

Potential Improvement in North American Monsoon Forecasts Using Dynamically Downscaled Data

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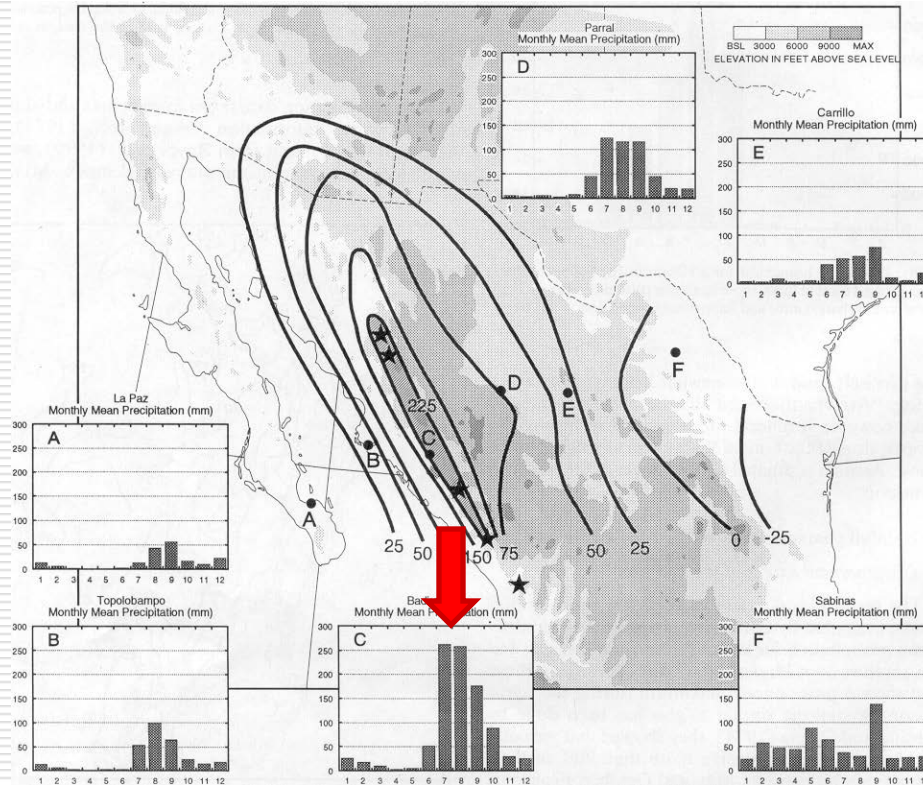


Presentation Outline

- Motivation:
 - Background on the North American Monsoon System
 - Importance in the Southwest U.S. and northwest Mexico
- Current NCEP monsoon seasonal projections
- Dynamical downscaled WRF-CFS reforecasts
- Improvements in climatology and interannual variability in WRF simulations
- Conclusions

Acknowledgements for data access: Jae-Kyung Schemm, Henry Juang, Matt Switanek, Ed Cook (LDEO) and Russ Vose, Richard Heim (NOAA)

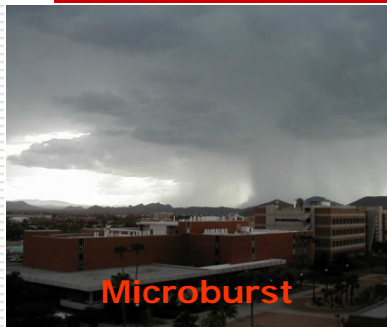
North American monsoon characteristics:



Average rainfall in western Mexico during summer monsoon (Douglas et al. 1993)

- Monsoon is a seasonal maximum in precipitation in northwest Mexico that progresses into Southwest U.S.
- Characterized by a rapid increase in thunderstorm activity in early summer.
- Thunderstorms largely driven by terrain forcing.
- Synoptic-scale forcing required for intense, organized convection.

Societal importance of the NAM:



Microburst



Flash flood



Landslide



Lightning



Dust storm



Wildfire

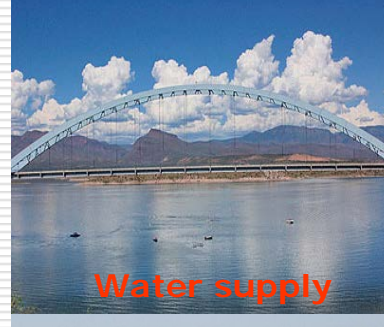
Severe weather hazard



Agriculture



Ecosystems



Water supply



Water demand



Power use



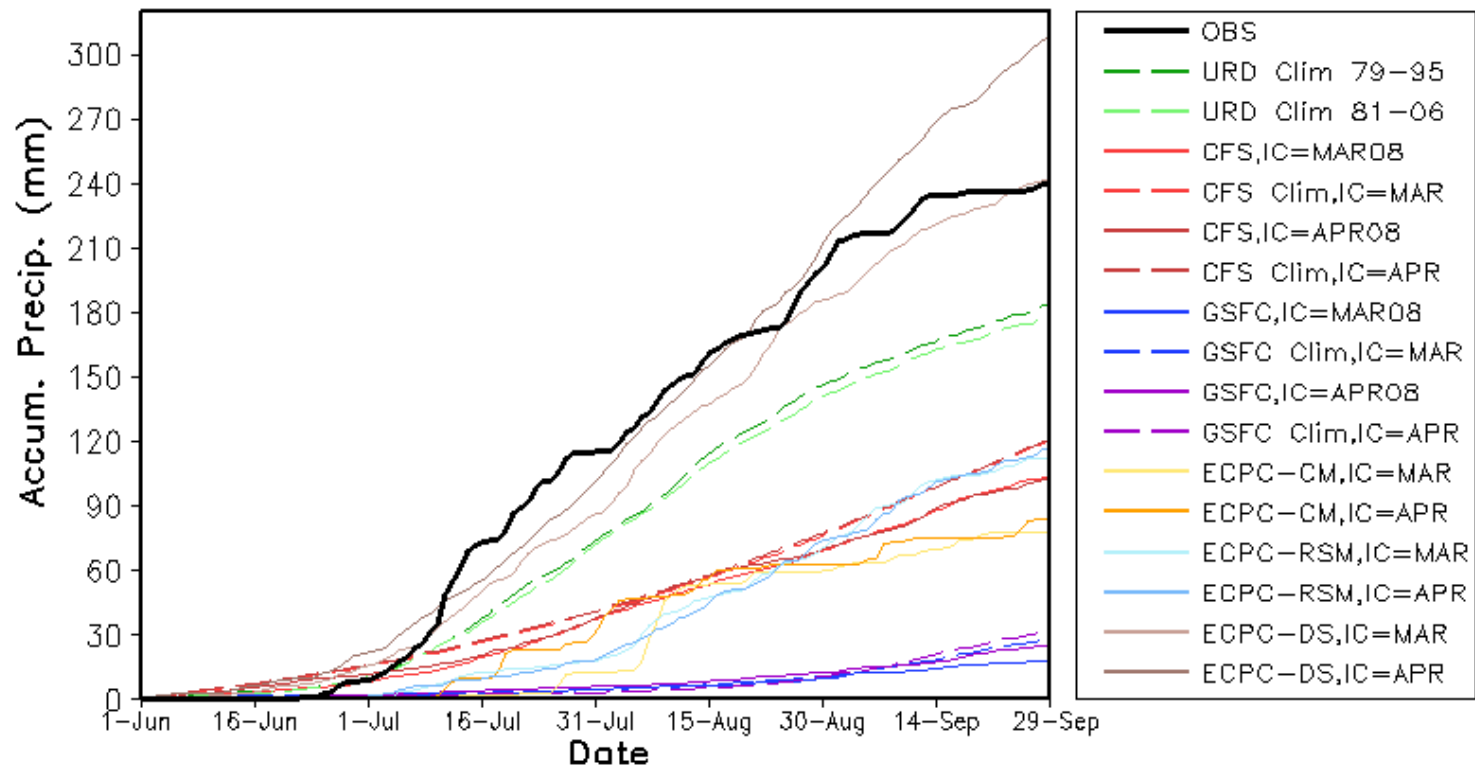
Extreme heat

Climate Impacts

Current issue:

Most global climate models cannot resolve the North American monsoon well—including CFS

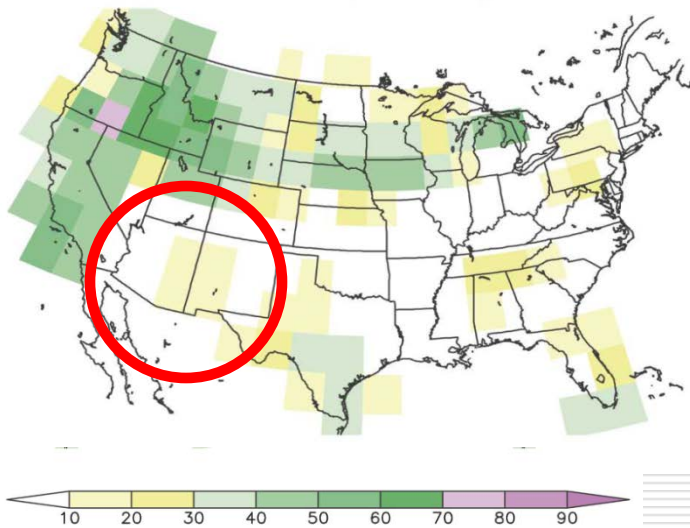
2008 NAME Forecast Forum Zone 2
Accumulated Precipitation



