One century of data from Vassouras Magnetic Observatory (1915-2015)

Artur Benevides, Edwin Camacho*, Vitor Silveira, Israelli Rodrigo, Rodrigo Melhorato e Kátia Pinheiro

Observatório Nacional

Introduction

Vassouras Magnetic Observatory (VSS) was the first observatory in Brazil, starting its measurements in 1915. VSS plays an important role in monitoring of the magnetic field in the south hemisphere mainly because is located in region of Southern Atlantic Magnetic Anomaly (SAMA), in addition, due to its high data quality and transmission in real time VSS is part of the INTERMAGNET (since 1999) network and contributes to development global model.

This work presents the history of VSS as well as the centennial dataset (1915-2015). We explore the comparison of VSS data and results of IGRF model. We present a Solar-quiet and storm day to eveluate the influence of the exernal field on VSS and the possible occurrences of the jerks addressing the main characteristics of the secular variation that evidence the variations of internal field.

History (1915 - 2015)

In 1913 the engineer and director of the Observatório Nacional (ON), Henrique Charles Morize in partnership with the astronomer Alix Correa Lemos idealized the city of Vassouras, RJ (Latitude 22.4° S and 43.35° W) as the ideal place for installation of the VSS, the old place at Morro do Castelo where the Imperial Observatório do Rio de Janeiro (IORJ) was located had a high level of magnetic noise, this problem affects the measurements of the Earth's magnetic field and was the reason for the change of the magnetic observatory from Rio de Janeiro to the Paraíba Valley.

Theorical Fundamentals

- **Relation between the elements of the geomagnetic field**

$$F^2 = X^2 + Y^2 + Z^2,$$
$$H^2 = X^2 + Y^2,$$
$$X = Hcos(D),$$
$$Y = Hsen(D),$$
$$Z = Fsen(I),$$
$$H = Fcos(I).$$

- **Secular variation**

The secular variation is the sucessive difference of the values of field components given by:

$$\frac{dX}{dt} = X(t+1) - X(t)$$

where t represents time in years.

- **Fit by spline interpolation**

The secular variation of X,Y and Z compontents were fitted using an algorithm of linear fit by spline method:

$$f(x) = f(x_{n-1}) + t_{n-1}(x - x_{n-1}),$$

for $x_{n-1} \leq x \leq x_n$

- **Root Means Square (RMS)**

We calculated the erro between the model IGRF and the data from VSS using RMS:

$$e_{RMS} = \frac{1}{N}\sqrt{\sum_{i=1}^{N}(m_i - d_i)^2},$$

the RMS can be view in the legends of figures.

Geomagnetic Field Elements

The evolution of the main field components over the last 100 years can be seen in the Figures (1 to 7). From 1915 to 1999 the annual means data were given directly by VSS, from 1999 to 2015 were performed annual means using the minute data of components from INTERMAGNET.

