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ORBITING NANO-SATELLITES FOR EARTHQUAKE PREDICTION (ONSEP), A FEASIBILITY STUDY

Abstract

Abstract: The ONSEP mission is a proposed nano-satellite constellation mission which is intended to perform measurements in the VLF (Very Low Frequency) and HF (High Frequency) bands in Low Earth Orbit (LEO) to understand the pre-seismic anomalies (in particular seismic-electromagnetic mechanisms) occurring in the ionosphere, which will help predict earthquakes.

Over the last 25 years, ground based and satellite based observations have been carried out to understand precursory signatures that could help reliably predict earthquakes. The ionosphere is a portion of the atmosphere that is densely populated with ionized particles and contains plasma, helping in long distance radio communications. But, the characteristics of the ionosphere have been highly un-predictable due to its dependence on various phenomena such as solar activity, thunder-storms, earth-quakes, volcanic eruptions and man-made noise. The seismo-electromagnetic process prior to an earth-quake have proven to be a reliable pre-seismic phenomenon for short-term prediction of earth-quakes. The plate tectonics close to the epicenter of an earthquake cause the rocks to compress and expand, causing a piezoelectric effect. As a result of this tribo-electric effect and rising warm gases, Earth's surface potential around the epicenter changes and this creates anomalies in the earth's electric field and subsequently the ion density in the ionosphere. The associated anomalies have been observed over a wide frequency range from DC to VHF.

The observations made by the DEMETER mission launched in 2004 have confirmed these anomalies. The results and observations made by the ICE (Instrument Champ Electrique) instrument on-board DEMETER mission is used as a case study to derive the mission requirements for the ONSEP mission. The primary mission objective of ONSEP is to perform measurements in the VLF and HF bands to record the anomalies during per-seismic activities, at the time of an earthquake and post-seismic activities and compare it with the measurements carried out during thunder-storms, volcanic-eruptions and other man-made noise. A feasibility study is performed to see if the OLFAR (Orbiting Low Frequency Antennas for Radio astronomy) payload (which forms a Low frequency radio-telescope), can also be used as the primary payload for the ONSEP mission. The main advantage of using a constellation concept for earthquake prediction is, apart from providing wider-coverage and better temporal resolution, that simultaneous measurements carried-out by the constellation of satellites will provide more consistent data and will help in predicting the location of seismic activity more accurately.