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Supplement of

Triggers of the 2022 Larsen B multi-year landfast sea ice breakout and initial glacier response

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Table 1: DEMs from Worldview Imagery			
Sensor	Acquisition Date	Sensor	Acquisition Date
WV2	3/9/17	WV3	4/21/21
WV2	4/18/17	WV3	1/15/22
WV1	4/22/17	WV2	2/14/22
WV2	11/27/17	WV3	2/19/22
WV2	3/26/18	WV2	10/3/22
WV2	9/30/18	WV3	11/21/22
WV3	2/9/20	WV3	12/25/22
WV2	3/22/21	WV2	2/16/23

Table 1: Date and sensor of Worldview images used for this study.

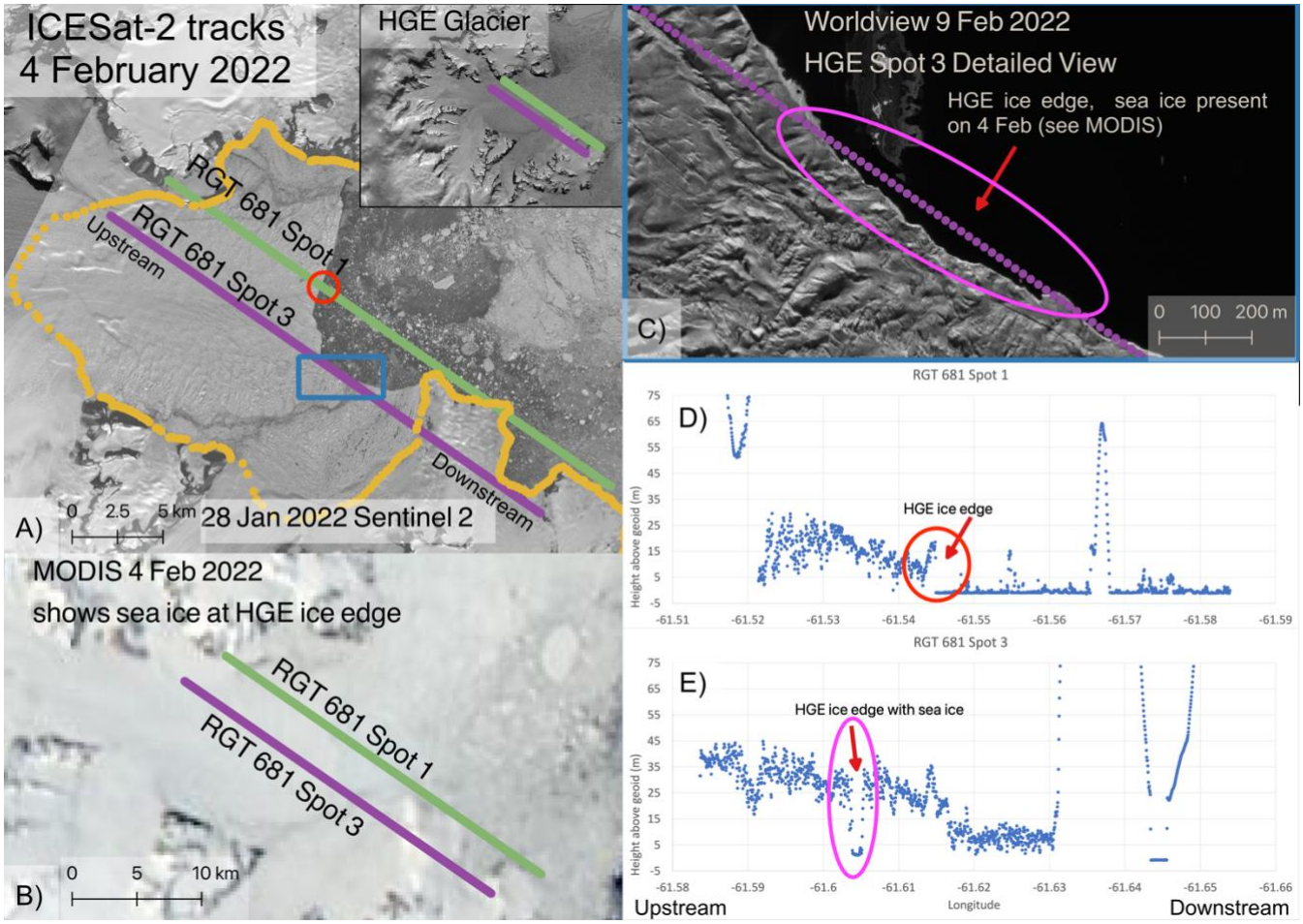


Figure S1

ICESat-2 data showing the freeboard elevation of the outer edge of the HGE floating tongue. A) 28 January 2022 ice edge during a period of open water at the front. B) MODIS image from 4 February 2022, the same day that the ICESat-2 data was acquired, shows sea ice in the embayment during the time the elevation data was collected. C) Worldview image from 9 February 2022 shows a detailed view (blue box on Panel A) of the ICESat 2 Spot 3 track. D) Elevation data collected on 4 February of Spot 1 ICESat-2 track (green), showing the ice edge near the center of the HGE floating front (red circle, red arrow). E) ICESat-2 Spot 3 track (purple track), where an ice edge is present for a small portion of the track (Panel C, pink circles).

