



Science Advisory Board

Priorities for Weather Research (PWR) Report

7 December 2021

**Brad Colman and Scott Glenn, PWR Co-
Leads**

Thank you!!!!

John Kreider, Lead, SAB PWR Steering Team

SAB Steering Team members

Steve Smith, NOAA Support Team (NST) lead,
and the entire NST

Task Team Co-Leads:

Information Delivery: Ann Bostrom & Mike Eilts

Forecasting: Fred Carr & Christa Peters-Lidard

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Core Executive Study Team:

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Task Team Members, External and NOAA SMEs

NOAA Assistant Administrators

Cynthia Decker, SAB, Executive Director

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Courtney Edwards, PWR project manager

PWR Subject Matter Experts	
PWR Team	39
NOAA	62
External	58
TOTAL	159

Priorities for Weather Research (PWR) -- Today's Discussion

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Summary & Discussion

December 2020 - An Urgent Directive from Congress

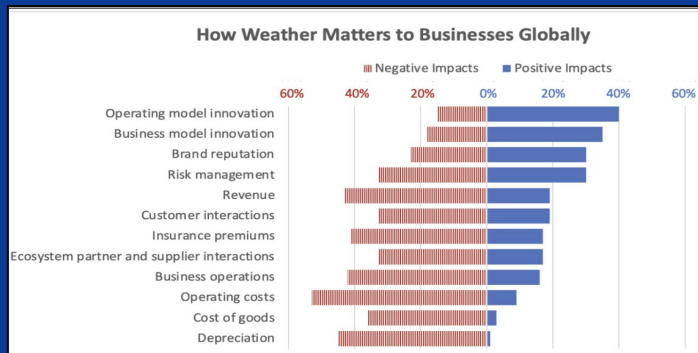
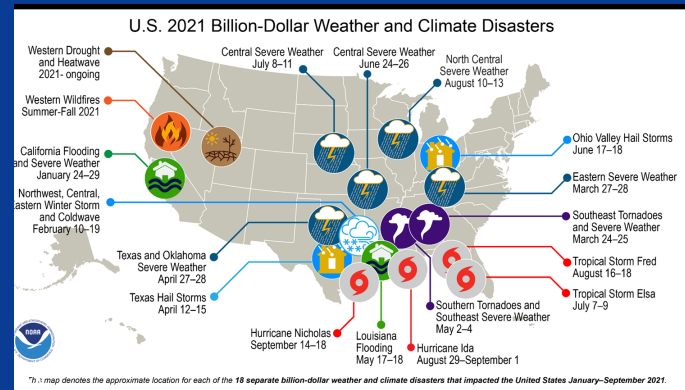
Report on Weather Research Priorities - In lieu of House language on a Weather Decadal, the agreement directs NOAA's Science Advisory Board to publish a report, not later than one year after enactment of this Act, that provides policymakers with the relevant information necessary to prioritize investments in weather forecasting, modeling, data assimilation, and supercomputing over the next ten years; and that evaluates future potential Federal investments in science, satellites, radars, and other observation technologies, to include surface and boundary layer observations so that all domestic users of weather information can receive data in the most efficient and effective manner possible.

