The Aleutian Low – Beaufort Sea Anticyclone: A new climate index for seasonal melt of the Pacific Arctic cryosphere

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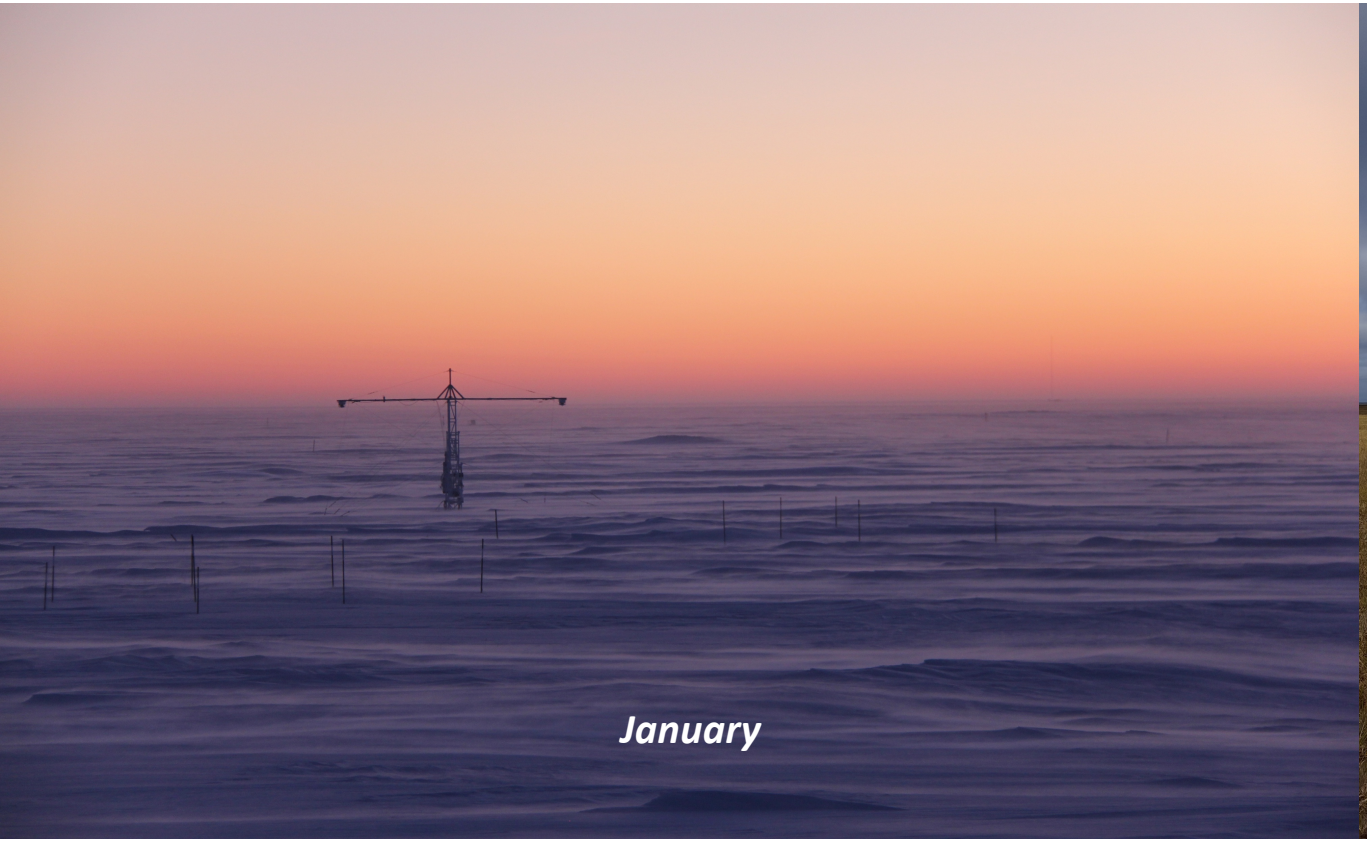
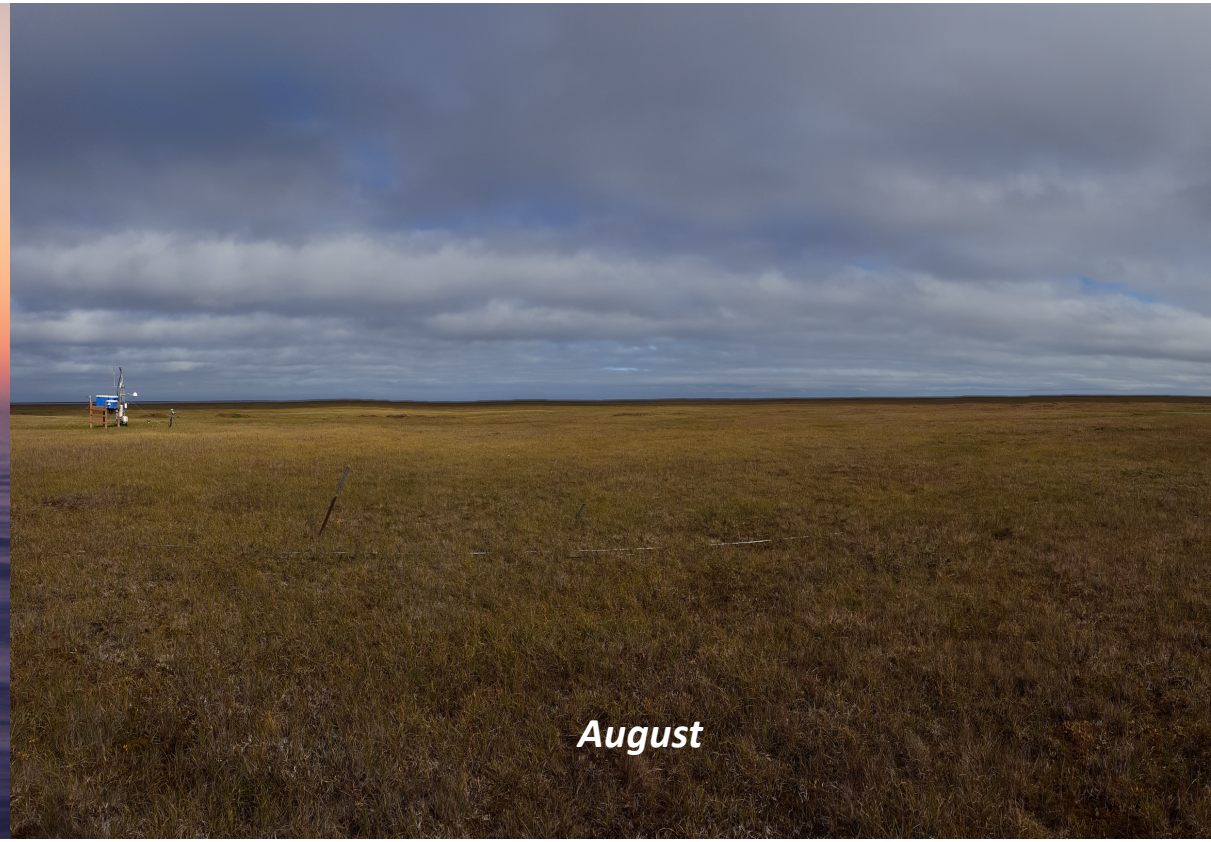
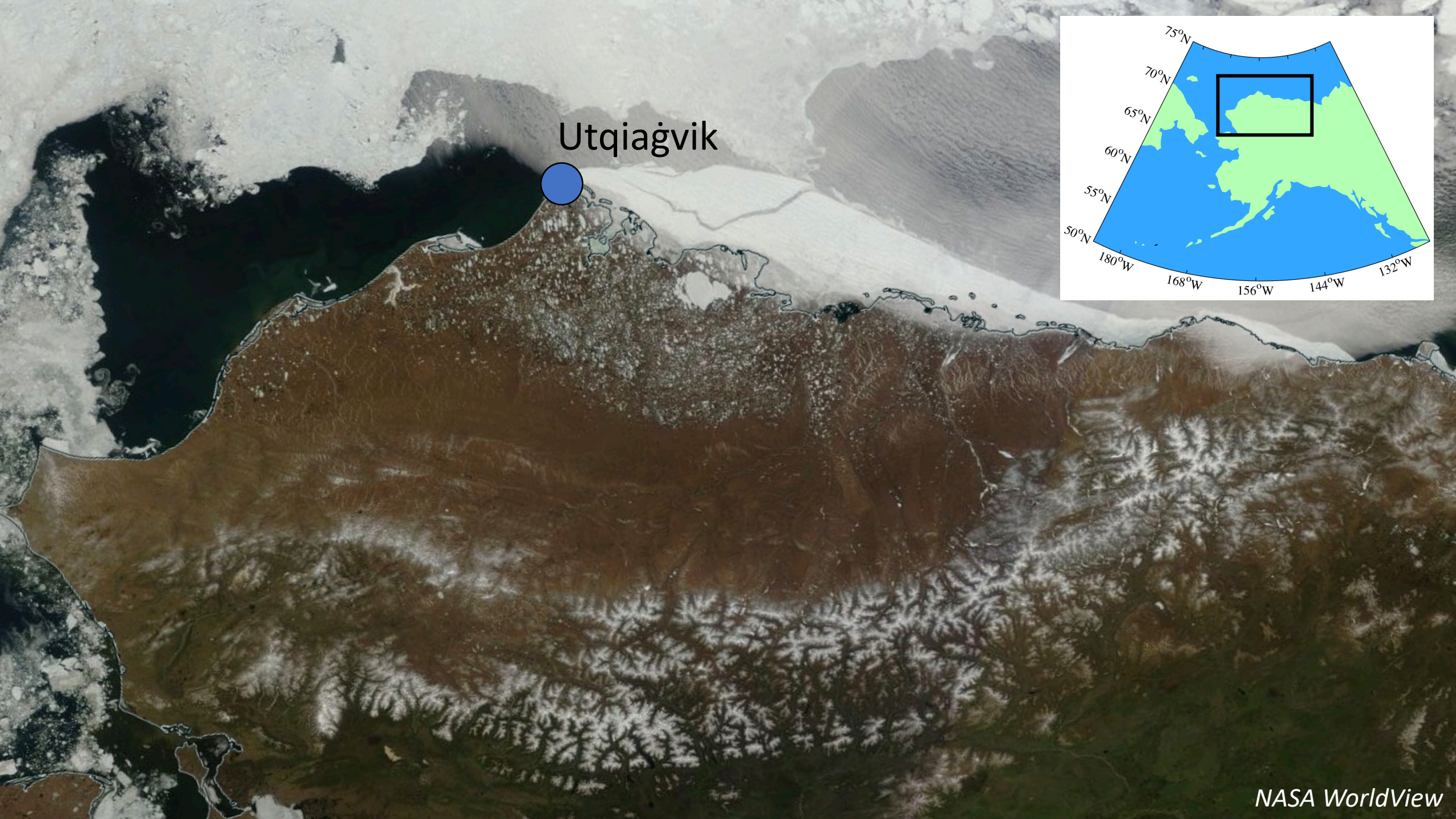
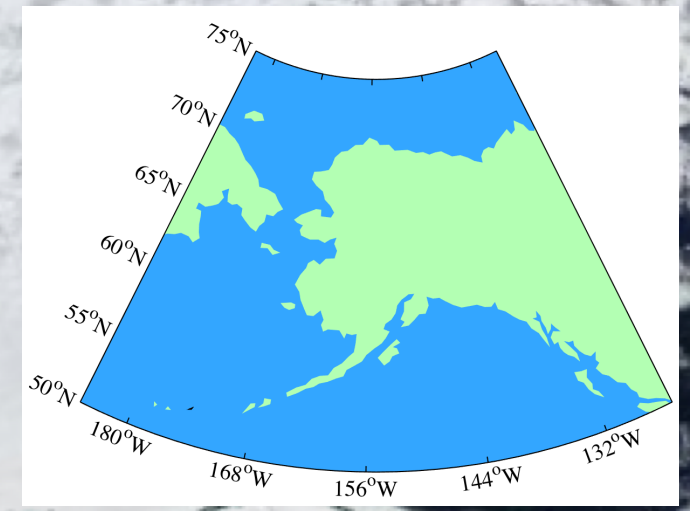




