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Changes in heliophysical parameter influence on environment of the Earth

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Abstract. Terrestrial as well as extraterrestrial satellite data and environmental parameter records were correlated. It has been observed that some relationship exists in between the changes in environment and extraterrestrial phenomenon. The star flare changes the cosmic parameters. The nearest star of earth, the Sun, is found to be under the influence of the star flare. It has been observed that there is some relationship in between the planetary indices (Kp) Electron flux (E flux) Proton flux (P-flux) of Sun-Earth environment with the changes in thermosphere, ionosphere, atmosphere and geosphere. The tsunami of 26 December 2004, abnormal snowfall in 2004-2005, sudden hike in global temperature and erratic monsoon in India and irregular rainfall in other parts of the world in 2006-2007 followed by snowfall and torrential rain are the impact of the star-sun-earth relationship.

Keywords : Sun – earth – environment – thermosphere – Tsunami – snowfall

1. Introduction

Terrestrial (NOAAA) and extraterrestrial (SOHO) satellite data reveal remarkable abnormalities in thermosphere, ionosphere, atmosphere and geosphere prior to earthquakes or tsunami (Cervone et al. 2004; Cervone et al. 2005; Singh et al. 2001; Singh et al. 2004; Tramutoli et al. 2001; Liu et al. 2001; Pulinets & Boyarchuk 2004; Mukherjee 2001). A new methodology, based on NCEP (National Centers for Environmental Prediction of America) data and GPS technology, has been developed for analysis and estimation of earthquakes (Weiyu et al. 2004, Baohua & Xiudeng 2004; Zhongjing et al. 2003; Kalnay

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et al. 1996). The fundamental principle of this method uses the abnormal phenomenon of increase in temperature (5°C–10°C) after the sudden change in planetary indices (Kp) and electron flux (E-flux) in earthquake prone areas of the earth. This phenomenon has been observed in various parts of the earth including Kutch, Gujarat earthquakes of India in 2001, tsunami and earthquake in Sumatra, Indonesia in 2004 and India-Pakistan border earthquake of 2005. However, measurement of land surface temperature is rather difficult because land surface with both vegetation canopy and background soil is heterogeneous and, therefore, non-isothermal. Further, the three-dimensional structure of canopy often makes the canopy radiation angular dependent (Chen et al. 2004). The surface latent heat flux (SLHF) from the epicentre regions of earthquakes that occurred in close proximity to the oceans was found to show anomalous behaviour. The maximum increase of SLHF was found 2–7 days prior to the main earthquake event (Dey & Singh 2003). In connection with the Sun-Earth study in order to forecast an earthquake, we generally utilize the Sun Observatory and Heliospheric Observatory (SOHO) satellite data for the study of Sun-Earth environment, which includes mainly Kp and E-flux values (Mukherjee 2001). The effect of star flare on Sun-earth environment is considered to be responsible for the sudden change in Kp and E-flux (Mukherjee 2006). Besides these, several other methods were also tried to forecast an earthquake based on the abnormal increase and drop in temperature of the earth and ocean in some specific locations. Mid-infrared emission prior to strong earthquakes, analyzed by Moderate Resolution Imaging Spectroradiometer (MODIS) data, has also been used successfully (Ouzonov & Freund 2004) but there are some limitations in using the satellite based abnormal infrared images because the infrared energy cannot penetrate the cloud layer (Shou 1999). Attempts were also made to use satellite cloud images like GMS, FY-2, NOAA etc to forecast an earthquake but every method had its limitations. It was our objective to evolve a suitable method out of the various methods tried and test its suitability and limitations. The data of NCEP has more advantages, such as spatial-time continuum, criterion coherence and global coverage. It resolves especially the problem of cloud layer obstruction when satellite infrared images are used to study earthquake. There are normal real time temperature data and several isobar layer altitude data, so we can thoroughly supervise the evolvement of the abnormal increase in global temperature. These observations were further supported by the sympathetic rise of Kp and E-flux and its sudden fall before the earthquakes (Mukherjee 2001). It was possible to predict and summarize earthquakes, such as Ms 7.0 Iran, December 26, 2003, Ms 8.0 Hokkaido, September by 26, 2003, Ms 7.0 Japan October 23, 2004, and Ms 6.2 Dayao, China, July 21, 2003, Ms 6.1 Dayao, China, October 16, 2003, Ms 6.7 Tibet, China, July 12, 2004, Indonesia Ms 9.0 December 26, 2004, Iran Ms 7.5 February 23, 2005 etc. and discover that the abnormal increase and fall in temperature is evidently consistent with seismic activity. In all these instances the changes in heliophysical parameters have been recorded.

