

## *Supplementary Material*

### 1 Supplementary Figures and Tables

**Supplementary Table 1.** Numbers of calving events per sector, type and magnitude detected with the sTLC. In 2018 the camera was installed from 8 to 12 July and in 2019 from 16 to 22 August.

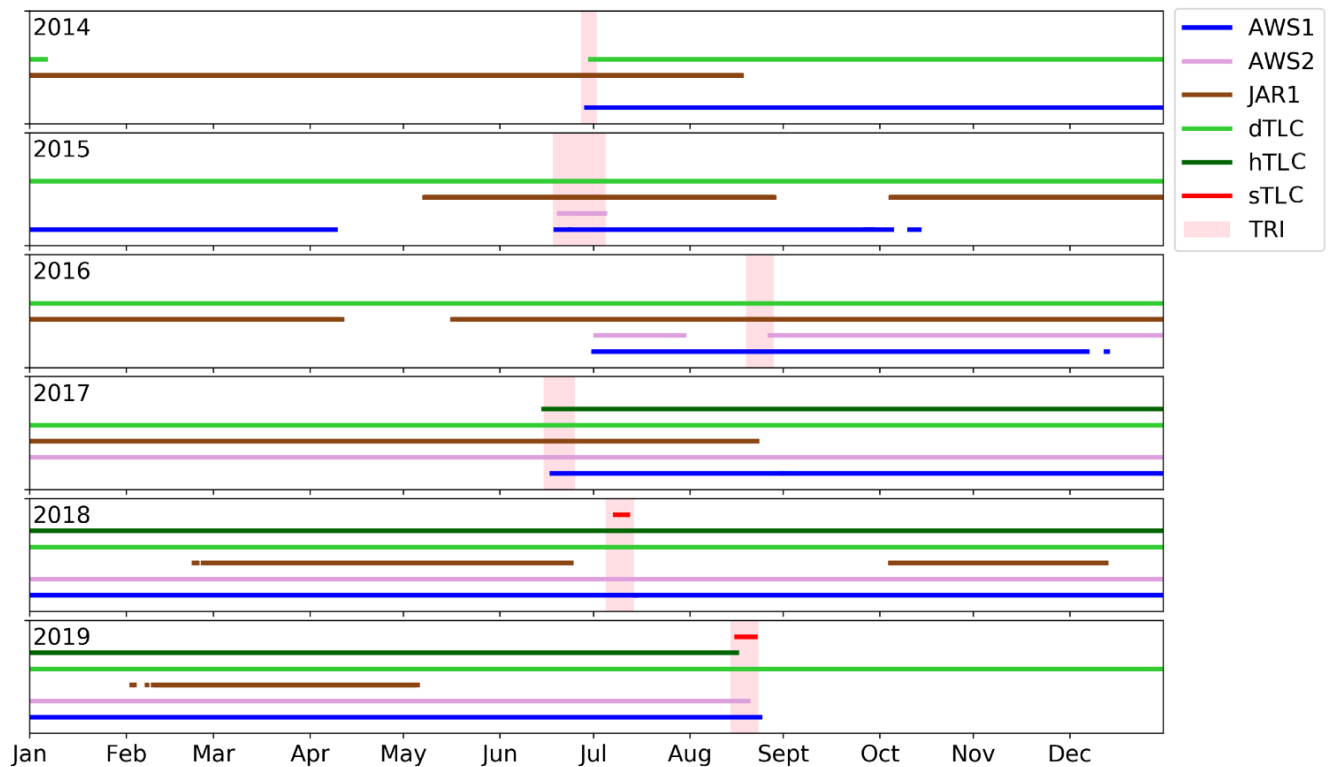
	Sector S1		Sector S2		Sector S3		Sector D4		Sector D5		Sector D6		Sector D7	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Ice fall	137	136	273	447	44	243	542	429	166	390	137	222	10	99
Sheet coll.	8	5	22	17	7	19	52	51	14	31	23	39	4	21
Stack topple	0	0	0	0	0	0	0	2	1	2	12	12	3	13
Subaquatic	0	0	1	0	1	0	29	62	10	72	33	137	1	37
Waterline	0	0	1	0	0	0	36	5	9	8	17	3	3	1
Unknown	11	39	0	1	324	353	2	0	0	1	105	10	0	7
<b>Total</b>	<b>156</b>	<b>180</b>	<b>297</b>	<b>465</b>	<b>376</b>	<b>615</b>	<b>661</b>	<b>549</b>	<b>200</b>	<b>504</b>	<b>327</b>	<b>423</b>	<b>21</b>	<b>178</b>
Magnitude 1	0	6	0	23	1	14	271	144	103	141	124	165	8	74
Magnitude 2	132	121	260	388	39	191	300	346	74	320	73	213	8	74
Magnitude 3	13	12	34	43	8	49	70	50	21	40	18	37	1	22
Magnitude 4	1	0	3	10	3	11	18	8	2	2	7	4	4	2
Unknown	10	41	0	1	325	350	2	1	0	1	105	4	0	6
<b>Total</b>	<b>156</b>	<b>180</b>	<b>297</b>	<b>465</b>	<b>376</b>	<b>615</b>	<b>661</b>	<b>549</b>	<b>200</b>	<b>504</b>	<b>327</b>	<b>423</b>	<b>21</b>	<b>178</b>

**Supplementary Table 2** Number, event sizes and frequency of calving events of the six TRI field campaigns.

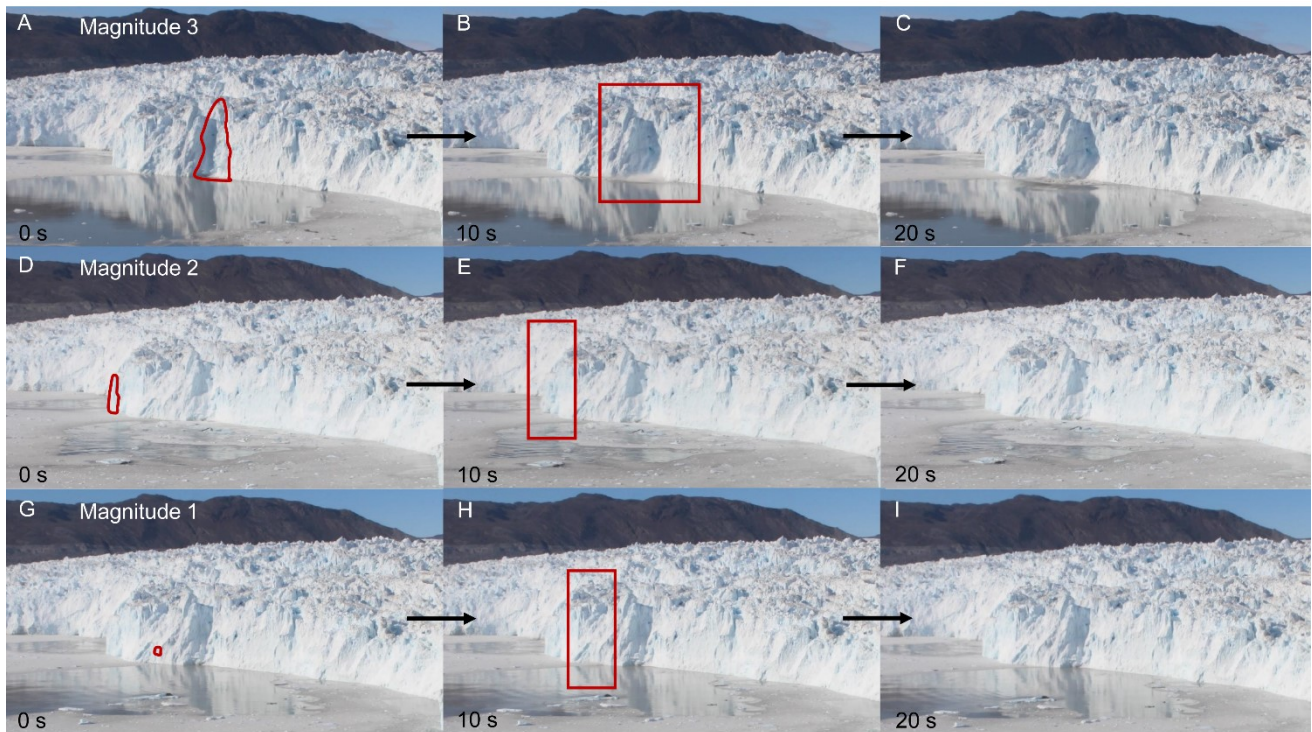
	2014	2015	2016	2017	2018	2019
<b>Start – End (date)</b>	6/28 – 7/02	6/19 – 7/05	8/19 – 8/27	6/16 – 6/25	7/06 – 7/14	8/15 – 8/23
<b>Campaign duration (days)</b>	2.2	12.2	6.1	8.6	8.2	7.7
<b>Total number of events</b>	220	960	906	917	697	1,137
<b>Event number per day</b>	100	79	149	107	85	148
<b>Total calving volume (10<sup>6</sup> m<sup>3</sup>)</b>	4.3	28.6	16.0	17.4	14.5	20.2
<b>Calving volume per day (10<sup>6</sup> m<sup>3</sup>)</b>	2.0	2.3	2.6	2.0	1.8	2.6
<b>Event sizes</b>						
Mean (m <sup>3</sup> )	19,800	29,700	17,700	19,000	20,700	17,800
Maximum (m <sup>3</sup> )	350,700	973,100	275,700	570,900	763,000	151,000
Minimum (m <sup>3</sup> )	2,970	449	660	613	3,505	783

