South Atlantic Anomaly throughout the solar cycle

Joao Domingos*[1,2], Alexandra Pais[2,3], Dominique Jault[4], and Mioara Mandea[5]

[1]Institut des sciences de la Terre (ISTerre) – Université Joseph Fourier - Grenoble I – BP 53 38041 Grenoble cedex 9, France

[2]Centro de Investigação da Terra e do Espaço - Universidade de Coimbra (CITEUC) – University of Coimbra, Almas de Freire - Sta Clara, 3040-004 Coimbra, Portugal

[3]Department of Physics, University of Coimbra – P-3004-516 Coimbra, Portugal

[4]Institut des sciences de la Terre (ISTerre) – CNRS : UMR5275, IFSTTAR, IFSTTAR-GERS, Université de Savoie, Université Joseph Fourier - Grenoble I, INSU, OSUG, Institut de recherche pour le développement [IRD] : UR219, PRES Université de Grenoble – BP 53 38041 Grenoble cedex 9, France

[5]Centre National d'Etudes Spatiales (CNES) – CNES – 18, Av. Edouard Belin, 31055 Toulouse, France

Abstract

The South Atlantic Anomaly (SAA) is a region of great concern in modern days. The growing reliance on satellites and space born instruments makes their protection an important area of study. The SAA is the region of space where the intensity of the magnetic field of the Earth is lowest and also, where the flux of energetic particles is highest.

High energetic particles trapped in the Van Allen radiation belts are the cause of many satellite problems. These energetic particles can penetrate the satellites and disturb the regular functioning of sensitive circuits, leading to bad data collection. This effect is nowhere better observed than in the South Atlantic Anomaly region. Here, the low intensity of the magnetic field leads to an increase in particle flux at lower altitudes, namely at satellite altitude.

Although a big reason why the particle flux patch is located where it is, is the low intensity of the internal magnetic field, this is not the only one. The influence of the Sun is clearly observed as well, as the variations in population of different radiation belts can be associated with the solar cycle.

To study the evolution of this particle flux anomaly, the Principal Component Analysis (PCA) method was used. This method, together with a knowledge of the radiation belts and the way particles behave in them, allowed us to properly describe the main aspects of the particle flux with only a few number of orthogonal components.

Using PCA we do not impose any restrictions in the shape of the anomaly, as previous studies do, and were able to identify separate modes with the different physical mechanics that affect the evolution of the particle flux SAA. By this, meaning both the mechanics derived from the interaction of the particles with the magnetic field of the Earth, and with the interaction with the Sun. The westward drift of the magnetic field is observed and we were able to clearly relate it with the shift in most populated radiation belts. And the 11 year cycle of the Sun is seen in the time series of the main PCA modes, those explaining the variation in total intensity and area of the particle flux.

*Speaker

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