CCPA Upgrade

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Ensemble and post processing team
Environmental Modeling Center
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Climatology Calibrated Precipitation Analysis

- Motivation and background - (QPF and PQPF calibration in NCEP)
  - Implemented on 2004 (HPC, CPC endorsed)
  - Bias corrected GFS/GEFS forecasts
    - At 2.5 degree resolution, every 24 hours, using Gauge (12UTC-12UTC)
    - Using decay average (or Kalman Filter) method for sampling
    - Using frequency match algorithm for CDF of OBS/FCST
- Climatological Calibrated Precipitation Analysis (CCPA)
  - Use CPC unified analysis at 1/8 degree, daily, global land - reliability
  - Use RFC/QPE (stage IV) 5km resolution, 6-h(CONUS) – resolution
  - Use regression method to generate a and b from above two datasets
  - Produce CCPA analysis (CCPA = $a*QPE_{rfc} + b$)
  - Resolution is 5km (NDGD) grid (and subsets) for CONUS for current production
  - Update frequently by apply longer stage IV to produce better regression coefficients
- Important Applications
  - Improving QPF/PQPF bias correction – GEFS, NAEFS, SREF and etc…
  - Statistical downscaling QPF/PQPF forecast for GEFS, NAEFS, SREF and etc…
  - WPC daily precipitation analysis products – CCPA web products (2012)
  - Daily precipitation verifications (WPC and EMC meg briefing)
  - NAM's precipitation analysis
  - Hydrological application – NWC and RFC
  - Research Communities
- Reference
  - Publication: http://journals.ametsoc.org/doi/abs/10.1175/JHM-D-11-0140.1
  - Web display (EMC): http://www.emc.ncep.noaa.gov/gmb/yluo/CCPA.html

Highlights of CCPA Upgrade

- Update regression coefficients by extending training data sets of CPC gauge based analysis and STAGE IV multi-sensor estimation
  - Current: 7 years (2002-2009)
  - Upgrade: 13 years (2002-2015)
  - Expectation: Improved analysis with expanded training data sets

- Make change to 3-hr CCPA due to poor data quality of Stage IV hourly data in CNRFC area
  - Current: using Stage II hourly in NWRFC only
  - Upgrade: will use Stage II hourly in both NWRFC and CNRFC
  - Expectation: Improve 3-hr CCPA with more accurate weights

- Make change to CCPA rerun schedule
  - Current: rerun at 1 day only after ending of the accumulation time
  - Upgrade: rerun at 1/3/5/7days
  - Expectation: Improved analysis with more accurate Stage IV inputs

Updating Regression Coefficients

1. Historical data sets
   Operational : June 1 2002 to July 31 2009 For CPC and STAGE IV
   Updated: June 1 2002 to July 31 2015 (six more years of data)

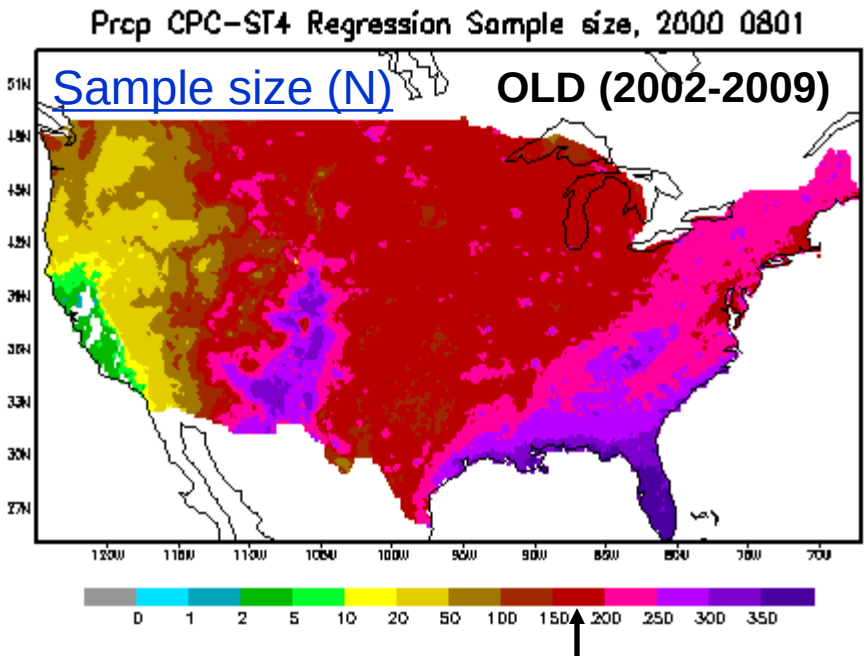
2. Match resolutions
   a. Accumulate RFC over 24 hours
   b. Interpolate to ⅛° (copygb w/ volume preservation)

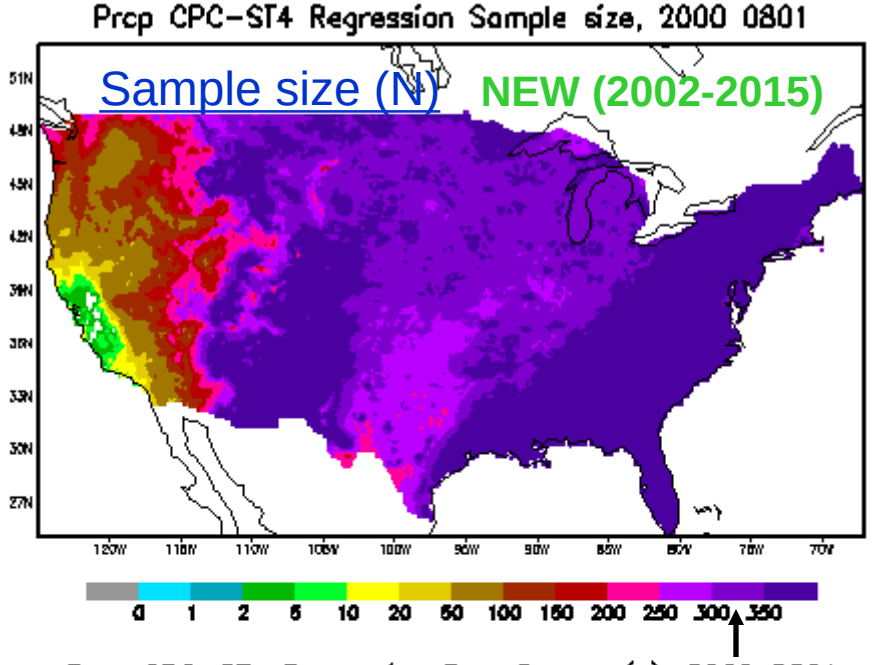
3. Collect precip samples
   a. For each day of the year and at each grid point, collect all precip within 60 day window centered around that day, over all 13 years (max ~793 data points)
   b. Use only data points with ST4 > 0

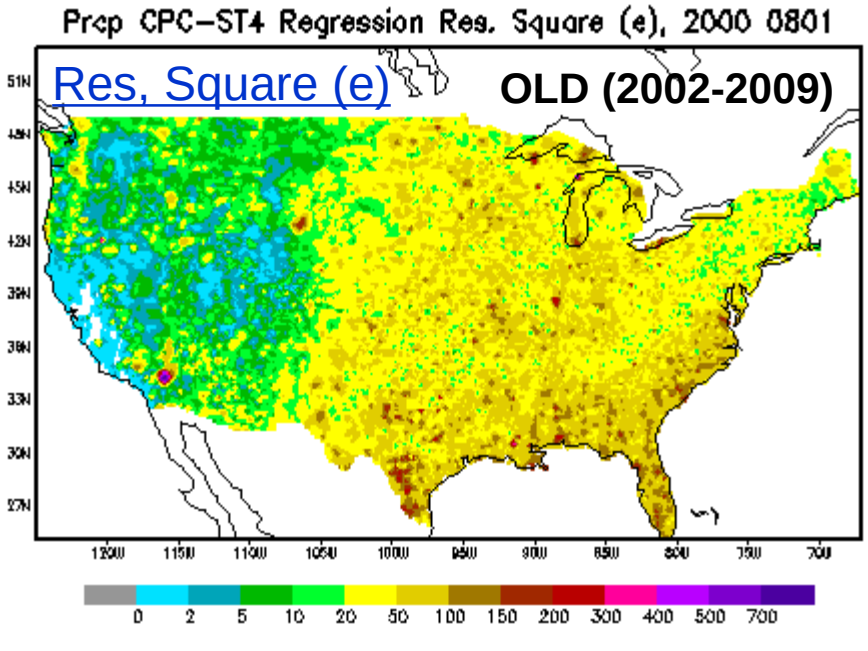
4. Linear regression
   – CPC = a·ST4 + b

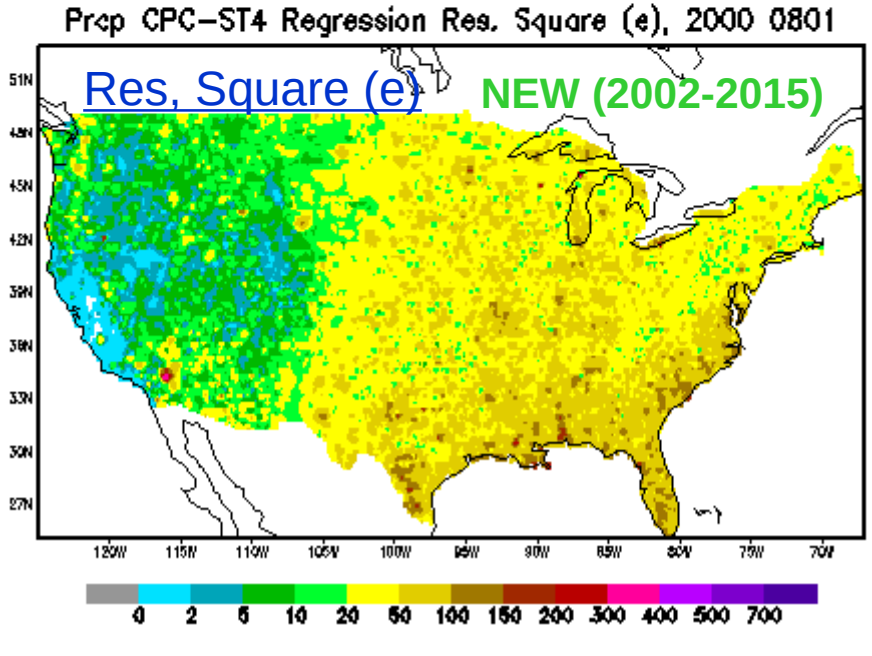
5. End Result
   – Linear relationship (a & b) on ⅛° grid for each day of the year

