

EXTENSION FOR THE COOPERATION ARRANGEMENT FOR THE  
NORTH AMERICAN MULTI-MODEL ENSEMBLE - SEASONAL SYSTEM AMONG

THE

NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION  
NATIONAL WEATHER SERVICE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
U.S. DEPARTMENT OF COMMERCE

GEOPHYSICAL FLUID DYNAMICS LABORATORY  
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
U.S. DEPARTMENT OF COMMERCE

WEATHER PROGRAM OFFICE  
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
U.S. DEPARTMENT OF COMMERCE

NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION  
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
U.S. DEPARTMENT OF COMMERCE

ENVIRONMENT AND CLIMATE CHANGE CANADA  
GOVERNMENT OF CANADA

EARTH SCIENCES DIVISION, SCIENCE MISSION DIRECTORATE  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY  
COLUMBIA UNIVERSITY LAMONT CAMPUS

AND

UNIVERSITY OF MIAMI

## **1. PARTICIPANTS**

This document constitutes an extension of the arrangement for cooperation for operation and research with reference to the North American Multi-Model Ensemble (NMME) Seasonal System, among the:

- National Centers for Environmental Prediction (NCEP), National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (DOC);
- Geophysical Fluid Dynamics Laboratory (GFDL), Office of Oceanic and Atmospheric Research (OAR), NOAA, U.S. DOC;
- Environment and Climate Change Canada (ECCC), Government of Canada;
- Weather Program Office, OAR, NOAA, U.S. DOC;
- Earth Science Division, Science Mission Directorate, National Aeronautics and Space Administration (NASA), through tasking of work to the Global Modeling and Assimilation Office (GMAO), Earth Sciences Division, Sciences and Exploration Directorate, NASA Goddard Space Flight Center (GSFC);
- National Centers for Environmental Information (NCEI), NOAA, U.S. DOC;
- International Research Institute for Climate and Society (IRI), Columbia University;
- University of Miami.

## **2. TERMS OF NMME SYSTEM OPERATION FOR SERVICE AND RESEARCH PURPOSES**

### **2.1. Purpose**

The Participants in this arrangement intend to extend their cooperation for the operation of the NMME Seasonal System and related research following the initial and follow-on arrangements from the last arrangement until three years following the date of the final signature below.

This arrangement intends to allow continued coordination among partners for the operational NMME Seasonal System with the dual purpose of: 1) enhancing operational seasonal forecasts at NCEP and ECCC; and 2) enabling research on prediction and modeling based on NMME Seasonal System data. This arrangement for the continued operation of the NMME Seasonal System intends to allow the operational centers to receive improved forecast data while the research centers have their models tested in an operational environment, which should inform the future development of their models and better assessments of predictability limits. The NMME real-time and retrospective forecasts also enable research and development at the participating centers, as well as

in the larger climate community.

## **2.2. System Definition**

The NMME seasonal prediction system to be utilized operationally is defined based on the primary specifications that characterized the system during the 2012-2014 test and demonstration phase as part of a NOAA Climate Testbed (CTB) project, and follow-up 2015-2021 Cooperation Arrangements. These are described below and include: I) the underpinning prediction systems; II) the prediction protocol; III) the data and product specifications; and IV) the computational strategy. This document extends the Cooperation Arrangement for the NMME system described below.

I. The current NMME system includes model contributions from the following prediction centers:

- a. NCEP (operational)
- b. ECCO (operational)
- c. NASA/GEOS-S2S
- d. GFDL
- e. NCAR/CCSM4

During the period of operation defined by this plan, the participating centers may replace their prediction systems with improved releases superseding their current NMME system contribution conditional upon making the reforecast data available at their own expense. During this period, upgrades to the GFDL (January 2021), NCAR (May 2021) and NASA (circa January 2022) models are anticipated. Also, during the course of operations defined by this plan more advanced merging techniques may be transitioned into CPC's operations for upgraded NMME products. As the NMME system continues to evolve the teams will update web site documentation with the dates and models included in the operational suite.

Additional experimental NMME system versions, including prediction systems from centers not listed above, should not be considered part of the official NMME system and are not covered by the terms of operation defined by this plan.

II. The NMME Prediction Protocol to be followed by all participating

prediction systems is defined in Appendix A.

