Impact Relevance and Usability of High-Resolution Climate Modeling and Datasets

FINAL TECHNICAL REPORT

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1. Summary of Activities

The Aspen Global Change Institute hosted a technical science workshop entitled, "Impact Relevance and Usability of High-Resolution Climate Modeling and Datasets," on August 2-7, 2015 in Aspen, CO. Kate Calvin (Pacific Northwest National Laboratory), Andrew Jones (Lawrence Berkeley National Laboratory) and Jean-François Lamarque (NCAR) served as co-chairs for the workshop. The meeting included the participation of 29 scientists for a total of 145 participant days. Following the workshop, workshop co-chairs authored a meeting report published in *Eos* on April 27, 2016. Insights from the workshop directly contributed to the formation of a new DOE-supported project co-led by workshop co-chair Andy Jones. A subset of meeting participants continue to work on a publication on institutional innovations that can support the usability of high resolution modeling, among other sources of climate information.

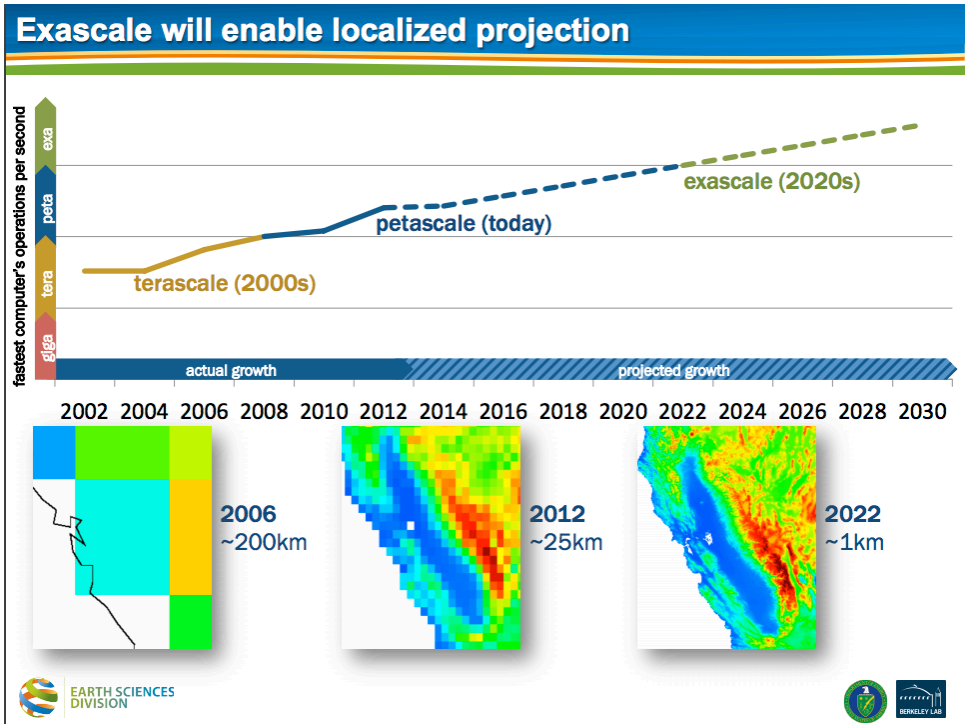
2. AGCI Workshop on High-Resolution

From August 2-7, 2015 AGCI gathered 29 researchers and users of research across diverse disciplines and applied contexts. Included in this meeting were experts on physical climate modeling, climate impacts and vulnerability, and science usability. Senior-level practitioners also attended, representing four sectors of focus: coastal planning & management, water resources management, agriculture, and public health & safety.