Example of Regression for August 1st

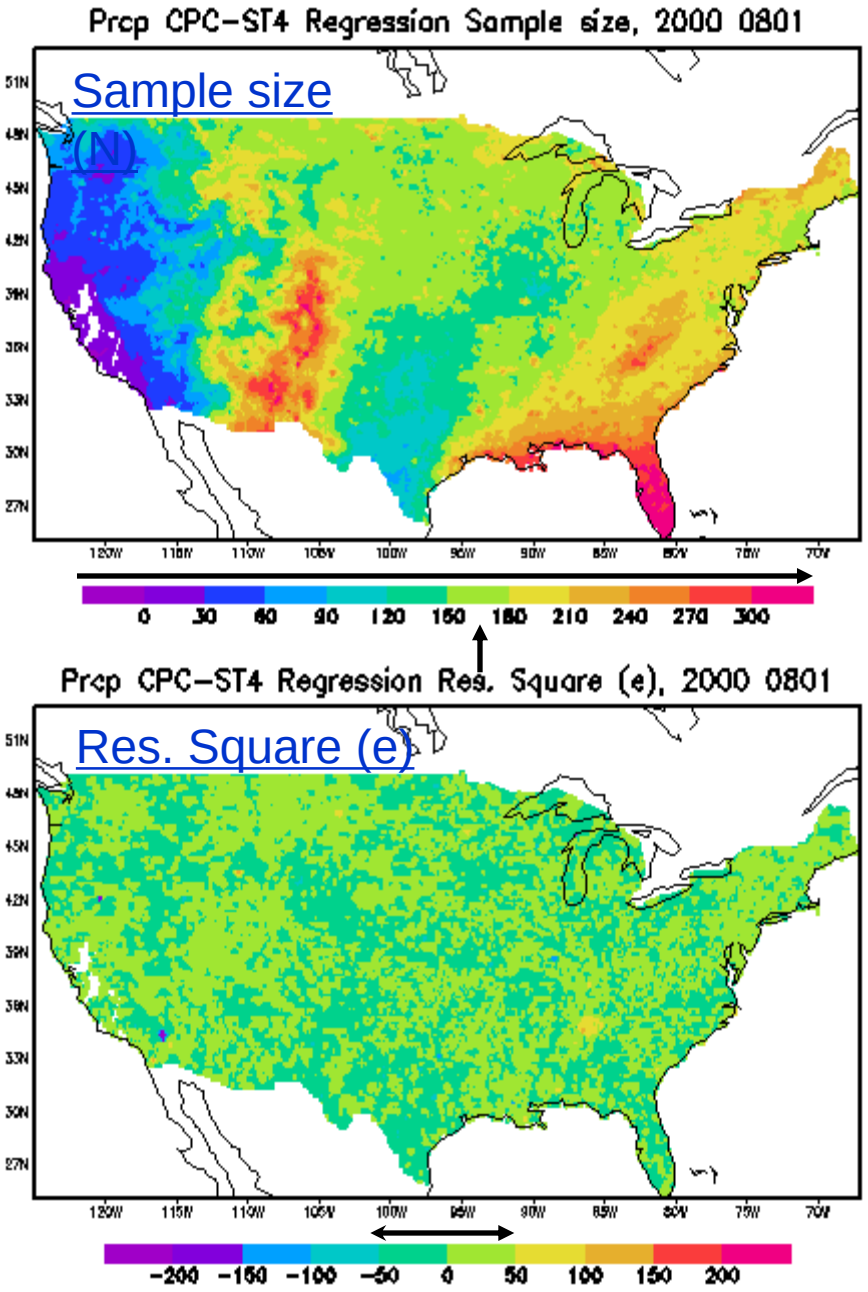




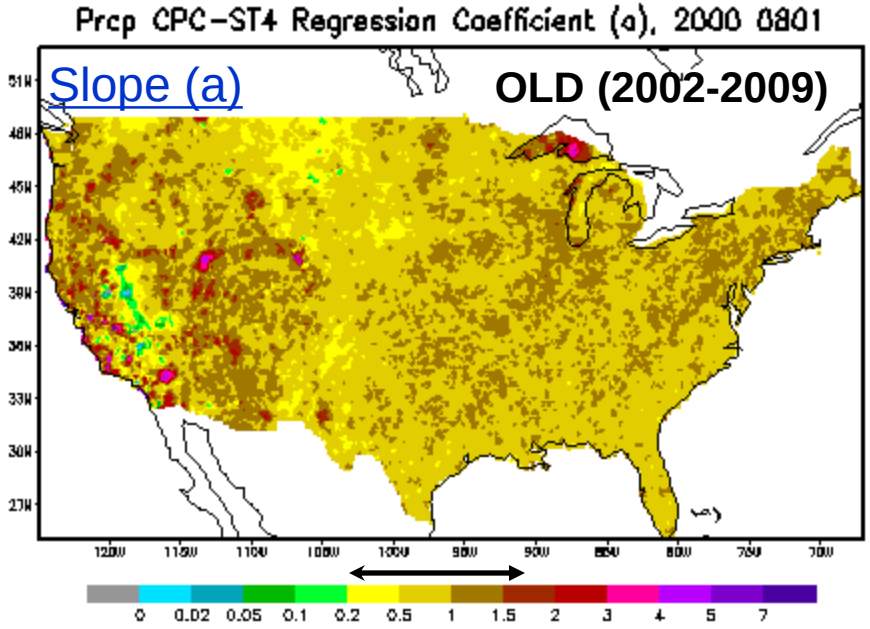


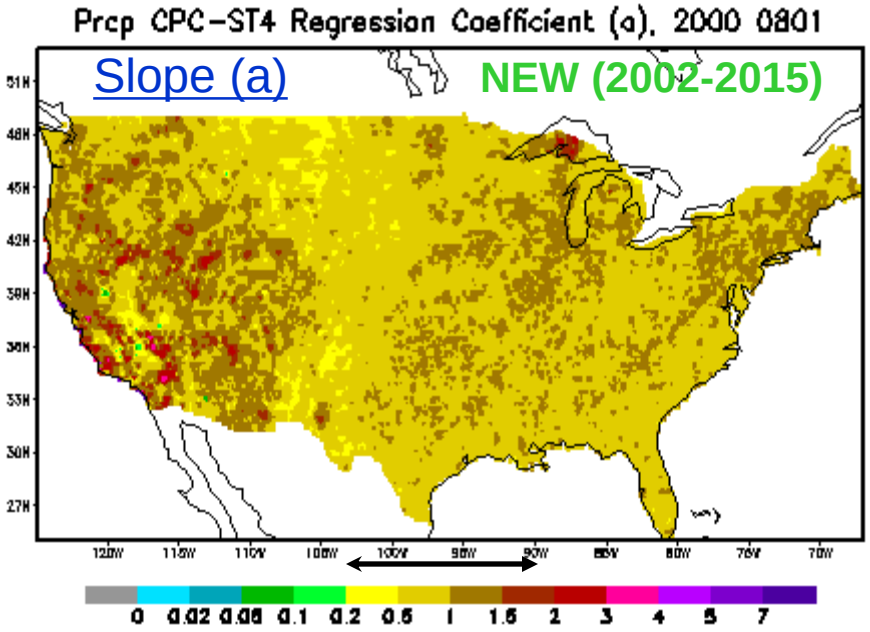


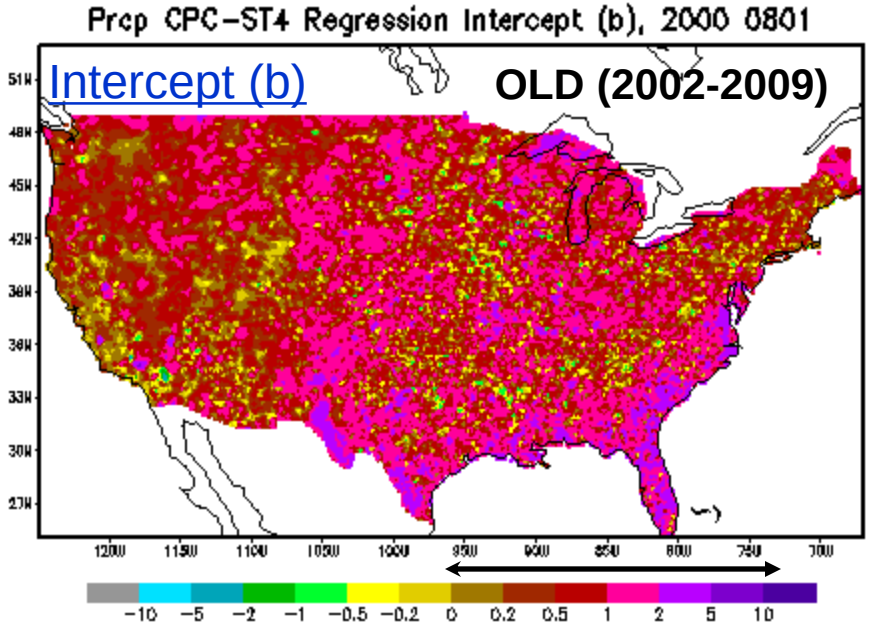
Regression for Aug. 1st – Difference (NEW-OLD)

