Trace Gas Measurements

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From their vantage point in space, satellites can measure atmospheric trace gases on a global scale with a single instrument. Early instruments, such as the Total Ozone Mapping Spectrometer (TOMS, 1978-1994), were designed to measure the ozone abundances using just two different wavelength channels in the UV spectral region. Modern instruments use moderate to high-resolution spectrometer with thousands of spectral elements to measure fingerprints of atmospheric trace gases. Here, we focus on recent results from Nadir (downward) looking instruments in the UV/Vis to thermal infrared spectral region. UV/Vis spectrometers such as GOME, SCIAMACHY or OMI can retrieve ozone abundances as well as multiple species in the troposphere such as NO_2, SO_2 or CH_2O. Owing to their global coverage and long life-time, they enabled quantification of emission trends of, for instance, nitrogen oxide where a decline in the US and Europe was contrasted with rapid increases in Asia.

Measurements in the short-wave infrared spectral range enable accurate quantification of atmospheric greenhouse gases with sensitivity towards the entire atmospheric column. SCIAMACHY enabled first accurate retrievals of atmospheric methane and new satellites with high spectral resolution (such as GOSAT and OCO-2) aim at retrieving atmospheric CO_2 with a precision and accuracy needed to use them in atmospheric source-sink inversions. The focus will be on some highlights regarding SCIAMACHY methane, GOSAT CO2 as well as water isotopologue retrievals. In addition, high-resolution spectra from GOSAT allowed, for the first time, retrievals of chlorophyll fluorescence, which is strongly related to gross primary production through terrestrial vegetation.

Measurements in the thermal infrared spectral range are less sensitive towards trace gas concentrations but can be used to retrieve profiles of various atmospheric constituents. Some highlight from the Thermal Emission Spectrometer TES will be shown.