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太阳活动低年时太阳同步轨道电场高频(HF)波的观测特性研究

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Features of the electric field HF wave of the Sun-synchronous orbit in the solar minimum year

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摘要 文章使用搭载在DEMETER卫星上的电场探测仪器(Instrument Champ Electrique,ICE)在太阳活动低年(2007年2月4日到2008年2月3日)所探测的数据,研究频率从10 kHz到3.33 MHz宽频段的高频(HF)电场波功率谱的空间分布特征.地磁宁静期间,从2.08 MHz到3.33 MHz的高频段,电场HF波功率谱密度随频率升高而升高,且电场HF波功率谱密度的全球分布比较均匀,基本上不随地球的经度和纬度变化.向阳面时,不同经纬度间HF波功率谱密度的差异小于背阳面的.电场HF波功率谱的季节变化主要表现为:向阳面1.25 MHz和1.66 MHz频段,在低纬度出现峰.地磁平静时期电场HF波功率谱密度的区域分布变化比较大的是0.42 MHz和1.66 MHz两个频段,尤其是在背阳面的北半球高纬度区域.地磁活动引起电场HF波功率谱扰动的非均匀性增强,主要表现在电场HF波的低频段(3.25~416 kHz),扰动响应区域发生在高纬度区.在赤道和低纬附近(纬度:~±40° 之间),地磁活动的响应很小.在背阳面的磁尾方向,电场HF波功率谱表现出明显的磁暴增强.磁暴(*Dst*<-30 nT)期间的南北半球高纬度区,电场HF波功率谱的最大增幅比地磁平静时期大一个数量级.向阳面的南半球高纬度区域,亚暴(*AE*>200 nT)和高纬磁扰动(*Kp* >3)期间,功率谱的最大增幅比地磁平静时期大一个数量级.考虑到亚暴和高纬磁扰期间,来自空间的扰动影响主要是高纬度区域,电场HF波功率谱的增强主要受空间物理过程的影响.鉴于本文使用的是在太阳活动低年的数据,观测到的磁暴基本上都是弱磁暴,最大的也只是中等磁暴;可以推测强磁暴、烈磁暴甚至巨磁暴发生时,电场HF波功率谱的增强应该更加显著.如果在地磁平静时期尤其是没有磁暴期间,地球的局部区域出现电场HF波功率谱(尤其是1.66 MHz以上的)异常增大,那么就要着重考虑是否为地球内部的异常现象(如地震)所导致的电离层响应.

关键词: 电场HF波 功率谱密度 电离层地震响应 地磁异常 地磁活动

Abstract: Using the electric field High Frequency (HF) waves recorded by the Instrument Champ Electrique (ICE) onboard the DEMETER spacecraft, the spatial features of the waves from 10 kHz to 3.33 MHz are studied. During the quiet time, the higher the HF wave, the bigger the power spectrum intensity when the frequency lies between 2.08 MHz and 3.33 MHz. At the same time, the power spectrum intensity is almost uniform in different longitudes and latitudes. The difference of the power spectrum intensity between different longitudes and latitudes in the dayside is less than that of the nightside. The seasonal changes of the HF power spectrum intensity mainly show that there are peaks at the dayside low latitudes in the frequency bands of 1.25 MHz and 1.66 MHz. During the quiet time, the discrepancy of the power spectrum intensity between different longitudes and latitudes obviously occurs at the frequency bands of 0.42 MHz and 1.66 MHz especially at high latitudes of the northern hemisphere in the dayside. During the geomagnetic activity, the HF response mainly appears at the low frequency band especially in the high latitude area. At the equator and low latitudes (latitude is between ±40°), the geomagnetic response of the HF is weak while that of the nightside in the magnetotail direction becomes strong especially during the storms. Both in the northern and southern high latitudes during the storms on the nightside, the biggest power spectrum intensity is ten times as large as those of the quiet. The biggest

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power spectrum intensity on the dayside of the high latitude of the southern hemisphere during the substorm and the period of the high latitude magnetic perturbation is ten times as large as that of the quiet. Considering that the perturbation coming from the space has an effect on the high latitude area during the substorm and the period of the high latitude magnetic perturbation, the enhancement of the HF power spectrum intensity may originate from the spatial process. In view of that the data used in this paper occur in the solar minimum year and most of the storms are very weak with the strongest storm belonging to the moderate storm, the enhancements of the HF power spectrum intensity during the strong, severe even the great storms may be more obvious. If there is anomalous accretion in local area during quiet time especially when there is no storm, the abnormal phenomena will be the ionospheric seismo-response mainly brought by the factors of the internal earth.

Keywords: Electric field HF wave Power intensity spectrum Ionospheric seismo-response Geomagnetic anomaly Geomagnetic active

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