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Comment on npg-2021-23

Anonymous Referee #2

Referee comment on "Investigation on the characteristics of the South Atlantic Anomaly"
by Khairul Afifi Nasuddin et al., Nonlin. Processes Geophys. Discuss.,
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Investigation on the characteristics of the South Atlantic Anomaly

Khairul Afifi Nasuddin, Mardina Abdullah, and Nurul Shazana Abdul Hamid

The paper analyzes the persistent and anti-persistent character of the horizontal component (H) of the magnetic field fluctuations during geomagnetically quiet and disturbed periods at different latitudes. The authors find that the magnetic field fluctuations have a persistent character in the South Atlantic Anomaly (SAA) region regardless of the geomagnetic activity level. Conversely, the magnetic field fluctuations have an anti-persistent character at high latitude and both persistent and anti-persistent character at mid latitude. The authors ascribe the different behavior (persistent/anti-persistent) of the magnetic field fluctuations to the presence of the ring current at low latitude (SAA region) and to plasma motion and seasonal variation at higher latitude.

The study of the persistent and anti-persistent character of the horizontal component of the magnetic field fluctuations through the estimation of the Hurst exponent is not new. For example, De Michelis & Consolini (J. Geophys. Res. Space Physics, 120, doi:10.1002/2014JA020685, 2015) investigated the changes of the Hurst exponent values and reconstruct maps of this index as a function of the geomagnetic activity level by using 45 ground-based geomagnetic observatories distributed in the Northern Hemisphere. They found that the geomagnetic field fluctuations associated with the different ionospheric current systems have different scaling features, which can be evidenced by the Hurst exponent values. They also showed that in general, the local Hurst exponent for quiet periods was higher than that for more active periods suggesting that the dynamical processes that were activated during disturbed times were responsible for changes in the nature of the geomagnetic field fluctuations.

By using time series of the geomagnetic horizontal component data, acquired by the Magnetic Data Acquisition System (MAGDAS), Hamid and collaborators (Hamid et al., doi:10.1109/ICONSPACE.2009.5352642) found that the values of Hurst exponent ranged between 0.3-0.5 for quiet periods and between 0.5-0.7 for active periods for all the

analyzed stations. They found that the H component became more persistent during geomagnetically active periods at the selected equatorial stations.

The same authors of this manuscript have already published a similar work in 2019 (Nasuddin et al., *Nonlin. Processes Geophys.*, 26, 25–35, 2019 <https://doi.org/10.5194/npg-26-25-2019>). The difference is the total number of the selected geomagnetic observatories (9 new observatories have been added in this paper) and the total number of analyzed days (from the initial two days to the current eight).

In addition to the fact that the analysis is not original, that the results obtained do not agree with what was previously found and that the authors give no explanation for this, the proposed study has some inaccuracies which provide poor results.

- The Dst index cannot be used to describe the level of geomagnetic activity at high latitudes. This index is a measure of the geomagnetic disturbance level at low/mid latitude due to the occurrence of geomagnetic storms. It is well known that magnetospheric substorms can occur at high latitude without the development of geomagnetic storms at low latitude. For this reason, the “normal period” selected by the authors using values of $Dst > -30$ nT can correspond to a “disturbed period” at high latitude. For example, one of this “normal period”, 4/4/2013, is characterized by the occurrence of an intense geomagnetic substorm ($AE > 600$ nT) at high latitude. In two others “normal periods”, 25/3/2012 and 21/3/2012, there are some low intensity substorms (AE around 300 nT). Therefore, the selection of the two different levels of geomagnetic activity is not correct.
- The authors suggest that the persistent behavior of the magnetic field fluctuations in the SAA region may be due to the presence of the ring current. The effect of the ring current on the magnetic field recorded on the ground should be the same in all magnetic observatories at low/mid latitude. What is the value of Hurst exponent in the case of magnetic field fluctuations recorded at the same SAA latitude but outside of it? The ring current always flows around the Earth but its intensity changes during disturbed periods and consequently changes also its effect on the H component of the magnetic field. Is it possible that this change does not influence the character of the magnetic field fluctuations?
- The authors suggest that at mid-latitude region the mixture of the persistent and anti-persistent character of the magnetic field fluctuations may be due to plasma transport and seasonal variations. The authors selected 8 days around the spring equinox and 2 days during summer. This selection does not allow a seasonal study.
- The authors suggest that the behavior of the magnetic field fluctuations at high latitude can be due to the particle precipitation that characterized the auroral region. They found that it doesn't depend on geomagnetic activity level. The processes identified by the authors depend on the geomagnetic disturbance level. Conversely, the magnetic field fluctuations have always an anti-persistent character. How can the authors explain that?

The study of the properties of the magnetic field fluctuations in the SAA region is interesting but the obtained results are not supported by a correct analysis and interpretation. For this reason, I am sorry but I cannot recommend the publication of this

work in the present form.