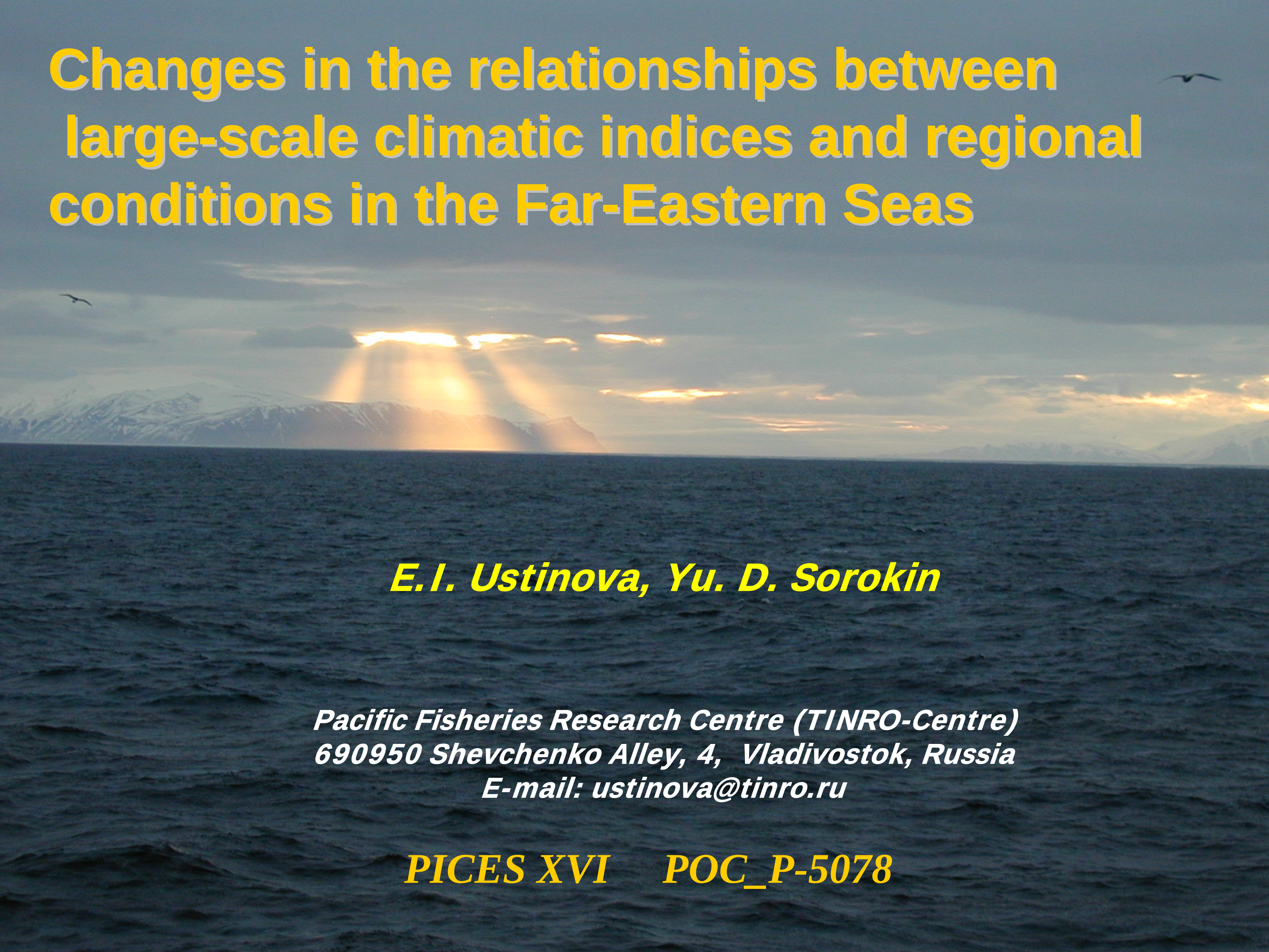

Changes in the relationships between large-scale climatic indices and regional conditions in the Far-Eastern Seas

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INTRODUCTION

Any prominent changes in the North Pacific are reflected in the Far-Eastern seas. On the other hand, the regional processes also should be taken into account, because sometimes they modify the global impact considerably. **Scale issue and scale interactions of thermal processes are one of the basic problems.**

Since large-scale patterns are used to represent the essential elements of climate, we analyzed the stability of the relationships of the regional characteristics (mainly sea ice coverage, air and water temperature) and large-scale climatic indices.

GOAL

The purpose of the study is to evaluate the relationships of the regional thermal characteristics in the Far-Eastern Seas using regional data sets based on historical observations and large-scale climatic patterns and principal oscillations such as Arctic Oscillation (AO), Pacific Decadal Oscillation (PDO), Victoria pattern, SOI, West Pacific (WP) Index, etc.).

REGIONAL DATA SOURCES:

1. Time series of the ice cover in the Okhotsk Sea in March (annual maximum) for 1929-1956 collected by Kryndin (1964) from various visual observations (shipboard, aircraft, coastal).

2. Regular ten-days aircraft observations conducted by Russian Hydrometeorological Service: Okhotsk Sea for 1957-1991, Bering Sea and Japan Sea (Tatar Strait) for 1960-1991.

3. Satellite information obtained from Far-Eastern Regional Center, Khabarovsk (1992-1998) and from National Ice Center U.S.A (since 1999) (http://www.natice.noaa.gov/pub/west_arctic)

4. Ice charts of the Japanese Meteorological Agency for the Okhotsk Sea (1998-2008).

5. Monthly mean air temperature data at coastal meteorological stations published by Russian Hydrometeorological Agency (as monthly and annual reports and climatic directories).

6. Monthly mean air temperature data at the meteorological stations data from NASA GISS (http://www.giss.nasa.gov/data/update/gistemp)

7. Time series of the monthly mean SST (COBE-SST) from 1950 to latest month for each 1 degree latitudinal and longitudinal square of the Pacific Ocean from the Real Time Data Base, NEAR-GOOS (http://goos.kishou.go.jp/rrtdb).

8. Time series of the 10-day mean SST for each one degree square of the Northwestern Pacific from the Real Time Data Base, NEAR-GOOS (http://goos.kishou.go.jp/rrtdb).

DATA SOURCES:

9. Climatic indices from:

http://www.beringclimate.noaa.gov/data/index.php,
http://www.cgd.ucar.edu/cas/catalog/climind/,
http://www.cpc.ncep.noaa.gov/products/, http://jisao.washington.edu/,
http://www.pac.dfo-mpo.gc.ca/sci/sa-mfpd/climate/clm_index.htm.

