



NOAA EAGLE

(Experimental AI Global and Local Ensemble)
Research to operations pipeline for AI weather
models at NOAA

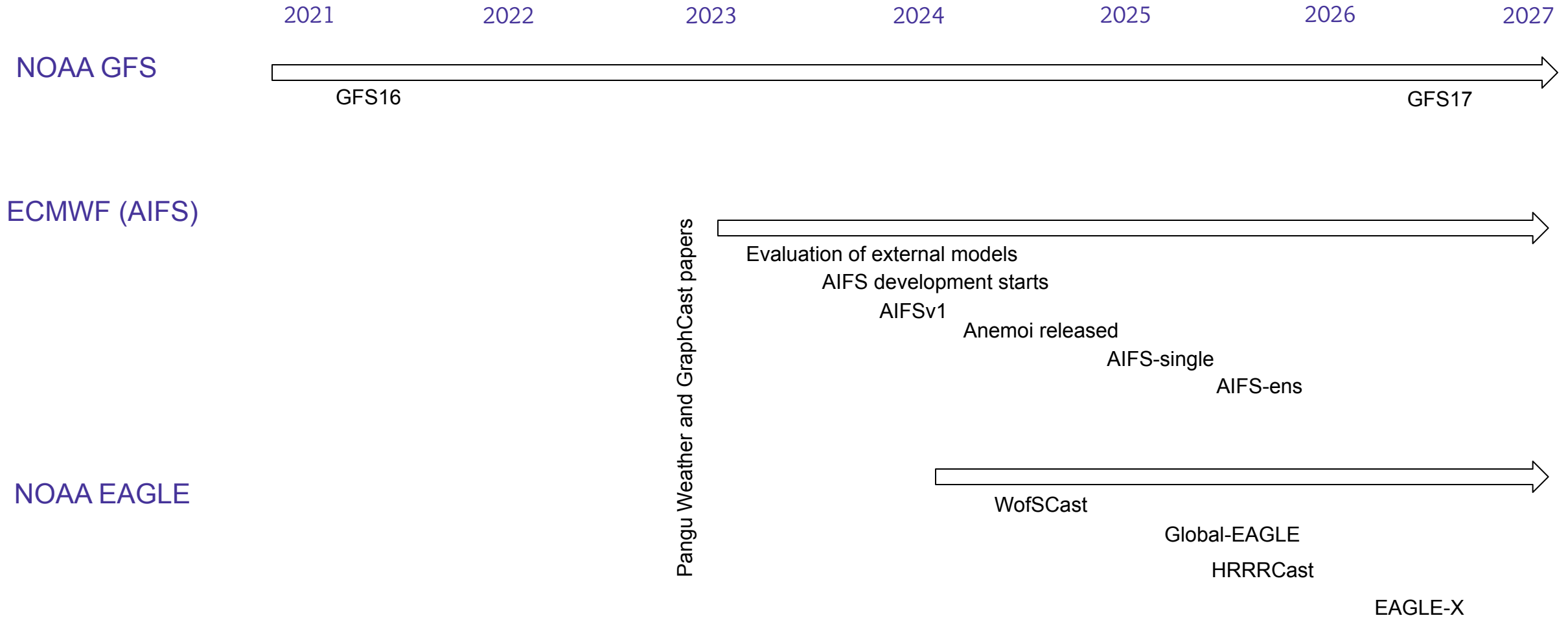
Sergey Frolov

EAGLE's original flight:

Jun Wang, Isidora Jankov, Jacob Carley, Keven Blackman, Daryl Kleist, Travis Wilson, Linlin Cui, John Ten Hoeve and Maoyi Huang

