Preliminary Findings from Model Inter-comparisons of the MRED Project

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Outline

- Overview of model comparisons
- Locations of improved skill with downscaling
- Benefits of a multi-model ensemble
- A new skill metric
- Effects of ensemble size on skill

(These are preliminary results!)

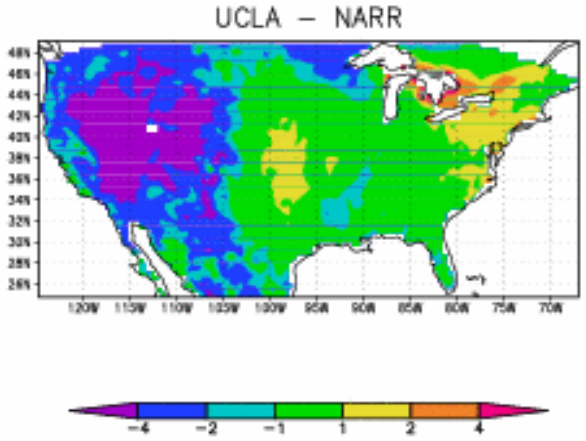
Multi-RCM Ensemble Downscaling Project (MRED)

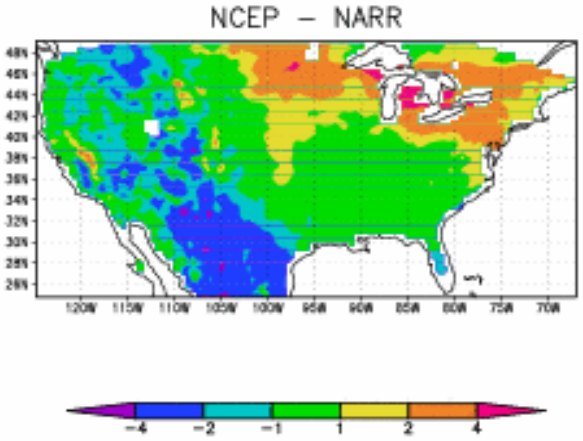
ECPC is host for gathering data

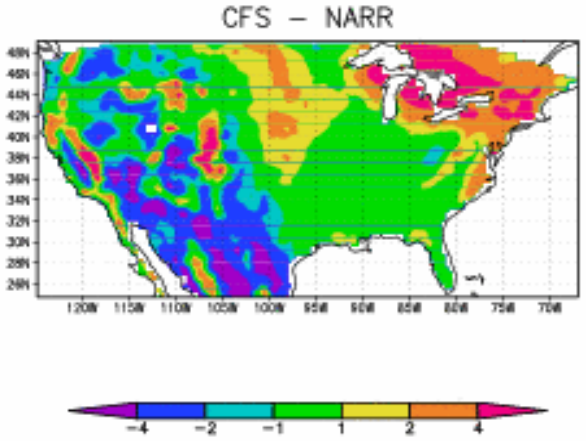
To Date (out of 8 centers):

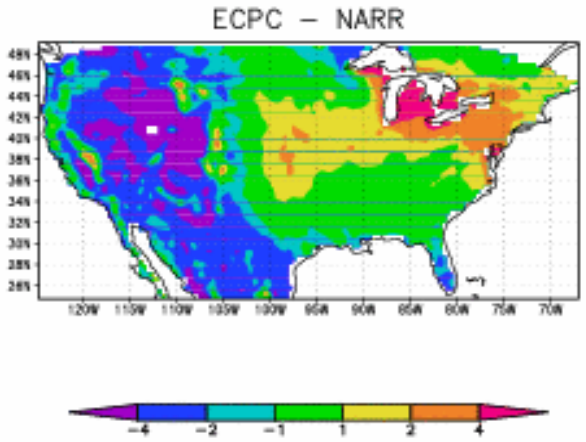
- UCLA has uploaded 5 members from 1983-2003 (ETA)
- Iowa State has uploaded 5 members from 1983-2003 (MM5)
- ECPC has uploaded 10 members from 1983-2008 (RSM)
- NCEP has uploaded 15 members from 1983-2008 (RSM)

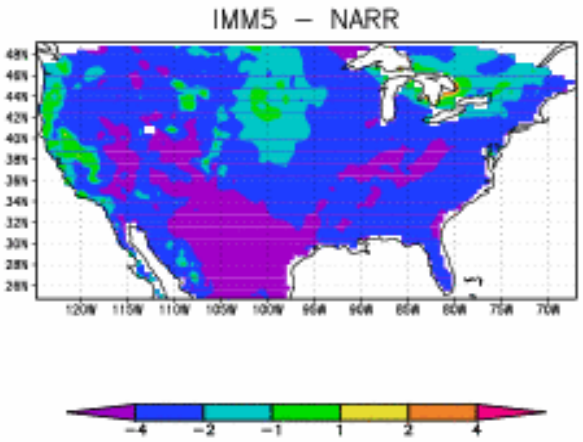
Surface Temperature Bias (1983-2004 JFM)





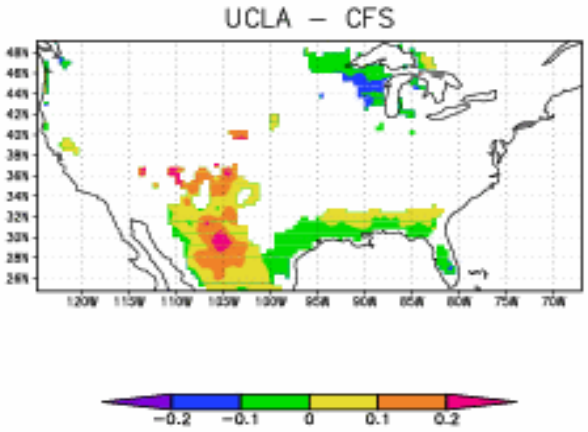


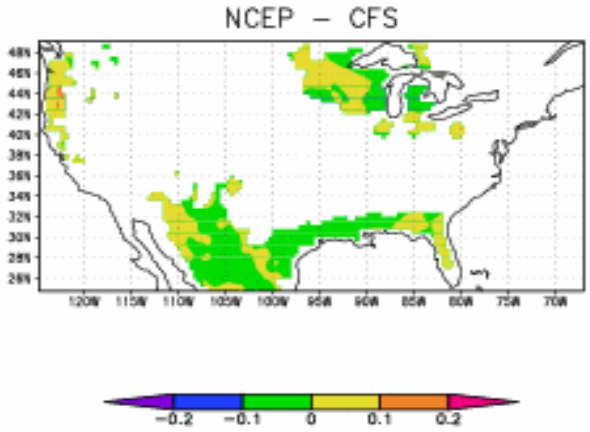


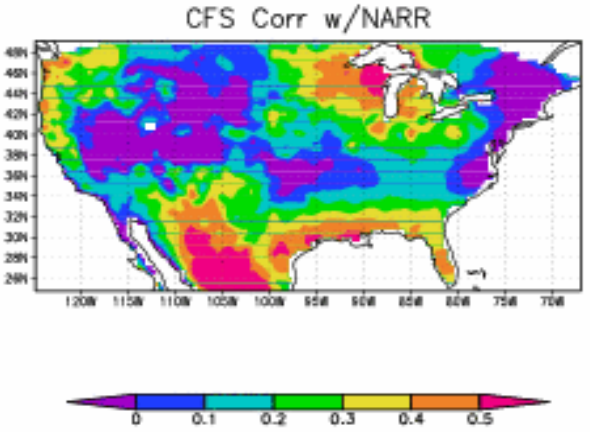


-These are differences between models and NARR
-5 members for each
-all models are colder than NARR in the west
-the warm area around the great lakes could be artificial