Southern Arizona and northern Sonora

GCM forecast: CFS Component of NCEP Seasonal Forecasts

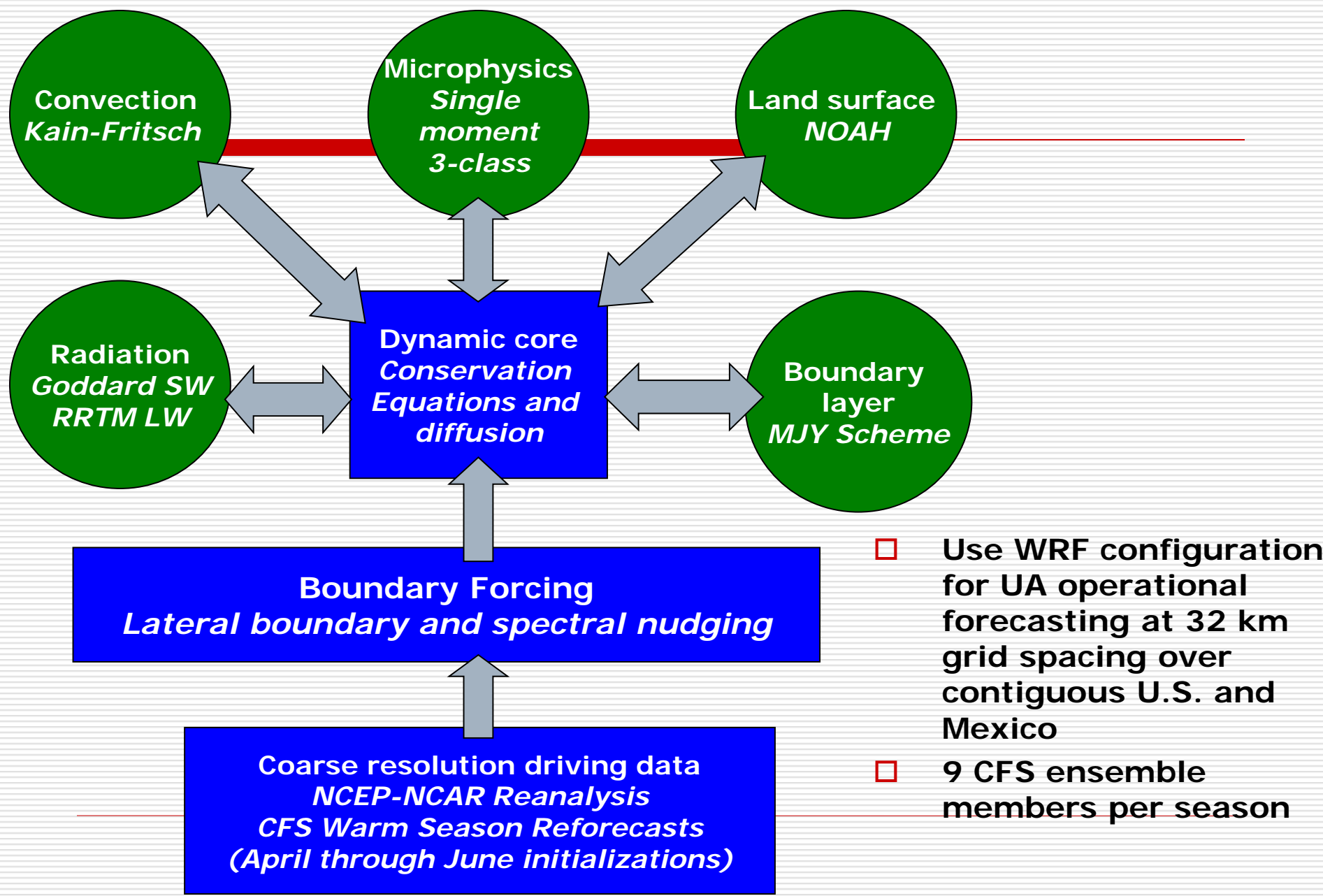
Skill of JJA Precipitation forecasts
Late spring initialization