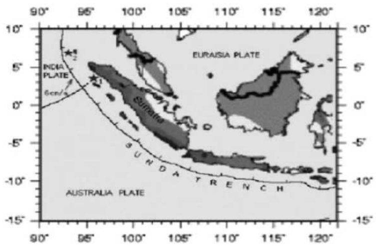

Figure 1. Location of Indonesia earthquake and movement of crustal plates.

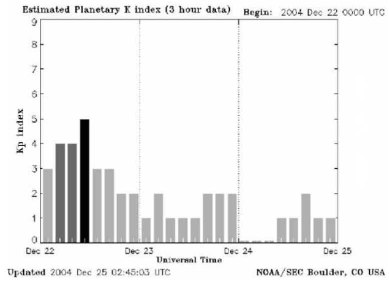

Figure 2. Rise in Kp-index before Indonesia Tsunami on 24 December 2004.

2. Materials and methods

The SOHO Extreme ultraviolet Imaging Telescope data was acquired from NASA, USA through the website. The data of planetary indices (Kp) and electron flux (E-flux) were downloaded and updated every 15 minutes to observe the changes in these heliophysical data (sohowww.nascom.nasa.gov/data/realtime-images.html). NCEP and Cosmic ray variation data was downloaded from the website www.emc.ncep.noaa.gov/data http://cr0.izmiran.rssi.ru/mosc/main.htm. These data were reanalyzed and correlated to develop the Sun-Earth connection hypothesis on changes in the environment of the earth.

3. Results

3.1 Earthquake of Sumatra and its environmental parameters

Sumatra-Indonesia region is known as a "country with thousands of islands", belongs to an island arc subduction zone (Yumin 1981). Taking Sunda trench as the boundary, the Indo-Australian plate is at west-southwest and southeast Asia plate, namely the Burma plate, which is part of Eurasia plate at northeast. The Indonesia archipelago arc extends northward to join Himalayan colliding zone and then extends eastward to join the subduction zone of west pacific ocean. The opposite movement of two large plates is mainly successive after the island arc was formed. Now India plate of west side of Sumatra seismogenic region moved towards north-northeast in respect to the Burma plate with a speed of about 6 cm/year. (Fig. 1).

3.2 Anomalous change in Kp and E-flux before earthquake and tsunami

Significant solar disturbances, such as coronal mass ejections and solar flares, can perturb the geomagnetic field worldwide and severely disturb the Earth's magnetosphere,

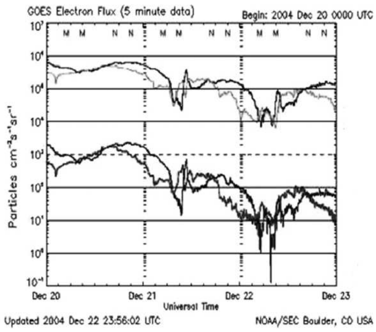

Figure 3. Rise and fall of electron-flux before the tsunami of 24 December 2004.

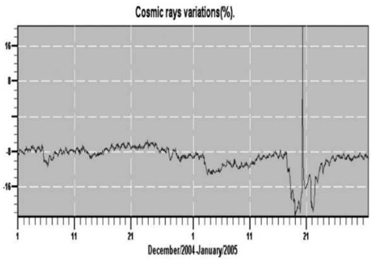

Figure 4. Cosmic ray variation before sudden change in Sun-earth weather. Courtesy: Moscow Neutron Monitor. http://cr0.izmiran.rssi.ru/mosc/main.htm

ionosphere, thermosphere, atmosphere and geosphere (Mukherjee & Mukherjee 2002). Anomalous changes in planetary indices (Kp) and Electron flux (E-flux) due to earth directed Coronal Mass Ejection (CME) might be a precursor of the earthquakes and tsunami. Daily regular magnetic field variation arises from current systems caused by regular *solar radiation* changes. Kp and E-flux measurements are being carried out continuously by satellite. Other irregular current systems produce magnetic field changes caused by the interaction of the solar wind with the magnetosphere, by the magnetosphere itself, by the interactions between the magnetosphere and *ionosphere*, and by the *ionosphere* itself. Magnetic activity indices were designed to describe variation in the geomagnetic field caused by these irregular current systems. Change in Kp on a particular geo-latitude influences changes in the stress level in active fault areas in litho-spherical as well as oceanic plates.

