Using AI/ML to Advance NOAA Missions
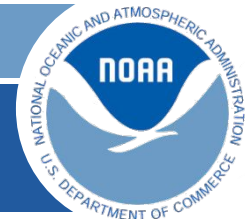## *AI in Government*

Eric A. Kihn, Ph.D.

NESDIS AI Lead, Chief of NCEI Oceans Geophysics Science and Services

Contributions from: NAIEC, NCAI Team

1/20/2022

NOAA People Supporting AI

AI Executive Committee (NAIEC) (as of January 2022*)

NMFS
Ben Richards (co-chair)
Brett Alger

OAR
Jebb Stewart (co-chair)
Venkatachala 'Ram' Ramaswamy

NESDIS
Eric Kihn
Vacant

NWS
Jamese Sims
Hendrik Tolman

NOS
Neil Weston
Tyler Christensen

OMAO
John Katebini
Vacant

OCIO
Frank Indiviglio

NAIEC Executive Secretary
Vacant

NCAI
Rob Redmon (Lead)
Jordan Watson (Deputy - LANTERN) until Feb 2022
Heather McCullough (Deputy - LANTERN) as of Feb 2022

AI Working Group (NAIWG)
Christin Khan (NMFS)
Erin Moreland (NMFS)
Christian Jones (NMFS)
Bryan Costa (NOS)
Mamoudou "Ama" Ba (NWS)
Vacant (NESDIS)
Vacant (OAR)
Vacant (OMAO)

Comms Team
Jennifer Fulford
Heather McCullough
Brian Meyer
Douglas Rao

Training Team
Douglas Rao
Chris Slocum

AI-Ready Data Team
Douglas Rao
Tyler Christensen through Jan 2022

NOAA AI Executive Committee (NAIEC)

NOAA AI WG (NAIWG)

Technical Guidance

Oversight & Guidance

Reporting & Annual Report

NOAA Center of AI (NCAI)
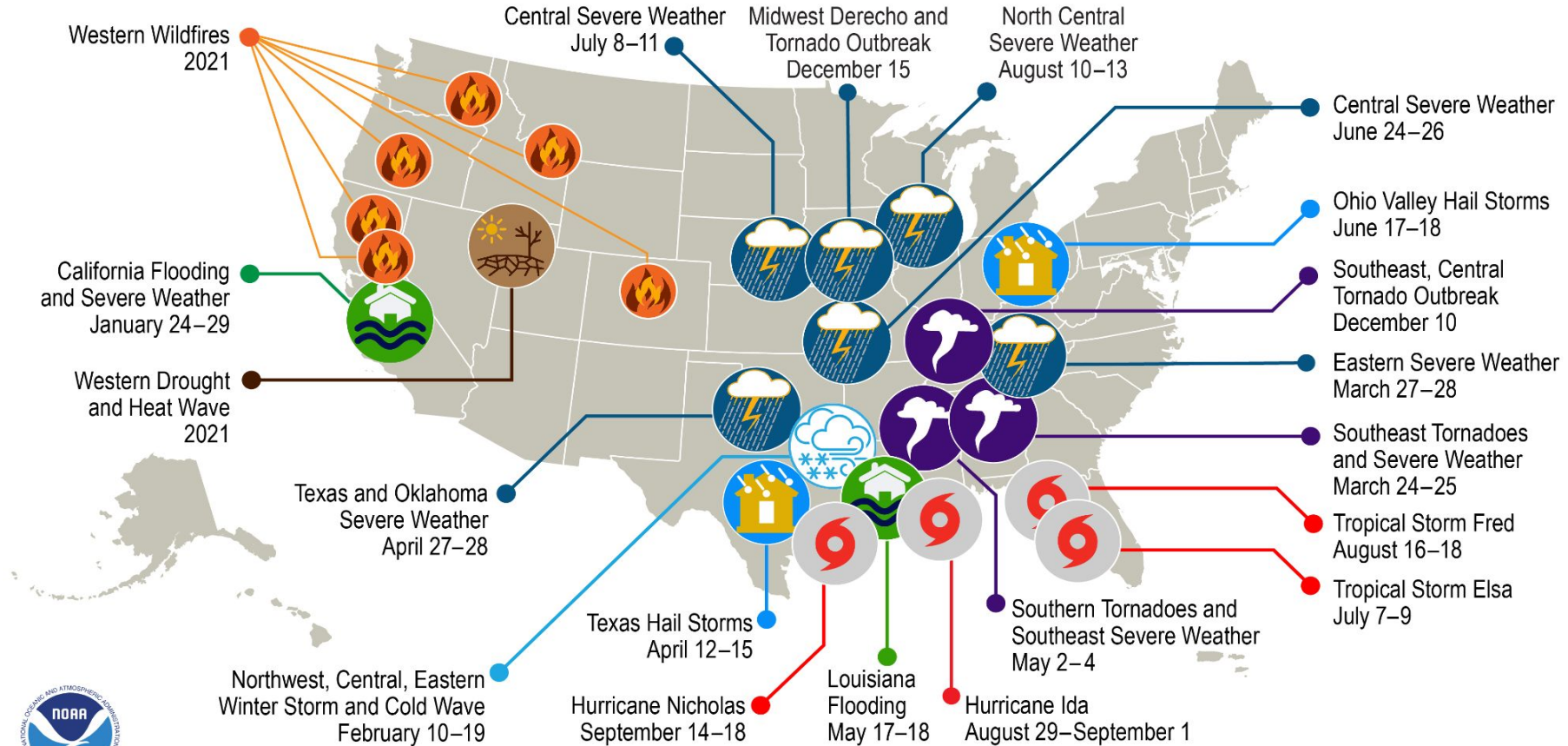
*Changes to NAIEC January 2022
Tyler Christensen replaces Greg Dusek as NOS rep
Ben Richards replaces Greg Dusek as co-Chair

Outline

- Background
  - NOAA's Mission Space
  - Drivers for AI in NOAA
- NOAA's Center for Artificial Intelligence
  - Developing and Applying an "AI-ready" standard
  - Training the Workforce
  - Engagement and Partnerships - Leveraging cross sector investments
  - NOAA Community of Practice
- Summary and Next Steps

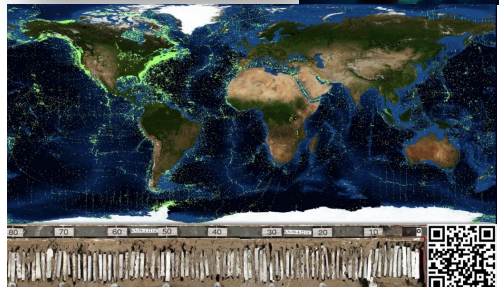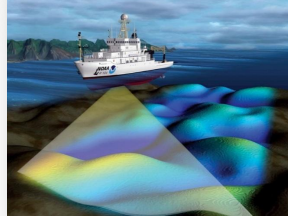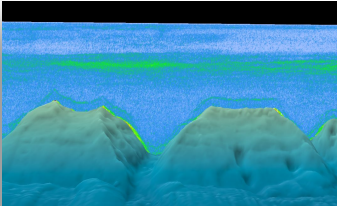# U.S. 2021 Billion-Dollar Weather and Climate Disasters

Western Wildfires
2021

Central Severe Weather
July 8–11

Midwest Derecho and
Tornado Outbreak
December 15

North Central
Severe Weather
August 10–13

Central Severe Weather
June 24–26

Ohio Valley Hail Storms
June 17–18

California Flooding
and Severe Weather
January 24–29

Southeast, Central
Tornado Outbreak
December 10

Western Drought
and Heat Wave
2021

Eastern Severe Weather
March 27–28

Southeast Tornadoes
and Severe Weather
March 24–25

Texas and Oklahoma
Severe Weather
April 27–28

Tropical Storm Fred
August 16–18

Tropical Storm Elsa
July 7–9

Texas Hail Storms
April 12–15

Southern Tornadoes and
Southeast Severe Weather
May 2–4

Northwest, Central, Eastern
Winter Storm and Cold Wave
February 10–19

Hurricane Nicholas
September 14–18

Louisiana
Flooding
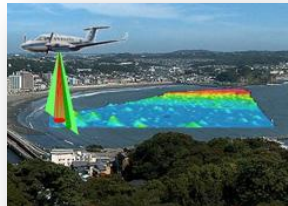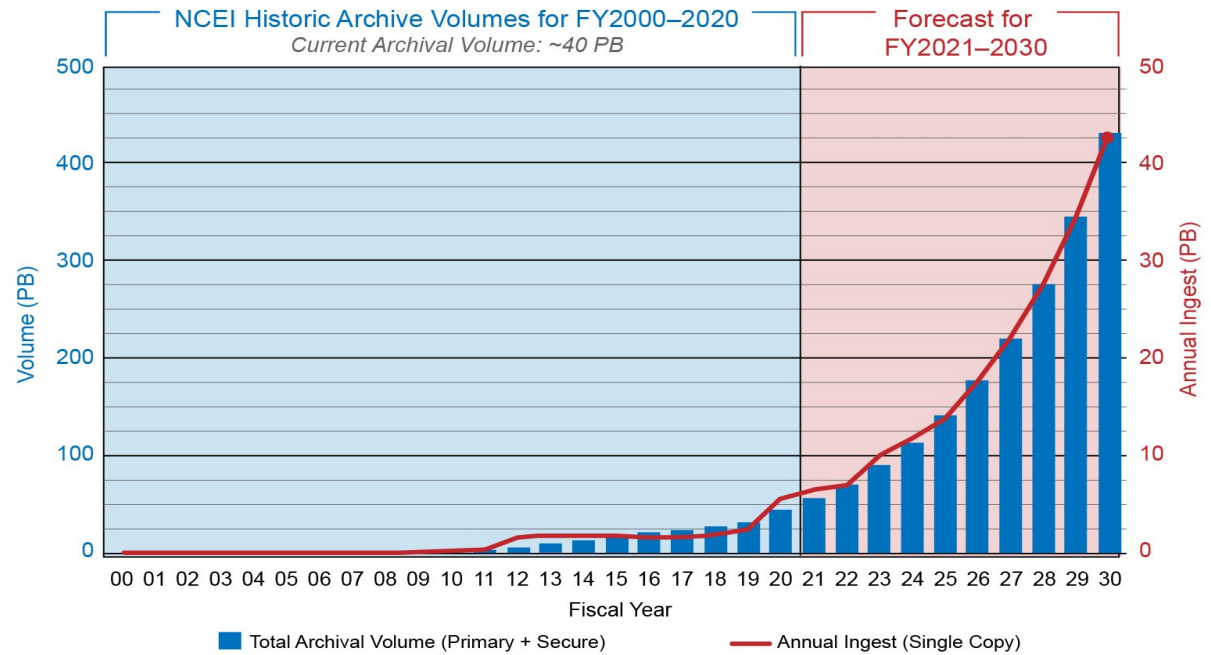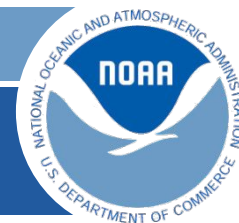May 17–18

