

# Variability of characteristics and conditions leading to the formation of extreme precipitation events in the south of Western Siberia

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Against the background of the socio-technical development of territories there is a growth of the damages in economic and social spheres caused by increasing frequency of hazardous events' occurrence. Global warming is happening now, and the changes in the statistics of extreme events are diagnosed in various regions of the Earth. Humidification conditions relate to the most essential indicator of both global and regional climate. Indicators of humidification regime variability, which also includes hazardous events in the precipitation regime, vary significantly in different regions. In this context, taking into consideration ongoing climate changes, it is relevant to elaborate on a regional approach to assessing the availability of moisture resources and possible risks in connection with extreme events in the rainfall regime.

## DATA:

Territory: Tomsk, Kemerovo, Novosibirsk regions and Altai territory

Warm period (April-October)

Precipitation (days with precipitation/no),  
The amount of rainfall in 12 hours

68 meteorological stations  
1966-2018

WAREP (warning reports)

cases with the hazardous event :

- "heavy rain" which defined as rainfall greater than 35 mm in 12 hours

- "severe rain" - significant liquid or mixed precipitation, namely rain, rain shower, sleet, wet snow greater than 50 mm in 12 hours

Satellite remote sensing data

127 meteorological stations  
2015-2018

MOD(MYD)21KM, ATML2

<https://modis-atmos.gsfc.nasa.gov/>

30 cases were considered  
(15 – heavy rain and 15 – severe rain)

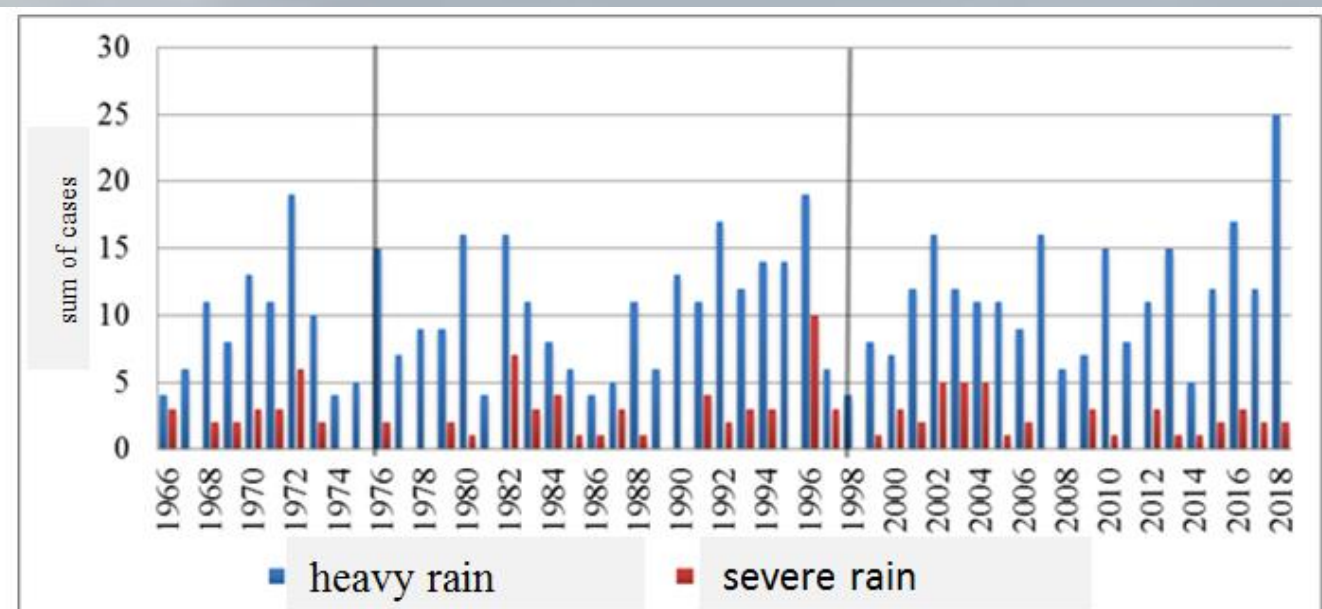


Fig.1 Dynamics of cases with the hazardous event on average for the south-east of Western Siberia

