A. Title Page

Funding Opportunity Number: NOAA-OAR-CPO-2021-2006389
Competition: Modeling, Analysis, Predictions, and Projections (MAPP) Competition 2: Process-Oriented Diagnostics for NOAA Climate Model Improvement and Applications

An Open Framework for Process-Oriented Diagnostics of Earth System Models

(Type II Team proposal)
Project dates: 09/01/2021-08/31/2024

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Institution	Year 1	Year 2	Year 3	Total
UCLA	$201,012	$201,067	$205,931	$608,010
GFDL	$350,000	$350,000	$350,000	1,050,000
NCAR	99,533	$100,164	$100,247	$299,944
CSU	$34,900	$35,948	$29,052	$99,900
UC Davis	$59,869	$58,724	$60,797	179,390
Total	**$745,314**	**$745,903**	**$746,027**	**$2,237,244**

B. Abstract: *"*An Open Framework for Process-Oriented Diagnostics of Earth System Models"
Problem addressed and rationale: Process-oriented diagnostics (PODs) aim to characterize physical processes in a manner that relates directly to mechanisms essential to their simulation, providing guidance for improvement of a climate/weather model or assessment of its ability to address a specific research question. The predecessor Team project (PIs of which form part of the current team) advanced an initial bare-bones framework into a community-based software framework that brings process-oriented diagnostics into the diagnostic suite for modeling centers at the Geophysical Fluid Dynamics Laboratory (GFDL) and the National Center for Atmospheric Research (NCAR). Experience with the recent development suggests multiple areas where refinement and expansion would be beneficial for both modeling centers and POD developers.
Work Summary: The proposed work will build on the previous Model Diagnostics Task Force (MDTF) framework and coordinate with the Type I individual proposals to expand the open framework to entrain PODs developed by multiple research teams into the development stream of the modeling centers. The framework developed over the previous two phases specifies POD protocols for the target model version and the comparison to observations and permits diagnostics to be placed in a multi-model context using results from the CMIP6 archive. The Type II framework team maintains consistency with the previous lead team while expanding the coordination with the diagnostic streams at GFDL and NCAR, and formalizing common standards with the Department of Energy (DOE) Coordinated Model Evaluation Capabilities (CMEC) effort to further coordinate US-based model evaluation efforts. The proposed work will include the following elements. (1) The current Team project has established GitHub-based documentation, setup and configuration protocols. With the successful incorporation of a substantial number of PODs, developments on the software side proposed for the next phase expand on this process, emphasizing maintainability, interoperability, portability, provenance and usability. (2) PODs targeting related phenomena and on similar timescales will be identified and grouped to coordinate development teams and assist navigation of the results. This organization will also help model developers assess the output frequency requirements for PODs targeting phenomena on different climate timescales. (3) A task force will be led by the Type II team, modeled on the current MDTF with regular teleconferences, facilitated scientific conference sessions, and coordinated publications. New community-building activities planned by the Type II team include "Developer days" to facilitate communication between climate model and POD developers and tutorials to familiarize diagnostic developers with coding best practices in the context of the framework. (4) The Type II team will explore ways to include mean-state and variability diagnostics as context for PODs. Both GFDL and NCAR have expressed the need to modernize their legacy diagnostic suites and the MDTF Framework can help prevent redundancy. Enhancements to the framework will be implemented to handle common functions, such as atmospheric pressure-level sub-setting and ocean depth range integrals. (5) Similar to the previous Team Proposal, the team will develop tools and additional prototype PODs in key areas.
Relevance to competition: This proposal addresses the call for the "Modeling, Analysis, Predictions, and Projections (MAPP) Competition 2: Process-Oriented Diagnostics for NOAA Climate Model Improvement and Applications" for a Type II proposal that advances the model diagnostics software package led by the MDTF and a synergetic process for integrating results of individual projects on process-oriented diagnostics. It proposes infrastructure for code and data sharing that engages researchers in model evaluation and facilitates integration of their research products into the diagnostics packages used by modeling centers, as well as dissemination of this information. It addresses NOAA's long-term climate goals by strengthening foundational capabilities, combining observations with modeling and prediction, and communication of scientific understanding.

C. Results from Prior NOAA-Supported Research

1) *Development of a Framework for Process-Oriented Diagnosis of Global Models*

The development of the framework code matured during the most recent phase of the project. Framework code development during the first phase of the project originated at NCAR and was successfully transitioned to GFDL during this second phase. The framework code is now a fully open-source community project with global visibility. The code is now under version control and developers have the ability to interact with code and the framework development through the open-source GitHub coding platform. The software framework was upgraded from Python version 2.7 to version 3.6 and uses a Conda-based installation routine that affords the package portability between Linux and Mac OS platforms. Extensive quality updates (i.e., "linting") were made to the framework code and initial steps for unit testing and end-to-end verification were made to the project. The framework team initiated development of a common format JSON file in coordination with the DOE CMEC effort to handle framework and POD settings.

The documentation of the framework code was overhauled in this phase of the project. The "Getting Started" and "Developer Walkthrough" documents were upgraded to reflect code changes that were introduced into the framework code during this round of development. Additional documentation and training was provided to POD developers on using Git version control, and a Python "Best-Practices" set of standards was shared with the task force. The previous documentation was a collection of Word documents and PowerPoint slides that have now been standardized and converted to the Restructured Text markdown language allowing the content to be version-controlled alongside the code and seamlessly delivered in multiple formats (e.g., PDF, HTML). A public webpage describing the MDTF task force was developed and is hosted on GFDL's main webpage. A security policy for accepting community contributions was developed at GFDL and posted on the project's GitHub site.

Initial work was completed to better integrate the MDTF Diagnostics package into the model development workflow at GFDL. An overview and how-to seminar was presented at GFDL that described the scientific use cases of the current set of diagnostics and demonstrated their use on GFDL's CMIP6-class model simulations. A central installation of the MDTF Diagnostics package was made available on GFDL's internal scientific network along with specific drivers and examples. Basic MDTF functionality was tested in GFDL's Flexible Runtime Environment (FRE) workflow engine and portions of the framework were updated to be compatible with internal GFDL file conventions. The framework was also upgraded to use CMIP6-formatted data from GFDL that uses the Data Reference Syntax (DRS) standard.

The framework lead team coordinated on planning a session for the 2020 American Geophysical Union Fall Meeting. The session includes invited speakers to provide an overview of the MDTF Diagnostics effort and how it fits into the growing ecosystem of model diagnostics packages that are being developed in the modeling community. The planned session will provide a technical overview of the software with scientific presentations for PODs currently in development.

The lead team has developed several PODs targeting a variety of processes across the earth system. The UCLA team—along with collaborators—has formulated PODs on evaluation of precipitation distributions (Martinez-Villalobos and Neelin 2019), convective transition diagnostics (Kuo et al. 2018, 2020), precipitation-buoyancy relationships (Ahmed and Neelin 2018, Ahmed et al. 2020, Adames et al. 2020) and temperature extremes in observations and CMIP6 models (Catalano et al. 2020). These PODs are either integrated into the MDTF GitHub codebase or in an advanced stage of development. New diagnostic development by the CSU team includes those related to MJO

teleconnections (Tseng et al. 2020; Wang et al. 2020a,b, Toms et al. 2020a), and development of weak temperature gradient (WTG) diagnostics to understand MJO change under global warming (Bui and Maloney 2019a,b).

A number of PODs have also been developed to address the diagnostic needs at the modeling centers. One of them targeted the number, genesis location, intensity, lifetime and large-scale environment of monsoon low-pressure systems (MLPSs), which are among the most important synoptic-scale disturbances. It was shown that GFDL's latest climate model CM4 can skillfully simulate the main characteristics of MLPSs (Dong et al., 2020a). Another POD concerned diagnosis of tropical mesoscale convective systems (MCSs) with a comprehensive long-term observational dataset (Dong et al, 2020b). It was found that the simulated spatial distribution of MCSs simulated with GFDL AM4.1 (a 50-km atmospheric model) broadly agrees with observations. This is also true for seasonality and interannual variability over different land and oceanic regions. On the other hand, the simulated MCSs are generally longer-lived, weaker and larger than observed.

2) Other relevant prior research. The co-PI Maloney is also involved in ongoing NOAA MAPP (NA18OAR4310296) and CVP (NA18OAR4310299) projects that are fostering improved process understanding of the tropics and their teleconnections to higher latitudes in models and observations. These projects contributed to teleconnection and WTG diagnostic development mentioned above. Regional observational and modeling work has also been conducted to understand interactions between the northward-propagating boreal summer intraseasonal oscillation and the diurnal cycle near the Philippines (Riley Dellaripa et al 2020; Natoli and Maloney 2019), the dynamics of the MJO (Jiang et al. 2020a,b), and convective morphology in the Maritime Continent and how it affects MJO behavior (Toms et al. 2020b). Co-PI Gettelman has been involved in ongoing NOAA MAPP MDTF development efforts (NA15OAR4310090, NA18OAR4310280), and is also co-I on a NOAA MAPP funded effort as part of the Climate Sensitivity Task Force.

D. Statement of Work

1. Introduction and Statement of the Problem

1.1. Process-oriented diagnostics and relationship to prior Type I work

The team developing a new version of an Earth System Model (ESM) typically aims to improve the simulation of various climate and weather phenomena while incorporating additional or better representations of sub-grid scale processes, or additional components of the system. An ESM in this proposal is defined as a numerical model representing a component of the Earth system (e.g., the atmosphere or ocean) or a collection of coupled components used in the simulation of weather and climate. The set of phenomena that a model is expected to capture is continually expanding, as are the observational datasets to which the model can be compared (Teixeira et al. 2014; Eyring et al. 2016). A model development team normally has a set of diagnostics from prior model development, but with limited resources for upkeep and further development on that diagnostics. Legacy diagnostics packages can quickly become outdated as new observational datasets are developed and are often associated with a particular developer who may have moved on from the organization. It can thus be highly advantageous to have a mechanism by which diagnostics development in a wider set of research groups can be brought into a coherent framework for use by the model development group.

Furthermore, even when a bias in model simulation of a particular phenomenon has been identified in performance metrics (i.e., typically scalar metrics assessing model performance compared to observations or reanlayses), it can be challenging to identify the precise physical process or step

in a physical pathway that is yielding the bias in the overall simulation. The bias associated with a particular misrepresented process may have expressions in the basic state climatology, variability, or statistics of precipitation (e.g., Hwang and Frierson 2013; Rosa and Collins 2013; Grose et al. 2014; Wu et al. 2019; Held et al. 2019; Voldoire et al. 2019; Tatebe et al. 2019; Danabasoglu et al. 2020; Kelly et al. 2020; Boucher et al. 2020). Conversely, working backward from a given error in simulation to the process producing it is often a sustained effort involving a dialogue between theory for mechanisms and new diagnostics for observation-model comparison. A "process-oriented diagnostic" (Eyring et al. 2005; Sperber and Waliser 2008; Maloney et al. 2014; Kim et al. 2014; Eyring et al. 2019; Maloney et al. 2019) characterizes a physical process that is hypothesized to be related to the ability to simulate an observed phenomenon. Furthermore, as models grow in complexity, the degrees of freedom within the model increase as processes may interact with each other in new and potentially unanticipated ways. Evaluating a candidate model version against observations analyzed with such a process-oriented diagnostic can give insight into whether a particular process is being well represented, focus model improvement on specific processes, and identify gaps in the understanding of phenomena.

This combination of needs led to a Model Diagnostics Framework Team project under prior NOAA funding. The predecessor Team project (PIs D. Neelin, E. Maloney, A. Gettelman, Y. Ming and J. Krasting form part of the current team) in a first phase piloted an initial framework to implement process-oriented diagnostics for modeling centers at NCAR and GFDL, with a lightweight framework wrapping modules from several developer groups. In the current phase of the project, the number of diagnostics being contributed by developer groups has more than doubled to include 20 either completed or under development, and the framework has been adapted accordingly. In addition to developing detailed documentation, the framework has been moved to GitHub to facilitate community-based development. The principles applied in this effort include the following, which are relevant for the proposed effort:

- A critical need exists on the part of the modeling centers to expand the amount of process-oriented information in their diagnostics packages.
- These advanced diagnostics should be incorporated into standard diagnostics packages that can be applied to development versions of the models, operating in different experimental designs (e.g., prescribed SST and sea ice (AMIP), prescribed surface forcing (OMIP), and pre-industrial control simulations for coupled models), and which allow the application of diagnostics to be repeatable across multiple model versions rapidly and routinely during the development process.
- The diagnostics should provide information directly relevant to physical parameterizations in the model components.
- A streamlined process for entraining diagnostics into standard modeling center diagnostics packages should be grown in concert with clear partners in the academic and private sectors given that time constraints on model development staff make it difficult to individually engage with multiple community members and diagnostic efforts

The framework produced by the current Team effort is schematized in Figure 1. The most essential design feature is to provide a protocol for the POD developer teams, such that each module can be ingested relatively easily into the development stream of the modeling centers.

Key features include:

- A Python driver script sets up paths, variable names, etc. for the model data to be analyzed. It calls process-oriented diagnostics modules (PODs) contributed by various groups; these yield plots (and associated data for generating them); each group provides the observational

comparison for its own POD as a compact dataset that has been digested to make the comparison plots (indicated as POD obs in Figure 1).

- These plots are then composed into a webpage, with subpages that permit easy comparison of the candidate model and observations.
- The PODs must be open source (with preference for Python) and follow the specified conventions for interacting with the framework.
- PODs are repeatable in modeling center workflow, and focused on model improvement.
- Community development makes use of GitHub: POD developers download the framework, test a diagnostic, and then submit to the repository, contributing to the library of diagnostics.

The details of the format vary according to the POD, but each provides the developer with model-to-observation comparison for a process of interest. In the first phase of the project, considerations of coding language, style, etc. were left to the POD developers. With an increasing number of PODs scheduled to be delivered in the final year of the current phase, the framework develop team is noticing a number of factors that will become important to the framework and the library of PODs going forward, as elaborated below.

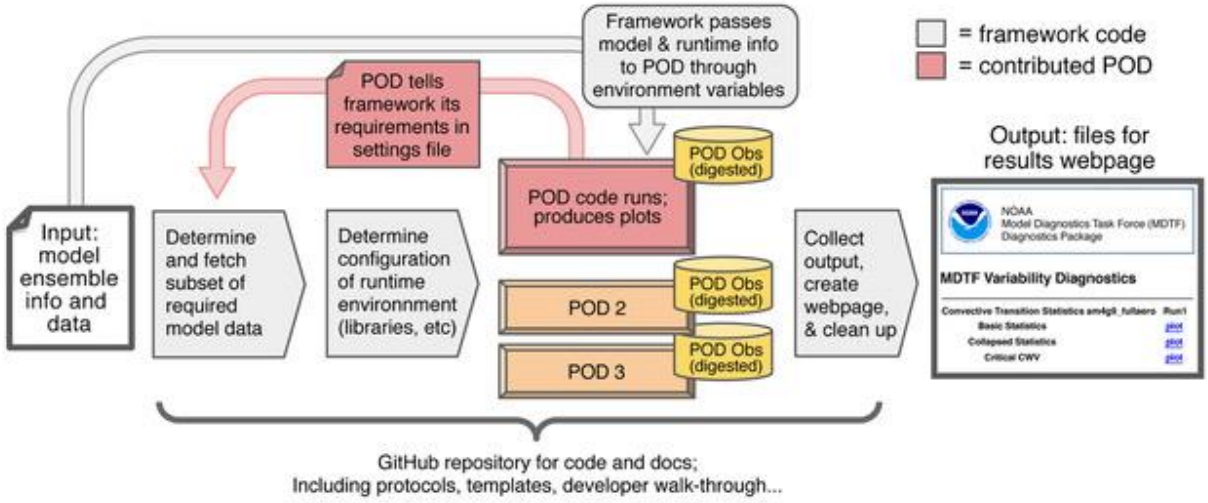

Figure 1: Diagram of the MDTF framework under the current phase of development. Model output for comparison to observations under the set of Process-Oriented Diagnostics modules (PODs) is parsed by the framework according to requirements of each POD's settings file. Each POD uses information provided in environment variables to carry out diagnostics and produce figures (and corresponding data), composed into a webpage for review by the modelers.

1.2. Issues and opportunities in diagnostics of Earth system processes

Key opportunities for the next phase of development of the framework range from opportunities at the software and organizational level to issues in the science of model development and process-oriented diagnostics in the CMIP6 era and beyond. On the software side, the open source community has grown significantly in the past several decades and has led to a proliferation of scientific software packages for analyzing weather and climate data and model output. Much of this work has been done using the Python programming language, and since the MDTF framework is written primarily in Python, the project has the opportunity to be a leader in promoting open source coding practices and standards in writing ESM analysis code. Previous versions of the MDTF framework have prioritized flexibility and design principles that transcend specific implementations. Focus

on the overall structure and workflow of model analysis are now needed. The MDTF framework has the opportunity to facilitate coordination among multiple agencies and modeling efforts across the United States, including the Department of Energy and the National Center for Atmospheric Research. Development of a community-wide standard for aspects of model analysis continues to be a unifying goal that can reduce duplication of efforts and promote interoperability.

Analyzing weather and climate model output is increasingly a "big data" problem. The recently-completed sixth Coupled Model Intercomparison Project (CMIP6) is projected to have an aggregate data volume on the order of several petabytes. The community is already presented with data download, data access, and eventually data analysis challenges. These issues cascade down to the development center level where institutions are forced to rethink how to store, analyze, and extract information content from large datasets. There is an increasing need to locate data analysis closer to where model computation occurs, and analysis frameworks like the MDTF Diagnostics package provide a conduit for domain expertise in the community to be integrated directly into the modeling workflows of institutions like GFDL and NCAR. Furthermore, NOAA continues to prioritize cloud computing and cloud data storage through efforts such as the NOAA Big Data program.

As the software package grows in complexity, it is important that reliability, portability, and interoperability are protected through robust testing strategies and code management practices. Opportunities exist, for example, to expand the ability to run the software and test its functionality on cloud computing platforms and to engage with the broader community through social coding platforms such as GitHub. Code citeability and provenance become increasingly important in this paradigm, complementing the peer-reviewed papers describing the scientific content of the analyses.

On the science side, we anticipate PODs contributed by research team efforts that will address a broader range of phenomena and model processes including in open and coastal ocean systems, coastal inundation, extremes of heat and water resources, land-system processes. The framework team will need to be responsive to the wider range of space and time scale inputs that may be required, and to create organizations of the PODs that will be scientifically meaningful, and make use of the fact that particular users will tend to run different sets of related PODs when they are analyzing phenomenon in different realms, focused geographical areas, or with shorter or longer time scales. The coordination of diagnostics will need to include recognition that a model developer focusing on a particular area will also need to access background information from more conventional diagnostics (e.g., for climatological means and variability) while considering POD output. At the same time, we anticipate that processes that are proving particularly challenging for climate models to simulate at the required level of accuracy will have ongoing diagnostic development beyond the existing PODs, and that there will be a need to provide coordination and orientation for modelers to optimally make use of the additional information. Conversely, the lead team will need to foster activities aimed at ensuring that POD development teams are aware of and responsive to current model developer needs.

