



Computer simulation of spectral response of the atmosphere-snow system as a tool for validating snow retrieval algorithms

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A new tool, SRS (Snow Reflectance Simulator) software was developed specifically to study the accuracy of various retrieval techniques for snow remote sensing. The validation of algorithms to retrieve snow grain size and pollution amount from satellite data requires simultaneous under-satellite measurements of snow and atmosphere parameters that is very expensive and difficult to organize. In this situation, the development of the program package that simulates the spectral radiance coefficients in the channels of the used satellite optical instruments for a changeable realistic model of a coupled atmosphere-snow system is supposed to be the optimal solution to this problem. The developed SRS software provides calculations of the bi-directional reflectance from a coupled snow-atmosphere system and simulates signals in the spectral channels of satellite optical instruments.

In the SRS algorithm the atmosphere-snow system is included as one (coupled) stratified system. The snow is allowed to consist of several layers with different microphysical and optical properties and to include the crust. The microphysical model of snow is close-packed non-spherical crystal particles with bubbles and soot inclusions. The model of the stratified atmosphere with molecular and aerosol scattering and gas absorption is included. The input of the SRS specifies the optical snow model (profiles of extinction and absorption coefficients and phase function) and the model of atmosphere (the number of aerosol layers, aerosol optical thickness at $[U+F06C] = 0.55$ $[U+F06D]$ m and aerosol type for each layer, profiles of temperature and pressure). These two optical models (of snow pack and of atmosphere) are the input of the radiative transfer code. Accurate and extremely fast RAY code developed by authors earlier is deployed to calculate the radiative transfer in the coupled atmosphere-snow system.

The output of SRS is bi-directional reflection functions in different spectral channels of satellite optical instrument that can serve as the input of the snow retrieval algorithms. The comparison of the retrieved data on snow grain size and pollution concentration with the input data used for simulation allows one to judge about accuracy of the tested retrieval procedure.