

# CCPA Precipitation Analysis: Data Set, Cross Validation and Evaluation

*Dingchen Hou<sup>1</sup>, Yan Luo<sup>1</sup>, Yuejian Zhu<sup>1</sup>,  
Pingping Xie<sup>2</sup>, and Ying Lin<sup>1</sup>*

<sup>1</sup> Environmental Modeling Center/NCEP/NWS/NOAA

<sup>2</sup> Climate Prediction Center/NCEP/NWS/NOAA

## **Acknowledgements**

*Mike Charles, Zoltan Toth, Roman Krzysztofowicz, Dong-Jun Seo,  
Malaquias Pena, Bo Cui, Steve Lord, Letitia Soulliard, Julie Demargne, John Schaake*

25<sup>th</sup> Conference on Hydrology  
23-27 January, 2011, Seattle, WA

# **What is CCPA?**

## **(Climatology-Calibrated Precipitation Analysis)**

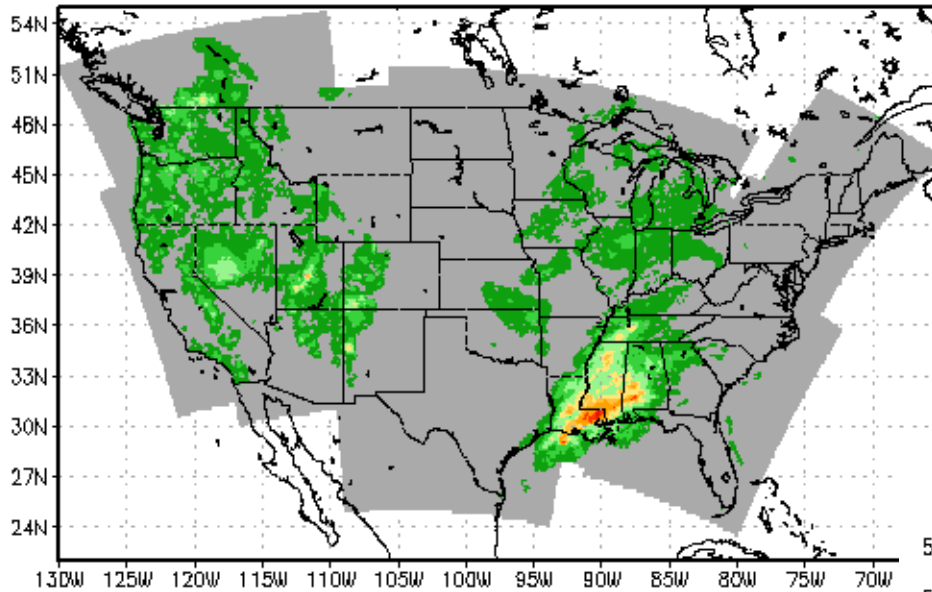
- A new dataset of precipitation analysis, over CONUS at 6h, ~4km resolution
- Statistical adjustment of Stage IV data toward CPC analysis
- Simple linear regression at 0.125 degree and 24h accumulation
- Spatial interpolation and temporal smoothing to regression coefficients
- Keep the fine scale structures of Stage IV
- Closer to CPC Unified Precipitation Analysis, in the sense of climatology
- Provide a proxy of truth for precipitation forecast calibration and downscaling

## Status and Availability of CCPA data sets

- Operational implementation at NCEP on July 13, 2010
  - Real time generation of CCPA after STAGE IV
  - Generate at noon and update in the evening
- Generate the historical data set of CCPA for 2002-2010
- Product grids:
  - HRAP (primary)
  - NDGD, 0.125, 0.5 and 1.0 degree resolutions (byproducts)
- Contact information: [Yan.Luo@noaa.gov](mailto:Yan.Luo@noaa.gov)
- CCPA website:  
[http://www.emc.ncep.noaa.gov/gmb/yzhu/html/imp/201007\\_imp.html](http://www.emc.ncep.noaa.gov/gmb/yzhu/html/imp/201007_imp.html)

# Comparison of CCPA and Stage IV

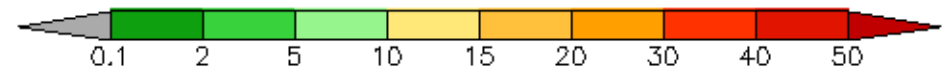
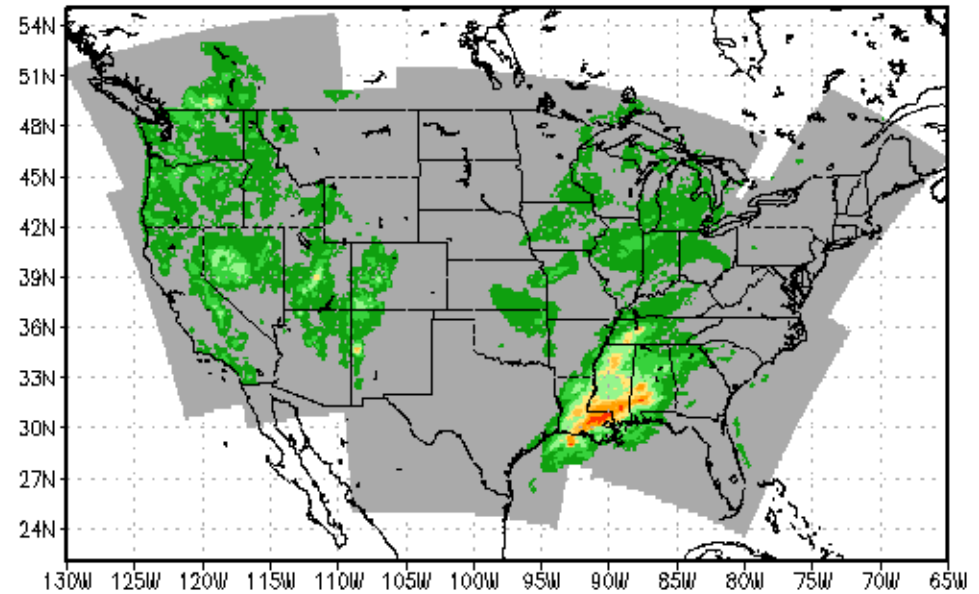
(a) CCPA 06h Accum (mm) Ending 2009123100



