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A new algorithm for the implementation of spectroscopic lineshapes and speed-dependence for radiative transfer modeling in planetary atmospheres

F. J. Martin-Torres (1), K. L. Letchworth (2), and D. C. Benner (3)

(1) AS&M, Inc, Hampton, VA, (Jet Propulsion Laboratory/Caltech, Pasadena, CA), USA, (2) Cornell University, Department of Physics, Ithaca, NY, USA, (3) Department of Physics, College of William and Mary, Williamsburg, VA, USA

The modeling of atmospheric transmittances is used by atmospheric scientists and astronomers for applications ranging from monitoring carbon dioxide levels in the atmosphere to detecting extrasolar planets. For an appropriate calculation of these transmittances the selection of an appropriate lineshape is of fundamental importance.

Technological advances have created opportunities to map spectra with unprecedented resolution and signal to noise ratios. These advances have also increased the need for more accurate models to analyze the data. For many years, the Voigt profile, a convolution of the Lorentz profile, which models collisional broadening, and the Doppler profile, which models the broadening caused by the Doppler shift due to molecular motion, has been adequate for describing line shapes. Nevertheless now, as data fits are reaching the level of tenths of a percent in accuracy, a more detailed lineshape modeling is needed. For example very often atmospheric lineshape models assume that all collisions occur at the statistical average velocity; however, molecules actually have a distribution of speeds. Line mixing is another process leading to non-Voigt lineshapes.

Here is presented a generic and efficient algorithm for the calculation of spectral absorption of a wide set of lineshapes. The algorithm accounts for the speed-dependence of the line shapes and line mixing. Besides the usual Doppler, Lorentz and Sub-lorentizian lineshapes, the code allows to handled the following lineshapes: Rautian-

Sobelman, van VleckWeisskopf, Galatry, BenReuven, Keilson-Storer, Nelkin-Ghatak, and Zhevakin-Naumov.

Results will be presented of the application of the algorithm to Earth and planetary atmospheres simulations.