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Deriving stratospheric trace gases from balloon-borne infrared/microwave limb sounding measurements

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Abstract

Infrared (IR)/microwave limb sounding is a well-established technique for remote sensing the Earth's atmosphere. The TELIS (TErahertz and submillimeter LImb Sounder) instrument is a state-of-the-art balloon-borne cryogenic heterodyne spectrometer developed by a consortium of major European institutes that include the German Aerospace Center (DLR), the Netherlands Institute for Space Research (SRON), and the Rutherford Appleton Laboratory (RAL) in the United Kingdom. The ambitious spectral coverage of the TELIS instrument is accomplished by use of three frequency channels: $500\,\mathrm{GHz}$, $480 - 650\,\mathrm{GHz}$, $1.8\,\mathrm{THz}$ for RAL, SRON and DLR, respectively. The instrument was designed to monitor the diurnal variation of key atmospheric constituents within the far infrared (FIR) and microwave spectral range and is capable of providing broad spectral coverage, high spectral resolution and long flight duration. Furthermore, TELIS shares a common balloon platform to that of the MIPAS-B (Michelson Interferometer for Passive Atmospheric Sounding - Balloon) instrument, developed by the Karlsruhe Institute of Technology (KIT), Germany. The combination of TELIS and MIPAS-B provides scientists with a wide spectral range of measurements for scientific research and, in addition, acts as a prelude to future spaceborne missions dedicated to IR/microwave limb sounding.

The developments in IR/microwave limb sounding have triggered the demand for adequate and reliable data analysis models and methods. One of the variants of GARLIC (General Atmospheric Radiation Line-by-Line Infrared Code) called PILS (Profile Inversion for Limb Sounding) has been recently developed at the Remote Sensing Technology Institute of DLR. It aims to solve the nonlinear inverse problems arising in the analysis of limb sounding measurements from TELIS, SMILES (Superconducting subMIllimeter-wave Limb-Emission Sounder), or Odin/SMR (Sub-Millimetre Radiometer) instruments, and to derive the vertical distribution of target gas species associated with ozone depletion and climate change. This work provides a brief description of the employed forward model and inversion algorithms. The main emphasis is then put on the retrieval results from the TELIS measurements of the DLR/SRON channels. In order to investigate the performance of the instrument and consolidate the quality of data products, an intercomparison between TELIS and SMILES is currently ongoing. A theoretical error analysis is also conducted to estimate the retrieval feasibility of key profiles of the processing.