地球物理学报 » 2012, Vol. » Issue (6) :1876-1883 doi:10.6038/j.issn.0001-5733.2012.06.008
空间物理学·大气物理学

引用本文(Citation):
刘厚通, 陈良富, 苏林.FFIM用于机载大气激光雷达 ABCT反演的可行性研究. 地球物理学报, 2012,(6): 1876-1883,doi: 10.6038/j.issn.0001-5733.2012.06.0
LIU Hou-Tong, CHEN Liang-Fu, SU Lin.A feasibility study of aerosol backscatter coefficient inversion of airborne atmosphere detecting lidar by Fernald forward integration method.Chinese J.Geophys. (in Chinese),2012,(6): 1876-1883,doi: 10.6038/j.issn.0001-5733.2012.06.008

FFIM用于机载大气激光雷达 ABCT反演的可行性研究

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A feasibility study of aerosol backscatter coefficient inversion of airborne atmosphere detecting lidar by the Fernald forwa integration method

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摘要 Fernald前向积分法能否用于机载大气探测激光雷达气溶胶后向散射系数的反演一直是一个有争议的课题.本文利用青岛机载大气探测激光雷达实测数据、国外机载大气探测激光雷达实测数据和机载大气探测激光雷达模拟数据,对Fernald前向积分法应用于不同高度的机载大气探测激光雷达气溶胶后向散射系数反演的误差进行了定量分析,分析结果表明:飞机的飞行高度在3.5 km左右,标定值存在20%的误差时,离地面2 km的高度范围内反演得到的气溶胶后向散射系数的相对误差在12%以内,但在标定点附近相对误差可达20%;飞机飞行高度在7 km左右,当标定值存在100%的误差时,反演得到的气溶胶后向散射系数的相对误差大都在10%~15%之间,标定值存在400%的误差时,反演得到的气溶胶后向散射系数的相对误差大部分在15%~50%之间.本文从理论上对Fernald前向积分法应用于机载大气探测激光雷达气溶胶后向散射系数反演出现负值的原因进行了探讨.研究表明:Fernald前向积分法能够较准确地反演出中高空探测(4.5 km以上)机载大气探测激光雷达气溶胶后向散射系数,但应用于低空探测(4.5 km以下)机载大气探测激光雷达气溶胶后向散射系数反演时,反演误差较大甚至反演结果会出现负值.

关键词 大气光学, Fernald前向积分法, 机载大气探测激光雷达, 气溶胶后向散射系数

Abstract: Whether Fernald forward integration method can be used for aerosol backscatter coefficient inversion of airborne atmosphere detecting lidar is always a controversial issue. In this paper, using the airborne atmosphere detecting lidar data measured at Qingdao and abroad as well as from simulation, the inversion error of aerosol backscatter coefficient is quantitatively analyzed for Fernald forward integration method being applied to aerosol backscatter coefficient inversion of airborne atmosphere detecting lidar at different heights. Analysis results show that the relative error below altitude 2 km is less than 12% when flying height of the aircraft is about 3.5 km and the calibration value error is 20%, but the relative error may reach 20% nearby the calibration site. When the flying height of the aircraft is about 7 km and calibration value error is 100%, the inversion value relative error of aerosol backscatter coefficient is mostly between 10%~15%. When the calibration value error is 400%, the relative error of aerosol backscatter coefficient is mostly between 15% and 50%. The reasons for causing negative aerosol backscattering coefficient value were discussed from a theoretical perspective when Fernald forward integration method being applied to aerosol backscattering coefficient inversion of airborne atmosphere detecting lidar. Research shows that the inversion value of aerosol backscattering coefficient obtained by Fernald forward integration method is relatively accurate when the aircraft flying height is more than 4.5 km, but the inversion error is large even results in negative coefficient values when the flying height is less than 4.5 km.

Keywords Atmospheric optical, Fernald forward integral method, Airborne Atmospheric detection lidar, Aerosols backscattering coefficient

Received 2011-09-25;

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