Naval Research Laboratory

The Navy and Marine Corps Corporate Laboratory

Establishment of NRL

THOMAS A. EDISON

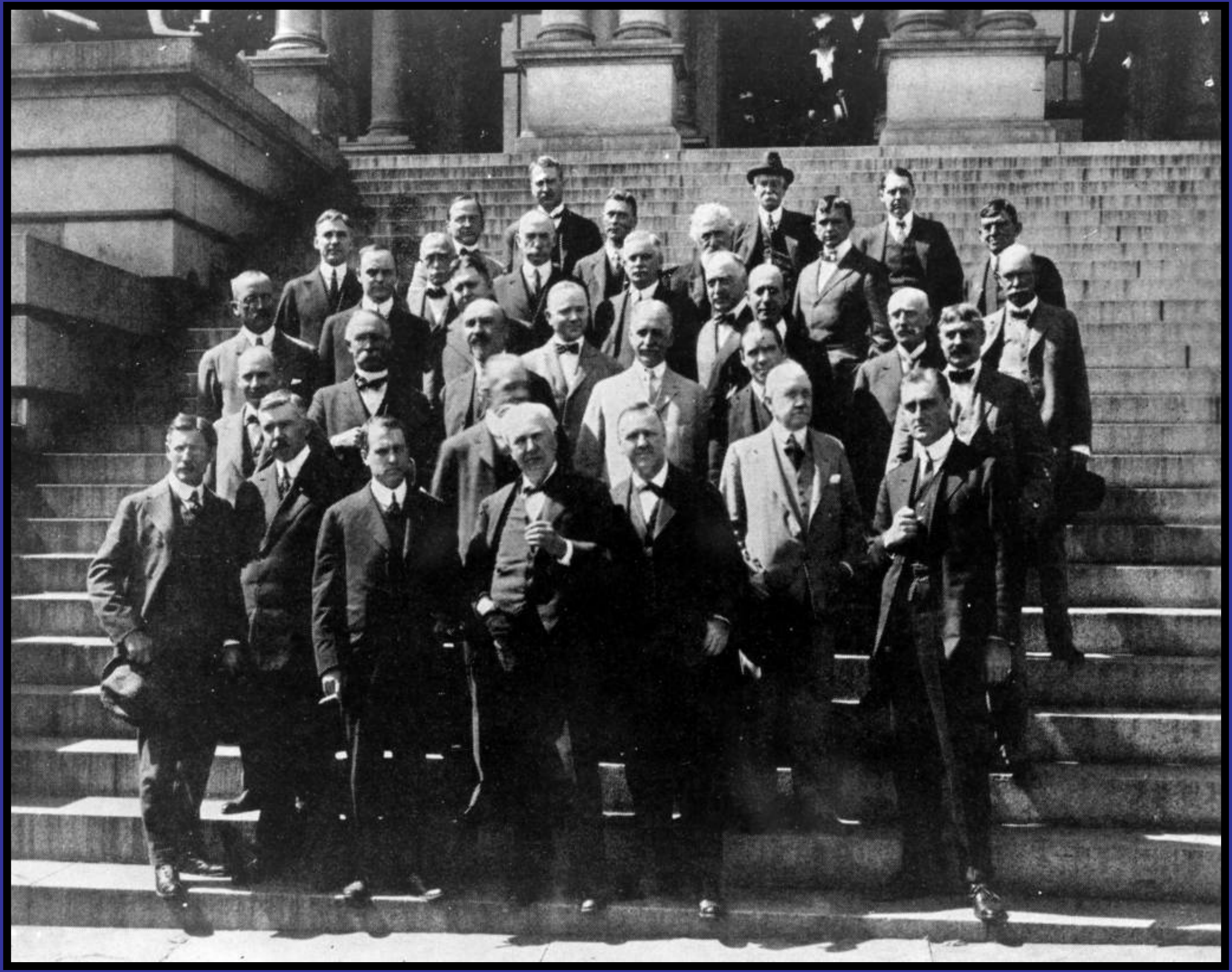
"GOVERNMENT SHOULD MAINTAIN A GREAT RESEARCH LABORATORY TO DEVELOP GUNS, NEW EXPLOSIVES AND ALL THE TECHNIQUE OF MILITARY AND NAVAL PROGRESSION WITHOUT ANY VAST EXPENSE."

THOMAS A. EDISON,
THE NEW YORK TIMES MAGAZINE
SUNDAY, MAY 30, 1915

A WORLD-CLASS LABORATORY

- **Idea followed the sinking of the Lusitania in 1915**
- **Secretary Josephus Daniels Established Naval Consulting Board with Edison Chair, meeting October 7, 1915**
- **August 29, 1916 Congress appropriates funds to establish the Lab**
- **Delayed by WW-I, Assistant Secretary of the Navy, Theodore Roosevelt, Jr. Commissions the Lab at Bellevue site on July 2, 1923**

Building on the Legacy and Spirit of Thomas Edison



NRL Mission

- To conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, equipment, systems and ocean, atmospheric, and space sciences and related technologies.
- Primary in-house research for the physical, engineering, space, and environmental sciences
- Broadly based applied research and advanced technology development program in response to identified and anticipated Navy and Marine Corps needs
- Broad multidisciplinary support to the Naval Warfare Centers
- Space & space systems technology development & support
- Designated as the Navy's corporate laboratory by SECNAV 1991

NRL: The DoN's Corporate Laboratory

Lines of Business

- Sensors, Electronics and Electronic Warfare
- Materials/Processes
- Battlespace Environments
- Undersea Warfare
- Information Systems Technology
- Space Platforms

