Evaluation of climatic variability in the Far-Eastern Seas using regional data sets

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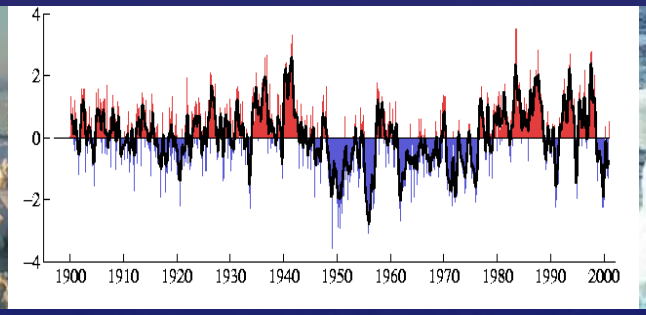



PICES XV W5-2874

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)

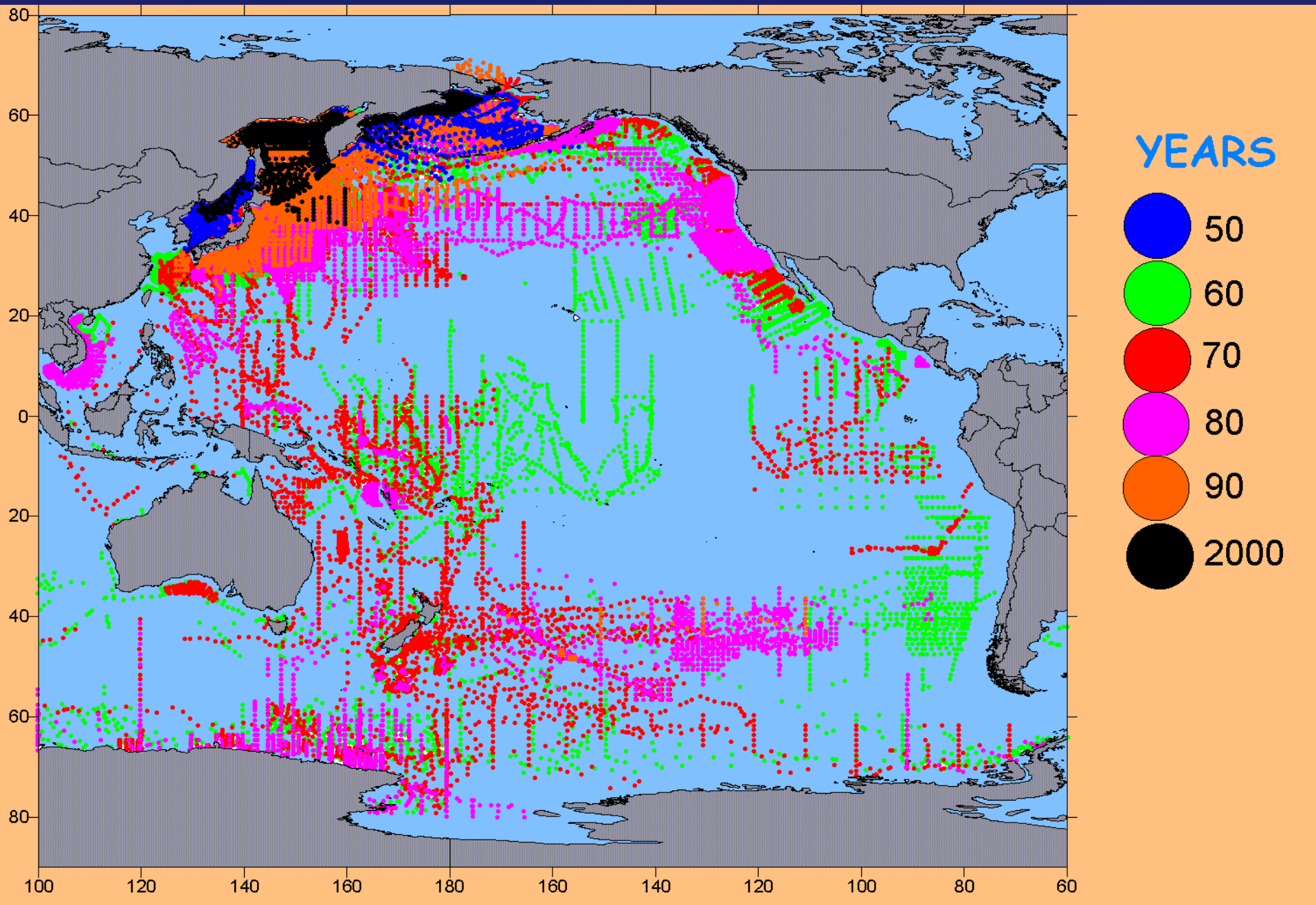
4. Ice charts of the Japanese Meteorological Agency for the Okhotsk Sea (1998-2006).
5. Monthly mean air and water temperature data at coastal meteorological stations published by Russian Hydrometeorological Agency (as monthly and annual reports and climatic directories).

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

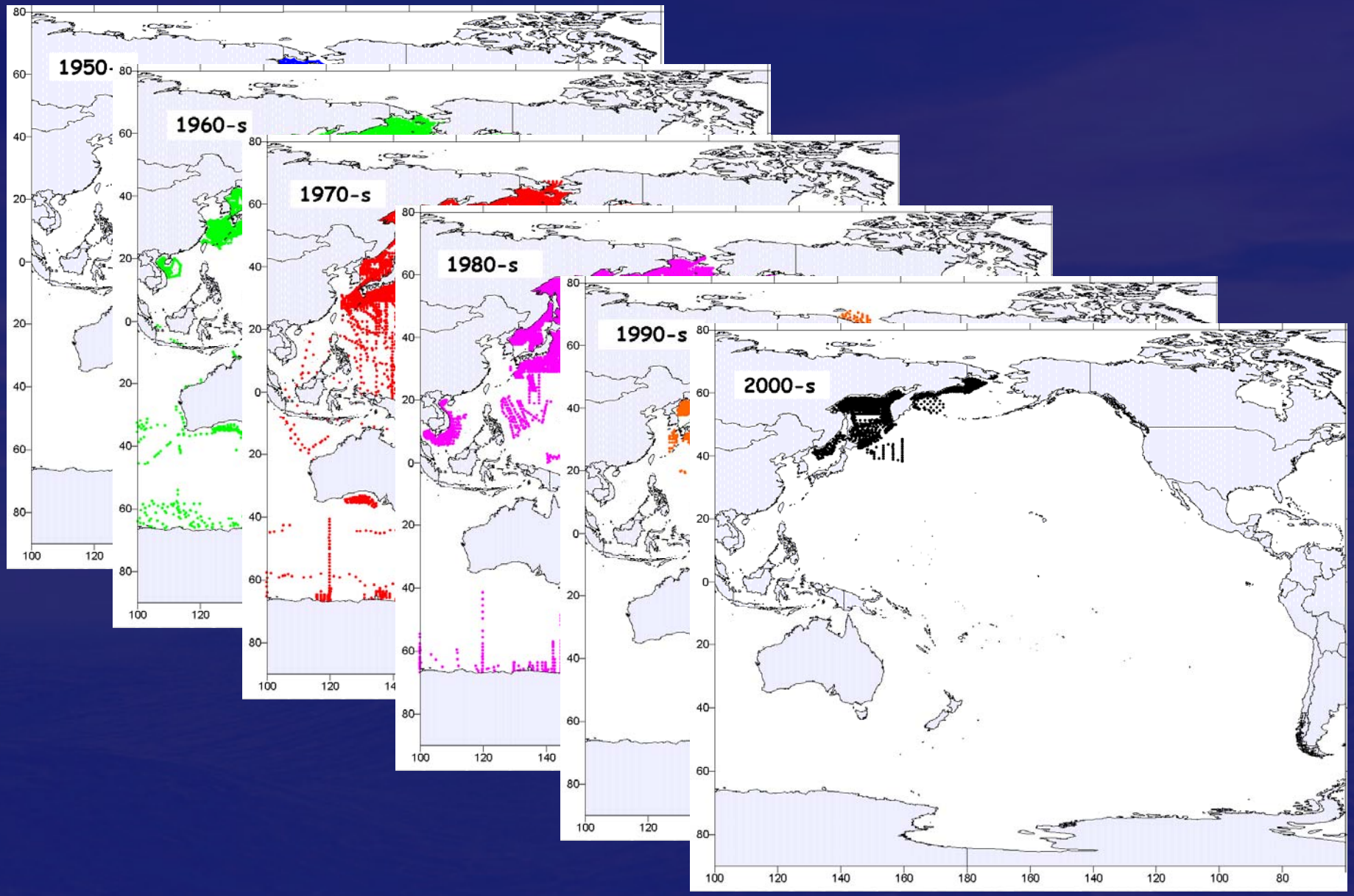
7. Time series of the monthly mean analyzed SST from 1950 to latest month for each 2 degree latitudinal and longitudinal square of the Pacific Ocean from the Real Time Data Base, NEAR-GOOS (http://goos.kishou.go.jp/rrtdb).

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).

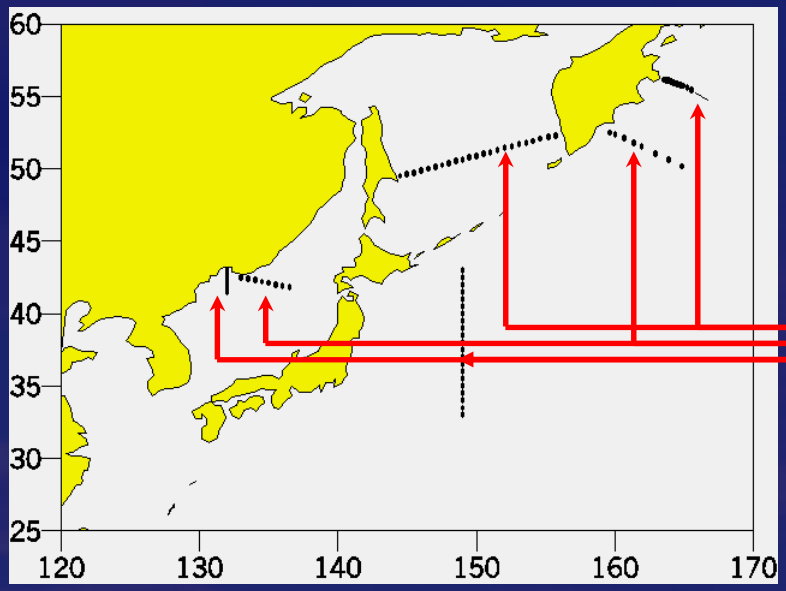
EXPEDITION RESEARCH



EXPEDITION RESEARCH FOR THE DIFFERENT PERIODS



STANDARD SECTIONS



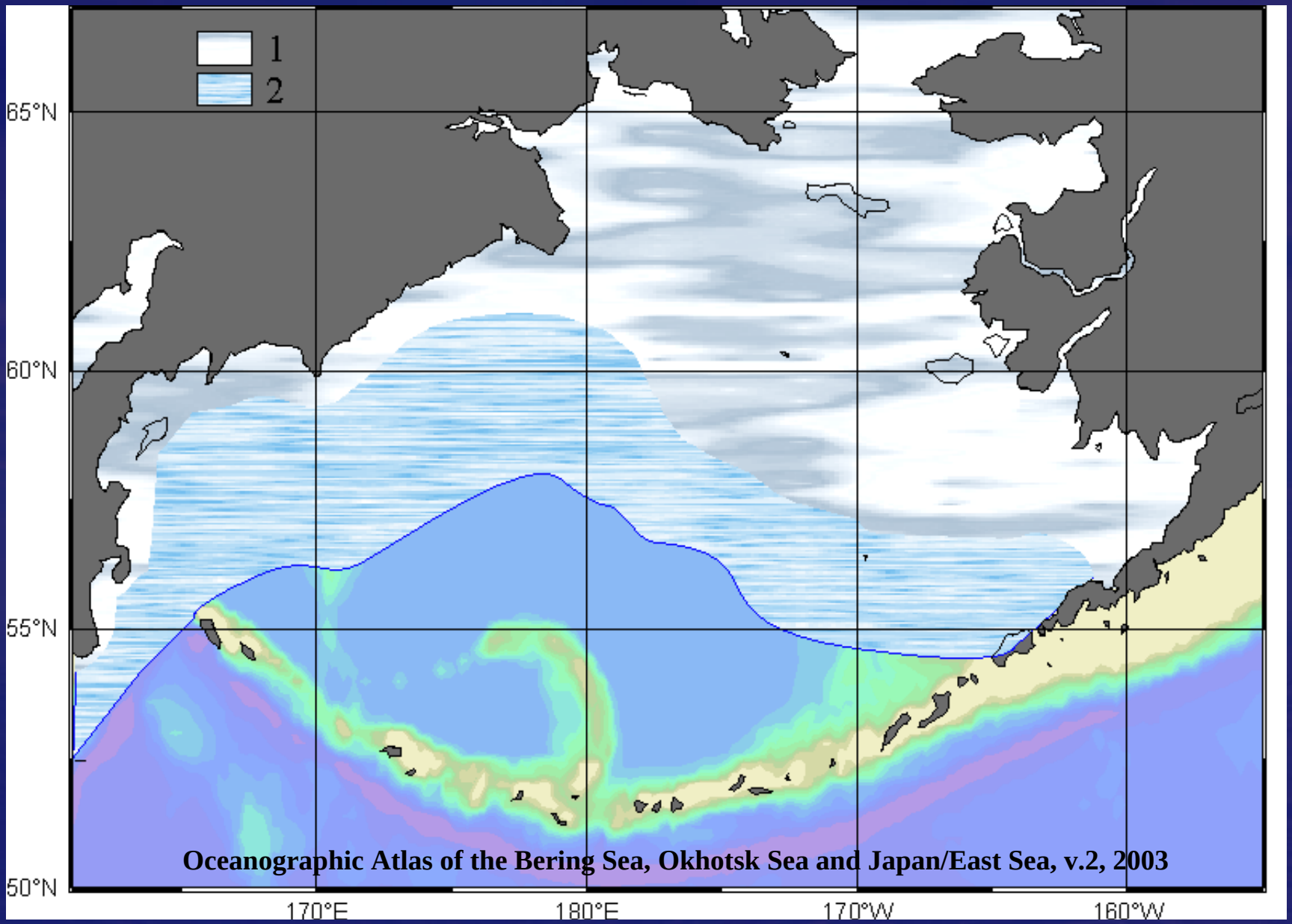
Frequency of observations at standard sections in the NW Pacific