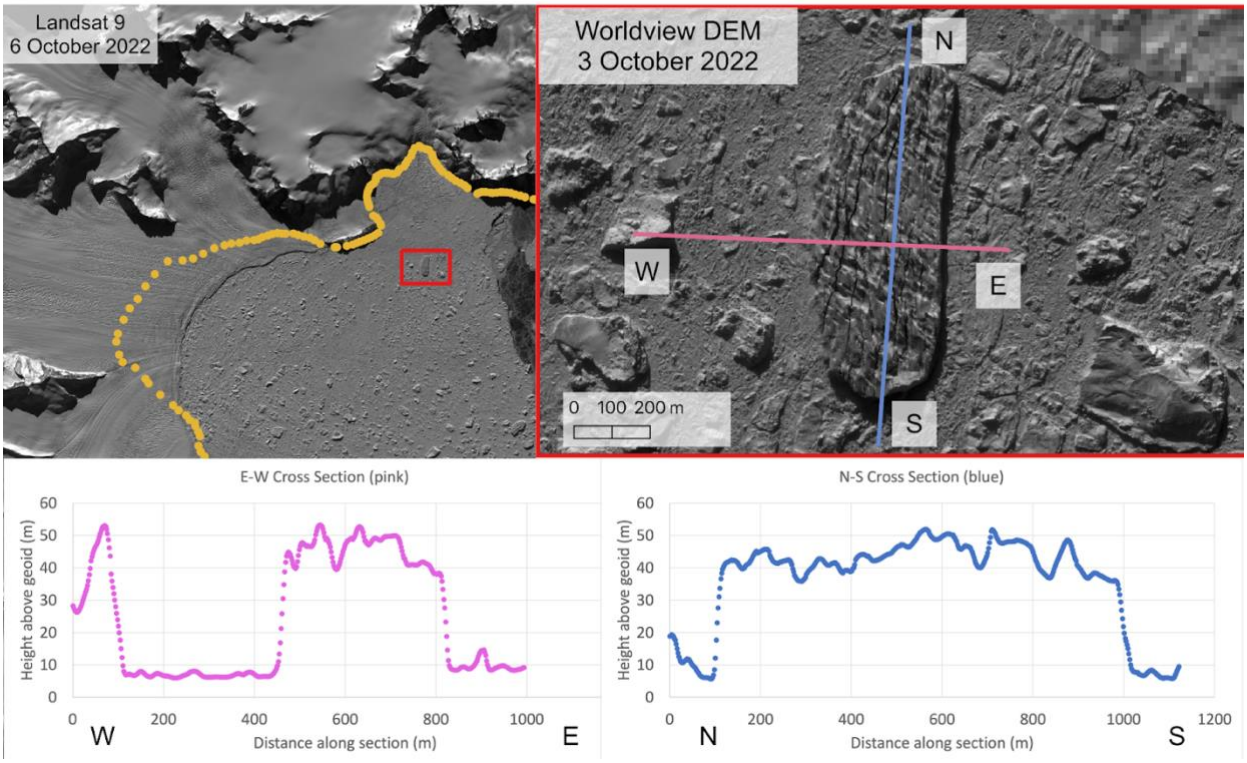


Figure S2

Worldview DEMs from October 2022 show the freeboard of tabular bergs calved from the HGE ice tongue, note that north is Grid North in ESPG: 3031.

