NWS Office of Science and Technology Integration: Unified Forecast System

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NOTICE OF FUNDING OPPORTUNITY

EXECUTIVE SUMMARY

Federal Agency Name(s): National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), Department of Commerce

Funding Opportunity Title: NWS Office of Science and Technology Integration: Unified Forecast System

Announcement Type: Initial

Funding Opportunity Number: NOAA-NWS-NWSPO-2022-2007072

Federal Assistance Listings Number: 11.468, Applied Meteorological Research

Dates: Full applications must be received by 5:00 PM Eastern Time (ET) on February 7, 2022. Applications received after the deadlines will not be considered. Pre-proposal Letters of Intent (LOIs) are strongly encouraged and must be received by 5:00 PM Eastern Time (ET) on December 6, 2021. Expected project start date is September 1, 2022.

Funding Opportunity Description: NOAA's National Weather Service (NWS) Office of Science and Technology Integration (OSTI) Modeling Program Division is soliciting research proposals to support NOAA's development of the community-based and comprehensive coupled modeling system, the Unified Forecast System (UFS). The UFS is designed to provide more accurate forecast guidance through operational numerical weather prediction applications. These applications span local and global domains, and predictive time scales from sub-hourly to seasonal (S2S). This solicitation favors projects at specific stages of maturity as signified by their readiness level as described in Section 1.A.

There are three competitions from this notification valued at approximately $3,000,000 for the first year of multi-year (2 or 3 year) projects that will advance development of the UFS: 1) Next Generation Global Prediction System (NGGPS); 2) Weeks 3-4/S2S Program; and 3) Hurricane Forecast Improvement Program (HFIP).

Research projects to advance NGGPS will propose accelerating improvement of operational global weather prediction models; coupling among atmosphere, ocean, waves, ice, land and atmospheric composition systems; improving data assimilation techniques; improving physical parameterization schemes; improving ensemble techniques; developing post-processing forecast tools and techniques; or improving software architecture, computational performance and system engineering.

Proposals pertaining to the advancement of the Weeks 3-4/S2S Program will focus on the development of a coupled UFS system including coupled data assimilation approaches, extending the forecast of the UFS from 3 weeks to seasonal timescales, and developing metrics including validation/verification and process-level diagnostics.

Proposals for the HFIP initiative will relate to research required to improve operational tropical cyclone forecasting to meet societal requirements to save lives and effectively mitigate economic disruption.

FULL ANNOUNCEMENT TEXT

I. Funding Opportunity Description

A. Program Objective

The focus of this funding opportunity is to seek research projects and applications of modeling procedures that have the potential to be incorporated into NOAA's operational Numerical Weather Prediction (NWP) analyses and forecasts. Efforts to expand and accelerate critical weather forecasting research to operations will address growing service demands, increase the accuracy of weather forecasts, and contribute to a newly developed Unified Forecast System (UFS). The UFS provides a framework to engage the extensive research community and creates an environment for NOAA to more efficiently and effectively translate research advances into operational outcomes. Detailed information regarding UFS can be found on the UFS portal: https://ufscommunity.org/.

UFS is also a paradigm shift for NOAA that will enable NOAA to simplify the production suite at the National Centers for Environmental Prediction (NCEP) to produce more accurate forecasts for the U.S. and its partners. NOAA's Research to Operations (R2O) Initiative is an effort to upgrade the operational numerical weather prediction system to a unified, fully coupled Next Generation Global Prediction System (NGGPS). On June 12, 2019, NOAA upgraded the Global Forecast System (GFS) to GFS v15 for deterministic weather forecasts up to 16 days, with a newly selected finite-volume cubed-sphere (FV3) dynamical core and new microphysics scheme. NOAA further upgraded the GFS to GFS v16 on March 22, 2021, with increased vertical layers (from 64 to 127 levels) and raised model top (from 50 to 80 km), upgraded physics and data assimilation systems, and one-way coupling with waves. Based on the FV3 dynamical core, NOAA also upgraded the Global Ensemble Forecast System (GEFS) to GEFS v12 on September 23, 2020. GEFS v12 is a major upgrade since 2015, including increased forecast length to 35 days, increased model resolution to 25 km and ensemble to 31 members, coupling with waves and aerosol components, and a 30-year reanalysis and reforecast. All system upgrades have incorporated recent advances in weather prediction modeling from NOAA and the research community.

To engage the research community to use the UFS codes, NOAA formally released the Medium-Range Weather (MRW) Application in March and October 2020, and the Short-Range Weather (SRW) Application in March 2021 (see https://ufscommunity.org/science/code). The "ufs-weather-model" repository contains the model code and external links needed to build the UFS Applications. UFS user's support forums, learning portals and graduate student tests are also available at the UFS portal.

In July 2020, NOAA started the Unified Forecast System (UFS) Research to Operations (UFS R2O) Project, which supports a large team of researchers, both inside and outside NOAA, to accelerate the development and implementation of NOAA's next generation operational forecast models for Hurricane Analysis and Forecast System (HAFS v1), Rapid Refresh Forecast System (RRFS v1) for short-range weather, Global Forecast System (GFS v17) for medium-range weather, and Global Ensemble Forecast System (GEFS v13) for subseasonal time scales (see details in https://vlab.noaa.gov/web/ufs-r2o). The Seasonal Forecast System (SFS v1) will be a new UFS application, to be developed by extending key features of GEFS v13, and is targeted to replace the current operational Climate Forecast System (CFS v2) in FY26.

The UFS is configured to be a six-way coupled prediction system, including atmosphere, ocean, land, ice, waves and atmospheric composition. A sequence of coupled model prototypes for GFS v7 and GEFS v13 have been developed and the model output is made available on Amazon Web Services (AWS). The prototype model code, referred to as "ufs-weather-model", is continuously updated on Github (https://github.com/ufs-community/ufs-weather-model). The UFS R2O team is also developing a prototype for RRFS v1 and HAFS v1. In order for NOAA to successfully transition new technology to operations following the completion of selected projects, proposals should work with the "ufs-weather-model", which is the basis for all UFS applications. Applicants should also establish a collaboration with the UFS R2O team (UFS R2O Project Leads: ufs-r2o-leads@noaa.gov; UFS R2O Project Engineers: ufs-r2o-engineers@noaa.gov). NOAA is seeking projects with the potential to provide promising near term improvements to NOAA's operational numerical prediction suite and forecaster applications. Applicants should aim to address the model issues and requests from the NWS forecast community, one of the key drivers that informs the funding offices on research and development priorities (see details in https://www.weather.gov/media/sti/Final%20Consolidated%20Forecasters%20requests%20April%202021.pdf).