10. Repeatability of the types of atmospheric processes over the Far-Eastern Seas (by Glebova, 1999);

11. Macro-scale pressure gradient between the Siberian High and Aleutian Low and intensity of the Far-Eastern centers of atmosphere action
(by Vasilevskaya et al, 2003);

We analyzed well-studied climatic indices:

- Aleutian Low Pressure Index (ALPI),
- North Pacific Index (NPI),
- Atmosheric Forcing Index (AFI),
- Pacific Circulation Index (PCI),
- West Pacific (WP) Index,
- Pacific Decadal Oscillation (PDO) and
- Victoria index (named after the location where its significance was first identified);
- Arctic Oscillation (AO) Index, ENSO

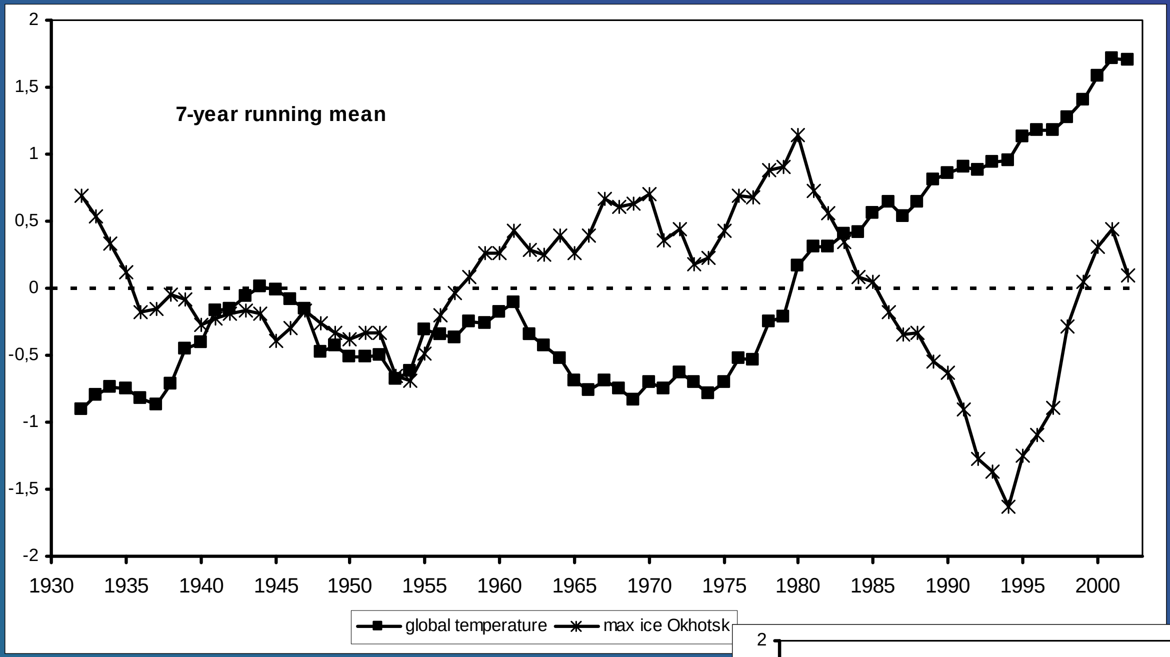
global and Northern Hemisphere averaged surface air temperature

and less often used indexes:

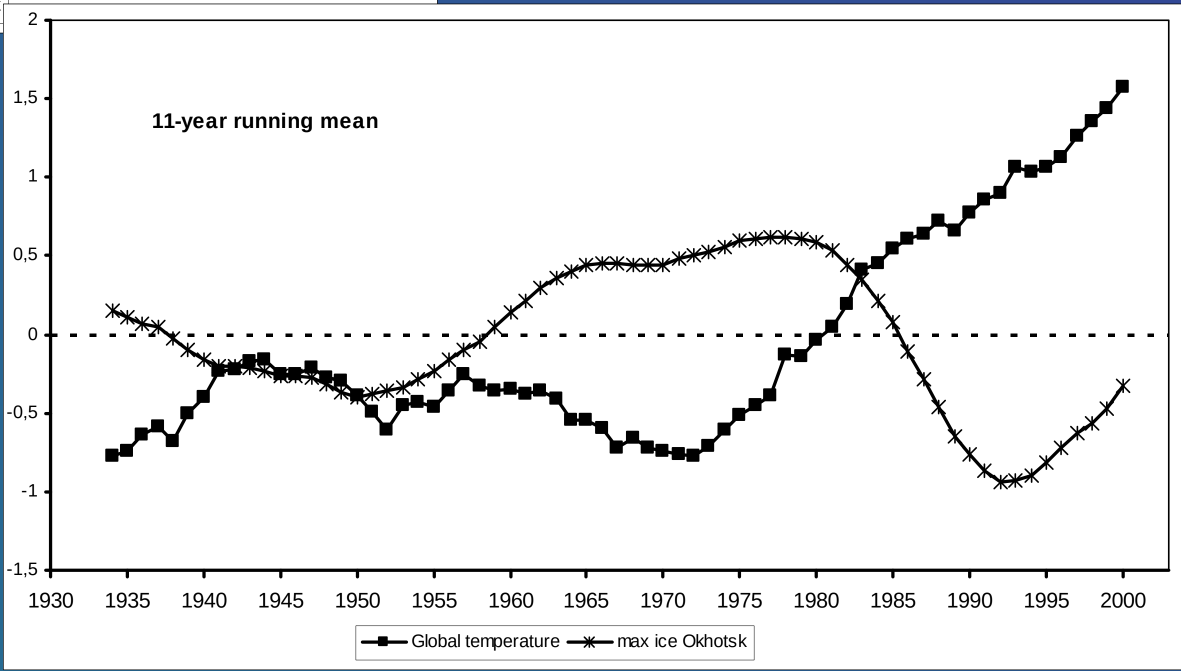
- macro-scale pressure gradient between the Siberian High and Aleutian Low;
- repeatability of regional atmospheric circulation types (after Glebova, 1999, 2001)

together with some regional thermal characteristics

Winter global temperature anomalies and annual maximum ice cover anomalies in the Okhotsk Sea

