ROMS in the Bering Sea

Kate Hedstrom, ARSC/UAF
With help from many!
January, 2011

Outline

- **Bering sea overview**
- **Setup of NEP and Bering domains**
  - Usual stuff
  - Extra code not in trunk

Bering Sea Projects

- **Built NEP grid for GLOBEC – covers California waters to Bering**

- **MMS oil spill risk assessment – needed a model for Bristol Bay EIS**

- **BEST/BSIERP – ecosystem changes with climate**

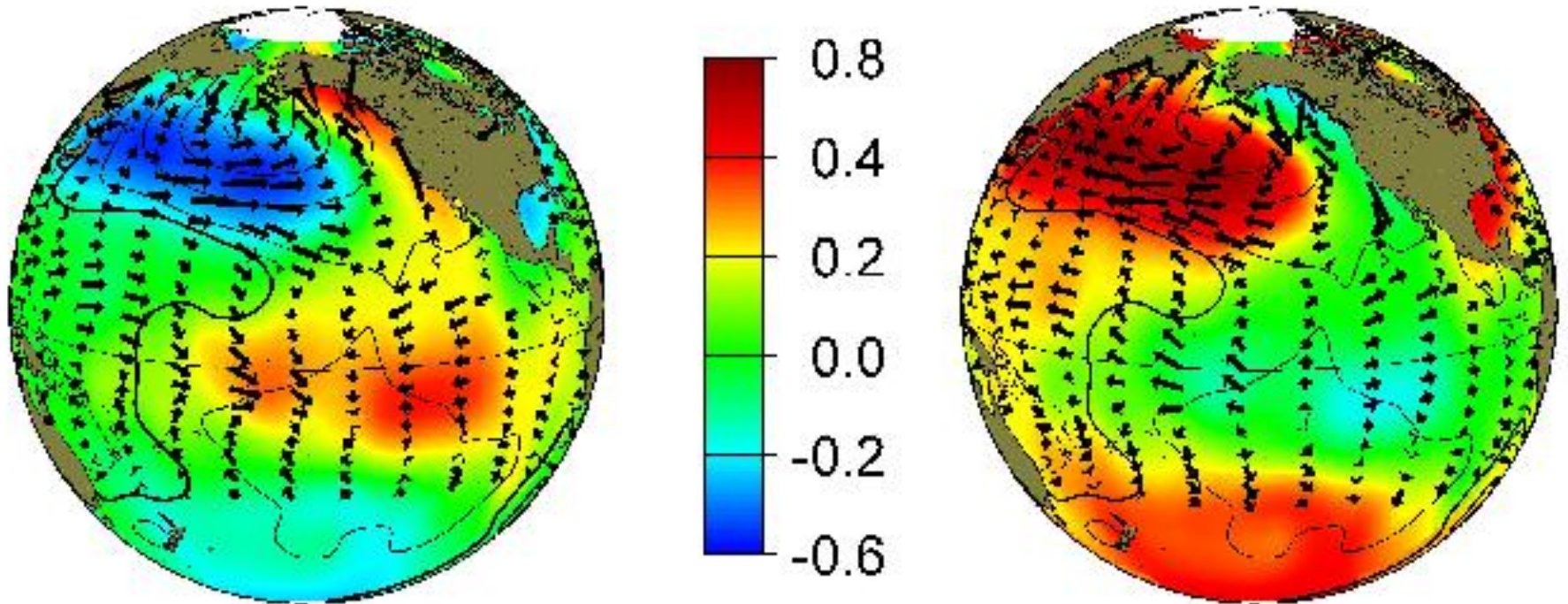- **Float tracking project – promised a nested Bering model**
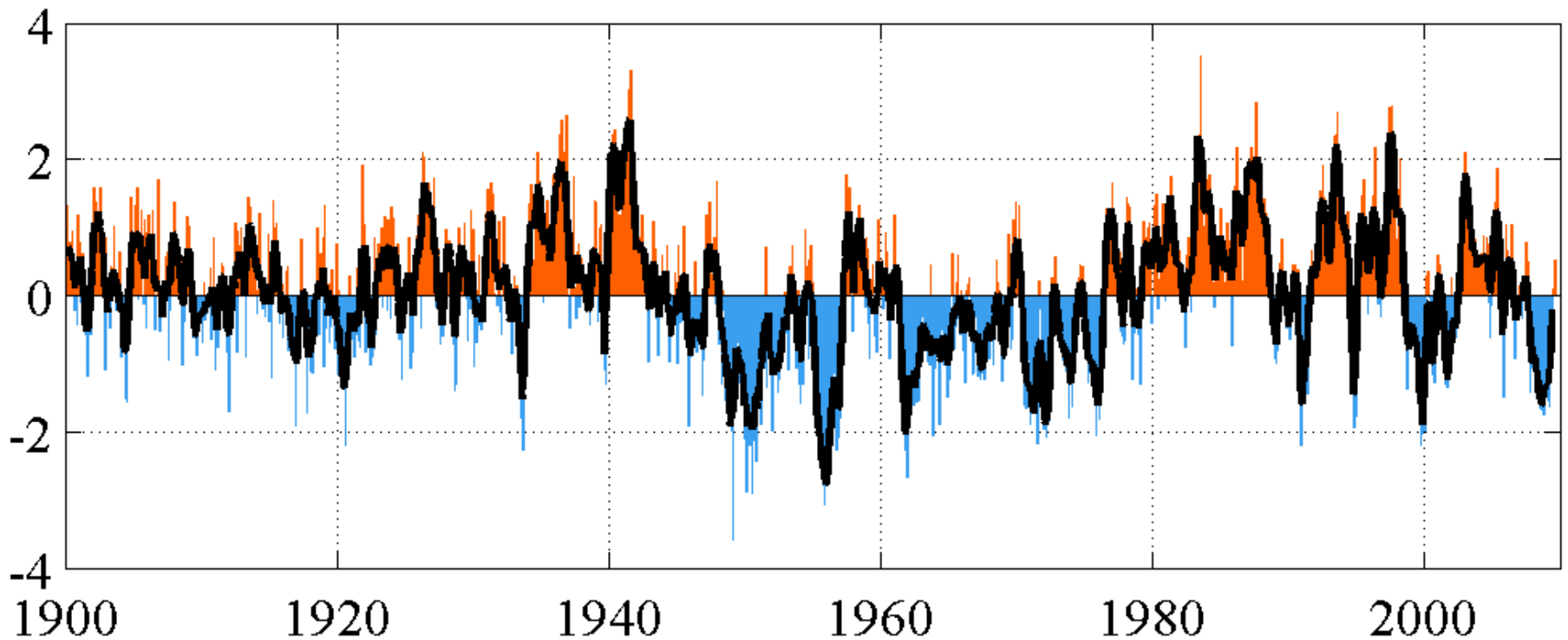
Early 1970's

Mid1970's

1980's

Changes in species composition in small mesh bottom trawls in Pavlof Bay. *Rev. Aquat. Sci.* (1992)

