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Geomagnetic activity influence on the dynamics of the upper mesosphere and lower thermosphere

A. N. Fahrutdinova, O. N. Sherstyukov, and S. V. Maksyutin

Kazan State University, Kazan, Tatarstan, Russia

Abstract. The magnetic activity influence on the dynamics of the upper mesosphere and lower thermosphere is considered. A considerable influence of geomagnetic activity on the dynamics of the neutral wind in the 80–110 km height region is revealed on the basis of wind radiometeor data for Kazan Station (56°N, 49°E) during 1986–1990 and 1993–1995. The influence dependence on spatial and temporal scales of the dynamical processes considered is discovered.

1. Introduction

Intense studies of atmospheric physics and solar-terrestrial relations carried out during the recent decade [*Fahrutdinova and Berdunov*, 1994; *Fahrutdinova et al.,* 1994; *Kazimirovsky and Vergasova*, 1991; *Salah and Deng*, 1996; *Vergasova and Kazimirovsky*, 1992; *Wand*, 1983] made it possible to discover solar and geomagnetic impacts on the state of the Earth's atmosphere. For example, *Wand* [1983] has found a reduction of the semidiurnal tide amplitude by 20–50% at heights of 105–115 km during a geomagnetic disturbance and change of the prevailing zonal wind value above 115 km by $\sim$25 m s^{-1}. *Salah and Deng* [1996] discovered an intensification of the zonal prevailing winds and zonal tidal component around 110 km during a period of a strong geomagnetic disturbance. *Kazimirovsky and Vergasova* [1991] discovered a reverse of the wind direction during intense magnetic storms accompanied by a dispersion of the wind velocity. A considerable change of the phase of the semidiurnal tidal component under small-amplitude changes was also discovered. Performing a correlation analysis of the prevailing wind components with the $F_{10.7}$ indices of the solar radio emission at $\lambda = 10.7$ cm, *Vergasova and Kazimirovsky* [1992] found that a significant correlation is mainly observed in summer and winter, changing the sign from year to year. The correlation of the prevailing wind components with the *Ap* geomagnetic activity indices is small, and a considerable negative correlation of the zonal prevailing wind with the *Ap* indices was found only for some years for the Irkutsk Station. The temporal change of the correlation coefficients depends on seasonal peculiarities of the prevailing wind and is mainly determined by the presence of the annual oscillations. *Singer et al.* [1994] discovered a latitudinal dependency of the zonal prevailing wind reaction on geomagnetic disturbances: an attenuation and intensification of the prevailing zonal winds during geomagnetic disturbances was observed below the 60°N geomagnetic latitude and above it, respectively. An appearance of the northward meridional component of the prevailing wind at heights of 79–85 km was also observed above the 60°N geomagnetic latitude.

Developing a methodical approach for discovering solar and geomagnetic effects, one should bear in mind that they appear on the background of well-pronounced height-temporal variations of the atmospheric thermodynamic parameters.

In this paper the problem of the detection of geomagnetic disturbance effects is considered in the behavior of the following dynamic processes: prevailing, tidal, and mesoscale turbulence motions at heights of the upper mesosphere and lower thermosphere (80–110 km).

The dynamical process parameters in the 80–110 km region were obtained from radiometeor measurements in Kazan during 1986–1995 at the radar station with an altimeter. The technical characteristics of the latter were described by *Sidorov and Fahrutdinova* [1991]. Because there are pronounced annual and semiannual variations of the dynamical processes and their vertical variations, we studied geomagnetic effects as functions of the altitude and season.

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Table 1. Magnetic Activity Influence on the Prevailing Zonal Wind for Various Seasons

Season	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	quiet	13.46	11.26	305
	disturbed	11.59	10.55	125
Spring	quiet	−5.24	12.31	209
	disturbed	−4.41	11.76	97
Summer	quiet	6.55	12.4	364
	disturbed	6.01	12.93	85
Autumn	quiet	5.63	9.11	224
	disturbed	5.64	9.44	83

2. Data Processing Method

Data on the Kp geomagnetic activity indices for 1986–1990 and 1993–1995 and the prevailing wind in the neutral atmosphere measured in the height range 80–110 km with the help of the radar station with the phase altimeter in Kazan (56°N, 49°E) [*Sidorov and Fahrutdinova*, 1991] for the same time period were used in the study.

