Precipitation Calibration Updates

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Objective

- Develop and enhance bias-correction and downscaling techniques that are applicable to NCEP precipitation ensemble forecasts to gain more reliable and much finer resolution products.

NCEP GFS/GEFS precipitation forecast products

Level 1 products- model direct output

6h-QPF–
High Reso. GFS
Low Reso. GEFS/CTL
20 GEFS ensembles:
1 deg, globally

Level 2 products - 1st Post-processing

Bias corrected
6h-QPF/PQPF –
High Reso. GFS
Low Reso. GEFS/CTL
20 GEFS ensembles:
1 deg, globally

More reliable

Level 3 products – 2nd Post-processing

Downscaled
6h-QPF/PQPF –
High Reso. GFS
Low Reso. GEFS/CTL
20 GEFS ensembles:
5KM, NDGD, CONUS

Much finer

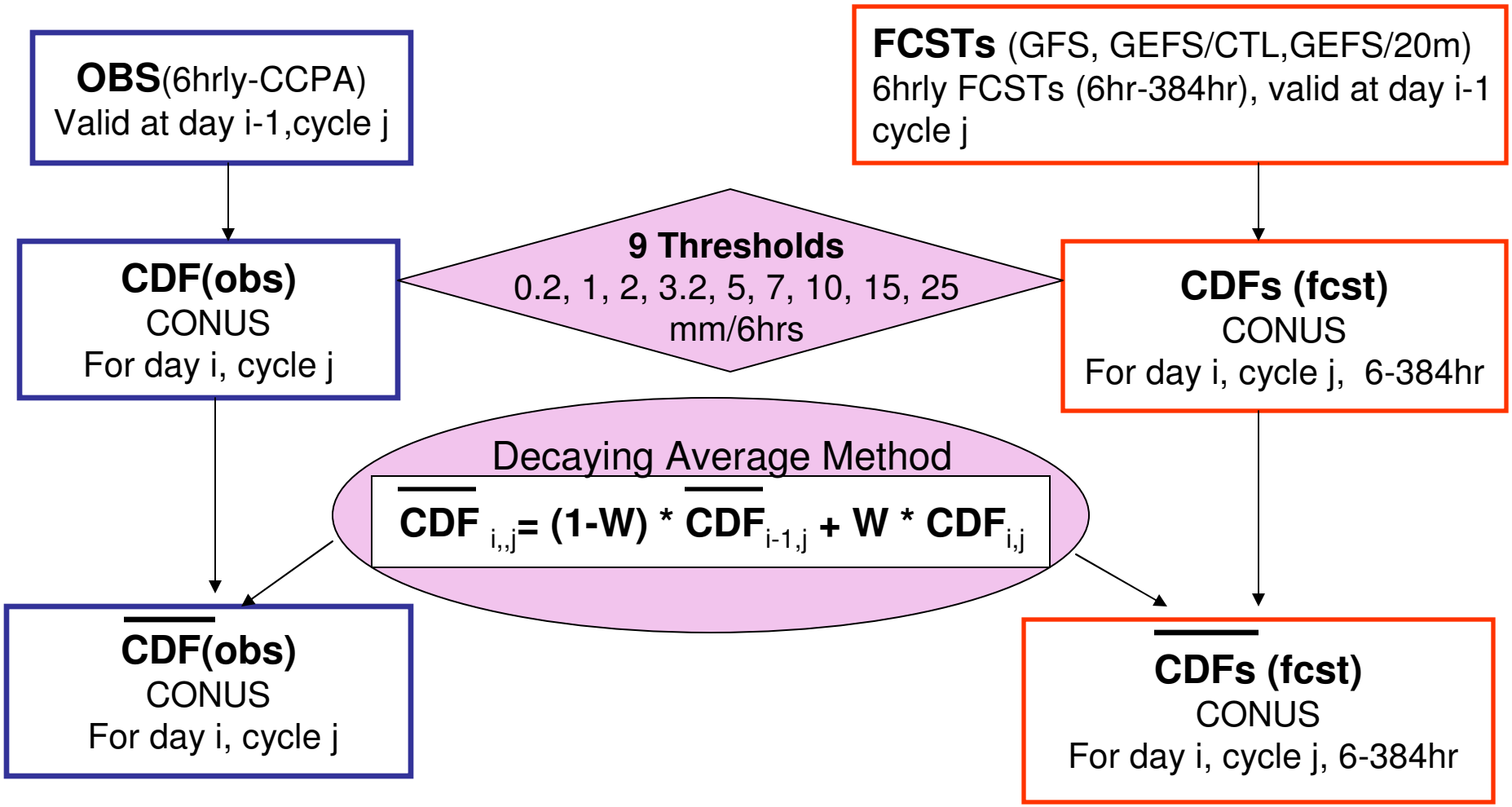
Green: operational, verified against 1deg CCPA
Blue: developed and tested, verified against 1 deg CCPA
Purple: under development, verified against 5KM NDGD CCPA

Current capabilities in calibration of QPF/PQPF for NCEP ensembles

- Bias correction for NCEP operational precipitation ensemble forecasts at higher temporal and spatial resolution

- An upgrade from May 2004 implementation
- CDF based QPF bias-correction algorithm
- Select 9 thresholds: 0.2, 1, 2, 3.2, 5, 7, 10, 15, 25 mm/6hrs
- Construct Cumulative Frequency Distribution over CONUS
- Use decaying weight = ~0.033 (30 days decaying)
- CCPA used as observations
- Bias corrected at 1 degree model output grid, globally
- 4 cycles per day, 6-hr amounts
- Every 6 hours, out to 384 hours
- GFS, GEFS 20+1 members

How the Precipitation Calibration System Works



$\overline{CDF}_0$: initialized from any a 30-day average of CDF

How the Precipitation Calibration System Works (continued)

$\overline{\text{CDF(obs)}}$
CONUS
For day i, cycle j

IN

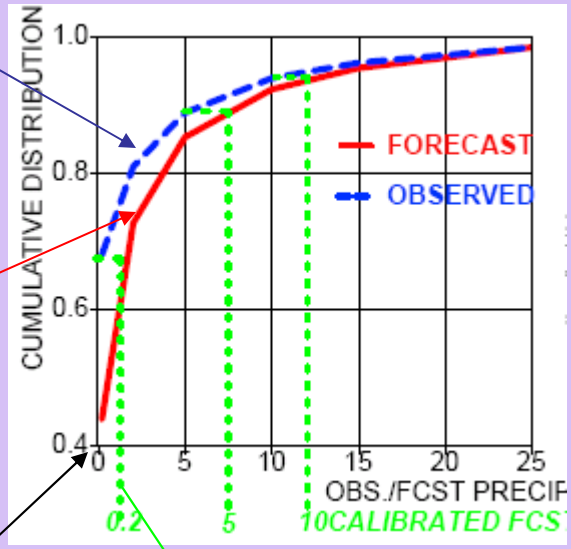
$\overline{\text{CDFs (fcst)}}$
CONUS
For day i, cycle j, 6-384hr

