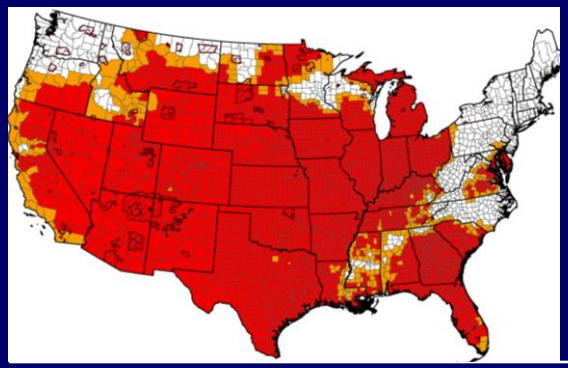
CWRF Optimized Physics Ensemble Modeling to Advance US Drought Forecast

2012 October 25



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Hope for Drought Prediction

- The 2012 drought was widespread over the U.S.
- Is there any hope to predict such an extreme?
- High-resolution CWRF that incorporates advanced physics representation at regional-local scales may offer a hope.

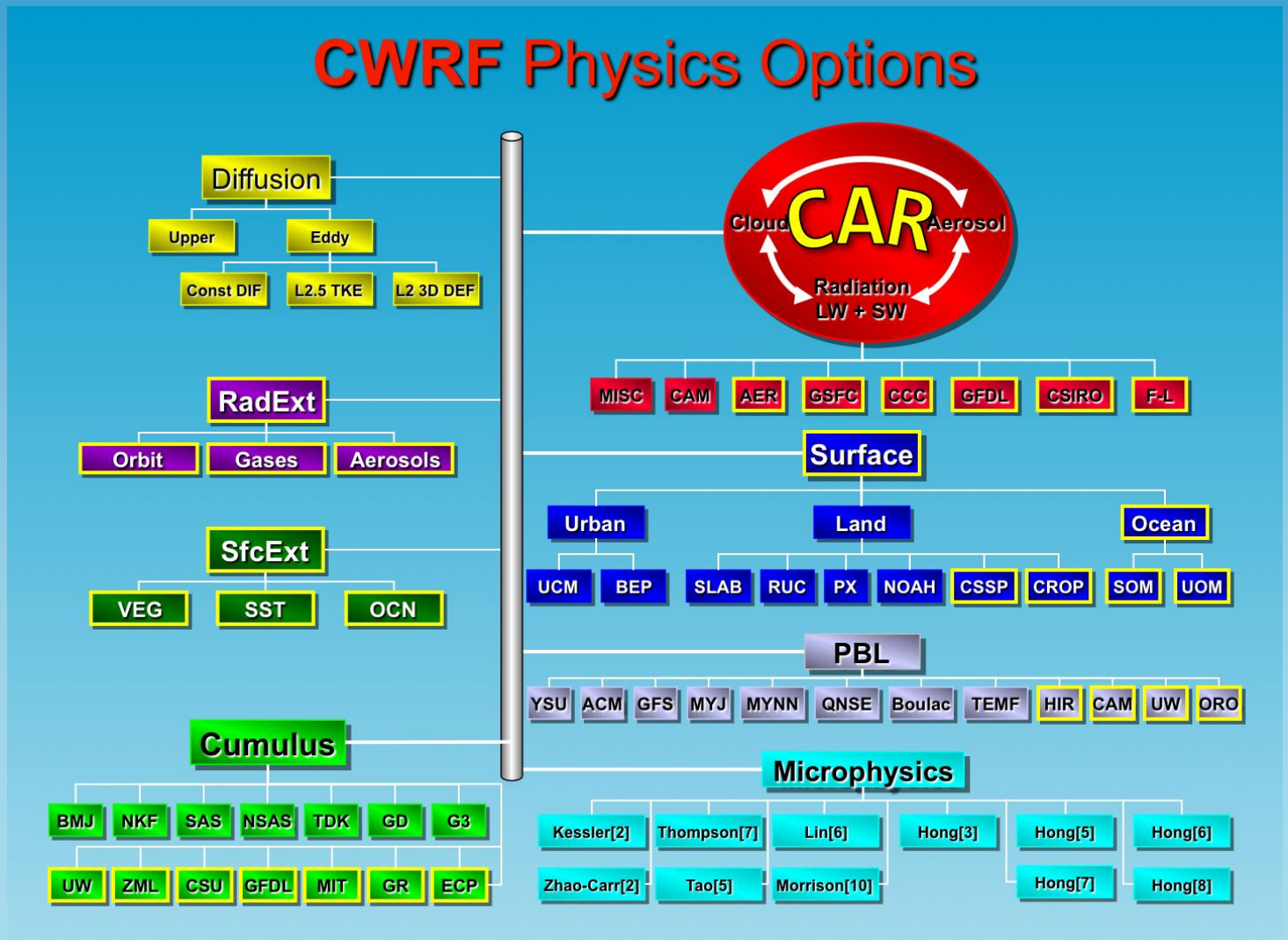
eSM R&D ESSIC, UMD

Climate - Weather Research and Forecasting model

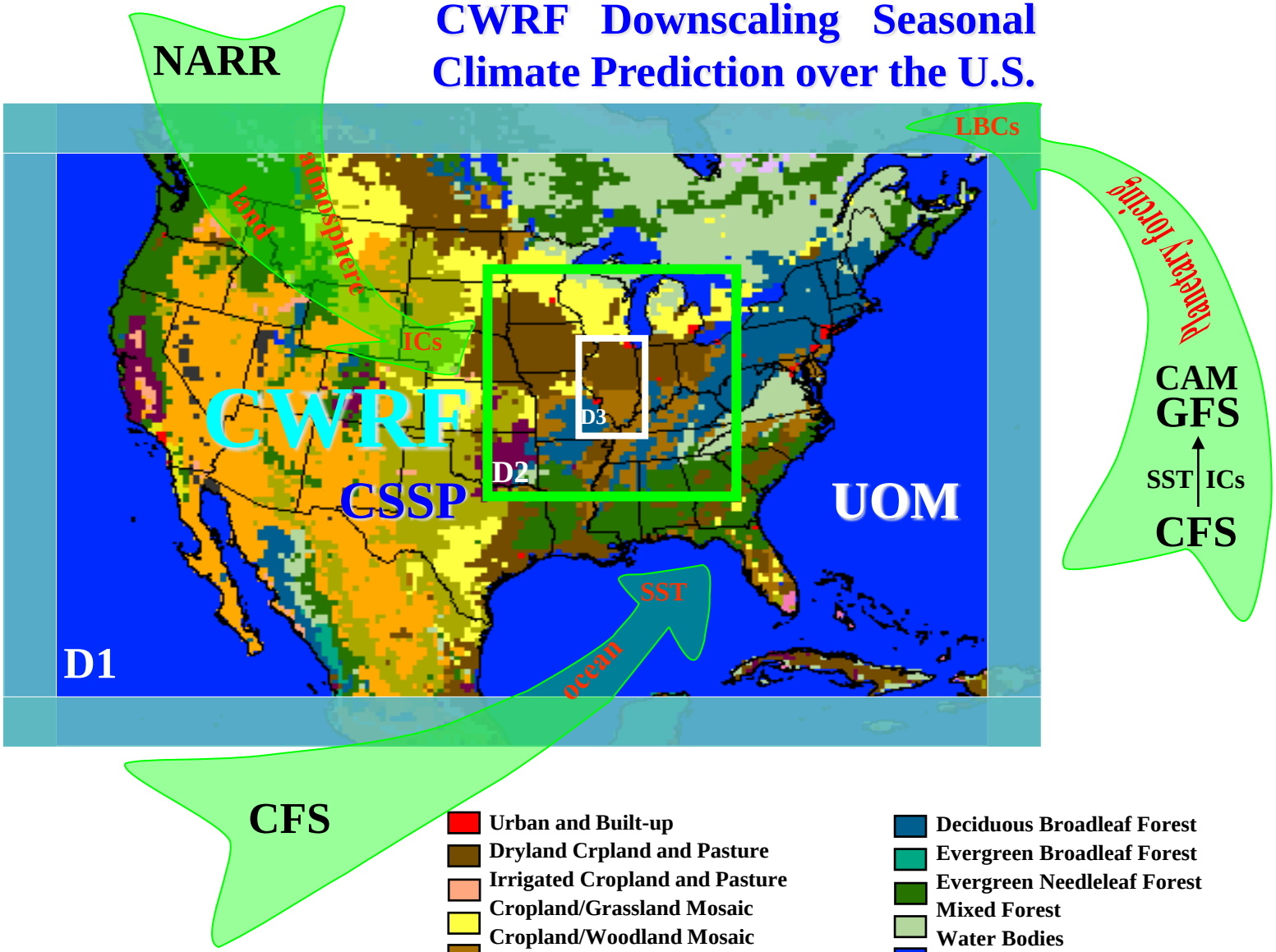
Home | Developer | Physics | Forcing | Application | Download | Publication