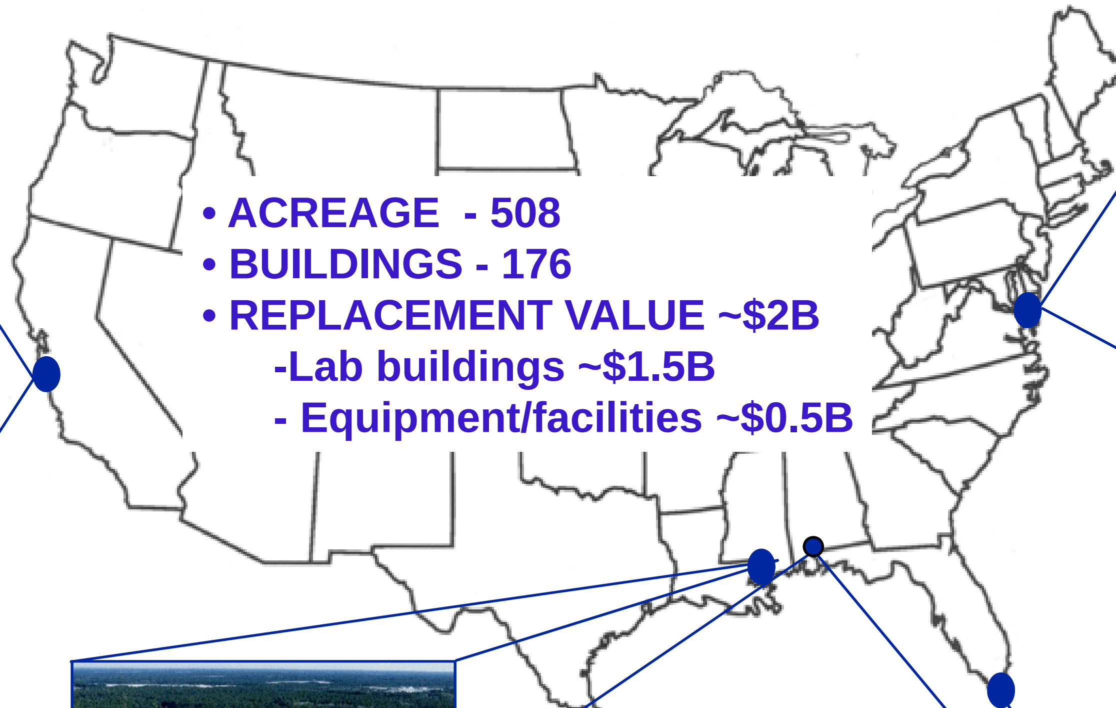
- Technology Transfer

Naval Research Laboratory's Organizational Relationships

- **Assistant Secretary of the Navy (Research, Development & Acquisition)** – The Honorable Sean Stackley
  - **Chief of Naval Research** – RADM Nevin P. Carr, Jr. ★★
    - **NRL Commanding Officer** ★ – CAPT. Paul C. Stewart, USN
      - **NRL Director of Research** – Dr. John Montgomery
        - **Business Operations** – Mr. D. Therning
        - **Systems Directorate** – Dr. G. Borsuk
          - Radar
          - Electronic Warfare
          - Optical Sciences
          - Information Technology
        - **Materials Science and Component Technology** – Dr. B. B. Rath
          - Chemistry
          - Materials Science & Technology
          - Comp. Phys & Fluid Dynamics
          - Plasma Physics
          - Electronics Science & Tech
          - Biomolecular Science & Engr
        - **Naval Center for Space Technology** – Mr. P. G. Wilhelm
          - Space Systems Dev
          - Spacecraft Engineering
        - **Ocean and Atmospheric Science & Technology** – Dr. E. Franchi
          - Acoustics
          - Remote Sensing
          - Oceanography
          - Marine Geosciences
          - Marine Meteorology
          - Space Sciences

Naval Research Laboratory

- ACREAGE - 508
- BUILDINGS - 176
- REPLACEMENT VALUE ~$2B
  - -Lab buildings ~$1.5B
  - - Equipment/facilities ~$0.5B



MONTEREY, CA

PATUXENT RIVER
VXS-1 Squadron

NRL D.C.

Chesapeake Bay Div
Tilghman Is.
Midway Res Ctr
Blossom Point
Pomonkey

BAY ST. LOUIS, MS
John C. Stennis Space Center

MOBILE, AL
Ex-USS Shadwell

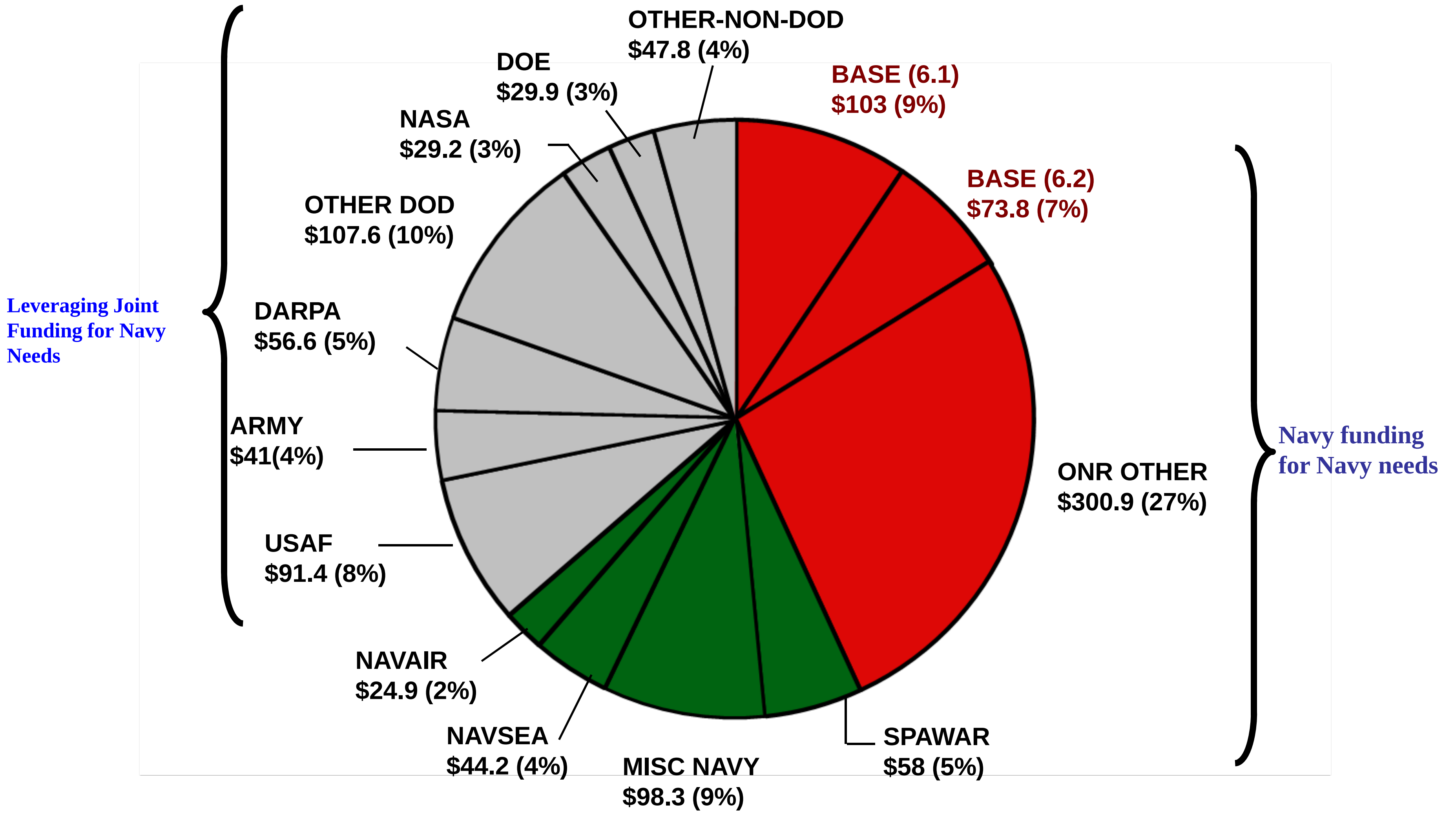
KEY WEST
Marine Corrosion
Facility

* Additional sites
based on sponsors

Scientific Development Squadron ONE (VXS-1)

- Provides airborne research capability to NRL
- Sensor and system test bed, airborne surrogate
- Worldwide deployable
- 5 Aircraft
  - **2 Research Modified NP-3D**
  - **1 AEW Rotodome NP-3D**
  - **2 Research Modified RC-12**
- 12 Officers, 76 Enlisted, 4 Civilians

