NOAA Science Update
to the Science Advisory Board

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- Let's kick off this discussion with one recent NOAA's CDR and SRM efforts.
- The Strategy for NOAA Carbon Dioxide Removal (CDR) Research was published in June 2023
- $24M in marine CDR awards were made
- The Fast Tract Action Committee on marine CDR is was established September, 9th, 2023. NOAA's Special Advisor for Carbon Dioxide Removal and Solar Radiation Modification, Dr. Greg Frost is co-chairing the group with Dr. Scott Doney, from OSTP.
- Over the next year, the interagency Committee will develop an implementation plan to advance marine CDR and establish sufficient knowledge that can potentially guide CDR deployment decisions as part of America's net-zero emissions future.
- NOAA Earth Radiation Budget (ERB) research initiative hosted its first public science meeting in November 2023
- NOAA will be circulating a draft SRM research agenda for review soon

- Another important research item to note is what is occurring with AI within the Federal space. In July of 2023, DOC released its Interim Generative AI Policy.
- On October 30, President Biden signed an Executive Order to build U.S. capacity to evaluate and mitigate the risks of Artificial Intelligence (AI) systems to ensure safety, security, and trust while promoting an innovative, competitive AI ecosystem that supports workers and protects consumers.

The NOAA R&D Vision Areas provides direction on NOAA's R&D and enables proactive actions to align NOAA's resources, budget, and functional activities to achieve stated goals.

- This briefing has been organized under these three vision areas

Vision Area 1: Reducing societal impacts from hazardous weather and other environmental phenomena
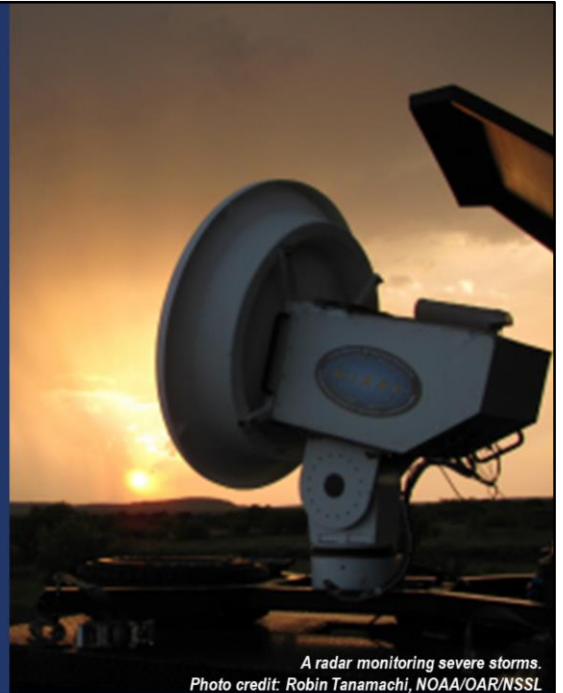
A radar monitoring severe storms.
Photo credit: Robin Tanamachi, NOAA/OAR/NSSL

OAR Social Science Product Transitions to the NWS
Winter Storm Severity Index (WSSI)

- OAR/NWS
- Using Social Science to Enhance Weather Outlooks: WPO's Joint Technology Transfer Initiative (JTTI) and Social Science Program (SSP) are leading the charge to integrate social science data into hazardous weather communications. **JTTI transitioned its first ever Social and Behavioural Science project from the nonprofit sector to NWS operations, improving usability of the Winter Severe Storm Index by adding updated risk categories which contribute to understanding usage of impact-based forecast products.** In addition, supplemental appropriations provided NOAA with a unique opportunity to integrate social science into NOAA's tropical products, information, and services. Four projects were developed with a complementary design, but still produced lengthy, individual reports that detailed the findings from each project. NWS and WPO social scientists synthesized and translated findings across projects to develop actionable recommendations for NOAA research, development, and operations. Recent societal impacts from hurricanes, floods, wildfires, and other weather hazards shows a great need to understand the intersection of people and meteorology.

OAR Social Science Product Transitions to the NWS
Major Findings and Takeaways from FY18 SBES Hurricane Supplementals

Provide **short explanations** that describe how to interpret probabilities.