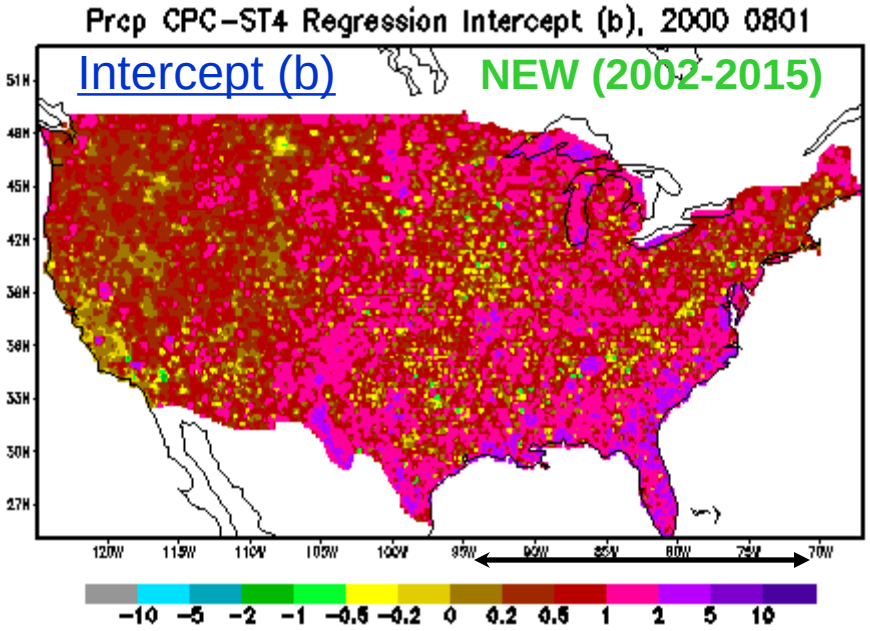


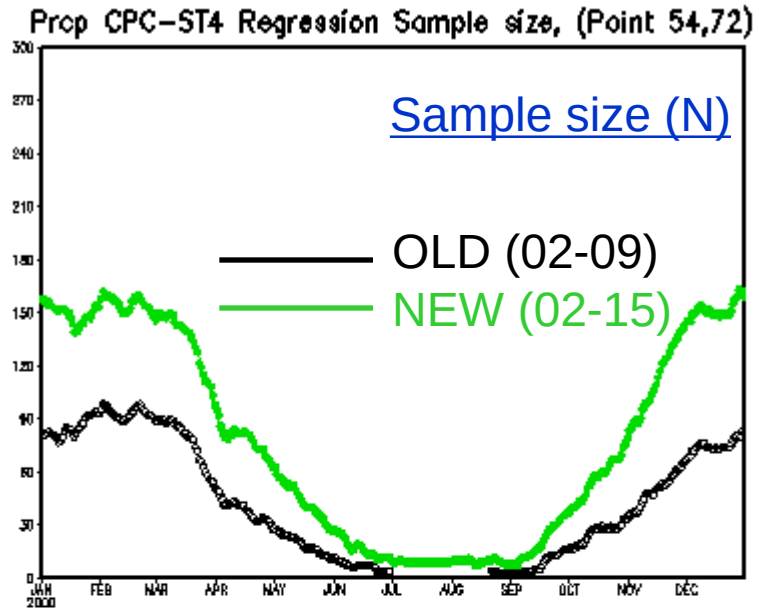
Example of Regression for Aug. 1st

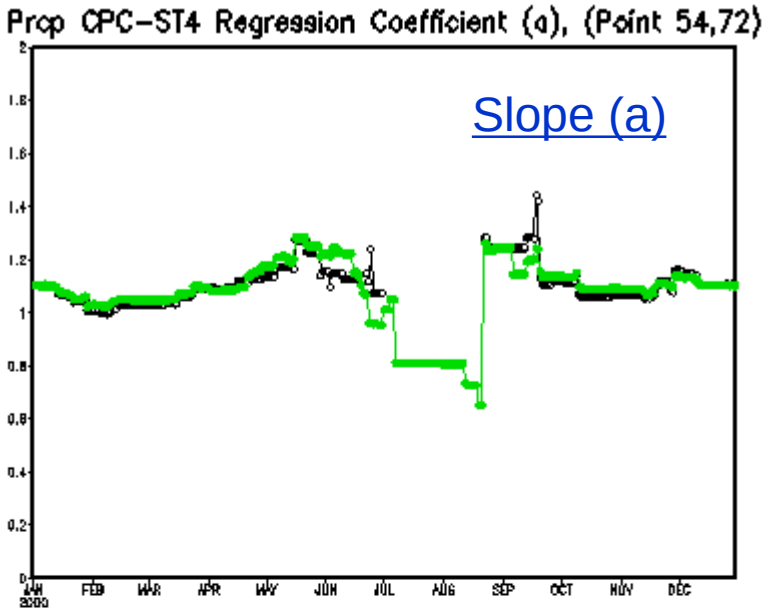




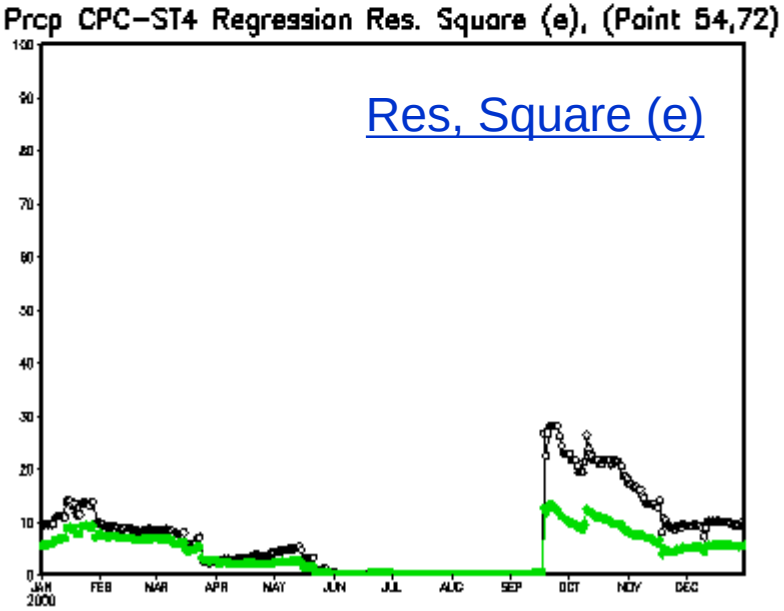


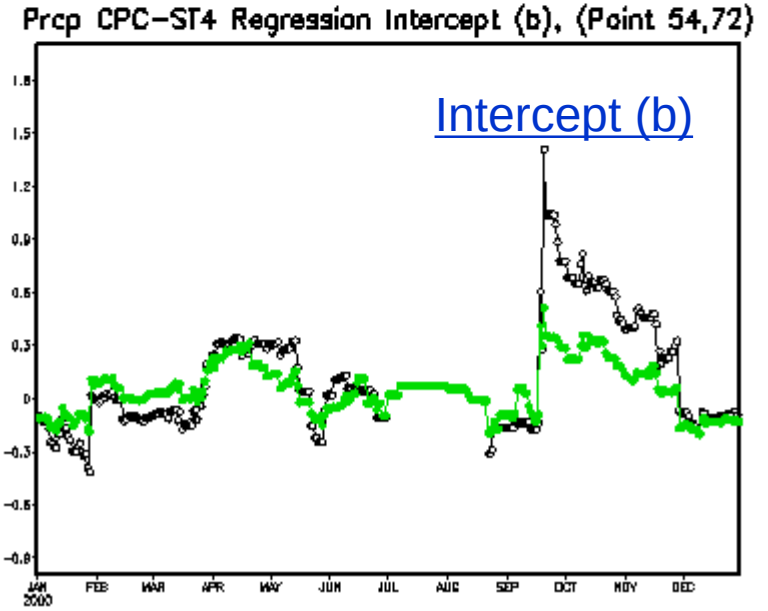




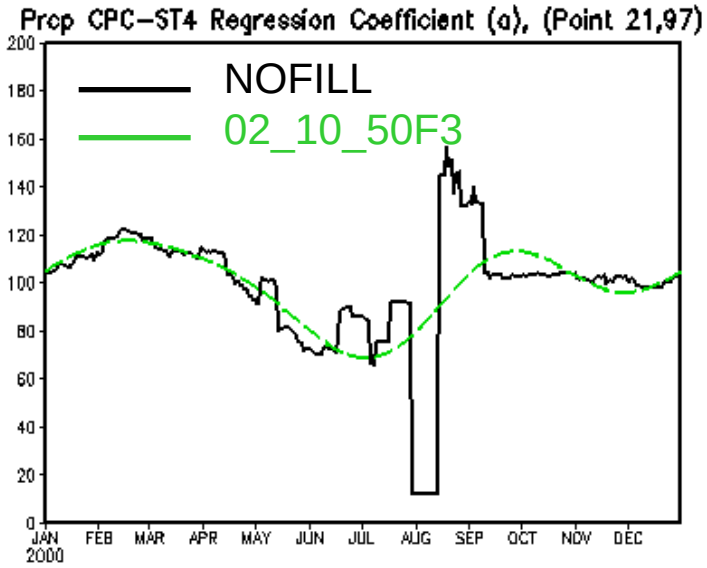


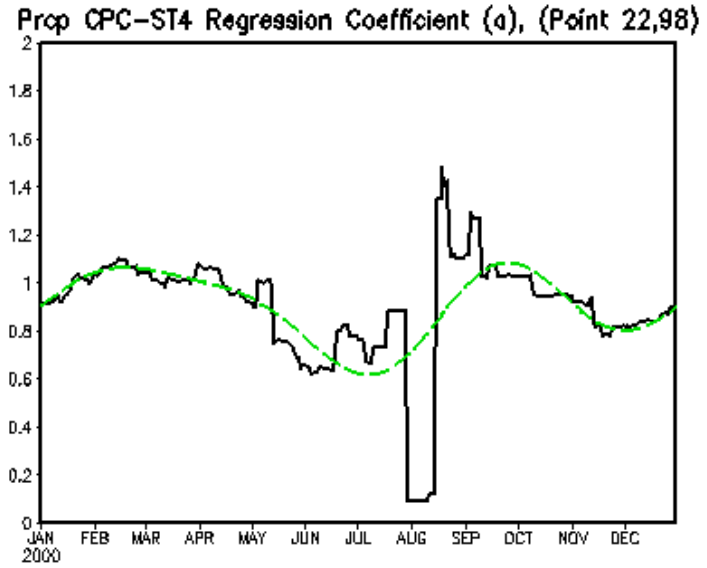
Time series of regression

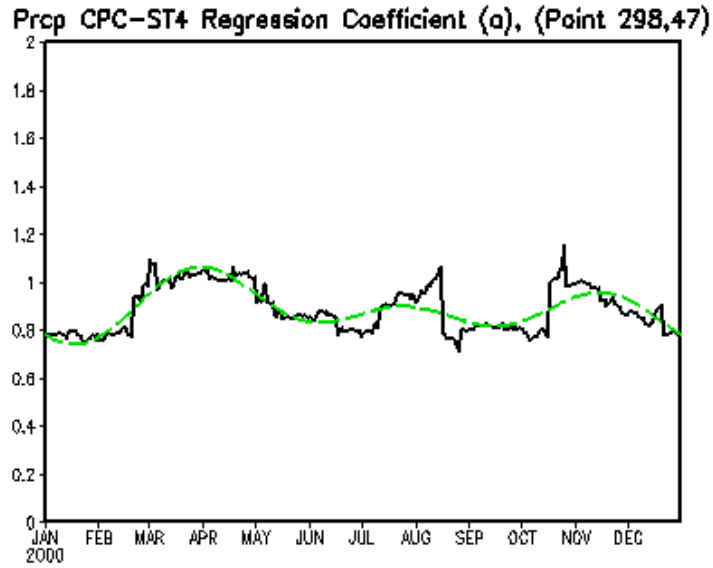


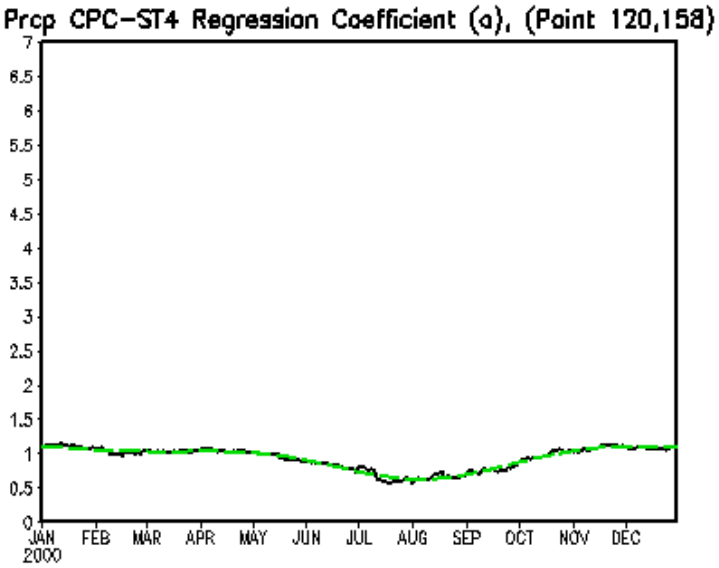


Temporal Smoothing (3 harmonics) of a

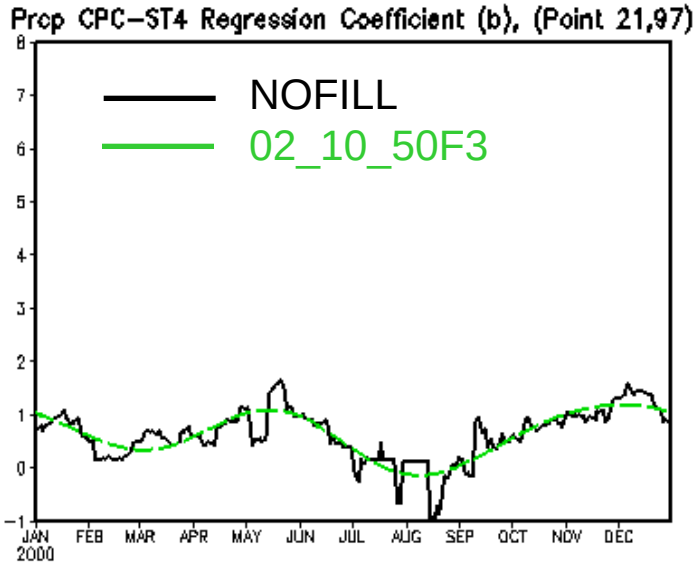


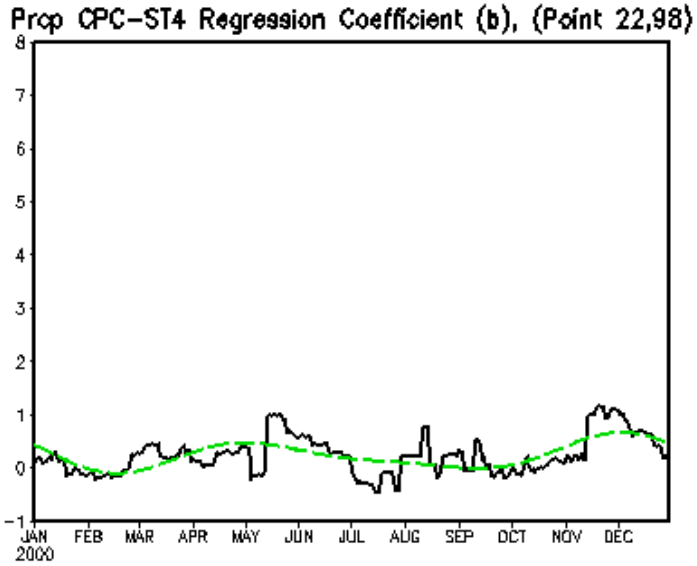


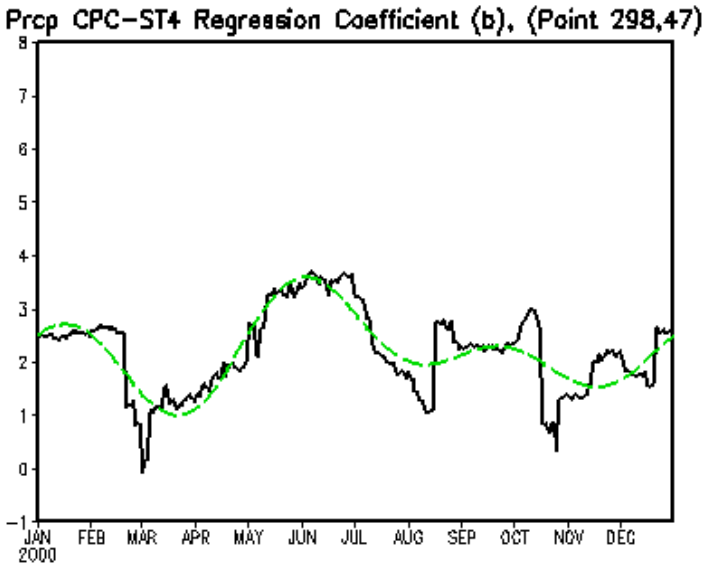


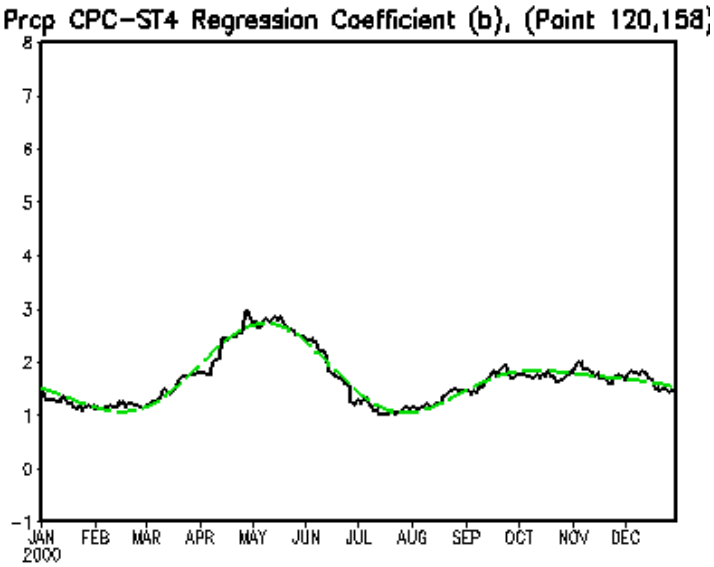


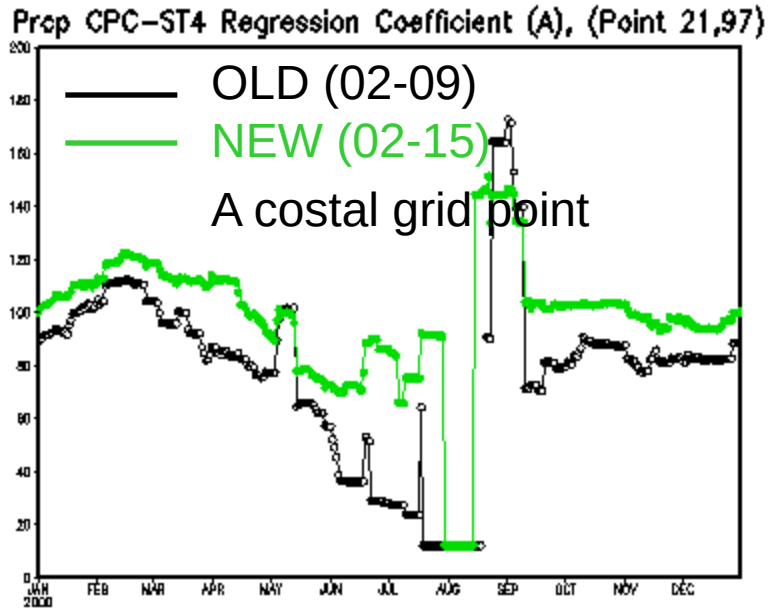
Temporal Smoothing (3 harmonics) of b

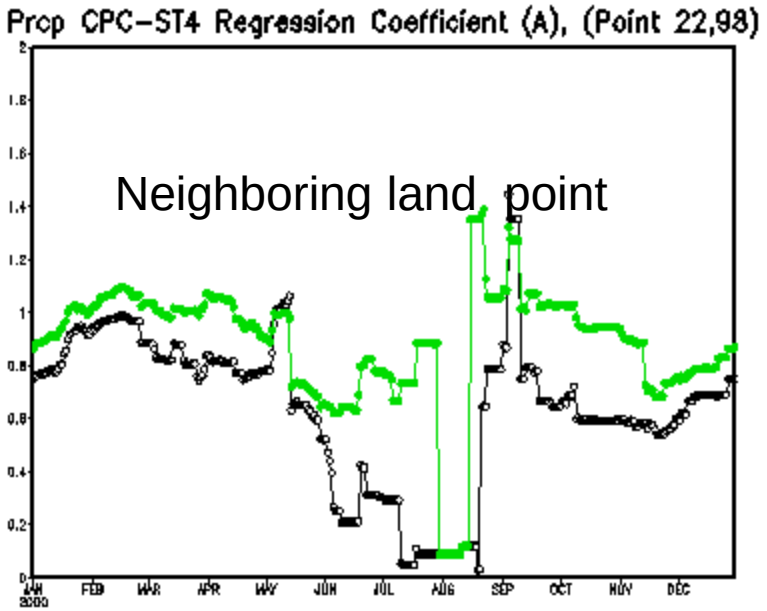




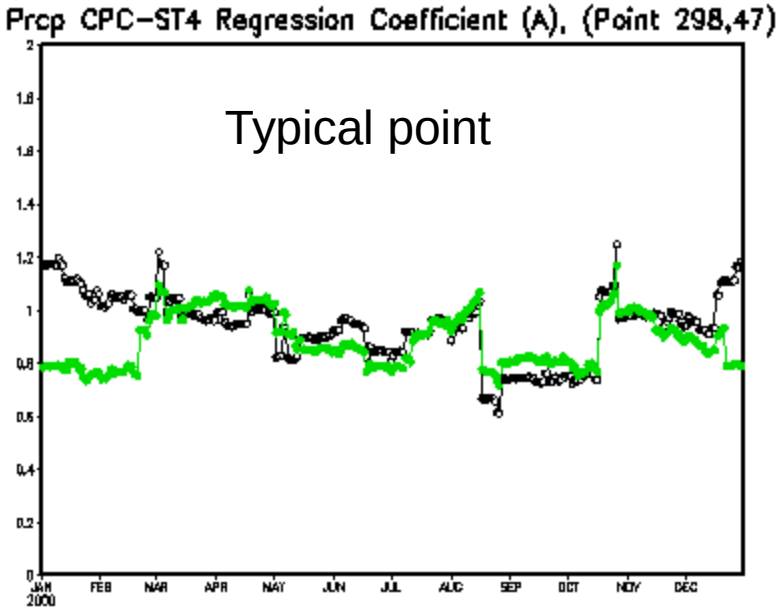


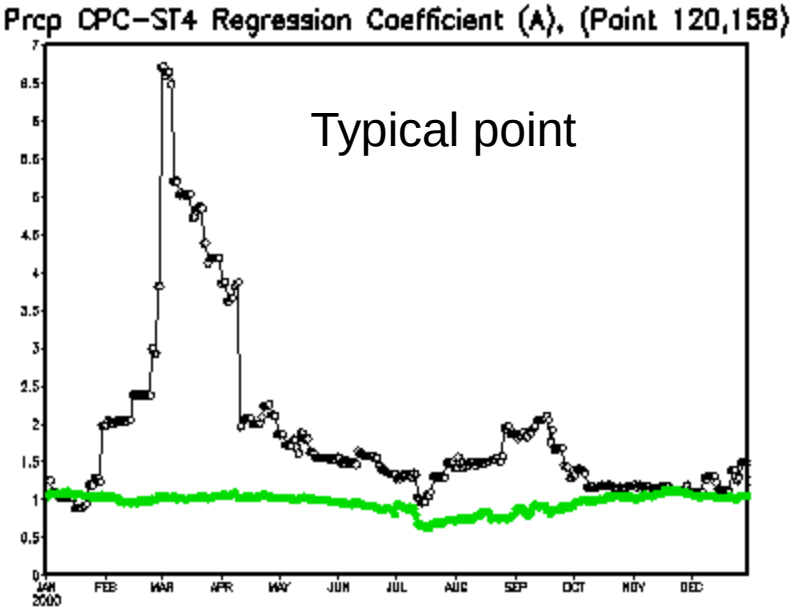


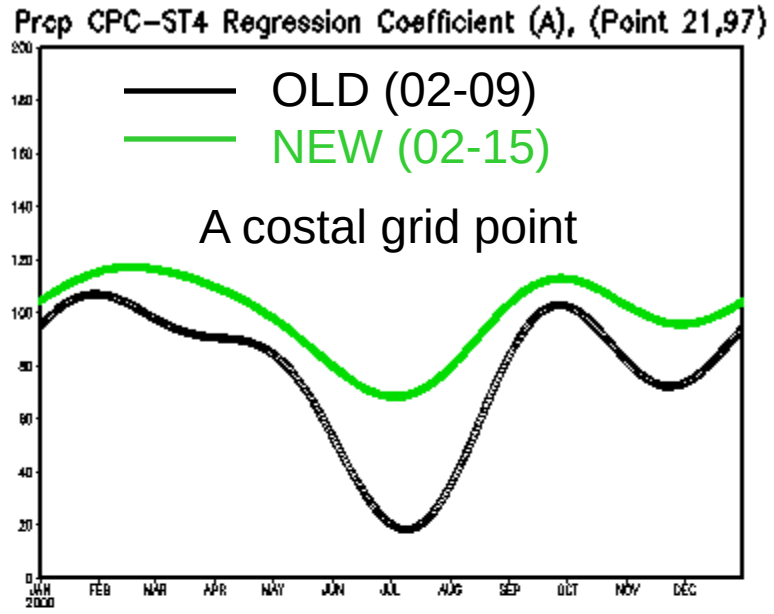

Prcp CPC-ST4 Regression Coefficient (A), (Point 21,97)
OLD (02-09)
NEW (02-15)
A costal grid point