And many more working on the future EAGLE products

AI world is moving fast

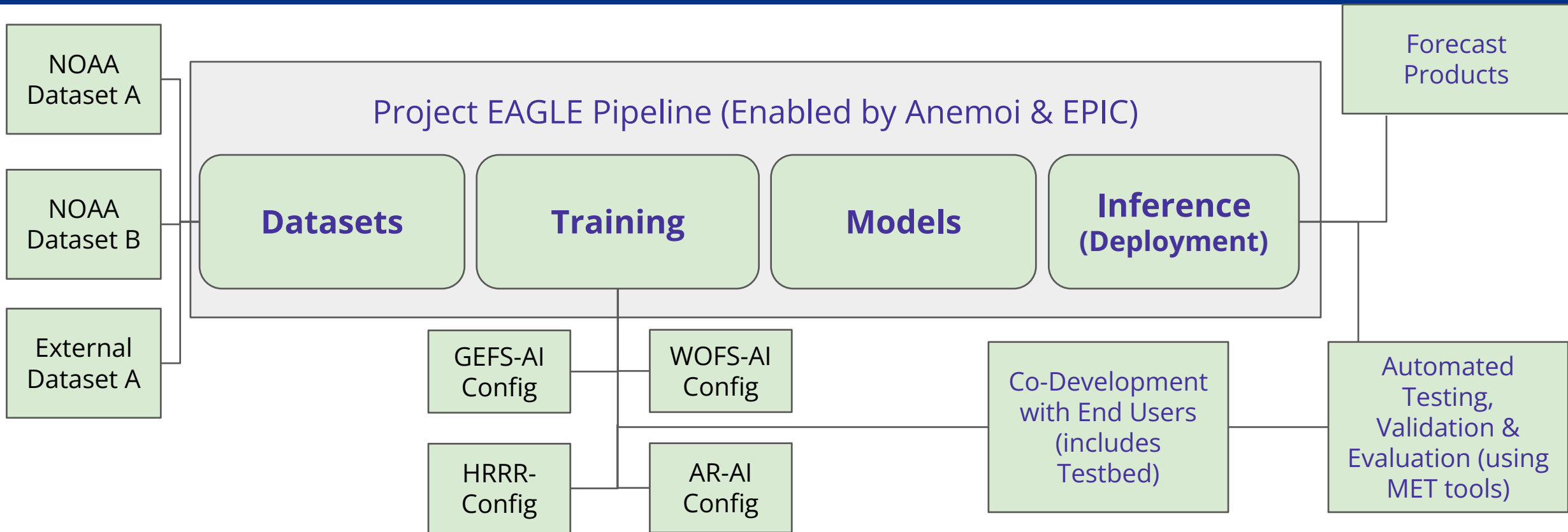


- Major upgrade to a legacy NOAA model is taking 5 years.
- ECMWF went from evaluation of external models to operational AIFS in 2 years.
- NOAA went from grass root efforts to real-time demonstration in about a year.

How does NOAA stay relevant?

- New and robust R2O pipeline
- Unified platform for AI forecast
- Robust verification pipeline
- Drawing on the strength of the community
- Separating EAGLE vs “OAGLE”

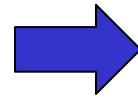
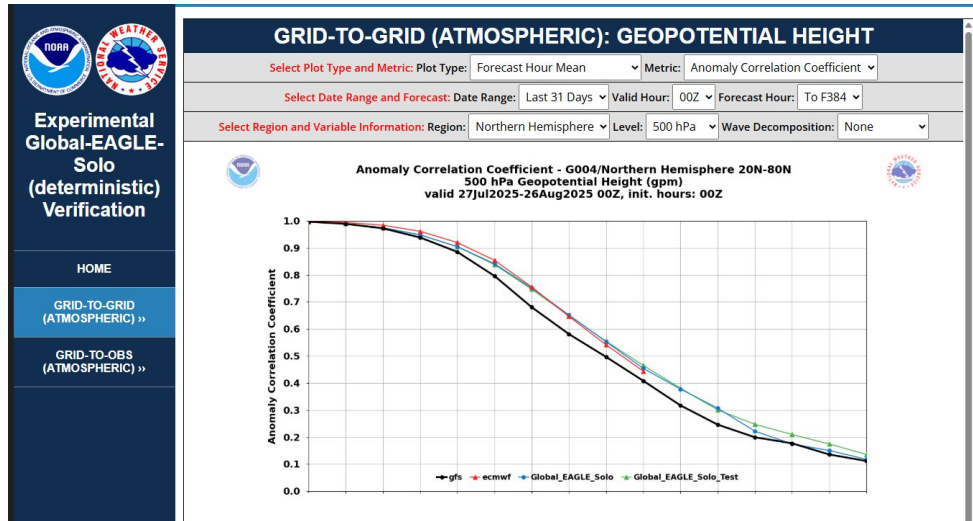
EAGLE: a robust pipeline of innovation



- An aspiration to an integrated, open-development program that will:
 - Produce and release training datasets, models, and verification tools
 - Co-development of models and products with end-users and NWS partners
 - Pipeline for innovation across NOAA and wider community that funnels innovations to operations.

