Global Systems Division

Overview

Kevin Kelleher, Director
NOAA/ESRL/GSD

3-5 Nov 2015
Welcome & Thank You!
GSD Overview

- Who is GSD?
- Workforce
- Budget

Evaluation Criteria

- Quality
  - Awards
  - Service to Professional Societies
  - Publications
  - Tech Transfer

- Relevance
  - To Dept. of Commerce
  - To NOAA
  - To OAR
  - To Commercial Sector
  - To Applications (R2O, R2A, R2X)

Evaluation Criteria (cont.)

- Performance
  - Strategic Accomplishments
  - Leveraging Collaborations
  - Portfolio Balance
  - Leadership & Innovation
  - Intellectual Property
  - Strategic Agreements & Direction

Path to the Future

Outline for the Next 2 Days
Who is GSD?
Overview

Vision

“Making Forecasts Better!”

Mission

“GSD is a leader in the applied research, directed development, and technology transfer of environmental data, models, products, and services that enhance environmental understanding with the outcome of supporting commerce, supporting operations in protecting life and property, and promoting a scientifically literate public”
Our Scientific Partners

GSD

CIRA

CIRES
Our Roots

1980
Program for Regional Observing and Forecasting Services (PROFS)

1990
Forecast Systems Laboratory (FSL)

2000

2005
Global Systems Division (GSD)

2015
GSD Core Competencies

- Modeling and Numerical Weather Prediction
- Forecaster and Aviation Decision Support Tools
- Research to Operations
- Forecast and Observation Assessment and Verification
- Observing System Analysis and Verification
- IT and High Performance Computing, Big Data
- Education and Outreach
Review Themes

Theme 1: Numerical Weather Prediction
- Regional Models
- Global Models
- Cross-Cutting Activities

Theme 2: Decision Support
- Forecaster Support
- Aviation Support

Theme 3: Advanced Technologies and Outreach
- Advanced Tech
- Outreach and Research to Operations
GSD Workforce
GSD Re-Organization (new FY2016)

Director's Office
Kevin Kelleher, Director
Jennifer Mahoney, Deputy

DTC Science Advisor
Ligia Bernardet

Global Observing Systems Analysis Group
Chief, Lidia Cucurull

Information & Technology Services
Branch Chief, Scott Nahman

Renewable Energy Program
Program Manager, Melinda Marquis

Research Support Services
Penny Granville, AO

Senior Scientist
Zoltan Toth

Evaluation and Decision Support
Branch Chief, Michael Kraus

Earth Modeling
Branch Chief, Stan Benjamin

Assimilation

Model Physics

Global Modeling

Chem/Earth System

Model Assessment

Advanced Technology & Outreach
Branch Chief, John Schneider

FIQAS

Forecast System Evolution

Decision Support

Systems Support

Exploratory Visualization & Outreach

High Performance Computing

Information and Visualization

Innovative Weather Delivery Systems
Staff Diversity

2010
- White/Non-Hispanic: 85%
- East and South Asian: 9%
- Hispanic: 2%
- African American: 1%
- Native American: 3%
- White/Hispanic: 1%

2015
- White/Non-Hispanic: 82%
- East and South Asian: 14%
- Hispanic: 3%
- African American: 1%
- Native American: 2%
- White/Hispanic: 1%
GSD Staff Distribution

2005
- Contractors: 28%
  - Federal: 40%
  - CIRA & CIRES: 32%

2010
- Contractors: 18%
  - Federal: 38%
  - CIRA & CIRES: 44%

2015
- Contractors: 17%
  - Federal: 26%
  - CIRA & CIRES: 57%

2010
- Male: 71%
- Female: 29%

2015
- Male: 67%
- Female: 33%
Federal Retirement Eligibility

% of Federal Employees Eligible to Retire

- **2010**: Eligible to retire = 20%
- **2015**: Eligible to retire = 40%
- **2020**: Eligible to retire = >70% (est.)

**Average age of Federal Employees**

- **2015**: Average age = ~60
- **2020**: Average age = 65

Eligible to retire = 43%
GSD FY15 Federal Staff by Age Group

CIRES & CIRA employees are ~ 15 years younger!
Total GSD Staff and Affiliates: 174
Currently representing OAR, CIRES, CIRA, NWS
GSD Budget
GSD 10-Year Funding Profile

- BASE
- Other NOAA
- HPCC
- Non-NOAA

NWS
MADIS
HFIP
NEXGEN

Sandy Sup.

