# Fiscal Year 2024 Competition Information Sheet - Process-Oriented Diagnostics for NOAA Climate Model Improvement and Applications

## Program Name

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

## Program Mission

The 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. MAPP is a program in the Earth System Science and Modeling (ESSM) division in NOAA's Climate Program Office. ESSM supports research to advance broad understanding of the Earth system through observations, monitoring, process science, and modeling; and to advance NOAA's mission through collaborations with the external community.

## Focus for Fiscal Year (FY) 24

### Process-Oriented Diagnostics for NOAA Climate Model Improvement and Applications

Proposals may respond to only one of the FY 2024 MAPP competitions, which must be clearly identified in the proposal summary.

## Funding for FY24

Pending the availability of funds in FY 2024, the MAPP program anticipates a funding allocation of $2,000,000 per year for this competition.

Proposals may be for up to three years, up to $190,000/year for each Type I project and up to $750,000/year for the Type II project (only one Type II project may be funded; see below for definition of project types and differentiation between external and internal Type II proposal funding). A total of 7-9 projects may be funded.

## Competition Information

### Title: Process-Oriented Diagnostics for NOAA Climate Model Improvement and Applications

In FY 2024, the MAPP Program is soliciting proposals to advance model diagnostic activities.

Climate and Earth System Model (ESM) development is a key component of NOAA's mission.[1,2] Many of the agency's strategic goals rely on the development and application of class-leading models to key applications and societal challenges: "These models will capture a more comprehensive description of the complexity and interactions of climate and extreme weather events and their societal impacts." As model complexity increases, and as the importance of models as tools in evaluating mitigation and adaptation options increases, the need grows for key process-oriented diagnostics to ground the models in reality as they are developed. CPO has identified a set of societal challenges[3] relevant to NOAA's mission. Development of accurate, reliable climate and Earth system models is key to addressing each of these challenges.

NOAA's models provide a vast resource of information to NOAA managers, decisionmakers, and scientists as well as external stakeholders interested in environmental change on various timescales. These models also serve as an incubator for and source of technology to advance operational prediction efforts across all timescales. Climate projections produced with NOAA's models undergird efforts to assess climate change and its impacts, and serve as direct inputs to the National Climate Assessment.[4,5] NOAA is embarking on an effort to provide Forward Looking Projections products and services[6], which will increase the need for accurate, useful model information years to decades into the future. NOAA's Earth System Models also serve as a laboratory to codify and test improved understanding of how the climate and Earth systems work, and engage NOAA scientists and the broader research community with each other to advance our understanding and ability to simulate the integrated climate and Earth systems.

To improve models, we need to better understand and benchmark process-level deficiencies that result in model performance biases for simulated Earth system and climate phenomena. Some of these biases are evidenced in long-running climate and ESM simulations while some biases can arise at the weather timescale, within a few days of model initialization. We need to better understand and describe the source of biases such as issues in models' physical or biogeochemical process representation, model component interaction, and/or numerical approach. To this end, since FY 2015, the MAPP Program has been supporting community-based approaches to improve NOAA models via the development of process-level metrics and an open-source framework, an effort spearheaded by the MAPP Model Diagnostic Task Force (MDTF)[7]. This work comes out of preceding work by the CLIVAR MJO Working Group[8] and the MAPP CMIP5 Task Force[9], and collaborations between NCAR and NOAA GFDL on diagnostic development. The MDTF's work has served as a model for collaboration between GFDL and the external scientific community, and the MDTF software framework has become a key component of GFDL's model development and analysis efforts.

---

[1] NOAA Next Generation Strategic Plan: https://www.noaa.gov/organization/budget-finance-performance/value-to-society/noaa-fy22-26-strategic-plan

[2] NOAA Office of Oceanic and Atmospheric Research Strategic Plan: https://research.noaa.gov/external-affairs/strategy/

[3] https://www.cpo.noaa.gov/Initiatives/Climate-Risk-Areas-Initiative

[4] Fourth National Climate Assessment, Volume I: https://science2017.globalchange.gov/

[5] Fourth National Climate Assessment, Volume II: https://nca2018.globalchange.gov/

[6] https://www.commerce.gov/news/press-releases/2023/06/biden-harris-administration-announces-26-billion-framework-through

[7] https://cpo.noaa.gov/Meet-the-Divisions/Earth-System-Science-and-Modeling/MAPP/MAPP-Task-Forces/Model-Diagnostics-Task-Force