6-h accumulation  
(18Z , 30th to 00Z 31st, December 2009)  
~4km HRAP

Spatial pattern correlation coefficient  
= 0.990016

(b) Stage IV 06h Accum (mm) Ending 2009123100



# CCPA Evaluation Study

## Goal

- Examine the impact and robustness of the CCPA methodology and evaluate the quality of CCPA data set

## Data availability and processing

### CPC Unified Precipitation Analysis :

- 1/8 deg, daily(12UTC-12UTC), 24 hr accumulation

### RFC Rain Gauge Analysis:

- Point data, daily(12UTC-12UTC), 24 hr accumulation
- Box averaged to 1/8deg

### Stage IV and CCPA:

- Aggregated from HRAP to 1/8 deg
- Aggregated from 6-hourly to daily

### CVA (Cross Validation Analysis):

- An alternative data set of CCPA
- Cross validation method (see next slide)

Linear Regression:  
 $CPC = a * ST4 + b$

# Cross Validation Method

(Data holding technique, similar to Xie et al, 2007)

Estimate a & b for CCPA from data pool  
 6/1/2002 – 7/31/2009 (7yr)

CCPA =  $a * ST4 + b$   
 (1/1/2002 – 6/30/2002)  
 (7/1/2002 – 6/30/2003)  
 (..... )  
 (7/1/2008 – 6/30/2009)  
 (after 6/30/2009 )  
 Same a&b for all years

Estimate a & b for CVA from data pool

( 6/1/2002 – 7/31/2003 )  
 ( 6/1/2003 – 7/31/2004 )  
 ( 6/1/2004 – 7/31/2005 )  
 ( 6/1/2005 – 7/31/2006 )  
 ( 6/1/2006 – 7/31/2007 )  
 ( 6/1/2007 – 7/31/2008 )  
 ( 6/1/2008 – 7/31/2009 ) 6yr

CVA =  $a * ST4 + b$  (7/1/2008 – 6/30/2009)

Estimate a & b for CVA from data pool

( 6/1/2002 – 7/31/2003 )  
 ( 6/1/2003 – 7/31/2004 )  
 ( 6/1/2004 – 7/31/2005 )  
 ( 6/1/2005 – 7/31/2006 )  
 ( 6/1/2006 – 7/31/2007 )  
 ( 6/1/2007 – 7/31/2008 )  
 ( 6/1/2008 – 7/31/2009 ) 6yr

CVA =  $a * ST4 + b$  (7/1/2007 – 6/30/2008)

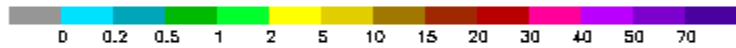
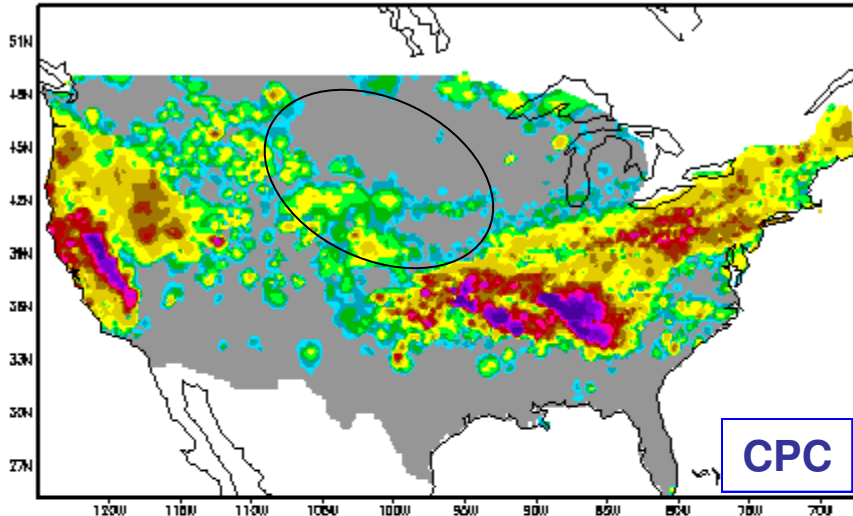
and so on, a&b vary year by year .....

# Evaluation method

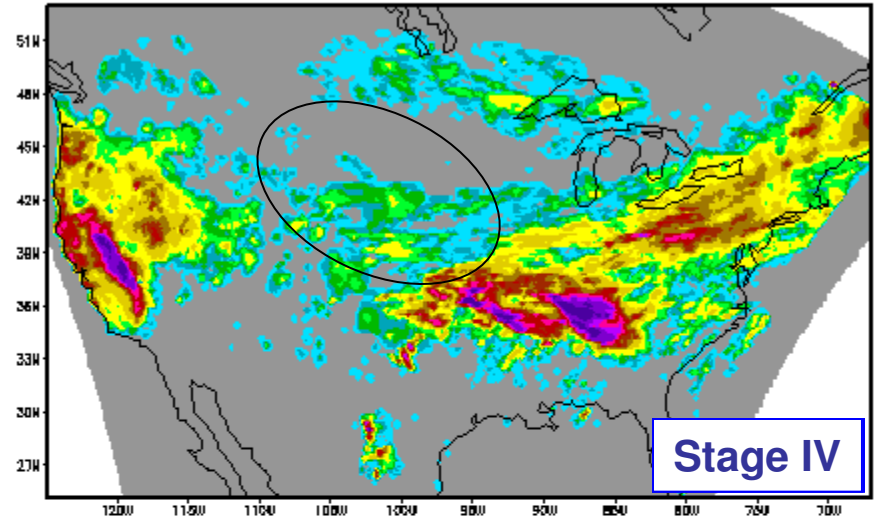
- Comparisons of ST4, CVA and CCPA against CPC
  - Daily based (12UTC-12UTC, 24 hr accumulation)
  - Daily cases
  - Annual Average
  - Time Series
- Verifications of ST4,CVA and CCPA against RFC rain gauge observations
  - Daily based (12UTC-12UTC, 24 hr accumulation)
  - 1/8 deg over CONUS domain
  - Annual statistics (7/1/2008 – 6/30/2009 shown)
  - Verification Metrics: RMSE, ABSE, ETS and TSS scores
  - For various thresholds