**Supplementary Table 3.** Numbers and volumes of calving events in 2015 with and without mélange in front of the glacier detected with the TRI.

	whole	shallow	deep
<b>Time with mélange (days)</b>	8.125		
Total Event Number	177	97	85
Event Number per day	21.8	11.9	10.5
Total Event Volume (m <sup>3</sup> )	8,793,000	3,586,600	5,206,400
Mean Event Volume (m <sup>3</sup> )	49,700	37,000	61,300
<b>Time without mélange (days)</b>	7.85		
Total Event Number	783	550	241
Event Number per day	99.7	70.1	30.7
Total Event Volume (m <sup>3</sup> )	19,758,100	11,729,800	8,028,300
Mean Event Volume (m <sup>3</sup> )	25,200	21,300	33,300

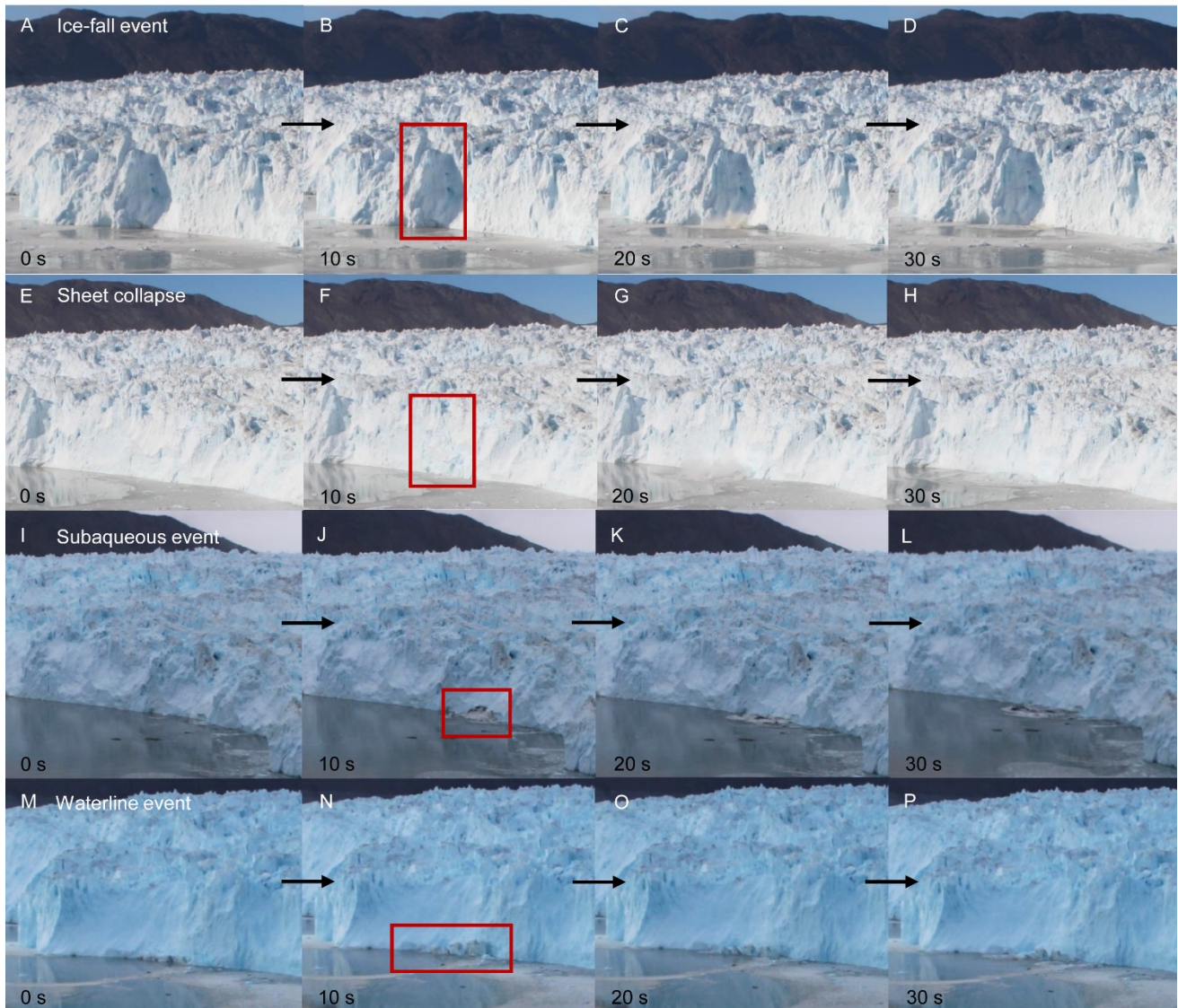


**Supplementary Figure 1.** Running times of the meteo stations AWS1, AWS2 and JAR1 as well as the time-lapse cameras (sTLC, hTLC, dTLC) and the TRI.



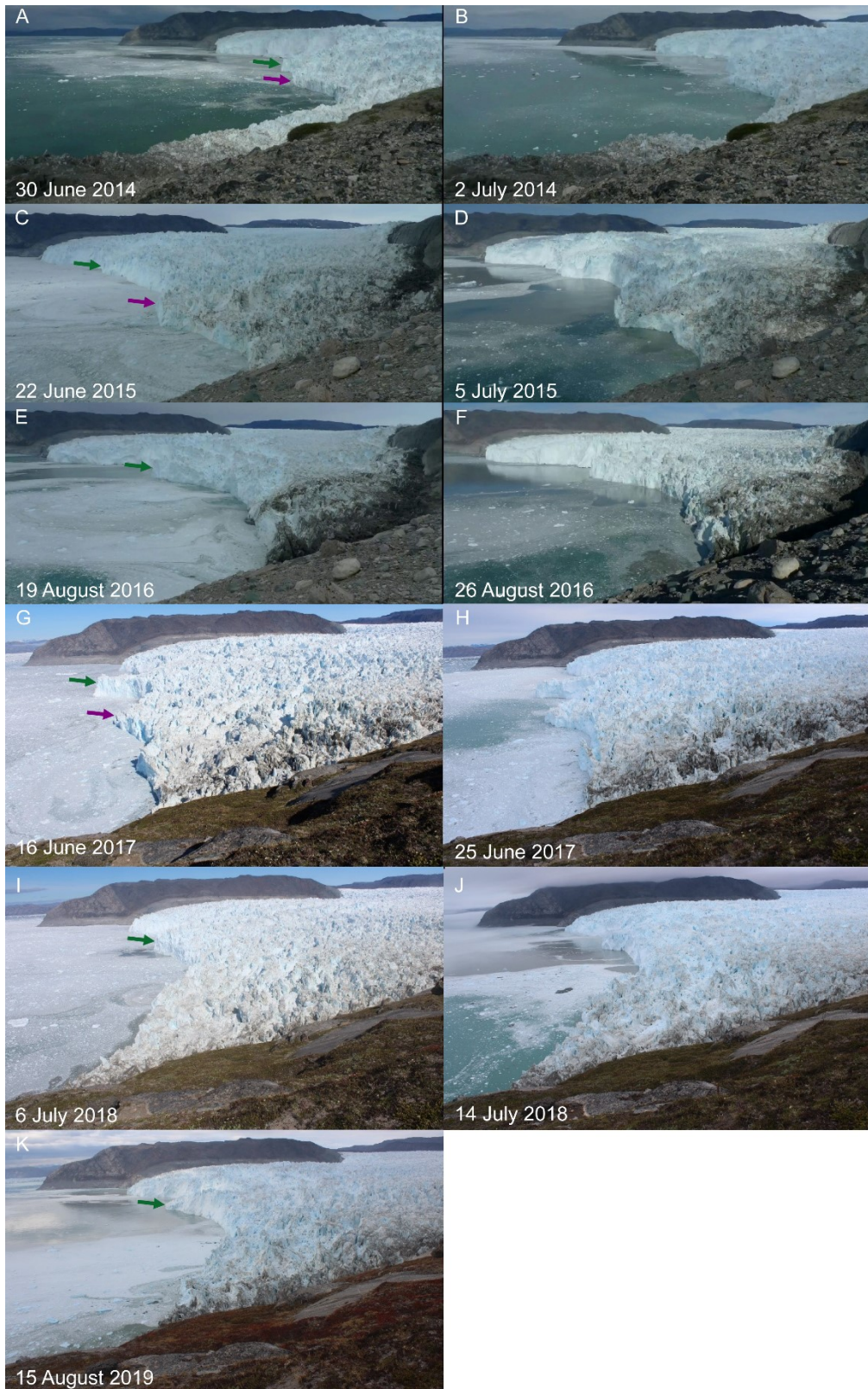
**Supplementary Figure 2.** Examples illustrating the definition of calving event magnitude for the sTLC images on 8 July 2018. (A-C) magnitude 3 , (D-F) magnitude 2 and (G-I) magnitude 1. In each

horizontal image sequence one example of the magnitude is shown over time from 0 seconds (left) to 20 seconds (right).

