Effects of different forcing data on a global FESOM configuration with a focus on the Northwest Pacific.

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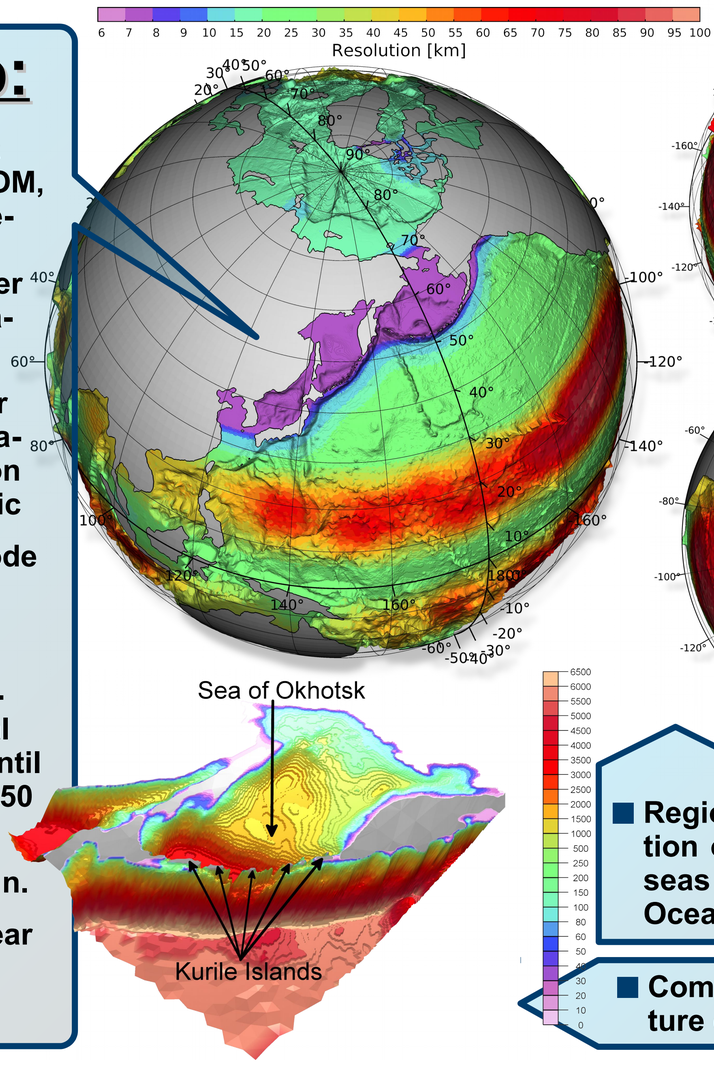
Abstract:

The subarctic oceans like the Sea of Okhotsk, the Bering Sea, the Labrador Sea or the Greenland-Irminger-Norwegian (GIN) Sea react particularly sensitive to global climate changes and have the potential to reversely regulate climate change by CO2 uptake in the other areas of the world. So far, the natural processes in the Arctic and Subarctic system, especially of the Pacific realm, remains barely studied in terms of sedimentary records, but especially in terms of numerical modeling. In this study we focus on the marginal seas of the Northwest Pacific (e.g. the Sea of Okhotsk, the Bering Sea and the Sea of Japan), which have nowadays a significant role in the climate system of the Northwest Pacific by influencing the atmospheric and oceanic circulation as well as the hydrology of the Pacific water masses. Especially the Sea of Okhotsk is characterized by a highly dynamical sea-ice coverage, where, in autumn and winter, due to massive sea ice formation and brine rejection, the Sea of Okhotsk Intermediate Water (SOIW) is formed which contributes to the mid-depth (500-1000m) water layer of the North Pacific known as newly formed North Pacific Intermediate Water (NPIW). We use the Finite-Element Sea-Ice Ocean Model (FESOM) in a global configuration with a regional focus on the marginal sea of the Northwest Pacific ocean. As a preliminary study we compare the influence of the Comprehensive Ocean Ice Reference Experiment version 2 (COREv2) and ECMWF Era 40/interim forcing data set on the general circulation and stratification of the Northwest Pacific Ocean. We evaluate the reliability of both forcing data sets based on a comparison with observational derived data from the World Ocean Atlas 2013.