Years	Vladivostok Section (along 132E)	Sangarsky Section	Trans-Okhotsk Section (Kamchatka-Sakhalin)	Kamchatsky Strait	Avachinsky Section	Section along 149 E
1982	11	3			1	
1983	19	5			1	4
1984	28	15				
1985	25	18			1	7
1986	10	25			1	2
1987	7	18			1	
1988	33	38		1		
1989	22	30				
1990	10	21		2	1	
1991	10	11		1	1	
1992	7	11		1	1	
1993	5	4		1	1	
1994	7	1		1	1	
1995	3	5	1	1	1	
1996	5	1		2	1	
1997	2	2	1		1	
1998	3	2	1	2	1	
1999	2	1	1	1		
2000	2	2	2	3		
2001	3	2	1	2		
Total	372	229	7	29		

Animation disengaged

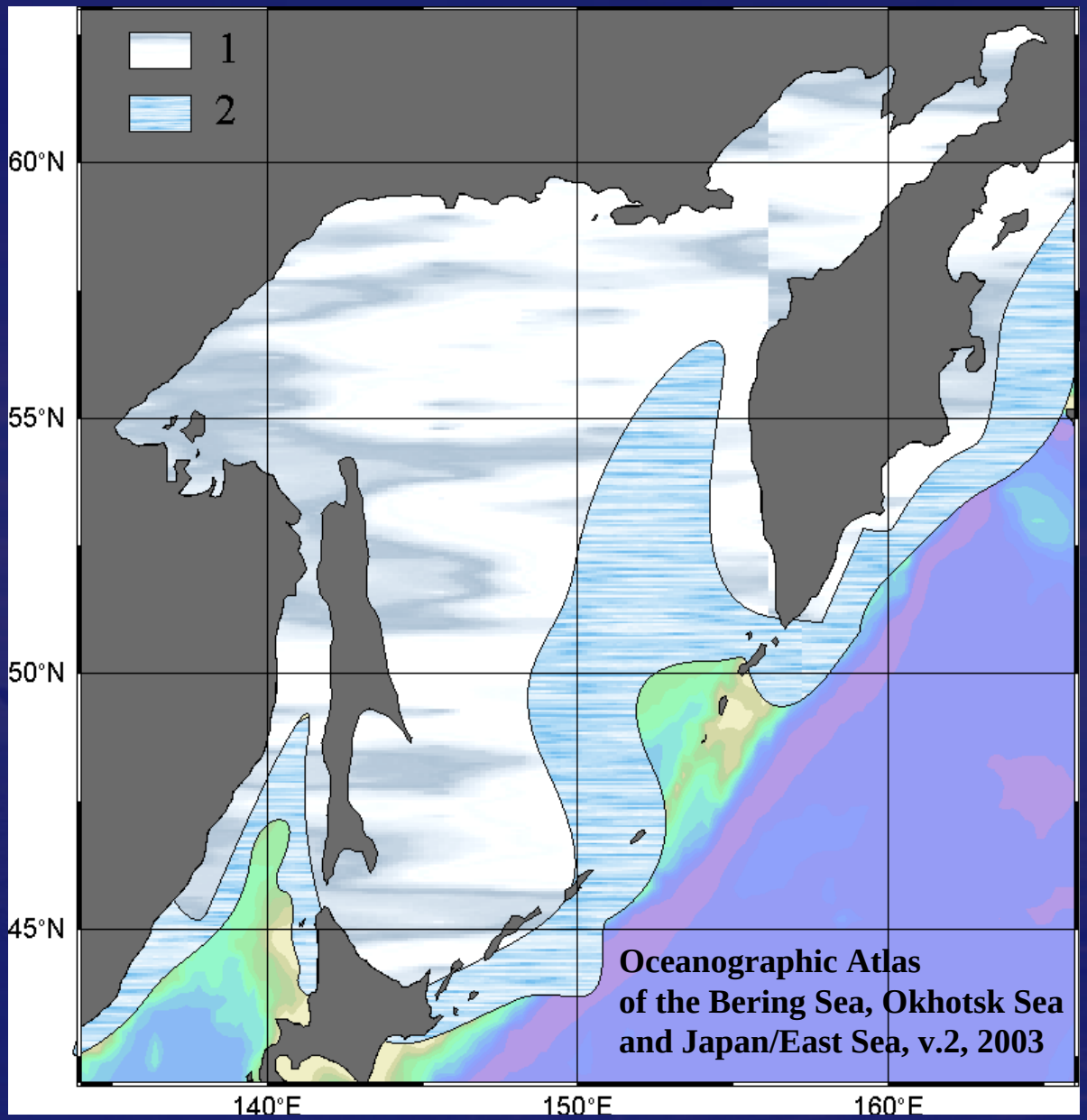
All these sections (except for Avachinsky conducted by KamchatNIRO) are carried out by TINRO-Center vessels. Kamchatsky section is made jointly with KamchatNIRO. Only in last years dates of cruises were stabilized and sections were carried out in approximately the same time of year: Sangarsky and Trans-Okhotsk sections – in winter and summer; Kamchatsky section and section along 132 E – in summer and autumn, Avachinsky – mainly in June.

Normal (1) and maximal (2) ice extent in Bering Sea

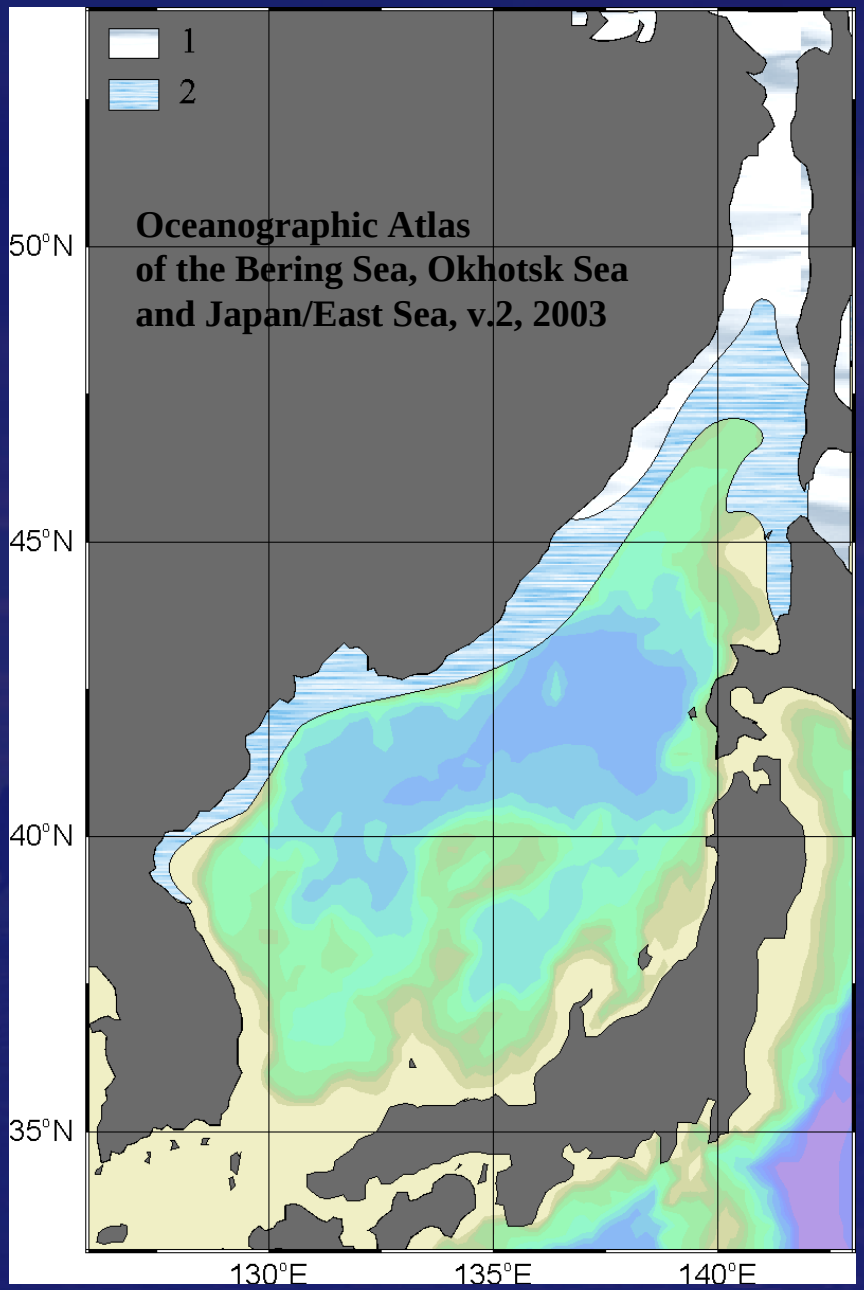


Oceanographic Atlas of the Bering Sea, Okhotsk Sea and Japan/East Sea, v.2, 2003

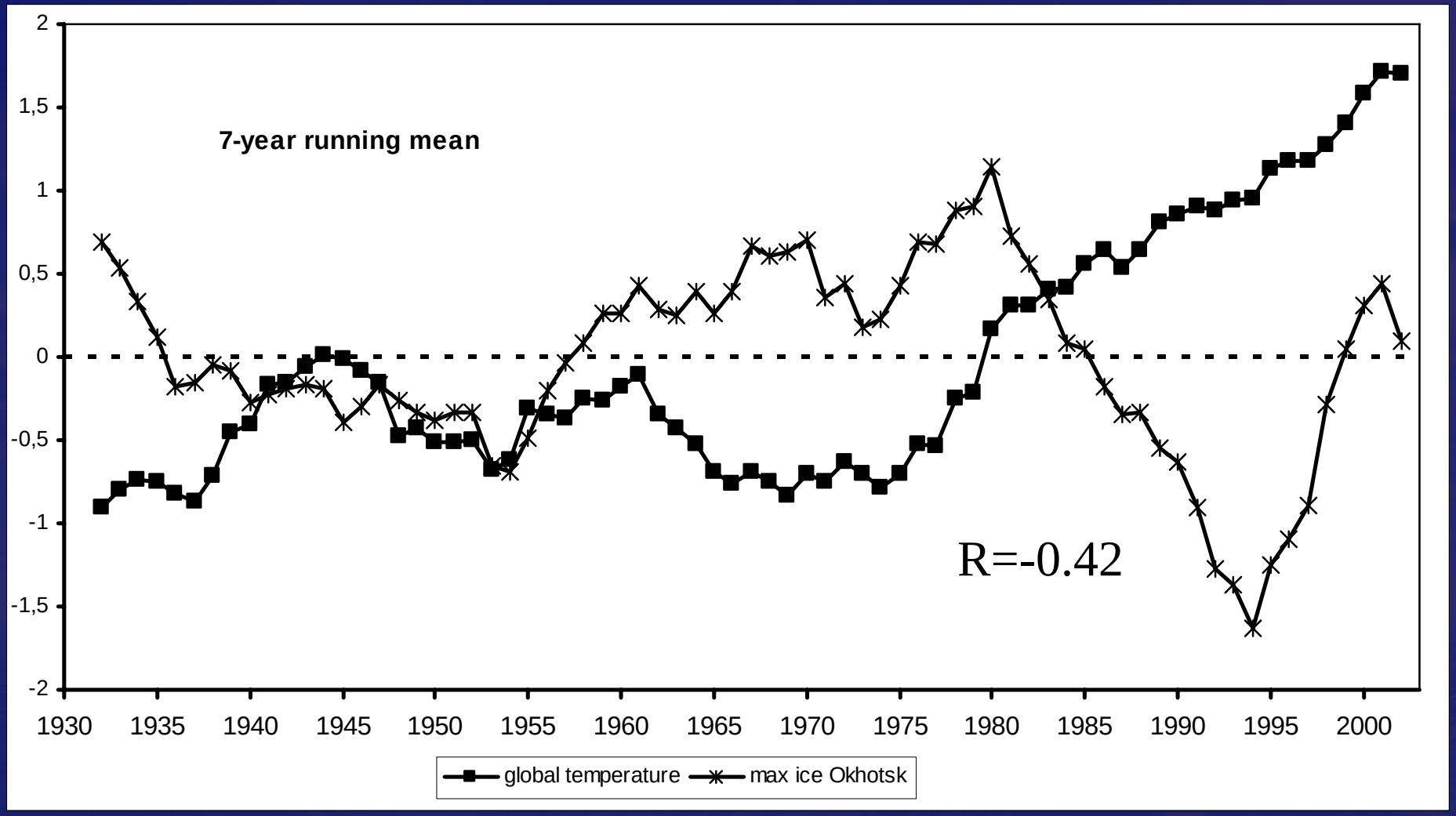
Normal (1) and maximal (2) ice extent in the Okhotsk Sea