CWRF First Release at http://cwrf.umd.edu

BAMS 2012/9



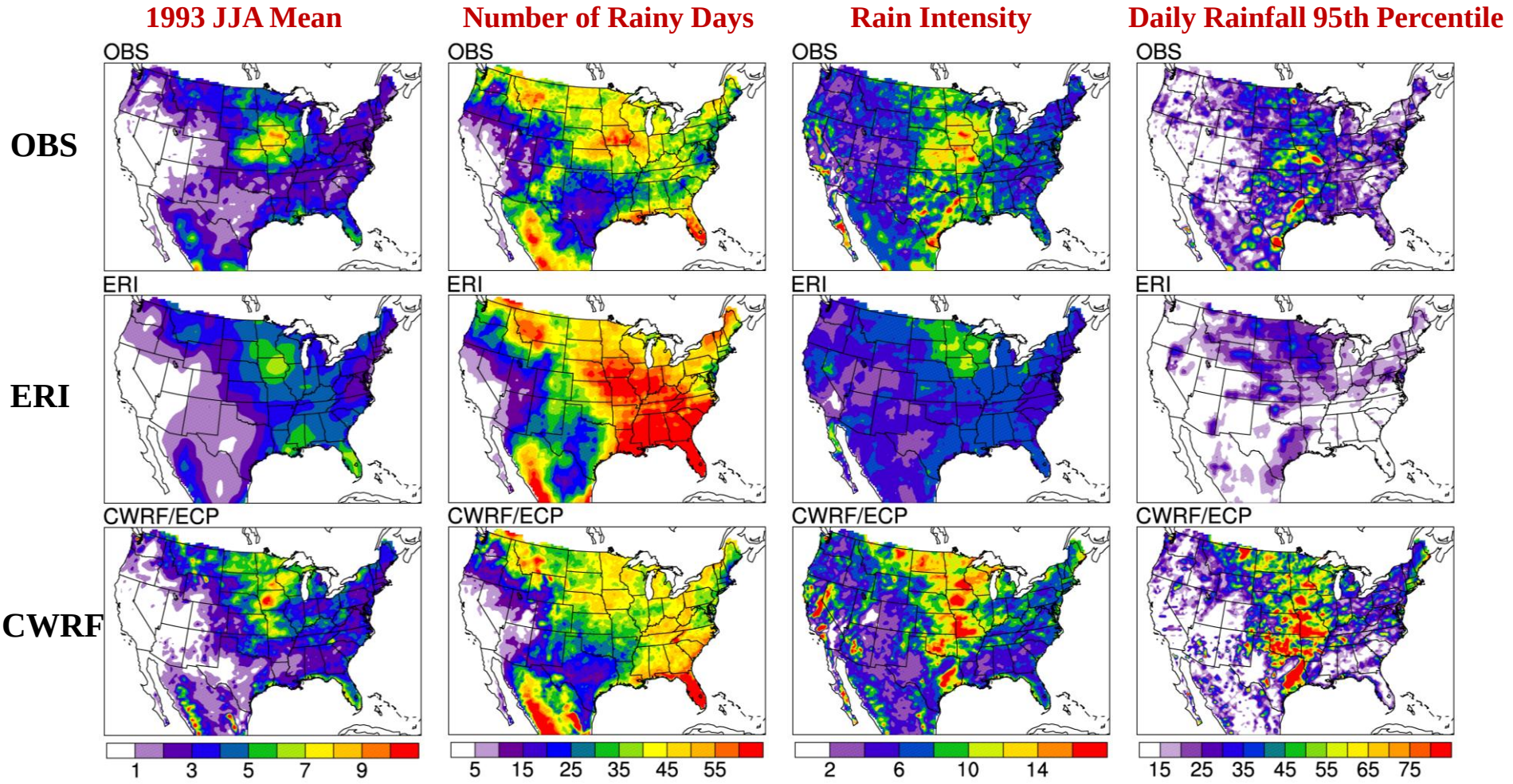
CWRF Downscaling Seasonal Climate Prediction over the U.S.



NOAA

2008-2012

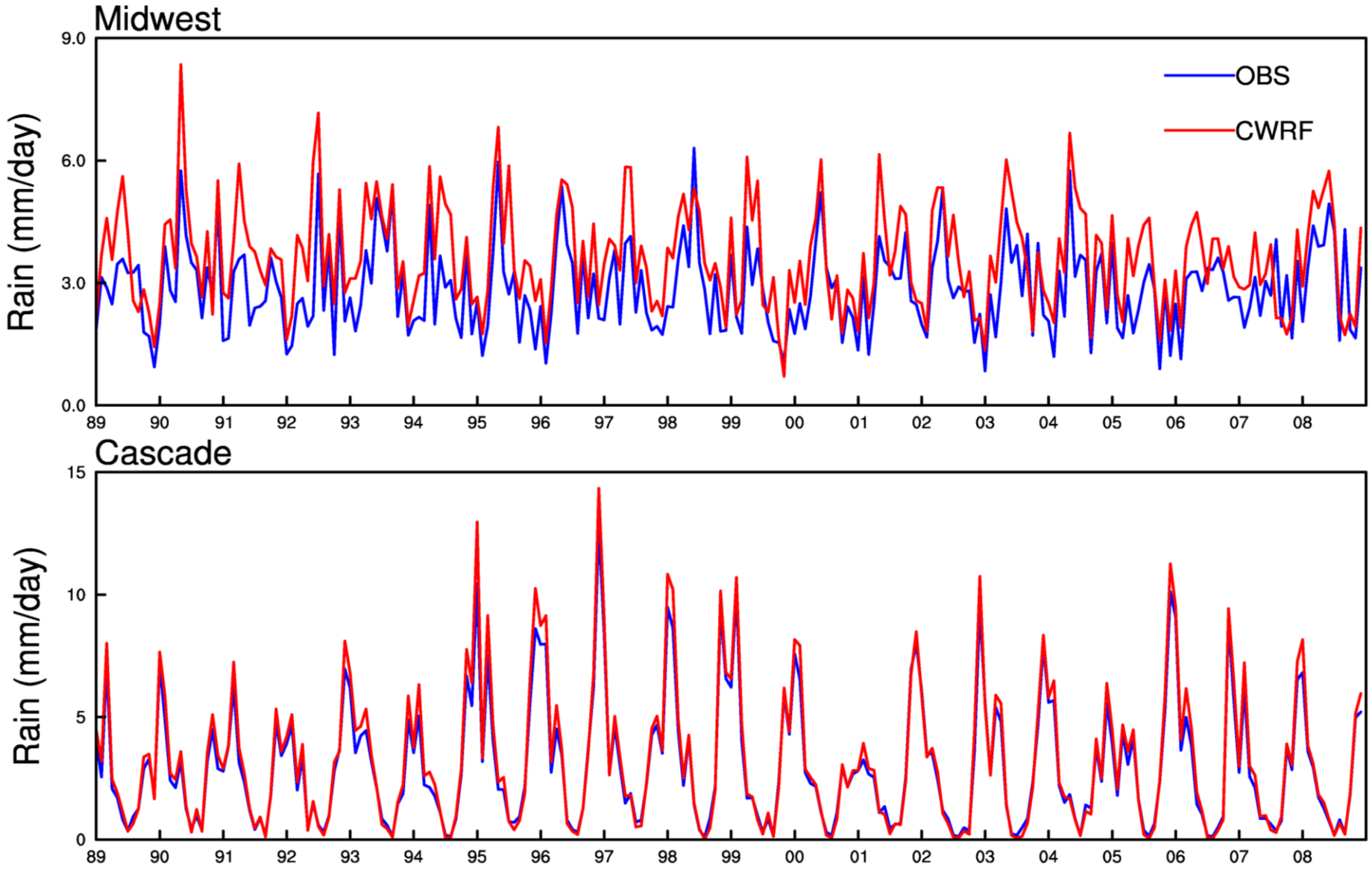
CWRF with ECP/W closure over the U.S. land