Model Setup:

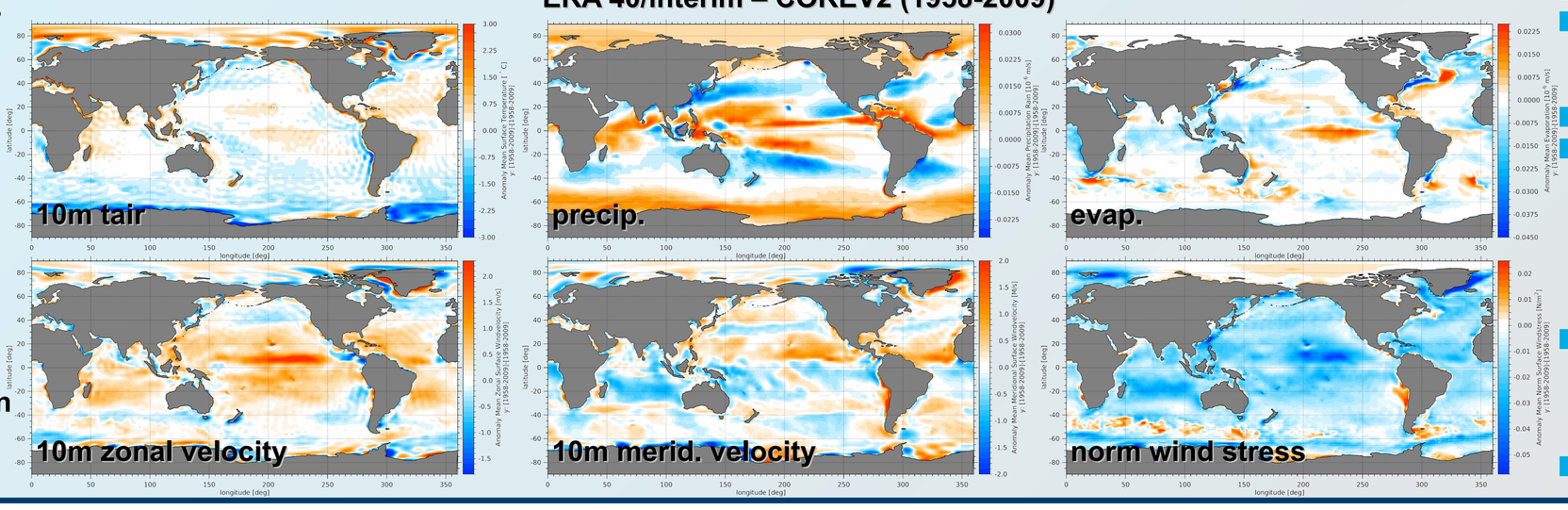
- The Finite Element Sea Ice-Ocean Model (FESOM, developed at Alfred Wegener Institute) Solve primitive equation under Boussinesq approximation
- Unstructured triangular FESOM mesh configuration with high resolution in the Northwest Pacific
- ~550 000 2d surface node points
- $15*10^6$ 3d node points
- 61 vertical layers, stepwise increasing vertical resolution from 10 m until 150 m after depth of 1450 m
- Model timestep = 15 min.
- Runtime for 1 model year ~ 3h (using 70 nodes, 1680 CPUs)



- Regional homogenous resolution of ~ 6-7 km in the marginal seas of the Northwest Pacific Ocean.
- Complicated bathymetry structure of Kurile Islands chain.

Atmospheric Forcing:

ERA 40/interim – COREV2 (1958-2009)



COREv2

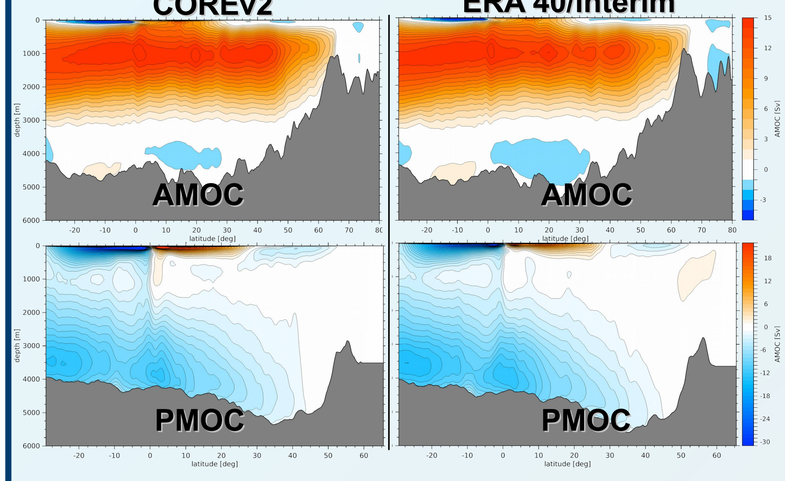
- Large and Yeager (2008)
- Resolution: ~1.875°x1.875°
- Period: 1948-2009
- 6 hourly 10m wind speed, 10m surface air temperature , 10 specific humidity
- daily shortwave- and longwave radiation flux
- monthly precipitation and snow
- provides Sea Surface Salinity climatology and river runoff long term mean
- Not updated on regular basis !

