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Intercomparison of Eight Forward 1D Vector Radiative Transfer Models, with the Performance of Satellite Aerosol Remote Sensing Algorithms in Mind

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Quantification and characterization of the omnipresent atmospheric aerosol by remote sensing methods is key to answering many challenging questions in atmospheric science, in climate modeling and in air quality monitoring foremost. In recent years, accurate measurement of the state of polarization of photon fluxes at optical sensors in the visible and near-IR spectrum has been hailed as a very promising approach to aerosol remote sensing. Consequently, there has been a flurry of activity in polarized or "vector" radiative transfer (vRT) model development. This covers the multiple scattering and ground reflection aspects of sensor signal prediction that complement single-particle scattering computation, and lies at the core of all physics-based retrieval algorithms.

One can legitimately ask: What level of model fidelity (representativeness of natural scenes) and what computational accuracy should be achieved for this task in view of the practical constraints that apply? These constraints are, at a minimum: (*i*) the desired accuracy of the retrieved aerosol properties, (*ii*) observational uncertainties, and (*iii*) operational efficiency requirements as determined by throughput.

We offer a rational and balanced approach to address these questions and illustrate it with a systematic intercomparison of the performance of a diverse set of 1D vRT models using a small but representative set of test cases. This "JPL" benchmarking suite of cases is naturally divided into two parts. First the emphasis is on stratified atmospheres with a continuous mixture of molecular and aerosol scattering and absorption over a black surface, with the corresponding pure cases treated for diagnostic purposes. Then the emphasis shifts to the variety of surfaces, both polarizing and not, that can be encountered in real observations and may confuse the aerosol retrieval algorithm if not properly treated.