The MRED project: Ensemble downscaling of seasonal forecasts

Raymond W. Arritt for the MRED Team

Iowa State University, Ames, Iowa USA

Motivation for dynamical downscaling of global seasonal forecasts

- Seasonal prediction models are inherently global.
- Resolution of the global model is limited by practical constraints.
  - Physiographic characteristics such as coastlines, terrain, or land use may not be well represented.
- Can dynamical downscaling add useful detail to global seasonal forecasts?
  - Is there value from using ensemble downscaling?

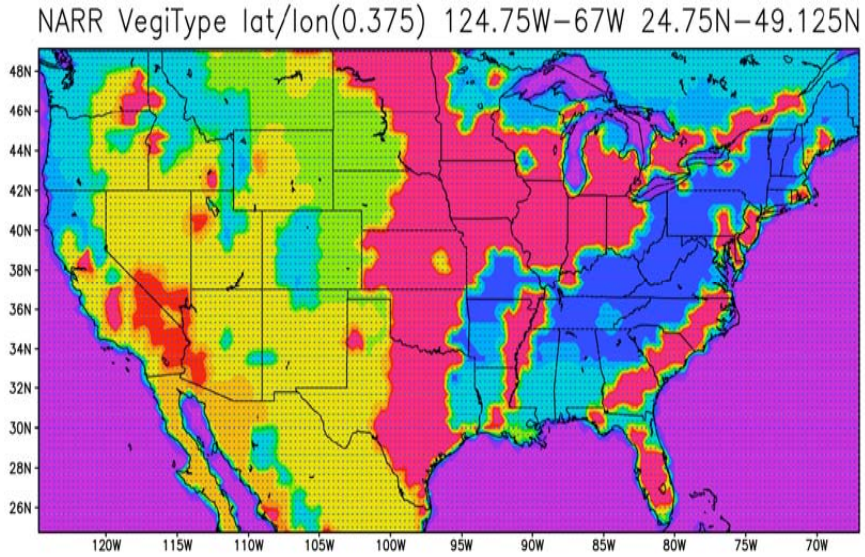
Multi-RCM Ensemble Downscaling of Global Seasonal Forecasts (MRED)

Objective: **Demonstrate the usefulness of multi-model downscaling of global seasonal forecasts for hydrologic applications** over the U.S.

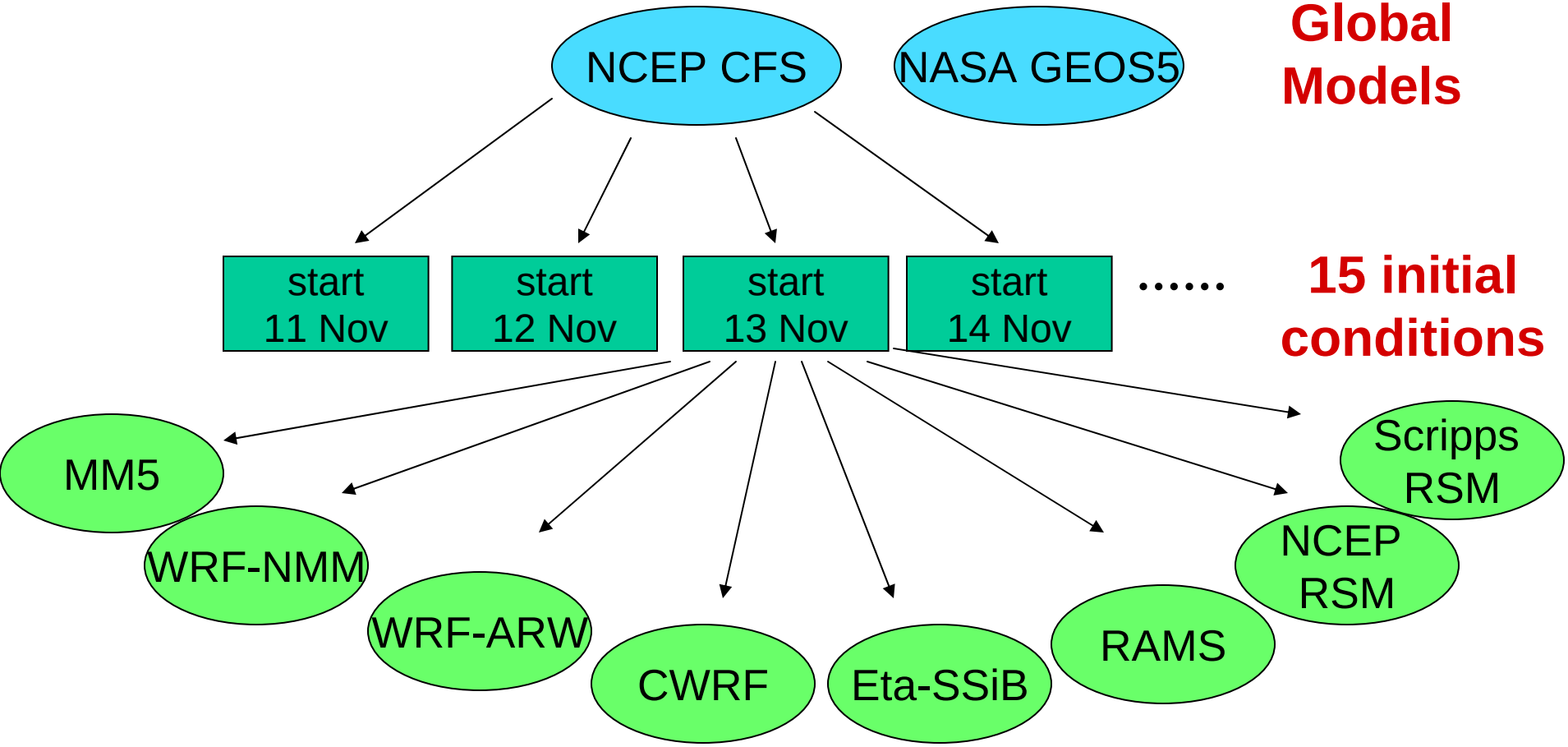
- Project was designed and brought to funding by John Roads.
- Sponsored by NOAA CPPA.
- Evaluate strategies for producing ensembles of downscaled seasonal predictions.
- Provide predictions at higher resolution and regional level for hydrologic applications.
- Initial focus is on winter (snow, terrain, ENSO).

