Sudan University of Science and Technology

College of Graduate Studies

A Study of Ionospheric Precursors due to Earthquakes in Africa

دراسة مؤشرات الايونوسفير بفعل الزلازل في افريقيا

A dissertation submitted in partial fulfillment for the requirements of a master degree (M. Sc.) in physics science

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March, 2017

الآية

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قال تعالى:

الْحَمْدُ لِلّهِ الّذِي أَنْزَلَ عَلَىٰ عَبْدِهِ الْكِتَابَ وَلَمْ يَجْعَلْ لَهُ عِوَجًا ۜ ﴿١﴾ قَيِّمًا لِيُنْذِرَ بَأْسًا شَدِيدًا مِنْ لَدُنْهُ وَيُبَشِّرَ الْمُؤْمِنِينَ الّذِينَ يَعْمَلُونَ الصّالِحَاتِ أَنّ لَهُمْ أَجْرًا حَسَنًا ﴿٢﴾ مَاكِثِينَ فِيهِ أَبَدًا ﴿٣﴾ وَيُنْذِرَ الّذِينَ قَالُوا اتّخَذَ اللّهُ وَلَدًا ﴿٤﴾ مَا لَهُمْ بِهِ مِنْ عِلْمٍ وَلَا لِآبَائِهِمْ ۚ كَبُرَتْ كَلِمَةً تَخْرُجُ مِنْ أَفْوَاهِهِمْ ۚ إِنْ يَقُولُونَ إِلّا كَذِبًا ﴿٥﴾ فَلَعَلّكَ بَاخِعٌ نَفْسَكَ عَلَىٰ آثَارِهِمْ إِنْ لَمْ يُؤْمِنُوا بِهَٰذَا الْحَدِيثِ أَسَفًا ﴿٦﴾ إِنّا جَعَلْنَا مَا عَلَى الْأَرْضِ زِينَةً لَهَا لِنَبْلُوَهُمْ أَيُّهُمْ أَحْسَنُ عَمَلًا ﴿٧﴾ وَإِنّا لَجَاعِلُونَ مَا عَلَيْهَا صَعِيدًا جُرُزًا ﴿٨﴾ أَمْ حَسِبْتَ أَنّ أَصْحَابَ الْكَهْفِ وَالرّقِيمِ كَانُوا مِنْ آيَاتِنَا عَجَبًا ﴿٩﴾ إِذْ أَوَى الْفِتْيَةُ إِلَى الْكَهْفِ فَقَالُوا رَبّنَا آتِنَا مِنْ لَدُنْكَ رَحْمَةً وَهَيِّئْ لَنَا مِنْ أَمْرِنَا رَشَدًا ﴿١٠﴾

سورة الكهف الآيات ١ - ١٠

ACKNOWLEDGEMENT

I would like to express my gratitude to my supervisor **Dr. Magdi Elfadil Yousif Suliman** for his continuous guidance and advice led to the achievement of my final objectives and my gratitude to all those who have assisted me in completing this work successfully, and much indebted to those who have guided and supported me throughout our work particularly.

Abstract

Precursors due earthquake have been studied in the history; whence, scientists were striving for finding an effective way to forecast earthquakes. When looking at the physics scientists formulated scenario of earthquakes and the system of atmosphere, accordingly, they found some obvious precursors in the ionosphere due earthquakes.

In this research we selected data of earthquakes in magnitude range (5.5 to 8.0) (Mwc - Mwb) in Africa continent. And the selected data are collected from U.S. Geological Survey (USGS) in period ranged from 1990 to 2010. These data were used to review the seismic activity in the region. Further; two events from these data have been selected and checked for ionospheric anomalies. A precursor test was carried out via using the ionospheric critical frequency data in the F2 layers, i.e. the (foF2) data; the foF2 data were taken from Grhamstown station (longitude=-33.30, latitude=26.50) in South Africa. These data were used in the anomalies analyses for two events: the event of magnitude (6.4 mwc) in 2003 at Prince Edward Island epicenter (longitude=-46.048, latitude=35.057) and the event of magnitude (7.0 mwb) in 2006 at Mozambique (longitude=-21.324, latitude=33.583) epicenter. Analyses results showed anomalies for both earthquakes events. These anomalies were further confirmed when compared with geomagnetic indices Dst, Kp.

المستخلص

تمت دراسة المؤشرات بفعل الزلازل في السابق، بحيث انه قد سعي العلماء بجد لايجاد طرق فعالة للتنبؤ بحدوث الزلازل. وعلى ضوء الفيزياء قد تم اختبار سيناريو للربط بين الزلازل و نظام الغلاف الجوي، و قد وجد الباحثون ان هنالك مؤاشرات واضحة في طبقة الايونوسفير تحدث بفعل الزلازل.

في هذا البحث جمعت بيانات الزلازل المرصودة في القارة الافريقية من جمعية المسح الجيولوجية في الولايات المتحدة الامريكية في مدى القوة بمقياس ريختير بين 5.5 ال 8.0 وذلك في الفترة الزمنية بين 1990 الى 2010، حيث جمعت هذه البيانات بغرض عرض النشاط الزلزالي في القارة. وعلاوة على ذلك تم اختيار حدثي زلزالين لاجراء اختبار مظاهر الشذوذ في طبقة الايونوسفير كمؤشر لحدوث الزلازل حيث استخدمت الترددات الراديوية الحرجة في طبقة الأيونسفير F2 وهي الترددات (foF2). جمعت بيانات الترددات تلك من مرصد محطة جيرهامز تاون (خط طول=-33.30,خط عرض=26.50) في جنوب افريقيا. واستخدمت بيانات الترددات في تحليل تحديد الشذوذ لبيانات زلزالين كالاتي : الزلزال في جزيرة برينس ادورد (خط طول=-46.048,خط عرض=35.057) حدث في عام 2003 بقوة (6.4) والاخر زلزال موزمبيق (خط طول=-21.324,خط عرض=33.583) حدث في عام 2006 بقوة (7.0). وقد عرضت هذه التحليلات لكلا الزلزالين نتائج واضحة لرصد شذوذ وتم تأكيد هذه النتائج بالمقارنة مع المؤشرات الجيومغناطيسية Dst, Kp.

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2	**E_s**- Sporadic E layer	7
3	**Kp**- Planetary Average Value	8
4	**TEC**- Total Electron Content	9
5	**foE, foEs, foF1, foF2**- Critical Frequency of Ionosphere Layers	9
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10	**M_L**- Local Magnitude	14
11	**GPS**- Global Positioning System	15
12	**fo-** Critical Frequency	15
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21	**IP**-Ionosphere Precursors	22
22	**LTT**-latitude-time-TEC	22
23	**EQ**- Earthquake	22
24	**mwc-** Moment tensor inversion of long-period (body-waves)	26
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