National Severe Storms Laboratory Review

Dr. Steven Koch

February 25–27, 2015

National Weather Center
Norman, Oklahoma

NOAA National Severe Storms Laboratory

VISION

The National Severe Storms Laboratory will be the world's leader in basic and applied research on severe convective storms to support an informed society that is resilient to high impact weather.

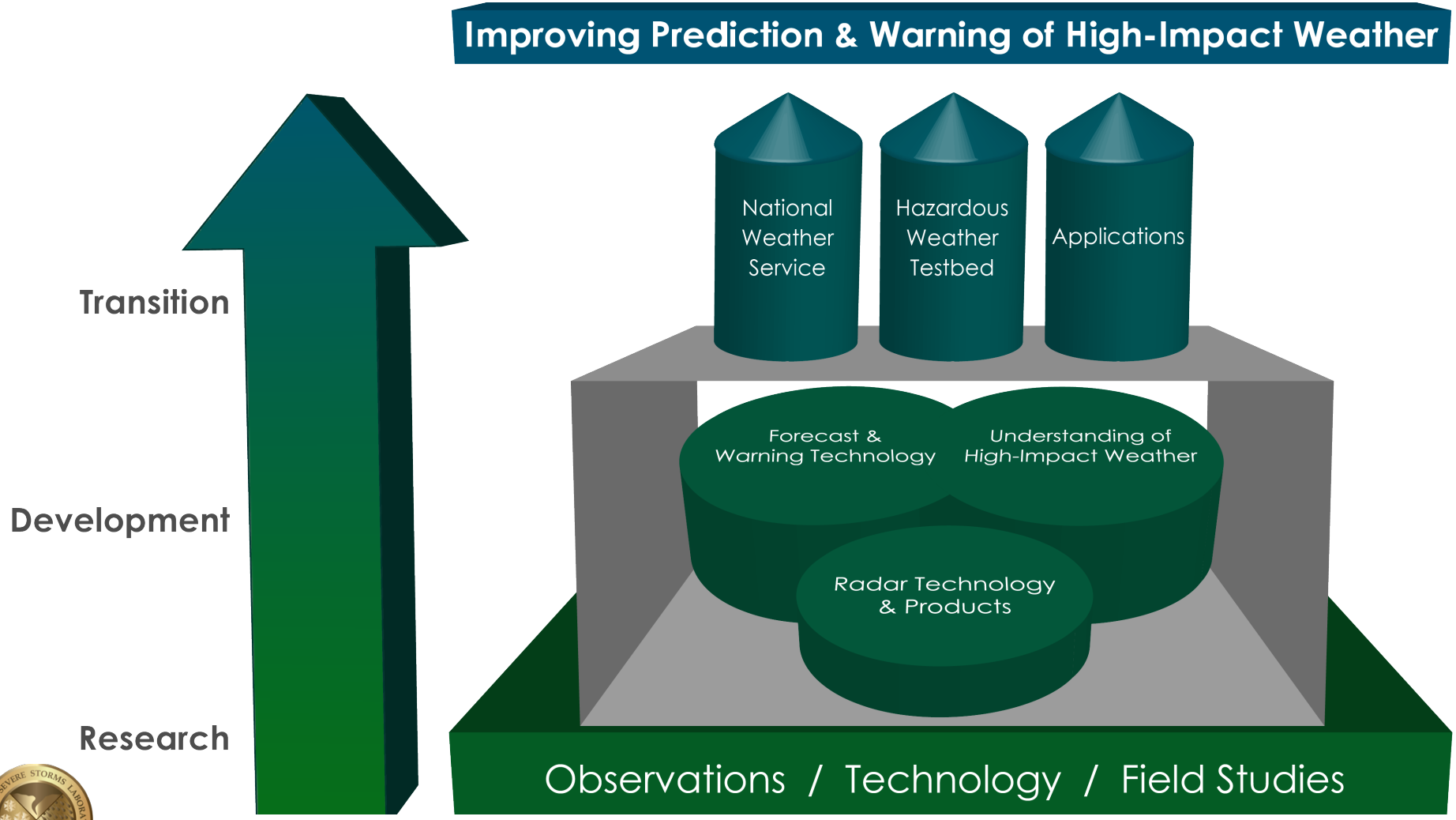
MISSION

The National Severe Storms Laboratory conducts fundamental research to advance our knowledge and understanding of meteorological processes associated with severe convective storms.

NSSL performs applied research and development leading to the transition of new and improved tools and techniques for observation, analysis, and prediction to the National Weather Service and other stakeholders.

These efforts are aimed at improving the accuracy and lead-time of severe weather forecasts and warnings, lending support to a Weather-Ready Nation that is resilient in the face of increasing vulnerability to severe and disruptive weather.

NSSL Research Themes

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NSSL Organization Chart

Director's Office
Steven Koch, Director
Lans Rothfusz, Deputy Director

Field Observing Facilities
Doug Kennedy, Lead

Information & Technology Service
Jeff Horn, Lead

Administrative Services
Patrina Gregory,
Administrative Officer

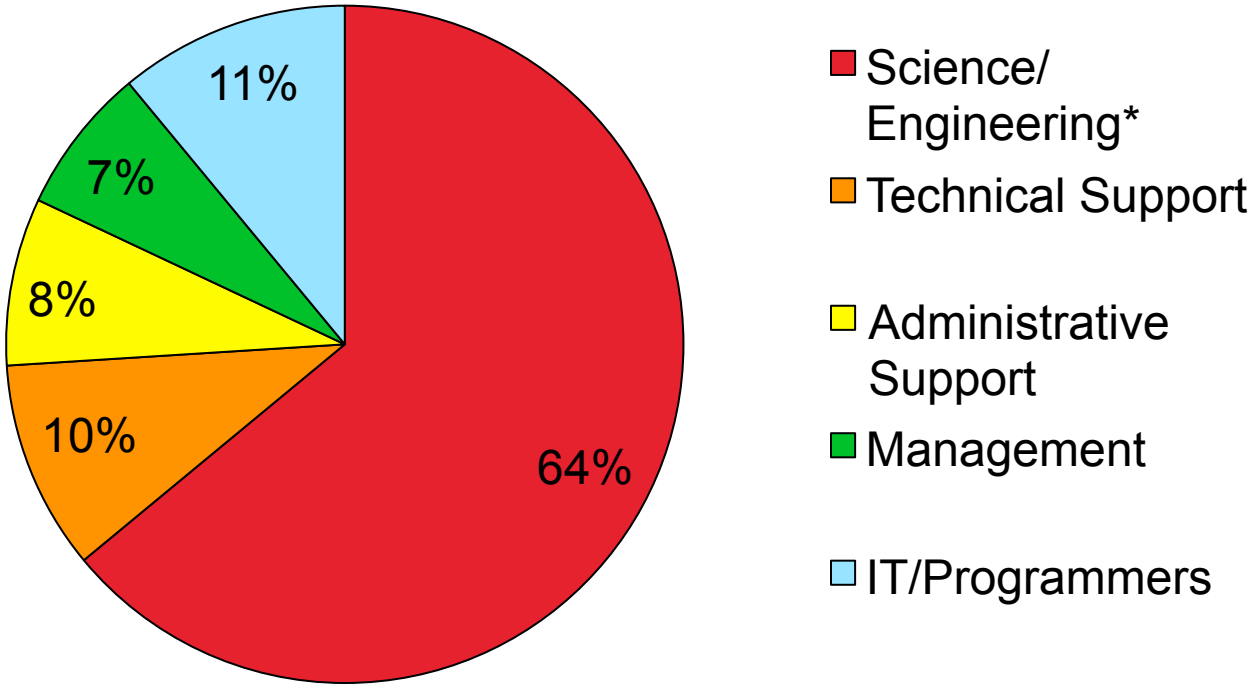
CIMMS
Randy Peppler, Acting Director
Sebastian Torres, CIMMS/NOAA Liaison