Multi-RCM Ensemble Downscaling of multi-GCM Seasonal Forecasts (MRED)

- Downscale 23 years of winter (December-April) reforecasts from NOAA CFS global seasonal forecast model (T62L64, ~1.9^{o} lat/lon) and new NASA model based on GEOS5 and MOM4.
- Domain is the coterminous U.S. at grid spacing 32 km.



MRED Ensemble



MRED Team

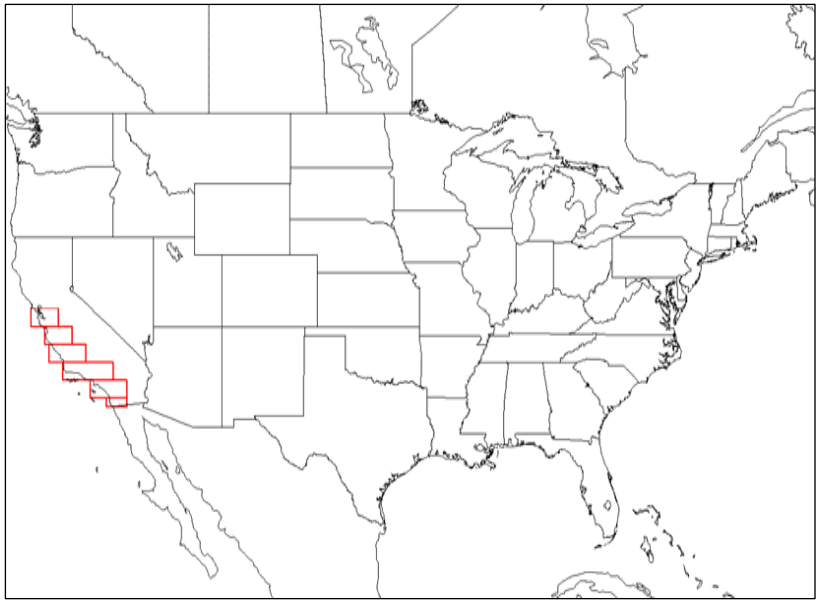
• Jin Huang, Annarita Mariotti, NOAA	Program managers
• John Roads (deceased), Scripps	Project originator, lead coordinator
• Raymond Arritt, ISU	Lead coordinator, MM5
• Chris Anderson, ISU	WRF-NMM
• Laurel Dehaan, UCSD/Scripps	Scripps RSM, central analysis
• Mike Ek, NOAA	NCEP coordination
• Bill Gutowski, ISU	Hydrological analysis
• Daryl Herzmann, ISU	MM5
• H.-M. Henry Juang, NOAA	CFS forcing, NOAA RSM
• M. Kanamitsu, UCSD/Scripps	Scripps RSM, central analysis
• Dennis Lettenmaier, U.Wash	Statistical downscaling
• Lai-Yung (Ruby) Leung, James Correia, PNNL	WRF-ARW
• Xin-Zhong Liang, ISWS	CWRF
• Lixin Lu, CIRA/CSU	RAMS
• Ken Mitchell, NCEP	CFS forcing, operational transition
• Roger Pielke Sr., Univ. Colorado	RAMS
• Jack Ritchie, Laurel DeHaan, UCSD/Scripps	QC and central analysis
• Siegfried Schubert, NASA/GSFC	NASA forcing
• Gene Takle, ISU	Applications
• Yongkang Xue, UCLA	Eta-SSiB
• Rongqian Yang, NOAA	CFS forcing

Some preliminary results

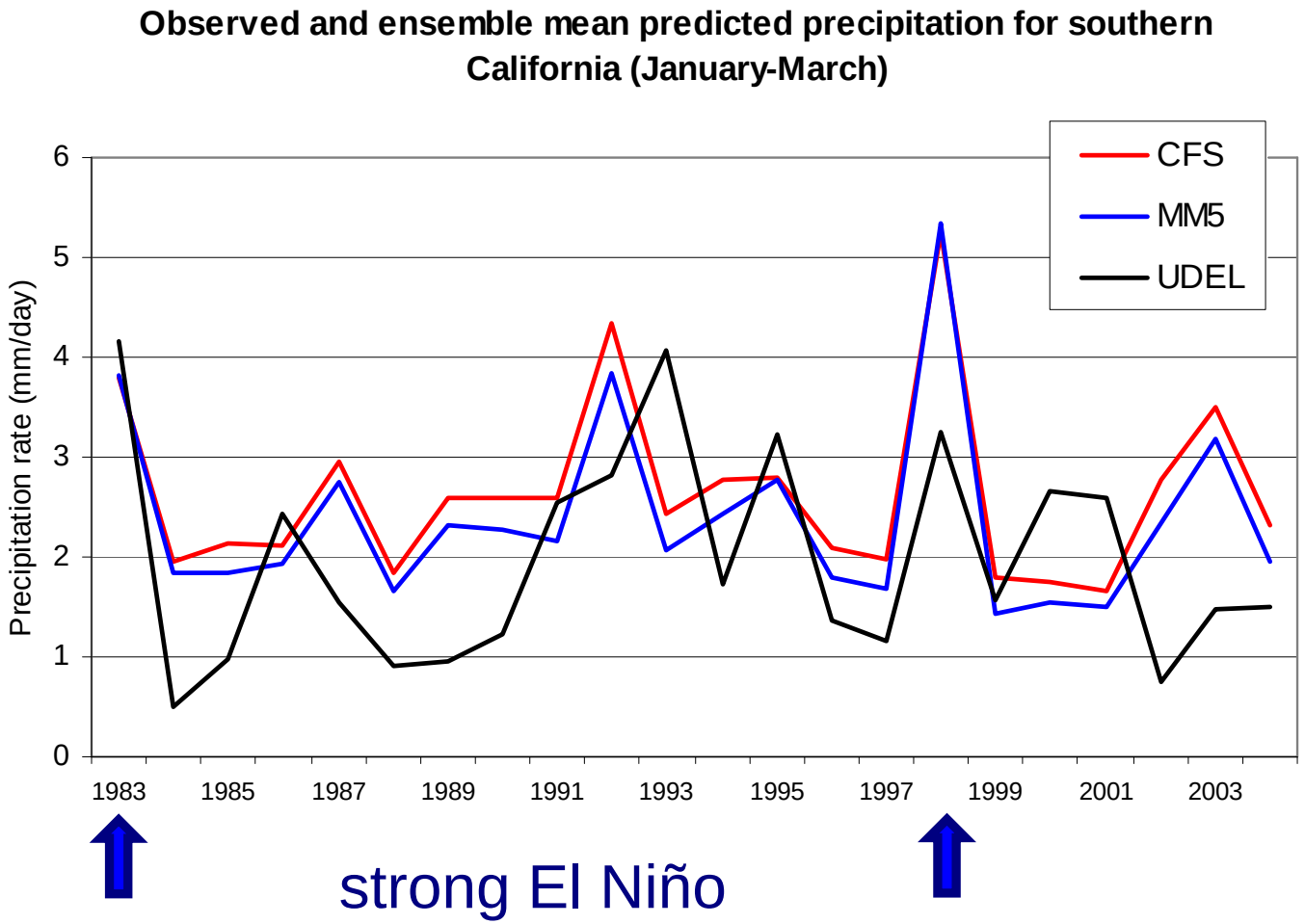
- A few models have completed all 15 ensemble members.
  - Several other models have downscaled the first block of five members from CFS.
- Output is being submitted to the central archive.
- Results are shown here for the 15-member CFS ensemble downscaled by MM5.

