Magnetic Survey of Geomagnetic Field at College of Science / Kufa and Neighboring Area by WMM-10 Software

Aref Saleh Baron
Kufa University-College of Science –Dep. of Physics
Arif.aljuburi@uokufa.edu.iq

Abstract

In this work numerical simulation of the Earth magnetic field at college science of Kufa University and neighboring region have been investigated by using WMM2010 model . This region located at north of Kufa city and called Al-Qezwenea (Lat.= 32.1264-32.1048 N, Long.= 44.3556-44.3844 E in degree and altitude 25-32 m above sea level) and featured by Agricultural area and sandy soil . WMM2010 model dependent on the data provided from ØRSTED and CHAMP satellites and the result converted to the contour map by using kriging method to find the characteristics of Earth magnetic elements (total intensity (F), horizontal intensity (H), declination (D), inclination (I), the north component(X),the east component(Y),and Down component(Z)).

Keywords:WMM2010, Geomagnetic field anomaly ,Kriging method

مسح المجال المغناطيسي الارضي لموقع كلية العلوم جامعة الكوفة والمناطق المجاورة لها باستخدام البرنامج WMM-10

عارف صالح بارون

الخلاصة :-

في هذا البحث تم محاكاة المجال المغناطيسي الارضي لمنطقة كلية العلوم جامعة الكوفة والمناطق المجاورة لها عدديا باستخدام برنامج WMM2010 . وهذه المنطقة تقع شمال مدينة الكوفة وتسمى بالقزوينية (خط عرض32.1048-32.1264 شمالاً وخط طول 44.3556-44.3844 شرقاً وعلى ارتفاع يتراوح 25- 32 m من مستوى سطح البحر وتمتز بكونها منطقة زراعية ذات تربة رملية . يعتمد برنامج WMM2010على البيانات المأخوذة من الاقمار الاصطناعيةØRSTED/ CHAMP حيث تحول النتائج الى خرائط كنتورية باستخدام طريقة kriging method لإيجاد خواص عناصر المجال المغناطيسي الارضي (المركبة الكلية ، المركبة الافقية، الميل الزاوي، الانحدار ، المركبة الشمالية ، المركبة الشرقية والمركبة السفلى).

كلمات مفتاحية: شذوذ المجال المغناطيسي ، طريقة كريكنج ، WMM2010

1.Introduction

The WMM used to calculate the geomagnetic field and their annual changes for navigation ,attitude and heading referencing systems ,also used widely in civilian navigation and heading system .The WMM produced jointly with the US Department of Defense , the UK Ministry of Defense ,the North Atlantic Treaty Organization (NATO), and the World Hydrographic office (WHO).It is widespread , in the meantime , also in the civil navigation. The model , the accompanying software and documentation are administered by the United States National Geophysical Data Center (NGDC) and the Us National Geospatial-Intelligence Agency (NGA). The geomagnetic survey at 135 stations in China were carried out in 2003 by Zuowen Gu and group [1]. Angelo De Santes and group calculated the Earth magnetic elements by using a new model(ITGRF) and compare this model with IGRF model to the Italian observatory (Castello Tesino) [2].In 2010 Enkelejda Q. and group measured the magnetic taken during different campaigns in Albania and Italy in the time of concern, together with a total intensity data set from the Ørsted and CHAMP satellite missions [3]. while Giuliana investigated of the potential observatory location and paves the way for better understanding of the geomagnetic field behavior over Croatia [4]

In this paper the region of interest was divided into grid points with equal distances between two adjacent points (9 line of longitude and 9 lines of latitude .The results were obtained in the form of contour map for each component of the Earth magnetic field by using Kriging method .

2. Geomagnetic Field Components

The geomagnetic field vector B is fully described by an appropriate set of three elements selected from the seven possible elements (Fig. 2). The orthogonal set is the northerly intensity X, the easterly intensity Y and the vertical intensity Z (positive downwards). The other elements are the horizontal intensity H, the total intensity F, the inclination angle I, (also called the dip angle and measured from the horizontal plane to the field vector, positive downwards), and the declination angle D (also called the magnetic variation and measured clockwise from true north to the horizontal component of the field vector). In this description of X, Y, Z, H, F, I and D, the vertical direction is assumed perpendicular to the WGS84 reference ellipsoid model of the Earth's surface and the clockwise rotational direction is determined by a view from above the Earth. Conventionally the intensities are given in units of nano Teslas (nT)[5].