III. The NMME data plan for reforecasts and real-time forecast data output, archive and access is defined in Appendix B. This plan also defines the NMME prediction products. A number of different deterministic and probabilistic model combination techniques are used, some of which weight the models equally and some of which weight the ensemble members equally.

IV. The NMME seasonal prediction system is expected to continue to be run as a distributed system in which all participating modeling centers generate their own model reforecasts and provide real time forecasts to NCEP per the protocol in Appendix A. This distributed strategy leverages capacity at participating modeling centers. This approach also ensures that the participating groups are fully cognizant of and dedicated to addressing operational concerns and that they use the NMME operational forecasts to evaluate model performance and to inform model development in their own centers.

### **2.3. Meeting Operational Service Needs--General Description**

NCEP's operational system depends upon the NMME system delivering timely and reliable seasonal forecast products. To meet such a requirement the NMME system intends to use the following approach:

- The operational NMME will be a product-based system (see Appendix B). The metric of system reliability will be based on the timeliness of delivery of the NMME products rather than the availability of the individual participating models.
- The operational NMME will deliver timely, reliable products by including prediction systems from the NCEP and EC operational centers (reliability is 99% for NWS operational systems).
- Participants intend to deliver timely real-time forecasts following NCEP operational launch schedules as specified in the protocol (see Appendix A).

To evaluate whether the NMME System is meeting its operational service system requirements, NCEP/CPC intends to track the following metrics regularly:

- Timeliness: On-time delivery of the operational models and merged products is necessary for NMME forecasts and products. The baseline is

NWS's 99% on-time product delivery requirement. Note that product delivery within 15 minutes of the published delivery time described in Appendix A is considered on time. Research models are considered beneficial data of opportunity.

- Seasonal Forecast skill:
  - For deterministic/continuous forecasts, skill will be measured using anomaly correlation (AC), root mean square error (RMSE), amplitude, and biases.
  - For probabilistic forecasts, skill will be measured based on Brier Score (BS), Rank Probability Score (RPS) and Heidke skill score.
- The number of forecast data downloads and web page access.
- An official NMME email address, [ncep.cpc.nmme.production@noaa.gov](mailto:ncep.cpc.nmme.production@noaa.gov), can be used to provide feedback directly to CPC staff about the monthly production. [Ncep.cpc.nmme.notifications@noaa.gov](mailto:Ncep.cpc.nmme.notifications@noaa.gov) can be used to disseminate relevant information to any user that has asked to be included in that email list. Typical announcements range from production problems to seminar announcements and model upgrade schedules.

Forecast skill metrics are to be applied to NMME derived products and physical variables including temperature, precipitation, SST and major climate phenomena including ENSO, MJO, indices for major monsoon systems, and major drought indicators. Metrics will be provided as a function of lead-time, number of models and ensemble members. Skill of the NMME system products using different merging techniques (NMME-Phase II v.1 and follow-ups) will be documented. NMME skill metrics will be compared to that of the operational NOAA prediction system for seasonal forecasts.

NCEP/CPC intends to prepare annual reports on the NMME product timeliness and skill based on the metrics above. Reports will be made available to all participating centers and their sponsors.

#### **2.4. Meeting Research Needs**

In addition to meeting operational needs, the NMME system also has the goal of enabling research within participating modeling centers and as part of NOAA/OAR activities, and in the broader community. To enable this, research terms of operation include:

- I. Staff from the modeling centers that develop research prediction systems will be involved in the real-time NMME predictions. The Participants intend

that an NMME Team involving representatives from the modeling centers producing the forecasts and evaluating the forecasts and NCEP staff will convene via monthly calls. These calls organized by the NOAA CTB will provide a means of research to operations communication and coordination.

II. The Participants intend that NMME data (both reforecasts and real-time forecasts as in Appendix B) will be archived and made openly accessible to the scientific community in a timely manner. Basic documentation regarding prediction systems contributing to NMME will be made publicly available with the data. This will allow the broad research community to perform NMME system evaluation to improve the underpinning prediction systems and develop applications as well as optimize predictions.

The NOAA CTB plans to prepare annual reports regarding: 1) the activities of the NMME Team and in particular research findings of relevance to improving predictions and modeling systems; and 2) reports on NMME data archive, access and usage by the broader community. Metrics in the reports will include timeliness of public availability for hindcasts and real-time forecasts, amount of data archived and downloaded from public archive, and publications citing NMME data. Reports will be made available to all participating centers and their sponsors.

