Supplementary

S1 Accuracy assessment

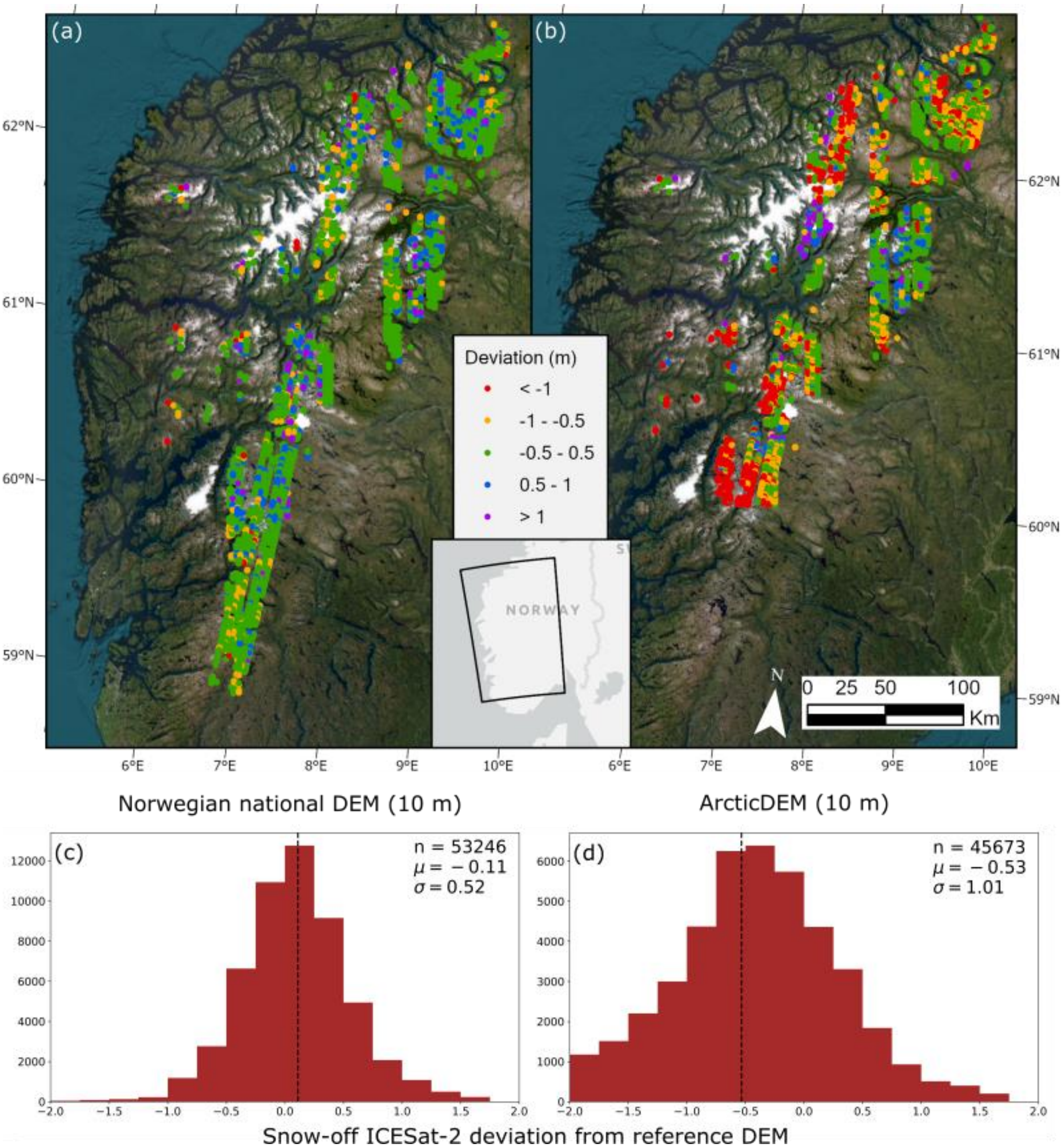


Figure S1: ICESat-2 and reference DEM accuracy assessment: Accuracy of ICESat-2 (500 meter smoothed) in snow-off conditions compared to **(a)** the Norwegian National DEM and **(b)** ArcticDEM mosaic. **(c)** Mean offset of -0.11 m and standard deviation of 0.52 between ICESat-2 and the Norwegian National DEM. **(d)** Mean offset of -0.53 and a standard deviation between ICESat-2 and ArcticDEM.