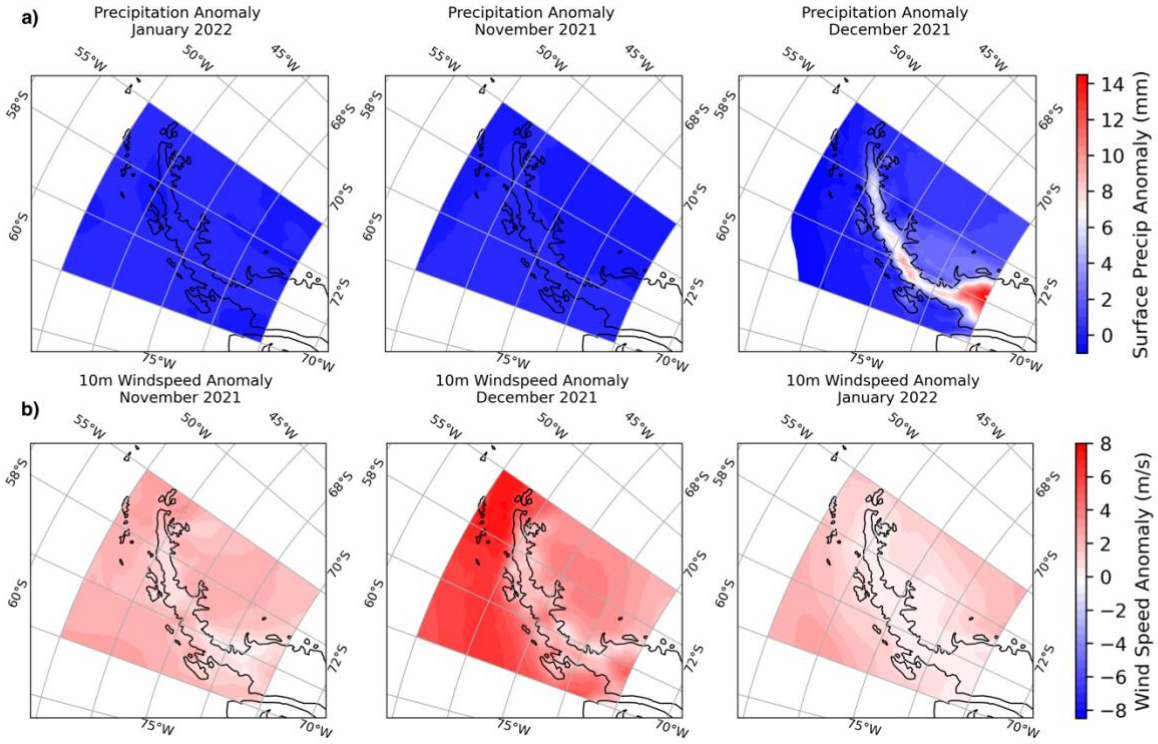
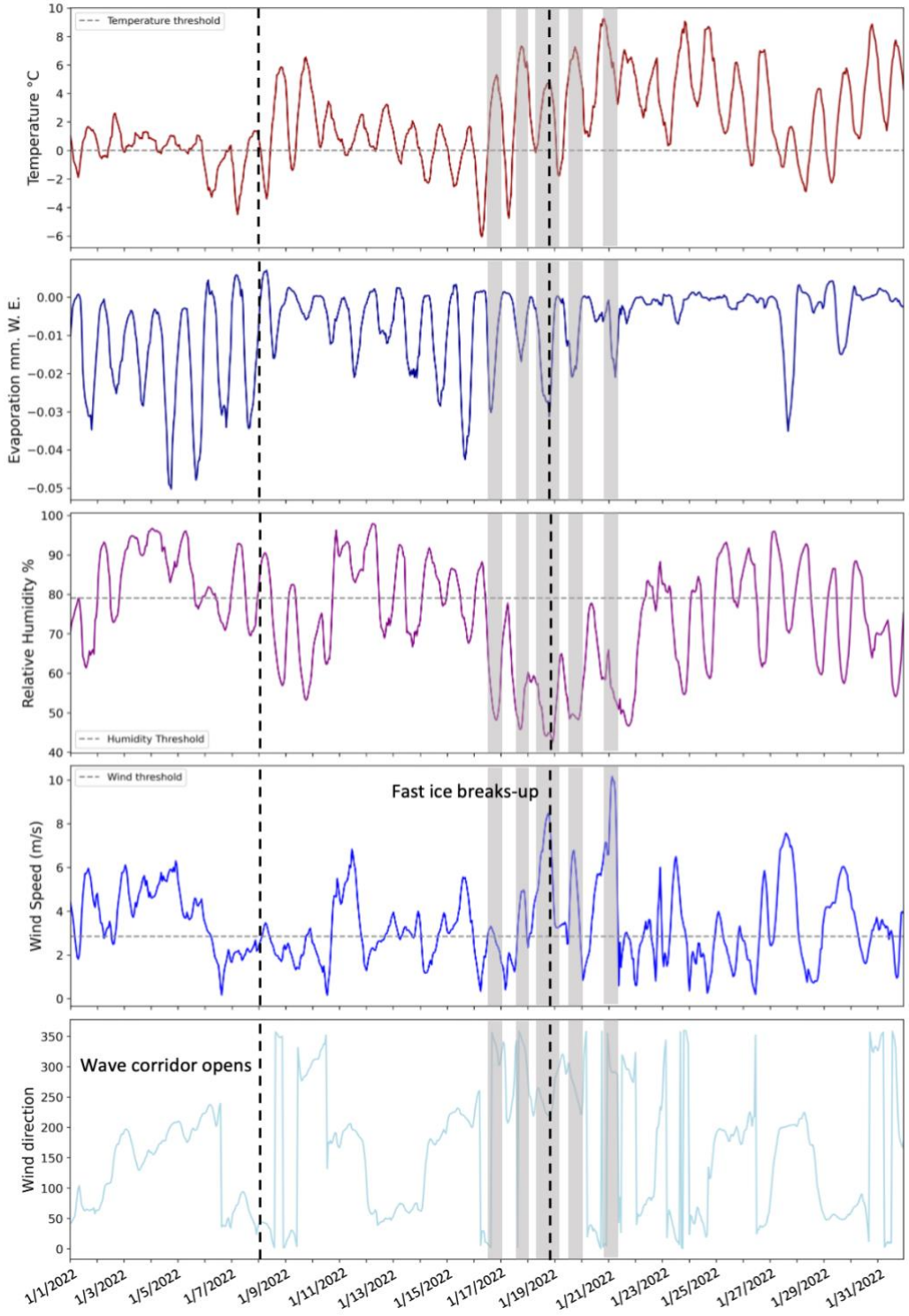