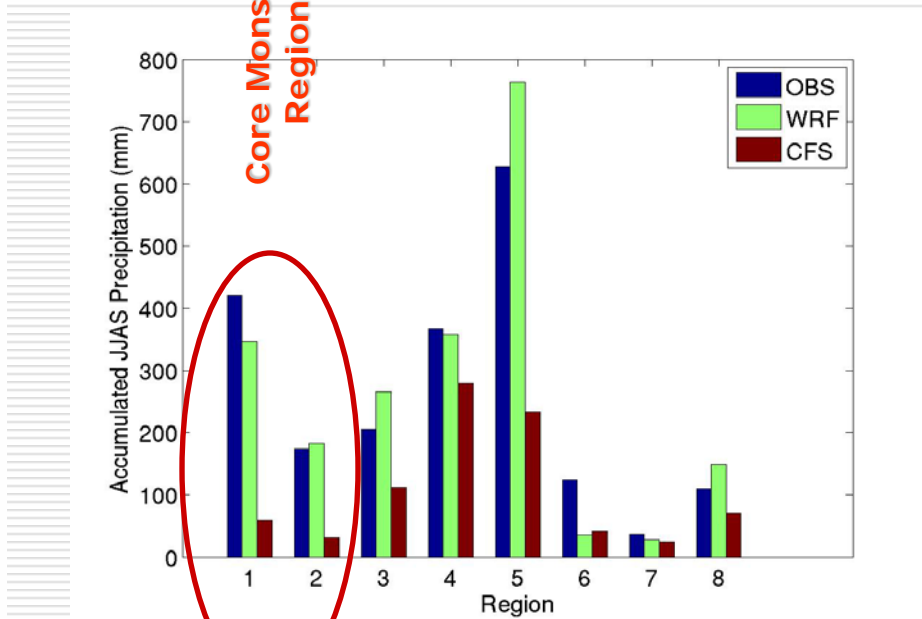
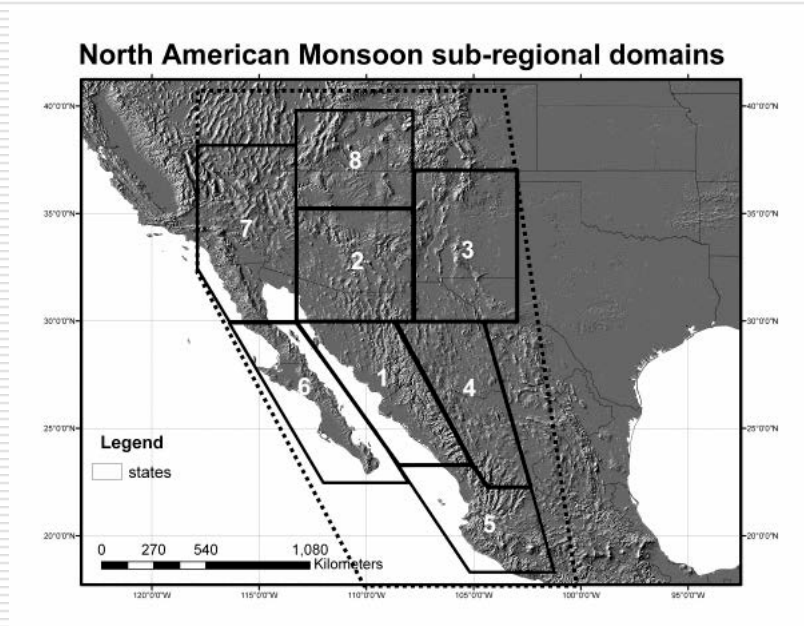
Spatial distribution of retrospective CFS model forecast skill (% anomaly correlation) of the 15 member ensemble forecasts of JJA. (Saha et al. 2006).

- ❑ Uses results from Climate Forecast System (CFS) AOGCM at T62 resolution
- ❑ 15 ensemble members initialized in late spring from NCEP Reanalysis II
- ❑ Results indicate very marginal performance for precipitation forecast skill in the Southwest U.S. region

Downscaling of CFS Reforecasts (1982-2000) with WRF:

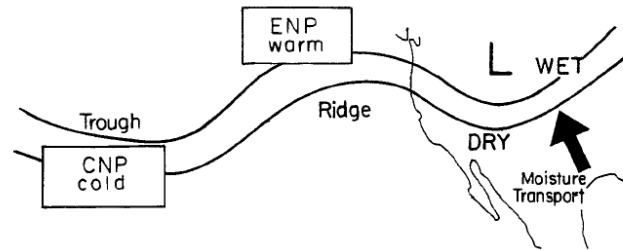


NAME Regions Monsoon Precipitation Climatology (JJAS): CPC gridded, global CFS, CFS-WRF downscaled



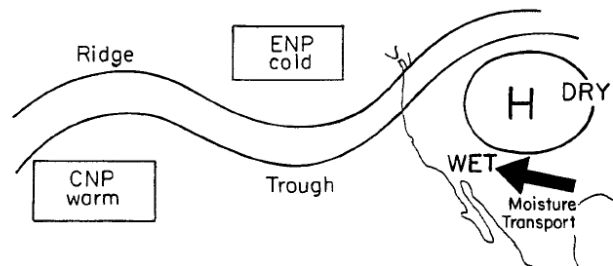
Dramatic improvement in the climatology of monsoon precipitation accounted for by a much better representation of the diurnal cycle of convection.

Dominant mode of precipitation variability in early summer and relationship to Pacific SST:



El Niño

El Niño
High NPO Phase



La Niña

La Niña
Low NPO Phase

FIG. 14. Idealized relationship of monsoon ridge position and midlevel moisture transport to Pacific SSTs at monsoon onset.

