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Seasonal evolution of Antarctic supraglacial lakes in 2015–2021 and links to environmental controls

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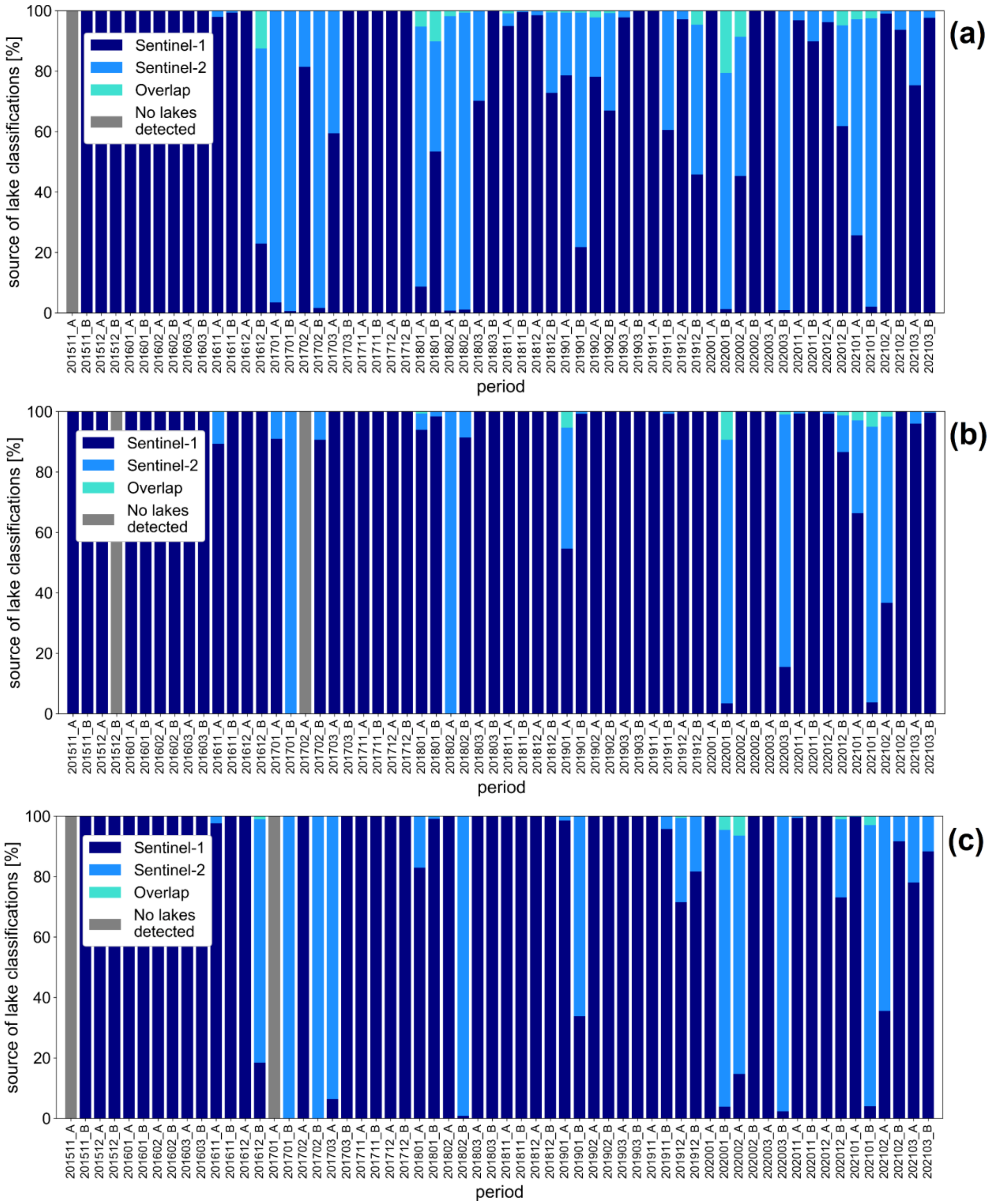

Figure S1 Data source of bi-weekly supraglacial lake extent classifications over George VI (a), Bach (b), Wilkins (c), Riiser-Larsen (d), Nivlisen (e) and Amery (f) ice shelves either from Sentinel-1 (dark blue), Sentinel-2 (light blue) or both (turquoise).

