Geophysical Research Abstracts
Vol. 18, EGU2016-7959-1, 2016
EGU General Assembly 2016

The high-performance electric field detector EFD for space-based measurements

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We present the prototype of a new electric field detector (EFD) for space applications, that has been built and fully tested in laboratory in the framework of the LIMADOU collaboration between Italy and China aimed at developing the CSES (China Seismo-Electromagnetic Satellite) space mission (launch scheduled by the end of 2016). Investigations of the electromagnetic near-Earth space environment represent an important field of research as demonstrated by the satellite missions, already accomplished and/or planned to be launched in the near future, devoted to such issue (e.g. INJUN-5; POLAR, DEMETER, THEMIS, TARANIS, CSES, etc.). The payload of these satellites includes several instruments to measure electric fields in a broad frequency band along with magnetic field, plasma parameters and high energy particles fluxes. Even though these phenomena are mainly dominated by the solar activity, they are also conditioned by atmospheric and ionospheric processes, seismic activity, and human electromagnetic sources. The CSES mission will prosecute the exploratory study performed by the DEMETER satellite, by studying the electromagnetic, plasma and particle perturbations caused by seismicity in the ionosphere, magnetosphere and inner Van Allen belts. This task will be carried out through a detailed investigation of the anomalous electromagnetic field fluctuations, ionospheric plasma perturbations and instabilities accompanying earthquakes of moderate and strong magnitude, as observed by numerous satellite. As a secondary objective, the CSES satellite will also investigate the influence of the electromagnetic emissions of anthropogenic origin on the ionosphere and magnetosphere. The EFD detector consists of four probes designed to be installed on four booms deployed from the 3-axes stabilized satellite. The instrument has been conceived for space-borne measurements of electromagnetic phenomena such as magnetospheric waves, seimo-electromagnetic perturbations, anthropogenic electromagnetic emissions and more in general to investigate lithosphere-atmosphere-ionosphere EM coupling. The EFD can measure electric field in a wide band of frequencies extending from quasi-DC up to about 5 MHz. The resolution in the ULF band is better than 1μV/m with a dynamic range of 120 dB. This is a value 40 times better than that of any other recent instrument of similar quality. The sensitivity, in measuring d.o.p., in the other bands (ELF, VLF and HF) is better than 300 nV/$\sqrt{}$Hz, i.e. - by considering the boom lengths - the sensitivity in measuring electric field is of the order of 50 nV/($\sqrt{}$Hz m). With these bandwidth and precision, the described electric field detector represents the most performing and updated device so far developed for electric field measurements in near-space applications. We present the description of the EFD instrument electronics and the results of the preliminary tests performed on the prototype in laboratory.