Forecast Research & Development
Jack Kain
Division Chief

Radar Research & Development
Mike Jain
Acting Division Chief

Warning Research & Development
Dave Jorgensen
Division Chief

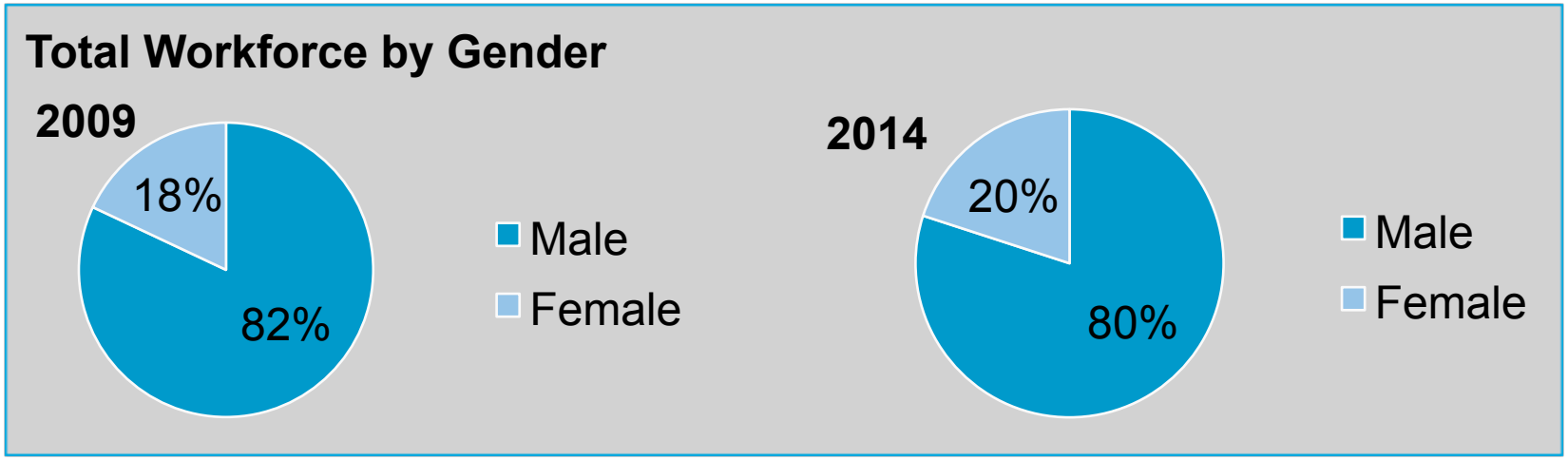
Workforce Distribution

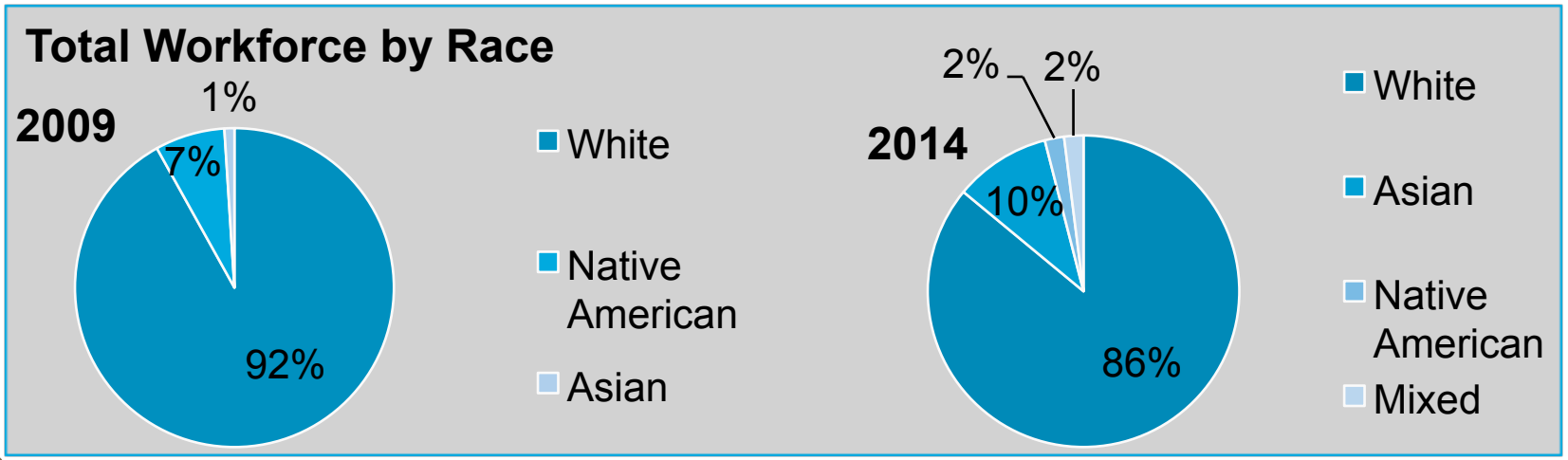


Federal	CIMMS	Contract	Total
42	48	10	100

* Federal: 16 Ph.D., 8 M.S.
* CIMMS: 25 Ph.D., 15 M.S.

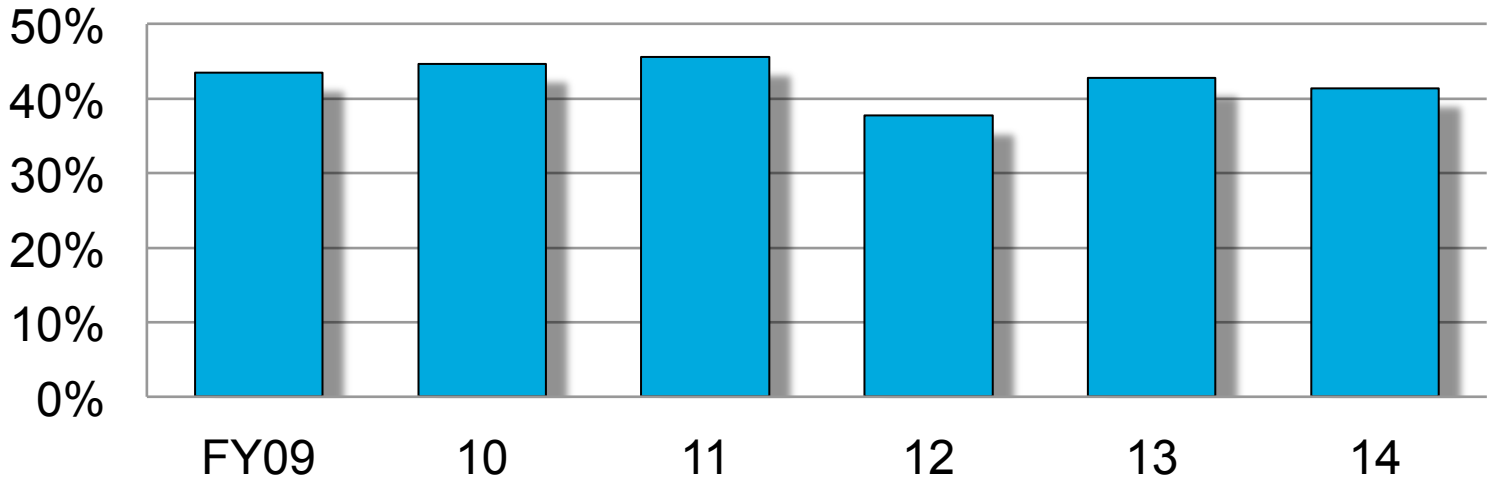
Workforce Diversity





Federal Employee Retirement Eligibility

% of current Federal Employees eligible to retire

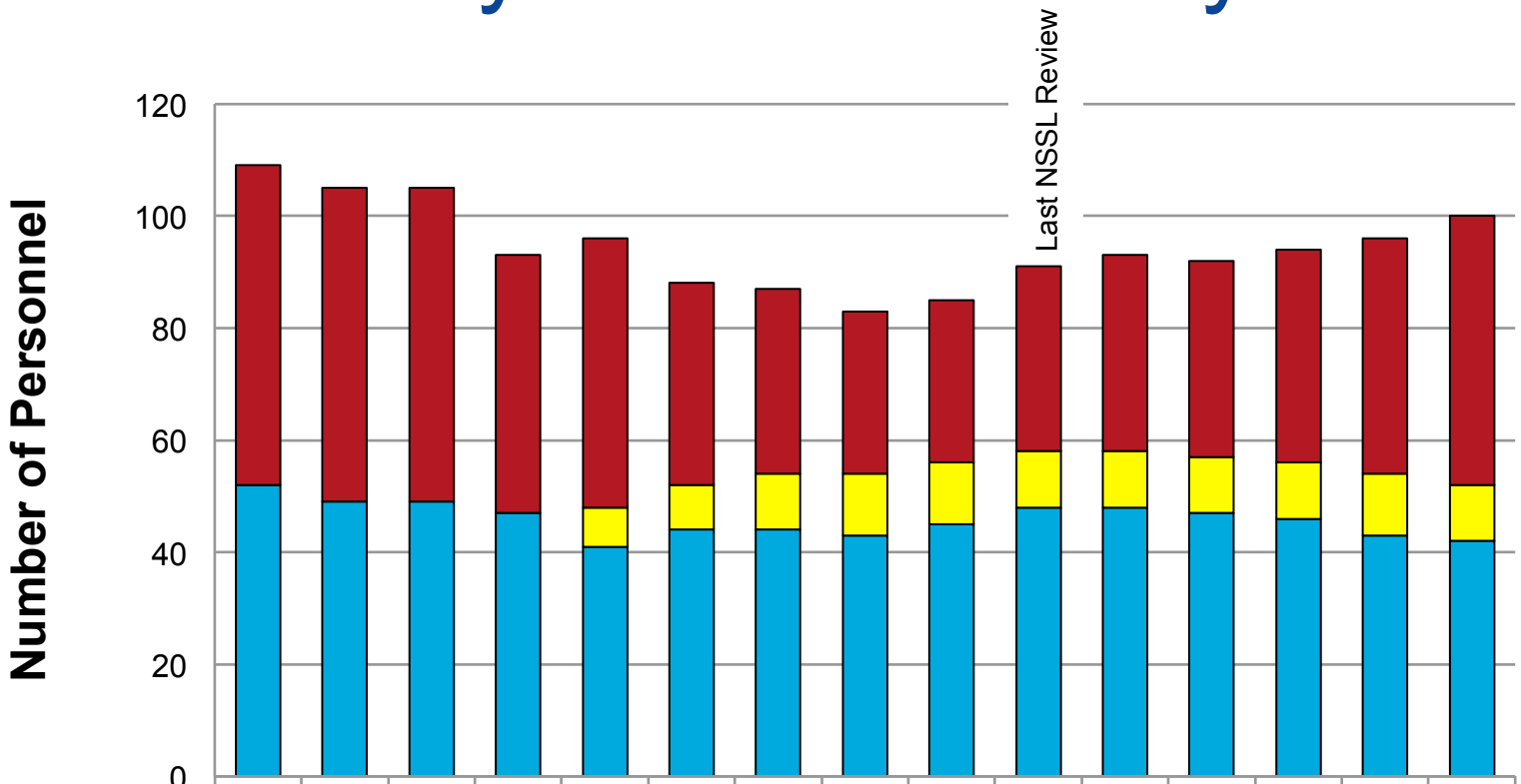


2009
Average age of Federal Scientists = 53.6
% Eligible to retire = 43.5

2014
Average age of Federal Scientists = 58.1
% Eligible to retire = 41.4

Attrition rate is stable (number retiring ~ number reaching retirement age)

