University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

LINA ROTERMUND

BSc Hons (Dalhousie University, 2016)

"The Effects of Sea Ice on the Tides in the Kitikmeot Sea: Results using Year–Long Current Meter Data from Dease Strait and Tidal Models"

Department of Physics and Astronomy

Monday, July 22, 2019
10:00 A.M.
Engineering and Computer Science Building
Room 104

Supervisory Committee:
Dr. Jody Klymak, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Bill Williams, Department of Physics and Astronomy, UVic (Co-Supervisor)

External Examiner:
Dr. Charles Hannah, Fisheries and Oceans Canada, Institute of Oceans Sciences

Chair of Oral Examination:
Dr. Pan Agathoklis, Department of Electrical and Computer Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

This paper examines the K1 and M2 tidal dynamics of the Kitikmeot Sea and shows that the Kitikmeot Sea experiences strong tidal damping in winter, likely due to seasonal sea ice formation. Sea ice extent and thickness is declining in the Arctic, so with increasing length of the ice–free seasons, larger tidal currents and elevation may last through the year. Stronger tidal currents will amplify vertical mixing in shallow channels, enhancing upward heat and nutrient fluxes which promote greater formation of polynyas and elevated biological production, impacting the region's ecosystem. Year-long acoustic Doppler current profiler (ADCP) data in Dease Strait shows a seasonal damping of 52% in the M2 tidal elevation and 58% in the K1 tidal elevation during the period of maximum ice cover compared to ice-free months. In the same time period, velocities along the major axis of the tidal current ellipse decrease by 65% for the M2 and K1 tidal constituents. The M2 phase of elevation (velocity) shifts by -13° (-10°) and the K1 phase of elevation (velocity) shifts by 7.5° (21°). The K1 elevation phase variability is not seasonal, while the other phase shifts are. The wintertime tidal amplitude decrease is hypothesized to be a result of a combination of (1) sea ice friction and (2) sea ice blockage in Victoria Strait, where thick ice from ridging accumulates over the shallow sill in the strait. Using a 3D barotropic tidal model and a simple analytical model these hypotheses are examined. The models show that the K1 tide is not influenced by western tidal forcing and is driven by eastern tidal forcing, which propagates far into the region and behaves as a Helmholtz resonator within Dease Strait and Coronation Gulf. On the other hand, the M2 tide is affected by both western and eastern tidal forcing. The bulk of the M2 tidal energy entering from the east does not reach Dease Strait because significant portions are diverted and dissipated around an amphidromic point west of King William Island, as well as in the neighbouring inlets, bays and straits. These dynamics are affected by sea ice, for example, sea ice increases tidal dissipation within Victoria Strait. By independently varying sea ice friction and the thickness of sea ice blockages we show that observed seasonal modulation in the tides is likely due to a combination of very rough sea ice and ridging in Victoria Strait.