

FNMOC Command Brief IOOS Advisory Committee Meeting 27 JUN 2023

CAPT Mathias Roth
Commanding Officer

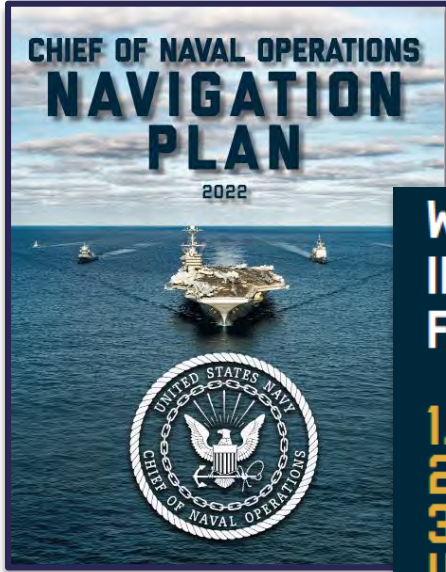


The overall classification of this brief is:

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U.S. Navy Context - CNO Navigation Plan 2.0



**WE WILL DELIVER COMBAT CREDIBILITY
IN CONTESTED SEAS THROUGH OUR
FORCE DESIGN IMPERATIVES:**

- 1. EXPAND DISTANCE**
- 2. LEVERAGE DECEPTION**
- 3. HARDEN DEFENSE**
- 4. INCREASE DISTRIBUTION**
- 5. ENSURE DELIVERY**
- 6. GENERATE DECISION ADVANTAGE**

*Integrated battlespace awareness is
foundational to sea control and the
delivery of credible naval combat power*

**“AMERICA HAS ALWAYS BEEN A MARITIME
NATION. THE SEAS ARE THE LIFEBLOOD OF
OUR ECONOMY, OUR NATIONAL SECURITY,
AND OUR WAY OF LIFE.”**

NAVIGATION PLAN PRIORITIES AND OBJECTIVES

READINESS

CAPABILITIES

CAPACITY

SAILORS

Maintenance

Terminal
Defense

Affordable
Force Structure

Ready
Relevant
Learning

End-to-End
Supply Chain

Counter-C5ISR

Inclusive and
Diverse Force

Manpower

Naval
Operational
Architecture

Unmanned
Systems

Education

Critical
Readiness
Infrastructure

Long-Range
Fires

Live Virtual
Constructive
Training

Requirements
Analysis

Contested
Logistics

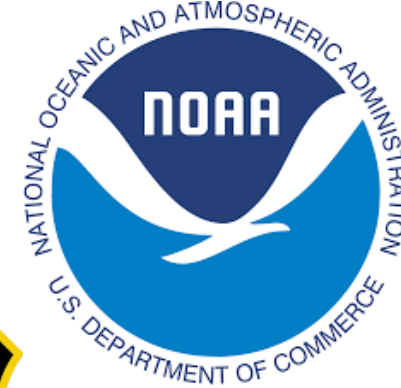
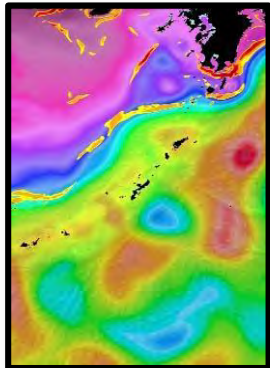
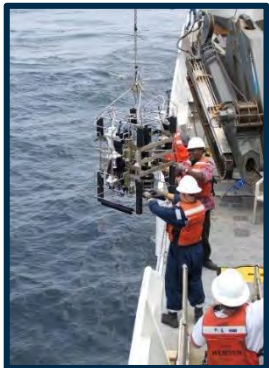
Artificial
Intelligence

Total Sailor
Fitness

https://media.defense.gov/2022/Jul/26/2003042389/-1/-1/1/NAVIGATION%20PLAN%202022_SIGNED.PDF



Naval Oceanography Organization and Partnerships





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Fleet Numerical Meteorology and Oceanography Center

Mission

Develop and provide assured global and regional numerical environmental prediction and applied decision-making services to enable fleet safety and warfighting effectiveness

Takeaways

*10 USC 8951: Safety and Effectiveness Information - The Secretary of the Navy shall maximize the safety and effectiveness of all maritime vessels, aircraft, and forces of the armed forces by means of a) marine data collection; b) **numerical weather and ocean prediction**; and c) forecasting of hazardous weather and ocean predictions.*

FNMOC is the Foundation for Fleet Safety

Across DoD operational forces, every forecast starts with FNMOC environmental prediction & production services