Partners asked for more information about **TC tracks, scenarios, and forecast models**.

NWS tropical products need to provide more **localized & personalized** information.

Partners suggested changes to **optimize the extraction of key information** from graphics & text.

Different types of **timing information** are critical for partner decision-making.

Partners asked for more **summary products** and **compiling information** in a single place.

- OAR/NWS
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AEROMMA: Investigating Emissions Impacting Urban Air Quality & Climate
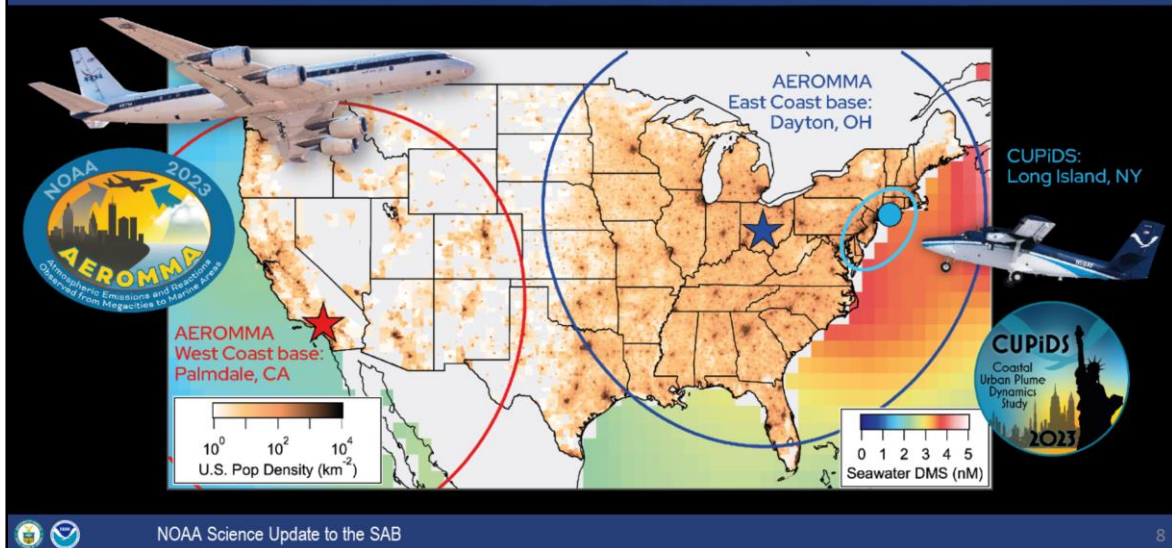
- ○ **OAR**
- ○ Nationwide collaborative field campaign investigates modern-day mix of urban air quality pollutants with next-generation observing tools:
  - ■ NOAA and numerous federal and academic partners conducted a coordinated set of nationwide atmospheric field research campaigns in summer 2023 using new research tools and observing systems to investigate persistent air quality challenges.
  - ■ The NOAA effort was headlined by CSL's Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) and Coastal Urban Plume Dynamics Study (CUPiDS) airborne campaigns alongside coordinated CPO AC4-funded ground sites that deployed state-of-the-art measuring instruments and models to investigate how the mix of air pollution sources have shifted over recent decades to identify causes of air quality impacts, including ozone production and particulate matter formation.
  - ■ The airborne measurements were also of vital importance for validating the recently-launched TEMPO geostationary atmospheric composition satellite, which is serving as a proving ground for NOAA's next-generation GeoXO satellite.
- ○ https://csl.noaa.gov/projects/aeromma/
- ○ https://csl.noaa.gov/projects/aeromma/cupids/

- https://csl.noaa.gov/projects/aeromma/nyc-mets/
- https://www.nesdis.noaa.gov/our-satellites/future-programs/geostationary-extended-observations-geoxo
- https://csl.noaa.gov/projects/ages/collaborations.html

Vision Area 2:
Sustainable use and stewardship of ocean and coastal resources

South entrance of Detroit River to the right and northeast corner of Lake Erie to the left. Photo credit: NOAA/OAR/GLERL

California Salmon Thiamine Deficiency Research and Mitigation Program

- Scientists and resource managers studied the negative impacts of thiamine deficiency (TDC) on California's salmon and steelhead.
- Actions taken have reduced the threats of this newly emerged stressor on California's endangered winter run Chinook salmon.
- California's salmonids are likely to remain at risk of TDC as long as their forage-base is dominated by northern anchovy.

