

Supplementary materials for

Tenuous correlation between snow depth or sea ice thickness and C- or X-band backscattering in three Nunavik fjords of the Hudson Strait

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Monthly precipitation data at Salluit airport

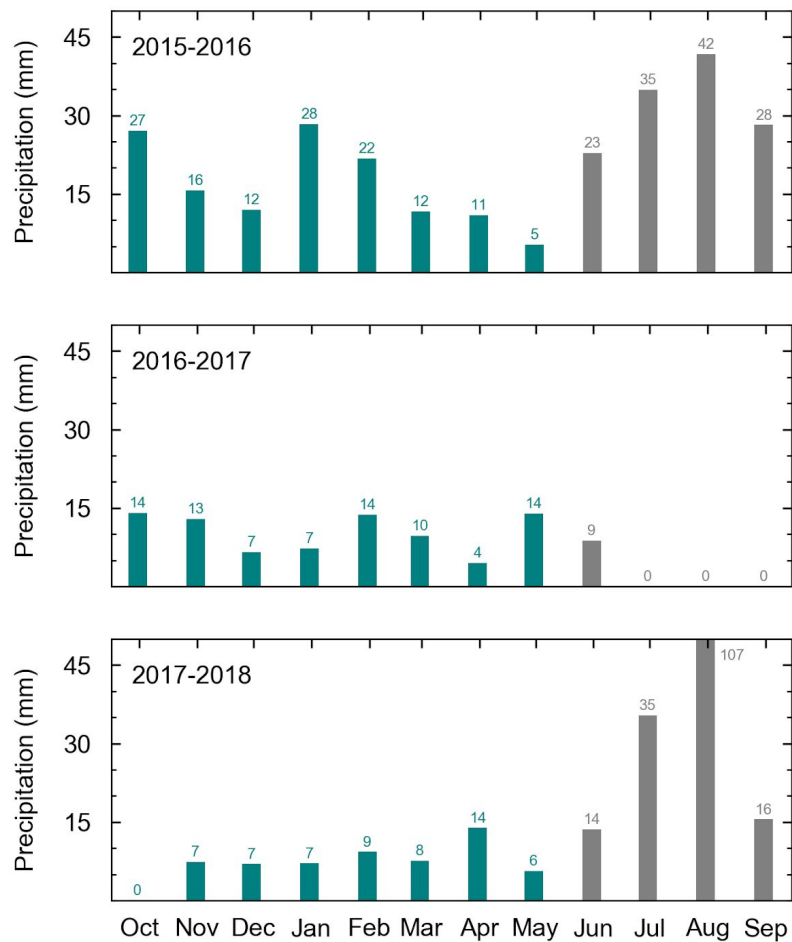


Figure S1: Monthly total precipitation measured at Salluit airport. Grey is used for months with median temperature over 0°C. Data source: Environment Canada.