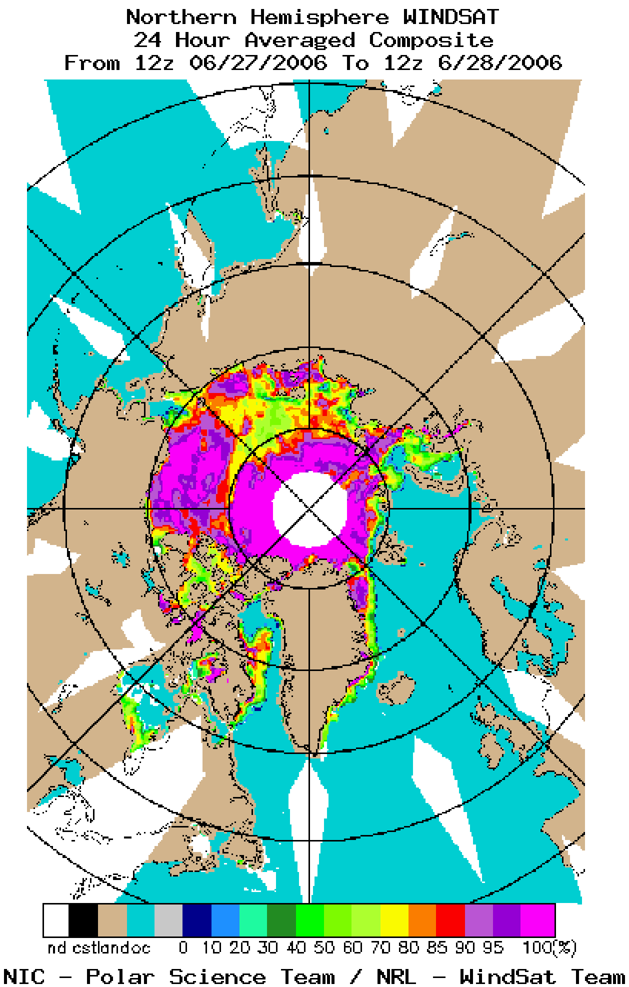
SPONSORS
FY08 COSTS
TOTAL $1.107 BILLION

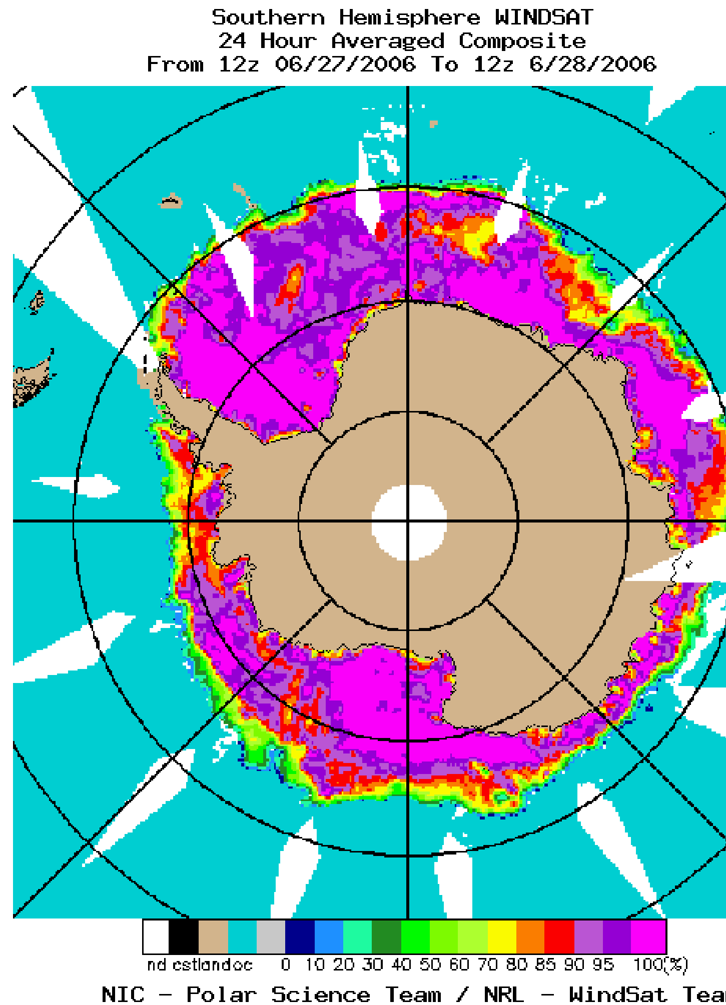


Current High Latitude Research

- Remote Sensed Sea Ice
- Modeling Sea Ice
- Atmospheric Modeling
- Exploring Methane Deposits
- Airborne Sensor Capabilities
- MDA

