Navy Research Participation in the U.S. National Earth System Prediction Capability (National ESPC) Partnership

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AMS
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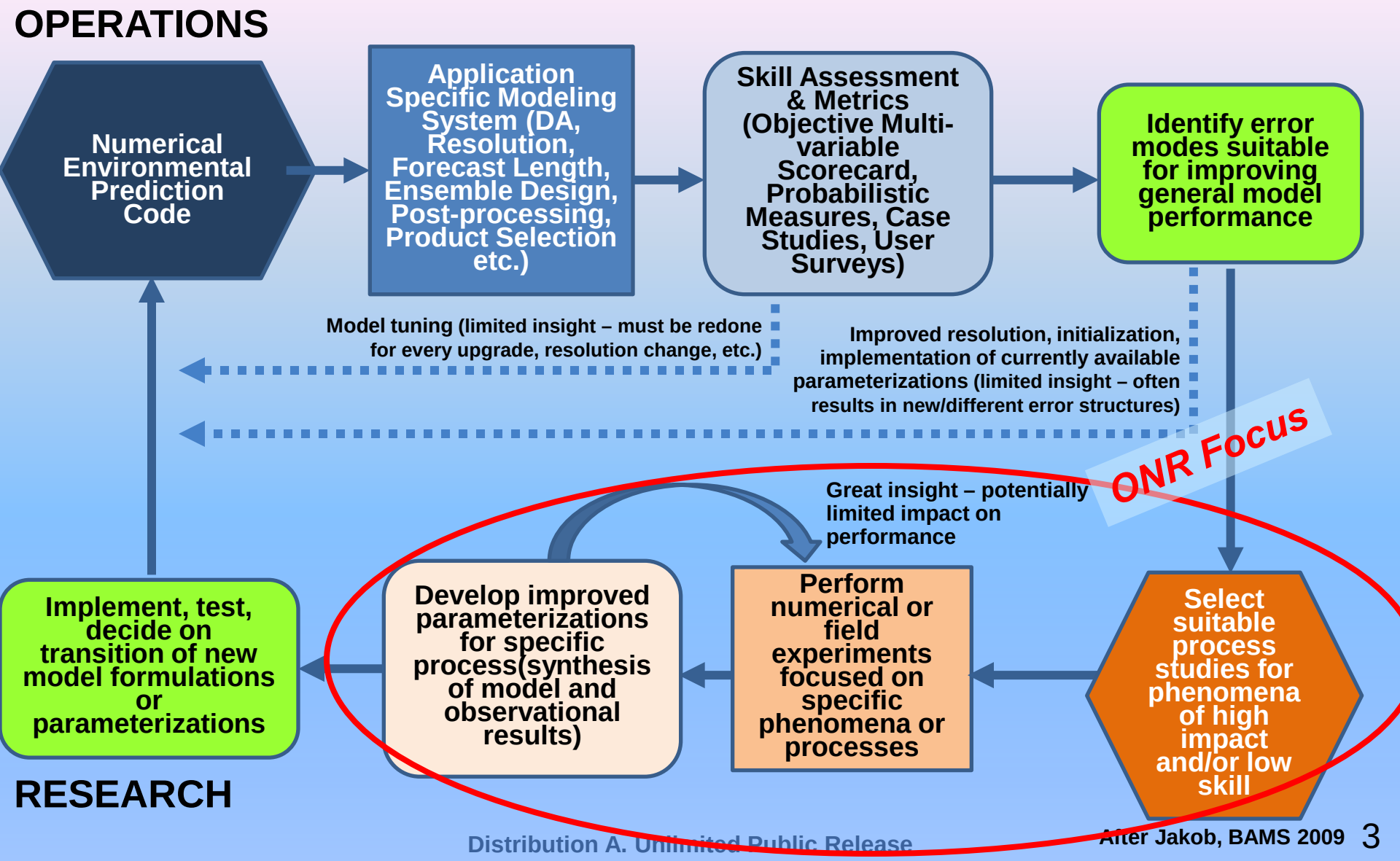
Ocean, Atmosphere, and Space Research Division

