

Characteristic of the snow cover for the Western Siberia territory

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Abstract. The warming for the Siberian territory has more rapid growth, than for Northern Hemisphere, in general. The purpose of the work is the description of characteristics of a snow cover for the south-east territory of the Western Siberia, which is great importance for many branches of the economy of Siberia. Date of appearance of snow cover, duration of a steady snow cover, thickness were analyzed in present research. The presented results are: the increase in duration of the presence the snow cover is revealed. The reason is the increase in amount of precipitation during the winter period.

1. Introduction

One of the features of global warming, observed from the middle of 70-s XX century, is its spatial inhomogeneity. Maximal warming, either observed or expected, spread over considerable part of the Russian territory. A trend towards the increase in the frequency and intensity of regional hydro meteorological anomalies has been observed in recent years in Western Siberia [1] and in the forest area of South Yakutia [2]. In general, changes in surface air temperature averaged for a year as well as for longer annual periods (i.e. half-year, season, month) are considered for the northern hemisphere, large geographical locations and economic areas. Hansen et al. [3] indicate that warming for the territory of Siberia has more rapid growth, than for Northern Hemisphere, in general. Significantly high values of the positive trend of annual averaged surface air temperature is 0.36°C per every 10 years with higher values in some months. It was found that the rise in temperature occurs in February, March, October and May basically [1]. Therefore studying of variability of characteristics of a snow cover in this territory is especially important.

The revealed quantitative indicators and trends of heat waves manifestations indicated a probability of an increased number of health deterioration cases of the regional population in future years. Long-term and qualitative evaluation of meteorological conditions affecting both economic complex and human activities as well as the possibility of responding to predicted weather change depends on the numerical characteristics determined for a certain territory at a definite time scale [4]. The climate change issue has raised serious questions about changes in repetition of weather extremes, such as hail, thunderstorm [5, 6], heavy rain [7, 8], strong wind, duration of high-low temperature periods [9], characteristics of the snow cover [10, 11] not only over Western Siberia.

The fundamental scientific problem of such studies is identification spatial and temporal changes of snow cover during the present climate conditions. Characteristics of snow cover are climate-dependent and determine a hydrological regime of the territory. Thus the snow cover is an indicator of changes in the condition of an environment.



The purpose of the present work is the description of characteristics of a snow cover (duration, thickness) of the south-east of Western Siberia, which is great importance for many branches of the economy of Siberia.

The database of forty nine meteorological stations located in investigated territory during period 1989-2016 was used.

2. Investigated territory

The researches have been carried out for the territories of south-east of Western Siberia: Tomsk, Novosibirsk, Kemerovo and Altai Regions. This territory is an unique natural laboratory for such researches, because it is one of the centers of the maximal warming now. This territory has several geographical conditions and features, including dense forests and mountainous regions.

The most part of territory of Tomsk region is occupied with West Siberian plain with flat relief. The Novosibirsk area is occupied basically with lowland which in the south of area merges with steppe. East part of Novosibirsk region and the western part of Kemerovo region are occupied with a range – a low ancient folded file (height 400-470 m). East part of the Kemerovo Region is occupied with Kuznetsk Alatau, southern part – mountain. The central part of the Kemerovo Region is occupied with the Kuznetsk raised hilly plain. South-east part of Altai Region is occupied by mountains, their height range up to 4500 m.

3. Characteristics of the snow cover

Observations of Northern Hemisphere snow cover indicate a reduction in extent over the last 20 years, especially in the most recent years; there is a close association with the hemispheric temperature record [10].

Snow cover plays an important role in the climate system. Snowfall is beneficial to agriculture by serving as a thermal insulator, conserving the heat of the Earth and protecting crops from subfreezing weather. This function (ability) of a snow is especially important in Siberia. The sensitivity of terrestrial snow covers to atmospheric conditions and to air temperatures makes snow cover a useful index for detecting and monitoring atmospheric change. Additional impacts of snow cover include those on surface hydrology; earlier/later snow cover melting influences river and soil-water regimes of investigated region. The most important characteristics of a snow cover are its duration, thickness, and density.

3.1. Appearance and disappearance of snow covers

Occurrence of a snow cover in researched territory is observed in the middle of the third decade of September. The earliest case was observed in the middle of the second decade of September, latest – in the second decade of October (1998) (figure 1).

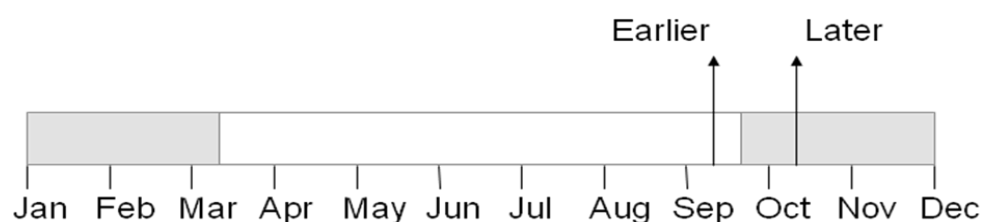


Figure 1. Appearance of snow covers for the south-east territory of Western Siberia.

Terms of formation of the steady snow cover as well as terms of occurrence of the first snow, strongly change from year to year with depending on character of weather. The time interval between these events makes usually 1-1.5 months. The time interval between destruction and disappearance a snow cover is the same.