S2 Sentinel-1 orbit correlations

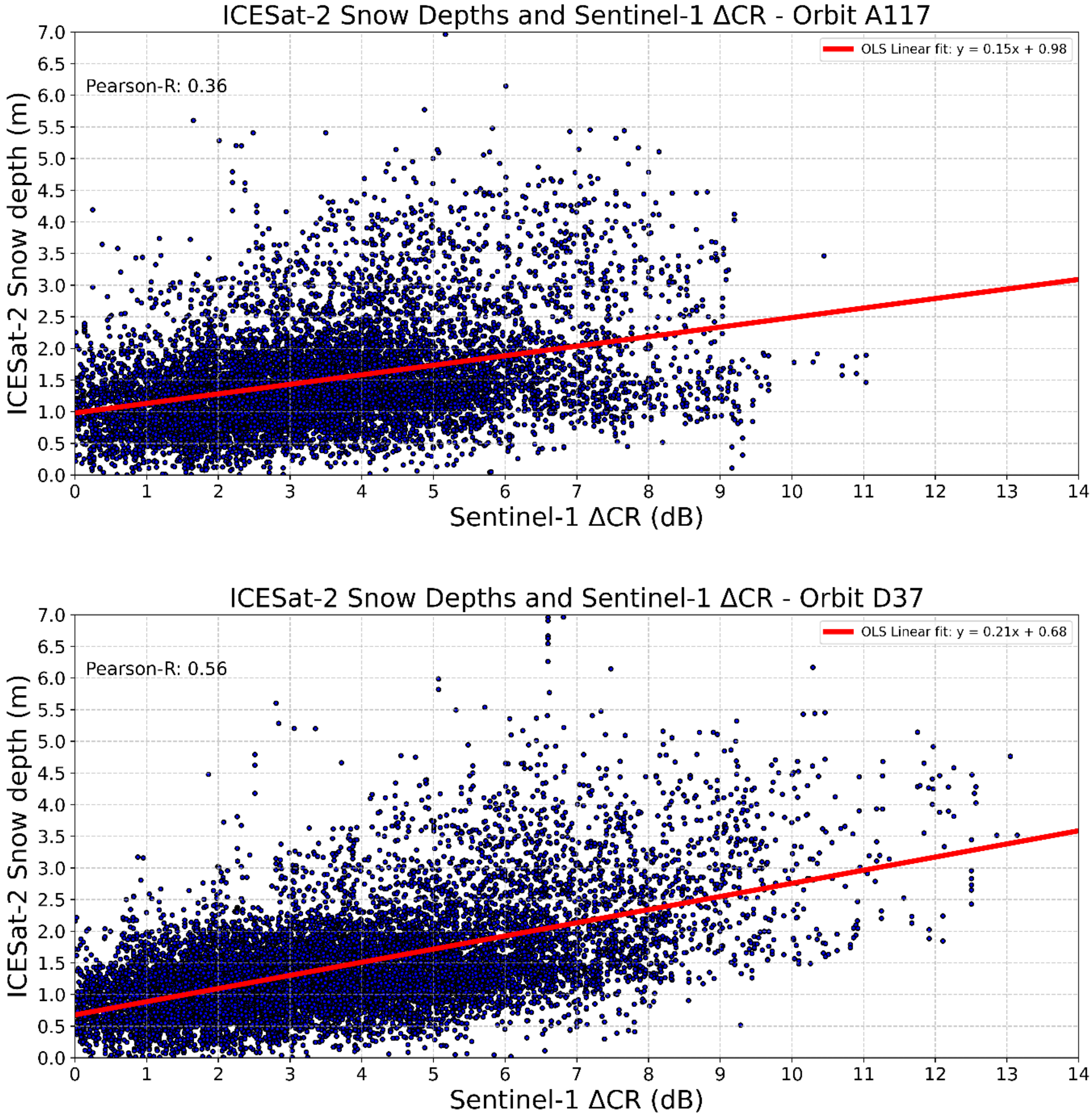


Figure S2: OLS linear regression for orbit A117 and D37. (a) Relationship between ICESat-2 snow depths and Sentinel-1 ΔCR for orbit A117. **(b)** Relationship between ICESat-2 snow depths and Sentinel-1 ΔCR for orbit D37.

S3: Sentinel-1 orbit comparison

Since our Sentinel-1 derived snow depths are orbit specific, we are also comparing orbits with each other. We found a strong agreement between the descending orbits (Figure S3a), whereas the ascending orbit produced different snow depths (Figure S3b). We assume that the most accurate snow depths are derived from the descending orbits as they have a slightly stronger correlation with ICESat-2 compared to the ascending orbit and attribute this discrepancy between ascending and descending orbits related to the local incidence angle and overpass time. While ΔCR is the difference between two images from the same orbit, we still consider local incidence angle to have a large effect on ΔCR, as shadow effects from different viewing angles based on local topography will influence the intensity of backscatter. The path length of the signal travelling through a dry snowpack can also vary significantly between ascending and descending orbits. We also theorize that overpass time influences the correlation between ΔCR and snow depth. The descending orbits have an overpass time of 5 am, while ascending orbit has an overpass time of 5 pm, and is therefore more prone to ΔCR being influenced by higher temperature fluctuations and undetected snow surface melt.