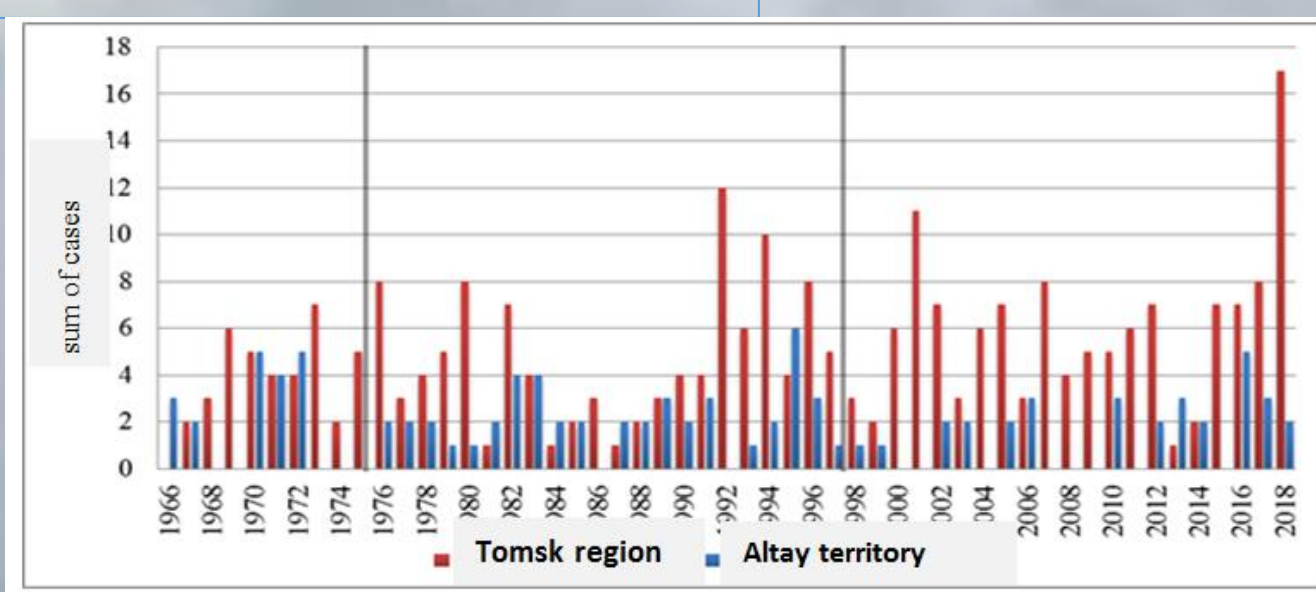


Fig.2 Dynamics of cases "Heavy rain" in the Tomsk region and Altai Territory

Table 1 - Average number of cases and repeatability of days (%) with "Heavy rain" and "Severe rain" in the south-east of Western Siberia for 1966-2018.

Region	Heavy rain		Severe rain	
	Number of cases	Repeatability for May-August %	Number of cases	Repeatability for May-August %
Tomsk region	11	0,1	2	0,03
Kemerovo region	11	0,1	2	0,03
Novosibirsk region	9	0,1	2	0,02
Altai Krai	9	0,1	2	0,02

Table 2 - Average repeatability (%) of the "Heavy rain" in the south-east of Western Siberia at different time intervals

Time intervals	1976-1997	1997-2018	1966-2018
Tomsk region	0,2	0,2	0,1
Kemerovo region	0,1	0,2	0,1
Novosibirsk region	0,1	0,1	0,1
Altai Krai	0,1	0,1	0,1

In general, for the 1966-2018, periods without precipitation are twice exceeded the number of periods with precipitation and predominately more extended.

