Development of a High-Resolution Precipitation Climatological Dataset from the Climatology-Calibrated Precipitation Analysis (CCPA)

Yan Luo[1,2], Yuejian Zhu[1], and Dingchen Hou[1]

[1] Environmental Modeling Center/NCEP/NWS/NOAA
[2] I. M. Systems Group, INC. at EMC/NCEP

Acknowledgements

Bo Yang and Bo Cui

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Introduction

- NCEP/EMC Climatology Calibrated Precipitation Analysis (over CONUS at 6h, ~5km resolution)
- Provides as a proxy of truth for precipitation forecast calibration and downscaling
- Focus of this work is to develop a dataset of precipitation climatology from CCPA
- The method of L-moments is applied

Background

What is CCPA?

- A dataset of precipitation analysis, over CONUS at 6h, ~5km resolution
- Statistically adjust Stage IV data at CPC analysis grid so their climatology is consistent with the CPC dataset, and then downscale back to the original Stage IV grid.
- Advantages:
  - Higher reliability of the CPC dataset, and
  - Higher spatial and temporal resolution of the Stage IV dataset
- Statistical adjustment – Linear regression: CPC = a·ST4 + b
- Products:
  - Operational since July 2010
  - Twice daily
  - Grids: HRAP (primary), and NDGD, 0.125, 0.5 and 1.0 degree resolutions (byproducts)
  - Period:2002~present

Motivation

Precipitation climatology products are desired to be extensively used for several studies on

- QPF/PQPF calibration
- Hydrological applications which include initiating regional/global hydrological forecast model
- Model forecast evaluation
- Generation of extreme forecast index (EFI) or anomaly forecast.
- Help to enhance the quality of the precipitation analysis
- Others

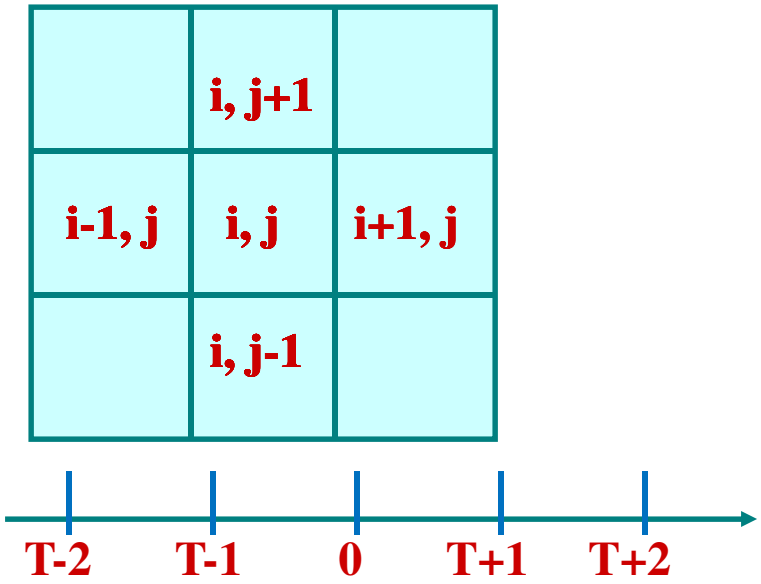
Methodology

- **Method of L-moments** (Hosking,1990 and Hosking and Wallis,1997)
- Why L-moment method?
  - Precipitation data is highly skewed
  - Only ten years of CCPA – maybe not sufficient data samples to construct climatology
  - Advantages of L-moments
    - ✓Efficiency and robustness
    - ✓Less affected by sample size
- Assumption: Precipitation estimates follow the **Gamma** distribution
  - References : Thom(1958), Friedman and Janes (1957), Barger et al. (1959),Greenwood and Durand (1960), Shenton and Bowman (1970)

Data sample collection and processing

CCPA at 1*1 degree and 24 hours accumulation

- Accumulate 6-houly analysis into daily with 24 hours accumulation
- Period – 10 year (2002-2012)
- Domain – CONUS only
- Increase sample size by using
  - 5 points (neighborhood locations)
  - 5 days time window (T-2, T-1, T0, T+1 and T+2)
- Up to 250(=10x5x5) samples in total for each day of the year and each grid point

