

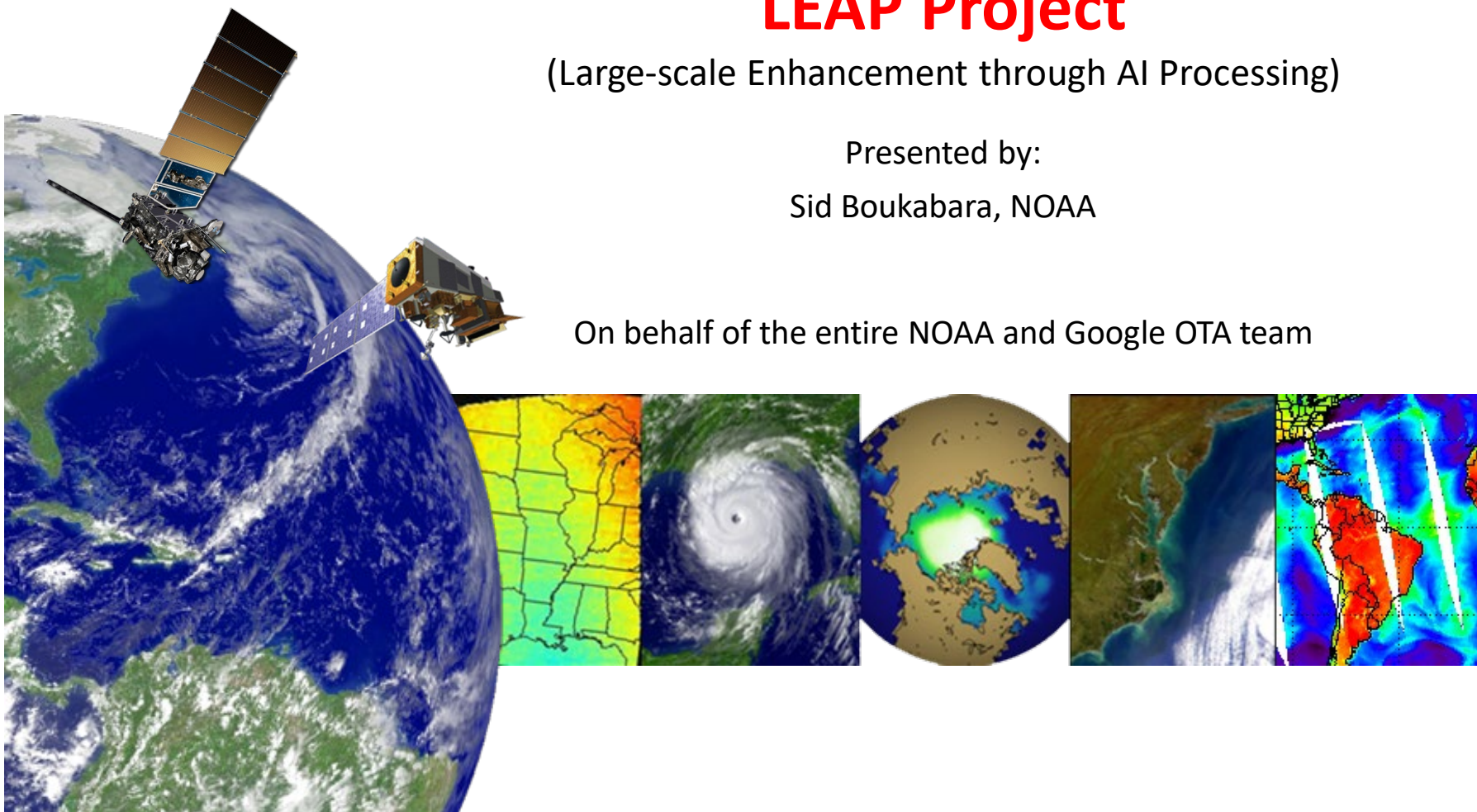
Overview of the **LEAP Project**

(Large-scale Enhancement through AI Processing)

