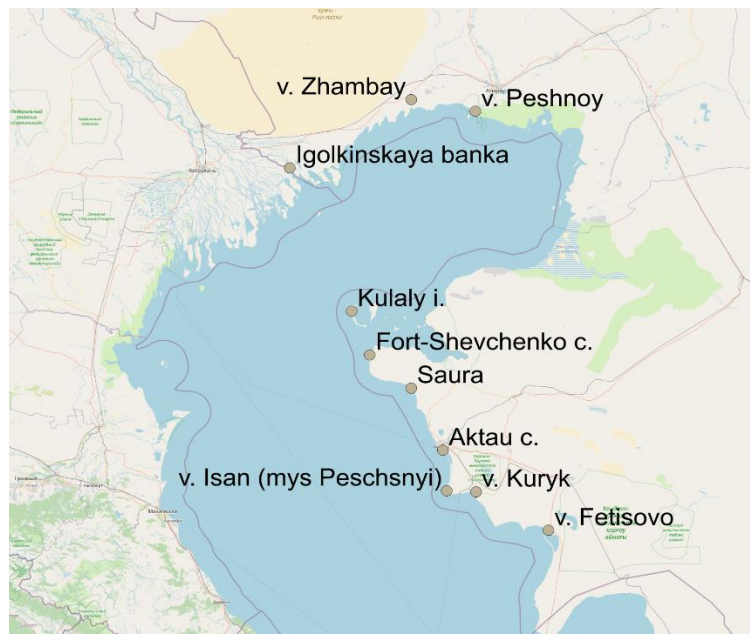


## REVIEW OF THE HYDROMETEOROLOGICAL STATUS OF THE CASPIAN SEA FOR 2023

The state observation network of marine hydrometeorological observations consists of 10 marine stations and posts (*Figure 1*).



*Figure 1. Location of marine observation stations*

The list of marine hydrometeorological stations and posts of the Kazakhstan coast of the Caspian Sea, the information on which is placed in this review, is given in *Table 1*.

*Table 1 - List of marine hydrometeorological stations and posts*

Station code	Name	Year of opening	Coordinates	
			latitude	longitude
97046	MHP-II Igolkinskaya banka	2008	46° 22'	49° 11'
97047	MHP-II Zhanbay	2003	46° 45'	50°47'
97048	M-II Peshnoy	1944-53, 1969	46°55'	51°41'
97059	MH -III Kulaly Island	1957	45° 01'	50° 02'
97060	MH -I Fort Shevchenko	1921	44° 33'	50° 15'
97061	MH -II Aktau	1964	43° 40'	51° 10'
97062	MHP -II Peschanyi	2008	43° 11'	51° 16'
97063	MHP -II Fetisovo	2003	42° 49'	52° 35'
97064	MHP -II r/c Saura	2008	44° 19'	50° 48'
97065	MHP -II Kuryk	2008	43° 56'	50° 59'

## *Air temperature*

In 2023, the average annual air temperature in the Kazakhstan part of the Caspian Sea will be 13.5°C, according to data from monitoring stations.

Average monthly air temperatures are shown in Figure 2. The minimum temperatures are observed in the cold period of the year (January) with a gradual increase towards the summer period. The maximum values of the average monthly air temperature were observed in July-August with fluctuations from 25.4°C (Peschanyi) to 28.7°C (Saura).

	Igolinskaya banka	Zhanbay	Peshnoy	Kulaly	Fort-Shevchenko	Saura	Aktau	Peschanyi	Kuryk	Fetisovo
January	-6.6	-6	-7.1	-4.2	-0.6	-3.8	-1.9	-0.8	-2.1	-2.1
February	-4.1	-4.7	-4.7	-1.6	0.7	-3.4	1.8	2.6	2.5	2.6
March	6.8	7.1	7	7.8	9.3	7.8	10	9.5	10.4	11.1
April	12.9	14.9	13.8	13.5	13.5	13.6	14	13.6	15.1	15.3
May	18	22.6	20.4	19.3	19.1	19.1	17.9	17.9	18.9	20.6
June	24	26.4	24.1	24.3	24.4	25.7	23.5	23.3	25.2	25.8
July	26.3	27.4	26.5	26.7	27.3	27.3	26.4	25.4	28.1	28.3
August	26.7	26.4	25.9	27.1	27.6	28.7	27.2	26.5	27.9	27.7
September	19	18.7	17.8	19.9	21.1	20.6	20.2	19.5	19.7	21
October	12.5	12	10.4	13.4	14.6	14	14.5	14.1	14.4	15.2
November	8	6.9	6.7	9.4	11.4	9.9	11.5	11.4	11.6	12.4
December	0.02	-1.1	-1.7	0.5	2.8	0.9	3.1	3.3	3.4	3.4