IN

RAW FCSTs
(GFS, GEFS/CTL,GEFS/20m)
INI at day i, cycle j, for 6-384hr
At each model grid

IN

Frequency match algorithm



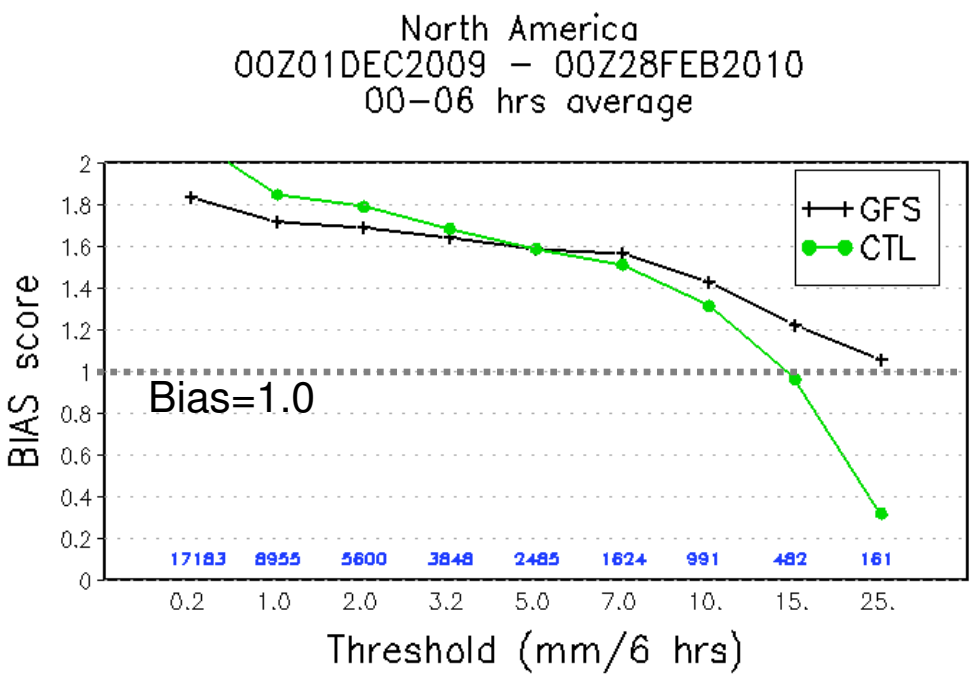
Linear inter/extrapolation
No bias correction on zero forecast value

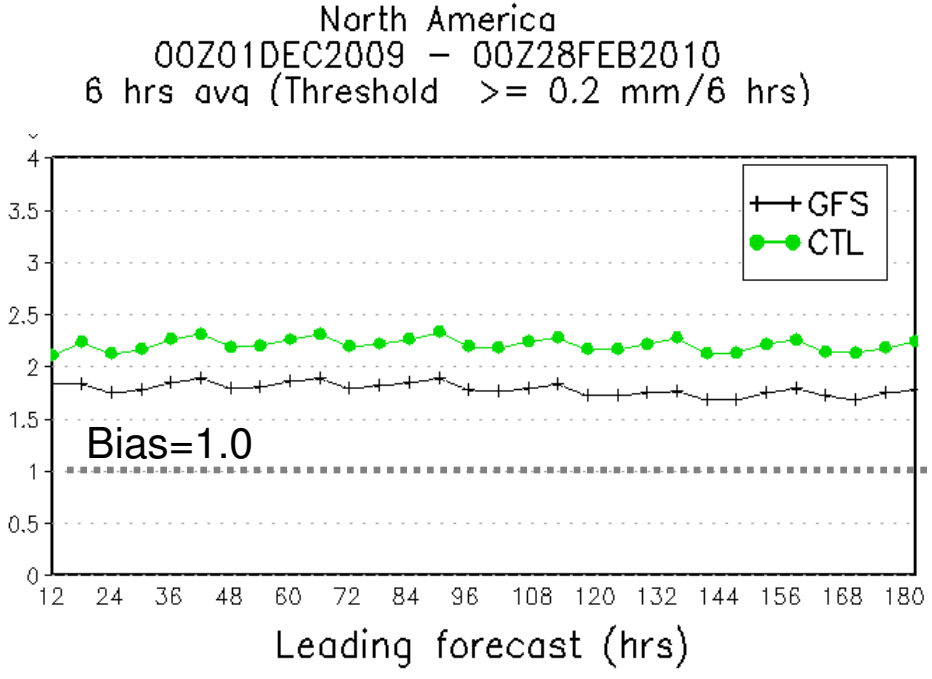
OUT

CAL FCSTs
(GFS, GEFS/CTL,GEFS/20m)
INI at day i, cycle j, for 6-384hr
At each model grid

