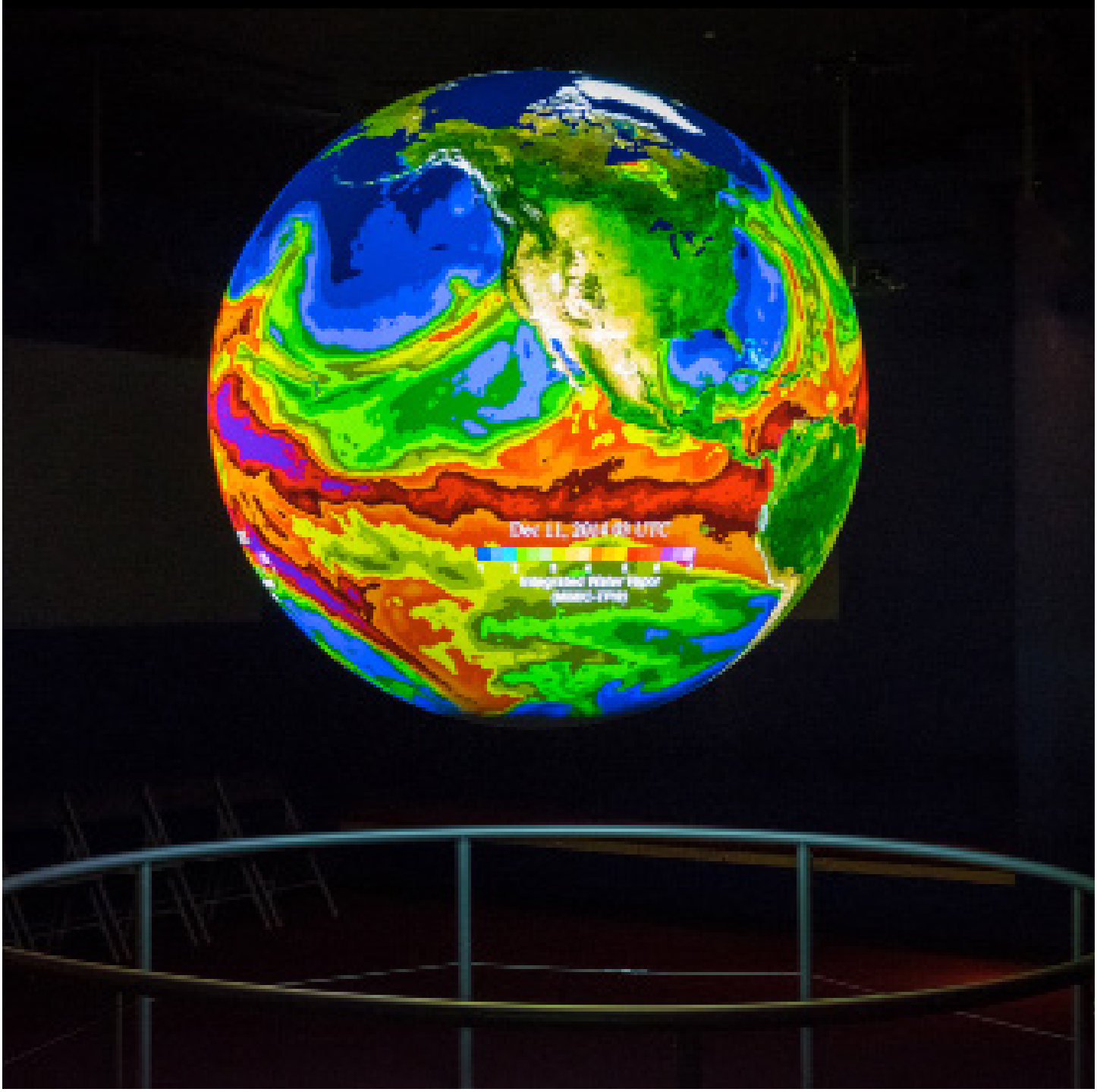
Earth System Research Laboratory

# Global Systems Division

# **Strategic Plan**

FY2016-2025



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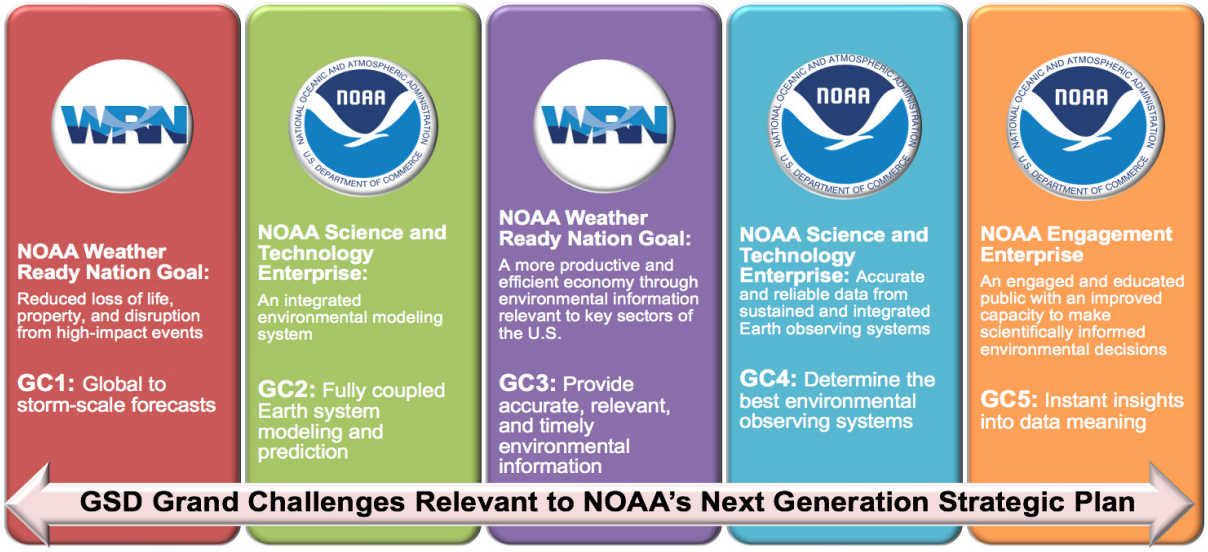
*Kevin Kelleher, Director*