*Figure 2. Average monthly air temperature values*

Maximum annual air temperatures ranged from 4.2 °C (February, Zhanbay) to 41.4 °C (July, Saura). The highest air temperatures during the year were also observed in July-August at all the stations considered. By season, the maximum air temperature was 17.2°C in winter, 36.5°C in spring, 41.4°C in summer and 37.2°C in autumn.

The recorded minimum air temperatures ranged from -25.9°C (January, Peshnoy) to 19.5°C (July, Fort-Shevchenko). The lowest values were observed in January (from -25.9°C in Peshnoy to -14.6°C in Fort-Shevchenko). The minimum air temperature was approximately -25.9°C in winter, -7.6°C in spring, 8.1°C in summer, and -6.3°C in autumn.

Figure 3 presents the specific values of air temperature observed at different stations.

## *Wind speed and direction*

Wind observations in the Kazakhstan part of the Caspian Sea were carried out at Peshnoy Kulaly Island, Fort-Shevchenko, Aktau, Peschanyi, Kuryk and Fetisovo stations at 00, 06, 12, 18 UTC.

The nature of winds over the Caspian Sea is determined by both the large-scale influence of atmospheric circulation and local baric-circulatory and thermal conditions.

The mean monthly wind speeds at the sea stations and posts in 2023 ranged from 2 m/s (September, Peshnoy) to 8 m/s (December, Kulaly Island, Fetisovo) (Fig. 4).