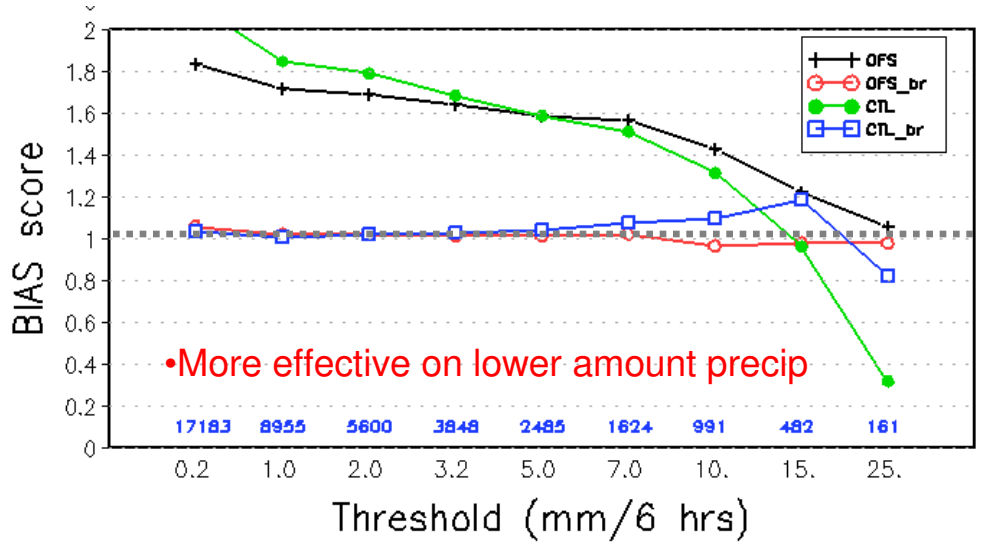
Bias Correction Experiment

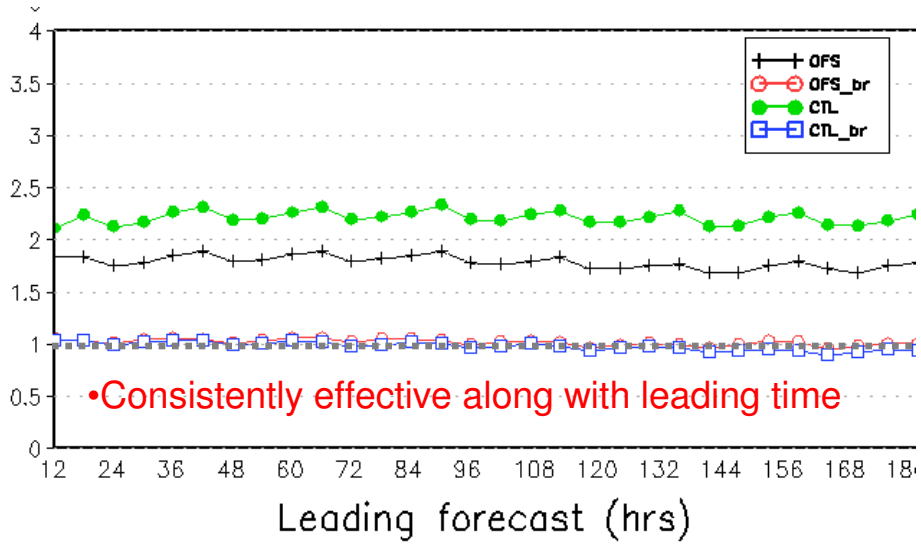
- Experiment period: January 1, 2009 – February 28, 2010
- Scores: ETS,TSS, and Bias Score
- Maps: QPF, PQPF
  - Verified against CCPA
  - Nine thresholds 0.2, 1, 2, 3.2, 5, 7, 10, 15 25 mm/6-h
  - CONUS domain
  - 00 UTC forecast cycle
  - Decaying weight W=0.033 (30day's decay)