Normal (1) and maximal (2) ice extent in the Japan Sea

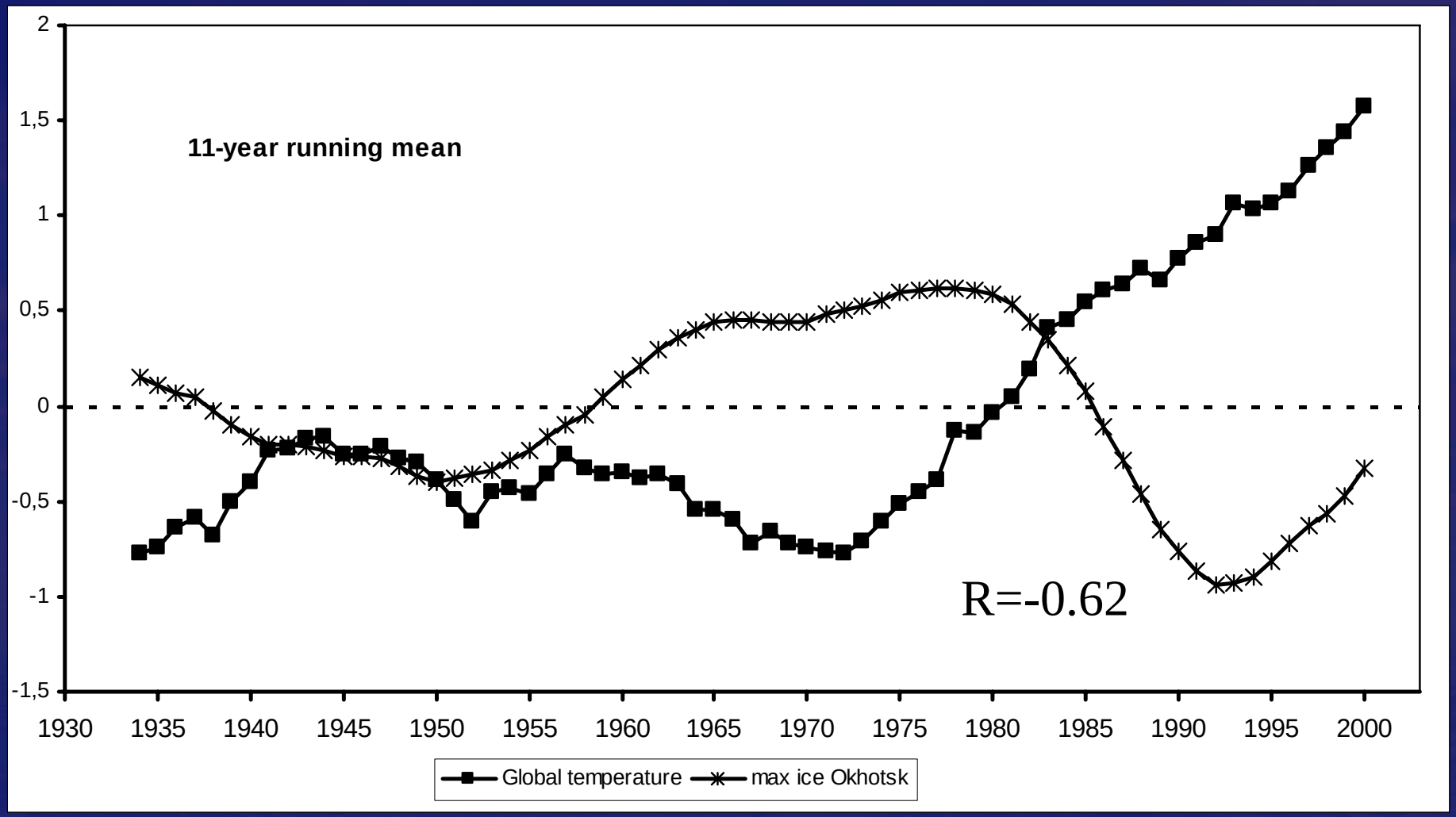


Winter global temperature anomalies and annual maximum ice cover anomalies in the Okhotsk Sea



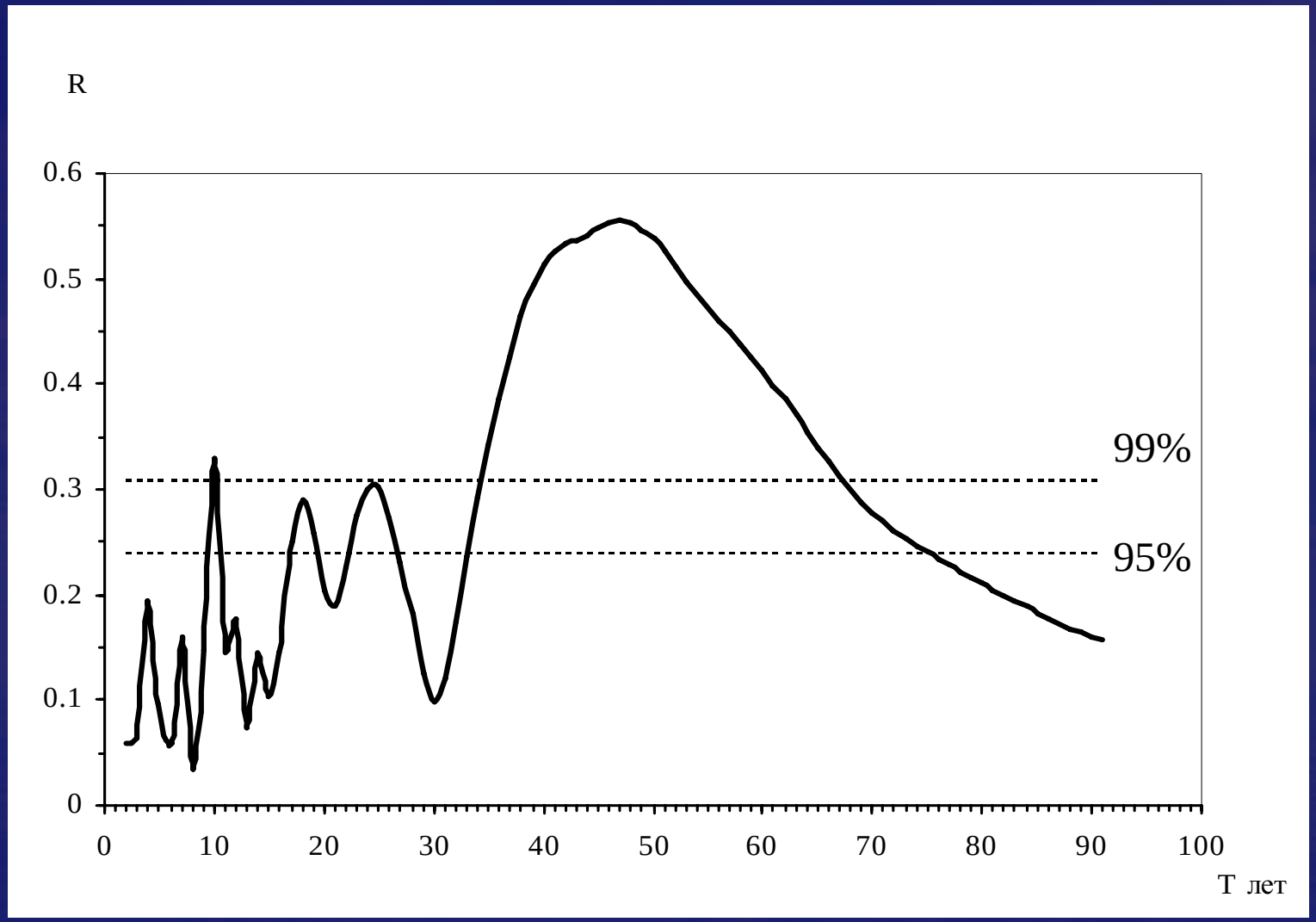
Time series are standardized and smoothed by a 7-year running mean.

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

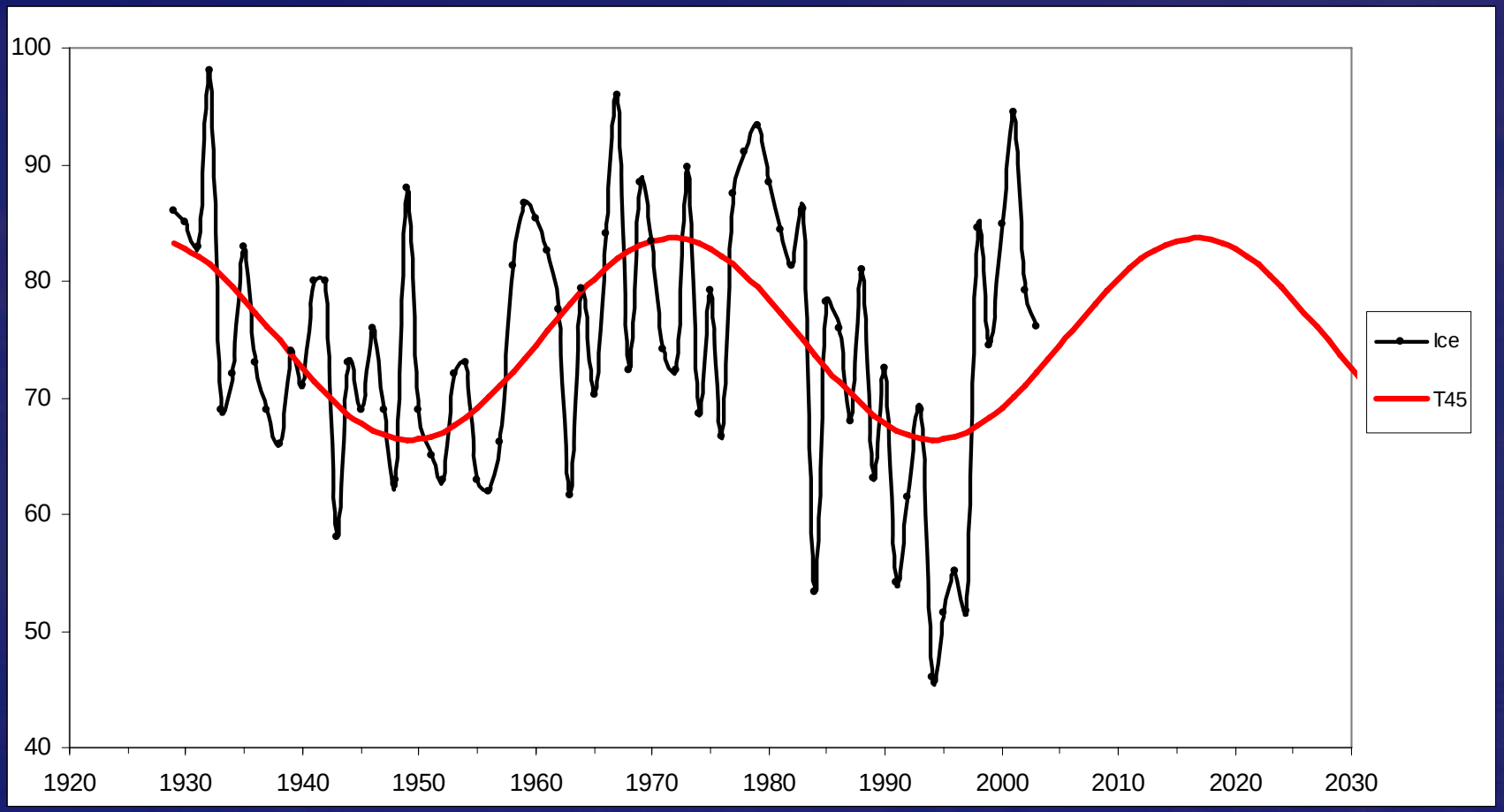


Time series are standardized and smoothed by a 11-year running mean.

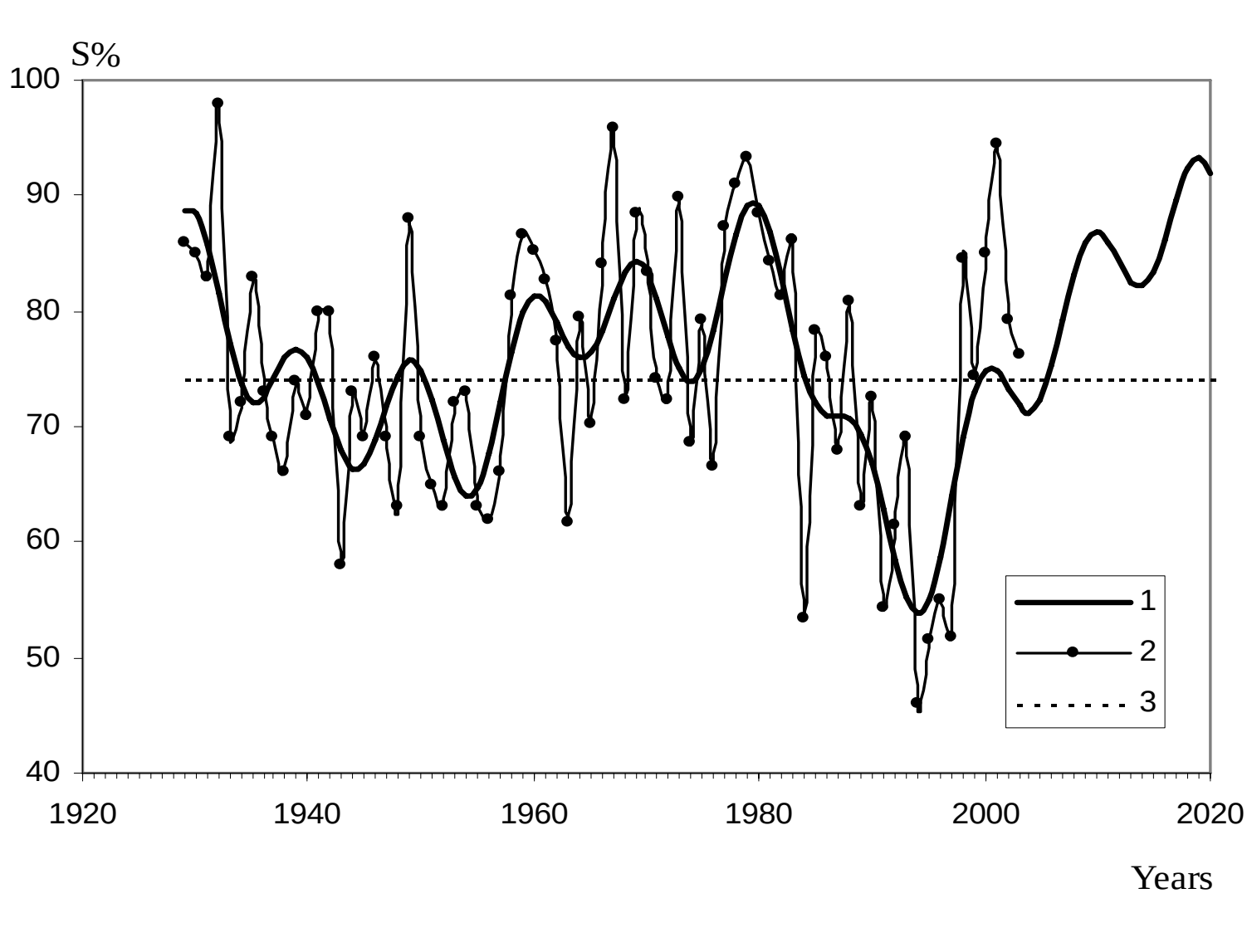
Periodogram of the maximal ice cover in the Okhotsk Sea



