The effect of horizontal resolution on simulation of very extreme precipitation events in a global atmosphere model.

Michael Wehner

Lawrence Berkeley National Laboratory

mfwehner@lbl.gov

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Summary of my talk

- Extreme precipitation
- Continental US
- Asia
- Discussion

(Lots of pictures, a few equations)

Model resolution and extreme precipitation

Typical CMIP3 models are too coarse to simulate rare intense storms.

fvCAM

- **NCAR Community Atmospheric Model version 3.1**
  - **–Finite Volume hydrostatic dynamics (Lin-Rood)**
  - **–Parameterized physics is the same as the spectral version**
- **Approximate resolution at the equator**
  - **–“B” 200km**
  - **–“C” 100km**
  - **–“D” 50km**

GEV cumulative distribution function

$$F(x) = \begin{cases} e^{-[1-k(x-\xi)/\alpha]^{1/k}} & k \neq 0 \\ e^{-e^{-(x-\xi)/\alpha}} & k = 0 \end{cases}$$

$\xi = \text{location}$

$\alpha = \text{scale}$

$k = \text{shape}$

GEV distribution

- GEV theory is well suited for “block maxima”
  - Annual or seasonal maximum of daily averages
- Simple three parameter distribution
  - In limit that the shape coefficient (*k*) becomes zero, the GEV distribution becomes the Gumbel distribution.
  - For climate statistics, as in many natural systems, the shape factor is usually positive. This distribution is often referred to as the Weibull distribution and is bounded.
- In this analysis, all coefficients are considered stationary.
  - Time dependence may actually be important for extreme precipitation.

GEV Return Value

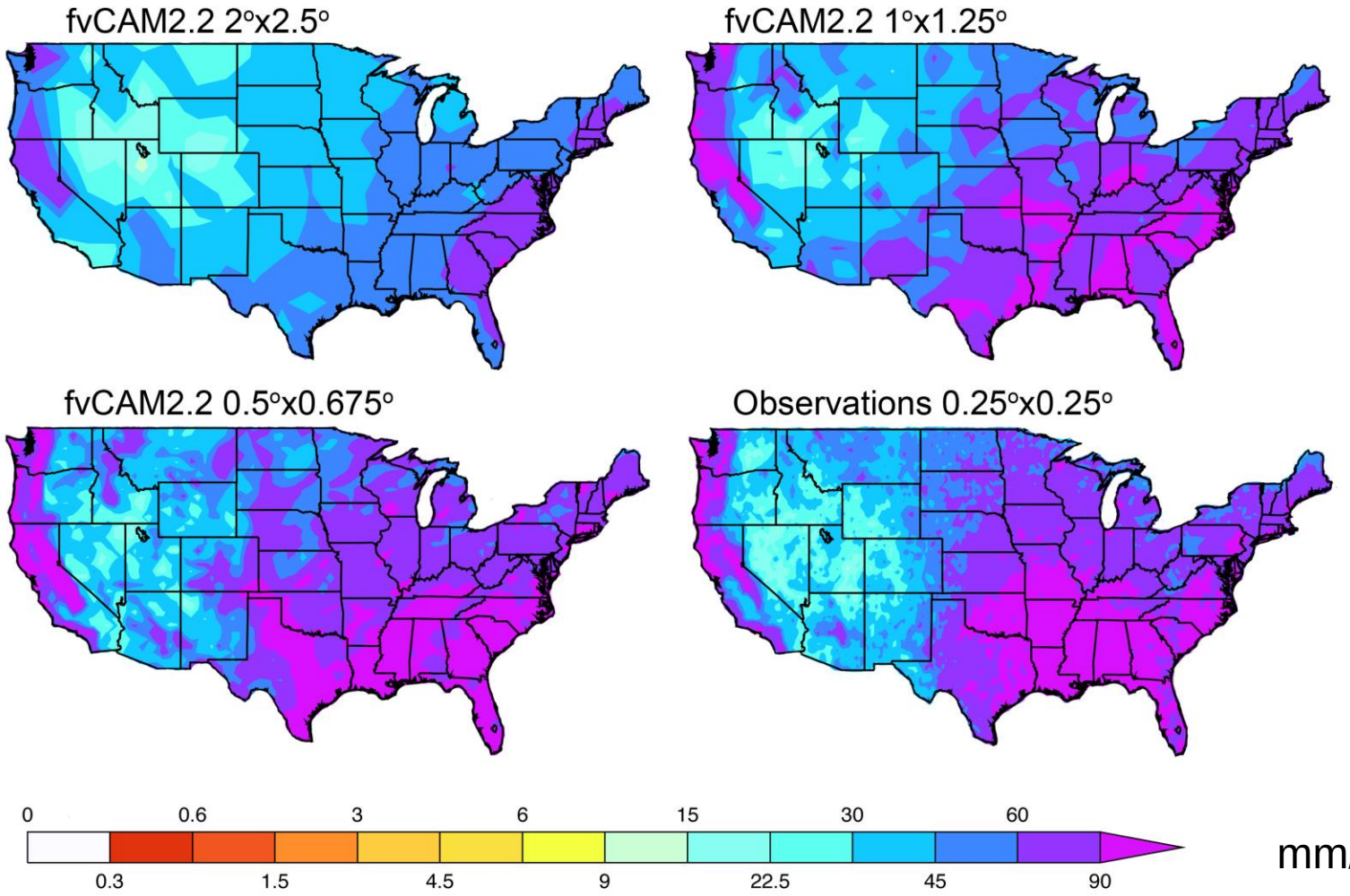
- The return value of a random variable, X_T is that value which is exceeded, on average, once in a period of time, T

- For the generalized extreme value distribution:

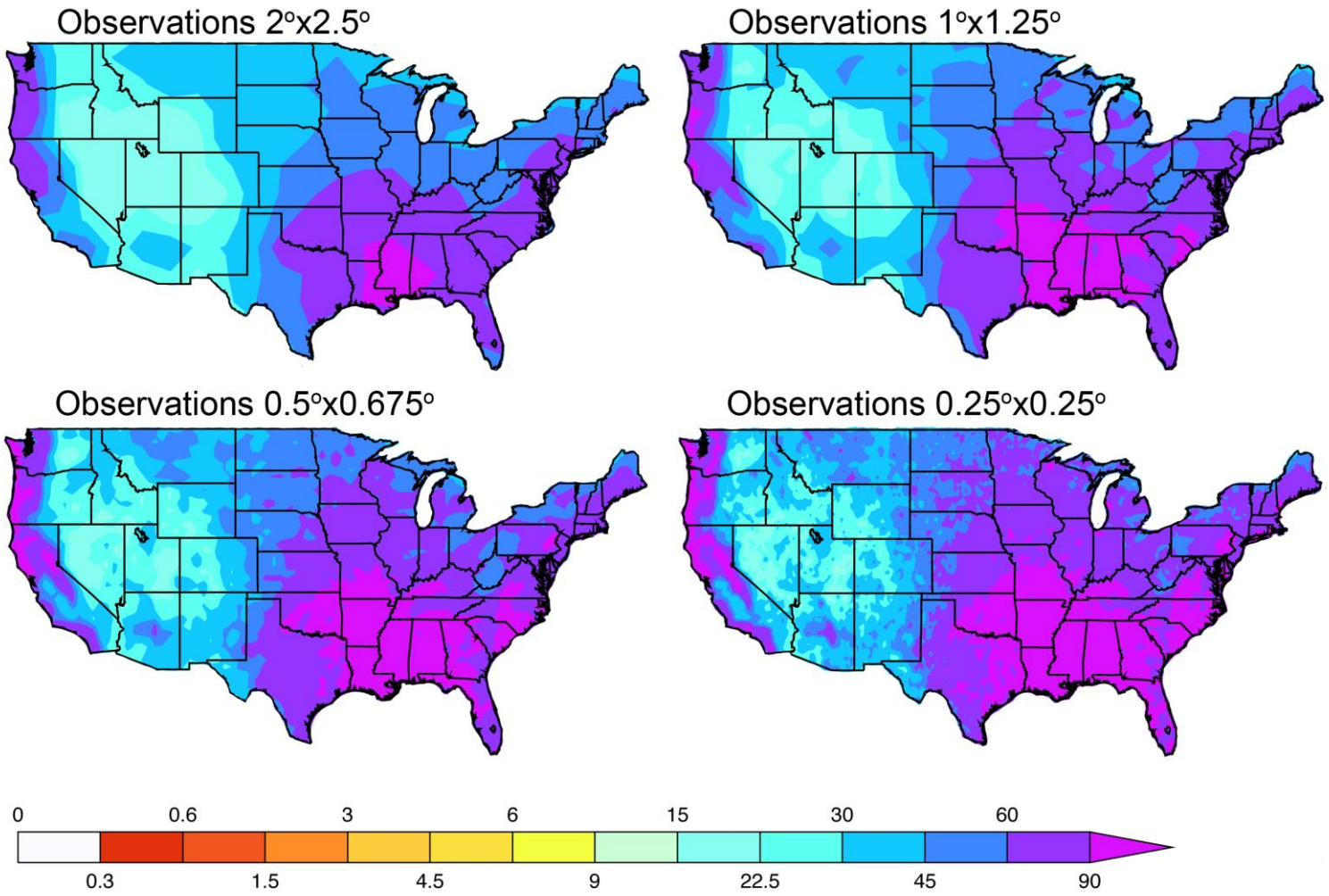
$$X_T = \begin{cases} \xi + \alpha[1 - \{-\ln(1 - 1/T)\}^k / k & k \neq 0 \\ \xi - \alpha \ln(-\ln(1 - 1/T)) & k = 0 \end{cases}$$

