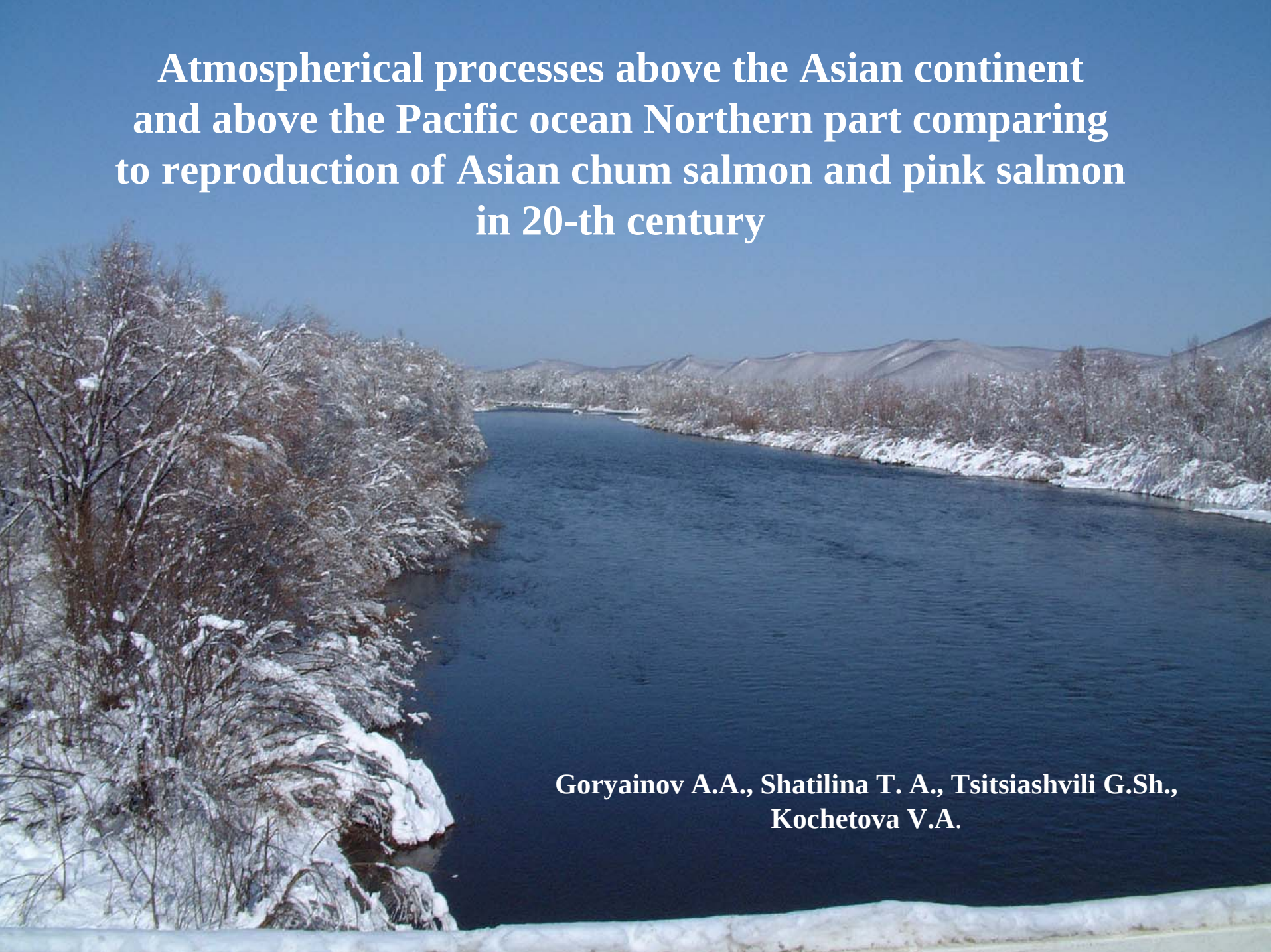
Atmospherical processes above the Asian continent and above the Pacific ocean Northern part comparing to reproduction of Asian chum salmon and pink salmon in 20-th century



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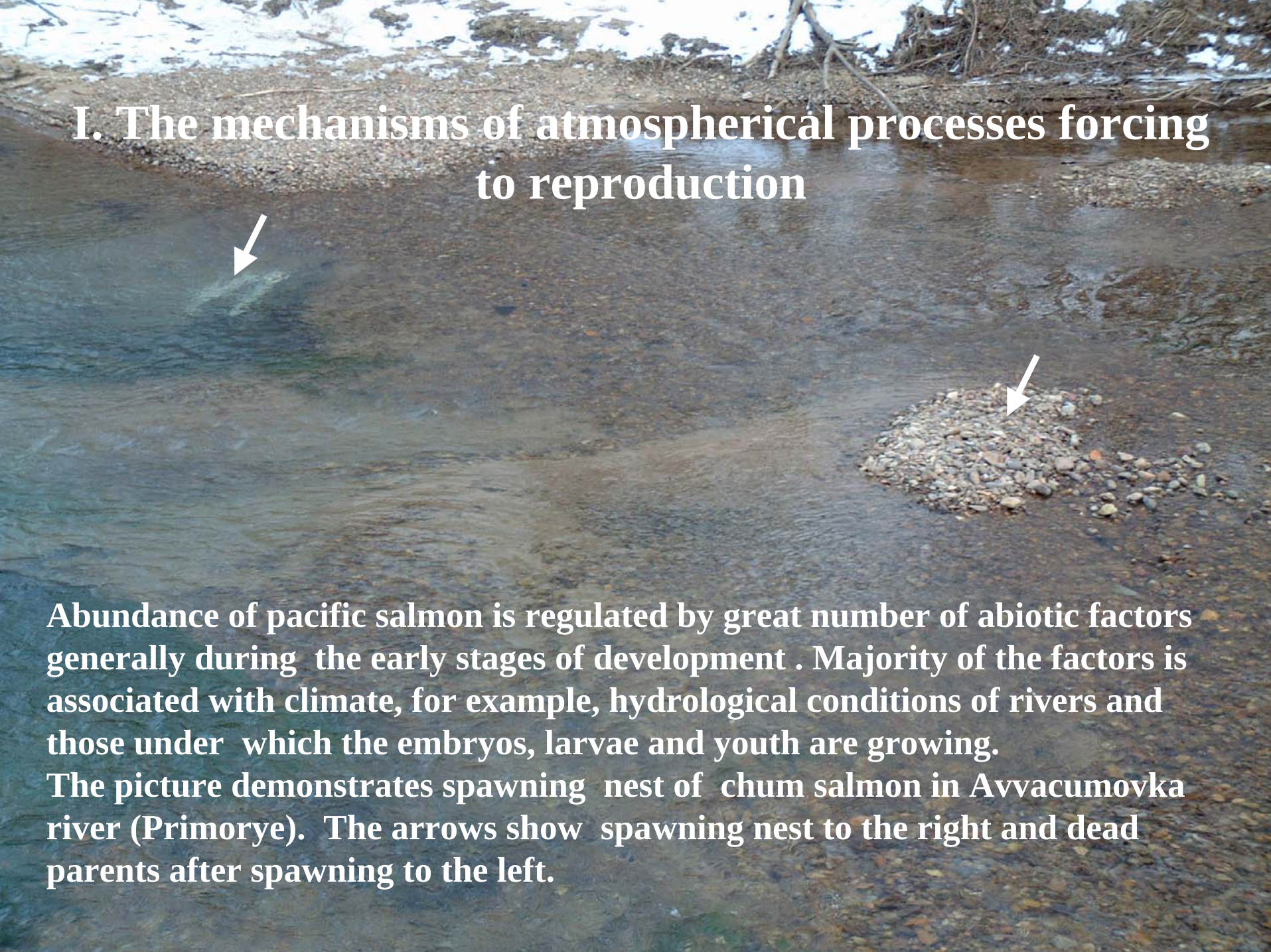
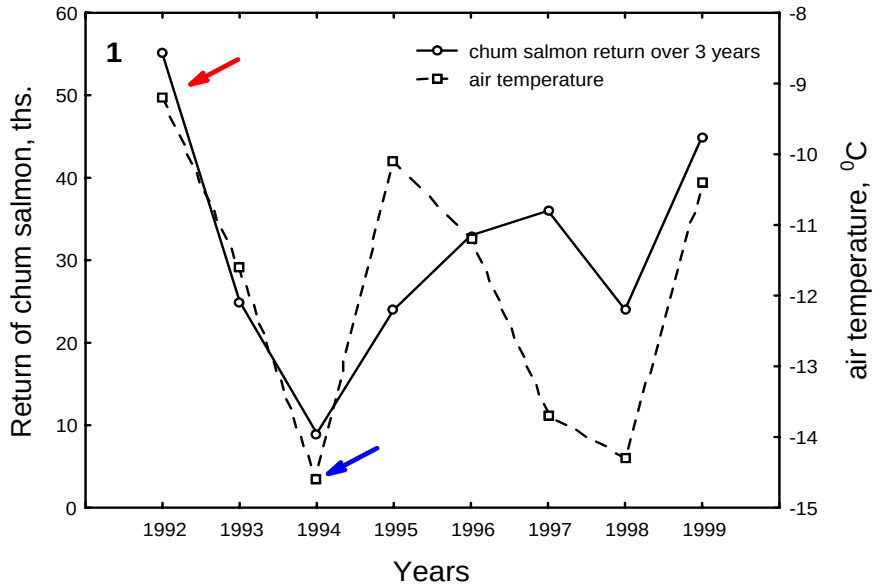
I. The mechanisms of atmospherical processes forcing to reproduction