The influence of geomagnetic conditions on the wind in the upper mesosphere and lower thermosphere was studied for various parameters. The changes of prevailing wind, amplitudes, and phases of the diurnal and semidiurnal tides separately for zonal and meridional components as well as parameter B characterizing the irregular wind structure in the region of mesoscale disturbances were considered. The value of the latter parameter was obtained from the following expression:

$$B = \frac{1}{24} \sum_{i=1}^{24} \frac{\sigma_l^2 U + \sigma_l^2 V}{2}$$

where $\sigma_l^2 U$ and $\sigma_l^2 V$ are the root-mean-squares of the zonal and meridional components of the hourly mean wind velocity for corresponding hour i. It was assumed that the vertical component of the wind velocity is small as compared to the horizontal component. The B value is determined by the wind irregularities in the region of spatial averaging in the process of meteor trail radiolocation. In our case the horizontal dimensions of the region of averaging were 700×700 km. As it follows from the method of $\sigma_l^2 U$ and $\sigma_l^2 V$ determination, parameter B is equal to the daily mean total kinetic energy of irregular (with the temporal scales of 1 hour and less) wind motions referred to as a unit mass.

While forming the experimental temporal series of dynamic parameters, the vertical scale of averaging was chosen to be 3 km to provide a statistical significance of the estimates obtained.

The daily mean value of the geomagnetic activity index was used as a criterion for estimation of the geomagnetic activity level. The geomagnetic situation was considered quiet or disturbed under $\bar{Kp} < 2.5$ or $\bar{Kp} > 2.5$, respectively. From the data on various components of the neutral wind, two samples were made for various states of geomagnetic activity [*Singer et al.*, 1994]. Furthermore, the geomagnetic activity influence on wind parameters was estimated for various seasons.

Analysis of the height dependence of the geomagnetic activity influence on the value and direction of the daily mean zonal and meridional prevailing wind, amplitude, and phase of the diurnal and semidiurnal tidal wind, and also the parameter B characterizing the intensity of the wind field disturbances with the temporal scales of 1 hour and less, was carried out.

3. Prevailing Wind

At the first stage, the analysis of geomagnetic activity influence on the components of the prevailing wind averaged over the entire height region considered was carried out. Tables 1 and 2 show the results of this analysis. In

Table 2. Magnetic Activity Influence on the Prevailing Meridional Wind for Various Seasons

Season	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	quiet	0.06	10.04	305
	disturbed	2.03	9.74	125
Spring	quiet	−0.77	7.14	209
	disturbed	−0.46	6.21	97
Summer	quiet	−8.88	9.23	364
	disturbed	−7.92	10.78	85
Autumn	quiet	−1.65	9.40	224
	disturbed	1.32	9.88	83

Table 3. Magnetic Activity Influence on Parameters of the Diurnal Tide Zonal Component

Season	Parameter	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	A_1	quiet	11.67	(4.75)	274
		disturbed	12.44	(4.13)	120
	F_1	quiet	10.81	(3.22)	274
		disturbed	10.77	(3.44)	120
Spring	A_1	quiet	(9.87)	(3.46)	205
		disturbed	(11.4)	(3.62)	88
	F_1	quiet	(14.9)	2.78	205
		disturbed	(14.1)	2.61	88
Summer	A_1	quiet	9.16	(3.29)	342
		disturbed	9.84	(3.73)	76
	F_1	quiet	12.41	3.73	342
		disturbed	12.86	3.56	76
Autumn	A_1	quiet	9.22	(4.08)	211
		disturbed	9.14	(3.44)	77
	F_1	quiet	13.26	(3.23)	211
		disturbed	13.88	(3.33)	77

Tables 1–7, N is the volume of the samples considered. A degree of difference of the mean values for the samples considered was evaluated by checking the hypotheses on equality of the means and excess over the mean under various conditions. The significance of changes of the standard deviation (SD) of the samples was estimated using the Fisher criterion [*Leman*, 1964]. In this case the SD characterizes a disturbance degree of the corresponding wind components. All checks of statistical significance were performed for a significance level of 0.05. In the tables presented the significant changes are in parentheses.

It follows from the data shown in the tables that for the zonal component of the prevailing wind a decrease of its value with increasing geomagnetic activity is mainly observed. In autumn no impact of the geomagnetic activity on the seasonal mean values of the zonal component of the prevailing wind is observed. The meridional component of the prevailing wind demonstrates the following reaction to variations of the geomagnetic activity level: in all seasons there appears a meridional wind component directed northward which results in an increase of the northward wind and a decrease of the southward wind. Moreover, the SD of both components of the prevailing wind decreases in winter and spring and increases in summer and autumn. For the samples considered, the observed reaction of the seasonal mean components of the prevailing wind caused by the variations of the geomagnetic activity level is statistically significant in 38% of the cases, and the SD variations are significant in 63% of the cases.

