Explicit IMF $B_y$-dependence in geomagnetic activity

Lauri Holappa, Timo Asikainen, and Kalevi Mursula
Space Physics and Astronomy Research Unit, University of Oulu, Oulu, Finland (lauri.holappa@oulu.fi)

The interaction of the solar wind with the Earth’s magnetic field produces geomagnetic activity, which is critically dependent on the orientation of the interplanetary magnetic field (IMF). Most solar wind coupling functions quantify this dependence on the IMF orientation with the so-called IMF clock angle in a way, which is symmetric with respect to the sign of the $B_y$ component. However, recent studies have shown that IMF $B_y$ is an additional, independent driver of high-latitude geomagnetic activity, leading to higher (weaker) geomagnetic activity in Northern Hemisphere (NH) winter for $B_y > 0$ ($B_y < 0$). For NH summer the dependence on the $B_y$ sign is reversed. We quantify the size of this explicit $B_y$-effect with respect to the solar wind coupling function, both for northern and southern high-latitude geomagnetic activity. We show that for a given value of solar wind coupling function, geomagnetic activity is about 40% stronger for $B_y > 0$ than for $B_y < 0$ in NH winter. We also discuss recent advances in the physical understanding of the $B_y$-effect. Our results highlight the importance of the IMF $B_y$-component for space weather and must be taken into account in future space weather modeling.