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Small-scale irregularities in the ionosphere studied by precise ionospheric TEC difference measurement

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In the ionosphere there are various kinds of ionospheric irregularities associated with different ionospheric phenomena. They have been studiend by in-situ meassuements, radar measurements, or radio scintillation techniques. However, it was not easy to study the structures of small-scale ionospheric irregularities with a scale size of a few hundred meters which known to cause scintillation of GNSS signals at the L-band effectively.

We have developed a method to estimate the difference in the ionospheric total electron contents (TECs) between two GNSS receivers even at very short baselines of a few hundred meters. Since this method is based on single-frequency measurements, it can be applied in disturbed conditions where the L2 signal is not available. With this method, difference in TECs between two stations can be estimated with an accuarcy of 0.02 TECU or 3mm in ionospheric delay at GPS L1 frequency (1.57542 GHz).

We applied this method to data obtained at Ishigaki Island (24.3N, 124.2E), Japan. We have installed five GNSS receivers in Ishigaki with mutual distances from 0.08 m to 1.57 km. We have detected very dinamic variations of small-scale irregularities associated with plasma bubbles. Furthermore, we have succeeded in detecting spatical TEC fluctuations in non-disturbed conditions.

This method appear to be promissing in studying various kinds of small-scale irregularities in everywhere in the ionosphere.

Keywords: ionosphere, small-scale irregularities, TEC gradient, advanced GNSS technique, plasma bubble, Es layer