Bathymetry

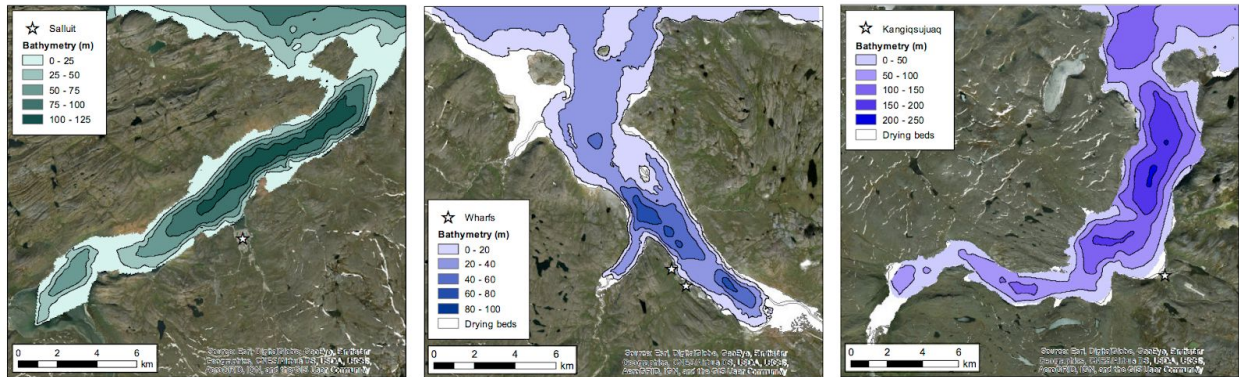


Figure S2: Bathymetry for Salluit (left), Deception Bay (center), and Kangiqsujuaq (left). Water depth colormaps are based on a different range for each site. Data source: Canadian Hydrographic Service, Fisheries and Oceans Canada. Basemap: ESRI.

Relative timing of fieldwork and image acquisitions

Table S1 shows fieldwork and RADARSAT-2 acquisition dates, as well as the difference between the two, for Salluit and Kangiqsujaq. Table S2 shows fieldwork, RADARSAT-2 and TerraSAR-X acquisition dates, and the difference between the two, for Deception Bay.

Table S1: Fieldwork dates in Salluit and Kangiqsujaq, RADARSAT-2 acquisition dates, and the difference between the two. Air temperature measured at Salluit and Kangiqsujaq airports at acquisition time is also indicated.

Fieldwork (Salluit)	RADARSAT- 2	Δ	T (°C)	Fieldwork (Kangiqsujaq)	RADARSAT-2	Δ	T (°C)
-	-	-	-	2016-04-20	2016-04-21	+1	-14
2017-04-27	2017-04-12	-15	-18	2017-04-25	2017-04-16	-9	-19
2018-05-09	2018-05-01	-8	-15	2018-05-08 and 2018-05-15	2018-05-29	+21 +14	-3

Table S2: Fieldwork dates in Deception Bay, RADARSAT-2 and TerraSAR-X acquisition dates, and the difference between the two. Air temperature measured at the nearest meteorological station (Salluit) at the acquisition time is also indicated.

Fieldwork (Deception Bay)	RADARSAT-2	Δ	T (°C)	TerraSAR-X	Δ	T (°C)
2016-04-23	2016-04-24	+1	-19	2016-04-22	-1	-16
2017-04-29	2017-04-19	-8	-16	2017-05-01	+2	-12
2018-05-11	2018-05-08	-3	-10	2018-05-10	-1	-10

Snow depth and ice thickness histograms

Figures S3 shows histograms for end-of-winter snow depth and ice thickness measurements. Based on the Shapiro-Wilk test, the measurements for those cases where the p-value is lower than the threshold are not normally distributed.

