NOAA National Weather Service (NWS) + NOAA Open Data Dissemination (NODD) + Microsoft

Office Hours

October 18, 2023 | 12-1:15 PM EDT | REGISTER HERE

- Share experiences on use and access of National Water Model via Microsoft
- Hear about data access via NOAA Open Data Dissemination (NODD)
- Connect with NOAA experts on data and model information changes

Tom Augspurger, Geospatial Infrastructure Engineer, Microsoft
Adrienne Simonson, Patrick Keown, Jenny Disson, Kate Szura, NODD
Cindy Elsenheimer, Partnership Engagement Lead, NOAA NWS Office of Organizational Excellence
Brian Cosgrove, Technical Director National Water Model, NOAA NWS National Water Center
Sudhir Shrestha, Technical Director Web and Data Services, NOAA NWS National Water Center
Thank you for your registration and interest.

Only hosts and presenters are asked to turn their video on.

If do not wish to be part of the recording, please feel free to drop off.

Meeting summary and presentation slides will be available on the NODD website:

- [NOAA.GOV/NODD](https://NOAA.GOV/NODD)
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GoogleMeet Webinar Logistics
How to join the discussion!

● Keep yourself muted throughout (for call-in participants: to mute and unmute use *6) and videos off
● Raise your hand if you have a question and we’ll respond in the order of the queue
● The following features of google meet:

  - Mute and Video
  - CC
  - Hand Raise
  - Settings

  - Chat
  - Polls

● This webinar will NOT be recorded.
● You can also join by phone line only if you are having connectivity issues.
● (US) +1 508-687-4473 PIN: 297 789 966#
Guidelines for Discussion

- Keep it brief
- Keep it respectful
- Use the chat function for links, references and/or resources
- Submit questions through the chat function or raise your hand
- Identify who the question is directed to where possible
Quick Google Poll

POLL1
- How do you access National Water Model data today?
  - On-prem via NOAA
  - Cloud
  - Both/Either
  - 3rd party/Web-based Viewer
  - None/Other

POLL2
- My primary goal for attending today is:
  - Technical use and access of NWM data
  - To learn about cloud access to data (e.g. NODD Program)
  - Meet and engage with NOAA staff scientists
  - Learn about Microsoft Cloud access and tools
NODD Disseminates NOAA Line Office Data

- Enables & Engages Users
  - Catalyzes innovation in environmental services
  - Enables interoperability

- Technology Modernization
  - Reduces stress on NOAA's on-premise dissemination systems
  - Improves services for Users

- Full & Open Public Access
  - Supports Federal Data Strategy & Evidence Act
  - Open Data Requirements
  - No egress costs

- Open & Free
  - Open data with value to the public
  - No use restrictions or user registration
  - Appropriate Metadata included

NOAA data is growing exponentially...

noaa.gov/nodd
National Water Model: Overview and Future Plans

Brian Cosgrove and Sudhir Shrestha
Large Collaborative NOAA/OWP and NCAR Team
The NWM provides both complementary and first-time streamflow and other hydrologic guidance to NWS forecasters, emergency and water resource managers and others.

Most recent NWM upgrade, v3.0 in Sept 2023, v3.1 planned for early 2025.
NWM Provides Multi-Scale Hydrologic Forecast Guidance
National Water Model: Filling in Coverage Gaps

- Population > 3 million in this region, much of which is more than 30 miles away from the nearest RFC forecast point (circles at right).
- NWM complements existing RFC forecasts by providing guidance over a very dense set of stream reaches (blue at right).

Coverage example over the Carolinas
National Water Model System Structure

Fusion of column structure of land surface models, distributed structure of hydrologic models and national USGS/EPA NHDPlusV2 stream network. Supported by verification and visualization elements.

**GIS processing** essential to forcing engine, hydrofabric, data assimilation, Noah-MP parameter grids, reservoir parameters, catchment mapping, evaluation and visualization.
NWM Model Output

Select NWM Output Fields

- Soil Moisture
- Streamflow
- Inundation (post-processed)
- Evapotranspiration
- Surface Temperature
- Snowpack
Putting it all Together in Operations: NWM v3.0 24x7 Cycling

- **CONUS Analysis***
  - Lookback Range 3-28 hrs
  - Including open loop (non-DA) members

- **CONUS Short-Range***
  - HRRR/RAP

- **CONUS Med-Range Ens***
  - GFS, NBM

- **CONUS Long-Range Ens***
  - CFS

- **Hawaii* / Puerto Rico USVI***
  - 3 Hour Lookback
  - 48 Hour Forecast
  - HIRES ARW/NAM-NEST/MRMS