Model resolution and extreme precipitation

- **20 year return value of annual maximum daily total precipitation**

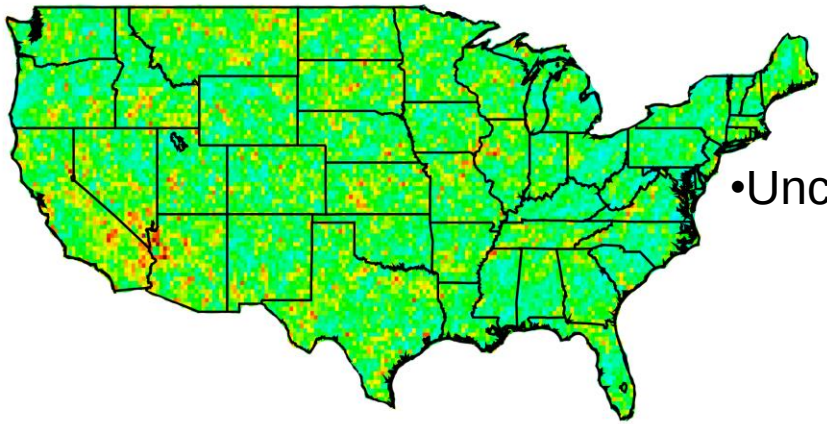


Regridded observed extreme precipitation

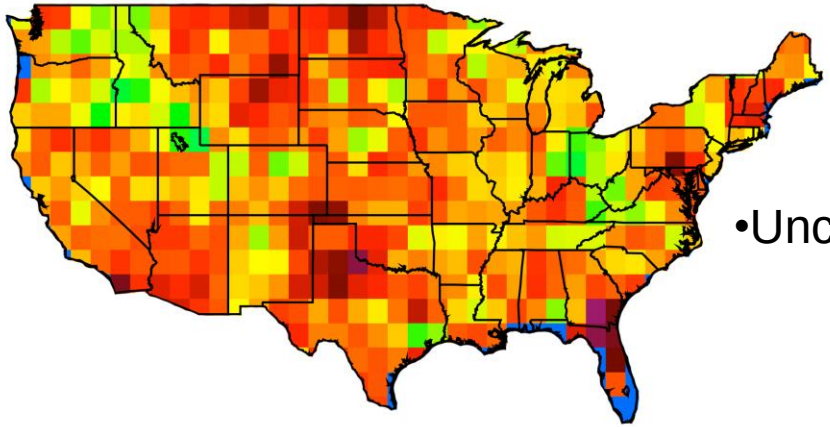


Uncertainty in annual precipitation 20 year RV

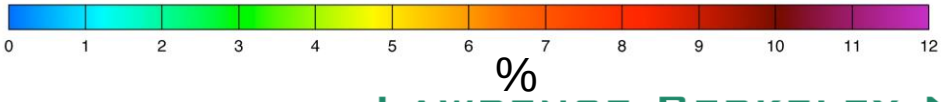
Width of 95% confidence interval



•Uncertainty in the statistical model
  •50km



•Uncertainty from internal variability
  • 600 year control run
  • T85 CCSM3.0



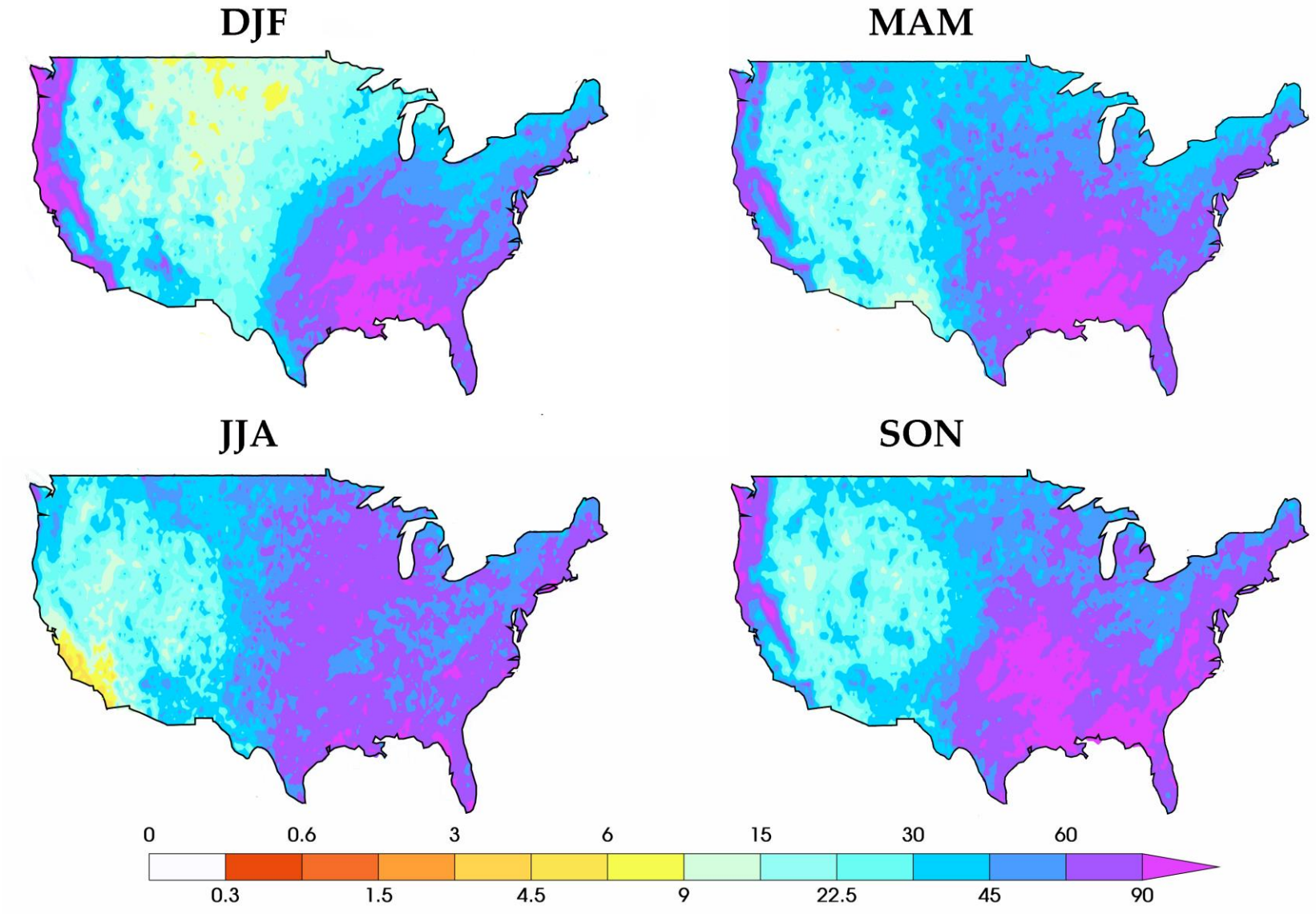
Seasonal cycle

- Arguably, the seasonal maxima are more relevant than annual maxima
  - –Winter storms have different causes than summer storms
  - –Impacts vary greatly seasonally. (Snow?)

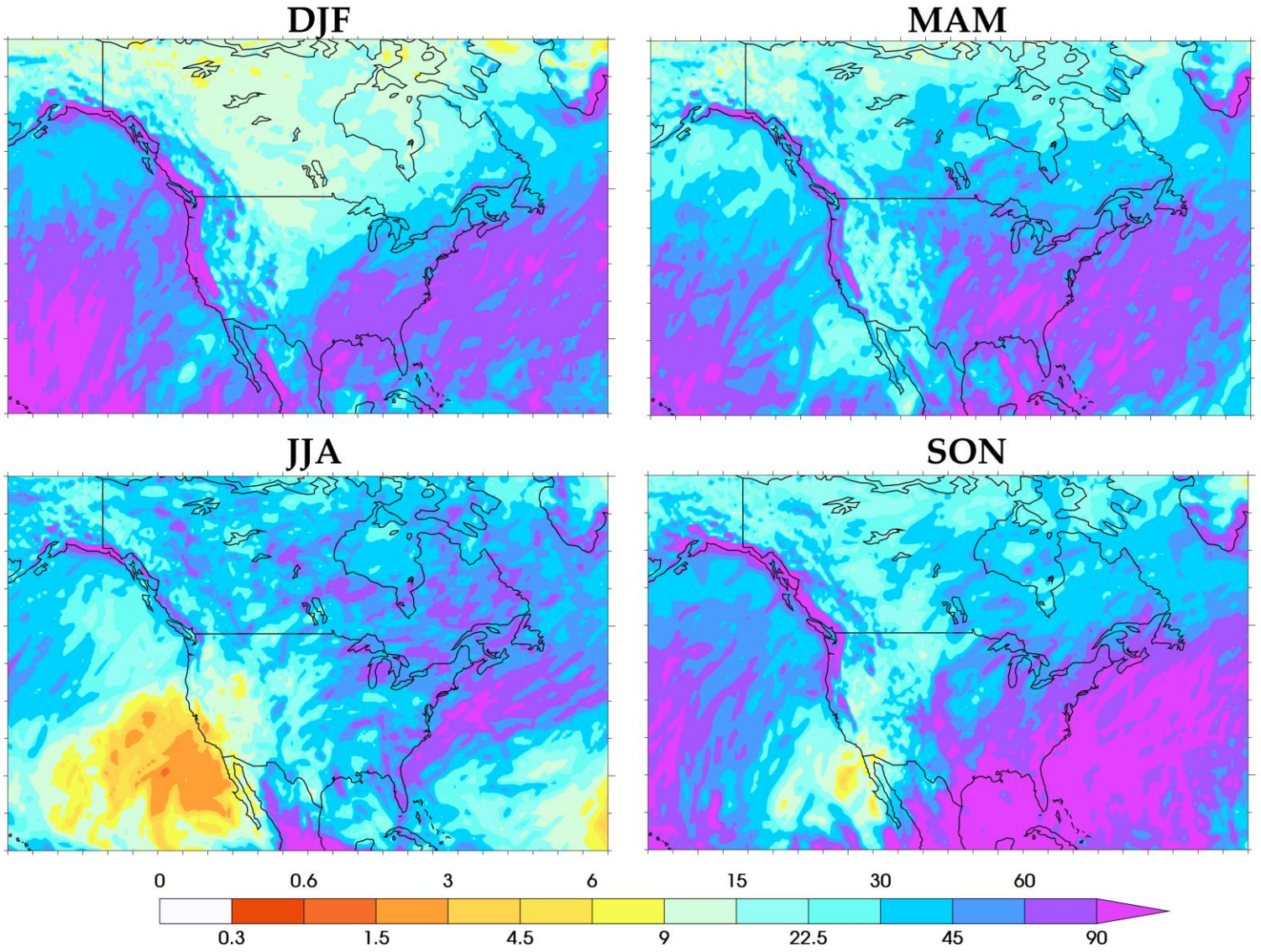
- The seasonal cycle of extremes appears to be difficult for some models.

