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Supplementary material for:

Ilulissat Icefjord Upper-Layer Circulation Patterns Revealed through GPS-Tracked Icebergs

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Iceberg ID	Footprint (m^2)	Avg. P_w from surface to keel depth ($kg\ m^{-3}$)	P_{atm} at DEM construction ($kg\ m^{-3}$)	Maximum distance from terminus (km)	Starting distance from terminus (km)	Horizontal distance covered (km)
IF0114	23516	1027.91	1010.9	168.8	23.5	144.5
IF0214	64161	1027.85	1005.2	181.9	31.5	150.4
IF0314	143014	1028.58	1009.2	91.5	35.6	55.9
IF0414	99251	1028.24	1010.9	58.7	10.2	48.5
IF0514	498198	1029.03	1010.9	19.1	4.6	14.5
IF0614	-	-	-	9.9	5.9	4.0
IF0714	61895	1027.90	1006.9	150.1	4.3	145.8
IF0814	44513	1027.55	1002.0	96.2	2.8	93.4
IF0719	56884.5	1025.76	1017.8	17.5	5.1	12.4
IF0819	443031.8	1026.29	1017.8	25.6	11.0	14.6
IF0919	281844.6	1026.20	1017.8	43.0	16.2	26.8
IF1019	47779.3	1025.72	1017.8	152.2	25.4	126.8
IF1119	101529.4	1025.86	1017.8	95.5	19.7	75.8

Table S1| Instrumented iceberg footprint (above-water area), maximum seawater density (P_w) at iceberg keel depth, atmospheric pressure at time of DEM/DSM acquisition, and maximum and starting iceberg distance from terminus.

Iceberg ID	Residence time (days)			Region distance (km)			Normalized residence time (days/km)		
	Mélange	Mid-fjord	Fjord mouth	Mélange	Mid-fjord	Fjord mouth	Mélange	Mid-fjord	Fjord mouth
IF0114	-	13	4	-	21.5◊	13	-	0.6	0.3
IF0214	-	6	8	-	13.5◊	13	-	0.4	0.6
IF0314	-	10	11	-	9.4◊	13	-	1.1	0.8
IF0414	5	11	27	7.8◊	27	13	0.6	0.5	2.1
IF0514	10	1	-	13.4◊	1.1*	-	0.7	0.9	-
IF0614	8	-	-	4◊*	-	-	2	-	-
IF0714	14	13	2	13.7◊	27	13	1.0	0.5	0.2
IF0814	10	9	5	15.2◊	27	13	0.65	0.3	0.4
2014 avg.	**9.4 ± 3.2**	**9.0 ± 4.3**	**9.5 ± 9.1**	**10.8**	**18.1**	**13**	**1.0 ± 0.6**	**0.6 ± 0.3**	**0.7 ± 0.7**
IF0719	106	-	-	12.4◊*	-	-	8.5	-	-
IF0819	93	-	-	14.6◊*	-	-	6.4	-	-
IF0919	42	40	-	15.8◊	11*	-	2.7	-	-
IF1019	18	26	30	6.6◊	11	15	2.7	2.4	2
IF1119	42	10	62	12.3◊	11	15	3.4	0.9	4.1
2019 avg.	**60.2 ± 37.5**	**25.3 ± 15.0**	**46.0 ± 22.6**	**12.3**	**11**	**15**	**4.1 ± 2.6**	**1.3 ± 1.0**	**2.3 ± 1.5**

Table S2| Iceberg position by region in Ilulissat Icefjord, including residence time (number of days) for each region, horizonal length of each region, and normalized residence time by region length. Modifications to region length take into consideration deployment within a region (denoted by◊), as well as loss of signal within a region (denoted by *). Iceberg IF0919 lost signal at the boundary between the mid-fjord and fjord mouth regions. Normalized residence time divides the days in each region by region length for each iceberg. Standard deviation noted for residence time and normalized residence time.