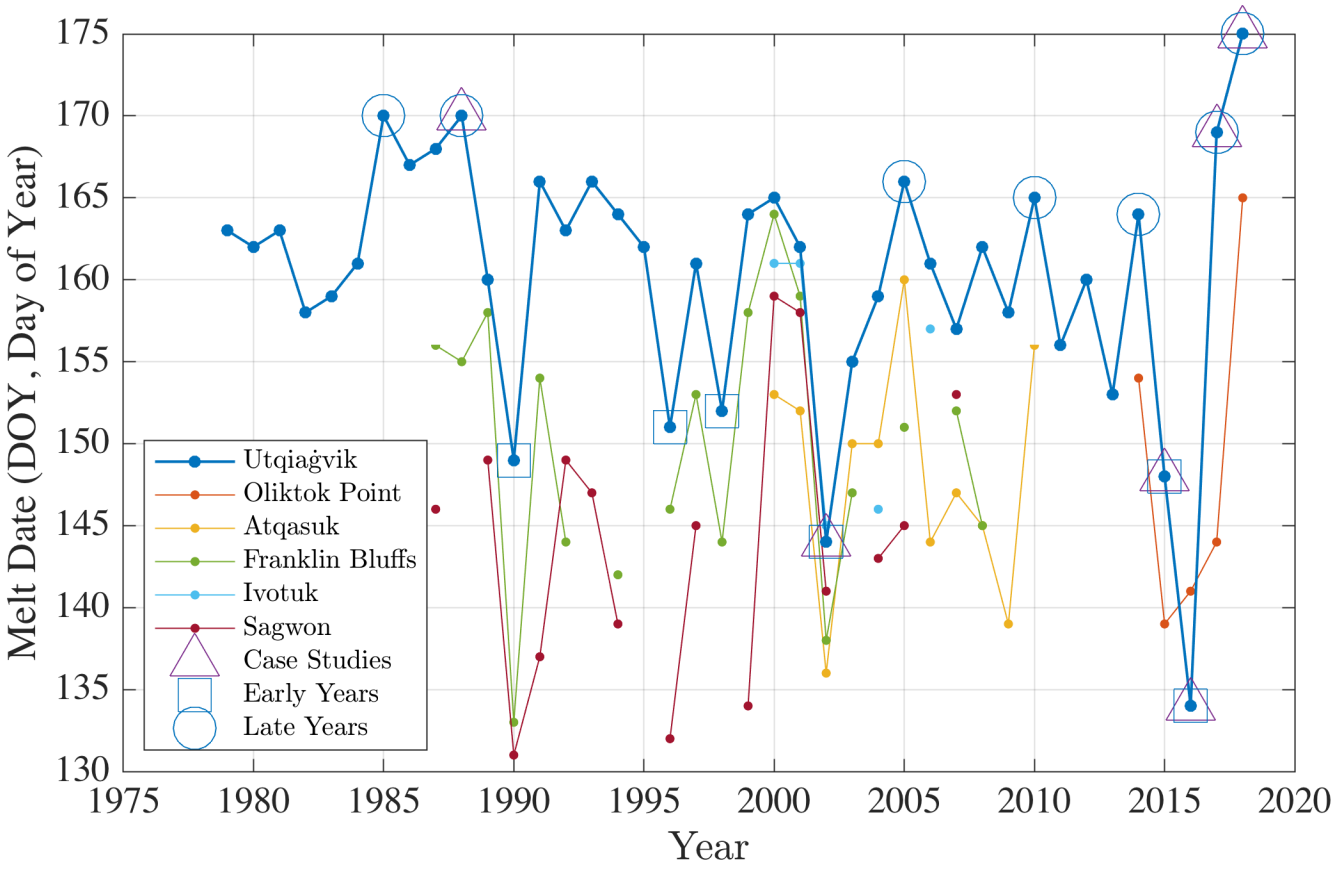
NOAA's 43rd Climate Diagnostics & Prediction Workshop
Santa Barbara, California, October 23-25, 2018

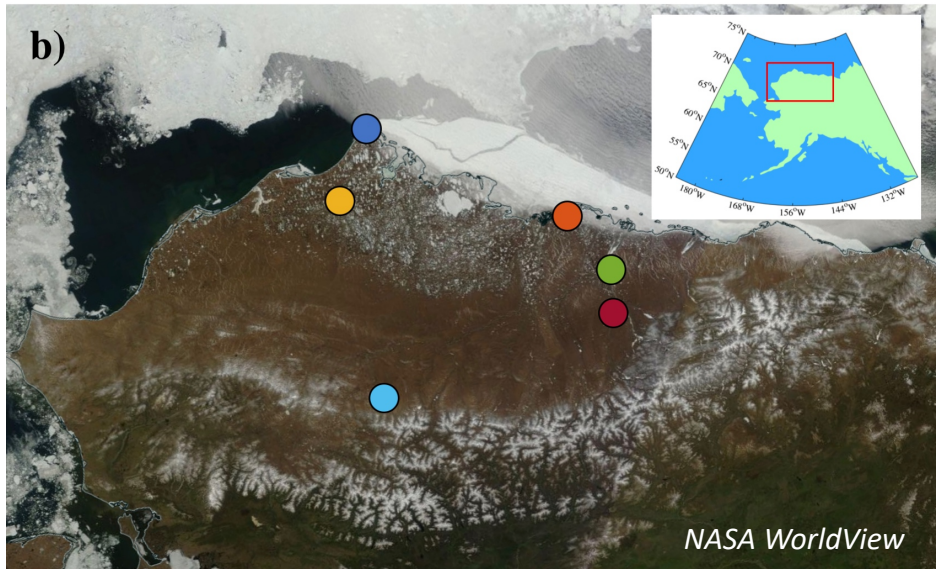

Utqiaġvik
75°N
70°N
65°N
60°N
55°N
50°N
180°W
168°W
156°W
144°W
132°W
NASA WorldView

Utqiaġvik

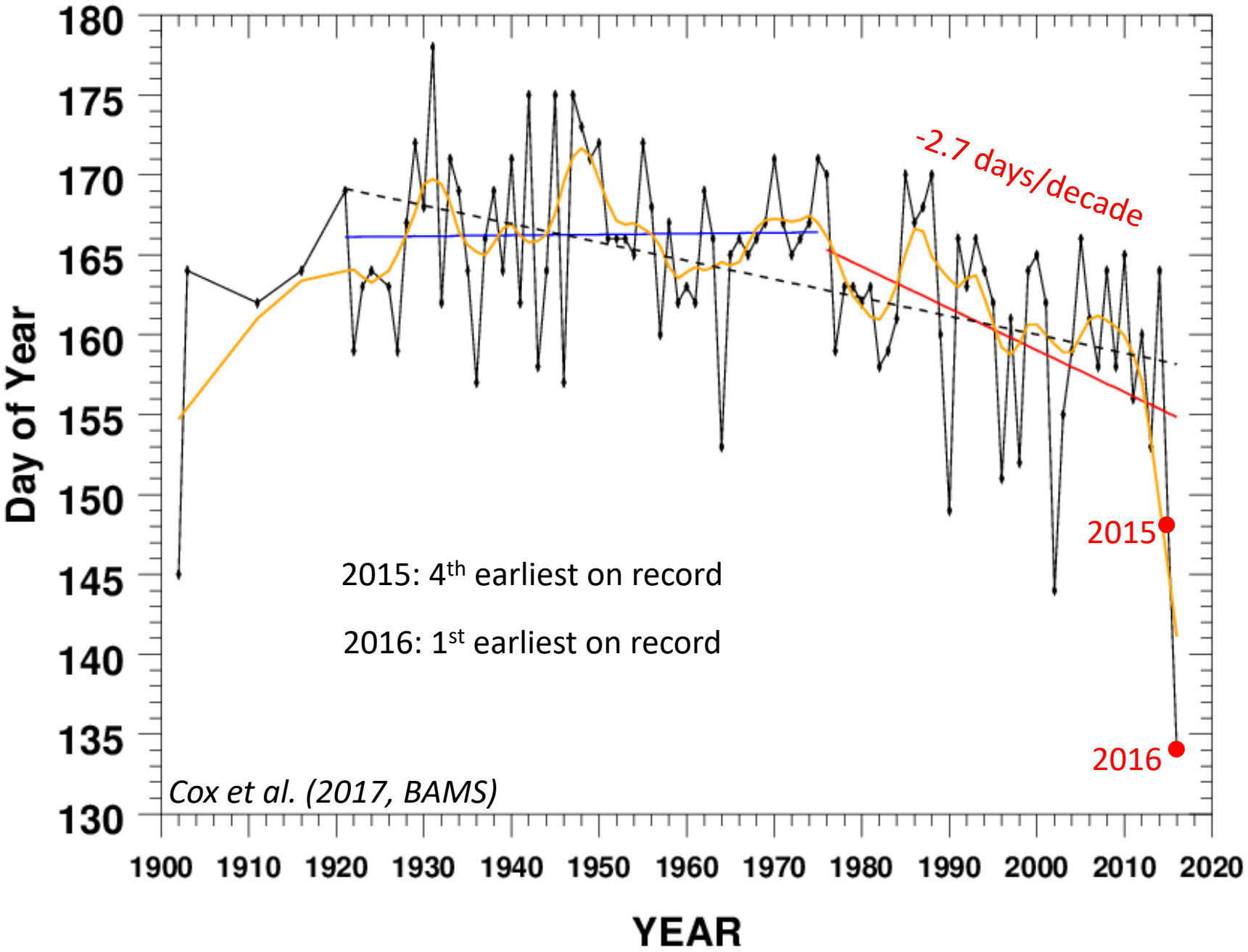


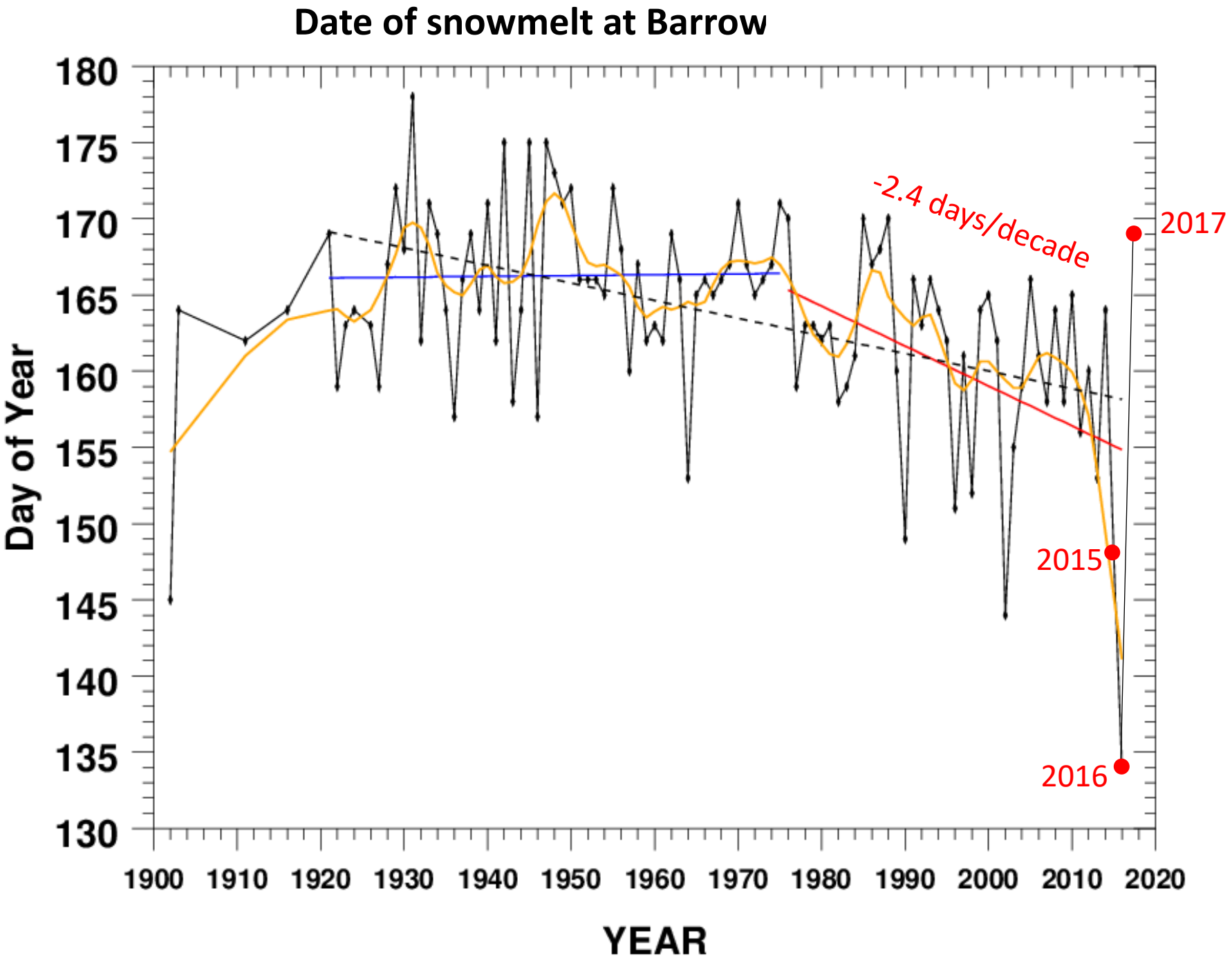
NASA WorldView


Melt Date (DOY, Day of Year)
Year
175
170
165
160
155
150
145
140
135
130
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Utqiaġvik
Oliktok Point
Atqasuk
Franklin Bluffs
Ivotuk
Sagwon
Case Studies
Early Years
Late Years


