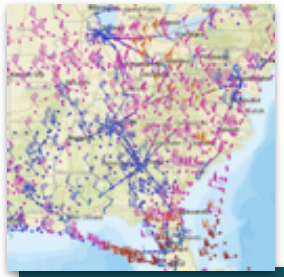
NOAA Global Systems Laboratory

# Organizational Excellence

Jennifer Mahoney, Director

# GSL - Forecast Systems that Provide Solutions

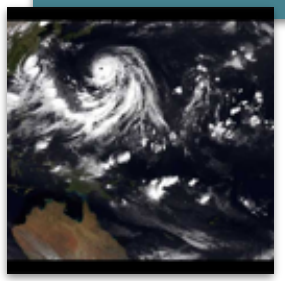


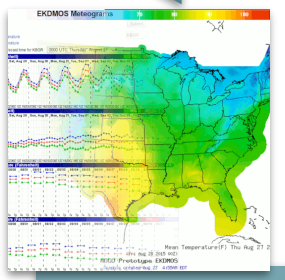
Data and Observations

Advanced Technologies

Data Assimilation

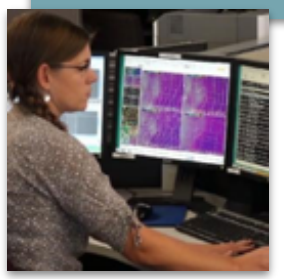
Earth System Prediction






Decision Support and Usable Output

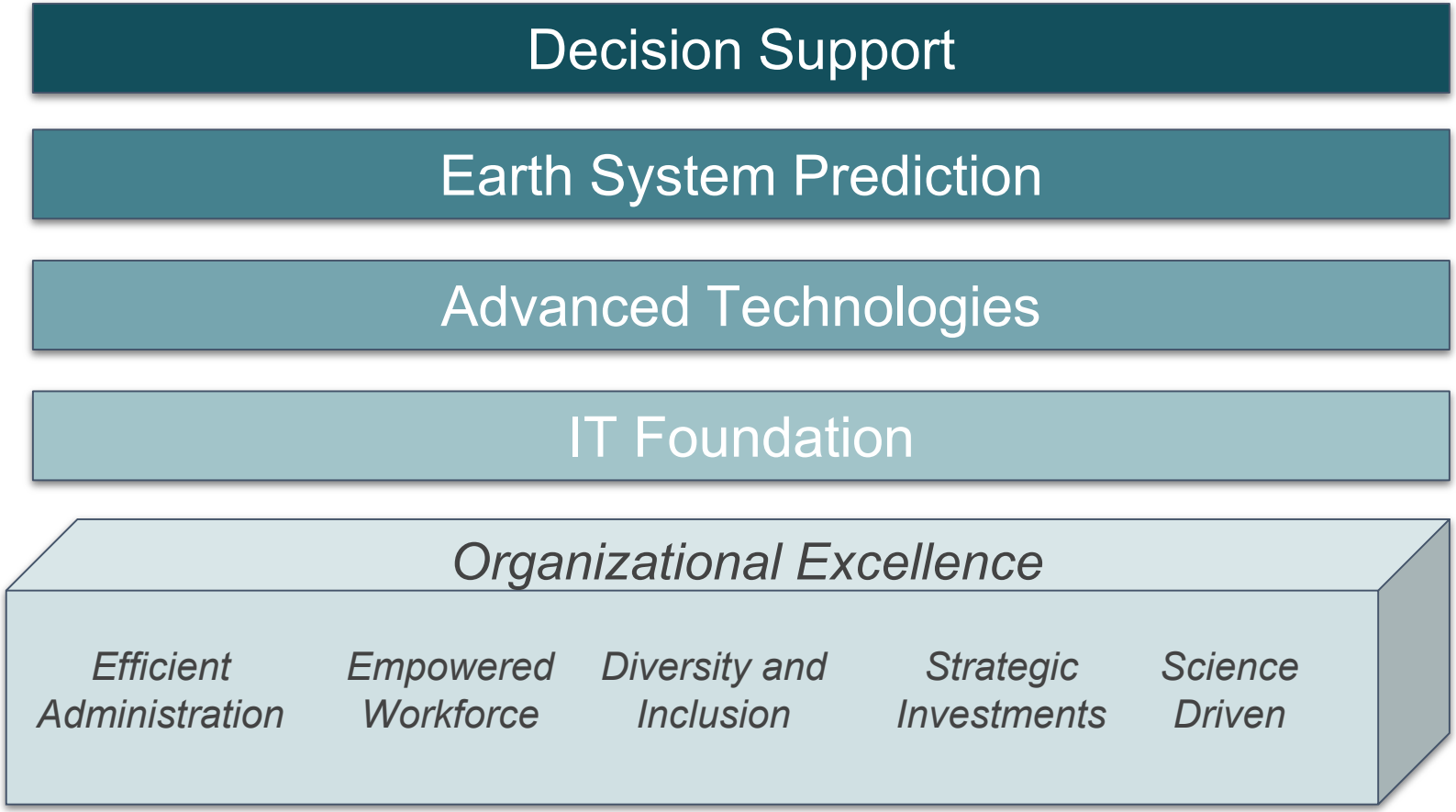
Forecaster



Effective Response

***Organizational Excellence and Information Technology***

# GSL Organizational Structure




B6.1, B6.8

NOAA Global Systems Laboratory

# Evaluation Criteria: Quality

Indicators ensuring that GSL is performing high-quality work now and into the future and progressing toward OAR's goal to conduct preeminent research.

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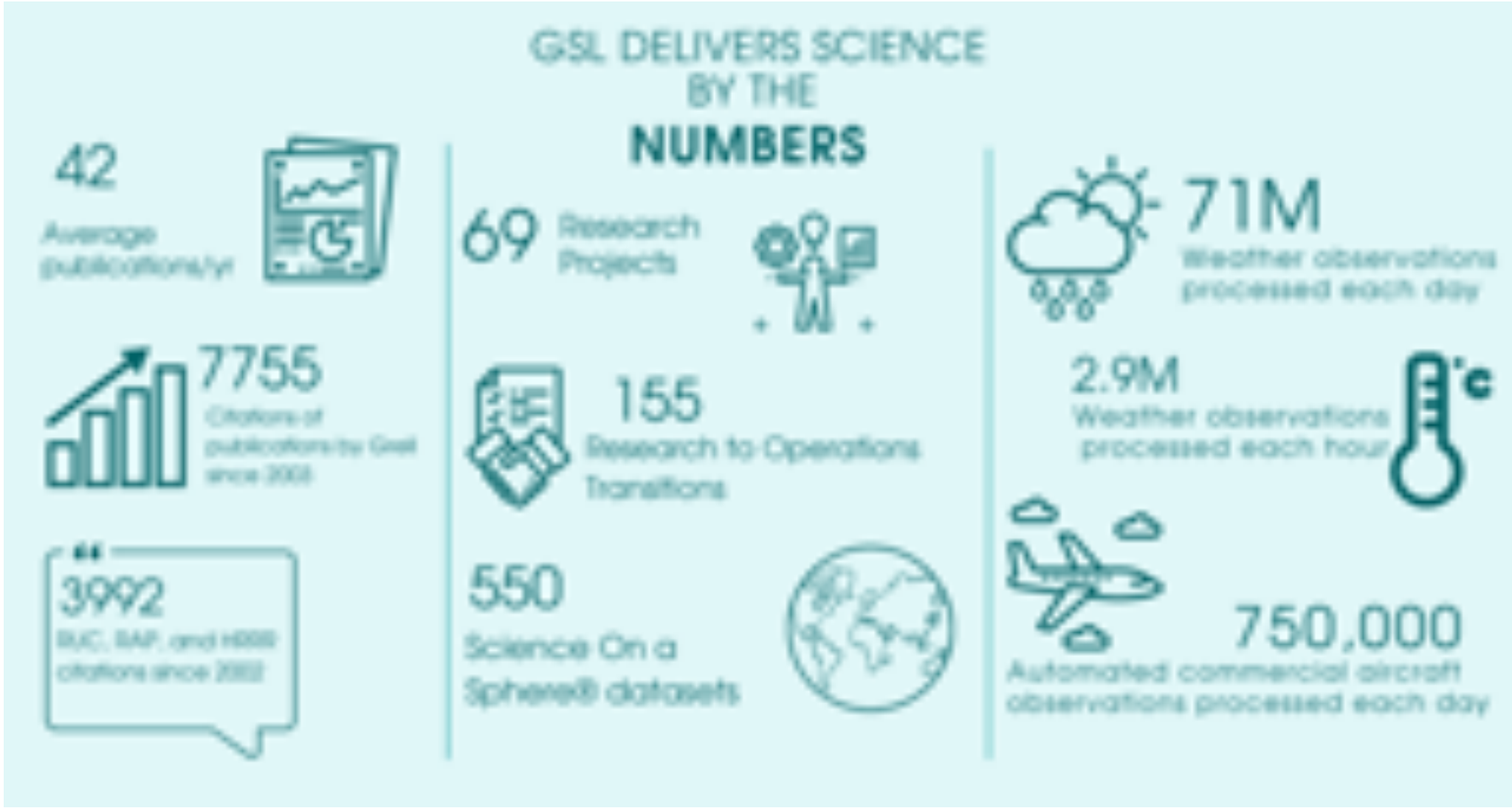
# Delivering Science



