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Estimating bottomside ionosphere electron content using navigation augmentation observations from two CENTISPACE™ LEO satellites

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The upcoming low earth orbit (LEO) constellations can bring new opportunities for ionospheric sounding below the LEO satellite altitude. The CENTISPACE™ LEO satellites working with an altitude of 700 km broadcasting navigation augmentation signals to the ground stations. This study established a regional bottomside ionospheric map (RBIM) using navigation augmentation signals from two CENTISPACE™ satellites on April 1, 2023, under moderate solar activity and quiet geomagnetic conditions. The RBIM accuracy was subsequently validated through comparison with multiple datasets, including Global and Regional Ionospheric Maps (GIMs and RIMs) constructed from ground-based GNSS observations, as well as the differential Slant Bottomside Electron Content (dSBEC) derived from LEO observations. To build the RBIM, the vertical bottomside electron content (VBEC) is fitted by two distinct methods, which are grid map and polynomial methods. The root mean square (RMS) values of the RBIM fitting residuals are 1.2 TECU and 0.7 TECU for the two methods, respectively. The RBIM precision evaluated by LEO dSBEC is better than 1.0 TECU. Comparing the VBEC from established RBIM to the GIM/RIM indicates that the RMS values mostly within 3-8 TECU, which can attribute to the limited modelling precision of the latter two models. What's more, the RBIM facilitates the probe of the proportional variation of the VBEC over the total electron content using experimental data. The results derived from LEO observations indicate that the VBEC proportion is 83% at noon and 53% at night in the north mid-latitude region, presenting a reduction of 35.36%, which is more realistic than that calculated values from the empirical International Reference Ionosphere (IRI-2020) model (4.65%). Thus, the RBIM can not only benefit LEO navigation augmentation but also provide significant observations on the vertical distribution of ionospheric electron content.