Interannual Variations of sea ice in the Pacific side of the Arctic and its relation with the Pacific Inflow

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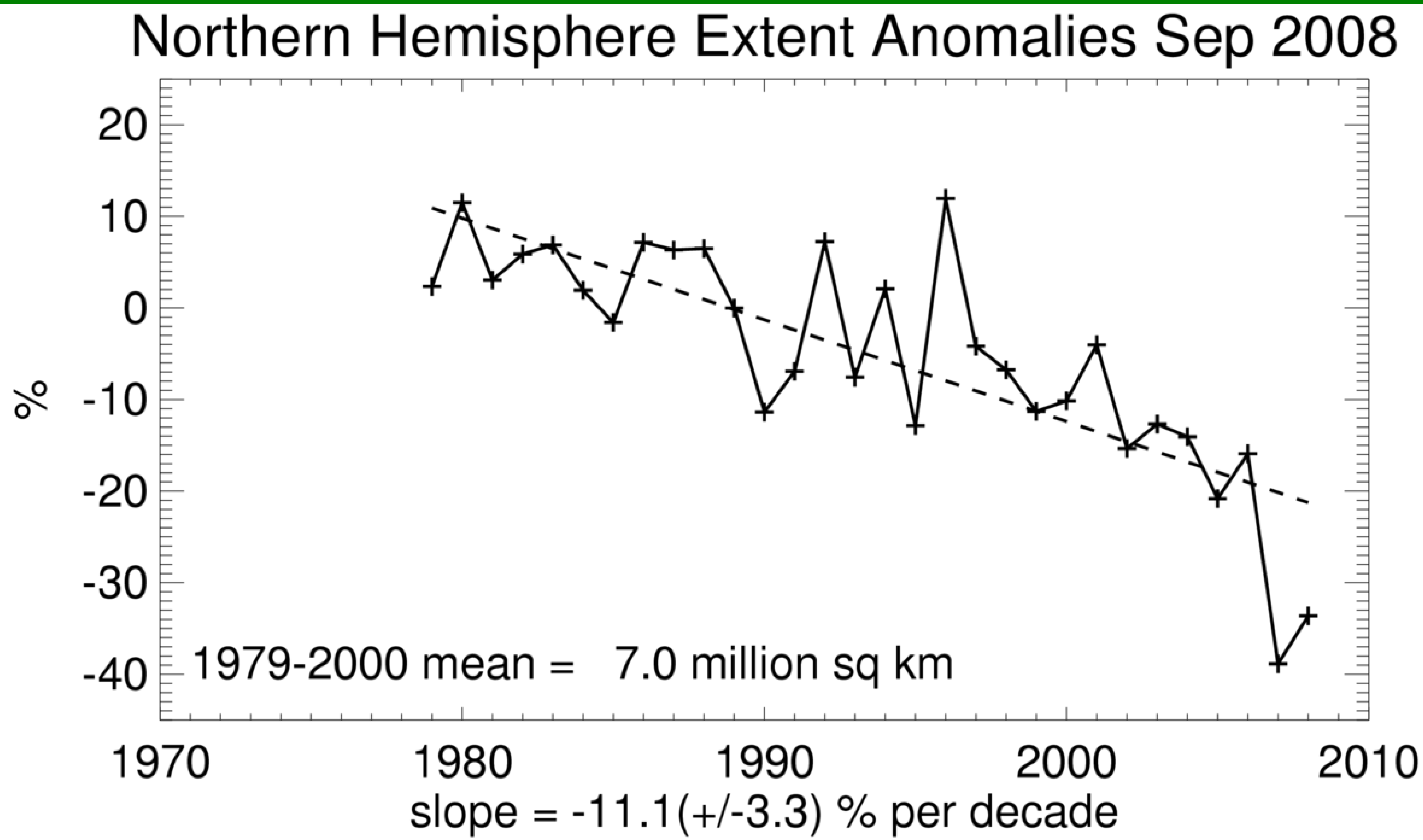
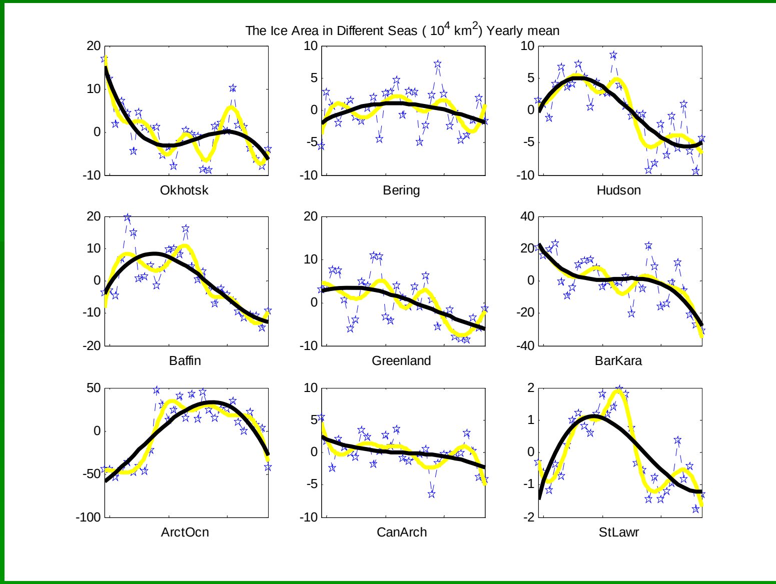
2008.10 Dalian

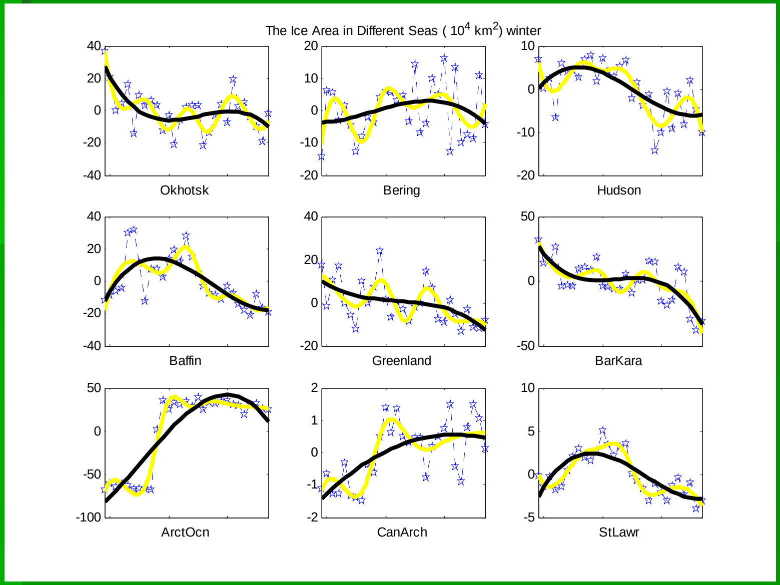


http://www-nsidc.colorado.edu/data/seaice_index/n_plot.html

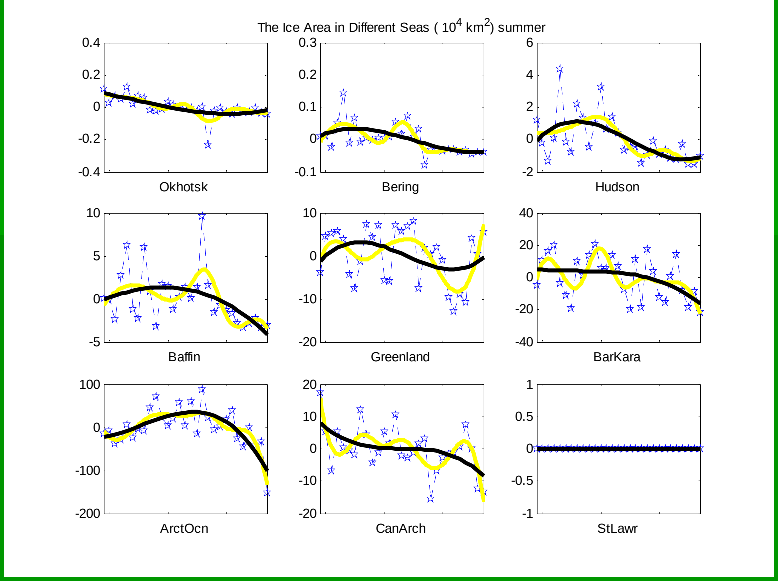
Ice Area (1978.11-2007.12)