Abundance of pacific salmon is regulated by great number of abiotic factors generally during the early stages of development . Majority of the factors is associated with climate, for example, hydrological conditions of rivers and those under which the embryos, larvae and youth are growing.
The picture demonstrates spawning nest of chum salmon in Avvacumovka river (Primorye). The arrows show spawning nest to the right and dead parents after spawning to the left.

Fig. 1. It is exhibited the possible mechanism of atmospheric circulation forcing to the abundance of chum salmon generations during the period of embryos growth and larvae, for example in Avvakumovka river (44º N, 135º E ★)

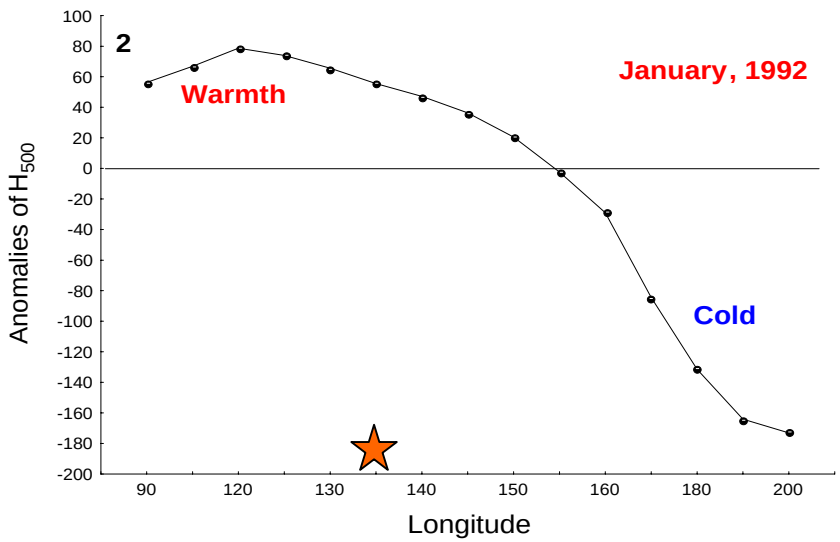
Frosty and dry winters are negatively forcing to the chum salmon abundance. For example, generations abundance formation in Avvakumovka river in 1994 (mainly returned in 1997) took place at the background of maximally low temperatures of air and precipitations.



1 – It is shown the average monthly temperature of air in January and return back of chum salmon into Avvakumovka river over three years. Red arrow sings maximally high magnitude of air temperature and blue arrow sings maximally low one.

2 – It is shown geopotential H_{500} anomalies between 90-160^0 W on 44^0 N latitude in January, 1992. It is evident that the river was under "warmth core".

3 –H_{500} geopotential anomalies are show between 90-160^0 N on 44^0 N latitude in January, 1994. It is evident that the rivers was under "cold core".



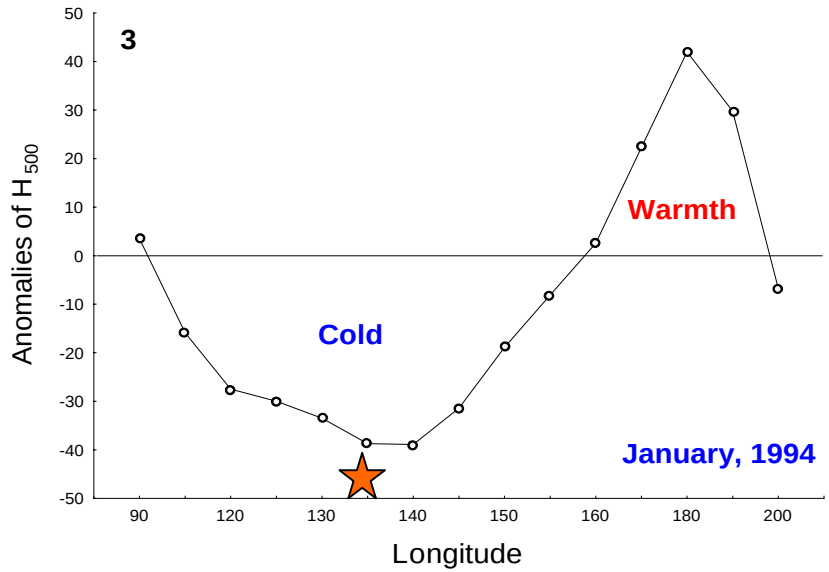
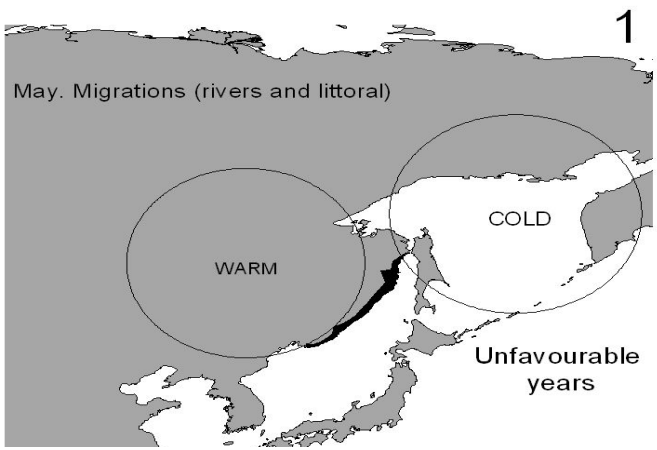
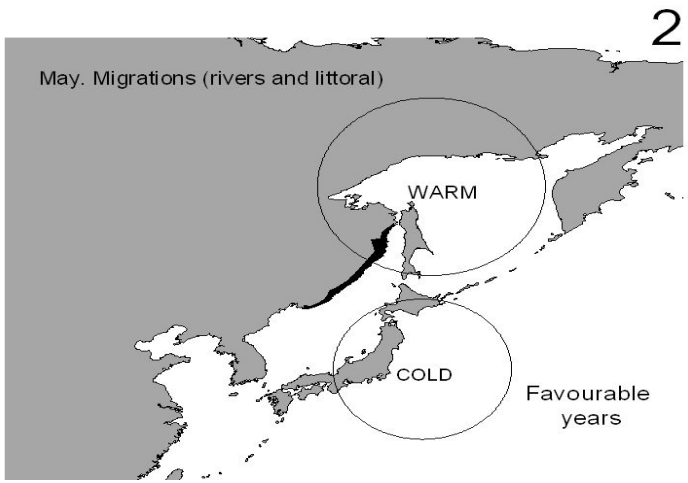


