Recent issues with NLDAS-2 precipitation resulting in soil moisture dry spots and their solution with a new CPC precipitation quality control strategy

David M. Mocko (SAIC at NASA/GSFC), presenting slides from:
Pingping Xie, Mingyue Chen, and Wei Shi (CPC)
Jon Case (ENSCO, Inc./SPoRT at NASA/MSFC)
Brad Zavodsky (NASA/MSFC)
Youlong Xia (IMSG at NCEP/EMC)

Dry bulls-eyes evident across localized portions of CONUS, suggesting gauges “stuck” at low/0 values and not being QC’d.

Precipitation in NLDAS Phase 2 and in SPoRT

NLDAS-2 uses a daily gauge analysis from NCEP/CPC

- Temporally disaggregated to hourly frequency using radar estimates (or other methods, if radar is not available)
- Blended with PRISM climatology
- Full details of NLDAS-2 precipitation generation given at: http://ldas.gsfc.nasa.gov/nldas/NLDAS2forcing.php#AppendixC

SPoRT's run of Noah LSM within LIS uses long-term input forcing exclusively from NLDAS-2

- Downscaled to 0.03-deg grid within LIS
- For percentiles, NLDAS-2 uses 1980-2007 climatology; SPoRT-LIS uses 1981-2013 climatology
- http://weather.msfc.nasa.gov/sport/modeling/lis.html

SPoRT 0-2m relative soil moisture – 19 Jan 2016

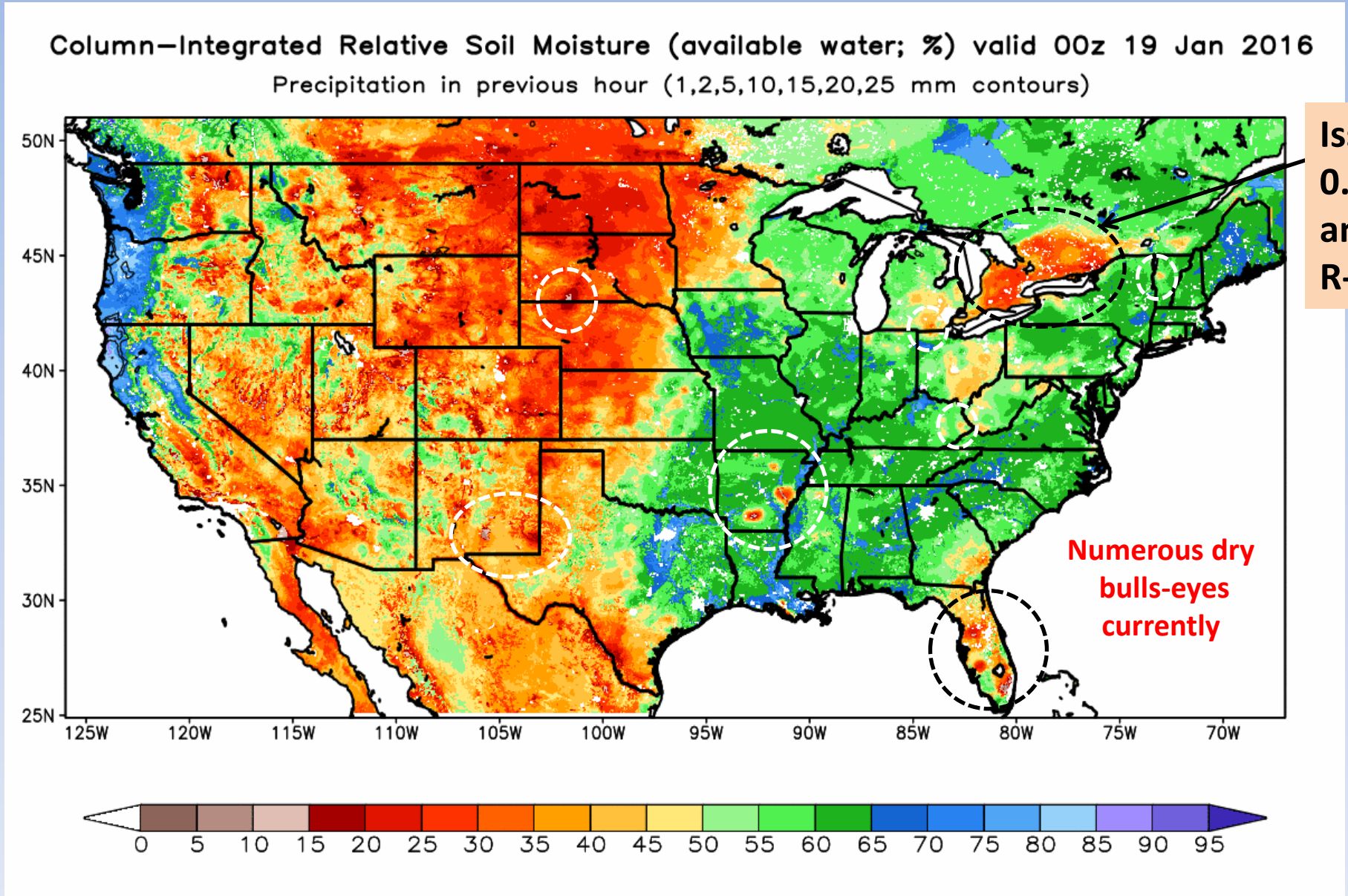


Image credit: Jon Case and Brad Zavodsky (NASA/MSFC)

SPoRT 0-2m relative SM percentile – 18 Jan 2016

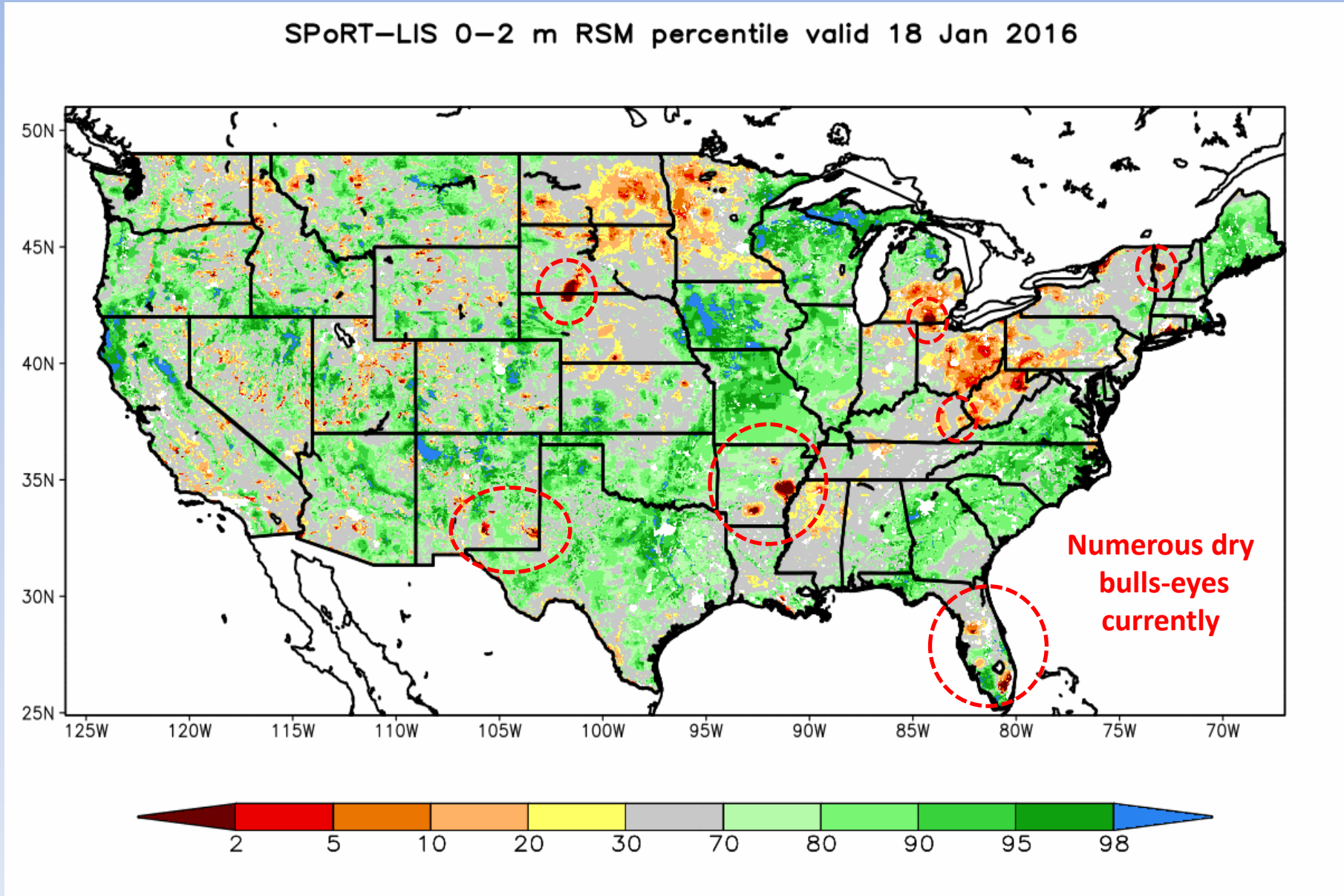


Image credit: Jon Case and Brad Zavodsky (NASA/MSFC)

