Blowing snow contributions to the Arctic snow-on-sea ice budget using ICESat-2 observations

Joseph Robinson[1], Lyatt Jaeglé[1], Stephen P. Palm[2,3], Glen E. Liston[4]

[1] Department of Atmospheric and Climate Science, University of Washington, Seattle, WA, USA
[2] Science Systems and Applications, Lanham, MD, USA
[3] NASA Goddard Space Flight Center, Greenbelt, MD, USA
[4] Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, USA

Contents of this file

Introduction

The included support information provides additional figures contextualizing the main text, including smoothing of ICESat-2 observations to increase signal-to-noise (Figure S1) and the relative occurrence frequency of cloud attenuation as observed by ICESat-2 (Figure S2). The timeseries of monthly Arctic Oscillation (AO) index and ICESat-2 derived blowing snow occurrence is shown in Figure S3. Figure S4 shows 5-day rolling timeseries of the percent of all sea ice covered by each ICESat-2 grid cell label (blowing snow, mixed, clear air, cloud attenuated; see Section 2.5 of the main text). Figure S5 shows the spatial distribution of seasonal mean ICESat-2 and SnowModel-LG blowing snow burdens (mass per square meter). Meteorological conditions averaged across all (the 2021-2022) cold seasons are shown in Figure S6 (Figure S7). Figure S8 shows the daily amount of snowfall offset by blowing snow sublimation and Figure S9 shows the 2018-2023 mean blowing snow sublimation predicted by SnowModel-LG and DY2001 under all conditions (regardless of ICESat-2 data availability).
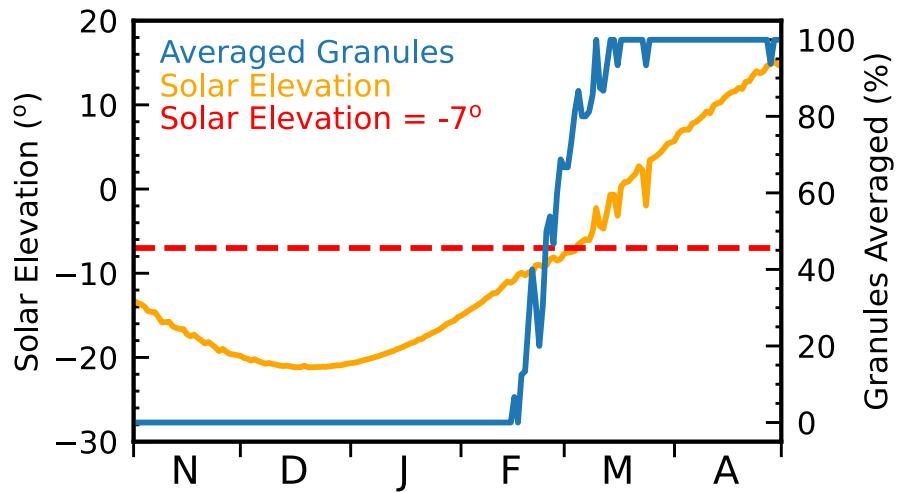
Figure S1. Characteristic cold season timeseries on the statistics of ICESat-2 data averaging from the native 280 m to 7 km along track. The average solar elevation is given in orange with the -7° cutoff shown as a red dashed line. The blue line shows the percent of ICESat-2 granules that are horizontally averaged.
