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### THE INFLUENCE OF CLIMATE CHANGES ON TEMPERATURE REGIME OF AIR OF THE CASPIAN SEA IN THE AZERBAIJAN AQUATORY

In studding of hydrometeorology regimes in the central part of the Caspian Sea there was a significant contribution of authors such as R.M. Mammadov [1], E.M. Shixlinski [2], N.A. Korestelevan, B.A. Anapolskaya, B.A. Apollov, K.K. Gul, A.A. Kalinov, B.A. Buqayeva and A.A. Kerimov, S.K. Korelovich, PP.PP. Qoptereva, K.M. Sirotova, L.N. Ikonniko [3], A.A. Madatzadeh [4], A.N. Kosarev [5] and others.

Nevertheless, at the present time the complex investigation of influence of climate change on hydrometeorology condition in the Caspian Sea as the actual problem is in the attention center of the investigators.

So, since 1977 the intensive increasing of level of the Caspian Sea both on the open sea and coast zones, the influence of ocean's water on governmental and different objects or their flood and it damaged to infrastructure territories and still continues. The long-team and reliable different hydrological equipments used in achievement of oil and gas on the open sea and from the view of reducing of damage in the Caspian Sea make it necessary to stuffy the characteristic of influence of climate change on hydrometeorological condition and it at the same time it has the scientific-practical meaning.

In order to estimate the distribution of temperature regime of air in the aquatory of Caspian Sea in the background of climate change there were used the observation indicators of temperature of air of the hydrometeorological stations 1961-2008 and at the same time was analyzed the temperatures norms (1961-1990) in comparison with temperatures indicators in 1991-2008 by the World Meteorological Organization.

In Lenkaran, the temperature norm was 3.4-24.9<sup>0</sup>C, multi-annual hesitated among 12.4-15.2<sup>0</sup> but perennial temperature norm -14.1<sup>0</sup>C.

But in 1991-2008 the monthly temperature hesitated from 3.9-25.7<sup>0</sup> and multi-annual mean temperature was 14.7<sup>0</sup>. This period according to the seasons mean temperature indicators was 5.0 in the winter, in the spring 12.9, in the summer 24.6 in the autumn 16.5<sup>0</sup>C. These temperature indicators are higher on 0.4.-1.0<sup>0</sup>C than temperature norms characteristic for these territories. Such temperature growth showed itself in the annual mean temperature and it was higher the norm on 0.6<sup>0</sup>. And this is one of the facts showing the temperature growth. In the territory after 1962 the most maximum mean annual temperature 15.4<sup>0</sup>C was observed in 2007.

In the territory of Neftchala, according to the seasons, temperature norms hesitated among 3.8-26.0<sup>0</sup>C. In this time the mean annual temperatures hesitated among 13.6-16.4<sup>0</sup> and temperature norms was equal to 14.7<sup>0</sup>C.

In 1991-2008 the mean monthly temperatures hesitated in the interval of 4.1-26.6<sup>0</sup>C and mean annual temperature was 15.4<sup>0</sup>C. And this was higher the annual temperature norm on 0.7<sup>0</sup>C. The maximum annual temperature in 1998 was 16.2<sup>0</sup>C, but the minimum annual temperature in 1993 was equal to 13.4<sup>0</sup>C.

The temperature indicators for these territories in the winter were 4.9, in the spring 13.8, in the summer 25.9 and in the autumn 16.7. These temperature indicators in comparison with temperature norms of the seasons show that the temperature norm in the winter was in the limit but in other seasons there was temperature growth and this was equal to 0.3, 1.3, and 0.4<sup>0</sup>C. The temperature growth was mostly observed after 1993 and this growth showed itself in the summer and winter.

The monthly temperature norms in the territories of Baku stations hesitated among 5.0-26.3<sup>0</sup>C and annual temperature norm was equal to 14.7<sup>0</sup>C. The indicators of temperature norms on seasons in the winter was 5.4<sup>0</sup>, in the spring 12.3<sup>0</sup>, in the summer 25.0 and in the autumn 16.3<sup>0</sup>C.