## **2.5. Management of the NMME system**

Participants intend that Scientific and Organizational Team Leads, as defined below, provide day-to-day management of NMME system activities and prepare annual reports on activities, as described above, by September 1st of each year.

Participants intend that overall oversight and management for NMME activities be provided by a Management Team with representation from each of the Participants and their sponsors. This Management Team will convene once a year via telecom to analyze and discuss the annual reports from the NMME Team.

## **2.6. Longevity of the NMME system**

The Participants intend to operate the NMME system, as described above, during the period of August 1, 2021, through July 31, 2024, unless superseded at an earlier time by a new research prototype demonstrated to have superior performance as a seasonal prediction system. The Participants recognize that lack of adherence to system specifications, as defined in Section 2 and Appendices, and resulting lack of performance may result in termination of funding for an underperforming center, or

in NMME, early system termination at the discretion of the institutions that provide support and oversight.

## **2.7. Terms of Use of NMME Data**

Data are available at the following three sources:

(i) ESG: <https://www.earthsystemgrid.org/search.html?Project=NMME>

(ii) IRI:

<https://iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/index.html?Set-Language=en>

(iii) NCEI:

<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-multi-model-ensemble>

In order to document NMME data impact and enable continuing support, users of NMME data are expected to acknowledge NMME data and the participating modeling groups. The NMME model output should be referred to as "the NMME System data [<https://www.earthsystemgrid.org/search.html?Project=NMME>]." In publications, users should include a table (referred to below as Table XX) listing the models and institutions that provided model output used in the NMME system, as well as the digital object identifier of publications documenting the models. In addition, an acknowledgment similar to the following should be included in any publication:

"We acknowledge the agencies that support the NMME system, and we thank the climate modeling groups (Environment Canada and Climate Change, NASA/GMAO, NOAA/GFDL, NOAA/NCEP, and University of Miami, IRI) for producing and/or making available their model output. NOAA/NCEP, NOAA/CTB, and NOAA/WPO jointly provided coordinating support and led development of the NMME system."

where "*Table XX*" in the paper should list the models and modeling groups that provided the NMME data.

Besides the above acknowledgement, users should register any journal articles (or other scientific documents) that are based on NMME results.

These terms of use will be published on the data dissemination sites at the IRI and NCAR.

### **3. ACTIVITIES**

#### **3.1. High Performance Computing (HPC) Infrastructure**

Operational Centers: The operational centers at NCEP and EC plan to run their operational prediction systems using their operational HPC resources as part of their existing operational requirements.

Non-Operational Centers: The non-operational centers at GFDL, NCAR, and GSFC plan to operate on their in-house research computers. The NCAR family of models participating in the NMME are run by the University of Miami on the University of Miami Institute for Data Science and Computing (IDSC) high performance computing system. The NCAR model contribution (operated by the University of Miami) is scheduled to be upgraded in May 2021 and will continue to run on University of Miami IDSC resources for operational forecasts. HPC costs are included in the funding to the University of Miami. Note that any NOAA computing being provided is only for operational running of the model under this arrangement and is subject to NOAA's annual HPC allocation process.

#### **3.2. Tasks and Roles**

Modeling centers are expected to produce NMME reforecasts using the same modeling system as the real-time system in order to meet NMME protocols. If the participating centers continue to utilize presently participating systems, then centers need only generate and evaluate the real-time forecasts according to the NMME protocol, including archive and access through the open archives. If systems are upgraded, new reforecasts would have to be generated.

##### **3.2.1. Operational Centers:**

- NCEP/Environmental Modeling Center (EMC) currently produces CFSv2 as part of their operational forecasts. ECCO runs two coupled models as part of their operations and contributes these to the NMME.
- NCEP/Climate Prediction Center (CPC) will lead the preparation of the NMME products involving the evaluation and combination of participating models.

Given the research-to-operations aspects of the NMME, the Participants intend to establish an Organizational Team and a Scientific Team. The NCEP/CTB Director will serve as the Organizational Team Lead and manage the research to operations communication and evaluations, including the organization of monthly telecons and the



preparation of annual reports.