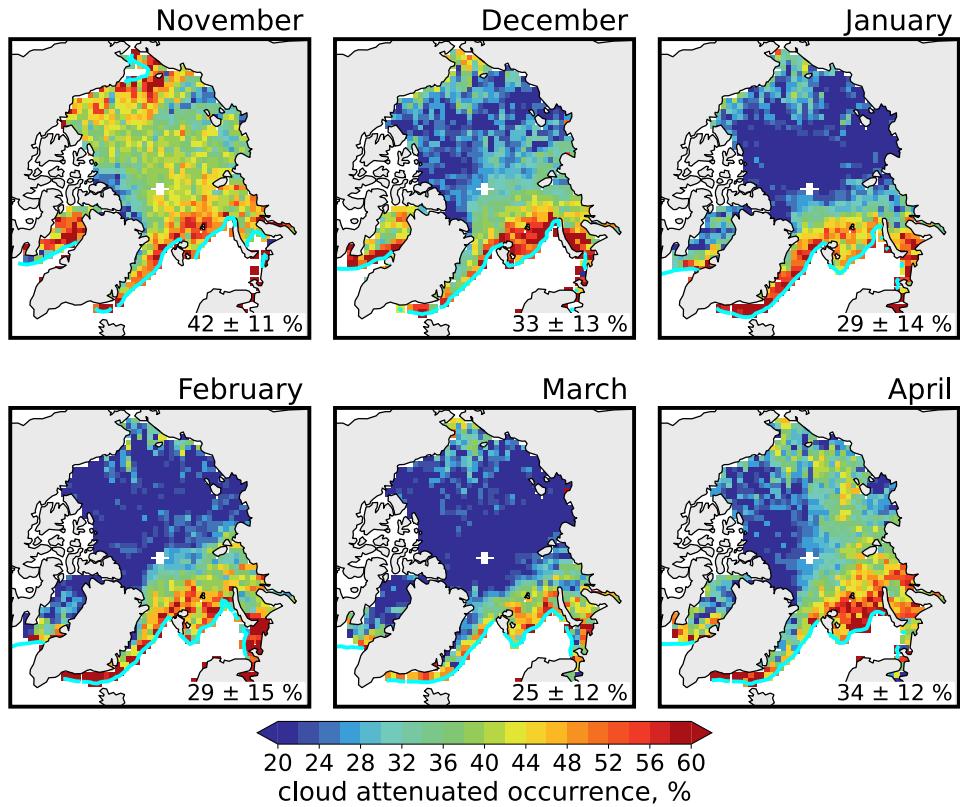
Figure S2. Monthly averaged cloud attenuated occurrence observed by ICESat-2 over the 2018-2023 cold seasons. The shading represents the percent of all ICESat-2 profiles in each grid box for which the surface could not be observed.
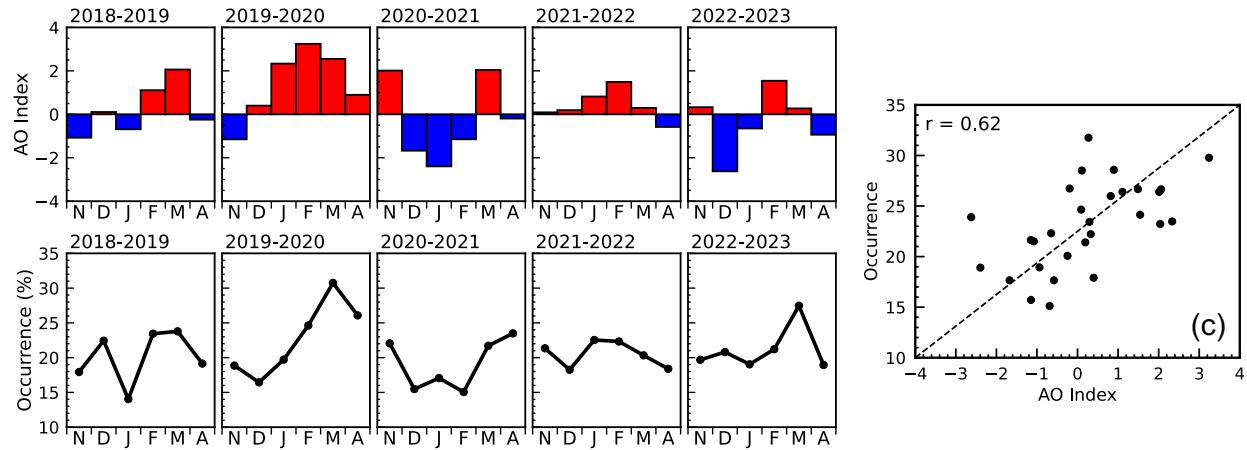
Figure S3. (top row) Monthly timeseries of the Arctic Oscillation index for the 2018-2023 cold seasons (accessed at http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii). **(bottom row)** Monthly timeseries of ICESat-2 derived blowing snow occurrence for the 2018-2023 cold seasons. **(c)** Correlation between monthly AO index (x-axis) and ICESat-2 monthly mean pan-Arctic blowing snow occurrence frequency (y-axis).