In various parts of the earth, sudden rise in Kp values and E-flux has been observed 36 to 24 hours before the occurrence of the earthquake. Before the occurrence of 26 December 2004 earthquake of Sumatra, anomalies in Kp and E-flux were observed (Figs 2 and 3). Kp values were increased from 3 to 5 and E-flux values dipped during this period at 12.00 noon on 22 December 2004. Similar observations were recorded before the occurrence of 26 January 2001 Earthquake of Kutch, Gujarat, India. Kp values increased from 1 to 5 on 24 January 2001 (36 hours before the occurrence of 26 January 2001 earthquake (Mukherjee 2002). Similar precursors were observed across the world in several other cases also. The occurrence of the earthquake on earth can be seen as a mirror image on the earth-facing part of the sun as active sunspots.

It may be mentioned that effect of CME is observed in areas of active faults. This information strongly supports the "relation of earthquake with CME" (Mukherjee 2001). Sudden rise and fall in E-flux before earthquake and tsunami due to solar and other cosmic activity may also have an impact on terrestrial thermal anomaly (Usoskin et al. 2003). Influence of star flare on the heliophysical parameters as well as its effect on the environment of the earth has been recorded (Mukherjee 2006). Variations of cosmic rays have influenced the development of Sunspots (Fig. 4). Monoceras V838 star flare has been lowering down the development of sunspots in the Sun on 17 December 2004 (Fig. 5).

3.3 Environmental anomalies correlation with heliophysical parameters

It has been recorded that the atmospheric temperature increases prior to an earthquake (Quang 1997; Tronin et al. 2002). We have tried a new method by utilizing NCEP data. These data, which include plenty of re-analyzing field and first guess field data of each isotonic level coordinate, have the real-time characteristics because the data were taken four times (00.06.12.18UTC.) everyday. NCEP data are considered to be better due to their temporal nature, spatial consistency and standardized grade. Further, it resolves the problem of cloud obstruction using satellite infrared images to study earthquake (Weiyu et al. 2004). To reduce the disturbance of other factors so as to pick up effectively the abnormal temperature increase caused by the constant movement of the earth's crust, we have utilized the method of subtracting the normal images from the abnormal images of NCEP. The temperature of the image area (N15°–S5° E80°–E130°) on December 13, 2004 was taken as the normal background and this was subtracted from that of the same area and altitude (500Pa) since December 14 to December 25 to get a series of images of abnormal increasing of temperature. It shows the common temperature-abnormal increase evolvement rule: The original temperature rise (December 13) → enhancing rise (December 14 - December 22), the extension of the temperature concentration toward the seismic structure zone from scatter, and the area and extent of temperature increasing is changing from small to large); → pinnacle rising (on December 13, the area reached over 60 million Km^2 and the extent of temperature increase reached 5°); → attenuation, calmness (both the area and extent of temperature increase dropped, December 25 to calmness); → earthquake occurrence (Fig. 6).

An earthquake occurs when the stress in the impending focal area reaches a critical value (Varotsos et al. 1982; Varotsos & Alexopoulos 1984). The main earthquake and aftershock of December 26 both occurred followed by the dynamic state of temperature abnormal images of NCEP data.

An integrated information content of Kp, E-flux and ΔT has been used to detect the precursor of earthquake and tsunami. Earthquake and Tsunami occurs due to dislocation or shifting of earth and oceanic crusts. Sun-earth environment studies in measuring the Kp and E-flux fluctuation have been considered to be the key factor in the active fault areas. Sunspot locations were found to be superimpossible on the triggered locations of earthquake and tsunami. The eruption of the masses from the corona of the Sun when directed towards a particular location of the earth may produce magnetic as well as thermal anomaly temporarily as well as locally. The temperature anomaly before an earthquake has been inferred by NCEP data and further it has been correlated with E-flux and Kp anomalies from SOHO satellite. Rainfall and snowfall anomalies have also been

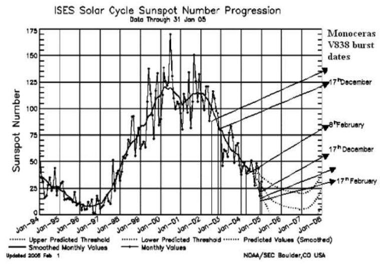

Figure 5. Influence of Monoceras V838 star on sunspots.

