



Supplement of

InSAR sensitivity to active layer ground ice content in Adventdalen, Svalbard

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Supplementary tables & figures

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- **Table S1:** Overview of selected interferograms for the thawing season 2023 and thawing seasons 2021.

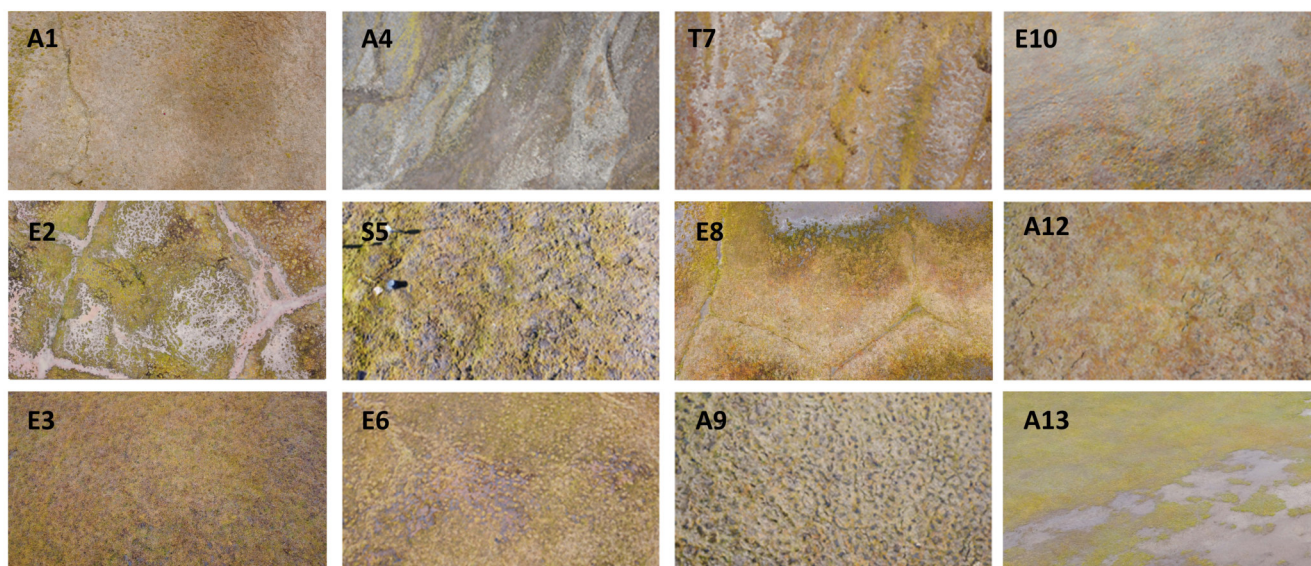


Figure S 1: Pictures of all coring sites from September 2023, taken with a drone approx. 20 m above ground (width of picture = approx. 30-40 m). The respective coring site is in the centre of each image.



Figure S 2: Cross-sectional photographs of all cores. The coring site name is shown on top, and depths (in cm) are increasing from top to bottom.