# Transitions, Consumers, and Impacts

## Weather and Air Chemistry Models

- Air quality
- Severe weather
- Flooding

## Assessments

- Supports informed decisions
- Makes models more accurate

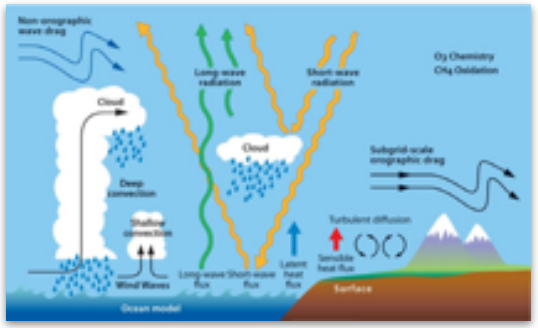


## Model Evaluation Tools

Accelerates model development

## Physics Packages

Accelerates model development



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# Transitions, Consumers, and Impacts

## Decision Support Systems

Data handling and visualization

## Data Processing

- MADIS
- AQPI

## Science Literacy

Reaching millions

- Science On a Sphere®
- Science on a Sphere Explorer
- Science On a Sphere Explorer Mobile

## Software Infrastructure

Efficient processing and computation

Optimize compute power

B6.11

# Major Awards

# GSL Service

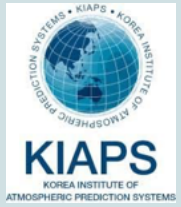
## National and International Societies























# Collaborations

| Primary Collaborations |
| --- |
| NOAA Research Laboratories |
| National Weather Service |
| Federal Aviation Administration |
| Department of Energy |
| Joint Center for Satellite Data Assimilation |
| NOAA's Office of Education |
| Earth Prediction Innovation Center (EPIC) |
| Interagency Council for Advancing Meteorological Services (ICAMS) |
| Developmental Testbed Center (DTC) |
| Cooperative Institutes |

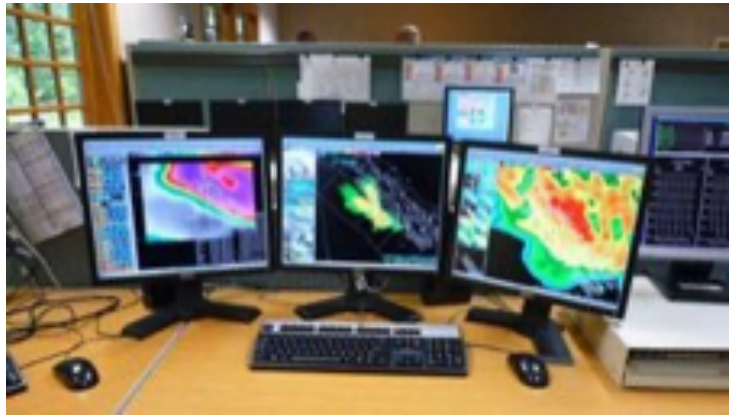
| Other Collaborations |
| --- |
| NOAA Line Offices and Programs |
| 13 International Government Agencies |
| 13 International Private Companies |
| 3 International Non-Profit Organizations |
| 18 U.S. Government Organizations |
| 40 State Government Organizations |
| 18 Universities |
| 18 U.S. Private Companies |
| 472 MADIS Data Providers |
| 3 U.S. Non-Profit Organizations |
| 215 Science On a Sphere® Installations |

# Recognition from Customers

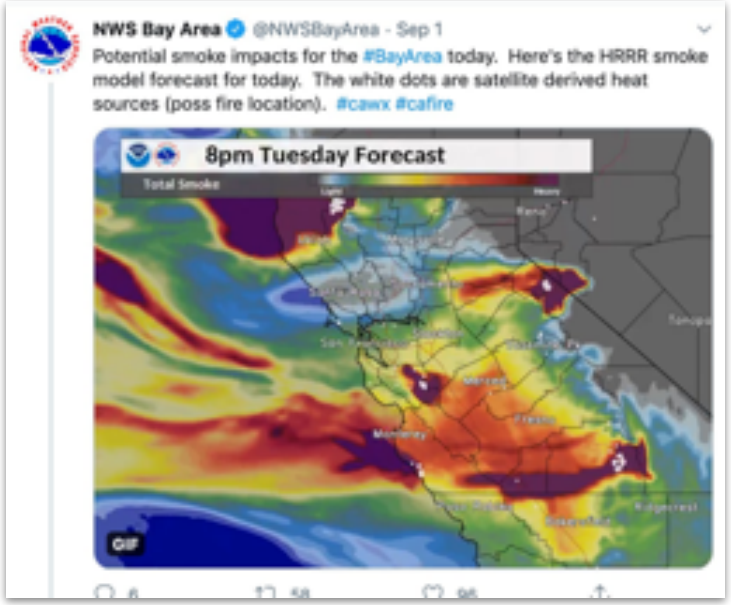

Jeff McQueen, Air Quality Modeling Team leader for the NWS “It was kind of **revolutionary** the first time we saw smoke forecasts at that resolution”

“I personally, while on shift, have seen the HRRR performing head over heels better than other models most of the time.”

SPP Southwest Power Pool



NWS Charleston, SC: "Software developed by GSL is always nothing short of **outstanding**. Having been a NWS forecaster for 18 years and dealing with the software side of things for more than 12 years, I can say unequivocally that GSL software is the **gold standard**."




“The Global Systems Laboratory’s development of foundational and pragmatic state-of-the-science technologies to improve predictions of weather and its impacts on society has been **one of the nation’s true success stories** that is **significantly under-appreciated** given the enormous value it returns to the nation.” Peter Neilley, The Weather Company

NOAA Global Systems Laboratory

# Evaluation Criteria: Relevance

Indicators describing the degree to which GSL's research and development is relevant to NOAA's mission and of value to the Nation

Global Systems Laboratory

# Congressional Drivers

## 2017

### Weather Research and Forecasting Innovation Act

Prioritize weather research to improve weather data, modeling, computing, forecasts, and warnings for the protection of life and property and the enhancement of the national economy.

- Earth System Modeling
- High-Resolution Weather Modeling
- Decision Support Systems
- High-Performance Computing

## 2018

### National Integrated Drought Information System Act

Carry out weather and air chemistry research programs, advance weather modeling skill, reclaim and maintain international leadership in the area of numerical weather prediction, and create a community global weather research modeling system that is accessible by the public.

- Earth System Innovation Center (EPIC)
- Air Chemistry Modeling
- Unified Forecast Systems

## 2020

### Floods Act

Requires NOAA to evaluate and improve flood watches and warnings and communication of information to support preparation and responses to floods

Requires NOAA to estimate and communicate the frequency of precipitation

- High-Resolution Weather Modeling
- Automated Quantitative Precipitation Information System
- Decision Support Systems

## 2021

### Clean Future Act

Improve public health, resilience, and environmental outcomes

- Air Chemistry Modeling
- Atmospheric Science for Renewable Energy

# Alignment with DOC/NOAA/OAR Goals

| DOC's Strategic Objectives | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Expand Commercial Space Activities | **Advance Innovation** | Increase Aquaculture Production | Reduce and Streamline Regulations | Strengthen Domestic Commerce | Enhance the Nations Cyber-security | **Reduce Extreme Weather Impacts** | Provide accurate Data to Support Economic Activity | Engage Commerce Employees | Accelerate Information Technology Modernization | Consolidate Functions for Cost Savings |

| NOAA Research and Development Priorities (2020-2026) | | |
|---|---|---|
| **Reducing societal impacts from hazardous weather and other environmental phenomena** | Sustainable use and stewardship of ocean and coastal resources | **A robust and effective research, development, and transition enterprise** |

| OAR's Strategic Goals | | | |
|---|---|---|---|
| **Drive Innovative Science** | **Make forecasts better** | **Detect Changes in the Ocean and Atmosphere** | Explore the Marine Environment |

| Global Systems Laboratory Strategic Goals | | |
|---|---|---|
| **Develop state-of-the-art Earth-system prediction capabilities** | **Revolutionize the communication of weather information and impacts to consumers** | **Invest in people, partnerships, and organizational performance** |