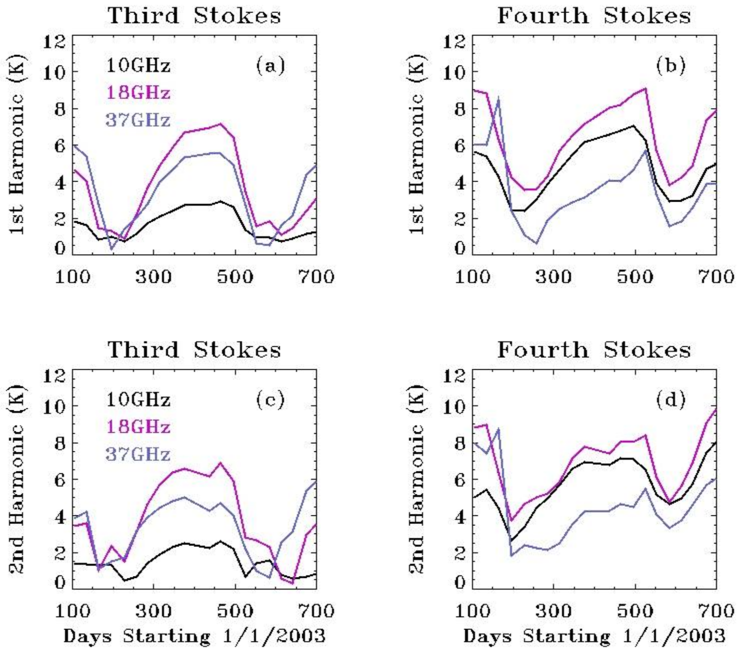
WindSat Sea Ice Products

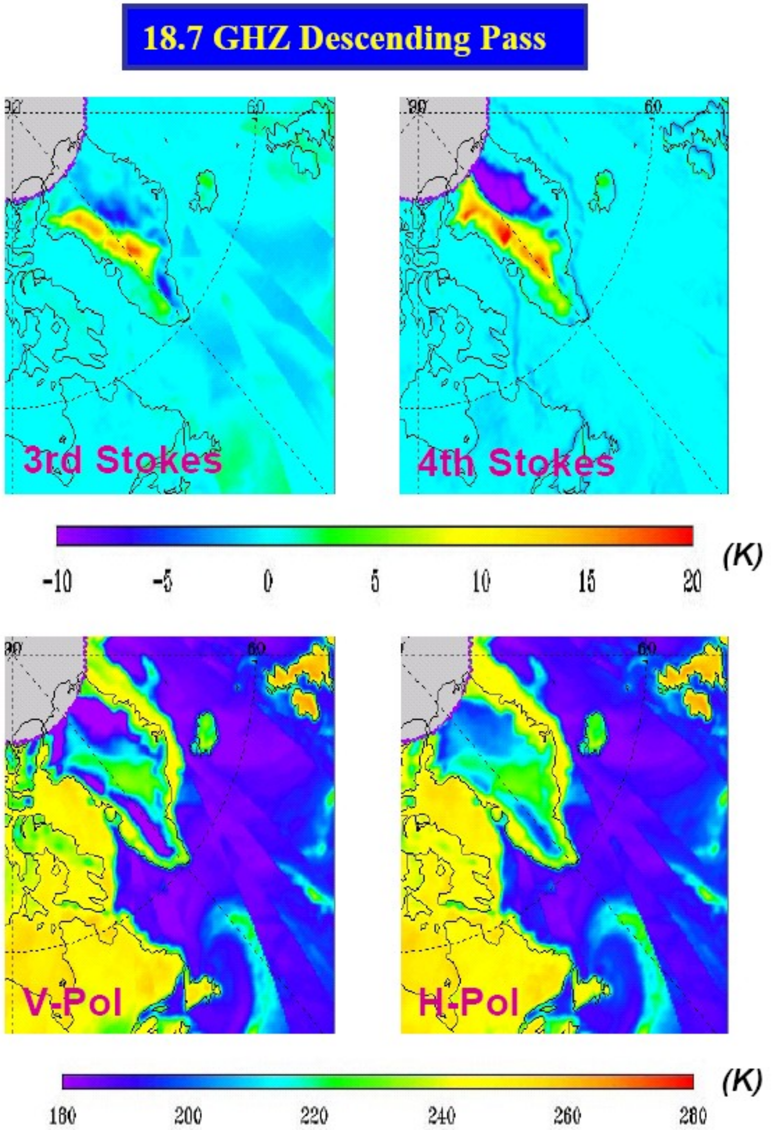




- Sea Ice Concentration (based on heritage algorithm)
- Product Provided Twice Daily to the National Ice Center

WindSat Polarimetric Signature of Polar Ice Sheet



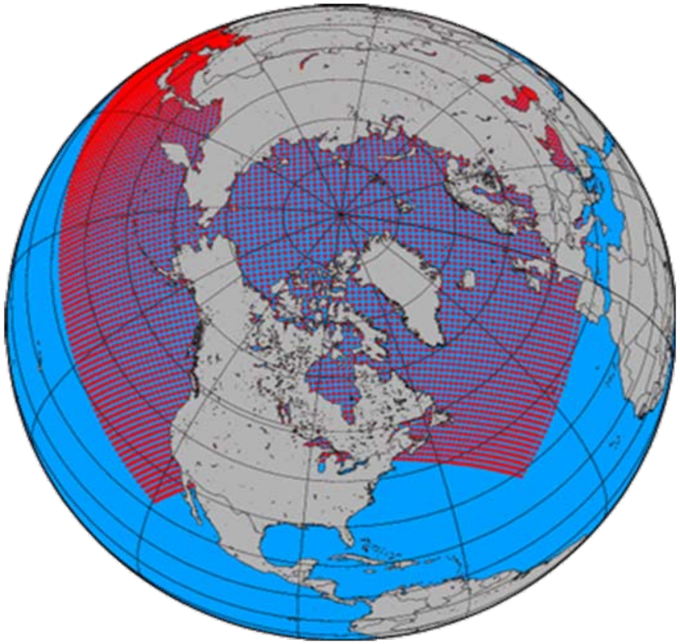


- The 3rd and 4th Stokes parameters are eight times stronger over Greenland and Antarctic ice sheet than over ocean.
- Polarimetric signature exhibits well defined azimuth modulation and seasonal variations.
- The signature is potentially related to the coupled volume and surface scattering by the multilayer asymmetry structure of polar ice sheet.
- Operational capability to provide maps of polarimetric climate time series for polar research.

NRL Sea Ice Prediction

Since the late 1980's, NRL has developed several Arctic sea ice prediction systems for the Navy, each having increasingly improved physics and higher resolution.

The Polar Ice Prediction System 2.0 (PIPS 2.0) has been running operationally since 1996 providing forecasts of ice thickness, drift and coverage. This model has a resolution of ~28km and assimilates satellite derived ice concentration data.



PIPS Products

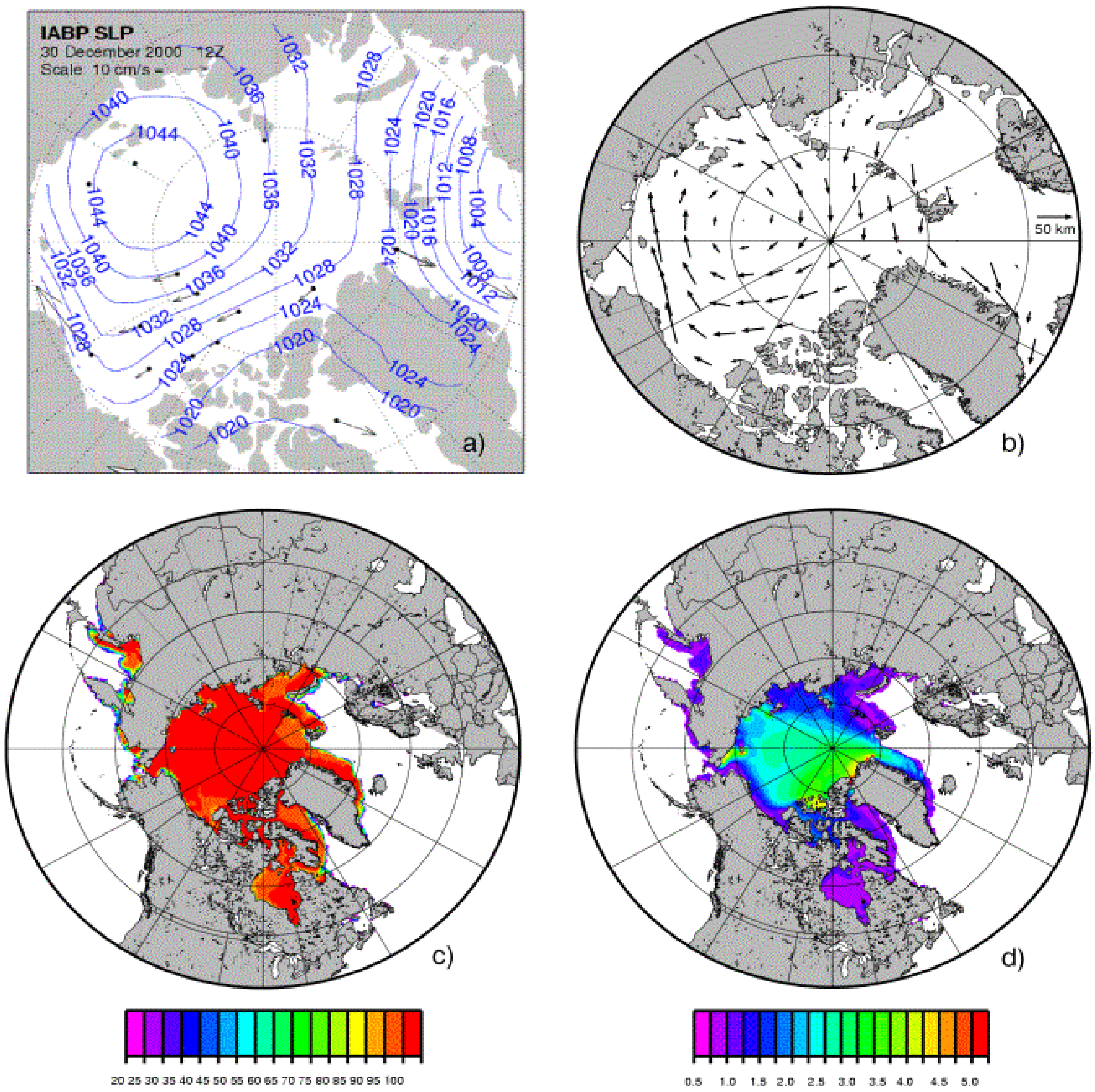
For Dec 30, 2000

a) IABP buoy drift and pressure (mb)