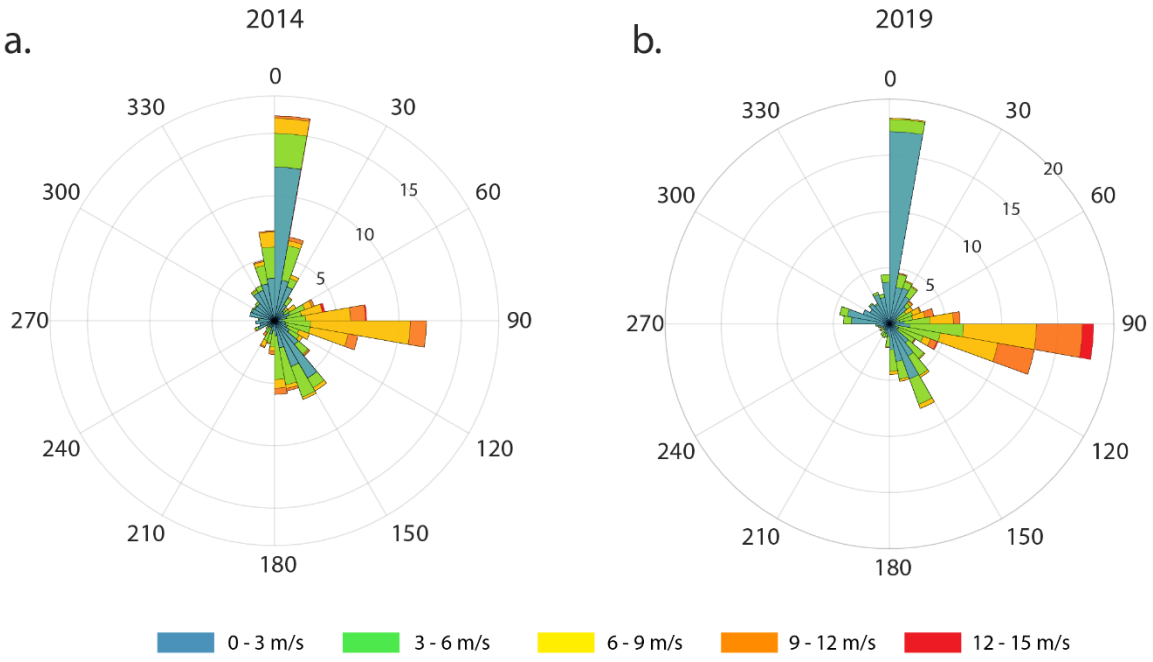


Figure S1| Direction Frequency/ "Wind Rose" in Ilulissat Icefjord. Hourly wind speeds (m s^{-1}) and direction (degrees) are measured and recorded in 2014 (**a**) and 2019 (**b**) at 10 meters above the ground with time resolutions of 1 hour. Data were obtained from a Danish Meteorological Institute Automated Weather Station (DMI Station #04221, Ilulissat Airport).

