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Overflow dynamics and Antarctic Bottom Water production in the western Ross Sea: The influence of tides

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The influence of tides on overflow dynamics and Antarctic Bottom Water (AABW) production in the western Ross Sea is studied with the Finite Element Ocean Model (FEOM), which allows seamlessly imbedding a mesh with $0.5\,\mathrm{km}$ resolution in a coarse resolution (30 km) setup without traditional nesting. The overflow properties in the western Ross Sea exhibit tidal variability at both daily and spring-neap time scales. During a daily cycle at spring tides, tidal currents advect the shelf water from Drygalski Trough northward to the isobath of about $1600\,\mathrm{m}$, shape plume jets at a bathymetric bend west the trough mouth, and push modified Circumpolar Deep Water (MCDW) about $15\,\mathrm{km}$ inshore. It is the plume jets that feed the AABW production. Tides increase mixing over both the outer shelf and upper slope. The mean export rate of shelf water with potential temperature $\theta \leq 0°C$ is about $2\,\mathrm{Sv}$ over the outer shelf. The mean outflow transport over the continental slope off Cape Adare is $1.8\,\mathrm{Sv}$. The plume transport is $3.7\,\mathrm{Sv}$ in a transect downstream off the Victoria Land coast, among which about $0.8\,\mathrm{Sv}$ has $\theta \leq -0.8°C$.

Tides increases the AABW production considerably. The outflow rate over the continental slope off Cape Adare is about 70% larger with tidal forcing of the two major constituents (K1 and O1) than when tides are absent. Tides do not increase the AABW production rate monotonically. The tidal forcing of intermediate strength leads to most efficient outflow and AABW production. This is because tides not only increase shelf water export from Drygalski Trough, but also enhances mixing over the outer shelf and continental slope. Increasing the bottom drag coefficient increases the offshore distance of the plume but reduces the AABW production rate in the western Ross Sea.