At the second stage, the influence of geomagnetic activity on the value and direction of the prevailing wind was studied as a function of height and season. Figures 1 and 2 show the results. It follows from these figures that the influence of geomagnetic activity on the zonal component of the prevailing wind is most considerable in summer, autumn, and winter. In summer, a typical height inversion of the zonal prevailing wind direction not related to the magnetic field state is observed in the height range 80–95 km (Figure 1). Moreover, in periods of magnetic disturbances the zonal component of the prevailing wind demonstrates a change of the wind velocity vertical gradient: the wind velocity gradient decreases at heights of 80–95 km and increases at heights of 95–100 km. Averaged over a season, the amplitude of the prevailing wind

Table 5. Magnetic Activity Influence on Parameters of the Semidiurnal Tide Zonal Component

Season	Parameter	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	A_2	quiet	25.36	(8.37)	297
		disturbed	25.91	(7.11)	120
	F_2	quiet	(8.26)	1.32	297
		disturbed	(8.56)	1.26	120
Spring	A_2	quiet	15.62	(5.83)	216
		disturbed	16.23	(5.96)	93
	F_2	quiet	8.13	(1.05)	216
		disturbed	7.94	(1.18)	93
Summer	A_2	quiet	(14.89)	5.28	379
		disturbed	(16.21)	6.30	90
	F_2	quiet	(7.90)	1.04	379
		disturbed	(7.69)	0.97	90
Autumn	A_2	quiet	21.46	(7.36)	228
		disturbed	22.42	(7.77)	83
	F_2	quiet	(7.14)	1.31	228
		disturbed	(6.84)	1.18	83

Table 4. Magnetic Activity Influence on Parameters of the Diurnal Tide Meridional Component

Season	Parameter	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	A_1	quiet	9.83	3.81	273
		disturbed	10.08	3.41	120
	F_1	quiet	(10.03)	(3.87)	273
		disturbed	(10.69)	(3.33)	120
Spring	A_1	quiet	(9.69)	(3.44)	205
		disturbed	(8.73)	(2.61)	91
	F_1	quiet	11.23	2.34	205
		disturbed	11.37	2.15	91
Summer	A_1	quiet	10.50	(3.80)	340
		disturbed	10.65	(3.85)	75
	F_1	quiet	11.60	2.61	340
		disturbed	11.92	2.27	75
Autumn	A_1	quiet	(8.84)	2.98	212
		disturbed	(9.60)	2.68	78
	F_1	quiet	11.52	2.88	212
		disturbed	11.10	2.51	78

Table 6. Magnetic Activity Influence on Parameters of the Semidiurnal Tide Meridional Component

Season	Parameter	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	A_2	quiet	26.82	9.63	298
		disturbed	26.04	9.05	120
	F_2	quiet	6.33	(1.22)	298
		disturbed	6.16	(0.94)	120
Spring	A_2	quiet	14.11	(5.78)	214
		disturbed	14.26	(4.69)	97
	F_2	quiet	(5.64)	(1.22)	214
		disturbed	(5.92)	(1.39)	97
Summer	A_2	quiet	(15.61)	5.81	376
		disturbed	(16.85)	5.78	90
	F_2	quiet	5.48	1.10	376
		disturbed	5.47	1.06	90
Autumn	A_2	quiet	22.45	8.61	229
		disturbed	23.15	8.50	85
	F_2	quiet	(4.72)	(1.82)	229
		disturbed	(4.34)	(1.42)	85