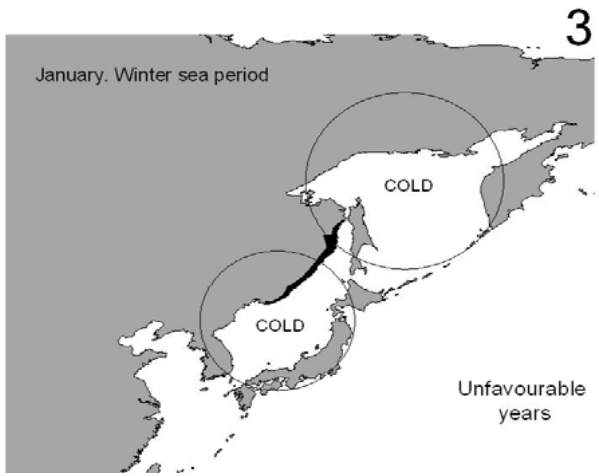
Fig. 2a. It is presented the hypothetical scheme of favourable and unfavourable climate conditions that are formed above the ocean and the continent for Primorye pink salmon in May



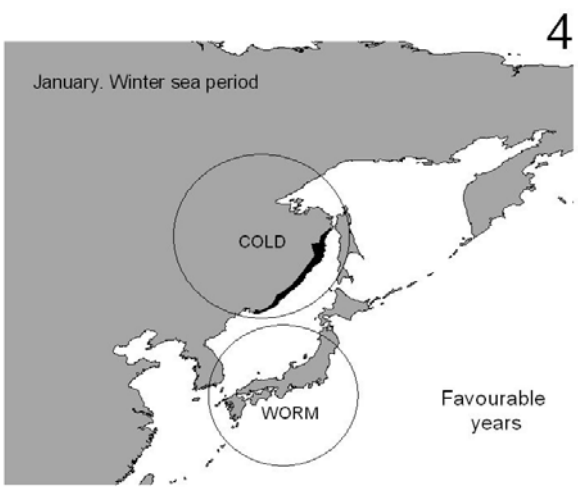


- **1**. During the run and living of youth in the coastal zone the **unfavourable** climate conditions should conditions should be considered those that have warmth core above the continental region, while at the same time above the Okhotsk sea some cold core is situated from where hollow of cold is spread to the Tatar Strait and Northern part of the Japan sea under such synoptic situation early warming of continental water occurs, migration from a river to the sea begins in earlier periods, but coastal parts of the sea adjacent t to the mouths of rivers for spawning aren't heated.
- **2**. During run into the sea and living in coastal zone the **favourable** climate conditions for youth are supposed probably those which are characterized by presence of warmth core above the Okhotsk sea, but cold core is shifted to the North-West part of Pacific ocean.

Fig. 2b. It is presented the hypothetical scheme of favourable and unfavourable climate conditions that are formed above the ocean and the continent for Primorye pink salmon in January



- **3. Unfavourable** conditions for wintering in the sea probably should be thought those, when strength intensification in the Okhotsk sea minimum and in connected with it cold climate hollow above the Japan sea takes place. Under such type of atmosphere the cold water forcing to the south part of the Japan sea, i.e. to the regions of pink salmon wintering is intensified.



- **4.** Favourable conditions for wintering should be thought such synoptical conditions when the Okhotsk sea minimum is shifted to the continent. This displacement resulted into weakening of the cold forcing onto the Japan sea central and south parts.

