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基于简化参数方法的蒙古干旱区土壤湿度被动微波遥感

田辉[1,2], 王澄海[1], 文军[2], 王欣[2], 陆登荣[3], 吕少宁[2]*

1. 兰州大学大气科学学院, 兰州 730000;
2. 中国科学院寒旱区陆面过程与气候变化重点实验室, 兰州 730000;
3. 甘肃省气象局, 兰州 730000

Soil moisture estimation over an arid environment in Mongolia from passive microwave remote sensing based on a simplified parameterization method

TIAN Hui[1,2], WANG Cheng-Hai[1], WEN Jun[2], WANG Xin[2], LU Deng-Rong[3], LÜ Shao-Ning[2]*

1. College of Atmospheric Sciences, Lanzhou University, Lanzhou 730000,China;
2. Key Laboratory of Land Surface Process and Climate Change in Cold and Arid Regions, Chinese Academy of Sciences, Lanzhou 730000,China;
3. Gansu Meteorological Bureau, Lanzhou 730000,China

摘要 卫星被动微波遥感土壤湿度,是准确分析大空间尺度上陆表水分变化信息的有效手段.美国航天局(NASA)发布的基于AMSR-E观测亮温资料的全球土壤湿度反演产品,在蒙古干旱区的实际精度并不令人满意.本文基于对地表微波辐射传输中地表粗糙度和植被层影响的简化处理方法,采用AMSR-E的6.9 GHz,10.7 GHz和18.7 GHz之V极化亮温资料,应用多频率反演算法,并以国际能量和水循环协同观测计划(The Coordinated Energy and Water Cycle Observations Project)即CEOP实验在蒙古国东部荒漠地区的地面实验资料作为先验知识,获取被动微波遥感模型的优化参数,以期获得蒙古干旱区精度更高的土壤湿度遥感估算结果.分析表明,本文方法反演的白天和夜间土壤湿度结果与地面验证值之间的均方根误差(RMSE)接近0.030 cm^3/cm^3, 证明所用方法在不需要其他辅助资料或参数帮助下,可较精确地反演干旱区表层土壤湿度信息,能够全天候、动态监测大空间尺度的土壤湿度变化,可为干旱区气候变化研究及陆面过程模拟和数据同化研究提供高精度的表层土壤湿度初始场资料.

关键词 蒙古干旱区, 被动微波遥感, 简化参数方法, 土壤湿度

Abstract: Satellite passive microwave remote sensing provides a major basis for the analysis of temporal and spatial variation of top soil moisture at large scales. A global soil moisture data product is currently released by the National Aeronautics and Space Administration (NASA) of USA based on AMSR-E (the Advanced Microwave Scanning Radiometer for the Earth Observing System onboard the NASA EOS Aqua satellite) global dual-polarization brightness temperature observations of the Earth. But the accuracy of this soil moisture product is not satisfactory in arid Mongolian regions. Based on a simplified parameterization method for characterizing the effects of the sparse vegetation cover and surface roughness on surface microwave emission, the estimation of daytime (local noon) and nighttime (local midnight) top soil moisture during a near two-year period from October 1, 2005 to September 20, 2007 over the arid CEOP(The Coordinated Energy and Water Cycle Observations Project)-Mongolia experiment area was conducted based on a multifrequency algorithm by mainly using AMSR-E 6.9 GHz, 10.7 GHz and 18.7 GHz vertical-polarized brightness temperature data. In the inversion model, the only model parameter asking for experimental calibration, i.e., the vegetation single scattering albedo, could be achieved through optimization technique by using in-situ soil moisture measurements. The results showed that the root mean square error (RMSE) between satellite estimated soil moisture and ground-measured soil moisture was close to 0.030 cm^3/cm^3. Without other supplementary data else, the retrieval algorithm proposed in this paper may be applied to near real-time monitoring of the dynamic variation in top soil moisture at large scales, in an all-weather working manner, over arid and or semiarid environments characterized by natural sparse vegetation conditions. Therefore, it will be promising to provide sustaining and reliable initial near-surface soil moisture information for the long term study of climate change and water cycle over arid and or semiarid regions.

Keywords Mongolia arid regions, Passive microwave remote sensing, Simplified parameter method, Soil moisture

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About author: 田辉,男,1970年生,兰州大学在读博士后,主要从事陆面过程和卫星遥感研究.E-mail:htian@lzb.ac.cn