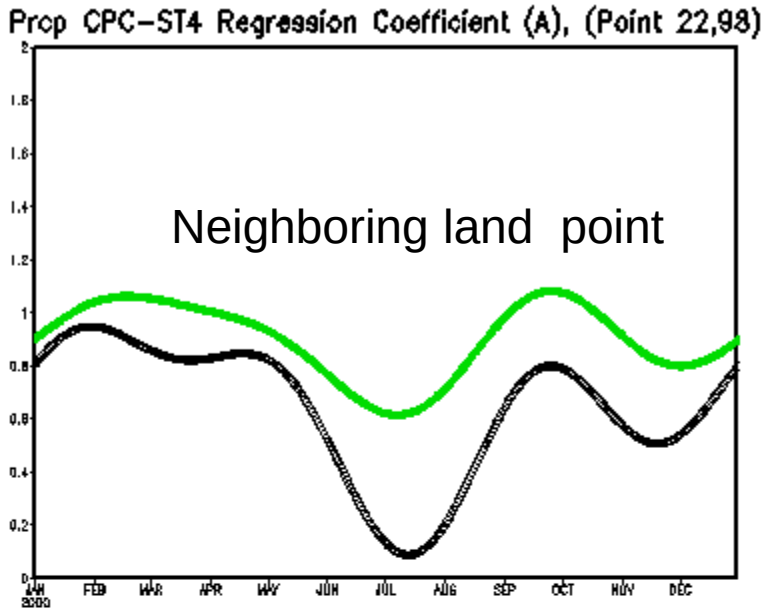

Prcp CPC-ST4 Regression Coefficient (A), (Point 22,98)
Neighboring land point

Slope (a)

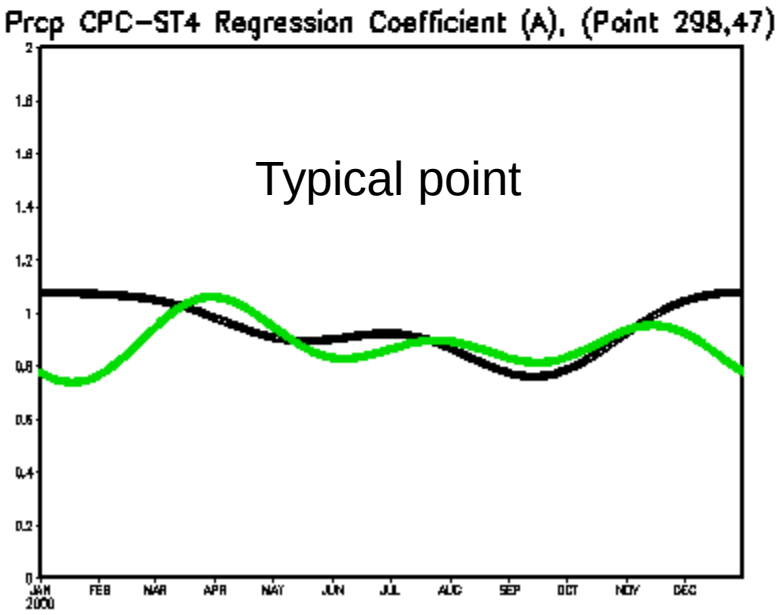

Prcp CPC-ST4 Regression Coefficient (A), (Point 298,47)
Typical point

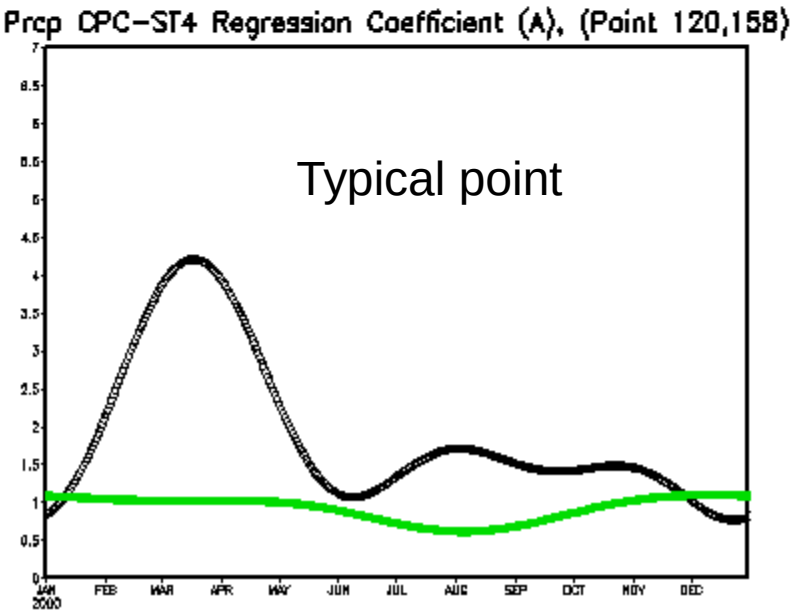

Prcp CPC-ST4 Regression Coefficient (A), (Point 120,158)
Typical point

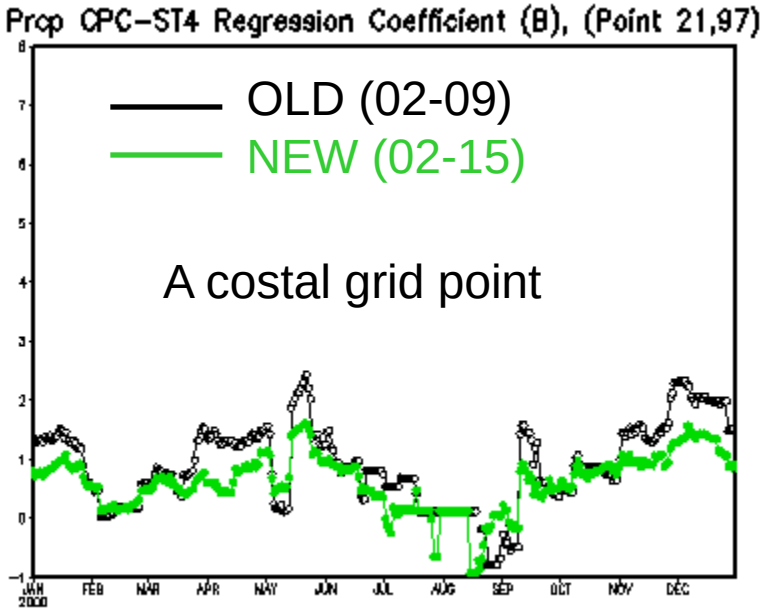




Slope (a) – smoothed






Prcp CPC-ST4 Regression Coefficient (B), (Point 21,97)
OLD (02-09)
NEW (02-15)
A costal grid point
JAN 2000
FEB
MAR
APR
MAY
JUN
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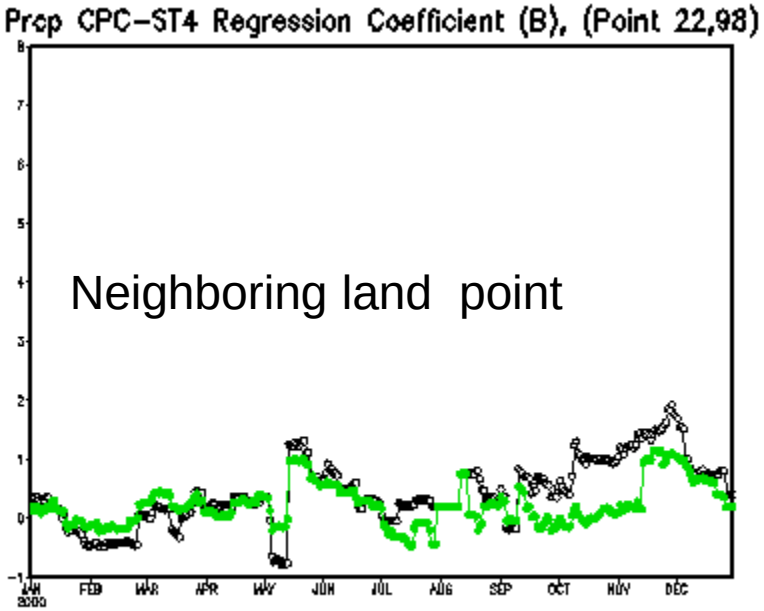
SEP
OCT
NOV
DEC


Prcp CPC-ST4 Regression Coefficient (B), (Point 22,98)
Neighboring land point
JAN 2000
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
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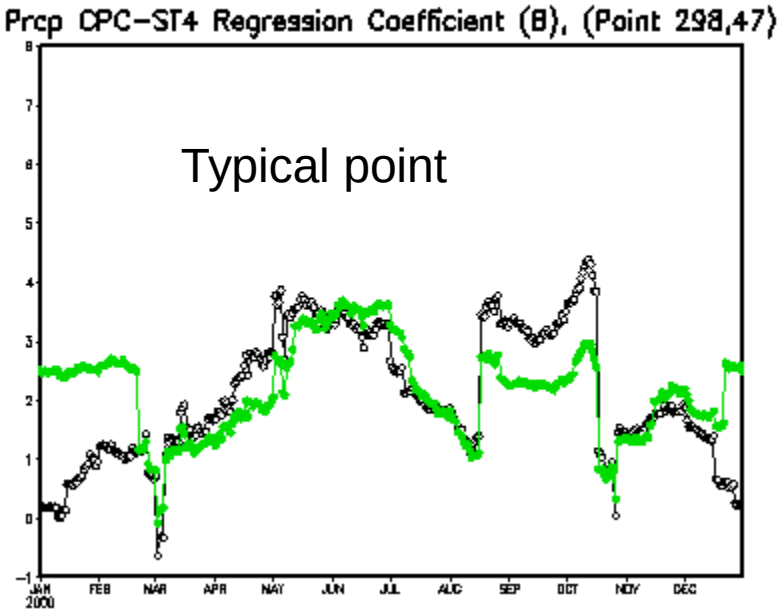
NOV
DEC

Intercept (b)