II. Atmospheric processes above the ocean and continent comparing to salmon reproduction

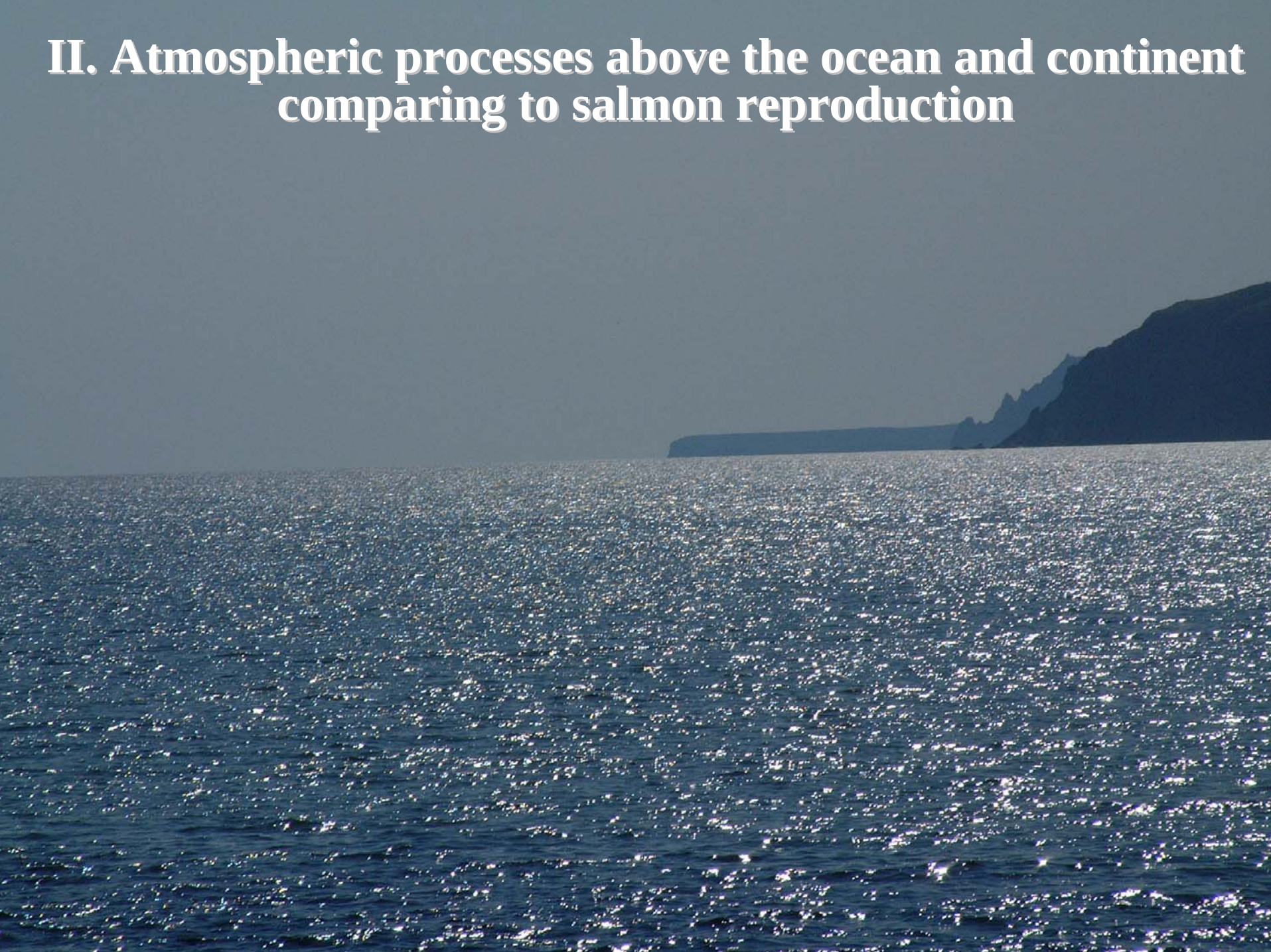
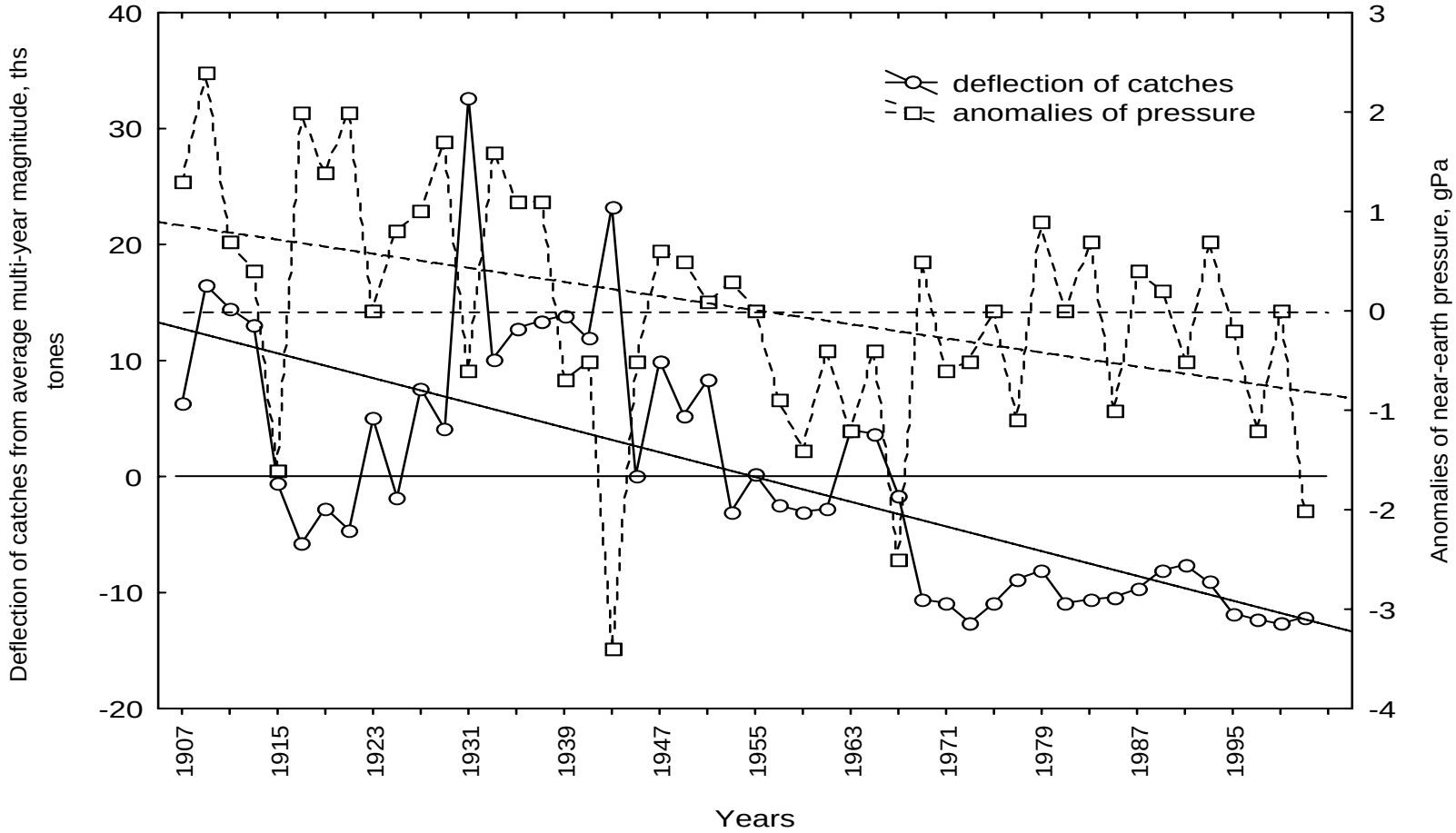