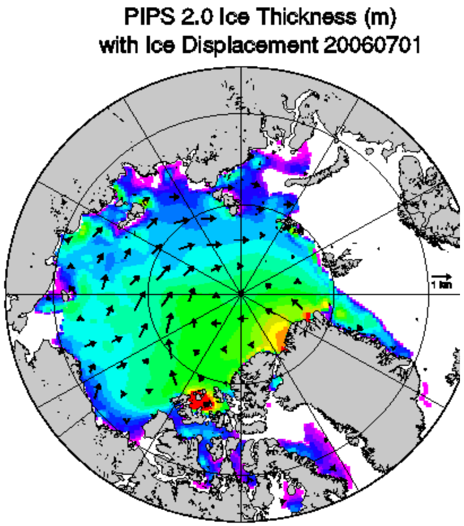
b) b) PIPS ice displacement (km)

c) PIPS ice concentration(%)

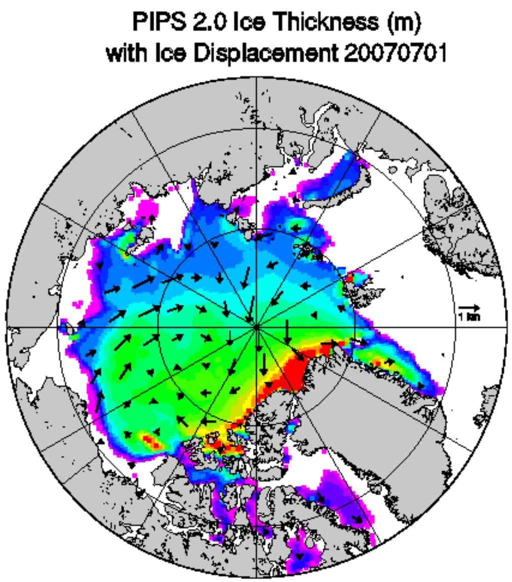
d) PIPS ice thickness (m)



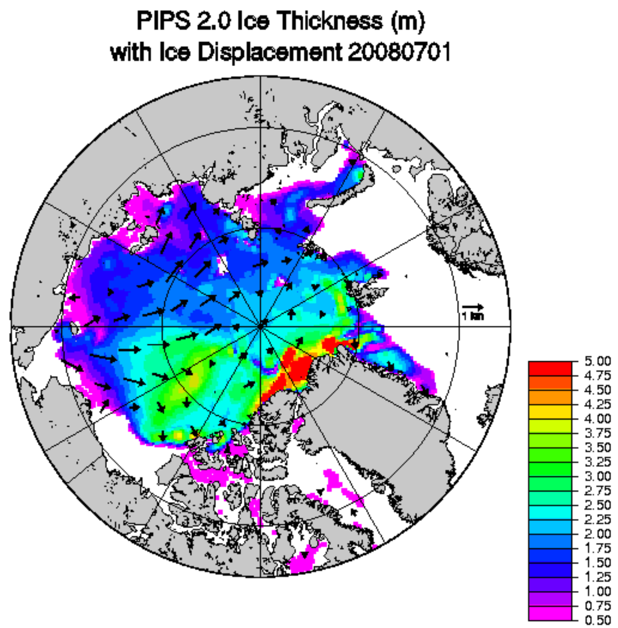
PIPS 2.0 Ice Thickness with Ice Drift July – November of 2006, 2007, 2008