15-year Staff History



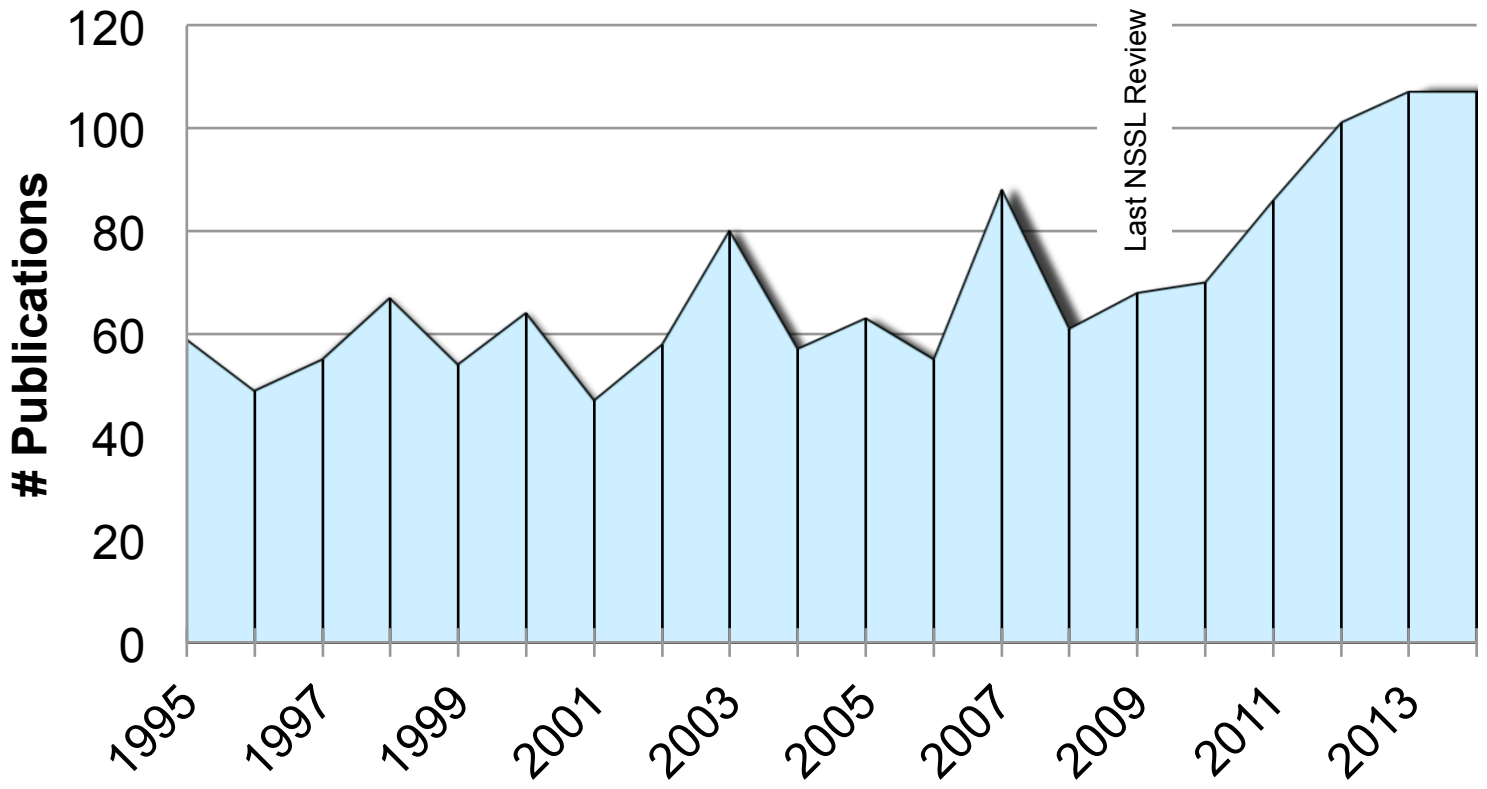
	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
CIMMS	57	56	56	46	48	36	33	29	29	33	35	35	38	42	48
IT Contract	0	0	0	0	7	8	10	11	11	10	10	10	10	11	10
Federal	52	49	49	47	41	44	44	43	45	48	48	47	46	43	42

Hires at NSSL since Feb 2009 Lab Review

Recommended Hires from July 2010 Review Response	Organizational New Hire	Additional Hires made since 2009 NSSL Lab Review	Organization
Radar hardware engineer	CIMMS	IT Security Officer	NSSL
VORTEX-2 process scientist	NRC (2)	AWIPS-2 Software Engineer	CIMMS
Microphysicist/radiation	NSSL + NRC	Warnings Software Engineer	CIMMS
HWT Warning Leader	NSSL	Warn On Forecast Programmer	CIMMS
Radar systems specialist	CIMMS	VORTEX-2 Meteorologist Analyst	NRC
Hydrologic modeler	NRC	MPAR Case Study Scientist	CIMMS
HWT applied statistician	CIMMS	NSSL Deputy Director	NSSL
Atmospheric electricity scientist	CIMMS	NSSL Administrative Officer	NSSL
Verification researcher	---	HWT Meteorological Modeler	NSSL
Field observing systems lead	---	HWT Forecast Lead	NSSL (hiring)

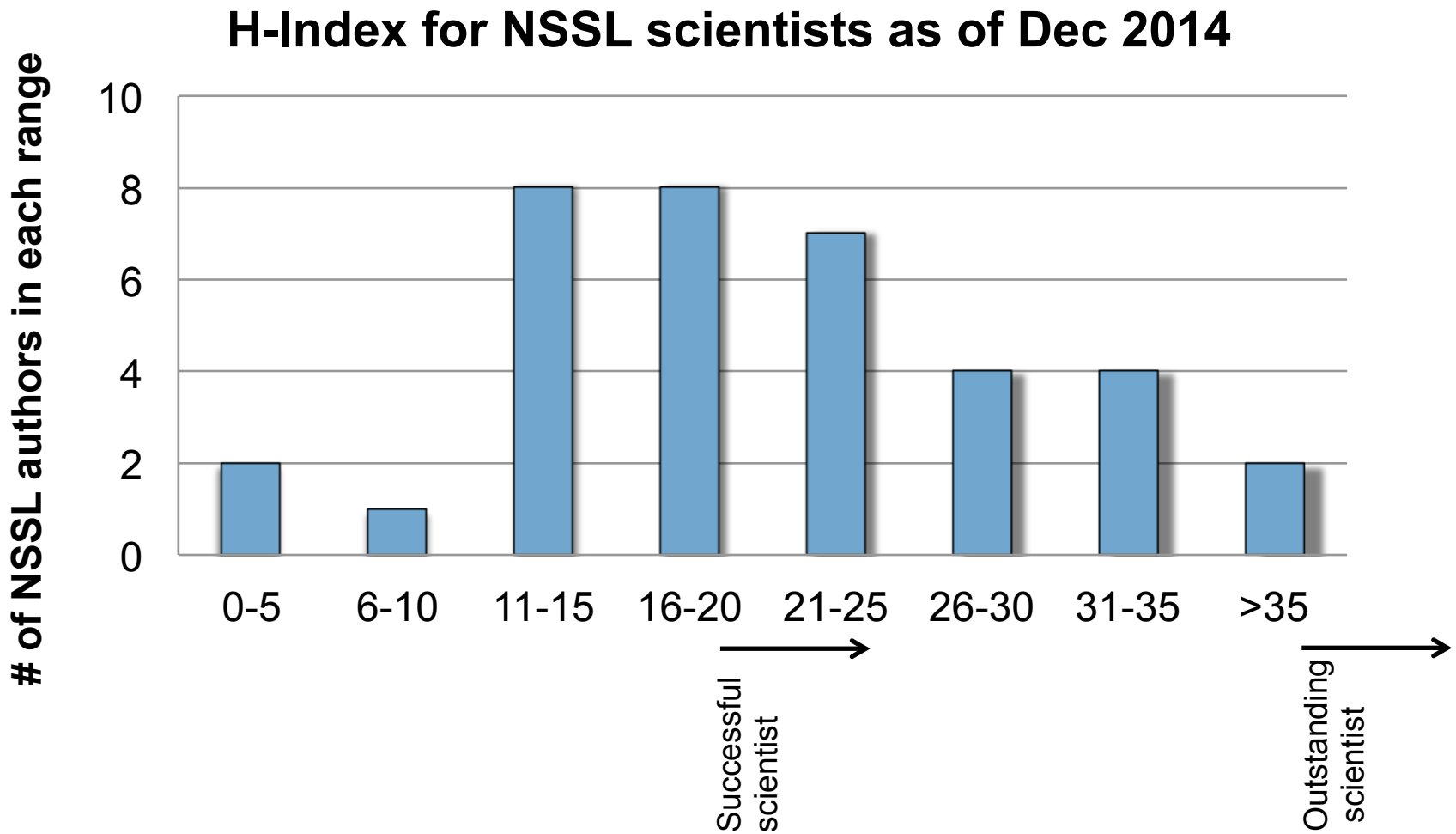
Quality

Quality: Annual Peer-Reviewed Publications



Average publications per scientist 2005–2009 = 0.88
Average publications per scientist 2010–2014 = 1.11

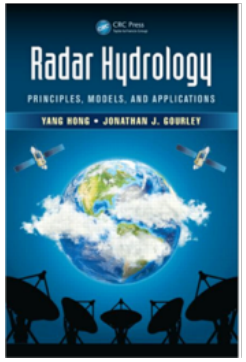
Quality: Citations



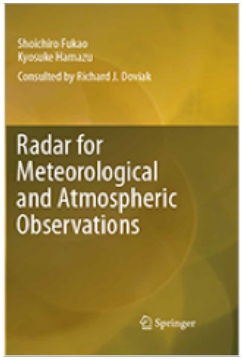
Quality: Authored Textbooks

Last 5 years

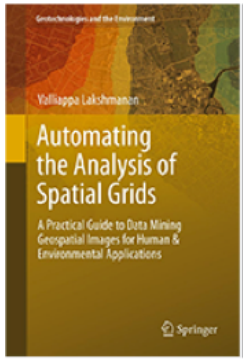
2014: Gourley



2013: Doviak (consultant)

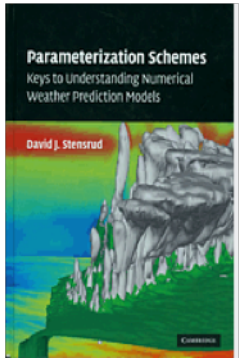


2012: Lakshmanan

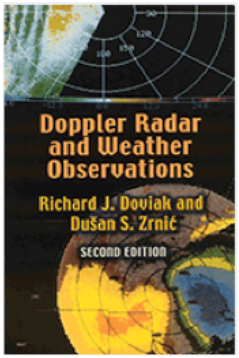


Previous 5 years

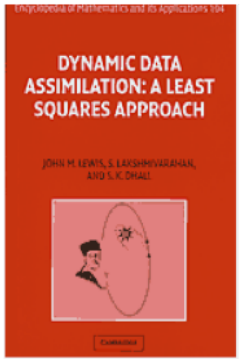
2007: Stensrud



2006: Doviak & Zrnic



2006: Lewis



Quality: DoC Awards 2010–2014

Department of Commerce Gold Medals

2014

- ★ **Jorgensen (NSSL)**, Kuligowski (NIST), Lombardo (NIST), and Phan (NIST), for conducting the Federal investigation of the 2011 Joplin Tornado.
- ★ Office of Science and Technology, Office of Operational Systems, Office of Climate, Water and Weather Services, and **National Severe Storms Laboratory**, for "developing and implementing Dual-Polarization technology on the Next Generation Weather Radar network to improve weather hazards warning services."

2011

- ★ **NSSL/CIMMS Radar Research and Development Division**, for "scientific and engineering excellence in adapting military phased array radar technology to improve U.S. weather radar capabilities."