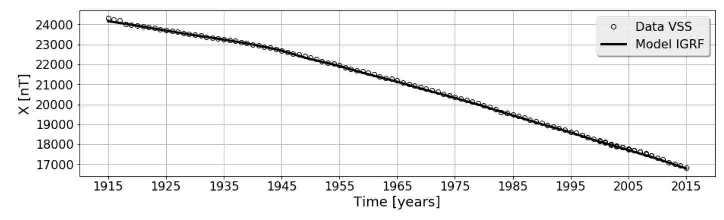


Figure: 1

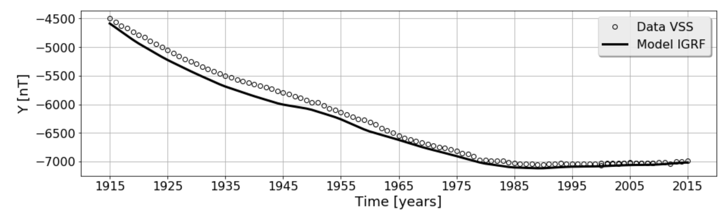


Figure: 2

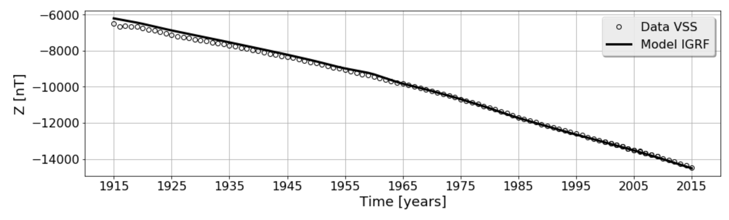


Figure: 3

Geomagnetic Field Elements

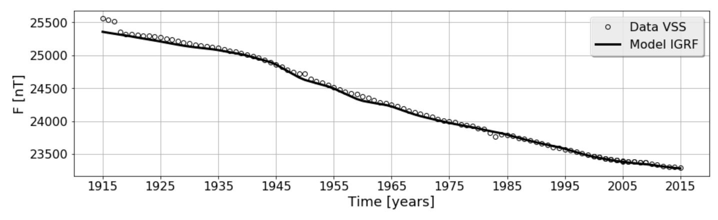


Figure: 4

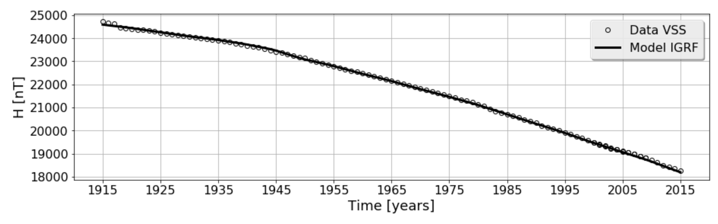


Figure: 5

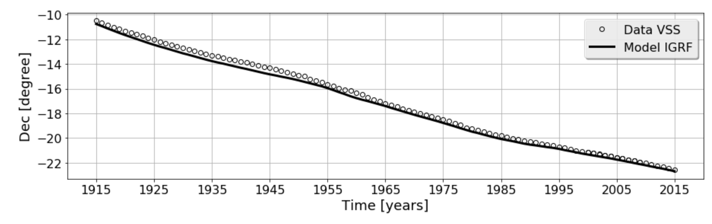


Figure: 6

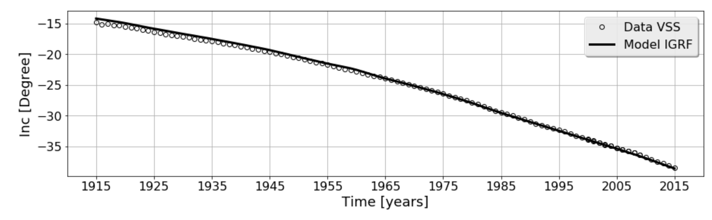


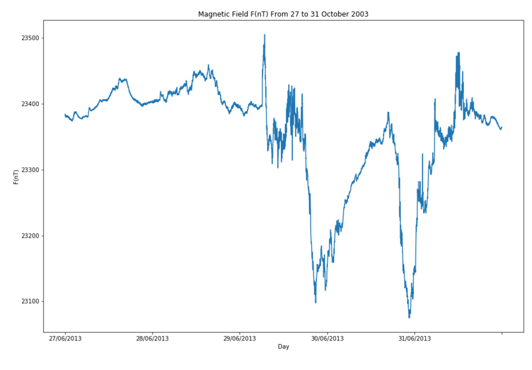
Figure: 7

VSS

	Change/year		
	VSS (nT)	IGRF12 (nT)	WM
Total intensity	-22,7	-3.0	
X component	-74,7	-98.0	
Y component	24,9	2.2	
Z component	-79,8	-91.6	
H component	-64,7	-85.3	
I component	−014′13″	−019′15″	
D component	−07′2, 28″	−06′25″	

Table: 2.

Sq and Storm Days



Geomagnetics Jerks

Possible ocurrence of geomagnetic jerks. Secular variation is loosely used to indicate slow changes with time of the geomagnetic field (often found in the Y, X and Z componentS) that are (probaly) due to the changing pattern of core flow: Analyzing directly the X, Y and Z components using LSM to fit trends:

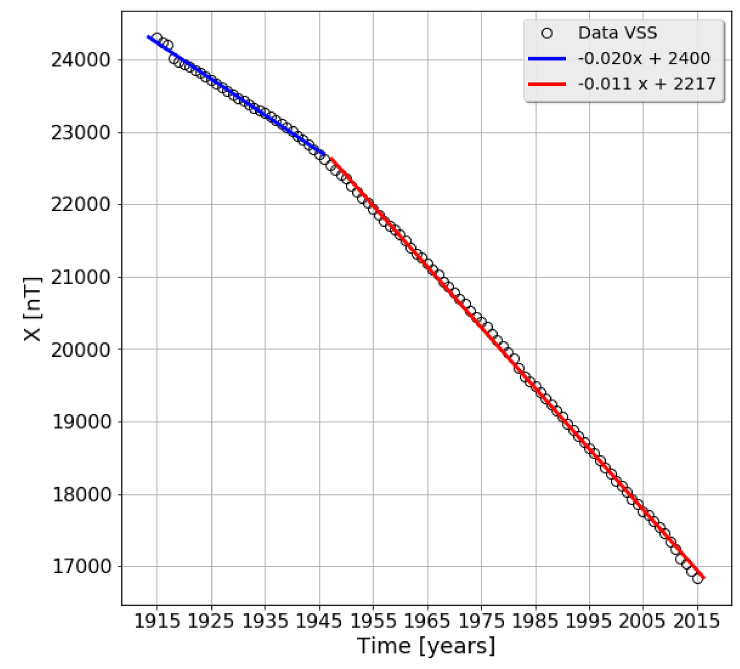


Figure: 9

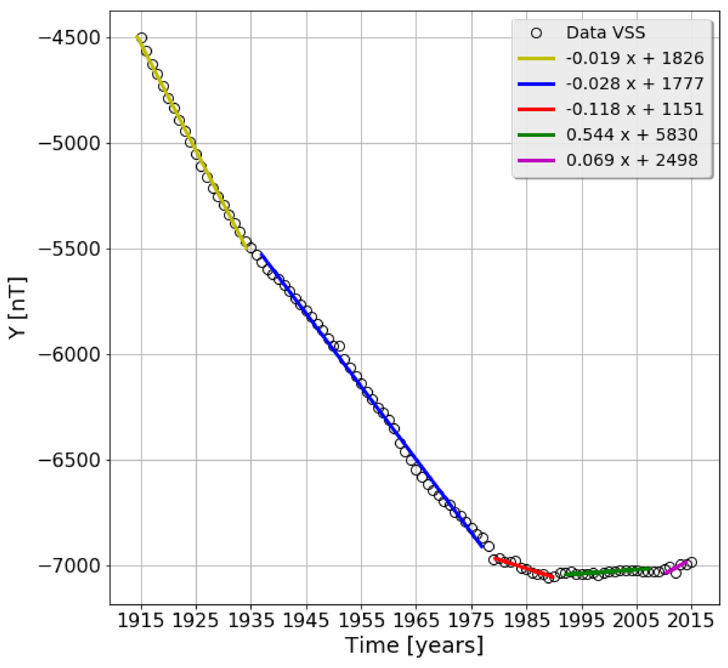


Figure: 10.

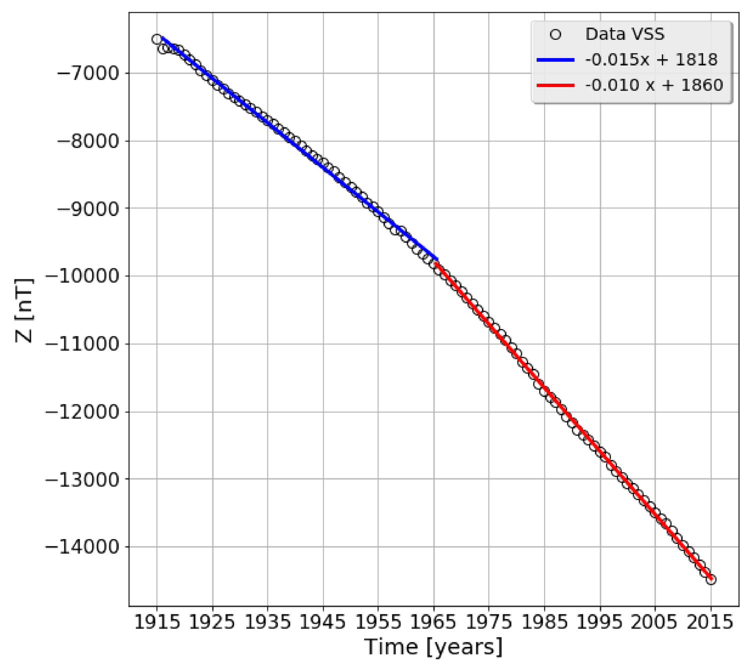


Figure: 11.

VSS

Figure:

VSS

Period — Instruments

1915 - 1982 — "Ruska Observatory Pattern (Declination), QHM 534 (Horizontal component) and Earth Inductor Toepfer (Inclination) Variometer unifilar Toepfer

1982 - 2012 — DI-flux Bartington, MAG-01 with theodolite Zeiss 010 (1") (Declination and Inclination), PPM Geometrics 816 (Total intensity F).

