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METEOROLOGICAL EXTREMUMS OF SIBERIA IN 2019 AND THEIR CORRELATION TO ATMOSPHERIC CIRCULATION

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According to the Weather News website, extreme events in the Asian territory of Russia for 2019 and related dangerous natural processes are considered by circulation seasons [Dzerdzeevskiy et al., 1946].

Their relationship with the circulation of the atmosphere of the Northern Hemisphere is shown [site Atmospheric circulation Fluctuations...1899–2018].

Key words: circulation seasons, meteorological extremes, dangerous natural processes, atmospheric circulation.

По циркуляционным сезонам [Дзердзеевский с соавт., 1946] по данным сайта Новости погоды рассмотрены экстремальные события на Азиатской территории России за 2019 г. и связанные с ними опасные природные процессы. Показана их связь с циркуляцией атмосферы Северного полушария [сайт Колебания циркуляции атмосферы...1899–2018].

Ключевые слова: циркуляционные сезоны, метеорологические экстремумы, опасные природные процессы, циркуляция атмосферы

INTRODUCTION

In recent years extreme situations are becoming more and more frequent in the Asian part of Russia.

This fact attracts close attention of researchers [Latysheva et al., 2010; Zolina, Bulygina, 2016]. They try to find out causes of such phenomenon [Vasiliev et al., 2018; Kononova, 2018; Kochugova, 2018; Tarabukina et al., 2018] and predict future patterns of extremes [Shkolnik et al., 2012]. It was interesting to analyze extremes of the current year in order to show the real situation for today.

STATEMENT OF PROBLEM

The objective is to identify weather extremes for 2019 and show their correlation with atmospheric circulation of the Northern hemisphere in typification by Dzerdzeevskiy B.L. et al. It is also necessary to show that a large number of extremes is quite consistent with the growth of inter-latitude exchange of air masses, frequent changeover of southern cyclones outs by blocking processes. Since more and more regions of Russia suffer from weather extremes and recently, due to the change in the nature of atmospheric circulation described in this paper, the same extremes occur simultaneously in different regions, so formulation of this task is relevant.

INFORMATION SOURCES AND METHODS

The main database source for daily meteorological extremes was Weather News website [Meteonovosti.ru], because daily data appear late on other sites.

We have considered only those extremes for which the dates of previous extremums, surpassed in 2019 and selected from the entire series of observations at a particular station, were specified. Totally 542 weather extremes have been analyzed. The same site has also provided brief information about fires and floods. More detailed information was taken from local sites [amur.info, taiga.info, ulpressa.ru, Social medianews]. The nature of atmospheric circulation for 1899–2018 was analyzed by typification [Dzerdzeevsky et al., 1946] using data from the site atmospheric-circulation.ru. This site was created by the author of the article. It hosts daily data of elementary circulation mechanisms (ECM) sequential change, circulation seasons annual start dates and length and calculations of varying types and groups of types for the whole series of observations and circulation periods. All investigation, as well as analysis of the relationship of extremes with the nature of atmospheric circulation are made by the author of this article.

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RESULTS AND DISCUSSION

Weather extremes are considered for circulation seasons. The most important ones are selected for discussion.

Wildfires

Wildfires represent a terrible disaster of Siberian and Far Eastern taiga [Tarabukina et al., 2018, 2018a]. Information about growing fire danger in South Siberia and Far East began to arrive in the second half of April. The reason of this phenomenon was the lack of precipitation and strong winds. By June 1, in the North of the Irkutsk region, in Buryatia, in the Transbaikal territory and in the West of the Kamchatka territory, the fire danger was already high, in some places extreme. According to socialmedia, in two districts of the Irkutsk region, Ust-Ilimsky and Zhigalovsky, on July 3, an emergency mode was introduced in connection with forest fires.

In June and July, wildfires broke out in the center of the Krasnoyarsk territory. By July 24, the area of forest fires in Siberia was 1.3 million hectares, among which the Krasnoyarsk territory accounted 850 thousand hectares.

According to Taiga.info, to July 26, the area of forest fires in the Krasnoyarsk territory, Irkutsk region, Buryatia, Transbaikalia and Yakutia exceeded 3.5 million hectares. According to Ulpress, smoke from forest fires in Siberia reached the Ulyanovsk region.

Floods

In the last decade of May, the Novosibirsk region and Far East were covered by freshets and floods, but the most catastrophic flood broke out in summer in the Irkutsk region.

Flooding in the Irkutsk region

On June 16, heavy rains fell in the north and west of the Irkutsk Region, and up to 43 mm of rain fell. On July 18, another 39 mm fell. Soil moisture was greatly increased. Heavy and very heavy rains did not stop in the following days.

The first signs of flooding, rising water levels and flooding in the lowlands, were noted in the morning of June 24 by the Ministry of Emergency Situations in the Irkutsk region.

On the night of June 25–26 in the Nizhneudinsky district a rapid rise in the rivers'water level began. Behind UDA and Angara the rivers Bolshaya Belaya, Oia, Oka, Biryusa, and Irkut rose. During the night the area of flooding increased by hundreds of kilometers, and in some places the rivers rose three meters above the critical mark. The emergency mode was firstly introduced in the Taishet district, and then expanded to the entire territory of the Irkutsk region.

