NOAA Plans for Arctic Sea Ice Studies

Presented to the Conference on

Impact of an Ice-Diminishing Arctic on Naval and Maritime Operations

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Sea Ice Activities at NOAA

* Covered by other presentations

- Contribute to Arctic Observing Network
- National Ice Center*
- Loss-of-Sea-Ice Impacts on Marine Ecosystems and Coastal Areas
- Improving Sea Ice Dynamics in Global Climate Models
- Data Analysis and Dissemination

NOAA Role In AON

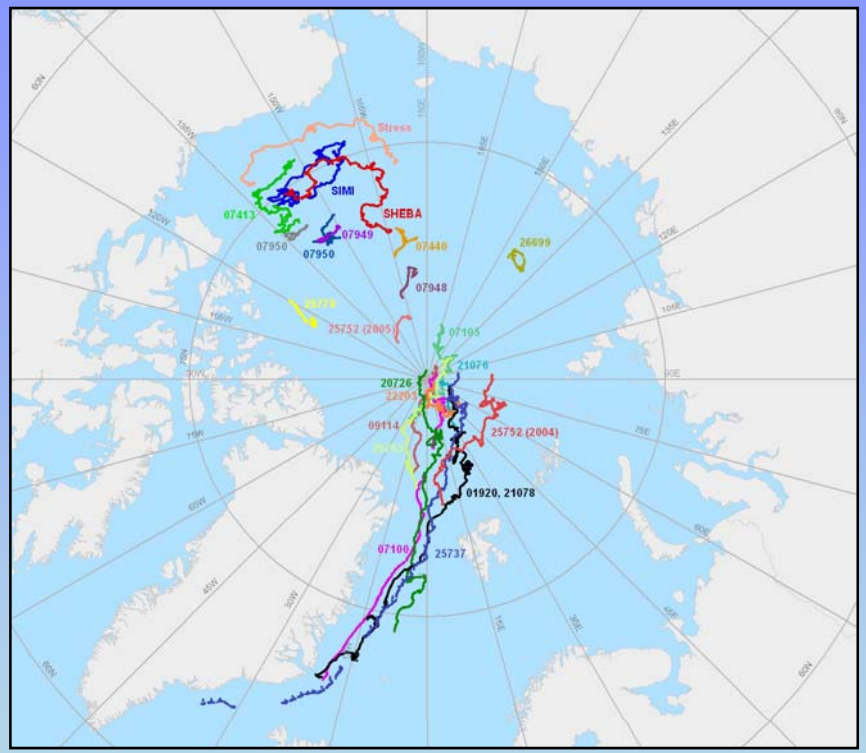
- Ice Mass Balance and IABP buoy programs
- Physical Variability and Ecological Response to Reduced Sea Ice in the Bering/Chukchi region
- Tracking Atlantic Water along Russia
- Atmospheric Observations
- Improving Remote Sensing
- Promoting National and International Coordination

AON - Ice Mass Balance Studies

- NOAA supports CRREL and IOS (Canada) to deploy and analyze results from buoys and moorings that determine ice thickness and other key variables
- Goal: provide long-term ice thickness trends and improve understanding of factors controlling ice thickness

