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极区电离层加热的数值模拟与实验对比

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A comparison of numerical simulation and measurements during ionospheric heating

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摘要

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摘要 大功率无线电波能加热电离层等离子体, 可以引起电离层电子温度和密度的扰动, 实现电离层的人工变态. 从电子的连续性方程、动量方程和能量方程出发, 我们给出了地面人工大功率无线电波加热电离层的数值模型. 通过对方程的数值求解, 计算了极地电离层条件下, 电子温度、电子密度的加热效应, 讨论了泵波参数对加热效应的影响. 研究表明, 电子温度几乎在整个高度上表现为一致性的幅度增强, 且在反射高度附近形成温度增强峰很平缓. 电子密度在峰上高度附近形成密度谷, 谷两侧存在密度增强. 加热效应基本随加热功率的增大而增大, 随加热频率的增大而减小. 使用我国2008年1月在挪威进行的电离层加热实验的电离层参量作为仿真初值, 对6个O波加热时刻进行了数值仿真, 仿真结果与实验观测基本保持一致.

关键词 电离层加热, 数值模拟, 电子温度与密度, 非相干散射雷达

Abstract: High power radio wave heating of the ionospheric plasma can induce disturbances of electron temperature and density, and modify the ionosphere. The numerical model can be presented from a series of continuity equation, momentum equation and energy equation. The heating disturbances of the electron density and temperature in polar ionosphere are presented and the effects of the pump parameters are discussed. It shows that electron temperature almost increases in all altitude, however, the peak at the reflection altitude is not clear. Electron density vale is formed at the altitude above peak, and density peaks appear around both sides of it. The heating characteristic increases with the increment of the heating power and the decrement of the pump frequency. Using the parameters of the ionospheric modification experiments carried out in January 2008 at Tromsø, Norway as initialization, the six O mode heating cases are simulated, and the results are consistent with the observation very well.

Keywords Ionospheric heating, Numerical simulation, Electron temperature and density, Incoherent scatter radar

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