Yearly Mean



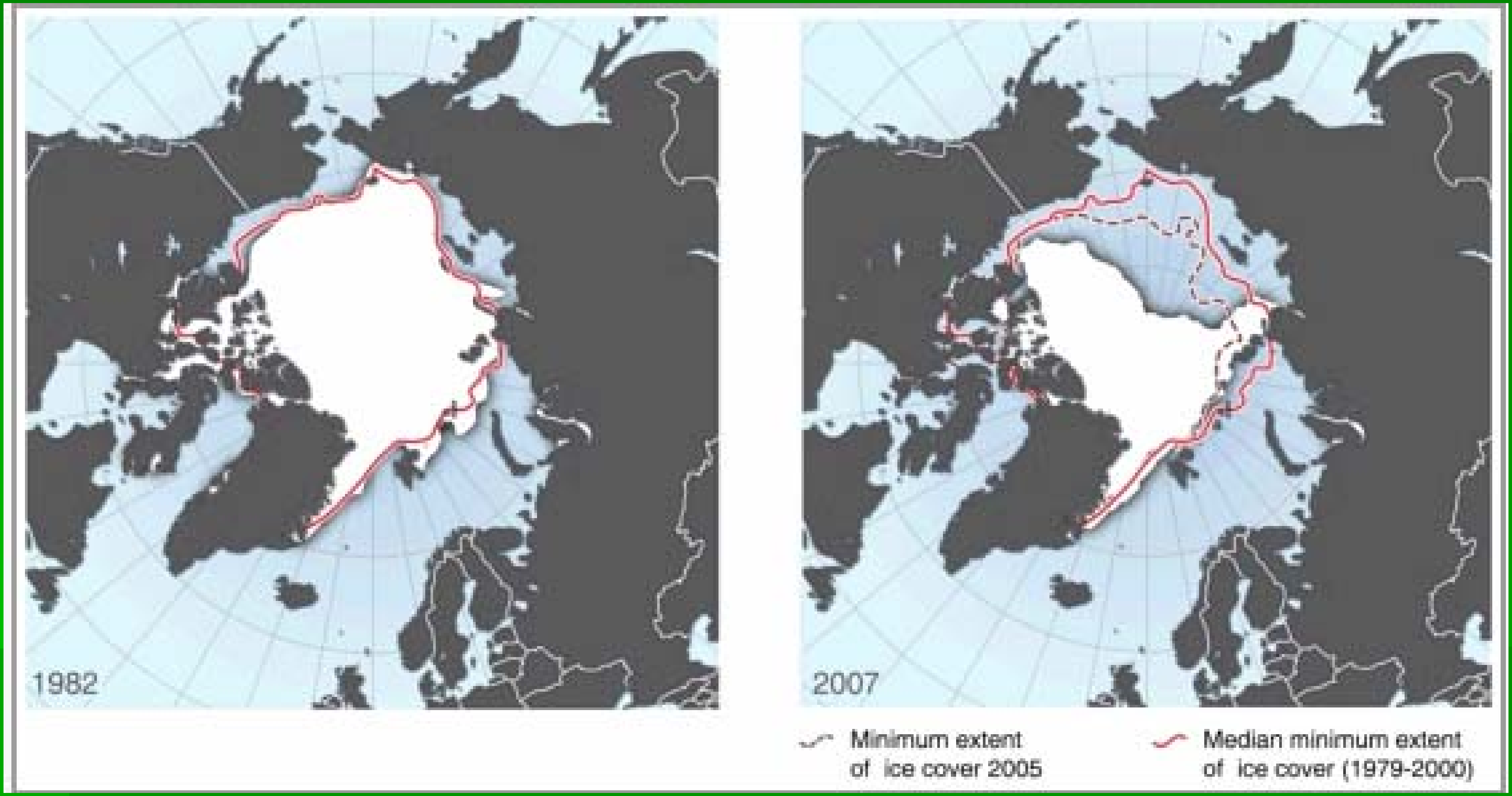
Winter



Summer

Monthly data from NSIDC

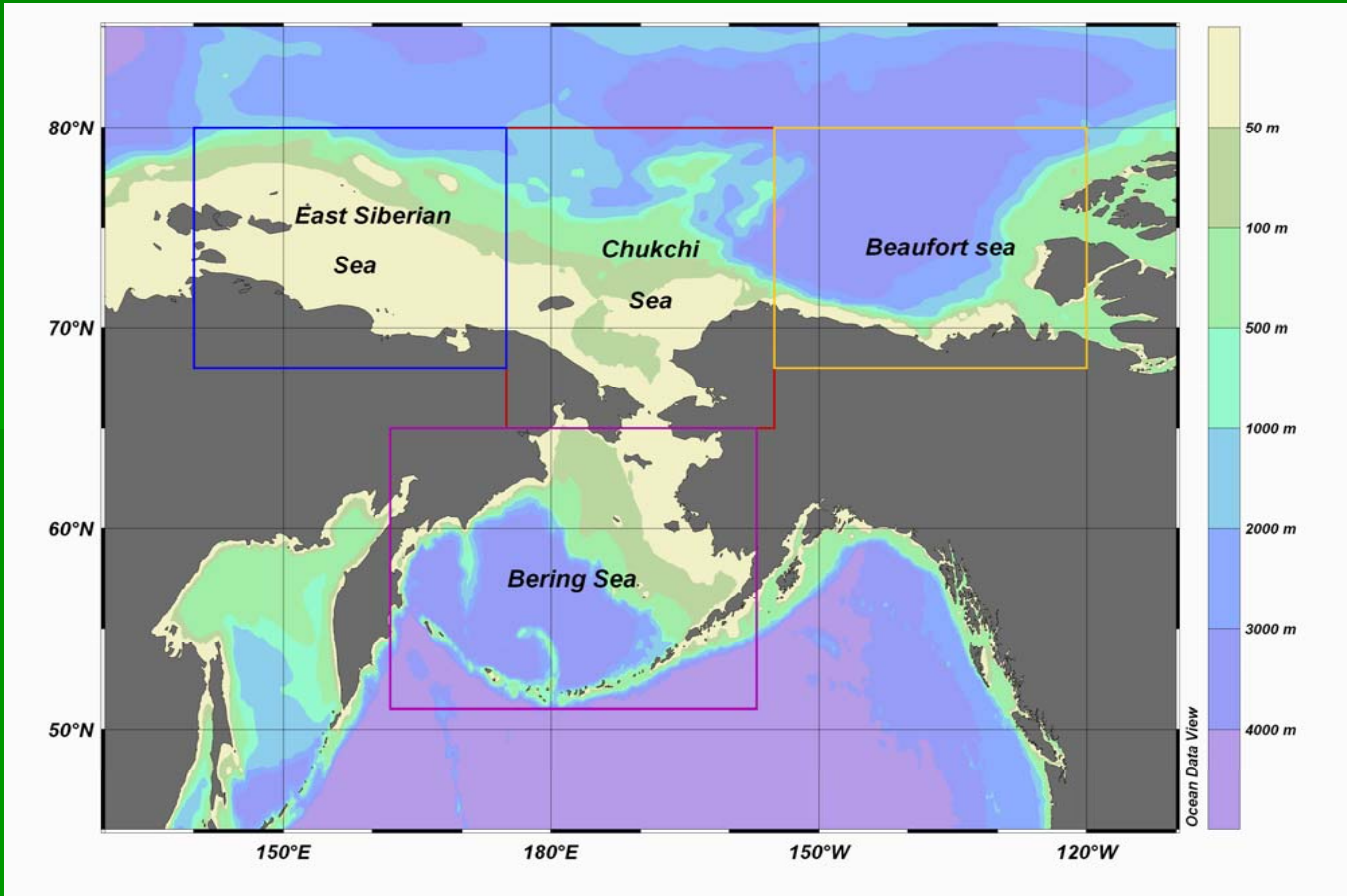
Comparison of yearly minimum ice extent in Arctic Ocean



solid:1979-2000; dash:2005

What we want to know and understand:

- **What's the special features of the sea ice inter-annual variation in Pacific side of Arctic (Total four regions; Separate regions)**
  - **Spatial distribution of variational trend**
  - **Abrupt test**
  - **Periodicity**



- **Links to AO and PDO**
- **Links to the Pacific Inflow**

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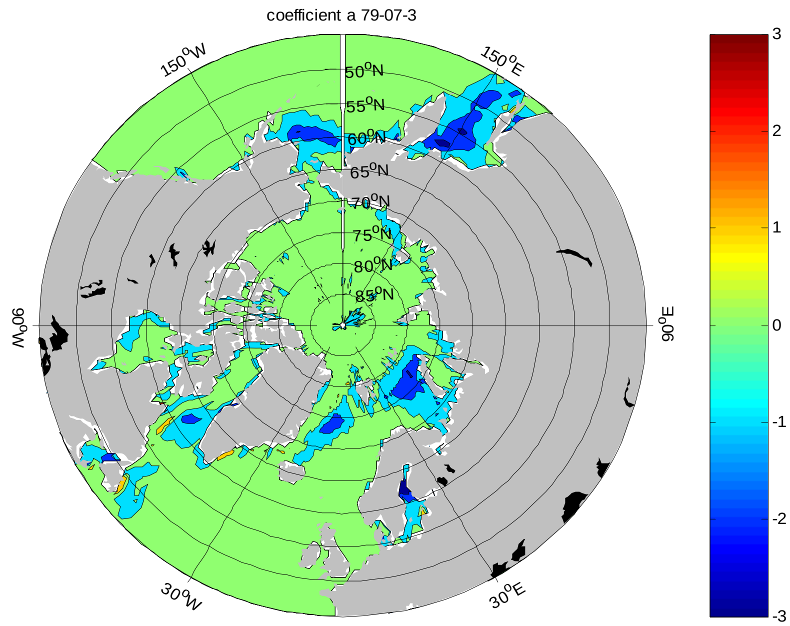
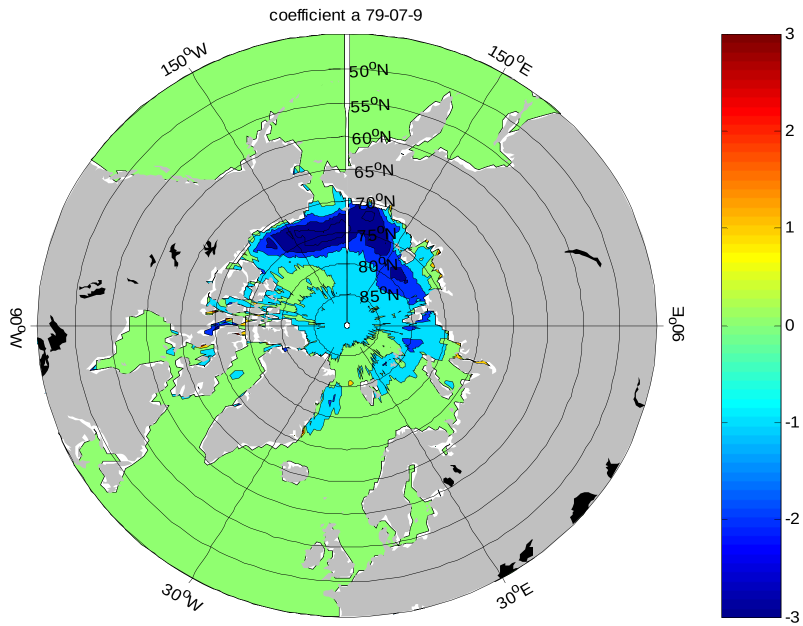
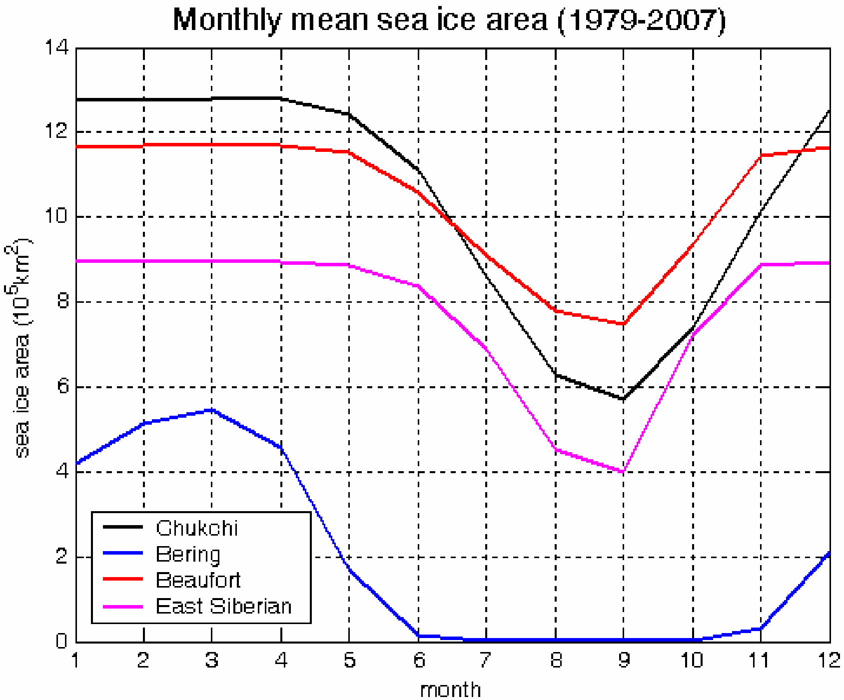
Distribution of sea ice concentration trend (1979-2007)

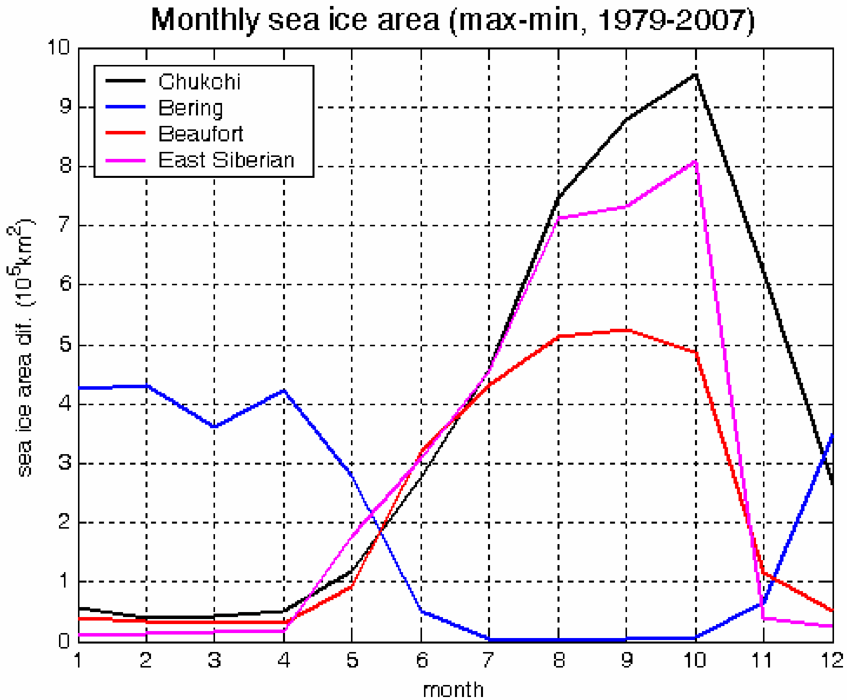
March **September**





Data from Met Office Haddley Center's HadISST1.1 (1871.01-2007.12), 1×1; We use 1979.01-2007.12)





