EFFECT OF DEC.26, 2004 EARTHQUAKE ON GLOBAL IONOSPHERE ELECTRON CONTENT

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Abstract

To study the impact of the Dec. 26, 2004 Nicobar Indonesia earthquake on the global ionosphere, GPS data from the IGS network of stations has been examined. A search for planetary waves shows that large period waves were seen on the day of the earthquake and continued for other two days. Apparently no precursors were seen before the earthquake although some instances of unusual large increase in ionosphere electron contend have been seen 1 to 5 days before the earth quake day. For the study of gravity waves, data from five stations lying within 20 degree of latitude and longitude of the epicenter of the earthquake was available. Data for each satellite was examined separately. In the Indian sector on all the two stations, data for more than seven satellites showed the presence of waves on the earthquake day. No waves were seen on the control days.

Introduction

Sudden input of energy into the atmosphere can trigger various kinds of waves. Chimonas and Hines(1970) predicted that gravity waves could be generated by a total solar eclipse. These waves travel upwards to reach F-region heights. The period of the wave that reaches a particular point in the F-region of the ionosphere depends upon the spatial distance between the source and the observer. According to Hanuise et al (1982) only waves with period less than T_bR/Z (T_b Brunt-Vaisala period, R, Z horizontal and vertical distance between source and observer) can reach the observation point. Based on this argument Lakha Singh et al. (1989) showed that gravity waves were produced by Feb. 16, 1980 total solar eclipse. The Dec. 26, 2004 Nicobar Indonesia earthquake has given rise to tsunami. Its impact was such that even the earth's rotation axis has been shifted by a few cm. It may have initiated waves in the troposphere which could then propagate to ionospheric heights. Because the impact was on a global scale it could have produced planetary waves also in addition to gravity waves. The GPS data from the IGS network of stations has been examined from that point view.

Data and method of analysis

Data from IGS network of stations was used for the purpose. 13 days of data from 19 Dec. to 31 Dec. 2004 was used. Ionosphere Electron Content (IEC) of the Ionosphere was derived using the carrier phase technique and was converted to absolute IEC using the pseudorange data. The derived IEC was then corrected for various biases

using values derived by CODE. In order to see whether any planetary waves are produced, for the given day, average of all the observations at any instant for all satellites and stations (global ionization) was taken. To know the effect on TEC data for each satellite on at a given individual station was used. For the study of gravity waves, a group of stations lying within 20 deg of lat and longitude of the epicenter of the earthquake were chosen. Only five stations data was available, two of them being in the same city Bangalore , India.

Results and Discussion

Earth quake epicenter was at Latitude of 3.3N and Longitude of 95.8E. It occurred at 00:58:53UTC on December 26, 2004 with a Magnitude of 9.0. Although data was available for more than 200 stations, only those stations data was used which had data for all the 13 days from Dec 19 to Dec. 31 2004. During this period Kp index was less than 4 and Dst index was less than 60 nT.

The stations within 20 degree of latitude and longitude from the epicenter are IISC (77.5700 ^{o}E 13.0210^{o}N) Bangalore India, BAN2(77.5100 ^{o}E 12.9500 ^{o}N) Bangalore India, HYDE(78.5509 ^{o}E 17.4173 ^{o}N) Hyderabad India, NTUS(103.6799 ^{o}E 1.3458 ^{o}N) Singapore and COCO(96.8339 ^{o}E 12.1883 ^{o}S) Australia. As all these stations are more than 700 km from the epicenter, the period of the waves will lie between 0.5 to 1.5 hours with a delay of more than 20 minutes for the nearest station. The data for each satellite was examined separately for these stations.

It has been found that morning sector TEC was suppressed in more than 80 % of cases for all the stations. A typical example is shown in Fig. 1.

As for Gravity waves are concerned in the Indian sector on all the three stations, data for more than seven satellites showed the presence of waves on the earthquake day. No waves were seen on the control days. Fig. 2 shows the waves present at Hyderabad on the Earthquake day. It shows a period of around one hour. Not much wave activity was seen on data both at COCO and NTUS stations.

In order to see whether any planetary waves are produced, for the given day, average of all the observations at any instant for all satellites and stations (global ionization) was taken. Large period waves are seen after the earthquake and continued for next two days Fig. 3. In the figure waves with period 10 to 12 hours are clearly seen. Although a disturbance is seen on the day previous to the Earth quake it has period of 1day. The characteristics are clearly different both in amplitude and period. This exercise was repeated with stations having latitude less than 50 degree to minimize the effect of magnetic disturbances. Same results were obtained.

Apparently no precursors were seen on data before the earthquake day. However, many instances of unusual large increase in ionosphere electron contend have been seen 1 to 5 days before the earth quake day.

Acknowledgement

The raw GPS data was downloaded from the IGS network website ftp://cddisa.gsfc.nasa.gov. The bias values were downloaded from CODE (**website** ftp://ftp.unibe.ch/aiub **or** http://www.aiub.unibe.ch/download/.

