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ACCURATE: Simultaneous Observation of atmospheric Profiles of Greenhouse Gases, Isotopes, Wind, and thermodynamic Variables from Space

S. Schweitzer and G. Kirchengast

Wegener Center for Climate and Global Change (WegCenter) and Institute for Geophysics, Astrophysics, and Meteorology (IGAM), University of Graz, Graz, Austria
(susanne.schweitzer@uni-graz.at / Fax: +43-316-380 9830)

ACCURATE (Atmospheric Climate and Chemistry in the UTLS Region And climate Trends Explorer) is a next generation climate mission concept conceived at the Wegener Center/Uni Graz in late 2004, which was proposed in 2005 by an international team of more than 20 scientific partners from more than 12 countries to an ESA (European Space Agency) selection process for next Earth Explorer Missions. It received, in a stringent scientific and technical peer assessment process, very positive evaluation and recommendations for further study. The concept currently undergoes scientific performance analyses and observational/system requirement refinements and preparations for instrument breadboarding.

ACCURATE employs the occultation measurement principle, known for its unique combination of high vertical resolution, accuracy and long-term stability, in a novel way. It systematically combines use of highly stable signals in the MW 17-23/178-184 GHz bands (LEO-LEO microwave radio crosslink occultation) with laser signals in the SWIR 2-2.5 μm band (LEO-LEO infrared laser crosslink occultation) for exploring and monitoring climate and chemistry in the atmosphere with focus on the UTLS region (upper troposphere/lower stratosphere, 5-35 km). The MW radio occultation is an advanced and at the same time compact version of the LEO-LEO MW radio occultation concept, studied in 2002-2004 for the ACE+ mission project of ESA for frequencies including the 17-23 GHz band, complemented by U.S. study heritage for frequencies including the 178-184 GHz band (R. Kursinski et al., Univ. of Arizona, Tucson). The core of ACCURATE is tight synergy of the SWIR laser crosslinks with

the MW radio crosslinks.

The observed parameters, obtained simultaneously and in a self-calibrated manner based on Doppler shift and differential log-transmission profiles, comprise the fundamental thermodynamic variables of the atmosphere (temperature, pressure/geopotential height, humidity) retrieved from the MW bands, complemented by line-of-sight wind, six greenhouse gases (GHGs) and key species of UTLS chemistry (H_2O, CO_2, CH_4, N_2O, O_3, CO) and four H_2O and CO_2 isotopes (HDO, $H_2^{18}O$, $^{13}CO_2$, $C^{18}OO$) from the SWIR band. Furthermore, profiles of aerosols, cloud layering, and turbulence are obtained. All profiles come with accurate height knowledge ($<$ 10 m uncertainty), since measuring height as a function of time is intrinsic to the radio occultation part of the ACCURATE observing system.

The presentation will start with an overview of ACCURATE along the lines above, with emphasis on the climate science value and the new laser occultation capability. The focus will then be on retrieval performance analysis results obtained so far, in particular regarding the profiles of GHGs, isotopes, and wind. The results provide evidence that the GHG and isotope profiles can generally be retrieved within 5-35 km outside clouds with $<$ 2% to 5% rms accuracy at 1-2 km vertical resolution, and wind to $<$ 2 m/s accuracy. Monthly mean climatological profiles, assuming $\sim$40 profiles per climatologic grid box per month, are found unbiased (free of time-varying biases) and at $<$ 0.5% rms accuracy. These encouraging results are discussed in light of the potential of the ACCURATE technique to provide benchmark data for future monitoring of climate, GHGs, and chemistry variability and change. Planned European breadboarding and demonstration activities are outlined, including international participation opportunities.