Prospectus for US CLIVAR Working Group on
Accelerating Research on the Scientific Foundations of
Regional Climate Risk Information

1. Motivation

There is an increasing demand for actionable information on climate hazards and risks to support climate adaptation. A broad spectrum of users, in both the public and private sectors, need information on regional manifestations of climate change, especially (but not only) the probabilities of extreme events, their potential impacts on various sectors and enterprises, how those are changing, and the associated uncertainties. The research-type data that is output routinely from existing climate models does not meet this need, due to the models' biases, low resolutions, and poor representations of extreme events, as well as the large data volumes that require considerable skill and judgment to render decision-relevant. In the last decade, the private sector has leapt into this gap, and a new industry has come into existence, largely focused on serving the financial sector. Catastrophe modeling firms that serve the insurance industry have also been adding climate change components to their models. While this is an exciting development, the private sector tools are generally proprietary, not fully documented, and not generally peer reviewed, making it difficult to evaluate their strengths and weaknesses, despite profound known scientific challenges with the production of the underlying climate data. Additionally, these models are generally expensive to license.

Governments —federal, state, and local— hold a great amount of climate risk and urgently need information on both present and future risk. So do nonprofit non-governmental organizations involved in development finance and disaster response. Private sector models are not ideal to meet these needs. Besides the expense involved, social-ethical considerations make proprietary models undesirable. Accountability to citizens requires openness and traceability. In order to accelerate progress, it is critical that the underlying scientific assumptions and methodologies that are foundational to making risk projections at regional scales are widely and openly debated in the scientific community. Our US CLIVAR Working Group will gather a group of scientists to assess the gaps in current science and formulate a strategy to fill those gaps.

Broadly, the science in question –climate risk– forms a layer between standard climate models (such as those used in CMIP) and the user, consisting of GCM and scenario selection, bias correction, downscaling, impact modeling, and uncertainty quantification. While all of this is studied to some degree by academic and government scientists, it is

not done in a coordinated way. There is nothing analogous, for example, to the reanalysis products that form the best estimates of the instantaneous state of the climate system, or the CMIP archive that comprises the best projections of future climate. These latter products are produced by large groups of scientists working in the open. Large numbers of research articles are published documenting their strengths, weaknesses, and uses for many applications. A user can freely obtain these data sets and use them in the knowledge that they are the scientific community's best efforts and that their shortcomings are also well understood. There is no such thing for actionable climate risk information, but there should be, and our Working Group will aim to move the scientific community towards this goal.

We note that, at present, no US science agency takes ownership of this area. Oddly, it is generally more difficult to obtain research funding for this kind of work, with its direct societal benefit, than for traditional climate science. As a consequence, the scientific community working on actionable climate risk is much more fragmented and disorganized than that working on traditional climate dynamics. We believe there is an opportunity to organize fundamental science activities to address the urgency of the current moment.

A particular emphasis will be on characterizing and managing the uncertainties in the large-scale climate state as it manifests in regional climate projections. This includes the ability of these high-resolution model fields to accurately capture the extremes that matter to human and natural systems: temperature, humidity, precipitation, and streamflow, as well as the fields that matter for specific applications like renewable energy (e.g., 100 m winds and surface solar insolation). It also includes how to handle fundamental uncertainties in our projection of large-scale climate, including not just in global metrics of climate change but also those associated with internal variability as well as the spatial patterns of climate change, in the way that is most relevant to adaptation decisions.

The focus on uncertainty, particularly with regard to the connection of user needs to questions of underlying climate dynamics, is perhaps what is most lacking in the private sector, and is also where the basic research community has the most to offer. Consistent with this, our group will comprise largely of academic and government scientists. We will, however, seek input from private and public sector colleagues in the so-called "stakeholder" community, as their knowledge and experience in developing climate risk data sets and products are highly relevant and valuable. While the emphasis will be on climate science, the membership will include colleagues with expertise in engineering, economics, and other areas that are essential to the application of regional climate risk information.

2. Objectives, Tasks, Timeline

The goal of this effort is to develop the foundations for a new scientific field of climate risk, adjacent to and drawing strongly upon traditional climate science, but distinct from it in the focus on actionability and explicit representation of impacts. Central to this goal are: (1) the development of open models and data on physical climate risk; (2) characterization of their limitations and uncertainties, so that they will be as usable and reliable as possible for real-world decision-making; and (3) documentation and strengthening of the underlying scientific understanding necessary to make those models and data as good as possible. This working group will work to develop a strategy for the community to address these needs.