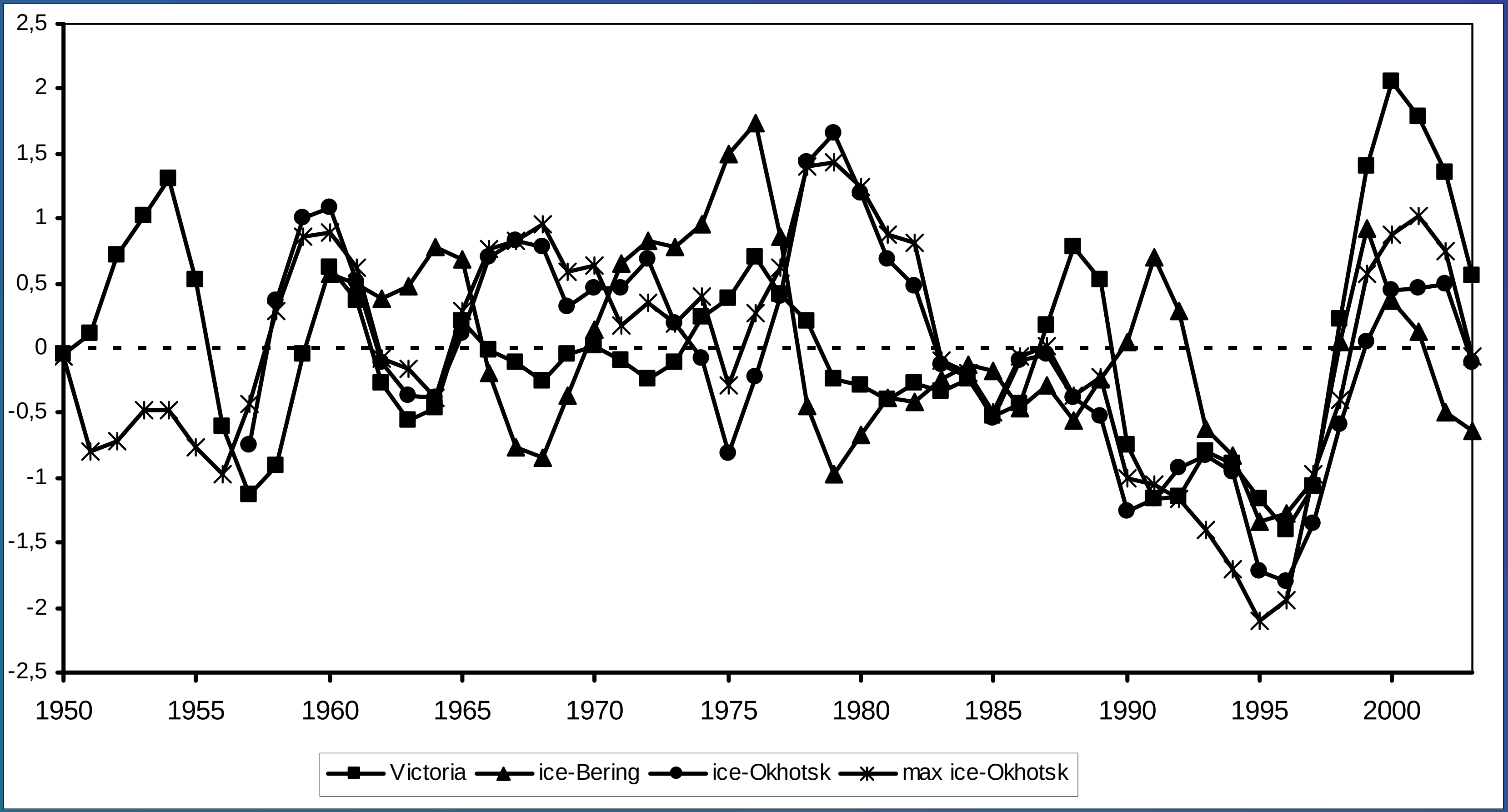


Time series are standardized and smoothed by a 7-year and 11-year running mean.



Victoria Index (winter) vs mean winter ice cover of the Okhotsk and Bering Seas and maximal ice cover of the Okhotsk Sea.

Time series are standardized and smoothed by a 3-year running mean



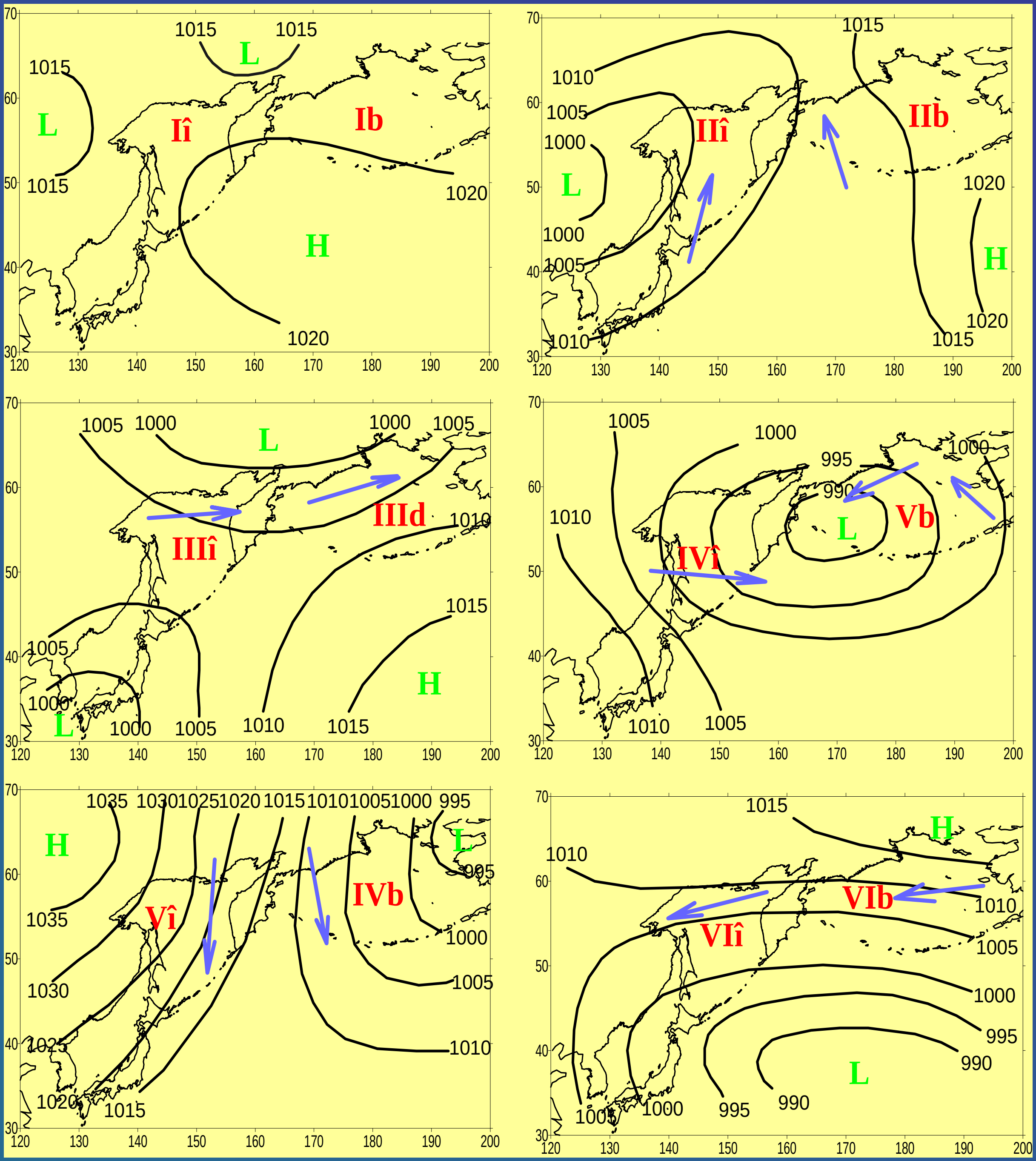
Victoria Index (winter) and

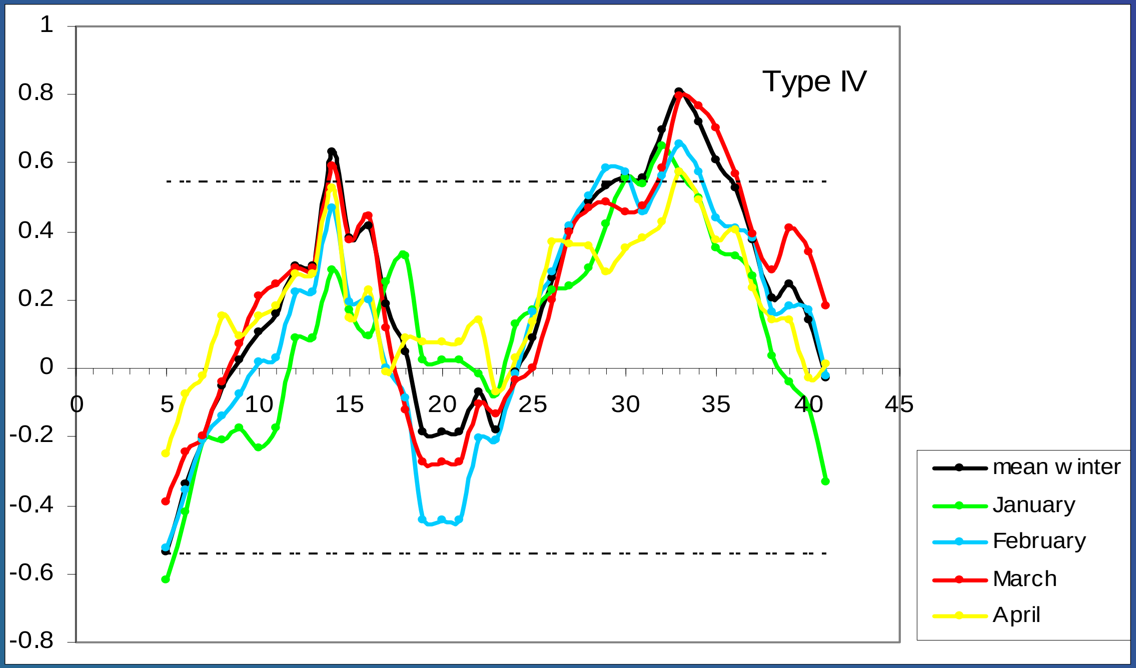
mean winter ice cover of the Okhotsk Sea: R= 0.36
maximal ice cover of the Okhotsk Sea: R=0.48
mean winter ice cover of Bering Seas: R=0.62