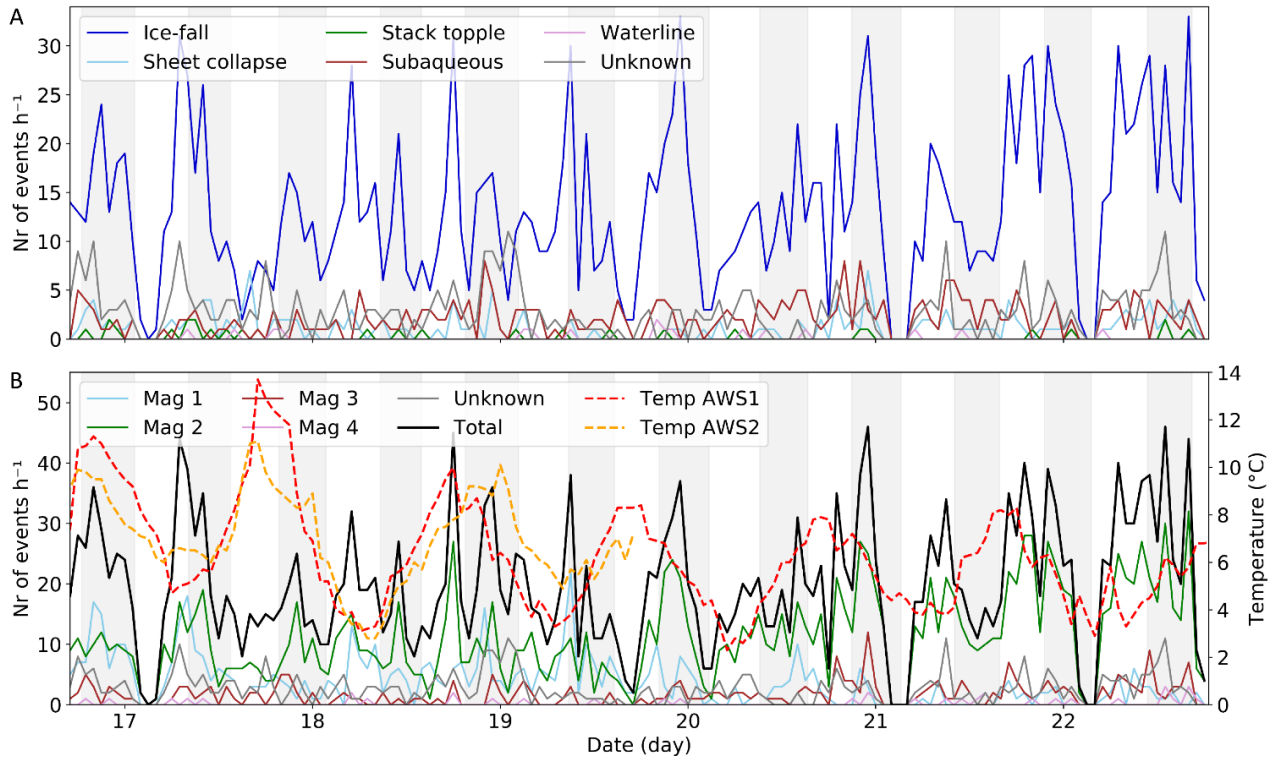


**Supplementary Figure 3.** Examples of the calving event types detected in the sTLC images on 8 and 9 July 2018. (A-D) ice-fall event, (E-H) sheet collapse, (I-L) subaqueous event and (M-P) waterline event. In each horizontal image sequence one example of the calving type is shown over time from 0 seconds (left) to 30 seconds (right).

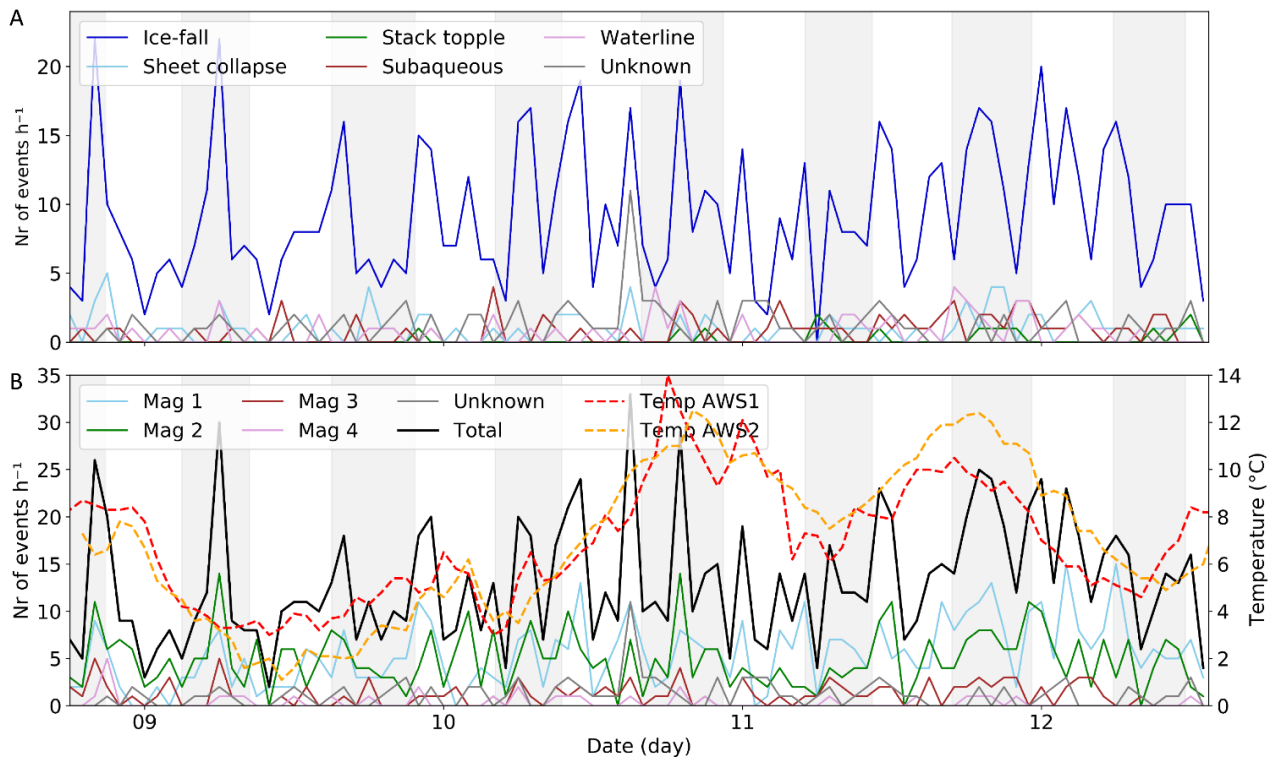




**Supplementary Figure 4.** Time-lapse images at the beginning and the end of the TRI observation period. The green arrow shows the spire in the northern deep sector (DN), while the purple arrow indicates the spire in the southern deep sector (DS).

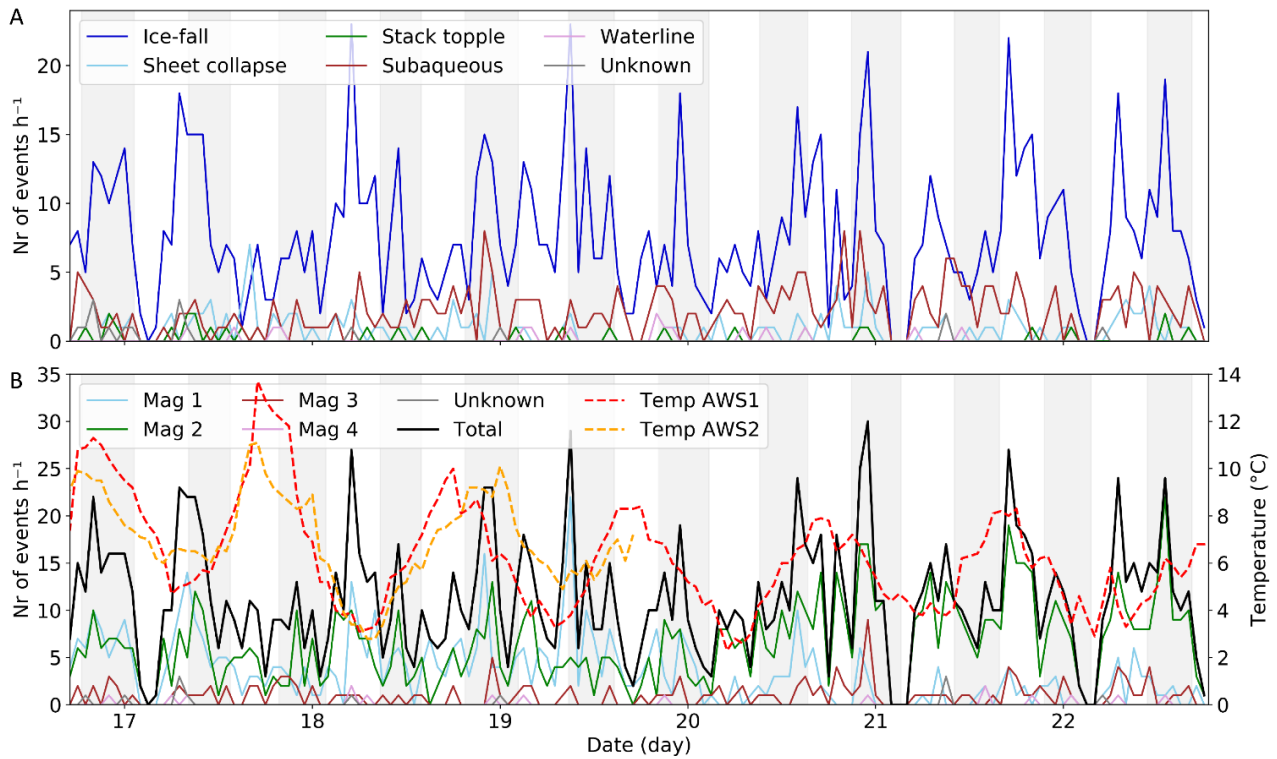


**Supplementary Figure 5.** Calving events over time in August 2019. (A) Number of events per hour divided into different calving types. (B) Number of events per hour of the different magnitudes. Additionally, the temperature is shown on the right axis. The grey bars indicate raising tides.

