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A satellite-based ice fraction record for small water bodies of the Arctic Coastal Plain (2017 to 2023)

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Supplementary figures

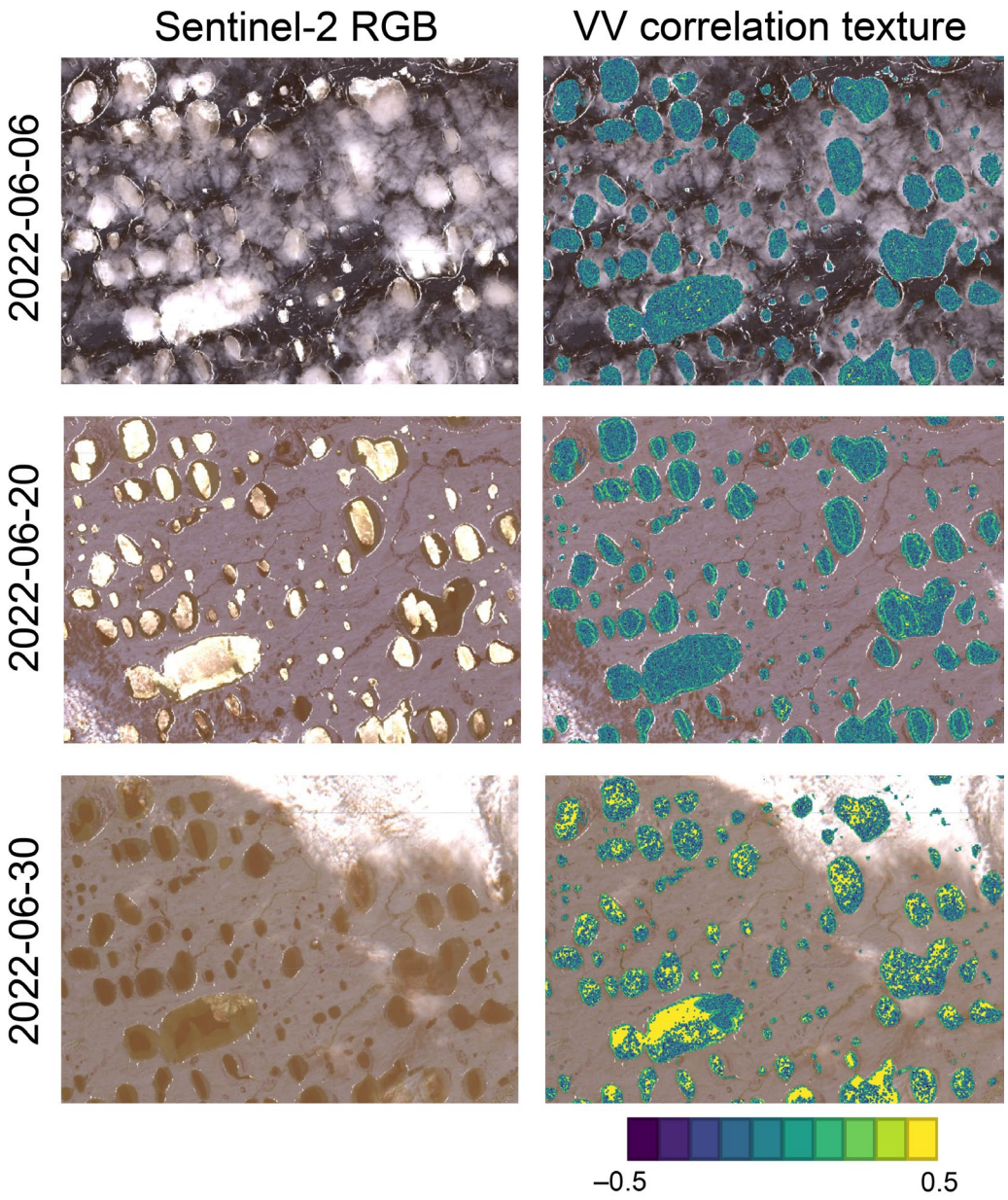

Figure S1

The texture derived from SAR imagery provides spatial information for distinguishing lake ice and open water, illustrated here using a selected area within the study region. The figure shows three stages of lake ice break-up: (1) the early stage (first row, 6 June 2022), (2) the rapid melt stage (second row, 20 June 2022), and (3) the late stage (third row, 30 June 2022). For each row, the two panels from left to right represent the Sentinel-2 RGB image, and the correlation texture computed from the VV band.

