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Supplement of

Accumulation by avalanches as a significant contributor to the mass balance of a peripheral glacier of Greenland

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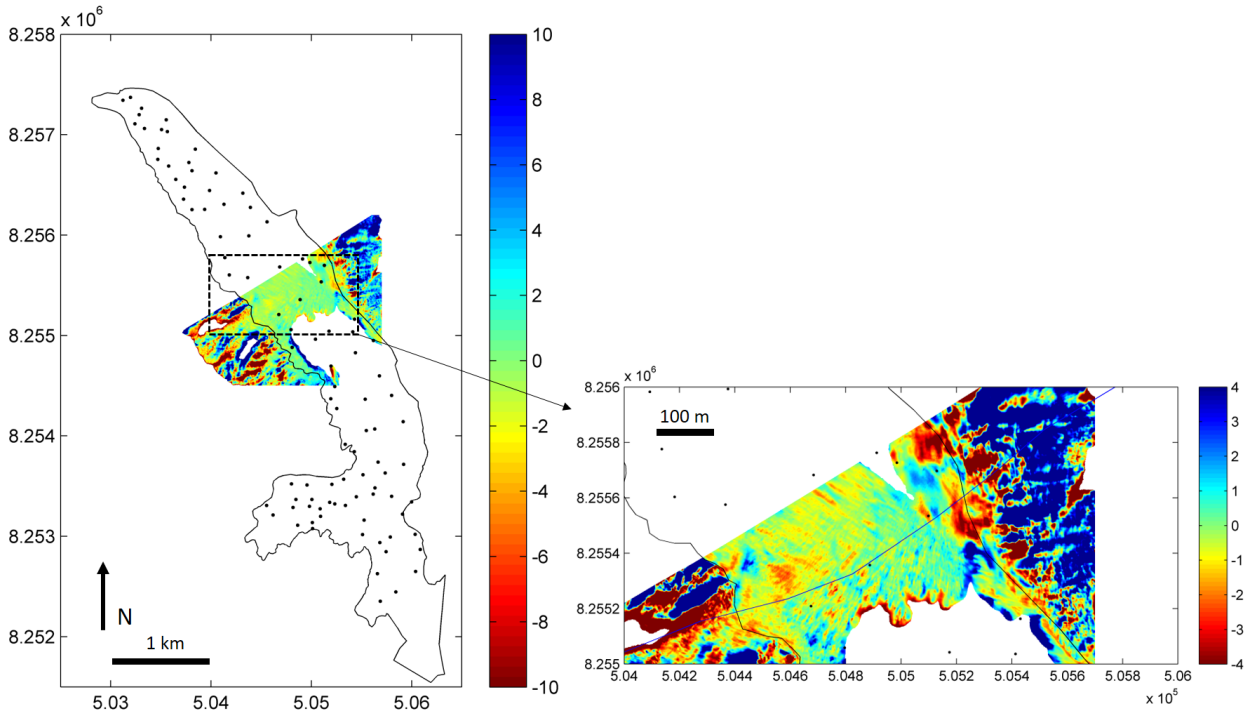

Fig. S1: Difference in elevation [m] of the 2013 Upper and Lower DEM. The chosen border between the two DEMs is shown. Coordinates in UTM 27N. Approximately 100 m on both sides of the boundary a smooth transition between the two DEMs was created.