Figure S3

Precipitation and windspeed anomalies (1979-2022) for the AP region in November 2021, December 2021, and January 2022.


Temperature threshold
Temperature °C
Evaporation mm. W. E.
Relative Humidity %
Humidity Threshold
Wind threshold
Fast ice breaks-up
Wind Speed (m/s)
Wave corridor opens
Wind direction
1/1/2022
1/3/2022
1/5/2022
1/7/2022
1/9/2022
1/11/2022
1/13/2022
1/15/2022
1/17/2022
1/19/2022
1/21/2022
1/23/2022
1/25/2022
1/27/2022
1/29/2022
1/31/2022

25

Figure S4

ERA-5 climate variables on hourly time scale during January 2022. The horizontal dashed lines indicate foehn wind thresholds determined by Laffin et al., 2022. The vertical dashed lines show the when the wave corridor opened and when the fast ice broke-up. The gray shaded lines indicate periods when all of the foehn wind thresholds were met, suggesting times of foehn wind events.

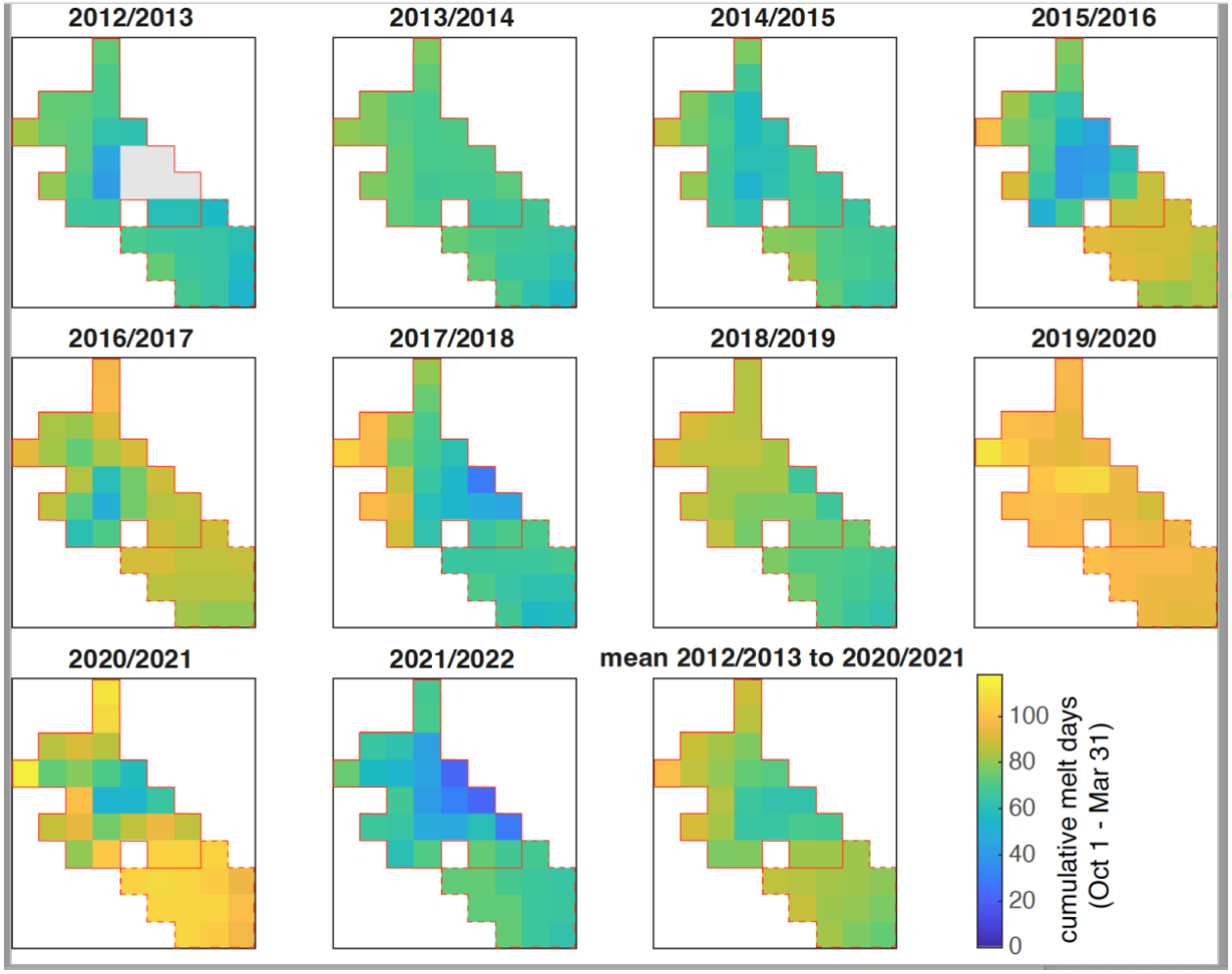


Figure S5

Cumulative melt day maps from 2012/2013 to 2020/2021 for the Larsen B embayment (solid lines) and Scar Inlet Ice Shelf (dashed lines).

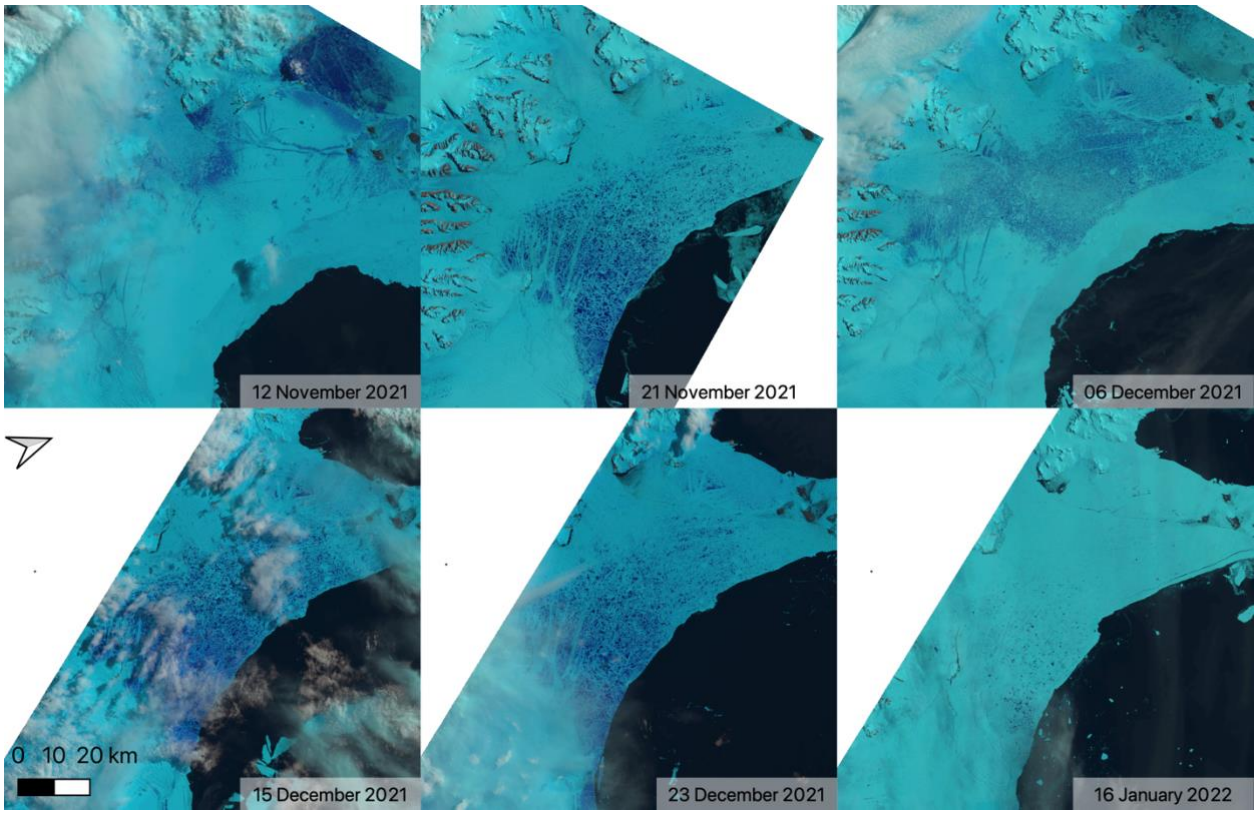


Figure S6

Melt pond evolution using Landsat imagery from November 2021 to January 2022.

