Trends in Frequency of Overcast Clouds over the Arctic Region of Russia

I.V. Chernykh and O.A. Aldukhov

Russian Institute of Hydrometeorological Information – World Data Center, Obninsk, Russia,
E-mail: civ@meteo.ru, aoa@meteo.ru

Cloudiness is one of the main components of a climatic system. In this study, the trends of frequency anomalies for cloud layers with clouds covering 80-100% of the sky (the so-called overcast cloud layers) are presented for the Arctic region of Russia. Calculations were conducted for the atmospheric layers 0–2, 2–6, 6–10 km above the surface level for autumn. These layers correspond to low, middle and high-level clouds.

In our research we used the CE-method for cloud boundaries and cloud amount reconstruction [1, 2] and radiosonde sounding data for eleven Arctic Russian stations from dataset CARDS [3] supplemented by current data from datasets AROCTAB [4] and AROCTAC [5] for the 1964-2016 period. The stations are located in the North-European, West-Siberian and East-Siberian climatic areas of the Arctic region of Russia.

The linear trends in the time series of frequency anomalies of the overcast cloud layers were calculated by the least squares method. To compute the trends, only those observations were used that included data both on temperature and on humidity from the surface to the height of 10 km. Together with overcast cloud layers, an existence of cloud layers with other cloud amount was allowable. We did not consider cloud layers for which the CE-method gave thicknesses less than 50 m.

The linear trends of the anomalies of the overcast cloud layers in the atmospheric layers 0-2, 2-6 and 6-10 km are presented for autumn in the Table.

Table

The ranges of changes for the linear trends of anomalies frequency, %*decade^{-1}, of the overcast cloud layers in the atmospheric layers 0-2, 2-6, 6-10 km in autumn for climatic areas of the Arctic region of Russia and the trend significances. 1964–2016.

North-European area		West-Siberian area		East-Siberian area	
Trend, %*decade^{-1}	Significance, %	Trend, %*decade^{-1}	Significance, %	Trend, %*decade^{-1}	Significance, %
6–10 km					
-3,1– -0,1	5–99	-3,9– 0,0	5–99	-1,5–0,5	6–92
2–6 km					
0,4–4,0	31–99	0,1–3,0	4–99	2,7–5,0	99
0–2 km					
3,8–5,1	99	3,0–5,2	96–99	2,3–4,8	98–99

The anomaly time series and their linear trends in autumn are shown in figure for Murmansk and Salekhard for the atmospheric layers considered in the study. Trends obtained after the tenfold smoothing of time series by using the three-point smoothing are also shown.

The presented results demonstrate that the long-time changes of the overcast cloud layers frequency are inhomogeneous in time and space in the atmosphere over the Arctic region of Russia in autumn.

