NWS SOO/DOH GenAI Team

A Focus on GenAI for Improved Operational Efficiency

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Overview and Purpose

This NWS Team Sees Three Main Categories of GenAI Use (as of now):

- **Improve NWS Operational Efficiency/Workflow**
- **Generate Impact Based Information for DSS**
- **Unique Data Analysis/Coding**

Motivation…

AI is Creeping in Everywhere…

Dr. Jeannette Sutton @suttonj · 22h

ECMWF | Charts

Home / Charts catalogue

Search products...

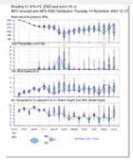
Range
- Medium (15 days)
- Extended (42 days)
- Long (Months)

Type
- Forecasts

Component
- Surface
- Atmosphere
- Next IFS version (cy49r1)

Product type
- Control Forecast (ex-HRES)
- Ensemble forecast (ENS)
- Extreme forecast index
- Point-based products
- Experimental: AIFS
- Experimental: Machine learning models
- Atmospheric composition

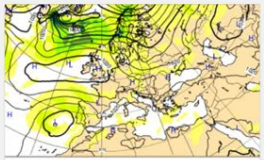
Parameters
- Wind



Latest point-based forecast

Experimental: AIFS (ECMWF) ENS Meteograms

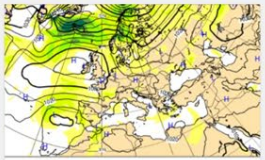
AIFS Meteograms show a probabilistic interpretation of the ENS forecasts for specific locations using a box and whisker plot. It shows the time evolution of the distribution of several meteorological parameters on a single diagram...



Latest forecast

Experimental: AIFS (ECMWF) ML model: Mean sea level pressure and 850 hPa wind speed

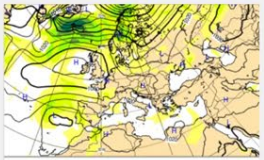
AIFS (ECMWF): a deep learning-based system developed by ECMWF. It is initialised with ECMWF HRES analysis. AIFS operates at 0.25° resolution



Latest forecast

Experimental: Aurora ML model: Mean sea level pressure and 850 hPa wind speed

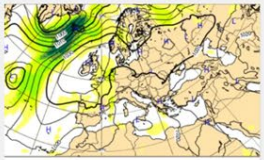
Aurora: a deep learning-based system developed by Microsoft. It is initialised with ECMWF HRES analysis. Aurora operates at 0.1° resolution.



Latest forecast

Experimental: FourCastNet ML model: Mean sea level pressure and 850 hPa wind speed

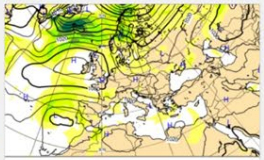
FourCastNet v2-small:a deep learning-based system developed by NVIDIA in collaboration with researchers at several US universities.It is initialised with ECMWF HRES analysis. FourCastNet operates at 0.25° resolution.



Latest forecast

Experimental: FuXi ML model: Mean sea level pressure and 850 hPa wind speed

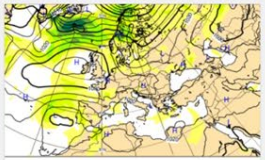
FuXi: a deep learning-based system developed by researchers at Fudan University. It is initialised with ECMWF HRES analysis. FuXi operates at 0.25deg resolution.



Latest forecast

Experimental: GraphCast ML model: Mean sea level pressure and 850 hPa wind speed

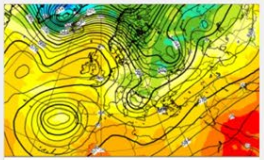
GraphCast (Google DeepMind): a deep learning-based system developed by Google DeepMind.It is initialised with ECMWF HRES analysis. GraphCast operates at 0.25° resolution.



Latest forecast

Experimental: Pangu-Weather ML model: Mean sea level pressure and 850 hPa wind speed

Pangu-Weather: a deep learning-based system developed by Huawei. It is initialised with ECMWF HRES analysis. Pangu-Weather operates at 0.25° resolution.



