Cloudiness over the North-Asian Region

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Abstract – The cloudiness above the North-Asian region for 1998-2004 has been researched on NOAA satellite data. The cloudiness has been estimated for three latitudinal zones: “Southern”, “Central” and “Northern”. During 1998-2004 the ratios of cloudiness in northern and southern zones to cloudiness in the central zone decreased on 10 %. These years correspond to a phase of a maximum of solar activity. The latitudinal displacement of cloudiness of northern and southern zones to the central zone can be explained by displacement of the basic ways of movement of the cyclones formed at the Atlantic and Arctic oceans and determining the cloudy cover in northern Eurasia up to 140th meridian.

Keywords: cloudiness, remote sensing, solar activity.

1. INTRODUCTION

Researches during several centuries have shown that character of change of atmosphere's circulation is connected to a level of solar activity (Morozova, 2000). Variations of circulation are observed, both during a 11-years cycle of solar activity, and on shorter time intervals.

Many researchers mark change of atmospheric pressure near a ground surface and heights of geopotential surfaces after geomagnetic disturbances or the solar flashes accompanying with splashes of solar cosmic rays (Morozova, 2000).

The historical data (Abrosov, 1962) testify that during epoch of increased solar activity the pressure in area of maximum in low latitudes is increasing and in high latitudes is decreasing; as a result the cyclones trajectories shift poleward. The results which confirm the dependence of paths of cyclones in northeast Atlantic and Europe from a phase of a solar cycle are presented in (Tinsley, 1988). During an epoch of a solar maximum the "northern" way of the Atlantic cyclones is shifting to the south while the "southern" way is shifting to the north, and the amplitude of variations is approximately 10 degrees of latitudes. The author of work (Abrosov, 1962) furnish proofs that cyclones and anticyclones in Northern Asia up to 140th east meridian also are moving poleward during the increased solar activity, and during an epoch of weak solar activity has more southern placement. The latitudinal dependence of variations of total solar radiation in an 11-years cycle of solar activity is explained in work (Veretenenko, 1999) by latitudinal displacement of cyclones trajectories. Also dependence of the changes of baric fields and cloudiness from variations of cosmic rays is observed. During the strong geomagnetic disturbances accompanying with Forbush-decreasing of intensity of galactic cosmic rays the pressure increase in more northern area than 55^0N and the decrease in more southern latitudinal areas (Pudovkin, 1992) are observed.

Basically the atmospheric precipitation over the north of the Asian continent is carried cyclones from North Atlantic region (Semiletov, 1998). Lena River considerably decreases at passage of the Mid-Siberian plateau. The common trend in average annual sums of precipitation is negative for last 50 years.

Cloudiness in northern hemisphere anticorrelates with solar activity. However, in small scales it behaves differently, depending on latitude and a relief, trajectories of cyclones and anticyclones.

In comparison with traditional ground-based methods the satellites allow to observe cloudiness on the large space, but not just in a point of the meteorological station. Therefore, the satellite images allow making more detailed map of distribution of a cloudy cover.

The purpose of this article is research of spatial-temporal picture of distribution of a cloudy cover on the Northern Asia.

2. DATA & METHODS

Cloudiness has been considered for two altitude zones (low and high cloudiness) on NOAA satellite data obtained on the North-Asian Region (80^0-170^0E and 50^0-80^0N) for the period of 1997-2004.

The cloudiness was estimated for three latitudinal zones (a "southern" zone - 56°-40°N, the "central" zone - 56°-66°N, "northern" zone - 66°-74°N). Cloudiness on the satellite images was determined by standard algorithms as recommended by NOAA. For every latitudinal zone the cloudiness was estimated as percent of the square of zone.

The data received from May till September were considered only as it is difficult to automatically detect the clouds into winter months on a background of a snow. The period with a steady snow cover for northern zone (66°-74°N) lasts from 1st October till 20th May. The period with a steady snow cover for the central zone (56°-66°N) lasts from 14th October till 1st May. The period with a steady snow cover for a southern zone (40°-56°N) lasts from 28th October till 16th April.

The ratios of average annual values of cloudiness of the central zone to a southern and of central zone to northern, are taken for consideration of dynamics of distribution of cloudiness.

