ONR’s Arctic S&T Program

RADM Nevin Carr
Chief of Naval Research
**Naval S&T Strategic Plan**

**Focus Areas**
- Power and Energy
- Operational Environments
- Maritime Domain Awareness
- Asymmetric & Irregular Warfare
- Information Superiority and Communication
- Power Projection
- Assure Access and Hold at Risk
- Distributed Operations
- Naval Warfighter Performance
- Survivability and Self-Defense
- Platform Mobility
- Fleet/Force Sustainment
- Total Ownership Cost

**Discovery & Invention** (Basic and Applied Science) ≈ 40%

**Leap Ahead Innovations** (Innovative Naval Prototypes) ≈ 10%

**Acquisition Enablers** (FNCs, etc) ≈ 30%

**Quick Reaction & Other S&T** ≈ 10%

**Near**
- Solid State Lights for Submarines

**Mid**
- Advanced Materials

**Long**
- LD UUV
- D&I
How We Execute

- 70 Countries
- 50 States
- 1,078 Companies
  - 859 small businesses
- 1,035 Universities & Nonprofit Entities
  - 3,340 principal investigators
  - 3,000 grad students
Historical Perspective

- **1947**: IPY
- **1957**: NARL
- **1981**: Closing of NARL
- **1990**: End of the Cold War
- **2003**: End of High-Latitude Dynamics Program
- **2011**: Establish Arctic Research Program

**INVESTMENT**

**ONR BASIC ARCTIC RESEARCH FUNDING**

**NSF AND OTHER FEDERAL AGENCIES**

**VARIOUS FIELD EFFORTS**: AIDJEX, CANBAREX, ETC
Historical Perspective

Reduction in Summer Sea Ice Cover since 1979
Emerging Requirements

N2N6E’s Task Force Climate Change: Must have Arctic environmental information to support future operations

NORTHCOM: Must have “improved ability to observe and predict the Arctic environment”

S&T required to enable Arctic domain awareness
Arctic Questions

Operational

• When is the sea ice going away?
  - Requires improved physical knowledge and a better prediction capability

• How is the Arctic going to be different?
  - Need comprehensive knowledge of the fully-integrated Arctic system

• What does the Navy need to know to operate in the current and future Arctic?
  - Will require the ability to observe and predict the Arctic environment, and a better understanding of how platforms, sensors, and systems will be impacted

• How will the changing Arctic impact the rest of the globe?
  - Arctic system model must be part of global seamless prediction
• If the Arctic sea ice volume continues to diminish, what are the implications of the shift from a "cold desert" to a "lake effect" climate?
  - impact on waves, snowfall, surface fluxes, storm strength and frequency, etc

• Can we extend our synoptic forecast skill by using earth system models developed for climate?

• How can we capture these new processes in a model constrained by remote sensing and sparse in situ data (AUVs)?

• How can we effectively use commercial imaging radars (like SAR)?

• How is Arctic acoustic propagation and scattering changing?
Development & Transition

Fieldwork to better understand key physical processes

Improved physics built into Arctic system models

New observation types used to constrain model predictions

Arctic Prediction System Development

Validation and Verification

Transition to Operational Use
MAJOR THRUSTS:

• Generation of **new technologies** (platforms, sensors, communications) that will enable **persistent observation and operation** in the Arctic

• **Improved basic physical understanding** of the Arctic environment and important coupled processes operating in the Arctic region

• **Development of a new, dynamic, fully-integrated Arctic System Model** incorporating the ocean, sea ice, waves and atmosphere for improved prediction at longer lead times, including the use of **satellite SAR data** for assimilation into integrated models

Advances in technology will be required to develop an Arctic Observing Network that will support scientific exploration and be able to initialize predictive models of the environment.
A sensing system must be developed to provide persistent observations that can further scientific understanding, provide long-term monitoring, and constrain the predictive models.