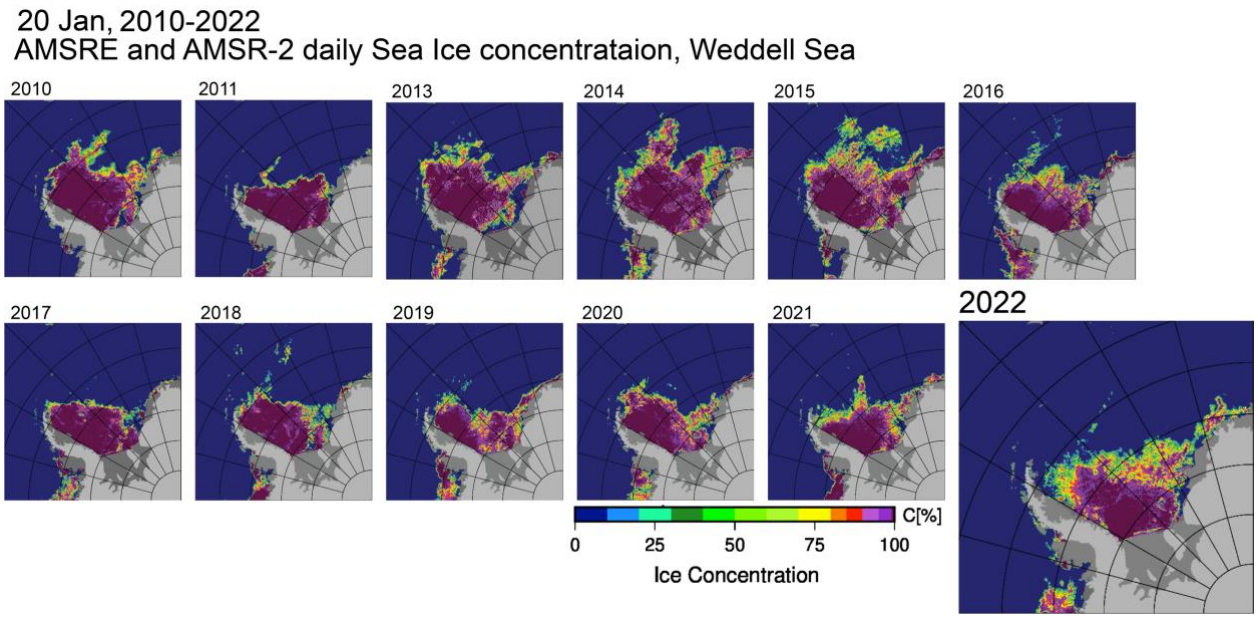


Figure S7

Sea ice concentration in Weddell Sea on 20 January from 2010 to 2011 and 2013 to 2022. The open corridor was not present in any of the previous seasons on record during this time of year.

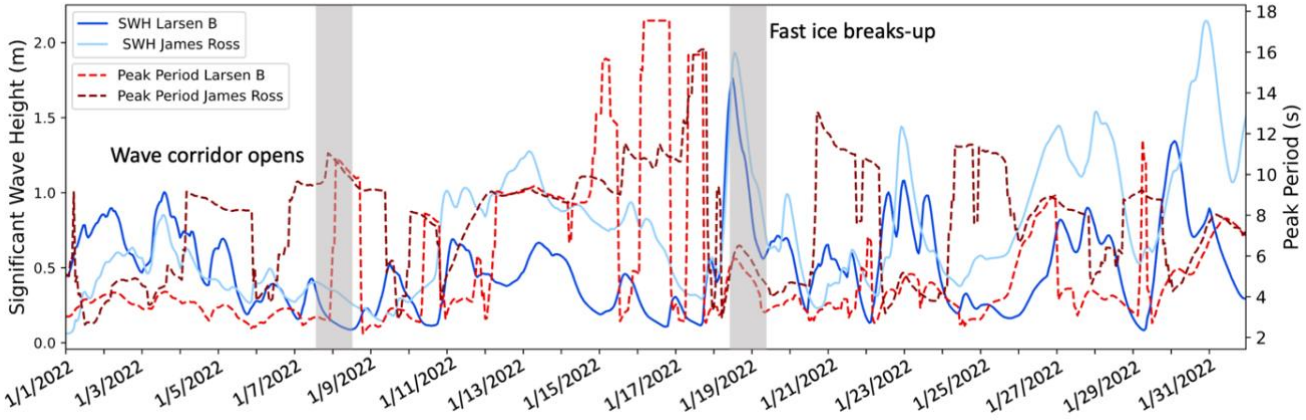


Figure S8

We obtain ocean wave-field data from the WaveWatch III model hindcast from the Collaboration for Australian Weather and Climate Research (CAWCR; Wave Hindcast Aggregated Collection; Durrant et al., 2019). From June 2013 onwards the dataset is generated using WaveWatch III v4.18 wave model forced with NCEP CFSv2 hourly winds and daily sea ice producing