b)
NASA WorldView

Date of snowmelt at Barrow

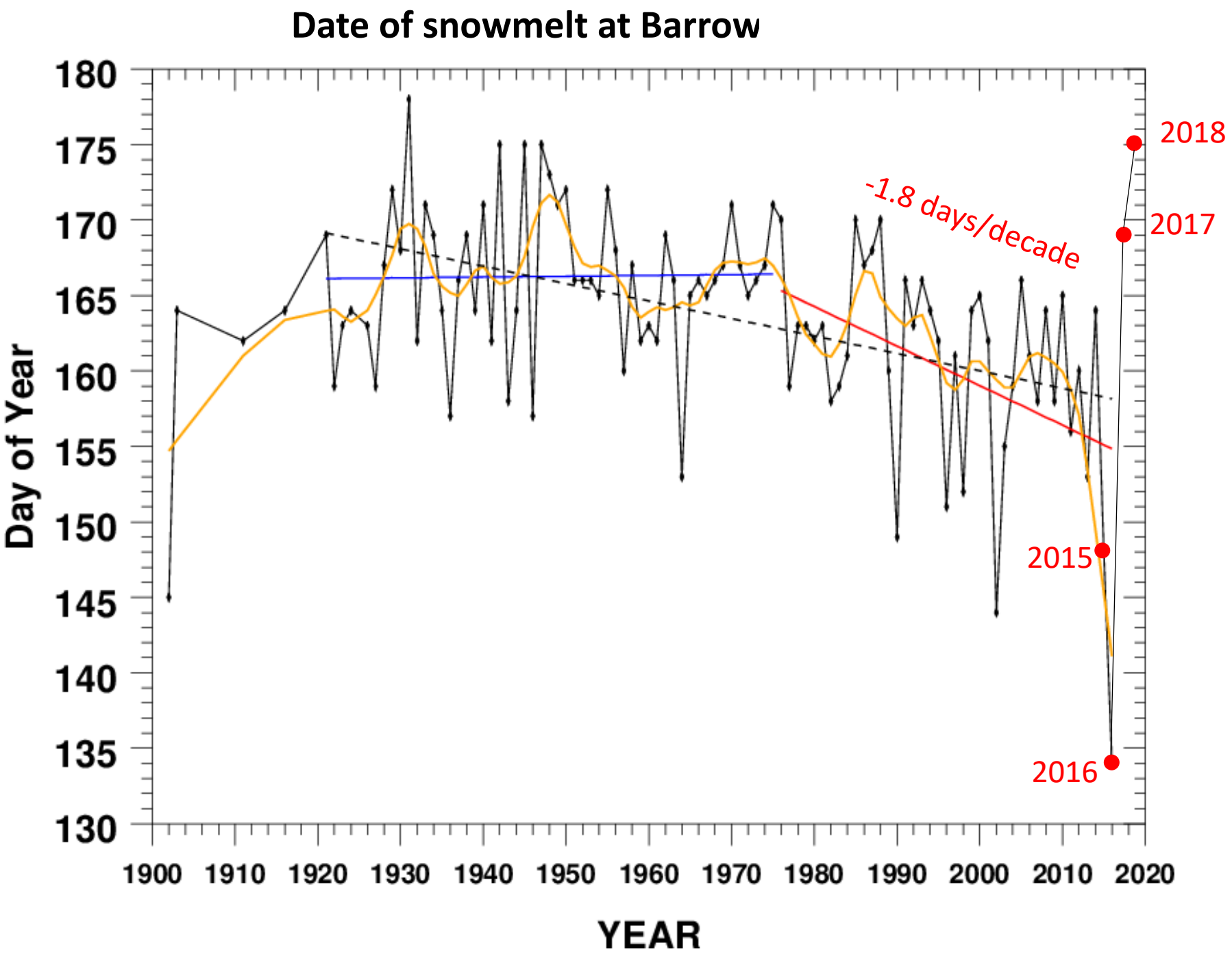




2015: 4th earliest on record

2016: 1st earliest on record

2017: latest since 1988



2015: 4th earliest on record

2016: 1st earliest on record

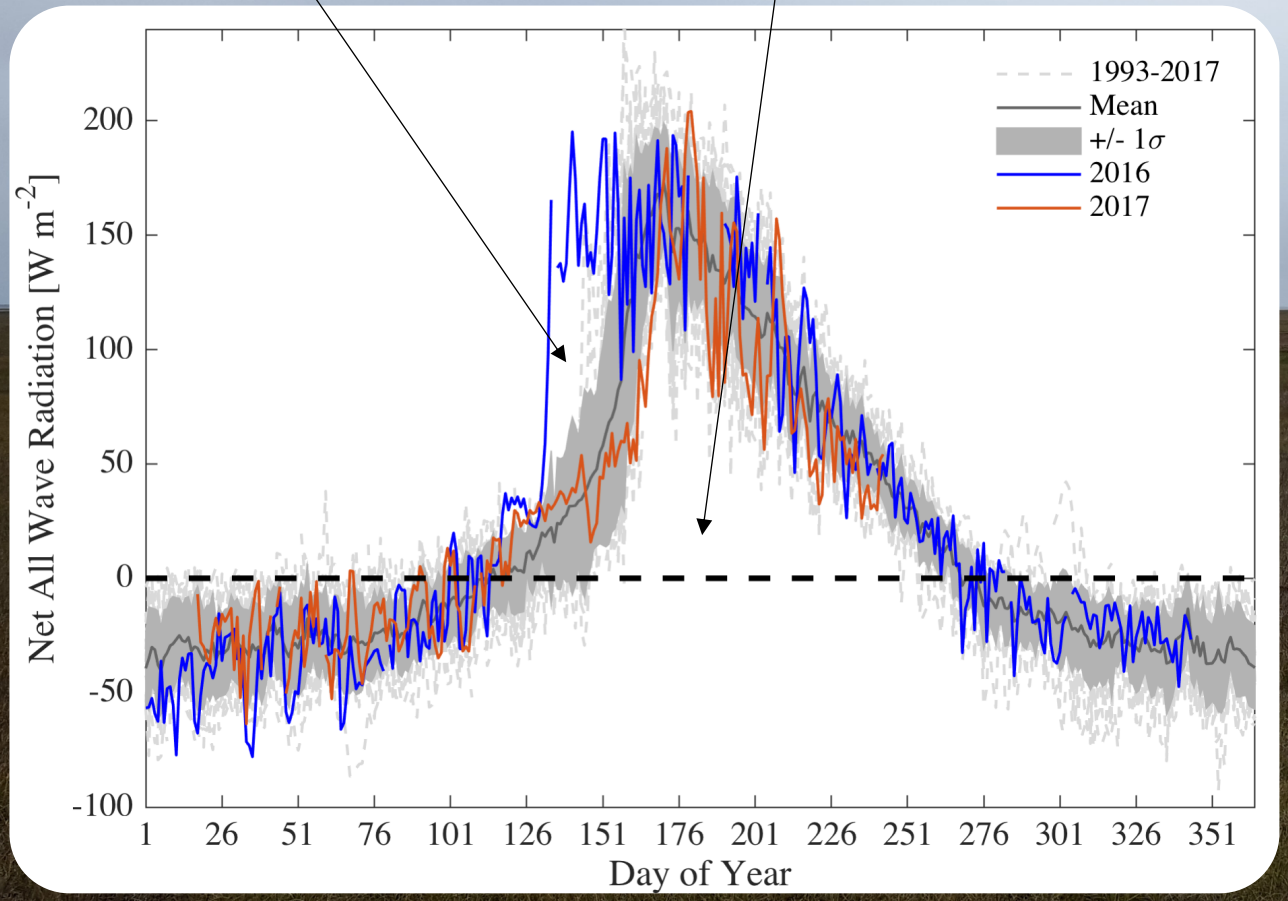
2017: latest since 1988

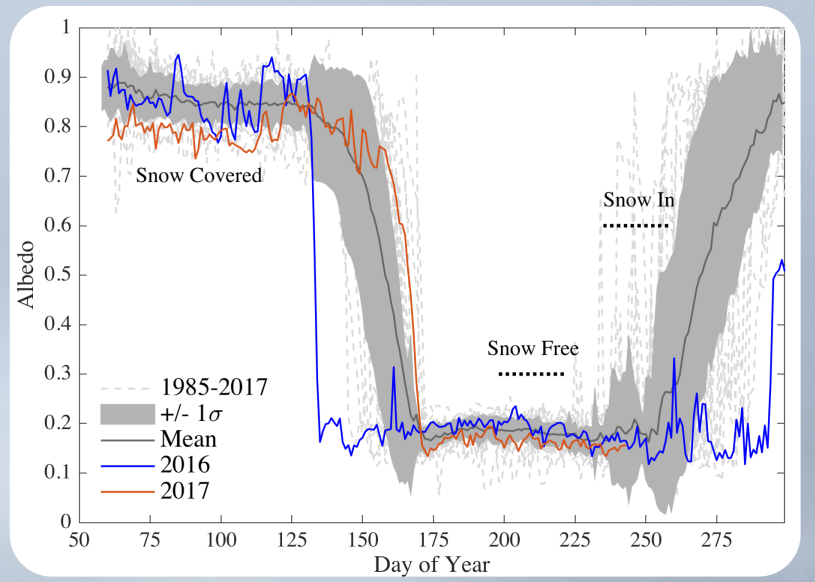
2018: latest since 1947

Impact on the surface radiation budget

