Regional Climate Modeling

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Goals:

To develop a tool and a capability for providing reliable, credible, and state-of-art climate and climate change information on regional to local scales for assessments, services, applications and decision making

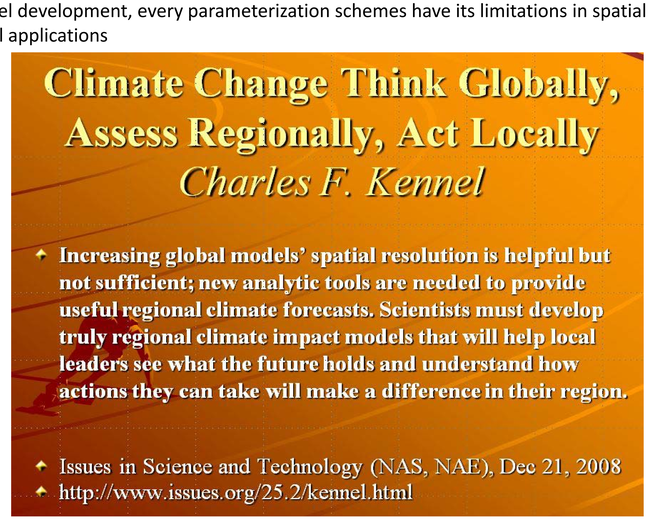
Summary of CWRF Development

- CWRF – (Regional) Climate version of WRF (Weather Research and Forecast) Model
- Since 2001, in parallel with WRF development
- A joint project with ISWS/UIUC and a close collaboration with WRF development community
- Funding sources (all through funded research proposals): EPA, NOAA, DOE, NASA, USDA, NSF
- HPC (High Performance Computing) support: NOAA, NCSA, DOE
- Annual operations funding level: about 1.5 million dollars
- People: 4-6 FTE, 1-2 postdoctoral research associates, 1-2 visiting scientists
- CWRF group is recently relocated from UIUC to University of Maryland at College Park

Rationales and Approaches

By recognizing a few myths in regional climate modeling development discussions and debates, we believe:

- Predominant climate sensitive physical processes are not exactly the same as weather sensitive ones in modeling.
- Off the shelf meso-scale weather model is not, by default, a regional climate model
- It is only true in theory that by increasing resolution, global model should be able to simulate regional characteristics. In reality, regional climate model is in great demand to provide useful information of climate and climate change for local communities and decision makers
- In model development, every parameterization schemes have its limitations in spatial and temporal applications



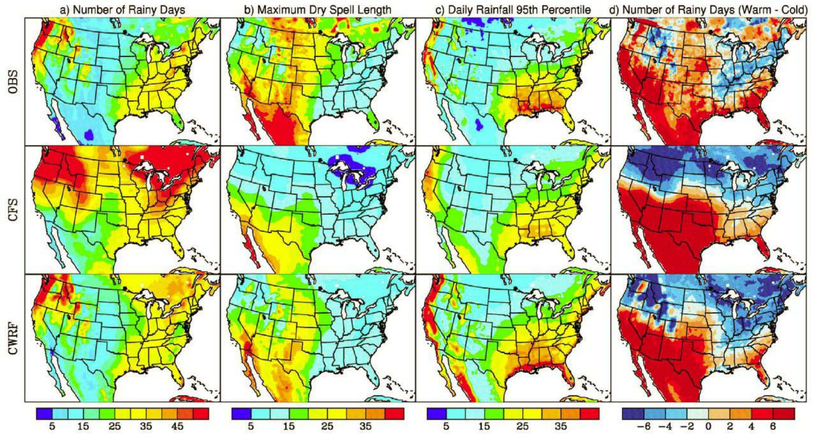
While performing proposed research tasks, we have planned and coordinated CWRF development and upgrades focusing on climate sensitive processes which often are not priorities in weather research and forecasts:

- Improving model surface conditions and characteristics using latest satellite observations
- Optimizing PBL schemes through ensemble experiments
- Improving stratus clouds and radiation feedbacks using long term simulations
- Improving cloud-aerosol-radiation (CAR) coupling processes
- Integrating surface and sub-surface hydrological processes
- Developing optimal physics and parameterization ensembles
- Synchronizing regional domain with global model

Current Status of CWRF Capabilities

By incorporating the improvements with WRF (ARW core) model, CWRF has shown better performance and capability

- By downscaling CFS (Climate Forecast System, NCEP) winter season forecasts from 1982-2008, CWRF reduces seasonal biases in precipitation over U.S. CONUS by 22 % on average
- Much improved simulations of precipitation intensity, temporal and spatial distribution, and areal estimates
- Much improved surface temperature simulations
- Using analyses or global model outputs as lateral boundary conditions, CWRF is able to simulate and provide downscaling capability continuously



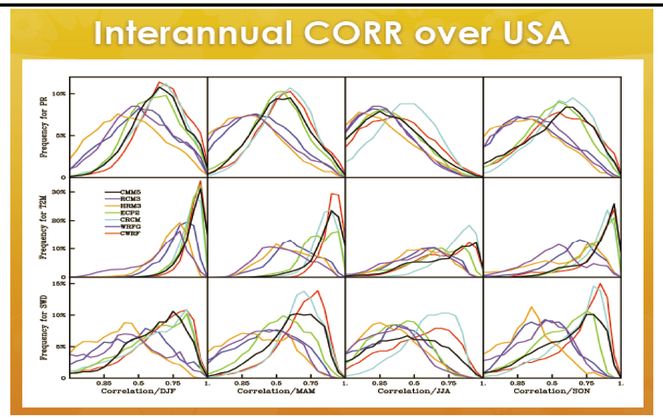
Observed (OBS), CFS-predicted, and CWRF-downscaled (a) number of rainy days, (b) maximum dry spell length (day), (c) daily rainfall 95th percentile (mm/day), and (d) difference in number of rainy days averaged between the El Niño (warm) and La Niña (cold) events for JFM during 1983–2008.

Accomplishments

- During last ten years, CWRF group has published more than 20 journal papers and presented at numerous national and international meetings and conferences
- NOAA supports in project management, strategic planning in development, resources coordination, visiting scientists and grants funding, partial HPC support are vital to CWRF development
- CWRF development has been greatly leveraged by 5 EPA STAR grants
- Visiting scientists
- Sponsored graduate students
- CWRF group is an important partner of NCAS (NOAA Center for Atmosphere Sciences, Howard University)

Indicators of Success

- CWRF group recently joined the Earth System Science Interdisciplinary Center (ESSIC) of University of Maryland at College Park, and formed the Earth System Modeling Research and Development (EaSM R&D) Laboratory and becoming the core modeling group of ESSIC
- CWRF is invited to participate IPCC AR5 CORDEX
- CWRF group developed cloud-aerosol-radiation (CAR) module is being tested in NCAR CCSM for uncertainty estimates
- Some of CWRF improvements are implemented in the forecast model of China Meteorological Administration
- CWRF and its performance is rapidly gaining attractions from community
- North American Regional Climate Change Assessment Program (NARCCAP) is actively seeking collaboration with CWRF group



This comparison includes all models from NARCCAP and CWRF groups

Collaborators and Partners

Future Directions

- Toward a regional Earth system modeling capability
- Incorporating a data assimilation capability
- Developing a model-based Satellite data calibration and validation tool
- Collaborating with impact modeling groups for supporting downstream applications