Distribution A. Unlimited Public Release

Long Term Division Thrusts

- Develop the Navy Global Earth System Model (Navy ESPC)
  Build a new generation of coupled prediction systems through process and modeling research: bottom of the ocean to the top of the atmosphere, from sea onto land, from synoptic to seasonal forecast horizons.
- Arctic Environmental Research (a subset of ESPC)
  Dramatic changes require revised analysis; important connection to global environment.
- Remote Environmental Characterization and Prediction
  Build on inverse models, data assimilation, remote and autonomous sensing.
- Coupling of Acoustics and Ocean Prediction
  Use better ocean prediction to improve acoustical analyses and use acoustical information to constrain ocean prediction.
- Mammals and Sound in the Ocean
  Major impact on Navy training.
- Advanced Sensors and Sensor Platforms
  Coastal and Maritime - light, agile, mobile; robust communications, on-board processing.

Environmental Research in a Mission Agency



After Jakob, BAMS 2009

Coupled Environmental Prediction (Models + Data Assimilation)

Major transitions:

1) NAVGEM next-generation global numerical weather prediction model; **FY14** replaced NOGAPS at FNMOC Major resolution and physics increase in FY15. Transitioned to Distributed HPC in FY16.

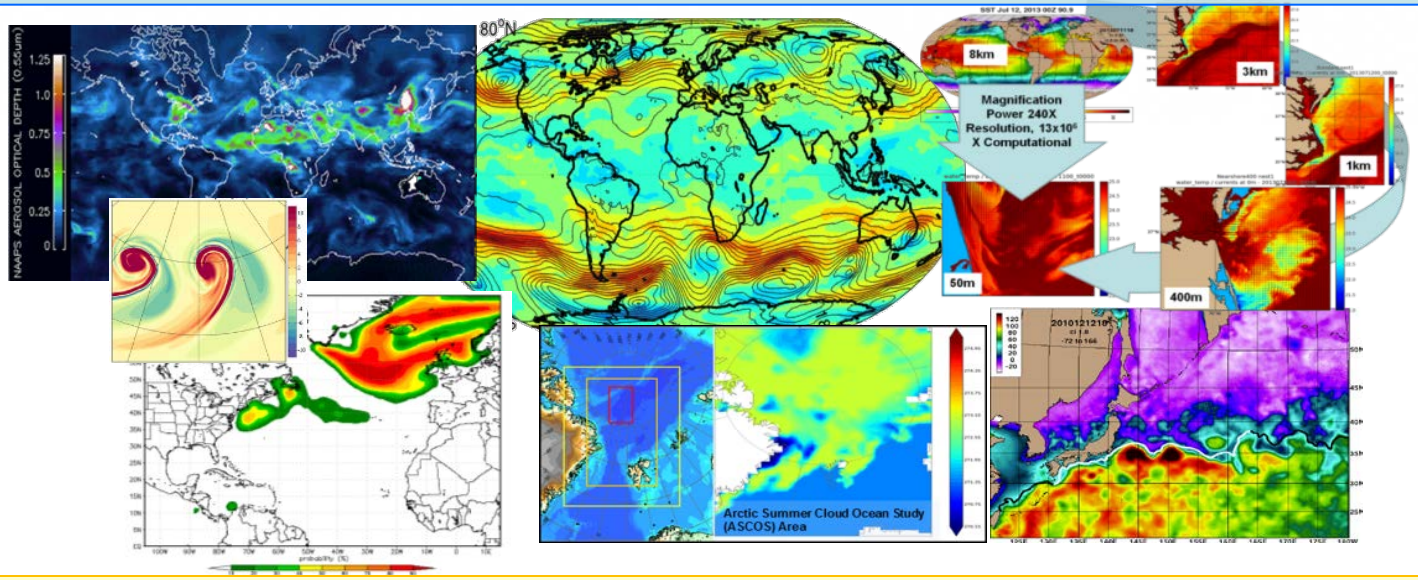
2) COAMPS-TC new mesoscale tropical cyclone model **FY14** operational at FNMOC. Predicts dynamically-driven TC intensity changes for the first time. Coupled version in FY15. Unified with COAMPS-OS in FY16.