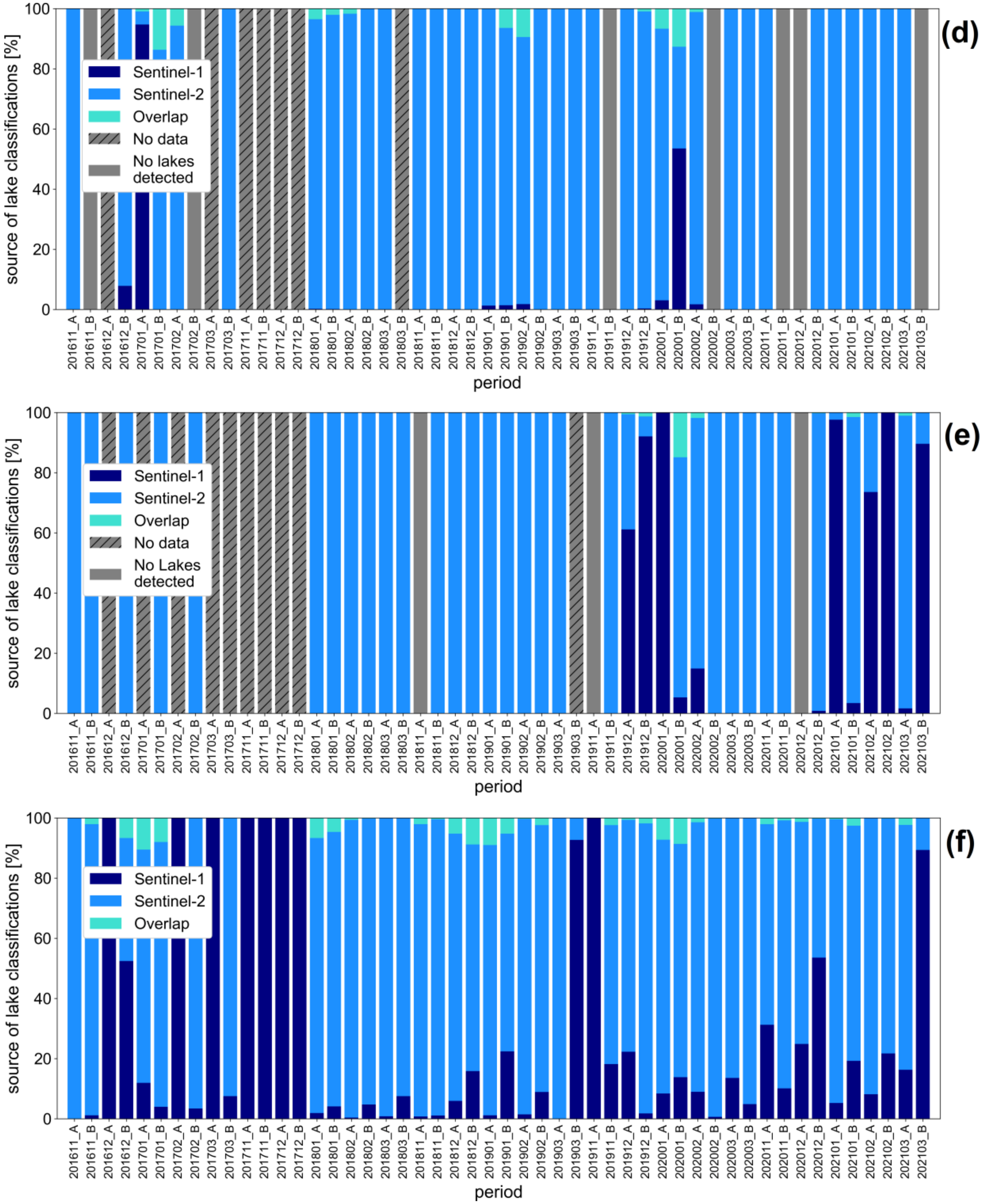

Figure S1 *Cont.* Data source of bi-weekly supraglacial lake extent classifications over George VI (a), Bach (b), Wilkins (c), Riiser-Larsen (d), Nivlisen (e) and Amery (f) ice shelves either from Sentinel-1 (dark blue), Sentinel-2 (light blue) or both (turquoise).

