The fact that solar activity affects atmospheric circulation in the Northern Hemisphere winter is well known whereas the response of the lower atmosphere to geomagnetic activity is less understood. The aim of this study is to investigate whether strong short-term geomagnetic disturbances may affect the distribution of stratospheric and tropospheric pressure and temperature fields in the Northern Hemisphere winter. The analysis includes 34 isolated geomagnetic storms, which occurred in winter seasons (December-March) of 1952-2003. Atmospheric circulation is described by geopotential height anomalies along a vertical profile (from 20 hPa to 850 hPa). Composite mean maps and superposed epoch analysis are used; data are taken from NCEP/NCAR reanalysis. Statistical significance is tested using Monte Carlo method. The results indicate that after a storm onset the decrease of pressure and temperature occur in the high-latitude lower stratosphere. Strengthening of stratospheric polar vortex is followed by an increase of daily NAO index. The impact of geomagnetic storms is modulated by the solar activity, phase of quasi-biennial oscillation and occurrence of stratospheric warmings. The tropospheric response is dependent on stratosphere-troposphere coupling and the distribution of pressure systems occurring in the Euro-Atlantic region. In the case of atmospheric blocking, the response of the lower atmosphere to geomagnetic storm is restricted to stratosphere only.