3) GOFS (Global Ocean Forecast System) Ver. 3.1 operational in **FY14.** [Adds CICE to HYCOM, with tides, 7km resolution]. Replaced Arctic Cap Forecast (ACFNS) in **FY15**.

4) WaveWatch 3 (Global and Regional Wave Model) Ensemble operational in **FY14** [joint with NOAA via NOPP]. Couples within ESPC in FY16.

5) Regional Arctic Coupled Forecast System in development for transition ~2020.

Future transitions: Coupled Air-Wave-Ocean-Ice COAMPS, Coupled NAVGEM/NAAPS/GOFS via ESMF, COAMPS Ensemble, GOFS 3.5.



Operational Numerical Predictions made by CNMOC Production Centers in Mississippi and California

Department Research Initiatives (DRI)

Since 1995, 55 Five Year Studies Completed (through end FY15)

DRI's by FY	07	08	09	10	11	12	13	14	15	16	17	18	19	20
Atmosphere-Ocean Processes for WestPac Tropical Storms														
Tidal Flat Dynamics														
Quantifying, Predicting, Exploiting Uncertainty														
High Resolution Air-Sea Interaction Processes (CBLAST)														
Impact of Typhoons in the Ocean (ITOP/ TCS-10)														
Space Weather Forecasting Capability														
Western Pacific Tropical Cyclone Structure (TCS-08/T-PARC)														
Surf Zone Optical Variability														
Scalable Lateral Mixing and Coherent Turbulence Program (LATMIX)														
Internal Waves in Straits Experiment (IWISE)														
Origins of Kuroshiro and Mindanao Currents (OKMC)														
Inlet and River Mouth Dynamics														
Littoral Air-Sea Processes (DYNAMO)														
Vietnamese Shelf Variability														
Parameterizations for Seasonal Predictions														
Active Transfer Learning														
Predictability of Seasonal and Intraseasonal Oscillations														
Emerging Dynamics of the Marginal ice Zone (MIZEX)														
Remote Sensing of Deltas														
Bay of Bengal Freshwater Flux (ASIRI)														
Fluxes Through the Ocean Boundary Layer (Langmuir Cell)														
Increasing Open Water in the Arctic Ocean (Arctic Sea State)														
Tropical Cyclone Intensification & Structure (TCI OUTFLOW)														
Northern Arabian Sea Circulation - autonomous research (NASCar)														
Flow Encountering Abrupt Topography (FLEAT)														
The Inner Shelf														
Propagation of Intra-Seasonal Tropical Oscillations (PISTON)														
Coastal Land-Air-Sea Interactions (CLASI)														
Stratified Ocean Dynamics in the Arctic (SODA)														

