NOAA AI Agency Update for 1st ICAMS AI/ML Workshop

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ICAMS AI/ML Workshop

[1]NOAA Center for Artificial Intelligence (NCAI)
[2] National Centers for Environmental Information (NCEI)
[3] NOAA AI Executive Committee including NOAA HQ and LOs
Contributions from the NOAA AI governance team

Top **Successes**, Challenges, and Areas for Collaboration

Successes:

- NOAA is successfully integrating AI technologies into all aspects of its Sun to seafloor mission space. There are 100's of use cases in development covering Weather, Climate and Ecosystems.
- NOAA Center for AI (Public Law 116-283) launched and providing initial operating capabilities, including facilitating a 1000+ person AI community of practice. (National AI Initiative Act of 2020)
- NOAA AI for Weather Prediction team has conducted state of the science workshops, and initiated partnerships evaluating the latest AI models including some trained and/or fine-tuned with NOAA data (e.g. Warn-on-Forecast).

Top Successes, **Challenges,** and **Areas for Collaboration**

Challenges:

- NOAA Center for AI is not fully appropriated, hampering corporate coordination, innovation, and technology transfer.
- NOAA is understaffed and under resourced with respect to data science, limiting NOAA's ability to accelerate the pace of AI for data-driven Earth System Modeling and Prediction, leverage external investments, and create public facing AI-ready training datasets for Weather, Climate, Ecosystems.
- NOAA's existing high performance GPU infrastructure (on-prem and Cloud) is insufficient to meet modeling and evaluation demands.

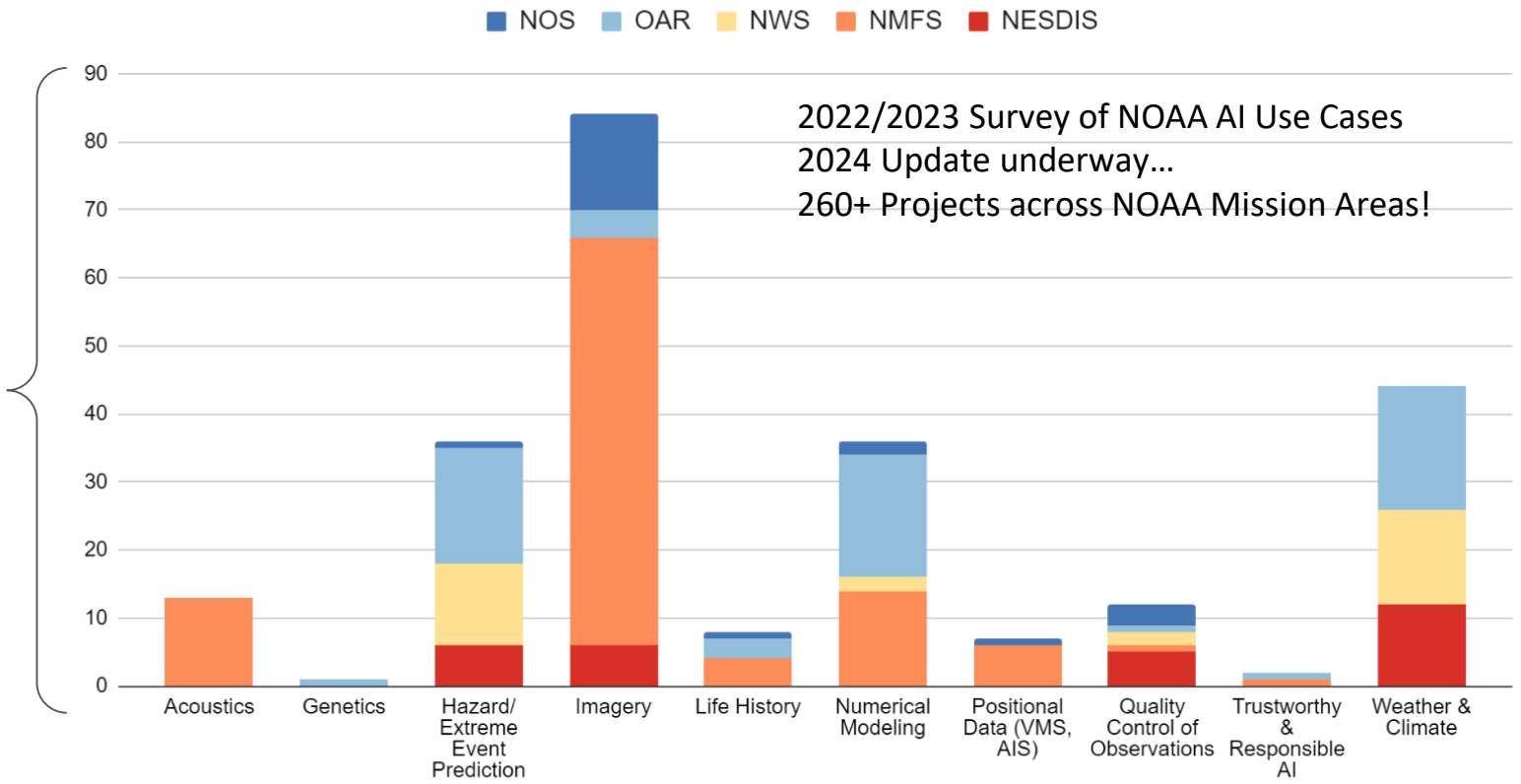
Areas for Cross-Agency Collaboration:

- Workforce development to specifically improve Retention and Recruitment of data scientists for ESM through co-produced training events, hackathons, and Staff exchange.
- AI-ready data to optimize use of ICAMS Agency data for data driven modeling and evaluation, including observations, analysis, reanalysis, and model output data.
- AI modeling and validation methods and metrics including storm and longer spatial / temporal scales, KPPs (e.g. precipitation) and open community foundation models for downstream specialization.
- Leveraging High Performance Computing with GPUs for training and evaluation.

NOAA Current AI Application Areas

AI Areas

Imagery
Wx / Climate
Modeling
Hazards
Acoustics
Quality Control
…
Responsible AI



2022/2023 Survey of NOAA AI Use Cases
2024 Update underway…
260+ Projects across NOAA Mission Areas!

NOAA Leadership in Using and Enabling AI

National AI Initiative Act of 2020:

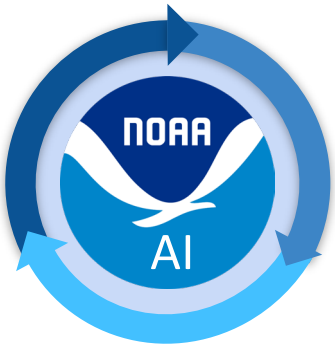
"The Administrator of NOAA [...] shall establish, a Center for Artificial Intelligence"

"There are authorized to be appropriated to the Administrator to carry out this section $10,000,000 for fiscal year 2021" (Public Law 116-283, Section 5303, pp 1153)

Rip currents

Ecosystem monitoring

Space weather forecasts



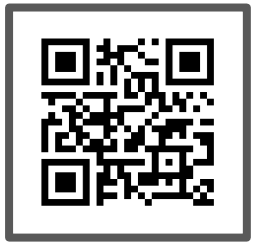
AI ready data

Community of practice

Reanalysis data sets

Wildfires

Numerical weather prediction



Scientific stewardship (QA/QC)

Repository of 60 PB of data

NCAI Tech Hub – Roadmap

Training
AI Workflows

Cloud Sandboxes
Public and Private

NCAI Program Office & Tech Hub

Ethical AI Innovation
Why, What, How

Training Responsible AI

AI-Ready Data Standards

Partnerships & Engagement

Communities of Practice Coordination

AI-Ready Standard

Checklist Maturing and Automation

New AI Ready Data in 2024/2025:

- World Ocean Database
- Sea Surface Temperature
- Offshore Winds
- Sea Ice
- Humidity / Heat Health

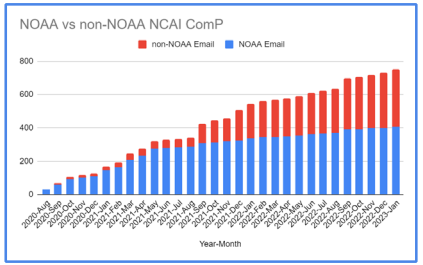
Workshops
7th AI Workshop Events and Topics? Hybrid?

