A 35-Year Analysis of Global Daily Precipitation for Improved Hydroclimate Monitoring and Modeling

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Hydroclimate Requirements for precipitation analyses

- A long-term record (>=30+ years) with complete spatial coverage and temporal homogeneity

- Reasonable Time and Space Resolution (Daily/0.5° or finer)

- Quantitative Accuracy (Capturing Precipitation Events of Various Intensities)

- (optional) Real-time availability
Existing Precipitation Data Sets
Can Not Satisfy Hydroclimate Requirements

- Daily gauge analyses (e.g., CPC daily gauge analysis)
  - Acceptable temporal resolution
  - Poor quality over gauge sparse areas
  - **Systematic under estimation** due to the quality of daily GTS reports

- Monthly gauge analyses (GPCC/CPC gauge analyses)
  - Relatively accurate magnitude over most places with reasonable gauge networks
  - Poor quality over gauge sparse areas
  - Temporal resolution too coarse

- Hi-Resolution Satellite Estimates (CMORPH/TRMM/GPM)
  - Good quality; high-resolution, quasi global coverage
  - Short record (from 1998)
  - Quality for high-latitude / cold season precip not as good

- Heritage Gauge-Satellite Blended Analyses (GPCP/CMAP)
  - Long-term analyses (from 1979) of reasonable quality and homogeneity
  - Coarse time / space resolution (2.5°lat/lon)
Objective

Develop a long-term precipitation analysis of

• reasonably fine time/space resolution; and
• temporal homogeneity

for hydroclimate applications

→ Daily, 0.25° grid over the global land for 1979-2013 (and continues on)
Strategy

Combine information from the four individual sources including CPC daily gauge analysis, GPCC monthly gauge analysis, CMORPH high-resolution integrated satellite precipitation estimates, and the HIRS OLR data in a three-step approach:

1. **Adjusting daily gauge analysis against monthly GPCC gauge data**

2. **Deriving precipitation estimates from satellite observed OLR, and**

3. **Blending the adjusted daily gauge analysis with satellite-based estimates;**
Step 1: Adjusting Daily Gauge Analysis

Adjust the **CPC Daily Gauge Analysis** against the **Monthly GPCC Gauge Analysis** to achieve a gauge-based analysis of daily precipitation with relatively accurate magnitude.

- Overall magnitude close to the monthly GPCC gauge analysis over gauge dense regions
- Temporal / spatial variation patterns controlled by the CPC daily gauge analysis
Adjustment of CPC Daily Gauge Analysis Referenced to GPCC

RAW CPC mm/day

ADJ. CPC mm/day

Raw CPC – GPCC

ADJ. CPC – GPCC

correlation

correlation
Step 2: Deriving OLR-based Precip Estimate

- The colder the OLR, the heavier the precip;
- Quantify the non-linear relationship between OLR and precip through PDF matching using co-located HIRS OLR and CMORPH precip data for 1998 - 2012;
- Construct PDF tables for each $1^\circ$lat/lon and for each pentad to capture regional / seasonal variations of the OLR-precip relationship;
- Derive precipitation estimate from the $0.25^\circ$lat/lon and half-hourly gridded HIRS OLR data via the PDF tables;
- Perform bias correction for the OLR based estimates against daily gauge analysis.

Bias-corrected OLR precipitation estimates show good pattern agreement with CMORPH with magnitude close to the gauge analysis.
Step 3: Blending gauge OLR precip

- Using **optimal interpolation (OI)** framework (Xie and Xiong 2011) to blend the Adjusted Daily Gauge (ADG) analysis and the bias corrected OLR precipitation estimates (OPE).

- Blended analysis shows improvements over both inputs, particularly over equatorial Africa and Amazon where gauge-based analysis is usually in poorer quality.
Blended OLR-Gauge Daily Precip Analysis

Comparisons by monthly fields
Comparison with GPCP Monthly Analysis

Overall very close agreement with GPCP monthly analysis, except over the Antarctic.
Comparison with GPCP Monthly Analysis

- No discontinuities visible over the 35-year data period
- Very good agreement with the GPCP monthly analysis (on much coarser resolution)
- Our analysis is slightly lower than the GPCP monthly analysis, primarily because the GPCP analysis applied a wind effect correction using climatology coefficients
**ENSO signals in the blended precip analysis**

**Regional coefficients against NINO3.4**

- Regression using monthly data for 1979 to 2013 [mm/day per 1°C of NINO3.4]
- ENSO signal captured quite well over the global land
Summary

- A test version daily gauge analysis is developed for a 35-year period from 1979-2013 on a 0.25° lat/lon grid over the global land

- This analysis was generated through combining information from four sources: CPC daily gauge analysis, GPCC monthly gauge analysis, HIRS OLR data, and the CMORPH high-resolution satellite estimates

- The analysis shows reasonable quality and temporal homogeneity throughout the data period

- Further work underway to perform comprehensive examinations and to examine the performance of this data set in forcing a land-surface model