FY06
FY07
FY08
FY09
FY10
FY11
FY12
FY13
FY14
FY15

DTC

NWS

3-5 Nov 2015
GSD Science Review
GSD Expenditures

FY 2010 Total
$29.4M

- Federal Labor, 30.2%
- Joint Institutes, 31.8%
- Contract Services, 18.4%
- Supplies, 3.3%
- Equipment, 1.5%
- Training, 0.1%
- Comms & Utilities, 2.6%
- Travel, 1.7%
- Rent, 5.0%
- Publications, 0.1%
- Joint Institutes, 31.8%
- OAR/ESRL Overheads, 5.3%
- Federal Labor, 23.4%
- Contract Services, 18.4%
- Supplies, 1.6%
- Equipment, 1.2%
- Training, 0.5%
- Supplies, 1.6%
- Equipment, 1.2%
- Rent, 5.0%
- Travel, 1.0%

FY 2015 Total
$32.0M

- OAR/ESRL Overheads, 7.3%
- Joint Institutes, 42.9%
- Contract Services, 13.8%
GSD Funding by Project

FY 2015 Total ~$32M

- Decision Support, 19.2%
- Global Modeling, 9.5%
- Assessments/Verification, 7.7%
- Science-On-A-Sphere, 7.3%
- MADIS, 4.1%
- Fine Grain Computing, 9.2%
- Misc, Data Centers, etc., 13.8%
- Renewable Energy, 3.5%
- OSSE/OSE, 4.0%
- Regional Modeling, 15.4%
- Environmental Info Systems, 6.1%
We strive to improve every link in the chain!

**Theme 1: NWP**
- Optimal Network OSE/OSSE
- Assimilation
- NWP
- Post-Processing

**Theme 2: Decision Support**
- Forecaster
- Stakeholders

**Theme 3: Advanced Technologies**
- HPC
- Data Visualization
- Education & Outreach
Show video...
Quality
“Quality” is “a measure of the novelty, soundness, accuracy, and reproducibility of a specific body of research.” This refers to the merit of R&D within the scientific community.
Quality: DOC Awards

2015 DoC Gold Medal: [HRRR] GSD Modeling Branch w/NWS/EMC for the success of High-Resolution Rapid Refresh, the first storm-scale model to give forecasters and decision-makers fast, local weather guidance.

2015 Bronze Medal: [SOS] GSD Staff for achieving the 100th worldwide Science On a Sphere installation and continue to grow its global engagement of the public in NOAA Science.

2014 Bronze Medal: [HPC] Joint award for dedication in acquiring supercomputing services to sustain production of the Nation’s operational numerical weather and climate forecast systems.

2010 Bronze Medal: [Data Assimilation] For developing the first NCEP operational radar reflectivity assimilation technique and improving storm forecasting.

2010 Bronze Medal: [GPS-Met] For innovative contributions to the development of the Coastal Atmospheric River Monitoring and Early Warning System.
Quality: NOAA Awards

2015 NOAA Administrator’s Award
Meteorological Assimilation Data System (MADIS)

2014 NOAA Administrator’s Award
NOAA Testbeds and Proving Grounds

2014 Distinguished Career Award
• Darien Davis

2012 NOAA Research Employee of the Year
• David Himes
• Staff of the Assimilation and Modeling Branch

2011 NOAA Administrator’s Award
Leadership in Ground-based GPS Observing Network
Quality: Awards

HRRR Model (High-Resolution Rapid Refresh)

AMS Editors Award (2015)
AMS Outstanding Leadership Award (2015)
CIRES Bronze Medals (2010, 2015)
Quality: Service to Professional Societies

- American Meteorological Society Fellows (4)
- Chief, Co-Chief, and Assoc. Editors (9)
- Conference/Program Chairs (3)
- Committee Chair (8)
- Session Chairs (numerous)
• Adjunct, affiliate, or emeritus faculty (14)

• Undergrads mentored, M.S. and Ph.D. Committees (12)
Science On a Sphere®

- 70 teachers trained in SOS
- Accredited classes
- 128 installations
- 33 million viewers/year
- 12 distributors
- 500 free datasets
Quality: International Service

- World Meteorological Organization Commission for Instruments and Methods of Observation
  - Remote Sensing
  - Aircraft Display Panel
  - Science Advisory Group

- The Observing Research and Predictability Experiment (THORPEX)
  - International Core Steering Committee
  - Global Interactive Forecasting System Ensemble

- International Panel on Climate Change
  - Editor of Assessment Reports

- European Geophysical Union
  - Secretary for Predictability Section in Nonlinear Processes in the Geosciences Division

- Arctic Climate Impact Assessment
  - Lead author Arctic Climate Impact Assessment
Quality: International Service

