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A further step forward in the study of the Earth's climate and magnetic field connection by means of transfer entropy

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The possible relation between the Earth's climate and magnetic field is a debated question that has been usually addressed from direct correlations between different time series representing both systems. Although the physical mechanism able to potentially explain this connection is still an open issue, finding hints about how this connection could work would suppose an important advance in the search for an adequate physical mechanism that explains it. In this work, we study two real time series, the Global Sea Level (GSL) rise (representing the climate system) and the South Atlantic Anomaly (SAA) area extent at the Earth's surface (for the geomagnetic field system) for the last 300 years. This connection was previously suggested considering only the long-term trend (De Santis et al., 2012) while now we study this possibility also in shorter scales. For this purpose, we use an innovative information-theoretic tool, i.e. the transfer entropy, as a good candidate for determining, not simply the possible existence of a connection, but even the direction in which the link is produced. The new results seem to support the existence of this connection, with more information transferred from the SAA to the GSL time series than vice versa, with about 90% of confidence level. This finding provides new clues on the existence of a link between the geomagnetic field and the Earth's climate in the past and on the physical mechanism involved: thanks for the application of the transfer entropy, we have determined that the sense of the connection seems to go from the system that produces geomagnetic field to the climate system. Of course, the found connection does not mean that the geomagnetic field is fully responsible of the climate changes, rather that it is an important driving component to the variations of the climate (Campuzano et al., 2018).