

Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR)

Meeting 2018-3

August 14, 2018

Opening Remarks

Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR)

*Dr. Jack Kaye (NASA)
Chair, ICMSSR*

- **Welcome**
- **Roll Call**
- **Approve Agenda & Record of Action.**
- **Meeting will be recorded**

Today's Agenda

- **OPENING REMARKS:** Jack Kaye (NASA)
- **ADMIN REMARKS:** Michael Bonadonna (OFCM)
- **FEDERAL COORDINATOR'S UPDATE:** William Schulz (OFCM)
- **COMMITTEE FOR OPERATIONAL ENVIRONMENTAL SATELLITES UPDATE:** Ajay Mehta (NOAA-NESDIS)
- **RECAP OF THE ATMOSPHERIC TRANSPORT AND DISPERSION WORKING GROUP** - Dave Chorney (OFCM)
- **SPACE WEATHER ENTERPRISE FORUM:** Michael Bonadonna
- **HAZARD SIMPLIFICATION PROJECT UPDATE:** Eli Jacks (NOAA-NWS)
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- **ACTION ITEM REVIEW:** Michael Bonadonna (OFCM)
- **CLOSING COMMENTS / ADJOURN**

Administrative Info

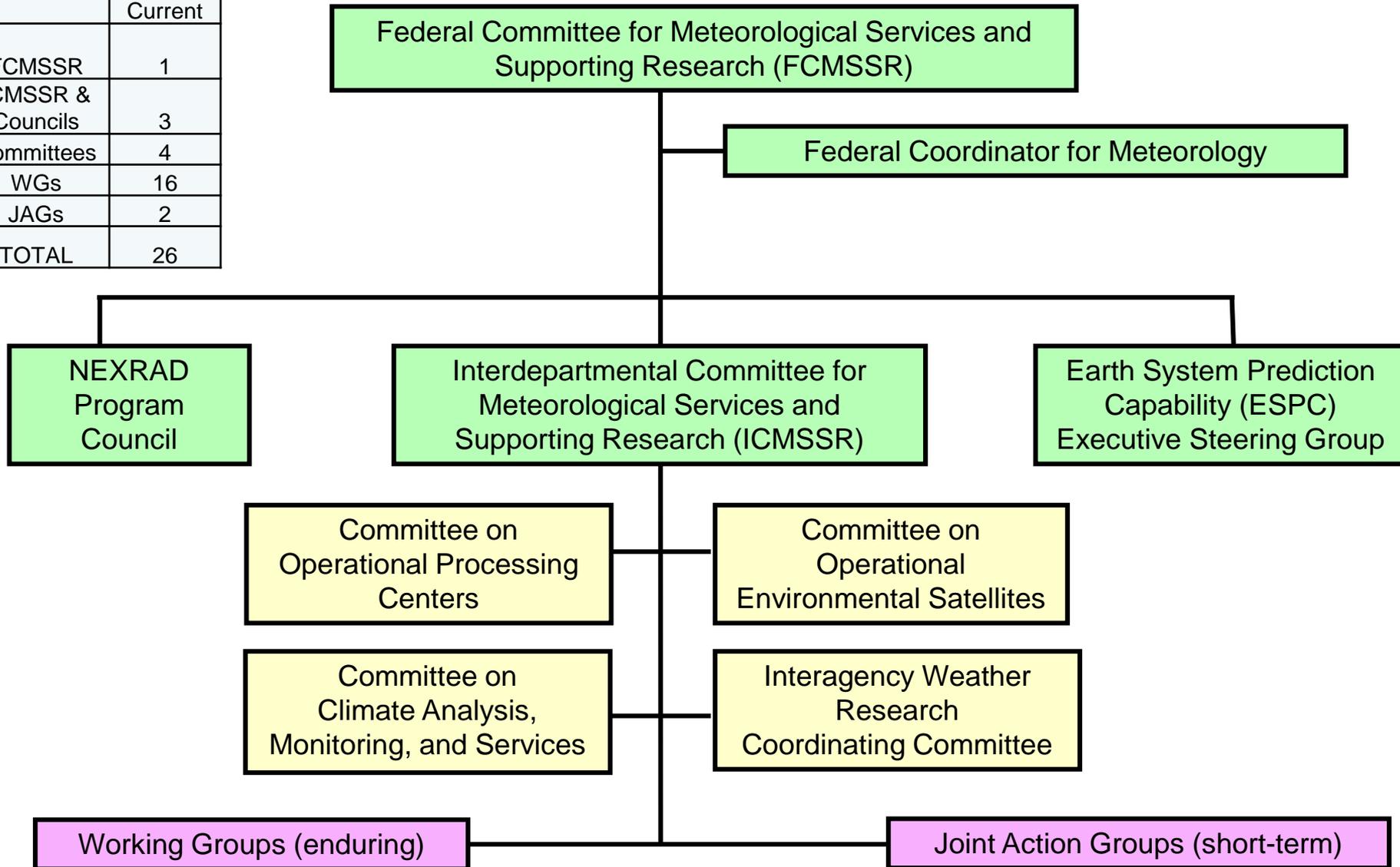
- **Facilities**
- **Telecon / GoToMeeting**
 - Dial-in 1-888-680-9581, passcode 535430#
- **GoToMeeting:** <https://global.gotomeeting.com/join/293418653>
- **Slides posted at:** <http://www.ofcm.gov/icmssr/meetings.htm>
 - **Please advise us of any sensitivities**

FEDERAL COORDINATOR'S UPDATE

Bill Schulz
Federal Coordinator

FWE Coordinating Infrastructure

	Current
FCMSSR	1
ICMSSR & Councils	3
Committees	4
WGs	16
JAGs	2
TOTAL	26



Federal Coordinator's Update

- Tracking outgoing correspondence:
 - Recommendation to OPM for modifying meteorologist qual (1340 series)
 - Proposal to convert FCMSSR to ICAWS
- Upcoming Events:
 - Guidance for Budget and Coordination Report FY20 in draft for agency working level review.
 - Expect formal issuance in December
 - Suspense will be immediately after release of PBR (approx. late Feb 2019)
 - Federal Coordination Session at AMS Conference (January 2019, Phoenix.) Briefings from:

NEWP	COES	National ESPC
WG/OD (WIGOS)		Space Weather
 - Data Accessibility vs National Security
- Proposed new objective for the Strategic Plan:

** Additional information later in the meeting*

Federal Coordinator's Update

Proposed Objective 4.5:

Develop coordination processes that facilitate operational feedback to the research community, and that accelerate the integration of promising research from federal, commercial and academic partners into operational improvements in observing, forecasting, warning and threat communication.

Proposed in response to ICMSSR AI 2018-2.1

Includes language from Section 105 of the Weather Act:

- *'federal, commercial and academic partners'*
- *'forecasting, warning and threat communication'*

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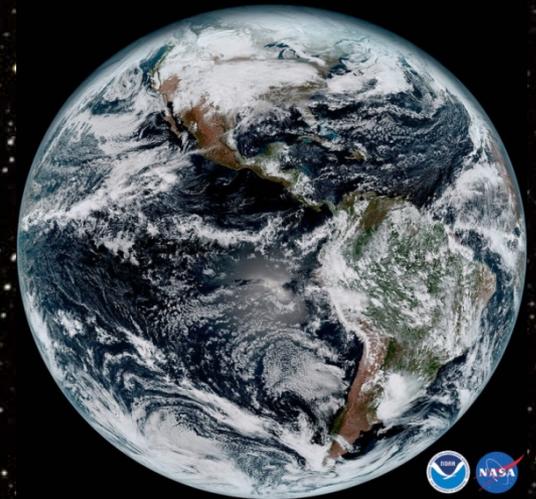
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Committee for Operational Environmental Satellites (COES) Update

*Interdepartmental Committee for Meteorological Services
and Support Research (ICMSSR)*

Meeting 2018-3

August 14, 2018



Overview



- Background
- Terms of Reference
- Activities, Issues, Interests, and Going Forward
- Conclusion

Background



- **1982:** COES established as part of the FWE coordinating Infrastructure
- **1996:** COES deactivated after the NPOESS Senior Users Advisory Group (SUAG) was established
- **2010:** NOAA response to GAO 10-799, Recommendation 3 stated GOES-R would report status through OFCM to the interagency partners annually.
- **2013:** US Navy requested and ICMSSR approved COES be reactivated to provide interagency coordination of environmental satellite issues.
- **2014:** COES was re-established in 2014
- **2016:** GAO- 16-252R recognizes COES value:
 - “One potential vehicle for formalizing collaboration”
 - “DOD official have stated (COES) is one way DOD can connect with NOAA’s international affairs ”
 - “...we believe DOD should formalize its coordination and collaboration...through committees... such as COES..”



