Ionospheric disturbances recorded by DEMETER satellite over active volcanoes: August 2004 to December 2010

Jacques Zlotnicki[1], Li Feng[2], Michel Parrot[3]

[1]CNRS ; UMR6524-OPGC-UPB, av des Landais, BP80026, 63177 AubiÃÍre cedexZlotnicki, France, [2]CNES ; CNRS, UMR6524-OPGC-UPB, 24 av des Landais, 63177 AubiÃÍre cedex, France, [3]LPC2E, 3 Av. de la Recherche Scientifique 45071 OrlÃľans, France

E-mail: jacques.zlotnicki@wanadoo.fr

Every year, Natural Hazards are the cause of millions of casualties and wounded persons. Large size economical infrastructures are devastated. Human and economical costs are so high that it may take tens of years for mitigating the effects of the catastrophes. Earthquakes and volcanic eruptions are mostly responsible of the largest disasters. Satellites appear to become unavoidable tools for monitoring the Earth at large scale, in addition to available ground based observations or when these latter are deficient. The present study analyzes electromagnetic data as well as plasma characteristics in the ionosphere recorded by DEMETER micro-satellite over erupting volcanoes during the life of the mission: August 2004 to December 2010. The database is restricted to segments of orbits located between 50S and 50N in latitude for avoiding the effects of large natural magnetic disturbances. The time window in which anomalous changes are searched brackets the onset of the eruptive activity from 60 days before to 15 days after. Along each orbit, we consider that an anomaly linked to a volcano should reasonably appear within a maximum distance of 900 km between the footprint of the satellite and the centre of the edifice; the consequence of which restricts the interesting part of a related orbit to 244 seconds duration, based on the 7.4 km/sec satellite velocity. 73 volcanoes have entered into eruption during the six years and a half of surveys. For 57 of them, 269 anomalies were found in relation with 89 eruptions. The anomalies are distributed in 5 types, similarly to the ones observed above impeding earthquakes. The two main types are electrostatic turbulences (type 1, 23.4%) and electromagnetic emissions (type 2, 69.5%). The number of anomalies is reduced at most of 27% when a daily Kp index threshold is applied and lessened from 30 to 15. Therefore, the anomalies detected in the ionosphere appear to be related to the fore coming volcanic activity. For anomalies of types 1 and 2, the maximum number of anomalies is recorded between 30 and 15 days before the surface activity, while the number drastically decreases for more remote time windows. Finally, it seems that the number of anomalies recorded for one eruption is related to the powerfulness of the eruptive activity based on the Volcanic Explosivity Index (VEI). The appearance of anomalies seems not to depend on the size of volcano or the type of activity, but rather on the likelihood to release bursts of gases during preparatory eruptive phases. In the case of the huge centenary Oct. 26, 2010 Merapi (Indonesia) eruption, 11 ionospheric type 2 anomalies appeared before the eruption. They have mainly emerged during the mechanical fatigue stage during which micro-fracturing occurred. The anomalies seem to be related with SO2 gas discharges. Although the database is relatively small, the results show that volcanic activity may be preceded by anomalous transient ionospheric effects