Prcp CPC-ST4 Regression Coefficient (B), (Point 298,47)
Typical point
JAN 2000
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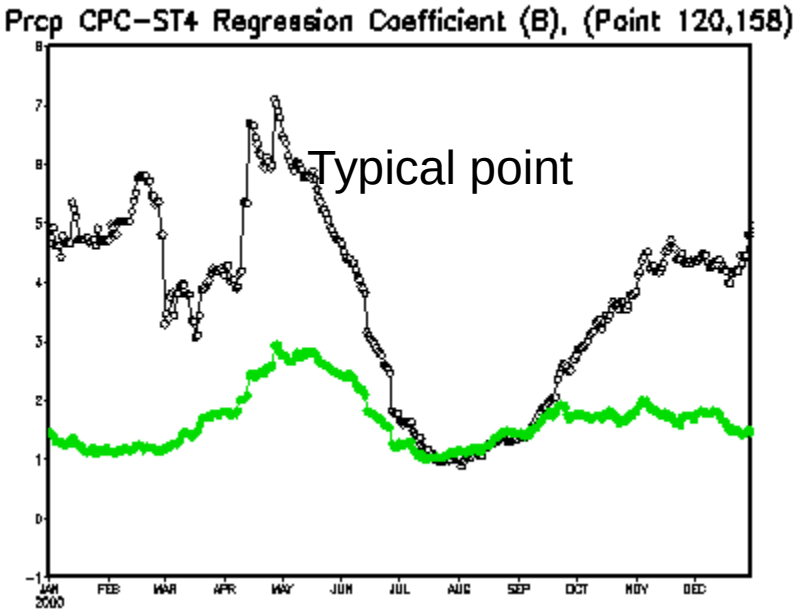
Prcp CPC-ST4 Regression Coefficient (B), (Point 120,158)
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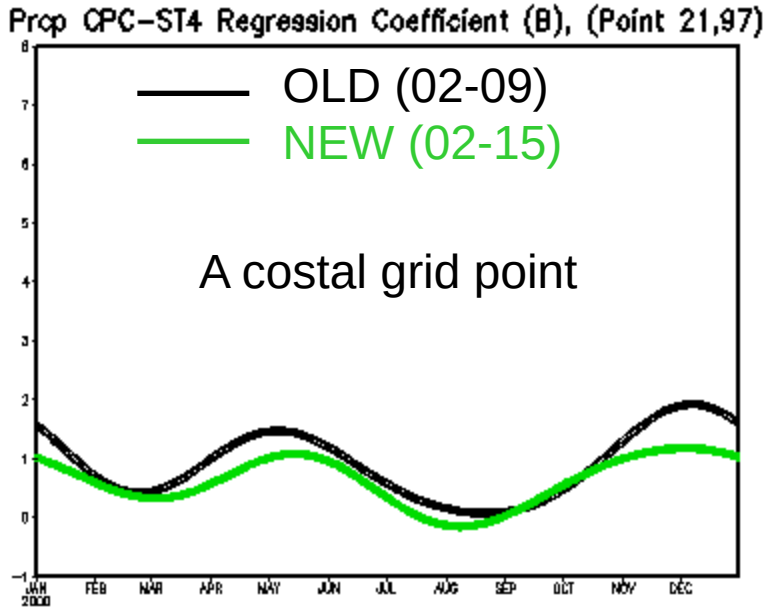
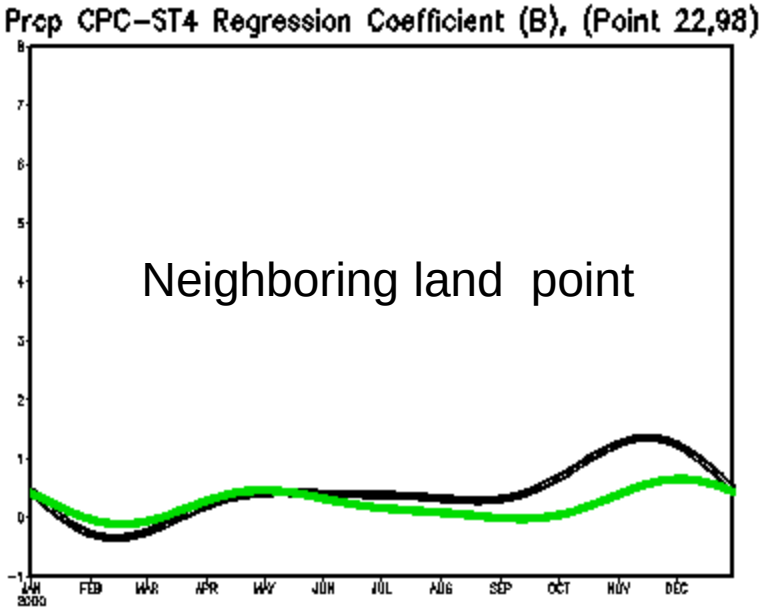
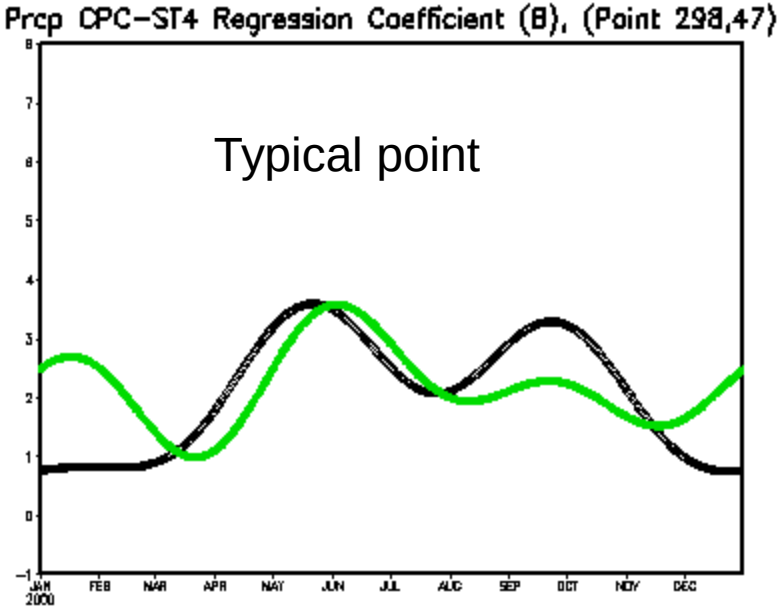
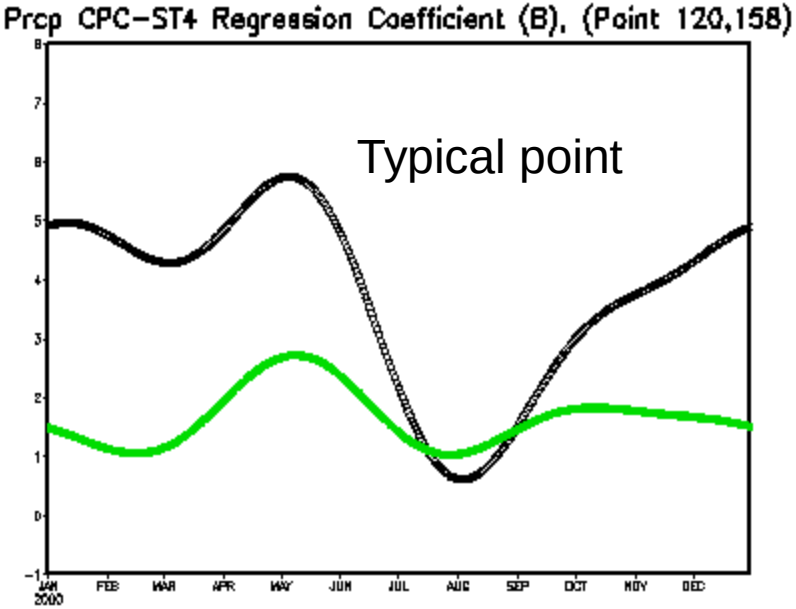


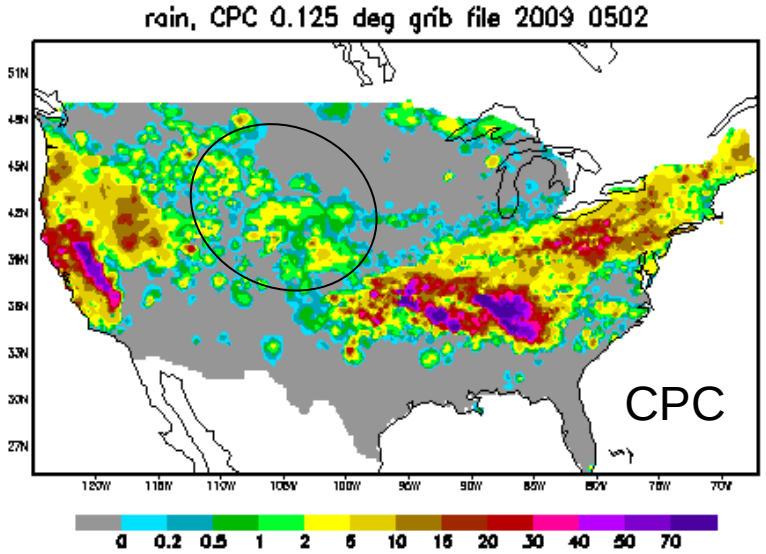


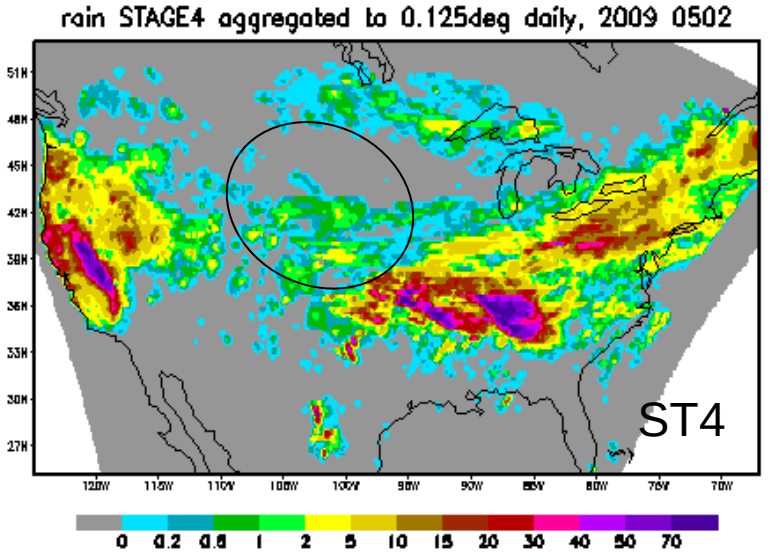
Intercept (b) – smoothed

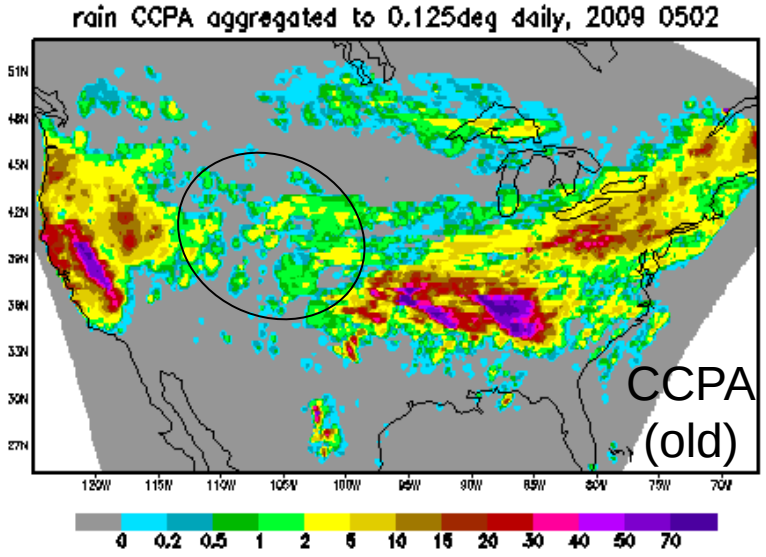


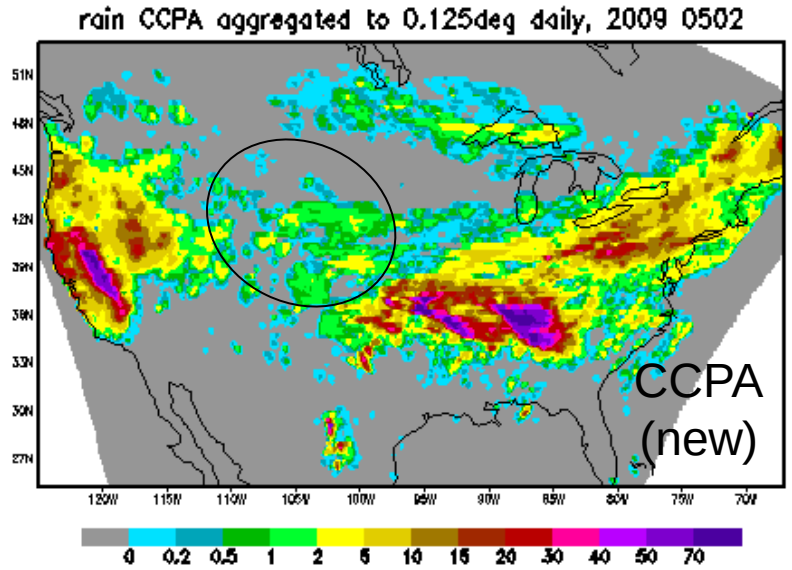


Example of analyses (24hours valid at 12Z May 02 2009)





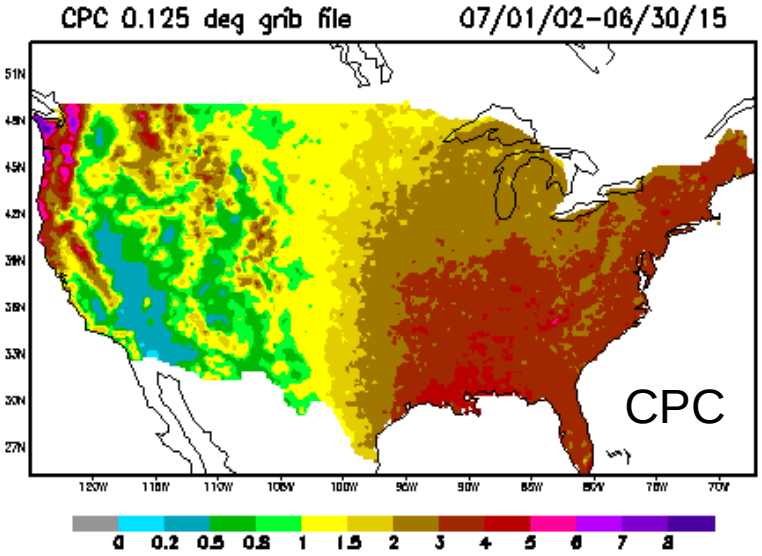


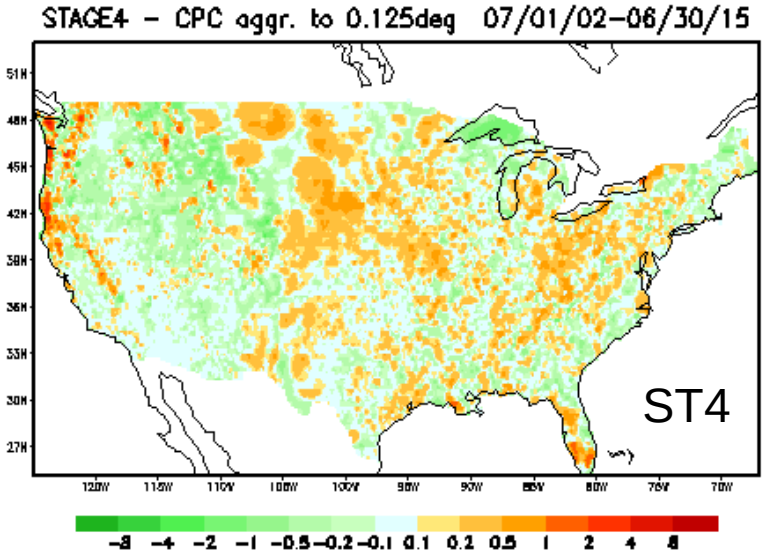


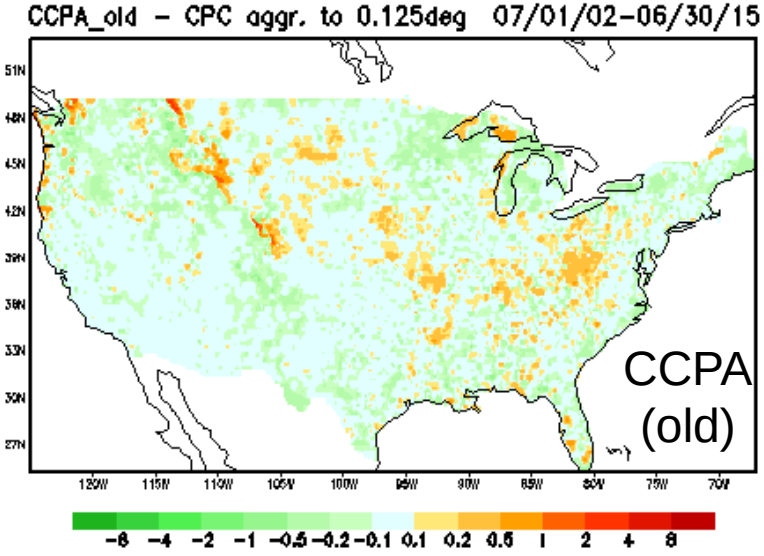
$CCPA\_old = a_{7yr} \cdot ST4 + b_{7yr}$