ToR: Purpose

The COES shall advance the goals of the ICMSSR to achieve interagency coordination in planning for use of sustained environmental satellite systems to support federal meteorological and oceanographic operational services providers and their customers.



NOAA, NASA, and USAF
partner on DSCOVR



DMSP Operations at
NOAA NSOF



NOAA, NASA, DoD
Partnership in JCSDA

ToR: Objectives

- Ensure interagency review and coordination of approved requirements for operational environmental satellite programs.
- Promote an open dialog concerning environmental satellite systems development, satellite data systems architecture, continuity plans, data exploitation readiness plans.
- Consider potential use of research satellite capabilities to augment operational systems in meeting user needs, and plans to transition research data into operational products and new applications.
- Facilitate working-level relationships between Federal members and other stakeholders to effectively resolve interagency issues with regard to the availability of environmental satellite data and products from future systems.

ToR: Objectives

- Establish dialog with other standing groups currently engaged in various aspects of environmental satellite and data readiness and exploitation, including: USGEO, CEOS, CGMS, GOES User conference, and other relevant user groups.
- Coordinate with the Committee for Operational Processing Centers (COPC) on issues of mutual interest, i.e. data availability and data assimilation, and share information.
- Address other matters as directed by the ICMSSR.
- Provide regular updates to the ICMSSR and other elements of the Federal Coordination Infrastructure as necessary.

Participation

CoChairs



- NOAA
 - **Ajay Mehta** (NESDIS)
 - NWS (CoChair in 2020)
- DOD
 - **Dave McCarren** (Oceanographer & Navigator of the Navy)
 - HQ USAF Dir. of Weather (CoChair in 2019)



Members/Participants:

- DOC: NOAA: NWS, NESDIS, OMAO
- DOD: USAF, USN, USA, AFSPC, USSTRATCOM, SMC, PDSA
- DOE: LANL
- DHS: FEMA, USCG
- DOI: BLM, USGS
- DOT: FAA, FHWA
- NASA: ESD, JASD
- NGA, NRO
- NSF: AGS
- USDA
- EOP: OSTP (Observers)

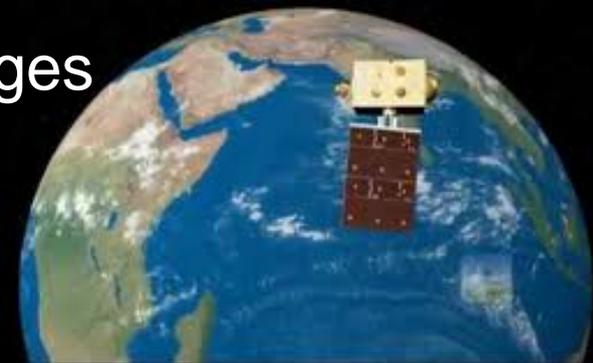
Activities



- COES ToR Update
 - New procedures for the CGMS coordination
- Monitoring plans for environmental satellite programs
 - S-NPP, JPSS, GOES-R, COSMIC2, DoD SBEM
- Crossfeed and cooperation with COPC
- JCSDA and NOAA STAR updates
 - Comprehensive list of research satellite data for operational use
- Satellite Telemetry Interagency Working Group (STIWG) ToR Updated
 - Primary user group for GOES Data Collection System
 - STIWG is aligned under COES and the Advisory Committee on Water Information (ACWI) Subcommittee for Hydrology (SOH)

Issues

- Keeping abreast of evolving DoD SBEM programs
 - Defense Meteorological Satellite Program (DMSP)
 - EO/IR Weather System (EWS)
 - EO/IR Weather System - Geostationary (EWS-G)
 - Weather System Follow-on Microwave (WSF-M)
 - WSF Energetic Charged Particle (WSF-ECP) sensor
 - Compact Ocean Wind Vector Radiometer (ISS, COWVR)
 - Operationally Responsive Space-8 (ORS-8)
 - Space Situational Awareness Environmental Monitoring (SSAEM)
- Indian Ocean satellite coverage challenges
 - Use of INSAT 3D-R
 - SCATSAT-1 data exploitation
 - Policy, connectivity, quality, and timeliness issues to be resolved



Interests

- Leveraging NASA research satellite capabilities
 - CYGNSS, TROPICS, PACE, RapidScat, CATS, GPM
- Commercial Weather Data Acquisition Programs
 - Monitoring progress on Commercial Weather data provisions of the Weather Forecast Improvement Act of 2017
 - Monitoring Commercial Weather Data Pilot programs in NOAA, DOD, and NASA
- Radio Frequency Interference and bandwidth encroachment
 - Command and data communications
 - Impacts to passive remote sensing windows
- Decadal Survey and NSOSA implications for future environmental satellite systems
 - New concepts, new opportunities, new challenges



Going Forward

- Is COES doing all tasks identified in the Terms of Reference and whether COES is meeting agency expectations?
- Is COES addressing pertinent goals and objectives identified in the Strategic Plan for Federal Weather Enterprise coordination?
- Does ICMSSR have any guidance or direction for COES?

Conclusion

- COES supports coordination between Federal Agencies, EOP, and International groups
- The GAO recognizes the need for coordination and has identified COES as part of the solution for interagency environmental satellite issues
- COES provides a forum for issue discovery and the means to connect stakeholders with organizations providing environmental satellite services and system development

The FWE agencies can work together to solve environmental satellite issues beyond the reach or scope of individual agencies.

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RECAP OF THE ATMOSPHERIC TRANSPORT AND DISPERSION WORKING GROUP

- Hosted the 2018 Special Session, 22nd Annual George Mason University (GMU) Atmospheric Transport and Dispersion (ATD) Conference.
- Agencies provided briefings on the history of Interagency Modeling and Atmospheric Assessment Center (IMAAC), what is currently being done at IMAAC by DTRA, and the operational use of the HYSPLIT model at the NWS FO's.
- OFCM recommended possibly starting two new working groups, one on updating plans that have not been updated since 2004 and another working group to discuss urban modeling. Possibly making just one working group to accomplish both shortfalls.
- Working with Tom Watson, from Brookhaven Labs, to write point paper on why a working group is needed.
- Attended 2018 AMS Urban Climate and Dispersion conference to meet others working in the modeling and urban dispersion modeling and get volunteers to join working group



RECAP OF THE ATMOSPHERIC TRANSPORT AND DISPERSION WORKING GROUP

So where does the ATD working group go from here?

- The most current OFCM plans relating to ATD are FCM-R17-2002 called *Atmospheric Modeling of Releases from Weapons of Mass Destruction for Homeland Security*, from 2002, and FCM-R23-2004 *Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling* from 2004. Both of these publications are outdated.
- A working group is proposed to review these two plans and decide if it is necessary to update, cancel or start completely from scratch with new plans.



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SWEF 2018 Recap

- **When :** 25 July from 1200-1600
- **Where:** Library of Congress
- **Sponsor:** Representative Ed Perlmutter (D-CO)
 - Sponsor for H.R. 3086 “Space Weather Coordination Act”
- **Support:** NASA and Secure World Foundation
- **Theme:** “Advancing National Space Weather Research and Forecast Capabilities”
- **Panel Sessions:**
 - Understanding and managing risks and impacts associated with space weather
 - Implementation of activities across the space weather enterprise for the protection of critical infrastructure



2018 Space Weather Enterprise Forum



Keynote Speaker

**The Honorable
Ed Perlmutter**

United States
Representative



Session 2: Understanding and Managing Risks and Impacts Associated with Space Weather

Moderator: **Mr. Benjamin Reed**, Executive Office of the President, National Space Council

- **Ms. Devon Striet**, Deputy Assistant Secretary for Infrastructure Security and Energy Restoration
- **Mr. Ralph Stoffler**, U.S. Air Force Director of Weather
- **Dr. James Spann**, Acting Heliophysics Chief Scientist, Headquarters National Aeronautics and Space Administration
- **Dr. William Lapenta**, Director, National Centers for Environmental Prediction, National Oceanic and Atmospheric Administration.