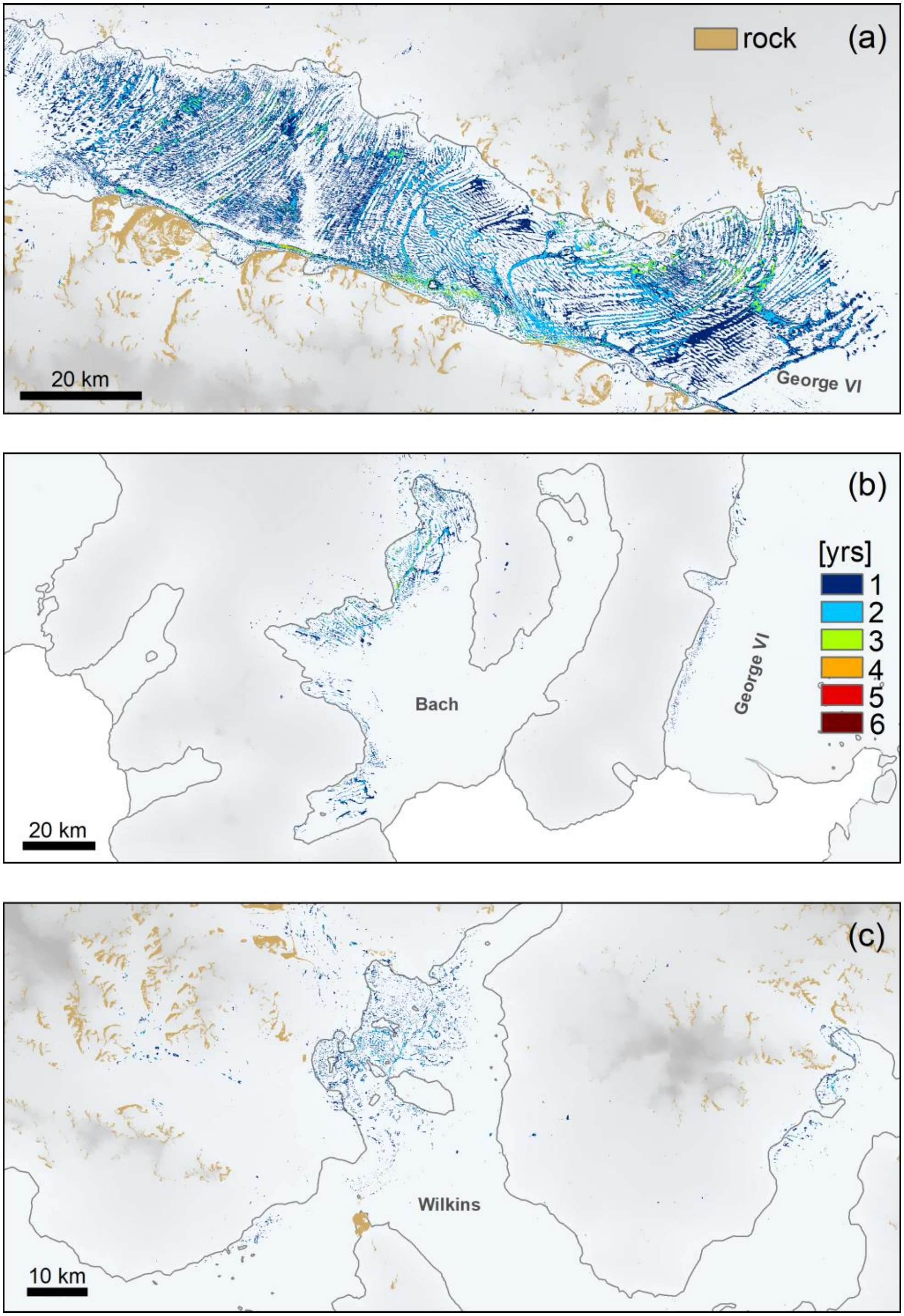

Figure S2 Inter-annual January recurrence of supraglacial lakes over George VI (a), Bach (b), Wilkins (c), Riiser-Larsen (d), Nivlisen (e) and Amery (f) ice shelves. The coastline and grounding line (grey) data are from Mouginot et al. (2017) and Rignot et al. (2013) and Sentinel-2 bedrock data are from Dirscherl et al. (2020). The background elevation is the gap-filled 200 m Reference Elevation Model of Antarctica (Howat et al., 2019).