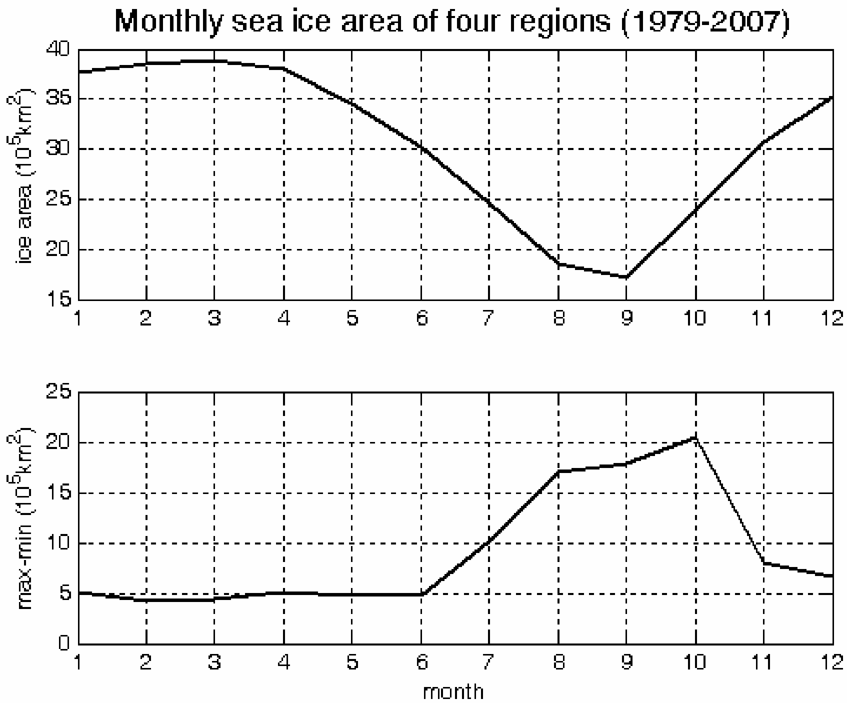
Total: Oct. (Aug.-Oct.)

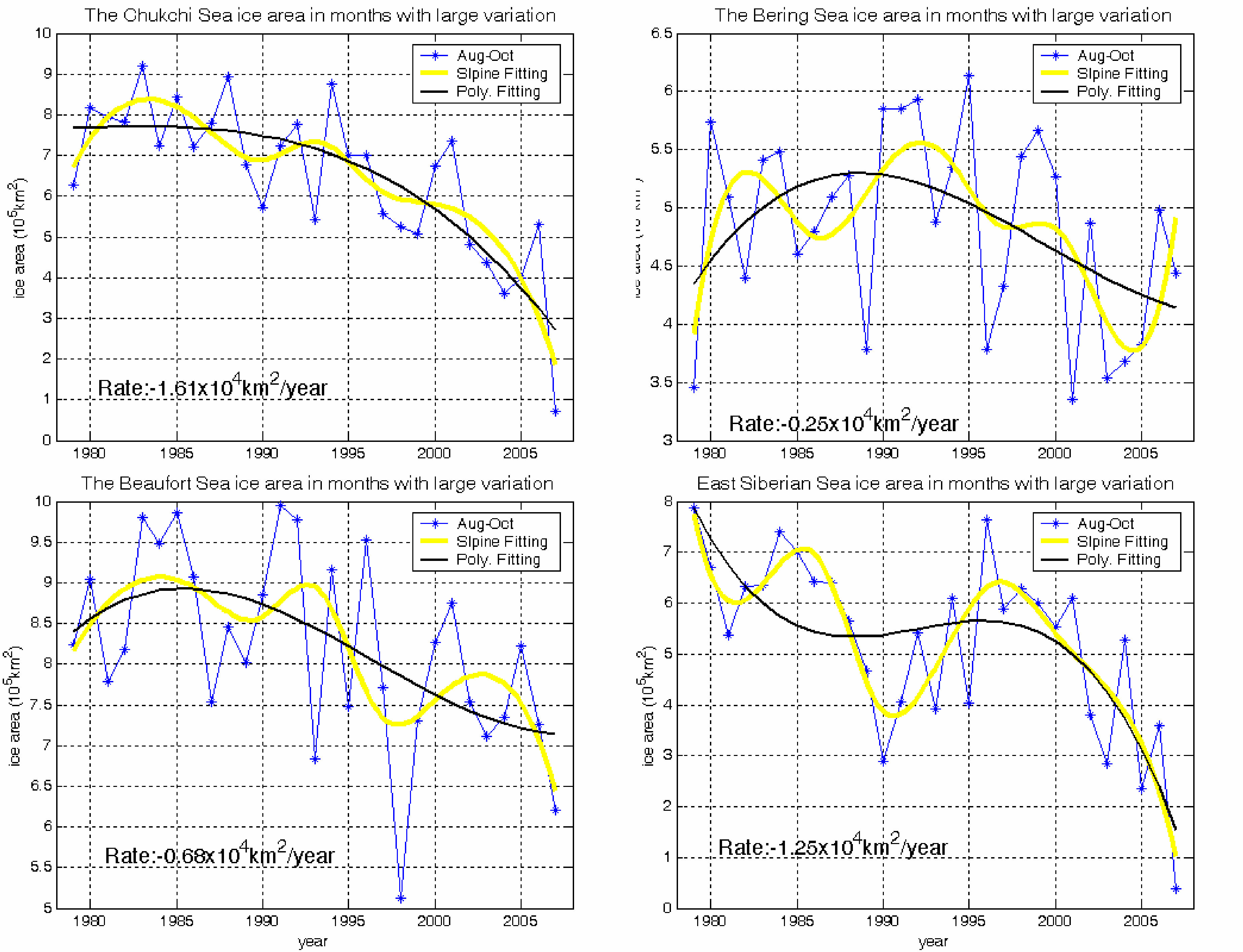
Chukchi Sea :Oct. (Aug.-Oct.)

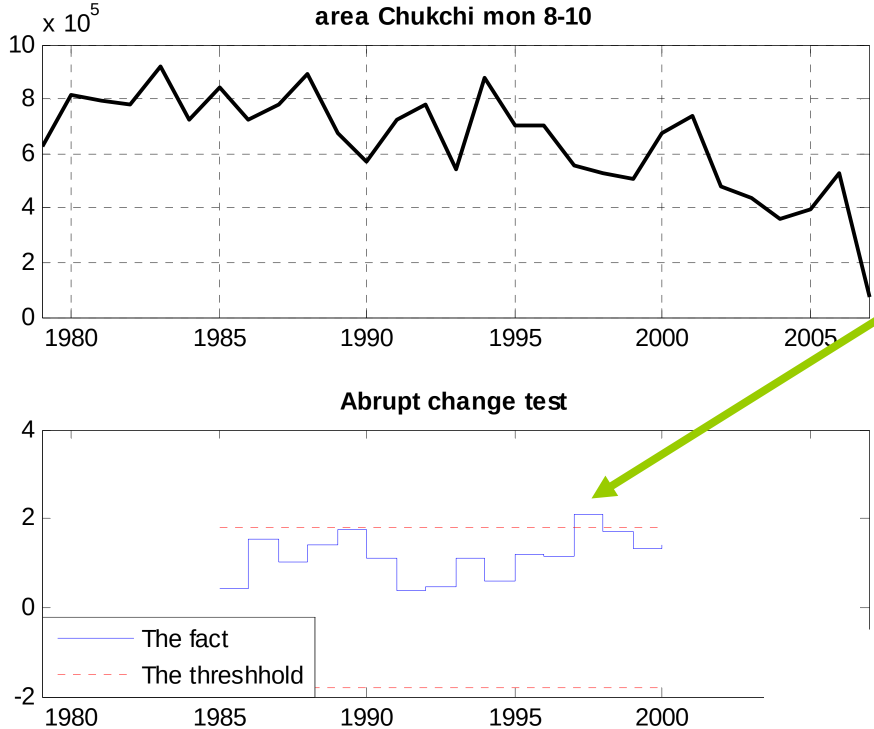
Bering Sea:Apr. (Jan. –Apr.)

Beaufort:Sep.(Aug.- Oct.)

East Siberian: Oct.(Aug.-Oct.)

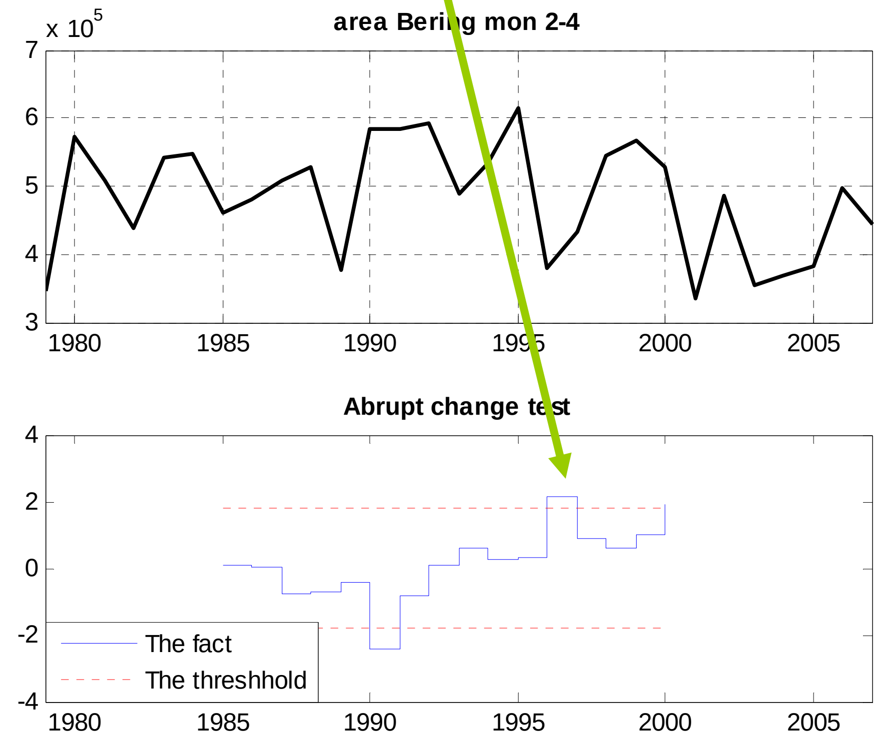



The Chukchi Sea ice area in months with large variation
Aug-Oct
Slpine Fitting
Poly. Fitting
Rate:-1.61x10⁴km²/year
ice area (10⁵km²)
The Bering Sea ice area in months with large variation
Aug-Oct
Slpine Fitting
Poly. Fitting
Rate:-0.25x10⁴km²/year
The Beaufort Sea ice area in months with large variation
Aug-Oct
Slpine Fitting
Poly. Fitting
Rate:-0.68x10⁴km²/year
ice area (10⁵km²)
year
East Siberian Sea ice area in months with large variation
Aug-Oct
Slpine Fitting
Poly. Fitting
Rate:-1.25x10⁴km²/year
ice area (10⁵km²)
year



Abrupt？Change?Shift?