The selection of projects will focus on those associated with Readiness Levels (RL) 4 through 7 as described below, and on the NAO 216-105B Policy on Research and Development Transitions website: https://www.noaa.gov/organization/administration/nao-216-105b-policy-on-research-and-development-transitions.

RL 4: Successful evaluation of system, subsystem, process, product, service, or tool in a laboratory or other experimental environment; this can be considered an intermediate phase of development.
RL 5: Successful evaluation of system, subsystem process, product, service, or tool in a relevant environment through testing and prototyping; this can be considered the final stage

of development before demonstration begins.
RL 6: Demonstration of a prototype system, subsystem, process, product, service, or tool in a relevant or test environment (potential demonstrated).
RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).

The R2O Initiative effort to implement a weather-scale, fully-coupled NWP system includes extending deterministic forecast skill beyond 8 to 10 days, improving hurricane track and intensity forecasts, and extending probabilistic forecasting out to 9 months. NOAA has established objectives to accelerate weather forecasting skill, including: 1) maximizing the benefits of high performance computing; 2) increasing the resolution of key environmental models to improve the specificity of forecasts; 3) developing effective assimilation of environmental observations at global and regional scales; 4) advancing model component coupling; 5) developing advanced data assimilation (DA) methods at both global and regional scales; 6) advancing physical parameterizations; 7) refining post-processing methods for key variables including methods for subseasonal and seasonal forecast and the data sets needed to support them (retrospective reanalyses and reforecasts); and 8) developing process-level diagnostic packages that can be used as tools for model development, model evaluation and model inter-comparison. The UFS is designed to serve both the research, development and operational communities engaged in the numerical prediction of the Earth System.

Proposals should adhere to advanced software practices such as documentation of code and testing for the ease of transition to operations. In order for NOAA to successfully transition new technology to operations following the completion of selected projects, proposals should specify work with UFS codes. Proposals should include a plan for testing and evaluating new capabilities. A hierarchy of testing should be proposed, ranging from demonstration of at least comparable performance to existing model capabilities, to case studies and/or multi-season tests to demonstrate achievement of benchmarks in the objective, subjective and engineering readiness required for transition to operations.

Applicants are encouraged to visit the UFS Portal (https://ufscommunity.org/) to learn more about the UFS, plans for the coupled system, information pertaining to the UFS Working Groups and Application Teams (https://ufscommunity.org/science/working-groups), and key documents (https://ufscommunity.org/documents/keydocs) such as the Strategic Plan, supporting and describing UFS development. For questions and points of contact related to the working groups, please email nws.sti.modeling.team@noaa.gov.

B. Program Priorities

There are 3 competitions under this announcement: NGGPS, Weeks 3-4/S2S and HFIP. Applicants should clearly indicate the competition to which they are applying.

NGGPS Competition: Research proposals to advance the UFS Medium-Range Weather Application will focus on accelerating coupled model development to improve forecast accuracy. This includes coupling among the weather prediction model components (atmosphere, ocean, wave, ice, land and atmospheric composition system), advancing coupled data assimilation and ensemble techniques, developing post-processing forecast tools, and improving probabilistic forecast skill by improving software architecture, computational performance and system engineering. Additional information on NGGPS can be found at: https://www.weather.gov/sti/stimodeling_nggps.

Weeks 3-4/S2S Competition: Proposals pertaining to the advancement of the Weeks 3-4/S2S Program will contribute to the development of coupled data assimilation approaches; extending the forecast of the UFS subseasonal-to-seasonal (S2S) prototypes from 3 weeks to seasonal timescales; process-level diagnostic tools and validation/verification metrics for the coupled system; and addressing challenges in S2S prediction that project onto NOAA's requirements for Weeks 3-4, monthly and seasonal forecast products (https://www.cpc.ncep.noaa.gov). Additional information can be found at: https://www.weather.gov/sti/stimodeling_nggps_weeks3-4.

HFIP Competition: Proposals for the HFIP initiative will support hurricane research and development required to improve operational hurricane forecasts of higher accuracy and greater reliability to meet societal requirements to effectively mitigate loss of life and economic disruption. This includes specific goals to reduce the average errors of hurricane track, intensity and structure forecasts guidance errors by 20% relative to the 2017 baseline within five years and 50% in ten years with a forecast period out to 7 days in the UFS Hurricane Analysis and Forecast System (HAFS). The specific research, development, and technology-transfer activities necessary to address HFIP's science and R2O challenges can be found in the HFIP Strategic Plan document (https://hfip.org/sites/default/files/documents/hfip-strategic-plan-20190625-final.pdf) available on the HFIP website (http://www.hfip.org/).

Applicants for a given competition should clearly indicate and address in their proposal one or more of the associated priorities listed below. Proposals not directly associated with one or more of these priorities are discouraged.

1. Advances in verification & validation: Construct optimal verification methods and tools to evaluate the performance of the newly coupled UFS applications for medium-range weather, subseasonal-to-seasonal and hurricane forecasts. New verification and validation tools should be integrated into the Model Evaluation Tools (METplus, https://dtcenter.org/community-code/model-evaluation-tools-met), the community-based unified verification system for UFS applications. Applications will include one or more of the following:
a) Design and develop process-level diagnostics tools that identify key processes that lead to coupled model errors and systematic biases that are most detrimental to UFS forecast skill for hurricane, weather and S2S forecasts, and incorporate those tools into METplus.
b) Identify model deficiencies in representing key processes that influence precipitation forecast skill in particular, and design metrics to benchmark model performance in representing those key processes and provide feedback to the UFS prototype model development team.
c) Identify and reduce model deficiencies in representing key sources of predictability on weather and S2S time scales including, but not limited to, atmosphere-ocean-ice coupling, atmosphere-land coupling, stratosphere-troposphere coupling, tropical convection and teleconnections, climate modes such as El Niño–Southern Oscillation (ENSO), Madden-Julian Oscillation (MJO), and Quasi-Biennial Oscillation (QBO). The studies should take advantage of S2S prototype runs available as part of the NWS operational model development and/or perform additional model sensitivity experiments with the “ufs-weather-model” code on Github and provide feedback to the UFS prototype model development team.
d) Enhance the MET/METplus tools that support verification and guidance of probabilistic forecasts including, but not limited to, verification and guidance tools at a variety of probability levels via a Cumulative Distribution Function (CDF).