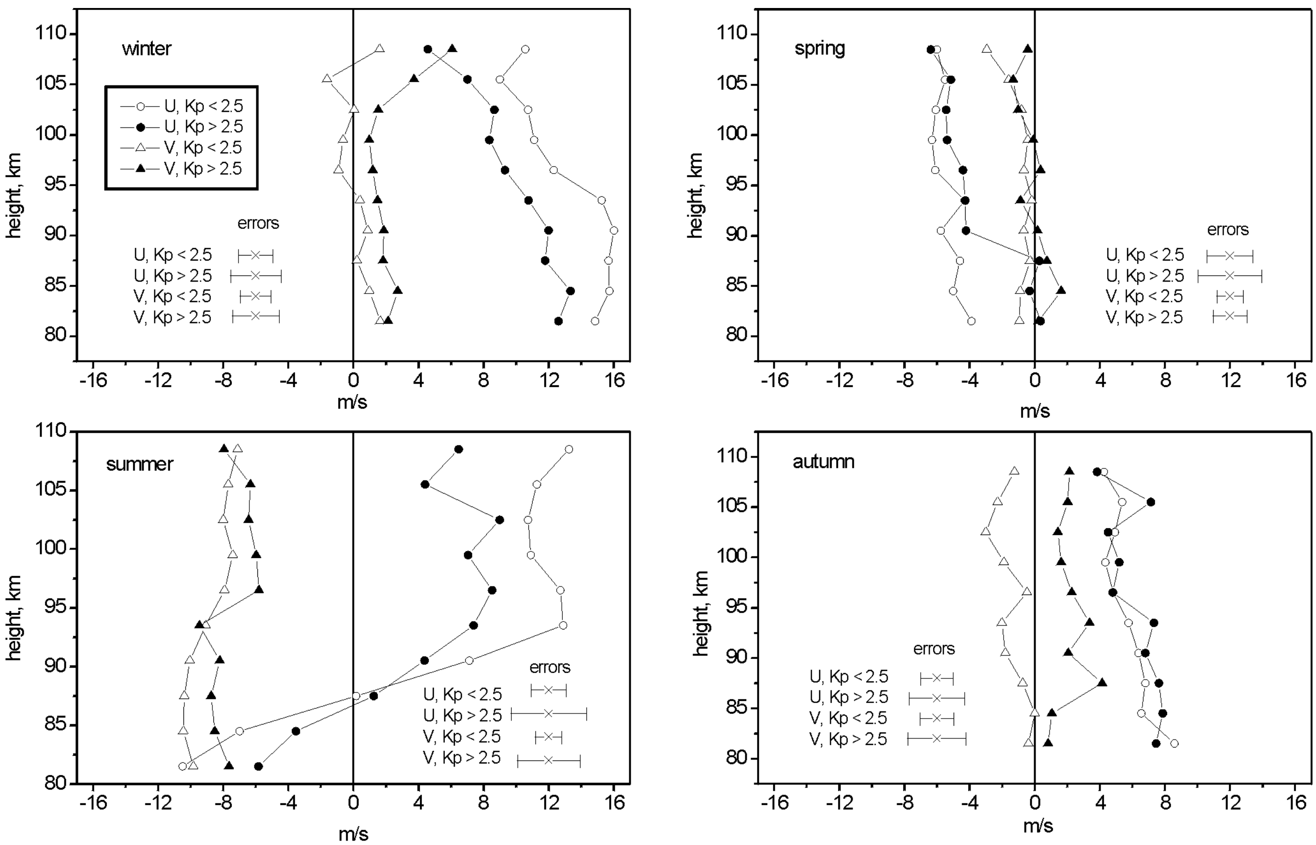

Figure 1. Geomagnetic activity influence on the vertical profiles of the zonal (U) and meridional (V) components of the prevailing wind. Open and solid circles correspond to quiet and disturbed magnetic conditions, respectively.

zonal component decreases during magnetic disturbances in the entire height region considered. The variations of the seasonal mean values of the zonal component for disturbed magnetic conditions reaches 50% at some altitudes. A strong influence of geomagnetic activity on the meridional component of the prevailing wind up to a reversal of its direction is observed in all seasons.

In winter and in autumn an anticlockwise turn of the prevailing wind vector (in the coordinate system shown in Figure 2) under disturbed geomagnetic conditions, as compared with quiet conditions, is observed in the entire height region considered. The turn is especially pronounced in winter at altitudes above 104 km and in autumn above 89 km. In summer the clockwise turn of the prevailing wind vector with a decrease of altitude typical for this height region is observed for quiet geomagnetic conditions. Under disturbed geomagnetic conditions, some advance and some delay of the resulting wind vector, as compared with quiet geomagnetic conditions, are observed at altitudes of 89–110 km and 80–89 km, respectively. Therein in winter and summer under increased levels of geomagnetic disturbances a decrease of the prevailing wind vector value is observed in the entire height region considered.

4. Tidal Motions

The influence of geomagnetic activity on the diurnal and semidiurnal tides of the neutral wind was studied. Tables 3–6 show the influence of geomagnetic activity on the parameters of the tides considered for four seasons on the average in the height range 80–110 km. The following symbols are used: $A_{1,2}$ and $F_{1,2}$ are the amplitude and phase of the (1) diurnal and (2) semidiurnal tides, respectively. In this case the tidal phase corresponds to the local time of the maximum of the corresponding component (zonal or meridional) of the tide. The statistical significance of the observed changes caused by the variations of the magnetic activity level was checked by the method described above.

The zonal component of the diurnal tide demonstrates an increase of the seasonal mean amplitude for disturbed magnetic conditions in winter, spring, and summer and a decrease of this amplitude in autumn. For the zonal component of the diurnal tide a phase advance for disturbed magnetic conditions, as compared with quiet conditions in winter and spring and a delay in summer and autumn, is observed. In spring the above advance observed for disturbed magnetic conditions as compared with quiet conditions at heights of 100–107 km, reaches 2.5 hours. The SD of the amplitude of the diurnal tide zonal component decreases in winter and autumn and increases in spring and summer. On the contrary, the SD of the phase of the diurnal tide zonal component increases in winter and autumn and decreases in spring and summer.

