How can we know the Atmospheric Composition – and Why do we want to know?

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The properties of our planet's atmosphere are determined by complex physical and chemical processes. In order to understand these processes, to provide early warning against potentially dangerous changes, and also to monitor air quality the concentration of atmospheric trace constituents must be measured. These measurements must be made on large scale and with good spatial resolution. For that purpose traditionally a dense network encompassing a special instrument for each trace gas had to be installed. In contrast to that spectroscopic remote sensing measurements, e.g. by Differential Optical Absorption Spectroscopy (DOAS) allow spatially resolved measurement of most relevant species (like ozone, nitrogen dioxide, or sulphur dioxide) with a single instrument. Moreover, measurements with suitable observation geometries from the ground, from aircraft or from satellite platforms allow to derive the 2-dimensional or even 3-D distribution of trace gases in the atmosphere. Thus, a contact-free highly specific and very sensitive measurement of many trace gases, which are of great interest for atmospheric chemistry and climate research, becomes feasible. For instance, the application of DOAS from satellite platforms delivers a global view of trace gas distributions, which already revolutionized the development of atmospheric chemistry models.
The lecture gives an overview of remote sensing of the atmospheric composition, the DOAS principle, its evolution, and present range of applications. Sample results from satellite and ground-based observations are presented, also an attempt is made to provide a look into the future of atmospheric remote sensing.