Regional and seasonal inhomogeneity of climatic variability in the Far-Eastern Seas

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PICES-2011 (POC-P-7862)

This presentation summarizes our studies on inhomogeneity of climatic variability in the Japan/East, Okhotsk and Bering Seas. We estimated the regional and seasonal features of climatic variability.

We used historical and contemporary sources of regional data of the observations on various thermal and atmospheric circulation parameters

- **State of atmosphere: thermal (air temperature) and dynamic (SLP, trajectories of cyclones, Kunicin's index, types of regional atmospheric circulation, *etc*)**

- **Thermal parameters in the Seas:**

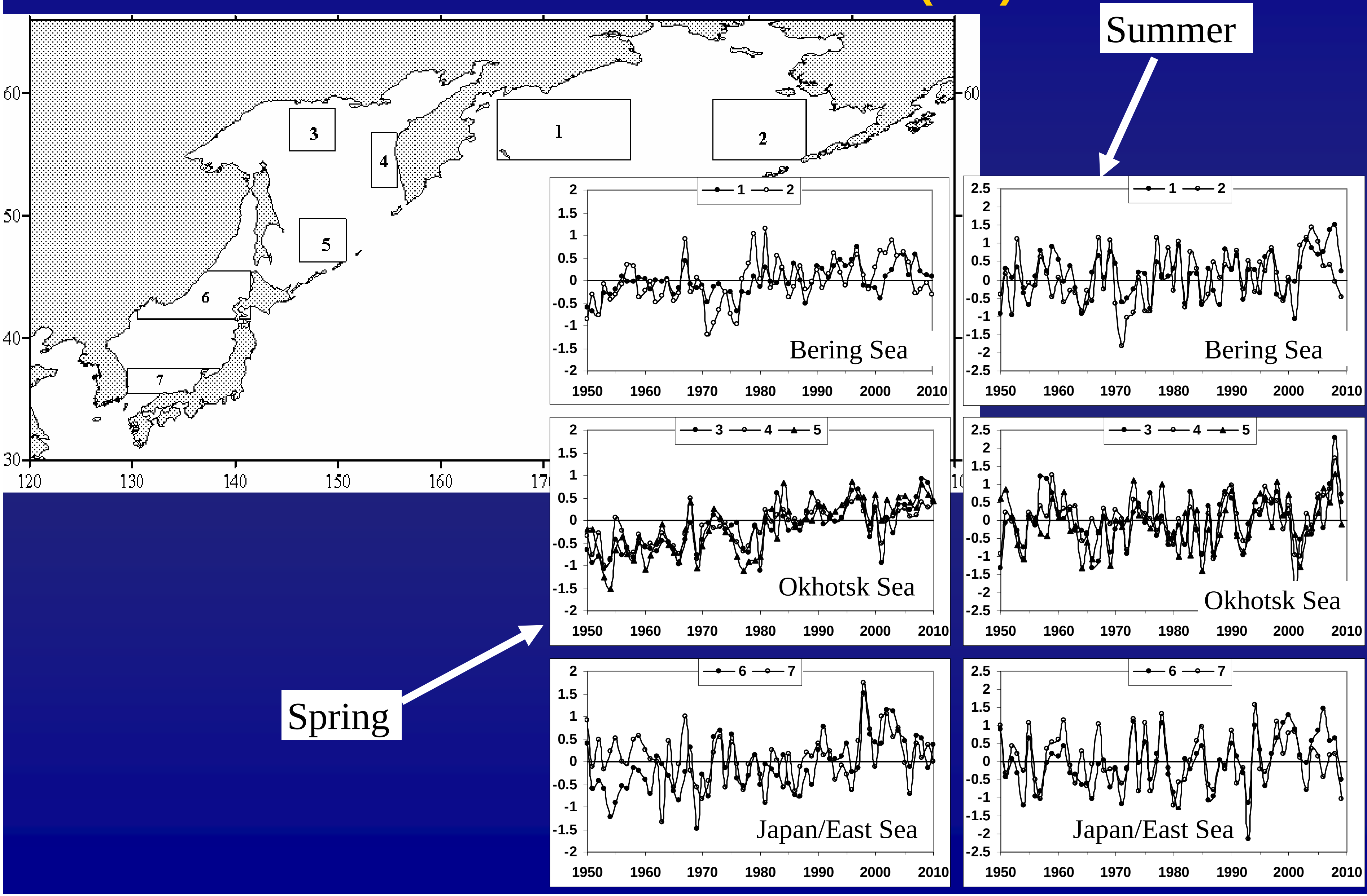
  long time series:

  ice cover (regular ten-days aircraft observations conducted by Russian Hydrometeorological Service and satellite information**)**

  SST (Time series of the 10-day mean SST from 1950 to latest month for 1 degree square of the Northwestern Pacific from the Real Time Data Base, NEAR-GOOS, http://goos.kishou.go.jp/rrtdb)

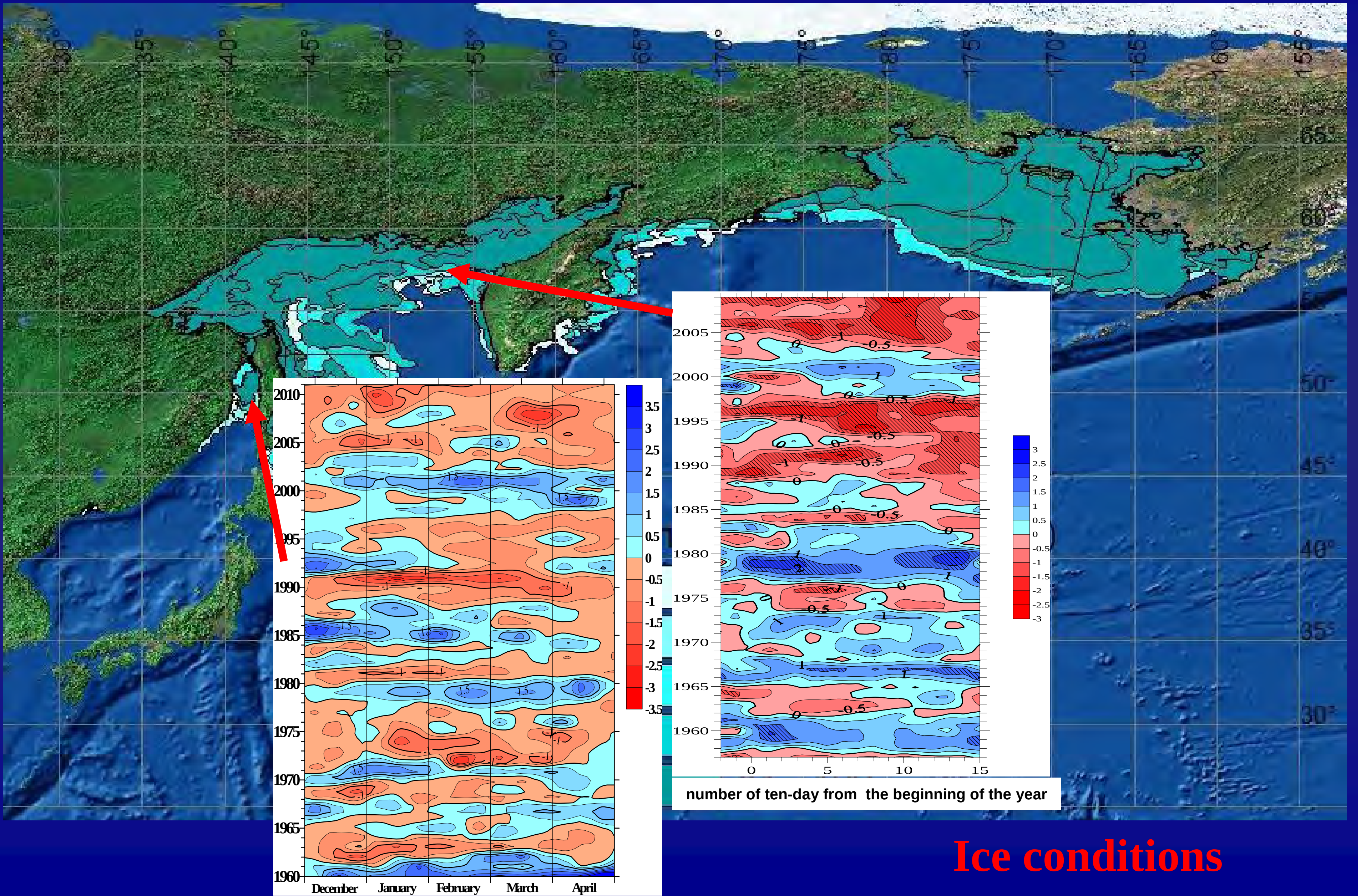
- **T and S by oceanographic expedition researches**