Session 3: Implementation of activities across the space weather enterprise

Moderator: **Mr. Mike Ryschkewitsch**, Head, Space Exploration Sector at Johns Hopkins University Applied Physics Laboratory

- **Mr. Steven Clarke**, Deputy Associate Administrator for Exploration, Headquarters National Aeronautics and Space Administration
- **Dr. Conrad Lautenbacher**, CEO, GeoOptics Incorporated and American Commercial Space Weather Association.
- **Dr. Daniel Baker**, Director Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder.
- **Dr. Christopher Cannizzaro**, Office of Space and Advanced Technology in the Bureau of Oceans, Environment and Science, Department of State.
- **Dr. Mizuhiko Hosokawa**, Vice President of National Institute of Information and Communications Technology, Japan



2018 Space Weather Enterprise Forum



The screenshot shows the OFCM website for the 2018 Space Weather Enterprise Forum. The header includes the OFCM logo and navigation links for GROUPS, PUBLICATIONS, MEETINGS, and ABOUT. Below the header is a banner for the forum with the text "SPACE WEATHER ENTERPRISE FORUM" and "Image courtesy of NOAA". The main content area features the title "2018 Space Weather Enterprise Forum" and the date "July 25, 2018 | Library of Congress, Madison Building, Montpelier Room | Washington, D.C.". A MENU section lists links for Introduction, Registration, Agenda, and About Space Weather. A PRESENTATIONS section lists links for presentations from 2018 down to 2009. A large image of a solar flare is displayed, with the caption "Image courtesy of Space Weather Prediction Center" and the theme "Advancing National Space Weather Research and Forecast Capabilities".

- Small-SWEF concept
 - Half-day on the Hill
 - Small venue (120 attendees)
 - Raise Congressional interest
- Broad Government, Commercial, Academic Partnership supports Executive Order 13744 directive & H.R. 3086
- Coordinated with State Dept. “Space Weather as a Global Challenge” event Embassy of Japan on 24 July
 - Raised international participation
- Presentations, audio transcripts, and report available through online OFCM.GOV



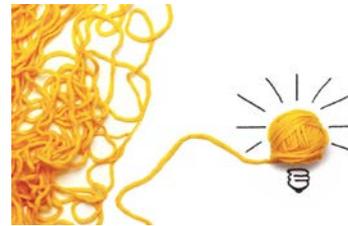
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Update on the NWS Hazard Simplification Project

Interdepartmental Committee for Meteorological Services and Supporting Research



***Eli Jacks, Chief, Forecast Services Division
NOAA/National Weather Service
Aug. 14, 2018***



Outline



- **The NWS “Watch, Warning and Advisory” (WWA) System:** Definitions, issues related to confusion, user feedback
- **The Weather Act, Section 406:** Key elements
- **Response to Section 406:** The NWS Hazard Simplification Project
- **WWA “Repair” and “Revamp”:** Possible Headline Alternatives
- **Path Forward:** Project elements, challenges, collaboration request

The NWS WWA System:

Definitions

Watch

We **FORECAST THE POTENTIAL** for a significant hazard. Timing and/or occurrence is still uncertain.

Warning

We **WARN FOR A DANGEROUS** hazard that is imminent or occurring. Significant threat to life and/or property.

Advisory

We **ADVISE CAUTION** for less serious hazards that are also imminent or occurring - but could pose a threat to life and/or property if caution is not exercised.

The NWS WWA System: Issues Related to Confusion

Confusing terms




Too many products

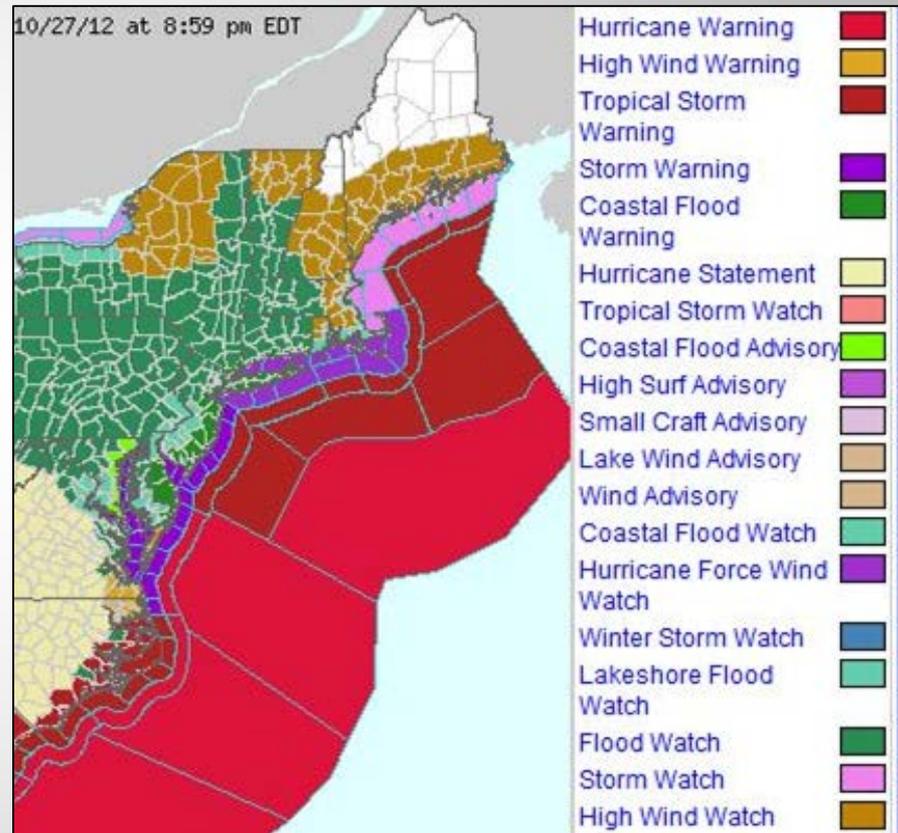
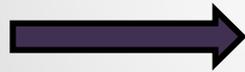
The NWS WWA System

Service Assessment Feedback on Message Complexity

Hurricane/Post Tropical Cyclone Sandy: “...NWS products for coastal storms are confusing...”

19 products to describe 2 hazards:

Windy and *Flood*



“Sandy” - Oct. 27th, 2012 at 8:59pm

The Weather Act, Section 406

Key Elements

ACTIONS/STATUS:

Element #1: ASSESSMENT

Evaluate NOAA's system for issuing watches and warnings and ensure assessment is validated by social and behavioral science using a generalizable sample



Generalizable public surveys completed by social science to test understanding of current terms and propose possible alternative language

Element #2: CONSULTATION

Consult across federal, academic, media, emergency planners and non-federal forecaster sectors



Initial and future stakeholder/academic engagement through focus groups, webinars, workshops, professional conferences