## Message from the Director

The Global Systems Division (GSD) is one of four Divisions within the Earth System Research Laboratory (ESRL) and is part of National Oceanic and Atmospheric Administration's (NOAA) Office of Oceanic and Atmospheric Research (OAR) within the U.S. Department of Commerce. GSD is a primary contributor to NOAA and the nation in the areas of Numerical Weather Prediction (NWP), data assimilation, environmental information, decision support, observing system analysis and optimization, advanced visualization and education tools, and research involving advanced computing system architectures crucial for analyzing and predicting weather and air quality across a broad spectrum of time and space scales. The chief NOAA mission goal that currently directs our weather research and development (R&D) efforts, in partnership with the National Weather Service (NWS), is the goal of a "Weather Ready Nation." GSD's also seeks opportunities to leverage advances made under this goal to address other NOAA mission goals and enterprise objectives as articulated in NOAA's Next Generation Strategic Plan.

When ESRL was created in October 2005, the Forecast Systems Laboratory (FSL) mission focused the majority of its efforts on deterministic regional- and local-scale forecasts of the atmosphere. At that time, the FSL changed its name to the Global Systems Division (GSD). Through the years, GSD's mission evolved into one that embraced probabilistic modeling of the atmosphere, its chemistry, and oceans at spatial scales extending from global-to-local, and time scales from weeks to minutes. GSD also enhanced its focus on decision support systems to help the NWS evolve its Forecast Offices toward the future and to help the Federal Aviation Administration (FAA) prepare for the emerging technologies of the 21st century. Further, GSD took advantage of its core capabilities to provide technology advances in Information Technology (IT), data-management systems, visualization tools, and educational tools for not only NOAA, but also for other federal agencies and numerous private and public sector partners throughout the world.

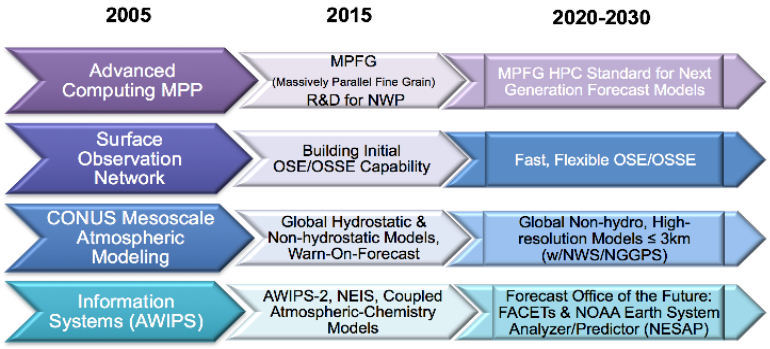
Given this history, GSD has re-aligned its core competencies, scientific and technical expertise, its Branches, and finances toward five Grand Challenges that are well aligned with existing DOC, NOAA, NWS, and OAR objectives. This 5-20 year GSD strategic plan builds upon past accomplishments, current workforce strengths, and existing collaborations toward exploring and building new relationships with the private sector, other government agencies and non-government organizations to provide and evaluate advanced observing, assimilation, modeling, and information systems.



GSD has made important strategic decisions to **shift** current research and development efforts focused on:

- High resolution regional models **to** high resolution, rapidly updating, integrated coupled global model analysis and prediction systems,
- Producing weather forecasts **to** providing impact-based information services and decision support systems,
- Developing observing systems **to** assessing the value, impact, and optimal configuration of observing systems,
- Investigating innovative data management and visualization tools **to** positioning NOAA to overcome the challenges of Big Data problems and utilizing advanced computing architectures.

This new emphasis is fully consistent with our intention to coordinate closely with the DOC Strategic Plan, NOAA Next Generation Strategic Plan, the NWS Strategic Plan and the newly released FY18 NOAA Strategic Research Guidance Memorandum.




*GSD's path forward*

The activities conducted by GSD help develop operational weather, water, and renewable energy services through improvements made to the accuracy and reliability of forecasts produced by numerical modeling and data assimilation systems using advanced computing technologies. Commerce and transportation are enhanced, and public safety and health are improved through informed decision-making and improved scientific understanding by federal agencies, businesses, various public sectors, and private individuals that use these advanced services developed at GSD.