- **Alaska***
  - 3 Hour Lookback
  - 48/240 Hr Forecasts
  - HRRR, GFS, NBM, MRMS

- **18 Hour Forecast**

- **~10 Day Ens Forecast**
  - Including open loop (non-DA) member

- **30 Day Ensemble Forecast**

*Coastal Total Water Level
NWM Operational Computing Environment

• The NWM runs on the NOAA Weather and Climate Operational Supercomputing System (WCOSS2)
  ─ The operational model runs in a fully automated fashion with no interactive user modifications allowed
  ─ Main data ingest sources should be operational themselves

• NWM Compute and disk usage
  ─ NWM V3.0 reaches a high water mark of ~105 nodes (overlapping jobs)
    ─ Daily disk footprint of > 6 TB, with more than 1TB posted for dissemination

• Annual upgrade cycle targeted, but varies with internal/external factors
The National Water Model outputs massive amounts of data
- NWM V3.0 Real-time Operations: > 1 TB / Day
- 44-Year Retrospective Simulation: >50 TB for model output (forcing more)

NWS NCEP Central Operations handles distribution of real-time operational data via NOMADS distribution service

NOAA Open Data Dissemination (NODD) makes possible the provision of real-time and retrospective NWM data available via three Cloud Service Providers: AWS, Microsoft, and Google Cloud
National Water Model v3.0 Upgrade Highlights: Providing improved guidance for flood and hydrologic forecasts

- With this version, NWM is supporting congressional direction from the Coordinated Ocean Observations and Research Act of 2020
  - Provides first-time NWM Total Water Level (TWL) guidance for coastal areas of the CONUS, Hawaii and Puerto Rico / USVI
  - Supports nationwide flood inundation mapping
- Other major elements which improve hydrologic guidance
  - Expansion of domain to cover south-central Alaska
  - Addition of National Blend of Models as a forcing source for NWM CONUS medium-range and Alaska forecasts
  - Ingestion of MRMS precipitation forcing over NWM PR/VI domain
  - NWS Field-Driven Enhancements: Field input into calibration/regionalization, inclusion of additional RFC reservoir sites, and design of SHEF-formatted TWL output files
NWM v3.0: Improved CONUS Performance, Region-by-Region

- Median peak bias improves across all River Forecast Center domains in NWM v3.0
NWM v3.0 Real-time Improvement: Additional RFC Data Ingest

- NWM v3.0 assimilates RFC outflow forecasts at additional reservoir locations, improving downstream forecast accuracy, versus persistence or no-DA treatment in NWM v2.2.
Example NWM Data Use Cases: Supporting Coast-to-Coast Flood Inundation Mapping at the National Water Center

- NWM-Driven Maximum FIM, Hurricane Maria (PR)
- NWM-Driven Maximum FIM, Hurricane Harvey (Houston, TX)

A critical advance: total water level output from NWM-SCHISM will be joined with NWM inland streamflow forecasts to create national summit-to-sea flood inundation maps.
Example NWM Data Use Cases: NWC Experimental Products

https://www.weather.gov/owp/operations

- NWC Visualization Services
  - Probability of high flow
  - Arrival time
  - Other value-added products
- National Hydrologic Discussion (NHD)
- Area Hydrologic Discussion (AHD)
- Flood Hazard Outlook (FHO)
- **Note:** Flood Inundation Mapping (FIM) Services are targeted for public release --
  (10% of country as of Sept., ~100% by Q4 FY26)
Integration of Hydro Program’s Web Presence in National Water Prediction Service (NWPS)

AHPS
water.weather.gov

Office of Water Prediction
water.noaa.gov

NWC Experimental Products
weather.gov/owp
Modernizing Hydrologic Data Dissemination in Office of Water Prediction

- National Water Prediction Service (NWPS): Authoritative, unified dissemination Platform

  One stop Access to Data, APIs and Web Services

  Improving Data Discovery, Access and Interoperability:

    - Analysis Ready data (ARD)
    - Cloud Optimized
    - Towards Cloud-native formats and libraries [netcdf —> Zarr, COG, Future: Kerchunk]
    - Indexed Metadata

  Where are we going?