- fvCAM2.2 (global)
- NARCCAP (a regional multi-model experiment)

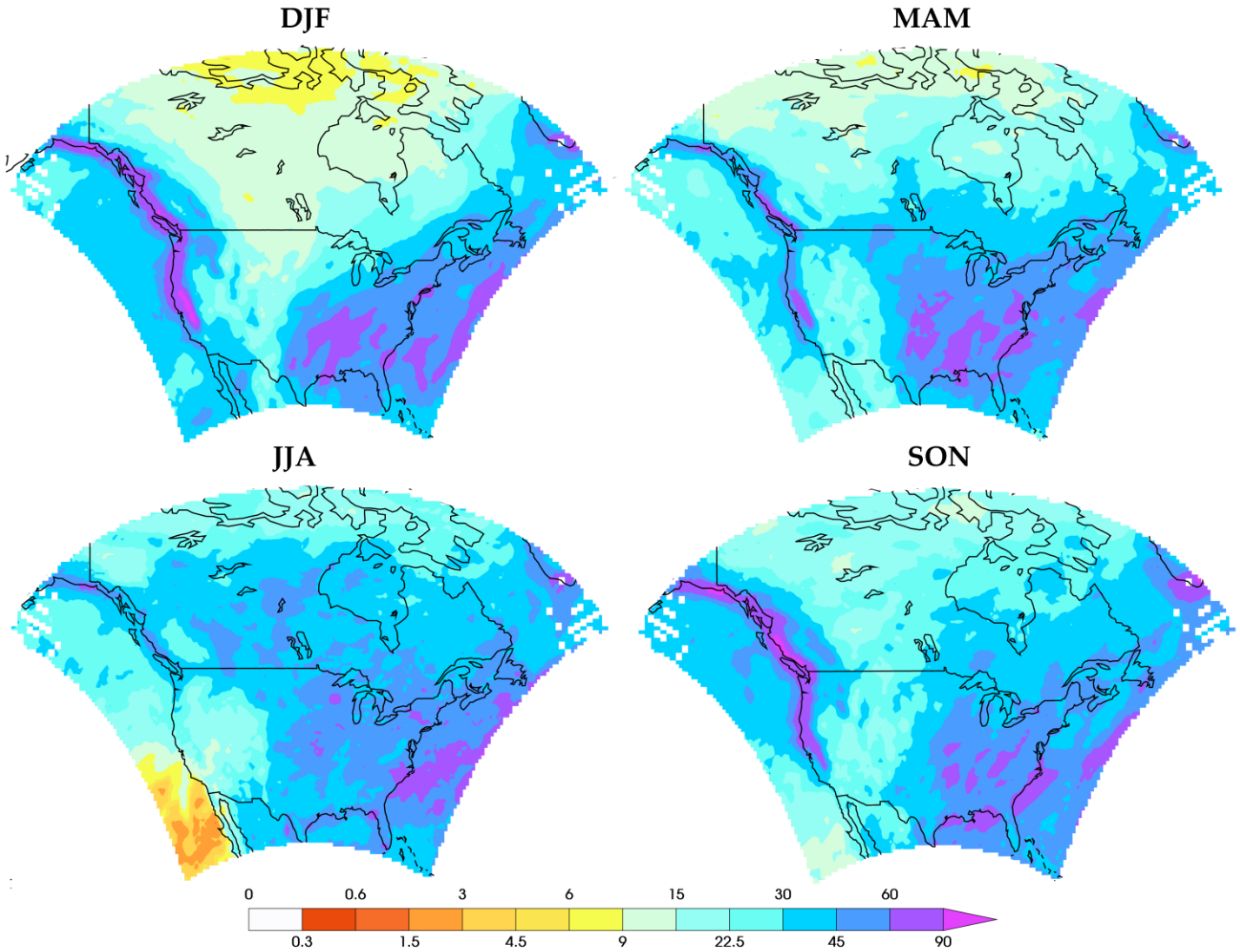
Observed seasonal RV



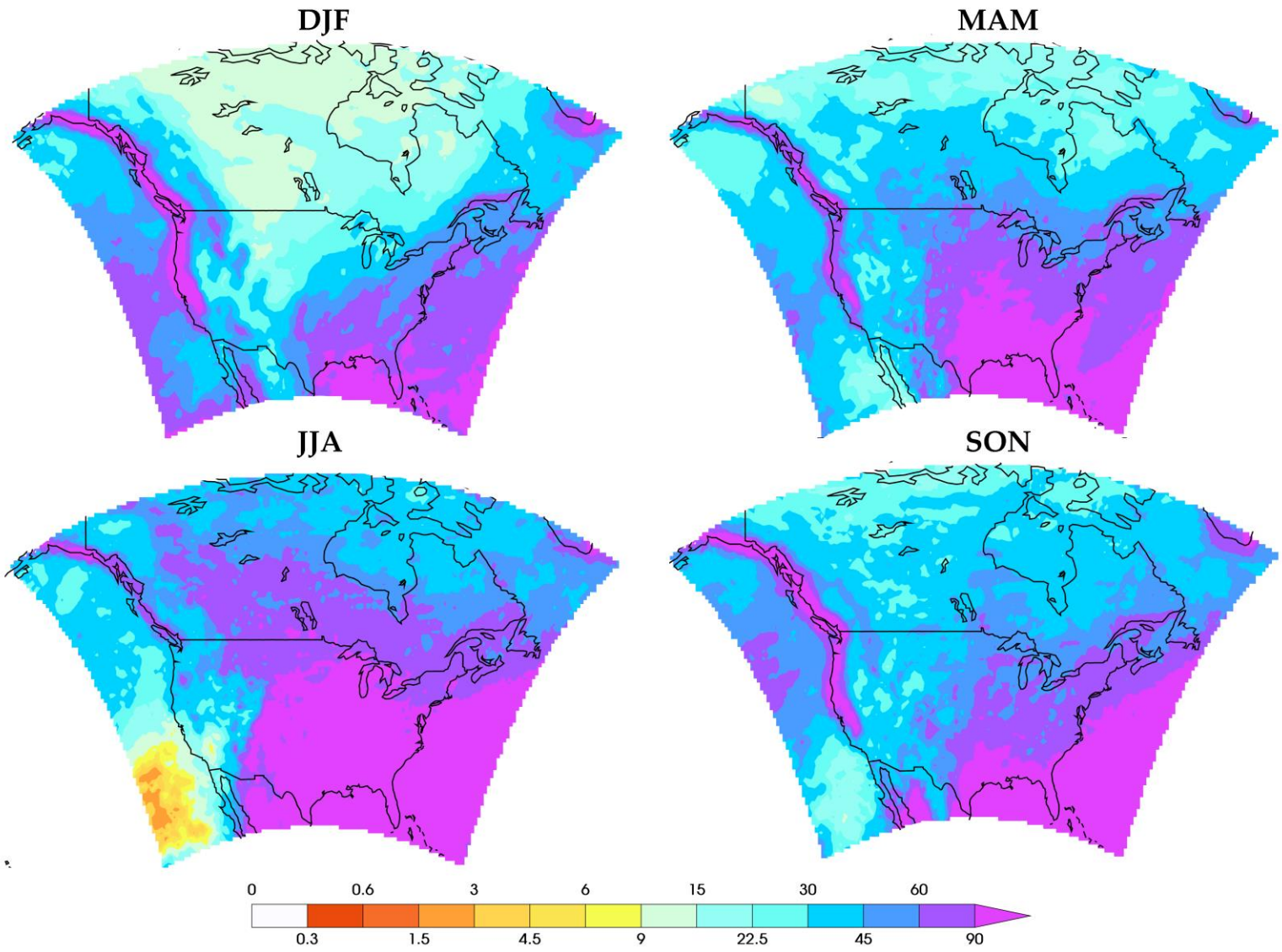
fvCAM2.2