Latest forecast

Experimental: AIFS (ECMWF) ML model: 500 hPa geopotential height and 850 hPa temperature

AIFS (ECMWF): a deep learning-based system developed by ECMWF. It is initialised with ECMWF HRES analysis. AIFS operates at 0.25° resolution

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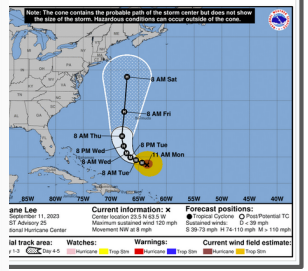


NWS "Views" of AI

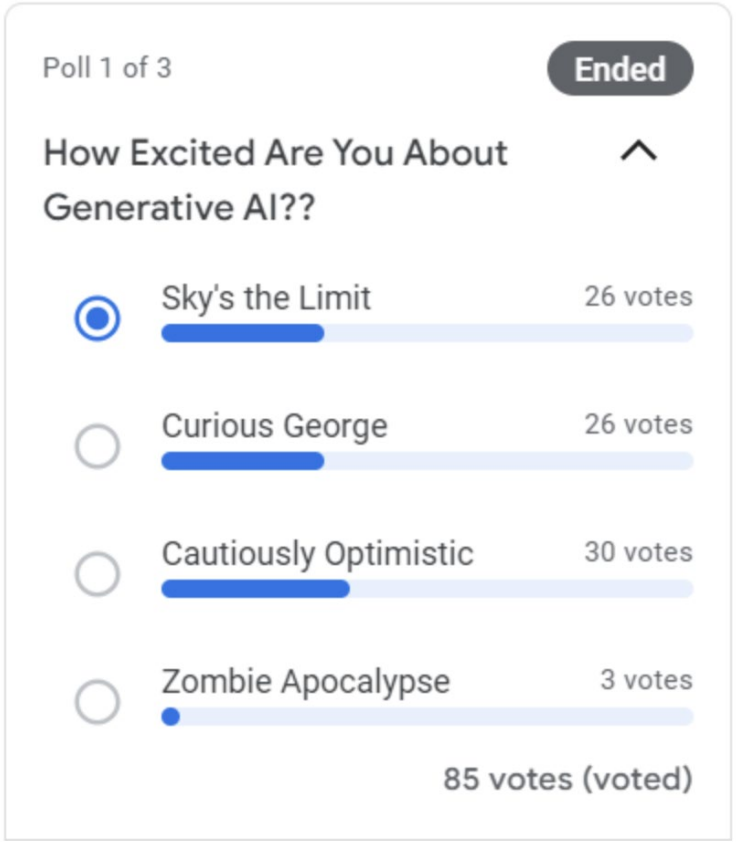
Table 4. Overview of the themes for what NWS forecasters view as the positives and negatives of AI/ML and forecasting.

Specific applications and implications of AI/ML that forecasters discussed
What forecasters view as <u>positives</u> of AI/ML
• Better-performing guidance • Enhanced pattern recognition across large amounts of data • Increased computational efficiency and reduced latency of model guidance • Increased spatial and temporal resolution of guidance and downscaling • Bias correction • Limiting forecasters' biases • Guidance that continually improves over time as it 'learns' from more cases • Increased confidence in forecasts and improvements in their ability to message that would come with better and more efficient guidance
What forecasters view as <u>negatives</u> of AI/ML
• Not being able to catch extreme or rare events given the lack of cases models are trained on • Over-reliance on AI/ML products beyond their application areas or training data • Have not seen the AI/ML products in action and would need hands-on experience before really evaluating how they feel about them • Might be too black-boxed for some to feel confident using • Guidance might not be smooth over time, but rather jump around run to run • Replacing or removing forecasters from the forecasting process

From: Wirz, C. D., J. L. Demuth, M. G. Cains, M. White, J. Radford, and A. Bostrom, 2024: National Weather Service (NWS) Forecasters' perceptions of AI/ML and its use in operational forecasting. Bull. Amer. Meteor. Soc., https://doi.org/10.1175/BAMS-D-24-0044.1, in press