SST in the selected sub-regions of the Far-Eastern Seas (1-7)



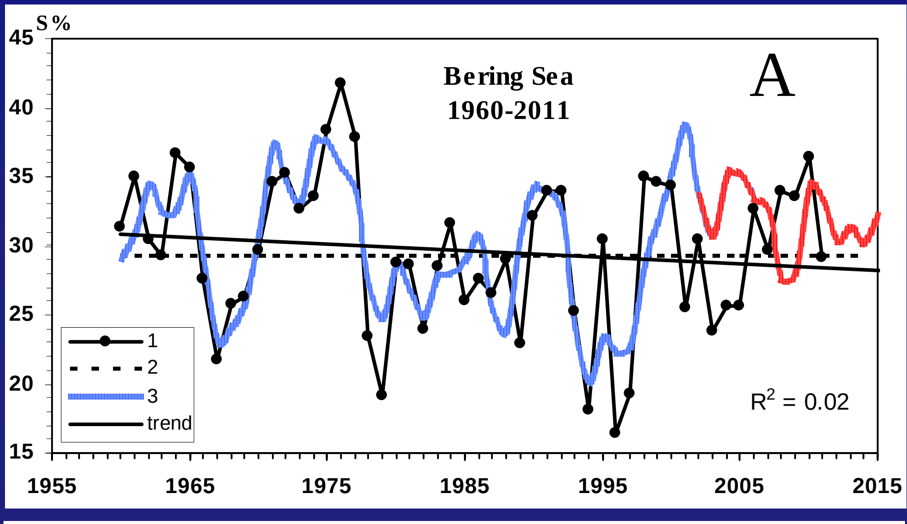
Interannual variability of ten-day ice coverage anomalies in the Far-Eastern Seas

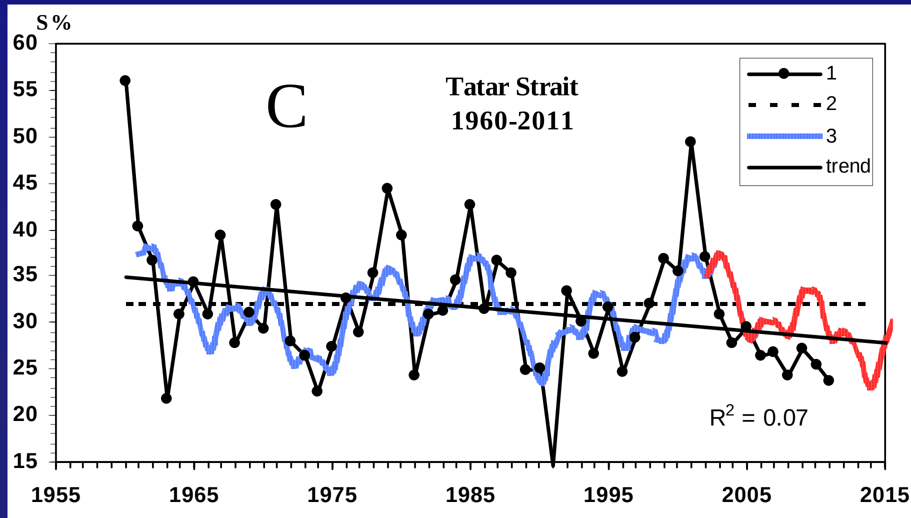
Time series are standardized.

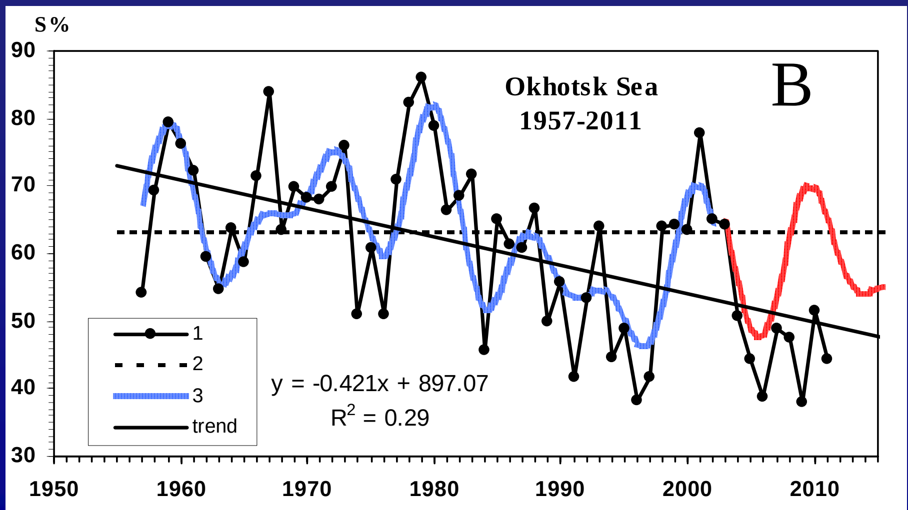


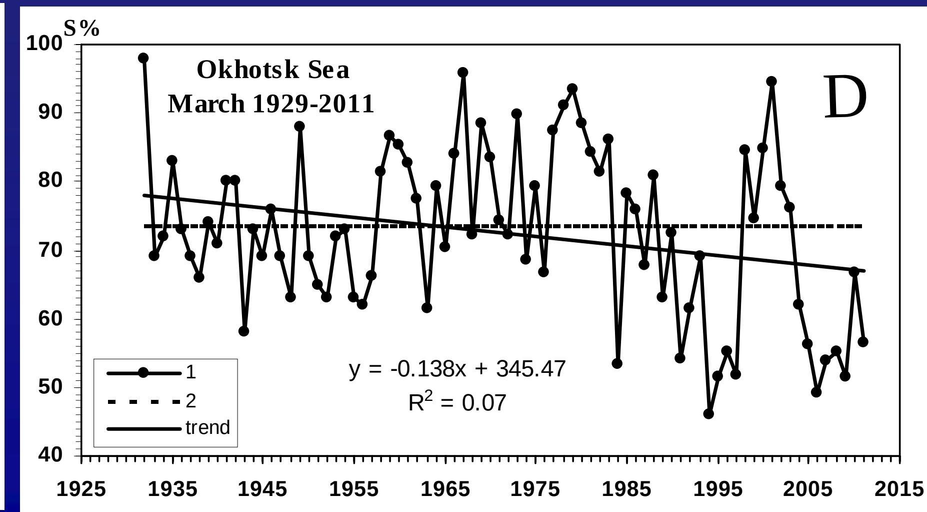
Ice conditions

Mean winter (January – April) - A, B, C and annual maximum ice cover (in March) D (1), mean multi-year value (2), long-term contributions (3) and linear trend. “S” is % to the total area of the Sea