# Comparison of Stage IV, CVA and CCPA against CPC

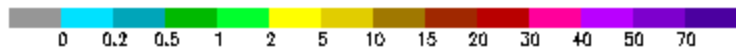
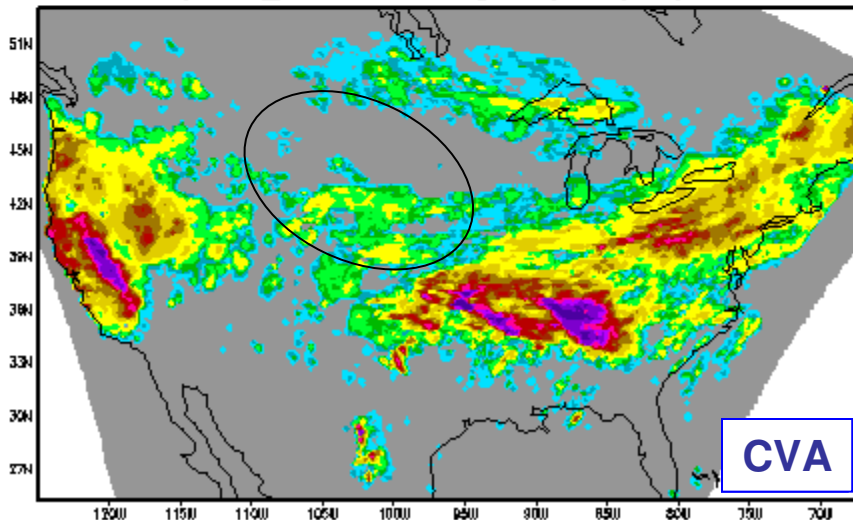
Prcp CPC 0.125 deg daily, 05/02/2009



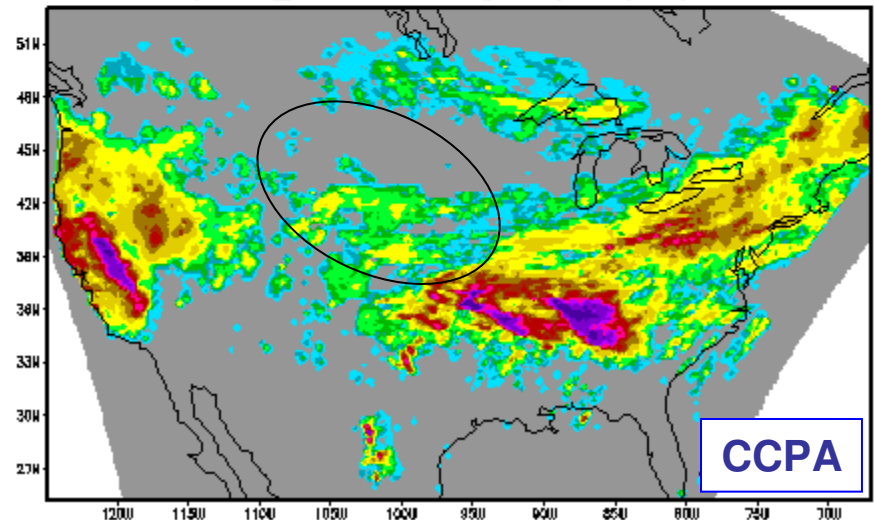
Prcp STAGE4 0.125 deg daily, 05/02/2009



Prcp ST4\_CR7 0.125 deg daily, 05/02/2009



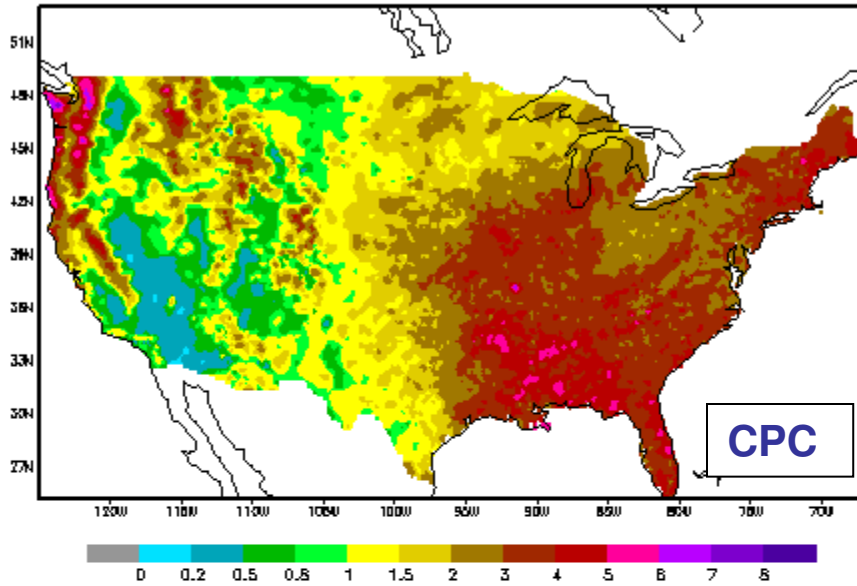
Prcp ST4\_ADJ 0.125 deg daily, 05/02/2009