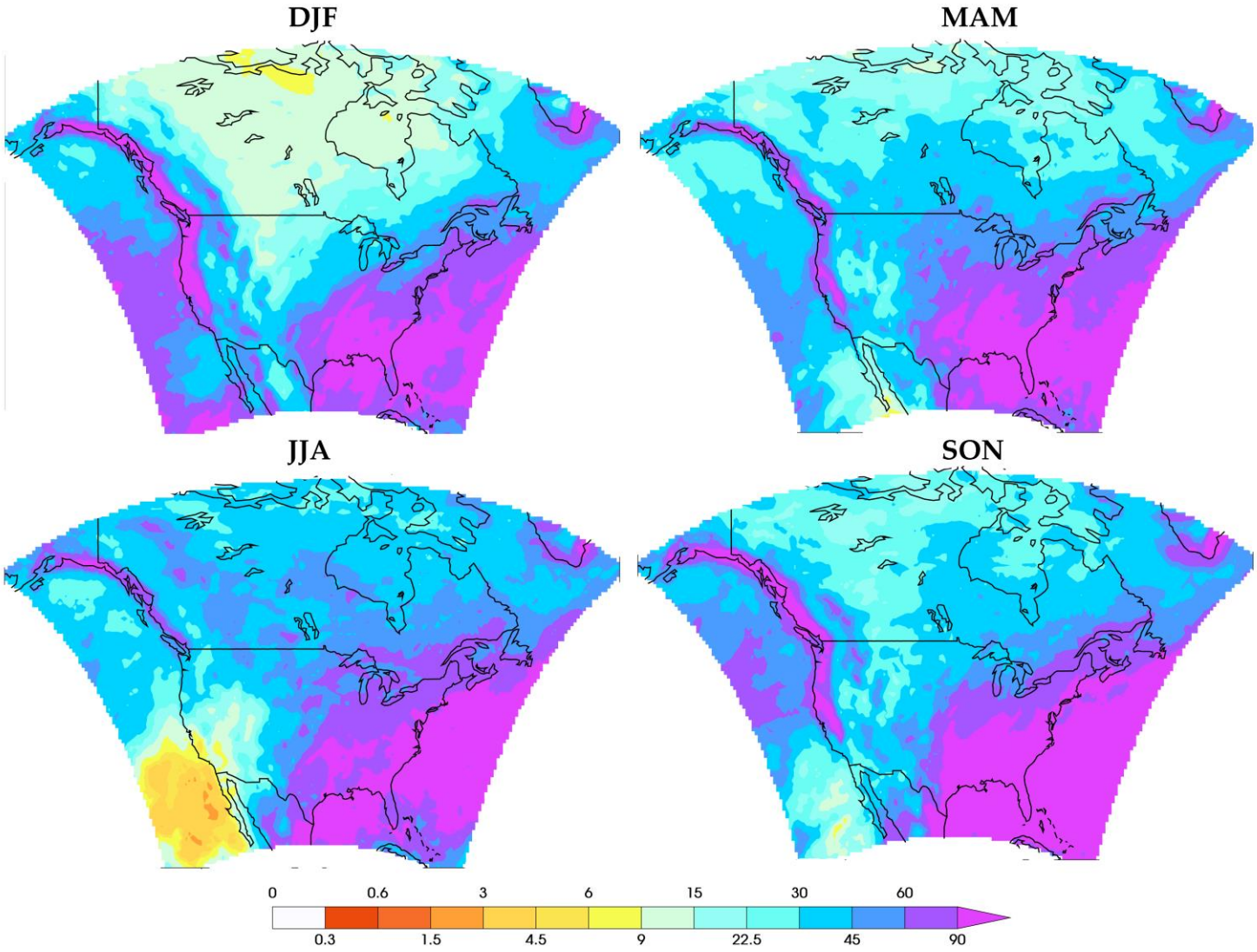
CRCM



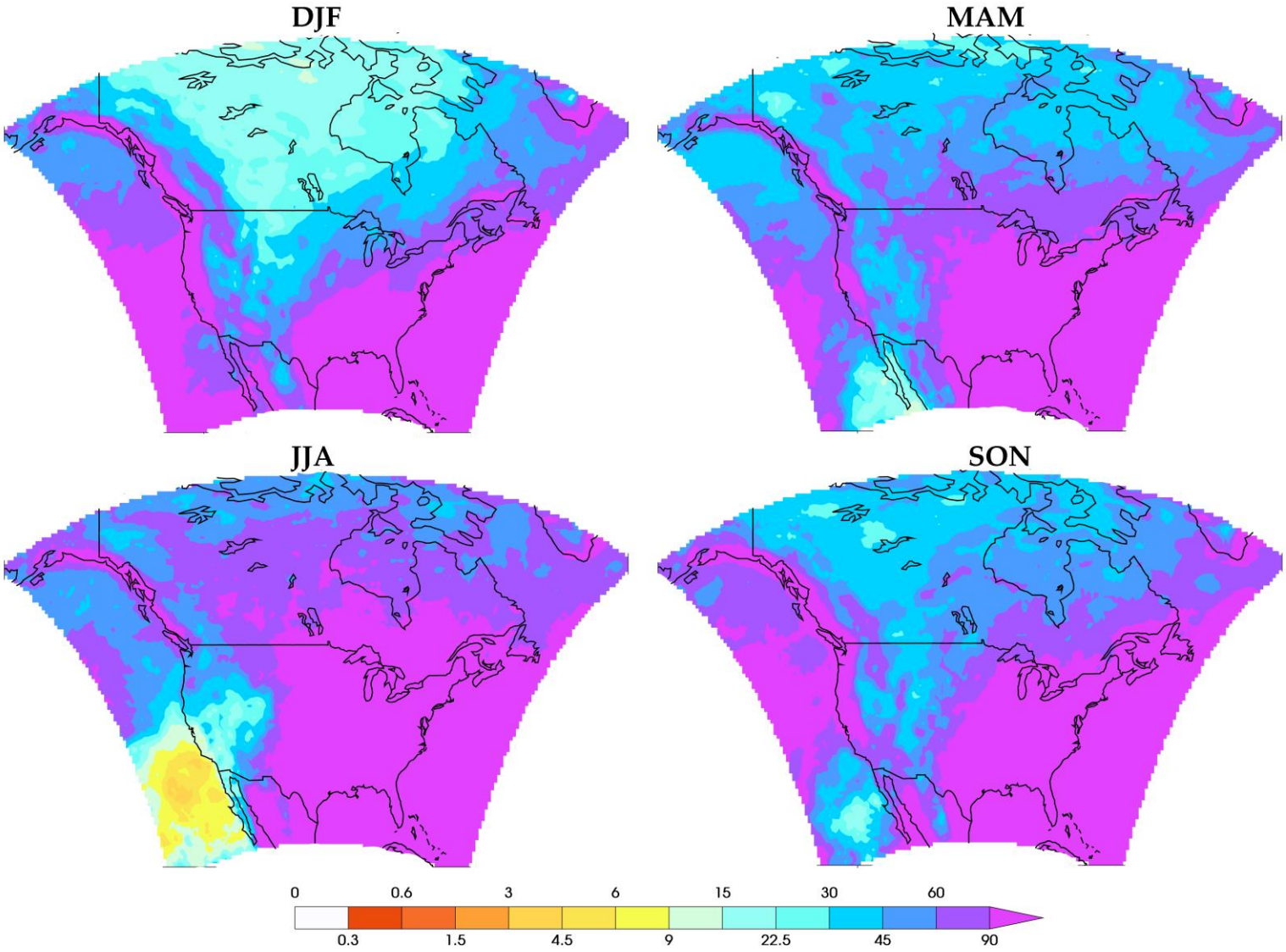
RCM3



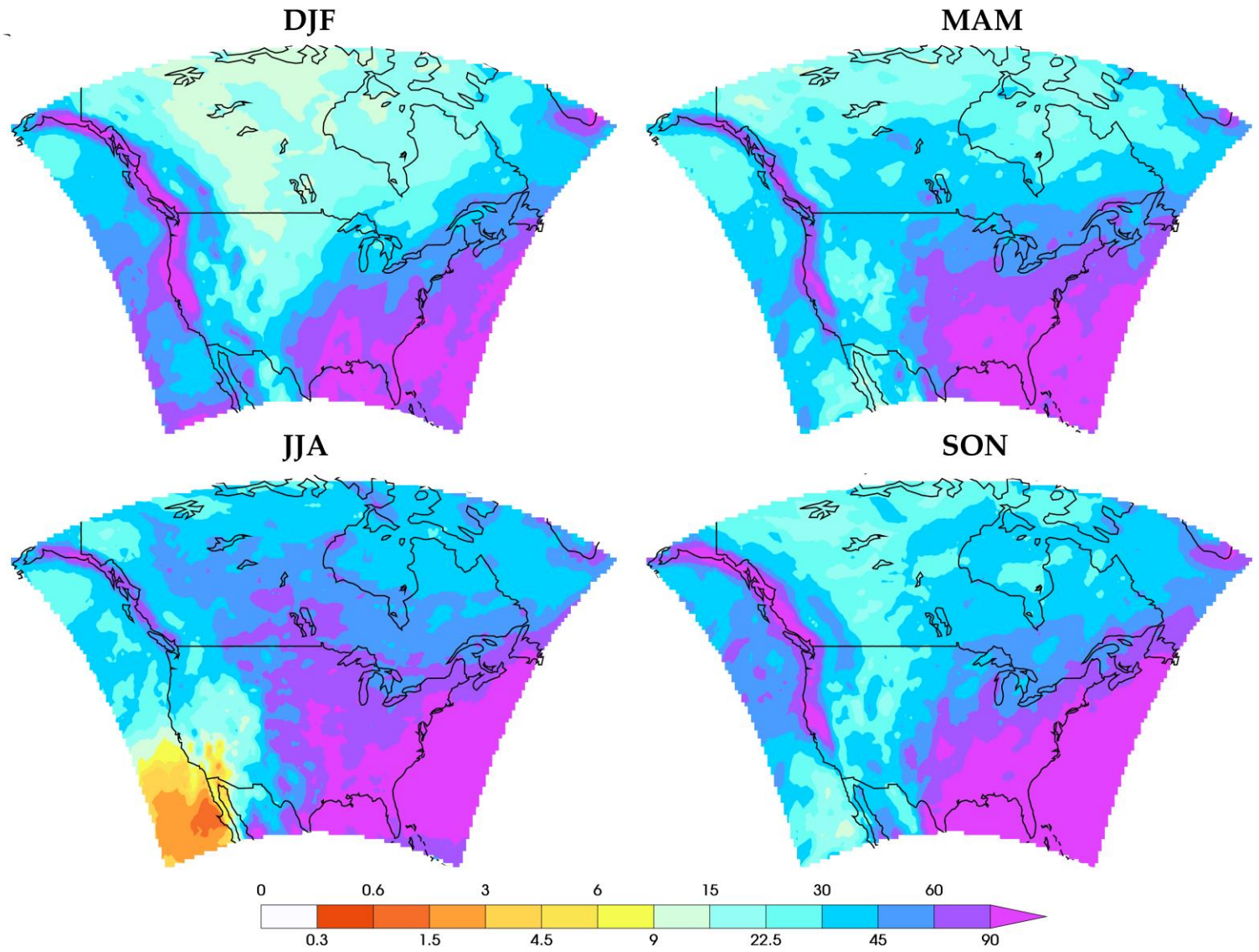
WRFP



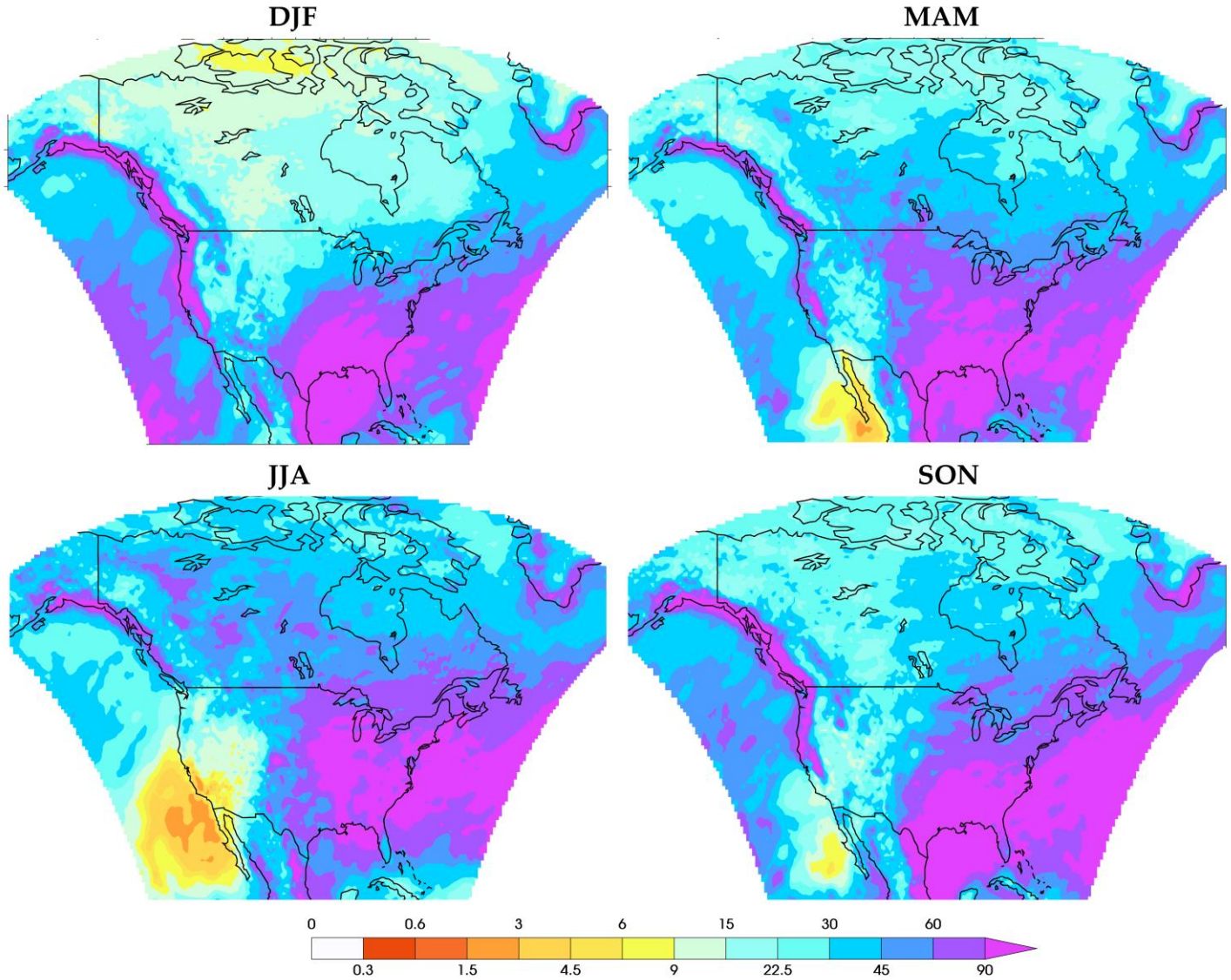
WRFG



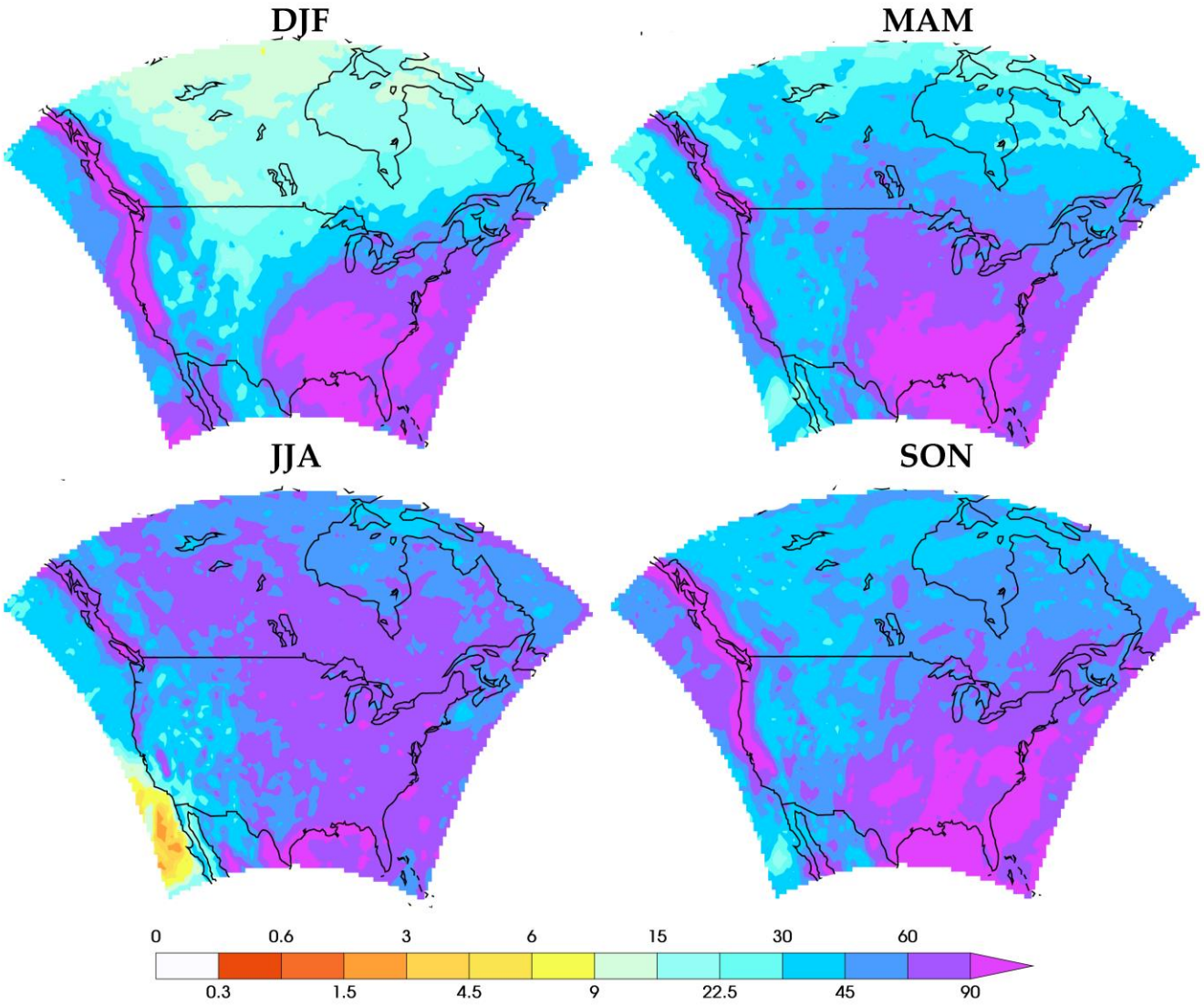