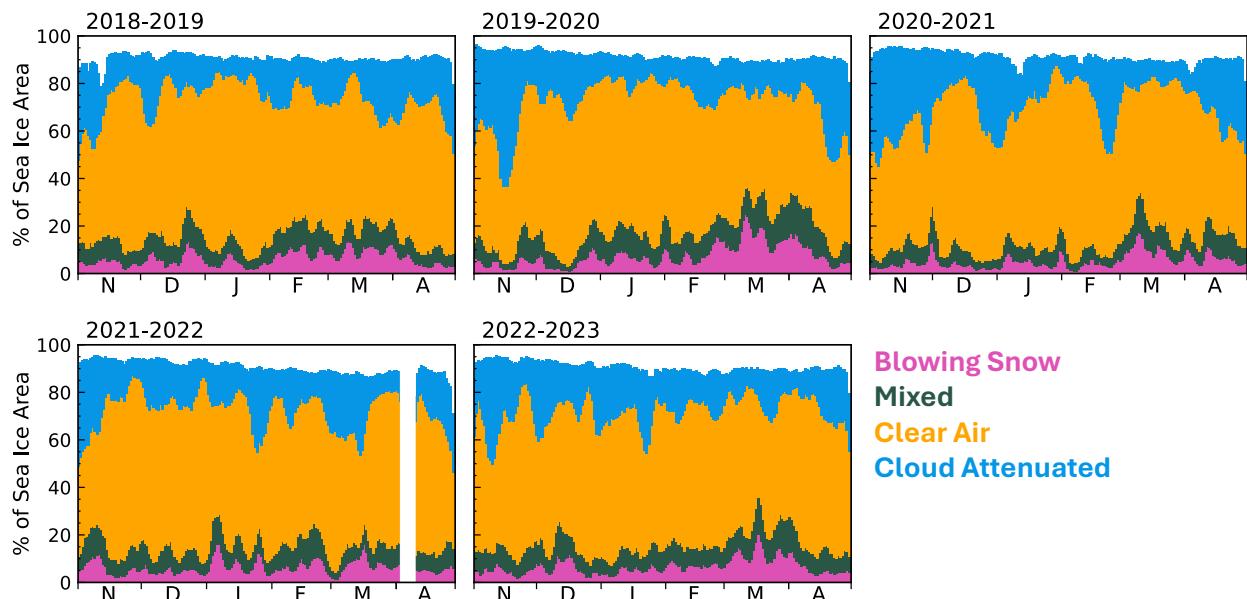
Figure S4. Timeseries of ICESat-2 observed grid cell labeled areas (in % of total sea ice area poleward of 65° N) for each individual cold season. The labelling is done using a 5-day running average of ICESat-2 profiles and each grid cell is labeled as blowing snow (magenta), mixed (green), clear air (orange), or cloud attenuated (blue) as described in Section 2.5.
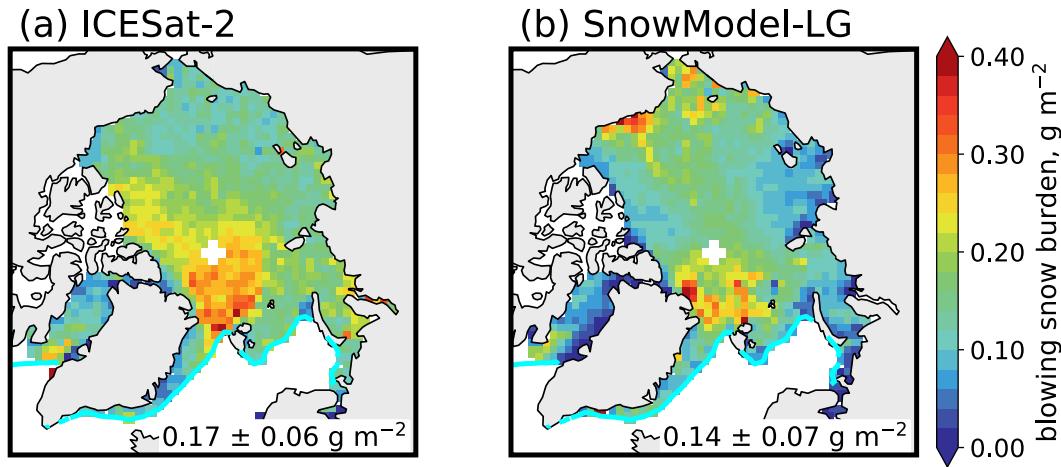
Figure S5. Seasonally averaged blowing snow mass burdens (units g m⁻²) over the 2018-2023 cold seasons from **(a)** ICESat-2 and **(b)** SnowModel-LG.
