Predictability of 2012 US Drought in a Different Representation of Atmospheric Processes

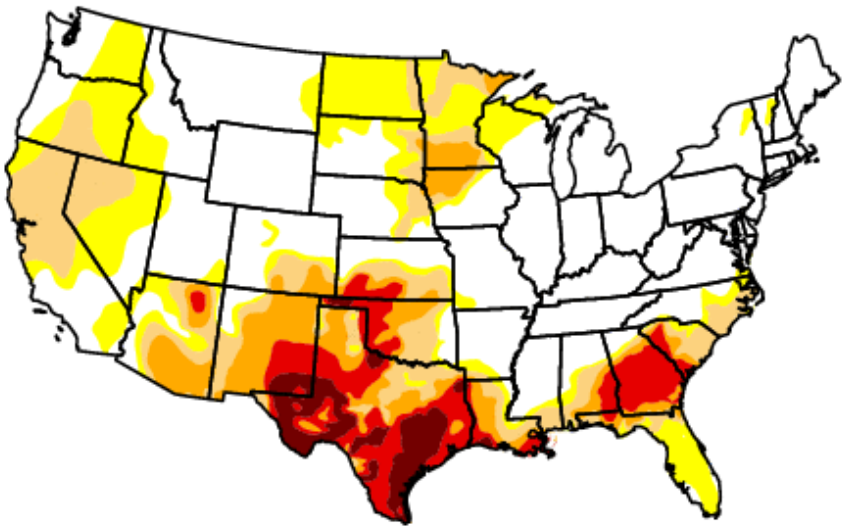
Debasish PaiMazumder & James Done

Regional Climate Section (RCS)

Mesoscale & Microscale Meteorology Lab (MMM), NCAR

NCAR is Sponsored by NSF and this work is supported by NCAR's Engineering for Climate Extremes Partnership

U.S. Drought Monitor
CONUS



January 3, 2012
(Released Thursday, Jan. 5, 2012)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	50.41	49.59	31.90	18.83	10.18	3.32
Last Week 12/27/2011	50.89	49.11	28.49	18.95	10.01	3.31
3 Months Ago 10/4/2011	55.13	44.87	30.00	23.76	17.99	11.69
Start of Calendar Year 1/3/2012	50.41	49.59	31.90	18.83	10.18	3.32
Start of Water Year 9/27/2011	56.45	43.55	29.13	23.44	17.80	11.37
One Year Ago 1/4/2011	60.50	39.50	21.74	8.50	2.60	0.00

Intensity:

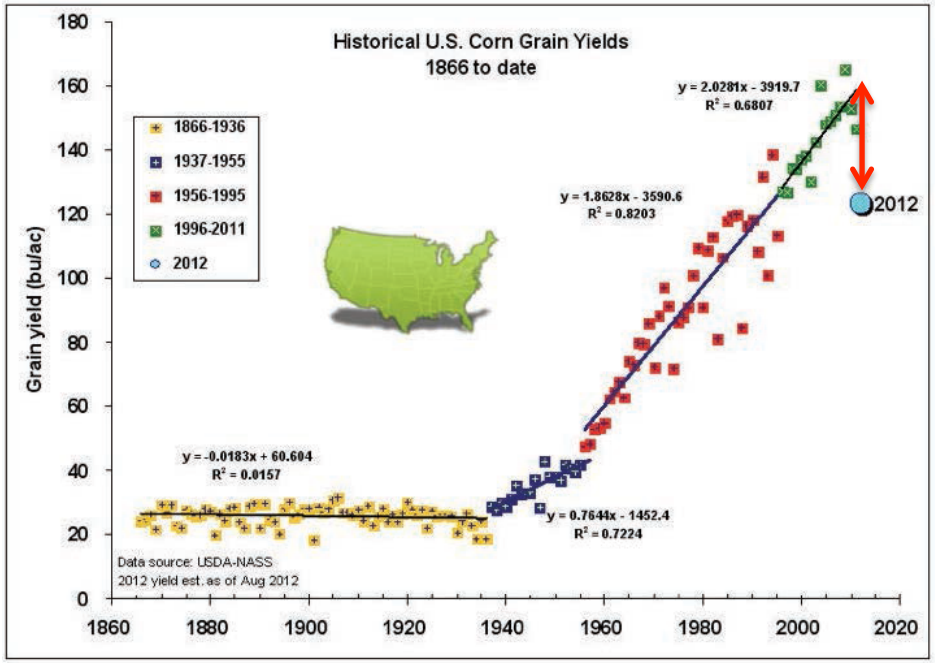
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

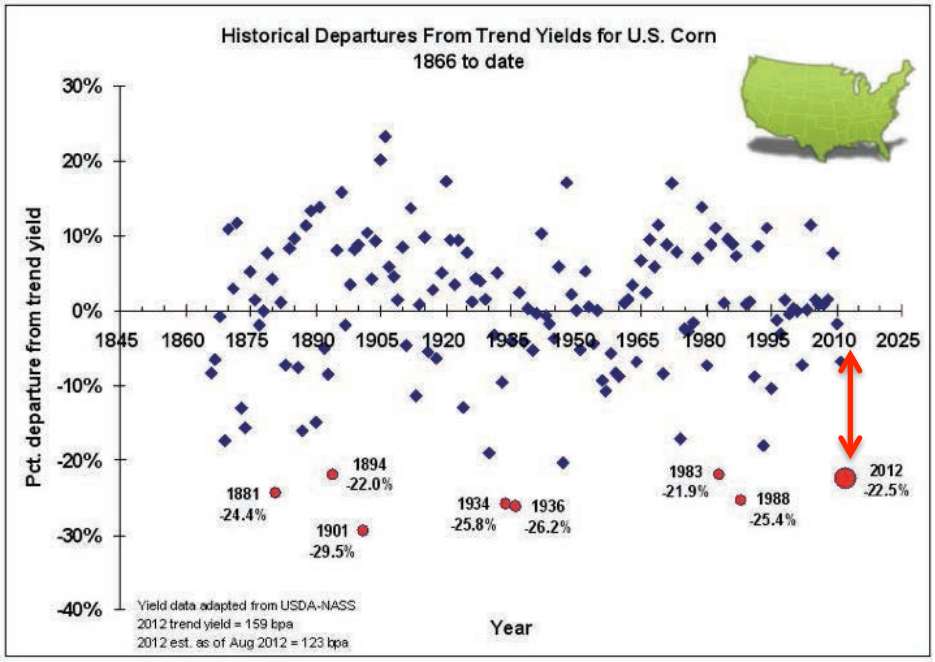
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author(s):
Brad Rippey
U.S. Department of Agriculture