The meridional component of the diurnal tide demonstrates an increase of the seasonal mean amplitude during magnetic disturbances in all seasons except spring, when a decrease is observed. The meridional component of the diurnal tide averaged over season demonstrates a phase advance for disturbed magnetic conditions as compared with quiet magnetic conditions in autumn and a phase delay in other seasons. The SD of the amplitude of the diurnal tide meridional component decreases in winter, spring, and autumn and increases in summer. The SD of the phase of the diurnal tide meridional component decreases in all seasons.

For the samples considered, the observed reaction of the seasonal mean amplitudes of the diurnal tide components caused by variations of the geomagnetic activity level and the changes of SD are statistically significant in 38% and 75% of the cases, respectively. The changes of the seasonal mean values of the diurnal tide phase caused by an increase of the geomagnetic activity level and the changes of SD are statistically significant in 25% and 38% of the cases, respectively.

The amplitude of the zonal and meridional components of the semidiurnal tide demonstrates an increase of the seasonal mean amplitude during magnetic disturbances in all seasons except winter, when the meridional component decreases. For both components of the semidiurnal tide a phase advance under disturbed magnetic conditions in comparison with quiet conditions is observed for all seasons. The zonal component in winter and the meridional component in spring, when a delay is observed, present an exception. The changes observed of the seasonal mean parameters of the semidiurnal tide and the SD changes are statistically significant in 44% and 50% of the cases, respectively, though the sign of the changes is not constant and varies depending on the season.

The increase of tide amplitude detected in most cases under an increase of geomagnetic activity related to an increase of solar activity corresponds to the current hypothesis on the source of tidal motions.

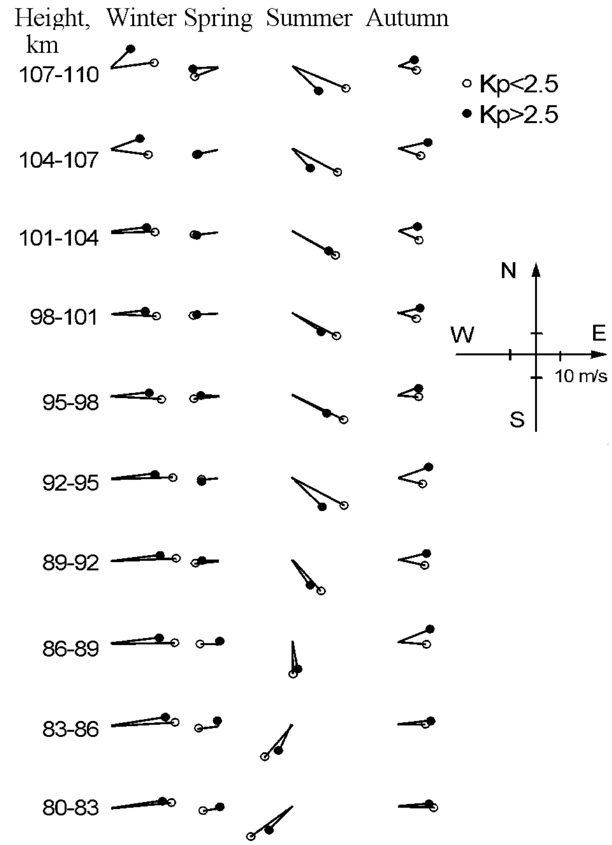

Figure 2. Geomagnetic activity influence on the value and direction of the prevailing wind at various heights. Open and solid circles correspond to quiet and disturbed magnetic conditions, respectively.

Table 7. Magnetic Activity Influence on the Small-Scale Irregular Structure of the Wind (Parameter B)

Season	Geomagnetic Condition	Mean, m s^{-1}	SD, m s^{-1}	N
Winter	quiet	(596.3)	(277.9)	286
	disturbed	(541.9)	(224.6)	112
Spring	quiet	394.9	176.2	192
	disturbed	375.3	184.0	86
Summer	quiet	(480.8)	146.0	337
	disturbed	(540.3)	180.0	77
Autumn	quiet	442.1	140.4	223
	disturbed	461.4	174.0	84