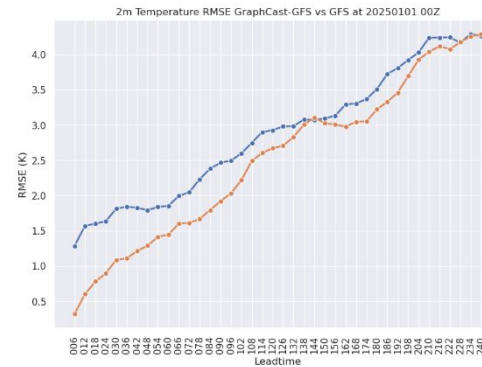
EAGLE: robust verification pipeline

EVS from NOAA EMC



wxvx from GSL/EPIC

Package Name	Access	Summary	Updated
<input type="checkbox"/> wxvx	public	No Summary	2025-06-19
<input type="checkbox"/> met2go	public	No Summary	2025-05-15



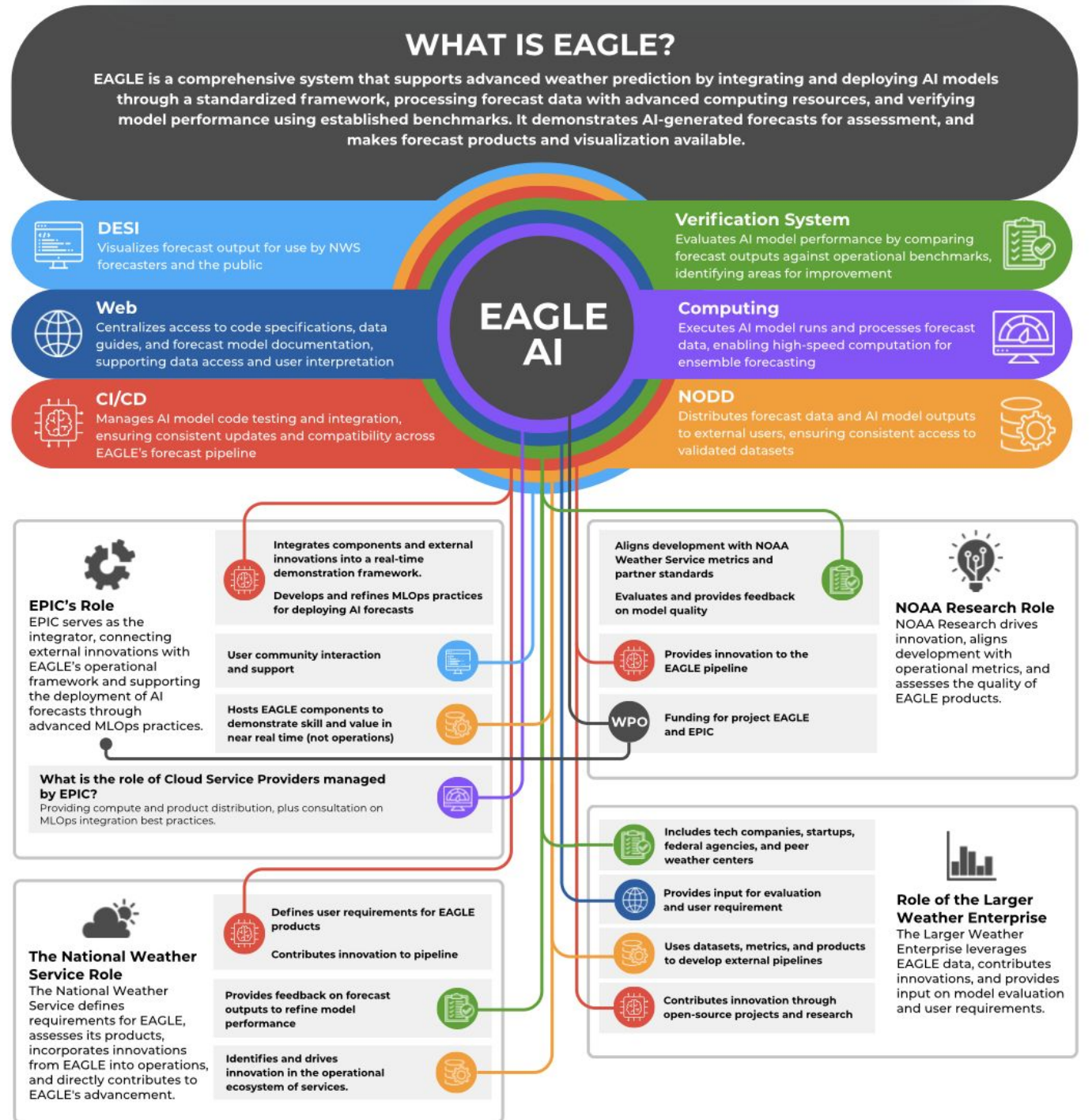
- For this one-cycle, one-variable run, **wxvx** also:
- Extracted 80 netCDF forecast grids
 - Downloaded 122 GRIB index files
 - Downloaded 122 GRIB messages
 - Produced 160 MET **.stat** files, which could be analyzed, visualized, etc. separately