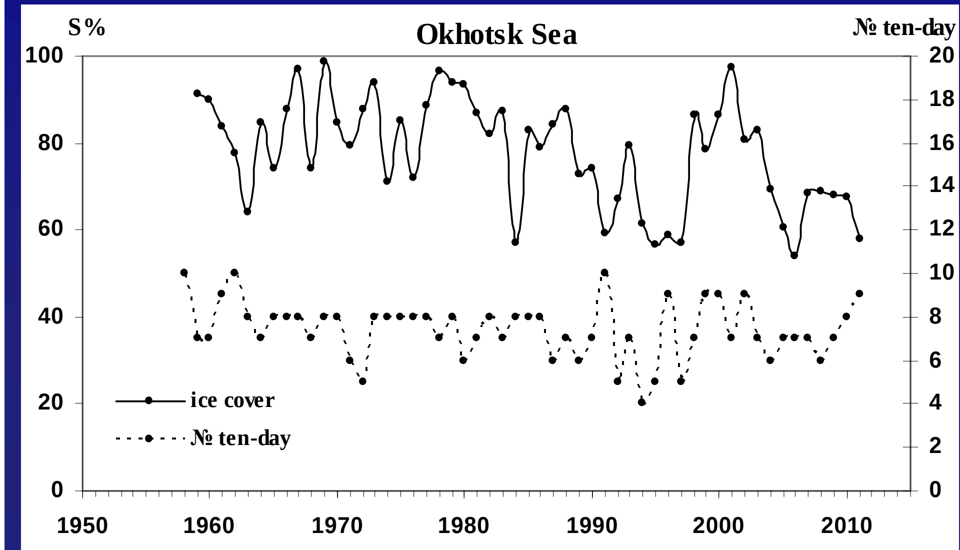




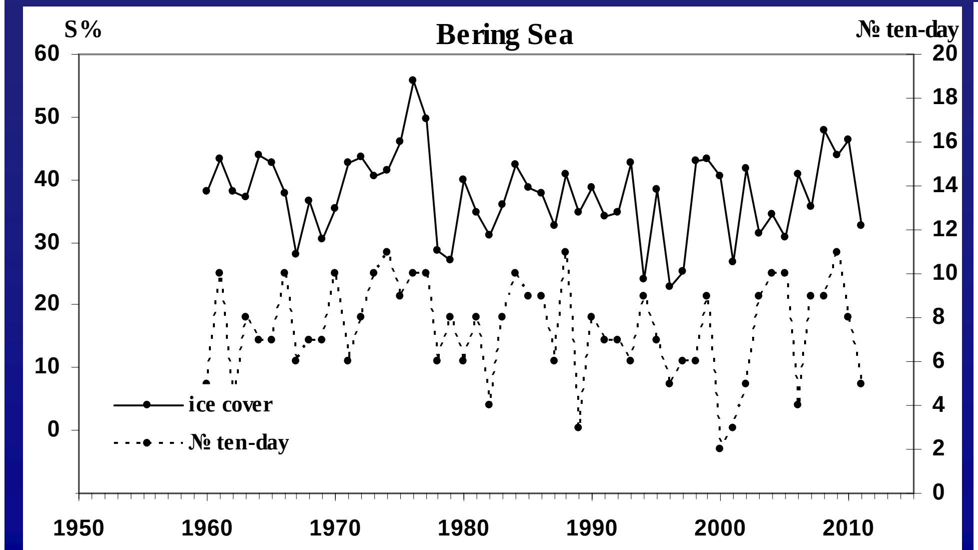


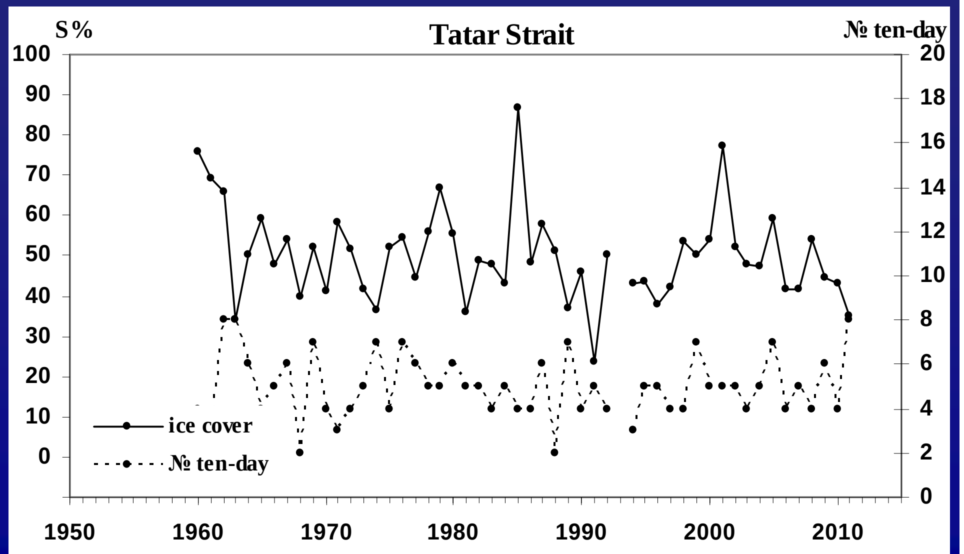


REGIONAL THERMAL CONDITIONS IN THE FAR-EASTERN SEAS

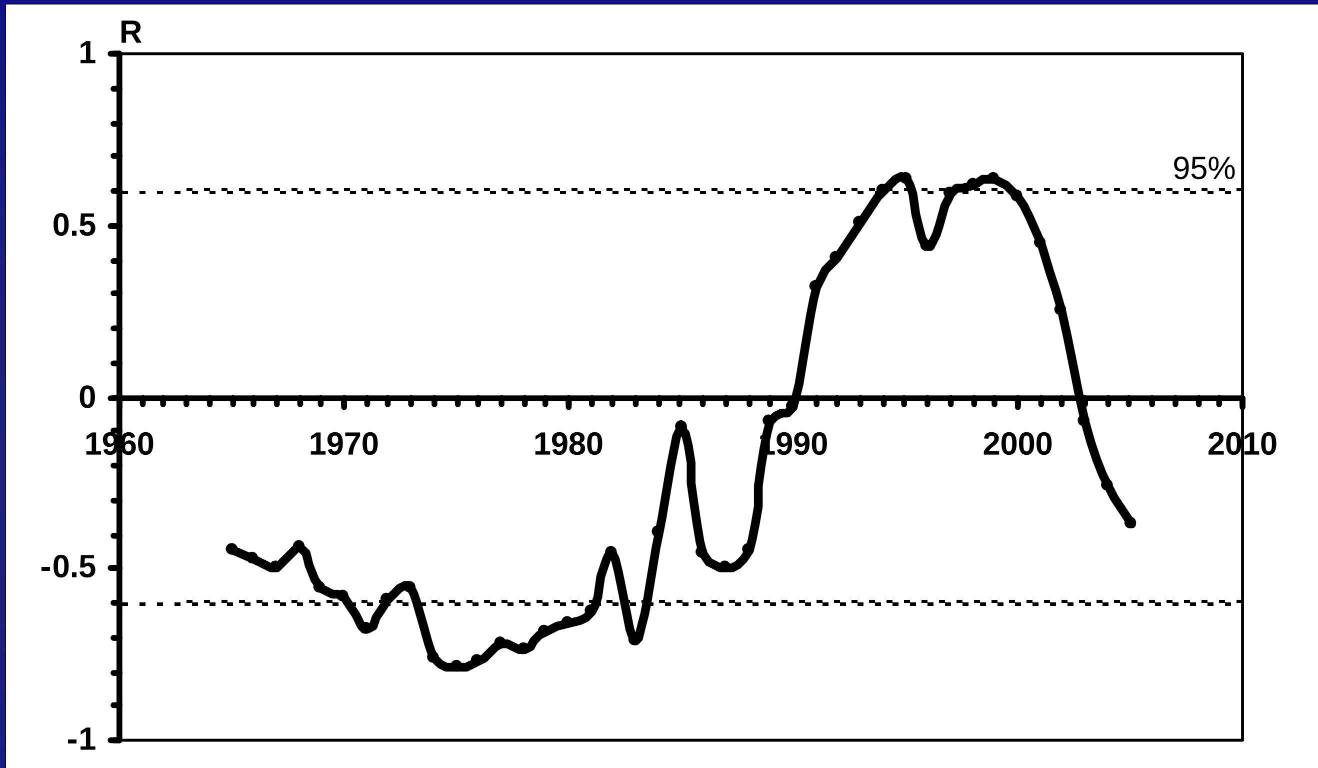


Annual maximum ice cover