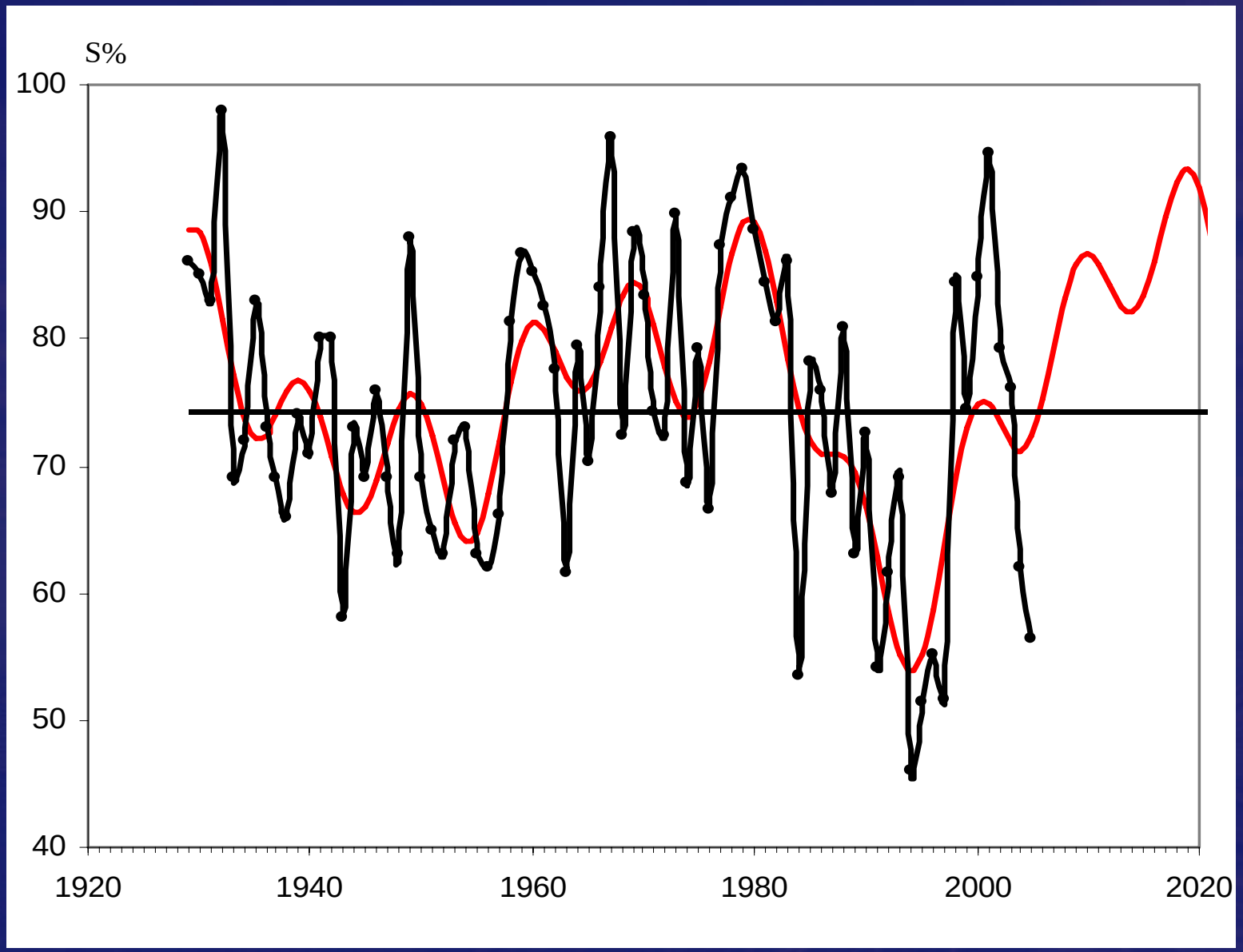
Interannual variations of the maximal ice cover in the Okhotsk Sea and harmonic oscillation with about 50-year period

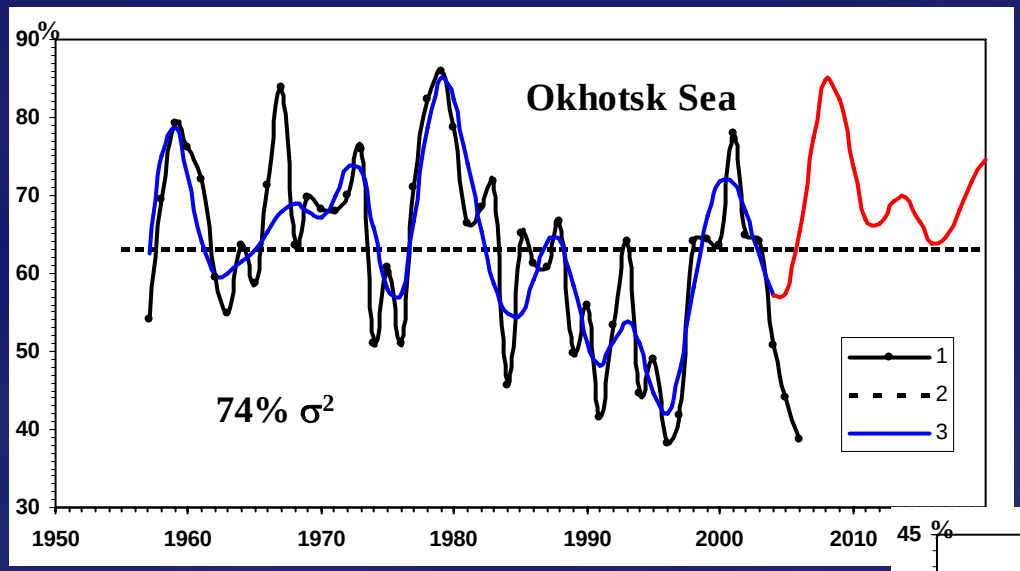


Approximation of ice cover variability by sum of long-term harmonics (1), year-to-year variation (2) and mean value of the maximal ice cover (3) in the Okhotsk Sea

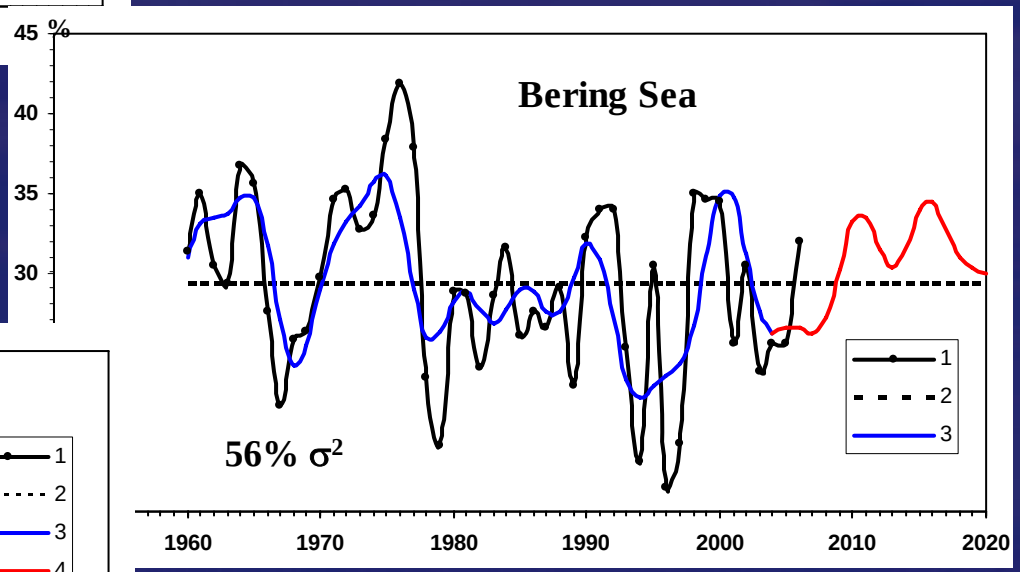


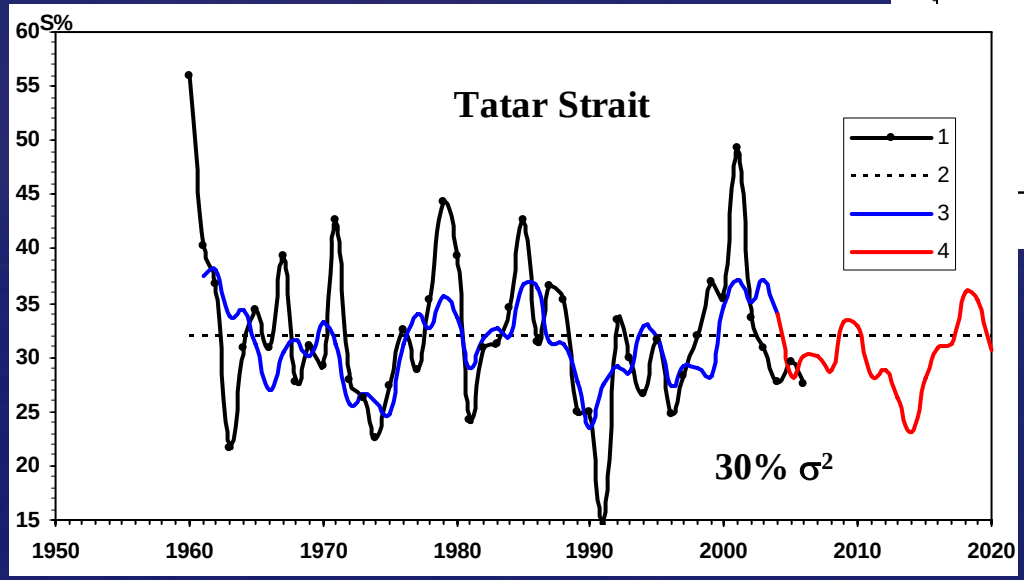
Approximation of ice cover variability by sum of long-term harmonics, year-to-year variation (1929-2005) and mean value of the maximal ice cover in the Okhotsk Sea





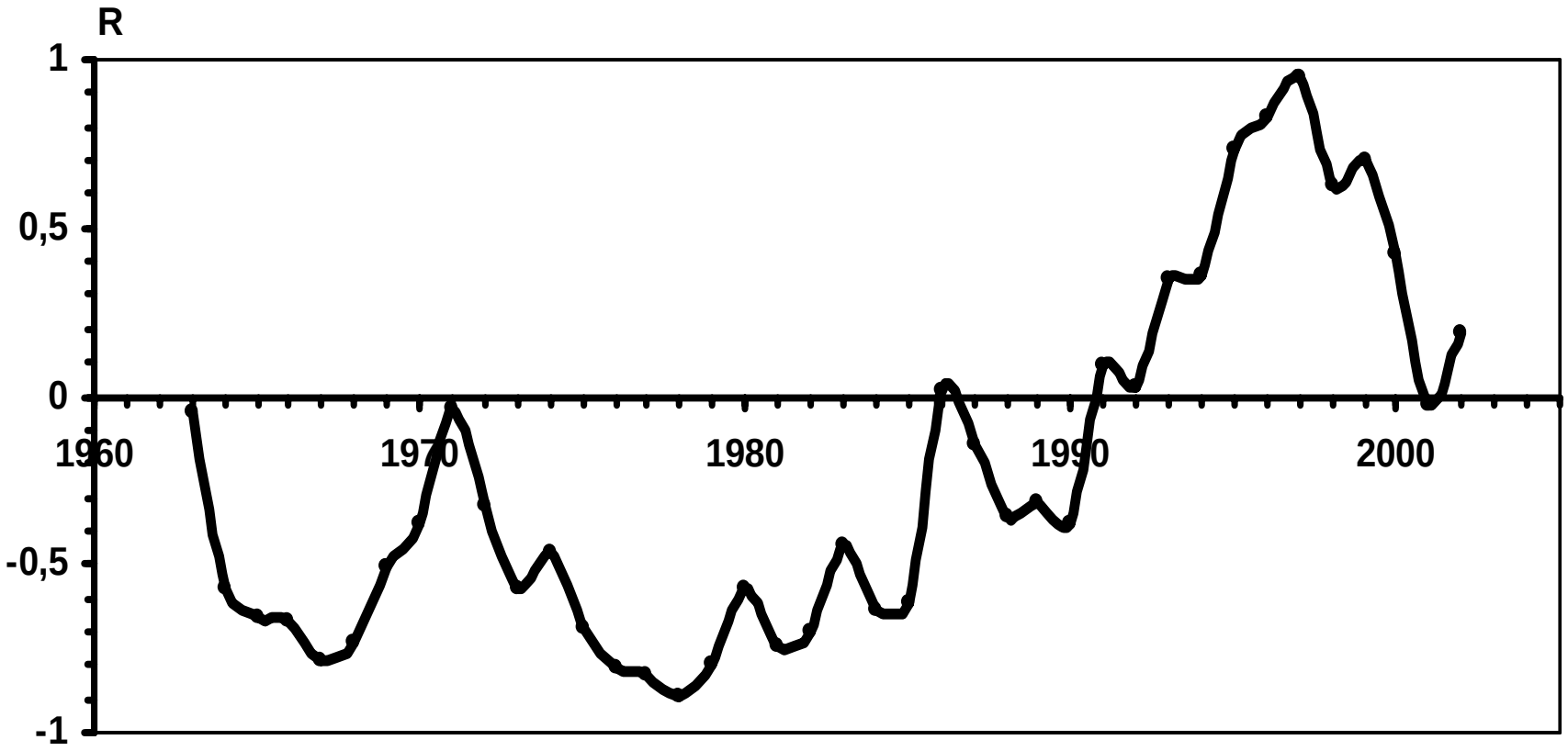
Year-to-year changes of ice cover averaged for January – April (1), its mean values (2)