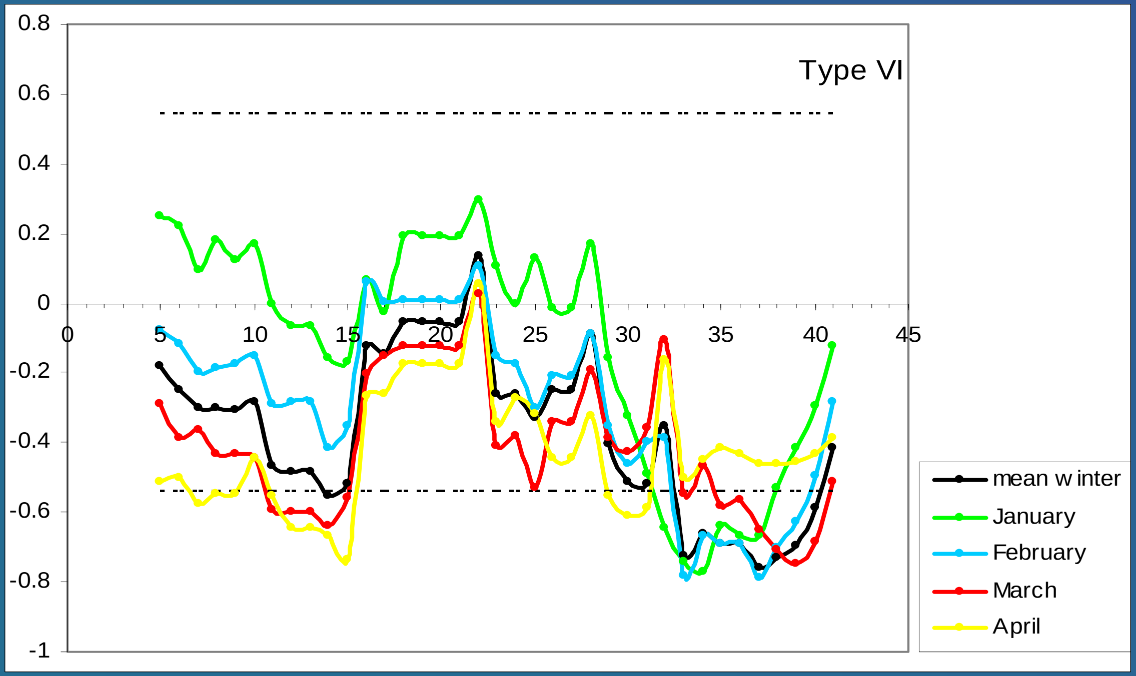
Indices for regional scales:

Types of atmospheric processes over the Okhotsk and Bering Seas

(after Glebova, 1999; 2001)







Correlations between regional atmospheric indices (by Glebova's) and ice extent on the Okhotsk Sea

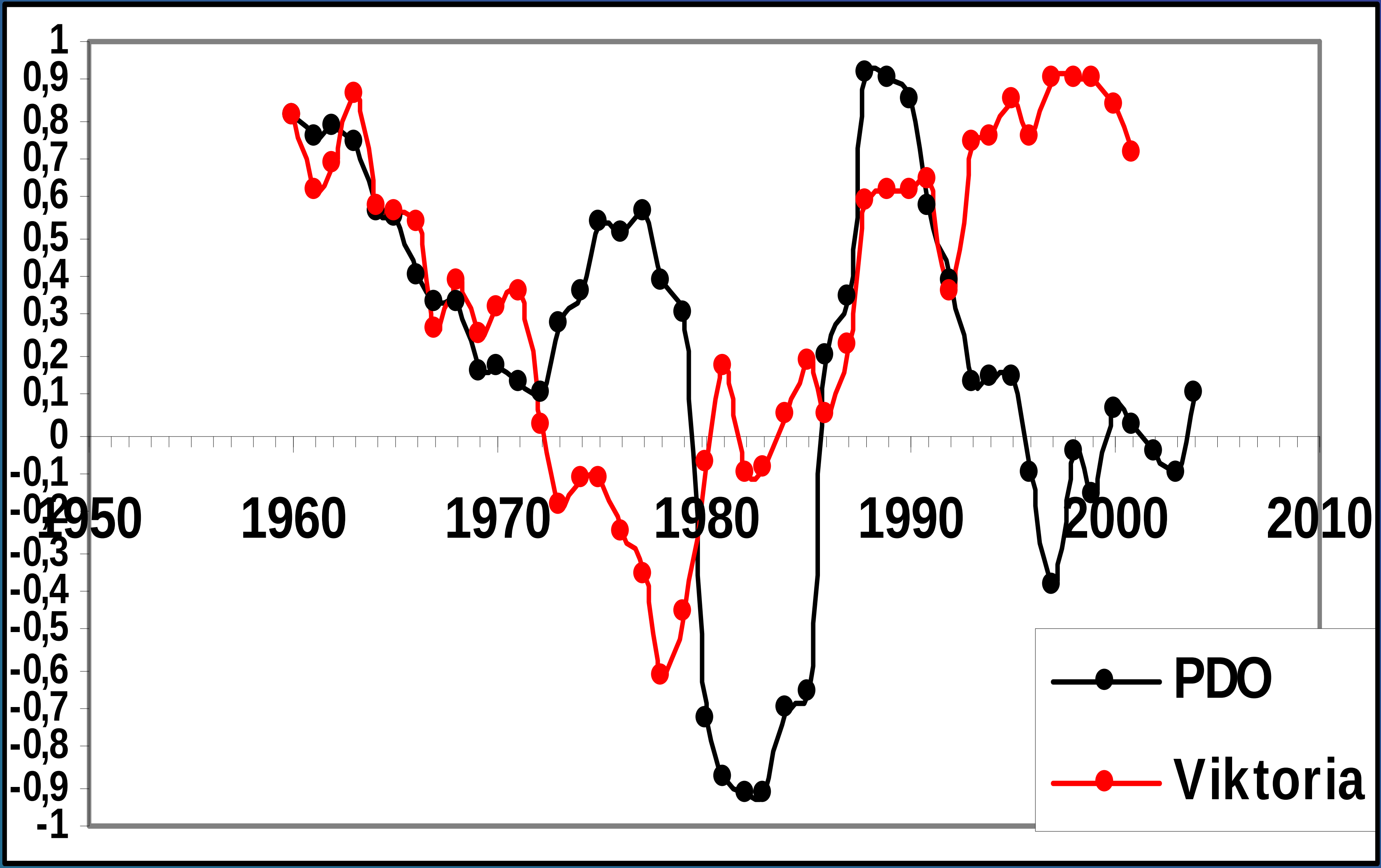
WINTER THERMAL CONDITIONS IN THE FAR-EASTERN SEAS AND CLIMATIC IDICES

- For the ice cover of the Okhotsk Sea Victoria Index is the most essential among other indices.
- PDO index is “better” for Bering Sea: PDO index have little correlation with ice cover of the Okhotsk Sea and higher correlation for Bering Sea.
- AO index is more important for the Okhotsk Sea.
- Parameters of Aleutian Low is more important for Bering Sea.
- Winter monsoon index (macro-scale pressure gradient between the Siberian High and Aleutian Low) is significant for thermal state in the Okhotsk and Japan/East Seas.
- For the temporal scales from quasi-two-years to 5-7-years repeatability of the winter regional types of atmospheric processes reflected the main features of the local heat exchange in ocean-atmosphere system, therefore repeatability of the types is closely connected to ice cover.

