



Supplement of

Sea ice breakup and freeze-up indicators for users of the Arctic coastal environment

John E. Walsh et al.

Correspondence to: John E. Walsh (jewalsh@alaska.edu)

The copyright of individual parts of the supplement might differ from the article licence.

1 **Supplementary material**

2

3 Table S1. Dates (Julian day numbers) corresponding to the modal values (peaks) of the
 4 distributions in Figure 4. (Insufficient number of years met Bliss criteria in Central
 5 Arctic).

6

	Break-up Start		Break-up end		Freeze-up start		Freeze-up end	
	J&E	Bliss	J&E	Bliss	J&E	Bliss	J&R	Bliss
11 Beaufort Sea	145	187	167	208	292	287	296	279
12 Chukchi Sea	147	177	181	202	315	312	325	302
13 E. Siberian Sea	150	182	195	207	281	293	280	294
14 Laptev Sea	140	192	188	207	280	271	285	279
15 Kara Sea	145	193	190	209	304	299	307	296
16 Barents Sea	146	164	152	186	315	297	328	302
17 Greenland Sea	150	177	162	207	308	290	342	280
18 Baffin Bay	121	152	149	186	331	311	346	324
19 Canadian Arctic	147	208	190	207	279	274	298	275
20 Hudson Bay	139	159	177	198	322	317	326	325
21 Central Arctic	199		200		306		310	
22 Bering Sea	110	123	123	142	343	337	362	349

23

24

25

26

27

28

29

30

31 Table S2. Slopes (least-squares linear regression lines) of the MASIE regions in Figures 5-6 and
 32 8-11. Also shown are the explained variances (r^2 values of the trend lines and their levels of
 33 statistical significance.

34

Region	Indicator Group	Indicator	Slope (days yr ⁻¹)	r ²	significance level
Baffin Bay	Bliss	Day of Advance	0.4	0.57	< 0.01**
Baffin Bay	Bliss	Day of Closing	0.4	0.52	< 0.01**
Baffin Bay	Bliss	Day of Opening	-0.5	-0.74	< 0.01**
Baffin Bay	Bliss	Day of Retreat	-0.7	-0.77	< 0.01**
Baffin Bay	J&E	Break-up End	-0.2	-0.44	< 0.01**
Baffin Bay	J&E	Break-up Start	-0.1	-0.07	0.67
Baffin Bay	J&E	Freeze-up End	0.4	0.57	< 0.01**
Baffin Bay	J&E	Freeze-up Start	0.5	0.71	< 0.01**
Barents Sea	Bliss	Day of Advance	1.3	0.7	< 0.01**
Barents Sea	Bliss	Day of Closing	1.3	0.7	< 0.01**
Barents Sea	Bliss	Day of Opening	-1.1	-0.72	< 0.01**
Barents Sea	Bliss	Day of Retreat	-1.2	-0.79	< 0.01**
Barents Sea	J&E	Break-up End	-1.0	-0.72	< 0.01**
Barents Sea	J&E	Break-up Start	-0.4	-0.38	0.02*
Barents Sea	J&E	Freeze-up End	1.0	0.72	< 0.01**
Barents Sea	J&E	Freeze-up Start	1.0	0.8	< 0.01**
Beaufort Sea	Bliss	Day of Advance	0.8	0.61	< 0.01**
Beaufort Sea	Bliss	Day of Closing	0.9	0.63	< 0.01**
Beaufort Sea	Bliss	Day of Opening	-0.7	-0.51	< 0.01**
Beaufort Sea	Bliss	Day of Retreat	-1.0	-0.56	< 0.01**
Beaufort Sea	J&E	Break-up End	-0.7	-0.48	< 0.01**
Beaufort Sea	J&E	Break-up Start	-0.6	-0.51	< 0.01**