gridded spectral wave data on a global 0.4 (24 arcminute) grid. Here we examine an hourly time series of the variables for January 2022, averaging over four grid cells in front of the Larsen B embayment and near the James Ross Island, where a wave corridor was present.

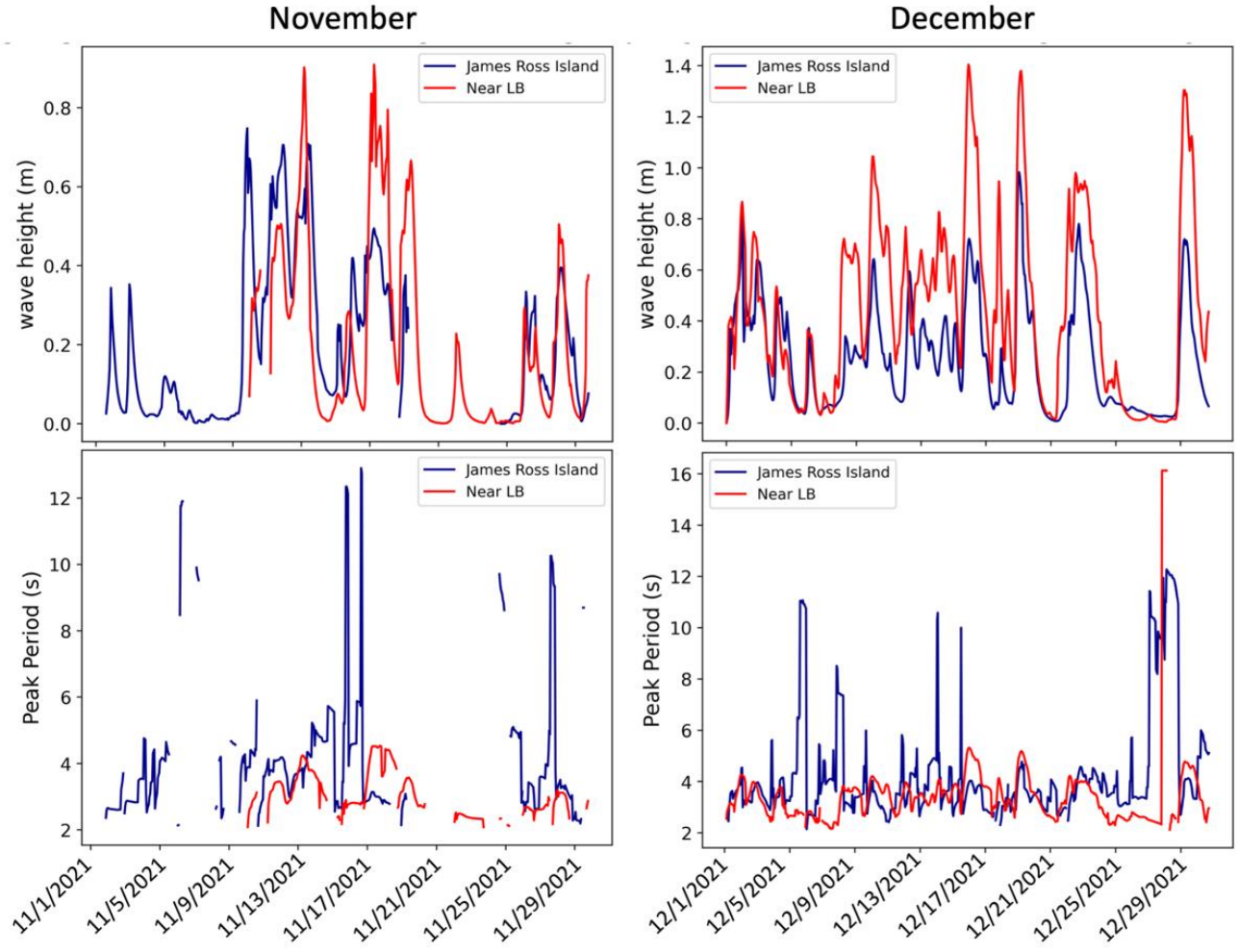


Figure S9

Wavewatch wave data showing the peak period and significant wave height for November and December 2021 for locations near James Ross Island and in front of the Larsen B embayment.