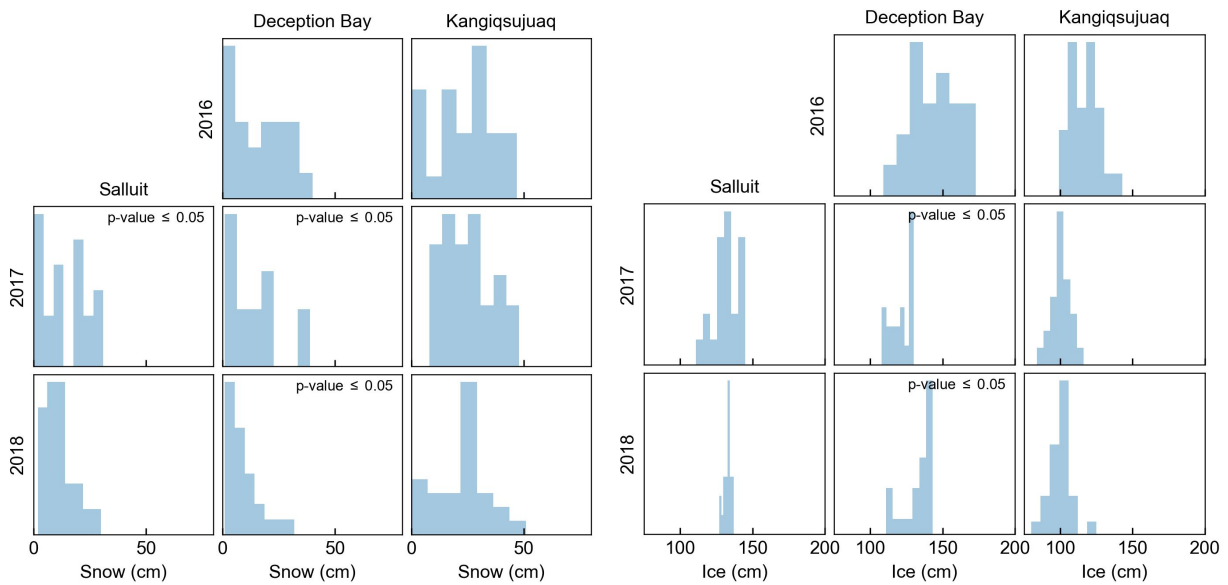


Figure S3: Measurement distributions for snow depth (left) and ice thickness (right) measured in April-May of each season. Means and standard deviations are annotated on the graphs.

SAR parameters vs snow depth or ice thickness

Figures S4-S6 show the C-band HH backscattering coefficient as a function of snow depth and ice thickness for Salluit, Deception Bay and Kangiqsujaq. For Deception Bay, X-band data is also presented.

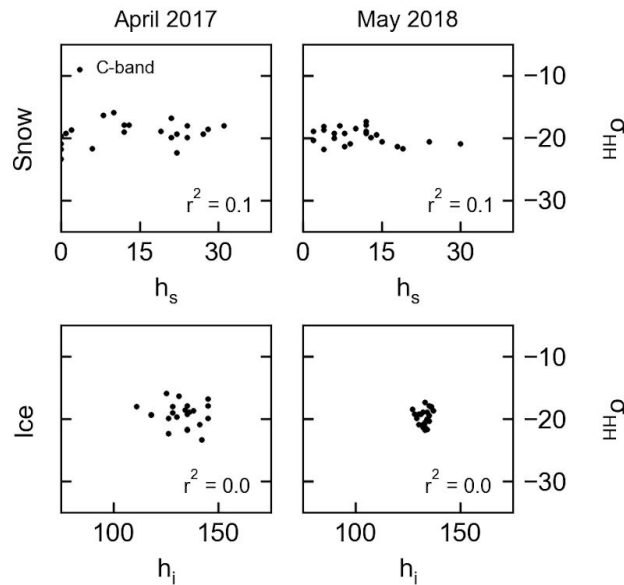


Figure S4: C-band backscattering HH coefficient versus snow depth (top) and ice thickness (bottom) for available cases in Salluit. The associated linear correlation coefficient r -squared is indicated on the graphs. Trend line is plotted when r -squared is greater than or equal to 0.3.

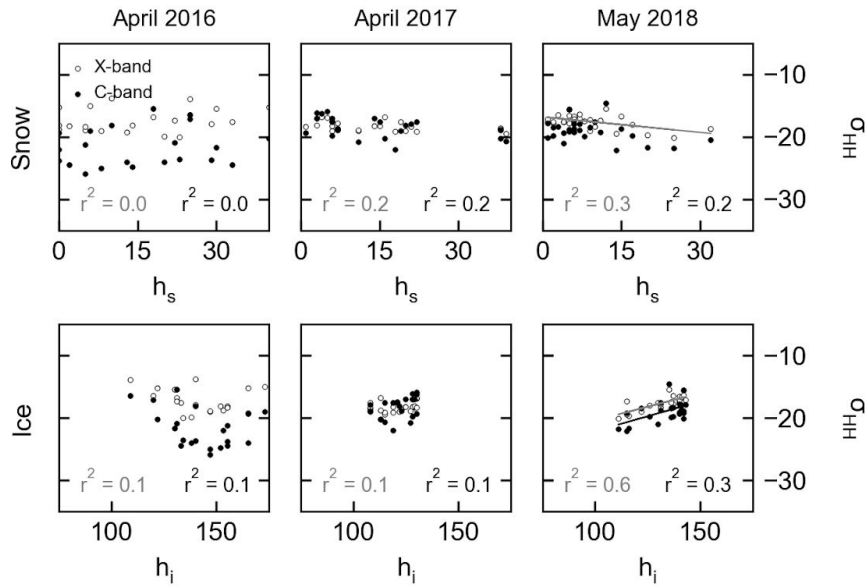


Figure S5: Same as S4 for Deception Bay. X-band data is also shown with empty markers and gray lines.