Masked Temporal Correlation of T sfc with NARR

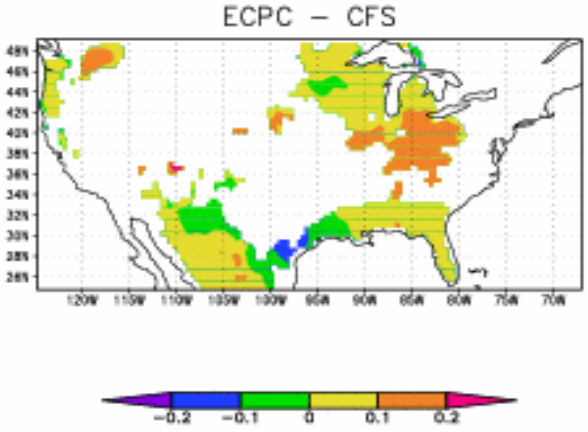


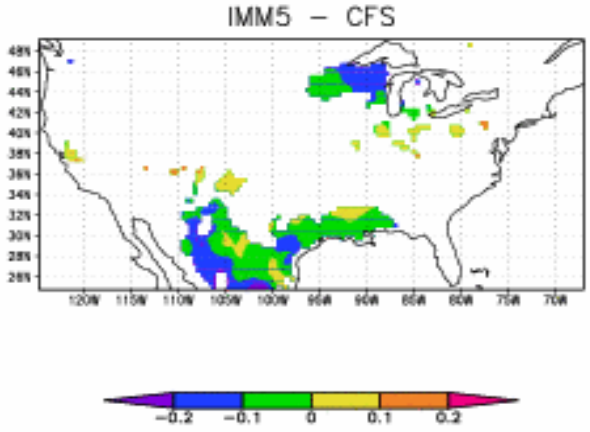




Differences with CFS

-1983-2004 JFM



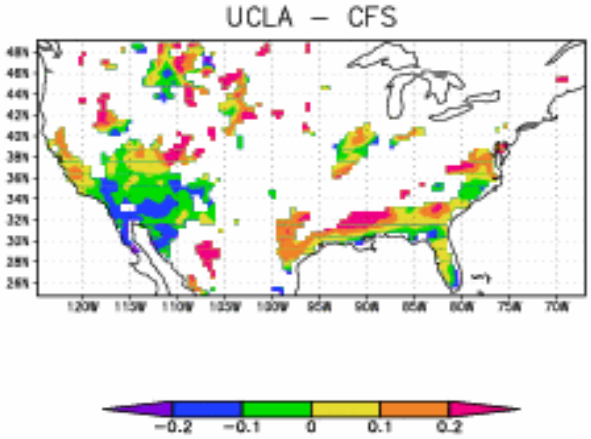


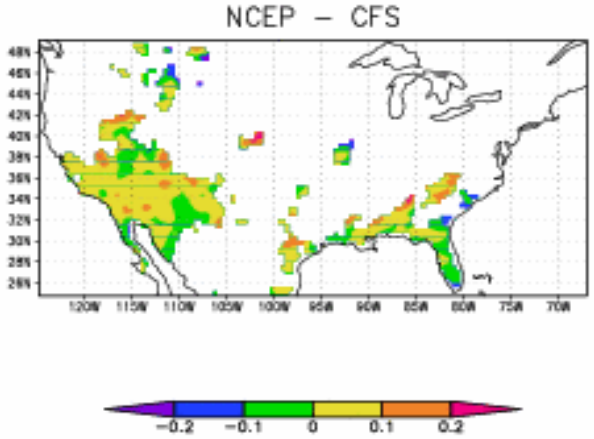
-5 members each

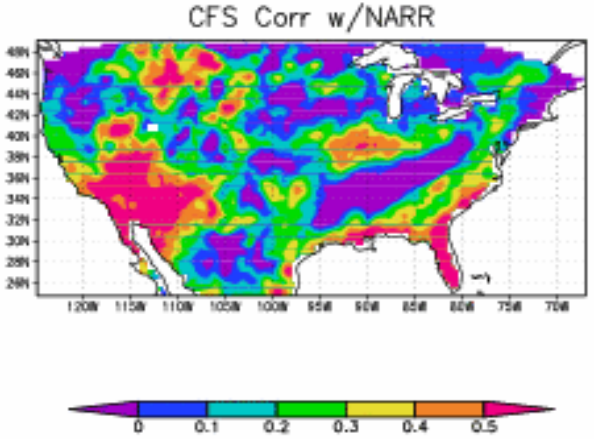
-Masked with skill > 0.3

-all models have skill > 0.3 in Texas/Mexico

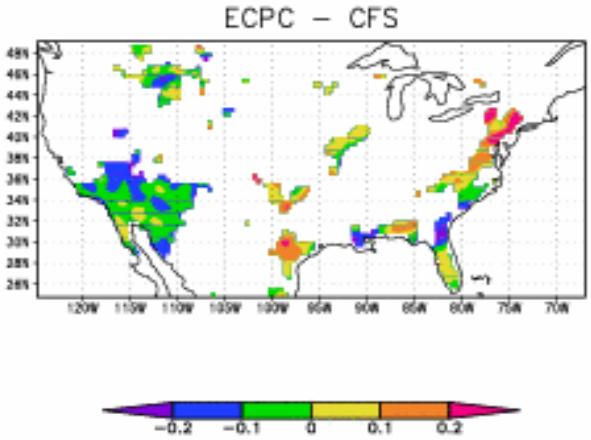
Masked Temporal Correlation of Precip with NARR

