A Synoptic Analysis of the 1988 Midwestern Drought and 1993 Flood Using CFS Reanalysis Data

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Goals:

1) Compare the synoptic patterns of the 1988 Drought and 1993 Flood

2) Assess the role of storm tracks

3) What of external climate influences?

Satellite photos of the Mississippi, Missouri and Illinois rivers near St. Louis during the Great Flood and nine years later.

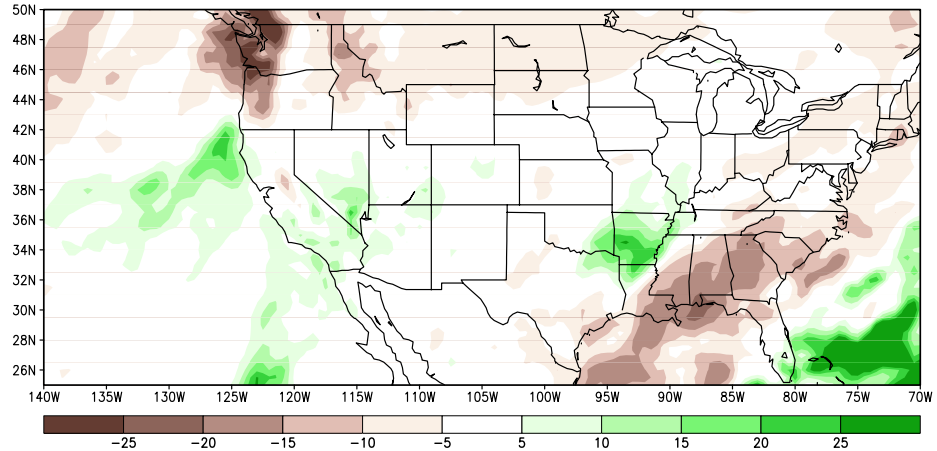
WATERWAY – At the flood's peak on August 1, more than 1,000,000 cubic feet of water rushed past the Gateway Arch in St. Louis every second.

Datasets Used

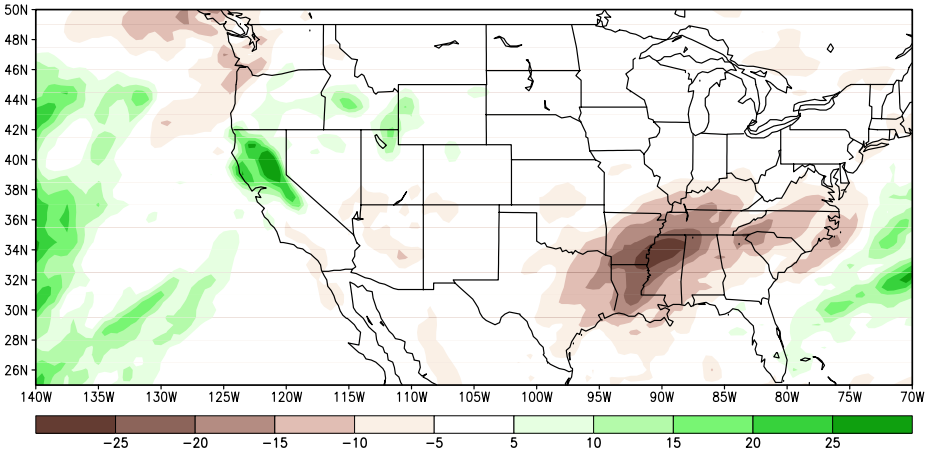
- CFSR Monthly and 6-Hourly Data
- Storm tracks calculated using 6-hourly SLP as input into storm track program (Serreze et al. 1995 and Serreze et al. (1997).
- Storm track climatology generated by binning into 5° Lat x 5° Lon boxes
- Storm-related rainfall calculated by mapping CFSR 6-hourly precipitation onto a 9.5°Lat x 9.5°Lon box centered on storm

CFSR Precipitation Anomaly (mm) 1987-1988

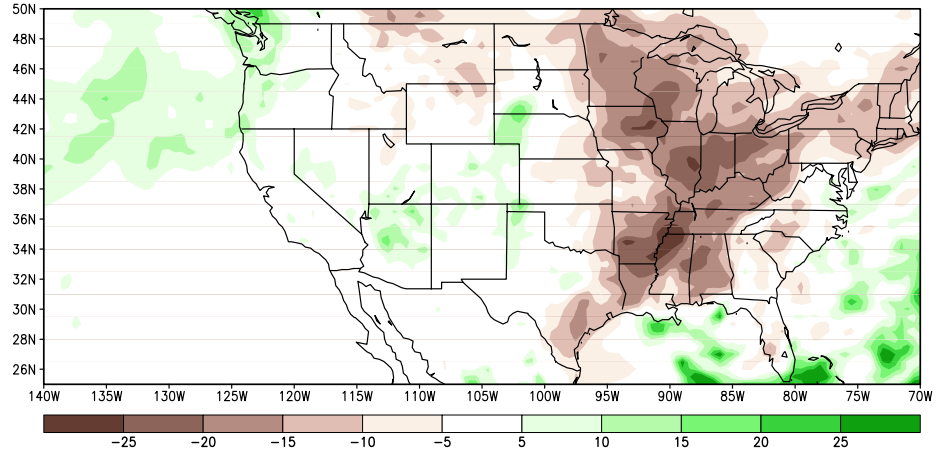
OND87



JFM88



AMJ88



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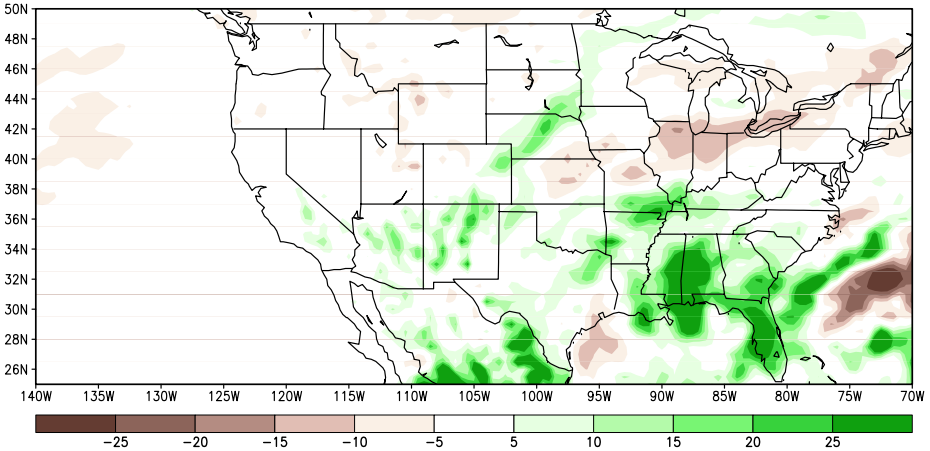
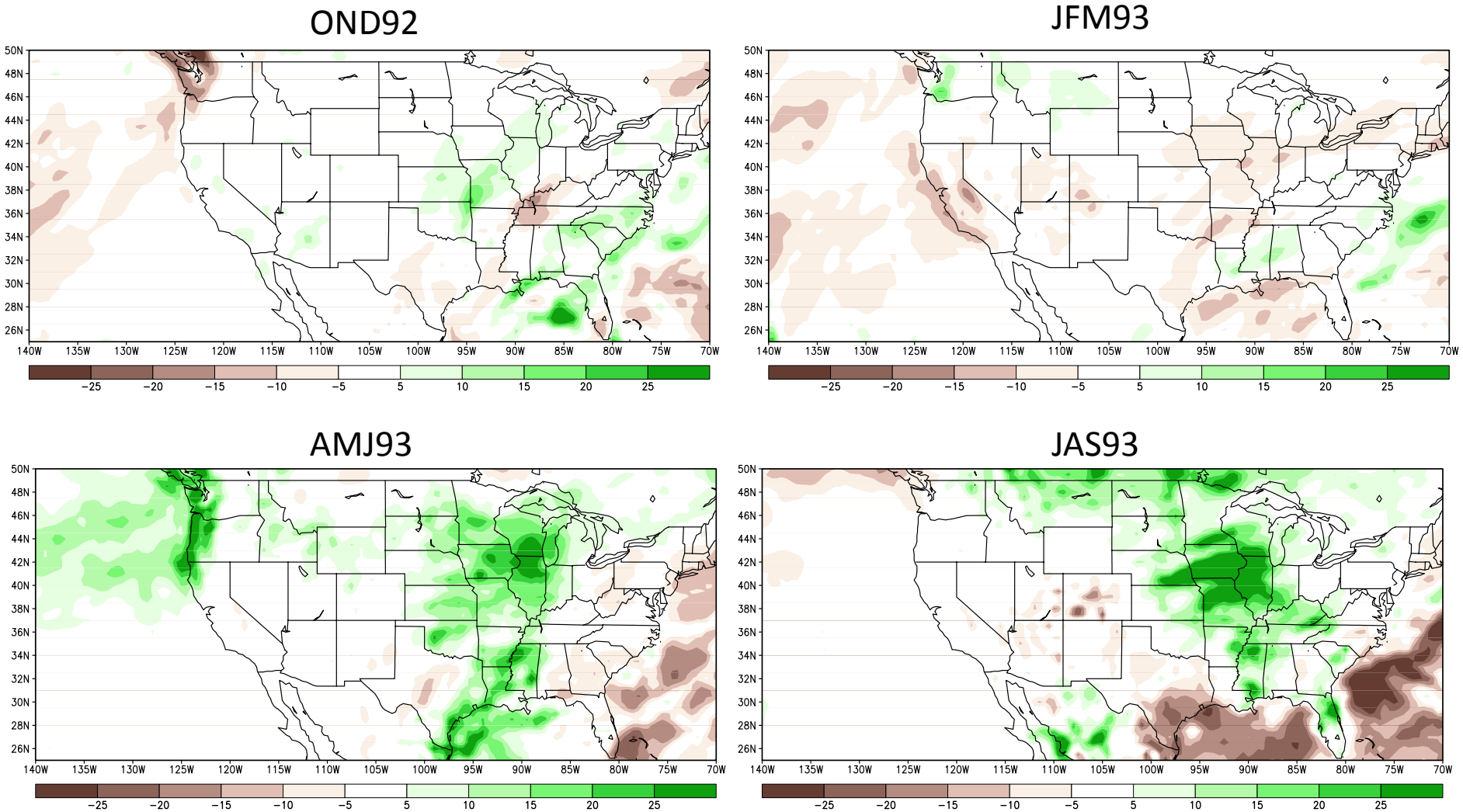
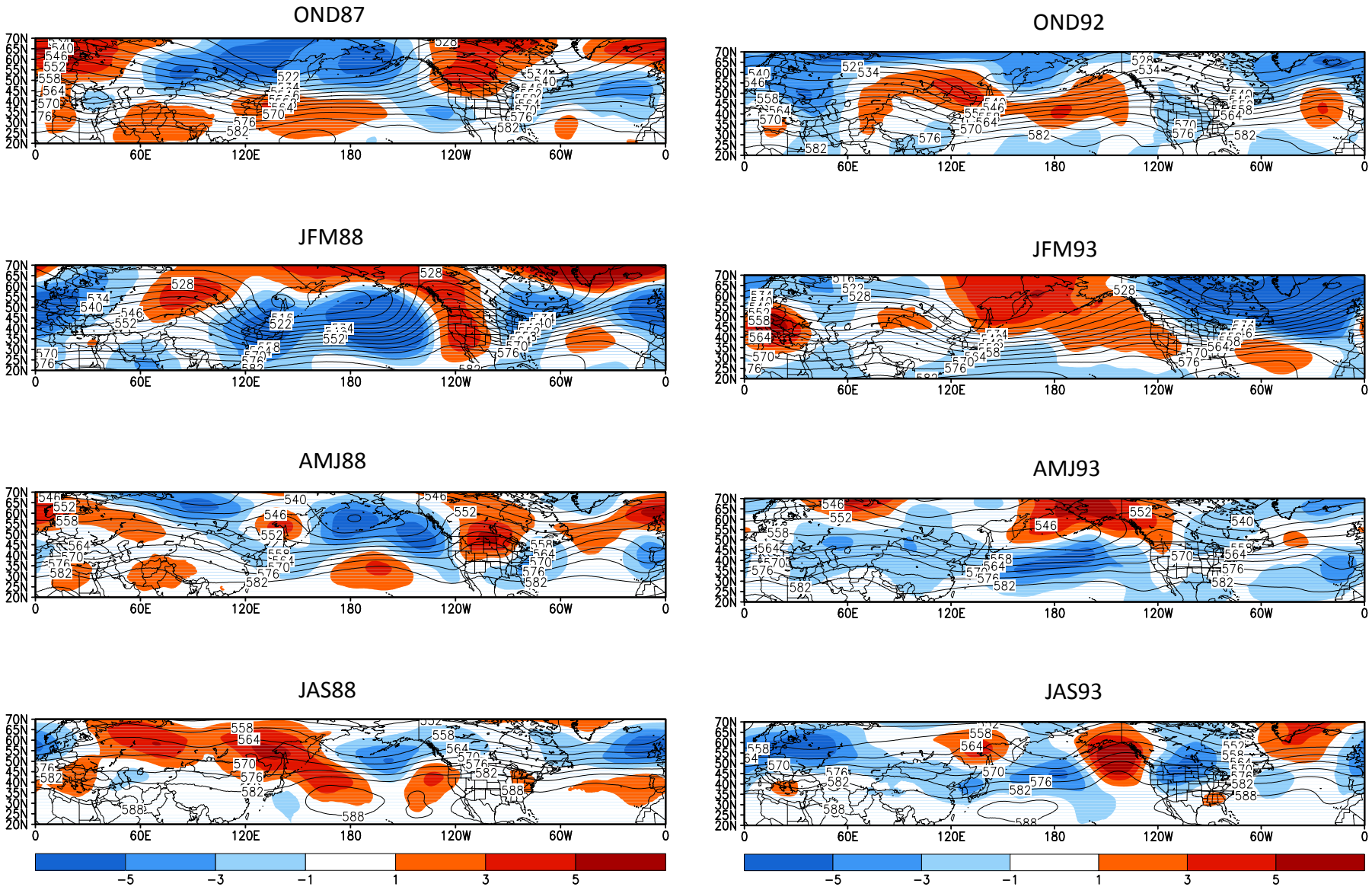


CFSR Precipitation Anomaly (mm) 1992-1993

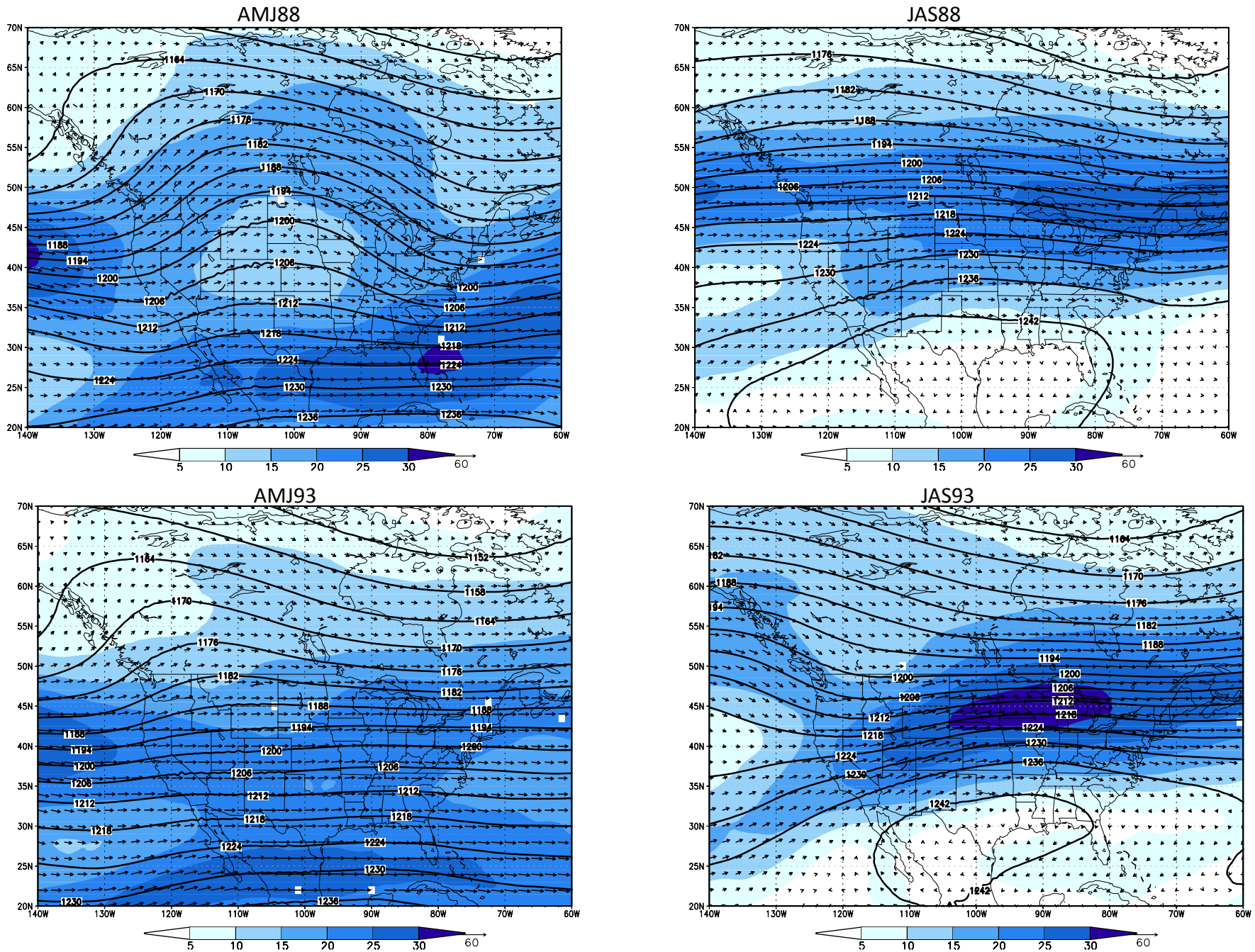


Note: For fun, I looked up StL snow for 1992/1993. They received 30” which is 11” above normal.