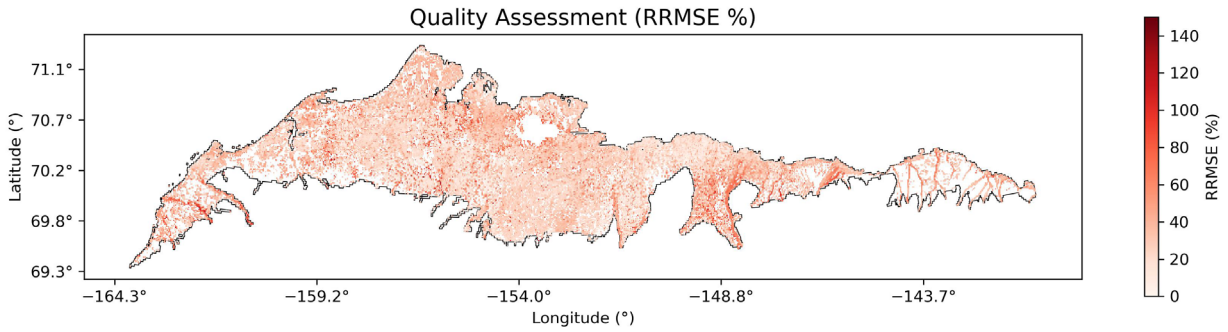

Figure S2

The quality layer of the S1 ice fraction product in this study shows that the areas with larger errors are mainly located along rivers and their surrounding regions, as well as in very small lakes and ponds within the study area. The quality layer provides an evaluation of the ice fraction quality for each 1-km grid cell, where each cell's value represents the Relative Root Mean Square Error (RRMSE) between all same-day Sentinel-1 and Dynamic World ice fraction data pairs during the study period (2017–2023), expressed in percentage (%).