2. Advances in data assimilation (DA) and ensemble techniques: Improve methodologies for initializing the UFS applications, including hybrid (3D- or 4D-Var + EnKF) techniques, weakly or strongly coupled DA, and ensemble perturbation techniques that improve ensemble DA as well as ensemble forecasts. Applications will include one or more of the following:
a) Improve accuracy of data assimilation in each Earth System component, particularly in ocean, sea ice and land (including snow cover), that is critical for initialization of the low frequency components of the coupled system for extending predictability from subseasonal to seasonal time scales.
b) Advance coupled data assimilation techniques and a coupled reanalysis capability within the Joint Effort for Data assimilation Integration (JEDI) framework. Coupled data assimilation techniques should aim to improve estimation of the ocean, sea ice and land state

where observations are sparse, through exchange of information with the atmosphere where observations are rich using coupled background error covariance.
c) Develop and refine the ensemble framework for the coupled UFS prototypes as the basis for the next generation subseasonal (GEFS) and seasonal (SFS) applications. Improve stochastic physics parameterizations to represent uncertainties in each model component including ocean, sea ice and land, and quantify impacts of different ensemble perturbation techniques on the ensemble forecast skill from subseasonal to seasonal time scales.
d) Improve data assimilation techniques targeted for the Hurricane Analysis and Forecast System (HAFS) under the Joint Effort for Data Assimilation Integration (JEDI) framework. Improve use of in-situ data, e.g., airborne Doppler radar data, Doppler wind Lidar, Stepped-Frequency Microwave Radiometer (SFMR), GPS dropwindsonde, in supplement to next-generation satellite data for accurate three-dimensional depictions of the tropical cyclone circulation. Improve high resolution vortex initialization techniques for tropical cyclones.
e) Develop and evaluate a basic GFS native resolution ensemble. A native resolution GFS ensemble has potential benefits as 1) a forecast uncertainty tool consistent with the deterministic GFS; 2) a higher-resolution source for initial-first guess and boundary conditions for the RRFS; and 3) a potential contribution to an ensemble data assimilation approach for the GFS. In order to keep this computationally feasible, it is suggested to initially design the ensemble to support the RRFS with respect to ensemble size and forecast length, but more ambitious proposals are welcome. As NOAA presently does not have compute resources to support such a project, it is essential that the proposal includes a clear computational resources plan.

3. Advances in coupled model development: Improve the coupled UFS prototypes as the basis for the next generation medium-range weather (GFS), subseasonal (GEFS) and seasonal (SFS), and hurricane (HAFS) applications. Applications will include one or more of the following:
a) Reduce coupled model systematic error through physics updates and model resolution refinement (horizontal and vertical) that improve representation of diurnal cycles, convection, coupled boundary layer processes, surface fluxes and aerosol-radiation-cloud-precipitation interactions.
b} Improve the land component by incorporating critical physical processes that improve forecasting of near-surface temperature, pressure, moisture and winds, precipitation and snowfall.
c) Improve the sea ice component and its coupling with the atmosphere and ocean component. Improve representation of key processes that improve forecast of sea-ice concentration, sea-ice thickness, sea-ice drift, sea ice melting and freezing.
d) Improve high resolution (e.g., scales less than 3 km) model physics, focusing on microphysics and boundary layer parameterization that can accurately represent moist

processes in the hurricane core and land-air-sea-wave-aerosol interactions. Use of in-situ observations for parameterization scheme developments is encouraged.

4. Develop and improve post-processing forecast tools and techniques: Improve post-processing forecast tools and techniques that meet the growing service demands on improved forecast products from hurricane, weather and S2S time scales.
a) Improve forecaster's use of post-processed guidance, tools, and technologies to better assess uncertainty and historical context of hazardous weather events. A particular gap exists in the Day 4-10 forecast timeframe spanning weather-to sub-seasonal prediction.
b) Translation of NWP to products and services - Further develop tools and techniques to improve the translation of NWP into meaningful products and services that convey probabilistic hazard information for hazardous weather events (e.g. extreme precipitation, extreme temperatures, extreme wind events, tropical cyclones). This includes artificial intelligence and machine learning (AI/ML) or other techniques that help diagnose systematic model errors, support data mining and feature extraction of NWP, and actionable visualization for the forecaster and users.
c) Develop post-processing software for the UFS. This includes novel algorithms and methods for model bias correction and calibration, including developing and implementing machine learning and artificial intelligence (ML/AI) tools operationally, software optimization and compression techniques, visualization techniques, and probabilistic data sets and statistics derived from ensemble systems.
d) Develop post-processing techniques that increase hurricane forecaster utility of tropical cyclone forecast guidance. This includes techniques, such as AI/ML, for hurricane model guidance for genesis, track, intensity, surface wind structure and estimating forecast uncertainty.
e) Improve downstream applications for landfalling storms for improved size, structure, rainfall, storm surge and coastal inundation forecasts. Enhance communication of risk and uncertainty for tropical cyclone hazards, including wind, surge, and rainfall.

C. Program Authority

Public Law 115-25 Weather Research and Forecasting Act of 2017, 15 U.S.C. 8512(c)

II. Award Information

A. Funding Availability

The total funding amount available under this announcement is estimated to be approximately $3,000,000 per year. It is anticipated that approximately 10 to 15 awards will be provided. Funding of any proposal is contingent upon the availability of these funds. The

funding estimates allocated for each competition may be altered depending on the number and quality of proposals submitted within each competition.