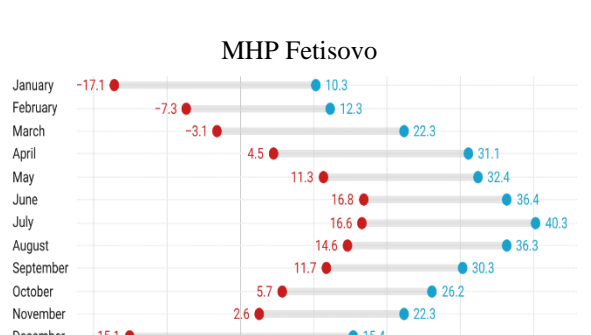
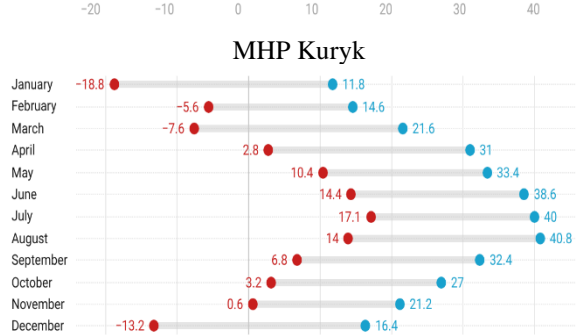
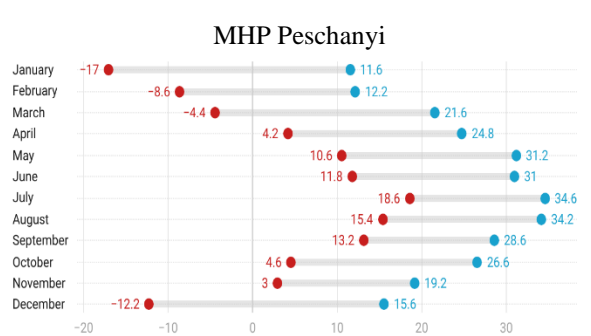
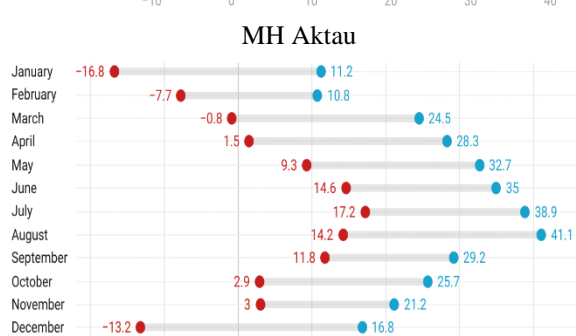
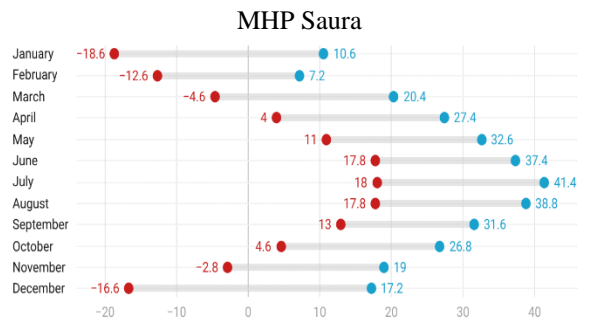
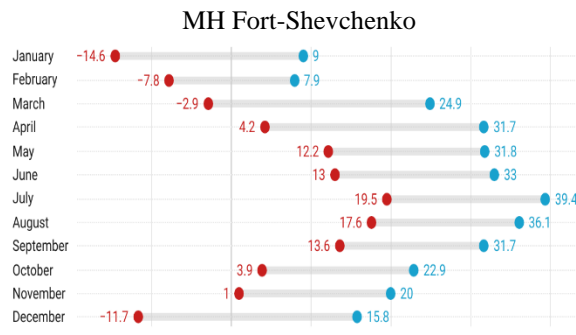
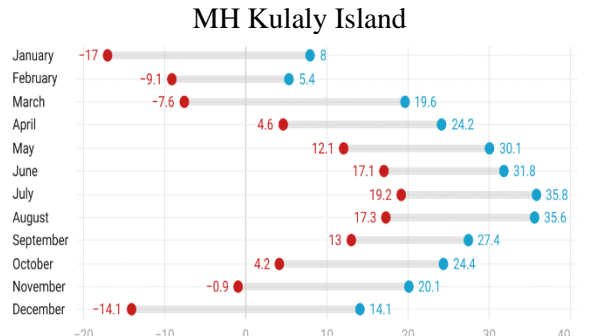
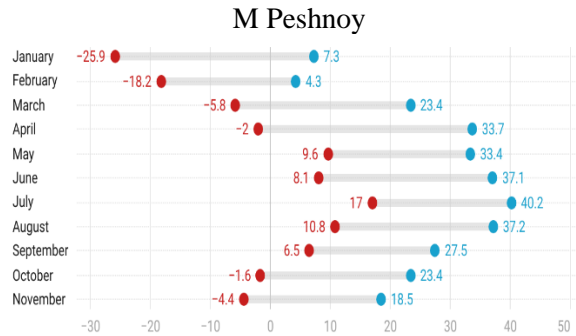
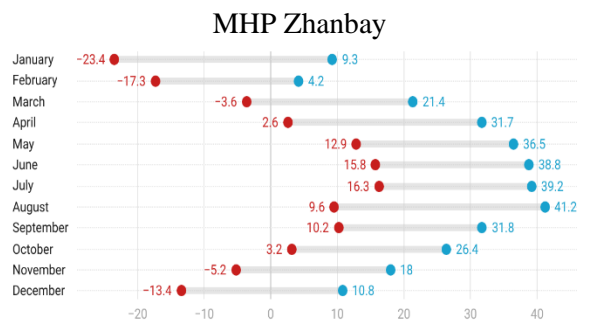
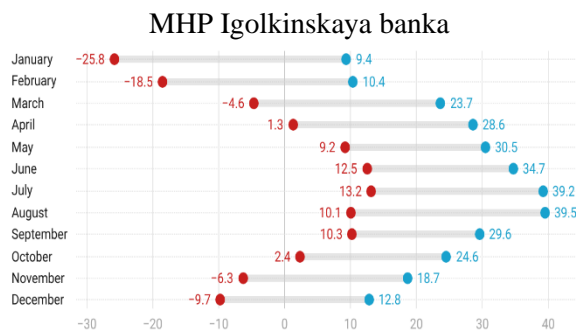