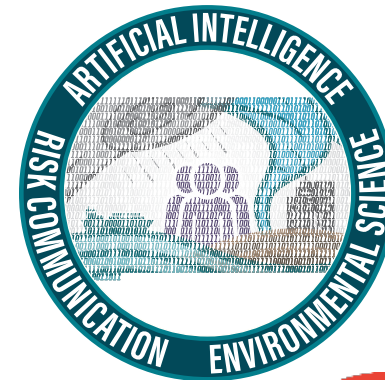
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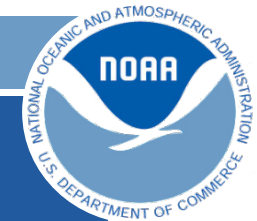
Sid Boukabara, NOAA

On behalf of the entire NOAA and Google OTA team



- **Establishing a NOAA Foundation for AI: NOAA AI Strategy with 5 Strategic Goals:** (1) Efficient Organization to Promote AI, (2) Coordinated AI R&D, (3) Accelerated AI-related R2X, (4) Partnerships, (5) Workforce training
- **Harvesting the mutual benefits of Partnership:**
 - **NOAA Partnering in the Multi-Sector AI2ES:** AI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal. Led by OU (Amy McGovern).
 - **NOAA in Public/Private AI Partnerships.** E.g. (1) **LEAP** Project: NOAA/Google AI recent OTA agreement on Enhancing the use of environmental data for Nowcasting and Data Assimilation. (2) NVIDIA Partnership for Supporting AI Activities
 - **Open Source CC0.** All Joint efforts in AI2ES and OTA collaborations are governed by Open Source CC0.
 - **Data on the cloud.** BDP, LEAP, etc.





LEAP Overview - Objectives

Objective from NOAA/Google Agreement:

"..... jointly explore the use of AI/ML for a better exploitation of satellite data for new applications, for weather forecasting skill improvement, research, and innovation with the end goal of producing an AI-based system that addresses the large and diverse environmental data sets, for both weather prediction and environmental monitoring."

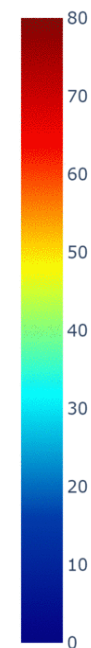
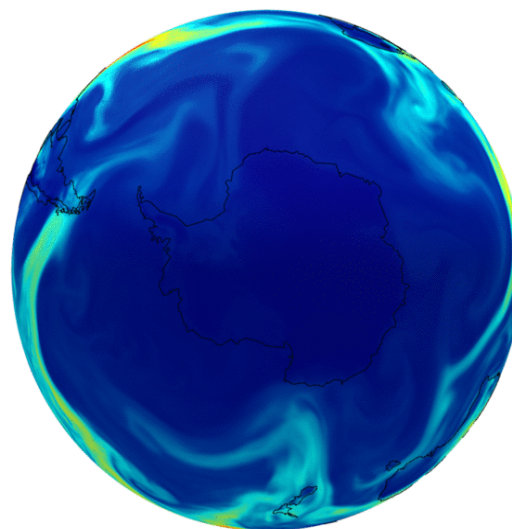
Google & NOAA collaboration will aim to:

- ☐ Combining AI and Physics to Improve Forecast Skills (incl global model, hurricanes, storms,...)
- ☐ Using AI to increase the rate of data assimilation in NOAA models from 3% (current) to 30%
- ☐ Using AI to increase spatial resolution of forecast models
- ☐ Using AI to generate added-value info to society (help with drought, fire, flood, coast human activity, etc.)
- ☐ Using AI to help ingest crowd-source and citizens data to improve forecast skills

- **Challenges include:**
 - Physical constraints
 - Trustworthiness
 - Explainability
 - Robustness/extrap.
 - Uncertainty quantification
 - Accounting for Obs. Errors
 - Scalability
- **Data Assimilation could be tackled from multiple angles:**
 - Data Merging/Fusion
 - Pre-Processing & QC
 - Model Emulation
 - Etc.
- **Post-Processing could be for:**
 - Medium Range Forecast.
 - Climate scale forecast

