

## **Fiscal Year 2023 Competition Information Sheet: Climate Futures: Projections for Societally-Relevant Problems**

### **Program Name**

Modeling, Analysis, Predictions, and Projections (MAPP) Program

### **Program Mission**

The Modeling, Analysis, Predictions, and Projections (MAPP) program supports advances in the development and application of Earth system models and analyses across NOAA for the purpose of building resilience to climate impacts, predicting and projecting change from years to decades in the future, and improving our understanding of and ability to simulate the Earth system. MAPP works with partner agencies in the U.S. Global Change Research Program, and focuses on engaging the non-NOAA research community to help advance NOAA's modeling capabilities and applications.

### **Focus for FY 2023**

#### **Climate Futures: Predictions and Projections for Societally-Relevant Problems**

### **Funding for FY 2023**

Pending the availability of funds in FY 2023, it is anticipated that \$1,000,000 will be available to fund 5-6 type 1 proposals, which should propose a funding level of up to \$200,000 per year for three years.

It is anticipated that one type 2 proposal will be funded at a level of up to \$2,000,000 per year for four years with \$1,000,000 available for a fifth year. The bulk of the funds for type 2 proposals should be used to support activities based at NOAA laboratories, centers, and Cooperative Institutes, although collaborators from non-NOAA institutions are welcome to join or lead the project. Proposing teams for type 2 projects should consider a declining funding profile as part of a demonstration that the capability could be maintained as part of existing activities, or leveraging existing activities. Additional resources outside of the above total may be available to the team to help support proposed community workshop logistics and planning.

### **Competition Information**

There is a long-identified need for reliable Earth system information that looks forward years to decades in the future. That need is only growing as awareness of infrastructure vulnerability to changing climate and weather conditions increases, and as climate change impacts manifest ever more clearly in real time. In the United States, the information need is currently met in a heterogeneous fashion depending on the forward-looking timescale -- through individual researcher-stakeholder interactions, bespoke data and information provision approaches that use a diverse array of methods (e.g., downscaling), loosely coordinated interannual to decadal prediction efforts, and a panoply of tools and private services targeting individual user communities with a diverse range of expertise, needs, and technical proficiency. A rich network of user-scientist relationships and an array of approaches has emerged to draw on.

As NOAA considers and develops its role in this information and service space, a number of motivating factors have converged. First, the agency is increasingly being asked by National-scale organizations to produce consistent, reliable, transparent mid-to-long-range forward-looking climate information. These inquiries come in addition to the myriad requests for prognostic climate information that come to various NOAA offices and staff, e.g., NWS forecast offices, Regional Climate Centers, Regional Climate Service Directors, etc. Second, NOAA has a number of unique and preeminent capabilities and organizational components that may be optimally assembled to meet this need. Third, NOAA has a mission requirement to serve as a provider of authoritative and transparent information services and products across a wide array of Earth system features and sectoral needs.

NOAA currently serves as the National lead in producing weather and seasonal forecasts and information products, a task that necessitates high-quality research, observations, and modeling to produce reliable, transparent, and equitable information for a diverse array of users. The NOAA Geophysical Fluid Dynamics Laboratory's (GFDL's) distinguished climate models, Earth system models, and cross-timescale prediction systems are available to tackle extended prediction and projection needs. These systems have been applied to weather forecast improvements at NOAA, but have not yet been connected to a routine product and service delivery effort for longer timescales outside of the Coupled Model Intercomparison Project, which does not directly feed into products and services. The National Centers for Environmental Information (NCEI), and various laboratories and other operational centers, routinely provide high information-quality climate products and services, but not for forward-looking, multi-year to multi-decade timescales. A number of information, service delivery, and collaboration structures with deep experience in climate information and services currently exist at NOAA -- the Regional Integrated Sciences and Assessments program, Regional Climate Centers, Regional Climate Service Directors, for example. NOAA is currently experimenting with a prediction/projection-to-product pipeline through the Climate, Ecosystems, and Fisheries Initiative, although this effort is specifically focused on marine ecosystems and the National Marine Fisheries Service mission. However, it serves a model for how focused product and service development on longer lead timescales could work for other impact areas.