Figure 3. Specific air temperature values

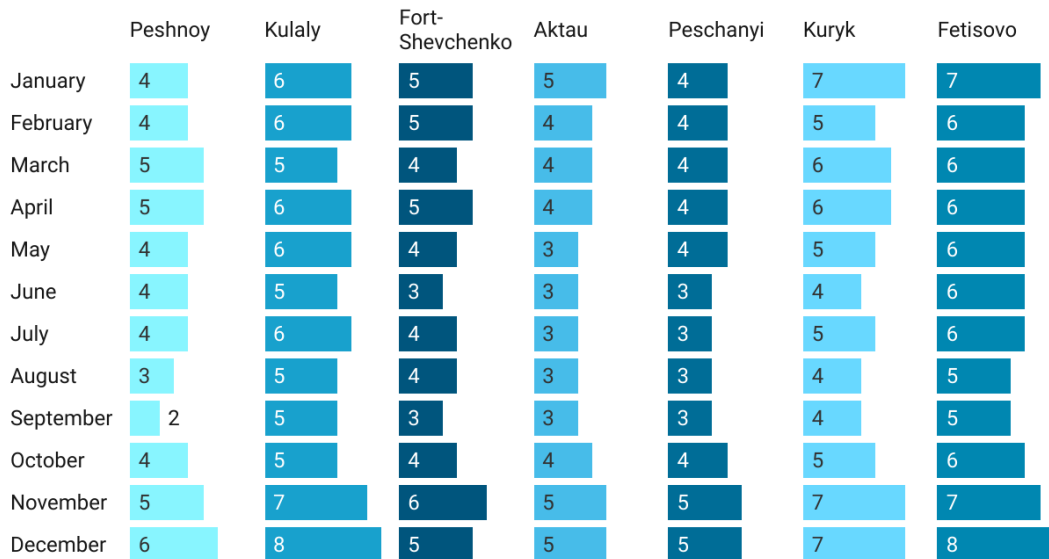


Figure 4. Monthly average wind speeds

Figure 5 shows that in 2023, the winds with the highest recurrence were those from the east, southeast, west, and northwest directions.

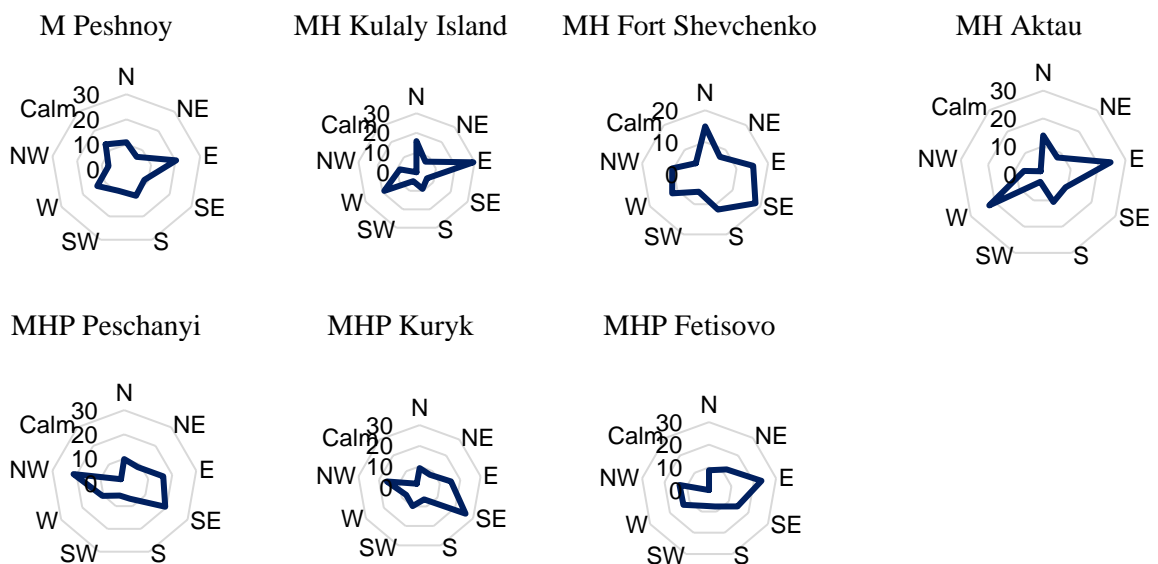


Figure 5. The frequency of annual wind patterns and periods of calm (%)

During summer and autumn, prevailing wind directions at the sea stations of Peshnoy, Aktau, and Fetisovo were from the west and northwest.