Hurricane Ida
August 29–September 1

*This map denotes the approximate location for each of the **20 separate billion-dollar weather and climate disasters that impacted the United States in 2021***
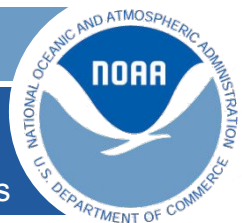
NCEI Archival Volume History and Forecast

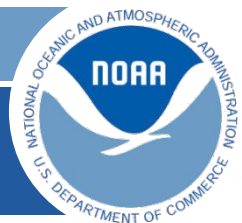Increasing Data Volumes from Station, Model, Radar, UxS, Acoustics, 'Omics, and Satellite Sources

NCEI Historic Archive Volumes for FY2000–2020
Current Archival Volume: ~40 PB

Forecast for FY2021–2030

Volume (PB)

Annual Ingest (PB)

Fiscal Year

■ Total Archival Volume (Primary + Secure) — Annual Ingest (Single Copy)

NOAA Cloud Migration

NESDIS Common Cloud Framework Roadmap
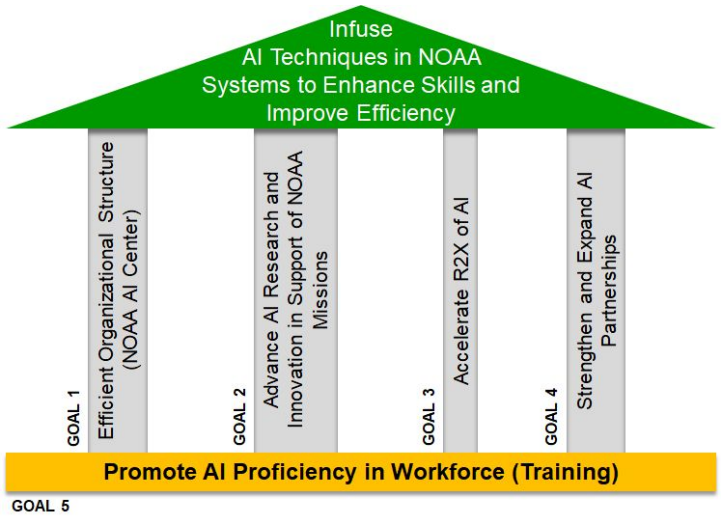
System Functionality Migration to NCCF
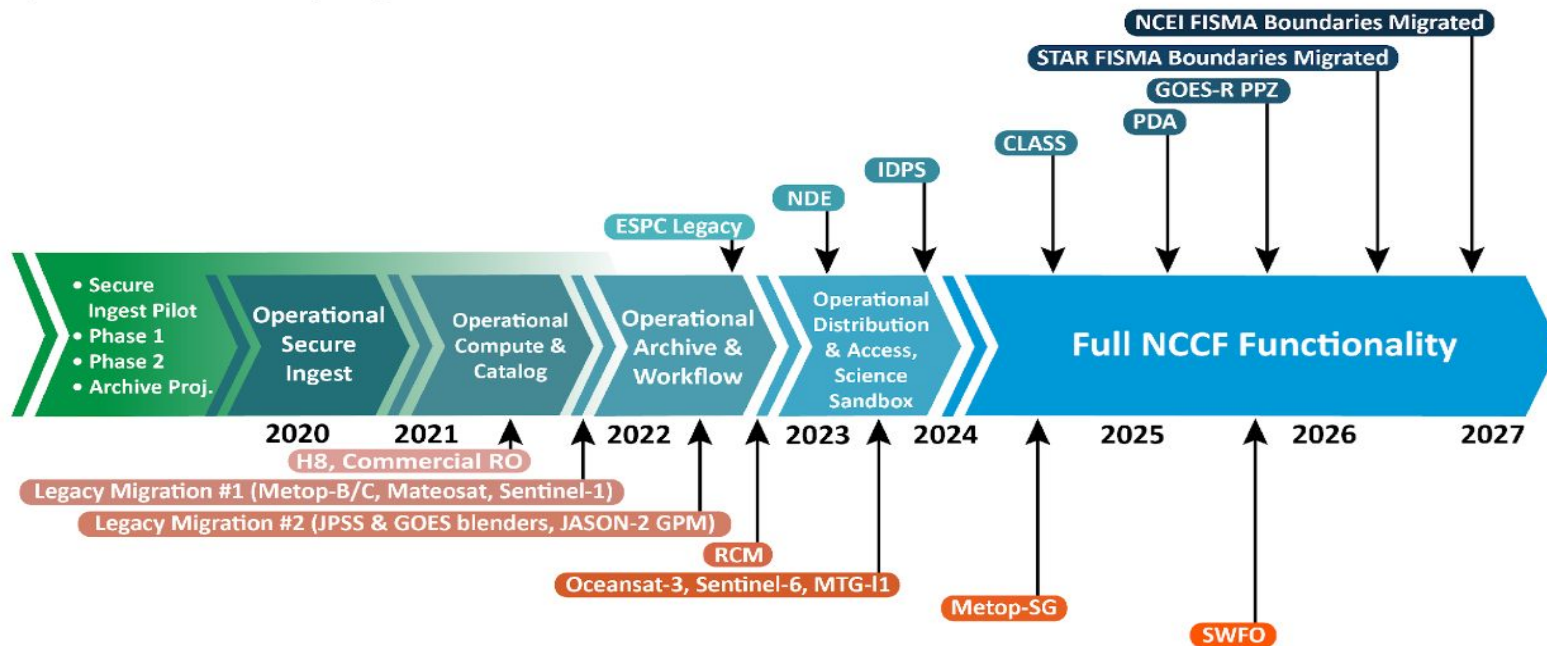
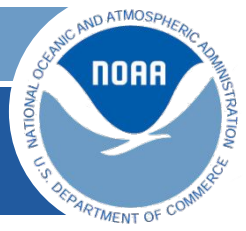**Data Stream into NCCF Operational Functions**

5/1/2021
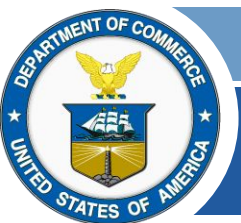
Background

National AI Initiative Act of 2020:
"The Administrator of the National Oceanic and Atmospheric Administration (hereafter referred to as ''the Administrator'') shall establish, a Center for Artificial Intelligence"

Infuse AI Techniques in NOAA Systems to Enhance Skills and Improve Efficiency

GOAL 1 Efficient Organizational Structure (NOAA AI Center)

GOAL 2 Advance AI Research and Innovation in Support of NOAA Missions

GOAL 3 Accelerate R2X of AI

GOAL 4 Strengthen and Expand AI Partnerships

Promote AI Proficiency in Workforce (Training)

GOAL 5

NOAA Artificial Intelligence Strategy
Analytics for Next-Generation Earth Science

Draft NOAA Citizen Science Strategy
Applying the Power of the Crowd

NOAA Data Strategy
Maximizing the Value of NOAA Data

NOAA Cloud Strategy
Maximizing the Value of NOAA's Cloud Services

NOAA Uncrewed Systems Strategy
Maximizing Value for Science-based Mission Support