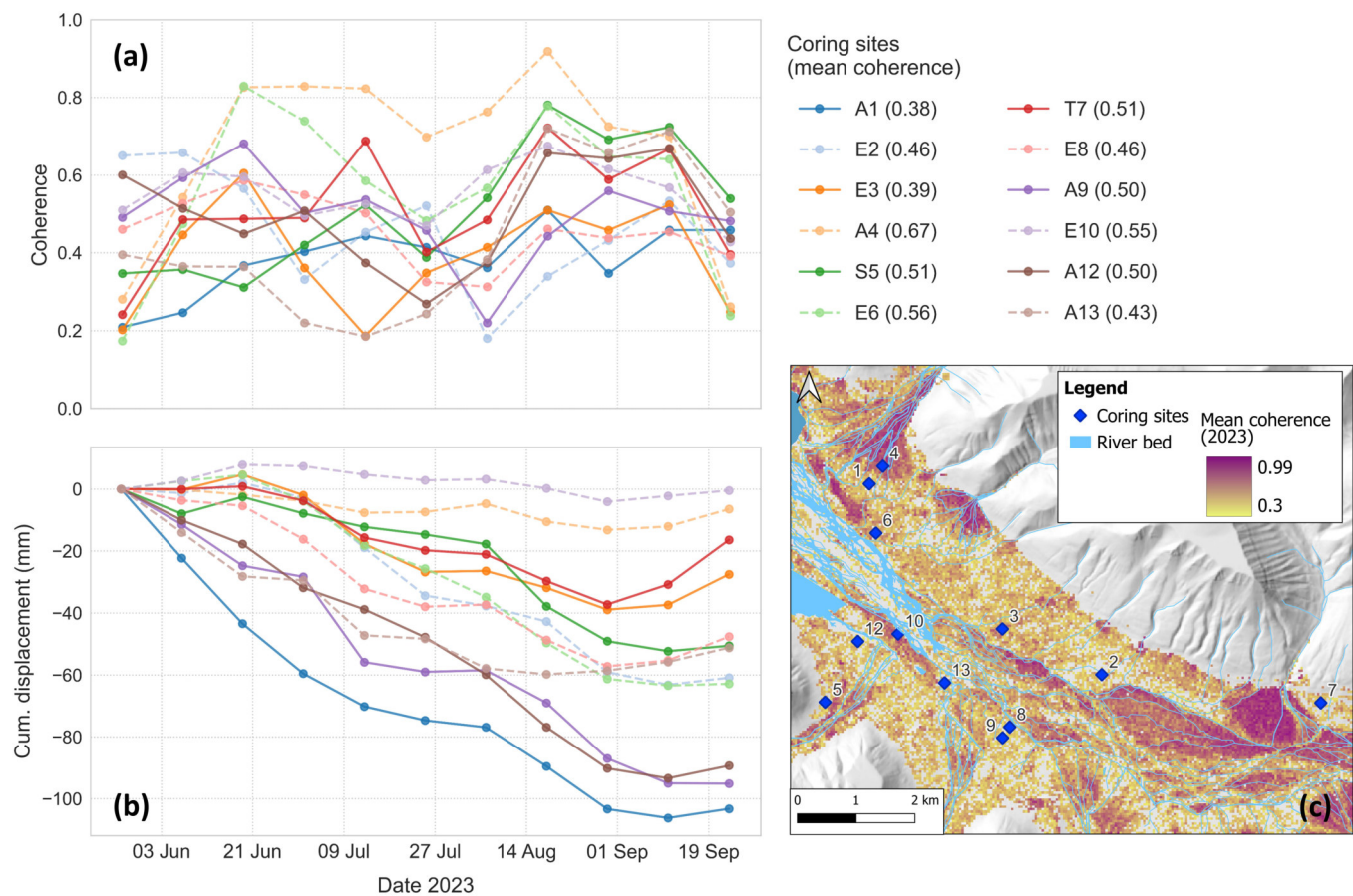


Figure S 3: (a) Coherence time series for each coring site during the thawing season of 2023. For each date, the coherence is computed at the pixel level by averaging the coherence of all interferograms that include the date. This results in a time series of average coherence per date for each pixel. (b) The InSAR cumulative displacement over the thawing season 2023, with the same colouring per coring site and aligned x-axis as in (a). The mean coherence per coring site is included in the legend. The map in (c) displays the spatial distribution of the mean coherence of the thawing season 2023, with a hillshade background based on a digital elevation model (Norwegian Polar Institute, 2014a,b).

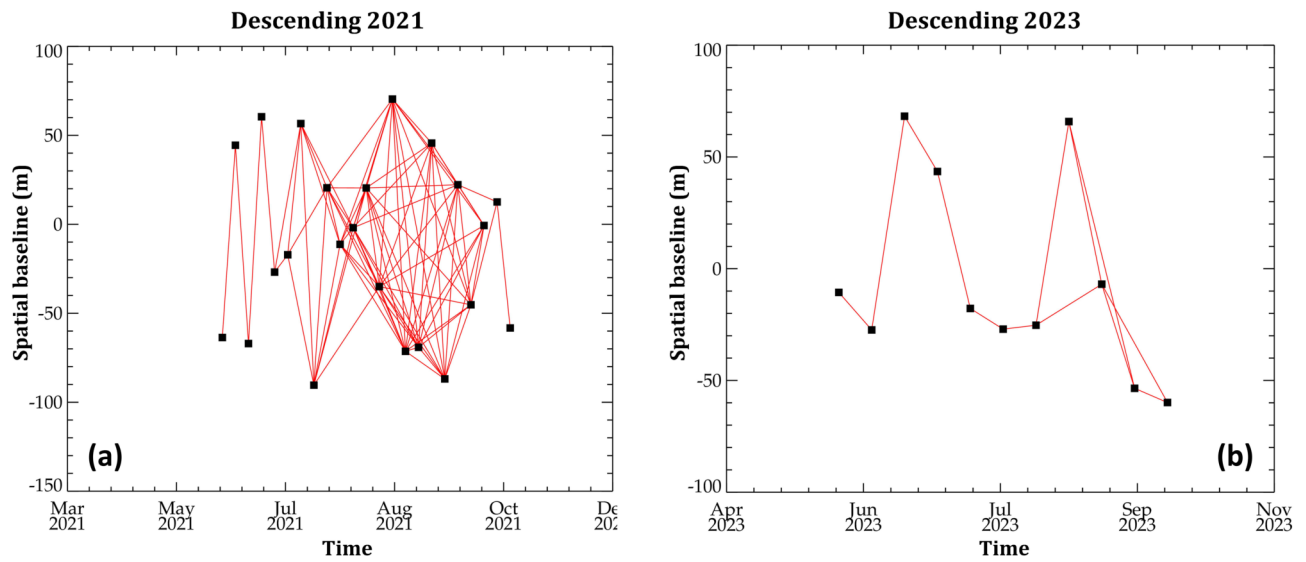


Figure S 4: Baseline plots for the InSAR SBAS time series analysis: descending 2021 (a) and descending 2023 (b). Descending 2023 was constructed from 12 to 24 day interferograms, whilst descending 2021 was constructed from 6 to 36 day interferograms. The start of the thawing season always required short temporal baselines to avoid decorrelation.