http://droughtmonitor.unl.edu/

The 2012 Drought's Impact



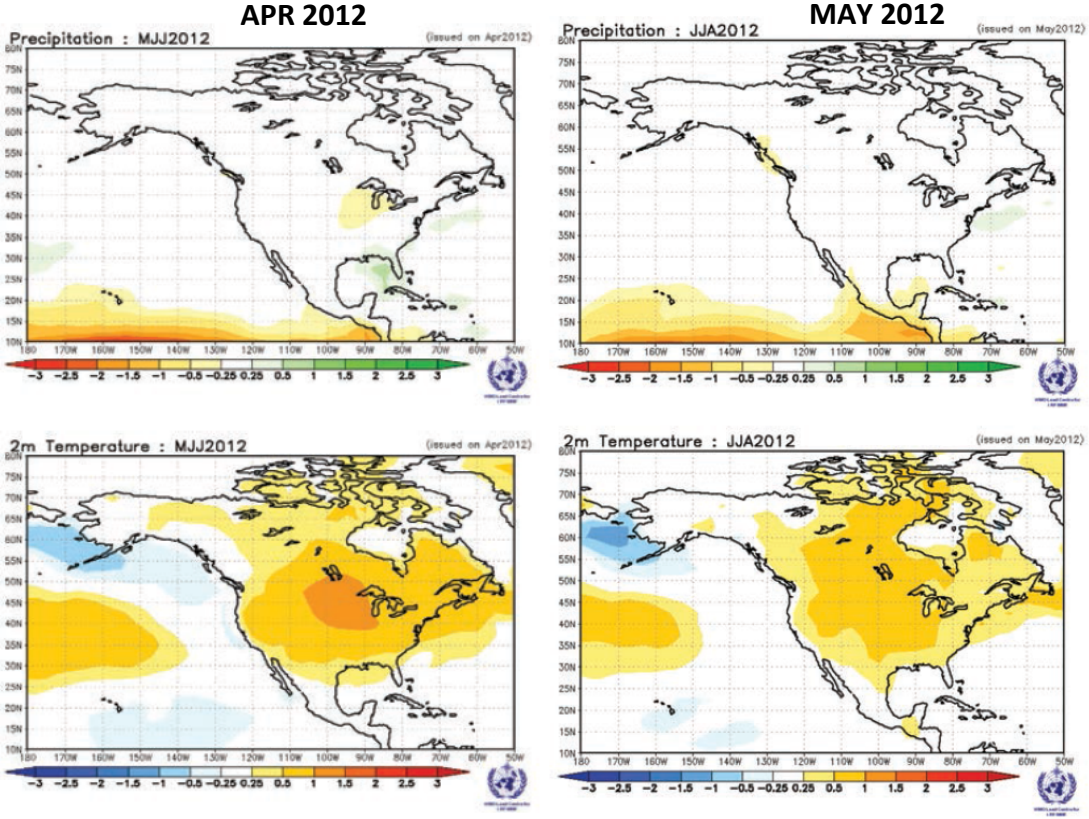


- **The 2012 drought is the most extensive drought to affect the U.S. since 1930s. Total Estimated Costs: $31 Billion; 123 Deaths (due to summer heat-wave)**
- **Wildfires burned over 9.2 million acres across the U.S. in 2012. This is the 3rd highest annual total since 2000. Total Estimated Costs$1 Billion; 8 Deaths**
- **The 2012 crop yield deficit and the implied climatic impact was a historic event.**

2012 was a “flash drought”

Equal-weighted composites of 12 operational centers’ seasonal predictions (Data source is the WMO GPC Project)