NLDAS-2 Noah 0-2m SM percentile – 15 Jan 2016

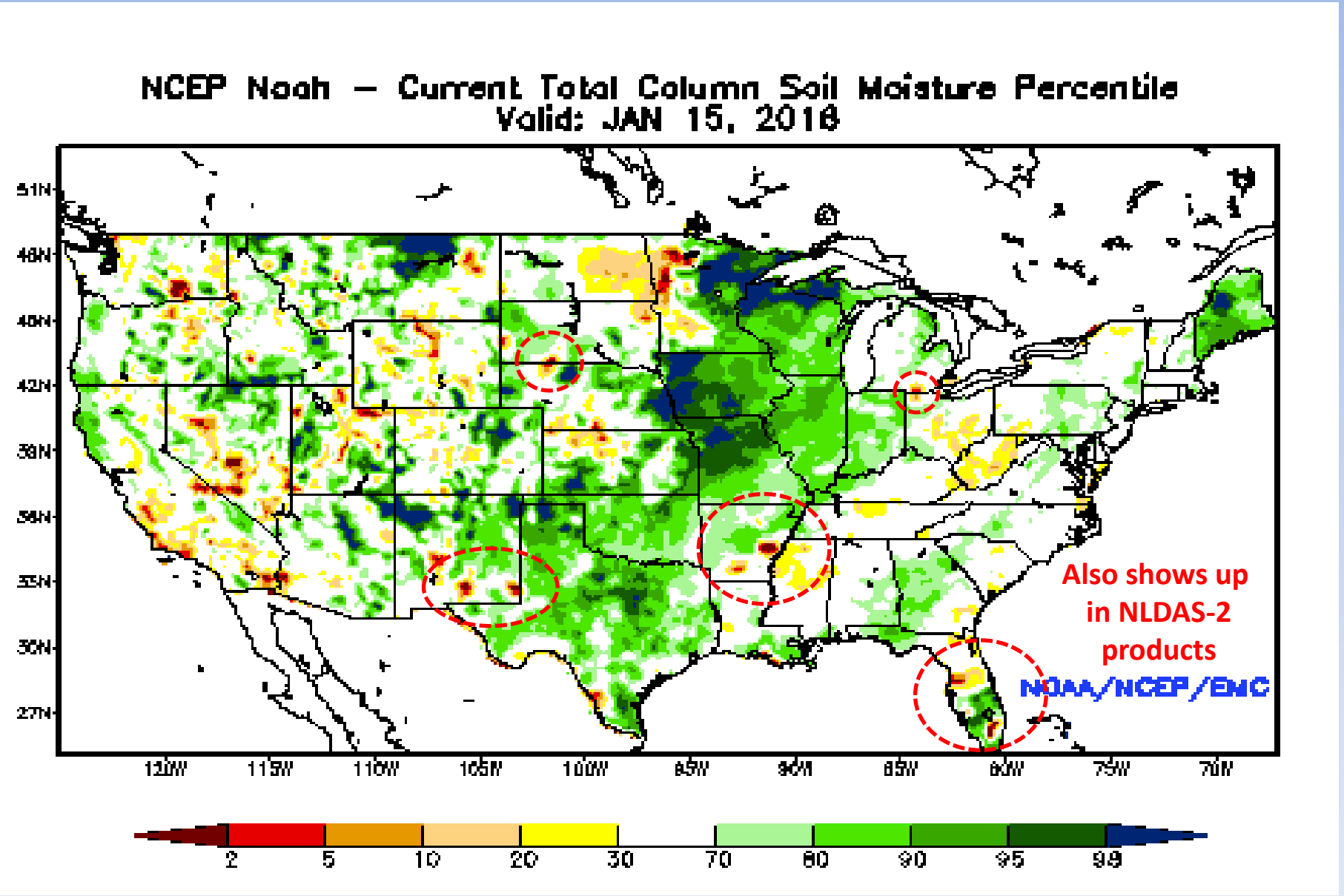
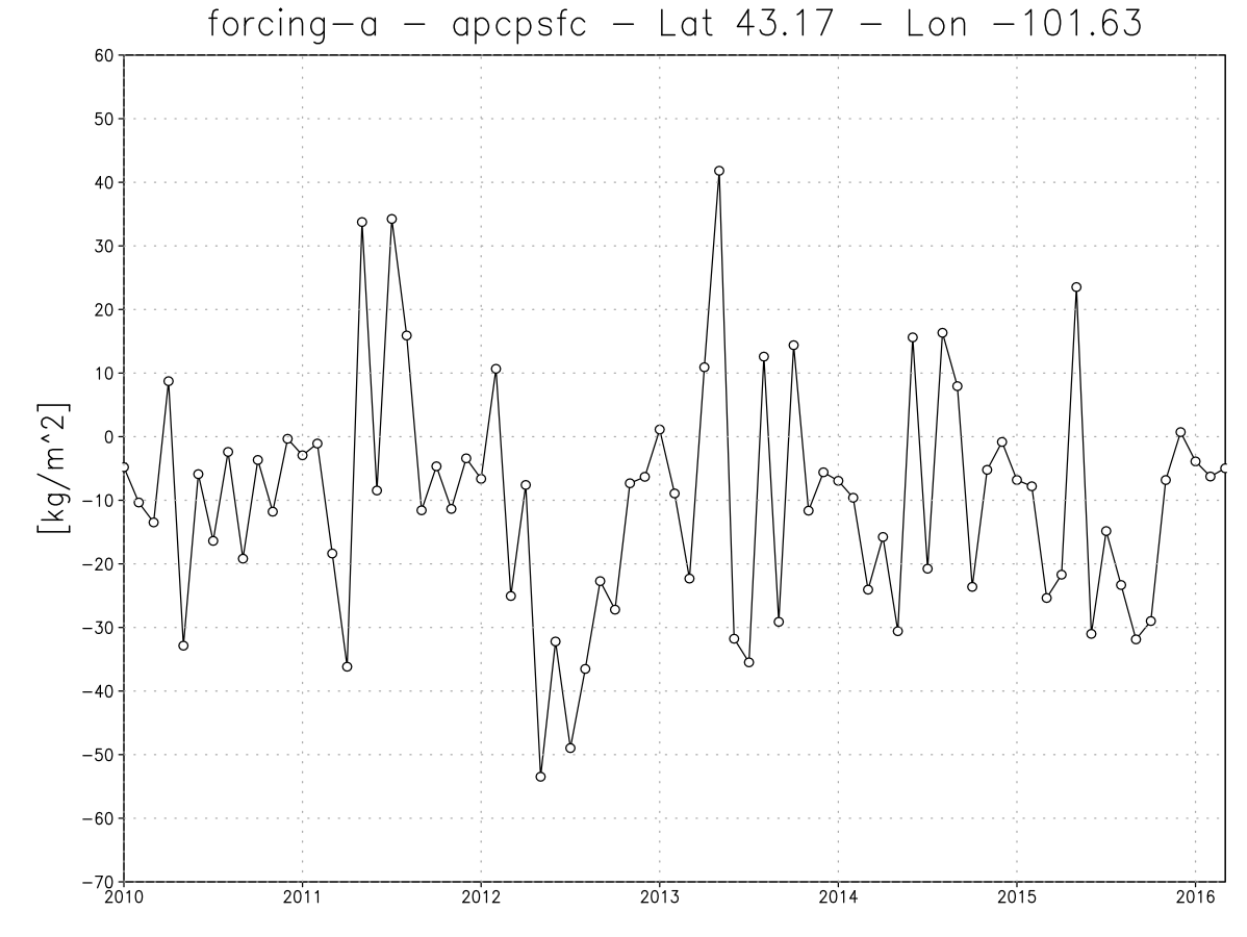
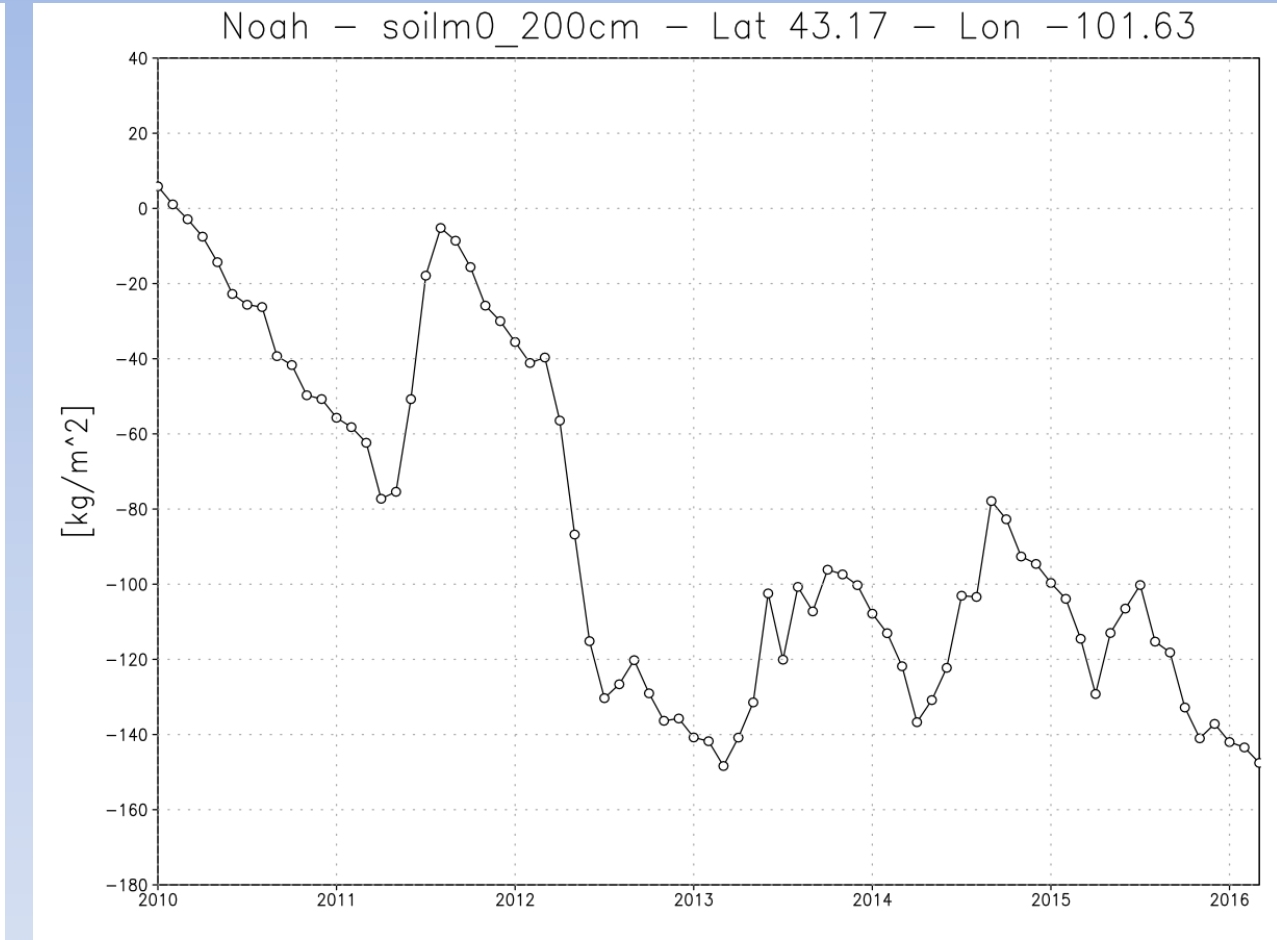


Image credit: Youlong Xia (NCEP/EMC)