NOAA Science Update to the SAB
10

- ○ **NMFS**
- ○ California Salmon Thiamine Deficiency Research and Mitigation Program
- ○ We established a multiagency team of scientists and resource managers to monitor, detect, and mitigate the negative impacts of thiamine deficiency on California's salmon and steelhead.
- ○ Actions taken to treat hatchery salmon with Vitamin B1 have reduced reproductive failure and mitigated the threats of this newly emerged stressor on California's endangered winter run Chinook salmon that have been under extreme threat from ongoing multi-year drought conditions.
    - ■ Thiamine (vitamin B1) deficiency in marine systems is recognized as a globally-significant emerging threat to marine life. Thiamine Deficiency Complex (TDC, a nutritional deficiency in Vitamin B1) was first linked with high mortality of juvenile Chinook salmon in California's Central Valley (CCV) hatcheries in 2020.
- ○ We subsequently launched investigations into the extent and impacts of TDC, and mitigation strategies and causes for TDC in California's salmon.
    - ■ We established an egg surveillance effort that found widespread thiamine deficiency in CCV Chinook salmon in 2020 and 2021,

10

and emerging TDC in Klamath and Trinity River coho salmon in 2021.

- ■ We demonstrated effective methods to prevent mortality of young at three life stages: thiamine injection of pre-spawn females, and thiamine baths at egg fertilization and at the post-hatch juvenile stage.
- ■ We developed a model for predicting population-level fry mortality rates from egg thiamine samples- which have been as high as 36% of the population.
- ■ We analyzed five common salmon prey items and found that northern anchovy had the highest lipid, highest thiaminase activity, and lowest thiamine levels.
- ■ Our gut content analysis found that northern anchovy were the dominant prey item for Chinook salmon captured in California's ocean fisheries with a decrease trend in diet diversity.
  - ● Previous research showed that diets dominated by lipid-rich or thiaminase-carrying clupeids can result in consumers with thiamine-deficient eggs and TDC in their offspring.
- ○ Our research suggests that California's salmonids are likely to remain at risk of TDC as long as their forage-base is dominated by northern anchovy, thereby adding a new stressor to highly-valued, but already highly-stressed, populations.
- ○ News story: https://www.fisheries.noaa.gov/west-coast/science-data/monitoring-thiamine-deficiency-california-salmon

NOAA 3-D Surge and Tide Operational Forecast System for the Atlantic Basin (STOFS-3D-Atlantic)

STOFS-3D-Atlantic Bathymetry and Topography

STOFS-3D-Atlantic

Horizontal mesh for Lower Mississippi River
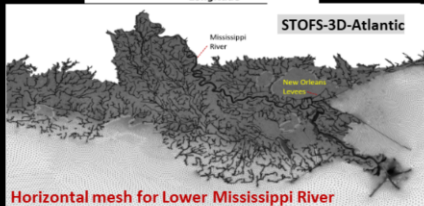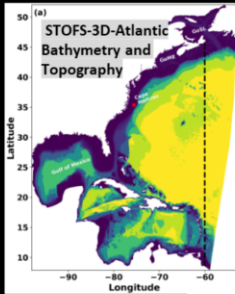
- The NOS storm surge modeling portfolio has transitioned into operations (Jan 2023) a three-dimensional (3D - layered density) surge and tide forecast model to support: disaster mitigation, coastal resilience, and safe marine navigation.
- With this 3D approach, it is now possible to receive currents (layered) and salinity & temperature forecast guidance in the Atlantic, Gulf of Mexico, and Caribbean.
- Coastal flooding prediction is improved with full integration of the NOAA National Water Model (river flooding and heavy precipitation)