Creation of this draft strategic plan began with a GSD Retreat in March 2014 and culminated in October 2015 after a series of meetings to identify GSD's evolving role within NOAA. A broad crosscut of GSD personnel participated in these meetings and contributed to this document. Part of the exercise included a strengths, weaknesses, opportunities, and threats analysis, (also known as the SWOT analysis) as well as a thoughtful assessment of what the forecast office of the future may be, given the NWS is evolving as the private sector's capabilities are advancing quickly within the weather enterprise.

Kevin Kelleher, Director

## Vision:
### "Making Forecasts Better"

## Mission:
The Global Systems Division (GSD) of the Earth System Research Laboratory (ESRL) is a leader in the applied research, directed development, and technology transfer of environmental data, models, products, and services that enhance environmental understanding.

## Core Values
At our core, GSD strives to perform its mission with integrity which we see as an adherence to moral and ethical principles. Together with these principles, we strive toward these values:

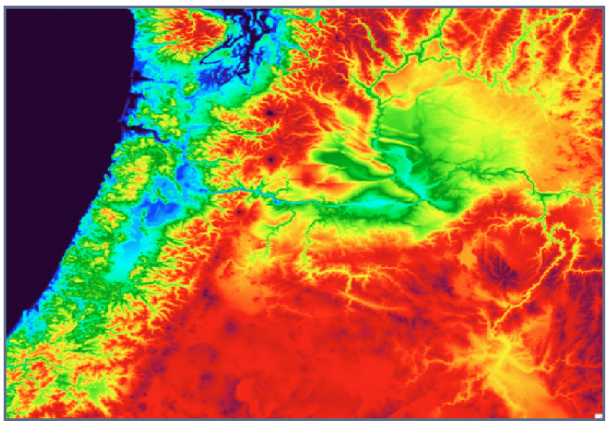
- Science-Driven - stewards of science
- Innovation - encouraging new ideas, creativity and future vision
- Inclusiveness - interacting and collaborating with others to achieve our shared goals

- Public Service - responsive to the public and society for the greater good
- Agility - ability and willingness to change as conditions and requirements change
- Excellence - striving to be the best at what we do in our research and public service

## Aims (what drives us)

GSD is driven to enable operational weather forecasters to produce the best possible forecasts using the state of the art technology that incorporates the latest science. In partnership with the NWS, GSD has a history of successfully transitioning research into advanced products and services for operations. GSD values its strong relationships with forecasters, the aviation community, university research partners, other NOAA organizations, the private sector, and its Cooperative Institute partners (CIRES and CIRA) in accomplishing its mission.

Motivated by our vision of "Making Forecasts Better," GSD will use its core competencies to guide resource investments over the next 5-20 years toward achieving five Grand Challenges. The Grand Challenges are listed below.



*750-m HRRR nest over the Wind Forecast Improvement Project - 2 (WFIP2) project region.*

## Grand Challenge #1

### Develop a continuous global to storm-scale (≤3km) ensemble data assimilation and ensemble forecasting capability for global situational awareness

Hazards know no geopolitical boundaries. Connecting a continuous atmosphere/Earth system model using global high resolution temporal and spatial density data will support critical situational awareness for global users and decision-makers. Applications include global aviation and shipping guidance, situational awareness of high impact storms anywhere in the world that could affect US interests and impact the global economy, weather impacts on tourism, and support for search and rescue. GSD plans to explore the research, development, and technical challenges associated with achieving this Grand Challenge in anticipation of the potential benefits it might have to NWS future operations. The scientific and technical challenges that need to be addressed include high performance computing requirements for the ensemble global model runs, improving the ensemble data assimilation especially for radar and satellite data, and global cloud assimilation and accounting for sub-grid scale clouds in the assimilation. To accomplish this, we will:

- Develop an effective hourly-updated ensemble-based 3km CONUS-domain data assimilation system to improve High Resolution Rapid Refresh (HRRR) forecasts (starting with regional demonstrations), all dependent on high-performance computing available to NOAA Research
- Develop an hourly updated 3km HRRR ensemble using the 3km ensemble-based data assimilation also over a CONUS domain, including use of 4d ens-var technique and 3km-specific radar- or satellite-based innovations required
- Develop an initial global rapid refresh capability using global satellite, radar, aircraft, GPS-Meteorology, and other data-sets used over CONUS. This initial global rapid refresh will be at ~10-15km scale
- Transfer regional/CONUS-scale 3km hourly-update ensemble data assimilation to global scale applications using NOAA's Next Generation Global Prediction System (NGGPS) model
- Collaborate with NSSL, NCAR, NCEP, other OAR laboratories to accomplish this goal
- Work toward the following, after the above mentioned tasks have been accomplished:
  - Providing information on the time (sub-15-min) and space scales (sub-1-3km)
  - Providing uncertainty information, representing level of confidence in the forecasts

