Sensitivity of aerosol refractive index to particle composition and component index uncertainties

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Stegmann and Yang [1] developed a novel, comprehensive refractive index database for dust aerosol species. This database accounts for various dust compositions, including silicates, quartz, carbonates, sulfates, soot (black carbon), and iron oxides. The database was compiled from multiple sources to cover a spectral range from 0.1 to 150 μm and beyond for specific individual species. Furthermore, the database also provides a software tool to compute the Bruggeman effective medium refractive index [2] of an arbitrary mixture of the components for real-world remote sensing applications. This is achieved through an invariant-imbedding-like approach that not only furnishes a unique solution for the effective index, but also allows to study the sensitivity of the Bruggeman effective medium to its input parameters in a rigorous manner. Similarly, Jacobian and adjoint equations for data assimilation applications can be formulated analytically. While slightly more involved than the traditional weighted summation approach, the proposed method thus offers distinct advantages. In addition to the database itself, the provided code is also available as an open source under the GPL v3.0 and can be cloned from its online repository [3].

In this talk we summarize the development and extent of the aerosol refractive index database, discuss the approach towards finding a unique solution for a Bruggeman effective medium, and provide sample results to illustrate the sensitivity of the effective refractive index to uncertainties in its composition and input component refractive indices.

References

[1] Stegmann, P. G., and P. Yang, 2017: A regional, size-dependent, and causal effective medium model for Asian and Saharan mineral dust refractive index spectra. *J. Aerosol Sci.* **114**, 327–341.
[2] Bruggeman, D. A. G., 1935: Calculation of various physical constants of heterogeneous substances: 1. Dielectric permittivities and heat conductivities of mixed bodies made out of isotropic substances. *Ann. Phys.* **5**, 636–664.
[3] https://github.com/PStegmann/Bruggeman_Effective_Medium

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