# GEOMAGNETIC FIELD AND STATION K-INDEX ESTIMATION AT AIGUÁ GEOPHYSICAL OBSERVATORY

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**ABSTRACT.**

Since 2010 a team of the "Laboratorio de Geofísica y Geotectónica" started the construction of a magnetic observatory as part of the Aiguá Geophysical Observatory (34° 20' S; 54° 42' W) located in the south-east side of the Uruguayan territory. The aim of this project is to study the phenomena related to the Space Weather and its influence over the entire region covered by the South Atlantic Anomaly (SAA). Due to its proximity to the centre of the Anomaly and the scarce research done in the Rio de la Plata area, the new magnetic observatory will provide a closer look to the SAA related phenomena.

Currently the equipment consists on a GEM 90S Overhauser magnetometer for the absolute measurement of the total field and a GSM-90F5D suspended dIdD as variometer for the continuous record the *(X,Y,Z)* field components. Both sensors were supplied by GEM Systems Inc. This is the first magnetic observatory located in Uruguayan territory.

The preliminary data was analyzed and used for the calculation of the baselines for the components *(X,Y,Z)* and for the total field F. All the datasets consist on data registered during the months of June-July 2013 plus additional records for the total field obtained since March 2013. An estimation of the station K-index was made considering the reduced data. Despite a further calibration is needed to adjust more accurately the orientation of the dIdD sensor. The comparison of data obtained with similar data registered at the nearest observatory located at São Martinho da Serra (Southern Brazil) leads to conclude that the field values are close to the expected ones.

**Keywords**: Geomagnetism, Geomagnetic Indices, Geomagnetic Observatories.

## 1. Introduction

According to the WMM 2010 the Rio de la Plata region lies entirely under the South Atlantic Magnetic Anomaly (SAMA). Scarce geomagnetic coverage has been done in this area during the last decades (Jayanthi *et al*., 1997). Most of the current working magnetic observatories lie around the external part of the anomaly, but only two in this moment are closer to the centre of the anomaly. Since 2012, a new magnetic observatory has been mounted in the east side of the Uruguayan territory near the town of Aiguá (34° 20' S; 54° 42' W). Due to the weak magnetic field intensity, the intense particle precipitation into the SAMA has been ascribed as the principal cause of the highest failure rate in spacecraft's electronics travelling at lower orbits (Heirtzler, 2002; Heirtzler *et al*., 2002). Additionally the enhanced particle precipitation may led to field pulsations during geomagnetic disturbances. To determine the actual influence of such weak field over the entire area it is necessary to provide continuous monitoring stations, the aim of the project is to determine the geomagnetic field values, space weather activity indexes and serve as observational platform in all issues related to space weather assessment in this area.

## 2. The Geophysical Observatory of Aiguá

The observatory equipment consist of two magnetometers a scalar Overhauser for the absolute determination of field components and a suspended dIdD vectorial magnetometer as variometer. Both magnetometers are made by GEM Systems Inc.. The dIdD magnetometer works adding a bias field to the actual field the field components are calculated following the Serson's method (Heilig, 2007; Wienert, 1970). Only four parameters are required to perform a correct dIdD sensor calibration ($D_0$; $I_0$ $\varepsilon_0$; $\varepsilon ID$), which consists of two initial angles for declination, inclination and two orientation angle offsets. When compared with fluxgate ones that requires the determination of twelve of such parameters for properly measurements, dIdD system makes easier the calibration process (Heilig, 2007). But still it is necessary the precise determination of such angles. A third portable Geometrics GX856 proton precession magnetometer has been used also at several points along the Uruguayan territory. The data from de dIdD and GEM90 magnetometers are sampled at one second and at one minute cycling time respectively. The data is sent through wireless link to a computer and processed afterwards. The dIdD calibration was the most difficult task due to the difficulty to obtain a precise orientation of the sensor and a patient manual calibration was done until the sensor start to give reasonable measurements. The intercalibration was performed between the absolute magnetometer and variometer sensors which are s1.5 m apart.

