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Half-Hour Rainfall Retrieval based on multispectral geostationary satellite images

Yuan Wang (1) and Xiao-Yong ZHUGE (2)

(1) School of Atmospheric Sciences, Nanjing University, Nanjing, China (yuanasm@nju.edu.cn), (2) School of Atmospheric Sciences, Nanjing University, Nanjing, China (zgxy_nju@126.com)

A method for both precipitation area and intensity retrievals is developed based on multispectral geostationary satellite images. This method can be applied to continuous observation of large-scale precipitation so as to solve the problem from the measurements of rainfall radar and rain gauge.

Satellite observation is instantaneous, whereas the rain gauge records accumulative data during a time interval, and thus, using the 10-min gauge rainfall data rather than 1-hr gauge rainfall data as the reference value, can obviously improve the accuracy of satellite rainfall retrieval.For this reason, a 10-min rainfall algorithm is established firstly. It includes two steps. 1) A Rainfall probability identification matrix (RPIM) is used to distinguish rainfall clouds from nonrainfall clouds. This RPIM is established by combining infrared brightness temperatures (BTs) with visible reflectivity at daytime and dual-channel brightness temperature differences (BTDs) at nighttime. It is more efficient in improving the retrieval accuracy of rainfall area than previous threshold combination screening methods. 2) the multispectral segmented curve-fitting rainfall algorithm (MSCFRA) is proposed to estimate the 10-min rain rates. Rainfall samples taken from June to August 2008 and 2010 are used to assess the performance of the rainfall algorithm. Assessment results show that the MSCFRA improves the accuracy of rainfall estimation for both stratiform cloud rainfall and convective cloud rainfall. These results are practically consistent with rain gauge measurements in both rainfall area division and rainfall intensity grade estimation. Furthermore, this study demonstrates that the temporal resolution of satellite detection is important and necessary in improving the precision of satellite rainfall retrieval.

The current geostationary satellite provides an image every half an hour, so the temporal “gaps” exist when the satellite images are directly used to retrieve 10-min rainfall. To implement continuous and reliable rainfall retrieval, an immediate tracking and continuous accumulation technique (ITCAT) of half-hour rainfall retrieval is proposed. The ITCAT includes two steps. 1) The cross-correlation method is applied to track cloud-motion currents and establish 10-min-interval image sequences. 2) A continuous retrieval of 10-min rain rate is conducted with the image sequences, and finally a total half-hour rainfall is determined by accumulations. The satellite retrieval tests on the typical precipitation process in summer of 2008 show that, compared with the previous direct rainfall retrieval for half-hour to one-hour, this rainfall retrieval technique significantly improves the retrieval accuracy of rainfall scope and rainfall intensity ranging from slight rain to rainstorm for both real-time monitoring or nowcasting processes. This technique is more effective than the previous algorithm, and the fundamental reason lies in its consideration of the movement of cloud cluster. On this basis, coverage duration of rainfall clouds can be reliably estimated. It is of significance to the retrieval of deep convective cloud rainfall with rapid movement speed and drastic intensity variation. This technique also provides a feasible idea for improving the accuracy of rainfall nowcasting.