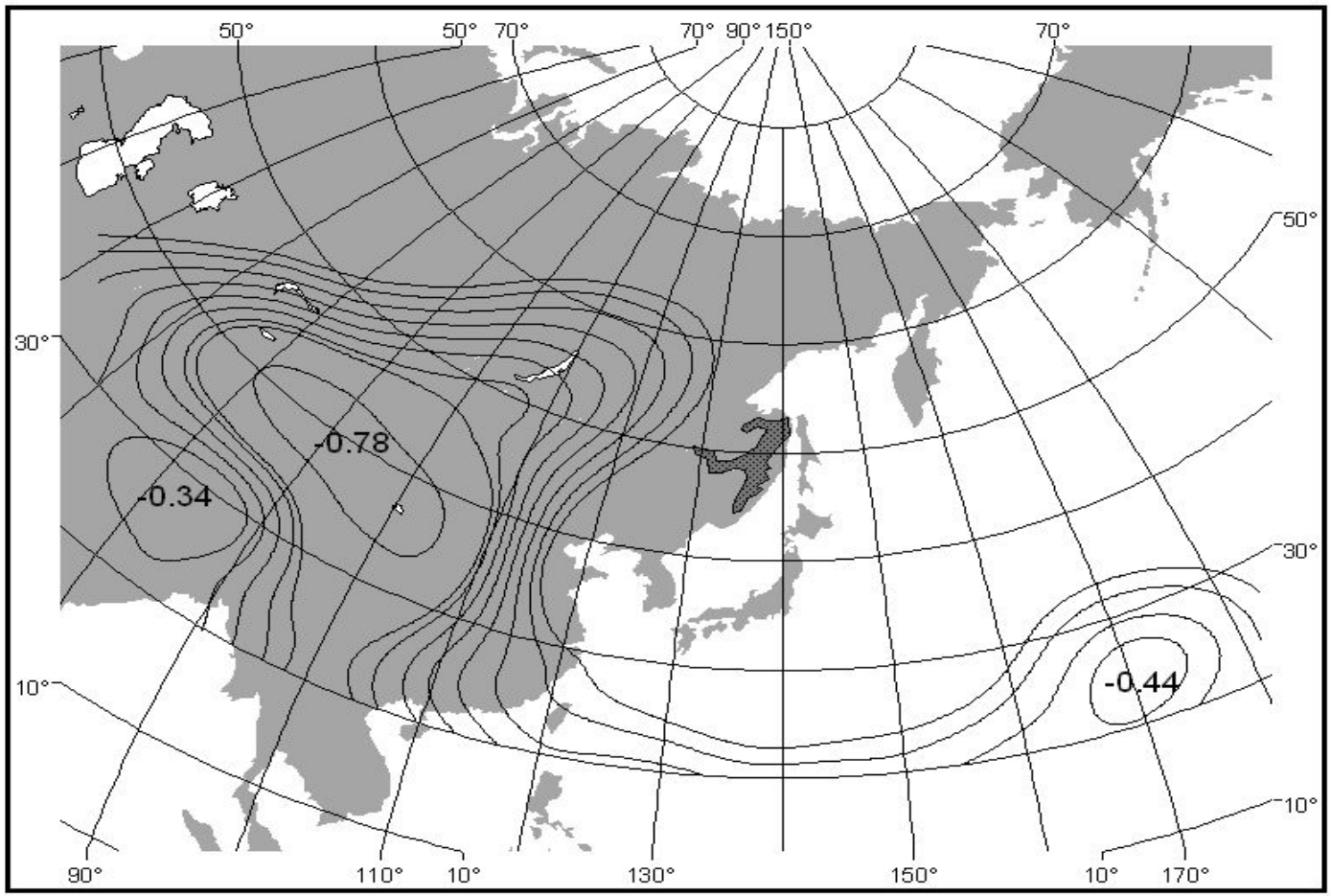
Fig. 3. Climate trends run and salmon catches trends exhibit their similar direction. These give us basis to search quantitative statistical links between the atmosphere processes and catches. The picture displays run of anomalies of near-earth pressure in the Pacific maximum area and catches of Amur river autumn chum salmon.



Climate forming zones in every part of the sea or the continent embrace significant space, so, the search of reliable connections was fulfilled above the wide Asian territory and over the Pacific ocean area in the zone with coordinates: 20°-80° N and 60° E–140° W.

Applying statistical standard methods we identified the most informative regions of reliable correlations

Fig. 4a. The picture displays iso-correlates ($p<0.05$) of geopotential H_{500} in May and catches of autumn Amur river chum salmon over three years. Region of Amur river chum salmon reproduction is signed by dark field.



It is evident that areas of most correlations are placed above the Asian continent in the Asian depression region. The less correlations are marked in the Pacific maximum area

Fig. 4b. It is demonstrated areas (solid isolines) of reliable correlation (p<0.05) between near-earth pressure in January and catches of chum salmon at the Okhotsk sea continental coast over three years. (Dotted lines mean isobars of near-earth pressure and dark field signs the region of reproduction)