MM5I



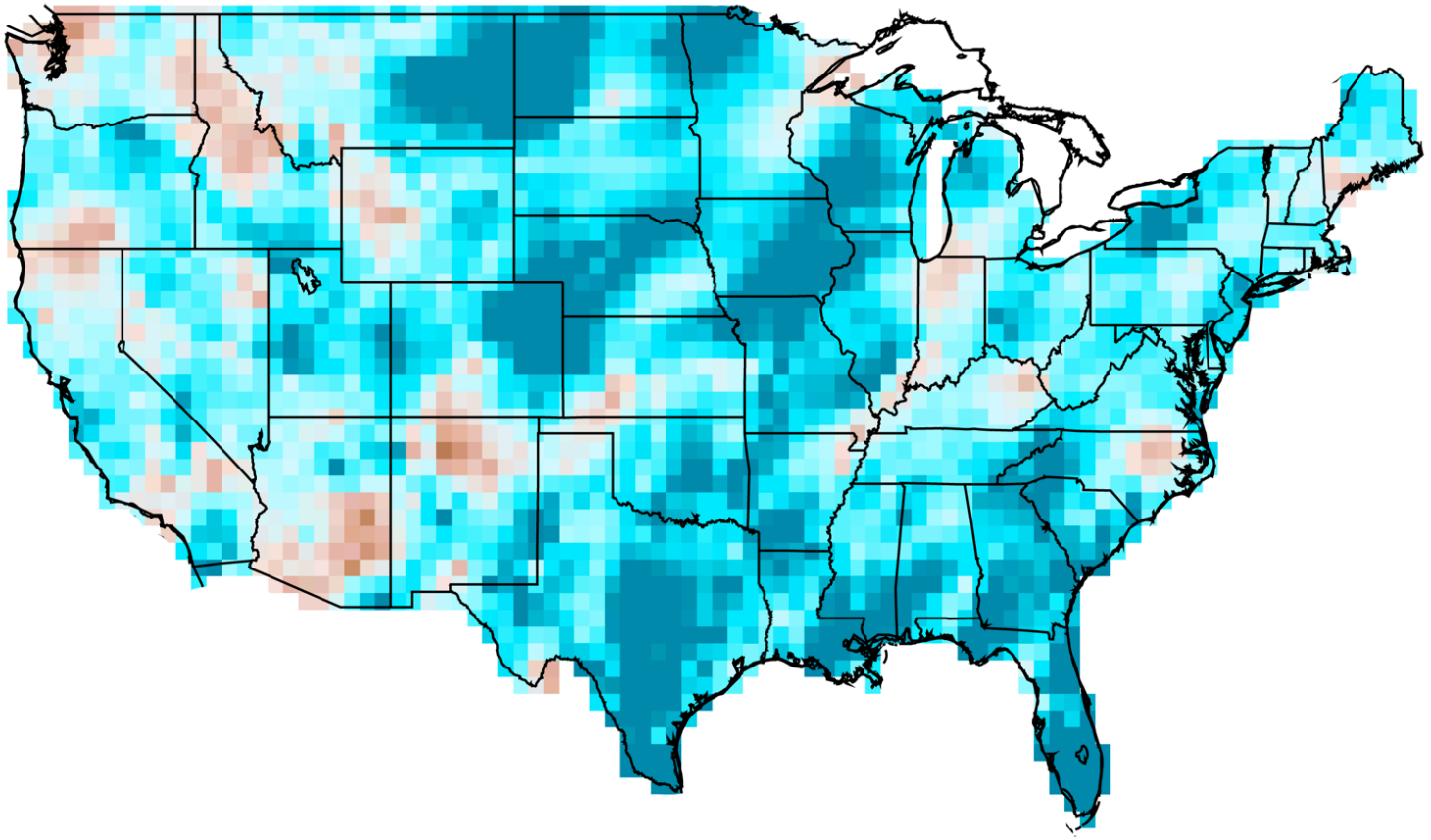
HRM3

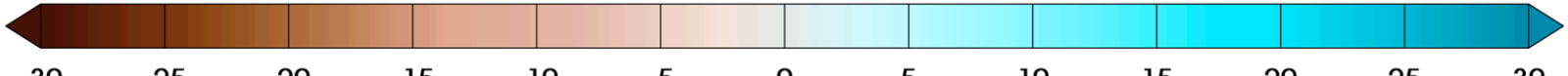


ECPC

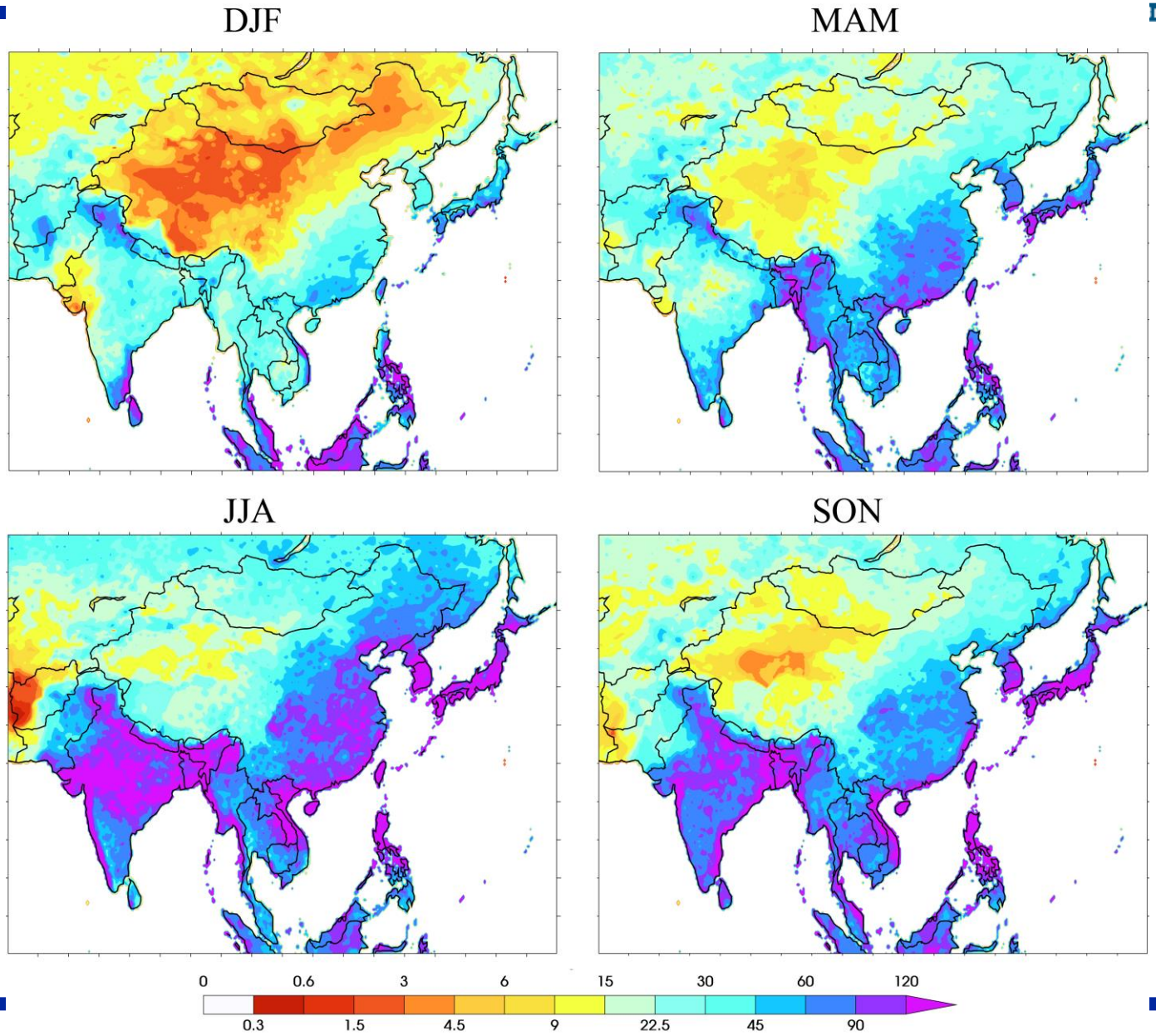


DJF % change RCM3

