

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

Raymond W. Arritt
Iowa State University, Ames, Iowa

Multi-RCM Ensemble Downscaling of multi-GCM Seasonal Forecasts

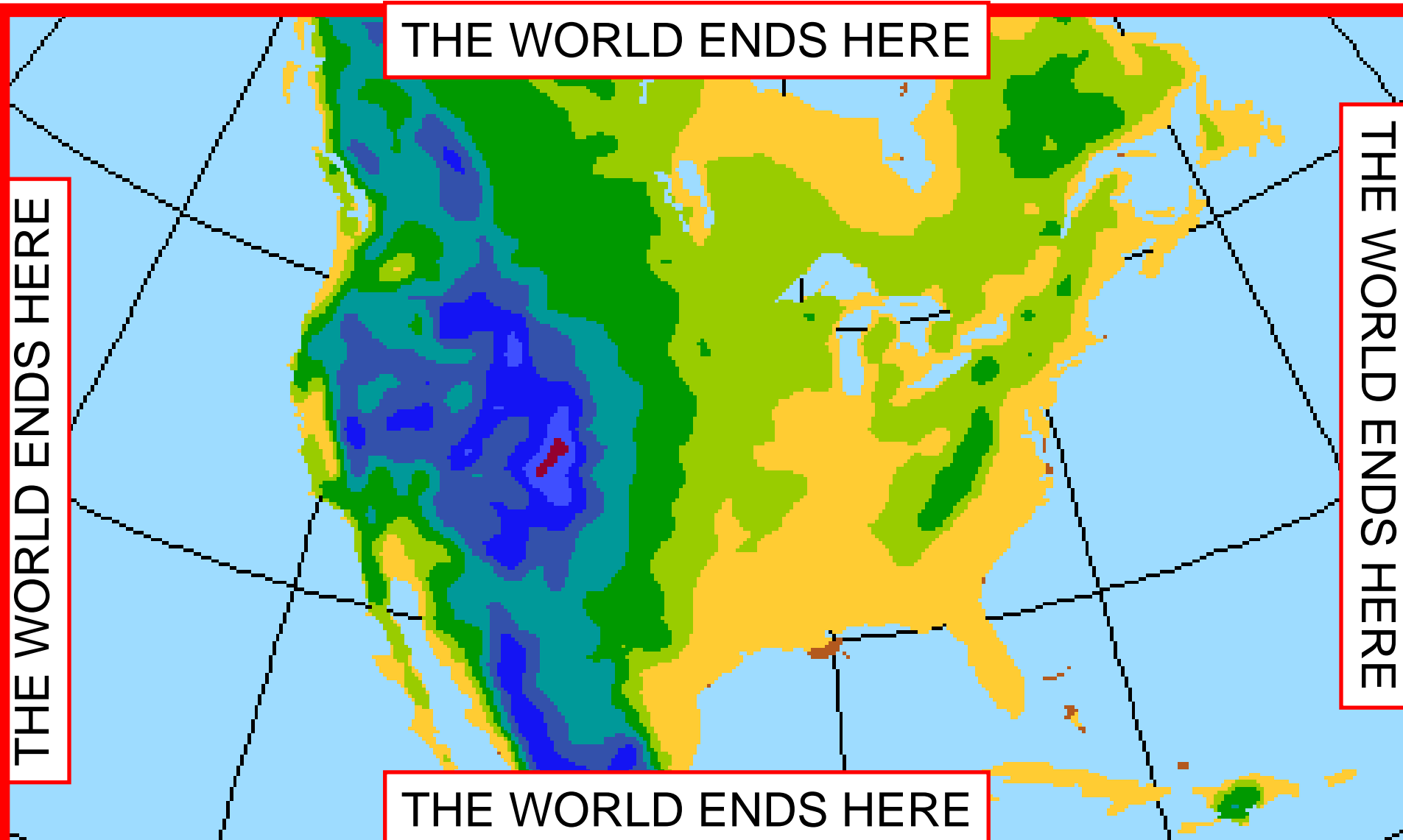
Objective: **Demonstrate the usefulness of multi-model downscaling of global seasonal forecasts for hydrologic applications.**

- Evaluate usefulness of dynamical downscaling for seasonal prediction over the coterminous U.S.:
 - Studies of dynamical downscaling have mostly focused on climate projections.
 - Evaluate strategies for producing **ensembles** of downscaled seasonal predictions.
- Provide predictions at higher resolution and regional level for **hydrologic applications.**

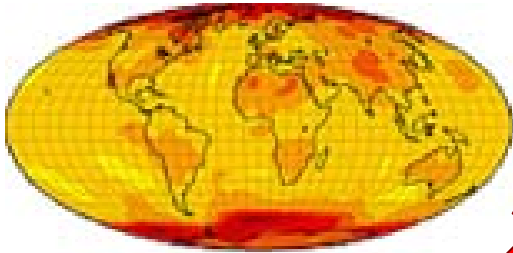
Dynamical Downscaling

- Regional models allow use of finer grid spacing than global models.
 - Regional = “not global”
- Benefits of finer grid spacing:
 - Numerical: $\frac{dy}{dx} = \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x}$
 - Better representation of terrain, coasts, land surface characteristics.
 - Simulate atmospheric structures that are too small even to exist at coarser resolution.
- But: we have a problem...