Quality: NOAA Awards 2010–2014

2011 – NOAA Bronze Medals

- ★ **Howard, Zhang, Gourley and Vasiloff**, for the design and implementation of a seamless gridded system for multi-sensor-derived precipitation estimation over the continental U.S.
- ★ **Brown, Wood**, Parish, Enders, Ahlert, Peabody, Horvat, Weeks, Jing, for "excellence in transferring research to operations and providing a new WSR-88D radar capability that significantly enhanced forecast operations."

Quality: NOAA Awards 2010–2014

NOAA Distinguished Career Awards

- ★ **2014** - **Richard J. Doviak**, "for development of breakthrough radar methods that have greatly enhanced operational severe weather detection and advanced meteorological research."
- ★ **2014** - **David J. Stensrud**, "for exemplary service as a brilliant scientist, inspiring mentor, and generous collaborator in 28 years with the National Severe Storms Laboratory."
- ★ **2011** - **W. David Rust**, "for contributions to the understanding of lightning and storm electrification and to the development of mobile storm observing systems."
- ★ **2010** - **Robert Davies-Jones**, "for scientific achievements in the application of observations and theory to the understanding of the dynamics of severe convective storms and tornado genesis mechanisms."

Quality: NOAA Awards 2010–2014 (cont.)

2013 – NOAA Technology Transfer Award

★ **Smith** (CIMMS), **Ortega** (CIMMS), S**tumpf** (MDL), **Manross** (NCAR), **Lakshmanan** (CIMMS), **Cooper** (INDUS), **Miller** (CIMMS), **Cintineo** (UW-CIMSS) and **Jorgensen** (NSSL) were recognized "for leading the development of an on-demand, near real-time, web-based tool for tracking severe weather and hail swaths across the continental US."

2012 – NOAA Research Albritton Outstanding Scientific Communicator Award

★ **Harold Brooks**, "in recognition of outstanding achievement in communicating the meaning and value of NOAA-related science and research to non-scientific audiences."

2011 – OAR Outstanding Paper Award

★ **Kumjian** and **Ryzhkov**, for Storm-Relative Helicity Revealed from Polarimetric Radar Measurements, *Journal of Atmospheric Sciences*, 2011.

Quality: Non-NOAA Awards 2010–2014

2014 – AMS Charles Franklin Brooks Award

★ **David P. Jorgensen** for over two decades of substantial contributions to, and visionary leadership of, the Society's all-important scientific publication process, including tireless service as Publications Commissioner (2007–2012).

2013 –Presidential Early Career Award

★ **Adam Clark** (NSSL/CIMMS), for pioneering contributions to the study of forecast-system predictability, significant mentoring of students, and building bridges between the different components of the weather enterprise.

2012 - AMS Kenneth Spengler Award

★ **NOAA Hazardous Weather Testbed Team** - Bright (NWS), Carbin (SPC), **Coniglio, Kain**, Levit (NWS), Liang (SPC), Schneider (SPC), Weiss (SPC), for "bringing the government, academic, and private sectors together in a visionary, proactive, and exemplary manner to deal with the challenges posed by hazardous weather."

Quality: Prestigious Memberships

NATIONAL ACADEMY OF ENGINEERING

Dusan Zrnic

RMetS
Royal Meteorological Society

Harold Brooks
Rodger Brown

IEEE
Advancing Technology for Humanity

Dusan Zrnic
Richard Doviak

Quality: 11 Current AMS/AGU Fellows

- Harold Brooks
- Donald Burgess
- Robert Davies-Jones (ret.)
- Richard Doviak
- Douglas Forsyth
- David Jorgensen
- Steven Koch
- John Lewis
- Donald MacGorman
- Dave Rust (ret.)
- Dusan Zrnic

Quality: Service

- AMS Publications Commissioner (Jorgensen)
- 21 Chief, Co-Chief, Associate Editors of professional journals since 2009
- 31 members on national/international scientific and technical advisory committees
- Nat'l Institute of Science and Technology (NIST) team investigating the May 22, 2011 Joplin, Missouri tornado (Jorgensen)
- AMS Editor's Awards (3)
- Volunteerism (38 separate organizations)

Quality: Collaborations

Private Sector

Raytheon
Willis Re
Northrop Grumman
UNIDATA
Lockheed Martin
General Dynamics
Ball
NDT
BCI
VAISALA
regulus group
Lawrence Livermore National Laboratory
The Weather Channel
EARTH OBSERVING LABORATORY
Sensis Corporation
NCAR
Earth Networks
Taking the Pulse of the Planet
radiometrics
Seahorse Coastal Consulting
SMA
Sandia National Laboratories
aer
Atmospheric and Environmental Research
SRP
BROOKHAVEN NATIONAL LABORATORY
Argonne NATIONAL LABORATORY
AvMet
Pacific Northwest NATIONAL LABORATORY

International

ESSL
Central Weather Bureau
Met Office
NERC
SCIENCE OF THE ENVIRONMENT
Deutscher Wetterdienst
Environment Canada
National Centre for Atmospheric Science
UNIVERSITÉ DE GRENOBLE
KMA
KU LEUVEN
MANCHESTER 1824
The University of Manchester
UH
THE UNIVERSITY OF MELBOURNE
FINNISH METEOROLOGICAL INSTITUTE
INVAP
Tecnología argentina de Río Negro para el mundo
VNiVERSiDAD D SALAMANCA
CAMPUS OF INTERNATIONAL EXCELLENCE
universitätbonn
BSF
McGill
Universidad de Valparaíso CHILE
UiA
Universitat de les Illes Balears

University

Illinois
PennState
Purdue University
Colorado State University
MIT Lincoln Laboratory
Columbia University
Washington State University
Cleveland State University
Vanderbilt University
Ball State University
University of Washington
Creighton University
University of Connecticut
Florida State University
University of Wisconsin
Western Michigan University
Georgia Tech Research Institute
The University of Alabama in Huntsville
University at Albany
UtahState University
College of DuPage

Cooperative Institute, State

cimms
HyDROS
ARRC
Center for Analysis and Prediction of Storms
CAPS
CIMSS
SSEC
Oklahoma Climatological Survey
CIRES
CIRA
Sea Grant
SCO
ADCIRC
CoSEE SouthEast
SPORT
renci

Federal

NOAA
WSR-88D
National Weather Service
NSF
Storm Prediction Center
Earth System Research Laboratory
NCEP
Department of the Air Force
Department of Homeland Security
United States Navy
Federal Aviation Administration
Department of Defense
NESDIS
GOES-R
NCDC
Air Force Weather Agency
USGS
science for a changing world
IOOS
ARM
CLIMATE RESEARCH FACILITY
NASA
DTC Developmental Testbed Center

Quality: CRADAs and MOUs

Formal Reimbursable Agreements

National Weather Service

Federal Aviation Administration

Colorado Water Conservation Board — State of Colorado — 1876 — 1937

NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

SRP

OU

Memorandum of Understanding (MOU)

DRI

National Centre for Atmospheric Science
Natural Environment Research Council

University of Nebraska Lincoln

Met Office

Cooperative Research and Development Agreement (CRADA)

aer
Atmospheric and Environmental Research

Managing Extremes
Willis Re

Quality: Involvement in Education

NSSL and CIMMS scientists:

- Have faculty appointments in meteorology, electrical engineering, computer science, and physics. Courses taught by some.
- 24 serve as adjunct, affiliate, or emeritus faculty at OU or other universities

- NSSL/CIMMS faculty have served on **98 M.S**. and **69 Ph.D**. committees since 2009. Many OU GRA stipends are paid by NSSL.
- NSSL and CIMMS scientists have **mentored 69 undergraduate** students (e.g. Hollings Scholars, Senior Capstone projects)

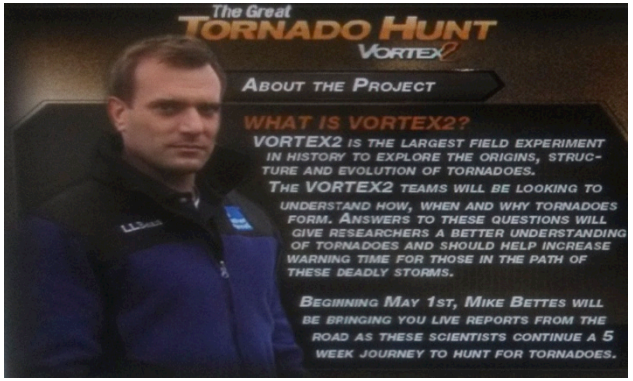
Quality: Media Stories

POPULAR SCIENCE

SCIENCE

THE MOST AMBITIOUS WEATHER EXPERIMENT: A 1,000-SQUARE-MILE TORNADO TRAP

HOW 140 SCIENTISTS LOOK INSIDE THE WORLD'S MOST DANGEROUS WEATHER



The Washington Post

"Lack of Twisters Aside, VORTEX2 Gets Useful Data"

Smithsonian MAGAZINE

"Tornadoes Are Now Ganging Up in the United States"

npr

"This App Uses The Power Of You To Report The Weather"

Quality: Community Connections

- Rust: NOAA Scientist in Residence at San Francisco Exploratorium
- 5,000 visitors to Annual National Weather Festival
- NSSL Website redesigned in 2012 to be public-friendly
- Severe Weather 101 education pages, NSSL News Blog, strong social media presence (21 YouTube videos, 70K FaceBook followers, 20K Twitter)
- Brooks: contributed to the Norman Public Schools tornado safety review, served on the OKC Mayor's Safety Task Force and the Moore Tornado Science Working Group