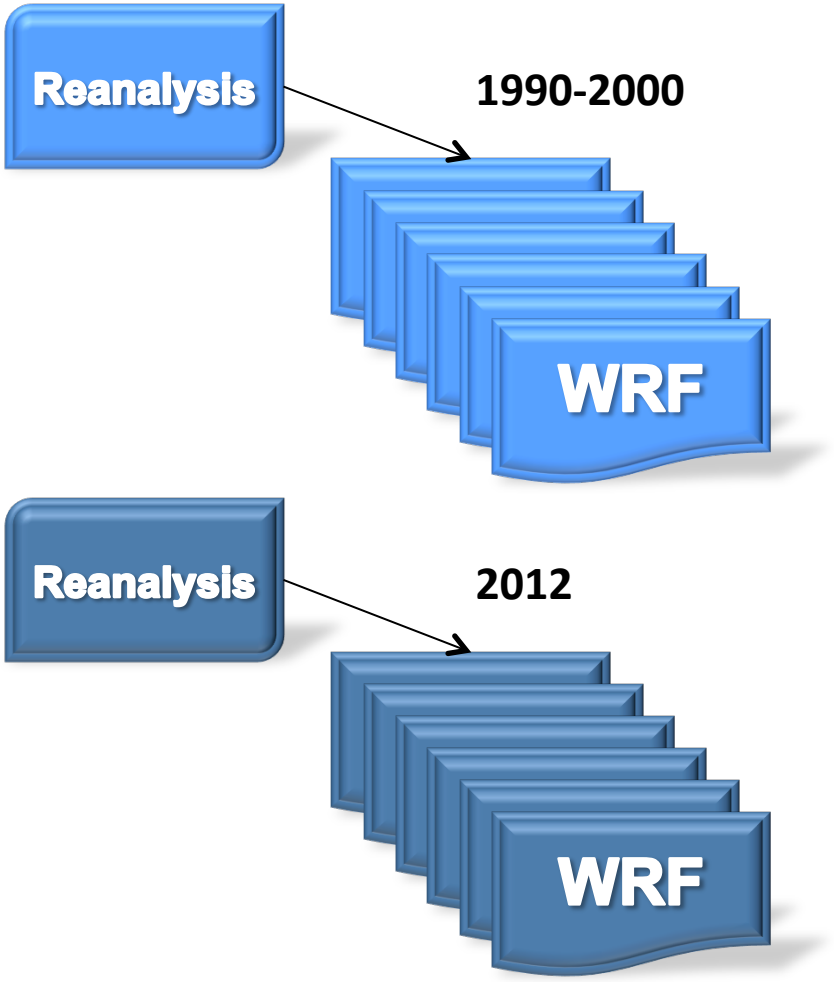
APR 2012 **MAY 2012**

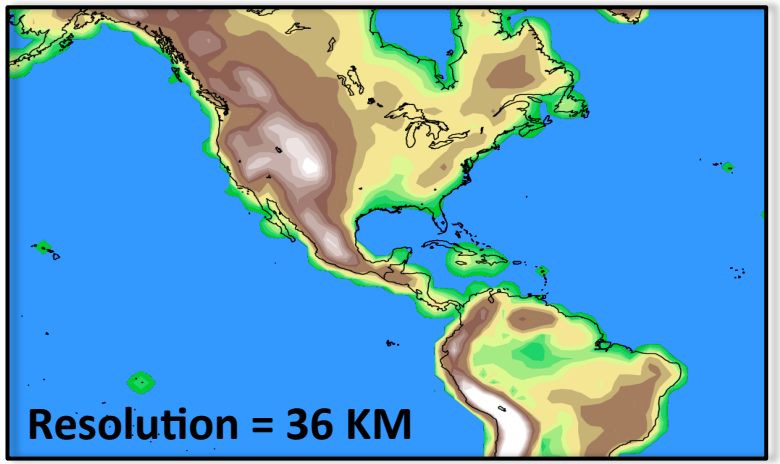


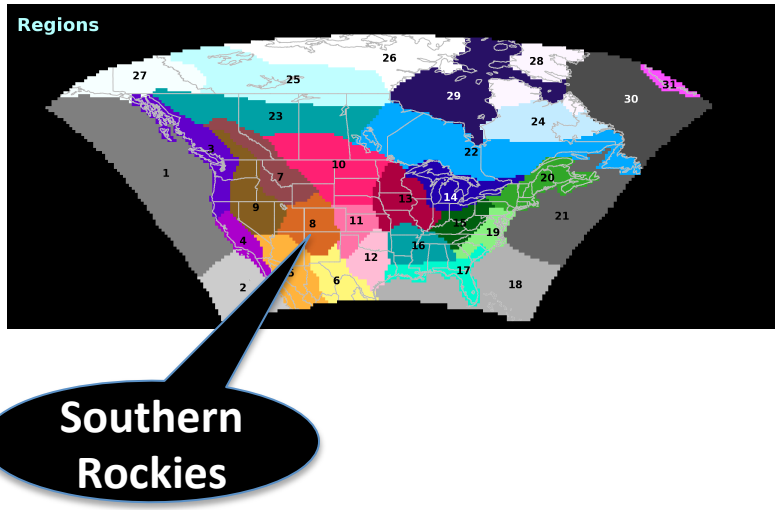
Prediction: there was an appreciable increase in probability that the central Great Plains would experience warmer than normal temperatures during summer 2012

Operational predictions failed to increase the probabilities of drought in June-August

High Resolution Climate Ensemble







Observed data: NASA Modern-Era Retrospective analysis for Research and Applications (MERRALand), available on a 2/3º X 1/2º grid from 1 January 1980 onwards

WRF Model Ensemble

Radiation Schemes: CAM, RRTMG
PBL Schemes: MYJ, YSU
Cumulus Schemes: KF, NSAS, Tiedtke
Microphysics Schemes: WSM6, Thompson

CAM , MYJ KF , WSM6	CAM , YSU KF , WSM6	RRTMG, MYJ KF , WSM6	RRTMG, YSU KF , WSM6
CAM , MYJ KF , Thompson	CAM , YSU KF , Thompson	RRTMG, MYJ KF , Thompson	RRTMG, YSU KF , Thompson
CAM , MYJ Tiedtke, WSM6	CAM , YSU Tiedtke, WSM6	RRTMG, MYJ Tiedtke, WSM6	RRTMG, YSU Tiedtke, WSM6
CAM , MYJ Tiedtke, Thompson	CAM , YSU Tiedtke, Thompson	RRTMG, MYJ Tiedtke, Thompson	RRTMG, YSU Tiedtke, Thompson
CAM , MYJ NSAS, WSM6	CAM , YSU NSAS, WSM6	RRTMG, MYJ NSAS, WSM6	RRTMG, YSU NSAS, WSM6
CAM , MYJ NSAS, Thompson	CAM , YSU NSAS, Thompson	RRTMG, MYJ NSAS, Thompson	RRTMG, YSU NSAS, Thompson

Objectives

- **Explore the differences in memory between precipitation and soil moisture in a regional climate ensemble compared to observation.**

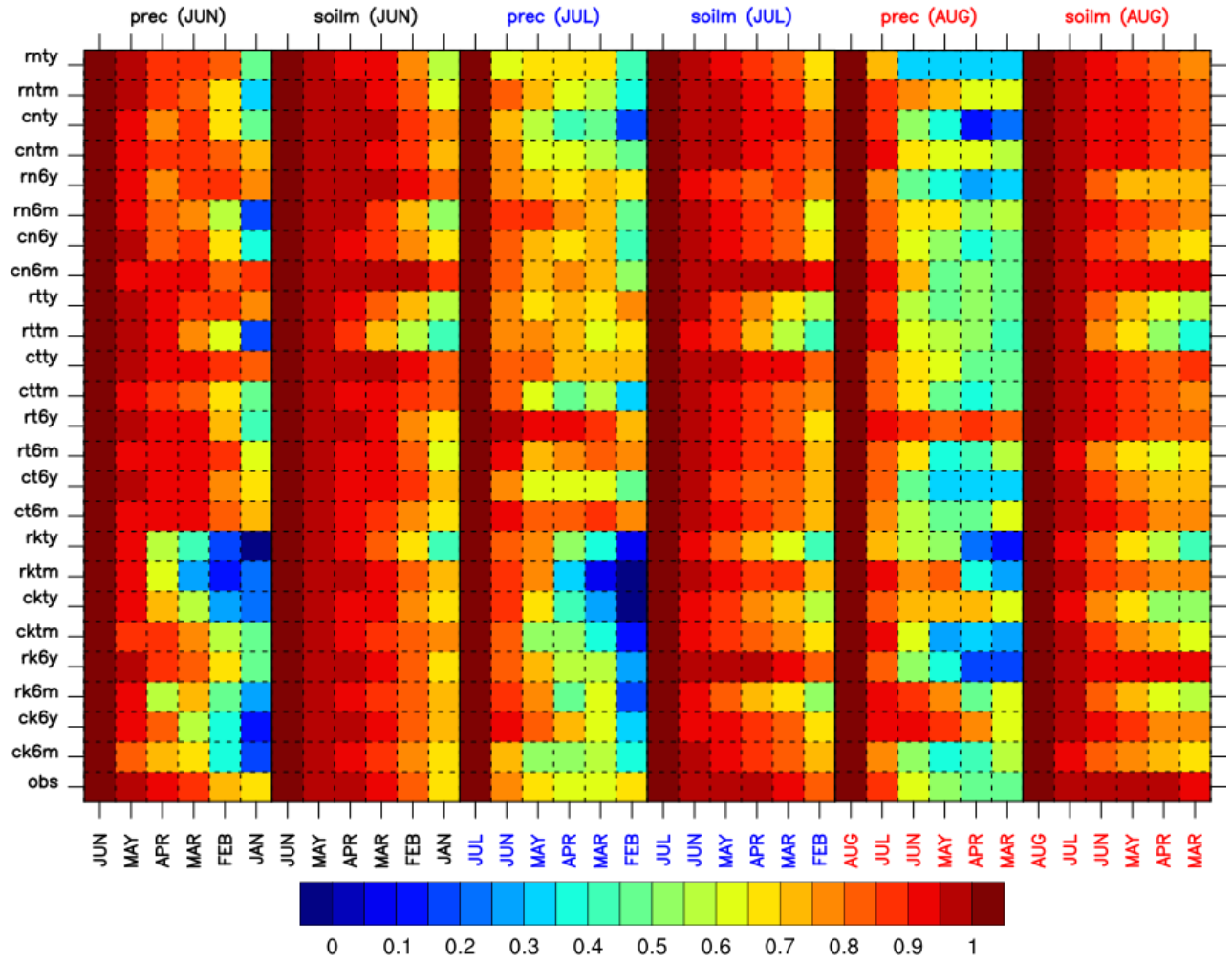
- **Explore the relationship of summer precipitation-concurrent and preseason soil moisture-winter snow melt anomaly in a regional climate ensemble compared to observation.**

