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Alfvén波在低纬电离层中的传播研究

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Study of Alfvén waves propagation in low-latitude ionosphere

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摘要

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摘要 Alfvén波在低纬地区电离层的传播有其特殊性,一方面,低纬地区同样存在Alfvén速度梯度的巨大变化,导致电离层Alfvén谐振器(Ionospheric Alfvén resonator, IAR)的形成;另一方面,由于在低纬地区磁倾角很小,所以剪切Alfvén波在传播的过程中纬度方向跨度很大,不同纬度电离层参数将共同对其产生影响;并且,由于电离层水平分层,故磁力线与电离层不正交.本文选取双流体力学模型,在忽略场向电场的条件下,利用非正交坐标系,结合IRI07模型与MSISE00模型模拟低纬地区Alfvén波的传播,得到其反射及耦合特性.结果表明,低纬地区同样存在电离层Alfvén谐振现象,由耦合产生的压缩模有向磁赤道方向传播的趋势,夜间电离层状态相对于白天更适合IAR的形成,谐振频率沿磁力线 L 值增大单调递增.

关键词 IAR, 双流体力学, 耦合, 非正交坐标系

Abstract: Alfvén waves propagating in the low-latitude ionosphere exhibit particular characteristics. [JP] Firstly, sharp Alfvén wave velocity gradient in the low-latitude ionosphere introduces ionospheric Alfvén resonator (IAR). Secondly, shear Alfvén waves can propagate over a long distance at the latitude direction due to the small magnetic inclination angle, and the propagation properties of Alfvén waves can be affected by the ionospheric parameters at different latitudes. Thirdly, the low-latitude magnetic field lines are oblique to the ionosphere which is horizontally isotropic. In absence of the field aligned electric field and by use of IRI07 model and MSISE00 model, a two-fluid momentum model based on non-orthogonal coordinate system is used to simulate the characteristics of Alfvén wave propagation, reflection, and coupling. The results indicate that IAR can also occur in the low-latitude ionosphere, and compressional mode excited by coupling with shear mode is likely to diffuse to the magnetic equator. It is also found that IAR tends to occur more frequently at nighttime than daytime with the resonance frequency increasing with the L -shell.

Keywords IAR, Two-fluid momentum equation, Coupling, Non-orthogonal coordinate

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