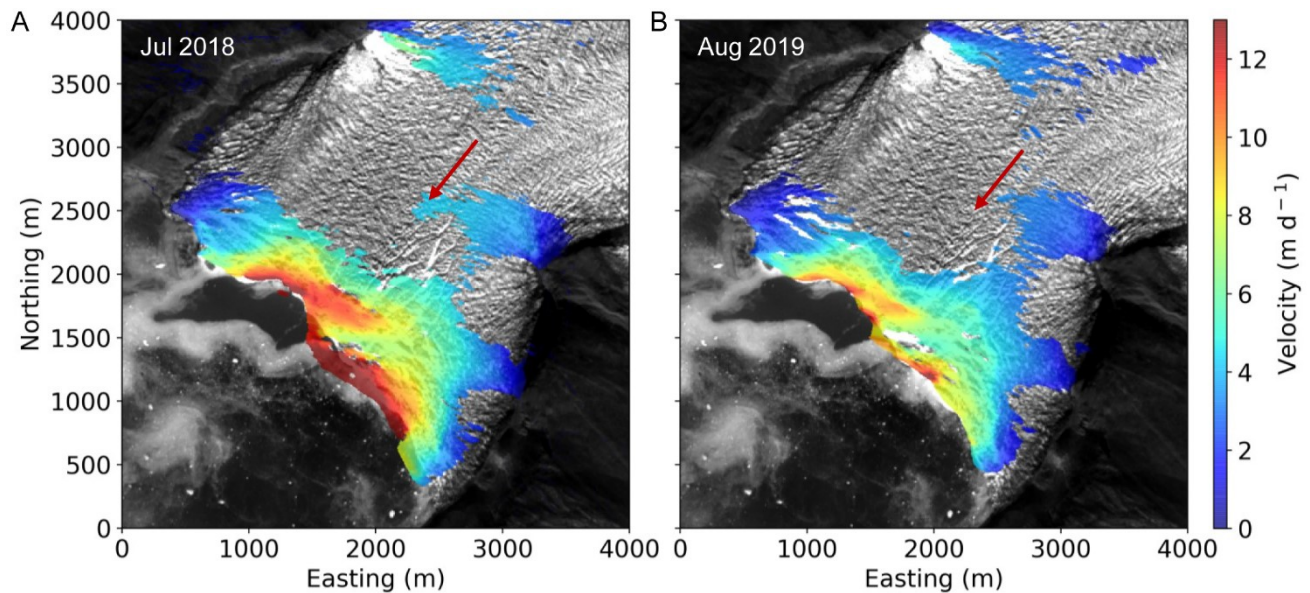


**Supplementary Figure 6.** Same as Figure S5 but for the calving events over time in July 2018 for the deep sector.

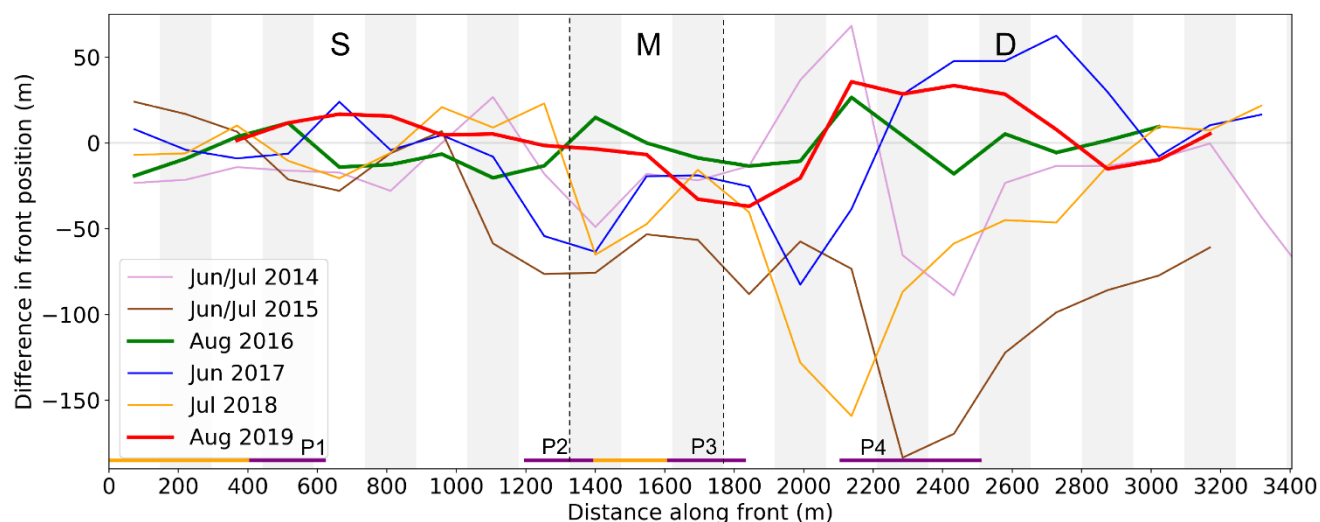




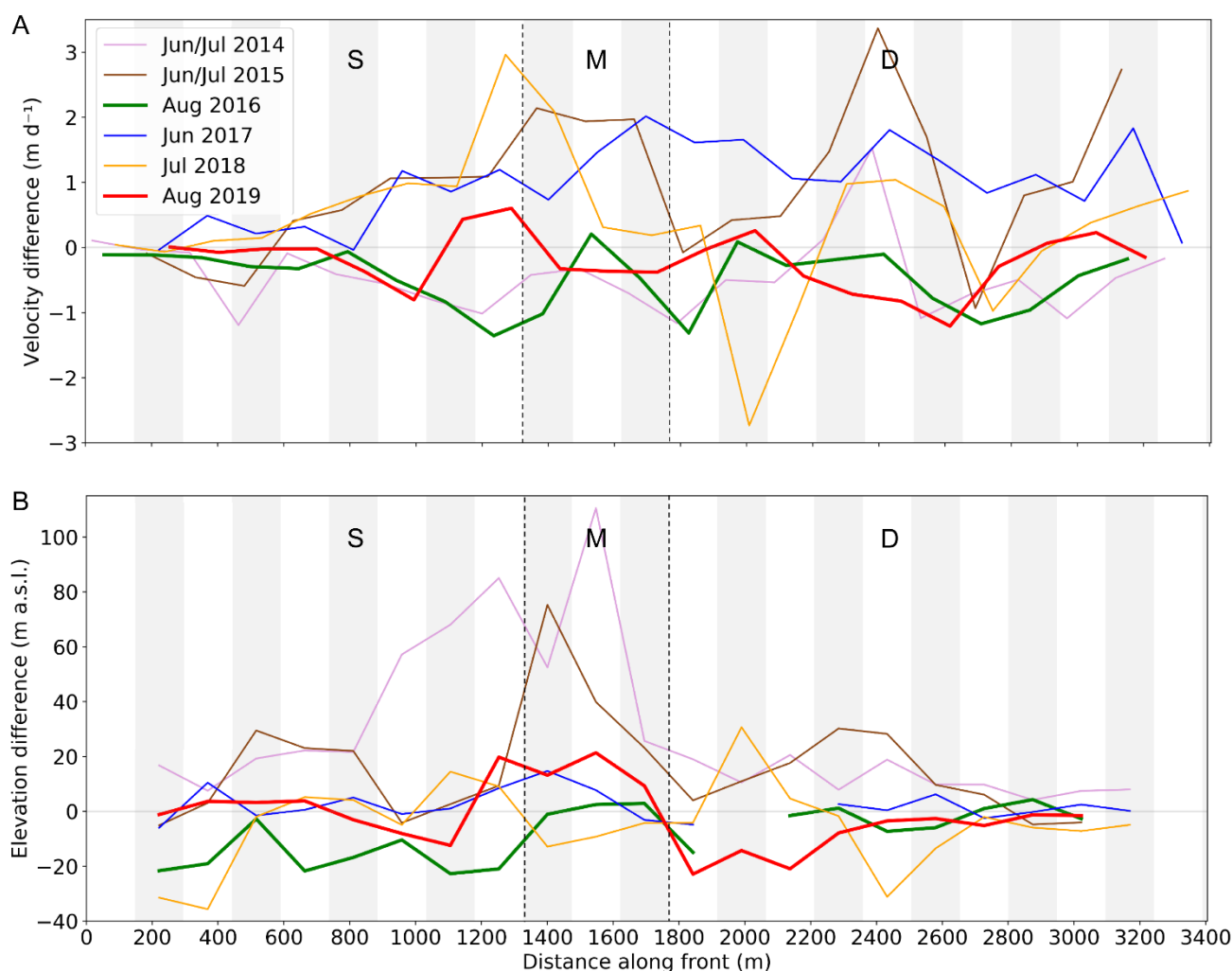
**Supplementary Figure 7.** Same as Figure S5 but for the calving events over time in August 2019 for the deep sector.