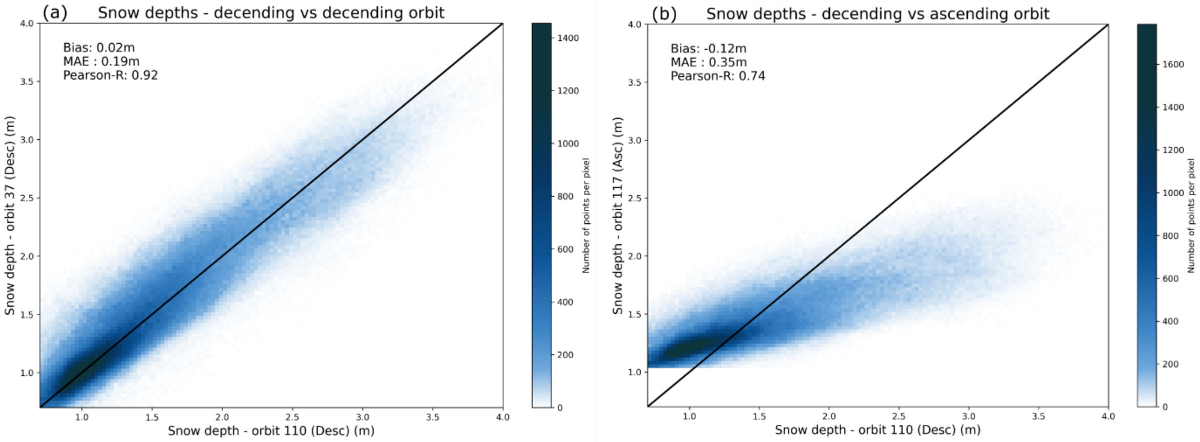
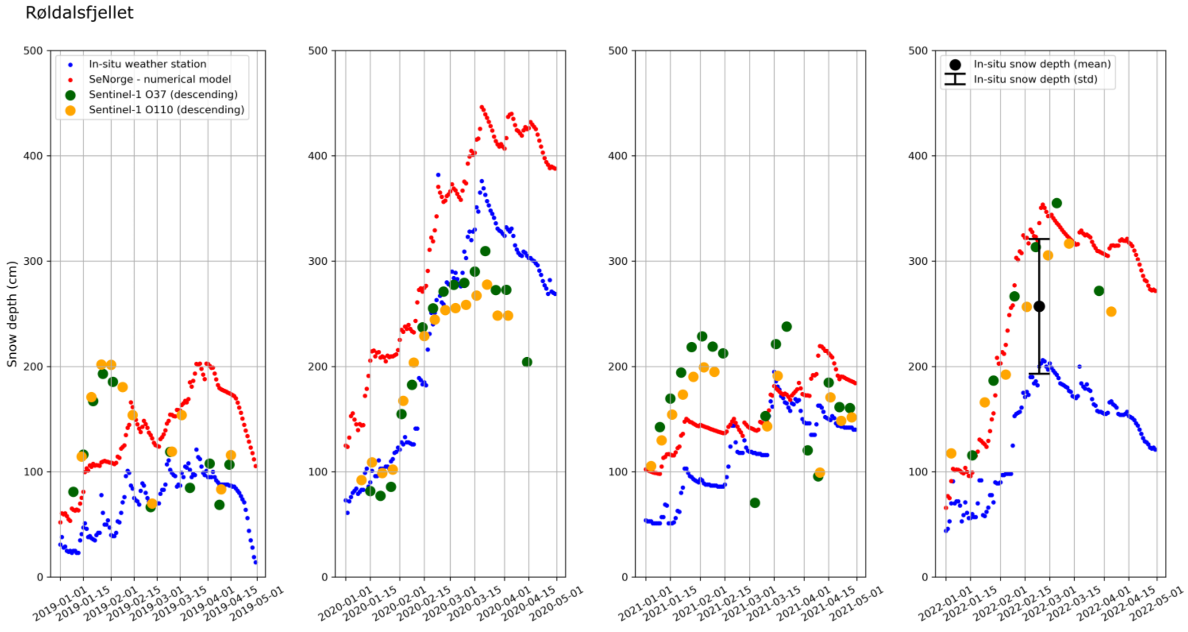
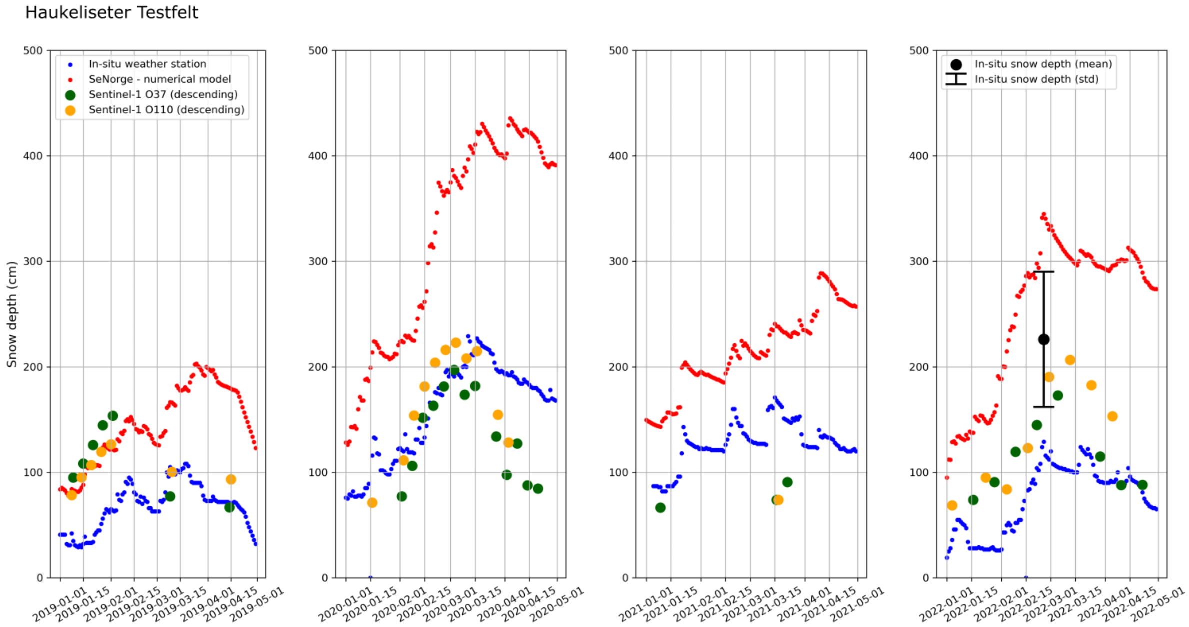


Figure S3: Sentinel-1 Orbit comparison. Decending orbits 110 & 37, shows a very strong correlation **(a)**, while the correlation between descending orbit 110 and ascending orbit 117 **(b)** is relatively low.