NOAA 'Omics Strategy
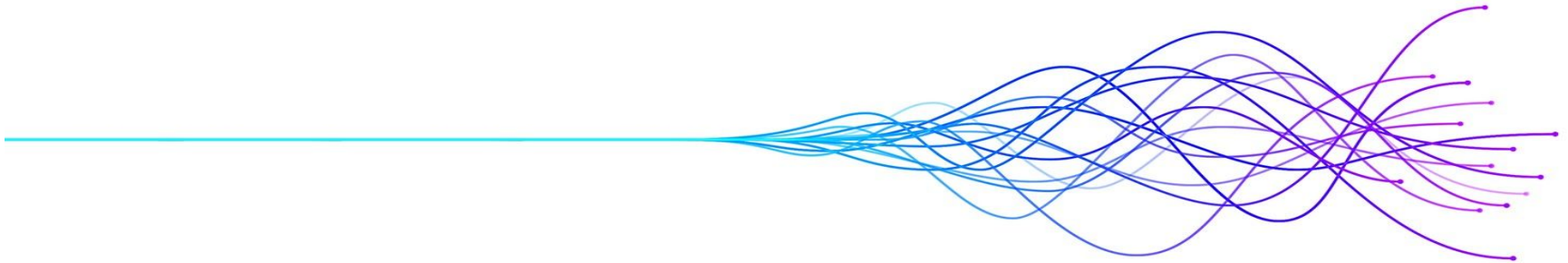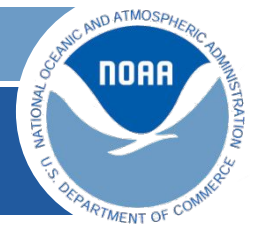Strategic Application of Transformational Tools
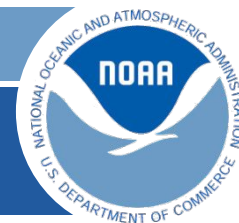
NOAA Center for AI

noaa.gov/ai

NCAI's Vision - "To empower the proliferation of AI at NOAA by lowering the cost of engaging curiosity through AI applications to capture mission value through its Community of Practice."
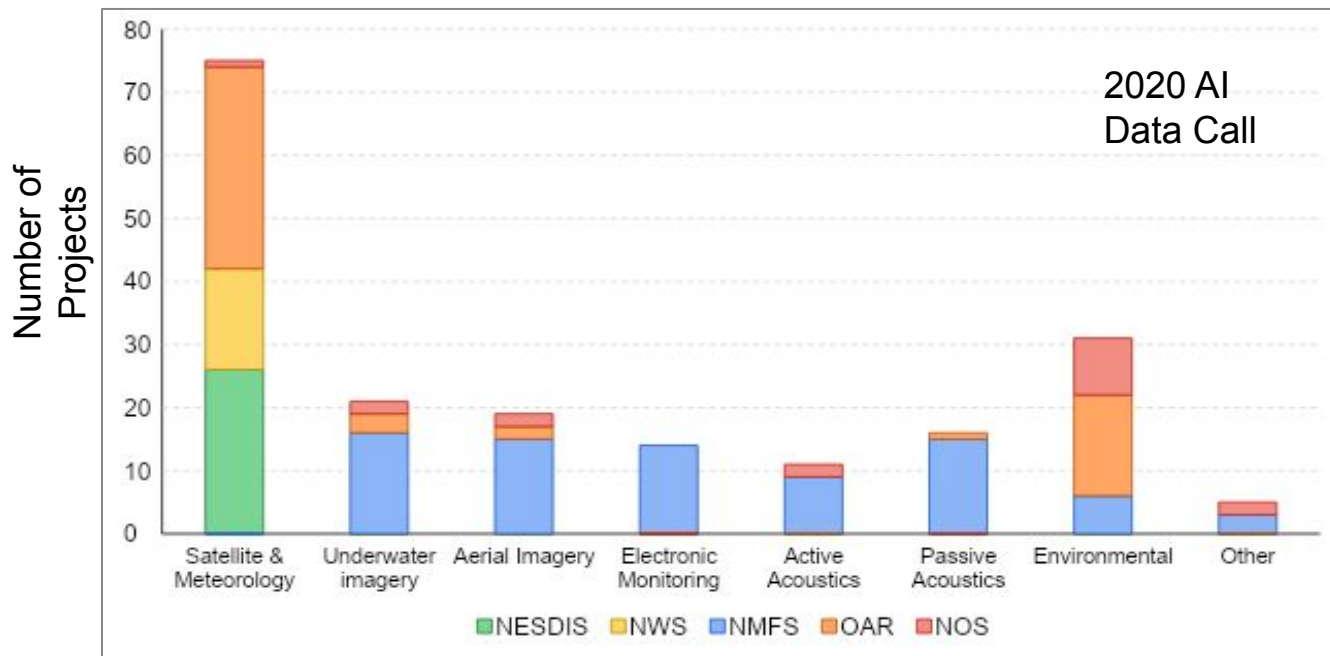
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NCAI Initial Efforts

- Understanding the NOAA AI Portfolio
  - Pilots->Operations-> Next Generation
- AI-Ready Data
  - Data deluge → Automating data wrangling → Actionable information
- Training our AI-ready Agency & Workforce
  - Differing Perspectives → Basic Fluency → Efficient R2X
- Partnership Development
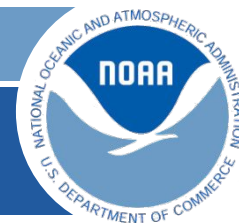 - Cross-sector Investments → Develop Partnerships → Harvesting & Cost Avoidance

NOAA 2020 AI Data Call – Data Types

NOAA has applied AI-ML to a variety of environmental data demonstrating its interdisciplinary research and operational capabilities in support of its cross-functional mission requirements.


Chart title: 2020 AI Data Call

Y-axis: Number of Projects (0 to 80)

X-axis categories: Satellite & Meteorology, Underwater imagery, Aerial Imagery, Electronic Monitoring, Active Acoustics, Passive Acoustics, Environmental, Other

Legend: NESDIS, NWS, NMFS, OAR, NOS

Analyzing the results of the 2022 Call is In Progress

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NOAA AI Data Call – Data types & TRLs

NOAA has made progress in transitioning the applications of AI-ML into operational efficiencies, as shown by the Technology Readiness Levels (TRLs). About 37% of the NOAA AI projects are in transition, while 25% reached the operational phase.
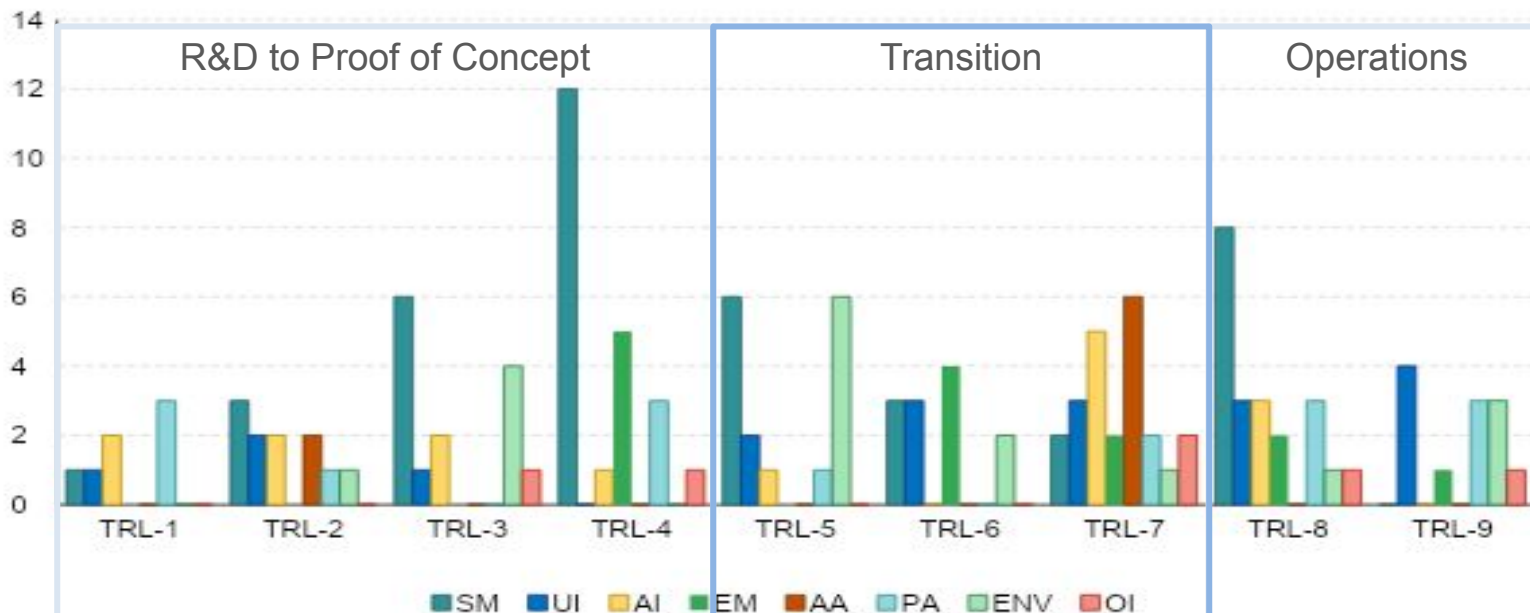
SM (Satellite/Weather), UI (Underwater Imagery), AI (Aerial Imagery), EM (Electronic Monitoring), (AA) Active Acoustics, (PA) Passive Acoustics, ENV (Environmental Observations), OI (Other imagery)

Advancing AI Research through Life Saving R2O
Detecting Rip Currents in Coastal Webcam Imagery

National Ocean Service

Objective: Detect rip currents in coastal webcam imagery using regional convolutional neural networks

Benefits: The algorithm will be applied to webcam imagery collected by the NOAA-funded WebCOOS camera network in the Southeastern US. The results will support implementation and improvement of the NOAA rip current forecast model

Partnerships: UC Santa Cruz; UNC Wilmington; U of South Carolina; SECOORA; USGS

De Silva, A., I. Mori, G. Dusek, J. Davis and A. Pang (2021), Automated rip current detection with region based convolutional neural networks, Coastal Engineering, https://doi.org/10.1016/j.coastaleng.2021.103859

Principal investigators: Gregory Dusek (gregory.dusek@noaa.gov), Alex Pang (pang@soe.ucsc.edu)
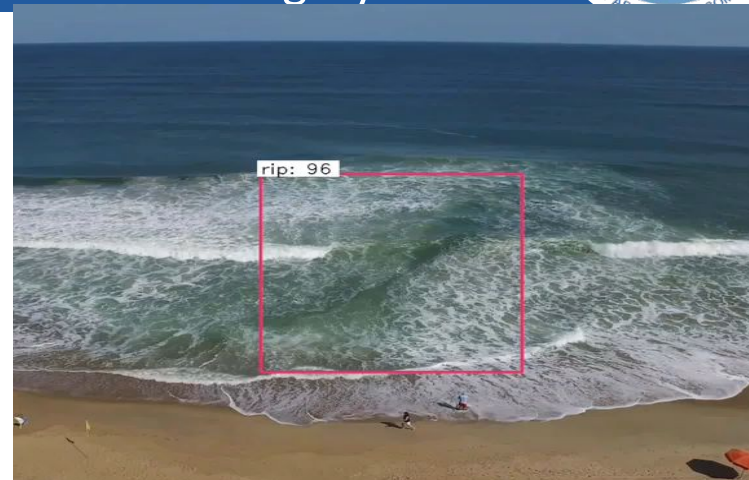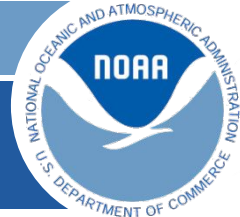
Example: Natural Language Processing