Beaufort Sea	J&E	Freeze-up End	0.7	0.68	< 0.01**
Beaufort Sea	J&E	Freeze-up Start	0.7	0.65	< 0.01**
Bering Sea	Bliss	Day of Advance	0.4	0.43	< 0.01**
Bering Sea	Bliss	Day of Closing	0.4	0.36	0.02*
Bering Sea	Bliss	Day of Opening	-0.2	-0.28	0.09
Bering Sea	Bliss	Day of Retreat	-0.3	-0.37	0.02*
Bering Sea	J&E	Break-up End	-0.0	-0.01	0.98
Bering Sea	J&E	Break-up Start	0.0	0.05	0.77
Bering Sea	J&E	Freeze-up End	0.3	0.33	0.04*
Bering Sea	J&E	Freeze-up Start	0.5	0.65	< 0.01**
Canadian Arch.	Bliss	Day of Advance	0.5	0.63	< 0.01**
Canadian Arch.	Bliss	Day of Closing	0.6	0.56	< 0.01**
Canadian Arch.	Bliss	Day of Opening	-0.3	-0.57	< 0.01**
Canadian Arch.	Bliss	Day of Retreat	-0.9	-0.7	< 0.01**
Canadian Arch.	J&E	Break-up End	-0.4	-0.62	< 0.01**
Canadian Arch.	J&E	Break-up Start	-0.4	-0.5	< 0.01**
Canadian Arch.	J&E	Freeze-up End	0.3	0.58	< 0.01**
Canadian Arch.	J&E	Freeze-up Start	0.2	0.51	< 0.01**
Central Arctic	Bliss	Day of Closing	0.7	0.33	0.04*
Central Arctic	Bliss	Day of Opening	-0.5	-0.17	0.31
Central Arctic	J&E	Break-up End	-1.0	-0.36	0.03*
Central Arctic	J&E	Break-up Start	-0.9	-0.31	0.06
Central Arctic	J&E	Freeze-up End	0.1	0.03	0.88
Central Arctic	J&E	Freeze-up Start	0.6	0.18	0.31
Chukchi Sea	Bliss	Day of Advance	1.0	0.75	< 0.01**
Chukchi Sea	Bliss	Day of Closing	1.1	0.73	< 0.01**

Chukchi Sea	Bliss	Day of Opening	-0.7	-0.71	< 0.01**
Chukchi Sea	Bliss	Day of Retreat	-0.7	-0.66	< 0.01**
Chukchi Sea	J&E	Break-up End	-0.6	-0.65	< 0.01**
Chukchi Sea	J&E	Break-up Start	-0.5	-0.46	< 0.01**
Chukchi Sea	J&E	Freeze-up End	0.8	0.69	< 0.01**
Chukchi Sea	J&E	Freeze-up Start	1.0	0.79	< 0.01**
E. Siberian Sea	Bliss	Day of Advance	0.8	0.74	< 0.01**
E. Siberian Sea	Bliss	Day of Closing	1.1	0.78	< 0.01**
E. Siberian Sea	Bliss	Day of Opening	-0.7	-0.51	< 0.01**
E. Siberian Sea	Bliss	Day of Retreat	-0.8	-0.6	< 0.01**
E. Siberian Sea	J&E	Break-up End	-0.5	-0.45	< 0.01**
E. Siberian Sea	J&E	Break-up Start	-0.7	-0.46	< 0.01**
E. Siberian Sea	J&E	Freeze-up End	0.6	0.76	< 0.01**
E. Siberian Sea	J&E	Freeze-up Start	0.7	0.77	< 0.01**
Greenland Sea	Bliss	Day of Advance	0.9	0.62	< 0.01**
Greenland Sea	Bliss	Day of Closing	0.5	0.45	< 0.01**
Greenland Sea	Bliss	Day of Opening	-0.4	-0.38	0.02*
Greenland Sea	Bliss	Day of Retreat	-0.6	-0.5	< 0.01**
Greenland Sea	J&E	Break-up End	-0.3	-0.32	0.05*
Greenland Sea	J&E	Break-up Start	-0.0	-0.04	0.79
Greenland Sea	J&E	Freeze-up End	0.4	0.38	0.02*
Greenland Sea	J&E	Freeze-up Start	0.7	0.63	< 0.01**