FNMOC enables combat effectiveness through physical battlespace awareness

Cybersecure assimilation, production and delivery enabling assured C2

Only center that models the Global and Regional Atmosphere to DoD cyber security standards

Provides climatological support to U.S., Joint, Intelligence Community, and USG



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Diverse team of highly-educated, technically proficient and warfighting-experienced Sailors, Civilians and Contractors

- Established in 1961
- Distributed Personnel and Computing
 - Monterey, CA / Stennis Space Center, MS
- 17 Officers
 - METOC, IP, Intel
 - 25% MS Degree
 - 90% Warfare qualified
- ~145 Civilian & 35 Contractors:
 - Predominantly Physical Science and Computer Science
 - 9% PhD, 30% MS Degree, 35% BS Degree

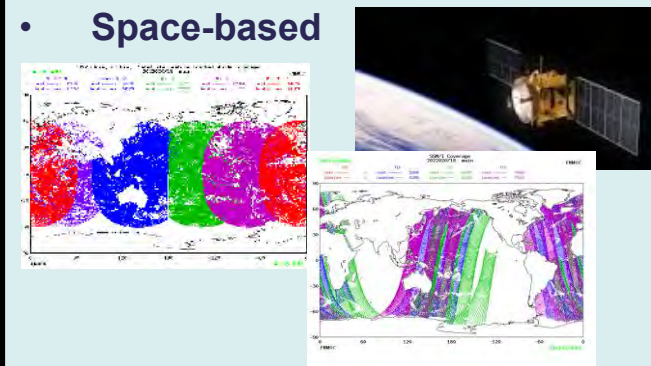




FNMOC Mission Flow

Observations → Supercomputer → Global Models → Regional Models

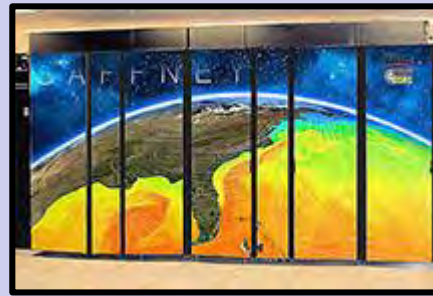
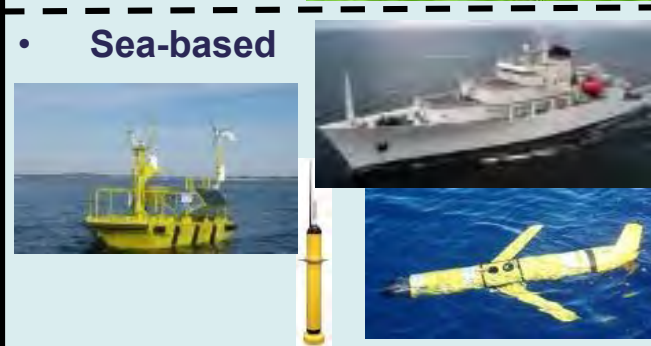
• Space-based