2006



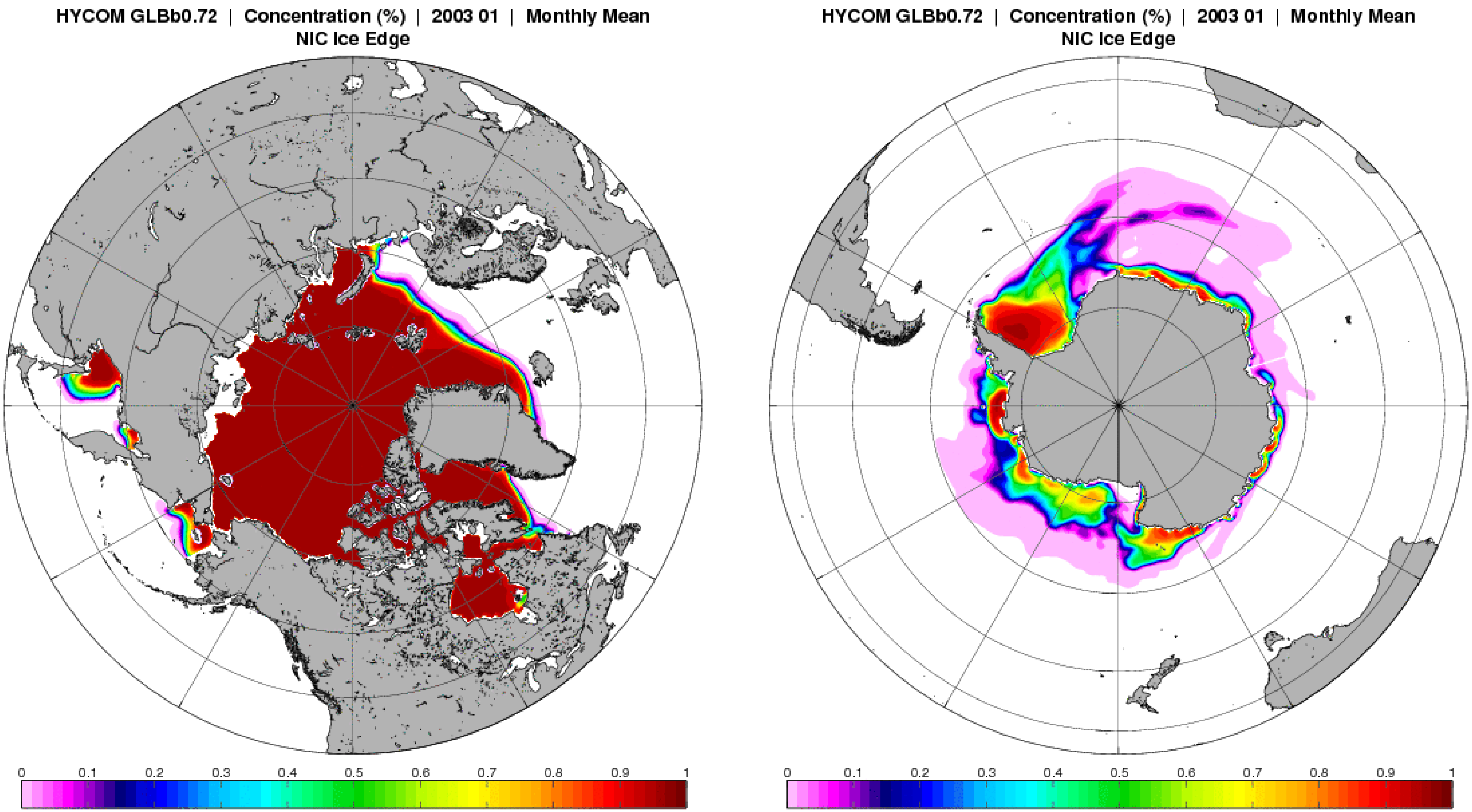
2007



2008

PIPS 3.0, Next Generation Forecast System
Improved Ice and Ocean Models

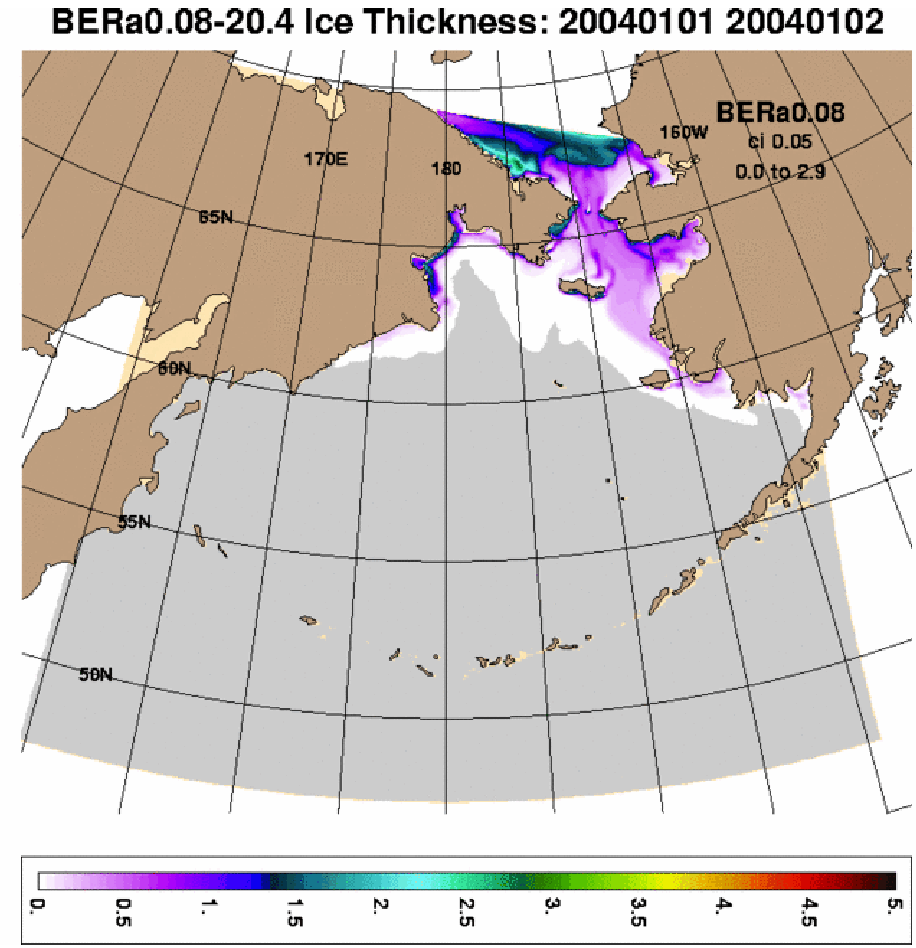
Global HYCOM coupled to CICE, includes both Arctic and Antarctic prediction.



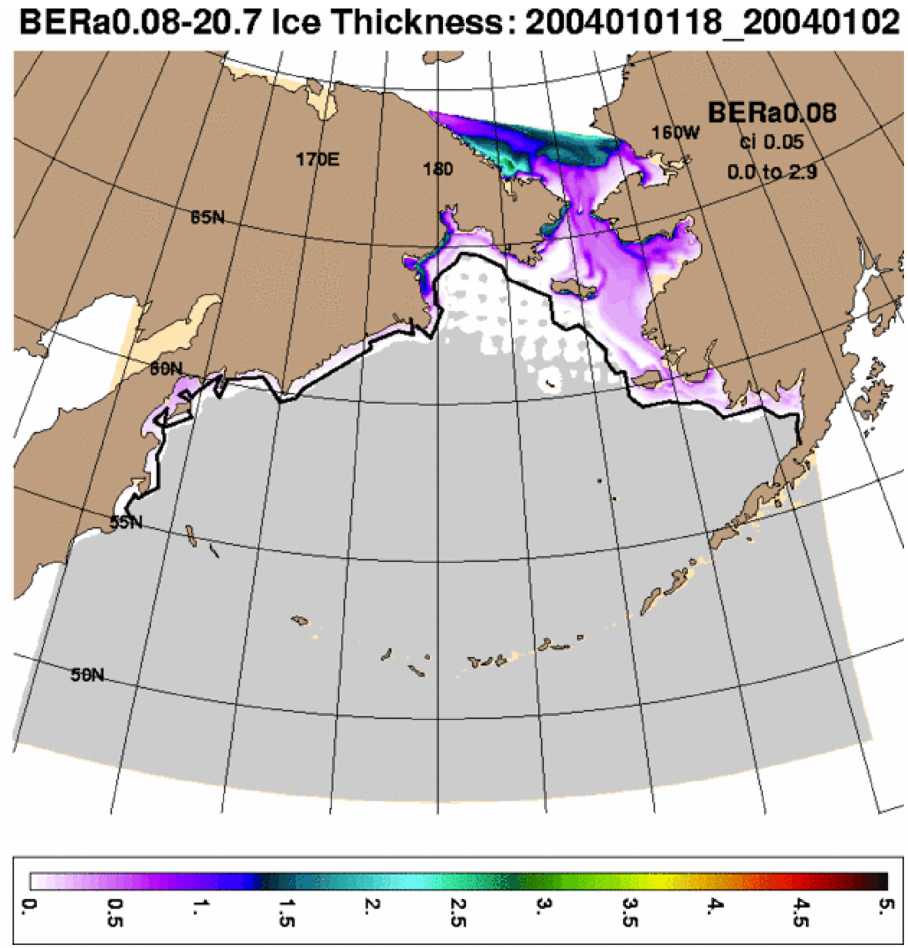
Ice concentration (%) for the Arctic (left) and Antarctic (right) with no data assimilation. Monthly means from Sept 2003 thru Dec 2006. NIC ice edge overlaid starting Jan 2004

Impact of assimilating SSMI ice concentration data into a 1/12 degree HYCOM-CICE Bering Sea model

HYCOM-CICE (non-assimilative)



HYCOM-NCODA-CICE (assimilative)



Ice thickness (m) and independent NIC ice edge (black line)

Atmospheric Prediction in the Changing Arctic Environment

Objective

- Improve our understanding of the physical processes in the Arctic
- Develop new physical parameterizations for Navy's global and mesoscale prediction systems (NOGAPS and COAMPS®) to improve weather forecast in the Arctic

Approach

- Develop new/improved radiation, cloud and turbulent mixing parameterizations for NOGAPS and COAMPS®
- Conduct data assimilation/medium range forecasts with NOGAPS new physics package and the 3D/4D variational analysis