## Relevant NOAA Goals

**NOAA Science and Technology Enterprise**
An integrated environmental modeling system

**NOAA Weather Ready Nation**

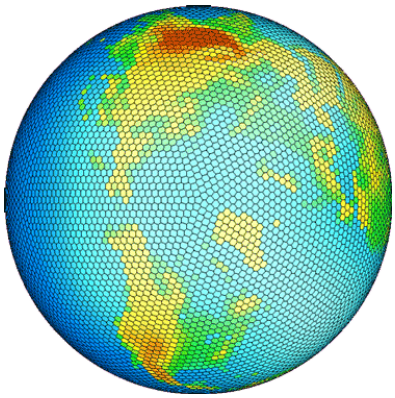
- Objective: A more productive and efficient economy through environmental information relevant to key sectors of the U.S. economy
- Objective: Healthy people and communities due to improved air and water quality services
- Objective: Improved transportation efficiency and safety
- Objective: Reduced loss of life, property, and disruption from high-impact events

# Grand Challenge #2

## Create a fully coupled earth system modeling prediction capability

In collaboration with its ESRL and CI partners, GSD has world-class expertise in atmospheric, chemical, and oceanic Earth system modeling, and high-performance computing. Utilizing a fully-coupled Earth system model framework that includes the physical, biological, and chemical environment will enable accurate predictions of complex and important Earth system problems. Such a system will have the capability to run potentially more "earth simulations" that could inform policy decisions, as well as support process and metrics evaluation and the development of tools for comparison, visualization, and analysis, effectively accelerating time-to-insight from the massive amounts of data that the earth system monitor will create. Applications include more timely and comprehensive information regarding disasters like Deepwater Horizon, volcano eruptions and impacts on aviation, and transport of aerosols associated with manmade (chemical releases) or natural causes (e.g., fires). Scientific and technical challenges include improving our understanding of first and second order effects of aerosols on clouds and precipitation, understanding sources and sinks of physical processes and how that can lead to improvements in model parameterizations, and general improvement in our understanding of how the biological, chemical, and physical components of the Earth System works. To accomplish this, we will:

- Couple atmospheric, oceanic, land surface, chemical, hydrological and ecosystem models within a NEMS (NOAA Environmental Modeling System) framework
- Maintain a NEMS framework for coupled models for testing and evaluation for accuracy
- Expand our focus from short term/today (e.g., today's weather, fire/smoke) to include sub-seasonal/seasonal (0 to 100 days) prediction challenges
- Collaborate with ESRL (PSD, GMD, CSD), GFDL, NCEP, NCAR, NASA and others to accomplish this leveraging resource from programs such as NGGPS



*The unique 20-sided mesh grid used in GSD's Flow-Following Finite-Volume Icosahedral Model (FIM).*

## Relevant NOAA Goals

N**OAA Organization and Administration Enterprise**
A modern IT infrastructure for a scientific enterprise

**NOAA's Science and Technology Enterprise**
Objective: An Integrated environmental modeling system
Objective: A holistic understanding of the Earth system through research

**NOAA Weather Ready Nation**
Objective: A more productive and efficient economy through environmental information relevant to key sectors of the U.S. economy
Objective: Healthy people and communities due to improved air and water quality services
Objective: Improved transportation efficiency and safety
Objective: Reduced loss of life, property, and disruption from high-impact events

*Pilots avoid a line of thunderstorms.*

## Grand Challenge #3

Provide the most accurate environmental information, including uncertainty and probabilities, to the right people at the right time, and in the right form for optimal understanding and decision-making.

GSD will develop tools to help decision makers best utilize all available information so that appropriate action can be taken. Our dynamic, mobile, and localized world has evolving and growing expectations to support the next generation of weather and aviation decision support tools. GSD will work within a changing technological environment to support a better-informed Weather-Ready Nation that is resilient in the face of high impact weather and environmental threats. To accomplish this, we will:

- Develop tools so forecasters and end users can continue to add value to computer-generated forecast guidance
- Help prototype the forecast office of the future and create tools to be used in the new forecaster decision support environment that:
  - Extract actionable information from large amounts of ensemble model output
  - Enable real-time comparison of model output
  - Help the forecaster utilize current observations to update model output
  - Modernize and simplify the production and dissemination of hazard warnings
  - Create a greater understanding so that uncertainty and probabilistic information may be effectively utilized
- Develop aviation decision support tools for traffic managers that:
  - Translate weather forecasts into aviation impact information
  - Synthesize weather and traffic flow constraint products into one display so that information on potential weather impacts to en-route traffic can be determined and communicated to the decision maker
  - Determine the best way to use probabilistic information to help the decision-maker think about a spectrum of possible decisions
- Develop methods to help build awareness within the public so they can effectively understand and interpret forecast and other information provided by NOAA
- Collaborate with the NWS Meteorological Development Laboratory, NWS/HQ, WFOs, National Centers, RFCs, CWSUs; NCAR, FAA's William J Hughes Tech Center (WJHTC), MIT/LL, CWB, ESRL/PSD, NSSL.