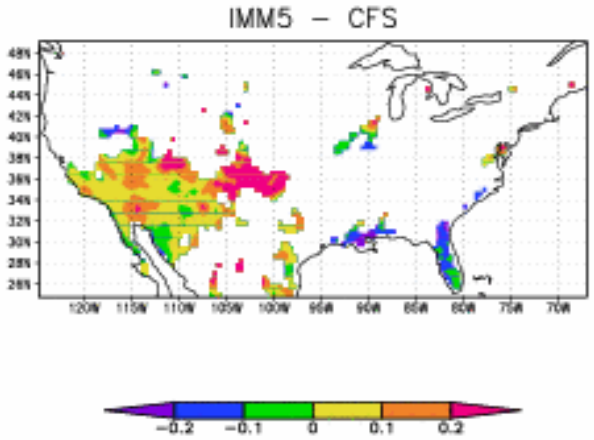






Differences with CFS





-1983-2004 JFM

-5 members each

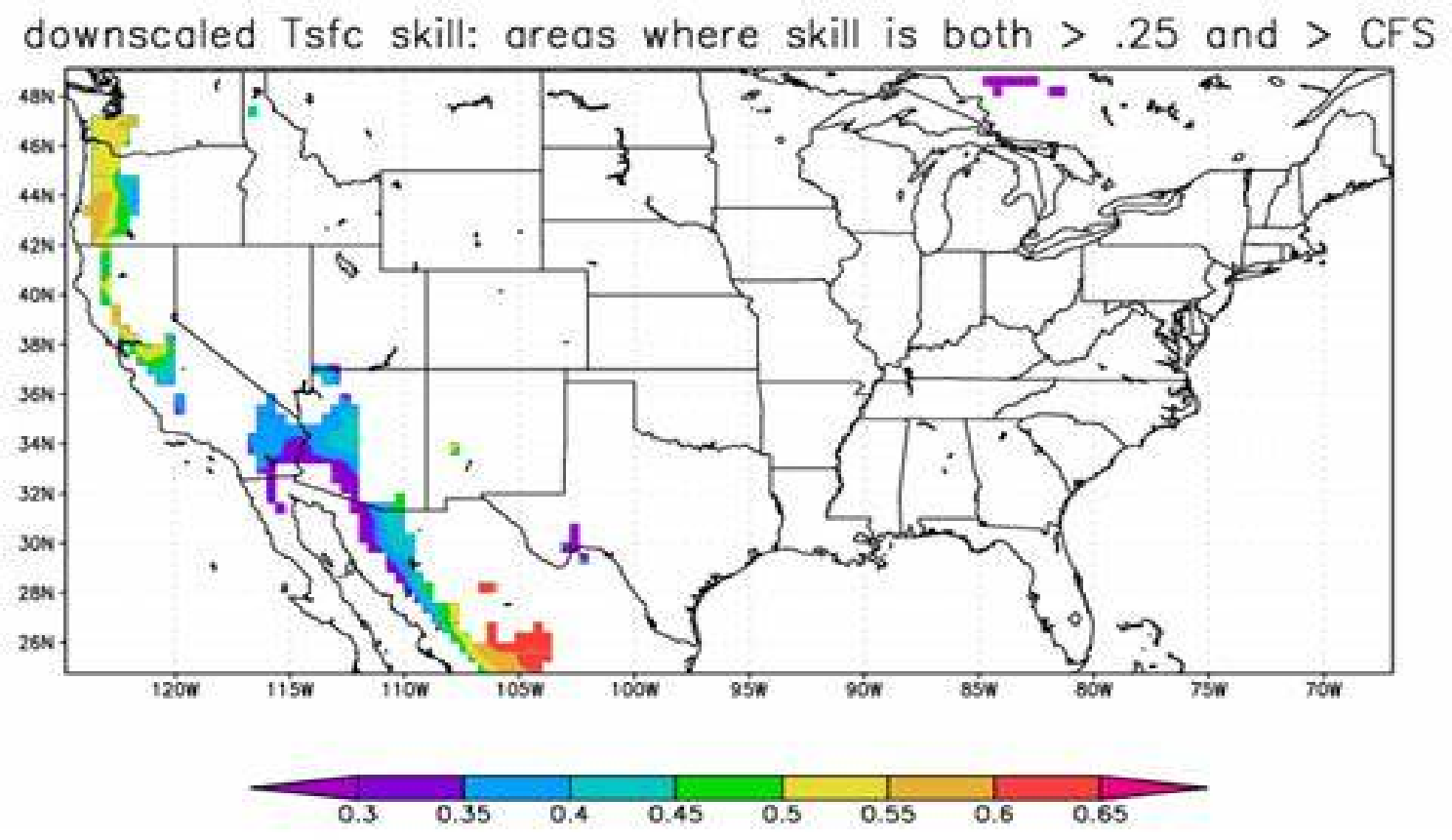
-Masked with skill > 0.3

ECPC RSM / NCEP RSM Comparison

	ECPC RSM	NCEP RSM
Convection	RAS	SAS
Land Surface	Noah	OSU
SW Radiation	Chou (94)	Hou (02)
LW Radiation	Chou (96)	Chou (99) / Fels & Schwarzkopf(75)
Orography	Smoothed	Mean
Ozone	Climatology	Production/reduction rates by NASA
PBL	Hong & Pan (96)	Hong & Pan (96)
Gravity Wave Drag	Alpert et al (88)	Alpert et al (88)
Liquid Water	Iacobellis & Sommerville	Ferrier

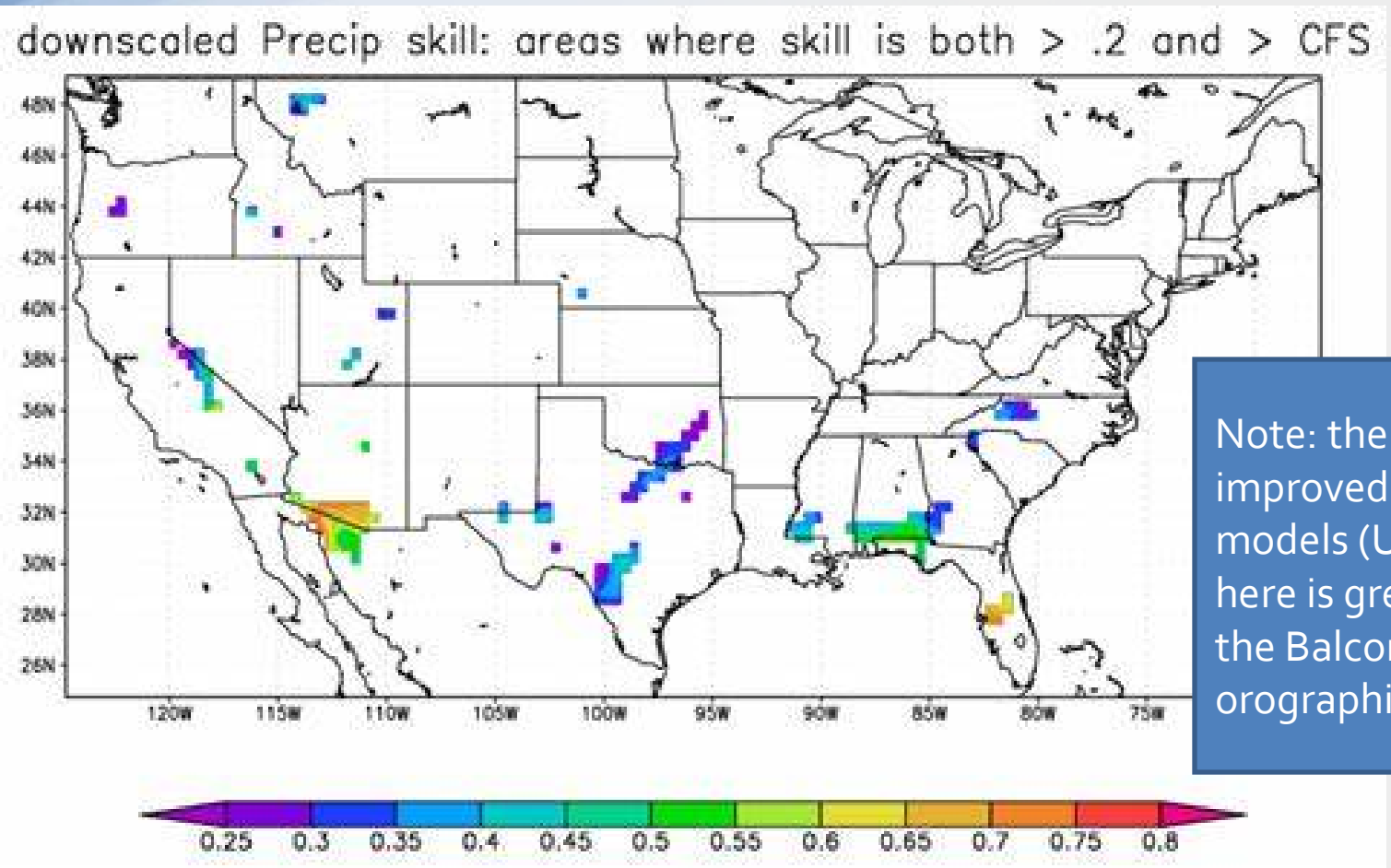
The next part of the talk will focus on the ECPC and NCEP RSMs, since they have more members and a longer time record.

Areas of improved Tsfc skill with downscaling



Areas where **both** the NCEP and ECPC 10 member ensembles have Tsfc skill (temporal correlation with NARR) greater than 0.25 **and** greater than CFS skill.