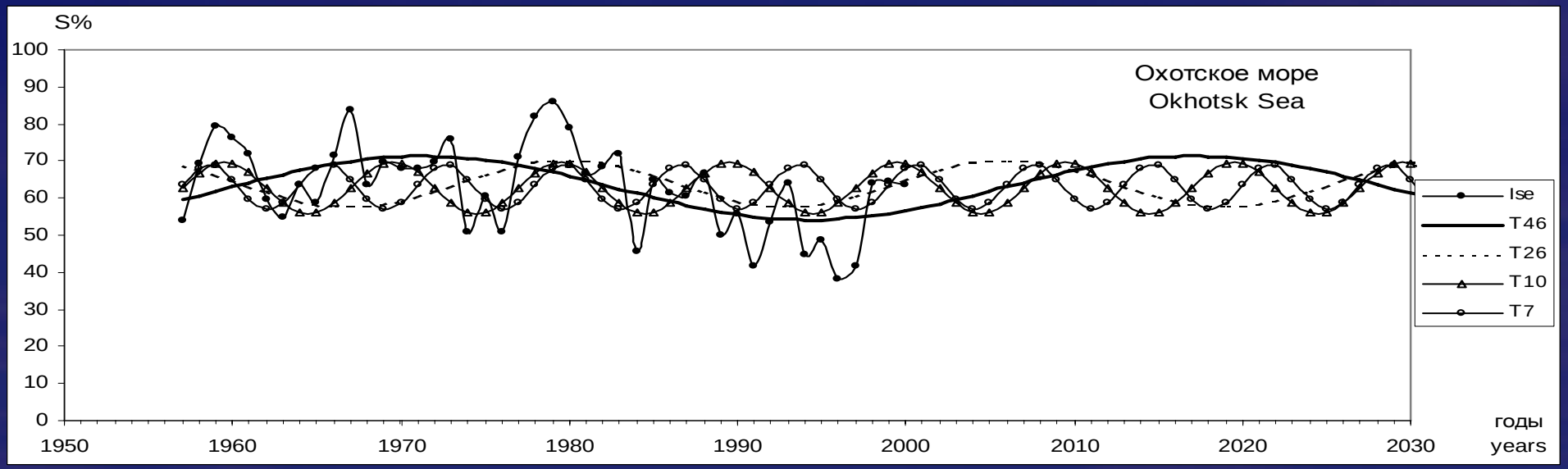


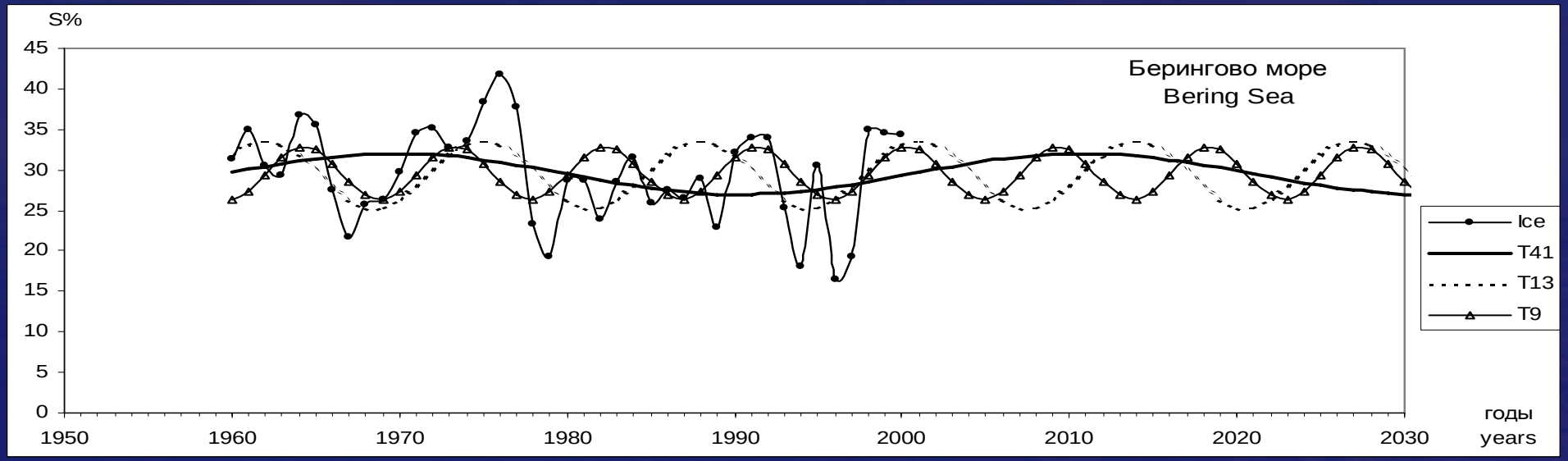
and its approximation and extrapolation by sum of harmonics (3, 4)

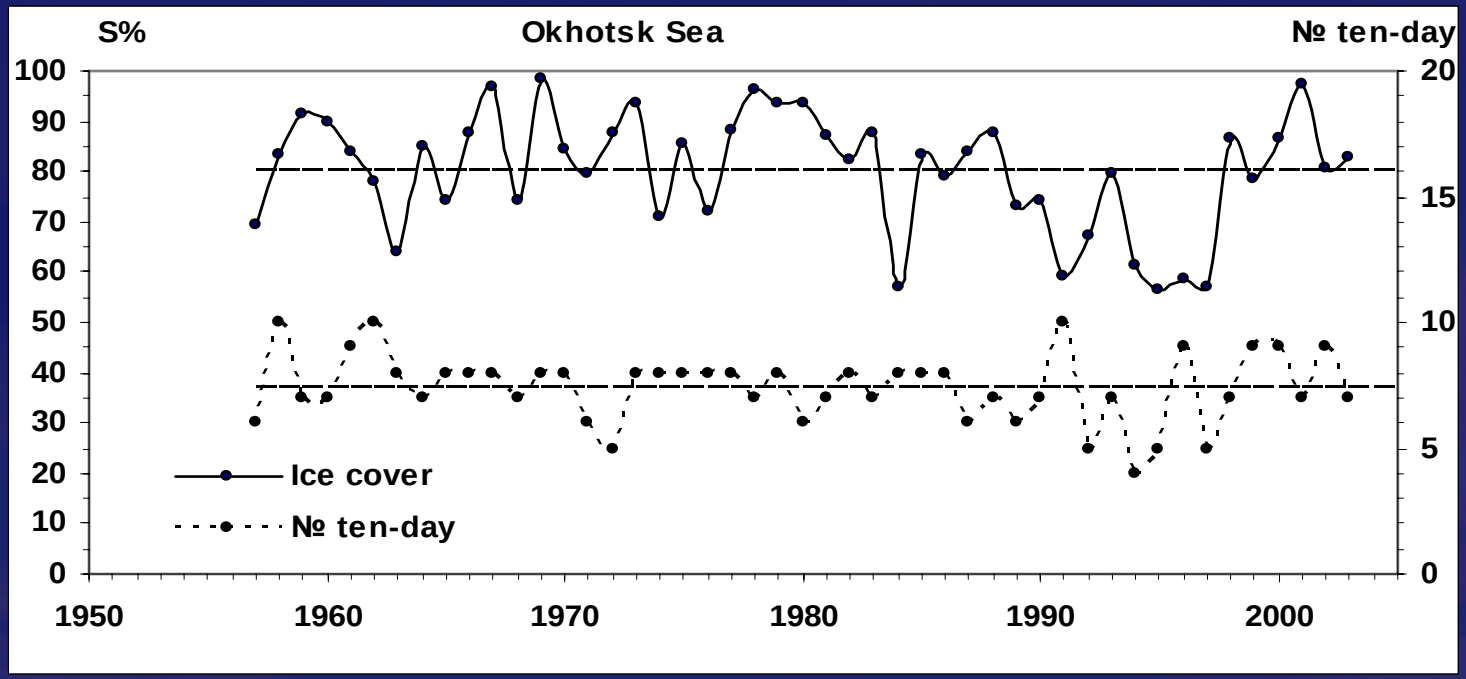
7-year “running correlation” between mean winter ice cover in the Okhotsk Sea and Bering Sea

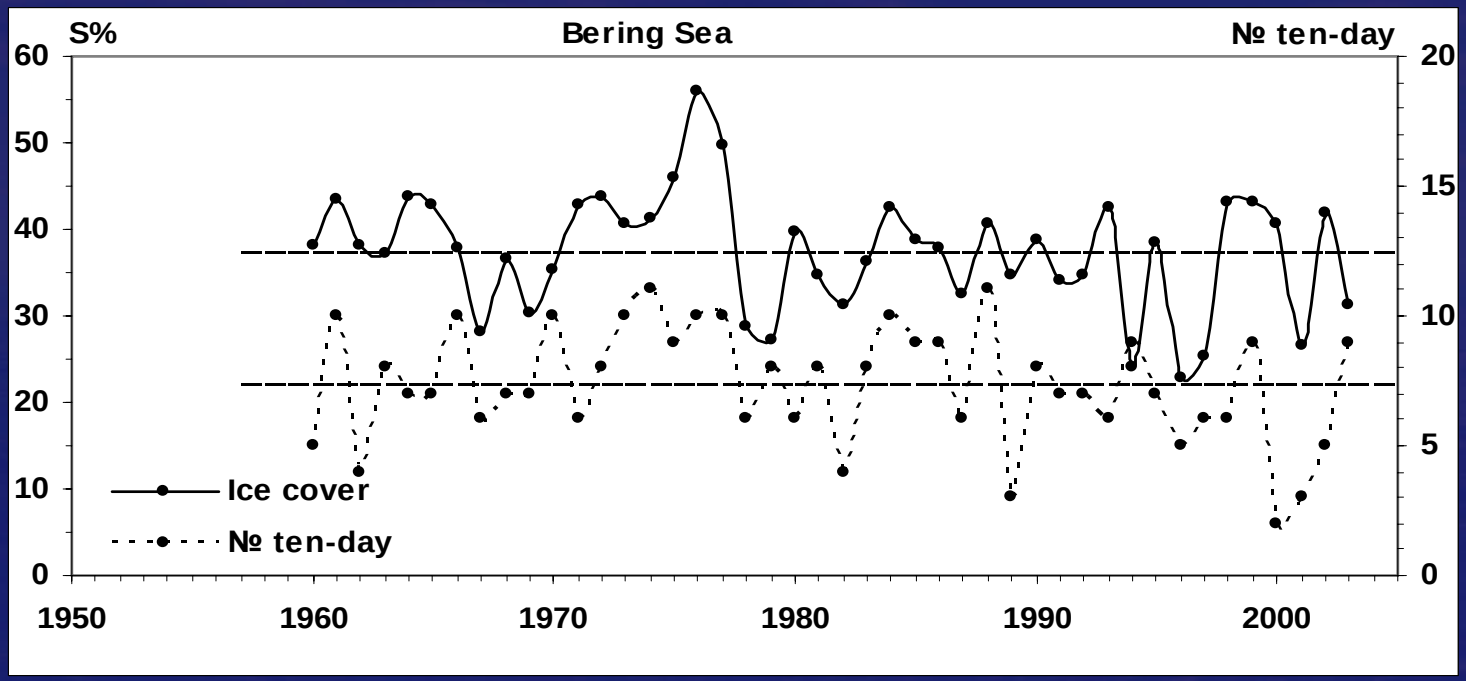


Long-term harmonics and interannual variations of the mean winter ice cover in the Okhotsk and Bering Sea