S4 Weather stations comparisons

Comparison between measured, modelled and Sentinel-1 snow depths at the location of each weather station.




Haukeliseter Testfelt
Snow depth (cm)
0
100
200
300
400
500
In-situ weather station
SeNorge - numerical model
Sentinel-1 O37 (descending)
Sentinel-1 O110 (descending)
In-situ snow depth (mean)
In-situ snow depth (std)
2019-01-01
2019-01-15
2019-02-01
2019-02-15
2019-03-01
2019-03-15
2019-04-01
2019-04-15
2019-05-01
2020-01-01
2020-01-15
2020-02-01
2020-02-15
2020-03-01
2020-03-15
2020-04-01
2020-04-15
2020-05-01
2021-01-01
2021-01-15
2021-02-01
2021-02-15
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2021-04-15
2021-05-01
2022-01-01
2022-01-15
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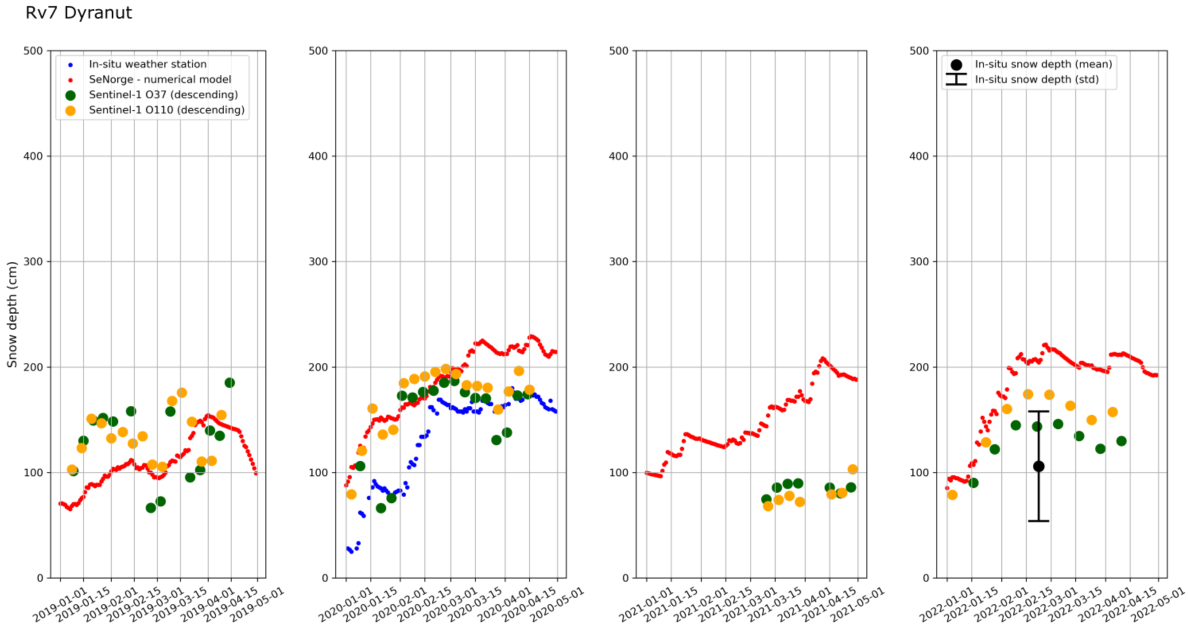
2022-03-15
2022-04-01
2022-04-15
2022-05-01