ECMWF ERA 40/interim

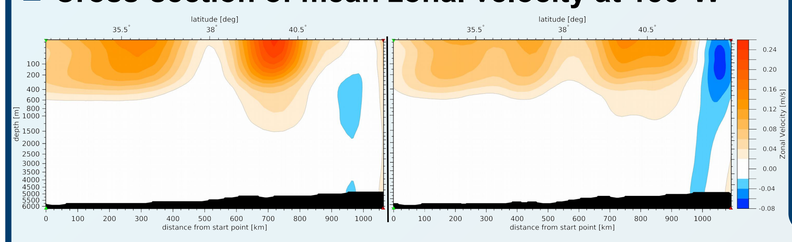
- Berrisford et al. (2011)
- Resolution: era40 ~1.5°x1.5°, erai ~0.7°x0.7° , 60 vertical levels
- Period: 1958-2015
- 6 hourly 10m wind speed, 2m surface air temperature , 10 specific humidity, shortwave- and longwave radiation flux, evaporation precipitation and snow
- No provided Sea Surface Salinity climatology or river runoff long term mean (use COREv2 fields)
- Is updated on regular basis !

Ocean Model:

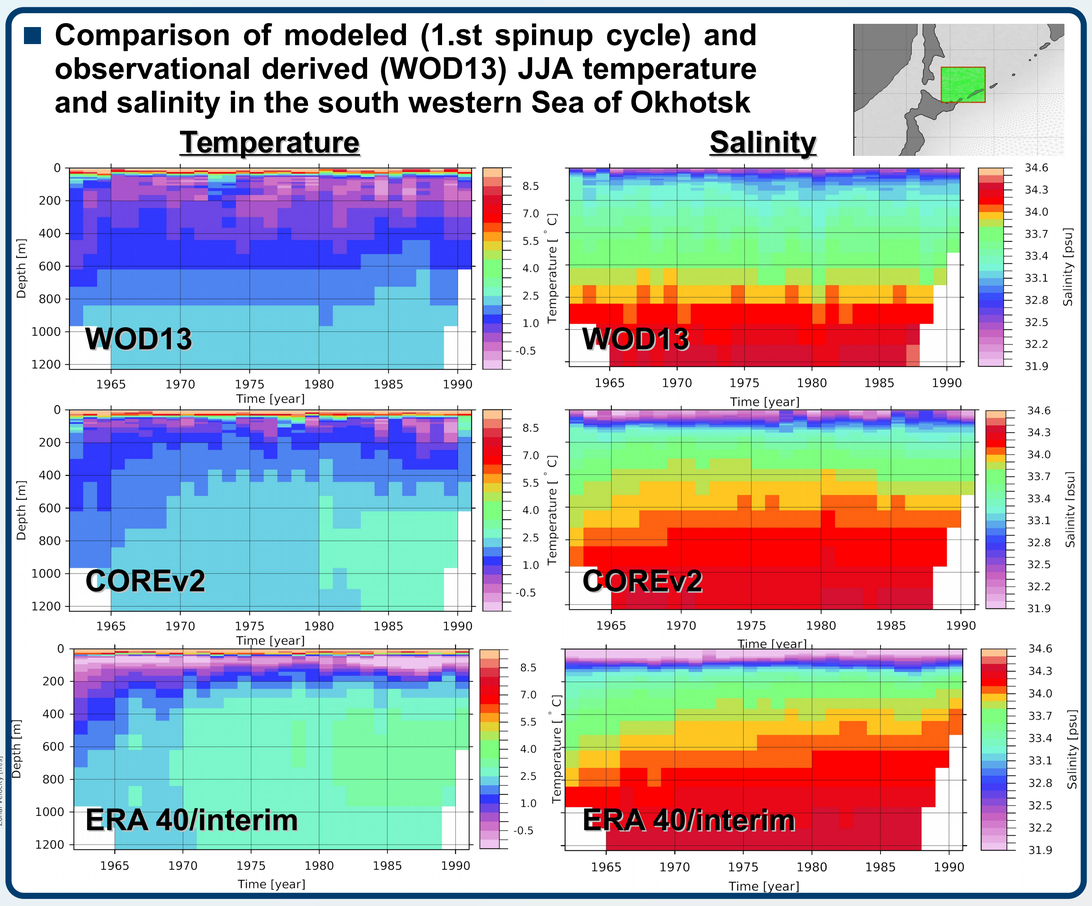
- Atlantic and Indo-Pacific Meridional Overturning Circulation averaged for the period 1958-2009