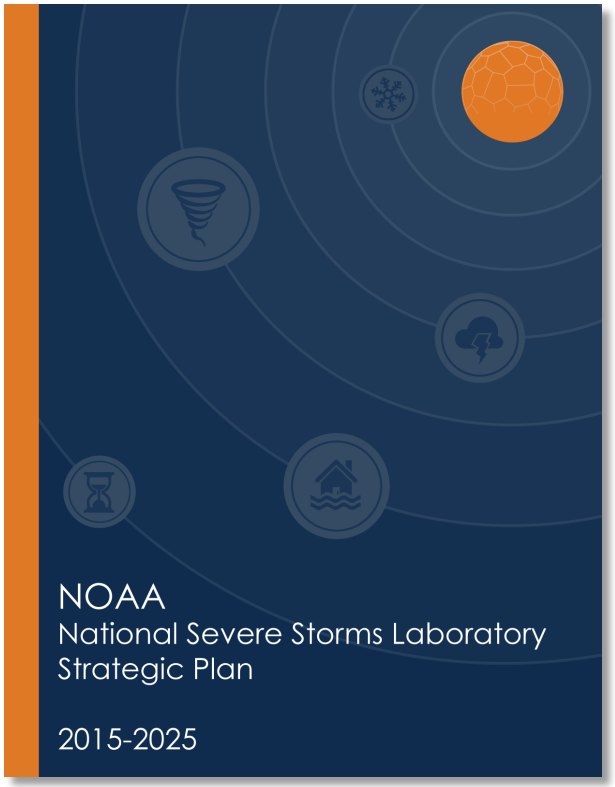
Relevance

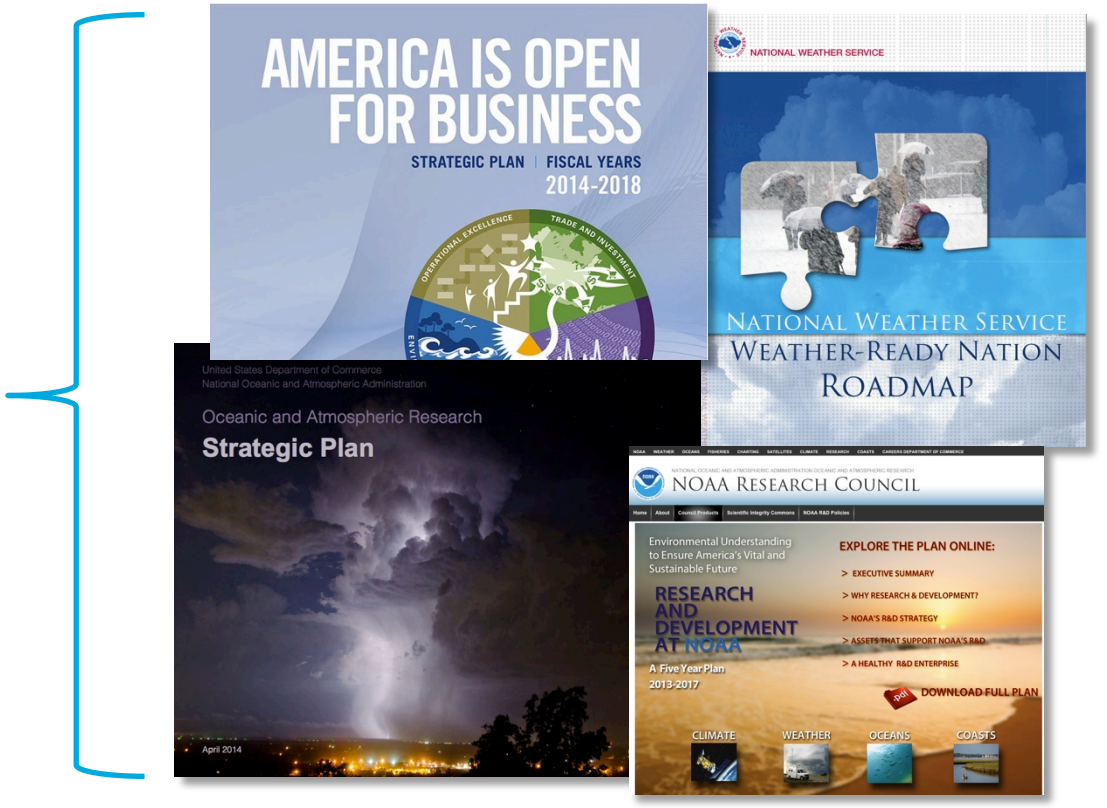
Relevance: In General

- Our research addresses existing (and future) societally relevant needs (national and international)
- Research at NSSL addresses issues identified in the NOAA research plans and other guiding documents
- NSSL's customers are engaged from the beginning of projects to ensure relevance of research
- There are few, if any, topics relevant to national needs and NOAA research and development priorities that NSSL should be pursuing but is not

Relevance to NOAA Planning

(details to follow in subsequent presentations)



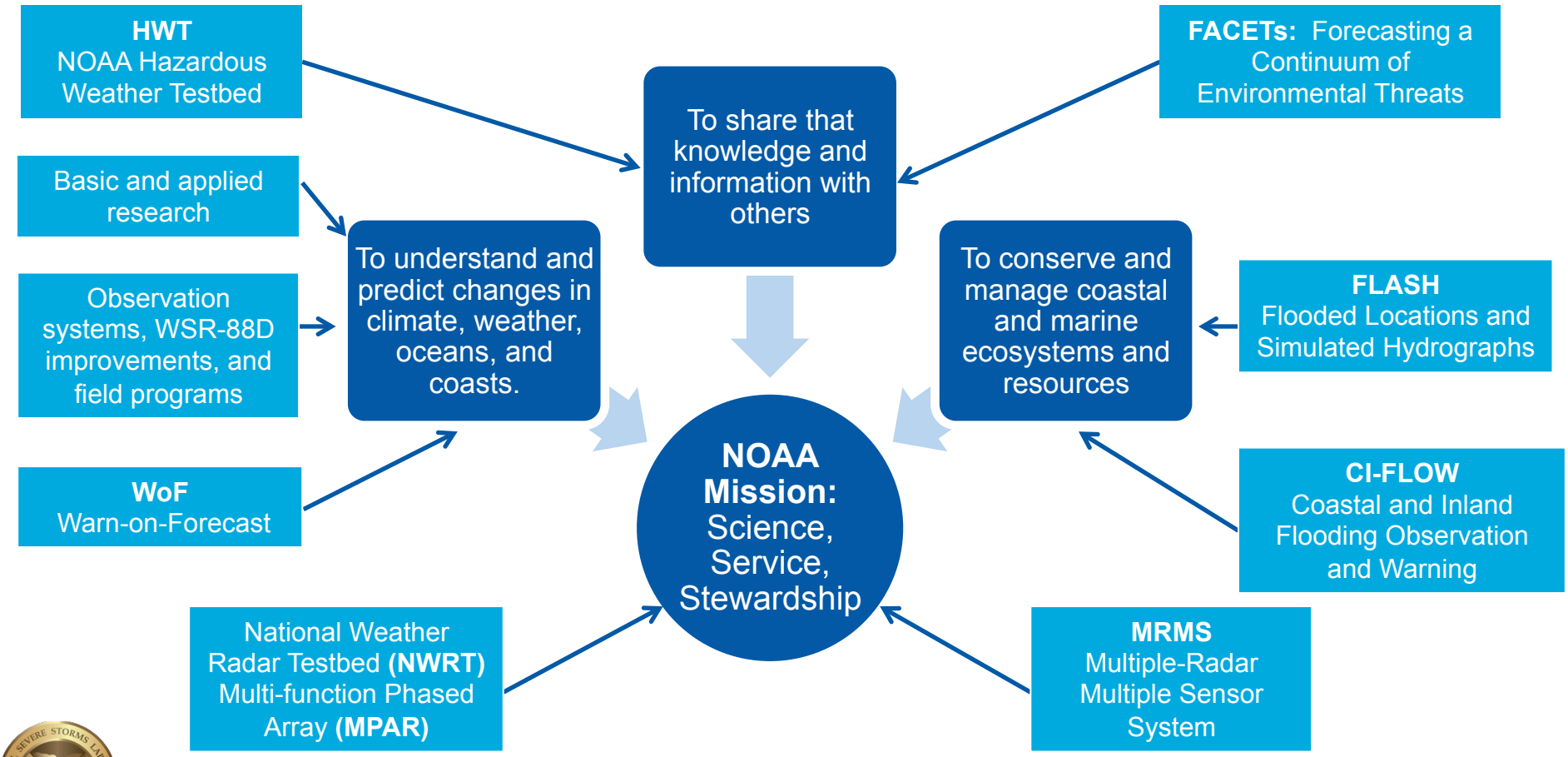


Relevance of NSSL Research to NOAA and OAR Missions

- **NOAA Strategic Plan:**
  - "Society is prepared for and responds to weather-related events"
  - "A holistic understanding of the Earth system through research"
  - "Accurate and reliable data from sustained and integrated earth observing systems"

- **OAR Strategic Plan:**
  - NSSL focuses on "How can we improve forecasts, warnings, and decision support for high-impact weather events?"

Relevance: NOAA 5-Year Research Plan



Acronyms: see previous slide

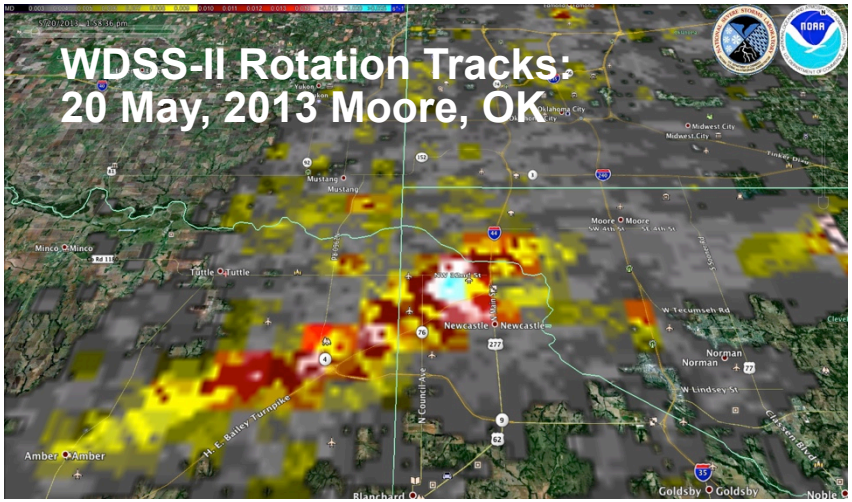
Relevance to NOAA Administrator's Top Priorities

1. **Provide information and services to make communities more resilient**
   - Dual Pol & other WSR-88D enhancements, MRMS, CI-FLOW
   - Leadership in Weather Ready Nation symposia
2. **Evolve the Weather Service**
   - Warn On Forecast, MRMS, FACETs, FLASH
3. **Invest in observational infrastructure**
   - WSR-88D, MPAR, CLAMPS, OSSEs, UAS, Field projects
4. **Achieve organizational excellence**
   - Strong emphasis on Research → Operations/Applications
   - Vital Signs Survey, NSSL Futures Conference, AOP Milestones met

Relevance:
Quotes from Users of NSSL WDSS-II
(Warning Decision Support System – Integrated Information)