1. NGGPS competition:
The total funding amount available for proposals in the NGGPS competition is anticipated to be approximately $1,000,000 for year 1. The maximum award that can be requested is $300,000 total cost per year per proposal. Proposals over $300,000 per year will be rejected. Individual award amounts are expected to range from $100,000 to $300,000 per year with a maximum funding request of three years. Approximately 4 awards are expected.

2. Weeks 3-4/S2S competition:
The total funding amount available for proposals in the Weeks 3-4/S2S competition is anticipated to be approximately $1,300,000 for year 1. The maximum award that can be requested is $300,000 total cost per year per proposal. Proposals over $300,000 per year will be rejected. Individual award amounts are expected to range from $100,000 to $300,000 per year with a maximum funding request of three years. Approximately 6 awards are expected.

3. HFIP competition:
The total funding amount available for proposals in the HFIP competition is anticipated to be approximately $700,000 for year 1. The maximum award that can be requested is $300,000 total cost per year per proposal. Proposals over $300,000 per year will be rejected. Individual award amounts are expected to range from $100,000 to $300,000 per year with a maximum funding request of three years. Approximately 3 awards are expected.

B. Project/Award Period

This announcement is for multi-year projects to be conducted for a maximum three-year period with an anticipated start date of September 1, 2022 unless otherwise directed. September 1, 2022 should be indicated as the project start date in the proposal. When a proposal is approved, funding may initially be provided for only the first year of the project. If a proposal is selected for initial funding, the NWS OSTI-Modeling Program Office has no obligation to provide additional funding in connection with that award for the following years. Funding for the following years is at the discretion of the Program Office. Second and third year funding may also be contingent upon satisfactory progress in relation to the stated goals of the proposal to address specific science needs and priorities of the Program Office, and subject to the availability of funds.

C. Type of Funding Instrument

The funding instrument for these awards will be a Cooperative Agreement. NOAA cooperative research activities provide financial support to enhance the public benefits to be

derived from these research activities and engage NOAA scientists and other personnel who are substantially involved in the project for frequent consultation and advice.

III. Eligibility Information

A. Eligible Applicants

Eligible applicants are U.S. institutions of higher education; U.S.-based commercial organizations; state, local and Indian tribal governments in the U.S.; and other U.S. non-profit organizations.

All funded investigators must assure and verify, if requested, that they will not be allocated for greater than 100% of their annual employment time should their proposal be selected for funding. NOAA will verify this requirement if funding is recommended.

B. Cost Sharing or Matching Requirement

No cost sharing is required under this announcement.

C. Other Criteria that Affect Eligibility

Collaboration with PIs at different institutes is allowed, but there must be a single application from a lead institute with subawards to the participants from other institutions. Other arrangements will not be considered. Proposals should clearly state the role of each PI in the proposal. While an eligible organization may submit more than one application, the Selecting Official may require that proposals be combined to increase the cost-benefit to the public. Only one proposal per principal investigator at a given institution may be funded.

IV. Application and Submission Information

A. Address to Request Application Package

The standard application package is available at http://www.grants.gov. There is no similar official application package for Letters of Intent (LOIs) other than the requirements identified below in Section IV.B.1.

B. Content and Form of Application

Applicants are required to submit a full proposal and are strongly encouraged (but not required) to submit an LOI. The requirements for preparation of full applications provided

below are mandatory. Failure to adhere to these instructions will result in LOIs and/or full proposals being rejected and returned without review.

1. Letter of Intent (LOI)
The purpose of the LOI process is to provide information to potential applicants on the relevance of their proposed project in advance of preparing a full application. For this announcement, it is strongly recommended that PIs submit a pre-application in the form of a LOI for each planned project. LOIs will be reviewed by the Program Office following the criteria specified in Section V.A to assess the potential value of the proposed research to NOAA. All PIs will be notified through email by Program Office whether a proposal is encouraged or discouraged about two weeks after the LOI due date. Even though a proposal may be discouraged, a PI is not precluded from submitting a full proposal. The LOI must be submitted via email to nws.sti.modeling.team@noaa.gov by 5:00 PM Eastern Time (ET) on December 6, 2021. Refer to Section IV.D for LOI submission information.

The LOI is expected to contain the following information, and be no more than 2 pages in length:
(a) The principal investigator's and co-investigator's names and institutions, yearly and total budget.
(b) The competition (NGGPS, Weeks 3-4/S2S or HFIP) and priority areas being targeted (as indicated in Section I.B).
(c) A brief description of the intended project, methodology, scope, general timeline, and expected project outcomes, in addition to its relevance to the specified competition and priorities of the announcement.
(d) The LOI must briefly describe the current Readiness Level (see Section I.A) of the proposed project at start-up and the expected Readiness Level at project completion. It should also briefly describe any future steps recommended to advance the project output(s) to its ultimate application and operationalization by NOAA).
(e) Due to NOAA’s shortage of high performance computing and storage for research, investigators are strongly encouraged to seek computing resources, including cloud computing resources, from other sources and should be aware that NOAA resources will most likely not be available for their project. Clearly state whether the project intends to leverage resources from NOAA.

2. Full Proposal
Proposals may total no more than 25 pages in length, single spaced including the title page and abstract. It is strongly recommended to use Times New Roman 12 point font, or an equivalent size. The proposal should be submitted as a PDF file. Each proposal must be dated and contain page numbers. Federally mandated forms, tables of contents, and any

letters of support (or statement acknowledging intention to collaborate by NOAA participants) are not included within the page counts, but all other information must be included. The project description should total no more than 15 pages in length. Project descriptions exceeding the 15 page limit will only be reviewed up to the page limit. Excess material will not be reviewed and may result in the proposal receiving a lower score.

The application elements are as follows:
(a) Title Page: The title page must be officially authorized by the institutional representative. All PIs and institutional representative(s) should be identified by full name, title, organization, telephone number, email address and mailing address. The title page should clearly indicate which competition (NGGPS, Weeks 3-4/S2S or HFIP) and priority area(s) are being addressed. Indicate the proposed yearly and total budget (for each institution as applicable).

