The National Unified Operational Prediction Capability (NUOPC) is a joint effort between NOAA and DoD to improve collaboration and accelerate operational numerical weather prediction. The Earth System Prediction Capability (ESPC) expands this collaboration to prediction of the physical earth system, expands required predictive capability to the decadal scale, and expands collaboration to include DOC, DoD, DOE and NASA. Both efforts seek to create partnerships, standardize numerical prediction practices in order to accelerate model development and achieve developmental and operational efficiencies for the next generation of systems. Coordination among the agencies will impact broad areas of environmental research and development and end users through standardized model architecture, establishment of common research requirements, and improved capability. This presentation will review the mission needs of the agencies in the various time scales discuss the overall programs, progress to date, areas of focused funding, and future plans.
NUMERICAL WEATHER PREDICTION AND EARTH SYSTEM PREDICTION TO
BETTER UNDERSTAND SEA LEVEL RISE/COASTAL ISSUES AS THEY
AFFECT READINESS

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Vision

The Future US National Global Prediction System
Managed in the national interest meeting the national need for better forecast guidance and built on:
- partnering of responsible Federal agencies
- common modeling framework linking operations, research and the Federal partners
- common R&D agenda guiding future development.

Example of probabilistic hurricane track forecast based on ensembles and depicting forecast uncertainty
Growing National Need

- National Security and Defense
- Natural Disaster Preparedness
- Energy and Transportation
- Food Security
- Quantify climate change risks

*U.S. must lead the way forward*
Approach

- AF, Navy, and NOAA partnership to address common operational global NWP needs/requirements
- Managed multi-model ensemble system
- Accelerate transition of new technology to operations
- Common modeling architecture for interoperability
- National Research and Development Agenda
Challenges

- Creating a common modeling infrastructure
- Fostering a collaborative research environment
- Improving R2O and O2R
- Resources: computing, investment
Benefits

**Improved capabilities to support agency missions measured by:**

- Effective disaster prediction, preparation, response and mitigation
- More effective global military operations
- Less weather delay and disruption for air transportation
- Energy saved
- Improved efficiencies throughout the Nation’s economy
- National response to changing climate
- Lives saved
- Dollars saved
Where We Are

• Well Established Tri-Agency Partnership
• Initial Operational Capability of National Unified Ensemble in January 2011
• Software architecture and interoperability standards part of latest release of the Earth System Modeling Framework.
• National R&D agenda for advancing global NWP presented to the American Meteorological Society Annual Meeting and to the Federal research funding agencies.
National Unified Ensemble

• IOC-1 January 2011
  3 models @ 1 degree output grid
  63 member ensemble
  Common output format
  Same forecast times
  73 common variables

• New products to support mission needs

• Tri-agency management committee to coordinate operations and plans
Common Model Architecture

- NUOPC Layer part of the Earth System Modeling Framework (ESMF)
- Agreed to interoperability standards implemented
- New areas being explored and standards developed
- Standards being implemented in many different modeling systems.
Operational Modeling Systems Implementing ESMF

- Global Forecast System (GFS)
- Global Ensemble Forecast System (GEFS)
- North American Mesoscale Model (NMM)
- Finite Element Icosahedral Model (FIM)
- NOAA Environmental Modeling System (NEMS)
- Global Assimilation of Ionospheric Measurements (HAF-GAIM)
- Weather Research and Forecasting Model (WRF)
- Land Information System (LIS)

- Naval Operational Global Atmospheric Prediction System (NOGAPS)
- Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS)
- Navy Coastal Ocean Model (NCOM)
- Hybrid Coordinate Ocean Model (HYCOM)
- Wave Watch 3 (WW3)
- Community Ice Code (CICE)
- Ensemble Forecast System (EFS)
- Simulating Waves Near Shore (SWAN)
- Advanced Circulation Model (ADCIRC)
National R&D Agenda

• Developed at Workshop fall 2010
• Published to community
• Workshop held for 1st focus area
  • User Products
• New initiatives underway supporting needs at Navy, NSF and NOAA
Future