Known users of WDSS-II On Demand:

- FEMA
- DHS
- NWS Forecast Offices
- Virginia Department of Emergency Management
- American Red Cross



"This technology cut our disaster assessment time down from 72 to 24 hours"

- Steven Klapp, a volunteer and disaster assessment team leader for the American Red Cross of Central Oklahoma

"This kind of technology has been nothing short of a blessing for the American Red Cross and those we serve"

- Rusty Surette, Director of Communications for the American Red Cross of Central Oklahoma

Performance

Performance: General

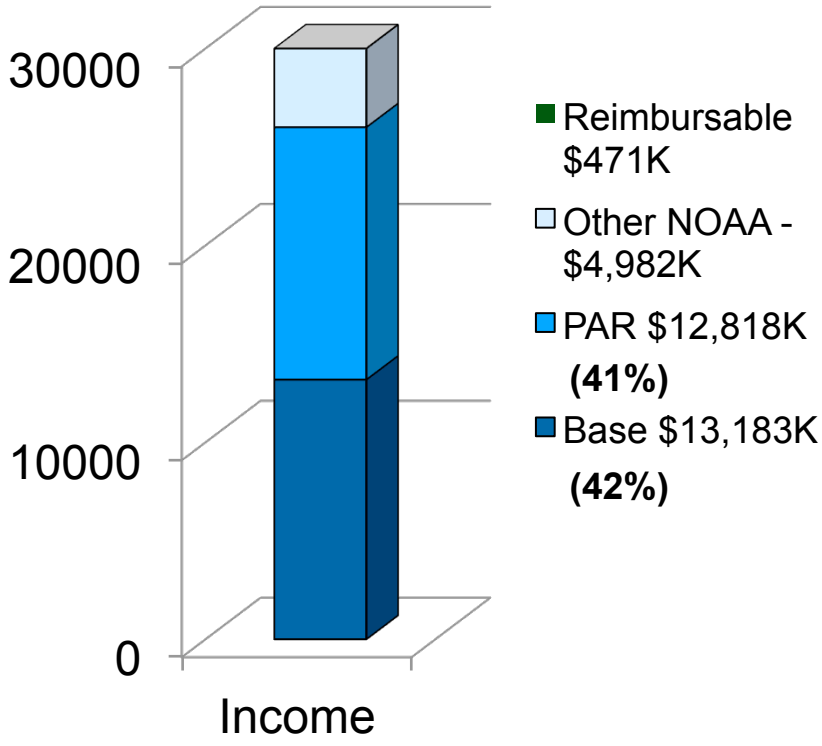
- NSSL managed and structured to optimize conduct of research even with big changes in management since last Lab Review
- Nice proportion of external to internal funding (17%)
- Adequate human, technical and support services (but in the future?)
- Projects on track – meeting annual milestones & targets

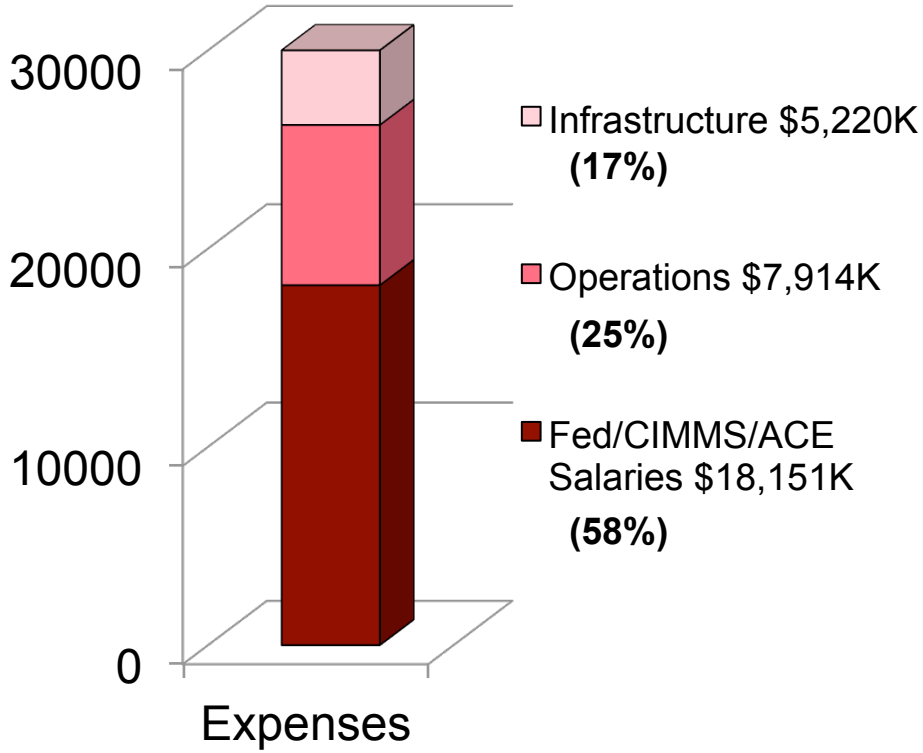
Performance: General

- Work well integrated with NOAA's planning and execution activities:
  - Leadership on "OAR Tiger Team" (2012) and OAR Strategic Planning (2013)
  - Broad NSSL input to OAR Strategic Plan and Priorities Exercise (2014)
  - Active involvement in development of OAR Budget Initiatives
- NSSL 10-year Strategic Plan
- Major Project Planning
  - Program Plans and Annual Operating Plans for MPAR, WoF, WSR-88D tasks
- Response to recommendations from previous NSSL Lab Review
  - Hiring recommendations implemented
  - NSSL Division Chief to detail other responses

Performance: FY14 Income and Expenses

(Total: $31.3M)