(b) Abstract Page: A one-page abstract must be included and contain an introduction of the problem, rationale, and a brief summary of research to be completed. The abstract should appear on a separate page, headed with the proposal title, institution's investigators, targeted program priority area(s) in Section I.B, total proposed cost, and budget period as well as any NOAA collaborating organization(s) (e.g., EMC). Any NOAA collaborating organization indicated in the proposal must have provided explicit pre-approval to the PI to be identified as a contributor to the proposed project prior to submission of the application.

(c) Results from Prior Research: The results of relevant projects supported by NOAA and other agencies must be described, including their relation to the currently proposed work. Prior research that demonstrated the potential to favorably impact and/or successfully transition operational environmental modeling and data assimilation system(s) should be emphasized. Reference to each prior research award should include the title, agency, award number, PIs, period of award, and total award. This section should be a brief summary and should not exceed two pages total.

(d) Project Description (15-page limit as indicated above): The proposed project must be completely described to include identification of the problem, scientific objectives, proposed methodology with a testing and evaluation approach, metric(s) for success, and a timeline with key milestones. The project description must also include relevance to the priorities of the UFS initiative; relevance to the program priorities outlined in Section 1.B; maturity of science and operational applicability as related to the proposed project readiness levels described Section I.A; scientific merit, including the benefits of the proposed project to improve operational forecasts; and cost effectiveness of research. A year-by-year summary of proposed milestones must be included. Specific collaborations with NOAA scientists and

technical personnel should also be detailed.
Due to NOAA’s shortage of high performance computing and storage for research, investigators are strongly encouraged to seek computing resources, including cloud computing resources, from other sources and should be aware that NOAA resources will most likely not be available for their project. The project description should clearly state whether the project intends to leverage computing resources from NOAA.

(e) Budget and Proposed Budget Justification: Applicants must submit a Standard Form (SF)-424, Application for Federal Assistance, including a detailed budget using the SF 424A, Budget Information-Non-Construction Programs. (The forms are available on Grants.gov.) Please pay careful attention to show the yearly budget breakout on the SF 424A for two or three-year proposals. In order to fully evaluate the appropriateness of costs, all applications must include a detailed budget narrative and justification to support all proposed budget categories for each project year. The budget narrative must be consistent with the budget table and must be broken out and detailed using the same budget categories as the SF-424A budget form. The funding amounts on federal budget forms must not include any funding allocated for federal collaborators: See Section IV.F "Funding Restrictions".
In addition, the body of the proposal must include a separate table showing total and annual budgets (if multi-year) corresponding with the project description. The table must also include multiple lines corresponding to multiple institutes, as applicable. Additional text to justify expenses should be included as necessary. PIs are strongly encouraged to plan and budget for travel during each year of the project for attendance at a PI and/or UFS-related meeting to present an update on the status and progress of their work and to communicate with UFS-R2O teams and UFS Working Groups.
Please take note of the important requirements included in Section IV.F., “Funding Restrictions”.

(f) Data Management Plan (up to 2 pages): See Section VI.B, Administrative and National Policy Requirements, for additional information on what the plan should contain.

(g) Letters of Support: For any participation or collaboration by federal employees or federal contractors indicated in the proposal, a letter of support (or statement acknowledging intent to collaborate by the federal participant) is required. Any other letters of support are permitted but not required.

(h) Curriculum Vitae (CV): A CV of 3 pages maximum for all PIs, co-PIs, and co-Is. The CV should include a reference list of all publications and conference presentations relevant to the proposed work within at least the last three years. CVs are not required for collaborator partners.

(i) Current and Pending Support: For each investigator, it is required to submit a list of pending support which includes project title, supporting agency with grant number, investigator months, dollar value, and duration. Requested values should be listed for pending support.

(j) This announcement does not require any National Environmental Policy Act (NEPA) questions to be answered as part of the application. This will be done after project selection if NOAA needs additional information beyond what is described in the proposal package. For additional information on NEPA, see Section VI.B.

(k) The full proposal package includes the information described above as well the following required federal forms: (1) Application for Federal Assistance (SF-424); (2) Budget Information--Non-Construction Programs (SF-424A): For multi-year proposals, pay careful attention to show the yearly budget breakout on the SF-424A; (3) Certification Regarding Lobbying (CD-511); (4) Assurances - Non Construction Programs (SF-424B); (5) Disclosure of Lobbying Activities (SF-LLL). Current versions of these forms are available on Grants.gov.

C. Unique Entity Identifier and System for Award Management (SAM)

To enable the use of a universal identifier and to enhance the quality of information available to the public as required by the Federal Funding Accountability and Transparency Act, 31 U.S.C. 6101 note, to the extent applicable, any proposal awarded in response to this announcement will be required to use the System for Award Management (SAM), which may be accessed online at https://sam.gov/content/home.

Each applicant (unless the applicant is excepted from those requirements under 2 CFR 25.110(b) or (c), or has an exception approved by the Federal awarding agency under 2 CFR 25.110(d)) is required to: (i) Be registered in SAM before submitting an application; (ii) Provide a valid unique entity identifier in the application; and (iii) Continue to maintain an active SAM registration with current information at all times during which the applicant has an active Federal award or an application or plan under consideration by NOAA (or any other Federal awarding agency).

NOAA may not make a Federal award to an applicant until the applicant has complied with all applicable unique entity identifier and SAM requirements. If an applicant has not fully complied with the requirements by the time NOAA is ready to make a Federal award, the Federal awarding agency may determine that the applicant is not qualified to receive a Federal award and use that determination as a basis for making a Federal award to another

applicant.

In order to submit an application through Grants.gov, an applicant must register for a Grants.gov user ID and password. Note that this process can take between three to five business days or as long as four weeks if all steps are not completed correctly. To avoid delays, applicants are strongly encouraged to start early and not wait until the approaching application deadline before registering, logging in, reviewing the application instructions, and applying. Organizations that are already registered with Grants.gov do not need to re-register.

D. Submission Dates and Times

LOIs are strongly encouraged (but not required) and must be received by email to nws.sti.modeling.team@noaa.gov by 5:00 PM Eastern Time (ET) on December 6, 2021. Full application packages for all competitions must be submitted via Grants.gov no later than 5:00 PM Eastern Time (ET) on February 7, 2022. When proposals are submitted through Grants.gov, a date and time receipt indication is included and will be the basis of determining timeliness. Proposals received after the deadlines will be rejected and returned to the sender without further consideration.