Precipitation for south-central coastal California

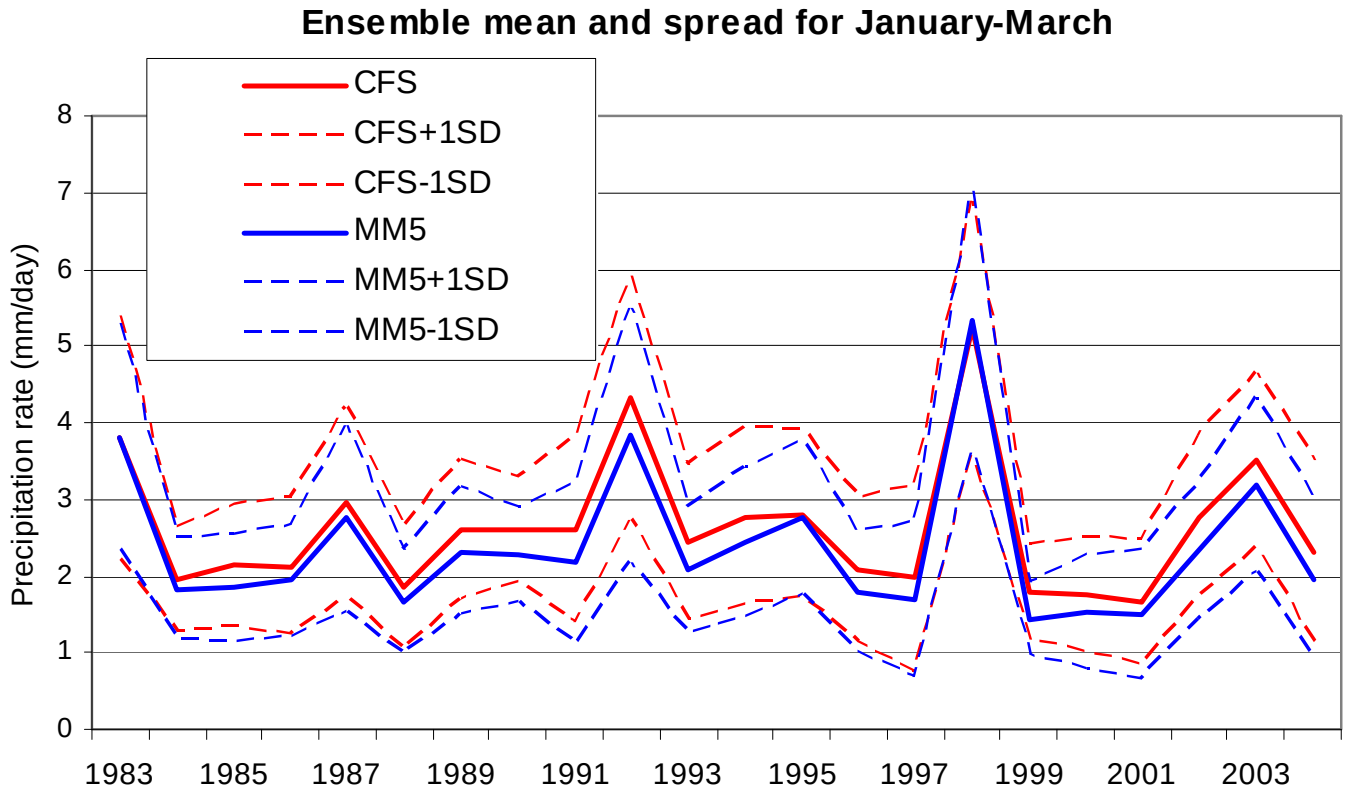
- Strong ENSO signal in precipitation for this region.
- Terrain and coastline are not well resolved at T62 resolution of CFS (~210 km).
- Mediterranean climate type with a pronounced annual cycle of precipitation (summer dry).



Observed and ensemble mean January-March precipitation for southern California



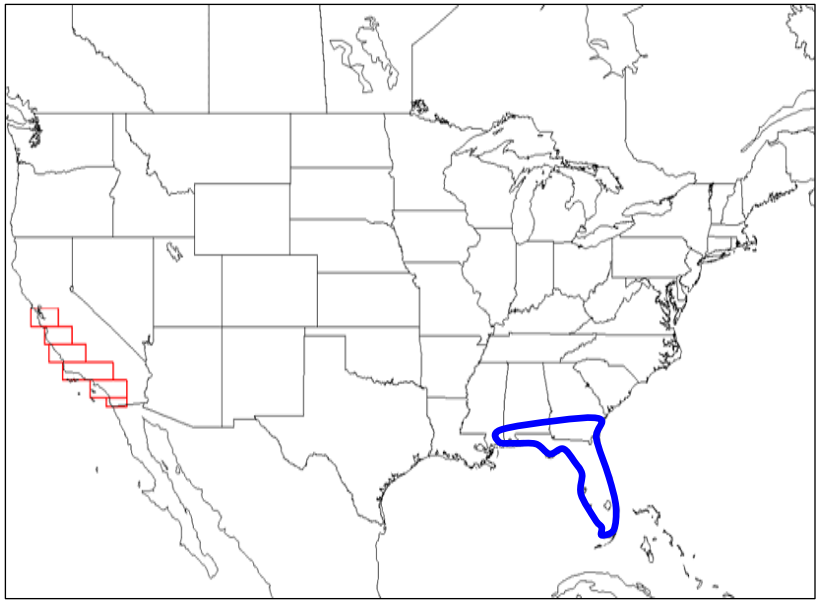
Ensemble spread is similar for the global (CFS) and downscaled (MM5) results