(% to the total area of the Sea)
and its terms (number of ten-day
from the beginning of the year)



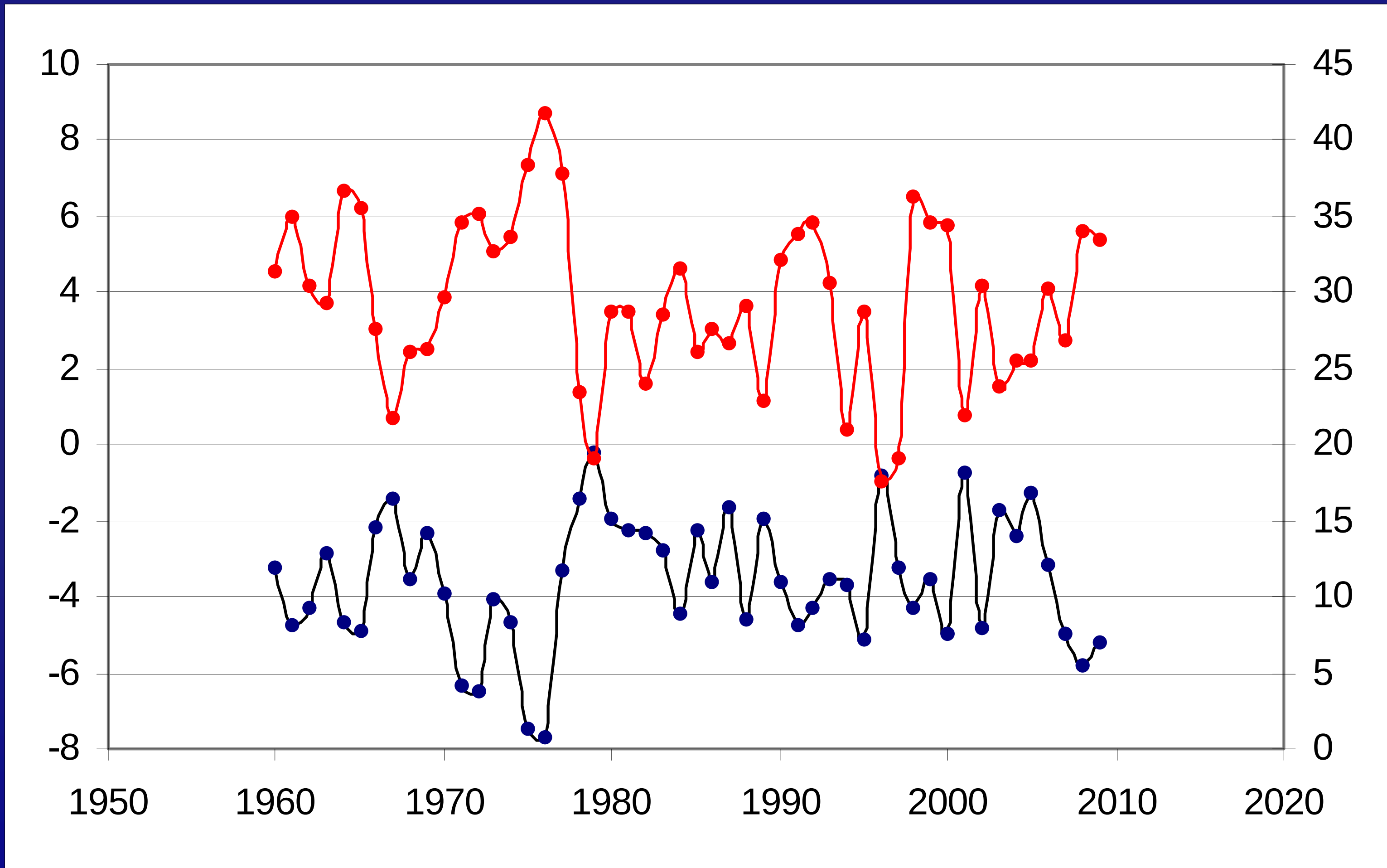


11-year "running correlation" of the mean winter ice extents in the Okhotsk and Bering Sea.