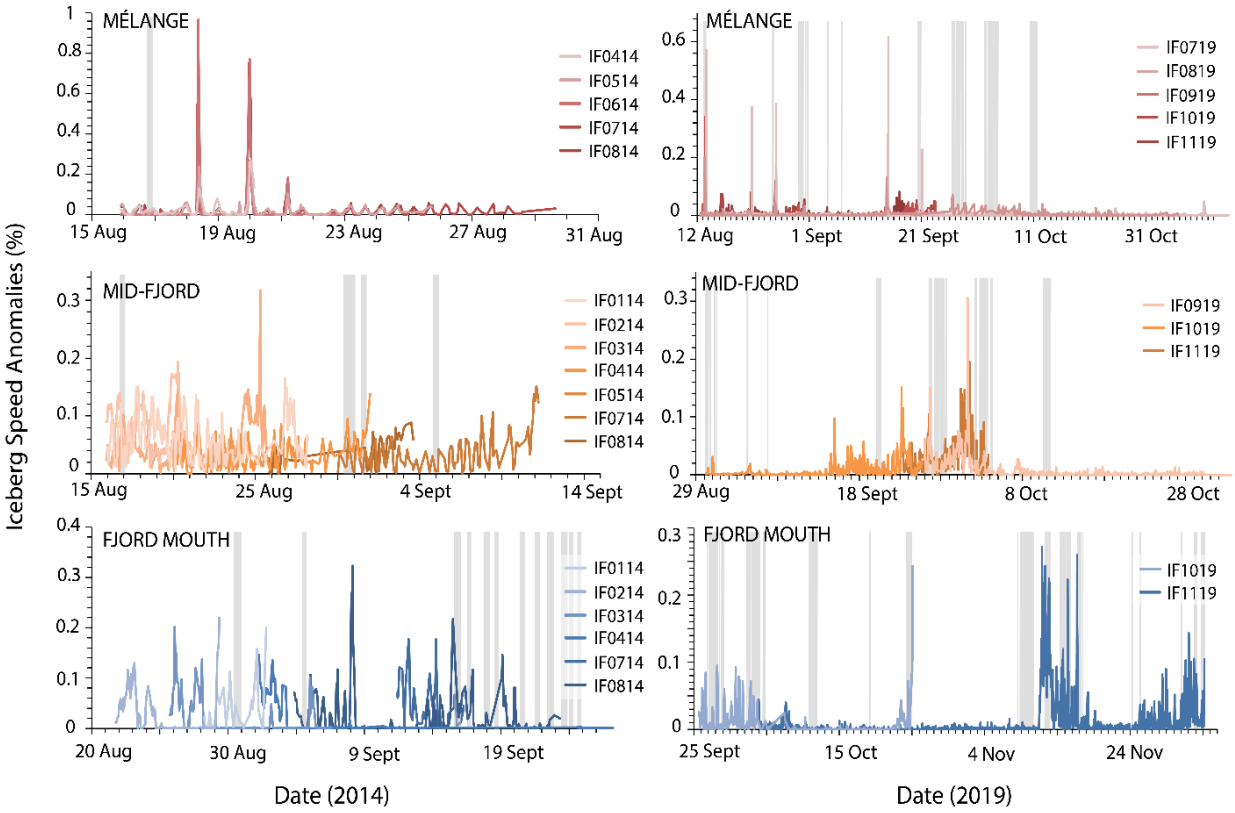


Figure S2| Iceberg speed anomalies during on-iceberg GPS deployment in 2014 (left panel) and 2019 (right panel). Grey vertical bars represent wind events over 9 m s^{-1}, and the solid-colored lines represent individual iceberg speed anomalies in the mélange (red, top), mid-fjord (yellow, middle) and fjord mouth (blue, bottom) regions.