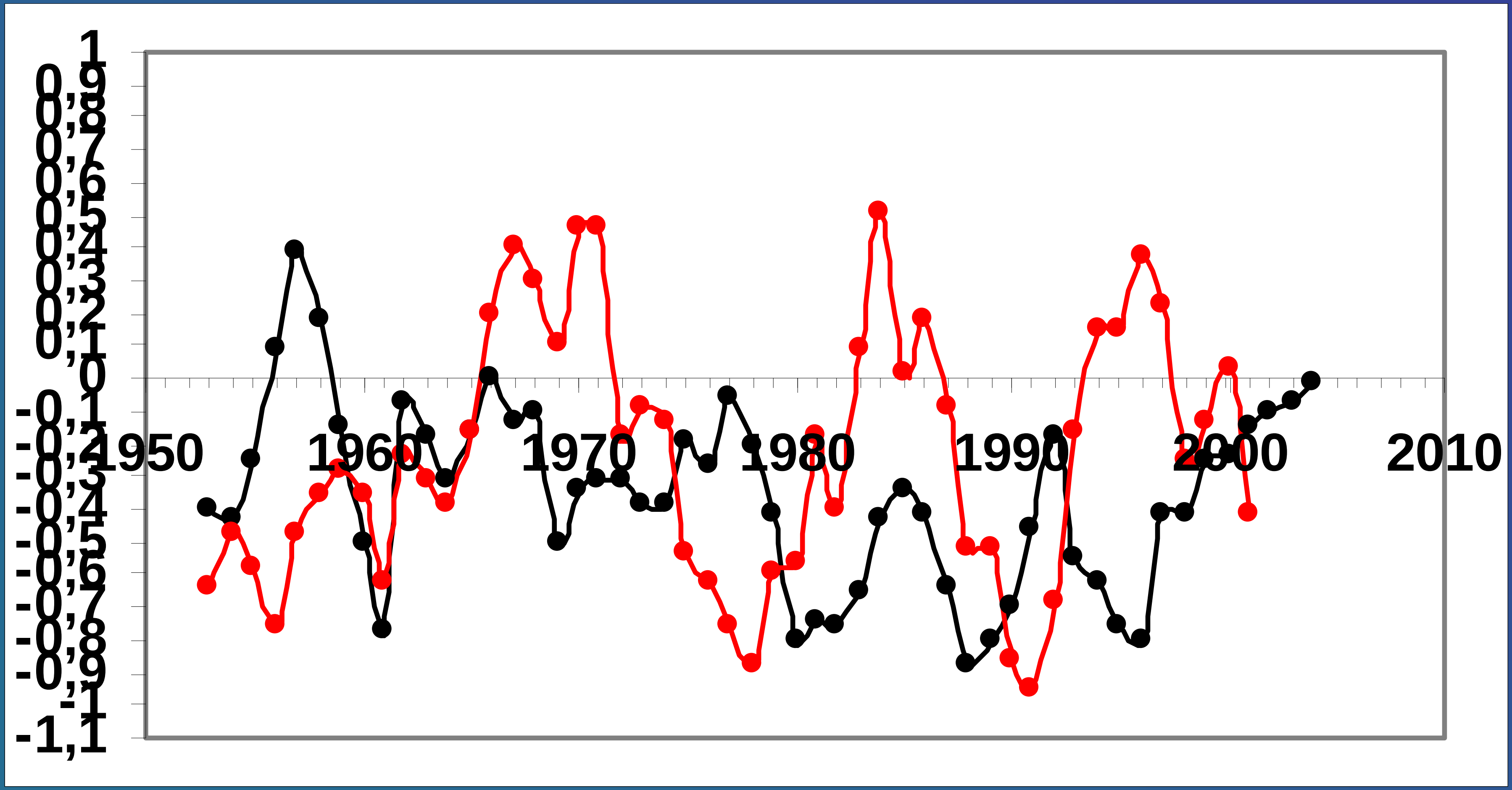
The different combinations of the regional thermal characteristics and climatic indices for various transformations of primary data with "running" time intervals from 11 to 30 years, a part of time series before and after regime shifts and complete time series were examined.

Further some examples only:

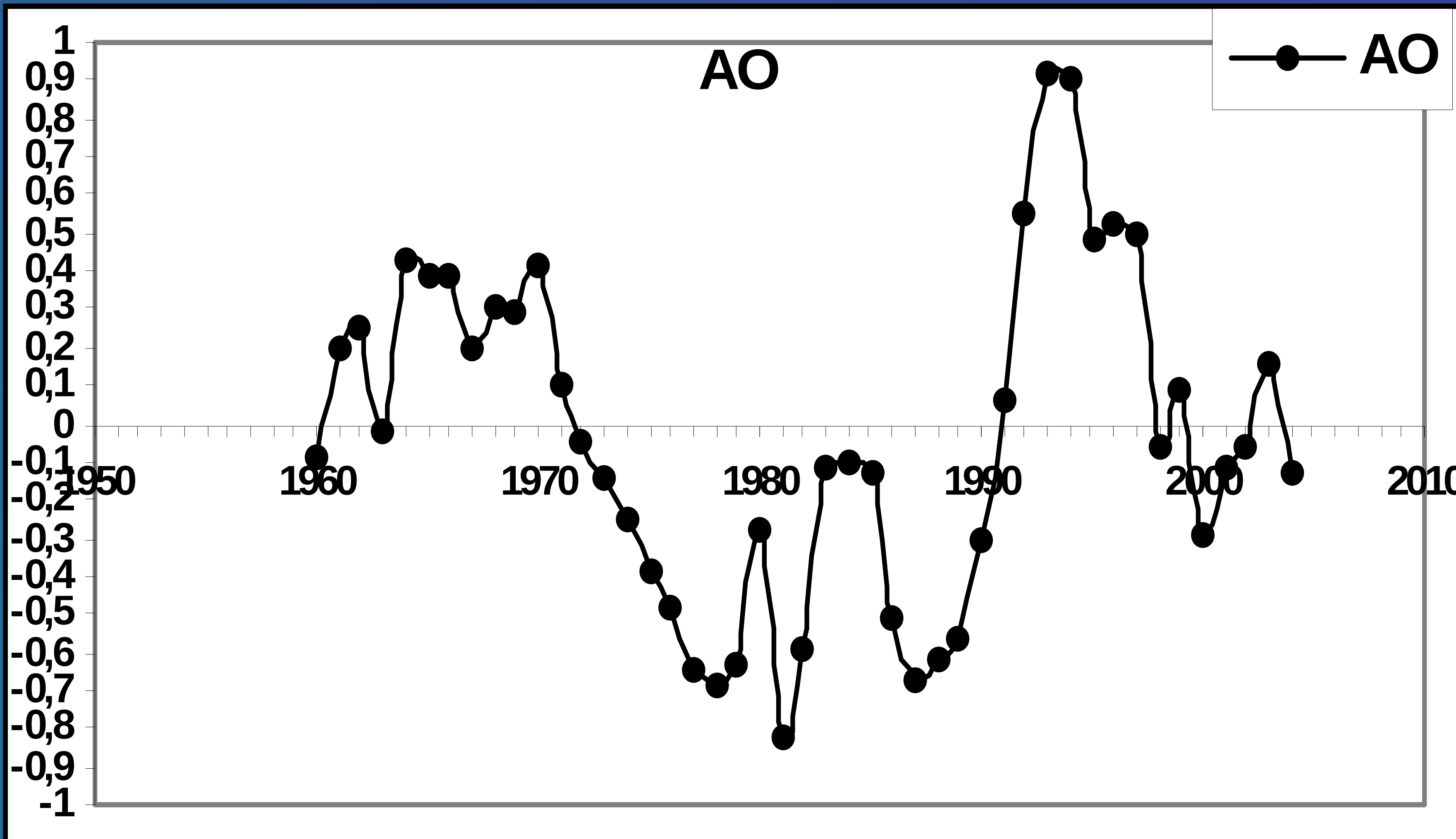
1 - decade "running correlation"
mean winter ice cover in the Okhotsk Sea with:
Victoria Index (winter) and PDO