NLDAS-2 Precip & Noah 0-2m SM monthly anomalies

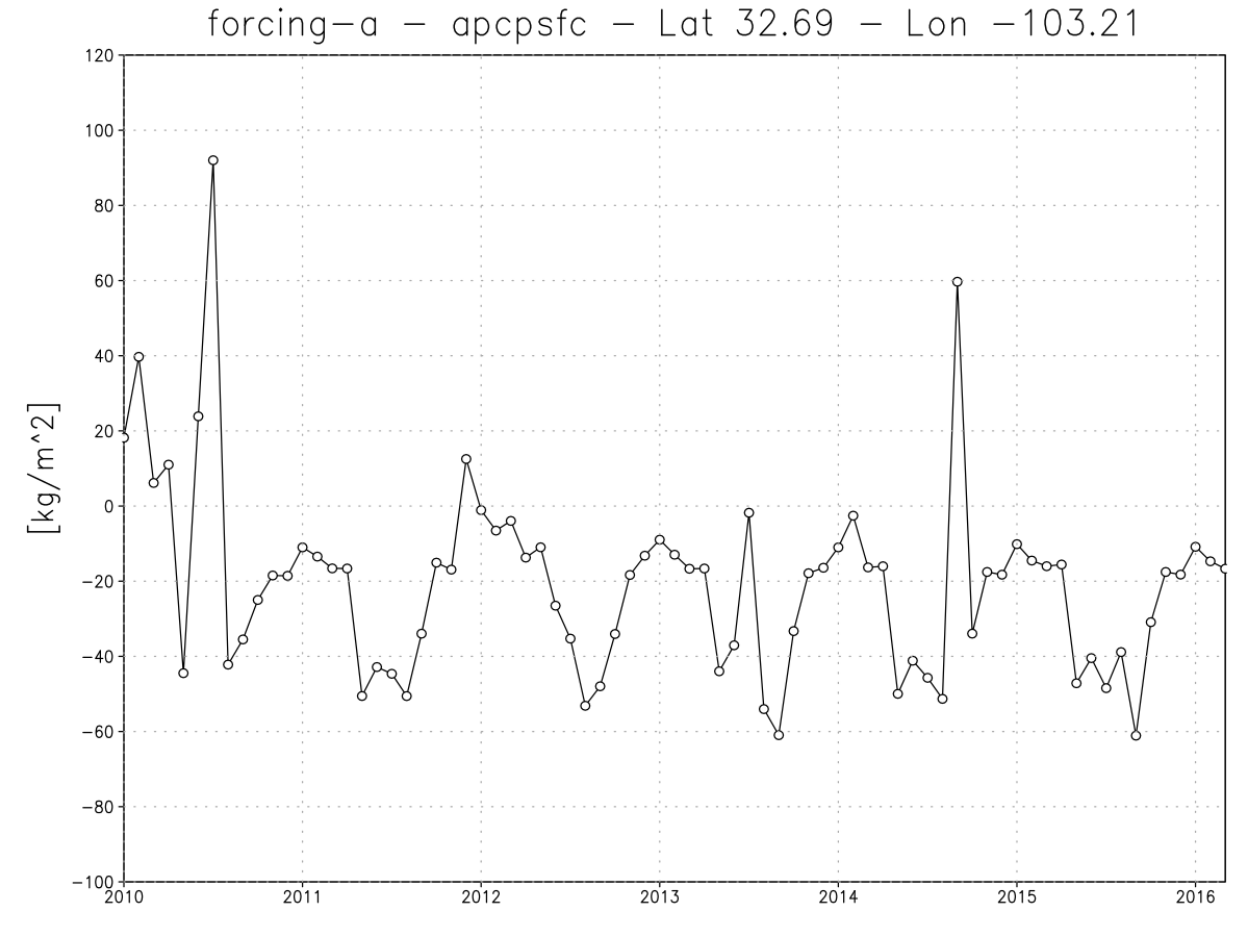


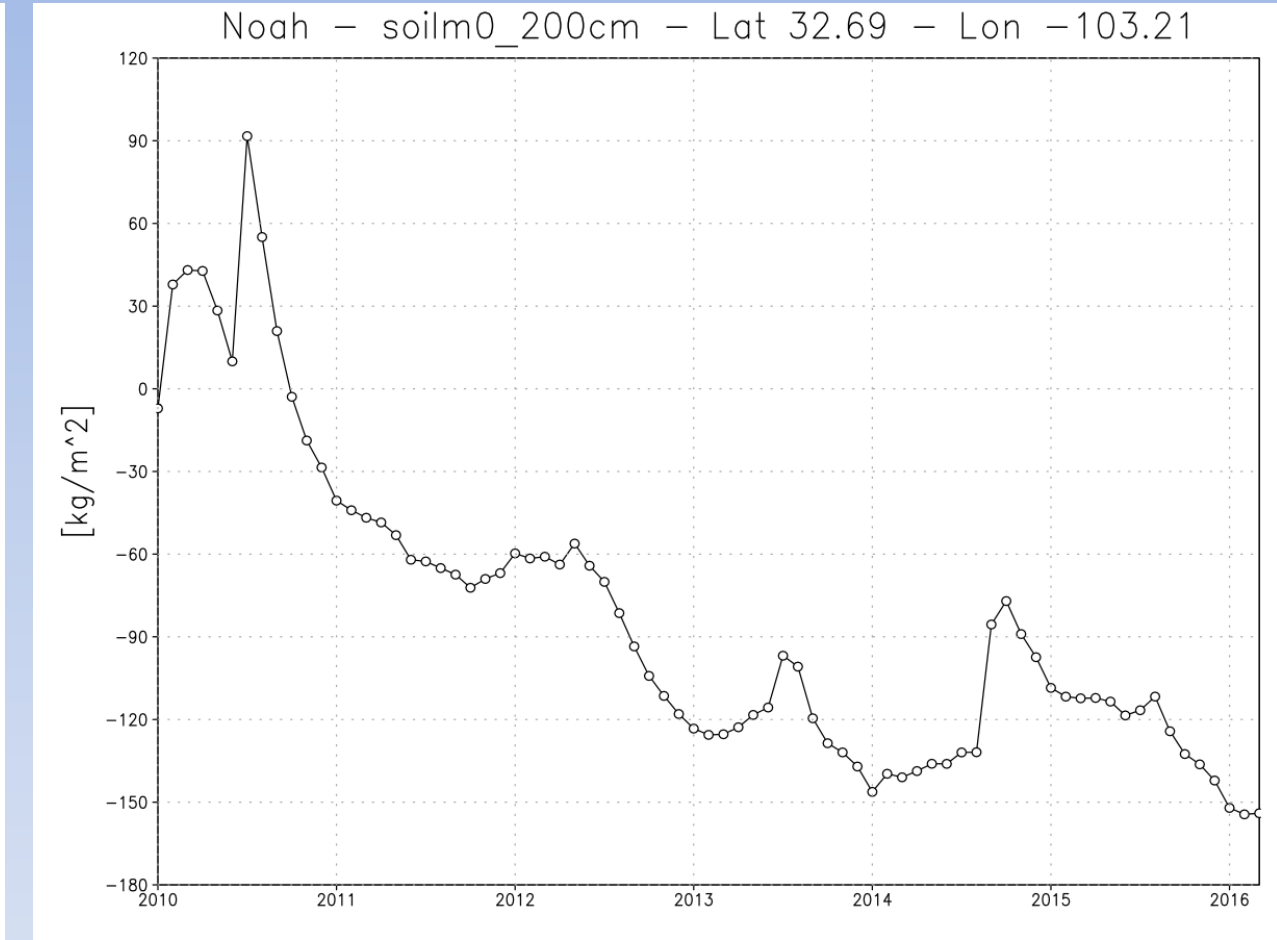


(Left) Monthly total precip anomalies (Right) Noah 0-2m SM anomalies **South Dakota** (43.17N & 101.63W). Note the "flash drought" in 2012. Nearly every month in 2015 has below-normal precipitation.

Image credit: David Mocko (NASA/GSFC)

NLDAS-2 Precip & Noah 0-2m SM monthly anomalies

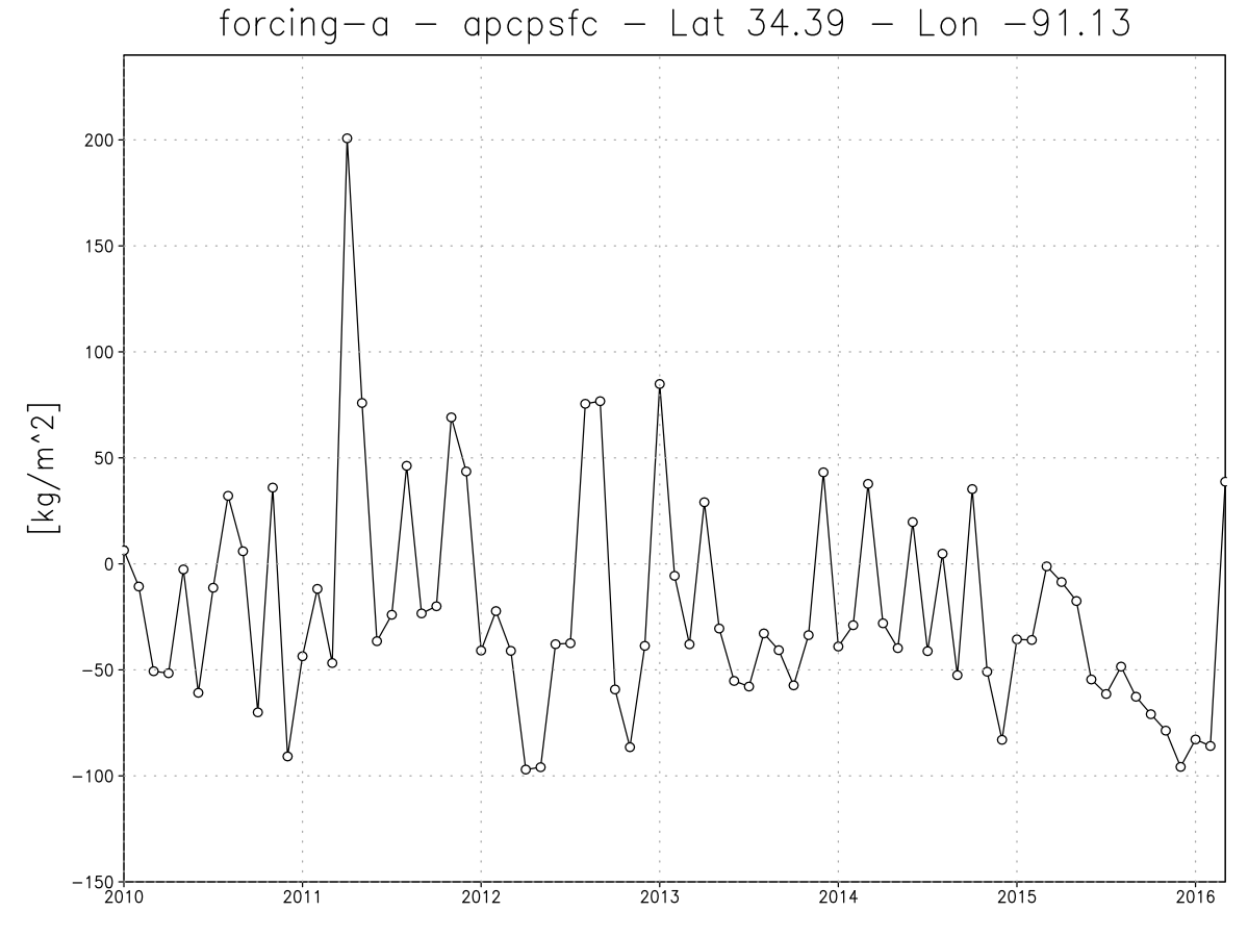


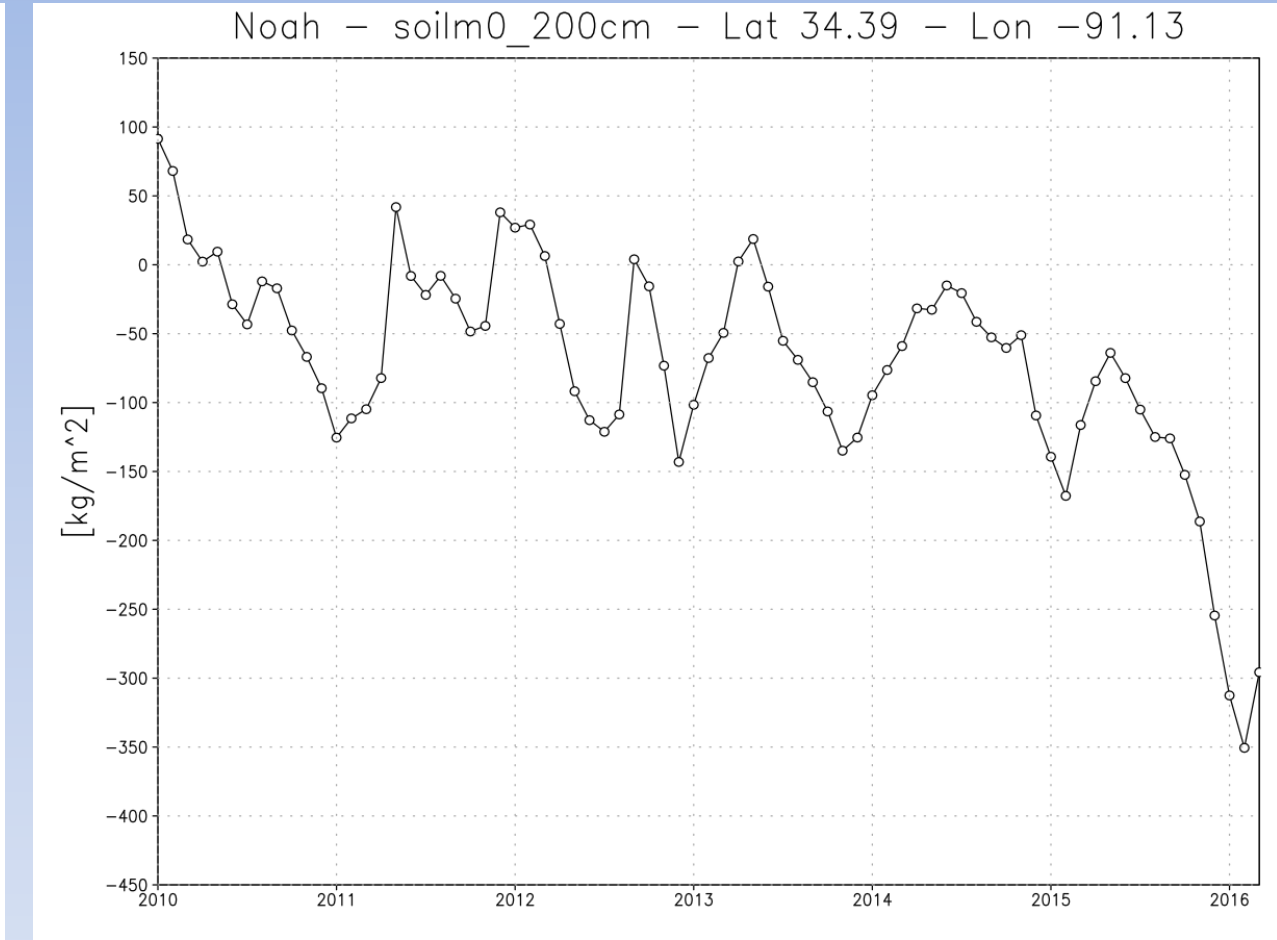


(Left) Monthly total precip anomalies (Right) Noah 0-2m SM anomalies **New Mexico** (32.69N & 103.21W). Below-normal precipitation for almost all months since mid-2010.