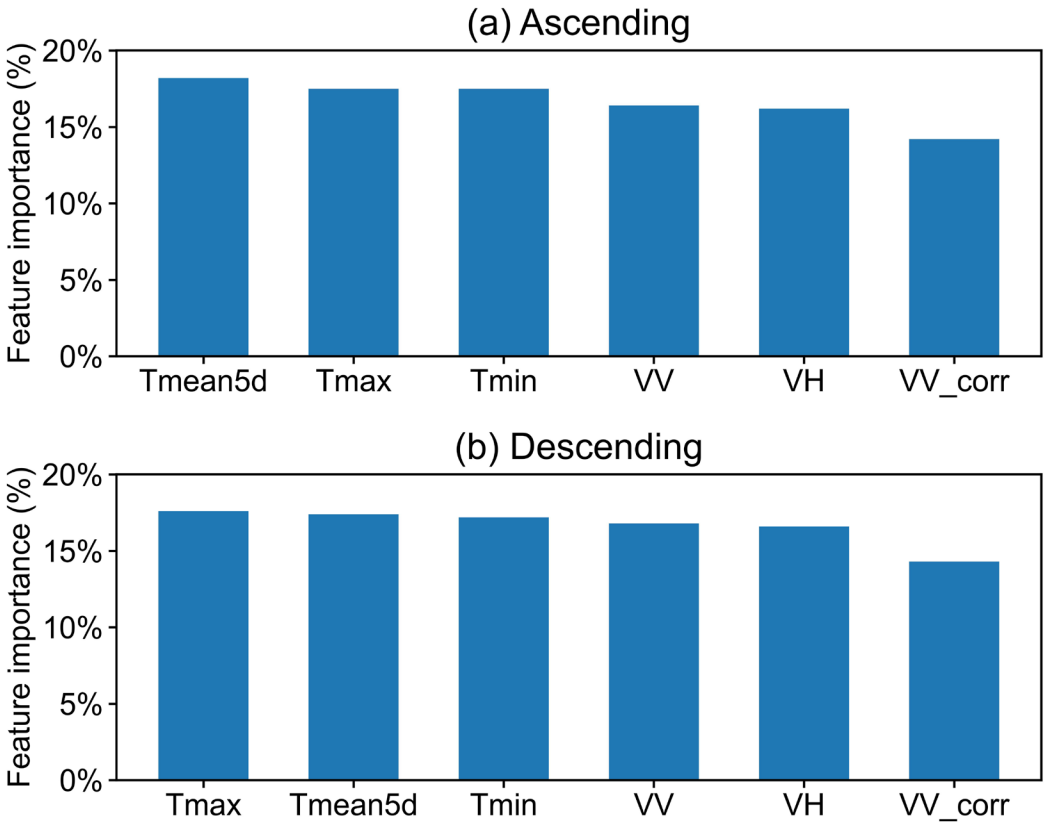

Figure S3

Feature importance of the random forest classifiers trained with ascending-pass data (a) and descending-pass data (b).

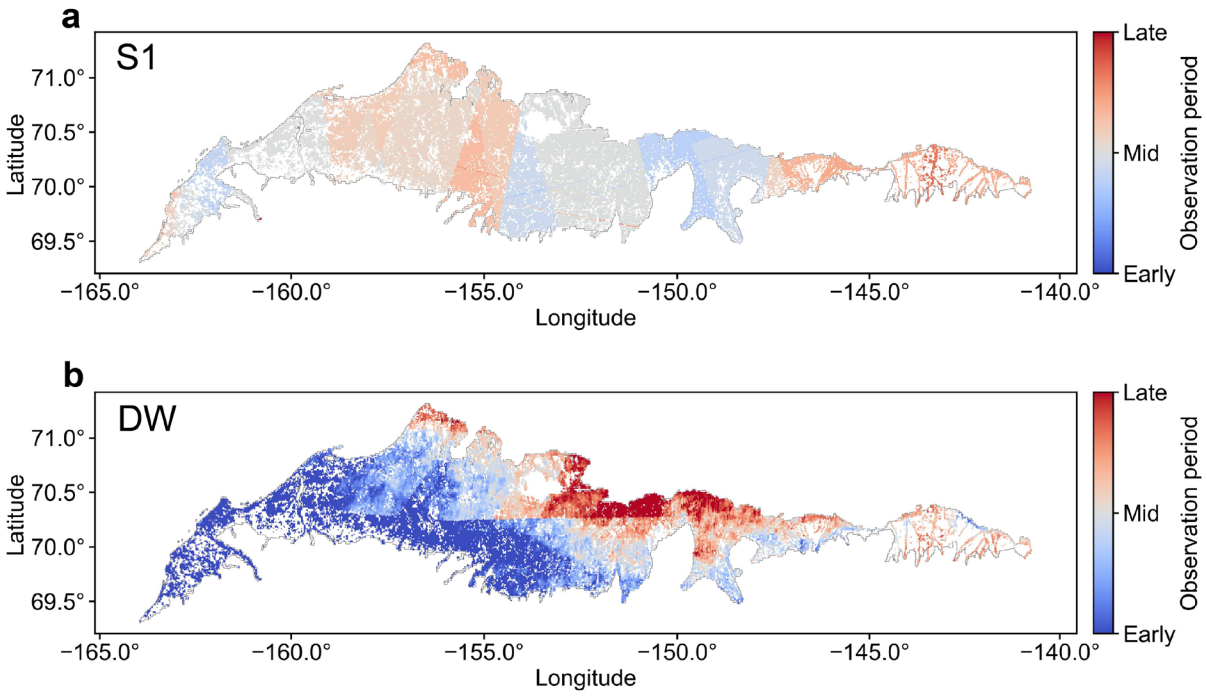

Figure S4

Observation timing of Sentinel-1 (S1) (a) and Dynamic World (DW) (b) in June from 2017–2023. Observations from June 1–10 are classified as Early, June 11–20 as Mid, and June 21–30 as Late.