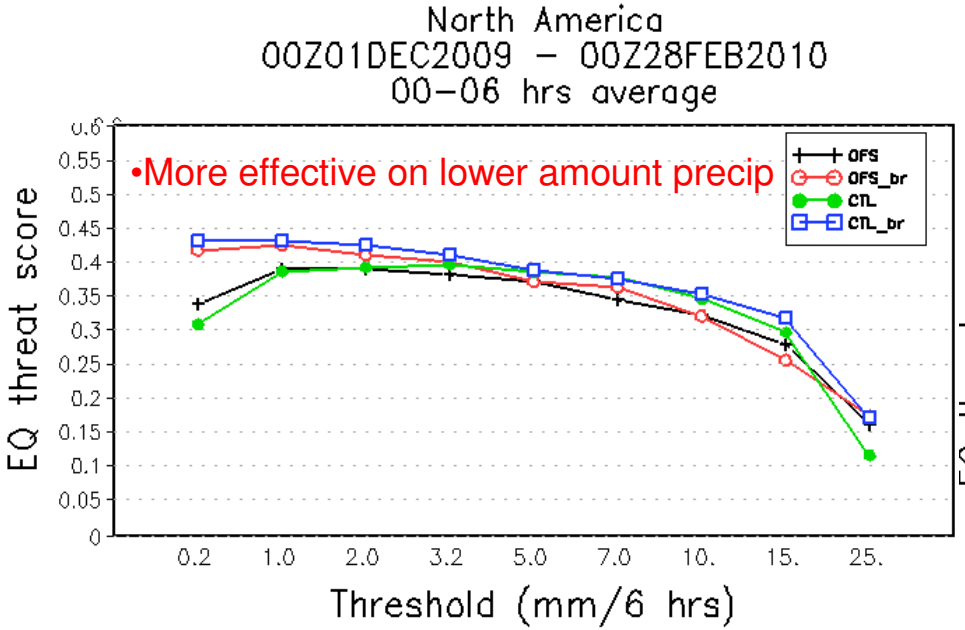


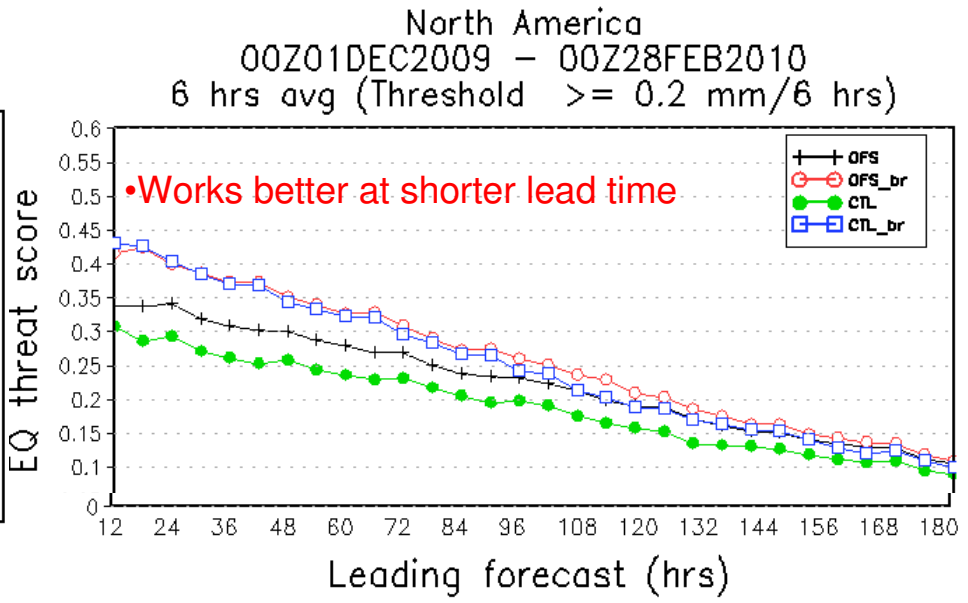
Significantly reduced bias



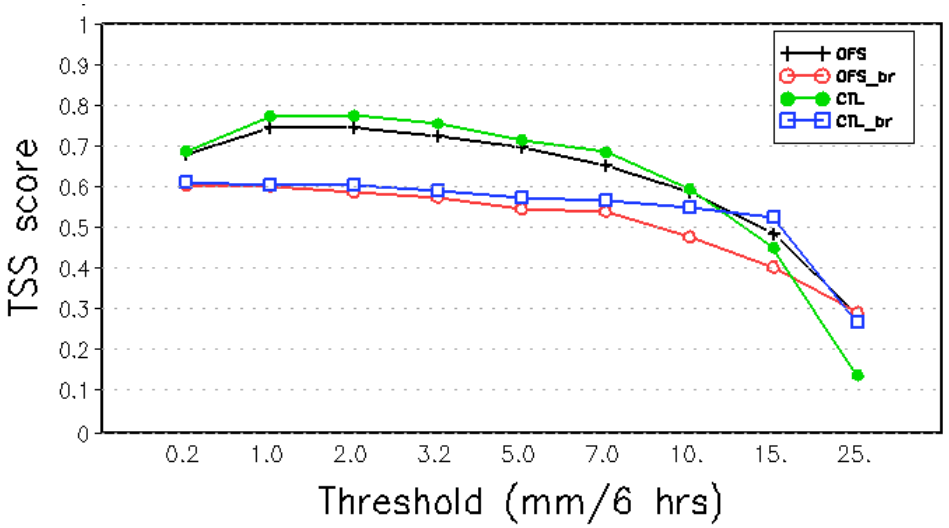


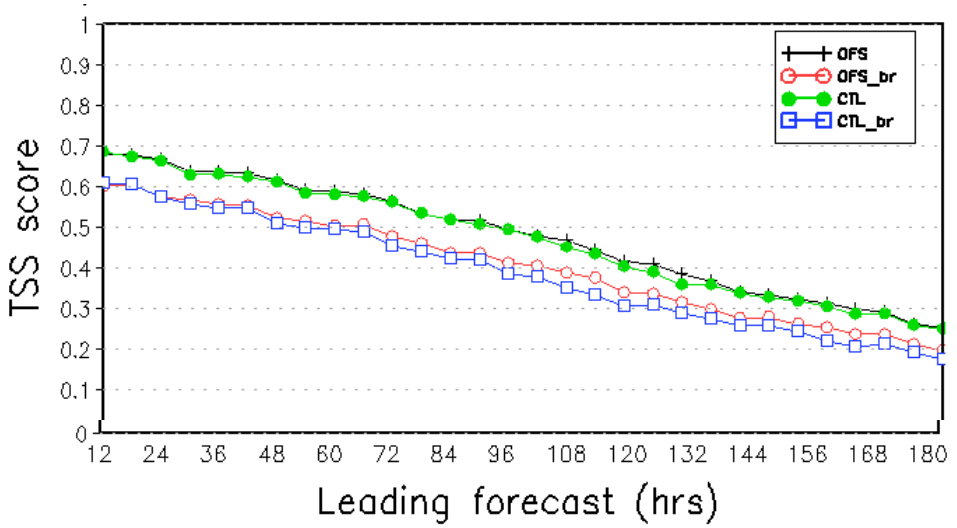
Mostly improved ETS





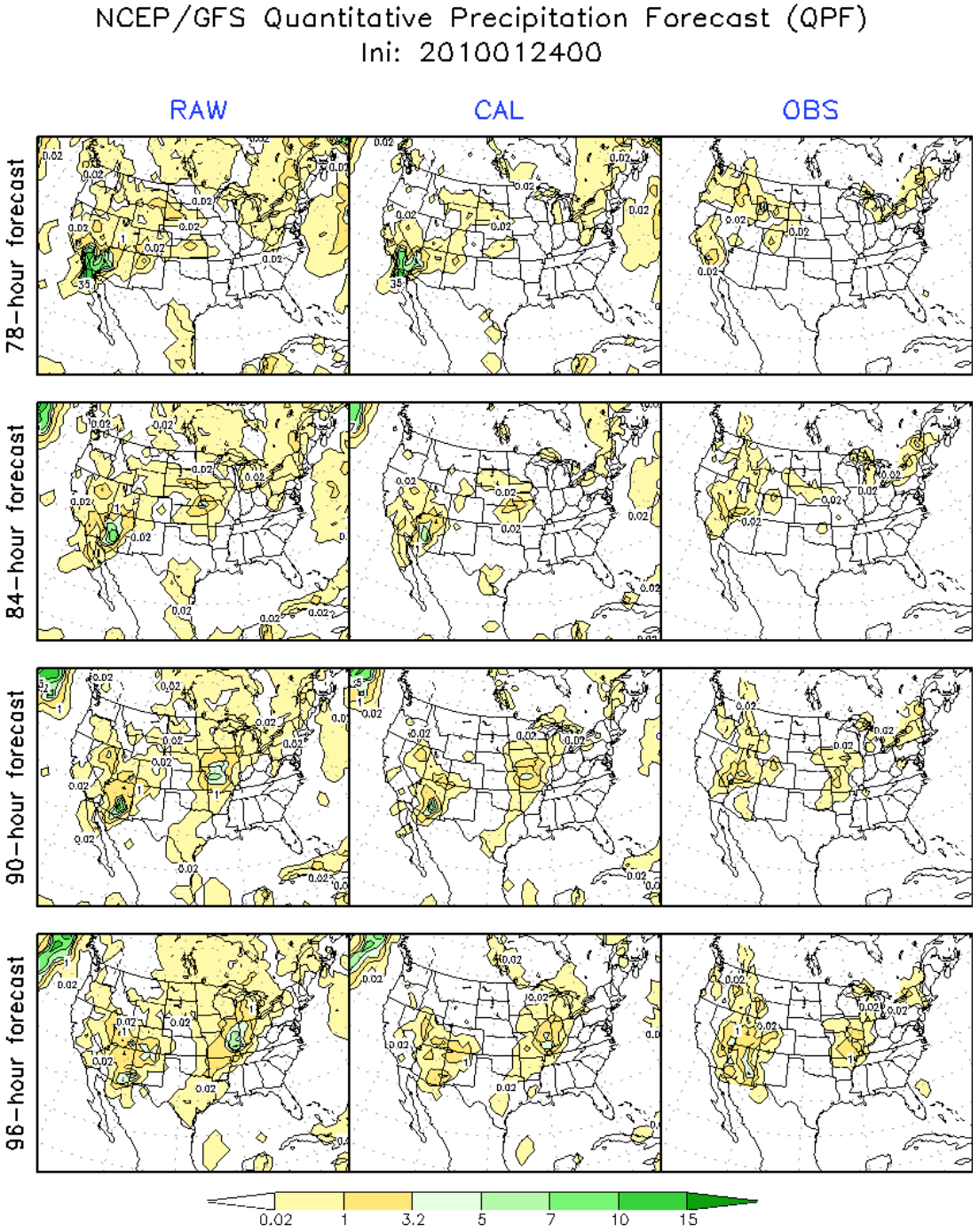
Lowered TSS– Problems with miss events





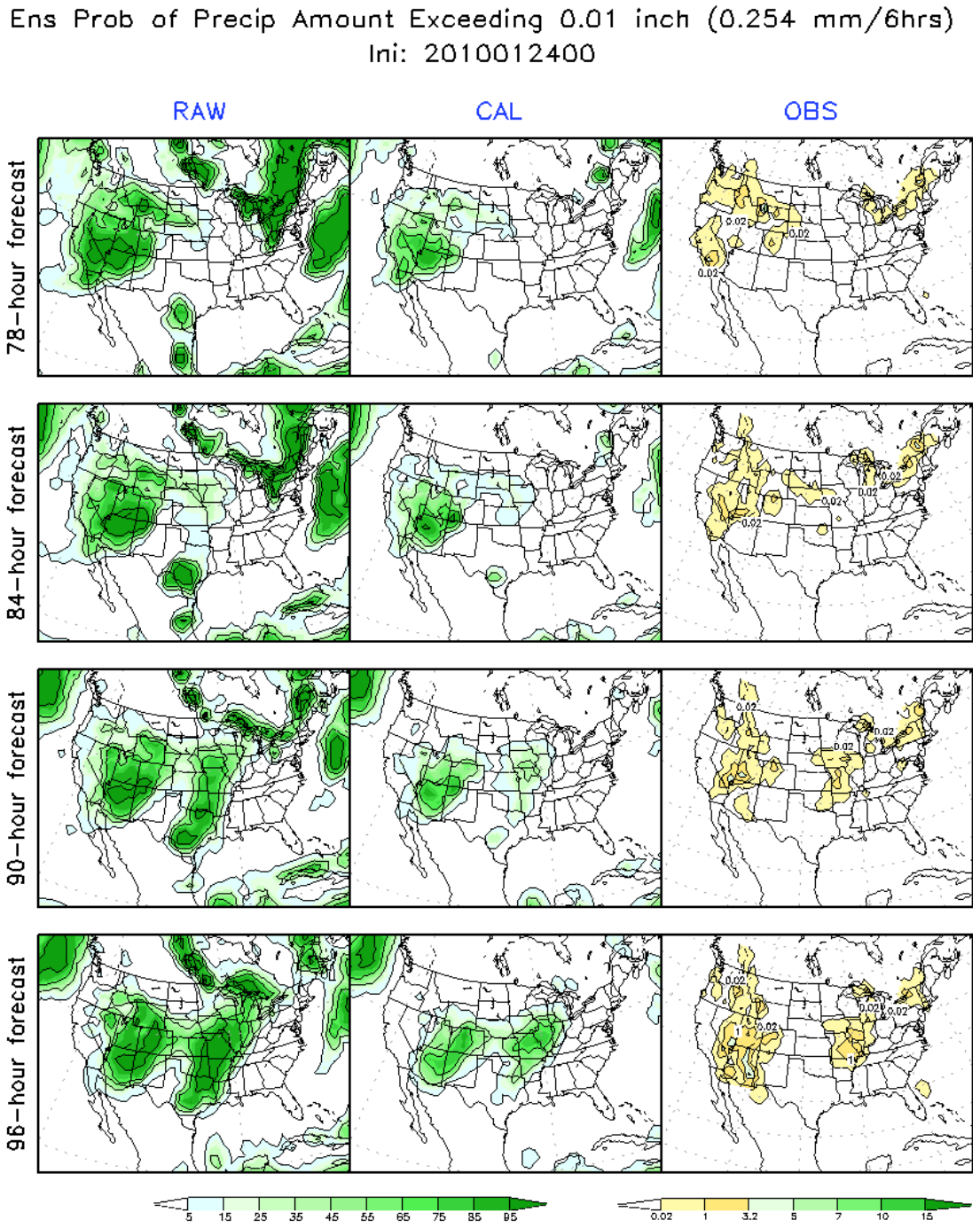
QPF EXAMPLE

- Larger reduction in precipitation extent
- Slight reduction in QPF amounts
- Much closer to OBS(CCPA)



PQPF EXAMPLE