Values obtained from both magnetometers were reduced following the IAGA standards (Campbell, 2007; Yanowski, Sucksdorff, 1996). A statistical treatment was performed to remove spikes, followed by the application of a Gaussian filter to the 1 second data series to remove the high frequency noise. The first and last filter coefficients were applied 45 s. before and after each minute respectively, in order to obtain the minute means for the *X*, *Y* and *Z* components. All the minute means were calculated centered in the minute. The time interval studied cover the months of June and July 2013.

In the Figure 1 we can see the values obtained during the first four days of July, this interval was chosen due to the relatively calm conditions $K \leq 3$ which is ideal for the determination of the baseline values for the field components and the diurnal variation.

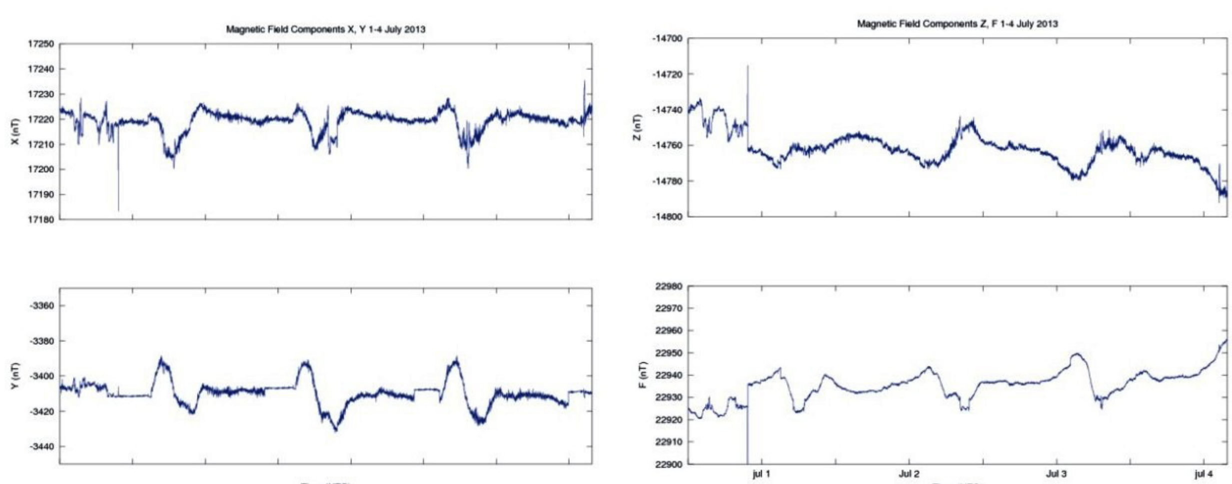


**Figure 1**. *Left*: Variations of X and Y components registered at OGA 1-4/7/2013.
*Right up*: Vertical Component variations. *Right down*: Total field component registered on July 1-4 2013

Observatory K-index calculation was performed for the time intervals considered. Comparing Figures 1, 2 and 3 we can see similarities in the variations of all components. The diurnal variation is shown clearly for the time interval considered.