Climatology delayed

Climatology accelerated

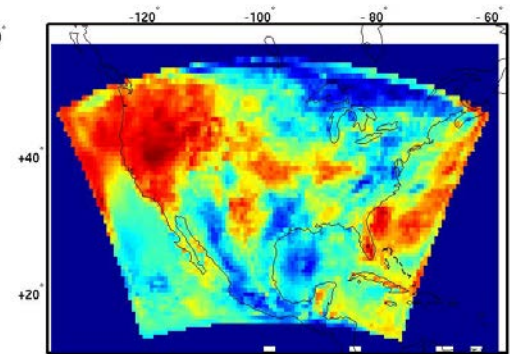
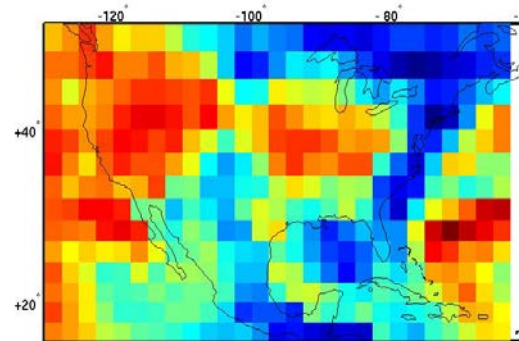
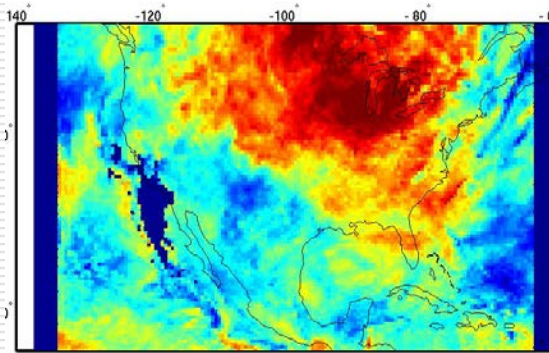
Dominant REOF Mode of Early Summer (JJ): *Standardized Precipitation Index (SPI) vs SSTA*

WRF Downscaled
NCEP Reanalysis

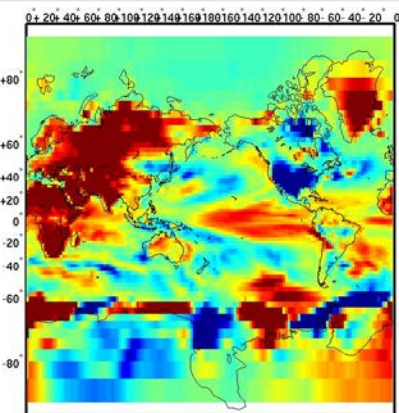
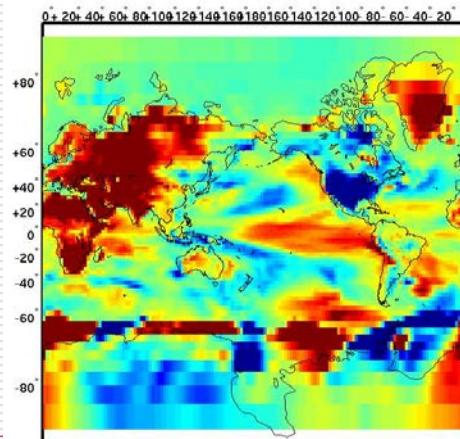
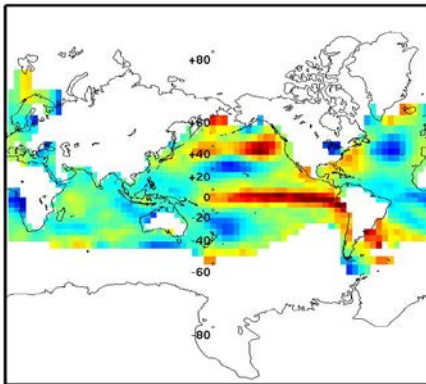
Original CFS