Machine Learning technique where algorithms identify patterns and context of words to find meaning in unstructured text documents

Example pilot application: A summer Hollings Scholar project used NLP to improve data discovery by harvesting structured metadata from unstructured text documents, demonstrating improved search precision

Example pilot application: Can machine learning find the link between the words used in research articles and the data referenced in the article?
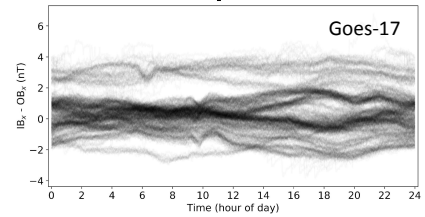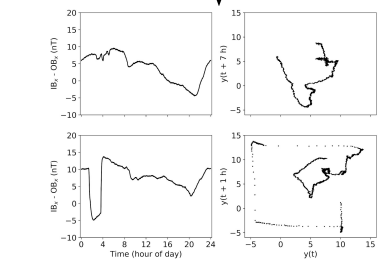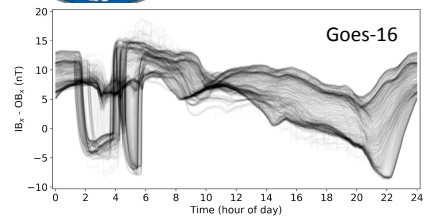- Collaboration led by the Coleridge Initiative
- Recent Kaggle competition using NOAA, USDA, and NSF datasets
- Early effort shows promise; planning phase 2 of "Show Us the Data".
- Potential benefits
    - Help researchers find data used in their research topic
    - NOAA understands our data users and shows the value of investing in our data
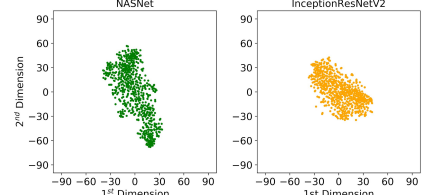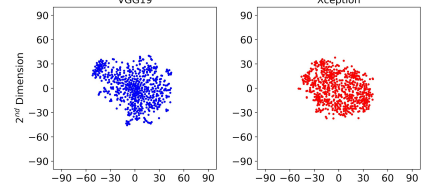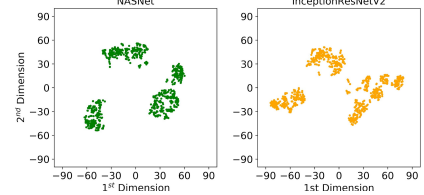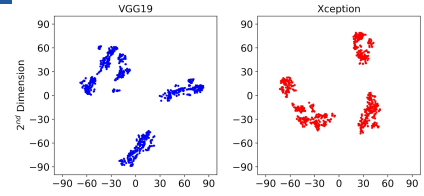

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
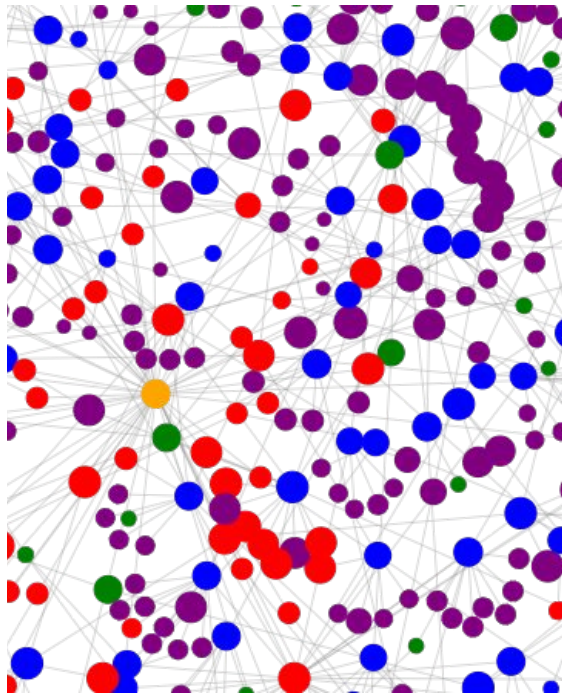
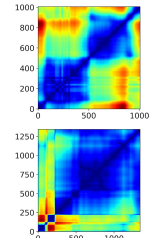# Advancing AI Research through Exploring Critical Problems
GOES-R Magnetometer Challenges - Classification of Differences

- Observed differences can be clustered into four main classes,

- Temporal distribution of classes points to major orbital effects on the measured magnetic field strengths by Inboard and Outboard Magnetometers,

- This result could potentially be used to build a step function to correct GOES-R MAG data that is used to provide real-time warnings of geomagnetic storms.
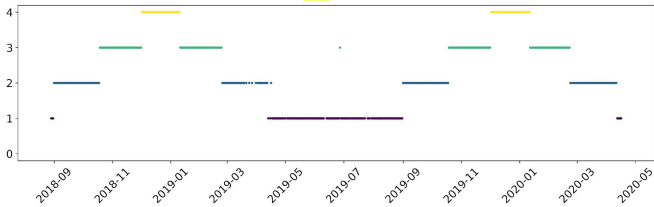
Time series → Phase space → Recurrence Plot → Transfer Learning for feature extraction & Dimension Reduction using TSNE → K-Means Clustering → How clusters are distributed in time

AI-Ready Data

"The most common reason I can't use a dataset is just that it doesn't have the right content, either in terms of what variables are in it, or its coverage, or its resolution, or the purpose it was created for, so having all of that information readily available speeds up discovery a lot."
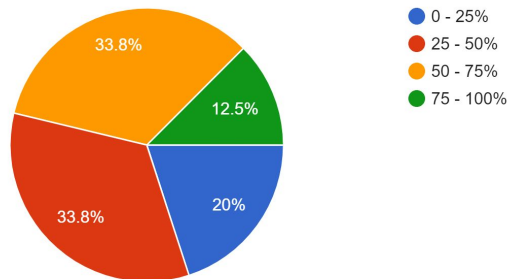
"Complete and consistent data sets are even more important in AI/ML projects"

AI-Ready Data: Why?, What? and How?

In your typical AI/ML application development, roughly what percentage of your time do you spend on finding, accessing, and preprocessing data?
80 responses

- 0 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%

33.8%
12.5%
20%
33.8%

Almost half of respondents spend **at least half of their time on data wrangling**, before they can get to work on the science questions they are trying to answer.

Goal: users spend less time data wrangling, more time on AI / ML
*How can data users find data that is easy to use in AI/ML?*
How can data providers assess and improve usability?

What's needed:
- Specific community driven definition of AI-readiness requirements
- Assessment tools for data providers
- Way to represent readiness level so providers can report data readiness and users can compare
- Feedback and iteration to improve the standard
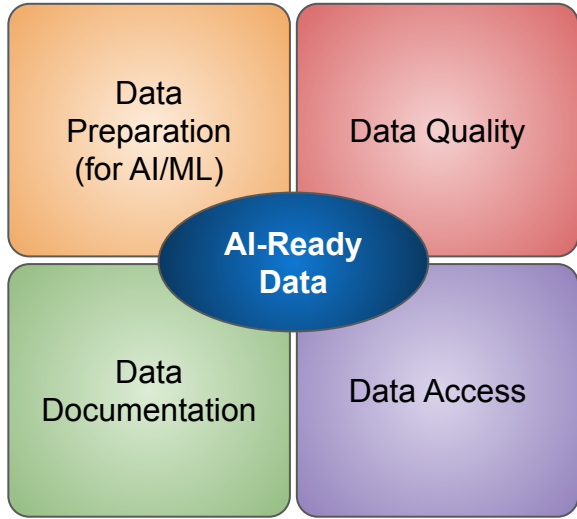- Ideally, a formally published standard (or set of standards)

NOAA is leading a collaboration under the Earth Science Information Partners (ESIP) working to develop the standard. Membership includes US Federal agencies, universities, NGOs, private sector, and international
- https://wiki.esipfed.org/Data_Readiness
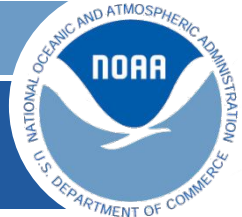
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AI Ready Data Survey
Req's for Open Environmental Data → Enable AI Applications

Data Preparation (for AI/ML)

Data Quality

AI-Ready Data

Data Documentation

Data Access

FY-22 Delivery: Develop a preliminary AI-ready data standard by engaging across NOAA and external stakeholders via ESIP, and workshops. Present the preliminary standard at AMS, AGU or ESIP Winter Mtg (FY22 Q2). Test the standard against a pilot set of data sets (FY22 Q3). Include the standard in at least 1 call for proposals or funded opportunity (FY22 Q4).

What makes a data set "AI-Ready"?
What usability improvements should providers prioritize?

Survey Categories and Sample Questions:

Demographic / Background - sector & research domain

Data Preparation - Gap filling, gridding, outliers, labels
- e.g. Which of these data preparation factors is most important for your most common application needs?