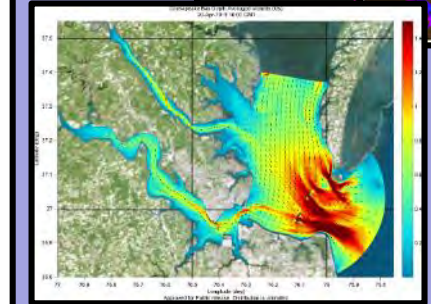
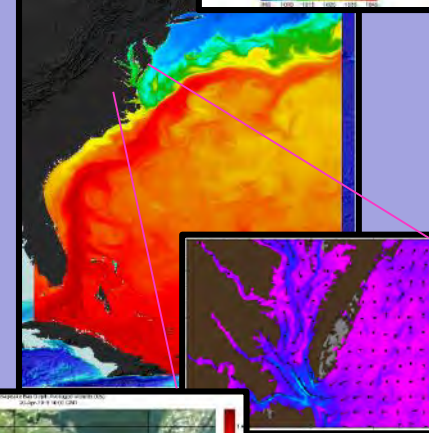
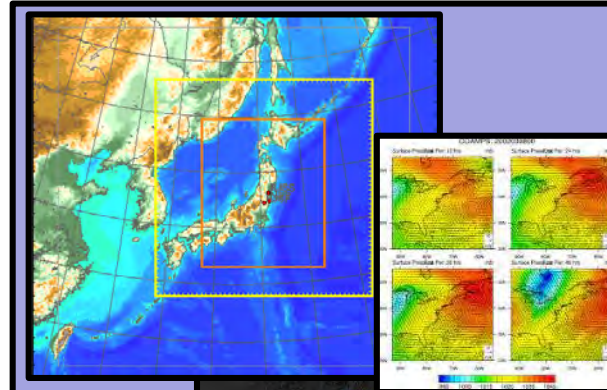
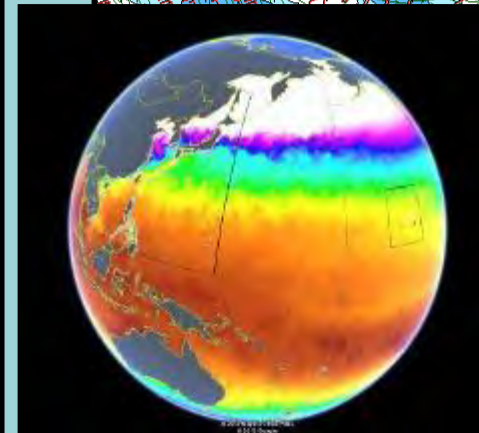
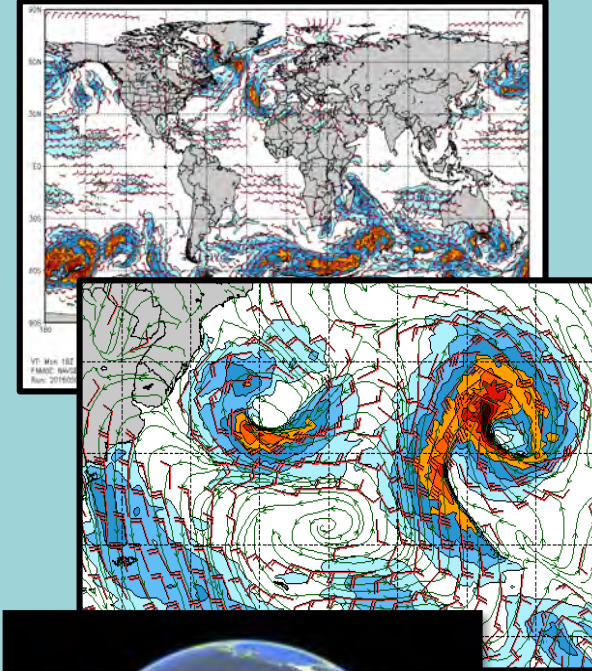
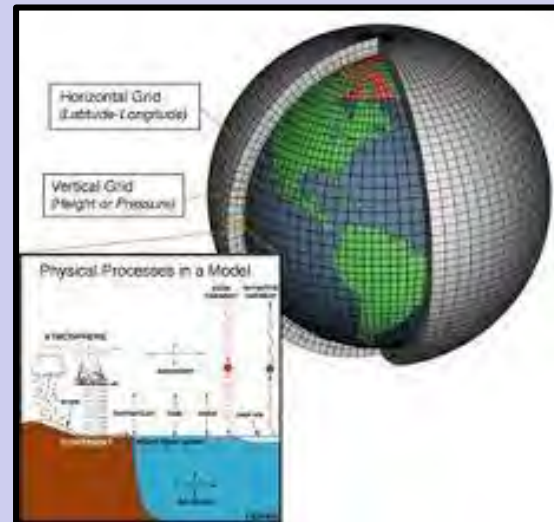
• Land/Air-based