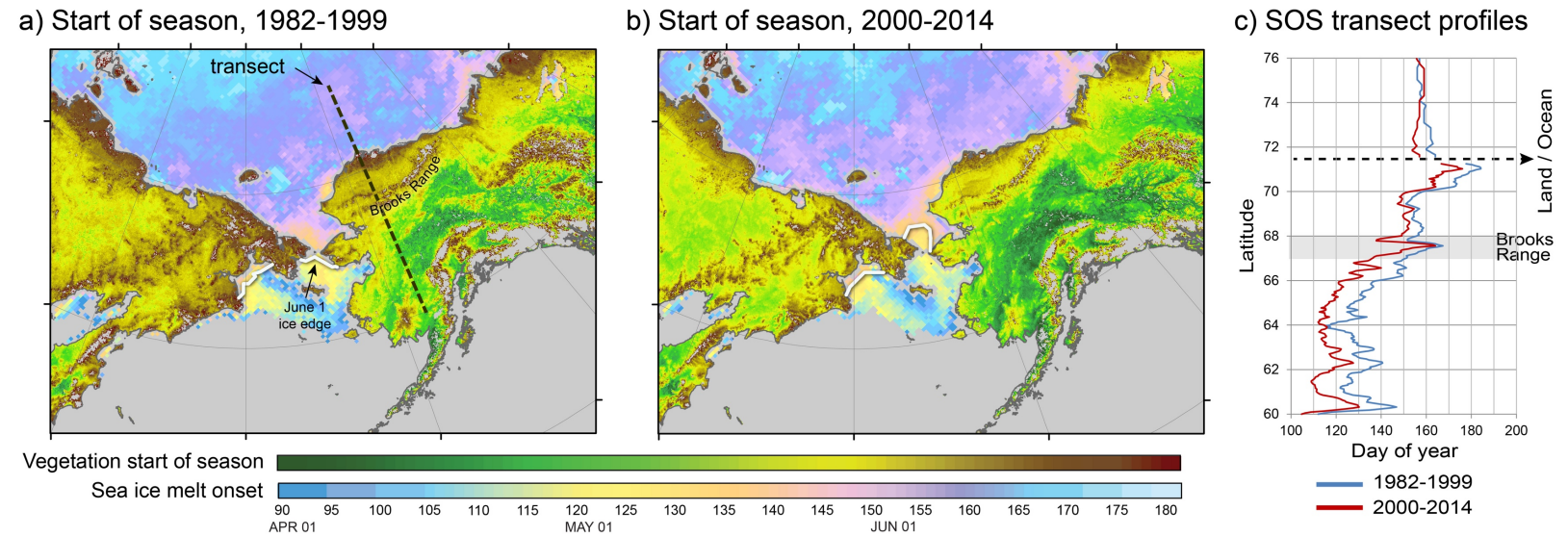
~294 MJ more in 2016 than 2017

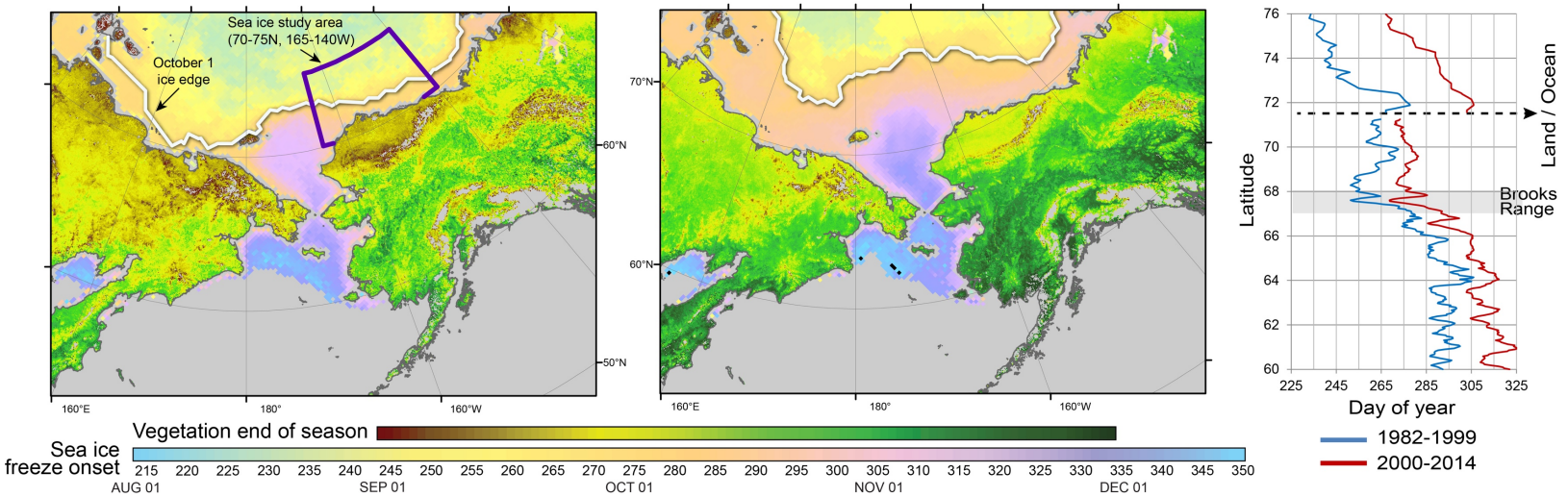
~969 MJ avg for positive net-rad period





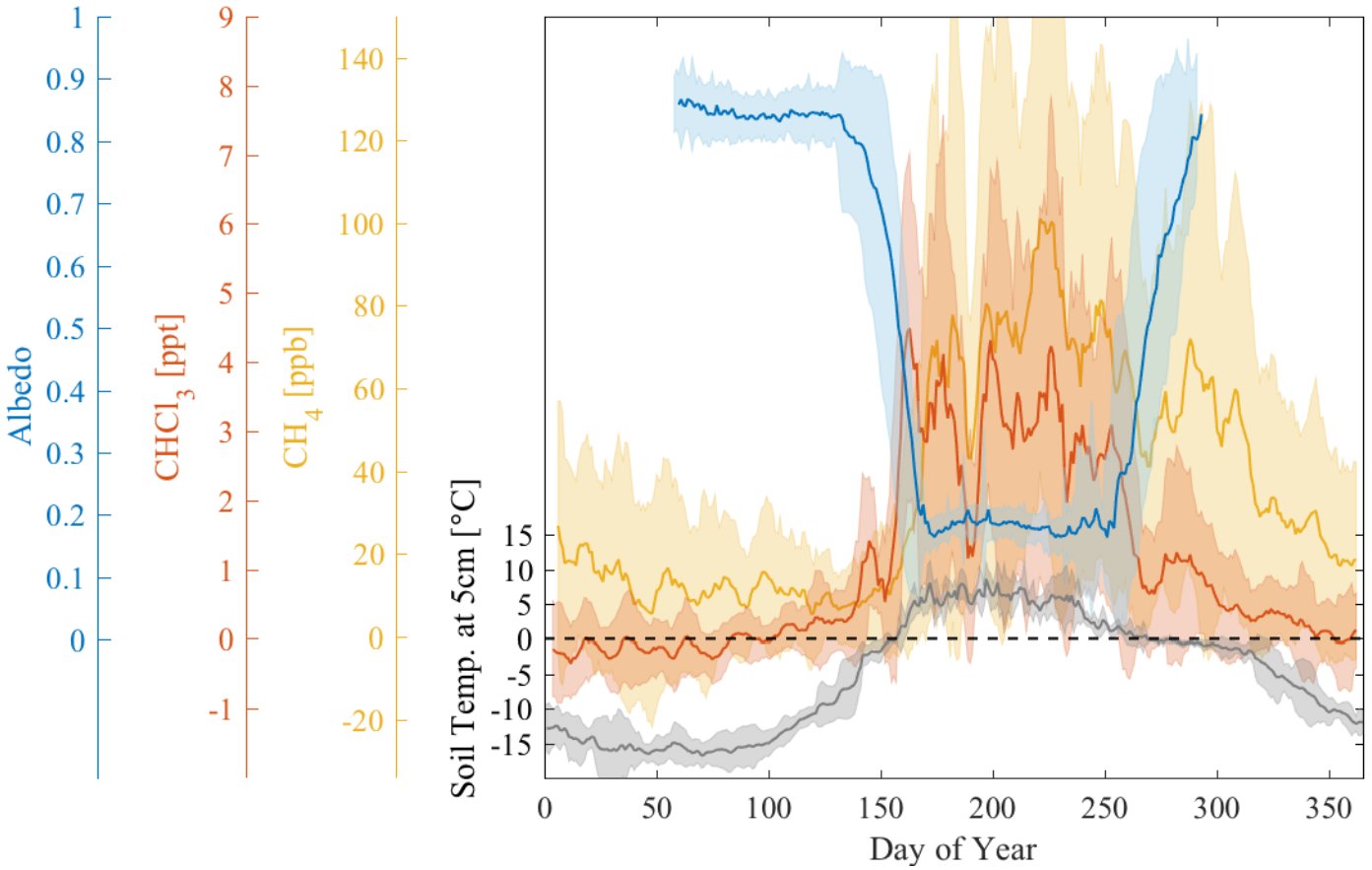
Why does this matter?





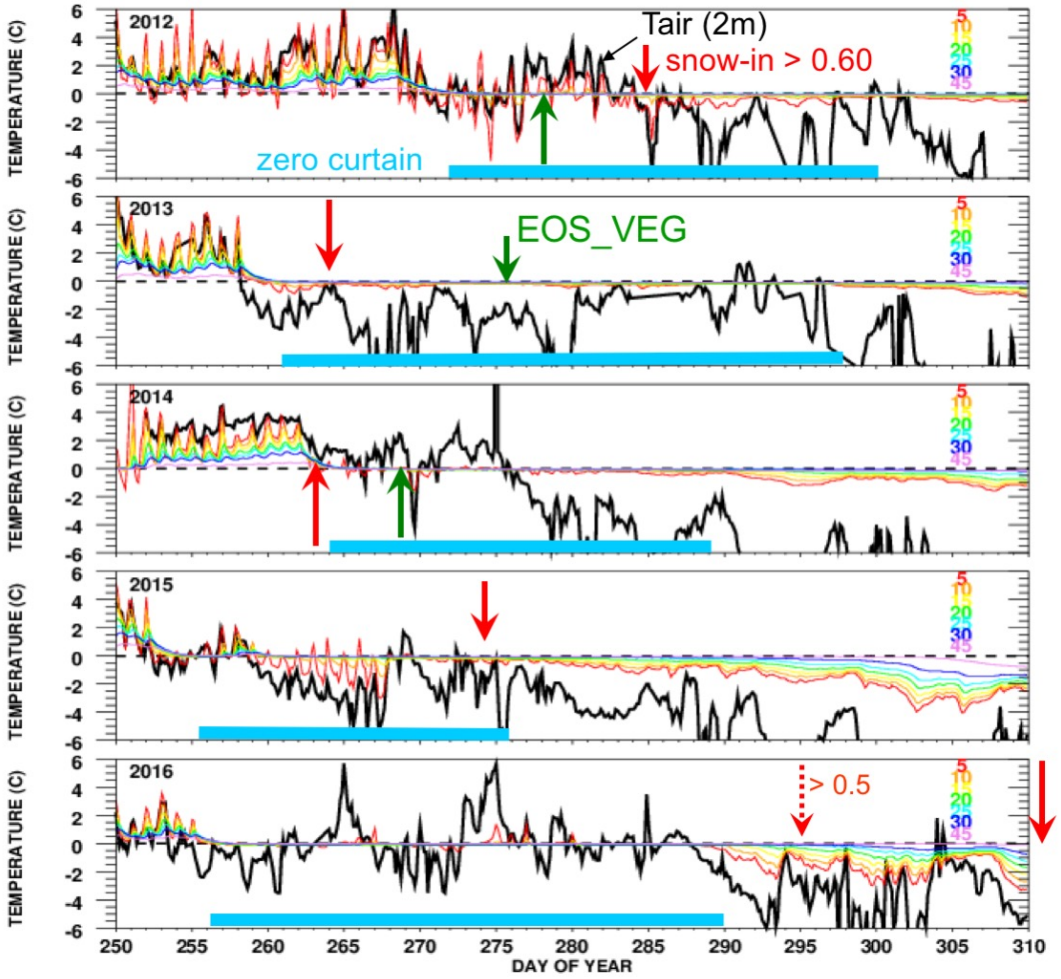
- Vegetation Phenology

Why does this matter?



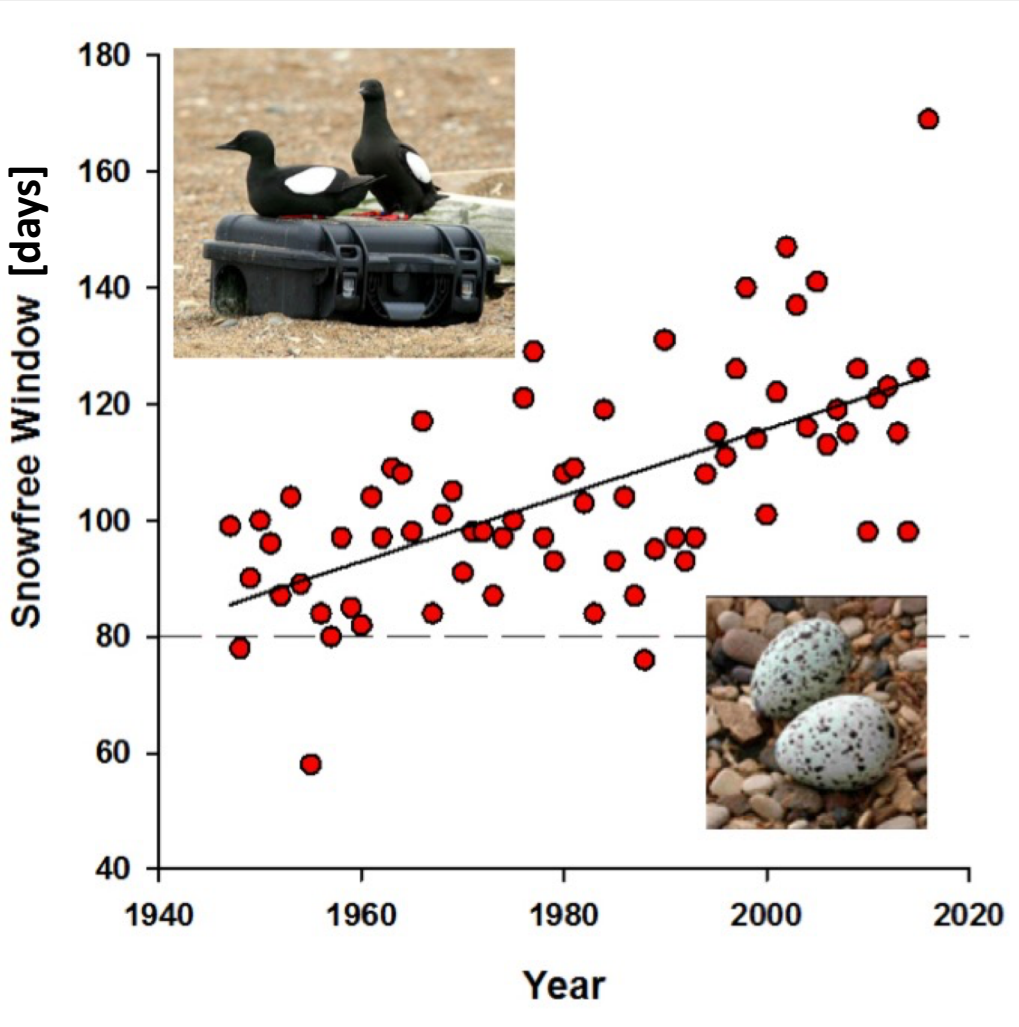
- Vegetation Phenology
- Biogeochemical Cycles

Why does this matter?