AI Based Analysis: Total Precipitable Water

2018-12-03 0z



Running AI DA Compute Time: 2.09 Seconds

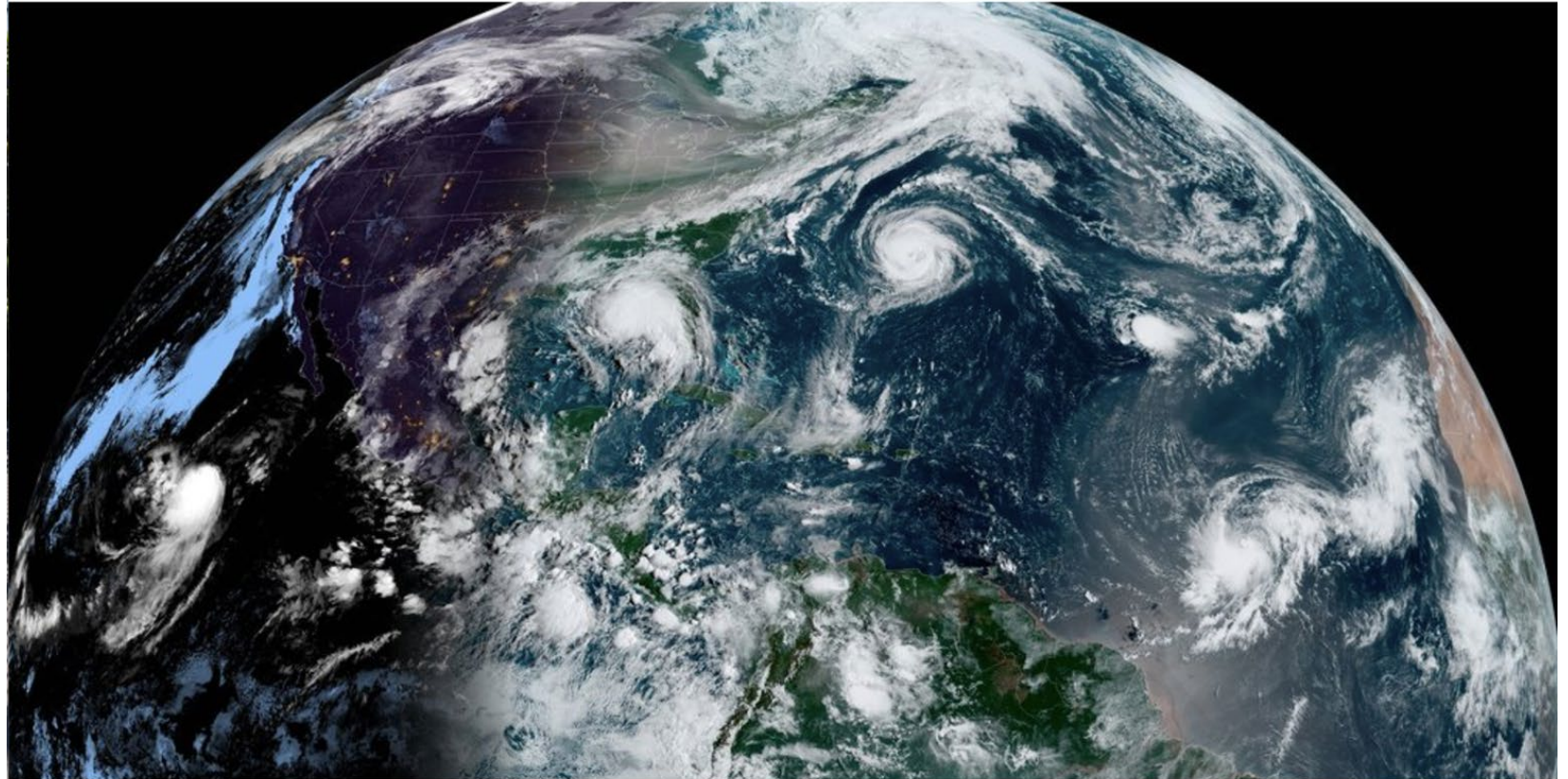
Overview of multi-sector partnerships at