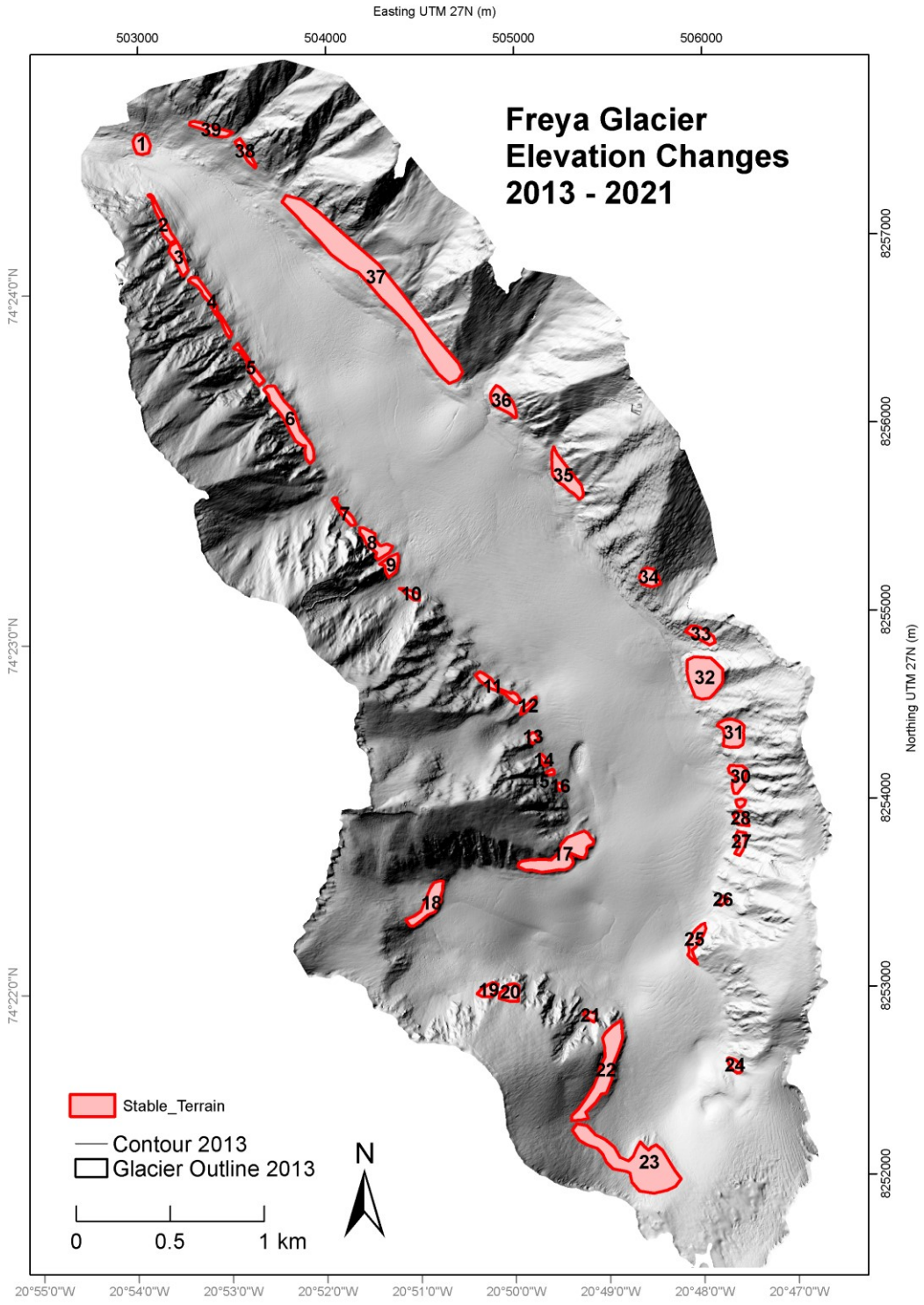

Fig. S2: Likely stable terrain areas on both sides of the glacier were used to check the quality of the DEM differencing. The numbers of the polygons refer to Fig. S3.