Element #3: IMPROVEMENTS TO SYSTEM

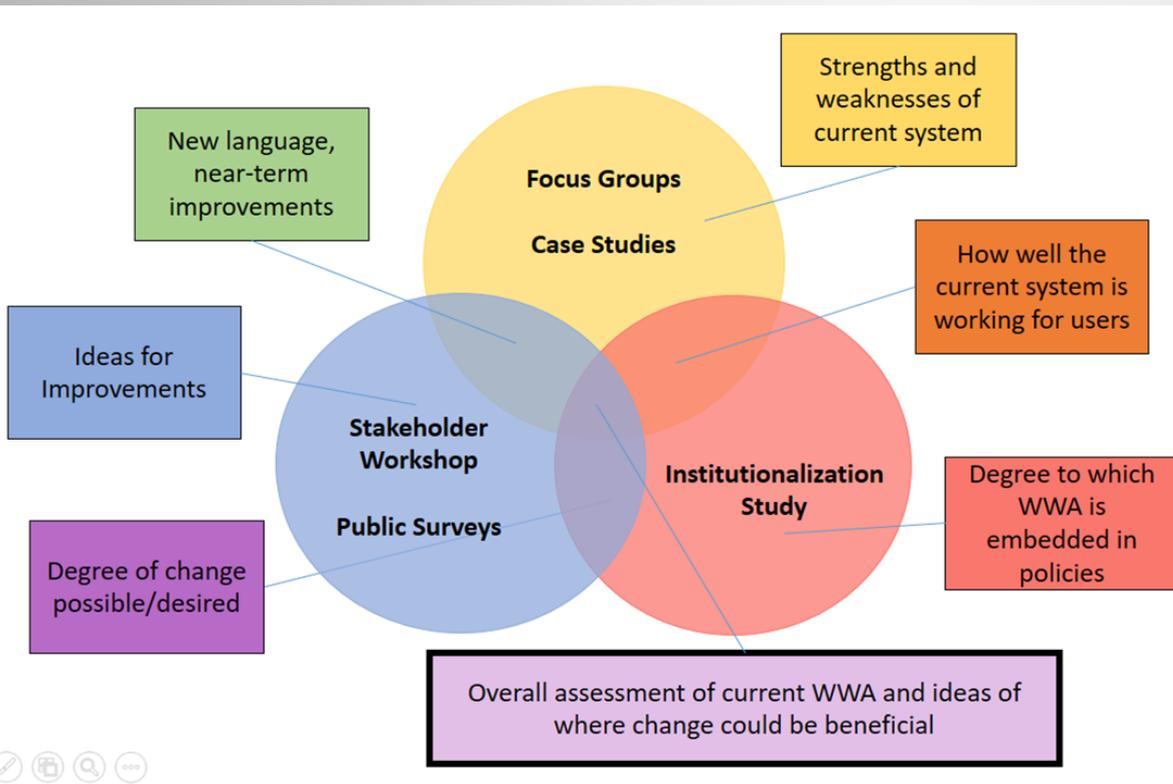
"Improve the system for issuing watches and warnings ... and support efforts to satisfy research needs to enable future improvements to such system"



"Repair" current system through changes that can be implemented relatively easily and quickly

Consider alternatives to the WWA system ("Revamp") via feedback and test beds

Response to Section 406: NWS Hazard Simplification Project



Key social science feedback:

- “Repair” WWA by reducing the number of WWA products and focusing the message
- Consider a system “Revamp” via use of a hierarchical color, numbering, and/or language

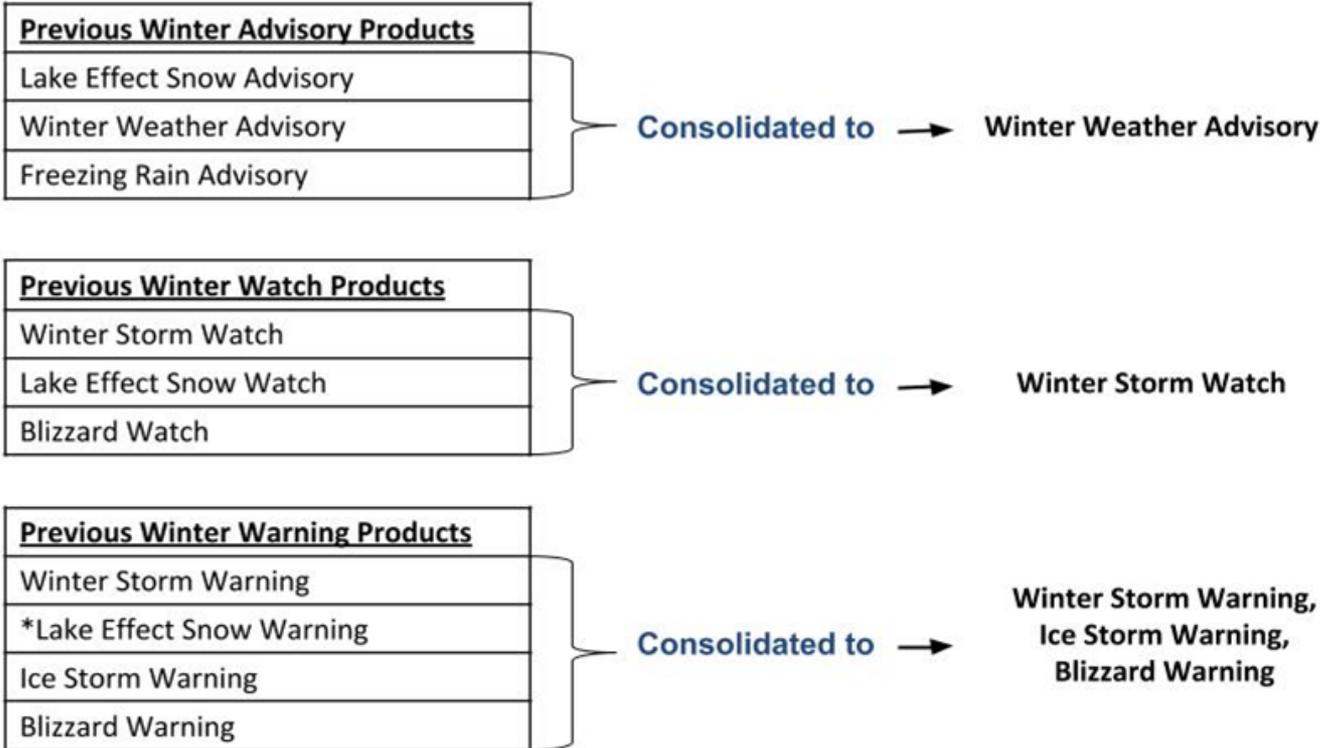


WWA “Repair”: Example of the Result



Consolidation

Reformatting



- * **WHAT**...Heavy snow possible.
- * **WHERE**...Bradford County
- * **WHEN**...From this evening through late Friday night.
- * **ADDITIONAL DETAILS**...Plan on difficult travel conditions

Additional Hazards Currently Planned for Consolidation and Reformatting:

Flooding, Marine, Heat, Cold Wind, Visibility

*Consolidated only in select Western and Central Region offices

Implement Flooding

Survey - August 2018

Implementation - June 2020

<u>Current Flood Products</u>
[Areal] Flood Advisory
[River] Flood Advisory for Forecast Points
Coastal Flood Advisory
Lakeshore Flood Advisory

Consolidate to →

Flood Advisory

[Areal] Flood Watch
[River] Flood Watch for Forecast Points
Flash Flood Watch
Coastal Flood Watch
Lakeshore Flood Watch

Consolidate to →

Flood Watch

[Areal] Flood Warning
[River] Flood Warning for Forecast Points
Flash Flood Warning
Coastal Flood Warning
Lakeshore Flood Warning

Consolidate to →

Flood Warning
Flash Flood Warning

A Possible WWA “Revamp”

Social Science Generalizable Public Surveys

Goals:

- 1) Provide validated result on public understanding of WWA terms
- 2) Test alternative language as possible WWA replacement

Hazards Tested:

- Winter Weather
- Thunderstorms
- Tornadoes
- Coastal Flooding
- Areal Flooding
- Flash Flooding
- High Wind
- Excessive Heat

Responses: 9,100

Information gathered on:

- Demographics
- Current knowledge
- Reaction to prototypes
- Risk perception
- Sources of weather information



Generalizable Public Surveys

Key Finding #1: Current System Misunderstood

- “Advisory” *very* poorly understood
- “Warning” best understood, but Watch/Warning confusion still present
- Except for Tornado Warning, no term reached 70% understanding

Correct Understanding of Current Terms				
Hazard	Watch	Advisory	Warning	Emergency
Winter	69.8%	16.0%	43.5%	N/A
Thunderstorm	43.5%	24.3%	56.8%	N/A
Tornado	67.3%	N/A	70.6%	28.9%
Coastal Flooding	41.6%	44.4%	55.6%	N/A
Flash Flooding	50%	N/A	64.5%	62.2%
Areal Flooding	44.4%	42.6%	43.6%	N/A

