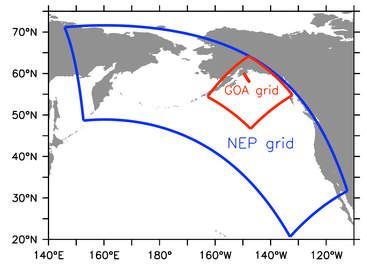
Gulf of Alaska Simulated by Regional Ocean Modeling System 2000-2005

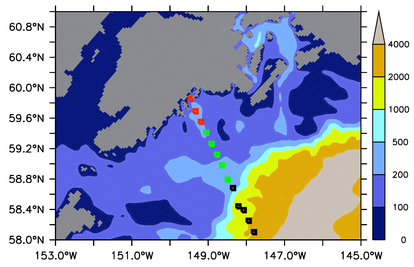
Wei Cheng (wei.cheng@noaa.gov), Albert Hermann

JISAO/College of Environment/University of Washington and NOAA/Pacific Marine Environmental Laboratory

Model Introduction

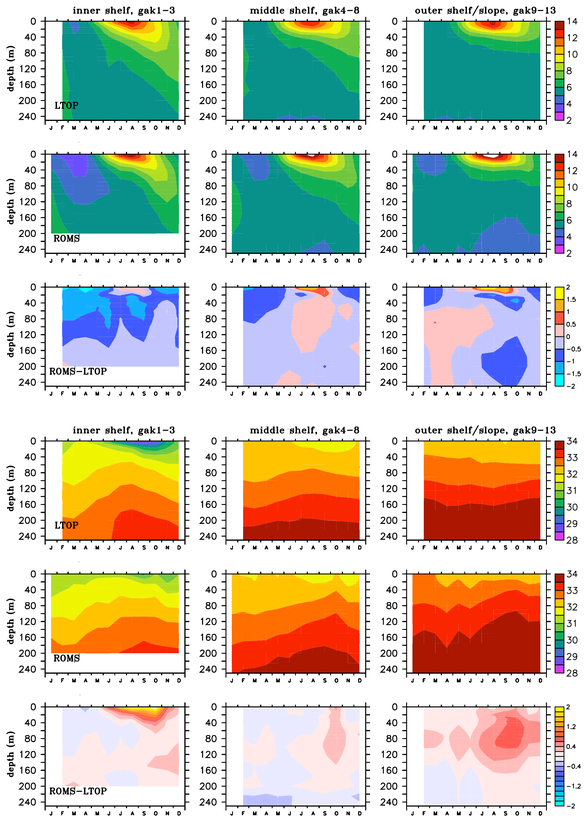
ROMS in this study enclose the GOA grid. It has 42 layers vertically, horizontal resolution is 3km. It includes tides and is coupled to a sea-ice model. ROMS is forced by interannual CORE forcing (Large and Yeager, 2004) from 2000 to 2005. The initial and lateral boundary conditions are from SODA (Simple Ocean Data Assimillation). Physics-only run was carried out. Daily averaged model output with tidal signal removed are analyzed.





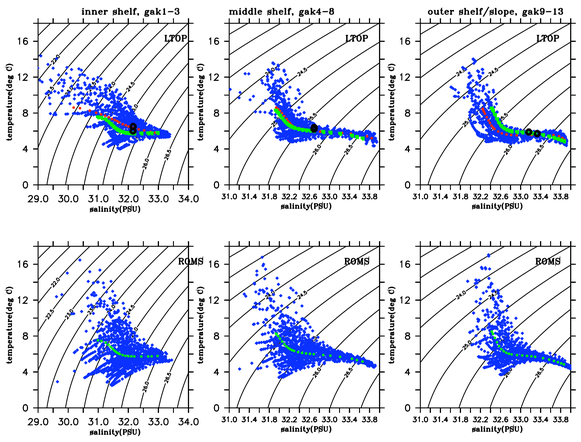
The relative position of the Gulf of Alaska (GOA) grid in the Northeast Pacific (NEP) grid is shown. The location of Long Term Observation Program (LTOP) hydrographic stations along the seward line in the GOA (also called GAK stations), which is the main source of data for model evaluation, is also marked. The 13 GAK stations are divided into three sub-regions: the inner shelf domain (GAK 1-3), the middle shelf domain (GAK 4-8), and the outer shelf/slope domain (GAK 9-13). Shading represents model topography.