# NOAA Science and Technology Strategies

NOAA Artificial Intelligence Strategy


NOAA Citizen Science Strategy

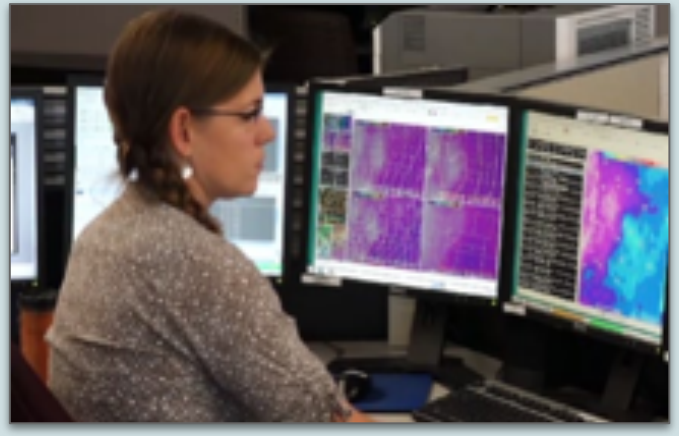

NOAA 'Omics Strategy


NOAA Uncrewed Systems Strategy


NOAA Data Strategy


NOAA Cloud Strategy

# The Impacts of GSL's Research



**Advancing the tools in NWS Offices**

GSL-developed technology helps the NOAA National Weather Service and emergency managers quickly respond to weather threats.

**Making Forecasts Better**

Increasingly accurate wind and precipitation forecasts are improving agriculture production and managing wildfires.

# The Impact of GSL's Research


**Supporting the U.S Economy**

GSL provides weather prediction modeling systems that improve weather services and provide a benefit of $41B to the American public each year.

**Improving Energy Forecasts**

GSL provides increasingly accurate weather forecasts to improve the stability of our power grid.

**Improving Aircraft Safety**

The HRRR is the foundation for FAA weather products and is helping to reduce weather aviation flight delays that cost air travelers billions of dollars each year.

# The Impacts of GSL's Research

**Advancing HPC Science**

GSL researches and hosts efficient high-performance computing to support NOAA's mission.

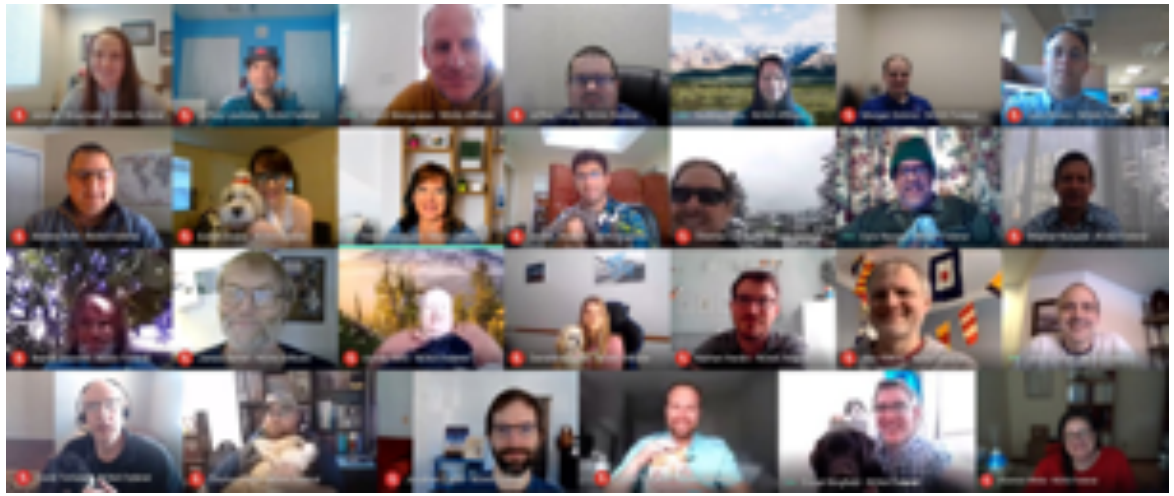
**Promoting a Scientifically Literate Society**

GSL technology encourages learning and discovery for a science-literate society.


**Improving Public Air Quality Forecasts**

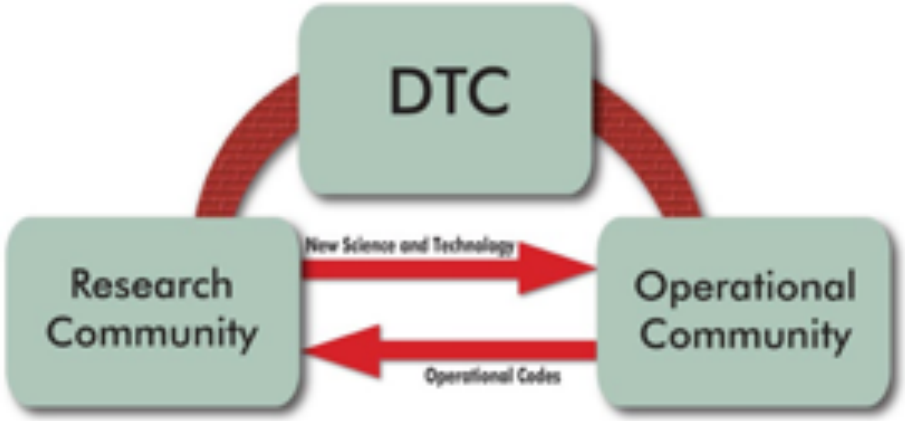
Increasingly accurate wind, smoke, and precipitation forecasts are essential for managing wildfire operations and alerting the public to air quality hazards.

# Community Engagement



GSL hosts:

- Forecaster Assessments
- Model training
- Model tutorials on YouTube




EPIC
Earth Prediction Innovation Center

UFS
UNIFIED FORECAST SYSTEM

JOINT CENTER FOR SATELLITE DATA ASSIMILATION
JCSDA

# Community Engagement: Testbeds

**Hazardous Weather Testbed**
Experimental Warning Program
- End Users Experiments
- Threats-in-Motion tests
- Probabilistic Hazard Information

**Hazardous Weather Testbed**
Spring Experiment
- GSL Ensemble Forecast Models
- 3D Real-time Mesoscale Analysis
- GSL FV3 Limited Area Model
- GSL Rapid Refresh Forecast System


**Aviation Weather Testbed**
- HRRR 750m Nest for SFO fog

**Hydrometeorology Testbed**
- Annual Flash Flood and Intense Rainfall Experiment
- Annual Winter Weather Experiment

# Community Engagement: Collaborations

| International | National | NOAA | Academic | Corporate |
|---|---|---|---|---|
| Met Office<br>KIAPS<br>ECMWF<br>Environment Canada | NASA<br>FAA<br>Air Force Weather Agency<br>Navy<br>Department of Energy<br>NSF<br>Naval Research Laboratory<br>ARM Climate Research Facility<br>NCAR | GFDL<br>National Weather Service<br>Atlantic Oceanographic & Meteorological Laboratory<br>National Severe Storms Laboratory<br>CSL NOAA Chemical Sciences Laboratory<br>JPSS NOAA NASA<br>GLERL Great Lakes Environmental Research Laboratory<br>Global Monitoring Laboratory Earth System Research Laboratories<br>Physical Sciences Laboratory | CIRES<br>University of Colorado Boulder<br>CIRA Connecting Models and Observations<br>Colorado State<br>Mississippi State University | Raytheon<br>amazon web services<br>aer Atmospheric and Environmental Research<br>IBM<br>CRAY<br>NVIDIA<br>intel |

# Public Engagement


American Indian Science and Engineering Society Annual Meeting (Milwaukee upper, OKC lower)

University of Wyoming Girls in STEM

Government Career Day CU Denver, Metro State, Community College of Denver


Denver Museum of Nature and Science Girls and Science Day

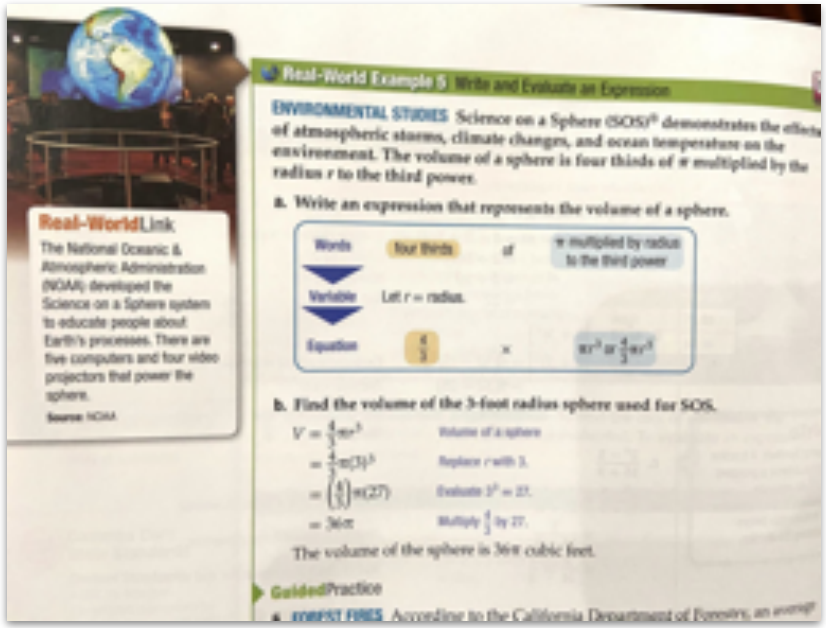
8th Grade Science Days

Colorado Science Teachers Conference

NOAA Research: Top tweet of the year, 200K impressions, 38% engagement rate

# Fostering an Environmentally Literate Society

## Science On a Sphere®




NOAA Global Systems Laboratory

# Evaluation Criteria: Performance

The effectiveness and efficiency with which research and development activities are organized, directed and executed. Overall effectiveness with which the Laboratory plans and conducts its research and development given the resources provided, to meet NOAA's Research mission and the needs of the Nation.

