



THE WEST ANTARCTIC ICE SHEET INITIATIVE

Julian, CA
2014

MODIS Terra, 2 Jan 2011



ANT-0838975



Satellite Imagery



Satellite Data



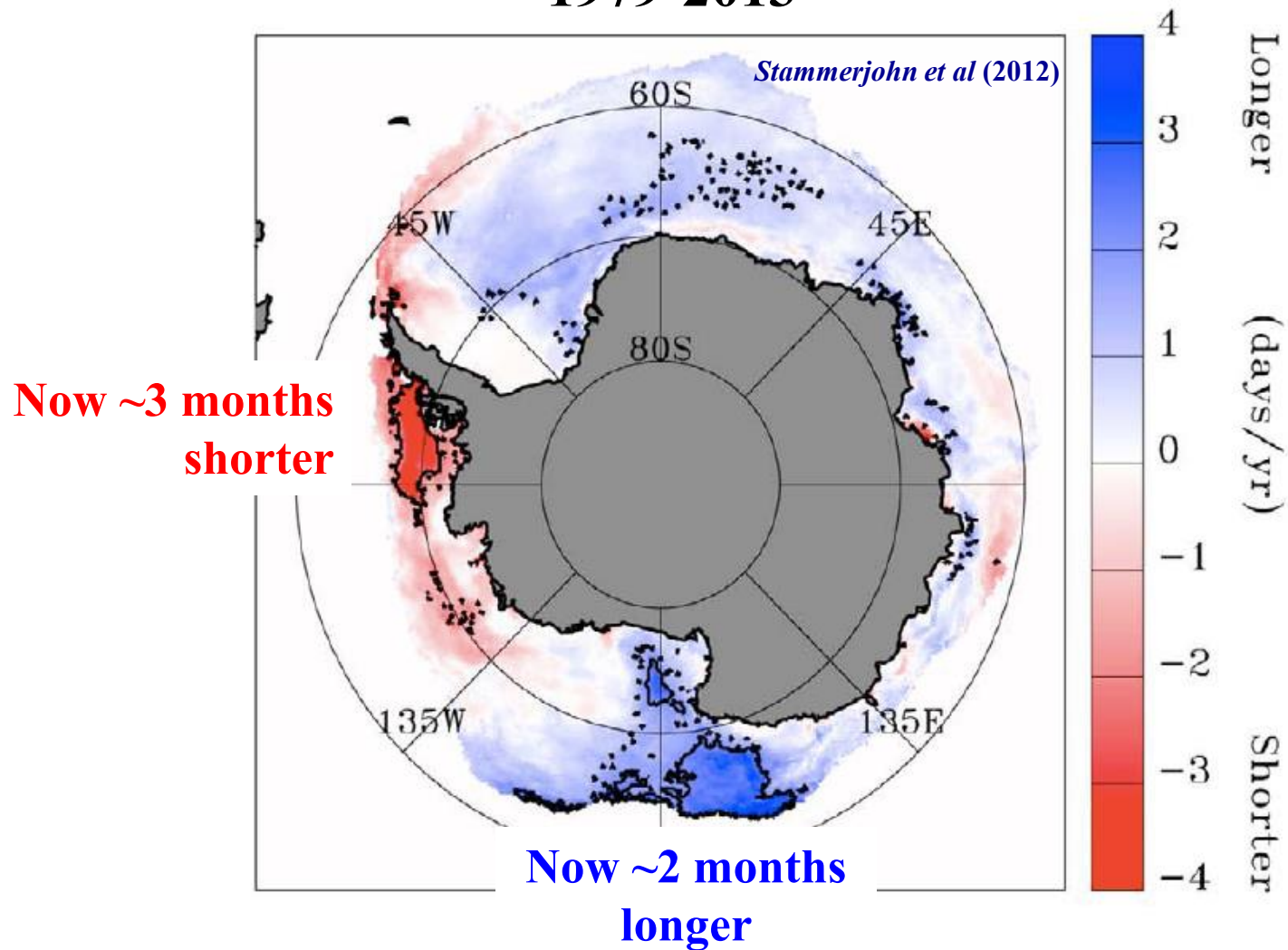
Home

Localized Sea Ice Changes in the Amundsen Sea

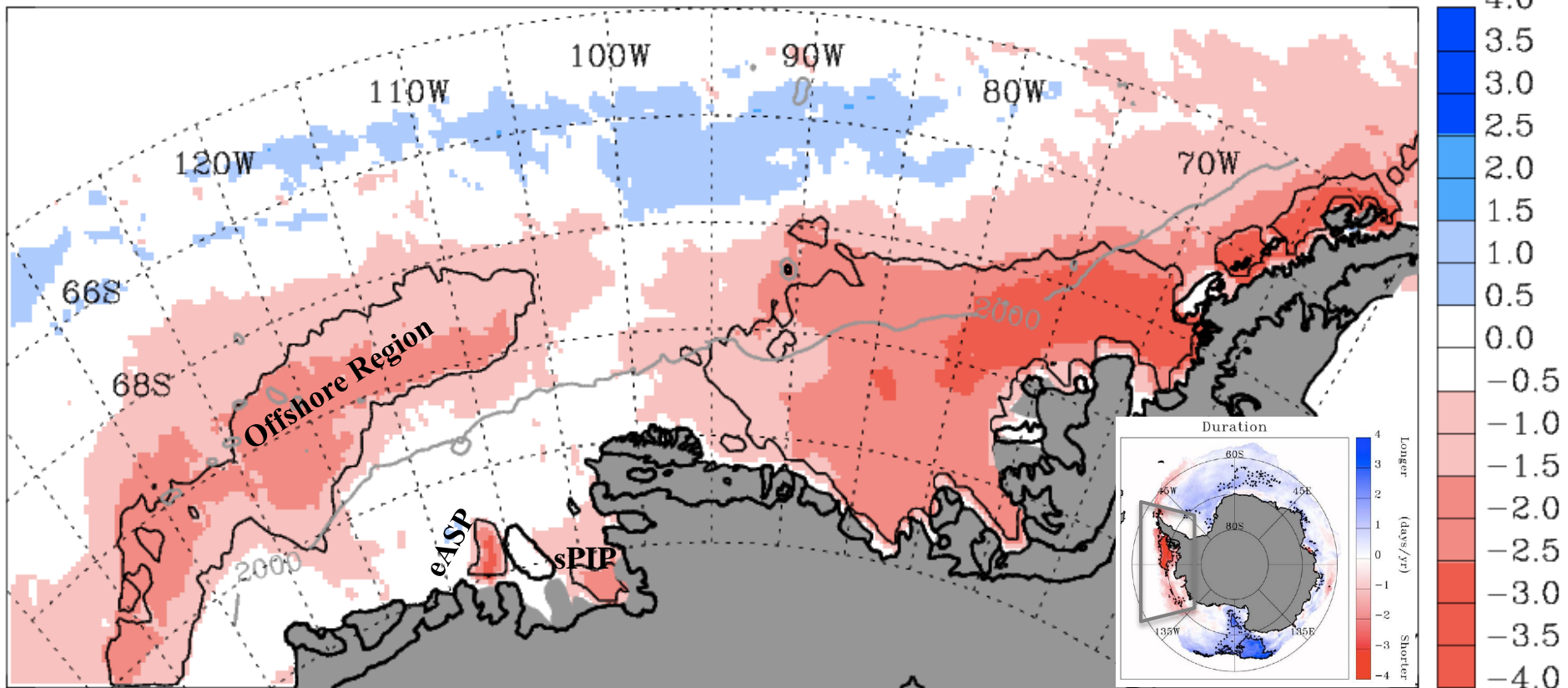
Sharon Stammerjohn¹, Ted Maksym², Rob Massom^{3,4}, Kate Lowry⁵, Kevin Arrigo⁵, Xiaojun Yuan⁶, Marilyn Raphael⁷, Evan Randall-Goodwin⁸, Rob Sherrell⁹, Patricia Yager¹⁰

¹INSTAAR/CU-B, ²WHOI, ³AAD, ⁴ACE/CRC, ⁵Stanford, ⁶LDEO/CU, ⁷UCLA, ⁸SIO, ⁹RU, ¹⁰UGA

Ice Season Duration Trend 1979-2013



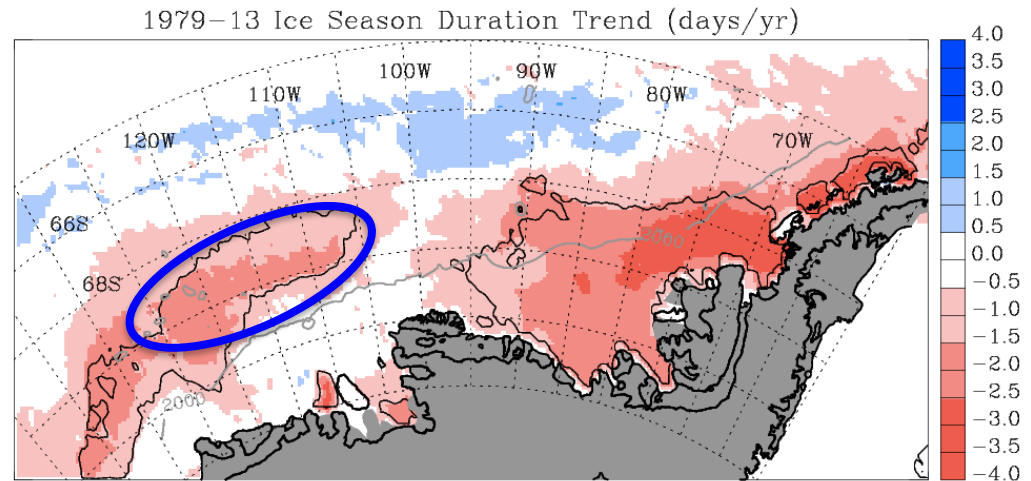
1979-2013 Ice Season Duration Trend (days/year)



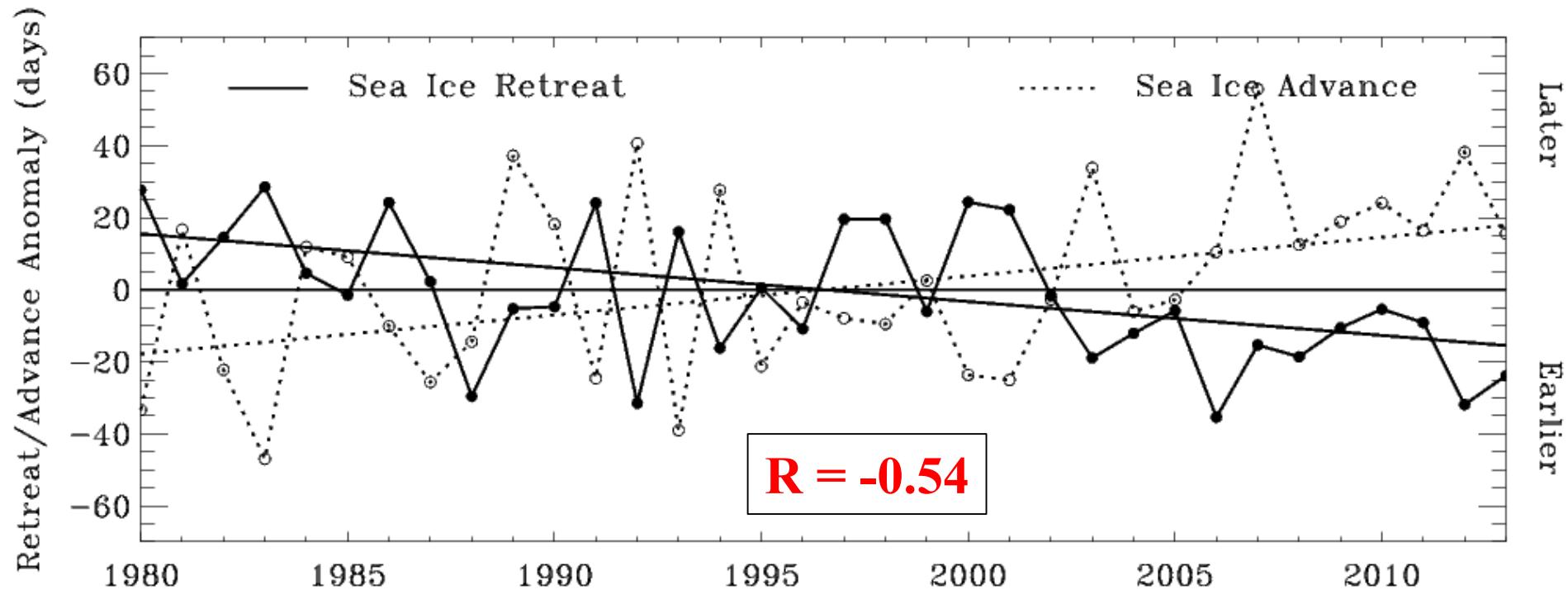
Stammerjohn et al (submitted)