At Kulaly Island and Fort-Shevchenko stations, the prevailing wind direction was northerly, while at Peschanyi and Kuryk stations, it was north-westerly. During winter, the wind direction was predominantly from the east and southeast at all stations (see Fig. 6).

Table 2 shows that the maximum wind speeds ranged from 7 m/s to 21 m/s. Gusts of up to 27 m/s were also recorded. The prevailing wind directions were from the southeast and northwest.

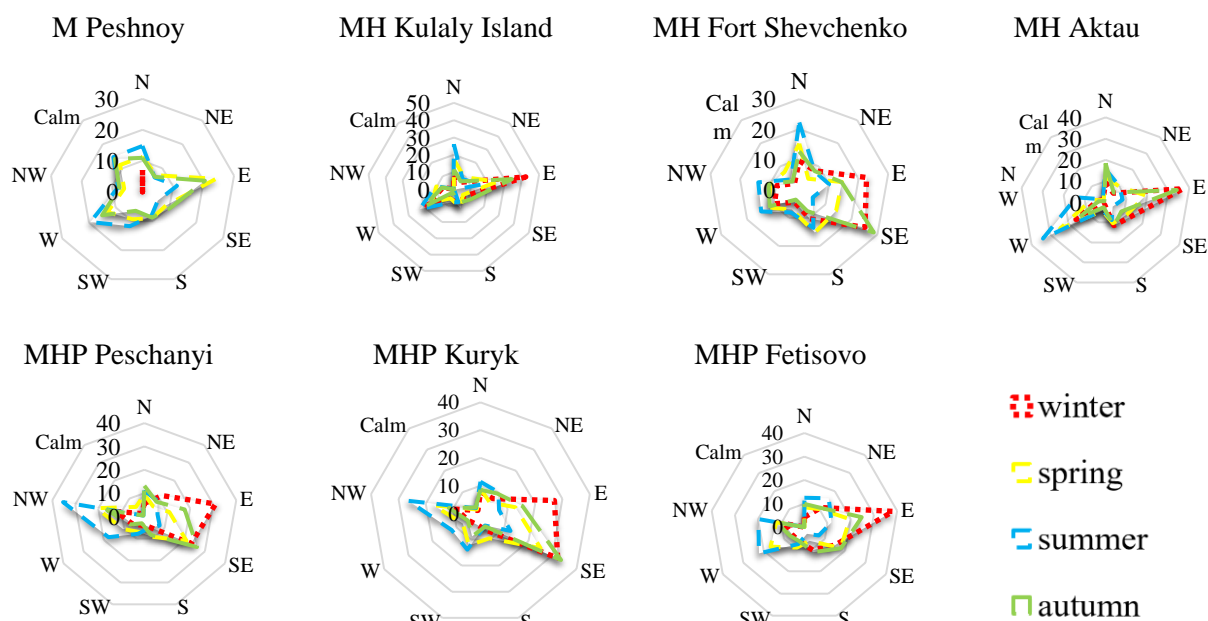


Figure 6. Repeatability of wind direction by season for 2023 (%)

At maximum wind speeds, the prevailing directions during winter were southeastern, eastern, and northeastern; during spring they were northwestern, southeastern, and eastern southeastern; and during summer and fall they were northwestern and southeastern.

Table 2 - Values of maximum wind speeds, m/s

Month	Peshnoy	Kulaly Island	Fort Shevchenko	Aktau	Peschanyi	Kuryk	Fetisovo
january	16	12	15	15	12	16	15
february	16	12	15	11	13	16	12
march	16	12	16	15	12	18	14
april	16	16	15	15	10	15	16
may	12	15	15	7	8	12	14
june	16	11	9	8	8	10	12
july	16	11	10	8	8	13	12
august	10	16	15	15	8	10	12
september	8	12	15	15	10	11	16
october	16	12	10	12	10	18	14
november	18	21	15	14	11	15	15
december	16	20	17	16	13	16	19

### Sea level

Based on data collected from coastal and island marine stations and posts in 2023, the water level of the Caspian Sea in its northeastern shallow area fluctuated between minus 27.67 m and minus 29.59 m, with an average of minus 28.73 m (see Figure 7).