3. Measuring the magnetic field from space

Currently three satellites dedicated to measuring the magnetic field are gathering magnetic data in low Earth orbit; Ørsted, Champ, and SAC-C. These three satellites were all launched around the turn of the millennium and are still operating[6]

The Ørsted satellite (Danish satellite) was launched on February 23, 1999 in a near polar orbit with an inclination of 96.5^{o}, a perigee at 638

km and an apogee at 849 km while Champ satellite (German satellite) was launched in July 2000, It has a nearly circular orbit with an inclination of 87.3^o. The altitude was initially 456 km, but it has decreased to about 360 km after five years in space.

The Argentinean satellite SAC-C was launched in November 2000. It is in a near circular, sun-synchronous orbit sampling at 10.30 local-time. It has an altitude of about 712 km, an inclination of about 97^o.

The principal aim of these satellites mission are to map accurately the Earth's magnetic, [7][8]

4.Theoretical model

The World Magnetic Model (WMM) was implemented in the survey . This model can be applied for magnetic survey in air , sea navigation systems and ground

$$V(r,\theta,\emptyset,t) = a\sum_{n=1}^{N}\sum_{m=0}^{n}\left(\frac{a}{r}\right)^{n+1}[g_n^m(t)\cos m\emptyset + h_n^m(t)\sin m\emptyset] \times P_n^m(\cos\theta) \quad \ldots 1$$

where a = 6371.2 km is a reference radius, $(r,\theta,\emptyset)$are geographic coordinates where *r* is the distance from the center of the Earth in Km, θ denotes the co-latitude while $\emptyset$ denotes the longitude , P_n^m are the Schmidt quasi-normalized associated Legendre functions of degree *n* and order *m* , the coefficients $g_n^m$and h_n^m are the Gauss coefficients at time , and *N* is the maximum degree and order of the internal expansion, which is taken here to *N* = 50 [9][10] .

4-Result and Discussion

Earth magnetic elements ; total intensity (F), horizontal intensity (H), declination (D), inclination (I), north component(X), east component(Y),and down component(Z) for Al-Qezwenea district were simulated by the WMM2010 program, this district located north of Kufa city (Lat.= 32.1264-32.1048 N, Long.= 44.3556-44.3844 E in degree and altitude of 25-32 m above sea level) . By applying the kriking method at the above elements which appeared in the figures below, it can be see the behavior of the Earth magnetic components for this region .Figure(2) shows the conduct of the Declination component (D) of the geomagnetic field for five years (2009-2013) , it can be noticed from this figure that there is no any anomaly in this component at this region. Figure (3) explains the normal habit of Inclination component from the years 2009 to 2013 , and the same comportment was clear in all components of magnetic field like East, Horizontal , Down , the North , and Total intensity components which appeared in the figures 4,5,6 and 7 , respectively ,while fig. (8) explain behavior of all components after filtered.

Comparing each component separately for the period of five years(2009-2013) , it can be found that the changes in the behavior were very slight between the above years.

This case was due to the nature of the land area being agricultural land, which is likely to be free of rocks and minerals.