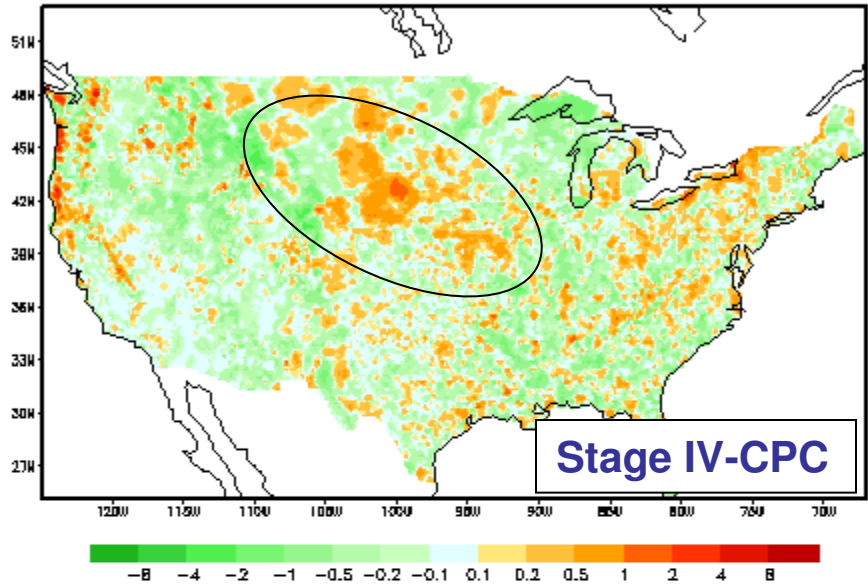


# Comparison of Stage IV, CVA and CCPA against CPC

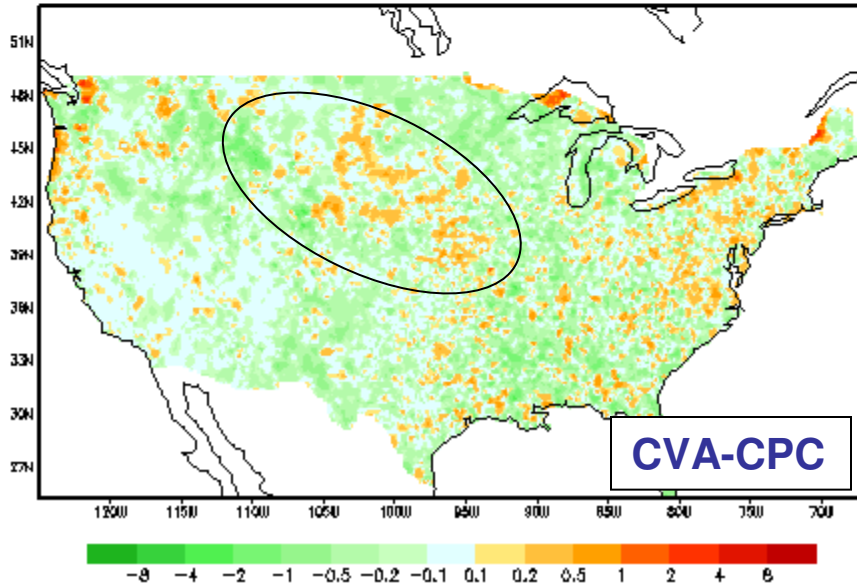
Prcp CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



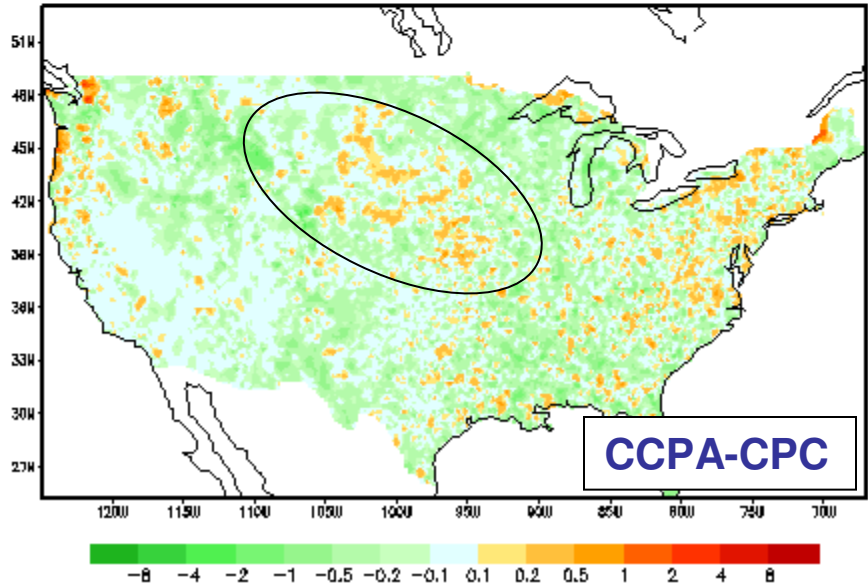
STAGE4 - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



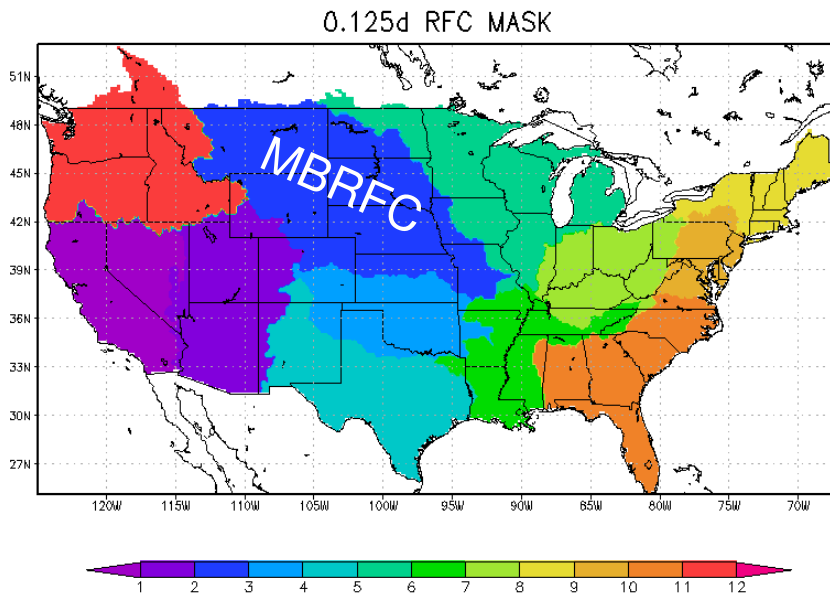
ST4\_CR7 - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