The workshop explored what the new generation of supercomputers will be able to do in predicting the climate – particularly at the regional scale – and how to generate more utility in these results for impacts research and planning. For example, at the workshop, Bill Collins presented a vision (Figure 1) for the improvements to resolution that may occur as climate modeling efforts move towards the use of exascale computing, although he added that gains in resolution are not necessarily to be accompanied by commensurate gains in predictability. Furthermore, discussion at the workshop examined the numerous tradeoffs for both research and application that occur as modeling resolution is refined. For instance, advancements in resolution may reduce the capacity for modeling centers to conduct numerous initializations of the same

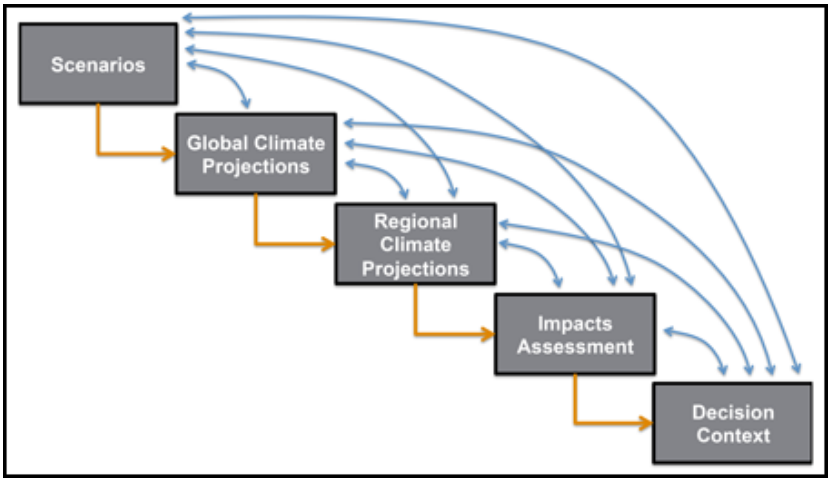
model, which some argue may mislead prospective users regarding the uncertainty of the model projections.

Figure 1. Computing Power & Climate Model Resolution
(Presented by Bill Collins, Berkeley Lab)



The spatial resolution of the current generation of global climate models does not always provide critical information at the scales considered helpful for planning and policy. User communities at the workshop expressed different desires for resolution and many acknowledged that resolution alone is not sufficient when predictability is low, uncertainty is high, or if support is not available to understand appropriate ways to utilize and make sense of model results. For example, workshop participants discussed the process for evaluating the performance of climate models at any resolution. They observed that existing approaches usually do not make clear to potential users (i.e., other researchers or end-user practitioners) what relevant capabilities a particular model or class of models may have for a particular application. This is especially relevant when realizing the number of separating steps between the generation of information in a climate model and the eventual end use in context. Andrew Jones presented a depiction of this chain of information at the start to the meeting, and it subsequently provided a framework for acknowledging the many technical and institutional connections and feedbacks that occur along the way from global climate projects to the decision context (Figure 2).

Figure 2. A Linked Chain of Models from Scenarios to Decision-Context (Presented by Andrew Jones, Lawrence Berkeley National Lab)



This workshop featured emerging capabilities for high resolution, both related to statistical and dynamical downscaling as well as for improved resolution within GCMs. Researchers and practitioners working actively in the sectors selected for this workshop, then provided examples of how current modeling tools are utilized, what kinds of benefits for analysis or planning models could accrue with improved resolution, and what other types of supporting resources would be required to realize the benefits of higher resolution. The workshop culminated in a discussion that identified critical technical and institutional opportunities for future work to improve the usability of high resolution modeling and datasets.

In the workshop, key instances emerged where high resolution modeling could make an important difference for practitioners, such as when:

- Relevant climate phenomena depend upon fine-scale physical processes that are difficult to parameterize in coarse-resolution models (e.g., hurricanes, topographically forced precipitation, extreme precipitation).
- Decision contexts involve planning at fine scales in complex terrain with diverse microclimates (e.g., conservation planning in coastal or mountainous terrain, extreme heat preparedness in complex urban environments).
- Impact models operate at fine spatial scales (e.g., hydrological models in complex terrain).

In addition to identifying areas of practice where high resolution may have benefit, ideas were presented at the meeting about how collaboration among different research communities, and between scientists and practitioner communities could be sustained and what particular outcomes from collaboration could have a meaningful impact on the usability of climate model data. At the workshop, social scientists presented examples of "boundary organizations" that help to broker, translate, and tailor climate information developed in research settings for applied purposes. It was proposed that one specific activity of collaboration, situated within a boundary organization or elsewhere, could be the development of a "Consumer Reports-style" guide to the utilization of different types of modeling products. This kind of approach would support a user-oriented model evaluation product, which was identified as currently absent but urgently needed.