Objectives

- **Explore the differences in memory between precipitation and soil moisture in a regional climate ensemble compared to observation.**

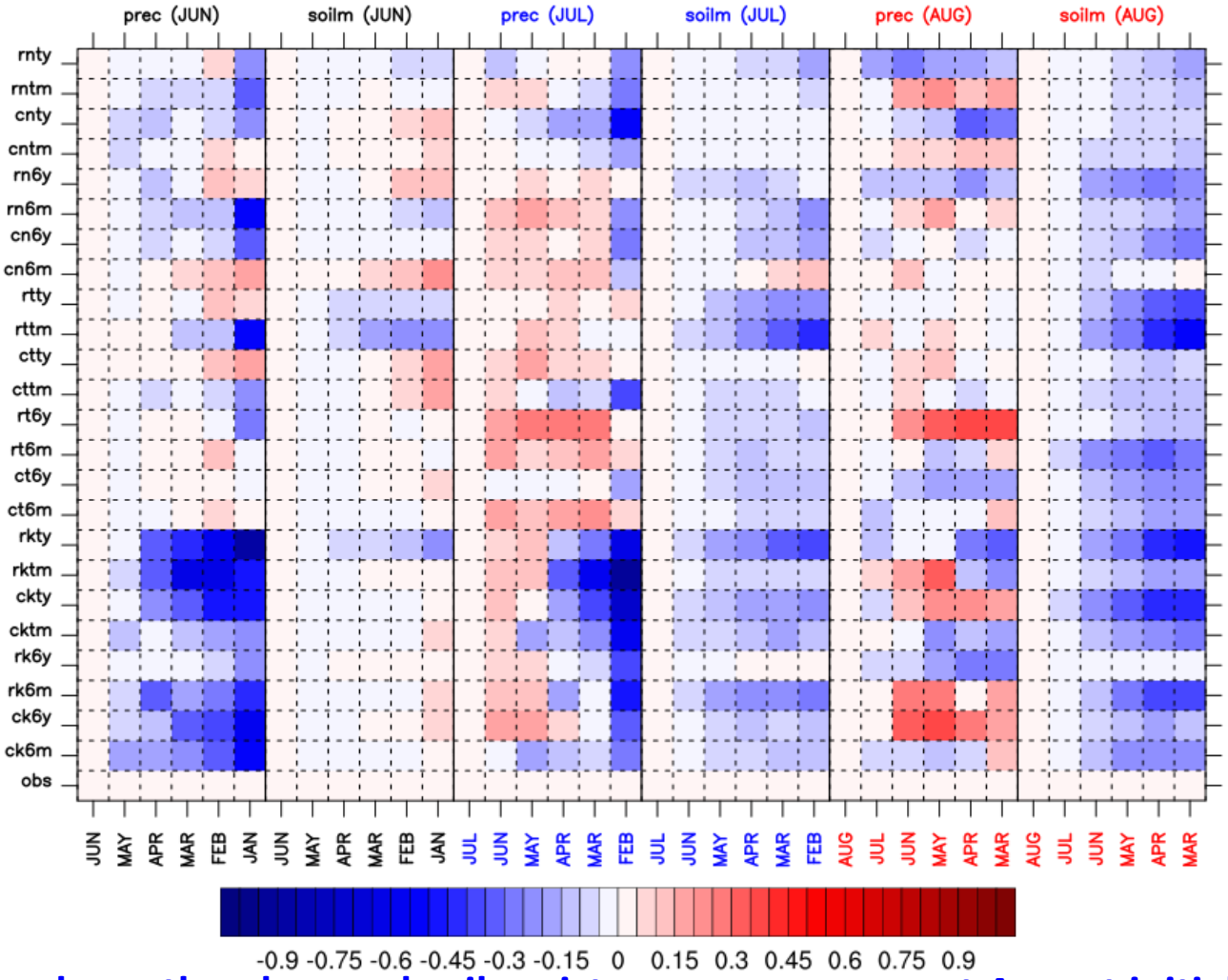
- **Explore the relationship of summer precipitation-concurrent and preseason soil moisture-winter snow melt anomaly in a regional climate ensemble compared to observation.**

Model has predictability based on persistence of soil moisture memory (1990-2000)



Autocorrelations of the accumulated 6-month soil moisture decay at a slower rate than the accumulated 6-month precipitation

Model has predictability based on persistence of soil moisture memory (1990-2000)



Model reproduces the observed soil moisture memory except August initial condition.

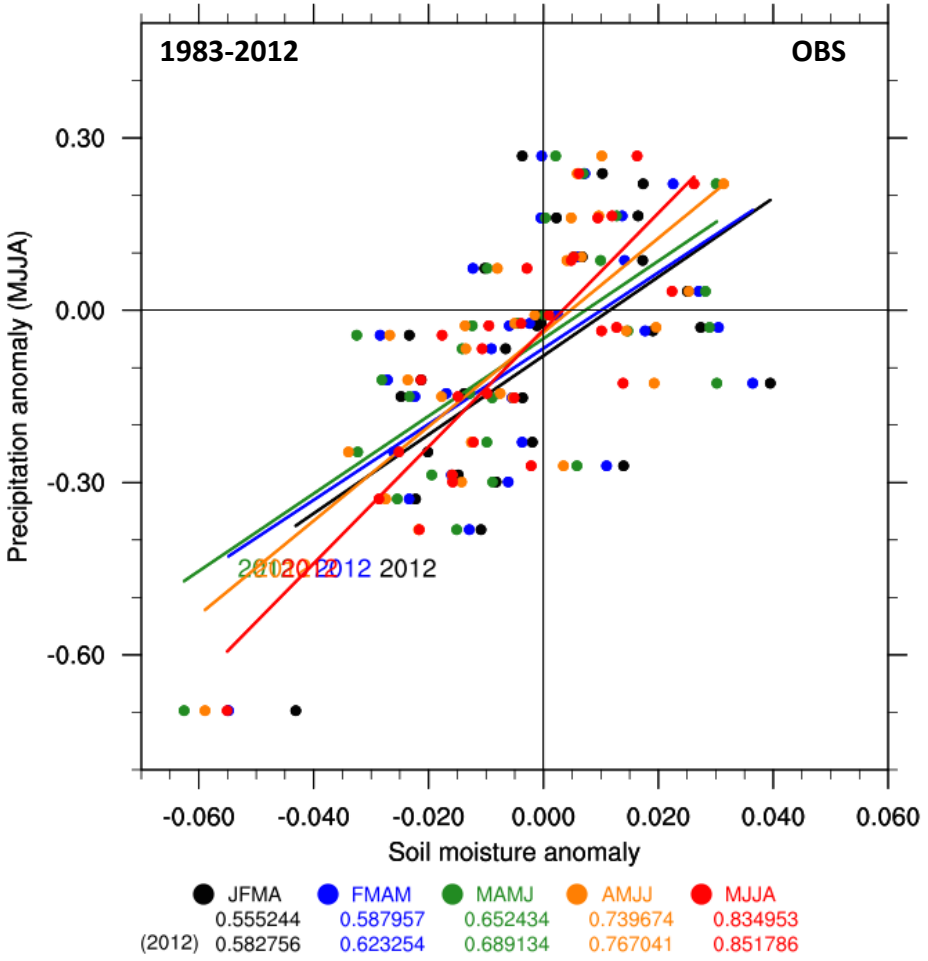
Model fails to reproduce precipitation memory, specially for KF.