CFSR 500 hPa Height (Contour) Anomaly (Shaded) (Dm)

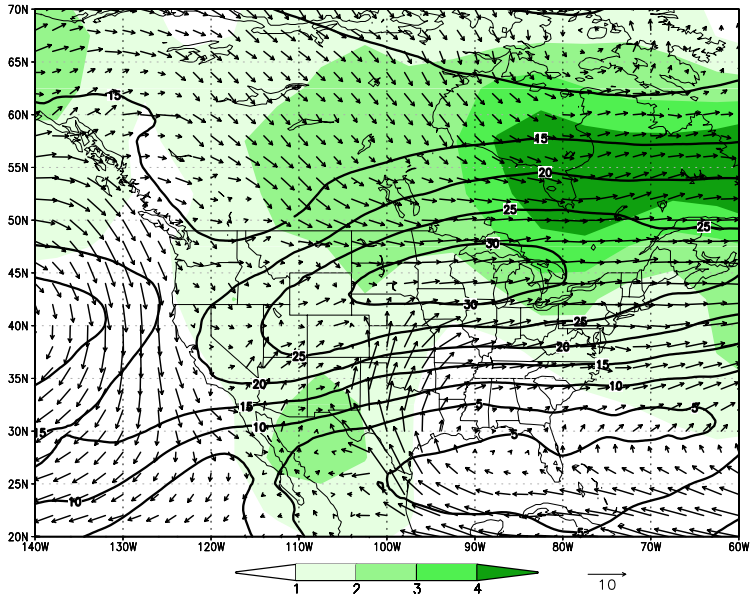


CFSR 200 hPa Height (Contour) Wind (vector, shaded) (shaded) (Dm)

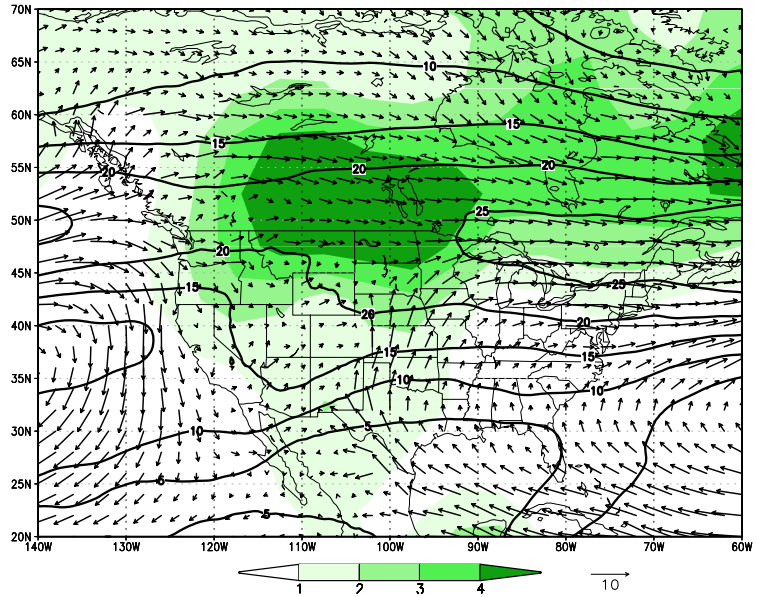


CFSR JAS Storm tracks (shaded) 200 hPa wind (contour) 850 hPa wind (vector) (wind: m/s)

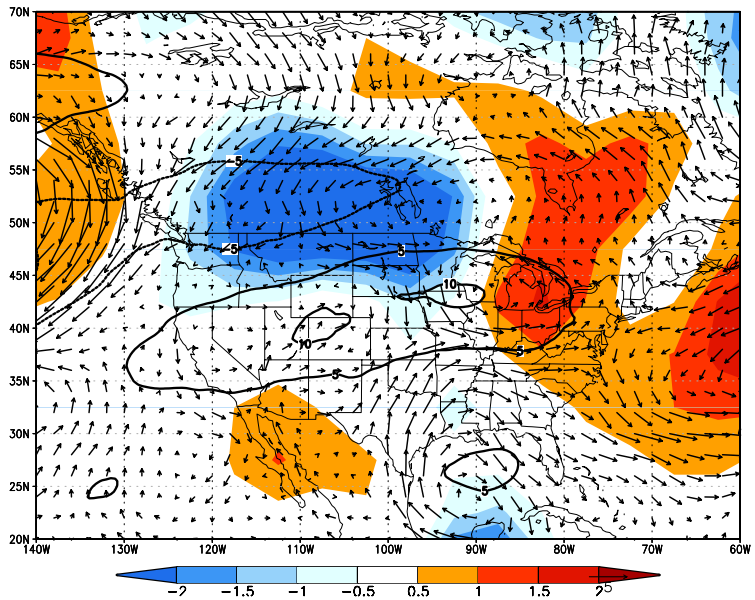
1993



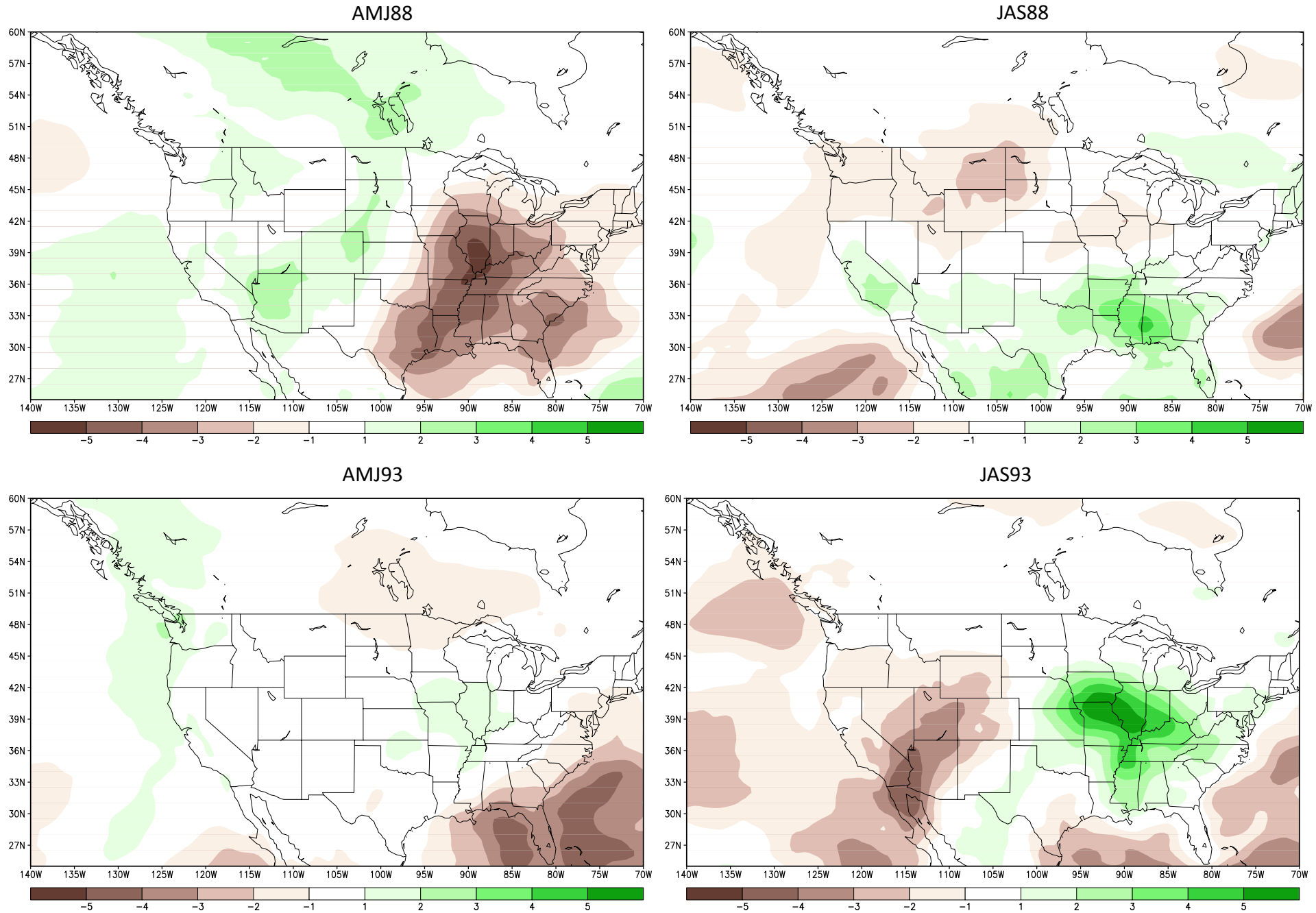
1988



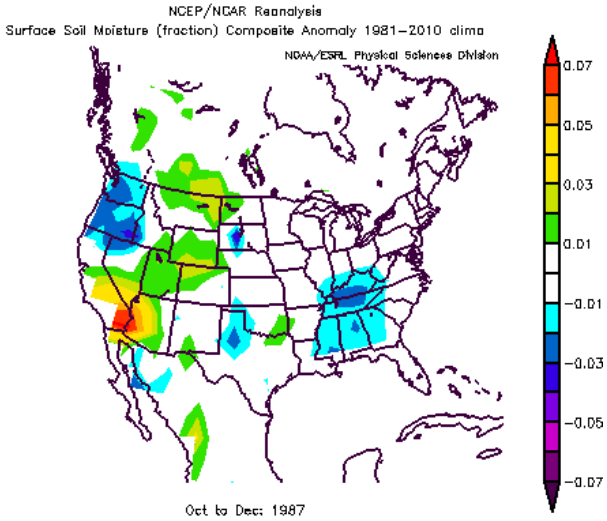
1993 - 1988

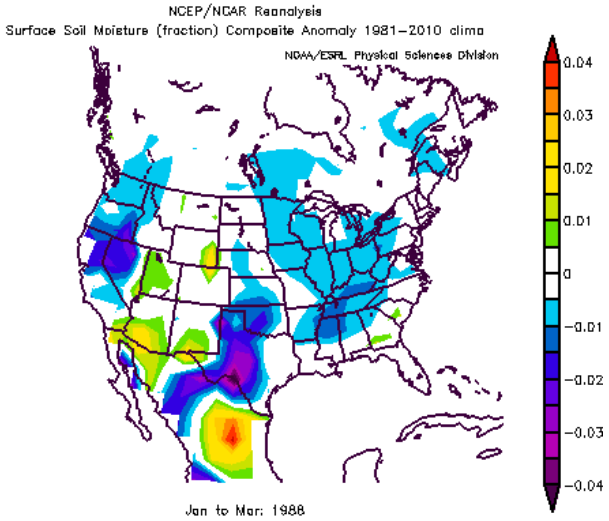


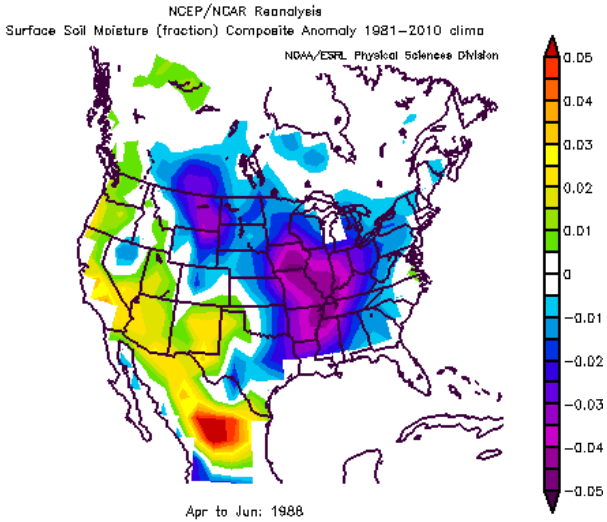
CFSR Precipitable Water Anomaly (kg/m**2)

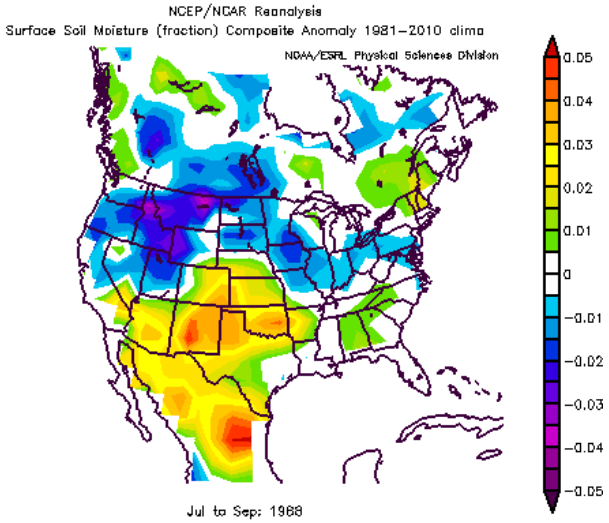


Soil Moisture (1987/1988)









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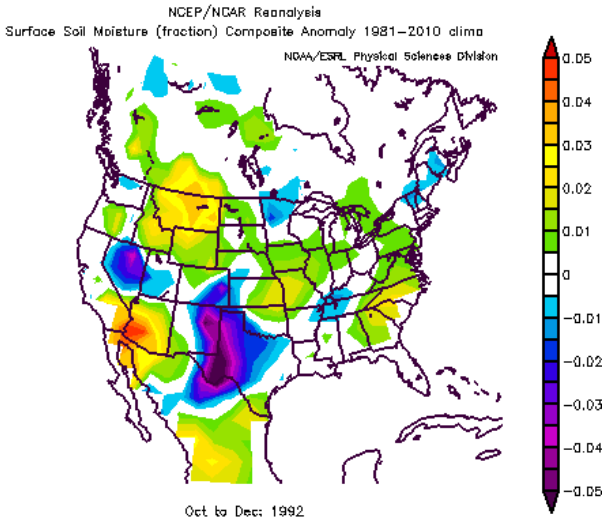
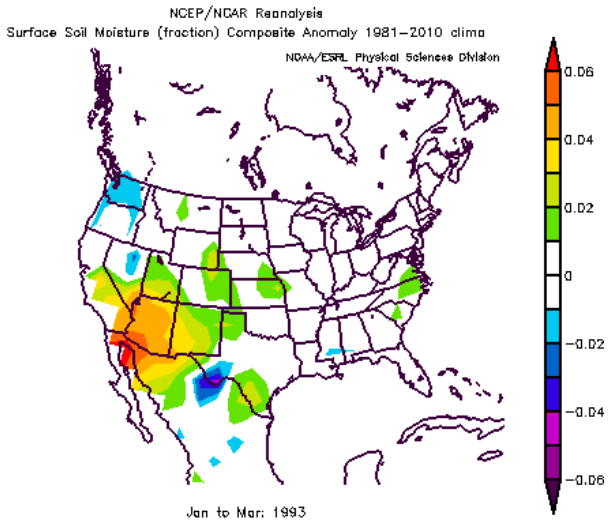
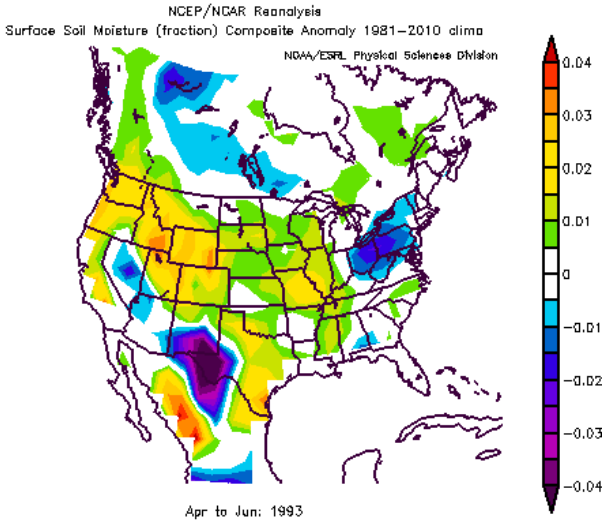
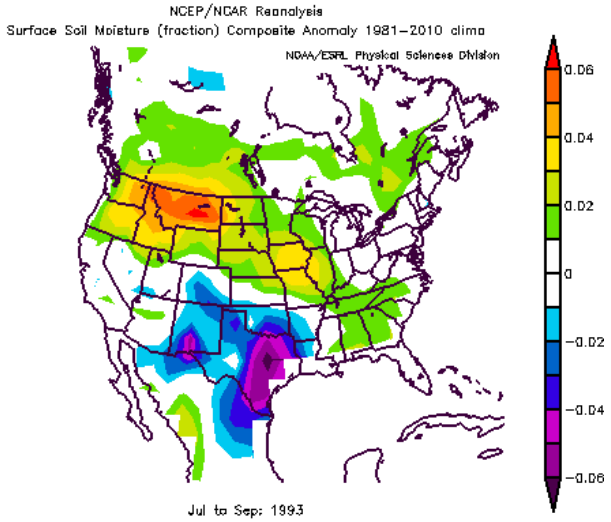
Soil Moisture (1992/1993)