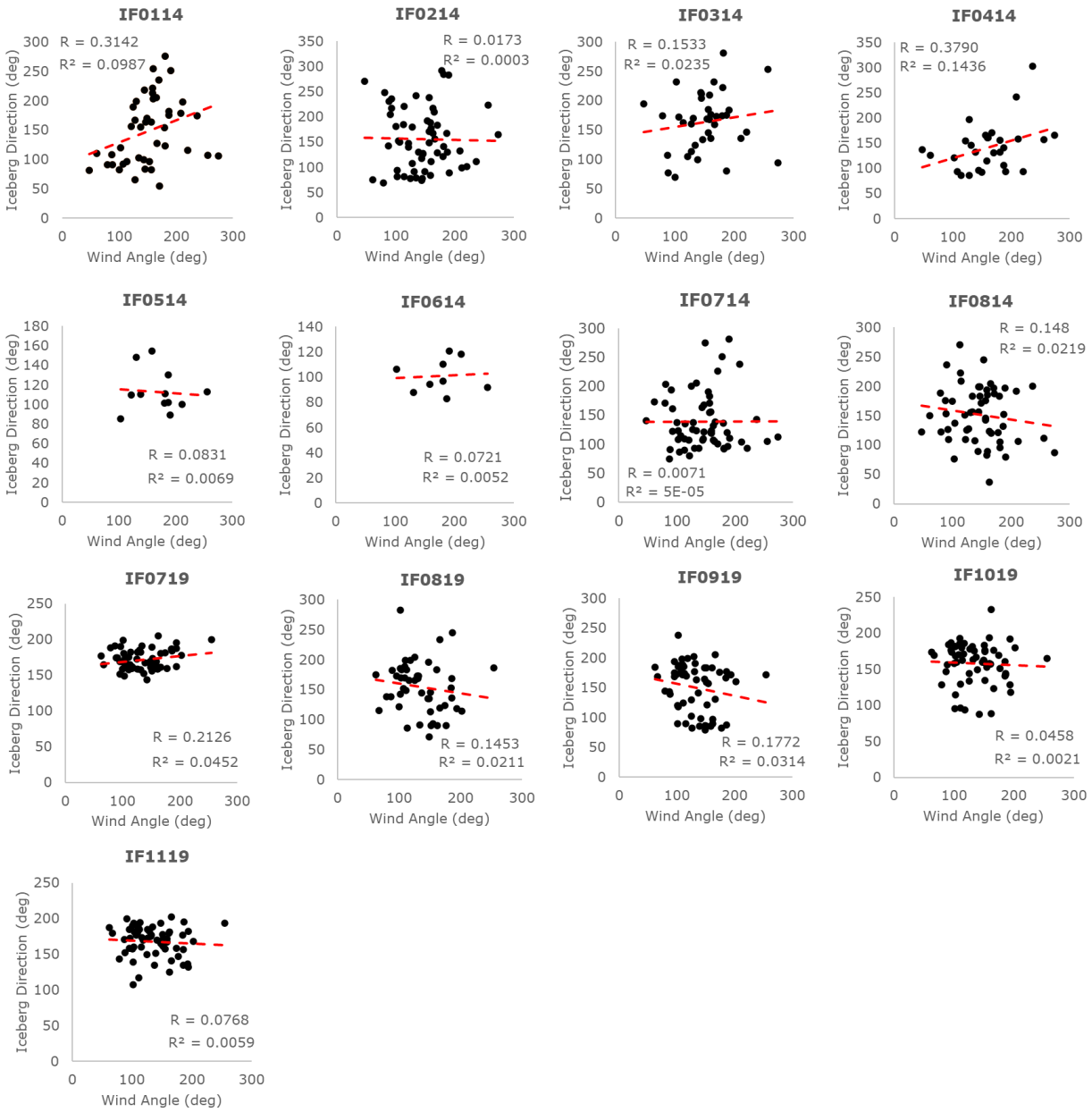


Figure S3| Daily mean iceberg direction versus wind angle for each instrumented iceberg while in Ilulissat Icefjord. Red dashed line represents line of linear regression (R^2).