In the deep-water region of Kazakhstan in the Caspian Sea, the average sea level was found to be -29.00 m based on data from Fort-Shevchenko, Aktau, and Fetisovo. The highest recorded level was -28.45 m and the lowest was -29.74 m during the fall (see Figure 7).



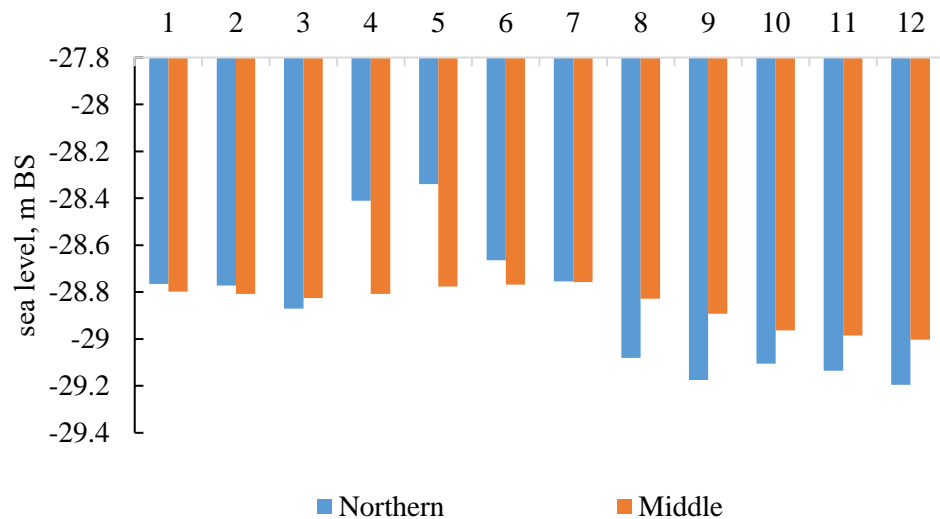


Figure 7. Intra-annual variation of mean monthly sea level

In 2023, RSE Kazhydromet's marine stations and posts off the north-eastern coast of the Caspian Sea recorded 43 up surge and 57 down surge events.

The most significant up surge and down surge events:

- A critical upsurge of 54 cm was observed near the Peshnoy station on 13-17 March, caused by a sustained east-southeasterly wind of up to 16 m/s (Figure 8).

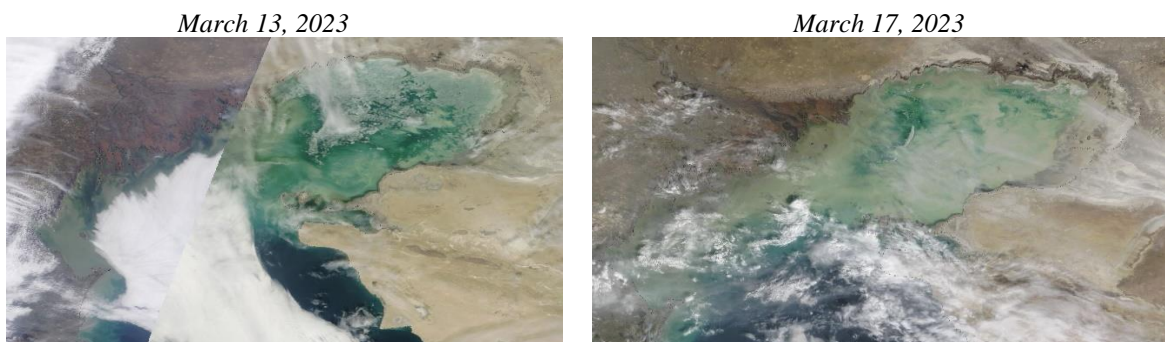


Figure 8. Terra/MODIS space images (NASA data)

- On June 2-14, the water level near the Peshnoy sea station dropped by 68 cm due to sustained southeast winds with speeds of up to 10 m/s (Figure 9).



Figure 9. Terra/MODIS space images (NASA data)

- A water level rise of 73 cm was observed at Peshnoy from October 5-9 due to sustained south-southwest winds of up to 16 m/s.
- On October 8-9, the Fort Shevchenko recorded a critical water level drop of 56 cm caused by a south-southeast wind direction with maximum wind speeds up to 10 m/s.