E. Intergovernmental Review

Applications under this program are not subject to Executive Order 12372, Intergovernmental Review of Federal Programs.

F. Funding Restrictions

NOAA will not fund federal employee salary costs for federal government employees. Applicants may budget up to, but not more than 30% of the proposed budget in support for NOAA laboratory or NCEP modeling center collaborators for expenditures such as travel or contract support. This funding must be specified in the proposal as an expense separately from the amount that would be provided directly to the grantee. For a collaboration that includes some funding for NOAA offices, the actual amount to be awarded through Grants Online would only be the portion for the non-government recipient and would be less than the $300,000 maximum project cost. The total cost of a proposal, including any costs associated with supporting federal employees or contractors, cannot exceed $300,000 per year.

In approved cases of support for federal expenditures, funds will be transferred directly within NOAA through an intra-agency fund transfer. This funding request must be coordinated with the affiliated NOAA organization. Any and all eligible costs associated

with supporting NOAA federal employees or contractors for a given project must be clearly identified in a separate federal budget table to be included with the application and be justified in an associated federal budget justification section but excluded from the non-federal applicant's budget tables and budget forms.

Funding beyond the first year may be dependent upon satisfactory performance and continued availability of funds. NOAA is not responsible for proposal preparation costs. NOAA cannot fund any research work through a federal grant or cooperative agreement in which the awardee proposes to develop or deliver to NOAA any tangible product deliverable beyond research results as reported in standard semi-annual progress reports and final reports, including, for example, software modules that the recipient might wish that NOAA would use for its operational forecasting mission. NOAA cannot fund or accept any such award deliverable that would be more appropriately funded through a procurement mechanism. However, NOAA may possibly pursue such follow-on contract mechanisms with the recipient after the award ends if the project is successful and follow-on contractual work is warranted. Do not propose to provide NOAA any deliverable other than the semi-annual progress reports and final reports. No more than one award per Principal Investigator will be awarded under this announcement.

G. Other Submission Requirements

Proposals submitted in response to this Announcement must include a Data Management Plan (up to 2 pages). See Section VI.B., Administrative and National Policy Requirements, below for additional information on what the plan should contain.

V. Application Review Information

A. Evaluation Criteria

Applicants are required to address in their proposal the criteria described in this section, which serves as the fundamental basis for reviewing, scoring, and ranking of the proposals. The reviewers for each competition will base their recommendations regarding each proposal upon the extent to which the following criteria (listed with assigned weights) are satisfied. The evaluation criteria and weighting of the criteria are as follows (for a total of 100 points):

1. Importance and/or relevance and applicability of the proposed project to program goals (30 points): This criterion ascertains whether there is intrinsic value in the proposed work and/or relevance to NOAA, federal, regional, state or local activities. This includes the

following questions:
a. What is the likelihood of the proposed science activities to improve operational environmental analyses and/or forecasts?
b. Are proposed research activities easily transitioned to development of UFS and a coupled system (for the NGGPS competition), to improvement of the operational hurricane prediction subsystem (for the HFIP competition), or extended prediction and development of S2S products (for the Weeks 3-4/S2S competition)?
c. Is there sufficient collaboration with NCEP modeling centers, NOAA research labs, and other NOAA personnel throughout the project to determine potential transition by NOAA of proposed research into operations?
d. What is the level of planning by researchers to test and evaluate proposed modeling advancements to meet operational model and/or data assimilation skill standards for potential transition into operations successfully and efficiently?
e. Is the proposed work responsive to the topics identified in the funding opportunity?

2. Technical/Scientific Merit (30 points): This criterion assesses whether the approach is technically sound and innovative, if the methods are appropriate, and whether there are clear project goals and objectives. This includes:
a. What is the intrinsic scientific or technical value and maturity of the subject and the study proposed as they relate to the specific science priorities?
b. Does the proposal demonstrate adequacy of the metrics proposed for testing and evaluation, and quantify the potential impact of the project on NCEP's operations?
c. Are focused scientific objectives and strategies, including data management considerations and project milestones used?

3. Overall Qualification of Applicants (25 points): This criterion ascertains whether the applicant possesses the necessary education, experience, training, facilities and administrative resources to accomplish the project. This includes:
a. Do PIs have the necessary education, experience/expertise, training, facilities, and resources (including the availability of computing resources) to accomplish the project?
b. Do PIs clearly document past scientific collaborations with operational modeling scientists or operational weather forecasters that contained potential to improve operational forecasts?
c. Have past interactions with NOAA been successful?
d. Are researchers likely to maintain effective and consistent interactions with NCEP and other NOAA modeling scientists or operational weather forecasters throughout the course of the proposed research program?
e. Have researchers demonstrated the ability to conduct successful research?

4. Project Costs (15 points): This criterion evaluates the budget to determine if it is realistic

and commensurate with the project needs and time-frame. This includes:
a. Are the requested costs realistic, reasonable, allowable, allocable, necessary and commensurate with the project benefits, deliverables, and time period?
b. Is there a high ratio of operationally useful results versus proposed costs?

B. Review and Selection Process

Once a full application package has been received, an initial administrative review will first be conducted to determine compliance with all submission requirements, completeness of the application, and responsiveness to the NOAA priorities in Section I.B. If all requirements are satisfied and the application is responsive to the priorities, the application will move to the next stage of review. If not, the application will be rejected and the PIs will be notified.
All compliant applications (proposals) will then receive an objective peer review within one of the three competition category pools to which it was submitted. All proposals within a given competition category pool will be competed and ranked against each other. All proposals will be evaluated and scored individually by a group of at least three professionally and technically qualified reviewers in accordance with the assigned weights of the above evaluation criteria by independent peer mail review and/or by independent peer panel reviews. Reviews will be conducted by scientific experts, primarily representing operational environmental modeling, data assimilation, service improvement and forecast communities. The merit reviewers' ratings and comments are used to produce a rank order of the proposals for final consideration by the program office. A separate rank order will be produced for each competition: NGGPS, Weeks 3-4/S2S and HFIP. The Selecting Official selects proposals after considering the peer panel reviews and selection factors listed below. Any application considered for funding may be required to address the issues raised in the evaluation of the application by the reviewers, Program Office, Selecting Official, and/or Grants Officer before a selection recommendation decision is made and/or before an award is made.