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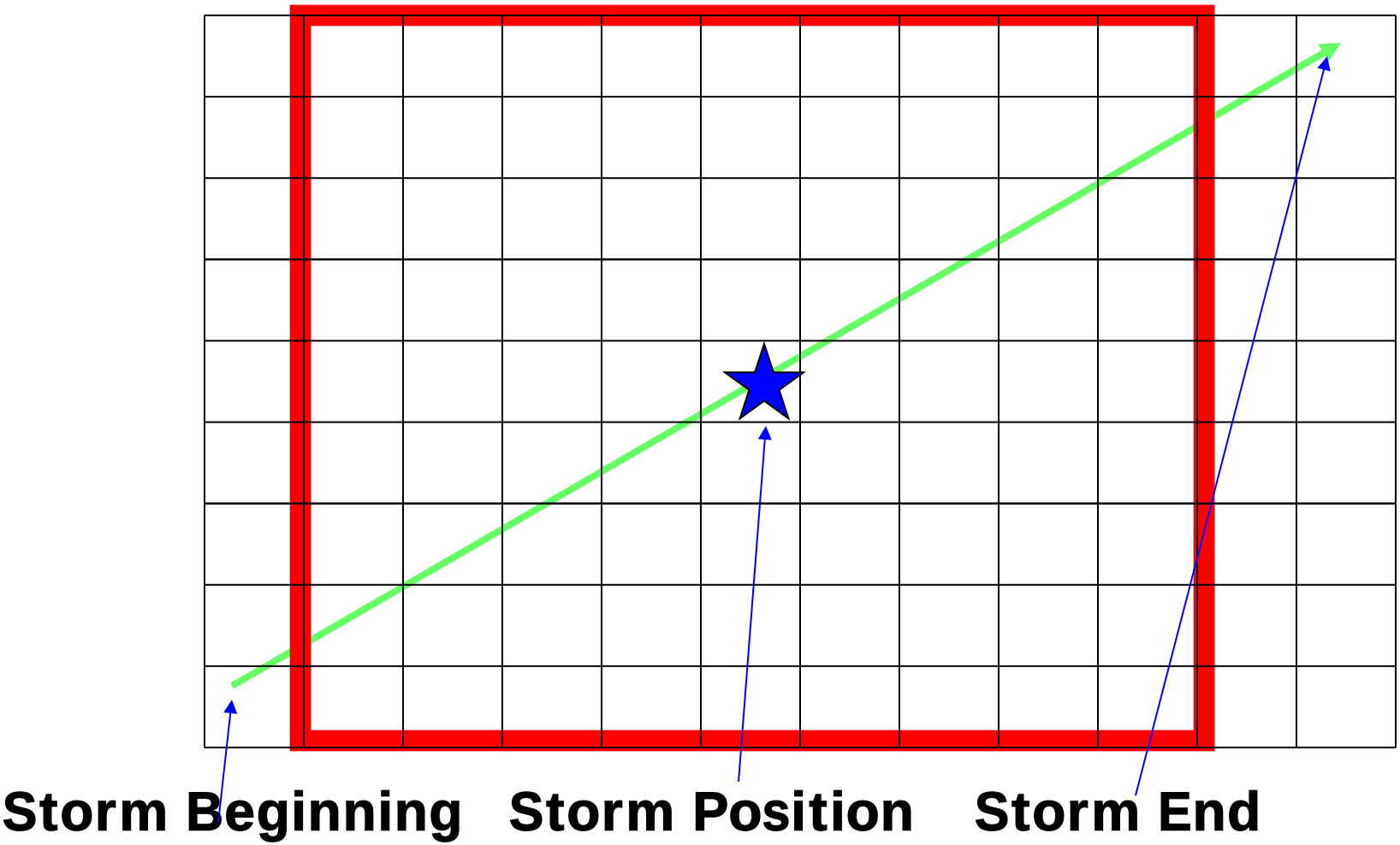
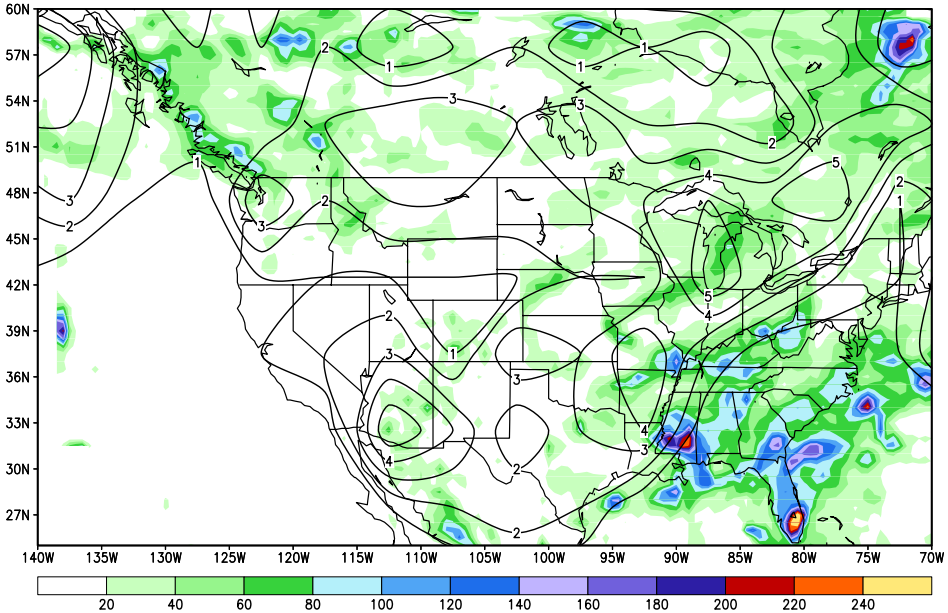
Calculating precipitation associated with a storm

- Need to look at what the storms are doing! (e.g. how much rain are they producing)
- May be critical when looking at future climate change! (precipitation efficiency of storms may change!)

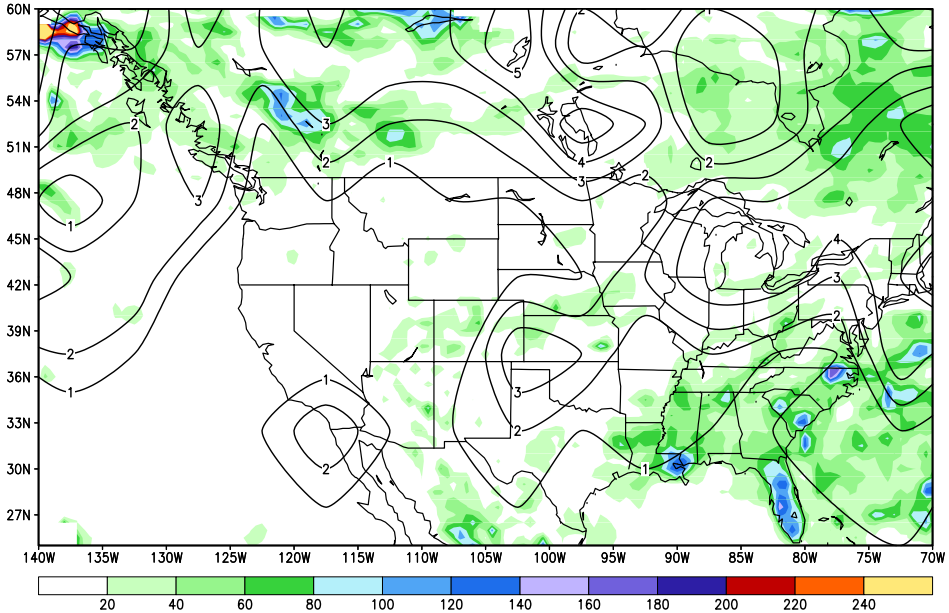


OND Storm Tracks (contour) Storm-Related Rainfall (mm)

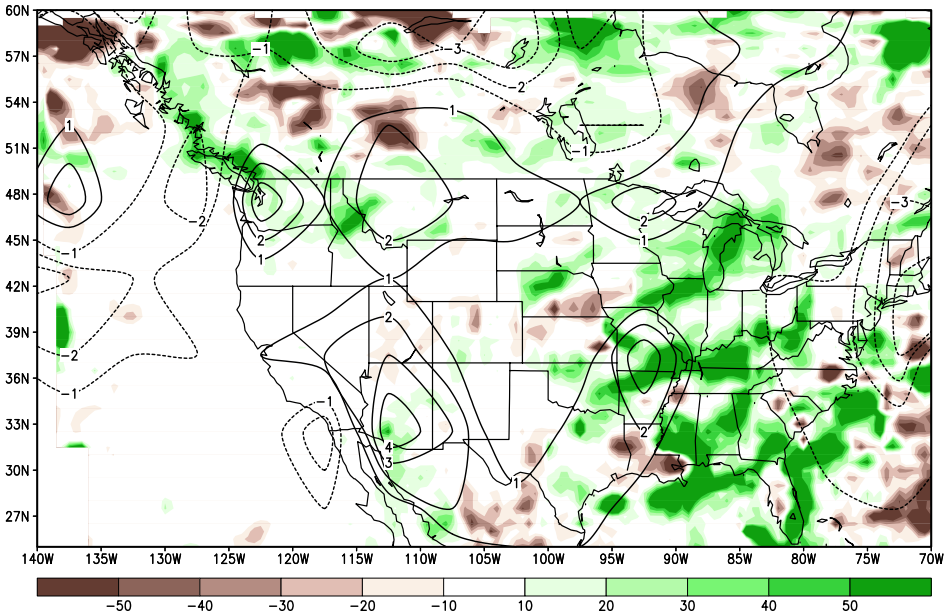
1993



1988

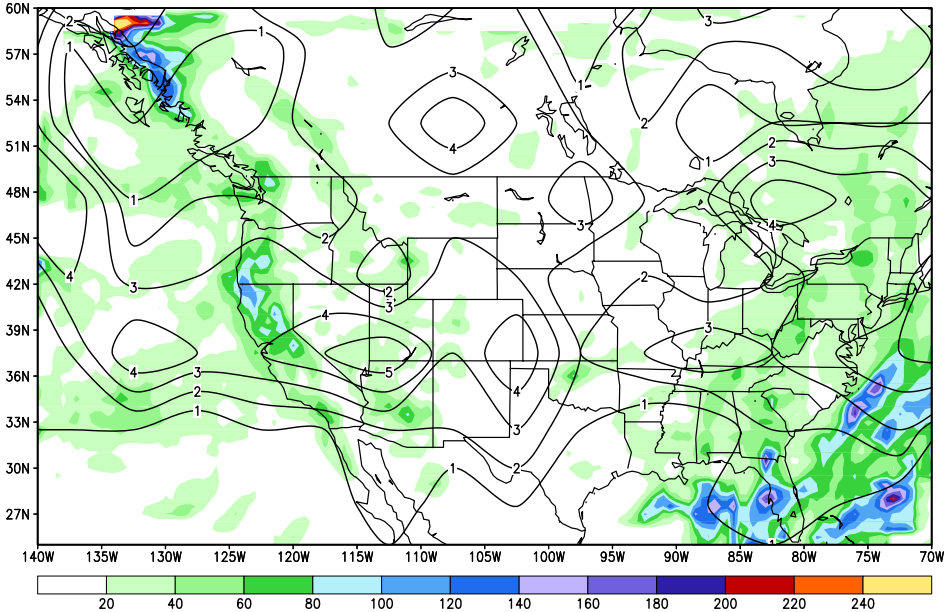


1993 - 1988

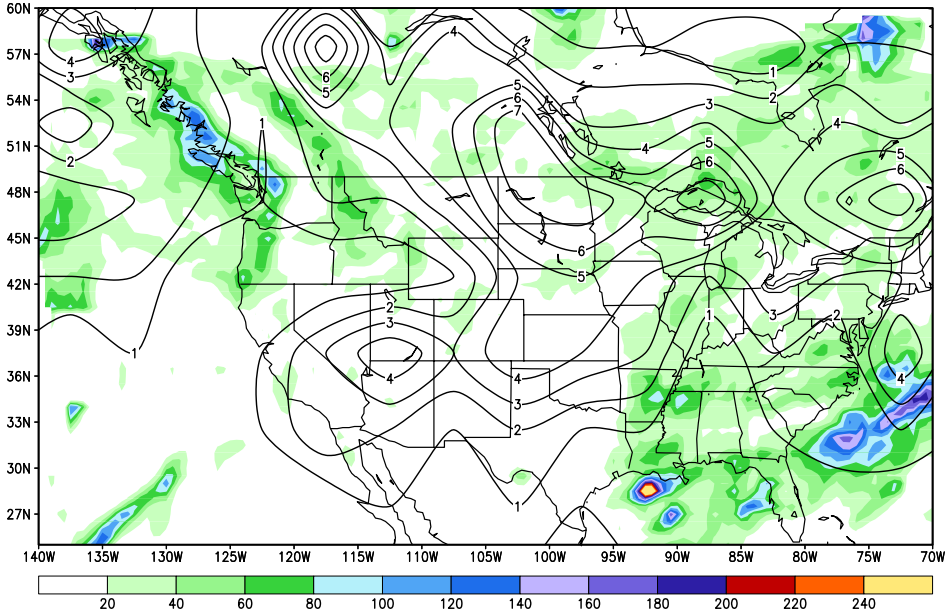


JFM Storm Tracks (contour) Storm-Related Rainfall (mm)

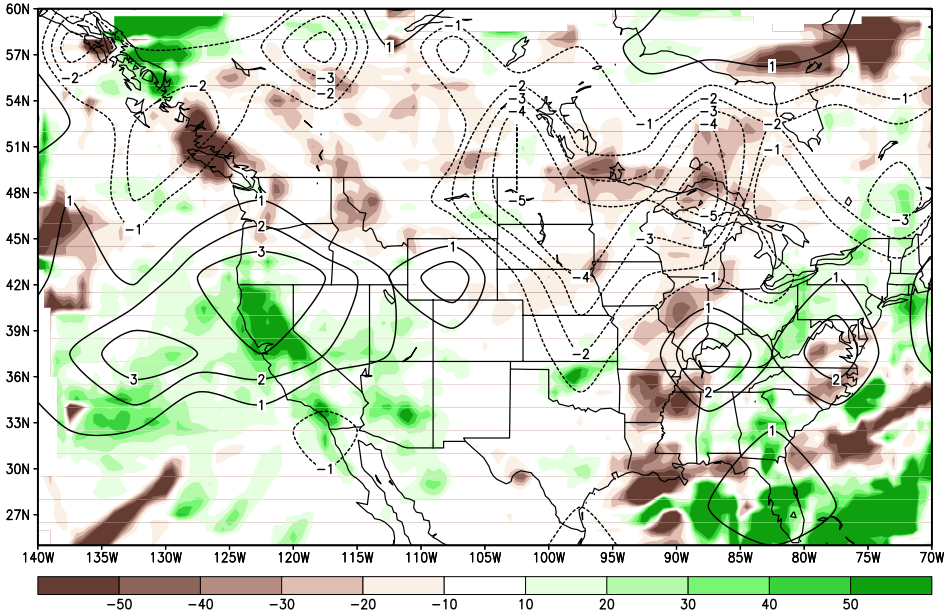
1993



1988

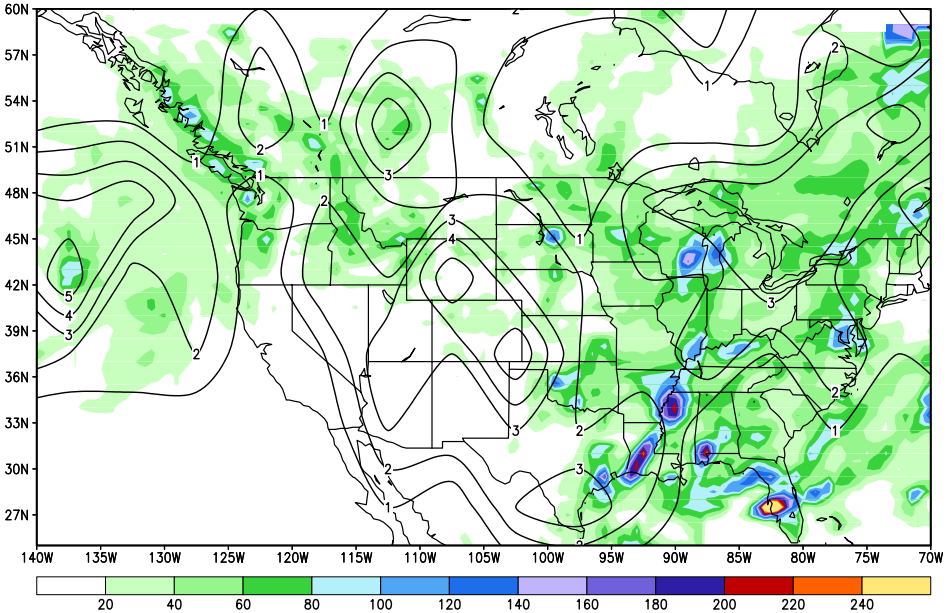


1993 - 1988



AMJ Storm Tracks (contour) Storm-Related Rainfall (mm)

1993



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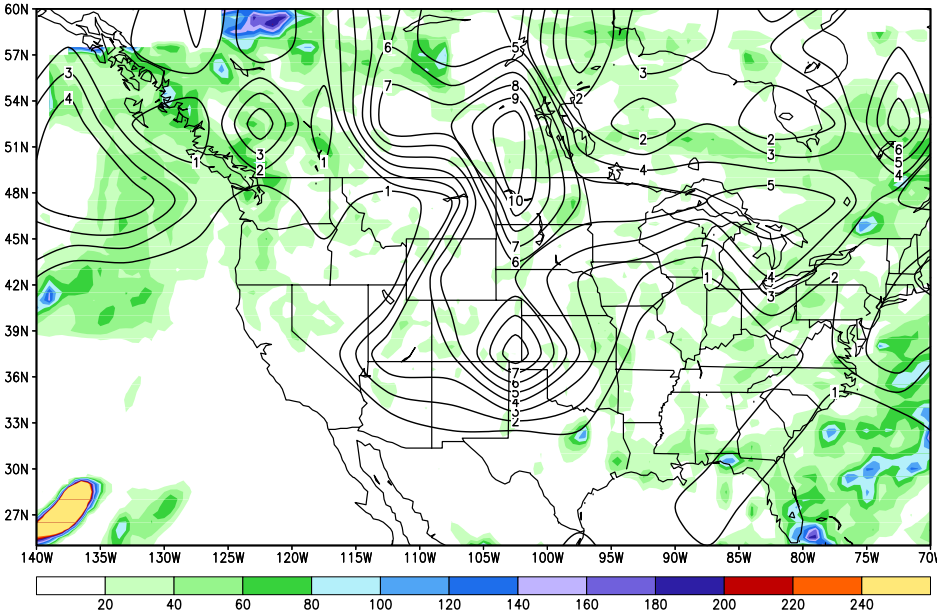
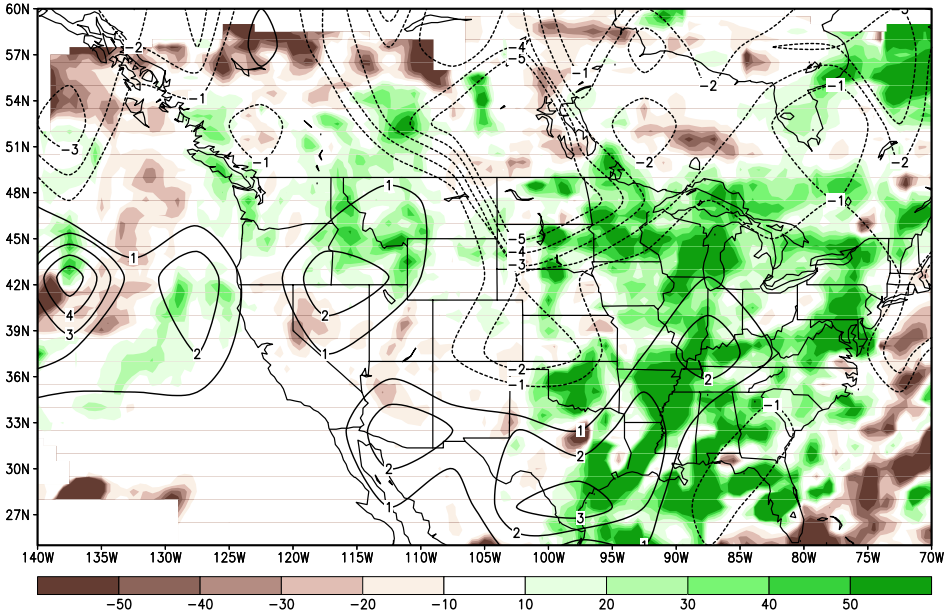
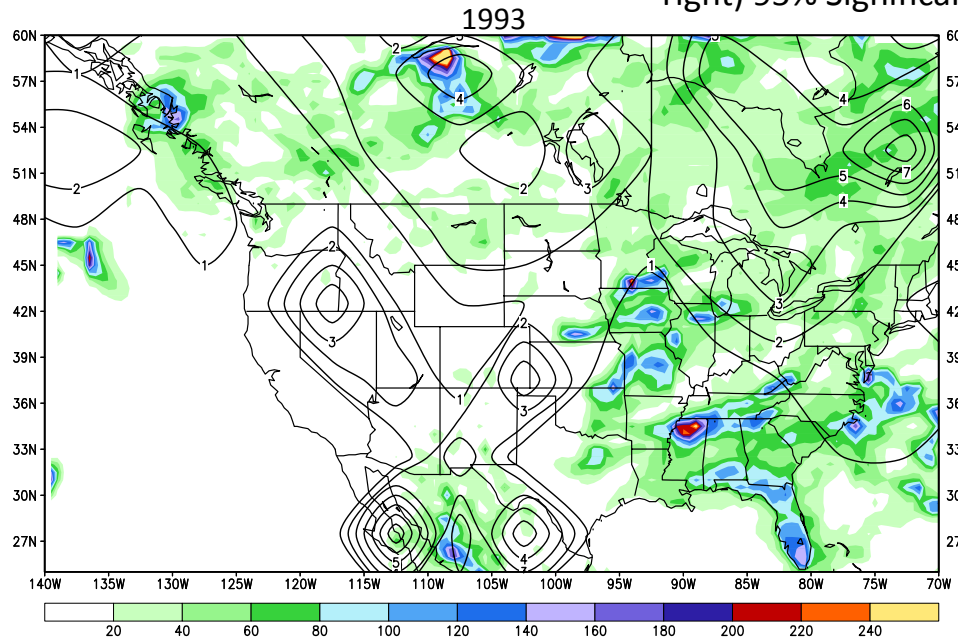
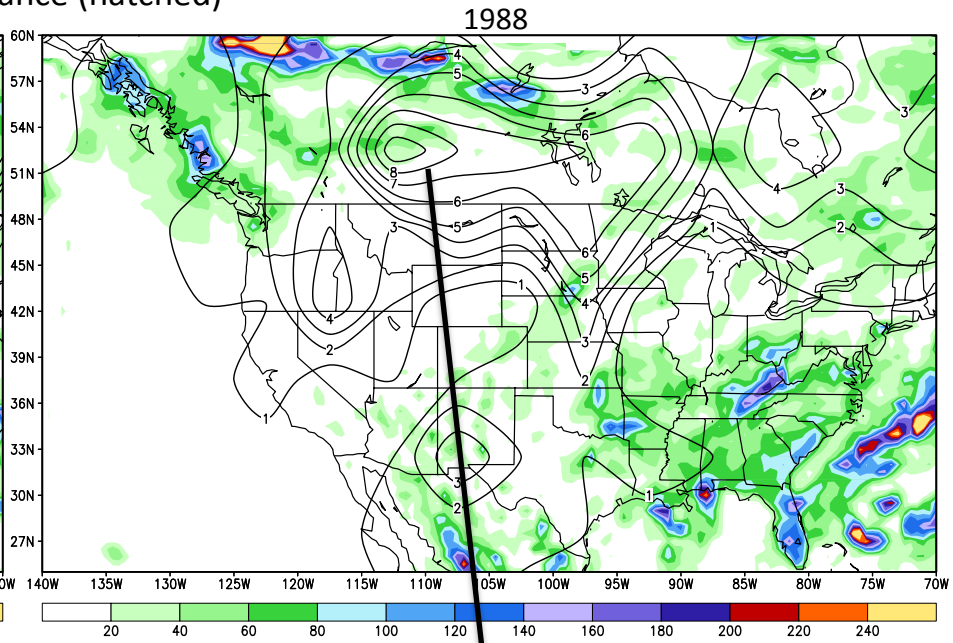