Lidia Cucurull, Chair, Expert Team on New-Remote Sensing Technology

Zoltan Toth, THORPEX U.S. Representative, International Core Steering Committee
(The Observing system Research and Predictability Experiment)

- Nonlinear Processes in the Geosciences Division
- Editor of Assessment Reports
- International Panel on Climate Change
- Global Interactive Forecasting System Ensemble
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- Research and Predictability Experiment (THORPEX)
- Aircraft Display Panel
- Science Advisory Group

3-5 Nov 2015
Quality: Publications

Journal Articles

Number of Publications

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<th>Year</th>
<th>GSD</th>
<th>ARL</th>
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Quality: Publications

Web of Science
GSD H-Index as of 2014

Number of authors in each range

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Web of Science
NSSSL H-Index as of 2014

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Quality: Focus on Tech Transfer

Technical Readiness Level

1. Research
2. Requirements
3. Development
4. Proof of Concept
5. Test and Evaluation
6. Test Deployment
7. Operational Deployment
8. Distribution And Success!
9. GSD’s Heritage
Evaluation Criteria

Relevance
“Relevance” is “a measure of how well a specific body of research supports NOAA’s mission and the needs of users and the broader society.” Primarily refers to value of R&D to users beyond the scientific community. Includes not only hypothetical value, but actual impact.
DOC Goal 1: Trade and Investment
Increase opportunities for U.S. companies by opening markets globally
- Science on a Sphere (SOS)
- Taiwan (Central Weather Bureau collaboration)

DOC Goal 3: Environment
Advance the understanding and prediction of changes in the environment
- High-Impact Weather Improvement Project (HIWPP)
- Next-Generation Global Prediction Modeling (NGGPS)
- Developmental Testbed Center (DTC)

DOC Goal 3: Environment
Build a Weather Ready Nation
- High Resolution Regional Models (HRRR)
- Decision Support Systems (INSITE)
- FACETs (end-to-end Warning)

DOC Goal 3: Environment
Enable U.S. businesses to adapt and prosper by developing environmental and climate informed solutions
- Aviation weather forecasting
- TerraViz/NEIS
- Renewable Energy

DOC Goal 4: Data
Position the Department of Commerce to meet society’s future data needs
- Massively Parallel Fine Grain (MPFG) computing
- OSSEs/OSEs

DOC Goal 5: Operational Excellence
Improve facilities, support services, and IT products and services to drive mission success
- AWIPS-2
- FACETs
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Position the Department of Commerce to meet society’s future data needs
- AWIPS
- FACETs

DOC Goal 5: Operational Excellence
Improve facilities, support services, and IT services to drive mission success

Relevance: DOC FY14-18 DOC Goals

“Build a Weather Ready Nation”
Regional Models – HRRR; improving high impact weather forecasts
Decision Support Systems – INSITE; improving aviation safety
FACETs – Improving the end-to-end Warning process
## Relevance: NOAA’s Strategic Plan

1 = primary partner, 2 = contributing partner, 3 = proposed future partner.

<table>
<thead>
<tr>
<th>GOAL</th>
<th>OBJECTIVE</th>
<th>GSD</th>
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</thead>
</table>
| CLIMATE ADAPTATION AND MITIGATION | Assessments Of Current And Future States Of The Climate System That Identify Potential Impacts And Inform Science, Service, And Stewardship Decisions  
A Climate-literate Public That Understands Its Vulnerabilities To A Changing Climate And Makes Informed Decisions | 3   |
| WEATHER-READY NATION              | Reduced Loss Of Life And Disruption From High-impact Events  
Improved Transportation Efficiency And Safety  
Healthy People And Communities By Improving Air And Water Quality Services  
A More Productive And Efficient Economy Through Environmental Information Relevant To Key Sectors Of The U.S. Economy | 1   |
| SCIENCE & TECHNOLOGY ENTERPRISE   | A Holistic Understanding Of The Earth System Through Research  
Accurate And Reliable Data From Sustained And Integrated Earth Observing Systems  
An Integrated Environmental Modeling System | 1   |
| ENGAGEMENT ENTERPRISE             | An Engaged And Educated Public With An Improved Capacity To Make Scientifically Informed Environmental Decisions  
Integrated Services Meeting The Evolving Demands Of Regional Stakeholders  
Full And Effective Use Of International Partnerships And Policy Leadership To Achieve NOAA’s Mission Objectives | 1   |
| ORGANIZATION & ADMINISTRATION ENTERPRISE | Diverse And Constantly Evolving Capabilities In NOAA’s Workforce  
A Modern IT Infrastructure For A Scientific Enterprise | 2   |
**GSD is a primary partner** – e.g., Regional Modeling / HRRR / RAP)