• Sea-based



$$\frac{dT}{dt} = \frac{1}{c_p \rho} \frac{dp}{dt} + \frac{\dot{Q}}{c_p}$$

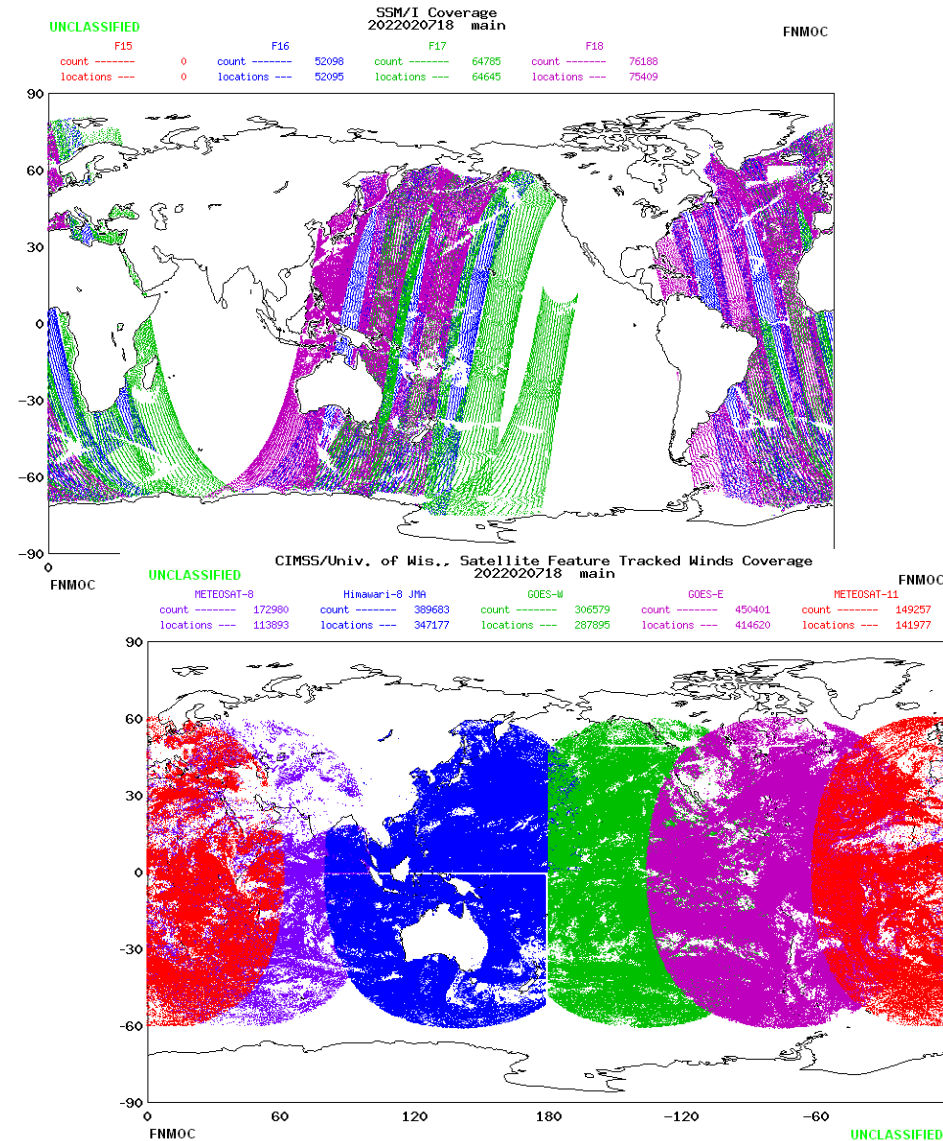
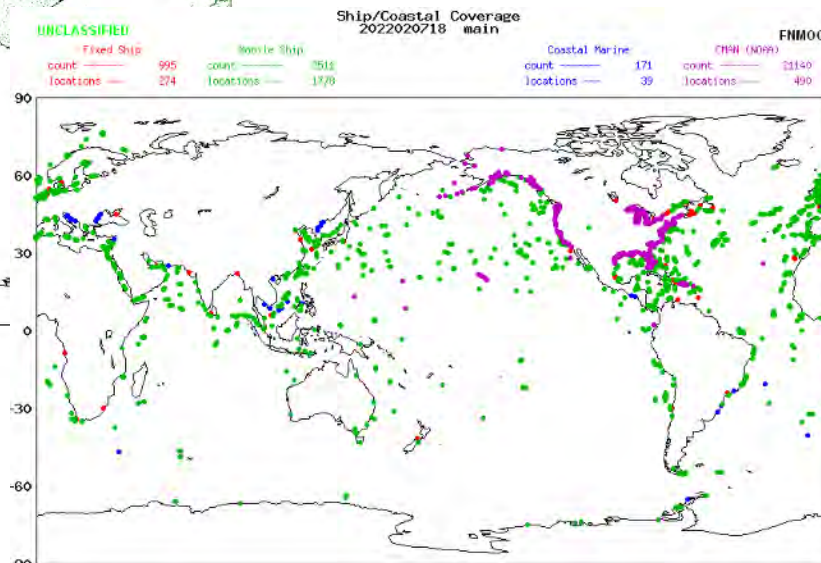
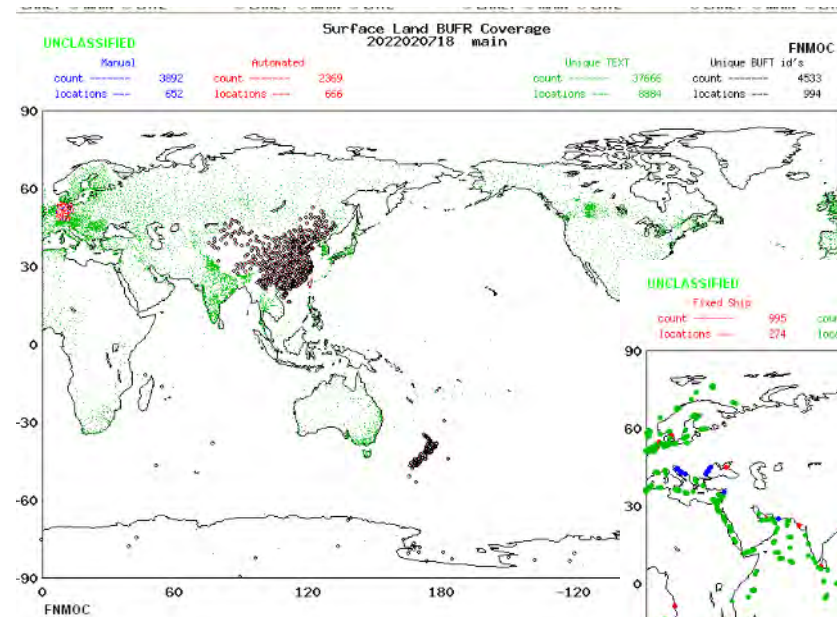




