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考虑雷暴活动的全球近地稳态大气电场的精确数学解

柳士俊;周小刚*

中国气象局培训中心，北京 100081

The state analytical solution of global atmospheric electricity model on the charging of thunderstorms in lower atmosphere

LIU Shi-Jun; ZHOU Xiao-Gang*

China Meteorological Administration Training Centre，Beijing 100081，China

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摘要 全球大气电模式是指大气和地表构成的闭合回路，其中考虑雷暴为主要充电电源，并将雷暴作为一个垂直电偶极子来考虑.本文从电流连续方程出发，采用球谐函数展开法，边界条件采用下边界为地表大气电势，上边界为电离层底部电势，非齐次电流源函数项采用垂直偶极子假设.通过所做的非线性函数变换，得到了考虑雷暴活动的全球电模式的近地稳态解析解，并证明其能展开为有限多项式级数之和.所得结论与过去的理论分析结果和实验观测是一致的.该文的工作是对以前相关工作仅能得到近似解的一种改进，同时本文所得公式可用于今后对大气电参量进行相关的数值计算及模拟之中.

关键词 全球大气电模式， 雷暴， 解析解， 晴空大气电场， 球谐函数

Abstract： Global atmospheric electricity model is the circuit between atmosphere and surface. In lower atmosphere, the main sources of electric current within the model are thunderstorms, which are considered as vertical electric dipoles. Based on the current continuity equation, using spherical harmonic function expansion, where lower boundary condition is the surface atmospheric electric potential, upper boundary condition is the electric potential of the bottom of the ionosphere, and non-homogeneous current source function of the vertical dipole assumptions is used for the charging of thunderstorms, the state analytical solution of global atmospheric electricity model in lower atmosphere is gotten. The solution is proved that it can be written as the sum of limited polynomial series. The conclusions are consistent with the past theoretical analysis and experimental observation. It is an improvement of previous approximate solution, and the formula in this article can be used in numerical calculation and simulation of atmospheric electric parameters in the future.

Keywords Global atmospheric electricity model， Thunderstorms， Analytical solution， Fair-weather atmospheric electrification， Spherical harmonic function

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