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Arctic Ocean Centennial-Scale Rossby modes

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The Arctic Ocean has a characteristic stable stratification with fresh and cold water occupying the upper few hundred meters and with warm and more saline Atlantic waters underneath. These water masses are separated by the cold halocline. The stability of the cold halocline regulates the upward directed turbulent heat flux from the Atlantic water to the Arctic water. Since this heat flux is an important part of the ocean energy budget it is important for the large scale sea ice formation and melting.

Due to the sable vertical stratification combined with its almost circular symmetry the Arctic Ocean may support internal Rossby modes. In this study we investigate these modes in a theoretical framework. We apply the free surface two layer model with a linear damping on the sphere and solve this in idealised geometries. We solve this system numerically by a finite difference scheme based on the Arakawa C-grid.

We find that solutions to the system have a damping time scale comparable to the propagation time scale, both in the order of a few centuries. Furthermore, this damping time scale is rather independent of the local damping coefficient. For a circular symmetric geometry the amplitude is zero at the boundary. Interestingly, for a more realistic sector-geometry we find finite amplitudes at the borders. We interpret this in the model as anomalies in the halocline height being exported as fresh water anomalies via the Fram Strait where they further south they may modulate deep water formation and strength of the thermohaline circulation.