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Atmospheric Sciences Meet Astronomy: Mutual Benefits from two Different Approaches

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Light from astronomical targets has to pass the Earth's atmosphere when being observed by ground-based telescope facilities. The signal detected by modern astronomical spectrographs is significantly influenced by molecular absorption and airglow emission. The first mainly arises from various species in the lower, thus denser atmosphere, whereas the latter is caused by chemiluminescence in the mesopause region and above. As ground-based astronomical spectrographs are optimised from the near-UV to the mid-infrared regime ($0.3....25\,\mu$m), a number of absorption features from numerous species are directly visible (e.g. H_2O, CO_2, CH_4, O_2, O_3,...). The same is true for the airglow emission arising e.g. from the hydroxyl radical and oxygen. The high resolution provided by some spectrographs and their frequent usage allows a detailed investigation of atmospheric lines.

Usually being a source of noise for astronomers, which needs to be corrected for, this influence can be used to precisely analyse the composition and the state of the Earth's atmosphere above an observatory. On the other hand, a good knowledge of this allows astronomers to better correct for this influence. Thus, both, atmospheric and astronomical sciences highly benefit from a good understanding of the atmospheric state above an observatory.

During the past years we conducted several studies to link astronomical and atmospheric data. For this purpose we use data taken with the Very Large Telescope (VLT) operated by the European Southern Observatory, and the Cerro Armazones Observatory (OCA, University of Bochum, Germany; Universidad Católica del Norte, Chile), both located in the Chilean Atacama desert. The three spectrographs used in our studies are X-Shooter@VLT (resolving power $R \sim 3300...18000$, wavelength range $\lambda = 0.3...2.5\,\mu$m), UVES@VLT ($R \sim 20.000....110.000$, $\lambda = 0.3....1.1\,\mu$m), and BESO@OCA ($R = 50000$@$H_\alpha = 0.656\,\mu$m, $\lambda = 0.38 - 0.84\,\mu$m). In addition, we use atmospheric data obtained with the satellites ENVISAT (MIPAS instrument), Aura (MLS), and TIMED (SABER), and modelled data from the Global Data Assimilation System (GDAS), and the ERA/MACC reanalysis from the European Centre for Medium-Range Weather Forecasts (ECMWF). In this presentation we give an overview on our methods to link these various data, the impact/application of these data on atmospheric sciences and observations with classical and future astro-particle Cherenkov telescopes, and present recent results.