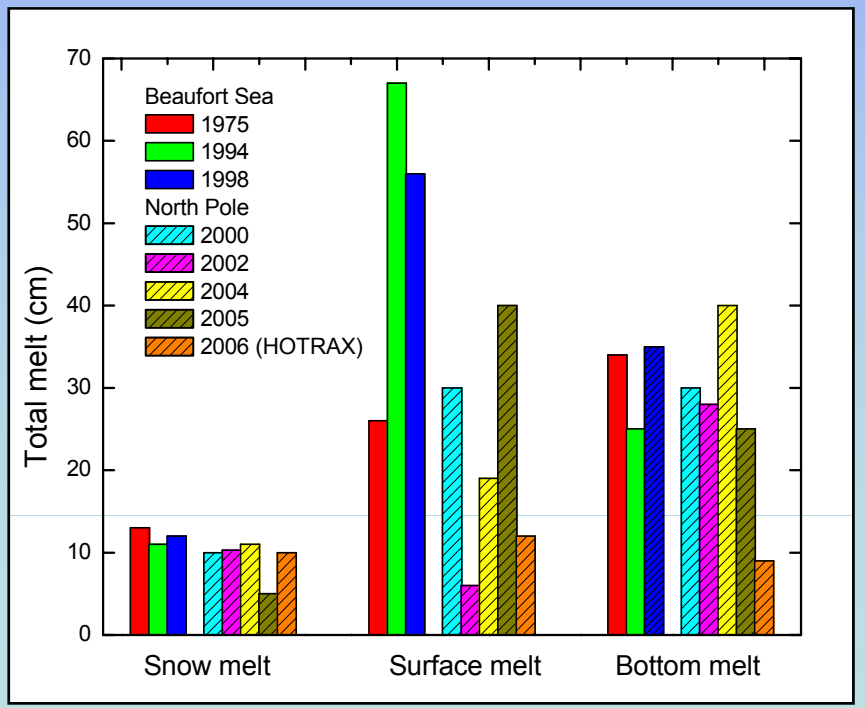
Ice Mass Balance Buoy Network

2000 - 2006



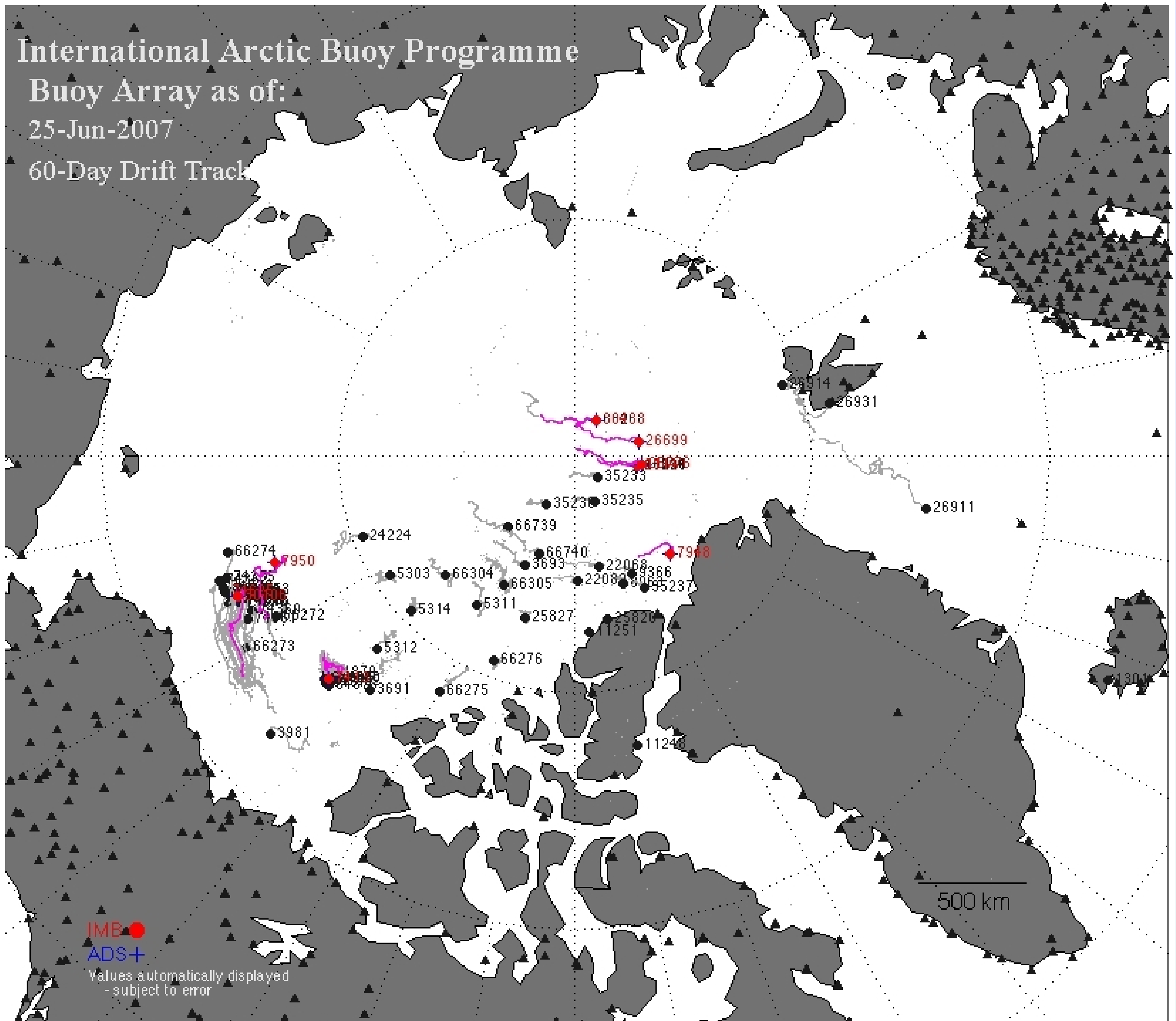
- Repeated installations:
  - North Pole Environmental Observatory
  - Beaufort Gyre
- IPY deployments as part of Arctic Observing Network

- Observed regional variability
- Comparison of NP and BG
- Most pronounced difference in surface melt
- Consistent with solar input as function of latitude



AON - NOAA Support for IABP

- International Arctic Buoy Program (IABP)
- NOAA, through NIC, coordinates interagency participation
- NOAA funds buoy purchases and ARGOS costs