### **3.2.2. Non-Operational Centers:**

Each non-operational center expects to produce real-time forecasts and make them available following the NMME protocol and the NCEP operational schedule. The University of Miami representative will serve as the Scientific Team Lead and will work together with the Organizational Team Lead to provide requisite leadership and coordination for NMME Participant activities.

### **3.3. Data Archive, Management, and Access Infrastructure**

A plan for data management is described in Appendix B. NMME data is to be made publicly available free of charge and no restrictions will apply except the requirement for an acknowledgement regarding the source of the data. The preferred text of the acknowledgement is provided in section 2.7, above.

### **3.4. Change management**

The NMME system is designed to allow model center contributions to evolve over time. To minimize disruption to operations and provide proper continuity for research, the following change management procedures will be followed

#### **3.4.1. Procedural:**

3.4.1.1. To allow a smooth transition from one modeling system to another for the constituent models and/or the merged products, the following outlines the order of events

1. Modeling center
  - a. Readies a new model
  - b. Produces a hindcast consistent with the protocols in this document
  - c. Analysis of the hindcast
  - d. Present results to NMME group at one of the monthly meetings.
  - e. Ideally done 6 months before implementation of new/termination of old
2. Then internal and external notifications, consistent with 3.4.1.2 and 3.4.1.3.
3. Then technical hand-offs begin 3 months before implementation and termination.

3.4.1.2. Internal notifications (to the agreement participating agencies): The

contributing agencies are all usually represented at the monthly teleconference. Any planned or known changes to models should be announced there as far in advance as possible, ideal 6 months out for major system changes. Smaller changes can be accommodated on a shorter window.

#### 3.4.1.3. External notifications:

- Model changes and upgrades will be posted to the NMME “About page: [https://www.cpc.ncep.noaa.gov/products/NMME/about\\_test.html](https://www.cpc.ncep.noaa.gov/products/NMME/about_test.html)
- Additionally, emails will be sent to the NMME notifications mailing list

**3.4.2. Technical:** When a new modeling system is brought online at one of the contributing centers, and readied for inclusion into the NMME process, the following should be provided to CPC, NCEI, and IRI.

- URL/FTP location from which download the real-time and hindcast files
  - For data from ECCO, if it is integrated into the routine push to NCEP, then this would not be required.
- File names (which will ideally not change)
- An overlap period, where both the existing and the new model runs are provided to the operational, research, and archiving groups, of 3 months is required. 1 month to get the new data and confirm files meet specifications, then 2 months of overlap for consistency checks versus the real time.
  - Example -
    - Dec 6th - provide new data paths and URLs
    - Jan 6th - 1st parallel run (both streams provided)
    - Feb 6th - 2nd parallel run (both streams provided)
    - Mar 6th - Only new system
  - Additionally, further verification and validation of the new system (hindcast based validation) can be presented during this time.

## 4. CONTACTS

The contacts for each Participant to this arrangement are:

### a. **Weather Program Office**

Dr. Jessie Carman

NOAA Weather Program Office  
1315 East West Highway, Silver Spring, MD20910  
Phone: 301 734-1022  
E-mail: [jessie.carman@noaa.gov](mailto:jessie.carman@noaa.gov)

**b. Environment and Climate Change Canada**

Radenko Pavlovic  
Chief, Numerical Weather Prediction Section  
Canadian Centre for Meteorological and Environmental Prediction, 2121  
Transcanada Highway, Dorval (Quebec), H9P 113  
Phone: 514-604-1686  
E-mail: [radenko.pavlovic@canada.ca](mailto:radenko.pavlovic@canada.ca)

**c. Geophysical Fluid Dynamics Laboratory**

Dr. Whit Anderson  
Deputy Director, Geophysical Fluid Dynamics Laboratory  
201 Forrestal Road  
Princeton, NJ 08540  
Phone: (609) 452-5308  
E-mail: [whit.anderson@noaa.gov](mailto:whit.anderson@noaa.gov)

**d. University of Miami**

**Technical Contact:**

Prof. Benjamin Kirtman  
Professor, Department of Atmospheric  
Sciences University of Miami  
4600 Rickenbacker Causeway, Room 305  
Miami, FL 33149  
Phone: 305 421 4046  
E-mail: [bkirtman@miami.edu](mailto:bkirtman@miami.edu)

