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

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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: $\text{CPC} = a \cdot \text{ST4} + b$

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-hourly 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:**
- $\text{Var}[X] = \kappa \theta^2$
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 every ten percentages of probability
Daily every 10 percentages of probability at Point (37N, 77W)
Comparison of CDF

**Daily Precipitation at Point (37N, 77W) January 1**

**Daily Precipitation at Point (37N, 77W) July 1**
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