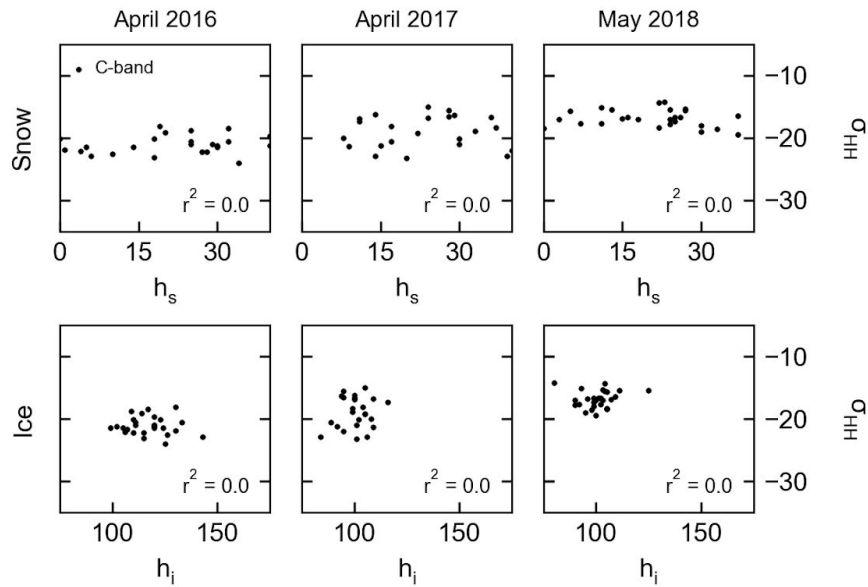


Figure S6: Same as S4 for Kangiqsujuaq.

Table S3: Linear correlation coefficient (r-squared) between C-band SAR parameter values and April-May snow depth (top) and ice thickness (bottom).

Snow depth	Salluit			Deception Bay			Kangiqsujaq		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Sigma_HH	n/a	0.1	0.1	0.0	0.2	0.2	0.0	0.0	0.0
Sigma_HV	n/a	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Sigma_VV	n/a	0.1	0.3	0.0	0.3	0.1	0.0	0.0	0.1
VV/HH ratio	n/a	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
HV/HH ratio	n/a	0.0	0.3	0.0	0.0	0.1	0.0	0.0	0.0
VH/VV ratio	n/a	0.2	0.3	0.0	0.2	0.0	0.1	0.0	0.0
H (entropy)	n/a	0.1	0.1	0.0	0.3	0.0	0.2	0.0	0.0
A (anisotropy)	n/a	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.0
a (alpha angle)	n/a	0.1	0.1	0.0	0.5	0.1	0.1	0.0	0.0

Ice thickness	Salluit			Deception Bay			Kangiqsujaq		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Sigma_HH	n/a	0.0	0.0	0.1	0.1	0.3	0.0	0.0	0.0
Sigma_HV	n/a	0.1	0.0	0.2	0.0	0.2	0.1	0.1	0.1
Sigma_VV	n/a	0.1	0.0	0.1	0.2	0.3	0.0	0.0	0.0
VV/HH ratio	n/a	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
HV/HH ratio	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
VH/VV ratio	n/a	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0
H (entropy)	n/a	0.0	0.0	0.1	0.3	0.1	0.1	0.0	0.1
A (anisotropy)	n/a	0.2	0.1	0.2	0.0	0.1	0.0	0.0	0.0
a (alpha angle)	n/a	0.0	0.0	0.1	0.5	0.2	0.1	0.0	0.1

Bayesian linear regression

Figure S7 shows an example of a marginal probability distribution, taken from the H_{snow} hypothesis, most likely in the Salluit 2018 case. γ is the snow depth slope, is an offset term and η_{σ} is the noise term. The maximum probability for the gamma parameter is negative, indicating a negative relationship between snow depth and the C-band HH backscattering coefficient.

