Community structure of Earth's magnetic field measurements.

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Abstract:

The Earth's magnetic field has dependence both in the time and spatial domains. Also, due to the underlying physical processes involved, the change of the magnetic field in a given point or at a given instant may induce variations at other points and/or subsequent times. We propose to study this complex dynamic by means of tools derived from graph theory and complex networks, which have shown to be useful to describe the behavior of various systems of geophysical interest [1,2,3]. In particular, we intend to study the evolution of the community structure of magnetic field measurements on the Earth's surface along the 23rd solar cycle. Based on records by 59 magnetometers during the 23rd solar cycle (taken from the World Data Center for Geomagnetism, Kyoto, http://wdc.kugi.kyoto-u.ac.jp/hyplt/index.html), we define a complex network where nodes are the magnetometers, and their connection is determined by the correlation between their respective magnetic field time series. The network is defined by two similarity methods between time series, namely, the Pearson correlation [4,5] and event synchronization [6]. Complex networks are built for each year from 1996 to 2008, covering the full 23rd solar cycle. Then, the community structure is analyzed, and some of its basic features are analyzed along the cycle: the number and area covered by the communities. We find that the community structure, in effect, has information on solar activity. For instance, we find that the average area of the communities increases during solar maximum, and is minimum at the start and end of the solar cycle. But we also show that results strongly depend on the choice of similarity methods, and the thresholds involved.

Acknowledgment: We thank the support of The Department of Physics of the Faculty of Sciences of the University of Chile has the necessary computational resources to carry out this project, access to bibliography and necessary code licenses. Additionally, the following research project will partially cover the expenses of this proyect: FONDECYT 1201967, "Time series and complex networks approaches for nonlinear processes in space plasmas".

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Session: Space Plasma Physics and Nonlinear processes in Space Geophysics.

Oral or Poster: Poster.