The Zugspitze radiative closure experiment: Quantification of the near-infrared water vapor continuum from atmospheric measurements

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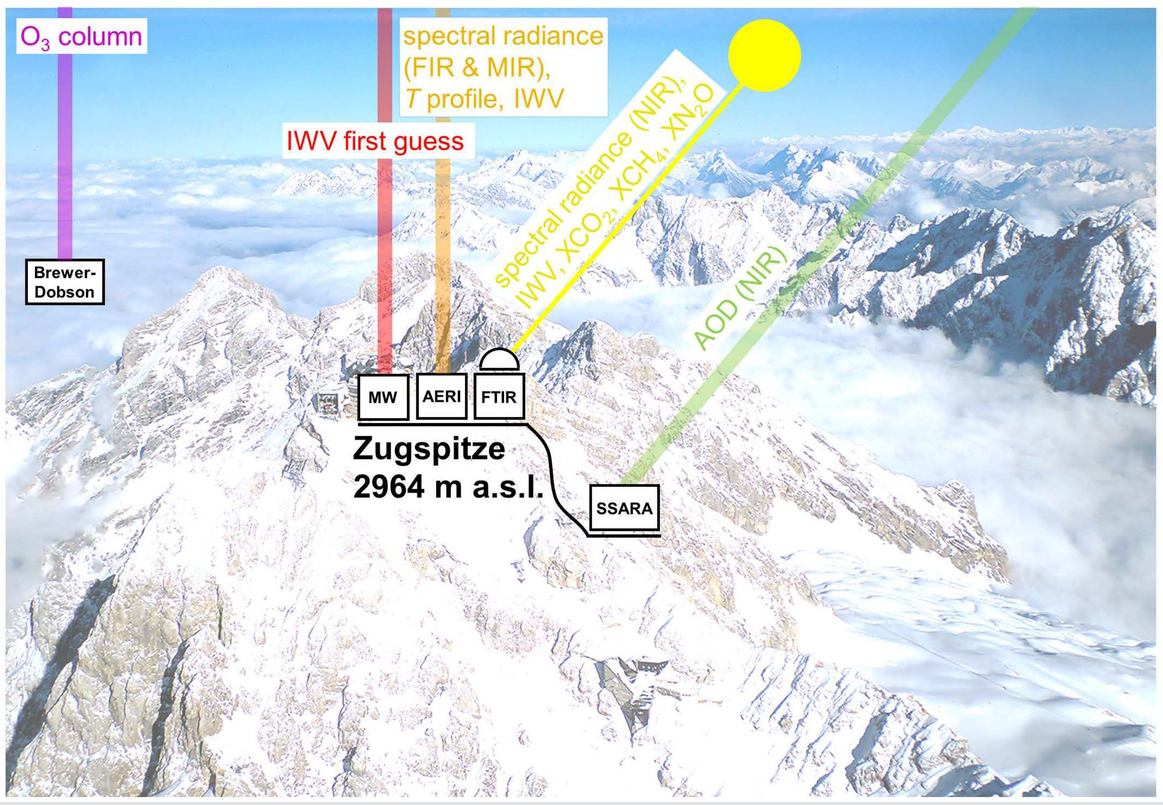
Goal

- Missing quantitative knowledge of water vapor continuum absorption is a key problem that limits accuracy of atmospheric radiative transfer calculations, e.g. in climate models
- Lack of atmospheric measurements of continuum absorption in the near infrared (NIR), no consensus among recent laboratory studies, laboratory results are not easily transferable to atmospheric conditions

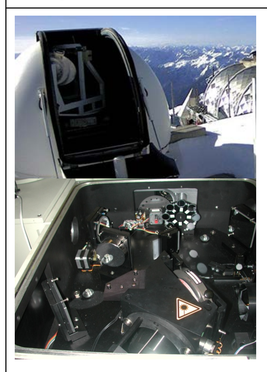
⇒ Derive more accurate NIR water vapor continuum constraints from atmospheric closure experiment

Instrumental setup



Principle of radiative closure

Spectral radiance measurements



NIR spectral radiance measurements:
Solar FTIR
2500-7800 cm^{-1}, radiometric calibration by means of a high-temperature (1970 K) blackbody source in combination with spectrally resolved Langley method

→ **Measured spectral radiance**

↓

Difference spectrum ("residuals")

↑ ↓ **minimization of spectral residuals via adjustment of absorption parameters**

Modeled spectral radiance

↑

Radiative transfer model (LBLRTM)