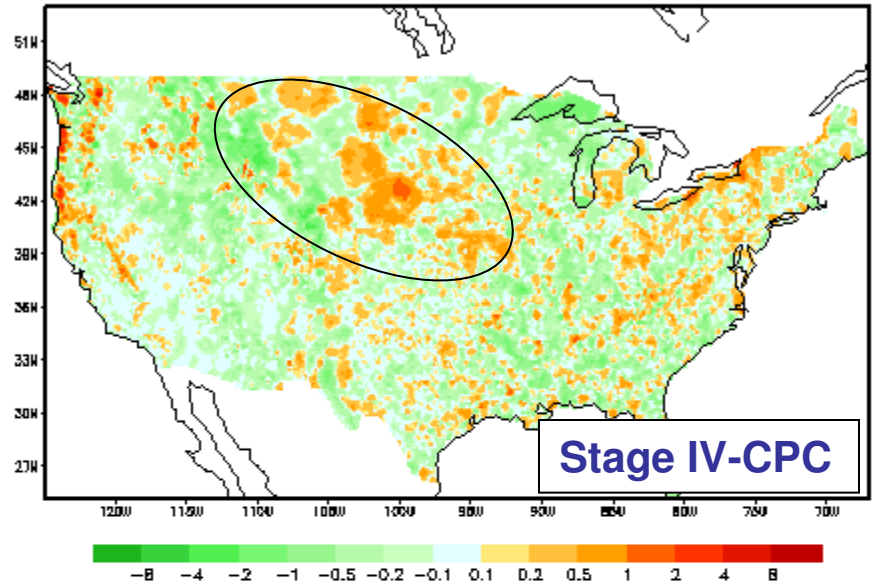
ST4\_ADJ - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



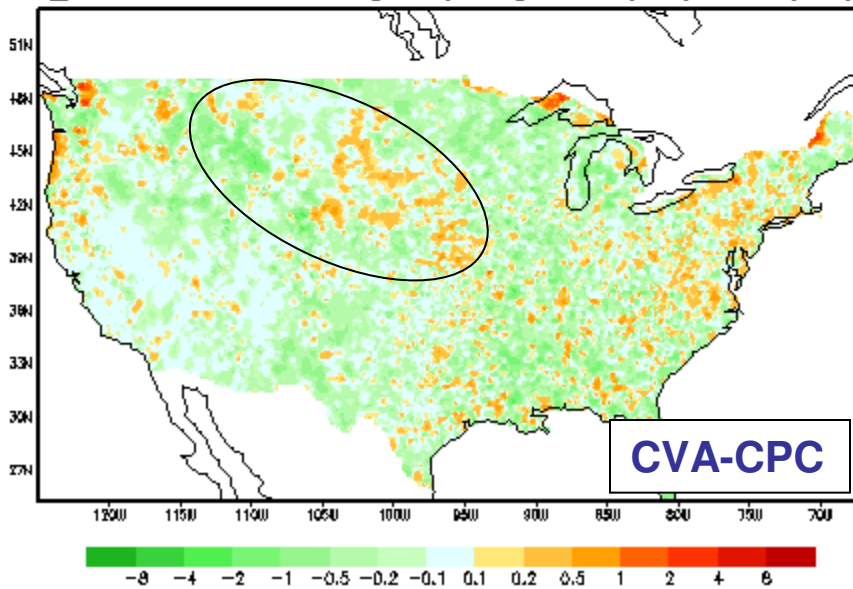
# Comparison of Stage IV, CVA and CCPA against CPC



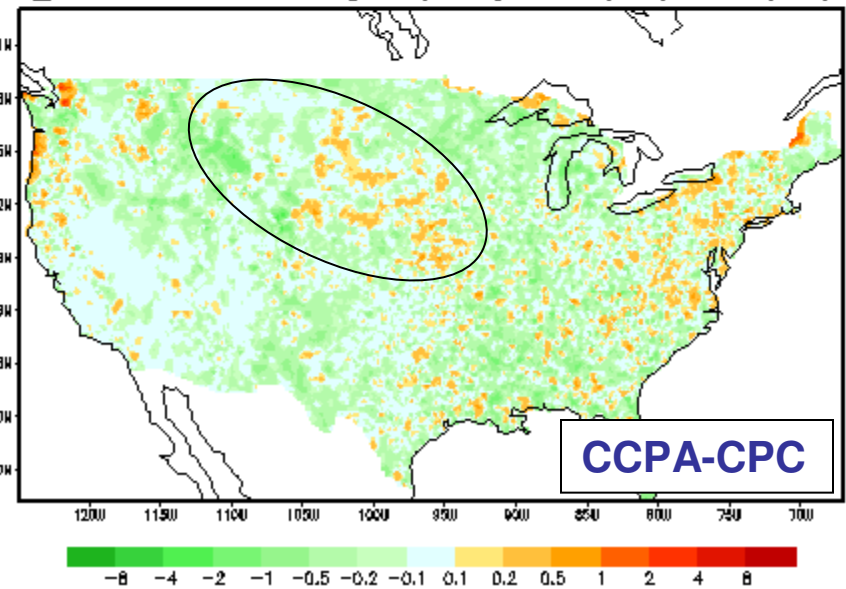
STAGE4 - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