- From the FY21 Omnibus (Dec 2020) Appropriations Act

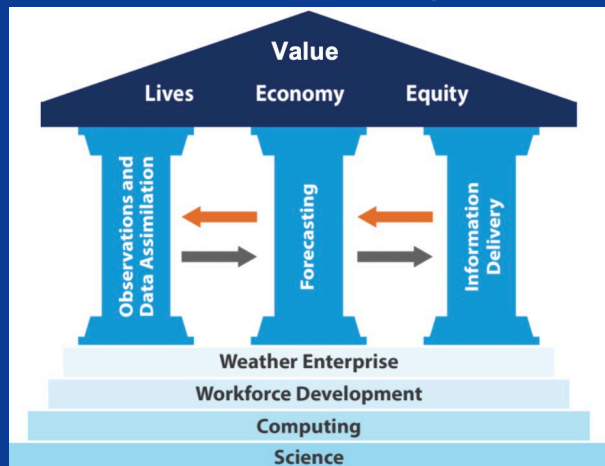


Escalating Demand for Accurate & Actionable Weather Information

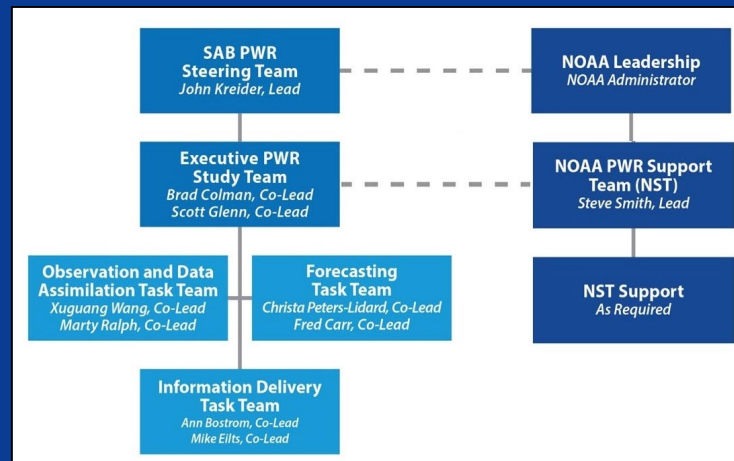
- In 2021, the U.S. experienced 18 billion-dollar Weather & Climate Disasters, resulting in >\$105 B in damage, in an increasing trend.
- Weather forecasts are used daily in business decisions; they support food, water, energy and national security, as well as economic well being.
- Weather disproportionately impacts historically underserved and socially vulnerable communities.



SAB Approved (15 March) the Charge to the PWR Study Team



Framework

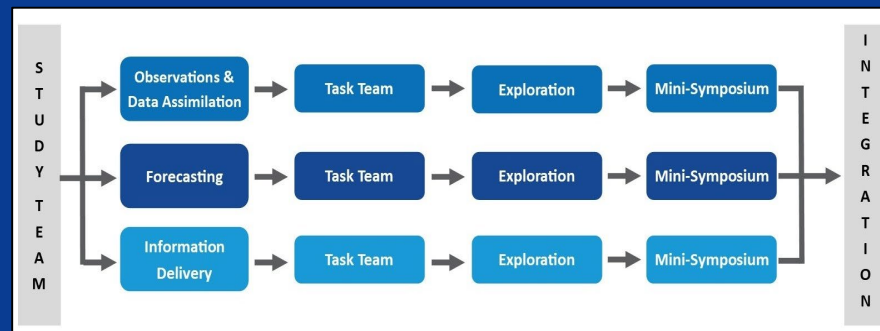


Organization

10-month Collaborative Process

- In excess of 150 subject matter experts
- Multiple weekly Executive Study/Task Team meetings
- Briefed SAB Steering Team monthly
- Briefed full SAB at critical milestones
- Four SAB working sessions during writing phase
- Adjudicated over 100 SAB comments and questions

