Global pattern of the large-scale IGW effects in the upper ionosphere from the topside and bottomside sounding

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Global pattern of the ionospheric effects of the large-scale internal gravity waves, IGWs, has been constructed. A large data set from satellites and a global network of ground ionosondes for several strong substorms has been used. The response of the upper ionosphere in hmF2, NmF2 and Ne to IGW propagation was investigated in detail. It is shown, that the ionospheric response can cover all latitudes, longitudes and altitudes of the topside ionosphere up to 1000 km. The response is characterized by the lifting of the ionosphere by up to ~200 km, large increase in Ne in the topside ionosphere, large decrease in Ne in the botomside ionosphere and weak wave-like variations in NmF2. During the solstice, the region where the hmF2 increase after IGW passage is observed looks like the wedge. At subauroral latitudes this wedge covers the night-time hours, but it quickly converges to post-midnight hours at low latitudes. The ionospheric response is symmetrical in the night-time equinoctial conditions, but strongly asymmetric in the day-time conditions and at any local time during solstices. The clear evidence of the traveling ionospheric disturbance, TID, passage from the winter hemisphere into the summer one was obtained. The dependence of the IGW effects in hmF2 and foF2 on local time for the mid-latitude ionosphere during the equinox has been derived. It is shown that a localization of the IGW ionospheric effects at the UT and LT (longitude) is determined by the pattern of the abrupt Joule heating of the auroral atmosphere. Joule heating is strongest in the westward or(and) eastward electrojet region, but the dayside cusp can be the source of the strong IGW also. The patterns of the Joule heating for two substorms on 22 March, 1979 were very different because they depend on the magnetospheric substorm evolution, characteristics of the ionosphere and ionosphere-magnetosphere feedback coupling. The response of the ionosphere changed accordingly. The IGW and electric field effects were clearly divided. The electric field effects in hmF2 in the day-time equatorial ionosphere prevail over IGW effects, in the night-time their amplitudes are comparable. The effect of the fast ionospheric dynamo, created by the passage of the IGW in the day-time ionosphere was revealed. At mid-latitudes the electric field effects become most apparent about L ~ 3. The reasons of the revealed effects are discussed.