Furthermore, the influence of geomagnetic activity on the vertical profiles of the amplitude of the diurnal tide zonal and meridional components was analyzed. Figure 3 shows the results of this analysis. It shows that the influence of geomagnetic activity on the amplitude of the zonal and meridional components of the diurnal tide is most significant in winter and spring when at some altitudes, the variations of the seasonal mean amplitudes of the diurnal tide components reach 40% for the geomagnetic activity levels considered. However, for these parameters the presence of height regions where the influence of geomagnetic activity is not seen or is poorly pronounced is also typical. For the diurnal tide zonal component the influence of geomagnetic activity is small at heights of 89–92 km in summer, autumn, and winter, at heights 101–104 km in spring and winter, and at heights of 104–107 km in summer and autumn. The influence of magnetic activity on the meridional component is the weakest in the height range 92–95 km during the entire year and at heights of 86–89 km in winter, spring, and summer. Moreover, the influence of geomagnetic activity on the vertical profiles of the phase of the diurnal tide zonal and

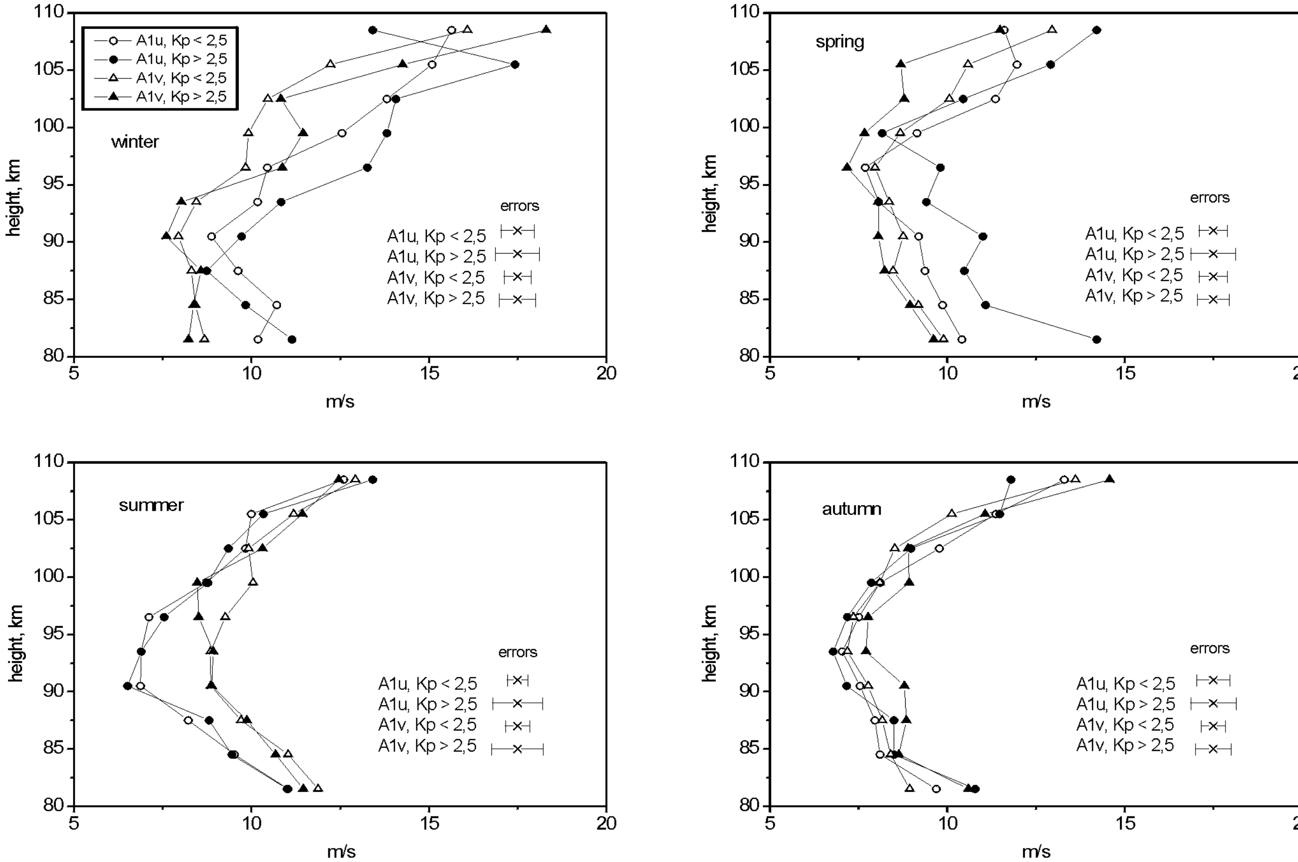

Figure 3. Geomagnetic activity influence on the vertical profiles of the zonal (U) and meridional (V) components of the diurnal tide amplitude. Open and solid circles correspond to quiet and disturbed magnetic conditions, respectively.

meridional components was analyzed. It was found that the phase reaction on magnetic disturbances also depends on altitude. A minimum of the phase change is observed in all seasons within the height range 95–101 km. The seasonal mean change (advance or delay) of the phase of the diurnal tide components under the influence of geomagnetic activity for some height ranges reaches 3 hours.