○ **NOS**
○ The storm surge modeling portfolio has transitioned into operations (implemented in January 2023) a 3D (layered density) storm surge and tide forecast model to support: disaster mitigation, coastal resilience, and safe marine navigation.
  ■ STOFS-3D-Atlantic runs daily (at 12 UTC) to provide users with 24-hour nowcasts (analyses of near present conditions) and up to 48-hour forecast guidance (96-hour starting January 2024)
  ■ Grid resolution is 1.5-2 km near the shoreline, 200-550 m for the floodplain, and **up to several meters** for both **waterways, levees and some small rivers**.
  ■ It is developed in a collaborative effort between the NOAA/National Ocean Service (NOS)/Office of Coast Survey, the NOAA/National Weather Service (NWS)/National Centers for Environmental Prediction (NCEP) Central Operations (NCO), and the Virginia Institute of Marine Science.
○ Using **full integration with the NOAA National Water Model,** STOFS-3D-Atlantic includes river discharge and precipitation, and therefore **the combined ocean storm surge and inland flooding are captured**

- With this 3D approach, it is now possible to receive the full water profile of currents and salinity/temperature forecast guidance for the Atlantic, Gulf of Mexico, and Caribbean.
- Model performance both in terms of timing and surge magnitude are very accurate
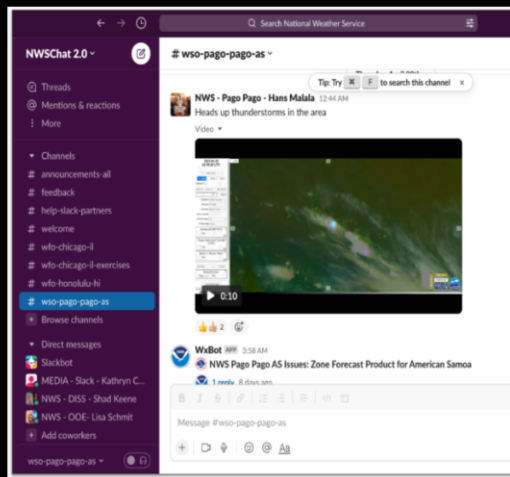
The GOES-17 satellite above the thermal vacuum chamber.
Photo credit: Lockheed Martin.

Vision Area 3:
A robust and effective research, development, and transition enterprise
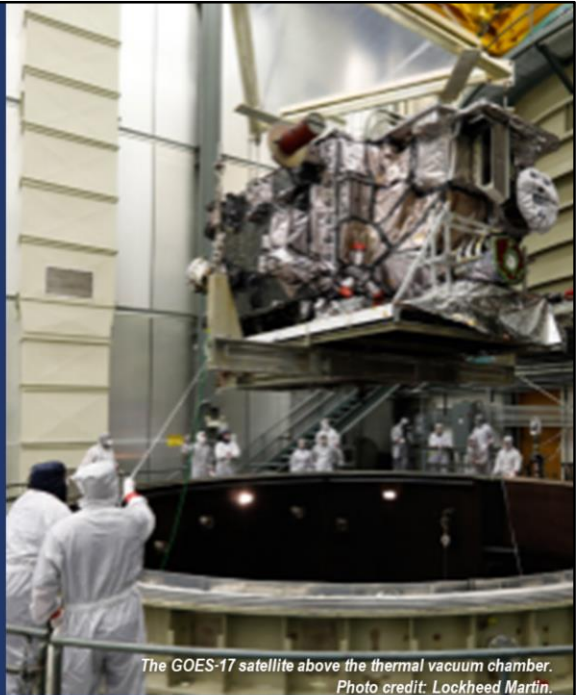
- ○ **NWS**
- ○ NWS implements NWSChat 2.0 via Slack for modern partner and internal collaboration
- ○ The National Weather Service is streamlining the way it communicates during extreme weather and for day-to-day business, both internally and with public safety partners.
  - ■ By adopting Cloud-based technology to power its primary collaboration tool, NWSChat, the nation's weather agency is becoming more nimble, flexible and mobile – change that will lead to better forecasts and better decisions on the ground.
- ○ This initiative is vital because the legacy NWSChat system is outdated and unreliable. NWSChat 2.0 is custom-built to meet the agency's modern needs and growing demand for fast and seamless information sharing.
- ○ NWSChat 2.0 connects forecasters and their partners in real time during extreme weather to support the highest level of collaboration and communication.
- ○ NWSChat 2.0 will run on Slack, a secure and reliable platform that offers new features, such as photo and video sharing and cross-device

compatibility.
- The new platform will launch in the Pacific Region in early 2023, and nationwide testing, training and deployment will start shortly thereafter.
- https://www.noaa.gov/NWSChat