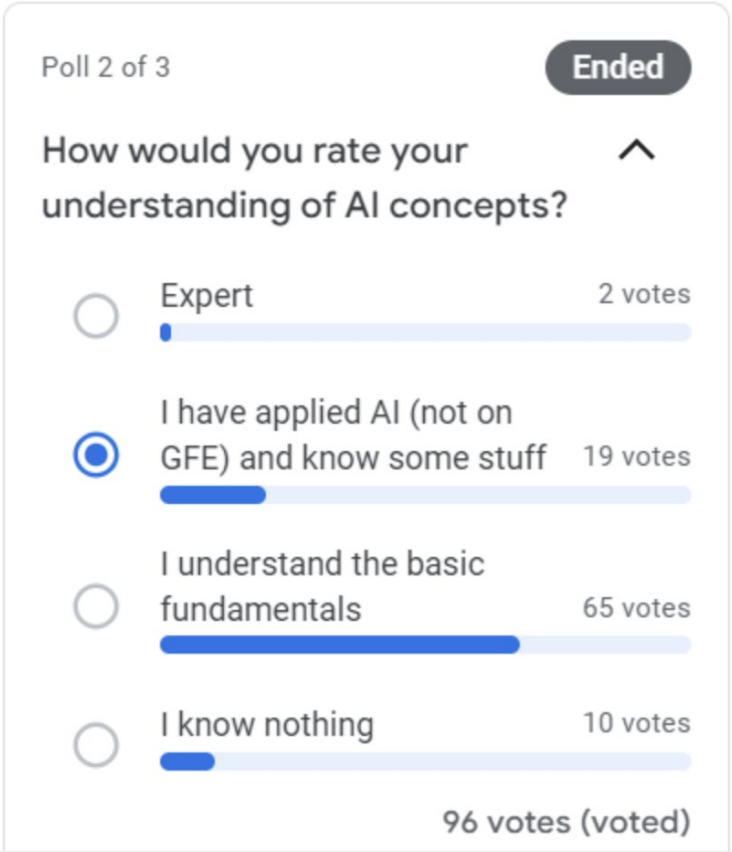
Science and Operation Officer “Views” of AI

How excited are you abou *tional tasks and workflows more efficient?*



Science and Operation Officer “Views” of AI

How would you rate <u>your</u> (neural networks, deep learning, and generative r



At a Glance …

It's Everywhere…

Unsupervised ML

Cluster Analysis - K-means algorithm

Supervised ML

- **MOS** - Regression ML
- **CSU ERO/SPC outlooks** - Random forest
- **ProbSevere** - Bayesian
- **Nadocast -** Gradient boosted Random forest
- Convolutional Neural Net to downscale GEFS for week-2 hydrology application
- CFSv2 mapped to Obs via NN for weeks 1-6 T&P
- Data-driven AI tools for ENSO forecasting (seasonal timescales)
- NN using MJO, SST, and trend predictors to forecast T&P on S2S timescales

Supervised Deep Learning

- **Product translation** - GenAI LLM
- **Data driven global models** - deep learning neural networks
- Probabilistic FIM uses ML to get mannings N and depth of river channels - composite of ML techniques
- **LightningCast** - Conv. Neural Net
- Next Generation Fire System (VolCat)
- CIPS Analogs
- UCAR - Neural Net
- WoFS
- DL-NN to target excessive heat events on S2S timescales

GenAI Team Goals

Generative AI: Generative AI refers to deep-learning models that can generate high-quality text, images, and other content based on the data they were trained on. (IBM)

1. Review and document the latest research on generative AI across various fields to evaluate its applicability and potential for enhancing the efficiency and quality of NWS Operations.