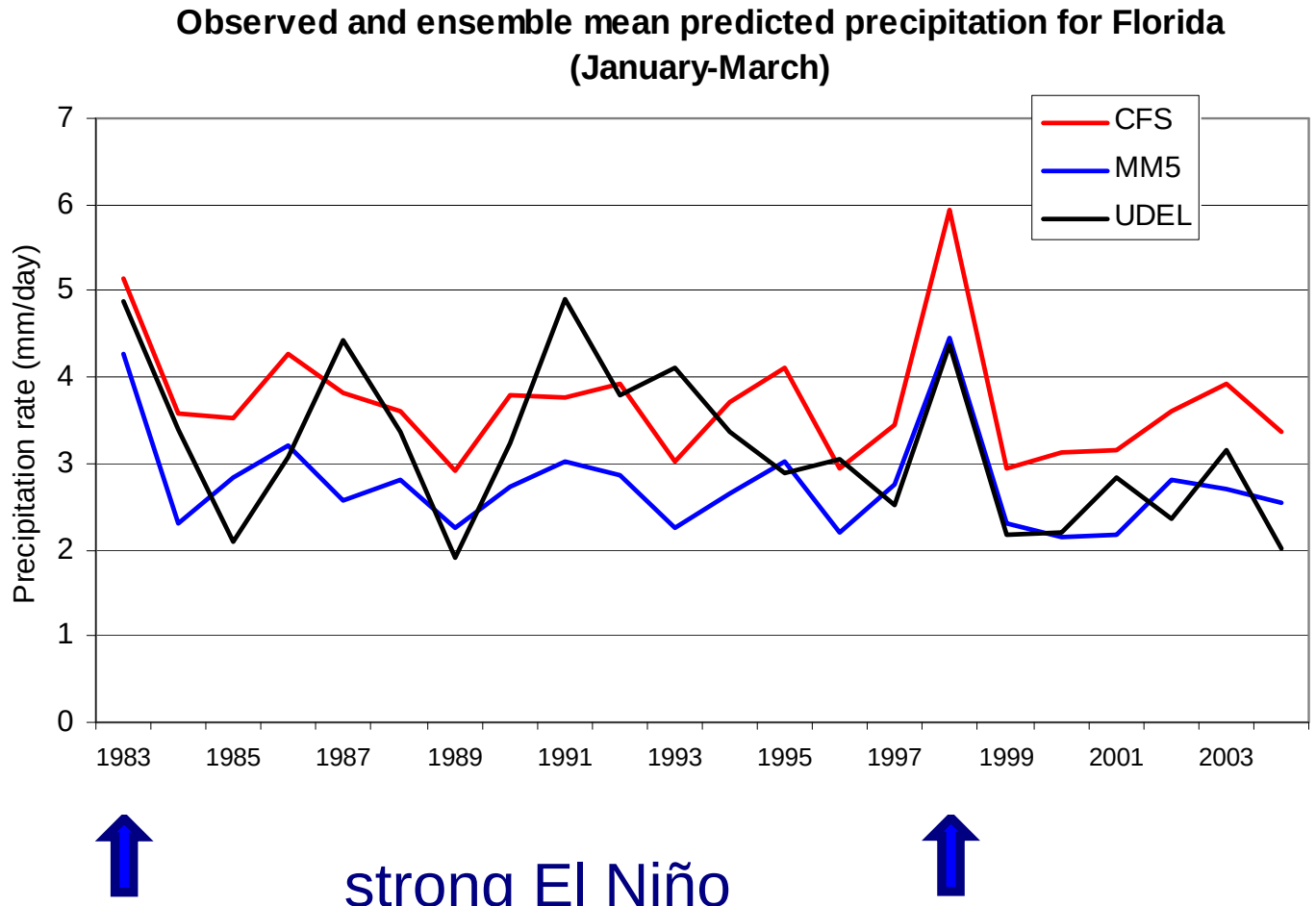
strong El Niño

Precipitation for Florida

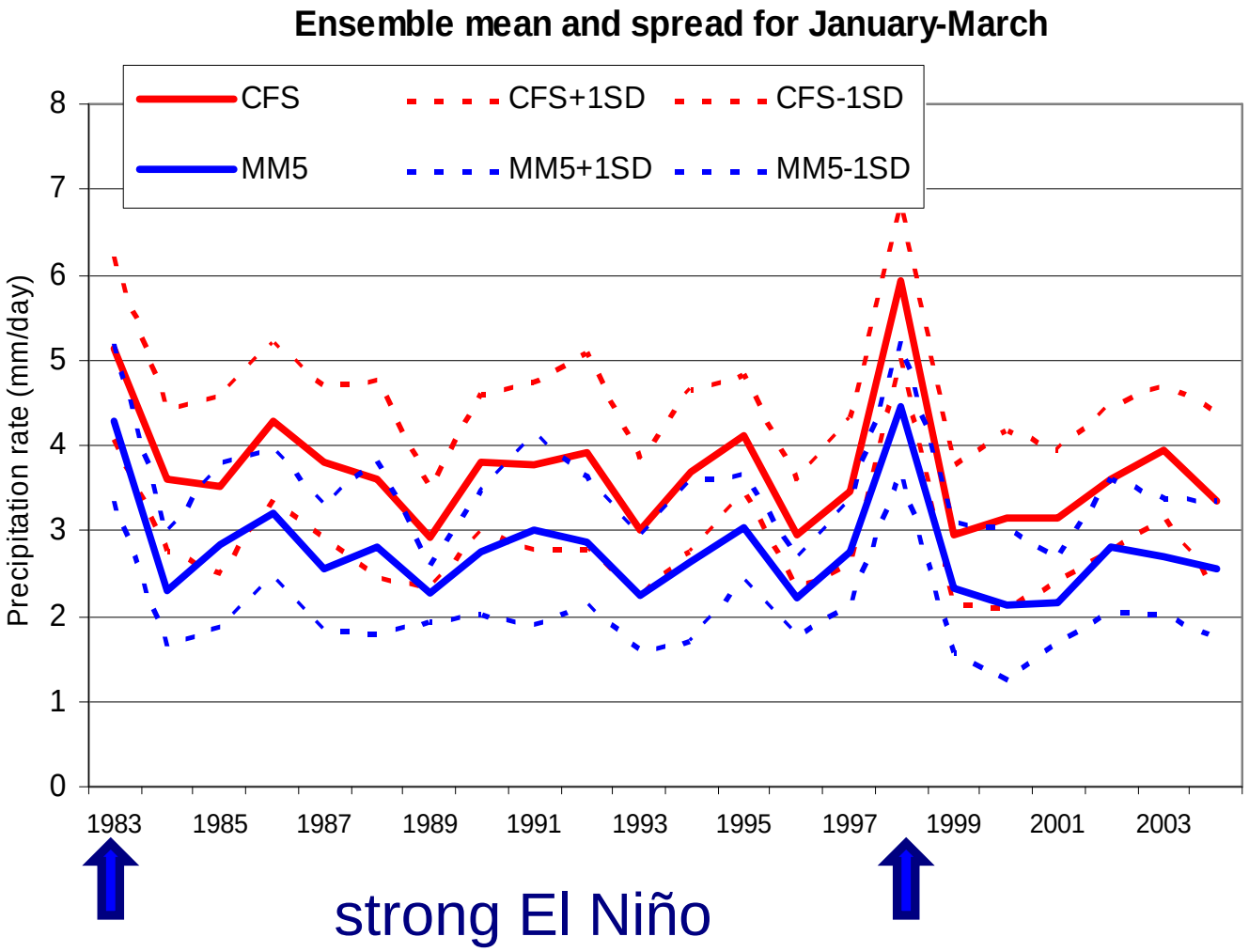
- Also influenced by ENSO, but precipitation is not as seasonal as California.
- No significant terrain features though coastal effects can be important.