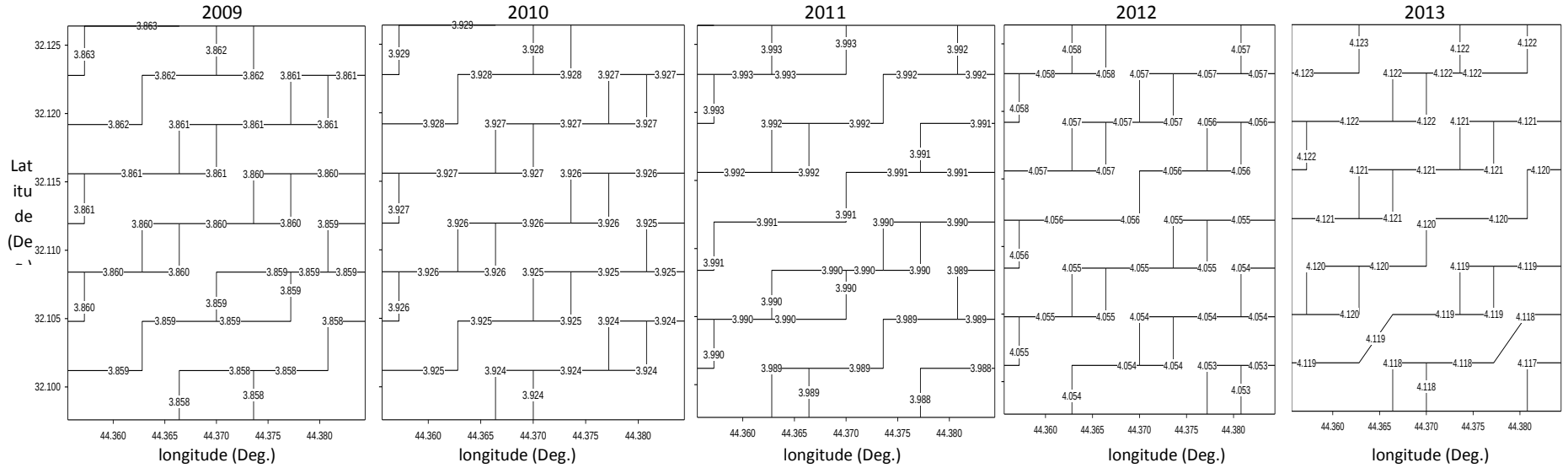

Fig.(1) The behavior of the Declination component D for five years

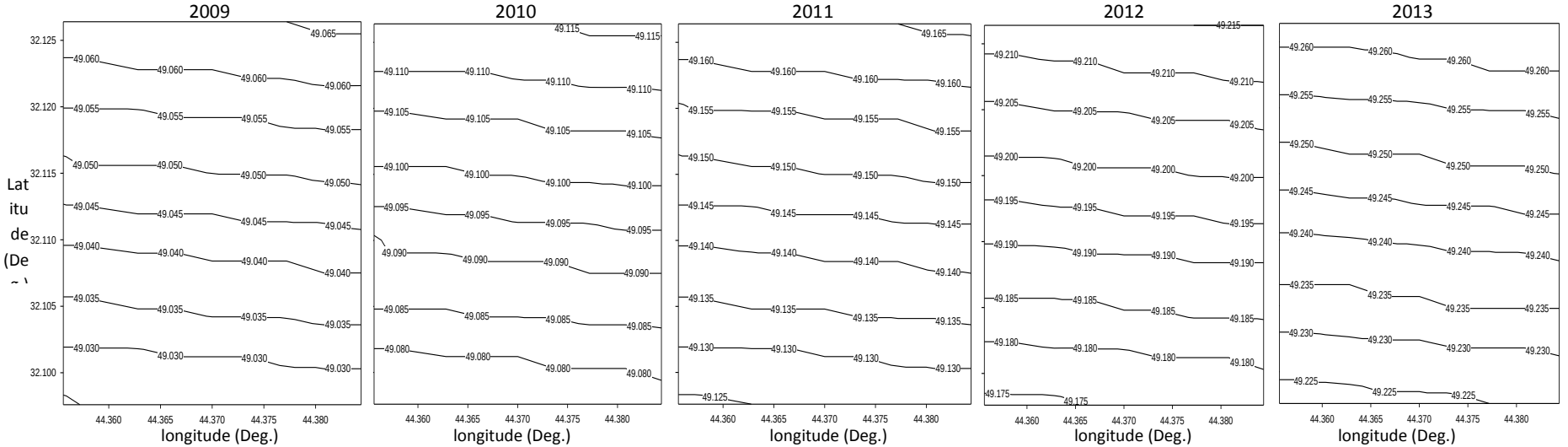