To address the above context, and extract new value from NOAA's well-positioned organizations and capabilities, this research solicitation seeks to test and build the science and structure needed to support NOAA's nascent efforts to provide information on mid-to-long timescales, and to connect NOAA's research and modeling capabilities with its product development and services capabilities.

Over the past few years, NOAA's GFDL developed and released the Seamless System for Prediction and Earth System Research (SPEAR)<sup>1</sup> to support R&D and forecast efforts in the seasonal to multi-decadal time frame. The SPEAR system uses many of the components of GFDL's flagship CM4, but is optimized to run large ensembles for prediction purposes over a wide variety of timescales, and in a computationally-flexible manner generally favoring higher atmospheric resolution over ocean resolution<sup>2</sup>. Predictions from the system are currently contributed to the North American Multi-Model Ensemble<sup>3</sup> project as well as the Lead Centre for Annual-to-Decadal Climate Prediction organized by the UK Met Office<sup>4</sup>. The system is also designed to flexibly take advantage of future advances in GFDL's atmospheric, land, and ocean modeling; for example, types of variable resolution grids are being prototyped in GFDL's atmospheric modeling efforts which could enable high-resolution telescoping over regions of interest for weather and climate impacts. SPEAR offers the opportunity to leverage and apply

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<sup>1</sup> <https://www.gfdl.noaa.gov/spear/>

<sup>2</sup> <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS001895>

<sup>3</sup> <https://www.cpc.ncep.noaa.gov/products/NMME/>

<sup>4</sup> <https://hadleyserver.metoffice.gov.uk/wmolc/>

GFDL's class-leading climate modeling capabilities toward new products and services on multi-annual to multi-decadal timescales as a key part of NOAA's emerging Climate-Ready Nation effort<sup>5</sup>.

The MAPP program has a long history of supporting prediction and projection research and development, climate and Earth system model evaluation and analysis, applications of modeling and prediction systems to climate impact problems, investigations of multi-timescale predictability in the Earth system, the development of prediction and projection products, and R&D for the testing and transition of systems and products to real-time or operational use. Much of this work is focused on extending the strong internal efforts at NOAA's laboratories and operational centers, demonstrating new capabilities, and transitioning those capabilities into routine use. An example of this type of work is a project recently funded by multiple CPO programs (CVP, COM, MAPP, Assessments) focusing on explaining climate extremes events. This project offers a demonstration of the potential connectivity between research, modeling, observations, and products that could exist across NOAA in support of forward-looking climate products and services. Leveraging and building on this history, proposals are solicited through this competition that will evaluate and test NOAA prediction and projection systems on multi-annual to multi-decadal timescales.

For FY23, the MAPP program invites proposals that use data from the SPEAR system in combination with other large ensemble and projection datasets in R&D projects exploring the representation of processes and phenomena that serve as sources of predictability, the fidelity of SPEAR's simulation of high-impact extreme events, and applications of SPEAR toward near-term climate projections (i.e., timescales up to 50 years in the future). Proposals may also apply SPEAR and other datasets toward the development of experimental projection products using existing SPEAR forecast variables. Such projects should focus on phenomena or projections for which the expectation of useful model performance and fidelity may exist, based on existing research. Proposals may include offline or secondary modeling or statistical work to extend SPEAR projections into different systems (e.g., the atmospheric boundary layer or coastal regimes) or to apply bias correction, and may apply machine learning or other artificial intelligence approaches. In addition to SPEAR data, proposals should use data from other projection datasets (e.g., CMIP6), or other large ensemble datasets as part of the proposed work. Use of projection and large ensemble data from other U.S. modeling centers is encouraged. When possible, proposals are encouraged to link their evaluations back to recommendations for model and system improvements, for example, through published journal articles, collaborations with GFDL staff, or contributions to the Model Diagnostics Task Force package<sup>6</sup>

CPO has organized its programs to focus on high-priority climate risk areas<sup>7</sup> including extreme heat, hydroclimate and water resources, marine ecosystems, and coastal inundation. The motivation behind these risk areas is to organize collective opportunities to focus research toward applications for the work CPO's individual programs fund. Proposers are encouraged to think about potential applicability of their work within the context of those climate risk areas. Proposals focused on marine ecosystems are **not encouraged** through this competition, as those topics are covered through other MAPP solicitations. Proposers are encouraged (although not required) to focus on one or more of the following phenomena in their projects, which have been identified as a high priority to stakeholders with which NOAA is currently working: precipitation (mean and extreme), temperature extremes, coastal sea level and inundation, and near-surface (boundary+surface layer) winds that are relevant for human infrastructure.