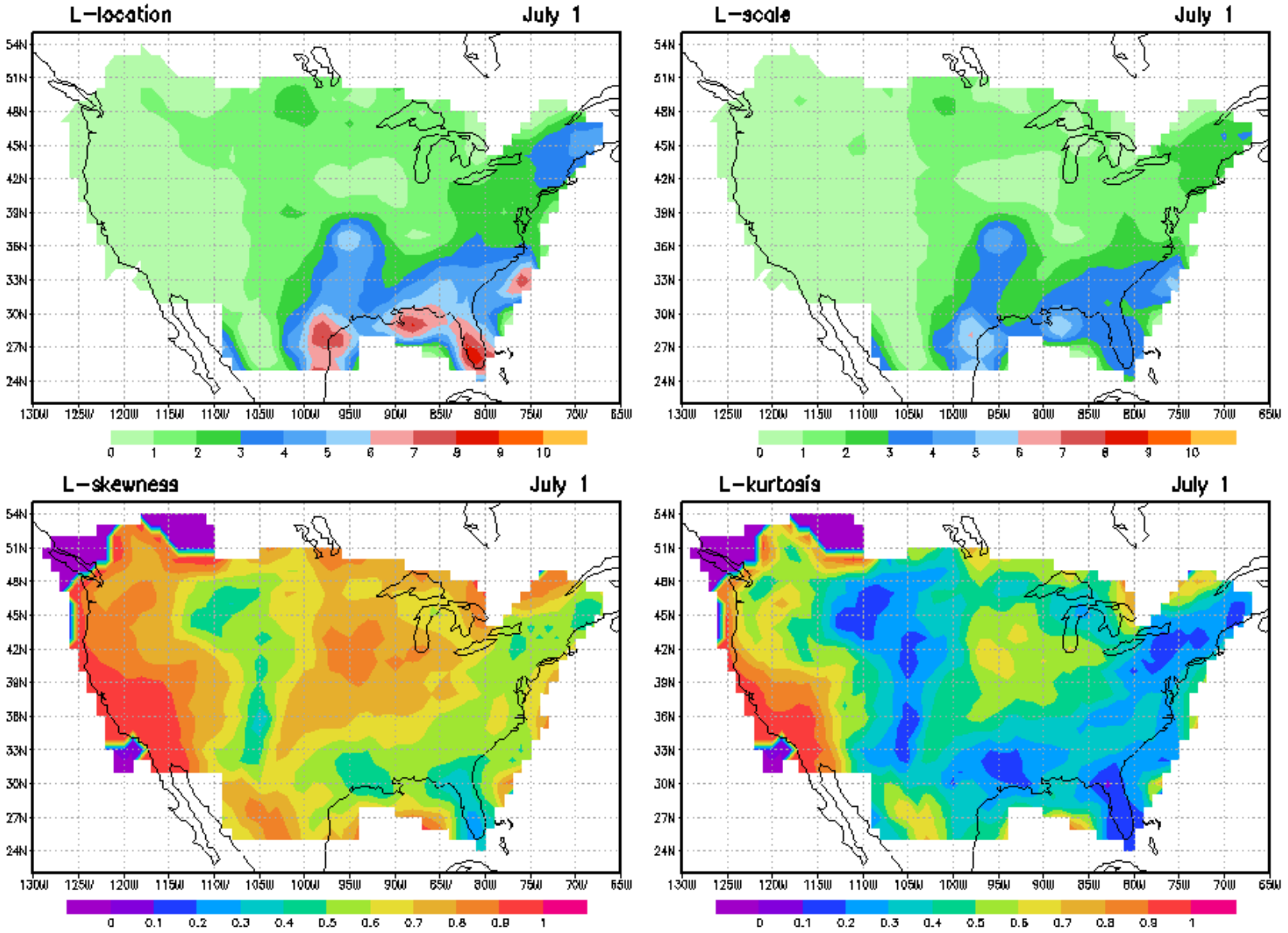


Estimation Procedures

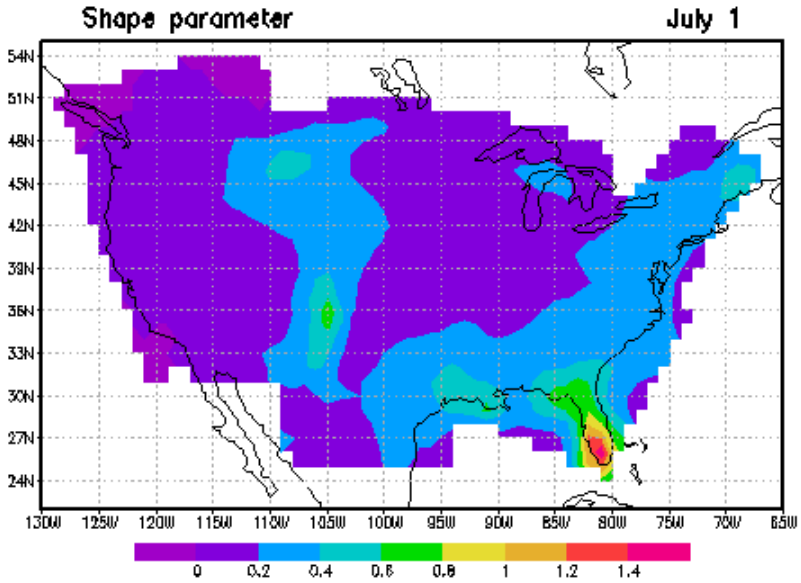
Steps to compute precipitation frequency curve (distribution):

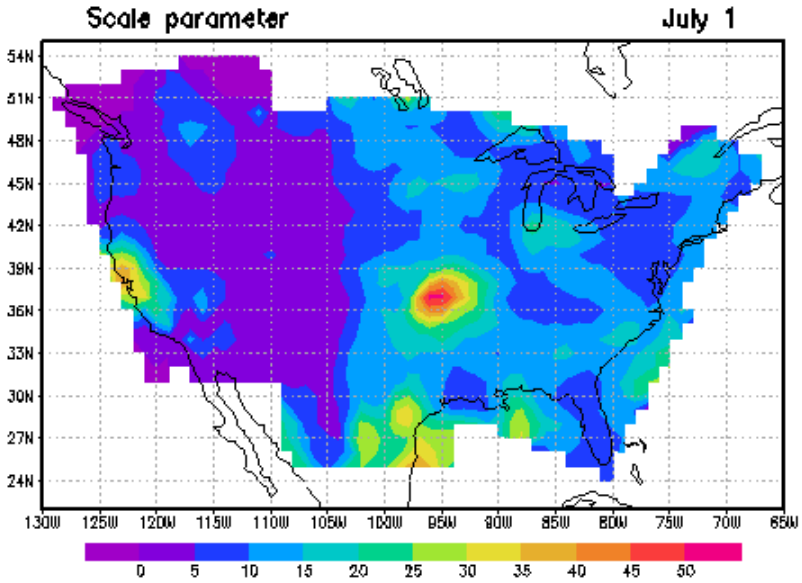
1. L-moments and L-moment ratios (L-location, L-scale, L-skewness, and L-kurtosis) were computed for the CCPA sample data set
2. These ratios were used to find a set of Gamma distribution parameters, defining a single probability distribution function for each day of the year and each grid point over CONUS
3. Every 10 percentages of probability were calculated based on the Gamma parameters

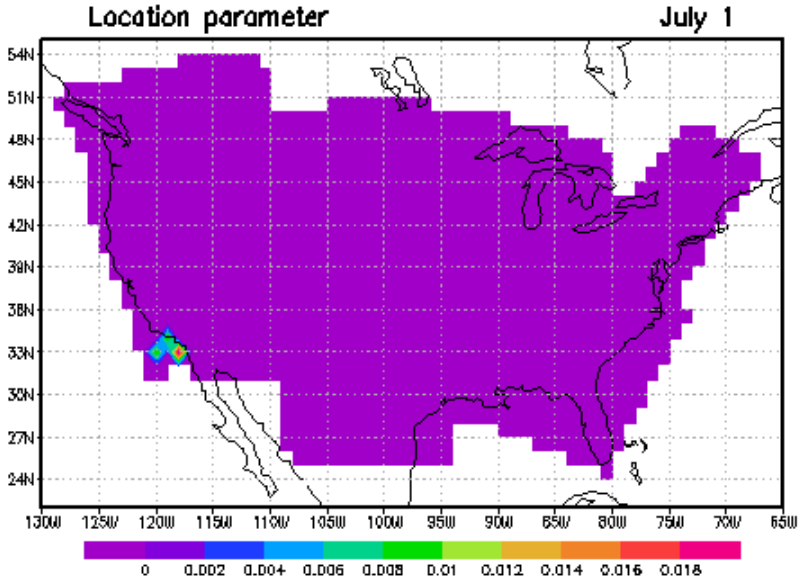
L-moments and L-moment ratios



Estimation of Gamma parameters







Parameters:

- $\kappa > 0$ shape
- $\theta > 0$ scale

Mean:

$$E[X] = \kappa\theta$$

Variance:

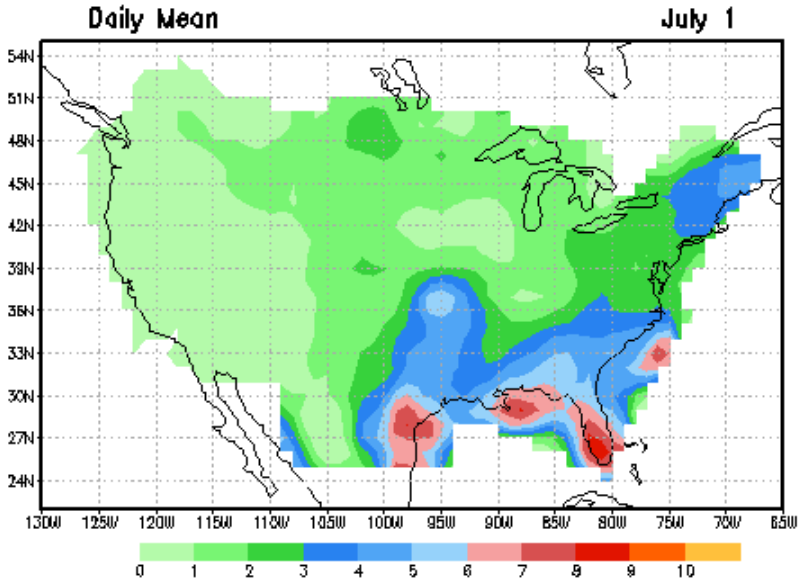
$$Var[X] = \kappa\theta^2$$

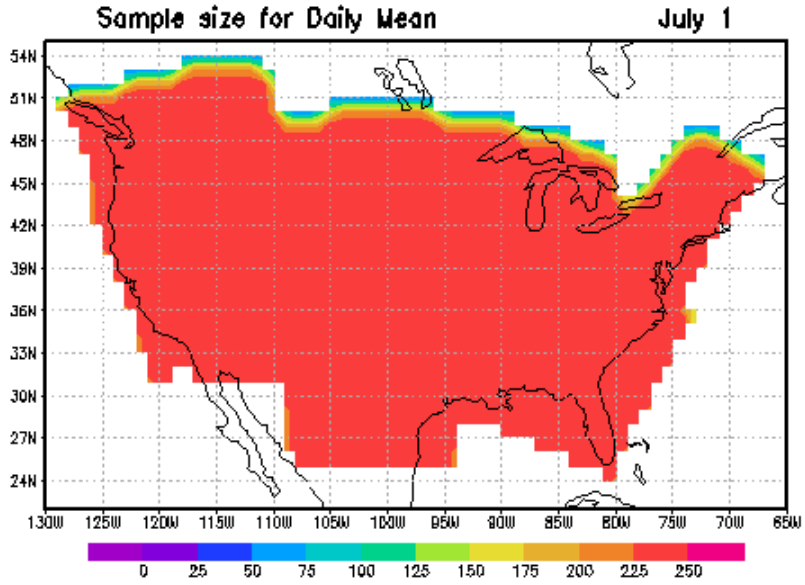
Proposed climatology products

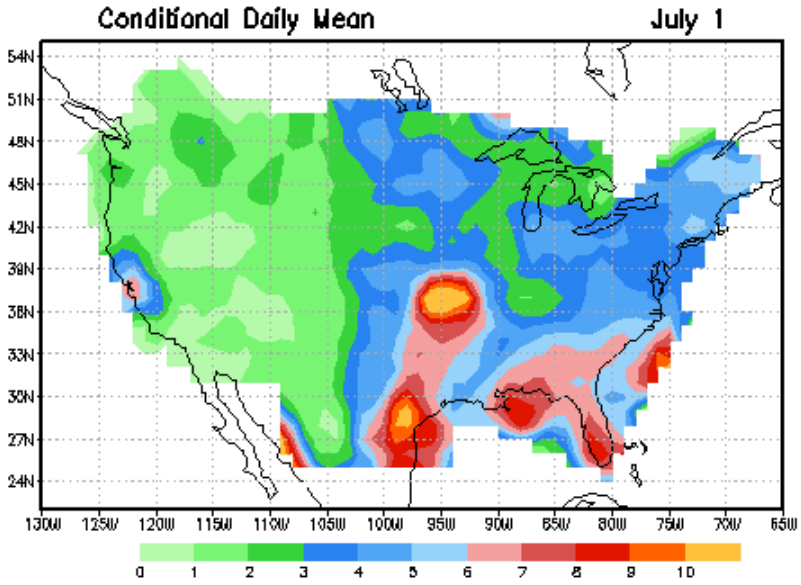
At 1*1 deg (lat/lon) over CONUS

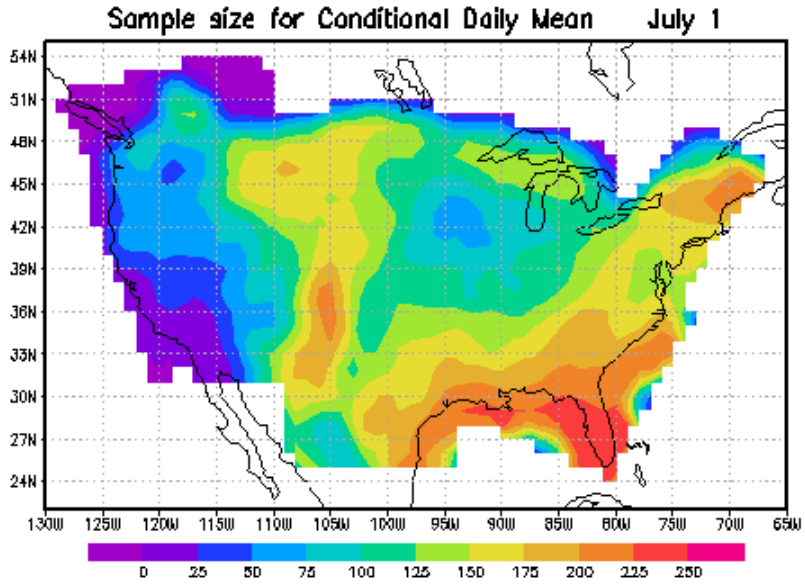
- Daily mean and median
- Conditional daily mean and median (non-zero precipitation only; no rain events are excluded)
- Every daily 10 percentages of probability (i.e. 10 climatologically equally likely bins) for each grid point
- Climatological variances (for grid points, domains)
- Expand to finer spatial and temporal resolutions in the future

Results


Daily Mean
July 1
54N
51N
48N
45N
42N
39N
36N
33N
30N
27N
24N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 1 2 3 4 5 6 7 8 9 10


Sample size for Daily Mean
July 1
54N
51N
48N
45N
42N
39N
36N
33N
30N
27N
24N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 25 50 75 100 125 150 175 200 225 250


