The Cryosphere

Supplement of
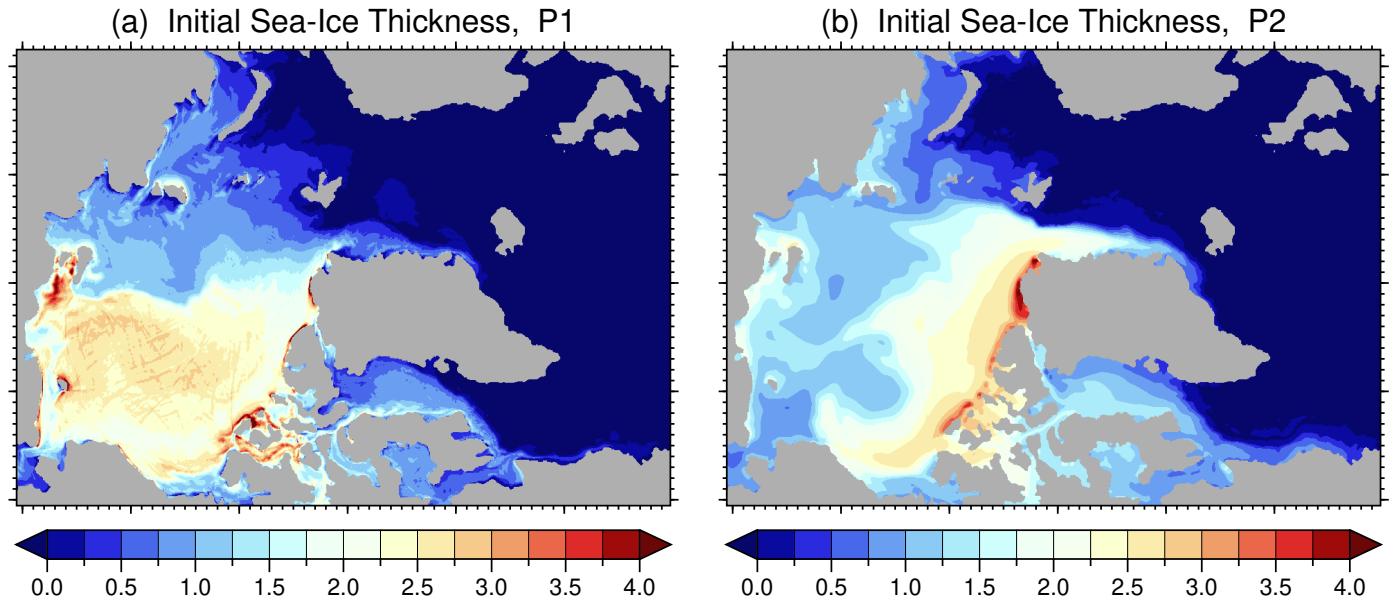
On the importance to consider the cloud dependence in parameterizing the albedo of snow on sea ice