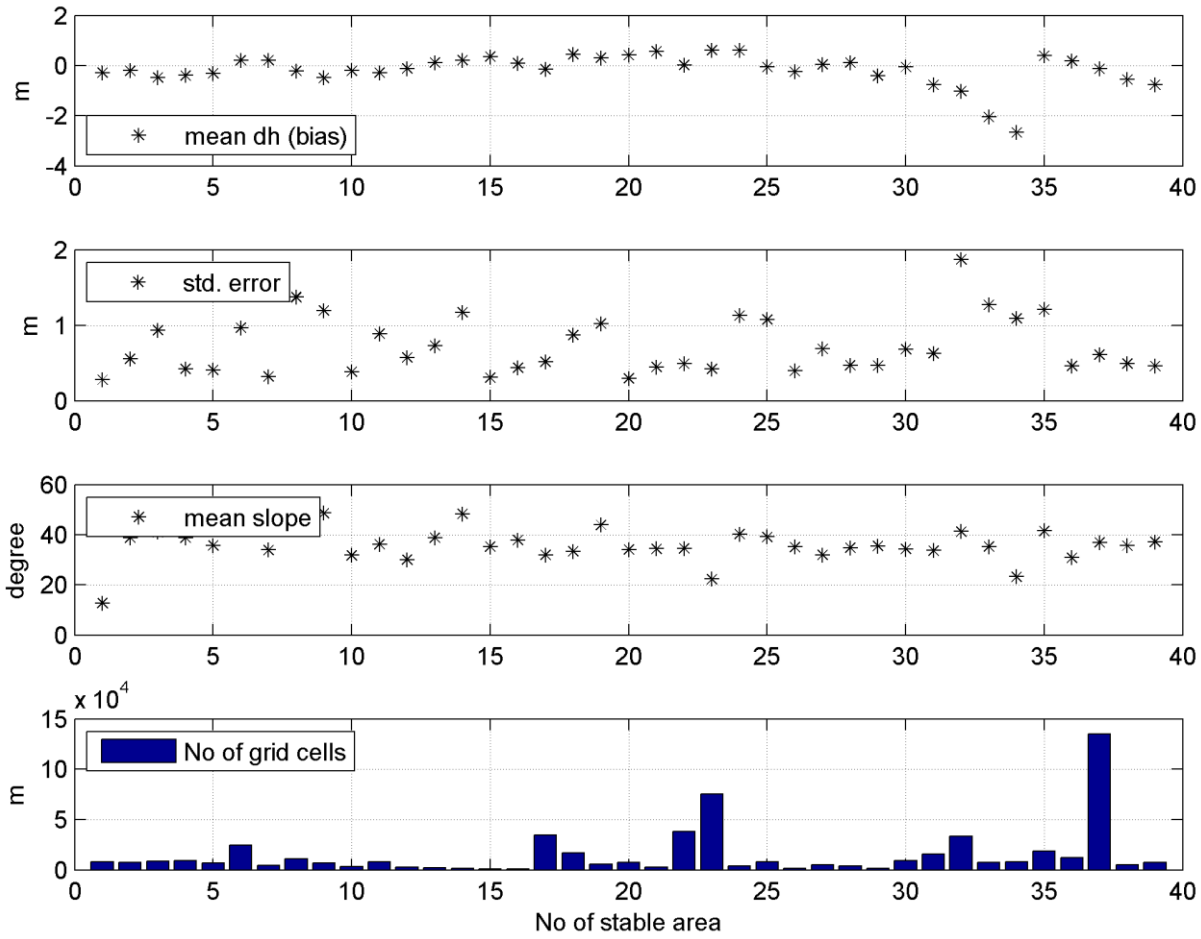

Fig. S3: Average values of elevation difference, standard error, slope and number of 1x1 m grid cells within the stable area polygons shown in Fig. S2.

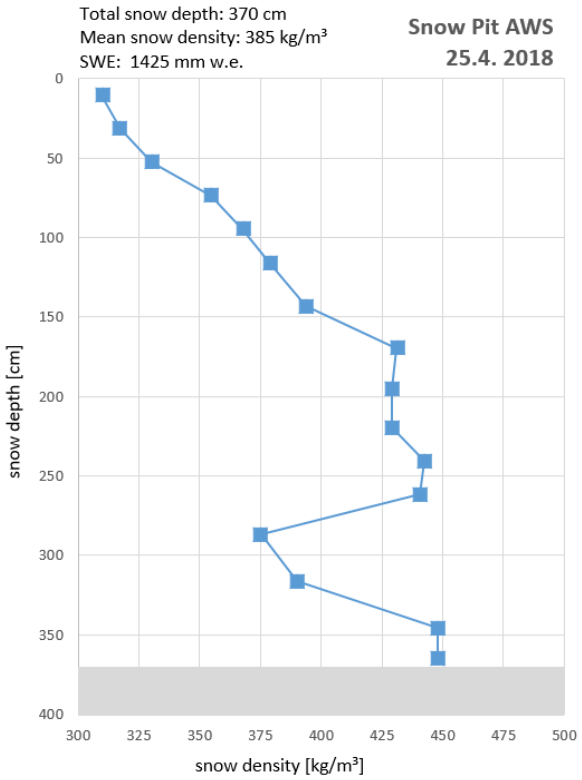

Fig. S4: Snow density at the snow pit next to the AWS on Freya Glacier in 2018.