The workflow task graph can get quite large!

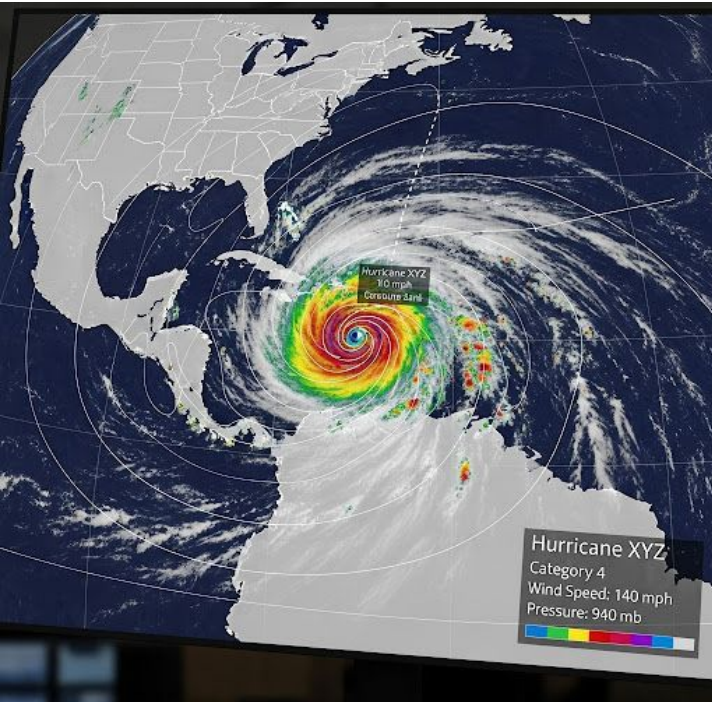
- NOAA EMC developed a comprehensive verification system for all NOAA forecast products
 - Based on the UCAR MET software
 - EVS software stack wasn't designed to be portable and used by the community.
- EPIC and GSL are packaging verification science from EVS as community python package (wxvx and met2go):
 - Should allow wider community of AI model developers to use NOAA metrics for verification of AI models.
 - Includes verification against observations.

EAGLE community

Project EAGLE is aspiring to deliver the best AI model for the U.S. by leveraging the best in the U.S. weather enterprise.