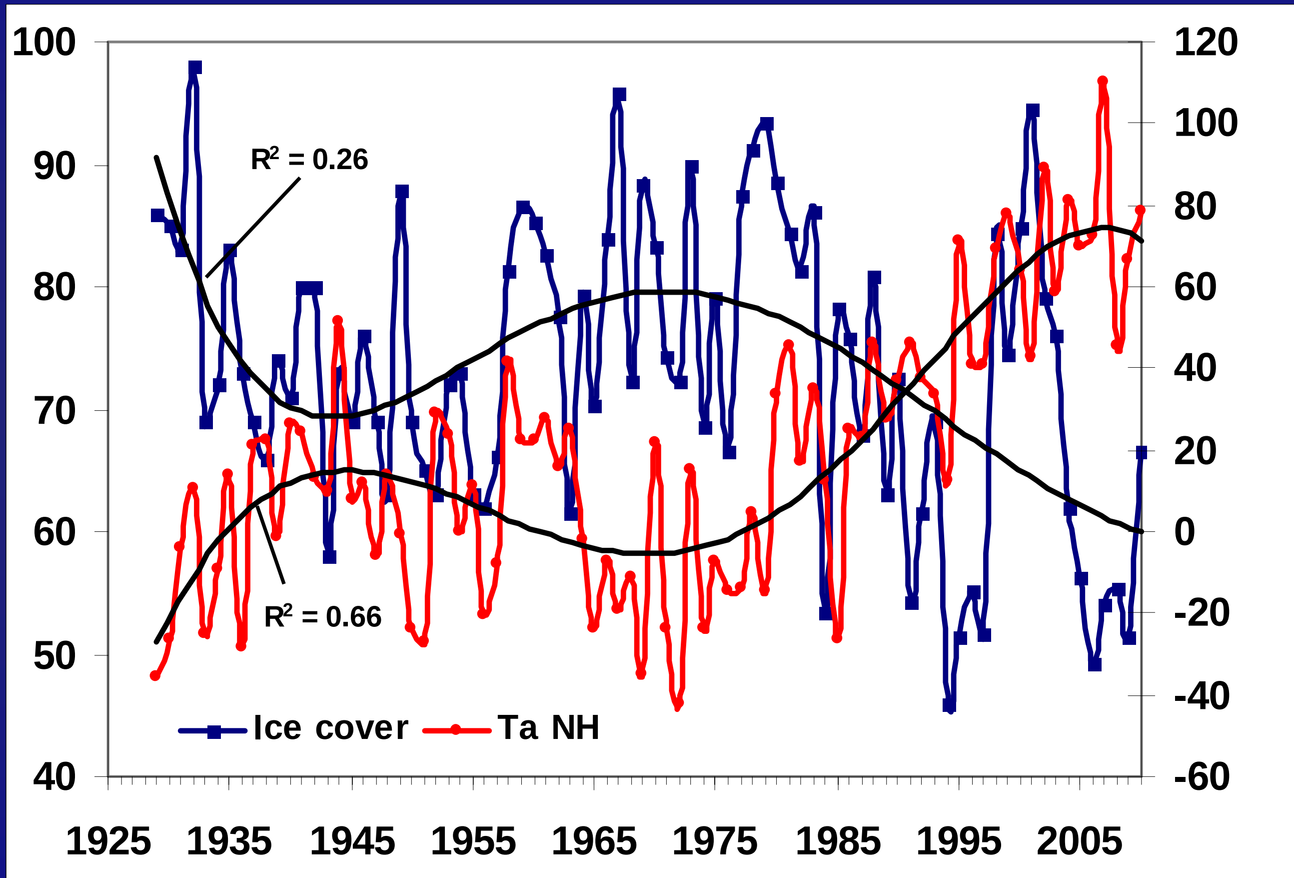


The ice cover fluctuations show a remarkable feature: their phases are opposite between the Okhotsk and Bering Seas (Yakunin, 1966; Khen, 1997; Plotnikov, 1997; 2002). However, after the long period of anti-phase variability, the ice cover in these seas began to fluctuate synchronously since late 1980s. Recently, ice extent is decreasing in the Okhotsk and Japan/East Seas: the last severe winter was there in 2000-2001, and the ice extent is low during the last 7 years. Recent changes of ice cover in the Bering Sea have positive tendency, and its year-to-year variations are opposite to the Okhotsk Sea again.

Year-to-year variation of mean winter (January-April) ice cover in the Bering Sea (red) and mean winter temperature in St. Paul (black)



Winter North Hemispheric temperature anomalies, annual maximal ice cover in the Okhotsk Sea and its polynomial trends



SUMMARY FOR AIR TEMPERATURE

Consistent estimations of regional climatic tendencies of air temperature are received by many authors by observations of Russian meteorological stations (Varlamov et al., 1998; Ponomarev et al., 2000, 2002, 2005, 2007; Assessment Report.., 2008). Principal features of air temperature climatic tendencies are the following:

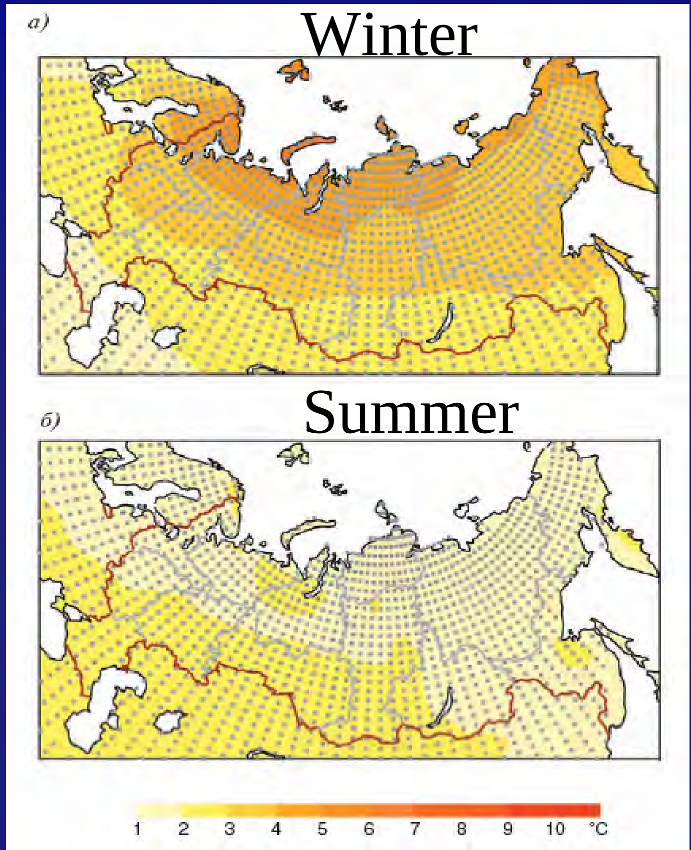
- strong irregularity and inhomogeneity in time and space connected with specific macrocirculating atmospheric processes on the boundary between Eurasian continent and the Pacific Ocean;

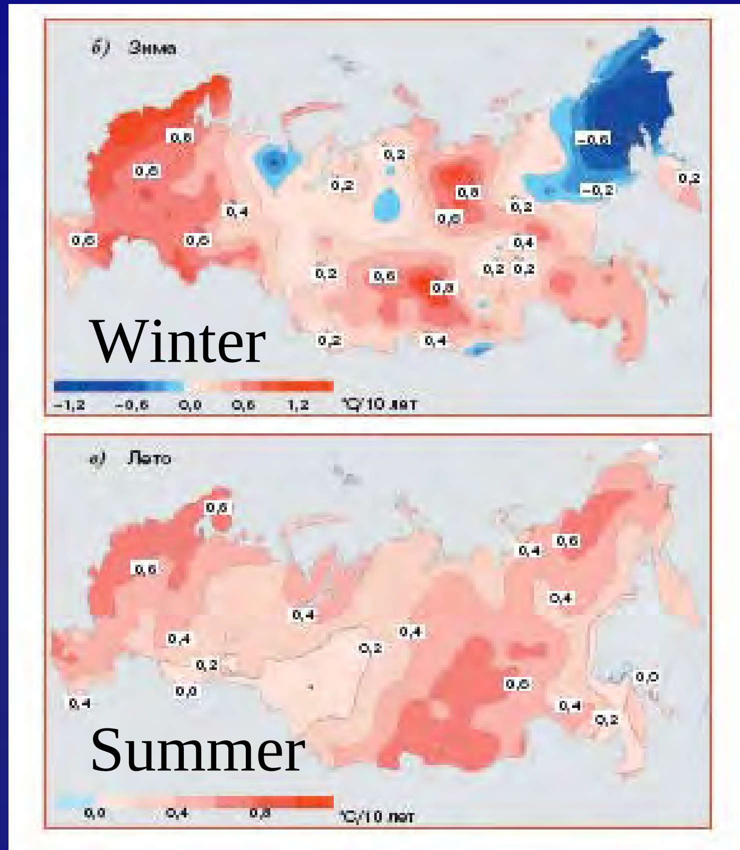
- maximal trends to warming in winter and spring in the southern part of the region (Primorye, Japan, southern Kamchatka) and in spring, summer and autumn over Chukotka;

- weak negative trends in the areas to the north from the Okhotsk Sea and to the west from the Bering Sea in winter;

- tendency to decreasing of the difference between summer and winter air temperatures at the Japan/East Sea and its increases at the northwestern Okhotsk Sea; i.e. the continentality increases in the northern part of Far East and decreases in its southern part.