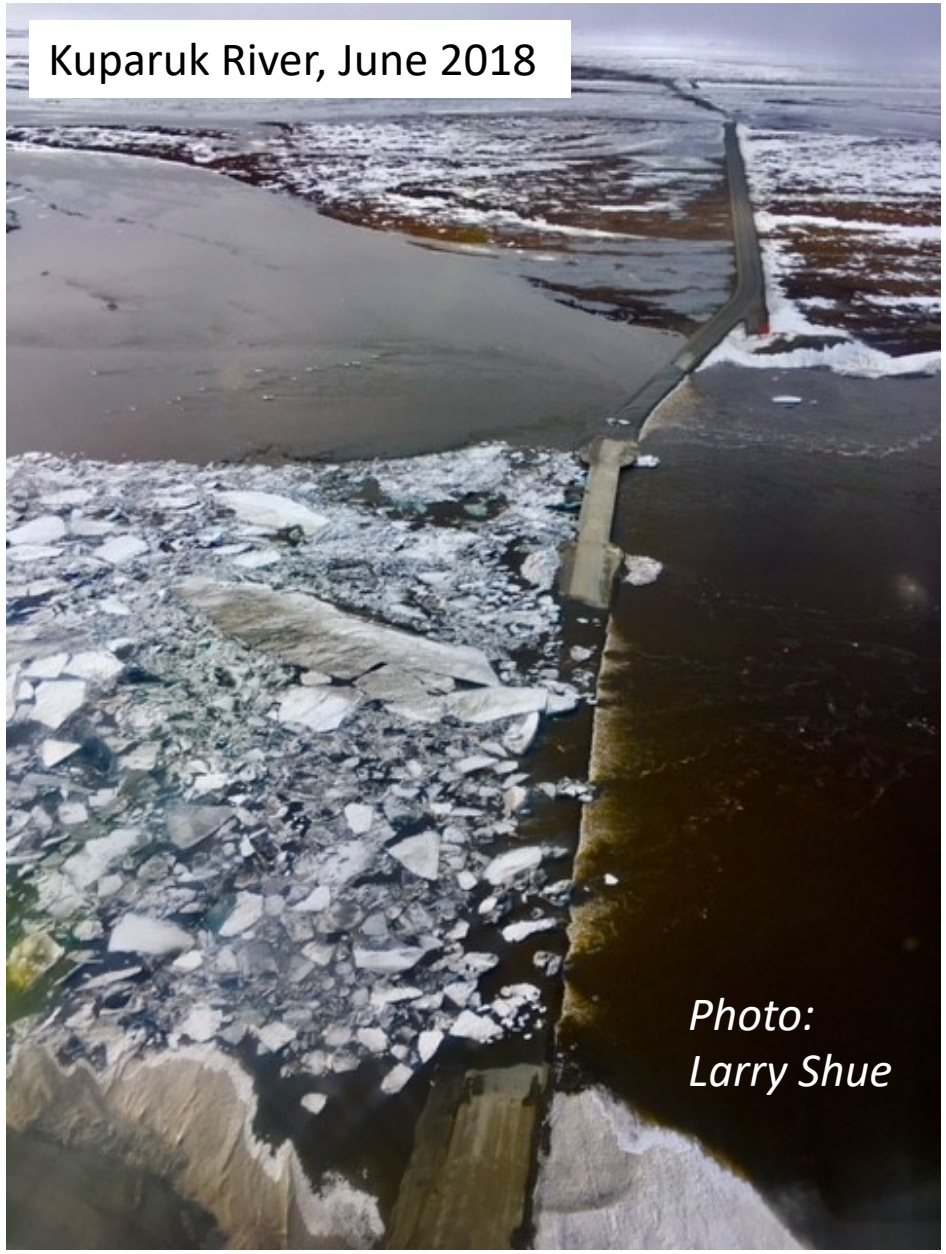
- Vegetation Phenology
- Biogeochemical Cycles
- Soil Temperature and Active Layer Depth

Why does this matter?



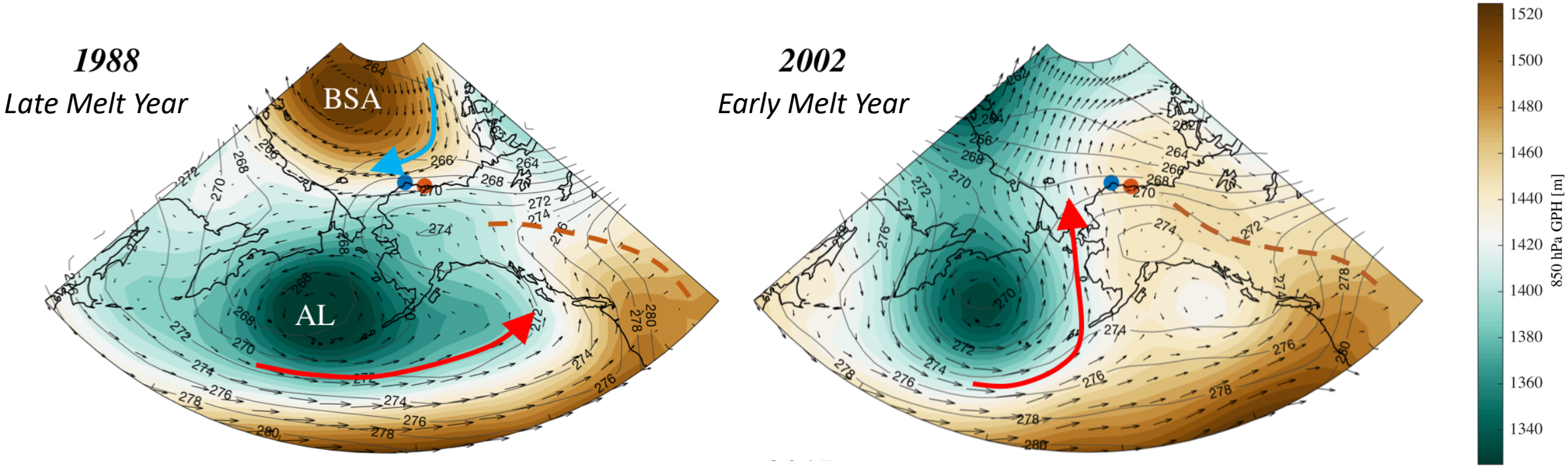
- Vegetation Phenology
- Biogeochemical Cycles
- Soil Temperature and Active Layer Depth
- Ecology

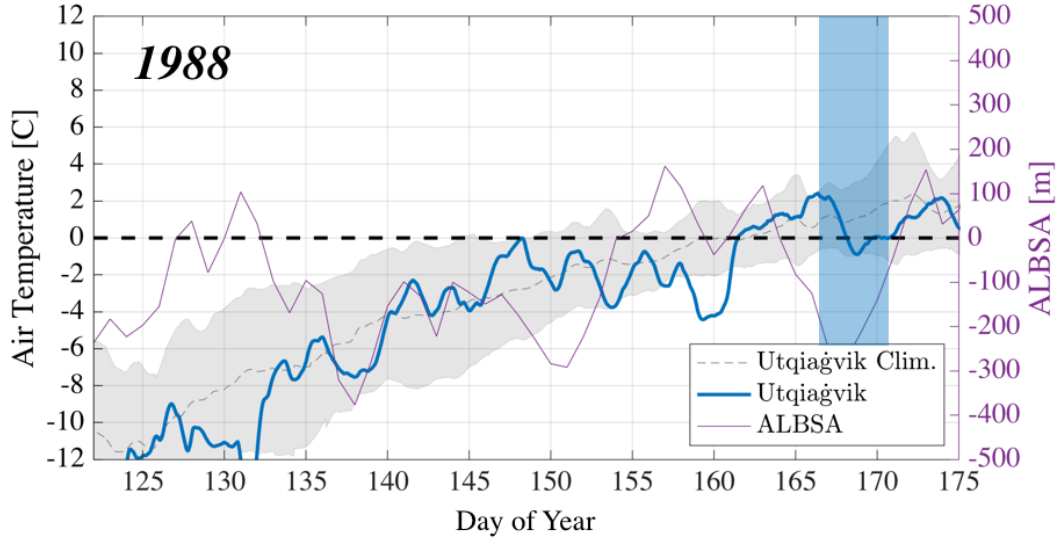
Why does this matter?

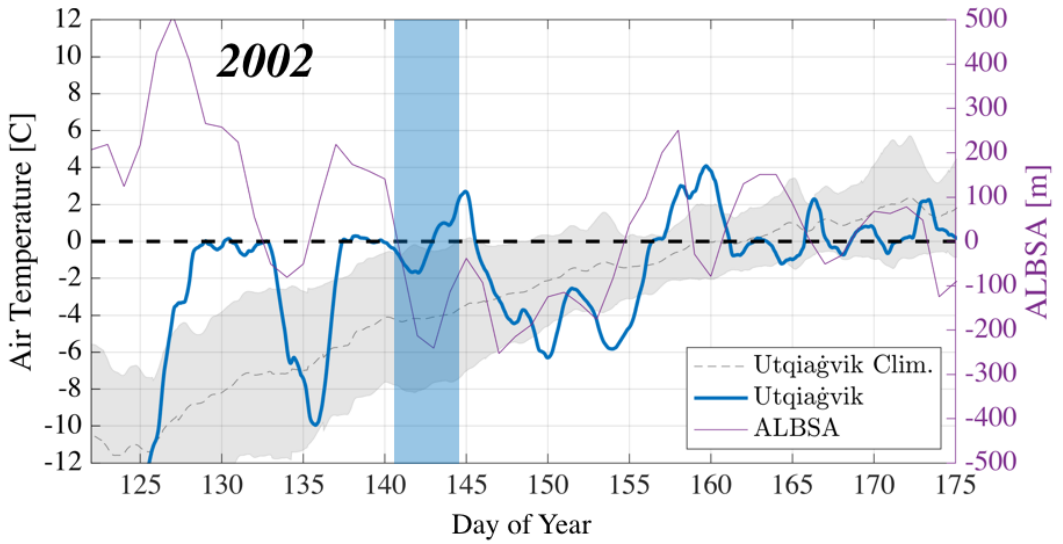


- Vegetation Phenology
- Biogeochemical Cycles
- Soil Temperature and Active Layer Depth
- Ecology
- Seasonal Planning