Operational wing of EAGLE



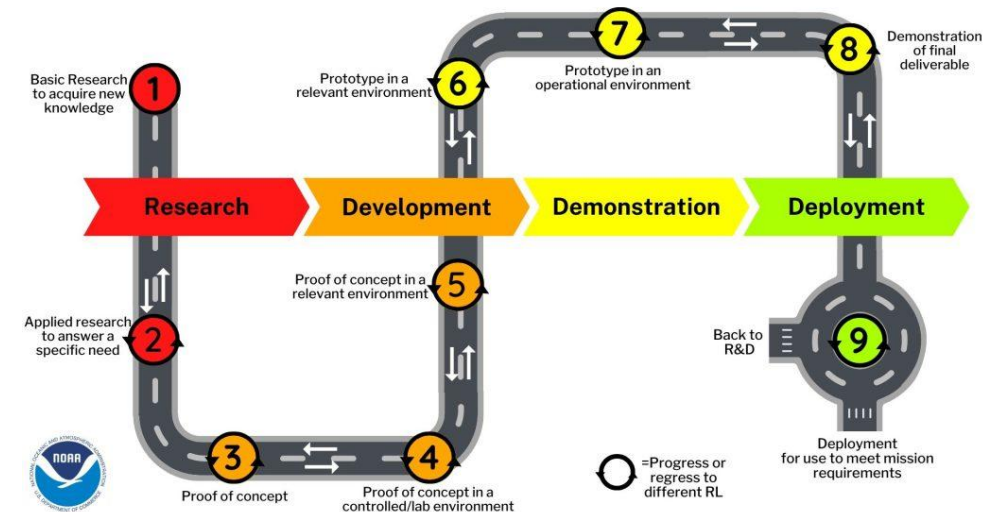
- **Data** - Ensure data quality, presence, and efficient management
- **Performance** - Monitor model performance for accuracy
- **Reliable and Secure** - Guarantee system scalability and reliability
- **Forecaster Interpretation** - Provide comprehensive operational training
- **Resources** - Computational and personnel resources to ensure 24/7 operations



- Transition of Global-EAGLE-solo and Global-EAGLE-ensemble from demonstration to operations is planned for late 2025.

What is next for project EAGLE: map of future products

Application	Current RL	
	SOTA	at NOAA
Atmosphere-only	9	8->9
Regional atmosphere	7	8
Storm scale	5	8
Nested atmosphere	5	5
Coupled GEFS-like	3	3
Coupled seasonal	5	3
Data assimilation	4	2
???		



- Operational suite provides good guidance to future EAGLE products.
 - NOAA is catching up fast to the state of the art.
 - What would it take for NOAA to lead across the board?

What is EAGLE today

NOAA's Project EAGLE

Welcome!
NOAA's Project EAGLE

NOAA research, Global Systems Laboratory (GSL), Physical Sciences Laboratory (PSL), Environmental Modeling Center (EMC), Earth Prediction Innovation Center (EPIC), Cooperative Institute for Research in the Atmosphere (CIRA)

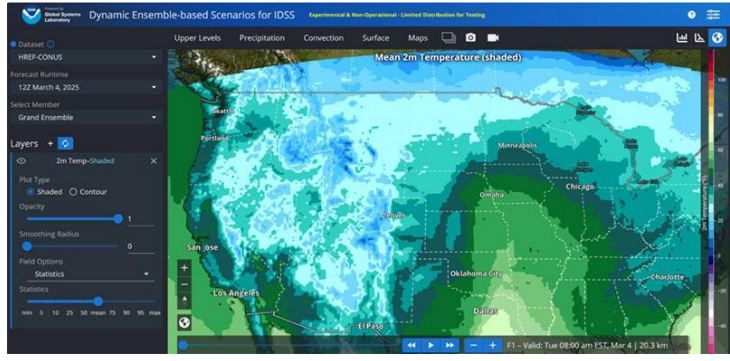
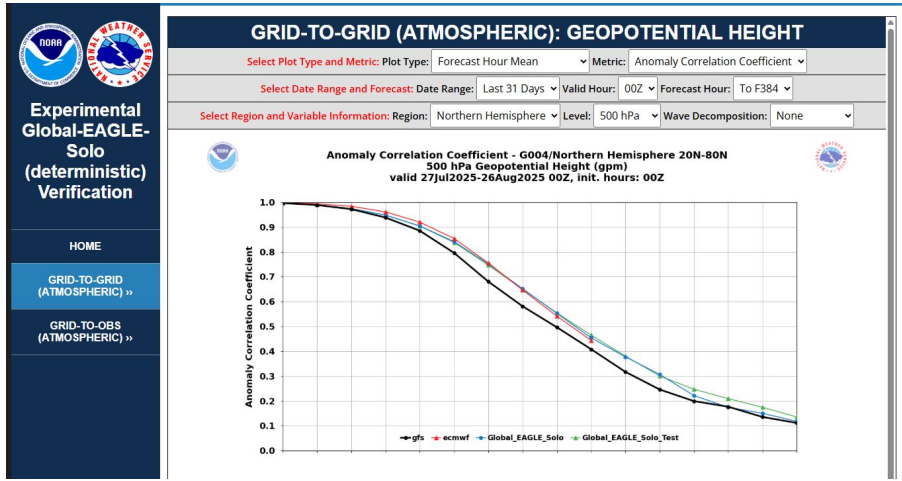
What is project EAGLE?

