About Increasing of Water Vapour Amount in Troposphere over North-West of Russia

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The warming in Arctic region is one of actual problems both for science and for economic. In particular warming in troposphere leads to increasing of moisture capacity of atmosphere. But water vapour is one of greenhouse gases. Moreover changes in distributions of temperature and humidity in troposphere can lead to changes of macrostructure of cloudiness. Below estimations of climatic changes for water vapour amount (VA) for standard isobaric levels in troposphere over part of Arctic region, over North-West of Russia, are presented on base dataset CARDS [Eskridge et al, 1995] over period 1964-10.2007 years for stations Murmansk and Nar'jan-Mar. The method for detecting of trends [Alduchov et al, 2006, Alduchov, Chernykh, 2008], developed especially for study of climatic changes over Polar Regions with probably not full time series of observations, was used for estimations. It is shown that water vapour amount is increasing with significance not less than 95% over Murmansk in low troposphere for autumn and year and over Nar'jan-Mar - in high troposphere for summer, autumn and year.

Time series of observations for these arctic stations are enough full. Number of sounding for 00 GMT and 12 GMT are practically the same. Number of humidity observations used for researches have shown in Table for different months for standard isobaric levels: 850 hPa, 700 hPa, 500 hPa and 400 hPa. Nevertheless Table demonstrates some inhomogeneous in humidity data by reason of the decreasing with height of number of humidity observations, especially in cold months.

TABLE. Number of humidity observations used for researches for different standard isobaric levels for different month

Level (hPa)	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
	Murmansk											
400	1747	1548	1720	1752	1848	1867	1811	1890	1899	1897	1699	1702
500	2109	1908	2080	2006	2061	1894	1821	1907	1984	2084	1993	2010
700	2194	1961	2123	2068	2072	1905	1828	1917	1994	2118	2055	2115
850	2194	1964	2121	2070	2071	1908	1831	1922	1994	2123	2060	2120
	Nar'jan-Mar											
400	1473	1330	1541	1597	1708	1887	1942	1872	1689	1651	1421	1454
500	1828	1662	1932	1911	1881	1901	1951	1890	1766	1873	1726	1794
700	1963	1827	2021	1960	1896	1907	1968	1907	1770	1895	1780	1891
850	1963	1825	2019	1963	1899	1908	1971	1902	1776	1894	1779	1889

The multiannual monthly mean values for VA for isobaric levels and linear trends in correspondent time series for VA anomalies, calculated on the base of hourly observations with taking into account the time correlations of observations are presented at Figure 1. The trends are presented for different months, seasons and for year without estimation of significance, with significance not less than 50% and not less than 95%.

Figure 1a demonstrates that biggest mean values of VA in troposphere over both stations take place in summer. For 500 hPa it equal to 16.5 kg/m^2 for Murmansk and 17.4 kg/m^2 - for Nar'jan-Mar. But tendencies of climatic changes of VA for summer are some different for the stations. Most increasing of VA for summer was detected over Murmansk - in low troposphere and over Nar'jan-Mar - in high troposphere (fig. 1b, 1c). For example, trends of VA for 850 hPa, detected with significance 88% and 82%, equal to 0.11 kg/m^2/decade and 0.14 kg/m^2/decade for Murmansk and Nar'jan-Mar correspondently. Trends of VA for 300 hPa, detected for summer with significance 60% and 99%, equal to 0.13 kg/m^2/decade and 0.65 kg/m^2/decade for Murmansk and Nar'jan-Mar correspondently.

Figure 1d shows that trends with significance not less than 95% are detected only in low troposphere over Murmansk for autumn and year (for 850 hPa trends equal to 0.14 kg/m^2/decade and 0.1 kg/m^2/decade correspondently); over Nar'jan-Mar its are detected in low troposphere only for year (for 850 hPa decadal changes equal to 0.1 kg/m^2/decade), in middle troposphere - for January, autumn and year (for 400 hPa decadal changes equal to 0.35 kg/m^2/decade, 0.45 kg/m^2/decade, 0.29 kg/m^2/decade correspondently). The trends with significance not less than 95% are detected in high troposphere over Nar'jan-Mar for summer, autumn and year (for 300 hPa decadal changes equal to 0.65 kg/m^2/decade, 0.44 kg/m^2/decade, 0.32 kg/m^2/decade correspondently).

Note, warming for year with significance not less than 95% was detected only in low troposphere over Murmansk and at all levels in troposphere over Nar'jan-Mar [Alduchov, Chernykh, 2009]. Moreover, it was founded the decreasing for low boundary of cloud layers with cloud amount 80-100% of the sky for year for both stations [Chernykh, Alduchov, 2009].

