Optimization of the Voigt algorithms for the ISS/JEM/SMILES L2 data processing system

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To demonstrate the high sensitivity of 4-K cooled sub-mm limb sounders and to monitor global distributions of the stratospheric trace gases, the Japan Aerospace eXploration Agency (JAXA) will launch the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) instrument to the International Space Station (ISS) in 2009 using the H-II Transfer Vehicle (HTV). Since SMILES observes sub-mm limb emission from stratospheric molecules in the highly sensitive 640-GHz band, it requires a higher accuracy forward model (target accuracy is provisionally about 0.01 K). On the other hand, computation time is also restricted (one-scan 53 s) for any given SMILES observation. There is therefore the requirement for high-accuracy and rapid arithmetical calculations for the SMILES L2 processing system under the given budget limitation.

Dealing with radiative transfer in the upper atmosphere, one encounters the so-called 'Voigt Profile'. This is the spectral line shape defined by the 'Voigt function'. Since the SMILES level 2 (L2) data processing system performs calculations on a line-by-line method in the simulation of the forward model, any improvement in the accuracy and processing speed of the calculation of the Voigt function correspond to large increases in accuracy and speed of the SMILES L2 data analysis.

We present a calculation the accuracy and speed of the Voigt function of various algorithms (Armstrong (1967), Hui et al. (1978), Humlicek(1982), Kuntz (1997) and its improved version developed in this study) for making the faster and higher accuracy forward model required for the SMILES L2 processing system. Although the maximum relative error of Hui's and Armstrong's algorithm exhibits a minimum value (1.07e-05) in the mid and low-altitude (y gt. 1) region, the maximum relative error of the improved Kuntz's and Armstrong's algorithm has a minimum value (9.38e-05) in the high-altitude (y lt. 1) region. The improved Kuntz's algorithm also shows the fastest calculation time compared to the other alogrithms over the observable altitudes of SMILES. It is therefore concluded that the improved algorithm should be applied for the SMILES L2 processing system.