Trends: Current Regional Focus
WESTPAC & IO Operational Environments

2016-20
Monsoon Intra-seasonal Oscillations – Bay of Bengal

2011-15
Vietnamese Shelf and South China Sea Variability

2013-17
Bay of Bengal Air-Sea Interactions

2014-18
Northern Arabian Sea Circulation

2010-14
Dynamics of the MJO/ Air-Sea Processes

2011-15
Remote Sensing of Deltas

2008-12
Impacts on Western Pacific Typhoon Predictability

2007-11
Quantifying, Predicting, Exploiting Uncertainty

2010-14
Origins of the Kuroshiro and Mindanao Currents

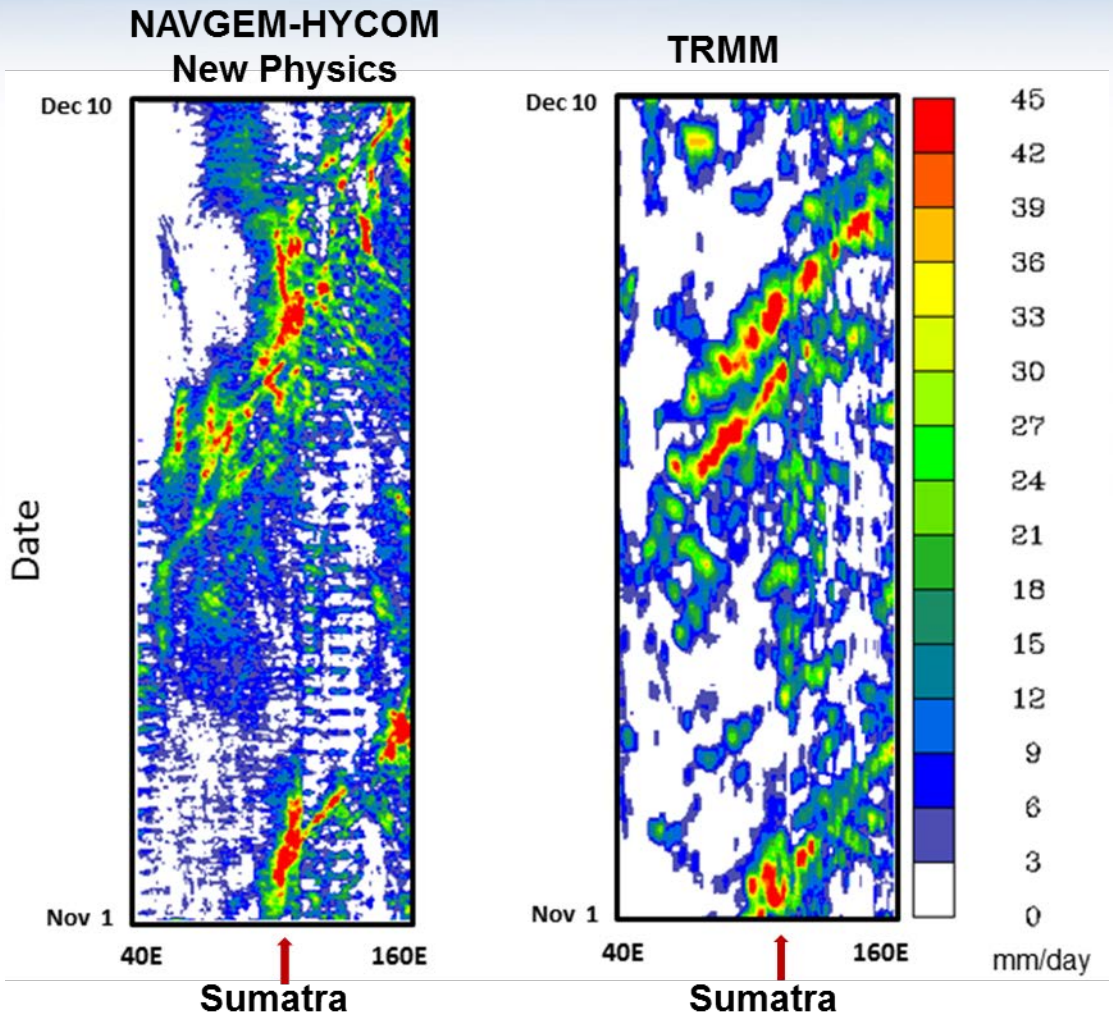
2009-13
Internal Waves in Straits Experiment

2008-11
Typhoon Impacts on the Western Pacific Ocean.