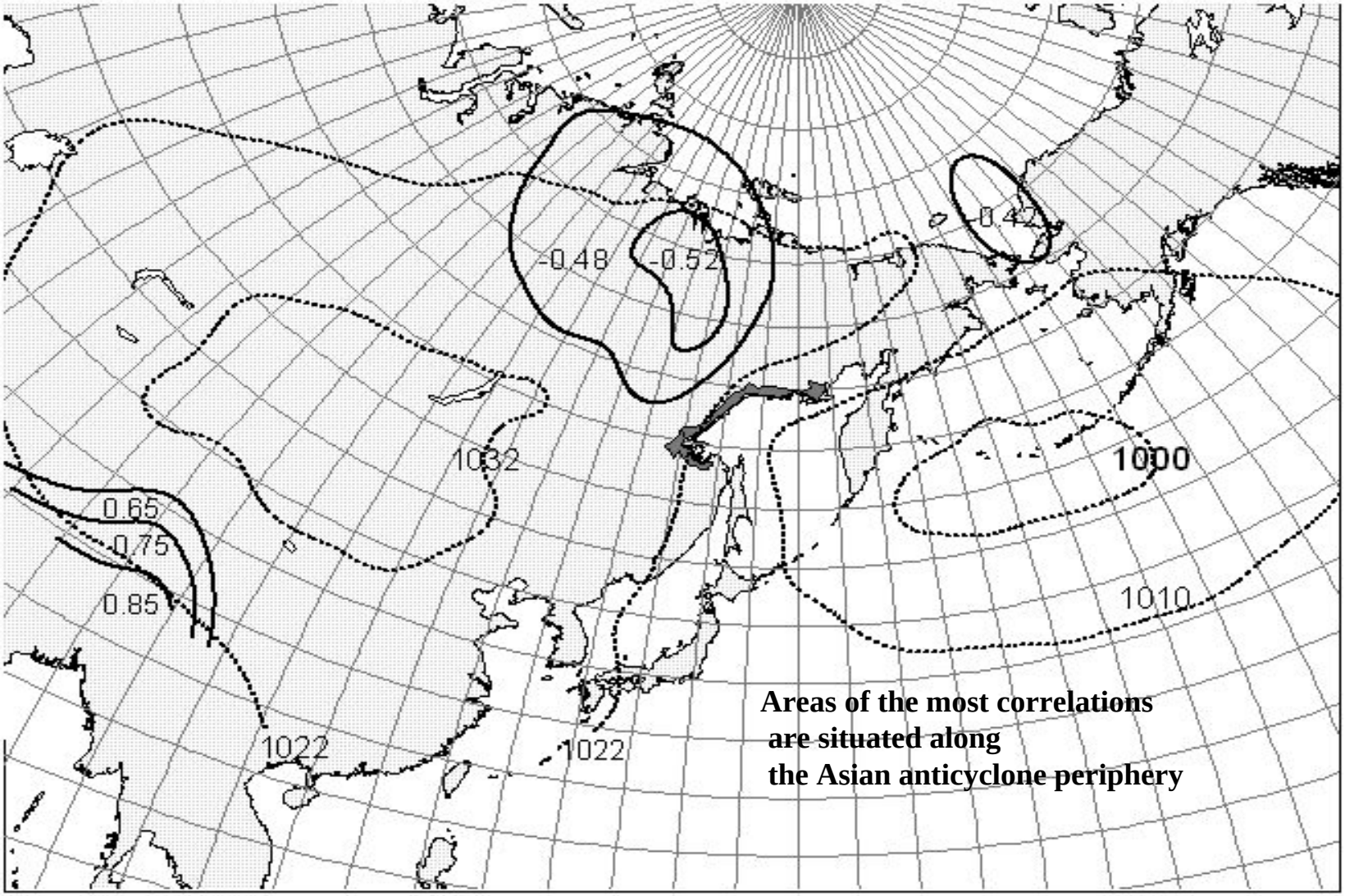
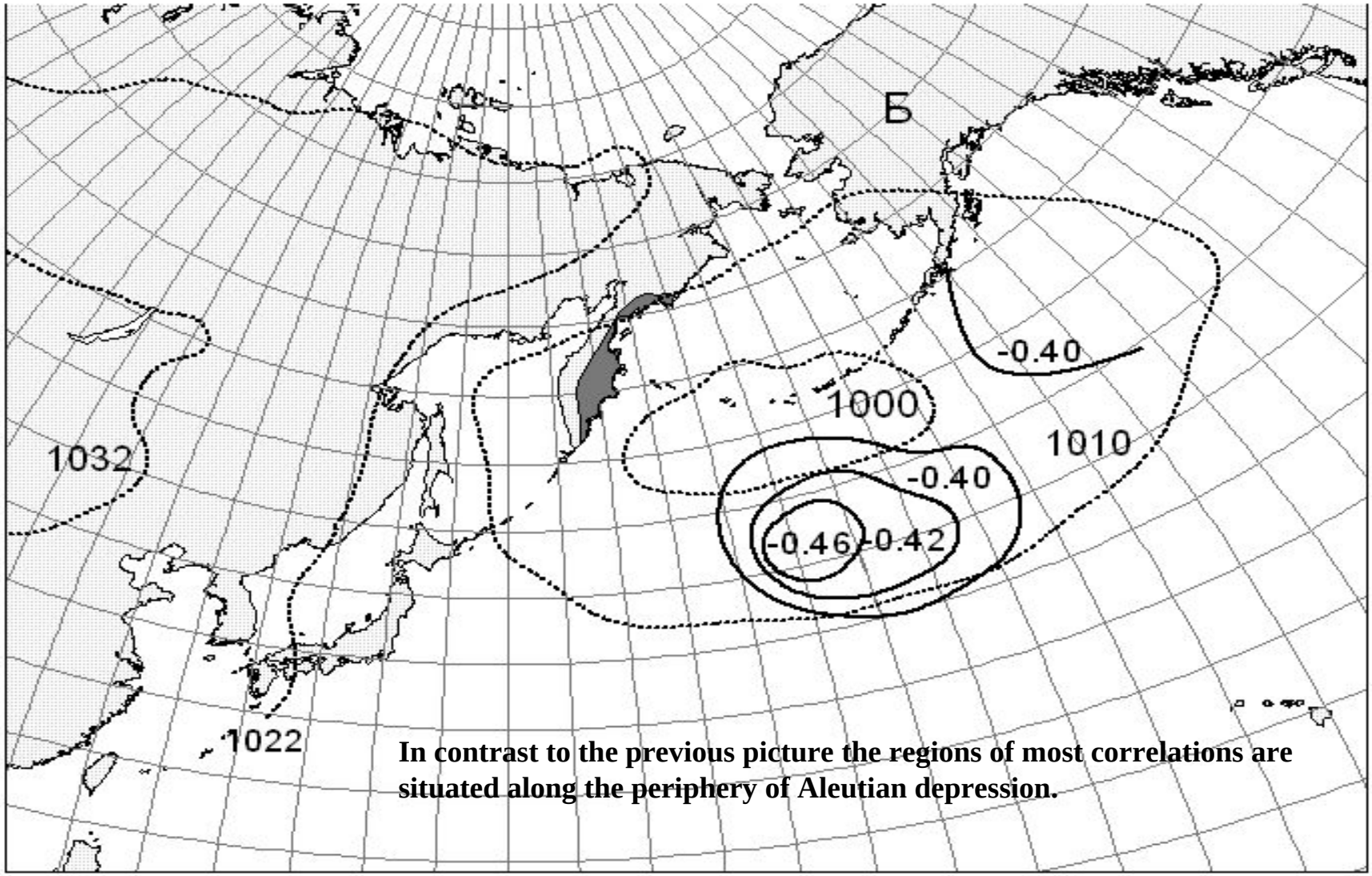


Fig. 4c. It is demonstrated areas (solid isolines) of reliable correlation (p<0.05) between near-earth pressure in January and catches of chum salmon at the East Kamchatka continental coast over three years. (Dotted lines mean isobars of near-earth pressure and dark field signs the region of reproduction)

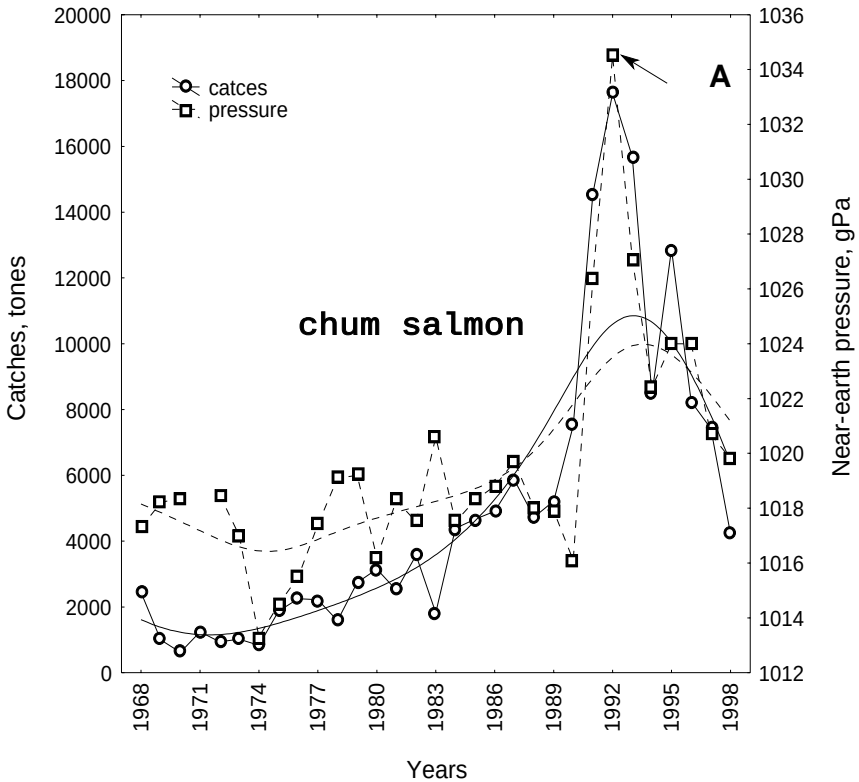


In contrast to the previous picture the regions of most correlations are situated along the periphery of Aleutian depression.

Fig. 5a. Climate forcing to salmon reproduction usually being discovered in the years of large anomalies clearly exposes the mechanism of such forcing.

A – there is shown –near-earth atmosphere pressure above area with geographical coordinates: 30º N, 90º E in January and catches of chum salmon on the North Western coast of the Okhotsk sea over three years.

B – there is shown near-earth atmosphere pressure above this area in January and catches of pink salmon on the Okhotsk sea North Western coast over 1.5 year.