Objectives

- Explore the differences in memory between precipitation and soil moisture in a regional climate ensemble compared to observation.

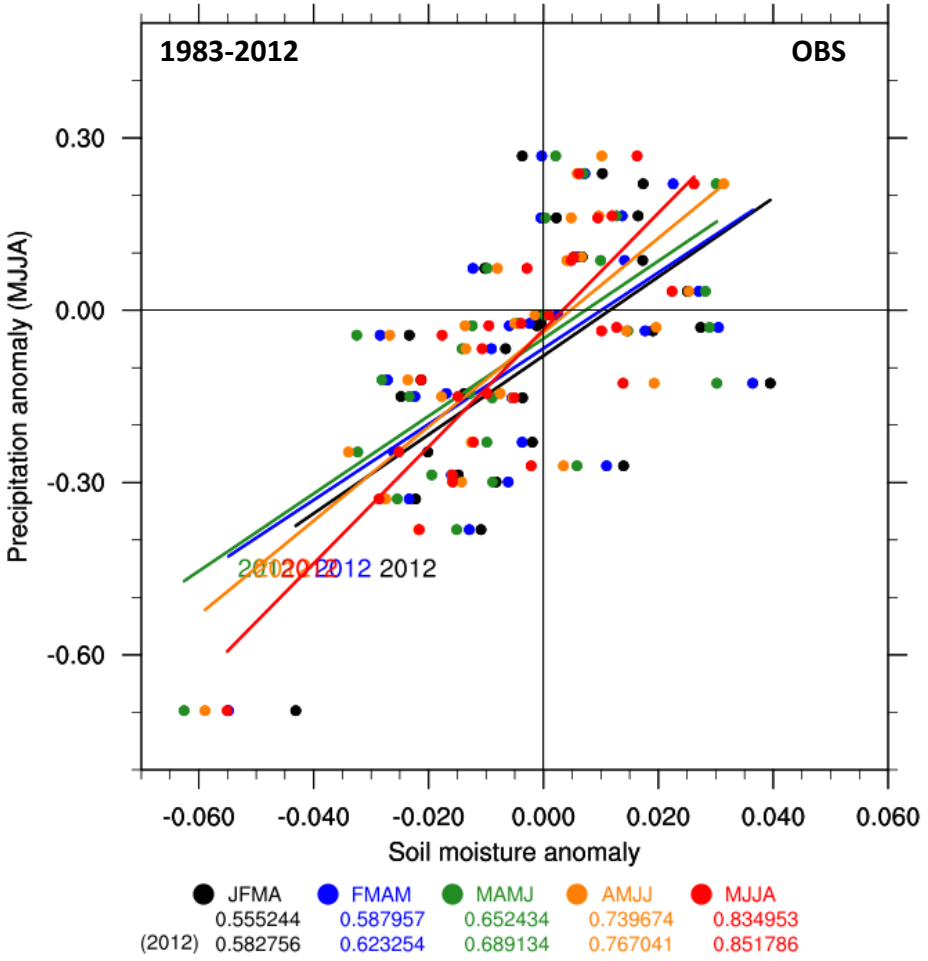
- **Explore the relationship of summer precipitation-concurrent and preseason soil moisture-winter snow melt anomaly in a regional climate ensemble compared to observation.**

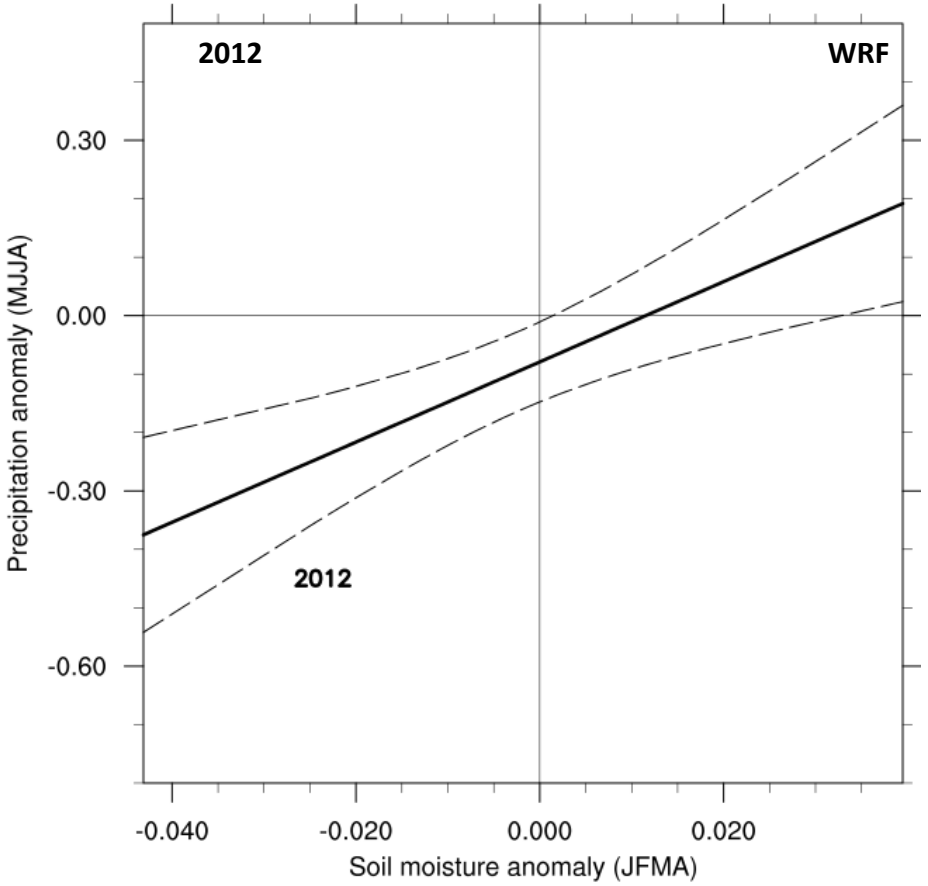
Strong correlation between summer Prec anomaly and pre-season SM anomaly