**Retreat is now
22 +/- 8 days earlier
($p = 0.005$)**

**Advance is now
33 +/- 14 days later
($p = 0.01$)**

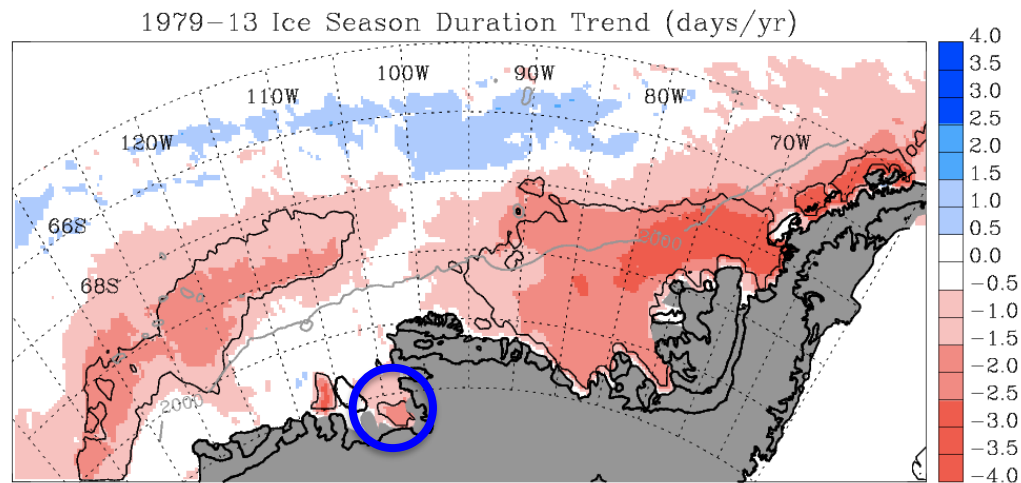


Offshore, High Trending Area

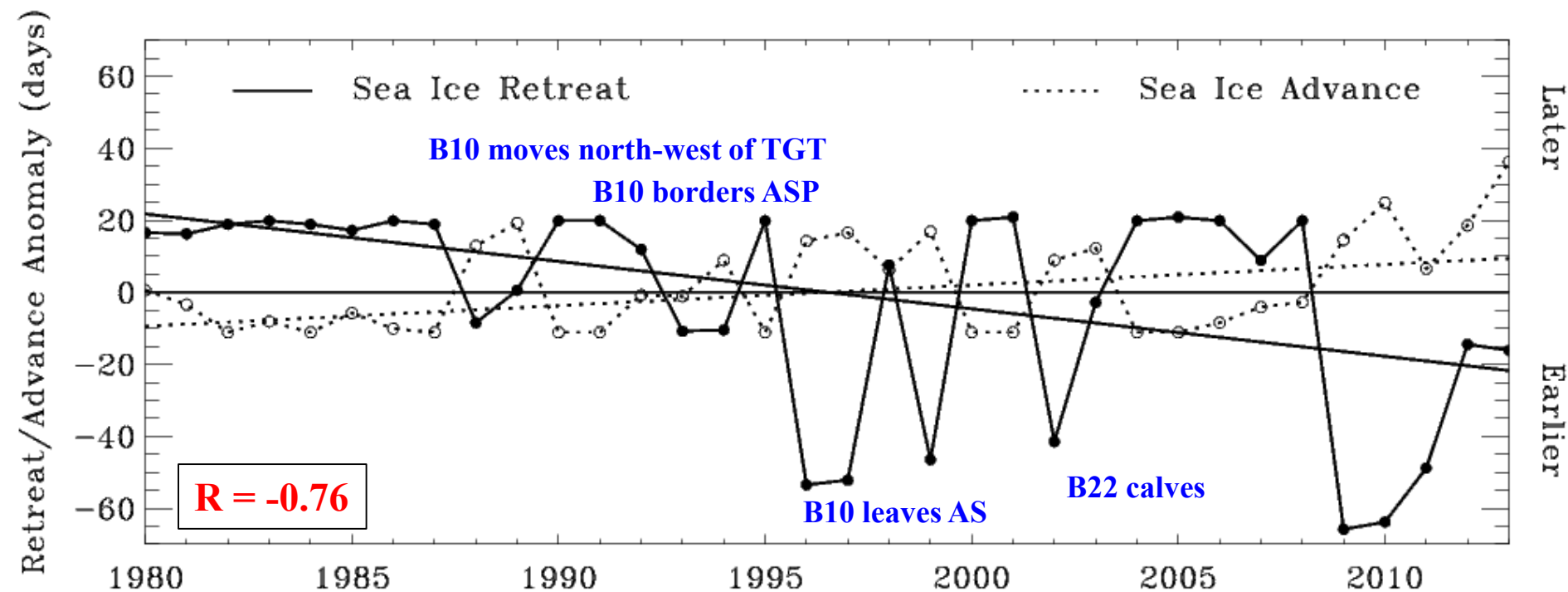


**Retreat is now
43 +/- 19 days earlier
($p=0.02$)**

**Advance is now
21 +/- 8 days later
($p=0.01$)**

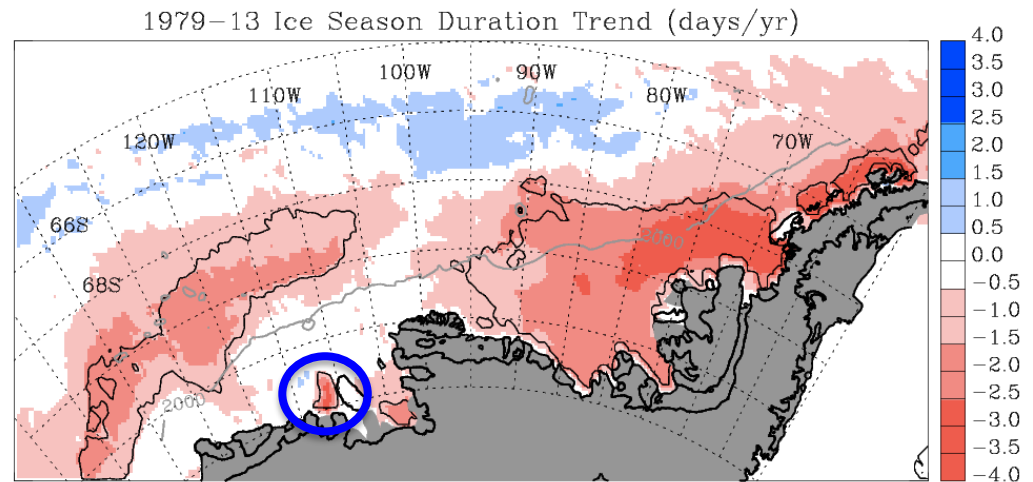


Pine Island Polynya

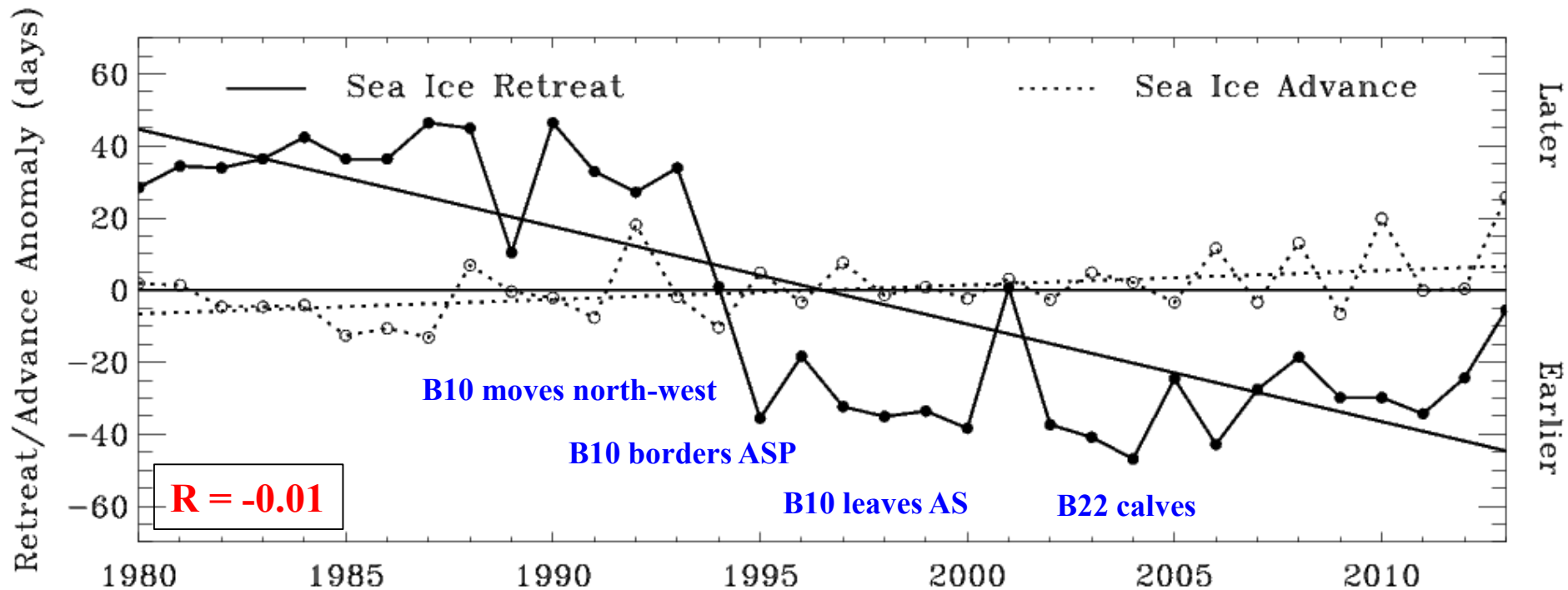


**Retreat is now
67 +/- 14 days earlier