Observed and ensemble mean January-March precipitation for Florida



As with California, ensemble spread is similar for the global regional models

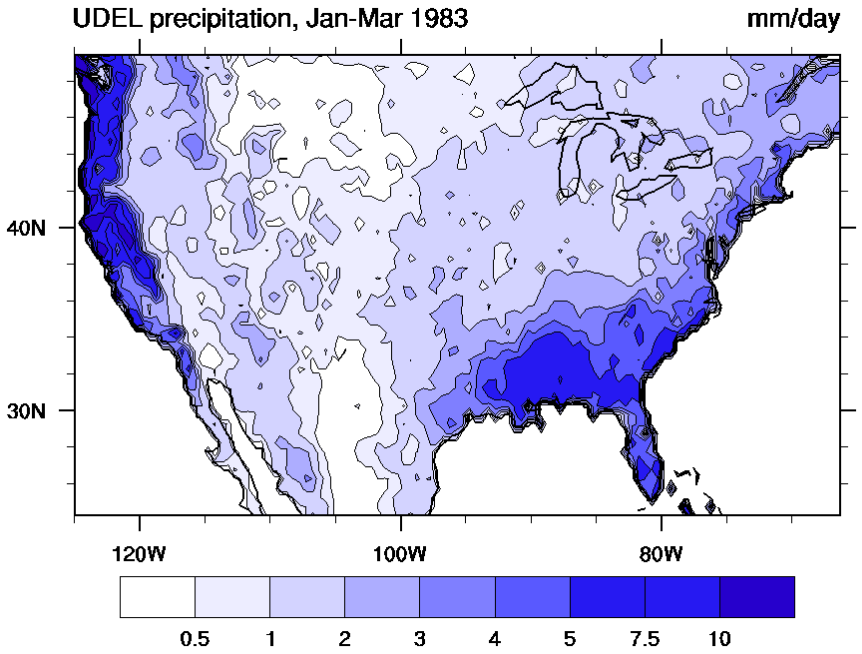


Predicted January to March precipitation for two strong ENSO events

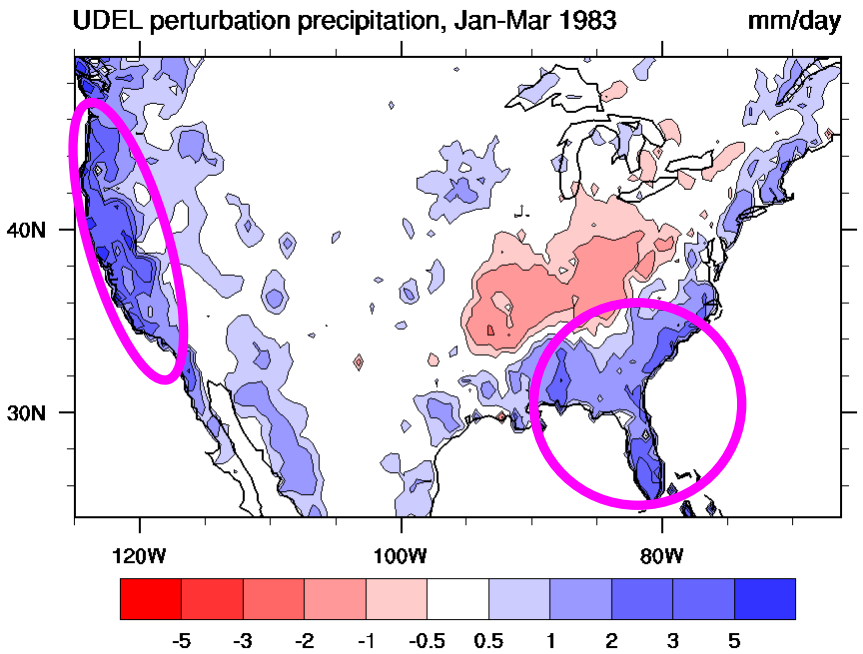
- Precipitation for 1982-83 and 1997-98 events.
- Look at both predicted precipitation and anomalies:
  - Model anomalies are from each model's own climatology for those months.
  - Results are averaged over all 15 ensemble members for both CFS and MM5.