Presented by: Jason Hickey
(jyh@google.com)
AI for Weather & Climate team



Partnerships for advanced weather and climate prediction



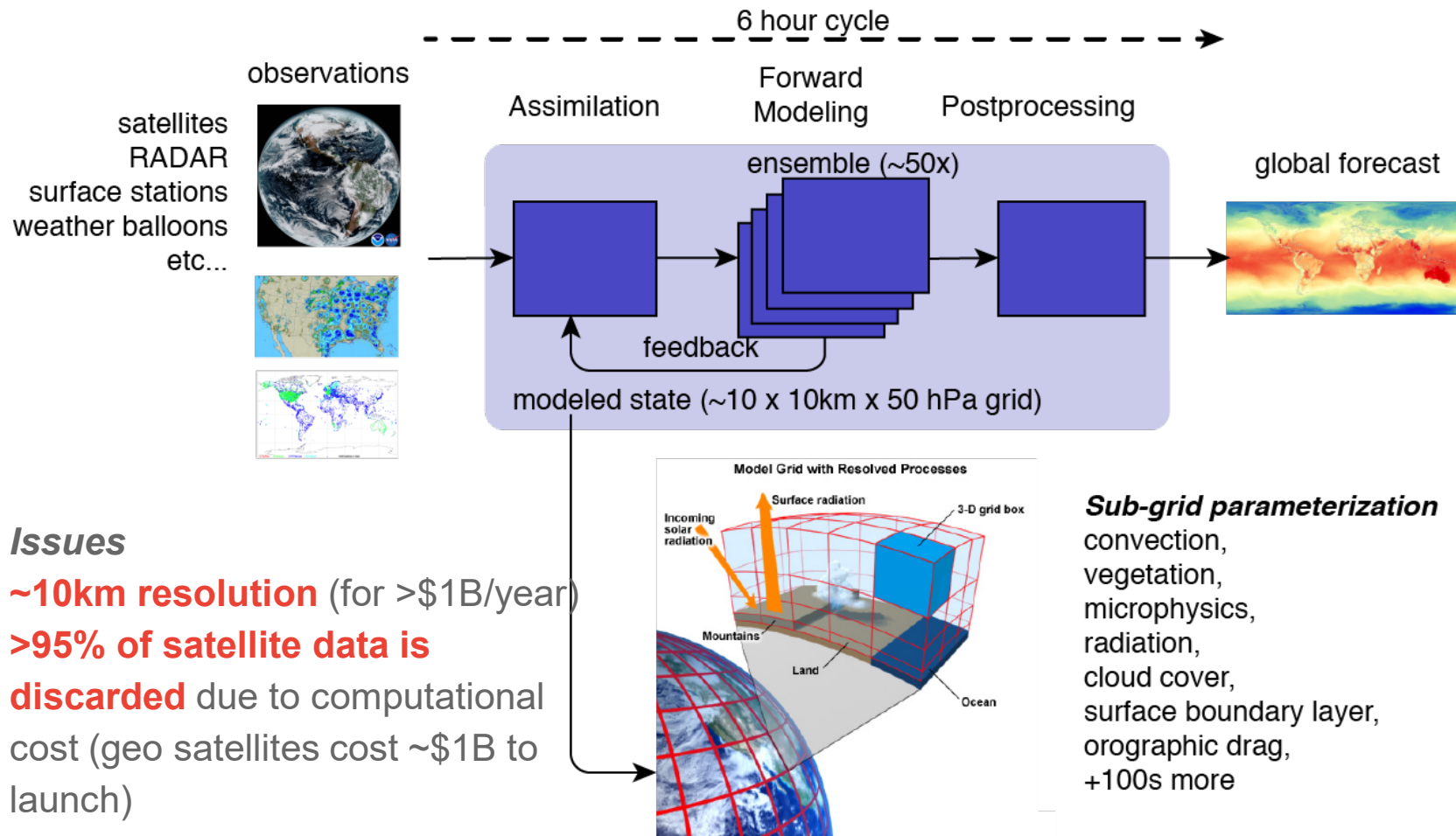
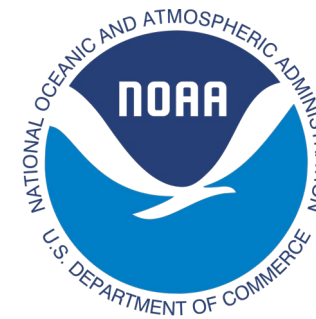
Jason Hickey
Software Engineer

