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Fast technique to retrieve aerosol optical thickness from satellite data with statistical optimization: application to MERIS data

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We present here the aerosol retrieval techniques that use radiative transfer computations in the process of retrieval rather than look-up-table (LUT). This approach provides operational satellite data processing due to the use of the accurate and extremely fast radiative transfer code RAY developed by authors. The aerosol optical thickness (AOT) and Angström exponent are optimized in the iteration process using the least mean square technique with fast computations of the derivatives of radiative characteristics in respect to retrieved values. The developed technique can be adapted for processing data of various satellite instruments (including any spectral multi-angle polarization-sensitive sensors). For many years all main techniques to retrieve a spectral AOT from satellite data include radiative transfer (RT) in the data processing using LUT. The main advantage of this technique is time saving. But increasing information provided by satellite sensors (multi-angle, multi-spectral data, polarization measurements) opens the possibility to use various statistical optimizations in satellite data processing. The necessity to compute derivatives of radiative characteristics over retrieved values in the process of the retrieval requires using RT calculations in the satellite data processing. With this in view a few years ago we started to develop the aerosol retrieval techniques that use radiative transfer computations in the process of retrieval rather than LUT. Such approach can be applied operationally only if the accurate and extremely fast radiative transfer code is used. Previously, we have developed the RAY code for simulation of the radiative transfer in the atmosphere-underlying surface system with regard to polarization that meets accuracy and speed requirements. RAY's high processing speed allows use of iterative radiation transfer computations in the processing of satellite data for the AOT retrieval, eliminating the need for LUT techniques. The RAY became a core of our codes for the AOT retrieval. The first simple implementation of this idea (use RT computations in the process of the retrieval with least square optimization) was realized as ART code and presented at EGU-2009. It was successfully verified and operates now. Here we present the new speedup technique FAR (Fast Aerosol Retrieval). FAR differs from ART in RT calculation procedures. FAR computes RT in the lower troposphere homogeneous layer using analytical solutions developed by authors earlier. As a result of this innovation retrieval with FAR is about 60 times faster than with ART. Verification of FAR technique by comparison FAR retrieval with AERONET field data showed FAR reasonable accuracy. The use of RT computations in the process of retrieval instead of LUT allows one: 1) to vary atmosphere models easily and also change the used spectral channels; 2)to adapt these techniques for processing data of various satellite instruments; 3)to use various optimization techniques in the retrieval process. Beside the one important problem of effect of adjacent cloud pixels on the retrieved value of AOT due to the spread of a narrow beam in atmosphere is discussed.