Fig.(2) The behavior of the Inclination component I for five years

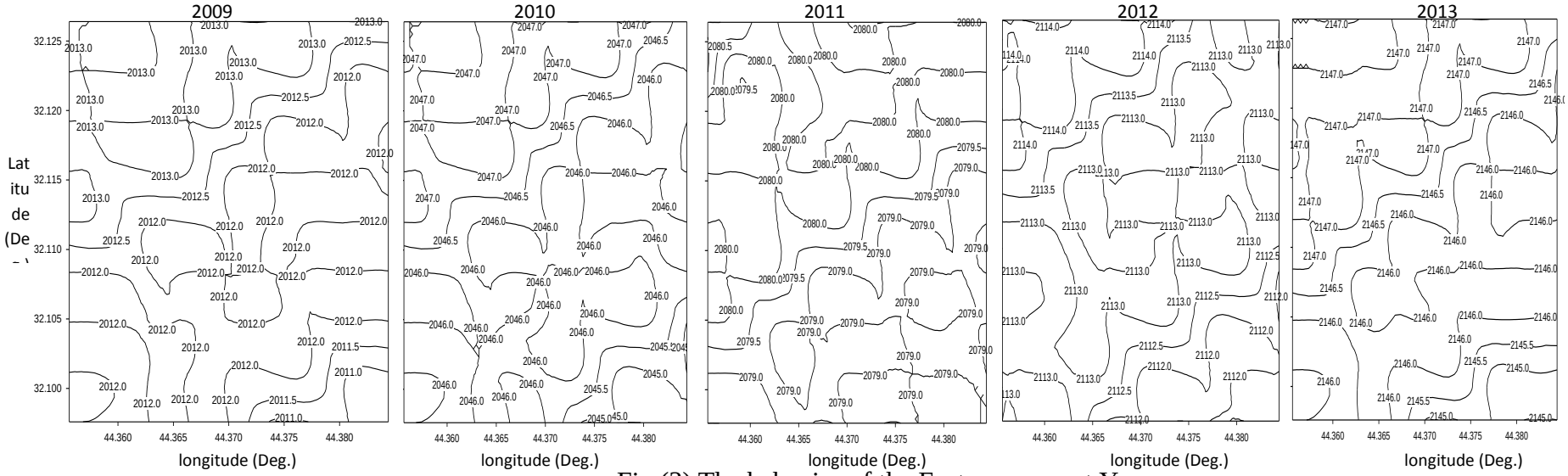

Fig.(3) The behavior of the East component Y

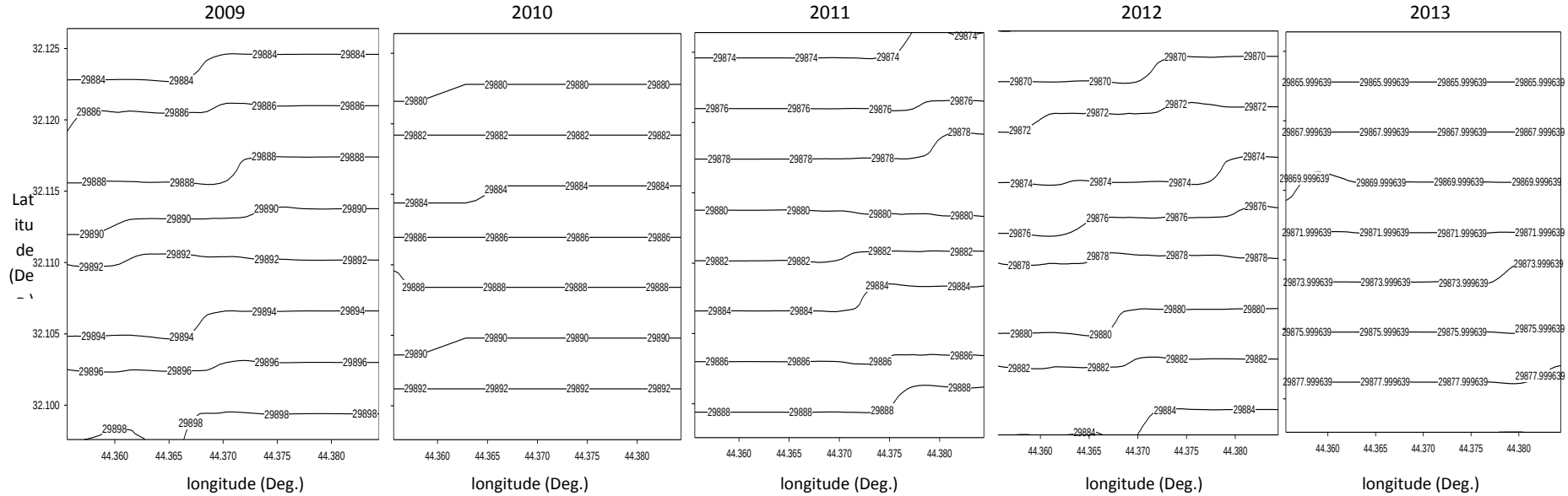