Generalizable Public Surveys

Prototype Testing

X = Hazard type (e.g. Wind, Flood, Winter Weather)

Level	Current System	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Watch level	X Watch	X Outlook	X Notice	Possible X Event	Possible X Conditions
Advisory level	X Advisory	X Warning	X Alert	Moderate X Warning	Level Orange X Warning
Warning level	X Warning	X Warning	X Warning	Severe X Warning	Level Red X Warning
Emergency level	X Emergency	X Warning	X Emergency	Extreme X Warning	Level Purple X Warning

Specific goals of each prototype



Importance of headlines



Replacement of problem terms



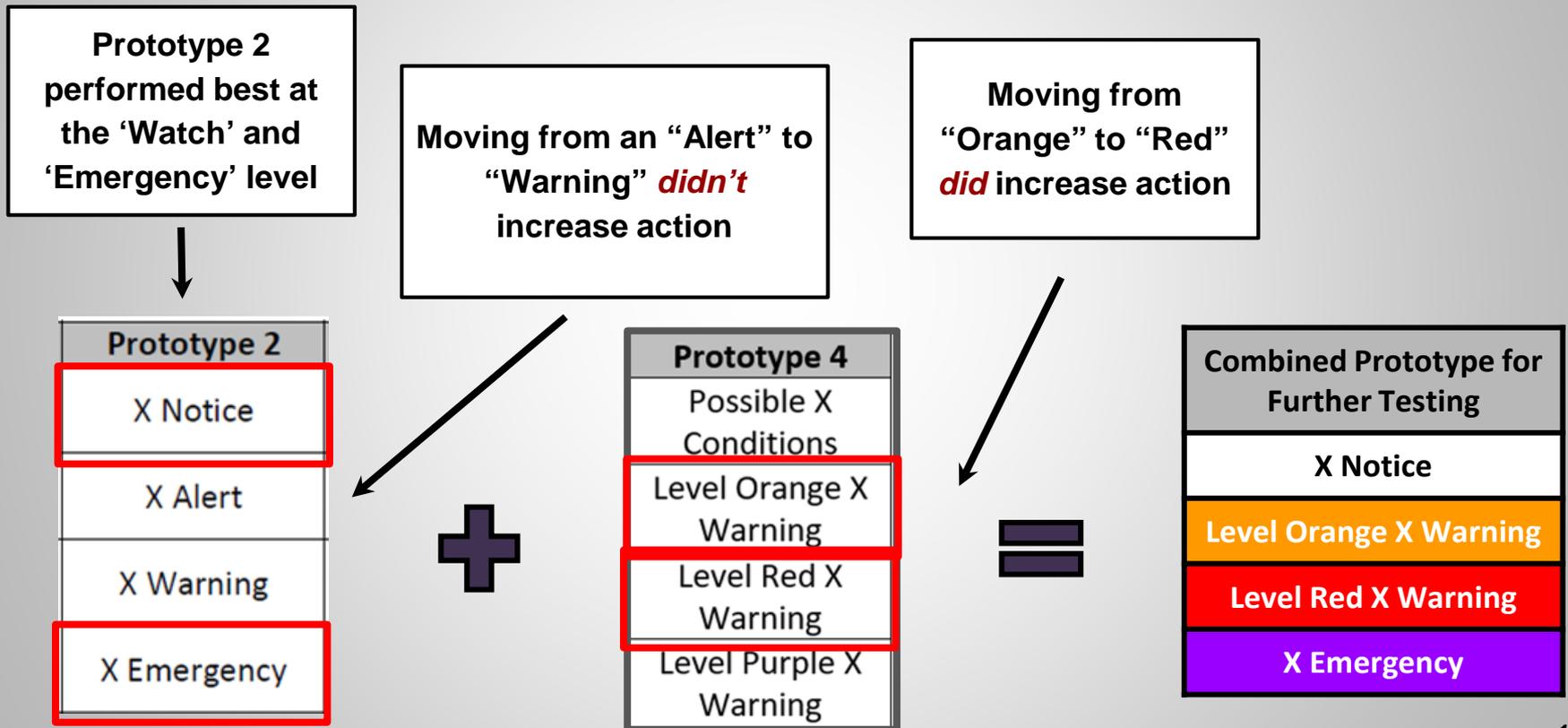
Hierarchical Adjectives



Hierarchical Color

Generalizable Public Surveys

Key Finding #2: Results of Prototype Testing



Recommended Option for Initial Testing

The Hazard Is Either “Possible” Or “It’s Happening!”

Possible

“Notice”
(replaces “Watch”)

Happening

“Orange Warning”
(replaces “Advisory”)

“Red Warning”
(for today’s “Warning”)

“Emergency”
(Rare, high impact situations)

Possible Applications to Winter (Variation on Combined Prototype)

Winter Weather Notice
Orange Warning: Winter Weather
Red Warning: Winter Weather
Red Warning: Blizzard Conditions
Red Warning: Ice Storm
Winter Weather Emergency (Applied for high impact events)

Colors & Terms: Federal and Int'l Landscape Opportunities For Alignment?

USGS: Volcano

Normal
Advisory
Watch
Warning

USGS: Earthquake

Not Felt
Weak
Moderate
Very Strong
Violent

NPS: Fire

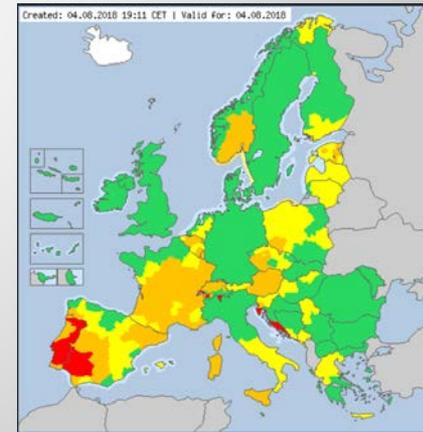
Low
Moderate
High
Very High
Extreme

EPA: AQ Index

Good
Moderate
Unhealthy (sens.)
Unhealthy
Very Unhealthy
Hazardous

CDC: Health

Info Service
Health Update
Health Advisory
Health Alert



Major Project Elements & Associated Challenges

OPTIONS FOR LARGE SCALE CHANGE

Stakeholder Engagement on proposed WWA alternatives

Pre-Testbed Workshop

Testbed and Non-Operational Demonstrations

Operations Proving Ground

Phased Roll Out

IMPROVEMENTS TO CURRENT SYSTEM

Continued consolidation to a set of "primary hazards"

Continued reformatting of product text to simple, clear language

Concurrently

CHALLENGES

- Culture change
- Operational policy details (e.g., multiple hazards)
- Technical issues (e.g., software and alerting)
- Public/Partner education and adjustment
- International considerations
- Institutionalization

Collaboration Request of Federal Leadership

- **The federal sector is a key WWA system stakeholder. We need to learn more about:**



- The level of WWA “institutionalization” within your agency
- How changes to WWA would impact your operations
- How the preferred prototype could be adjusted to better meet your needs

Our Request: Please advise us of opportunities to engage your experts to socialize the prototype and collect feedback. This will help drive project direction!



Thank you! Any Questions?

Elliott.Jacks@noaa.gov

<https://www.weather.gov/hazardsimplification/>



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Purpose-Built HPC: Last Hope for Earth System Prediction?