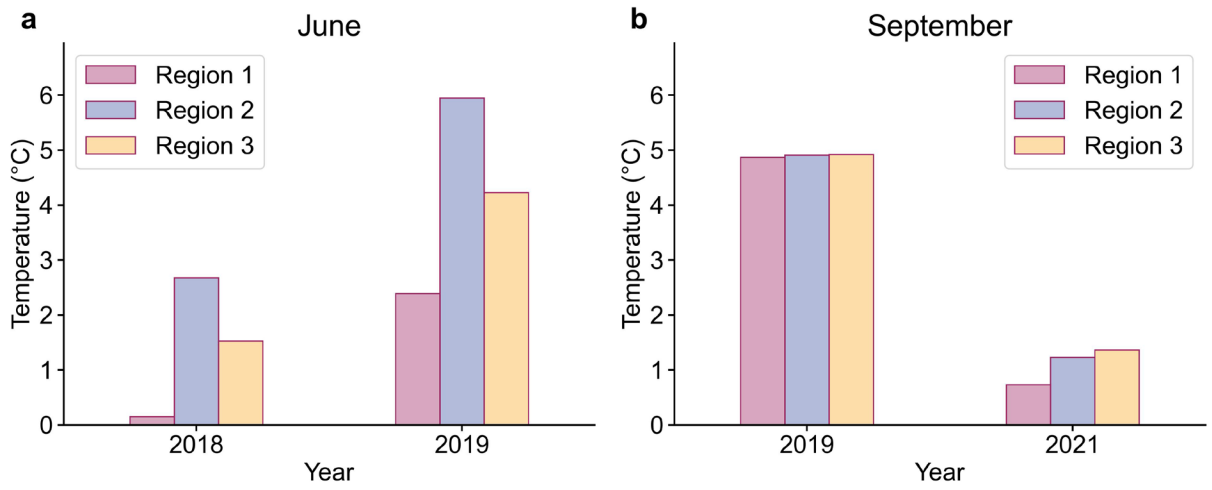

Figure S5

The mean temperature in June 2019 was higher than in June 2018 across the three selected regions (a), while the mean temperature in September 2021 was significantly lower than in September 2019 (b). Temperature data are derived from daily temperature records in the Daymet dataset.

Supplementary tables

Table S1

Comparison between observed ice phenology data and satellite-based estimated phenology dates. The table presents seven observed ice phenology records from four rivers, including the site name, location, event type, and the observed date. It also includes phenology dates estimated from the 1-km Sentinel-1 (S1) and Dynamic World (DW) ice fraction data, along with the date errors calculated as the difference between the estimated and observed dates.

Site name	Lat	Lon	Event	Observed date	Estimated date		Date error	
					S1	DW	S1	DW
Colville River (ColvilleVillage)	70.43	−150.39	Freeze-up	20171015	20170926	20170927	−19	18
Colville River (ColvilleVillage)	70.43	−150.39	Break-up	20180605	20180611	20180622	6	17
Colville River (ColvilleVillage)	70.43	−150.39	Freeze-up	20181009	20181015	20180920	6	−19
Colville River (ColvilleVillage)	70.43	−150.39	Break-up	20190527	20190519	20190522	−8	−5
Kuparuk River (Kuparuk)	70.33	−149.01	Break-up	20180605	20180605	20180713	0	38
Meade River (Atqasuk)	70.49	−157.41	Break-up	20210530	20210524	20210615	−6	16
Sagavanirktok River (Deadhorse)	70.25	−148.31	Break-up	20210524	20210522	20210609	−2	16

Table S2

Training and testing data used in the random forest models.

Orbit type	Training data		Testing data		Total
	Ice	Non-Ice	Ice	Non-Ice	
Ascending	9083	6174	2383	1484	19,124
Descending	16,184	10,032	3929	2589	32,734

Table S3

Hyperparameter settings for the random forest classifiers (ice detection models).

Hyperparameter	Ascending	Descending
Number of trees	50	50
Variables per split	2	3
Minimum leaf population	1	1
Bag fraction	0.5	0.5
Maximum nodes	2010	2010

Table S4

Comparison of 1-km S1 and DW ice fraction on the same days each year from 2017 to 2023. The table lists the *R*, RMSE, RRMSE, and bias values, as well as the number of matched S1 and DW dates for each year and the total number of data points per year.

Year	*R*	RMSE	RRMSE	Bias	Dates	Points
2017	0.90	0.21	0.38	0.05	61	54,057
2018	0.88	0.22	0.31	0.04	127	152,963
2019	0.94	0.16	0.23	0.03	126	140,814
2020	0.92	0.19	0.38	0.04	122	185,053
2021	0.94	0.13	0.16	0	121	151,235
2022	0.86	0.22	0.32	−0.02	97	95,325
2023	0.92	0.18	0.29	−0.02	100	87,791