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Observational Data Processing

- Every 24 hours, we process/decode roughly
 - **4 billion** satellite observations from **2.5TB** of satellite data
 - **48 million** observations from **17GB** of received conventional data



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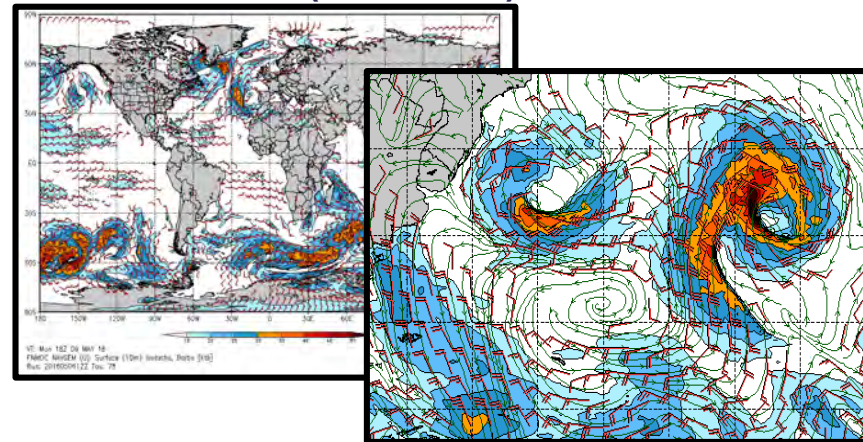


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Global Models

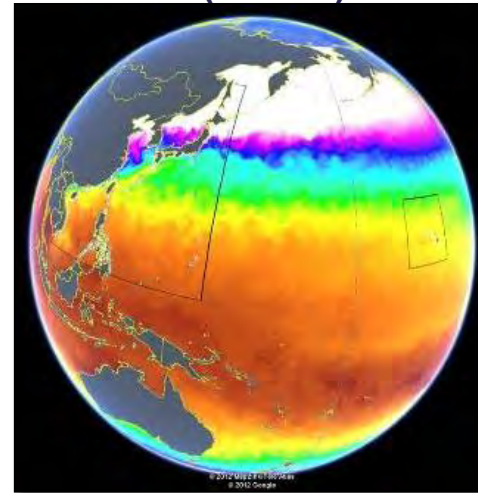
Atmosphere

Navy Global Environmental Model (NAVGEM)



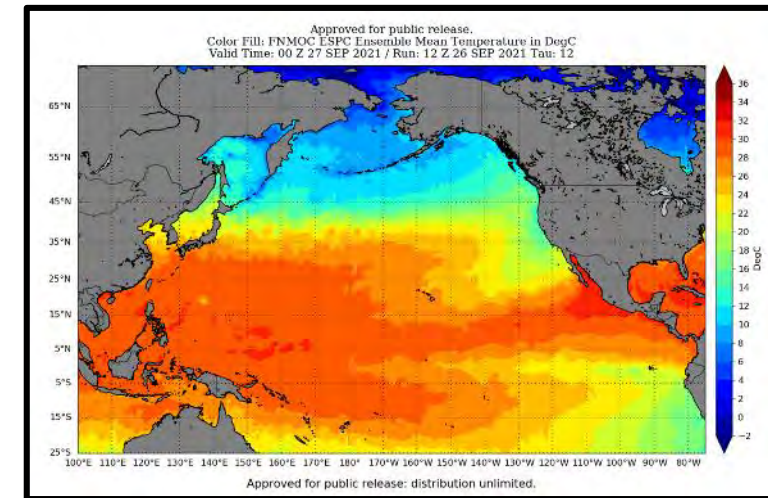
Ocean

Global Ocean Forecast System (GOFS)