Hudson Bay	Bliss	Day of Advance	0.5	0.64	< 0.01**
Hudson Bay	Bliss	Day of Closing	0.4	0.57	< 0.01**
Hudson Bay	Bliss	Day of Opening	-0.5	-0.67	< 0.01**
Hudson Bay	Bliss	Day of Retreat	-0.7	-0.74	< 0.01**
Hudson Bay	J&E	Break-up End	-0.4	-0.65	< 0.01**
Hudson Bay	J&E	Break-up Start	-0.1	-0.06	0.72
Hudson Bay	J&E	Freeze-up End	0.4	0.55	< 0.01**
Hudson Bay	J&E	Freeze-up Start	0.6	0.73	< 0.01**
Kara Sea	Bliss	Day of Advance	0.7	0.63	< 0.01**
Kara Sea	Bliss	Day of Closing	0.9	0.66	< 0.01**
Kara Sea	Bliss	Day of Opening	-1.0	-0.75	< 0.01**
Kara Sea	Bliss	Day of Retreat	-1.1	-0.76	< 0.01**
Kara Sea	J&E	Break-up End	-0.9	-0.7	< 0.01**
Kara Sea	J&E	Break-up Start	-0.3	-0.22	0.18
Kara Sea	J&E	Freeze-up End	0.8	0.62	< 0.01**
Kara Sea	J&E	Freeze-up Start	0.7	0.64	< 0.01**
Laptev Sea	Bliss	Day of Advance	0.6	0.65	< 0.01**
Laptev Sea	Bliss	Day of Closing	0.7	0.64	< 0.01**
Laptev Sea	Bliss	Day of Opening	-0.6	-0.55	< 0.01**
Laptev Sea	Bliss	Day of Retreat	-0.7	-0.58	< 0.01**
Laptev Sea	J&E	Break-up End	-0.6	-0.52	< 0.01**
Laptev Sea	J&E	Break-up Start	-0.7	-0.48	< 0.01**
Laptev Sea	J&E	Freeze-up End	0.4	0.68	< 0.01**
Laptev Sea	J&E	Freeze-up Start	0.4	0.64	< 0.01**

35

36

37 Table S3. Same as Table S2, but for the local indicators. Slopes (linear regression lines)
 38 correspond to Figures 8-11. Also shown are the explained variances (r^2 values of the trend lines
 39 and their levels of statistical significance.

40

Location	Indicator Group	Indicator	Slope (days yr ⁻¹)	r ²	Significance level
Churchill	Bliss	Day of Advance	0.3	0.52	< 0.01**
Churchill	Bliss	Day of Closing	0.4	0.51	< 0.01**
Churchill	Bliss	Day of Opening	-0.8	-0.59	< 0.01**
Churchill	Bliss	Day of Retreat	-1.0	-0.67	< 0.01**
Churchill	J&E	Break-up End	-0.7	-0.54	< 0.01**
Churchill	J&E	Break-up Start	-0.5	-0.3	0.07
Churchill	J&E	Freeze-up End	0.4	0.49	< 0.01**
Churchill	J&E	Freeze-up Start	0.7	0.53	< 0.01**
Clyde River	Bliss	Day of Advance	0.3	0.46	< 0.01**
Clyde River	Bliss	Day of Closing	0.3	0.45	< 0.01**
Clyde River	Bliss	Day of Opening	-0.6	-0.47	< 0.01**
Clyde River	Bliss	Day of Retreat	-0.5	-0.42	< 0.01**
Clyde River	J&E	Break-up End	-0.6	-0.5	< 0.01**
Clyde River	J&E	Break-up Start	-0.5	-0.22	0.18
Clyde River	J&E	Freeze-up End	0.3	0.45	< 0.01**
Clyde River	J&E	Freeze-up Start	0.3	0.43	< 0.01**
Mestersvig	Bliss	Day of Advance	0.6	0.36	0.05*
Mestersvig	Bliss	Day of Closing	0.9	0.52	< 0.01**
Mestersvig	Bliss	Day of Opening	-0.7	-0.36	0.02*
Mestersvig	Bliss	Day of Retreat	-0.6	-0.37	0.04*
Mestersvig	J&E	Break-up End	-0.2	-0.2	0.26
Mestersvig	J&E	Break-up Start	0.1	0.04	0.83