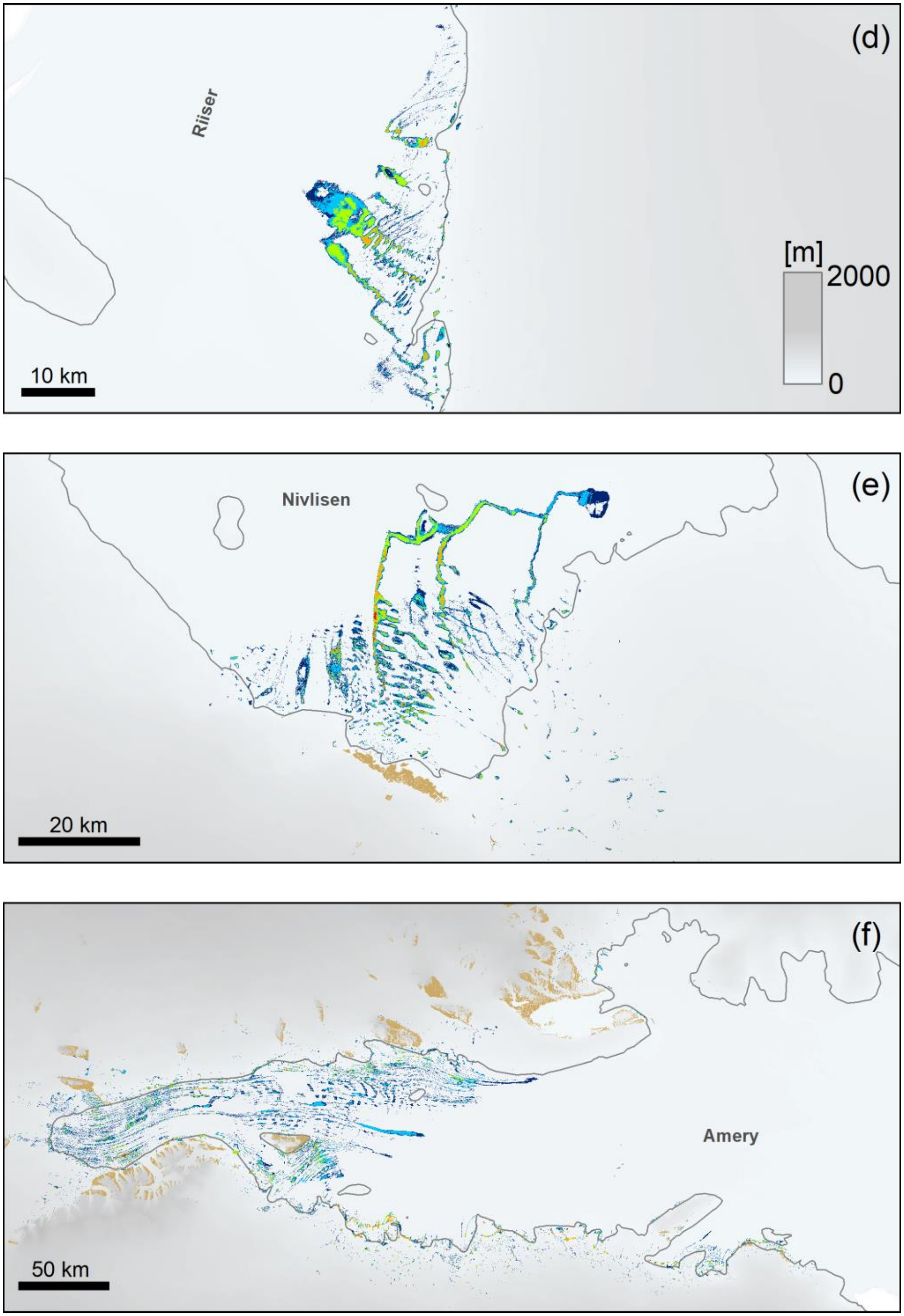

Figure S2 *Cont.* Inter-annual January recurrence of supraglacial lakes over George VI (a), Bach (b), Wilkins (c), Riiser-Larsen (d), Nivlisen (e) and Amery (f) ice shelves. The coastline and grounding line (grey) data are from Mouginot et al. (2017) and Rignot et al. (2013) and Sentinel-2 bedrock data are from Dirscherl et al. (2020). The background elevation is the gap-filled 200 m Reference Elevation Model of Antarctica (Howat et al., 2019).

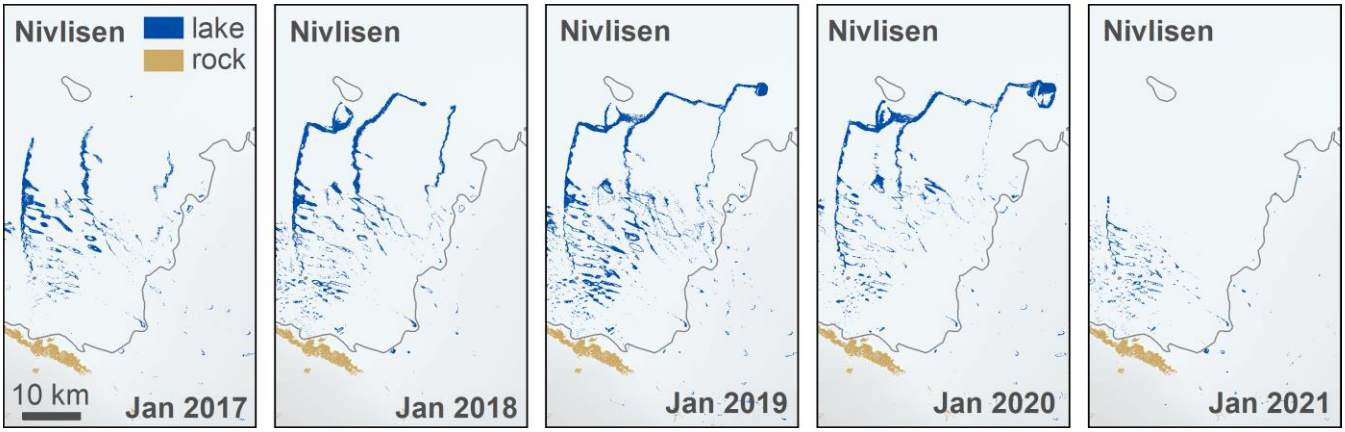

Figure S3 January maximum lake extent mapping products for years 2017-2021 over Nivlisen Ice Shelf. The grounding line data (grey) are from Mouginot et al. (2017) and Rignot et al. (2013) and Sentinel-2 bedrock data are from Dirscherl et al. (2020).