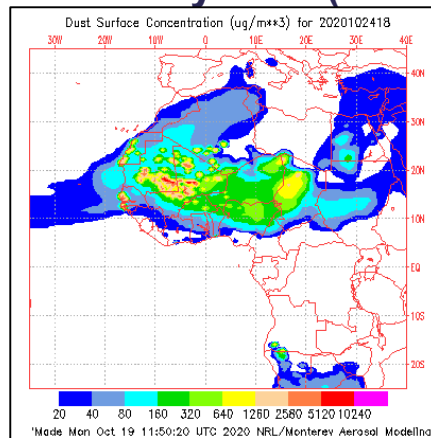


Coupled

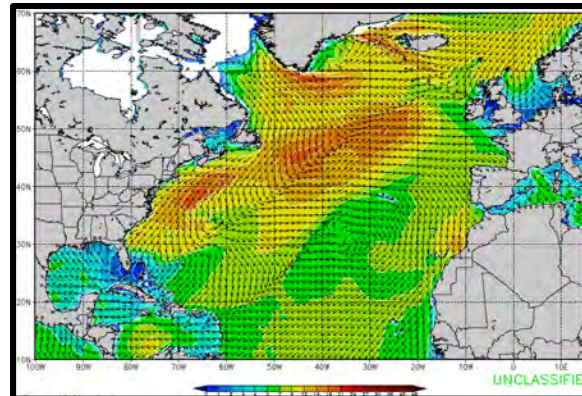
Earth System Prediction Capability (ESPC)



Navy Aerosol Analysis and Prediction System (NAAPS)



Wave Watch 3



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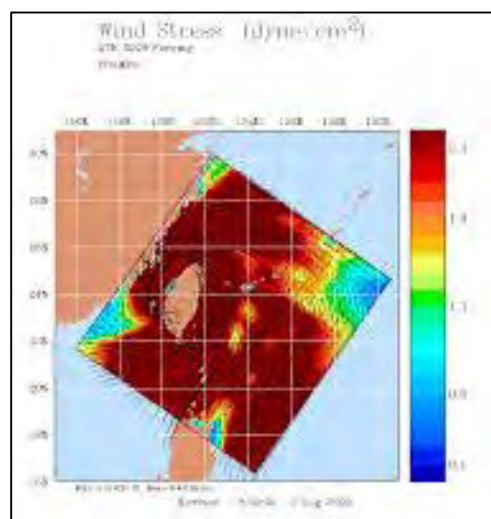
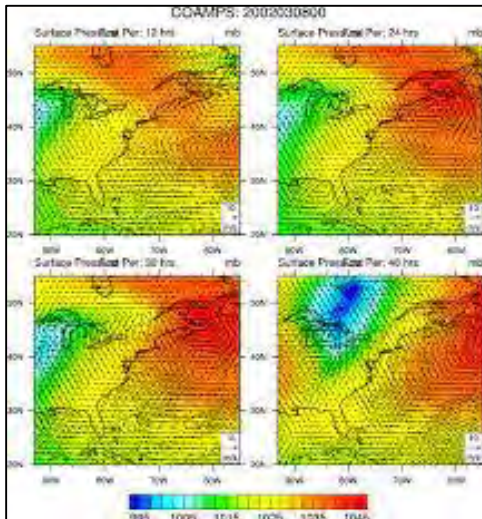
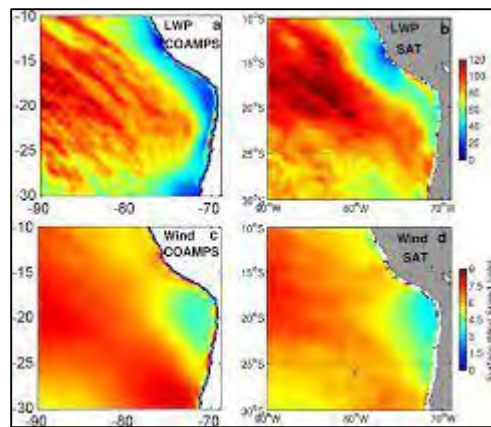
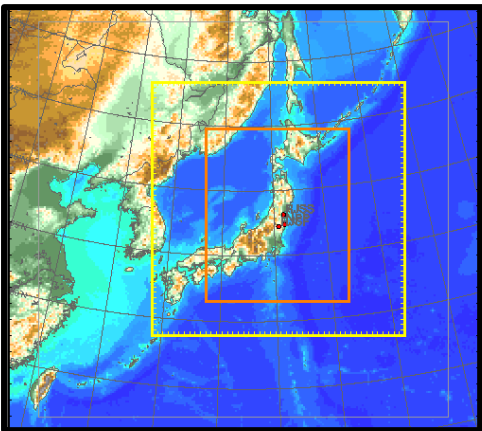
Approved for public release; distribution unlimited.