References

Chimonas G. and Hines C.O. 1970 J. geophys. Res. 75, 875.
Hanuise et al. 1982 J. atmos. Terr. Phys. 44, 963.
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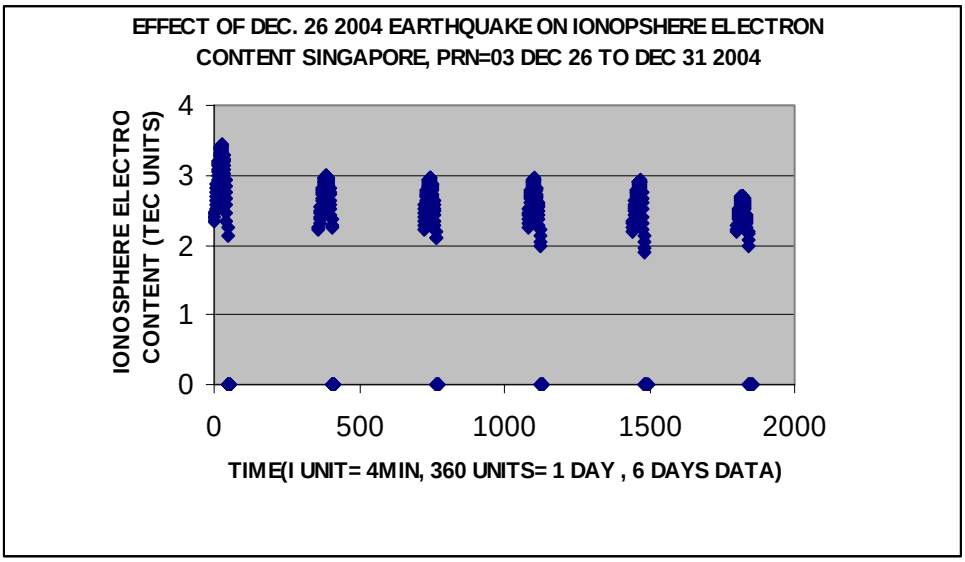

Fig. 1

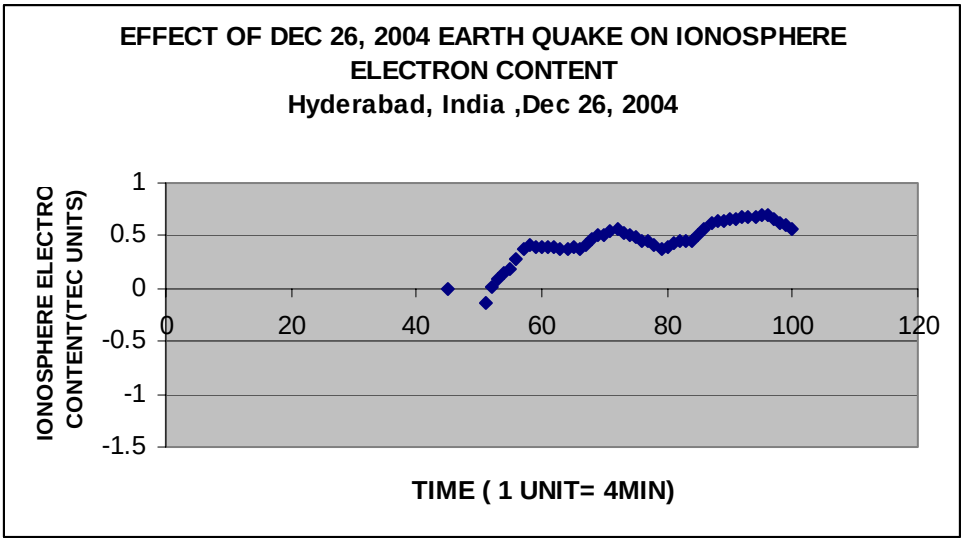
EFFECT OF DEC 26, 2004 EARTH QUAKE ON IONOSPHERE
ELECTRON CONTENT
Hyderabad, India ,Dec 26, 2004
IONOSPHERE ELECTRO CONTENT(TEC UNITS)
1
0.5
0
-0.5
-1
-1.5
0
20
40
60
80
100
120
TIME (1 UNIT= 4MIN)

Fig. 2

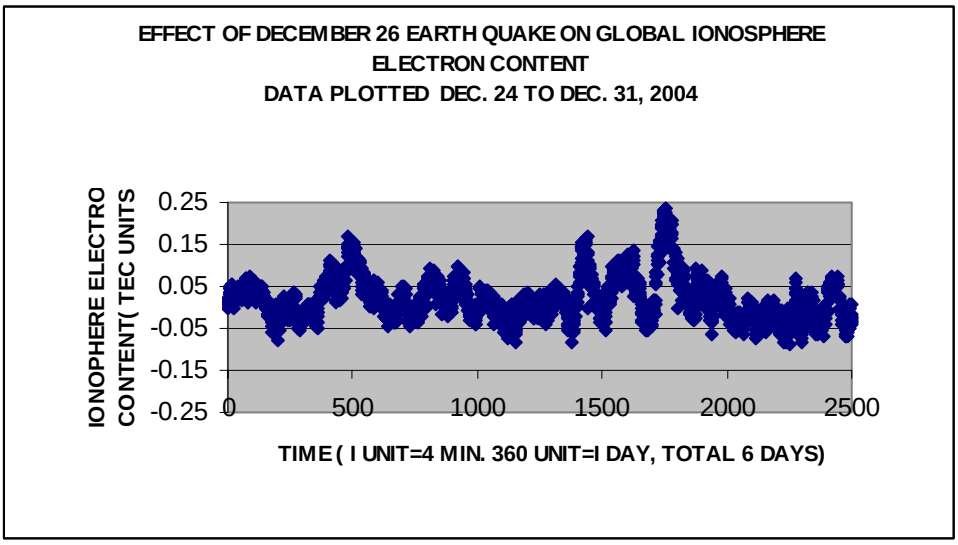
EFFECT OF DECEMBER 26 EARTH QUAKE ON GLOBAL IONOSPHERE
ELECTRON CONTENT
DATA PLOTTED DEC. 24 TO DEC. 31, 2004
IONOPHERE ELECTRO CONTENT(TEC UNITS
0.25
0.15
0.05
-0.05
-0.15
-0.25
0
500
1000
1500
2000
2500
TIME (I UNIT=4 MIN. 360 UNIT=I DAY, TOTAL 6 DAYS)

Fig. 3