2. Approach and Scientific Objectives

The Type II team will build upon the work of the previous lead team with an expanded group of university researchers, and members of model and diagnostic development teams at GFDL and NCAR. The main objectives of this lead team are summarized here before elaboration in later sections:

1) Balance the need to expand the MDTF framework to accommodate an increasing range of process-oriented diagnostics with the overall aim of keeping the framework code lightweight and not burdensome to maintain;

2) Integration in modeling center workflows to maximize use and return on investment for model development;
3) Experience with the previous effort indicates that ongoing work to emphasize the usability and maintainability of PODs will continue to be a substantial effort. Individual development teams, being science focused, do not necessarily optimize for efficiency, plan for how their module will operate as dataset sizes increase with higher resolution, or as part of the package with many modules running, nor do they necessarily plan for future updates to the observational datasets. A significant task of the lead team will be to continue identifying best practices in this regard.
4) Add connectivity to scientific software such as feature trackers or interpolation packages that may be required for analysis but not part of PODs per se, and may be externally maintained.
5) The Type II team will develop selected process-oriented diagnostics for which they have particular expertise, or which provide test cases for expanding the framework tools at hand, and that can thus provide a natural expansion of the existing PODs.
6) GFDL will continue to lead the primary development of the MDTF framework and coordinate community development among individual POD development projects and contributions from broader Climate Program Office-sponsored task forces. GFDL is seeking to expand the personnel working on the MDTF project through additional funding for 2 postdoctoral research associates and partial funding for a software engineer. This structure will allow the MDTF project to coordinate more closely with model development workflow activities at GFDL, as well as a point of contact for NCAR development efforts (see next point). Along with GFDL's participation in both the land model and climate sensitivity task forces, this will inform the development of next generation component and coupled models that span timescales from weather to climate.
7) NCAR will continue to coordinate with the POD developers and with the MDTF leads. In addition, funding to NCAR will be used to further integrate the MDTF into evolving CESM workflows. These workflows will be pushed out to the community, providing another entry point for MDTF diagnostics.
8) Continued coordination with NCAR is essential as both GFDL and NCAR share similar priorities for model development and modeling workflow infrastructure, including the development of the community MOM6 ocean model. Personnel from GFDL, NCAR, and UCLA will continue a robust relationship and coordinate at both the software and scientific levels.
9) We will make use of opportunities to coordinate with the DOE Coordinated Model Evaluation Capabilities (CMEC) project. CMEC provides access to the PCMDI Metrics Package (PMP), Toolkit for Extreme Climate Analysis (TECA 2017), and the International Land Model Benchmarking Tool (ILAMB). Although our mandate will be focused on deliverables for NOAA, there are clear efficiencies to be gained from coordination among US metrics and diagnostics projects. Likewise, the scientific coordination of scalar evaluation metrics, commonly used to assess CMIP and development models, with more complex process-oriented diagnostics can help fill in the continuum of diagnostics methods between these end-members. The coordination mechanisms are fleshed out in section 3.3. Development of common standards and protocols between the DOE and NOAA efforts also benefit the community by facilitating the flow of diagnostics among model development groups across agencies.

3. Methodology and implementation

3.1. The next Phase of the MDTF framework

3.1.1 Proposed updates to the framework

Three main features of the proposed work are:

(1) enabling a broader set of process-oriented diagnostics, while also supporting the effort to push diagnostics toward even more direct constraints on model processes;
(2) design improvements to the framework emphasizing maintainability, interoperability, usability, and the ability to scale up to increasing number of diagnostics;
(3) coordination with the GFDL and NCAR center workflow and with other US diagnostics/metrics efforts including other NOAA task forces and process teams.
We propose to build on experience in the previous phase, both in terms of the software aspects of the framework and the scientific interactions that the framework aims to facilitate. We have found that the interaction with diagnostic development groups in the framework is very much a two-way street. Adaptations and extensions to the framework have been needed to support capabilities requested by the POD developers, while with the guidelines for formatting and documentation and training from the lead team in the key software tools has helped improve the PODs. At the same time, discussions with GFDL and NCAR staff have indicated substantial need for renewal in some of the basic diagnostic packages and there is an opportunity for beneficial interaction: on the one hand leveraging the developments of the MDTF framework to assist that effort, and on the other being able to bring diagnostics needed for reference in understanding more specialized process-oriented diagnostics into a common workflow.

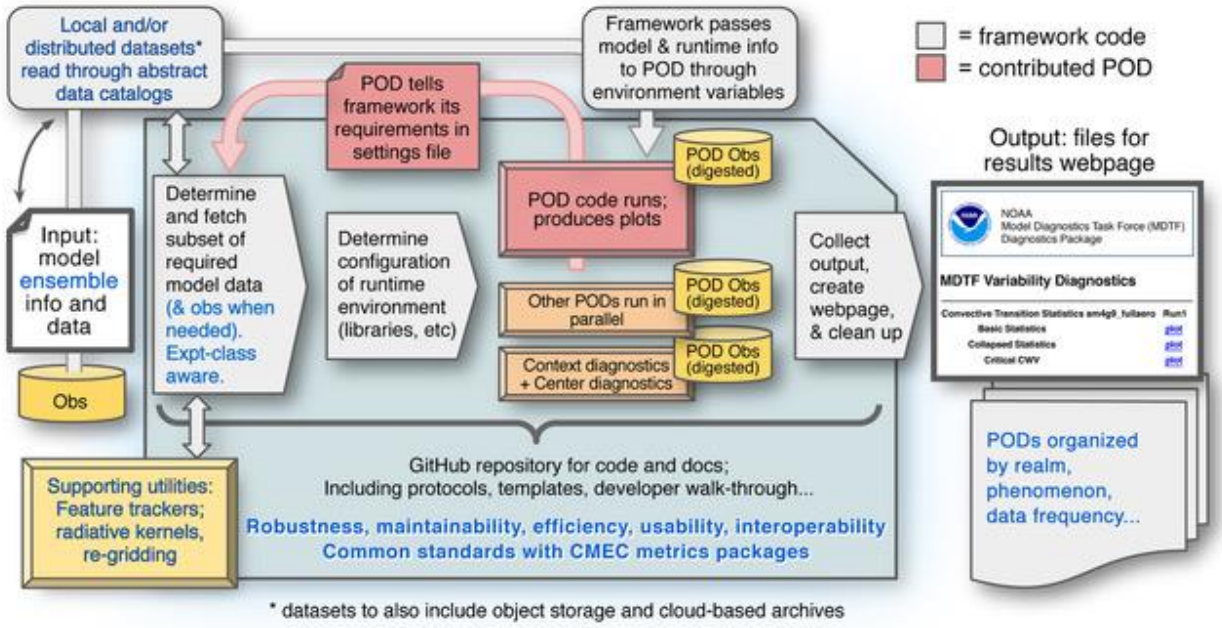

Figure 2: Diagram of the proposed evolution of the MDTF framework under the next phase of development. The set of Process-Oriented Diagnostics modules (PODs) is augmented by more basic diagnostics for context and to enhance connectivity to GFDL and NCAR diagnostic workflows. In addition to scientific expansion within the set of PODs, capability is included for running "Supporting Utility" software such as feature trackers as a step between raw model output and the PODs. Coordinated standards facilitate inclusion/exchange of metrics and diagnostics with other parts of the US diagnostics community.

The proposed next phase of the framework is schematized in Figure 2. While maintaining continuity with the existing framework, we propose a number of ways in which it will be advantageous to expand.

- Overall structure remains the same, including the primary role for the model data from the center development team and a criterion that the interface should remain stable for POD

developers. Changes "under the hood" should bring benefits for users and developers but should avoid requiring changes to the existing PODs and prioritize continuity of experience for developers.

- As in the current framework, modularity is maintained for the contributed PODs, with the standard output being plots and associated modest size data files. Plots are assembled into a webpage, with sub-pages that permit easy comparisons of the candidate model and observations, with the option to include CMIP6 ensemble information for context. With a growing number of PODs, organization of POD output by phenomenon addressed (e.g., precipitation processes, section 3.4.6), and of POD requirements (by factors such as high time-resolution) will be necessary
- In addition to ongoing commitment to open source diagnostics and community development on GitHub, there will be a sustained effort to foster POD developer awareness of best practices for robustness, maintainability, and efficiency and to enhance features of the framework that enable this.
- The addition of supporting utilities that may be run on development model simulation output to produce quantities required by PODs. These can be externally supported software and/or require a substantial one-time computation, such as interpolation, or provide quantities that may be useful to several PODs. Providing the hooks to use these as needed reduces effort for POD developers and facilitates maintenance while often reducing runtime for the diagnostics set.
- Different institutions and users have different data storage architectures, data standards, file naming conventions, etc. Services for abstracting these differences loading data irrespective of these differences is important for portability. Data catalogs (e.g., intake-esm, SpatioTemporal Asset Catalog; STAC) can leverage developments in the larger Python ecosystem to address this problem (e.g., Hamman et al., 2018; Abernathy et al. 2020).
- Capability to run diagnostics across model output from a wider class of experiments—such as initial-condition ensembles—will be added where needed by POD developers and model development centers.
- Changes will be driven by expressed needs of centers and POD developers; needs anticipated here will be prioritized using feedback from the Task Force. Seamless transition for POD developers, backward compatibility and cost-benefit considerations for each added feature will be factored in. The added services that can be provided to model development centers will need to be balanced with an overarching aim of keeping the framework reasonably lightweight and easy to use.
- Documentation: protocols for documentation will be carried forward continuously with the prior phase to ensure uniformity in POD documentation, including a summary and suggested usage, and references in the peer-reviewed literature. We propose to establish best practices for complementing peer-reviewed papers with other tools for the creation of citable resources (i.e., DOIs) for software code and datasets. These can aid provenance and traceability, and promote recognition of software contributions.
- With early examples and communication, standards can be fostered for high-level uniformity among PODs, simplifying use, and facilitating coordination with other efforts, while assisting Type I groups with common tools.

The software framework expansion for Model Output types is illustrated with initial-condition ensembles in Figure 2 since these are becoming increasingly common. As warranted by needs from centers and POD developers, this could also include parameter-perturbation ensembles or

anthropogenic scenario runs, with conventions compatible with those used for the CMIP archive, with the associated meta-information available to the PODs. The leading emphasis remains process-oriented comparison of model simulations to observations, but experiments with a limited set of parameter perturbations are common in model development to test hypothesize physical mechanisms. Similarly, some Type I teams are likely to examine emergent constraints, i.e., observational constraints from current climate on a metric that correlates with projected changes in a regional or global metric of climate change impacts, and this can provide key information on the importance of a current-climate observational constraint.

The lead team in previous phases introduced a time-slice experiment protocol, as a way to obtain additional diagnostics not yet part of the development group standard output stream. The set of diagnostics was developed in coordination with the POD-developer groups and simulations were conducted with both GFDL and NCAR models with the common protocol. This protocol will be updated as warranted by needs of POD-developer groups.

Multiple angles for coordination will be considered in such updates, with GFDL-NCAR coordination providing the leading prototype. Coordination with other NOAA funded efforts and with DOE efforts is elaborated in section 3.3 below.

3.1.2 Supporting utilities

Based on experience in the current phase, there are certain types of analysis that are not directly part of diagnostics but which PODs may need to invoke to process output from a new simulation from a model under development. We use the term "Supporting utilities" as a shorthand for this class of software. In many cases, such software has its own development path and user community and enables performance metrics, mean-state and variability evaluation diagnostics and process-oriented diagnostics. Its use case is to operate on a simulation of a new model version from a lab development team to produce modestly sized intermediate data that would be then used by other PODs. The framework would set up the appropriate interface for a POD to invoke the software if it requires such intermediate data (checking first that the output dataset is not already available), and saving the intermediate data to a location that will depend on the particular lab installation and the size of the dataset. This requires only a modest expansion of the framework to accommodate—we already support an analogous function within a given POD, but not in a way that can export the data for use by multiple PODs nor coordinated with potentially external software. One simple example of this would be interpolation software, which we anticipate will be likely to be used by more PODs as ocean diagnostics and high-resolution simulations expand.

A leading scientific example of this functionality is feature tracking, which is used by certain PODs that are scheduled to be delivered in this phase. For instance, Kim et al. (2020) uses tropical cyclone (TC) track centers from a variety of tracking algorithms, piggybacking on tracking that had been applied to simulations by different models. This includes the TempestExtremes (TE) tracker (Ullrich and Zarzycki 2017; Zarzycki et al. 2017), the TC tracking algorithm from Zhao et al. (2009), the tracking algorithms from Camargo and Zebiak (2002) and the tracking algorithm developed by Harris et al. (2016), as implemented in Murakami et al. (2015), the latter also used by Kim et al. (2018). Because results can be tracker-dependent (e.g., Ullrich and Zarzycki 2017) there is value in using an ensemble of tunings for trackers (Roberts et al. 2020a).

We can anticipate the usefulness of feature tracking for current and future PODs from individual groups and for work connecting features to their environment proposed in section 3.4.5. We propose to use TE as the example to develop this functionality because one of the PIs (P. Ullrich) has developed this software to be robust and support a variety of configurations. It is also widely used, including in other agencies, which facilitates coordination across agencies. Furthermore, there is

proposed work by at least one Type I team that would use this software if successful. To make TE available within the framework, a Python interface must be developed to allow TE to be called directly from Python. The TE tracking output is either in the form of NOAA GFDL standard tracker files, for nodal features such as tropical cyclones, or in raster mask files stored in NetCDF format. Additional Python code must be developed that allows the POD to load these files, compare them against observational benchmarks, and output relevant diagnostics.

Interpolation software is another example of a supporting utility that multiple POD developers can benefit from, that typically needs to be run once on a development run, and that can be an externally maintained tool for which the framework team provides an interface. The Pangeo and Xarray communities have made progress in this effort through the development of the xESMF regridding package and the finite-volume-grid-aware xgcm utilities.

A radiative kernel POD developed by B. Soden and collaborators under the current phase provides an example of a procedure that produces intermediate variables that are potentially useful to a variety of PODs. It can thus be advantageous to separate the initial kernel operations as a supporting utility, with the time series available to PODs that produce specific observational comparisons.

3.1.2 Technical advances for the framework code

While maintaining continuity with the existing framework, we propose a number of ways in which it will be advantageous to expand. We aim to leverage recent technological advances to improve the user experience, performance, and robustness of the MDTF framework. We will continue to use the GitHub code hosting platform as a central clearing house for collaborative code development and user contributions, versioning, feature requests and issue tracking. This will provide a "one-stop shop" for code, documentation, training materials, and communication with the community. We propose to emphasize increased automation, accuracy and smart code management in a collaborative workspace by the enhanced use of cloud-based continuous integration tools, containerization of PODs and establishment of unified testing protocols. In addition to existing strategies for installation, we will explore standard python code packaging and delivery through PyPi, Anaconda and DockerHub (Merkel 2014; Radhakrishnan 2019) to improve the installation experience for the MDTF framework, supporting both diagnostic developers and end-users. To further improve usability, data discovery, and portability, best practices for data management will be augmented by the use of data cataloging utilities (e.g., "intake-esm", which provides an Earth System Model Catalog specification that points to the data locations and associated metadata designed by the Pangeo project, Hamman et al. 2018; Abernathy et al. 2020). Enhancements will also be made to the user interface and improvements will be made in the organization and display figures on the results web pages. Additional training materials and coding examples will be provided in the form of Jupyter notebooks developed by the framework team.

We propose to make progress towards improving the interoperability and performance of the MDTF framework software. Expanding the usage of xarray within new and existing diagnostics is an important part of the strategy. This will allow the framework to natively take advantage of Dask parallelism and leverage efforts within xarray to support ensemble analysis. Improvements in dependency resolution will also be made, allowing the MDTF framework to identify what inputs are needed to run, what output is expected, and communicate this information back to the modeling center workflows of GFDL and NCAR. To ensure that the framework continues to work efficiently with the next generation of models, forward thinking on increases in model resolution will guide considerations for parallelism and for interpolation.

As the number of PODS scale up, we seek to improve the self-awareness and error checking capabilities of the framework code by enhancing ways to monitor its status, gather performance metrics, improve logging features, and provide intuitive error notifications, overall improving the robustness and user experience of the framework. The proposed MDTF framework will be a crucial component in the future computational modeling and analysis workflow, both at GFDL and NCAR. Thus, we strive to incorporate provenance and unification of the code base by continuing to support the community standards such as Climate Forecast conventions, Climate Model Output Rewriter (CMOR; Taylor et al. 2004; Balaji et al. 2018) variable names, and the continued coordination with the DOE CMEC effort. Data management best-practices, leveraging community standards, exploration of containerized (e.g., docker technology) workflow for testing and deployment, and a strategy to foster packages such as xarray and dask will also seamlessly fit into the future cloud-optimized workflows and data formats. We envision the next phase of MDTF to be a cornerstone for best practices in sophisticated analysis workflows that invites further collaborations and is resilient to technological changes.

3.2. Task force and integration of efforts with Type I diagnostics PIs

A Task Force will be created, modeled on the current Model Diagnostics Task Force that will emphasize proactively reaching out to PIs of Type I diagnostics development proposals funded under this MAPP call. As for the current task force, communications via regular teleconferences will be supplemented by team meetings, coordinated with national or international conferences of interest to model development and analysis groups. Based on experience with the previous framework project and Task Force, a set of interactions will be planned as follows. A series of early teleconferences will (i) have the Type II team present the existing MDTF framework and proposed development pathway to POD teams for early feedback; and (ii) invite all POD teams to present plans so there is an overview of anticipated activities. Through the project, we will (iii) create continuous two-way updates, with presentations from the lead team on framework developments, and (iv) "Science blurbs" from the POD teams to provide a sense of progress and an opportunity for feedback. We will also interactively (v) choose groupings of PODs that will tend to be used together, as a way of organizing the diagnostics both scientifically and in terms of dataset use (e.g., high-frequency atmospheric diagnostics versus long runs using variables from more than one realm).

An interaction that we propose to introduce early in the coming phase is a series of small online tutorials for the POD developers, to help transfer technical expertise. We have found that individual groups have different levels of familiarity with software tools, from GitHub to tips for writing robust, efficient Python code. With a new set of grad students, postdocs (and often, PIs) it will be useful to make sure they have the tools they need. The tutorials offered will be interactive, and responsive to the needs of Task Force members. We will also use these as an opportunity to identify common tools and to provide examples of recognized standards that will aid development and help to unify the overall Task Force effort.

Another feature we propose to introduce is "Developer Days". These will be online sessions with selected model developers from GFDL and NCAR to provide feedback on potential use of proposed diagnostics, and to identify unfilled diagnostic needs that could benefit the GFDL and NCAR development teams. We anticipate that this coordination will benefit POD projects by sharpening their objectives to be more useful.

The prior lead team also introduced a time-slice experiment protocol, as a way to obtain additional diagnostics not yet part of the development group standard output stream. The set of diagnostics

was developed in coordination with the POD developer groups and simulations were conducted with both GFDL and NCAR models with the common protocol.
The Task Force will also coordinate publications that provide synthesis of the contributions of the groups, as well as a special issue of a leading journal or group of journals, as is being done for the current Task Force. Type I diagnostic projects, along with the lead team, will be encouraged to contribute publications that provide standard references in the refereed literature for the diagnostics contributed to the framework. Following the protocol set up in the current phase, these will be coordinated with the documentation protocols established in the framework.

