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# Improvement of inversion algorithm for SMILES Level2 data processing

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SMILES (Superconducting Submillimeter-Wave Limb Emission Sounder) is an instrument to measure 3-dimensional global distribution of trace gases etc. between the upper troposphere and the lower mesosphere by limb observation. SMILES was attached to the Japanese Experiment Module (JEM) on the International Space Station (ISS) and obtained a half year's worth of data between mid October, 2009 and mid April, 2010. SMILES has an advantage in low system noise realized by cooling the receiver to 4 degrees kelvin with a mechanical cooler, and it has an ability to measure distribution of trace gases such as ozone, hydrogen chloride, chlorine monoxide, etc. with the best accuracy ever.

In the Level2 (L2) data processing of SMILES, already-calibrated observed spectra obtained by the Level1B (L1B) data processing are compared with calculated spectra obtained by forward calculation based on an atmospheric radiative transfer model and an instrumental model. Then the model parameters (altitude profiles of trace gases etc.) are determined by matching the calculated spectra with the observed spectra. When solving this inverse problem, it is possible that we cannot get a unique answer because the number of independent conditional equations is not sufficient to determine all of the unknown parameters (ill-posed problem). Also, the retrieved profile may exhibit oscillating behavior because of the random noise in the observed spectra. A lot of techniques have been developed for such problems by many researchers, and in the SMILES L2 data processing we now use the Levenberg-Marquardt Method (LMM), i.e., the Optimal Estimation Method (OEM) with a damping factor. In this research, we compare inversion analysis methods such as OEM, Tikhonov Regularization (TR), Maximum Entropy Method (MEM), and investigate reliable methods suitable for the SMILES L2 data processing.

Keywords: satellite observation, inversion problem, regularization, smoothing