Global Systems Laboratory

# Measures of Performance

- Leadership and strategic planning
- Budget
- Workforce
- Information Technology

NOAA Global Systems Laboratory

# Research Leadership and Planning

Global Systems Laboratory

# GSL Organizational Leadership

- Senior Leadership Team
  - Deputy Director and Associate Director
  - Division Deputy Chiefs
- Mid-career empowerment
  - Evergreen Group
  - IT Enterprise Team
  - Mentoring team
  - Peer Coaching
- Scientific strategic decisions
  - Science Board - to begin this year
  - Strategic Plan
  - Scientific Grand Challenge
- Resource alignment toward Grand Challenge
  - Director Directed Funding Opportunities
  - Base funding

Team Member of the Month

# Strategic Planning

2019

2020 – Virtual participation nearly exceeded 100


- Annual all staff retreats.
- Stakeholder meetings (NWS, FAA, NCAR, GFDL)
- Writing team composed of GSL Division Deputies
- GSL staff review
- Senior Leadership review
- Release draft for Science Review Panel

# Strategic Goals

## Scientific Grand Challenge

Provide actionable environmental information through the research and development of global storm-scale prediction and innovative decision support capabilities to serve society.

| GOAL 1 | GOAL 2 | GOAL 3 |
| --- | --- | --- |
| Develop state-of-the-art Earth-system prediction capabilities | Revolutionize the understanding and communication of weather-affected impacts | Achieve excellence through investment in people, partnerships, and organizational performance |

# Effective Tracking and Managing Projects and Program

- NOAA Research and Development Database (NRDD)
- Program management table

**FY2021 GSL Project Status Summary**

Status Date

08/31/2021

NOTE: FY21 Funding in this table is draft information that may not be completely accurate for all projects. Amounts include 65% overhead, grants to CIs, Hurricane Supp grants, et al.

**Assimilation and Verification Innovation Division (AAVD)**

| FY2021 PROJECT NAME | PROJECT MANAGER | RL | FY21 Milestone/Deliverable (from GSL Projects Info sheet) | FY21 Funding with GSL Overhead (DRAFT) | Funding Source(s) | FY21 Project Status As of 12/31/2020 | | | | | Rationale for Yellow and Red scores and Readiness Level comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Funding | Cost | Sched. | External Dep. | Key Assump. | |
| GSL/NAVI-Development of Rapid Refresh Forecast System (RRFS)/Limited Area Model (LAM) on the Stand Alone Regional FV3 for the Unified Forecast System (UFS) | Curtis Alexander | 4 - Val in Lab | 1. 2/31/2021 - With support from the Developmental Testbed Center (DTC), release UFS Short Range Weather v1.0 model (RRFS/LAM) with FV3 capabilities to the modeling community for research/testing (Completed 9/9/21)<br>2. 6/30/2021 - Conduct high resolution model improvement demonstrations using additional satellite data assimilation of observations in the NOAA Hazardous Weather Testbed<br>3. 9/30/2021 - Forecast performance benchmark of the RRFS baseline physics suite created with MET | | NWA, UMAQ/CWAQ(CTT), GSL Base/AAVD | Green | Green | Green | Green | Green | Limited Area Model (LAM) FV3 development efforts progressing on multiple fronts |

# Leveraging Partnerships to Increase Efficiency

- Modeling and observations - Unified Forecast System
- Aerosols and air chemistry - OAR Labs and NCAR
- Boundary layer - OAR Labs
- Atmospheric Science for Renewable Energy Program - Broadening to OAR Labs
- Decision support - NWS and user community
- Data assimilation - Joint Center for Satellite Data Assimilation (JCSDA)
- Community based tools (e.g. CCPP)
- International partnerships (e.g. Taiwan, UKMet)

# Involvement in NOAA and OAR Budget Planning

Fire weather

Clean Energy

EPIC Earth Prediction Innovation Center

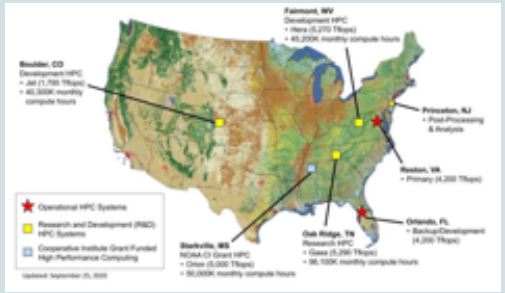
UFS UNIFIED FORECAST SYSTEM

NATIONAL WEATHER SERVICE EMC ENVIRONMENTAL MODELING

Modeling

ARTIFICIAL INTELLIGENCE · RISK COMMUNICATION · ENVIRONMENTAL SCIENCE

Artificial Intelligence



HPC

NOAA Cloud

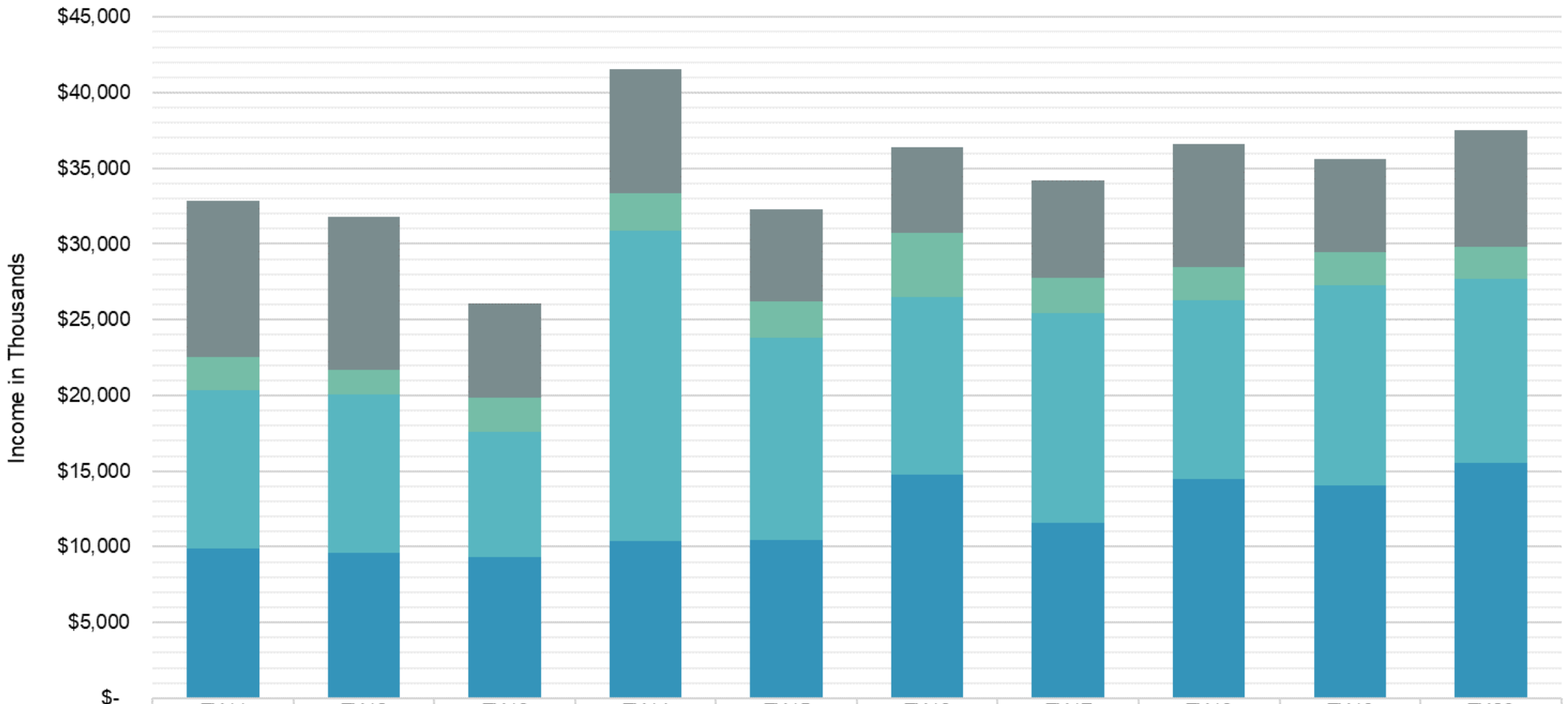
# Scientific Leadership in the Weather Community