Welcome to the overview page for Project EAGLE (Experimental AI Global and Limited-area Ensemble forecast system), which is a joint effort between NOAA Research Laboratories and the Earth Prediction Innovation Center (EPIC) in the Office of Oceanic and Atmospheric Research (OAR), and the National Weather Service (NWS). Project EAGLE provides NOAA and the broad weather enterprise with the ability to rapidly test, develop, and demonstrate in the near-real-time Artificial Intelligence (AI) models for global ensemble forecasting. Once fully-developed, Project EAGLE will enable researchers within NOAA and across the weather enterprise to rapidly test their AI models against trusted forecast metrics that are currently used to evaluate the performance of NOAA flagship systems like the Global Forecast System (GFS), the Global Ensemble Forecast System (GEFS), High Resolution Rapid Refresh (HRRR), and Warn on Forecast System (WoFS). We envision that Project EAGLE will allow NOAA to identify the best performing AI innovations rapidly and advance them into near real-time demonstration that can deliver value to the Nation, save lives and property, and enhance the national economy.

Today, Project EAGLE includes two components:

- Global-EAGLE-Solo** is a demonstration environment for "deterministic" models that are initialized from a single GFS initial condition. Global-Eagle-Solo is a complement to the existing NOAA GFS physics-based forecast. In the first version of the Global-Eagle-Solo, NOAA EMC re-trained the GraphCast model using Global Data Assimilation System (GDAS) data as inputs and training targets (Tabas et.al 2025).
- Global-EAGLE-Ensemble** is a demonstration environment for ensemble forecast systems initialized with the ensemble of GEFS initial conditions. Global-Eagle-Ensemble is a complement to the existing NOAA GEFS

EAGLE Description
 Verification
 Graphics
 Ensemble Configuration
 Change Log

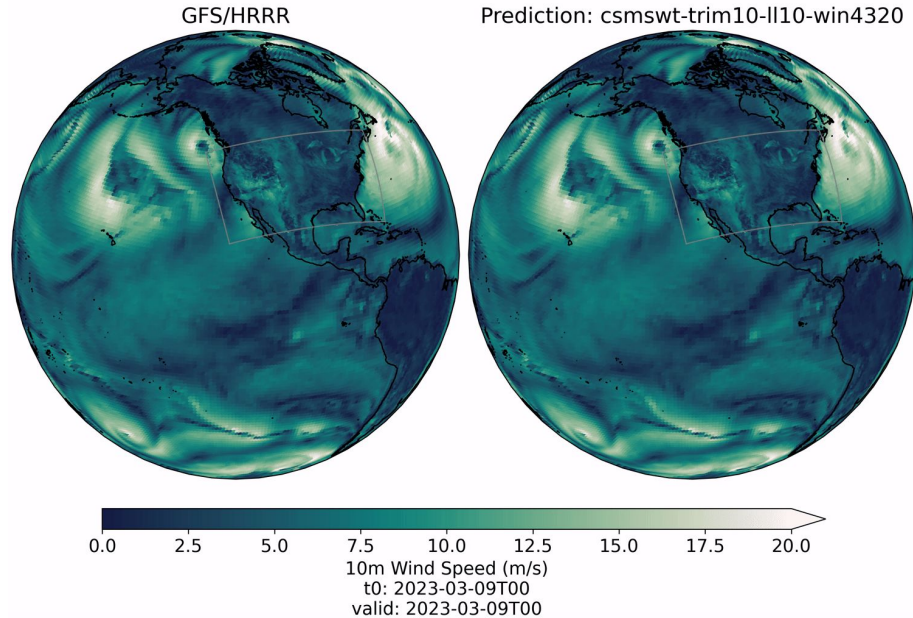


Model name	Get Model	Get Data
Global-EAGLE-Solo	GitHub , Weights	Available from NODD under "graphcastgfs.YYYYYMDD" directory structure.
Global-EAGLE-Ensemble	GitHub , Weights	On NODD