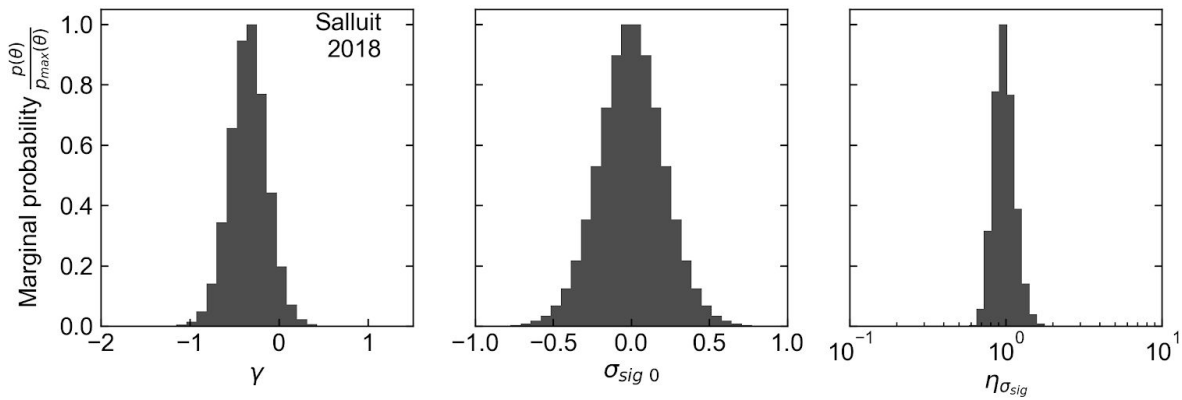


Figure S7: Example: marginal probability distributions for the H_{snow} hypothesis parameters in the Salluit 2018 case.

Figures S8 and S9 show the pair-wise logarithmic Bayes factors and most likely hypothesis for each case, respectively for the C- and the X-bands. The mean and standard deviation for each parameter's marginal probability distribution are shown for the C- and X-bands in Fig. S10-S13 for each hypothesis: the snow-driven backscattering coefficient, ice-driven backscattering coefficient and snow-and-ice-driven backscattering coefficient.