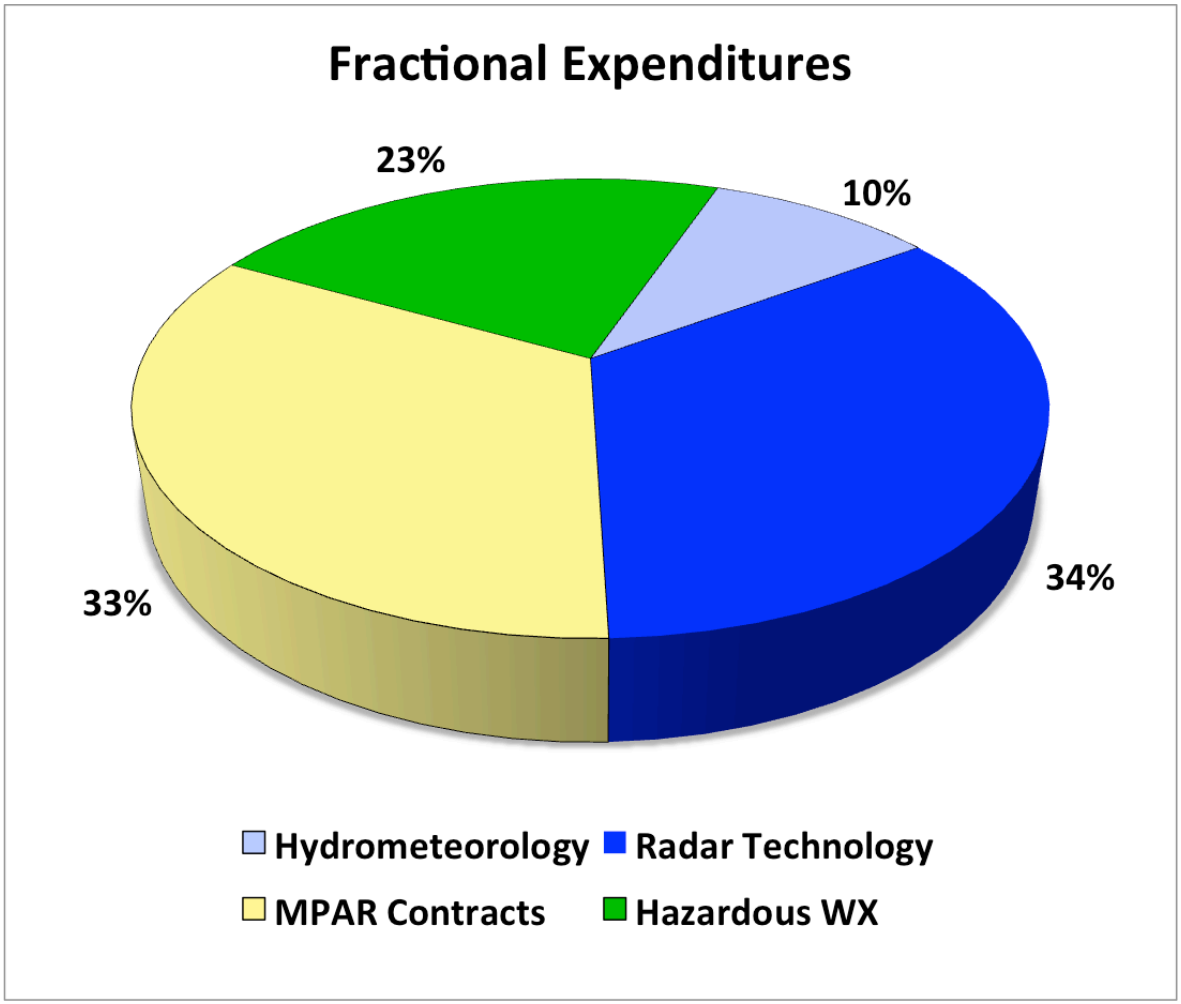




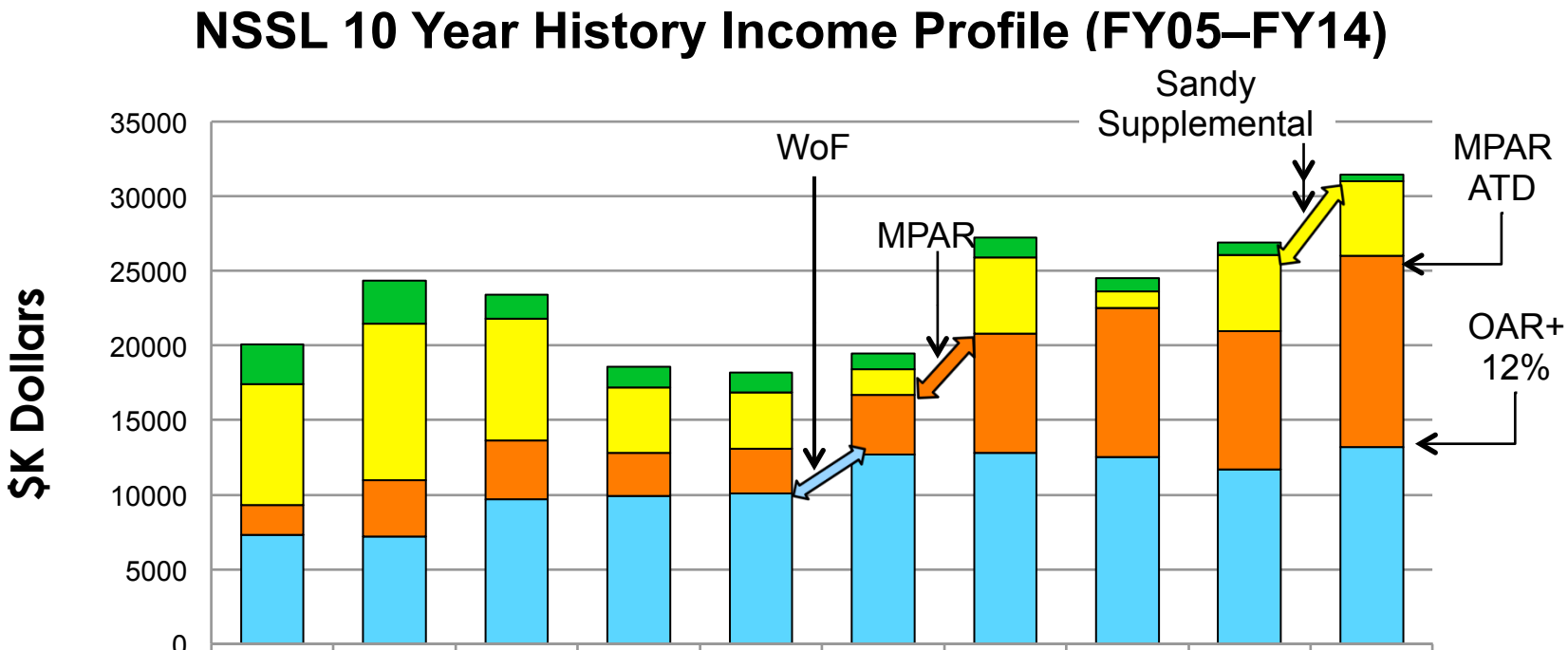
Infrastructure: NWC Lease, Line Office Overhead, CIMMS, copiers/telephones, other lease and utilities, Tech Transfer
Operations: CIMMS, contracts, property, federal travel

Performance: Expenses by Science Theme

(excludes administration/infrastructure costs)



Performance: Healthy Funding



	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
Other Agency	2668	2905	1585	1354	1331	1066	1333	902	869	471
Other/NOAA	8123	10464	8191	4410	3821	1724	5139	1111	5118	4982
MPAR Funding	1971	3799	3945	2898	2969	4000	7976	9966	9264	12818
Base w/o MPAR	7312	7196	9676	9898	10085	12678	12803	12538	11679	13183

Grand Scientific Challenges
from the NSSL Strategic Plan for 2015-2025

Goal 1: Aim to develop reliable severe convective probabilistic guidance products with a **lead-time of 60 min for weather hazards including tornadoes** via the Warn-on-Forecast program.

Goal 2: **Produce enhanced radar capabilities** for WSR-88D as well as radar replacement technologies such as phased array radar.

Goal 3: Intend to achieve the proven capability to **reliably predict flash flooding** for both urban and complex landscapes several hours in advance.

Goal 4: Attempt to predict useful **warnings of lightning activity one hour in advance** from the very onset of convection to its demise.

Goal 5: Develop and field test **innovative atmospheric observing systems** needed for reliable nowcasting of convection initiation.

Goal 6: Provide **grid-based probabilistic uncertainty information** for high impact weather to reduce warning false alarms.

Performance:
Research Leadership & Planning

2012 — Vital Signs Survey (NSSL management initiated)

2013 — NSSL management team building

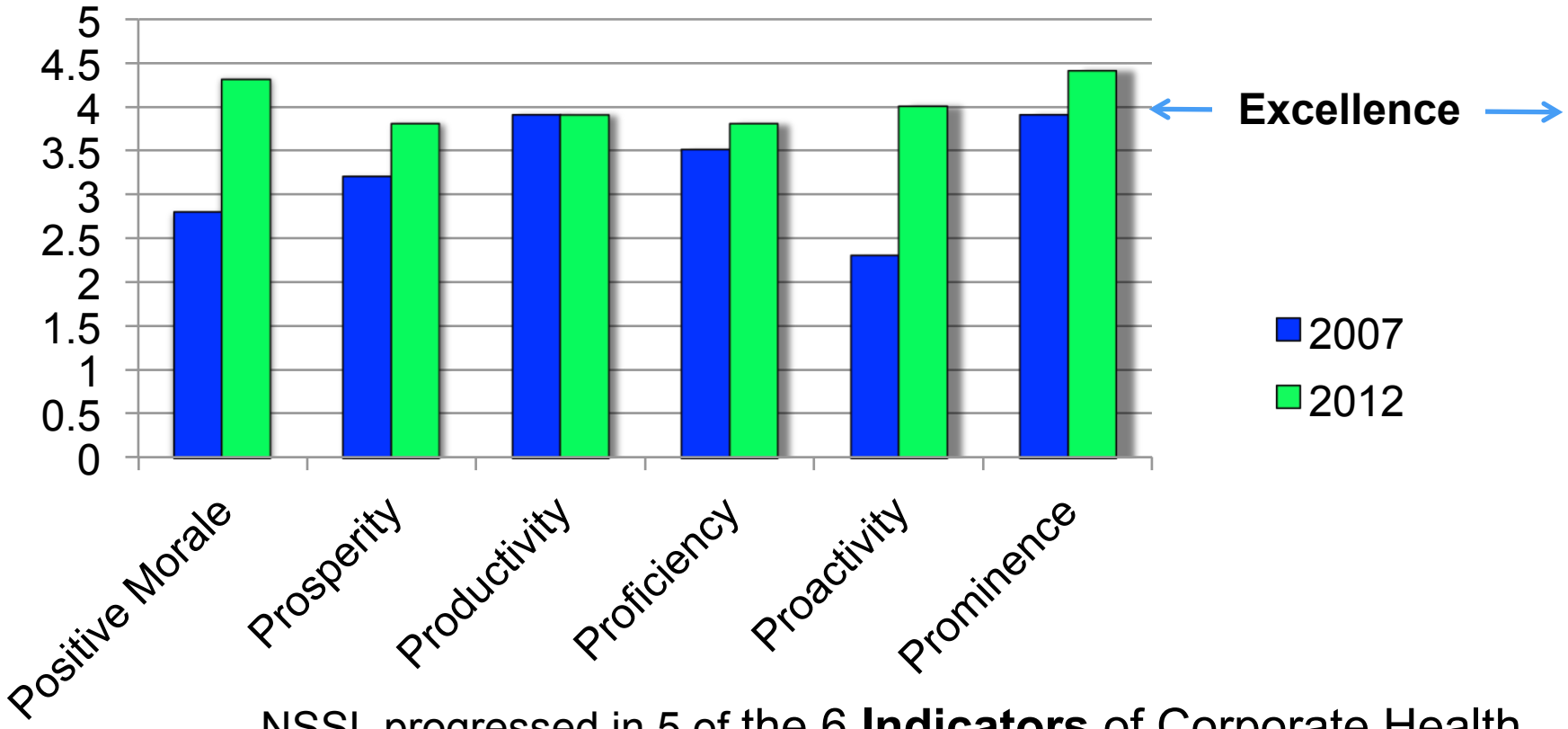
2014 — NSSL Management Retreat

2014 — NSSL All-Hands Futures Conference

2015 — NSSL/ESRL/GLERL Water Prediction Summit

Performance:

Progress from Vital Signs Revisited Report



NSSL progressed in 5 of the 6 **Indicators** of Corporate Health

Performance: Workforce Management Plan

- **HIRING**
  - NSSL Management Retreat → Strategic Hiring Plan
  - Use of Research Experience for Undergraduates (REU), NOAA Hollings Scholars program, National Research Council (NRC) post-doc, and NOAA Educational Partnership Program
- **RETENTION**
  - Individual Development Plans and Stay Interviews
  - LEAP (Leadership Effectiveness & Advancement Program) and other opportunities
  - Strong emphasis on award nominations (with results)
  - Merit Principles consistently applied to Employee Performance Evaluations
- **SUCCESSION PLANNING**
  - Visiting Scientist and IPA personnel arrangements
  - Assignments to OAR HQ for career enhancement / efficient research to operations efforts
  - CIMMS-NSSL rotating liaison position