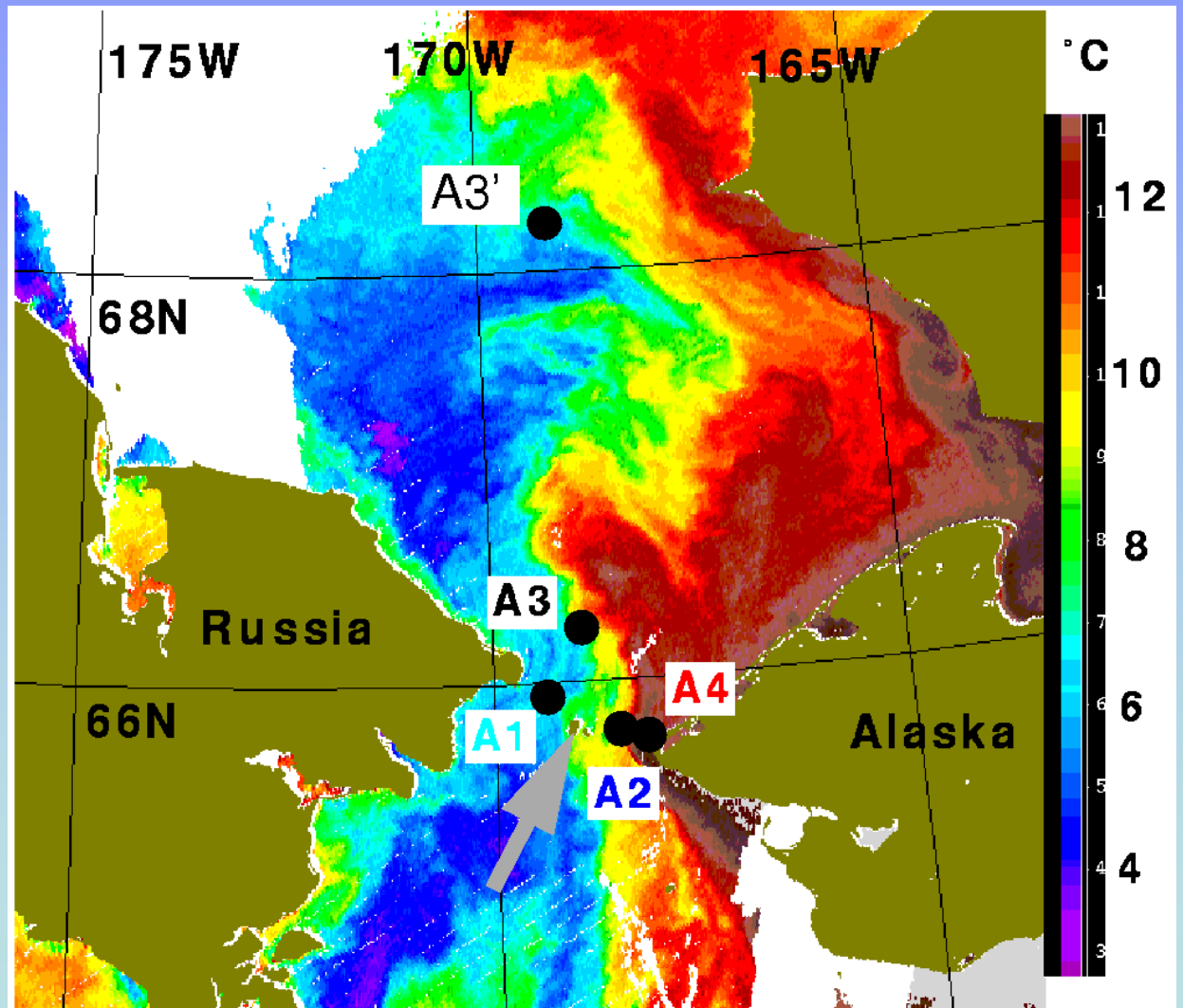

International Arctic Buoy Programme
Buoy Array as of:
25-Jun-2007
60-Day Drift Track
26914
26931
26699
35233
35236
35235
26911
66739
24224
66274
7950
66740
3693
7948
22068
66304
5303
66305
35237
5314
5311
25827
66272
11251
66273
5312
66276
3691
66275
3981
11248
500 km
IMB
ADS
Values automatically displayed
- subject to error

AON - Physical Variability and Ecological Response to Reduced Sea Ice in Bering/Chukchi Region

- NOAA, with NSF and Russian partners, conducts annual observation and mooring deployment in Bering Strait to observe physical state, fluxes through the Strait, and their trends
- Physical-Ecological surveys every 4 years detect water column structure, productivity, biomass, and biodiversity trends
- Major program planned for summer 2008

A RUSALCA Goal: Gateway Fluxes via Long-term Moorings in Bering Strait

2007. NOAA, NSF, RAS will install 8 moorings across the Bering Strait



RUSALCA

RUSALCA Goals:

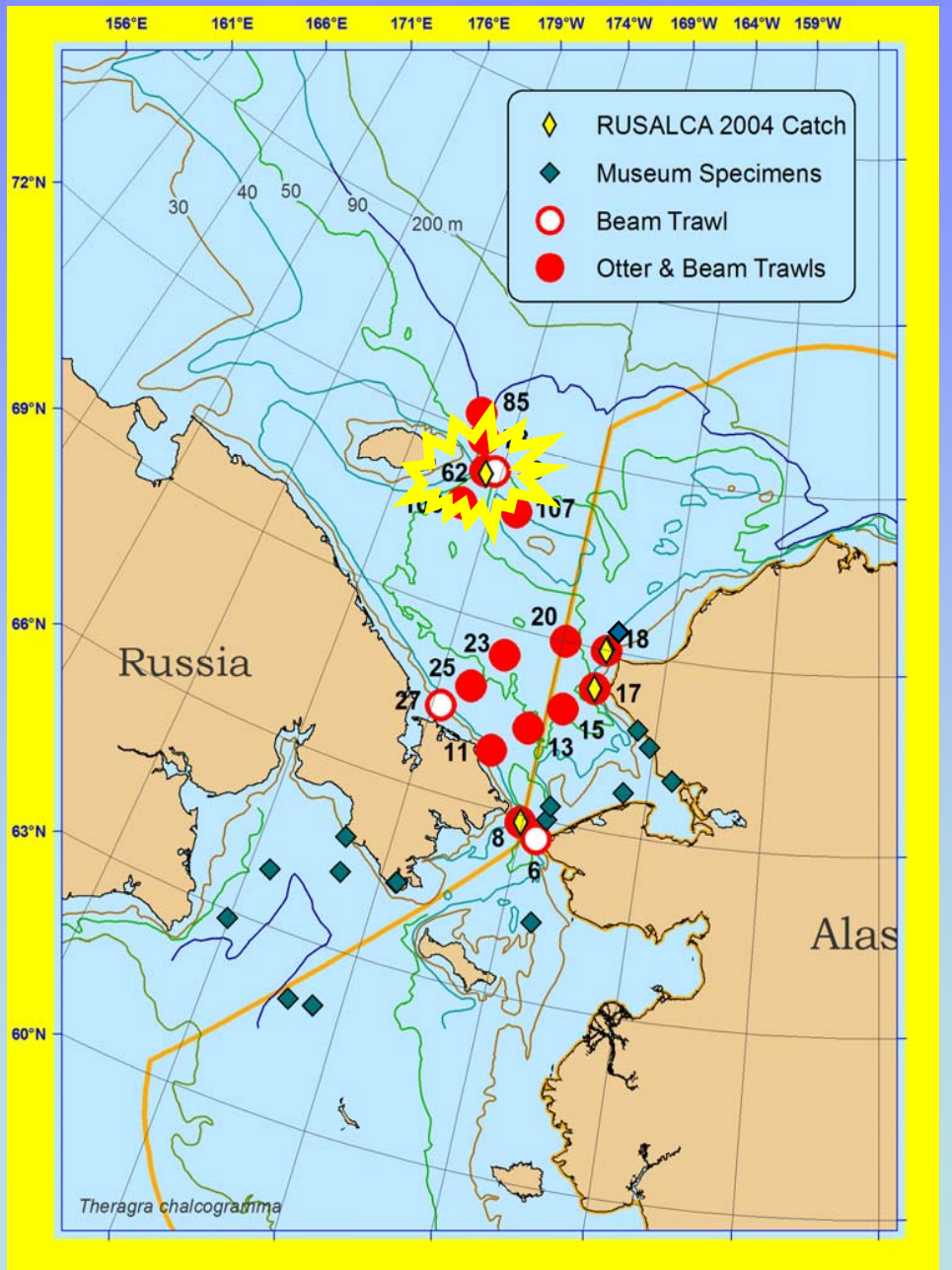
- Observations where Arctic sea ice is reducing
- Monitor fresh water, nutrient fluxes
- Monitor ecosystem indicators of climate change.
- Improve international Arctic science collaboration
- Explore the unknown Arctic