Process

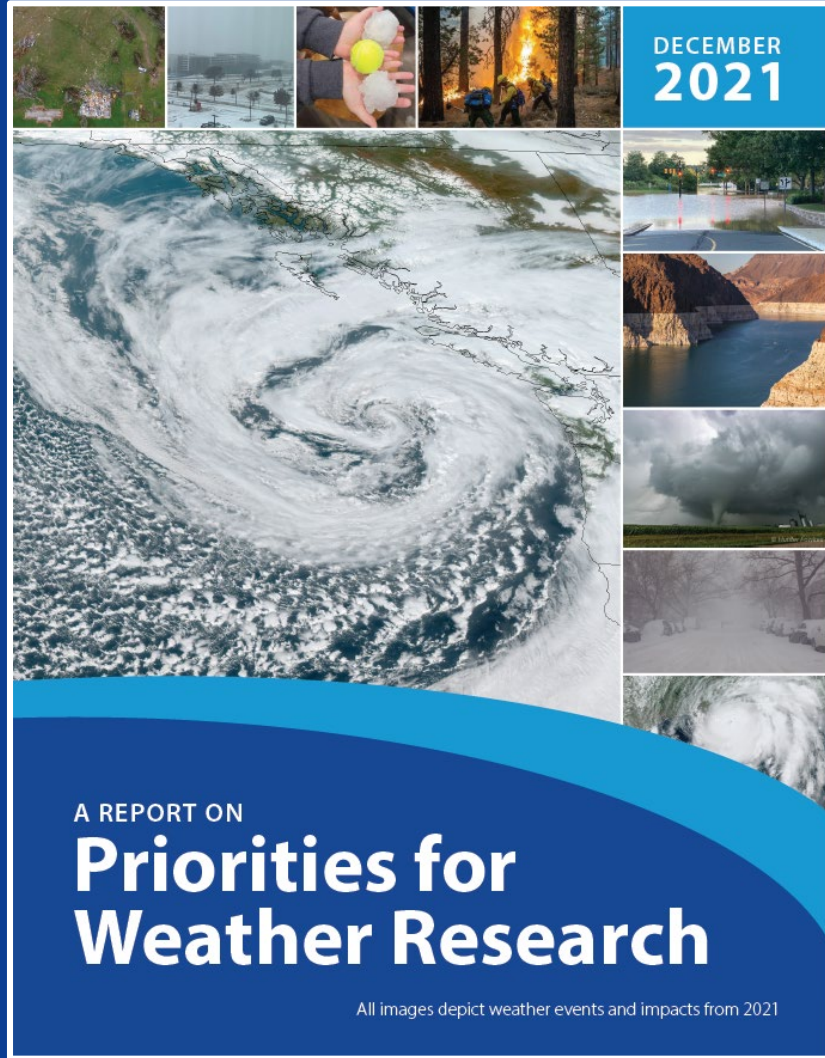


Approach

PWR Report Draft Posted on SAB [Website](#)

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- Section 9: Future Engagement
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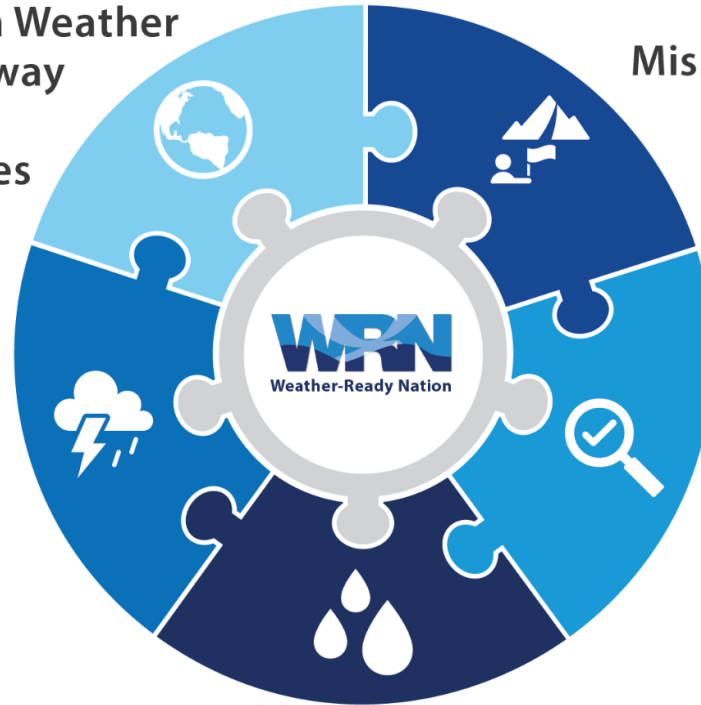
Five Narrative Themes Illustrate Value