Rv7 Dyranut
Snow depth (cm)
0
100
200
300
400
500
In-situ weather station
SeNorge - numerical model
Sentinel-1 O37 (descending)
Sentinel-1 O110 (descending)
In-situ snow depth (mean)
In-situ snow depth (std)
2019-01-01
2019-01-15
2019-02-01
2019-02-15
2019-03-01
2019-03-15
2019-04-01
2019-04-15
2019-05-01
2020-01-01
2020-01-15
2020-02-01
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2022-02-01
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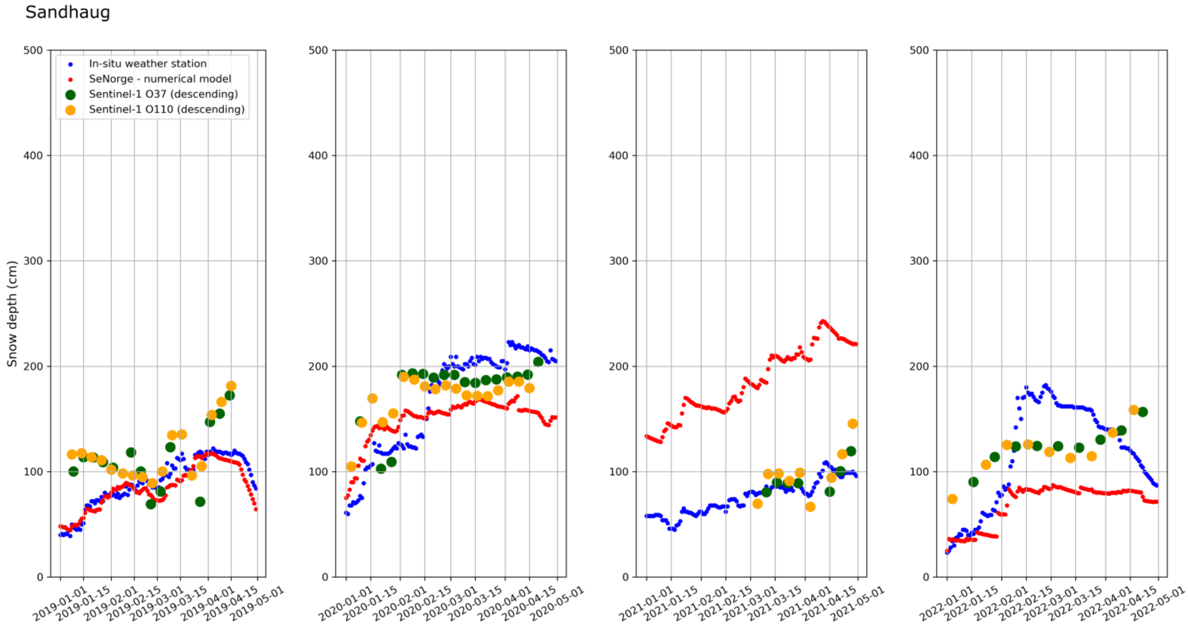
2022-03-15
2022-04-01
2022-04-15
2022-05-01


Sandhaug
Snow depth (cm)
0
100
200
300
400
500
In-situ weather station
SeNorge - numerical model
Sentinel-1 O37 (descending)
Sentinel-1 O110 (descending)
2019-01-01
2019-01-15
2019-02-01
2019-02-15
2019-03-01
2019-03-15
2019-04-01
2019-04-15
2019-05-01
2020-01-01
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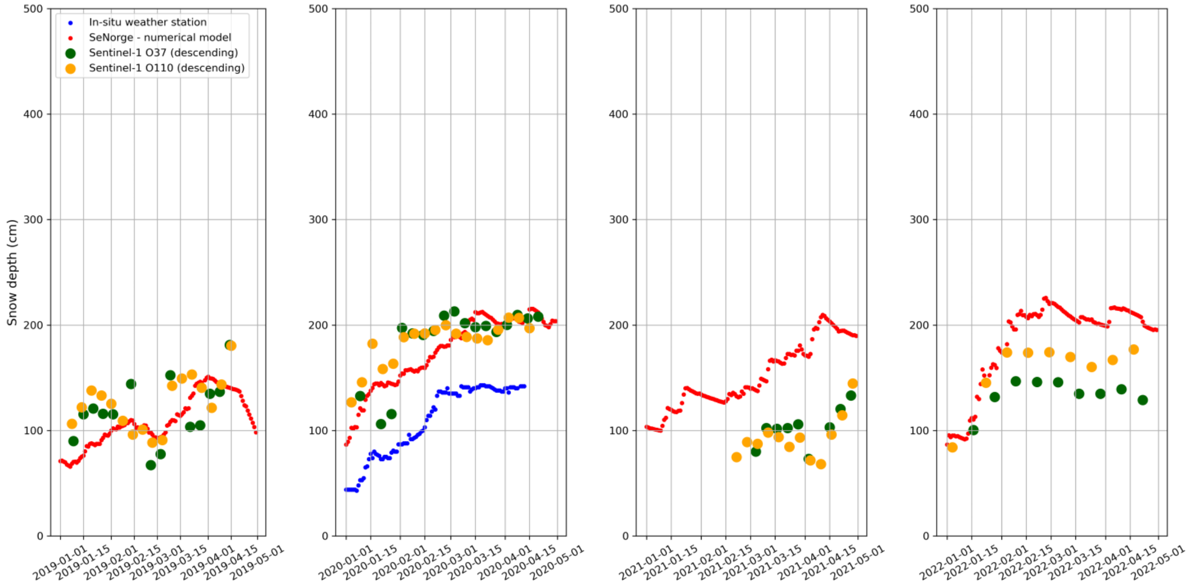
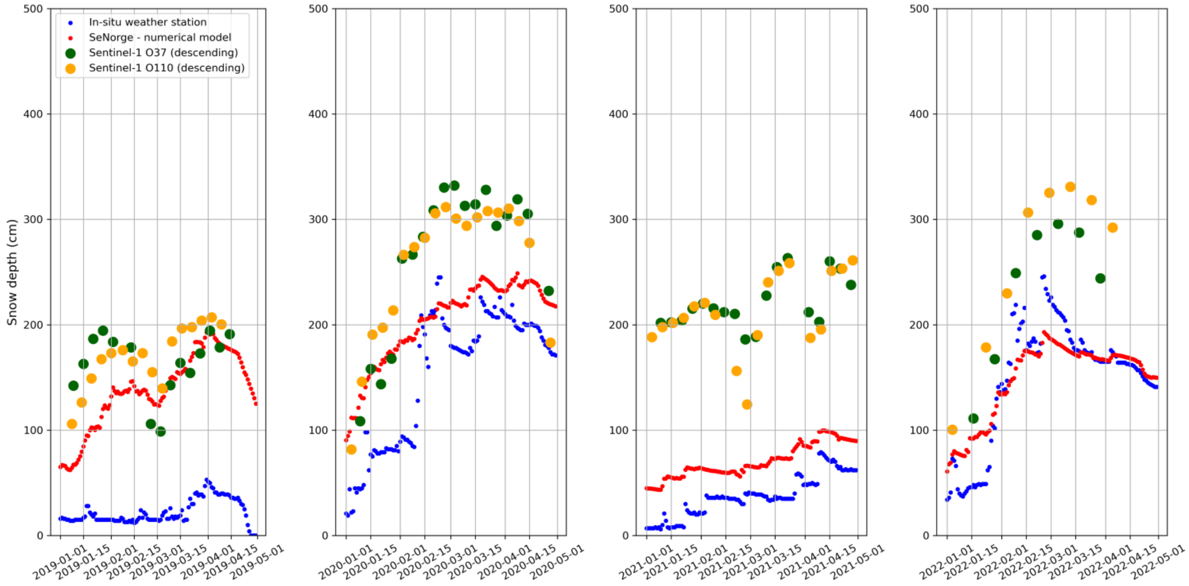
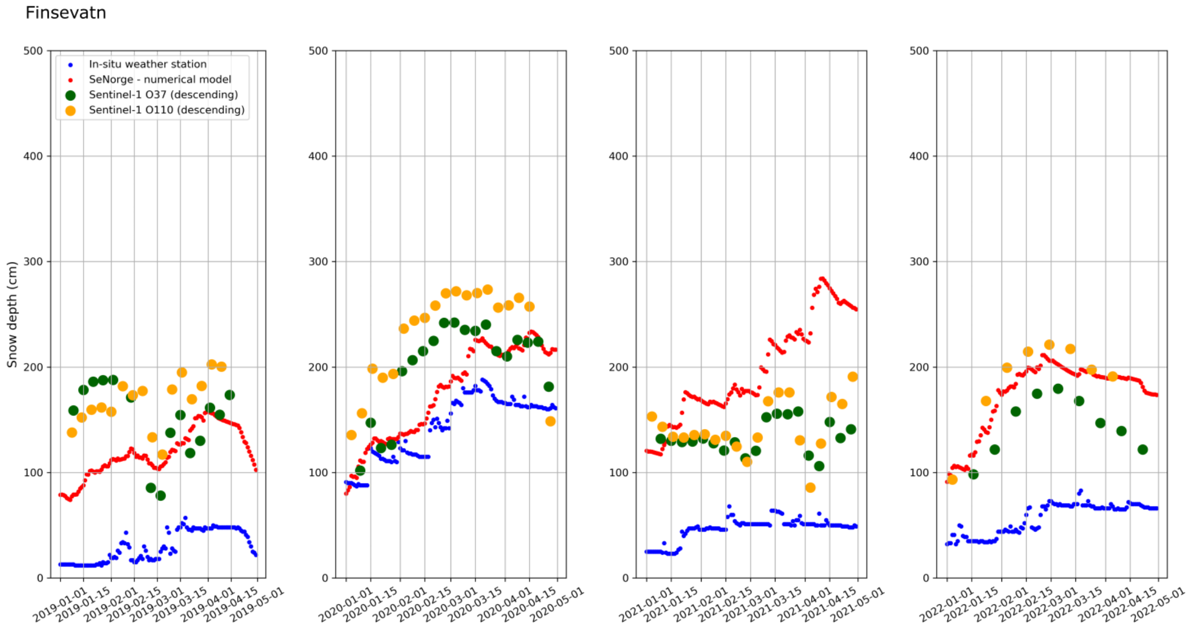
2022-05-01

