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Set up of a long-term, near-infrared to far-infrared radiative closure experiment at Mt. Zugspitze. Quantifying the greenhouse effect of water vapor and ice clouds

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Radiative heating and cooling in the mid-to-upper troposphere, caused primarily by absorption and emission of infrared radiation within strong water-vapor absorption bands, contributes significantly to the dynamical processes and radiative balance that regulate Earth's climate, yet has been understudied due to the opacity of the atmosphere at the Earth surface in a wide range of the infrared spectrum.
A new experiment at the Zugspitze (47.48 °N, 10.98 °E, 2964 m a.s.l.) is targeted at resolving remaining important gaps in our knowledge of atmospheric radiative processes of water vapor in the near-infrared to far-infrared. The extremely low water vapor columns above Mt. Zugspitze during major parts of the year provide a unique possibility for the long-term evaluation of spectroscopic features which normally remain obscured in surface measurements, and, thus, allow investigations leading to improvements in radiative transfer models and greater confidence in our predictive capabilities via climate models. The technique to be used is radiative closure analysis, i.e. comparisons of high-spectral resolution IR radiometric measurements with corresponding model calculations driven by coincident measurements of the state of the atmosphere (i.e. profiles of water vapor and temperature). These studies focus on a critical examination of the radiation measurements, the radiative transfer models, and the measurements of the atmospheric state, (mainly profiles of temperature, water vapor, and ozone). The experimental basis for these investigations is the spectroradiometric instrumentation run by KIT/IMK-IFU at the Zugspitze (solar FTIR system (e.g., Sussmann et al, 2009) including the near infrared (1-5 [U+F06D]m) using a currently developed radiometric calibration plus an Extended-Range-Atmospheric Emitted Radiance Interferometer (ER-AERI, ABB) covering the mid infrared and far infrared up to 25 [U+F06D]m) together with measurements of the state of the atmosphere (lidar systems for water vapor profiles (Vogelmann and Trickl, 2008; Vogelmann et al., 2010) and temperature profiles, FTIR for columnar ozone). For the statistical residual analysis comparing the measured surface spectral radiances with model calculations, the Line-By-Line Radiative Transfer Model LBLRTM (e.g., Clough et al., 2005) will be used. The Zugspitze/Schneefernerhaus facilities offer the opportunity of performing the described closure experiments on a long-term basis which allows larger data sets with improved statistics to be gathered, an advantage over other campaign-type investigations.
Our current quantitative understanding of ice cloud radiative processes is even less mature than that of water vapor. However, ice clouds cover more than 20 % of the globe and it has long been recognized that they play an important role in determining the Earth′s climate. In climate models clouds cannot be directly modeled because of the scale and the complexity of the processes involved. Instead their properties must be parameterized in terms of other larger scale variables like temperature and/or ice water content which is a major source of error in general circulation models. Therefore, in a second step the Zugspitze clear sky closure studies shall be extended to the quantification of ice cloud radiative processes. The paper will include an outlook on this theme.

References
Clough, S. A., Shephard, M. W., Mlawer, E. J., Delamere, J. S., Iacono, M. J., Cady-Pereira, K., Boukabara, S., and Brown, P. D.: Atmospheric radiative transfer modeling: a summary of the AER codes, Short Communication, J. Quant. Spectrosc. Radiat. Transfer, 91, 233-244, 2005.

Sussmann, R., Borsdorff, T., Rettinger, M., Camy-Peyret, C., Demoulin, P., Duchatelet, P., Mahieu, E., and Servais, C.: Technical Note: Harmonized retrieval of column-integrated atmospheric water vapor from the FTIR network – first examples for long-term records and station trends, Atmos. Chem. Phys., 9, 8987-8999, 2009.

Vogelmann, H. and Trickl, T.: Wide-range sounding of free-tropospheric water vapor with a differential-absorption lidar (DIAL) at a high-altitude station, Appl. Opt., 47, 2116-2132, 2008.

Vogelmann, H., Sussmann, R., Trickl, T., and Borsdorff, T.: Intercomparison of atmospheric water vapor soundings from the differential absorption lidar (DIAL) and the solar FTIR system on Mt. Zugspitze, Atmos. Meas. Tech. Discuss., 3, 5411-5428, 2010.