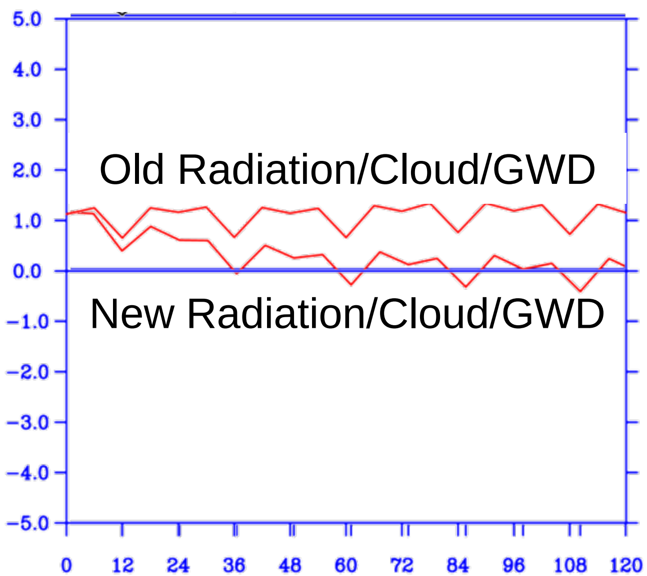
Payoff

- Improved understanding of the Arctic physics
- Improved weather prediction for the Arctic region
- Improved fluxes for the Navy's ocean, ice and wave models

Improving Physical Parameterizations and Forecasting in the Changing Arctic Environment

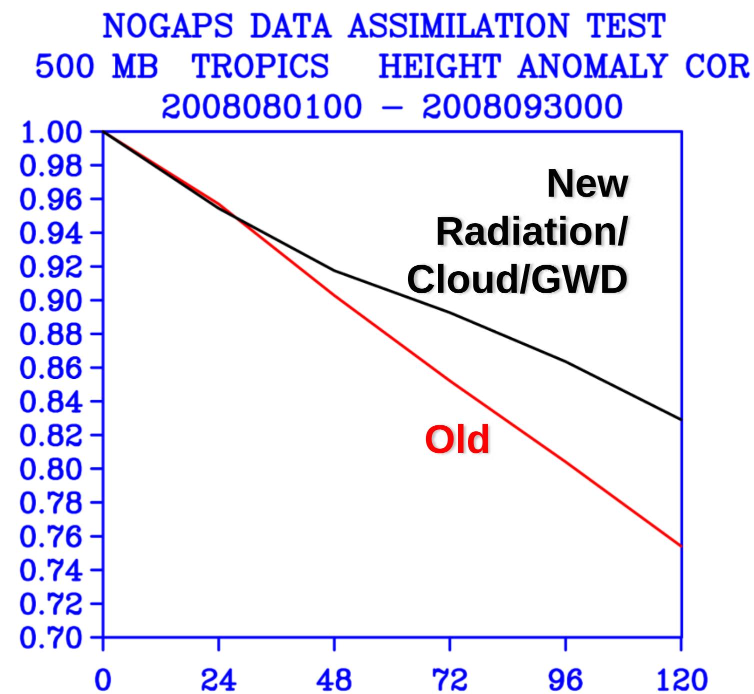
NOGAPS T239L42
(2007-12-27 ~ 2008-02-28)

Surface Temperature Error [K]
in Arctic (60N-90N)



Forecast Time in Hours

NOGAPS T239L42
(2008-08-01 ~ 2008-09-30)



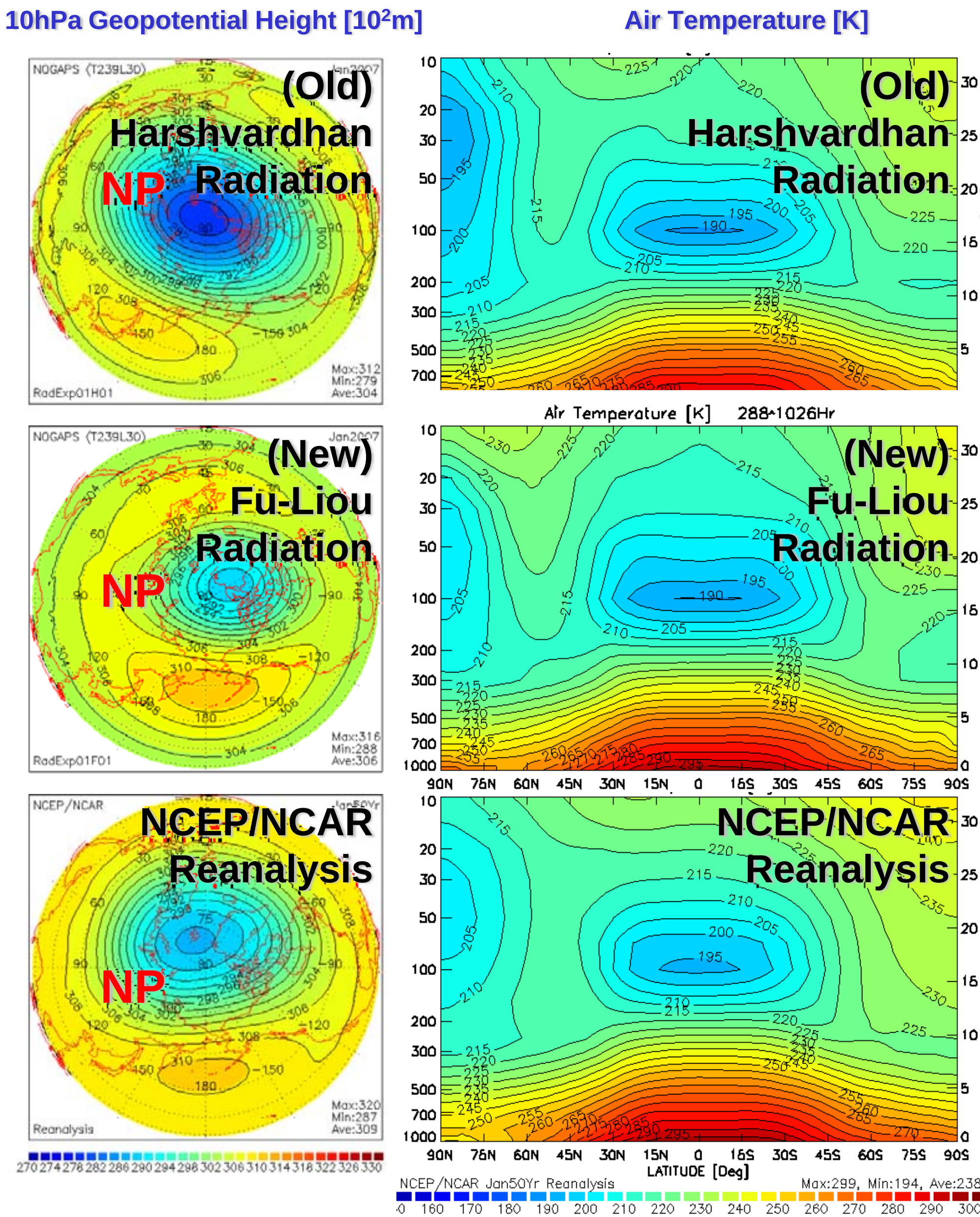
Forecast Time in Hours

New radiation/cloud/GWD parameterizations improve Arctic surface temperature prediction and improve geopotential height anomaly correlation in Tropics.