**Administrative Contact:**

Ms. Soraida Diaz  
Assoc. Director, Sponsored Programs, Business and  
Financial Affairs University of Miami  
4600 Rickenbacker Causeway, Room  
111A Miami, FL 33149  
Phone: 305 421 4089

E-mail: [Aida.diaz@miami.edu](mailto:Aida.diaz@miami.edu)

**e. National Centers for Environmental Prediction (NCEP):**

Mr. Matthew Rosencrans  
Director, NOAA Climate Test Bed  
5830 University Research Court, Suite 3100 College Park, MD 20740  
Email: [matthew.rosencrans@noaa.gov](mailto:matthew.rosencrans@noaa.gov)  
Phone: (301) 683-3413

**f. National Centers for Environmental Information (NCEI):**

Mr. Joseph Pica  
NOAA/NCEI Deputy Director  
151 Patton Ave, Asheville, NC 28801  
Email: [joseph.a.pica@noaa.gov](mailto:joseph.a.pica@noaa.gov)  
Phone: (828)-271-4848

**Technical Contact**

Rich Baldwin  
NOAA/NCEI Data Access Branch  
151 Patton Ave, Asheville, NC 28801  
Email: [rich.baldwin@noaa.gov](mailto:rich.baldwin@noaa.gov)  
Phone: 828-271-4094

**g. Goddard Space Flight Center (GSFC):**

Dr. David B. Considine  
Manager, Modeling, Analysis and Prediction Program  
Earth Science Division, Science Mission Directorate  
Mail Suite 3B74  
NASA Headquarters  
Washington, DC, 20546-0001  
Email: [david.b.considine@nasa.gov](mailto:david.b.considine@nasa.gov)  
Phone: (202) 358-2277 (office)

**Technical Contact**

Dr. Steven Pawson  
Chief of the Global Modeling and Assimilation Office  
NASA Goddard Space Flight Center  
Mail Code: 610.1

Greenbelt, MD 20771  
Email: steven.pawson-1@nasa.gov  
Phone: 301.614.6159

**h. International Research Institute for Climate and Society (IRI):**

**Technical Contact:**

Dr. Andrew Robertson  
Climate Group Head  
International Research Institute for Climate and Society (IRI)  
Columbia University Lamont Campus  
Palisades, NY 10964  
Phone: 845-680-4491  
E-mail: awr@iri.columbia.edu

**Administrative Contact:**

Ms. Maribel Respo  
Manager, Contracts & Grants  
Sponsored Projects Administration  
Lamont-Doherty Earth Observatory of Columbia University  
61 Route 9W  
Palisades, NY 10964-1707  
Phone: 845-365-8829  
Email: mr256@columbia.edu

The Participants plan to notify other Participants in writing of any changes to the contact information.

**5. PERIOD OF ARRANGEMENT, MODIFICATION, AND DISCONTINUATION**

This arrangement will begin when signed by all Participants and will continue for a period of three (3) years. This arrangement may be renewed for additional periods upon mutual confirmation of the Participants.

This arrangement may be discontinued at any time by mutual decision of the Participants, or unilaterally by any Participant upon ninety (90) days written notice to the other Participants. In the event this arrangement is discontinued, each Participant is solely responsible for the payment of any expenses it has incurred. This arrangement is subject to the availability of funds.

## **6. OTHER PROVISIONS**

Should disagreement arise regarding the interpretation of the provisions of this arrangement, or changes and/or revisions thereto, that cannot be resolved at the operating level, the area(s) of disagreement may be stated in writing by each Participant and presented to the other Participants for consideration. If resolution on interpretation is not reached within thirty (30) days, the Participants may forward the written presentation of the disagreement to respective higher officials for appropriate resolution.

The arrangement is not intended to be legally binding under domestic or international law. Each Participants is subject to the laws and regulations of its own country/agency.

### **Environment Canada and Climate Change (ECCC):**

The ECCC is bound by its own domestic obligations under Section 12 of the Copyright Act of Canada; therefore, ECCC weather, climate, and environmental forecast and reforecast data are copyrighted to ECCC. The NMME data (both retrospective forecasts and real-time forecasts) produced by ECCC may be freely distributed if the NMME data distribution sites and any subsequent users include an acknowledgement that recognizes ECCC's contribution. The acknowledgement language is provided in section 2.7, above.