Image credit: David Mocko (NASA/GSFC)

NLDAS-2 Precip & Noah 0-2m SM monthly anomalies

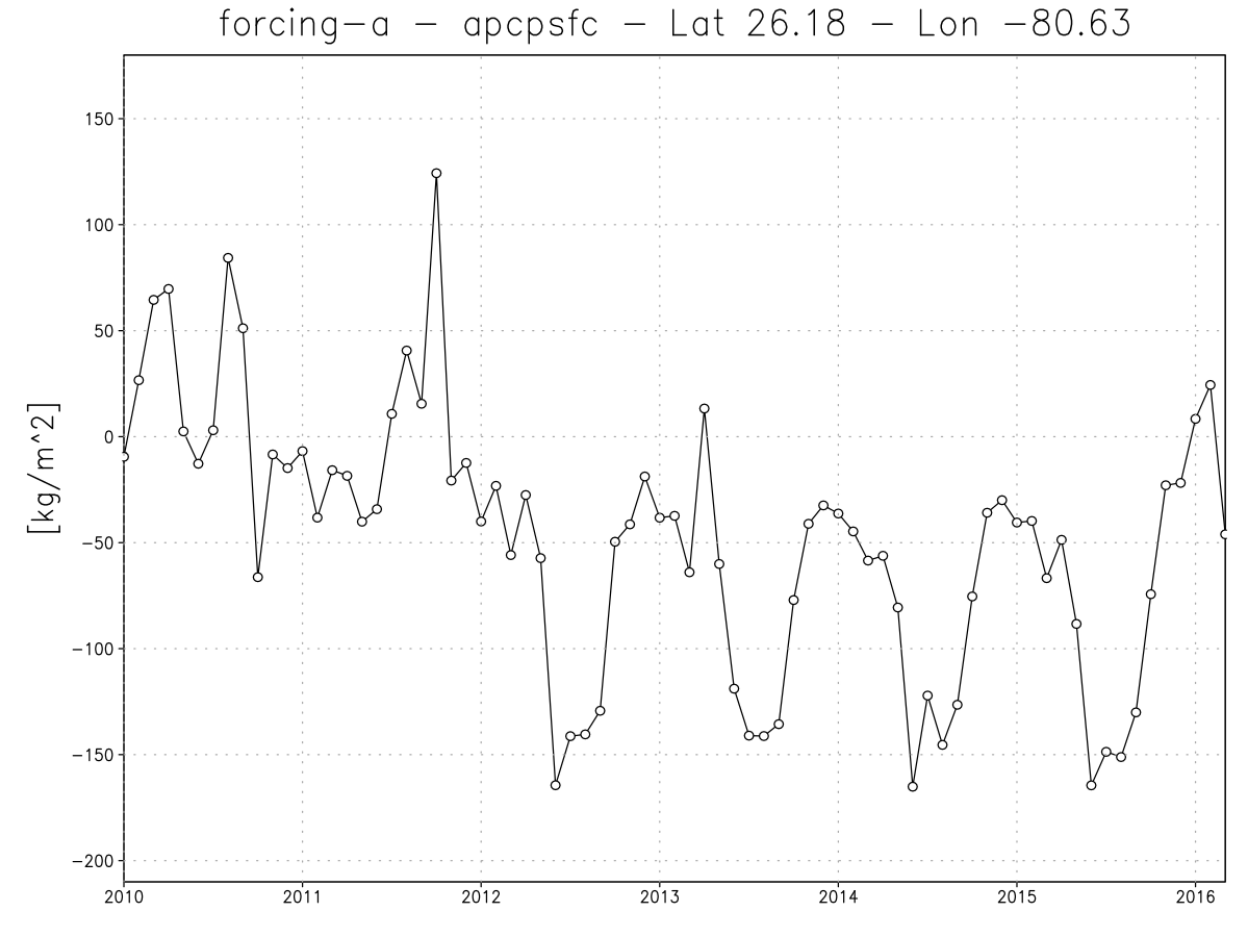


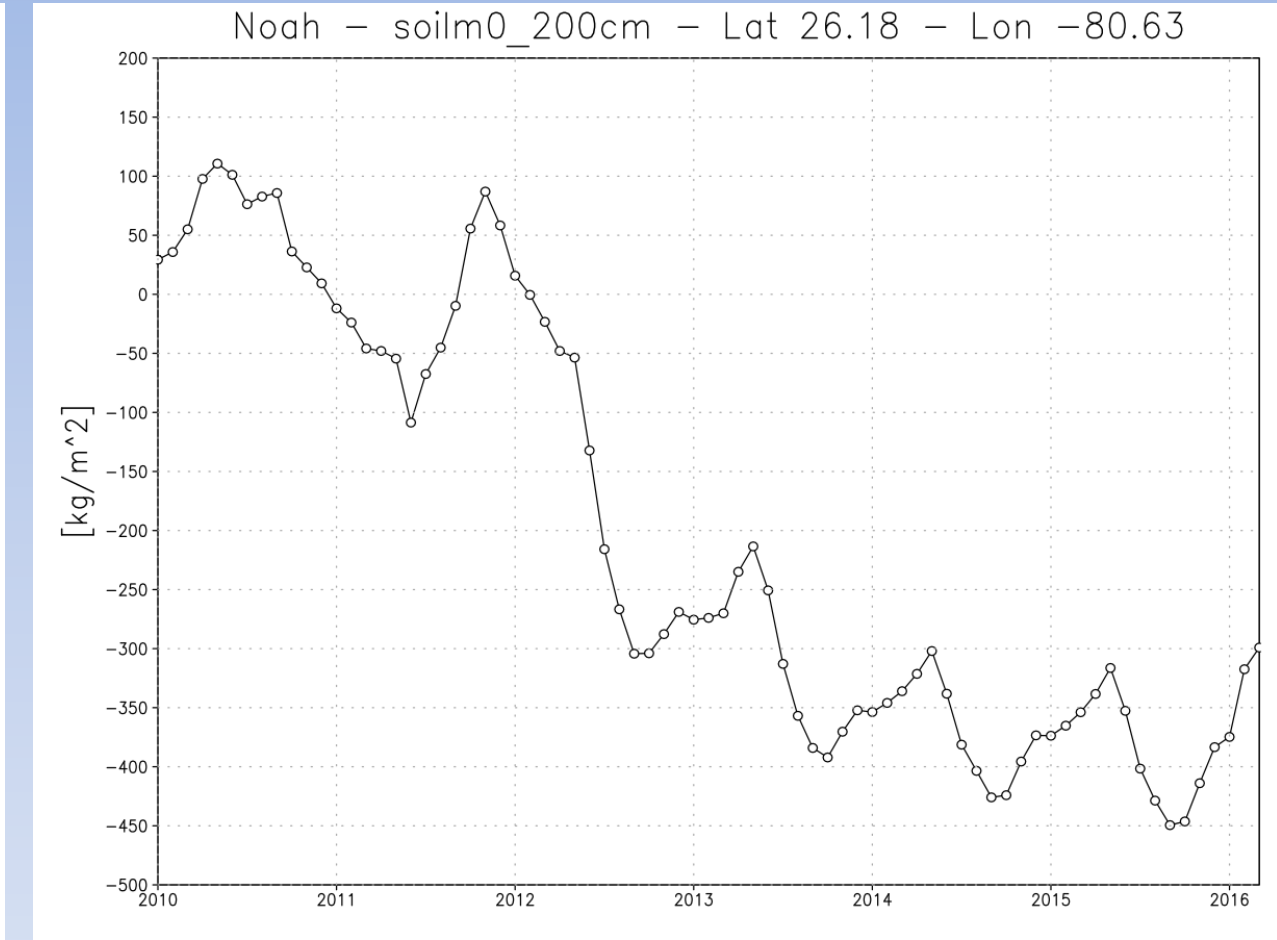


(Left) Monthly total precip anomalies (Right) Noah 0-2m SM anomalies **Arkansas** (34.39N & 91.13W). Below-normal precipitation for all of 2015. Some indications perhaps reporting was fixed in Mar 2016.

Image credit: David Mocko (NASA/GSFC)

NLDAS-2 Precip & Noah 0-2m SM monthly anomalies





(Left) Monthly total precip anomalies (Right) Noah 0-2m SM anomalies **Florida** (26.18N & 80.63W). Below-normal precipitation began at the end of 2012, but may have been corrected in the last few months.

Image credit: David Mocko (NASA/GSFC)

Solution – CPC QC fix

The CPC group undertook the following actions:

- Identified stations sending out reports of zero rainfall (about 95% of cases) or sending out reports with the incorrect decimal point
- Contacted local meteorological offices to inform them of problems
- Modified QC procedures to not include these erroneous reports

The following two slides contain a map and a listing of stations with erroneous reports for 2015.

Per CPC's operational guidance, they are unable to generate or release the gauge analysis for the past period with the re-QC'ed station inputs. However, they are planning for a new version of the gauge analysis (re-processing) sometime in FY17.

Location of stations with QC issues identified by CPC

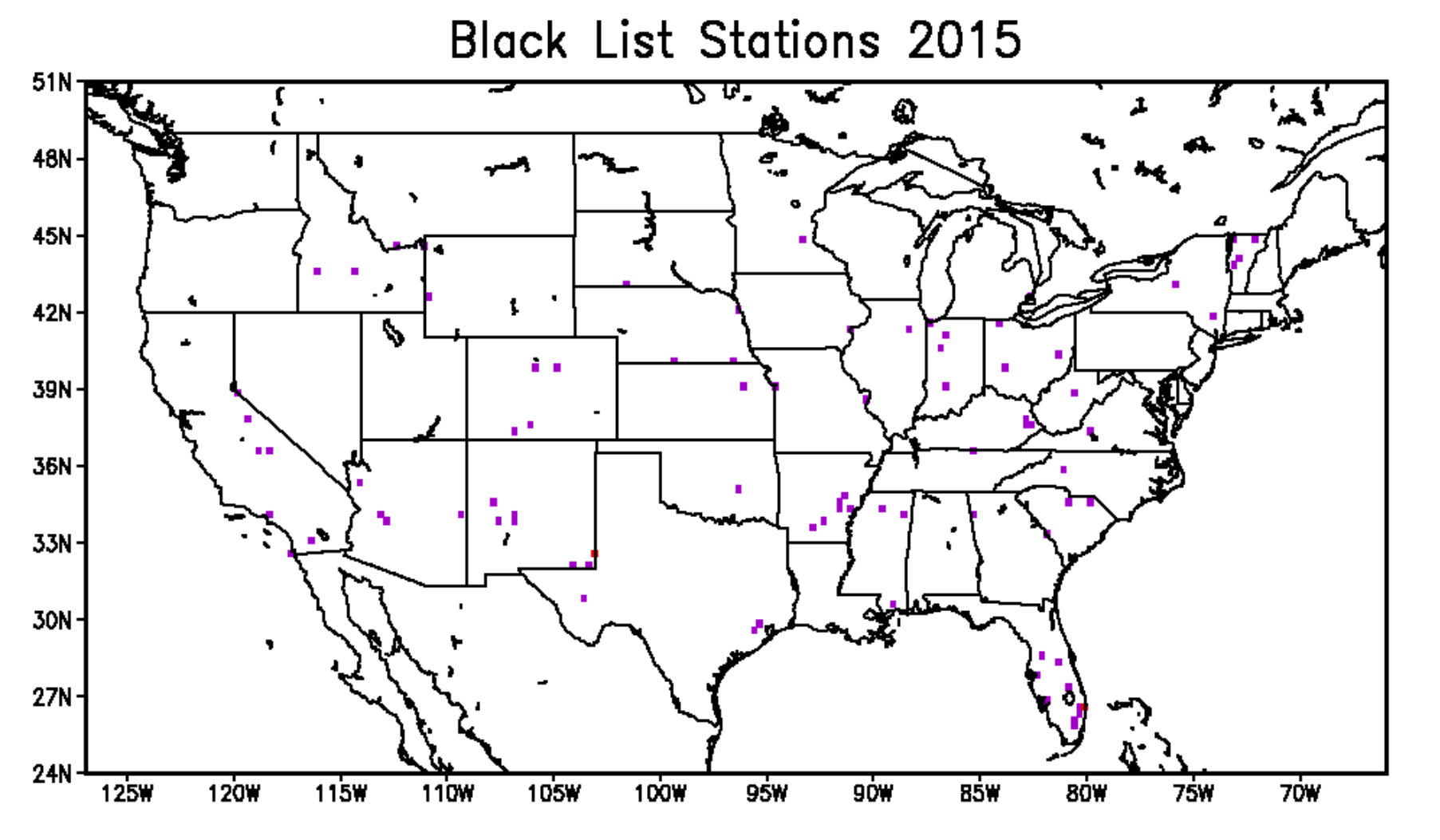


Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)