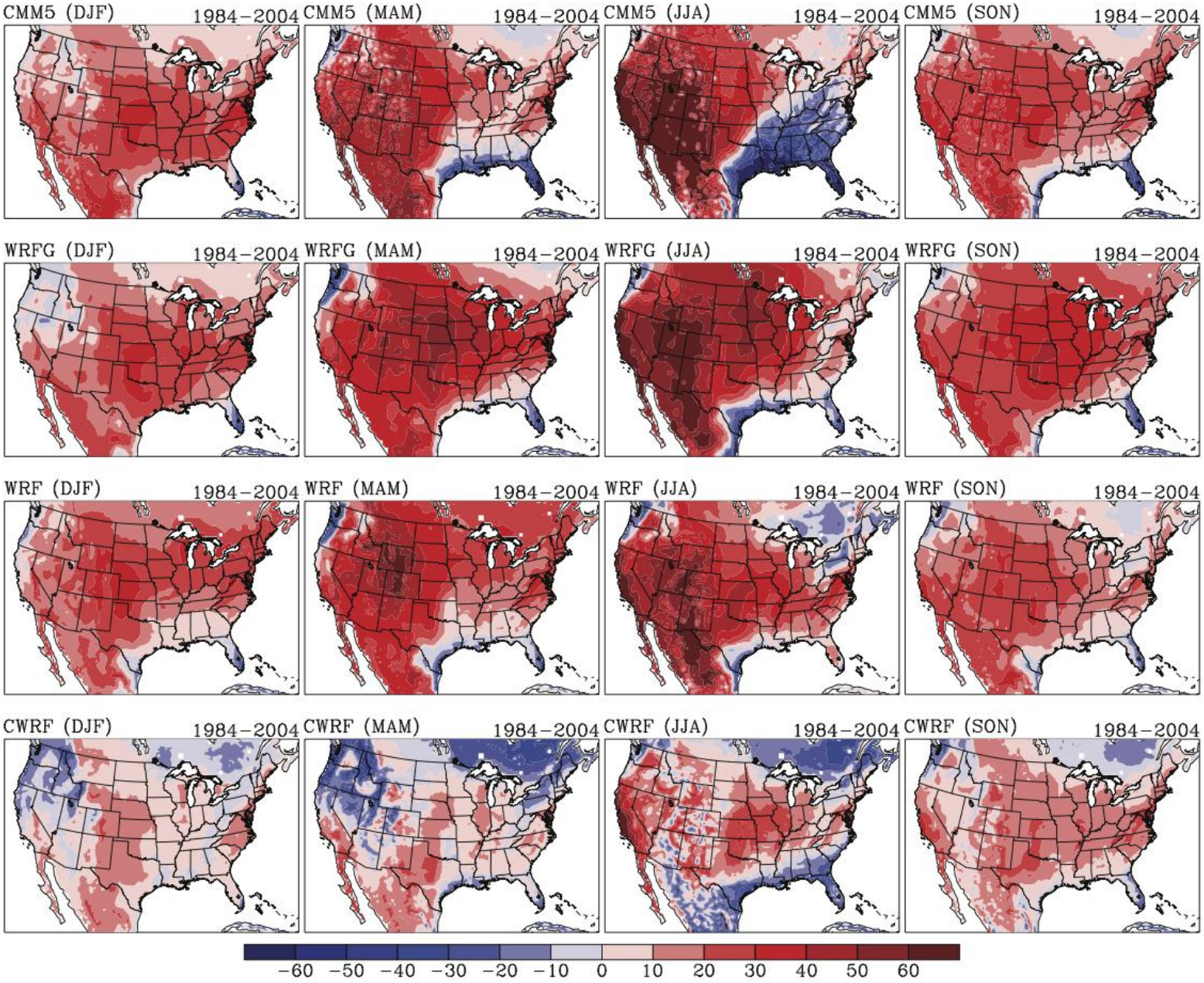
The reanalysis has already assimilated *local* observational data, while CWRF is driven by only LBCs. The CWRF skill will be enhanced if assimilating local data.

