ACCURATE: MULTI SPECIES RETRIEVAL FROM COMBINED IR-LASER AND MICROWAVE OCCULTATION DATA

V. Proschek*(1), G. Kirchengast (1), S. Schweitzer (1), J. Fritzer (1)

(1) Wegener Center for Climate and Global Change (WEGC)and Institute for Geophysics, Astrophysics, and Meteorology/Inst.of Physics (IGAM/IP), University of Graz, Graz, Austria

ACCURATE is a new climate satellite concept combining the novel LEO-to-LEO infrared-laser occultation (LIO) technique and the better known LEO-to-LEO microwave occultation (LMO) technique. Evenly distributed occultation measurements from LEO satellites around the world, with high vertical resolution, accuracy and long-term stability, enable retrieval of simultaneously measured greenhouse gases (GHGs), isotopes, wind and thermodynamic profiles. The LIO uses near-monochromatic signals in the short-wave infrared range, which are absorbed by trace species in the Earth's atmosphere. From the transmission profiles, obtained while scanning the atmosphere during the occultation event, concentrations of absorbing species can be derived. Accurately known temperature, pressure and humidity profiles derived from simultaneously measured LMO signals are essential pre-information for the retrieval of the trace species profiles. The absorbers are six GHGs (H_2O, CO_2, CH_4, N_2O, O_3, CO) and four isotopes ($^{12}CO_2$, $C^{18}OO$, HDO, $H_2^{18}O$), with focus on the upper troposphere/lower stratosphere region.

In this presentation we introduce the methodology to retrieve GHG profiles from quasi-realistic forward-simulated intensities of LIO signals and retrieved thermodynamic profiles. Refractivity, impact parameter and thus the tangent point height of the LIO raypaths can be computed from the LMO-derived thermodynamic profiles. Defocusing correction and conversion into transmissions in dB prepares the profiles for a next key step, namely the differencing of a LIO transmission profile pair with one being GHG sensitive on a target absorption line and one being a close-by reference outside of any absorption lines. The reference signal is used to remove atmospheric broadband effects by this differential absorption approach. Since the absorption and reference signal are as well slightly sensitive to foreign species, these absorptions need to be corrected by modeling the foreign species transmission on the basis of background GHG profiles. Then a pure target species transmission remains. An Abel transform converts the species log-transmission profile into an absorption coefficient profile and combined with a modeled absorption cross section of the GHG under investigation, using LMO-derived temperature and pressure profiles, the number density or volume mixing ratio profile of the desired trace species (GHG) can finally be retrieved.

Using several LIO signals, which are best sensitive to the same trace species at different heights, a joint optimal profile can be constructed by combining the individual profiles in an inverse-variance-weighted manner (practically used for H_2O and CO_2). In running the full multi species retrieval over a range of absorption lines, a carefully defined order of trace species retrievals guarantees a sensible stepwise update of the background GHG profiles and provides a better foreign species correction for the next GHG in the retrieval sequence, as the GHGs are ordered

to benefit best from preceding retrievals. Letting the basic run over the full multi-species chain then be repeated in an update loop, it guarantees that the results do not depend on a poorly chosen initial background profiles for the foreign species correction.

Retrieval tests and performance analysis results demonstrated the capacity of the combined LMO and LIO technique - the LMIO method - as an observing system with benchmark potential. The retrieval results from quasi-realistic end-to-end simulations show accuracies for the thermodynamic parameters (temperature, pressure, humidity) derived from LMO of better than 0.5 K for temperature, 0.2% for pressure, and 10% for humidity and for retrieved GHG profiles better than 1% to 4% for individual profiles in the UTLS region. This confirms previous simplified performance estimates and, despite that a range of further improvements are still possible to the current LMIO retrieval, it overall confirms the promising potential of ACCURATE.