NOGAPS T239L30 (40-day Extended Forecast)

• The performance of the old and new solar/terrestrial radiation parameterizations for NOGAPS were tested in climate mode w/o data assimilation.

• The 40-day forecast experiments reveal that the new Fu-Liou radiation scheme *outperforms* the old scheme over the *Arctic (Northern Polar) region* in *positioning the polar vortex* in the middle atmosphere (left panels) and in *reproducing the observed state of the atmosphere (e.g., temperature;* right panels), especially in the middle atmosphere.

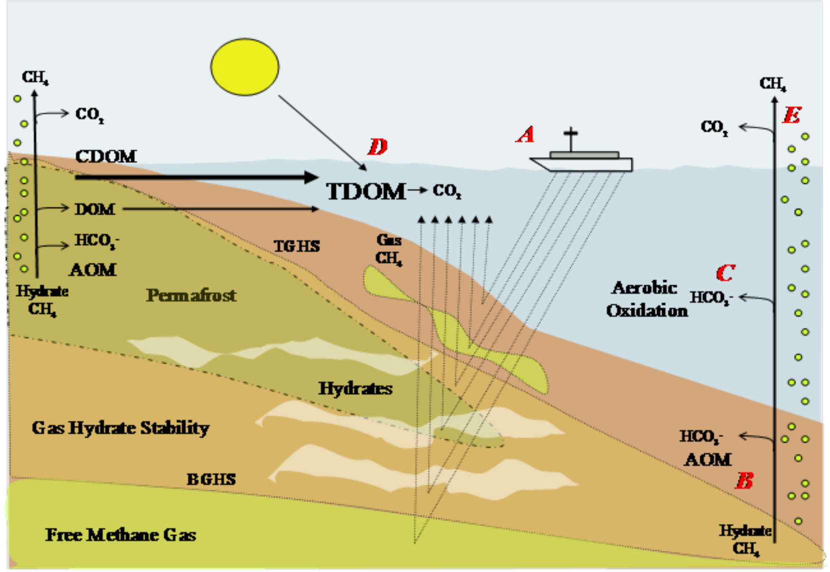


Climate Change and Energy Exploration in the Arctic

- Seismic and geochemical data to predict deep sediment hydrates
- Estimate spatial variation in the vertical methane fluxes
- Shallow sediment methane contribution to sediment and water column carbon cycling.
- Sediment methane flux to the water column and into the atmosphere.
- Microbial communities in sediments and the water column.
- Model development that tracks the fate of methane in the sediment and the water column, for both the dissolved and free gas phase

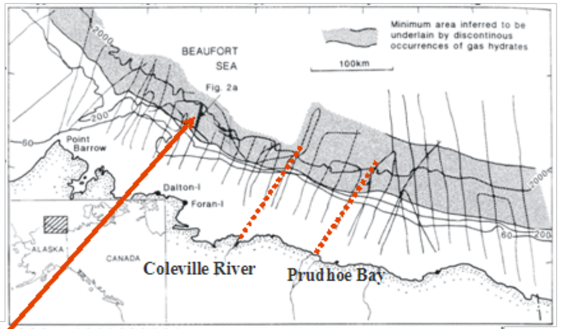
PI: Richard B. Coffin, NRL,

CO-PIs: Jens Greinert, NIOZ Netherlands; Warren Wood, NRL Stennis; Kelly Rose, NETL-DOE

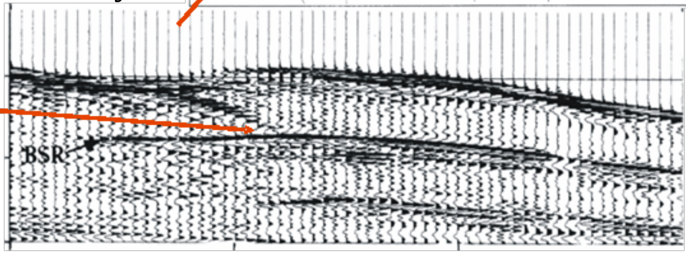


Data includes: A) seismic profiles, B) sediment geochemistry; C) water column methane cycling; D) tundra carbon transport; and E) gas flux to the atmosphere.

Offshore from the current tundra methane hydrate exploration lead by BP Amoco. Transects from nearshore to the slope to evaluate permafrost and deep sediment hydrate distribution and stability.



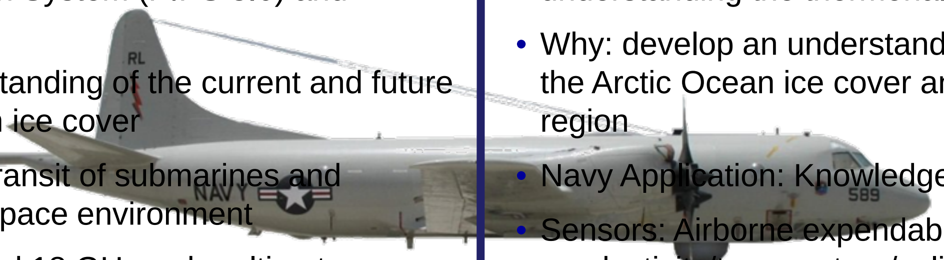
Bottom Simulating Reflector indicating potential gas hydrate beds



Arctic Airborne Geophysical Research Capabilities

Sea-Ice Thickness

- Capability – Measurement of extended profiles of sea-ice thickness, age and surface characteristics (age, snow-cover, contaminants)
- Modeling Component : validation and calibration of the Navy Polar Ice Prediction System (PIPS 3.0) and CRYOSAT II Satellite
- Why: develop an understanding of the current and future state of the Arctic Ocean ice cover
- Navy Application: Safe transit of submarines and knowledge of the battlespace environment
- Sensors : airborne 10 and 18 GHz radar altimeters, scanning lidar altimeter, thermal imager, hyperspectral imager, Multi-Band Synthetic Aperture Radar



Synoptic Arctic Water-Column Grid

- Capability – Acquisition of synoptic, large-scale grid of water-column data over the Arctic Ocean Basins
- Modeling Component – data needed to test various models of ocean circulation in a vastly undersampled region that is key to understanding the thermohaline circulation of the major basins
- Why: develop an understanding of the current and future state of the Arctic Ocean ice cover and the heat-transport budget of the region
- Navy Application: Knowledge of the battlespace environment
- Sensors: Airborne expendable bathy-thermograph and conductivity/temperature/salinity buoys to be dropped in leads in the ice from a long-range aircraft

* *Note – capability can be combined with sea-ice measurements*

Remote Sensing and Definition of the Ice-Covered Continental Shelf Break

- Capability: Rapidly localizing the continental shelf-break by means of airborne remote sensing measurements in ice-covered regions that are difficult to survey by conventional shipboard methods
- Modeling component – forward and inverse crustal gravity and magnetic models
- Why: Direct application to sovereignty determinations under the Law of the Sea for underwater territories in the ice-covered Arctic
- Navy Application: Naval operations in the region
- Sensors – Airborne gravimeter, magnetometer, radar altimeter, precise aircraft trajectory determination via long-baseline, kinematic Global Positioning System

Naval Research Laboratory

Questions?

The Navy and Marine Corps Corporate Laboratory