## Wave

The highest wave heights were observed in the Middle Caspian at Saura and Peschanyi (Table 3). Strong waves of 2 m and more were observed at Peschanyi from January to April and in November-December.

Table 3 - Wave Characterization in the Caspian Sea

Observation station	Average wave height, m	Maximum wave height, m	Prevailing wave direction, rhumb
Kulaly	0,5	1,5	E
Fort-Shevchenko	0,4	1,8	SE
Saura	0,4	2,0	SE
Aktau	0,4	1,5	SE
Sandy	0,6	2,5	NW
Kuryk	0,4	1,5	SE
Fetisovo	0,3	1,3	E

The majority of wave events occurred when wave heights were less than 0.5 m (8-12%, depending on the observation site). The highest number of observed waves was recorded in July. The predominant wave directions are east, southeast, and northwest.

## Ice phenomena

On November 28, 2023, the Peshnoy sea station reported the first observed ice phenomena near the northern coast of the Caspian Sea. On December 5, primary ice types appeared (Figure 10).

December 1, 2023



December 4, 2023

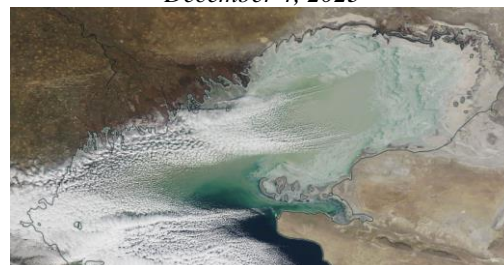
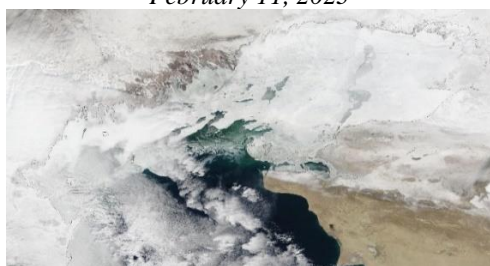


Figure 10. First ice phenomena off the northern coast of the Caspian Sea. (NASA EOSDIS Worldview project image)

The maximum ice thickness was recorded in the area of the marine hydrometeorological station Peshnoy - 42 cm from February 7 to 19, in the area of Zhanbay - 38 cm from January 30 to February 19 (Figure 11).

February 11, 2023



February 18, 2023



Figure 11. Formation of stable ice cover (NASA EOSDIS Worldview image)

The spring ice breakup began on February 3, 2023. By March 13, 2023, the landfast ice in the area of Zhanbay station had been completely destroyed. Six days later, on March 19, 2023, the entire northern coast of the Caspian Sea was ice-free (see Figure 12).

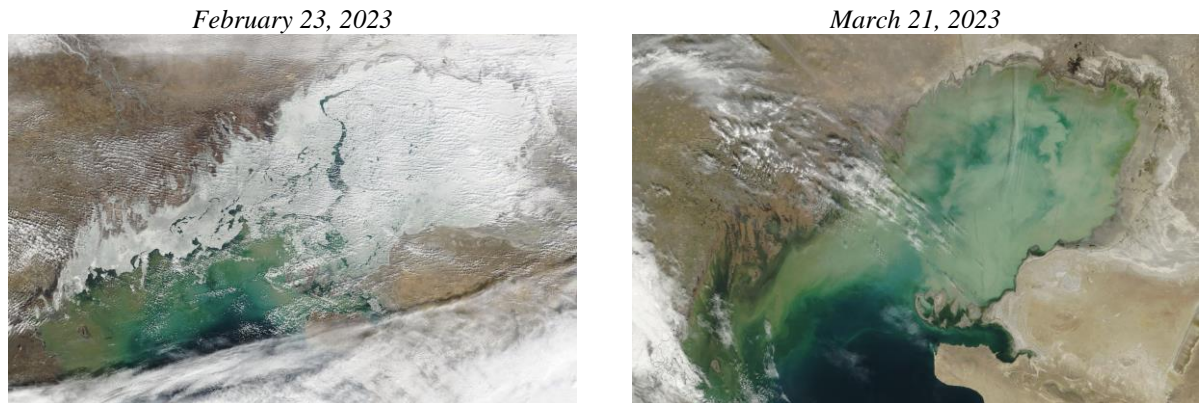


Figure 12. Beginning of spring breakup of the ice cover and complete ice clearance of the North Caspian Sea.  
(NASA EOSDIS Worldview image)

### Water temperature

Based on coastal observations, the water temperatures ranged from 10.4-15.6°C on average, with maximum values reaching 22.3-32.5°C and minimum values dropping to minus 2.3-1.8°C.