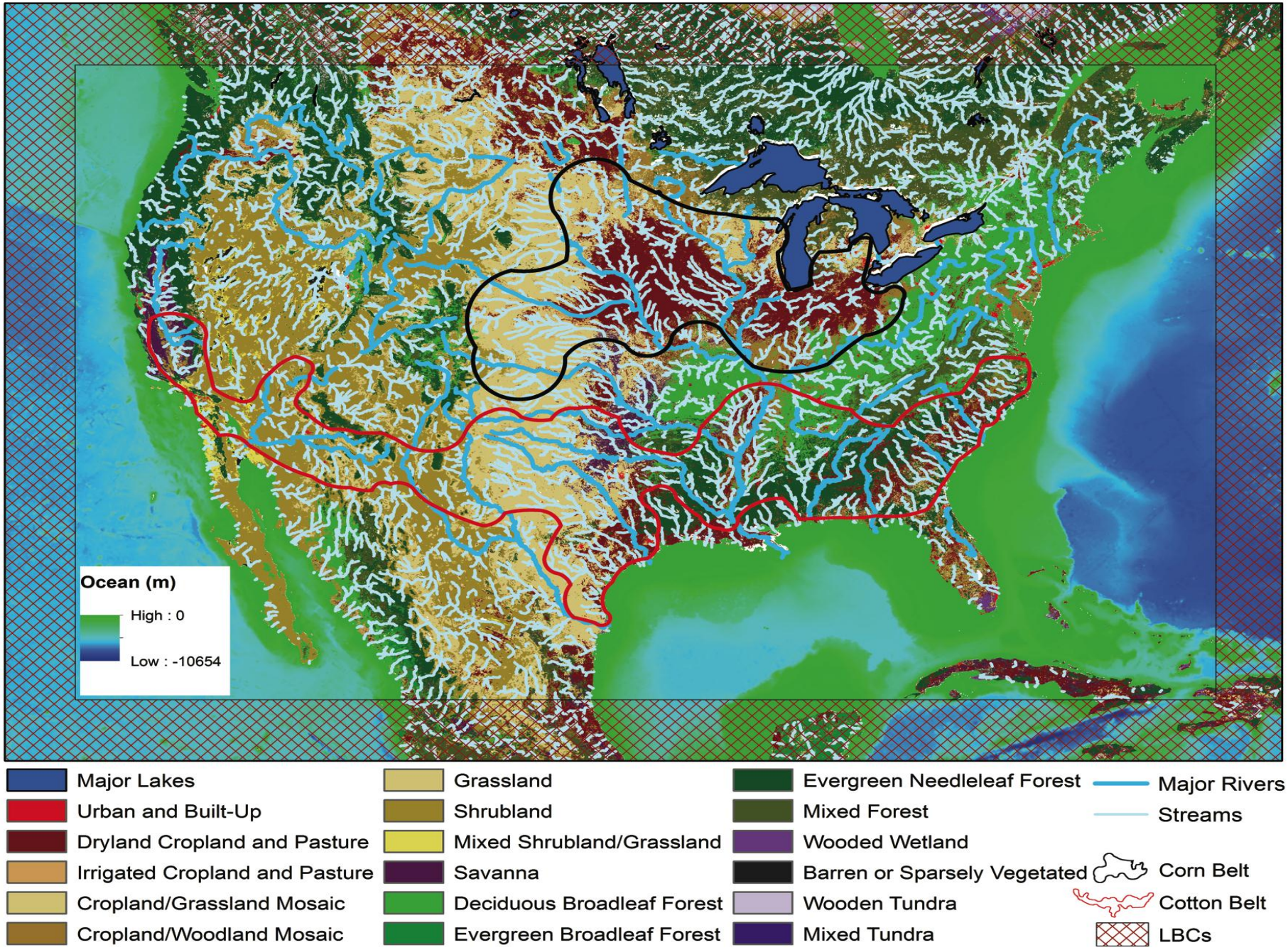
CWRF

Monthly

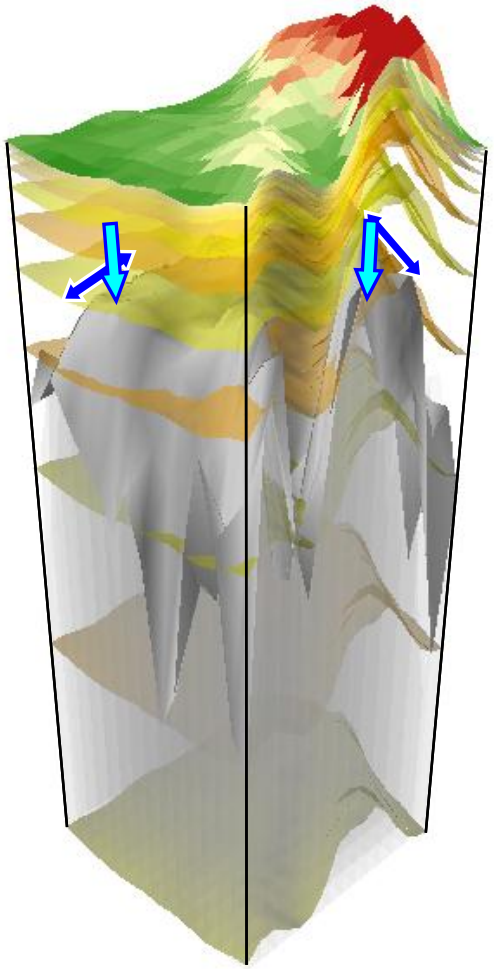


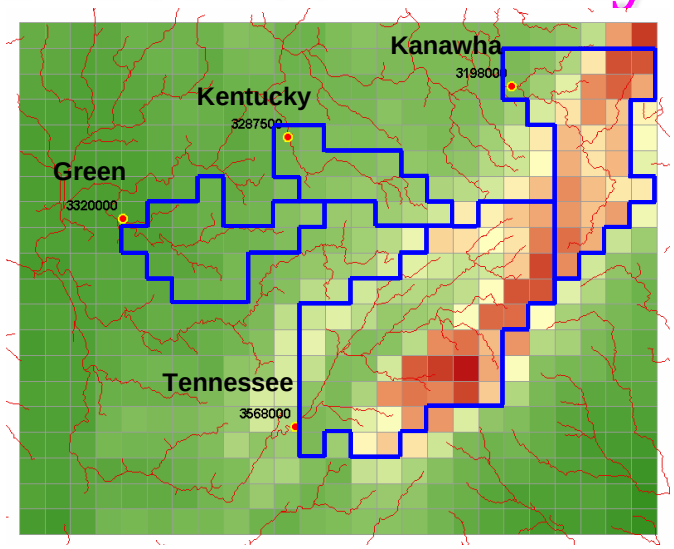
CWRF Improves Surface Solar Radiation

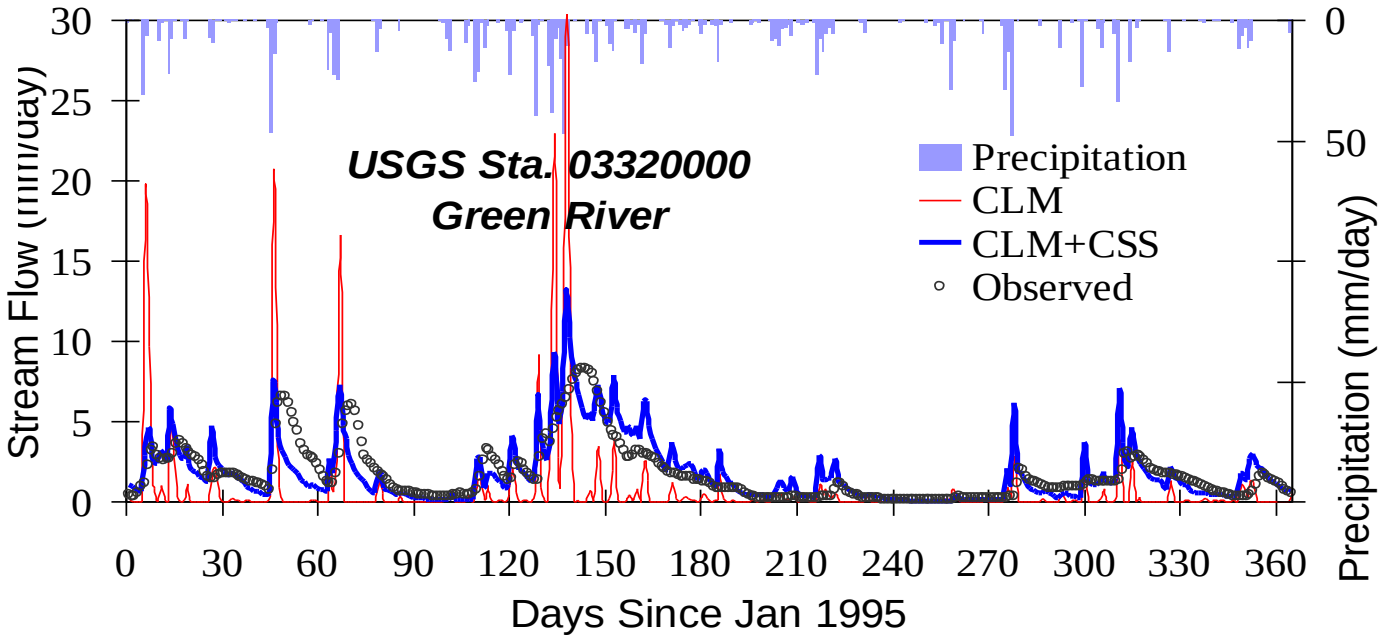



Ocean (m)
High : 0
Low : -10654
Major Lakes
Urban and Built-Up
Dryland Cropland and Pasture
Irrigated Cropland and Pasture
Cropland/Grassland Mosaic
Cropland/Woodland Mosaic
Grassland
Shrubland
Mixed Shrubland/Grassland
Savanna
Deciduous Broadleaf Forest
Evergreen Broadleaf Forest
Evergreen Needleleaf Forest
Mixed Forest
Wooded Wetland
Barren or Sparsely Vegetated
Wooden Tundra
Mixed Tundra
Major Rivers
Streams
Corn Belt
Cotton Belt
LBCs

CWRF Terrestrial Hydrology

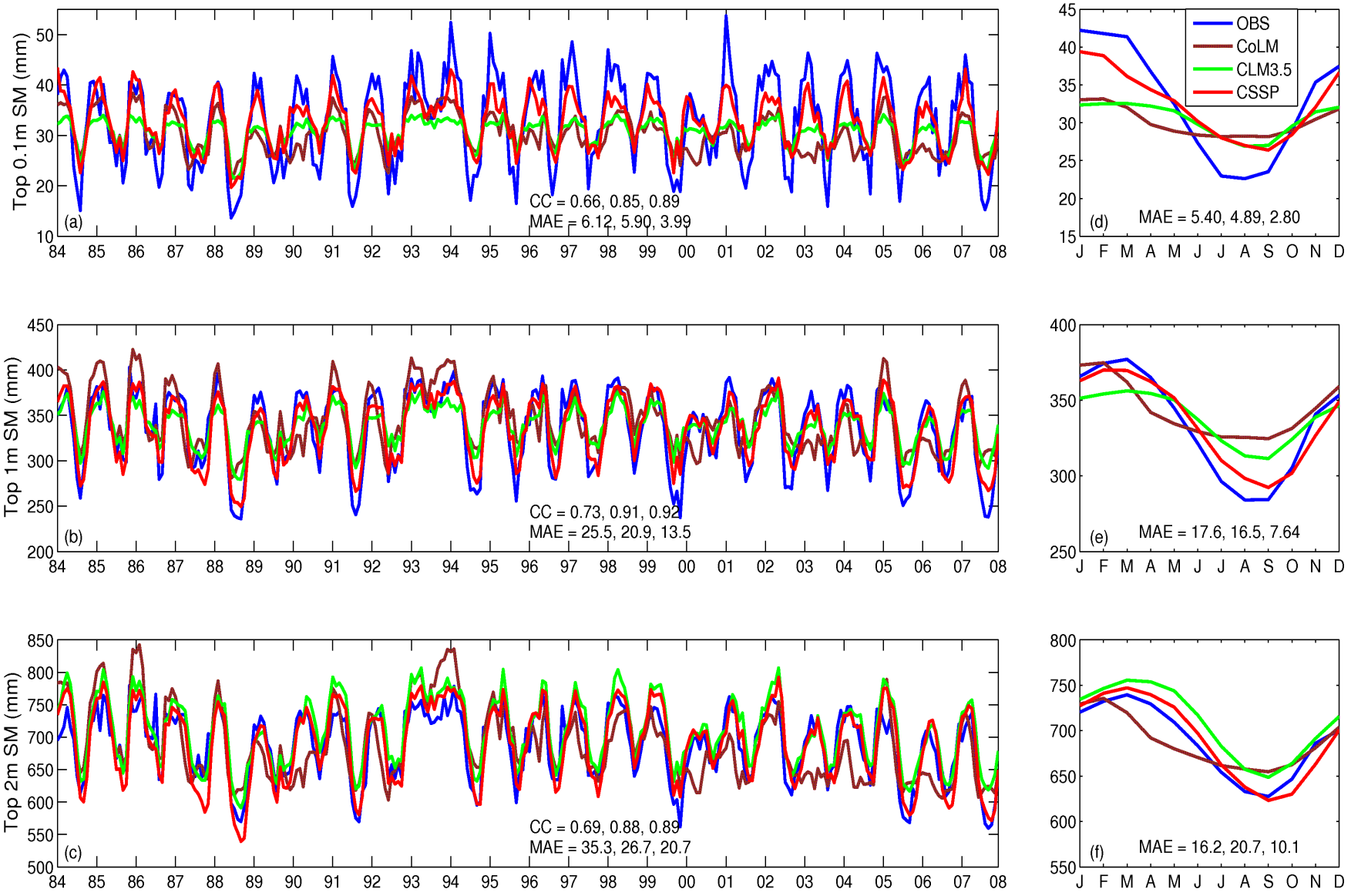






Choi 2006; Choi et al. 2007; Choi and Liang 2010; Yuan and Liang 2010; Liang et al. 2010d

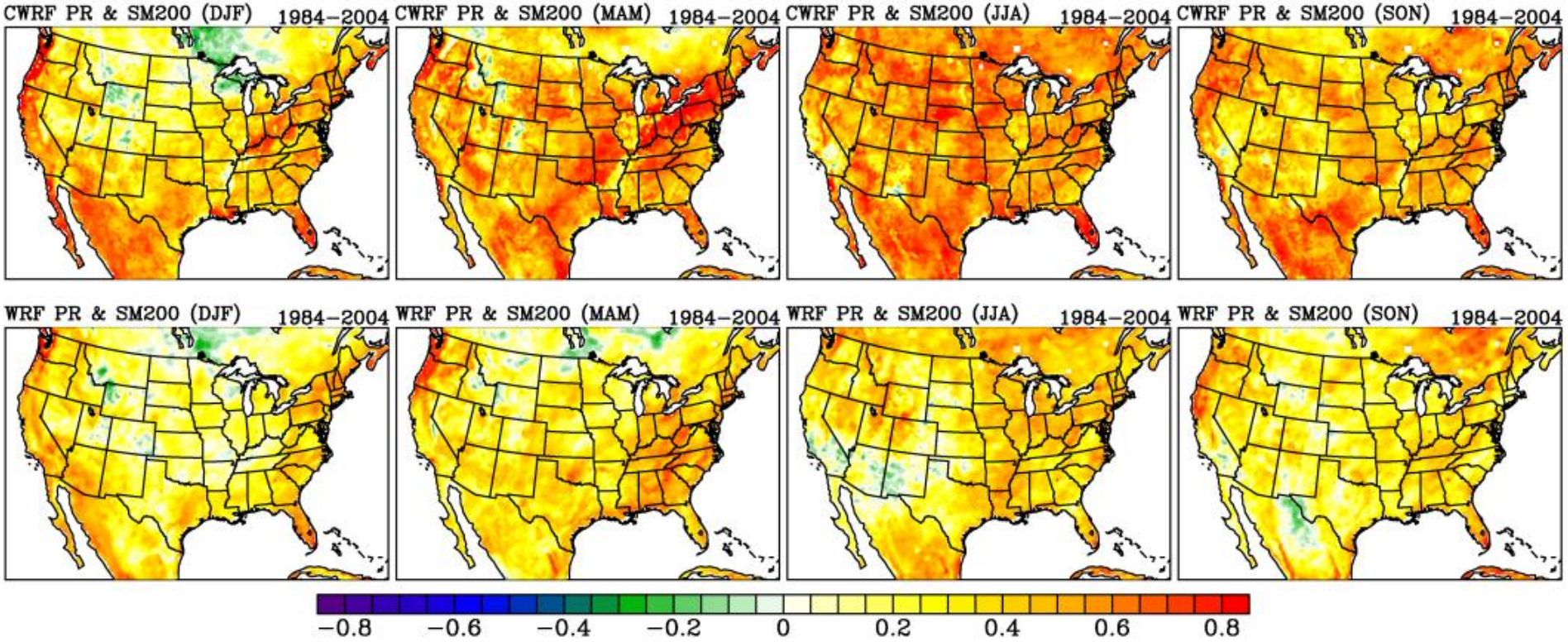
Illinois Soil Moisture Simulations Driven by NARR



