基于 GNSS-PWV 三因子阈值方法的降雨预报研究

董传凯[1*], 余法承[1*], 魏康丽[2], 方礼喆[1], 张卫星[3], 欧书圆[3], 楼益栋[3]

1 武汉大学数学与统计学院, 武汉 430072

2 武汉大学国家网络安全学院, 武汉 430072

3 武汉大学卫星导航定位技术研究中心, 武汉 430072

摘要： 大气可降水量(PWV)在研究大气水汽含量与降雨之间关系的研究中发挥着越来越重要的作用. 基于 GNSS PWV 的三因子阈值降雨预报方法已经在一些场景中取得了不错的效果, 但该方法目前仍存在一些问题, 比如没有充分利用实时信息. 本文改进了以 PWV 为主要预测因子，PWV 增量和 PWV 增率为辅助预测因子的月阈值降雨预报方法, 改进后的方法能够充分利用 PWV 的季节特征和实时信息, 有效刻画 PWV 和降雨之间的关系. 此外完善了命中率(POD)，误报率(FAR)，临界成功指数(CSI)和正确率(CR)等降雨预报模型评价指标的定义, 为同类模型提供了一种可能的评价范式. SuomiNet网络提供了记录高精度，低延迟的PWV和其它水汽资料的大量测站, 本文从其中筛选出 11 个数据较为完整的测站, 并在其上进行算法的测试与验证. 结果显示, 降雨预报的正确率为 92%, 误报率为 63%, 命中率为 67%；与传统三因子算法相比, 正确率提高了近 6%, 误报率降低了 4%以上, 且命中率处于相同水平. 说明改进后的算法能够有效预测不同地区的降雨, 且适应性较好.

关键词：SuomiNet；GNSS；PWV；三因子阈值方法；降雨预报

The rainfall forecasting research based on GNSS-PWV three-factor threshold method

DONG ChuanKai[1], YU FaCheng[1], WEI KangLi[1], FANG LiZhe[1], ZHANG WeiXing[2], OU ShuYuan[2], Lou YiDong[2]

1 School of mathematics and statistics, Wuhan University, Wuhan 430072, China

2 National College of network security, Wuhan University, Wuhan 430072, China

3 Satellite navigation and positioning technology research center of Wuhan University, Wuhan 430072, China

Abstract: Precipitable water vapor (PWV) plays an increasingly important role in the study of the relationship between the atmospheric water vapor content and the precipitation. The three-factor threshold method based on GNSS PWV has achieved some good results in some scenarios of rain forecast while it still remains some issues, for example, the real-time information can not be fully exploited. Therefore, we modify the definitions of the factors and improve the monthly threshold method with PWV as the main factor and PWV increment and the rate of PWV increment as auxiliary factors. This method can make full use of the seasonal characteristics and real-time information of PWV to effectively describe the relationship between PWV and precipitation. In addition, we have improved the definition of evaluation indexes, such as Probability of Detection (POD), False Alarm Rate (FAR), Critical Success Index (CSI) and Correct Rate(CR), of rain forecast models which provides a possible evaluation paradigm for similar models. SuomiNet provides a large number of stations recording PWV and other water vapor data with high precision and low delay. 11 stations with relatively complete data are selected to test and verify the the effect of the algorithm. The resultshow that the correct rate of rainfall prediction is 92%, the false alarm rate is 63%, and the probability of detection is 67%; Compared with the traditional three factor algorithm, the accuracy is improved by nearly 6%, the false alarm rate is reduced by more than 4%, and the the probability of

*: contribute equally to this paper.

detection is at the same level. It shows that the algorithm has good applicability for short-term and imminent rainfall prediction in different regions.
Keywords SuomiNet; GNSS; PWV; three-factor threshold method; rain forecast