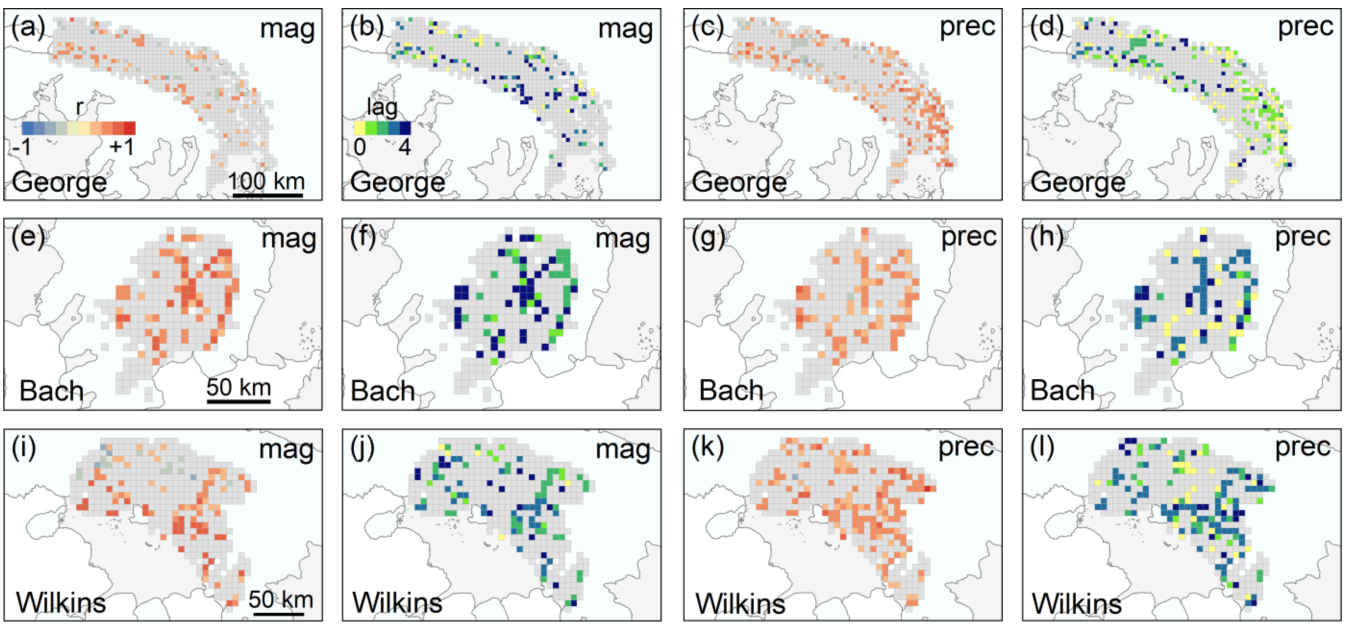

Figure S4 Pixel-based correlations (a,c,e,g,i,k) and corresponding temporal lags (b,d,f,h,j,l) between fractional lake extents and climate variables wind magnitude (mag) and precipitation (prec) over the API ice shelves George VI (a-d), Bach (e-h) and Wilkins (i-l). Pixels with p>0.05 are masked. The coastline and grounding line (grey) data are from Mouginot et al. (2017) and Rignot et al. (2013).