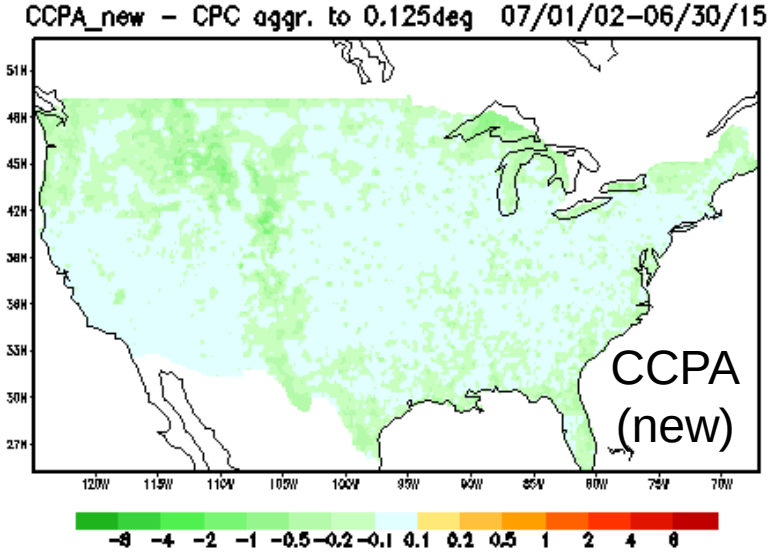
$CCPA\_new = a_{13yr} \cdot ST4 + b_{13yr}$

Comparison against CPC analysis

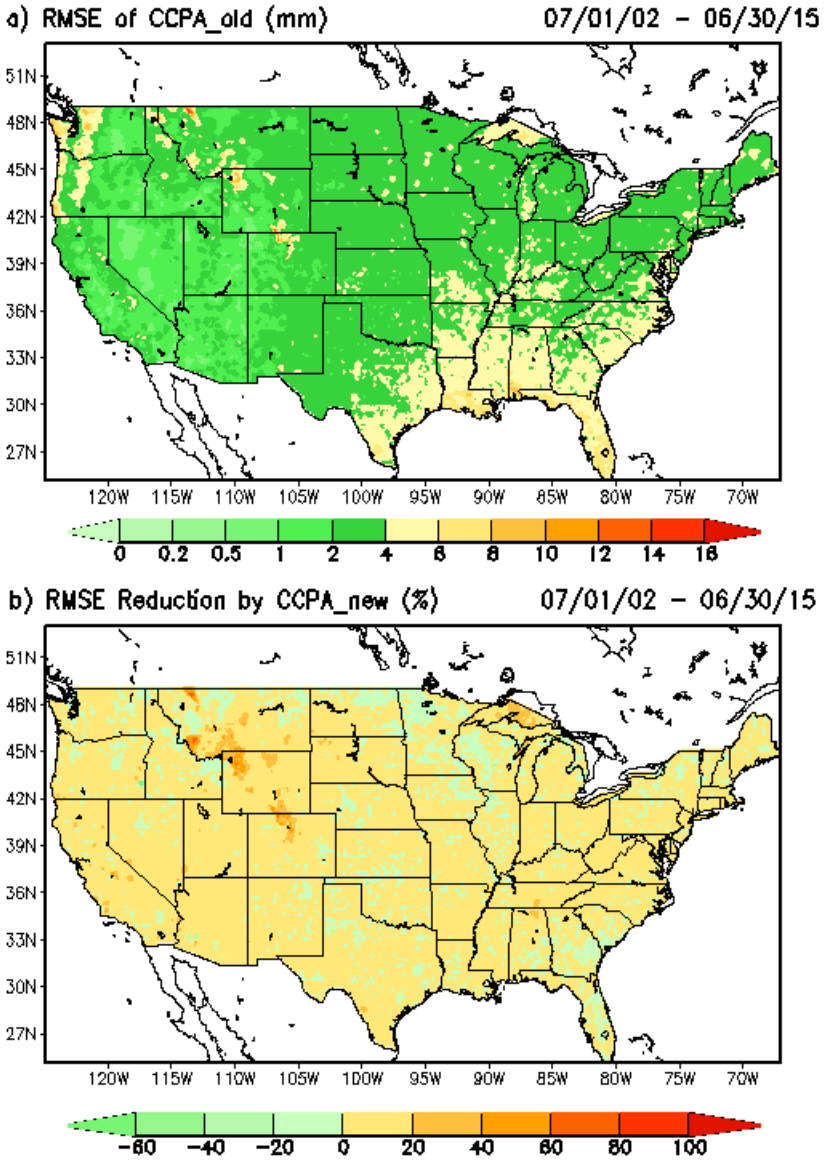




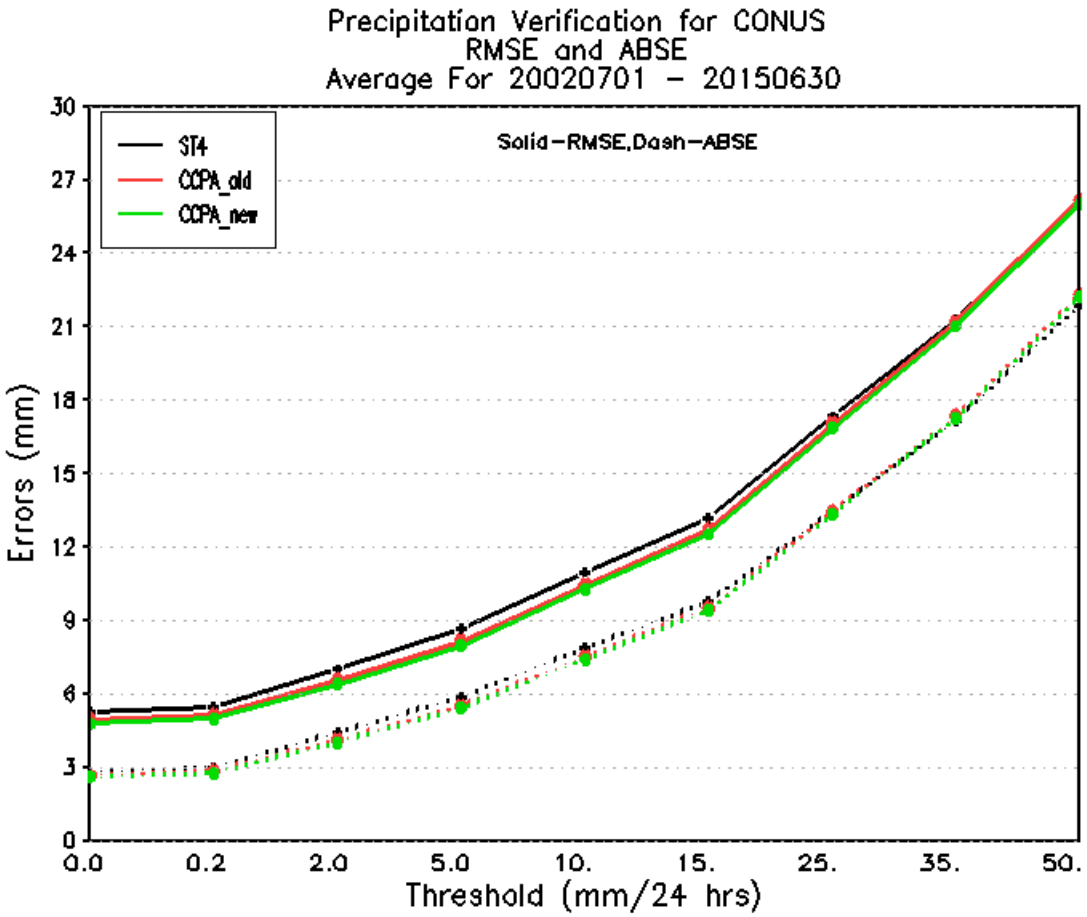




Comparison against CPC analysis



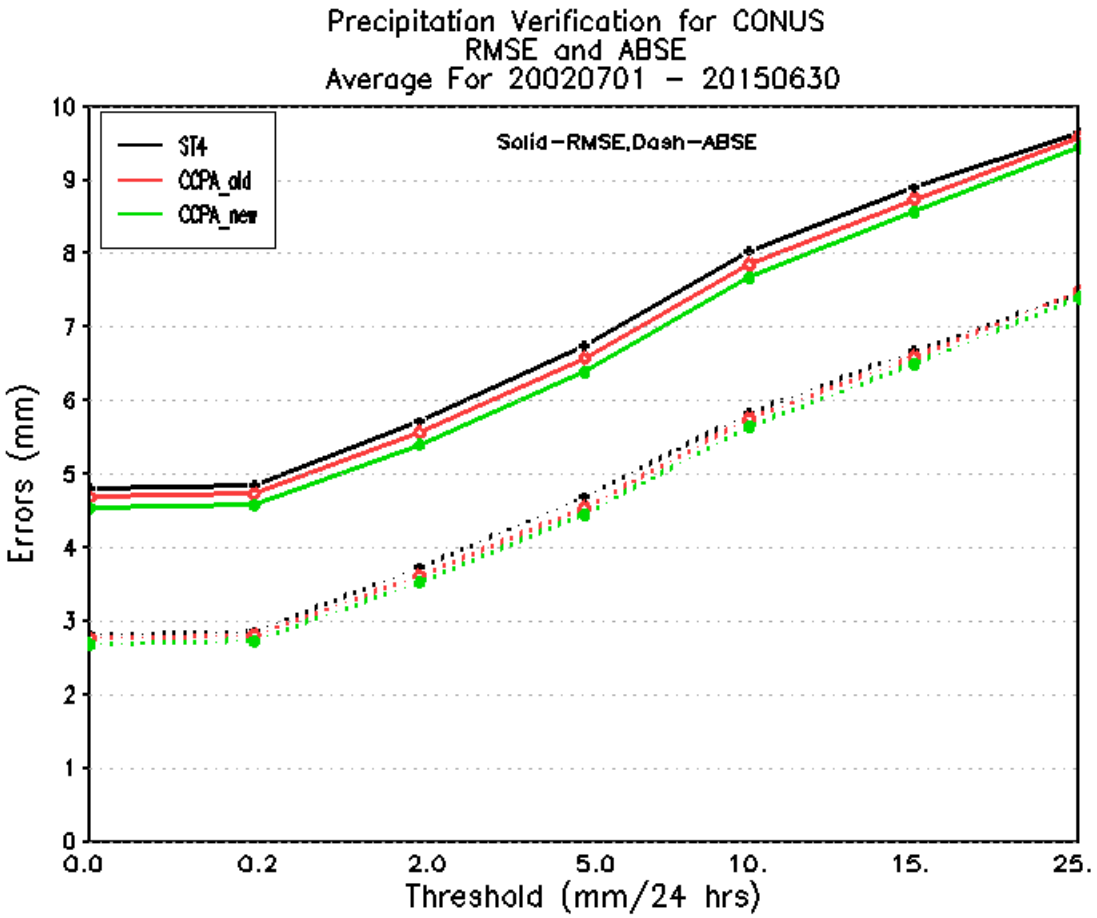
Evaluation against CPC Analysis



Greater than thresholds

Evaluation against observation

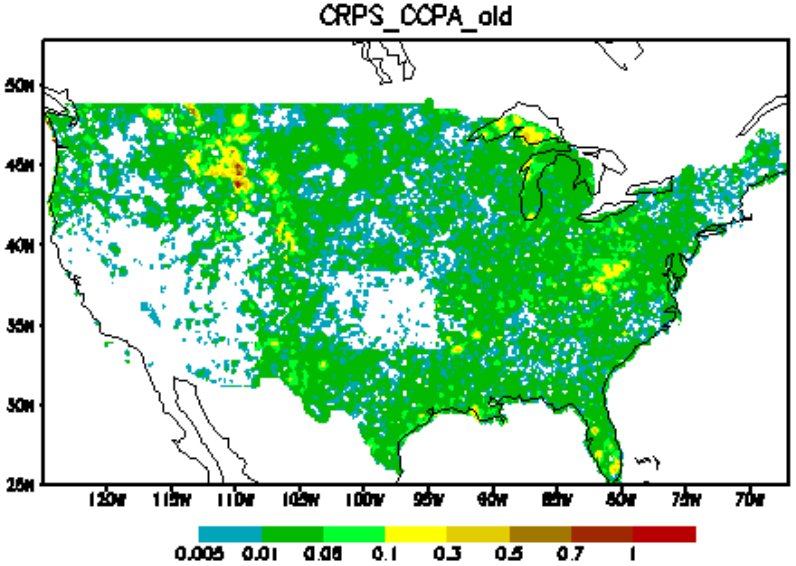
(RFC rain-gauge network)

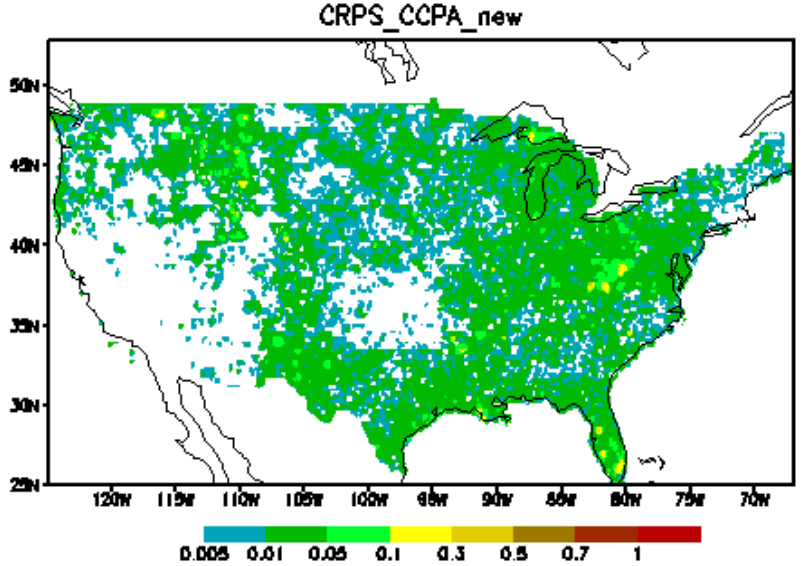


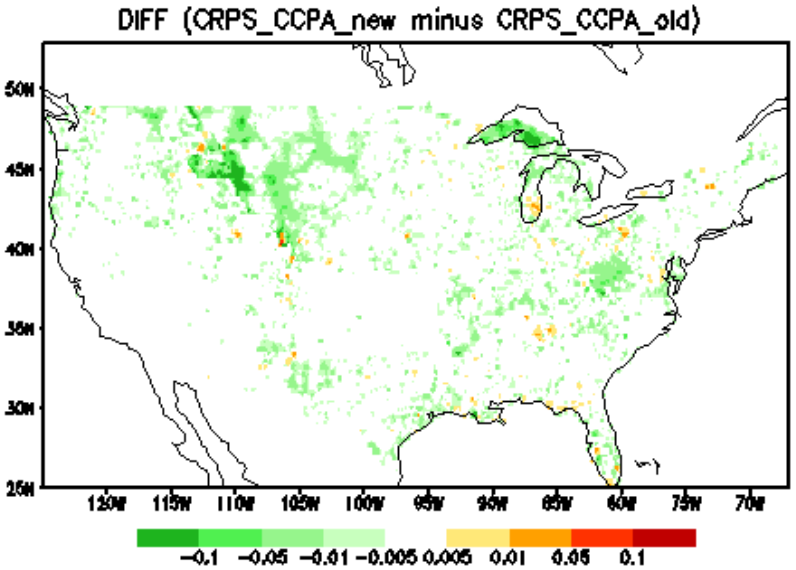
Greater than thresholds

Comparison of CCPA production (old) and parallel (new) - CRPS

$$\text{CRPS} = \sum_{i=1}^{npoint} \sum_{j=1}^{nthres} \left[\frac{1}{nday} \sum_{k=1}^{nday} Count_{ccpa}(i,j,k) - \frac{1}{nday} \sum_{k=1}^{nday} Count_{cpc}(i,j,k) \right]^2$$