Russian American Long-term Census of the Arctic

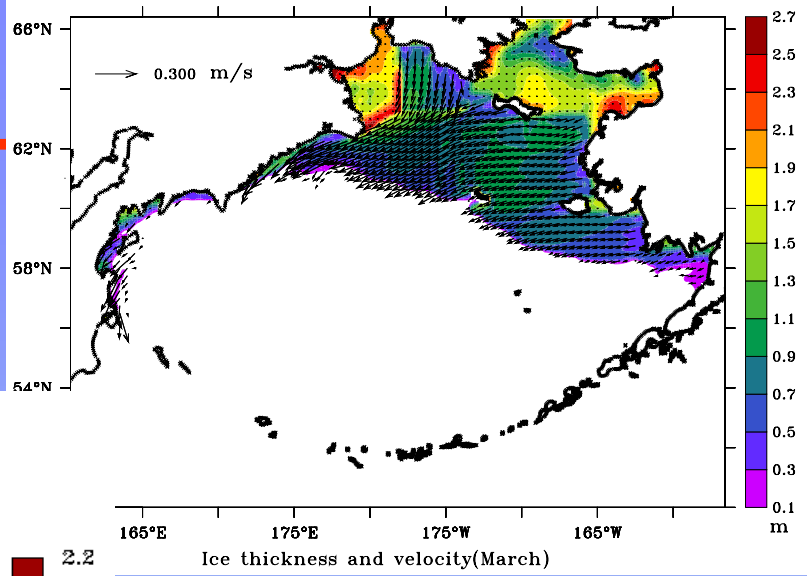
RUSALCA

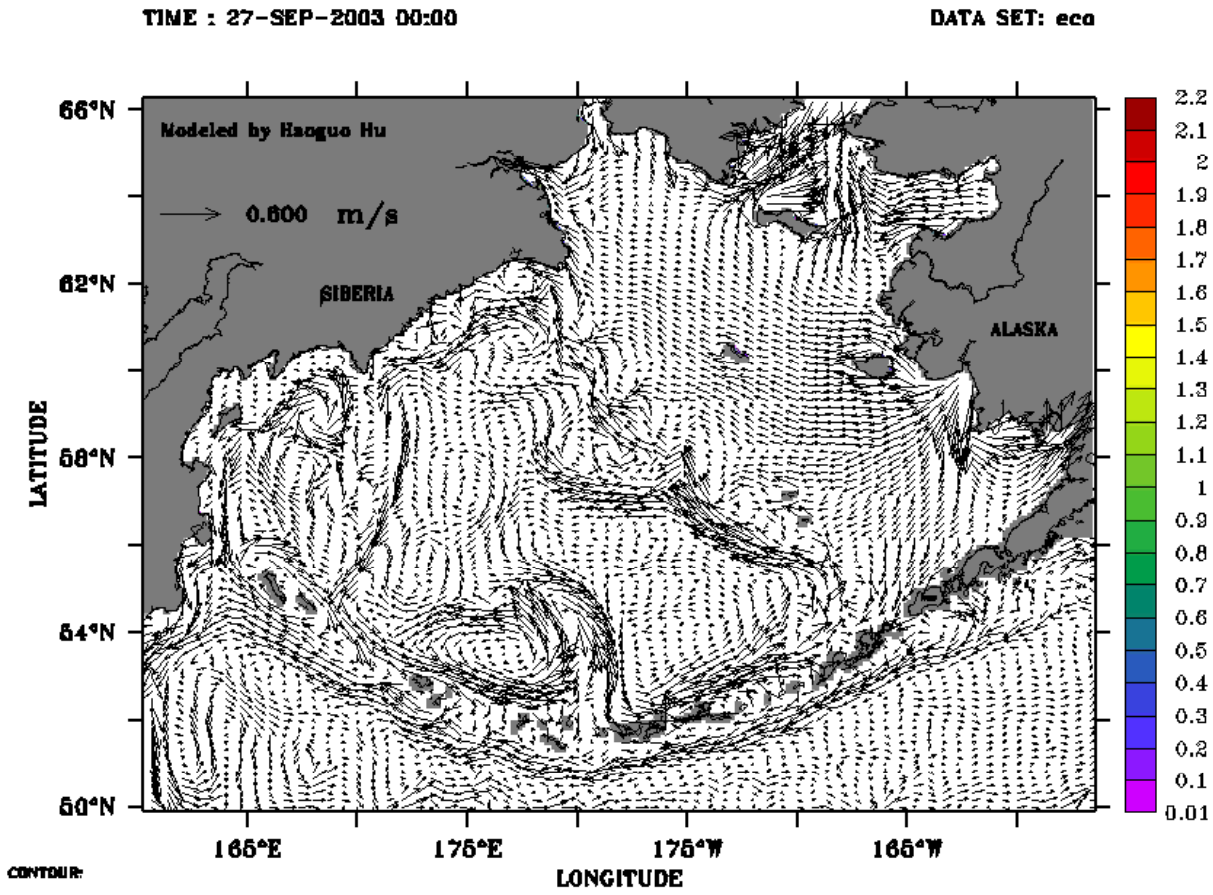
Found Further North

Walleye Pollock
Theragra chalcogramma



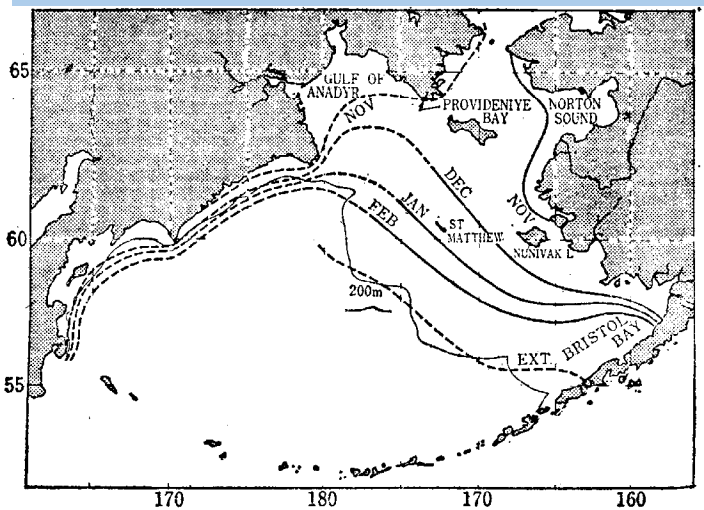
Coupl[illegible] CIOM (Coupled Ice-Ocean