### Relevant NOAA Goals

**NOAA Engagement Enterprise**
Integrated services meeting the evolving demands of regional stakeholders

**NOAA Weather Ready Nation**
Objective: Reduced loss of life, property, and disruption from high-impact events
Objective: Improved transportation efficiency and safety

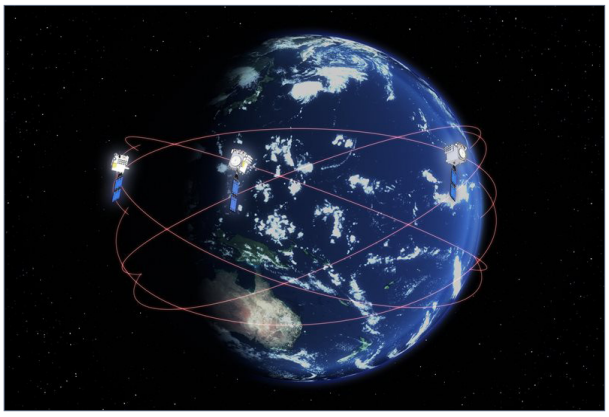
## Grand Challenge #4

Determine the best, most cost effective environmental observing systems needed to improve earth system predictions

Designing optimal configurations for global observing systems will improve our understanding of the atmosphere and increase numerical weather prediction forecast skill. Quantitatively evaluating the complementarity and benefits of current and proposed observing systems will help NOAA management prioritize mission designs in a cost-effective way. Furthermore, it will

save the taxpayer and NOAA money by analyzing tradeoffs in the design and configuration of proposed observing systems. To accomplish this, we will:

- Develop the capability to conduct in-house global and regional Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) on a routine basis to maximize and optimize the uses of current and proposed observations to improve earth system predictions, at all spatial and temporal scales
- Help identify and prioritize in situ and remotely sensed observations to support earth-system global modeling and select optimal observing systems to improve characterization of specific atmospheric phenomena
- Determine the optimal configuration of global and regional networks of observations to reduce the high costs of NOAA's data and observing systems by analyzing tradeoffs in the design and configuration of proposed observing systems, including, coverage, resolution, accuracy and data redundancy
- Accomplish this in coordination with the NOAA Quantitative Observing System Assessment Program and in collaboration with the Joint Center for Satellite Data Assimilation, NASA, and other NOAA Line Offices. QOSAP reports to the NOSC and its activities are coordinated with NOSIA/TPIO



*COSMIC-2/Formosat7 Constellation - a constellation of twelve remote sensing microsatellites to collect atmospheric data for weather prediction and for ionosphere, climate and gravity research*

## Relevant NOAA Goal

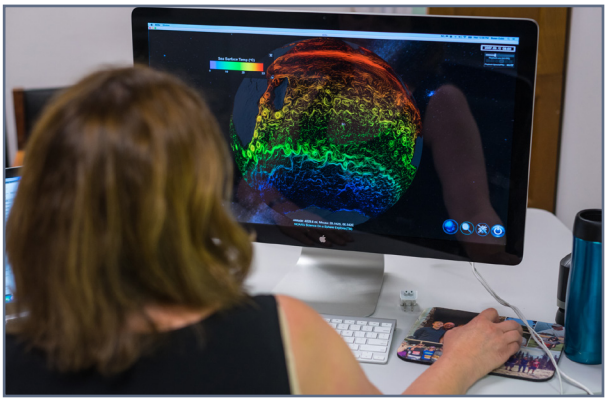
**NOAA Science and Technology Enterprise**
Accurate and reliable data from sustained and integrated Earth observing systems

# Grand Challenge #5

Create easily accessible systems to offer instant insights into the meaning of information and data.

Excellent research and clear understanding of science and scientific data often depends upon having great data and the capability to manipulate and understand the data. GSD will explore emerging technologies and concepts in the development of the next generation of tools needed to efficiently access and visualize large data sets for decision-making, response, and understanding of the Earth system environment. GSD will also build scientific literacy to allow understanding of this information by the public. To accomplish this, we will address some of NOAA's key "Big Data" challenges by:

- Developing methods to use innovative and emerging High Performance Computing (HPC) architectures, methods, and applications for application towards NOAA's mission objectives. Evaluations may include the use of NOAA-owned resources or other resources, such as commercially available cloud computing
- Working with the NOAA Office of Chief Information Officer (OCIO) to participate in the development of requirements and in identifying methods to evaluate new computing procurements to help assure the most appropriate new architectures and related systems are being procured
- Leading the discovery and understanding of the data and information from many sources
- Finding methods to make data discovery across NOAA easy and transparent for users and decision makers, in coordination with NOAA's National Centers for Environmental Information (NCEI)
- Understanding the quality, uncertainties, relationships, and efficient applications of information



*Science on a Sphere Explorer ™ is a new, downloadable flat-screen version of Science on a Sphere® to help make big data accessible to everyone*

- Selectively discovering important and credible information among "Big Data" sources to allow selective and efficient extraction of the most important information versus all the data
- Seeking and developing methods to access information from new sources that may be useful for the NOAA mission or is required by our partners
- Discovering efficient ways to compare, analyze, and/or blend information in ways to enhance understanding and decision making
- Evaluating the latest commercially available technology to determine its efficacy to the NOAA mission and GSD objectives
- Leveraging NOAA systems and architectures in new ways to build efficiency, reliability, and ease of access to important information sources
- Accelerating processes to bring new technologies and important data from concept to development to prototype to production
- Developing methods to allow collaboration and enhancement in a secure, flexible and open environment
- Providing tools to allow the public, teachers, and students to access and understand interesting and important NOAA data in museums, classrooms, and in the home.
- Collaborators include NWS, Taiwan, NCEI, NOAA OCIO, private industry involved in HPC and development of advanced computing architectures, gaming companies leading in visualization and processor technologies, museums and distributors of SOS, NOAA and non-NOAA organizations involved in solving the Big Data challenges.