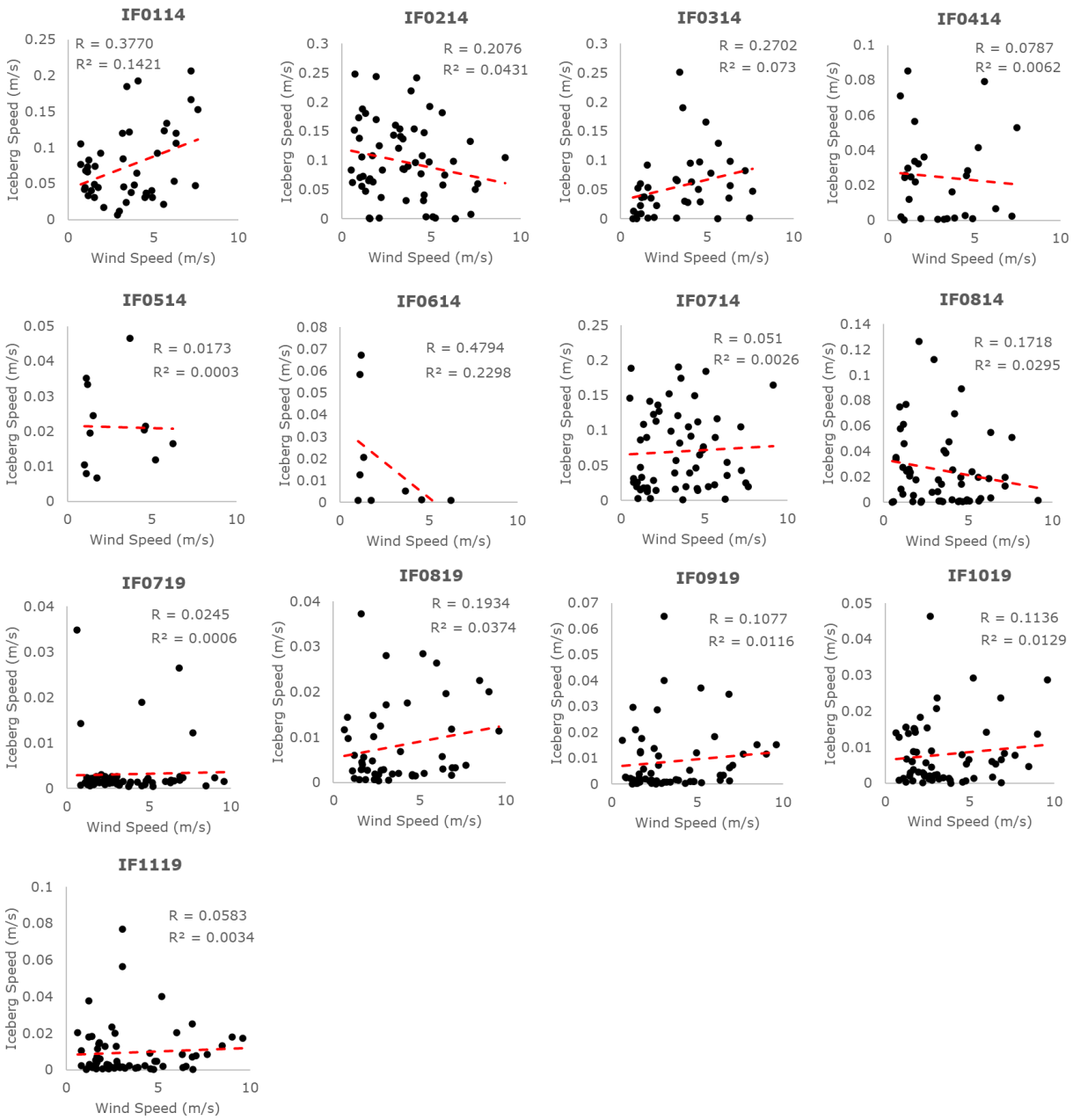


Figure S4| Daily mean iceberg speed versus wind speed for each instrumented iceberg while in Ilulissat Icefjord. Red dashed line represents line of linear regression (R^2).