| NOAA | OAR | DTC | External |
|---|---|---|---|
| • Co-Chair for NOAA's HPC Allocation Committee<br>• Co-Chair for NOAA Research Council's Unified Modeling Committee (UMC)<br>• Management Oversight Board and Executive Team for JCSDA<br>• NOAA AI Executive Committee<br>• NOAA Modeling Board Member<br>• NOAA Central Region Team | • OAR Cloud Tiger Team<br>• OAR Representative for OMB Federal Data Center Optimization Initiative<br>• Chair of the FACETs Working Group<br>• OAR Awards Committee<br>• OAR/NWS Bilateral Steering Committee | • Deputy Director<br>• Management Board<br>• Executive Committee<br>• Science Advisory Board | • Unified Forecast System<br>• Interagency Council for Advancing Meteorological Services (ICAMS)<br>• NASA PBL Incubation Team |

NOAA Global Systems Laboratory

# Budget

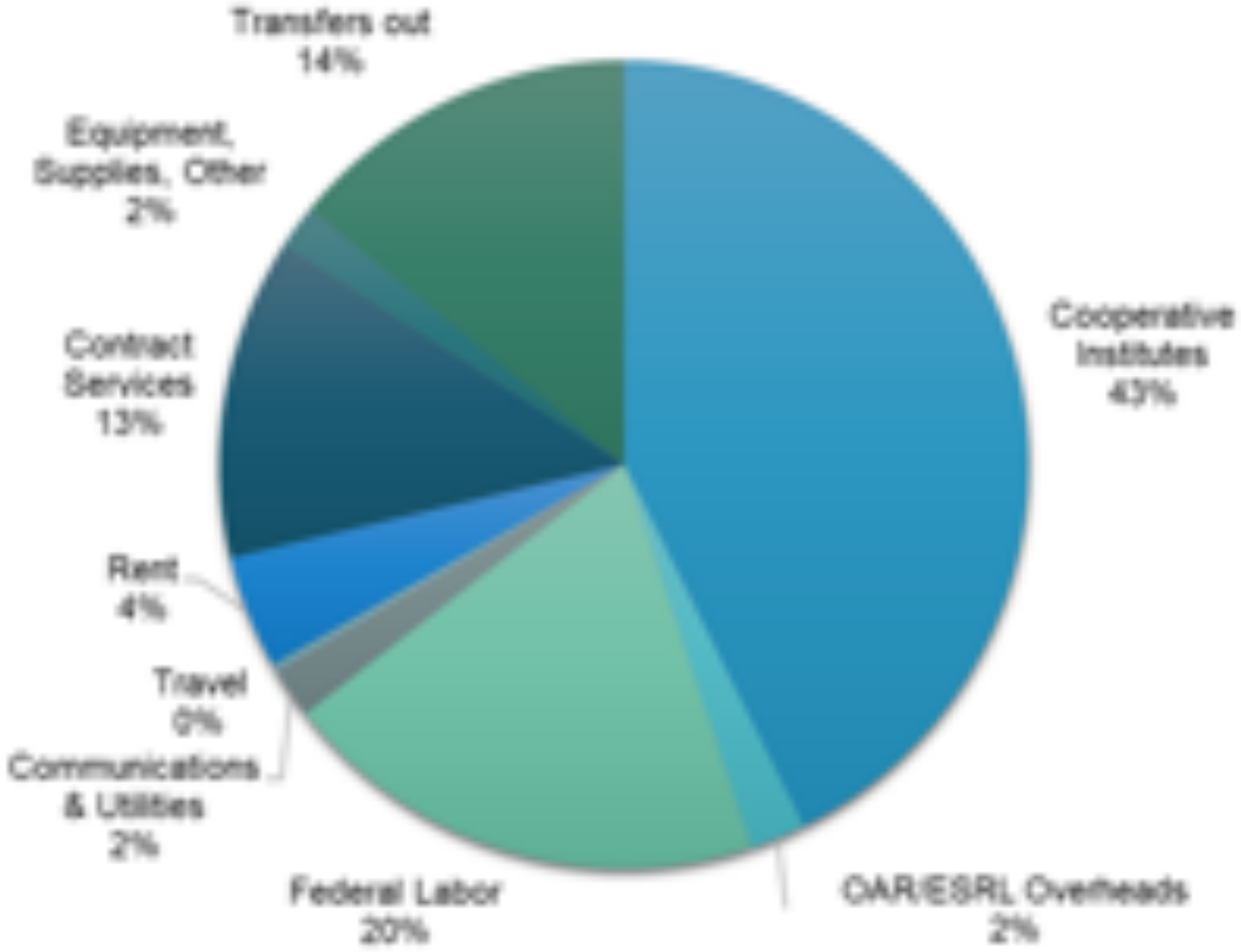
# GSL 10-Year Funding Profile




| | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 | FY20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Non-NOAA | $10,322 | $10,091 | $6,216 | $8,244 | $6,123 | $5,679 | $6,417 | $8,170 | $6,144 | $7,650 |
| HPCC | $2,191 | $1,629 | $2,275 | $2,448 | $2,381 | $4,208 | $2,375 | $2,187 | $2,182 | $2,184 |
| Other NOAA | $10,495 | $10,426 | $8,281 | $20,466 | $13,348 | $11,763 | $13,824 | $11,812 | $13,260 | $12,138 |
| Base | $9,868 | $9,626 | $9,290 | $10,409 | $10,476 | $14,744 | $11,591 | $14,459 | $14,051 | $15,532 |

