Why do Simulated Trends of Arctic Sea Ice Drift Speed go from Positive in the 20th Century to Negative in the 21st Century?

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ABSTRACT

In addition to its importance for ecosystems and shipping activity, motion of Arctic sea ice might also strongly influence the rate of Arctic sea ice extent decline. Sea ice motion is driven by a combination of wind stress, ocean stress, sea ice internal stress, and sea surface height (SSH) gradients. Buoy observations indicate that sea ice drift speed has been increasing since the 1980s due to increased sea ice deformation associated with reduced sea ice thickness. Modern coupled climate models generally produce similar behaviour during this time period, but puzzlingly, most climate models also project that drift speed will decline over the middle and late 21st century. In this study, we investigate the reasons for this sign change in simulated Arctic drift speed trends using an ensemble of 17 models participating in the Coupled Model Intercomparison Project phase 6 (CMIP6) under the shared socioeconomic pathway (SSP) 585 warming scenario.

We find that, with the exception of one model (NorESM2-MM), all models in our ensemble project decreasing Arctic-average September sea ice drift speeds in the mid-to-late 21st century. Our analysis indicates that these declining drift speeds are primarily due to reduced SSH gradients over the Arctic Ocean. Trends in sea ice internal stress have also been examined, and these do not explain the decline in sea ice drift speed. Analysis of CMIP5 in an earlier study also indicates that changes in wind stress and ocean stress likely do not explain these trends. Altogether, our results suggest that, in addition to understanding sea ice internal stresses, gradients of sea surface height must also be considered in order to accurately project long-term changes in sea ice motion.

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