Fig.(4) The behavior of the Horizontal component H

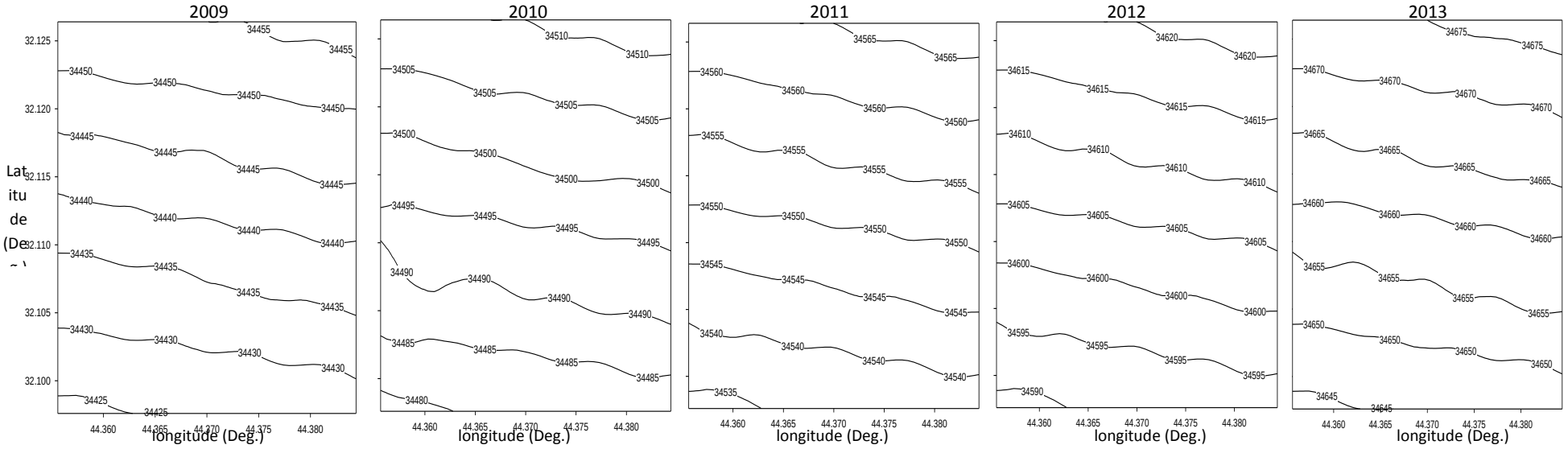

Fig.(5) The behavior of the down component Z