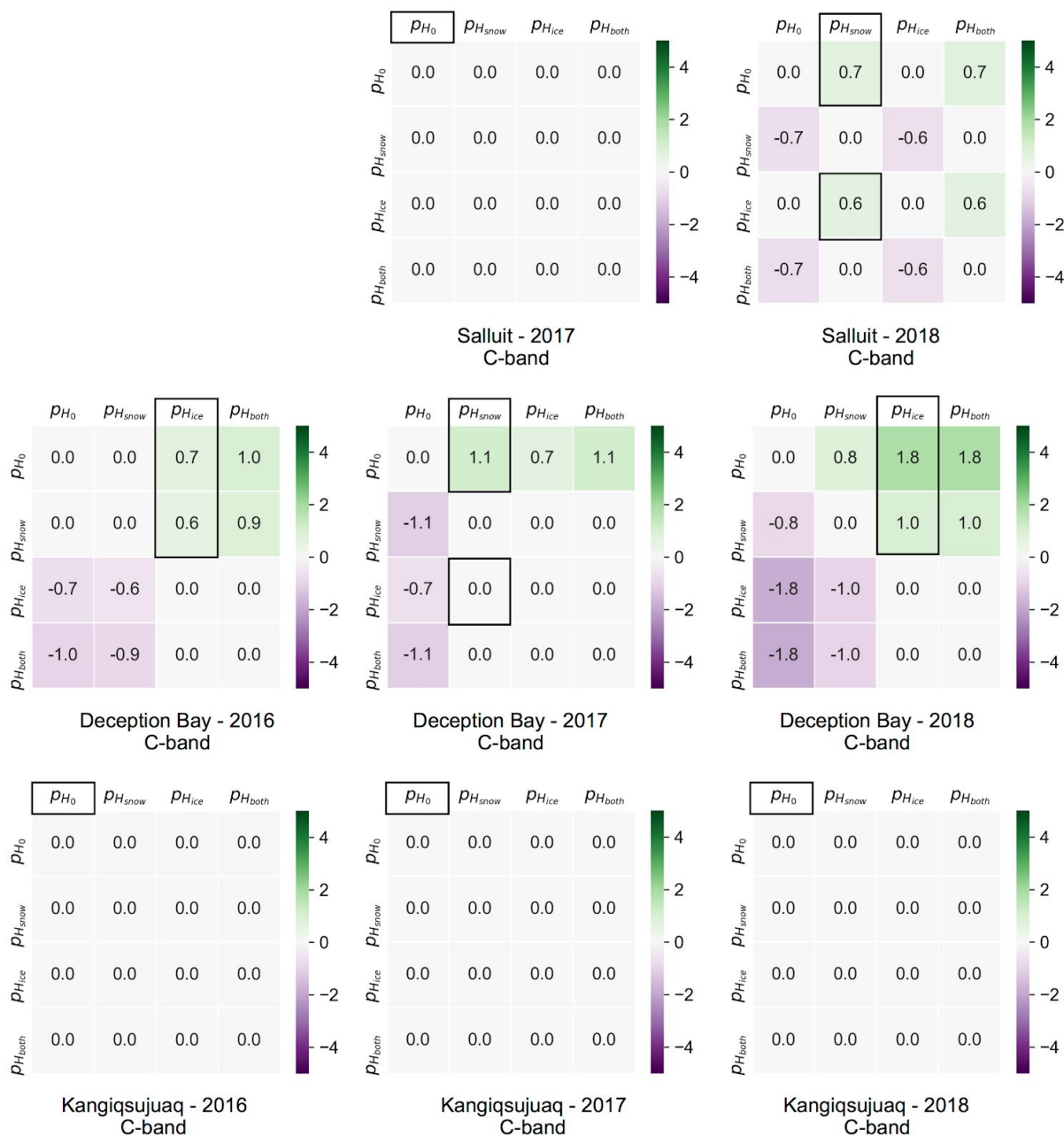


Figure S8: Pair-wise logarithmic Bayes factors $\log_{10}(K) = \log_{10}(p(D|H_i)/p(D|H_j))$ for the Bayesian linear regression analysis of the relationship between the C-band HH backscattering coefficient and either snow depth, ice thickness, or both. A $\log_{10}(K)$ value of 0.5 or higher denotes substantial evidence against the hypothesis being tested. The most likely hypothesis given the data is framed in black.

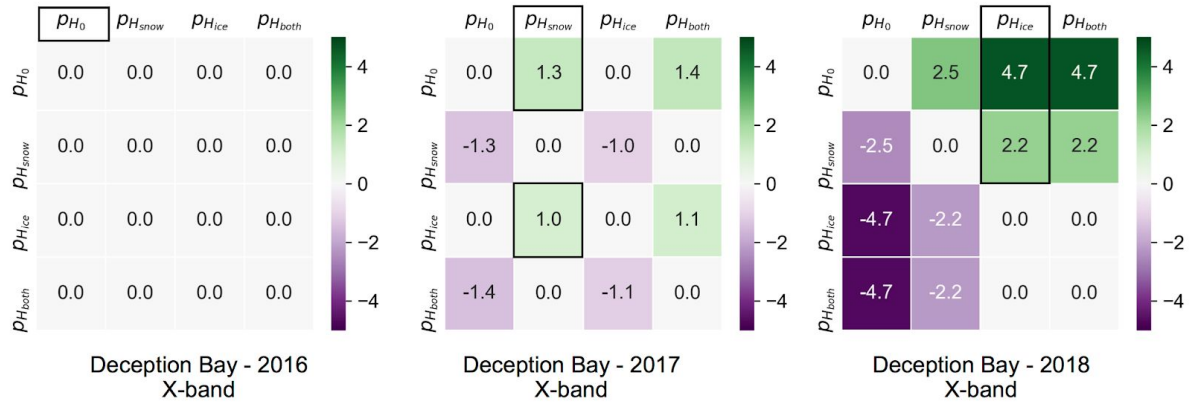


Figure S9: Same as S8 for the X-band in Deception Bay.