Air temperature changes in Russia to middle XXI century (2041–2060), CMIP3 A2 (left) and observed trends (right) (Assessment Report…, 2008)

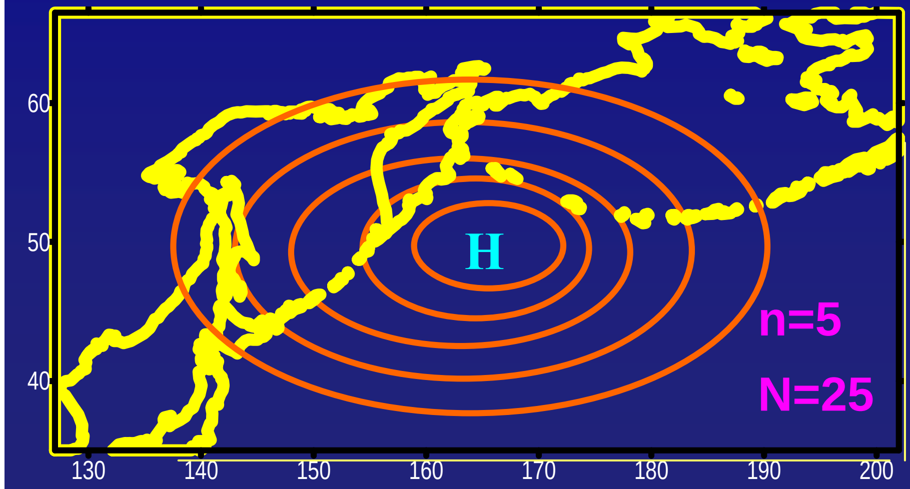


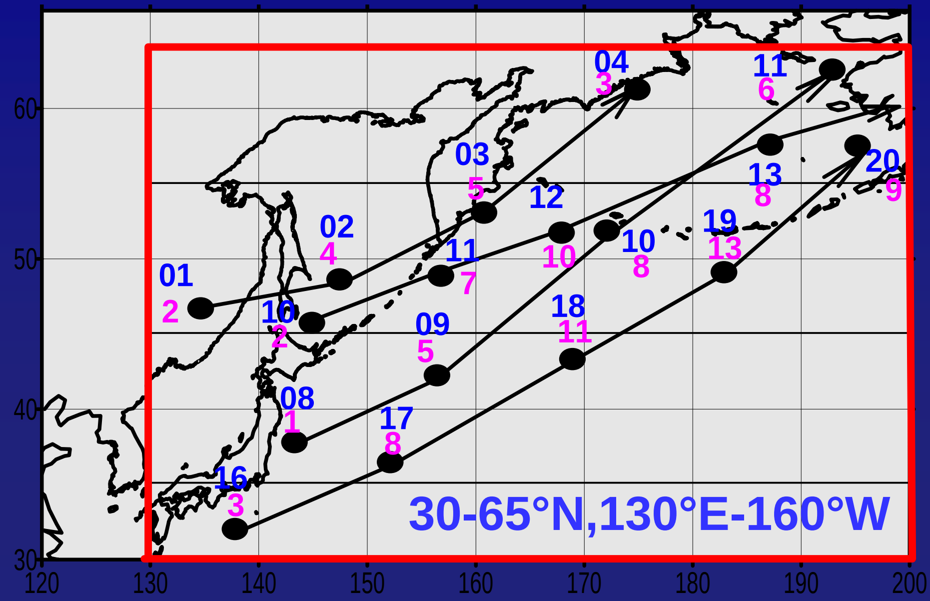


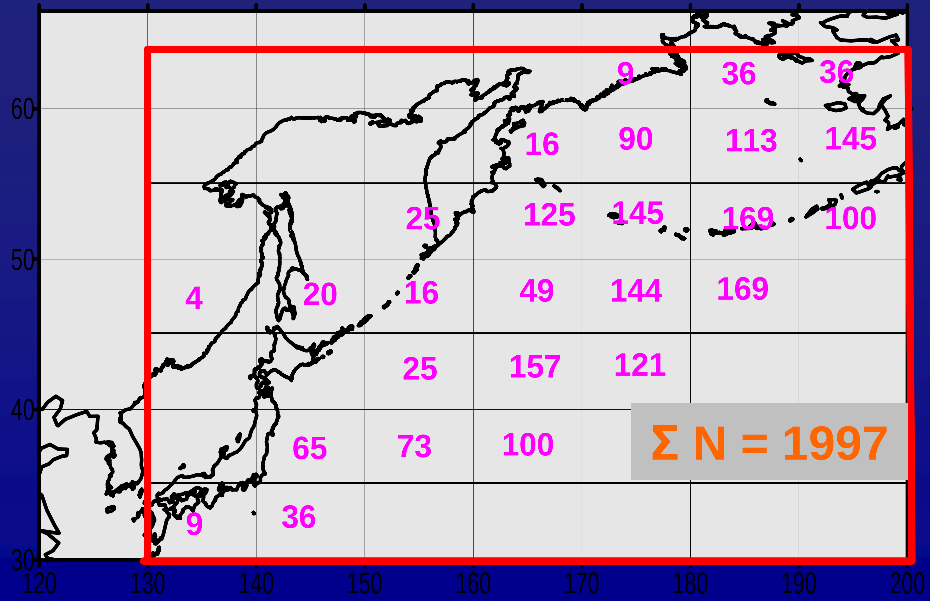
Recent Russian studies (Kattsov et al., 2007; Meleshko et al., 2008; Assessment Report…, 2008; Gruza and Ran'kova, 2009) show the difficulty in realistic simulating regional features of climate in Far East of Russia by atmosphere-ocean circulation models (AOGCMs) presented in IPCC, 2007.

By models ensemble, the trends of air temperature are positive over the whole Far East region in all seasons, with maximal inclination in its northern part in winter. On the contrary, observed trends to winter warming are the strongest in southern part of the region, but weak negative trends are observed over North-East Asia in winter, and strong positive trends in this area are observed in spring and autumn.

These differences between modelled and observed climate changes are obviously caused by processes of regional scale and should be analyzed by regional models of high resolution.





