Indications of the influence of vegetation on the snow cover distribution and albedo.

L.Kitaev

Institute of Geography RAS, 109017, Staromonetniy per. 29., Moscow Rusia – lkitaev @online.ru

The signs of the correspondence of the spatial distribution of ground albedo, snow cover, air temperature and types of vegetation were considered on example of the southern part of West Siberia and Northern Europe. The differences of the long-term variability of the snow cover on territories with different types of vegetable community are revealed. The role of snow cover for regime of albedo and air temperature in autumn and spring is defined.

Keywords: albedo, jump of air temperature, formation and melt-off of snow cover.

1. INTRODUCTION

Albedo of ground surface is one of parameters of changes of air temperature. The area occupied by snow is the most changeable factor of variation of albedo. Thus, changes of a snow coverage depend on climate, changes of ground albedo depend on snow coverage, and changes of albedo of snow cover are the important factor of changes of a climate.

Earlier we investigated features of spatial and time changes of a snow cover of Northern Eurasia (L. Kitaev *et al*., 2000; L. Kitaev *et al.,* 2004). Tendency of increases of a snow cover in period 1936-2000 on a background of increase of air temperature and precipitation of the winter period for all territory is revealed by us. The differentiation of volumes of a snow cover and speed of its long-term changes is carried out also.

The purpose of the given work is the estimation of influence of a snow coverage on meteorological conditions of the autumn and spring periods within key typical landscapes of Northern Eurasia.

2. INITIAL DATA AND METHOD

Mean albedo (AVHRR, NASA 7, 9,11), ground data of snow depth and snow storage for December 1981-1991 have been used for estimation of intersections of parameters over southern part of Eastern Siberia (45-60 N, 60-90 E).

Daily ground observed data of air temperature, snow storage and depth have been prepared for estimation of influence of snow storage on albedo and meteorological regime over above mentioned part of East Siberia and over Northern Europe (55-72 N, 5 - 58 E).

Standard statistical receptions have been employed for the analysis of the connected changes of parameters.

Deviations of air temperature from its seasonal autumn and spring trend have been calculated for an estimation of changes of air temperature at the moment of formation and destruction of snow cover. This values was compared with data of snow storage in moment of appearance of snow in autumn and at moment of disappearance of snow in spring.

3. ALBEDO AND SNOW COVER IN DIFFERENT VEGETATION TYPES

Variability of albedo (remote sensing data, VHRR, NASA 7, 9,11) in autumn (December 1981-1991) have been viewed for semidesert, steppe, deciduous woods and a taiga of Western Siberia.

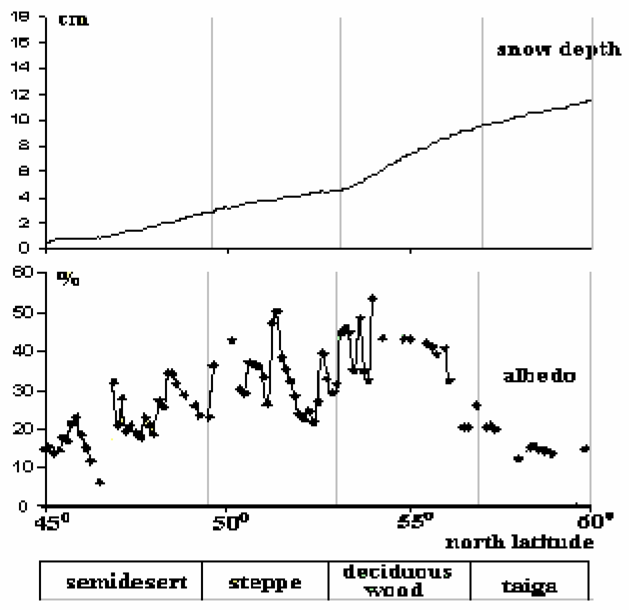

Figure 1. Relationship between snow depth and albedo along profile 45-60 N.

As we see in Fig. 1, simultaneously with increase of snow depth and snow storage from semidesert up to a taiga the albedo has increase from semidesert up to a deciduous wood, and then falls in a taiga in itself. Low albedo of coniferous wood is the reason of it.

