WHAT IS THE BEST HEIGHT FOR THE TOPSIDE SOUNDING: 1000 KM OR 350 KM?

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Ground-based ionospheric stations realize the ionosphere monitoring mainly. However planetary monitoring of one ground-based stations has many lacks. The limitations of the ground-based ionosonde network are well known and are the following:

1. The network is helpless when total radio waves absorption in the ionospheric D-region occurs.
2. The network is inhomogeneous. In some places the absence of stations is irreplaceable (for example, near the planet's poles and over the oceans).
3. Measurement of the topside ionosphere is impossible from the ground, but the role of the topside ionosphere will increase as trans-ionospheric radio communication lines are developed while variations in ionospheric disturbances limit the possibilities of their practical application.
4. The ground network does not allow continuous measurement of electron concentration dependence along any direction to take account of horizontal gradients.
5. The ground network is unable to trace the movement of local and stable ionospheric disturbances and plasma waves.
6. Last, but not least, the argument for today is as follows: It is necessary to measure the dynamical regime of the planetary ionosphere as a whole, especially the rhythmical changes of the electron cover of the Earth. Because now we understand that the main influence of space weather on the Earth's atmosphere is the rhythmical changes of plasma cover of our planet. If earlier we measured the static characteristics of the topside and bottom side ionosphere in different experiments, nowadays we must measure and see the picture of the dynamic life of the plasma of the Earth's atmosphere cover. Especially here the peculiarities of the dynamic processes determine many of the rhythmical properties of the ionosphere.

The planetary ionospheric monitoring can also be realized from space-based ionospheric sounders [1]. It is shown, that the indicated restrictions for ground-based ionospheric net in case of sounding from above by system of space ionospheric sounders are removed. Space ionospheric sounders allow to create planetary ionospheric maps and to realize a monitoring of a global ionosphere.

A number of ionosonde was launched during the XX century into orbits with height near and more 1000 kms: Alouette-1 and -2; ISIS-1, ISIS-2; Explorer-XX, ISS-b, ISS-c, Intercosmos-19, and Cosmos-1809. These gave a vast ocean of ionosphere knowledge, allowing to work up a new theory of ionosphere-magnetosphere interaction. The installation of an ionosonde on board the MIR Manned Space Station (MMSS), which orbited at altitudes of about 350 km, meant a new step in ionospheric sounding from satellites [2]. The orbits of all the previous satellites with ionosonde were considerably higher. The Alouette 1, ISS, Cosmos 1809 and ISIS 2 flied along polar (or close to polar) circular orbits with the height of about 1000 km (the last two), 900 km and 1400 km, respectively. The orbits of Alouette 2, ISIS 1, and Intercosmos 19 (in the end of its functioning) were elliptical: 500-3000 km, 570-3550 km, and 500-900 km, respectively. Installation of an ionosonde directly within the region of the ionization maximum in the atmosphere became possible after conducting experiments on transionospheric sounding [3]. In the course of these experiments it became clear that one could obtain the main practically important ionospheric parameters (the critical frequency, peak ionization height, and half-width of the F region) under any position of the ionosonde relative the ionospheric maximum. The orbiting height of MMSS on the average corresponded to the height of the electron concentration maximum in the ionosphere. However, the ionosphere is a very changeable medium both in time and space, so during the measurements, MMSS was located either above the main electron concentration maximum or below it.

Registration of ionograms of the satellite sounding for the position of the ionosonde below the F-region maximum provided new possibilities for calculation of the Nh-profiles in the bottom side of the ionosphere. These possibilities appeared due to a combination of the solutions based on the methods using radio wave reflection from the ionosphere and methods used in

transionospheric radio wave propagation. The methods are based on a possibility to use in the calculations at least one point at the Nh-profile the position of which is determined from navigation satellite data with unusually high for Nh-profile calculation accuracy. The latter means that the entire profile is also derived with much higher accuracy.

Other feature of sounding from low heights is the reception of the ionograms of a new type. The analysis results these ionograms in a conclusion, that they are a consequence of an oblique reflection of radio waves from the Earth and "lateral" reflection of radio waves from the ionosphere, when the wave "returns" to the satellite due to a strong gradient [3] of the electron concentration situated aside the gravitational vertical. Actually, it is a new method of ionosphere irregularity diagnostics.

During Intercosmos-19 flight was shown, that the system monitoring of a condition of an ionosphere is possible also to realize by use of transionospherical radio sounding ideas, making sounding not from height of 1000 kms, and is much lower, including from those heights (~350 - 450 km), on which the manned space stations fly. For want of use of such orbits the ionospheric sounder appears that below, is higher or in the maximum of electron concentration in the F2 layer. The appropriate mathematical modeling shown, that in all cases the determination of main ionospheric parameters used in the practical purposes is possible.

Major condition of ionospheric monitoring from space is it the constant character and possibility of a cyclical replacement of out-of-date or spoiler of ionospheric sounders on new. Really, even first from ionospheric sounders - Allouette-1 (by the way, on some performances - best from all) would be quite suitable and today for work, if on it to replace power supply units.

The manned space stations have before automatic satellites advantage, that for them a replacement of power supply units and the periodic replacement of faulty or out-of-date ionospheric sounders on new is not a hard task and can be made within the framework of the usual cargo traffic, regularly realized between by a manned space station and Earth.

An ionospheric sounder (ionosonde) is installed on the Mir Manned Space Station (MMSS). One applied problem that it is intended for is real-time monitoring of the ionosphere and the determination of radio communication parameters. Topside sounding (may be better to say in this case: satellite sounding) were made with MMSS from heights 340 – 360 km. Ionosonde disposition at such height in the Ionospheric Service structure has from one side a number of advantages and from another side a number of disadvantages in comparison with a routine place location of ionospheric sounders at height 1000 km.

Disadvantages:

- absence of the information about the ionospheric condition and structure at heights 360 - 1000 km,
- impossibility of diagnostics of vertical walls of ionization in polar and equatorial topside ionosphere. (Author does not guarantee performance of this item, but the year MMSS measurements have not given any supervision of a vertical wall in equatorial topside ionosphere).

Advantages:

- opportunity of replacement or repair of the equipment in the space (this advantage takes place only in case of an ionosonde arrangement in form a part of manned space stations, on which there is a constant cargo flow of the equipment between the Earth and Satellite of the Earth);
- definition of the high-altitude characteristics of the F2 region of the Ionosphere with unusual accuracy for ionospheric measurements. This opportunity is a consequence of that fact, that the part of the local ionospheric characteristics (for example: plasma resonance’s, F2 layer maximum, etc.) is determined in the place of location of the satellite, which height above the Earth is known with a very high degree of accuracy with the help of the satellite navigating data;
- diagnostic of the ionospheric irregularities far from a gravitational vertical line of the satellite at its location is lower than an ionospheric maximum. This diagnostics became possible after opening of the new types of ionograms, which appear for satellite place location below than height of the F2 region maximum and after development of quantitative methods of their interpretation.

References

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