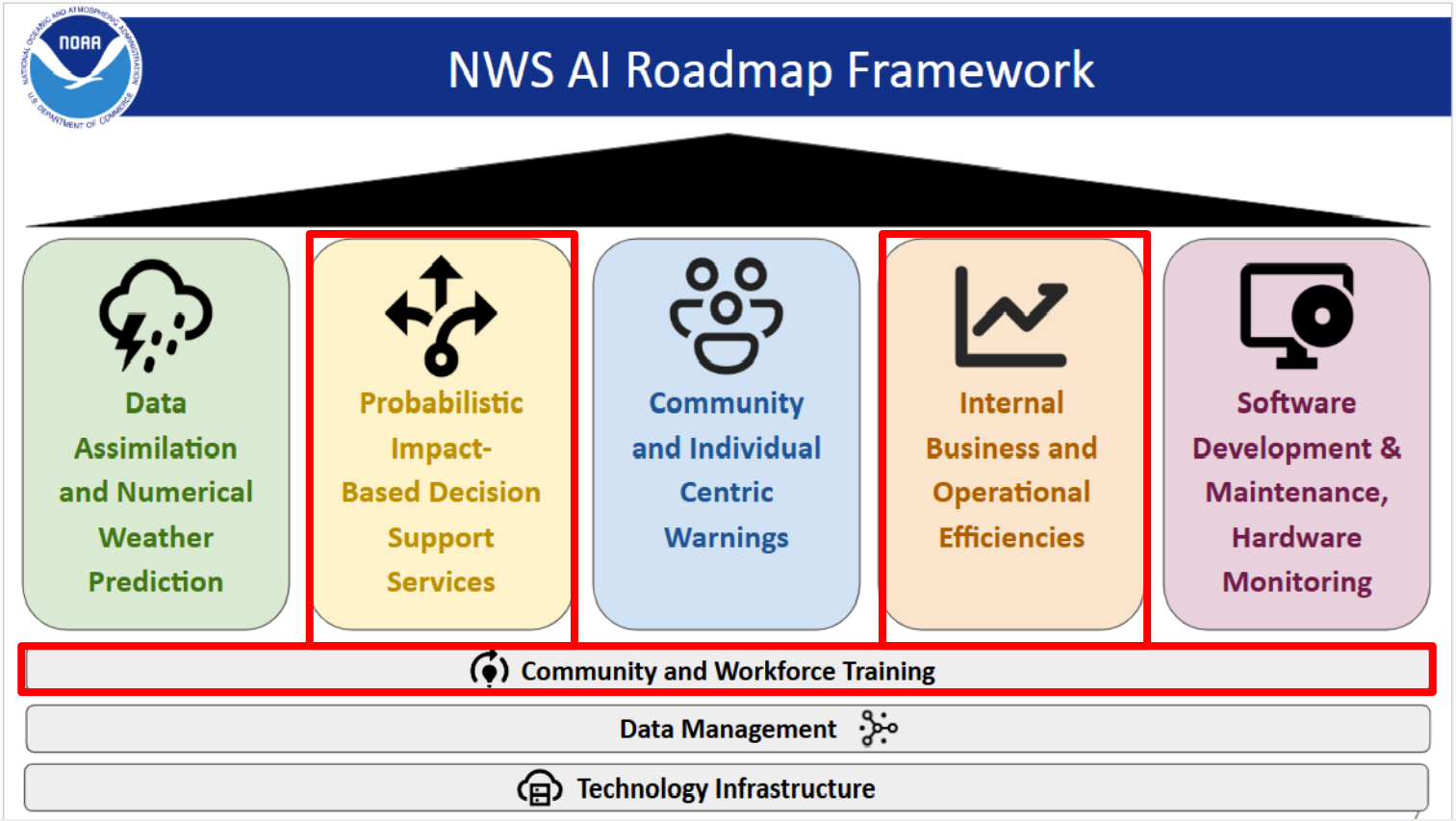
1. Investigate generative AI and large language model capabilities for NWS forecast operations.

1. Recommend priorities for short- vs long-term use of Generative AI and LLM for NWS forecast operations.

1. Testing (e.g., at the OPG) the improvement of local operational efficiencies through the use of generative AI.

Note: Team conceived in late 2023, born in spring 2024.