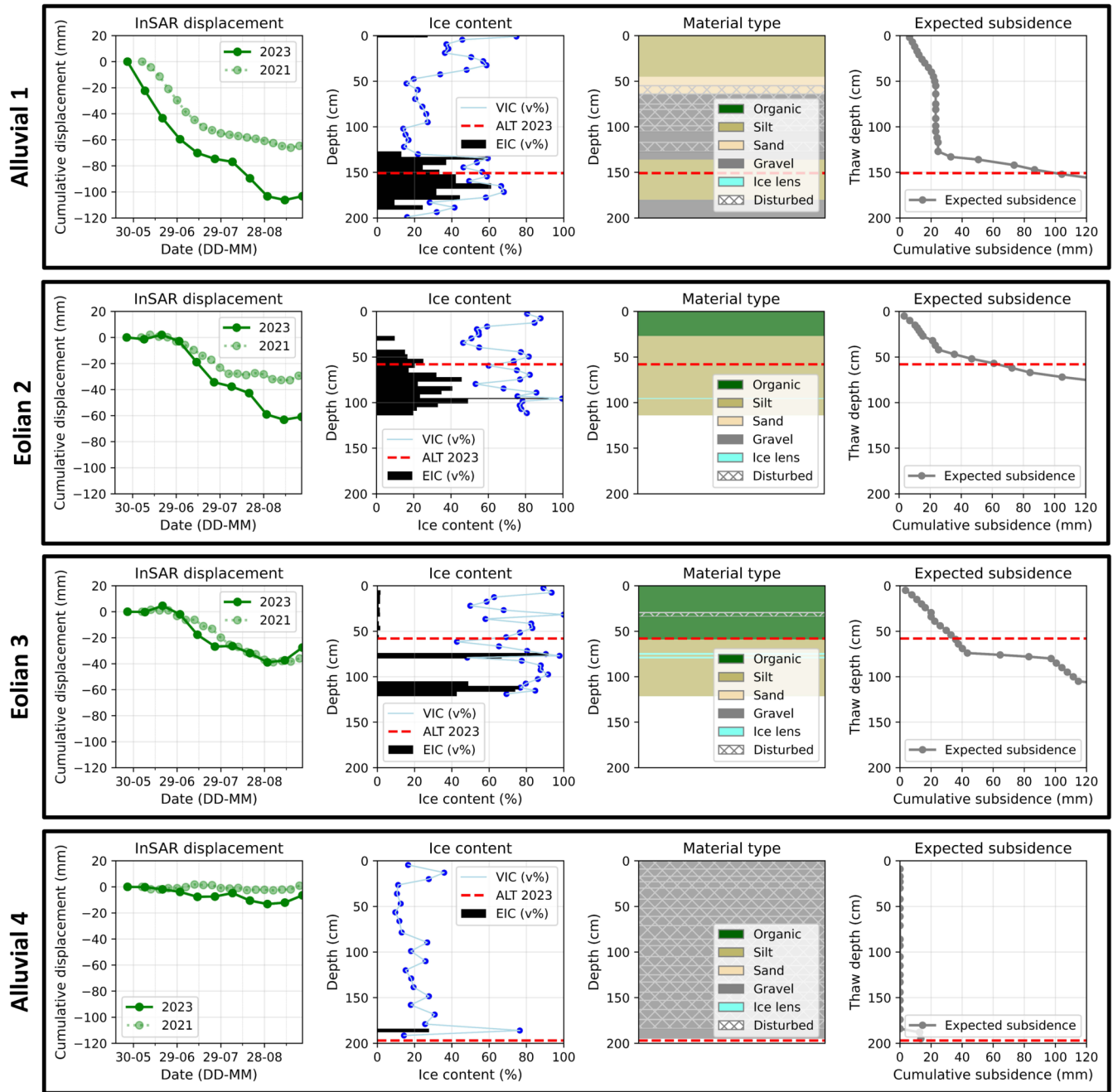
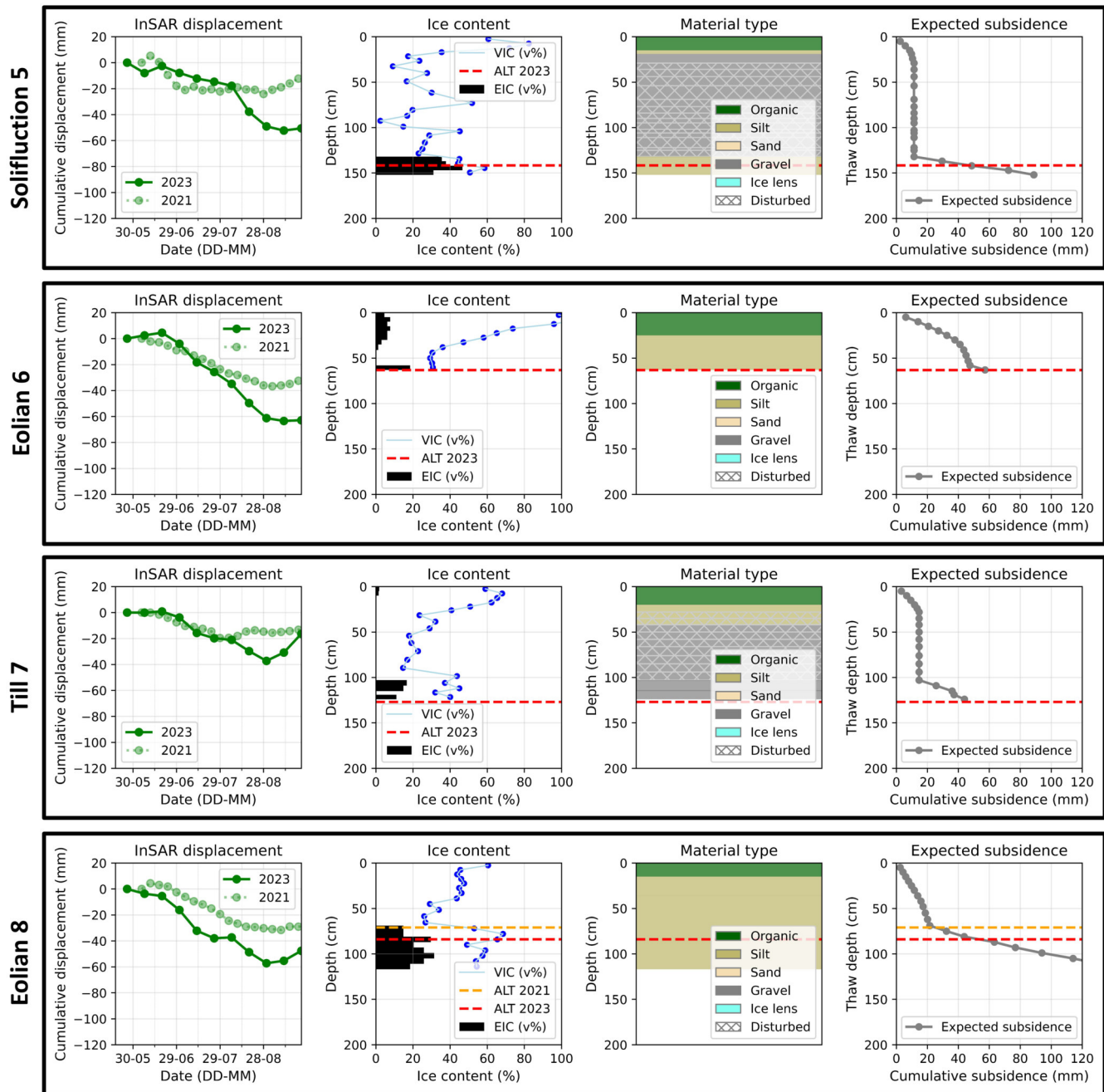


