Studies of Large TEC Gradients Associated with Equatorial Plasma Bubbles in the South American Sector

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Ionospheric plasma distribution around the low-latitude region is well known to be highly inhomogeneous, marked especially by the characteristic equatorial anomaly pattern. In addition, the development of equatorial plasma bubbles in the post-sunset local time sector further complicates the overall ionospheric plasma distribution profile in these regions. The steep total electron content (TEC) gradients associated with these space/ionospheric phenomena might pose some serious challenges to the establishment and operation of augmentation system(s) for GNSS application, particularly in aviation. We report our recent observational study of such steep TEC gradients using instruments in the Low-latitude Ionospheric Sensor Network (LISN).

Using network of GNSS receivers in the South American sector, we studied cases of these steep TEC gradients in considerable detail. We found that the side boundary wall(s) of equatorial plasma bubbles, as well as the irregularities in the interior of these bubbles, can have extremely large TEC gradients associated with them. In a number of cases, the magnitude of these TEC gradients can easily exceed 4 TECU/km (roughly 600 mm/km at the GPS L1 frequency). Hence, this experimental finding reveals the presence of a highly variable TEC distribution over certain spots in the South American sector, which could cause some difficulties for ground-based augmentation systems (GBAS).

Moreover, HF radio diagnostics using VIPIR ionosondes in the South American sector also revealed some additional complexities in the occurrence and development of equatorial spread-F/bubbles. Namely, the intensity and duration of spread-F/bubble events from the point of view of ground observations can vary greatly, even for two closely-spaced longitude sectors on the same night. Here, we also discuss some of our spread-F observations using VIPIR ionosondes operating at Puerto Maldonado, Tupiza and Tucuman.