Published 27 Oct 2020

Weather - Hybrid Weather Models

NOAA / Google OTA = LEAP

Large-scale Enhancement through AI Processing



Architecture of a global medium-range forecast

- **Data assimilation** takes observations to initialize a numerical model.
- Statistical **post-processing** is used to correct systematic errors
- The **dynamics** / physics are modeled numerically, using an ensemble to estimate uncertainty
- **Parameterizations** correct for significant unresolved physics
- Time complexity is $O(dx^{-4})$, where dx is spatial resolution

Issues

~10km resolution (for >\$1B/year)
>95% of satellite data is discarded due to computational cost (geo satellites cost ~\$1B to launch)

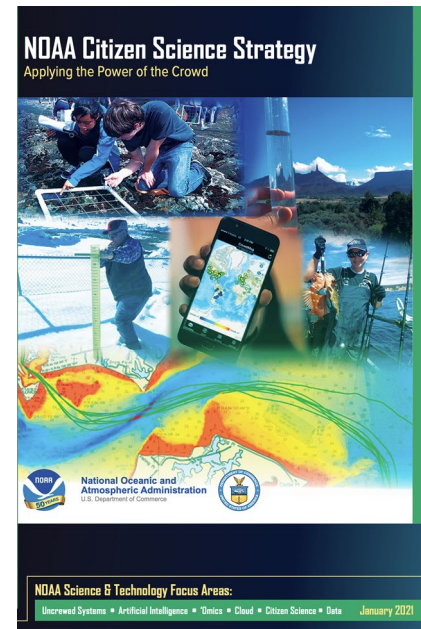
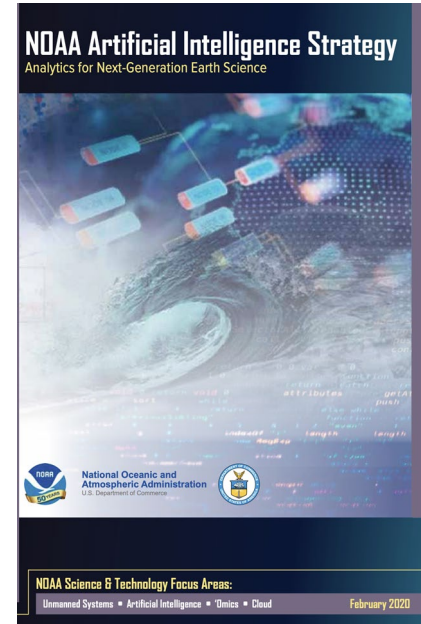
LEAP Research Agenda in 2021

Initial focus & aspirations:

1. **Greater Accuracy:** Combining AI and Physics to Improve Forecast Skills (incl. global model, hurricanes, storms, etc).
2. **More Data:** Use AI to increase the rate of satellite data assimilation in NOAA models by 10x, from 3% to 30%, or more.

Long-term aspirations:

1. **Better Resolution:** Use AI to increase spatial resolution of forecast models from county level to block level.
2. **Targeted Forecasts:** Generate added-value info to society (help with drought, fire, flood, coastal human activity, etc.).
3. Use AI to help ingest crowd-sourced and citizen's data to improve forecast skills.



AI2ES

AI2ES will uniquely benefit humanity by developing novel, physically based AI techniques that are demonstrated to be trustworthy, and will directly improve prediction, understanding, and communication of high-impact environmental hazards.