ST4\_CR7 - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09

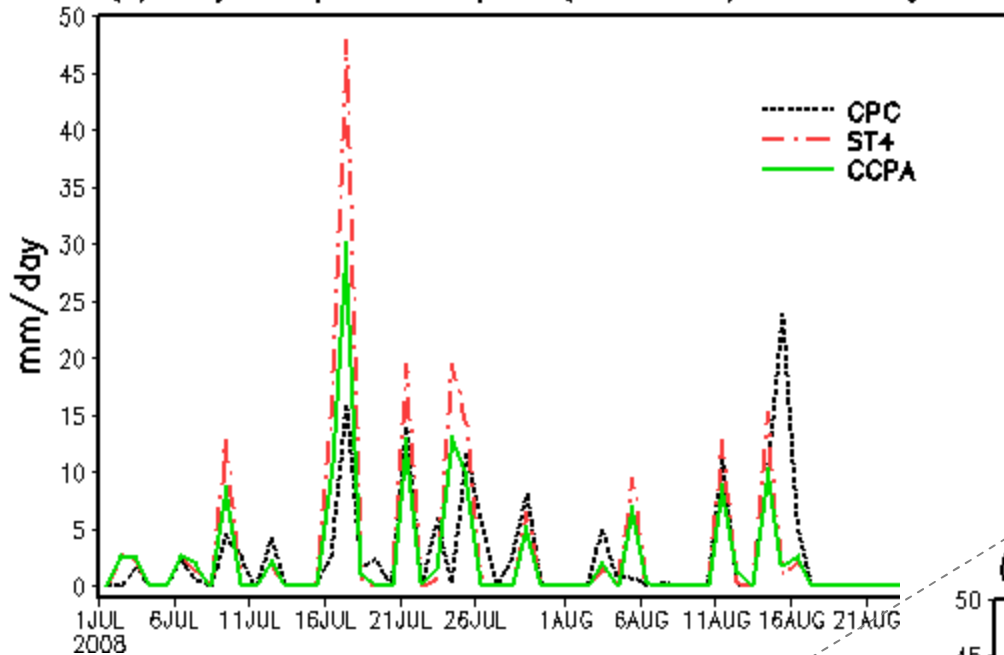


ST4\_ADJ - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



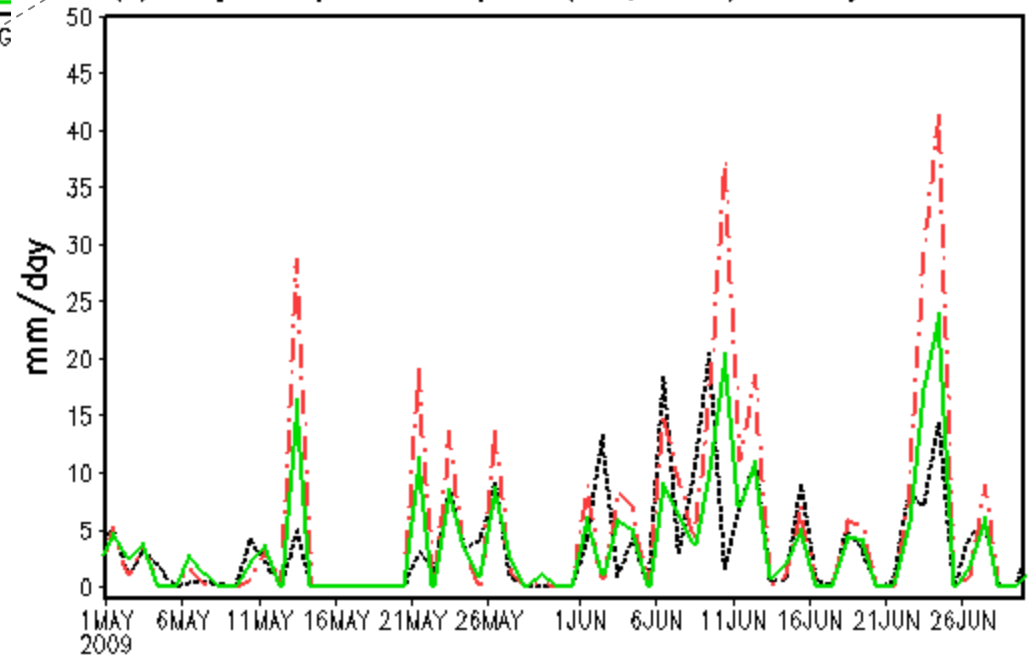
# Comparison of CCPA and Stage IV against CPC

(a) Daily Precipitation at point (42N, 102W) for Jul–Aug 2008

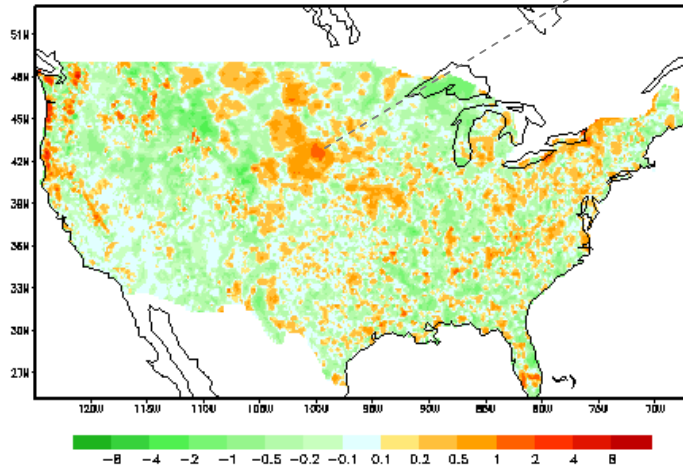


- Example: A Point (42N, 102W) near Ashby, NE in MBRFC
- Selected from 0.125 deg datasets for two warm and wet seasons