← Chukchi Sea



Bering Sea →

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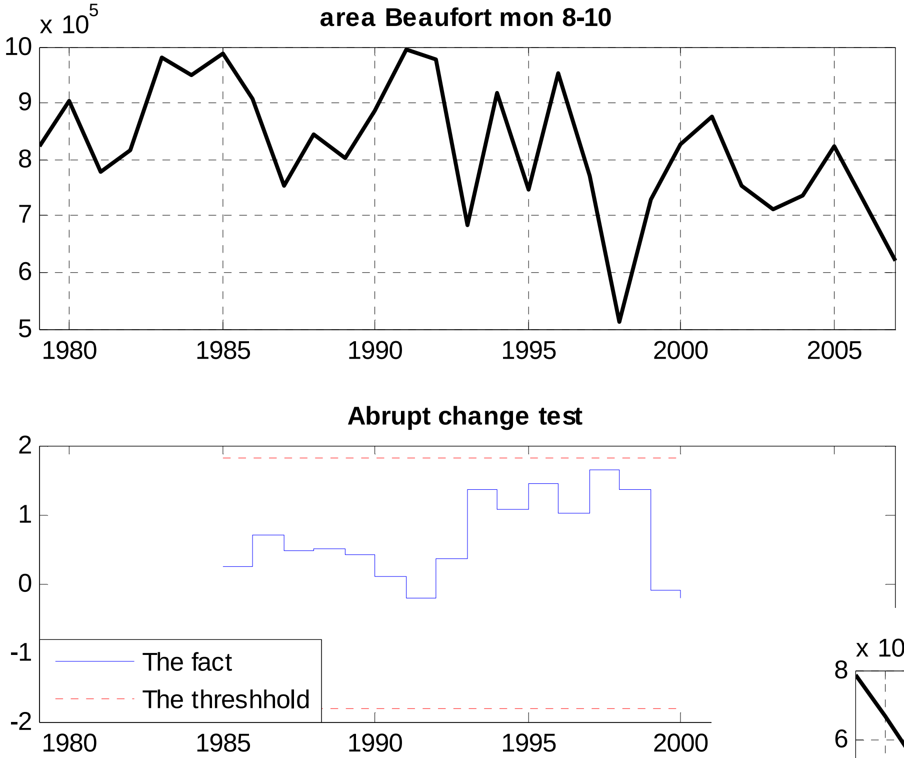
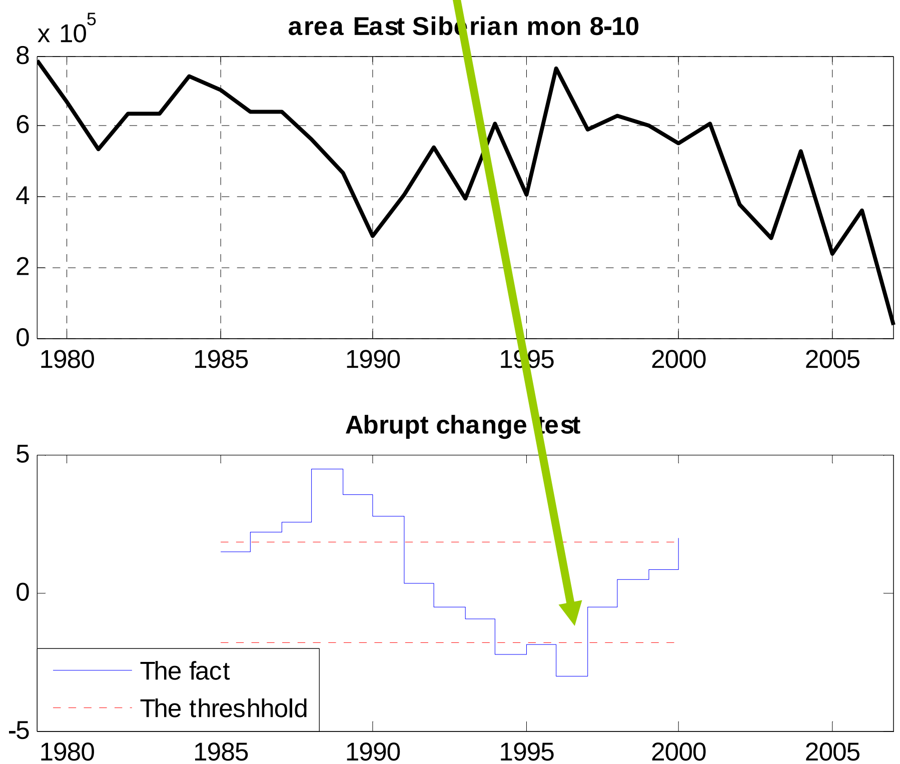


Abrupt？
Change?Shift?

Beaufort Sea



East Siberian Sea

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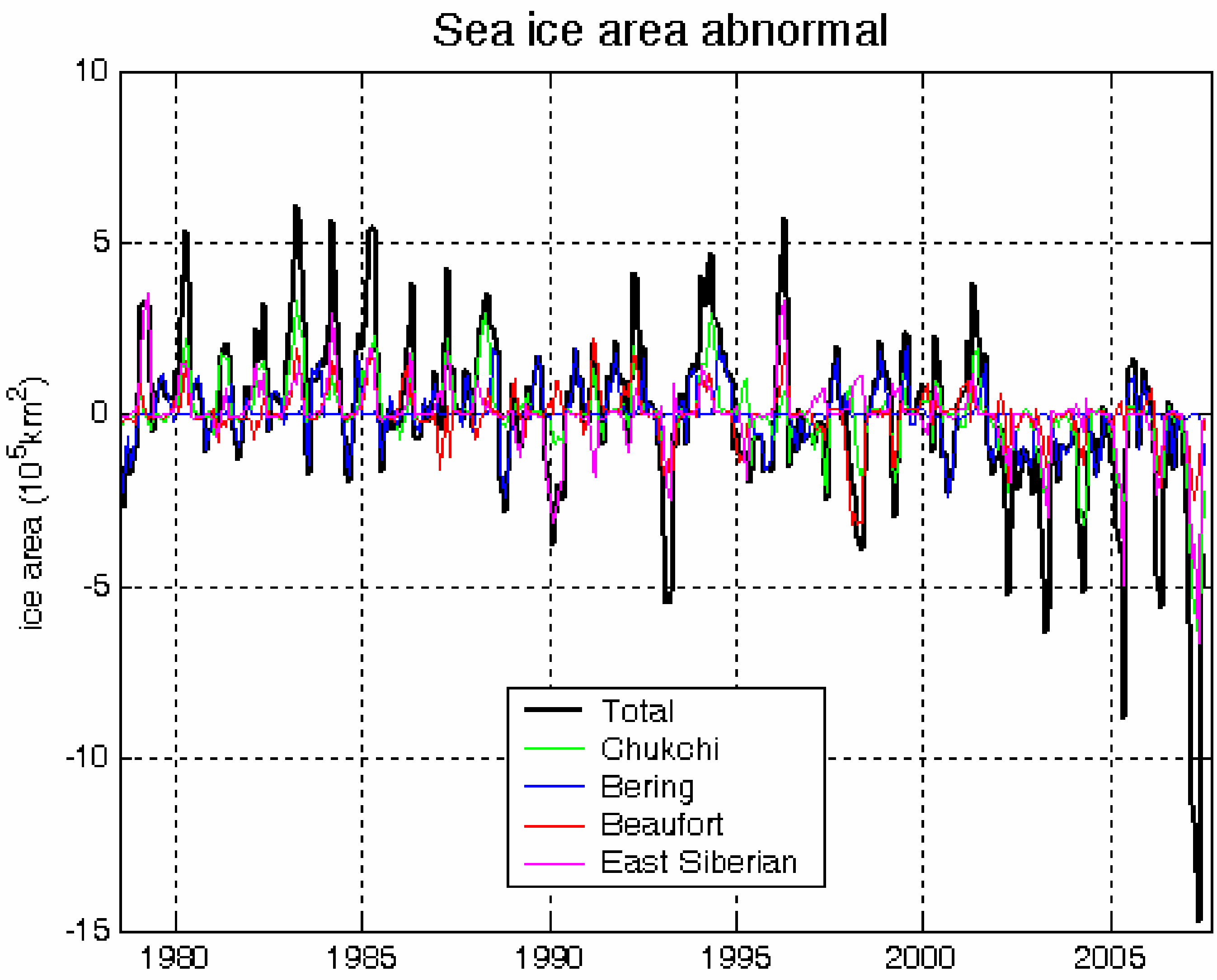
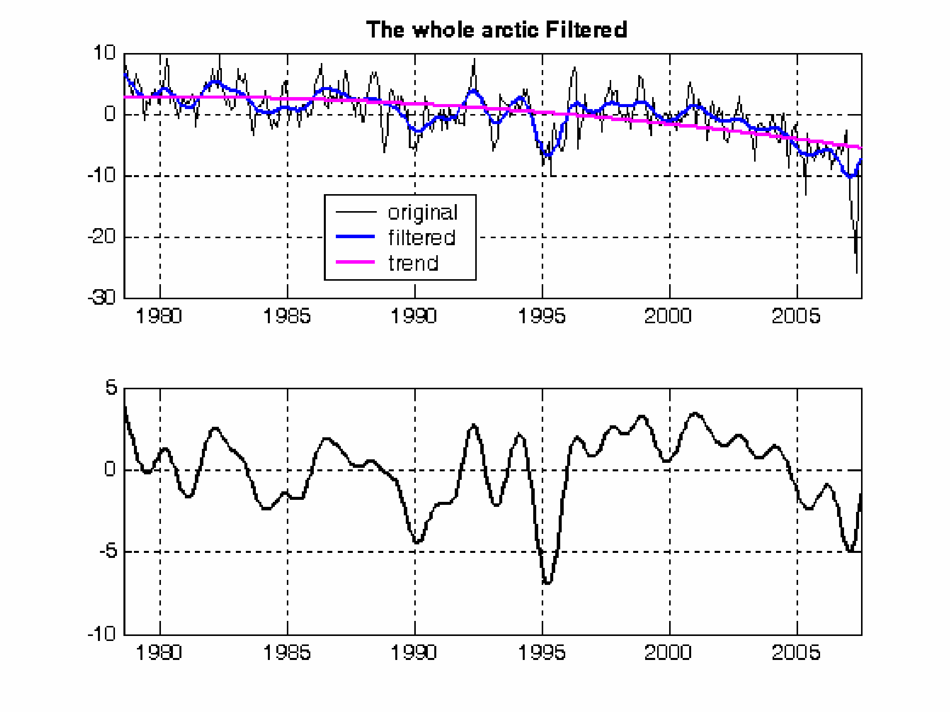
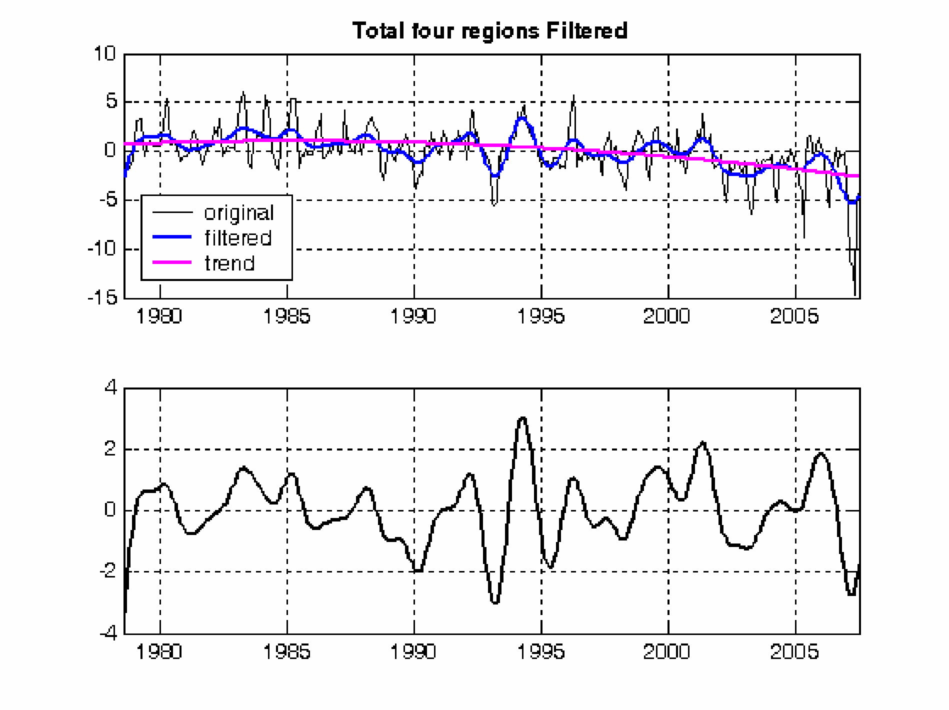
Periodicity