The influence of geomagnetic activity on the vertical profiles of the amplitude of the semidiurnal tide zonal and meridional components was analyzed. It follows from the analysis performed that the influence of geomagnetic activity on the amplitude of the semidiurnal tide components is most significant in winter and summer when at some heights the variations of the seasonal mean amplitudes of the semidiurnal tide components reach 15% for the geomagnetic activity levels considered. In spring and winter the influence is much less pronounced. The amplitude of the semidiurnal tide components also has height regions where the geomagnetic activity influence is not manifested or is weakly pronounced. For example, for both components this height region is 92–95 km in winter and summer and 89–92 km in spring and autumn. The geomagnetic activity influence on the vertical profiles of the phase of the semidiurnal tide zonal and meridional components was also studied. The reaction of the semidiurnal phase on magnetic disturbance depends on altitude (as is the case for the diurnal tide), but this dependence varies from season to season. In autumn a change of the vertical gradient of the seasonal mean values of the phase of the semidiurnal tide zonal component is observed for various geomagnetic conditions. The phase of the semidiurnal tide meridional component demonstrates a seasonal dependence of the vertical gradient of the seasonal mean values: in winter the gradient is maximum, and in summer, it is minimum.

It is discovered that the reaction of the diurnal tide phase to magnetic disturbance is more pronounced than the reaction of the semidiurnal tide phase, this fact probably being one of the causes of the phase instability of the diurnal tide.

Besides the influence of geomagnetic factors, the seasonal mean vertical profiles of the tide amplitude demonstrate also a difference in vertical profiles for the zonal and meridional components in quiet magnetic conditions, caused evidently by the influence of physical factors that are not related to geomagnetic activity and in a different way influence the zonal and meridional components of the tidal wind. The observed effect has the order of magnitude, compared with the influence of magnetic activity, and is more pronounced at heights above 95 km in winter and summer.

5. Irregular Wind Structure in the Region of Mesoscale Disturbances

We considered the influence of geomagnetic activity on the irregular structure of the neutral wind in the region of mesoscale disturbances on the example of parameter B. Table 7 shows the analysis results of this influence on the average for the height range 80–110 km. The analysis shows that the influence of geomagnetic activity on the irregular structure of the neutral wind in the mesoscale disturbance region is less pronounced than the influence on larger-scale components. The observed changes of the mean values and SD for the sample of the parameter B considered have no permanent sign.

Figure 4 shows the influence of geomagnetic activity on vertical profiles of the neutral wind irregular structure in the mesoscale disturbance region. This influence is weakly pronounced except for the height range 104–110 km. Large increases of B (up to 60%) related to increases of geomagnetic activity are observed here in summer.

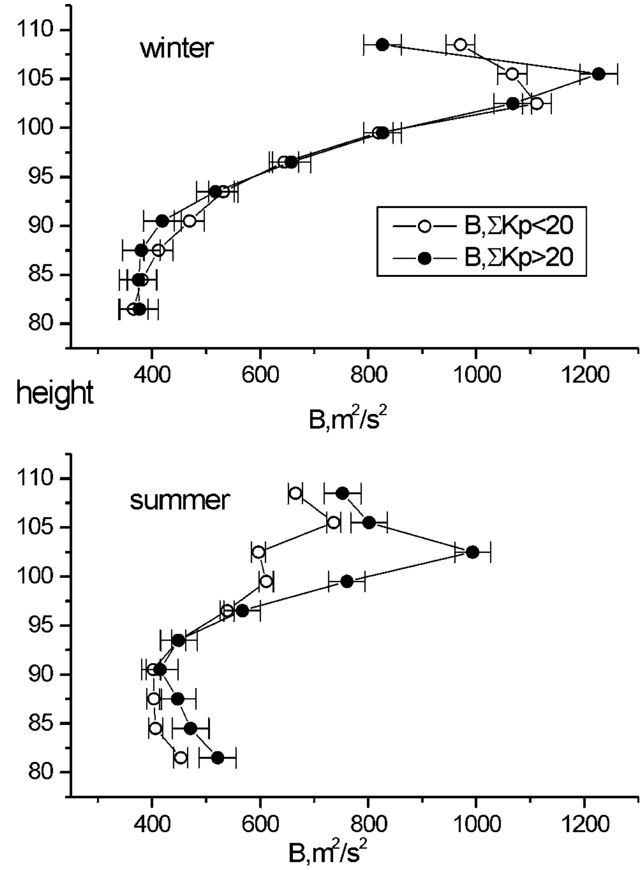

Figure 4. Geomagnetic activity influence on the vertical profiles of the neutral wind irregular structure. Open and solid circles correspond to quiet and disturbed magnetic conditions, respectively.