@ai2enviro

<https://www.ai2es.org>



NSF AI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal Oceanography

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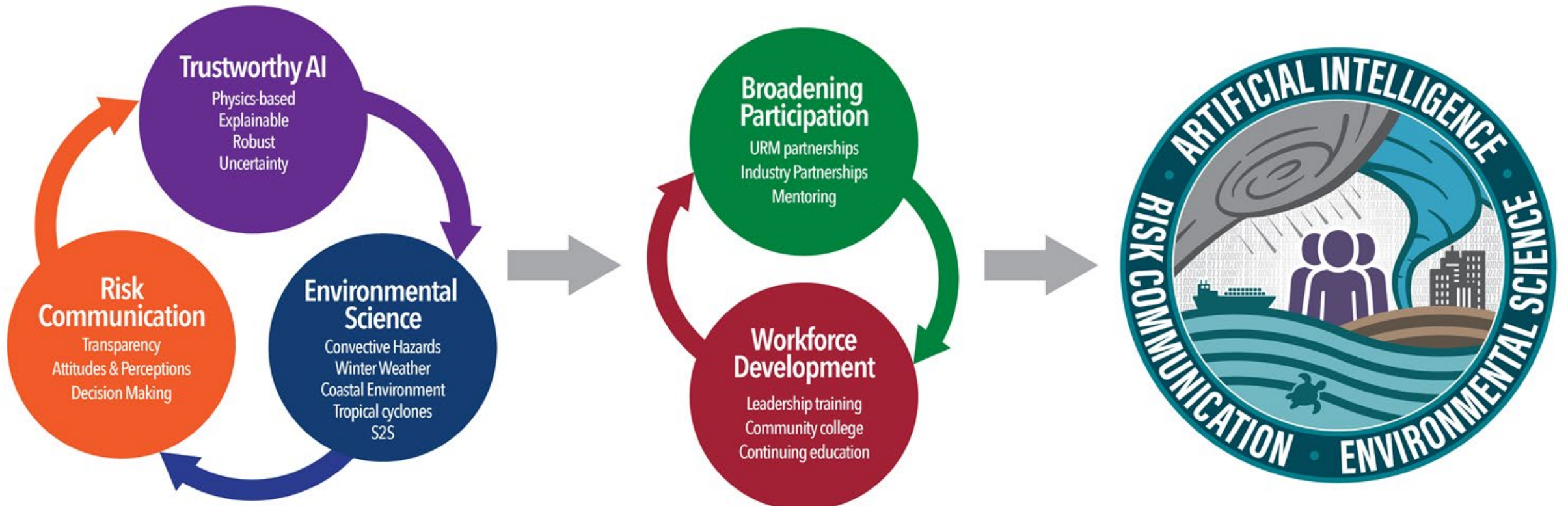


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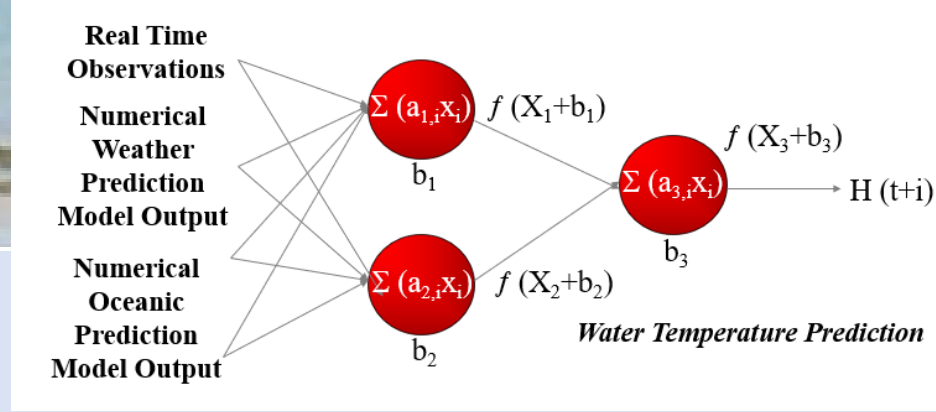
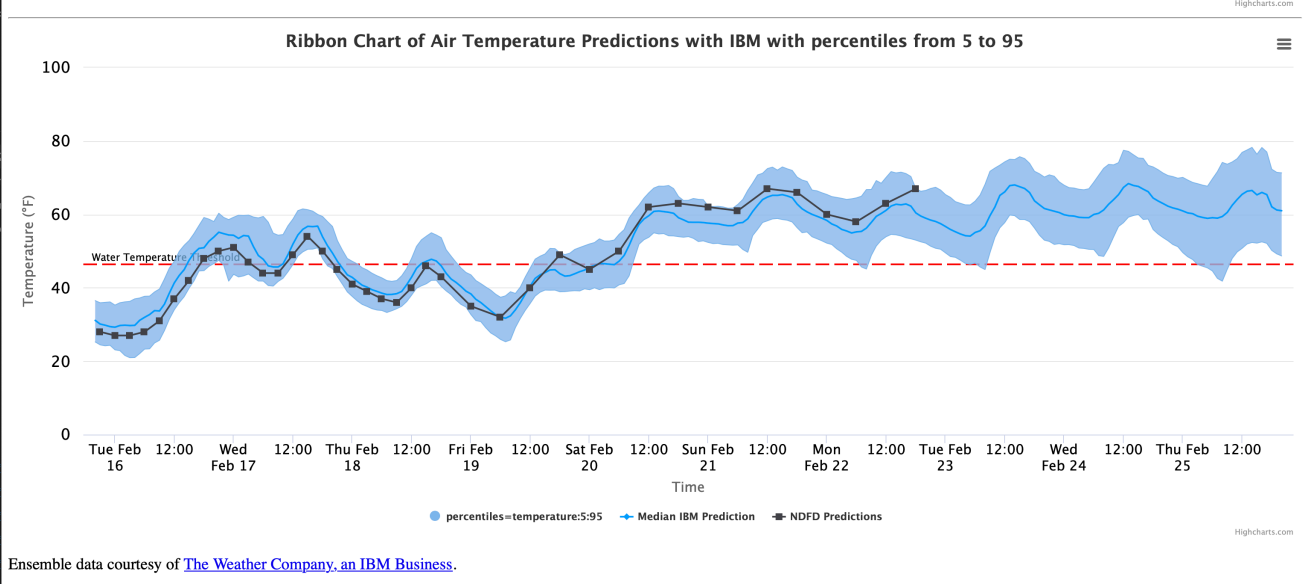
AI2ES Research