Dave McCarren, Project Manager
National ESPC



Earth System Prediction Computing Needs

- Predict hazards at short time ranges *and* enable decision making in weather-to-climate overlap
 - Weather predictions:
 - Strict time requirements (1 model day \leq 8 min wall time)
 - Seasonal through decadal predictions:
 - Short run times for evaluation, development, reforecasting
- Future computing needs will exceed 1000 times of today's existing computing and possibly require custom built hardware & software
 - Need accurate forecasting of local floods at catchment level and to resolve hurricane structure/rainbands.
 - Significant investment will be needed to port our models to exascale systems.
- White paper

Earth System Prediction in the Exascale Era

- Improved prediction accuracy tied to HPC
 - More science (multiscale physics, ocean, chemistry)
 - Further system coupling
 - More ensemble members
 - Higher resolution – toward 1-km resolution
- Earth System Prediction Capability (ESPC) HPC working group formed to discuss the computing challenges now and in the future
 - NOAA, NASA, NCAR, Navy, DoE, DoD
 - Monthly meetings since 2016
 - Developed position paper



Carman, et al. "Position Paper on High Performance Computing Needs in Earth System Prediction." National Earth System Prediction Capability (ESPC) program. April 2017.
<https://doi.org/10.7289/V5862DH3>

Earth System Modeling Requirements

- **“HPC architectures are developing in the wrong direction for state-heavy, low computational intensity (CI) Earth system applications.” - ESPC HPC White Paper**

- Top500 (June 2018, <https://www.top500.org>):

Rank	System	Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
1	Summit - IBM Power System AC922, IBM POWER9 22C 3.07GHz DOE/SC/Oak Ridge National Laboratory United States	2,282,544	122,300.0	187,659.3	8,806
				<i>Developed for 9 flop/byte application</i>	
2	Sunway TaihuLight - Sunway SW26010 260C 1.45GHz, NCRCP National Supercomputing Center in Wuxi China	10,649,600	93,014.6	125,435.9	15,371
				<i>Developed for 25 flop/byte application</i>	
3	Sierra - IBM Power System S922LC, IBM POWER9 22C 3.1GHz DOE/NNSA/Lawrence Livermore National Laboratory United States	1,572,480	71,610.0	119,193.6	--
				<i>Developed for 9 flop/byte application</i>	

- Exascale systems will require applications providing upwards of **50 flops/byte** [Goodacre, J., Manchester U., ECMWF Oct. 2016]

- Most computationally intense components in **today’s Earth system models rarely reach two operations per byte and typically run less than one operation per byte** over the full application. (Carman et al. 2017)

Earth System Prediction Computing: Technical Challenges

- Models do not scale up efficiently:
 - Performance wall: workload grows as 4th power of resolution, resources grow as 2nd power of resolution
 - fluid flow calculations are parallel in 3 spatial dimensions, limited by data bandwidth to memory, other supercomputer components
 - physical parameterizations are parallel in 2 spatial dimensions (parallelism in vertical is limited due to extremely fast physical coupling)
- Even those that do scale only use 6% of current CPU processor, and 1-2% of GPU processors
- Key: exploit parallelism, computational intensity

We ask for support for: Interagency Study on Purpose-Built HPC

- The National ESPC HPC working group advocates for an interagency study investigating:
 - the **widening gap between earth system application requirements and currently evolving HPC**
 - a hypothetical supercomputer designed with the singular purpose of running **exascale earth system prediction models**
- This study will:
 - help identify the current needs of earth system prediction models
 - determine whether or not a purpose-built earth system prediction computer is feasible, from several perspectives, including cost and efficiency
- Proposed Birds of Feather session at SuperComputing 2018 to discuss this study with the broader community

Study Objectives

- Performance measurement and modeling to systematically collect and characterize detailed, quantitative requirements from the earth system modeling community;
- Corresponding detailed measurement and characterization of current and roadmap technologies for processor, memory system and network technologies;
- Gap analysis to determine if custom design or manufacture of components would be cost-effective for a system focused on PDE solution, including the level of customization and spanning the processor, interconnect, memory, and other essential parts of a computing system;
- Determine if a PDE-solving supercomputing platform would benefit from specific (and custom) software such as compilers, libraries, programming models or domain-specific languages;
- Estimation of a rough order of magnitude of investment needed for such a custom-built supercomputer

Priority: Share results with vendors

What is Required for an Interagency Study?

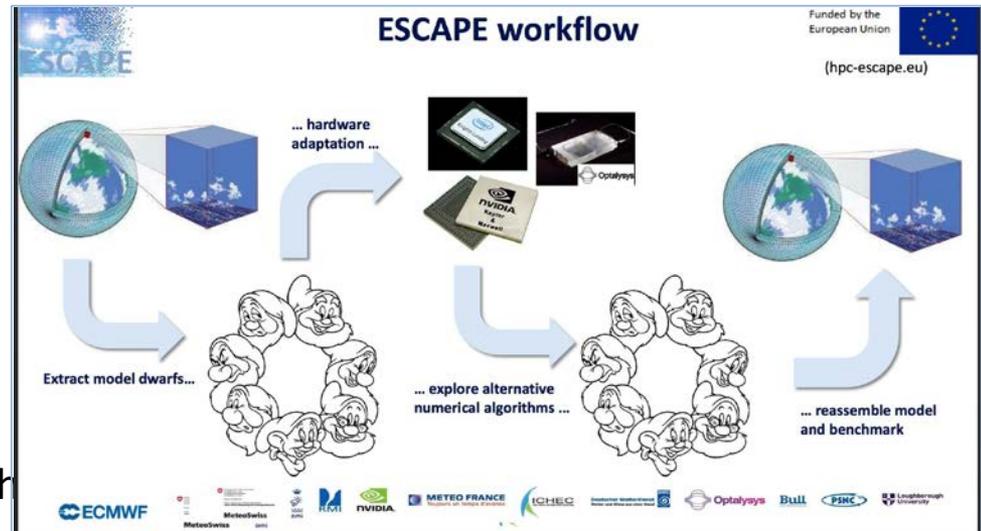
- Planning and coordination across the involved agencies
 - Identify common objectives
 - Promote cross-agency visibility for understanding the current state of HPC platforms for earth system prediction
 - Involve HPC hardware & software experts
- Identify deliverables and estimate costs
- Agree to funding commitments
- Options for Agency funded study:
 - Agency PMs fund
 - NOPP study - invited hardware vendors and/or HPC research firms
 - NRC study - funded by ESPC agencies