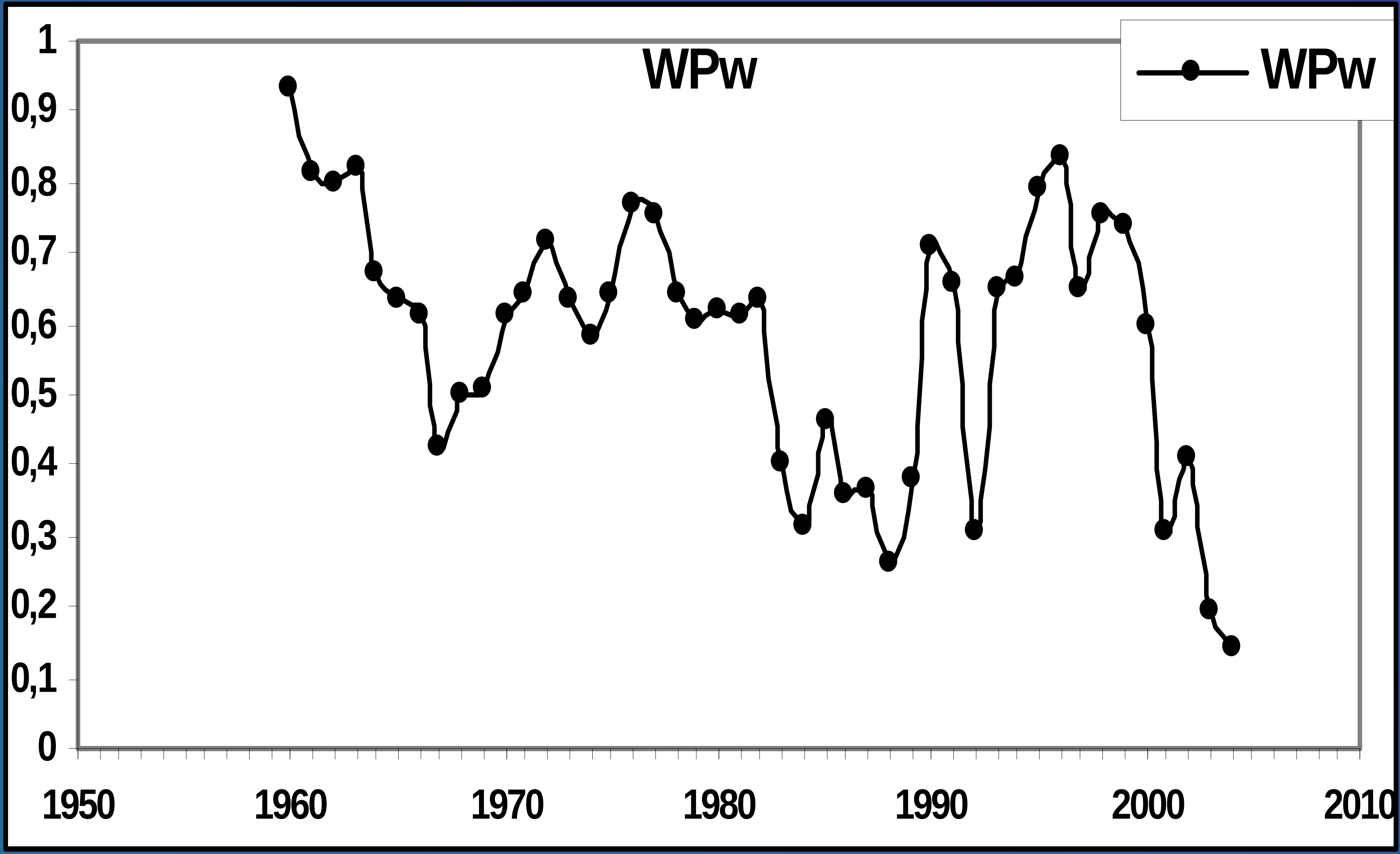
1 - decade "running correlation"
mean winter SST in the Japan/East Sea with:
Victoria Index (winter) and PDO



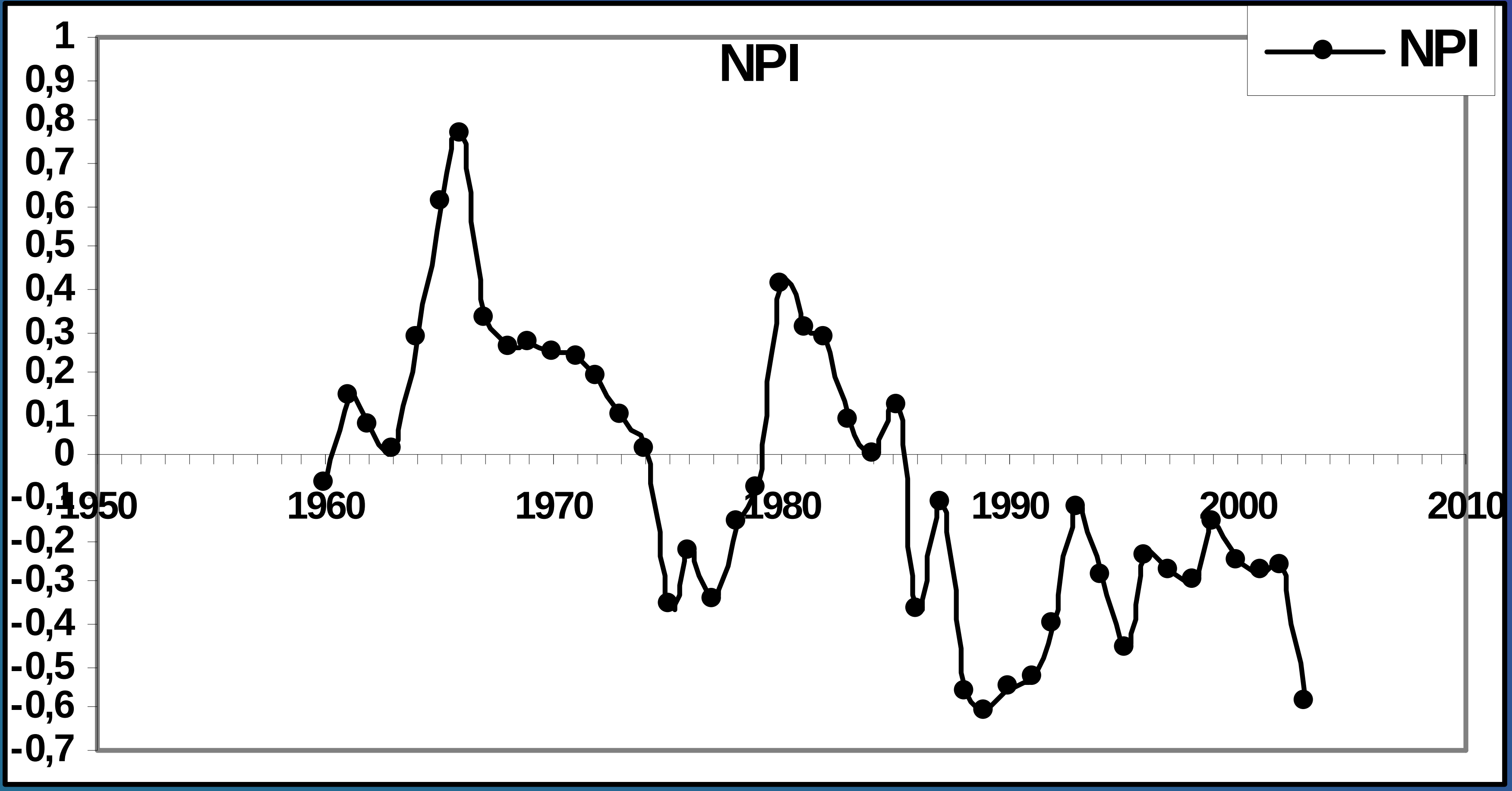
1 - decade "running correlation"
mean winter ice cover in the Okhotsk Sea with:
AO