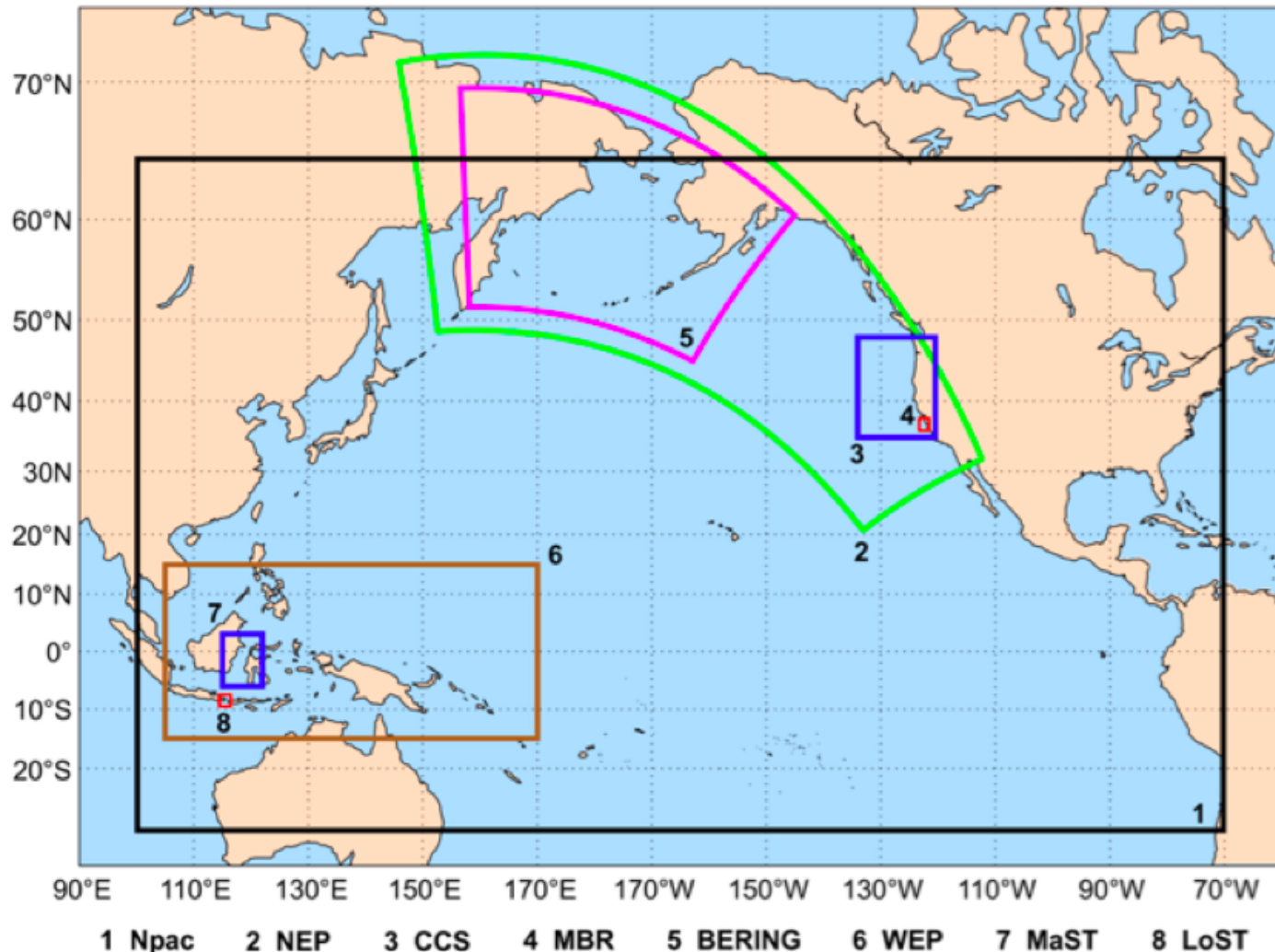# Pacific Decadal Oscillation

Regime shift and PDO

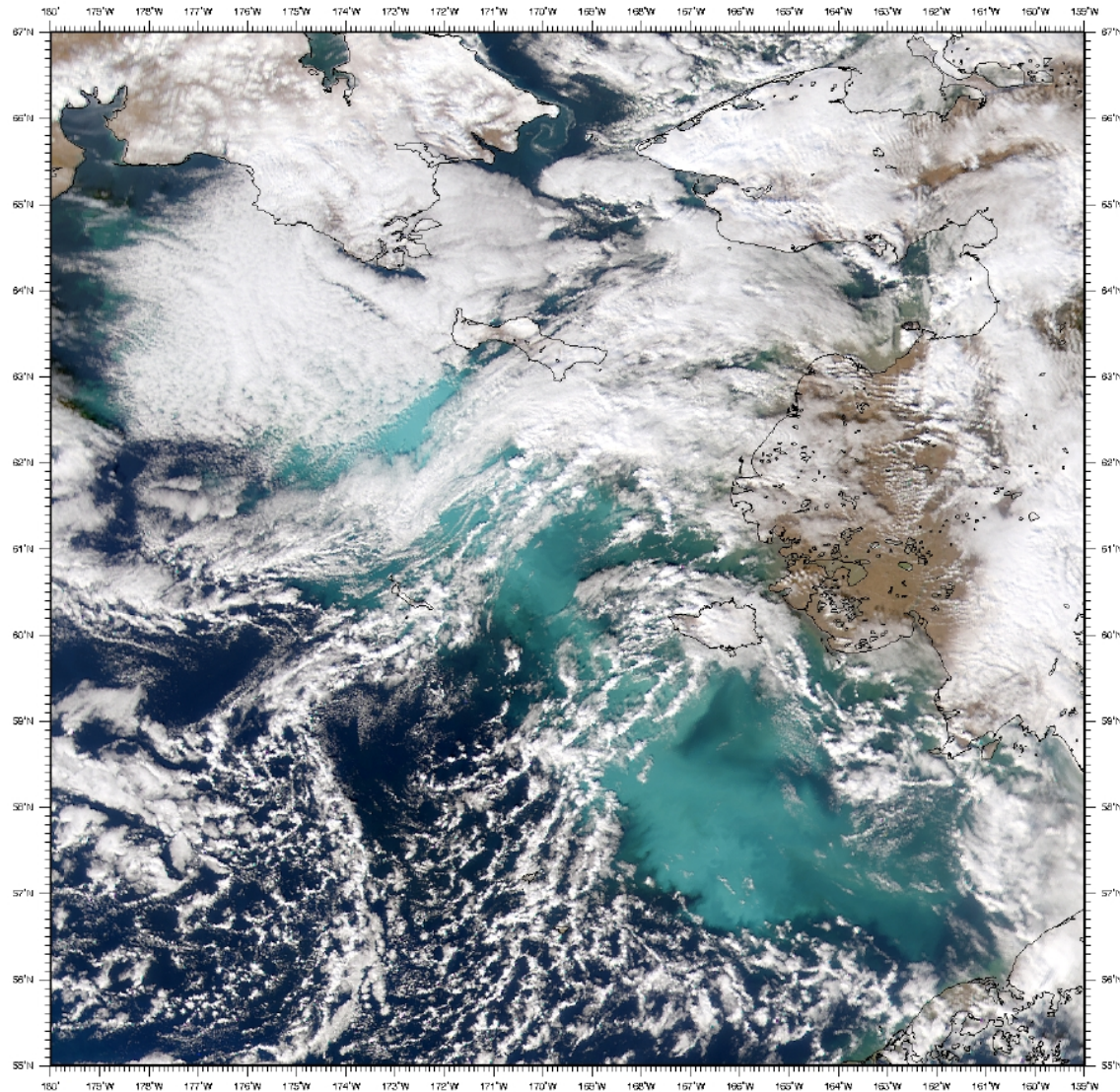monthly values for the PDO index: 1900-September 2009

