Image fusion of AATSR AOD products based on the maximum likelihood estimate method

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Keywords: AOD, image fusion, Maximum likelihood method.

Abstract

The traditional station measurement of aerosol optical depth (AOD) is currently widely employed. But this traditional approach has limitations with respect to wide-range coverage and spatial continuity. Comparing with traditional station observation, satellite remote sensing provides a possibility to high frequency monitor continuously spatial coverage of AOD (Xue et al., 2014). Based on these advantages, satellite measurements are widely applied to the monitoring of aerosol AOD in recent decades. However, the values of the AOD provided by different satellites show spatial and temporal differences due to the instrument characteristics and aerosol retrieval algorithms used for each instrument (Xu et al., 2015). This greatly limits its application in the direction of climate change and quantitative remote sensing. Through fusion of image from different remote sensors and methods, we can improve the image spatial coverage of valid values and accuracy, and further improve its application range (Xu et al., 2015).

In this paper, we use the maximum likelihood method to determine the weights of various images involved in fusion to produce an Asian regional AOD data set in 2008 based on three AOD products: ADV, ORAC and SU that obtained from the Advanced Along-Track Scanning Radiometer (AATSR) according to the error size of each pixel. First of all, we compare the values of various products with the ground observation values obtained from the Aerosol Robotic Network (AERONET) and the China Aerosol Remote Sensing Network (CARSNET) to determine the error size of the pixels of the various products. Then, we study and determine the relationship between the values of the remote sensing observations and the value and surface albedo, so as to determine the error size of the observation value in the absence of the ground sensing station. Finally, we determine the weight of the fusion according to the root mean square error of the different products (Xu et al., 2015).

After comparing the original data and the fused data with the CARSNET observations, we find that the absolute error of the fused image is smaller than any of the original data. Meanwhile, the proportion of the fused AOD image with valid value is greatly large than any of the original products. Thus, the fusion increases the spatial coverage.

摘要

目前，对大气气溶胶光学厚度（AOD）的传统站点测量方法得到了广泛的应用，但是由于是单点测量，传统的测量方法得到的数据在空间覆盖度和连续性上往往存在着不足。相比于传统的站点观测，卫星遥感反演可以实现对 AOD 的大范围高频连续观测（Xue et al., 2014）。基于这些优点，近几十年来卫星遥感反演技术被广泛的应用于对 AOD 的监测研究。然而由于传感器特性以及应用于不同传感器的 AOD 反演算法的差别，不同的卫星数据反演的 AOD 值往往并不相同，存在着时间和空间上的差异（Xu et al., 2015），这也极大地限制了 AOD 的遥感反演在气候变化以及定量遥感等方向的研究中的应用。而通过将来自不同传感器和反演方法的图像进行融合，我们能够有效地提高反演结果有效值的空间覆盖度和准确度，并可以进一步扩大卫星遥感数据的应用范围（Xu et al., 2015）。

在本文中，我们使用从先进的沿轨迹扫描辐射计（AATSR）得到的三种 AOD 产品：ADV，ORAC 和 SU，并利用最大似然法根据每个像元的误差大小确定不同图像参与融合的权重生产了 2008 年亚洲区域的 AOD 数据集。首先，我们将不同的 AOD 产品与从全球气溶胶自动观测网（AERONET）和中国气溶胶遥感监测网（CARSNET）获得的站点观测数据进行比较，用来确定不同图像的像元的误差大小。然后，为了可以在没有地面观测站的区域仍能够确定遥感观测值的误差大小，我们探究并确定了遥感观测值和地表反射率的关系。最后，我们根据不同产品的均方根误差大小确定其参与融合的权重。

在将原数据以及融合后的数据与 CARSNET 的观测结果进行比较之后，我们发现融合后的图像的绝对误差要比任何一种原数据的绝对误差都要小。同时，融合后图像的有效值的比例比任何一种原数据都要大很多，从而通过融合增加了有效数据的空间覆盖度。.