Skurdevikåi



Midtstova




Finsevatn
Snow depth (cm)
0
100
200
300
400
500
In-situ weather station
SeNorge - numerical model
Sentinel-1 O37 (descending)
Sentinel-1 O110 (descending)
2019-01-01
2019-01-15
2019-02-01
2019-02-15
2019-03-01
2019-03-15
2019-04-01
2019-04-15
2019-05-01
2020-01-01
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2022-01-15
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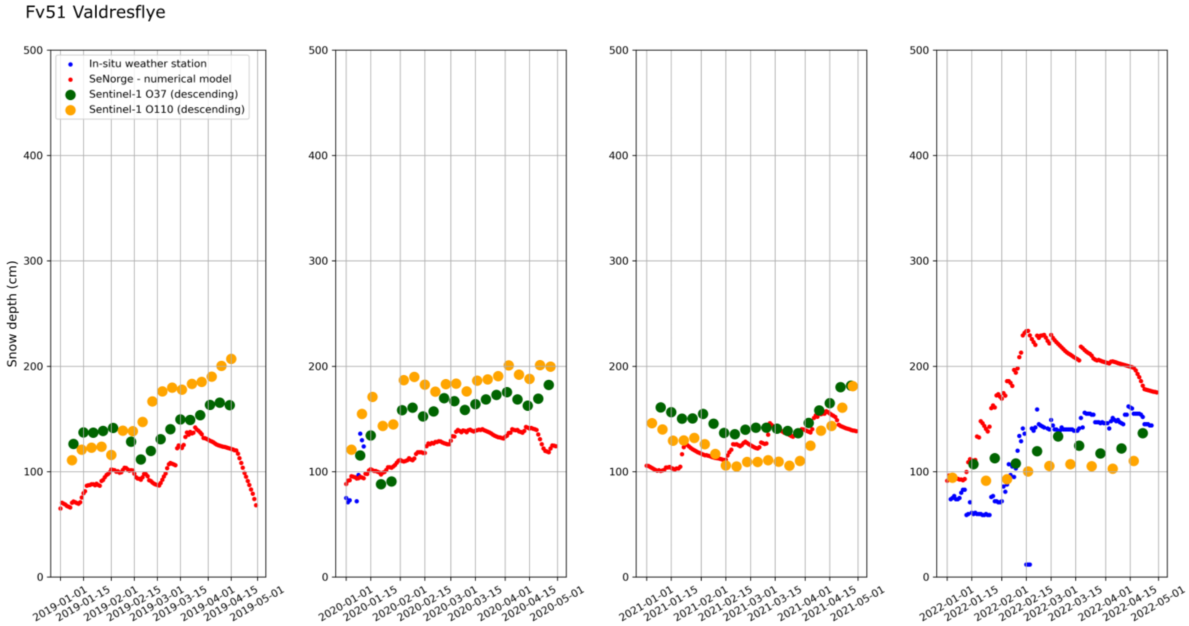
2022-04-15
2022-05-01