Data Quality - Completeness, consistency, bias, provenance

Documentation - Metadata, DOIs, example code
- e.g. Which of these data documentation factors is most important for your most common application needs?
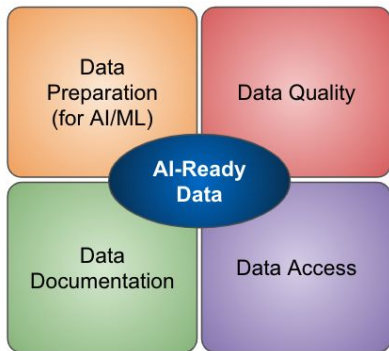
Data Access
- e.g. Which file formats can you work with in your AI/ML applications? Which do you prefer?

Training Data Reuse - Sharing labeled datasets

AI Ready Data Survey
Req's for Open Environmental Data → Enable AI Applications

Data Preparation (for AI/ML)	Data Quality
AI-Ready Data	
Data Documentation	Data Access

Initial findings January 2022:

(93 responses to date with most from USG, 9% NGO, 12% Private)

Data Preparation: Outliers included & tagged, gridded in space & time, labeled targets

Documentation: Metadata w/details about all parameters, example code/Notebooks, and information about space/time extent,

Data Quality: Consistency, Completeness, Resolution, Lack of Bias

Data Access: Cloud, File download, API are fairly evenly split

Training Data Re-Use: 58% published their training data, and 50% used training data from another group

What formats can you work with for AI/ML?
- Self-describing formats preferred
- Text formats (e.g. csv) also good
- Some prefer cloud-optimized

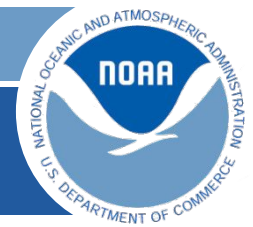Flexible: 67% can handle 4 or more formats
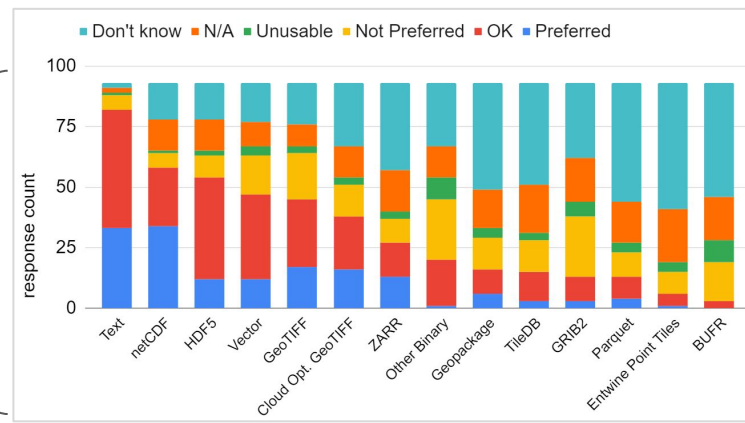
Training our AI Ready Agency & Workforce

"Tell me and I forget, teach me and I may remember, involve me and I learn."

– Benjamin Franklin

Assessing NOAA's training resources & requirements

NOAA AI Strategic Plan:

"complete annual assessment of NOAA AI training resources and requirements"

(Strategic Action 5.1.1; starting FY2022)

NCAI Goals for Survey:

- Prioritize training needs
- Identify gaps & develop training plan
- Engage Community of Communities of Practice in development of training plan

(Draft NCAI Actions 5.1.1. A and B)


Center for Artificial Intelligence

NCAI Resource Assessment

This is a request for information on NOAA artificial intelligence (AI) specific to workforce development. The information collected here will assist in ranking training/resource priorities, focusing development of NOAA-specific training needs and activities, and highlighting existing AI training material and toolkits across the agency.

This assessment has three components, and you may select any of the three to contribute. The broad topics are:

- Training priorities input: help NCAI rank priorities for identified training needs based on community of practice input.
- Specific training needs/resources: if NCAI missed a critical training priority, submit a new need.
- Existing resource awareness/contribution: if your office has a resource, please alert NCAI to its existence.
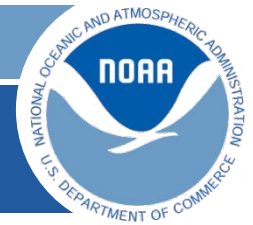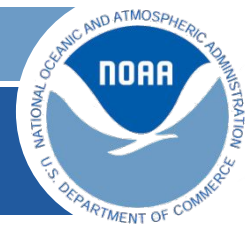
Assessing NOAA's training resources & requirements

High Level Summary

- 81 respondents
  - 75% – federal employees
  - 25% – affiliates

- 75% of the respondents are AI/ML practitioners

- ~40% respondents with managerial roles
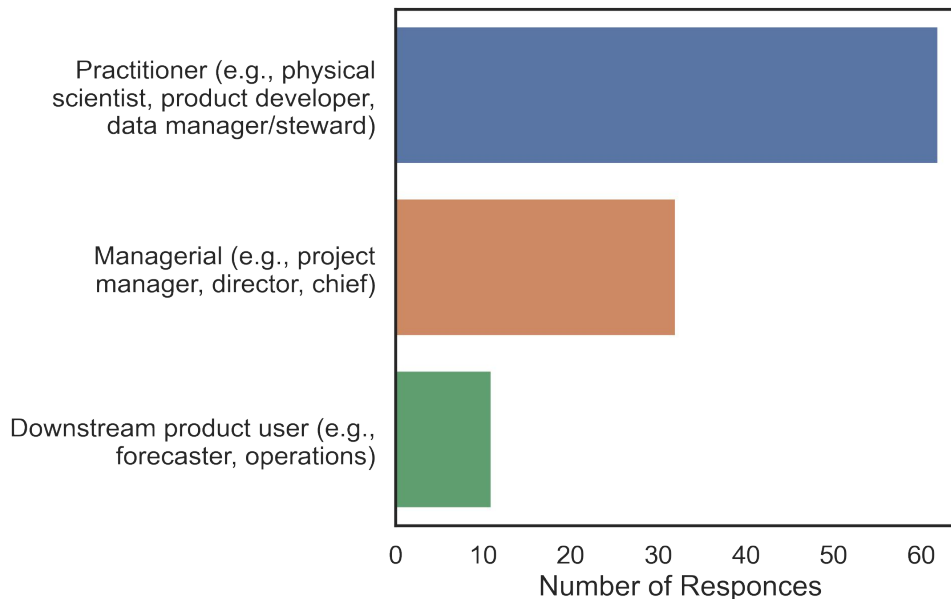
Powering Discovery and Innovation
with Training, Trustworthy, and Equitable AI-ready Services

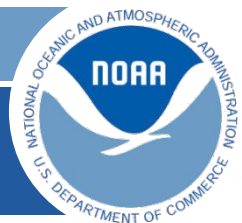## Training + AI-ready data for Trustworthy + Equitable AI-ready Services

Factsheet: *https://www.noaa.gov/ai/training*

*Urgent: need **NOAA-specific training material** using NOAA data and computing resources to **remove common barriers** to the "Research to Operations, Applications, and Services" pipeline.*

*To address needs, resource creation should be prioritized to **convert NOAA AI success stories** into interactive training material in a **sandbox computing environment** that allows the workforce to immediately apply learning outcomes to support NOAA's mission via the AI strategic plan.*
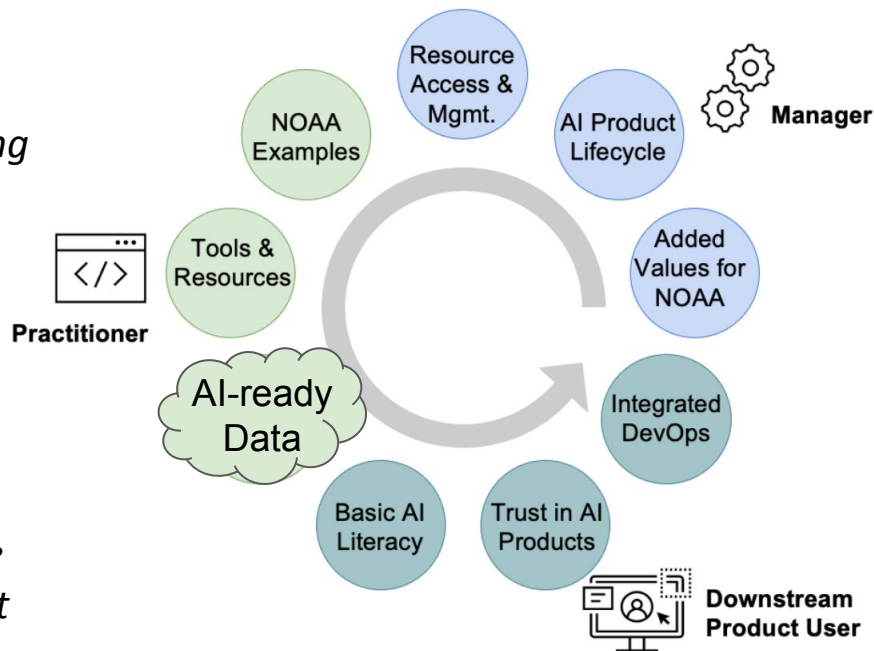
NOAA training action priority lifecycle highlighted by workforce role and relationship to AI. (noaa.gov/AI/training)