2016-20
Predictability of Intra-Seasonal Trop. Oscillations

Convective Parameterization Improvements

Navy ESPC 40-day reforecasts (5S-5N precip) from 1NOV2011



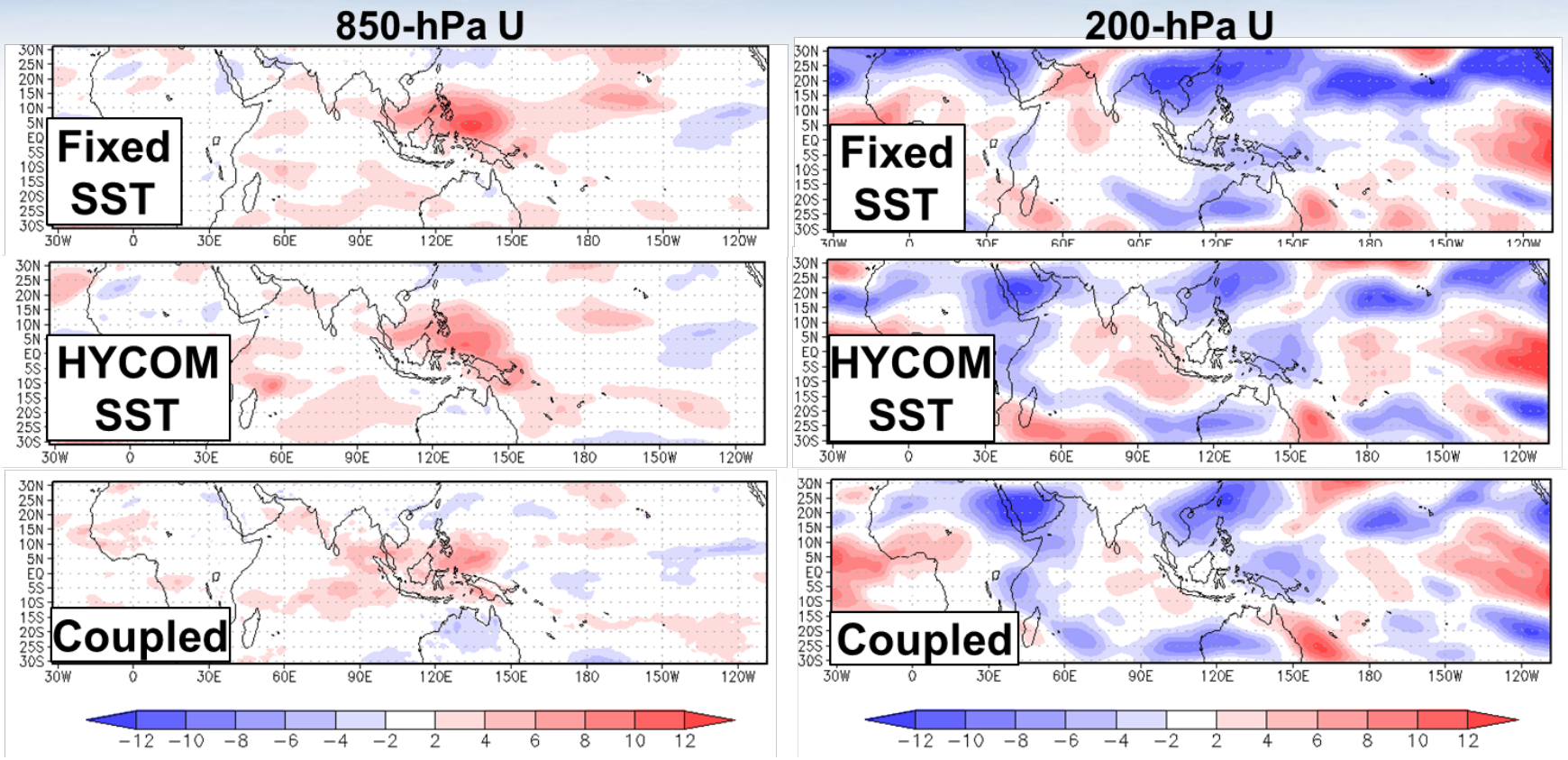
While results suggest some predictability beyond one month, both MJO episodes in the reforecast exhibit excessive slowing in propagation while crossing the Maritime Continent.

Work continues on addressing the problem of the MJO "idling" over the Maritime Continent.

Reynolds et al. 2016

Navy ESPC
Zonal Wind Sensitivity to SST

Zonal Wind Biases (m/s) 1-30 NOV 2011 (DYNAMO)



Low-level biases clearly reduced when going to observed SST, reduced further when going to fully coupled system.

