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Spatiotemporal evolution of snow depth distribution on Antarctic sea ice

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Snow cover is a primary control on Antarctic sea ice mass balance as it controls basal ice growth and snow ice formation. It is also a primary control on the surface energy budget, partitioning of solar radiation, and sea ice biological communities. Finally, knowledge of its distribution is critical for accurate estimation of sea ice thickness from satellite altimeters. The floe-scale distribution of snow is highly variable, driven by wind redistribution over complex sea ice surface topography. Yet, our understanding of the seasonal evolution of snow depth distribution is poor and its representation in models is simple or non-existent.

We present observations of the three-dimensional distribution of snow depth, ice thickness, and surface topography from a suite of cruises in the Weddell, Bellingshausen, Ross, and East Antarctic Seas that span the full growth season – from autumn, through winter, to late spring. The distribution of snow depth changes from a right-skewed distribution in autumn as snow initially accumulates around ridges to a gaussian by spring as snow deepens and ice surface topography roughens. While the distribution is spatially complex, the spectral distribution of snow features is similar across seasons. Using these data we construct a simple statistical model for the seasonal evolution of floe-scale snow depth distribution. We also compare our results to prior observations from drilling transects and larger-scale airborne observations from NASA's Operation IceBridge. For the latter we use a convolutional neural network to demonstrate that the surface topography can be used as a reliable predictor of the snow depth

distribution at regional scales.