Next Generation Prediction Capability

- New modeling techniques to improve predictive skill
- Exploit interoperability architecture for a fully coupled system: land, ocean, ice, wave, atmosphere, space, ecosystem.
- Exploit emerging computing capabilities
- Improved inter-annual to decadal predictions

Earth System Prediction Capability (ESPC)
Climate Change Impacts on DoD

• Risks to regional stability
  • Drought
  • Storms
  • Arctic
  • Sea Level
  • Perma frost

• Military preparedness
  – Equipment
  – Facilities
  – Training
Immediate Recognition for Where to Focus Resources

Weather Impact Distribution (example of a typical Air Force Base)
(Based on Capt Jeffrey C. Jarry, Analysis of Air Mobility Command Weather Missions Execution Forecasts: Metrics of Forecast Performance and Impacts on War Fighting Operations, thesis prepared for the Naval Postgraduate School, Monterey, CA, Apr 2005.)
Benefits: Air Space Management

- The total cost of domestic air traffic delays to the U.S. economy was as much as $41 billion for 2007."

- Weather accounts for 70% of all air traffic delays within the U.S. National Airspace System (NAS)

- The Federal Aviation Administration (FAA) has determined two thirds of this is preventable with better weather information

- "A key finding, based on an analysis of several 2005-2006 convective events, is that as much as two-thirds of the weather related delay is potentially avoidable."

- $19 Billion in Avoidable Costs
Benefits: Improved Water Management

- Hydropower – $100M with improved forecasts
- Improved River Commerce – $200M efficiency gain
- Agriculture – $300M with better balance between irrigation, regional water supply and fisheries
- Flooding Damage Reduction – $400M

Annual Benefits exceeds $1B
National Hurricane Forecast System

Goals

Track forecasting today

Track forecasting after HFIP Improvements

50% reduced forecast errors

- 50% improvements to hurricane track and intensity forecasts out to 7 days
- Reduce cone of uncertainty
Cost to the Nation for False Warnings

**Inaccurate Track Forecast Costs**
- Hurricane Charlie – 2004
- Hurricane Floyd – 1999
  Forced major evacuations of areas not affected by the storm
  **Charlie Unnecessary Cost:** $380M

**Inaccurate Intensity Forecasts Costs**
- Wilma – 2005
- Lili – 2002
  Neither Wilma’s explosive intensification, nor Lili’s rapid weakening just before landfall was forecast. Sub-optimal skill with rapid intensification changes lead to improper warnings, with significant economic consequences
  **Lili’s Unnecessary Cost:** $225M

**Plus—loss of work and inconvenience… will they leave next time?**
Cancelled Sorties during OIF Dust Storm

(Based on LCDR Jake Hinz, Tom Murphree, LCDR Brett Martin, LCDR Alex Cantu, and Carlyle Wash, Systems for analyzing METOC impacts on military operations, Briefing, Dept. of Meteorology, Naval Postgraduate School, 2004, slides 1-15; and, Prof Carlyle Wash, Meteorological requirements and contribution to ‘sea strike’, *Naval Postgraduate School Research*, Vol 14, No. 1, Feb 2004, pp 2-4.)
QUESTIONS??
Backup Material
NUOPC Implementation Schedule


Prelim Phase I  IOC-1 Implementation Phase II  IOC-2 Beta Test Phase III  FOC

INTEROPERABILITY
INIT.STANDARDS  ADOPT INTEROPERABILITY STANDARDS  DEVELOP FUTURE MODEL ARCHITECTURE

OPERATIONS
CONOPS, BUDGET  EXCHANGE NAEFS DATA AND  ENSEMBLE OPS, METRICS, COMM, IA, HPC  BIASED FIELDS, ARCHIVE, TRAINING TOOLBOX

TRANSITION
CONOPS, IMPLEMENTATION PLAN, BUDGET  VISITING SCIENTIST PROGRAM
RESEARCH TRANSITION FACILITY (RTF)

OUTREACH
AMS CONFERENCES  RESEARCH AGENDA
FELLOWSHIP PROGRAM

DECISION BRIEF TO PRINCIPALS