Regional Models

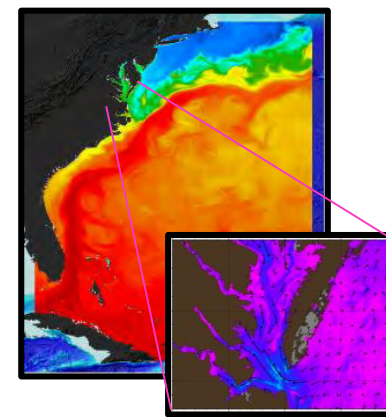
Atmosphere

Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS)

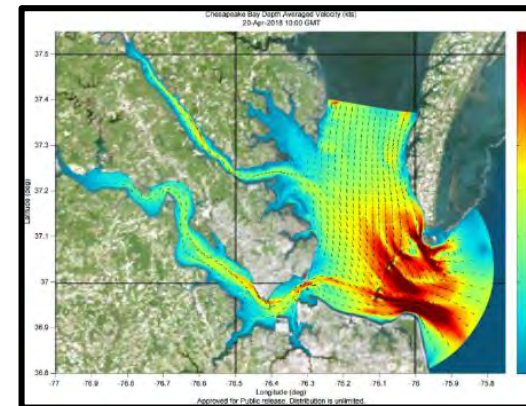


Ocean

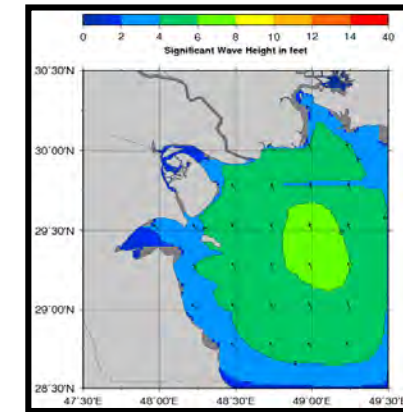
Navy Coastal Ocean Model (NCOM)



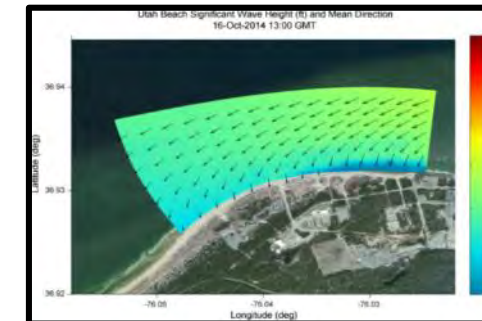
DELFT-3D



Simulating Waves Nearshore (SWAN)



Coastal Wave Height



Near-Shore Wave Height



Navy Earth System Prediction Capability (ESPC)

What is it?

- A fully coupled forecasting system using the Earth System Modeling Framework for two-way coupling of the atmosphere, ocean and sea ice.
- As a 'system' it runs its "own" version of NAVGEM, GOFS/HYCOM, and CICE
- Operationally, FNMOC runs ESPC as an ensemble model (Ver. 1) but plans to deploy a deterministic version soon

ESPC Ver. 2 – Deterministic; *Deploying Q4FY23*

- NAVGEM (2.1) – 19km horizontal, 143 levels in vertical & 4D- VAR data assimilation
- Upgraded HYCOM (2.2.99DHi) at 1/25° horiz. resolution, 41 vertical levels, 3D-VAR DA (8 tidal constituents)
- Upgraded CICE model (Ver. 6.1.4) at 1/12° resolution and 3D-VAR DA
- Global WWIII IRI (one-way coupled), 1/8° resolution
- Land surface from Land Surface Model (LSM)
- 16-day forecast generated 1x per day

ESPC Ver. 1 – Ensemble – Operational Now

- NAVGEM (1.4) at 37-km, 60 levels with 4D-VAR data assimilation
- HYCOM (2.2.99DHi) at 1/12° resolution, 41 levels with 3D-VAR data assimilation (no tides)
- CICE (4.0) at 1/12° resolution (2D-VAR DA)
- Land surface from Land Surface Model (LSM)
- 16 members, including 1 control, generated using perturbed observation method
- 45-day forecast generated once per week