3. Outcomes

Following the workshop, a meeting report on Climate Modeling with Decision Makers in Mind was submitted by meeting co-chairs and organizers and submitted to Eos. The article was published 27 April 2016.

Jones, A., K. Calvin, and J.-F. Lamarque (2016). Climate modeling with decision makers in mind. Eos, 97, doi:10.1029/2016EO051111. Published on 27 April 2016. https://eos.org/meetingreports/climate-modeling-with-decision-makers-in-mind

A public lecture in honor of Walter Orr Roberts was held during the workshop. Katharine Hayhoe (Texas Tech University) presented to a standing room only audience in Aspen, Colorado. The lecture was entitled "Climate Change: Connecting the Global Challenge to our Local Response," and presented the importance of creating high-resolution projections to understand and prepare for what our future climate will be. The recording of Hayhoe's talk can be viewed at: https://www.agci.org/lib/15s2wor/climate-change-connecting-global-challenge-our-local-response

Katharine Hayhoe was interviewed by the Aspen Public Radio about how climate change impacts Aspen, the White House's Clean Power Plan, and insights into her public lecture. The interview can be listened to at http://aspenpublicradio.org/post/climate-scientist-visits-aspen-weighs-white-house-clean-power-plan#stream/0

In response to ideas generated at the meeting about a Consumer Reports-style of user-relevant model evaluation, Andrew Jones along with Paul Ullrich at UCD designed a project called Hyperion that involves collaboration of several universities and national labs across the US. Hyperion is largely based around addressing a critical need identified at the AGCI workshop: engaging scientists with stakeholders, via several boundary organizations, to create a set of 'climate information report cards' that rate climate information datasets in both a process-based and impact oriented way. The project officially started on October 1, and the group will be holding the first of three face-to-face stakeholder engagement workshops on December 2, 2016 in the Washington DC area.

A workshop webpage is maintained by AGCI and features presentations and videos of workshop lectures and discussion: https://www.agci.org/event/15s2

4. Evaluation of 2015 Workshop

Evaluation Results

Impact Relevance and Usability of High Resolution Climate Modeling and Datasets

	Poor	Fair	Good	Very Good	Excellent	Totals
Session Theme Selection	0	0	0	8	9	17
	0%	0%	0%	47%	53%	
Quality of Presentations	0	0	1	7	9	17
	0%	0%	6%	41%	53%	
Logistical Support	0	0	1	0	16	17
	0%	0%	6%	0%	94%	
Personal Value	0	0	0	5	12	17
	0%	0%	0%	29%	71%	

Selected Comments from participants:

"AGCI continues to drive the conversation on many important frontiers of global change science through its convening of leading minds in a stimulating environment."

"The theme selection transitioned logically from the production of downscaled datasets through applications in major sections: agriculture, water management, coastal management and in the structure and health."

"Coming to the AGCI workshop opened my eyes to a new transdisciplinary way of thinking. It has shaped the direction I will take in my career."

"For more than 25 years, AGCI has shown the way in advancing interdisciplinary Earth Science. Its influence on the field has been far out of proportion to its small budget. Its track record is stellar and sustained."

"The discussions with individuals and meeting practitioners from different disciplines is of enormous personal value."

"As a junior person, this was tremendously valuable to my career."

"I didn't know anyone else at the meeting and I made connections I'll definitely use."

"I've got 4-5 research concepts to pursue as a result of attending."

"This was one of the most stimulating workshops I've ever attended."