4. SNOW COVER AND SEASONAL REGIME OF AIR TEMPERATURE

Changes of air temperature (jump of temperature), connected with formation of a snow cover in an autumn and its destruction in spring are revealed for the basic types of vegetation of a key area. The decreasing of the air temperature at the moment of occurrence of a snow cover is estimated on the average in 1.5°C. Full destruction of a snow cover causes rise in temperature on 1.5°C in the spring.

As we see in Fig. 2 the distinctions in albedo various of different types of surfaces are decreased after an formation of a snow cover, to that there correspond insignificant distinctions of air temperature. Especially strong negative anomalies of temperature in the beginning of winter in a taiga are observed. Coniferous woods have the lowest albedo in snowless conditions. Changes of albedo here are most appreciable at occurrence of a snow cover, which causes intensive downturn of temperature.

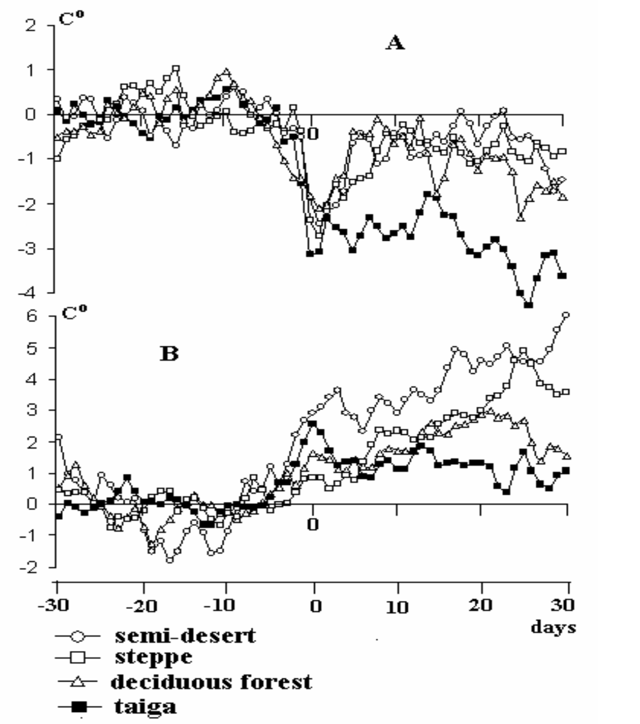

Figure 2. Deviation of air temperature from seasonal trend in autumn (A) and in spring (B) in key area in Eastern Siberia.

The least positive anomalies of air temperature after destruction of snow cover take place in a taiga in the spring. Thus albedo of coniferous woods is insignificant also and warming up within the taiga sites should be big. It is possible to assume, that significant snowiness in taiga sites and long melting period are promoted to this.

The estimation of influence of creating and melt-off of snow cover on meteorological conditions was studied for tiga of Northern Europe also. The main direction of spatial variation of period with snow cover and mean winter air temperature from SW to NE take place and it is defined by the general climatic situation. Three regions would be selected about long-term trends of parameters:
1. To the north 65 N negative temperature trends define long-term increase of duration of a snow cover.
2. To the west 15 E the long-term increase of temperature defines decrease of duration of a snow cover.
3. Over East European plain to the south of 65N the long-term increase of temperature is accompanied by increase of duration of a snow cover.

The situation of the first and second regions is logical. Downturn or increase of air temperature defines reduction or increase of duration of the snow period and on the contrary. The situation of the third region shows necessity of the account of absolute values of parameters. Increase of winter air temperature on the west of Scandinavian Peninsula determines increase of liquid precipitation and reduction of solid precipitation in winter time (Forland and Hanssen-Bauer, 2000). It entails decrease of snowiness and durations of snow cover. The winter air temperature is much lower on East European plain and in this case the increase of air temperature without transition through zero determines growth of solid precipitation, snowiness and duration of snow cover.

Three regions were selected for analysis of jump of air temperature in autumn and spring: mountain area of northern part of Scandinavian Peninsula (Norway), plain area of southern part of Scandinavian Peninsula and northern part of East European plain (Russia). This regions have similar tipe of vegetation – northern European taiga.

Air temperature has jamp -2.5°C in first three days after snow appearance over Northern Europe in total. Jump of air temperature +1.1°C in first three days after start of snow melting take place.