The temperature norm in the autumn in comparison with spring was higher on 4<sup>0</sup>C. During these years mean annual temperatures hesitated among 13.3-16.2<sup>0</sup>C and difference of temperature was equal to 2.9<sup>0</sup>C.

The comparison of analysis of indicators in 1991-2008 shows that the mean monthly temperature indicators are closer to the norm and mean annual temperature norm was in the limit. And this shows that multi annual mean temperature is in the norm in background of climate change in the territories of Baku station.

In the territories of Pirallahi station the temperature norm of atmosphere on the months hesitated among 4.2-25.2<sup>0</sup>C and annual temperature norms were 14.2<sup>0</sup>C. The distribution of temperature norms on seasons are following: in the winter 5.2, in the spring 11.2, in the summer 23.8, in the autumn 16.5<sup>0</sup>C.

As it is seen the temperature norm in the autumn comparatively higher than in the spring and this difference is equal to 5.3<sup>0</sup>C. During these years mean annual temperatures hesitated among 13.1-15.8<sup>0</sup>C. In general, since 1995 the mean annual temperature of atmosphere in the territory of Pirallahi was higher the norm. This showed itself in the distribution of the temperature on the seasons. In 1991-2008 the distribution of temperature on the seasons was following: in the winter 6.1, in the spring 11.9, in the summer 24.8, in the autumn 17.5<sup>0</sup>C. This time the multi-annual mean temperature in the autumn was higher on 5.6<sup>0</sup>C than in the spring.

The annual temperature norm in the territory of Sumgayit was equal to 14.1<sup>0</sup>, minimum mean annual temperature 12.4<sup>0</sup> and maximum mean annual temperature 15.8<sup>0</sup>C. The temperature norms on seasons in the winter were 4.4<sup>0</sup>, in the spring 11.8<sup>0</sup>, in the summer 24.4<sup>0</sup> and in the autumn 15.9<sup>0</sup>C.

The temperature indicators in the autumn were higher on 4.1<sup>0</sup>C in comparison with spring. These years mean monthly temperature norms changed in 3.6-25.7<sup>0</sup>C diapason.

In 1991-2008 mean annual temperature indicators in comparison with annual temperature norms shows that in this time the temperature was higher the norm on 0.7<sup>0</sup>C.

In the territory of Chilov station the monthly temperature norms hesitated among 4.4-25.2°C and annual temperature norm was equal to 14.3°C.

The distribution of temperature norms were following: in the winter 5.7, in the spring 11.0, in the summer 23.7 and in the autumn 16.8°C. The temperature norm in the autumn was the temperature norm in the autumn was higher on 5.8°C than in the spring. During these years mean annual temperatures changed to 13.3-15.9°C and temperature difference was equal to 2.6°C.

In 1991-2008 in the territories of the station mean monthly temperature indicators hesitated among 5.2-26.3°C and mean annual temperature was higher the norm on 0.4°C. This the fact of temperature growth in the background of climate changes in the territory of Chilov station.

The mean monthly temperature norms of atmosphere in the stations of Neft Dashlari hesitated among 6.1-25.2°C and annual norm was equal to 14.9°C.

The temperature norms of atmosphere on the seasons are following:

in the winter 7.9, in the spring 9.7, in the summer 23.1, in the autumn 18.4°C. The temperature norm of atmosphere in the autumn was higher on 8.7°C than in the spring.

In 1991-2008 the mean monthly temperatures of atmosphere hesitated among 6.2-26.1°C and mean annual temperature was equal to 15.4°C. This time the positive trends observed in the mean monthly temperatures became the reason for growth of mean annual temperature and this was higher the temperature norm on 0.5°C.

The mean temperature of atmosphere on the seasons in the winter was 7.9 in the spring 10.4, in the summer 23.7, in the autumn 19.2°C. The temperature of atmosphere in the autumn was higher on 11.3°C in comparison with spring. During these years minimum annual temperature in 1987 was 13.8°C, but the maximum annual temperature in 2005-16.1°C. In general, since 1997 excepting from 2003, the mean annual temperature of atmosphere was always higher the norm.