Advancing Innovation Inflation Reduction Act / HPC

Communities of practice

Powered by

slack or Similar



Building Community around AI @ NOAA

noaa.gov/ai

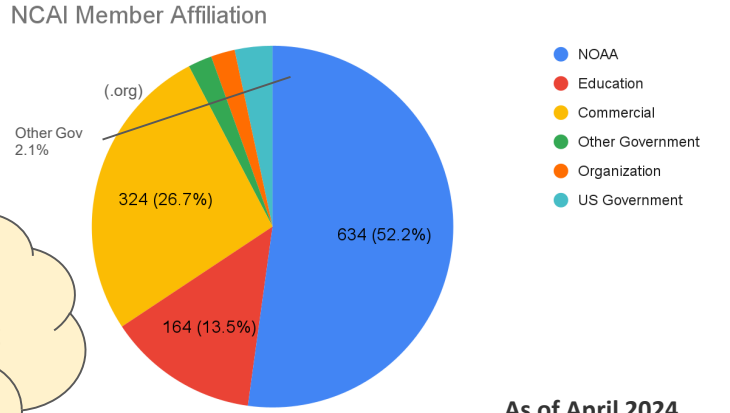
Community of Practice 1100+ Members

Members in NOAA's AI Community of Practice from USG, Academia and Industry are looking to NCAI to facilitate conversations around infusing AI into Climate, Wx, Ecosystems and Environmental Justice.

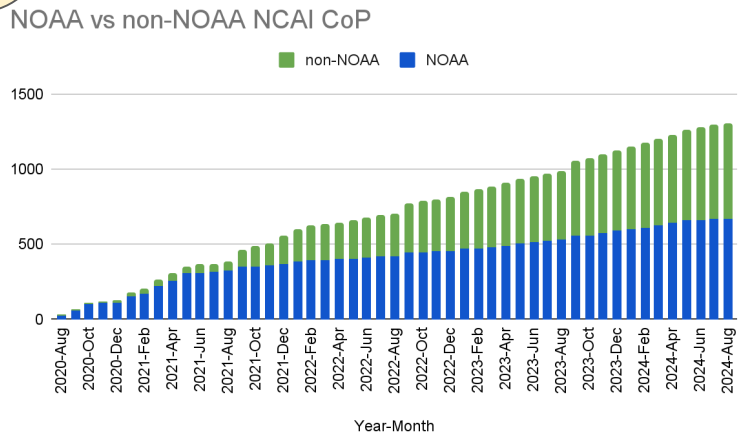
- 1100 (*as of April 2024*): more than half are NOAA
- 100+ Organizations
  - NASA, USGS, USCG, WYO, USDA, US Navy, NREL
  - University of Colorado and Colorado State, Hawaii, North Carolina State, Albany, Alaska, Montana, Massachusetts, Montana, UC San Diego, Texas, Exeter and many more
  - AECOM, AccuWeather, BAH, IBSScorp, Riverside, tomorrow.io, Raytheon, and many more

Join the mailing List: tinyurl.com/y2ehvhfg

AI and HPC Slack Pilot with Dynamic Collaboration underway



As of April 2024



Engagement: NOAA's AI Workshop Series

Highlights from the 6th Workshop in September

Featured speakers

Jainey Bavishi (NOAA)
Michael Morgan (NOAA)
Steve Thur (NOAA/OAR)
Derrick Hiebert (FEMA)
Zachary Iscol (New York City)

Community-led Tutorials

AI for Weather Prediction
Virtual reality
Generative AI/LLM (AWS, IBM)
Explainable AI
Cloud-based analytics

Use Case Development

12 participant-driven use cases were generated to foster collaboration across the community on various topics related to heat resilience.