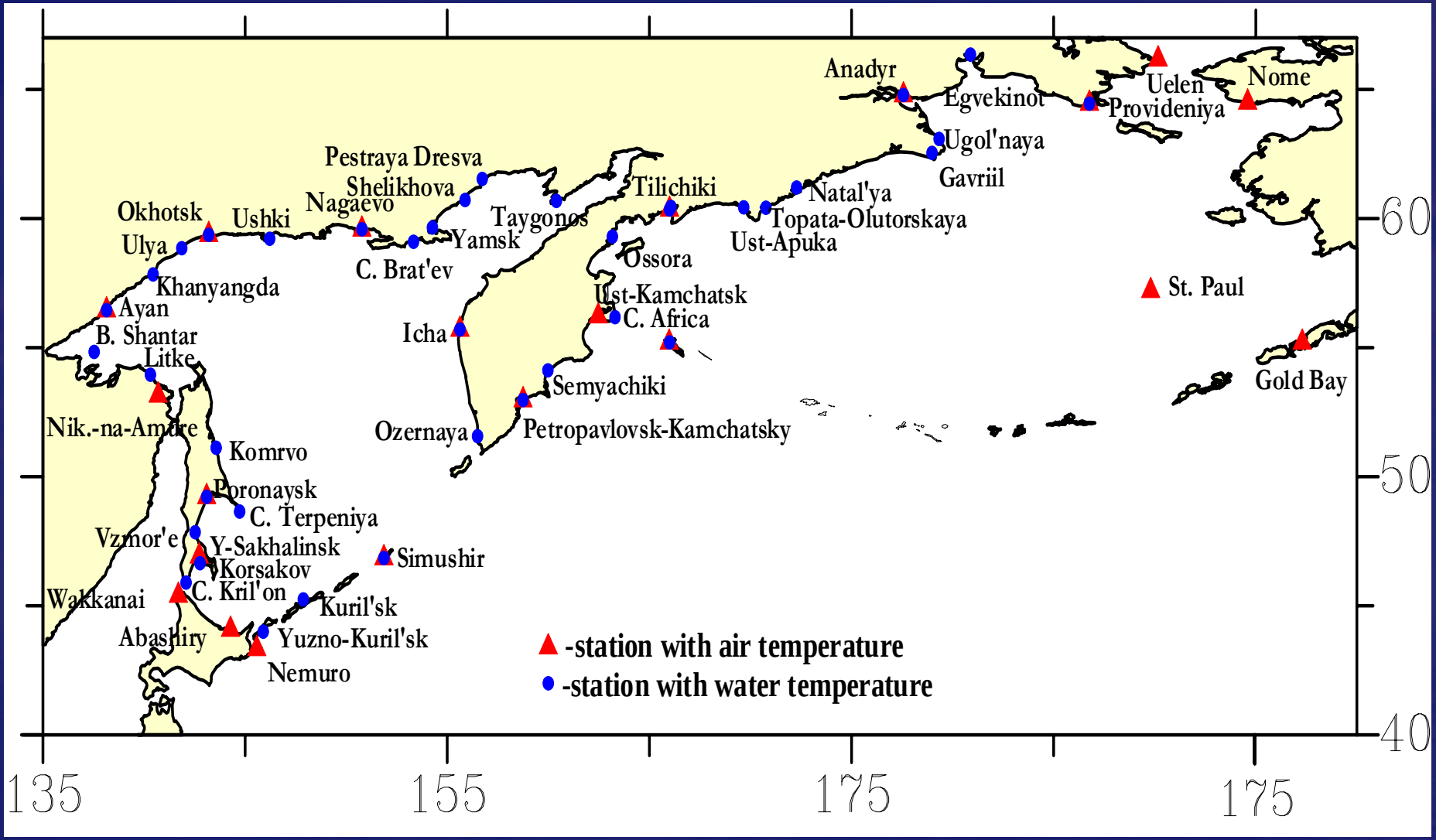






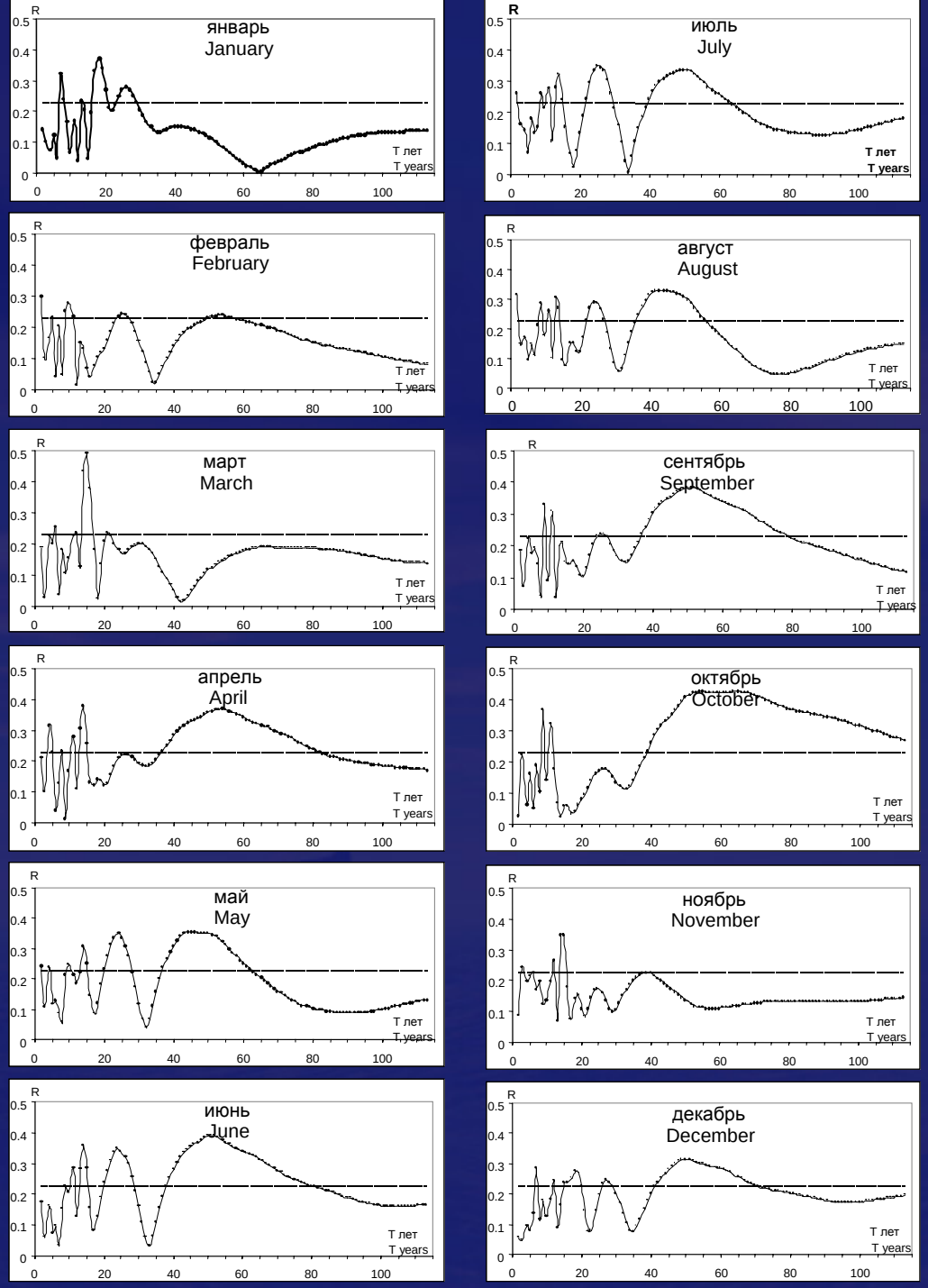
Annual maximum ice cover in the Okhotsk and Bering Seas and its timing

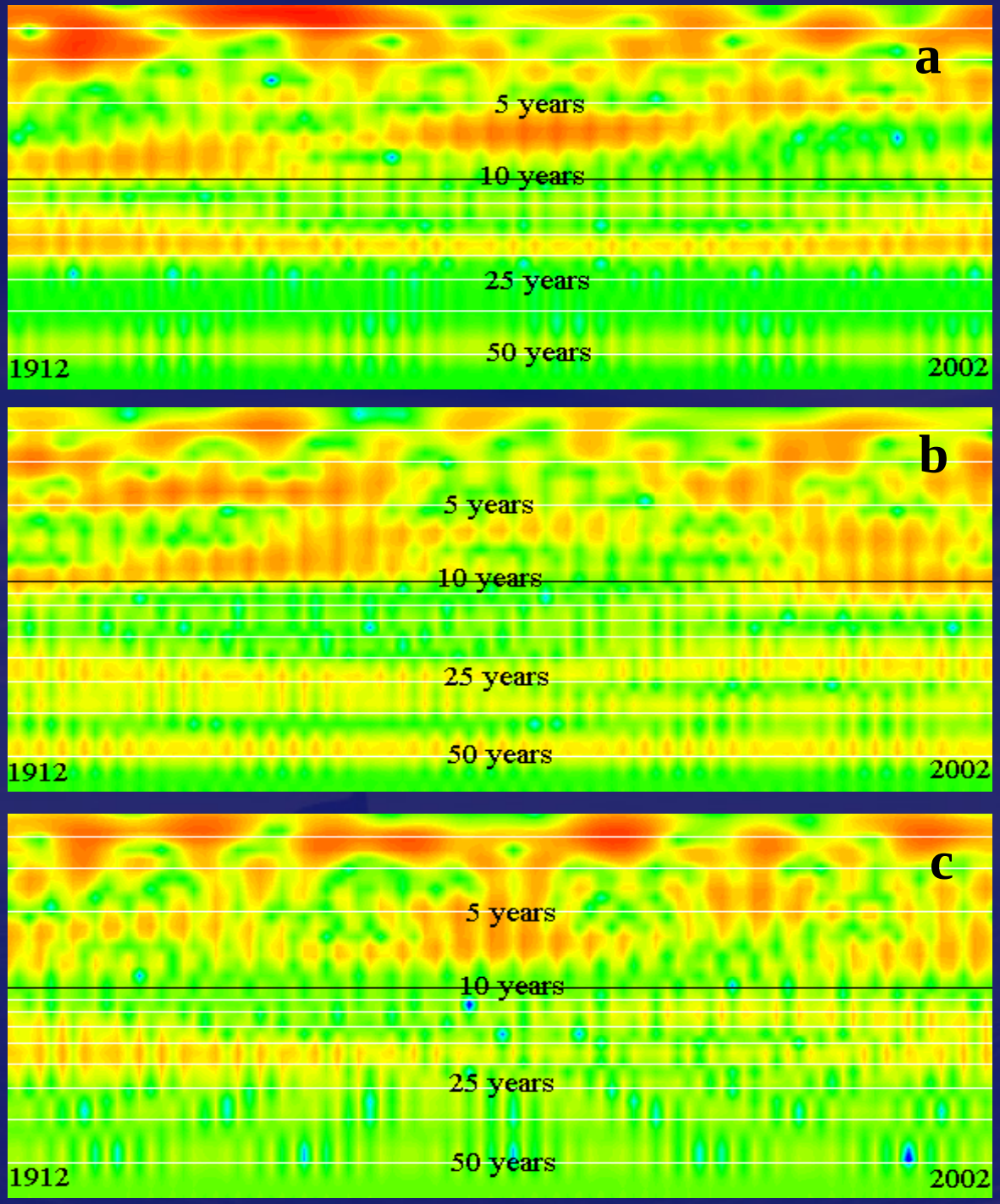
Another source: data of meteorological stations



Location of the meteorological stations

Examples of periodogram for monthly mean air temperature at meteorological station St. Paul





Spectral-time diagrams of (a) winter mean air temperature, (b) summer mean air temperature (c) amplitude of annual harmonics of air temperature for the station Okhotsk.

Horizontal axis is time (years) and vertical axis is frequency on a logarithmic scale.

Color palette is used with maximal spectral amplitude colored by red.

(after Ustinova and Shevchenko, 2004)

Correlation coefficients between mean winter (January-April) ice cover and seasonal and annual mean air temperature at meteorological stations in Bering Sea

Time series are not smoothed

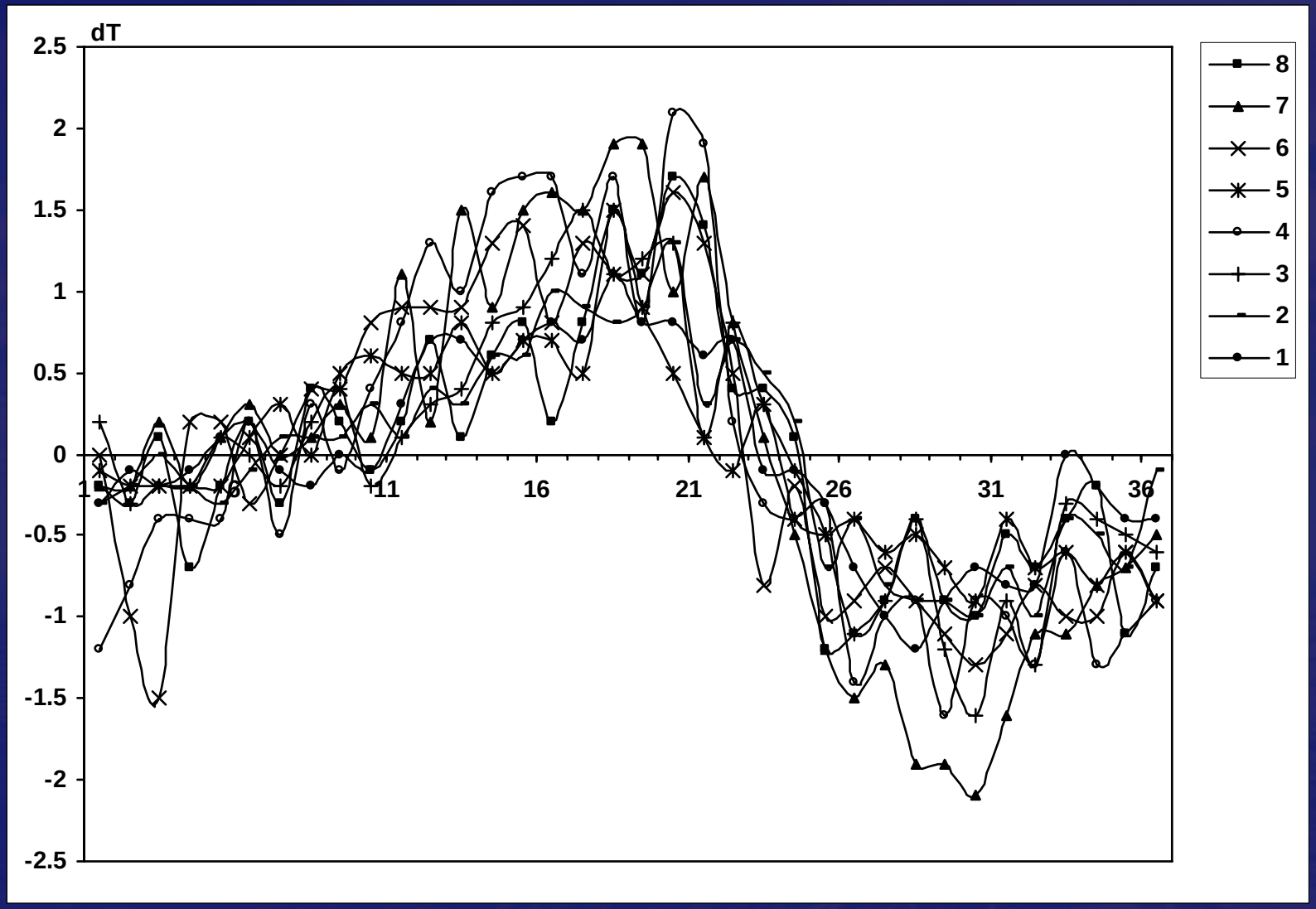
Stations \ season	Winter	Spring	Summer	Autumn	Year
Uelen	-0,57	-0,55	-0,35	-0,23	-0,66
Provideniya	-0,67	-0,55	-0,08	-0,12	-0,77
Nome	-0,47	-0,42	-0,04	-0,27	-0,59
Anadyr	-0,71	-0,52	-0,09	0,12	-0,67
Korf	-0,25	-0,27	-0,19	0,02	-0,38
St. Paul	-0,81	-0,65	-0,28	-0,50	-0,73
Cold Bay	-0,44	-0,57	-0,27	-0,32	-0,59
Ust-Kamchatsk	0,02	-0,39	-0,22	0,13	-0,13
Nikol'skoe	0,03	-0,44	-0,45	-0,12	-0,40
Petropavlovsk-Kamchatsky	0,20	-0,28	-0,12	0,02	0,05