Model) to 3D Ph[illegible]M (Physical-Ecosystem Model): Mesoscale eddies on-shelf adv. nutrients, upwelling, Nutrient pumping, Ice-edge bloom, under-ice bloom, and open-water bloom (Wang's Arctic Modeling Group, IARC/GLERL)

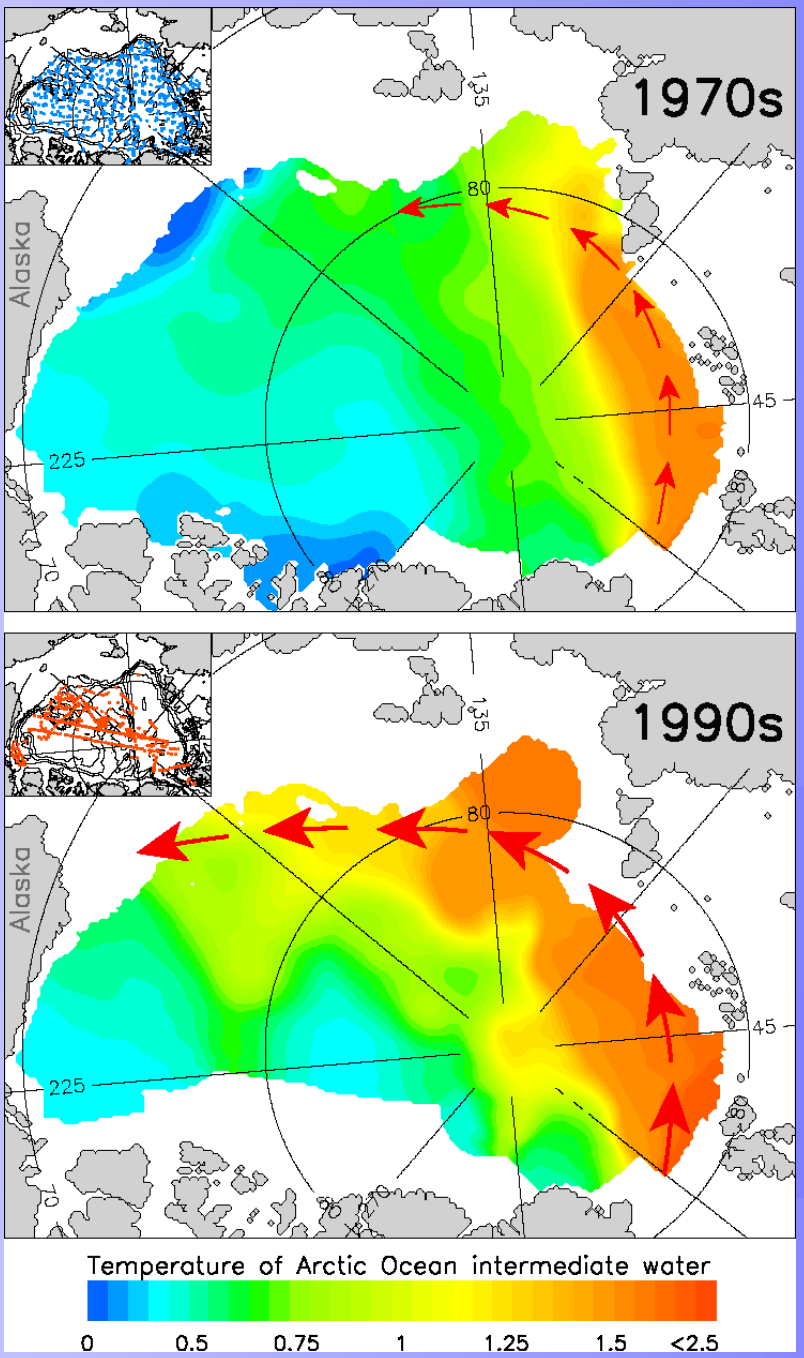




Improvement/Para.:

1) Wind-wave mixing
2) Tidal mixing
3) Lateral melting

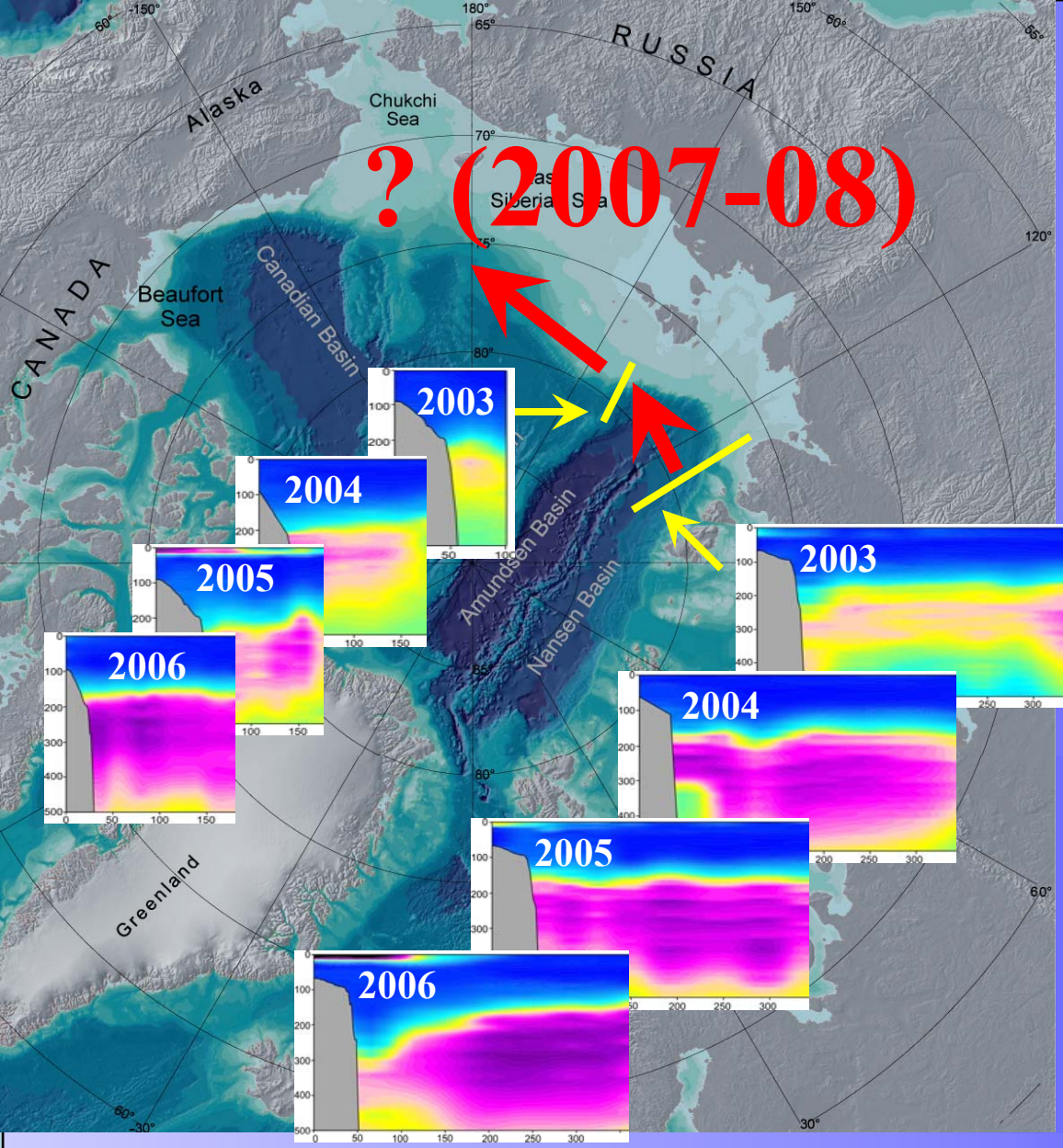




Inflow of Atlantic Water into the Arctic Ocean: different rates during different phases of multidecadal variability?

[Adapted from *Polyakov et al., 2004*]

Increase of the Atlantic Water heat content associated with multi-decadal variations could cause 0.8-1.0 m loss in ice thickness over the last 20 years.



NABOS observations capture propagation of warm water anomalies further eastward, towards Alaskan backyard – how far will it go?