The monthly temperature norms in the territory of Khachmaz hesitated among 1.6-22.7°C and annual temperature norm was equal to 12.5°C. The temperature norms indicators on the seasons are following: in the winter 2.6, in the spring 11.0, in the summer 22.8, in the autumn 13.8. This time the minimum mean annual temperature was observed 11.4°C but maximum mean annual temperature 13.7°C. Autumn in the territory of Khachmaz as in the other territories was warmer in comparison with spring.

1991-2008 plays the significant role in the studding of temperature regimes. This time the mean monthly temperature indicators of the territory hesitated among 2.5- 24.7°C and perennial temperature was equal to 12.8°C. As it is seen the temperature indicators of the territory is higher on 0.3°C than the annual temperature norm is. Such temperature growth was usually observed in the winter, spring, summer and autumn. But the temperature indicators in the autumn (11.9°C) were lowers the norm on 1.9°C. This time the minimum mean annual temperature was equal to 11.5°C (1993), maximum mean annual temperature 13.9°C (2005).

After analysis of mean annual perennial temperature indicators shows that last years in the territories there was observed the weak temperature growth of atmosphere.

There are temperature indicators of the existing hydrometeorology air observed in the each of the existing hydrometeorology stations of the Caspian Sea total need about perennial temperature regime of the aquatory carry out of the their statistical analysis in Azerbaijan aquatory generalizing these information for the expressing opinion on statistical after analyzing separately. Temperature norms have counted Azerbaijani aquatory of the Caspian Sea from this cause accept as a unique place. So, the monthly temperature norms hesitated from 4.3-25.0°C and annual temperature norm was equal to 14.2°C. The temperature norm on the seasons in the winter was 5.5, in the spring 11.3, in the summer 23.7, in the autumn 15.9°C.

In 1991-2009 in the aquatory the mean monthly temperature hesitated from 4.8-25.4°C and multi-annual mean temperature was equal to 14.7°C and it was higher the norm on 0.5°C. This time only in April and December the mean monthly temperature was lower the norm but in other months was higher.

During the distribution of temperature on seasons it is seen that only in the winter the temperature (5.5°C) was in the norm. But in other seasons, the norm was 11.5 in the spring, 24.5 in the summer, 17.2°C in the autumn and was higher the temperature norms which is characteristic for its territory. It shows that the temperature growth in the aquatory mostly observed in the spring, summer and autumn. The visual description of temperature changeability in 1991-2008 was given in the fig.1. The temperature growth of last years is shown in a clear way.

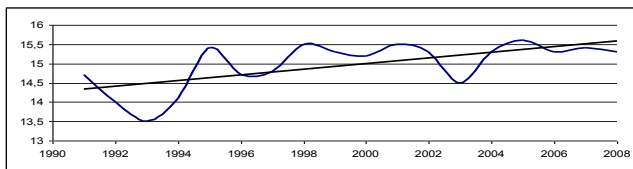


Fig.1 The process of air temperature of the Caspian Sea in the aquatory of Azerbaijan Republic.

Along with a statistical analysis there is a drawn graphic of perennial temperature in the aquatory and presented in the fig.2.

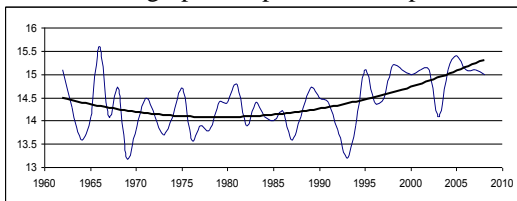


Fig.2. The process of perennial temperature of air of the Caspian Sea in the Azerbaijan aquatory.

There we can clearly see the growth of air temperature since 1995. So, there were investigated received results of observation information in the atmosphere in the hydrometeorological stations both separately and generalized form in the aquastory of the Caspian Sea:

- The multi-annual mean temperature was 14.7<sup>0</sup>C, and higher on 0.5<sup>0</sup>C of characteristic norm (14.2<sup>0</sup>C) in the Caspian Sea of the Azerbaijan aquatory during the years (1991-2008) of climate changes.
- The temperature growth in the Azerbaijan aquatory of the Caspian Sea is mostly observed in the spring, summer and autumn.