Regional models don't know about the world outside unless we tell them.

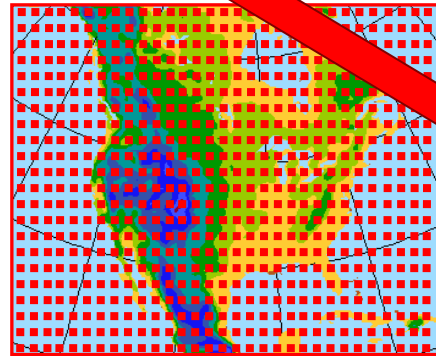


Dynamical Downscaling

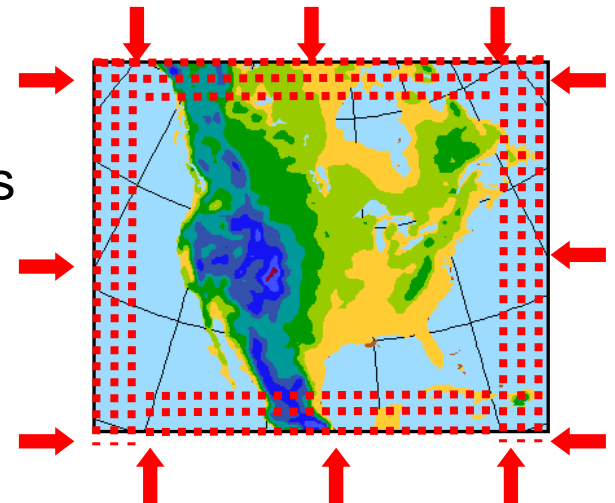


Run the global model, storing output several times per day.

Interpolate global model results to initialize the regional model grid.

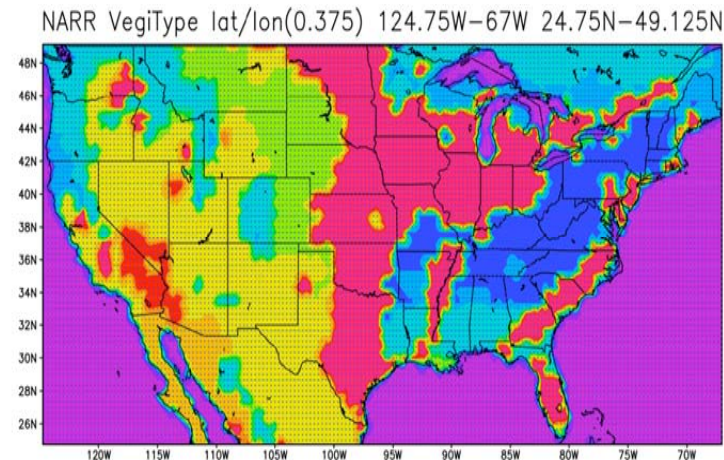


Continually update the regional model around its lateral boundaries using later results from the global model.



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

- Downscale 25 years of winter (December-April) **reforecasts** from new NOAA CFS global seasonal forecast model: T126L64 ($\sim 0.95^\circ$ lat/lon, 105 km).
- Will also downscale reforecasts from new NASA seasonal forecast model based on GEOS5 GCM coupled with MOM4 ocean (configuration testing in progress).
- Regional models will cover the coterminous U.S. at grid spacing 32 km, similar to North American Regional Reanalysis (NARR).



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

- **Initial focus is on winter** (1 December – 30 April)
- Evaluate effects of topographic forcing, snowmelt, and the potential to demonstrate the usefulness of higher resolution.
 - especially for near-surface fields influenced by high resolution orography.
- Winter focus provides linkage to the **cold season hydrometeorological research** area of CPPA.
- Winter season reflects **ENSO** forcing.

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

- Regional models will be used to create a **multi-model** ensemble with **multiple runs by each model**.