3. RESULTS & DISCUSSIONS

The satellite observation of cloudiness was carried out from 8 o'clock till 20 o'clock of local time. Note, for northern zone the minimum (decrease on 20 % concerning an average level of 70 %) in high cloudiness at 16-17 o'clock, a small minimum (decrease on 5 %) at 10-11 o'clock and a small maximum (increase on 5 %) of cloudiness for 12-15 o'clock are observed. The similar picture is observed and for a southern zone. The similar picture is observed and for a southern zone. But the minimum (decrease on 30 % concerning an average level of 50 %) here is observed at 11-

12 o'clock and the maximum with 12 up to 16 equals 75 %. Low cloudiness of northern zone equals 15 % and varies within day a little bit. For the central and southern zones the low cloudiness equals about 20 % and has a minimum (decrease on 15 %) at 11-12 o'clock and the maximum for 12-16 o'clock equals 25 %.

Distribution of full cloudiness in 1997 (a minimum of solar activity) is shown on Fig. 1. The density of cloudiness increases with increase of latitude. Also the decreasing of density of a cloudy cover is observed from the West to East, especially for the central zone. The greatest density of clouds is observed above the seas of Arctic Ocean (above 70^0N); especially above Kara Sea.

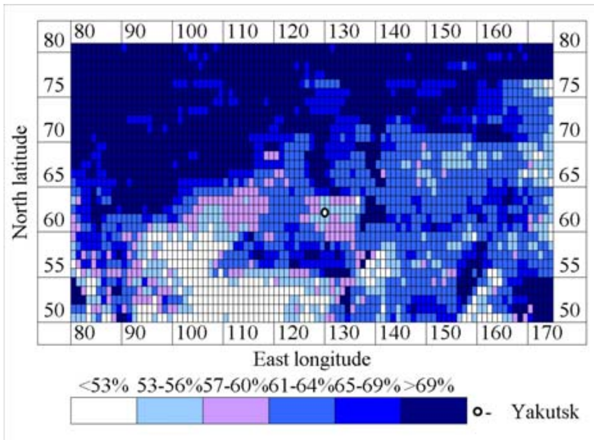

Figure 1. Map of cloudiness of the North-Asian Region is constructed for snowless season of 1997 (the minimum of solar activity).

Above a land the maximal density of clouds is observed above the Central Siberian plateau. The high density of clouds is observed above the ridges: Verkhoyanskii, Cherskii, Suntar-Khayata, Stanovoi, Djugjur, Central mountain ridge of Kamchatka, Aldanskii and Stanovoi uplands. The minimal cloudiness is observed above the Baikal Lake and the Brotherly water basin.

In seasonal distribution of cloudiness (both for the high clouds and for low clouds) during the snowless time the halfwave with a minimum in July (Fig. 2) is observed. And if the minimum of the high cloudiness is observed in June - July the minimum of the low cloudiness is observed in July - August.

The percent of territory covered with low cloudiness for all three latitudinal zones is minimal in August. From May till August the cloudiness decreases, and from August till September its value increases. The high cloudiness of northern zone decreases from May till July-August, and then increases by September. Cloudiness of the central zone has a minimum in June - July and increases by September. The variations of high cloudiness of a southern zone have different character for different years: for example, in 1999, 2000 the minimal value of cloudiness was observed in September, and in 1998 the minimum of high cloudiness is observed at May and a maximum is observed at September.

On Fig. 3 the variations of the low, high and full cloudiness with 1997 on 2004 are shown. The data of observation obtained for eight years is not enough to draw conclusions on long-term variations. However it would be desirable to note an observed maximum of cloudiness of the North-Asian Region with delay for two years after a minimum of solar activity (1996-1997) and its decrease up to a minimum with the same delay after a maximum of solar activity (2001-2002).

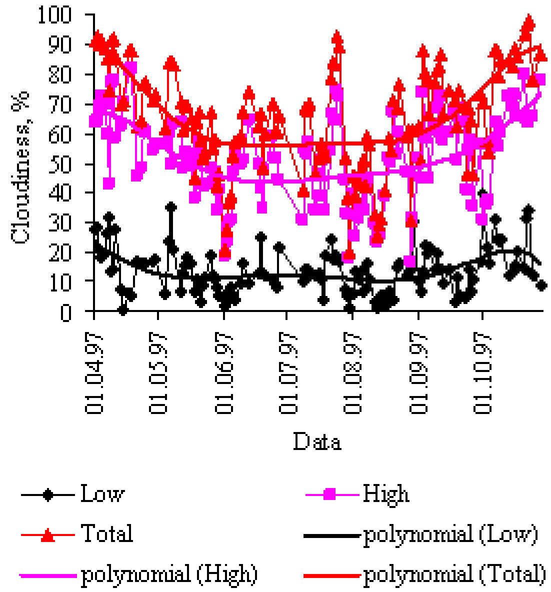

Figure 2. The seasonal variation of cloudiness of the North-Asian Region in 1997: ■ - % of territory covered by high clouds, ♦ - % of the territory covered with low clouds.