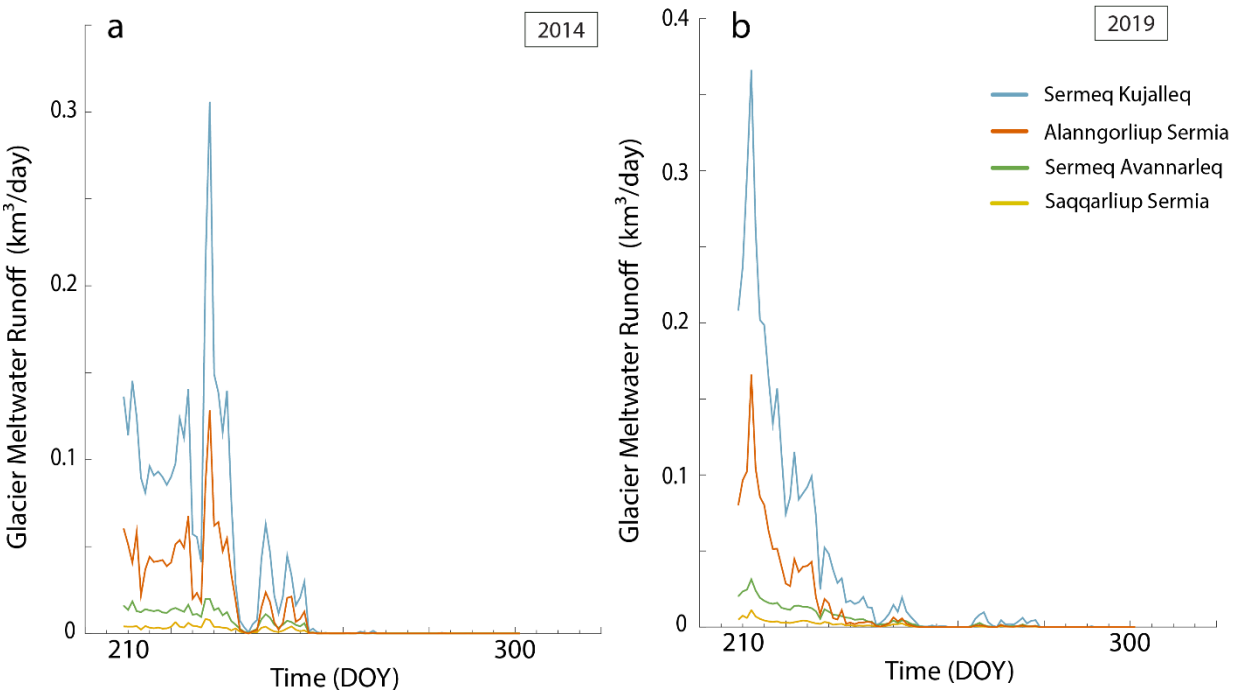
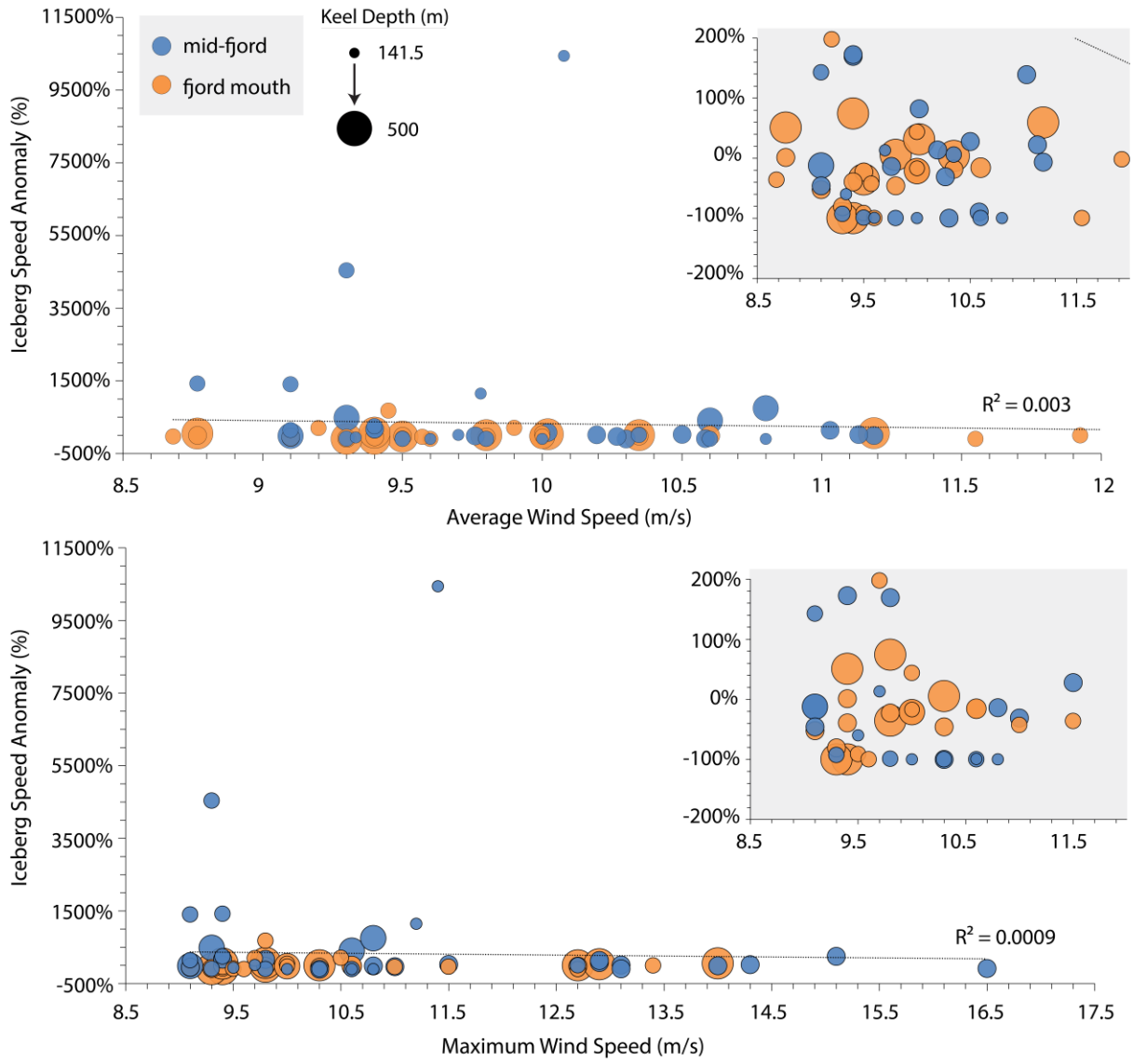