Figure S 5: Detailed time series for cores A1, E2, E3 and A4. Each black rectangle represents one coring site, with the coring site name on the left, and includes four subplots. “InSAR displacement”: Cumulative InSAR displacement of the thawing seasons 2021 and 2023. “Ice content”: In-situ ground ice contents from spring 2023 displaying the volumetric ice content (VIC) and excess ice content (EIC). “Material type”: Material type over depth. “Expected subsidence”: The cumulative expected subsidence from in-situ ground ice melt over thaw depth. The red dashed line indicates the active layer thickness (ALT) of the thawing season 2023.



55 **Figure S 6:** Detailed time series for cores S5, E6, T7 and E8. Each black rectangle represents one coring site, with the coring site name on
the left, and includes four subplots. “InSAR displacement”: Cumulative InSAR displacement of the thawing seasons 2021 and 2023. “Ice
content”: In-situ ground ice contents from spring 2023 displaying the volumetric ice content (VIC) and excess ice content (EIC). “Material
type”: Material type over depth. “Expected subsidence”: The cumulative expected subsidence from in-situ ground ice melt over thaw depth.
The red dashed line indicates the active layer thickness (ALT) of the thawing season 2023. The yellow dashed line for site E8 indicates the
60 ALT for 2021 based on the mean ALT of the Ice-Wedge CALM grid.