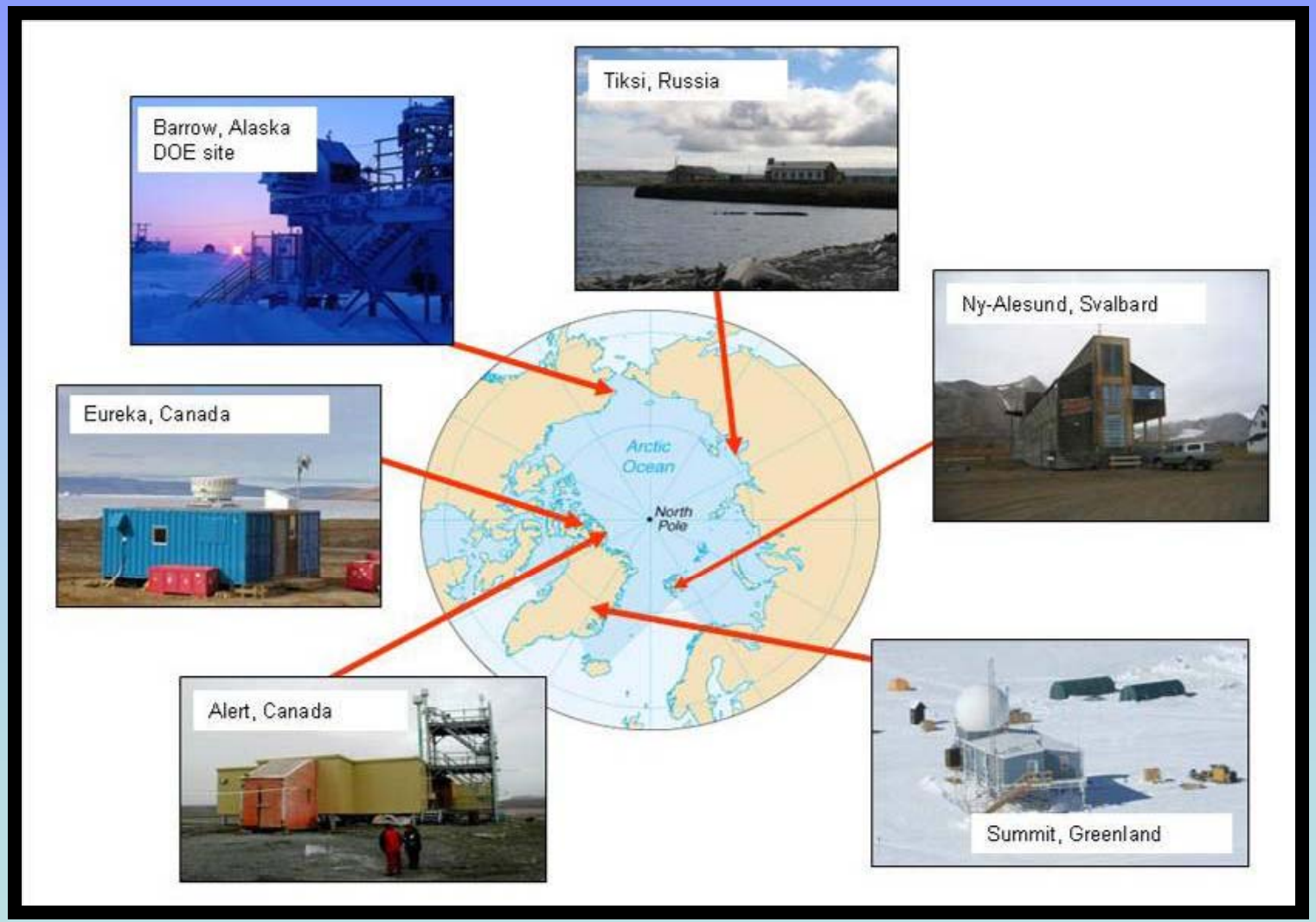
Arctic Ocean freshwater content changes

and their causes

AON - Atmospheric Observations

- Small network of observatories for clouds, radiation, aerosols
- Anchor points for satellite observations of the Arctic basin
- Improve model projections of sea ice

AON - Atmospheric Observatory Locations



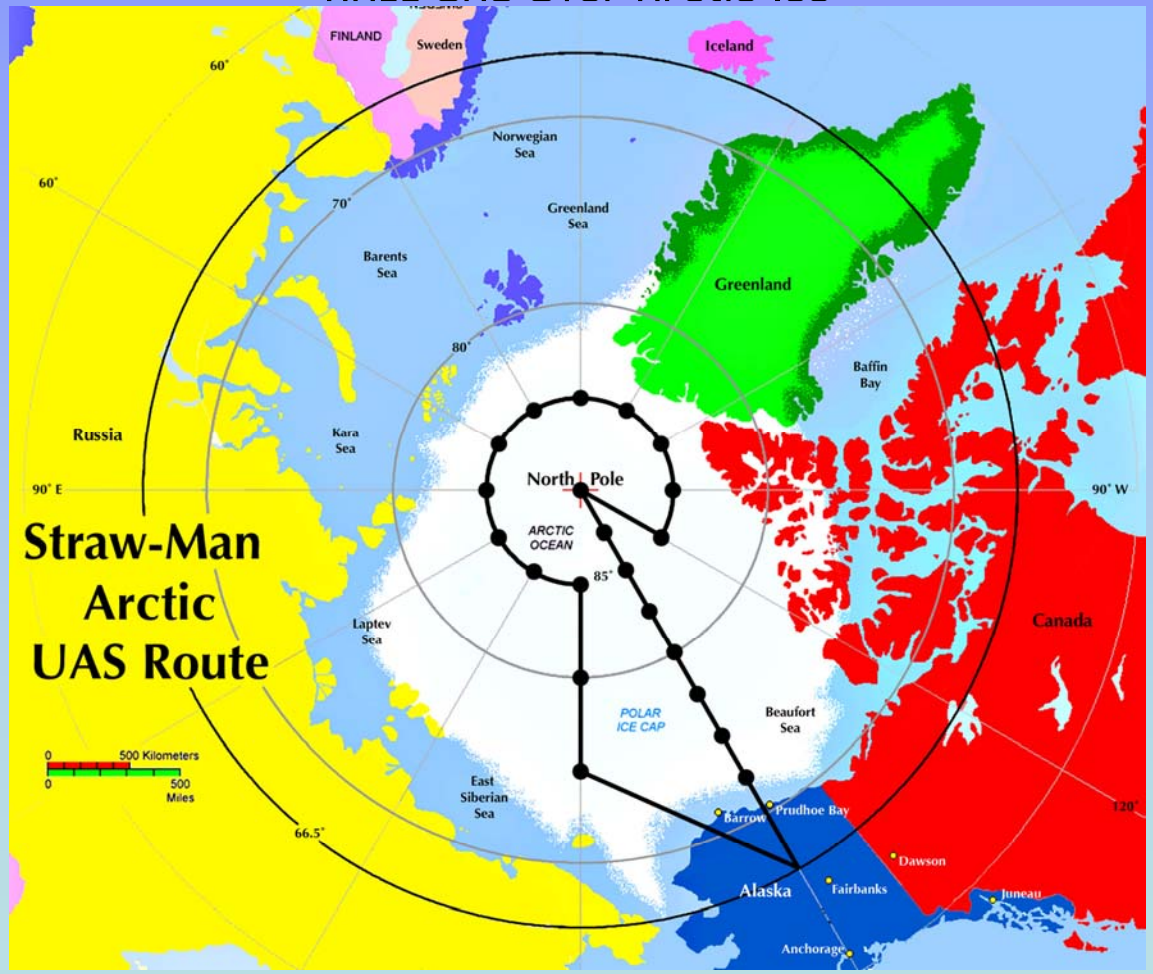
SEA ICE:

Amount and quality of sea ice can change rapidly in the Arctic. Current monitoring is inadequate to understand changes and make short or long-term predictions about conditions of the ice.