[8] https://usclivar.org/working-groups/mjo

[9] https://usclivar.org/sites/default/files/webform/meetings/2014/summit-presentations/Kinter_2014Summit.pdf

In FY 2024, the MAPP program is soliciting proposals that address key issues in the representation of Earth system processes in CMIP6-era and developmental models to improve model fidelity. Proposals should focus on clearly-identified gaps in the existing MDTF software package[10,11,12], for example, for the following diagnostic development areas:

- Advancing the simulation of climate and weather extremes, particularly tropical and extratropical storms, mesoscale convective systems, and atmospheric rivers
- Benchmarking model processes that undergird the successful prediction of extreme events on subseasonal to seasonal timescales
- Characterization of the aerosol-indirect effect and its implications for climate sensitivity and climate projections
- Addressing model precipitation biases and how they drive key societal impacts such as floods, droughts, and wildfires
- Advancing diagnostics of stratosphere-troposphere coupling and associated modes of coupled variability
- Vanguard areas of Earth System Model development, where the availability of process-oriented diagnostics is currently limited, such as glacial processes and wetlands

Projects selected via this solicitation are expected to go beyond diagnostic evaluations of model performance, to evaluate processes relevant to one or more of the above areas using CMIP6 or other relevant state-of-the-art datasets. Proposed work should develop and apply process-oriented diagnostics (PODs) to enhance a process-oriented framework approach to discriminate and better understand the sources of bias in the models. Projects should develop a clear set of pathways for model improvement, and should examine the ways in which resolution, model formulation, and model components relate to the ability of the models to faithfully simulate the Earth system and its variability on various timescales. PODs may focus on processes covering a variety of timescales, including seasonal.

Model PODs and improvement pathways should be physically- and observationally-based, and be applicable across a variety of models to ensure robustness. Proposals are expected to have a very strong grounding in observational data, and should leverage publicly-available observational process data and observational resources such as Obs4MIPs, as well as new observational datasets that have been under-utilized for POD development and model evaluation. Use of NOAA in-situ and remote observations, as well as collaboration with NOAA observational entities, for example, within NESDIS, are strongly encouraged. If appropriate, use of observations from recent NOAA-funded field campaigns and modeling projects is encouraged, such as Eastern Pacific Investigation of Climate (EPIC), Pan American Climate Studies (PACS), VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS), Dynamics of the Madden-Julian Oscillation (DYNAMO), Years of Maritime Continent (YMC), Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ), Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign/ Elucidating the Role of Clouds-Circulation Coupling in Climate (ATOMIC/EUREC 4A), and/or North American Multi-Model Ensemble (NMME).

Targeted experiments that extend proposed evaluations for the improvement of models, particularly NOAA climate and Earth System Models and their components (e.g., GFDL's AM5), may also be proposed. Proposed projects should have the overall aim to advance understanding of biases generally

---

[10] https://www.gfdl.noaa.gov/MDTF-diagnostics/

[11] https://mdtf-diagnostics.readthedocs.io/en/latest/

[12] https://journals.ametsoc.org/doi/full/10.1175/BAMS-D-18-0042.1

affecting CMIP6-era and next-generation models and to identify targeted model improvements that can improve model fidelity. The expected outcome of funded projects is a clear understanding of the sources of model biases and viable pathways for improving the models.

To address the above research areas, projects may use CMIP6 data[13], with a particular focus on MIPs that use the structure and organization provided by the CMIP umbrella. If using data from a particular MIP experiment, the proposal should demonstrate that the available data meets broadly-accepted resolution, frequency, and variable requirements to support the analysis and diagnostic development steps described in the project work plan. The use of additional model datasets including high-resolution model runs, model large ensembles, etc., outside of the CMIP6 framework is encouraged, to accentuate the proposed evaluation and development activities. These can include existing public model datasets or model experiments described in the proposal and carried out as part of the project activities.

The diagnostics software package designed by the MDTF provides context for new PODs developed under this solicitation. Proposals should plan to contribute new PODs to the software package; to apply the software package to models; or to expand the use of the software through relevant collaborations with modeling centers, agencies, research groups, or laboratories (for example, NCAR, PCMDI, E3SM, etc.). The software package is coded in Python and available for use and development through GitHub[14]. Proposers should demonstrate a facility with these or similar software and development environments to be able to develop and test PODs within the software framework.