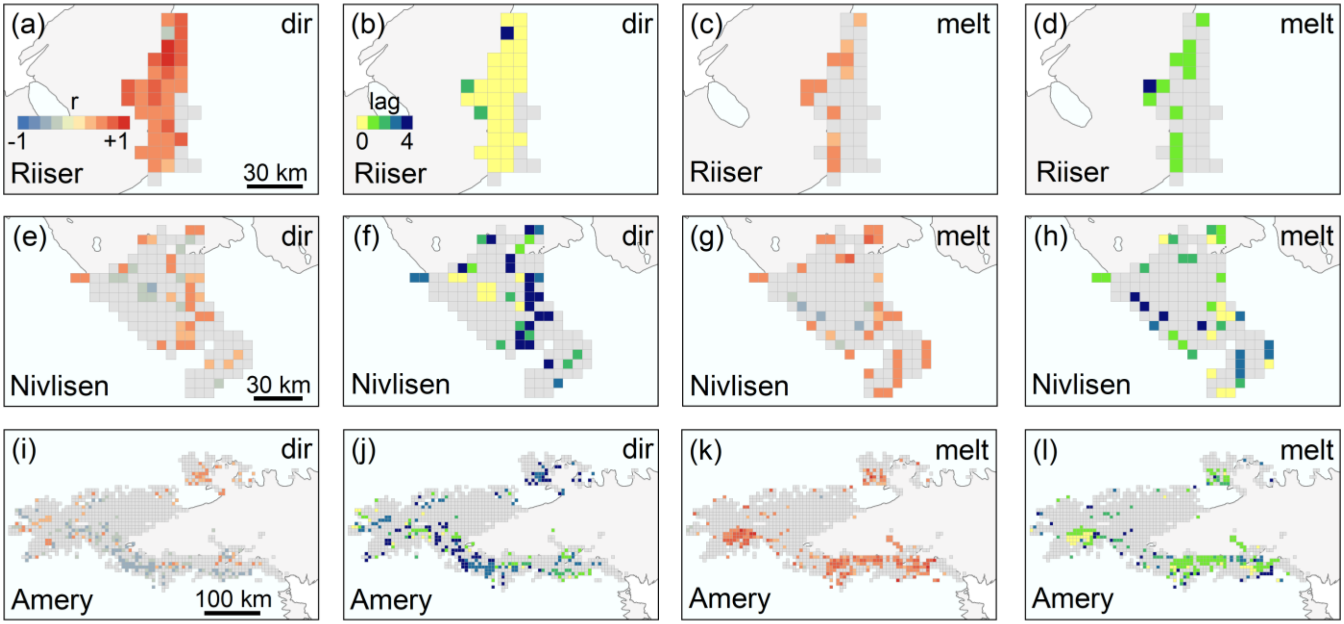

Figure S5 Pixel-based correlations (a,c,e,g,i,k) and corresponding temporal lags (b,d,f,h,j,l) between fractional lake extents and climate variables wind direction (dir) and snowmelt (melt) over the EAIS ice shelves Riiser-Larsen (a-d), Nivlisen (e-h) and Amery (i-l). Pixels with p>0.05 are masked. The coastline and grounding line (grey) data are from Mouginot et al. (2017) and Rignot et al. (2013).

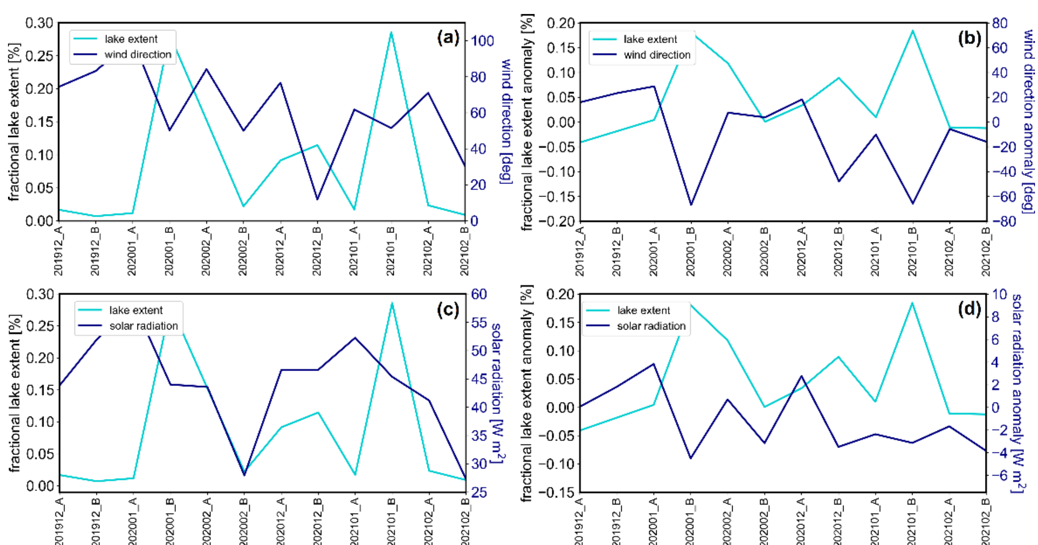

Figure S6 Spatially averaged fractional lake extents and lag 1 wind direction (a) and solar radiation (c) as well as anomalies thereof (b,d) for melting seasons 2019-2020 and 2020-2021 over Wilkins Ice Shelf. Wind from north, east, south and west corresponds to 0°, 90°, 180° and 270° in degrees (deg).