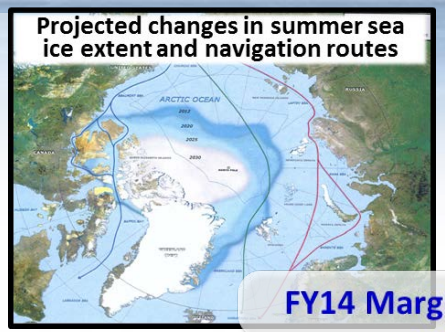
Upper level biases are reduced as well, but impact not as pronounced.

Trends: Arctic Research Program MIZEX FY12-16

Task Force Climate Change and TF Arctic

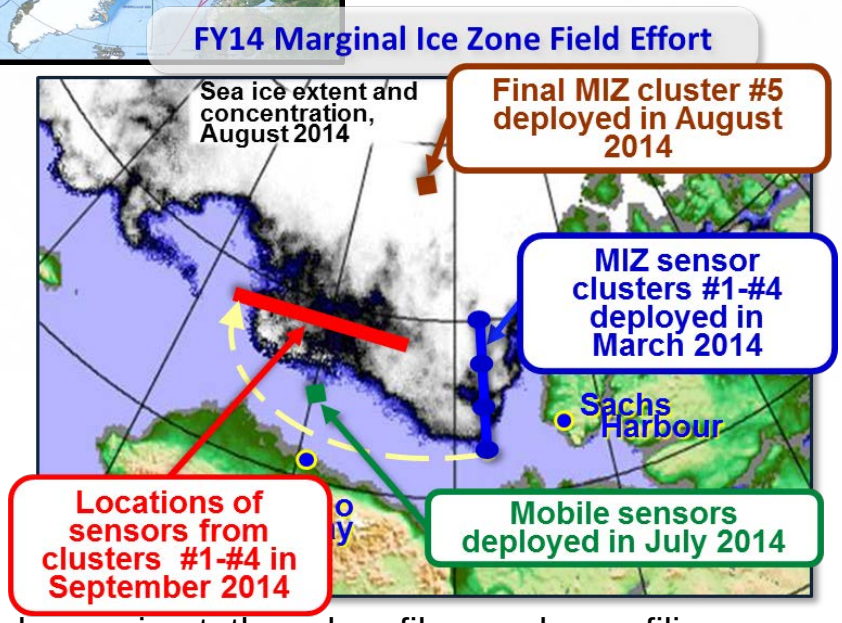
Navy's "Arctic Roadmap":

- Arctic Ocean becoming more accessible during summer
- Harsh operational environment still a significant limiting factor
- Improvements in Arctic sensing and prediction are required
- Navy has national lead on improved sea ice forecasting



Long-Term Research Program Thrusts

- Develop fully-coupled ocean-wave-ice-atmosphere models for forecasting and prediction
- Improve basic understanding of the Arctic environment and key physical processes, e.g., the marginal ice zone
- Develop an observing system for sustained observations to enable long-term scientific understanding



Sensing Array for the Marginal Ice Zone DRI

Sensor field included: Ice mass balance buoys, wave buoys, flux buoys, ice-tethered profilers, polar profiling floats, autonomous weather stations, acoustic communications and navigation beacons

- Sensor array drifted westward and rotated during evolution and retreat of the pack ice during Summer 2014
- Seagliders, wavegliders and wave floats deployed in late July in open water out of Prudhoe Bay, Alaska
- Geophysics and biogeochemistry collaboration with Korea Polar Research Institute (KOPRI) aboard R/V *Araon* in August
- Other collaborations: BOEM, NASA IceBridge, NOAA, CRREL, European Space Agency

Thank you

(Additionally please see)

US Navy Research and Development under the National Earth System Prediction Capability Partnership
Thursday, 14 January 2016: 8:45 AM
Room 338/339

Carolyn A. Reynolds, NRL, Monterey, CA; and M. S. Peng, G. A. Jacobs, J.G. Richman, J. A. Ridout, and D. P. Eleuterio