*GSD benefits from world-wide collaborations.*

## Relevant NOAA Goals:

**NOAA Weather Ready Nation**
A more productive and efficient economy through environmental information relevant to key sectors of the U.S. economy

**NOAA Engagement Enterprise**
An engaged and educated public with an improved capacity to make scientifically informed environmental decisions

**NOAA's Science and Technology Enterprise**
A holistic understanding of the Earth system through research

**NOAA's Organization & Administration Enterprise**
A modern IT infrastructure for a scientific enterprise

## Activities (what we do)

GSD has a skilled staff with hard-earned and enduring experience and leadership in a number of areas. In particular, we find in our core competencies a depth and breadth of skills that, at least in part, are unique within OAR and NOAA and, in some cases, the world. These include:

- Modeling, data assimilation, and numerical weather prediction in general
- Research to operations and applications, and operations to research (particularly through the Developmental Testbed Center)
- Forecaster and aviation decision support tools to support the NWS AWIPS Program and FAA's Aviation Weather Research Program
- Forecast and observation assessment and verification for both internal and external requirements. GSD is working to coordinate verification systems internally and with NCAR and NWS
- Observing system analysis and optimization in coordination with NOAA's Quantitative Observing System Assessment Program and in collaboration with the Joint Center for Satellite Data Assimilation
- IT and high performance computing essential for GSD to execute its mission. GSD has been a pioneer in High Performance Computing technologies and architectures. GSD continues to research the newest HPC architectures, such as Massively Parallel Fine Grain computing

chips (e.g., Graphical Processing Units or GPUs, and Many Integrated Core or MIC accelerators). In addition, GSD also is investigating ways to mine, transmit efficiently, and visualize large data sets known as "big data"

- Education and outreach are important components of GSD's mission. By using the Science-on-a Sphere, GSD is able to reach millions of people across the globe to help educate them on the important interactions with the Earth System.

## Organization (who does what)

*The David Skaggs Research Center in Boulder, Colorado houses GSD and three other divisions within the Earth System Research Laboratory.*

GSD is part of NOAA under the Oceanic and Atmospheric Research Office (see link for complete list: http://research.noaa.gov/LabsPrograms/OAR-Labs.aspx) and is one of four Divisions within OAR's ESRL (see figure). GSD is organized into three science Branches: Earth Modeling Branch, Evaluation and Decision Support Branch, and Advanced Technology and Outreach Branch. In addition to the three Branches, GSD also supports a significant computing data center that is part of NOAA's Research and Development High Performance Computing, organized under the Information and Technology Services Group, which underpins nearly all of GSD's R&D activities. The Director's Office currently includes two new areas of research in 1) renewable energy and 2) global observing systems and analysis. The Director's Office also supports and helps guide the direction of the Development Testbed Center (DTC), in collaboration with our National Center for Atmospheric Research (NCAR) colleagues.

### Earth Modeling Branch

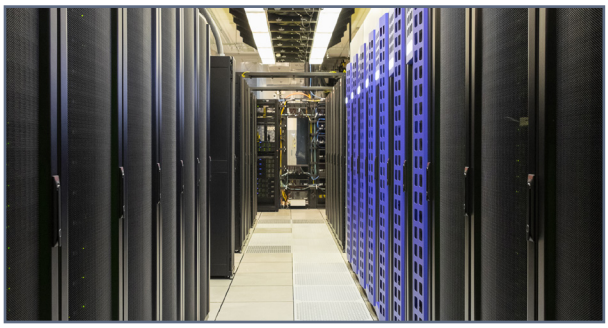
The Earth Modeling Branch (EMB) develops local-to-global scale weather, air quality, and extended weather (0 to 100 days) data assimilation and prediction models to be used in forecast operations. These modeling systems deliver forecasts and predictions of weather, including severe weather events, within the next few minutes to weeks away. Specifically, EMB develops research modeling and assimilation suitable for operations and transfers these technologies and techniques into operations, primarily within NOAA's NWS. EMB collaborates and innovates within community modeling and assimilation efforts including those at NCEP, NCAR, NWS/Environmental Modeling Center, other ESRL divisions and OAR laboratories, universities, international communities. EMB is working to expand atmospheric modeling to include the chemistry, oceans, and biosphere of the Earth system.

### Evaluation and Decision Support Branch

The Evaluation and Decision Support Branch (EDS) supports the NWS Advanced Weather Interactive Processing System (AWIPS-II) enterprise and explores new data management and processing capabilities to enhance situational awareness that allow forecasters to work more efficiently. EDS develops verification techniques and tools that generate and display statistical information in near real time and integrates NWS hazard tools while fostering collaboration among stakeholders. EDS tests, manages, and provides support services for system development and compliance with security requirements. EDS customers include military and civilian forecasters, air traffic controllers, air traffic managers, airline dispatchers, and general aviation pilots. EDS collaborates with the FAA, the NWS, and the Departments of Defense and Transportation.

