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与日夜交替线移动相关的中尺度电离层扰动GPS网观测

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GPS observations of TID events generated by the moving solar terminator

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摘要

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摘要 本文选取由国际GPS服务中心(IGS)提供的北美中纬度地区GPS网TEC观测数据,通过多通道最大熵频谱分析方法研究了2005年(太阳活动低年)地磁活动平静期间日出和日落时由于日夜交替线的移动而激发的中尺度电离层扰动(MSTID),并统计分析其季节变化特性.结果表明:(1)日出或日落期间,在中纬度地区经常观测到由日夜交替线移动激发的中尺度电离层扰动.扰动主要沿日夜交替线运动方向传播,平均持续时间约2~3 h;振幅在0.2~0.8 TECU之间,水平波长,水平相速度和周期分别为 300 ± 150 km, 150 ± 80 m/s和 25 ± 15 min;(2)由日夜交替线移动激发的中尺度电离层扰动在春秋分出现率较少;在夏季,扰动在黄昏时出现率达最大值,在日出后少量出现;而冬季则日出后的扰动效应更为明显.分析表明,在中纬地区,这种扰动出现率随季节的变化与不同季节的日出日落时刻太阳EUV辐射通量变化过程的快慢,以及电离层中离子损失过程快慢有关.

关键词 日夜交替线 (Solar terminator), 中尺度电离层扰动 (MSTID), GPS, 最大熵谱分析

Abstract: GPS-TEC data from the International GNSS Services (IGS) were used in this paper to analyze the medium scale traveling ionospheric disturbances (MSTIDs) which are generated by the moving solar terminator (ST) during the quiet days in 2005. We collected the most comprehensive and dense GPS network's data from North-America region and introduce here a strategy that combines polynomial fitting and multi-channel maximum entropy spectral analysis to obtain TID parameters. The results of our study are summarized as follows: (1) MSTIDs stimulated by the moving ST (ST-MSTIDs) are detected at mid-latitudes after the passage of the solar terminator with the life time of 2~3 h and the variation amplitude of 0.2~0.8 TECU. Spectral analysis indicated that the horizontal wavelength, average period, horizontal phase velocity of the MSTIDs are around 300 ± 150 km, 150 ± 80 m/s, and 25 ± 15 min, respectively. In addition, ST-MSTIDs have wavefronts elongated in the moving ST direction and almost parallel to ST. (2) The statistical results demonstrate that the dusk MSTIDs stimulated by ST is more obvious than the dawn MSTIDs in summer days. On the contrary, the more-pronounced dawn MSTIDs occur in winter days. Further analysis indicates that the seasonal variations of ST-MSTIDs occurrence frequency are most probably related to the seasonal differences of the variations of EUV flux in the ionosphere region and recombination process during sunrise and sunset period at mid-latitudes.

Keywords Solar terminator (ST), Medium scale traveling ionospheric disturbances (MSTID), Global positioning system, Maximum entropy method

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