Conditional Daily Mean
July 1
54N
51N
48N
45N
42N
39N
36N
33N
30N
27N
24N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 1 2 3 4 5 6 7 8 9 10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39N
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27N
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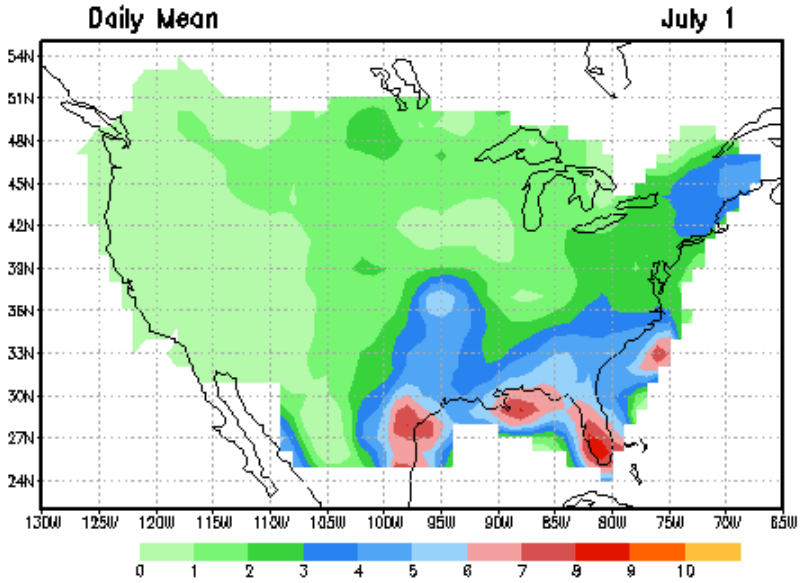
0 25 50 75 100 125 150 175 200 225 250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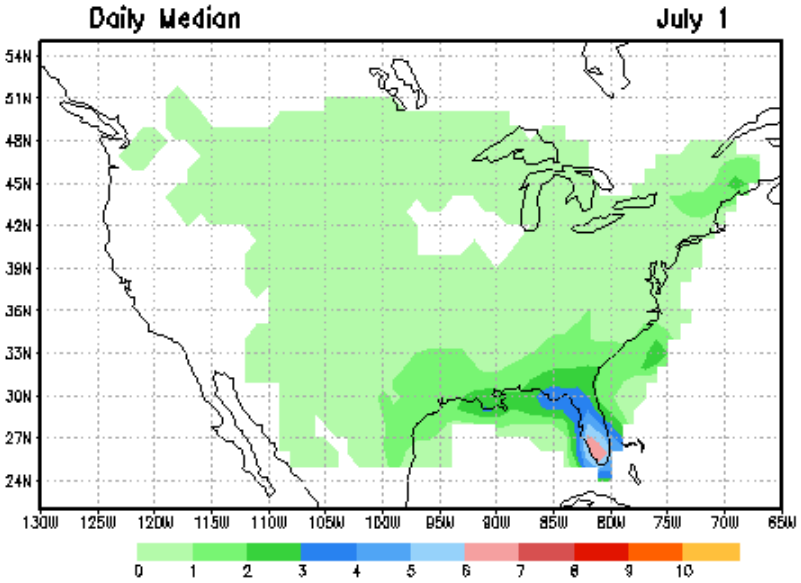
0 1 2 3 4 5 6 7 8 9 10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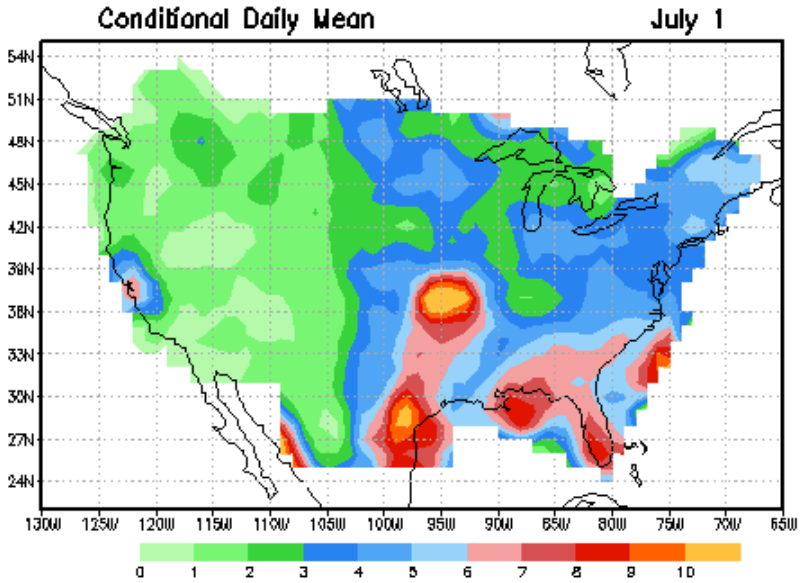
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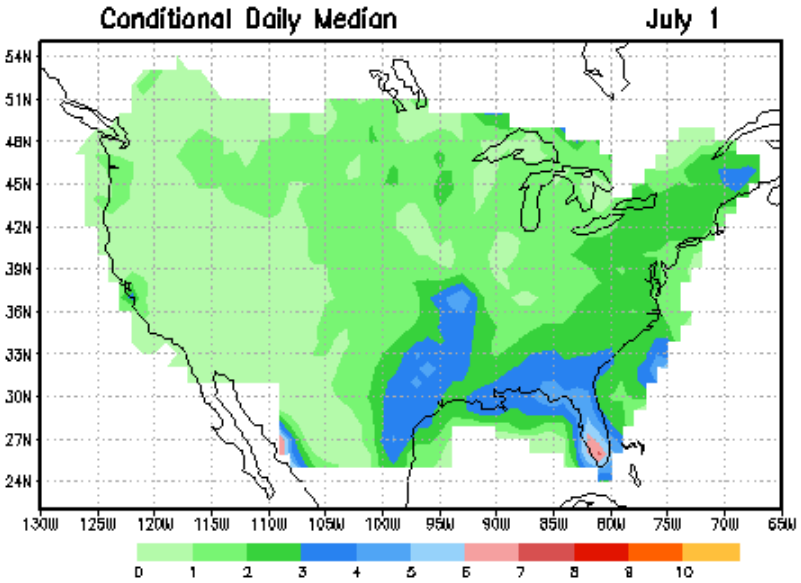
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30N
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24N
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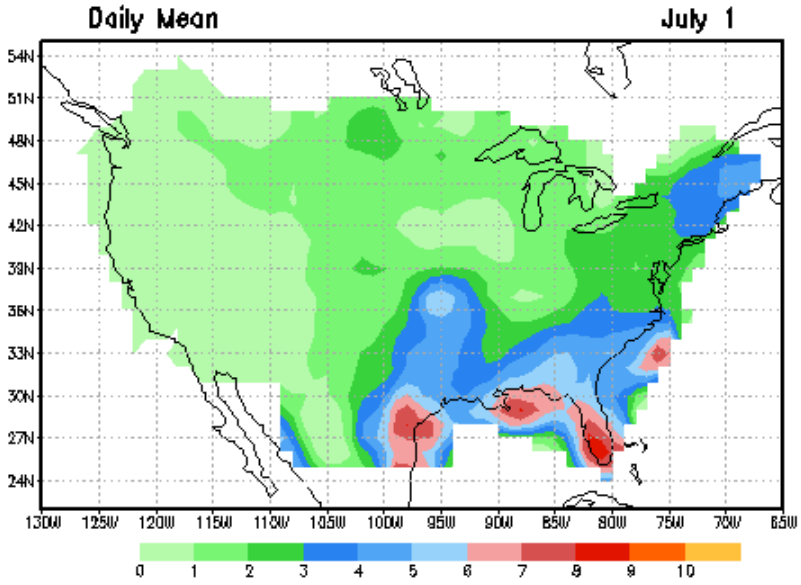
0 1 2 3 4 5 6 7 8 9 10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39N
36N
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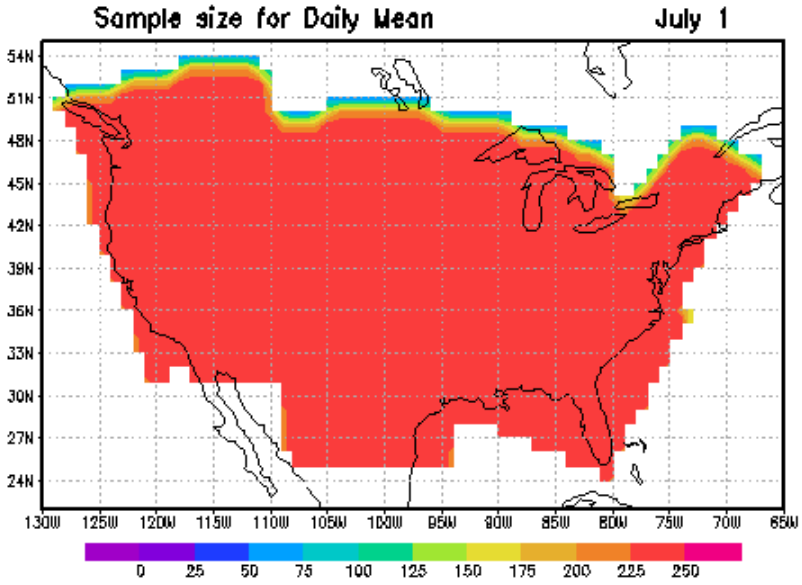
27N
24N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 1 2 3 4 5 6 7 8 9 10


