In the frame of global atmospheric electric circuit concept, thunderstorms are responsible for maintaining a slowly time-varying electric potential difference of ~250 kV between the ionosphere and the earth surface. In the polar regions a current flows from the ionosphere to the ground and a vertical electric field ($E_z$) can be measured near ground-level. In addition to the meteorological generator, at high latitudes the solar wind-and magnetospheric phenomena imposes relatively rapid potential variations ($U$) in the overhead ionosphere. Regular measurements of $E_z$ variations are performed at Vostok station (mlat 83.6°S) in Antarctica. In the northern hemisphere $E_z$ is measured at Hornsund observatory (mlat 74°N) at Spitsbergen. In this paper we evaluate the relationship between the $E_z$ obtained under the conditions of “fair weather” and the $U$ obtained from the SuperDARN observations, convection models and ground magnetic measurements on the basis of selected days and a larger statistics. It is shown that under certain IMF/solar zenith angle conditions the $E_z$ reflects fairly well the overhead $U$ in the near-pole region. At the auroral latitudes $E_z$ primarily responds to the substorm development. Quantitative characteristics of the $E_z$-$U$ relationship are presented.