January-March 1983 observed precipitation

Precipitation

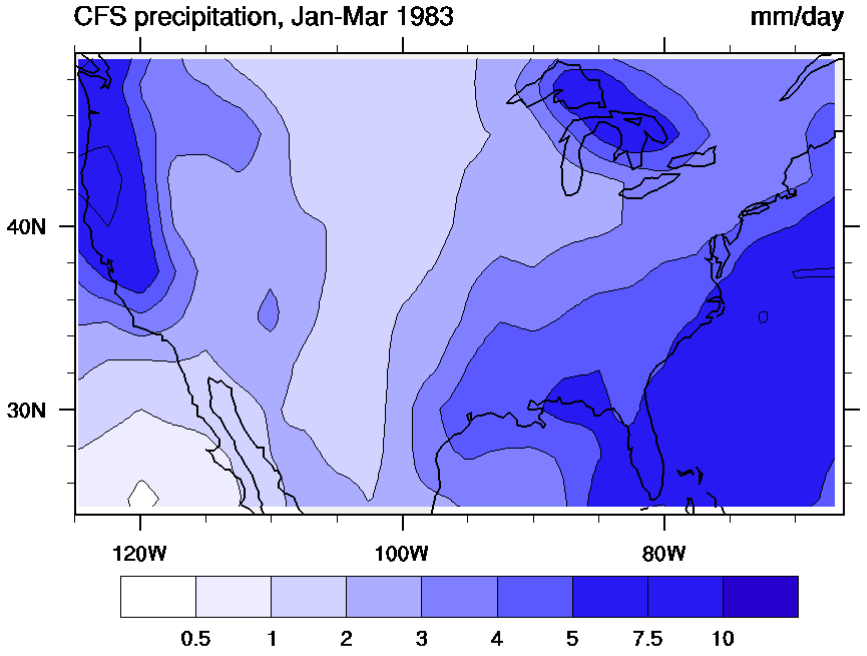


Anomaly

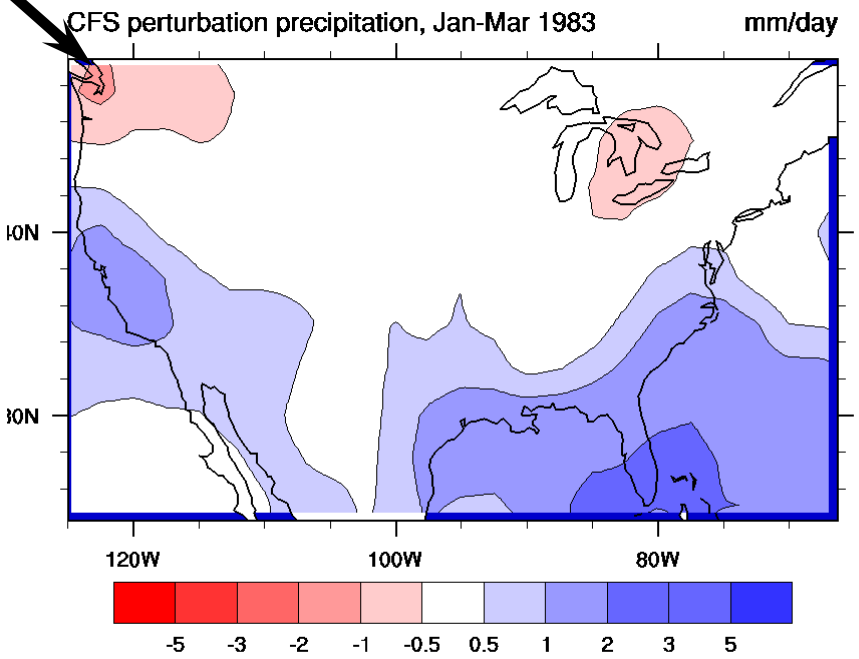


January-March 1983, global model (CFS)

Precipitation

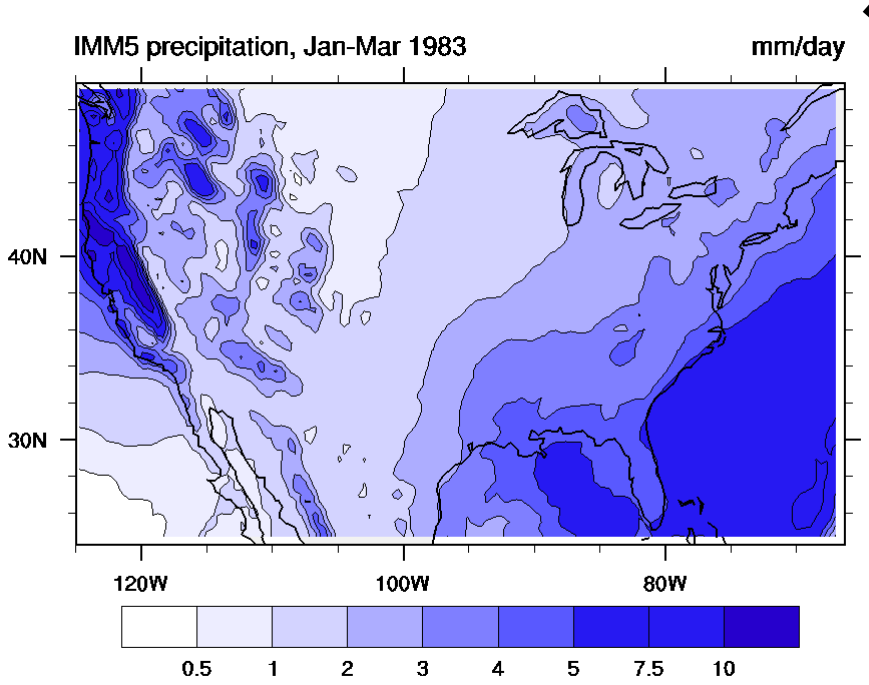


Anomaly

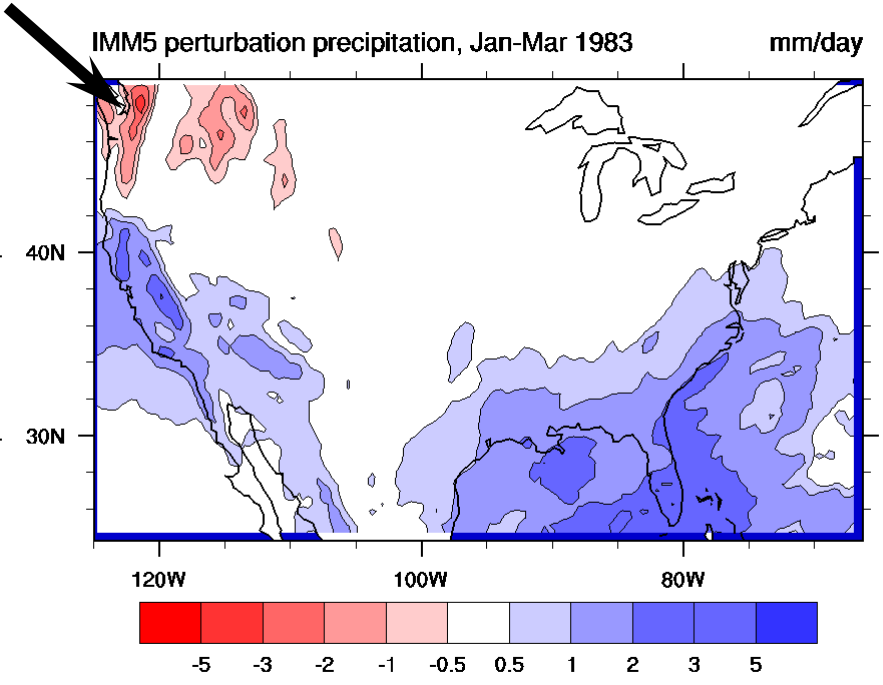


January-March 1983, regional model (MM5)

