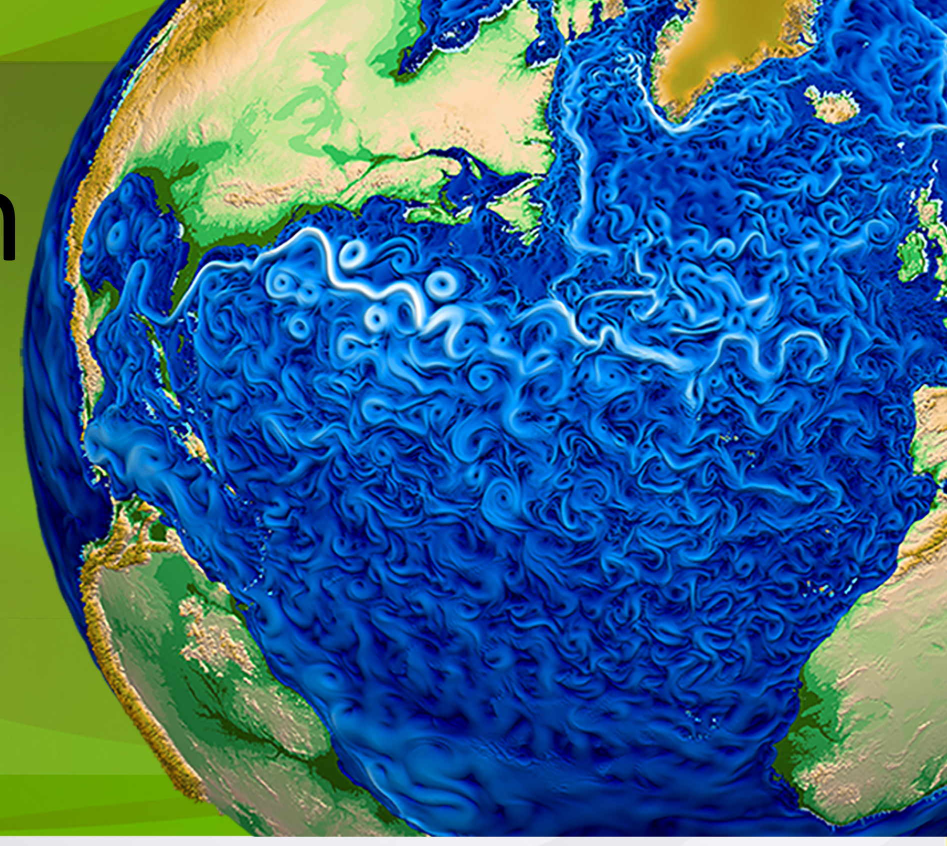

R: Fidelity of Precipitation Extremes in High Resolution Global Climate Model Simulations

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Objective

We evaluate stationary and non-stationary statistics of precipitation extremes in low and high resolution climate simulations.

We compare Generalized Extreme Value (GEV) distribution parameters between simulations and observations.

We use a region-of-influence regionalization framework to improve sampling of extremes.

We apply a parallel implementation of the alogrithms in Python to analyze Big Data.

Approach

Data and Simulations:

NOAA Climate Prediction Center (CPC) Gauge-based Unified Daily Precipitation Data: Optimally Interpolated to quarter degree resolution.

NASA MERRA Reanalysis: 0.5°x0.67°

CAM4 T341 (quarter degree) and T85 (one degree) simulations from the High-Res project: 5 member AMIP ensemble for the period 1979-2005

Generalized Extreme Value (GEV) Distribution:

Annual maximum of daily precipitation is assumed to follow a GEV distribution:

$$G(z) = \exp\left\{-[1+\xi(\frac{z-\mu}{\sigma})]^{-1/\xi}\right\}$$

where μ, σ and ξ represent the location, scale and shape parameter respectively.

Non-stationarity is captured by a linear time-dependent (or some other index) parameter in μ

$$\mu = \mu_0 + \alpha t$$

The parameters are estimated by using the maximum likelihood method, which maximizes the probability of the occurrence of each of the annual maximum values in *G(z)*

Regionalization Framework:

We exploit climate homogeneity to determine region of influence for each grid box.
Two grid boxes are assumed to have a homogeneous climate if they satisfy all of the following:

- The distance between them is within the length scale of daily precipitation (300km here)
- Their means are statistically equal
- They exhibit statistically significant correlation in the daily anomalous precipitation time-series

Annual maximum of each grid box is computed as the annual maximum precipitation among all the grid boxes within its region of influence.