Global Leadership in Weather Prediction as a Pathway to Higher Quality Products and Services

Mission Critical Mile

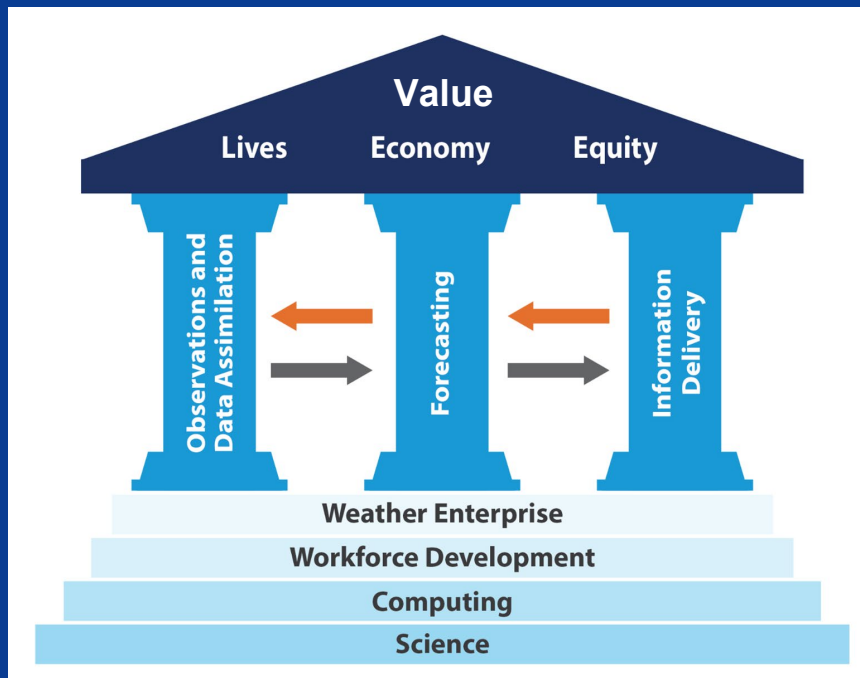
High-Impact Weather

Highly Reliable, Fully Accessible Weather Information



Improve Prediction of Water Cycle Extremes and Their Cascading Impacts

Pillars & Foundational Elements: Priorities for Investment



Core Content of this Report:

- Pillars & Foundational Elements each designate **Priority Areas** for investment
- Each Priority Area contains multiple **Recommendations**
- Each Recommendation contains multiple **Critical Actions**

PWR Recommendations By-The-Numbers Summary

	Observations & Data Assimilation	Forecasting	Information Delivery	Foundational Elements	Total
Priority Areas	3	2	2	4	11
Recommendations	10	7	6	10	33
Critical Actions	33	27	18	24	102

