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Aurora and substorm triggering by high-power radio emission of SURA facility

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We present the results of the experiments on modification of the ionosphere by high-power high-frequency (HF) waves from the SURA heating facility. It is important to notice that from among all of 15 our experiments spent to 2007-2012 with ionosphere modulated heating only in two of them very similar disturbances in a magnetic field are registered which can be interpreted as a signature of man-induced substorms by SURA heater. The effects of modification were observed on board the International Space Station (ISS), DEMETER satellite and groundbased observatories. For all Sura-ISS experiments the HF ordinary waves are used had the frequency more than plasma frequency at F2 max. As results the radiated powerful waves illuminate the full volume of ionosphere inside the FOV for antenna (36º in meridian plane) of SURA facility.
The first complex experiment on modification of the ionosphere by high-power radio emission from the SURA heating facility was carried out on October 2, 2007 at 18:40 – 19:00 UT. The ISS observations with an optical TV camera have provided more than 1000 images of a bright local glow, which appeared within the field of view of the camera as the Space Station was passing over the location of the active SURA facility. The brightness of the glow reached tens of kiloRayleighs. The compact bright aurora appeared Northeast of the heating facility (200 - 300 km) and was moving Eastward in the image plane.
Making use of GPS and DEMETER satellite data, that reveal the plasmapause position close to SURA latitude during the first SURA experiment (02.10.2007), and geomagnetic data, defining the time of beginning of a regenerative phase of a geomagnetic storm, leads to conclusion that these conditions promoted the substorm triggering in the first SURA experiment with the advent of the bright local aurora registered on the Russian Segment 0f ISS at the moment of artificial substorm activation. In second experiment of 25.10.2010 almost identically to the first one the same process of events was repeatedly observed. The analysis of helio-geophysical conditions did not reveal any significant anomalies during the experiments.
In the present study the ray tracing analysis clearly shows that ionosphere density decreasing (from DEMETER and IONEX data) at higher than SURA latitudes can redirect and refocused transmitter beam power in northward structure away from the beam center by refraction. By this way we have chance to participate by means of radiated SURA HF power in subauroral and auroral processes. As conclusion, the results of our SURA - ISS experiment series have shown that for possible localization of a substorm the active experiments on the basis of the SURA facility should be planned during the periods near to local midnight (sector of Harang discontinuity or around 21-24 LT) and preferably in the end of a regenerative phase of a geomagnetic storm (in undisturbed ionosphere conditions).