3.2. Duration of a steady snow cover

Snow cover is a layer of snow on the ground surface resulting from snowfalls. It exerts immense influence upon climate, relief, hydrological and soil-forming processes as well as on plants and animals. Formation of snow cover on the globe is conditioned by geographical zonality, terrain relief, and by general circulation of the atmosphere. The snow cover duration is another important parameter for winter tourism, water resource management, agricultural and disaster / flood forecasting. But statistical material on the occurrence of snow cover of various regions is singularly meager in published sources.

Duration of a presence of a steady snow cover in researched territory changes on the average from 130 days in the south till 170 days in the north. Duration of the snow cover lying is determined by the number of days in a year when, in the morning hours, more than half of the visible land surface is covered with snow. Time variability of snow cover duration in northern areas is less than in southern areas.

During investigated period duration of a steady snow cover has increased on the average for 4 days (up to 10 days on the north). Nevertheless at some weather stations inside researched region opposite tendencies can be observed.

3.3. Thickness of a snow cover

Thickness of a snow cover (figure 2) depends on weather during analyzed winter season, orographic factors, a vegetative cover and a lot of other geographical conditions.

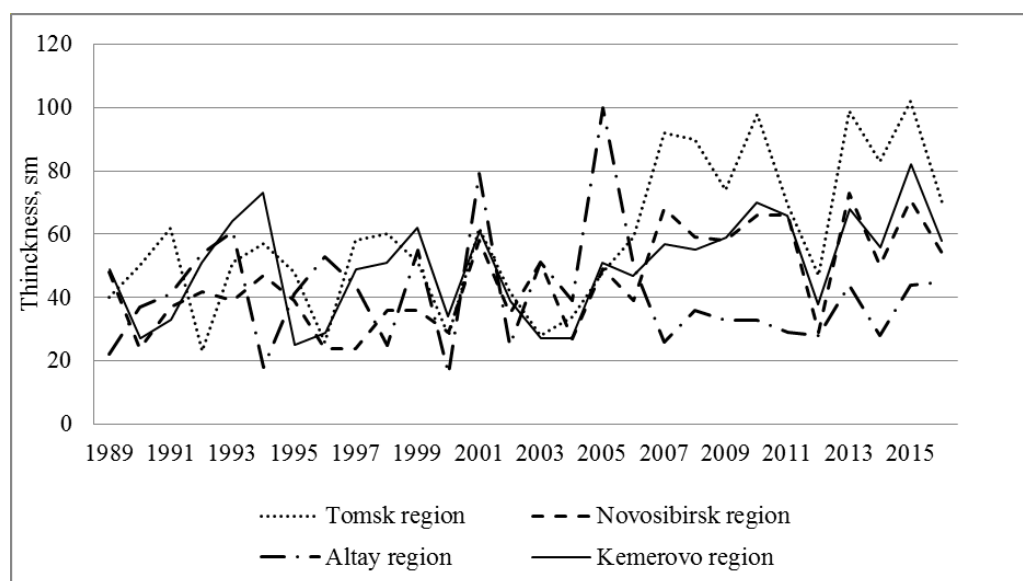


Figure 2. Thickness of a snow cover

The most powerful snow cover is characteristic for territory Mountain Shoria. The first snow appears here in September, and a steady snow cover forms usually by November and keeps up to the end of April. Thickness of a snow cover in mountain and river valleys can range up to 200-250 sm. Practically everywhere the maximal height of a snow cover for winter is observed in the first – second decade of March.

In table 1 the repeatability of heights of a snow cover in several gradation within some administrative areas are presented.

Freezing of soil in a south-east of Western Siberia begins at the end of October – the beginning of November when the snow cover is absent. Average value of soil freezing depth in investigated territory changes from 80 to 120 cm, and has the big time and spatial variability. At the end of the winter freezing ranges up to the maximal value.

Table 1. The repeatability (per cent) of heights of a snow cover.

Regions	Thickness of a snow cover, cm				
	0-20	21-40	41-60	61-80	>80
Tomsk Region		10	40	40	10
Novosibirsk Region		35	50	10	5
Kemerovo Region		10	75	15	
Altay Region	30	50	20		

For discovering changes of the characteristics of a snow cover comparison of the data for period 1989-2016 with characteristics for the period of 1935-1960 has been carried out. The following basic conclusions have been received: duration of a steady snow cover has increased on the average for 4 days. On the north of the territory duration has increased for 10 days, but on the south has almost not changed. The formation of the snow cover began to be observed later for 1-4 days, and destruction for 2-7 days; occurrence of the first snow began to be observed before average long-term terms for 20 days. Disappearance of the snow cover is marked later on the average for 20 days too; the maximal height of a snow cover has increased for 4-17 sm; the increase in duration of the steady snow cover, on a background of the general increase in thickness is revealed due to increase in amount of precipitation during the winter period.

4. Conclusions

As a result the general regularity of spatial heterogeneity and the long-term variability of snow cover were revealed. The following results have been received:

- Occurrence of a snow cover is observed in the middle of the third decade of September.
- The time intervals between the first snow and the steady snow cover and between destruction and disappearance a snow cover are 1-1.5 months.
- Duration of the steady snow cover changes on the average from 130 days in the south till 170 days in the north.
- During period 1989-2016 any significant tendencies in duration of steady snow cover is not marked.
- Average value of soil freezing depth changes from 80 to 120 sm.
- Duration of a steady snow cover has increased on the average for 4 days (up to 10 days on the north).
- First snow is observed earlier on 20 days, and last snow is observed later on 20 days.
- The maximal height of a snow cover has increased for 5-20 sm.

The increase in duration of the presence the snow cover is revealed. The reason is the increase of precipitation amount during the winter period. The conclusions received for Western Siberia are well coordinated to results of researches for the north of Eurasia [10, 12].

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