($p < 0.001$)**

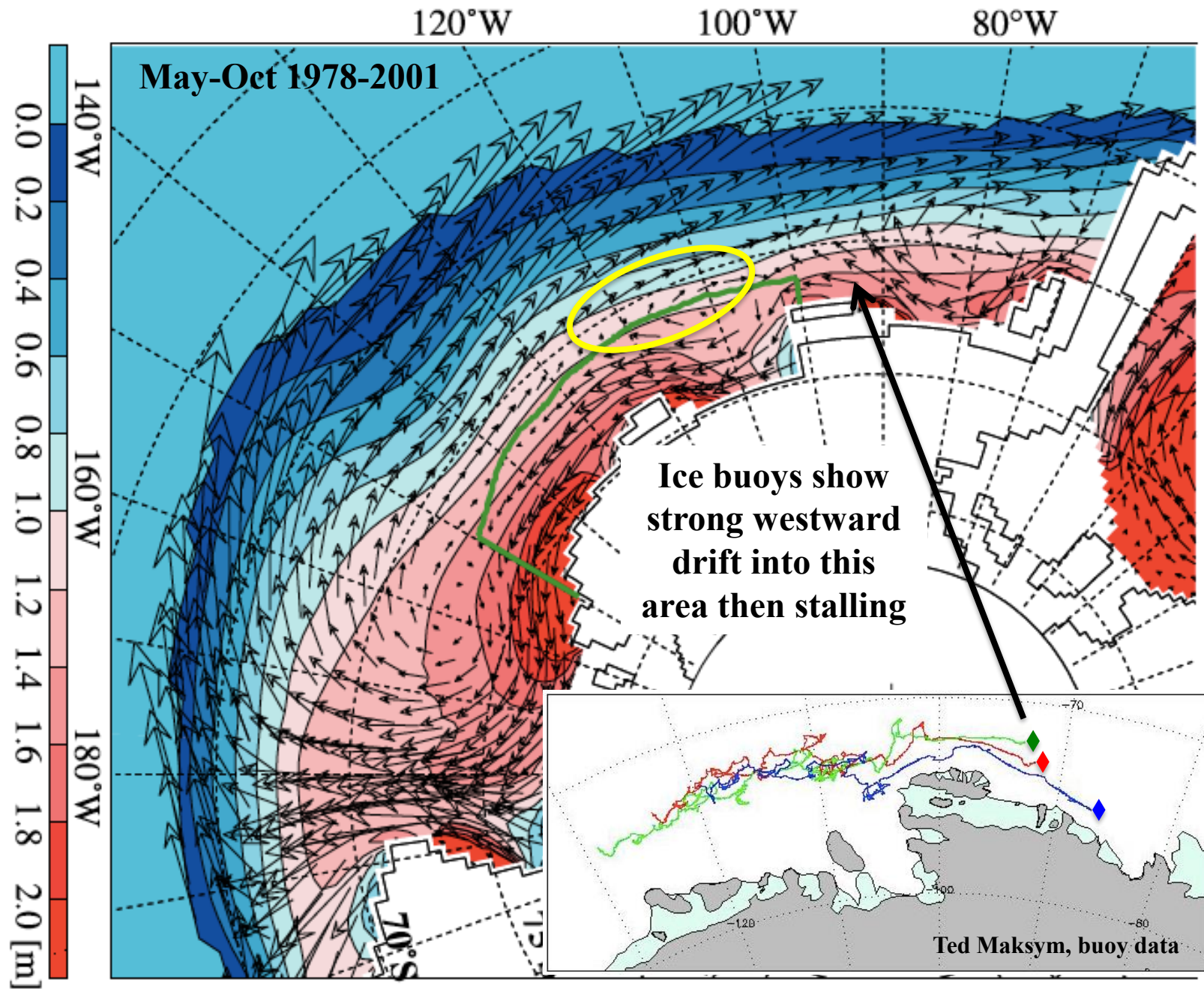
**Advance is now
13 +/- 7 days later
($p = 0.04$)**



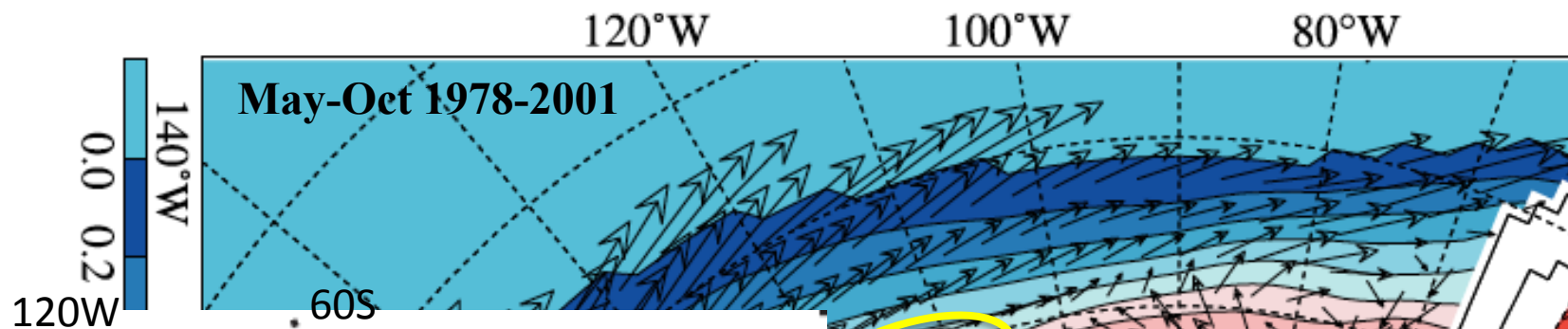
Amundsen Sea Polynya



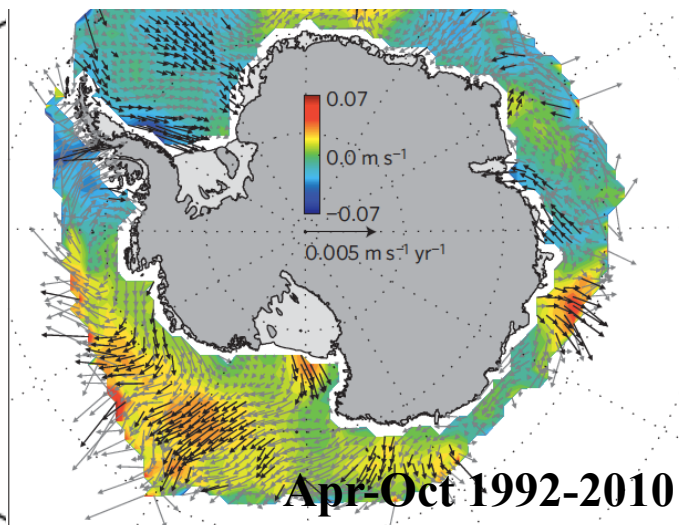
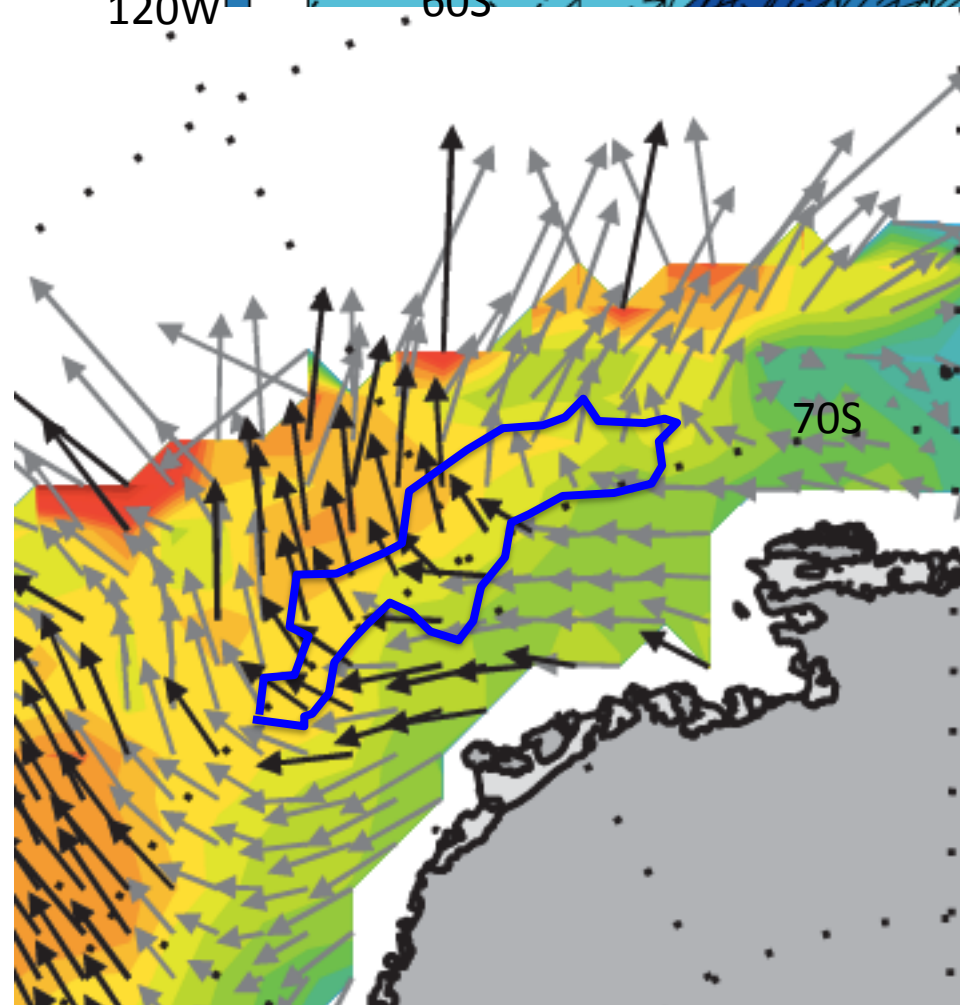
Assmann et al (2005): Modeled Winter Ice Drift & Ice Thickness



Assmann et al (2005): Modeled Winter Ice Drift & Ice Thickness

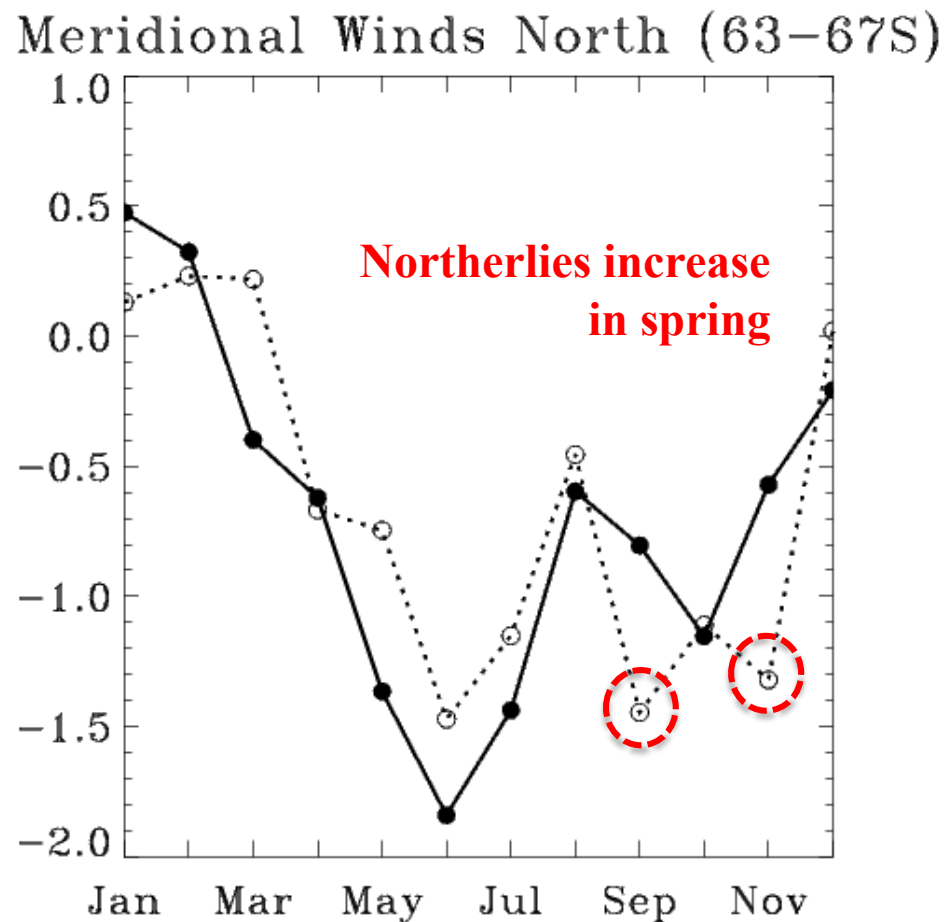
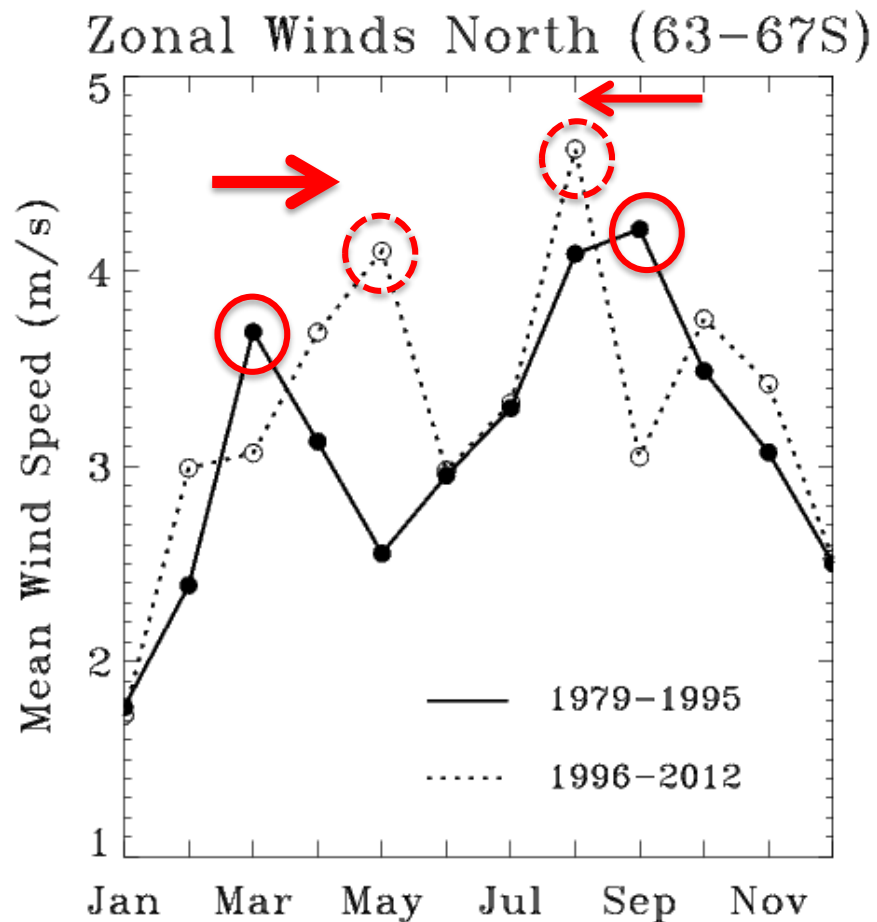