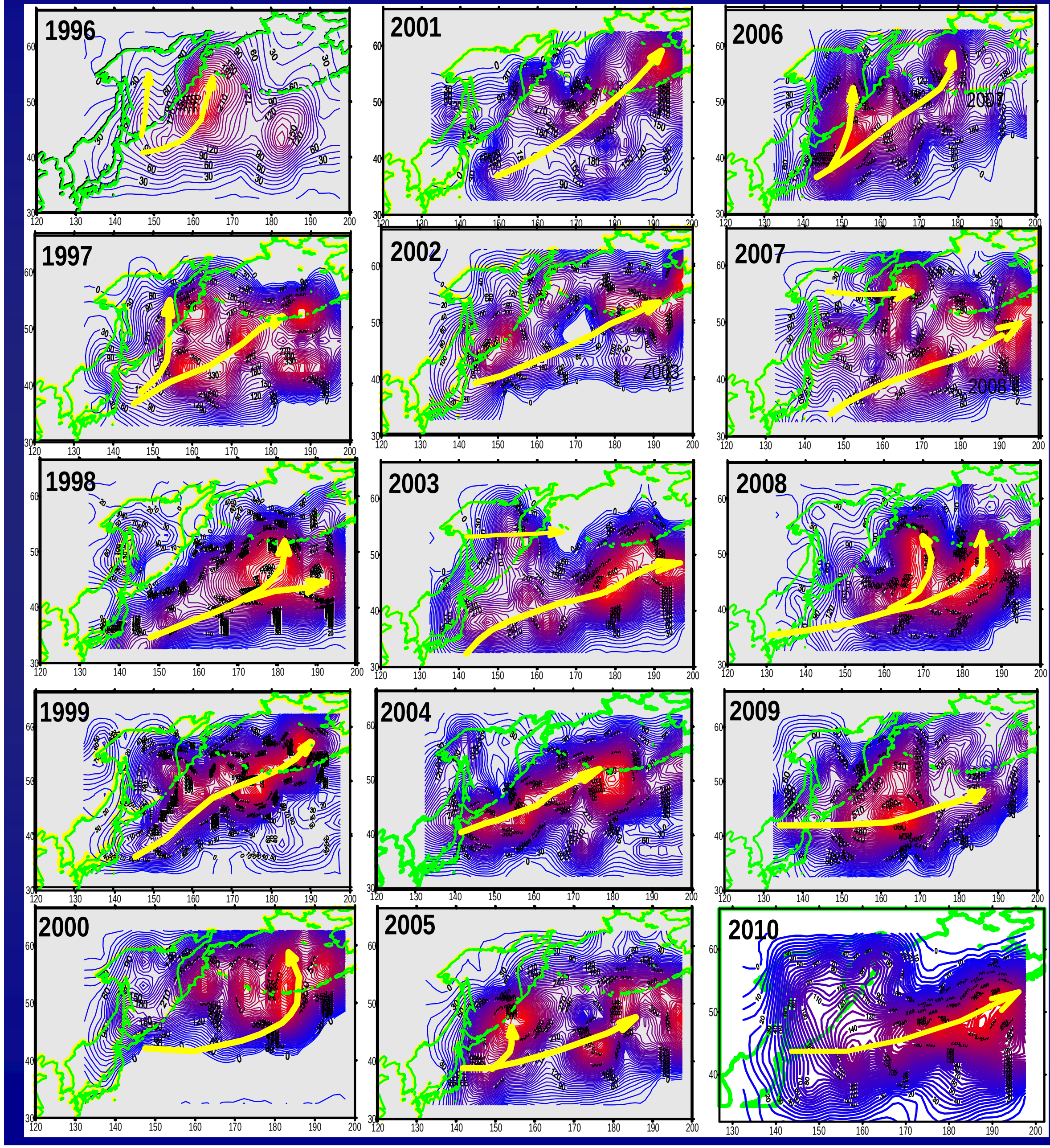


n – number of isobars

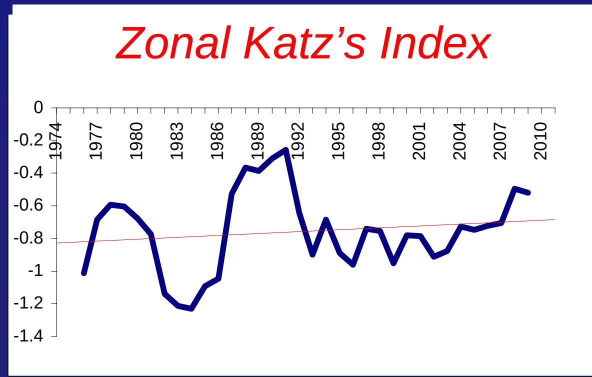
N – Kunicin‘s Index

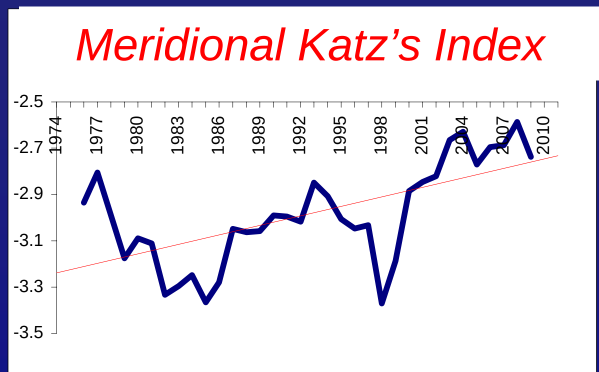
General Kunicin‘s Index (Σ N) is measure of cyclonic intensity