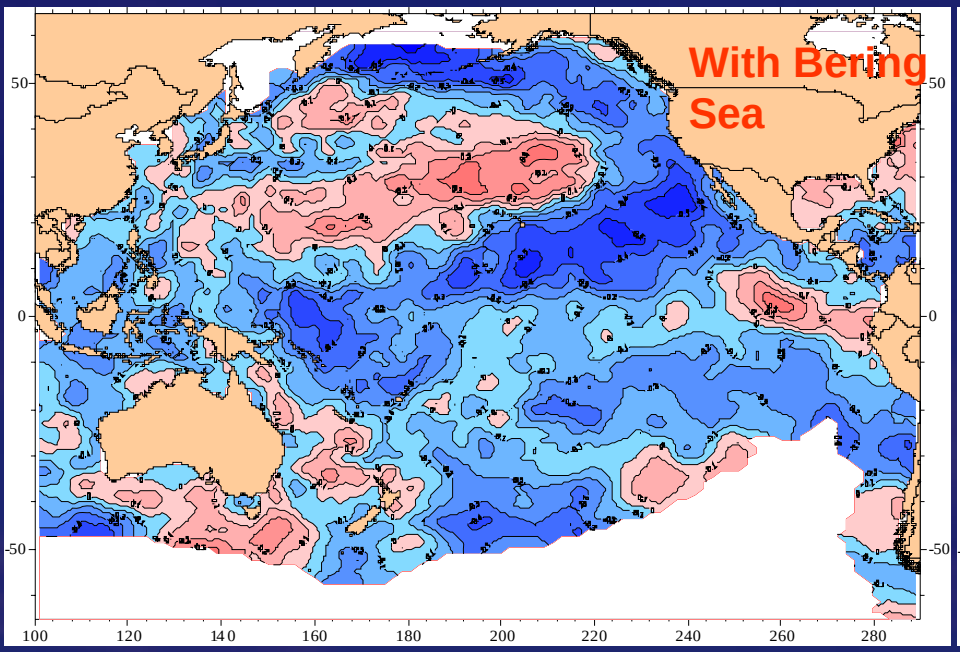
Correlation coefficients for the Okhotsk Sea between mean winter (maximal annual, additionally) ice cover and seasonal and annual mean air temperature at meteorological stations

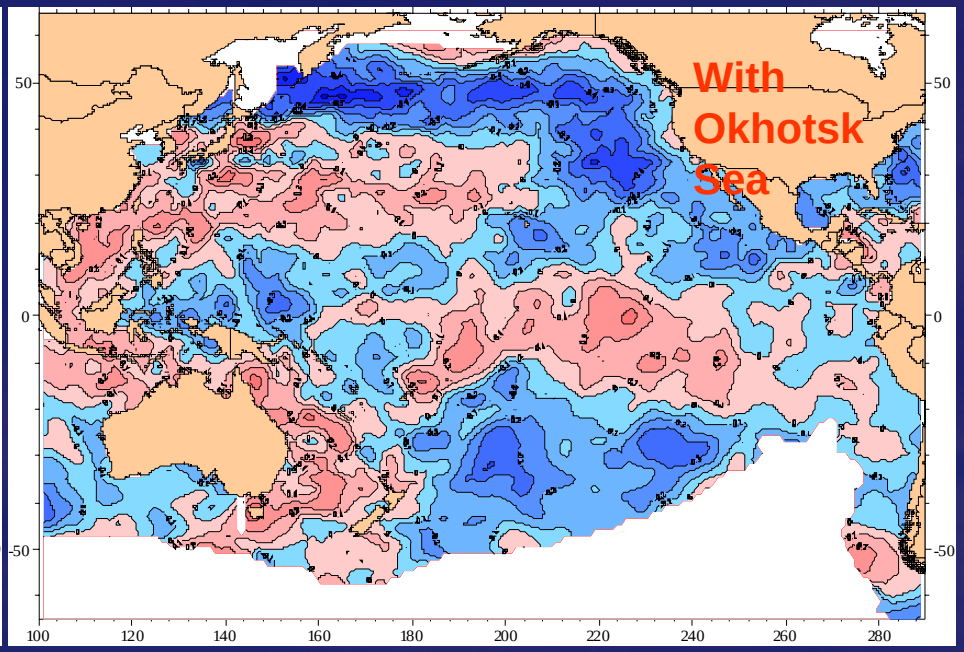
Time series are not smoothed

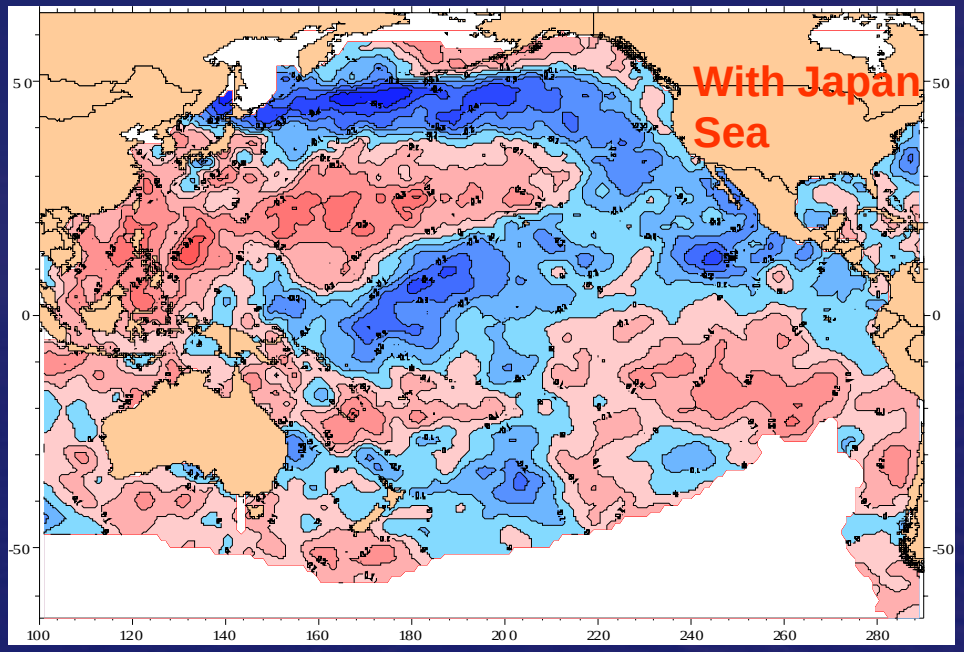
Stations \ season	Winter		Spring		Summer		Autumn		Year	
	I_{winter}	I_{max}	I_{winter}	I_{max}	I_{winter}	I_{max}	I_{winter}	I_{max}	I_{winter}	I_{max}
Nagaevo	-0,40	-0,40	-0,10	-0,27	-0,04	-0,11	0,09	-0,06	-0,04	-0,19
Okhotsk	-0,69	-0,67	-0,52	-0,55	-0,10	-0,08	-0,15	-0,12	-0,80	-0,77
Ayan	-0,40	-0,41	-0,13	-0,16	-0,07	-0,18	-0,05	-0,07	-0,16	-0,23
Nikolaevsk-na-Amure	-0,40	-0,41	-0,17	-0,19	-0,15	-0,14	0,04	0,03	-0,21	-024
Alexandrovsk-Sakhalinsky	-0,51	-0,56	-0,15	-0,18	-0,03	-0,03	-0,10	-0,12	-0,27	-0,33
Poronaysk	-0,74	-0,76	-0,35	-0,36	0,01	0,03	-0,19	0,22	-0,50	-0,56
Yuzhno-Sakhalinsk	-0,57	-0,58	-0,08	-0,10	0,08	0,11	-0,06	-0,09	-0,28	-0,33
Vakkanai	-0,16	-0,17	-0,22	-0,29	0,02	0,04	0,14	0,13	-0,10	-0,17
Abashiry	-0,26	-0,34	-0,13	-0,16	0,02	-0,14	0,06	-0,02	-0,14	-0,25
Nemuro	-0,32	-0,36	-0,19	0,0	0,07	-0,12	0,08	-0,03	-0,14	-0,26
Sapporo	-0,25	-0,28	-0,22	-0,26	0,07	-0,08	0,03	0,05	-0,15	-0,20
Simushir	-0,57	-0,62	-0,08	-0,20	0,08	0,11	-0,06	-0,11	-0,28	-0,35
Petropavlovsk-Kamchatsky	-0,54	-0,49	-0,19	-0,23	0,02	-0,07	-0,32	-0,21	-0,43	-0,41
Icha	-0,56	-0,55	-0,41	-0,50	-0,24	-0,16	-0,08	-0,11	-0,55	-0,60

Rate of SST seasonal changes, °/10 days :
1 - western Bering Sea, 2 – off south-east Kamchatka, 3 – off south-west Kamchatka, 4 – eastward from Tsugaru Strait, 5 – off south Honshu, 6 – southern Japan Sea, 7 – northern Japan Sea, 8 - central North Pacific

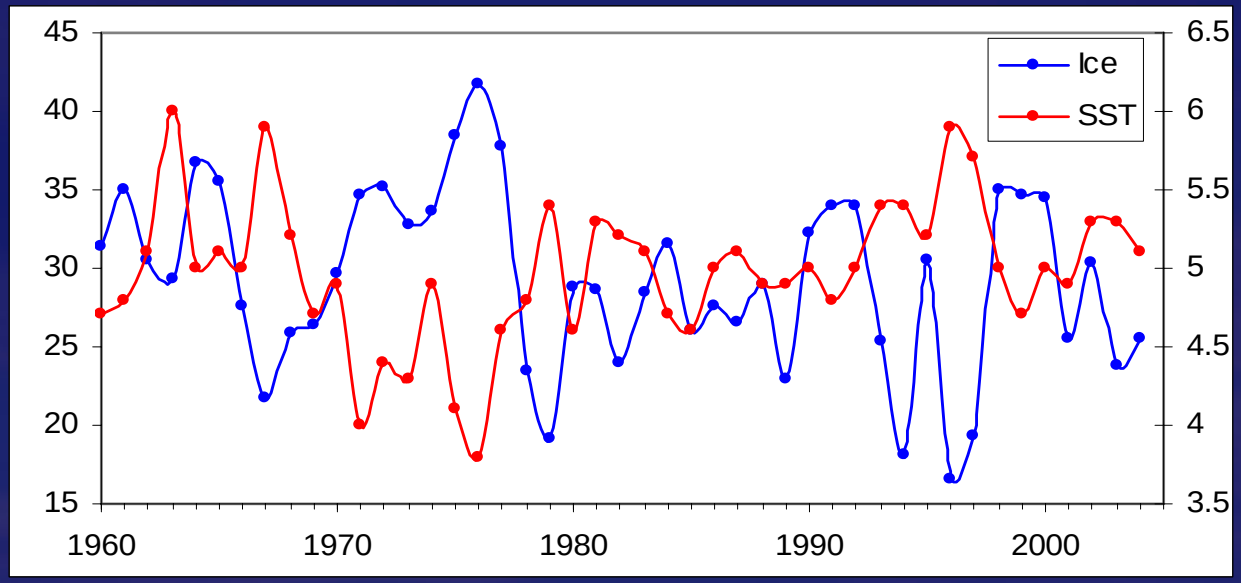






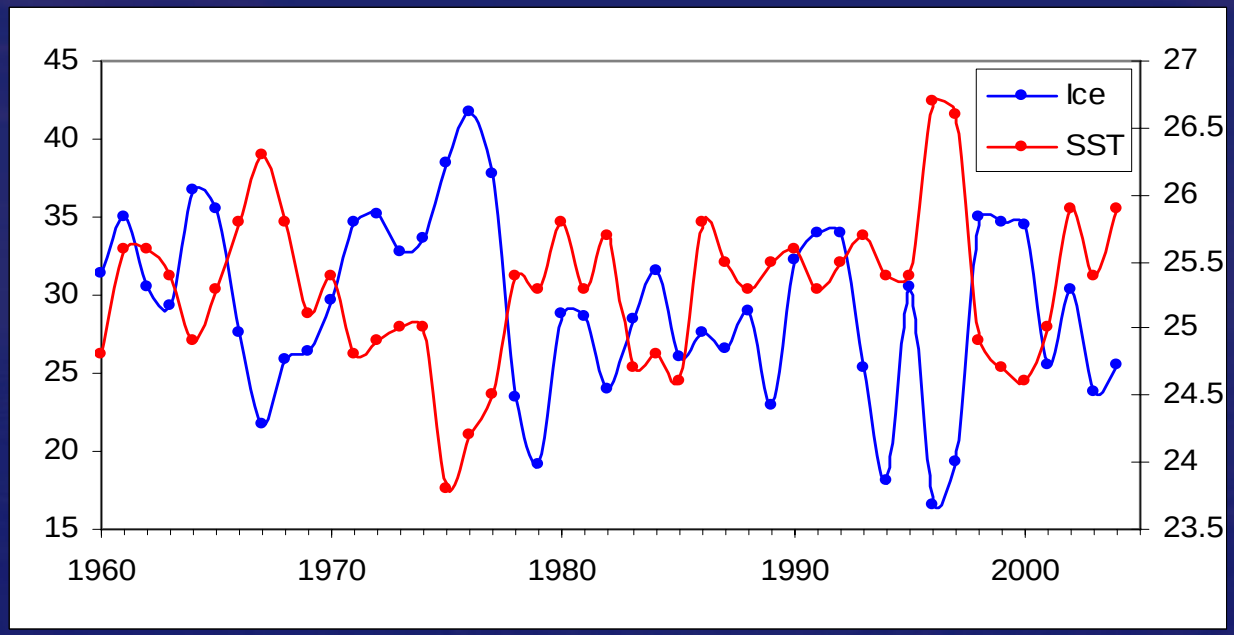


Correlations R between mean winter ice cover in Bering, Okhotsk and Japan Sea and SST anomalies in March. Contour interval is 0,1. Negative correlation is blue. Areas of significant correlation are dark blue and dark red. (R95% = 0.29)