Holland & Kwok (2012): Trends in Winter Ice Motion & Meridional Speed



Change in Monthly Mean Winds – Offshore Region

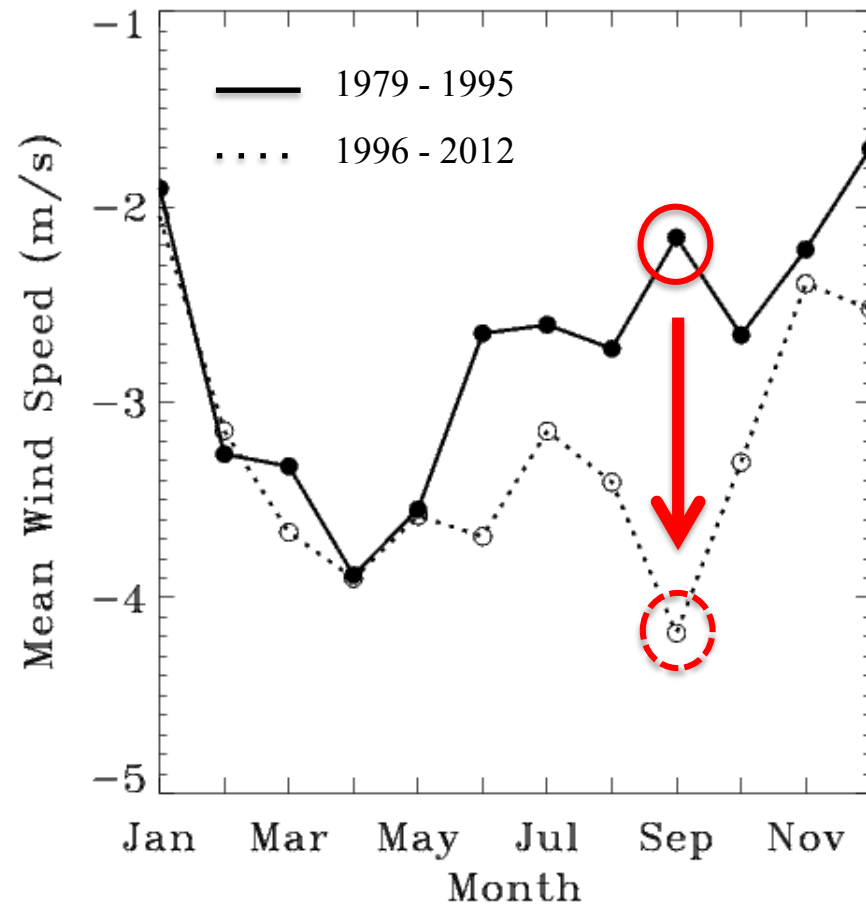
Peak westerly winds shift later in autumn, earlier in spring



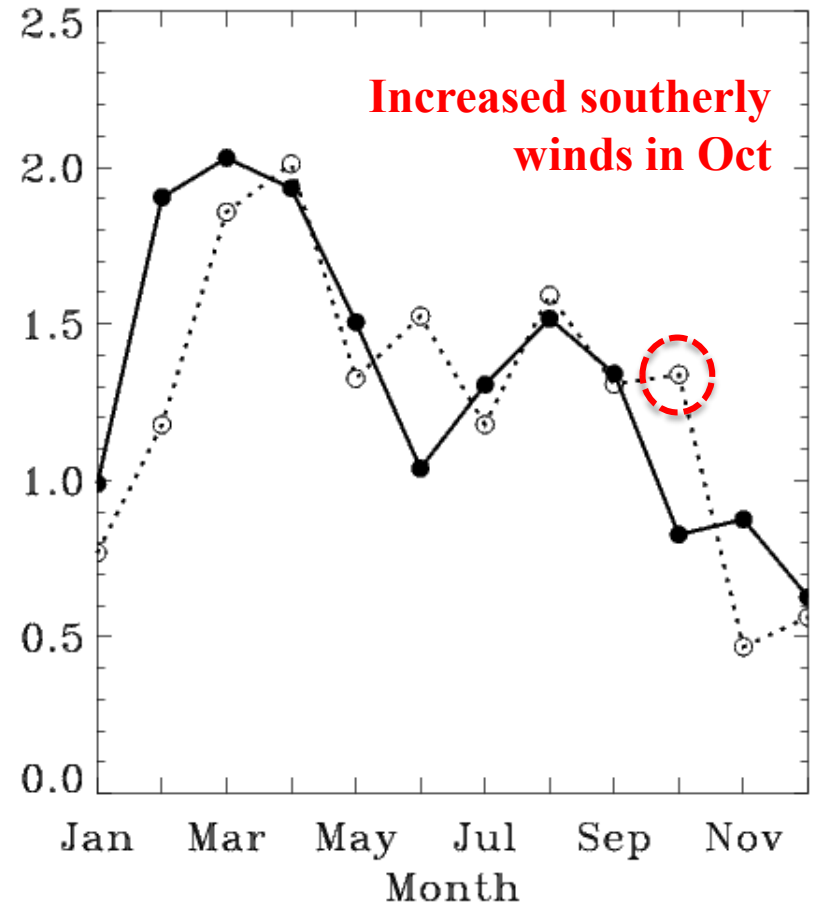
Change in Monthly Mean Winds – Coastal Region

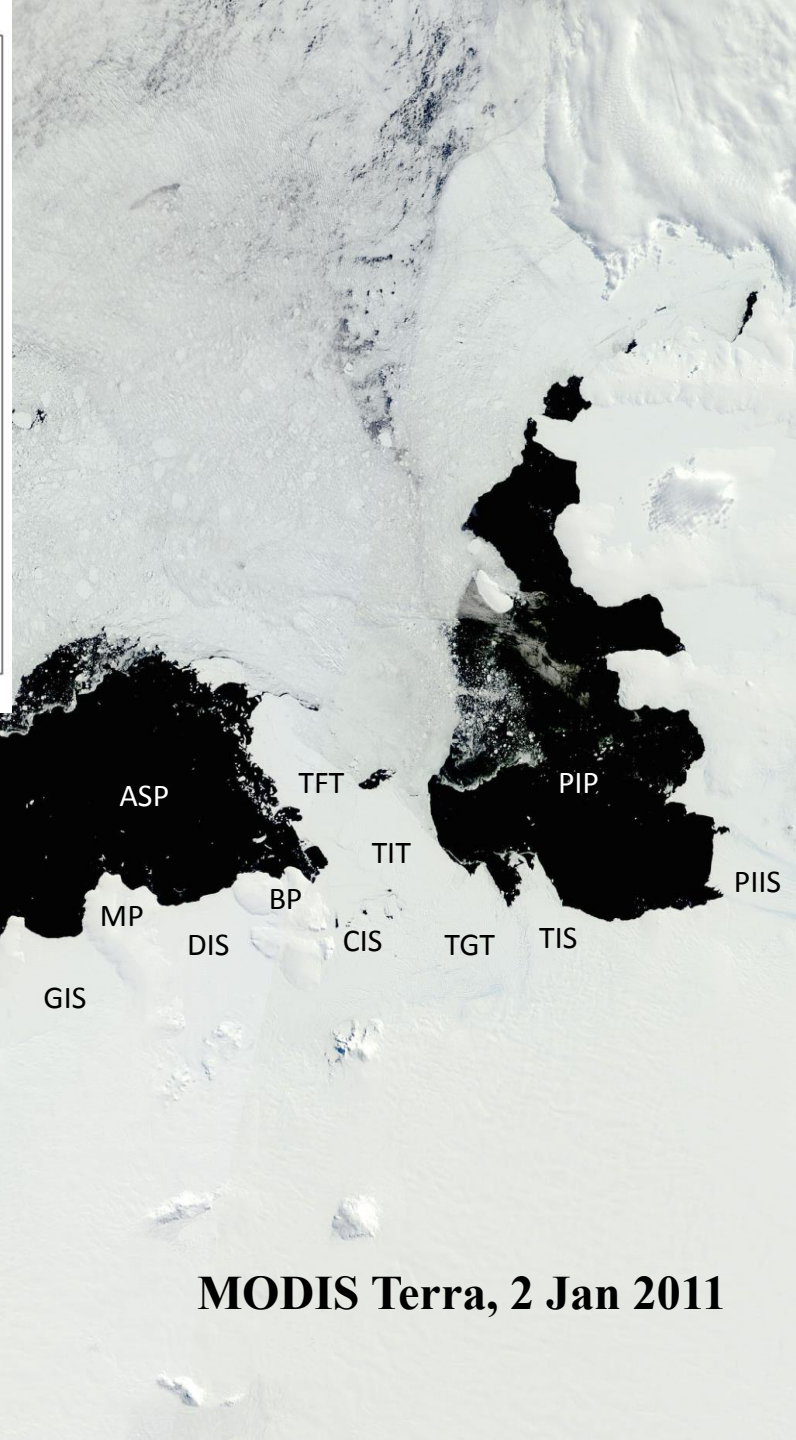
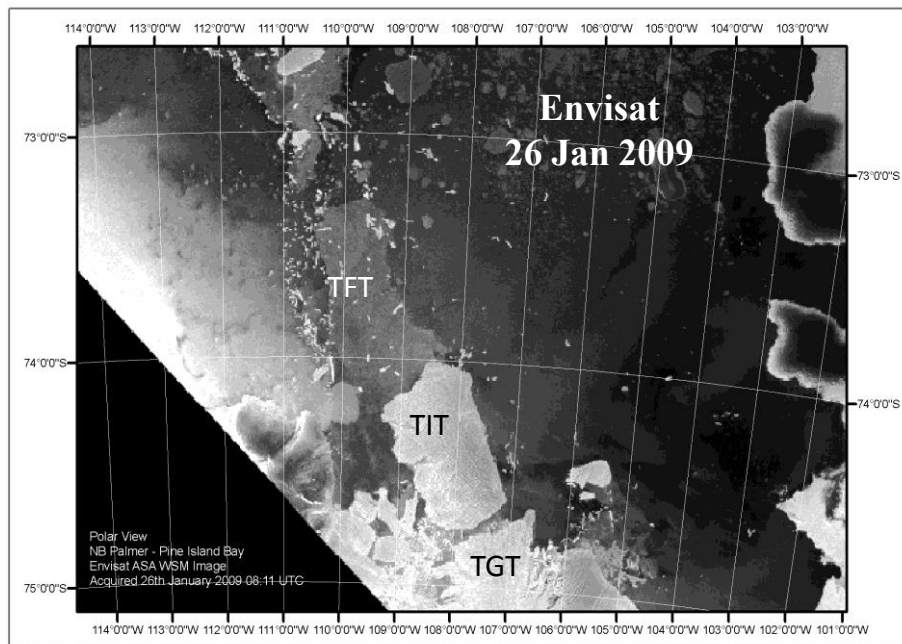
Pronounced increase in spring easterly winds