Efforts to Improve Real-Time Tropical Cyclone Rapid Intensification Prediction

1. Scientists have developed and transitioned the Rapid Intensification Deterministic Ensemble (RIDE) as an operational method used to estimate the probability of tropical cyclone rapid intensification in the DoD's Joint Typhoon Warning Center area of responsibility. RIDE provides skillful rapid intensification forecasts (right) by providing probabilities based on seven routinely available deterministic intensity forecast models

1. Scientists have developed a real-time tropical cyclone rapid intensification prediction method that uses GOES Lightning Mapper information. And, those predictions are available for use by operational forecasters at the National Hurricane Center.
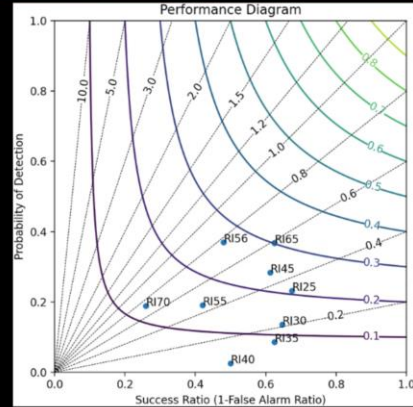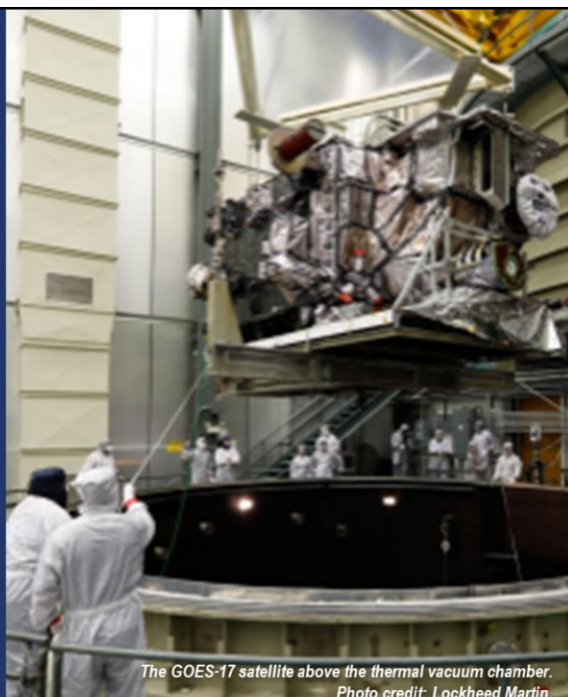
Performance diagram for RIDE deterministic forecasts made in JTWC's area of responsibility during the 2021 season. Shown are RI25, RI30, RI35, RI40, RI45, RI55, RI56, RI70, and RI65, corresponding to changes of 25, 30, 35, and 40 knot in 24h, 45 and 55 knots in 36h, 55 and 70 knots in 48 h, and 65 knots in 72h, respectively

- NESDIS
- Real-time tropical cyclone rapid intensification prediction using GOES Lightning Mapper information
- A ML method to estimate the probability of a tropical cyclone rapidly intensifying and makes explicit use of GLM data is running at the National Hurricane Center and available for real time forecasting. Paper showing verification and details: https://doi.org/10.1175/WAF-D-23-0012.1
- https://noaa-nesdis-tcprimed-pds.s3.amazonaws.com/index.html.

Vision Area:
Building a Climate
Ready Nation

The GOES-17 satellite above the thermal vacuum chamber.
Photo credit: Lockheed Martin.