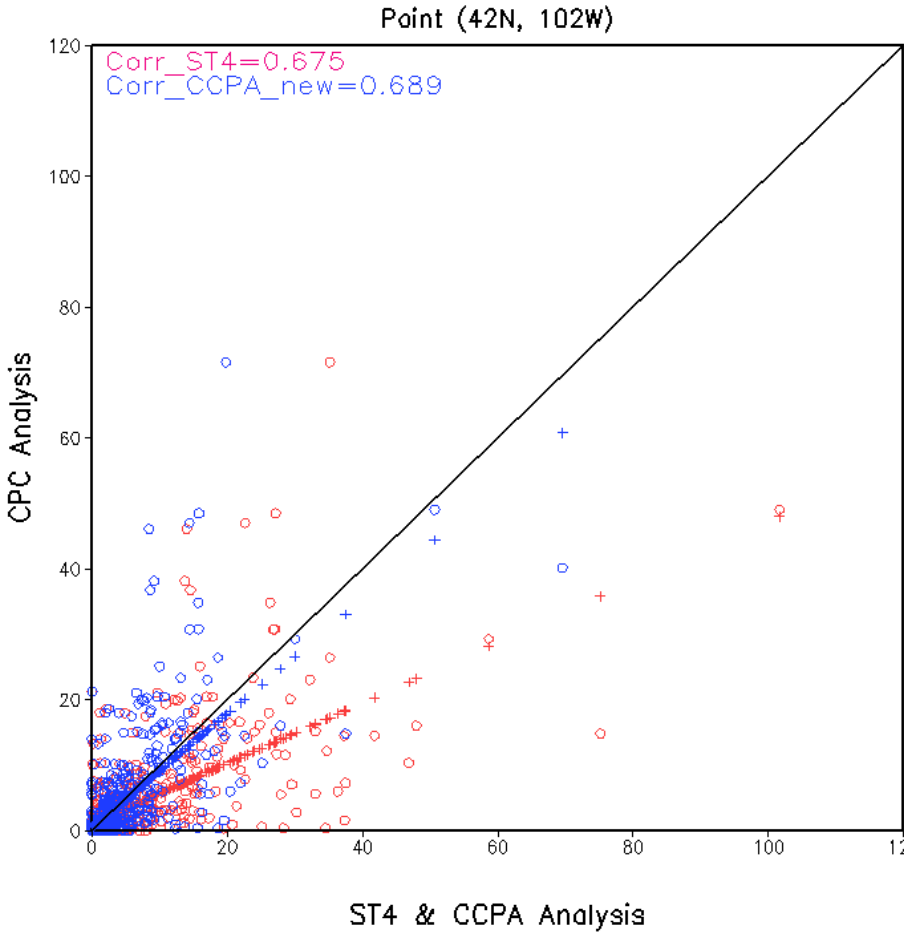


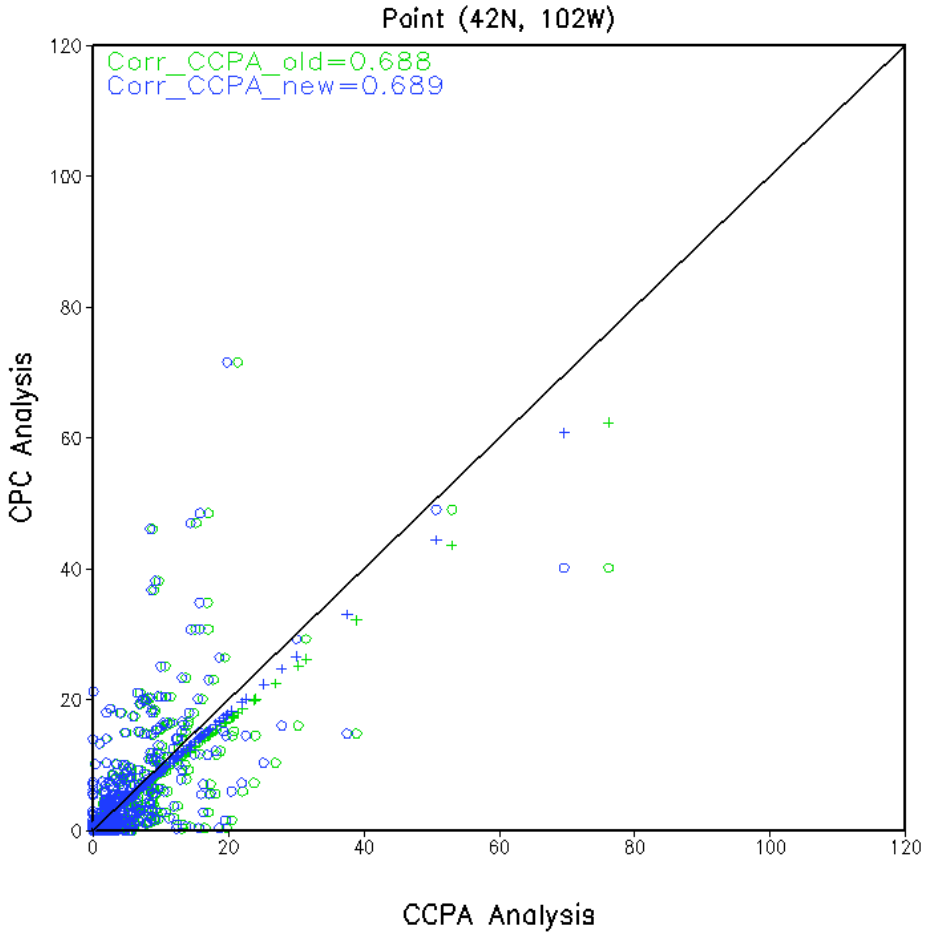
Against CPC analysis

Period: 7/1/2014 – 6/30/2015

Negative (green) is better

Example of one scatter plot for one grid point



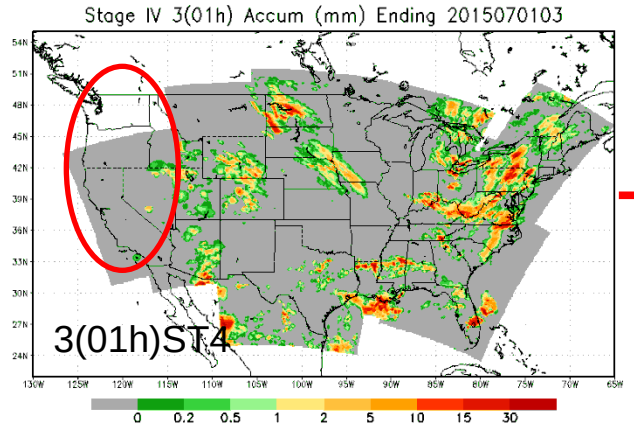


- All data pairs are sampled at point (42N,102W) for 61 days centered around July 1st for 14 years (2002-2015).
- Sample size : 14 years x 61 days (6/1-7/1-7/30) = 854
- The fitting line which is the closer to the diagonal line is the better:
  - CCPA_new is slightly better than CCPA_old
  - Both CCPA_new & CCPA_old are better than ST4

Change Specific to 3-hr CCPA

- Stage IV hourly has no data record in NWRFC and has not good data record in CNRFC as well
- Current CCPA production is using Stage II hourly in NWRFC only and Stage IV hourly in remaining areas as weights to update 3-hr CCPA
- CCPA upgrade will use Stage II hourly in both NWRFC and CNRFC while use Stage IV hourly in remaining areas as weights to update 3-hr CCPA

Why Change to 3-hr CCPA?



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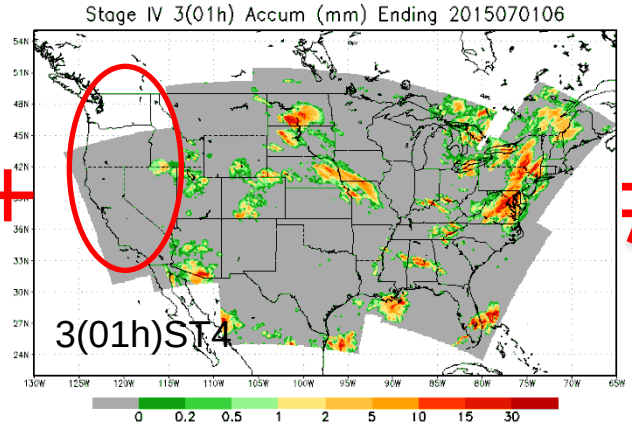

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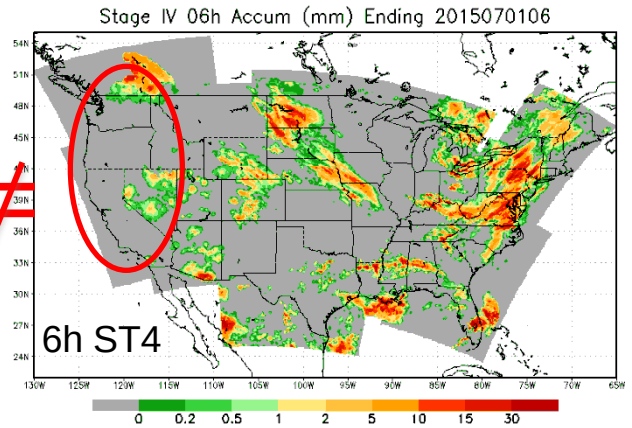

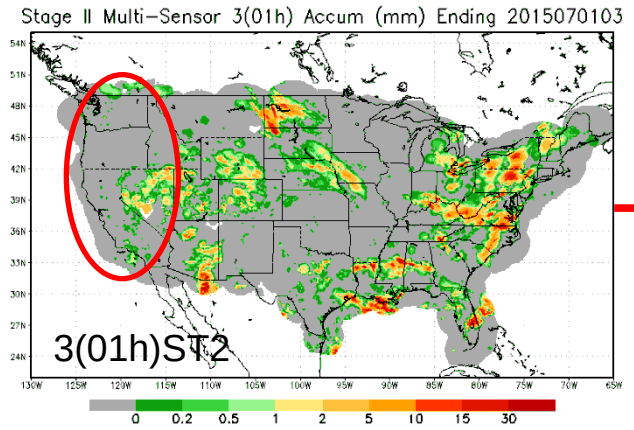

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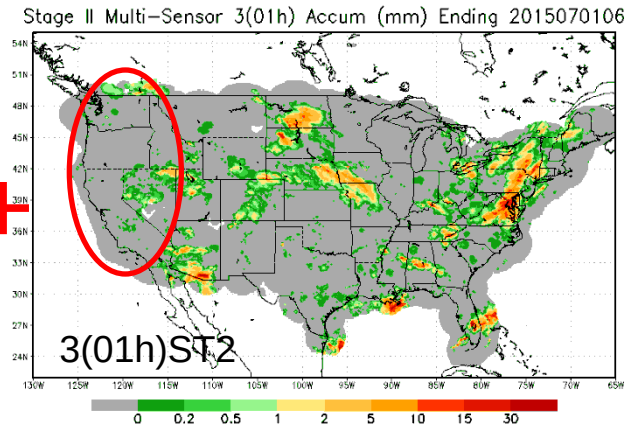
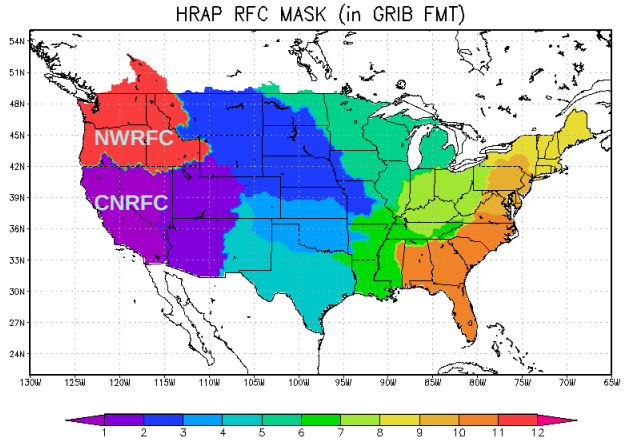
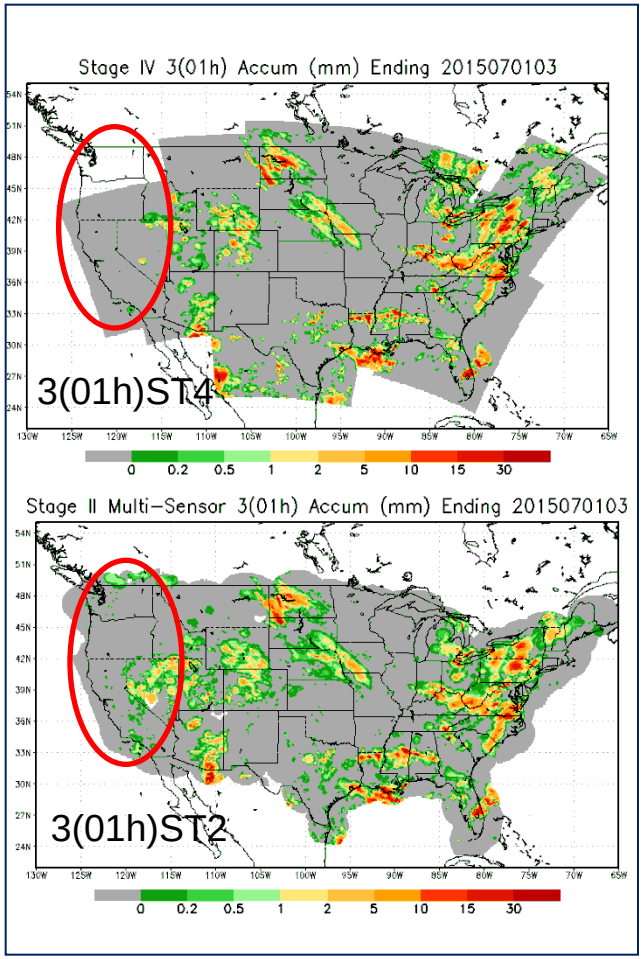
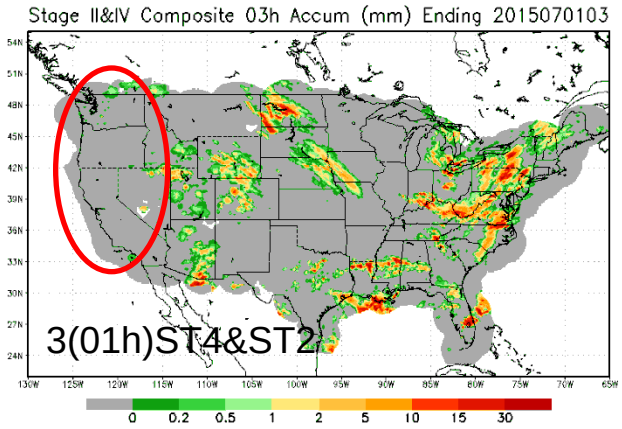
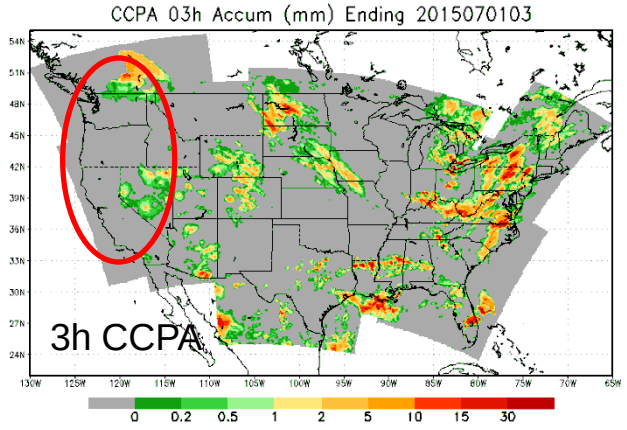