- Innovative approaches for data integration for heat resilience
- Improving forecast skills for heat resilience
- Monitoring and predicting impacts related to extreme heat
- Developing information services to support decision making

AI4NWP Value Chain - Activities in Progress

An overall perspective: "Integration of emerging data-driven models into the NOAA research to operation pipeline for numerical weather prediction" doi.org/10.1175/BAMS-D-24-0062.1

Dataset Generation

Getting CONUS404 in an AI-ready format

Added ~1 FTE to accelerate coupled reanalysis for SFS for AI applications

Project Year 3/3 of developing shared integrated observational dataset (NNJA) used for DA and AI applications

Global Data Assimilation System analysis

Warn on Forecast (WoFS) archive

High-Resolution Rapid Refresh (HRRR) archive

Infrastructure

Developed an infrastructure team to focus on common infrastructure & MLOps pipeline w/Microsoft

Added ~1.5 FTE to support infrastructure team, developing a Github repo, and community access for select data and models

Added 0.75 FTE for dataset processing, collaboration with Earth Prediction Innovation Center

Funding for shared native cloud Azure as a prototype sandbox

Developing a Cloud data lake to support AI-ready data and AI applications.

Development and Testing

Running 3 real-time data driven models with GFS/Global Ensemble Forecast System (GEFS) initialization, running retrospectives, making data available (0.5 FTE)

Running GraphCast and FourCastNet initialized with GFS. Retraining from Global Data Assimilation System.

Evaluating data driven models in Spring Forecast Experiment. Adapted Graphcast for WoFS and training WoFS emulation models.

Experimenting with AI/ML approaches for Atmospheric Rivers (multiple FTE)

Experimenting with AI for DA emulators

Evaluation and R2O

Added 0.5 FTE to research/develop evaluation methodologies

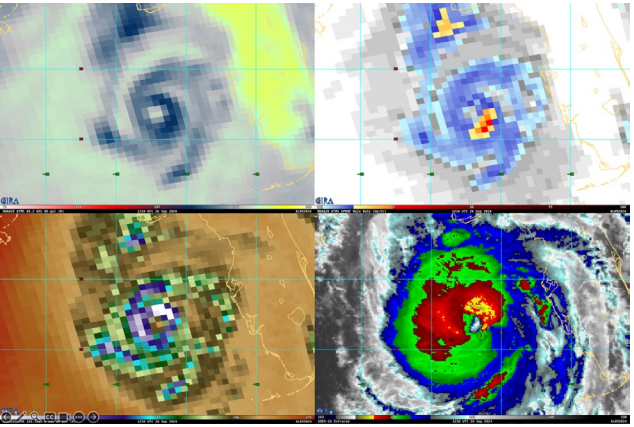
Added 0.5 FTE to evaluate deterministic runs described in previous column

Validation of real-time and retro runs

*Partial survey of a growing set of key activities. Acronyms in speaker notes.

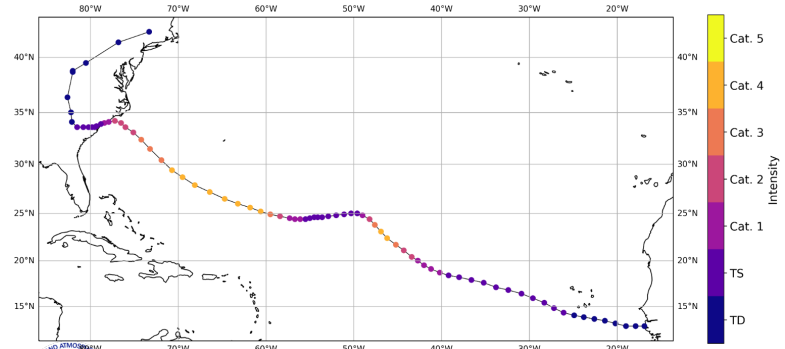
Research, Community Engagement, Partnerships

TC PRIMED - Tropical Cyclone PRecipitation, Infrared, Microwave, and Env. Dataset



- NOAA JPSS passive microwave imagery
- NASA GPROF passive microwave retrieved rainfall
- NOAA GOES-16 nearly-coincident infrared brightness temperature

