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GPS无线电掩星后向传播方法

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Back propagation method for GPS radio occultation data

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摘要 在大气多路径传播条件下,讨论了两种无线电信号的反演方法:几何光学方法和后向传播方法.当大气存在多路径效应时,采用几何光学方法反演大气参数会引入较大误差.后向传播方法将无线电信号从多路径区域反推至单路径区域,减少了大气多路径效应的影响.为了比较不同的反演方法,利用多相位屏模型,数值模拟了大气多路径条件下无线电信号在大气中的传播过程.假设信号处于理想条件下(仅受大气多路径效应的影响),分别用几何光学方法和后向传播方法对模拟信号进行反演,结果表明:后向传播方法能消弱大气多路径效应的影响,后向传播方法优于几何光学方法.对2007年第60天至180天4个月共约15000个CHAMP掩星观测数据进行反演,将其折射率反演结果与ECMWF分析场资料进行统计比较,结果说明:在南半球(30° S~90° S)、热带(30° S~30° N)以及北半球(30° N~90° N)的低对流层,后向传播方法反演的折射率的相对误差的平均偏差和均方差普遍小于几何光学方法.从而证实:后向传播方法确实能消弱大气多路径效应的影响,获得较好的反演结果.

关键词: GPS/LEO掩星 大气多路径 后向传播方法 几何光学方法 多相位屏模型

Abstract: For determination of bending angle profiles from radio occultation in multipath areas, two methods, i.e., the geometric optics (GO) method and back propagation (BP) method, are compared and discussed. The GO method does not work well in multipath areas while in the BP method electromagnetic field can be back-propagated from multipath area to a single-ray area for reducing multipath effects. The atmospheric propagation of GPS signals under multipath conditions and their detection are simulated by using multiple-phase-screen model. Under the assumption of ideal signal, bending angles computed by the GO method and BP method are compared with corresponding solutions to Abel integral (true), the results reflect that the BP method is much closer to Abel integral in multipath area. About 15000 CHAMP radio occultations from March to July in 2007 are retrieved by the GO method and BP method, statistical comparisons of the retrieval refractivity profiles with that of ECMWF show that the average deviation and variance of fractional difference in refractivity retrieved by the BP method are generally smaller than that by the GO method in the lower troposphere of the southern hemisphere (30° S ~ 90° S), the tropics (30° S ~ 30° N), as well as the northern hemisphere (30° N ~ 90° N). The results confirm that the BP method can solve the problem of calculating bending angle profiles within multipath regions better than the GO method.

Keywords: GPS/LEO radio occultation Atmospheric multipath Back propagation method Geometric optics method Multiple-phase-screen model

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