Joint Analysis of Climatic Changes of Surface Temperature and Cloudiness Vertical Structure in Antarctic Region on base CARDS

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In previous study it was shown that climatic changes of cloudiness vertical structure are space inhomogeneous (Chernykh et al. 2001). Also increasing of cloud amount at the station South Pole was detected (Neff, 1999). In this paper joint analysis of climatic changes of surface temperature and cloudiness vertical structure in different atmospheric layers (0-2 км, 2-6 км, 6-10 км, 0-10 км) for nine coastal Antarctic stations (Table 1) is presented. For researches Aerological dataset CARDS (Eskridge et al. 1995) for period 1964-2001 years was used.

Chernykh and Eskridge method was used to determine cloud amount and boundaries from temperature and humidity profiles [Chernykh and Eskridge 1996]. Trends in anomalies for all parameters were calculated by linear regression with using the measuring data with provision for correlation dependence in time.

As it follows from previous researches (Comiso, 2000) and Table 2, values and sign of trends in surface temperature depend from station, period of observations and season.

In atmospheric layer 0-10 km for all studied stations, with exception Bellingshausen, number of cloud layers with cloud amount 0-100% of the sky increases (Table 3) and total thickness, on the contrary, decreases (Table 4). Only for Bellingshausen number of cloud layers decreases and total thickness increases. Note, that highest warming is detected namely for Bellingshausen (Table 2). Low boundary is stable or decreases. High boundary is stable or increases for all station, with exception Bellingshausen, for which it decreases (Table 5).

For atmospheric layers 0-2 km and 2-6 km number and total thickness of cloud layers trends have the same tendencies (Table 3, Table 4). It will be observed, that for most of stations, placed in Eastern Antarctica, the highest decreasing of total thickness take place for low clouds and highest increasing of cloud layers number – for middle and high clouds. Note, that for most stations, stability of cloud layers total thickness go with its number stability or increasing only for high clouds.

TABLE 1. List of stations

Station	Index	Latitude	Longitude	Height (m)	Period
Novolazarevskaya	89512	-70.75	11.8	130	1969.12-2001.12
Syowa	89532	-69.00	39.6	21	1969.10-2001.12
Mawson	89564	-67.60	62.9	16	1970.01-2001.12
Davis	89571	-68.58	78.0	13	1969.02-2001.12
Mirny	89592	-66.55	93.0	30	1969.10-2001.12
Casey	89611	-66.25	110.6	15	1967.02-2001.12
McMurdo	89664	-77.85	166.7	24	1964.01-2001.12
Bellingshausen	89050	-62.18	-58.9	42	1970.02-1999.01
Halley Bay	89022	-75.50	-26.6	29	1966.12-2001.12

TABLE 2. Surface temperature anomalies trends °C decade^{-1}, calculated by linear regression on base CARDS by using measured values with provision for correlation dependence in time. The trend values at the 95% significant level marked by *; other trends are at significant level not less than 50%. Seasons: I - December - February; II – March- May; III – June- August; IV – September-November.

Station	Seasons/ Year				
	I	II	III	IV	Year
Novolazarevskaya	-	-0.78*	0.22	-0.26	-0.20
Syowa	-0.17	-0.80*	-	-0.25	-0.29*
Mawson	-0.46*	-0.40	-	-0.21	-0.25*
Davis	-0.12	-	-	0.51	-
Mirny	-0.30	-0.53	-	-	-0.16
Casey	-0.20	-0.90*	0.35*	-	-0.21
McMurdo	0.16	-0.2	0.23*	0.45	0.20*
Bellingshausen	0.33*	0.65*	0.81	-	0.40*
Halley Bay	-	-0.45	0.30	-0.20	-0.12

TABLE 3. Means (m, meters) and decadal changes (tr, number decade^{-1}) for number of cloud layers with cloud amount 0-100% of the sky for different atmospheric layers. The trend values at the 95% significant level marked by *; other trends are at significant level not less than 50%.

Station	Atmospheric layer							
	0-2 км		2-6 км		6-10 км		0-10 км	
	m	tr	m	tr	m	tr	m	tr
Novolazarevskaya	1.8	0.05*	2.4	0.23*	2.6	0.26*	6.2	0.44*
Syowa	1.9	0.15*	2.7	0.17*	2.2	-	5.0	-
Mawson	2.1	0.33*	2.9	0.67*	2.8	0.77*	7.4	1.99*
Davis	2.1	0.36*	2.8	0.83*	2.7	086*	7.3	2.40*
Mirny	1.8	0.05*	2.2	0.21*	2.6	0.35*	6.0	0.63*
Casey	2.1	0.31*	2.9	0.70*	2.9	0.75*	7.5	1.90*
McMurdo	2.2	0.11*	3.1	0.11*	3.1	-	8.0	-
Bellingshausen	1.9	-0.02	2.1	0.03	2.4	-	5.8	-0.17*
Halley Bay	1.9	0.09*	2.4	0.42*	2.6	0.50*	6.4	1.22*

TABLE 4. Means (m, meters) and decadal changes (tr, meters decade^{-1}) for total thickness of cloud layers with cloud amount 0-100% of the sky for different atmospheric layers. The trend values at the 95% significant level marked by *; other trends are at significant level not less than 50%.

Station	Atmospheric layer							
	0-2 км		2-6 км		6-10 км		0-10 км	
	m	tr	m	tr	m	tr	m	tr
Novolazarevskaya	600	-23	1070	-42*	1414	-41*	3000	-57*
Syowa	560	-17*	1076	-	1507	-	2493	-
Mawson	634	-41*	1083	-27*	1367	-	3078	-92*
Davis	620	-72*	1096	-23*	1332	-	3089	-151*
Mirny	547	-62*	1017	-68*	1368	-75*	2832	-159*
Casey	602	-69*	1092	-24*	1322	64*	2999	-
McMurdo	604	-21*	1074	21	1366	-	2962	-
Bellingshausen	587	14	968	-	1356	-	2781	60*
Halley Bay	508	-35*	1023	-36*	1304	-128*	2740	-154*

TABLE 5. Means (m, meters) and decadal changes (tr, meters decade^{-1}) for low and high boundaries of cloud layers with cloud amount 0-100% of the sky for atmospheric layer 0-10 км. The trend values at the 95% significant level marked by *; other trends are at significant level not less than 50%.

	Low boundary		High boundary	
Station	m	tr	m	tr
Novolazarevskaya	852	-41*	9435	12
Syowa	770	-	7325	-
Mawson	652	-28	9343	104*
Davis	590	-	9340	132*
Mirny	864	-30	9456	36*
Casey	576	-61*	9347	114*
McMurdo	545	-	9229	-
Bellingshausen	723	-66*	9402	-14
Halley Bay	1029	-184*	9319	67

This study is useful to gain insight into climate change in Antarctica. Further researches should be useful. The research was partly supported by RBRF, project 01-05-65285.

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