Impact

Stationary Extremes:

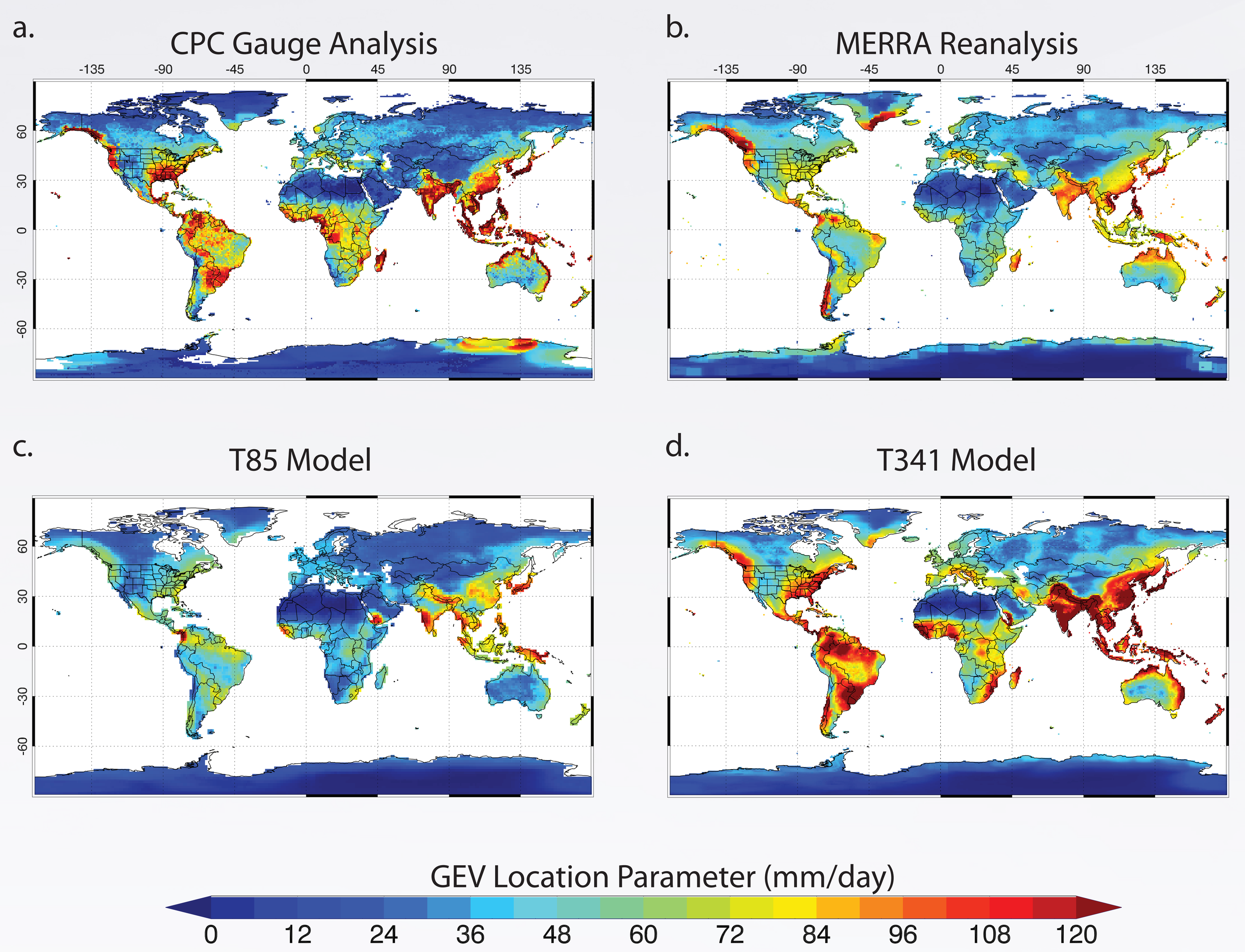

Figure 1: GEV location parameter. GEV location parameter for (a) CPC data (b) MERRA reanalysis (c) T85 and (d) T341 model ensemble

Non-stationary Extremes:

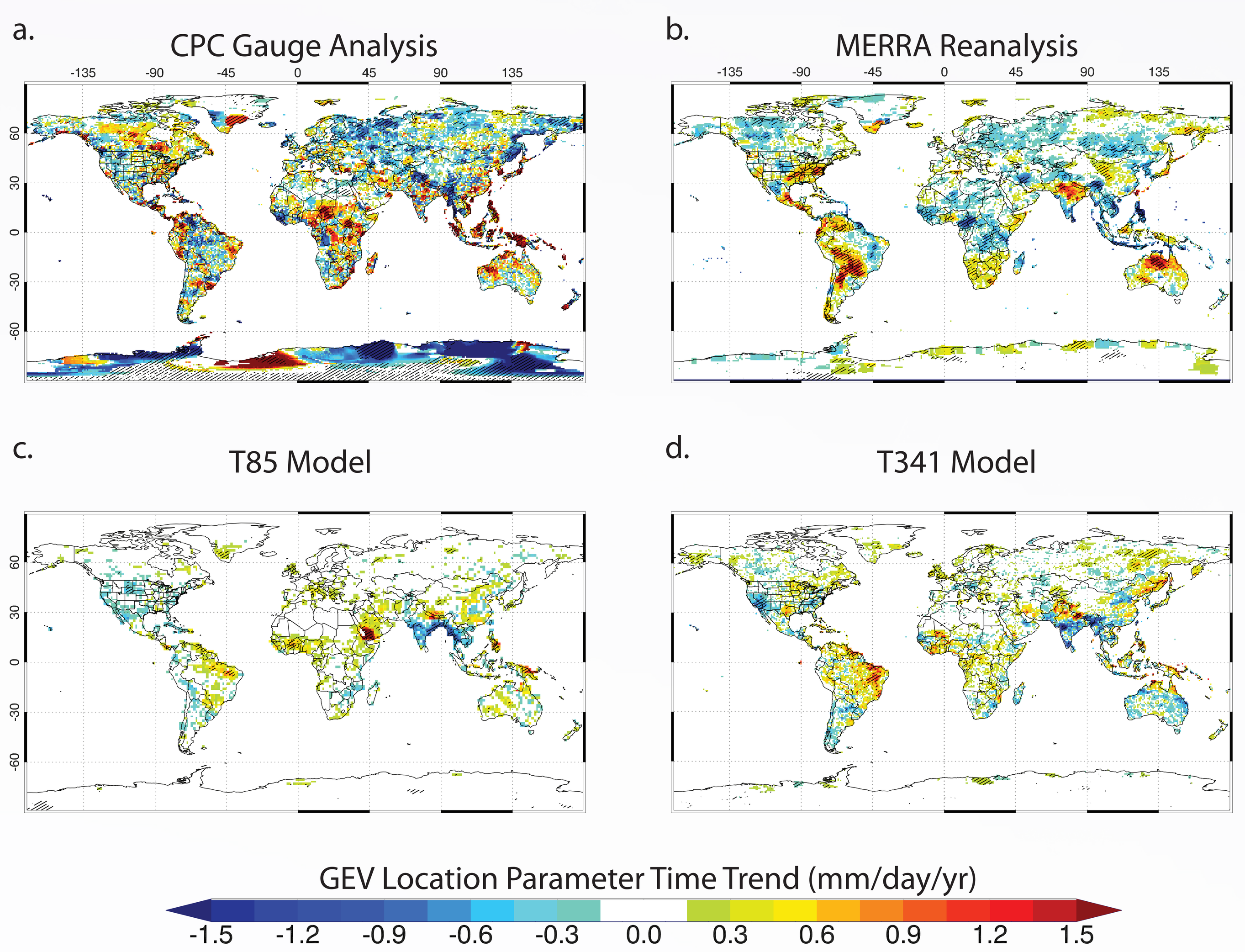

Figure 2: Time trend of GEV location parameter. Rate of change of the GEV location parameter with time for (a) CPC data (b) MERRA reanalysis (c) T85 and (d) T341 model ensemble

Summary:

Parallel implementation on a distributed memory architecture (Rhea) resulted in ~100x speedup.

High resolution model generally shifts the GEV pdf to the right, better capturing extremes.

Very few regions exhibit non-stationarity in precipitation extremes in the CPC gauge analysis. Model simulations seem reasonable, i.e. are not producing spurious time trends in extremes.

Precipitation extremes generally do not show statistically significant dependence on ENSO in the observed data (not shown). Reasonable simulations, no spurious dependence.

Similar techniques can be used to quantify the impacts of NAO, AMO, PDO, etc. on extremes.

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