RETRIEVING ATMOSPHERIC PROFILES WITH HIGH RESOLUTION SPECTRAL INFRARED MEASUREMENTS

Xuebao Wu[a], Peng Zhang[a], Hong Qiu[a] and Jun Li[b]

[a]National Satellite Meteorological Center, Beijing 100081

[b]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin, WI 53706

ABSTRACT

The shortage of conventional RAOB (RAdiosonde Observation, RAOB) and surface observation is one of the main issues in the synoptic weather diagnosis and numeric weather prediction. Some measurements from weather satellite have low spacious and temporal resolution, however they are irreplaceable due to their continuous coverage in the spatial and temporal domain. In this paper, the measurements from high spectral resolution infrared sounder AIRS (Atmospheric InfraRed Sounder, AIRS) and MODIS (the Moderate Resolution Imaging Spectroradiometer, MODIS) onboard EOS satellite Aqua have been synergistically used to retrieve the atmospheric temperature and moisture profiles. AIRS has thousands of sounding channels with valuable information content in the infrared spectral region. The data volume of these satellite observations is huge. By analyzing the spectral characteristics of AIRS measurements, a new physical retrieval method of obtaining atmospheric temperature and moisture profiles has been developed based on the synergic use of AIRS/MODIS data. A subset of channels has been selected because of the high correlation between AIRS spectral channels, and some abnormal channels have been excluded in the atmospheric retrieval processing. Each AIRS footprint is determined as clear sky from contaminated clouds with the help of high spatial resolution MODIS cloud mask. The algorithm employs a statistical retrieval followed by a subsequent nonlinear physical retrieval. The regression coefficients for the statistical retrieval are derived from a dataset of global radiosonde observations comprising atmospheric temperature, moisture, and ozone profiles. The physical retrieval method is only applied to the clear-sky radiances, achieving good retrieval accuracy. For example, in the experiment of AIRS clear radiances from ARM site, the retrieved atmospheric temperature and moisture profiles show good agreement with RAOB observations. For the level above 850hPa, the RMS is less than 1K on the average for temperature profile. The RMS is large for the near surface levels. The RMS of moisture profile for the physical retrieval is approximately 10%. Case study indicates that the calculated brightness temperatures agree well with the observed ones. The residual is within the instrument noise level. The temperature and moisture fields agree well with the NWP analyses of ECMWF. This physical approach is also applied to the cloud cleared radiances provided by AIRS science team. The RMS is almost 3K for the near surface levels while it is about 1-2K at all other levels for temperature profile. The RMS of moisture profile is approximately 10-20% for the physical retrieval. The AIRS standard products show the similar statistics, however this new physical retrieval approach is able to better capture the fine structure than the AIRS standard product. With its improved spectral resolution, AIRS depicts much more detailed structure. By investigating the spectral characteristics and the sensitivity of AIRS measurements, a new physical retrieval method of obtaining atmospheric temperature and moisture profiles has been developed based on the synergic use of AIRS/MODIS data. Comparisons show that AIRS retrievals of temperature and moisture profiles are in general agreement with the distributions from the radiosonde observations and the NWP analyses of ECMWF.

Keywords: High Spectral Resolution Infrared Measurement, Physical Retrieval, Atmospheric Temperature and Humidity Profile, radiosonde observations, Validation