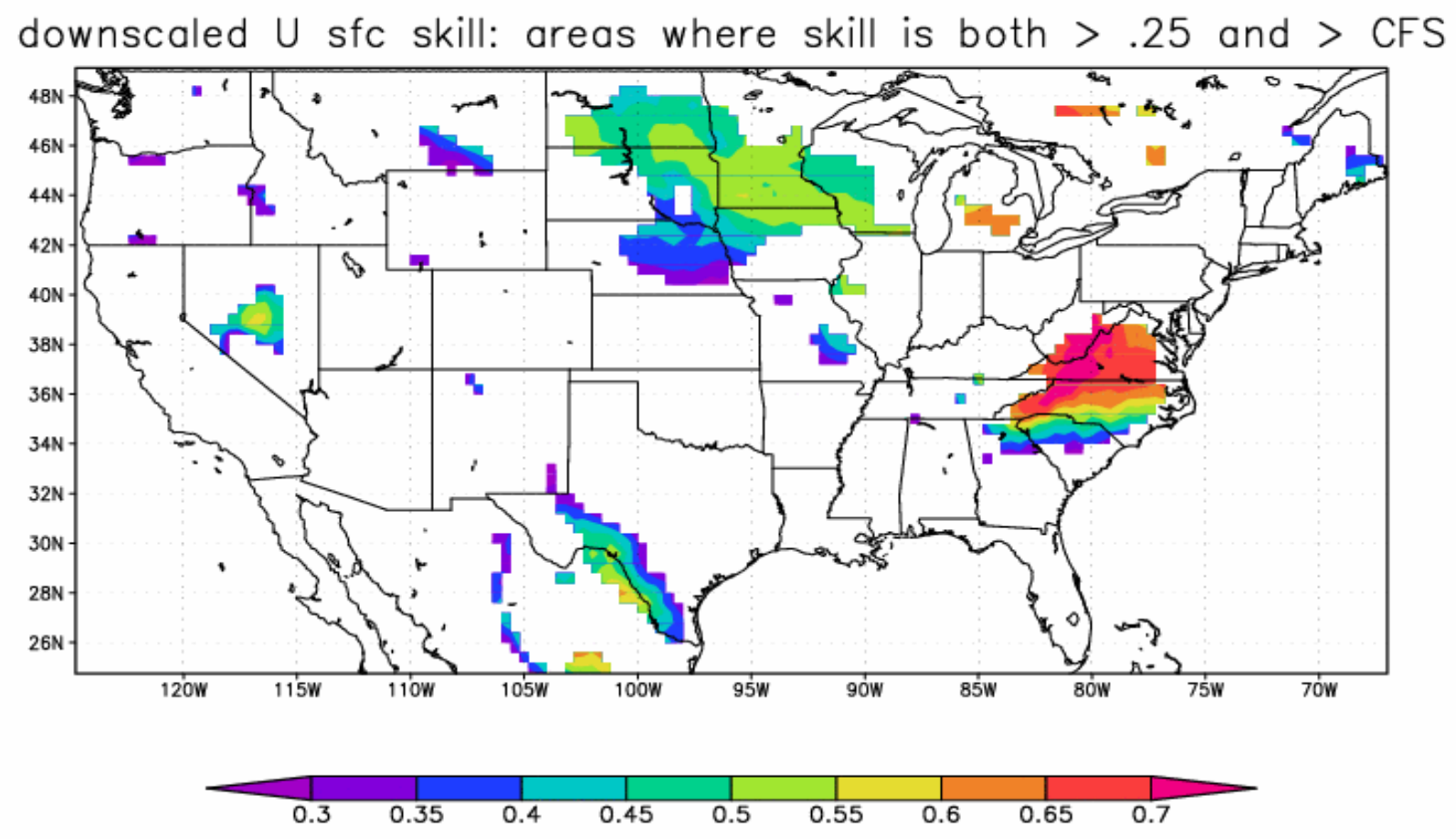
Areas of improved Precip skill with downscaling



Note: the region in TX is also improved in both 5 member models (UCLA&ISU). Precip here is greatly influenced by the Balcones Escarpment (an orographic feature).

Areas where **both** the NCEP and ECPC 10 member ensembles have Precip skill greater than 0.2 **and** greater than CFS skill.

Areas of improved U sfc skill with downscaling

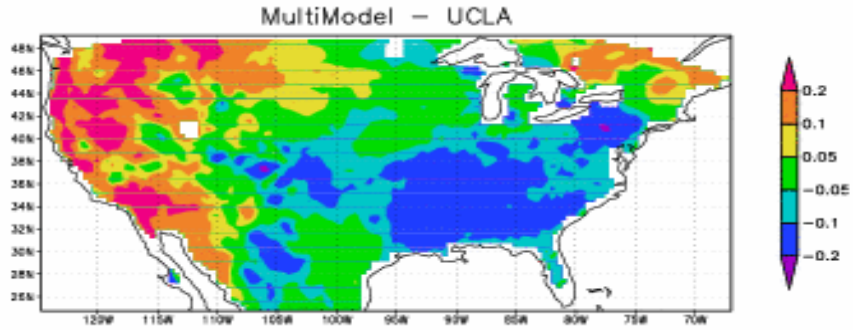


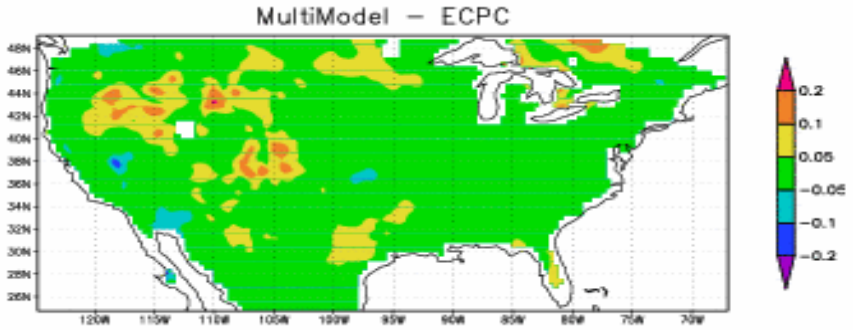
Areas where **both** the NCEP and ECPC 10 member ensembles have U sfc skill greater than 0.25 **and** greater than CFS skill

Multi-Model Ensemble

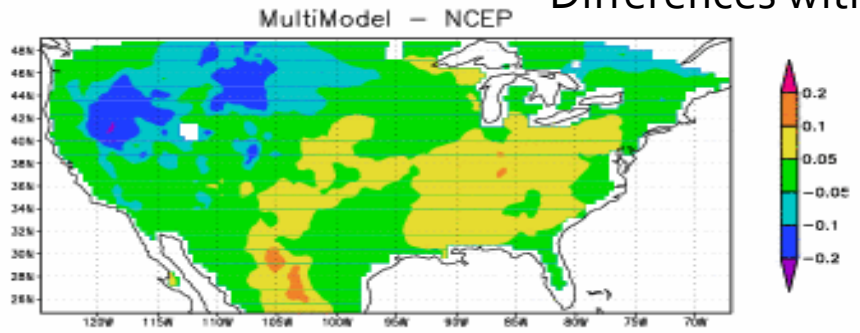
- A simple multi-model ensemble was created by:
  - Finding the anomaly for each member, based on the climatology for that model. (For this example, we took Tsfc anomalies from each of 15 members of the NCEP RSM, 10 members of the ECPC RSM, and 5 members of the UCLA ETA run).
  - Each anomaly was then normalized by the standard deviation (of Tsfc, in this case) from its respective model.
  - The normalized anomalies were averaged to produce a multi-model forecast of anomalies only.

Multi Model (Tsfc correlation with NARR)

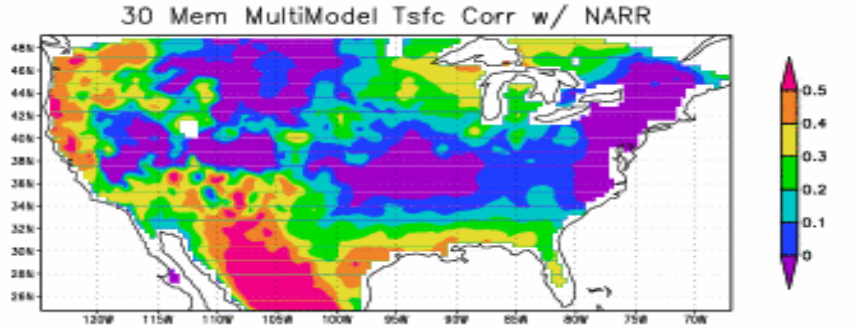




Differences with multi-model



The multi-model ensemble has skill similar to the individual regional models.