Fv51 Valdresflye
Snow depth (cm)
0
100
200
300
400
500
In-situ weather station
SeNorge - numerical model
Sentinel-1 O37 (descending)
Sentinel-1 O110 (descending)
2019-01-01
2019-01-15
2019-02-01
2019-02-15
2019-03-01
2019-03-15
2019-04-01
2019-04-15
2019-05-01
2020-01-01
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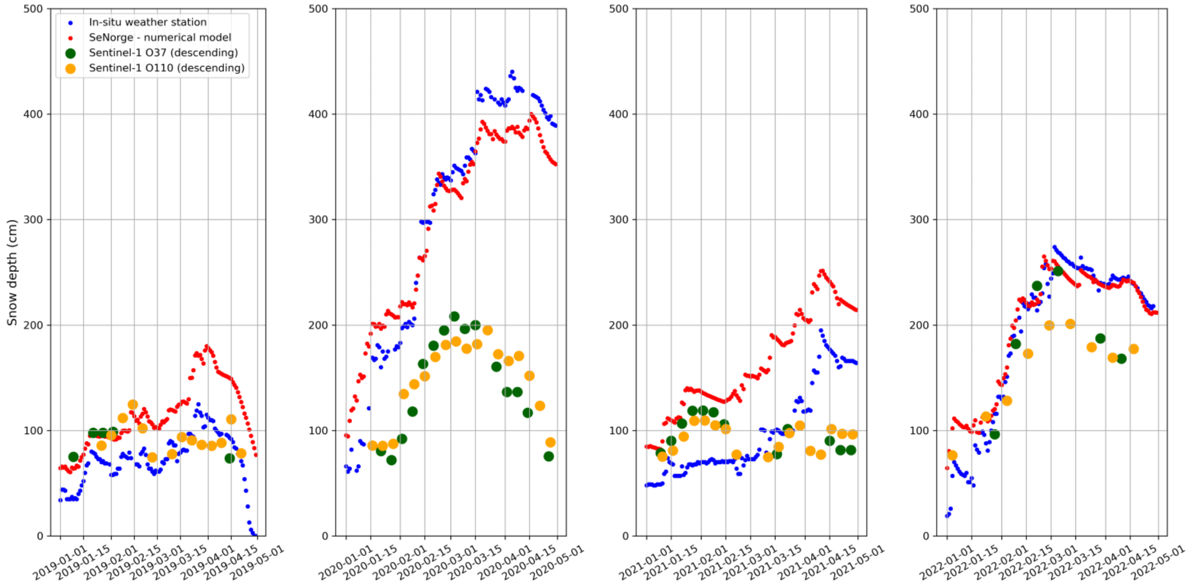
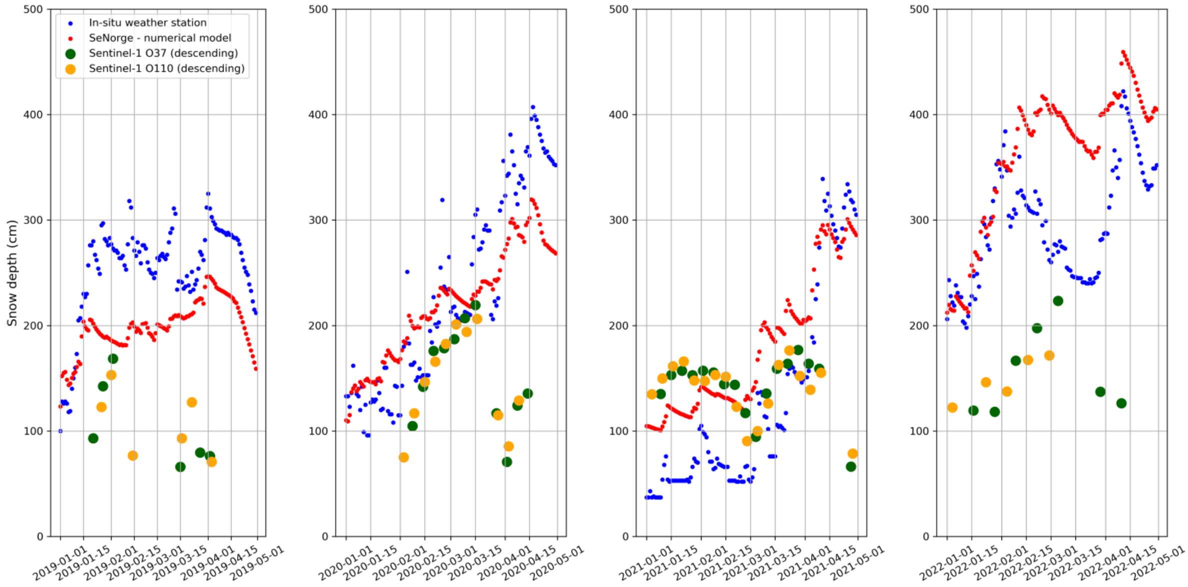
2022-04-15
2022-05-01

