



Supplement of

Winter Arctic sea ice thickness from ICESat-2: upgrades to freeboard and snow loading estimates and an assessment of the first three winters of data collection

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Figure S1: (bottom row) number of 10 km along-track reference surfaces from the three strong beams from November 2018 to April 2019 for Release 002/rel002 (left) to Release 005/rel005 (right). Panels above show the difference in reference surface counts between releases rel003 to rel005 relative to rel002. Expanded version of Figure 2 in the main manuscript.



15 Figure S2: (bottom row) number of 10 km along-track reference surfaces from November 2018 to April 2019 for beam 1/B1 (left) through beam 6/B6 (right) using Release 005 data only. Beams 1, 3 and 5 are strong, 2, 4 and 6 are weak. Panels above show the difference in counts between beams.



Figure S3: Comparison of the gridded consensus/MEDIAN Operation IceBridge (OIB) daily spring 2013 to 2015 snow depth estimates with gridded quick-look (QL) OIB snow depths.



Figure S4: Comparisons of snow depth from NESOSIM v1.1 (left column), modified Warren climatology (mW99) snow depths (middle column) and the difference between the two (right column) for 2018-2020 October means (top row) and

25 2019-2021 April means (bottom row). Note that the mW99 results are calculated each month using OSI SAF ice type data (to halve snow over first-year ice) then averaged.



Figure S5: Comparisons of IS2SITMOGR4, v2 (Nov 2018-April 2019, September 2019-April 2020, September 2020-April 2021) converted to ice draft against ice draft measurements obtained by Beaufort Gyre Exploration Project (BGEP) upward looking sonar moorings. The mean of all IS2SITMOGR4 data within (a) 25 km, (b) 50 km, (c) 100 km (as in Figure 10 of the primary manuscript), and (d) 150 km, of the given mooring are shown here.



Figure S6: Time series of monthly mean 2 m temperature and downwelling longwave radiation from ERA5 within our Inner Arctic Ocean region.