WRF Downscaled
CFS

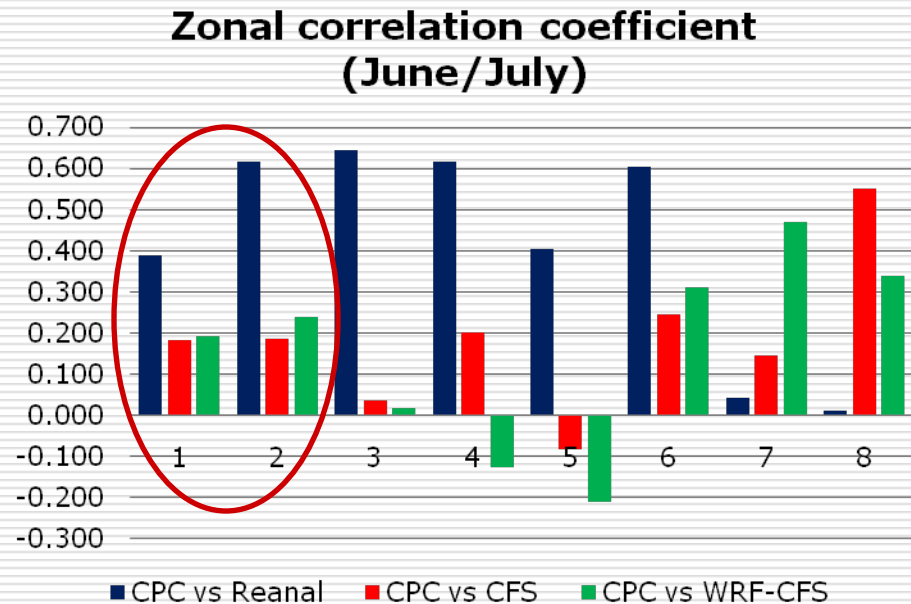
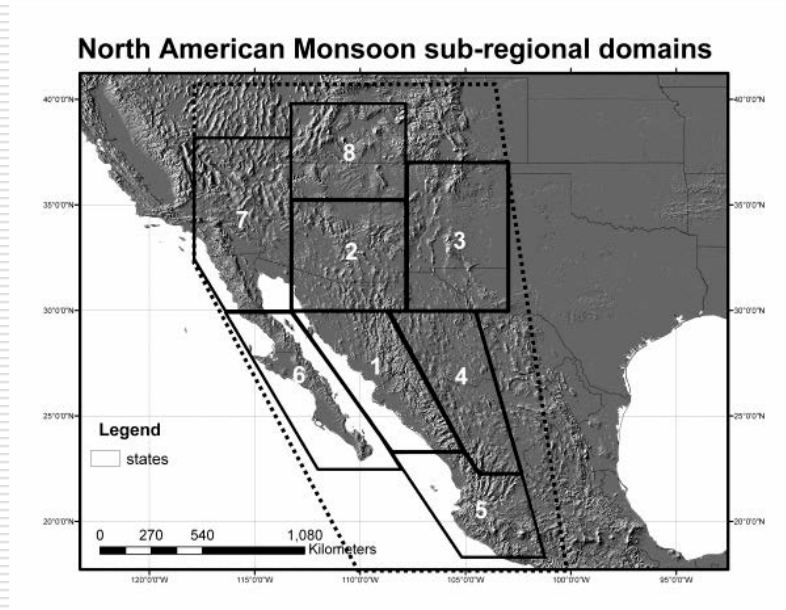
First REOF



Correlation
with SSTA

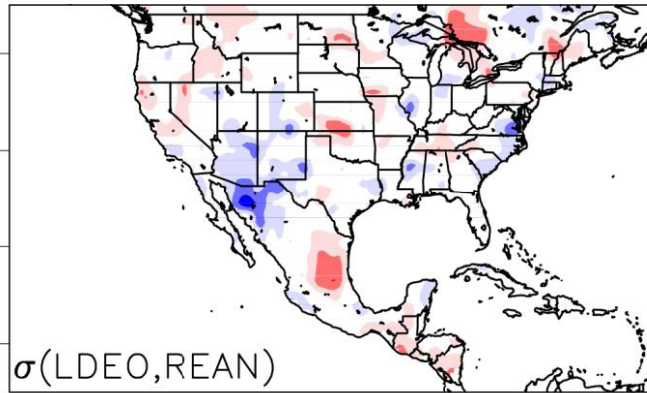


Anomaly Correlation for NAME Regions: Standardized Precipitation Index Global and regional model data vs. CPC obs.

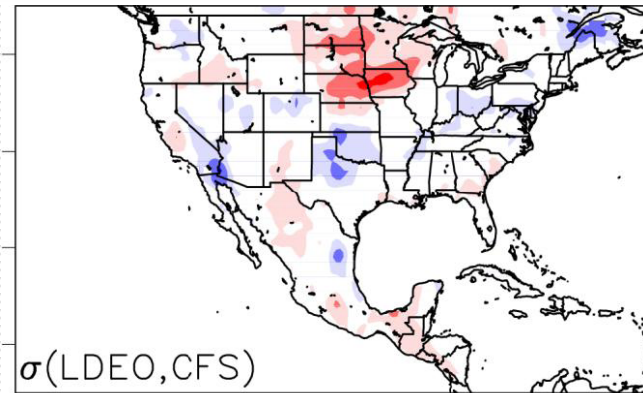


- Dynamical downscaling only leads to marginal improvements in seasonal forecast SPI for core regions (1,2), but does much better for westernmost regions (6,7).
- Discrepancies in reanalysis downscaled SPI anomaly correlations between adjacent U.S. and Mexican core regions (1,2). **Maybe indicative of a problem with CPC observed data??**