T and S Clim. Seasonal Cycle and Errors



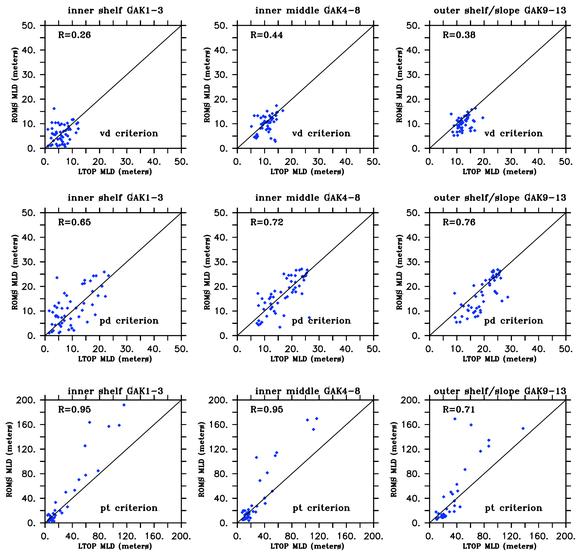
While capturing the basic structure of T and S seasonal cycles, model shows a warm bias of 1-2 deg C in summer and a cold bias of 1 deg C in winter. The cold bias could be partially related to 'bias' in observations (less observations were done in cold seasons). Is summer bias caused by albedo effect (need to check!)? Salinity simulation is much improved over older versions, with errors generally less than 1 PSU. Inner shelf and outer shelf/slope region salinity bias shows different spatial structures, which may reflect different causes for the bias: lack of freshwater forcing for the inner shelf region vs. errors in model physics such as mixing for the outer shelf/slope region.

T and S relationship

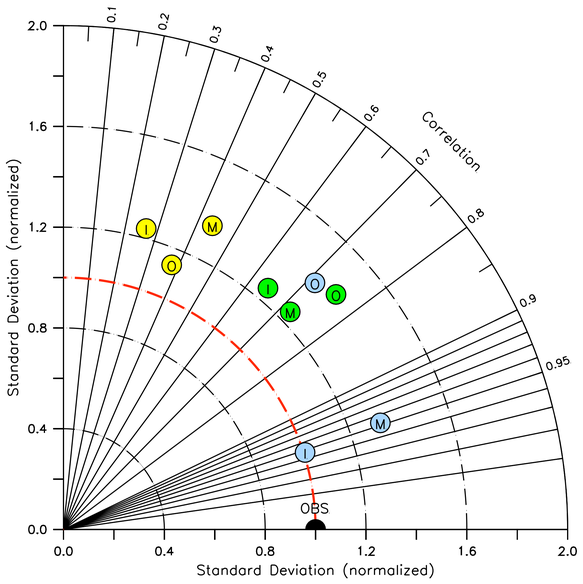


Simulated T and S relationship follows the general shape of observations. Water column is strongly stratified: densier water stratification is saline effect dominant while lighter water stratification is thermal effect dominant. Modeled inner shelf has less mixing than in the real world? Outer shelf lighter waters are too salty.