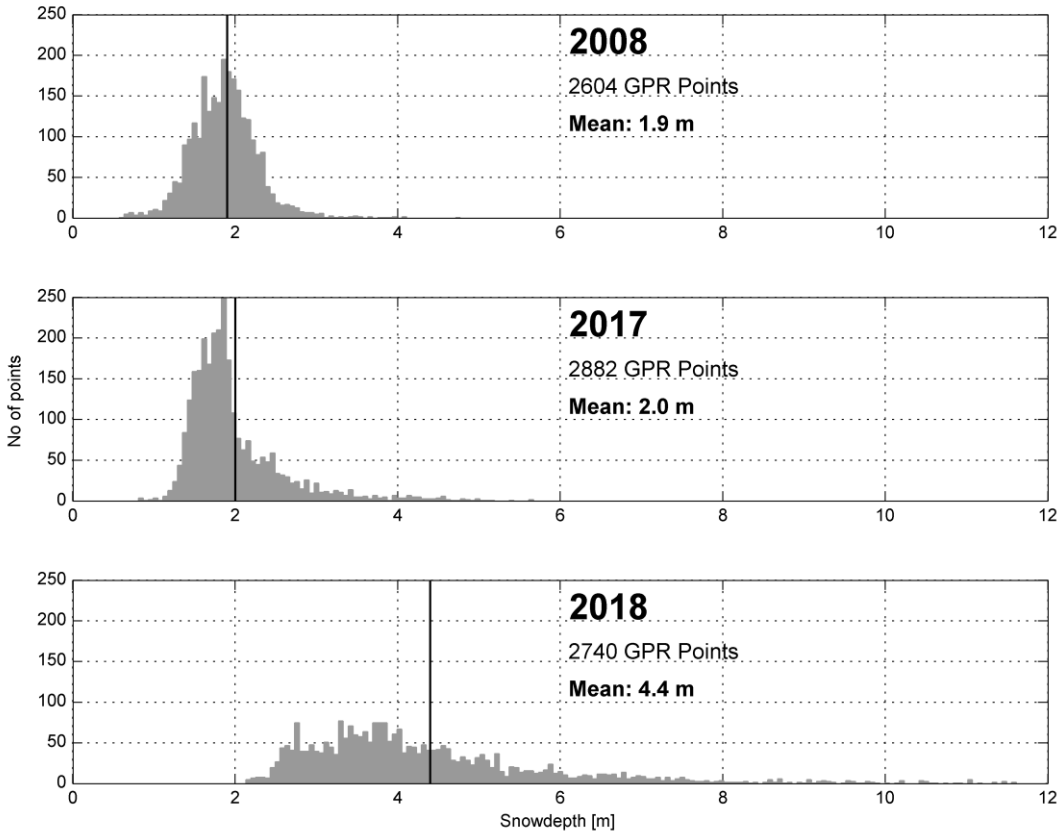

Fig. S5: Histogram plots of GPR snow depth track (10 m mean values) of April 2008, 2017 and 2018. Accumulation in winter 2008 and in winter 2017 was close to average.