List of stations with QC issues identified by CPC

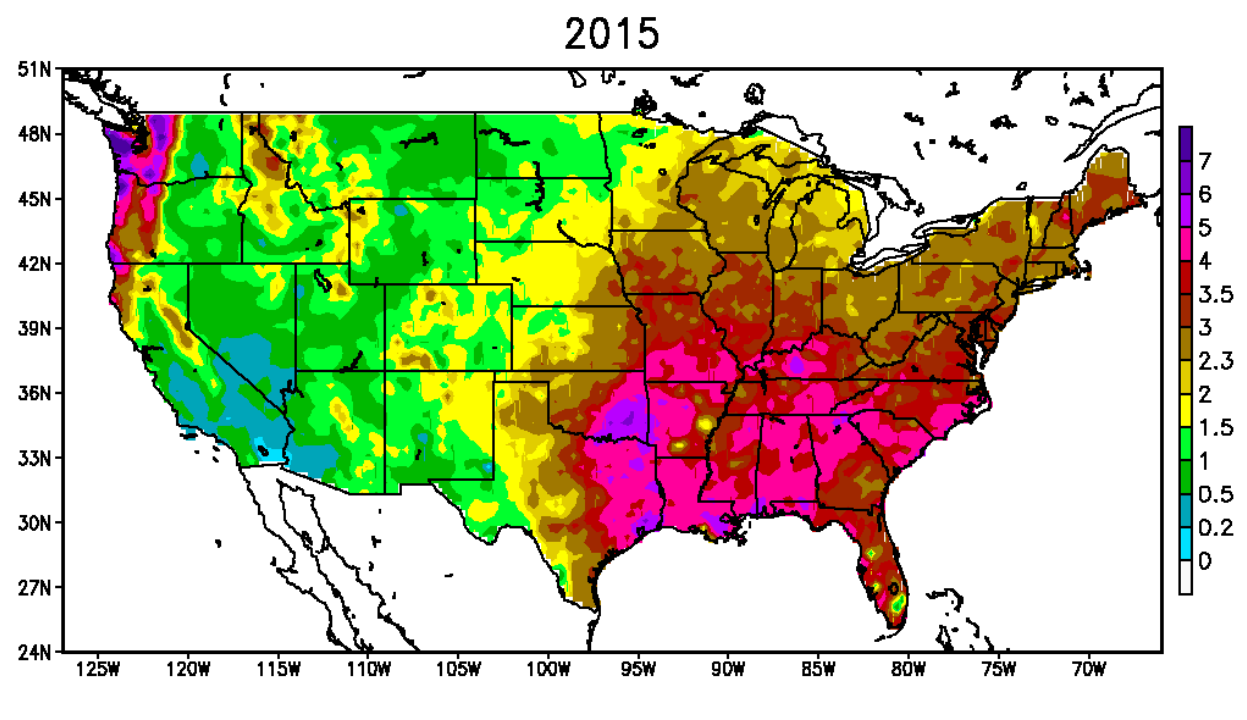
1	415	UOX	34.380	89.550
2	1474	KSDM7	39.060	94.510
3	2435	COOG1	34.200	85.450
4	2751	BENS1	34.610	79.790
5	2856	AROC2	39.920	105.760
6	3121	CSPF1	26.280	80.420
7	3304	BOYF1	26.520	80.350
8	3389	CBTC1	36.560	118.350
9	3494	BIMC1	36.720	118.850
10	4328	DLYF1	27.900	82.380
11	4375	LRRM8	44.650	112.360
12	4381	L13	32.670	117.480
13	4649	DLRF1	26.500	80.220
14	4665	DRBC2	39.830	104.960
15	5259	OAKF1	27.310	80.840
16	5550	MCPA3	35.400	114.160
17	5594	PUNF1	26.980	81.940
18	5984	MSO	46.920	114.090
19	6101	LIDT2	29.570	95.580
20	6119	ORNF1	28.430	81.400
21	6120	ORNN1	40.130	99.500
22	6177	NIAV2	37.260	79.870
23	6569	TFX	47.460	111.380
24	6745	RERF1	28.570	82.160
25	6822	CLRS1	33.480	81.910
26	7002	UCLC1	34.070	118.440
27	7095	SOL	44.070	72.970
28	7908	ASWN6	41.950	74.250
29	8105	EAGO1	39.920	83.870
30	8475	WSAC2	37.480	106.790
31	8908	TLRN7	35.920	81.170
32	9351	CENC2	37.700	106.130
33	9418	BBLT2	29.750	95.370
34	9518	TUMC1	37.870	119.350
35	9674	MUT	41.370	91.150
36	10424	BROC1	33.230	116.410
37	10494	DAHT1	36.530	85.450
38	11094	SPVA3	34.130	109.290
39	11156	SUN	43.500	114.300
40	11396	RLD	46.310	119.300
41	11722	BASM5	44.980	93.320
42	11830	COLI2	41.290	88.360
43	11919	CIU	46.250	84.470
44	11960	WEWO2	35.150	96.480
45	12642	EFK	44.890	72.230
46	12718	PNRI1	43.620	116.190
47	12798	NWPO1	40.480	81.450
48	12843	HDBI3	39.000	86.520
49	13127	MADM8	45.490	111.630
50	13666	AFO	42.720	110.930
51	13870	WCKA3	33.950	113.000
52	13872	JOTA3	34.160	113.020
53	14159	DLPI3	40.590	86.770
54	14335	DLBF1	26.520	80.250
55	14338	SWEF1	25.880	80.570
56	14340	ADYF1	26.180	80.530
57	14356	BLWM6	30.550	89.120
58	14558	TABM8	45.800	111.590
59	14563	LDSM8	47.200	105.180
60	14628	CRNM4	45.910	87.210
61	14654	BCRO1	41.680	84.230
62	14676	NJNM4	45.940	86.710
63	14778	PAUM4	46.350	89.850
64	14791	AMEN8	47.020	97.210
65	15192	GTFS1	34.550	80.880
66	15491	PXCK1	39.060	96.150
67	15587	WDFC1	38.770	119.810
68	15905	UNCM7	38.680	90.360
69	15921	ORAI3	41.150	86.570
70	15945	DEAM4	42.550	82.580
71	15947	BURW2	38.870	80.680
72	15956	GCGI3	41.610	87.390
73	16351	NETM6	34.070	88.630
74	16529	MTHN8	46.300	103.920
75	16532	WHLN1	42.150	96.480
76	16551	WYS	44.690	111.120
77	16561	BARN1	40.050	96.580
78	17101	FSO	44.930	73.100
79	1374	LFKM5	48.400	93.550
80	3858	FTHS2	45.200	102.150
81	7575	YXC	49.600	115.780
82	11718	BLHT2	30.980	103.740
83	15280	HOB	32.690	103.210
84	3979	LITS2	43.170	101.630
85	2713	ACON5	34.720	107.850
86	10259	MGLN5	33.850	107.540
87	12061	ONM	34.070	106.900
88	13423	SAAN5	33.770	106.900
89	6190	MLGN5	32.210	104.020
90	10078	OCHN5	32.170	103.430
91	11230	CLEN6	43.230	75.880
92	15280	HOB	32.690	103.210
93	1405	FRDA4	33.820	92.400
94	14530	CDH	33.620	92.760
95	1055	SGT	34.600	91.570
96	1329	DESA4	34.970	91.500
97	9959	SCHA4	34.390	91.130
98	11337	SGTA4	34.480	91.530
99	15162	FTGV2	37.580	82.730
100	17078	PTVK2	37.820	82.800
101	17079	PSTK2	37.670	82.770
102	16259	SBYV1	43.930	73.100

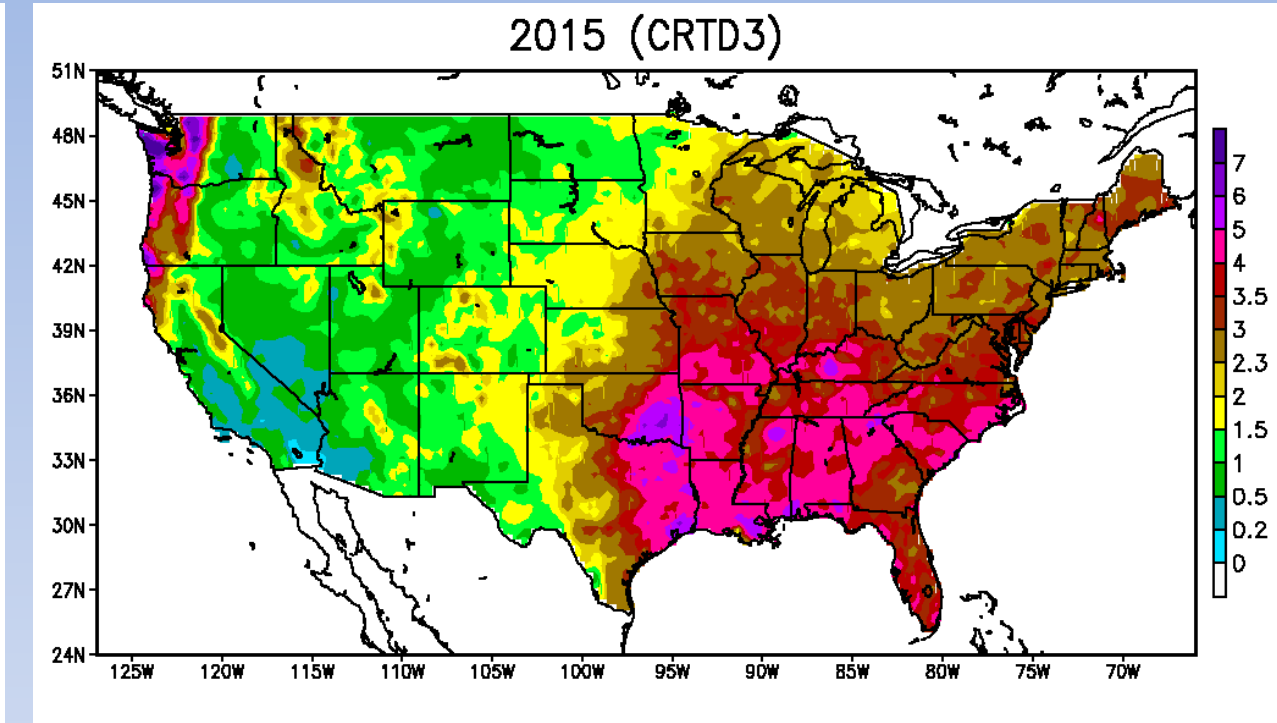
Columns:

1) “Bad” station number
2) Station ID number
3) Station ID
4) Latitude
5) Longitude

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)