**Supplementary Figure 8** Velocity map of A) July 2018 and B) August 2019 derived with the TRI. The red arrows show the flow direction of the glacier. Background: Sentinel-2A scene from 30 August 2019 (from ESA Copernicus Science Hub: <https://scihub.copernicus.eu>).

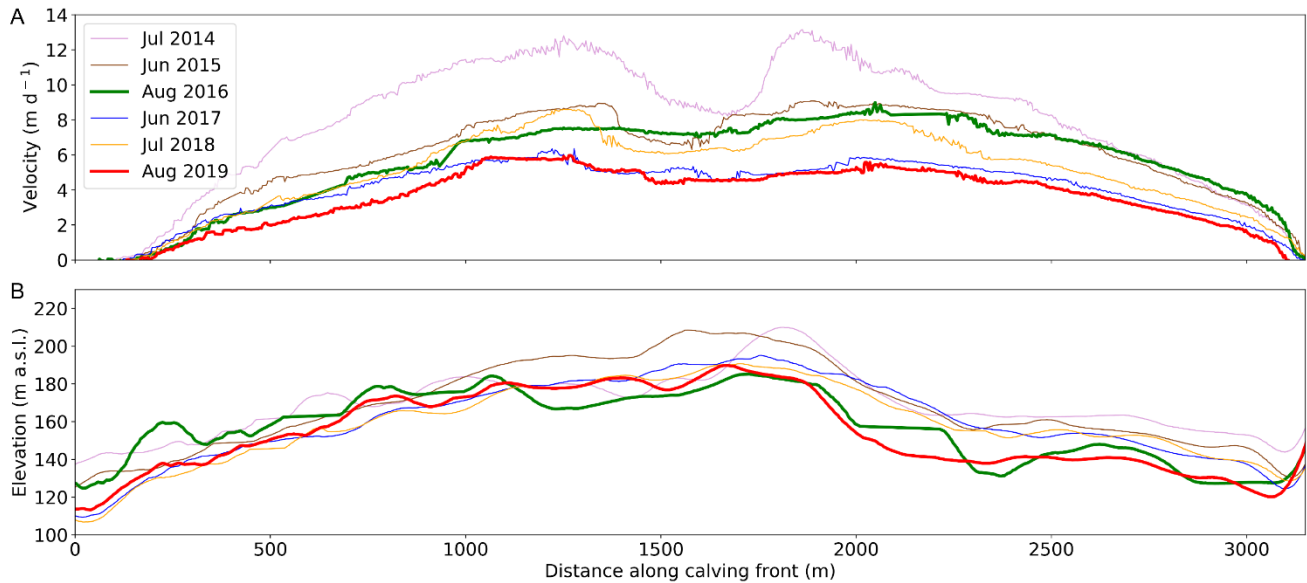


**Supplementary Figure 9.** Difference in front position at the beginning and the end of the TRI field campaign. Negative values indicate a retreat, while positive values show an advance. The location of the subglacial meltwater plumes (P1, P2, P3, P4) is indicated in purple.

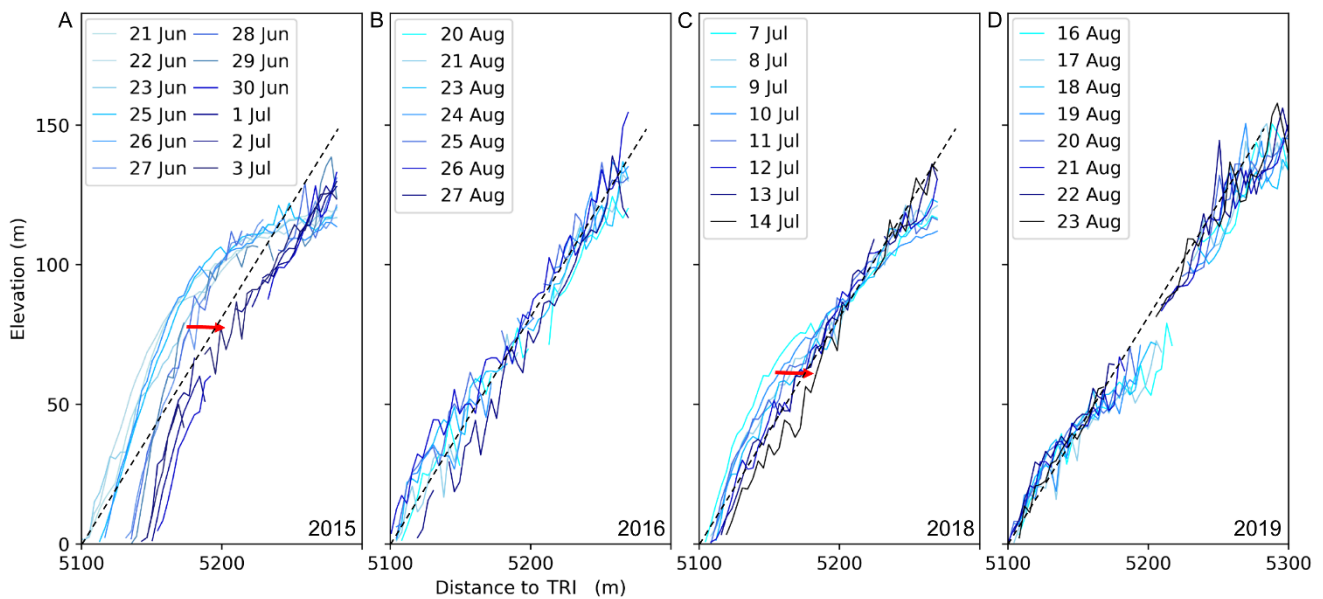




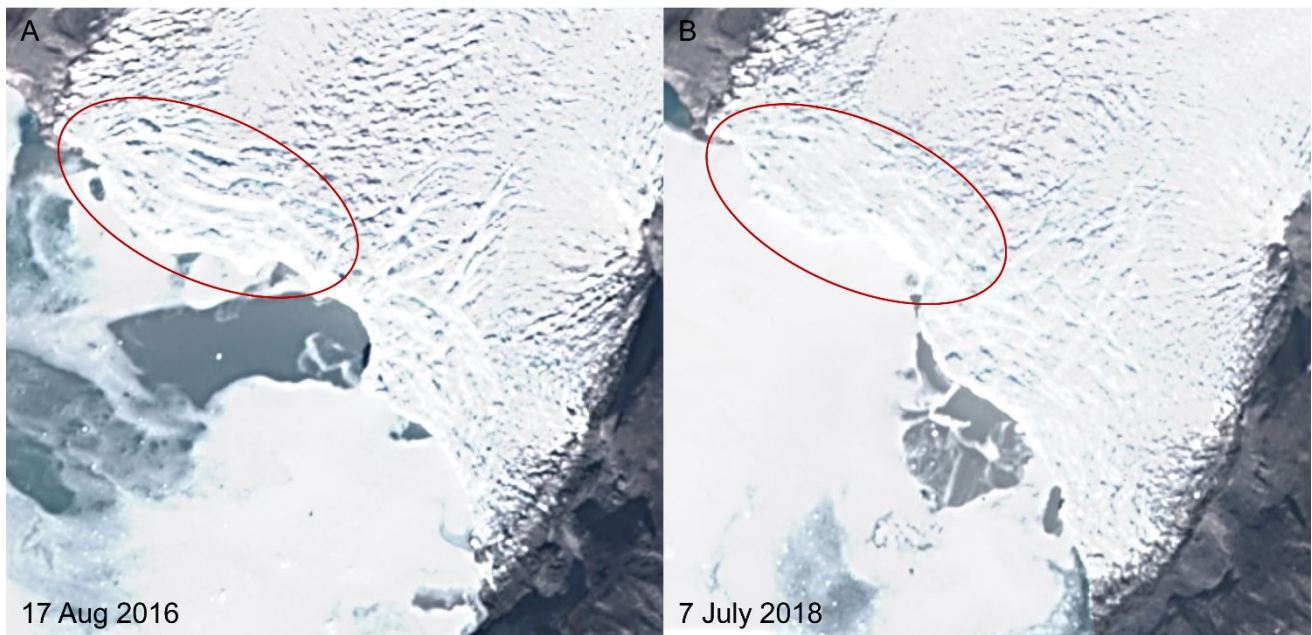
**Supplementary Figure 10.** Changes of (A) velocity and (B) elevation at the calving front by calculating the difference between the end and the beginning of the TRI field campaigns.