Zonal Winds South (71–75S)

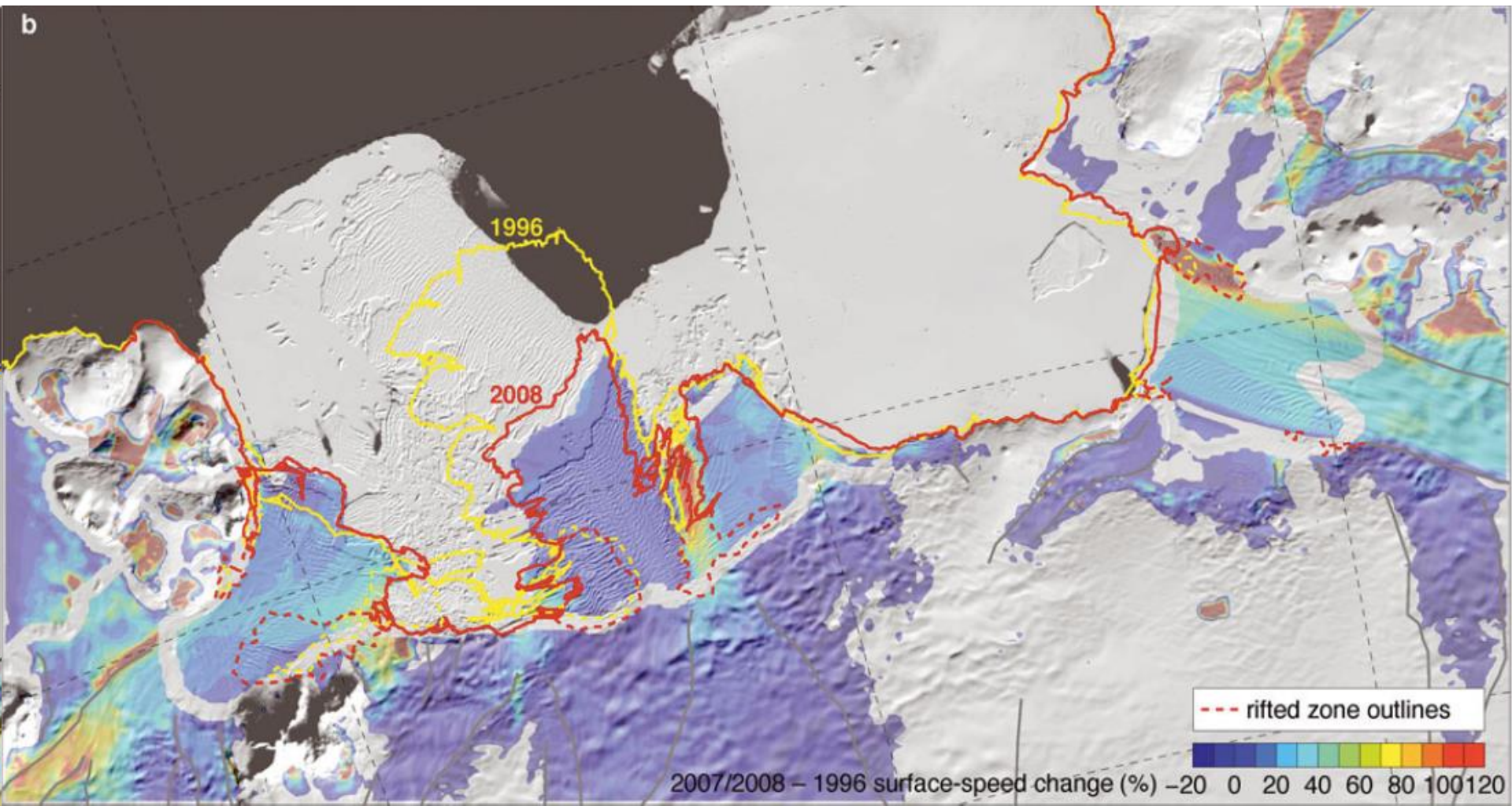


Meridional Winds South (71–75S)





MacGregor et al (2012): Evolution of the Eastern ASE Coastline
(1972 to 2011)

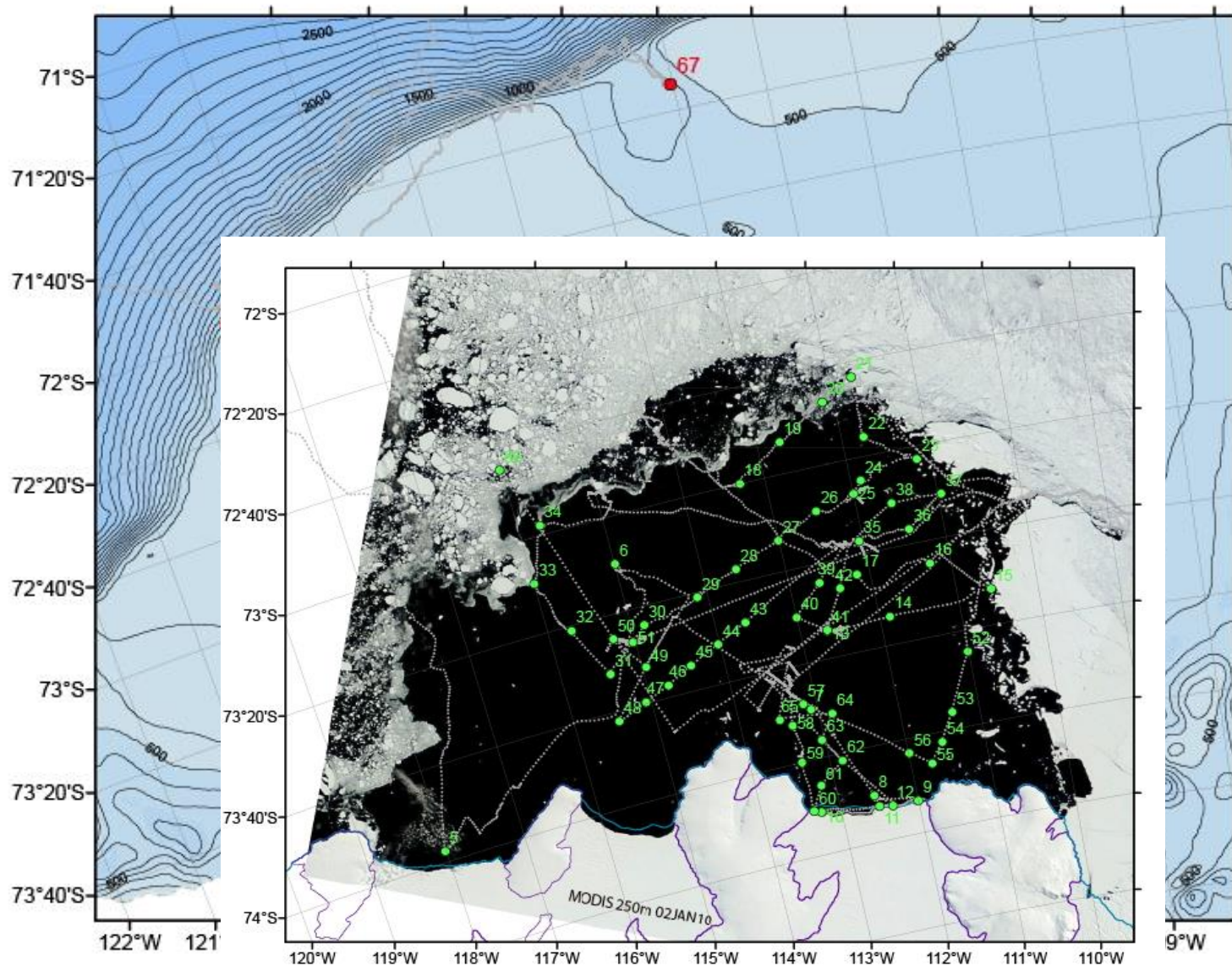


Summary: strong sea ice changes in 3 localized areas:

- 1. Offshore: shift in peak winds during spring/autumn contribute to earlier spring retreat & later autumn advance**
 - Wind changes are consistent with changes in depth/location of Amundsen Sea Low & increased amplitude of Semi-Annual Oscillation (*Turner et al, 2013*)**
- 2. eASP: increased spring easterly winds consistent with earlier spring retreat**
- 3. sPIP : more episodic, constrained by Thwaites Iceberg Tongue & fast ice**
 - Both polynyas affected by variable import of thick multiyear sea ice from the southern Bellingshausen Sea**
 - Temporal correlations between 3 regions are weak, indicating different local forcing and/or different response to large-scale forcing**
 - Attribution is made difficult by a myriad of teleconnections, superimposed on local changes in ocean heat & freshwater inputs resulting from longer ice-free periods & warm buoyant waters exiting the ice shelf cavities**

Amundsen Sea Polynya International Research Expedition (ASPIRE)

Sampling Stations during Dec-Jan 2010-11 (NBP10-05)