3.3. Coordinating US diagnostic efforts

In this phase we propose to expand coordination of the MDTF effort with other US diagnostics efforts. While the various diagnostic efforts may vary in their specific aims and requirements, there can be significant benefits from creating bridges among them wherever possible.
Within NOAA, we propose undertaking coordination with several efforts. We have initiated coordination with the Climate Sensitivity Task Force led by Brian Soden, Brian Medeiros and Ming Zhao. We have offered to host any appropriate diagnostics PODs within the MDTF framework. Climate sensitivity PODs using current-climate simulations fit straightforwardly within the framework, and as noted in section 3.1.1, modest updates to Model Output types can be accommodated wherever this is useful to the model development centers.
Similarly, we propose to coordinate with MAPP-funded Climate Process Teams Coupling Land and Atmosphere Subgrid Parameterization (CLASP) led by N. Chaney (Duke) and K. Findell (GFDL), and Three-dimensional Land Energy and Moisture Exchanges led by K.-N. Liou (UCLA) offering to host PODs as appropriate and providing standards and protocols for interconnectivity. Inter-POD co-ordination within NOAA is also being initiated with anticipated science and coding framework exchange between the UCLA team and a team from the NOAA Physical Sciences Laboratory (B. Wolding, J. Dias, G. Kiladis) in a no-cost collaboration discussed in section 3.4.6.
Coordination with Department of Energy efforts was launched during the current phase, and for the proposed phase P. Ullrich has joined as co-PI to enhance this coordination. He leads the Coordinated Model Evaluation Capabilities (CMEC) effort which currently includes three analysis packages: the PCMDI Metrics Package (PMP; PCMDI 2017), the International Land Model Benchmarking (ILAMB 2017), and the Toolkit for Extreme Climate Analysis (TECA 2017). Under current work we have begun preparation of a CMEC-MDTF standard, which we propose to formalize and extend under the proposed work. This standard builds on structure from the MDTF framework so a level of interoperability is already built in.
An MDTF-CMEC standards committee will be established that will operate by consensus, setting the manner in which analysis modules — whether they be for metrics or for process-oriented diagnostics — interact with the framework, including conventions for a settings json file by which the module tells the framework its requirements (pink box and arrow in Fig. 2).The standard will be set at the level of the framework aiming at common functionality between the packages to permit interoperability without strongly constraining the specific goals of each package.
We have also initiated coordination with DOE-NOAA effort on precipitation evaluation led by C. Jakob, P. Gleckler and A. Pendergrass) including the Exploratory Precipitation Metrics effort being led by R. Leung. This will be an excellent example of the interaction between process-oriented diagnostics and evaluation metrics. The proposed work (see section 3.4.6 for specifics) will seek to help fill out the spectrum between these and coordinate among packages.
Overall, the aims are: to meet the needs of the model development centers at GFDL and NCAR, while coordinating with DOE efforts to jointly move the community towards common standards.

3.4. Diagnostic development and adaptation by the core team

In addition to providing the framework and leadership for the Type I diagnostic-development projects, the Type II lead team will work on development and incorporation of selected process-oriented diagnostics that fit with their expertise, leveraging prior work and collaborations. This can provide useful test cases for the framework, expanding in ways that push the boundaries of the existing diagnostics, provide science deliverables from the lead team members and provide examples for Type I diagnostics contributors. Wherever there is connectivity to other NOAA funded projects, the lead team will reach out to ensure coordination.

3.4.1. Exploration of ocean surface state extremes.

The development of ocean-based diagnostics by the framework team will center on characterizing the variability of sea surface state variables from daily to decadal timescale. This variability is important for detection of the local impact of anthropogenic climate warming as well as for the health and functioning of marine ecosystems (Frölicher and Laufkötter 2018), including coral reefs (e.g., Tuckett et al. 2017).

The initial focus will be on sea surface temperature (SST). Similar to work already conducted over the continental United States for surface air temperature (Catalano et al. 2020), probability density functions of SST extremes will be calculated and compared with available observations and reanalysis products. Projected changes in these distributions will be explored under both idealized warming and future climate scenarios.

This work is relevant to the understanding of the climatology of marine heatwaves (MHWs, Holbrook et al. 2019; Hobday et al. 2016; Oliver et al. 2018) in GCMs which complement ongoing activities at GFDL to explore the biogeochemical impacts of such events. The proposed work will consider high-level process interactions between the atmosphere (e.g., long-lived blocking events (e.g., Behrens et al. 2019; Rodrigues et al. 2019)) and ocean (e.g., wind driven mixing (e.g., Amaya et al. 2020; Gao et al. 2020) and their influence on the ocean mean state. A more detailed approach of diagnosing changes in the surface ocean and mixed layer heat, salt, and momentum budgets will be used to target dominant processes that are driving MHWs in different regions and seasons. On the atmosphere side, diagnosing changes in large-scale circulation (e.g. geopotential height patterns), cloud cover, surface winds, and lower tropospheric temperature profiles would complement the ocean analysis. The approach could be further generalized and extended to look at other surface extremes, including sea surface salinity and sea surface height.

The work would be performed by a postdoctoral researcher seated at GFDL that is jointly mentored by Krasting (GFDL) and G. Marques (NCAR Project Scientist) in collaboration with Neelin (UCLA) and P. Loikith (Portland State). Loikith led the development of an existing POD for surface air temperature extremes and associated large-scale meteorological patterns over land. Adaptation of that POD will be a cost-efficient contribution to the atmospheric side of the MHW work above, with Loikith contributing advice as an unfunded collaborator. The expected outcome of this work would be to target geographical areas and physical processes for improvement that are relevant to the simulation of MHWs and to provide a physical baseline for more detailed biogeochemical analysis of MHWs and their impacts.

It would be coordinated with work under the Marine Ecosystems Process team by Antonio Capotondi (NCAR) on extreme SST conditions in the Northeast Pacific, and by Malte Stuecker and Brian Powell (U. Hawaii) on time evolution of marine heatwave changes in the subtropical Pacific.

3.4.2 Process contextualization of ocean mean state

The ability to assess the ocean mean state, seasonal cycle, and variability characteristics underpins the ability to interpret process level diagnostics as the model biases and overall fidelity must be established. Although a strong multi-institutional collaboration on model code exists for MOM6, each development center is engineering their own mean state diagnostics with a significant amount of overlap. These include the "mom6-tools" package developed by NCAR (Marques et al. 2020) and the "om4labs" package developed at GFDL (Dussin et al. 2020). The framework development will facilitate the coordination of ocean mean state diagnostics to develop a common set of tools that is usable by the broader MOM6 community and compatible with and callable by the MDTF framework for use with GFDL and NCAR's modeling workflows. Proposed diagnostics include diagnostics of annual and monthly biases of potential temperature and salinity, ocean model potential temperature drift, global and basin-wide poleward heat transport, mixed layer depth climatology, characterization of upper ocean mixing biases, and baseline evaluation of global and basin overturning circulation. A common set of tools for working with ocean model data on both native irregular and spherical grids, basin masking, and simple regridding will also be part of this effort. The code for Type II team diagnostics using these tools will also be useful as examples for Type I teams.

3.4.3. Integration with broader CESM diagnostic workflows

We will also work to integrate the evolving MDTF framework and diagnostics into the broader internal and external diagnostic workflows used by the CESM community. This includes linking process-oriented diagnostics under the MDTF umbrella with climatological diagnostics and climate variability diagnostics. NCAR already maintains the very successful Climate Variability Diagnostic Package (Phillips et al. 2014), and is rebuilding its Atmosphere Working Group diagnostic package to be compatible with the MDTF python workflows. The workflow for the revised package will use MDTF at its heart, with links to more traditional climate diagnostics. We will integrate this workflow into NCAR atmospheric model development efforts. We will also make this workflow available to the CESM community as the other NCAR diagnostics have been. We intend to advance training efforts in use of the MDTF diagnostics for NCAR staff and CESM users, and work towards improved usability of the MDTF framework. In addition, we will work with other working groups within CESM, such as the Ocean Model Working Group, to integrate diagnostics for non-atmospheric components into the MDTF.

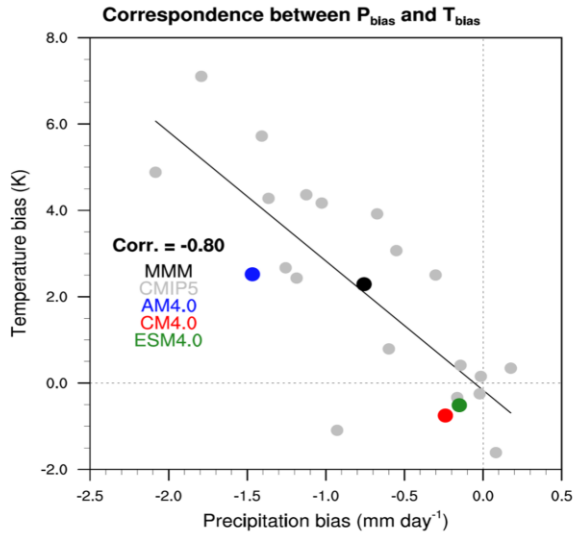

Figure 3: Scatter plot of precipitation versus temperature biases over SGP for GFDL's latest models (AM4.0, CM4.0 and ESM4.0) with CMIP5 models and multi-model mean (MMM) providing context for the process relationship.

3.4.4. North American regional hydroclimate

The development of atmosphere-centric PODs at GFDL will be structured around better understanding the North American regional hydroclimate, as part of the concerted effort toward meeting the NOAA Precipitation Prediction Grand Challenge. The initial focus will be on diagnosing the long-standing warm-dry bias over the

Southern Great Plains (SGP). A POD will be designed to calculate the summertime precipitation and surface temperature biases over SGP and shed light on the underlying physical mechanisms. As shown by Lin et al. (2017), the warm bias over this region originates primarily from the dry bias through a series of land-atmosphere feedbacks. The relationship between the two biases in the current climate (Fig. 3) can serve as an emergent constraint for future projections. Another focus area will be the western United States. A POD is planned for diagnosing Rossby Wave Breaking (RWB), the main dynamical mechanism of atmospheric rivers, following the method proposed by Browley (2019), and for connecting RWB with extreme precipitation events. Efforts will also be made to better diagnose the physical mechanisms of North American Monsoon (NAM), a major source of precipitation in the Southwest, with the initial focus on the characteristics of easterly waves and their impacts on NAM (e.g., Adams and Stensrud, 2007).

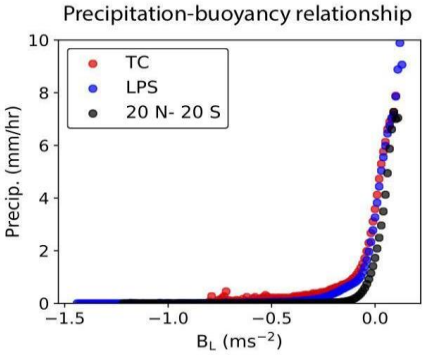

Figure 4. The buoyancy relationship for precipitation in deep tropics (black), TCs (red) and LPSs (blue).

3.4.5 Process-oriented environment for tropical features with buoyancy diagnostics

We anticipate that the next generation of climate models will more commonly run at resolutions for which it is reasonable to be evaluating features such as TCs (Camargo and Wing 2016, Strachan et al. 2013, Roberts et al. 2020b) or cyclonic low pressure systems (LPSs). Despite increased resolution, errors in feature statistics can still result from biases in mean-state (Manganello et al. 2012) or differing model physics such as the model convection scheme (Vitart et al. 2001; Kim et al. 2012, 2020, Lim et al. 2015). We propose to diagnose model errors in TC and LPS precipitation statistics by assessing their typical precipitating environment. In doing so, we aim to leverage the TE feature tracker available as a supporting utility in the next phase of the MDTF framework.

Diagnostics aimed at understanding the onset of tropical deep convection in terms of its thermodynamic environment were developed under previous phases (see Prior Work Section). This included a measure of buoyancy available to deep convective features based on the combined effects of the temperature and moisture profile that has a strong relationship to precipitation (Ahmed and Neelin 2018, Schiro et al. 2018, Ahmed et al. 2020). The buoyancy measure (B_L) can be decomposed into two components that measure the relative free tropospheric temperature relative to

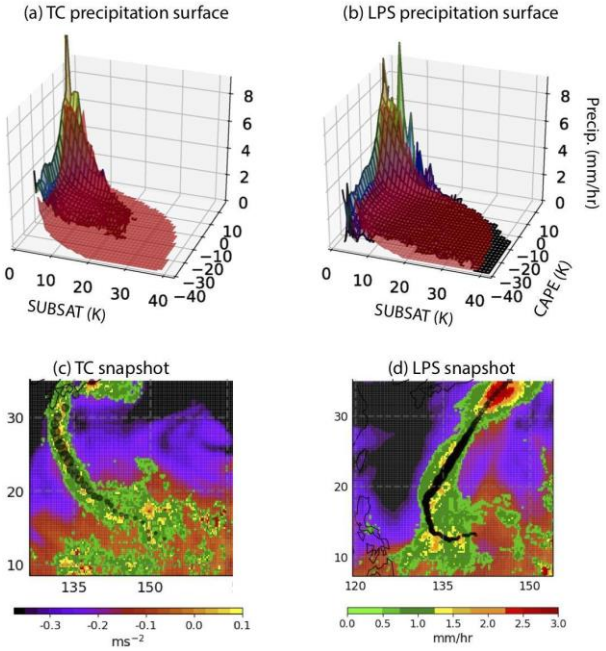

Figure 5. Precipitation surfaces for (a) TCs and (b) LPSs. Reference tropical precipitation surface is over-lain in red. Snapshots of (c) TC and (b) LPS tracks as identified by TE (black dots) along with composite B_L and precipitation contours

boundary layer equivalent potential temperature (CAPE) and the ambient sub-saturation (SUBSAT). We propose to exploit this relationship in combination with the TE feature tracker to composite the thermodynamic environment for which deep convection is a key mechanism, including LPSs and TCs. Fig. 5c and d show how the TE can be used to identify the relevant near-field environment of tracked features with example TC and LPS tracks overlain on a composite map of the precipitation and BL.

An examination of the precipitation- B_L statistics (Fig. 4) composited over instances of TCs and LPSs in the ERA-5 dataset reveals the same qualitative relationship as for general deep tropical precipitation. The precipitation conditionally averaged by the B_L components CAPE and SUBSAT is displayed as a 'precipitation surface' in Figs. 5a and b. The precipitation from LPSs and TCs are sensitive to perturbations in both CAPE and SUBSAT— much like the general tropical precipitation surface (red shading in Figs. 5a and b). Differences in the model convection sensitivity to environmental thermodynamics generate errors in the model precipitation surfaces. These errors are expected to affect the incidence and intensity of tracked features such as LPSs and TCs that depend on the circulation coupling to moist convection. The TE tracks also show that the predominant TC/LPS environment is near-saturated with high CAPE. The related POD will allow users to parse errors in the statistics of these tracked features into contributions from errors in the model convection scheme and biases in the large-scale environment.

3.4.6. Coordination of precipitation PODs

As an example of multi-POD organization by focus area, we anticipate interacting with other efforts from Type I teams (M. Genhe, NOAA; B. Wolding NOAA; Z. Wang, UIUC) that create or employ precipitation-related diagnostics. At a general level of coordination, we expect to standardize data input catalogs, to identify common supporting utilities, to identify PODs relevant to precipitation processes as a related subset of diagnostics in the framework, and to provide worked examples of models assessed with multiple precipitation-related PODs. At a more detailed level, there is great potential synergy between moisture-convection coupling diagnostics (Wolding et al. 2020a,b) and precipitation buoyancy diagnostics (Ahmed and Neelin 2018).Thus, Neelin and Co-I Ahmed will serve as unfunded collaborators on a Type I proposal led by B. Wolding and the NOAA/PSL team B. Wolding, J. Dias, G. Kiladis will serve as unfunded collaborators on this proposal to facilitate inter-POD science interactions.

The current MDTF lead team is participating in the Exploratory Precipitation Metrics effort led by R. Leung (PNNL), which involves NOAA- and DOE-funded personnel and collaborators at the UK Met Office and National Centre for Atmospheric Science. We are testing a new set of metrics building on the existing convective transition POD. We expect this collaboration to be an initial example of processed-oriented diagnostics interacting with evaluation metrics, leading to a better integration of the diagnostics into modeling center workflow. The proposed MDTF framework coordination with CMEC should make it straightforward to take metrics based on PODs and migrate them to the PMP metrics package and we propose to use precipitation probability-distribution and convective-transition PODs as worked examples for developing this capability. This effort will also lead to a better coordination among the participants on (1) the software framework design; (2) management of observational and reanalysis datasets for model comparison; and (3) presentation of diagnostics in the context of multi-model ensemble.

3.4.7. Weak Temperature Gradient (WTG) Diagnostics for Tropical Convection

Given the small value of the Coriolis force, the tropical atmosphere cannot sustain strong temperature gradients (e.g., Sobel and Bretherton 2000). This constrains the dominant thermodynamic energy balance of the tropics on synoptic scales to a balance between adiabatic cooling and diabatic

heating, a useful constraint that when applied to the moisture budget helps to highlight deficiencies in moistening processes that help support tropical convection (e.g., Chikira 2014; Wolding and Maloney 2015). For example, a vertical velocity that balances a radiative heating anomaly in tropical convective regions can be determined if the static stability is known. How this radiative heating anomaly contributes to the column moisture budget can then be determined through examination of vertical moisture advection produced by the balancing vertical velocity (e.g., Wolding et al. 2016). If a model radiative heating anomaly in tropical convective regions is too strong or weak, or improperly distributed in the vertical, it will not produce a radiative feedback onto moisture in tropical precipitation regions that is realistic. Climate models are associated with systematic mean tropical precipitation biases and biases in tropical precipitation variability on a variety of timescales (e.g., Lin 2007; Tian and Dong 2020; Ahn et al. 2017). The co-PI Maloney has recently been funded as part of a complementary NASA NEWS project to use satellite (CERES) 3-d radiative heating fields and GPM precipitation, global surface flux estimates, and reanalysis datasets to assess the importance of the vertical profile and strength of radiative heating and other diabatic heating terms for supporting organized tropical convection in the context of the total WTG-constrained moisture budget. This observational analysis using NASA satellite products and reanalysis fields provides an outstanding diagnostic against which to compare model moisture budgets that can be related to biases in mean tropical precipitation. We will leverage work under this NASA project for development of a POD that uses WTG moistening diagnostics to understand mean tropical precipitation biases.

4. Relevance to the Climate Program Office and MAPP Goals

This proposal responds to the call for the "Modeling, Analysis, Predictions, and Projections (MAPP) Competition 2: "Process-Oriented Diagnostics for NOAA Climate Model Improvement and Applications" to develop a Type II team to "integrate results and activities of the individual projects in a Task Force collectively and synergistically" including "collaborative activities to unify participating researchers, infrastructure for data and code sharing, technical support for integration of PODs developed by community members" (quotes here and below are from the 2021 MAPP Information Sheet). The proposed work includes plans for "engag[ing] researchers in model evaluation and development activities", and 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 software package". The proposal also includes "support for the integration of PODs from research teams funded outside of this solicitation". Proposed work will "enhance a process-oriented framework approach" with "the overall aim to advance understanding of biases generally affecting CMIP6-era and next-generation models and to identify targeted model improvements". In particular, we propose 1) to expand the existing MDTF framework to facilitate a incorporation of a wider range of PODs targeting "gaps in the existing" set of diagnostics; 2) to enhance the interoperability and "use of the software through relevant collaborations with […] for example NCAR, PCMDI, E3SM…" through common standards with NCAR diagnostics and CMEC; 3) scientific development of new process oriented diagnostics that provide integrative examples or in-depth process-oriented approach; 4) protocols to engage and synthesize the efforts of Type I projects, enhance collaboration with the modeling centers and synthesize results.

5. Work Plan and Experience of the PIs

5.1. Project team

David Neelin is lead-PI the effort and will coordinate activities in the proposed work. Neelin will coordinate with GFDL lead J. Krasting to oversee the arrangement of video conferences and team

meetings, and coordinate tasks between the modeling centers involved in this proposal in collaboration with the other PIs. He will also lead interactions with Type I project teams. Neelin and the UCLA personnel will also contribute to further development of process-oriented diagnostics described in Section 3.4, will adapt and implement contributions from no-cost collaborators, and will work with the other groups on the software framework development. Neelin and J. Krasting will co-lead the Task Force.

John Krasting is a co-PI of the effort and has been leading the implementation of the software framework in the GFDL diagnostics workflow in the current phase. He will lead the GFDL effort, coordinating with Y. Ming on atmospheric diagnostics, with A. Radhakrishnan on software and coordination into the GFDL development workflow, and with NCAR investigators on ocean diagnostics supervising the postdoc on this task. Krasting will co-lead the Task force with D. Neelin.