Remote sensing by Unmanned Aircraft Systems can provide detail greater than satellites and cover larger areas than in situ. NOAA and partners are evaluating UAS use in the Arctic

“Strawman” Route

HALE UAS Over Arctic Ice



AON - National and International Coordination

- Co-lead with NSF development of AON National Implementation Plan
- Working with many partners to develop international approach to AON
- Build on existing activities
- Encourage gap-filling and coordination
- Coordinate funding decisions by various national agencies

Loss-Of-Sea-Ice Impacts

- Living Marine Resources
  - Evaluating impact of retreating sea ice in Bering Sea on marine fisheries and mammals. Cooperate with NSF and NPRB*
- Coastal issues
  - Support research at UAF on coastal processes as affected by sea ice reduction
  - Support Alaska Center for Climate Assessment and Policy (ACCAP)*

NOAA-GFDL Sea Ice Model: 2001 Formulation

- No dynamics: ice moves with current, ad hoc adjustment prevents excessive build-up.
- Single layer thermodynamics with no treatment of heat capacity
- No explicit treatment of snow; Snow albedos factored in based on surface temperature
- No leads: each cell is either ice-covered or ice-free

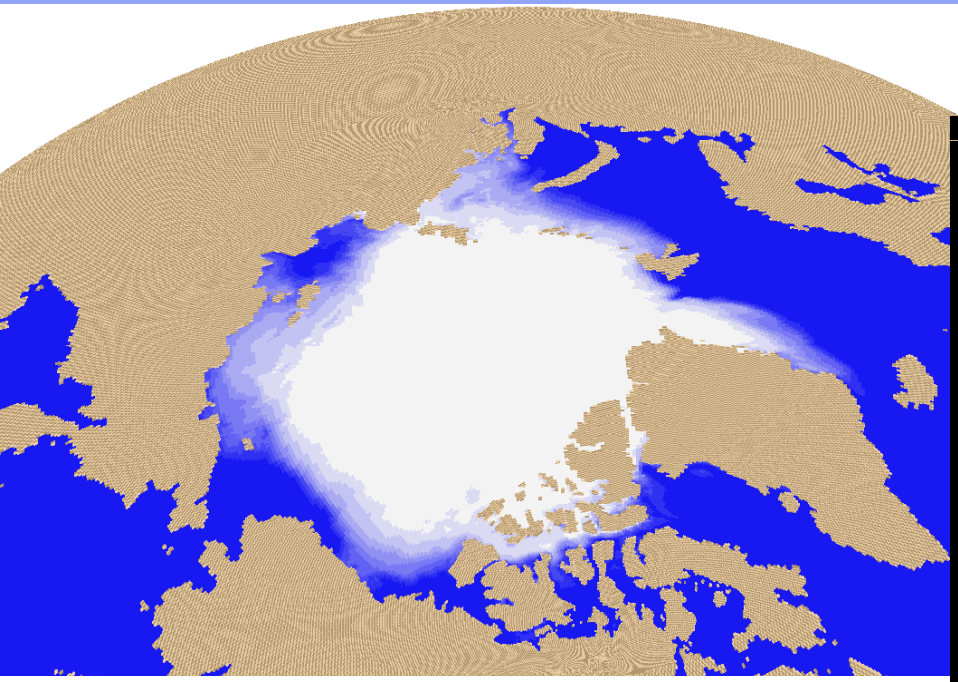
NOAA-GFDL Sea Ice Model: Current Formulation

- Full sea ice dynamics with elastic-viscous-plastic rheology
- 5 ice thickness categories + open water (leads) to represent subgrid heterogeneity
- 3 layer thermodynamics; 2 ice layers, 1 snow layer; representation of sensible and latent (internal brine) heat capacity

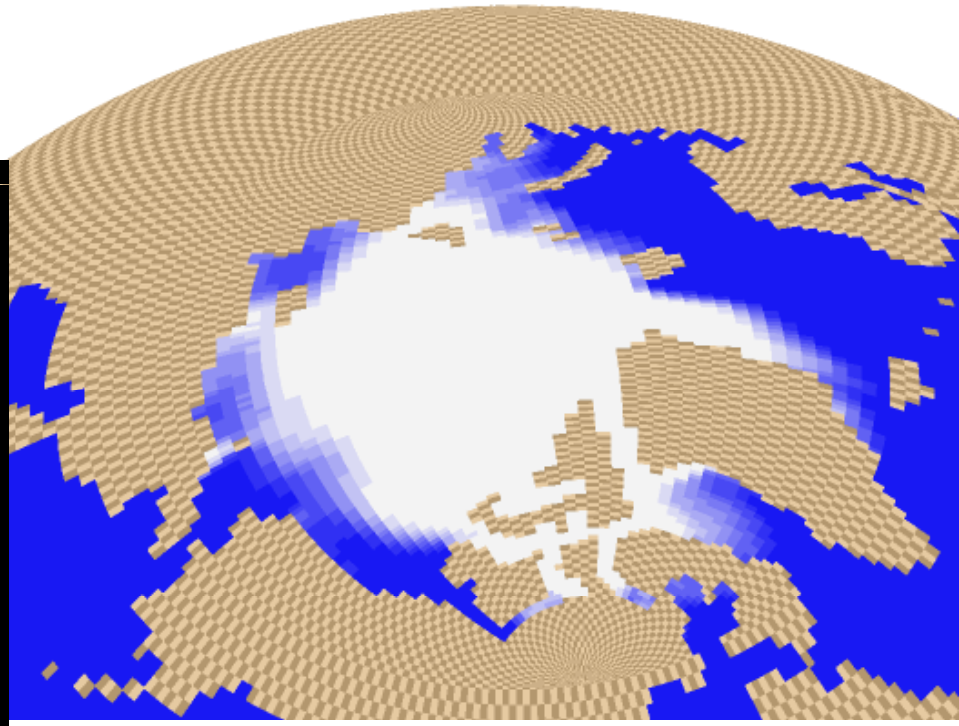
NOAA-GFDL Sea Ice Model: Future Plans

- Review and tune-up of dynamical parameters to reproduce satellite and buoy drift observations
- Implement ridging scheme for better representation of subgrid ice deformation
- Explicit representation of visible/near-ir and direct/diffuse solar radiation streams
- Simulate, rather than parameterize, apparent optical properties (reflectivity and transmissivity) based upon inherent optical properties of ice and snow

Planned improvements in sea ice model component of GFDL's global climate model



Next generation GFDL Model? running test cases now ("workhorse" circa 20??)



Current "workhorse" GFDL CM2.1 Model (circa 2005)

Data Analysis and Dissemination

- State of the Arctic Report*

- Arctic Change Detection and Analysis*