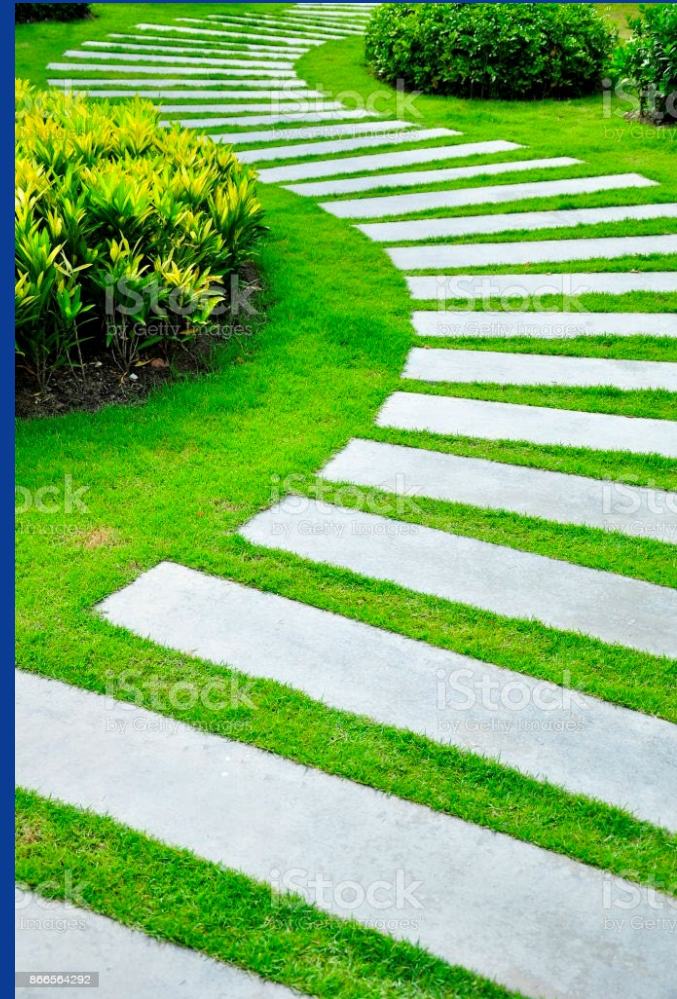
*“When taken as a whole, the investments will be **transformational**, enabling NOAA and the nation’s Weather Enterprise to meet accelerating weather, water and climate challenges, better protect life and property, and promote greater economic prosperity and environmental justice for all.”*

- From PWR Report Executive Summary

Immediate First Steps

- Objective is to identify:
 - Critical gaps or shortfalls
 - Temporal dependencies
 - High-readiness / high-reward activities

- Core areas:
 - Research and Development
 - Infrastructure
 - Action and Impacts
 - Prioritization and Investment

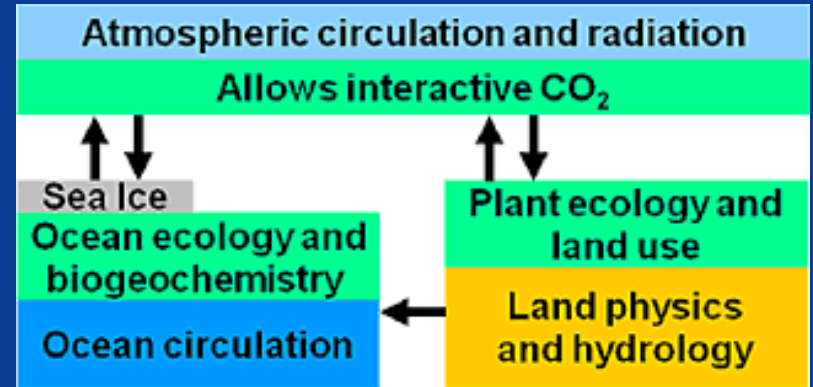


Research & Development

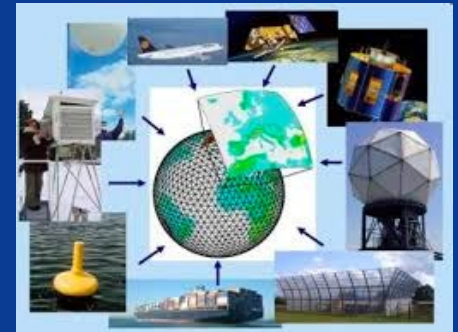
Accelerate **Earth system modeling** approach to improve forecast accuracy and lead time



Prioritize **research on data assimilation** to deliver sustained improvements in forecast skill and to train the next generation workforce in this area



Increase **human behavioral data collection and sciences** to support co-development of improved products and services



Infrastructure

Improved **weather data dissemination** to support the Enterprise through open science approaches