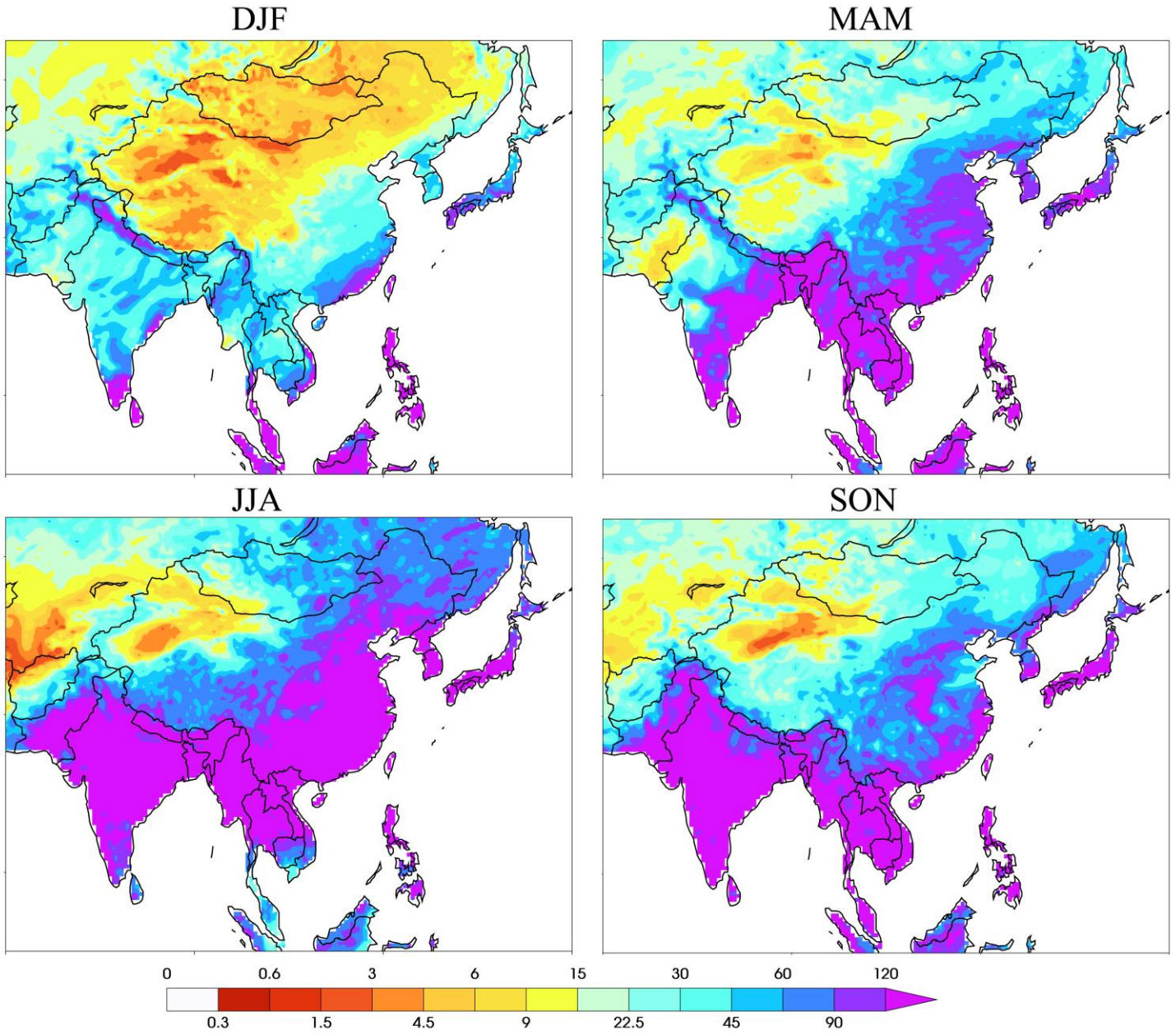




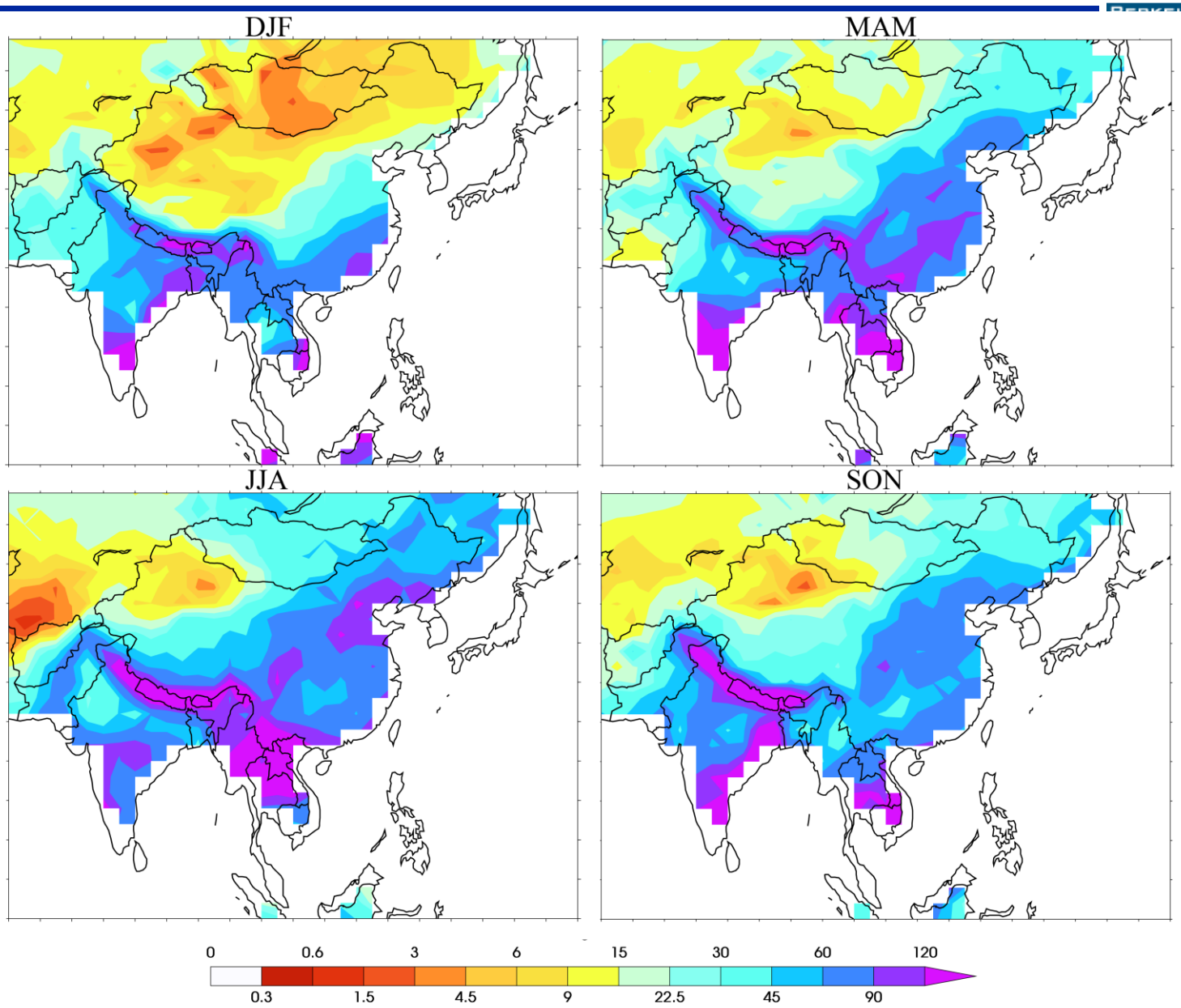
APHRODITE Observations



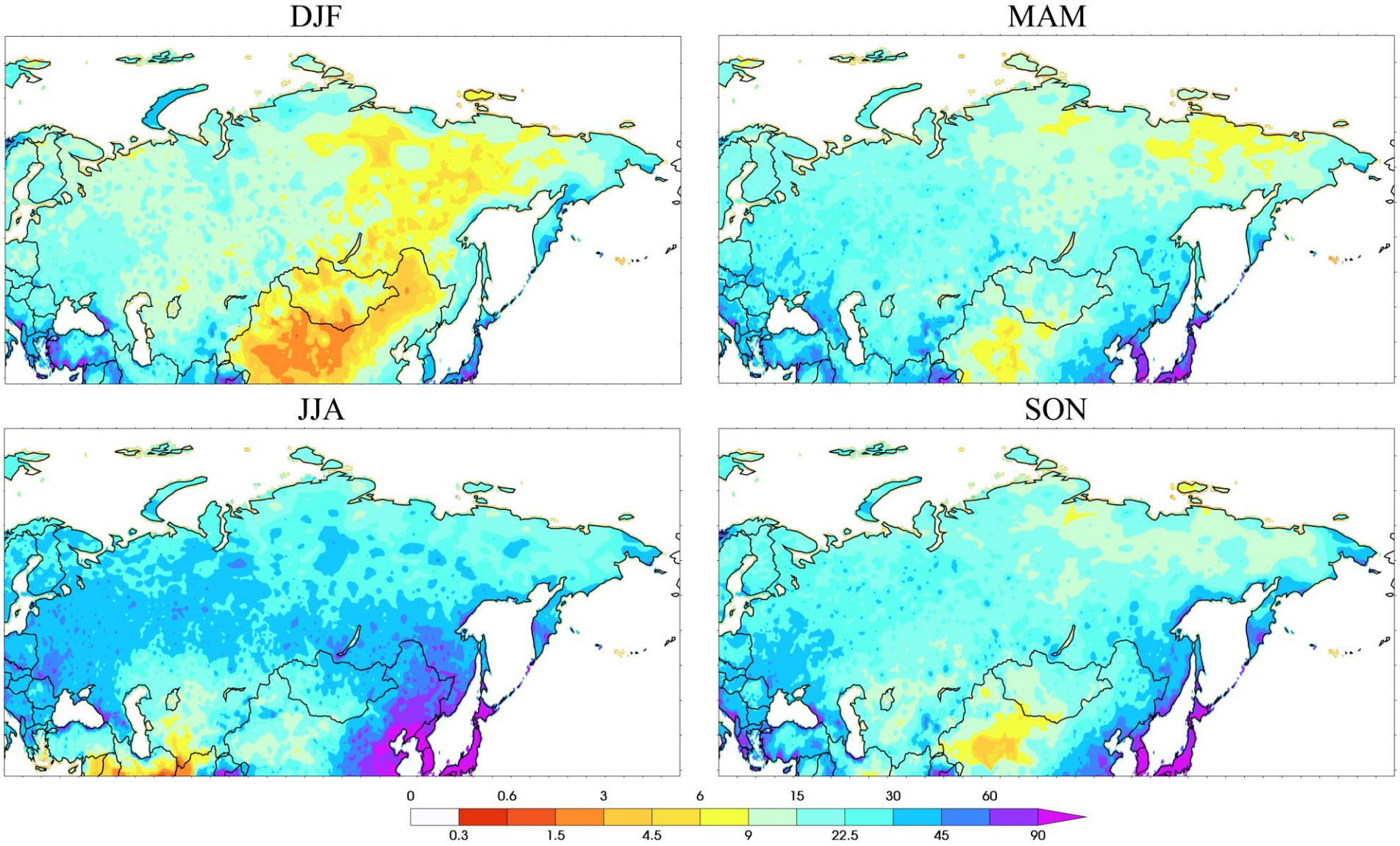
fvCAM2.2 0.5º X 0.625º



fvCAM2.2 2º X 2.5º



APHRODITE Observations