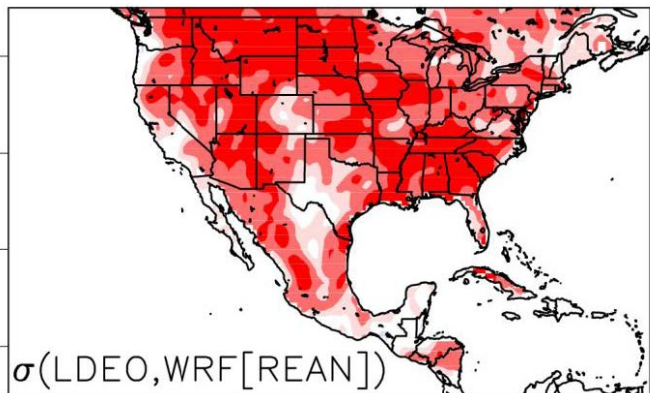
JJ SPI Anomaly Correlation: using new NOAA precipitation data product (similar to PRISM)



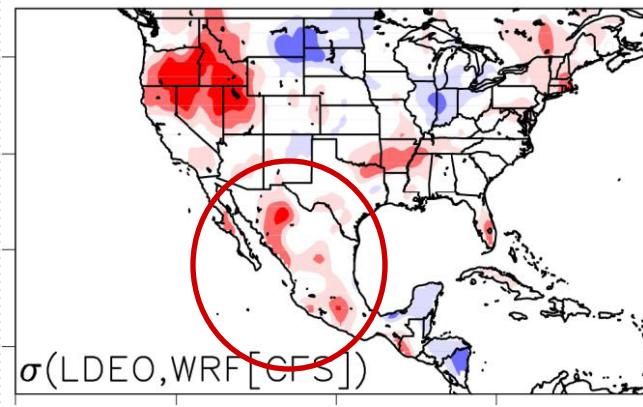
NCEP Reanalysis



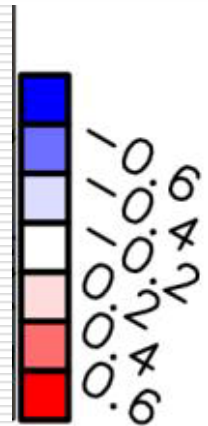
CFS model



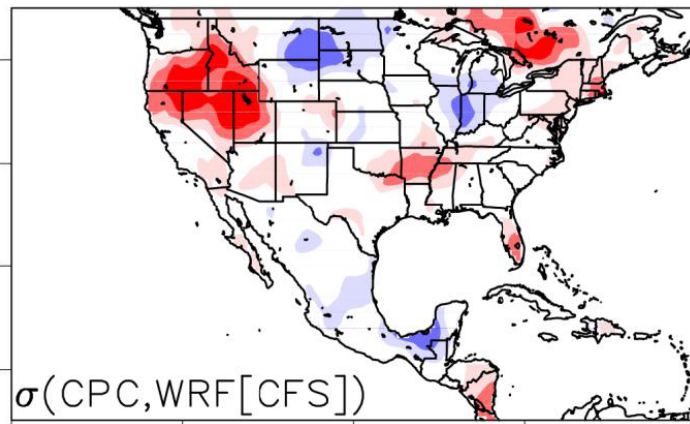
WRF Downscaled
NCEP Reanalysis



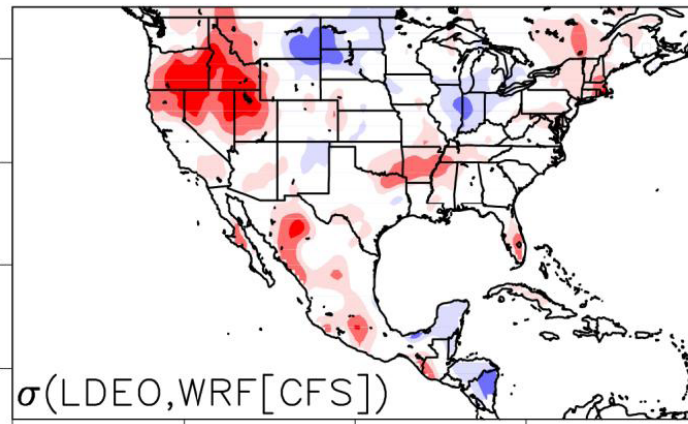
WRF Downscaled
CFS model



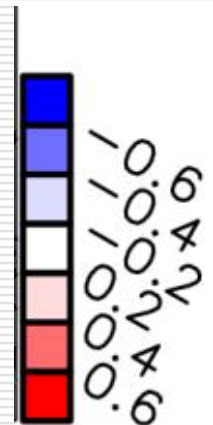
JJ SPI Anomaly Correlation: for WRF-CFS CPC vs. NOAA observed precipitation data