Some Regional Domains
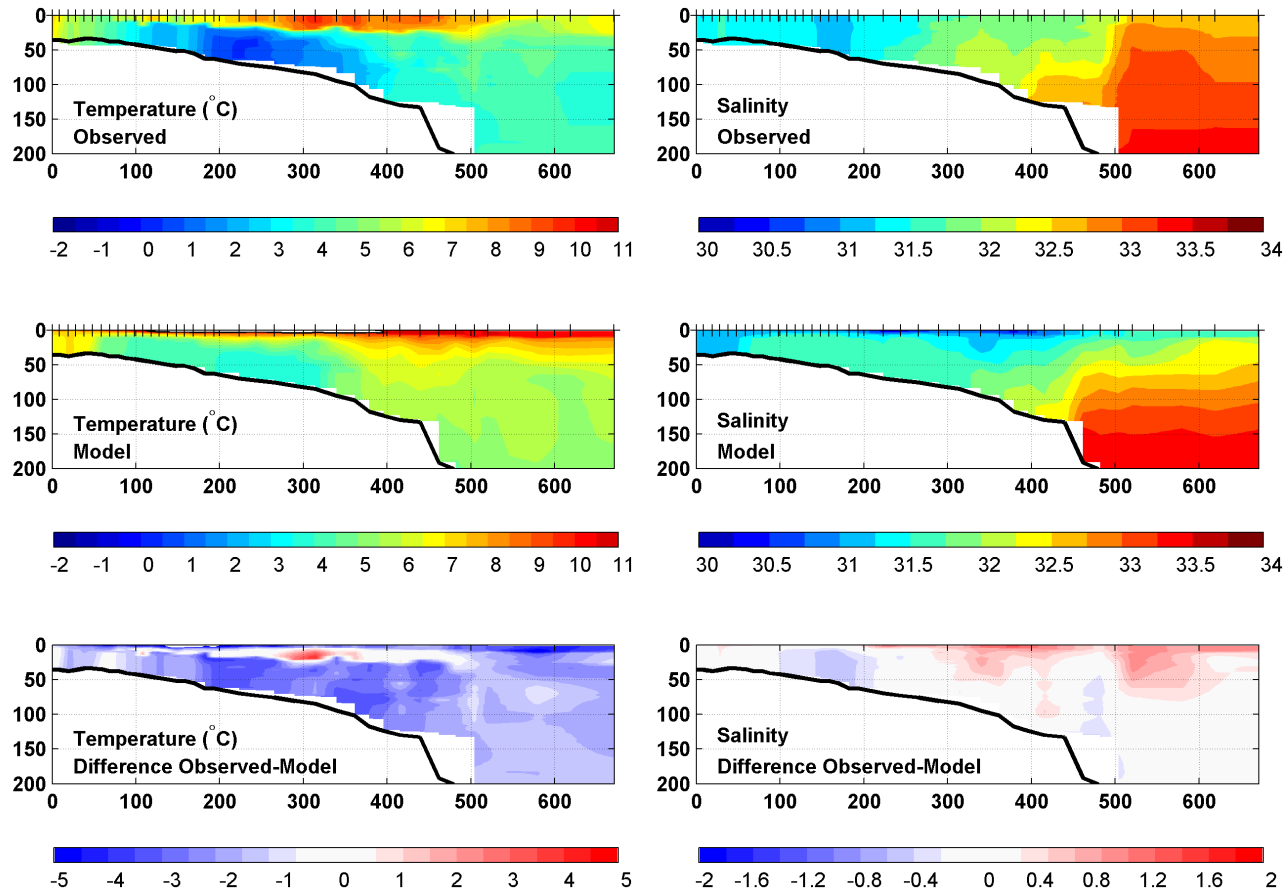
Eastern Bering Sea

- **Goal is to model:**
  - Ocean physics
  - Phytoplankton bloom
    - Spring, fall, ice algae
  - Zooplankton
  - Fish
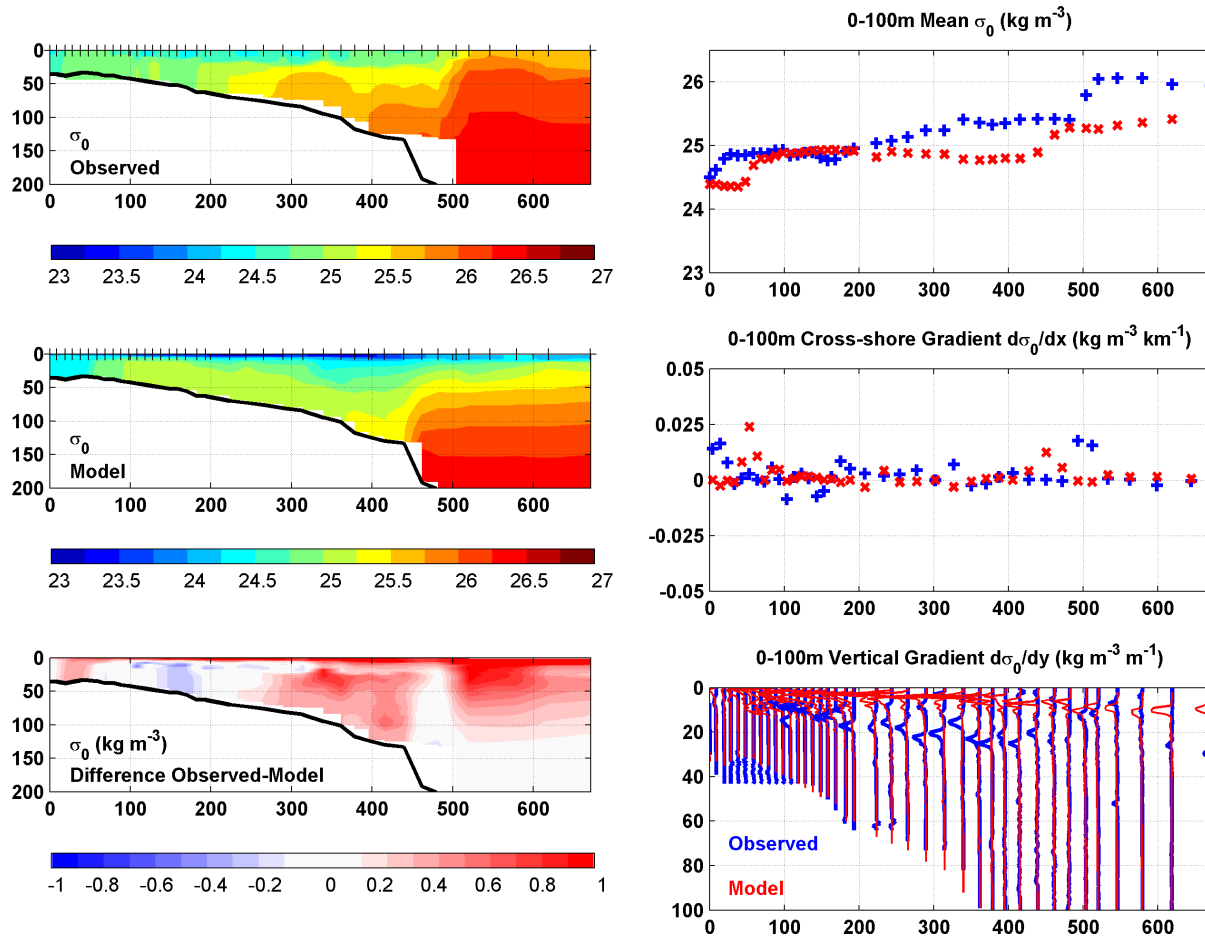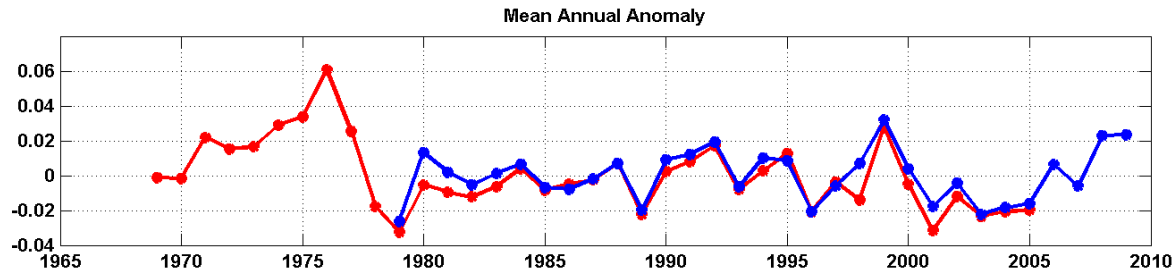 - Fishing fleet
- **Timing of spring bloom depends on sea ice melt**
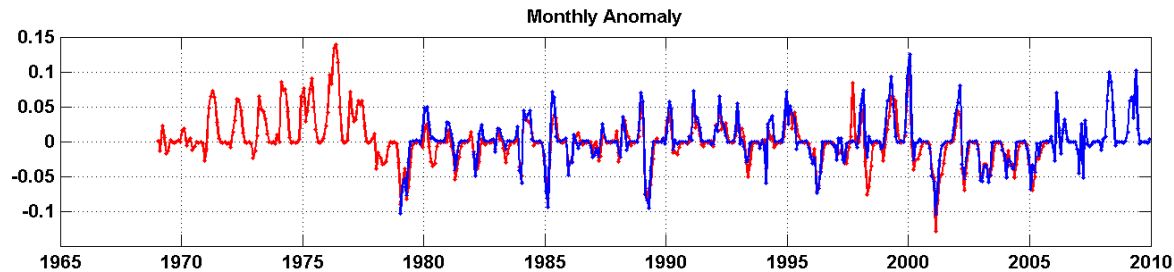
Model Validation
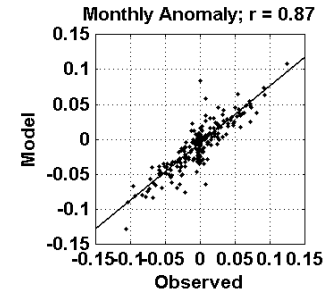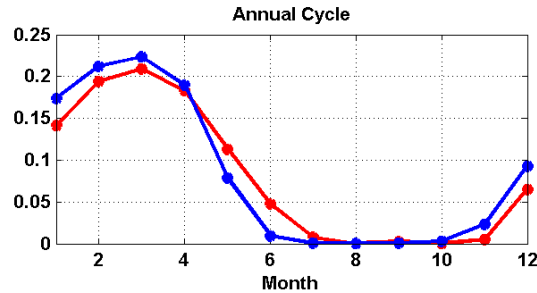
Cape Newenham Transect: June 1997