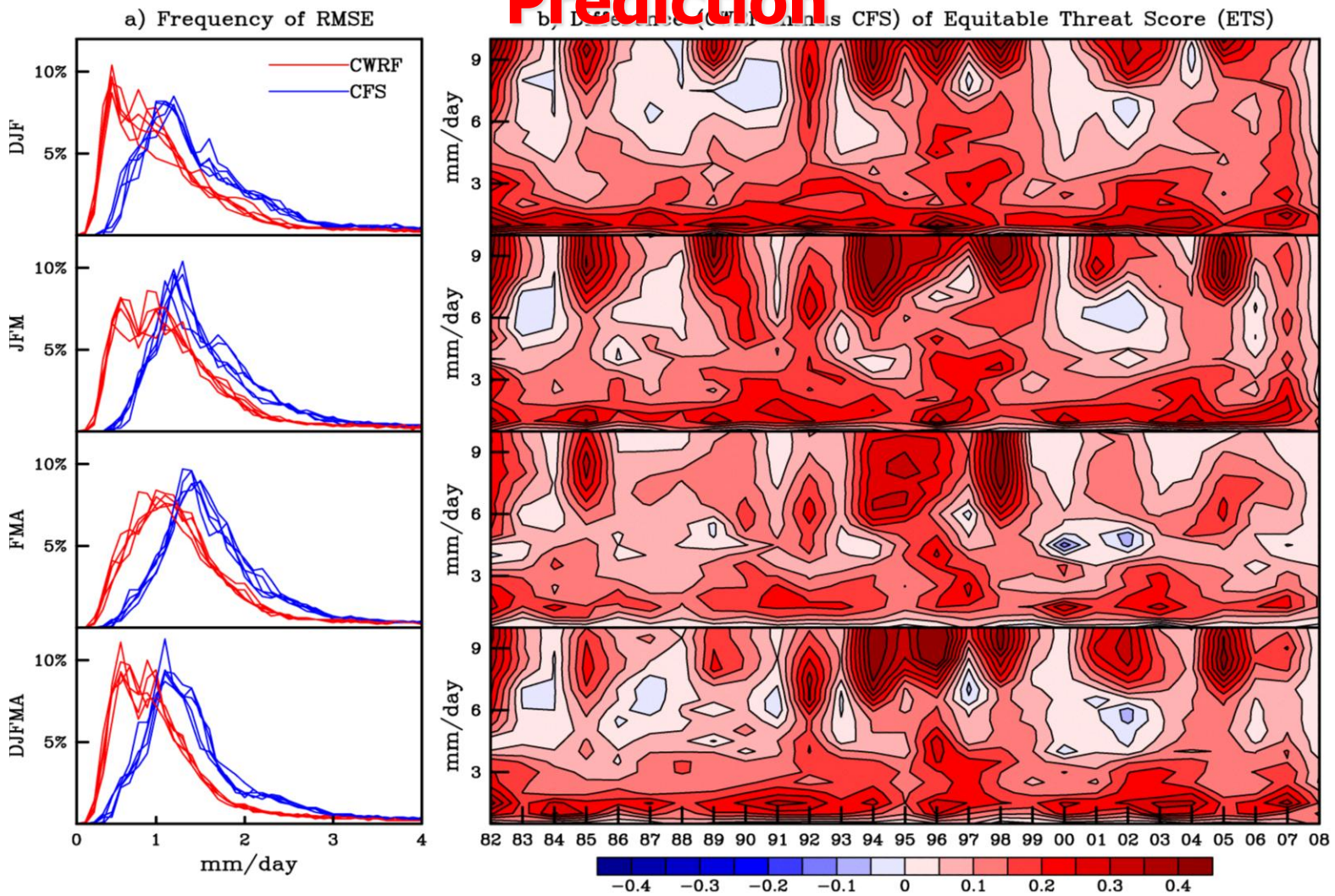
Yuan and Liang 2011 (J. Hydrometeorology)