Precipitation

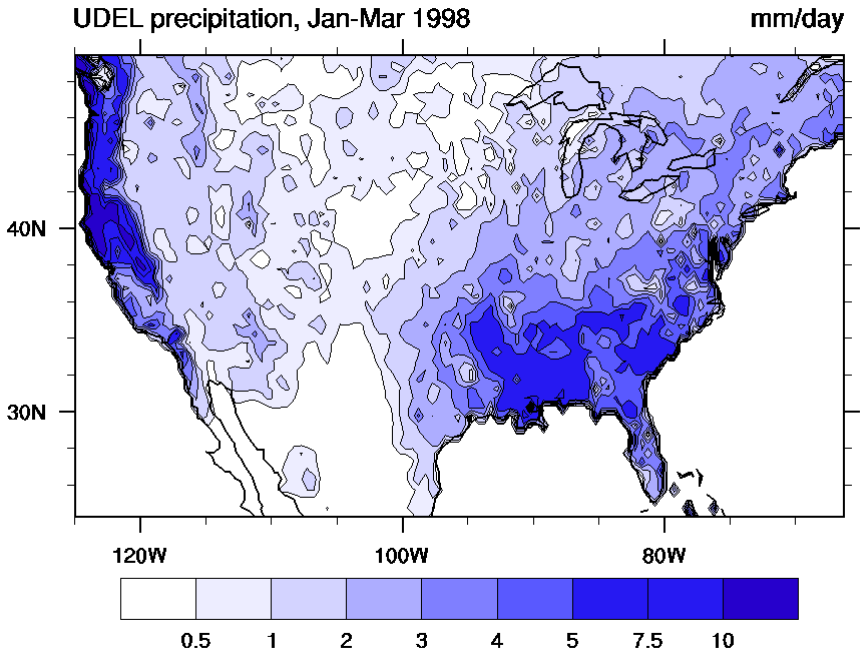


Anomaly

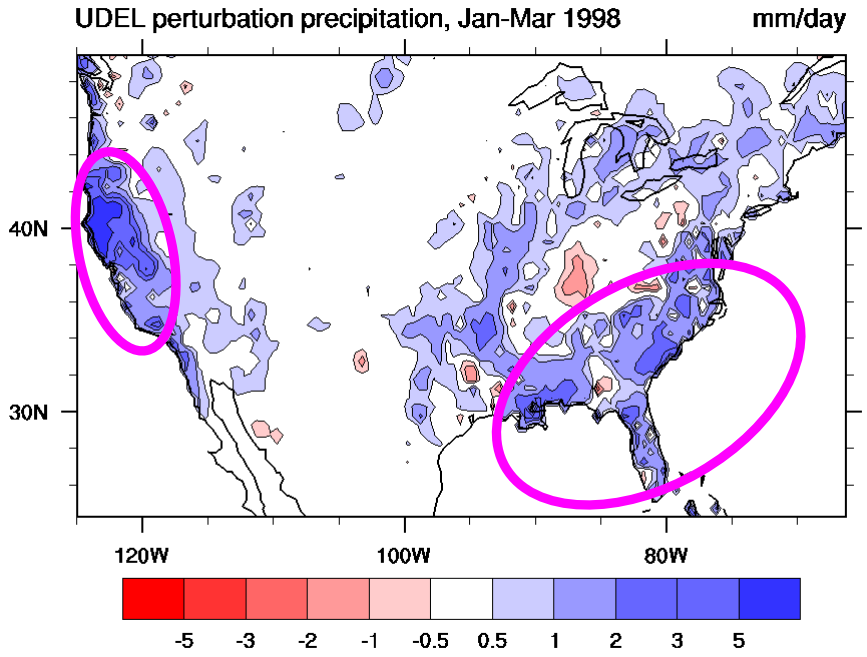


January-March 1998 observed precipitation

Precipitation

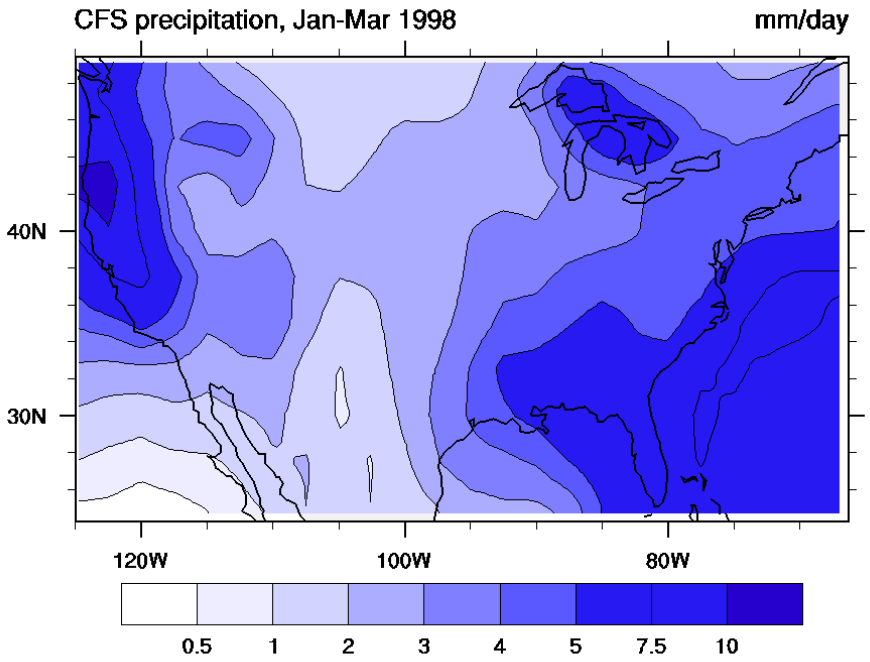


Anomaly

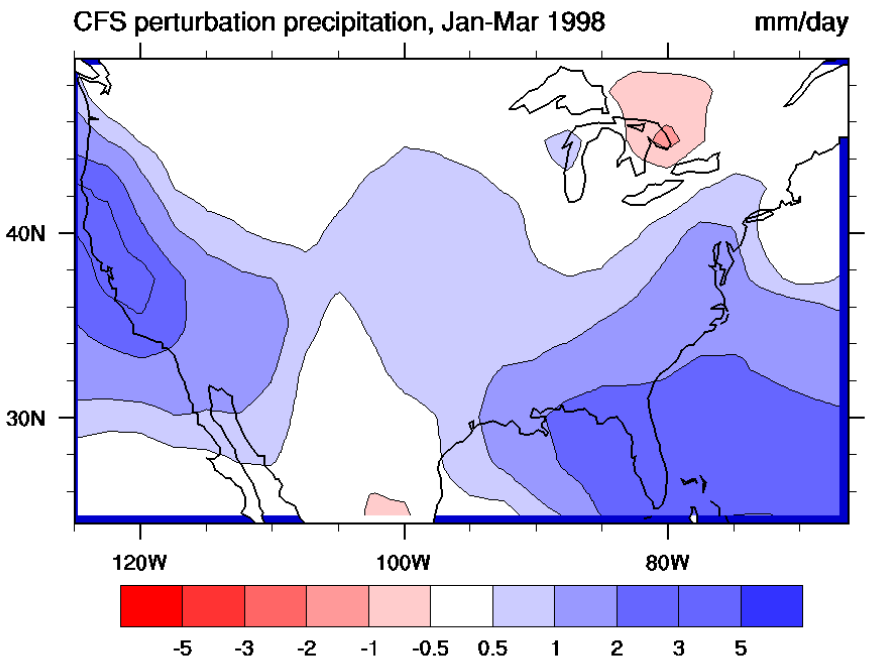


January-March 1998, global model (CFS)

Precipitation

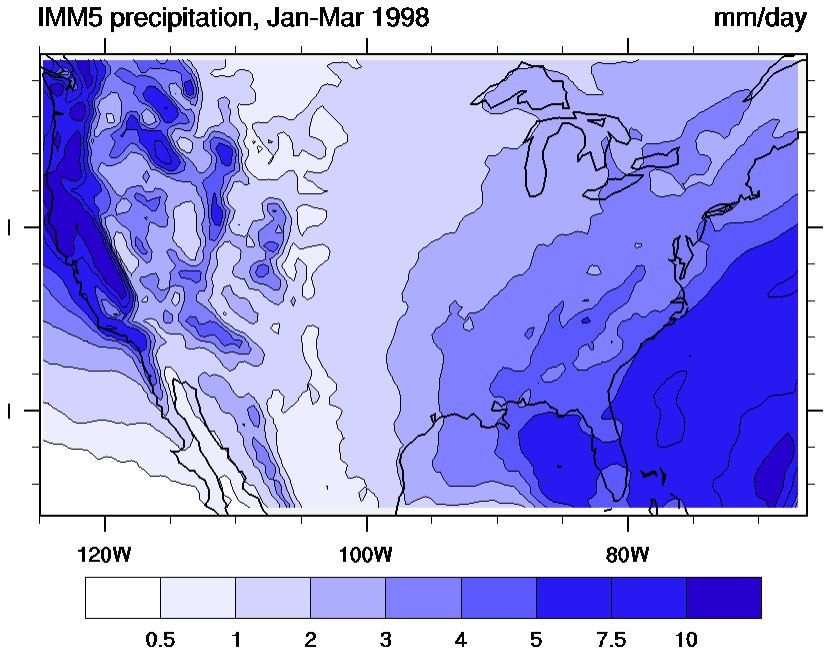


Anomaly

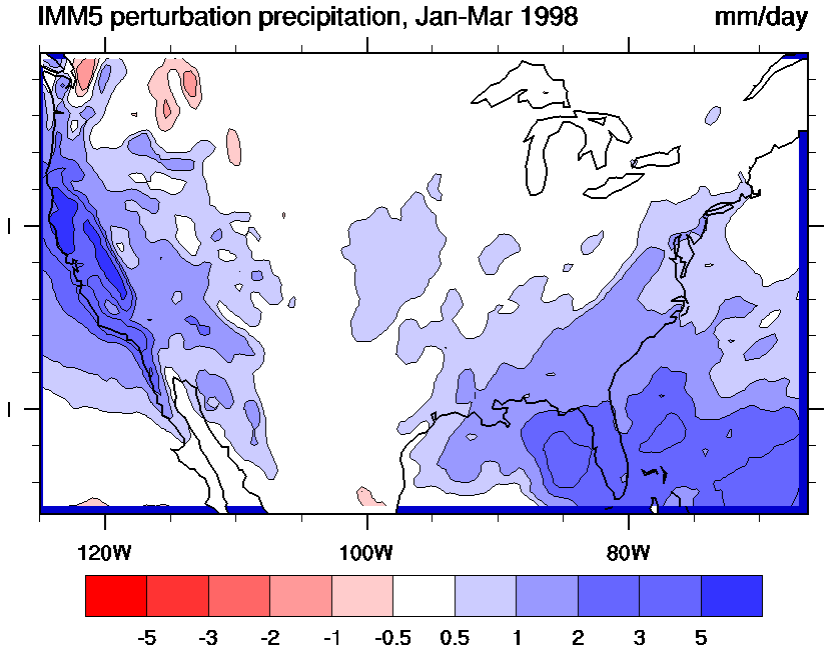


January-March 1998, regional model (MM5)

Precipitation



Anomaly



Some preliminary findings

- **Status:** Downscaled ensembles of seasonal projections from the NCEP CFS global coupled model are complete for some of the regional models.
- The results from MM5 give a true **downscaling**: they follow the large-scale features of the global model.
  - Area mean results are similar but there is more spatial detail.
  - As with CFS, the best skill is for strong El Niño events.
  - The downscaled results better reflect the observed distribution of precipitation intensity (not shown here).
  - **Skill ultimately is tied to the ability of the global model to reproduce the large-scale flow.**

Thank you!

For more information:

Web site:

http://rcmlab.agron.iastate.edu/mred

Mail list:

http://mesonet.agron.iastate.edu/mailman/listinfo/mred

Email me:

rwarritt@bruce.agron.iastate.edu

Or just Google us!