ECCC Operations Division is to deploy best effort to support the data transfer from CMC to NCO in a similar way it does for the NAEFS data exchange:

- Support with a phone number to call in case of data transfer issues. The calls would be answered on a 24/7 basis but the timeliness of corrective actions would depend on the urgency to solve the issue. For instance, corrective actions might be done only during business hours if this does not impact the NMME product quality and delivery timeliness.
- The data will be pulled from ECCC servers by NCO unless both parties decide otherwise.
- The data format will be GRIB2.
- The operational data exchange will involve only the forecasts (all members), not the hindcasts data.

At this moment, the official CanSIPS 12-month forecasts are issued on the last day of every calendar month. This schedule is not expected to change in the future. The current number of members is 20. This number may increase.

It is expected that NCO will provide the same level of services in the case CMC

decides to pull the full or part of NMME real-time forecast ensemble members.

It should be noted that this agreement is for the current NMME real-time forecasts for seasonal forecasting purposes only. In the event that the new sub-seasonal NMME initiative becomes operational, it is expected that the NAEFS agreement would cover that new operational data transfer

**Geophysical Fluid Dynamics Laboratory (GFDL):**

GFDL intends to make a good faith effort to meet the operational data delivery timelines within the constraints inherent to their research goals, mission, and computational and human infrastructure.

**National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC):**

NASA GSFC intends to make a good faith effort to meet the operational data delivery timelines within the constraints inherent to their research goals, mission, and computational and human infrastructure.

## Appendix A - NMME Hindcast and Real-time Prediction Protocol

This appendix describes the protocol as of signing. The protocol may be modified through a joint decision of all the Participants and updates will be clearly posted at [https://www.cpc.ncep.noaa.gov/products/NMME/about\\_test.html](https://www.cpc.ncep.noaa.gov/products/NMME/about_test.html).

- Real-time ISI (intra-seasonal to interannual) prediction system is to be identical to the system used to produce hindcasts. This necessarily includes the procedure for initializing the prediction system and the number of ensemble members per forecast, but can be larger for the real-time system.
- Hindcast start times must include all 12 calendar months, but the specific day of the month or the ensemble generation strategy is left open to the forecast provider.
  - Lead-times up to 9 months are required, but longer leads are encouraged.
  - The target hindcast period is the WMO standard period as defined at [https://www.wmo.int/pages/prog/wcp/wcdmp/GCDS\\_1.php](https://www.wmo.int/pages/prog/wcp/wcdmp/GCDS_1.php).
  - Centers are encouraged to create hindcasts in excess of the 30 year base period.
- The ensemble size is left open to the forecast provider, but larger ensembles are considered better.
- Data distributed must include each ensemble member (not the ensemble mean). Total fields are required (i.e., systematic error corrections to be coordinated by MME combination lead, NOAA/CPC).
- Model configurations - resolution, version, physical parameterizations, initialization strategies, and ensemble generation strategies - are left open to forecast providers.
  - Required output is as per Appendix B of this plan
- Routine real-time forecast data must be available by the 8<sup>th</sup> of each month. Pre-release of real-time forecasts (COB on the 6<sup>th</sup> of each month) in support of the ENSO Diagnostic Discussion (EDD) is strongly encouraged.



## Appendix B - NMME Data and Product Archive and Access Plan

### 1) Archive and dissemination of real-time monthly forecast and hindcast data from all NMME models:

The real-time monthly data include 6 fields: SST; T2m; precipitation; 200 mb geopotential height; Tmax; Tmin. This data is made available in near real-time by CPC

([ftp://ftp.cpc.ncep.noaa.gov/NMME/realtime\\_anom/](ftp://ftp.cpc.ncep.noaa.gov/NMME/realtime_anom/)). The supporting monthly hindcasts are made available by the IRI at <http://iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/> and this site is typically updated with the real-time data by the end of the month. Additional real-time daily data is also being archived at NOAA/NCEI

(<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-multi-model-ensemble>).