Yi Ming is a co-PI of the effort, and is a member of the GFDL Model Development Team Steering Committee. As the head of the Division of Atmospheric Physics, he oversees the development of atmospheric physics parameterizations at GFDL. He was a core developer of GFDL's CMIP5 and CMIP6 models, and has designed and implemented diagnostics related to clouds and aerosols. Ming will lead the atmospheric diagnostics portion of the GFDL contribution, supervising the postdoc on this, and coordinating with J. Krasting and A. Radhakrishnan.

Aparna Radhakrishnan is a co-PI of the project and will lead software development aspects described in section 3. Radhakrishnan will oversee the scientific programmer at GFDL and coordinate MDTF activities with other diagnostic and workflow efforts at GFDL. Radhakrishnan will also coordinate with Krasting and Ming on the implementation of atmospheric and ocean diagnostics developed at GFDL. She will coordinate with the rest of the task force to provide documentation and training materials and promote the incorporation of community-developed diagnostics.

Andrew Gettelman is a co-PI of the project, leading the NCAR contribution. He is a core developer of the atmospheric model of the Community Earth System Model at NCAR. He helped develop the NCAR diagnostics package, the Chemistry Climate Model Validation project (CCMVal), and the current MDTF software framework. He will ensure compatibility in incorporating community diagnostics into the NCAR model evaluation stream, and work with the other co-PIs to implement them. Dr. Gettelman will supervise an Associate Scientist (Dani Coleman) at NCAR to integrate the MDTF framework into NCAR workflows. Dr. Gettelman will also coordinate with NCAR ocean model diagnostic development efforts.

Eric Maloney is a co-PI of the project, was the lead PI and Chair of the Model Diagnostics Task Force during its initial phase, and previously played leadership roles in process-oriented diagnostics development as co-chair of the World Meteorological Organization Working Group on Numerical Experimentation (WGNE) MJO Task Force and NOAA MAPP CMIP5 Task Force. He will collaborate with UCLA and GFDL personnel on expansion of the framework and on the diagnostics in Section 3.4.7 and will contribute to representing the Team at meetings.

Paul Ullrich is a co-PI of the project, leading the coordination with CMEC and DOE efforts in collaboration with Neelin and the other co-PIs, and working on adapting the TempestExtremes feature tracker that he has developed to MDTF. He leads the CMEC effort and has substantial past experience in model evaluation as lead of the Dynamical Core Model Intercomparison Project.

Fiaz Ahmed, a Project Scientist at UCLA, is a co-I of the effort, and will coordinate with Neelin and P. Ullrich on work in section 3.4.5 and with B. Wolding and collaborators on work in section 3.4.6, as well as providing input on framework updates.

5.2. Work Plan

Year 1: Task Force with POD developer (Type I) teams will be initiated. In the monthly teleconferences, the existing MDTF framework and proposed framework development pathway will be presented to Type I teams for early feedback, identification of common needs and tools, and to guide development directions. All Type I teams will be invited to present plans in early teleconferences so there is an overview of anticipated activities. "Developer days" will be initiated, with feedback from modeling centers on proposed diagnostics, as will "Best practices" sessions for information transfer on coding practices. Work on the expansion of the framework described in section 3.1, and on Lead (Type II) team diagnostics in section 3.4 will begin.
Year 2: Task force teleconference series continues, promoting updates on development from both Type I and II teams. Continued two-way feedback with Type I teams on improvements to the framework and PODs. A special issue will be proposed to a leading journal (or group of journals) for groups to contribute their results on a coordinated theme. Incorporation of initial PODs from Type I teams into framework and GFDL and NCAR development stream.
Year 3: Integration of all diagnostics from Type I and Type II teams into the framework, with final adjustments based on experience in year 2. Assessment and implementation of integration paths with other national efforts. Publications for the special issue will be encouraged for all projects, with a particular eye to providing references in the refereed literature for each POD.

E. Data/Information Sharing Plan

Both code and documentation products from this work will be publicly released. Documentation will be linked from the NOAA Task Force webpage, and code will be made publicly available from the GitHub repository. Full access to each updated version of the software framework will be granted to the community as soon as it has completed beta testing. Webpages showing products from the framework will be accessible to the community as part of the NCAR and GFDL websites. The examples and design will be available to anyone who wants them, with the aim of encouraging an even larger community to contribute diagnostics compatible with the centers' workflows. The source of associated outside datasets (maintained by other federally funded groups) will be documented as they were obtained at the time of analysis.
Significant derived datasets that might be useful to the community will be distributed via the existing data portal. Model output from development runs by NCAR and GFDL will be subject to the data sharing plans of those institutions (e.g., adhering to GFDL's Fair Use Policy, which is a set of guidelines for sharing code and data with collaborators and the wider research community to maximize the scientific and societal impact, while also striving to ensure that this is done in a fair manner that recognizes the diverse contributions). Information on the software framework and access will be advertised at the meetings and workshops related to the proposed work discussed above, as well as through publications. The research results from the proposed work will be documented and published in the peer-reviewed scientific literature. The University of California has an open access policy ensuring that research articles authored by faculty at all UC campuses will be made available to the public at no charge.

F. Statement of Diversity, Inclusion, and Broader Impacts

The proposed work will have broader impacts both through the research itself and through related activities. The research will help to improve models that are used in the prediction of extreme events, including precipitation and temperature extremes, and in preparation for changes in these and other climate variables such as sea level trends that have strong societal impacts. The project will contribute to communicating the physical mechanisms and likely impacts of these, helping to build an informed, resilient society. The project will facilitate coordination among leading US

institutions in model development, yielding a more coherent national effort. Each of the institutions involved in this proposal has a deep commitment to fostering diversity, including full participation of women, persons with disabilities, and underrepresented minorities in the science, technology, engineering, and mathematics (STEM) field. Practices that expand the set of citable sources (e.g., including code and datasets) assist in giving broader credit to all team members. Each institution aims to build a diverse and inclusive workforce and workplace environment, and the investigators in this proposal will continue working to support these aims. Specific activities that have been undertaken by the investigators will continue to be undertaken as part of the proposed work, and include: communication with general public audiences to increase public scientific literacy and to contribute to a society that is technically informed on environmental issues; undergraduate education, including incorporating the latest information available from this project and related work in the field in undergraduate teaching materials; aiding undergraduate students to develop professional judgment regarding the uses and the limitations of climate and weather models and forecasts; introducing undergraduates from diverse backgrounds to research via projects and internships, which helps to develop a competitive STEM workforce; and training graduate students and postdoctoral fellows involved in this research, which contributes to human infrastructure for the STEM field.

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H. Vitae
J. David Neelin
Current/recent Positions
Distinguished Professor, Dept. of Atmospheric and Oceanic Sciences, UCLA, 2016-present
Professor, Dept. of Atmospheric and Oceanic Sciences, UCLA, 1995-2016
Chair, Dept. of Atmospheric and Oceanic Sciences, UCLA, 2010-2013

Doctorate: Princeton University, Geophysical Fluid Dynamics Program, 1987

Selected Recent Publications
Book: **Neelin, J. D.**, *Climate change and climate modeling*, Cambridge University Press, 282 pp. (2011). ISBN: 9780521602433

1. Kuo, Y.-H., **J. D. Neelin**, and Coauthors, 2020: Convective transition statistics over tropical oceans for climate model diagnostics: GCM evaluation. *J. Atmos. Sci.*, 77, 379-403.
2. Schiro, K. A. and **J. D. Neelin**, 2019: Deep convective organization, moisture vertical structure, and convective transition using deep-inflow mixing. *J. Atmos. Sci.*, 76, 965-987.
3. Ahmed, F., and **J. D. Neelin**, 2019: Explaining scales and statistics of tropical precipitation clusters with a stochastic model. *J. Atmos. Sci*., 76, 3063-3087.
4. Swain, D. L., B. Langenbrunner, **J. D. Neelin**, and A. Hall, 2018: Increasing climate volatility in 21st century California. *Nat. Climate Change*, 8, 427-433.
5. Ahmed, F. and **J. D. Neelin**, 2018: Reverse engineering the tropical precipitation-buoyancy relationship. J. Atmos. Sci. 75, 1587-1608.
6. Martinez-Villalobos, C. and **J. D. Neelin**, 2018: Shifts in precipitation accumulation distributions during the warm season over the United States. *Geophys. Res. Lett.*, 45, 8586-8595.
7. Langenbrunner, B. and **J. D. Neelin**, 2017: Pareto-Optimal Estimates of California Precipitation Change. *Geophys. Res. Lett*., 44, 12436-12446, doi:10.1002/2017GL075226.
8. Su, H., J. H. Jiang, **J. D. Neelin**, T. J. Shen, C. Zhai, Q. Yue, Z. Wang, L. Huang, Y.-S. Choi, G. L. Stephens, and Y. L. Yung, 2017: Tightening of tropical ascent and high clouds key to precipitation change in a warmer climate. *Nat. Commun.*, 8, 15771, doi:10.1038/ncomms15771.
9. Quinn, K. M., and **J. D. Neelin**, 2017: Distributions of Tropical Precipitation Cluster Power and Their Changes Under Global Warming. Part I: observational baseline and comparison to a high-resolution atmospheric model. *J. Climate*, 30, 8033-8044.
10. **Neelin**, **J. D.**, S. Sahany, S. N. Stechmann, and D. N. Bernstein, 2017: Global warming precipitation accumulation increases above the current-climate cutoff scale, *Proc. Nat. Acd. Sci. USA*, 114, 1258-1263, doi:10.1073/pnas.1615333114.

Publication Summary Information
Total peer-reviewed publications: over 180 journal articles, 5 book chapters, 1 textbook
H-index: 76/60 (Google Scholar/ISI); i10 180; *Papers with over 100 citations* (Thomson ISI): 32

Selected Awards
2019: Charney Medal of the American Meteorological Society; ***2017:*** Bert Bolin Global Environmental Change Award/Lecture, American Geophysical Union; ***2015:*** elected Fellow of the Royal Society of Canada; ***2012:*** Fellow, American Association for the Advancement of Science and American Geophysical Union; ***2008***: Professeur Invité, Ecole Normale Supérieure, Paris;

Fellow of the John Simon Guggenheim Memorial Foundation; ***2003***: Fellow, American Meteorological Society and Royal Meteorological Society; ***2000:*** NSF Special Creativity Award; and ***1991-96:*** Presidential Young Investigator Award.

Selected Service/Affiliations

Boards: Jet Propulsion Laboratory Center for Climate Sciences, 2012-present; Natl. Center for Atmos. Research, Climate & Global Dynamics Laboratory, 2015-present; ***Other:*** Contributing author, 5th & 2nd Assessment Reports of the Intergovernmental Panel on Climate Change.

Andrew Gettelman

Current/Recent Positions

Scientist I-IV, National Center for Atmospheric Research (NCAR), Boulder CO, 2003-Present
Visiting Professor, Department of Physics, Oxford University, UK, Aug 2019-Aug 2020
Esrkine Fellow, University of Canterbury, New Zealand, June-August 2016
Visiting Professor, ETH Zürich, Switzerland, August 2011-July 2012,
Project Scientist, NCAR, 2001-2003

Doctorate: University of Washington, Seattle, WA, Atmospheric Sciences, 1999

Selected Recent Publications (from over 150)

Book: **Gettelman, A.** and R. B. Rood, *Demystifying Climate Models*, Springer, Berlin, 274 pp. (2016). ISBN 978-3-662-48957-4

1. **Gettelman, A.**, and Coauthors, 2019: High climate sensitivity in the Community Earth System Model Version 2 (CESM2). *Geophys. Res. Lett.*, 46, 8329- 8337, doi:10.1029/2019GL083978.
2. **Gettelman, A.**, H. Morrison, K. Thayer-Calder, and C. M. Zarzycki, 2019: The impact of rimed ice hydrometeors on global and regional climate. *J. Adv. Model. Earth Syst.*, 11, 1543-1562.
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6. **Gettelman, A.**, and H. Morrison, 2015: Advanced Two-Moment Bulk Microphysics for Global Models. Part I: Off-Line Tests and Comparison with Other Schemes. *J. Climate*, 28, 1268-1287, doi:10.1175/JCLI-D-14-00102.1.
7. **Gettelman, A.**, H. Morrison, S. Santos, P. Bogenschutz, and P. H. Caldwell, 2015: Advanced Two-Moment Microphysics for Global Models. Part II: Global model solutions and Aerosol-Cloud Interactions. *J. Climate*, 28, 1288-1307, doi:10.1175/JCLI-D-14-00103.1.
8. **Gettelman, A.**, D. T. Shindell, and J.-F. Lamarque, 2015: Impact of Aerosol Radiative Effects on 2000-2010 Surface Temperatures, *Climate Dyn.*, 45, 2165-2179, doi:10.1007/s00382-014-2464-2.
9. **Gettelman, A.**, and S. C. Sherwood, 2016: Processes Responsible for Cloud Feedback. *Curr. Climate Change Rep.*, 2, 179-189, doi:10.1007/s40641-016-0052-8.

Publication Summary
Total peer-reviewed publications: Over 150 journal articles
H index: 57 (Google Scholar)

Selected Awards
2014-2020: Thomson Reuters Highly Cited Researcher
2015: AGU Ascent Award

Selected Service/Affiliations
DOE Atmospheric System Research, User Executive Committee Member, 2015-2018; Co-Chair, Community Earth System Model, Whole Atmosphere Community Climate Model Working Group, 2013-2019; Lead Author for SPARC Chemistry Climate Model Assessment UT/LS Chapter, 2007-2010; Steering Committee, SPARC-IGAC Atmospheric Chemistry and Climate Initiative 2007-present; and Associate Editor, Reviews of Geophysics, 2010-present.

John P. Krasting
Current/recent Positions
Physical Scientist, NOAA-GFDL, 2009-Present
Adjunct Lecturer, Dept. of Environmental Science, Rutgers University, 2011-Present

Doctorate: Rutgers University, 2008

Selected Recent Publications:

1. **Krasting, J. P.**, R. J. Stouffer, S. M. Griffies, R. W. Hallberg, S. Malyshev, B. L. Samuels, and L. T. Sentman, 2018: Role of Ocean Model Formulation in Climate Response Uncertainty. *J. Climate*, 31, 9313-9333, doi:10.1175/JCLI-D-18-0035.1.
2. **Krasting, J. P.**, J. P. Dunne, R. J. Stouffer, and R. W. Hallberg, 2016: Enhanced Atlantic sea-level rise relative to the Pacific under high carbon emission rates. *Nat. Geosci.*, 9, 210-214, doi:10.1038/ngeo2641.
3. **Krasting, J. P**., J. P. Dunne, E. Shevliakova, and R. J. Stouffer, 2014: Trajectory sensitivity of the transient climate response to cumulative carbon emissions. *Geophy. Res. Lett.*, 41, 2520-2527, doi:10.1002/2013GL059141.
4. Arora, V. K., A. Katavouta, R. G. Williams, C. Jones, V. Brovkin, P. Friedlingstein, J. Schwinger, L. Bopp, O. Boucher, P. Cadule, M. A. Chamberlain, J. R. Christian, C. Delire, R. A. Fisher, T. Hajima, T. Ilyina, E. Joetzjer, M. Kawamiya, C. D. Koven, **J. P. Krasting**, and Coauthors, 2020: Carbon-concentration and carbon-climate feedbacks in CMIP6 models, and their comparison to CMIP5 models. *Biogeosciences*, 17, 4173-4222, doi:10.5194/bg-17-4173-2020.
5. Dunne, J. P., M. Winton, J. T. Bacmeister, G. Danabasoglu, A. Gettelman, J. C. Golaz, C. Hannay, G. A. Schmidt, **J. P. Krasting**, L. R. Leung, L. Nazarenko, L. T. Sentman, R. J. Stouffer, and J. D. Wolfe, 2020: Comparison of equilibrium climate sensitivity estimates from slab ocean, 150-year, and longer simulations. *Geophy. Res. Lett.*, 47, e2020GL088852, doi:10.1029/2020GL088852.
6. Eyring, V., P. Cox, G. M. Flato, P. J. Gleckler, G. Abramowitz, P. Caldwell, W. D. Collins, B. K. Gier, A. Hall, F. Hoffman, G. C. Hurtt, A. Jahn, C. Jones, S. A. Klein, **J. P. Krasting**, and Coauthors, 2019: Taking climate model evaluation to the next level. *Nat. Climate Change*, 9, 102-110, doi:10.1038/s41558-018-0355-y.

7. Frölicher, T. L., J. L. Sarmiento, D. J. Paynter, J. P. Dunne, **J. P. Krasting**, and M. Winton, 2015: Dominance of the Southern Ocean in anthropogenic carbon and heat uptake in CMIP5 models. *J. Climate*, 28, 862-886, doi:10.1175/JCLI-D-14-00117.1.
8. Eyring, V., M. Righi, A. Lauer, M. Evaldsson, S. Wenzel, C. Jones, A. Anav, O. Andrews, I. Cionni, E. L. Davin, C. Deser, C. Ehbrecht, P. Friedlingstein, P. J. Gleckler, K.D. Gottschaldt, S. Hagemann, M. Juckes, S. Kindermann, **J. P. Krasting**, and Coauthors, 2016: ESMValTool (v1.0) - a community diagnostic and performance metrics tool for routine evaluation of Earth system models in CMIP. *Geosci. Model Dev.*, 9, 1747-1802, doi:10.5194/gmd-9-1747-2016.

Publication Summary Information
Total peer-reviewed publications: 27
H-index: 16/20 (ISI/Google Scholar)

Recent Awards
2014: United States Department of Commerce Silver Medal Award *(for Earth System Model Development)*

Selected Service/Affiliations
Boards: Co-chair, NOAA-GFDL Model Diagnostics and Evaluation Team; and Former Chair, NOAA High Performance Computing User Group.

Eric D. Maloney
Current/recent Positions
Assoc. Department Head, Atmospheric Science, Colorado State University, 2019-present
Professor, Atmospheric Science, Colorado State University, 2015-present
Associate Professor, Atmospheric Science, Colorado State University, 2008-2015
Assistant Professor, Oceanic and Atmospheric Sciences, Oregon State University, 2002-2008

Doctorate: Atmospheric Sciences, University of Washington, 2000

Selected Recent Publications (selected from over 120)
1. **Maloney, E. D**., A. Gettelman, Y. Ming, J. D. Neelin, D. Barrie, A. Mariotti, C.-C. Chen, D. R. B. Coleman, Y.-H. Kuo, B. Singh, H. Annamalai, A. Berg, J. F. Booth, S. J. Camargo, A. Dai, A. Gonzalez, J. Hafner, X. Jiang, X. Jing, D. Kim, A. Kumar, Y. Moon, C. M. Naud, A. H. Sobel, K. Suzuki, F. Wang, J. Wang, A. A. Wing, X. Xu, and Ming Zhao, 2019: Process-oriented evaluation of climate and weather forecasting models. *Bull. Amer. Meteor. Soc*., 100, 1665-1686, doi.org/10.1175/BAMS-D-18-0042.1.
2. Eyring, V., and Coauthors, 2019: Taking model evaluation to the next level. *Nat. Climate Change*, 9, 102-110, doi.org/10.1038/s41558-018-0355-y.
3. Wolding, B. O., J. Dias, G. Kiladis, F. Ahmed, **E. Maloney**, and M. Branson, 2020: Interactions Between Moisture and Tropical Convection. Part I: Convective Lifecycle and Spatiotemporal Dependence. *J. Atmos. Sci.*, 77, 1783-1799, doi.org/10.1175/JAS-D-19-0225.1
4. Kuo, Y.-H., J. D. Neelin, C.-C. Chen, W.-T. Chen, L. Donner, A. Gettelman, X. Jiang, K.-T. Kuo, **E. Maloney**, C. Mechoso, Y. Ming, K. Schiro, C. Seman, C.-M. Wu, and M. Zhao, 2020: Convective transition statistics over tropical oceans for climate model diagnostics: GCM evaluation. *J. Atmos. Sci.*, 77, 379-403, doi.org/10.1175/JAS-D-19-0132.1.