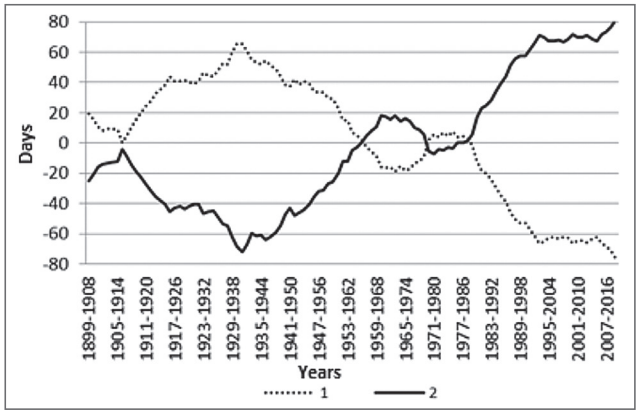

Fig. 1. Changes in duration of generalized zonal (zonal + disturbance of zoning) and meridional (north + south) circulation groups for 1899–2018. (10-year moving averages, www.atmospheric-circulation.ru)

Рис. 1. Изменения продолжительности обобщенных зональной (зональная + нарушение зональности) и меридиональной (северная + южная) групп циркуляции за 1899–2018 гг. (10-летние скользящие средние, www.atmospheric-circulation.ru)

The main cause of flooding was extreme precipitation, which for the period of June 25–29 amounted to more than 3.7 monthly norms. The situation was aggravated by the fact that the rains coincided with the belated snowmelt in the Eastern Sayans.

I.V. Latysheva, PhD of geographical Sciences, ISU's geographical faculty's associate professor of the Department of meteorology and near-earth space physics, noted that during the flood, the territory of the Irkutsk region at the same time was influenced by North-Western flows, Arctic air masses and hot subtropical air. Causes of flooding were closely consistent with observed variations in climate and atmospheric circulation.

One more important reason of floods is deforestation. The presence of forest in the upper reaches creates a drainage cushion that delays precipitation. Due to decades of deforestation or forest fires in flood-affected areas and the lack of reforestation, vast areas are being emptied and forests no longer perform a water-resistant function.

Another cause of the flooding in Tulun was named by the mayor of this city. It is an insufficient height of the dam on the Oia river. Built in 2008, it is only 10 m high, although the flood of 1984 was 11 m 33 cm high, and this year the level of the Oia river rose to 13 m 89 cm. As a result of the flooding 98 localities in the Nizhneudinsky, Taishetsky, Tulunsky, Chunsky, Ziminsky and Kuitunsky districts of the Irkutsk region more than 10,000 houses were destroyed. There were 43 socially

significant objects in the flood zone: midwifery centers, schools and kindergartens. According to July 11, 2019 25 people died [taiga.info].

Flooding in the Amur region

Cyclone that came to the Amur region from China, caused heavy rains and thunderstorms. 21 and on the night of July 22 the amount of precipitation reached 86 mm. On July 23, in the North of the Amur region, in the Selemdzhinsky district, due to rivers that overflowed after rains, the Norsky reserve was under water.

DISCUSSION

Causes of extreme events

The main cause of weather extremes is the extreme nature of atmospheric circulation. The daily maximums of air temperature are formed during long-term stationing of the anticyclone over the continent in the warm season, in the cold half-year — when the southern cyclone exits. Daily minima are formed due to Arctic air's penetrating into the territory, the formation of a stationary anticyclone and air's cooling over the cold earth's surface at night. Heavy rainfall are formed on the cold fronts of cyclones due to large contrasts in the temperature of the air masses separated by the front. Especially heavy rains occur when anticyclone is in the path of cyclone.

Natural fires occur in long-term stationary anticyclones, in dry air mass, as a rule, from lightning during dry thunderstorms [Tarabukina et al., 2018]. Floods are preceded by prolonged rainfall that moistened the soil well, and extreme rainfall.

Atmospheric circulation analysis

The analysis of atmospheric circulation was carried out using typification by B.L. Dzerdzeevskiy, V.M. Kurganskaya and Z.M. Vitvitskaya [Dzerdzeevskiy et al., 1946]. In this typification the whole variety of atmospheric processes in the Northern Hemisphere is divided into 4 groups, 13 types, 41 subtypes that is elementary circulation mechanism, in short, ECM.

If we combine the first two groups into a generalized zonal group, and the other groups into a generalized meridional group, we get a graph of changes in inter-latitudinal exchange for the entire period from 1899 (Fig. 1)..

As we can see, over the past 40 years duration of groups with two to four blocking processes and two to four southern cyclones outs and duration of groups without blocking processes with three to four southern cyclones outs has increased by 80 days due to the same reduction in the groups of zonal processes.

This fact means that the inter-latitudinal exchange of air masses has grown by the same amount, and the air intake from the south in cyclonic series is almost twice as much as from the north with Arctic invasions. This also explains an increase in average annual air temperature and more frequent occurrence of extreme amounts of precipitation, often simultaneously in regions that are far from each other, as shown by the example of summer extremes of precipitation.

CONCLUSION

The research allows us to draw the following conclusions. In the 21st century the number of extremes of both air temperature and precipitation continues to grow. For example, according to VNIIGMI-WDC, there were 14 rainfalls in 1990, 35 in 2000 and 57 in 2010. Negative precipitation extremes combined with positive air temperature extremes lead to natural fires, and positive precipitation extremes lead to catastrophic floods, intensification of landslides and mudflows. The increasing repeatability of both those and others is facilitated by the changing nature of atmospheric circulation: an increase in the repeatability of blocking processes (arctic penetrations that lead to formation of an extensive stationary anticyclone) and southern cyclones outs.

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