(b) Daily Precipitation at point (42N, 102W) for May–Jun 2009

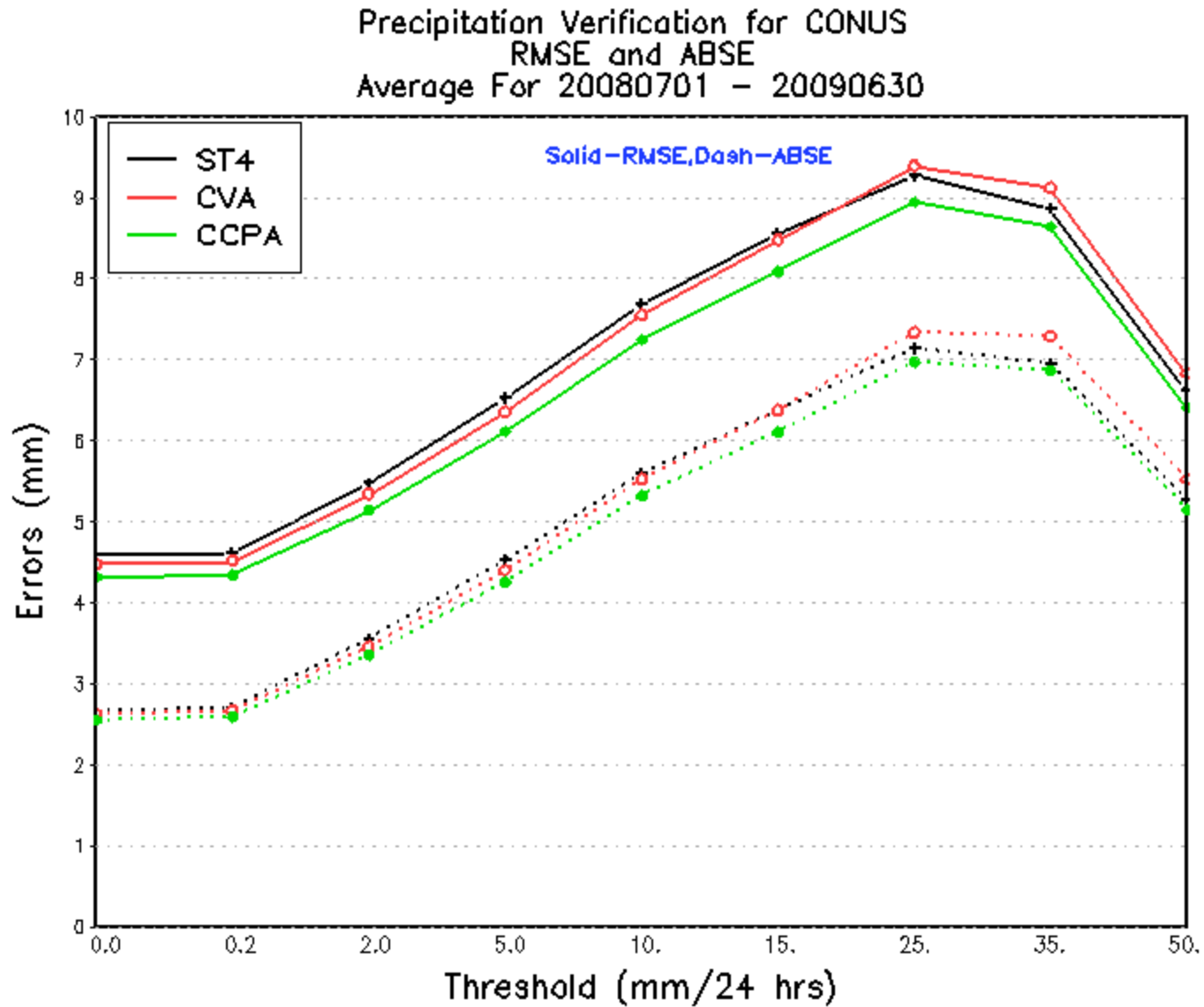


STAGE4 - CPC 0.125 deg daily, Avg for 07/01/08-06/30/09



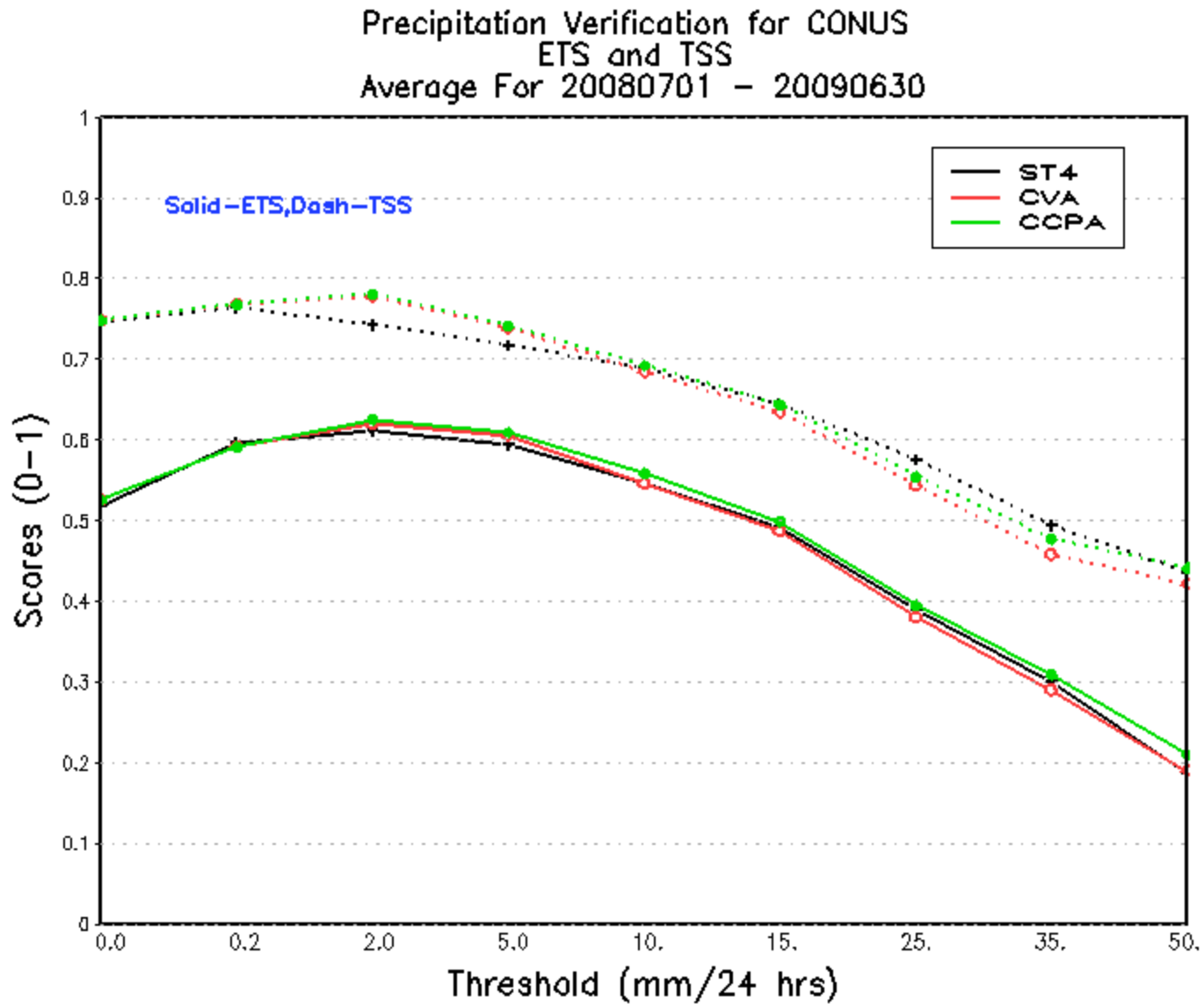
# Verification against RFC-gauge network