As we see in Fig. 3 the jump of air temperature make -2.8°C in first three days after formation of snow cover in autumn over northern part of Scandinavian Peninsula (Norway), -3.6°C over Southern part of Scandinavian Peninsula (Finland) and +0.5°C over Northern part of East European plain (Russia).

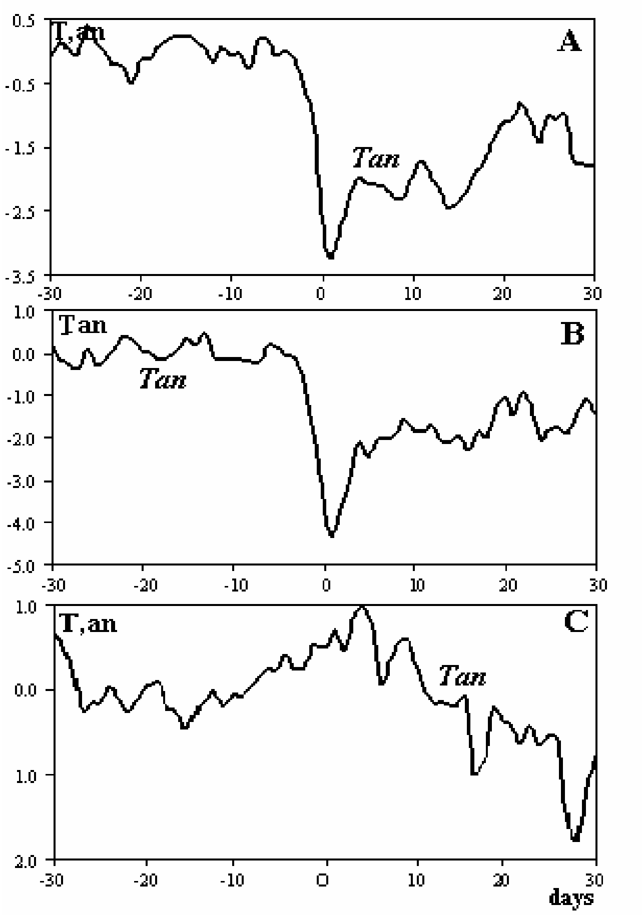

Figure 3. Trend deviation of air temperature (Tan) in autumn.
A – Northern part of Scandinavian Peninsula (Norway)
B – Southern part of Scandinavian Peninsula (Finland)
C – Northern part of East European plain (Russia).

As we see in Fig. 4 the jump of air temperature make +0.8°C in first three days after melt-of of snow cover in spring over northern part of Scandinavian Peninsula (Norway), +1.5°C over Southern part of Scandinavian Peninsula (Finland) and +0.2°C Northern part of East European plain (Russia) (figure 4).