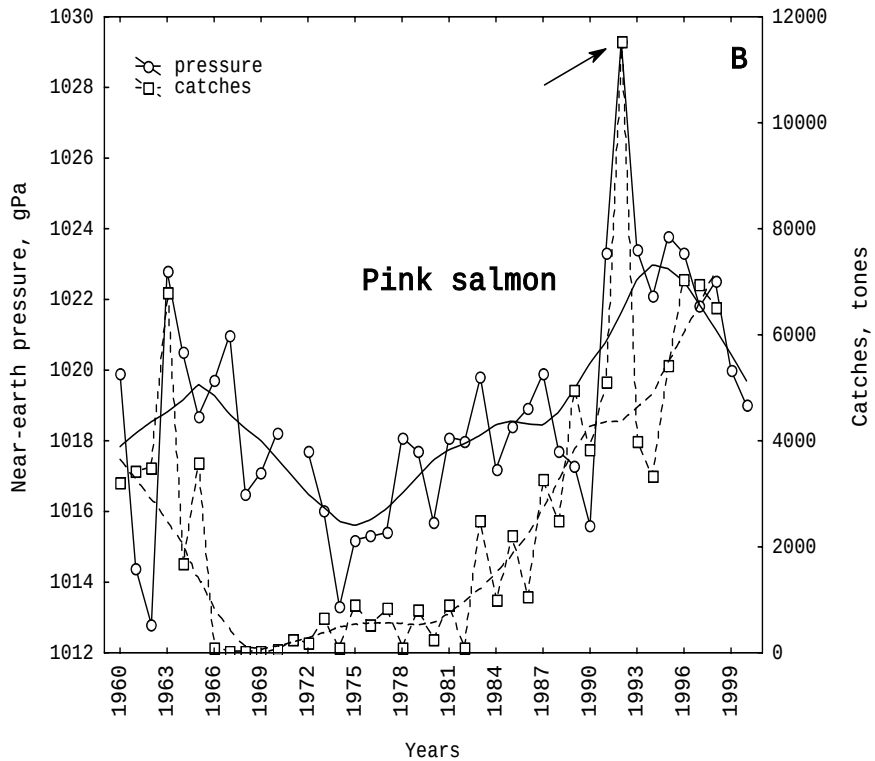
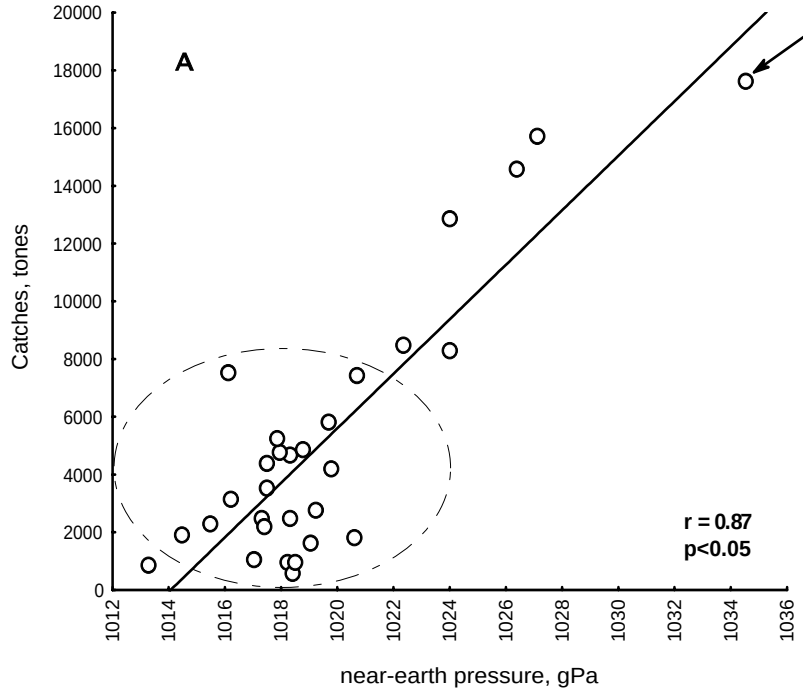
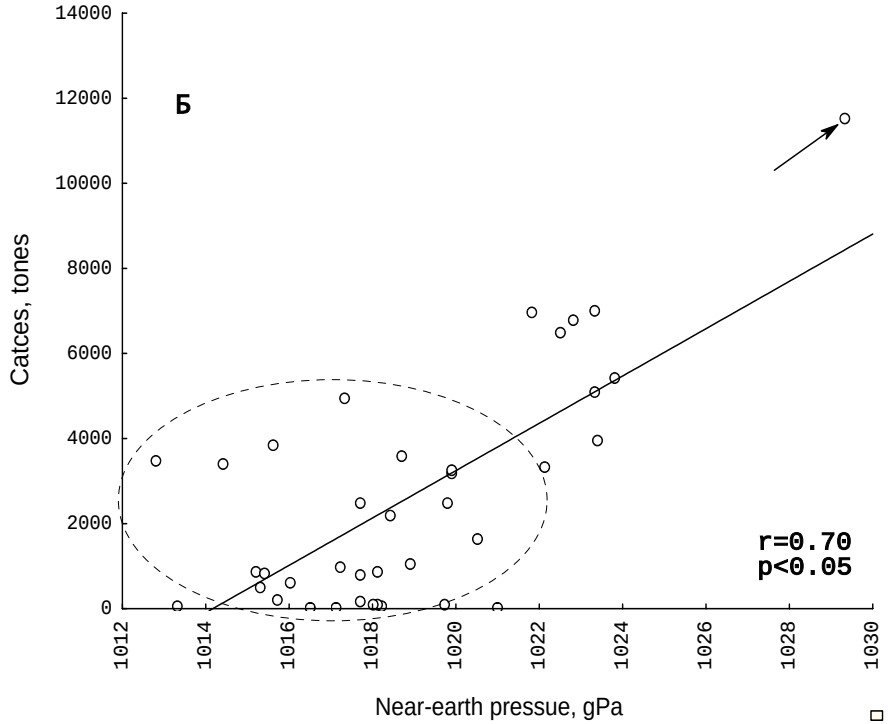


Fig. 5b. Although during the periods of stable climate such forcing is weakened to identify statistically reliable link between given phenomena is impossible applying the standard methods

A – near-earth pressure of atmosphere above the region with geographical coordinates 90^0 N, 90^0 E in January and chum salmon catches on the Okhotsk sea continental coast over three years.