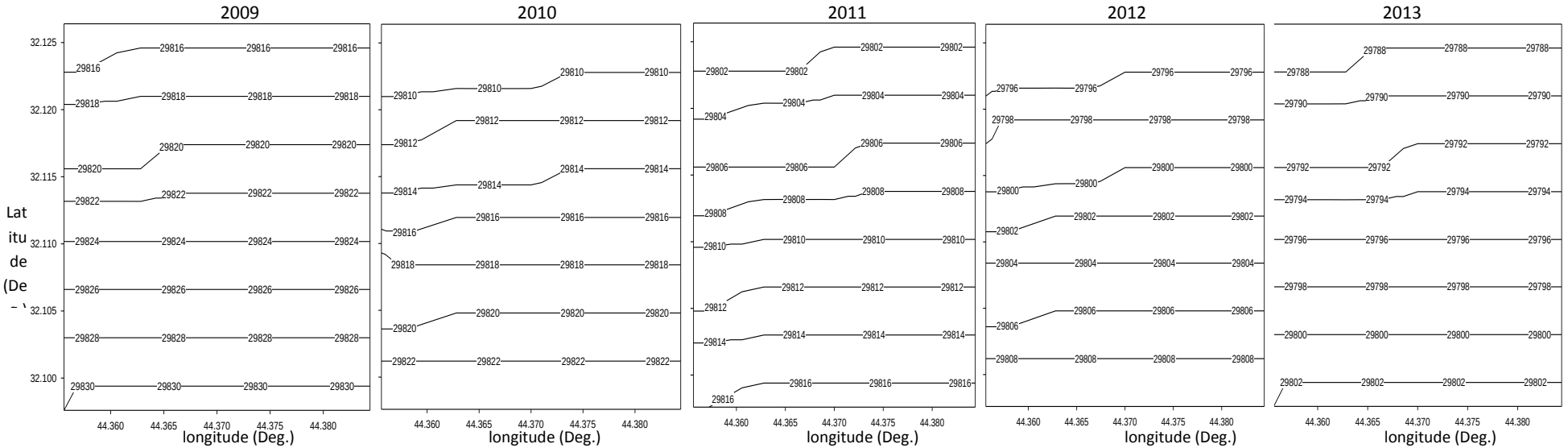

Fig.(6)The behavior of the North component X

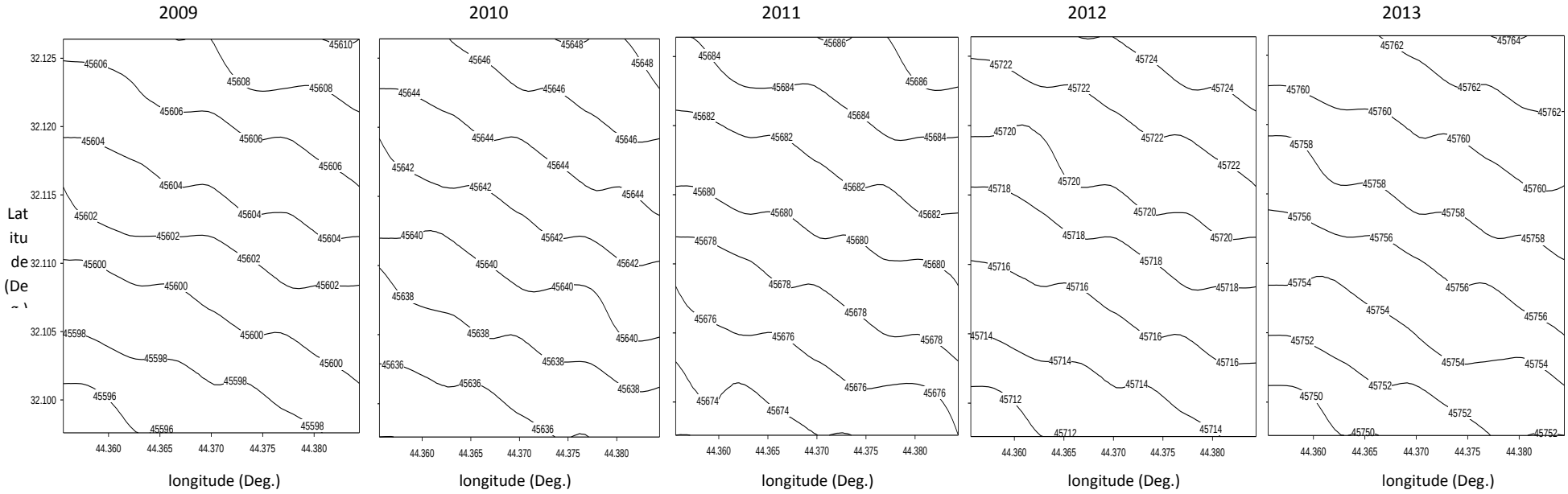

Fig.(7) The behavior of the Total intensity component F