Model Validation

Cape Newenham Transect: June 1997
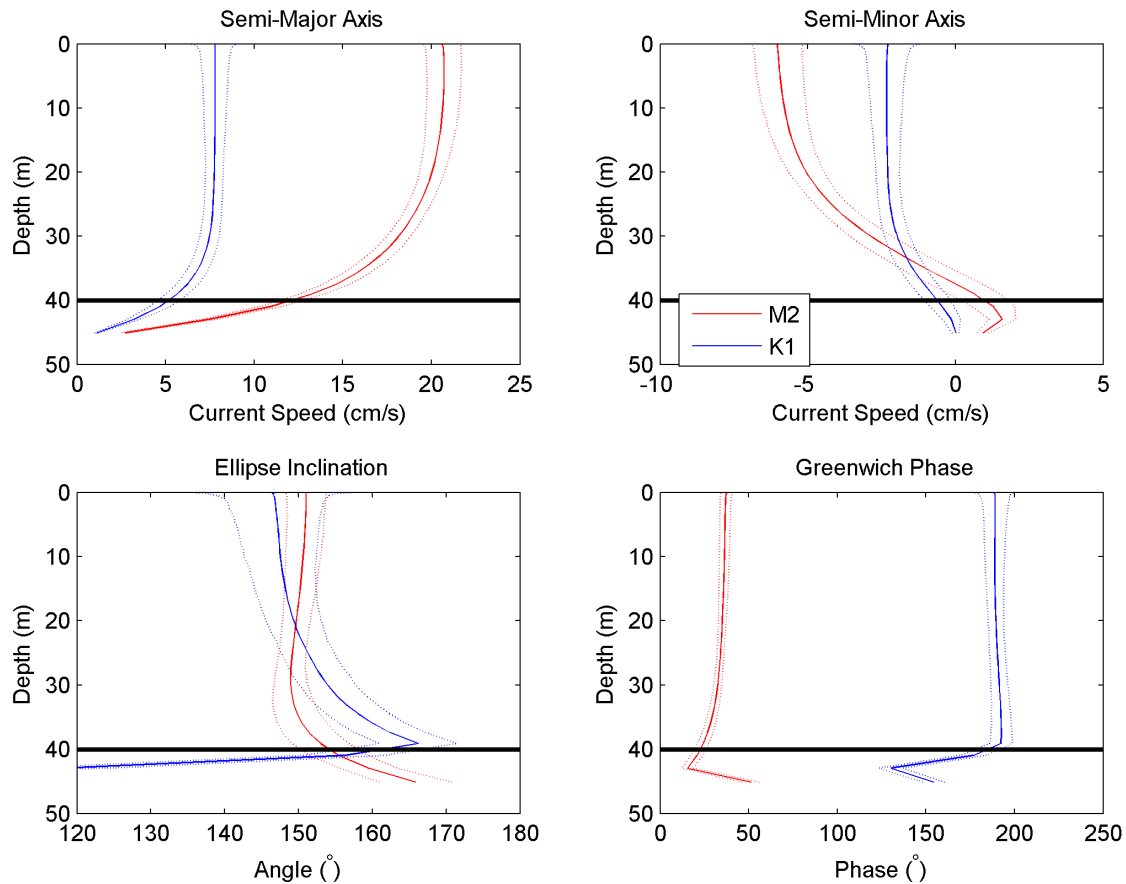
Sea Ice Concentration

NEP5 Run42 Eastern Bering Sea areally weighted sea ice concentration: Observed (blue) and Modelled (red)

M2 and K1 Tides

NEP5 Run35: M2 & K1 Mean Monthly Profiles Near Mooring F8

Model Requirements

- **Input files**
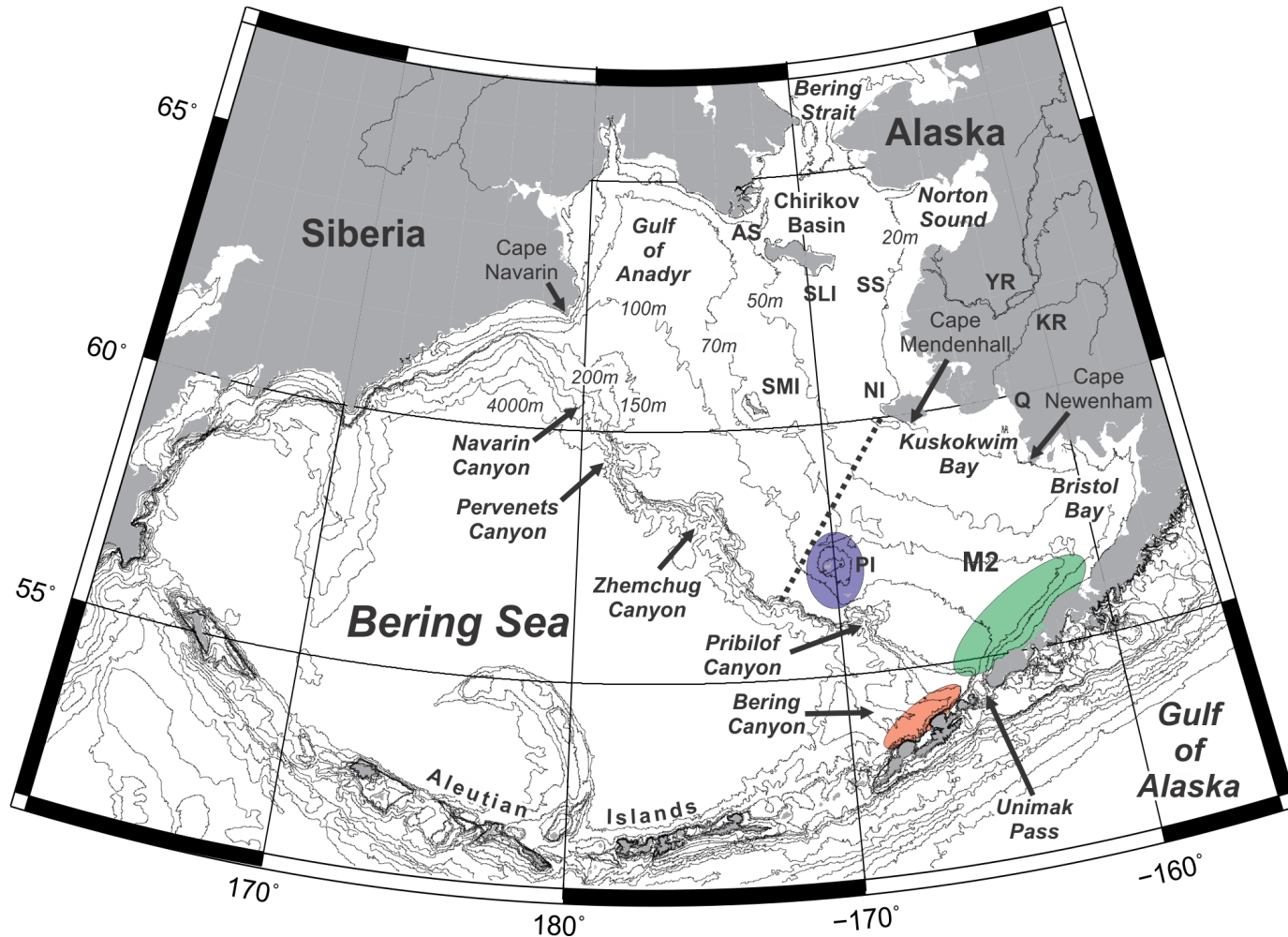 - Grid
  - Initial conditions
  - Boundary conditions
  - Forcing
- **Code changes**
  - cpp flags
  - Other changes
  - More in next talk

