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亚洲地区ECMWF/NCEP资料计算 ZTD的精度分析

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An analysis of the accuracy of zenith tropospheric delay calculated from ECMWF/NCEP data over Asian area

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摘要 对流层延迟是卫星导航定位的主要误差源,气象观测的数值预报资料可用来计算对流层延迟改正量.本文通过分布于亚洲地区的49个GPS台站一年的实测ZTD资料,对利用欧洲中尺度天气预报中心(ECMWF)分析资料、美国国家环境预报中心(NCEP)再分析资料和NCEP预报资料,计算对流层天顶延迟(ZTD)改正的有效性和可能达到的精度进行了评估,分析了ECMWF和NCEP在亚洲地区的适用程度和其分辨率对计算ZTD精度的影响.研究结果表明:(1)相对于 GPS实测ZTD,用ECMWF资料计算ZTD的bias和rms分别为-1.0 cm和2.7 cm,优于NCEP再分析资料,可用于高精度ZTD研究和应用;NCEP预报数据计算ZTD的bias和rms分别为2.4 cm 和 6.8 cm,足以满足广大GNSS实时导航定位用户对流层延迟改正的需要.(2)bias和rms呈现明显的季节性变化,总体上夏季大,冬季小;在空间分布上随着纬度的变化不明显,但随高度的增加rms总体上有递减趋势.另外还发现,亚洲东部地区夏季日平均bias和rms和南部热带地区冬季的日平均bias和rms变化相对较大.(3)ECMWF2.5° 和0.5° 的资料进行了对比分析,发现0.5° 分辨率资料的rms比2.5° 减小1~5 mm.这些结果,为在亚洲地区的空间大地测量、导航定位和INSAR等工作中,应用ECMWF/NCEP的资料进行对流层大气延迟改正的有效性和可能达到的精度提供了重要参考.

关键词 全球定位系统(GPS), 对流层天顶延迟(ZTD), ECMWF, NCEP

Abstract: The tropospheric delay is an important error source for the satellite navigation and positioning, and the numerical forecast data derived from meteorological instruments can be used to calculate the tropospheric delay. In this study, the zenith tropospheric delay (ZTD) observed from 49 Global Positioning System (GPS) sites distributed in Asian area is used to assess the effectiveness and accuracy of ZTD calculated with the data from the European Center for Medium-Range Weather Forecasts (ECMWF) and the United States National Centers for Environmental Prediction (NCEP). The practicability of ECMWF/NCEP data in Asian area and the relation between the resolution and the accuracy for the ECMWF data are also studied. The results are: (1) relative to GPS observed ZTD (GPS ZTD), the bias and rms for the ECMWF data are -1.0 cm and 2.7 cm respectively, which are better than that for the NCEP data and can be used for ZTD study and application with high accuracy; the bias and rms for the NCEP forecast data are 2.4 cm and 6.8 cm, which are sufficient for the tropospheric delay correction in the real-time GNSS navigation and positioning. (2) The bias and rms show a seasonal variation, which generally show larger values in summer months and smaller values in winter months; however, the relation between the bias and rms and the latitude is not obvious, but the rms decreases with increasing altitude. In addition, the daily bias and rms at eastern Asian area in summer and at southern in winter have a relatively larger variation. (3) The resolutions of 2.5 degree and 0.5 degree ECMWF data are compared; the rms for the latter is decreased by 1~5 mm than the former. These results provide a reference for the effectiveness and accuracy of the ECMWF/NCEP data used for calculating the tropospheric delay in the space geodesy, navigation and positioning, and INSAR, etc.

Keywords GPS, ZTD, ECMWF, NCEP

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