Figure S5| Individual glacier contribution of meltwater delivery to Ilulissat Icefjord from 01 July – 31 December 2014 (a) and 2019 (b). Each line represents daily meltwater runoff volume, accounting for transit time to Ilulissat Icefjord.



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59 **Figure S6|** Companion figure to Figure 7, in text. Iceberg speed anomaly during wind events (>9
60 m s^{-1}) as a function of average (top) and maximum (bottom) wind speed during the 2014 and
61 2019 campaigns. Circle diameter is scaled to iceberg keel depth, with colors representing fjord
62 region at time of associated wind event.
63

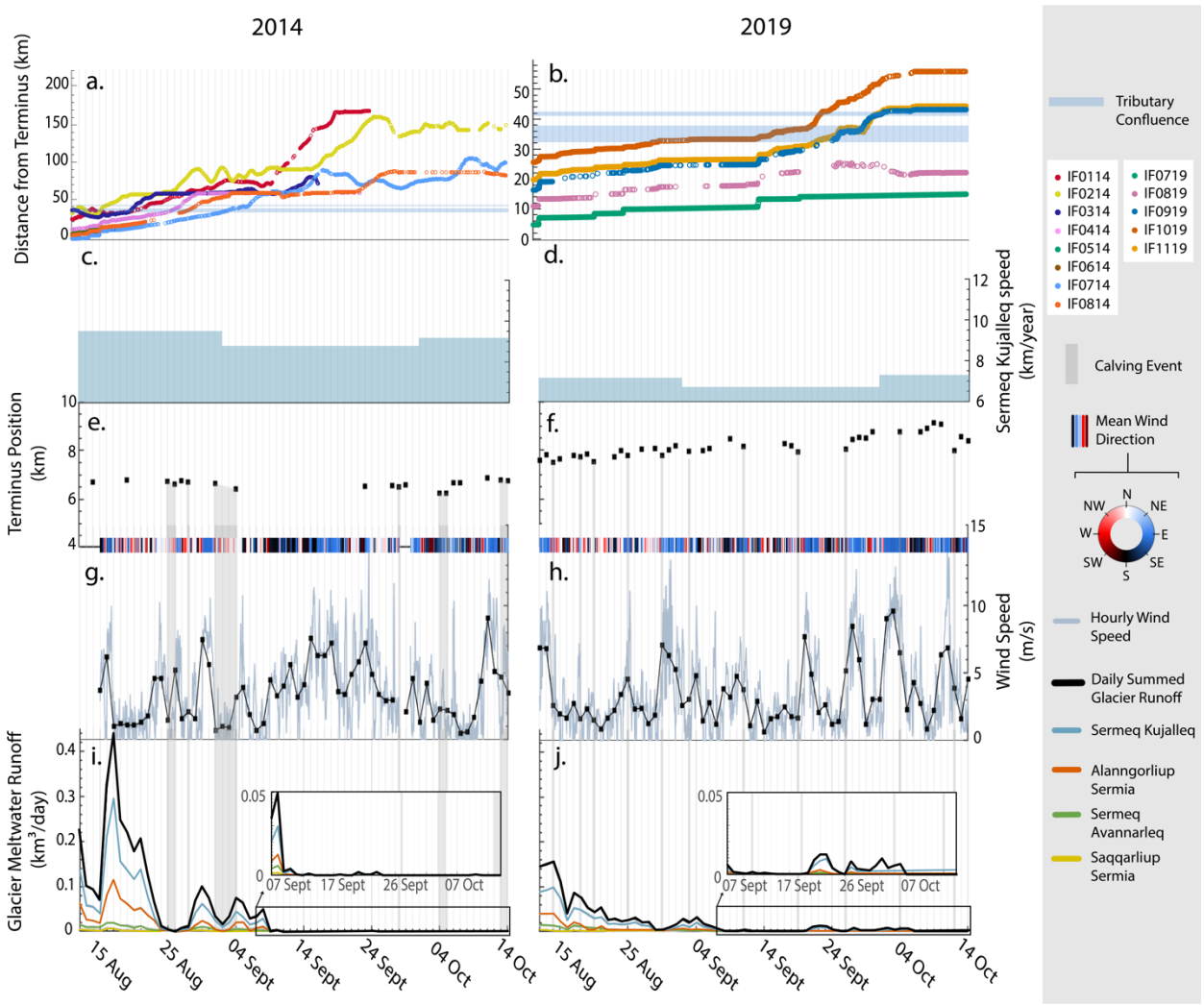

Figure S7| Top panel is the time series of iceberg distance from the terminus (as in Fig. 2c, d), for 2014 (a) and 2019 (b) with blue bands representing the confluence location of tributary fjords. Additional panels show time series of Sermeq Kujalleq speed (c, d), terminus position (e, f, black squares), wind speed and direction (g, h), and glacier meltwater runoff (i, j) in 2014 (left column) and 2019 (right column). Sermeq