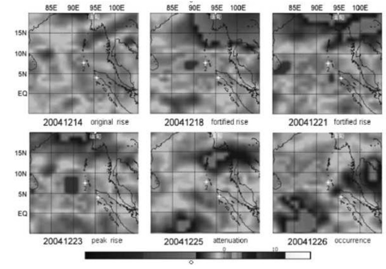

Figure 6. NCEP data showing rise in temperature from December 13 to 15; Fortified temperature rise; peak of temperature rise from December 16 to 20; Pinnacle on December 20; Attenuation, calmness from December 21 to 26; Normal resumed after Tsunami and earthquake of December 26 in Indonesia area.

noticed during the earthquake and tsunami and the existing model (ANITA, BONDO and CLOVIS) are unable to explain the reason of irregular atmospheric condition (Yassine 2007).

Preliminary statistics proves it as a new weapon to utilize the seismic geology as base, the SOHO and NCEP data as dominant factors, sudden change in atmospheric temperature due to electron flux (E-Flux) and Planetary indices (Kp) anomaly are manifestations as well as triggering factors to forecast the short-term impending earthquake.

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References

Baohua, X. & Xiudeng, X. 2004, Science Technology and Engineering, 7(4): 542
Cervone, G., Kafatos, M., Napoletani, D., & Singh R.P., 2004, NHESS 4, 359
Cervone, G., Singh, R.P., Kafatos, M. & Yu, C. 2005, NHESS 5, 87
Chen, L.F., Li, Z.-L., Liu, Q.H., Chen, S., Tang, Y., & Zhong, B., 2004, IJRS, 25, 1, 231
Dey, S., & Singh, R. P. 2003, NHESS 3, 749
Kadri Yassine, 2007, Report of RSMC La Réunion, http://www.wmo.ch/web/www/DPFS/Meetings/RAI-SWFDP_Maputo2007/Doc4-2 (1). Doc
Kalnay, E., Kanamitsu, M., & Kistler, R., 1996, Bull. Amer. Meteor Soc., 77(3), 437
Liu, J., Chou, Y., Shan, S., Tsai, Y., Chen, Y., Pulinets, S., & Yu, S., 2004, AnG, 22, 158
Mukherjee, S., 2006, EGGS News Letter, EGU, 14, 14

Mukherjee, S., & Mukherjee A., 2002, Proc. 1st Potsdam Thinkshop on Sunspots and Starspots. Astronomical Notes, AN 323 ed. K.G. Strassmeir, 139

Mukherjee, S., 2001, Gov. of India Special Publication, 65(II), 39

Ouzonov, D., & Freund, F., 2003, AdSpR, 133, 3, 268

Pulinets, S.A., & Boyarchuk, K.A., 2004, Ionospheric precursors of earthquakes, Springer Verlag, Berlin

Qiang, Z., 1997, Pure Appl. Geophys., 149, 159

Shou, Z.H., 1999, Sci. Utopia, 64, 53

Singh, R.P., Sahoo, A.K., Bhoi, S., Kumar, M.G., & Bhuiyan, C.S., 2001, J. Geological Soc. India, 58, 209

Singh, R.P., Dey, S., Singh, V.P., Cervone, G., Sarkar, S., & Kafatos, M., 2004, Proceeding of the World Congress on Natural Disaster Mitigation, 2, 129

Tramutoli, V., Bello, G.D., Pergola, N., & Piscitelli, S., 2001, Annali di Geofisica, 44, 295

Tronin, A., Hayakawa, M., & Molchanov, O., 2002, J. Geod., 33, 519

Usoskin, I.G., Solanki, S.K., Schüssler, M., Mursula, K., & Alanko, K., 2003, PhRvL, 91, 21, 211101

Varotsos, P., & Alexopoulos, K., 1984, Tectonophysics, 110, 99

Varotsos P., Alexopoulos K., & Nomicos, K., 1982, Phys. Status Solidi (B), 111, 581

Weiyu, M., Xiudeng, X., Hangcai, Z., & Yun, H., 2004, Science Technology and Engineering, 11(4), 909

Yumin, Z., 1981, The instruction for seismotectonic map of Asia and Europe. Earthquake Press

Zhongjing, M., Pingren, D., & Hangzhen, H., 2003, Earthquake tectonics and dynamics. Guangdong Science & Technology Press, 140