Autonomous platforms – Robust Sensors – Real-time Data Delivery – Key Environmental Variables

**Novel Sensing Systems**

**Real-Time Data Communication**

**Autonomous Platforms and Enabling Technologies**

- Acoustically-navigated Gliders
  - Repeated sections
  - Resolves deformation scale (5 km)
  - Samples at ice-ocean interface
  - T, S, dissolved oxygen
A better understanding of the integrated physics and dynamics in the Arctic will enable more accurate representation of these processes in the models, leading to improved predictions.
Integrated Arctic Modeling and Prediction

Fully-coupled ocean-wave-ice-atmosphere models with sufficient resolution to represent the relevant processes, and that assimilate in situ and remotely-sensed observations to create useful predictions of the operational Arctic environment at a wide range of lead times.

Integrated Arctic System Models
ocean – ice – wave – atmosphere

Advanced Data Assimilation

Coupling with Global Earth System Models

Ice thickness measured from below

J. Wallace, University of Washington
First Field Effort: Emerging Dynamics of the Marginal Ice Zone

Reduction in Summer Sea Ice Cover since 1979

The Arctic is becoming more ice-dynamic, with a larger area of sea ice melt and re-freeze on an annual basis.

GOAL: Better understanding of the coupled physical processes operating in the Marginal Ice Zone

Better understanding of the MIZ physics will enable improved ice-dynamic models of the Arctic

Targeting 2014 for a major observational field program

Snapshot of Ice Concentration from coupled HYCOM / CICE model
Questions?
Backup Slides
Formulating Arctic S&T Priorities

High Level DOD, Navy, and Executive Branch Priorities

Specific Strategic Naval Needs

Academic Recommendations

ONR Arctic Program Research Goals
Establishment of an Arctic Research Program

Program Goals:

- Improved basic understanding of the physical environment and relevant processes in the Arctic region
- Development of integrated (ocean-ice-wave-atmosphere) earth system models for improved prediction of the Arctic operational environment at longer lead times
- Exploration of new technologies (platforms, sensors, communications) required for persistent observation and operation in the harsh Arctic environment

In response to priorities identified by N2/N6 Task Force

Climate Change

Reduction in Summer Sea Ice Cover since 1979

FY11 Activities: Begin fund realignment by supporting observations related to the Arctic Submarine Lab’s SCICEX Program (SCience Ice EXercise) and 2011 ICEX Ice Camp
- Funding NRL-DC to make airborne measurements of sea ice thickness
- Testing new submarine-launched XCTD system
- Enabling calibration of on-board biogeochemical sampling equipment
- Processing ice draft information from sub-based Upward Looking Sonar (ULS) data

FY12-start DRI: Dynamics of the Marginal Ice Zone

- Reduction in Summer Sea Ice Cover since 1979

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ONR’s new effort will focus on building the next-generation integrated global prediction system to support the needs of the US Navy in 2020:

- **Fully-integrated** ocean-wave-ice-atmosphere model
- Appropriately coupled across a **wide range of space and time scales**
- Provide **improved short-term ( < 7 days ) predictions** of the physical environment in support of safe, efficient, and effective naval operations
- Provide **extended-range predictions** for Navy strategic resource decisions
- Understand **relevant physics** to inform and enable longer (decadal+) predictions
- Define the **limits of predictability** for different physical variables and processes
Basic and Applied Research for Building the Navy’s Environmental Prediction System
(The world’s largest operational, integrated environmental prediction system)

**ONR Field Studies**

- Impacts on Western Pacific Typhoon Predictability
- Quantifying, Predicting, Exploiting Uncertainty
- Internal Waves in Straits Experiment
- Origins of the Kuroshiro and Mindanao Currents
- Vietnamese Shelf and South China Sea Variability
- Remote Sensing of Deltas
- Typhoon Impacts on the Western Pacific Ocean

* Ongoing FY11

**ONR Model Development**

- HYCOM 1/25th Degree Tide Resolving Model
- Internal Waves = Propagation Variability
- Ocean structure For ASW

**CNMOC Transitioned Predictions**

- Regional EAS NCOM nested in Global NCOM
- TASWEX-04 Nesting in East Asian Seas NCOM
- NRL-Stennis HIRES NCOM

**Probability of Submarine Detection**

- FNMOC & NAVOCEANO distribute 1000s of product sets per day to Support Navy and other DoD users in Peace and war

New technology

Autonomous Underwater Systems

Navy R&D focus on OCONUS areas of special operational interest and for specific Warfare missions

120°E 140°E

Sea Surface Height (SSH)

Temperature Vertical Section

Sea Surface Temperature (°C)