Climate-Hydrology Interaction

Interannual Precipitation-Soil Moisture correlation

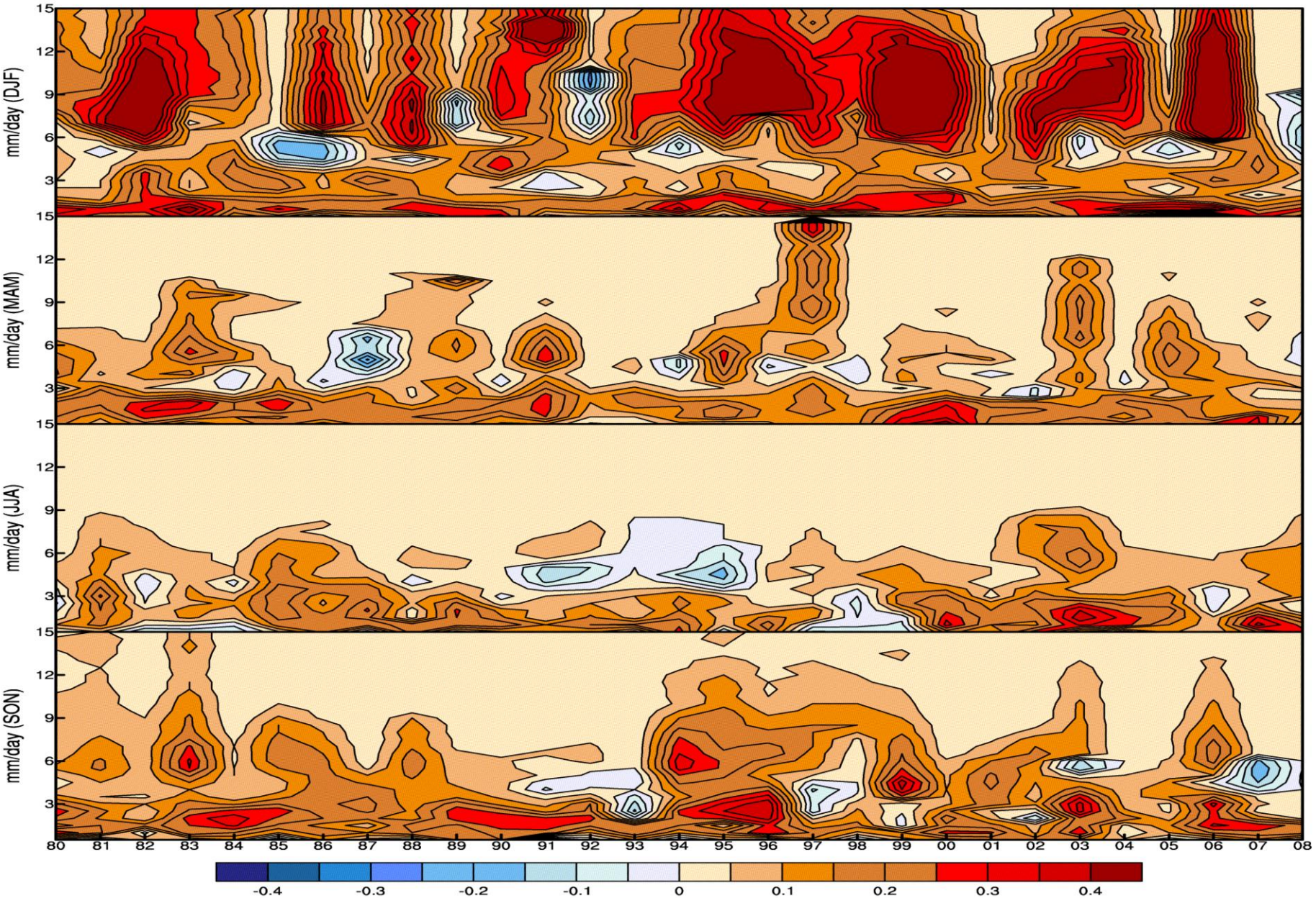


CWRF Improves Seasonal Climate Prediction



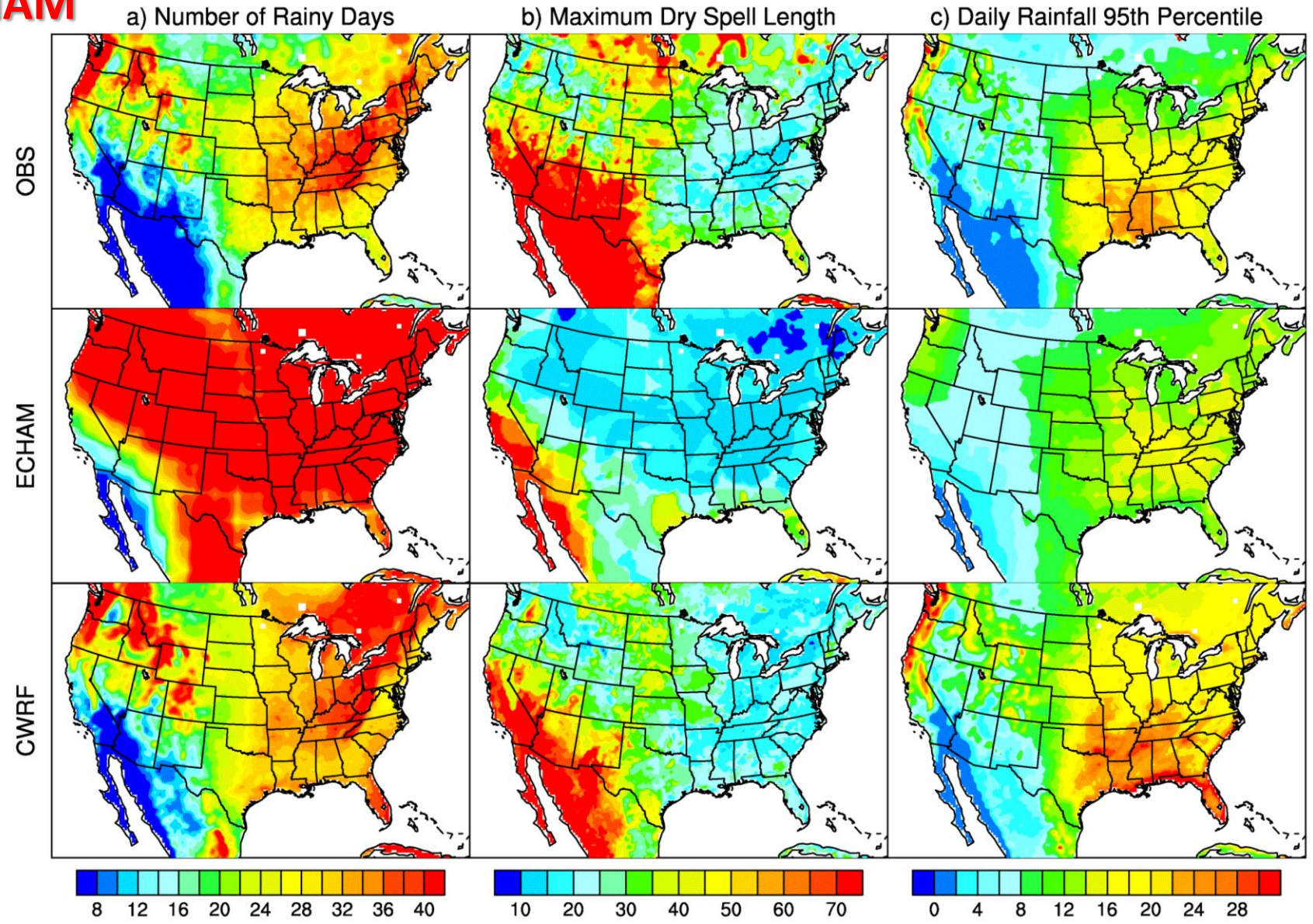
a) Spatial frequency distributions of root mean square errors (*RMSE*, mm/day) predicted by the CFS and downscaled by the CWRF and **b)** CWRF minus CFS differences in the equitable threat score (*ETS*) for seasonal mean precipitation interannual variations. The statistics are based on all land grids over the entire inner domain for DJF, JFM, FMA, and DJFMA from the 5 realizations during 1982-2008. *From* Yuan and Liang 2011 (GRL).

