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Estimates of Freshwater Content from ICESat-2 Derived Dynamic Ocean Topography

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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 and 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+-116 km3/year. 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. The total climatological freshwater content 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 remotely sensed 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. NASA's Advanced Topographic Laser Altimeter System (ATLAS) derived dynamic ocean topography (DOT), and Air Expendable CTD (AXCTD) derived Freshwater Content are used to develop a linear regression model. In-situ data for the regression model is collected across the 150° West meridian, which typically defines the centerline of the Beaufort Gyre. Two freshwater content models are determined by integrating the freshwater volume between the surface and an isopycnal corresponding to reference salinities of 28.7 and 34.8. These salinities correspond to those of the winter pycnocline and total climatological freshwater content, respectively. Using each model, we determine the strength of the linear relationship between freshwater content and satellite derived DOT. The result of this modeling study 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 reduce reliance on field deployment platforms to characterize physical ocean properties.

Keywords : ICESat-2, dynamic ocean topography, freshwater content, beaufort gyre
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