Supplement of The Cryosphere, 15, 5115–5132, 2021
https://doi.org/10.5194/tc-15-5115-2021-supplement

The Cryosphere Open Access EGU

Supplement of

Supraglacial lake bathymetry automatically derived from ICESat-2 constraining lake depth estimates from multi-source satellite imagery

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Supplemental Tables and Figures.

Lakes Over Sermeq Kujalleq

Designation	**Ground track/spot**	**Min/Max Lat**	**Min/Max Lon**	**Max Lake Surface Area from imagery (m^2)**	**ICESat-2 track length (m)**	**ICESat-2 track Max depth**
RGT 727 May 15th, 2019						
Landsat: LC08_L1TP_009011_20190514_20190521						
1 Lake Julian Coincide with OIB	gt1l	68.707455 68.712048	-49.847328 -49.845716	160800	2754.44	3.95
Sentinel: T22WEB_20190512T151809 T22WEB_20190514T150921						
RGT 841 May 23rd						
Landsat: LC08_L1TP_010011_20190521_20190604_01_T1						
Sentinel: T22WEB_20190520T152911 T22WEB_20190525T152819						
1	gt1l_	68.616957 68.618372	-50.028838 -50.028284	357900	2398.82	1.31
PlanetScope: 2386345_2270816_2019-05-23_1035_BGRN_SR						
SkySat: 20190522_180624_ssc6d1_0087_analytic						
2 Lake Ayse	gt1l	68.647653 68.655258	-50.041117 -50.038496	880300	3092.19	4.50
PlanetScope: 2386345_2270816_2019-05-23_1035_BGRN_SR 2389698_2270816_2019-05-24_1002_BGRN_SR						
SkySat: 20190522_180624_ssc6d1_0082_analytic 20190522_180624_ssc6d1_0083_analytic						
3	gt1r	68.563169 68.568040	-50.009826 -50.008147	804873	2786.51	3.03
SkySat: 20190522_180624_ssc6d1_0092_analytic 20190522_180624_ssc6d1_0093_analytic						

4	gt1r	68.646358 68.656471	-50.039232 -50.035775	880300	3372.80	4.82
PlanetScope: 2386345_2270816_2019-05-23_1035_BGRN_SR 2389698_2270816_2019-05-24_1002_BGRN_SR						
SkySat: 20190522_180624_ssc6d1_0082_analytic 20190522_180624_ssc6d1_0083_analytic 20190522_180624_ssc6d1_0084_analytic						
5	gt3l	68.805579 68.808883	-49.931074 -49.929887	625127	2608.30	1.81
PlanetScope: 20190523_143311_1035_3B_AnalyticMS_SR 20190524_115042_0f46_3B_AnalyticMS_SR 20190524_115043_0f46_3B_AnalyticMS_SR						
SkySat: 20190522_180624_ssc6d1_0067_analytic						
RGT 1108 June 9th, 2019						
Landsat: LC08_L1TP_008012_20190608_20190619_01_T1						
1	gt1l	68.521802 68.531710	-48.870196 -48.866903	574200	3350.97	2.99
2	gt1r	68.521989 68.529861	-48.872277 -48.869664	574200	3123.05	1.51
SkySat: 20190608_152016_ssc2d3_0080_analytic 20190608_152016_ssc2d3_0081_analytic						
3	gt2l	68.729626 68.736651	-48.881484 -48.879153	596931	3026.49	2.99
SkySat: 20190608_152016_ssc2d3_0080_analytic 20190608_152016_ssc2d3_0081_analytic						
4	gt2l	68.845743 68.855759	-48.842804 -48.839477	956190	3360.29	2.18
SkySat: 20190608_152016_ssc2d3_0066_analytic 20190608_152016_ssc2d3_0067_analytic						

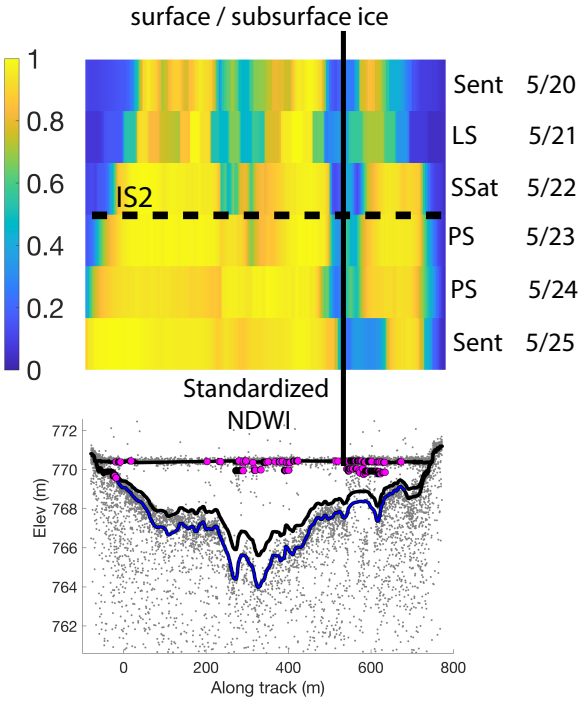
5	gt3l	68.587228 68.591745	-49.008428 -49.006958	772089	2746.55	1.95
SkySat: 20190608_152016_ssc2d2_0093_analytic 20190608_152016_ssc2d2_0094_analytic						
6	gt3l	68.562104 68.565898	-49.016567 -49.015336	54167	2665.72	1.51
SkySat 20190608_152016_ssc2d2_0096_analytic 20190608_152016_ssc2d2_0097_analytic						
7	gt3l	68.658882 68.667144	-48.985110 -48.982403	987300	3165.52	3.04
SkySat: 20190608_152016_ssc2d2_0085_analytic 20190608_152016_ssc2d2_0086_analytic						
8	gt3l_	68.624851 68.633176	-48.996200 -48.993466	738000	3172.79	3.52
SkySat: 20190608_152016_ssc2d2_0089_analytic 20190608_152016_ssc2d2_0090_analytic						
9	gt3l	68.839747 68.843797	-48.925694 -48.924355	1165500	2691.53	0.81
SkySat: 20190608_152016_ssc2d2_0064_analytic 20190608_152016_ssc2d2_0065_analytic						
10	gt3r	68.659000 68.665508	-48.987365 -48.985236	987300	2968.48	2.42
SkySat: 20190608_152016_ssc2d2_0085_analytic 20190608_152016_ssc2d2_0086_analytic						
11	gt3r	68.625432 68.634258	-48.998301 -48.995422	738000	3228.69	3.22
SkySat: 20190608_152016_ssc2d2_0089_analytic 20190608_152016_ssc2d2_0090_analytic						
RGT 1169 June 13th, 2019						
Landsat: LC08_L1TP_008011_20190608_20190619_01_T1						

1	gt1l	69.284828 69.286312	-49.389595 -49.389018	158400	2885.59	1.64
Sentinel: T22WEB_20190619T152911						
2	gt1l	69.274398 69.277766	-49.393229 -49.391994	513200	2455.54	2.58
Sentinel: T22WEB_20190619T152911						
3	gt1l	69.352096 69.357914	-49.366099 -49.363984	224100	2396.62	1.33
Sentinel: T22WEB_20190619T152911 T22WEC_20190616T151911						
4	gt1l	69.498031 69.500010	-49.314688 -49.313908	478100	3307.89	1.50
Sentinel: T22WEC_20190616T151911						
5	gt1l	69.543649 69.545104	-49.298510 -49.297920	904600	2817.40	4.39
Sentinel: T22WEC_20190616T151911						
6	gt1r	69.759632 69.769272	-49.223378 -49.219881	904600	2720.19	5.28
Sentinel: T22WEC_20190616T151911						
7 Lake Cecily	gt3r	69.432711 69.437927	-49.506539 -49.504628	1113500	3698.78	2.40
Sentinel: T22WEC_20190616T151911						
SkySat: 20190614_003736_ssc1d1_0070_analytic						
8 Lake Cecily	gt3l	69.433379 69.437723	-49.503956 -49.502329	1113500	2401.77	1.34
Sentinel: T22WEC_20190616T151911						
SkySat: 20190614_003736_ssc1d1_0070_analytic						
9	gt3l	69.811377 69.824516	-49.371724 -49.367008	1113500	2612.26	1.63
Sentinel: T22WEC_20190616T151911						

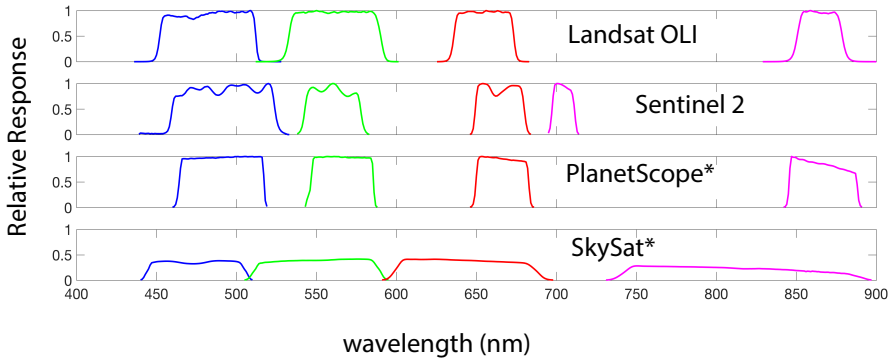
RGT 1222 June 17th, 2019						
Landsat: LC08_L1TP_007012_20190617_20190620_01_T1						
1	gt1l	68.456170 68.464562	-48.939912 -48.937145	2060100	3134.91	3.62
2	gt1l	68.620541 68.643170	-48.999022 -48.991496	48600	2618.15	1.70
3	gt1l	68.704751 68.719064	-49.024388 -49.019587	1635300	4089.09	8.93
4	gt1l	68.811525 68.814417	-49.056461 -49.055466	255600	2718.01	1.23
5	gt1r	68.620741 68.641831	-48.996396 -48.989386	1635300	4129.21	10.62
6	gt1r	68.705881 68.713877	-49.020457 -49.017786	1692900	2679.53	1.50
7	gt1r	68.810934 68.814324	-49.054218 -49.053076	2225700	3181.78	3.89
8	gt2l	68.427765 68.444251	-48.853795 -48.848446	1611900	4443.29	11.43
9	gt2l	68.808374 68.812653	-48.975070 -48.973635	998574	2541.70	2.14
10	gt2r	68.428276 68.445114	-48.851875 -48.846413	998574	2802.32	1.70
11	gt2r	68.523066 68.526979	-48.878531 -48.877251	1025100	3193.46	2.86
SkySat: 20190616_144210_ssc4d2_0122_analytic 20190616_144210_ssc4d2_0123_analytic 20190616_144210_ssc4d2_0124_analytic 20190617_152915_ssc1d2_0122_analytic 20190617_152915_ssc1d2_0123_analytic						
12	gt3l	68.443954 68.463598	-48.780603 -48.774288	1611900	4210.25	11.55
13	gt3l	68.621338 68.624034	-48.832513 -48.831615	1025100	3860.27	1.59

14 Lake Zadie	gt3l	68.731742 68.736769	-48.869345 -48.867678	4101300	4774.88	11.49
SkySat: 20190616_144210_ssc4d3_0092_analytic 20190616_144210_ssc4d3_0093_analytic						
15	gt3l	68.837005 68.845532	-48.905172 -48.902345	2060100	3842.27	3.08
16	gt3r	68.445097 68.462664	-48.778073 -48.772433	998574	2562.81	0.35
17	gt3r	68.835768 68.850254	-48.904473 -48.899674	4101300	4602.40	10.64
18	gt3l	69.614426 69.630295	-49.172278 -49.166720	5656500	4005.92	6.13
Landsat: LC08_L1TP_008011_20190608_20190619_01_T1						
Sentinel: T22WEC_20190616T151911						
19	gt3l	69.645719 69.651690	-49.179791 -49.177687	2982600	2899.97	1.70
Landsat: LC08_L1TP_008011_20190608_20190619_01_T1						
Sentinel: T22WEC_20190616T151911						

Table S1: Lakes used in this study noting Lake number, ICEsat-2 details (RGT/ground track/spot), maximum latitude and longitude boundaries for the lake, maximum surface area of the lake detected from imagery and the length of the ICESat-2 pass over the lake. Concurrent imagery sources with unique identifiers are shown below each lake (with imagery associated with the full RGT noted blow each RGT/date designation).. Lake numbers correspond to profiles shown in Supplemental Figure 3.