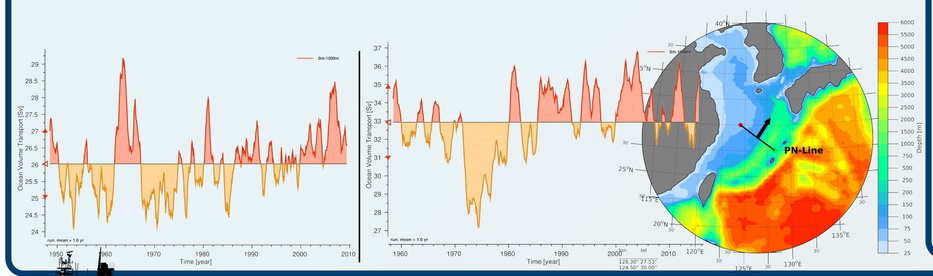
- Cross-section of mean zonal velocity at 150°W



- Comparison of modeled (1.st spinup cycle) and observational derived (WOD13) JJA temperature and salinity in the south western Sea of Okhotsk



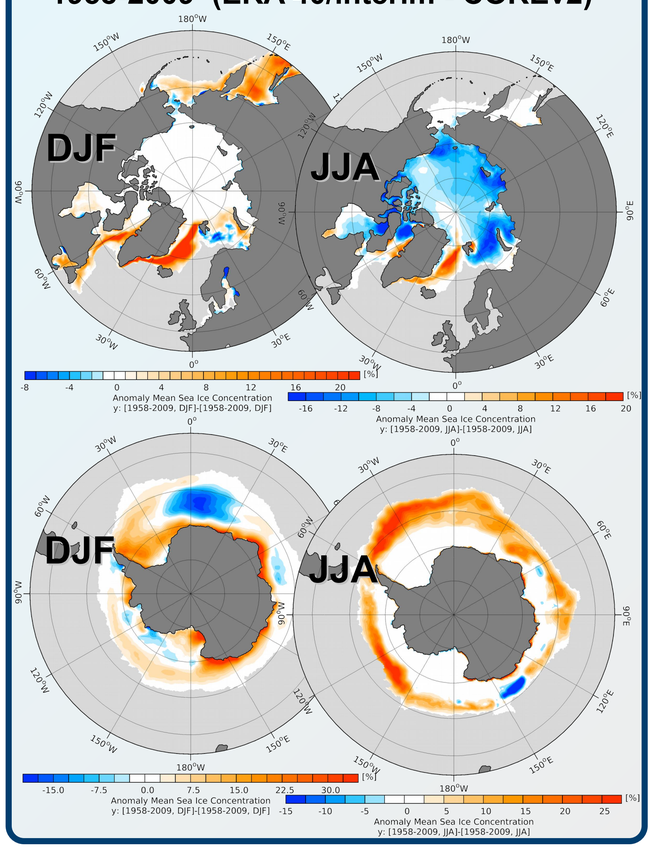
- Northward Volume transport through PN-line, observational values are in order of ~25 Sv (B.Qui, 2001, nature)



- Entire North Pacific subpolar gyre transports to much heat and salt, under COREv2 as well as ERA 40/interim forcing, to the northwest.
- Leads to a intrusion of warm and salty water mass into the intermediate layers of the Sea of Okhotsk and suppresses their the vertical ventilation of cold water and fresh surface water.
- The overestimated northward transport of heat and salt could be related due to a northward shift of the Kuroshio and North Pacific current under COREv2 and ERA 40/interim forcing.

Sea-Ice

- DJF and JJA anomalous mean sea ice concentration for the common period 1958-2009 (ERA 40/interim - COREv2)



Outlook

- FESOM parameter adjustment and ERA 40/interim sensitivity runs regarding the strength of the SSS restoring to improve the hydrography of the North Pacific