The minimum annual temperature occurs in January-February (as shown in Figure 13), while the maximum temperature occurs in July-August.

The maximum water temperature values varied between 2.3 °C (Kulaly, February) and 36.4 °C (Kuryk, July). In detail, the maximum water temperature reached 13.1 °C in winter, 28.5 °C in spring, 36.4 °C in summer, and 28.6 °C in fall.

The minimum water temperature ranged from -3.4°C (January, Fetisovo) to 26.1°C (July, Kulaly). The minimum water temperature was approximately -3.4°C in winter, -1.1°C in spring, 6.9°C in summer, and 1.7°C in fall.

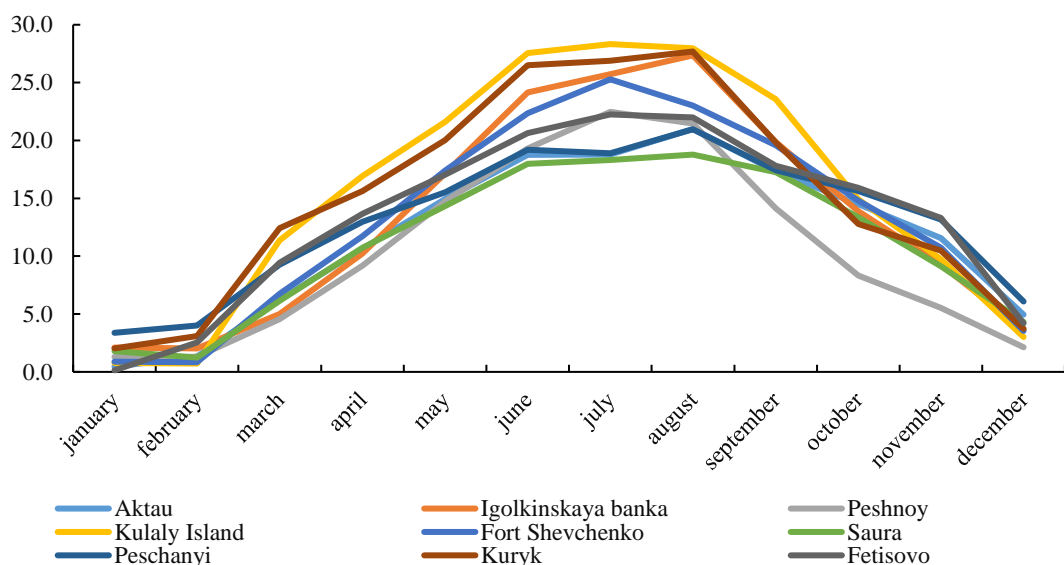


Figure 13. Graph of intra-annual variations of water temperature

Table 4 shows the highest and lowest surface water temperatures recorded in 2023.



*Table 4 - Characterization of annual water temperature variations*

<b>Station</b>	<b>Average annual</b>	<b>Maximum</b>	<b>Minimum</b>	<b>Annual variations</b>
Igolkinskaya banka	13,4	28,4	1,6	26,8
Peshnoy	10,4	26,3	0,4	25,9
Kulaly Island	15,6	29,5	-1,1	30,6
Fort Shevchenko	13,1	27,5	-1,9	29,4
Aktau	11,8	26,2	-2,1	28,3
Saura	11,2	22,3	0,3	22
Peschanyi	13,1	23,6	1,8	21,8
Kuryk	15,2	32,5	-0,6	33,1
Fetisovo	13,3	26,2	-2,3	28,5

*The review was compiled by the Unit of Hydrometeorological Research of the Caspian Sea  
Research Center of RSE " Kazhydromet"*

*e-mail: [ugmikm@meteo.kz](mailto:ugmikm@meteo.kz)*

*Executors: Yeltay A., Bazarbay L., Nurysh A.*

When using information, it is obligatory to reference RSE Kazhydromet.