Online Dissemination

Video recordings of workshop presentations were taken and available on the AGCI website. The presentations and videos can be viewed at: https://www.agci.org/event/15s2

5. Appendix: Roster and Topical Agenda

Roster

Jeff Arnold
Sr. Climate Scientist
U.S. Army Corps of Engineers

Katharine Calvin
Scientist
Pacific Northwest National Laboratory

Bill Collins
Senior Scientist
Lawrence Berkeley National Laboratory

Kristie Ebi
Professor
University of Washington

Jack Fellows
Director
Oak Ridge National Lab

Alan Flint
Research Hydrologist
U.S. Geological Survey

Lorraine Flint
Research Hydrologist
U.S. Geological Survey

Lisa Goddard
Director of IRI, Senior Research Scientist
IRI, Earth Institute, Columbia University

Alex Hall
Professor
UCLA

John Hall
Program Manager for Resource Conservation and Climate Change
Department of Defense

Katharine Hayhoe
Professor
Texas Tech University

Andrew Jones
Research Scientist
Lawrence Berkeley National Lab

Jennifer Jurado
Director, Environmental Planning and Community Resilience
Broward County

Laurna Kaatz
Climate Program Manager
Denver Water

Amber Kerr
Outreach Coordinator
USDA Regional Climate Sub Hub (CA)
University of California, Davis

Patrick Lott Kinney
Professor
Columbia University

Christine Kirchhoff
Assistant Professor
University of Connecticut

Jean-François Lamarque
Senior Scientist
NCAR

Maria Lemos
Professor
University of Michigan

Fred Lipschultz
Senior Scientist
U.S. Global Change Research Program

Neil Maizlish
Epidemiologist
Center for Climate Change and Health of the Public Health Institute

Linda Mearns
ISSE Senior Scientist
NCAR

Travis O'Brien
Research Scientist
Lawrence Berkeley National Lab

Bruce Riordan
Program Director
Climate Readiness Institute

Alex Ruane
Research Physical Scientist
NASA GISS

Constantine Samaras
Assistant Professor
Carnegie Mellon University

Richard Somerville
Distinguished Professor Emeritus
Scripps Institution of Oceanography

Claudia Tebaldi
Project Scientist III
NCAR

John Weyant
Professor
Stanford University

Daniel Williamson
Lecturer in Statistics
University of Exeter

Agenda

Workshop 2. IMPACT RELEVANCE AND USABILITY OF HIGH RESOLUTION CLIMATE MODELING AND DATASETS
2 August 2015 – 7 August 2015

AGENDA
SUNDAY, AUGUST 2
Arrivals in Aspen

MONDAY, AUGUST 3

Welcome and Introductions

9:00 am Introductions and purpose of the meeting
Remarks by **James Arnott & John Katzenberger**

9:10 am Stage setting
by **Katherine Calvin, Andrew Jones, Jean-François Lamarque**

Part I: Foundations in the production and use of high resolution datasets
Discussion leader: Jean-François Lamarque

11:00 am High Resolution Climate Modeling in Historical Context: Where are We Now, and How Did We Get Here? by **Richard Somerville**

11:20 am Peering into Pandora's Box: A Brief History of High Resolution Climate Projections and their Use in Impact Assessments by **Katharine Hayhoe**

11:40 am Update from EMF and Perspective from Integrated Assessment Modeling by **Kate Calvin**

12:00 pm Panel Discussion

Part I Continued: Foundations in the production and use of high resolution datasets

Discussion leader: James Arnott

2:00 pm Opportunities and Limitations of High Resolution Climate Data to Inform Adaptation and Development by **Lisa Goddard**

2:20 pm Useful to Usable: Strategies to Increase the Usability of Climate Information by **Maria Carmen Lemos**

2:40 pm The Practitioner's Dilemma: Useful versus Usable by **Laurna Kaatz**

Part II: Frontiers for the production and use of high resolution datasets

Discussion leader: Andrew Jones

4:00 pm Prospects for Converting Climate Models from Macroscopes to Microscopes by **Bill Collins**

4:20 pm Perspectives from USGCRP's Leadership Role at the Boundary of Science Advancement and Application by **Fred Lipschultz**

4:40 pm A Bay Area Perspective on Needs (with Universal Appeal) by **Bruce Riordan**

TUESDAY, AUGUST 4

Part III: Representative use cases for high resolution models and datasets:
Water resource management

Discussion leader: Katherine Calvin

Part IV: Representative use cases for high resolution models and datasets:
Agriculture and managed land
Discussion leader: Andrew Jones