C. Selection Factors

Merit review ratings shall provide a rank order to the Selecting Official for final funding recommendations. The Selecting Official shall recommend awards in the rank order unless the proposal is justified to be selected out of rank order based upon one or more of the following factors:
1. Availability of funding
2. Balance/distribution of funds by (a) geographic area; (b) type of institutions; (c) type of partners; (d) research areas; and (e) project types
3. Whether a project duplicates other projects funded or considered for funding by NOAA or other federal agencies

4. Program priorities and policy factors
5. Applicant's prior award performance
6. Partnerships with and participation of targeted groups
7. Adequacy of information necessary for NOAA staff to make a NEPA determination and draft necessary documentation before recommendations for funding are made to the Grants Officer.

D. Anticipated Announcement and Award Dates

NOAA's Grants Management Division will normally make official award offers approximately one month before the planned project start date. The assumed start date for funded projects will be September 1, 2022 unless otherwise directed by the Program Office.

VI. Award Administration Information

A. Award Notices

Applicants will receive notification from NWS that their application has either been recommended or not recommended for funding to the NOAA Grants Management Division after completion of the review process. Notice of recommendation for funding is not an authorization to initiate the project. Official notification of funding of the grant award, signed by a NOAA Grants Officer, is the authorization that allows the project to begin. NOAA's Grants Management Division will normally make award offers approximately one month before the planned start date. This notification will be issued to the Authorizing Official of the project after approval and is the official document that authorizes the project to begin.

B. Administrative and National Policy Requirements

DEPARTMENT OF COMMERCE PRE-AWARD NOTIFICATION REQUIREMENTS FOR GRANTS AND COOPERATIVE AGREEMENTS - The Department of Commerce Pre-Award Notification Requirements for Grants and Cooperative Agreements contained in the Federal Register notice of December 30, 2014 (79 FR 78390) are applicable to this solicitation and may be accessed at: http://www.gpo.gov/fdsys/pkg/FR-2014-12-30/pdf/2014-30297.pdf.

UNIFORM ADMINISTRATIVE REQUIREMENTS, COST PRINCIPLES, AND AUDIT REQUIREMENTS. Through 2 C.F.R. § 1327.101, the Department of Commerce adopted Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards at 2 C.F.R. Part 200, which apply to awards in this program.

DOC TERMS AND CONDITIONS. Successful applicants who accept a NOAA award under this solicitation will be bound by Department of Commerce Financial Assistance Standard Terms and Conditions. This document will be provided in the award package in NOAA's Grants Online system at: https://www.noaa.gov/sites/default/files/legacy/document/2021/Mar/Administrative%20Standard%20Award%20Conditions%20for%20NOAA%20Financial%20Assistance%20Awards%2002.18.2021.pdf

LIMITATION OF LIABILITY - Funding for programs listed in this notice is contingent upon the availability of appropriations. Applicants are hereby given notice that funds may not have been appropriated for the programs listed in this notice. In no event will NOAA or the Department of Commerce be responsible for proposal preparation costs. Publication of this announcement does not oblige NOAA to award any specific project or to obligate any available funds.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA). NOAA must analyze the potential environmental impacts, as required by the National Environmental Policy Act (NEPA), for applicant projects or proposals which are seeking NOAA federal funding opportunities. Detailed information on NOAA compliance with NEPA can be found at the following NOAA NEPA website: http://www.nepa.noaa.gov/, including our NOAA Administrative Order 216-6 for NEPA, http://www.nepa.noaa.gov/NAO216_6.pdf, and the Council on Environmental Quality implementation regulations, http://energy.gov/sites/prod/files/NEPA-40CFR1500_1508.pdf. Consequently, as part of an applicant's package, and under their description of their program activities, applicants are required to provide detailed information on the activities to be conducted, locations, sites, species and habitat to be affected, possible construction activities, and any environmental concerns that may exist (e.g., the use and disposal of hazardous or toxic chemicals, introduction of non-indigenous species, impacts to endangered and threatened species, aquaculture projects, and impacts to coral reef systems). In addition to providing specific information that will serve as the basis for any required impact analyses, applicants may also be requested to assist NOAA in drafting an environmental assessment, if NOAA determines an assessment is required. Applicants will also be required to cooperate with NOAA in identifying feasible measures to reduce or avoid any identified adverse environmental impacts of their proposal. Failure to do so shall be grounds for not selecting an application. In some cases if additional information is required after an application is selected, funds can be withheld by the Grants Officer under a special award condition requiring the recipient to submit additional environmental compliance information sufficient to enable NOAA to make an assessment on any impacts that a project may have on the environment.

REVIEW OF RISK - After applications are proposed for funding by the selecting official, the Grants Office will perform administration reviews. These may include assessments of the financial stability of an applicant and the quality of the applicant's management systems, history of performance, and the applicant's ability to effectively implement statutory, regulatory, or other requirements imposed on non-Federal entities. Special conditions that address any risks determined to exist may be applied. Applicants may submit comments to the Federal Awardee Performance and Integrity Information System (FAPIIS) about any information included in the system about their organization for consideration by the awarding agency.