Grid Files

- **First NEP grid is over ten years old, created with old Fortran code**

- **Rectangular in a Lambert conformal conic projection**

- **Bering grid has four corners extracted from the NEP grid – 3:1 ratio of grids**

Better Bathymetry

Smoothed Bathymetry
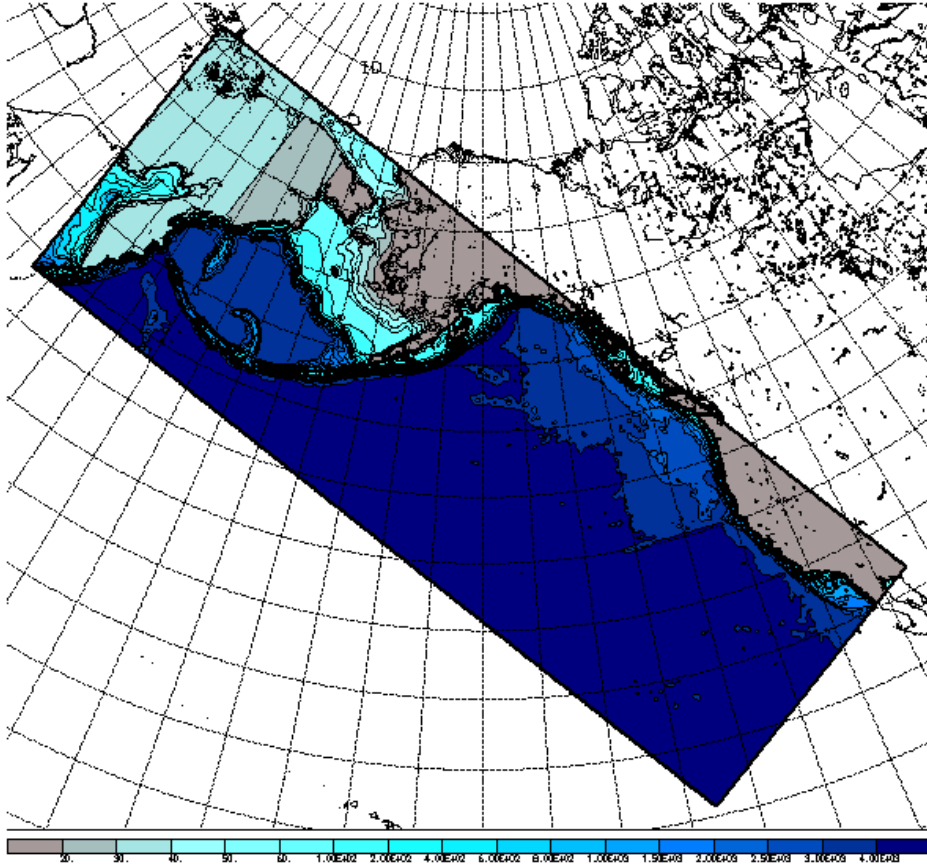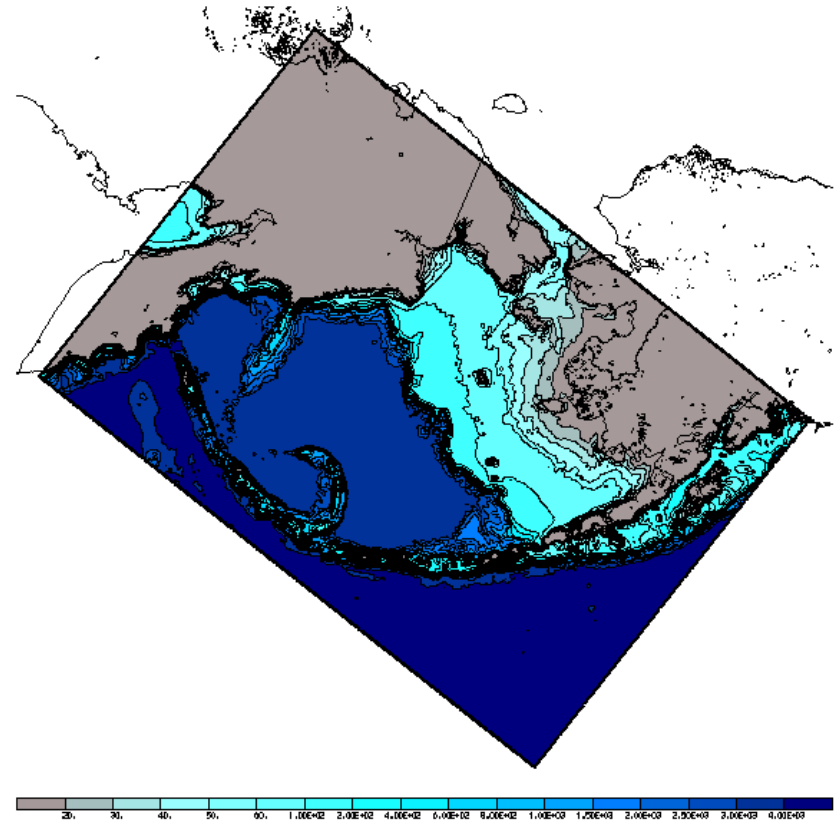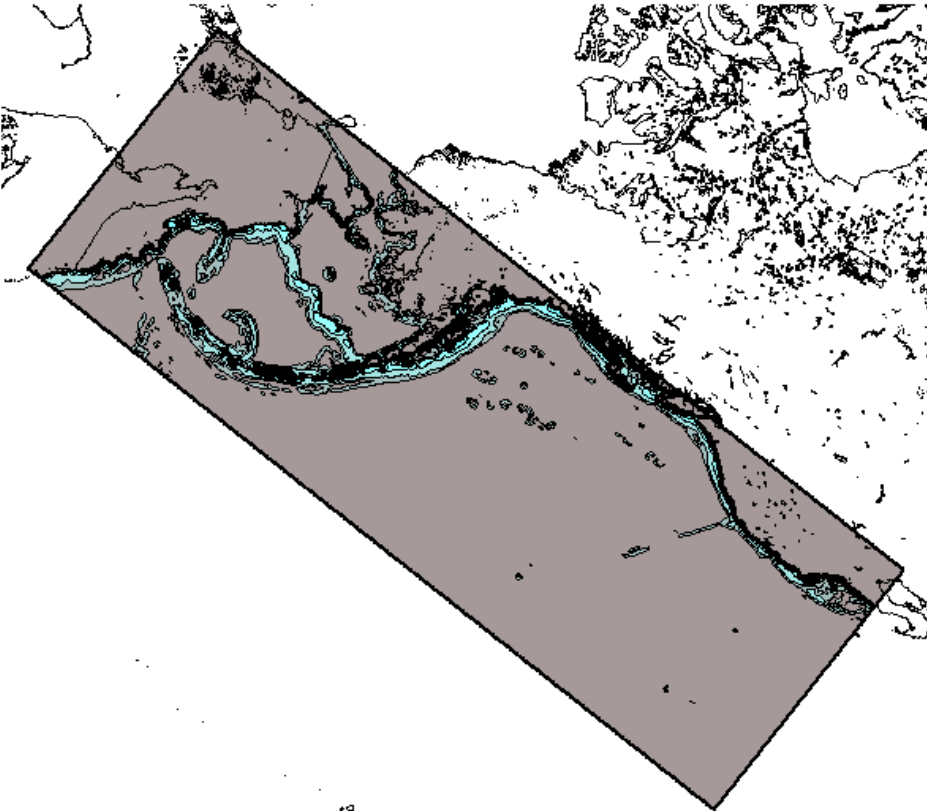
R-value
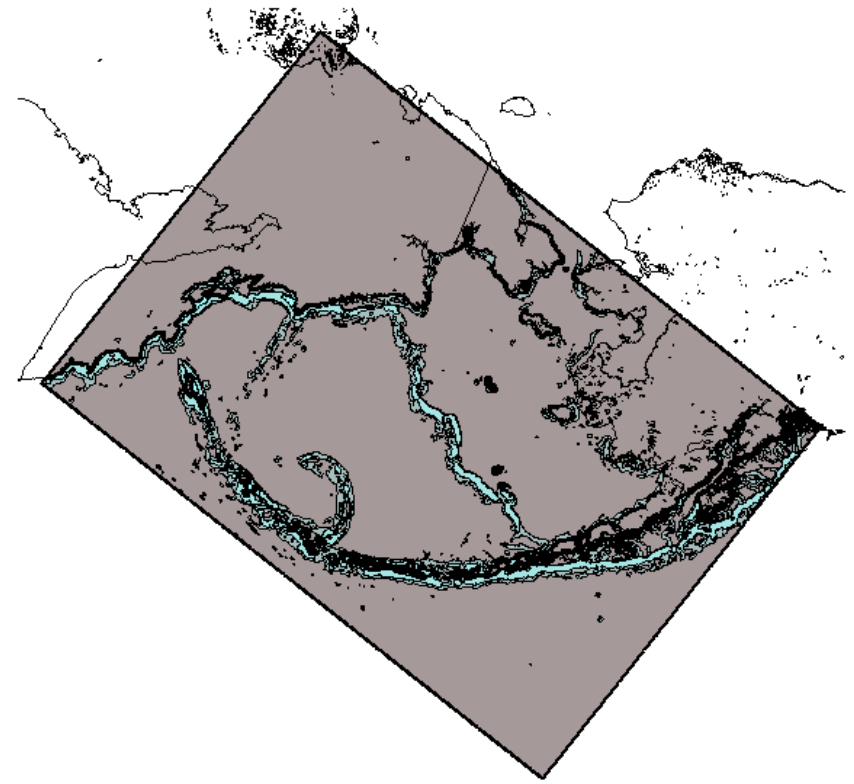
Zoom in
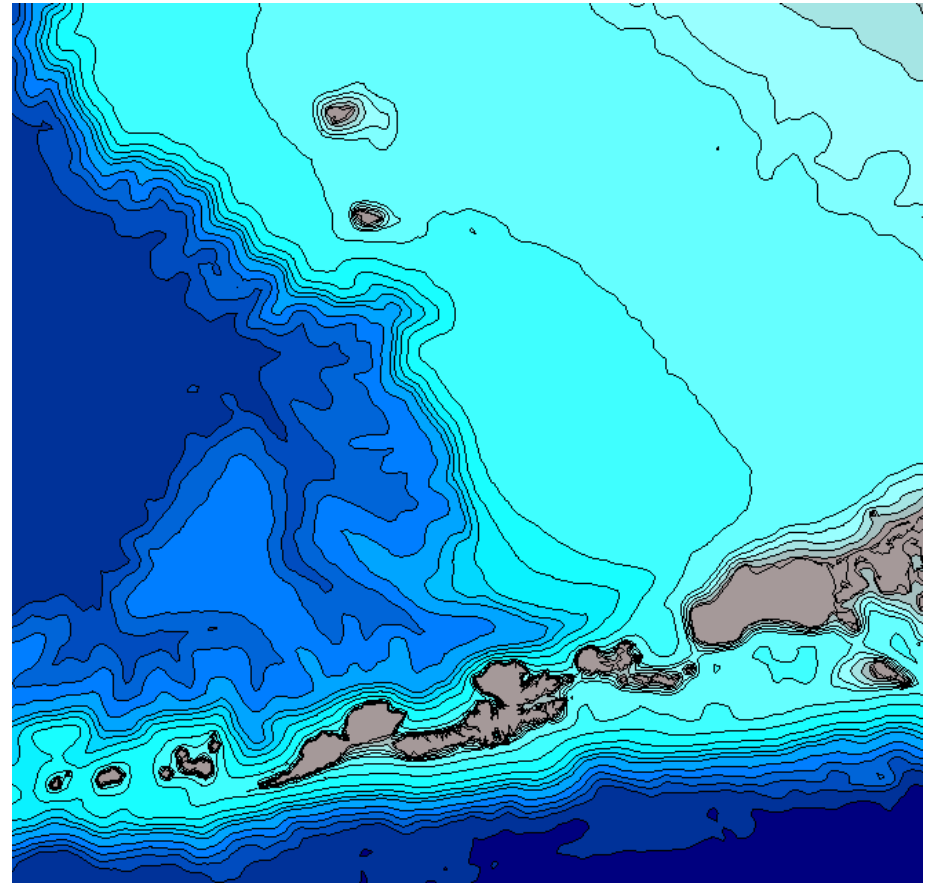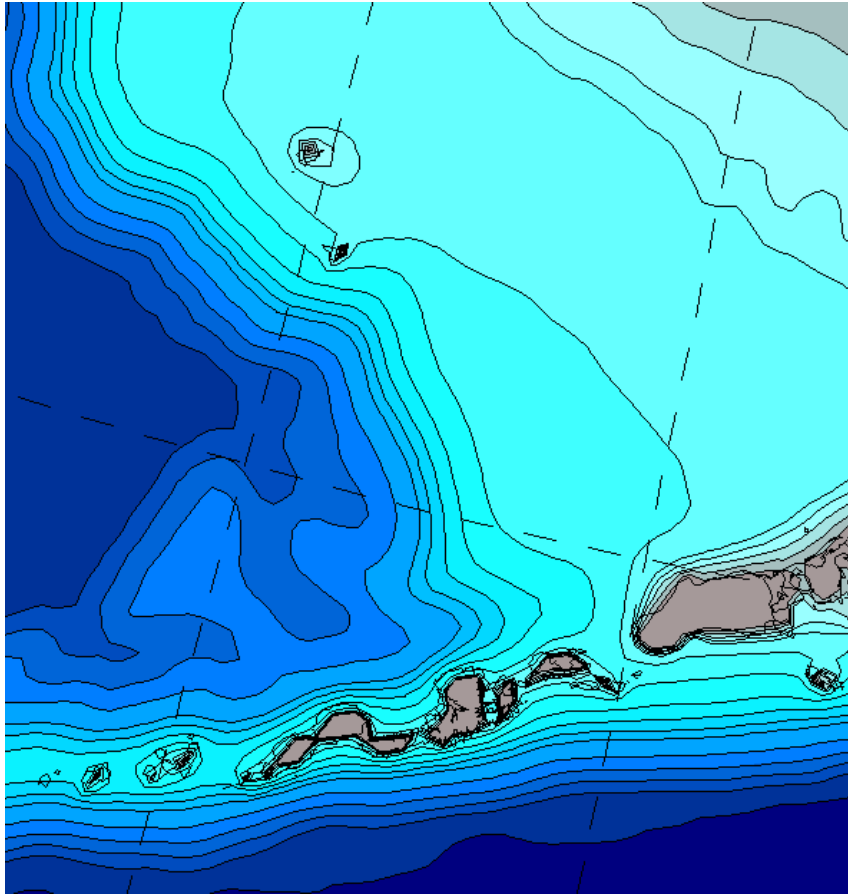
Land Mask