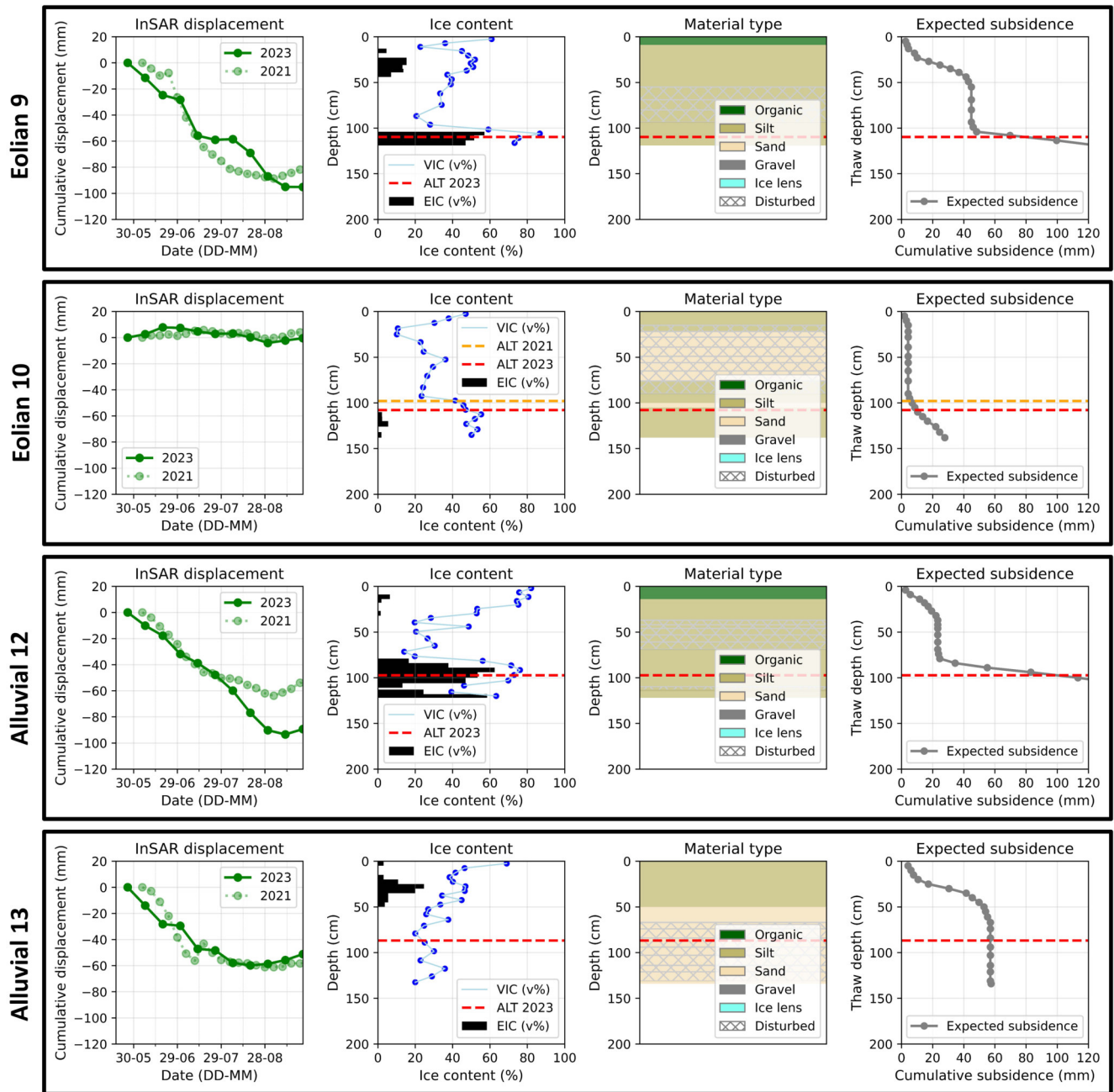
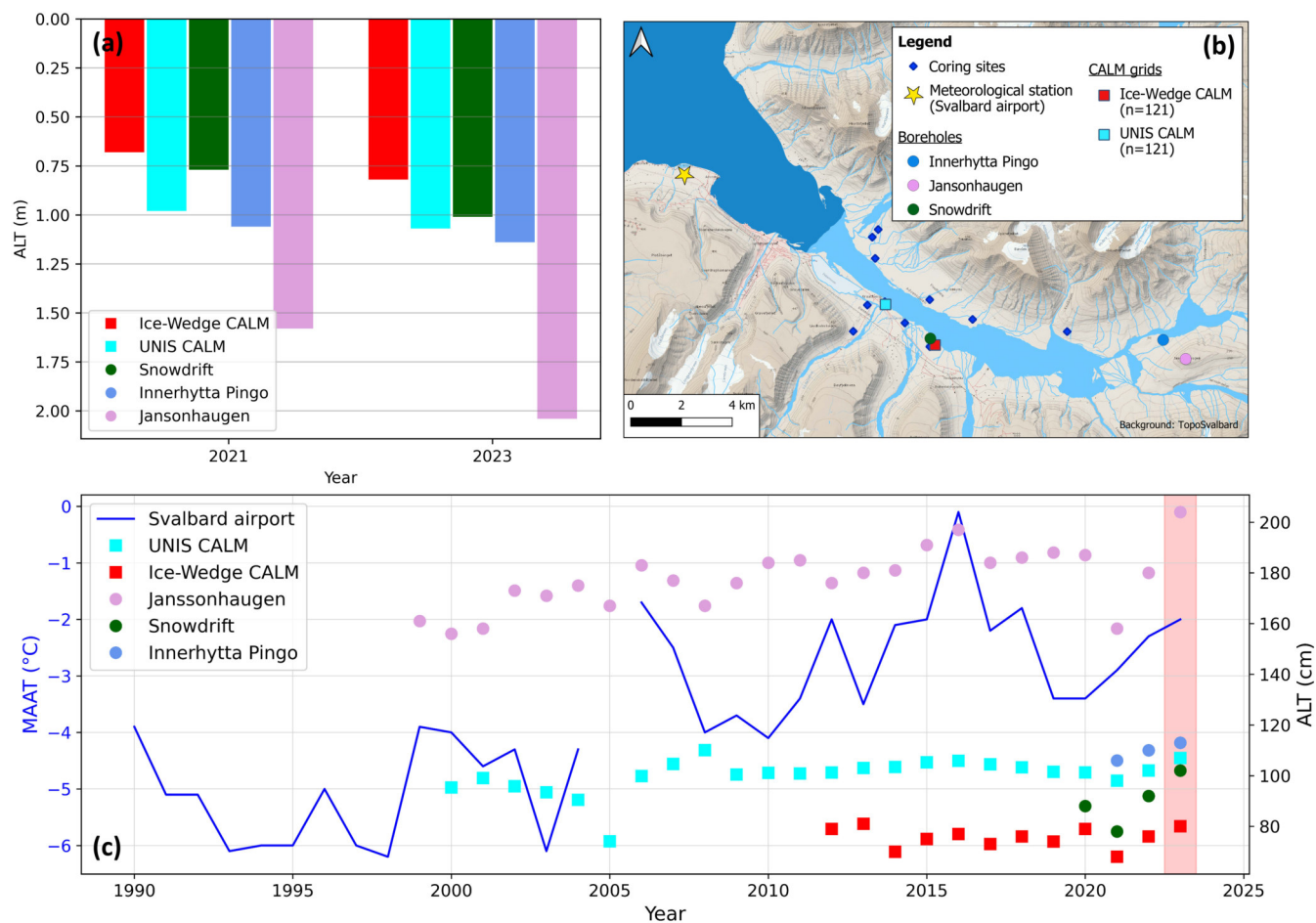