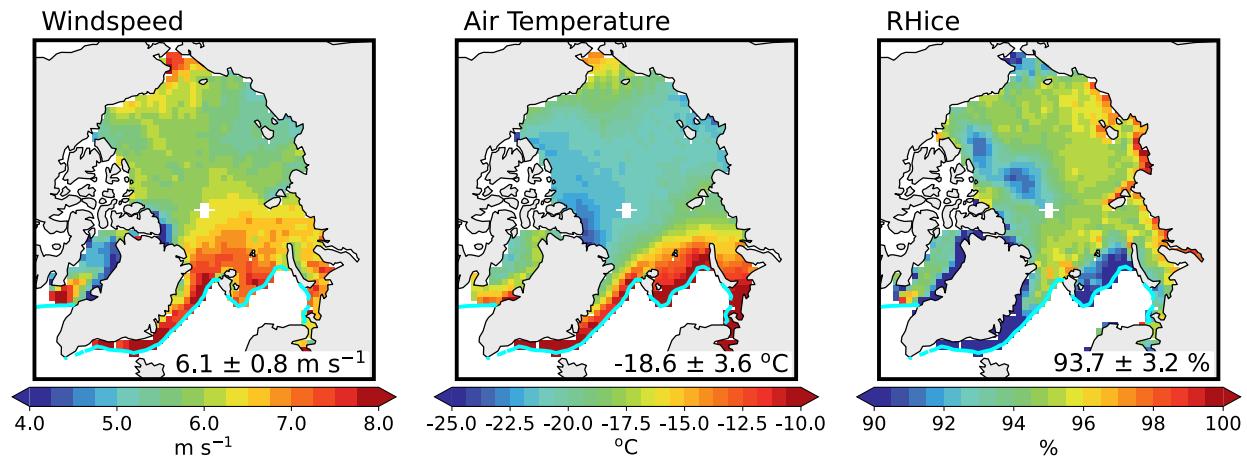
Figure S6. Seasonally averaged MERRA-2 meteorological conditions (10 m windspeed, 2 m air temperature, and 2 m relative humidity with respect to ice) over the 2018-2023 cold seasons. The fields are averaged regardless of whether ICESat-2 has available observations for a given grid cell on a given day.
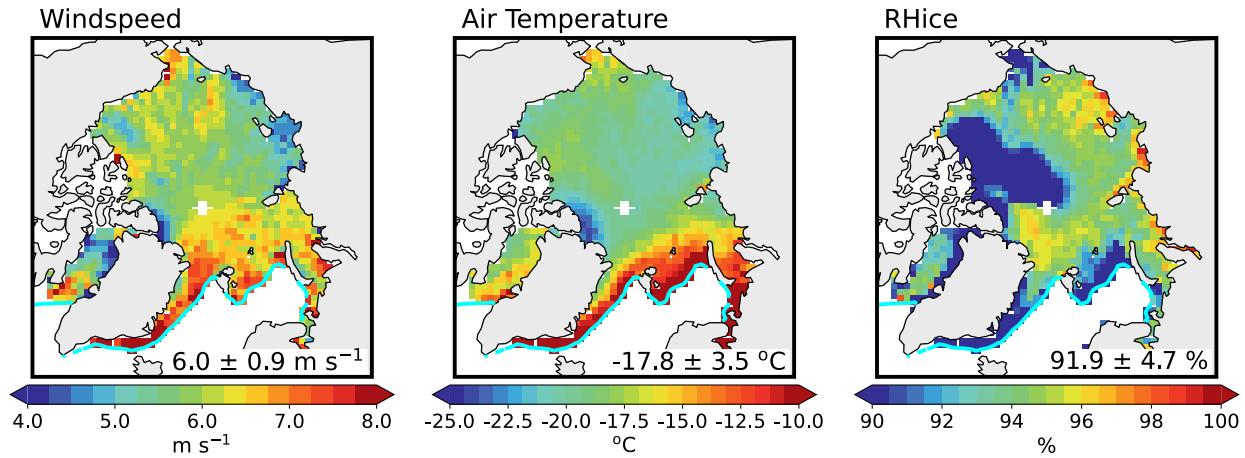
Figure S7. Seasonally averaged MERRA-2 meteorological conditions (10 m windspeed, 2 m air temperature, and 2 m relative humidity with respect to ice) for the 2021-2022 cold season. The fields are averaged regardless of whether ICESat-2 has available observations for a given grid cell on a given day.