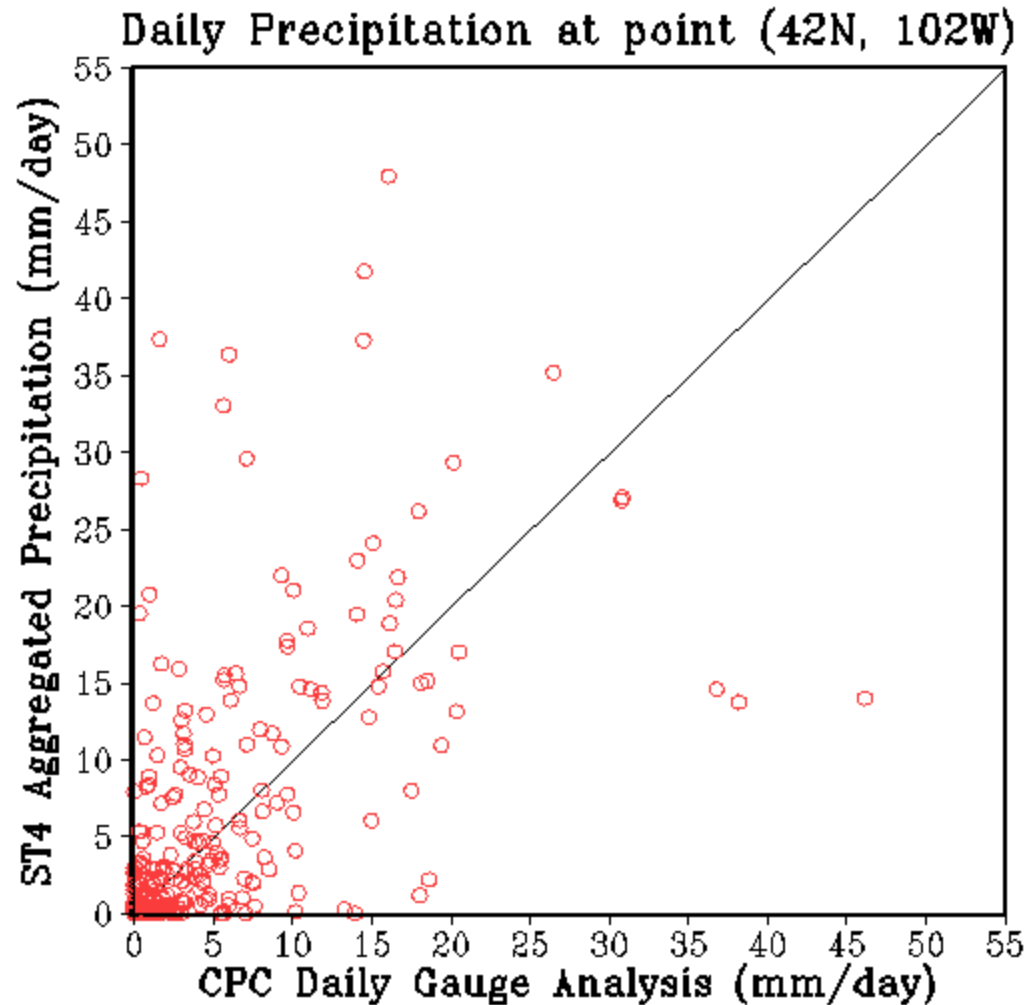
## Results – RMSE and ABSE



# Verification against RFC-gauge network

## Results – ETS and TSS





Scatter plot of Stage IV against CPC. All data pairs here are sampled to estimate regression coefficients at point (42N,102W) for day July 1<sup>st</sup> (Julian day 182).

- Different sample size for the lower and higher precipitation ranges
- Small size for heavy precipitation
- A “linear” regression likely dominated by the lower precipitation points.

# Conclusion

- CCPA methodology is robust; this is supported by the fact that cross validation analysis is fairly close to CCPA.
- Non-uniform quality control as one shortcoming of Stage IV is (at least partially) corrected.
- CCPA retains spatial and temporal patterns of Stage IV data set.
- CCPA long term average is closer to that of CPC analysis than Stage IV.
- The improvement is more significant with low and medium daily precipitation amounts.

# Limitations and Future Work

- Limitations
  - Inadequate sample of high amount precipitation
  - Validity of the simple linear regression model
- Future Work
  - Perform annual updating of the regression coefficients with increased sample size
  - Employ more realistic non-linear regression models
  - Other calibration methods