The maximum duration of dry periods is generally higher than the duration of wet periods.

For the period under consideration, the number of periods without precipitation lasting 6-10 days is much less than the number of long periods with precipitation.

There is a decrease in short-term periods (1-5 days in duration) and an increase in longer ones (6-10 days), both for cases with/without precipitation. Trends range from 0.1 to 0.6 periods / 10 years, and in most cases are not statistically significant.

Table 3 - Satellite-based sensing data for cases "Severe rain"

Station	Date	Time of a extreme precipitation events	Time of the satellite pass	Amount of precipitation, mm	Cloud type	Optical Thickness	Top height, m	Water Patch, g/m <sup>2</sup>
Kupino	07.06.2015	8:11	8:35	63	MCSs	150	16450	2856
Molchanovo	02.08.2015	12:00	7:45	69	cyclonic cloud system with a trail	150	12800	3793
Turochak	19.07.2016	8:55	7:45	53	MCSs	150	12100	4058
Shipunovo	19.07.2016	8:38	7:45	59	MCSs	150	12100	4058
Krasnoshchekovo	22.07.2016	12:07	8:15	57	MCSs	150	12200	4580
Soloneshnoe	22.07.2016	12:27	8:15	59	MCSs	150	12200	4580
Pudino	25.07.2016	11:57	7:10	50	cold front	150	17000	5158
Rubtsovsk	06.08.2016	1:53	5:45	67	MCSs	150	14550	3799
Bakchar	25.06.2017	7:40	6:25	50	MCSs	150	12200	3171
Ust-Kalmanka	02.07.2017	11:54	6:30	56	cold front	150	10600	3586
Bagan	26.06.2018	0:13	4:50	96	mesovortex	150	10650	3283
Novostroyka	27.06.2018	17:05	5:35	92	cold front	150	16900	1751
Khabary	14.07.2018	13:30	8:05	72	MCSs	150	10800	3181
Tisul	28.07.2018	0:00	6:40	80	cyclonic cloud system with a trail cold front	150	10650	1724
Kargasok	26.08.2018	15:00	7:45	64		150	10500	4478