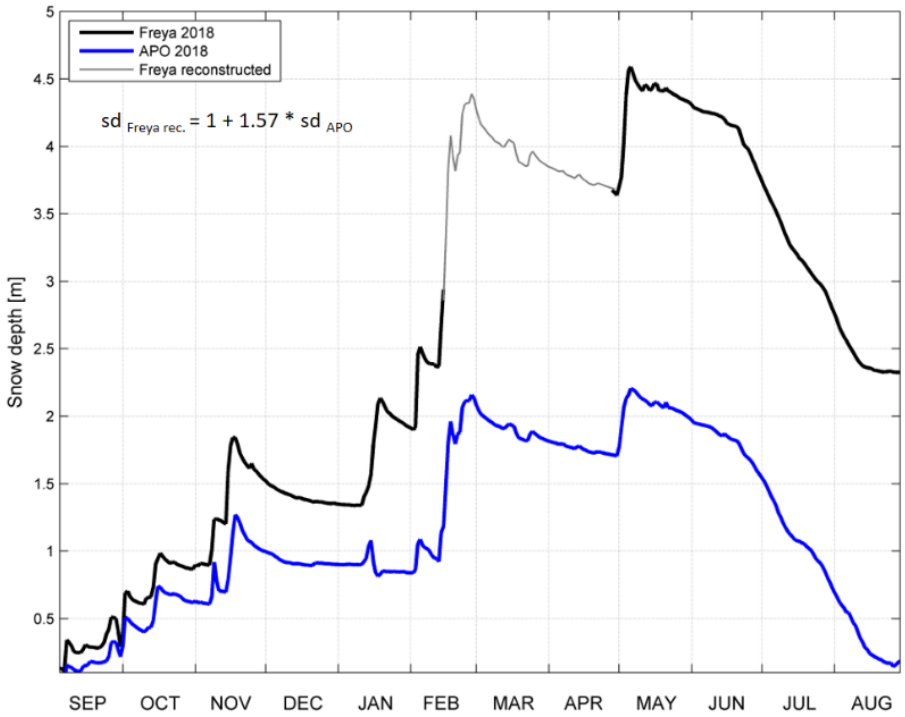

Fig. S6: Continuous snow height data from AWS Freya and an AWS on A. P. Olsen Ice Cap in 40 km distance (Greenland Ecosystem Monitoring (2020); Larsen et al., (2023)). Snow height on Freya Glacier is measured by two Campbell SR 50 ultrasonic devices, one fixed at the mast of the weather station 3.4 m above the ground and one fixed at an ablation stake. Both sensors were snowed in mid-February 2018. On 28th April the weather station was reestablished on the surface. The data gap of 2.5 months was reconstructed using snow height data from the main weather station at A. P. Olsen Ice Cap using the formula in the diagram. Data from the Greenland Ecosystem Monitoring Programme were provided by the Geological Survey of Denmark and Greenland (GEUS), Denmark and Asiaq – Greenland Survey, Nuuk, Greenland.

Table S1: Individual components of the mass balance 2013/08 - 2021/07: Measured height change at the stakes, corresponding elevation change from DEM differencing and calculated horizontal and vertical ice motion. All values are given in m (not in m w.e.).

Stake ID	Easting [UTM 27X m]	Northing [UTM 27X m]	Elevation [m a.s.l.]	Height Change at Stake [m]	Elevation Change [m]	Vertical Ice Motion at Stake [m]	[ma^{-1}]	Horizontal Ice Motion at Stake [ma^{-1}]
1	503288	8257250	374	-0.1*	0.1	0.2	0.0	2.1
2	503560	8256983	437	-6.5	-1.8	4.7	0.6	2.9
3	503860	8256626	501	-7.2	-2.2	5.0	0.6	3.5
4	504289	8256151	589	-2.4	3.0	5.4	0.7	6.5
5	504557	8255751	642	-4.3	0.7	5.0	0.6	5.9
6	505022	8255312	684	-0.3	2.2	2.5	0.3	7.9
6a	505079	8255238	692	-0.2	2.5	2.7	0.3	8.2
7	505275	8254870	730	1.6	4.0	2.5	0.3	6.8
8	505574	8254438	776	1.9	0.5	-1.4	-0.2	7.7
9	505759	8253984	797	2.8	0.6	-2.2	-0.3	8.7
10	505632	8253552	853	2.3	1.4	-0.9	-0.1	6.4
11	505522	8253200	870	4.1*	2.0	-2.1	-0.3	
12	504932	8253430	937	2.3	1.5	-0.8	-0.1	2.5