Three versions of WRF

Two versions of RSM

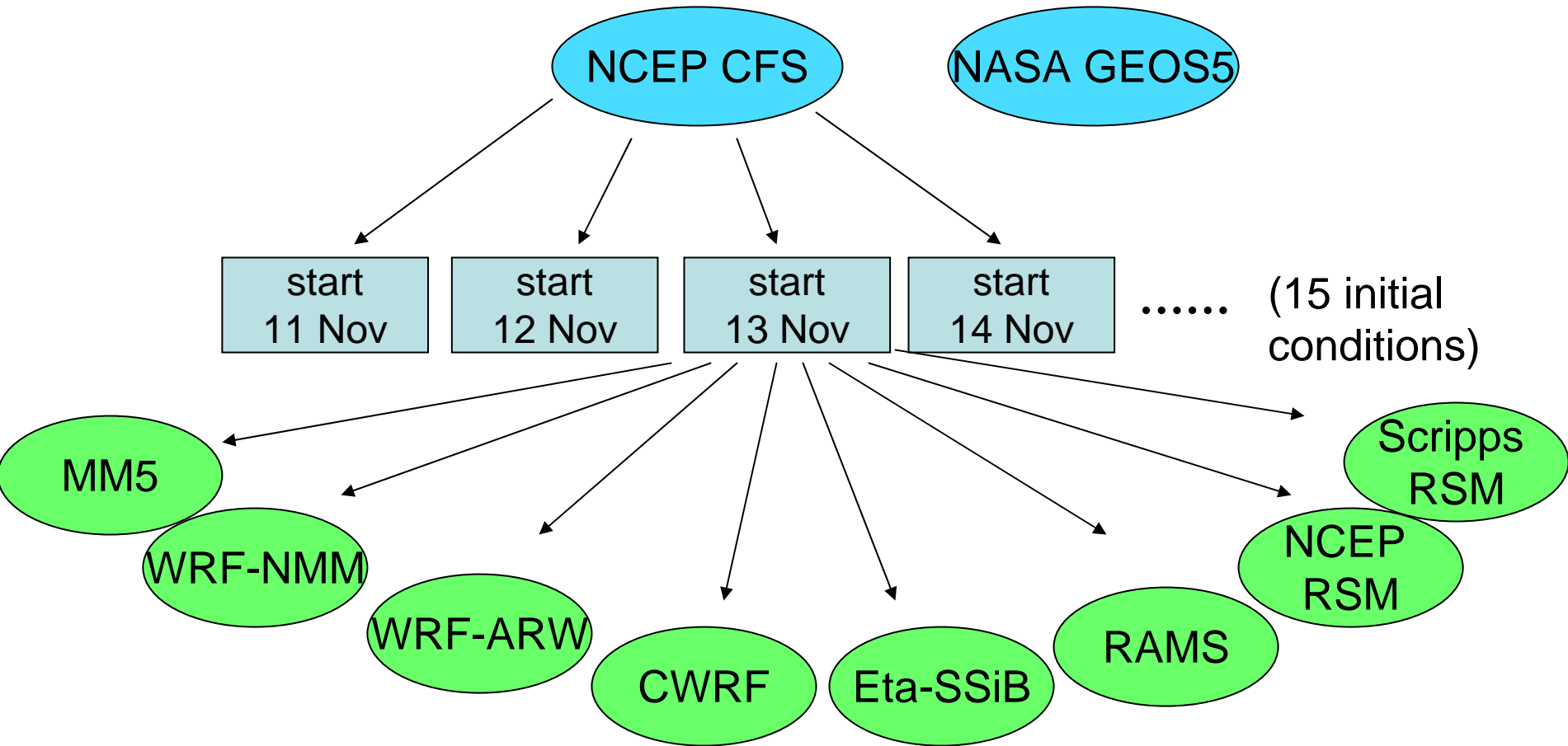
MM5

RAMS

Eta-SSiB

- Each regional model will run 15 ensemble members from each global model.

MRED Ensemble



MRED Participants

- Jin Huang, NOAA Program manager
- Annarita Mariotti, NOAA Associate program manager
- John Roads (deceased), Scripps Project originator, lead coordinator
- Raymond Arritt, ISU Lead coordinator, MM5
- Chris Anderson, ISU WRF-NMM-ESRL, MM5
- Bill Gutowski, ISU MM5
- H.-M. Henry Juang, NOAA CFS forcing, NOAA RSM
- M. Kanamitsu Scripps RSM, central analysis
- Lai-Yung (Ruby) Leung, PNNL WRF-ARW
- Xin-Zhong Liang, ISWS CWRF
- Chungu Lu, NOAA/GSD WRF-NMM-ESRL
- Lixin Lu, CIRA/CSU RAMS
- Ken Mitchell, NCEP CFS forcing, operational transition
- Roger Pielke Sr., Univ. Colorado RAMS
- Siegfried Schubert, NASA/GSFC NASA forcing
- Gene Takle, ISU MM5, applications
- Patrick Tripp, Scripps/UCSD Central analysis
- Yongkang Xue, UCLA Eta
- Rongqian Yang, NOAA CFS forcing

Output archive

- RCM output will be produced using a **standard output format** using netCDF.
 - Based on the format used in IPCC AR4 and adapted by NARCCAP for regional models.
 - Standard output format simplifies analysis and use of results for other applications, such as hydrologic modeling.
- Results from each model will be interpolated to a common grid (0.375° lat/lon over coterminous U.S.)

Relationship to Other Collaborative Projects

- **GEWEX**

- Prediction on seasonal to interannual time scales.

- **Coordinated Energy and water cycle Observations Project (CEOP)**

- Overarching CEOP goal: “Understand and predict continental to local-scale hydroclimates for hydrologic applications.”

- **Hydrologic Ensemble Prediction Experiment (HEPEX)**

- MRED results as input to hydrologic ensemble predictions. (Workshop on Downscaling of Atmospheric Forecasts for Hydrologic Prediction, July 15-17, 2009, Toulouse)

- **Suggestions?**