May Average 850 hPa GPH

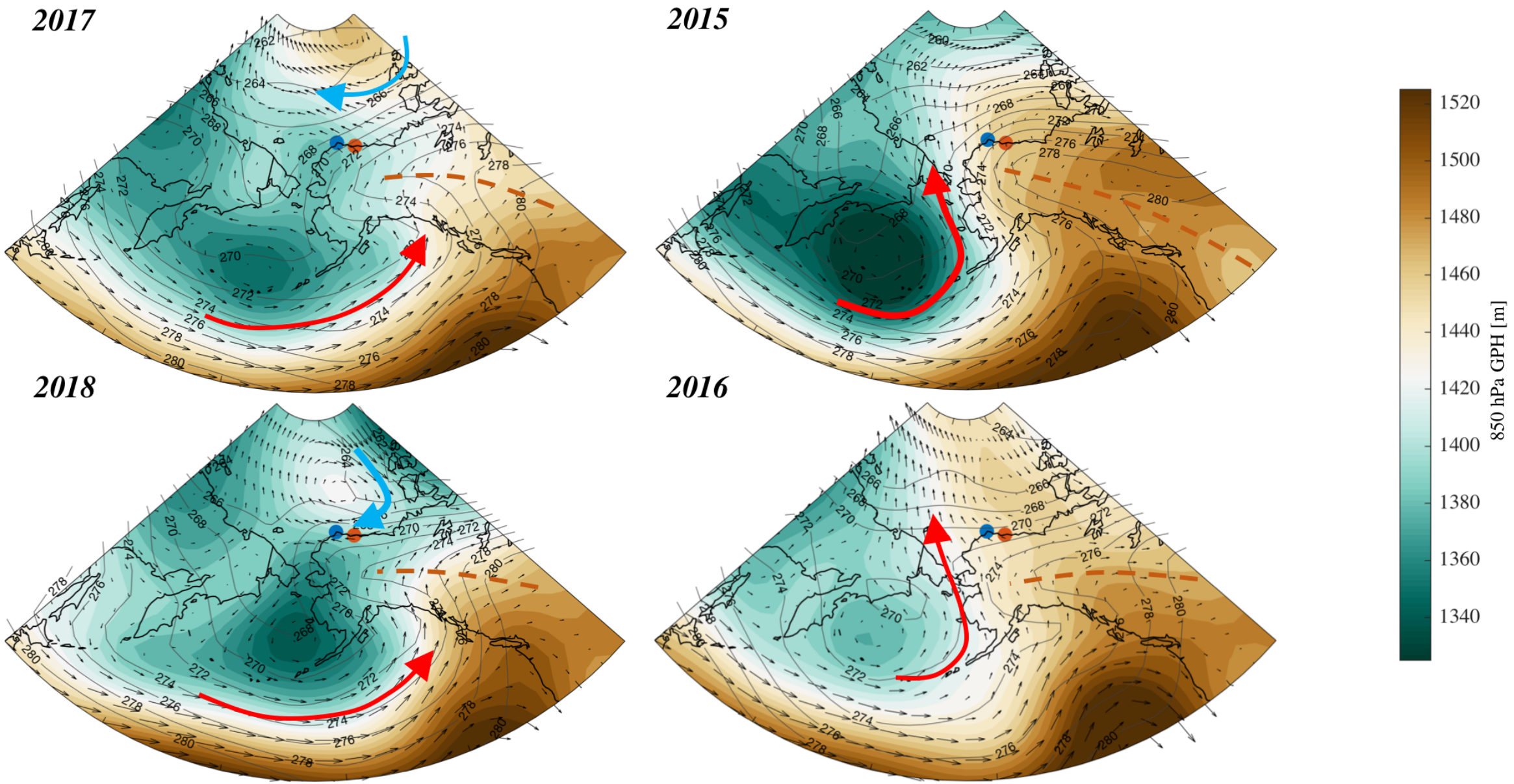




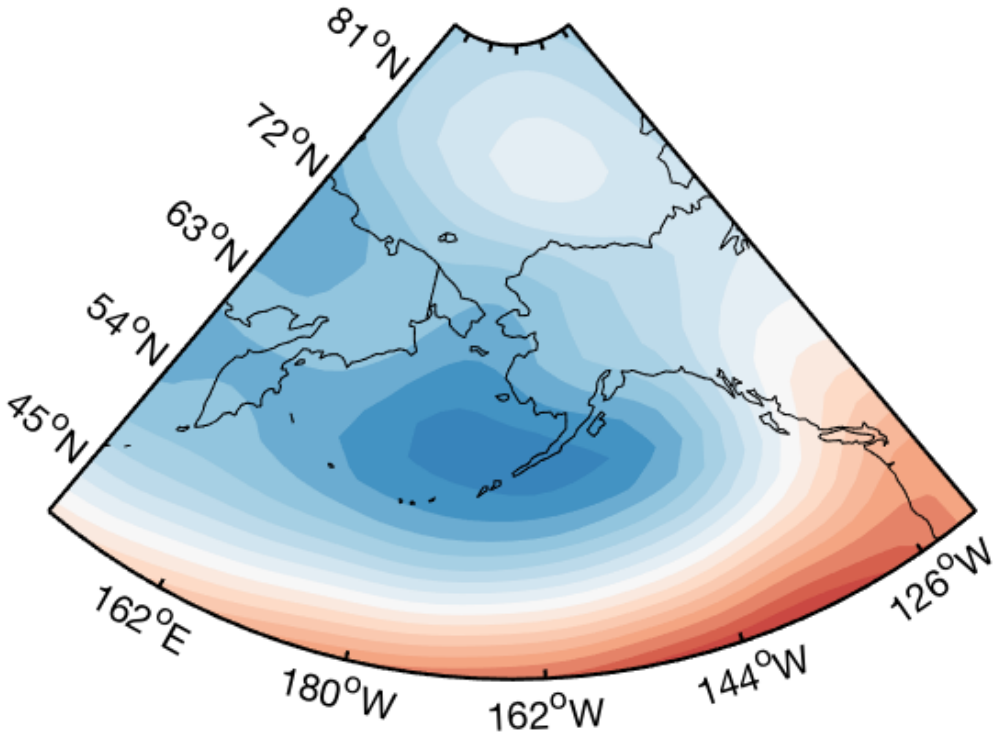


Late Melt Years

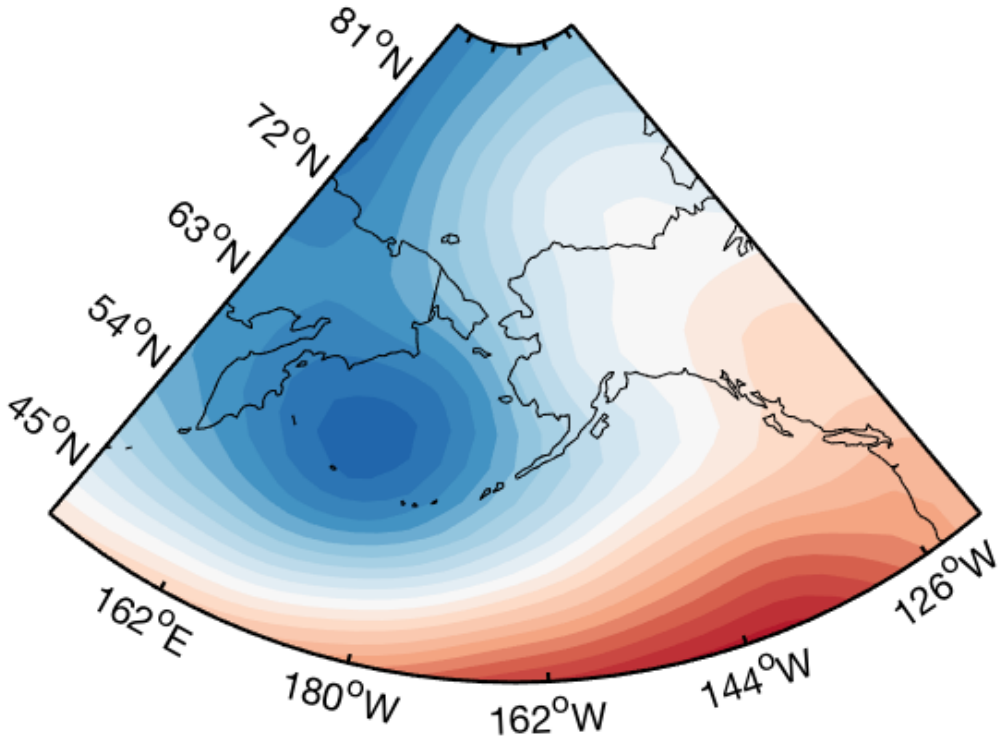
Early Melt Years



Years >= 5 Days late

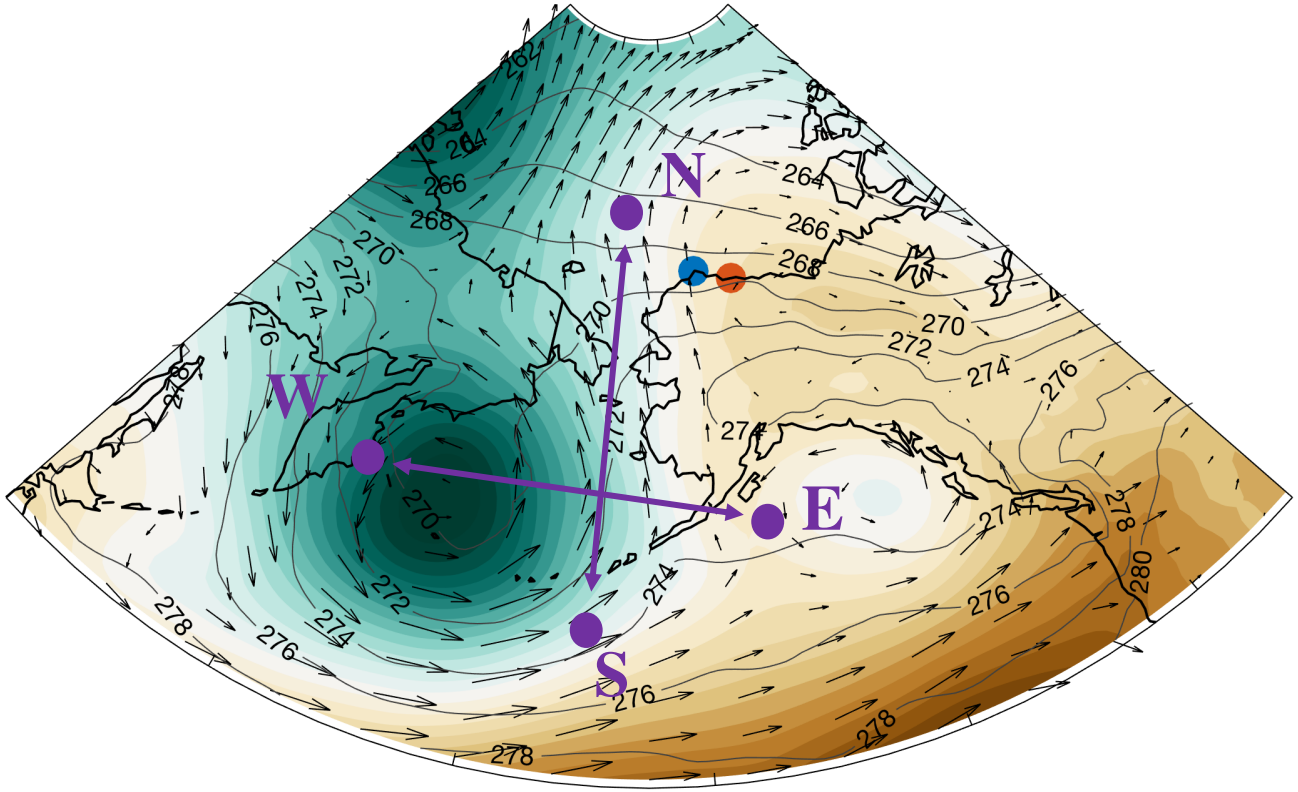