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A Flexible Training Framework Driven by Open Science
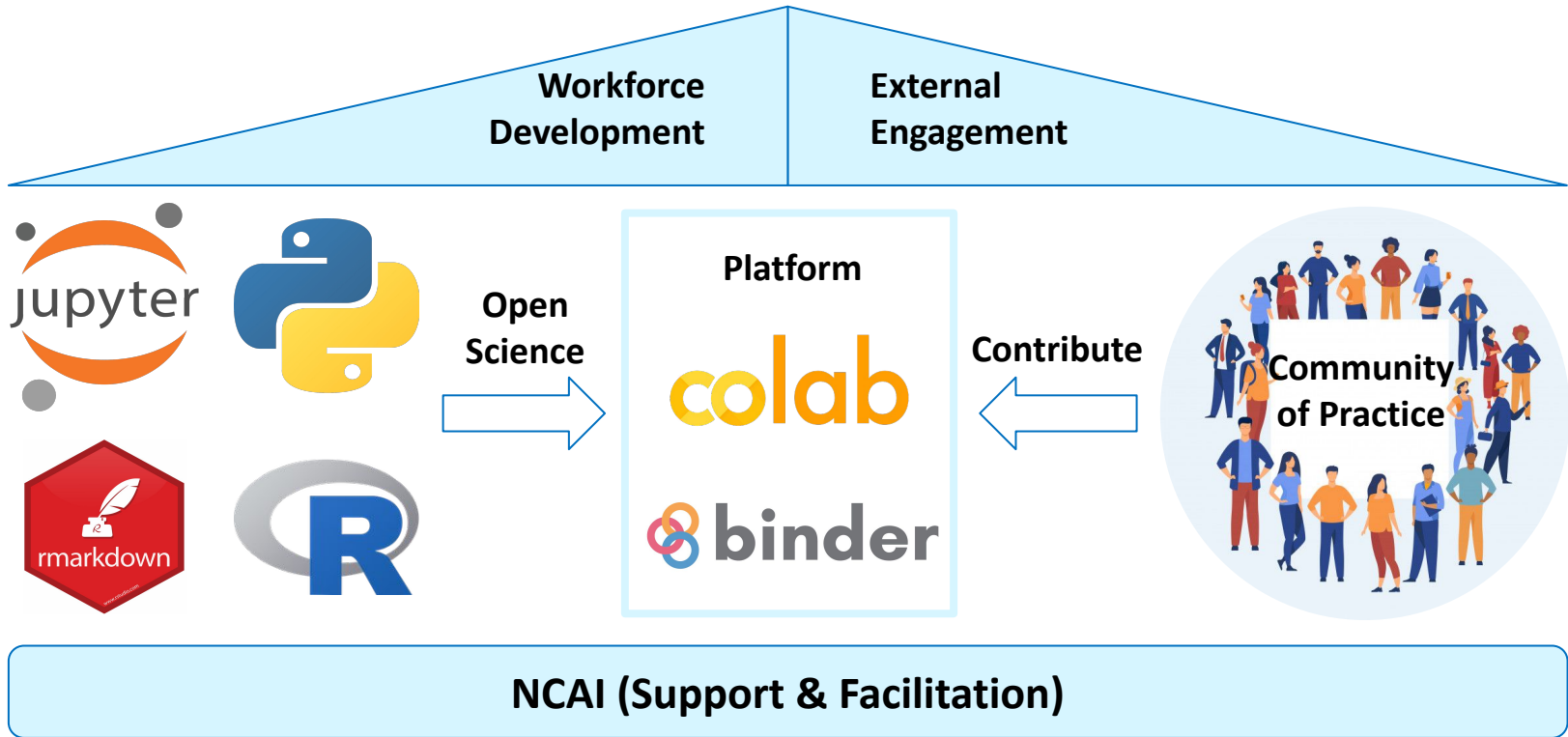
Learning Journeys to Empower Diverse Learners

Beginner Users
- No previous background
- Need comprehensive info about problems & overall workflow

Intermediate Users
- Have basic knowledge & experiences
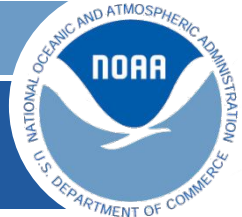- Want to learn advanced AI/ML tools for applications

Advanced Users
- Experienced in AI/ML applications
- Want to keep up with tools & best practices

Experience-based *user profiles to navigate learning journeys*

Multilinear Regression → Decision Tree → Extreme Gradient Boosting

Decision Tree → Random Forest

Multilinear Regression → Neural Network → Convolutional Neural Network

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Learning Journeys to Empower Diverse Learners

Understand values and risks of AI/ML

Managers

Understand how to be involved in defining the problem

Users

Learn lifecycle management for AI/ML DevOps

Enhance users' trust in AI/ML products

Problem Definition

Performance Monitoring & R2X

AI/ML Lifecycle

Data Engineering

AI/ML Development

Practitioners

Optimize data pipeline for AI/ML development

Learn various AI/ML tools for domain applications

Understand Research-to-Operation best practices

NCAI Learning Journeys to empower different **role-based user profiles** *to develop AI proficiency.*

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Tools Development to Empower the Community

Jupyter notebook template with guidebook

Notebook readability assessment

RATCHET - Readability Assessment Tool for Code that Helps with Effective Training

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Partnership Development
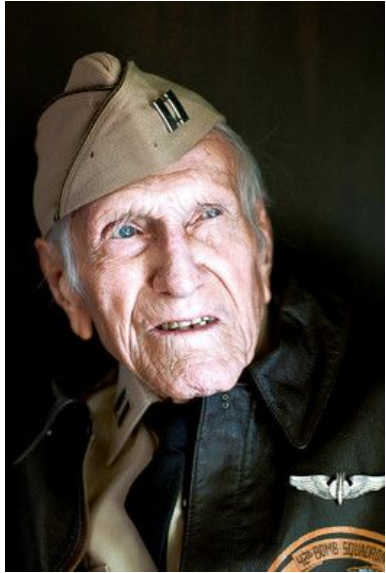
Everyone needs that support-even if at first you don't think you do. Look around. See who's on your side and in your corner. You don't have to go it alone. - *Louis Zamperini*
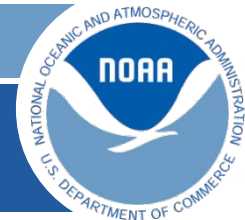
Partnership Development - through Competition

MagNet: Model the Geomagnetic Field - Internationally Open Machine Learning Competition

- *NCEI innovates* 2020 funded an open data-science competition to improve our ML model to predict *Dst* from solar-wind data, mitigating the impacts of space weather geomagnetic storm events on magnetic navigation systems
  - 600 participants and 1200 model submissions, with prize finalists achieving ~11.1 – 11.5 nT RSME on the private test set, very close to the theoretical limit.
  - NCEI internally validated all four of the winning models
- R2O: Incorporate the winning model in the HDGM-RT (ongoing)
- Training: Documentation - Develop an NCAI Learning Journey interactive notebook (ongoing)
- Partnerships: Sponsored by NOAA, with support from NASA's Center of Excellence for Collab. Innovation (CoECI). Challenge was conducted by DrivenData and HeroX.
  - Long term collaboration with the 2nd place winner, Dr. Belinda Trotta
- Contacts: Manoj Nair (PI), Rob Redmon (Gov't POC)

Article in *Room Space* Magazine

Forecasting space-weather effects on Earth

Dr. Belinda Trotta
Melbourne, Australia
Senior Software Engineer
2nd Place
Private score: 11.25

User or team	Best private ↕ RMSE ⓘ
Ammarali32	11.1311
belinda.trotta	11.2532
LosExtraterrestres	11.2944
k_squared	11.5293
leigh.alt	11.6183
LastRocky	11.6504

: Model the Geomagnetic Field

COMPETITION COMPLETE
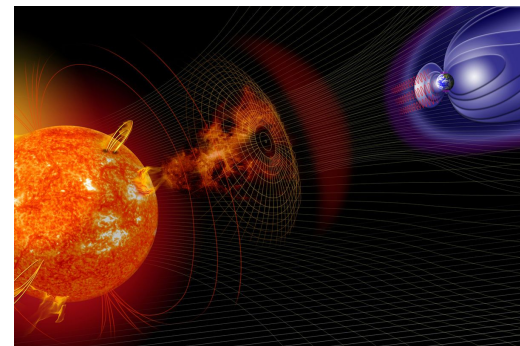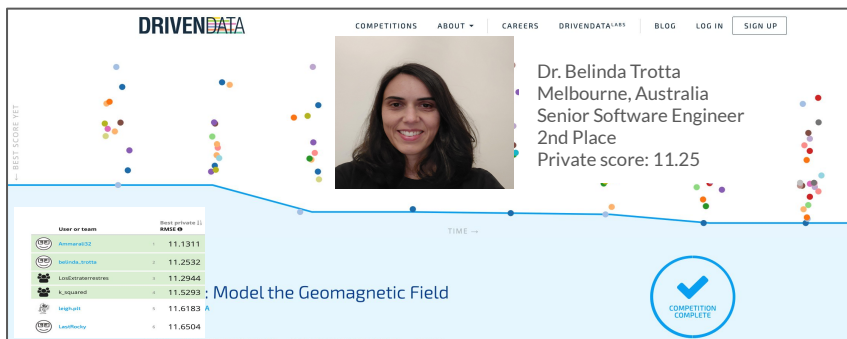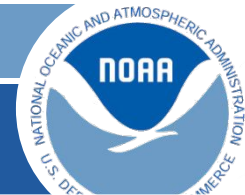
Partnership Development - through Common Goals
OK Google, Find the humpback whales