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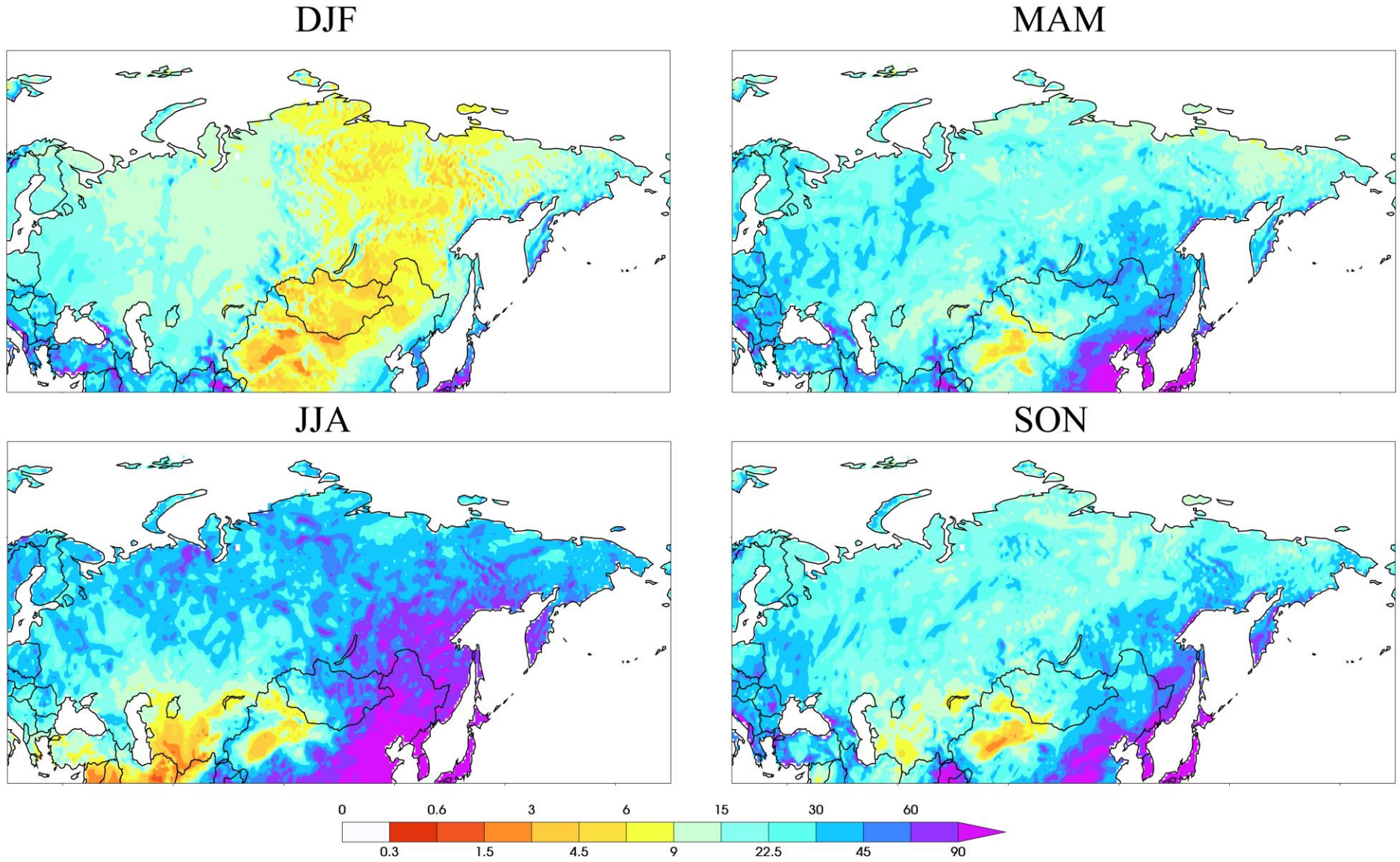

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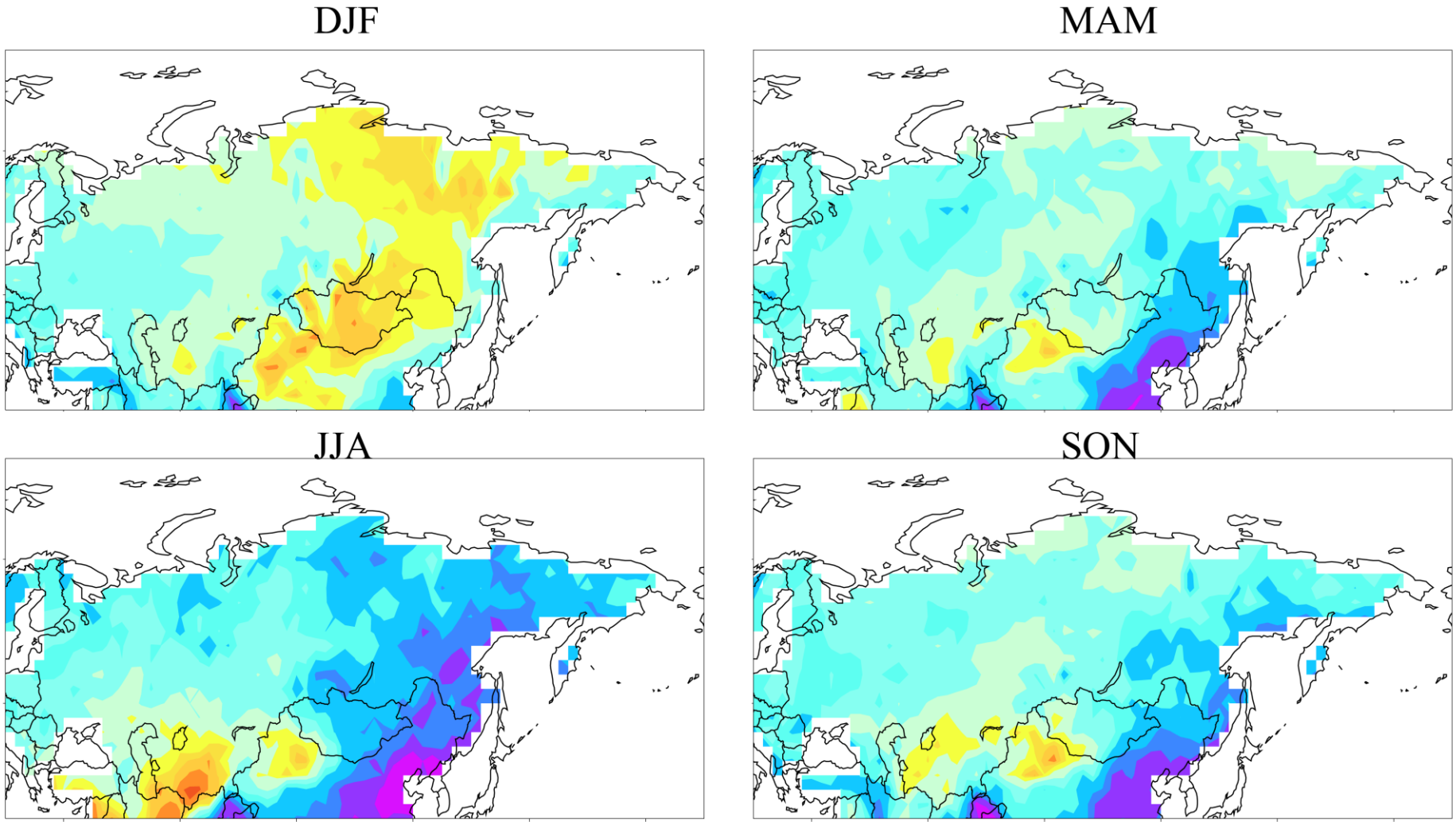