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S1   Supplementary figures

(a) Initial Sea-Ice Thickness, P1   **(b)** Initial Sea-Ice Thickness, P2

Figure S1. Initial sea-ice thickness fields (in meters) for the simulations of the pairs P1 **(a)** and P2 **(b)**. Each pair consists of two simulations, one simulation with the original snow albedo parameterization (HNold), the other with the revised snow albedo parameterization (HNnew).
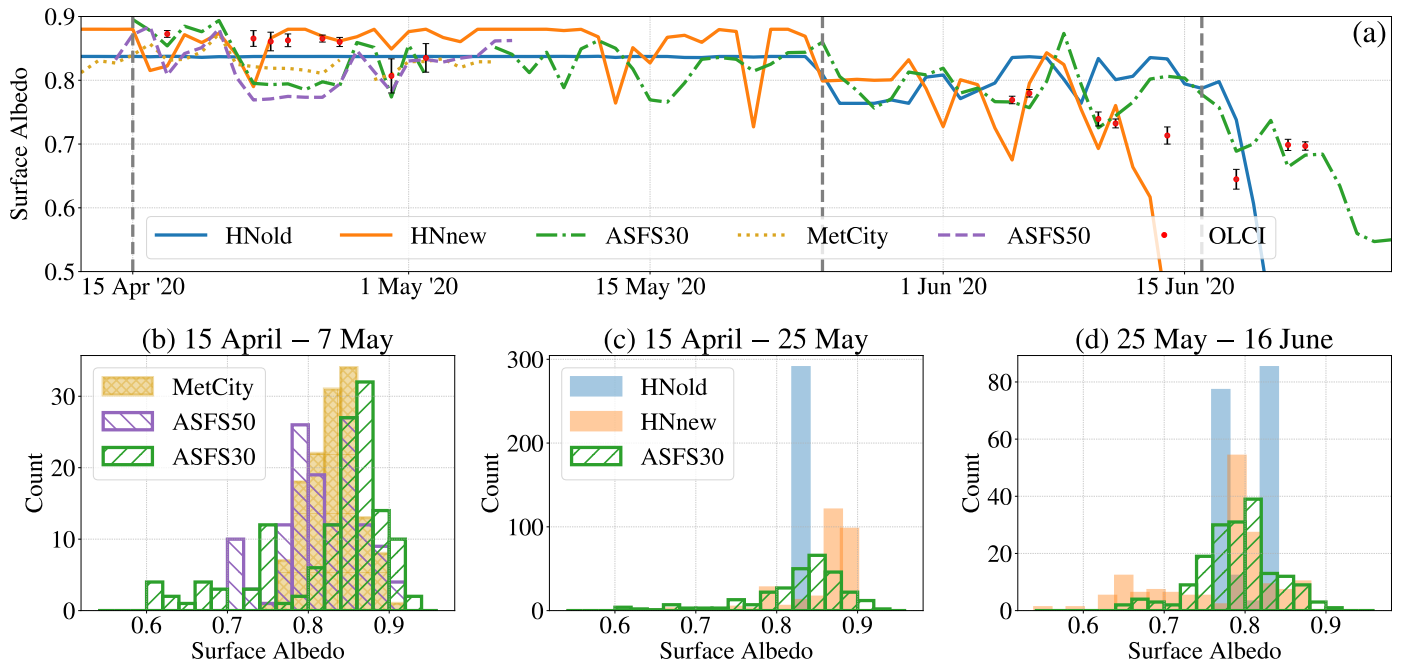
Figure S2. Top: **(a)** time series of daily mean sea-ice surface albedo from the two P2 simulations (HNold and HNnew), from three irradiance measurements (ASFS30, MetCity, ASFS50), and from the satellite observations (OLCI) for the period from mid-April 2020 to the end of June 2020. The dashed vertical lines indicate the beginning and the end, respectively, of the two evaluation periods: the cold period (15 April–25 May) and the snowmelt period (25 May–16 June), based on the P2 simulations. Bottom: frequency distributions of three-hourly mean sea-ice surface albedo from **(b)** the three irradiance measurements for the period when measurements from all three sites are available, **(c)** the two simulations and ASFS30 for the cold period, and **(d)** the two simulations and ASFS30 for the snowmelt period.
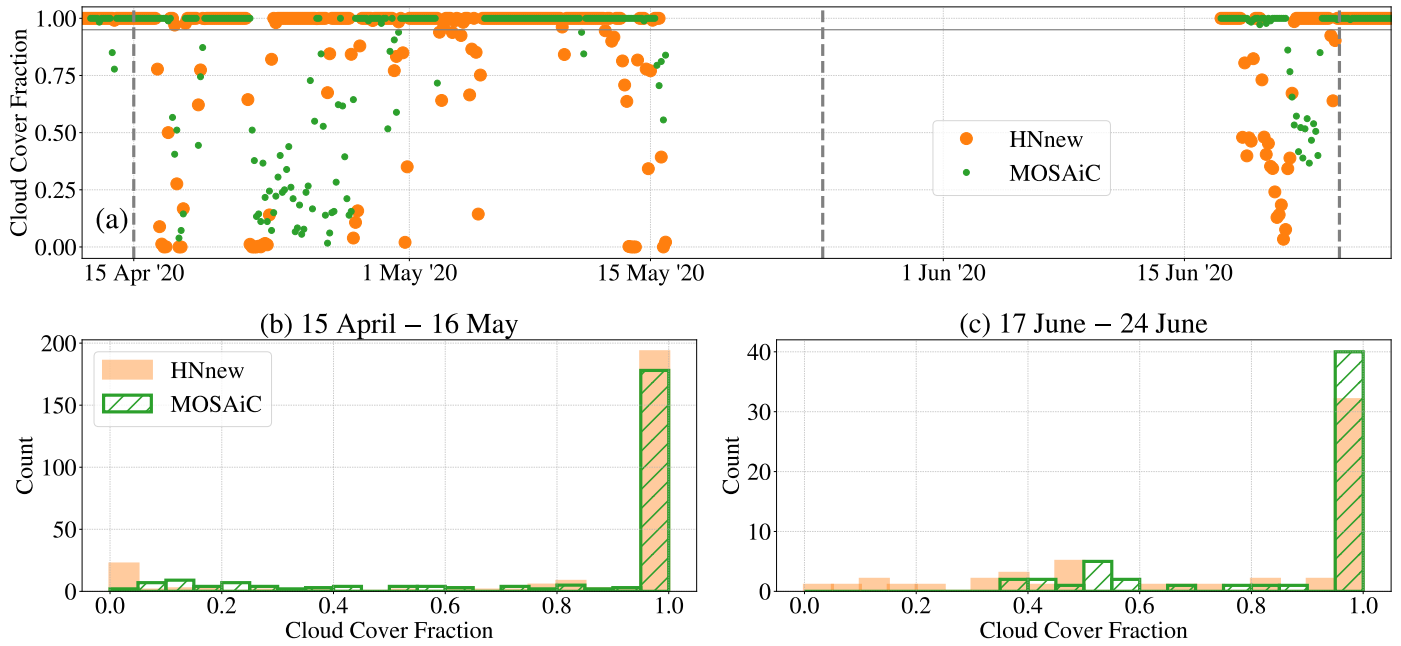
Figure S3. Top: **(a)** time series of three-hourly mean total cloud-cover fraction from the P2 simulation HNnew and the MOSAiC measurements for the period from mid-April 2020 to the end of June 2020. The dashed vertical lines indicate the beginning and the end of the two evaluation periods: the cold period (15 April–25 May) and the snowmelt period (25 May–24 June), based on the P1 simulations. Bottom: frequency distributions of three-hourly mean total cloud-cover fraction from the simulation HNnew and the MOSAiC measurements for **(b)** the cold period and **(c)** the snowmelt period. MOSAiC measurements are not available between 16 May and 17 June due to the transition of the research vessel *Polarstern*.