Total 2020
$37.5M

# GSL Expenditures FY20



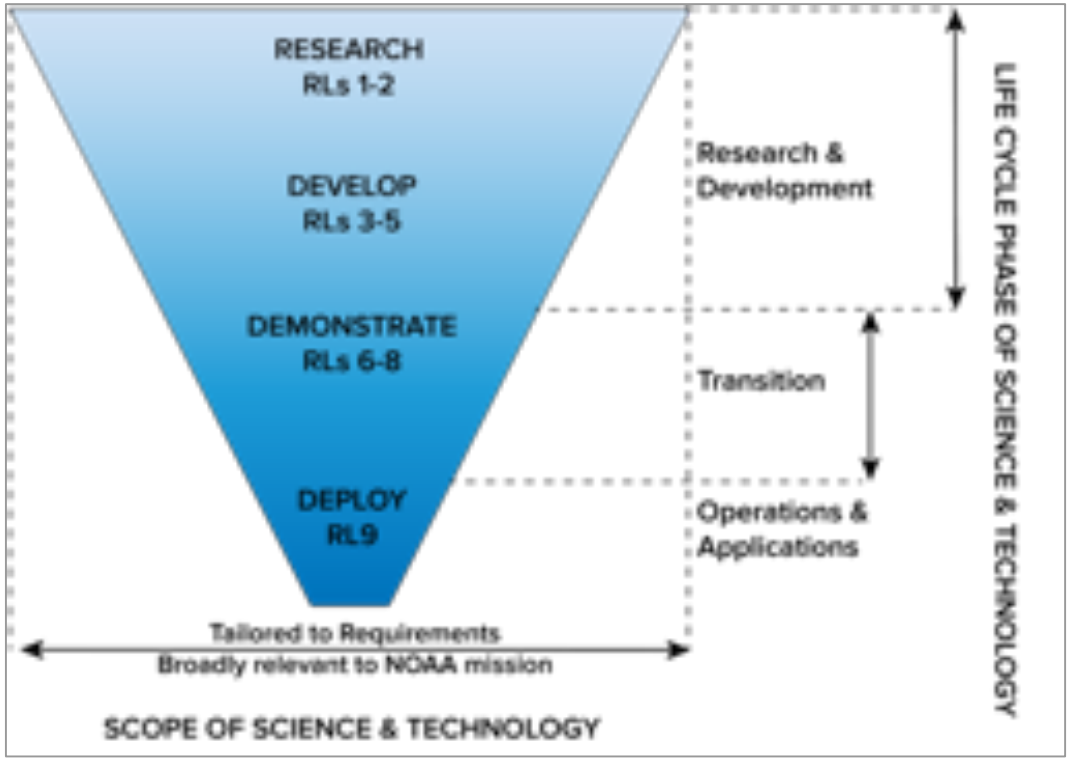
# GSL Funding by Project FY20

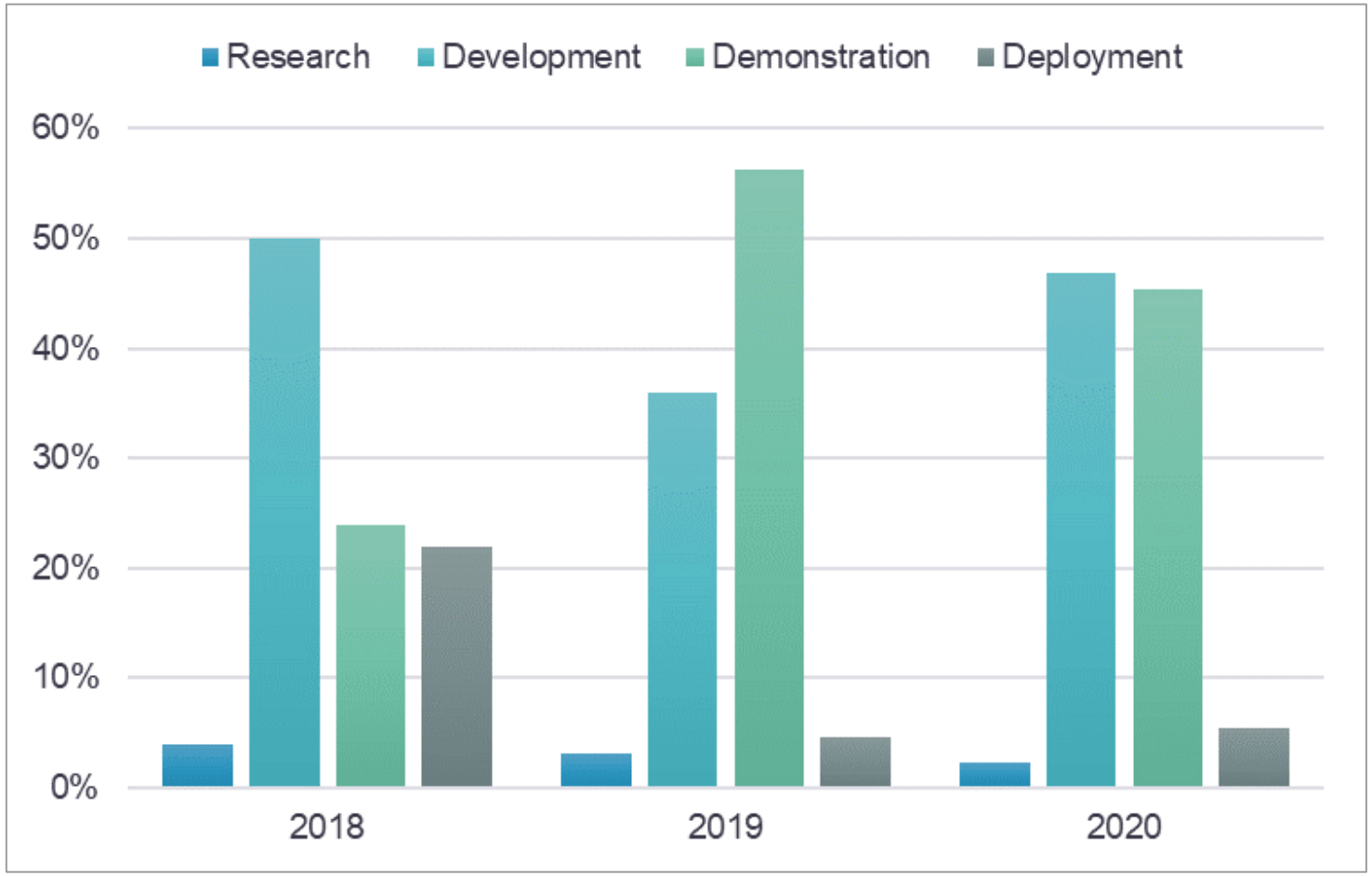
# Investments: Now and into the future

| Organizational Excellence | Revolutionize communication of weather information to customers | Earth System Prediction |
|---|---|---|
| - Balance funding portfolio long-term research and short-term development<br>- Build collaboration across the Lab Divisions<br>- Champion a healthy organizational environment<br>- Develop plans for career growth and succession<br>- Modernize IT infrastructure<br>- Nurture and expand collaborations | - Improve access to environmental data and deliver information for diverse uses<br>- Develop client applications and decision support capabilities<br>- Develop techniques to effectively communicate weather impacts and educate society | - Advance data assimilation concepts<br>- Accurately represent physical and atmospheric composition processes in models<br>- Further seamless short-range to subseasonal prediction capabilities<br>- Develop leading-edge forecast verification techniques and tools<br>- Create next-generation models that run efficiently on diverse exascale computing systems |
| 16% | 34% | UFS, EPIC, JCSDA 50% |