### 2) Archive and dissemination of real-time NMME forecast and verification products:

The real-time NMME forecast and verifications products (digital data and/or images) for SST, T2m, and precipitation available at the CPC NMME web site (<https://www.cpc.ncep.noaa.gov/products/NMME/index.shtml>) are:

- a. 1-month and 3-month spatial anomaly forecasts;
- b. Skill maps based relevant sub periods within the hindcast;
- c. Nino 3.4 Plume;
- d. Probability forecasts in three (above/below/near normal) categories;
- e. NMME based Standard Precipitation Index (SPI); and
- f. Real-time verification.

### 3) Real-time Daily Data Dissemination to NOAA NCEI

The NMME team has made available daily data from the NMME complete real-time phase (2011-present) at NOAA/NCEI

(<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-multi-model-ensemble>). The daily data through Phase-II and continuations has

included:

- 1) Precipitation
- 2) Tmax at 2m
- 3) Tmin at 2m
- 4) Zonal Surface Stress
- 5) Meridional Surface Stress
- 6) Sea Level Pressure
- 7) 850 mb Zonal Wind
- 8) 850 mb Meridional Wind
- 9) 200 mb Zonal Wind
- 10) 200 mb Meridional Wind
- 11) 850 mb Specific humidity
- 12) Surface Temperature (T2m over land and SST over ocean).
- 13) 500 mb geopotential height.

The GFDL data will only include T2m, Tmax and Tmin and precipitation and the CFSv2 data will be 6-hourly instead of daily.

This list and specifications will be revised consistent with the data sharing policies and IT considerations.

#### **4) Extension of archive and dissemination strategy**

A new comprehensive data archive and dissemination strategy, including exploration of cloud solutions, will be developed within one year of the signing of the agreement by all parties. As part of this revised data strategy the list of required and recommended fields will also be updated.

SIGNATURE PAGES

Signature page for National Centers for Environmental Prediction

*Michael Farrar*

June 30, 2021

---

Michael Farrar

Date

National Centers for Environmental Prediction, Director  
5830 University Research Court, Room 4800  
College Park MD, 20740

**Bouchet, Veronique** Digitally signed by Bouchet,  
Veronique  
Date: 2021.07.13 10:25:06 -04'00'

---

Veronique Bouchet

Date

Director General

Canadian Centre for Meteorological and Environmental Prediction (CCMEP)

2121 Trans-Canada Hwy, Dorval (Quebec) H9P 1J3

Signature page for National Center for Environmental Information

PICA.JOSEPH.A.1086  
500961

Digitally signed by  
PICA.JOSEPH.A.1086500961  
Date: 2021.05.27 09:56:29 -04'00'

---

Joseph Pica

Date

Deputy Director

151 Patton Avenue, Bldg. FED,  
Asheville, NC 28801-5001

Signature page for University of Miami



Digitally signed by Karen  
Deborah Hurdle  
Date: 2021.05.24 18:34:33 -04'00'

5/24/2021

---

Karen Hurdle  
Director, Office of Research Administration  
University of Miami  
1320 S. Dixie Highway, Suite 650  
Coral Gables, FL 33146

---

Date

Signature page for International Research Institute



---

John Furlow

Director

The International Research Institute for Climate and Society

The Earth Institute, Columbia University

Lamont Campus

Palisades, NY 10964

---

May 28th, 2021

Date



Signature page for Weather Program Office

KOCH.DOROTHY.M  
ARIE.1554223393

Digitally signed by  
KOCH.DOROTHY.MARIE.1554223393  
Date: 2021.05.27 14:41:13 -04'00'

---

Dorothy Koch

Date

Director

Office of Weather Prediction

NOAA/OAR

1315 East West Highway

Silver Spring, MD 20910

Signature page for Geophysical Fluids Dynamics Laboratory

RAMASWAMY.VEN  
KATACHALAM.136  
5856776

Digitally signed by  
RAMASWAMY.VENKATACHALA  
M.1365856776  
Date: 2021.06.21 16:59:16 -04'00'

---

V. Ramaswamy  
Director  
Geophysical Fluid Dynamics Laboratory  
201 Forrestal Road  
Princeton, NJ 08540

---

Date

Signature page for Goddard Space Flight Center



5/28/2021

---

Dr. David B. Considine

---

Date

Manager, Modeling, Analysis and Prediction Program

Earth Science Division, Science Mission Directorate

Mail Suite 3B74

NASA Headquarters