- **The bathymetry finder will optionally set the land mask based on sea level**

- **The land mask might not be quite how you want it, so run editmask**

- **Interactive matlab tool needing a matlab coastline file too**

Editmask
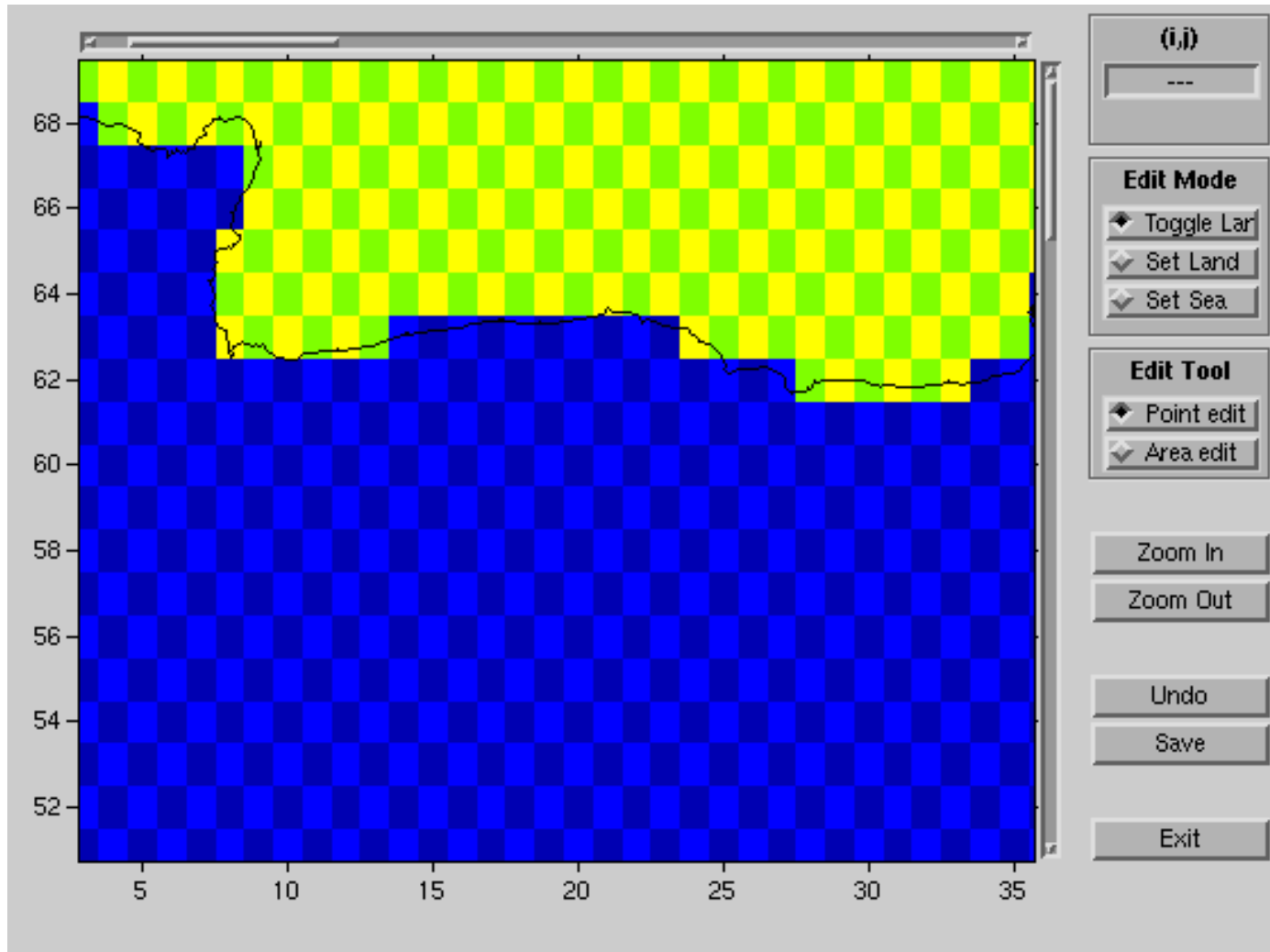
CDL Files

- **Provide the standard interface specification**
- **Ncdump format**
- **Let's go see...**

Initial and Boundary Files

- **Matlab scripts to create them from SODA for NEP**

- **Python scripts to create them from NEP for Bering**

- **We now have Python scripts for SODA too**

Forcing Files

- **ROMS can internally interpolate from coarse forcing files to the ROMS grid**

- **We have used NCEP, then CORE1, now CORE2**

- **Need to change some NetCDF details to match what ROMS expects – mostly using NCO**

Other Forcings

- **Fresh water**
  - Line source – used a PDL script
  - RUNOFF
  - SSS nudging
- **Tides – NCL scripts for OTPS tides**
- **Bering outflow – ana_psource.h**