11:15 am High Resolution Climate Information Needed for Agricultural Modeling Applications by **Alex Ruane**

11:35 am Using Downscaled Climate Products to Enhance Decision-Making in US Agriculture: Current Applications and Future Needs by **Amber Kerr**

11:55 am Landscape Responses to Changes in Climate by **Lorraine Flint**

12:15 pm Panel Discussion

Part V: Uncertainty and skill characterization
Discussion leader: Katherine Calvin

2:00 pm The Added Value of Considering Added Value in High Resolution Climate Simulations by **Linda O. Mearns**

2:20 pm Quantifying Uncertainty in Climate Model Projections: Challenges and Opportunities by **Claudia Tebaldi**

2:40 pm Uncertainty and Skill in Climate Models: Just How Important are the Parameters? by **Daniel Williamson**

9:00 am Barriers to Incorporating High Resolution Climate Information at Denver Water by **Laurna Kaatz**

9:20 am High Resolution (Mostly) Means Fewer Runs: How Big a Problem is That for Water-Resource Impacts? by **Jeff Arnold**

9:40 am Translating Climate into Hydrology at Fine Spatial Scales by **Alan Flint**

10:00 am Lessons Learned from Studies of Climate Information Brokering and Usability: Thresholds, Seasonality, and other Complications by **Christine Kirchoff**

10:20 am Panel Discussion

3:00 pm On the Need to Evaluate Physical Mechanisms Associated with Downscaled Future Climate Change Patterns by **Alex Hall**

3:20 pm Panel Discussion

6:00 pm **Walter Orr Roberts Memorial Public Lecture**
Climate Change: Connecting the Global Challenge to Our Local Response
Speaker: **Katharine Hayhoe**

WEDNESDAY, AUGUST 5

Part VI: Representative use cases for high resolution models and datasets:
Urban Planning, Coastal Management, & Infrastructure
Discussion leader: Andrew Jones

9:00 am The Use of Higher Resolution Climate Information for Water Resources and Climate Resilience Planning in South Florida by **Jennifer Juardo**

9:20 am ORNL Recent Experiences Working with Cities to Incorporate a Changing Climate into Their Urban Planning and Coastal Management by **Jack Fellows**

9:40 am Challenges to the Use of Climate Information by the Department of Defense: When Does "Resolution" Matter? by **John Hall**

10:00 am How Much Resolution is Necessary for Designing Infrastructure Under Uncertainty? by **Costa Samaras**

10:20 am Panel Discussion

Part VII: Representative use cases for high resolution models and datasets:
Public Health and Safety
Discussion leader: Katherine Calvin

11:00 am Human Health Morbidity and Mortality in High Resolution by **Kristie Ebi**

11:20 am Predicting and Preparing for the Public Health Impacts of Climate Change in California by **Neil Maizlish** –

11:40 am Health Impacts Modeling and Risk Management Needs in the Urban Setting: Examples from NYC by **Pat Kinney**

12:00 pm Panel Discussion

THURSDAY, AUGUST 6

9:00 am	Synthesis and Reflections Panel
9:10 am	Reflections of an Itinerant Systems Analyst on this Workshop by **John Weyant**
9:20 am	Translation, Communication, Trust by **Travis O'Brien**
9:30 am	Synthesis and Reflections by **Bruce Riordan**
9:40 am	Synthesis and Reflections by **Maria Carmen Lemos**
10:00 am	Panel Discussion
10:45 am	Breakout Group Session
11:45 am	Reconvene in Plenary to Report and Discuss
11:50 am	Breakout Group Session I Report: Climate by **Jean-François Lamarque**
12:00 pm	Breakout Group Session I Report: Decision Context by **Kate Calvin**
12:10 pm	Breakout Group Session I Report: Impacts by **Alex Ruane**
1:45 pm	Breakout Group Session II
2:45 pm	Reconvene in Plenary to Report and Discuss
3:45 pm	Breakout Group Session III

FRIDAY, AUGUST 7

9:00 am	Synthesis discussion
11:00 am	Discussion of Products and Wrap Up

Afternoon Departures