CPC gauge analysis for 2015 before and after QC fix





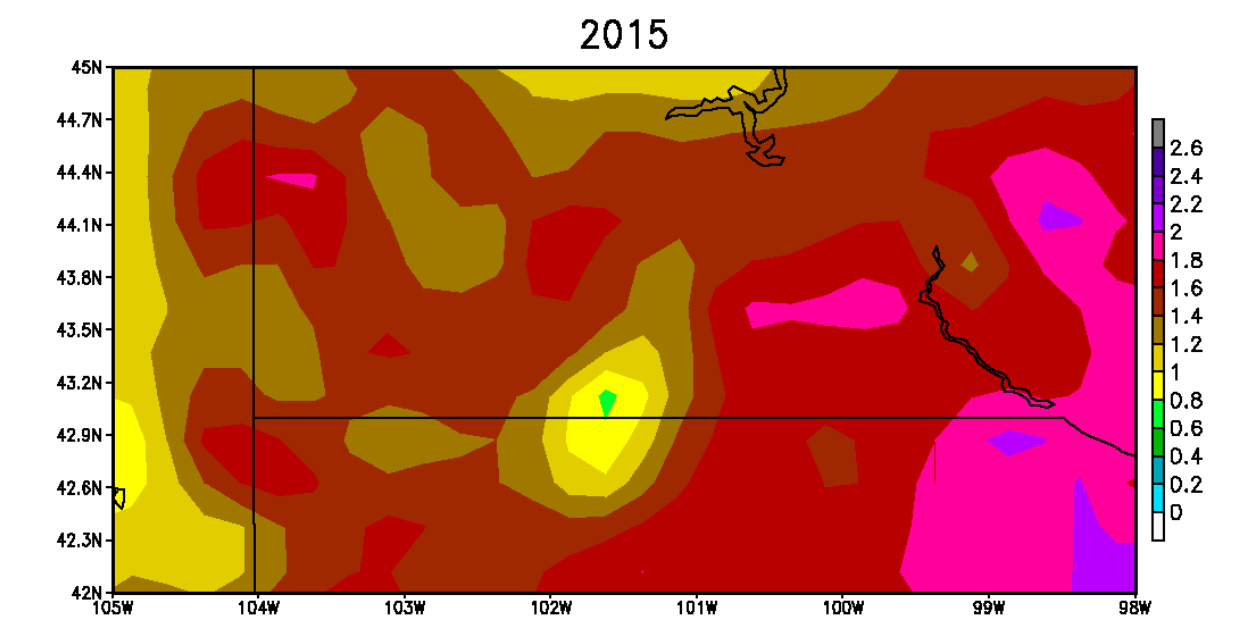
Original CPC Units: mm/day **CPC after QC fix**

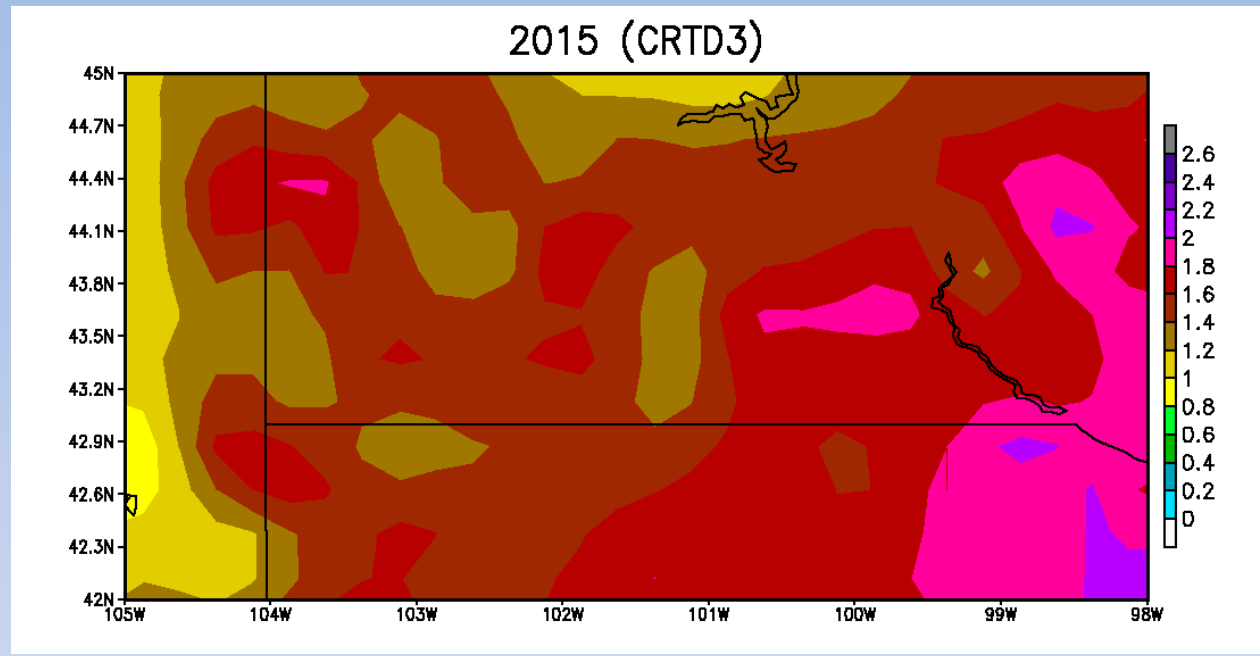
Before the QC fix, the dry bulls-eyes were very noticeable.

After the QC fix, these issues appear to be resolved.

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)

CPC gauge analysis for 2015 – South Dakota





Original CPC

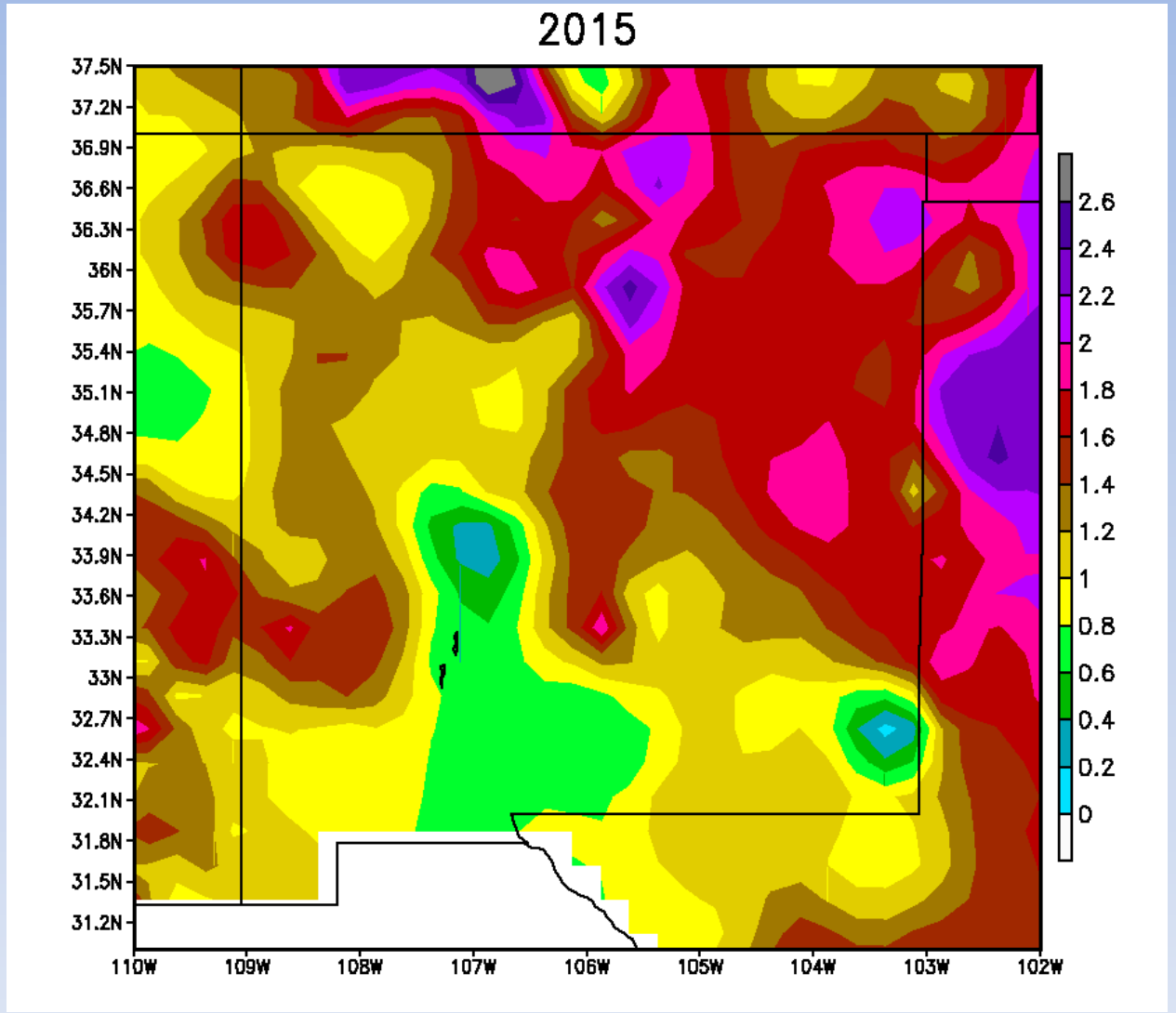
Units: mm/day

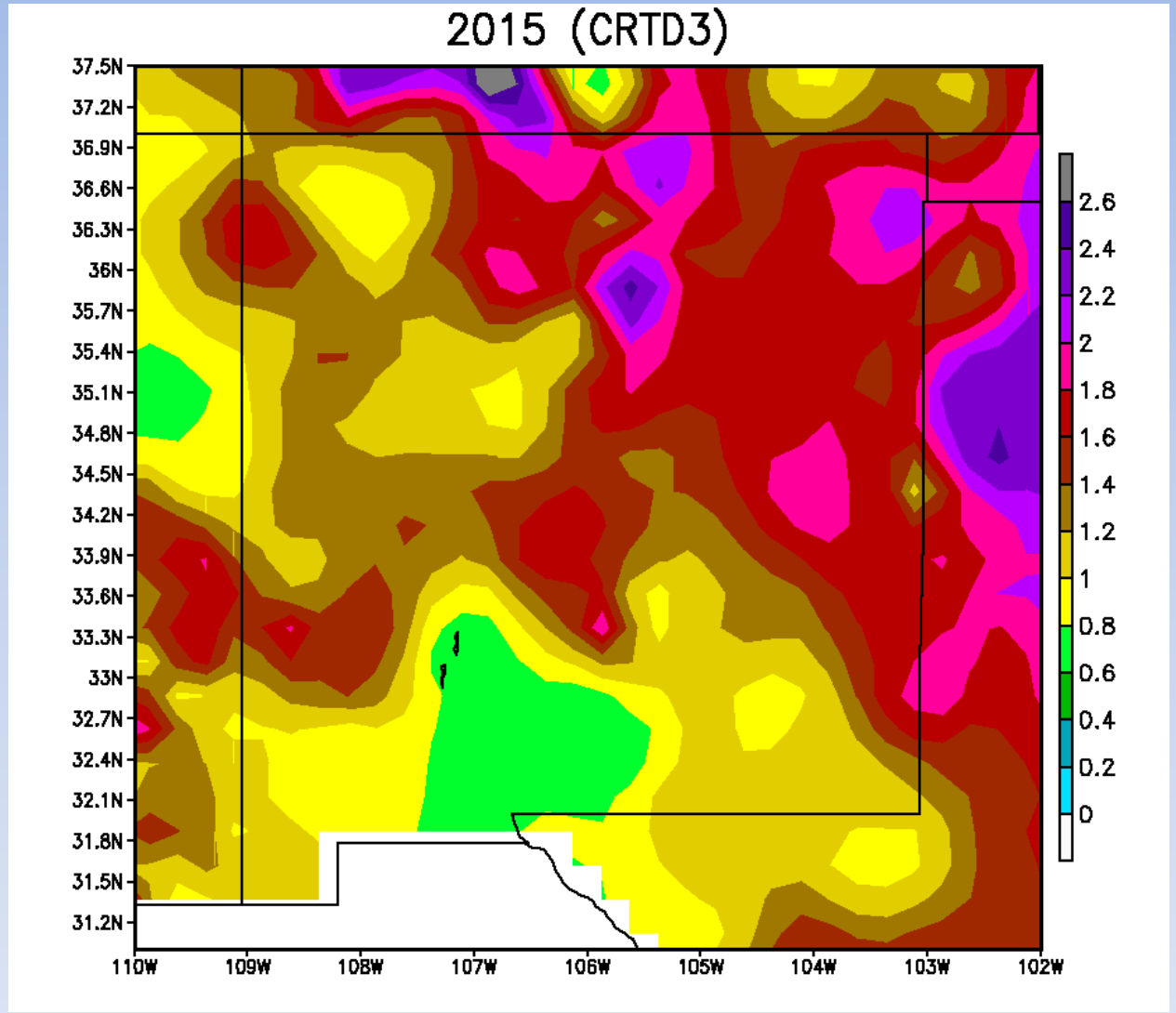
CPC after QC fix

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)

CPC gauge analysis for 2015 – New Mexico

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)