Note: Does not include contribution from OH

# Funding Distributions



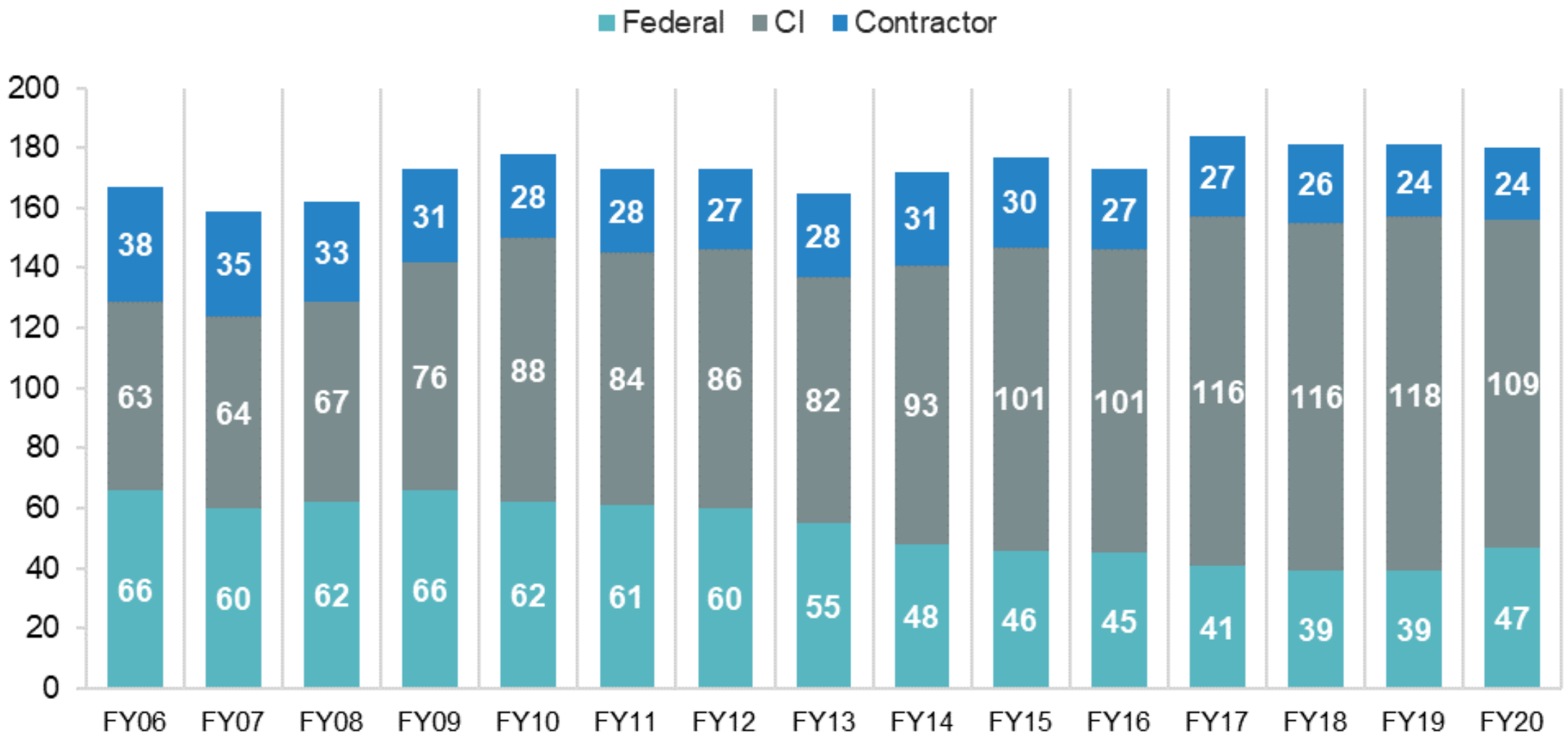



NOAA Global Systems Laboratory

# Workforce

Global Systems Laboratory

# GSL Workforce Distribution by Organization

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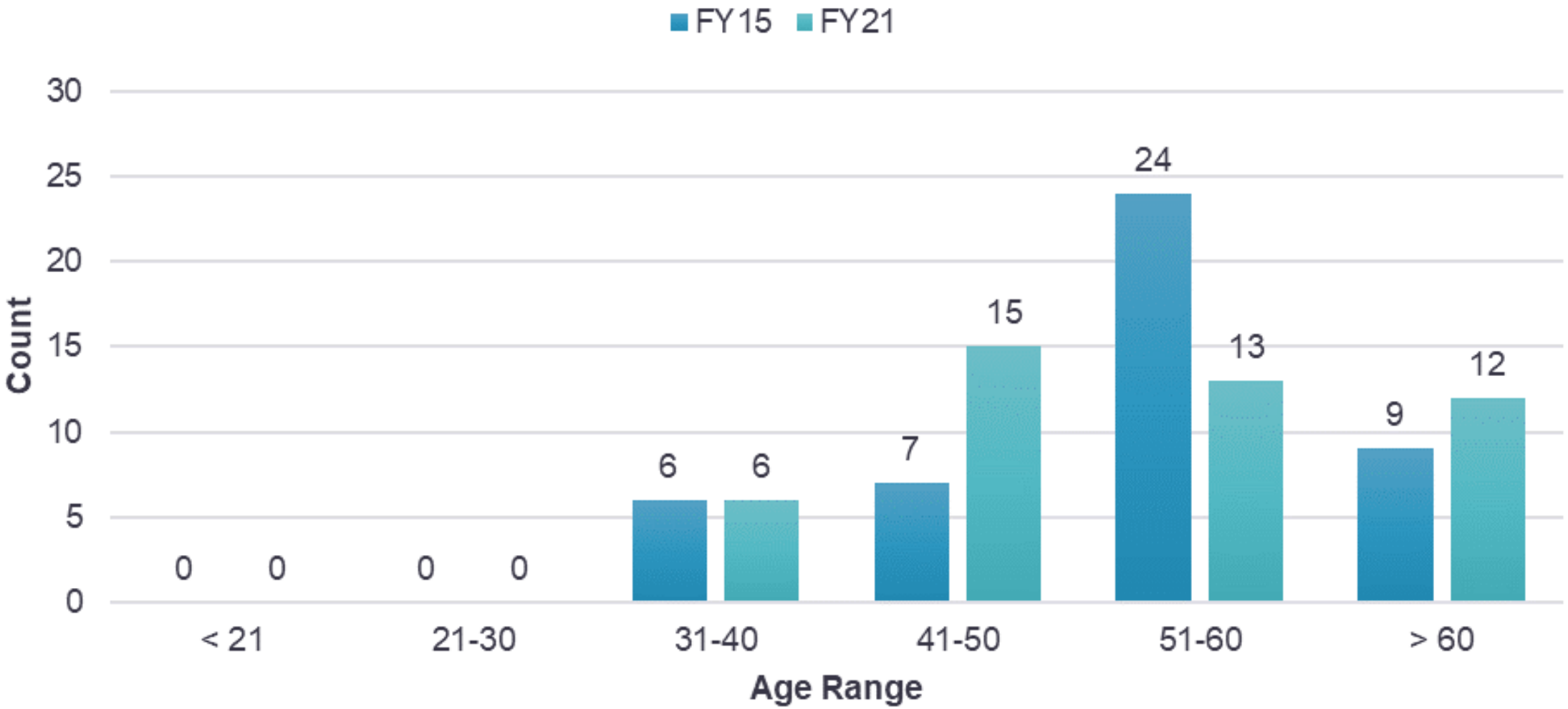
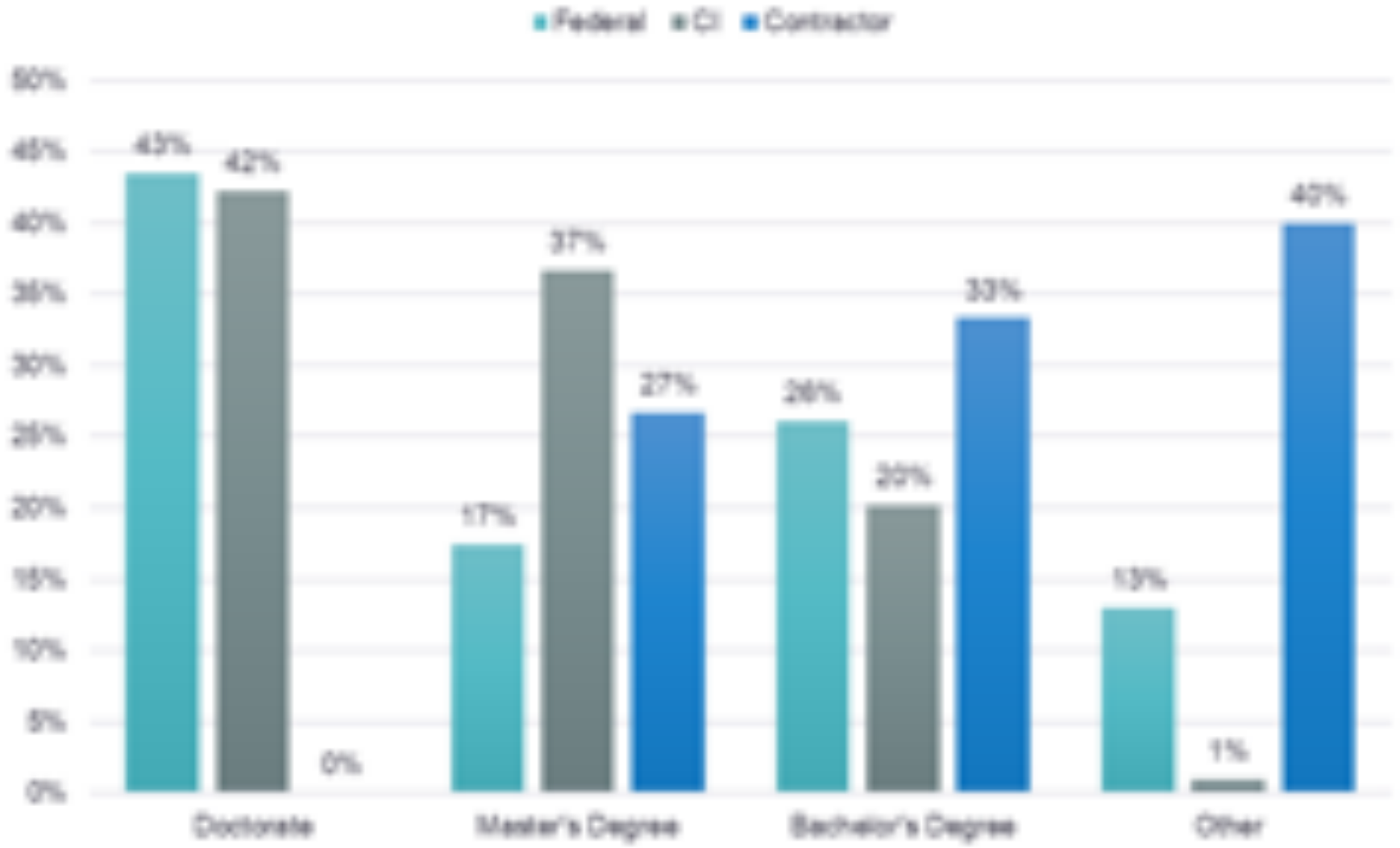
# Generations by Organization

# Federal Staff by Age Range



# Education by Organization



# GSL Workforce by Function

# Diversity, Equity, and Inclusion

## NOAA's Vision for Diversity and Inclusion

An inclusive environment in which NOAA leverages diversity to achieve mission goals and business objectives and maximizes the potential of individuals and the organization.

**DIVERSITY** is the mixture of the unique attributes that shape an individual's identity which they bring into the workplace to help NOAA accomplish its goals. Diversity refers to demographic diversity (e.g., race, gender, sexual orientation), experiential diversity (e.g., affinities, hobbies, and abilities), and cognitive diversity (e.g., sensory processing and problem solving).

**INCLUSION** is a culture that values the unique attributes of all team members. It is an environment which is respectful, collaborative, supportive, and one that allows for equal access. Inclusion requires active and intentional engagement on the part of everyone and provides a feeling of belonging.