- Focus 1: Foundational research in trustworthy AI/ML
- Focus 2: Use-inspired research in ES
- Focus 3: Foundational research in AI risk communication for ES hazards
- Focus 4: AI workforce development and broadening participation

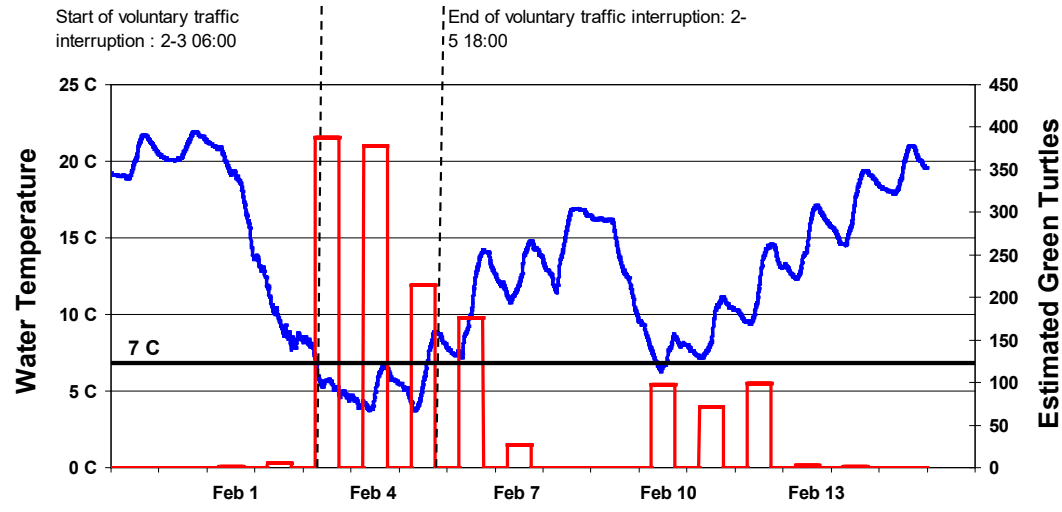




Laguna Madre Water Temperature Prediction System for Mitigation of Cold-Water Events



Predictions shared with 70+ stakeholders, local, state and federal partners



- Develop & operationalize better Cold Stunning models
- Assess variability through AI Ensemble models and trust from stakeholders



AI for Environmental Science

- AI can help us be resilient to climate change!
 - Climate change and environmental science are “wicked problems”
 - Issues are deep and complex and need more than 5 years of funding to be addressed
 - Foundational research all the way to operations
- Vision: Multi-agency, multi-sector center
 - Academia, Government, Private Industry, NGOs all involved
 - Multi-agency funding
 - International partnerships
- This material is based upon work supported by the National Science Foundation under Grant No. ICER-2019758.