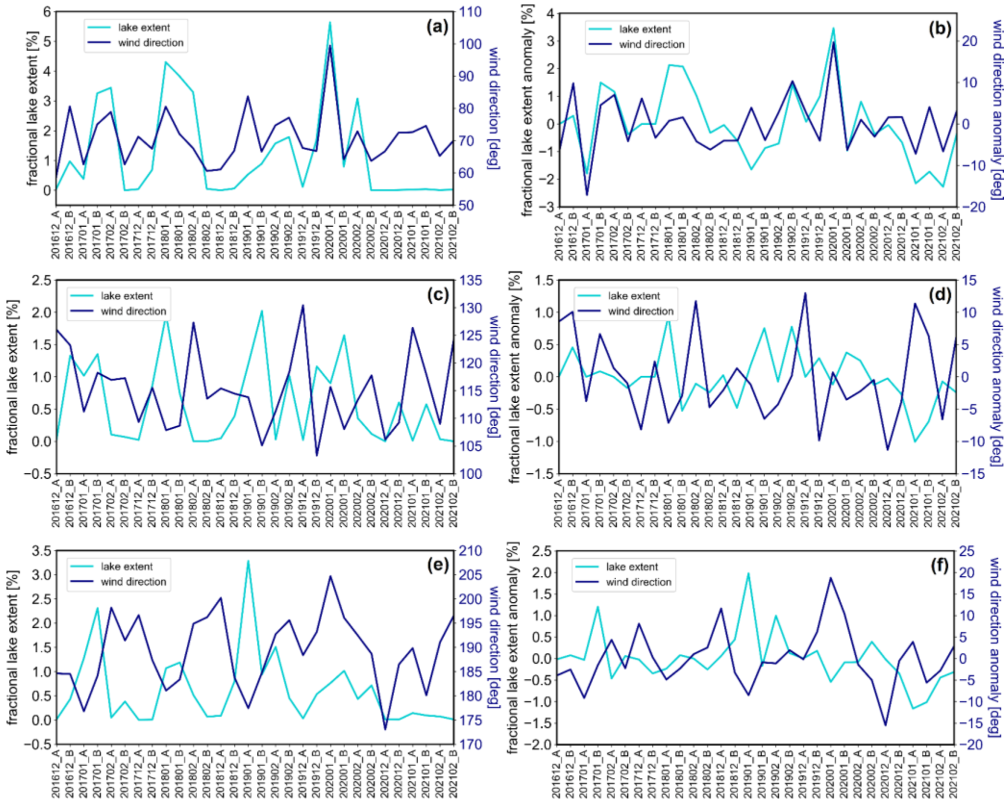

Figure S7 Spatially averaged fractional lake extents and wind direction as well as corresponding anomalies for the period 2016-2021 over Riiser-Larsen Ice Shelf at lag 0 (a-b), Nivlisen Ice Shelf at lag 1 (c-d) and Amery Ice Shelf at lag 1 (e-f). Wind from north, east, south and west corresponds to 0°, 90°, 180° and 270° in degrees (deg).

Table S1 Results of the multi-temporal linear correlation analysis with spatial averages of fractional lake extents and climate variables over all six study regions. Correlation was performed at lags 0-4 for variables average air temperature (temp), maximum air temperature (temp max), solar radiation (solar rad), precipitation (precip), wind magnitude (wind), wind direction (wind dir) and snowmelt (melt).

AOI	time lag	temp	temp max	solar rad	precip	wind	wind dir	melt
George	lag 0	0.319	0.287	-0.059	0.015	0.145	-0.066	0.174
	lag 1	0.508**	0.404*	0.096	-0.115	-0.016	0.012	0.288
	lag 2	0.292	0.114	0.430**	-0.258	-0.171	0.268	0.047
	lag 3	0.204	0.219	0.306	-0.183	-0.086	0.279	-0.065
	lag 4	0.121	0.133	0.223	-0.156	-0.148	0.112	0.064
Bach	lag 0	0.313	0.325	-0.107	0.169	0.096	-0.146	0.359*
	lag 1	0.398*	0.256	0.020	0.015	0.130	-0.128	0.249
	lag 2	0.289	0.224	0.260	-0.033	0.027	0.010	0.400*
	lag 3	0.258	0.232	0.212	0.005	0.048	-0.041	0.196
	lag 4	0.079	0.075	0.184	-0.164	-0.081	-0.106	0.087
Wilkins	lag 0	0.258	0.283	-0.004	0.098	0.143	-0.095	0.203
	lag 1	0.258	0.231	-0.086	0.050	0.129	-0.163	0.149
	lag 2	0.093	0.132	0.088	0.017	0.180	0.071	0.168
	lag 3	0.057	0.084	0.002	0.178	0.138	0.129	-0.024
	lag 4	-0.053	-0.081	0.006	-0.143	0.041	0.117	0.317
Riiser-Larsen	lag 0	0.026	-0.105	0.071	-0.535**	-0.569**	0.656***	0.169
	lag 1	0.369*	0.268	0.264	-0.126	-0.220	0.033	0.377*
	lag 2	0.566**	0.321	0.424*	-0.202	-0.086	0.222	-0.019
	lag 3	0.362*	0.343	0.344	-0.127	-0.130	-0.277	0.223
	lag 4	0.330	0.359	0.225	0.292	0.301	-0.432*	-0.014
Nivlisen	lag 0	0.521**	0.479**	0.234	0.109	-0.239	-0.275	0.240
	lag 1	0.578***	0.441*	0.416*	0.242	-0.058	-0.414*	0.011
	lag 2	0.276	0.121	0.599***	-0.317	-0.184	0.131	-0.041
	lag 3	0.150	0.118	0.163	-0.130	-0.006	-0.071	-0.011
	lag 4	0.022	0.017	0.012	0.021	0.052	0.151	-0.212
Amery	lag 0	0.281	0.264	0.108	0.069	0.077	0.027	0.226
	lag 1	0.583***	0.450*	0.423*	-0.084	-0.145	-0.342	0.645***
	lag 2	0.305	0.148	0.574***	-0.210	-0.077	-0.129	0.276
	lag 3	0.112	0.023	0.373*	-0.266	-0.170	0.265	-0.033
	lag 4	0.153	0.134	0.251	-0.079	-0.281	-0.034	-0.095