Mean winter ice cover in Bering Sea and SST in May

around 50°N, 175°W

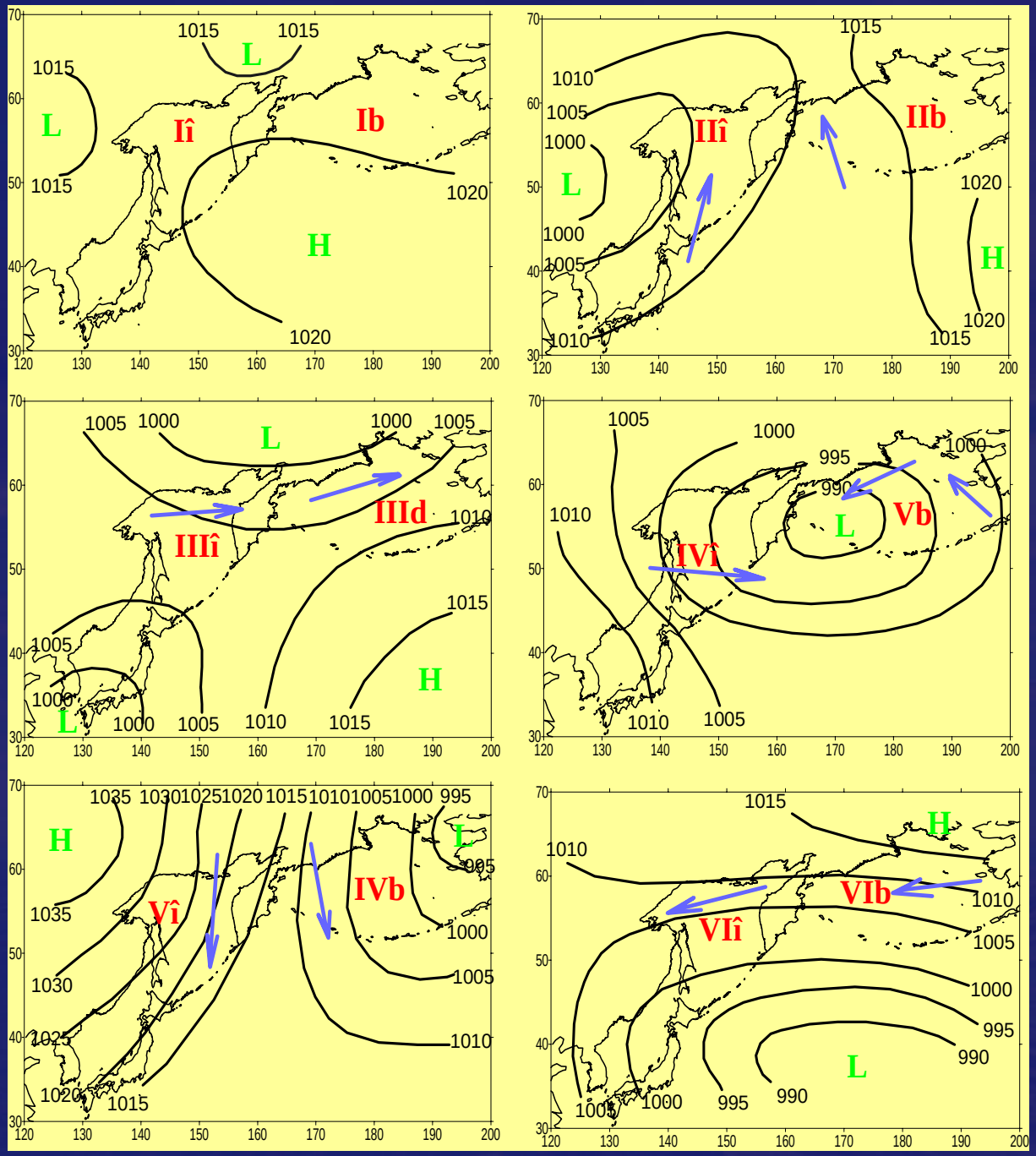


around 17°N, 155°W

Indices for regional scales:

Types of atmospheric processes over the Okhotsk and Bering Seas

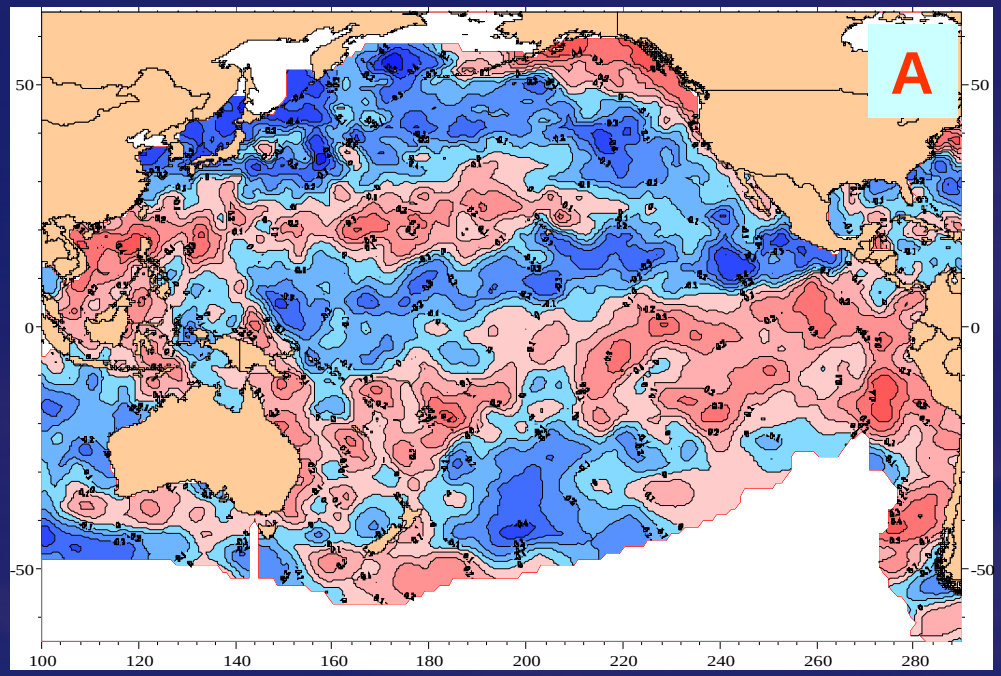
(after Glebova, 1999; 2001)

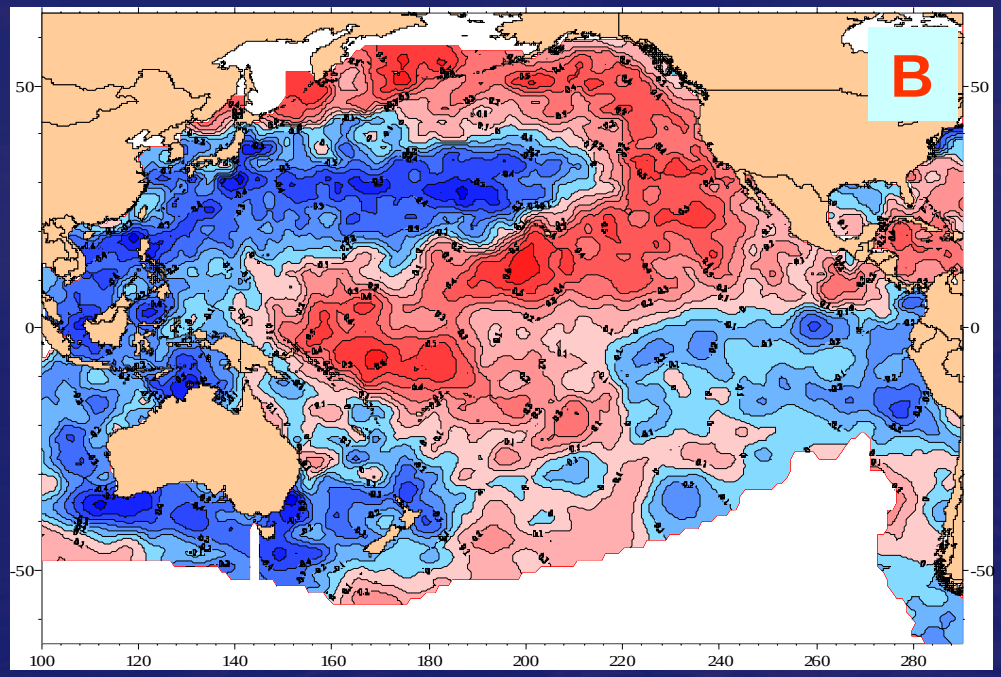


Correlations between repeatability of the “Extreme-Cold” (A) and “Warm” (B) types of atmospheric processes over the Okhotsk Sea (by Glebova, 1999) in January – March and SST anomalies in each grid point in March.

Contour interval is 0,1.

Negative correlation is blue.





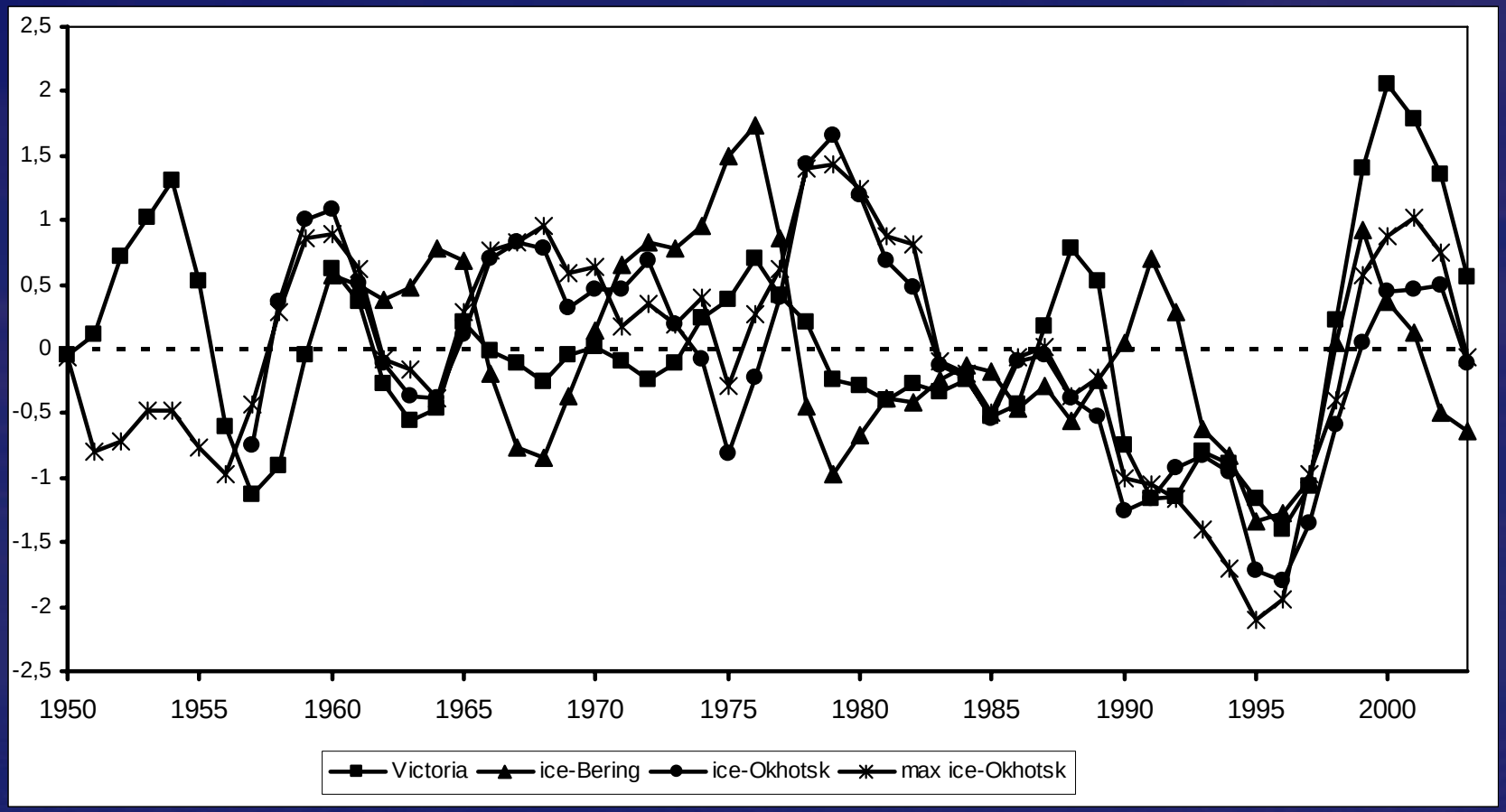
We analyzed well-studied climatic indices:

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;
Arctic Oscillation (AO) Index,
macro-scale pressure gradient between the Siberian High and Aleutian Low

together with some thermal characteristics

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

ICE COVER OF 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 Sea.
- 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.


Thank you for attention!