Backup material

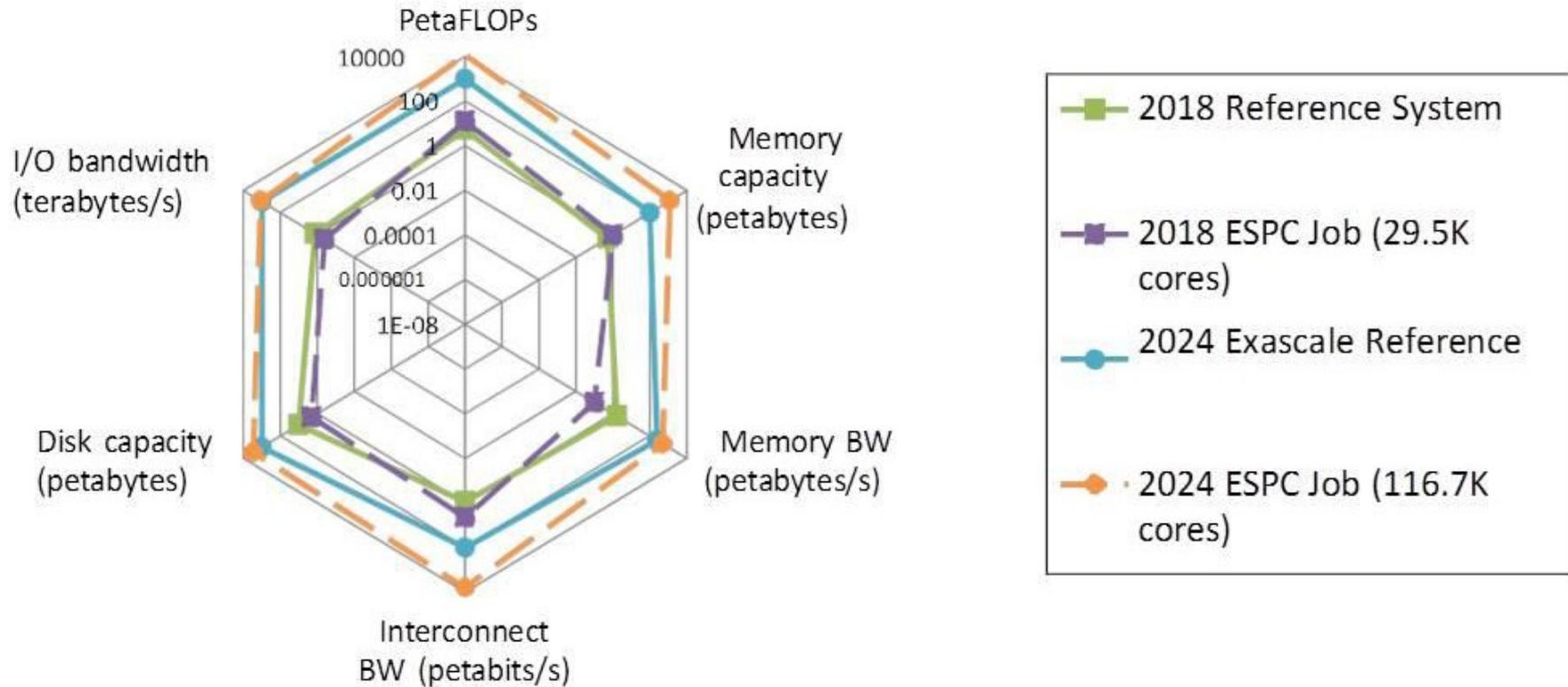


International Efforts Targeting Exascale

- Weather, climate models
 - MPAS (NCAR - IBM), Neptune (Navy)
 - COSMO (CSCS), ICON (DWD)
 - IFS (ECMWF)
 - NICAM (JMA), ASUCA (TokyoTech)
- Exascale focused efforts
 - LFRiC (UK-Met), FVM (ECMWF)
 - Energy-efficient and Scalable Algorithms (ESCAPE)
 - European flagship Program on Extreme Weather and Climate Computing (EPECC)
 - ESIWACE, NextGenIO

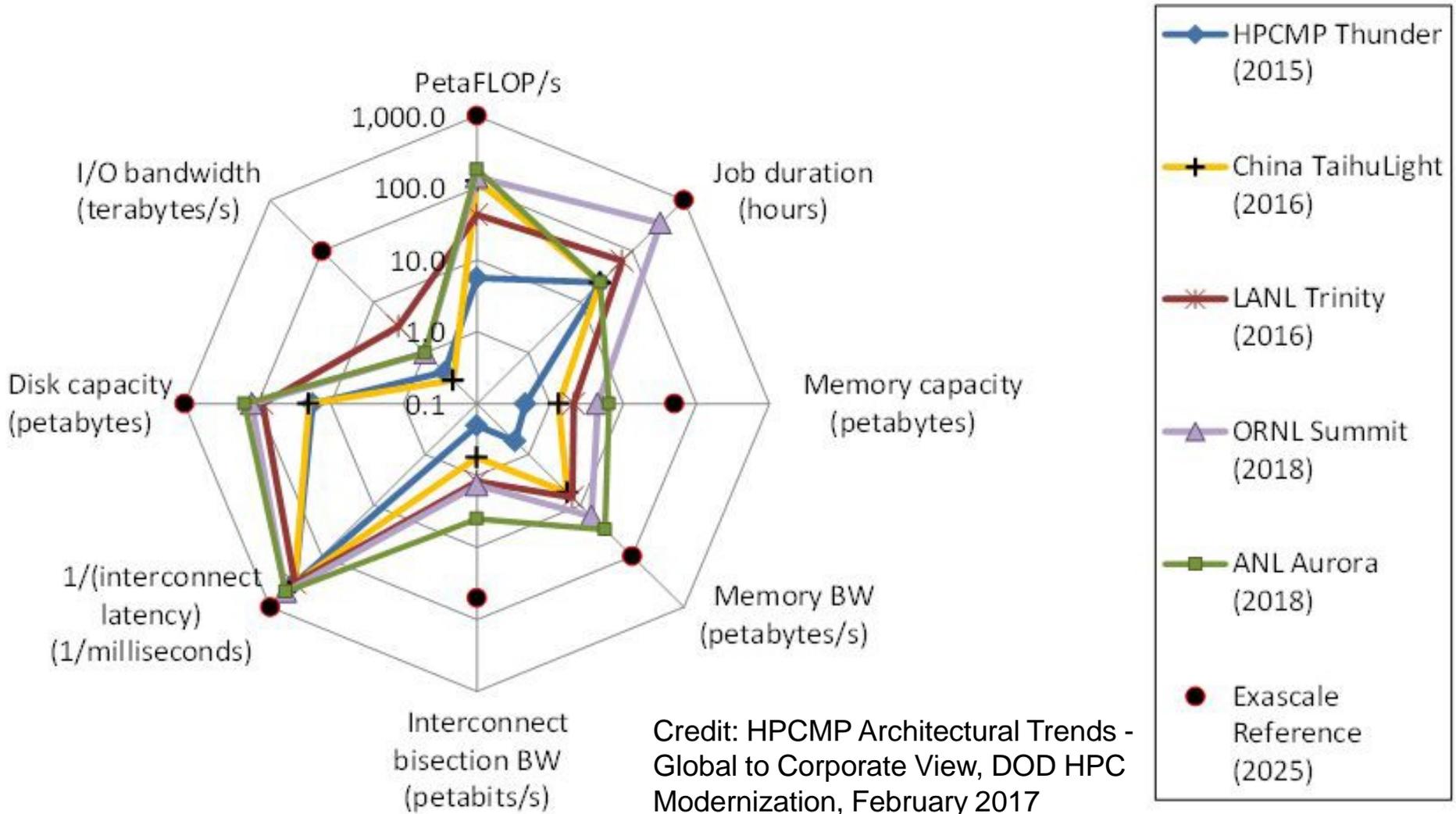


HPC Requirements for Earth System Modeling



Internal report: *The Future of DoD Climate, Weather and Ocean High Performance Computing Requirements*, 15 Aug 2016, Figure 24

HPC Outlook



Credit: HPCMP Architectural Trends - Global to Corporate View, DOD HPC Modernization, February 2017

HPC in the Exascale Era

- Exascale capability anticipated by ~2024
- HPC is not getting faster - end of Moore's Law (?)
 - Systems increasing beyond 10M cores (2024)
 - Inter-process communications, I/O are bottlenecks
 - Increasingly diverse processors
 - Fat nodes, thin nodes
 - Multi-level memory
 - Lightweight to heavyweight cores
- HPC development is being driven by market forces
 - Machine learning
 - Graphics processing

2018 Processors

Intel SkyLake - SP
48 cores

ARM

IBM POWER

AMD GPU

NVIDIA Volta GPU
5120 cores

Google TPU:
65,000 MXU



National Strategic Computing Initiative (NSCI)

Lead agencies

Department of Energy

Department of Defense

National Science Foundation

Foundational R&D agencies

Intelligence Advanced Research Projects Activity

National Institute of Standards and Technology

Deployment agencies

National Aeronautics and Space Administration

Federal Bureau of Investigation

National Institutes of Health

Department of Homeland Security

National Oceanic and Atmospheric Administration

Goals

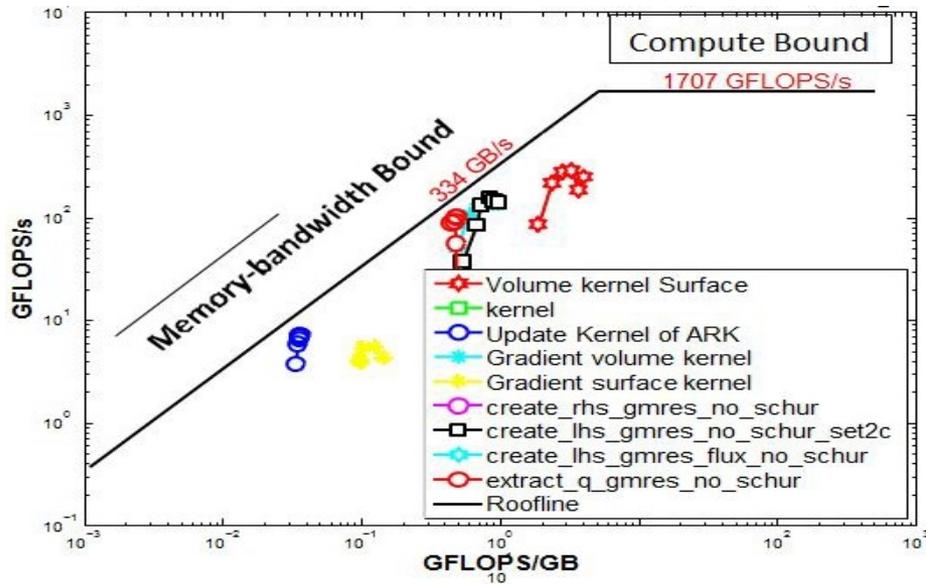
- Unite traditional HPC physical simulation focus with “big data”
- Preserve US HPC leadership by supporting users, vendors, developers, researchers
- Improve software interoperability between computers/architectures
- Provide widespread access to/training for HPC resources, to public and private sectors
- Develop post-silicon technologies for alternative computing