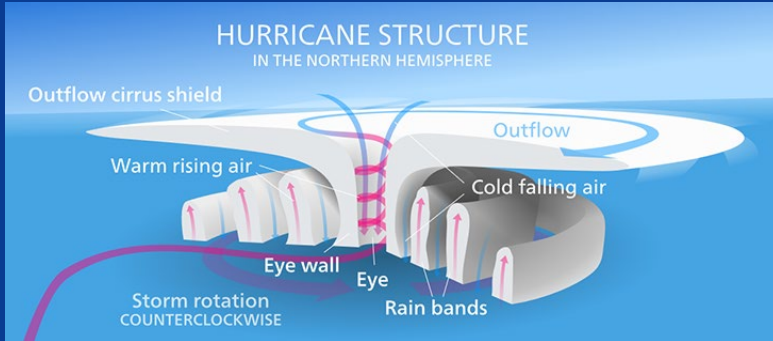
Expand **high performance computing** capacity by two orders of magnitude (over 10 years) to support research and operational forecasts

Fill gaps in existing **Earth system observing networks** with existing, proven or augmenting technologies to grow value



Actions and Impacts

Support **reanalysis and reforecasting** to support model evaluation and improvement, and for artificial intelligence (AI) product applications



Target **high-impact weather** to match the urgent need imposed by climate trends, population and infrastructure increases, and disproportionate impacts on vulnerable communities

Target **water cycle extremes** to improve flood and drought prediction and to enable forecast-informed reservoir operations



NOAA Prioritization and Investment

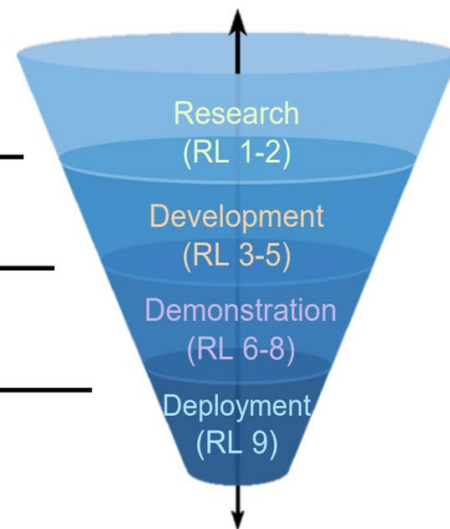
Develop **improved and increasingly objective methods to balance investments**;
Particularly, given the **urgent need** to immediately expand U.S. investments in
weather research and forecasting over the next decade

Weather Ready Nation (WRN)	
Mission Service Area (MSA)	
1	Aviation Weather and Volcanic Ash
2	Fire Weather
3	Integrated Water Prediction and Information
4	Marine Weather and Coastal Events
5	Public Weather
6	Severe Weather
7	Space Weather
8	Tropical Cyclones
9	Tsunami
10	Winter Weather
11	Weather Ready Nation Science, Services, and Stewardship Advances

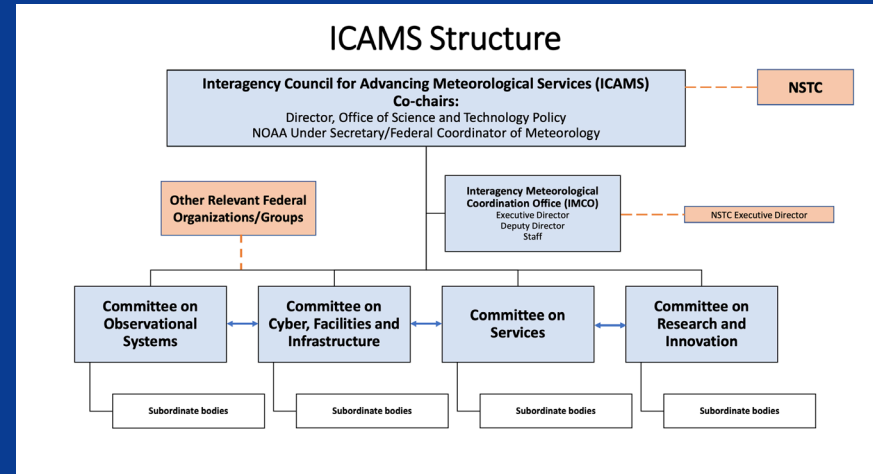
NOAA Readiness Levels (RL)