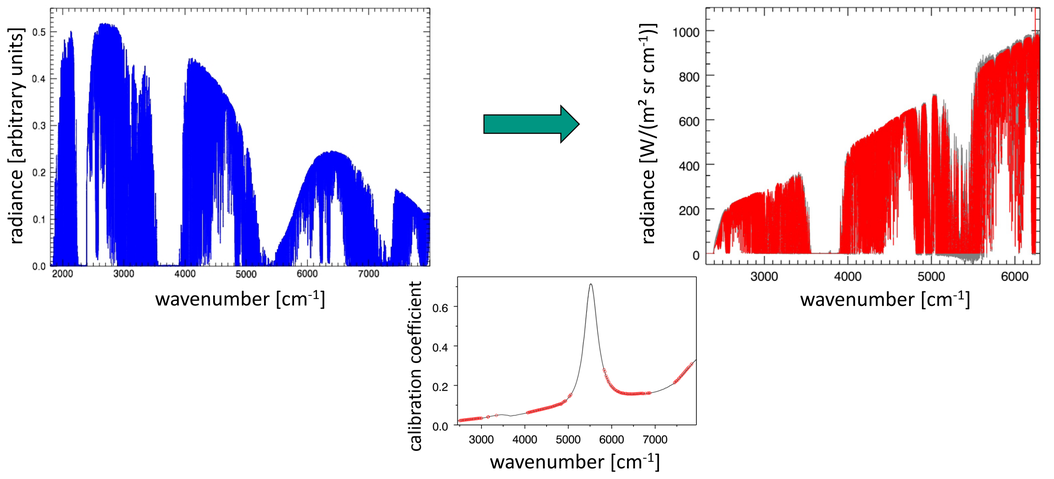
Atmospheric state

H_2O column	**CO_2, CH_4 and N_2O column**	**H_2O profile, *pT* profile** NCEP data
		**AOD** SSARA-Z sun photometer
Solar FTIR	Solar FTIR (NIR)	**O_3 column** Dobson/ Brewer

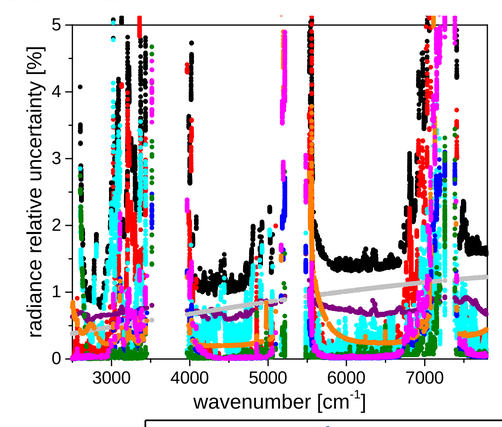
Radiometric calibration method

← High-temperature (1970 K) calibration blackbody source in the Zugspitze FTIR dome

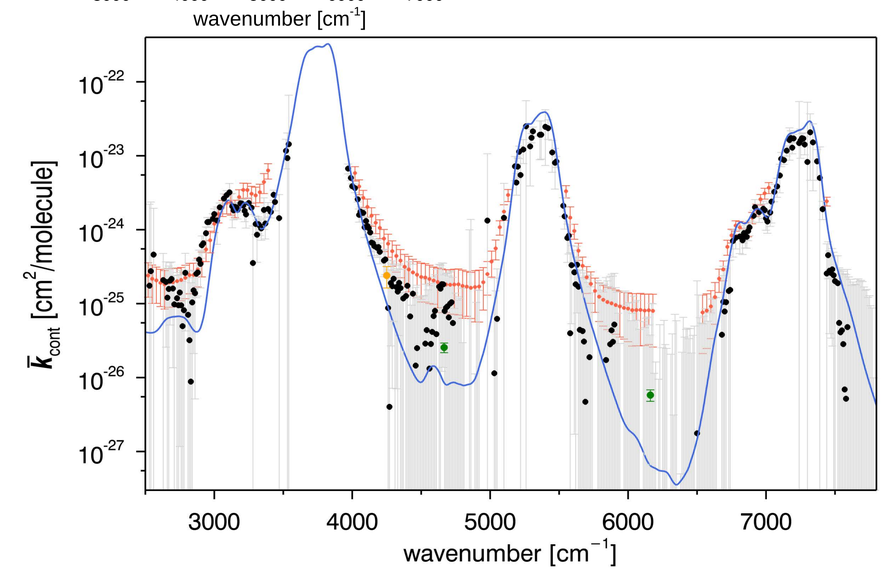
↓ Solar FTIR radiometric calibration: measurement (blue), calibration coefficients (bottom) derived from Langley fit (red circles) in combination with blackbody measurements (black line) and comparison of result (grey) with LBLRTM calculation (red)



Results



← Contributions to residual uncertainty budget and overall uncertainty (2 σ) of the NIR closure experiment



↑ Mean NIR water vapor continuum absorption coefficients derived from Zugspitze measurements (black), MT_CKD 2.5.2 model (Mlawer et al., 2012) (blue), CRDS measurements of Mondelain et al. 2015 (orange), calorimetric-interferometric measurements of Bicknell et al. (2006) (green) and FTIR measurements of Ptashnik et al. (2012; 2013) (red)

References:

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Mlawer, E. J. et al.: Development and recent evaluation of the MT_CKD model of continuum absorption, Phil. Trans. R. Soc. A, 370, 2520–2556, doi:10.1098/rsta.2011.0295, 2012.

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