Sample size for Daily Mean
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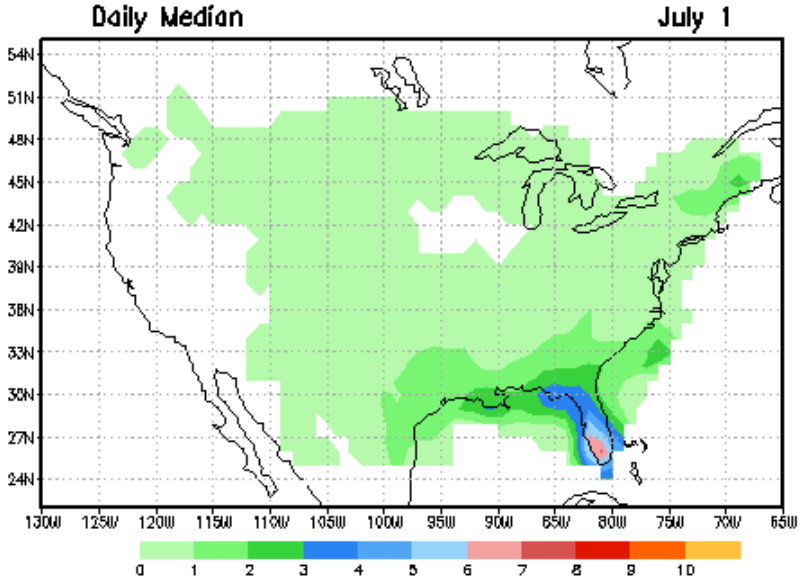
48N
45N
42N
39N
36N
33N
30N
27N
24N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 25 50 75 100 125 150 175 200 225 250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45N
42N
39N
36N
33N
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27N
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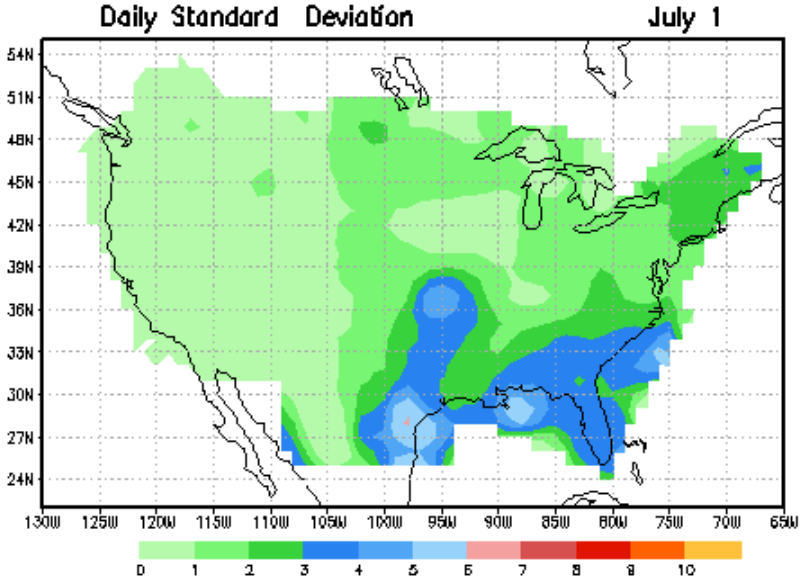
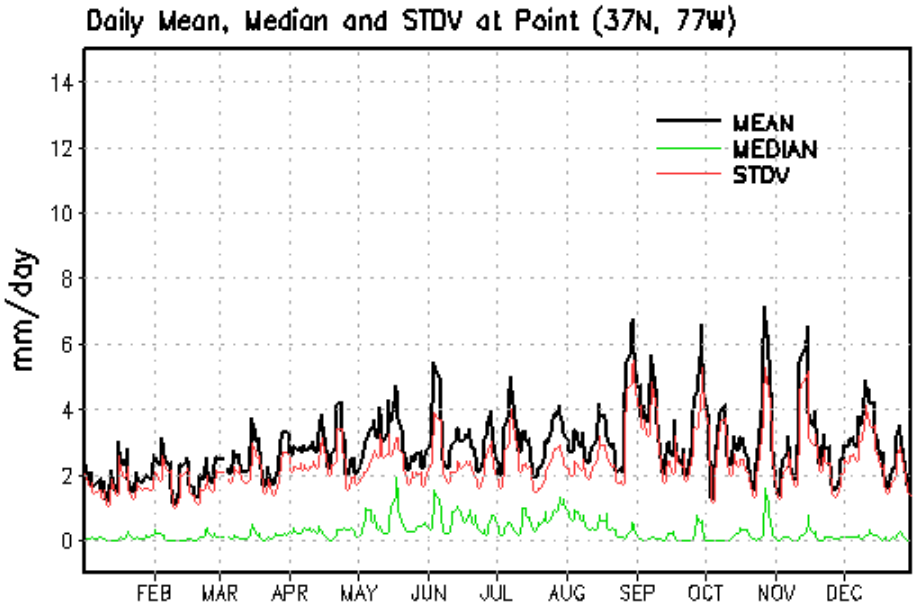
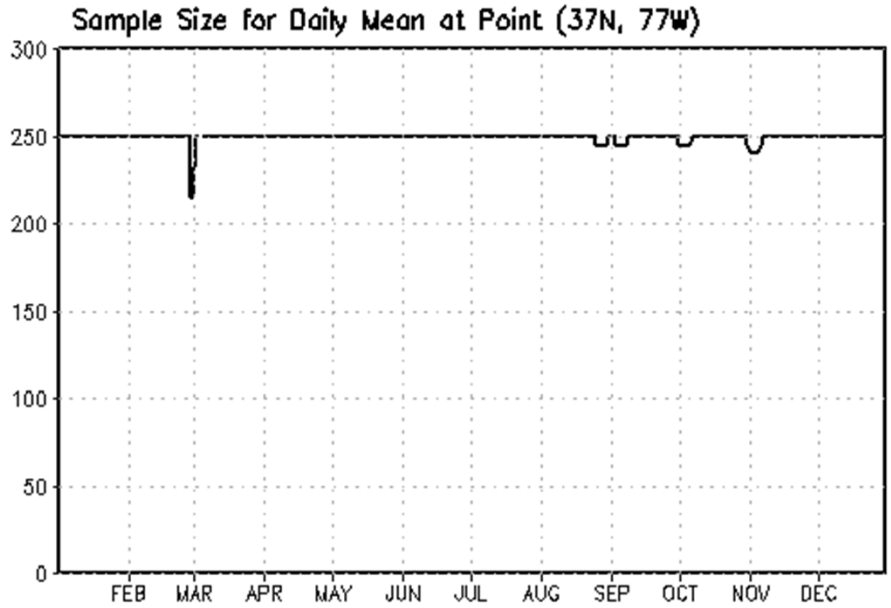
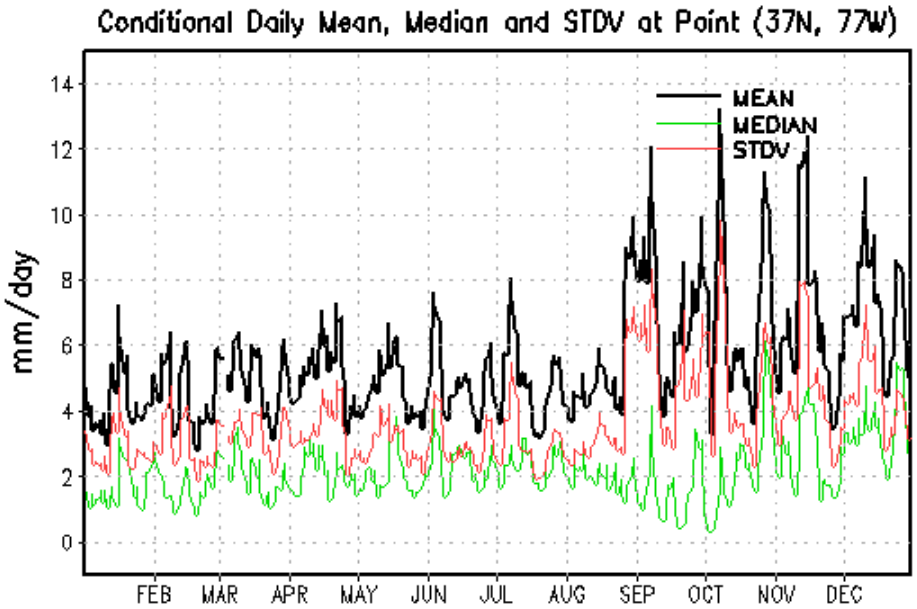
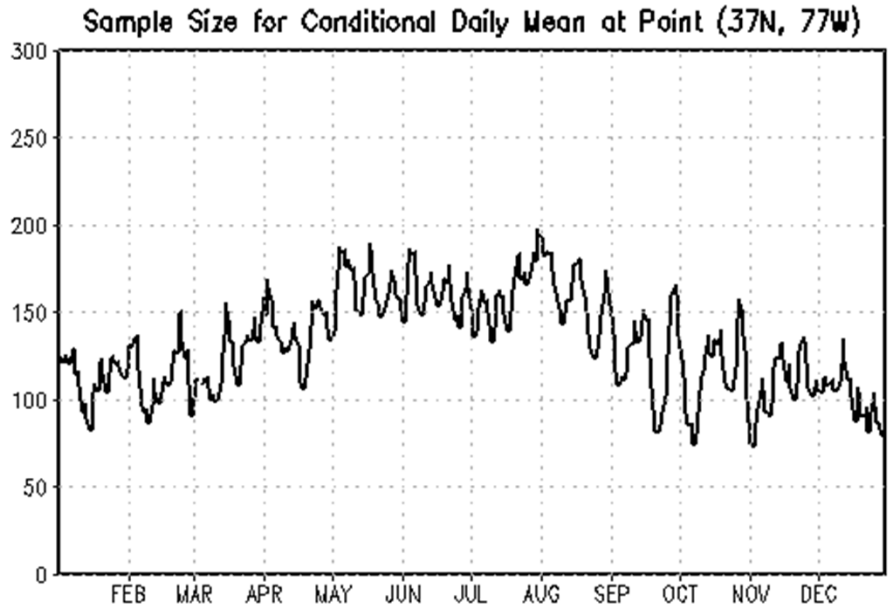
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 1 2 3 4 5 6 7 8 9 10


