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Advances in characterizing the ring current magnetic effect at ground level

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Electric currents flowing in the magnetosphere are the strongest external source of the superposed magnetic field measured on ground. Closest to Earth flows the ring current that is fed by ions which drift duskward from the magnetotail. The produced magnetic field inherently exhibits a dawn-dusk gradient, because part of the ion distribution is lost to the dayside magnetosheath – especially so when the magnetopause is pushed inward during geomagnetic storms triggered by interplanetary coronal mass ejections (ICMEs).

A continuous monitoring of this global magnetospheric field from ground is realized via the hourly Dst index since 1957 and the one minute resolved SYM and ASY indices since 1981. They provide relative strengths of both parts of the field, the one that is symmetric (Dst, SYM) and the one that is asymmetric (ASY) with respect to magnetic local time (MLT). Being based on averages or ranges of geographically scattered magnetic observatory measurements, these indices however fail to adequately characterize the magnetospheric field at a particular place during geomagnetically active times.

In this study we explore empirical ways to model the magnetospheric field signature on Earth under disturbed conditions with dependencies on MLT in space and solar wind/IMF conditions in time. We investigate a selection of geomagnetic storms based on observatory hourly means (OHMs), from which contributions of the main field, the crustal field and the ionospheric field are removed. The direct part of this residual signal is isolated from the secondarily induced part by means of a 1-D electrical conductivity model of the Earth's mantle.

The "cleaned" OHMs from different observatories provide global MLT resolved spatial patterns of the disturbance at each universal time hour during each storm. These patterns are temporally overlain according to the storm phases in a superposed epoch analysis to yield a statistically typical ICME driven disturbance field. We plan to identify the physical quantities that govern the dynamical change of this field throughout the storm via a comparison to solar wind/IMF properties measured by in-situ satellites, for example the energy transferred to the magnetosphere. Within the scope of a long-term continuous magnetospheric field description on Earth, we will try to render the deduced parameterization independent of the contemporaneous satellite measurements, so that it can be applied back in time through the magnetic observatory era.