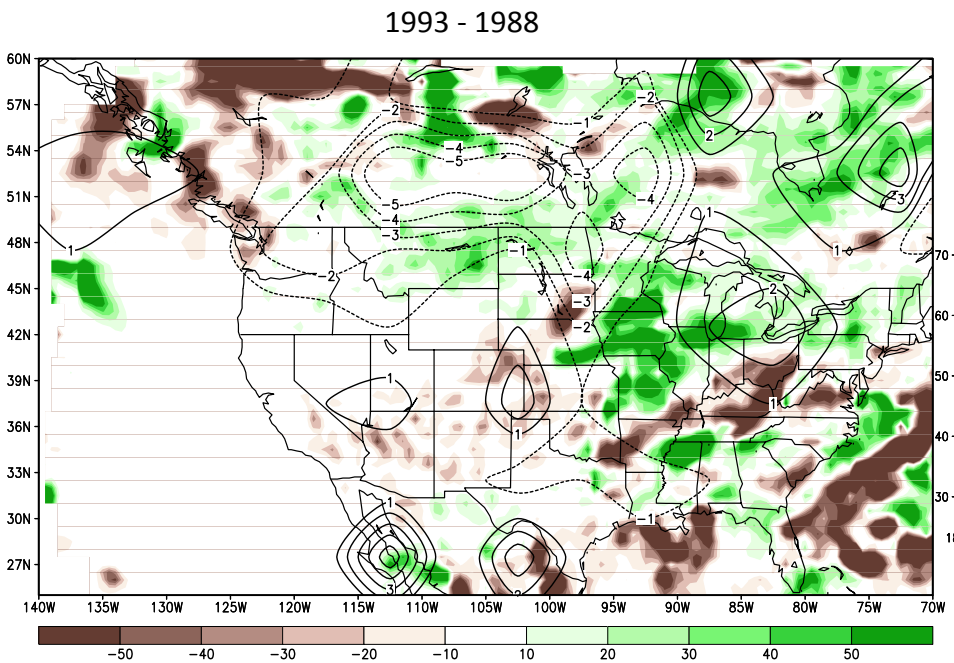
1993 - 1988



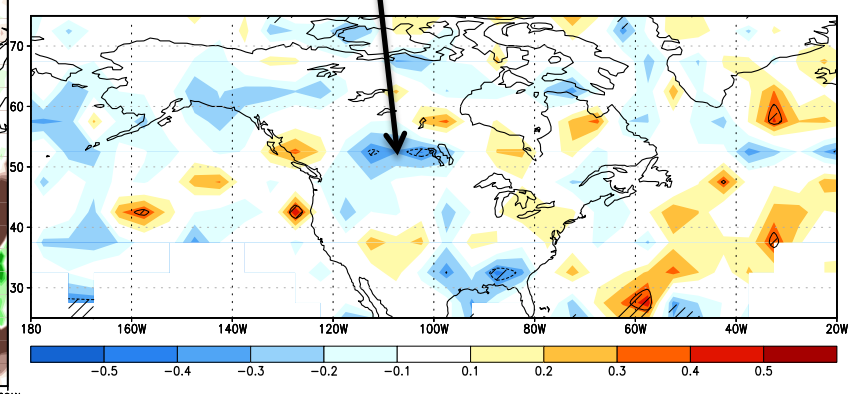
JAS Storm Tracks (contour) Storm-Related Rainfall (mm) Correlation of ENSO and storm track frequency (bottom right) 95% Significance (hatched)







La Niña induced?



What of External Climate Forcing?

- Evolving La Nina in 1988
- Evolving but weak el Niño in 1993
- Negative NAO in AMJ 1988
- Positive NAO in JFM 1993

- No plots here! Difficult to link storms to these factors! Perhaps played a role sub-seasonally (research needed of course! ☺)
- La Niña may play a role in northward displaced JAS storm tracks.
- Tempting to link strong JAS 200 hPa jet to 1993 El Niño but not well-supported in data.

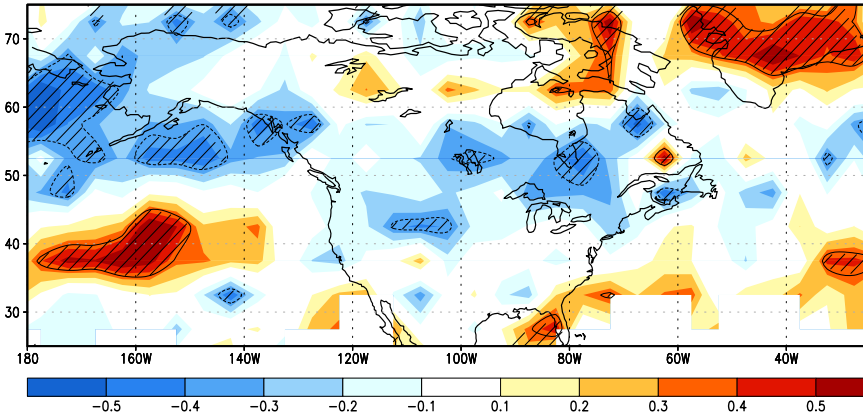
Conclusions

- Both 1988 drought and 1993 floods evolved over a multi-seasonal period
- 1988 drought featured anomalously strong 500 hPa ridge esp. in AMJ
- 1993 flood featured much stronger zonal flow from Pacific starting in AMJ
- Both 1988 droughts and 1993 floods had dry and wet springs respectively
- Storm tracks were suppressed equatorward over consecutive seasons in 1993 relative to 1988. Difficult to link to external forcing.
- Very strong 200 hPa jet over upper-midwest gave strong dynamic support to heavy rain in JAS 1993. Enhanced 850hPa flow from the Gulf of Mexico is noted in JAS 1993 relative to JAS 1988. Increased storms were also noted in right-entrance/left-exit portions of jet. Unusual to see this feature in the upper-Midwest in JAS!
- ENSO and teleconnections appear to play a limited role at best. La Niña may have played a role in poleward-displaced storm tracks in JAS 1988.

References

Serreze, M. C., 1995: Climatological aspects of cyclone development and decay in the Arctic. Atmos.–Ocean, 33, 1–23.

——, F. Carse, R. G. Barry, and J. C. Rogers, 1997: Icelandic low cyclone activity: Climatological features, linkages with the NAO and relationships with recent changes in the Northern Hemisphere circulation. J. Climate, 10, 453–464.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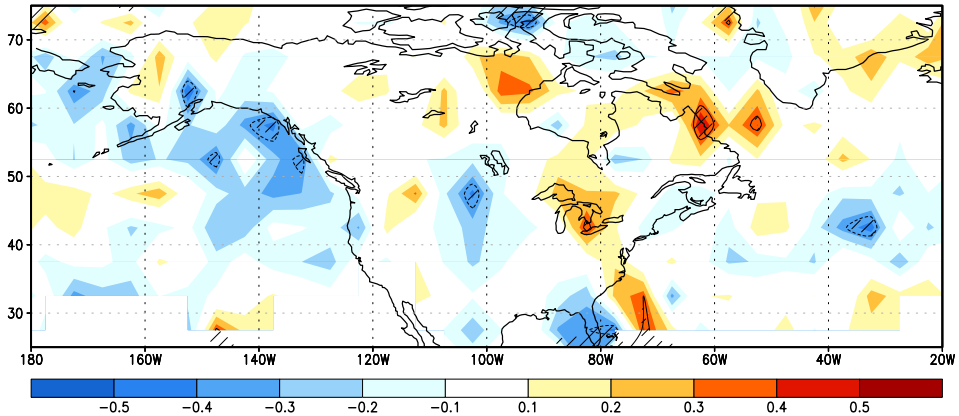
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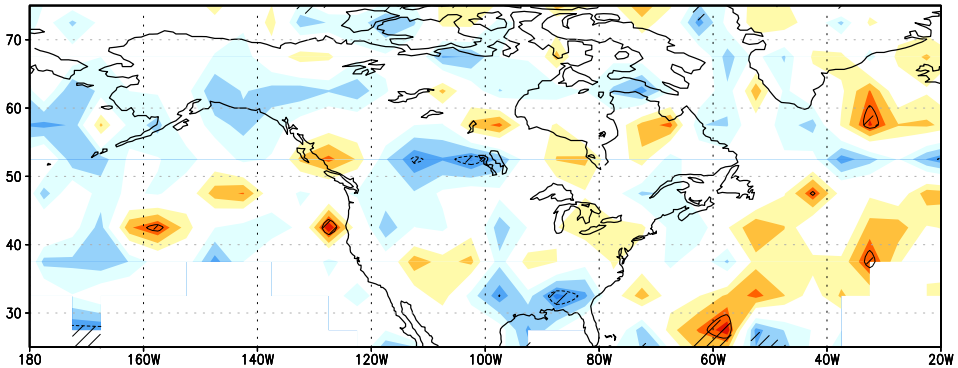
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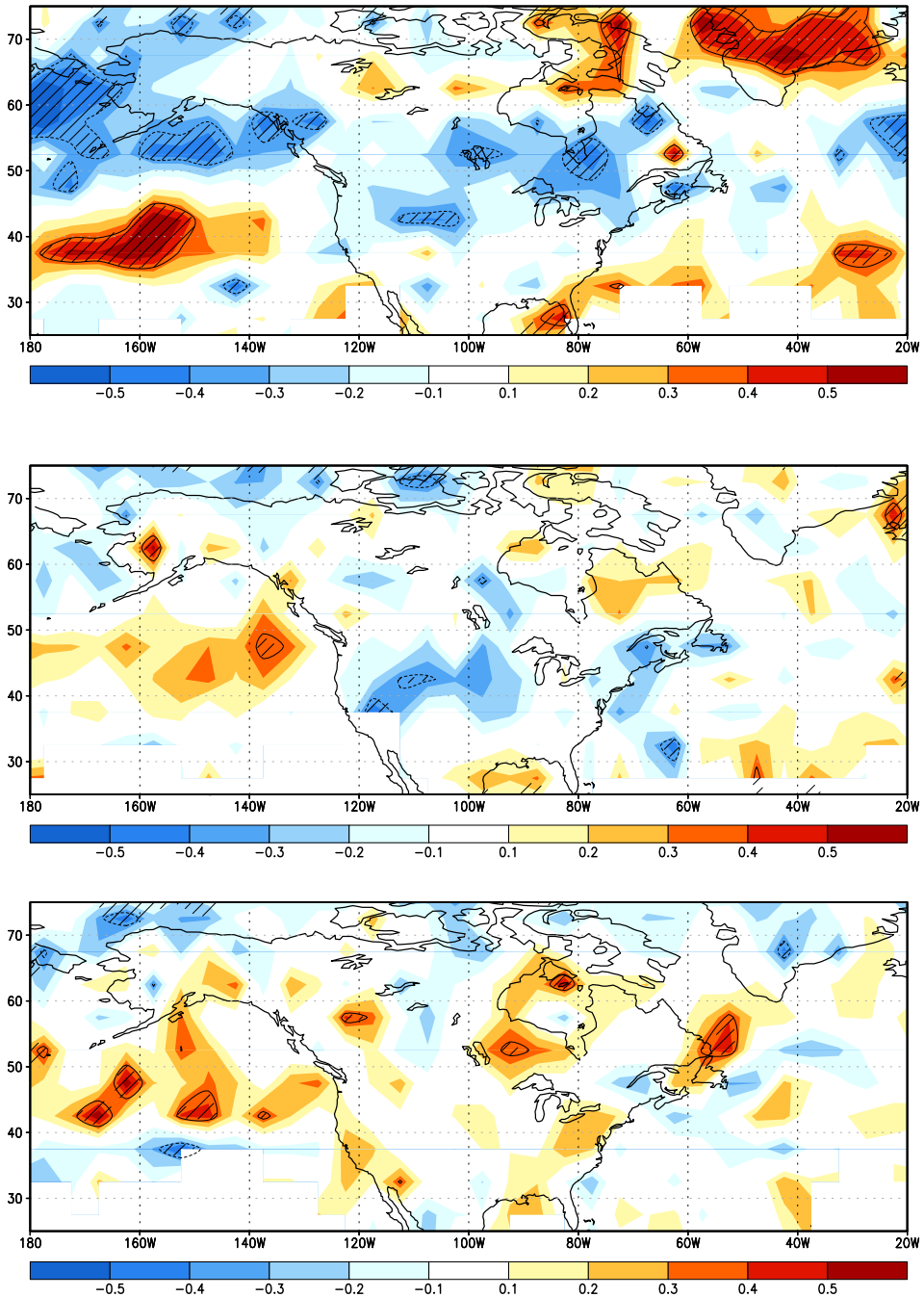
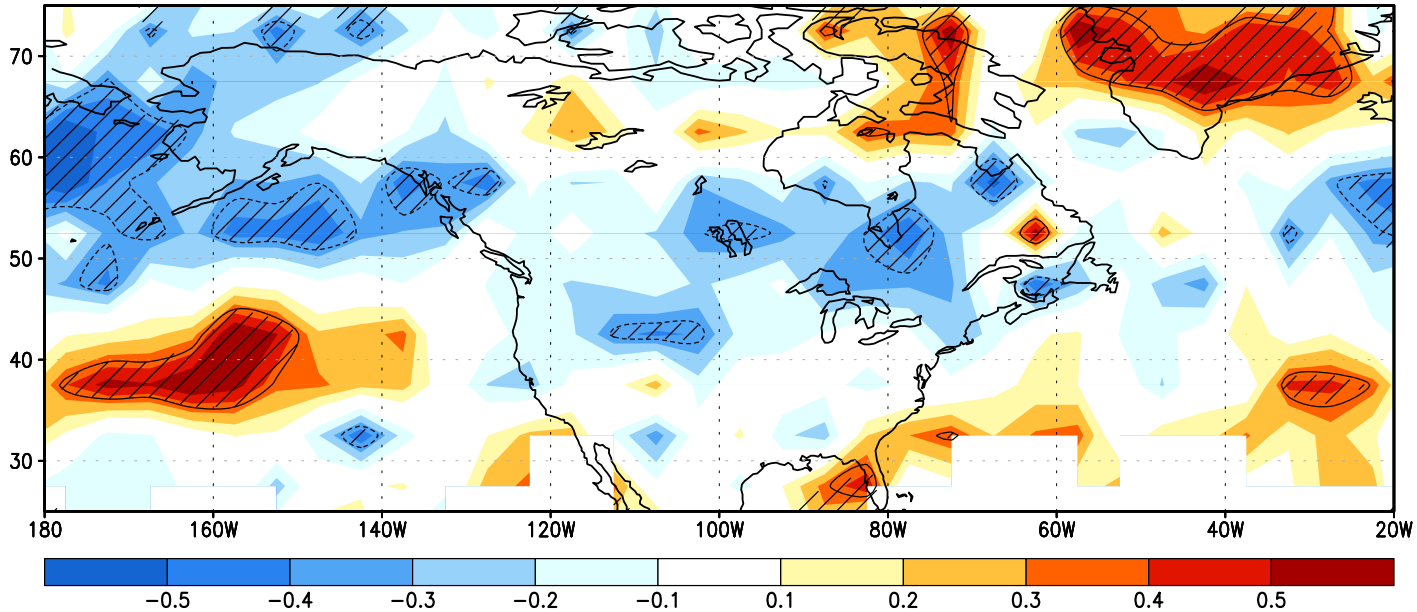
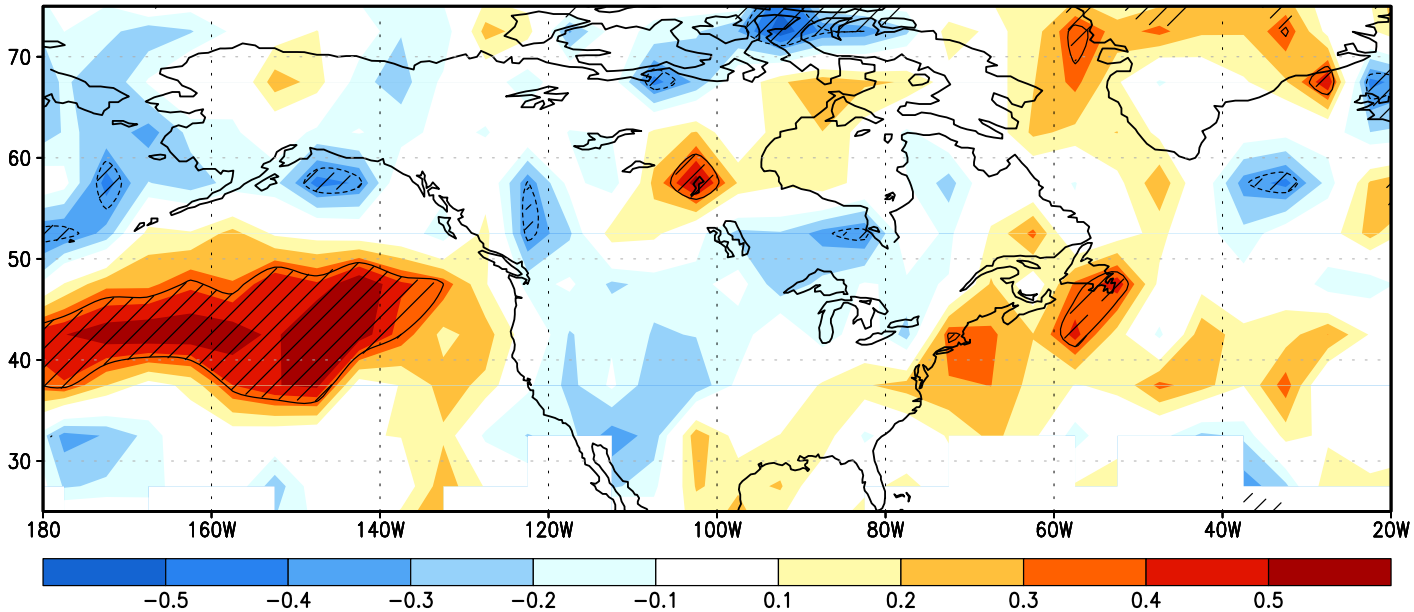
Pna enso JFM, AMJ, JAS







