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Interactive comment on "Transfer Entropy between South Atlantic Anomaly and Global Sea Level for the last 300 years" *by* Saioa A. Campuzano et al.

Anonymous Referee #2

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The paper explores potential relationships between the spatial extension of South Atlantic Anomaly SAA, a feature of the changing Earth's magnetic field, and the Global Sea Level GSL. The time period considered consists of the recent 300 years is. In this period, the magnetic dipole field of the Earth has been declining. The increasing (and westward moving) magnetic anomaly at the ocean surface over the South Atlantic is an important ingredient in this process (see, for example, Finlay et al., Nature, 2016). At the same time, Global Sea Level has been increasing. The parallel development of the phenomena has been discussed in a paper of De Santis et al., JASTP, 2012. Two of the current authors (De Santis and Qamili) have also been authors of the former paper.

While the 2012 paper focused on the long term trends, the current paper and seeks to

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investigate the shorter term variations beyond the nonlinear trend. For this purpose, the time series were smoothed using penalized cubic splines, and the long term trends we removed using 2nd order polynomials. A procedure called transfer entropy is applied in order to estimate the statistical relationship. It is stated that there is a significant relationship with a lag of one year or less, the South Atlantic Anomaly leading the Global Sea Level variations.

Considering two parallel trends without a physical explanation is generally a problematic approach. The supposed relationship of cosmic rays (with their intensity influenced by the magnetic field) and clouds (which are again affecting temperatures) has amply been discussed in the recent IPCC WG1 report. The synthesis given there is as follows: “Although there is some evidence that ionization from cosmic rays may enhance aerosol nucleation in the free troposphere, there is medium evidence and high agreement that the cosmic ray-ionization mechanism is too weak to influence global concentrations of CCN or droplets or their change over the last century or during a solar cycle in any climatically significant way. “ The manuscript doesn’t come up with another process that could physically explain the relationship (I do not consider a suspected regional O3 change a credible link between SAA and GSL). Still, a thorough demonstration of the characteristics of the relationships on shorter time scales may be of some value in order to point at close statistical links beyond a common trend in both time series.

Regretfully, the authors fail to produce a convincing strategy in this respect. Other than Finlay et al., 2016, they use data before 1840 (begin of the era of direct geomagnetic observations). These are apparently not covered by observations, and thus may not be reliable. Still, this part of the data represents almost half of the complete time series and thus has an obvious influence on the subsequent statistical analysis. The authors use a complicated methodology involving the estimation of additional parameters for demonstrating the existence of a relationship. In doing so, they fail to provide the information that could be used to point at underlying physical processes, which must be the

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intention. Looking at Fig. 2, I have doubts about the existence of a stable relationship between the parameters considered. I would also ask about the relationship in different frequencies which may hint at a relationship.

Solving these issues would considerably change the paper, and thus I recommend to reject it. In addition, I think that the paper is not particularly suitable for publication in NHESS as it is not considering a specific natural hazard.

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