Individual projects that address a set of processes relevant to one or more of the above research areas (type 1) may be funded at a level of up to $190,000/year for up to three years. Proposed work plans should account for time spent on participation in a Task Force[15] that will be constituted of the investigators funded as a result of this solicitation. In addition to project primary investigators, postdoctoral fellows and graduate students are also welcome to participate in Task Force activities. Task Forces enable collaboration between funded investigators via monthly teleconferences and through constructive collaborative activities. In the past, Task Forces have produced fact sheets, knowledge statements, collaborative analysis products, and group journal articles; and have organized meeting sessions, special collections, or other activities. Previous Model Diagnostic Task Forces have coordinated the development of the software framework and contribution of process-oriented diagnostics to the framework. Participants in previous MDTFs have coordinated with the Team leadership to develop diagnostics, have presented their work on teleconferences and community meetings, and have contributed to group papers. A team proposal (type 2) is also solicited.

The type 2 team proposal should address the research areas described above and advance key objectives of this solicitation, including the model diagnostics software package led by the MDTF. The team proposal should also describe plans for how to integrate results and activities of the individual projects in a Task Force collectively and synergistically, addressing the core scientific objectives of this solicitation. These will include a vision for collaborative activities to unify participating researchers, infrastructure for data and code sharing, technical support for integration of PODs developed by community members, a methodology to engage researchers in model evaluation and development activities, and plans for publications, documentation, or other outputs that can synthesize and disseminate the work of the Task Force and lead to increased community awareness and utility of the

---

[13] https://esgf-node.llnl.gov/projects/cmip6/

[14] https://github.com/NOAA-GFDL/MDTF-diagnostics

[15] https://cpo.noaa.gov/Meet-the-Divisions/Earth-System-Science-and-Modeling/MAPP/MAPP-Task-Forces

software package. Team proposals should also include support for the integration of PODs from research teams funded outside of this solicitation, depending on the relevance of those PODs. Team proposals should include contributions from multiple institutions and may request up to $400k/year for non-NOAA collaborators and up to an additional $350k/year for activities at or affiliated with NOAA laboratories, for a total annual team proposal resource ceiling of $750k/year.

Competition contact information: Daniel Barrie (daniel.barrie@noaa.gov)

General Guidelines for FY 2024 MAPP proposal submission:

- Principal investigators submitting a proposal in response to this MAPP Announcement are required to follow the Letters of Intent (LOI) and Proposal preparation and submission guidelines described in the Climate Program Office FY 2024 Notice of Federal Funding Opportunity announcement.
- Investigators are strongly encouraged to submit an LOI prior to developing and submitting a full proposal using the FY24 MAPP Letter of Intent submission form[16];  investigators unable to submit via the form should email their LOI to oar.cpo.mapp@noaa.gov. Investigators will be notified by the MAPP Program Competition Manager as to whether a full proposal is encouraged based on the LOI within four weeks of the LOI due date.
- Proposals must clearly identify in their summary which MAPP competition is being targeted (only one competition may be targeted by a given proposal).
- We encourage investigators to consider how their projects may engage individuals from underserved communities including internships or other opportunities, K-12 outreach, etc.
- Administrative questions regarding the Notice of Federal Funding Opportunity (e.g. proposal formatting or submission guidelines) should be directed to Diane Brown (diane.brown@noaa.gov).

A webinar will be offered to potential applicants for background on the MAPP program and this solicitation soon after publication of this announcement. For Information on webinar timing and registration procedures please check the MAPP website[17]; prior to when the webinar is held, potential applicants can also sign-up to receive an email notification[18].

## 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 with their proposal in order to apply for computational resources[19].

Questions regarding the use of NOAA's high-performance computing platforms should be directed to Dan

---

[16] FY24 Letter of Intent Submission Form

[17] MAPP Home Page

[18] MAPP Webinar Form

[19] HPC Request Form

Barrie (mailto:daniel.barrie@noaa.gov).

<u>Data Management Guidance</u>
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[20]. Point of Contact for NCEI is Nancy Ritchey (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 (describe 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.

---

[20] 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), for small volume, one-time only data collections) and Advanced Tracking and Resource tool for Archive Collections or ATRAC (www.ncdc.noaa.gov/atrac), for recurring and/or large volume data collections).