Note on Timescales

- **Surface stress**
  - We once used COADS monthly mean wind stress
  - Now use 6-hourly winds
  - Not enough temporal resolution
- **Boundary conditions**
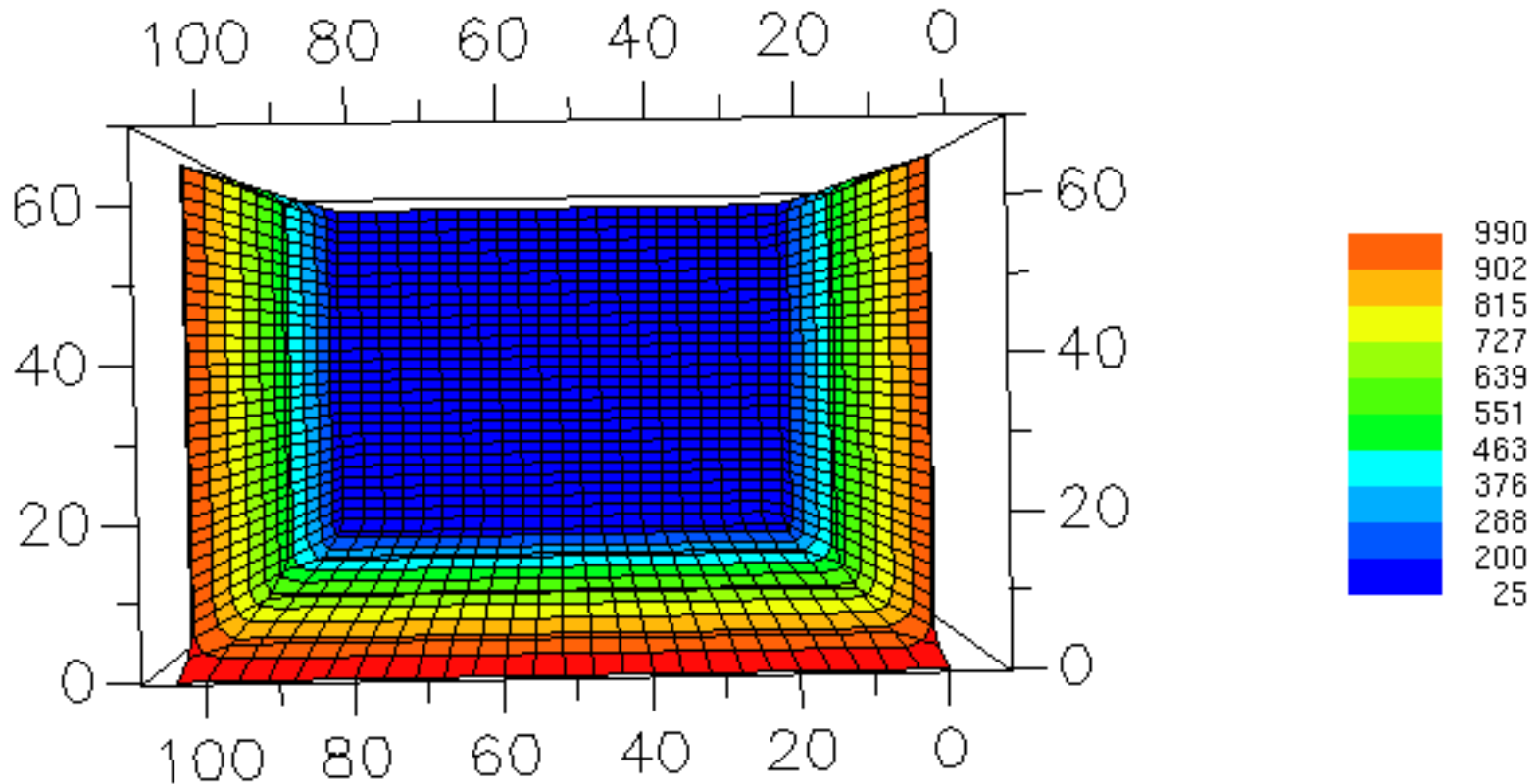 - We once used Levitus monthly climatology
  - Now use 5-day means from SODA
  - Like magic

Standard changes

- **nep5.h**
- **ana_hmixcoef.h**
- **ocean_nep.in**
- **floats.in**
- **stations.in**
- **Went from N=42 to N=60 for better representation of sharp thermocline**
- **Went from hmin=30 to hmin=10 for better bathymetric steering in shallow waters**

Horizontal Viscosity of a Sponge Layer

ROMS Code

- Sea ice from Paul Budgell
- Added tides to improve vertical stratification (and tidal filter)
- Hacked in TIDES_ASTRO code from Mike Foreman, POT_TIDES from Paul Budgell
- Added NEMURO (plus changes) and passive tracers
- Added AVERAGES2 output option

More...

- Added alternate bulk_flux routine from NCAR

- Added ALBEDO_CURVE hack to represent cloud effects

- Boundary conditions are two open, two closed, imposed Bering Strait flow (need to do better there)

- Georgina Gibson has been adding to BEST_NPZ model

NEP5 in Core ROMS

- Mods to varinfo.dat
- Change to output.F for more digits in ocean_avg_00001.nc name
- Change in output.F to set ldefout=.true. for stations
- Change in set_vbc.F because Tnudg is used for both OBC and SSS nudging
- Hack to step_floats.F to restart each year

Bering

- **Start 2-D, tides only**
- **Adjust spatially variable bottom drag for best results**
- **Still wonky in Cook Inlet**
- **In 3-D, had stability issues until added UV_SMAGORINSKY**

Tides (hourly)
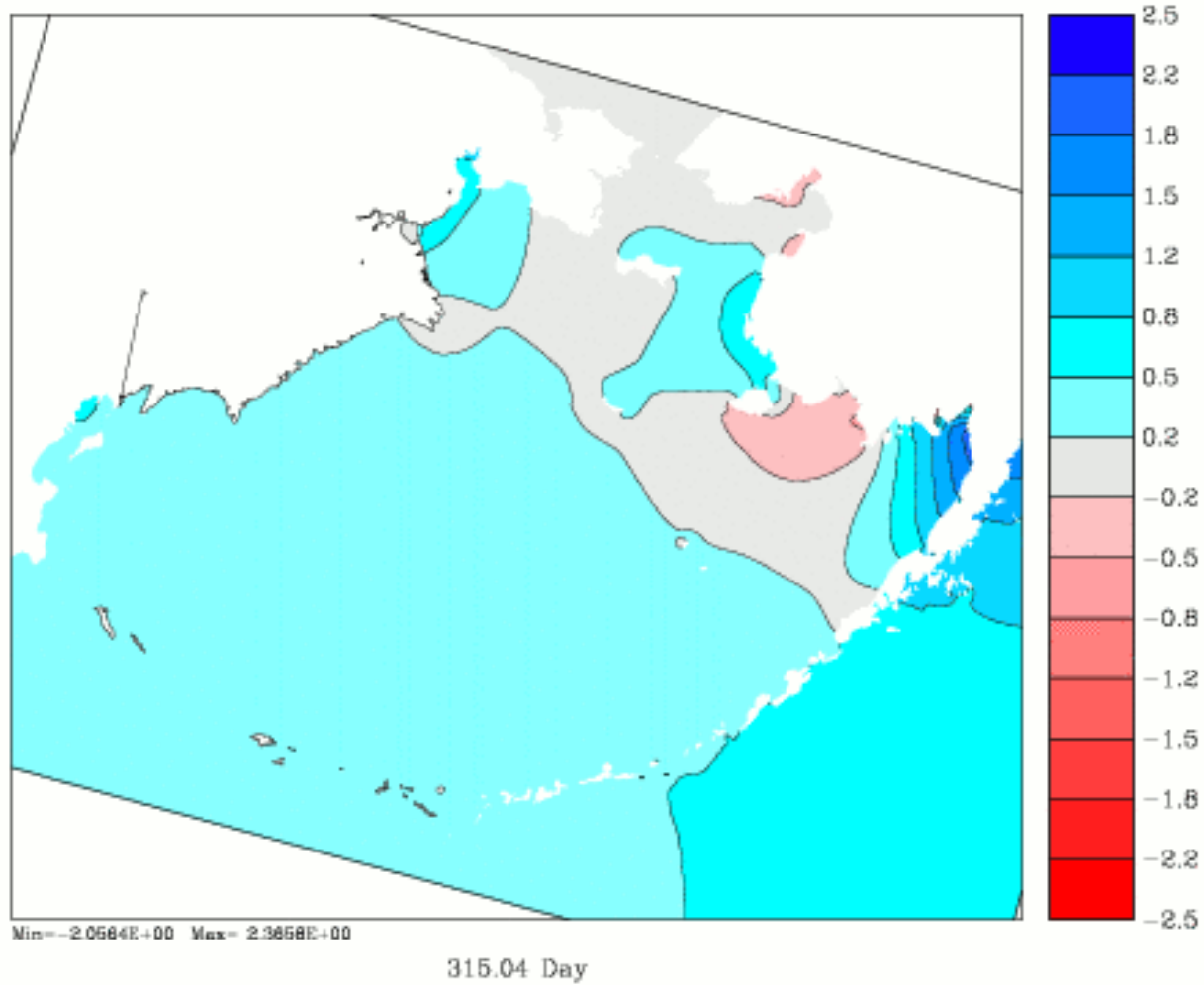
Conclusions

- **Many iterations**
- **Changes in response to thermal biases – big trouble for biology**
- **Simple change like "add tides" can be hell – see ROMS blog post**
- **There is a very slow timestepping instability in the ROMS I have – perhaps in sea ice coupling**