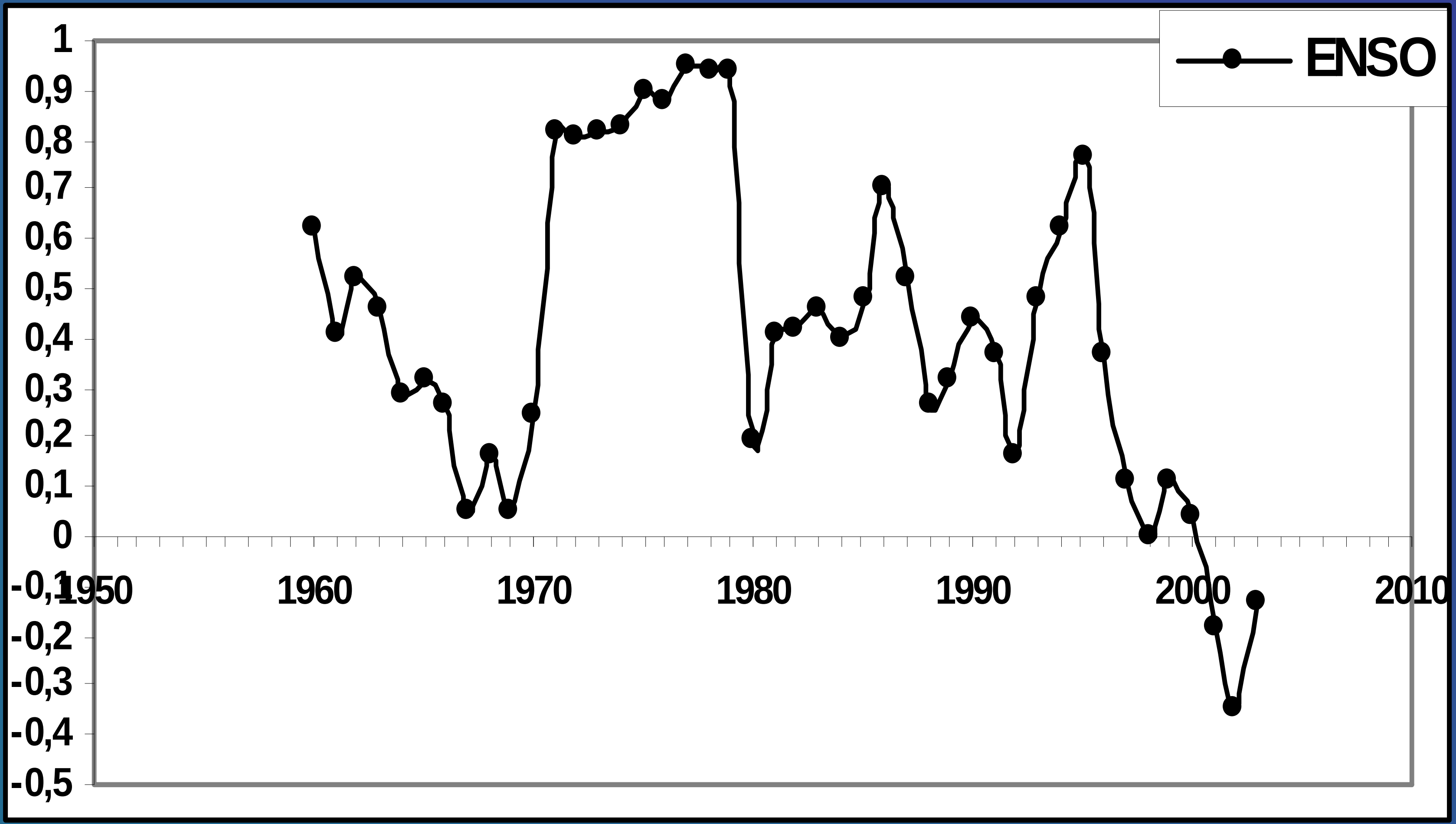
1 - decade "running correlation"
mean winter ice cover in the Okhotsk Sea with:
WPw



1 - decade “running correlation”
mean winter ice cover in the Okhotsk Sea with:
NPI