Daily Standard Deviation
July 1
54N
51N
48N
45N
42N
39N
36N
33N
30N
27N
24N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W
0 1 2 3 4 5 6 7 8 9 10

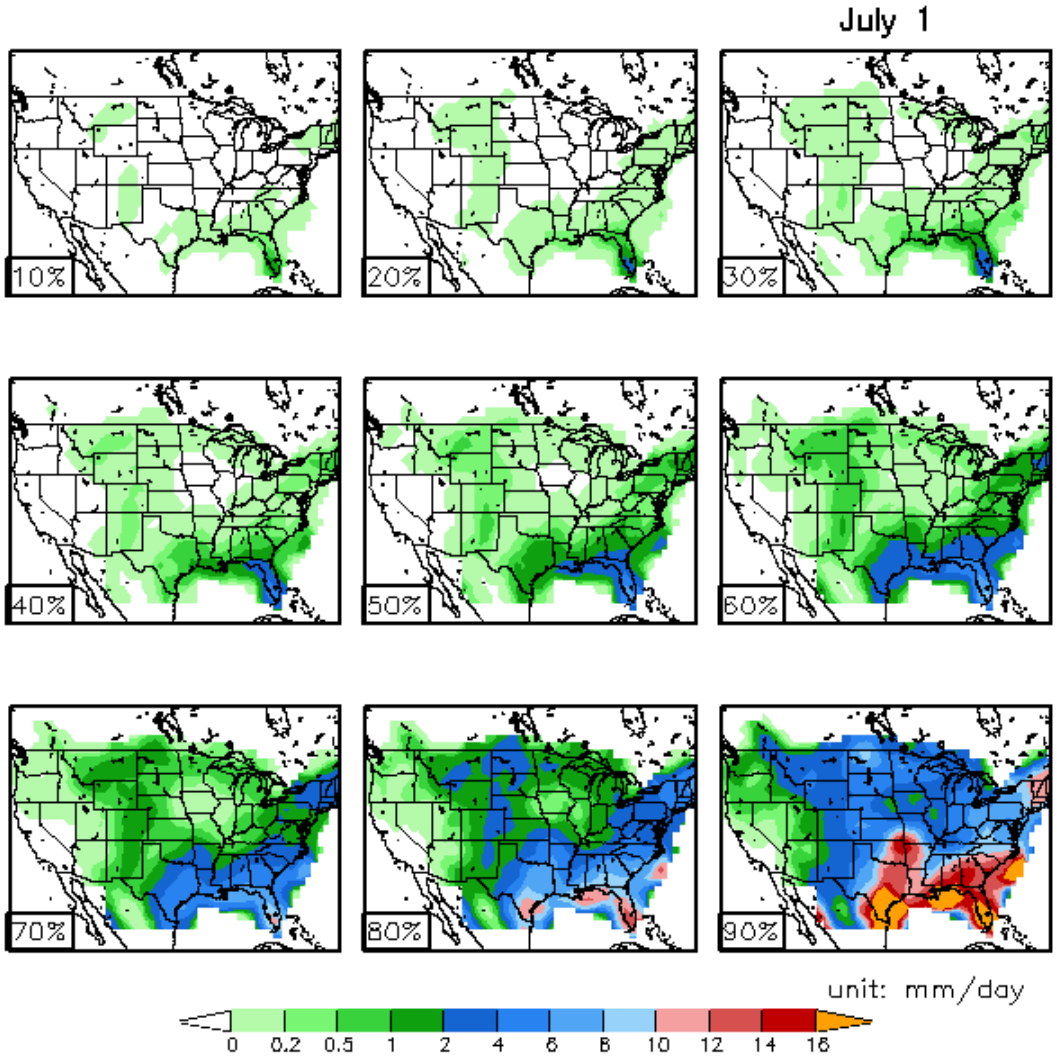

Daily Mean, Median and STDV at Point (37N, 77W)
mm/day
MEAN
MEDIAN
STDV
0
2
4
6
8
10
12
14
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