(a) Lake Amitav NDWI



(b) Spectral Response

Figure S1: (a) Watta calculated profile of depth, depth corrected for refraction and subsurface ice over Lake Amitav (bottom) with NDWI values co-registered to the ICESat-2 track (top) (b) Spectral Response curve for imagery sources used in main text. Note that PlanetScope and SkySat data are shown for the satellite used in imagery collected over Lake Amitav and are not representative of the entire constellation. Landsat OLI source (Barsi et al., 2014)., Sentinel-2 source (https://earth.esa.int/web/sentinel/user-guides/sentinel-2-msi), Planet Labs SkySat and PlanetScope (see: support.planet.com)

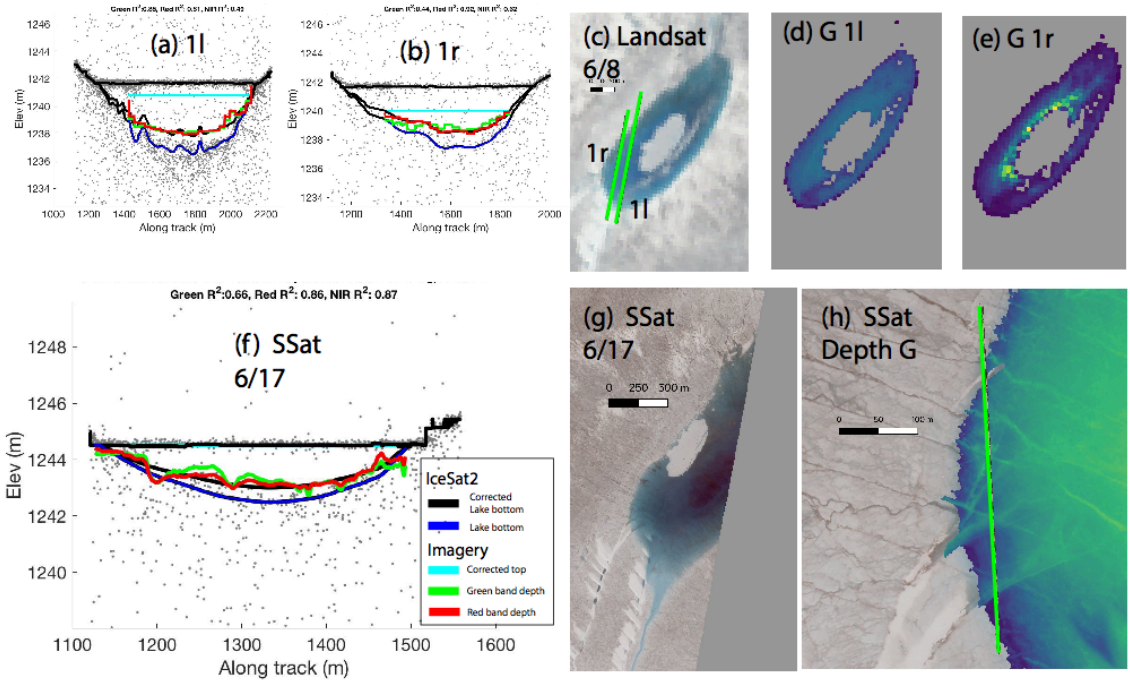


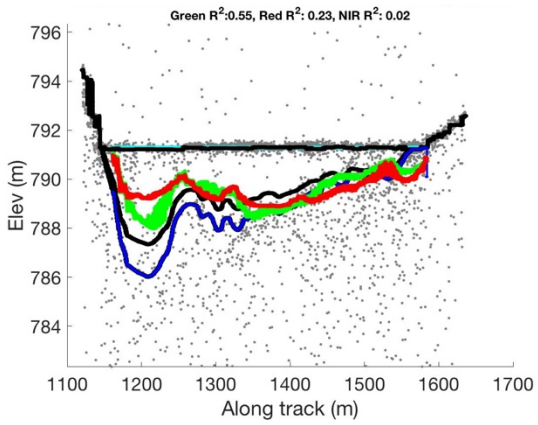
Figure S2: Watta-calculated depth, corrected depth and lake surface profiles for (top) RGT 1108 Lake 1 on June 9th, 2019, with gt1l (a,d) and gt1r (b,e). Landsat imagery collected on June 8th, 2019. (bottom) The same lake, also RGT 1222 Lake 6 on June 17th, 2019 (f-h), with SkySat imagery collected on June 17th, 2019.

Figure: S3. Lake Depth Profiles (corresponding to Table S1)

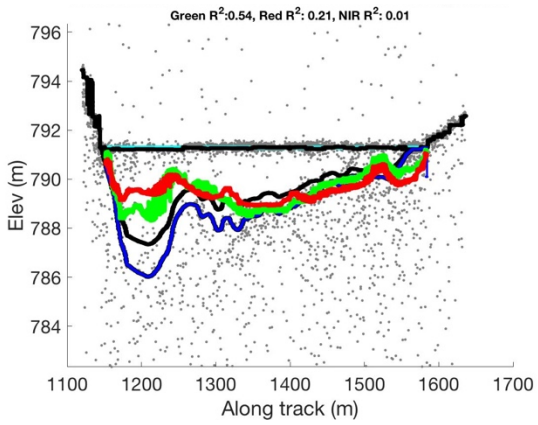
RGT 727 **May 15th, 2019**

Lake 1:

Sentinel-2: May 12th, 2019



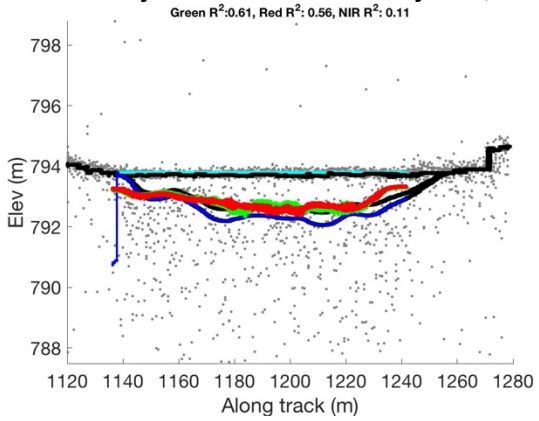
Sentinel-2: May 14th, 2019



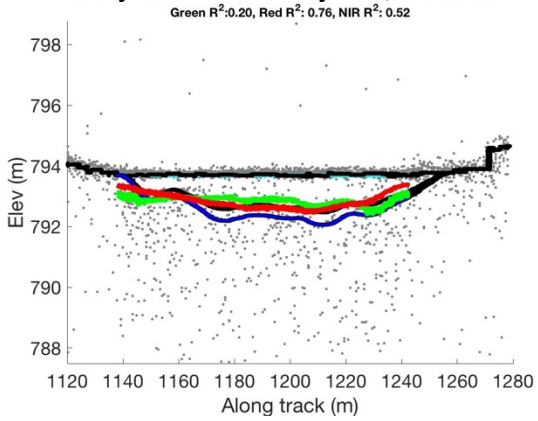
RGT 841 **May 23rd, 2019**

Lake 1

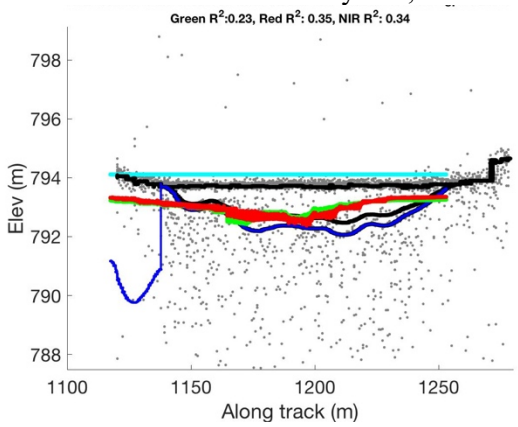
SkySat May 22nd, 2018



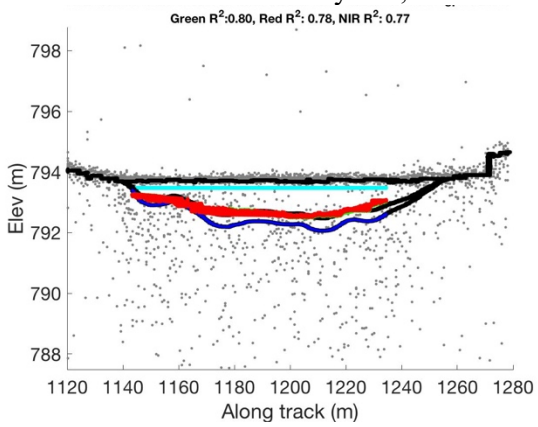
SkySat: May 23rd, 2019



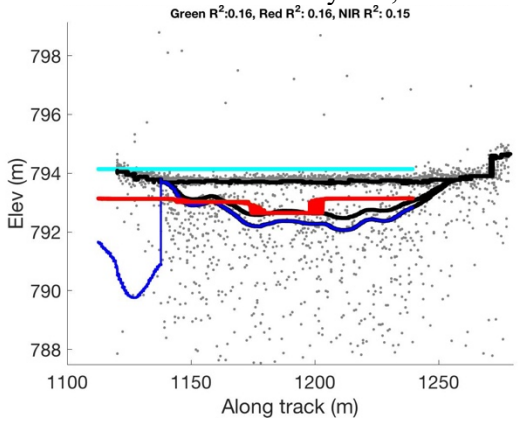
Sentinel-2 : May 25th, 2019



Sentinel-2 : May 20th, 2019

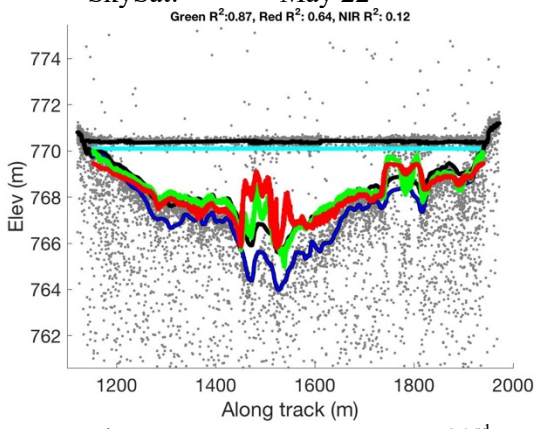


Landsat :May 21st, 2019

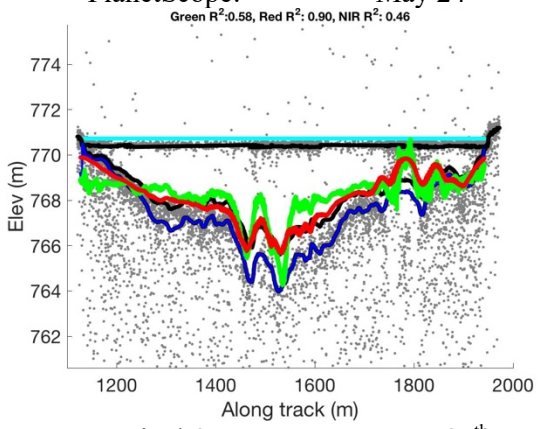


Lake 2:

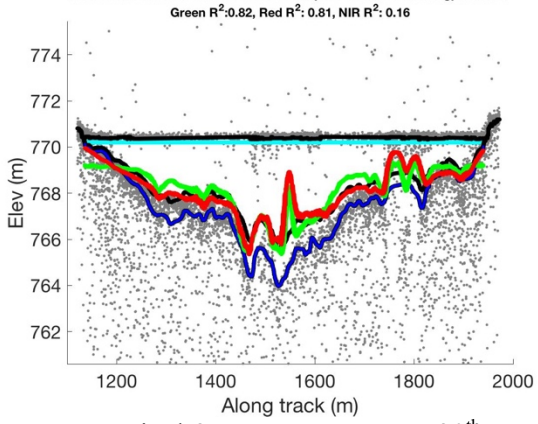
SkySat: May 22nd



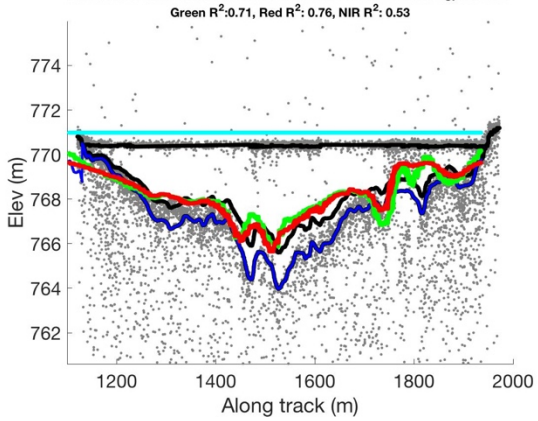
PlanetScope: May 24th



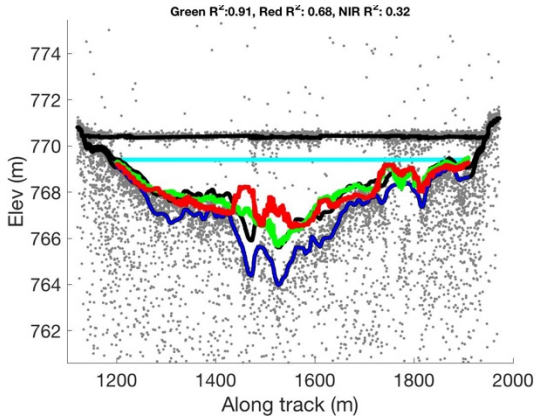
PlanetScope :May 23rd



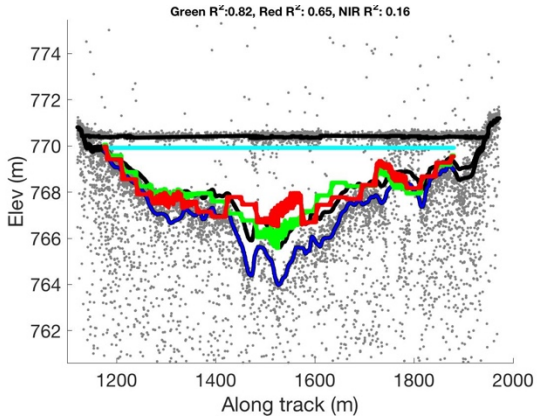
Sentinel-2 :May 25th



Sentinel-2 May 20th

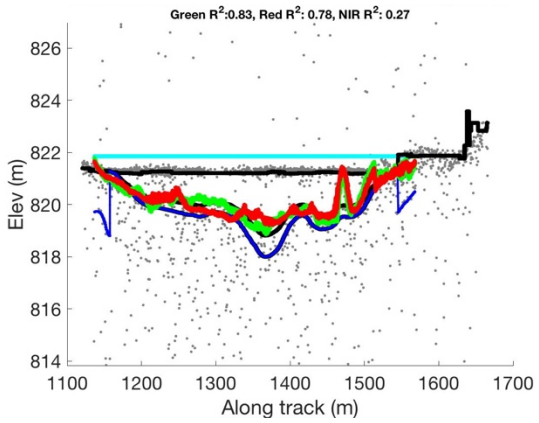


Landsat :May 21st

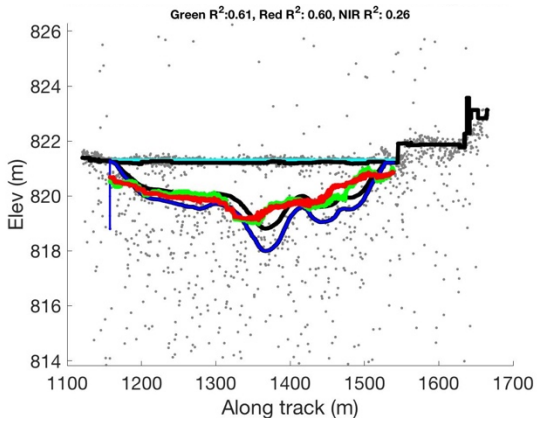


Lake 3:

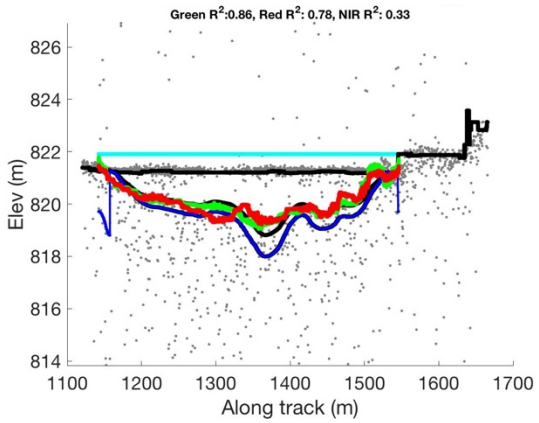
SkySat: May 22nd



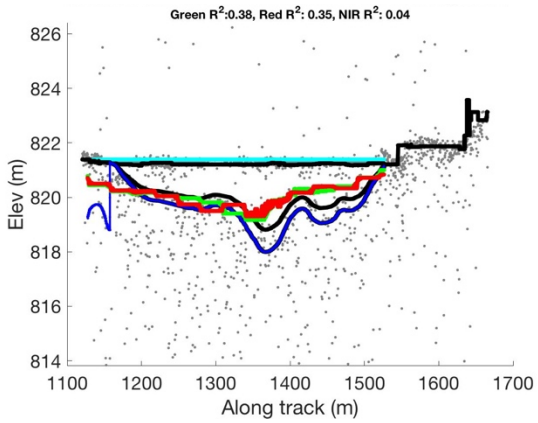
Sentinel-2 May 25th



Sentinel-2 May 20th

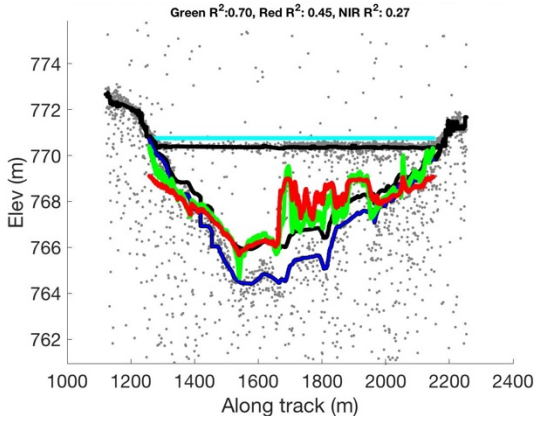


Landsat May 21st

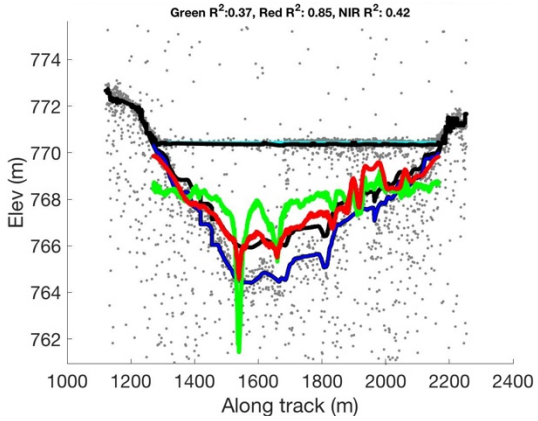


Lake 4:

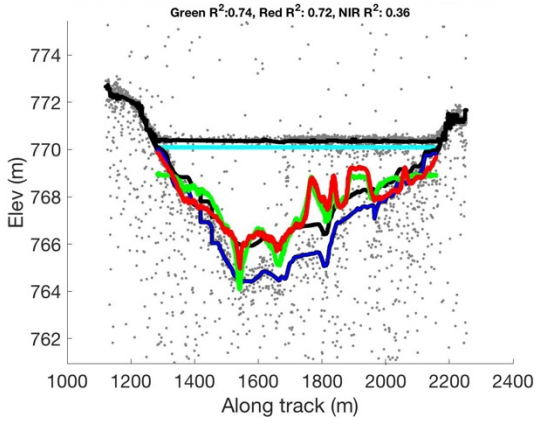
SkySat May 22nd



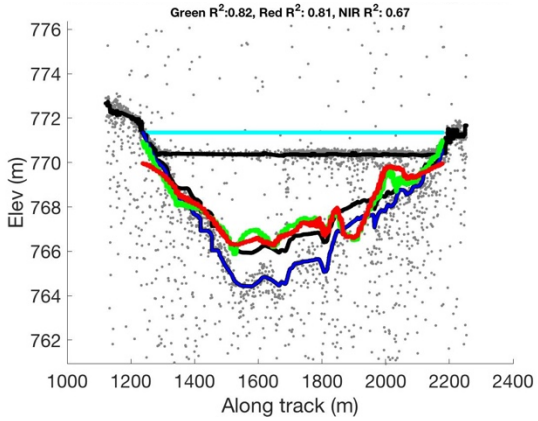
PlanetScope May 24th



PlanetScope May 23rd

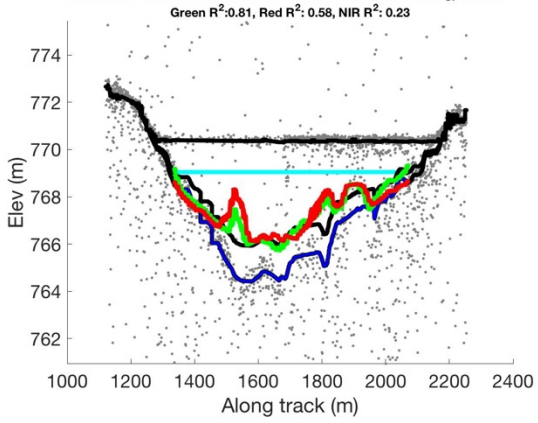


Sentinel-2 May 25th

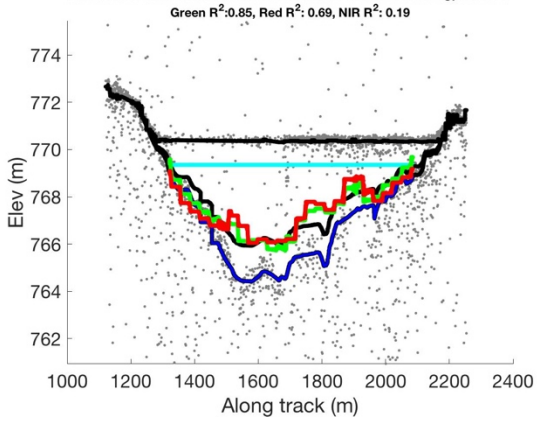


s

Sentinel-2 May 20th

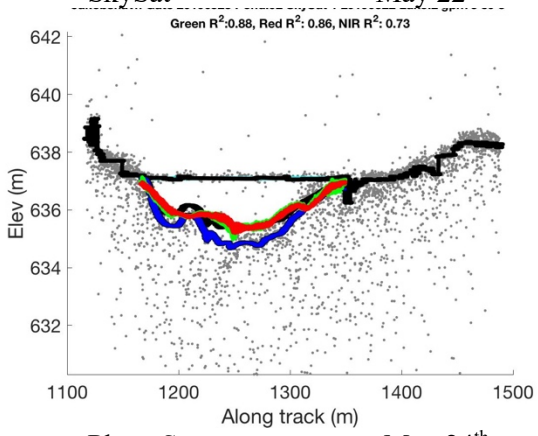


Landsat May 21st

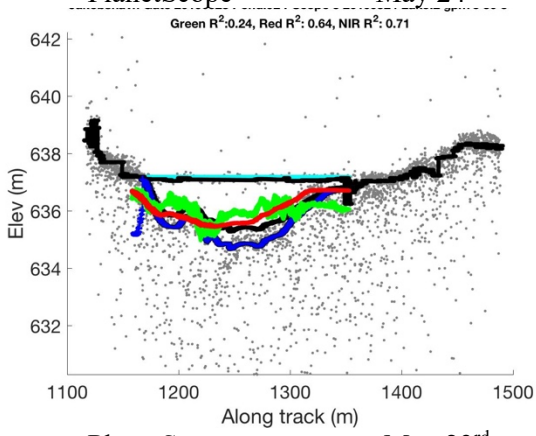


Lake 5:

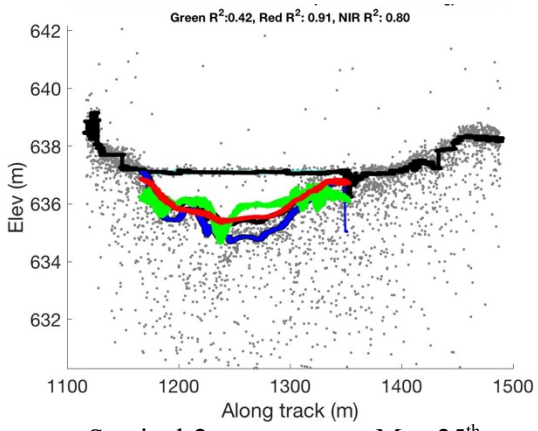
SkySat May 22nd



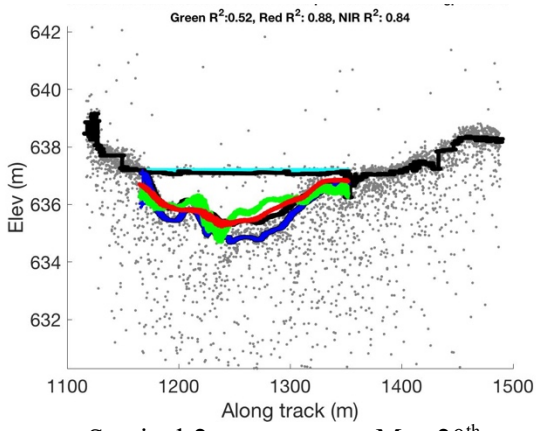
PlanetScope May 24th



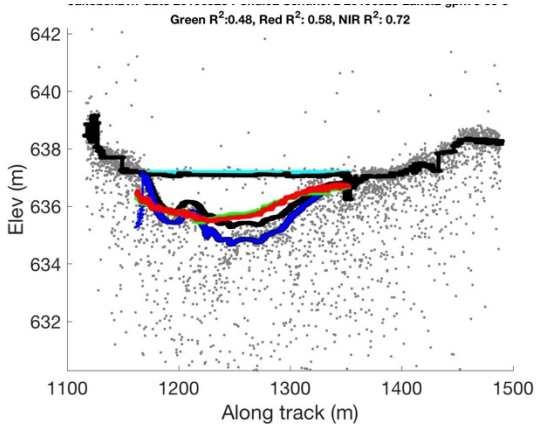
PlanetScope :May 24th



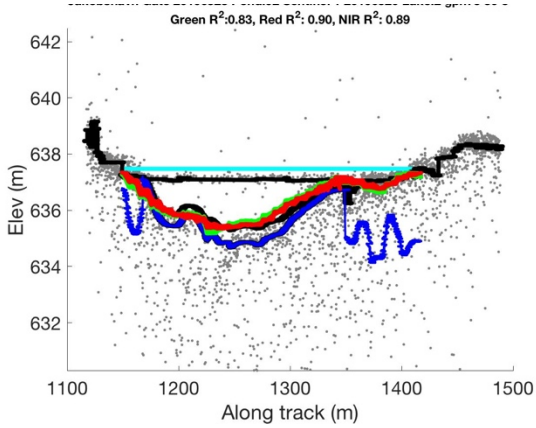
PlanetScope :May 23rd



Sentinel-2 May 25th

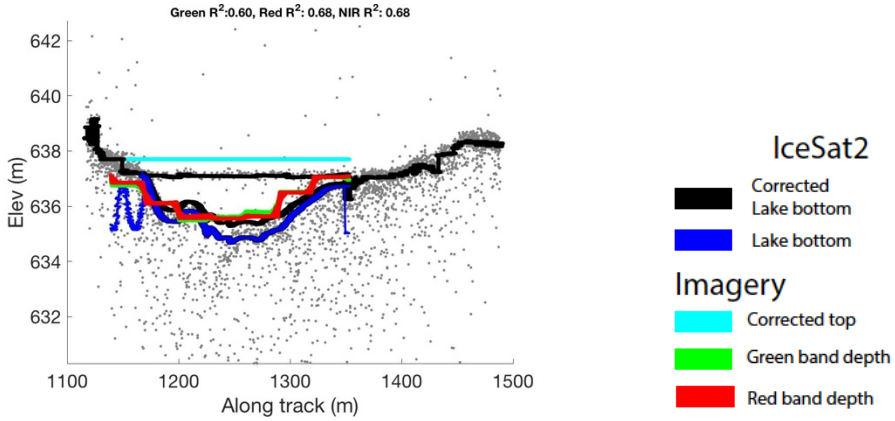


Sentinel-2 May 20th



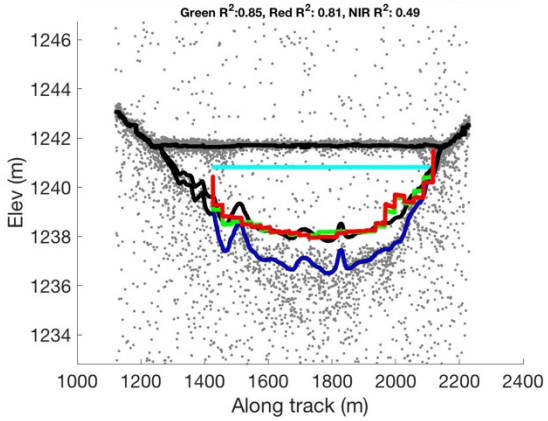
Lake 5 **cont…**

Landsat May 23rd



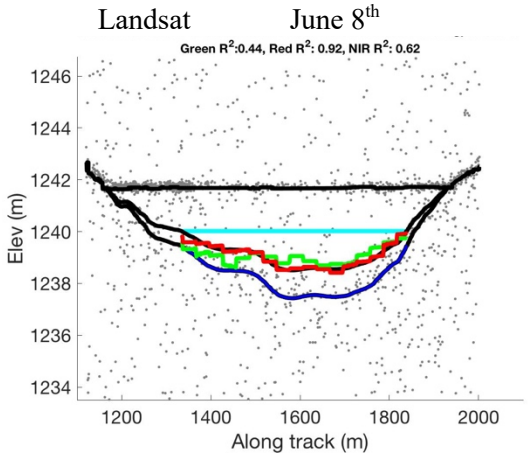
Lake 1

Landsat June 8th



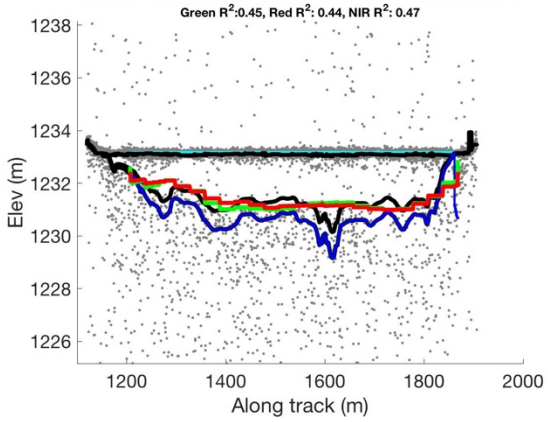
Lake 2:

Landsat June 8th

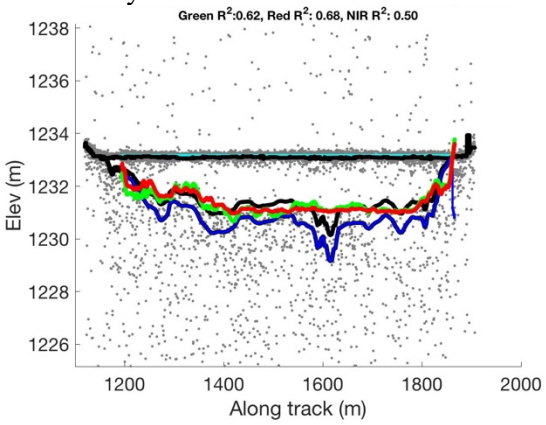


Lake 3:

Landsat June 8th

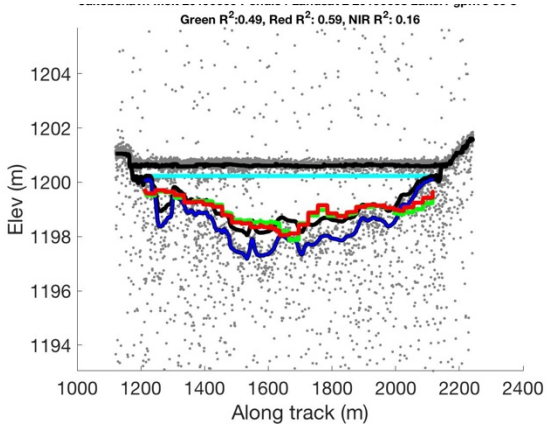


SkySat June 8th

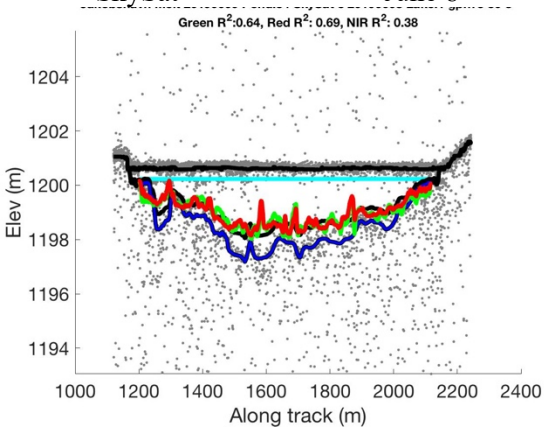


Lake 4

Landsat June 8th

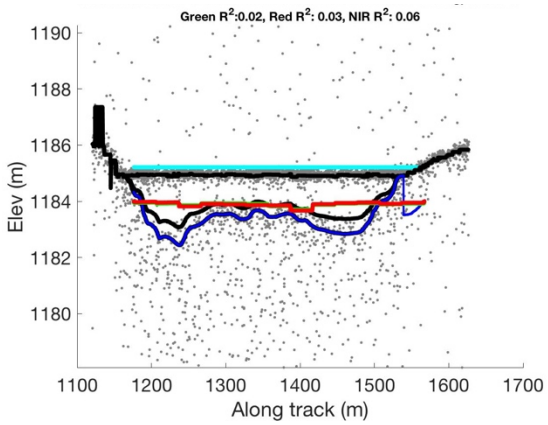


SkySat June 8th

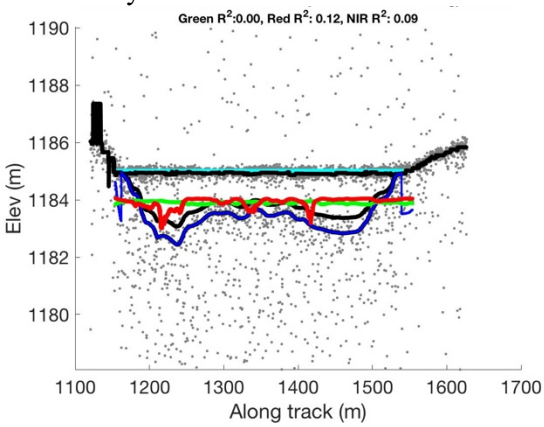


Lake 5

Landsat June 8th

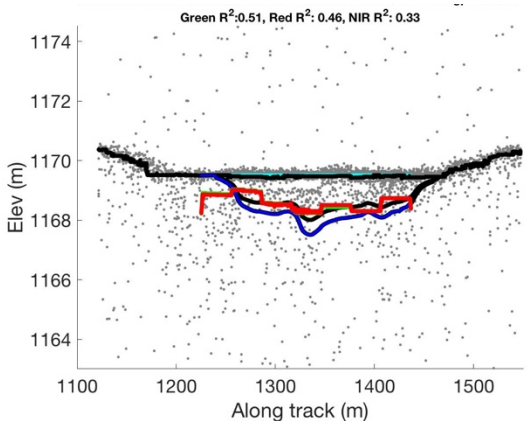


SkySat June 8th

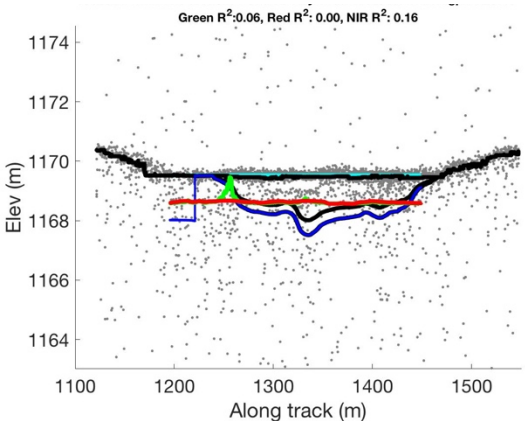


Lake 6

Landsat June 8th

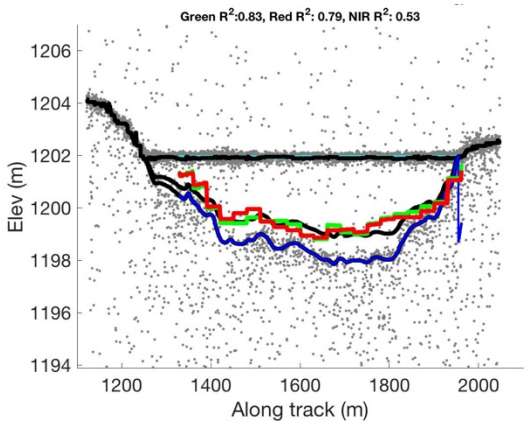


SkySat June 8th

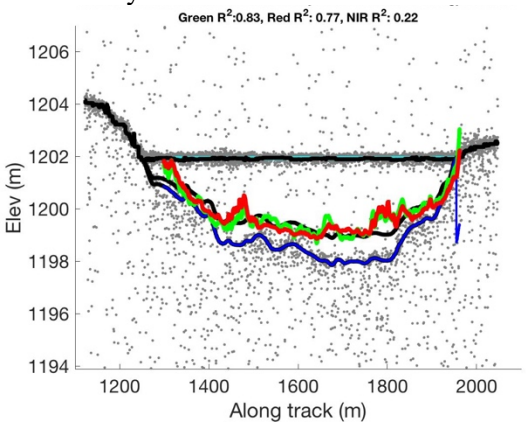


Lake 7

Landsat June 8th

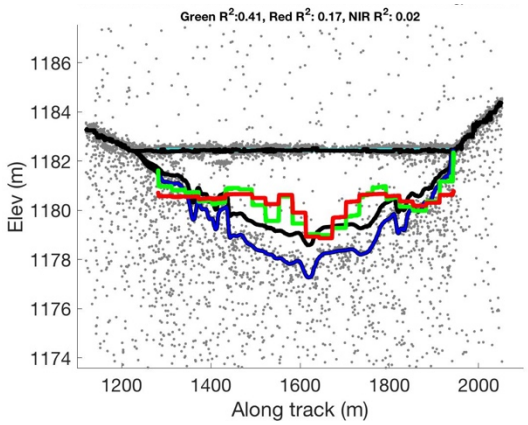


SkySat June 8th



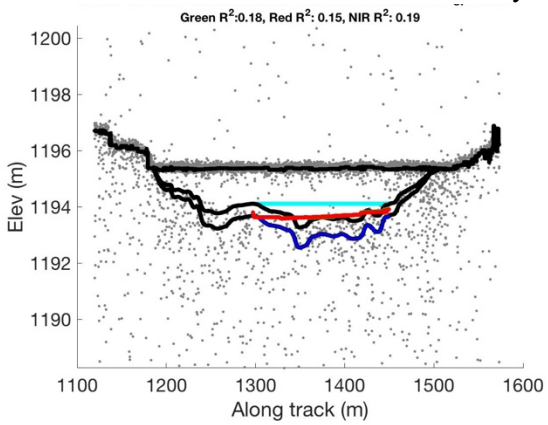
Lake 8

Landsat June 8th

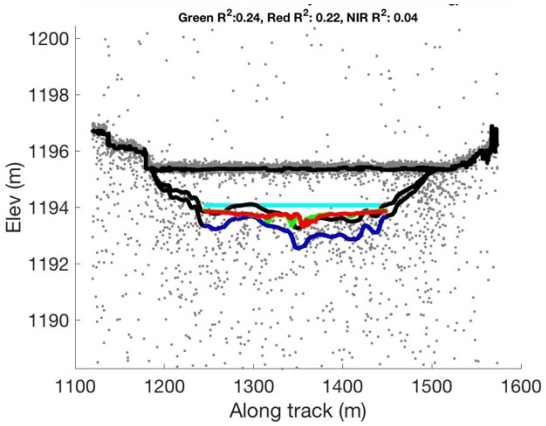


Lake 9

Landsat June 8th

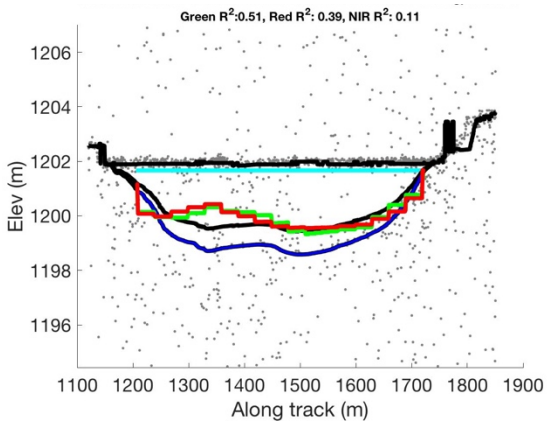


SkySat June 8th

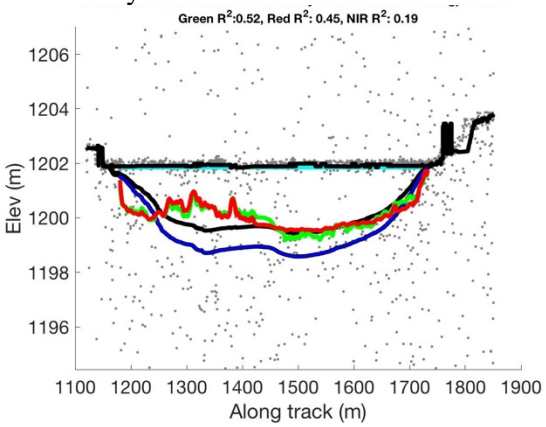


Lake 10

Landsat June 8th

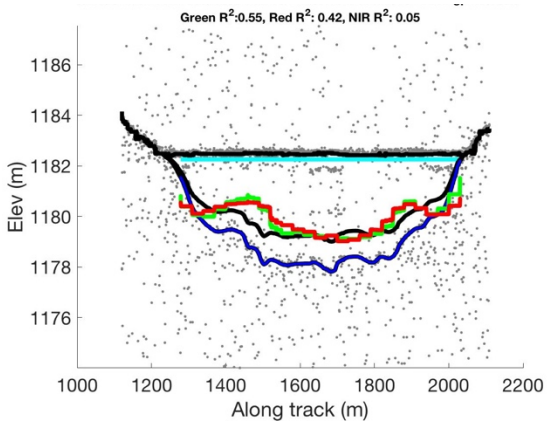


SkySat June 8th



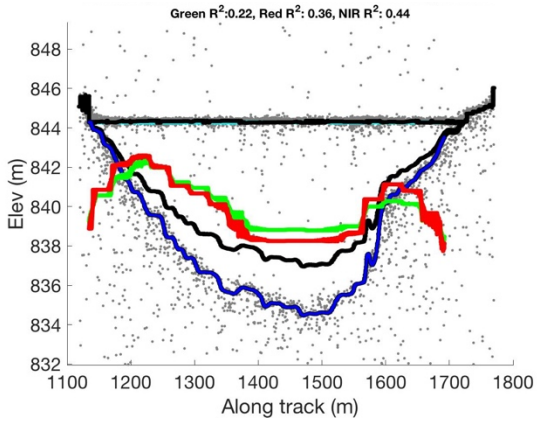