5. Wolding, B. O, **E. D. Maloney**, and M. Branson, 2016: Vertically Resolved Weak Temperature Gradient Analysis of the Madden-Julian Oscillation in SP-CESM. *J. Adv. Modeling. Earth. Sys.*, 8, 1586-1619, doi:10.1002/2016MS000724.
6. **Maloney, E. D**., S. J. Camargo, E. Chang, B. Colle, R. Fu, K. L. Geil, Q. Hu, X. Jiang, N. Johnson, K. B. Karnauskas, J. Kinter, B. Kirtman, S. Kumar, B. Langenbrunner, K. Lombardo, L. N. Long, A. Mariotti, J. E. Meyerson, K. C. Mo, J. D. Neelin, Z. Pan, R. Seager, Y. Serra, A. Seth, J. Sheffield, J. Stroeve, J. Thibeault, S.-P. Xie, C. Wang, B. Wyman, and M. Zhao, 2014: North American climate in CMIP5 experiments: Part III: Assessment of 21st Century projections. *J. Climate*, 27, 2230-2270, doi.org/10.1175/JCLI-D-13-00273.1.
7. **Maloney, E. D.**, A. F. Adames, and H. X. Bui, 2019: Madden-Julian Oscillation Changes under Anthropogenic Warming. *Nat. Climate Change*, 9, 26-33, doi.org/10.1038/s41558-018-0331-6.
8. Bui, H. X., and **E. D. Maloney**, 2019: Mechanisms for global warming impacts on Madden-Julian Oscillation precipitation amplitude. *J. Climate*, 32, 6961-6975, doi.org/10.1175/JCLI-D-19-0051.1.
9. Henderson, S. A., **E. D. Maloney**, and S.-W. Son, 2017: Madden-Julian oscillation teleconnections: The impact of the basic state and MJO representation in general circulation models. *J. Climate*, 30, 4567-4587, doi.org/10.1175/JCLI-D-16-0789.1.

Selected Awards
2016: AGU Atmospheric Sciences Section Ascent Award; ***2010, 2014:*** Dept. of Atmospheric Science, Colorado State University, Professor of the Year; and College of Engineering, George T. Abell Outstanding Mid-Career Faculty Award (**2010**) and Outstanding Research Faculty Award (**2018)**, Colorado State University

Selected Service/Affiliations
NOAA MAPP Task Force: *S2S* 2016- present, *Model Diagnostics* 2015- present (co-chair), and *CMIP5* 2011- 2014 (co-chair); Editor, Journal of Climate, 2011-2014; and WMO Working Group on Numerical Experimentation (WGNE) MJO Task Force (co-chair with Steve Woolnough up until 2016), 2009-2019.

Aparna Radhakrishnan
Current/recent Positions
Professional Specialist, Cooperative Institute for Modeling the Earth System, Princeton University/NOAA Geophysical Fluid Dynamics Laboratory, 2019-present
Senior Data Scientist, SAIC/NOAA Geophysical Fluid Dynamics Laboratory, 2009-2019
Scientific Programmer, NOAA Pacific Marine Environmental Laboratory, 2009.

Degrees: M.S Computer Science, Wayne State University, 2008, B.S Computer Science and Engineering, India. 2006

Publications
1. Dunne, J. P., and Coauthors, 2020: The GFDL Earth System Model version 4.1 (GFDL-ESM4.1): Model description and simulation characteristics. *J. Adv. Model. Earth Syst.*, 12, e2019MS002015, doi:10.1029/2019MS002015.
2. Adcroft, A., and Coauthors, 2019: GFDL Global Ocean and Sea Ice Model OM4.0: Model Description and Simulation Features. *J. Adv. Model. Earth Syst.*, 11, 3167-3211.

3. Balaji, V., and Coauthors, 2018: Requirements for a global data infrastructure in support of CMIP6. *Geosci. Model Dev.*, 11, 3659-3680.
4. Dixon, K. W., J. R. Lanzante, M. J. Nath, K. Hayhoe, A. Stoner, **A. Radhakrishnan**, V. Balaji, 2016: Evaluating the stationarity assumption in statistically downscaled climate projections: is past performance an indicator of future results? *Climatic Change*, 135, 395-408, doi:10.1007/s10584-016-1598-0.
5. M. Zhao, and Coauthors, 2018: The GFDL global atmosphere and land model AM4.0/LM4.0: 1. Simulation characteristics with prescribed SSTs. *J. Adv. Model. Earth Syst.*, 10, 735-769, doi:10.1002/2017MS001208.

Publication Summary Information
Total peer-reviewed work: 6 journal articles, 15 International conference proceedings, Total *Citations: 310 (Google scholar)*

Selected Awards
2014: Gold Stevie American Business Award for Technical excellence; Technical award for excellence HPTG.

Selected Service/Affiliations
Boards: Member, OAR Data management working group; Co-chair NOAA GFDL Diagnostics and Evaluations Team, 2019-Present; Co-chair GFDL Diversity Equity Inclusion (DEI) Community Forum; Member, GFDL DEI committee. **Other**: Technical Lead, Modeling Systems Division Data Services and ASDI Cloud computing initiative, 2018-Present; Member of GFDL Modeling Systems Division, 2009-Present.

Yi Ming
Current/recent Positions
Head of Division of Atmospheric Physics, NOAA/Geophysical Fluid Dynamics Laboratory, 2020-Present; Supervisory Research Physical Scientist, 2020-Present; Physical Scientist, 2010-Present; Project Scientist II, 2005-2010; Lecturer, Program in Atmospheric and Oceanic Sciences, Department of Geosciences, Princeton University, 2013-present

Doctorate: Princeton University, Civil and Environmental Engineering, 2003

Selected Recent Publications (from a total of 106)
1. Salzmann, M, **Y. Ming**, J.-C. Golaz, P. A. Ginoux, H. Morrison, A. Gettelman, M. Krämer, and L. J. Donner, 2010: Two-moment Bulk Stratiform Cloud Microphysics in the GFDL AM3 GCM: Description, Evaluation, and Sensitivity Tests. *Atmos. Chem. Phys.*, 10, 8037-8064, doi:10.5194/acp-10-8037-2010.
2. Donner, L. J., B. Wyman, R. S. Hemler, L. W. Horowitz, **Y. Ming**, and Coauthors, 2010: The Dynamical Core, Physical Parameterizations, and Basic Simulation Characteristics of the Atmospheric Component of the GFDL Global Coupled Model CM3. *J. Climate*, 24, 3484-3519, doi:10.1175/2011JCLI3955.1.
3. Shen, Z., **Y. Ming**, L. W. Horowitz, V. Ramaswamy, and M. Lin, 2017: On the Seasonality of Arctic Black Carbon. *J. Climate*, 30, 4429-4441, doi:10.1175/JCLI-D-16-0580.1.
4. Hill, S., **Y. Ming**, I. M. Held, and M. Zhao, 2017: A moist static energy budget-based analysis of the Sahel rainfall response to uniform oceanic warming. *J. Climate*, 30, 5637-5660, doi.org/10.1175/JCLI-D-16-0785.1.

5. Persad, G., D. J. Paynter, **Y. Ming**, and V. Ramaswamy, 2017: Competing Atmospheric and Surface-Driven Impacts of Absorbing Aerosols on the East Asian Summertime Climate. *J. Climate*, 30, 8929–8949, doi.org/10.1175/JCLI-D-16-0860.1.
6. **Ming, Y.**, and I. M Held, 2018: Modeling Water Vapor and Clouds as Passive Tracers in an Idealized GCM. *J. Climate*, 31, 775-786, doi:10.1175/JCLI-D-16-0812.1.
7. Clark, S. K., **Y. Ming**, and I. M. Held, 2018: The role of the water vapor feedback in the ITCZ response to hemispherically asymmetric forcings. *J. Climate*, 31, 3659-3678, doi:10.1175/JCLI-D-17-0723.1.
8. Dong, W., **Y. Ming**, and V. Ramaswamy, 2020: Future changes in Indian monsoon low pressure systems. *J. Climate*, 33, 7275-7287, doi:10.1175/JCLI-D-20-0168.17275-7287.

Selected Awards
2018: American Geophysical Union (AGU) Ascent Award
2014: American Meteorological Society (AMS) Henry G. Houghton Award
2012: Department of Commerce Group Gold Medal for Scientific Achievement; and World Meteorological Organization (WMO) Norbert Gerbier-MUMM International Award
2008: Presidential Early Career Award for Scientist and Engineers (PECASE)
National Science Foundation (NSF) Science Policy Fellowship

Selected Service/Affiliations
Co-chair, Working Group on Theories and Processes, White House Office of Science and Technology Policy (OSTP) Initiative on Earth System Predictability; Editor, Monsoons and Climate, Current Climate Change Reports; Chair, GFDL 5-10 Year Strategic Science Plan Writing Team

Paul Ullrich

Current/recent Positions
Associate Professor, Atmospheric Science, University of California Davis, 2017-Present
Assistant Professor, Atmospheric Science, University of California Davis, 2012-2017

Doctorate: University of Michigan, Atmospheric Oceanic and Space Sciences, 2011

Selected Recent Publications (from a total of 69):
1. Nair, V., W. Boos, **P. A. Ullrich**, and T. A. O'Brien, 2020: Assessing historical variability of South Asian monsoon lows and depressions with an optimized tracking algorithm. *J. Geophys. Res. Atm.*, 125, e2020JD032977, doi:10.1029/2020JD032977.
2. Srivastava, A., R. Grotjahn, and **P.A. Ullrich**, 2020: Evaluation of historical CMIP6 model simulations of extreme precipitation over contiguous US regions. *Wea. Climate Extr.*, 29, 100268, doi:10.1016/j.wace.2020.100268.
3. Stansfield, A., K. A. Reed, C. M. Zarzycki, **P.A. Ullrich**, and D. R. Chavas, 2020: Assessing tropical cyclones' contribution to precipitation over the Eastern United States and sensitivity to the variable-resolution domain extent. *J. Hydrometeor.*, 21, 1425-1445, doi:10.1175/JHM-D-19-0240.1.
4. Gutowski, W. J., **P. A. Ullrich**, and Coauthors, 2020: The ongoing need for high-resolution regional climate models: Process understanding and stakeholder information. *Bull. Amer. Meteor. Soc.*, 101, E664-E683, doi:10.1175/BAMS-D-19-0113.1.
5. Wang, M., **P. A. Ullrich**, and D. Millstein, 2020: Future projections of wind patterns in California with the Variable-Resolution CESM: A clustering analysis approach. *Climate Dyn.*, 54, 2511-2531, doi:10.1007/s00382-020-05125-5.

6. Pinheiro, M. C., **P. A. Ullrich**, and R. Grotjahn, 2019: Atmospheric blocking and intercomparison of objective detection methods: Flow field characteristics. *Climate Dyn.*, 53, 4189-4216, doi:10.1007/s00382-019-04782-5.
7. **Ullrich, P. A.**, Z. Xu, A. M Rhoades, M. D. Dettinger, J. F. Mount, A. D. Jones, and P. Vahmani, 2018: California's drought of the future: A midcentury recreation of the exceptional conditions of 2012-2017. *Earth's Future*, 6, 1568-1587, doi:10.1029/2018EF001007.
8. Rhoades, A. M., **P. A. Ullrich**, and C. M. Zarzycki, 2017: Projecting 21st century snowpack trends in western USA mountains using variable-resolution CESM. *Climate Dyn.*, 50, 261-288, doi:10.1007/s00382-017-3606-0.
9. Zarzycki, C. M. and **P. A. Ullrich**. Assessing sensitivities in algorithmic detection of tropical cyclones in climate data. *Geophys. Res. Lett.*, 44,1141-1149, doi:10.1002/2016GL071606.
10. **Ullrich, P. A.** and C. M. Zarzycki, 2017: TempestExtremes: A framework for scale-insensitive pointwise feature tracking on unstructured grids. *Geosci. Model Dev.*, 10, 1069-1090, doi:10.5194/gmd-10-1069-2017.

Selected Service/Affiliations
Lead organizer / co-organizer of the Dynamical Core Model Intercomparison Project (2016/2021/2012); Topical Editor of Geoscientific Model Development (2013-present); Associate Editor of Monthly Weather Review (2014-present); Contributing author to the National Climate Assessment and lead author for the Sacramento Region California Climate Assessment.

Fiaz Ahmed
Assistant Project Scientist, Dept. of Atmospheric and Oceanic Sciences, UCLA, 2019-present
Postdoctoral Scholar, Dept. of Atmospheric and Oceanic Sciences, UCLA, 2016-2019

Doctorate: Texas A&M University, Department of Atmospheric Sciences, 2016

Selected Recent Publications:
1. **Ahmed F**., J.D. Neelin and Á.F. Adames, 2020: Quasi-Equilibrium and Weak Temperature Gradient Balances in an Equatorial Beta-plane Model. *J. Atmos. Sci.*, In press, 10.1175/JAS-D- 20-0184.1
2. Adames, Á.F., S.W. Powell, **F. Ahmed**, V. Mayta and J.D. Neelin, 2020: Tropical Precipitation Evolution in a Buoyancy-Budget Framework. *J. Atmos. Sci.*, In press, 10.1175/JAS-D-20- 0074.1
3. **Ahmed F.,** Á.F. Adames and J.D. Neelin, 2020: Deep convective adjustment of temperature and moisture. *J. Atmos. Sci.*, 77, 2163–2186, 10.1175/JAS-D-19-0227.1
4. Wolding B., J. Dias, G. Kiladis, **F. Ahmed**, S. Powell, E. Maloney and M. Branson, 2020: Interactions Between Moisture and Tropical Convection. Part I: The Co-evolution of Moisture and Convection. *J. Atmos. Sci.*, 77, 1783–1799, 10.1175/JAS-D-19-0225.1
5. **Ahmed, F.** and J.D. Neelin, 2018: Reverse engineering the tropical precipitation-buoyancy relationship. *J. Atmos. Sci.*, 75, 1587-1608, doi: 10.1175/JAS-D-17-0333.1

Publication Summary Information
Total peer-reviewed publications: 11; *Citations:* 114 (Google Scholar).

I. Current and Pending Support

J. David Neelin

Current Support

Agency: NOAA NA18OAR4310280 ***Title:*** An Open Framework for Process-Oriented Diagnostics of Global Models ***Amount:*** $604,848 (UCLA portion) ***Period:*** 08/01/18-07/31/21 ***Commitment:*** 0.9 summer month

Agency: NSF AGS-1936810 ***Title:*** Studies in the climate dynamics of moist process variability and change ***Amount:*** $1,12,585 ***Period:*** 03/15/20-02/29/2024 ***Commitment:*** 2.00 summer month

Agency: NSF ***Title:*** Non-Gaussian Temperature Distribution Tails in Observations and Models: Implications for Future Extreme Temperature Exceedances ***Amount:*** $107,714 ***Period:*** 05/15/2017-04/30//20 ***Commitment:*** 0.10 summer month

Agency: NOAA NA20OAR4310394 ***Title:*** Linkage Between Deep Convection, Large-scale Circulation and Low Cloud Feedback ***Amount:*** $490,900 (as co-PI, with H. Su PI) ***Period:*** 09/01/20-08/31/23 ***Commitment:*** 0.25 summer month

Agency: DOE DE-SC0021312 Title: The Role of Deep Convection and Large-scale Circulation in Driving Model Spread in Low Cloud Feedback and Equilibrium Climate Sensitivity ***Amount***: $769,708 (as co-PI, with H. Su PI) Period: 10/01/20-09/30/23 ***Commitment***: 0.25 summer month

Pending Support

This Application. Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $608,010 (UCLA) ***Period:*** 9/01/2021-8/31/2024 ***Commitment:*** 0.67 summer month

Agency: NASA ***Title:*** A Comprehensive Assessment Capability for Hydroclimatic Extremes and their Environments ***Amount:*** $593,824 (UCLA portion) ***Period:*** 01/01/21-12/31/24 ***Commitment:*** 0.25 calendar month

Andrew Gettelman

Current Support

Agency: NASA 80NSSC17K0073 ***Title:*** Advancing Cloud Microphysics for Seamless Prediction of Weather and Climate ***Amount:*** $864,000 ***Period:*** 06/27/2017-06/26/2021 ***Commitment:*** Co-Sponsored by NSF Base funds: 1.20

Agency: UNIV/NSF UWSC9960 Project ***Title:*** Using SOCRATES datasets to improve simulations of clouds, aerosols and their climate impacts ***Amount:*** $766,792 ***Period:*** 06/15/2017-05/31/2020 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.52

Agency: NSF OPP-1744946 ***Title:*** Collaborative Research: Ice supersaturation over the Southern Ocean and Antarctica, and its role in climate ***Amount:*** $67,098 ***Period:*** 04/05/2018-03/31/2022 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.13

Agency: NOAA NA18OAR4310272 ***Title:*** An Open Framework for Process-Oriented Diagnostics of Global Models ***Amount:*** $222,547 ***Period:*** 08/01/2018-07/31/2021 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.02

Agency: DOE DE-SC0020098 ***Title:*** Freezing Processes in Southern Ocean Mixed Phased Clouds ***Amount:*** $748,653 ***Period:*** 09/01/2019-08/31/2022 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.05

Agency: NSF 1946664 ***Title:*** Collaborative Research: Bugs to clouds: Thawing permafrost, its microbes, and their possible role in Arctic climate feedbacks ***Amount:*** $100,000 Period: 04/01/2020-03/31/2023 ***Commitment***: Co-Sponsored by NSF Base funds: 0.21

Agency: NSF 2004973 ***Title:*** Collaborative Research: Frameworks: Community-Based Weather and Climate Simulation with a Global Storm-Resolving Model ***Amount:*** $1,993,269 ***Period:*** 05/01/2020-04/30/2025 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.31
Agency: NSF Unfunded Collaboration ***Title:*** STC: Center for Learning the Earth with Artificial Intelligence and Physics (LEAP) ***Amount:*** $0 ***Period:*** 06/01/2020-05/31/2025 ***Commitment:*** Co-Sponsored by NSF Base funds: de minimis
Agency: DOE Unfunded Collaboration ***Title:*** Drizzle and Evaporation Characteristics over the Southern Ocean **Amount:** $0 ***Period:*** 08/01/2020-07/31/2023 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.05
Agency: NASA Unfunded Collaboration ***Title:*** Quantifying Uncertainty and Constraining Parameterizations of Clouds in Models using NASA observations Earth System ***Amount:*** $0 ***Period:*** 01/01/2021-12/31/2024 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.05

Pending Support
This Application. Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $299,944 (NCAR) ***Period:*** 09/01/2021-08/31/2024 ***Commitment:*** Co-Sponsored by NSF Base funds: 0.31

John Krasting
Current Support
Agency: NOAA NA18OAR4310280 ***Title:*** An Open Framework for Process-Oriented Diagnostics of Global Models ***Amount:*** $634K (GFDL portion) ***Period:*** 08/01/18-07/31/21 ***Commitment:*** 2.00 calendar month
Agency: DOE Subcontract B640108 to Princeton University under Prime Contract No. DE-AC52-07NA27344 ***Title:*** Diagnostics and Performance Metrics for Evaluating Ventilation Pathways and Interior Water Mass Properties in Ocean Models ***Amount:*** $362K ***Period:*** 10/20-09/22 ***Commitment:*** 1.00 calendar month

