New advanced radio tools for monitoring and diagnostics near Earth plasma environment

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To give a more detailed and complete understanding of physical plasma processes that govern the solar-terrestrial space, and to develop qualitative and quantitative models of the magnetosphere-ionosphere-thermosphere coupling, it is necessary to design and build the next generation of instruments for space diagnostics and monitoring. Novel ground based wide area sensor networks, such as the LOFAR (Low Frequency Array) radar facility, comprising wide band, and vector sensing radio receivers and multi-spacecraft plasma diagnostics should help to solve outstanding problems of Space Physics and describe long-term environmental changes. The Low Frequency Array LOFAR is a new fully digital radio telescope designed for frequencies between 30 MHz and 240 MHz located in Europe. The three new LOFAR stations will be installed until summer 2015 in Poland. The LOFAR facilities in Poland will be distributed among three sites: Lazy (East of Krakow), Borowiec near Poznan and Baldy near Olsztyn. All they will be connected via PIONIER dedicated links to Poznan. Each site will host one LOFAR station (96 high band 96 low band antennas). They will be mostly working as a part of European network, however, when less occupied, they can operate as a national network. The new digital Radio Frequency Analyzer (RFA) on board the low orbiting RELEC satellite was designed to monitor and investigate the ionospheric plasma properties. This two-point ground-based and topside ionosphere located space plasma diagnostic can be a useful new tool for monitoring and diagnosing turbulent plasma properties. The RFA on board the RELEC satellite is the first in a series of experiments which was launched in July 2014 in order to study near-Earth environment. In order to improve and validate the large and small scales ionospheric structures we will used the GPS observations collected at IGS/EPN network employed to reconstruct diurnal variations of TEC using all satellite passes over individual GPS stations and the data retrieved from FORMOSAT-3/COSMIC radio occultation measurements. The main purpose of this presentation is to describe new advanced diagnostic techniques of the near-Earth space plasma and point out the scientific challenges of the radio frequency analyzer located on-board low orbiting satellites and LOFAR facilities.
The Sun releases sporadic bursts of energy the most violent of which are identified as coronal mass ejections (CME), clouds of highly ionized plasma ejected into interplanetary space. Solar storms are known to have a damaging effect on critical space-borne and ground-based technology systems and on the Earth's ecosystem, with immediate negative consequences for society. GPS and GALILEO can be harmfully affected, electrical power distribution systems can break down due to large geomagnetically induced currents. Thus, a reliable space weather forecast could mitigate the undesirable consequences of space weather, especially its economic and social effects. The investigations with the help of the LOFAR installation, besides monitoring the Universe, will also be oriented towards developing techniques to perform detailed diagnostics and monitoring of the electromagnetic environment of the Earth, and for proof-of-concept space weather applications, which is well in line with ongoing efforts to coordinate and develop European space weather research activities.