

## Statistical analysis of ionospheric total electron content (TEC): Estimation of extreme values in a hundred years in Japan

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The ionospheric condition is one of the most important space weather features for users of radio-based systems, such as the Global Navigation Satellite Systems (GNSS), high frequency (HF) communication systems, and space-based remote sensing systems. Radio wave which propagates in the ionosphere experiences a delay due to the electrons in the ionosphere. Total delay is proportional to the ionospheric total electron content (TEC) through the propagation path. Therefore, ionospheric TEC is a key parameter for users of radio-based systems. The purpose of this study is to understand the extreme values of TEC in some periods, especially with a probability of once per one, ten, and a hundred years in Japan. In order to estimate the extreme values of TEC, cumulative distribution of daily TEC is derived using 22-year TEC data from 1997 to 2018. The result shows the extreme value with probabilities with once per one year and ten years are 85TECU and 110TECU, respectively at Tokyo. On the other hand, 22-year TEC data would not be enough to estimate the extreme TEC value with a probability of once per a hundred years. Therefore, we also used long-term data of ionosonde observation in addition to 22-year TEC data. Ionosonde observation has been conducted in Tokyo since 1950s. Manually scaled parameters are available from 1957 to present. We analyzed manually scaled F2 layer critical frequency (foF2) for 62 years from 1957 to 2018. First, we study the relationship between TEC and foF2 for 22 years. Then the relationship is applied for the statistical distribution of foF2 for 62 years. The extreme value of TEC with a probability once per a hundred years is estimated as about 170TECU at Tokyo.

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