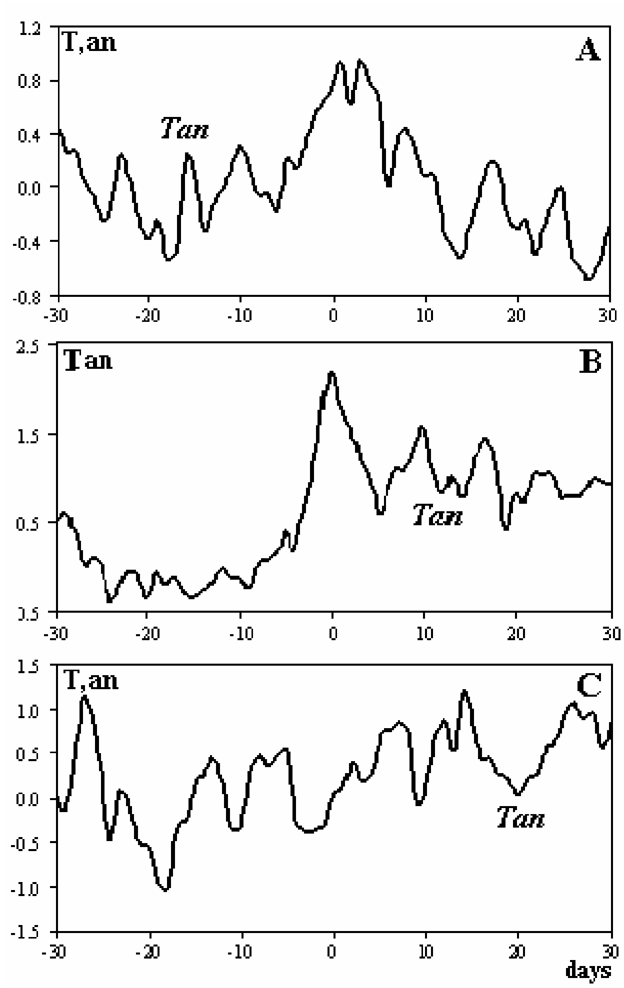

Figure 4. Trend deviation of air temperature (Tan) in spring. A – Northern part of Scandinavian Peninsula (Norway) B – Southern part of Scandinavian Peninsula (Finland) C – Northern part of East European plain (Russia).

In a southern part of Scandinavia (Finland) significant deposits during the prewinter period determine a fast establishment of a continuous snow covers during the period with temperature of air +5 - +6°C. Significant snowiness in the beginning of winter defines the biggest jump of air temperature at the moment of an establishment of a snow cover.

Similar precipitation over northern part of Scandinavian Peninsula and, accordingly, similar snowiness in the beginning of winter are characteristic, but at temperature of air +4 - +5°C. In these conditions jump of temperature is swept less up. In the north East Europe big snowiness are formed at temperature of air +1 - +2°C in the autumn. Jump of temperature at an establishment of a snow cover here is not swept up. At snow melt-off in the spring the situation repeats as mirror reflection

5. CONCLUSIONS.

For southern part of Eastern Siberia and Northern Europe features of influence of a snow cover and type of vegetation on albedo and dynamics of air temperature in autumn and spring are investigated (at the moments of formation and destruction of a snow cover). The original method of an estimation of features of changes of temperature is offered at a formation and destruction of a snow cover. For northern part of Eastern Siberia the decreasing of the air temperature at the moment of occurrence of a snow cover is estimated on the average in 1.5°C, Full destruction of a snow cover causes rise in temperature on 1.5°C in the spring. Higher are characteristic annual temperatures of the winter period and the greater trends of their changes are characteristic for taiga sites. It is would provide the least long-term increase of a snow cove. As a logical explanation of it may serve low albedo of taiga sites. Air temperature has jamp -2.5°C after snow appearance over Northern Europe in total. Jump of air temperature +1.1°C in first three days after start of snow melting take place.

Distinctions of size jumps of air temperature at an establishment and melt-off of snow cover in homogeneous meteorological conditions of the south of Western Siberia are connected in first of all to distinctions of vegetation. The taiga having lowest albedo is most sharply allocated. In conditions of homogeneous vegetation (the European taiga) in the north of Europe the distinction of value of jump of air temperature at an establishment and melt-off of snow cover are connected to spatial heterogeneity of a snow cover and air temperatures. The increase of a snow depth from the west on the east should raise albedo in this direction, but decrease of a background of air temperature from the west on the east smooth size of jump of air temperature in this direction.

5. ACKNOWLEDGMENTS.

The author thanks Boris Sherstyukov, major scientific researcher from All-Russian Research Institute of Hydrometeorological Information - World Data Center. The work has been realized with financial support of INTAS (project 77/2001) and Russian Found of Basic Researchs (project 03-05-64374).

6. REFERENCES.

E.J. Forland and I. Hanssen-Bauer. ”Increased precipitation in the Norwegian Arctic: true or false?,” Climatic Change, No 46, p.p. 485-509, 2000.

L. Kitaev, A. Kislov, A. Krenke, V. Razuvaev, R. Martuganov and I. Konstantinov “The snow cover characteristics of northern Eurasia and their relationship to climatic parameters,” Boreal Environment Research. Vammalan Kirjapaino Oy, P.O. Box 92, FIN-38201 Vammala, Finland, Vol. 7, N 4, p.p. 437-446, 2002.

L. Kitaev, V. Radionov and E. Forland. ”Spatial and temporal interannual variability of period with snow cover,”.The ACSYS Decade and Beyond. WCRP-118(CD), WMO/TD/No 1232, 5 p., September 2004.