Pending Support
This Application Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $1,050,000 (GFDL) ***Period:*** 09/01/2021-08/31/2024 ***Commitment:*** 1.00 calendar month
Agency: NOAA ***Title:*** Identifying processes controlling the representation of coastal sea level in climate models ***Amount:*** Unfunded Collaborator ***Period:*** 08/01/18-07/31/21 ***Commitment:*** 1.00 calendar month
Agency: NOAA (Climate Portfolio FY21 - OAR Unrequested Budget Increase) ***Title:*** Contextualizing Existing Sea Level Rise Scenarios in Light of a New Generation of Climate Models (LCI) ***Amount:*** $320K ***Period:*** 01/21-12/22 ***Commitment:*** 1.0 calendar month

Eric Maloney
Current Support
Agency: ONR N00014-16-1-3087 ***Title:*** Coupled ocean-atmosphere regional model simulations of diurnal Maritime Continent and its synergy with MJO propagation ***Amount:*** $544,056 ***Period:*** 08/16-10/21 ***Commitment:*** 0.5 PM/Y1-5, 0.12 PM/Y6
Agency: NSF AGS1735978 ***Title:*** A Modeling Study of Easterly Waves and Their Intraseasonal Variability in the East Pacific ***Amount:*** $431,851 ***Period:*** 11/17-10/21 ***Commitment:*** 0.12 PM

Agency: NASA NNX17AH77G ***Title:*** Understanding tropical convective dynamics and the MJO using CYGNSS observations ***Amount:*** $339,230 ***Period:*** 03/17-03/21 ***Commitment:*** 0.12 PM
Agency: NOAA NA18OAR4310280 ***Title:*** An Open Framework for Process-Oriented Diagnostics of Global Models ***Amount:*** $167,096 ***Period:*** 08/18-07/21 ***Commitment:*** 1.0 PM
Agency: NOAA NA18OAR4310299 ***Title:*** Understanding the role of diurnal cycle and the mean state on the propagation of the intraseasonal variability over the Maritime Continent ***Amount:*** $182,240 ***Period:*** 09/18-08/21 ***Commitment:*** 1.0 PM/YR
Agency: NSF AGS-1841754 ***Title:*** Changes to Madden-Julian Oscillation Winds and Convection in a Future Warmer Climate ***Amount:*** $538,058 ***Period:*** 06/19-05/22 ***Commitment:*** 1.0 PM/YR
Agency: NOAA NA19OAR4590151 ***Title:*** MJO and QBO Contributions to U.S. Precipitation Skills at S2S Leads ***Amount:*** $524,196 ***Period:*** 09/19-08/22 ***Commitment:*** 1.0 PM/YR
Agency: NASA 80NSSC20K1105 ***Title:*** Untangling Changes in the West Pacific Water Cycle ***Amount:*** $1,949,272 ***Period:*** 06/20-06/23 ***Commitment:*** 0.5 PM/YR

Pending Support
This Application Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $102,341 ***Period:*** 09/01/2021-08/31/2024 ***Commitment:*** 1.00 calendar month
Agency: DOE ***Title:*** Dynamics-Carbon Cycle Coupling by the Madden-Julian Oscillation ***Amount:*** $694,135 ***Period:*** 07/20-06/23 ***Commitment:*** 0.5 PM/YR
Agency: NASA ***Title:*** MJO teleconnections in the current and future climate and their implications for S2S predictability ***Amount:*** $688,606 ***Period:*** *01/21-12/24* ***Commitment:*** 0.5 PM/YR
Agency: NSF ***Title:*** Collaborative Research: The relationship between the MJO and midlatitude subseasonal-to-seasonal oscillatory modes ***Amount:*** $280,475 ***Period:*** *05/21-04/24* ***Commitment:*** 0.12 PM/YR
Agency: NASA ***Title:*** Latent heat flux-convection coupling on mesoscale through intraseasonal scales using CYGNSS ***Amount:*** $423,986 ***Period:*** 05/21-05/24 ***Commitment:*** 1.0 PM/YR

Yi Ming
Current Support
Agency: NOAA NA18OAR4310280 ***Title:*** An Open Framework for Process-Oriented Diagnostics of Global Models ***Amount:*** $634K (GFDL portion) ***Period:*** 08/01/18-07/31/21 ***Commitment:*** 1.00 calendar month

Pending Support
This Application Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $1,050,000 (GFDL) ***Period:*** 09/01/2021-08/31/2024 ***Commitment:*** 1.0 calendar month

Aparna Radhakrishnan
Current Support
None

Pending Support
This Application Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $1,050,000 (GFDL) ***Period:*** 09/01/2021-08/31/2024 ***Commitment:*** 1.0 calendar month

Paul Ullrich

Current Support

Agency: DOE (LLNL Subaward B639345-0) ***Title:*** Evaluation of Convection-Permitting Version of Energy Exascale Earth System Model ***Amount:*** $240,153 ***Period:*** 01/01/20-06/30/21 ***Commitment:*** 1.0 calendar month

Agency: DOE (LANL Subaward 493398-0) ***Title:*** SciDAC4: Coupling Approaches for Next Generation Architectures (CANGA) ***Amount:*** $527,020 ***Period:*** 09/01/17-08/31/22 ***Commitment:*** 0.0 calendar months

Agency: DOE DE-SC0019367 ***Title:*** Monsoon Extremes: Impacts, Metrics, and Synoptic-Scale Drivers ***Amount:*** $300,595 ***Period:*** 09/01/18-08/31/21 ***Commitment:*** 1.0 calendar month

Agency: DOE DE-AC05-76RL01830 ***Title:*** Integrated Coastal Modeling (ICoM) ***Amount:*** $560,000 ***Period:*** 10/01/19-09/30/22 ***Commitment:*** 1.0 calendar month

Agency: DOE DE-SC0016605 ***Title:*** A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales ***Amount:*** $913,511 ***Period:*** 09/01/19-08/31/22 ***Commitment:*** 1.0 calendar month

Pending Support

Agency: NSF ***Title:*** Comprehensive Analysis of US Compound Temperature Extremes ***Amount:*** $1,436,901 ***Period:*** 10/01/20-09/30/24 ***Commitment:*** 0.5 calendar months

Agency: NASA ***Title:*** A Comprehensive Assessment Capability for Hydroclimatic Extremes and their Environments ***Amount:*** $1,275,140 ***Period:*** 01/01/21-12/31/24 ***Commitment:*** 1.0 calendar month

Fiaz Ahmed

Current Support

Agency: DOE DE-SC0021312 Title: The Role of Deep Convection and Large-scale Circulation in Driving Model Spread in Low Cloud Feedback and Equilibrium Climate Sensitivity ***Amount***: $769,708 (as co-I, with H. Su PI) Period: 10/01/20-09/30/23 ***Commitment***: 3.00 calendar month

Pending Support

This Application. Agency: NOAA ***Title:*** An Open Framework for Process-Oriented Diagnostics of Earth System Models ***Amount:*** $608,010 (UCLA) ***Period:*** 9/01/2021-8/31/2024 ***Commitment:*** 3.00 calendar month

Agency: NASA ***Title:*** A Comprehensive Assessment Capability for Hydroclimatic Extremes and their Environments ***Amount:*** $593,824 (UCLA portion) ***Period:*** 01/01/21-12/31/24 ***Commitment:*** 3.00 calendar month

COLLEGES AND UNIVERSITIES RATE AGREEMENT

EIN: 846000545

ORGANIZATION:

Colorado State University
Business and Financial Services
202 Johnson Hall
Fort Collins, CO 80523

DATE:06/04/2020

FILING REF.: The preceding agreement was dated 06/14/2019

The rates approved in this agreement are for use on grants, contracts and other agreements with the Federal Government, subject to the conditions in Section III.

SECTION I: INDIRECT COST RATES

RATE TYPES: FIXED FINAL PROV. (PROVISIONAL) PRED. (PREDETERMINED)

	EFFECTIVE PERIOD				
TYPE	**FROM**	**TO**	**RATE(%)**	**LOCATION**	**APPLICABLE TO**
PRED.	07/01/2014	06/30/2015	48.70	On-Campus	Organized Research
PRED.	07/01/2015	06/30/2016	50.00	On-Campus	Organized Research
PRED.	07/01/2016	06/30/2017	51.00	On-Campus	Organized Research
PRED.	07/01/2017	06/30/2019	52.00	On-Campus	Organized Research
PRED.	07/01/2014	06/30/2019	26.00	Off-Campus	Organized Research
PRED.	07/01/2014	06/30/2019	56.00	On-Campus	Instruction
PRED.	07/01/2014	06/30/2019	26.00	Off-Campus	Instruction
PRED.	07/01/2014	06/30/2019	34.00	On-Campus	Other Sponsored Activities
PRED.	07/01/2014	06/30/2019	26.00	Off-Campus	Other Sponsored Activities
PRED.	07/01/2014	06/30/2019	8.00	Off-Campus	(A)
PROV.	07/01/2019	Until Amended		(B)	

*BASE

Modified total direct costs, consisting of all direct salaries and wages, applicable fringe benefits, materials and supplies, services, travel and up to the first $25,000 of each subaward (regardless of the period of performance of the subawards under the award). Modified total direct costs shall exclude equipment, capital expenditures, charges for patient care, rental costs, tuition remission, scholarships and fellowships, participant support costs and the portion of each subaward in excess of $25,000. Other items may only be excluded when necessary to avoid a serious inequity in the distribution of indirect costs, and with the approval of the cognizant agency for indirect costs.

ORGANIZATION: Colorado State University Business and Financial Services

AGREEMENT DATE: 6/4/2020

SECTION I: FRINGE BENEFIT RATES**

TYPE	FROM	TO	RATE(%)	LOCATION		APPLICABLE TO
FIXED	7/1/2020	6/30/2021	27.10	All	(A)	Fac. & Prof. (1)
FIXED	7/1/2020	6/30/2021	45.90	All	(A)	State Classified
FIXED	7/1/2020	6/30/2021	0.90	All	(A)	Student Hourly
FIXED	7/1/2020	6/30/2021	27.40	All	(A)	Temporary (2)
FIXED	7/1/2020	6/30/2021	9.50	All	(A)	All Graduate Students
FIXED	7/1/2020	6/30/2021	13.60	All	(A)	First Year Post Docs (3)
FIXED	7/1/2020	6/30/2021	13.50	All	(A)	Temporary (4)
FIXED	7/1/2020	6/30/2021	23.50	(5)	(B)	All Employees (5)
PROV.	7/1/2021	6/30/2024		(C)		

** DESCRIPTION OF FRINGE BENEFITS RATE BASE:

(A) Salaries and wages including vacation, holiday, sick leave pay and other paid absences.

(B) The total of salaries and wages plus appropriate fringe benefits excluding vacation, holiday, sick leave pay and other paid absences.

(C) Use same rates and conditions as those cited for fiscal year ending June 30, 2021.

(1) Faculty, administrative professionals and second-year plus post docs and interns

(2) Temporary non-student hourly

(3) First-year post docs and interns

(4) Temporary first-year faculty, administrative professionals, including continuing temporary faculty and administrative professionals at less than 50% time.

(5) Leave benefit rate for Center for Environmental Management of Military Lands (CEMML) & Colorado National Heritage Program (CNHP)

SECTION II: SPECIAL REMARKS

TREATMENT OF FRINGE BENEFITS:

The fringe benefits are charged using the rate(s) listed in the Fringe Benefits Section of this Agreement. The fringe benefits included in the rate (s) are:

WORKERS COMPENSATION, MEDICAL/LIFE INSURANCE, DISABILITY INSURANCE, UNEMPLOYMENT INSURANCE, MEDICARE, RETIREMENT PERA/DCP, RETIREMENT TERMINATION PAY, EXCESS LEAVE, RETIREE HEALTH INSURANCE, AND EMPLOYEES' TUITION (DOES NOT INCLUDE GRADUATE STUDENTS).

TREATMENT OF PAID ABSENCES

Except for CEMML & CHNP employees, vacation, holiday, sick leave pay and other paid absences are included in salaries and wages and are charged to Federal projects as part of the normal charge for salaries and wages. Separate charges for the cost of these absences are not made.

For CEMML & CHNP employees, the cost of vacation, holiday, sick leave pay, and other paid absences are included in a leave benefit rate which is applied to the total of salaries and wages plus appropriate fringe benefits for budgeting and charging purposes for Federal projects, and are not included in direct charges for salaries and wages. Charges for salaries and wages must exclude those paid to CEMML & CNHP employees for periods when they are on vacation, holiday, or sick leave, or are otherwise absent from work.

DEFINITION OF OFF-CAMPUS
For projects which include activities conducted at both on- and off-campus sites, the following criteria will determine costs to be allocated as off-campus: Must extend over a period of more than 120 consecutive days (or the duration of the project, if less than 120 days) at the off-campus site.

DEFINITION OF EQUIPMENT
Equipment means tangible personal property (including information technology systems) having a useful life of more than one year and a per-unit acquisition cost which equals or exceeds $5,000.

NEXT PROPOSAL DUE DATES
A fringe benefit rates proposal based on actual costs for fiscal year ended 06/30/20, will be due by 12/31/20.

This rate agreement updates fringe benefits rates only.

SECTION III: GENERAL

A. LIMITATIONS:

The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the organization were included in its facilities and administrative cost pools as finally accepted: such costs are legal obligations of the organization and are allowable under the governing cost principles; (2) The same costs that have been treated as facilities and administrative costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the organization which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. ACCOUNTING CHANGES:

This Agreement is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from facilities and administrative to direct. Failure to obtain approval may result in cost disallowances.

C. FIXED RATES:

If a fixed rate is in this Agreement, it is based on an estimate of the costs for the period covered by the rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

D. USE BY OTHER FEDERAL AGENCIES:

The rates in this Agreement were approved in accordance with the authority in Title 2 of the Code of Federal Regulations, Part 200 (2 CFR 200), and should be applied to grants, contracts and other agreements covered by 2 CFR 200, subject to any limitations in A above. The organization may provide copies of the Agreement to other Federal Agencies to give them early notification of the Agreement.

E. OTHER:

If any Federal contract, grant or other agreement is reimbursing facilities and administrative costs by a means other than the approved rate(s) in this Agreement, the organization should (1) credit such costs to the affected programs, and (2) apply the approved rate(s) to the appropriate base to identify the proper amount of facilities and administrative costs allocable to these programs.

BY THE INSTITUTION:

Colorado State University Business and Financial Services

(INSTITUTION)

(SIGNATURE)

DAVID RYAN

(NAME)

Controller

(TITLE)

JUNE 15, 2020

(DATE)

ON BEHALF OF THE FEDERAL GOVERNMENT:

DEPARTMENT OF HEALTH AND HUMAN SERVICES

(AGENCY)

(SIGNATURE)

Arif Karim

(NAME)

Director, Cost Allocation Services

(TITLE)

6/4/2020

(DATE) 2341

HHS REPRESENTATIVE: Jeffrey Warren

Telephone: (415) 437-7820

Budget Table: Colorado State University

	YR 1	*YR 2*	*YR 3*	*Totals*
Personnel				
Salary	$15,734	$16,206	$12,055	**$43,995**
Fringe	$4,264	$4,392	$3,267	**$11,923**
Personnel Subtotal	**$19,998**	**$20,598**	**$15,322**	**$55,918**
Non-Personnel				
Travel	$2,912	$2,999	$3,089	**$9,000**
Other Direct	$2,942	$3,031	$3,109	**$9,082**
Non-Personnel subtotal	**$5,854**	**$6,030**	**$6,198**	**18,083**
Totals				
Total Direct Cost	$25,852	$26,628	$21,520	**$71,000**
Total F&A (35%)	$9,048	$9,320	$7,532	**$25,900**
TOTAL	**$34,900**	**$35,948**	**$29,052**	**$99,900**
MTDC Base	*$25,852*	*$26,628*	*$21,520*	***$74,000***

Budget Narrative: Colorado State University

I. PERSONNEL – $43,996

Base salary included in this proposal reflects the salaries to be approved by the Governing Board of Colorado State University for the period July 1, 2020 through June 30, 2021. **Any salary beyond this period is budgeted at a 3% increase over the prior year's annual base.**

Role, Name & FY21 Base	***Year 1***	***Year 2***	***Year 3***	**Total**
CSU PI - Eric Maloney, $152,000	$15,734	$16,206	$12,055	$43,995

FRINGE – $11,923

The following approved FY2021 (July 1, 2020 – June 30, 2021) fringe rates were applied to the salaries based on the individual's payroll classification:

- Faculty/Administrative Professional/2nd Year PostDoc: 27.1%

Role, Name & Fringe Rate	***Year 1***	***Year 2***	***Year 3***	***Total***
CSU PI -Eric Maloney, 27.1%	$4,264	$4,392	$3,267	$11,923

Justification and description of each position (related specifically to project objectives):

Eric D. Maloney, *CSU-PI (*0.9 Person months/Y1 & 2, 0.65 PM/Y3), will collaborate with UCLA and GFDL personnel on expansion of the framework and on diagnostics related to tropical convection in Section 3.4. He will also contribute to representing the Team at meetings.

II. TRAVEL – $9,000

This proposal includes one trip each year for the CSU PI to one scientific meeting to present project-related science and results. The Annual Meeting of the American Geophysical Union (AGU) held in San Francisco, CA is used for budgeting purposes. Lodging and per diem rates based on federal guidelines found at gsa.gov. Other costs based on recent similar travel. A 3% inflation factor is included in each additional year.

1 person, 5 days/4 nights, San Francisco, CA (AGU)	***Year 1***	***Year 2***	***Year 3***	***Cumulative***
Airfare: $500/flight	500	515	530	$1,545
Lodging: $288/night @ 4 nights	1,152	1,186	1,222	$3,560
Per Diem: $76/day @ 5 days	380	391	403	$1,175
Ground Transportation	100	103	106	$309

Checked bags: $60/person (roundtrip)	120	124	124	$371
Conference Registration/abstract	660	680	700	$2,040
Total	**2,912**	**2,999**	**3,089**	**$9,000**

III. OTHER DIRECT – $9,082

1. ***ATS Network Use***: In order to perform the proposed research, it is necessary to use the Atmospheric Science Ethernet to connect to the Internet (this is a specialized network used by employees). The Department charges a fee for such connections. The amount is $47 per month, per person. The Computer Service charges are rates developed using Section 200.468 (Specialized Service Facilities) of the OMB Uniform Guidance and Colorado State University's internal policy for computing, charging and auditing such Service Facilities. Each additional year includes a 3% inflation factor.

ATS Network Use	***Year 1***			***Year 2***			***Year 3***			***Cumulative***
	Rate	PM	Total	Rate	PM	Total	Rate	PM	Total	Total
E. Maloney	$47	0.9	**$43**	$48.41	0.9	**$44**	$49.86	0.65	**$32**	**$118**

2. ***Publications***: Funding is requested for one publication per year in a peer-reviewed scientific journal. Year 1: A publication outlining weak temperature gradient diagnostics for the tropical atmosphere using reanalysis fields will be completed. Year 2: A publication outlining incorporation of NASA satellite fields into the diagnostic analysis will be produced, with emphasis on radiative heating fields. Year 3: A publication describing incorporation of the new process-oriented diagnostic into the diagnostics framework will be published. Results will be published as project milestones are reached, as outlined in the project narrative. The breakdown of costs is estimated: $145/page x 20 pages. Charges are based on the current American Meteorological Society (AMS) prices and include a 3% inflation factor in years 2 and 3.

Other Direct Costs	***Year 1***	***Year 2***	***Year 3***	***Cumulative***
Publications:	$2900	$2,987	$3,077	$8,964
ATS Network Use:	$42	$44	$32	$118
Total Other Direct Costs:	**$2,942**	**$3,031**	**$3,109**	**$9,082**

IV. INDIRECT COSTS – $25,900

An Indirect Rate of 35% is charged on this proposal. This is the negotiated rates for CIRA/Colorado State University for the period effective 1 July 2019 and running through June 30, 2024. This is reduced from the NICRA of 52%. The rate is applied to Modified Total Direct Costs (MTDC). MTDC is defined as Total Direct Costs less Equipment, GRA Tuition, and Subcontracts > $25,000. This rate was approved in amendment#0 of award# NA19OAR4320073.