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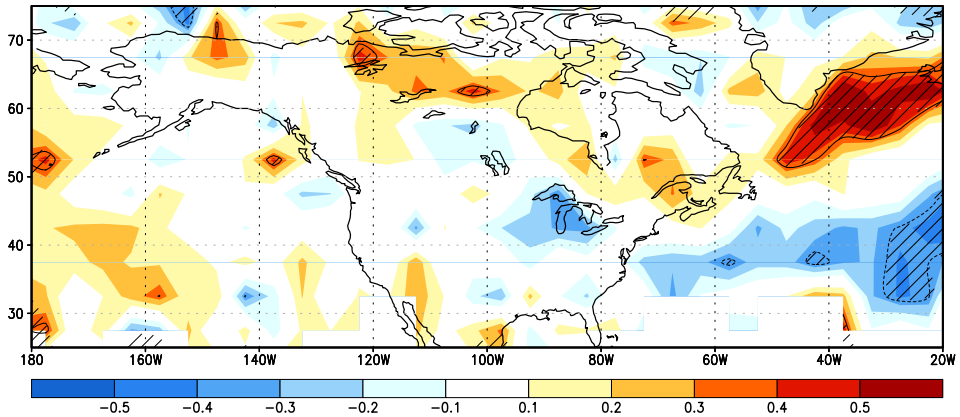
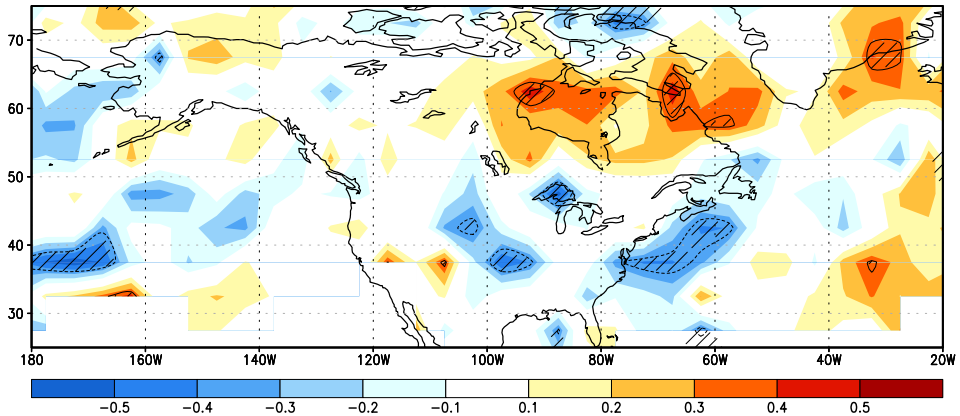
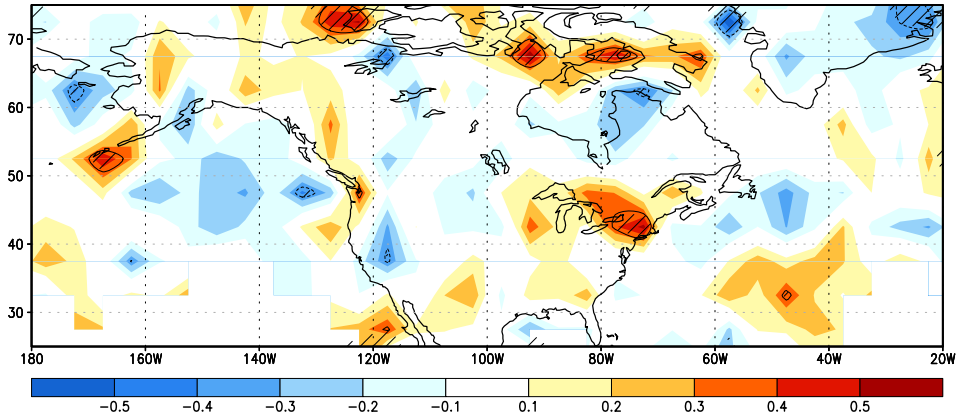
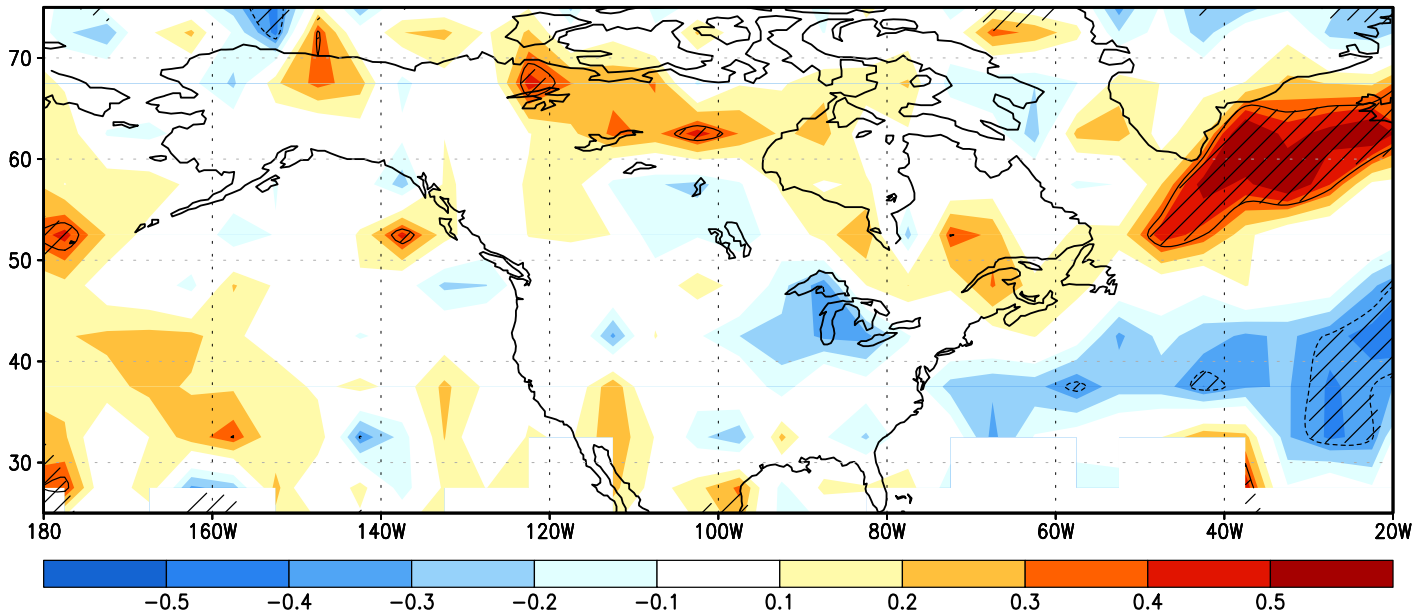
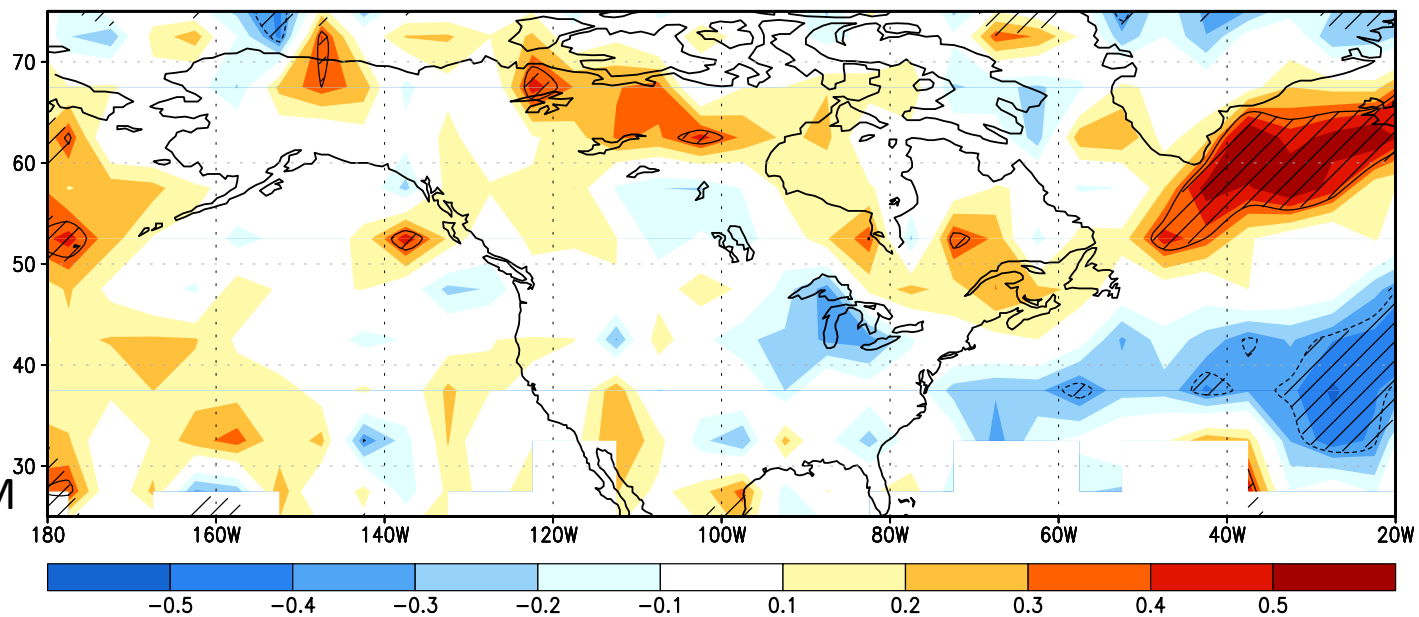