MCSs - mesoscale convective systems

Case: Severe rain

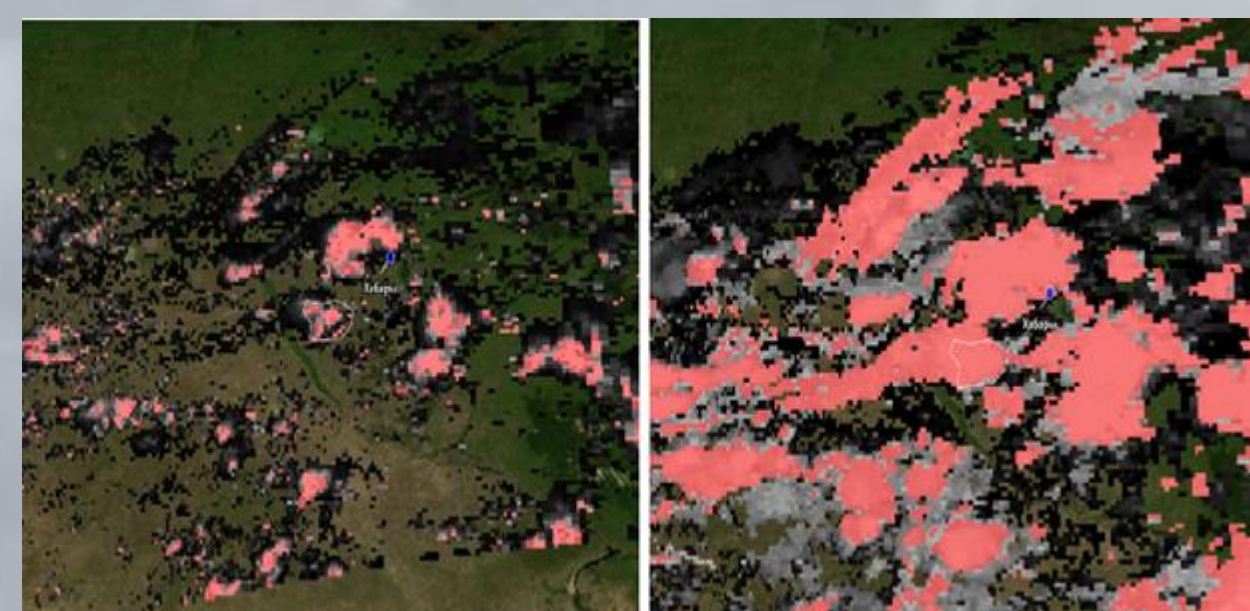
Khabary 14.07.2018

72 mm (13:30 UTC)

According to RGB composite images, a cloudy mesovortex was observed over the Altai Territory



Fig. 3 Fragment of RGB image (Aqua)



Water Patch (ATML2)

Top height (ATML2)

Water Patch = 3181 g/m<sup>2</sup>

Optical Thickness = 150

Top height = 10800 m

Table 4 - Satellite-based sensing data for cases "Heavy rain"

Station	Date	Time of a extreme precipitation events	Time of the satellite pass	Amount of precipitation, mm	Cloud type	Optical Thickness	Top height, m	Water Patch, g/m <sup>2</sup>
Ordynskoe	12.08.2015	9:34	6:35	35	MCSs	150	15600	4047
Talmenka	22.09.2015	1:08	4:50	37	cold front	150	10250	3617
Gornyyak	21.06.2016	2:18	5:35	45	MCSs	150	10650	4204
Volciha	23.07.2016	11:47	7:20	39	MCSs	150	14800	3154
Kuzedevo	24.07.2016	4:40	6:25	36	MCSs	150	12300	2101
Ust-Kabyrza	08.08.2016	6:40	7:20	41	cold front	150	12600	5140
Baturino	26.06.2017	2:44	5:20	44	cold front	150	17000	4434
Iskitim	18.07.2017	4:20	4:45	39	MCSs	150	10600	3142
Severnoye	25.07.2017	4:13	4:50	45	mesovortex	150	10700	3861
Ust-Tarka	28.07.2017	10:25	7:10	42	mesovortex	150	10700	3309
Shelabolikha	10.06.2018	9:35	8:15	37	cold front	150	12050	2498
Staritsa	26.06.2018	5:00	4:50	38	mesovortex	150	12150	2664
Bakchar	01.07.2018	7:29	6:45	37	MCSs	150	12150	4541
Troitskoe	01.07.2018	9:38	6:45	35	MCSs	150	16900	4659
Novokuznetsk	01.07.2018	10:40	6:45	43	MCSs	150	16900	4659

✓ Dangerous phenomena caused by heavy precipitation are unevenly distributed throughout the territory

✓ At all stations, the repeatability of extreme events in the cage regime does not exceed 0.1% per season

✓ It has been found that during the period of accelerated global warming the frequency of extreme precipitation remained almost unchanged within the study area.

✓ Periods without precipitation are twice exceeded the number of periods with precipitation and predominately more extended. Withal, there is a decrease in short-term periods (1-5 days in duration) and an increase in longer ones (6-10 days), both for cases with/without precipitation.

✓ The maximum continuous dry periods generally lasts longer than the duration of periods with precipitation and in most of the territory of the region goes up by a rate of 0.8 days per decade

✓ Extreme events in the precipitation regime in the study area were most often observed during mesoscale convective systems; in all cases of dangerous phenomena, cumulonimbus clouds with a high moisture content were observed.

✓ The identified criteria can be used to identify potential hazardous phenomena according to satellite sensing data in areas not covered by meteorological stations.