Budget justification NOAA MAPP 2020 UCLA: Narrative and Details

***PERSONNEL:**

Professor David Neelin (0.67 summer months/year) Yr. $23,316, Yr2 23,666, Yr.3 $24,021 is the lead PI of the proposed Type 2 team and will interact on all sections, provide overall direction to the team and Task Force and coordinate the linkages with other institutions.

Fiaz Ahmed, Project Scientist (3.0 Calendar Months/year) Yr.1 $15,150, Yr.2 $15,606, Yr.3 $16,074 will interact with the PI, the postdoc and other team members, focusing on work in sections 3.4.5 and 3.4.6.

TBN Post-Doctoral Researcher (12 months/year) Yr.1 $53,496, Yr.2 $55,104, Yr.3 $56,760 The postdoc will carry out work in the tasks in sections 3.4.5 and 3.4.6, coordinating with PI and Project Scientist and interacting with other team members on code framework.

Fringe Rate

Professor David Neelin: 2.90% Yr.1$676, Yr.2 $686, Yr.3 $697

Fiaz Ahmed, Project Scientist: 50% Yr.1$7,575, Yr.2 $7,803, Yr.3 $8,037

TBN Post-Doctoral Researcher: 23.80% Yr.1$12,732, Yr.2 $13,115, Yr.3 $13,509

TRAVEL: $6,000 Yr. 1-3 PI, PS and postdoc 1 trip each to present at scientific conference and meet with Task Force members: American Geophysical Union (locations rotate annually: San Francisco, Washington DC) or American Meteorological Society (locations Boston, New Orleans). Domestic Travel $400 Air fare, 5 days Lodging $900, 5 days Meals $300, Ground Transportation $200, Conference Registration $200. Total per Domestic trip $2000.

MATERIALS AND SUPPLIES - $1000 per year + Yr-01 includes a upgrades to RAID storage @ $4,000: Material and Supplies: research related copying, mailing, drafting, computing media & data acquisition, expendable materials. In year one, $3000 is requested to upgrade an existing local RAID storage server to increase local storage and computation capacity to meet the demands of proposed research.

PUBLICATION COSTS - $3750/year 1-3: estimated at ~ $125/page at ~30 pages per year.

COMPUTER USER'S FEES - $1,500/year Yr. 1-3: Usage and maintenance costs on workstations, printers and other peripherals, which will be dedicated to this research effort.

Technology Infrastructure Fee @ rate of $43.96/FTE/year @ $659/year

The Technology Infrastructure Fee (TIF) is a consistently-applied direct charge that is assessed to each and every campus activity unit, regardless of funding source, including units identified as individual grant and contract awards. The TIF pays for campus communication services on the basis of a monthly accounting of actual usage data.

Indirect costs are charged at the Federally negotiated rate of 56% MTDC. These negotiated rates are established through June 30, 2019 and are provisional as of July 1, 2019 and beyond. Awards using provisional rates must be adjusted once a new F&A rate agreement is negotiated and approved by the cognizant agency for indirect costs. For additional information visit: https://ocga.research.ucla.edu/facilities-and-administrative/

Total budget for all partners. *Federal Funds Requested for:*

Institution	Year 1	Year 2	Year 3	Total
UCLA	$201,012	$201,067	$205,931	$608,010
GFDL	$350,000	$350,000	$350,000	1,050,000
NCAR	99,533	$100,164	$100,247	$299,944
CSU	$34,900	$35,948	$29,052	$99,900
UC Davis	$59,869	$58,724	$60,797	179,390
Total	**$745,314**	**$745,903**	**$746,027**	**$2,237,244**

UCLA Detailed Budget
Title: An Open Framework for Process-Oriented Diagnostics of Earth System Models
Dates: 9/01/2021 to 8/31/2024

		Year 1	Year 2	Year 3	Total
NOAA 20					
Effort (in months)**:**					
David Neelin, PI		0.67	0.67	0.67	
Fiaz Ahmed, Project Scientist		3.00	3.00	3.00	
Post-Doctoral Researcher		12.00	12.00	12.00	
		15	**15**	**15**	
Rate:					
David Neelin, PI		34,800	35,322	35,852	
Fiaz Ahmed, Project Scientist		5,050	5,202	5,358	
Post-Doctoral Researcher		4,458	4,592	4,730	
Salaries:					
David Neelin, PI		23,316	23,666	24,021	**71,003**
Fiaz Ahmed, Project Scientist		15,150	15,606	16,074	**46,830**
Post-Doctoral Researcher		53,496	55,104	56,760	**165,360**
Total Salaries:		**91,962**	**94,376**	**96,855**	**283,193**
Benefit Rate:					
David Neelin, PI		2.90%	2.90%	2.90%	
Fiaz Ahmed, Project Scientist		50.00%	50.00%	50.00%	
Post-Doctoral Researcher		23.80%	23.80%	23.80%	
Benefits:					
David Neelin, PI		676	686	697	**2,059**
Fiaz Ahmed, Project Scientist		7,575	7,803	8,037	**23,415**
Post-Doctoral Researcher		12,732	13,115	13,509	**39,356**
Total Benefits:		**20,983**	**21,604**	**22,243**	**64,830**
Total Salaries & Benefits:		**112,945**	**115,980**	**119,098**	**348,023**
Travel:					
To participate in Annual Conferences					
Airfare: RT LAX / IAD	2,000				
Lodging: 4 days @ $231/day	0				
Meal perdiem: 5 days @ $69/	0				
Ground travel & car rental	0	3RT	3RT	3RT	
Total Travel		**6,000**	**6,000**	**6,000**	**18,000**
Other Direct Costs - A:					
Materials And Supplies		4,000	1,000	1,000	**6,000**
Equipment:		0	0	0	**0**
Publication cost		3750	3750	3750	**11,250**
Computer network and peripherals		1,500	1,500	1,500	**4,500**
GAEL 1.03 per $100 salary		0	0	0	**0**
TIF @ $43.96/FTE/mo		659	659	659	**1,977**
Subtotal Other Direct Costs-A:		9,909	6,909	6,909	**23,727**
Total Direct Costs:		**128,854**	**128,889**	**132,007**	**389,750**
Total Modified Direct Costs:		**128,854**	**128,889**	**132,007**	**389,750**
Indirect Costs @ 56.0% of MTDC:		**72,158**	**72,178**	**73,924**	**218,260**
Total Amount Requested:		**201,012**	**201,067**	**205,931**	**608,010**

2020-0829 NCAR Budget Narrative
NCAR PI: Andrew Gettelman

UCAR

UCAR Proposal Budget Detail

Proposal #	2020-0829
Proposal Title:	An Open Framework for Process-Oriented Diagnostics of Earth System Models
UCAR Entity:	NCAR
Period of Performance:	9/1/2021 - 8/31/24
Principal Investigator:	Andrew Gettelman

			Unit / Rate	Effort Year 1	Effort Year 2	Effort Year 3	Year 1 NOAA - Oceanic and Atmospher	Year 2 NOAA - Oceanic and Atmospher	Year 3 NOAA - Oceanic and Atmospher	Cumulative Grand Total
Salaries	Regular Salaries	Assoc Scientist III (Coleman)	FTE	0.35	0.35	0.35	30,344	31,255	32,193	93,792
		Proj Scientist I (TBD)	FTE	0.09	0.08	0.07	8,548	7,944	7,098	23,590
	Subtotal Salaries						38,892	39,199	39,291	117,382
Fringe Benefits		Regular Benefits @	54.50 %				21,196	21,363	21,413	63,972
	Subtotal Fringe Benefits						21,196	21,363	21,413	63,972
	Total Salaries and Benefits						60,088	60,562	60,704	181,354
	Modified Total Direct Costs (MTDC)						60,088	60,562	60,704	181,354
Indirect Costs		NCAR Indirect Cost Rate (M	56.60 %				34,010	34,278	34,358	102,646
	Total Indirect Costs						34,010	34,278	34,358	102,646
MTDC Costs that Include Indirect Costs	Computing Service Cent	Computing Service Center	$6.95 / hr				5,435	5,324	5,185	15,944
	Subtotal MTDC Costs that Include Indirect Costs						5,435	5,324	5,185	15,944
	Total MTDC + Applied Indirect Costs						99,533	100,164	100,247	299,944
	Total Funding To UCAR						99,533	100,164	100,247	299,944

Salaries

Proposed salary expenses are budgeted at 85% of individual annual salaries to include direct labor charges only for time worked. (Vacation, holidays, sick time, and other standard non-worked time are paid from the UCAR benefits pool). Salary is budgeted with an increase of 3% each fiscal year for inflation. The term "person-months" [PM] refers to the effort (amount of time) personnel devote to a specific project. UCAR's person-months effort is based on 85% of the total months in a work year, for a total possible 10.2 person-months per fiscal year, from 1 October through 30 September.

	Year 1	**Year 2**	**Year 3**
Associate Scientist III D. Coleman			
Base Salary	$101,997	$105,057	$108,210
Salary Request	$30,344	$31,255	$32,193
FTE %	35%	35%	35%
Cal. Months	3.57	3.57	3.57
Project Scientist I, TBD			
Base Salary	$109,320	$112,600	$115,978
Salary Request	$8,548	$7,944	$7,098
FTE %	9.2%	8.3%	7.2%
Cal. Months	0.94	0.85	0.73

Salary Justification:

The Associate Scientist III [Coleman] will be the primary developer of the software framework internally for the project, and will be the liaison with the other technical teams.

NCAR Project Scientist I [TBD] will assist with development and analysis of ocean diagnostics.

They will both work under the direction of co-PI Gettelman, and contribute to the overall MDTF task force development effort.

2020-0829 NCAR Budget Narrative
NCAR PI: Andrew Gettelman

Dr. Gettelman, co-PI, is not requesting salary funds. His estimated time commitment is 0.33 PM/year. He will provide management oversight and coordination of NCAR activities and integration of MDTF work with CESM workflows, and will work as part of the MDTF leads team to evolve the MDTF framework.

Dr. G. Marques, collaborator, is not requesting salary funds. His estimated time commitment is 0.2 PM/year. Dr. Marques will jointly mentor the GFDL-based postdoctoral researcher in collaboration with Krasting, Neelin, and Loikith.

Fringe Benefits - 54.50% of the base salary

	Year 1	**Year 2**	**Year 3**
Associate Scientist III, D. Coleman	$16,537	$17,034	$17,545
Project Scientist I, TBD	$4,659	$4,329	$3,868

Travel – None.

Other

	Year 1	**Year 2**	**Year 3**
Computing Service Center/CSC			
Associate Scientist III, D. Coleman	$4,302	$4,302	$4,302
Project Scientist I, TBD	$1,133	$1,022	$883

Scientific, computing and networking support costs have been allocated to this project through the *Computer Service Center (CSC)*, in accordance with 2 CFR 200, OMB Uniform Guidance (sec 200-468), and NCAR management policy allocating the costs of scientific computing system infrastructure. Indirect costs are not applied to CSC costs. The 2020 CSC rate for CGD is $6.95/work hour.

Total Direct Charges

A. Personnel	$117,382
B. Benefits	$63,972
C. Travel	$0
D. Equipment	$0
E. Supplies	$0
F. Contractual	$0
G. Construction	$0
H. Other	$15,944
Total Direct Costs	$197,298

Indirect Costs – 56.6% **Total: $102,646**

Indirect Costs are applied to all modified total direct costs (MTDC). Items excluded from MTDC are equipment costing $5,000 or more, participant costs, and individual subcontract amounts in excess of $25,000 per fiscal year. The rate is 56.60% and is computed on the following: Direct cost base @ $197,298 minus CSC = ($15,944). Total Indirect Cost $181,354 x 56.6% = $102,646

Total Direct and Indirect Costs: **$197,298 + $102,646 = $299,944**

For funds provided by direct agreement with UCAR, contractual arrangements should be made with Ms. Amy Smith, Manager, UCAR Contracts, 3090 Center Green Drive, Boulder, CO 80301-2252, Phone (303) 497-8872, Fax (303) 497-8501. Please refer to NCAR's proposal number on all correspondence with UCAR.

COLORADO STATE UNIVERSITY

Cooperative Institute for Research in the Atmosphere
Foothills Campus
1375 Campus Delivery
Fort Collins, Colorado 80523-1234
(970) 491-8448
FAX: (970) 491-8241

To: Daniel Barrie
Daniel.Barrie@noaa.gov

From: Samantha Reynolds
ATS/Colorado State University
(970) 491-8680
Samantha.Reynolds@colostate.edu

The attached proposal is being submitted to you for your consideration by a NOAA Cooperative Institute. Should you recommend funding for this proposal, we request that the funding be transferred through our current NOAA cooperative agreement, #NA19OAR4320073 or a TBD award number. The NOAA contact (described below) for this cooperative agreement should be contacted immediately if this proposal is accepted for funding.

Title of Proposal: An Open Framework for Process-Oriented Diagnostics of Earth System Models

Principal Investigator(s): Eric Maloney

Proposal #: 147693

Period of Performance: 09/01/21-08/31/24

Funding (by year, if multi-year): $99,900 ($34,900 Y1, $35,948 Y2, $29,052 Y3)

Task #: 3

Theme(s): Climate-Weather Processes

DUNS #: 78-597-9618

EIN #: 84-6000545

Congressional District: CO-002

Sponsored Programs Office Contact Person:
Linda Loing
Phone: (970) 491-6586
Fax: (970) 491-6147
E-mail: Linda.Loing@colostate.edu

NOAA Administrative Contact:

Shannon Louie
Phone: (301) 734-1180
Email: Shannon.Louie@noaa.gov

FMC for BOPS:

1) Is there a former DOC employee working for the CI host institution who represented or will represent the host institution before DOC or another Federal agency regarding this proposal? No
2) Does the award include any subaward to a Minority Serving Institution? No
3) Does the proposed award require any non-federal employees or subawardees to have physical access to Federal premises for more than 180 days or to access a federal information system? No
4) Is PGROGRAM INCOME anticipated being earned during performance of this project? No
5) Will a VIDEO be created for public viewing as part of this project? No
6) Will DOC/NOAA owned equipment be provided to any investigator for use outside of a Federal location for this project? No
7) Are any permits required to conduct this project? (If yes, please provide the name of the issuing agency and the permit number.) No

FORM **CD-511**
(REV 1-05)

U.S. DEPARTMENT OF COMMERCE

CERTIFICATION REGARDING LOBBYING

Applicants should also review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 15 CFR Part 28, 'New Restrictions on Lobbying.' The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Commerce determines to award the covered transaction, grant, or cooperative agreement.

LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 15 CFR Part 28, for persons entering into a grant, cooperative agreement or contract over $100,000 or a loan or loan guarantee over $150,000 as defined at 15 CFR Part 28, Sections 28.105 and 28.110, the applicant certifies that to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

* NAME OF APPLICANT

Colorado State University

* AWARD NUMBER

NA19OAR4320073

* PROJECT NAME

An Open Framework for Process-Oriented Diagnostics of Earth

Prefix: Ms.

* First Name: Linda

Middle Name:

* Last Name: Loing

Suffix:

* Title: Research Administrator

* SIGNATURE: Linda Loing

* DATE: 11/30/2020

OMB Number: 4040-0007
Expiration Date: 02/28/2022

ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C.§§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593(identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Linda Loing	Research Administrator
APPLICANT ORGANIZATION	DATE SUBMITTED
Colorado State University	11/30/2020

Standard Form 424B (Rev. 7-97) Back

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 02/28/2022

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. NOAA-OAR-CPO-2021-2006389	11.431	$ 99,900.00	$	$	$	$ 99,900.00
2.						
3.						
4.						
5. Totals		$ 99,900.00	$	$	$	$ 99,900.00

Standard Form 424A (Rev. 7- 97)
Prescribed by OMB (Circular A -102) Page 1

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) NOAA-OAR-CPO-2021-2006389	(2) N/A	(3) N/A	(4)	Total (5)
a. Personnel	$ 15,734.00	$ 16,206.00	$ 12,055.00	$	$ 43,995.00
b. Fringe Benefits	4,264.00	4,392.00	3,267.00		11,923.00
c. Travel	2,912.00	2,999.00	3,089.00		9,000.00
d. Equipment					
e. Supplies					
f. Contractual					
g. Construction					
h. Other	2,942.00	3,031.00	3,109.00		9,082.00
i. Total Direct Charges (sum of 6a-6h)	25,852.00	26,628.00	21,520.00		$ 74,000.00
j. Indirect Charges	9,048.00	9,320.00	7,532.00		$ 25,900.00
k. TOTALS (sum of 6i and 6j)	$ 34,900.00	$ 35,948.00	$ 29,052.00	$	$ 99,900.00
7. Program Income	$	$	$	$	$

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Prescribed by OMB (Circular A -102) Page 1A

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8. NOAA-OAR-CPO-2021-2006389	$	$	$	$
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$	$	$	$

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 34,900.00	$ 11,634.00	$ 11,633.00	$ 11,633.00	$
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$ 34,900.00	$ 11,634.00	$ 11,633.00	$ 11,633.00	$

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. NOAA-OAR-CPO-2021-2006389	$ 35,948.00	$ 29,052.00	$	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 35,948.00	$ 29,052.00	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:

22. Indirect Charges: Predetermined; Base = $74,000, Total = $25,900

23. Remarks:

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OMB Number: 4040-0004
Expiration Date: 12/31/2022

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 11/30/2020

4. Applicant Identifier: 147693

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: Colorado State University

* b. Employer/Taxpayer Identification Number (EIN/TIN): 84-6000545

* c. Organizational DUNS: 7859796180000

d. Address:

* Street1: 2002 Campus Delivery
Street2: 601 S. Howes St.
* City: Fort Collins
County/Parish:
* State: CO: Colorado
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 80523-2002

e. Organizational Unit:

Department Name: Sponsored Programs

Division Name: VP for Research

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Mr.
* First Name: William
Middle Name:
* Last Name: Moseley
Suffix:

Title: Senior Research Administrator

Organizational Affiliation:

* Telephone Number: 970-491-1541
Fax Number: 970-491-6147

* Email: bill.moseley@colostate.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Department of Commerce

11. Catalog of Federal Domestic Assistance Number:

11.431

CFDA Title:

Climate and Atmospheric Research

*** 12. Funding Opportunity Number:**

NOAA-OAR-CPO-2021-2006389

* Title:

Climate Program Office FY2021

13. Competition Identification Number:

2864458

Title:

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

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

An Open Framework for Process-Oriented Diagnostics of Earth System Models

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CO-002 * b. Program/Project: CO-002

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 09/01/2021 * b. End Date: 08/31/2024

18. Estimated Funding ($):

* a. Federal	99,900.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	99,900.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: Ms. * First Name: Linda

Middle Name:

* Last Name: Loing

Suffix:

* Title: Research Administrator

* Telephone Number: 970-491-6586 Fax Number: 970-491-6147

* Email: Linda.Loing@colostate.edu

* Signature of Authorized Representative: Linda Loing * Date Signed: 11/30/2020

FORM **CD-511**
(REV 1-05)

U.S. DEPARTMENT OF COMMERCE

CERTIFICATION REGARDING LOBBYING

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LOBBYING

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(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

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Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

* NAME OF APPLICANT

The Regents of the University of California, Los Angeles

* AWARD NUMBER

* PROJECT NAME

Prefix: * First Name: Middle Name:

* Last Name: Suffix:

* Title: Grant Analyst

* SIGNATURE: * DATE:

Frank Falcon II 11/25/2020

OMB Number: 4040-0007
Expiration Date: 02/28/2022

ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C.§§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

