Simultaneous Retrieval of Geophysical Properties and Atmospheric Parameters from the Infrared Hyperspectral Resolution Sounding Data Using Neural Network Technique

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The observed infrared data collected by the satellites contain both the land surface and atmospheric information. Until now, great efforts have been made to derive geophysical properties (surface temperature and emissivity) and atmospheric parameters (atmospheric temperature-humidity profiles), but most of these works are isolated. For land surface property retrieval procedure, although the split-window technique can partly correct atmospheric influences, this technique still needs an exact knowledge of surface emissivity better than 0.01 to meets the requirement of 1K Land Surface Temperature (LST) retrieval accuracy. The physics-based LST retrieval algorithm can reach a high accuracy, but it requires accurate atmospheric information, too. The retrieval of atmospheric temperature-humidity profiles using infrared data requires information on the emissivity and temperature of terrestrial materials. The usual assumption that the surface is a black body or a gray body typically results in large retrieval errors over heterogeneous land surface. To improve the accuracy of atmospheric profiles retrieval results, better knowledge for the surface emissivity and temperature is needed. It seems to form a problem-cycle. To solve these problems, and also to meet a higher accuracy requirement, in this paper, an attempt is made to retrieve simultaneously atmospheric parameters and geophysical properties [1][2][3].

This work is based on the infrared hyperspectral resolution sounding data because the sharp contribution functions of instruments are required to obtain exact atmospheric information. The limitation of the vertical resolution is caused mainly by the broadness of the contribution functions. When the contribution functions are broad, each channel of the satellite receives energy emitted from a thick layer of the atmosphere. Furthermore, broad contribution functions imply less instrument bands. Since the atmospheric temperature profile, surface emissivity, O_3, H_2O, and other minor constituents affect all together the observed data, less observed bands may leads bigger RMS errors in the retrieval results [4].

The goal of this work is to establish a statistical method for the retrieval of atmospheric temperature-humidity profiles, surface temperature, and surface spectral emissivity from the infrared hyperspectral resolution sounding data simultaneously. To meet this goal, firstly, we make a training data set using TIGR (Thermodynamic Initial Guess Retrieval) database and JHU emissivity spectral data library. Corresponding to each of the atmosphere from TIGR database, we assume variant of surface emissivity spectral and surface temperature changing from -10K to 15K to the surface temperature given by TIGR data. The atmospheric profiles, surface emissivity spectral and temperature are used as inputs of the 4A/OP (a radiative transmission model) to simulate the satellite observed radiance and brightness temperature. The training data set is composed of the 4A/OP input parameters and the simulated at-satellite brightness temperature. Then, the PCA (Principal Component Analysis) technique is used to compress and denoise the training data set, and the dimension of the data set is reduced significantly. At last, a multilayer perceptron (MLP) which has one hidden layer is developed and the net is trained using the compressed at-satellite brightness temperature data as inputs and the compressed atmospheric profiles, surface emissivity spectral and temperature as outputs. The neural network performances well under the clear-sky situation, but the results still need to be improved by the physical method.

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