*Reduced Loss Of Life And Disruption From High-impact Events*

*Healthy People And Communities By Improving Air And Water Quality Services*

**GSD is a contributing partner** – e.g., Atmospheric Chemistry modeling w/Air Resources Lab

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<td>A Holistic Understanding Of The Earth System Through Research</td>
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<td>A Modern IT Infrastructure For A Scientific Enterprise</td>
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<tr>
<td>ORGANIZATION &amp; ADMINISTRATION ENTERPRISE</td>
<td><strong>GSD</strong> is a primary partner – e.g., Regional Modeling / HRRR / RAP</td>
</tr>
</tbody>
</table>
## Relevance to OAR Strategic Plan Element

<table>
<thead>
<tr>
<th>OAR Strategic Plan Element</th>
<th>Relevant GSD Activities</th>
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</thead>
<tbody>
<tr>
<td>• Research</td>
<td>• Research</td>
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<tr>
<td>• Observations &amp; Data</td>
<td>• OSE/OSSE, MADIS, GPS</td>
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<tr>
<td>• Models and Experiments</td>
<td>• Regional/Global models</td>
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<tr>
<td>• Studies and Assessments</td>
<td>• Assessments (e.g., MRMS)</td>
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<td>• Development</td>
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<td>• Predictions and Projections</td>
<td>• Regional/Global models</td>
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<tr>
<td>• Emerging Technologies</td>
<td>• NEIS, MPFG computing</td>
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<td>• Transitions</td>
<td>• Transitions</td>
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<td>• Extension and Outreach</td>
<td>• SOS</td>
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<tr>
<td>• Technology Transfer</td>
<td>• HRRR, RAP, MADIS, GPS-RO</td>
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GSD Science Review
Relevance: Research to Applications

Numerical Weather Prediction 2010-2015

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## Advanced Technologies and Outreach  2010-15

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Trademarks
   Planet Theater

Patents
   • Science on a Sphere
   • Atmospheric Sondes and Method for Tracking

Patent Pending
   • NEIS
   • TerraViz
CRADAs (Cooperative Research And Development Agreements)
AURAIA (air chemistry/quality), ENI/Trimble (GPS-Met), IMSG (aviation)

Non-disclosure Agreements
- Iberdola Renewables
- XCEL Energy
- GIE EUMETNET (Network of European National Meteorological Service)
- Federal Aviation Administration

Memorandums of Understanding (MOUs)/Interagency Agreements
- 155
Evaluation Criteria

Performance
Evaluation Criteria: Performance

“Performance” is “a measure of both effectiveness (the ability to achieve useful results) and efficiency (the ability to achieve quality, relevance, and effectiveness in timely fashion and with little waste).” It refers to the effectiveness and efficiency with which R&D activities are organized, directed, funded, and executed.
Performance: Strategic

Organization

October 1, 2014 - GSD reorganized to reduce redundancy and confusion between Branches

Financial

- October 1, 2015 - $3.3M in recurring fixed costs were cut to reduce the internal overhead (IRA) charged to “customers”
- Reductions avoided an IRA of 42% in FY16 vs. 29%

Strategic Alliances

- NCAR - Signed 5 year MOU to collaborate on NWP and related topics
  - Similar MOU is planned for GFDL, AOML
- SOS – Multiple distributorships across the World
- GOSA Group is fully coordinated with NOAA’s QOSAP (Quantitative Observing System Assessment Program)
Strategic Direction

- GSD has identified 5 Grand Challenges for next 5-20 years
- GSD draft Strategic Plan ready for comment
- 60% of NIM modeling resources redirected to assist in NOAA’s NGGPS effort

Organizational Excellence

- Executive Coach working with GSD’s Senior Leadership Team

Succession Planning

- Ongoing GSD-wide Mid-Career Training
- Multiple sessions throughout FY15 with Executive Coach
- Several employees attended year-long Colorado Leadership Development
Performance: Leveraging Collaborations
NOAA Research and Development Funnel

- General research and development related to NOAA's mission
- Research Partners
- Mission-oriented research and development to improve NOAA's operational and information services
- Science and Technology Transition
- Test Beds
- Operational system development and implementation

Income - FY15 (~$32M)

- 20+ Yr
- 5-20 Yr
- 2-5 Yr
- 0-2 Yr

- % Other
- % of NWS
- % of Base
Performance: Portfolio Balance

TRL of Projects by GSD Theme

- TRL 1-2
- TRL 3-5
- TRL 6-8
- TRL 9

Numerical Weather Prediction Projects
Decision Support Projects
Advanced Technologies and Outreach Projects