CWRF minus ECHAM U.S. Land Precipitation ETS

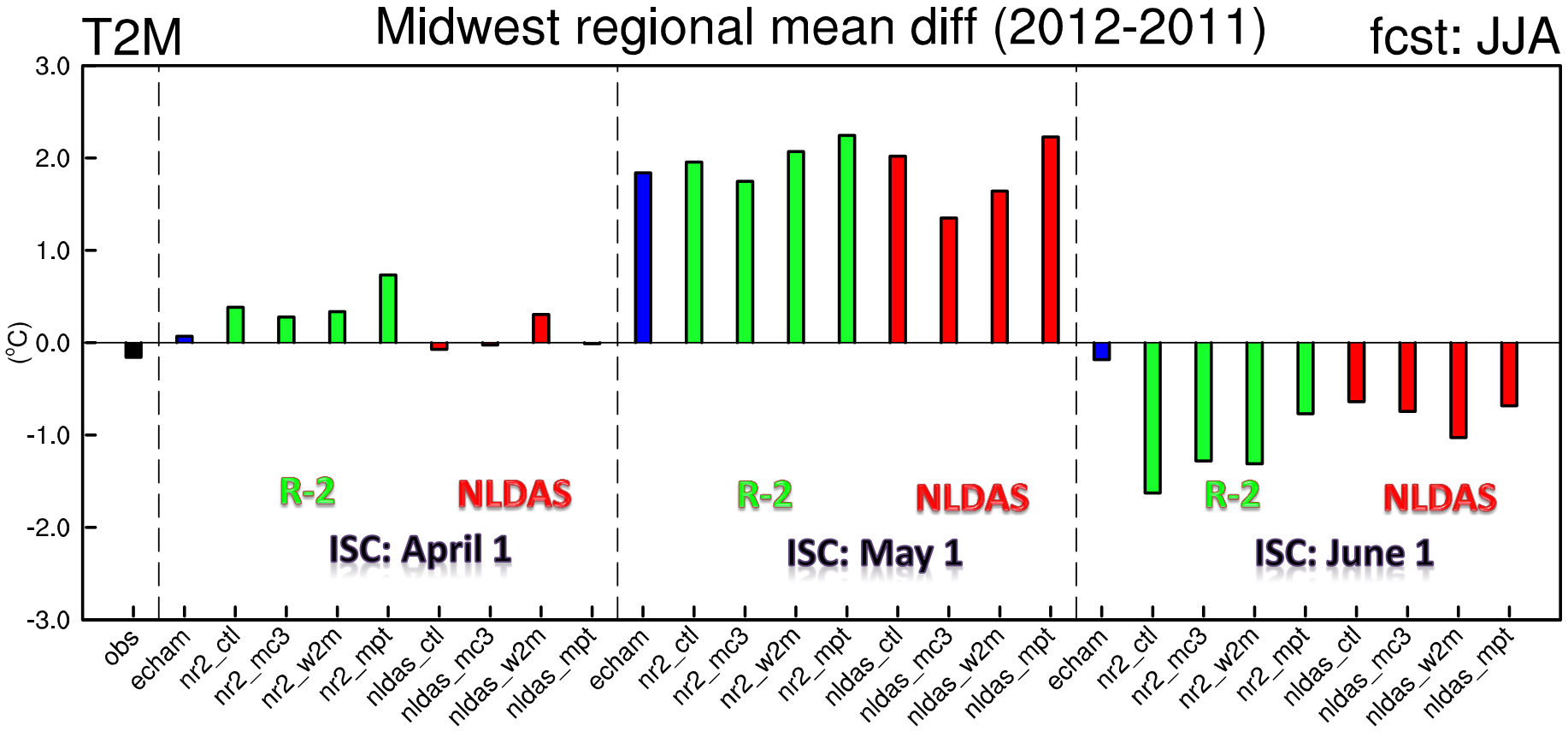


CWRF Downscaling Improves ECHAM Extreme Events

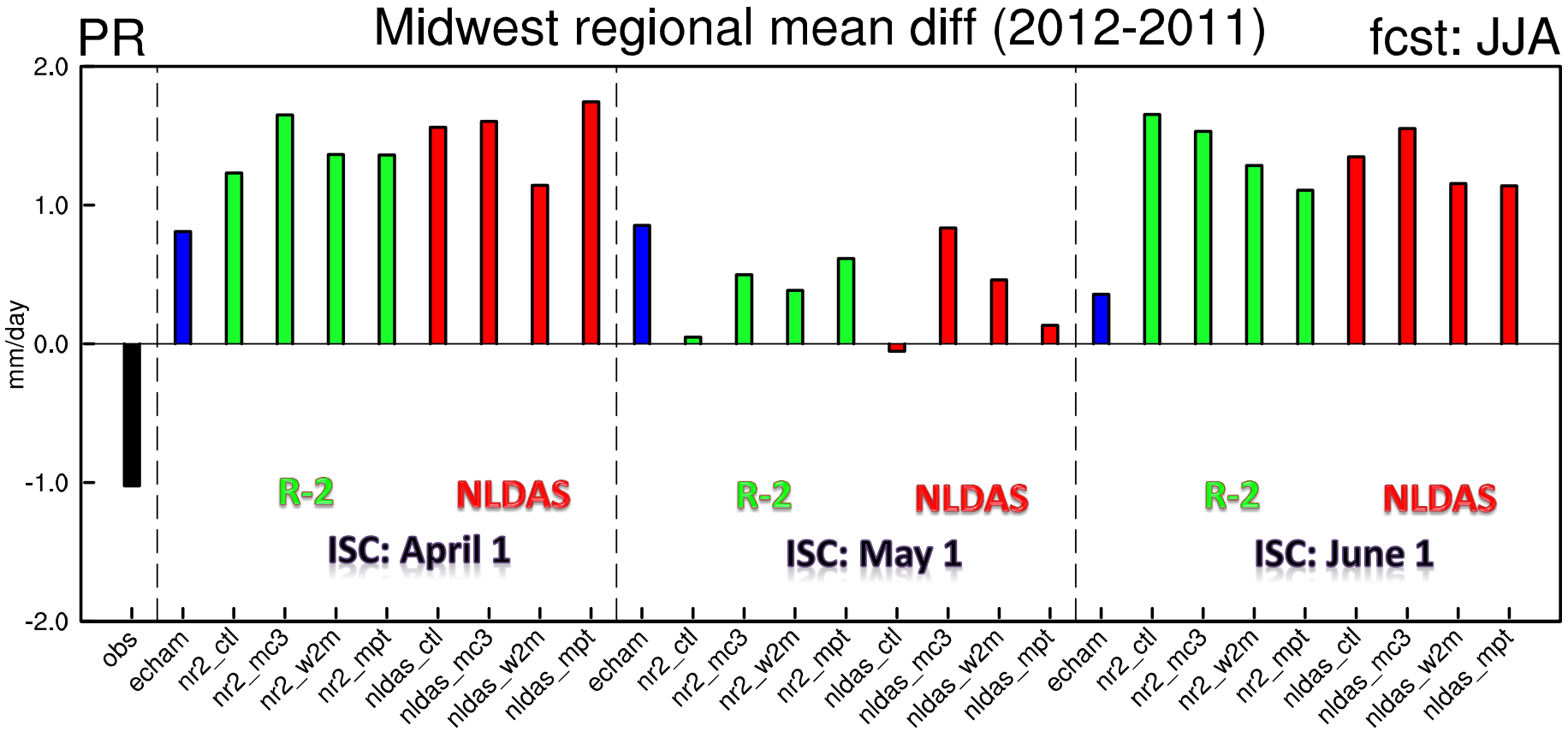
MAM



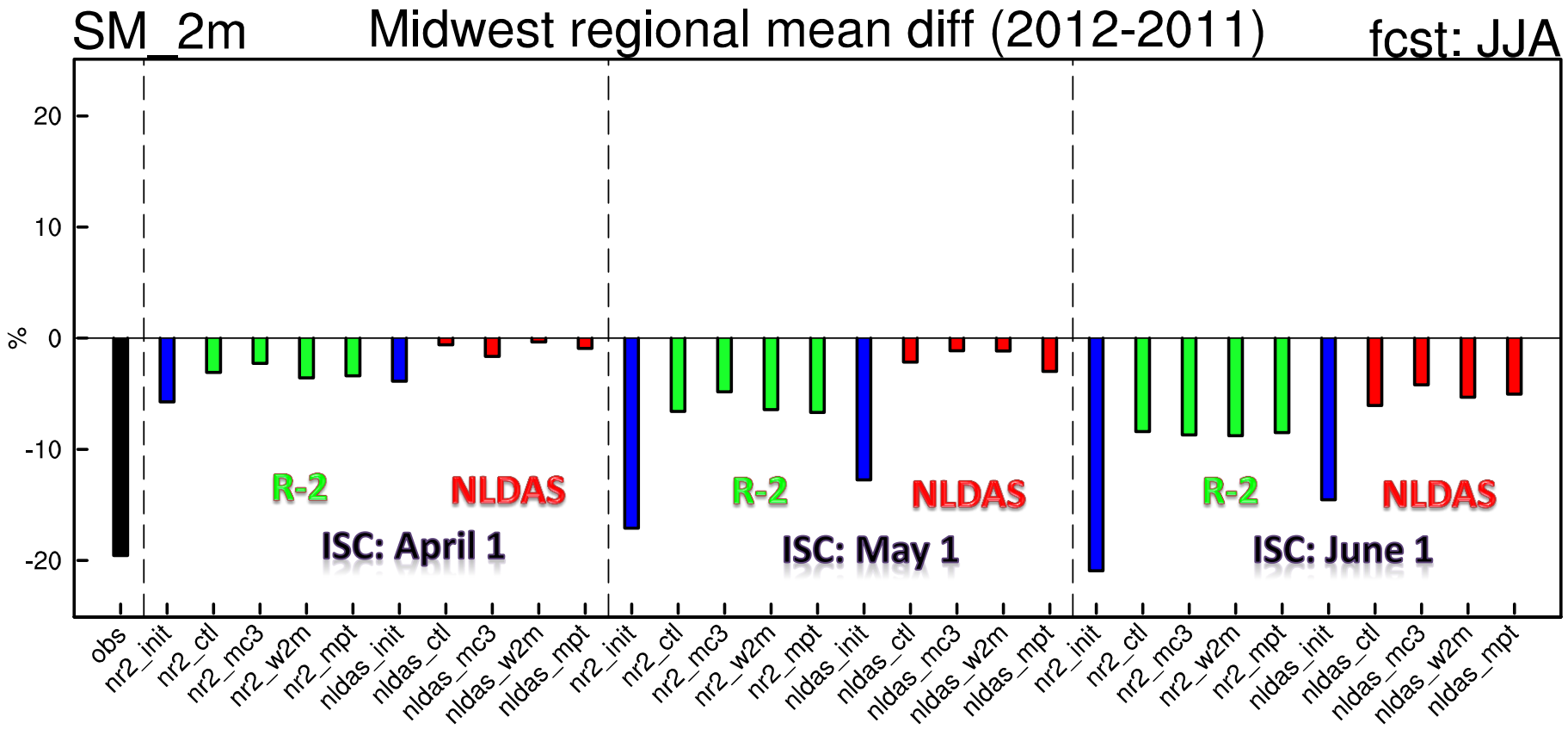
CWRF/ECHAM Prediction: 2012 versus 2011 Summer



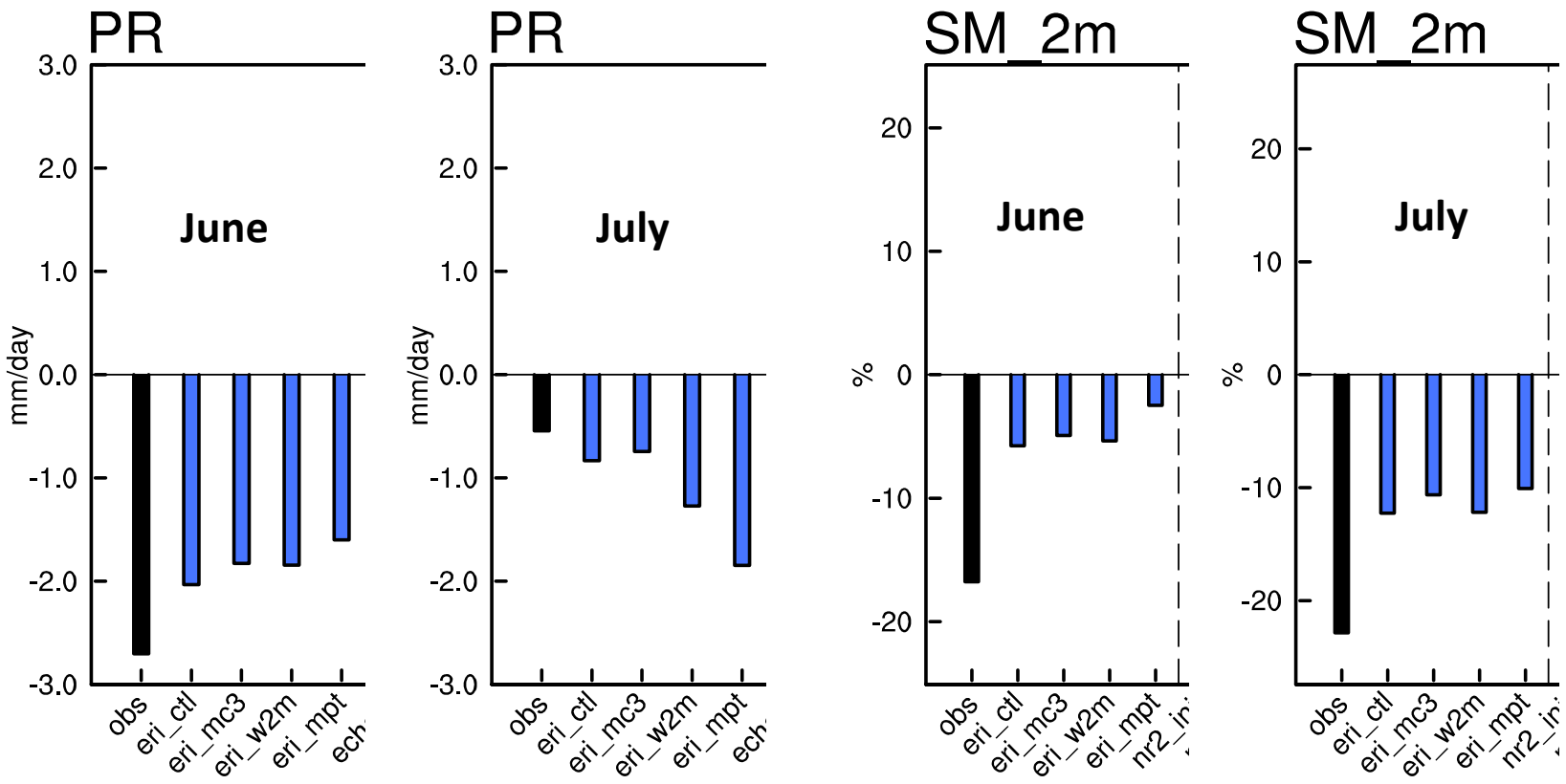
CWRF/ECHAM Prediction: 2012 versus 2011 Summer



