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The MOSAiC sea ice albedo record: its context and role for informing improved surface radiative budgets in a climate model

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Sea ice albedo is both a driver and a consequence of summer melt evolution. The ability to collect comprehensive observations and develop accurate, general, and consistent physics-based models is central to our quantitative understanding of sea ice mass and heat budgets and a variety of associated feedback processes. Sea ice albedos recorded during the MOSAiC field campaign have extended our knowledge of the optical properties of specific ice types as well as their seasonal evolution. This new dataset complements and extends observations made during the Surface Heat Budget of the Arctic Ocean (SHEBA) campaign in the Beaufort Sea in 1998. It also presents an opportunity to improve numerical treatment of shortwave radiation partitioning by sea ice covers in climate models. Specifically, the observations include spectral and broadband albedo measurements made by observers on the surface for two classes of measurement: 1) individual ice types including snow covered ice (prior to and during melt), bare melting ice, ponded ice, and sediment-laden ice, and 2) time series measured over the full seasonal cycles. The MOSAiC and SHEBA data sets show remarkable similarity with respect to the steady spectral albedo of bare, melting summer ice and the seasonal evolution measured over representative survey lines. Both data sets include coordinated physical property characterization, which is key to the development and refinement of radiative transfer treatment in climate modeling.

In this work, we compare the observational record with results generated from runs of the CESM2 model. The Community Earth System Model (CESM2) is a coupled climate model that includes a physics-based radiative transfer treatment for sea ice. This model relies on a 2-stream delta-Eddington solution with prescribed ice-type-specific inherent optical properties. Specifically, we consider newly available sub-gridscale diagnostics in the model that detail the radiative partitioning for individual surface types and thickness categories. Comparisons between observed and modeled values are considered for the albedo of individual surface types, aggregate albedo estimates, and their seasonal progression. In particular, we use these comparisons to derive a quantitative picture of the overall partitioning of shortwave radiation by the ice cover, and how it

has changed over past decades. These results can help pinpoint where the most substantial model upgrades can be accomplished as well as where the best observational investments should be made.