Lake 11

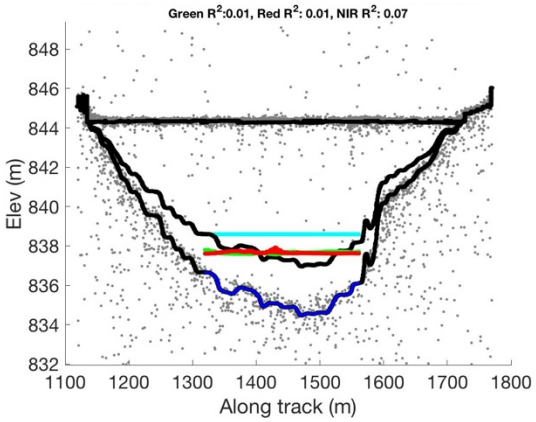
Landsat June 8th



Lake 1

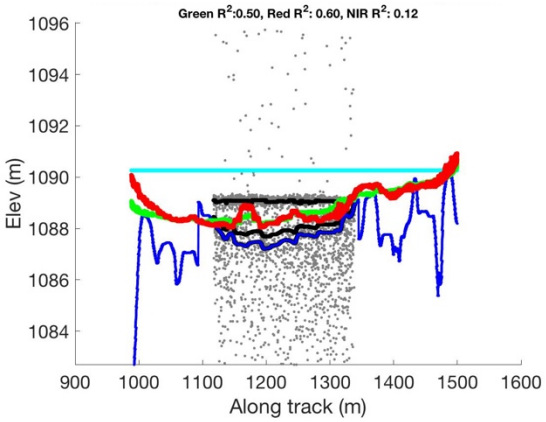
Landsat June 8th Sentinel-2 June 16th





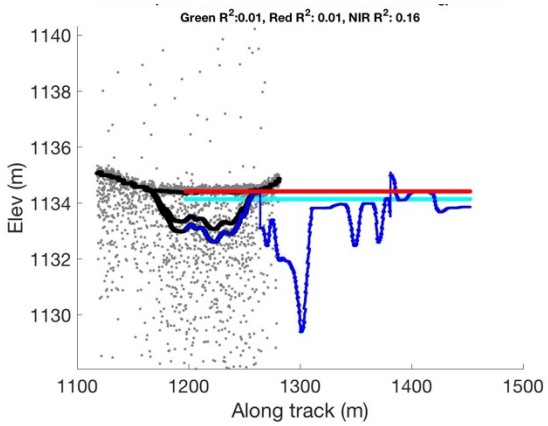
Lake 2

Sentinel-2 June 16th

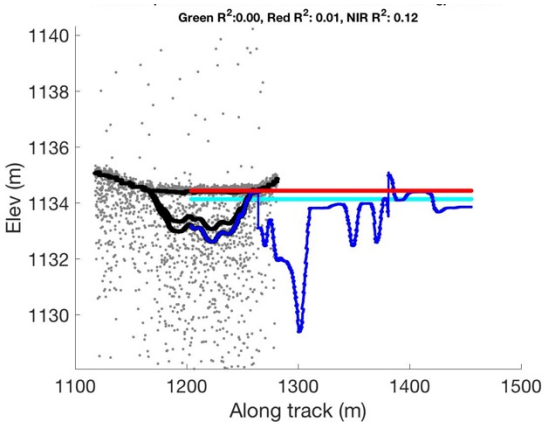


Lake 3

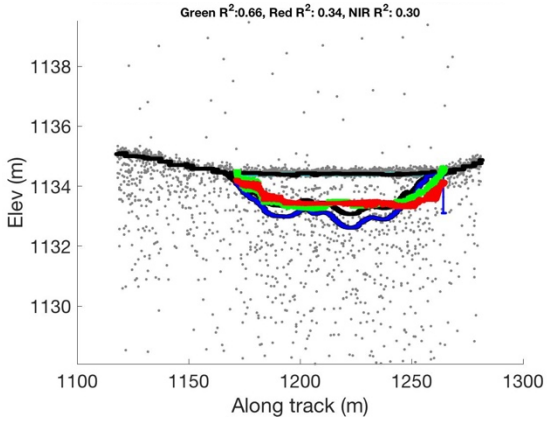
Landsat June 8th



Landsat June 8th

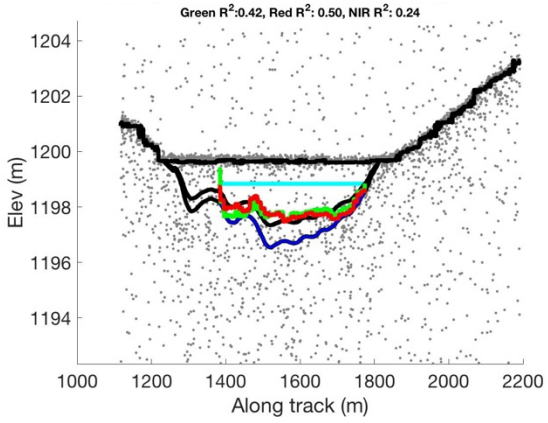


Sentinel June 16th



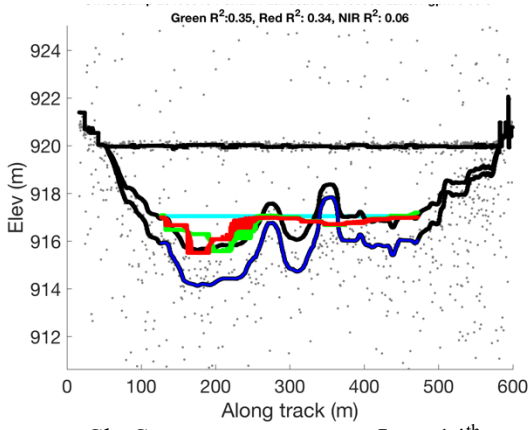
Lake 4

Sentinel-2 June 16th

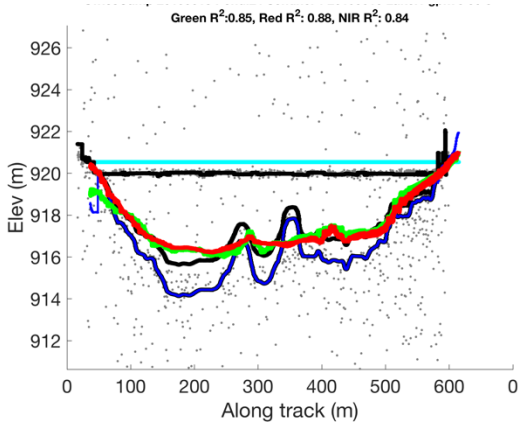


Lake 5

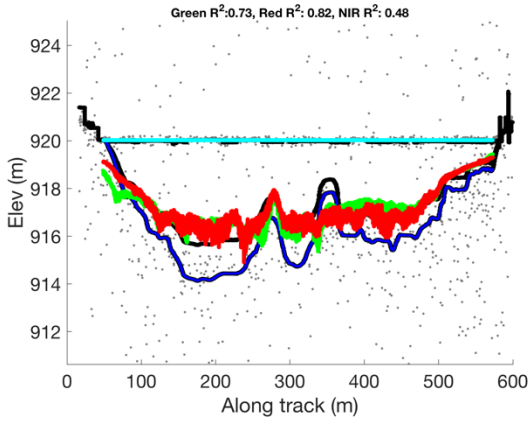
Landsat June 8th



Sentinel-2 June 16th

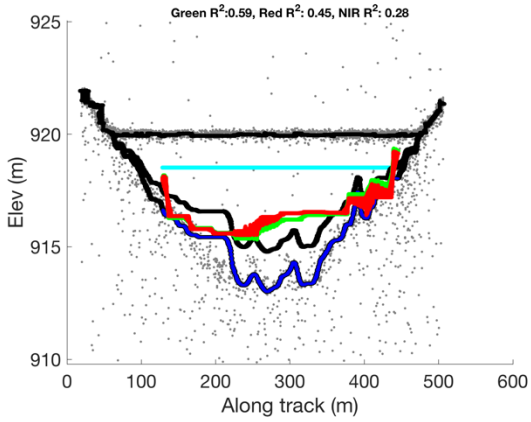


SkySat: June 14th

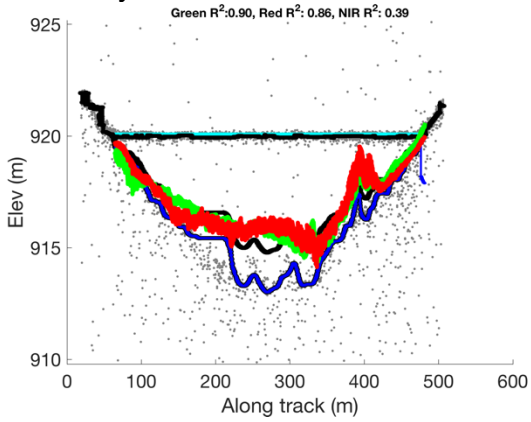


Lake 6

Landsat June 8th

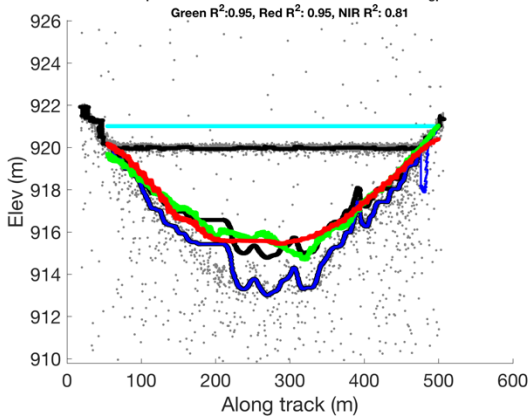


SkySat June 14th



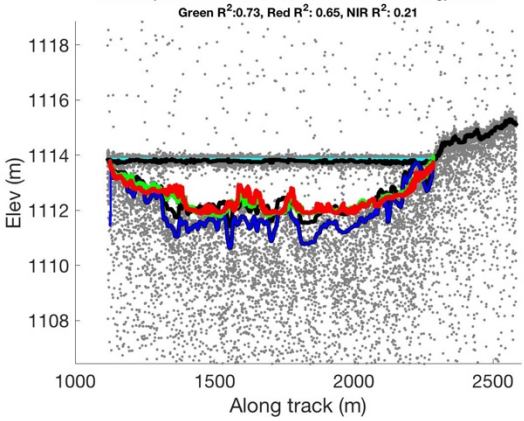
Lake 6 cont…

Sentinel-2 June 16th



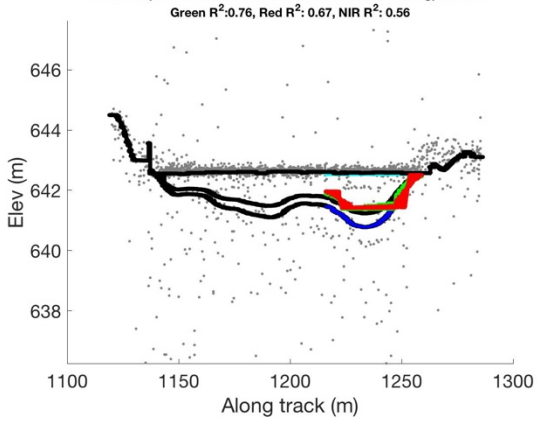
Lake 7

Sentinel-2 June 16th