Years <= 5 Days early



Aleutian Low Beaufort Sea Anticyclone

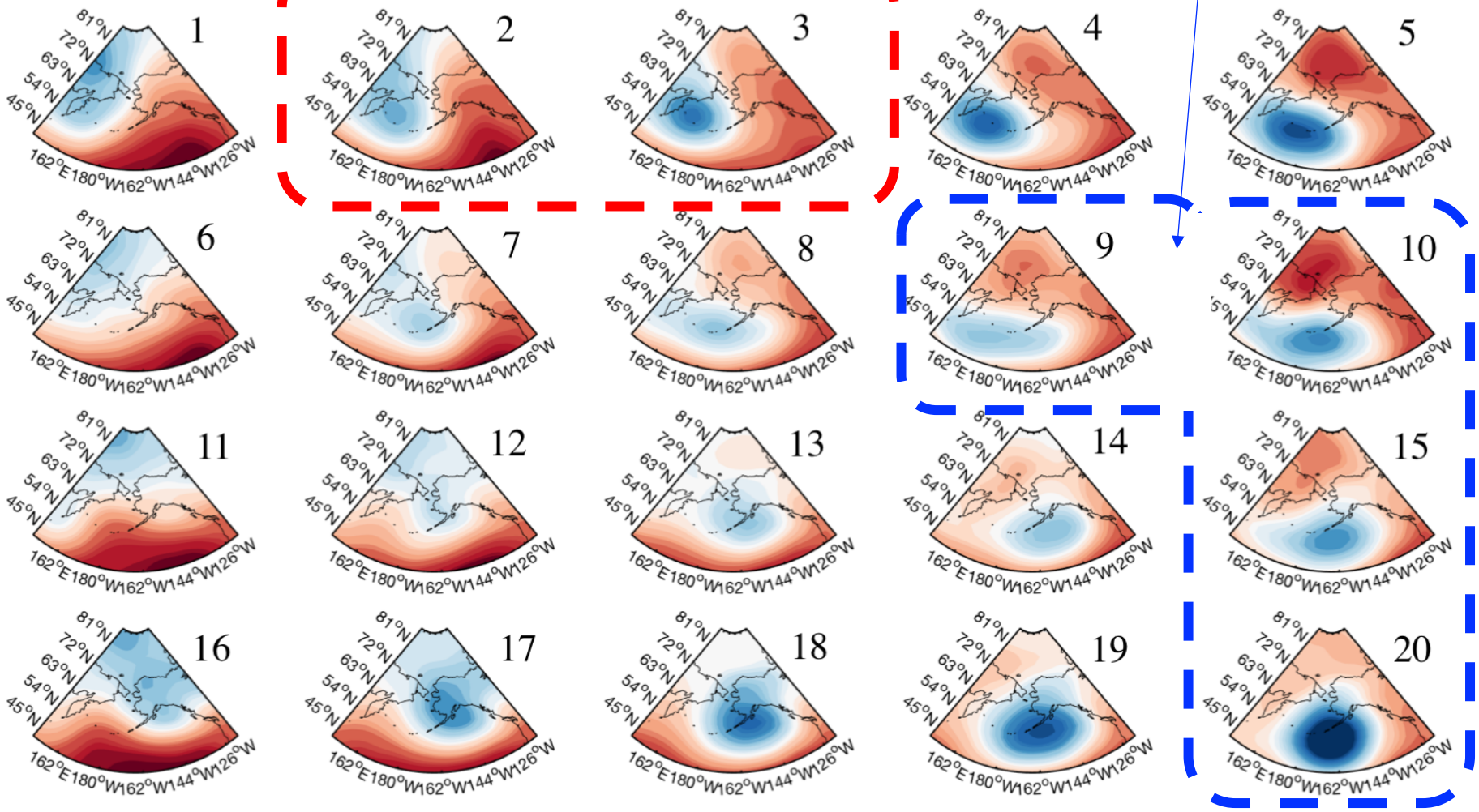
ALBSA = [E-W] – [N-S]

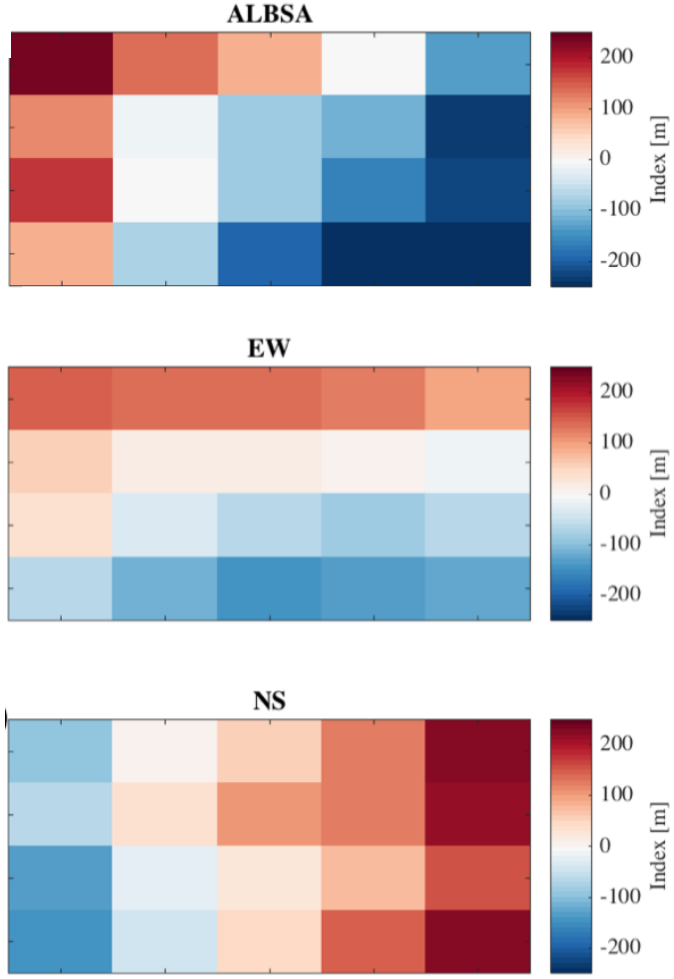


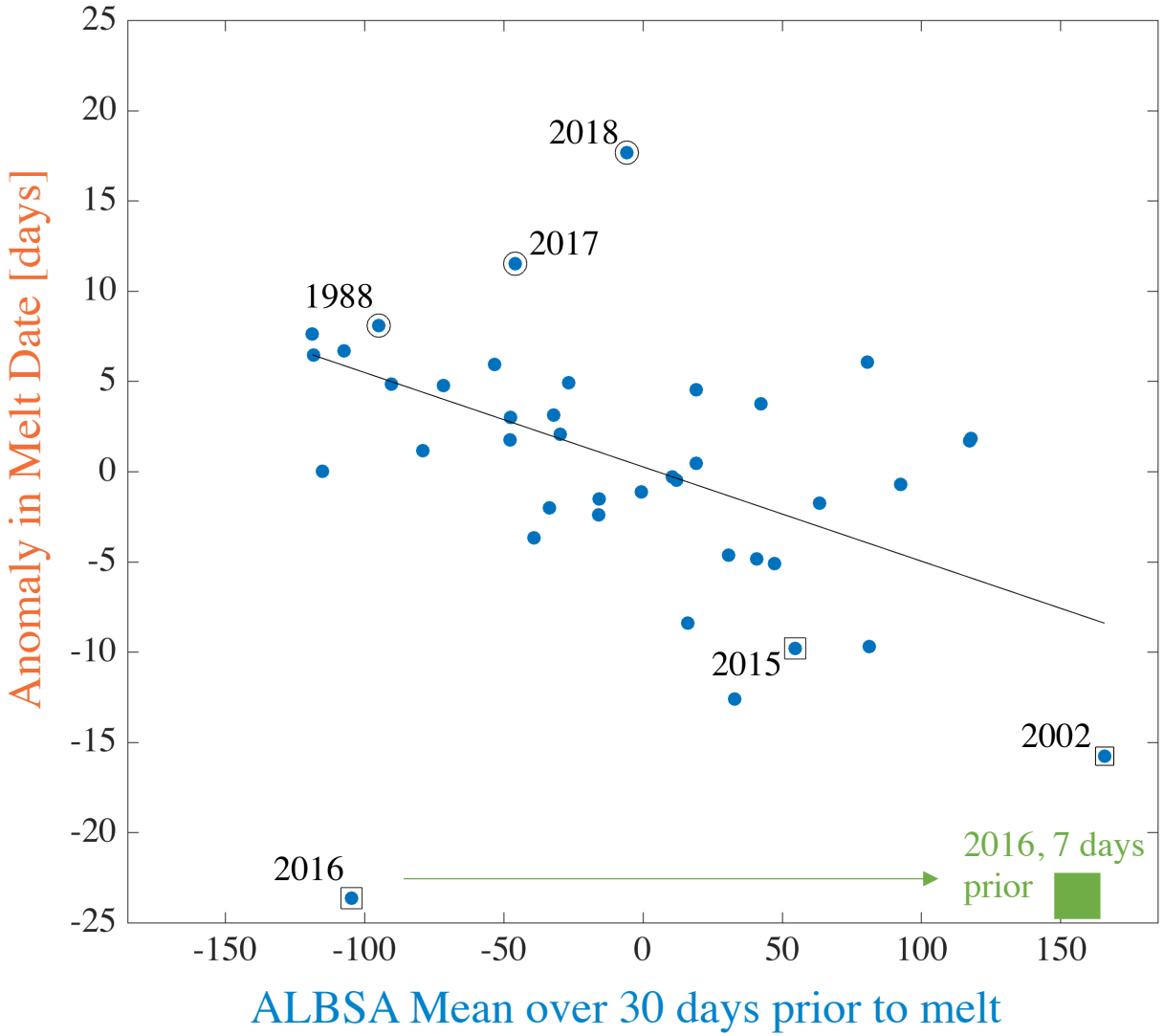
Mapping May-average ALBSA to a Self Organizing Map