The obtained knowledge about the long-time changes in overcast cloud layers frequency may be useful for studying climate changes in the Arctic region.
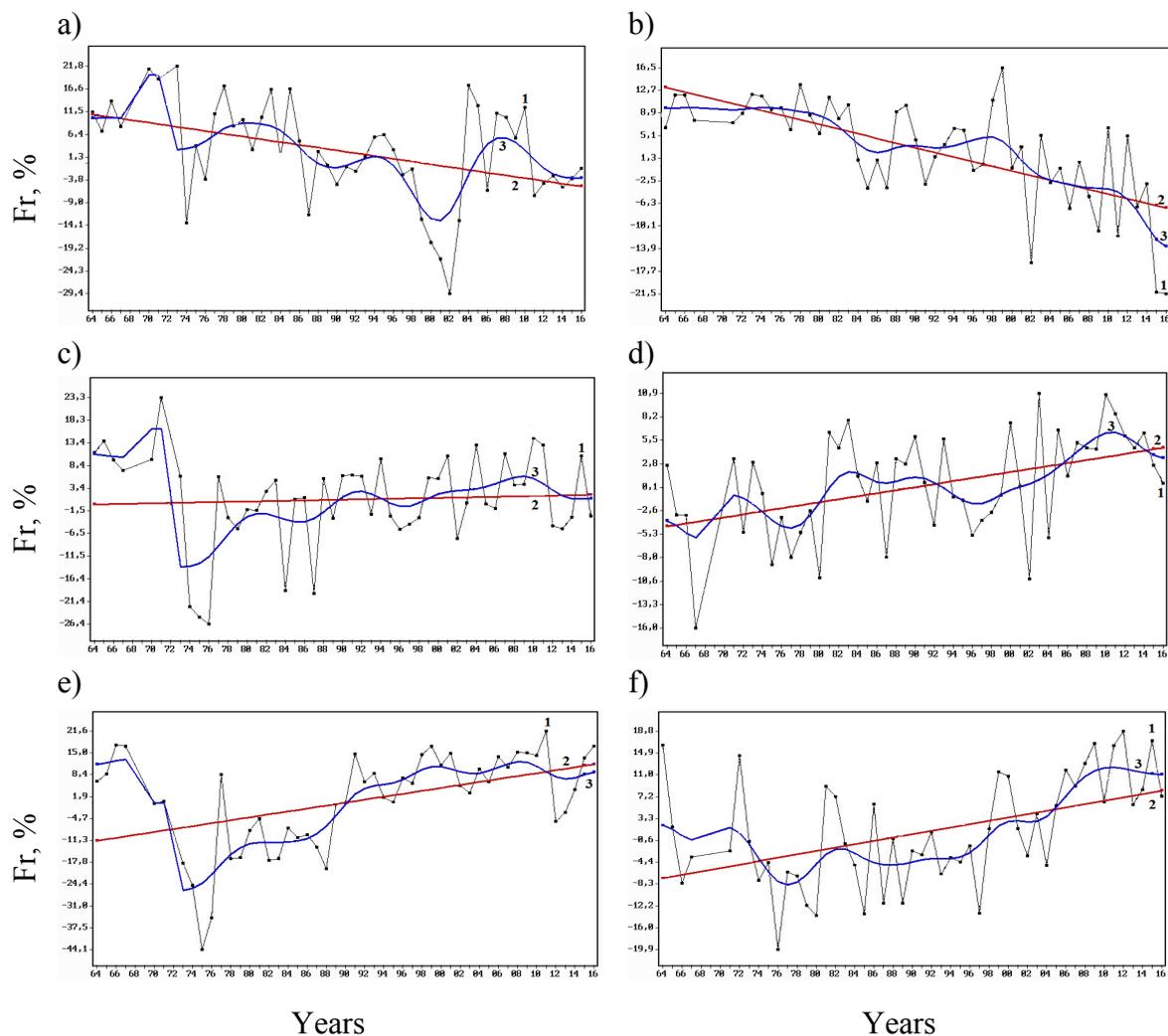
Black lines (1) show the time series for anomalies of frequency of the overcast cloud layers in different atmospheric layers for autumn a), b) layer 6–10 km , c), d) 2–6 km, e), f) 0–2 km, calculated based on the upper-air data for stations Murmansk (a, c, e) and Salekhard (b, d, f) for 1964– 2016. Red lines (2) show linear trends, blue lines (3) show smoothed trends.

References
1. Chernykh I.V. and Eskridge R.E. Determination of cloud amount and level from radiosonde soundings // J. Appl. Meteorol., 1996, vol. 35, pp. 1362—1369.
2. Chernykh I.V., Aldukhov O.A. Vertical distribution of cloud layers from cloud radiosounding data // Izvestiya, Atmospheric and Oceanic Physics. 2004. **40.** No 1. 41-53.
3. Eskridge R.E., Alduchov O.A., Chernykh I.V., Zhai P., Polansky A.C., Doty S.R. A comprehensive aerological reference dataset (CARDS): rough and systematic errors // Bull. Amer. Meteor. Soc. 1995. **76.** 1759-1775.
4. Aldukhov O.A. et al. Dataset of current aerological information AROCTAB. Description of the dataset. – Obninsk, RIHMI-WDC, 1990, 28 p.
5. Rudenkova T.V. Format for archiving of the current aerological data, received from GTS for PC // Proc. RIHMI-WDC, 2010, N 174, p. 41—63.