- PIFSC deployed bottom mounted HARPs since 2005
  - 13 Pacific Island sites
  - 200+ TB
- **AI for Social Good**
  - Identify humpbacks
  - Decimated to 9.2 TB
    - 200 kHz -> 10 kHz
  - Classifier for 75 sec segments attains 90% precision at 90% recall for supervised learning
  - Unsupervised learning retrieves similar song units
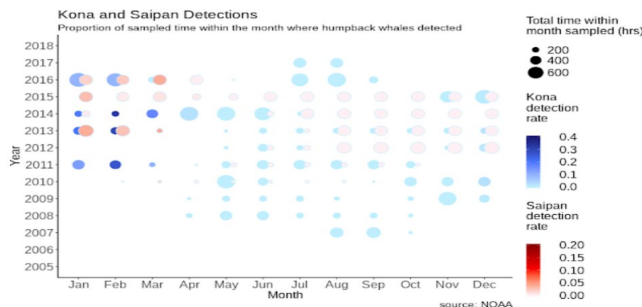
Time density of presence for Kona and Saipan
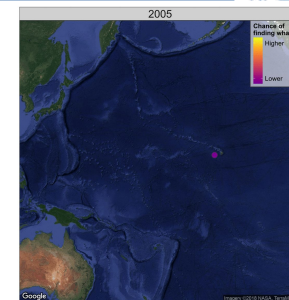
Relative call abundance identified by the classifier
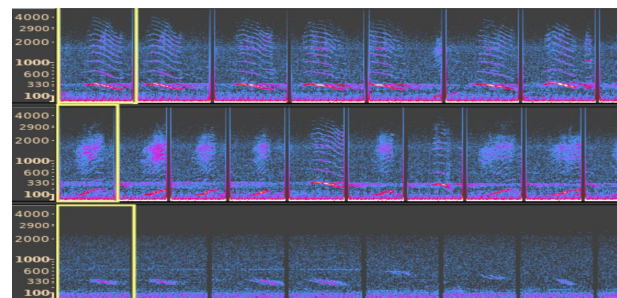
Manually chosen calls (boxed) and nearest neighbors

PIFSC: Ann Allen & Karlina Merkens
Google: Matt Harvey, Jiayang Liu, Julie Cattiau, Aren Jansen, Rif Saurous, & Lauren Harrell
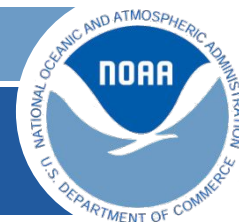
Partnerships Representative Callout
(Examples here - not an exhaustive list)

- **National Science Foundation**
  - [AI2ES](#) - Research on Trustworthy AI in Wx, Climate, & Coastal Oceanography, AI4ES Summer
  - AI-Ready data (via [ESIP Data Readiness](#)); Explainable AI; Trustworthy and Responsible AI
- **Industry**
  - Exploring OTAs, CRADAs and other opportunities to build on public private investments and partnerships; and develop our workforce.
- **UKMet Joint Centre for Excellence in Env. Intelligence**
  - Exploring co-developed Learning Journeys, Digital Twins

Partnerships are built around the relative strengths of the partners

Pilot Projects	WWCB Societal*	AI-Ready	Learning Journey	Training Data
Combining the power of citizen science and artificial intelligence to make new discoveries in our ocean soundscapes Crowdsourced annotation of acoustic Big Data and streamlined application to AI models will decrease latency in developing data products critical to managing the Blue Economy empowering citizen scientist exploration, leading to AI models to address NOAA science and management questions.	1			Y

30
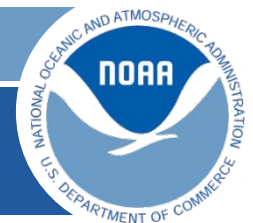
Transforming Weather, Climate Services, and Blue Economy with Artificial Intelligence

203
Submitted Abstracts
from government, academia, private industries, and international partners

1325
Registered Participants
from 34 countries
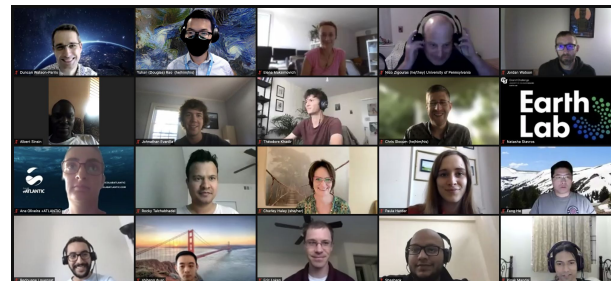
~ 50%
are students and early- career professionals

~ 60%
are non-NOAA participants

~175
international participants from outside of U.S.

~150
registered hackathon participants

Partnership Development
Through Workshop Engagement

580

Slack Workspace Members

3381

Messages in Slack during the workshop

enviro-ai ⌄

- Threads
- All DMs
- @ Mentions & reactions
- Saved items
- Slack Connect
- More

▼ Channels
- # 00_help-desk
- # 01_workshop
- # 02_introduction
- # 03_weather-and-climate
- # 04_blue-economy
- # 05_community-of-practice-wor...

📡 00_help-desk

00_help-desk ⌄   👤 569

Radha Jain   Wednesday, September 15th ⌄
Hi there - I don't have the link for getting into the poster session. Would you be able to send it to me @admin?
6 replies Last reply 1 day ago

Abigail Powell 4:26 PM
Hi there, I'm presenting in session 8A Research to Operation but the zoom link does not seem to be active yet. Has there been a change?
4 replies Last reply 1 day ago

Andrew Justin 5:04 PM
is there a zoom link for the poster presentations? I don't see a link or a button to join a zoom call
1 reply 1 day ago

Send a message to #00_help-desk

193 messages
#00_help-desk
Asking for help for workshop

118 messages
#02_introduction
Creating networking opportunities

435 discussions
#03_weather-and-climate
Active discussion for AI research in weather and climate

156 discussions
#10_hackathon
Active engagement during hackathon events
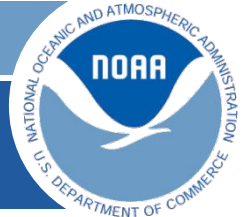
NOAA's 4th AI Workshop Ideation
Bridging the Gap Between Awareness and Actions

In 2022, the 4th NOAA AI Workshop will be a Hackathon approach.

Infusing ***NOAA priority areas*** in problem definition process by ***engaging with diverse stakeholders***.

Improving ***AI-readiness*** for NOAA data

Addressing NOAA priorities through ***co-development***

"Sweet spot" for hackathon-style event.

Problem Definition

Data → **Collect** — **Prepare** — **Analyze**

Model **Train** — **Evaluate** — **Optimize**

Production System **Deploy** — **Optimize** — **Monitor**

Lifecycle Management
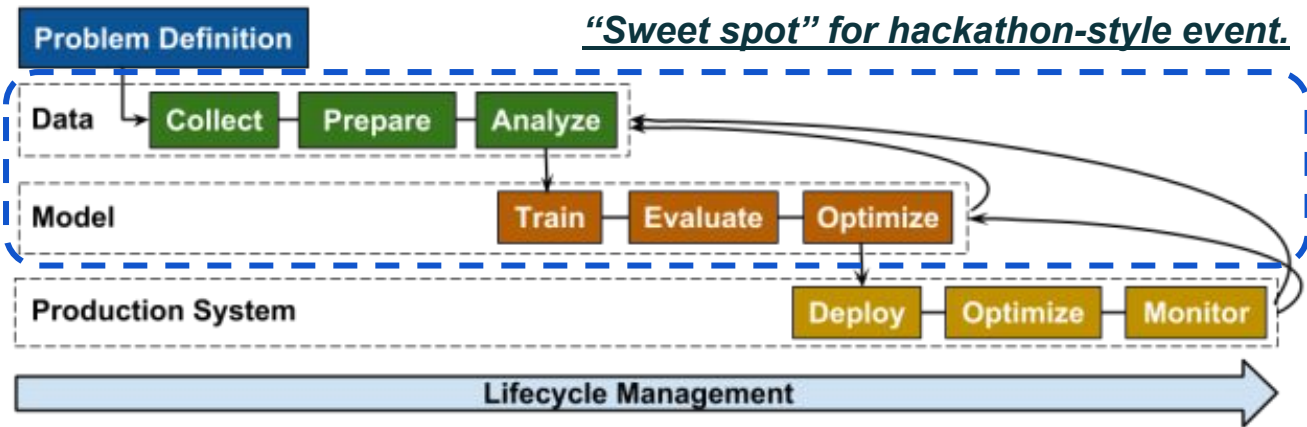
Facilitate ***workforce training*** & ***partnership*** to accelerate AI adoption.
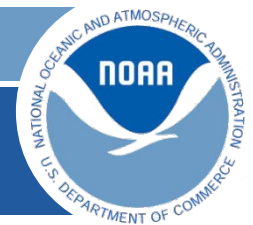
Connect with Us!

Join our *Public* Community

- ***NEW!*** noaa.gov/ai
- *Connect with NOAA's Community of Practice around AI for Earth system science*
- Mailing List: https://tinyurl.com/y2ehvhfg
- Contact the NCAI Team: ncai-team@noaa.gov

Inside NOAA's Ecosystem?