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<sup>5</sup> <https://www.noaa.gov/news-release/noaa-fy-2023-budget-advances-climate-ready-nation-new-blue-economy-and-equity>

<sup>6</sup> <https://www.gfdl.noaa.gov/mdtf-diagnostics/>

<sup>7</sup> <https://cpo.noaa.gov/News/ArtMID/7875/ArticleID/1945/NOAA%E2%80%99s-Climate-Program-Office-launches-Climate-Risk-Areas-Initiative>

Two types of proposals are solicited through this competition:

- (1) Proposals that will address the research questions noted in the solicitation above centered on evaluating and applying data from SPEAR to multi-decadal projections.
- (2) Proposals that will explore the research questions above as well as the **development of a NOAA multi-decadal projection capability** that connects NOAA's research capabilities to experimental products. Proposed work should focus on research questions regarding the appropriate approaches to providing routine multi-decadal projections including:
  - the types of techniques and datasets needed to develop projection products including observations, model data, statistical analysis techniques; and product development;
  - exploring the limitations of near-term projections, including the various sources of model, systemic, and external uncertainty;
  - connectivity between product development and delivery back to projection system design and improvement;
  - how to routinize methodologies, analysis, and product production in order to provide information with rapidity;
  - how to work with stakeholder communities to co-develop projection products useful to applications, but also generalizable to other community needs;
  - the types of platforms and tools needed to present and disseminate information to projection consumers;
  - bringing in datasets, approaches, and collaborators from other U.S. modeling centers;
  - how to handle large model datasets effectively across organizational boundaries at NOAA;
  - identification of modeling system and observational gaps that require focused research and development to better capture and project phenomena on multi-decadal timescales;
  - working with and integrating known stakeholders or groups into the project plan to help develop and test service delivery processes and frameworks;
  - leveraging existing NOAA regional information structures (e.g., RCCs, RCSDs, RISAs, NWS Field Offices) to receive and understand projection information requests, and disseminate products and services; and
  - how a projection service delivery framework would be sustained, including responsibilities and scheduling (e.g., how frequently should projection information be updated, and what are the internal and external drivers for those updates).

Type 2 teams should:

- scope this activity in the context of NOAA's Technical Readiness Levels roughly moving from RL 2 (applied research) to RL 7 (prototype system demonstration) over the course of the project;
- engage with and leverage the capabilities of the Technical Support Unit (TSU) at the National Centers for Environmental Information, exploring how the developed capability can augment existing NOAA Assessment activities led by the TSU;
- target the prospective capability to be flexible and efficient from a staff and resources perspective, leveraging ongoing activities and capabilities as much as possible, and envisioning how a capability would be operable within existing activities, structures, and resources;

- integrate management and collaboration plans that will effectively and productively engage scientists and staff from across NOAA institutions with each other by including elements such as co-designed and led community workshops, visiting scientist opportunities across NOAA institutions, regular team calls and/or meetings, or other elements that will encourage proximity and open collaboration across the research team;
- plan and prepare for a review of the project during the second half of the third year of the project period;
- propose a way to lead, entrain, and coordinate relevant type 1 projects funded as part of this solicitation to engage the broader community in this effort.

A limited set of variables is currently available from the SPEAR system<sup>8</sup>. Proposers are strongly advised to familiarize themselves with the available data as they scope their projects. For funded proposers, additional variables and data frequencies relevant for hydroclimate risks, and coastal impacts may be made available for funded investigators. Proposers should list variables and frequencies needed for proposed analyses in their Letters of Intent so that feasibility can be evaluated. Higher-resolution data (e.g., 25km atmospheric grid) also may become available during the course of the project.