- Basic research
- Applied research
- Proof of concept
- Validation of system in the lab or equivalent
- Validation of the system in a relevant environment
- Demonstration in a test environment
- Demonstration in a relevant environment
- Demonstration in the actual environment
- Deployment and regular use



Suggestions for Future Engagement



- Across Federal agencies - *leverage the Interagency Council for Advancing Meteorological Services (ICAMS), etc.*
- Across the Weather Enterprise, nationally and internationally - *through open science approaches (e.g., EPIC, etc.)*
- Across the science community - *through the NOAA Science Advisory Board, its multiple Working Groups, and their ability to engage subject matter experts when needed*

Summary Overview

- PWR is a **comprehensive** report that is focused on decadal priorities and builds upon existing programs
- It is a **community consensus** that delivers the requested information
- Taken as a whole, the balanced investments will be **transformative**
- It is an urgent **call to action!**



Discussion

Backup Slides

Observations and Data Assimilation (OD)	
Priority Area 1	Use and Assimilation of Existing Observations
OD-1	Maximize the use and assimilation of underutilized ground based, airborne and marine observations - <i>to ensure maximum value is derived from the full suite of observations in the Earth system model</i>
OD-2	Maximize the use and assimilation of underutilized satellite observations - <i>to ensure maximum value is derived from the full satellite constellation in support of an Earth system model approach</i>
Priority Area 2	Advanced Data Assimilation Methods, Capabilities and Workforce
OD-3	Establish new support of novel methodology research and workforce development for data assimilation - <i>to advance weather prediction and develop the future workforce</i>
OD-4	Advance coupled Earth system data assimilation for weather, water and sub-seasonal to seasonal forecasting - <i>to enable observations in one Earth system component to influence corrections in multiple components</i>
OD-5	Advance the production of regional and global reanalyses - <i>to improve detection of extreme events, forecast performance evaluation, improve use of observations</i>
Priority Area 3	Observation Gaps and Use and Assimilation of New Observations
OD-6	Develop and deploy a national boundary layer, soil moisture and aerosol observing system - <i>to improve research and prediction at the interfaces with other Earth system model components</i>
OD-7	Observe the ocean, its surface boundary layer, and ocean-atmosphere feedbacks - <i>to fully utilize knowledge of the ocean as a source of predictability in an Earth system model</i>
OD-8	Implement a multi-phase program to improve the forecasting of atmospheric rivers - <i>to better anticipate and mitigate water cycle extremes and their cascading impacts</i>
OD-9	Fill radar gaps using diverse weather radars and data assimilation - <i>to better detect significant precipitation and severe weather over a greater area and more equitably across the population</i>
OD-10	Prioritize smallsat/cubesat observation and data assimilation trade studies and demonstrations - <i>to define the role of smallsat/cubesat technologies for complementing large satellite systems</i>

Forecasting (FO)	
Priority Area 1	Foundational Earth System Modeling
FO-1	Accelerate Earth system model development and seamless prediction - <i>to improve forecasts of all components of the Earth system - atmosphere, oceans, cryosphere, land - on all time and space scales</i>
FO-2	Achieve the best possible operational numerical weather prediction system - <i>to provide more accurate weather information to the American public, thus decreasing our vulnerability to weather extremes</i>
FO-3	Establish a regular, sustained Earth system reforecasting activity - <i>to enable a more effective cadence and accelerated process for operational model improvements</i>
Priority Area 2	Advancing Critical Forecasting Applications
FO-4	Enhance prediction of Earth’s water cycle extremes - <i>to improve forecasting of floods, droughts and hydrologic processes</i>
FO-5	Increase efforts to advance predictive capabilities for fire weather and air quality - <i>to better inform the public during wildfire events and hazardous air pollution episodes</i>
FO-6	Improve forecasts of high-impact weather through multisector partnerships - <i>to provide more accurate and timely watches and warnings for extreme weather events</i>
FO-7	Advance research on coastal processes in Earth system models for comprehensive coastal analyses - <i>to improve coastal forecasts of waves, currents, storm surges, total water levels and water quality</i>