### Advanced Technology and Outreach Branch

The Advanced Technology and Outreach (ATO) Branch identifies, investigates, and develops high-performance computing methods, products, systems, and tools to support the NOAA Mission and to foster research and operations. ATO transforms these new technologies and capabilities into innovative and valuable forecast, analysis, and visualization systems that ingest, manage, analyze, distribute and display environmental data in ways that help the National Weather Service, other professional users, educators, and the public understand our complex Earth.



*GSD's ITS staff manage a 7550 square feet computing facility.*

## Information and Technology Services Group

The Information and Technology Services (ITS) group manages the computer facilities infrastructure, communication networks, and associated peripherals that GSD staff use to accomplish their research and systems development mission. ITS designs, develops and maintains the GSD Central Computer Facility which acquires, processes, and stores a large variety of meteorological data in real time, and manages the IT security program. GSD is one of NOAA's three sites that host Research and Development High-Performance Computing Systems (RDHPCS) shared by the entire NOAA community. ITS staff manage 7550 square feet of computing facilities, spread across four separate data centers housed at the NOAA campus in Boulder, Colorado. The facility enhances NOAA's efficient and timely delivery of products and services. ITS works closely with the NOAA Office of the Chief Information Officer.

## Office of the Director

The GSD Office of the Director provides overall leadership, planning, budgeting, financial, communication, and administrative infrastructure to support GSD's diverse and creative team of scientists, engineers, software developers, technicians, educators, managers, and administrative staff. Only by investing in this intellectual capital can GSD achieve its vision of "making forecasts better" by being a world leader in basic and applied research to support an informed society that is resilient to high-impact weather.

In addition, the Office of the Director is the home for the Global Observing Systems Analysis (GOSA) Group, the Renewable Energy Program, and leadership of the DTC. The GOSA Group was officially established in October 2014 under the OD, and since then its activities have been a growth area for GSD. GOSA's goal is to design optimal configurations for global observing systems and to quantitatively evaluate benefits of current and future observations in weather forecasting. Information from these studies can help NOAA management prioritize investments in observation systems by analyzing tradeoffs between observation systems and in the design of proposed future observing systems. The Renewable Energy Program, which moved to GSD in FY16, is working to bring together work done by other ESRL Divisions, the strong modeling effort within GSD, the wind and solar energy industries, and the Department of Energy to improve existing meteorological observing networks and weather forecast models for Renewable Energy applications. The DTC is a partnership between NOAA and NCAR where the Numerical Weather Prediction community can 1) test and evaluate new models and techniques for use in research applications (R2O) and 2) obtain operational code for learning and exploring ways to improve it (O2R).

# Approach (how we do it)

GSD's approach is to apply sound administrative and management principles toward existing resources and to aggressively build base funding to allow increased investment in high risk R&D to deliver "transformative" technologies, in addition to the incremental upgrades, all focused on improving weather forecasts and operations. GSD will work to improve its communication with its primary customers and partners to build strong, productive relationships. Specific goals in the areas of managing, planning, and guiding investments for the future follow.

## Managing

- Continuously align GSD core services toward evolving NOAA and NWS priorities, while periodically evaluating overhead costs to assure they are appropriate and competitive
- Build a stable financial base from which GSD will execute its projects
- Align base funding toward Grand Challenges
- Develop new approaches for streamlining MOUs and agreements
- Extend relationships with our CI partners that allow for intellectual property management

- Build strategic relationships (e.g., formal agreements) with both the university and government research communities to encourage collaboration and leverage talent

## Planning

- Use Grand Challenges as a guide to direct research and future investments
- Develop strategies and tactical plans to address the GSD Grand Challenges in a thoughtful, focused, transparent, and accountable way
- Continue to build and expand collaborations with other ESRL Divisions
- Pursue opportunities within NOAA that would allow wider use of important technologies developed within GSD
- Strengthen current collaborations with NWS and Federal Aviation Administration
- Open new business relationships with private sector and other government agencies
- Pursue CRADAs, reimbursable agreements, or other partnerships as appropriate to accelerate the development, transfer and evaluation of technologies and knowledge to the public, private sector, museums, and other government agencies outside NOAA


*GSD's Environmental Modeling Branch received the 2015 Colorado Governor's Award for High-Impact Research for the High-Resolution Rapid Refresh model that can predict individual thunderstorms.*

## Investing in the Future

- Assist NWS in the integration of the next generation non-hydrostatic global prediction model into NWS operations
- Lead and sustain R&D pertaining to the next generation of High Performance Computing architectures and their integration into NOAA modeling enterprise
- Increase the usage of satellite data within all aspects of GSD's R&D portfolio
- Lead and sustain research to use NOAA models to provide more accurate wind and cloud forecasts over a range of timescales (global to stormscale) to support the nation's increased demands for better products and services in support of the renewable energy industry
- Assist ESRL in the development of an NOAA Earth System Analysis and Prediction capability that integrates the physical, biological, and chemical components of the Earth system
- Assists NWS in the development of the next generation forecast office of the future
- Help lead and sustain NOAA efforts to maximize and optimize current and future global observations to improve numerical weather prediction forecast skill in NOAA models
- Help lead and sustain efforts to quantitatively evaluate the complementarity of different observing systems to help NOAA management prioritize observations systems and their design in a cost-effective way in full coordination and collaboration with the NOAA Quantitative Observing System Assessment Program