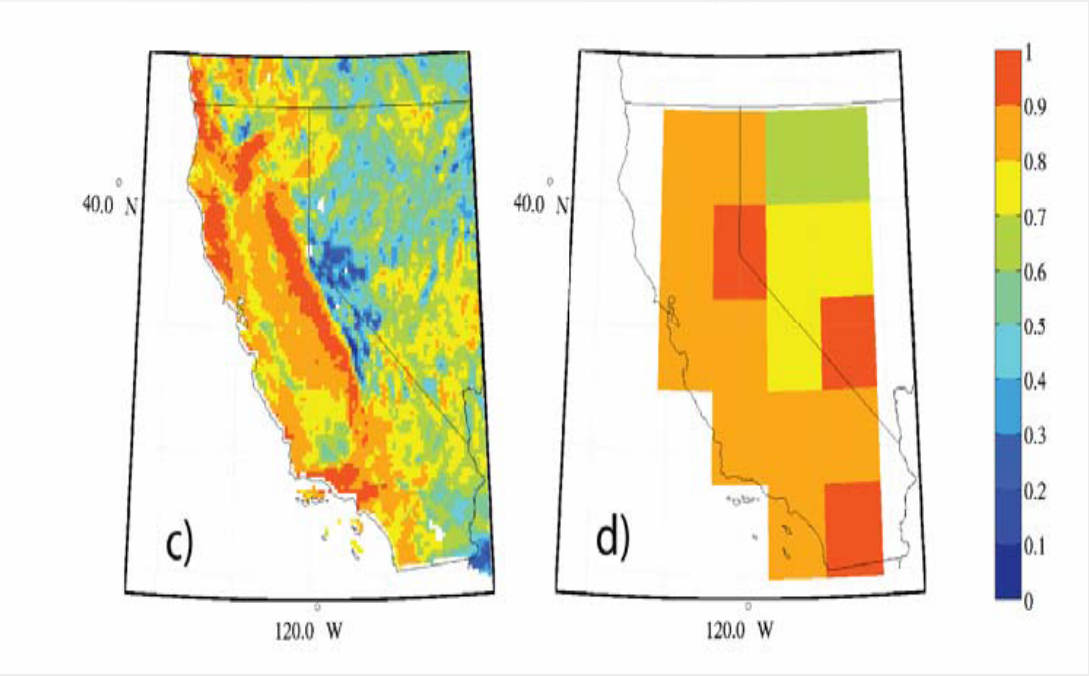


Multi-model Correlation

In a broad sense, it averages the skill of the individual models.

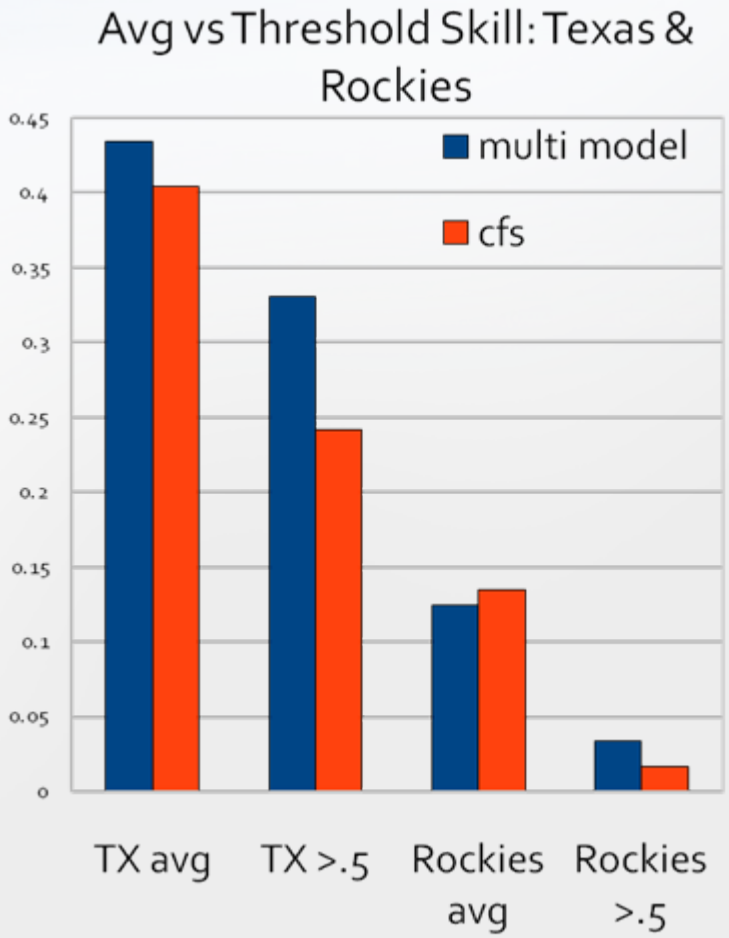
Threshold Skill Metric

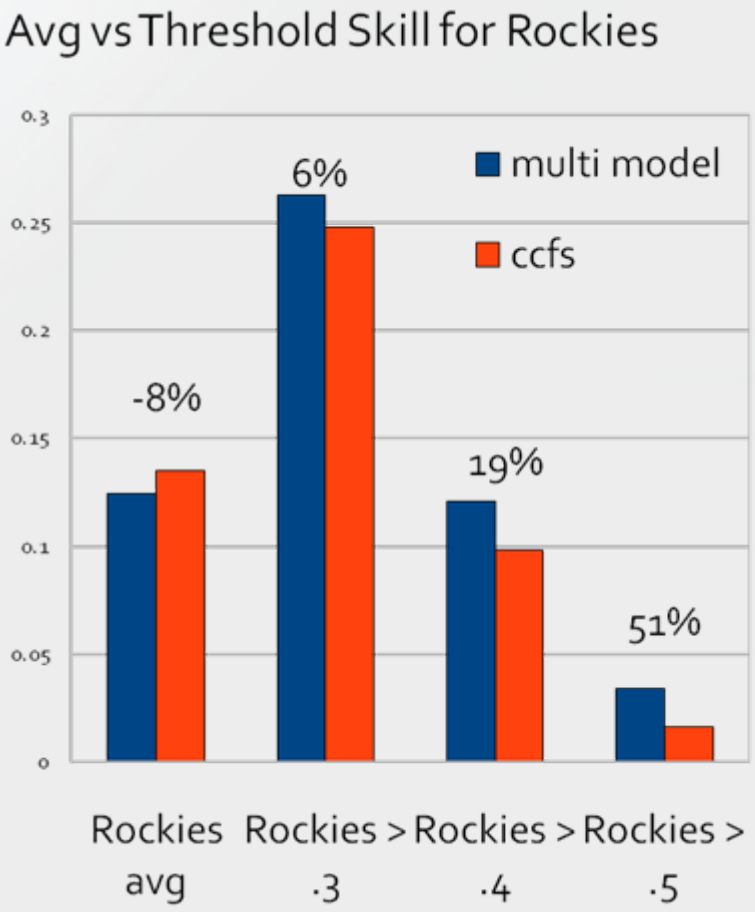
- Instead of looking at the average skill over an area, we consider the percent of that area with skill greater than a given threshold.



- Differences between average skill and the threshold skill:
  - Threshold skill only measures the amount of good skill (it does not penalize for a small area with very poor skill)
  - Threshold skill does capture small areas with very high skill (important for downscaling)

