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Detection of electromagnetic anomalies related to volcanic eruptions by DEMETER micro-satellite: August 2004 – December 2010

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More than 1500 volcanoes on the Earth can potentially enter into eruption but only some tens of them are equipped with dense and complex monitoring networks. In the electromagnetic field (EM), a long history of ground observations, data processing and analysis show that EM signals often appear before volcanic eruptions. The characteristics widely vary from one type of volcano to another one, going from smooth, continuous and slow changes over years to rapid signals of large amplitude during the hours preceding the eruptive phases.
The possibility that volcanic eruptions may also be preceded by transient electromagnetic anomalies in the ionosphere can be analyzed through DEMETER satellite which was a micro-satellite launched by the French National Spatial Agency (CNES) and devoted to the detection of ionospheric disturbances generated by natural hazards and human activity. EM studies can be performed on the records corresponding to the time life of the satellite: August 2004 to December 2010.
The first study focuses on the identification of ionospheric anomalies above erupting volcanoes within a time window starting 60 days before the surface activity till 15 days after. A threshold distance between the footprint of the satellite and the volcano was fixed to 500 and 900 km depending on the Volcanic Explosivity Index (VEI #1 or VEI >1). Five types of ionospheric anomalies were detected which may involve electric and/or magnetic anomalies, ionic or electronic densities and temperatures. 136 eruptions located within latitudes [-50°S, 50°N] where large natural magnetic activity does not arise too frequently, have occurred. 89 of them were accompanied by ionospheric anomalies. 269 anomalies were recorded during the 6.5 years of records. The peak of the number of anomalies appears to be between -30 days and -15 days.
The second study is related to ionospheric disturbances detected by DEMETER satellite over active volcanoes submitted to volcanic lightnings. The database is initially based on the one given by Mc Nutt (2010) for which the characteristics of eruptions are related to the time of lightnings. For each observation, data have been processed during 22 days, corresponding to the time starting 15 days before the lightning and ending 7 days later. No limitation was imposed on the distance of the footprint of the satellite and the volcano. 55 volcanic lightnings have been found on 13 volcanoes during 13 eruptions.