Table S2 Results of the multi-temporal linear correlation analysis with anomalies of fractional lake extents and climate variables over all six study regions. Correlation was performed at lags 0-4 for variables average air temperature (temp), maximum air temperature (temp max), solar radiation (solar rad), precipitation (precip), wind magnitude (wind), wind direction (wind dir) and snowmelt (melt).

AOI	time lag	temp	temp max	solar rad	precip	wind	wind dir	melt
George	lag 0	0.354*	0.300	-0.116	0.014	0.112	-0.021	0.197
	lag 1	0.454**	0.379*	-0.205	-0.019	0.160	-0.041	0.224
	lag 2	0.086	0.049	0.068	-0.087	-0.025	0.160	0.044
	lag 3	0.010	0.148	0.038	0.023	0.082	0.164	0.013
	lag 4	-0.026	-0.037	0.126	-0.119	-0.130	0.163	0.065
Bach	lag 0	0.403*	0.373*	-0.287	0.262	0.107	-0.105	0.461**
	lag 1	0.372*	0.184	-0.173	0.085	0.243	-0.261	0.183
	lag 2	0.196	0.196	-0.077	0.098	0.199	-0.100	0.287
	lag 3	0.172	0.226	-0.079	0.214	0.262	0.067	0.337*
	lag 4	-0.047	-0.015	0.126	-0.116	-0.004	0.066	0.384*
Wilkins	lag 0	0.342*	0.343*	-0.199	0.171	0.124	-0.039	0.329*
	lag 1	0.450**	0.279	-0.355*	0.100	0.178	-0.386*	0.120
	lag 2	0.170	0.179	-0.056	0.074	0.260	0.055	0.269
	lag 3	0.061	0.118	-0.011	0.223	0.268	0.167	0.044
	lag 4	-0.018	-0.067	0.157	-0.128	0.037	0.256	0.424**
Riiser-Larsen	lag 0	0.209	-0.027	0.422*	-0.450*	-0.423*	0.593***	0.002
	lag 1	0.314	0.152	-0.227	-0.009	-0.006	-0.269	0.354*
	lag 2	0.444*	0.119	-0.186	-0.076	0.105	0.164	-0.084
	lag 3	0.019	0.011	0.045	-0.225	-0.405*	-0.060	0.166
	lag 4	0.104	0.168	-0.031	0.151	0.023	-0.287	-0.126
Nivlisen	lag 0	0.442*	0.407*	-0.293	0.245	0.013	-0.261	0.185
	lag 1	0.431*	0.460*	-0.314	0.148	0.332	-0.326	-0.020
	lag 2	0.025	0.003	0.200	-0.205	-0.192	0.110	-0.009
	lag 3	0.306	0.178	-0.239	0.033	-0.002	-0.145	0.105
	lag 4	-0.011	-0.170	0.135	-0.185	-0.077	0.245	-0.389*
Amery	lag 0	0.128	0.090	-0.003	0.170	0.266	0.072	0.027
	lag 1	0.278	0.176	0.271	0.047	-0.102	-0.278	0.424*
	lag 2	0.001	-0.010	0.373*	-0.078	0.060	-0.126	0.243
	lag 3	-0.245	-0.310	0.438*	-0.283	0.082	0.331	0.129
	lag 4	-0.298	-0.438*	0.581***	-0.307	-0.067	0.199	0.060