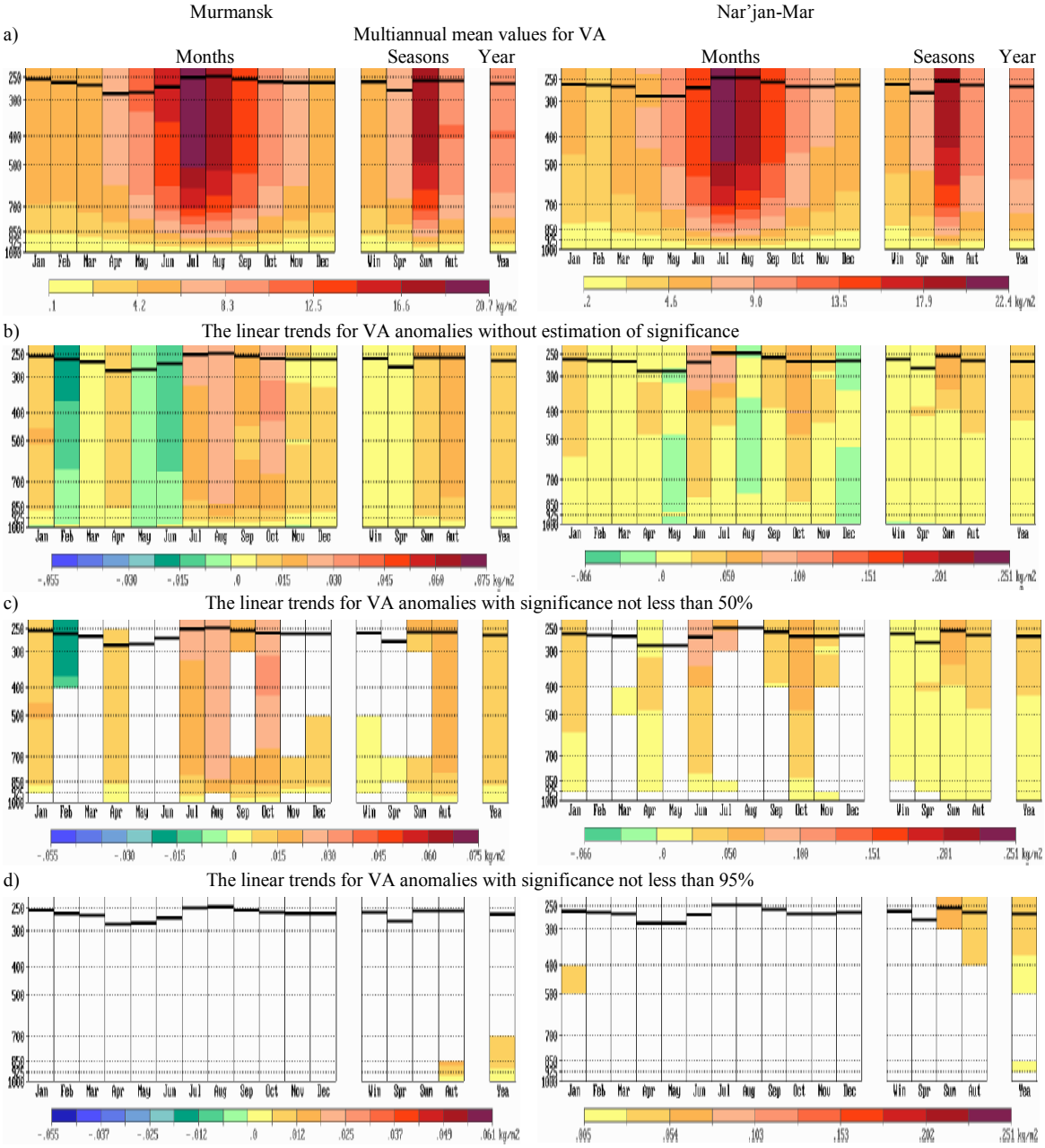

Fig. 1. Multiannual mean values (kg/m^2) for vapour amount VA (a) and linear trends in time series of vapour amount anomalies (kg/m^2/year) for the isobaric levels calculated on the base of hourly observations with taking into account the time correlations of observations for different months (in the left), seasons (in the center) and for year (in the right) without estimation of significance, with significance not less than 50% (c) and 95% (d). The first tropopause is marked by black line. Stations Murmansk (left column) and Nar'jan-Mar (right column). CARDS. 01.1964 – 10.2007.

The results can be used for analysis of climate change of humidity, cloudiness, precipitation for Arctic region.

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References

Alduchov O.A., Chernykh I.V. About changes of temperature-humidity regime in troposphere over Antarctic Peninsula // Proc. RIHMI-WDC. 2008., 173. 270-294.

Alduchov O.A., Chernykh I.V. About warming in troposphere over North-West of Russia // Research Activities in Atmospheric and Oceanic Modelling. WMO. http://collaboration.cmc.ec.gc.ca/science/wgne/BlueBook/ 2009.

Alduchov O.A., Lagun V. E., Chernykh I.V., Jagovkina S.V. About climatic changes of troposphere over Antarctic peninsula. - "Problemy Klimatologi Polarnej". 2006. **16.** 7-22.

Chernykh I.V., Alduchov O.A. Trends in low boundary of overcast clouds over North-West of Russia// Research Activities in Atmospheric and Oceanic Modelling. WMO. http://collaboration.cmc.ec.gc.ca/science/wgne/BlueBook/ 2009.

Eskridge R.E., Alduchov O.A., Chernykh I.V., Zhai P., Doty S.R., Polansky A.C. A Comprehensive Aerological Reference Data Set (CARDS): Rough and systematic errors // Bull. Amer. Meteor. Soc. 1995. **76.** 1959-1775.