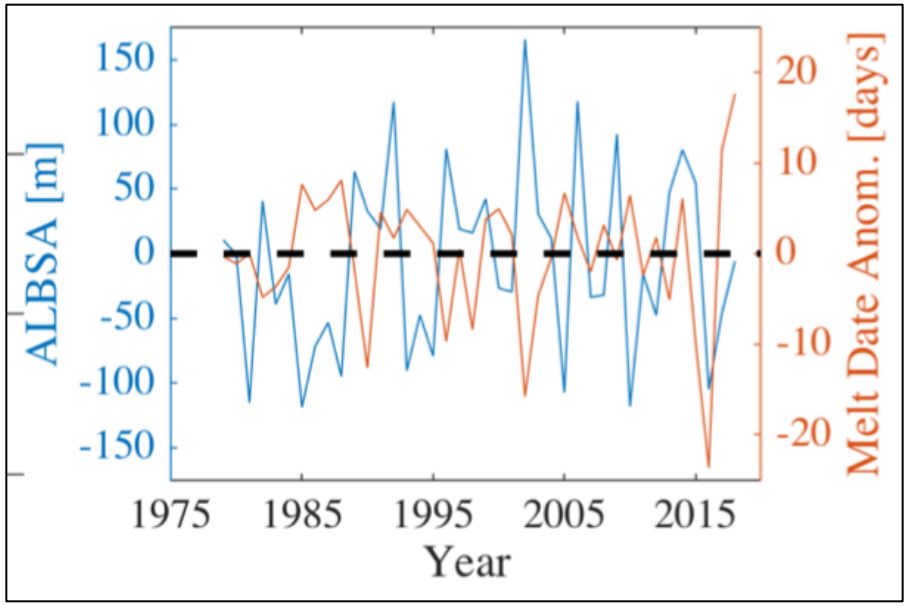
These are the main early melt patterns

These are the some late melt patterns

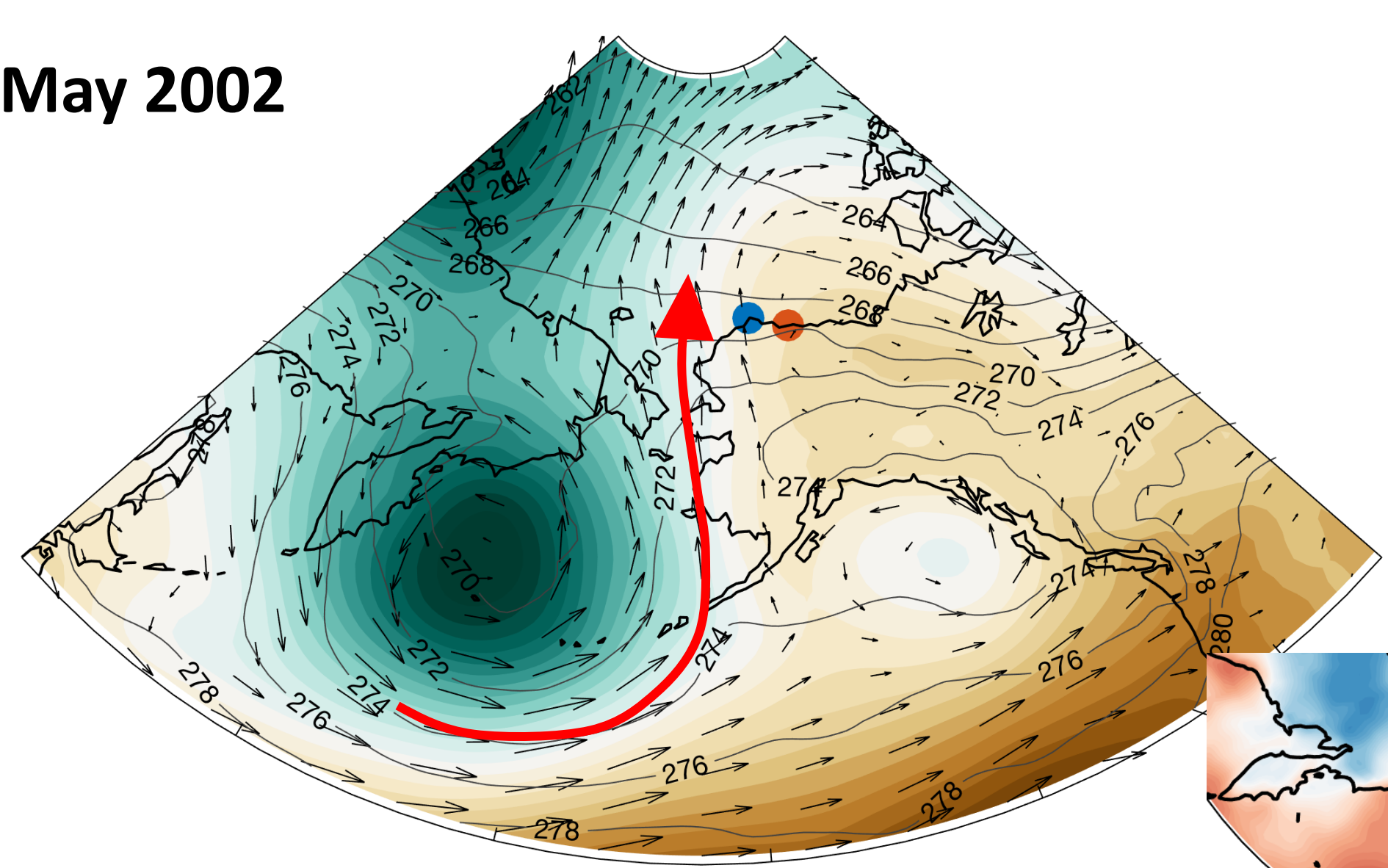




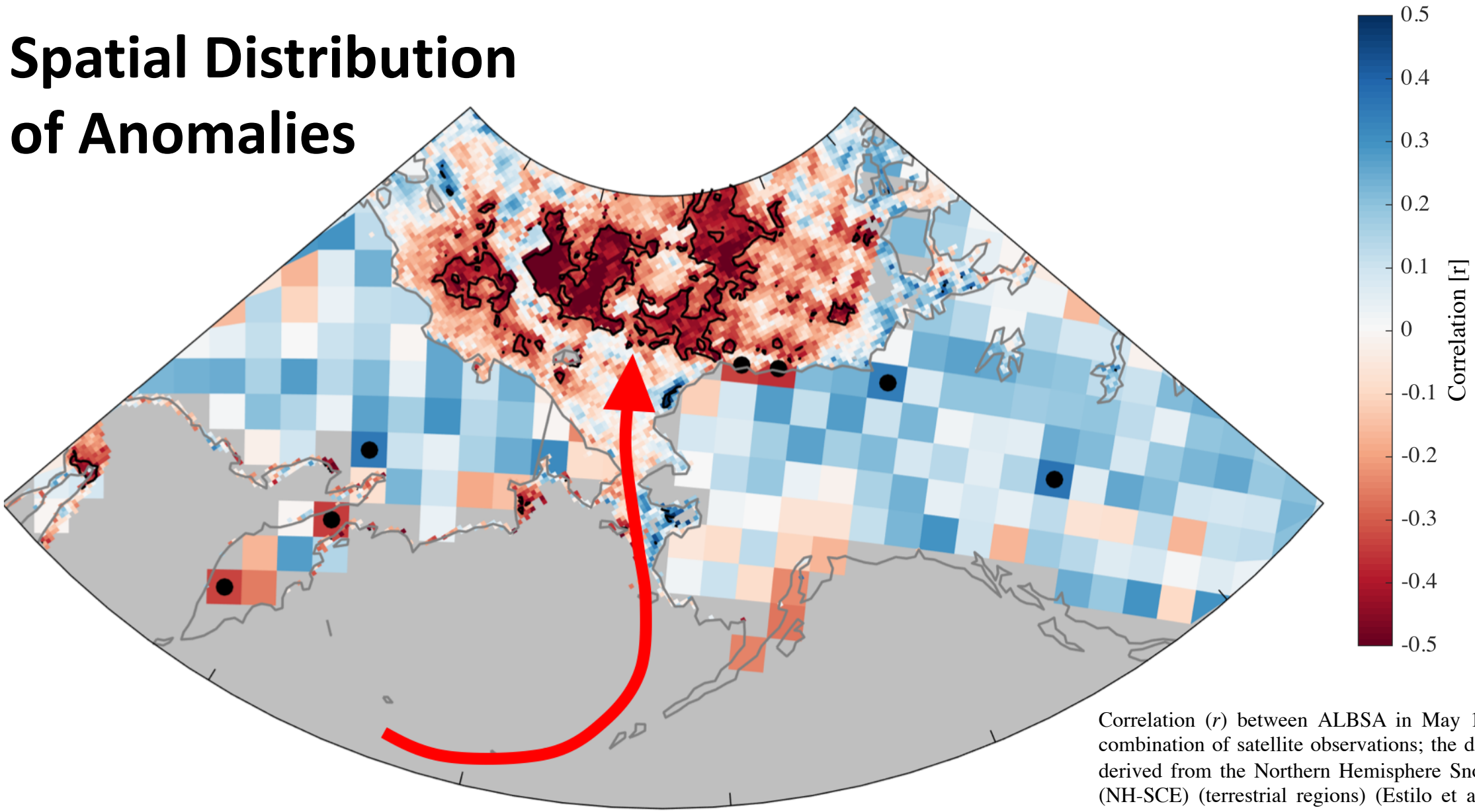

Anomaly in Melt Date [days]
25
20
15
10
5
0
-5
-10
-15
-20
-25
2018
2017
1988
2015
2002
2016
2016, 7 days prior
-150
-100
-50
0
50
100
150
ALBSA Mean over 30 days prior to melt


ALBSA [m]
150
100
50
0
-50
-100
-150
Melt Date Anom. [days]
20
10
0
-10
-20
1975
1985
1995
2005
2015
Year

May 2002

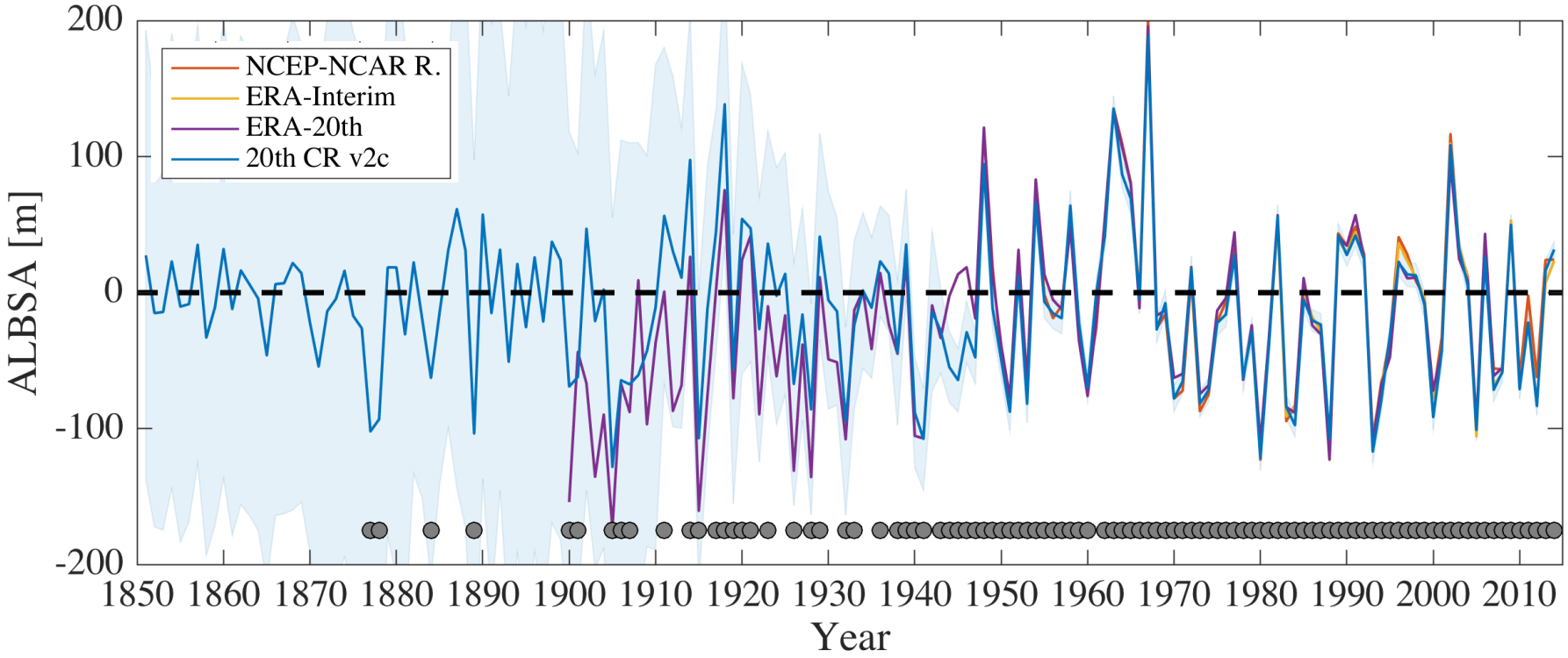


Spatial Distribution of Anomalies



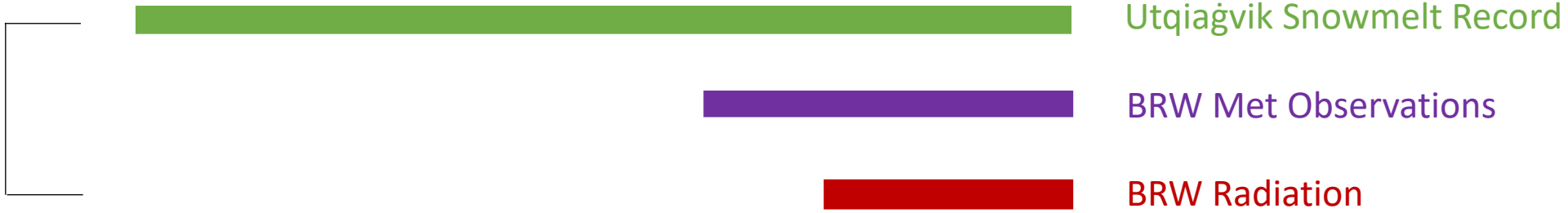
Correlation (*r*) between ALBSA in May 1979-2017 and a combination of satellite observations; the date of snow melt derived from the Northern Hemisphere Snow Cover Extent (NH-SCE) (terrestrial regions) (Estilo et al. 2015) and the date of melt onset over sea ice derived from SSM/I passive microwave data (sea ice regions) (Markus et al. 2009).

Long Term ALBSA Record (May) – 20th C. Reanalysis



Dots are years when |ALBSA| > 0 (p<0.01)

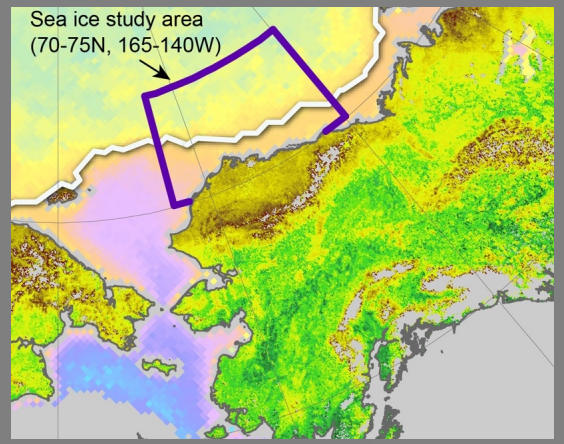
Time Lengths of Relevant Data Sets



Thanks to Gil Compo for help with 20CR

Conclusions

- **The date of snowmelt at Utqiaġvik has been documented by NOAA-NWS/NOAA-GMD for 101 of the past 117 years and every year since 1925.**
- **Extraordinary interannual variability from 2015-2018 motivates re-examination of the record and efforts to improve predictions of the timing of melt with lead times of weeks to months.**
- **The timing of snowmelt on Alaska's north coast and melt onset over sea ice in the Beaufort and Chukchi Seas are influenced by advection facilitated by the juxtaposition of the Aleutian Low and the Beaufort High.**
- **We developed a 4-pt climate index, "ALBSA", that represents the variability in Pacific-Arctic atmospheric circulation.**
- **Future efforts needed to assess predictability and incorporate state-wide observational data sets.**



DOY

320
310
300
290
280
270
260
250
240

1980
1985
1990
1995
2000
2005
2010
2015

Year

Mean Oct. Temp [C]

0
-2
-4
-6
-8
-10
-12
-14
-16
-18

EOS Ice
Mid Coast: Barrow 1
Mid Coast: Barrow 2
Mid Coast: Lonely
East Coast: Barter Is.
Prudhoe Area: Alpine
Prudhoe Area: Colville
Prudhoe Area: Prudhoe 1
Prudhoe Area: Prudhoe 2
Inland: Sagwon
Inland: Inigok
Inland: Kuparuk
Inland: Deadhorse 1
Inland: Deadhorse 2
West Coast: Wainwright
West Coast: Lisburne
ARM NSA
ARM ATQ
ARM OLI