The Effect of Tropical Cyclones in the Ionosphere According to the SWARM Satellite Mission 2014 data

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It is known that meteorological processes, as well as events in the lithosphere, can affect the Earth's ionosphere. Therefore, the important question is how perturbations in the lower atmosphere are transmitted to ionospheric heights and manifest themselves in the ionospheric plasma.

Usually, two possible mechanisms for this effect are considered. The first is the emergence and development of atmospheric turbulence, this may be accompanied by the generation of wave structures of the acoustic or acoustic-gravitational type. At the same time, turbulent movements lead to the generation of the changes in the electric field. Thus, a system of longitudinal currents is excited, and they can also carry a disturbance in the upper ionosphere.

To test hypotheses about these methods of energy transfer, we used the data of measurements of local electron concentration on SWARM satellites in quiet geo-heliomagnetic conditions. The total statistics of the observed shopping centers is 19 events. Of these, 6 reached the 5th category on the Saffir-Simpson scale and 13 - 4th. The full active phase of action (category over 3) is more than 48 days for cyclones of category 5 and 62 days for cyclones of category 4. Various manifestations of atmospheric activity are observed in the experimental SWARM data during periods of maximum development of high-power cyclones. The phenomena of space weather have a significant influence on the state of the ionosphere; therefore, quiet periods were chosen in the work.

We used the technique described in detail in [1,2]. With its help, experimental manifestations of the atmospheric-ionospheric interaction revealed during the operation of all the largest tropical cyclones and typhoons of 2014 are considered.

We processed data on more than 250 flights of SWARM satellite over a tropical cyclone region with a strength of more than 3 categories. The size of the disturbance region can reach up to several thousand km. This region in the ionosphere exceeds the region of the storm in the atmosphere. For the strongest cyclones of category 5, perturbations in the ionosphere are distinguished for almost 65% of cases of overflights over the storm region; for cyclones of category 4, perturbations are distinguished in 50% of cases. In a number of cases, we recorded fluctuations in the electron concentration with scales characteristic of acoustic waves in the frequency band 0.005 ... 0.1 Hz. The relative magnitude of the perturbation is proportional to the strength of the cyclone and is usually 3 ... 10%. In some cases, precision techniques based on spatial gradients of the electron concentration [1, 2] distinguish the region of electron concentration disturbances, which can be associated with the electric field perturbations transmission. These disturbances can manifest themselves in variations of the magnetic field [2] or in the form of electrostatic noise, often recorded by the onboard equipment of modern satellites.

This work was carried out as part of the State Assignment of Moscow State University (N 01200408544) with partial support from the RFBR grants 18-05-00108 (PVA) and 19-05-00941 (ZVI)

References

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