Figure S 7: Detailed time series for cores A9, E10, A12 and A13. Each black rectangle represents one coring site, with the coring site name on the left, and includes four subplots. “InSAR displacement”: Cumulative InSAR displacement of the thawing seasons 2021 and 2023. “Ice content”: In-situ ground ice contents from spring 2023 displaying the volumetric ice content (VIC) and excess ice content (EIC). “Material type”: Material type over depth. “Expected subsidence”: The cumulative expected subsidence from in-situ ground ice melt over thaw depth. The red dashed line indicates the active layer thickness (ALT) of the thawing season 2023. The yellow dashed line for site E10 indicates the ALT for 2021 based on the mean ALT of the UNISCALM grid.



70 **Figure S 8:** Comparison of active layer thickness (ALT) for 2021 (cold thawing season) and 2023 (warm thawing season) from three boreholes and two CALM grids in Adventdalen (a). The location of the boreholes and CALM grids is shown in (b). The long-term development of ALT measurements at these sites and the mean annual air temperature (MAAT) development at Svalbard airport is shown in (c), with 2023 underlain in red. The colours of the sites align between the subplots. The background in (b) is from TopoSvalbard (Norwegian Polar Institute, 2014a).

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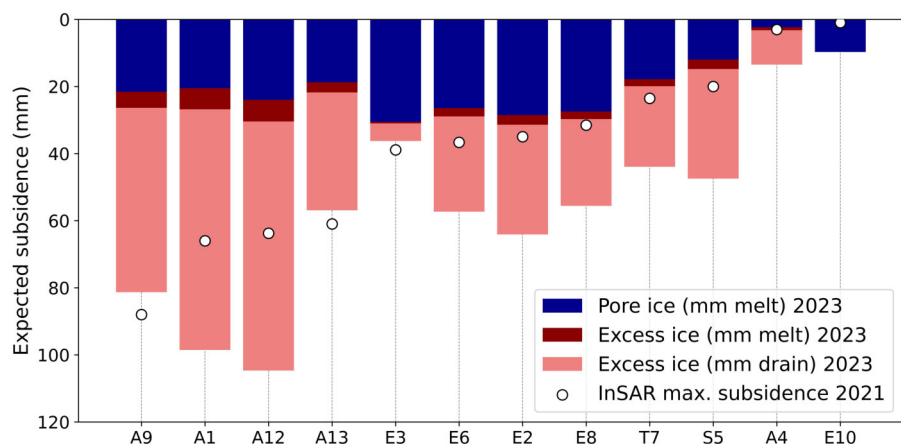


Figure S 9: Comparison of the maximum seasonal InSAR subsidence of 2021 to the expected subsidence contributions from ground ice melt in 2023. Note that most of the non-alluvial sites have an InSAR subsidence which aligns with the pore ice due to the likely lower thaw depth and thus decreased penetration into the transient, excess ice rich layer between the active layer and uppermost permafrost.