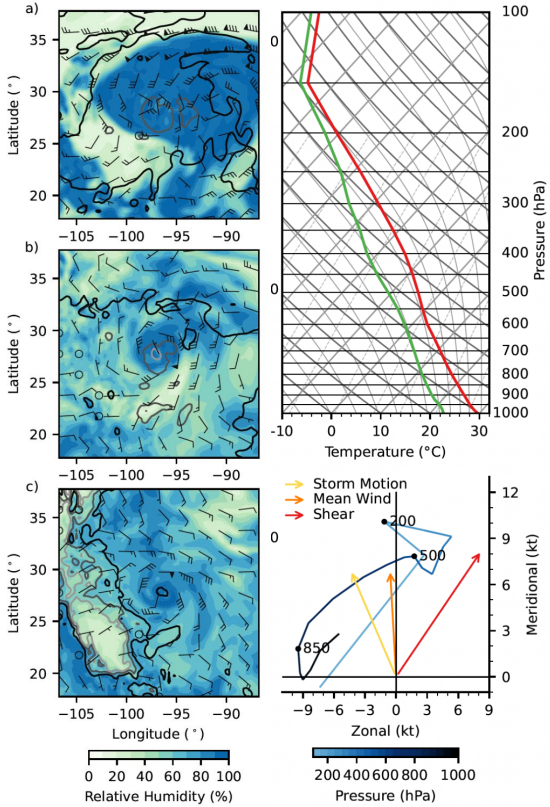
- ECMWF Fifth-Generation (ERA5) reanalysis fields
- Environmental diagnostics calculated from ERA5



NCAI

CIRA

- Tropical cyclone track and intensity information collected by the NOAA National Hurricane Center, Central Pacific Hurricane Center, and the DoD's Joint Typhoon Warning Center



Slide courtesy of Christopher.Slocum@noaa.gov

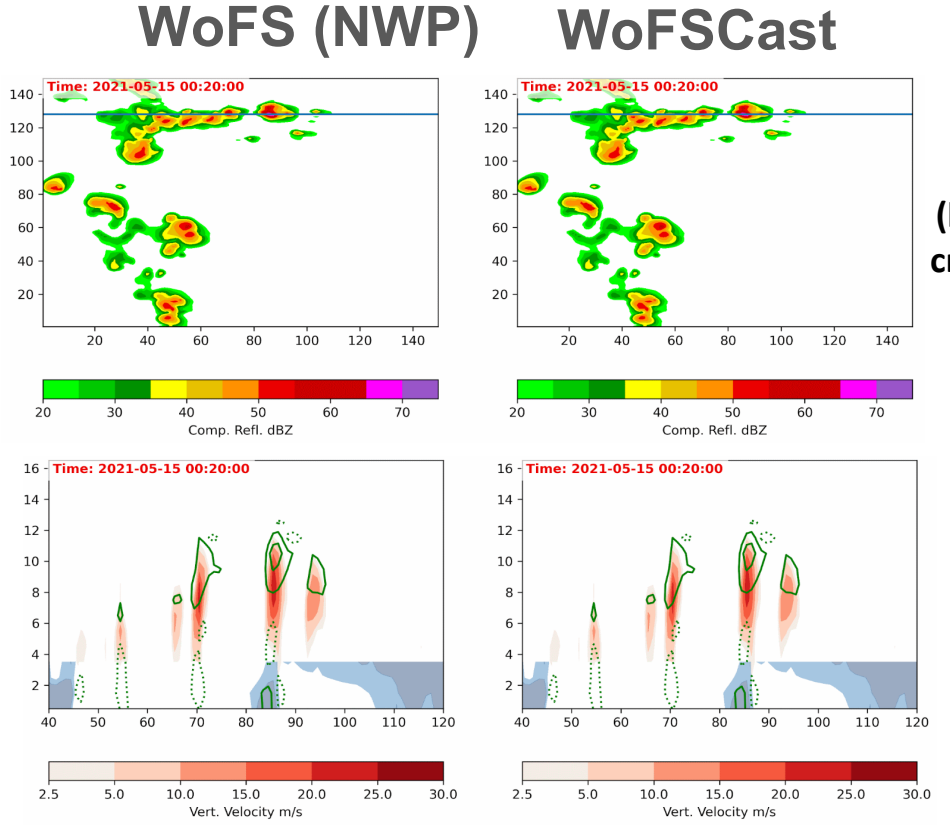
Highlight: Advancing Storm-Scale Wx Prediction