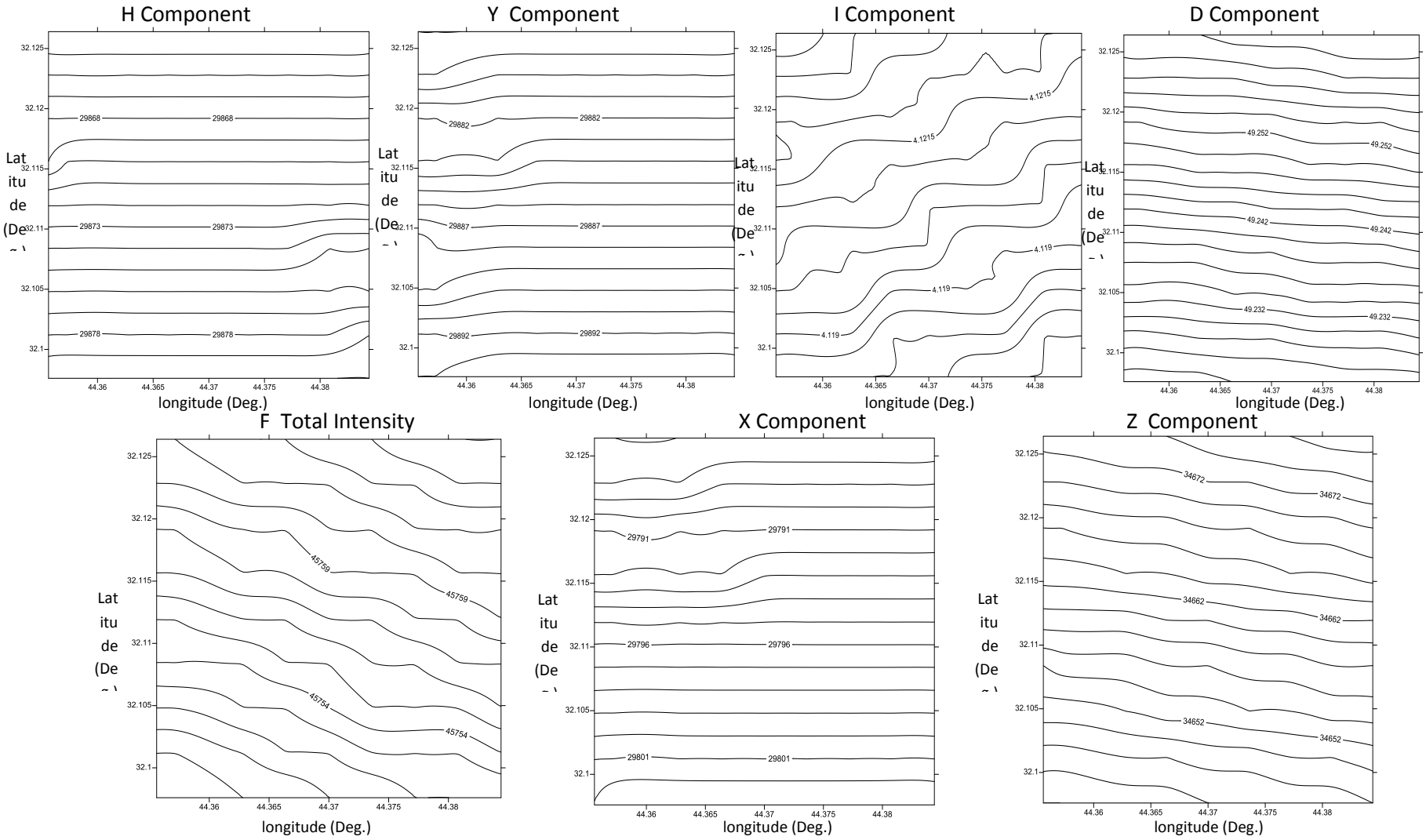

Fig.(8) The behavior of Earth magnetic elements after used filter

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