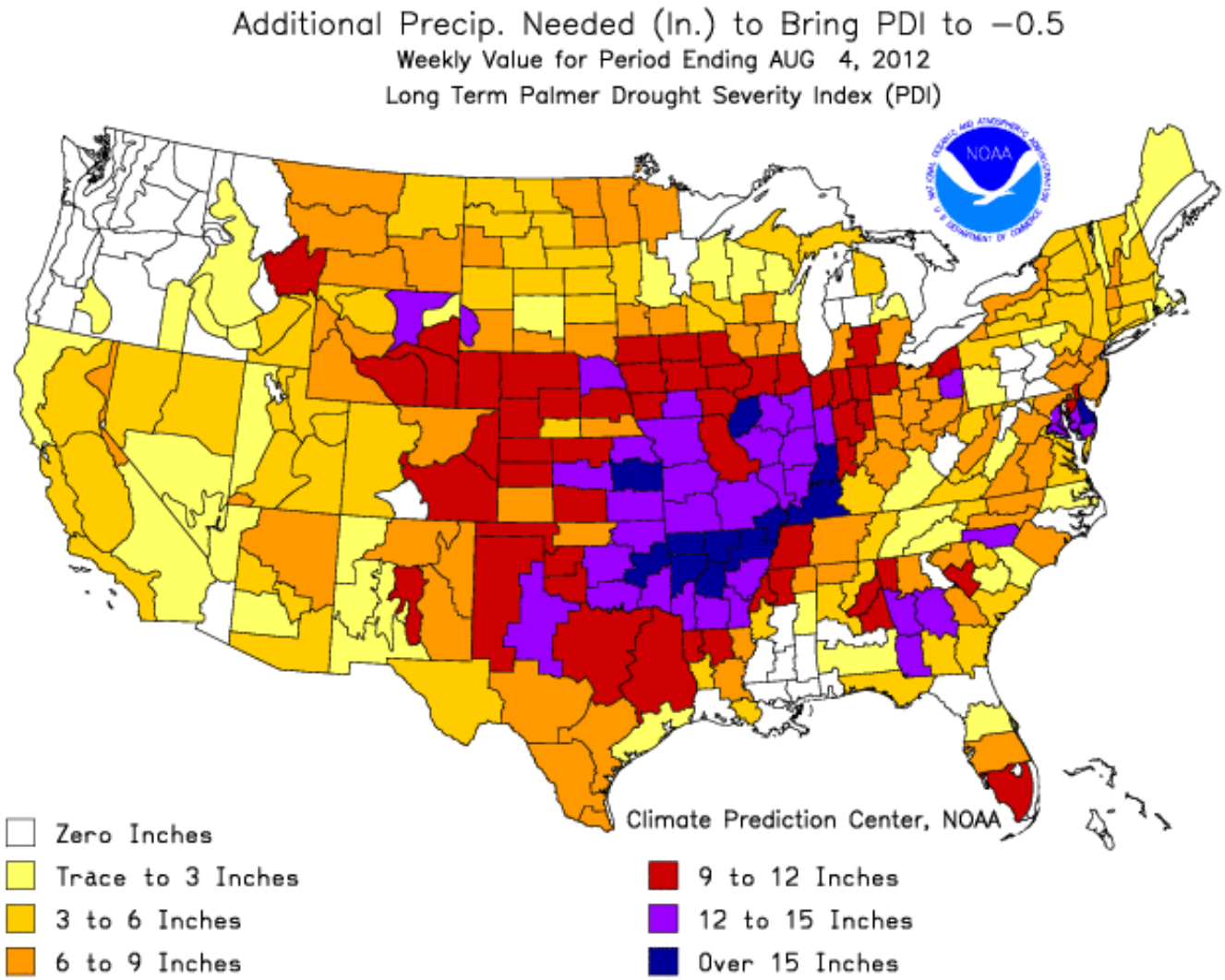








Nao enso,
noenso JFM



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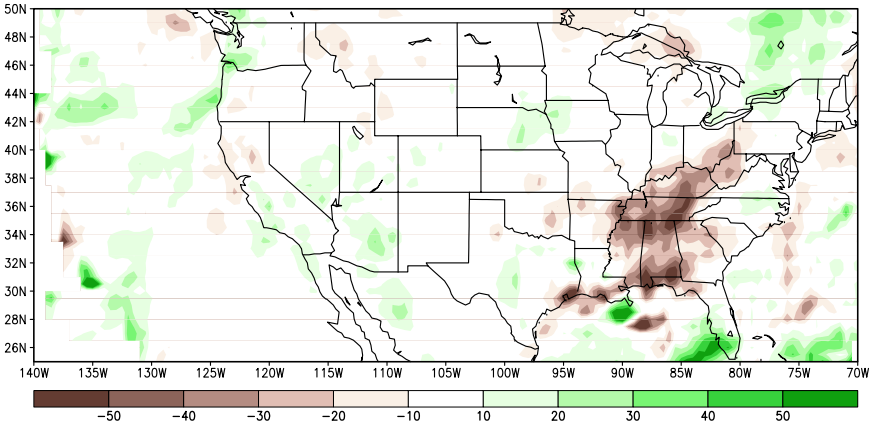
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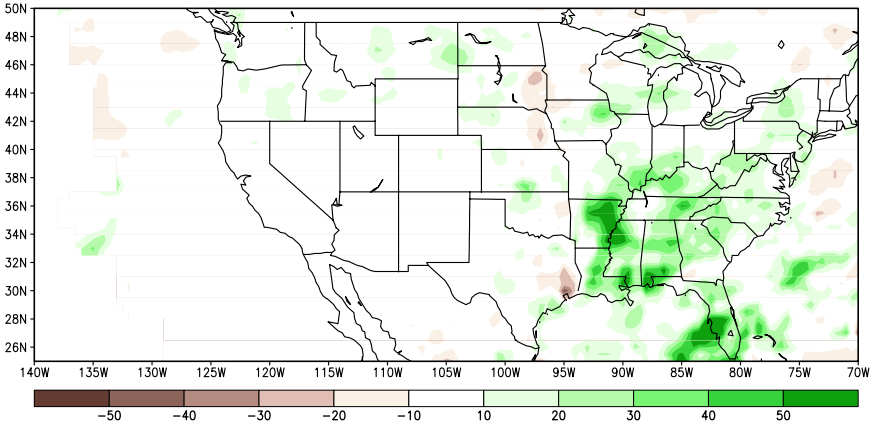
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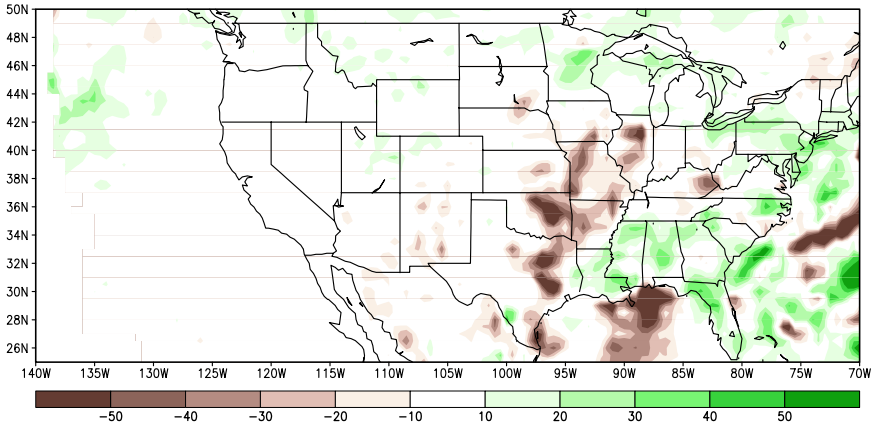
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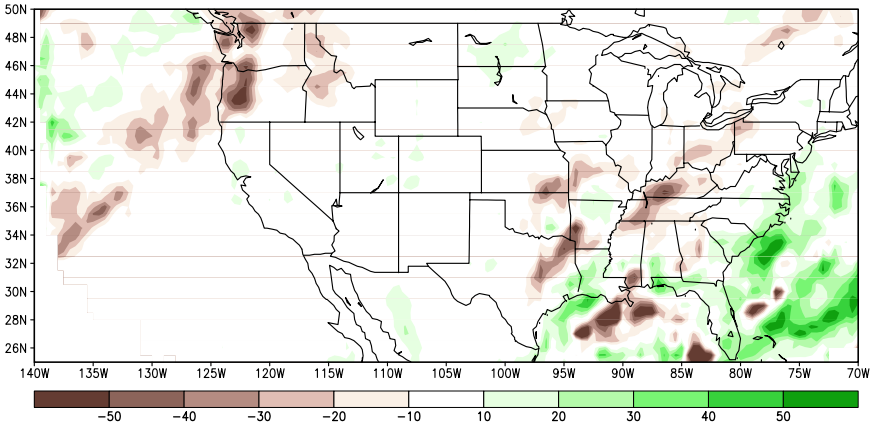
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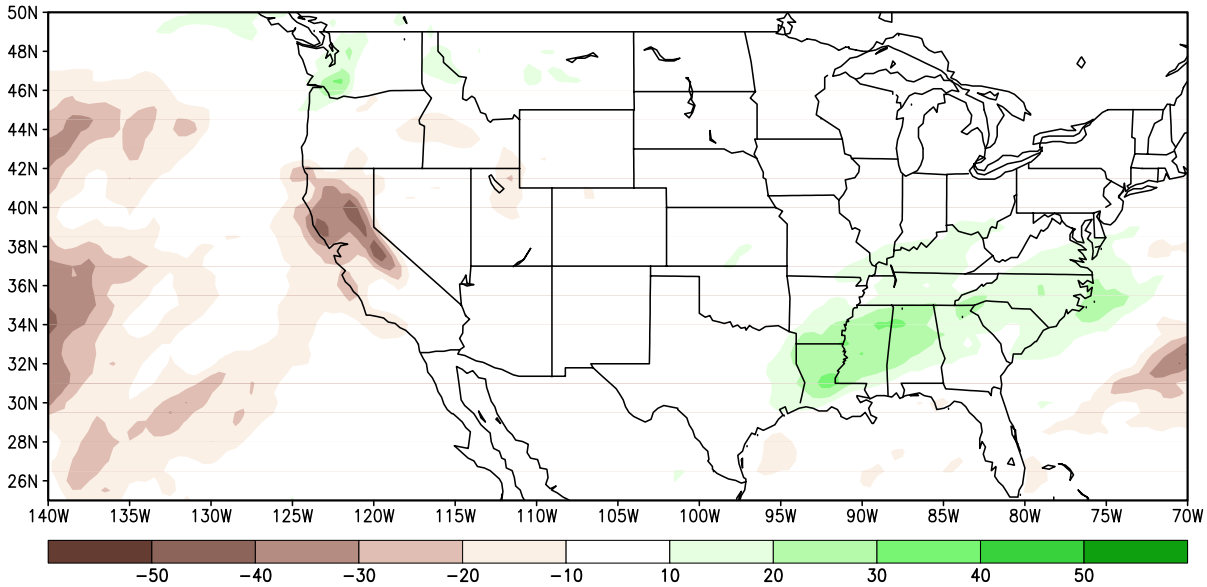
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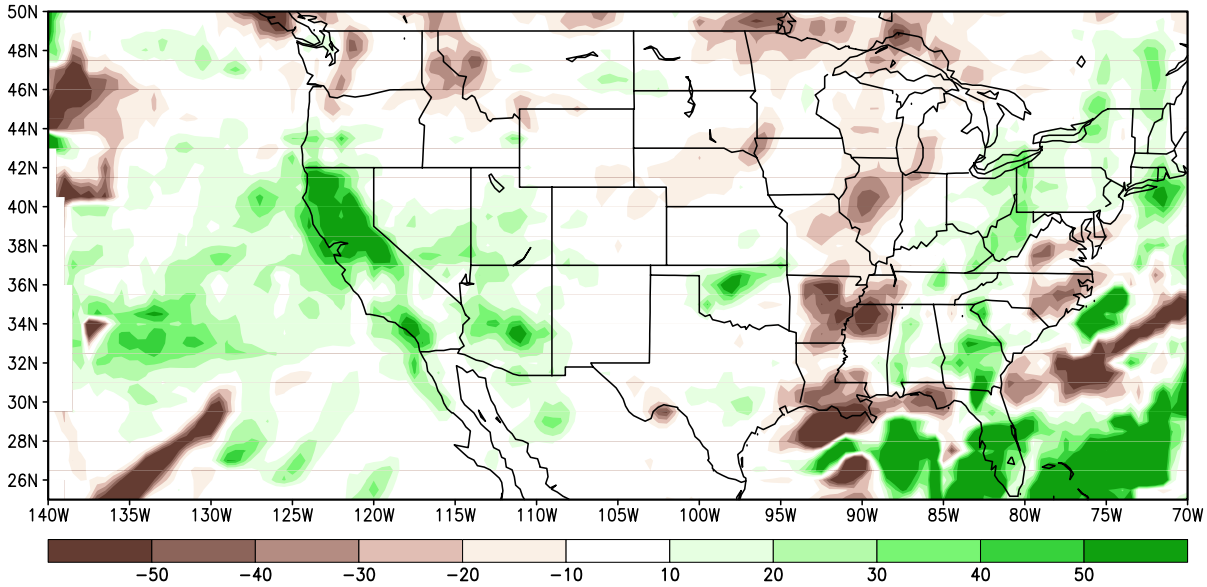
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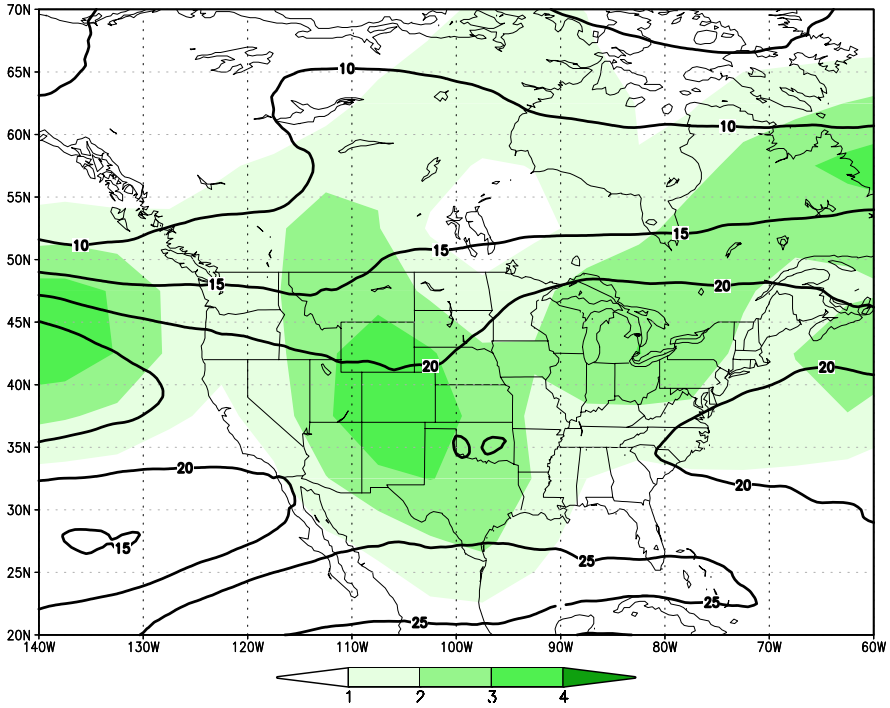
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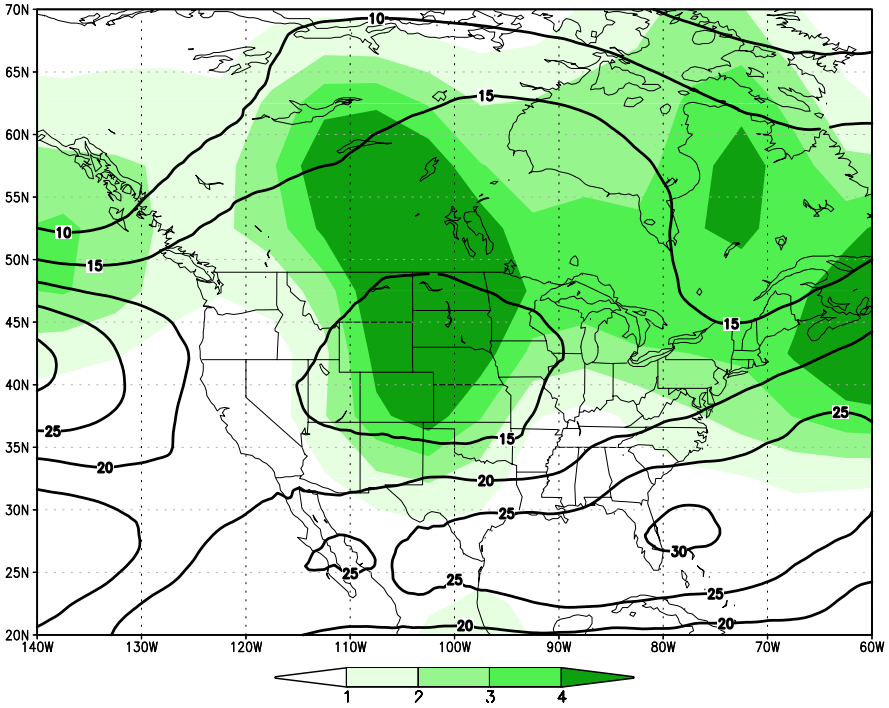
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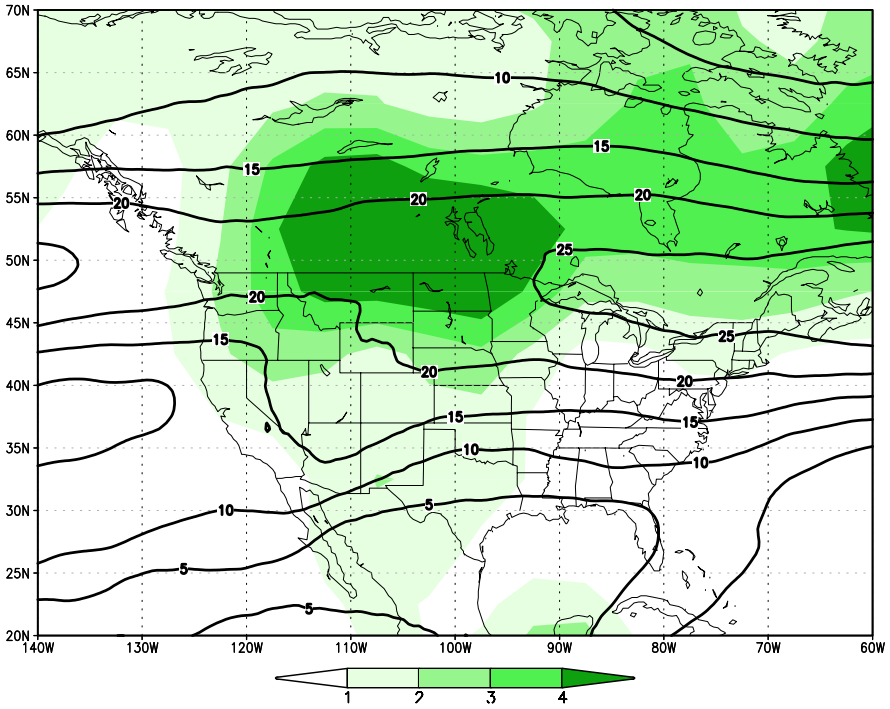
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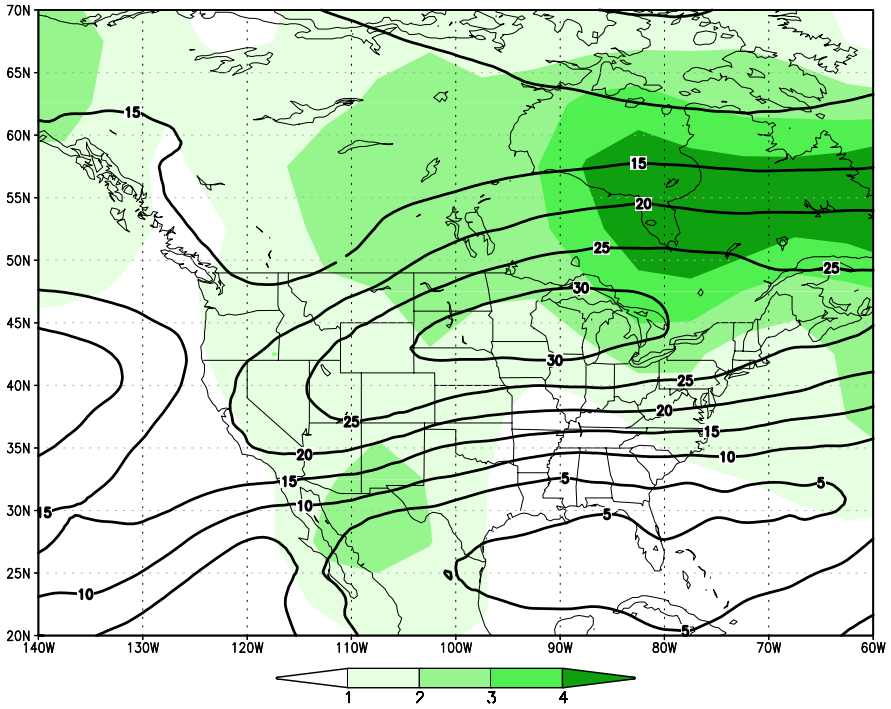
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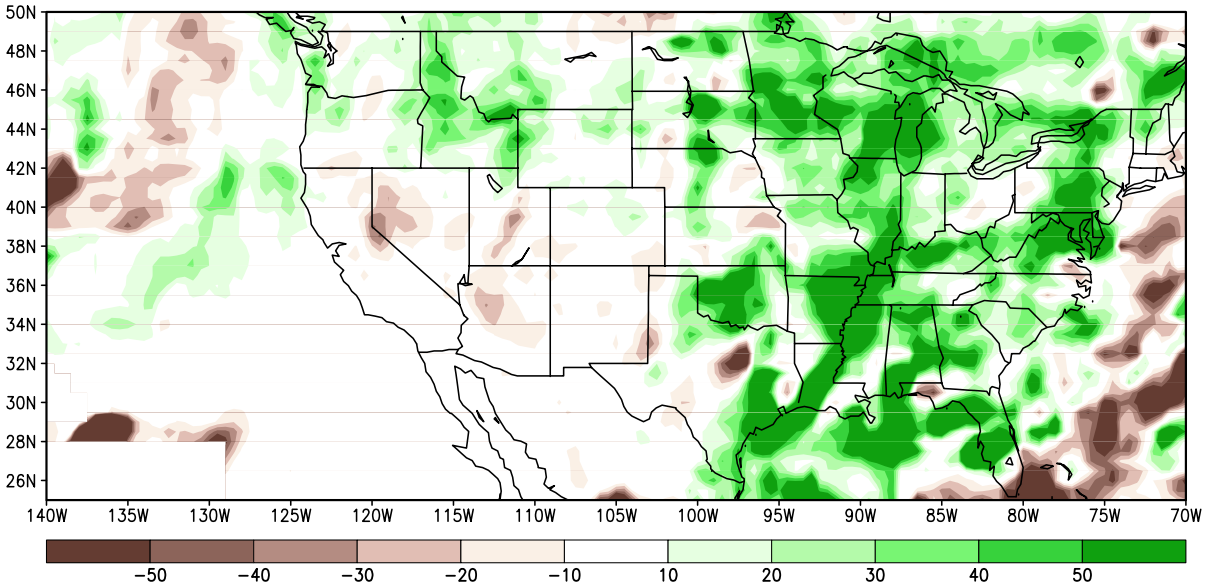
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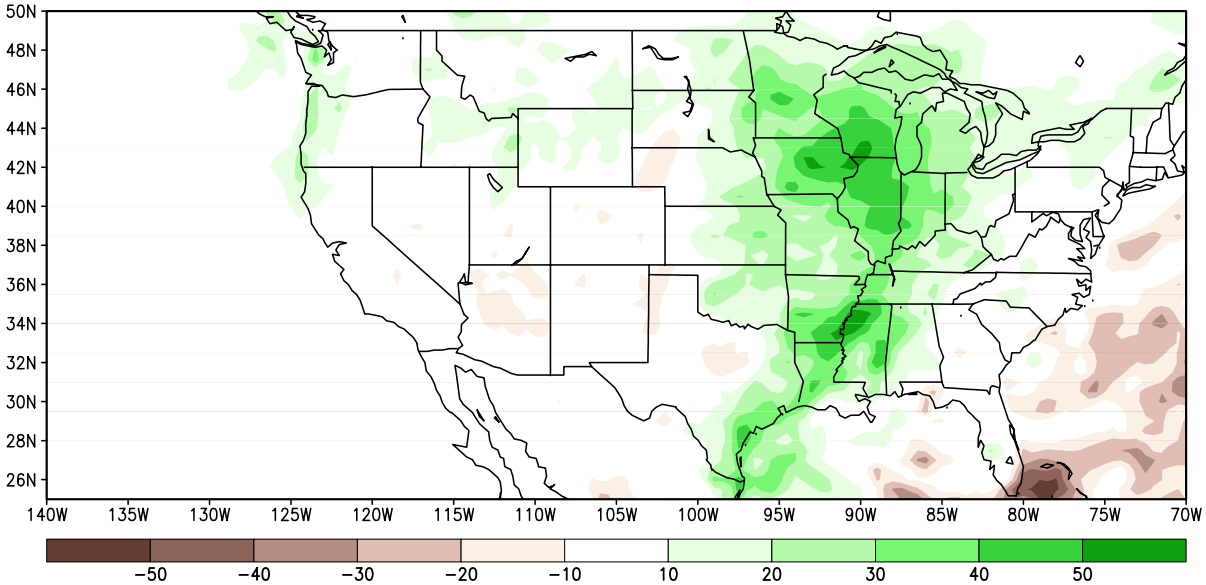
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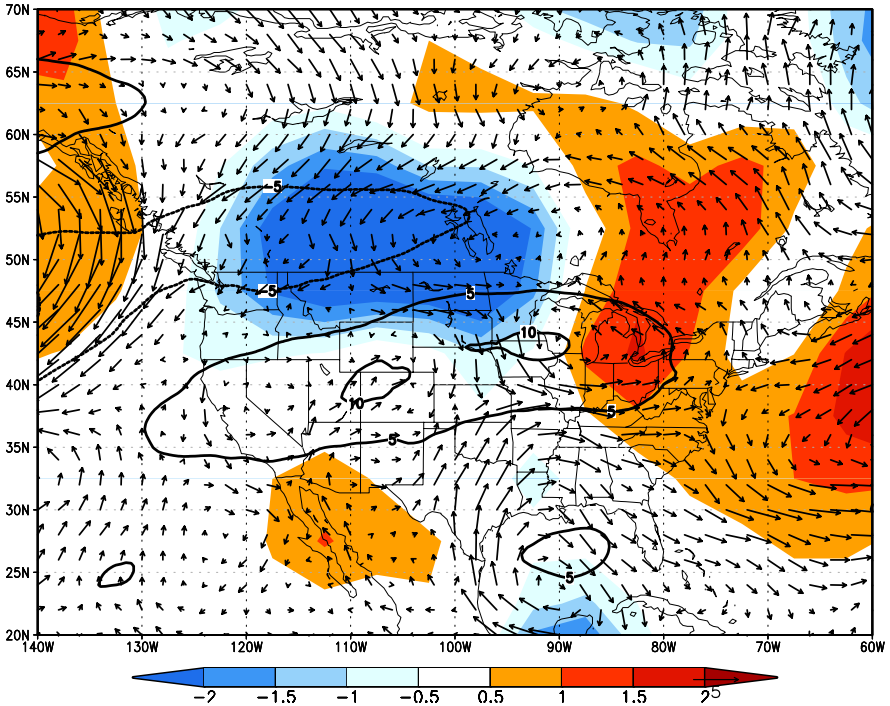
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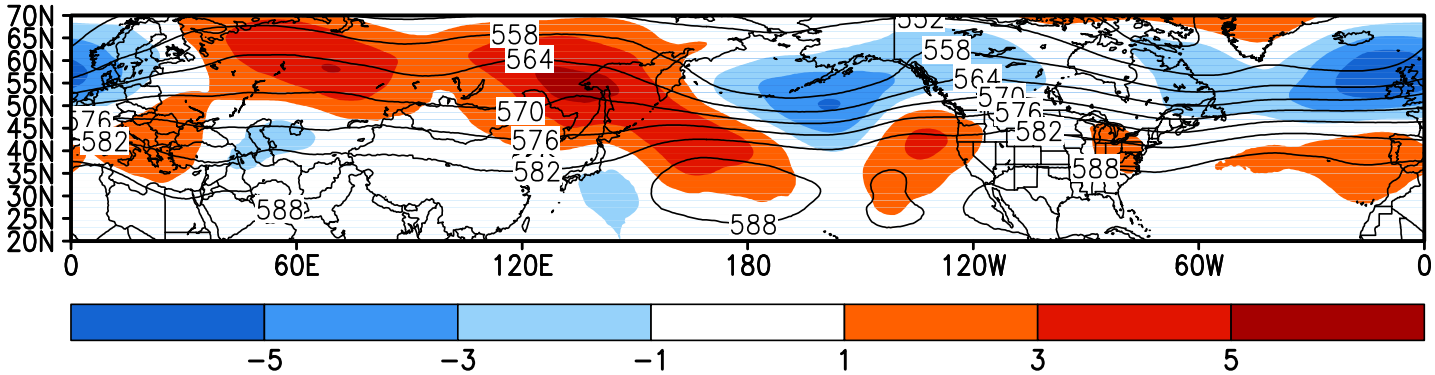
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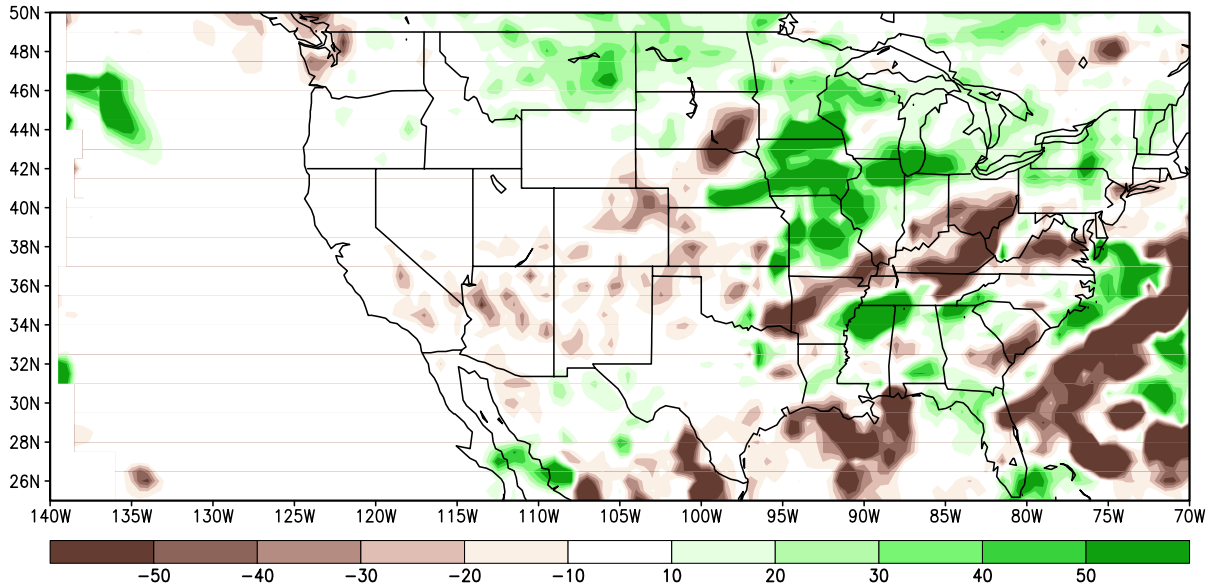