Global 3km
Global Storm-resolving Simulation

X-SHiELD

Global 25km
Subseasonal-to-seasonal Prediction

S-SHiELD

Contiguous US 3km
Severe Weather Prediction

C-SHiELD

SHiELD

Global 13km
Medium-range Weather Prediction

Tele-SHiELD

T-SHiELD

Northeast Corridor 1.4km
Urban-scale Impacts, Coastal Weather & Hydrology

North Atlantic 3km
Tropical Convection & Hurricane Prediction

- Kilometer-scale climate simulations are necessary to provide actionable hyper-local data and to explore extreme events, but are incredibly expensive computationally.
- Scientists at GFDL and Princeton partners have used a new global storm-resolving model called X-SHiELD to perform the world's first years-long climate simulations at these ultra-high resolutions.
- These simulations have already been used to better understand the effect of warming on convective storms and water resources. They could revolutionize our understanding of climate impacts and how clouds interact with the climate system.

NOAA Science Update to the SAB
16

- OAR
- World's first kilometer-scale global climate simulations: Kilometer-scale climate simulations are necessary to provide actionable hyper-local data and to explore extreme events under global warming, but these are extremely computationally expensive.
- Scientists at GFDL and Princeton partners have used a new global storm-resolving model (GSRM) called X-SHiELD to perform the world's first years-long climate simulations at these ultra-high resolutions. These simulations have already been used to better understand the effect of warming on convective storms and could revolutionize our understanding of climate impacts and how clouds interact with the climate system.
- http://www.gfdl.noaa.gov/shield#X-SHiELD
- GFDL is also collaborating with AI2 Climate Modeling to accelerate X-SHiELD using emerging computing platforms, and to train a Machine Learning system on the output to create an efficient emulator of the expensive GSRM

Monitoring And Analyzing Global Land Surface Temperature Anomalies And Their Impacts

- The STAR land product development (LPD) team has built up a monitoring system of global land surface temperature (LST) anomaly observation and analysis after over ten years of data development and production.
- The system is mainly based on a reference monthly LST dataset estimated from the historical JPSS LST product from 2014 to 2022.
- Monthly report of global LST anomaly are released to public and support the NOAA's Climate-Ready Nation Goal.

NOAA Science Update to the SAB

17
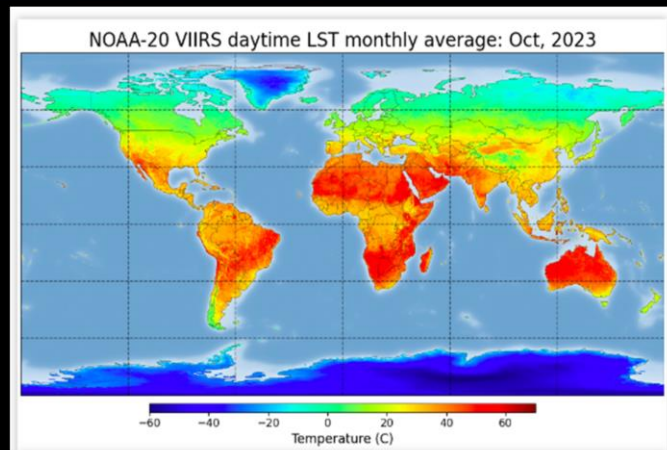
- ○ **NESDIS**
- ○ Monitoring and analyzing global land surface temperature anomalies and their impacts
- ○ After over ten years data development and production, the STAR land product development (LPD) team has built up a monitoring system of global land surface temperature (LST) anomaly observation and analysis.
- ○ The system is mainly based on a reference monthly LST dataset estimated from the historical JPSS LST product from 2014 to 2022; real-time JPSS LST data are used for the global LST anomaly statistics and analysis. Monthly report of global LST anomaly are released to public at https://www.star.nesdis.noaa.gov/smcd/emb/land/monthly_lst.php, supporting the NOAA's Climate-Ready Nation Goal.
- ○ In particular, the monthly report reveals significant land surface temperature changes and their global impact in the past month. It also provides objective analysis about how the LST anomalies may link to extremely climate events and theri possible trends in the near future worldwide
- ○ https://www.star.nesdis.noaa.gov/smcd/emb/land/monthly_lst.php

Thank you!