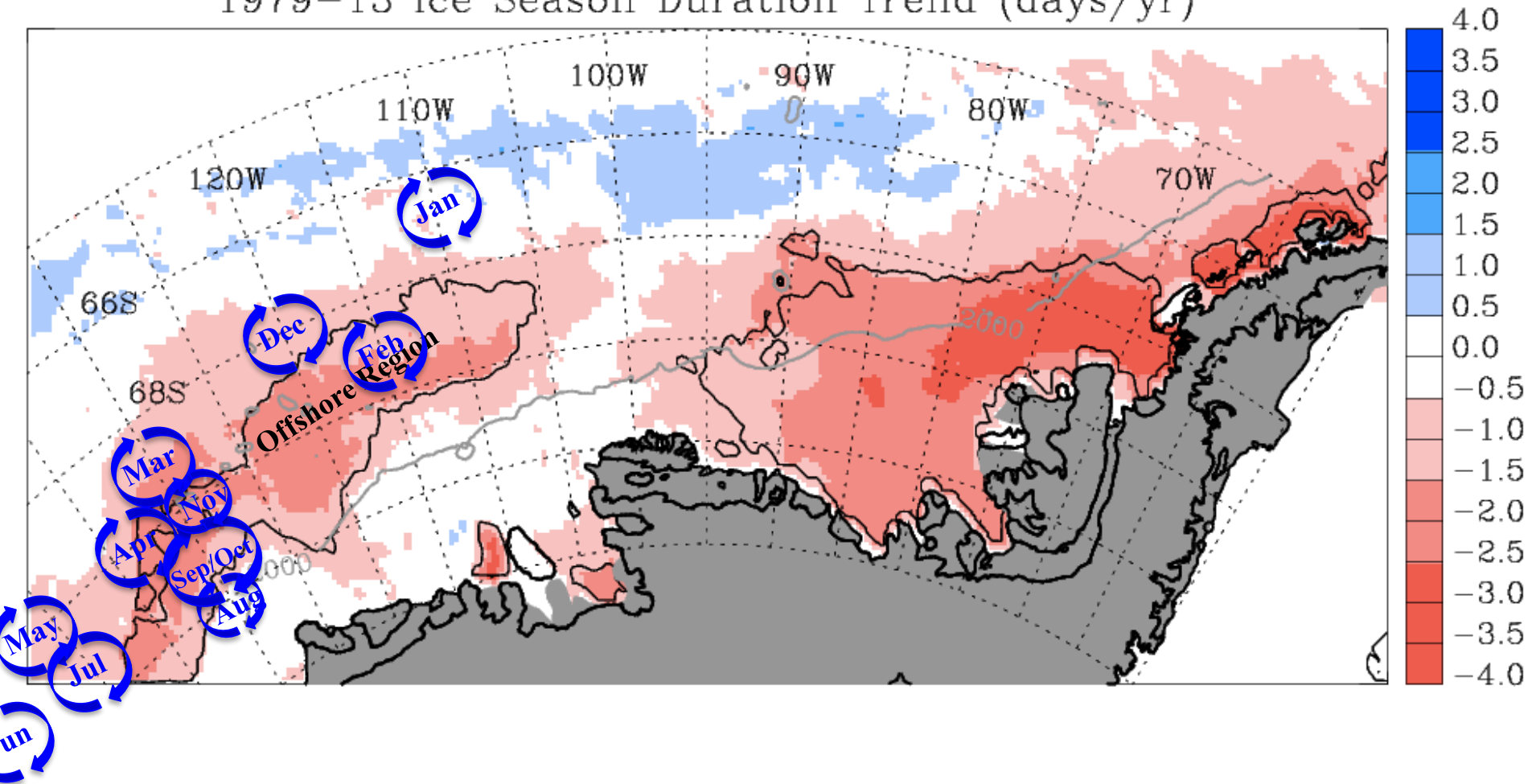


Extra Slides

Monthly Mean Location of the Amundsen Sea Low

(based on *Turner et al, 2013*)

1979–13 Ice Season Duration Trend (days/yr)



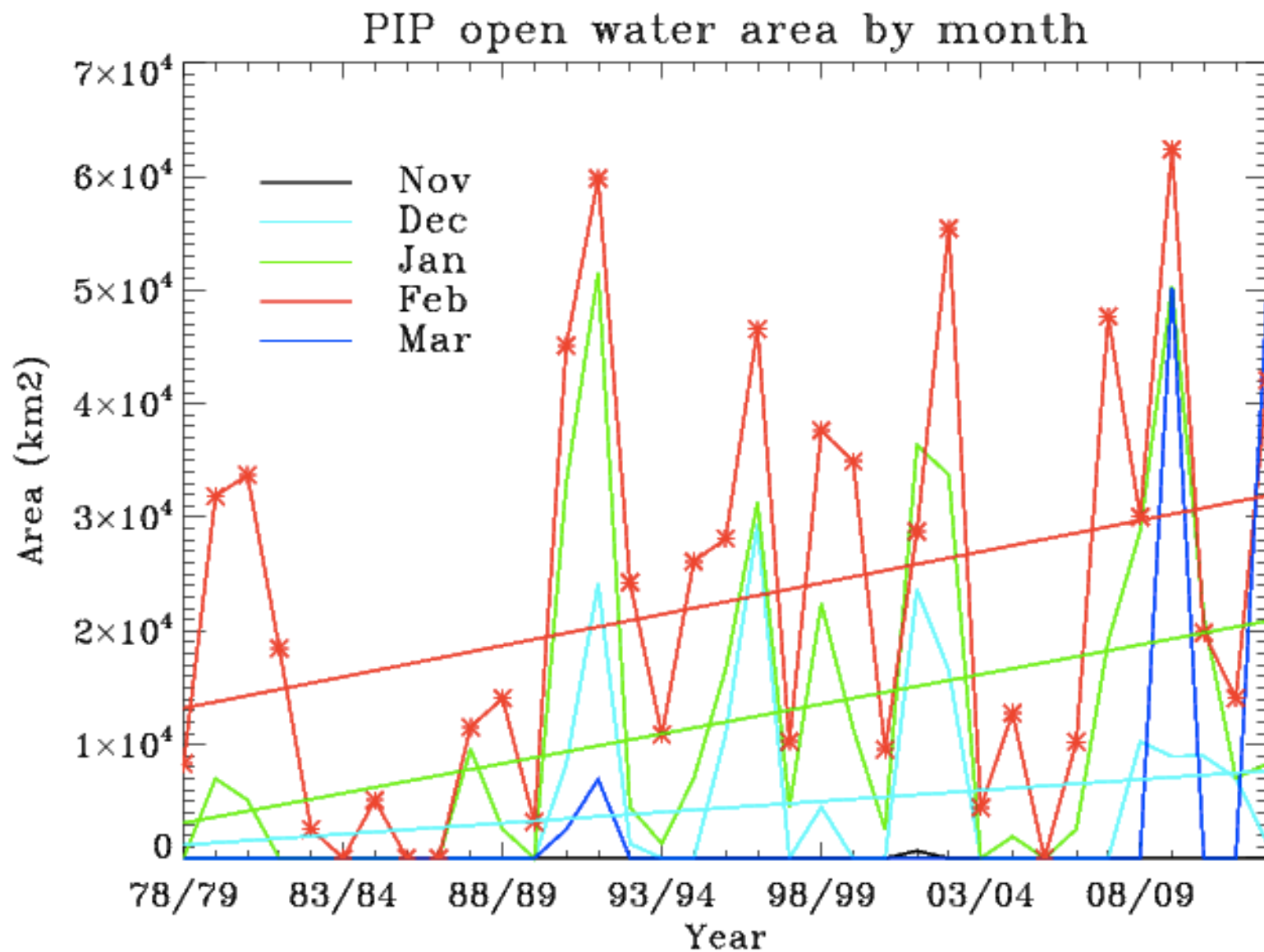


Figure 9

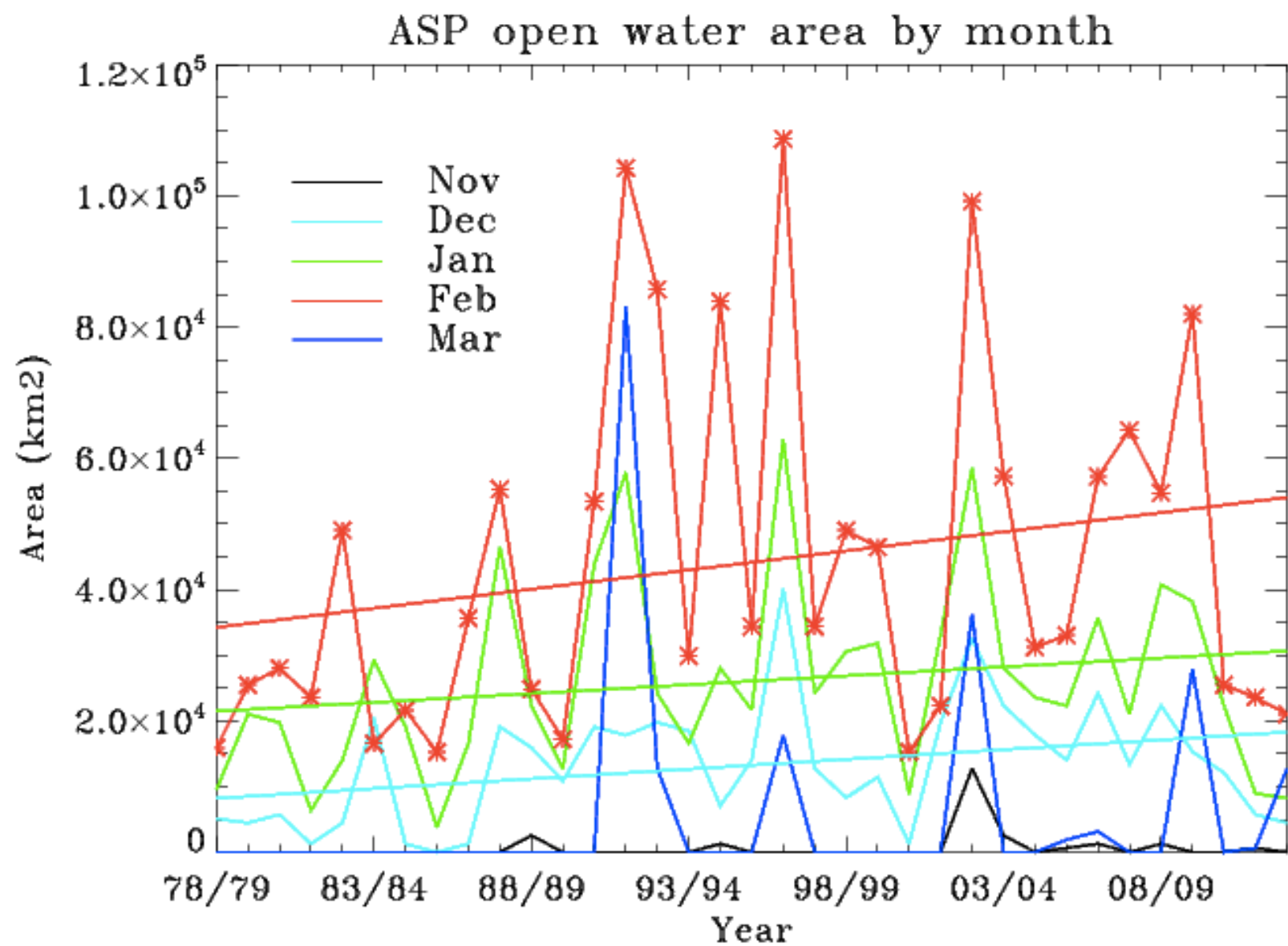
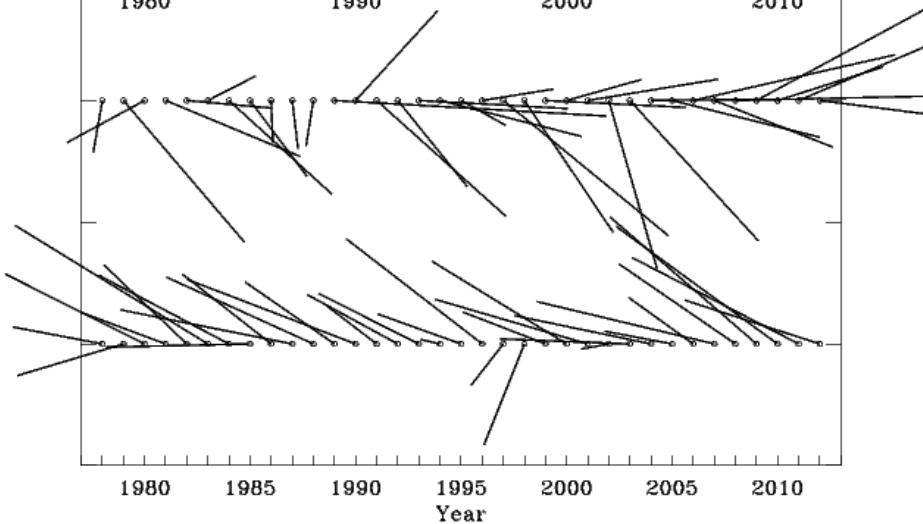
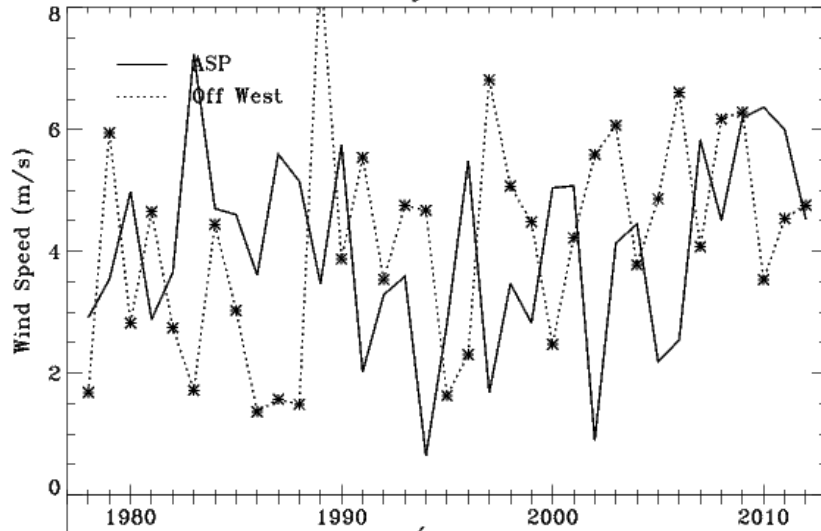