6. Discussion

In the analysis conducted we have discovered the following peculiarities of geomagnetic activity influence on the upper mesosphere and lower thermosphere dynamics.

The influence of geomagnetic activity on the neutral wind within the height range of the upper mesosphere and lower thermosphere is most significant for the components of large-scale winds (prevailing wind, tidal motions) and is considerably less for the reduced spatial and temporary scales of dynamic processes. This conclusion agrees with the results published earlier [*Kazimirovsky and Vergasova*, 1991; *Salah and Deng*, 1996; *Vergasova and Kazimirovsky*, 1992; *Wand*, 1983]. However, the conclusion on the absence of the geomagnetic disturbance influence on the neutral atmosphere below 100–105 km made by *Salah and Deng* [1996] and *Wand* [1983] is not confirmed by our results. This discrepancy evidently can be explained by a small amount of data used by *Salah and Deng* [1996] and *Wand* [1983]. Besides, an averaging over seasons was done in our work, and so the results obtained describe an average tendency for corresponding seasons. Thus contradictions with a neutral wind reaction to particular disturbances are possible.

It is found that under increased levels of geomagnetic activity a reduction of the zonal prevailing wind amplitude and appearance of the northward meridional component of the prevailing wind is mainly observed. Such a reaction of the zonal prevailing wind to geomagnetic activity completely confirms the result received by *Singer et al.* [1994] for geomagnetic latitudes below 60°N (the geomagnetic latitude of Kazan is 49°N). However, the *Singer et al.* [1994] conclusion on the absence of the specific reaction of meridional prevailing winds to an intensification of geomagnetic activity does not agree with our results. Such a discrepancy, apparently, is due to a small number of intense geomagnetic disturbances considered by *Singer et al.* [1994].

As a result of the analysis performed of the geomagnetic activity influence on the value and direction of the prevailing wind vector, it is discovered that under disturbed geomagnetic conditions (contrary to the quiet conditions) during winter and autumn within the entire height range considered and during summer within the height range 80–89 km, a rotation of the prevailing wind vector in the counterclockwise direction was observed. However, during summer, within the height range 89–110 km, the rotation was in a clockwise direction. Herewith, a reduction of the prevailing wind vector magnitude is observed both in winter and in summer.

It follows from the studies conducted earlier that the influence of geomagnetic activity on the tidal wind is of a variable nature. *Kazimirovsky and Vergasova* [1991] has found significant changes of the semidiurnal tide phase accompanied by small changes of the amplitude during geomagnetic disturbances. *Wand* [1983] has found a reduction of the semidiurnal tide amplitude by about 20–50% in the 105–115 km height range. *Salah and Deng* [1996] has found an intensification of the zonal components of the diurnal and semidiurnal tides around 100 km during geomagnetic disturbances and an absence of significant reactions of the tidal meridional components. *Singer et al.* [1994] has detected a weak reduction of the semidiurnal tide amplitude during the days of disturbed geomagnetic conditions for two of the seven stations considered and an absence of any specific reactions for quiet geomagnetic conditions. It is found here that the maximum influence of geomagnetic activity on the diurnal tide during spring and autumn and on the semidiurnal tide during summer is observed, an increase of the tidal components amplitude being mainly observed. An advance of the phase of the diurnal tide zonal component during winter and spring, and of the diurnal tide of the meridional component during autumn under disturbed geomagnetic conditions (contrary to quiet geomagnetic conditions), and a delay of the phase of the meridional component in other seasons are observed. It is also discovered that the reaction of the diurnal tide phase on geomagnetic disturbances is more significant than that of the semidiurnal tide phase. Thereby, the problem of the influence of geomagnetic activity on the tidal wind is not yet solved completely and requires an additional study.

The influence of geomagnetic activity on the irregular structure of neutral winds within the range of mesoscale disturbances is found to be weaker than that for larger-scale components, such as prevailing wind and tides. A significant (up to 60%) increase of the magnitude of parameter B (which characterizes the irregular structure of the wind within the range of mesoscale disturbances) related to an intensification of geomagnetic activity is observed during summer at heights 104–110 km.

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A. N. Fahrutdinova, S. V. Maksyutin, and O. N. Sherstyukov, Kazan State University, 18 Kremlevskaya Str., Kazan 420008, Tatarstan, Russia. (Antonina.Fahrutdinova@ksu.ru)

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