Rv13 Vikafjell



Mannen



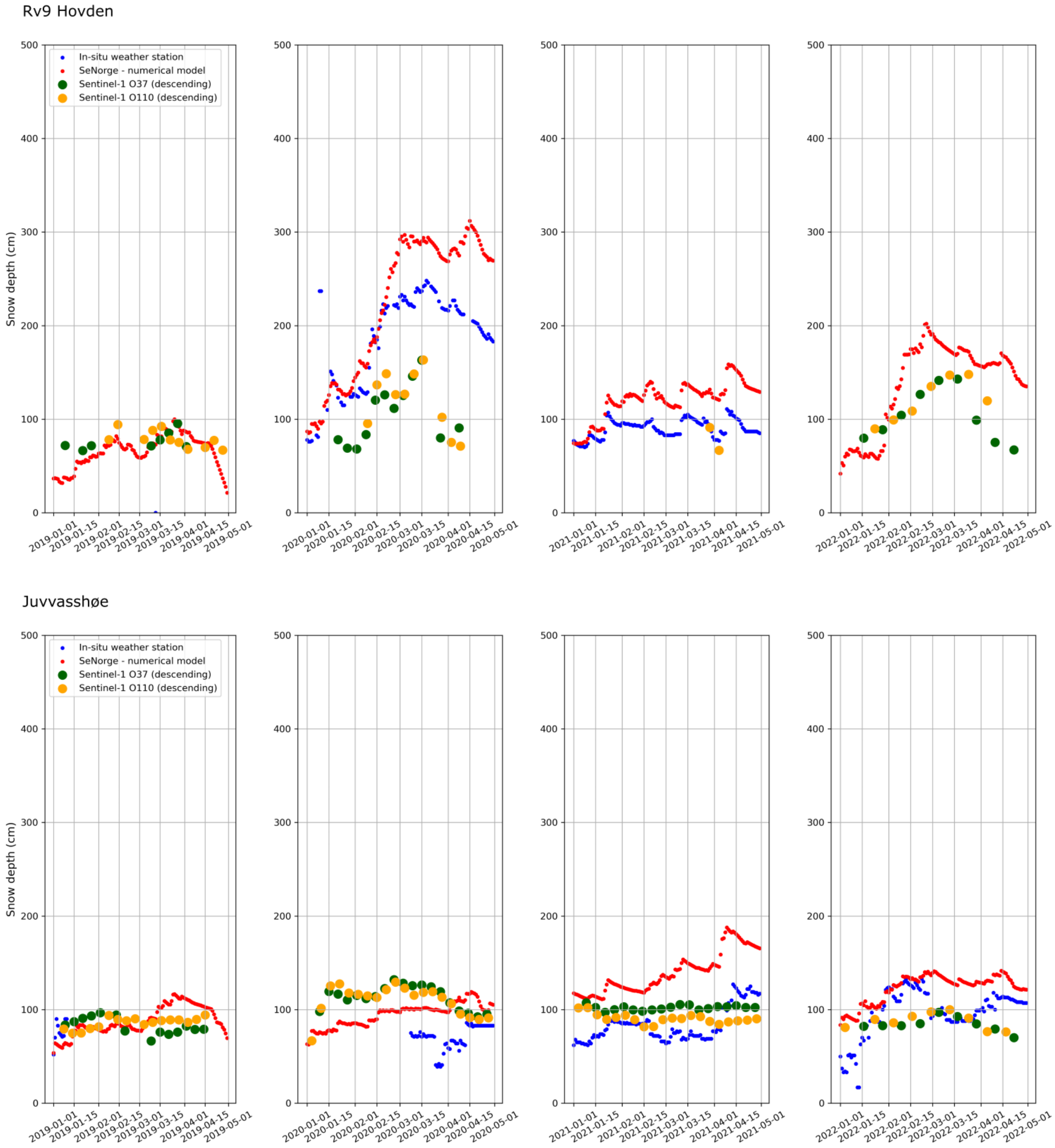


Figure S4: Comparison of snow depths at the location of 12 weather stations. Sentinel-1 decending orbits 37 and 110 are compared to SeNorge and weather stations.

S5 Field trip snow depth measurements

Table S1. In situ snow depth measurements from our field trip. 279 snow depths were measured between 2022-02-21 and 2022-02-25 at seven locations.

	Dyranut-1	Dyranut-2	Dyranut-3	Røldal-1	Røldal-2	Haukeli-1	Haukeli-2
No. of obs.	59	40	40	33	39	27	9

Mean (m)	1.21	1.06	0.95	1.72	2.57	2.26	1.55
Std. dev. (m)	0.65	0.52	0.41	0.33	0.57	0.64	0.19