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基于Millstone Hill非相干散射雷达观测的电离层电子浓度剖面的经验正交函数分析

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摘要 本文利用经验正交函数（Empirical Orthogonal Function，简称EOF）方法分析了Millstone Hill非相干散射雷达（Incoherent Scatter Radar，简称ISR）近三个太阳黑子周期（1976年2月～2006年4月）的实测电离层160～700 km的电子浓度剖面资料，并分别用Chapman-α函数拟合了平均电子浓度剖面和带有均值的前三阶EOF级数．结果表明：电子浓度剖面的EOF级数的第一阶项主要控制F_2层峰值浓度N_mF_2，第二阶项同时控制F_2层的峰高h_mF2和等效标高H_m，第三阶项主要控制等效标高H_m．进一步分析了对应的EOF系数的周日变化、季节变化和太阳活动周期变化，这些变化反映了N_mF_2，h_mF_2，H_m的气候学变化规律，例如电离层的冬季异常、半年异常等．EOF方法在级数展开方面收敛速度快，很少数低阶项即能反映电子浓度剖面的主要变化，因此可用于提取出电子浓度剖面的主要分布特征及其周日变化与气候学变化特性，并可用于进一步构建相应的经验模式．

关键词 电离层电子浓度剖面,非相干散射雷达,经验正交函数

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An empirical orthogonal function (EOF) analysis of ionospheric electron density profiles based on the observation of incoherent scatter radar at Millstone Hill

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Abstract The empirical orthogonal function (EOF) analysis has been applied to studying the ionospheric electron density profiles between 160 and 700 km, which is based on the data obtained from the incoherent scatter radar at Millstone Hill from February 1976 to April 2006. The mean electron density profile and the first three terms of EOF series with the mean term are fitted by Chapman-α function respectively. The results reveal that the first term of EOF series of the ionospheric electron density profiles mainly controls the ionospheric F_2 peak density N_mF_2, the second controls both the F_2 peak height h_mF_2 and the effective scale height H_m, and the third controls the effective scale height H_m. In addition, we have analyzed the diurnal, seasonal and solar activity variations of the corresponding coefficients of the EOF terms. These variations represent the climatic characteristics of N_mF_2, h_mF_2 and H_m, such as the ionospheric winter anomaly and semiannual anomaly. EOF series converge rapidly in analyzing the electron density profiles, and the first few terms can represent the main characteristics. So we can use EOF analysis to extract the main distributional characteristics as well as the diurnal and climatic variation characteristics of the electron density profiles, which can be used to build the empirical model for further study.

Key words Ionospheric electron density profile Incoherent scatter radar Empirical orthogonal function

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