2012 - 2014 — Variometer fluxgate (INTERMAGNET)

Analyzing the secular variations (dX/dt, dY/dt e dZ/dt) by spline fits:

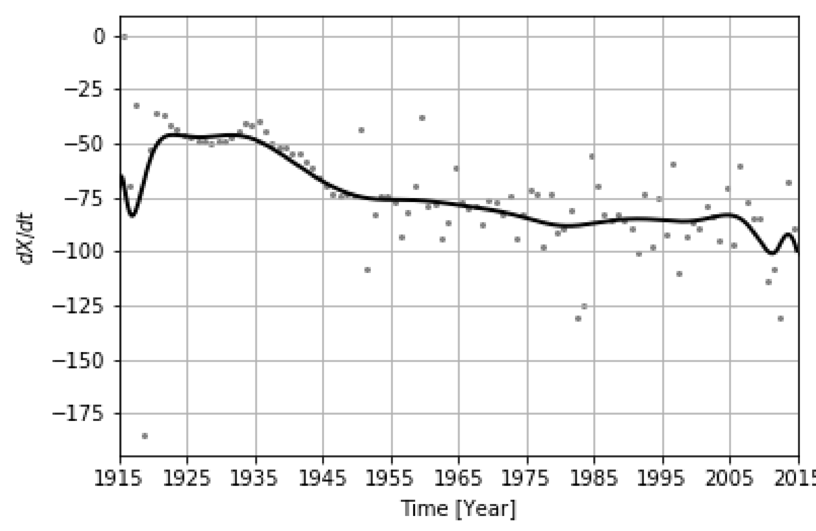


Figure: 12. Secular variation to X component

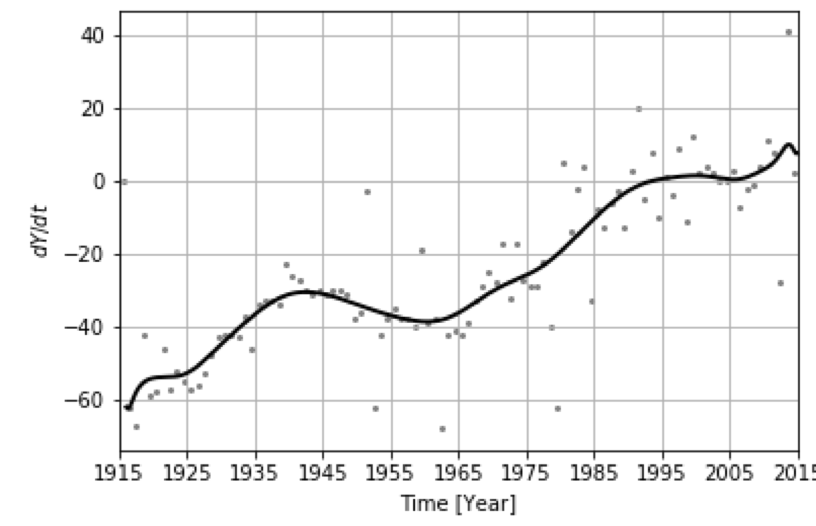


Figure: 13. Secular variation to Y component.

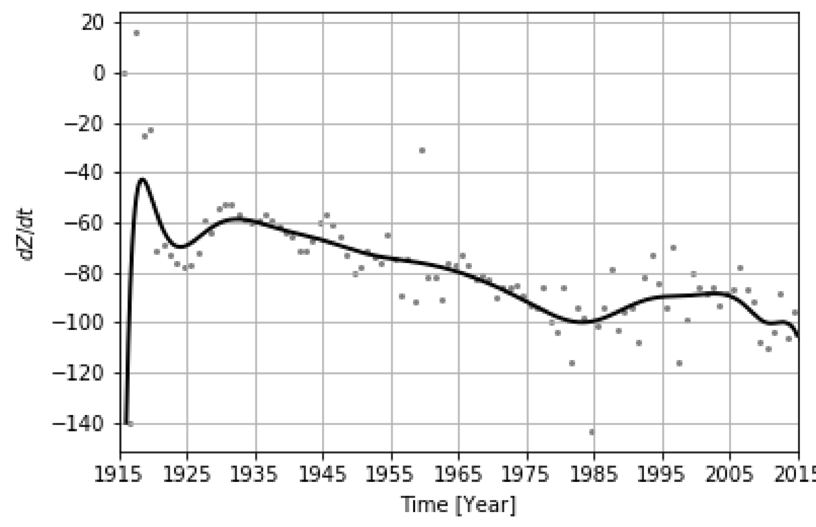


Figure: 14 Secular variation to Z component.

References