



Spring-Fall asymmetry of substorm strength, geomagnetic activity and solar wind: Implications for semiannual variation and solar hemispheric asymmetry

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We study the seasonal variation of substorms, geomagnetic activity and their solar wind drivers in 1993 - 2008. The number of substorms and substorm mean duration depict an annual variation with maxima in Winter and Summer, respectively, reflecting the annual change of the local ionosphere. In contradiction, substorm mean amplitude, substorm total efficiency and global geomagnetic activity show a dominant annual variation, with equinoctial maxima alternating between Spring in solar cycle 22 and Fall in cycle 23. The largest annual variations were found in 1994 and 2003, in the declining phase of the two cycles when high-speed streams dominate the solar wind. We find that there is a similar, large annual variation in the solar wind driver of substorms and geomagnetic activity, which implies that the annual variation of substorm strength, substorm efficiency or geomagnetic activity is not due to ionospheric conditions but to a hemispherically asymmetric distribution of solar wind which varies from one cycle to another. Our results imply that the overall semiannual variation in global geomagnetic activity has been seriously overestimated, and is largely an artifact of the dominant annual variation with maxima alternating between Spring and Fall. The results also suggest an intimate connection between the asymmetry of solar magnetic fields and some of the largest geomagnetic disturbances, offering interesting new pathways for forecasting disturbances with a longer lead time to the future.