OCEAN, EARTH & ATMOSPHERIC SCIENCES

OLD DOMINION UNIVERSITY

PhD DISSERTATION DEFENSE
Friday, June 10, 2016, 12:30 CCPO Room 3200

INFLUENCE OF TIDES AND MESOSCALE EDDIES IN THE ROSS SEA

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ABSTRACT

The Ross Sea, Antarctica is important in the climate system as a region where Antarctic Bottom Water is produced, and is the most biologically productive area in the Southern Ocean. Observing the Ross Sea is a challenge due to its remote location and extreme weather conditions, and observations tend to be biased towards the ice-free summer months.

A series of studies is motivated by the PRISM-RS project, that focused on the mesoscale effects influencing the supply of dissolved iron (dFe), a limiting micronutrient, to the surface ocean. This work focuses on the influence of tides and mesoscale eddies on dFe supply as well as on the transport and transformation of Circumpolar Deep Water on the continental shelf. To carry out this work, a regional ocean model is used, supported by data from the 2012 PRISM-RS cruise. Two model grids are created with 1.5 and 5 km horizontal resolution, where the finer grid represents eddy processes and the coarser does not. Four simulations are run covering the time span of the cruise, with and without tidal forcing on each of the grids. An extended 20 year simulation provides an estimate of model variability and significance.

The model is validated using temperature and salinity measurements from the cruise, which are in good agreement, although the model is consistently saltier at depth by about 0.14 g kg^{-1}. A water mass volumetric census of the continental shelf compares well with climatology, except for Ice Shelf Water, which is an order of magnitude lower than observations. The effect of tides on the water mass volumes and transport is small.

Analysis of eddy formation indicates that stratification is weak, especially in winter, suppressing the production of mesoscale eddies. Despite this, there is a significant increase in the number of eddies (almost doubling) and the amount of Eddy Kinetic Energy at higher model resolution. Eddies in the Ross Sea have an average diameter between 10-15 km, persist between 5-10 days, and are more likely to form during the summer months when stratification is higher.

DFe supply to the ocean surface is determined by calculating the flux of four passive tracer dyes that represent the main sources of dFe. The low resolution simulation without tides estimates the total supply of dFe at 6.63 µmol m^{-2} yr^{-1}. Tides increase this by 20%, while eddies decrease it by 15%, and the net change from both tides and eddies is not significant.