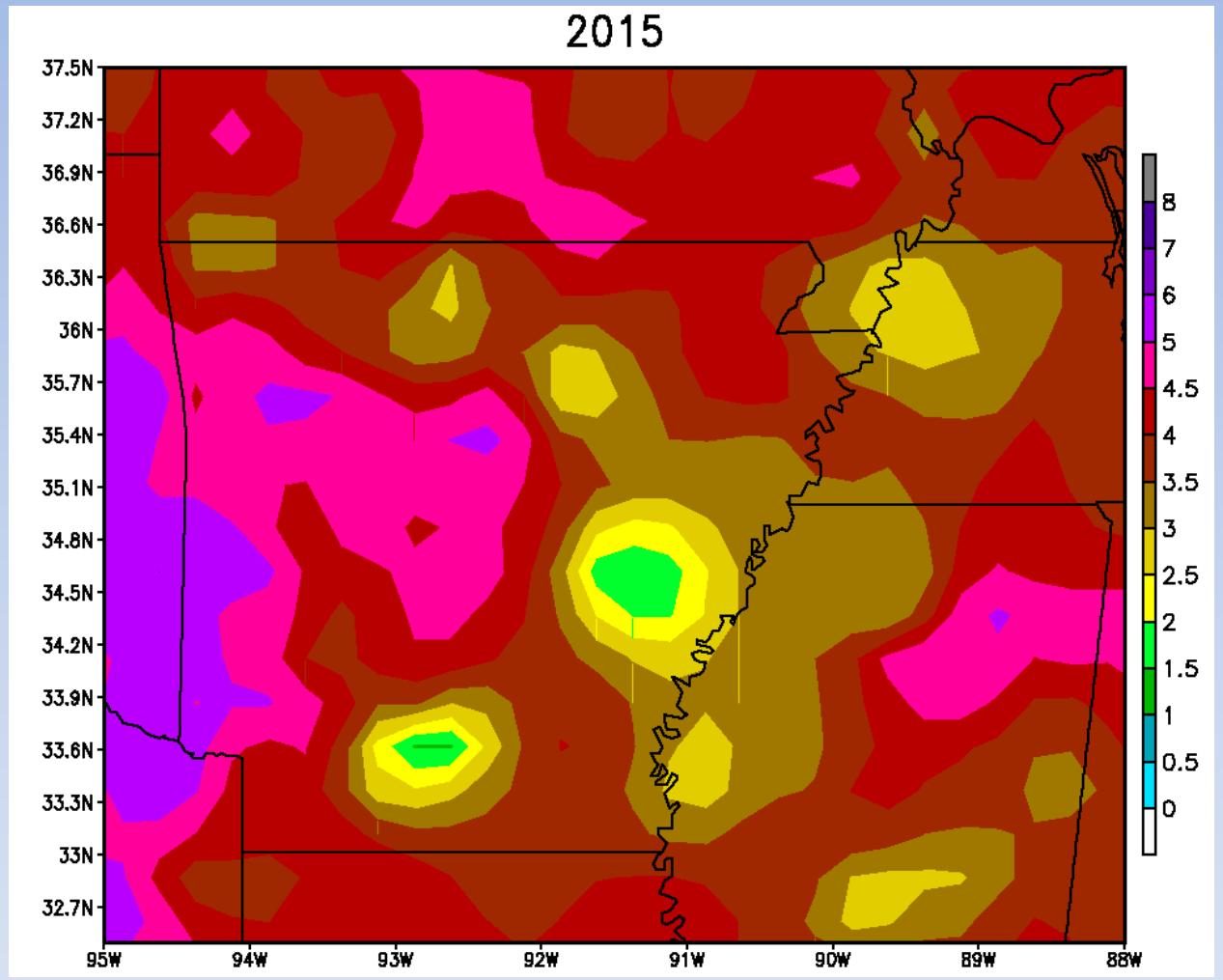
Original CPC

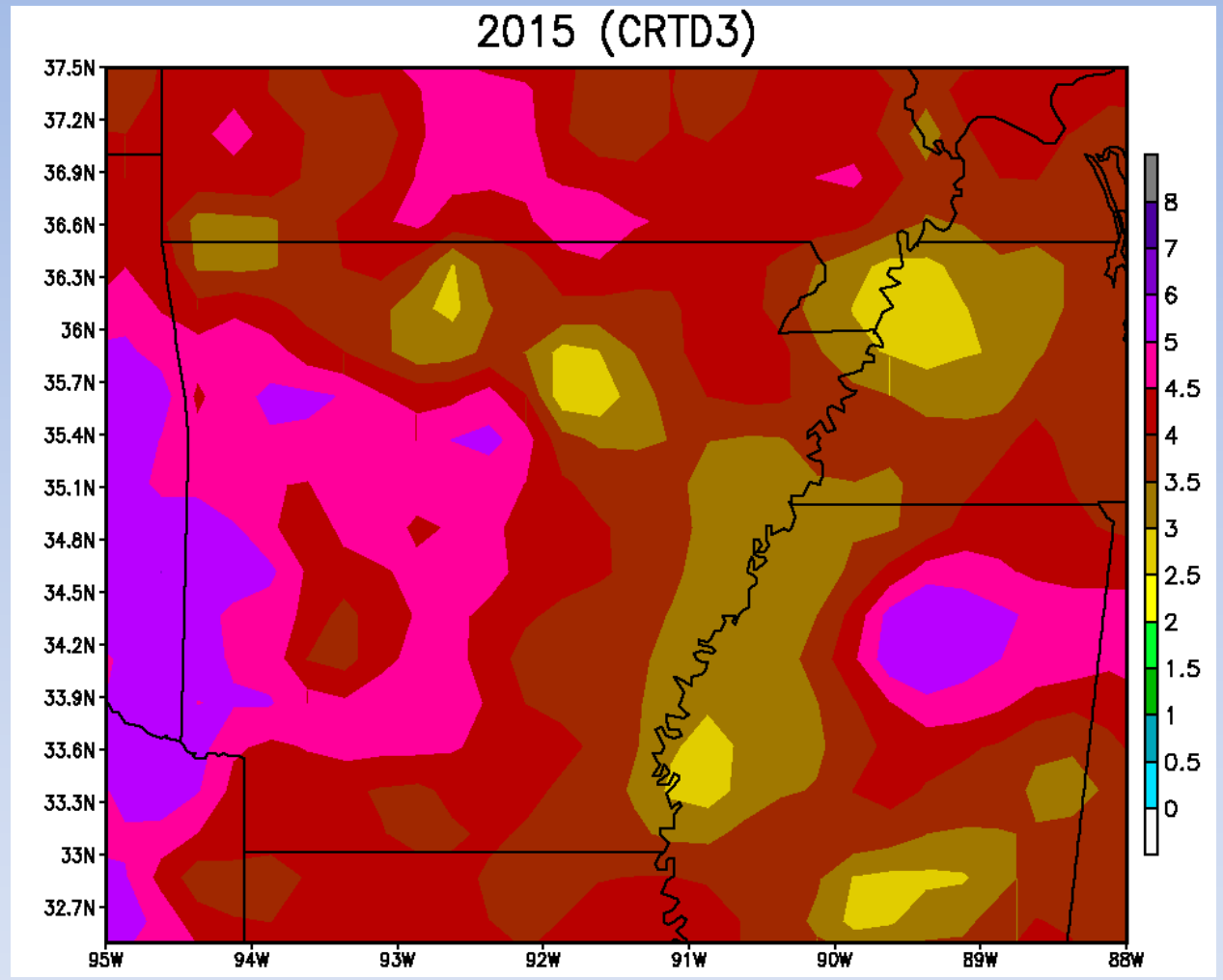
Units: mm/day

CPC after QC fix

CPC gauge analysis for 2015 – Arkansas

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)





