Explicit IMF By-dependence in geomagnetic activity

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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 By component. However, recent studies have shown that IMF By is an additional, independent driver of high-latitude geomagnetic activity, leading to higher (weaker) geomagnetic activity in Northern Hemisphere (NH) winter for By > 0 (By < 0). For NH summer the dependence on the By sign is reversed. We quantify the size of this explicit By-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 By > 0 than for By < 0 in NH winter. The physical mechanism of the By-effect is not yet fully understood. Here we show that IMF By modulates the flux of energetic electrons precipitating into the ionosphere which likely modulates the ionospheric conductivity and, thus, geomagnetic activity. Our results highlight the importance of the IMF By-component for space weather and must be taken into account in future space weather modeling.