- Larger reduction in precipitation extent
- Slight reduction in QPF amounts
- Agree much with OBS(CCPA)



Decaying averaging CDF

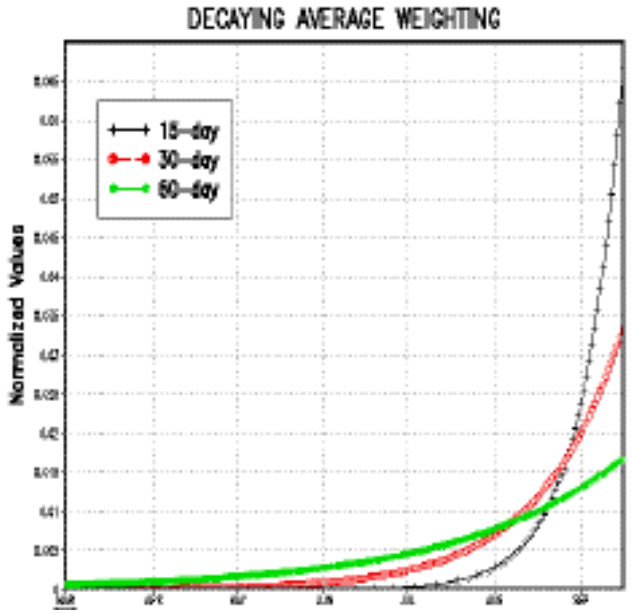
Calculate for Obs and Fcst respectively

$$\overline{CDF}_j = (1-W) * \overline{CDF}_{j-1} + W * CDF_j$$

Sensitivity experiments:

Chose different weight:

W_{5d} =0.2	~ 1/5	=> 5 days decay
W_{10d}=0.1	~ 1/10	=> 10 days decay
W_{30d}=0.033	~ 1/30	=> 30 days decay
W_{50d}=0.02	~ 1/50	=> 50 days decay