Figure 13

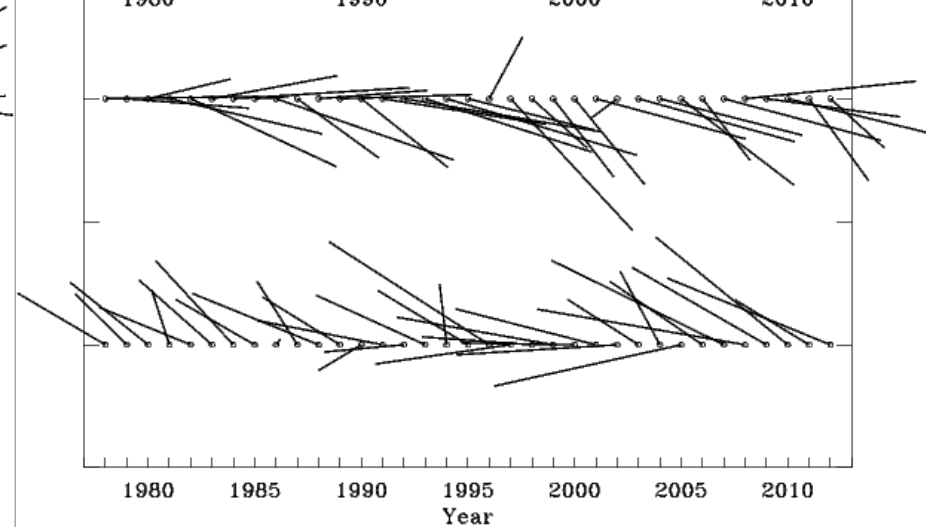
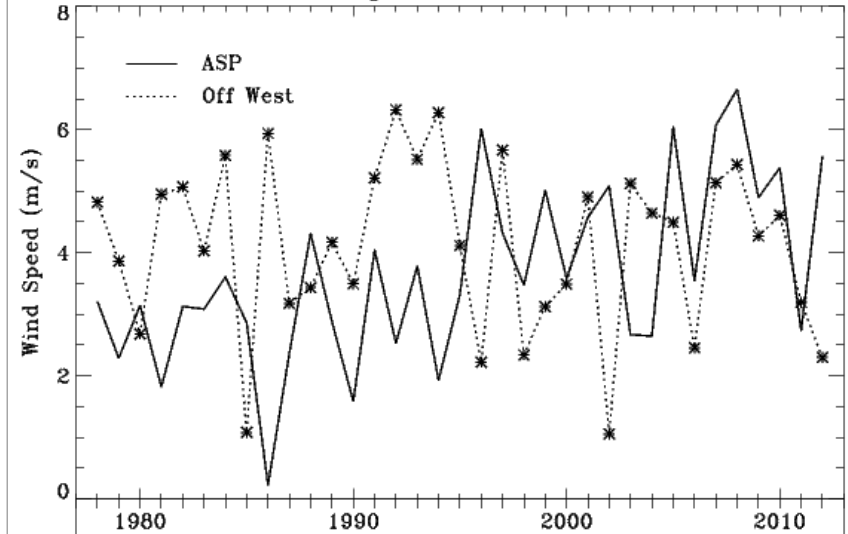
Variability in Coastal versus Offshore Winds

(often anti-correlated)

May Winds



September Winds

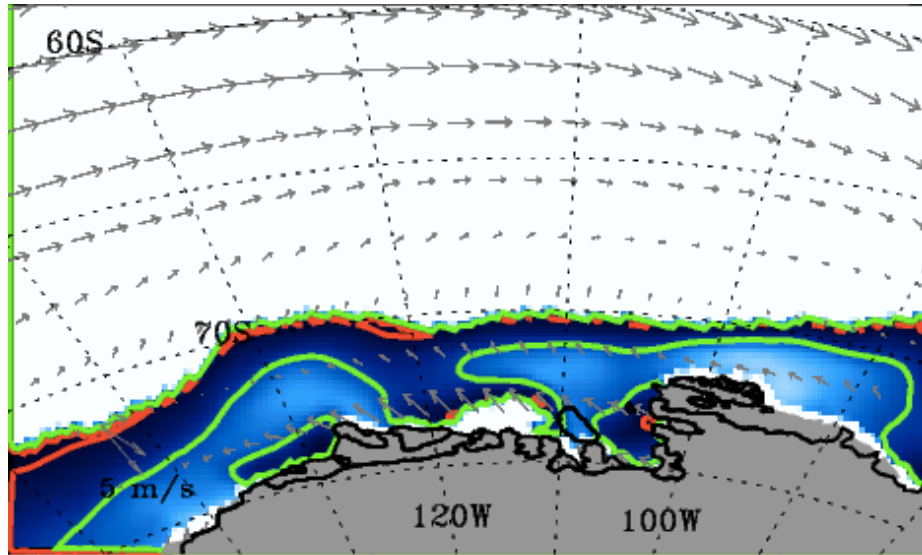


SIC and Wind Anomalies during Spring Retreat & Autumn Advance

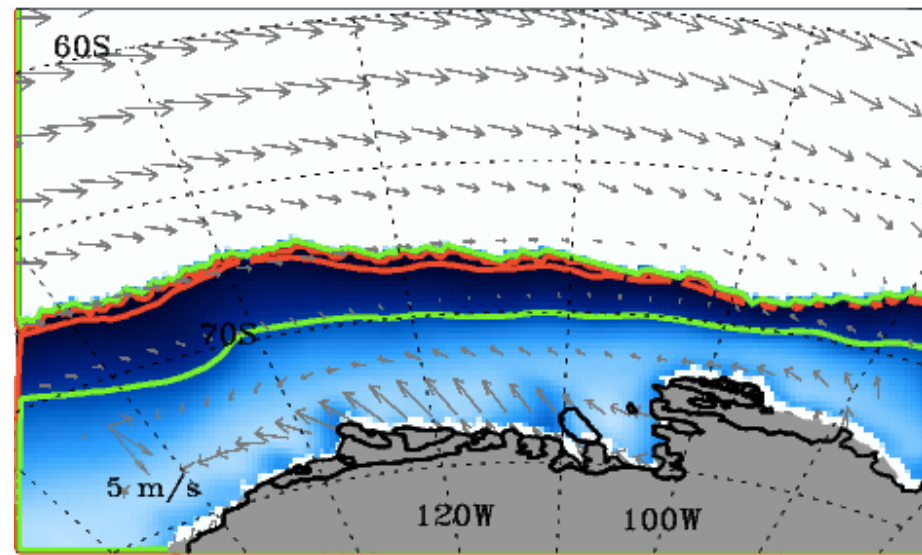
**Few examples relevant to (1) offshore region (slide 22), (2) PIP (slide 23), and
(3) ASP (slide 24), with mean conditions shown in slide 21**

Mean Monthly Sea Ice Concentration & Winds (1979-2013)