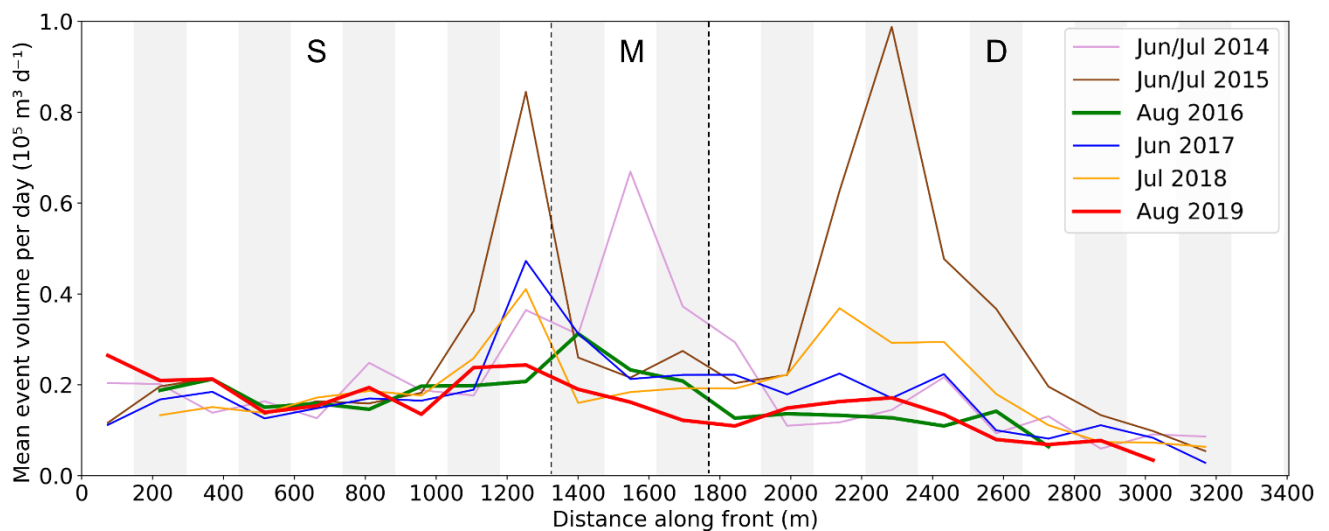
**Supplementary Figure 11.** (A) Velocity and (B) elevation about 300 m further upstream for the individual years. Data from field campaigns later in the melt season (which typically have higher calving activity) are indicated by thick lines.



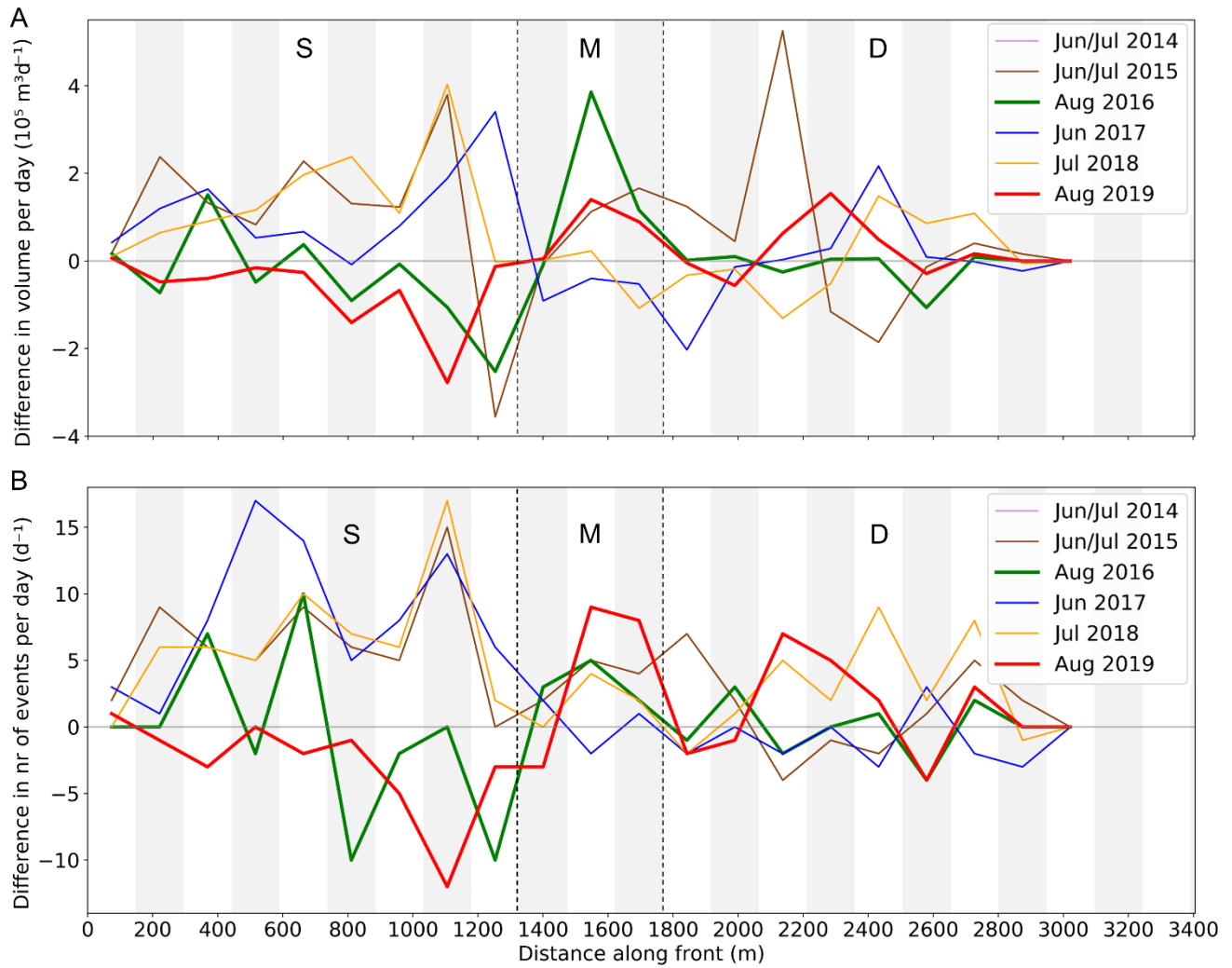
**Supplementary Figure 12.** Front elevation along a profile in the shallow sector (A in Fig. 10) for every day of the field campaign in (A) 2015, (B) 2016, (C) 2018 and (D) 2019. The red arrows indicate the transition from a convex to a more linear shape in the years 2015 and 2018. The black dotted line indicates the general slope in 2016.



**Supplementary Figure 13.** Comparison of the crevasse pattern for (A) August 2016 and (B) July 2018. In 2016 the crevasses seem deeper and more pronounced (Sentinel-2A scenes from ESA Copernicus Science Hub: <https://scihub.copernicus.eu>).