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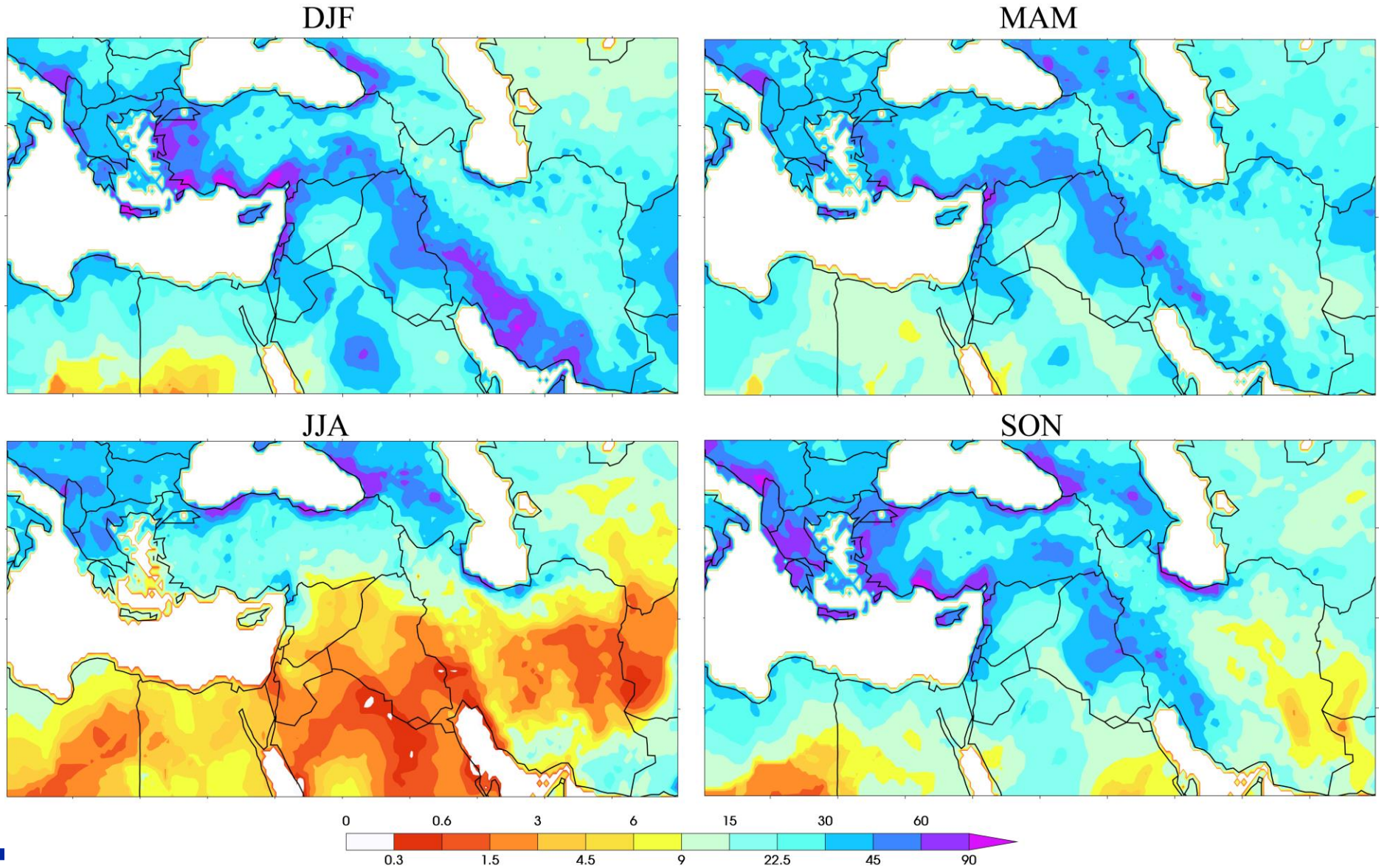

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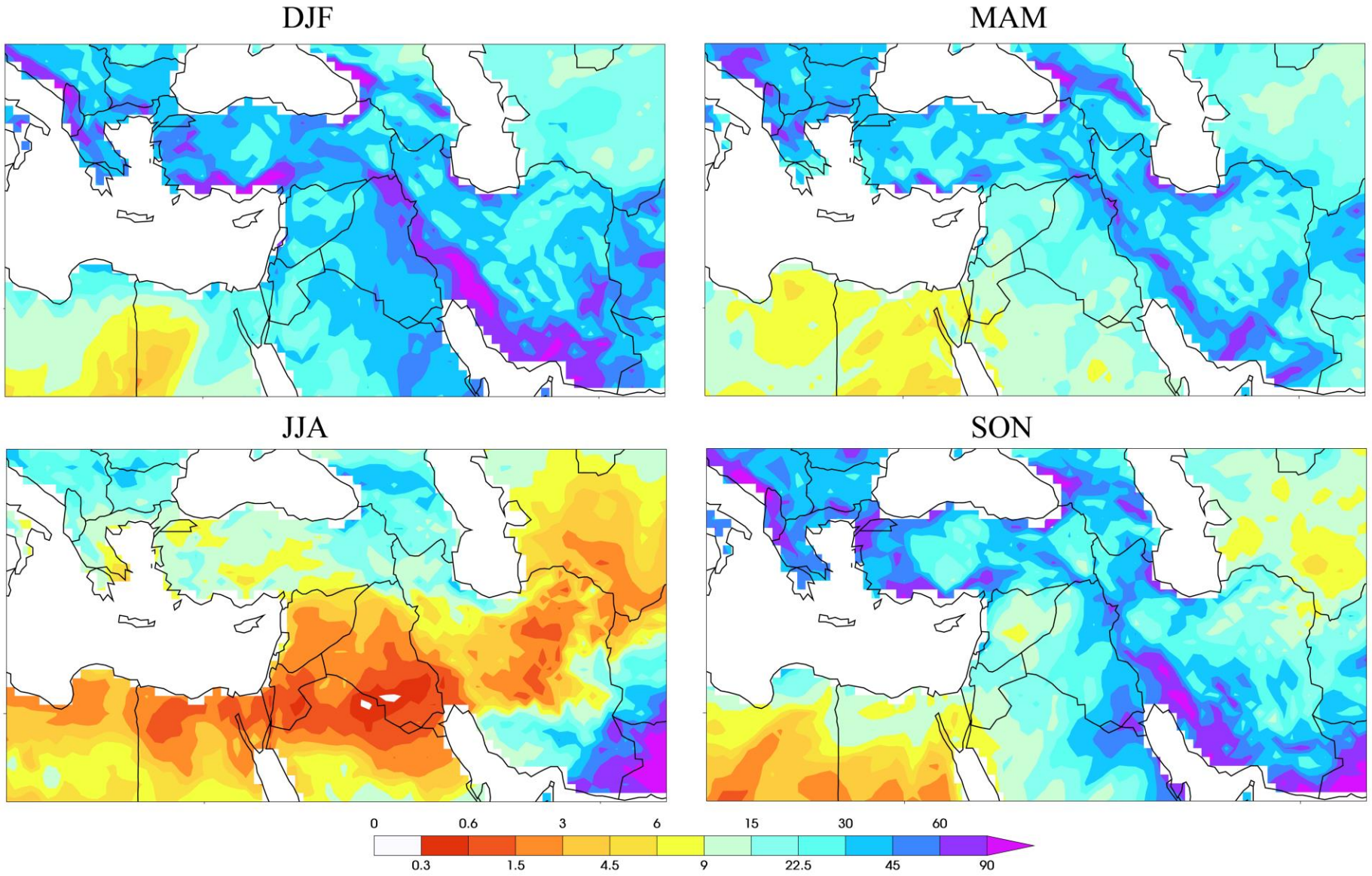

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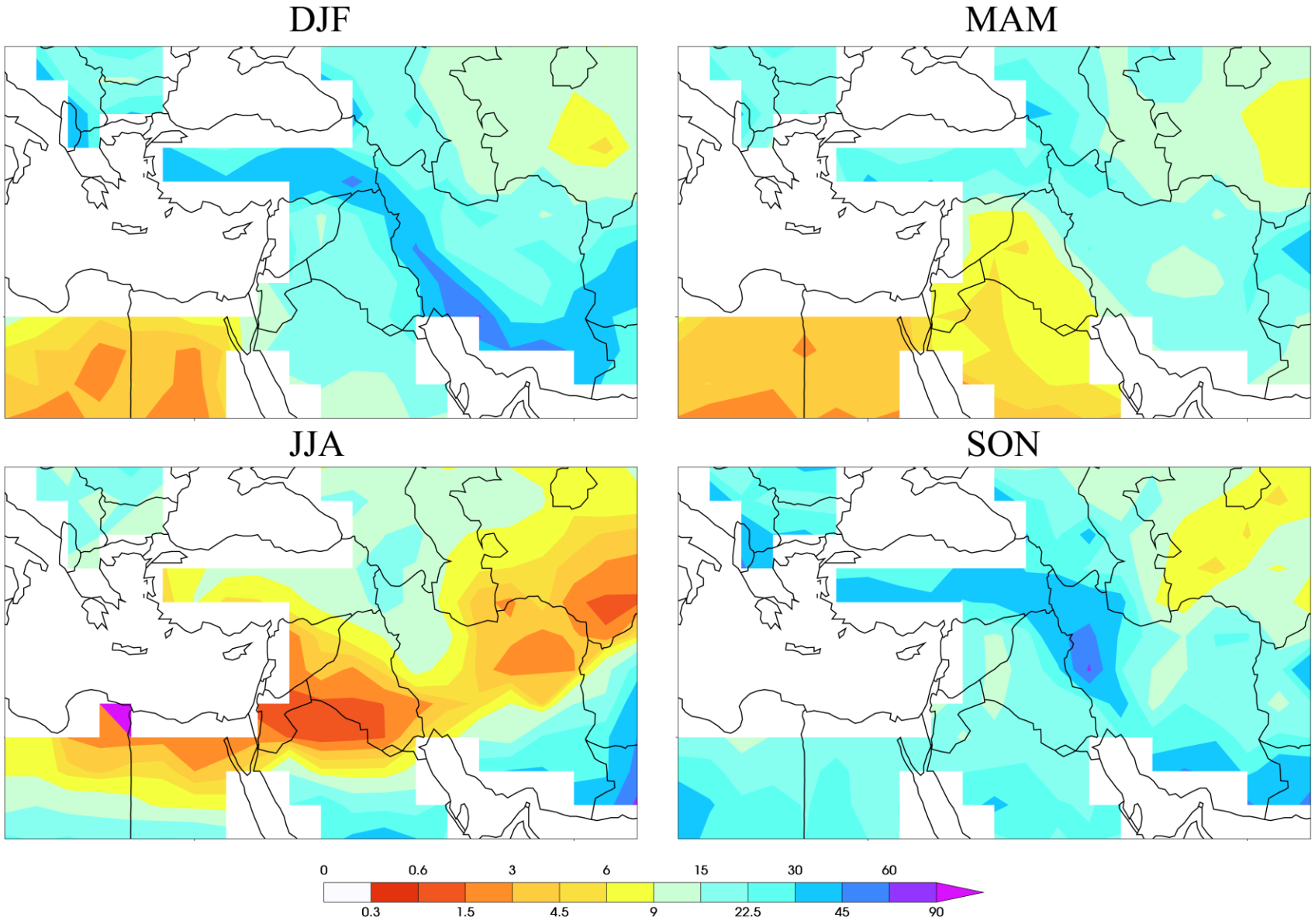

Summary (Part 1 models)

- Uncertainty from different models is relatively large.
  - Internal variability causes more uncertainty than the statistical models. Multi-model uncertainty is almost certainly very large.
- Resolution is important for simulating precipitation extremes especially where orography matters.
  - –but is not everything!
  - –Computing advances are helping.
  - –Large biases in some NARCCAP experiments
  - –Seasonal cycle is not well replicated in most
- Validation and observations?
  - –Sparse obs?

Summary (Part 2, observations)

- What is the best way to grid precipitation station data?
  - –May not be the same for mean vs. extremes?
- Consider NOAA and APHRODITE data sets, both from 0.25º daily datasets.