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Carbon dioxide and methane monitoring in the Chilean Atacama desert with astronomical spectra

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Any ground-based astronomical observation is influenced by the Earth's atmosphere. In particular, molecular absorption in the atmosphere can significantly affect astronomical data on various timescales.

In a past project, we developed a software to correct astronomical spectra for these fingerprints by means of fitting calculated atmospheric transmission curves to the observed data. The calculations use the radiative transfer code LNFL/LBLRTM, the line database HITRAN, and atmospheric profiles for pressure, temperature, and molecular abundances from different resources. As the profiles for the molecular concentrations are scaled for an optimal fit, the algorithm also derives column-averaged volume mixing ratios of the species taken into account. Thus, a snapshot of the chemical state of the Earth's atmosphere during the astronomical observation can be determined.

The European Southern Observatory has been operating the X-Shooter spectrograph in the Chilean Atacama desert since October 2009. Since this instrument consists of three parallel spectrographs, the Ultraviolet/Blue (UVB), visual (VIS), and near-infrared (NIR) spectral arm, it is able to simultaneously cover a total wavelength range between 0.3 to 2.5μm with a resolving power of up to about 18 000. Thus, the spectra contain atmospheric absorption features of several molecular species (O_2, H_2O, CO_2, CH_4, and O_3).

We have obtained all publically available X-Shooter data and processed them with optimised recipes for atmospheric research. Our data set already comprises more than 7 years and is still growing since X-Shooter is still in operation. Up to now, about $\sim$61 000 UVB, $\sim$61 000 VIS, and $\sim$77 000 NIR spectra have been processed. In this presentation, we describe the data set, the specific calibration needs in detail, and the method to determine molecular abundances. In addition, we present preliminary results on the monitoring of CO_2 and CH_4 based on this data set. To our knowledge, this is the first investigation of that kind of in-situ measurements in the Chilean Atacama desert along the Pacific east coast.