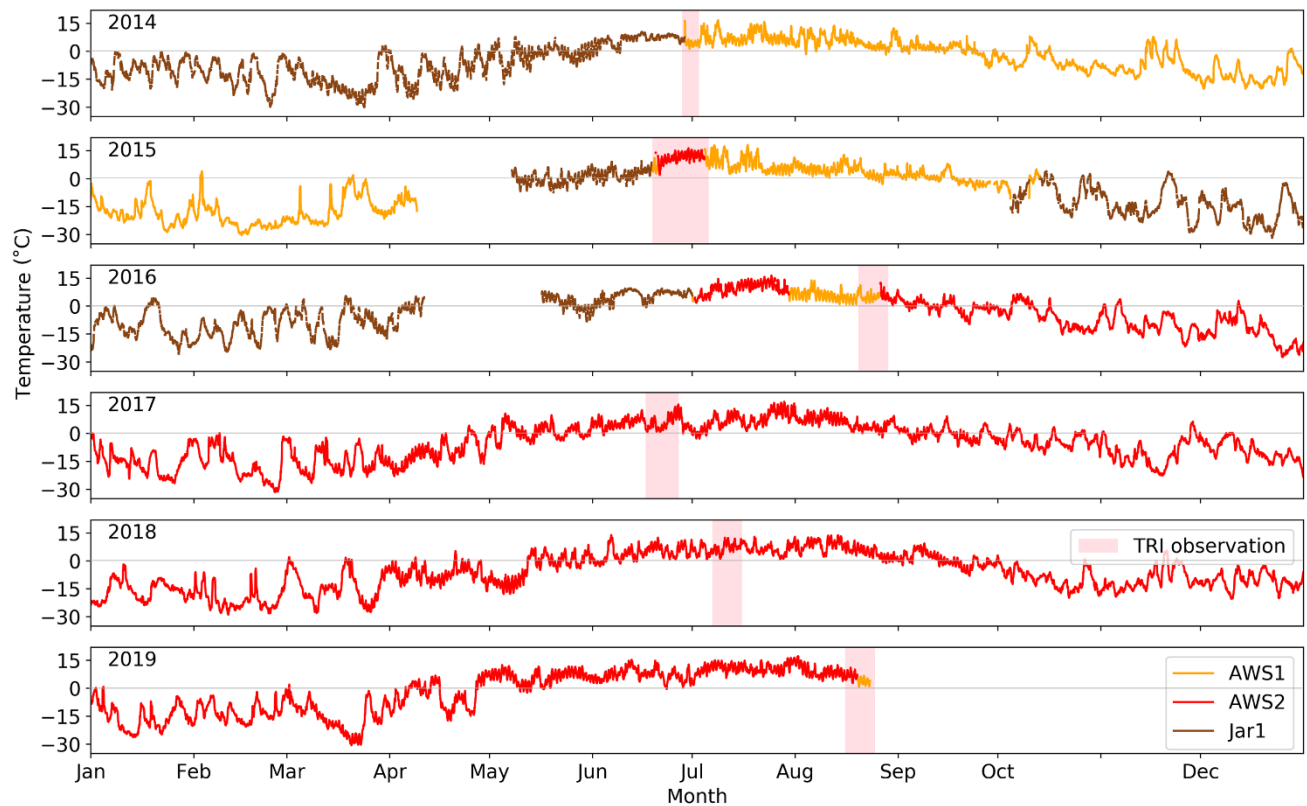


**Supplementary Figure 14.** Mean calving event volume of the different TRI field campaigns along the calving front.

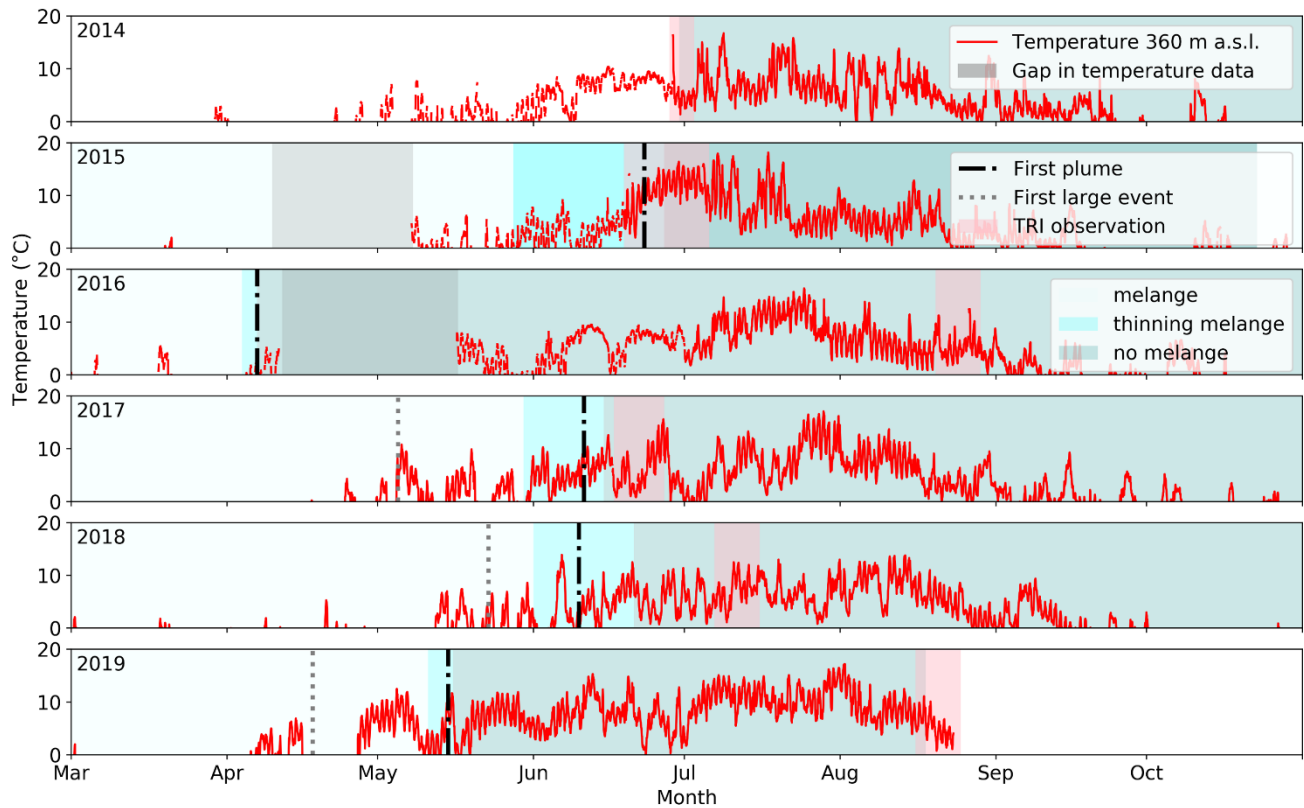


**Supplementary Figure 15.** Changes in (A) volume per day and (B) calving event number per day along the calving front by calculating the difference between the end and the beginning of the TRI field campaign.

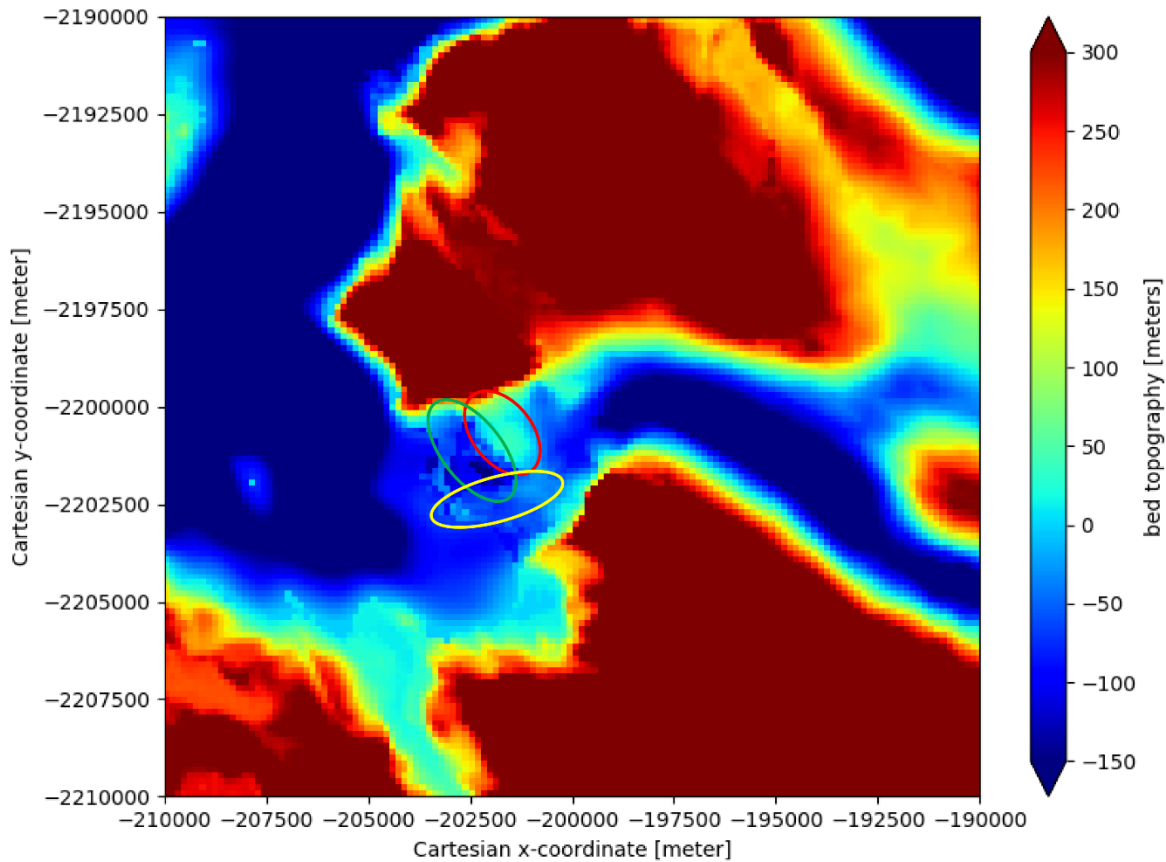




**Supplementary Figure 16.** Available corrected temperature data over the years 2014 - 2019 measured with the meteo stations AWS1, AWS2 and JAR1. The temperature of stations AWS1 and JAR1 was corrected onto AWS2 with an offset to account for the difference in elevation (section 3.4; Rohner et al., unpublished). Red shaded bars refer to the TRI field campaign periods.



**Supplementary Figure 17.** Positive temperatures over the years 2014 – 2019 measured with the meteo stations AWS1, AWS2 and JAR1. The temperature of stations AWS1 and JAR1 was corrected onto AWS2 with an offset to account for the difference in elevation (section 3.4; Rohner et al., unpublished). Additionally, the evolution of the mélange, the appearance of the first plume and the first large event are indicated. Red shaded bars refer to the TRI field campaign periods.