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კასპიის ზღვის აზერბაიჯანის აკვატორიაში ჰაერის ტემპერატურის რეჟიმზე კლიმატის ცვლილების გავლენა./ზ.ალაღვერდიევი/საქართველოს ტექნიკური უნივერსიტეტის ჰიდრომეტეოროლოგიის ინსტიტუტის შრომათა კრებული -2011.-ტ.117.-გვ. 33-35.- ინგლ.; რეზ. ქართ., ინგლ., რუს.

სტატიაში განხილულია კასპიის ზღვის აზერბაიჯანის აკვატორიაში ჰაერის ტემპერატურის რეჟიმზე კლიმატის ცვლილების გავლენა.

გამოკვლევების ჩასატარებლად გამოყენებული იქნა 1961-2008 წლების ჰაერის ტემპერატურაზე დაკვირვებათა მონაცემები. აღნიშნული მონაცემები განალიზებულია ტემპერატურების ნორმებთან შედარებით, რომლებიც განსაზღვრულია 1961-1990 წლებში. ამ გამოკვლევების შედეგად შეიძლება დავასკვნათ:

1. კლიმატის ცვლილების ხანგრძლივობის მანძილზე, რომელიც დაიკვირვება 1991-2008 წლებში კასპიის ზღვის აზერბაიჯანის აკვატორიაში ჰაერის მრავალწლიური საშუალო ტემპერატურა 0.5<sup>0</sup>-ით აღემატება ტერიტორიისათვის დამახასიათებელ ტემპერატურას.
2. აზერბაიჯანის აკვატორიის ჰაერის ტემპერატურის მატება ძირითადად დაიკვირვება გაზაფხულის, ზაფხულის და შემოდგომის სეზონებში.

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**THE INFLUENCE OF CLIMATE CHANGE ON THE AIR TEMPERATURE REGIME OF THE CASPIAN SEA AZERBAIJAN AQUATORY.** /Z.S. Allakhverdiyev/ Transactions of the Institute of Hydrometeorology, Georgian Technical University. -2011. - т.117. – pp. 33-35. - .; Eng .; Summ. Georg.; Eng.; Russ.

The influence of climate change on the air temperature regime of the Caspian Sea Azerbaijan aquatory has been discussed in the presented article. To conduct investigations 1961-2008 year air temperature observation data have been used. The data were analyzed in comparison with temperature norms identified in 1961-1990 years. Based on the carried investigations it may be concluded:

1. During climate change observed on 1991-2008 years the air multiyear mean temperature top the territory character temperature by 0.5<sup>0</sup> of the Caspian Sea Azerbaijan aquatory.
2. The temperature increasing of Azerbaijan aquatory has been observed mainly in spring, summer and fall seasons.

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**Влияние изменения климата на температурный режим воздуха на Азербайджанской акватории Каспийского моря.** / З.С. Аллаhverдиев/Сб. Трудов Института Гидрометеорологии Грузинского Технического Университета Грузии. – 2011 –т.117–с.33-35. –Анг.;Рез.Груз., Анг.,Рус

Статья посвящается исследованию влияния изменения климата на температурный режим воздуха на Азербайджанской акватории Каспийского моря.

Для проведения исследований были использованы данные наблюдения по температуре воздуха за 1961-2008 годы. Эти данные проанализированы со сравнением с температурными нормами, определенные 1961-1990 годах. В результате этих исследований можно сделать следующие выводы:

1. За время наблюдений за изменением климата в 1991—2008 годах, многолетняя средняя температура воздуха Азербайджанской акватории Каспийского моря превышает температуру, характерную для территории, на 0,5<sup>0</sup>C.
2. Повышение температуры воздуха над Азербайджанской акваторией наблюдается в основном в весеннем, летнем и осеннем сезонах.