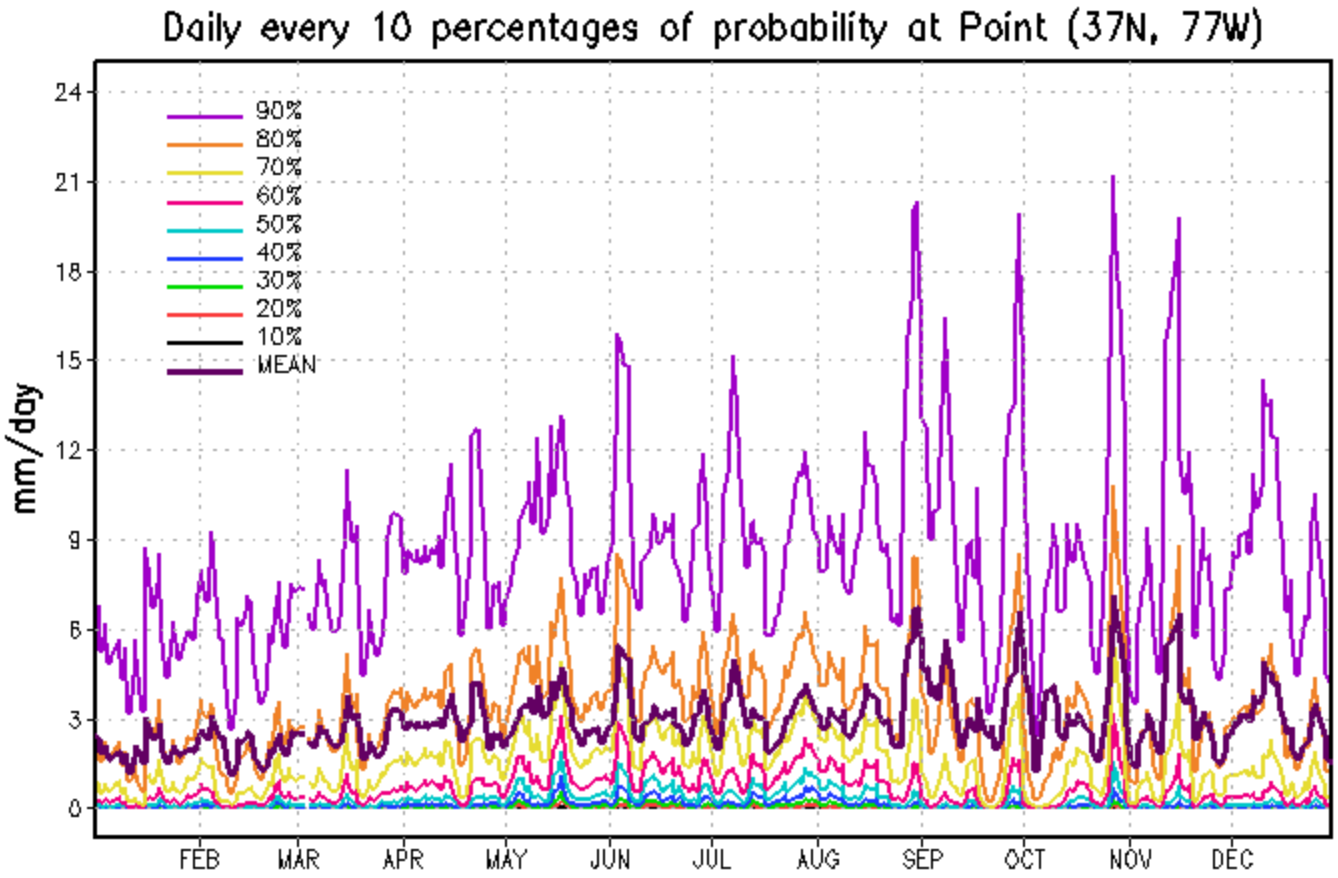

Sample Size for Daily Mean at Point (37N, 77W)
0
50
100
150
200
250
300
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


Conditional Daily Mean, Median and STDV at Point (37N, 77W)
mm/day
MEAN
MEDIAN
STDV
0
2
4
6
8
10
12
14
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

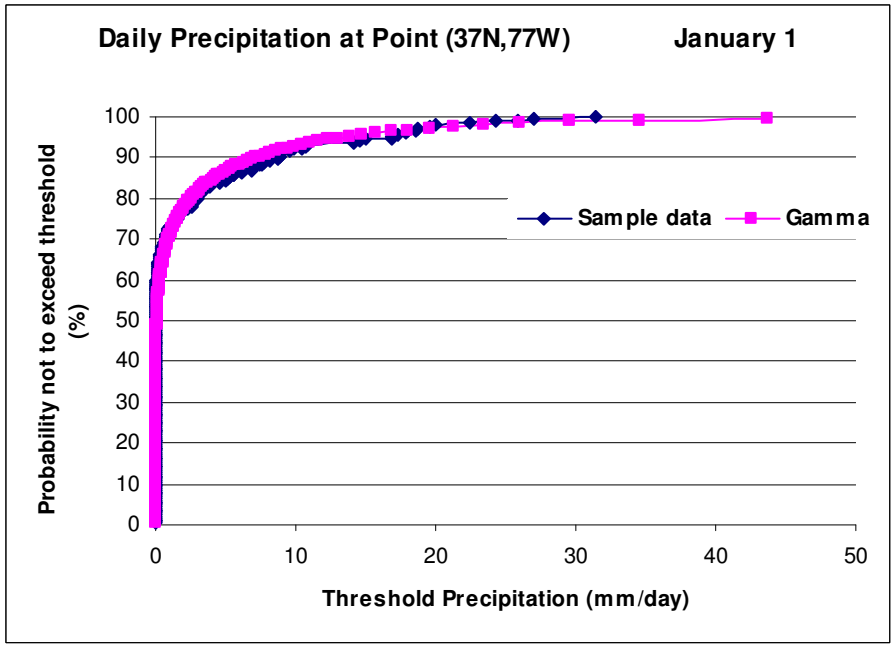

Sample Size for Conditional Daily Mean at Point (37N, 77W)
0
50
100
150
200
250
300
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

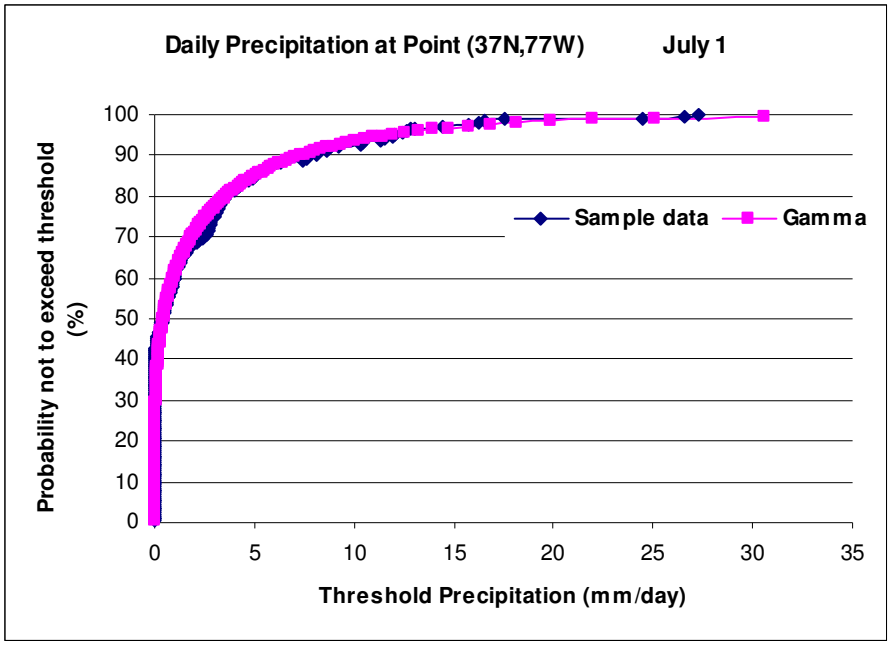
Daily every ten percentages of probability