CWRF/ECHAM Prediction: 2012 versus 2011 Summer



CWRF/ERI Hindcast: 2012 versus 2011 Summer

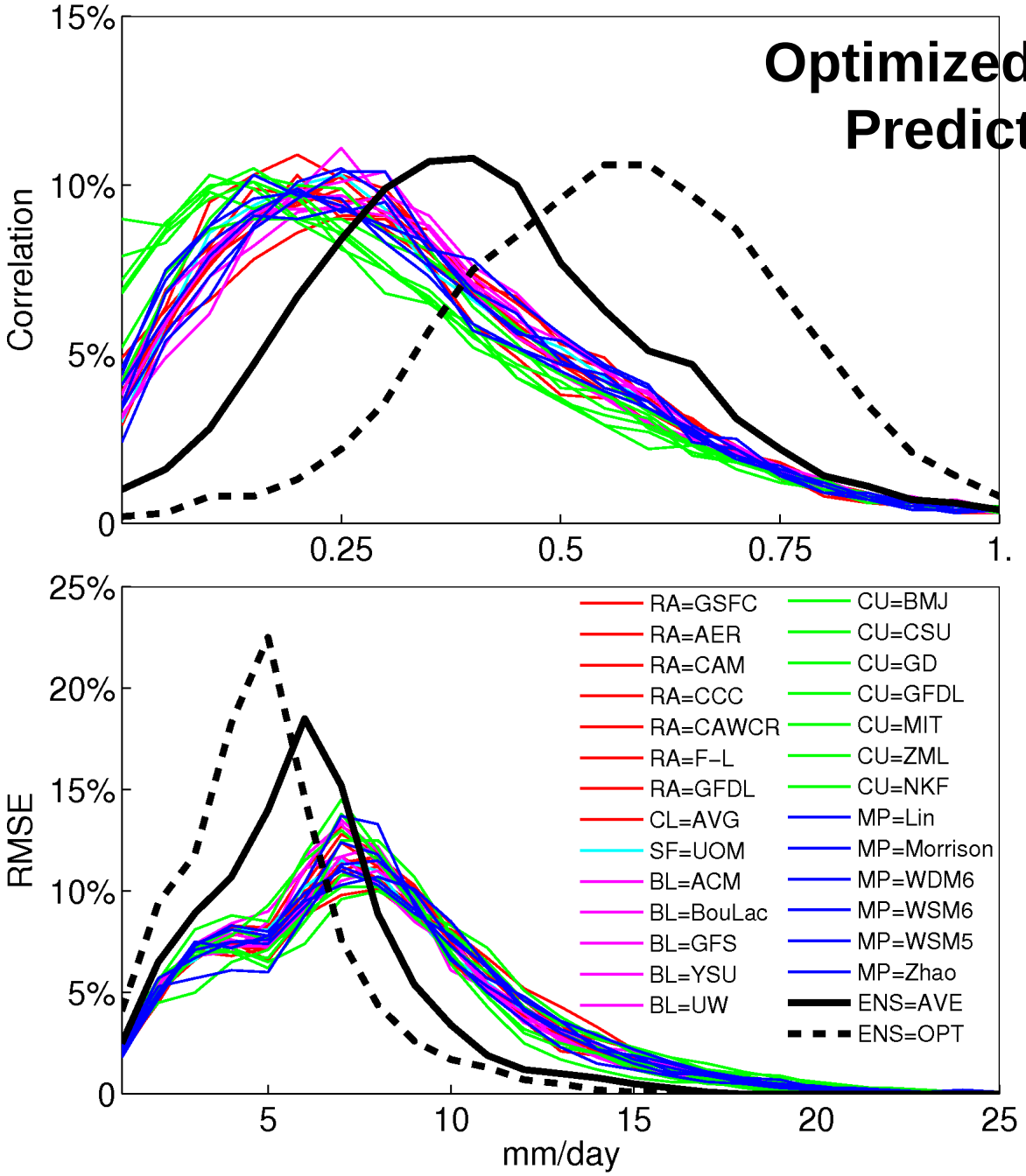


ECMWF-Interim

Drought Prediction Challenges

- Precipitation forecast is critical, requiring improved GCM forcing
- Initial soil state has strong sensitivity and may contribute half
- Regional processes may amplify the planetary forcing signals
- Inconsistent planetary forcing may lead to poor prediction
- Bias correction in GCM forcing conditions are necessary
- Land and coastal data assimilation needs to be explore
- Multi GCM forcing + optimized physics ensemble is yet to test

Optimized Physics Ensemble Prediction of Precipitation In summer 1993



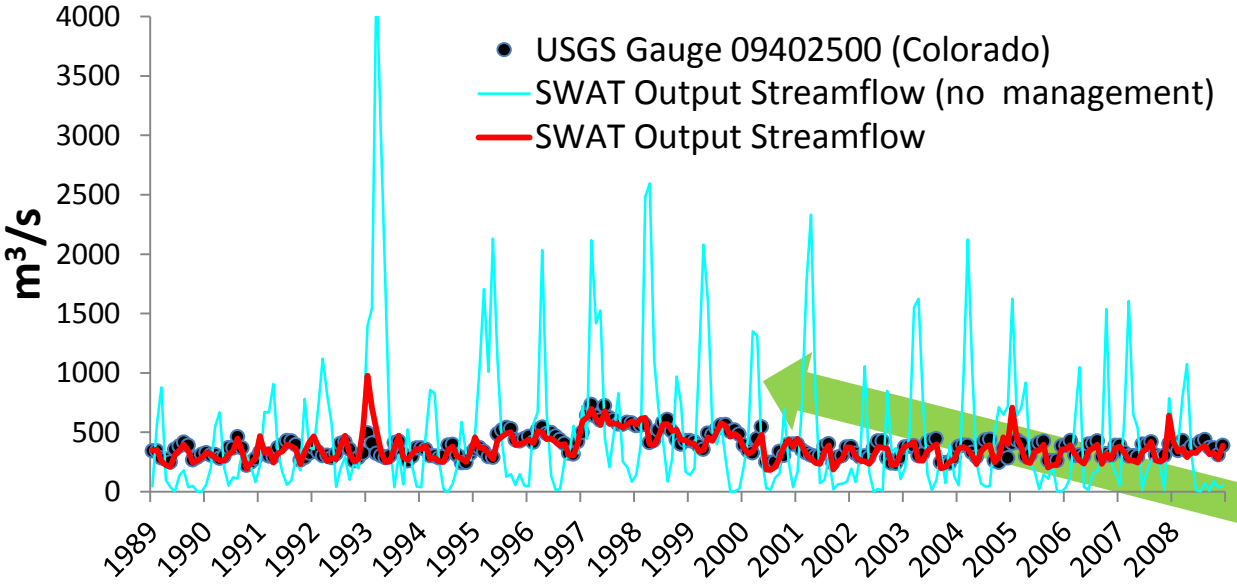
The physics ensemble mean substantially increases the skill score over individual configurations, and there exists a large room to further enhance that skill through intelligent optimization.

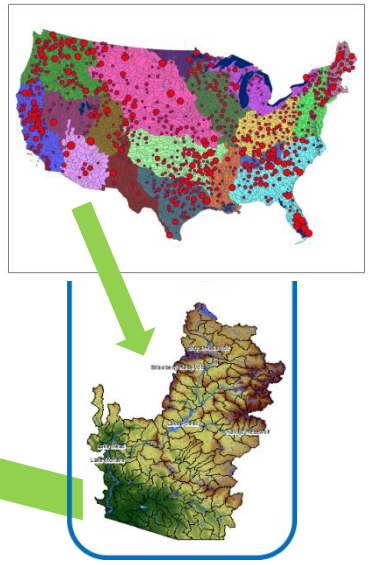
Spatial frequency distributions of correlations (*top*) and rms errors (*bottom*) between CWRF and observed daily mean rainfall variations in summer 1993. Each line depicts a specific configuration in group of the five key physical processes (*color*). The ensemble result (ENS) is the average of all runs with equal (Ave) or optimal (OPT) weights, shown as *black solid* or *dashed* line.

Simulating Human Management

from Historical Records to Future Predictions

- Numerical schemes in macroscale hydrological models for simulating reservoir outflow, irrigation, and other management strategies are very limited, especially lacking operation-based predictive schemes
- We have developed such a predictive scheme for
  - Reservoir management
  - Irrigation
  - Point sources, non point sources





CWRF OPE Prediction