Correlation between summer Prec and SM persisted in 2012

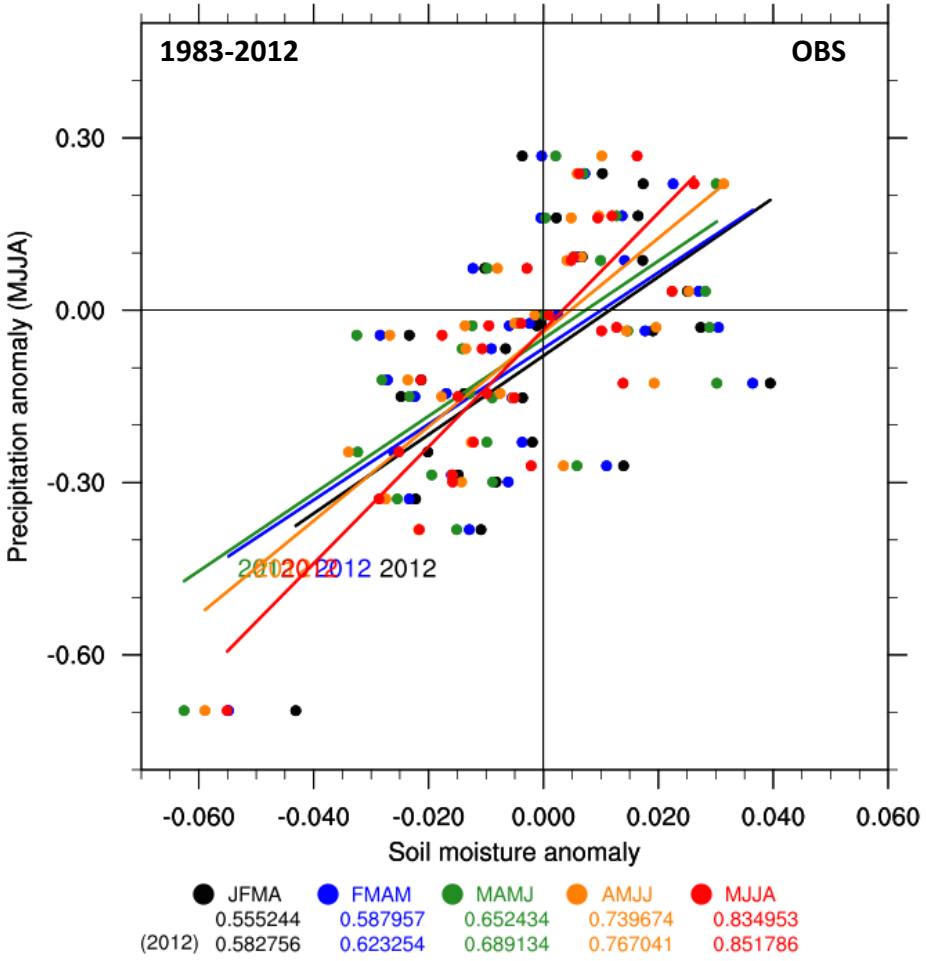
Strong correlation between summer Prec anomaly and pre-season SM anomaly

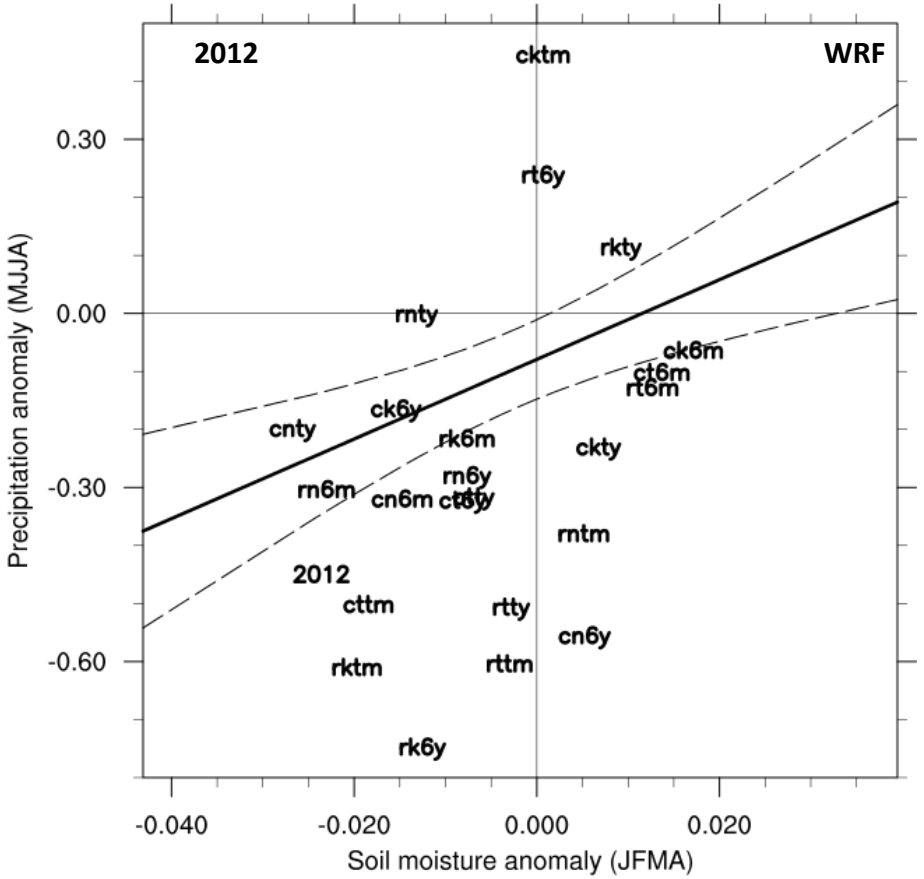




Correlation between summer Prec and SM persisted in 2012

10-30% of members reproduce the relationship (precipitation-soil moisture)