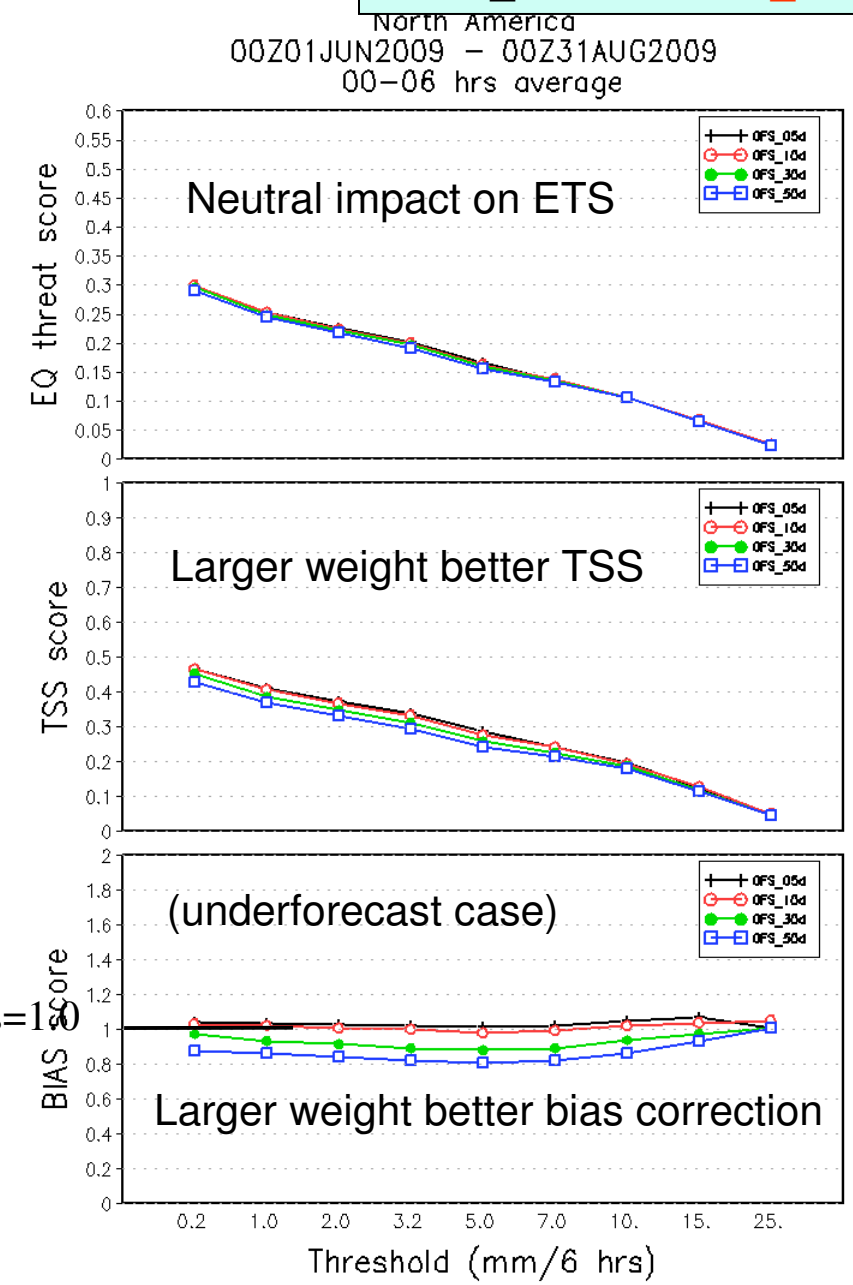


Larger weight => shorter decaying time => Use less historical info. < == > more weight on recent data

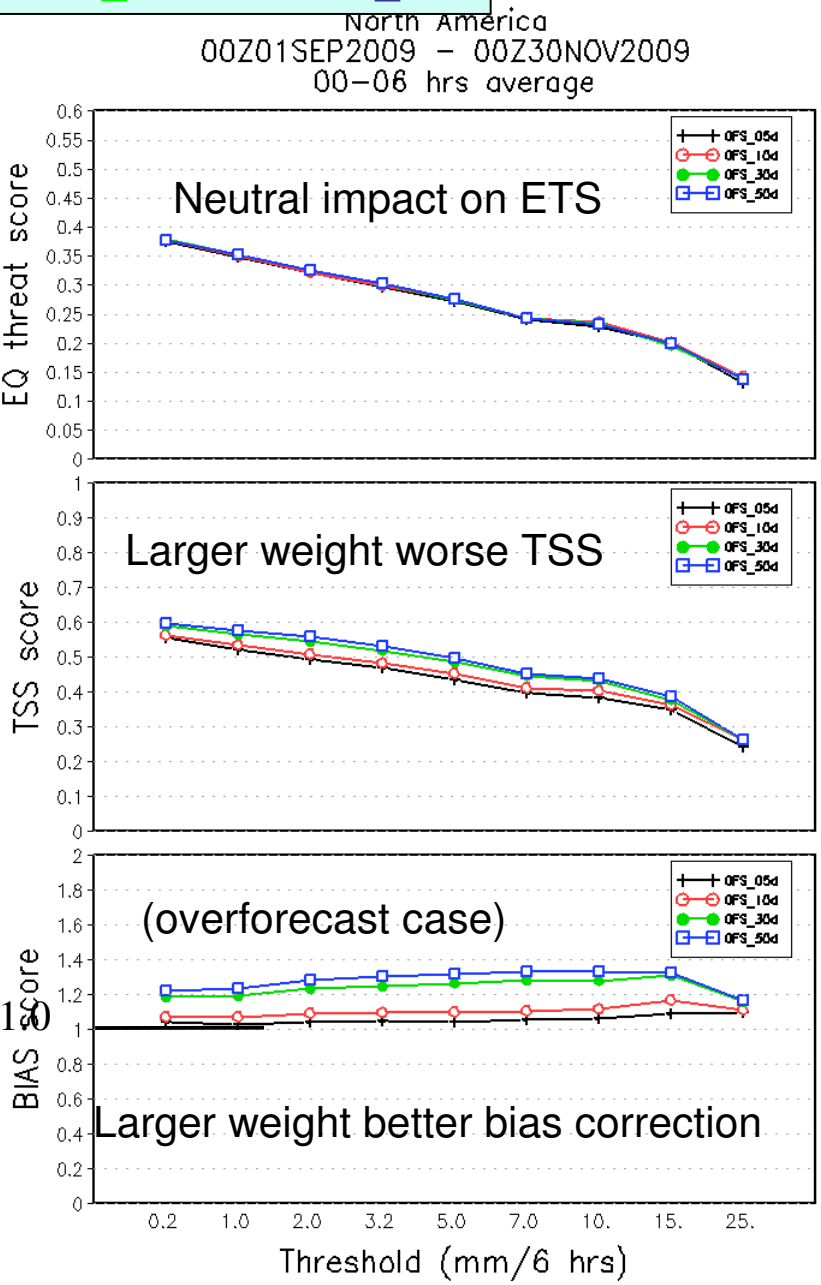
Smaller weight => Longer decaying time => Use more historical info.