Kujalleq glacier speeds (c, d) were measured using the MEaSUREs Greenland Ice Velocity dataset (Howat, 2020), with centerline transect velocities (solid lines) spanning the mélange region of the fjord to ~17 – 19 km up glacier. Measured terminus positions (e, f) were used to determine episodic calving events (vertical grey bars). Daily averaged (black) and hourly (light blue) wind speeds (g, h), is shown below hourly wind direction, which is color-coded by cardinal direction and denoted by the horizontal line of blue-red markers. Glacier meltwater runoff (i, j; cumulative, black line) is divided by glacier catchment and adjusted to include transit time to Ilulissat Icefjord.

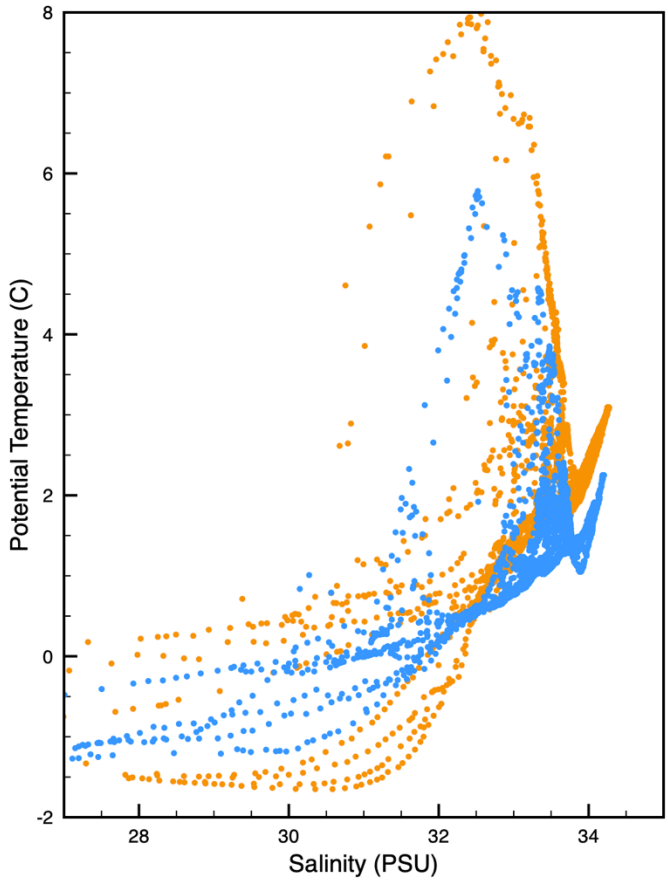

Figure S8| Temperature and salinity from CTD and X-CTD casts are shown in temperature-salinity (T-S) space for 2014 (orange) and 2019 (blue).

References:

Howat, I. (2020), MEaSUREs Greenland Ice Velocity: Selected Glacier Site Velocity Maps from Optical Images, edited, Distributed Active Archive Center, NASA National Snow and Ice Data Center, doi:10.5067/RRFY5IW94X5W.