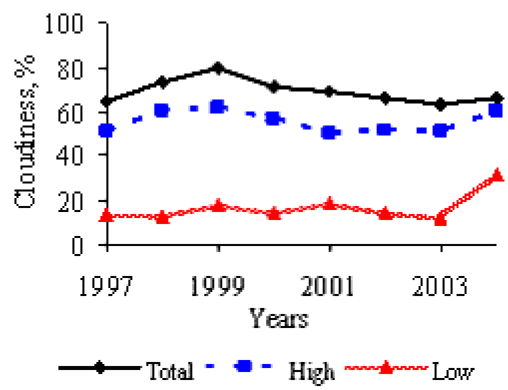

Figure3. The variations of cloudiness of North-Asian Region for 1997-2004.

The variations of ratios of cloudiness of three latitudinal zones (Fig. 4) speak about displacement of cloudiness from "northern" and "southern" zones to the "central" zone. It is corresponds to representations about change of cloudiness in northern, central and southern Europe depending on solar activity (Svensmark, 1977) and is defined by displacement to the center of southern and northern ways of movement of the western Atlantic cyclones with increase of solar activity.

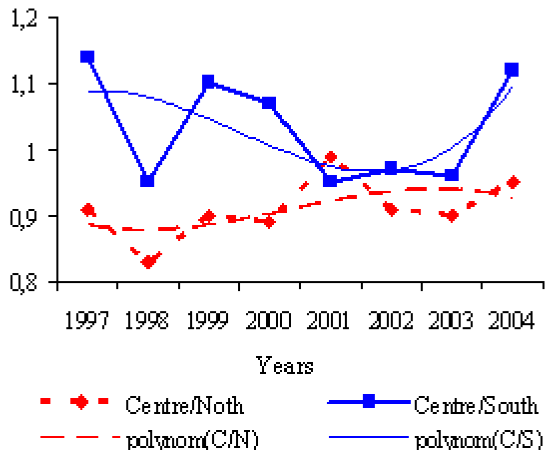

Figure 4. The variation of ratios of cloudiness of three latitudinal zones on North-Asian Region.

On the satellite data the influence of Forbush-decreases of intensity of cosmic rays on cloudiness over Yakutia was investigated for low and high auroral activity for various latitudinal zones.
For the analysis of data by method of epochs imposing the days of beginning of Forbush-decrease were selected as zero days. The data of neutron monitor in Moscow (http://helios.izmiran.rssi.ru/cosray/events/00.htm) for the summer period of 2000 were used. The data of a cloudy cover have been divided into two groups. The first group included events when the average daily AE-index in day of beginning Forbush-decrease did not exceed 300 nTl (18 events), in the second - events with AE> 500 nTl (12 events) (Fig. 5).

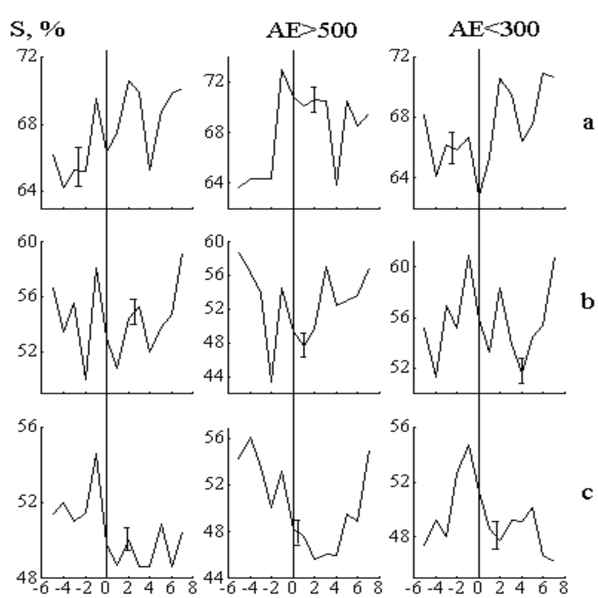

Figure 5. The influence of the Forbush-decrease of cosmic rays on change of total cloudiness above Yakutia.

During high auroral activity (the AE-index exceeded 500 nTl) the decrease of a cloudy cover both for high, and for the common cloudiness from 3 % up to 6 % is observed. The effect is better observed at high and middle latitudes. For events with AE <300 nTl in zero day the increase of cloudiness about of 2-4 % is observed. This result shows the influence of variations of cosmic rays on cloudiness at high and low auroral activity is different.

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