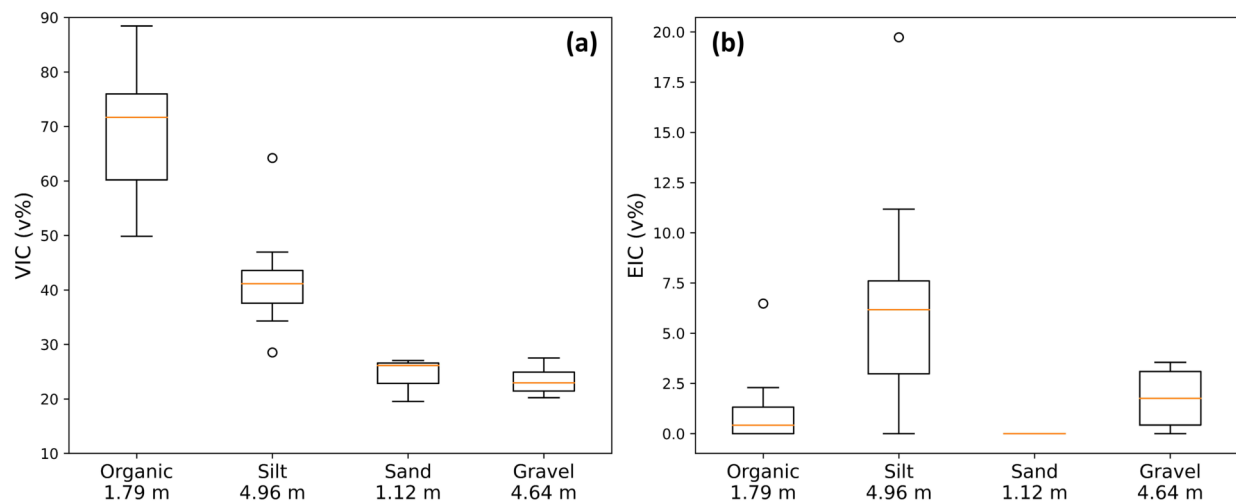
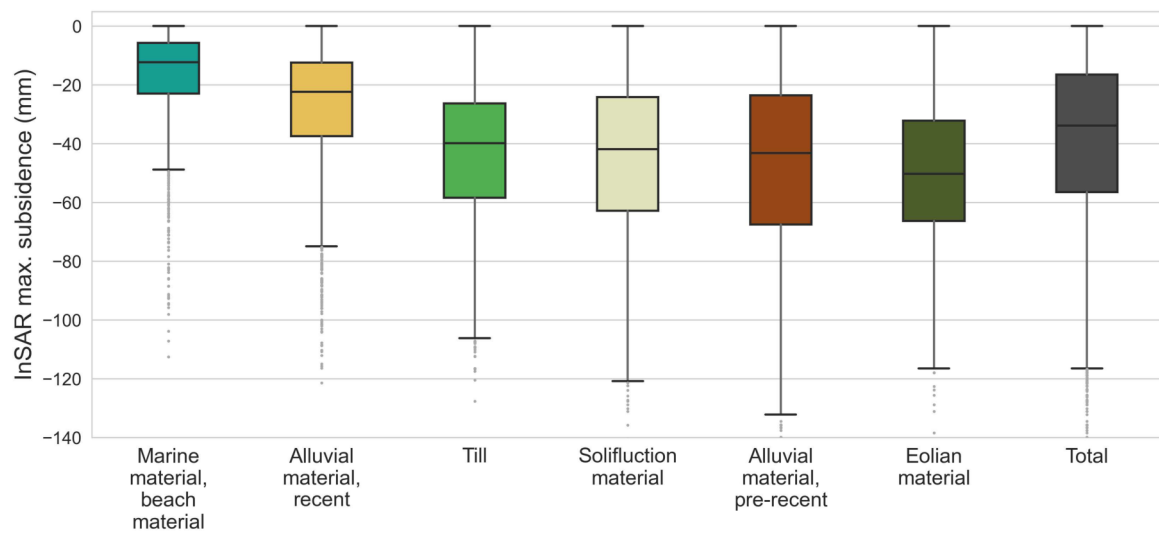


Figure S 10: Boxplot of (a) the volumetric ice content (VIC) and (b) the excess ice content (EIC) for the different material types within the active layer of 2023 across all coring sites. The total length of core sections contributing to each class is denoted in the x-tick label. Each boxplot illustrates the median (central line), the 25th to 75th percentile range (box), the full range of observed values (whiskers), and outliers (dots).