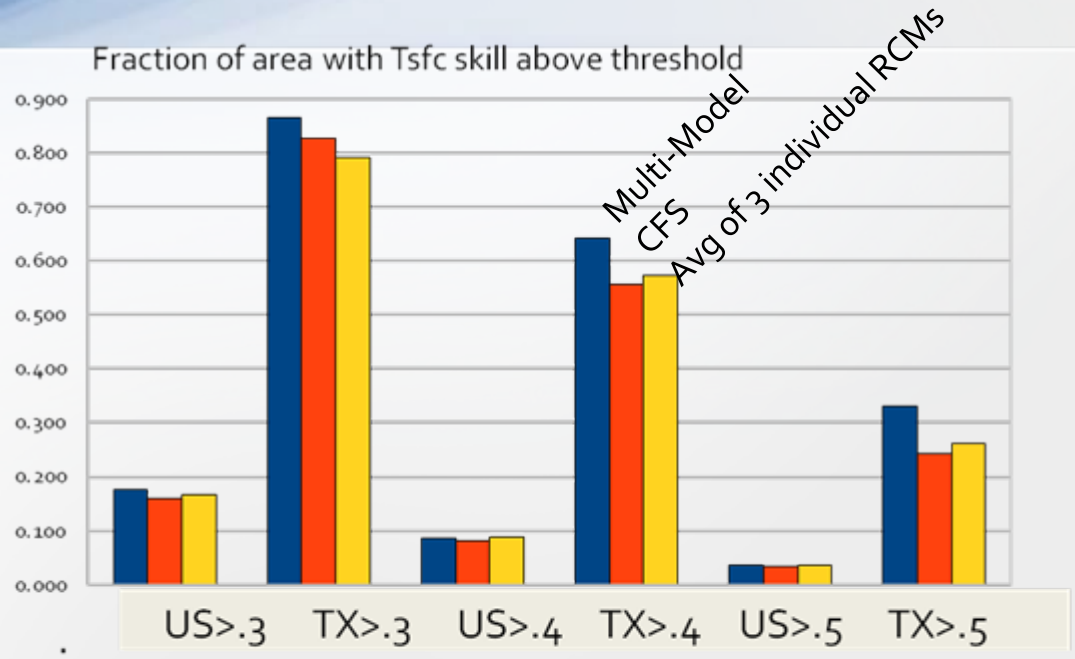
More on Multi-Model & Threshold Skill

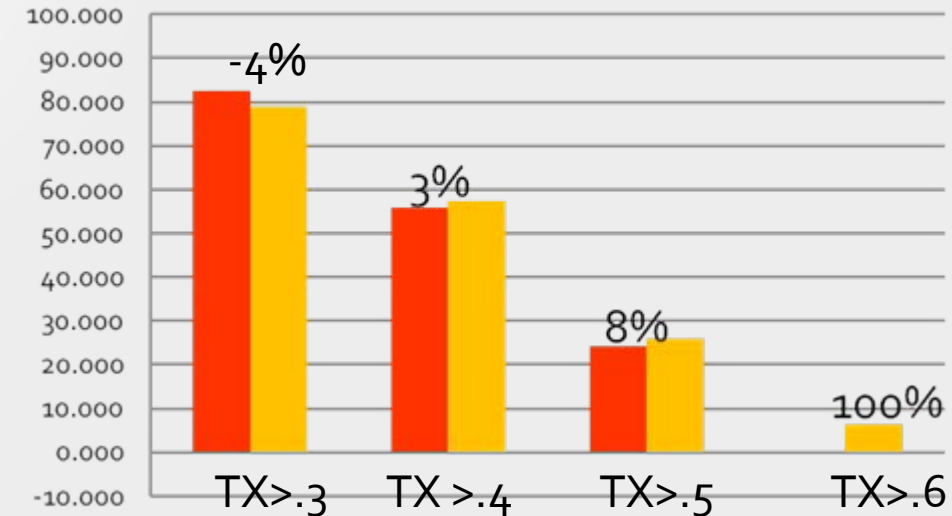




In Texas the RCMs show the better skill with both metrics.
In the Rockies the RCMs only show a better metric when considering the threshold.
In the Rockies the improvement of the RCMs over the CFS increases with higher threshold.

The Multi-Model Ensemble (Tsfc skill)



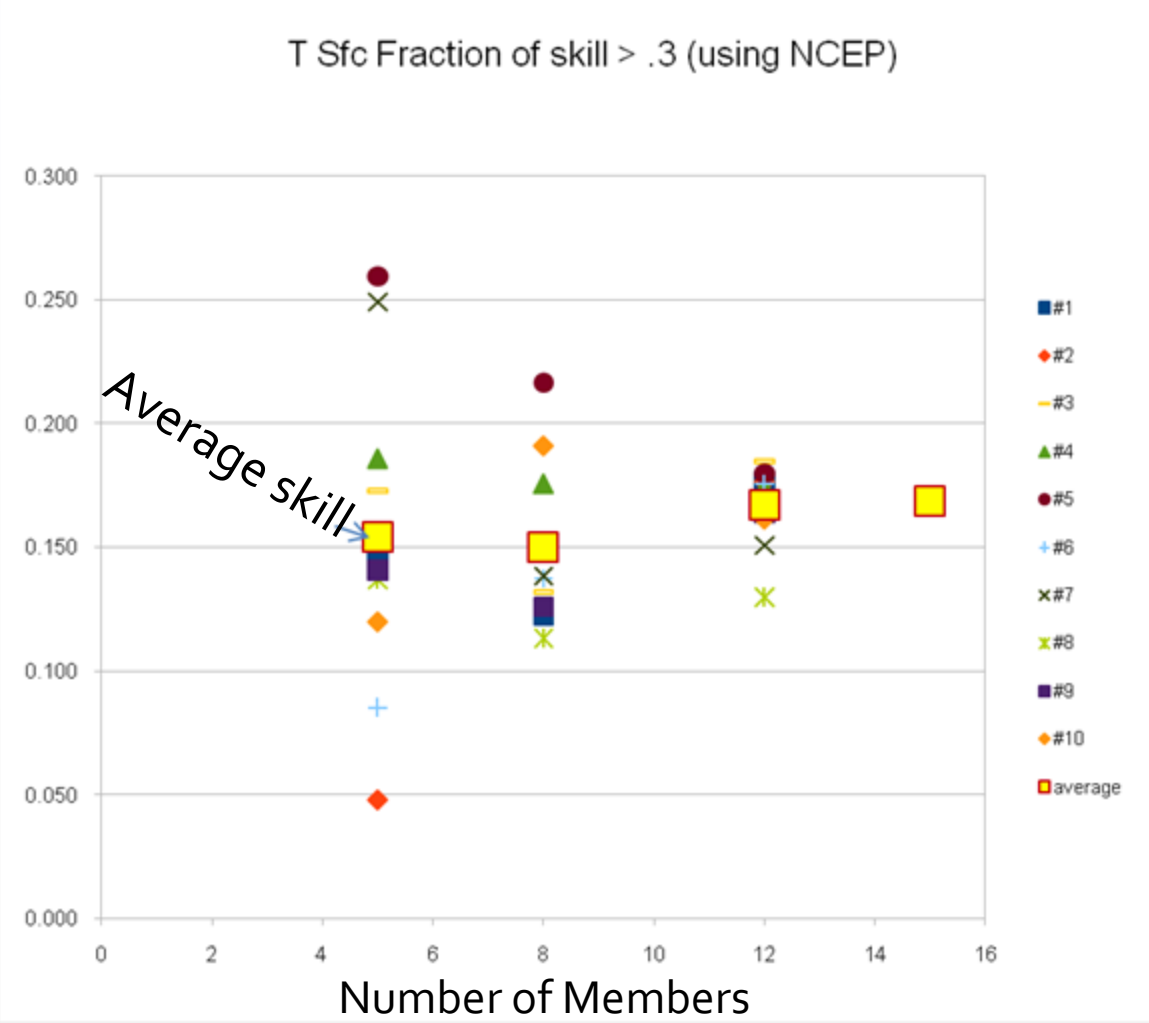


- When looking at the entire US, there are no significant differences in Tsfc skill between CFS, downscaling, and the multi-model results.
- When looking at Texas, the multi-model is significantly better than the CFS and the individual RCMs.
- Also in Texas, the RCMs are better than the CFS for high skill levels.