Large weight ⟶ Small weight

GFS_05d => GFS_10d => GFS_30d* => GFS_50d



Bias=1.0

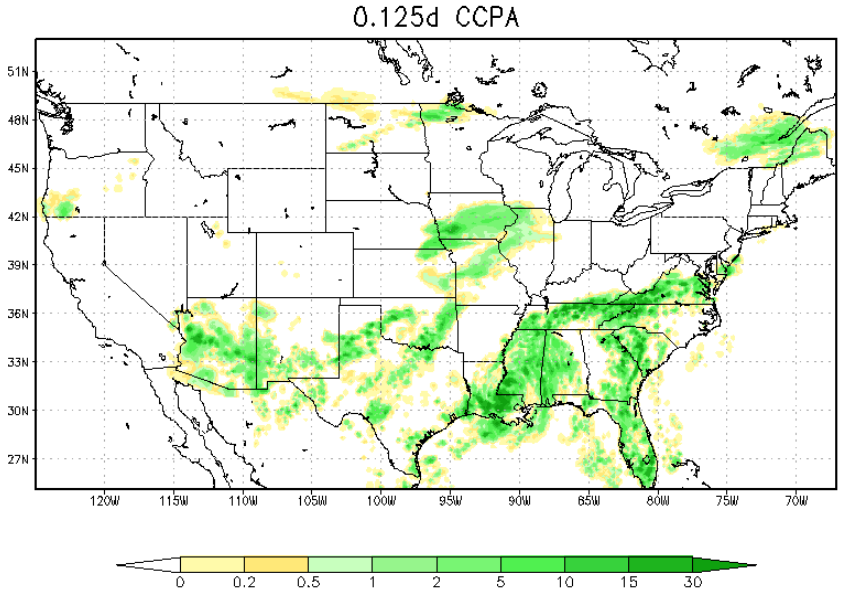


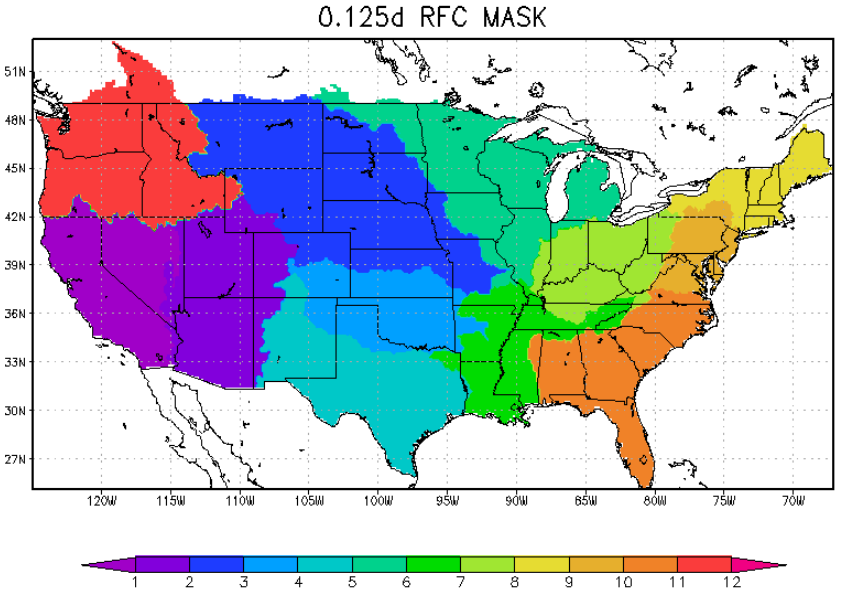
Bias=1.0

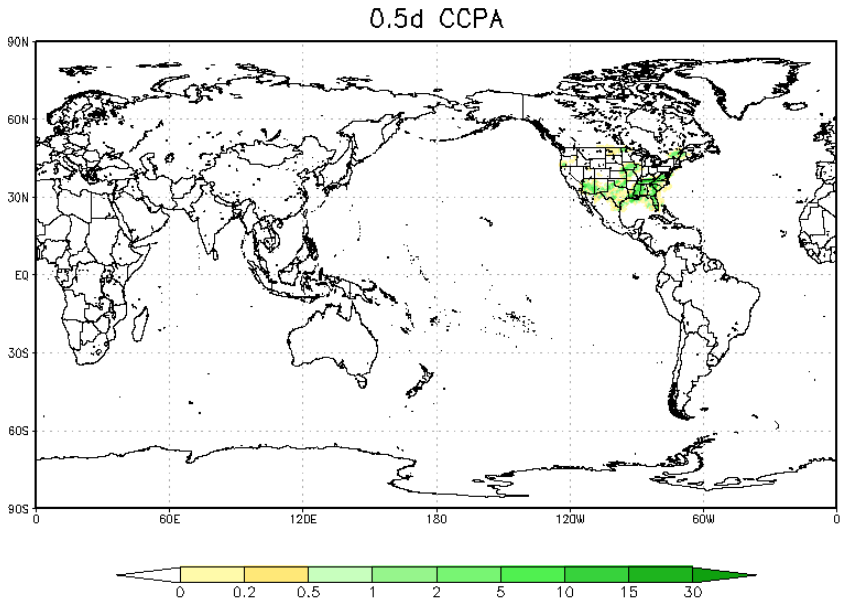
Work in Progress

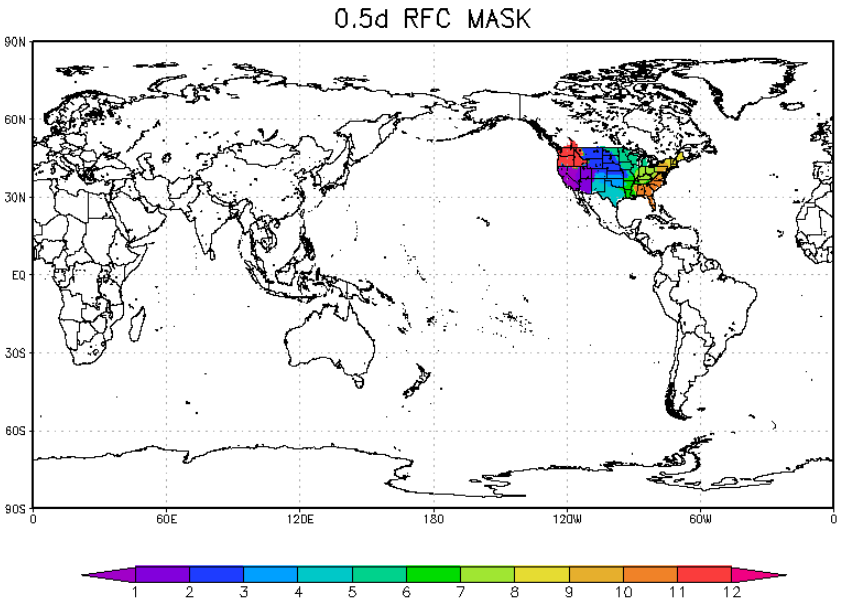
- Can do a very good job on 1st moment adjustment, may be not skillful for 2nd moment adjustment.
- Bias correction based on CDFs over CONUS is completed. Expect to improve by using respective regional RFC CDFs instead of CONUS CDFs given RFC area masks at 1 degree lat/lon grid provided by OHD.
- Downscaling vector needs RFC area masks at NDGD grid to calculate CDFs. (Also need OHD to provide the NDGD grid.)