Daily every 10 percentages of probability at Point (37N, 77W)
mm/day
24
21
18
15
12
9
6
3
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
MEAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

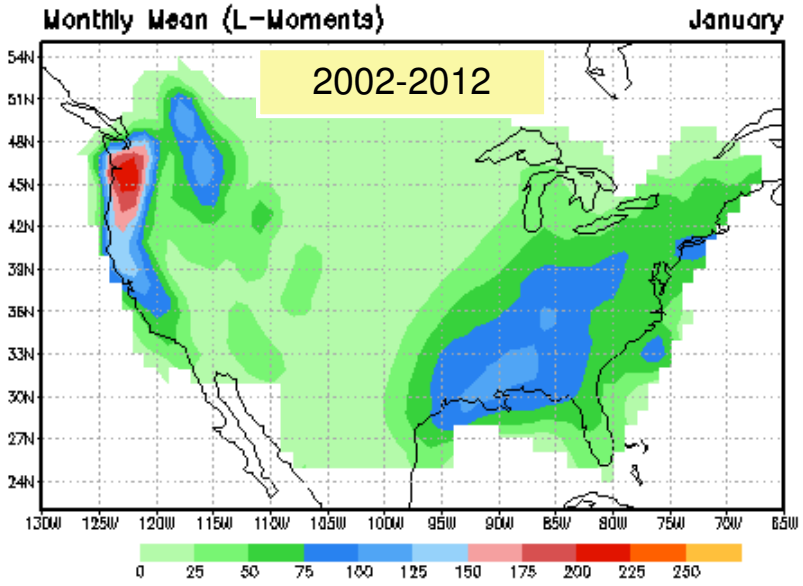
Comparison of CDF

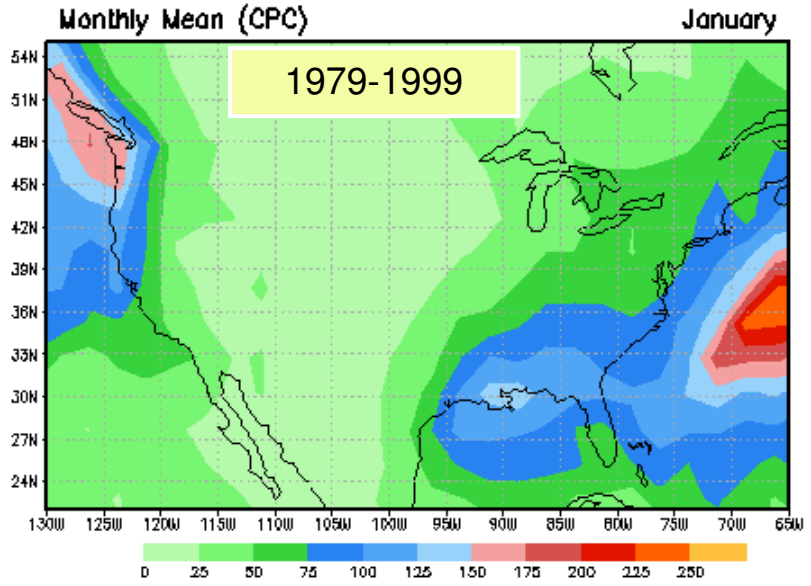




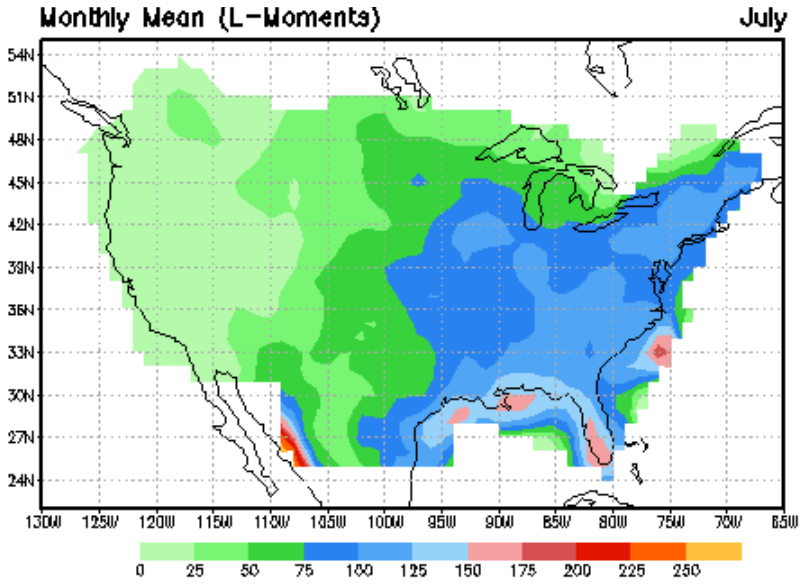
Comparison of monthly precipitation climatology

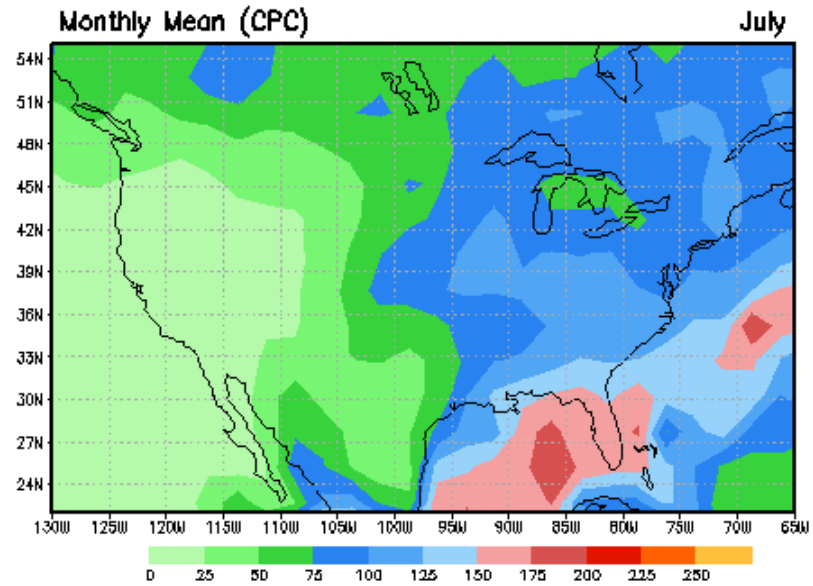
January - winter month





July - summer month





Unit: mm/month

(NOAA NCEP CPC CAMS_OPI original_version climatology Precipitation)

Summary

1. Daily precipitation climatology in CCPA

- Calculated using the L-moment method with an assumption of a Gamma distribution for each day of the year and each 1*1 degree grid point over CONUS.
- Provided reasonable fittings of data sample with Gamma distribution.
- When summed daily data up to monthly, they are fairly close to CPC monthly climatology.

2. Future work:

- Product expansion:
  - Domain: CONUS only -> other areas
  - Resolution:
    - Space: 1*1 deg lat x lon -> 5KM NDGD grid
    - Time: daily -> 6 hourly -> 3 hourly

Future Applications

- Amount of precipitation above climatology mean/median of ensemble mean/median
- Probabilistic anomaly forecast:
  - Probability of exceeding one standard deviation of climatology
  - Probability of exceeding two standard deviations of climatology
  - Probability of exceeding three standard deviations of climatology
- Verification
  - Probabilistic evaluation (GEFS standard package) should have precipitation evaluation