Ensemble Size

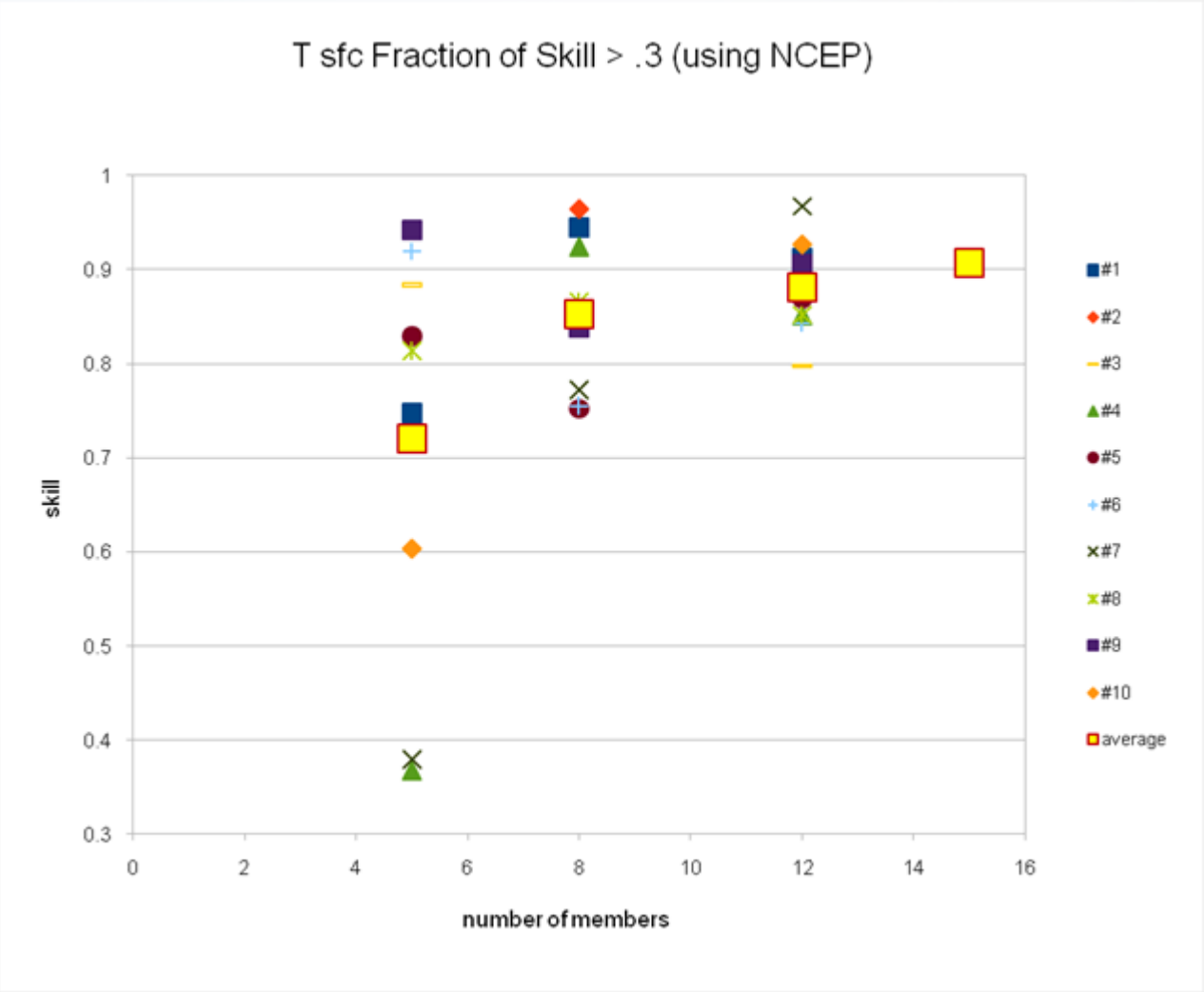
- Since different centers are producing ensembles of different sizes, it is important to address the effect of ensemble size.
- To do this, we use the NCEP RSM (which has 15 members) and randomly select smaller ensembles from it.
- We consider the fraction of land area with surface temperature temporal correlation over a given threshold.

The Effect of Ensemble Size: Entire US



- This is the fraction of land area (over the entire US) with skill greater than 0.3
- There is no significant difference between the average skill of the different ensemble sizes.
- The reduction in spread with ensemble size is significant.

The Effect of Ensemble Size: Texas/Mexico

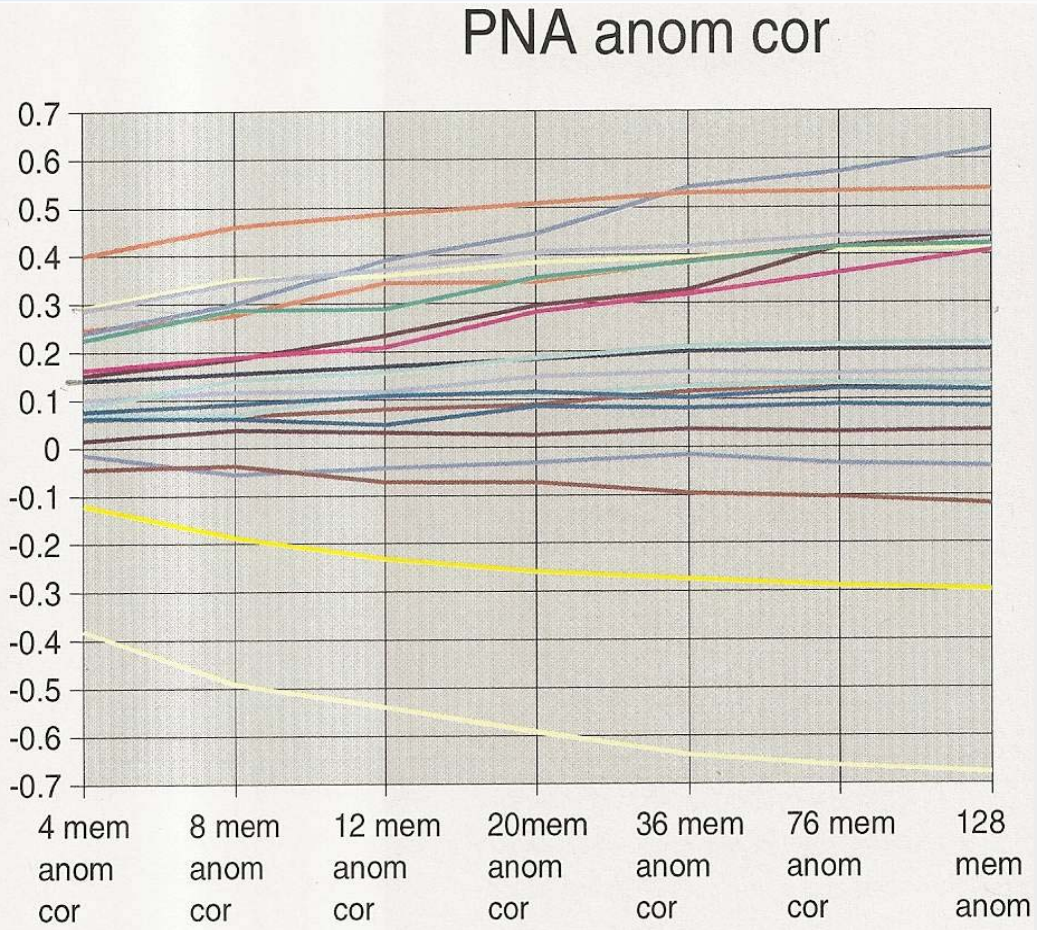


- Texas has large areas of skill > .3
- In Texas the increase in skill with ensemble size **is** significant
- Increasing ensemble size improves skill, only if there is some skill with a small ensemble.

Conclusions

- The data from the MRED project is coming in, and we should soon have a large data set for studying the downscaling of seasonal forecasts.
- Preliminary comparisons suggest there are specific, limited areas that see an improvement in skill with downscaling.
- Increasing ensemble size or creating a multi-model ensemble only improve the forecast skill if there is skill in the initial global forecast.
- Some of the greatest improvement in downscaling can be seen when looking at highest skill levels.

More on Ensemble Size



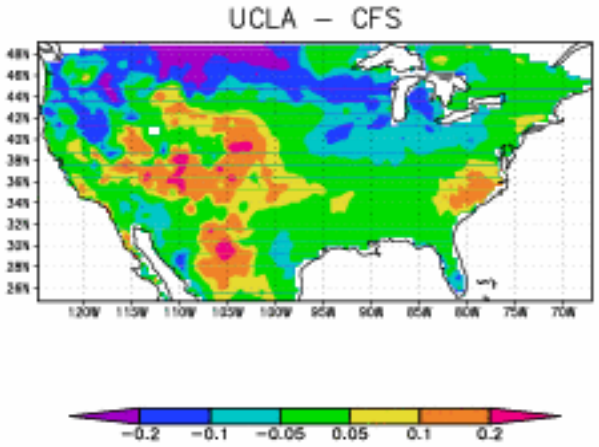
-1000 different combinations of ensembles were used to compute the spatial correlation of 500hPa height (using the bootstrap method).