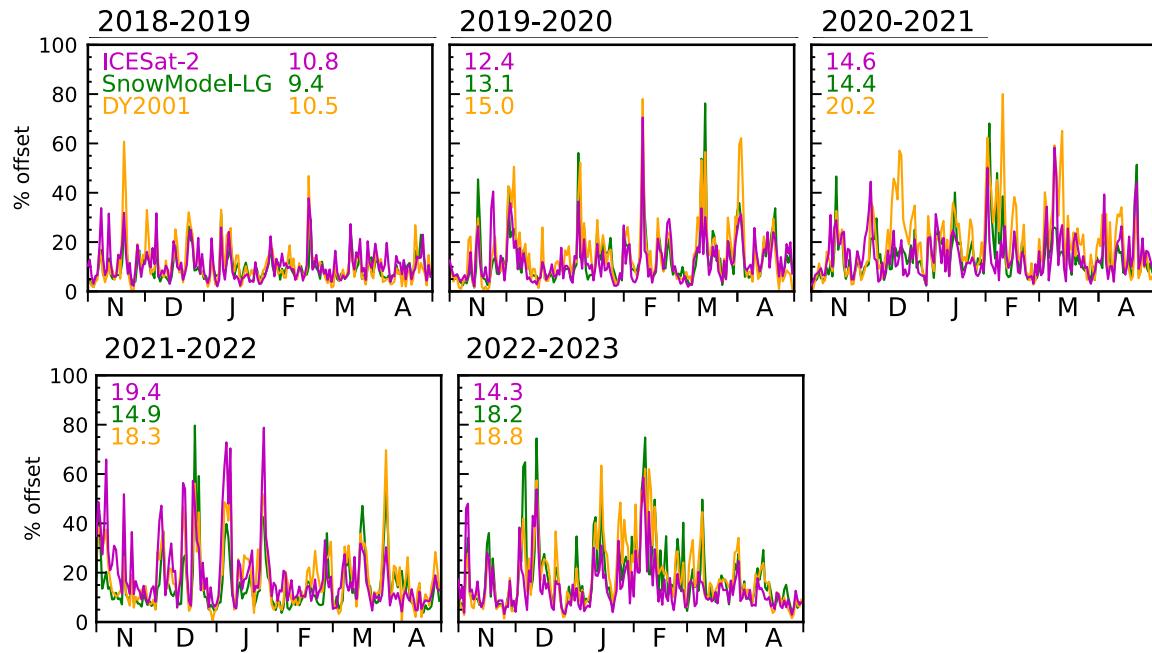
Figure S8. Timeseries of daily snowfall offset by blowing snow sublimation across the 2018-2023 Arctic cold seasons. Daily offsets (units %) are shown for ICESat-2 (magenta line), SnowModel-LG (green line), and DY2001 (orange line).
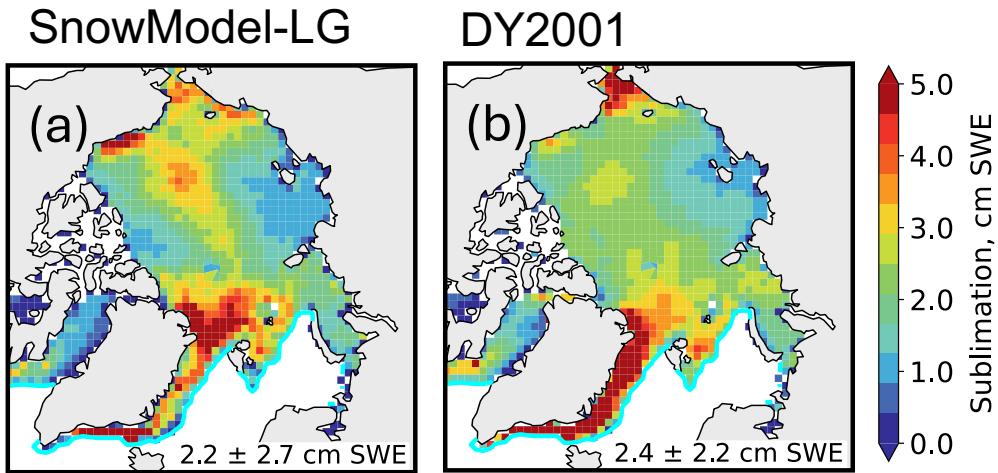
Figure S9. Spatial distribution of 2018-2023 all conditions blowing snow sublimation over Arctic sea ice predicted by **(a)** SnowModel-LG and **(b)** DY2001. All conditions means the SnowModel-LG and DY2001 results are analyzed regardless of whether ICESat-2 has available observations for a given grid cell on a given day. The bottom right of each panel shows the mean and standard deviation.