* Height Change reconstructed in individual years from neighboring stakes (higher uncertainty)

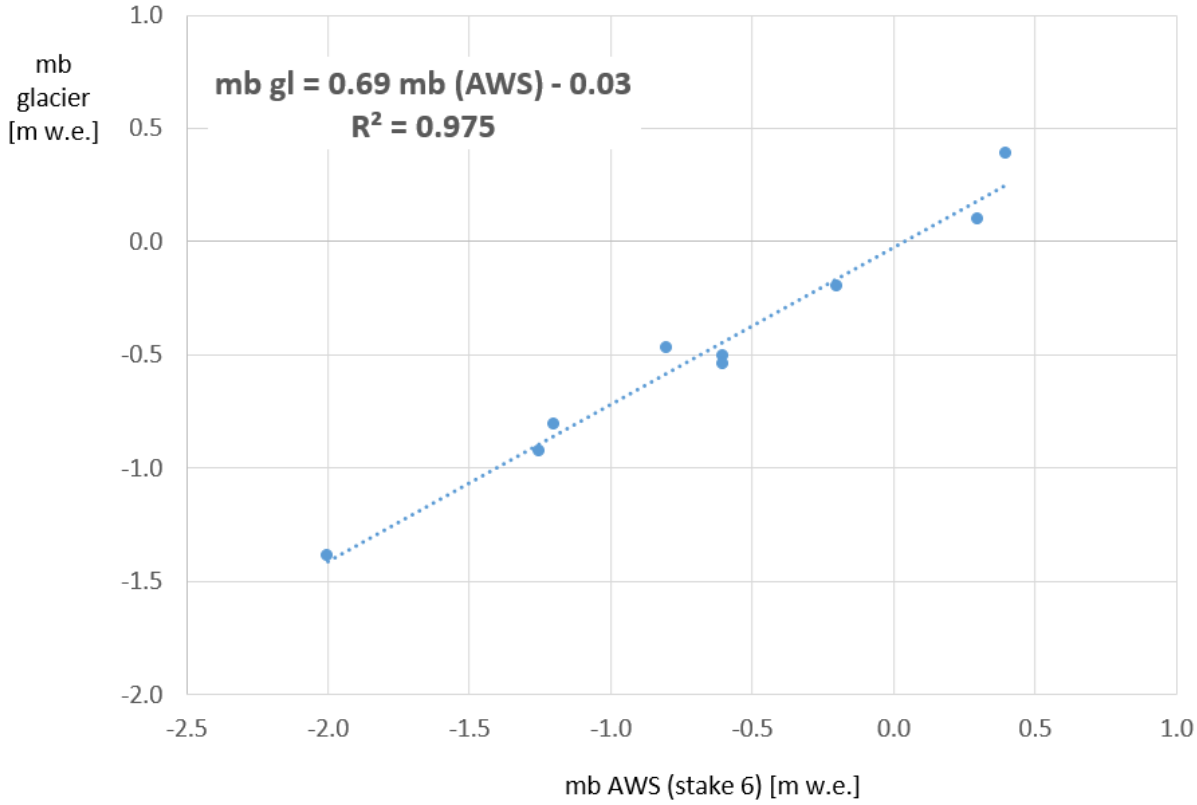

Fig. S7: Linear Relationship between the mass balance at stake 6 and the glacier-wide mass balance derived from 9 years of data (2008 – 2016). This relationship was used to reconstruct the annual glacier-wide mass balance in the years 2017-2021, when only one or two point measurements were available.

References:

Greenland Ecosystem Monitoring: GlacioBasis Zackenberg - Near surface climate - Boom height, ZAC_U (1.0), https://doi.org/10.17897/FWAV-KZ44, 2020b.

Larsen, S. H., Rutishauser, A., Binder, D., Korsgaard, N., Hynek, B., and Citterio, M.: Glaciological monitoring at A. P. Olsen Ice Cap in NE Greenland, oral, https://doi.org/10.5194/egusphere-egu23-15647, 2023.