NCEP grids

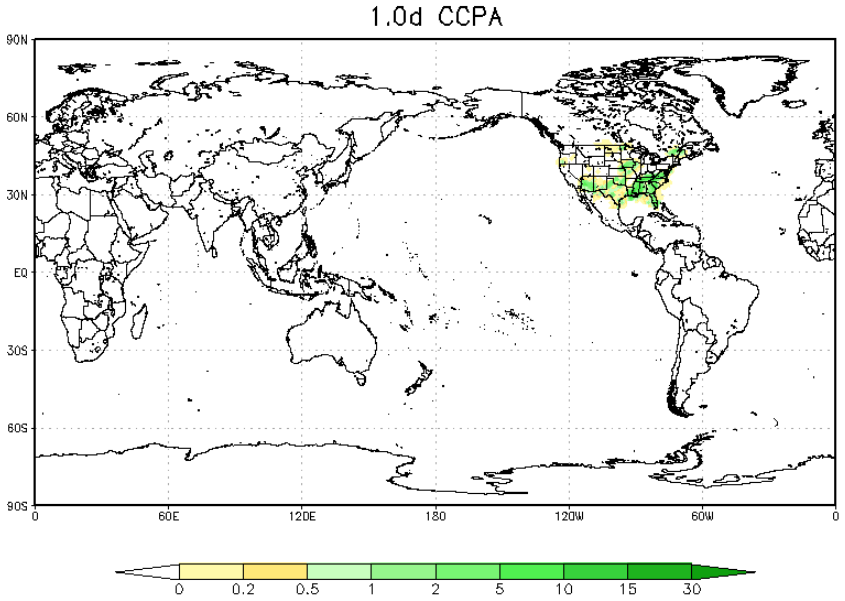

0.125d CCPA
51N
48N
45N
42N
39N
36N
33N
30N
27N
120W
115W
110W
105W
100W
95W
90W
85W
80W
75W
70W
0
0.2
0.5
1
2
5
10
15
30

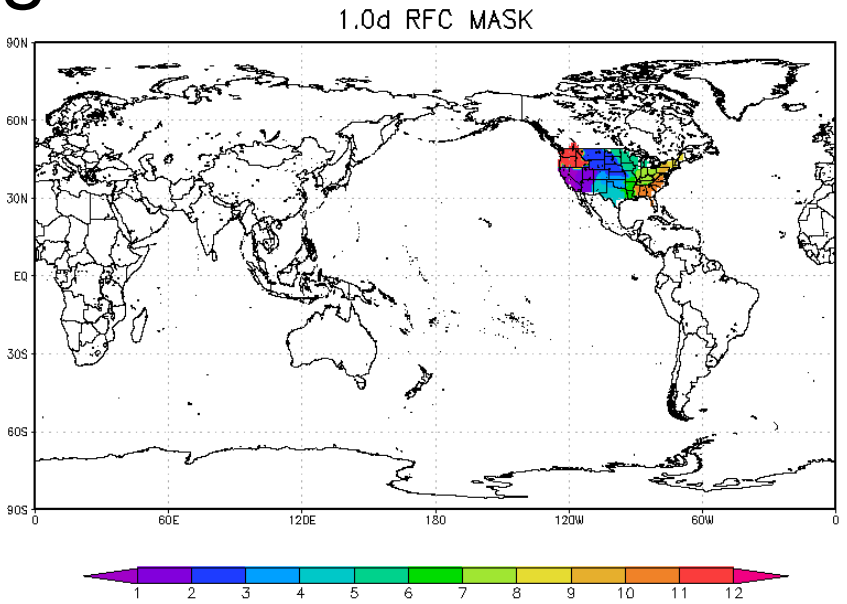

0.125d RFC MASK
51N
48N
45N
42N
39N
36N
33N
30N
27N
120W
115W
110W
105W
100W
95W
90W
85W
80W
75W
70W
1
2
3
4
5
6
7
8
9
10
11
12


0.5d CCPA
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
0
0.2
0.5
1
2
5
10
15
30


0.5d RFC MASK
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
1
2
3
4
5
6
7
8
9
10
11
12

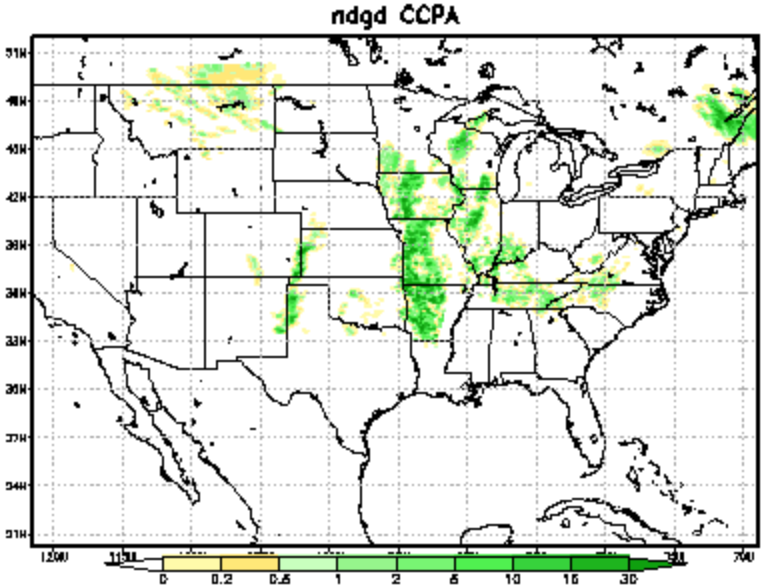
NCEP grids





The 1 degree grid RFC mask is being used in calculation of Cumulative Distribution Functions (CDFs) for each RFC mainly for bias correction, as well as some verification statistics at regional scale.

NCEP grids



NDGD RFC MASK

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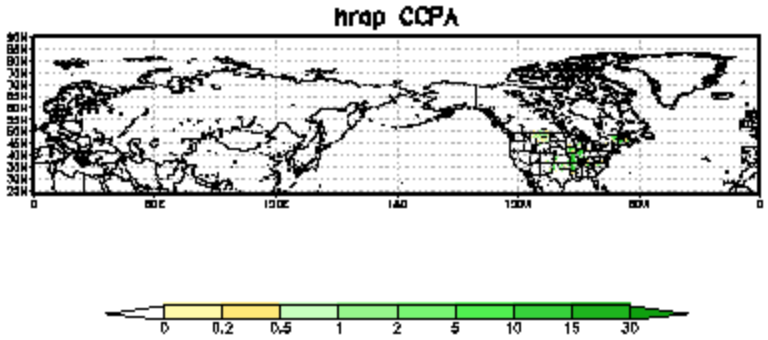
The RFC mask on NDGD grid is required to calculate Cumulative Distribution Functions (CDFs) for each RFC mainly for downscaling, as well as some verification statistics at regional scale.



HRAP RFC MASK

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