- https://sites.google.com/a/noaa.gov/ncai/
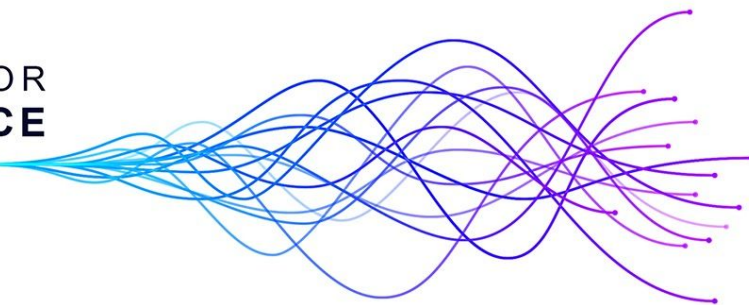
Help add to our AI Collaboration User Stories on noaa.gov/ai

NOAA CENTER FOR
ARTIFICIAL INTELLIGENCE

News and events

3rd NOAA Workshop on Leveraging AI in Environmental Sciences
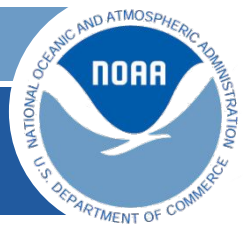
Backup Slides

CrowdMag

- NCEI develops and hosts the CrowdMag crowdsourced magnetic field smartphone app

  - From passive observing and background data collection to "Magtivities" to work within OS restrictions

- CrowdMag has over 12k participants on 6 continents

- Create multiple scales of magnetic field models

  - City/Regional and Global

- Flight Mode in development to turn commercial flights into aeromag data collection surveys

- ***Developing AI/ML algorithms to help clean data and identify biases based on phone make/model***

CrowdMag downward component data (nT)
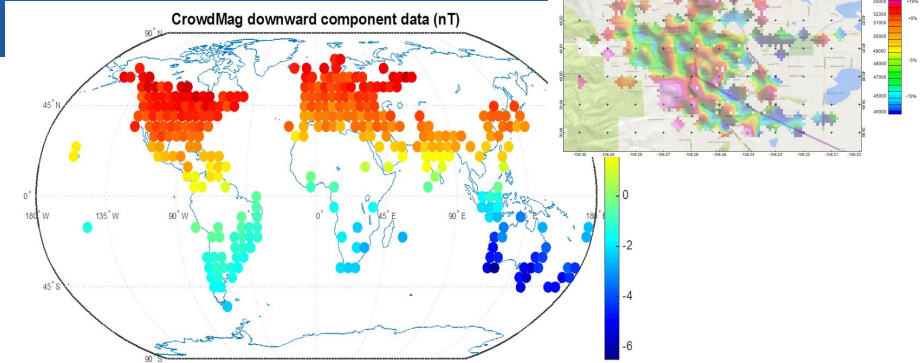
Help Improve Navigation for The World

CrowdMag
The First Crowd-Sourced Geomagnetic Mapping App

Download on the App Store

GET IT ON Google Play
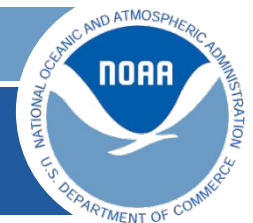
NOAA's Center for Artificial Intelligence

Team

Rob Redmon (NCAI Lead)

Jordan Watson (Deputy, LANTERN)

Eric Kihn (NESDIS AI Representative)

Douglas Rao   Chris Slocum

Jennifer Fulford   Heather McCullough

Brian Meyer   Jebb Stewart

Ben Richards   Paul DiGiacomo

Ken Casey   Dave Fischman

Huai-min Zhang   Stephanie Herring

Tyler Christensen (AI-ready, LANTERN)

Focusing on: Workshop and Engagement, Training, AI-Ready Data, Strategy

Coordination across NOAA Line Offices

NOAA AI Executive Committee

S&T Synergy Committee

NOAA AI Working Group (onboarding)

Foundations

[National AI Initiative Act of 2020 (DIVISION E, SEC. 5001)](#)

"The Administrator of the National Oceanic and Atmospheric Administration (hereafter referred to as ''the Administrator'') shall establish, a Center for Artificial Intelligence"

Goals

Goal 1: Efficient Governance

Goal 2: Advance AI Research

Goal 3: Accelerate R2X

Goal 4: Partnerships

Goal 5: AI Workforce Training

NOAA Artificial Intelligence Strategy — Analytics for Next-Generation Earth Science
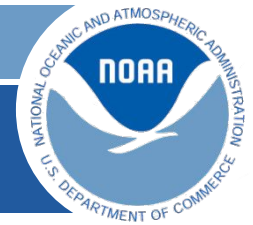
Background - AI Initiative Act of 2020

The National AI Initiative Act of 2020 (DIVISION E, SEC. 5001) became law on January 1, 2021, providing for a coordinated program across the entire Federal government to accelerate AI research and application for the Nation's economic prosperity and national security.

- *"IN GENERAL.—The Administrator of the National Oceanic and Atmospheric Administration (hereafter referred to as ''the Administrator'') shall establish, a Center for Artificial Intelligence"*
- *"AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Administrator to carry out this section $10,000,000 for fiscal year 2021."*

This legislative achievement had significant support from elected officials, e.g. Rep. Mike Garcia (R-CA) on the bill *"the bill invests in America's military families, readiness and modernization. I'm particularly pleased SST priorities are represented in the bill including my amendment to create a dedicated center for Artificial Intelligence at NOAA, helping detect and prevent wildfires."*

The White House's Office of Science and Technology Policy (OSTP) launched the National Artificial Intelligence Research Resource Task Force (NAIRRTF) on June 10th, and RFI on the Implementation Plan (due Oct 1).

NCAI Fully Resourced Capabilities

**Status: Developed a proposal framework for FY22+, pending FY24 PCS; exploring IIJA and WWCB connections.**

Once fully resourced, NCAI will achieve the following Strategic Goals:

- **Goal 1: Organization & Process - *Stand up Congressionally Authorized NCAI***
  - Program Office coordinated with Public and Private Partners (modeled on RESTORE);
  - AI expertise embedded in each LO supporting Mission Scientists;

- **Goal 2: Advance AI Research and Innovation in Support of NOAA's Mission**
  - Stimulation of AI outcomes across all mission areas with long-term impacts via Grants and Partnerships

- **Goal 3: Accelerate the Transition of AI Research to Applications (R2X)**
  - Bridging the R2X "valley of death" with a fully curated repository of AI software, apps, and policies on ethics, mission validation metrics, ops reqs and an AI App Handbook;

- **Goal 4: Strengthen & Expand Partnerships**
  - A robust and fully realized AI partnership program to leverage capabilities from commercial, academic and government partners.

- **Goal 5: AI Proficiency**
  - AI fully capable workforce established through widespread benchmark AI-ready data, Learning Journeys library, multiple developmental sandboxes, and professional training
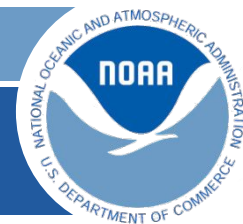
Advancing AI Research - Representative Pilots

Pilot Projects	WWCB Societal*	AI-Ready	Learning Journey	Training Data
Valuing NOAA's Data with User Publications Use Natural Language Processing (NLP) to value NOAA's data and products, and automate stewardship efforts, by finding uncited or inconsistently cited data in journal articles.	1,2,3,4, 5,6	Y		
Downscaling of Global Climate Projections to Regional Scales Advance Trustworthy and Equitable AI for Climate data services for fisheries management by exploring AI methods to relate global forcing to the regional response, trained on our existing, dynamically downscaled results.	5(?)		Y	
Sea ice detection in Saildrone images Reduce Saildrone collisions with sea ice floes by assessing the reproducibility and integrity of current convolutional neural net methodologies for detecting ice in images captured by the drones.	1	Y	Y	Y
Improvements to Numerical Weather and Climate Prediction Systems Use AI to speed up and improve model physics within the Global and Regional Forecast System by neural network emulation of components of Global Forecast System (GFS) physics suite.	5		Y	

*WWCB Societal Challenges: 1. Changing Oceans   2. Coastal Resilience
                                      3. Effects of Space Weather   4. Extreme Events & Cascading Hazards
                                        5. Monitoring and Modeling for Climate Change Mitigation   6. Water Availability, Quality, and Risk
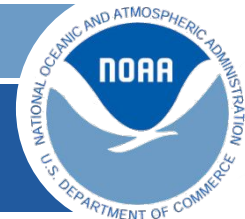
AI Ready Data - Representative Pilots

Pilot Projects	WWCB Societal*	AI-Ready	Learning Journey	Training Data
New Training Dataset for Tropical Cyclones This project would provide a case study for how NOAA datasets can be evaluated and updated for AI readiness before being made publicly available by NCEI.	2, 4, 5(?)	Y	Y	Y
Cloud optimized Water Column Sonar Develop a data lake of archived water column sonar data translated into cloud-friendly formats to improve interoperability and scaled processing. This effort will lower the learning curve to process the data more easily, especially in a cloud environment.	1	Y	Y	
Towards Ops - Conventional Observation Reanalysis (CORe) Distributing CORe, via the cloud, in AI-Ready formats will hasten the adoption process and speed access for transition of ongoing operations and developmental work.	5	Y	Y	
Improving Seal Detection Accuracy in Aerial Imagery Refining and testing algorithms so that we can produce critical high-quality datasets for marine mammal assessments.	1	Y	Y	

*WWCB Societal Challenges: 1. Changing Oceans   2. Coastal Resilience
3. Effects of Space Weather   4. Extreme Events & Cascading Hazards
5. Monitoring and Modeling for Climate Change Mitigation   6. Water Availability, Quality, and Risk
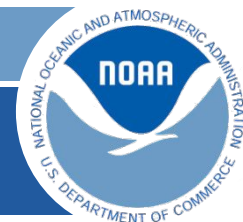
Research to Apps (R2X) - Representative Pilots

Pilot Project	WWCB Societal*	AI-Ready	Learning Materials	Training Data
AI Quality Control of NOAA Water Level Observations Water level processing system to provide near real-time QC'd tide gauge data, accelerating use for downstream products (e.g. Sea Level & High Tide Flooding monitoring).	2, 5		Y	
Near real-time ageing of fishing using AI Operationalize the integration of automated image analysis on fishing vessels for real or near real-time analysis, dramatically shortening ingest into Fisheries management timeline.	1	Y	Y	Y
AI + 'Omics: forecasting reef coral susceptibility to climate change Online "coral health map" to inform stakeholders, including FKNMS managers, which reefs within their jurisdiction are under greatest threat of climate change and which are more resilient to future stress events	1, 2, 5		Y	
Testing AI applications for weather forecasting in NOAA testbeds Leverage NOAA testbed infrastructure to put AI tools to the test with operational forecasters in a pseudo-operational environment. Aid training, and unique challenges of testing AI applications.	4?	Y	Y	Y

*WWCB Societal Challenges:
1. Changing Oceans
2. Coastal Resilience
3. Effects of Space Weather
4. Extreme Events & Cascading Hazards
5. Monitoring and Modeling for Climate Change Mitigation
6. Water Availability, Quality, and Risk