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Effects of tides on the quasi-steady upwelling-downwelling regimes and water mass exchange between the Arctic and Atlantic Oceans.

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Astronomical tides are strong in the regions of the Arctic shelf and GIN Seas, with amplitudes reaching up to 4.4m in the Hudson Strait, 2-3m in the White Sea and greater than 1m in the Canadian Archipelago. If nonlinear friction is present, at the sea bed or within a stratification water column, periodical motions transfer energy to shear stresses with a substantial non-periodic component. Over bottom topography, anomalous bottom shear stress generates vorticity and vertical motions, resulting in either an ageostrophic circulation or geostrophic upwelling/downwelling of isopycnals. Using a pan-Arctic and a North Atlantic ocean-ice model, both of which explicitly resolve tides, we examine the effects of tides on the vertical motions generated by Ekman pumping near the sea bed and at the ice-ocean interface, and the stretching and tilting of vorticity. We found that tides significantly increase the intensity of vertical upwellings and downwelling regimes near the shelf break. We extend the semi-geostrophic two dimensional Eliassen -Sawyer equation and three-dimensional omega-equation to take into account the effects of tides. We also discuss the application of the equations for the analysis of watermass transformations and dense water overflow in the main gateways between the Atlantic and Arctic Oceans : Fram Strait, Yermak Plateau, Barents Sea shelf break, Denmark Strait and Faroe Channel.