MAPP Competition Manager: Daniel Barrie ([daniel.barrie@noaa.gov](mailto:daniel.barrie@noaa.gov))

#### **Additional General Guidelines for Applicants**

- Principal Investigators submitting a proposal in response to this Announcement are required to follow the Letters of Intent (LOI) and Proposal preparation and submission guidelines described in the Climate Program Office FY 2023 Federal Funding Opportunity announcement.
- Investigators are strongly encouraged to submit an LOI prior to developing and submitting a full proposal. LOIs should be submitted through the [FY23 Letter of Intent submission form](#)<sup>9</sup>; investigators unable to submit via the Google form should email their LOI to [daniel.barrie@noaa.gov](mailto:daniel.barrie@noaa.gov). Investigators will be notified by the Competition Manager as to whether a full proposal is encouraged based on the LOI within 30 days of the LOI due date.
- Administrative questions regarding the Federal Funding Opportunity (e.g. proposal formatting or submission guidelines) should be directed to Diane Brown ([diane.brown@noaa.gov](mailto:diane.brown@noaa.gov)).

#### **Diversity and Inclusion**

The Climate Program Office's MAPP recognizes that it has a particular and unique opportunity and responsibility to support NOAA's and the community's commitment to diversity and inclusion by taking an intentional step that encourages program applicants to consider diversity and inclusion as part of their scientific projects. MAPP supports the goal of increasing the inclusion of underrepresented groups in NOAA-relevant modeling science. This action has the potential to make an impact on not only the diversity and inclusion in science at NOAA, but also beyond the agency. In your proposal, we encourage you to think about how your project can broaden the participation of underrepresented groups (e.g., gender, race, ethnicity, disability, geographic, etc.). Examples could include, but are not limited to, full participation of women, persons with disabilities, and other underrepresented minorities in science, technology, engineering, and mathematics (STEM). Opportunities that may engage students or early career scientists from underrepresented groups at different or earlier ages (e.g., even secondary) in the context of your proposed research are encouraged.

<sup>8</sup> [https://www.gfdl.noaa.gov/spear\\_large\\_ensembles/](https://www.gfdl.noaa.gov/spear_large_ensembles/)

<sup>9</sup> Note, a Google account is needed to submit via this LOI submission form: <https://forms.gle/JEHSWhos7EVmjsEZ7>

## Data Archiving and Computational Resources

### Computational Resources

Computational resources on NOAA's high-performance computing platforms may be requested for research sponsored as a result of this solicitation. Proposals should indicate the availability of alternative computing resources should NOAA resources not be available for the project. Proposers who choose to request computational allocations on NOAA's platforms must include in their proposal a request describing the computational resources and data storage required, as well as a description of how they will port their methodology to the NOAA platforms. Proposers must submit an HPC Request Form<sup>10</sup> with their proposal in order to apply for computational resources.

Questions regarding the use of NOAA's high-performance computing platforms should be directed to Dan Barrie ([daniel.barrie@noaa.gov](mailto:daniel.barrie@noaa.gov)).

### Data Management Guidance

The MAPP Program requires that all products and deliverables produced via solicitation will reside in the open access / open source domain, freely available to the public.

Public access to grant/contract-produced data will be enabled in one of the following ways (select one):

- Funding recipients are planning to submit data to NOAA National Centers for Environmental Information (NCEI), which will provide public access and archiving<sup>11</sup>. Point of Contact for NCEI is Nancy Ritchey ([Nancy.Ritchey@noaa.gov](mailto:Nancy.Ritchey@noaa.gov))
- Data are to be submitted to an International Council for Science (ICSU) World Data System facility: <https://www.icsu-wds.org/community/membership/regular-members>)
- An existing publicly accessible online data server at the funded institution is to be used to host these data (describe in proposal).
- An existing publicly accessible online "cloud" service is to be used to host the data (described in the proposal).

The Competition Manager (above) is the responsible NOAA Official for questions regarding this guidance and for verifying accessibility of data produced by funding recipients.

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<sup>10</sup> [https://cpo.noaa.gov/Portals/0/MAPP\\_FY23\\_HPC\\_Request\\_Form.docx](https://cpo.noaa.gov/Portals/0/MAPP_FY23_HPC_Request_Form.docx)

<sup>11</sup> NCEI supports the creation of adequate metadata and data ingest into long term repository holdings using tools such as Send2NCEI ([www.nodc.noaa.gov/s2n](http://www.nodc.noaa.gov/s2n)), for small volume, one-time only data collections) and Advanced Tracking and Resource tool for Archive Collections or ATRAC (<https://www.ncdc.noaa.gov/atrac/index.html>), for recurring and/or large volume data collections).