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.
NSSSL Research Themes

Improving Prediction & Warning of High-Impact Weather

Observations / Technology / Field Studies

Transition

Development

Research

National Weather Service
Hazardous Weather Testbed
Applications

Forecast & Warning Technology
Understanding of High-Impact Weather

Radar Technology & Products

NSSSL Lab Review Feb 25–27, 2015
Workforce Distribution

- Science/Engineering*
- Technical Support
- Administrative Support
- Management
- IT/Programmers

<table>
<thead>
<tr>
<th></th>
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<th>CIMMS</th>
<th>Contract</th>
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<td>48</td>
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</table>

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

Total Workforce by Gender
- **2009**
  - Male: 82%
  - Female: 18%

- **2014**
  - Male: 80%
  - Female: 20%

Total Workforce by Race
- **2009**
  - White: 7%
  - Native American: 92%

- **2014**
  - White: 86%
  - Asian: 10%
  - Mixed: 4%
Federal Employee Retirement Eligibility

% of current Federal Employees eligible to retire

<table>
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<th>Year</th>
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<td>14</td>
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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

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<tr>
<td>FY14</td>
<td>48</td>
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Number of Personnel

Last NSSL Review

NSSSL Lab Review Feb 25–27, 2015
Hires at NSSL since Feb 2009 Lab Review

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

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

H-Index for NSSL scientists as of Dec 2014

- Successful scientist
- Outstanding scientist

# of NSSL authors in each range

- 0-5
- 6-10
- 11-15
- 16-20
- 21-25
- 26-30
- 31-35
- >35

0 2 4 6 8 10
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), Stumpf (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

Dusan Zrnic

Harold Brooks
Rodger Brown

IEEE
Advancing Technology for Humanity
Dusan Zrnic
Richard Doviak

RMetS
Royal Meteorological Society

NATIONAL ACADEMY
OF ENGINEERING
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
NORTHROP GRUMMAN
...

International
ESGU
Environment Canada
...

University
OU
Purdue University
...

Cooperative Institute, State
CIMMS
HyDROs
...

Federal
Earth System Research Laboratory
 ...

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Quality: CRADAs and MOUs

Formal Reimbursable Agreements

Memorandum of Understanding (MOU)

Cooperative Research and Development Agreement (CRADA)
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

“The Most Ambitious Weather Experiment: A 1,000-Square-Mile Tornado Trap”

“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

- **NOAA Mission:** Science, Service, Stewardship
  - To understand and predict changes in climate, weather, oceans, and coasts.
  - To share that knowledge and information with others.
  - To conserve and manage coastal and marine ecosystems and resources.

- **HWT (NOAA Hazardous Weather Testbed)**
  - Basic and applied research
  - Observation systems, WSR-88D improvements, and field programs

- **WoF (Warn-on-Forecast)**

- **National Weather Radar Testbed (NWRT) Multi-function Phased Array (MPAR)**

- **FACETs:** Forecasting a Continuum of Environmental Threats

- **FLASH:** Flooded Locations and Simulated Hydrographs

- **CI-FLOW:** Coastal and Inland Flooding Observation and Warning

- **MRMS:** Multiple-Radar Multiple Sensor System

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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)

Income:
- Reimbursable: $471K
- Other NOAA: $4,982K
- PAR: $12,818K (41%)
- Base: $13,183K (42%)

Expenses:
- Infrastructure: $5,220K (17%)
- Operations: $7,914K (25%)
- Fed/CMMS/ACE Salaries: $18,151K (58%)

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)

- Hydrometeorology: 33%
- Radar Technology: 34%
- MPAR Contracts: 23%
- Hazardous WX: 10%
Performance: Healthy Funding

NSSL 10 Year History Income Profile (FY05–FY14)

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<tr>
<th>Year</th>
<th>Other Agency</th>
<th>Other/NOAA</th>
<th>MPAR Funding</th>
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<td>4982</td>
<td>12818</td>
<td>13183</td>
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</table>

MPAR ATD
OAR+ 12%
WoF
Sandy Supplemental

NSSL Lab Review Feb 25–27, 2015
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

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

Improving Prediction & Warning of High-Impact Weather

Observations / Technology / Field Studies

Transition

Development

Research

National Weather Service
Hazardous Weather Testbed
Applications

Forecast & Warning Technology
Understanding of High-Impact Weather
Radar Technology & Products
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 and **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 Multi-Year Reanalysis Of Remotely Sensed Storms (MYRORSS)

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

NSSL Lab Review Feb 25–27, 2015
NSSSL 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:

<table>
<thead>
<tr>
<th>Project</th>
<th>1 Basic Science</th>
<th>2 Concept formulated</th>
<th>3-4 Exp. Design &amp; Validate</th>
<th>5-6 Prototype Developed</th>
<th>7 Demo in Testbed</th>
<th>8 Implement</th>
<th>9 Transition / Deploy</th>
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<td>Dual-pol</td>
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<td></td>
</tr>
<tr>
<td>FLASH</td>
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<td>In progress</td>
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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