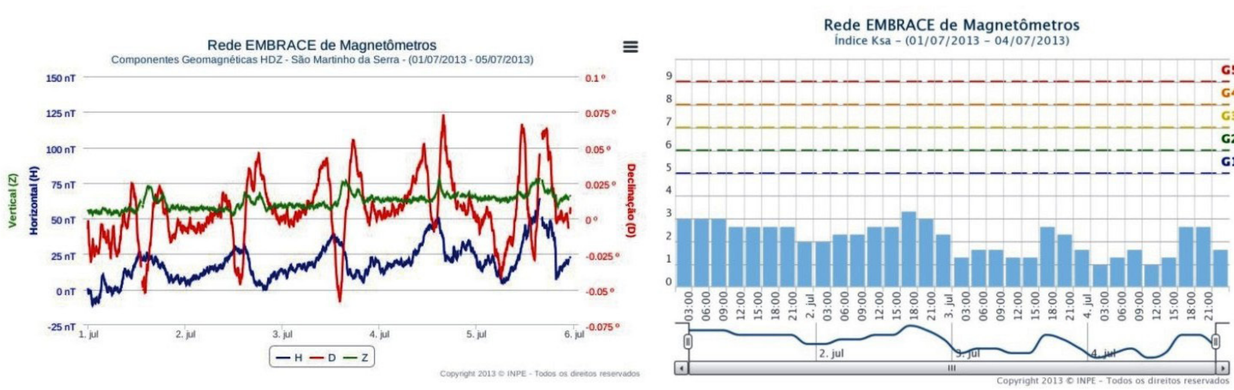


**Figure 3**. K index calculated at Aiguá July 1-4/07 2013

The calculation of the K index was based on the calculated ones at the Brazilian observatory at São Martinho da Serra. In this case the finnish method was chosen, (Campbell, 2003; Yanowski, Sucksdorff, 1996) to calculate the Sr curve and then proceed with the scaling of the k indexes for each time step.

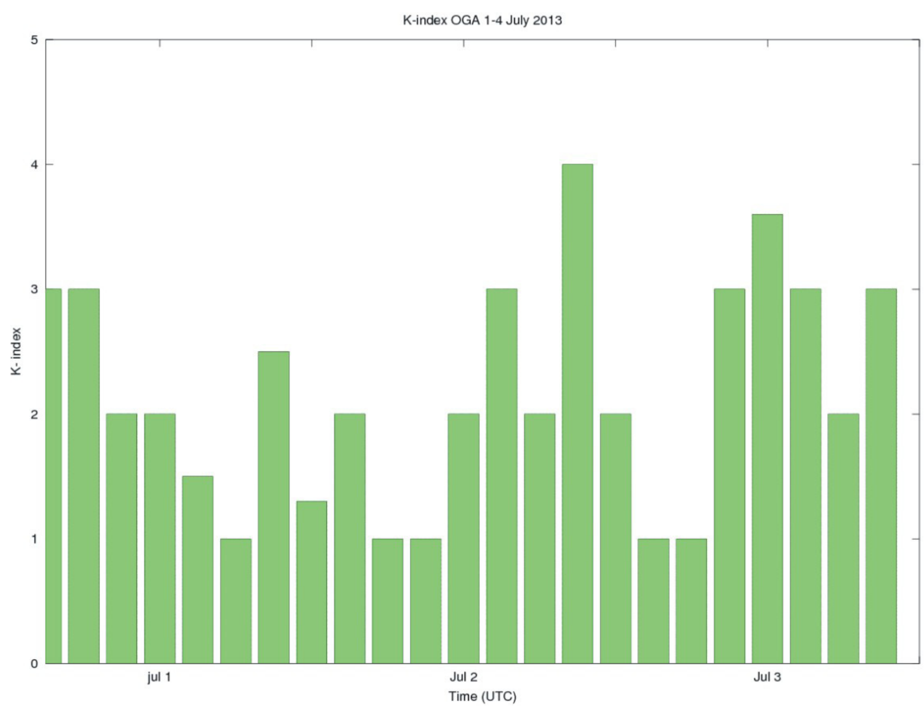


**Figure 2**. *Left*:Geomagnetic components measured at SMS Station July 1-4 2013. *Right*: Geomagnetic Index K calculated at SMS station July 1-4 2013. *Source: Rede EMBRACE INPE* (http://www2.inpe.br/climaespacial/)

## 3. Conclusions

The geomagnetic data obtained at OGA is in good agreement with similar data registered at the observatory of São Martinho da Serra ca. 500 km apart. Despite a further calibration is necessary to give a precise orientation of the sensor, the values obtained differs only by few nT of the calculated ones by the IGRF11. The K indexes obtained also are in concordance with the similar ones calculated for the SMS station. This led to conclude that the field variations show great uniformity across the central area of the SAMA. In other hand, the dIdD magnetometer has proved to be robust in conditions where there is a lack of precise orientation devices such a DI-flux theodolite.

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