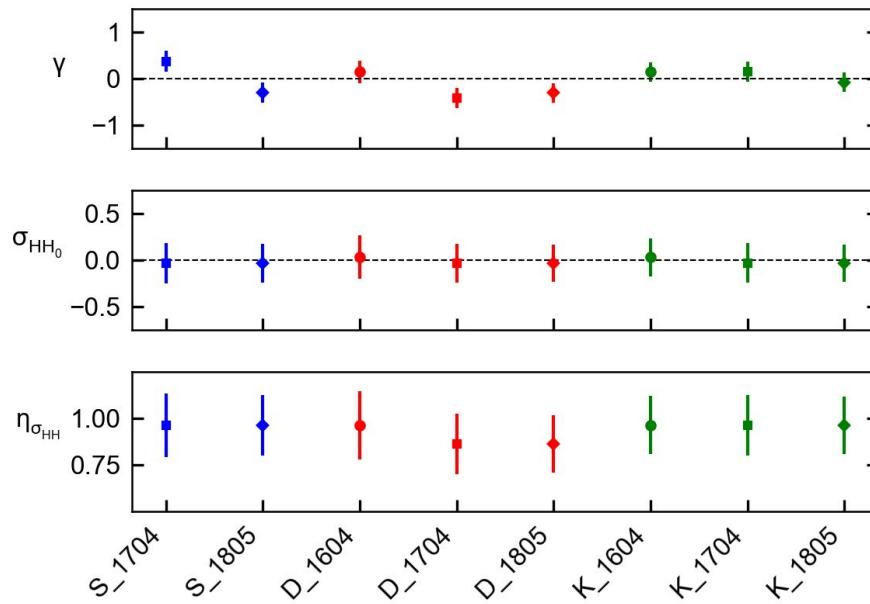


Figure S10: Mean and standard deviation of the parameters' marginal probability distributions for H_{snow} , the snow-driven backscattering coefficient model, applied to C-band data.

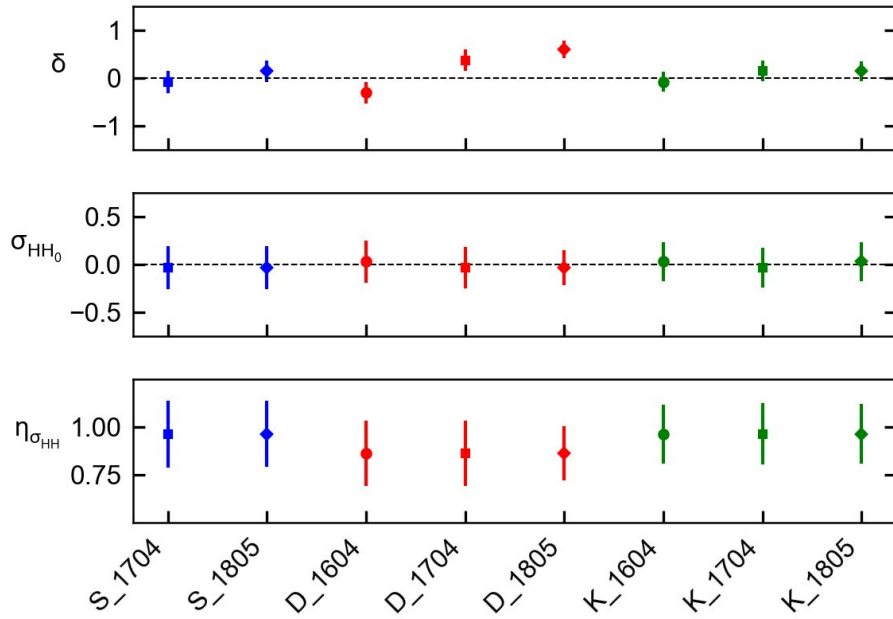


Figure S11: Mean and standard deviation of the parameters' marginal probability distributions for H_{ice} , the ice-driven backscattering coefficient model, applied to C-band data.