AI can accelerate and improve the accuracy of storm-scale (not just global) weather prediction

NSSL modified GraphCast to train on high-resolution regional forecasts from NSSL's Warn-on-Forecast System (WoFS)

WoFSCast accurately emulates WoFS forecasts in a fraction of the time (10 min → 30 sec)

Goal: Use WoFSCast to improve WoFS and get severe weather guidance to forecasters faster



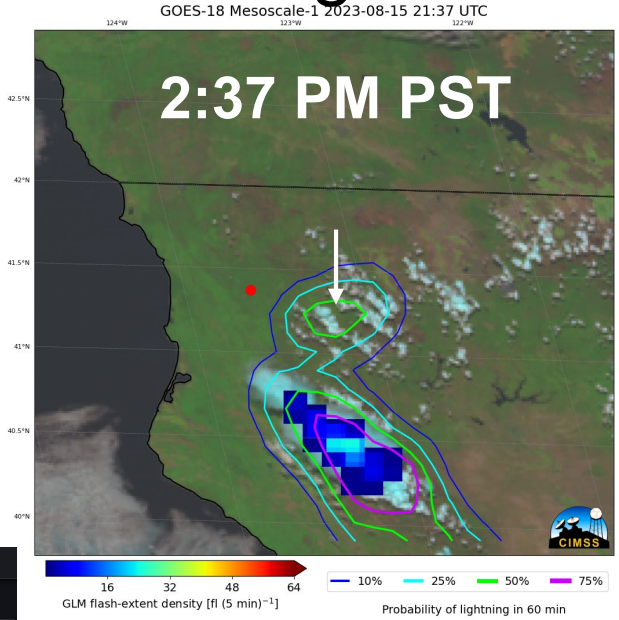
Composite reflectivity (horiz line → vertical cross-sections below)

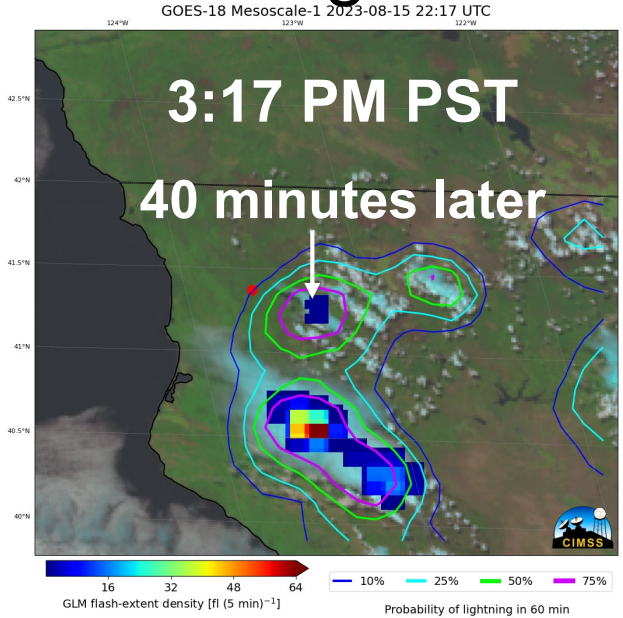
Updraft speed, divergence, θ_v perts (cold pools)