Information Delivery (ID)	
Priority Area 1	Highly Reliable, High-resolution Weather Information Dissemination
ID-1	Embrace open science - <i>to provide uniform access to all communities, support a geographically distributed, diverse workforce, broaden access to talent, and increase agility and innovation</i>
ID-2	Complete the existing plan to address National Weather Service operational data dissemination challenges - <i>to solve critical data access and visualization software issues facing weather forecasters</i>
ID-3	Develop NOAA-wide strategic and operational support for Weather Enterprise data integration and dissemination - <i>to ensure effective NOAA data sharing and use across all sectors and hazards</i>
Priority Area 2	Virtuous Cycle of Collecting and Analyzing Social, Behavioral and Interdisciplinary Observations
ID-4	Prioritize research on equitable and effective use of hazardous weather information - <i>to better understand and inform diverse hazard and risk assessment needs, protective decisions and action</i>
ID--5	Develop and evaluate probabilistic and deterministic hazard information delivery capabilities for diverse end-users - <i>for rapid dissemination of useful products and to strengthen decision support</i>
ID-6	Build capacity to collect and analyze baseline and event-specific social and behavioral data - <i>to learn what weather information is needed when, by whom, and how it can and will be used</i>

Foundational Elements (FE)	
Priority Area	Science
FE-1	Develop a weather-knowledge ecosystem - <i>to create, educate, apply and advance weather information synthesis, modeling, automated/human forecasting, communication & decision support</i>
FE-2	Continue to invest in understanding the basic physics and chemistry of the Earth system - <i>to ensure that all important processes that affect weather are accurately included in the forecast models</i>
FE-3	Accelerate the NOAA Artificial Intelligence (AI) Strategy and expand artificial intelligence research - <i>to provide higher quality and more timely products and services for societal benefits</i>
FE-4	Greatly increase university involvement in NOAA research - <i>to gain their assistance in advancing the NOAA mission and in training the next generation of NOAA scientists</i>
FE-5	Create multi-university research consortia - <i>to address critical research issues for NOAA</i>
Priority Area	Computing
FE-6	Immediately invest and develop plans for substantially more computing resources - <i>in order to achieve the goals recommended in this report that are vital to enhance the U.S. Weather Enterprise</i>
FE-7	Convert, prepare for, and leverage emerging high performance computing architectures - <i>to keep pace with technological advances and develop the software tools and IT workforce for the future</i>
Priority Area	Workforce Development
FE-8	Develop a pipeline of diverse talent from K-12 students to lifelong learning - <i>to train and keep current generations of researchers and practitioners in weather science and technologies</i>
FE-9	Develop an enterprise vision for workforce education and training - <i>to accommodate different line office needs and leverage existing resources available to the broader community</i>
Priority Area	Weather Enterprise Integration
FE-10	Support a Weather Enterprise data integration and dissemination strategy and sustained operational oversight - <i>to improve weather data, modeling, computing, forecasting, and decision support</i>

Immediate First Steps

- (a) Accelerate **Earth system modeling** approach
- (b) Increase investments in **social and human behavioral data collection and sciences**
- (c) Fully implement and expand rapidly the existing plans for improved **weather data dissemination**
- (d) Expand **high performance computing** capacity by two orders of magnitude (over 10 years)
- (e) Fill gaps in existing **Earth system observing networks** with existing, proven or augmenting technologies;
- (f) Prioritize immediate investments in fundamental **research on data assimilation**
- (g) Support **reanalysis and reforecasting** vital to Earth system model evaluation and improvements;
- (h) Target the **understanding and prediction of high-impact weather**
- (i) Target **water cycle extremes and their cascading impacts**
- (j) Develop **improved and increasingly objective methods to balance investments** across the weather information value chain