Mestersvig	J&E	Freeze-up End	0.6	0.5	< 0.01**
Mestersvig	J&E	Freeze-up Start	0.5	0.42	0.02*
Pevek	Bliss	Day of Advance	1.1	0.72	< 0.01**
Pevek	Bliss	Day of Closing	1.1	0.77	< 0.01**
Pevek	Bliss	Day of Opening	-0.9	-0.4	0.01*
Pevek	Bliss	Day of Retreat	-1.0	-0.46	< 0.01**
Pevek	J&E	Break-up End	-0.7	-0.33	0.05
Pevek	J&E	Break-up Start	-1.1	-0.37	0.03*
Pevek	J&E	Freeze-up End	0.8	0.76	< 0.01**
Pevek	J&E	Freeze-up Start	0.9	0.73	< 0.01**
Prudhoe Bay	Bliss	Day of Advance	0.8	0.52	< 0.01**
Prudhoe Bay	Bliss	Day of Closing	0.8	0.65	< 0.01**
Prudhoe Bay	Bliss	Day of Opening	-1.0	-0.56	< 0.01**
Prudhoe Bay	Bliss	Day of Retreat	-0.9	-0.51	< 0.01**
Prudhoe Bay	J&E	Break-up End	-0.8	-0.54	< 0.01**
Prudhoe Bay	J&E	Break-up Start	-0.5	-0.27	0.1
Prudhoe Bay	J&E	Freeze-up End	0.8	0.6	< 0.01**
Prudhoe Bay	J&E	Freeze-up Start	0.7	0.59	< 0.01**
Sabetta	Bliss	Day of Advance	0.4	0.55	< 0.01**
Sabetta	Bliss	Day of Closing	0.4	0.47	< 0.01**
Sabetta	Bliss	Day of Opening	-0.9	-0.59	< 0.01**
Sabetta	Bliss	Day of Retreat	-1.0	-0.78	< 0.01**
Sabetta	J&E	Break-up End	-0.8	-0.56	< 0.01**
Sabetta	J&E	Break-up Start	-0.9	-0.42	< 0.01**
Sabetta	J&E	Freeze-up End	0.4	0.41	< 0.01**
Sabetta	J&E	Freeze-up Start	0.4	0.56	< 0.01**

South Chukchi Sea	Bliss	Day of Advance	0.9	0.63	< 0.01**
South Chukchi Sea	Bliss	Day of Closing	0.7	0.58	< 0.01**
South Chukchi Sea	Bliss	Day of Opening	-0.6	-0.51	< 0.01**
South Chukchi Sea	Bliss	Day of Retreat	-0.7	-0.56	< 0.01**
South Chukchi Sea	J&E	Break-up End	-0.6	-0.52	< 0.01**
South Chukchi Sea	J&E	Break-up Start	-0.6	-0.39	0.02*
South Chukchi Sea	J&E	Freeze-up End	0.7	0.57	< 0.01**
South Chukchi Sea	J&E	Freeze-up Start	0.8	0.63	< 0.01**
St. Lawrence Island	Bliss	Day of Advance	0.6	0.33	0.05*
St. Lawrence Island	Bliss	Day of Closing	0.3	0.2	0.24
St. Lawrence Island	Bliss	Day of Opening	-0.1	-0.16	0.35
St. Lawrence Island	Bliss	Day of Retreat	-0.3	-0.28	0.09
St. Lawrence Island	J&E	Break-up End	-0.1	-0.11	0.49
St. Lawrence Island	J&E	Break-up Start	-0.0	-0.02	0.92
St. Lawrence Island	J&E	Freeze-up End	0.4	0.25	0.13
St. Lawrence Island	J&E	Freeze-up Start	0.5	0.33	0.04*
Tiksi	Bliss	Day of Advance	0.2	0.36	0.02*
Tiksi	Bliss	Day of Closing	0.2	0.41	0.01*

Tiksi	Bliss	Day of Opening	-0.4	-0.54	< 0.01**
Tiksi	Bliss	Day of Retreat	-0.6	-0.54	< 0.01**
Tiksi	J&E	Break-up End	-0.3	-0.53	< 0.01**
Tiksi	J&E	Break-up Start	-0.3	-0.34	0.03*
Tiksi	J&E	Freeze-up End	0.3	0.45	< 0.01**
Tiksi	J&E	Freeze-up Start	0.2	0.45	< 0.01**
Utqiaf°vik	Bliss	Day of Advance	1.1	0.6	< 0.01**
Utqiaf°vik	Bliss	Day of Closing	1.1	0.67	< 0.01**
Utqiaf°vik	Bliss	Day of Opening	-1.2	-0.52	< 0.01**
Utqiaf°vik	Bliss	Day of Retreat	-1.2	-0.71	< 0.01**
Utqiaf°vik	J&E	Break-up End	-0.7	-0.52	< 0.01**
Utqiaf°vik	J&E	Break-up Start	-0.7	-0.27	0.11
Utqiaf°vik	J&E	Freeze-up End	0.8	0.66	< 0.01**
Utqiaf°vik	J&E	Freeze-up Start	0.9	0.62	< 0.01**

41

42

43

44

45