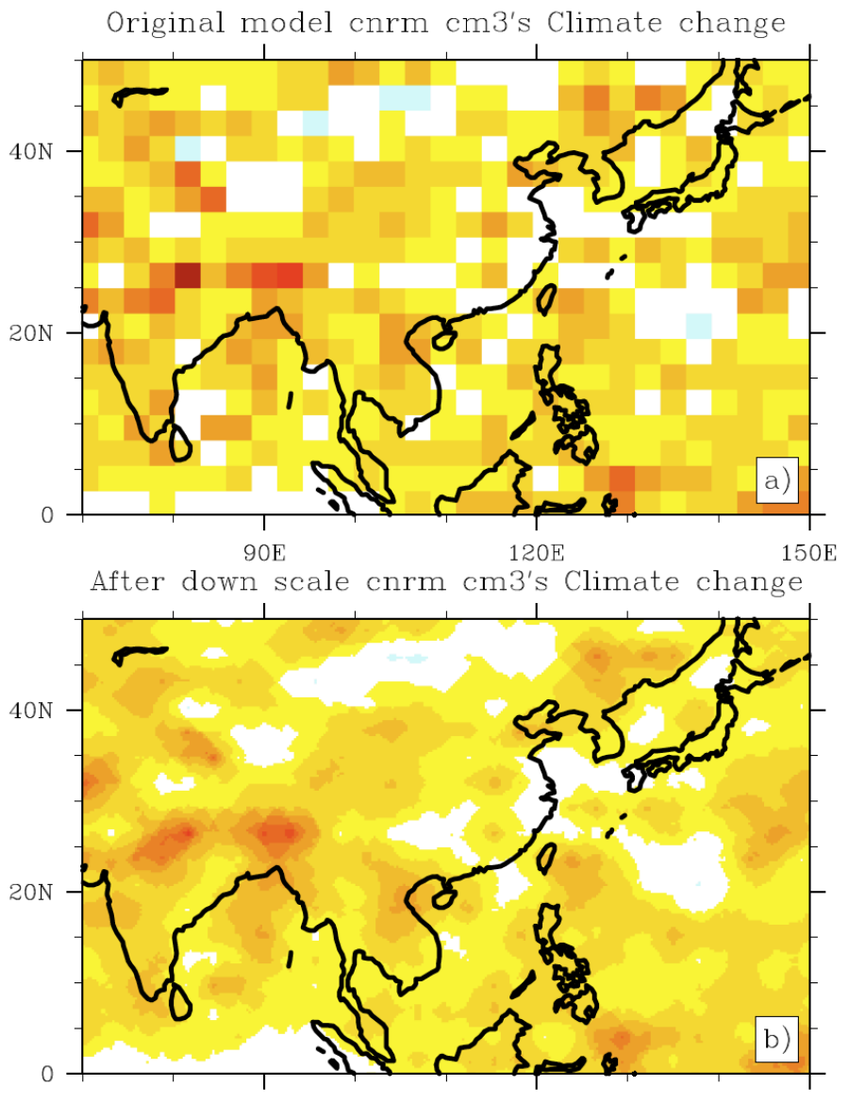
Model projected future change (%) in Rx1day (original resolution)

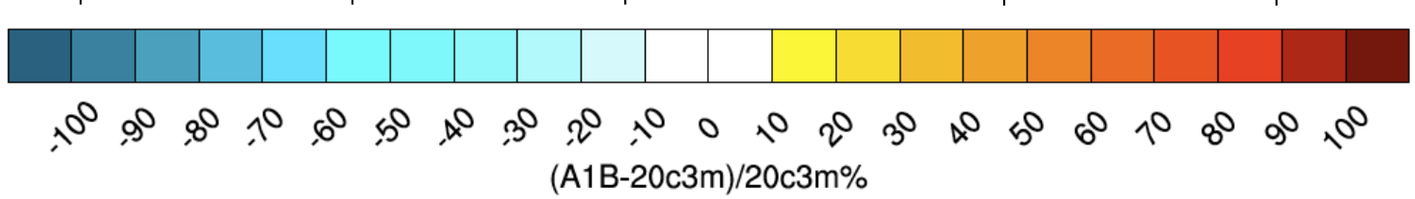
Regionalized to 0.25° x 0.25° resolution

ECHAM5/MPI-OM T63



CNRM CM3 T42





Concluding Remarks

- Spatial scale of daily precipitation data should be carefully considered in the extreme analysis, especially for model validation and comparison.
- While the model precipitation parameterization play important role in determining the simulated extreme daily rainfall amount, the spatial scale dependence of different climate models should be removed by up-scaling the high-resolution models or alternatively by downscaling the model simulation to higher resolution based on observational spatial statistics.
- The majority (not all) of CMIP/IPCC models still tends to underestimate extreme daily precipitation.
- Regionalization of CMIP model simulations and projections on the high-impact weather and climate extremes should be welcomed by climate impact studies which often required detailed local information.
- Limitations: Still need to correct model bias and whether the present observed statistics between different spatial scales stand.