90 **Figure S 11:** Boxplot of the maximum InSAR subsidence in 2023 per sediment deposit type in the study area. Each class consists of 2000 randomly chosen InSAR pixels which fall within the sediment deposition type (Rouyet et al., 2019; modified from Härtel and Christiansen, 2014). Each boxplot illustrates the median (central line), the 25th to 75th percentile range (box), the full range of observed values (whiskers), and outliers (dots).

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115 **Table S 1:** List of all interferogram pairs used in the analysis for thawing season 2023 (total number = 13) and thawing season 2021 (total number = 84). All Sentinel-1 IW SLC Scenes are from ground track 154 (Descending).

Interferograms 2023	Interferograms 2021	Interferograms 2021	Interferograms 2021
07.06.2023 - 26.05.2023	11.06.2021 - 05.06.2021	22.08.2021 - 29.07.2021	15.09.2021 - 09.09.2021
19.06.2023 - 07.06.2023	17.06.2021 - 11.06.2021	22.08.2021 - 04.08.2021	21.09.2021 - 04.08.2021
01.07.2023 - 19.06.2023	23.06.2021 - 17.06.2021	22.08.2021 - 10.08.2021	21.09.2021 - 10.08.2021
13.07.2023 - 01.07.2023	29.06.2021 - 23.06.2021	22.08.2021 - 16.08.2021	21.09.2021 - 16.08.2021
25.07.2023 - 13.07.2023	05.07.2021 - 29.06.2021	28.08.2021 - 23.07.2021	21.09.2021 - 22.08.2021
06.08.2023 - 25.07.2023	11.07.2021 - 29.06.2021	28.08.2021 - 29.07.2021	21.09.2021 - 28.08.2021
18.08.2023 - 06.08.2023	11.07.2021 - 05.07.2021	28.08.2021 - 04.08.2021	21.09.2021 - 03.09.2021
30.08.2023 - 06.08.2023	17.07.2021 - 11.07.2021	28.08.2021 - 10.08.2021	21.09.2021 - 09.09.2021
30.08.2023 - 18.08.2023	29.07.2021 - 11.07.2021	28.08.2021 - 16.08.2021	21.09.2021 - 15.09.2021
11.09.2023 - 18.08.2023	23.07.2021 - 17.07.2021	28.08.2021 - 22.08.2021	27.09.2021 - 10.08.2021
11.09.2023 - 30.08.2023	23.07.2021 - 05.07.2021	03.09.2021 - 29.07.2021	27.09.2021 - 16.08.2021
23.09.2023 - 30.08.2023	23.07.2021 - 11.07.2021	03.09.2021 - 04.08.2021	27.09.2021 - 22.08.2021
23.09.2023 - 11.09.2023	23.07.2021 - 17.07.2021	03.09.2021 - 10.08.2021	27.09.2021 - 28.08.2021
	29.07.2021 - 17.07.2021	03.09.2021 - 16.08.2021	27.09.2021 - 03.09.2021
	29.07.2021 - 23.07.2021	03.09.2021 - 22.08.2021	27.09.2021 - 09.09.2021
	04.08.2021 - 11.07.2021	03.09.2021 - 28.08.2021	27.09.2021 - 15.09.2021
	04.08.2021 - 17.07.2021	09.09.2021 - 04.08.2021	27.09.2021 - 21.09.2021
	04.08.2021 - 23.07.2021	09.09.2021 - 10.08.2021	03.10.2021 - 16.08.2021
	04.08.2021 - 29.07.2021	09.09.2021 - 16.08.2021	03.10.2021 - 22.08.2021
	10.08.2021 - 29.07.2021	09.09.2021 - 22.08.2021	03.10.2021 - 28.08.2021
	10.08.2021 - 17.07.2021	09.09.2021 - 28.08.2021	03.10.2021 - 03.09.2021
	10.08.2021 - 23.07.2021	09.09.2021 - 03.09.2021	03.10.2021 - 09.09.2021
	10.08.2021 - 29.07.2021	15.09.2021 - 04.08.2021	03.10.2021 - 15.09.2021
	10.08.2021 - 04.08.2021	15.09.2021 - 10.08.2021	03.10.2021 - 21.09.2021
	16.08.2021 - 29.07.2021	15.09.2021 - 16.08.2021	03.10.2021 - 27.09.2021
	16.08.2021 - 04.08.2021	15.09.2021 - 22.08.2021	09.10.2021 - 21.09.2021
	16.08.2021 - 10.08.2021	15.09.2021 - 28.08.2021	09.10.2021 - 27.09.2021
	22.08.2021 - 23.07.2021	15.09.2021 - 03.09.2021	15.10.2021 - 09.10.2021

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