Technical Challenges

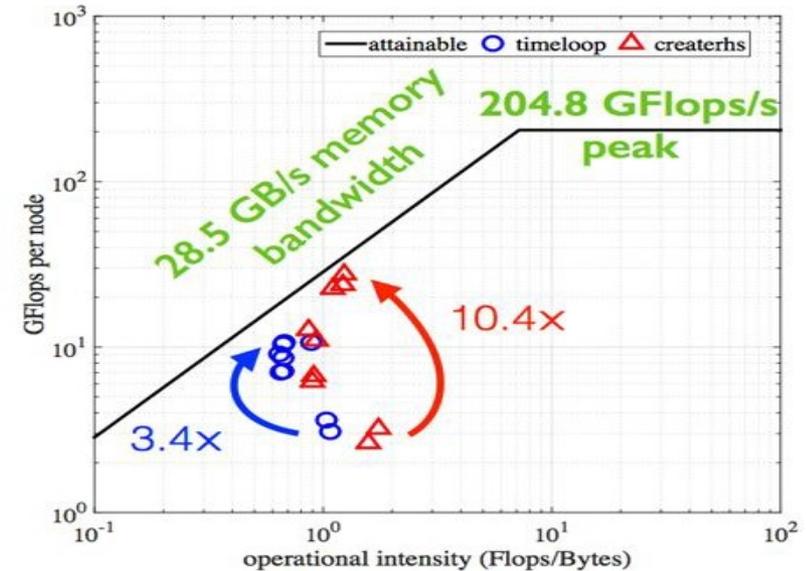
- What architecture will exascale computers have?
- What architecture should they have, for us to run efficiently and inform decisions across time scales?
- Near term pre-exascale HPC will be hybrid machines utilizing CPU + Accelerator.
- Running high performance codes at exascale requires recoding for each specific architecture types.
- Common technologies at the operational centers will simplify software compatibility.

Memory vs. Compute Bound

- Current models are memory-bandwidth bound.
- Here we show roofline plots for the NUMA model on Titan (Nvidia K20 GPUs) on the left and on one node of Mira (IBM BG/Q) on the right.
- The sloped line shows the peak memory-bandwidth of the hardware and the flat line shows the peak computational performance. Note that all the different parts of the code are near the memory-bandwidth line (we are at the mercy of the communication speed of the hardware because we are moving way too much data). We desperately need to get around this barrier.



* Results from recent publication by Abdi et al. (2016)



* Results from recent publication by Mueller et al (2016).

Possible Solutions to Future HPC Challenges

- Two Approaches
 - Hardware-optimized: Different compute-kernels for each computer.
 - e.g., CUDA/OpenCL or OpenACC for GPUs and Intel Cilk or OpenMP for Xeon Phi
 - Hardware-agnostic: Write compute-kernels in one language, then write translators for each platform.
 - This is the idea behind OCCA* (Virginia Tech), Kokkos* (Sandia National Laboratory), Stella* (ETH), PSyclone (UK Met Office), and OpenACC*(NOAA) hardware-agnostic languages.
- Main Metrics
 - Time-to-solution (wallclock time)
 - Percentage of computer required
- A common modeling or computing technology would simplify this effort, but may not be possible.

*OCCA: <http://libocca.org/> *Kokkos: <https://github.com/kokkos>

White paper by ESPC HPC Working Group:

Carman, et al. “Position Paper on High Performance Computing Needs in Earth System Prediction.” National Earth System Prediction Capability (ESPC) program. April 2017.
<https://doi.org/10.7289/V5862DH3>

“In contrast, ... today’s Earth system models typically run less than one operation per byte over the full application.”

“... average less than 2% of peak performance, constrained by their ability to perform sufficient calculations for each expensive access to memory.”

NEPTUNE: 0.4 flop/byte; < 2 percent D.P. peak fp; KNL

NUMA: 0.7 flop/byte (6 percent D.P. peak fp; Blue Gene Q)

WRF: ~2 percent S.P. peak fp; KNL (C.I. not available)

White paper by ESPC HPC Working Group:

Carman, et al. "Position Paper on High Performance Computing Needs in Earth System Prediction." National Earth System Prediction Capability (ESPC) program. April 2017.
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Programming challenges:

"Each processor design and system architecture requires specific coding structures optimized for that machine, forcing complete model redesign and rewriting for each subsequent and disparate hardware type."

"Architecture-agnostic programming could offer a possible solution to portability but may present a challenge to achieving performance across vastly different hardware."

FCMSSR Action Items

AI #	Office	Text	Comment	Status	Due Date
2018-1.1	OFCM	Send email to OSTP recommending Option A: Rename the FCMSSR as ICAWS and make other changes in order to comply with the 2017 Weather Act. Request a written response from OSTP.	5/2/18: Email has been sent. Awaiting Reply	Closed	05/04/18
2018-1.2	USAF A3W, OFCM, FCMSSR Chair	USAF A3W adjusts their 1340-series qualifications proposal letter as advised by FCMSSR and sends it to OFCM. OFCM drafts a cover letter for FCMSSR Chair endorsement and forwards the proposal to OPM	5/22/18: A3W Letter amended. Cover letter sent to NOAA for signature 7/9/18: DOC sent Ltr to NOAA HR for clearance 8/3/18: Ltr at HQ NOAA	Open	05/11/18
2018-1.3	USAF A3W, NWS	Review and brief FCMSSR on the impact of 1340-series qualification changes approximately one year after OPM implements the change.		Open	10/31/19
2018-1.4	NOAA	Brief FCMMSR on the NOAA Next Generation Global prediction Strategy as a possible framework for broader enterprise implementaion		Open	10/31/18

ICMSSR Action Item Review

AI #	Office	Text	Comment	Status	Due Date
2016-4.2	OFCM	Provide a copy of the Terms of Reference for the new Committee on Climate Services (CCS) for ICMSSR review.	11/22/17: Latest copy received. Awaiting CCS Chair to concur	Open	02/10/17
2017-4.2	NWS, ICMSSR	NOAA NWS will send a draft of their Section 201 response to ICMSSR members. ICMSSR members will provide recommendations or edits back to NOAA by 15 May 2018.	Response submitted	Closed	03/31/18
2018-1.5	OFCM, OSTP	Upon FCMSSR approval of the Section 402 implementation plan, submit the recommend plan to Director, OSTP and work with OSTP to submit a legislation change request to identify the Federal Coordinator as the ICAWS Executive Secretary rather than a Co-chair.	At OSTP for decision	Open	05/30/18

ICMSSR Action Item Review

AI #	Office	Text	Comment	Status	Due Date
2018-2.1	OFCM	Draft a new objective for the FWE Strategic Plan addressing the need for coordinated Research-to-Operation; Operations-to-Research activities. Request FCMSSR approval to add the new objective as a change to the current Strategic Plan.		Open	10/31/18
2018-2.2	OFCM, USAF	Convene an exploratory meeting to determine a framework (participants, subjects for considerations, timeline, etc.) for an interagency group to deliberate the need for policy or direction on the availability of potentially sensitive operational weather information.	A3W held meeting, collecting feedback and recommendations	Open	08/01/18
2018-2.3	OFCM	Convene an exploratory meeting to develop an approach for compiling the description of activities and requirements called for in Section 109 of the Weather Act of 2017.	w/IWRCC	Open	07/15/18

Wrap Up