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10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593(identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Frank Falcon II	Grant Analyst
APPLICANT ORGANIZATION	DATE SUBMITTED
The Regents of the University of California, Los Angeles	11/25/2020

Standard Form 424B (Rev. 7-97) Back

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 02/28/2022

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. MAPP	11.431	$	$	$ 201,012.00	$	$ 201,012.00
2. MAPP	11.431			201,067.00		201,067.00
3. MAPP	11.431			205,931.00		205,931.00
4.						
5. Totals		$	$	$ 608,010.00	$	$ 608,010.00

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Prescribed by OMB (Circular A -102) Page 1

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) MAPP	(2) MAPP	(3) MAPP	(4)	Total (5)
a. Personnel	$ 91,962.00	$ 94,376.00	$ 96,855.00	$	$ 283,193.00
b. Fringe Benefits	20,983.00	21,604.00	22,243.00		64,830.00
c. Travel	6,000.00	6,000.00	6,000.00		18,000.00
d. Equipment					
e. Supplies	4,000.00	1,000.00	1,000.00		6,000.00
f. Contractual					
g. Construction					
h. Other	5,909.00	5,909.00	5,909.00		17,727.00
i. Total Direct Charges (sum of 6a-6h)	128,854.00	128,889.00	132,007.00		$ 389,750.00
j. Indirect Charges	72,158.00	72,178.00	73,924.00		$ 218,260.00
k. TOTALS (sum of 6i and 6j)	$ 201,012.00	$ 201,067.00	$ 205,931.00	$	$ 608,010.00
7. Program Income	$	$	$	$	$

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Prescribed by OMB (Circular A -102) Page 1A

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8.	$	$	$	$
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$	$	$	$

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 201,012.00	$ 50,253.00	$ 50,253.00	$ 50,253.00	$ 50,253.00
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$ 201,012.00	$ 50,253.00	$ 50,253.00	$ 50,253.00	$ 50,253.00

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. MAPP	$ 67,022.00	$ 68,643.00	$	$
17. MAPP	67,022.00	68,644.00		
18. MAPP	67,023.00	68,644.00		
19.				
20. TOTAL (sum of lines 16 - 19)	$ 201,067.00	$ 205,931.00	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: 389750

22. Indirect Charges: 218260

23. Remarks:

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OMB Number: 4040-0004
Expiration Date: 12/31/2022

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 11/25/2020

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: The Regents of the University of California, Los Angeles

* b. Employer/Taxpayer Identification Number (EIN/TIN): 956006143

* c. Organizational DUNS: 092530369

d. Address:

* Street1: Office of Contract and Grant Administration
Street2: 10889 Wilshire Boulevard, Suite 700
* City: Los Angeles
County/Parish: Los Angeles County
* State: CA: California
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 90095-1406

e. Organizational Unit:

Department Name: Office of Contract & Grant Adm

Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Mr.
* First Name: Frank
Middle Name:
* Last Name: Falcon II
Suffix:

Title: Grant Analyst

Organizational Affiliation: The Regents of the University of California, Los Angeles

* Telephone Number: 310-206-9898
Fax Number:

* Email: frank.falcon@research.ucla.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Department of Commerce

11. Catalog of Federal Domestic Assistance Number:

11.431

CFDA Title:

Climate and Atmospheric Research

*** 12. Funding Opportunity Number:**

NOAA-OAR-CPO-2021-2006389

* Title:

Climate Program Office FY2021

13. Competition Identification Number:

2864458

Title:

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

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

An Open Framework for Process-Oriented Diagnostics of Earth System Models

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CA-033 * b. Program/Project: CA-033

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 09/01/2021 * b. End Date: 08/31/2024

18. Estimated Funding ($):

* a. Federal	608,010.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	608,010.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: Mr. * First Name: Frank

Middle Name:

* Last Name: Falcon II

Suffix:

* Title: Grant Analyst

* Telephone Number: 310-206-9898 Fax Number:

* Email: frank.falcon@research.ucla.edu

* Signature of Authorized Representative: Frank Falcon II * Date Signed: 11/25/2020

FORM **CD-511**
(REV 1-05)

U.S. DEPARTMENT OF COMMERCE

CERTIFICATION REGARDING LOBBYING

Applicants should also review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 15 CFR Part 28, 'New Restrictions on Lobbying.' The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Commerce determines to award the covered transaction, grant, or cooperative agreement.

LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 15 CFR Part 28, for persons entering into a grant, cooperative agreement or contract over $100,000 or a loan or loan guarantee over $150,000 as defined at 15 CFR Part 28, Sections 28.105 and 28.110, the applicant certifies that to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

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As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

* NAME OF APPLICANT

University Corporation for Atmospheric Research

* AWARD NUMBER

Not yet awarded

* PROJECT NAME

An Open Framework for Process-Oriented Diagnostics of Earth

Prefix: Mr.

* First Name: Steve

Middle Name:

* Last Name: Ritter

Suffix:

* Title: Budget Analyst

* SIGNATURE: Steve Ritter

* DATE: 11/25/2020

OMB Number: 4040-0007
Expiration Date: 02/28/2022

ASSURANCES - NON-CONSTRUCTION PROGRAMS

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As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

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11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593(identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

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17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Steve Ritter	Budget Analyst
APPLICANT ORGANIZATION	DATE SUBMITTED
University Corporation for Atmospheric Research	11/25/2020

Standard Form 424B (Rev. 7-97) Back

OMB Number: 4040-0004
Expiration Date: 12/31/2022

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 11/25/2020

4. Applicant Identifier: 2020-0829

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: University Corporation for Atmospheric Research

* b. Employer/Taxpayer Identification Number (EIN/TIN): 840412668

* c. Organizational DUNS: 0783395870000

d. Address:

* Street1: 3090 Center Green Drive
Street2:
* City: Boulder
County/Parish: Boulder
* State: CO: Colorado
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 803012252

e. Organizational Unit:

Department Name: NCAR

Division Name: CGD

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Ms.
* First Name: Marlene
Middle Name:
* Last Name: DiMarco
Suffix:

Title: Budget Analyst

Organizational Affiliation: University Corporation for Atmospheric Research

* Telephone Number: 3034971371
Fax Number:

* Email: cgdawards@cgd.ucar.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

M: Nonprofit with 501C3 IRS Status (Other than Institution of Higher Education)

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Department of Commerce

11. Catalog of Federal Domestic Assistance Number:

11.431

CFDA Title:

Climate and Atmospheric Research

*** 12. Funding Opportunity Number:**

NOAA-OAR-CPO-2021-2006389

* Title:

Climate Program Office FY2021

13. Competition Identification Number:

2864458

Title:

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

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

An Open Framework for Process-Oriented Diagnostics of Earth System Models

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CO-002 * b. Program/Project: CO-002

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 09/01/2021 * b. End Date: 08/31/2024

18. Estimated Funding ($):

* a. Federal	299,944.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	299,944.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: Mr. * First Name: Steve

Middle Name:

* Last Name: Ritter

Suffix:

* Title: Budget Analyst

* Telephone Number: 3034971107 Fax Number:

* Email: fedaward@ucar.edu

* Signature of Authorized Representative: Steve Ritter * Date Signed: 11/25/2020

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 02/28/2022

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Climate and Atmospheric Research	11.431	$	$	$ 99,533.00	$	$ 99,533.00
2. Climate and Atmospheric Research	11.431			100,164.00		100,164.00
3. Climate and Atmospheric Research	11.431			100,247.00		100,247.00
4. N/A	11.431					
5. Totals		$	$	$ 299,944.00	$	$ 299,944.00

Standard Form 424A (Rev. 7- 97)
Prescribed by OMB (Circular A -102) Page 1

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) Climate and Atmospheric Research	(2) Climate and Atmospheric Research	(3) Climate and Atmospheric Research	(4)	Total (5)
a. Personnel	$ 38,892.00	$ 39,199.00	$ 39,291.00	$	$ 117,382.00
b. Fringe Benefits	21,196.00	21,363.00	21,413.00		63,972.00
c. Travel					
d. Equipment					
e. Supplies					
f. Contractual					
g. Construction					
h. Other	5,435.00	5,324.00	5,185.00		15,944.00
i. Total Direct Charges (sum of 6a-6h)	65,523.00	65,886.00	65,889.00		$ 197,298.00
j. Indirect Charges	34,010.00	34,278.00	34,358.00		$ 102,646.00
k. TOTALS (sum of 6i and 6j)	$ 99,533.00	$ 100,164.00	$ 100,247.00	$	$ 299,944.00
7. Program Income	$	$	$	$	$

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SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8. Climate and Atmospheric Research	$ 99,533.00	$	$	$ 99,533.00
9. Climate and Atmospheric Research	100,164.00			100,164.00
10. Climate and Atmospheric Research	100,247.00			100,247.00
11.				
12. TOTAL (sum of lines 8-11)	$ 299,944.00	$	$	$ 299,944.00

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 99,533.00	$ 24,883.00	$ 24,883.00	$ 24,883.00	$ 24,884.00
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$ 99,533.00	$ 24,883.00	$ 24,883.00	$ 24,883.00	$ 24,884.00

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. Climate and Atmospheric Research	$ 100,164.00	$ 100,247.00	$	$
17. Climate and Atmospheric Research				
18. Climate and Atmospheric Research				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 100,164.00	$ 100,247.00	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: Modified Total Direct Costs (MTDC): $181,354

22. Indirect Charges: Indirect on MTDC: $102,646

23. Remarks: Indirect Costs: FY20 rate of 56.60% x MTDC = .0566 x $181,354 = $102,646

Budget Justification

"An Open Framework for Process-Oriented Diagnostics of Earth System Models"

September 1, 2021 to August 31, 2024

Requested Funding $179,390

PERSONNEL: $102,061

Salary costs use fiscal year 2020/2021 (July 1, 2020 through June 30, 2021) rates as the base and assumes a 3% increase in each subsequent fiscal year beginning July 1, 2021.

Dr. Paul Ullrich (Principle Investigator / Associate Professor): $72,577

Funding support in the amount of $72,577 is requested to cover salary expenses for Dr. Ullrich who will contribute 2.0 academic months (16.67% effort based on annual FTE) in project year 1-3. Dr. Ullrich will be responsible for coordination of joint CMEC-MDTF activities and implementation of a POD wrapper for the TempestExtremes feature tracking software.

BENEFITS: $29,484

Benefit Costs are based on Federally Approved Composite Benefit Rates which have been approved through June 30, 2021. Rates assume a 3% each subsequent fiscal year beginning July 1, 2020.

Dr. Paul Ullrich (Principle Investigator / Associate Professor): $29,484

The estimated composite benefit rates for Dr. Ullrich is 39.8%, 41%, and 42.2% have been used to calculate benefit costs for any salary costs (as additional compensation) paid out during the project periods.

TRAVEL: $6,200

Domestic Travel: $6,200

- Project Year 1 funding support for the amount of $2,000 to participate at the 2021 AGU Fall Meeting in New Orleans, Louisiana (Lodging $900, Airfare $300, Registration $400, Ground Transportation $150, Meals and Incidentals $250).
- Project Year 1-3 funding support for the amount of $1,400 per year to participate in an in-person MDTF working meeting for 3 days on the campus of the University of California, Los Angeles (Lodging $800, Airfare $300, Ground Transportation $100, Meals and Incidentals $200).

OTHER DIRECT COST: $6,000

Publication Costs: $6,000

Funds are requested for expenses associated with disseminating project results in the scientific community peer-reviewed journals. Publication costs are incurred from publication of work produced by this project at UC Davis. The associated annual cost is expected to be $2,000 in Year 1-3 for these publications.

INDIRECT COST: $65,129

Indirect costs for the duration of the project have been calculated at the University of California, Davis' last Federally approved Indirect Cost Rate for on-campus research of 57.0% Modified Total Direct Cost (MTDC).

Start Date:	9/1/2021	Non-NIH	Title:	An Open Framework for Process-Oriented Diagnostics of Earth System Models	Proposal Due Date/Archive:				11/30/2020	
End Date:	8/31/2024		PI(s):	Paul Ullrich	12 Months	12 Months	12 Months	0 Months	0 Months	36 Months

PERSONNEL		Annual Salary			Project Period % Effort					Salary Basis	*					Escalation:	FY	Multi
												Period 1	Period 2	Period 3	Period 4	Period 5	Total
Name/Role:		Base	Summer	Total	Per 1	Per 2	Per 3	Per4	Per5	Salary Basis and Type	Escal	9/1/21-8/31/22	9/1/22-8/31/23	9/1/23-8/31/24	-	-	9/1/21-8/31/24
1	Paul Ullrich	136,100		136,100	16.67%	16.67%	16.67%			CAL 12/12	3%	23,481	24,185	24,911	0	0	72,577
2				-						CAL 12/12	3%	0	0	0	0	0	0
3				-						CAL 12/12	3%	0	0	0	0	0	0
4				-						CAL 12/12	3%	0	0	0	0	0	0
Total Salaries												**23,481**	**24,185**	**24,911**	**0**	**0**	**72,577**

	FY Split:	10/2	10/2	10/2	0/0	0/0	Include CBR Add-On?	No	Escalations to fringe?	Yes		
Benefits by Person	UCPath CBR Group	%	%	%	%	%	Period 1	Period 2	Period 3	Period 4	Period 5	Total
1 Paul Ullrich	Faculty, Acad, MSP, Safety (C)	39.2/40.4	40.4/41.6	41.6/42.8			9,252	9,819	10,413	0	0	29,484
2 -	Choose						0	0	0	0	0	0
3 -	Choose						0	0	0	0	0	0
4 -	Choose						0	0	0	0	0	0
Total Benefits							**9,252**	**9,819**	**10,413**	**0**	**0**	**29,484**
Total Personnel							**32,733**	**34,004**	**35,324**	**0**	**0**	**102,061**

TRAVEL	International?	Period 1	Period 2	Period 3	Period 4	Period 5	Total
Domestic Travel	No	3,400	1,400	1,400			6,200
	No						0
	No						0
Total Domestic Travel		*3,400*	*1,400*	*1,400*	*0*	*0*	*6,200*
Total International Travel		*0*	*0*	*0*	*0*	*0*	*0*
Total Travel		**3,400**	**1,400**	**1,400**	**0**	**0**	**6,200**

Publication Costs							
Publication Costs		2,000	2,000	2,000			6,000
							0
							0
							0
Total Publication Cos		**2,000**	**2,000**	**2,000**	**0**	**0**	**6,000**

Other Expenses Subject to Indirect:	*0*	*0*	*0*	*0*	*0*	*0*
Other Expenses Excluded from Indirect:	*0*	*0*	*0*	*0*	*0*	*0*
Total Other Direct Costs	**2,000**	**2,000**	**2,000**	**0**	**0**	**6,000**

Total Direct Costs	Choose Rate Type from Dropdown Below:	38,133	37,404	38,724	0	0	114,261
Indirect Cost Base	**Rate Type:** On-Campus Research	38,133	37,404	38,724	0	0	114,261
Indirect Costs		*21,736*	*21,320*	*22,073*	*0*	*0*	*65,129*
Total Costs (Direct + Indirect)		**$59,869**	**$58,724**	**$60,797**	**$0**	**$0**	**$179,390**

FORM **CD-511**
(REV 1-05)

U.S. DEPARTMENT OF COMMERCE

CERTIFICATION REGARDING LOBBYING

Applicants should also review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 15 CFR Part 28, 'New Restrictions on Lobbying.' The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Commerce determines to award the covered transaction, grant, or cooperative agreement.

LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 15 CFR Part 28, for persons entering into a grant, cooperative agreement or contract over $100,000 or a loan or loan guarantee over $150,000 as defined at 15 CFR Part 28, Sections 28.105 and 28.110, the applicant certifies that to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

* NAME OF APPLICANT

The Regents of the University of California (Davis)

* AWARD NUMBER

* PROJECT NAME

An Open Framework for Process-Oriented Diagnostics of Earth

Prefix: * First Name: Middle Name:

* Last Name: Suffix:

* Title: Contracts and Grants Officer

* SIGNATURE:

Alyssa Bunn

* DATE:

11/25/2020

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 02/28/2022

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Climate and Atmospheric Research	11.431	$	$	$ 59,869.00	$	$ 59,869.00
2. Climate and Atmospheric Research	11.431			58,724.00		58,724.00
3. Climate and Atmospheric Research	11.431			60,797.00		60,797.00
4.						
5. Totals		$	$	$ 179,390.00	$	$ 179,390.00

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Prescribed by OMB (Circular A -102) Page 1

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) Climate and Atmospheric Research	(2) Climate and Atmospheric Research	(3) Climate and Atmospheric Research	(4)	Total (5)
a. Personnel	$ 23,481.00	$ 24,185.00	$ 24,911.00	$	$ 72,577.00
b. Fringe Benefits	9,252.00	9,819.00	10,413.00		29,484.00
c. Travel	3,400.00	1,400.00	1,400.00		6,200.00
d. Equipment					
e. Supplies					
f. Contractual					
g. Construction					
h. Other	2,000.00	2,000.00	2,000.00		6,000.00
i. Total Direct Charges (sum of 6a-6h)	38,133.00	37,404.00	38,724.00		$ 114,261.00
j. Indirect Charges	21,736.00	21,320.00	22,073.00		$ 65,129.00
k. TOTALS (sum of 6i and 6j)	$ 59,869.00	$ 58,724.00	$ 60,797.00	$	$ 179,390.00
7. Program Income	$	$	$	$	$

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SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8.	$	$	$	$
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$	$	$	$

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 59,869.00	$ 14,967.00	$ 14,967.00	$ 14,967.00	$ 14,968.00
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$ 59,869.00	$ 14,967.00	$ 14,967.00	$ 14,967.00	$ 14,968.00

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. Climate and Atmospheric Research	$ 58,724.00	$ 60,797.00	$	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 58,724.00	$ 60,797.00	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:

22. Indirect Charges:

23. Remarks:

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OMB Number: 4040-0007
Expiration Date: 02/28/2022

ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C.§§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593(identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Alyssa Bunn	Contracts and Grants Officer
APPLICANT ORGANIZATION	DATE SUBMITTED
The Regents of the University of California (Davis)	11/25/2020

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OMB Number: 4040-0004
Expiration Date: 12/31/2022

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 11/25/2020

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: The Regents of the University of California (Davis)

* b. Employer/Taxpayer Identification Number (EIN/TIN): 946036494

* c. Organizational DUNS: 047120084

d. Address:

* Street1: Office of Research Sponsored Programs
Street2: 1850 Research Park Drive
* City: Davis
County/Parish: Yolo
* State: CA: California
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 95618-6153

e. Organizational Unit:

Department Name: Land Air & Water Resources

Division Name: College of Agriculture/Env Sci

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:
* First Name: Paul
Middle Name: A
* Last Name: Ullrich
Suffix:

Title: Asst Prof-FY

Organizational Affiliation: The Regents of the University of California (Davis)

* Telephone Number: 530-400-9817
Fax Number:

* Email: proposals@ucdavis.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Department of Commerce

11. Catalog of Federal Domestic Assistance Number:

11.431

CFDA Title:

Climate and Atmospheric Research

*** 12. Funding Opportunity Number:**

NOAA-OAR-CPO-2021-2006389

* Title:

Climate Program Office FY2021

13. Competition Identification Number:

2864458

Title:

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

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

An Open Framework for Process-Oriented Diagnostics of Global Models

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CA-003 * b. Program/Project: CA-003

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 09/01/2021 * b. End Date: 08/31/2024

18. Estimated Funding ($):

* a. Federal	179,390.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	179,390.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: * First Name: Alyssa

Middle Name:

* Last Name: Bunn

Suffix:

* Title: Contracts and Grants Officer

* Telephone Number: 530-754-7996 Fax Number:

* Email: aabunn@ucdavis.edu

* Signature of Authorized Representative: Alyssa Bunn * Date Signed: 11/25/2020