# Evaluation (how we are judged)

## Science Quality, Relevance, and Performance:

GSD is evaluated every five years during a Science Review. A review panel is established and composed of national and international experts that evaluate GSD's research, development, and transition activities, including outreach and science education. The composition of the review panel reflect the diversity of expertise necessary to assess GSD's core competencies: modeling, decision support systems, advanced technologies, and science education and outreach. The reviewers assess the science, technology, their transition to applications, and portfolio management. Per NAO 216-115, the assessment criteria include quality, relevance, and performance. The recommendations of the review panel are provided to OAR Headquarters and a formal response by GSD, along with an implementation plan addressing approved recommendations, is required. Access to the documents and presentation for the 2015 GSD Science Review can be found at: http://www.esrl.noaa.gov/gsd/research/review/2015/

GSD is judged according to the quality, relevance, and performance of OAR's activities within the context of the agency's overarching mission of science, service, and stewardship.

*GSD scientists present their work to reviewers during the 2015 GSD Science Review.*

*2015 GSD Science Reviewers enjoy Science on a Sphere®.*

## Quality

- The quality of GSD work can be gauged by several factors including:
- Has merit within the scientific community
- Provides value to our customers
- Is recognized by our peers and customers
- Continued desire of our partners to maintain and extend our relationships

## Relevance:

- GSD's R&D activities will be effectively organized, directed, and executed to have maximum impact and benefits to society by the:
- Application of scientific knowledge to policy decisions
- Improvement of operational capabilities within NOAA's service lines
- Patenting and licensing of inventions for commercial use
- Transitioning of valuable NOAA developed technologies to partners both within and outside NOAA

## Performance:

The performance of GSD's efforts can be seen in how it executes the following functions:

- Research leadership and planning
- Maintain clearly defined and documented scientific objectives, rationale, and methodologies
- Maintain evaluation process for projects
- Stay flexible to respond to unanticipated events or opportunities
- Provide scientific leadership and interact with NOAA and the external community
- Efficiency and effectiveness
- Maintain infrastructure to support high quality research and development
- Execute research efficiently and effectively
- Leverage relationships with internal and external collaborators and stakeholders to maximize research outputs
- Transition of research to applications
- Plan and execute transition of research to applications and/or dissemination of knowledge involving end users in planning and delivery
- Measure user satisfaction
- Results communicated to stakeholders and the public

## Financial Management:

GSD reports on its financial management status with a full review of finances at the end of each Fiscal Year. ESRL and OAR headquarters provide continuous oversight of GSD financial management.

## Milestone Performance:

For the OAR Annual Operating Plan (AOP), GSD provides several performance measures and milestones which are tracked on a monthly basis. These AOP milestones are compiled within the OAR AOP to NOAA for the NOAA AOP.

## Personnel Evaluation:

Annually the GSD Director is required to defend all ratings for Federal staff to the OAR Deputy Assistant Administrator and staff.

## Cooperative Institute Personnel Performance:

At least annually, GSD Federal Science Advisors are required to review and provide input to the CI management related to overall performance of grantees. The CI's themselves are evaluated by NOAA every five years.

## Acronyms

AOP - Annual Operating Plan
ATO - Advanced Technologies and Outreach
CI - Cooperative Institute
CIRES - Cooperative Institute for Research in Environmental Sciences
CIRA - Cooperative Institute for Research in the Atmosphere
CONUS - Contiguous United States
CSD - Chemical Sciences Division
CWB – Taiwan Central Weather Bureau
CWSU – NWS Central Weather Service Unit
DOC - Department of Commerce
EDS - Evaluation and Decision Support
EMB - Environmental Monitoring Branch
ESRL - Earth System Research Laboratory
ESRL/PSD – ESRL Physical Sciences Division
FAA - Federal Aviation Administration
FSL - Forecast Systems Laboratory
GFDL Geophysical Fluid Dynamics Laboratory
GMD - Global Monitoring Division
GOSA - Global Observing Systems Analysis Group
GPS - Global Positioning System
GSD - Global Systems Division
HPC - High Performance Computing
HRRR - High Resolution Rapid Refresh
IT - Information Technology
ITS - Information Technology Services
MDL – Meteorological Development Laboratory
MIT/LL – MIT Lincoln Laboratory
MOU - Memorandum of Understanding
NCAR - National Center for Atmospheric Research
NCEI – National Centers for Environmental Information
NCEP - National Centers for Environmental Prediction
NGGPS - Next Generation Global Prediction System
NOAA - National Oceanic and Atmospheric Administration
NSSL – National Severe Storms Laboratory
NWS - National Weather Service
OCIO – Office of the Chief Information Officer
OD - Office of the Director
OSE - Observation Simulation Experiment
OSSE - Observation Simulation System Experiment
PSD - Physical Sciences Division
RFC – NWS River Forecast Center
WFO – NWS Weather Forecast Office
WJHTC - FAA's William J Hughes Technical Center