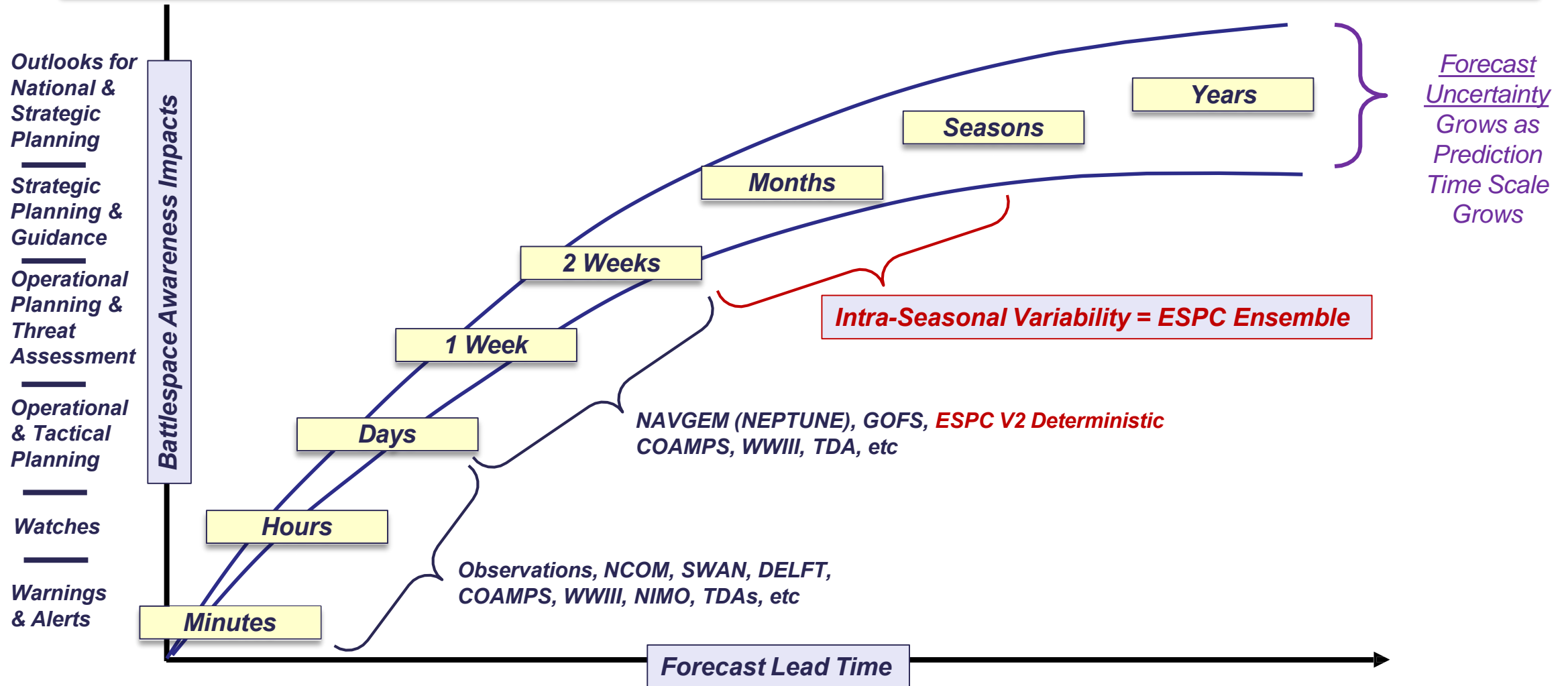
ESPC Ver. 2 – Ensemble; *Deploying ~Q4FY24*

- NAVGEM (2.1) at 19km, 143 levels with 4D-VAR data assimilation
- HYCOM (2.2.99DHi) at 1/12° resolution, 41 levels with 3D-VAR data assimilation
- Updated CICE (6.1.4) at 1/12° resolution (3D-VAR DA)
- Added Global WWIII IRI (one-way coupled), 1/8° resolution
- Land surface from Land Surface Model (LSM)
- 45-day forecast generated once per week



Advancing Prediction Across the Continuum of Conflict

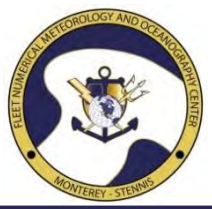
ESPC provides linking predictive capability from the Tactical and Operational Level, to the Strategic Planning Level
Partnerships with NOAA and others may allow us to link ESPC to global climate predictive capability





Common Challenges

- Budget stability
- Technical workforce
 - Recruitment, development, retention
- Big data
 - Storage, distribution, dissemination
- Information-based mission
 - Warfighting / blue economy
- Partnerships are key



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QUESTIONS AND DISCUSSION

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