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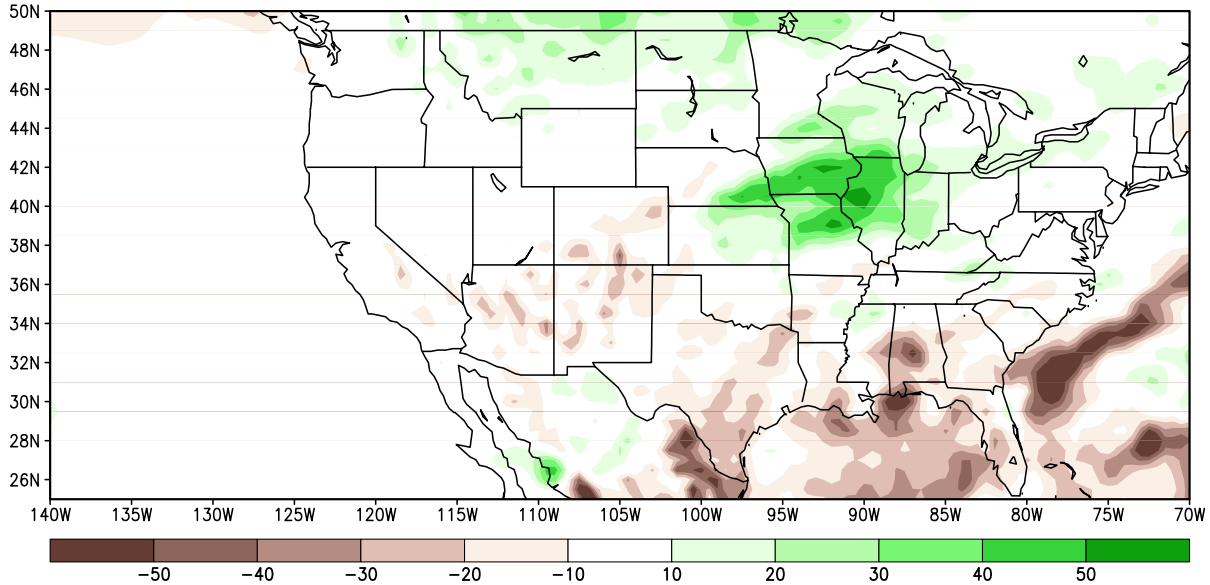