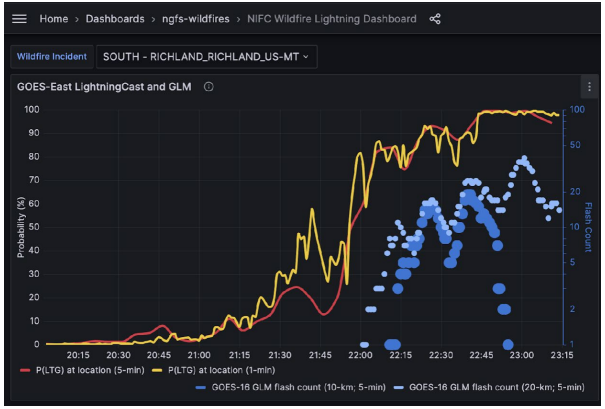
Slide courtesy of Corey.Potvin@noaa.gov, Monte Flora

Highlight: Advancing Wildfire Nowcasting

LightningCast Model
AI that transforms GOES-R satellite imagery into lightning predictions







Custom LightningCast forecasts are available for active wildland fire incidents (used by NWS IMETs)

Realtime access

Slide courtesy of Mike.Pavolonis@noaa.gov (NOAA/NESDIS)

Digital Twin(s) for the Earth System and Social Impact

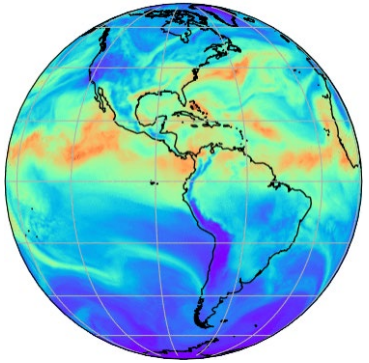
AI for Public Good:
Extreme Weather

NOAA + ECMWF

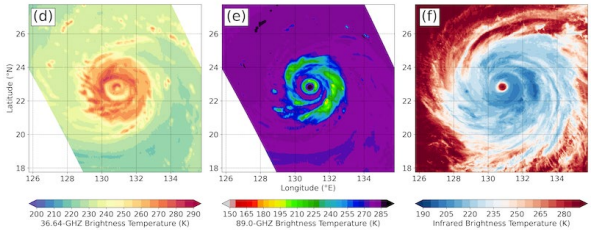
Photo Credit: US Naval Air Station of Hurricane Dennis in Key West, FL, July 2005

EU DestinE

NOAA EO-DTs

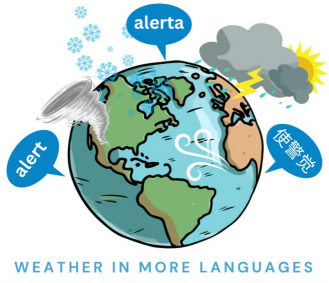


TC PRIMED



Slide courtesy of Jennifer.Webster@noaa.gov

Highlight: Communicating Weather Hazards



New York, NY - Comunicado de Condiciones Severas del Tiempo - Español

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SVSOKX

Comunicado de Tiempo Severo
Servicio Nacional de Meteorología New
429 PM EDT sábado 9 de septiembre 2023

NJC003-013-031-NYC087-092039-
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Passaic NJ-Bergen NJ-Essex NJ-Rockland
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...EL AVISO DE TORMENTA ELÉCTRICA SEVE
PASSAIC...NOROESTE DE BERGEN...NOROEST
CANCELA...
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WEATHER.GOV/TRANSLATE

We invite you to become a weather ambassador by sharing these translated NWS infographics online with your community, friends, and partners and using the hashtag ***#NWSTranslate***

Infographic translation is powered by AI and curated by NWS bilingual staff.

Slide courtesy of Monica Bozeman (NOAA/NWS)

Summary

AI's potential as a Service to NOAA's Mission success:

a. Mission Science and Decision Support – Wx, Climate, Ecosystem skill
b. Stakeholder / User Decisions – e.g. Translation Services, and tailored Agents
c. Human Administrative Workflows – 30% efficiency opportunity and necessity

Top Successes, Challenges and Areas for Collaboration (see slides 3 and 4).

Areas for Cross-Agency Collaboration:

- Workforce development to specifically improve Retention and Recruitment of data scientists for ESM through co-produced training events, hackathons, and Staff exchange.
- AI-ready data to optimize use of ICAMS Agency data for data driven modeling and evaluation, including observations, analysis, reanalysis, and model output data.
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noaa.gov/ai