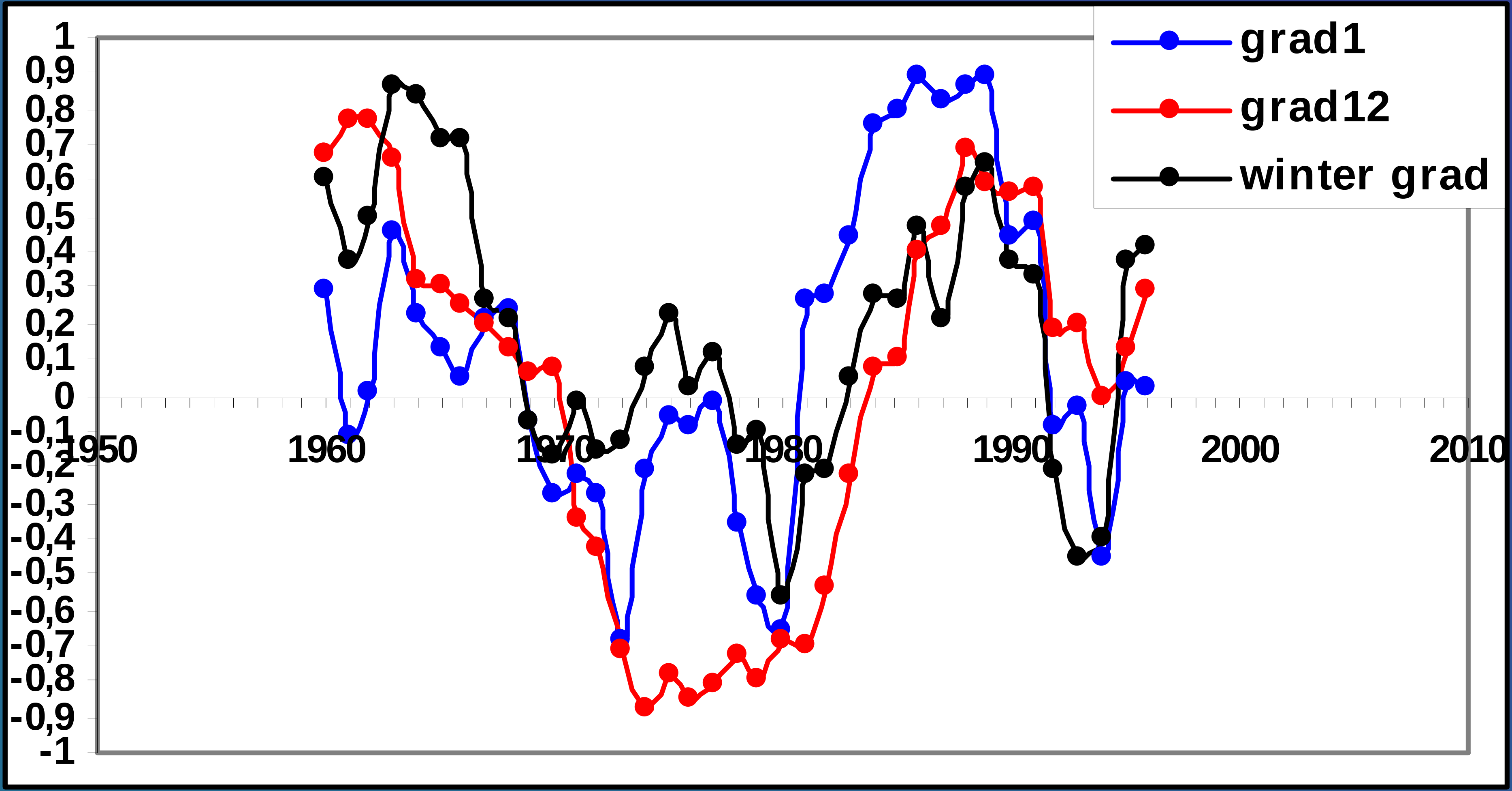
1 - decade "running correlation"
mean winter ice cover in the Okhotsk Sea with:



1 - decade “running correlation”

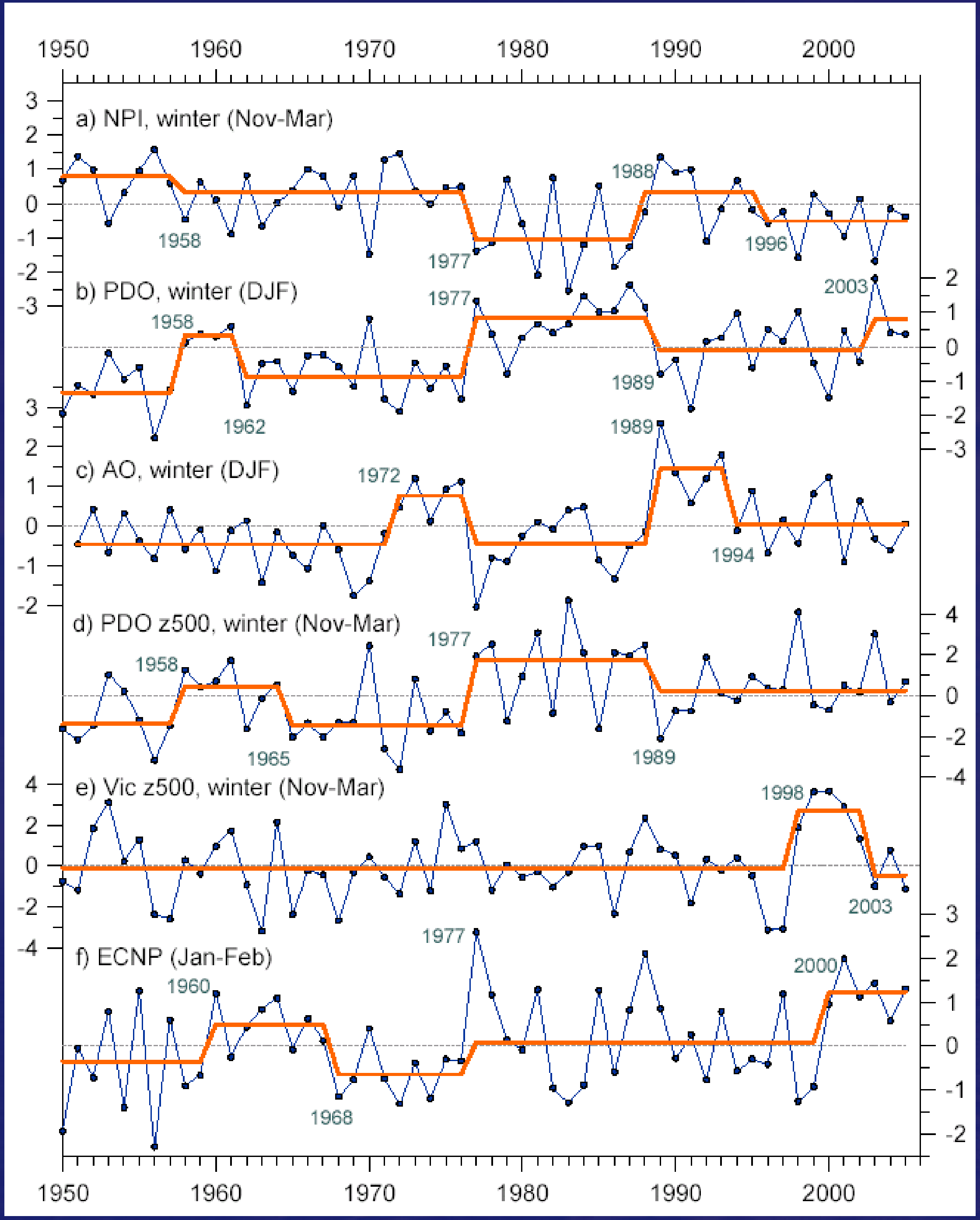
mean winter ice cover in the Okhotsk Sea with:

macro-scale pressure gradient between the Siberian High and Aleutian Low



After Rodionov et al, 2005:

a) Mean winter (Nov-Mar) NPINCAR, 1950-2005,
b) b) Mean winter (DJF) PDO index, 1950-2005,
c) Mean winter (DJF) Arctic Oscillation index
d) Mean winter (Nov-Mar) atmospheric PDO index at the 500-hPa level
e) Mean winter (Nov-Mar) atmospheric Victoria index at the 500-hPa level
f) January-February East-Central North Pacific index



The stepwise functions (orange lines) characterize regime shifts in the level of fluctuations of the indices.

SUMMARY

The stability of the connections (positive and negative) was analyzed by statistical methods according to hierarchy of the real scales of variability with an emphasis on the transition of quality of the connections: when connection becomes from positive to negative and visa versa. Many combinations of the characteristics for various transformations of primary data with “running” time intervals from 1 to 3 decades were examined.

Pronounced reorganizations of the relationships with accompanied inverse (for example, between ice cover in the Okhotsk Sea and PDO/AO, SST in the Japan/East Sea and AO), correspond to the 1976/77 and 1988/89 regime shifts most often.

The longest periods of relatively stable linkages were found for winter SST in the subtropical region of the Japan/East Sea with SOI and WP.

The steadiest relationships are between WP and regional thermal characteristics.

Scale issue and scale interactions of thermal processes are one of the basic problems. The quasi-steady state of the climatic system (from one regime shift to other) can be broken locally in the Far-Eastern Seas because of moving climatic atmospheric and oceanic fronts, trajectories of cyclones, change of blocking processes and other boundary phenomena.

Thank you for attention!