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云南地区观测的舒曼谐振背景变化特征

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Background features of Schumann resonance observed in Yunnan, southwestern China

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摘要

本文利用云南地区永胜台观测的地磁南北和东西分量开展舒曼谐振的背景变化特征分析.通过提取舒曼谐振各阶频率和功率谱密度的小时均值,分析了前三阶舒曼谐振频率和功率谱密度在分点和至点前后的周日变化特征.舒曼谐振功率谱密度的周日变化与亚洲、非洲和美洲三大闪电活动中心的活跃时段以及观测站相对于三大闪电活动中心的方位密切相关.舒曼谐振频率的周日变化特征更复杂.各阶功率谱密度和频率在夏至和秋分前后的变化幅度比春分和冬至前后大.从2011年舒曼谐振频率和功率谱密度日中值的年变化图中发现,谐振频率随季节变化的特征不明显,而功率谱密度的年度变化曲线呈半周期正弦波形态,以7月份为轴对称分布.功率谱密度的季节变化特征与闪电活动的季节变化特征相一致.南北和东西分量得到的前三阶谐振频率,第一阶约稳定在7.5 Hz.而随着阶数增加,南北分量得到的谐振频率比东西分量约大0.5 Hz.高阶谐振频率发生偏移的原因目前还不清楚.

关键词 舒曼谐振, 周日变化, 季节变化, 频率偏移

Abstract:

This paper presents the background features of Schumann resonance (SR) observed at Yongsheng observatory in Yunnan, southwestern China. Through obtaining the hourly average of the frequency and power spectral density (PSD) of the lowest three SR modes, we analyzed diurnal variation of SR frequency and PSD both in B_{NS} and B_{EW} components around equinoxes and solstices. Diurnal variation of SR PSD is found to be related to the dominant intervals of Asian, African and American thunderstorm centers and the relative position of the observatory to three thunderstorm centers. Diurnal variation of SR frequency is more complicated. SR frequency and PSD at the lowest three modes around summer solstice and autumn equinox are more changeable than that in spring equinox and winter solstice. The daily median of SR peak frequency in 2011 shows that seasonal variation of peak frequency is blurry, while annual variation of daily median of PSD shows a clear seasonal variation which resembled half a period of sine curve and was symmetrically distributed before and after July. The seasonal variation of PSD is in accordance with that of lightning activities. Frequency of the first mode is about at 7.5 Hz both in B_{NS} and B_{EW} components. However, with the higher mode, SR frequency in B_{NS} component is 0.5 Hz larger than that in B_{EW} component. The cause of this frequency shift is not clear yet.

Keywords Schumann resonance, Diurnal variation, Seasonal variation, Frequency shift

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