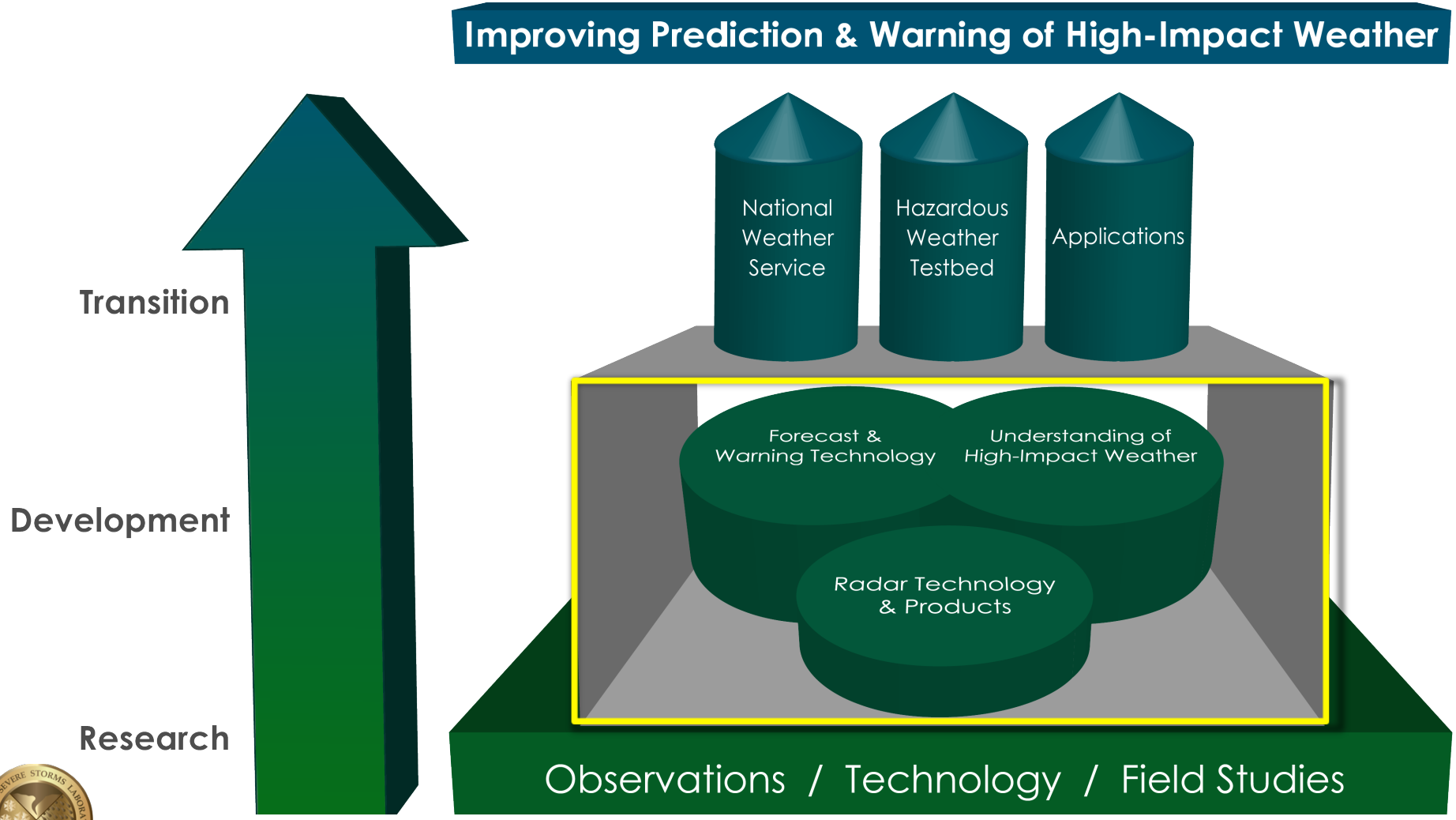
Performance: Research Leadership & Planning

- **Director's Discretionary Research Fund**
  - $300–400K annually
  - High-risk exploratory research seed projects competitively awarded
  - Usually 5-7 projects → some are proposed for future NOAA funding
- **MOU/SLA agreements** for NWS projects (e.g., WSR-88D improvements)
- **Clearly defined project objectives, scope, and methodologies** in Annual Operating Plan, Strategy, Execution, Evaluation (SEE) documentation, Memorandum Of Understanding (MOUs) with agencies
- **Project termination** when technology transitioned, customer support dies, or reimbursable funding ends

Performance:
Examples from FY 2014 Annual Operating Plan

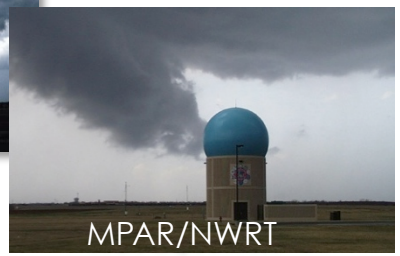
Measure	Target	Actual
Number of NSSL journal articles published in peer-reviewed literature	50	78
Cumulative number of experiments conducted in the HWT	13	13
Cumulative number of events demonstrating improved severe weather warning decision performance using the NWRT Phased Array Radar data compared to the WSR-88D data within the HWT	3	4
Cumulative number of years completed in historical re-analysis of CONUS WSR-88D data	14	14

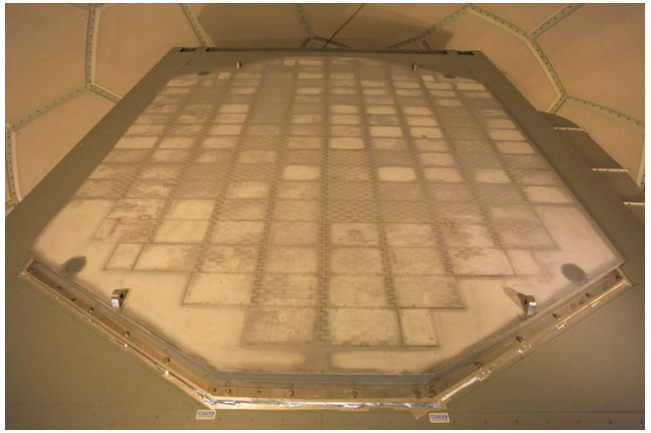
NSSL Research Themes



R2O Performance: Radar Technology and Products

- NOAA's primary weather radar lab
- Continuous **technology infusion** to help NWS improve operational NEXRAD radar system
- Developed **dual-polarization technology,** national NWS radar upgrade completed
- National Weather Radar Testbed
- Exploring replacement for the aging NWS NEXRAD and FAA radars by **MPAR** (**M**ultifunction **P**hased **A**rray **R**adar) at a savings of $5B to the Nation

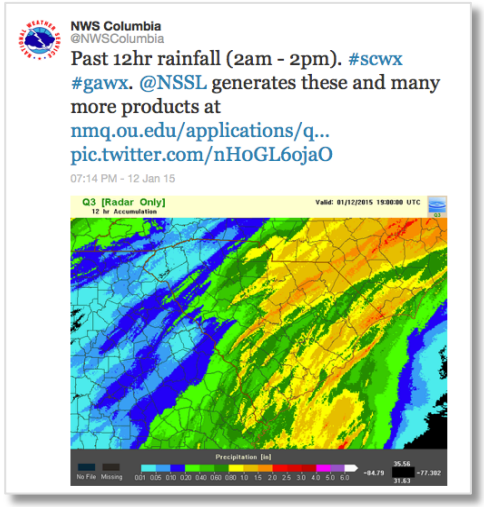


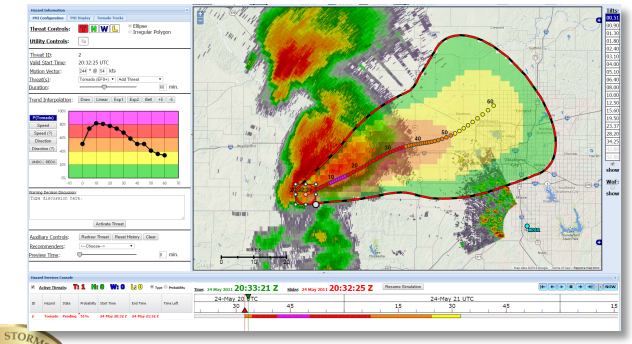


R2O Performance: Forecast and Warning Technology

Decision support system for more accurate, precise, and timely hazardous weather warnings (**MRMS**: **M**ulti-**R**adar / **M**ulti-**S**ensor) now in NWS operations

Flash flood forecasting demonstration system: **F**looded **L**ocations **a**nd **S**imulated **H**ydrographs (**FLASH**) used at NWS River Forecast Centers

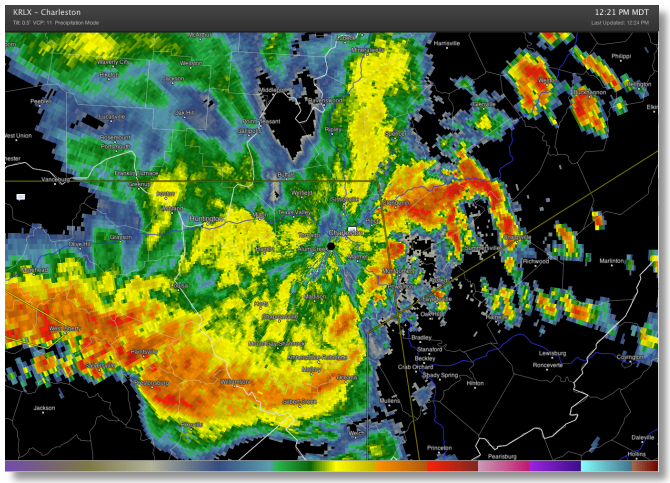




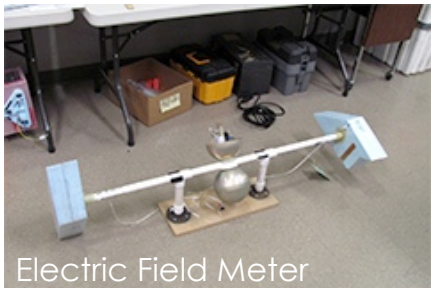
WOF: **W**arn-**O**n-**F**orecast research leading to quadrupling tornado warning lead time to 60 min on the basis of ensemble model forecasts

Performance:
Understanding High-Impact Weather

Jointly with NCDC, recalibration of 15 years of WSR-88D data nearly completed under the **M**ulti-**Y**ear **R**eanalysis **O**f **R**emotely **S**ensed **S**torms (**MYRORSS**)

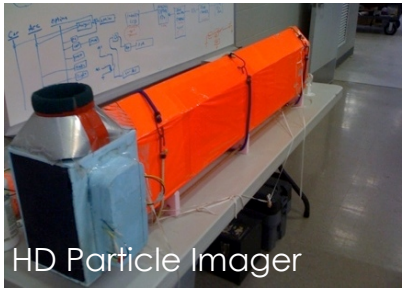


- Field program planning, leadership, and deployment
- Design and develop innovative instruments


Electric Field Meter


Mobile Mesonet


NOXP DP Radar


HD Particle Imager

Performance: Research to Operations (R2O)

NSSL has implemented more than **60 research to operations projects** over the past decade. Some of the most prominent ones – past and current – are shown below in terms of Technology Readiness Levels:

Project	1 Basic Science	2 Concept formulated	3-4 Exp. Design & Validate	5-6 Prototype Developed	7 Demo in Testbed	8 Implement	9 Transition / Deploy
Dual-pol	●	●	●	●	●	●	●
MRMS	●	●	●	●	●	●	●
FLASH	●	●	●	●	●	In progress	
CI-FLOW	●	●	●	●	●		
WoF	●	●	●	●	●		
MPAR	●	●	●	In progress	In progress		
FACETs	●	●	●	In progress			

10 - 20 years

Summary

Successes

- Preeminent severe storm research
- Strong sense of vision
- Improving NWS capabilities (R2O)
- Enthusiastic, dedicated professionals

Remaining challenges

- Maintaining “brain trust” in face of budget uncertainties
- Workforce diversity: age, gender, race
- Phased array radar decisions by NOAA & FAA