We propose the following tasks, spread out over three years.

1. Hold online meetings of the working group, approximately once per month in the first year, alternating between regular meetings and open webinars. Frequency in later years to be determined.
2. Hold one focused, in-person workshop, tentatively at Texas A&M University at the end of Year 1, 2-3 days in duration, to review and assess the working group's progress to that point and science of climate risk more broadly, and to advance the next steps. The attendees will be the working group members, plus possible additional participants, total number of participants perhaps 20-30.
3. Write a US CLIVAR white paper as the outcome of the first workshop.
4. Organize sessions or town halls at AGU and AMS annual meetings to allow for broader participation and visibility in years 2-3.
5. Write a BAMS article presenting the findings and recommendations of the working group in year 3.
6. Work with AWS to stage any relevant data to a central repository in year 3.

3. Publications and Outreach

We will write at least one article in a scientific journal (e.g., Bulletin of the American Meteorological Society) describing our findings and proposing strategies for addressing the problem, with the intended readership being federal program managers as well as academic, government, and private sector scientists. The journal article will provide recommendations on how to accelerate the development of the science foundation, and specifically identify: scientific/technical gaps; workforce development needs; resource needs; and organizational questions, including how to change the incentive structure to do the needed science as well as how to engage with user communities.

The overall purpose of the publication will be to recruit more academic and climate scientists to work on this problem; inform funding agencies of the needs and gaps in the development, study, and use of actionable regional climate risk models and data sets, including the underlying science needed to make them robust, reliable and well-characterized; and spur the development of such open-source models and data sets.

Our co-chairs and members regularly give talks to a wide range of audiences, both scientists and non-scientists, and will use the content produced by this group in those. Our co-chairs also both write for the mainstream media, do podcasts, etc., and will incorporate this material there as well.

4. Reporting Plan

We will report out on progress and plans to the US CLIVAR SSC and panels each summer. A white paper will be published in year 2, and a BAMS article presenting findings and recommendations will be published in year 3.

5. Leadership and Suggested Membership

Co-Leads: Adam Sobel (Columbia), Amy Clement (Miami), Andrew Dessler (Texas A&M), Alex Hall (UCLA)

The suggested membership, listed below, reflects a range of expertise and institutional types from academia, research labs, and private sector institutions.

1. Adam Sobel (Columbia): extreme weather, climate dynamics, climate risk
2. Amy Clement (Miami): climate dynamics and regional climate adaptation
3. Andrew Dessler (TAMU): climate impacts, urban meteorology, energy systems
4. Alex Hall (UCLA): regional climate dynamics and modeling
5. Jane Baldwin (UCI): climate dynamics and impacts of extreme events
6. James Done (NSF NCAR): extreme weather and climate risk
7. Kelly Hereid (Liberty Mutual): private sector, insurance
8. Sarah Kapnick (JP Morgan): climate dynamics, regional climate modelling, science policy
9. Dan Kirk-Davidoff (EPRI): atmospheric science, renewable energy, utility industry
10. Bob Kopp (Rutgers): climate and sea-level scientist and climate policy scholar
11. Paul Loikith (Portland State): regional climate dynamics
12. Justin Mankin (Dartmouth): impacts of climate change
13. Simona Meiler (Stanford): weather and climate risk

14. Frances Moore (UC Davis): environmental economics and climate science
15. JT Reager (NASA JPL): hydrologic extremes, changing water resources, and implications for society
16. Nick Siler (U of Oregon): regional climate dynamics
17. Deepti Singh (Washington State): climate dynamics and extreme event impacts
18. Paul Ullrich (LLNL/Davis): regional climate information

6. Relevance to US CLIVAR

The research initiative on regional climate risk information directly advances US CLIVAR's core area of climate variability and predictability across multiple timescales, with crucial implications for decision-making. By focusing on the scientific foundations that connect large-scale climate dynamics to regional manifestations of climate hazards, this working group addresses a critical gap between climate science and actionable information. This working group will strengthen the connection between US CLIVAR's emphasis on physical climate processes and the growing societal need for reliable risk information by developing open methodologies for using climate data for societal applications. These methodologies will ensure that the climate dynamics research fostered by US CLIVAR can be effectively translated into regional applications while maintaining scientific integrity, transparency, and rigor.

7. Resource Requirements

We request support of the in-person workshop (including travel for participants) as well as publication fees.