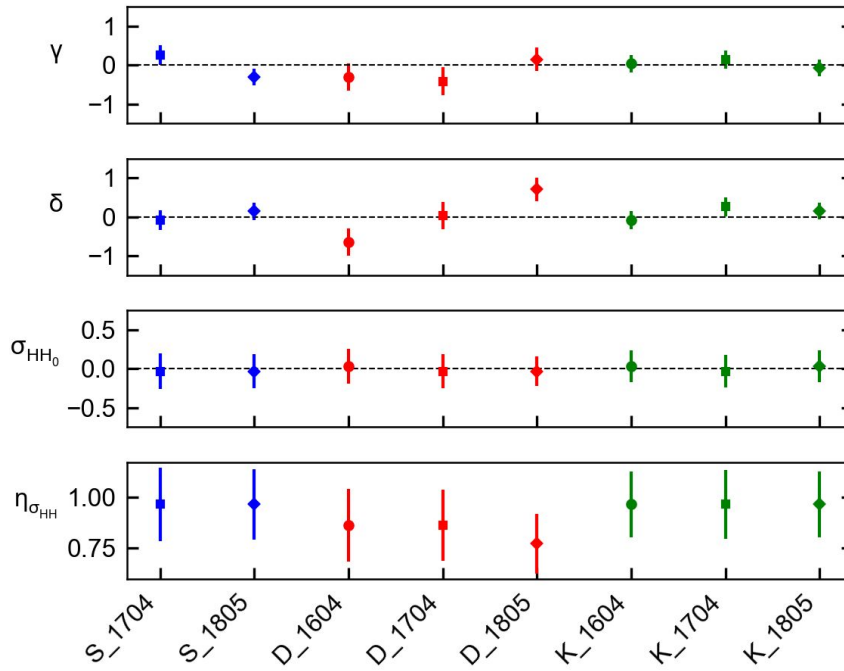


Figure S12: Mean and standard deviation of the parameters' marginal probability distributions for H_{both} , the snow-and-ice-driven backscattering coefficient model, applied to C-band data.

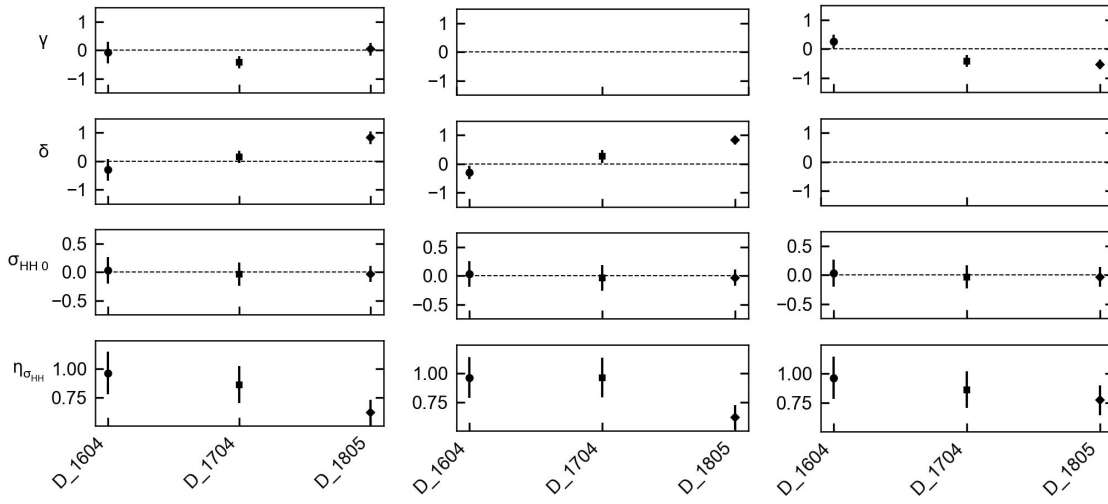


Figure S13: Mean and standard deviation of the parameters' marginal probability distributions for H_{snow} (left), H_{ice} (center) and H_{both} (right), applied to X-band data.