  Cloud-native data allowing improved Data Discovery, Processing, Analytics and Visualization promoting Scalability and Reproducibility
Data Dissemination in Cloud: Cloud Service Providers (CSPs)

- NOAA Open Data Dissemination

National Weather Service (NWS)  https://www.noaa.gov/nodd/datasets#NWS

- Climate Forecast System (CFS)  Amazon Web Services  Google  Microsoft Azure
- CFS Reanalysis  Google
- Global Forecast System (GFS)  Amazon Web Services  Google  Microsoft Azure
- Global Ensemble Forecast System (GFS)  Amazon Web Services
- High Resolution Rapid Refresh Model (HRRR)  Amazon Web Services  Google  Microsoft Azure
- Hurricane Analysis and Forecast System (HAFS)  Amazon Web Services
- National Blend of Models (NBM)  Amazon Web Services
- National Digital Forecast Database (NDFD) (Historical) - Cornell University, Earth & Atmospheric Sciences (EAS) Data Lake  Amazon Web Services
- National Digital Forecast Database (NDFD)  Amazon Web Services
- National Water Model
  - Analysis & Forecast  Amazon Web Services  Google  Microsoft Azure
  - Short Range Forecast  Amazon Web Services  Google
  - Reanalysis V 1.2  Amazon Web Services  Google
  - Reanalysis V 2.0  Amazon Web Services  Google
- Next Generation Weather Radar (NEXRAD)
  - NEXRAD Level 2 Real-Time and Archive Data  Amazon Web Services  Google
  - NEXRAD Level 3 Real-Time and Archive Data  Google
- Space Weather Prediction Center (SWPC) Forecasts  Amazon Web Services
- Rapid Refresh (RAP)  Amazon Web Services  Google  Microsoft Azure
- Real-Time Mesoscale Analysis (RTMA) / Unrestricted Mesoscale Analysis (URMA)  Amazon Web Services  Google
- Yesterday's Storm Reports  Google
Data Dissemination in Cloud: National Water Model (NWM) Data

**National Water Model**

- Analysis & Forecast » [Amazon Web Services](https://aws.amazon.com) » [Google](https://google.com) » [Microsoft Azure](https://azure.microsoft.com)
- Short Range Forecast » [Amazon Web Services](https://aws.amazon.com) » [Google](https://google.com)
- Reanalysis V 1.2 » [Amazon Web Services](https://aws.amazon.com) » [Google](https://google.com)
- Reanalysis V 2.0 » [Amazon Web Services](https://aws.amazon.com) » [Google](https://google.com)

Data in the pipeline:

NWM V3.0, Analysis of Record for Calibration (AORC)

https://www.noaa.gov/nodd/datasets#NWS
NWM v4.0 (2026): Advancing Operations with NextGen Framework

- The NWM software architecture is being rewritten from the ground up - Next Generation Water Resources Modeling Framework (NextGen)
- A core feature of the community-oriented Nextgen framework is the ability to vary model components by hydrologic catchment...

This will lead to key operational improvements

- **Forecast Accuracy**: Module selection tailored to each catchment’s hydrologic characteristics (soil, snow, other)
- **Computational Efficiency**: Lighter-weight formulations can be used when appropriate (i.e., turn off snow)
- **Model Capability**: Framework flexibility (LSTM, CFE, Topmodel, Noah OWP-Modular) enables ensembles
Closing Thoughts

• The coverage and breadth of the operational NWM drives operational forecasting, research, and commercial applications

• What exists now is a foundation that will continue to be built upon

• v3.0 implemented September 2023 with NextGen-based v4.0 2026

• Parallel upgrades to visualization products and flood inundation mapping techniques

• Partnership with the Big Data providers enhances data access for end users, benefiting research, commercial and government applications, and model development

→ Tom Augspurger, Microsoft Planetary Computer
Microsoft Planetary Computer

- About 60 PB of publicly available Earth Systems data
- STAC API for querying the data
Planetary Computer & NODD

Plain Azure User

```
curl https://goeswewest.blob.core.windows.net/.../asset.nc
```
Questions and Discussion

- Please be brief in your questions / comments
- Use the chat or raise your hand for questions
- Identify who the question is directed to where possible
  - As questions are answered, we will go to the next in the chat queue and call on you to unmute yourself and ask your question.
  - We appreciate there may be questions that cannot be answered immediately and even those that we won’t have an opportunity to get to: please be patient as we build our understanding and summary responses.
Resources

We invite you to stay engaged with NOAA!

- **NOAA National Water Model References**
  - [https://water.noaa.gov/about/nwm](https://water.noaa.gov/about/nwm)
  - [https://www.weather.gov/owp/operations](https://www.weather.gov/owp/operations)

- **NOAA NWS Office of Organizational Excellence**
  - Email: cindy.elsenheimer@noaa.gov

- **NOAA Open Data Dissemination**
  - Email: NODD@noaa.gov

- **Microsoft NWM Resources:**
  - [https://microsoft.github.io/AIforEarthDataSets/data/noaa-nwm.html](https://microsoft.github.io/AIforEarthDataSets/data/noaa-nwm.html)
  - [https://planetarycomputer.microsoft.com/](https://planetarycomputer.microsoft.com/)