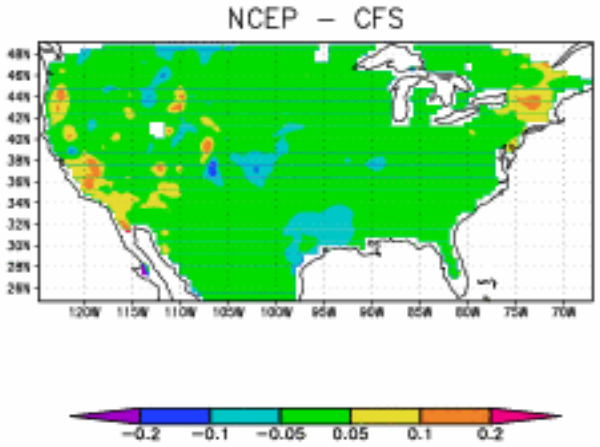
-Runs with initial (4 member) skill over a certain threshold increase with ensemble size, while runs with little initial skill do not.

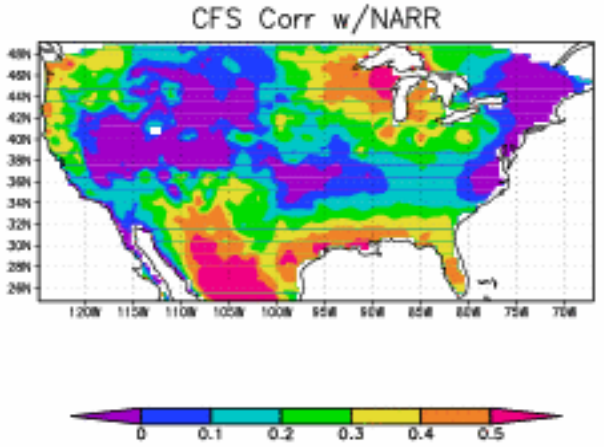
-The table shows that the variance of the 1000 anomaly correlations is reduced with ensemble size.

# members	8	12	20	36	76
skill variance	.064	.052	.041	.027	.019

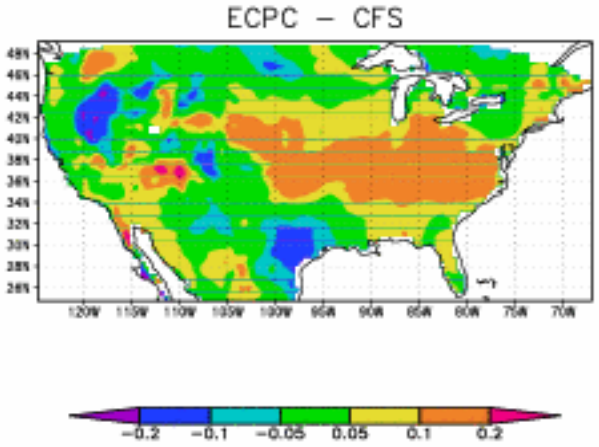
Temporal Correlation of T sfc with NARR

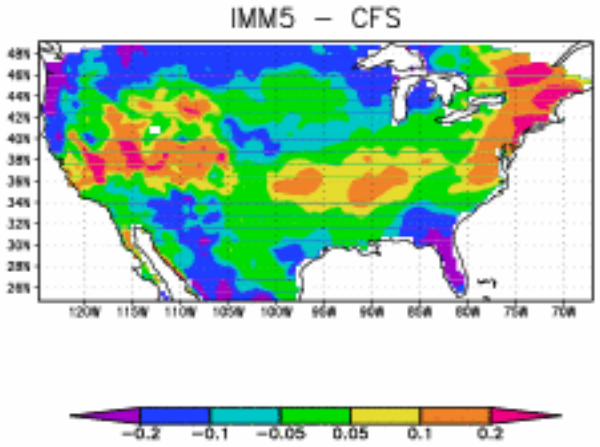






Differences with CFS



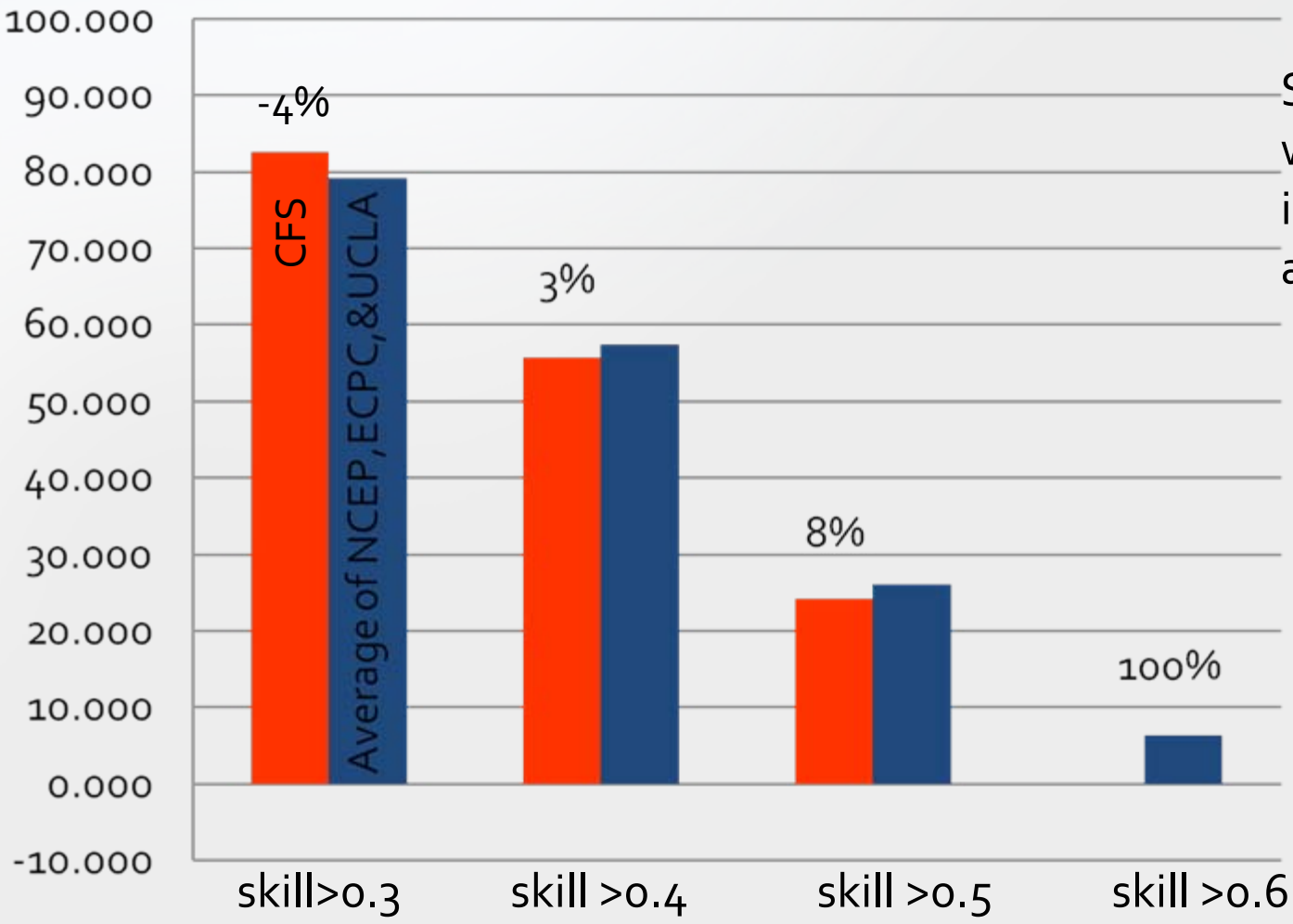


-1983-2004 JFM

-5 members each

-all models have skill in the Texas/Mexico region

Percent of Area (TX/Mexio) w/ Tsfc Skill > Threshold



Skill improvement with downscaling is most significant at high skill levels.