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A New Index to Describe the Response of Geomagnetic Disturbance to the Energy Injection from the Solar Wind

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In this paper, we establish a new non-dimensional global geomagnetic disturbance index J_p^G by applying the spectral whitening method to the horizontal components of geomagnetic fields observed at eight ground-based stations distributed at low and middle latitudes during years 1998 to 2014. This index can describe the development of geomagnetic storms and its relationship with the Dst index has been verified, which gives a correlation coefficient (CC) of about 0.72. We also check the response of J_p^G to the arrival of upstream solar wind energy based on a proxy that the ring current injection term Q. The variation of J_p^G in course of geomagnetic storms is similar to the variation of Q, and the recorded minimum values of Q (Q_{min}) and J_p^G ($J_{p_{min}}^G$) for 30 great storms yields a relatively better CC of about 0.82. These results illustrate that J_p^G can effectively depict the storm evolution and is well related to the associated Q in amplitude, which provides an alternative means of geomagnetic storm forecasting. In addition, we note that the time difference between Q_{min} and $J_{p_{min}}^G$, as well as the time difference when J_p^G recovers from $J_{p_{min}}^G$ to half and/or one-third of its value, are shorter than those of the corresponding Dst index. And especially, for multiple storms occurred continuously on a short time scale, the recovery of the Dst index to a quiet period level can be affected by the following solar wind energy input, while the J_p^G index does not and exhibits independently.