Zones of high cyclonic intensity by Kunicin's Index in winter

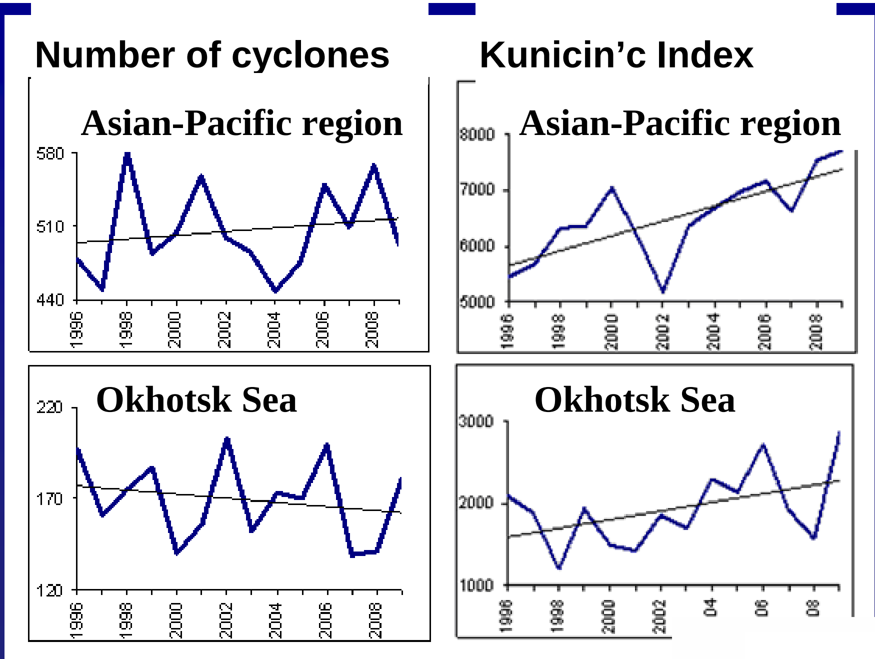


Wind transport over the Okhotsk Sea in winter

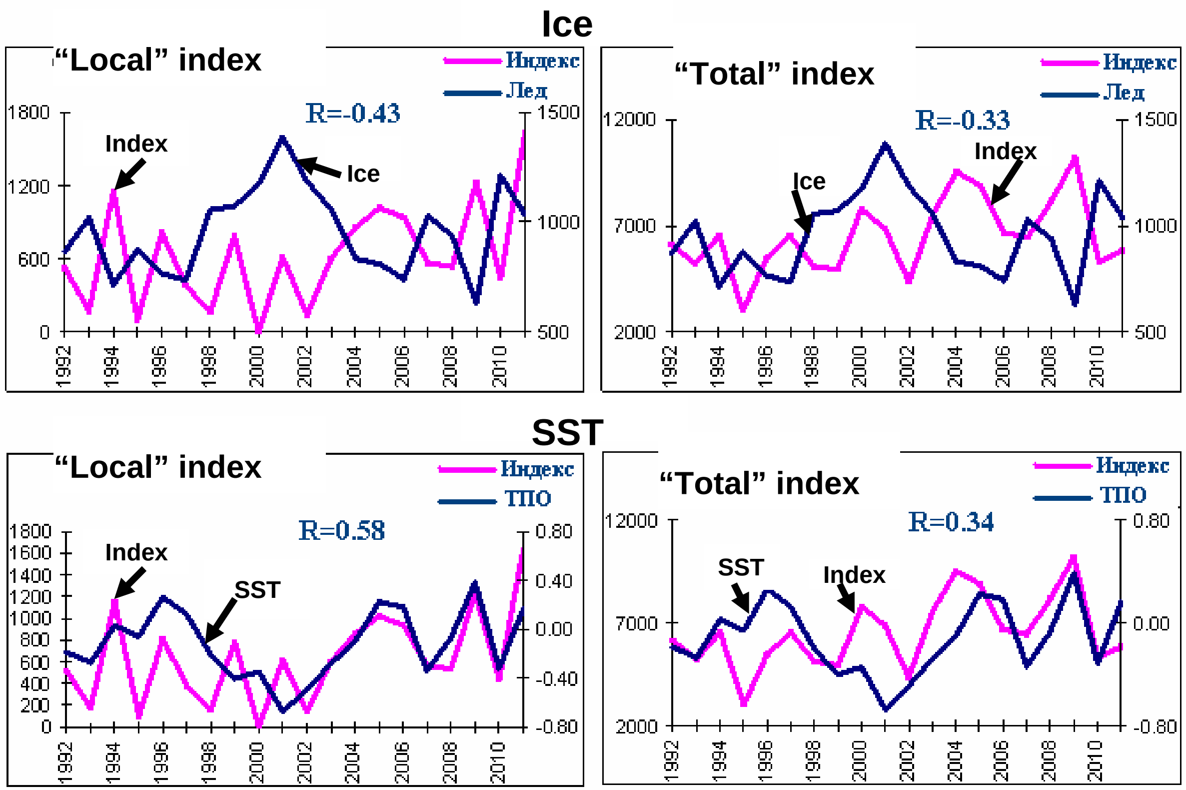




by Glebova, 2011

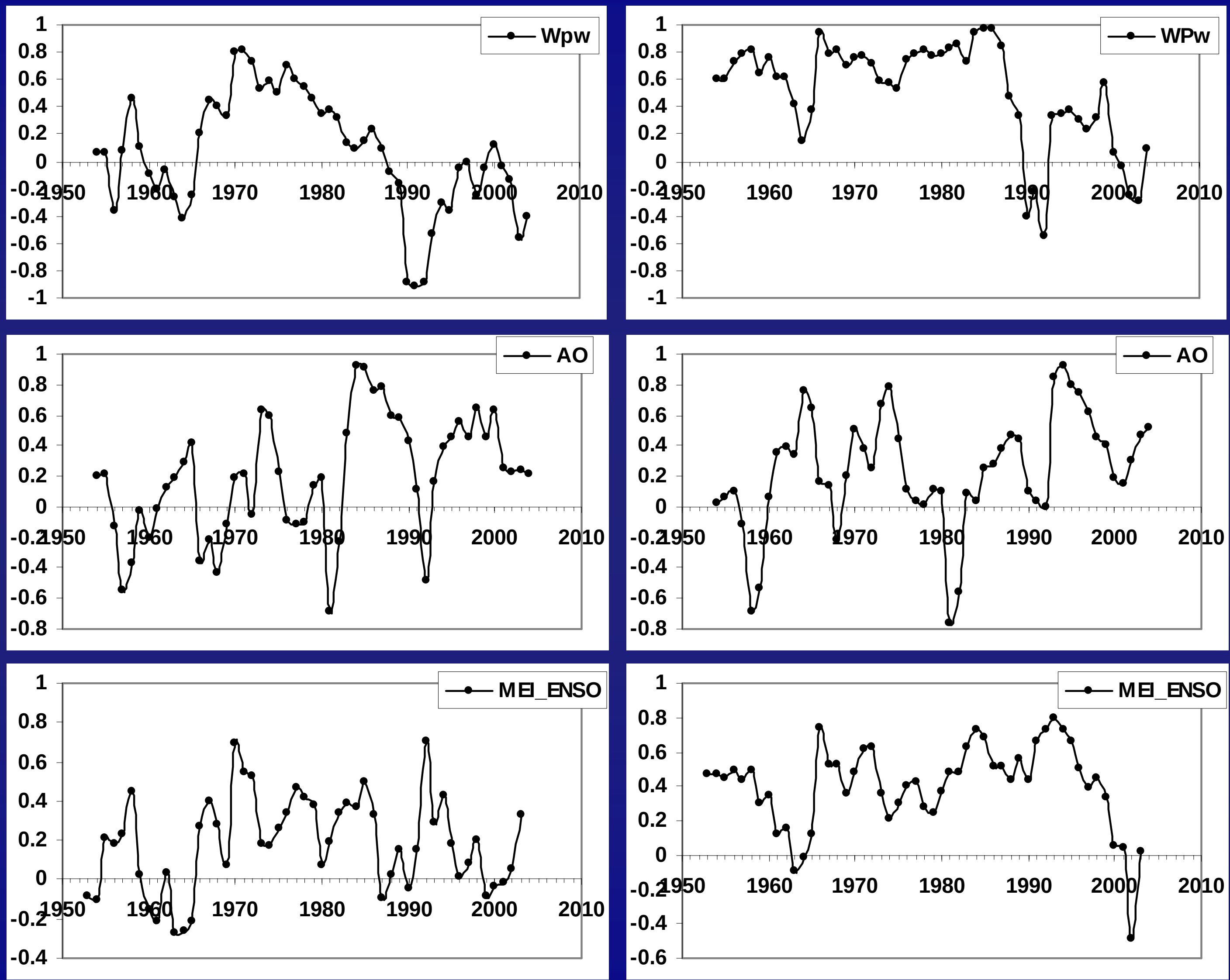


Winter cyclonic activity (number of cyclones and cyclonic intensity by Kunicin's Index) over the Asian-Pacific region and the Okhotsk Sea



"Local" (over the Okhotsk Sea) and "Total" (over the Asian-Pacific region) indices (February) *vs.* Ice and SST in the Okhotsk Sea (March)

"Running correlation" with 11-years period between winter SST in the north (left) and south (right) parts of the Japan/East Sea and large-scale climatic indices



In a number of cases spatial boundary between distinct types of the relationships is the Polar front in the Japan/East Sea.

SUMMARY

Among the Far-Eastern Seas, the most significant reduction of the mean winter ice extent occurred in the Okhotsk Sea, while in the Bering Sea and Tatar Strait a negative trend in ice cover was not statistically significant. Over the past 55 years (1957–2011), the mean winter value of ice cover in the Okhotsk Sea has decreased by 4% per decade.

In the last 15 years, the redistribution of quasi-periodical components contributing to the total variance of ice cover has occurred in the Far-Eastern Seas: the relative contribution of shorter components (with time-scale $\leqslant$ 10 years) had increased.

However, in the areas to the north from the Okhotsk Sea and in Chukotka, weak negative (or insignificant) winter trends of air temperature are observed, while maximal warming in winter and spring occurs over the southern part of the Russian Far East and over the coast of Japan.

Recent estimates confirm the tendency of decreasing differences between summer and winter air temperatures over the Japan/East Sea and increasing differences in the northwestern Okhotsk Sea; i.e. the continentality increases in the northern part of Far East and decreases in its southern part.

Integrated impacts of cyclones on the thermal variability depends on spatial scales of the atmospheric processes.

In a number of cases spatial boundary between distinct types of the relationships between large-scale climatic indices and regional thermal characteristics is the Polar front in the Japan/East Sea. 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.