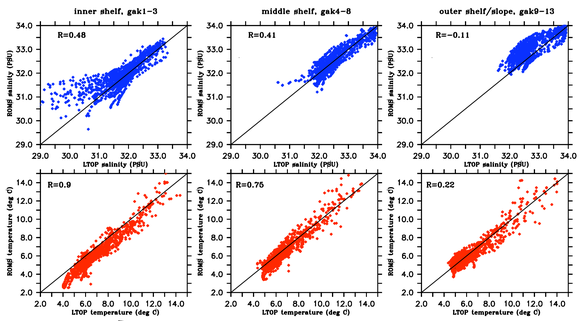
Quantify model MLD, T, and S errors

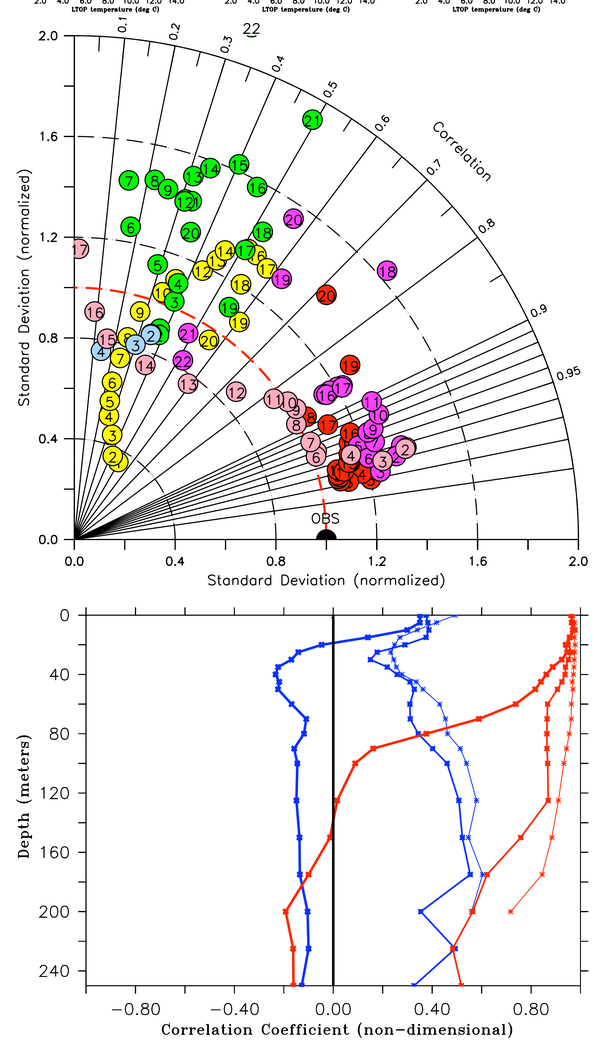


MLD is defined using variable density criterion (top row), fixed density (middle row) and temperature (bottom row) criterions. MLD based on temp criterion is significantly deeper than those based on density criterions. Which definition(s) makes sense for the region?



Accordingly, the performance of modeled MLD varies significantly based on how MLD is defined. T criterion MLD (blue dots) score the highest, variable density criterion MLD (yellow dots) score the lowest.