B – near-earth pressure of atmosphere above the same area in January and catches of pink salmon on the Okhotsk sea continental coast over 1.5 year





Depiction of climatal forcing to the dynamics of salmon abundance all over its diversity is very complicate, complex system almost giving no way for analytical comprehension when standard methods were applied. If extreme events would be under proper consideration, such question is answered much easier. So the next model satisfactorily responds to such task:

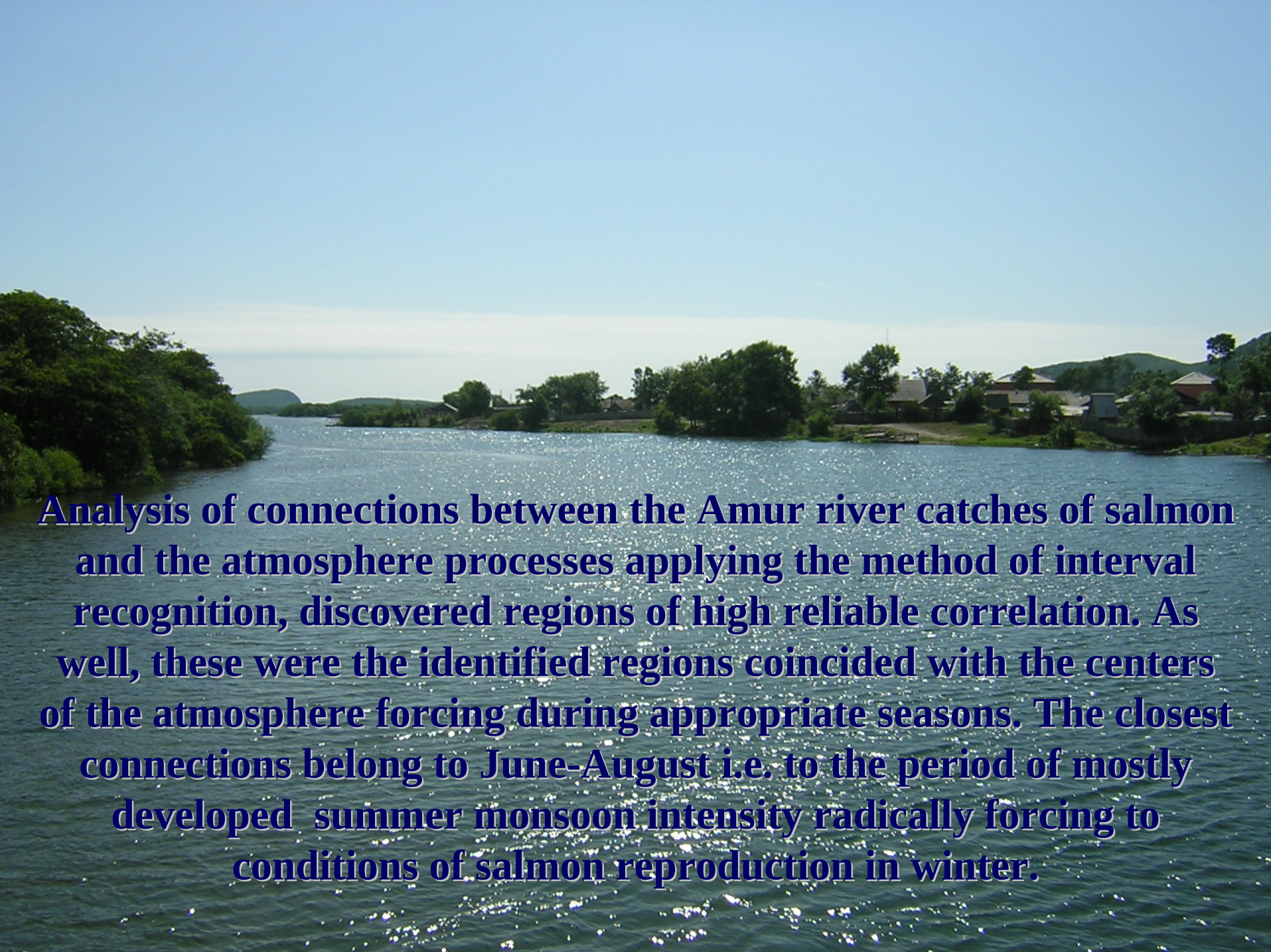
Suppose, that there are *N* objects *1…N,* characterized by main and attendant features: (*a(1,b(1)),…a(N),b(N)).* Let it be chosen some vertical level "*a*" for the main feature and all critical objects are singled out *i(1),…,i(r),* that corresponds to the next terms *a(i(1))>a,…,a(i(r))>a,r* – number of critical objects. Let sign *B=min(b(i(1)),…,b(i(r))), A=max(b(i(1)),…,b(i(r))),* then according to compound expression for any *"k", 1≤k≤r,* inequality is made up:

$$B \le b(i(k)) \le A \quad (1)$$

Let determine a number "*m*" of non-critical objects *"j"* apt to the inequality:

$$B \le b(j) \le A$$

These objects when applying of interval recognition rule (1) would be falsely related to the range of critical ones. Therefore the coefficient of interval recognition *n=r/(r+m)*, where "*r*" number of critical objects, and "*m*" number of non-critical objects, is the analog of coefficient of multiple regression.



Analysis of connections between the Amur river catches of salmon and the atmosphere processes applying the method of interval recognition, discovered regions of high reliable correlation. As well, these were the identified regions coincided with the centers of the atmosphere forcing during appropriate seasons. The closest connections belong to June-August i.e. to the period of mostly developed summer monsoon intensity radically forcing to conditions of salmon reproduction in winter.

The coefficients of interval recognition (*n*) are presented for catches of the Amur pink salmon according to data of near-earth pressure one year later.
The highest reliable coefficients of interval recognition in maximal catches during period since 1906 till 1960, were observed in may through-over regions of Pacific maximum and Asian depression but for period after 1961 they were in June and August.

№	Regions	Month	For catches >12000 tones 1906-60	For catches >3000 tones 1961-98	For catches <200 tones 1906-60	For catches <500 tones 1961-98
1	Pacific maximum (20^0 N,150-160^0 E). Asian depression (30-40^0 N, 85-115^0 E)	May	0,8	0,7	0,7	1
		June	0,67	0,78	0,58	0,86
		July	0,67	0,58	0,87	0,55
		August	0,67	0,78	0,58	0,86
2	Asian depression (30-40^0 N, 85-115^0 E)	May	0,57	0,78	0,44	0,38
		June	0,5	1	0,28	0,6
		July	0,31	0,64	0,7	0,3
		August	0,44	0,78	0,44	0,75
3	Pacific maximum (20^0 N,150-160^0 E)	May -August	0,27	0,7	0,78	1
4	Asian depression (30-40^0 N, 85-115^0 E)	May -August	1	1	1	1
5	Kuro-Shio (30-40^0 N 135-165^0 E)	May	0,8	0,47	0,58	0,6

Conclusion

- **The possible mechanism of atmosphere circulation forcing to abundance of Pacific salmon lies in the localization of large anomalies cores in baric fields above regions of reproduction. These mechanisms determine favorable or unfavorable periods for salmon reproduction.**

- **Conditions identified by the near-earth pressure and troposphere circulations of air mass in the Asian system of centers of atmosphere forcing, influenced the abundance formation of chum salmon generations in winter throughover regions of reproduction, that are located on the continental part of the North-Eastern Asia. In such regions of reproduction as Sakhalin, Kuril Islands and Eastern Kamchatka the favorable or unfavorable climatal conditions are being determined mostly by the atmosphere processes taking place above the Pacific ocean North-Western part.**

- **Climate forcing to the dynamics of abundance all over its diversity is complicated system and it is difficult for comprehension or for analytical depiction. In case of concentration upon the extreme events, the questions are replied in more simple way. Such task could get satisfactory decision in the frame of the mathematical model for image recognition.**


Thank you