DATA SHARING PLAN -
1. Environmental data and information collected or created under NOAA grants or cooperative agreements must be made discoverable by and accessible to the general public, in a timely fashion (typically within two years), free of charge or at no more than the cost of reproduction, unless an exemption is granted by the NOAA Program. Data should be available in at least one machine-readable format, preferably a widely-used or open-standard format, and should also be accompanied by machine-readable documentation (metadata), preferably based on widely used or international standards.
2. Proposals submitted in response to this announcement must include a Data Management Plan of up to two pages describing how these requirements will be satisfied. Administrative and National Policy Requirements, below for additional information on what the plan should contain. The Data Management Plan should be aligned with the Data Management Guidance provided by NOAA in the Announcement. The contents of the Data Management Plan (or absence thereof), and past performance regarding such plans, will be considered as part of proposal review. A typical plan should include descriptions of the types of environmental data and information expected to be created during the course of the project; the tentative date by which data will be shared; the standards to be used for data/metadata format and content; methods for providing data access; approximate total volume of data to be collected; and prior experience in making such data accessible. The costs of data preparation, accessibility, or archiving may be included in the proposal budget unless otherwise stated in the Guidance. Accepted submission of data to the NOAA National Centers for Environmental Information (NCEI) is one way to satisfy data sharing requirements; however, NCEI is not obligated to accept all submissions and may charge a fee, particularly for large or unusual datasets.
3. NOAA may, at its own discretion, make publicly visible the Data Management Plan from funded proposals, or use information from the Data Management Plan to produce a formal metadata record and include that metadata in a Catalog to indicate the pending availability of new data.
4. Proposal submitters are hereby advised that the final pre-publication manuscripts of

scholarly articles produced entirely or primarily with NOAA funding will be required to be submitted to NOAA Institutional Repository after acceptance, and no later than upon publication. Such manuscripts shall be made publicly available by NOAA one year after Notice of Federal Funding Page 14 of 17 publication by the journal.

MINORITY SERVING INSTITUTIONS - The Department of Commerce/National Oceanic and Atmospheric Administration (DOC/NOAA) is strongly committed to increasing the participation of Minority Serving Institutions (MSIs), i.e., Historically Black Colleges and Universities, Hispanic-serving institutions, Tribal colleges and universities, Alaskan Native and Native Hawaiian institutions, and institutions that work in underserved communities.

FREEDOM OF INFORMATION ACT (FOIA) - In the event that an application contains information or data that you do not want disclosed prior to award for purposes other than the evaluation of the application, mark each page containing such information or data with the words "Privileged, Confidential, Commercial, or Financial Information - Limited Use" at the top of the page to assist NOAA in making disclosure determinations. DOC regulations implementing the Freedom of Information Act (FOIA) are found at 5 U.S.C 552, which sets forth rules for DOC to make requested materials, information, and records publicly available under FOIA. The contents of funded applications may be subject to requests for release under the FOIA. Based on the information provided by you, the confidentiality of the content of funded applications will be maintained to the maximum extent permitted by law.

INDIRECT COST RATE - If an applicant has not previously established an indirect cost rate with a Federal agency they may choose to negotiate a rate with the Department of Commerce or use the de minimis indirect cost rate of 10% of MTDC (as allowable under 2 C.F.R. §200.414). The negotiation and approval of a rate is subject to the procedures required by NOAA and the Department of Commerce Standard Terms and Conditions. The NOAA contact for indirect or facilities and administrative costs is: Lamar Revis, Grants Officer, NOAA Grants Management Division, 1325 East West Highway, 9th Floor, Silver Spring, MD 20910 lamar.revis@noaa.gov.

SEXUAL HARASSMENT, OTHER FORMS of HARASSMENT or SEXUAL ASSAULT - NOAA will not tolerate sexual harassment, other forms of harassment or sexual assault within the agency, at awardee organizations, or anywhere NOAA-funded science and education are conducted. As a primary funding agency of fundamental and applied science research in the U.S., NOAA is committed to promoting safe, productive research and education environments for current and future scientists and engineers. NOAA considers the PI and any co-PI identified on a NOAA award to be in positions of trust. The PI and co-PI and all award personnel must comport themselves in a responsible and accountable manner

during the performance of award activities whether at the grantee organization, online, or conducted outside the organization, such as at field sites, or facilities, or during conferences and workshops.
The many U.S. institutions of higher education and other organizations that receive NOAA funds are responsible for fully investigating complaints and for compliance with federal nondiscrimination laws, regulations and executive orders. In support of this position, NOAA has taken steps to bolster our commitment to a safe research environment, including development and implementation of an award term and condition that requires NOAA to be notified: 1) of any findings/determinations regarding the PI or co-PI that demonstrate a violation of awardee codes of conduct, policies, regulations or statutes relating to sexual harassment, other forms of harassment, or sexual assault; or 2) if the awardee places, or has placed, the PI, or co-PI on administrative leave or imposes, or has imposed, an administrative action relating to a finding or investigation of a violation of awardee policies, codes of conduct, statutes or regulations relating to sexual harassment, other forms of harassment, or sexual assault. New awards funded in FY21 and beyond will have this special award condition (SAC) in the award terms and conditions. NOAA expects all research organizations to establish and maintain clear and unambiguous standards of behavior to ensure harassment-free workplaces wherever science is conducted. A community effort is essential to eliminate sexual and other forms of harassment in science and to build a scientific workspace where people can learn, grow and thrive.

C. Reporting

Award recipients will be required to submit project performance (technical) and financial reports via NOAA's Grants Online system. Progress reports and financial reports are required on a semiannual schedule and must be submitted no later than 30 days following the end of each 6-month period from the start date of the award. A comprehensive final report is due 90 days after the award expiration. Copies of all submitted reports will become the property of the U.S. Government.
All dissemination of results, including publications and written or oral presentations supported by this funding opportunity, should acknowledge NOAA/NWS and the specific NGGPS, Weeks 3-4/S2S and HFIP Program supporting the project.
Continuation review is based on the following criteria: (1) degree of progress toward meeting the original milestones in the proposal timeline; and (2) the potential for completing testing and evaluation or providing evidence of potential contribution to the UFS. Given a favorable review, each project may be funded for a second year. In certain situations, circumstances material to the stated objectives of the proposal may change sufficiently to require a modification to some aspect of the original proposal. The awardee may be asked by the NWS OSTI Modeling Program Office to address these concerns, and the Program Office will evaluate the adequacy of the awardees' response.

The Federal Funding Accountability and Transparency Act, 31 U.S.C. 6101 note, includes a requirement for awardees of applicable Federal grants to report information about first-tier subawards and executive compensation under Federal assistance awards. All awardees of applicable grants and cooperative agreements are required to report to the Federal Sub-award Reporting System (FSRS) available at https://www.fsrs.gov/ on all sub-awards over $25,000. Refer to 2 CFR Parts 170.

VII. Agency Contacts

For questions about this announcement, contact the NWS OSTI Modeling Program Office via email at nws.sti.modeling.team@noaa.gov.

VIII. Other Information

None.