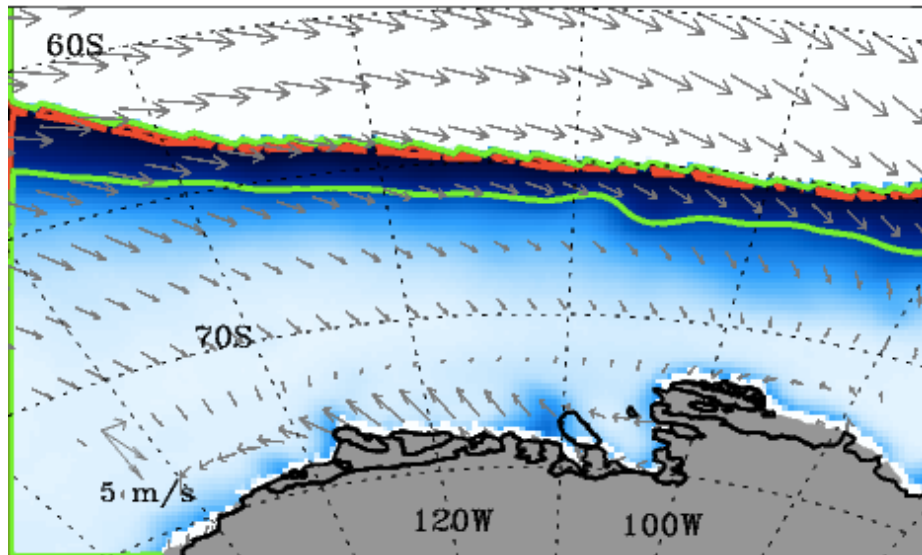
February



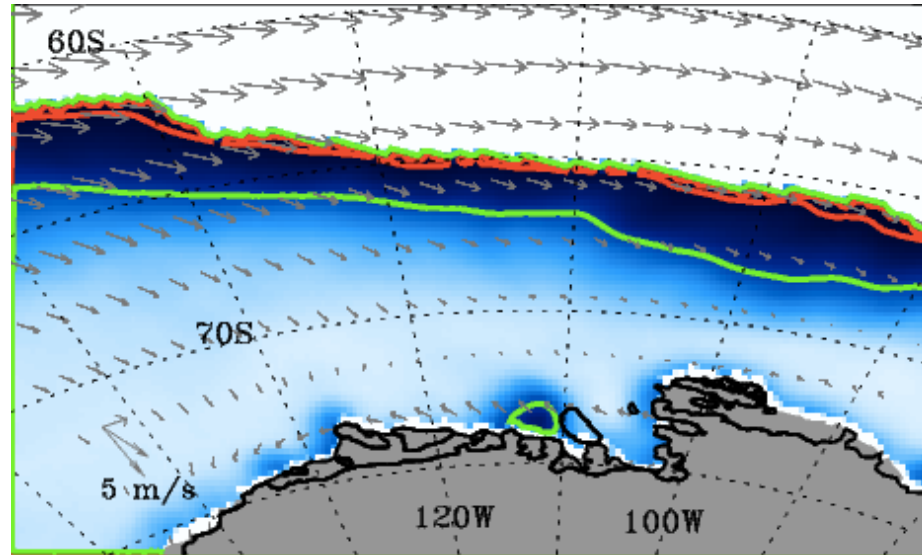
April



September



November



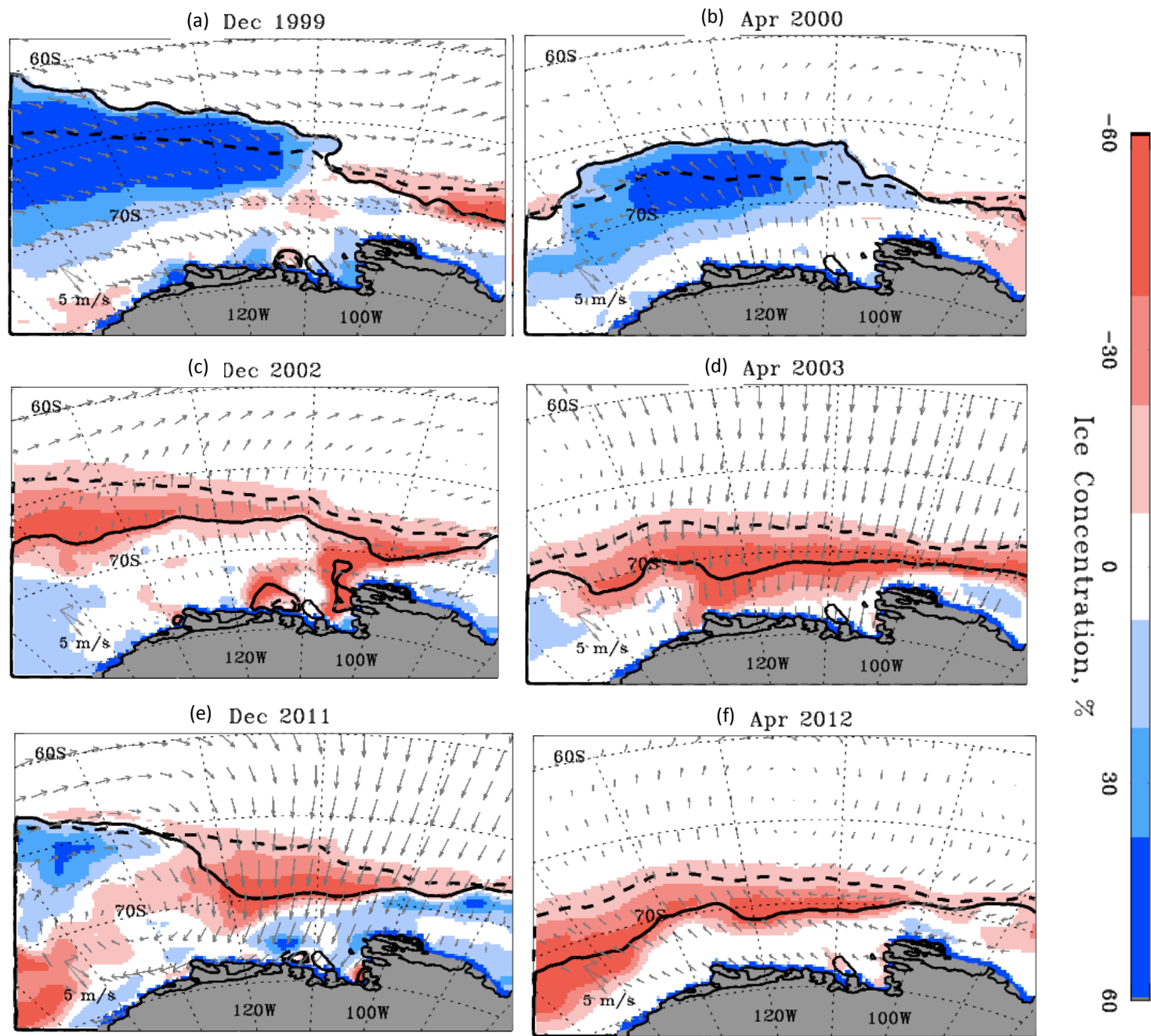


Figure 6

(a) Nov 1996

(b) Nov 1997

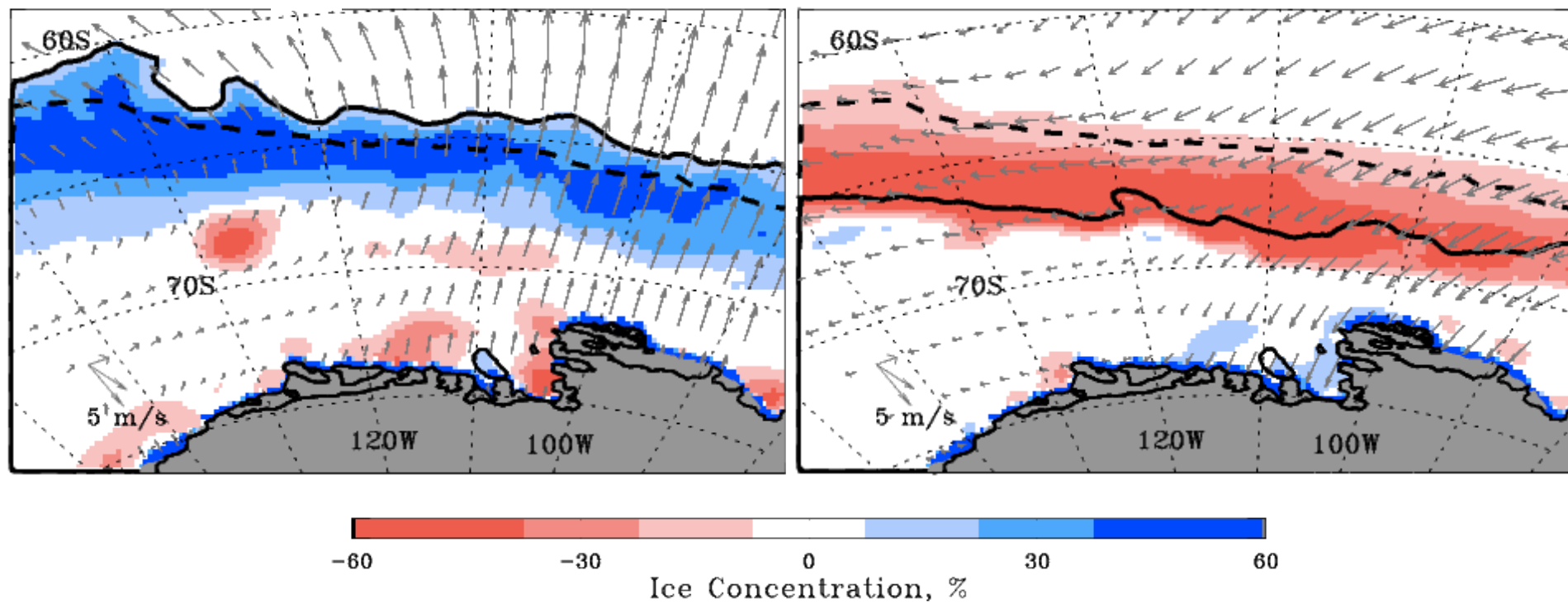


Figure 8

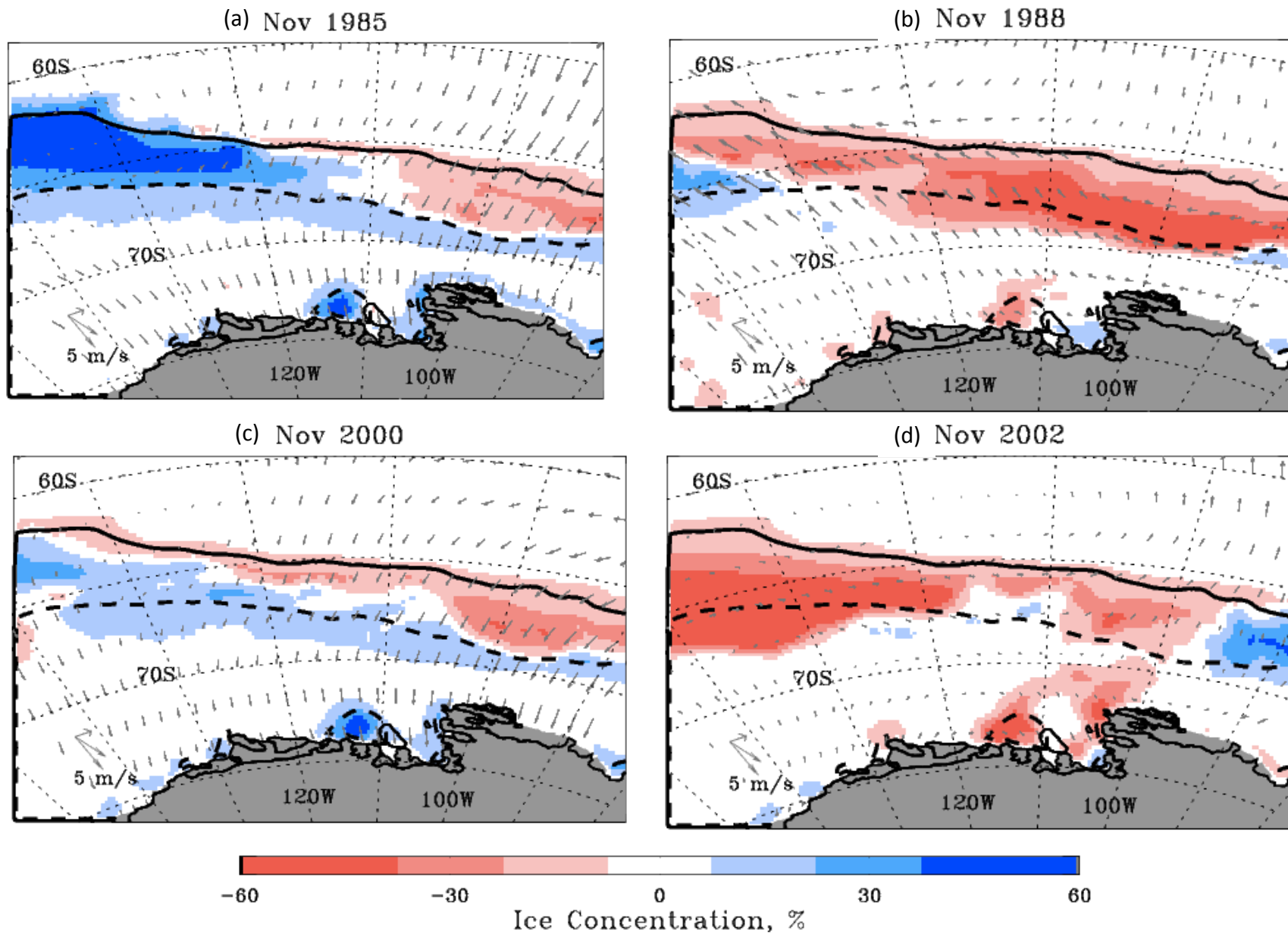


Figure 11

Table 1. Area-averaged trends^a in sea ice advance, retreat, ice season duration^b and open water duration over 1979/80 to 2013/14 (N = 35) for three Amundsen Sea regions (see Figures 3, 7 and 10)

Region	Day of Advance	Day of Retreat	Ice Season Duration	Open Water duration	Retreat versus Advance (R) ^c
Offshore	+0.95 ± 0.4 (p = 0.01)	-0.64 ± 0.3 (p = 0.005)	-1.6 ± 0.4 (p < 0.001)	+1.6 ± 0.6 (p = 0.006)	-0.54
sPIP	+0.59 ± 0.2 (p = 0.01)	-1.2 ± 0.6 (p = 0.02)	-1.8 ± 0.8 (p = 0.02)	+1.9 ± 0.8 (p = 0.02)	-0.76
eASP	+0.38 ± 0.2 (p = 0.04)	-1.9 ± 0.4 (p < 0.001)	-2.3 ± 0.4 (p < 0.001)	+2.2 ± 0.4 (p < 0.001)	-0.01

^aTrends are reported in days per year, with standard error and significance determined using the effective degrees of freedom present in the regression residuals (Santer et al., 2000).

^bPositive signed trends in advance and open water duration indicate trends towards later advance and longer open water season, respectively; negative signed trends in retreat and ice season duration indicate trends towards earlier retreat and shorter ice season, respectively.

^cCorrelations between spring sea ice retreat and subsequent autumn sea ice advance are with de-trended time series.