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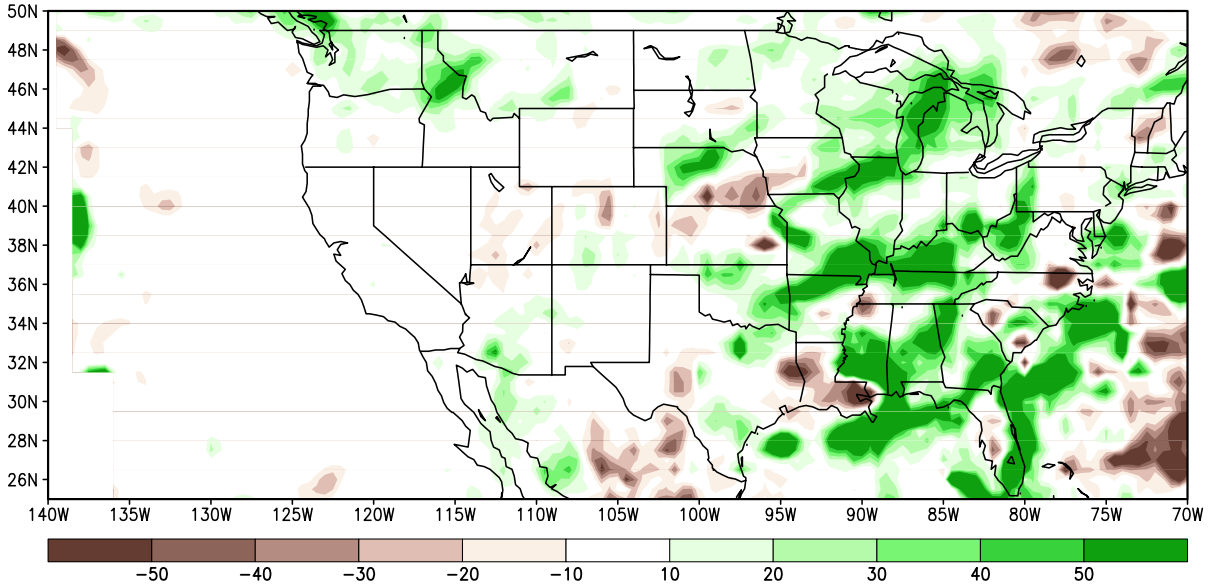
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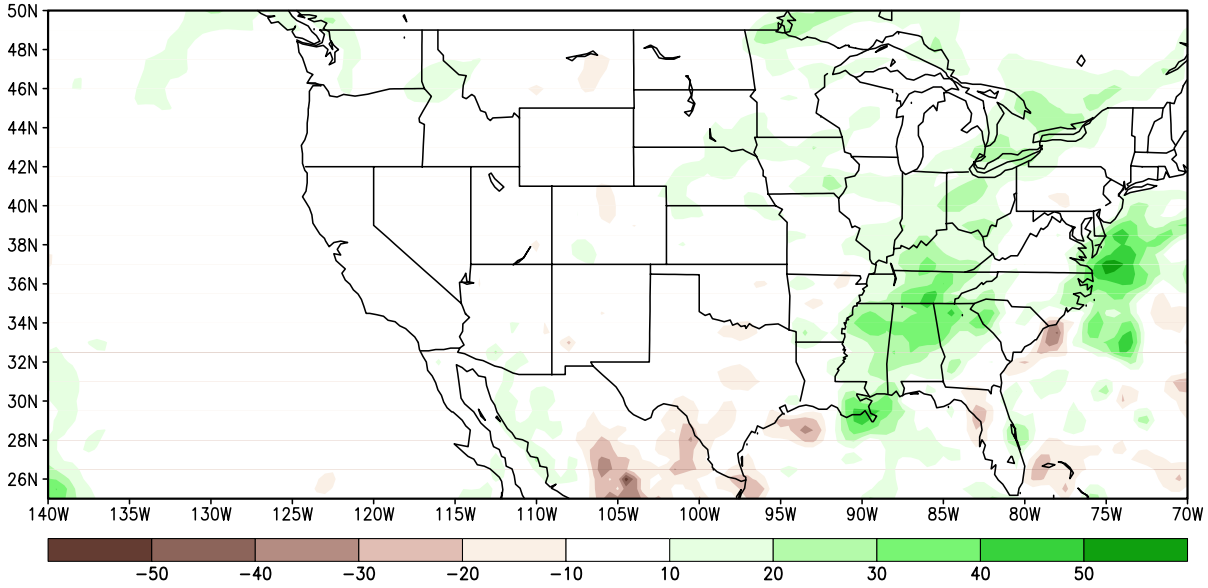
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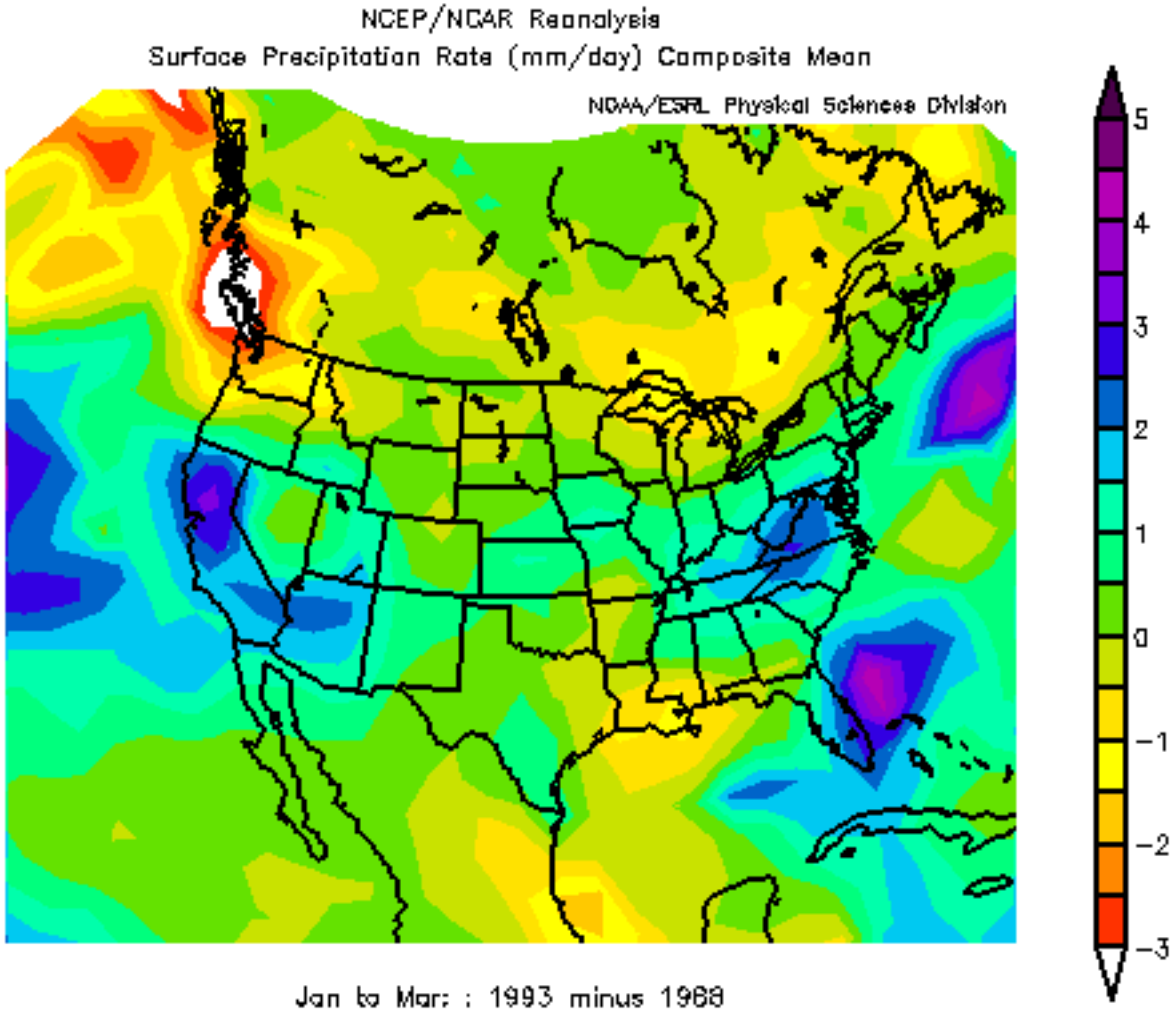
NCEP/NCAR Reanalysis
Surface Precipitation Rate (mm/day) Composite Mean
NOAA/ESRL Physical Sciences Division
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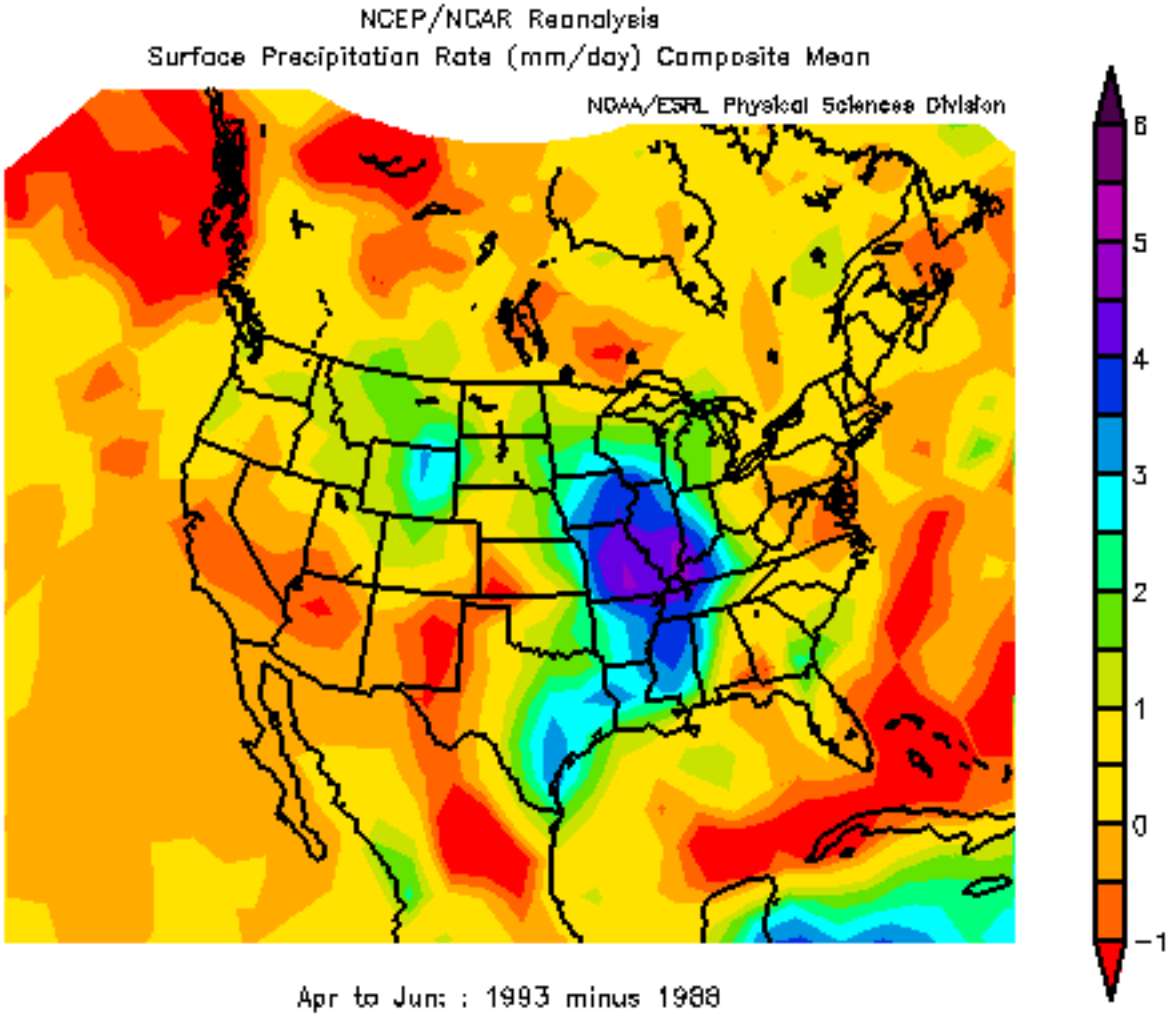
Jan to Mar: : 1993 minus 1988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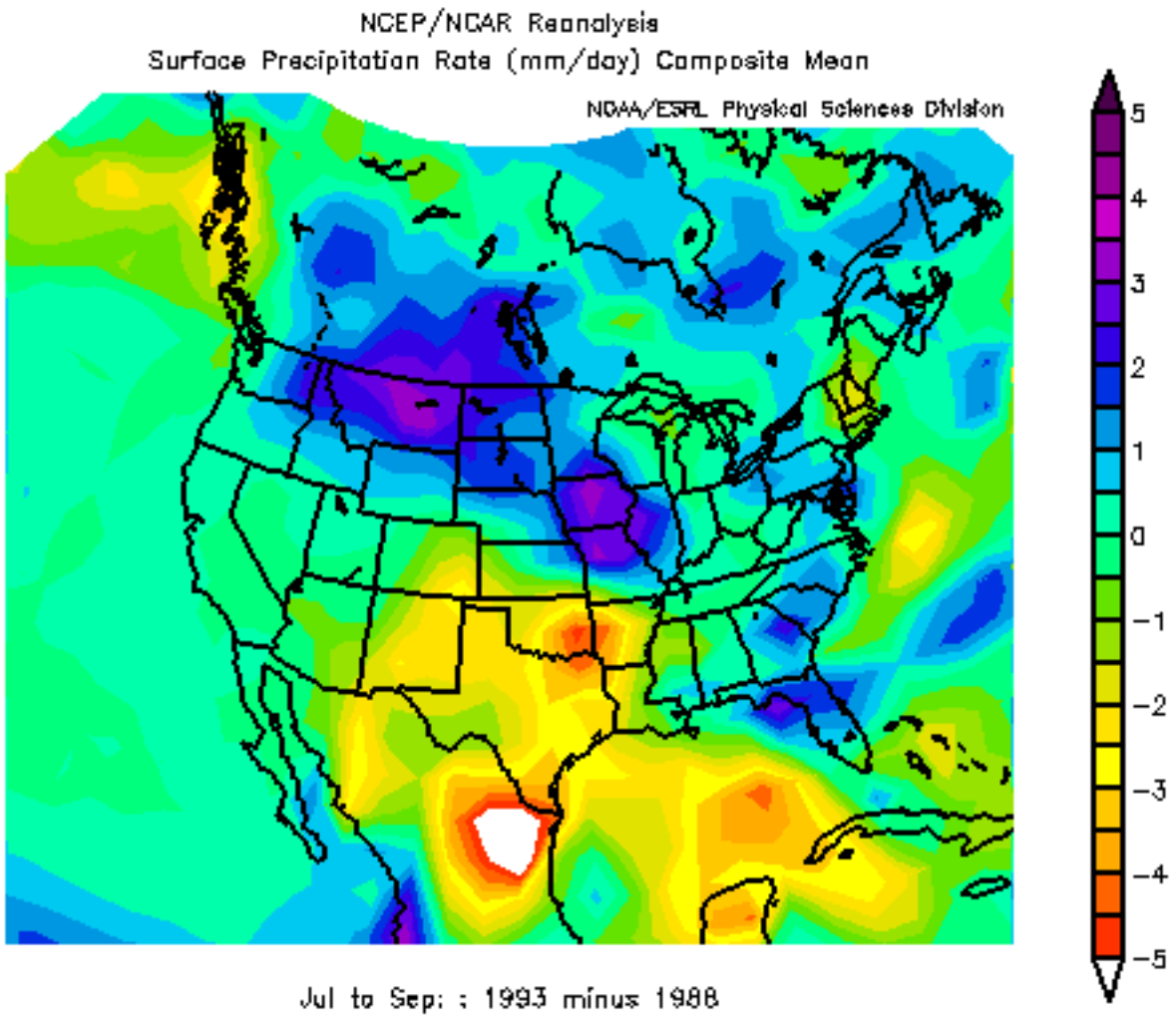
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Surface Precipitation Rate (mm/day) Composite Mean
NOAA/ESRL Physical Sciences Division
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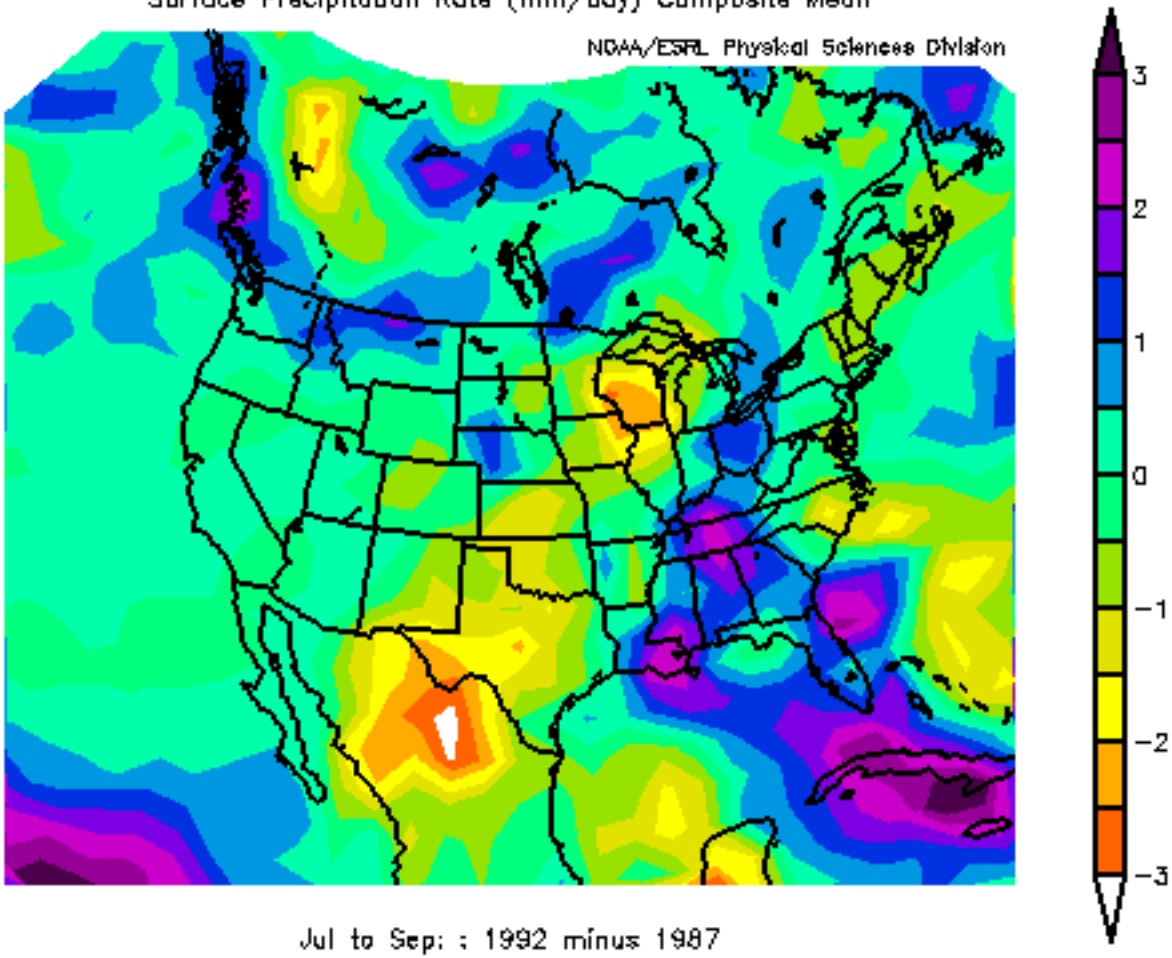
Jul to Sep: : 1993 minus 1988

NCEP/NCAR Reanalysis

Surface Precipitation Rate (mm/day) Composite Mean



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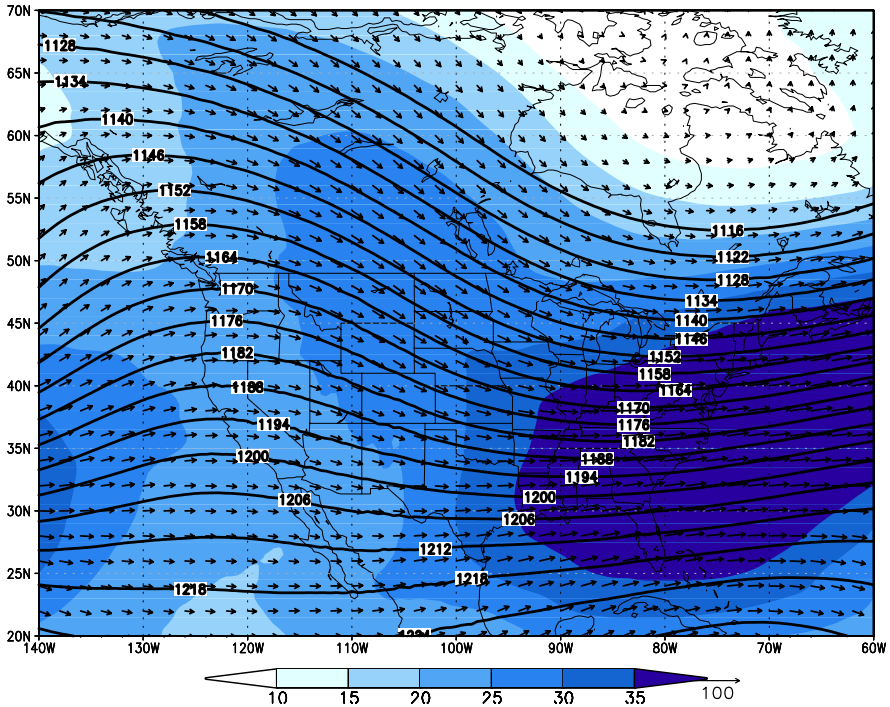
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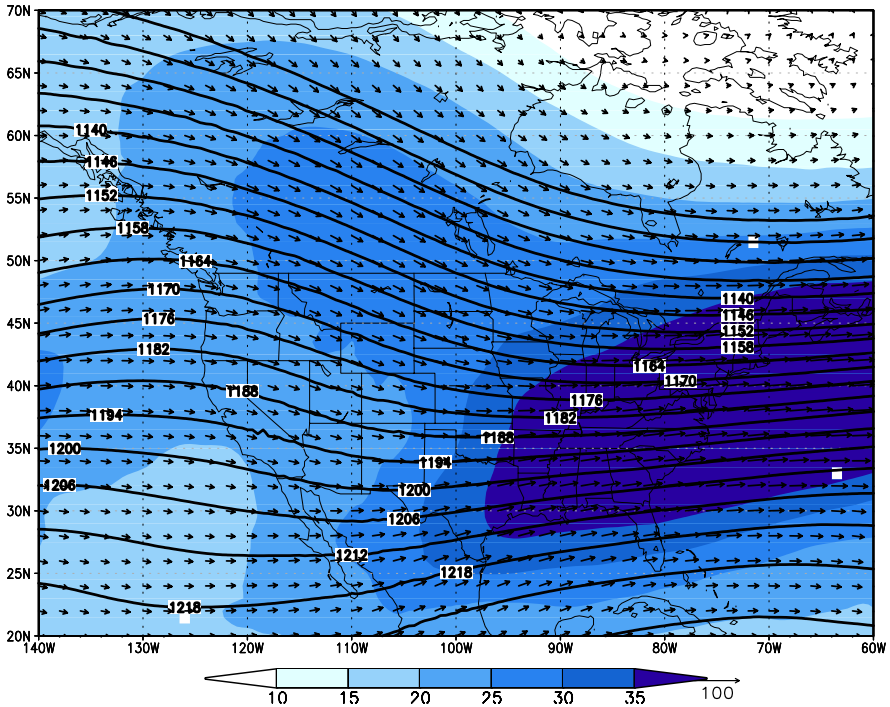
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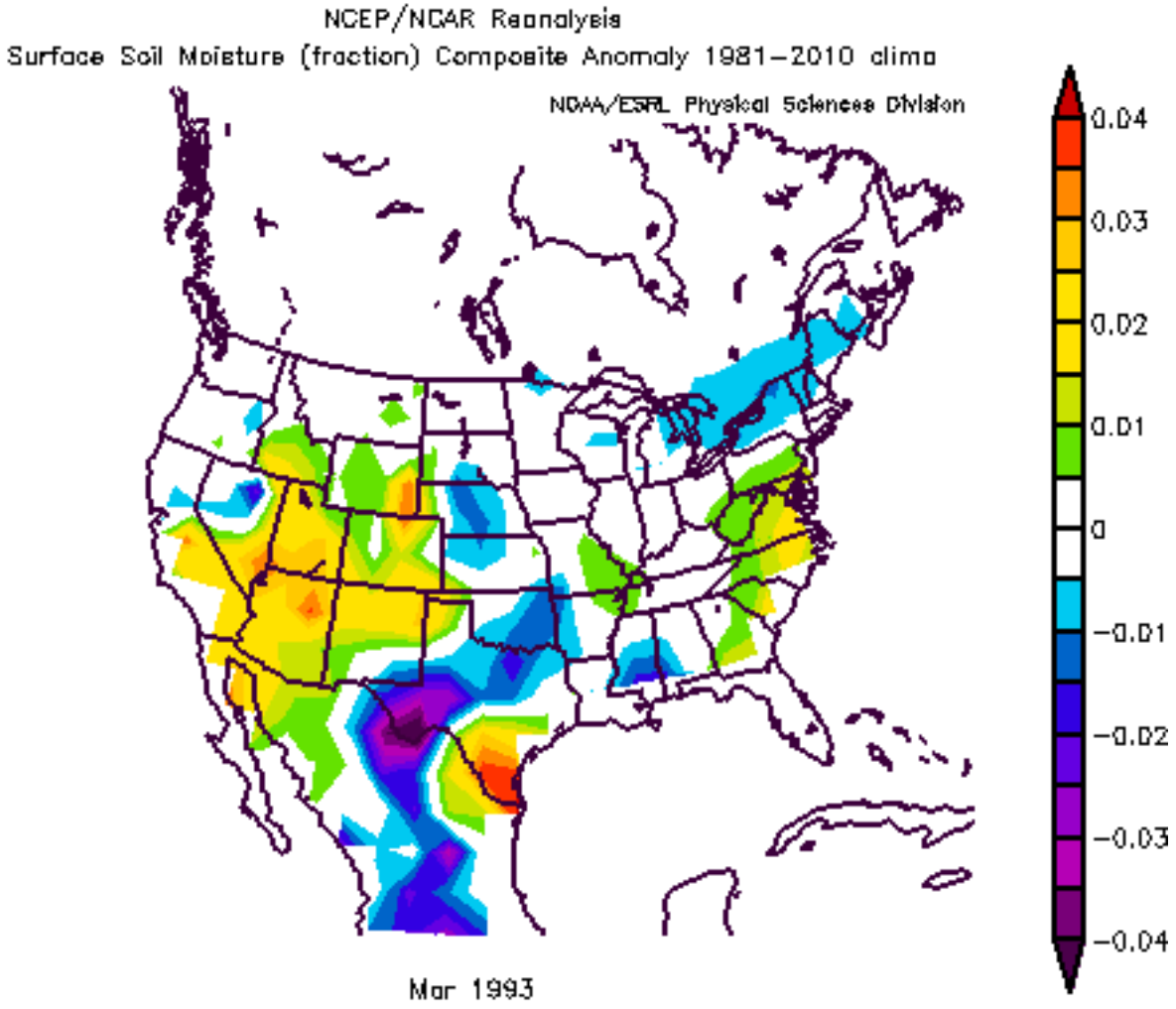
WATERWAY – At the flood's peak on August 1, more than 1,000,000 cubic feet of water rushed past the Gateway Arch in St. Louis every second.

http://www.crh.noaa.gov/lsx/?n=1993_flood



http://www.esrl.noaa.gov/psd/cgi-bin/data/composites/printpage.pl