Part of a Bigger Initiative…



NOAA NCAI…

NOAA Science Council

Dr. Michael Morgan
(ASEOP - AI Executive Champion)

NOAA AI Executive Committee (NAIEC)

NWS	NMFS	OAR	NESDIS	NOS	OMAO	OCIO	Executive Secretary
Monica Youngman (chair) Daryl Kleist	Benjamin Richards (co-chair) Christin Khan	Jebb Stewart Venkatachala 'Ram' Ramaswamy	Eric Kihn Changyong Cao	Hassan Moustahfid Brandon Krumwiede	John Katebini *Vacant*	Frank Indiviglio	Jason Eibner

NOAA Center for AI (NCAI)
Rob Redmon (Director)
James Connolly (Deputy [LANTERN through 2024-09-31])
Vacant (Program Analyst)
Vacant (AI Lead Scientist)

- **Training Team**: Douglas Rao, Chris Slocum
- **Web/Comms Team**: Heather McCullough, Brian Meyer, Douglas Rao
- **AI-Ready Data Team**: Douglas Rao (Tech-Co-Lead), ***Vacant*** (Fed-Co-Lead)

AI Working Group (NAIWG)
Erin Moreland (Chair) (NMFS)
Corey Potvin (co-chair) (OAR)
Li Bi (NESDIS)
Derek Bolser (NMFS)
Matt Grossi (NMFS)
Megan Cromwell (NOS)
Mamoudou "Ama" Ba (NWS)
Isidora Jankov (OAR)
Kevin Cromer (OMAO)
VACANT *(OCIO)*

Generative AI Working Group (gAIWG)
Frank Indiviglio (Chair) (OCIO)
Policy, membership and other details:
NOAA GenAI WG

Science Council

NOAA AI Executive Committee (NAIEC)

NOAA AI WG (NAIWG)

Technical Guidance

Oversight & Guidance

Reporting & Annual Report

NOAA Center for AI (NCAI)

All persons, including the NCAI Lead are fractional FTEs. See also: NCAI Full Operating Capability plan.

Example: Operational Efficiency

Climate “Factoids”

We often get asked by media, or other partners for “non official-record” information from the climate database, especially for Central Park.

2:37 PM **MEDIA - Spectrum News NY1 - John Davitt** Hi. I don't think these types of records exist but do we know if there's a record for wet weather on weekend ? Looks like this weekend would be 7th straight with rain on at least one weekend day for CPK. Seems like a task for AI ! Ha ! All the best.