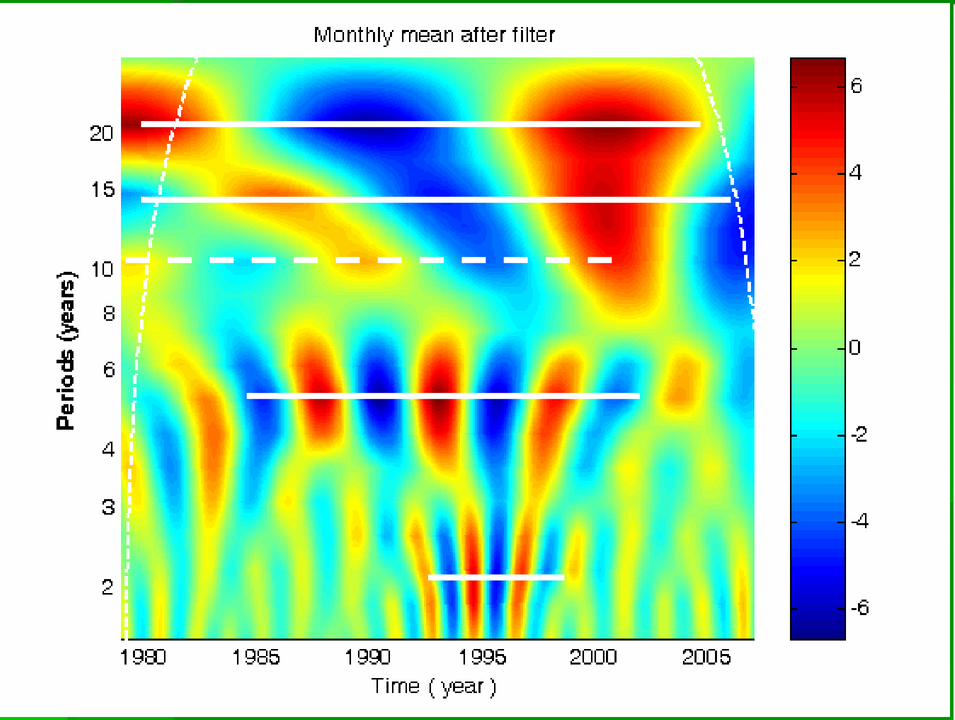
Filter the seasonal signal and subtract the trend

Periodicity :18 months lowpass

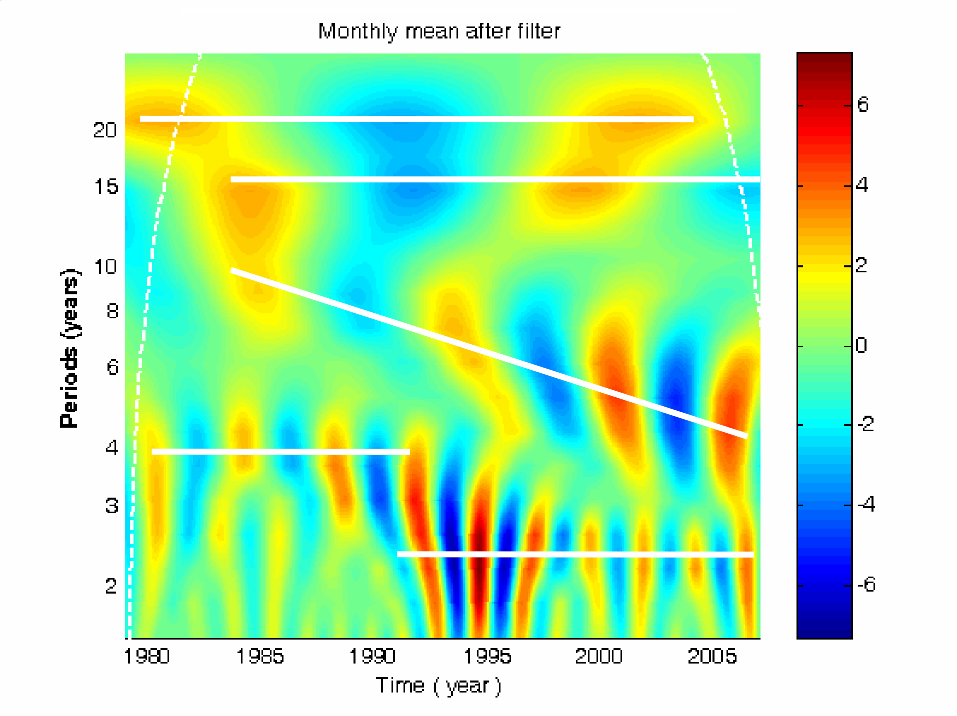


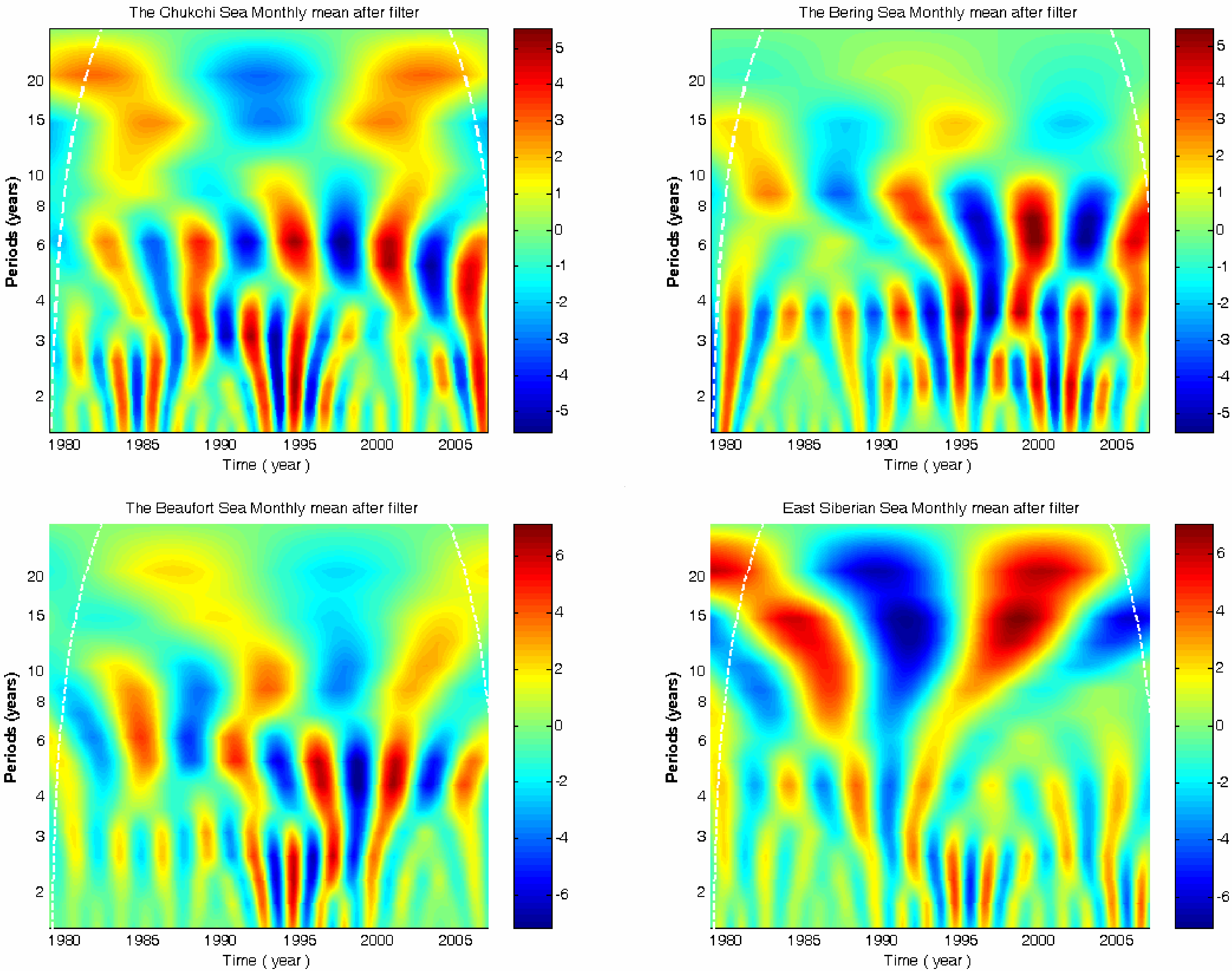


Whole Arctic



Total Four Regions





The Chukchi Sea Monthly mean after filter
The Bering Sea Monthly mean after filter
The Beaufort Sea Monthly mean after filter
East Siberian Sea Monthly mean after filter
Periods (years)
Time (year)
1980
1985
1990
1995
2000
2005
2
3
4
6
8
10
15
20

Is there any link to AO and PDO?