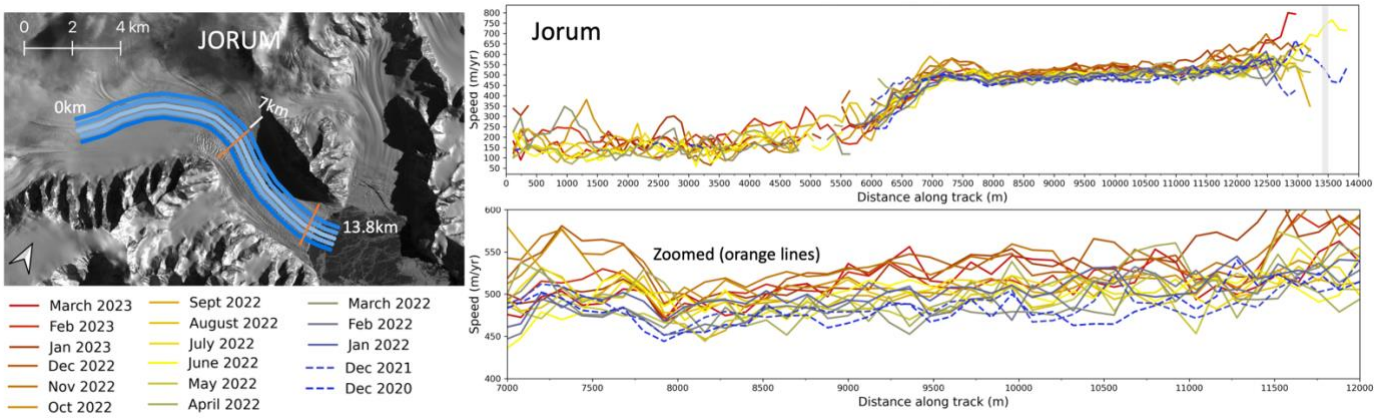


Figure S10

Jorum Glacier speeds derived from the ASF Vertex Tool and Hyp3 pipeline using Sentinel 1 imagery from December 2020 to March 2023.

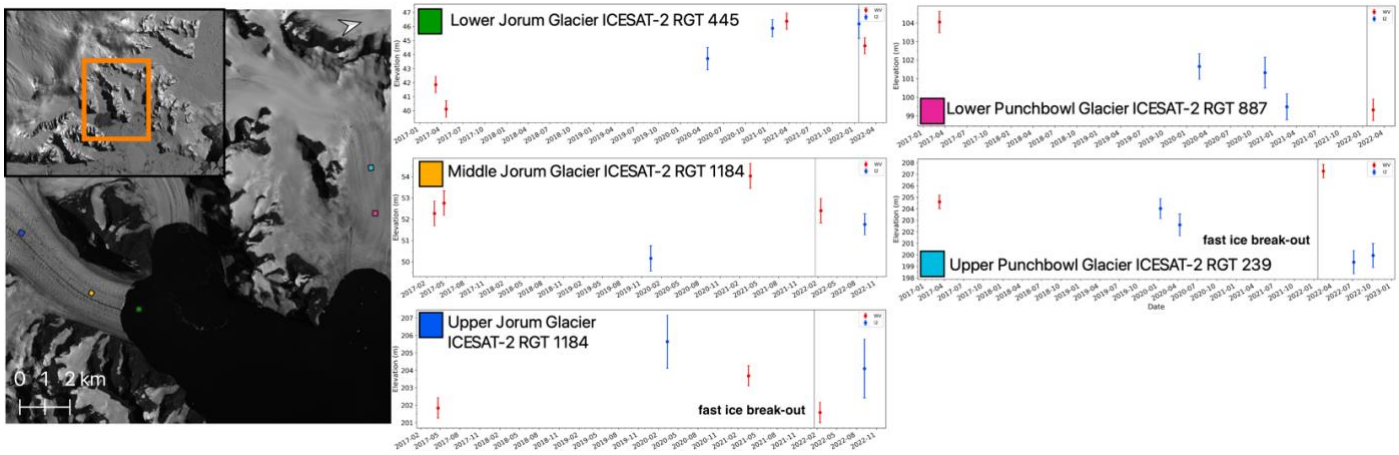


Figure S11

Jorum and Punchbowl elevation changes from ICEsat and Worldview DEMs.

Supplemental Video 1

Evolution of Larsen B embayment from 2012 to 2022 from MODIS imagery.

References:

Durrant, T., Hemer, M., Smith, G., Trenham, C., Greenslade, D.: CAWCR Wave Hindcast - Aggregated Collection. v5. CSIRO. Service Collection. http://hdl.handle.net/102.100.100/137152?index=1, 2019.