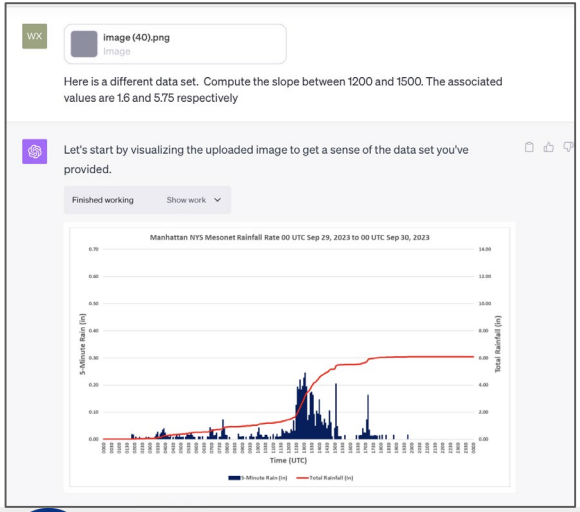
👀 2

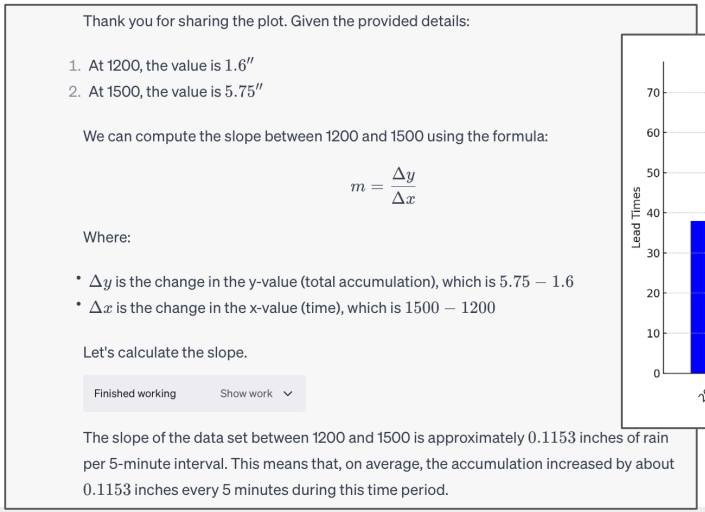
2:45 PM **NWS - New York - David Stark** Good afternoon John, unfortunately there is no record for the number of weekends in a row with wet weather. However, you are correct that this would be the 7th straight weekend of rain being recorded at Central Park, if measurable rain does occur.

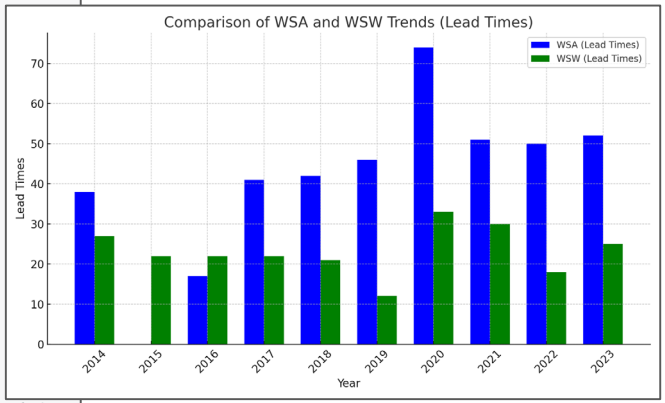
Example: Research/Data Analysis

You could use Excel, pyplot or your TI-83, but why?

For example, we were analyzing 1- and 5-minute ASOS precipitation rates for our flash flood events. AI has assisted in these and other computations very quickly (and will use ‘R’ for plots!):







NWS Short Term “Wins”

1. XMACIS Chatbot/AI interface for WFO/National Centers (NC) and media/public.

1. Upload NWS directives and policy supplementals to AWS and use a developed AI chatbot to extract information for WFO/NC operations.

1. Use of GenAI to determine 508 compliance of published weather graphics. Currently WFOs and NCs produce graphical information for the web and social media (see OKX Weather Story, FWD GraphicCast and MSO GraphiCast) on a routine basis.

1. Use of GenAI to create a first guess of appropriate weather key messages based on key points from existing forecaster-created NWS text products (AFD, HWO, ZFP, CPC PMDs, etc) or graphical information (WxStory, GraphiCast etc).

1. **Use of GenAI for LSR mining (or really any NWS, social media, DOT/FHWA, etc. data product) for statistical analysis.**

Science and Operation Officer “Views” of AI

Which of the current NWS pilot ou? (automated draft LSR generation, product language/b 2 chatbot, key message generation, automated 508 com n)