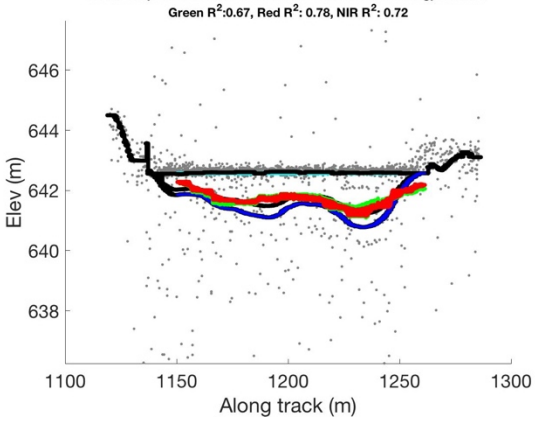


Lake 8

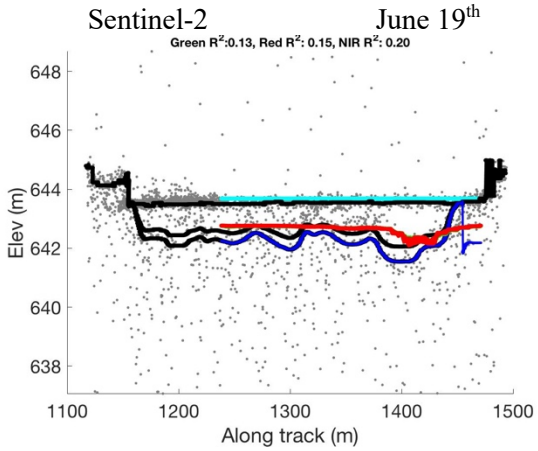
Landsat: June 8th



Sentinel-2 June 19th

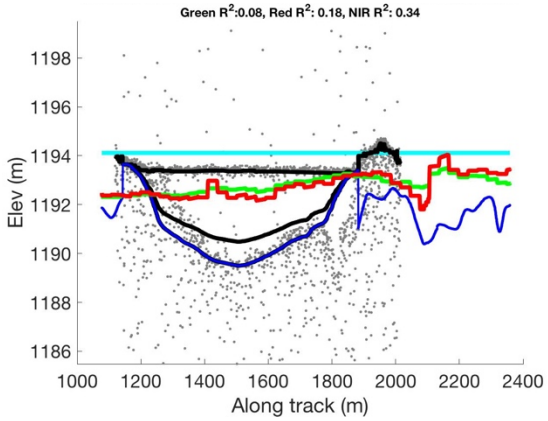


Lake 9


Sentinel-2 June 19th
Green R²:0.13, Red R²: 0.15, NIR R²: 0.20
Elev (m)
Along track (m)
648
646
644
642
640
638
1100
1200
1300
1400
1500

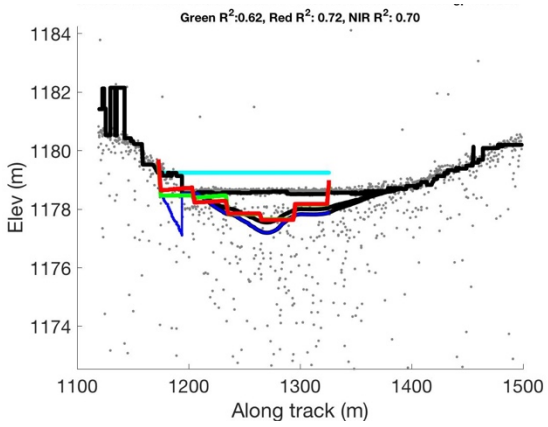
Lake 1

Landsat June 17th



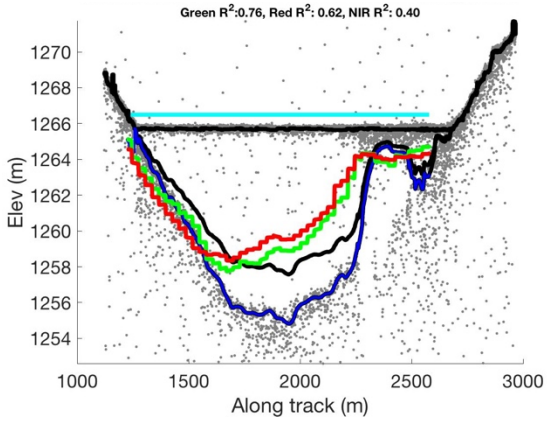
Lake 2

Landsat June 17th



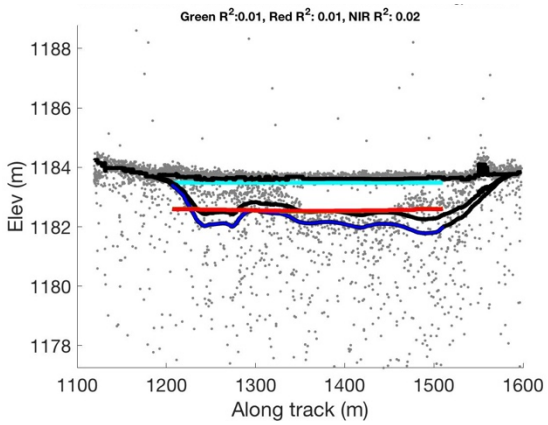
Lake 3

Landsat June 17th



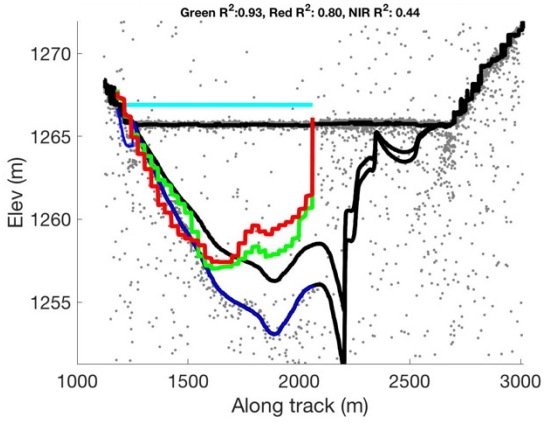
Lake 4

Landsat June 17th



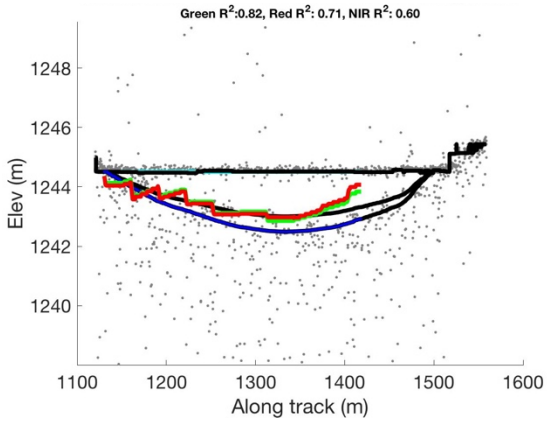
Lake 5:

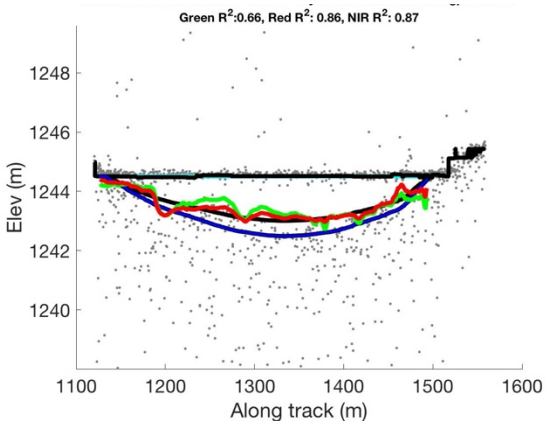
Landsat June 17th



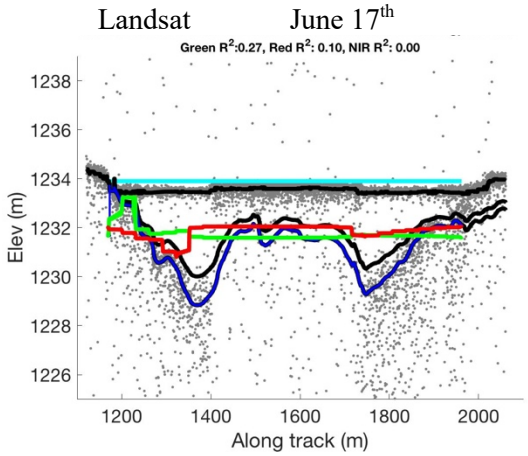
Lake 6

Landsat June 17th SkySat June 17th

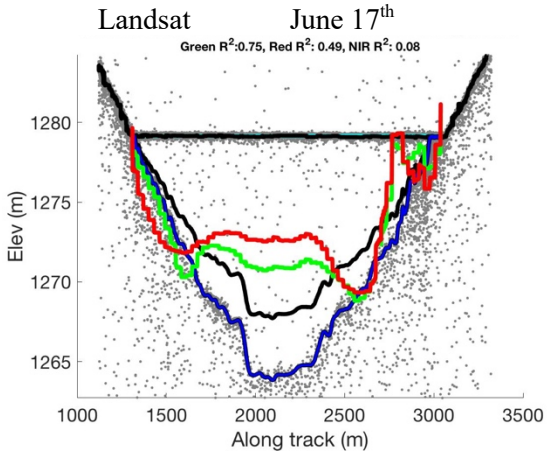




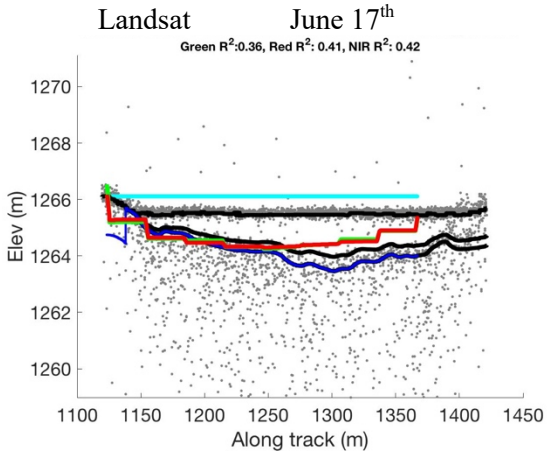
Lake 7:



Lake 8:

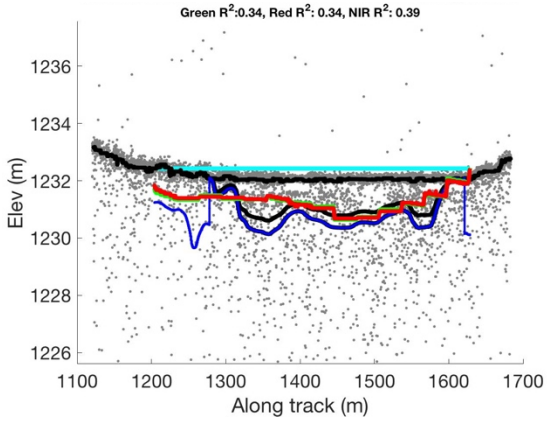


Lake 9:

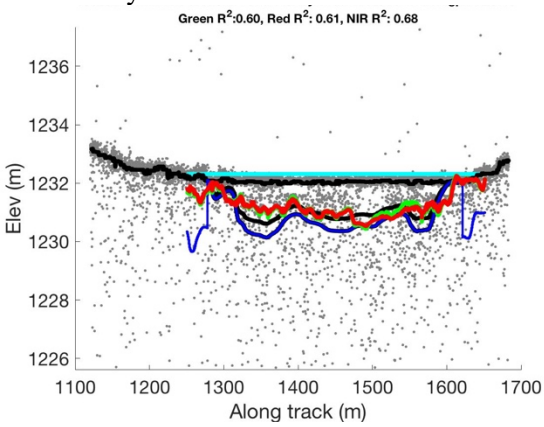


Lake 10

Landsat June 17th

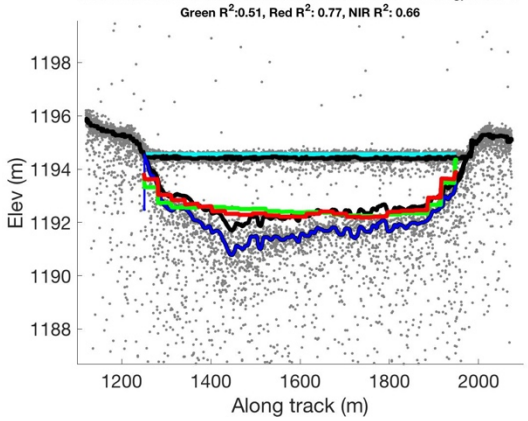


SkySat June 16th



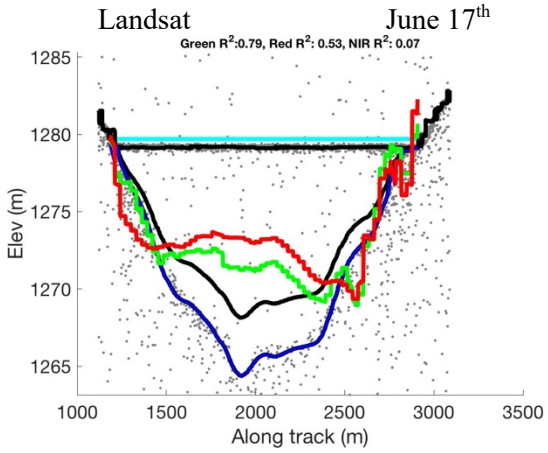
Lake 11

Landsat June 17th



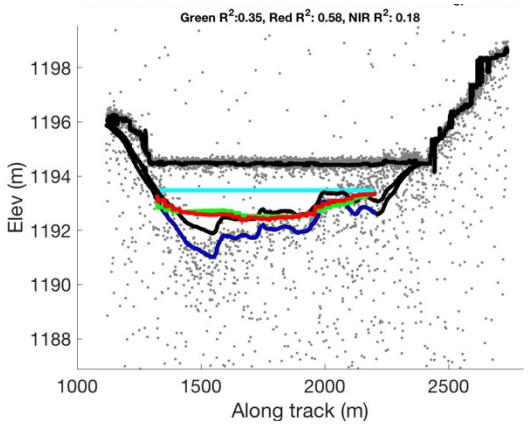
Lake 12

Landsat June 17th



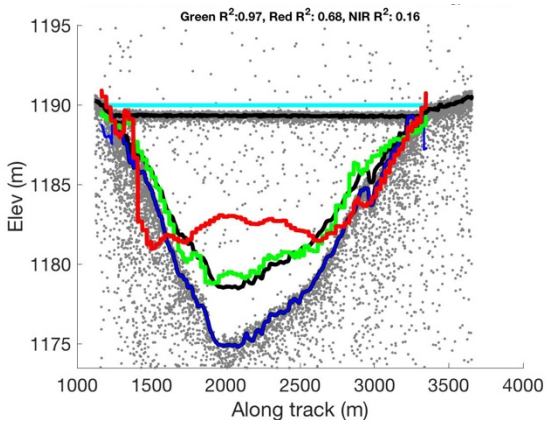
Lake 13

Landsat June 17th



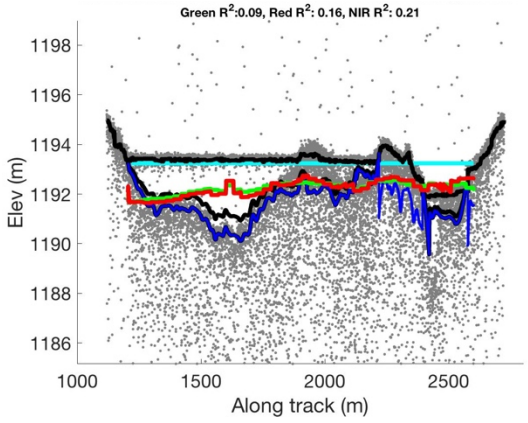
Lake 14

Landsat June 17th



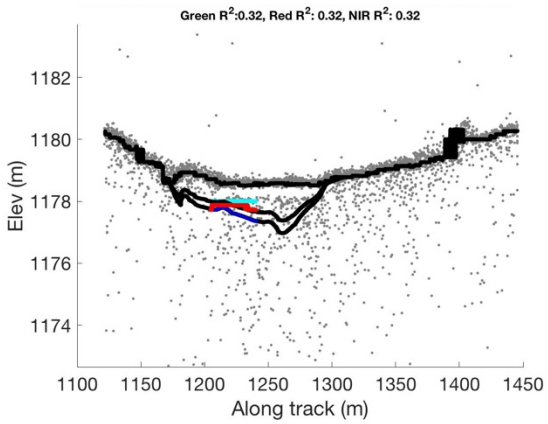
Lake 15

Landsat June 17th



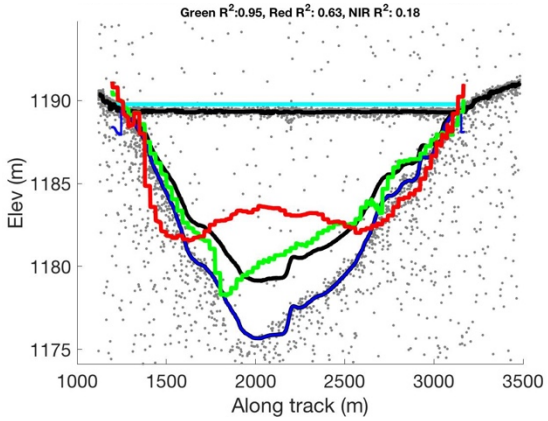
Lake 16

Landsat June 17th



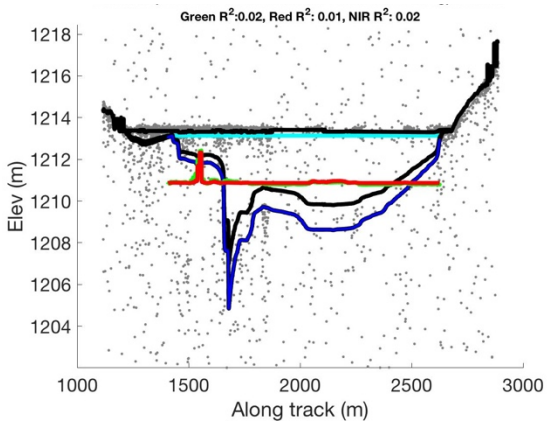
Lake 17

Landsat June 17th



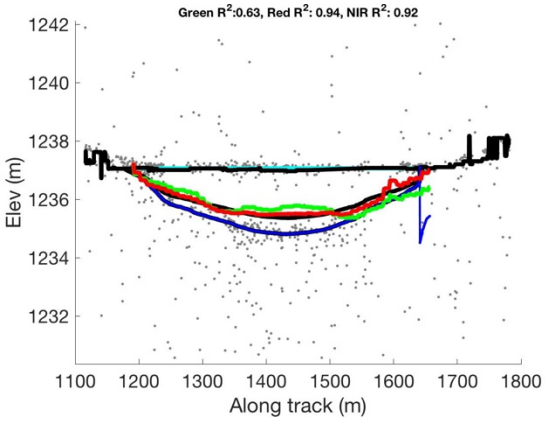
Lake 18

Sentinel-2 June 16th



Lake 19

Sentinel-2 June 16th



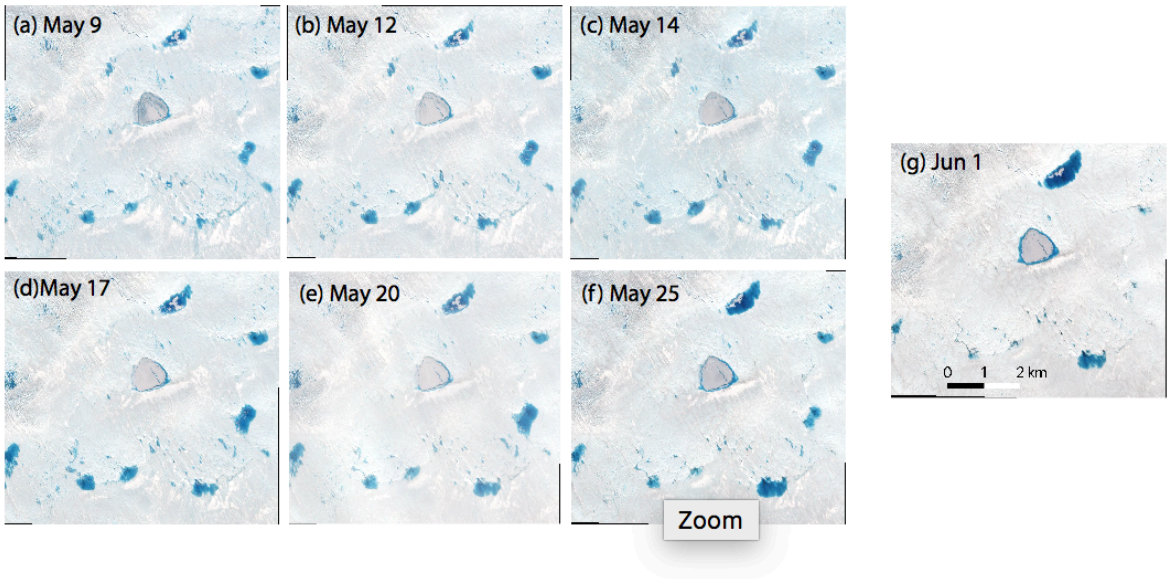


Figure S4: Lake evolution throughout the season in region of Western Greenland (see Fig. 1 in main) from Sentinel-2 imagery. Surface water extent (where NDWIice > 0.2) remains consistent at 3%

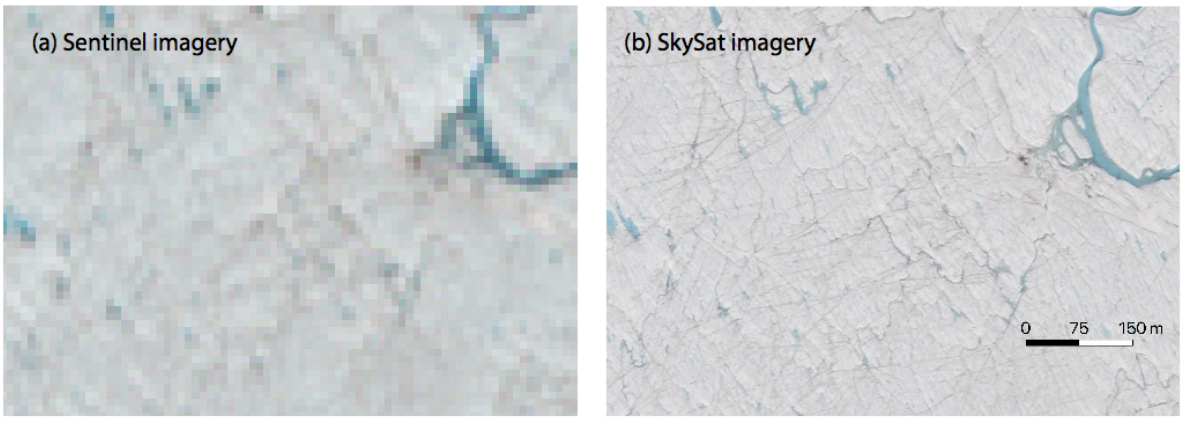


Figure S5: Higher resolution imagery capturing small-scale stream features on June 1st in Western Greenland. (a): Sentinel-2 imagery (10m) (b): SkySat imagery