# Workforce Diversity


Includes: Federal, CI and Contract staff

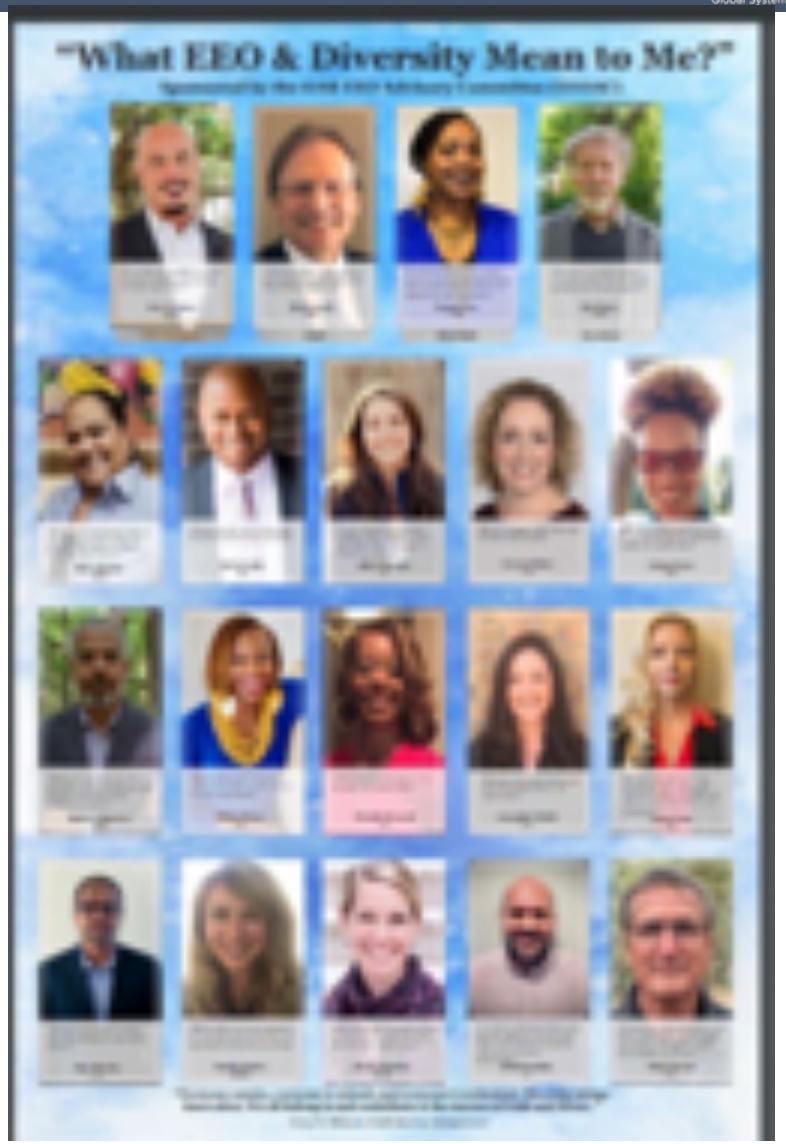
# FY20 Race/Ethnicity by Organization

# Working to Accelerate Diversity Objectives

- Recruiting by participating in public events
  - AISES, student career days, local science days
- Strengthening partnerships with NOAA Cooperative Science Centers
  - Recent re-engagement meetings with CSCs with tangible outcomes
- Utilizing NOAA hiring authorities to infuse early career underrepresented students into GSL
  - NOAA Experimental Research and Training Opportunities (NERTO) - 1 summer intern
  - SOARs - Significant Opportunities in Atmospheric Research and Science - 3 new summer interns
  - William M Lapenta Student Scholarship - 2 new summer interns

# Working to Accelerate Diversity Objectives

- Leading and participating in D&I working groups
  - OAR EEO Advisory Committee
  - ESRL Diversity and Inclusion Team
  - Boulder Laboratories Diversity Council



# Staff Inclusion


## Staff involvement

- Review and input to strategic plan
- Annual retreats - staff interaction, professional development, and strategic planning (B6.12, 6.14)
- Evergreen group -
  - Leadership opportunities
  - Contribution to Lab beyond technical projects
  - Training
- Employee satisfaction surveys
- Check-in surveys

## Communication and transparency

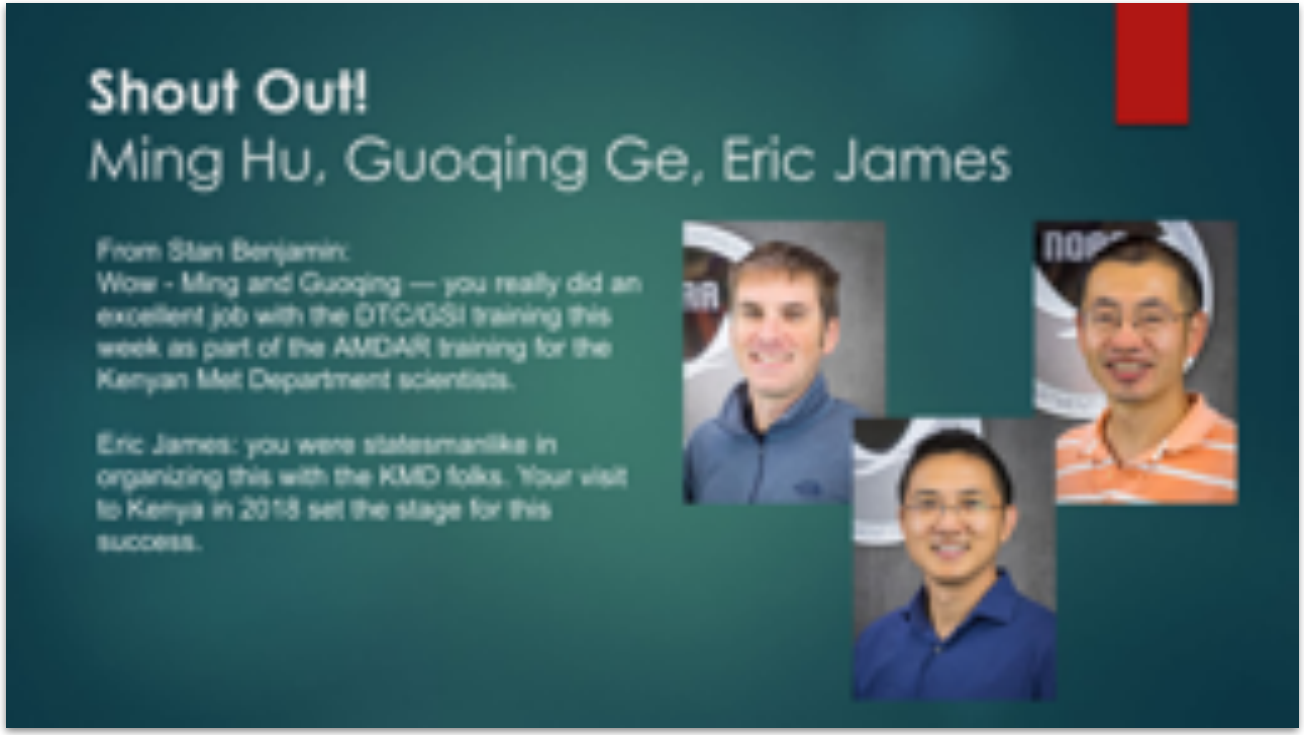
- GSL Weekly Briefs
- GSL Notes (weekly) internal newsletter
- GSL Social ½ hour
- Holiday parties
- GSL Talks
- GSL Weather Briefings

B6.12, 6.14

# Staff Recognition

- Team Member of the Month
- Shout-outs (from anyone to anyone)
- Numerous NOAA, OAR, CIRA, CIRES awards


April 2021
GSL TEAM MEMBER OF THE MONTH
Venita Hagerty




NOAA Global Systems Laboratory

# Information Technology

Global Systems Laboratory

# ITS Excellence

***State-of-the-art Facility***

**Data Center - provides data to researchers in and outside of GSL**

**Facility that supports HPC systems**

- **Monitored 24x7x365**
- **State-of-the art cooling and fire systems**
- **Technician expertise**

***Excelling in HPC Science***

**JET was one of the fastest computers in the world in 2002**

**File systems adopted by other NOAA systems**

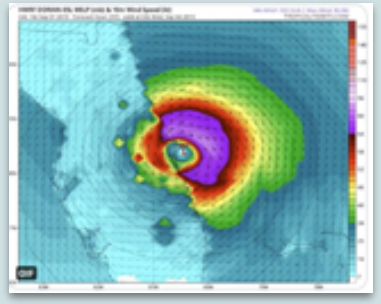
**Manage Jet (Boulder) and Orion (MSU) systems**

***Virtual Computing Infrastructure***

**Implemented a GPU cluster (proof of concept)**

**Only cluster to run NOAA's experimental models in real-time**

**GSL's computing resources converted to virtual machines saving resources**



***Enable Research to Operations***

**Supports GSL and the wider NOAA community**

**Data, ingest, decoding, reformatting, and monitoring**

**Real-time 'operations' for research development and testing before delivery**

***Leadership across NOAA***

# Questions?