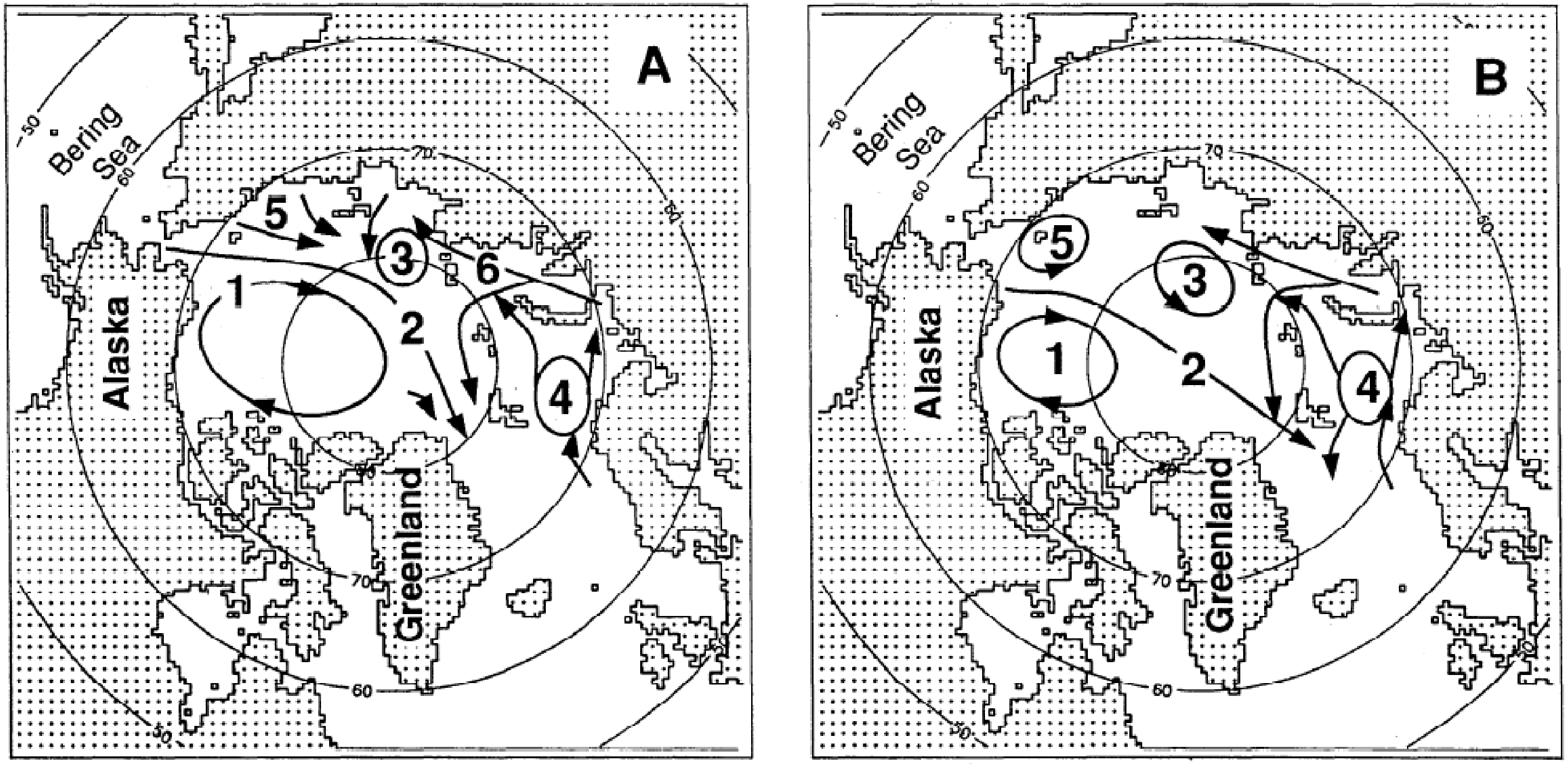
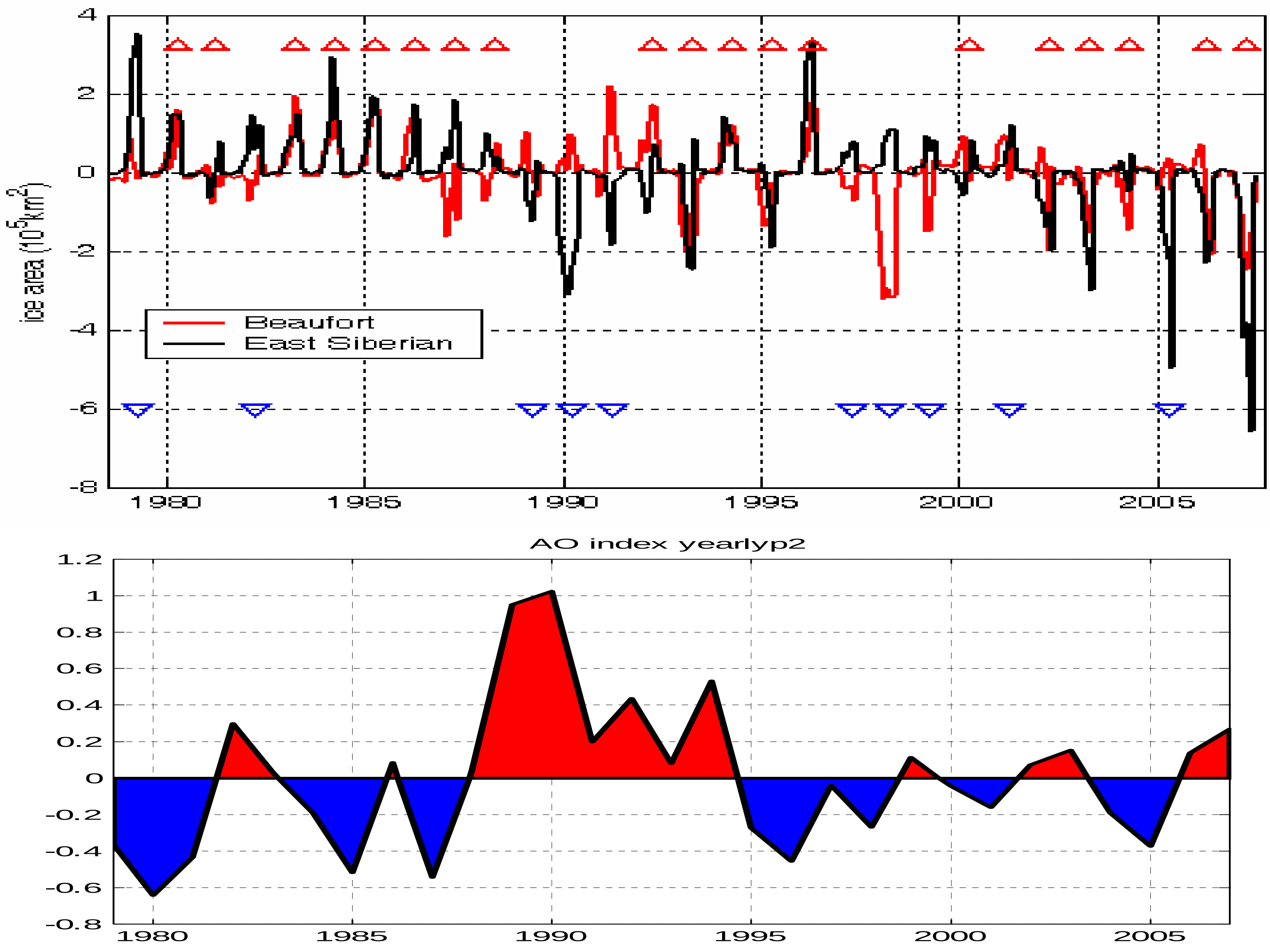
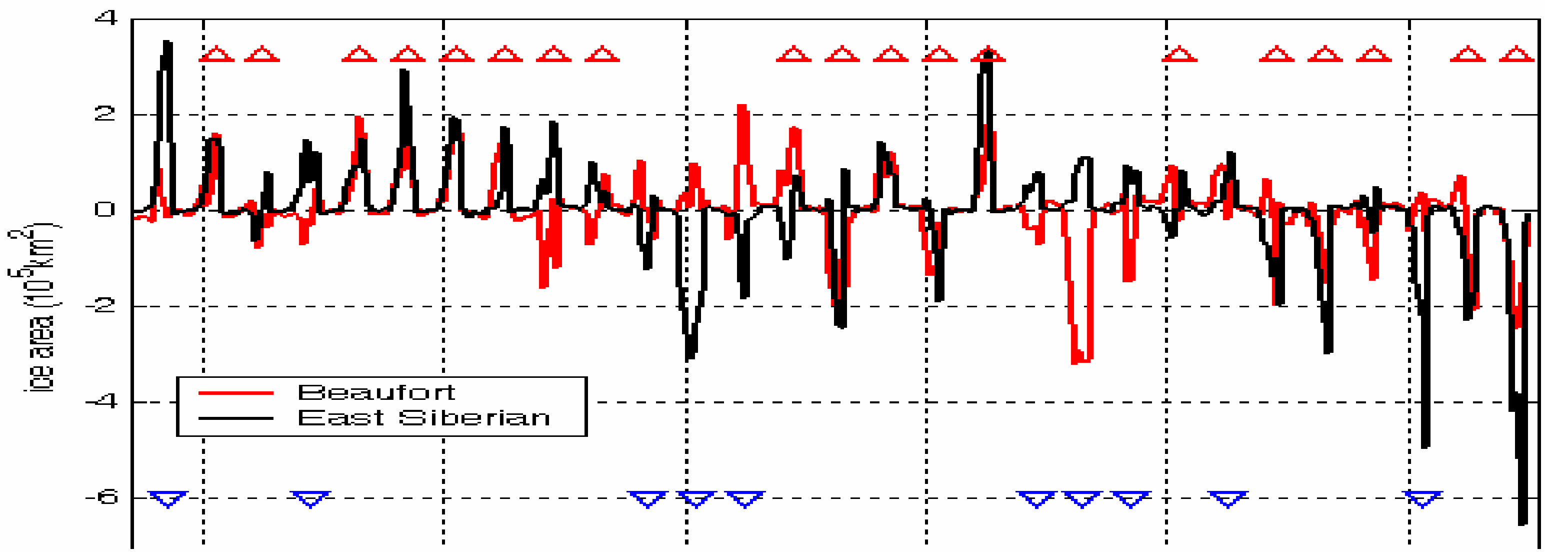


Figure 4. Regimes of surface currents and ice drift in the Arctic Ocean redrawn from *Sokolov* [1962]. (a) Type A circulation, corresponding to prevailing Arctic High atmospheric pressure; (b) Type B circulation, corresponding to prevailing Icelandic Low atmospheric pressure. Numbered features are 1, Beaufort Gyre; 2, Transarctic Drift Current; 3, Laptev Sea cyclonic circulation; 4, Barents Sea currents; 5, East Siberian Sea circulation; and 6, Kara Sea coastal flow.

