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赤道地区电离层 f_oF_2 在第23/24太阳活动周极低年期间创造了极低纪录?

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Does the equatorial ionospheric peak electron density really record the lowest during the recent deep solar minimum?

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摘要

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摘要 太阳辐射是电离层的电离源, 强烈地调制电离层的变化. 探索不同太阳辐射水平下的电离层状态, 有助于认识电离层演变及其内在的基本物理过程. 太阳活动在2008—2009年处于有记录以来的极低水平, 研究电离层在此期间的变化及与其它太阳活动低年的差异是一个有益的课题. 本文利用位于美洲扇区磁赤道地区Jicamarca台站(12.0° S, 283.2° E; dip 0.28°)测高仪观测的电离层F2层临界频率 f_oF_2 数据探讨赤道地区 f_oF_2 的行为. 分别对第22/23太阳活动周低年(1996—1997)和第23/24活动周低年(2008—2009)的月中值、季节中值和滑动年均值进行分析, 确认相比上一个太阳低年而言, 在2008—2009年 f_oF_2 滑动年均值和不同季节中值在各个地方时均降低, 而月中值存在降低和升高. 对 f_oF_2 的时间尺度特性的分析发现, 在本太阳周低年 f_oF_2 长时间尺度分量下降, 而短时间尺度分量呈现不一致的变化. 我们认为, 现有文献报道给出2008—2009年与以往太阳活动低年对比结果不一致有可能归因于所用分析方法关注的时间尺度不相同.

关键词 极低太阳活动, 赤道电离层, 临界频率 f_oF_2

Abstract: The solar activity in 2008—2009, located at the minimum phase of solar cycle 23/24, was unusually low, which attracts ionospheric physics scientists to explore the plasma behaviors in the ionosphere during the deep solar minimum. Some investigators reported a reduction in ionospheric electron density during this period, while others found a marginal and minor change. In this study we collected the critical frequency of the F2-layer ionosphere (f_oF_2) data retrieved from ionogram records observed by an ionosonde at Jicamarca (12° S, 76.9° W), an American station located near the dip equator, to examine the changes in electron density in equatorial region and explore what caused the inconsistency between the differences of solar minimum f_oF_2 in published works. We determined the f_oF_2 differences in moving yearly, seasonal and monthly medians and the Fourier series analysis.

The picture of ionospheric changes is found to be related with the data analysis method used. The seasonal median and moving yearly values of f_oF_2 are smaller in 2008—2009 than in 1996—1997, both in the daytime and nighttime. In contrast, the monthly median f_oF_2 is found to be of varying solar minimum-to-minimum differences. Although greater values in the last minimum are prevailing in the monthly median case at most local times, opposite changes are also found at some time intervals. Further analysis reveals that the reduction in f_oF_2 during the current solar cycle minimum is certainly presented in the longer time scale variations of f_oF_2 . Therefore, the inconsistent changes in the published investigations reflect the impact of f_oF_2 variability on the solar minimum-to-minimum difference over different time scales.

Keywords Solar minimum, Equatorial ionosphere, f_oF_2

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