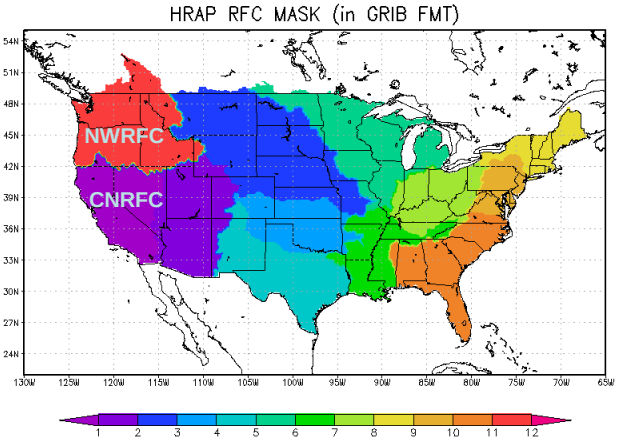


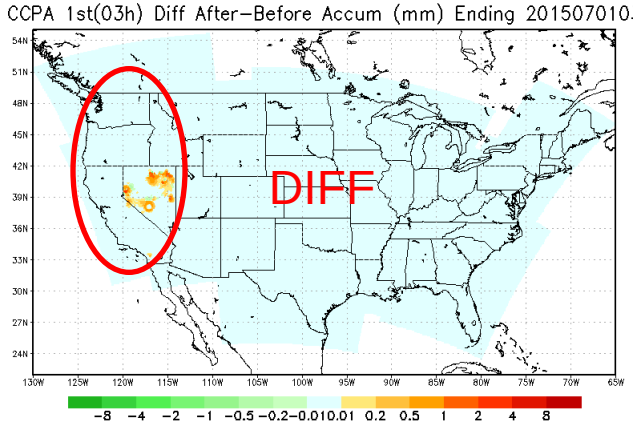
Before →



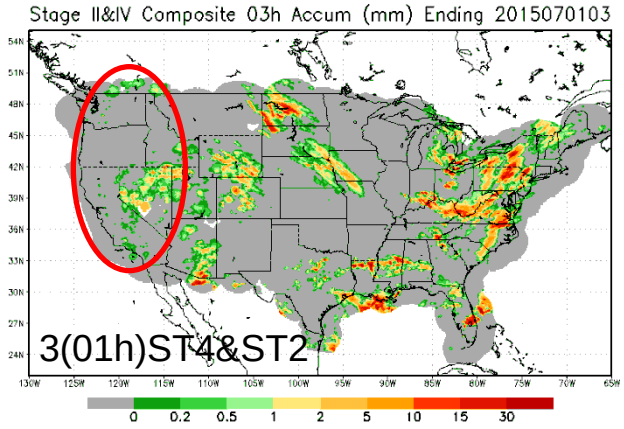


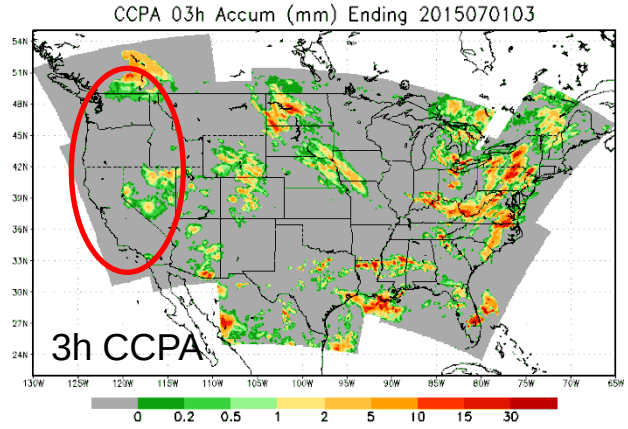




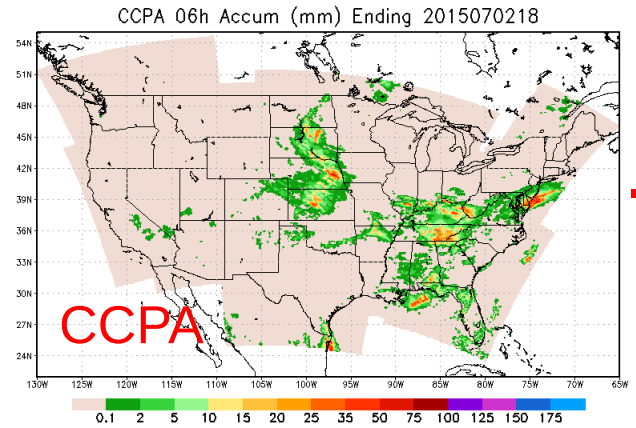


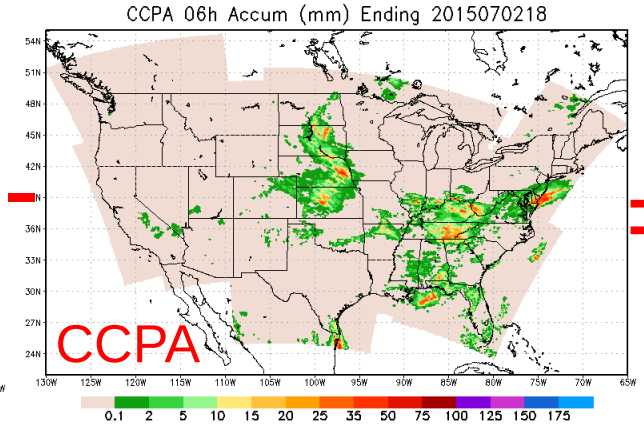
After →

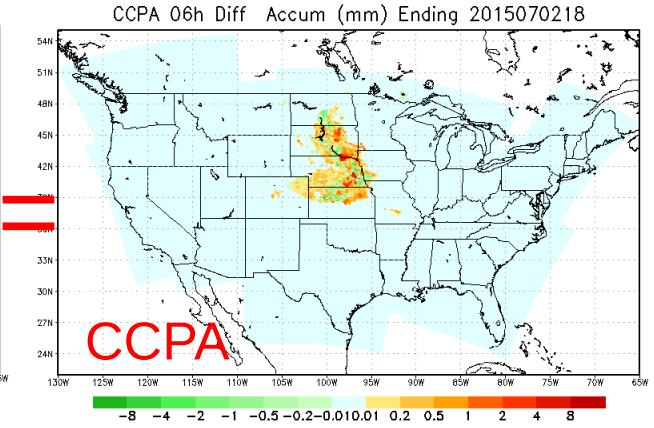


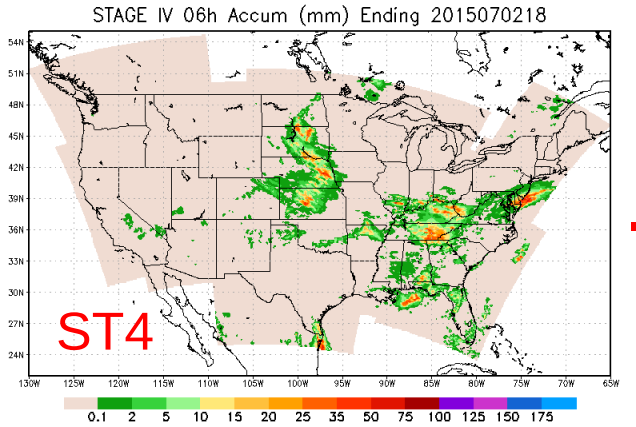


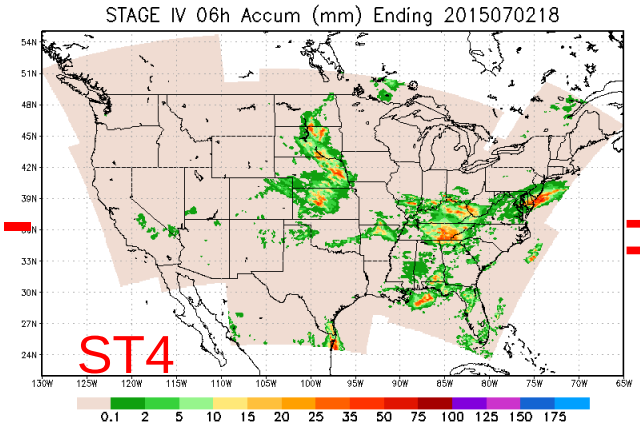
Example Impact of Change in Rerun Schedule

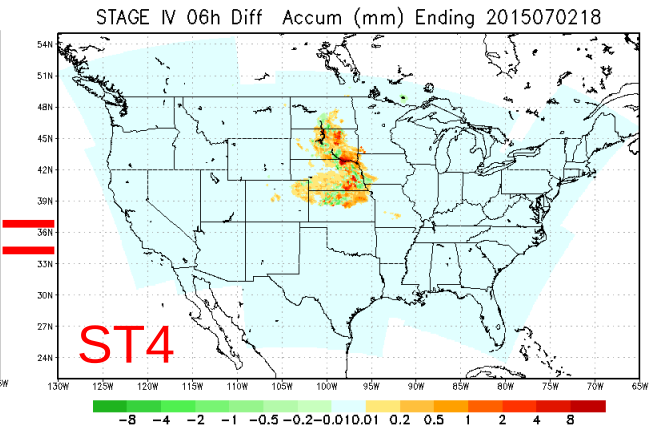












Look-back period
up to 2days

Look-back period
up to 7days - final

DIFF

Summary

- **Updating regression coefficients:**
  - **Some slight improvements can be seen in term of RMSE, MERR, CDF and CRPS.**
  - **No negative impact and degrade were found when regression coefficients are updated and applied to generate new version of CCPA.**

- **Periodic (annual) upgrading regression coefficients with increasing sample size makes CCPA methodology robust.**

- **The new version of CCPA historical data will be regenerated and available to the public.**

Acknowledgments:

- Dingchen Hou and Ying Li – EMC
- Pingping Xie - CPC

Background!!!

CCPA (V3.0.0) Upgrade for CONUS

Project Status as of 03/06/15

G Project Information and Highlights

Lead: Yuejian Zhu, Yan Luo EMC, Becky Cosgrove, NCO

Scope:

- Model – Climatology-Calibrated Precipitation Analysis (CCPA) system version 3.0.0
- Sciences:
  - Update regression coefficients based on 12-year (vs. 7-year) of training data sets of CPC gauge based analysis and STAGE IV multi-sensor estimation
  - Statistically adjust STAGE IV towards CPC analysis
  - Linear regression is applied at 0.125 degree resolution and 24h accumulation
- Output
  - Converted back to HRAP grid and 6 hour accumulation
  - Interpolated to1.0, 0.5, 0.125 degree and NDGD grids (5km, 2.5km)

Expected Benefits:

- Improved analysis quality with extended training data

G Issues/Risks

Issues:

Risks:

Mitigation:

Resource estimation:
1 node for 25 minutes

G Scheduling

Milestone (NCEP)	Date	Status
Initial coordination with SPA team	05/01/2015	
EMC testing complete/ EMC CCB approval	06/15/2015	
Initial Code Delivery to NCO	06/19/2015 → 7/01/15	
Technical Information Notice Issued	07/01/2015	
SPA begins prep work for 30 day test	06/22/2015 →7/06	
30-day evaluation begins	07/20/2015 →8/03	
30-day evaluation Ends	08/18/2015 →9/01	
Management Briefing	09/04/2015 → 9/11	
Operational Implementation	09/08/2015 → 9/15	

G Finances

Associated Costs:

Funding Sources: EMC Base: T2O 3 Man-months; NCO Base: 0.2 man-months for implementation, 0.2 man-month annually for maintenance

R	Management Attention Required	Y	Potential Management Attention Needed	G	On Target

Implementation Details

- Rules
  - Only Non-Zero Stage IV is adjusted
  - Zero values remains zero
  - Adjustment is applied over CONUS LAND only
- Leap Year
  - 366 day convention is adapted in regression calculations
  - Feb 29 has its own regression coefficients a and b
- Spatial Continuity
  - US Boundaries
  - Land/Ocean Boundary
  - Zero/Non-Zero Boundary
- Rare cases of abnormal regression coefficients
  - Temporal smoothing of a and b reduces abnormal values
  - Discard the regression coefficients a and b, if too large
  - Set an upper limit to the adjusted St4 value