Poll 3 of 3 — Ended

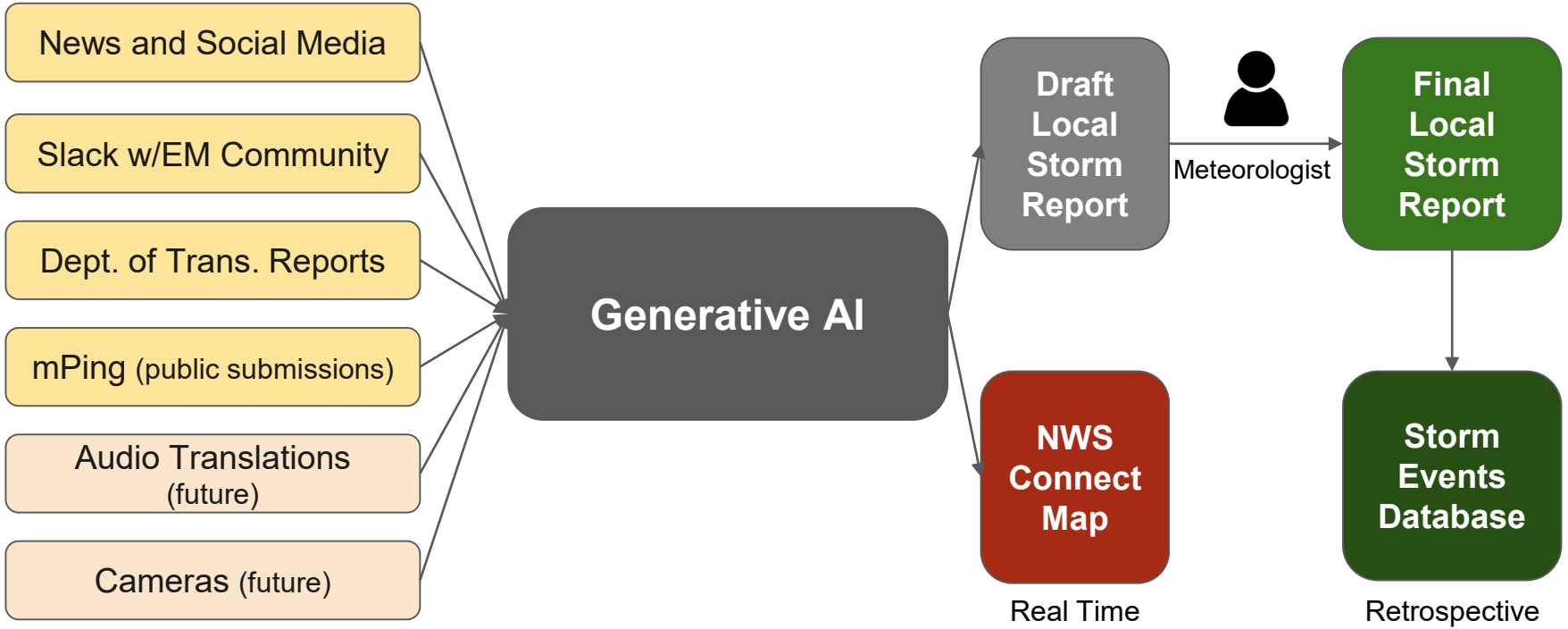
Which of the current NWS pilot projects is most exciting to you?

	votes
Automated draft LSR generation	21 votes
Product language/briefing translation	11 votes
xmACIS2 chatbot	33 votes
Key message generation	14 votes
Automated 508 compliance	8 votes
NWS Directives chatbot	5 votes

92 votes (voted)

Automating Draft Local Storm Reports

Leveraging AI to improve situational awareness and records of local storms.



NWS Training “Recommendations”

The team has discussed what, if any, training for the NWS workforce should be developed. Input from two academic partners was heavily considered.

1. **Short Term:** Vignettes on AI info now (broad defs and applications, CSU-MLP, NCAR neural network SVR, ethics of AI, etc.)
2. **Long Term:** More formally developed content with perhaps 2 tracks (technical vs. non technical etc).

Immediate Action: An introductory training video that provides high level understanding of of AI/ML with emphasis on current operational tools.
Style: Podcast / News Story with a host **Audience:** All NWS Mets
Length: Less than one hour **Available:** Early 2025

And Finally…

For NWS Folks:

- Must be part of an official NWS Pilot (Monica Youngman)
- No PII
- Do not copy code into operational systems

For Academic and Mesonet Folks:

- If you're researching or using GenAI for research that might benefit operational meteorology or NWS operations, we want to know!

More Information/VLab

- Idea Generation & Discussion
  - **AI Forum**
- Project Listing and Grouping
  - **NWS AI Project Tracking**
- People Database
  - **NWS AI/ML Community**
- **Training Resources**
- General Resources and Policy
  - **About**