Regional Climate Model Intercomparison Program for the United States

A White Paper

by

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The past decade has seen rapid growth in the development and application of regional climate models (RCMs) derived from limited-area mesoscale atmospheric models. The growth has been spurred in part by RCM ability to resolve climate processes on scales relevant to human activities affected by climate variability and change. As concern about climate change grows, federal and state agencies and the private sector are demanding better regional climate change information from RCMs. The climate research community thus has strong motivation to improve RCMs and narrow their range of uncertainty in regional climate projections. Coordinated efforts within the community will play a major role in improving projections, as demonstrated for global simulation by the Atmospheric Model Intercomparison Program (AMIP).

The rapid growth in use of RCMs is exposing their strengths and weaknesses, but systematic evaluation of RCMs is lacking. Several U.S. groups are addressing elements of this evaluation with limited suites of models, but more comprehensive evaluation is necessary if RCMs are to provide support for policy decisions on climate change and adaptation. This paper

proposes uniting U.S. efforts, blending their complementary features into a cooperative framework that promotes significant advances in regional climate research while contributing to national efforts to assess and mitigate vulnerability to climate variability and anthropogenic change. The framework for this unified effort will support coordinated intercomparison research with the freedom for individuals and groups to contribute ideas, simulations and analyses through the peer-review process.

The key to establishing and sustaining this framework will be a support base anchored in federal funding, with state and private sector roles, that has community-wide support. The National Science Foundation (NSF) and the Department of Energy (DOE), in particular, are well-positioned to provide complementary resources that could sustain a systematic intercomparison with a potentially wide range of participants. DOE has a dedicated mission for anthropogenic climate change research. NSF supports peer-reviewed, curiosity-driven science and has as an explicit part of its mission educating and training future generations of scientists. Other federal agencies (such as NOAA, NASA and EPA), along with private sector and non-federal public agencies, provide additional links with societal needs and consequently have expanding interests in regional climate issues that need to be included in dialogue prioritizing climate information needs. Rapid advances in the quality of regional climate information are best achieved by combining the diverse missions and interests of these groups in a complementary national research program.

DOE labs collectively provide an infrastructure that in a coordinated framework could sustain and advance an RCM intercomparison. Lawrence Livermore National Laboratory (LLNL) has a well-established infrastructure for coordinating all aspects of numerical model intercomparison. The Pacific Northwest Laboratory (PNL) has led development of a community RCM that could anchor intercomparisons by being a testbed within the proposed framework for simulation configurations and development of analysis tools. Argonne National Laboratory (ANL) has developed important tools for managing and visualizing RCM output. Other supporting research is also performed at DOE labs, such as links to the hydrology community, coupled ocean-atmosphere global modeling and development of advanced numerics.

NSF contributes to RCM research through support of academic scientists and their students. NSF-supported research programs engage a wide variety of scientific perspectives that continually challenge and refresh the climate community. These programs are based on an open peer-review process that supports strong research and also nurtures future generations of scientists. NSF contributes to RCM research also through support of the National Center for Atmospheric Research (NCAR), a major facility providing core scientific support for research and education programs, community models, data archives and analysis tools.

The Electric Power Research Institute (EPRI) is a prominent example of private sector support for climate modeling research. Through support for programs like the Project to Intercompare Regional Climate Simulations (PIRCS), EPRI has expressed continuing interest in

advancing climate research and its application to climate change impacts. Public state and regional agencies are emerging as important partners in regional climate research through their support for regional-scale observing networks such as the Oklahoma mesonet. Databases such as these are vital complements to the synoptic observing network for evaluating regional-scale models.

We propose a framework for RCM simulation, analysis and improvement based on the complementary strengths identified above in research and infrastructures supported by DOE, NSF and the private sector. DOE labs with LLNL leading will provide sustaining infrastructure and participant support to collect and archive RCM input and output for designated intercomparison simulations. The labs will also develop and distribute tools for accessing, managing, analyzing and visualizing regional intercomparison output. The university community and NCAR will provide research programs of individual scientists and groups that perform contributing simulations, analyze intercomparison output and engage in student training and education for regional climate modeling. Universities will also host exchanges with related programs outside the U.S., such as the Regional Model Intercomparison Project (RMIP) for eastern Asia operated by the START Temperate East Asia institute in Beijing. Building on its role established in PIRCS, Iowa State University together with laboratory and university partners will provide scientific coordination to the regional intercomparison framework.

University and national laboratory scientists will develop within this framework a core agenda involving multi-year simulations identified by the community for key physical processes they highlight, such as climatic extremes. Intercomparison participants will use (to the extent possible given different model numerics) common domains and grid spacing. These core agenda cases will form the basis for evaluating collective strengths and weaknesses of RCMs and will also serve as control cases for sensitivity studies that systematically alter, for example, simulation domain, resolution, or model physical parameterizations. In addition, they will form a baseline for comparison with other methods of modeling regional climate, such as statistical downscaling, stretched-grid modeling and time-slice simulation by fine resolution global climate models.

The proposed program will build on initial efforts of PIRCS to coordinate international interests in regional climate simulation. Several RCM intercomparison programs have arisen in response to the rapid growth RCM use, such as ARCMIP, MERCURE, PIRCS and RMIP. Global coordination of such efforts, perhaps by a WCRP working group, is highly desirable, for it could promote complementary cases for simulation and wide accessibility of output for analysis. Such coordination is beyond the scope of the framework proposed here, but a strong U.S. program sustained by such a framework could provide international leadership in regional climate modeling.

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