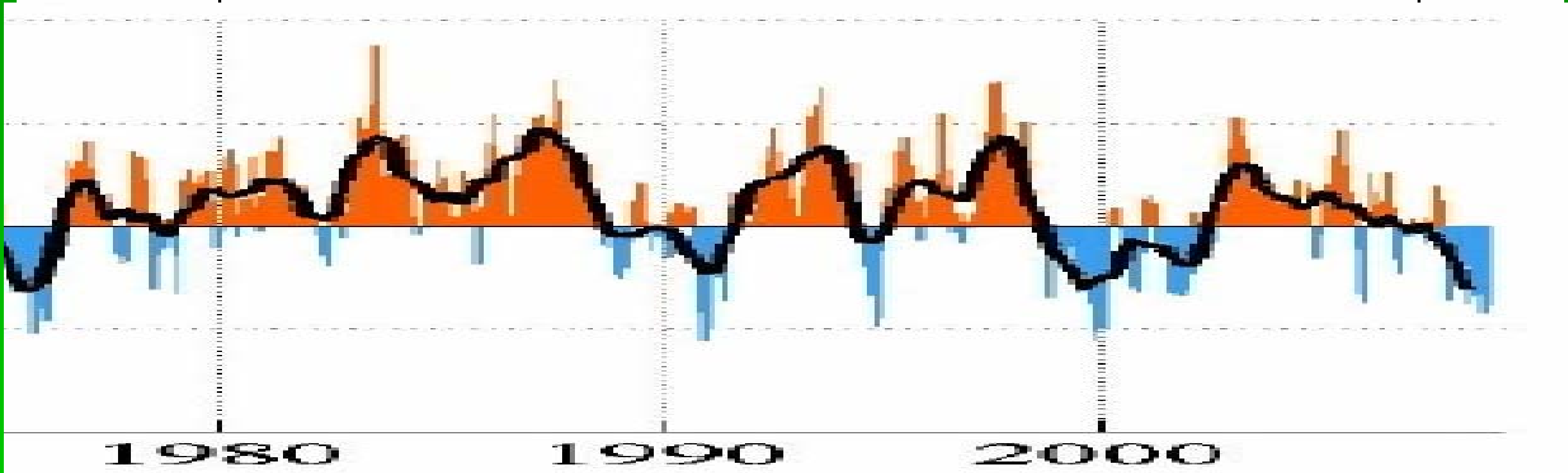
(Proshutinsky,1997)



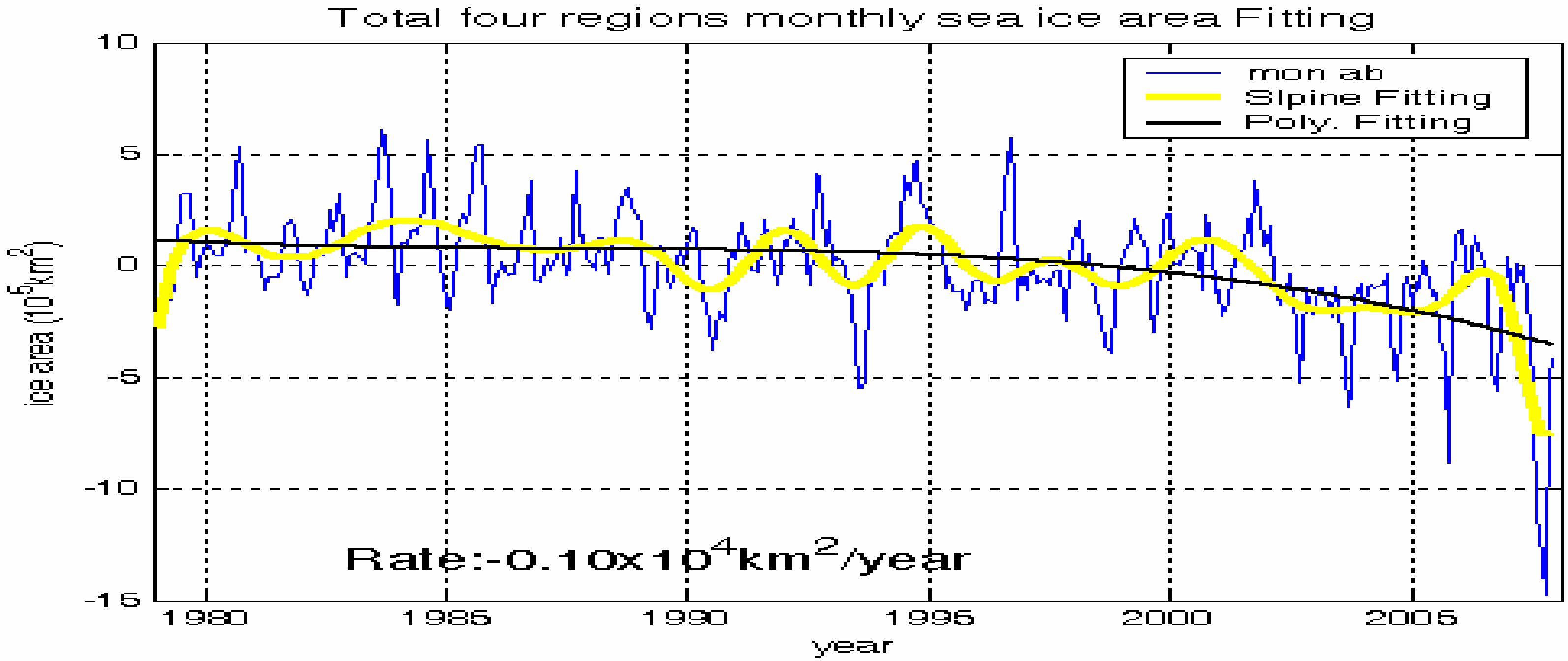
The opinion of AO connection and two regimes theory can't explain this !

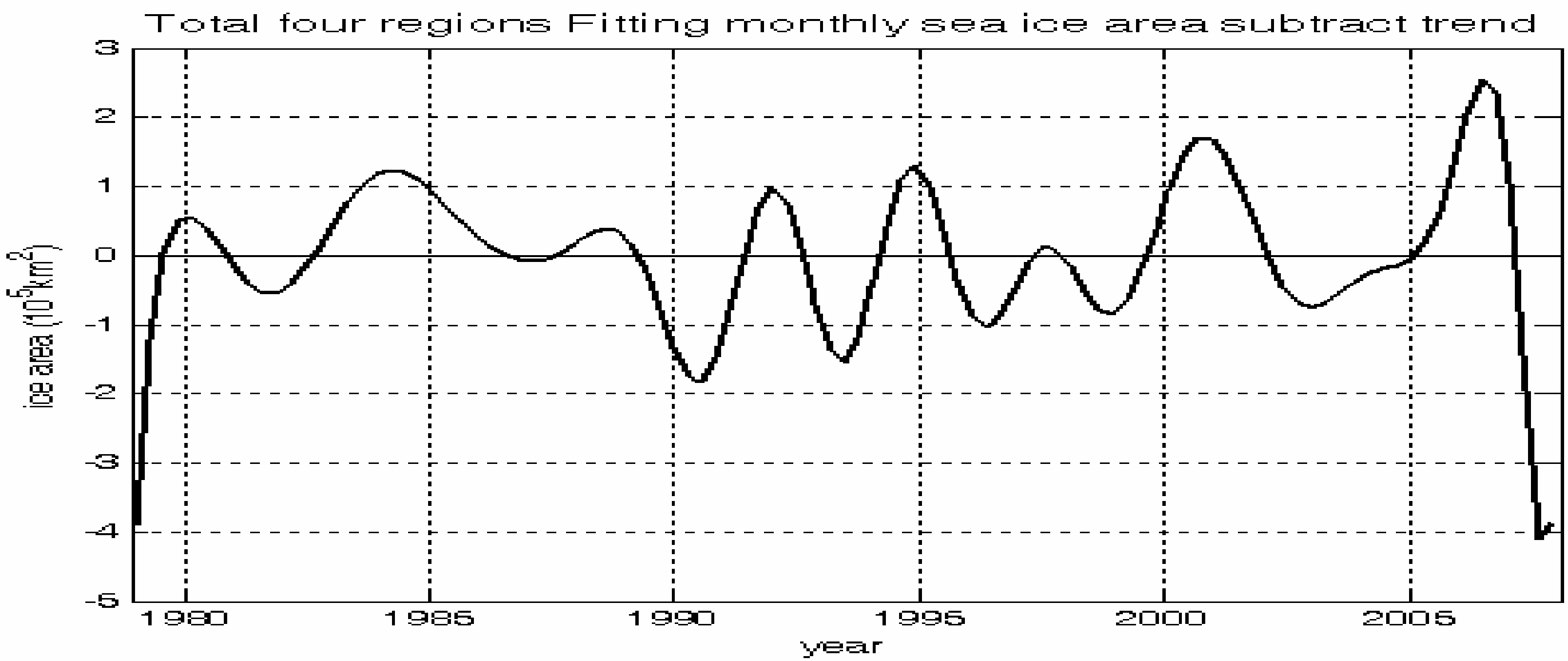


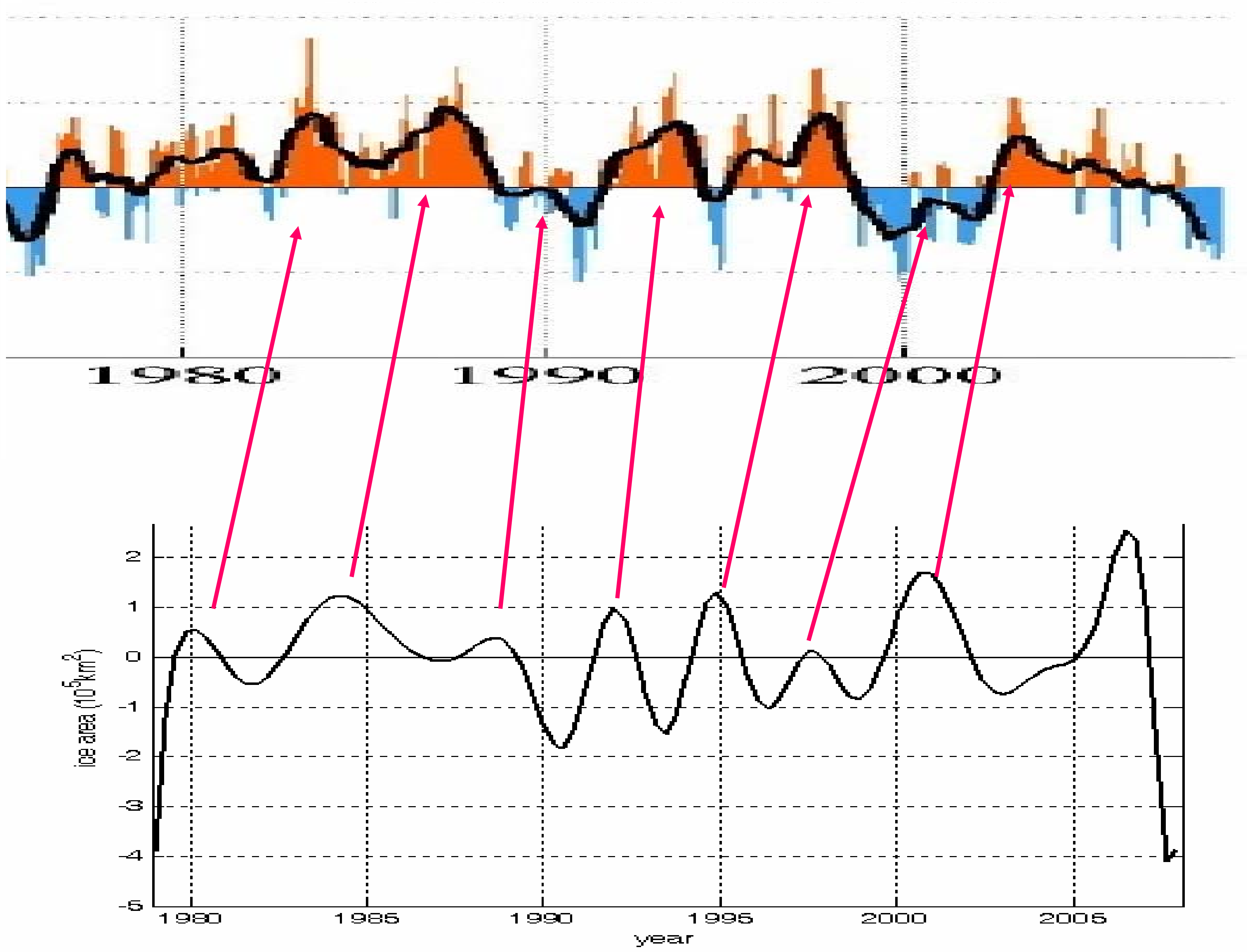
4
2
0
-2
-4
-6
ice area ($10^5 km^2$)
Beaufort
East Siberian



1980
1990
2000


Total four regions monthly sea ice area Fitting
mon ab
Slpine Fitting
Poly. Fitting
Rate:-0.10x10^4km^2/year
ice area (10^5km^2)
year


