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Using ICESat-2 Dynamic Ocean Topography to Estimate Western Arctic Freshwater Content

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Abstract : Global climate change has impacted atmospheric temperatures contributing to rising sea levels, decreasing sea ice, and increased freshening of high latitude oceans. This freshening has contributed to increased stratification inhibiting local mixing and nutrient transport, modifying regional circulations in polar oceans. In recent years, the Western Arctic has seen an increase in freshwater volume at an average rate of 397+-116km3/year across the Beaufort Gyre. The majority of the freshwater volume resides in the Beaufort Gyre surface lens driven by anticyclonic wind forcing, sea ice melt, and Arctic river runoff, and is typically defined as water fresher than 34.8. The near-isothermal nature of Arctic seawater and non-linearities in the equation of state for near-freezing waters result in a salinity-driven pycnocline as opposed to the temperature-driven density structure seen in the lower latitudes. In this study, we investigate the relationship between freshwater content and dynamic ocean topography (DOT). In situ measurements of freshwater content are useful in providing information on the freshening rate of the Beaufort Gyre; however, their collection is costly and time-consuming. Utilizing NASA's ICESat-2's DOT remote sensing capabilities and Air Expendable CTD (AXCTD) data from the Seasonal Ice Zone Reconnaissance Surveys (SIZRS), a linear regression model between DOT and freshwater content is determined along the 150° west meridian. Freshwater content is calculated by integrating the volume of water between the surface and a depth with a reference salinity of ~34.8. Using this model, we compare interannual variability in freshwater content within the gyre, which could provide a future predictive capability of freshwater volume changes in the Beaufort-Chukchi Sea using non-in situ methods. Successful employment of the ICESat-2's DOT approximation of freshwater content could potentially demonstrate the value of remote sensing tools to reduce reliance on field deployment platforms to characterize physical ocean properties.

Keywords : Cryosphere, remote sensing, Arctic oceanography, climate modeling, Ekman transport
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