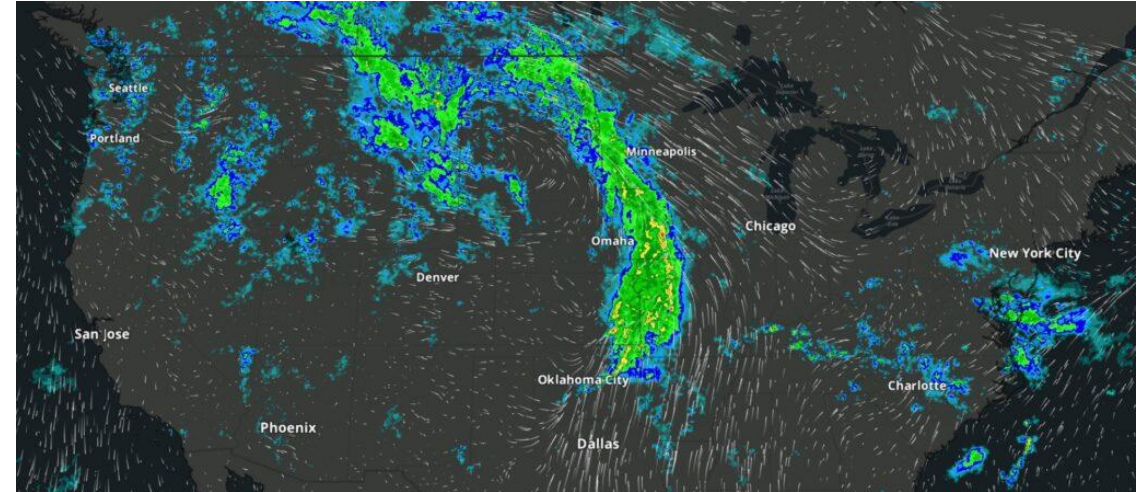
- A set of models: Global-EAGLE-Solo and Global-EAGLE-Ensemble (see Jun Wang's talk for how they fine-tuned GraphCast model on NOAA data).
- A monitoring and verification system (using NOAA EMC's EVS system).
- A visualization page (using NOAA GSI DESI).
- Model output, code, and weights in open access.

What is next for project EAGLE (6-12 months)

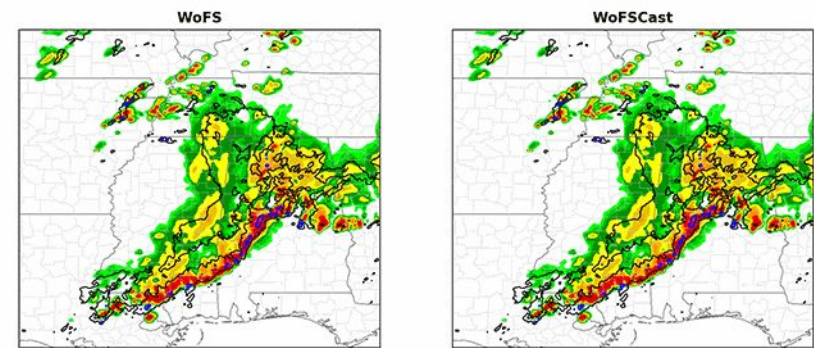
Nested-Eagle: combines the best of HRRR and GFS



HRRRCast and WofSCast: AI companions to traditional models



- WofSCast: on-demand runs (outside of EAGLE)
- HRRRCast: considered for EAGLE in parallel testing.
- Nested-EAGLE: under development based on Anemoi



What is next for project EAGLE (12-24 months)

- Migrating many of our applications to unified modeling platform (Anemoi):
 - See EPIC AI training for a preview.
- Release of the verification pipeline for AI models against observations.
- Addition of new AI systems:
 - HRRRCast, WofSCast, Nested-EAGLE, Coupled model?
- Developing release strategy
 - Aiming to frequent upgrades and releases (e.g. continuous deployment)
 - Driven by science results and verification.
 - Maintaining parallel experimental versions in addition to the operational version.

End