Total four regions Fitting monthly sea ice area subtract trend
ice area (10^5km^2)
year



1980
1990
2000
2
1
0
-1
-2
-3
-4
-5
ice area (10^5 km^2)
1980
1985
1990
1995
2000
2005
year

A parameter to represent Pacific Inflow's intensity

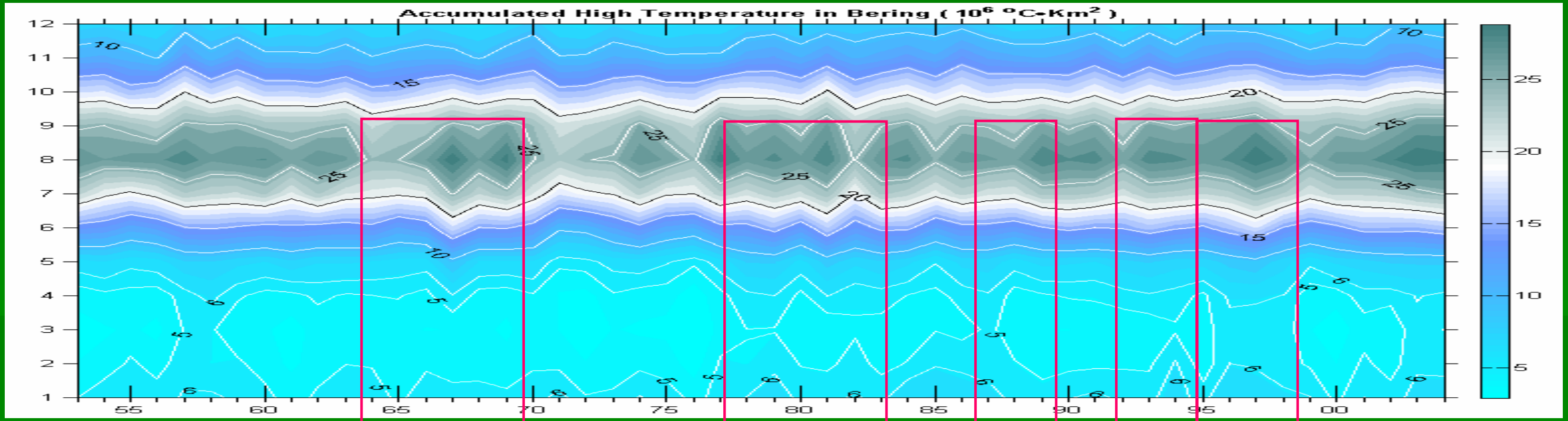
Accumulated heat: Q_t

$$Q_t = \sum w_i T_i S_i$$

$$w_i = \begin{cases} 0 & T_i < T_{threshold} \\ 1 & T_i \geq T_{threshold} \end{cases}$$

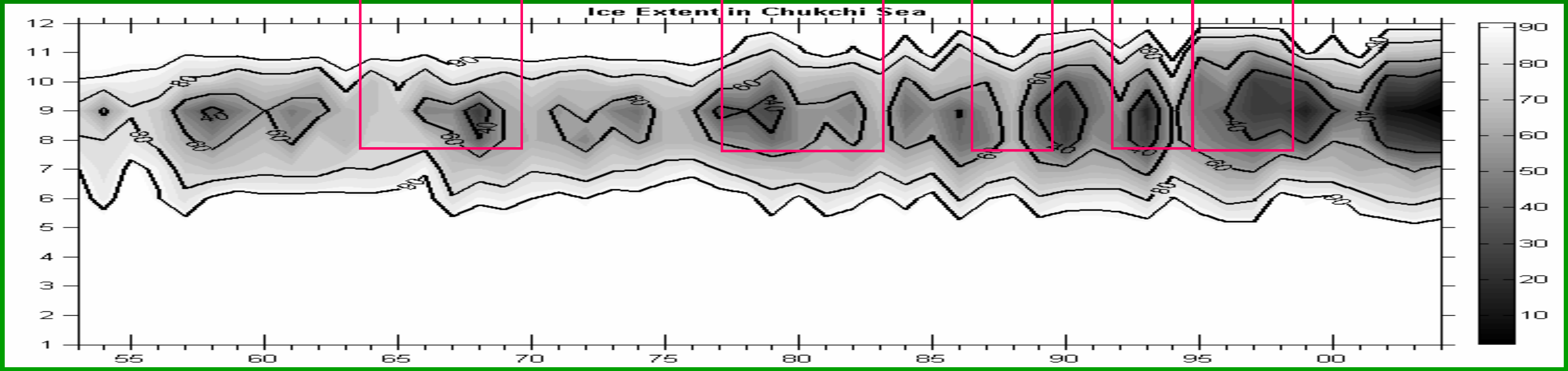
S_i :area of a grid， $T_{threshold}$ =-1.0℃

Bering Sea Qt

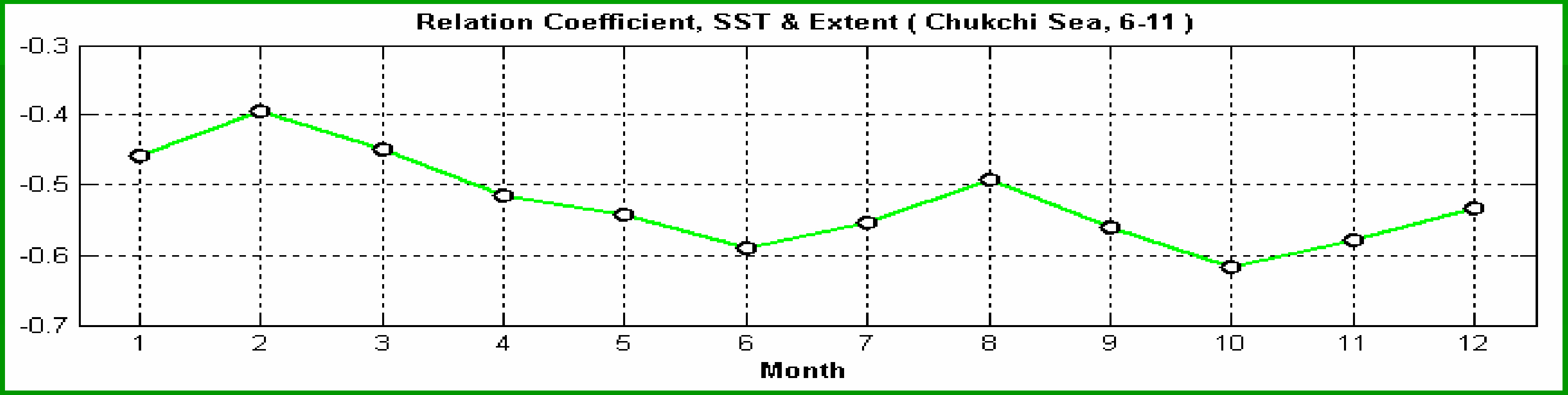


Chukchi Sea

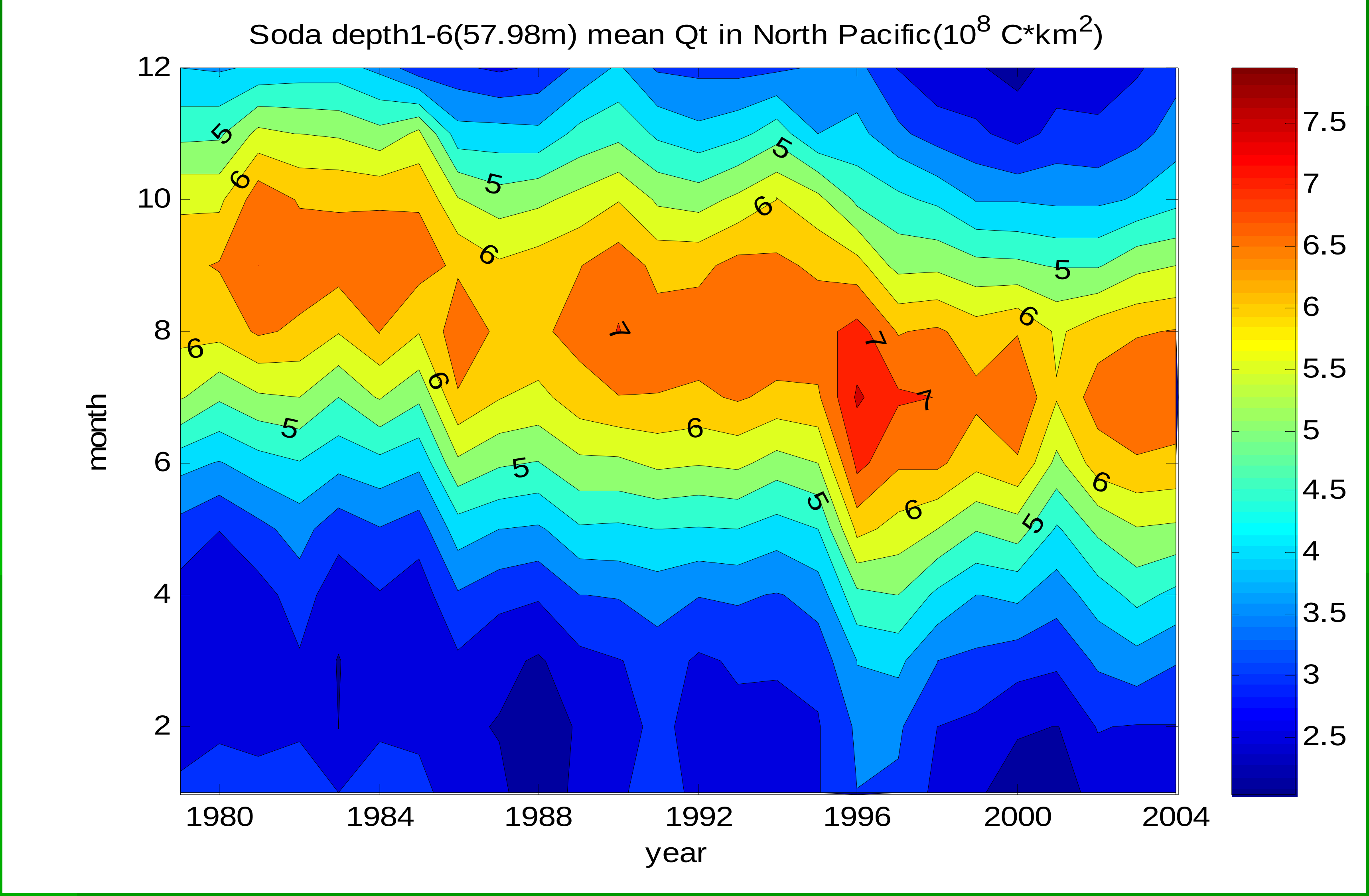
sea ice area



Relativity



Qt in Pacific (45N North, SODA)



conclusion

- **In summer, Sea ice concentration decreased more significant in Pacific side of Arctic. Except Bering Sea, sea ice area has significant interannual variation during Aug.-Oct.**
- **The four regional sea don't share the same interannual change in the trend as well as in the periodicity.**
- **There is a abrupt (change, shift) around 1997 in Chukchi Sea, Bring Sea and East Siberian Sea.**
- **The two regimes theory of AO is difficult to explain interannual variation of sea ice area, while PDO index matches with the filtered sea ice area series with 2-4 years lag**
- **A parameter Qt is defined to represent the strength of Pacific inflow. Qt in Bering sea matches well with sea ice area of Chukchi Sea during Jun.-Nov. Qt in North Pacific shows earlier and earlier warm in a year cycle these years.**

Thank you!