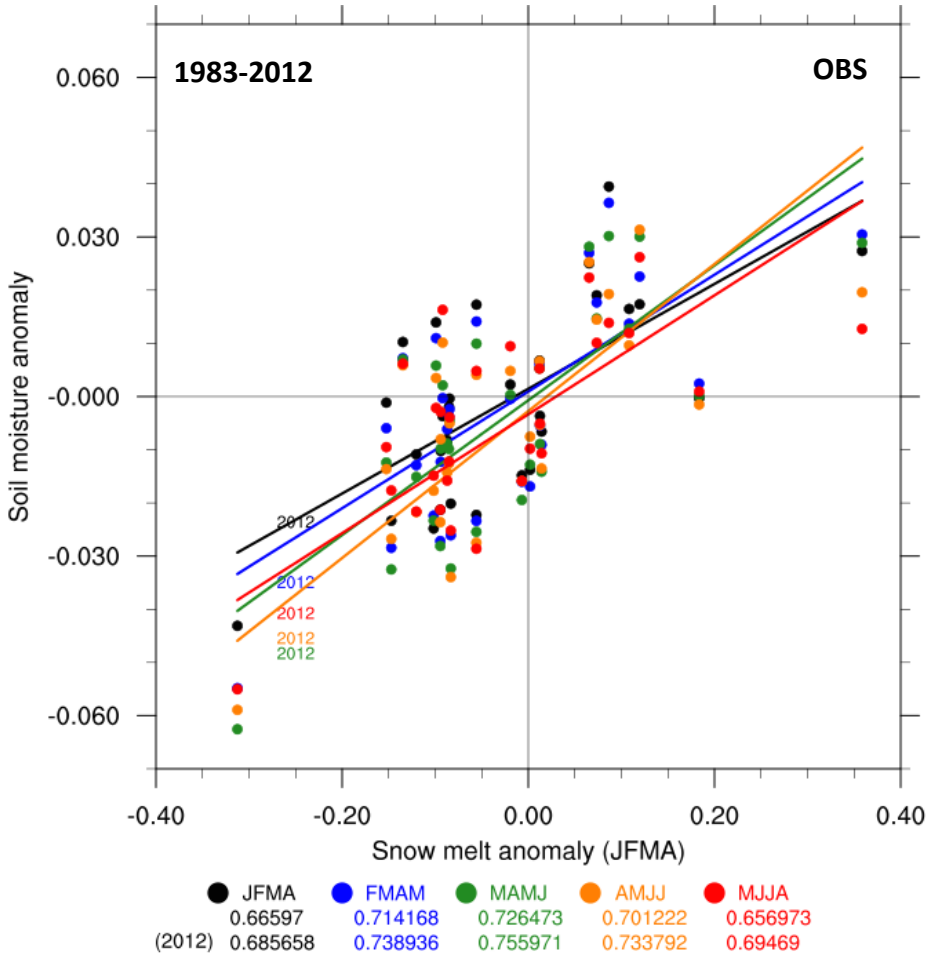




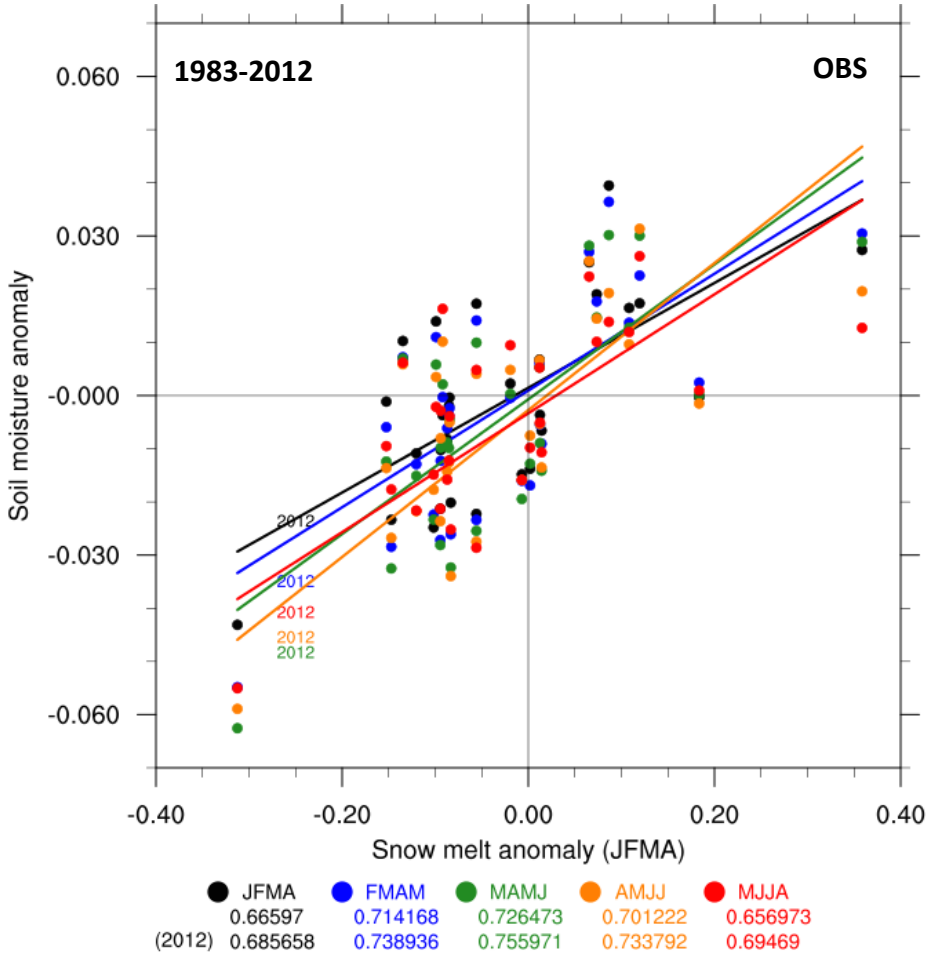
Correlation between summer Prec and SM persisted in 2012

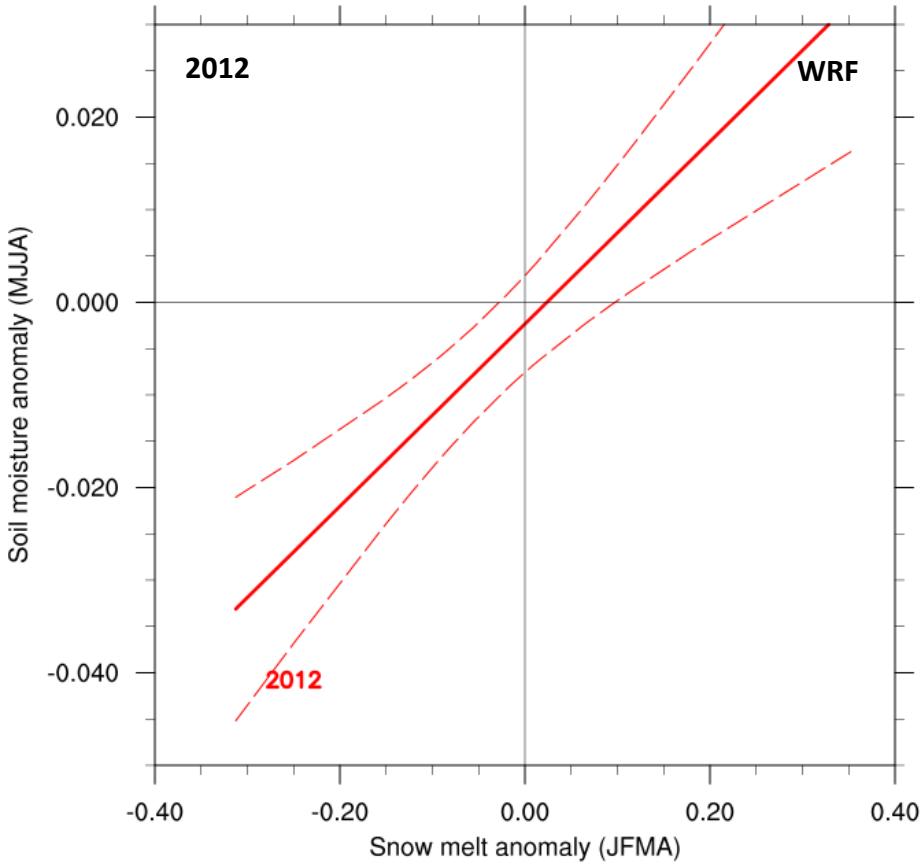
Relationship is robust for CAM and Tiedtk

