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Spatio-temporal Variablity of Arctic Sea Ice Freeboard, Thickness and Volume from CryoSat-2 and Its Possible Drivers

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Investigating the temporal and spatial changes in Arctic sea ice freeboard, thickness and volume is crucial for climate and environmental research. In this study, the freeboard, thickness and volume of the Arctic sea ice between 2011 and 2020 were acquired from CryoSat-2 data and it was compared with NASA Operation IceBridge and Alfred Wegener Institue AWI datasets. The effect of wind field and temperature and itscontribution on Arctic sea ice were also investigated. The main steps of our research are as follows. 1) Selecting data points above 66 degrees north latitude and filtering out sea ice by flag value and mask; Using OSI SAF sea ice concentration (SIC) data to further constrict the area; Interpolating the latest mean sea surface data DTU21 into CryoSat-2 data; Calculating the sea ice freeboard via spatial altimetry relationship. 2) Combining with snow density, snow depth, multi-year ice density and first-year ice density to estimate the sea ice thickness respectively from freeboard according to the assumption of hydrostatic equilibrium. 3) Using the area and extent provided by NSIDC to interpret the volume. 4) Utilizing Seasonal and Trend decomposition using Loess(STL) to analyse the seasonal and interannual variations of sea ice. 5) Dividing the Arctic Ocean by its marginal sea, coupled with the HY-2B microwave scatterometer data and NCEP/NCAR reanalysis data, the impact of the Beaufort Sea, the Chukchi Sea, the East Siberian Sea, the Laptev Sea, the Kara Sea, the Barents Sea, the Greenland Sea, and the Baffin Bay wind field on the sea ice were studied. 6) Exploring the correlation between the sea surface temperature and the sea ice freeboard, thickness and volume. The result indicated that (1) the freeboard and thickness was decreasing about 9.748% and 8.80% during 2011-2020,respectively; (2) there are interlunar variations in sea ice freeboard and thickness, the freeboard and thickness of sea ice reach the minimum in August to September each year and the maximum appears in March to April; (3) Arctic sea ice is affected by both thermodynamics and dynamics, the reduction of Arctic sea ice was largely due to the sea surface wind field, one of the dynamic factors is the wind field on the sea surface. The sea ice changes in the various sea areas of the Arctic Ocean are related to the wind field to varying degrees. The changes in the sea surface wind field in recent years have further promoted the reduction of sea ice, making it possible for the Arctic to open to navigation in the summer. Fully understanding the evolution of sea ice change in the Arctic Ocean is helpful for humans to better protect the earth.