System Test, Launch & Operations
System/Subsystem Development
Technology Demonstration
Technology Development
Research to Prove Feasibility
Basic Technology Research
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<td>Frequently-updated, short-range, high resolution model development</td>
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<td>Assessments of R2O Aviation Products</td>
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<td>High Performance Computing Techniques</td>
<td>Fine grain computing; Unified coding models to run on GPUs, MICs and CPUs</td>
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<td>Wind Forecast Improvement Projects 1 and 2 and Solar Forecast Improvement Project to improve skill of RAP and HRRR.</td>
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**“High Impact Weather Prediction Program (HIWPP)”**

Led by GSD, HIWPP, *for the first time*, it brought together Modeling Centers across US & **Accelerated** NGGPS and model improvements by 2 years…
## Performance: Innovation

*Research and development that supports applications*

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<td>Massively Parallel Fine Grain (MPFG) Computing</td>
<td>To run high resolution global forecast models at an affordable cost</td>
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<td>Manufacturers in the supercomputing industry are working on MPFG computing for weather forecasting models</td>
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<td>TerraViz</td>
<td>Improved visualizations of data for research and education</td>
<td>TerraViz is leveraged by SOS Explorer and NEIS</td>
<td>Thousands of SOSx downloads in more than 50 countries</td>
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<td>NEIS (NOAA Environmental Information System)</td>
<td>Big data will require a capability to mine, collect, consolidate, visualize, and interact with disparate data across NOAA using the Internet</td>
<td>Used as a platform to access and evaluate next-generation global forecast models</td>
<td>Experimental model data can now be compared over the Internet without the need for access to super computers</td>
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<td>Central Weather Bureau Taiwan</td>
<td>Leverage funds and talent for mutually beneficial projects</td>
<td>Share scientific talent and knowledge</td>
<td>New/improved severe weather forecast tools</td>
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## Performance: Innovation

### Research and development that supports applications

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**TerraViz and NEIS allow seamless data integration and interaction across 4D time and space for NOAA**
Performance: Strategic Agreements

- NWS Next Generation Global Prediction System
  - GSD leading 5 Year MOU for OAR to work on NGGPS (*in review*)

- NESDIS-NWS-GSD - 5 Year MOU for COSMIC-2 and GPS-RO

- Intellectual Property
  - Agreement with CIRES provides IP protection through Copyright
  - Incentives for licensing IP & royalty payments
  - Reinvestment of funds supporting R&D
GSD’s Grand Challenges

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

2. Create a fully coupled NOAA Earth System Analysis & Prediction capability

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.

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

5. Create easily accessible systems to offer instant insights into the meaning of information and data
NOAA Weather Ready Nation Goal: Reduced loss of life, property, and disruption from high-impact events

NOAA Science and Technology Enterprise: An integrated environmental modeling system

GC1: Global to storm-scale forecasts

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

GC2: Fully coupled Earth system modeling and prediction

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

GC3: Provide accurate, relevant, and timely environmental information

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

GC4: Determine the best environmental observing systems

GC5: Instant insights into data meaning

GSD Grand Challenges Relevant to NOAA’s Next Generation Strategic Plan
Examples: Paths to the Future

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<th>2005</th>
<th>2015</th>
<th>2020-2030</th>
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<td>Advanced Computing MPP</td>
<td>MPFG (Massively Parallel Fine Grain) R&amp;D for NWP</td>
<td>MPFG HPC Standard for Next Generation Forecast Models</td>
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<td>Surface Observation Network</td>
<td>Building Initial OSE/OSSE Capability</td>
<td>Fast, Flexible OSE/OSSE</td>
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<td>CONUS Mesoscale Atmospheric Modeling</td>
<td>Global Hydrostatic &amp; Non-hydrostatic Models, Warn-On-Forecast</td>
<td>Global Non-hydro, High-resolution Models ≤ 3km (w/NWS/NGGPS)</td>
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Vision

“Making Forecasts Better!”

GSD Strategic Plan

Draft GSD plan is available for comment at:

(http://esrl.noaa.gov/gsd)
Outline for Next 2 Days
Theme 1: Numerical Weather Prediction

Session 1: Regional Models

Session 2: Global Models

Session 3: Cross-Cutting Activities
Theme 2: Decision Support

Session 4: A Busy Day at Forecast Offices

Session 5: Decision Support for Aviation
Theme 3: Advanced Technologies

Session 6: Advanced Technologies

Session 7: Outreach and Research to Operations
Format for the Review

- Short overview
- 5 minute talks
- e-Posters
- Theme wrap-up and discussion
- Review panel writing period

Day
Theme
Session

3-5 Nov 2015
GSD Science Review
Discussion