Summer SM anomaly can be influence by winter snow melt anomaly

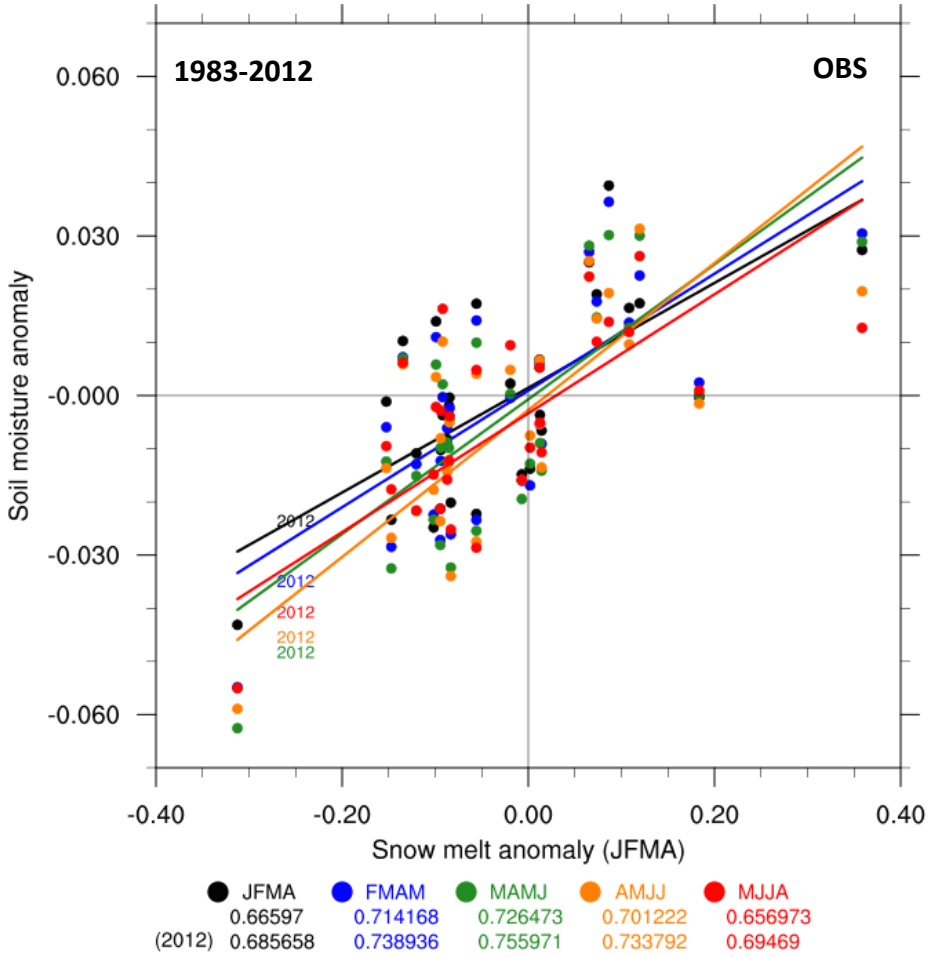


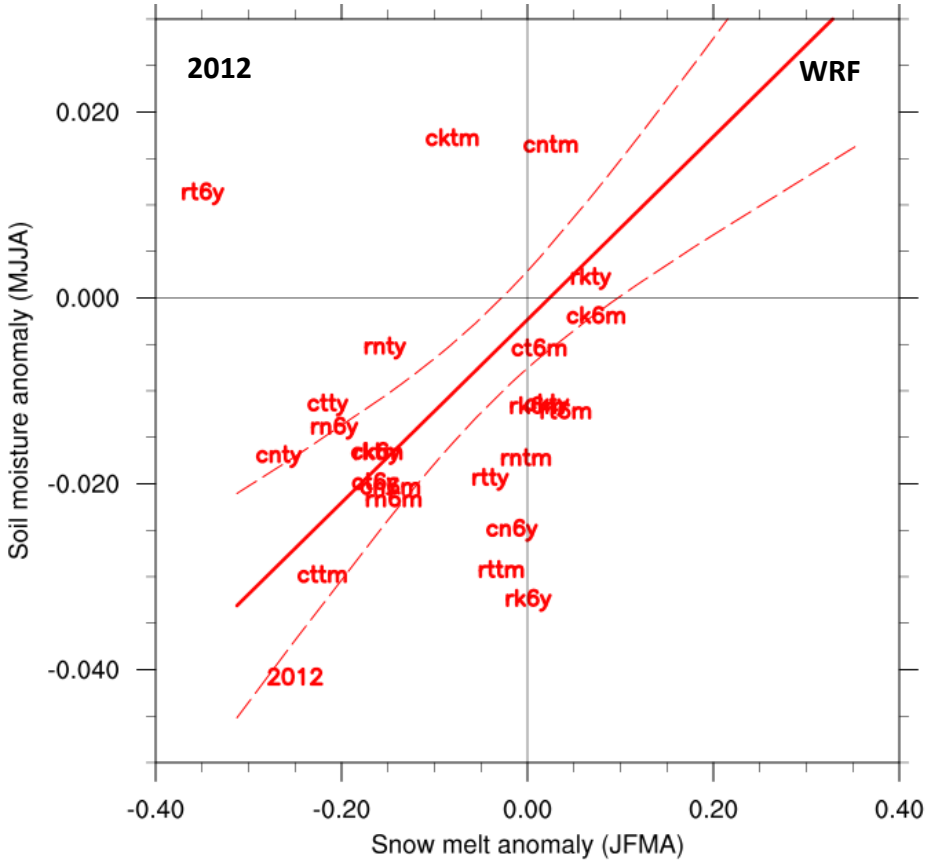
Summer SM anomaly can be influence by winter/ spring snow melt anomaly





More than 50% of members reproduce the relationship (soil moisture-snowmelt)





Summary & Conclusion

- **Explore the differences in memory between precipitation and soil moisture in a regional climate ensemble compared to observation.**
  - **2012 summer drought has predictability based on persistence of soil moisture memory in real world.**
  - **Model also has predictive skill based on persistence of soil moisture memory.**
  - **Persistence of precipitation memory is weak in real world and weaker in model.**
- **Explore the relationship of summer precipitation-concurrent and preseason soil moisture-winter snow melt anomaly.**
  - **Strong correlation between summer Prec anomaly and pre-season SM anomaly which is persisted in 2012.**
  - **Above relationship is robust for CAM and Tiedtk**
  - **Strong correlation between winter snow melt anomaly with concurrent and preseason soil moisture is robust for all the members.**

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

ECEP
ENGINEERING FOR CLIMATE EXTREMES PARTNERSHIP

NSF