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Atmospheric research with large astronomical facilities

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Ground-based astronomical observations are affected by the Earth's atmosphere. Hence, each observation contains information on the status of the atmosphere during the exposure. In view of the large data amounts that are produced by astronomical facilities in the wavelength regime from near-UV to mid-IR each night, the archived data are a treasure for atmospheric sciences. In particular, data from medium- to high-resolution spectrographs on telescopes with main mirrors of about 10 m are valuable if plain sky emission is present in the two-dimensional spectra or a bright astronomical target allows one to study atmospheric extinction. These data can be used to analyse abundances of trace gases by molecular emission and absorption, aerosol properties by extinction curves and scattered moonlight, and properties of the upper atmosphere by airglow line and continuum emission.

We will discuss the potential of astronomical spectra for atmospheric sciences by means of data taken at the Very Large Telescope (VLT) of the European Southern Observatory at Cerro Paranal in Chile. This mountain site at an altitude of 2635 m is interesting for atmospheric research due to its location far away from urban settlements in the very dry Atacama desert close to the Pacific Ocean. This remote location allows studies of long-range transport of trace gases and aerosols. The typical aerosol optical depth of 0.03 at 500 nm is very low and mainly produced by background and stratospheric aerosols. The high sensitivity of the VLT spectrograph X-Shooter in combination with a relatively high resolution ($3000 - 18000$) and a wide wavelength range ($0.3 - 2.5\,\mu$m) observed simultaneously is very valuable for analysing all prominent airglow emission lines at the same time and to detect weak airglow continua for which the typical instruments for airglow research are not sensitive enough. The observatory started operations in 1998. So investigations of relatively long time series of trace gas concentrations, aerosol extinction, and airglow emission are possible, although the set of instruments for the four 8.2 m telescopes has changed (e.g. X-Shooter since 2009).

(Pilot) studies related to the discussed research topics are already performed. We will report on early results.