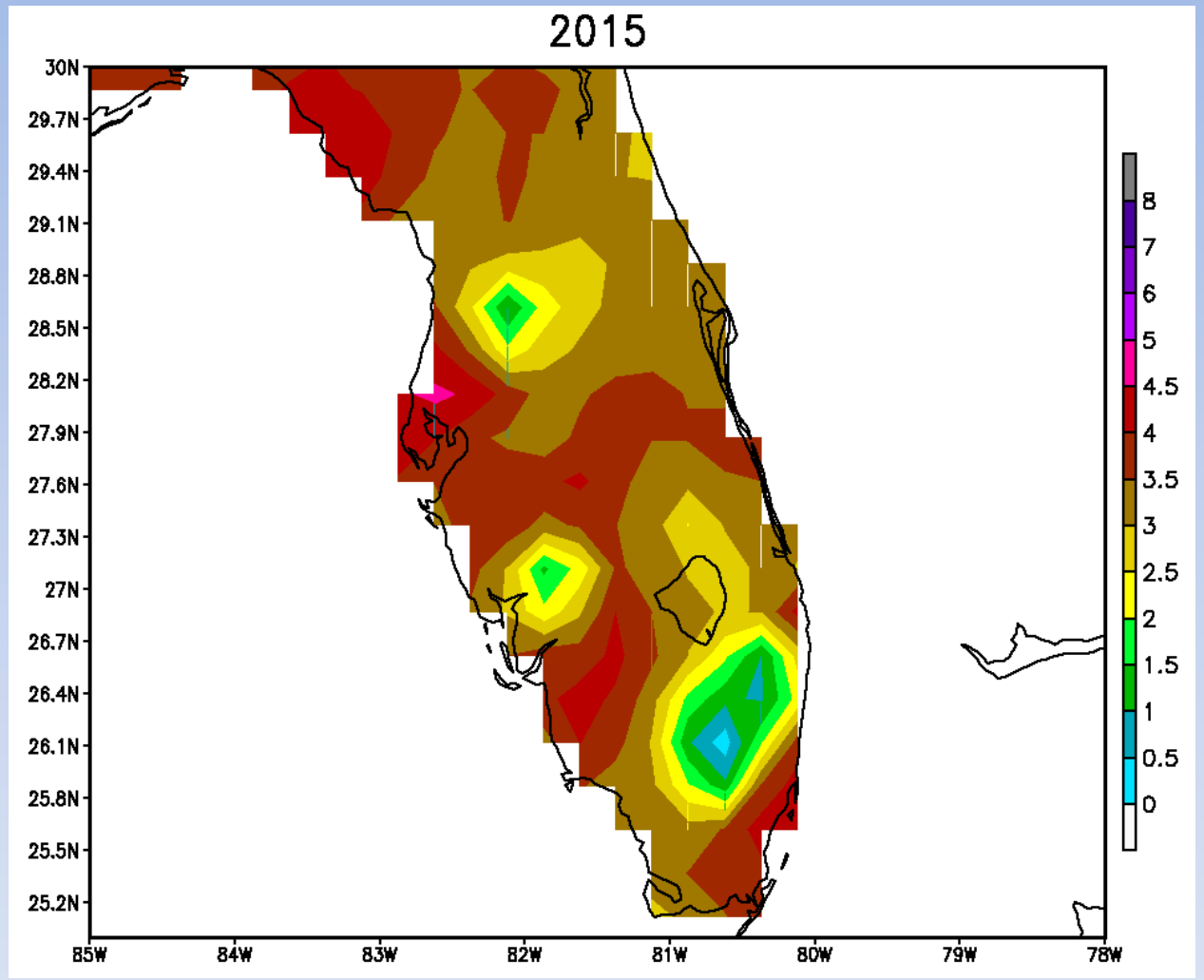
Original CPC

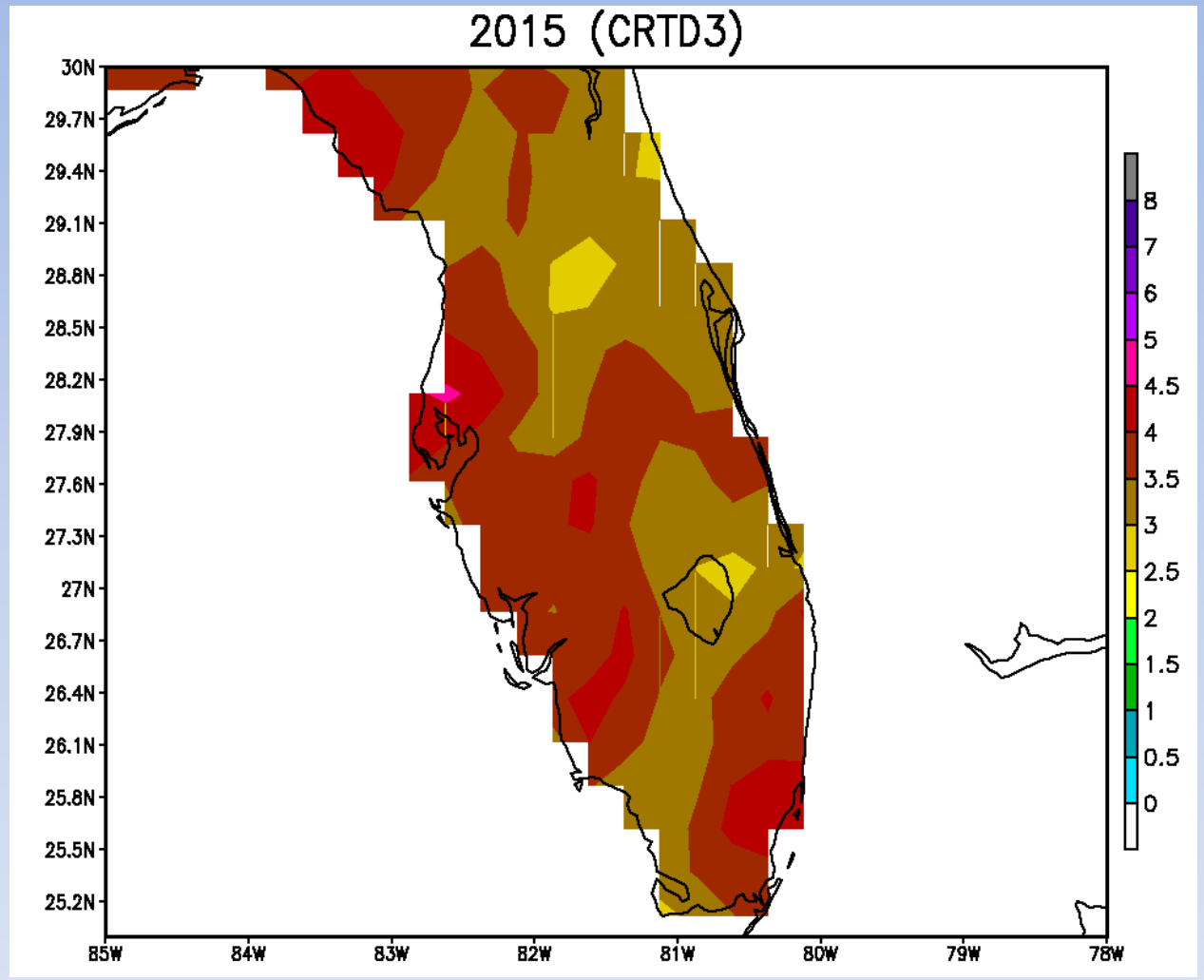
Units: mm/day

CPC after QC fix

CPC gauge analysis for 2015 – Florida

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)





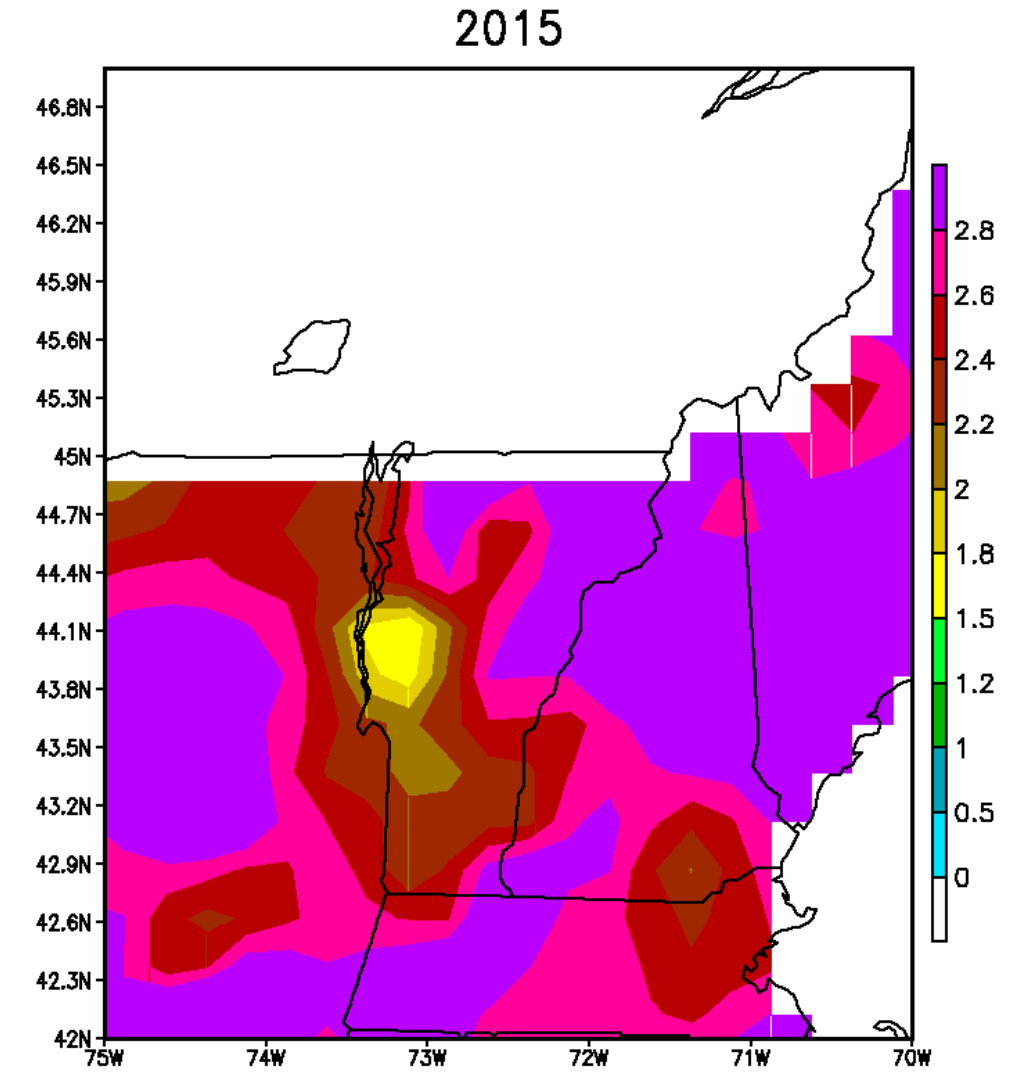
Original CPC

Units: mm/day

CPC after QC fix

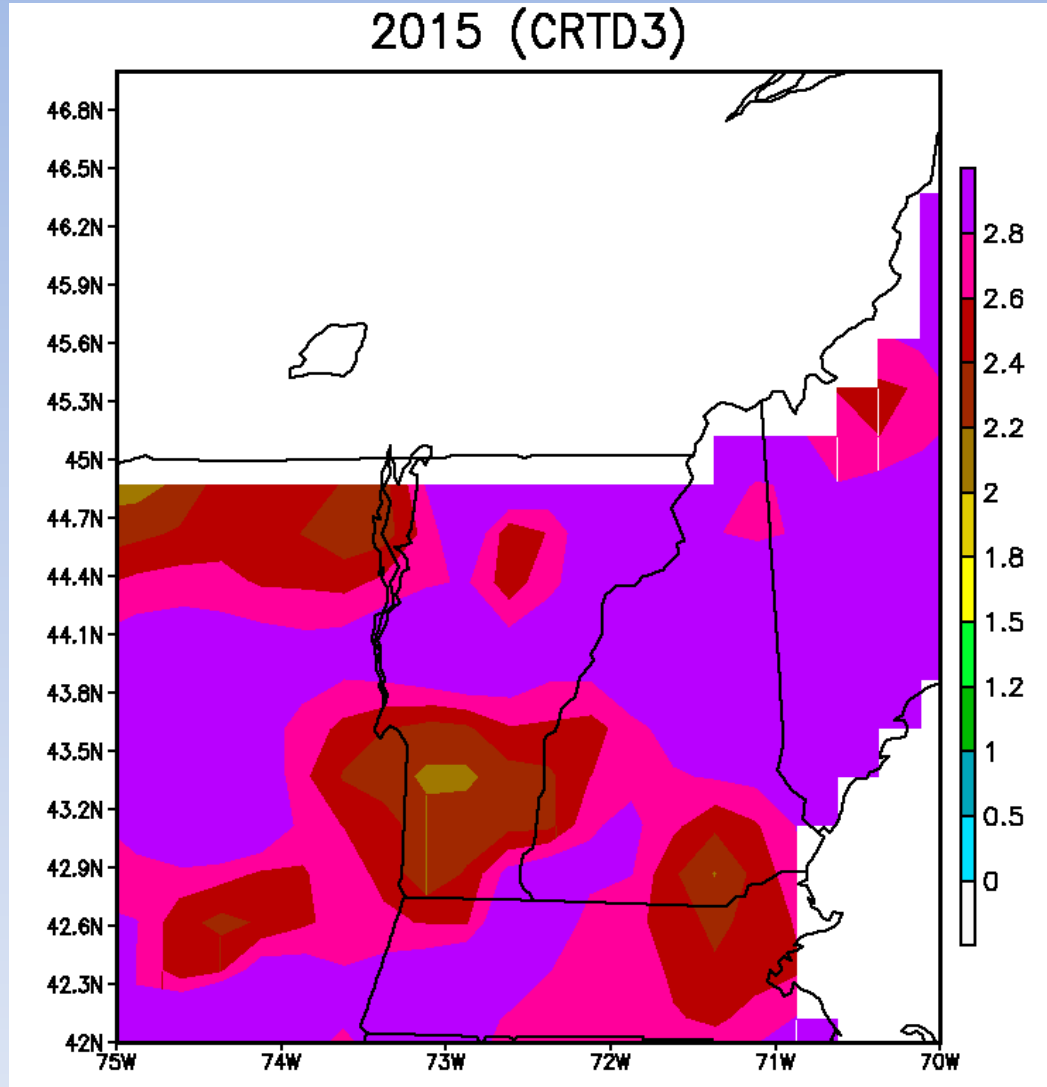
CPC gauge analysis for 2015 – Vermont

Image credit: Pingping Xie, Mingyue Chen, and Wei Shi (CPC)



Original CPC

Units: mm/day



CPC after QC fix

Implementation – CPC QC fix

On 6 Apr 2016, the new QC filter was implemented in the operational daily CPC gauge analysis.

The start dates of suspiciously-low precipitation reports vary widely by location. There is some indication for a few points that low precip was included in the analysis as far back as mid-2010. During 2015, many more points were shown to have near-zero precipitation.

Please identify/report any further suspicious stations, if noticed.

In FY17, CPC is planning to re-process from 1979 to present over all global land – except for CONUS, where the dataset will extend back at least from 1948, although CPC is investigating going back further.

Discontinuities with NLDAS Phase 2 Precipitation

- On 1 Apr 2010, the CPC daily 1.0-deg. U.S.-Mexico precipitation analysis (Higgins et al.) was stopped – and replaced with a 0.5-deg. CPC official global precipitation analysis over Mexico and Canada
- On 1 Jan 2012, NLDAS-2 transitioned from the unified CPC precip product to an operational CPC product. The primary difference between the two products is the interpolation algorithm, resulting in some differences in the behavior of precipitation, especially right on the U.S.-side of the border with Mexico (much lower precipitation), in western mountainous regions, and along coastlines.
- On 1 Mar 2012, the NARR was replaced with the operational R-CDAS, which is a real-time extension of the NARR

Summary

- The SPoRT-LIS group at NASA/MSFC identified spots of very dry soil moisture, in both their system and in the NLDAS-2 Drought Monitor
- These spots are from issues with the CPC gauge precipitation analysis
- The CPC group identified the bad stations and improved their QC procedure; sample images for 2015 show great improvement in the precipitation analysis
- CPC (and thus NLDAS) will be unable at this time to re-process the precipitation analysis, the NLDAS-2 forcing, and re-run the NLDAS-2 LSMs. An updated CPC analysis in FY17 will be used for improved precipitation forcing for the next phase of NLDAS.

http://ldas.gsfc.nasa.gov/nldas/ David.Mocko@nasa.gov