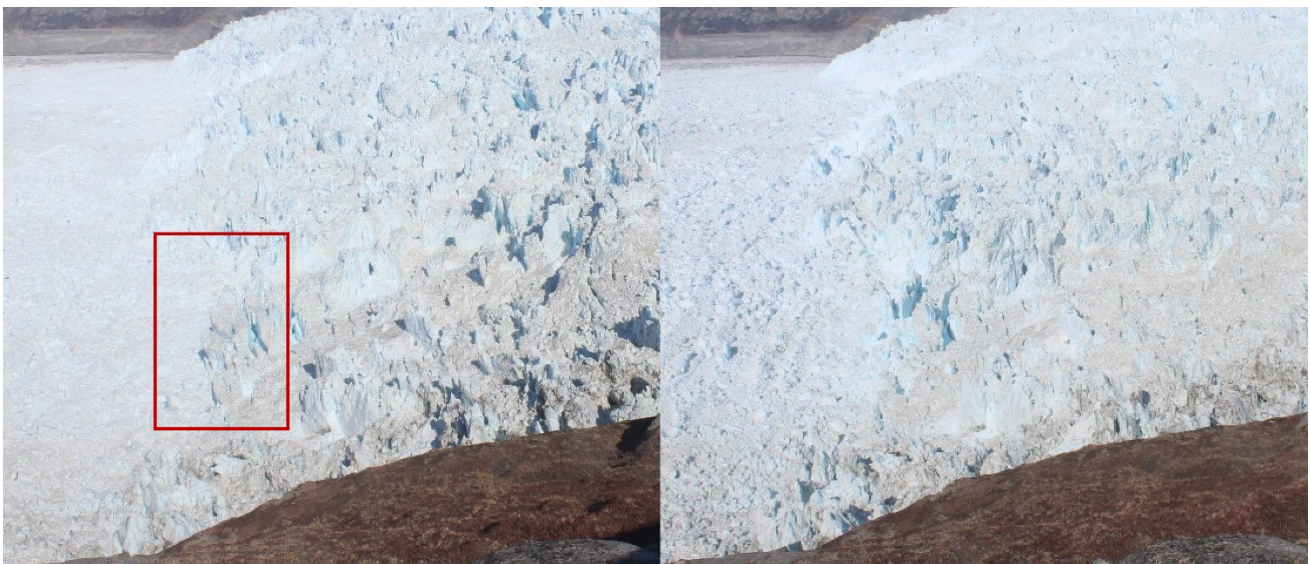


**Supplementary Figure 18.** Bed topography from BedMachine v3 (Morlighem et al. 2017) at Equip Sermia. The rock ridge causing the middle spire to advance is indicated in yellow, while the deep water preventing the shallow sector to advance further is marked green and the very shallow bed rock on which the shallow sector is located is indicated with red.

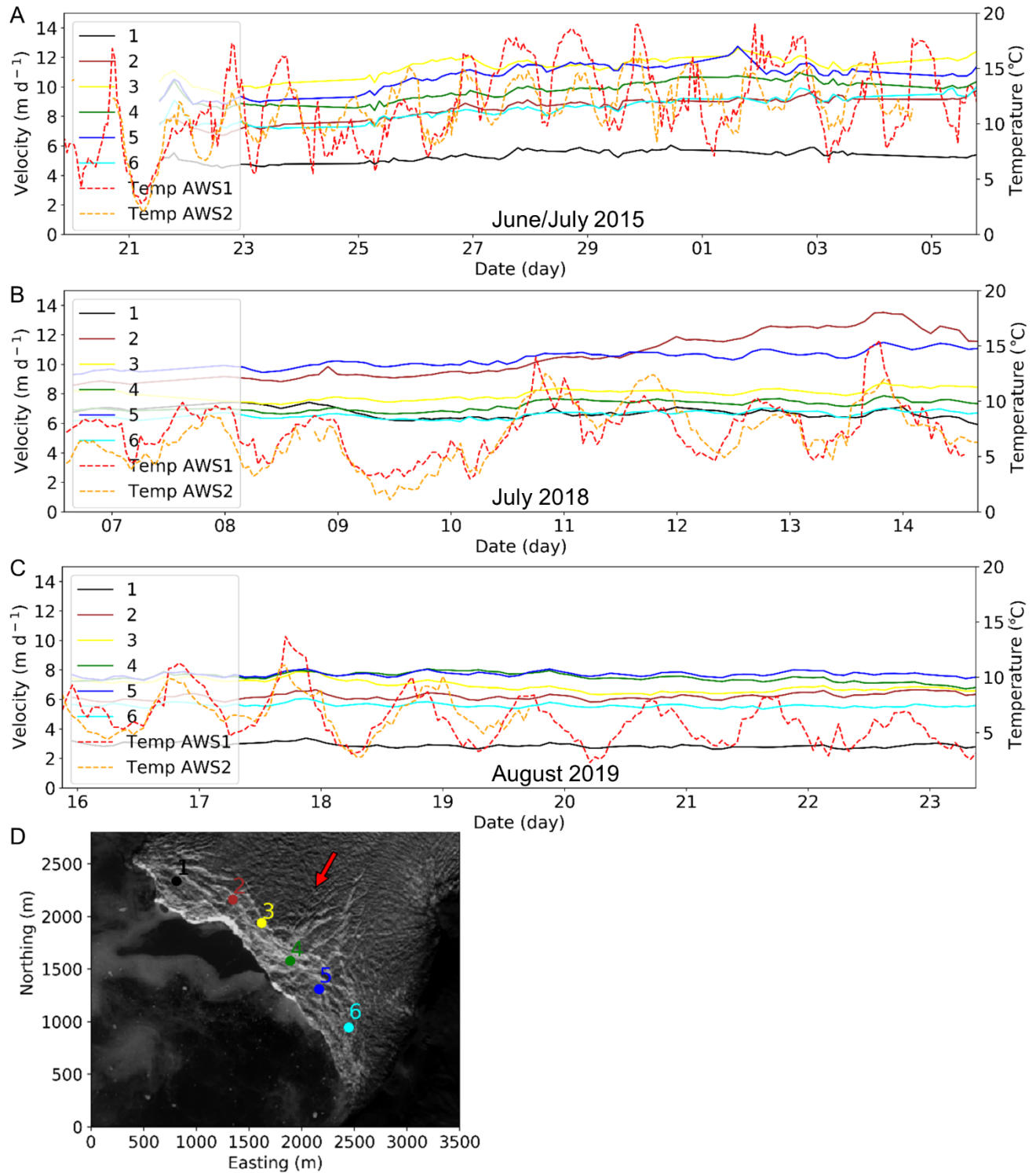




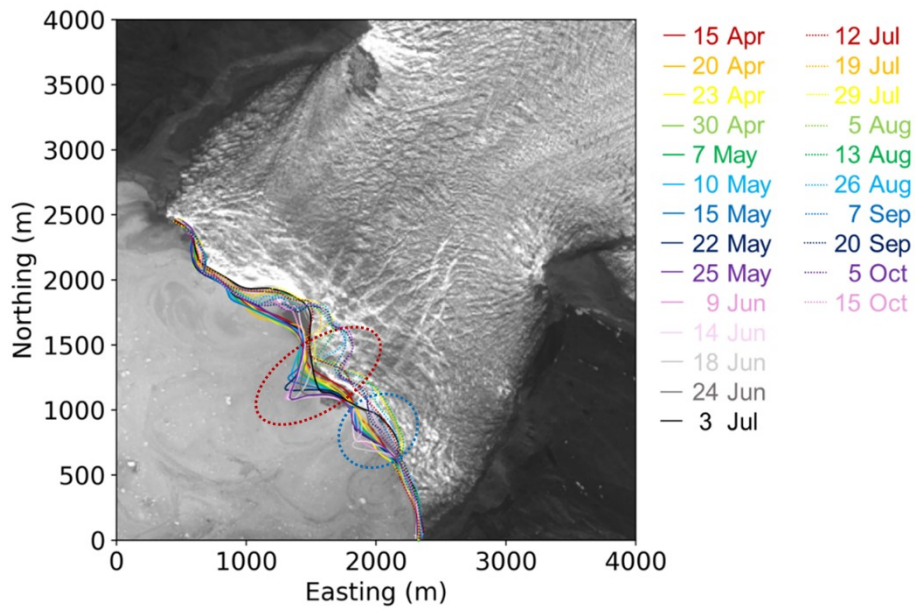
**Supplementary Figure 19.** Image of the calving front in September 2015. The red square marks the location where the bedrock appeared above the waterline (Image: Luc Moreau). This bed bump enables the spire in the southern deep sector to advance.



**Supplementary Figure 20.** Calving event in the deep sector on the 2 May 2019, when the mélange was still present.



**Supplementary Figure 21.** Flow velocity and temperature over time in (A) June/July 2015, (B) July 2018 and (C) August 2019 for (D) several points along the front. 2016 behaved similar than 2019, while 2017 follows more the trend of 2015 and 2018.



**Supplementary Figure 22** Front positions between April and October 2018 extracted manually from Sentinel 2 data (Sentinel-2A scenes from ESA Copernicus Science Hub: <https://scihub.copernicus.eu>). The northern spire in the deep sector (DN) is marked in red and the southern spire (DS) in blue. Background: Sentinel-2A scene from 6 July 2018 (from ESA Copernicus Science Hub: <https://scihub.copernicus.eu>).