CPC product

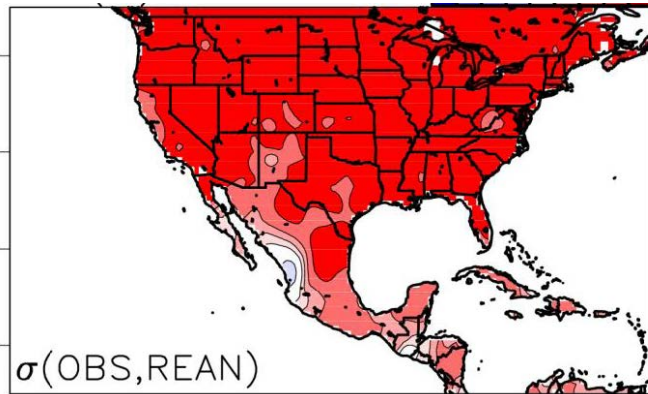


NOAA product

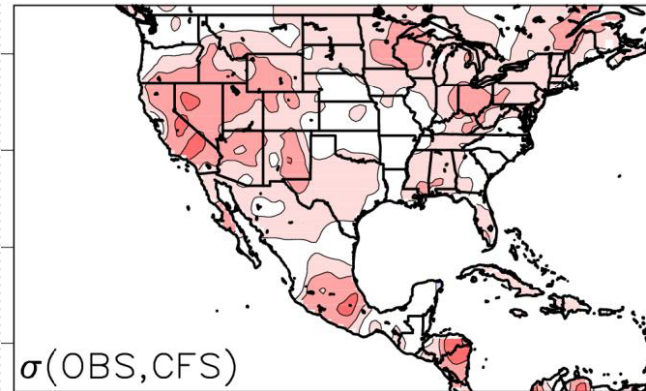


Use of new LDEO precipitation dramatically increases the precipitation anomaly correlation in Mexico—means the difference in concluding whether or not a RCM can really improve monsoon seasonal forecasts in Mexico!

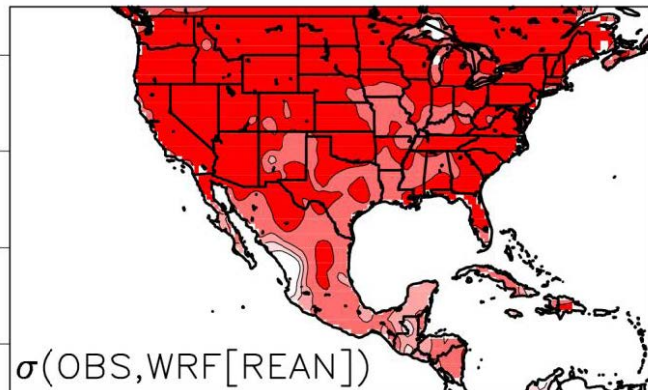
JJ Temperature Anomaly Correlation: with U. DEL data



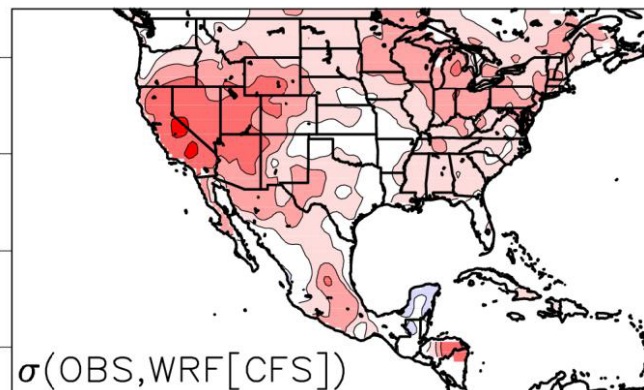
NCEP Reanalysis



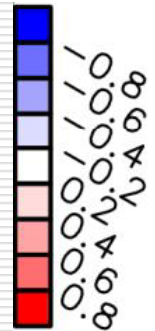
CFS model



WRF Downscaled
NCEP Reanalysis



WRF Downscaled
CFS model



Conclusions:

- ❑ NEED FOR IMPROVEMENT IN MONSOON FORECASTS: NCEP CFS cannot resolve the North American Monsoon as a salient climatological feature. This is mainly due to the inability of the global model to simulate convective precipitation.
 - ❑ PRESENCE OF LARGE-SCALE FORCING IN DRIVING GLOBAL MODEL: CFS performs reasonably well in capturing the dominant large-scale teleconnections in the warm season related to Pacific SST forcing. Thus it provides reasonable boundary forcing to a finer resolution regional model.
 - ❑ REGIONAL MODEL DYNAMICAL DOWSCALING ADDS VALUE: A model with a grid spacing of 10s of km is necessary to resolve the monsoon as a climatological feature and improves its representation of interannual variability, at least in areas of complex terrain. The choice of observed precipitation for validation matters a lot for Mexico!
 - ❑ INCORPORATION OF RCM DATA IN OPERATIONAL FORECASTS: More work is needed to formally demonstrate the utility of these regional model data for official operational forecast purposes through the NAME forecast forum and NCEP. Current effort of MRED group.
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Thank you

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