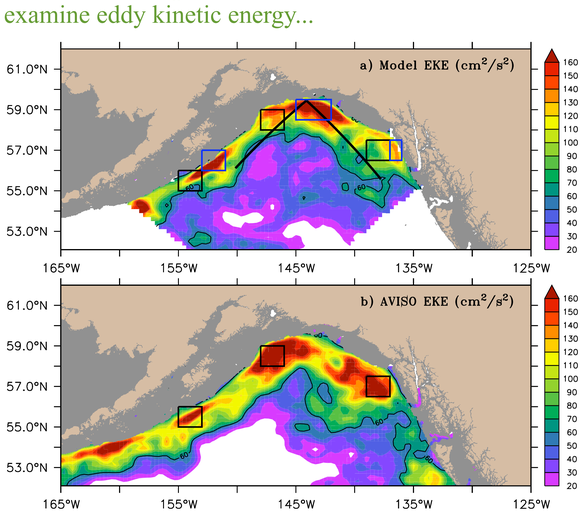


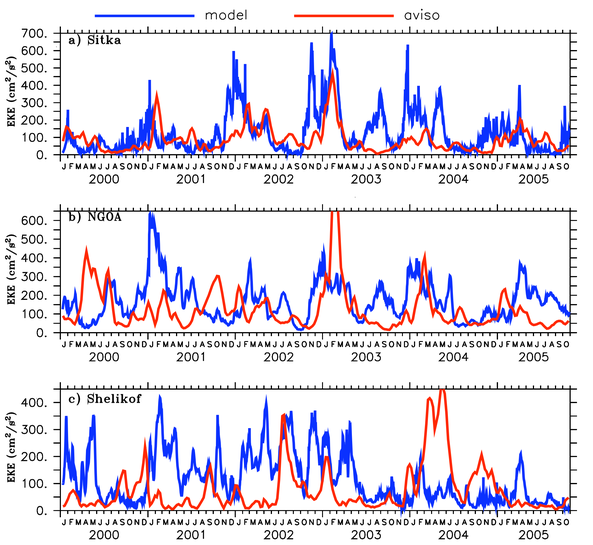


Overall conclusion from the above quantitative analyses: temperature simulation is better than salinity simulation, inner shelf is better simulated than outer shelf/slope region, and shallower layers are better modelled than deeper layers. This result is encouraging for ecosystem modeling, because many biology processes occur near shore, near the surface, and are temperature sensitive.

Eddies Fields

Since this is a high resolution model, it is natural to examine eddy kinetic energy...

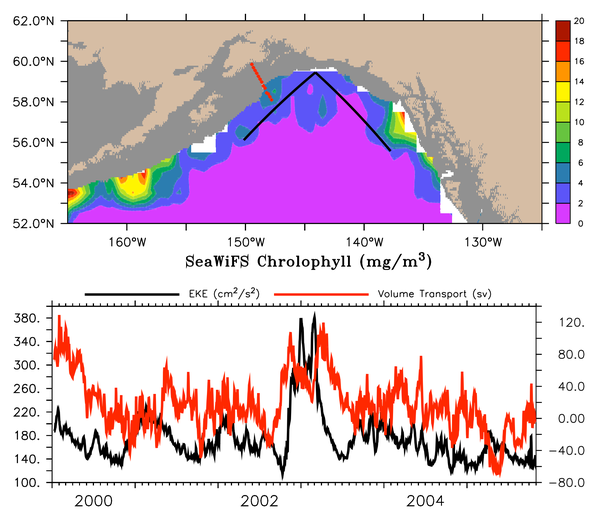




Both EKE map and EKE time series suggest that model is doing a reasonable job. Modeled high EKE is concentrated around 'hot spots' such as Sitka, northern head of GOA, and Shelikof strait (as in remote sensing data), less spatially continuous than EKE from lower resolution simulations (e.g., Combes et al. 2009). The model also appears to do a better job in reproducing observed temporal variability of EKE in the eastern basin than in the western basin, consistent with the argument that eastern basin eddies are externally forced whereas weatern basin eddies are more intrinsic (Combes and Di Lorenzo, 2007).

Future Work

Cross-shelf exchange processes are believed to be critical for GOA high productivity, which is accomplished under downwelling favorable winds. Studies on cross-shelf exchange are limited. One of the candidate processes is eddy induced mixing (Ladd et al. 2005). Using model output, relaively high EKE (>60 cm^2/s^2) in the GOA was spatially averaged and compared with vertical sum cross-shelf volume transport (perpendicular to the black lines shown in the figure below). There is a weak but significant correlation. We would like to address this question in the future: what does model simulation tell us about cross-shelf exchange in the GOA and its controlling mechanisms?



Acknowledgments

We thank Enrique Curchitser and Kate Hedstrom for developing/providing the ROMS code. We also thank Hal Batchelder for sending the LTOP data. Discussions with Carol Ladd on EKE were helpful. This work is surpported by NSF and NPRB grants.