Nitrogen dioxide and ozone monitoring at Stara Zagora

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Ozone and nitrogen dioxide (NO_2) are key species of the Earth atmosphere. Both ozone and the active nitrogen family (NO_x = NO+NO_2) play an important role in the tropospheric chemistry. Tropospheric NO_x resulting from natural processes and also from antropogenic activities, as the main part of the pollutants come from industrial burning processes (in power plants and in domestic heating as well), traffic, biomass burning, soil emissions, and lightnings. NO_x is primary emitted in form of NO, which by oxidation forms NO_2. The tropospheric NO_2 is a precursor of ozone in the planetary boundary layer and also it influences OH and the oxidation efficiency. The NO_x radicals contribute to photochemical smog and to higher ozone ground-levels at the planetary surface, as well. Since the pre-industrial times tropospheric NO_2 has increased six times being highest in large urban areas and at the same time ozone has been doubled in the Northern hemisphere. In contrast to NO_2, ozone is a direct greenhouse gas. In the stratosphere NO_2 is involved in catalytic cycles of ozone destruction, and it also takes part in processes of conversion of reactive chlorine in its reservoir form, mainly in the lower stratosphere. The relation of NO_2 to the ozone production and ozone destruction enhances its importance for climate models.

At the Stara Zagora Department of SSTRI monitoring of trace gases in the troposphere and the stratosphere is performed, conducted with the GASCOD-BG spectrometric device, developed at ISAC, Bologna, Italy. Since August 1999 daily ground-based spectrometric measurements are carried out during sunrise and sunset for the determination of the NO_2 slant column abundance (SCA) and by the instrument PHOTON-2 the total ozone content by spectrometric measurement of direct solar light is obtained.

The accumulated in Stara Zagora NO_2 time series show the well-known typical seasonal variations, caused by the solar insolation. The residual time series of the removed semi-annual seasonal cycles from the measured original series show many different variations, with short periods up to inter-annual variations. Single spikes of SCA are detected and we consider them a result of over-passing weather fronts and/or lightning. Variations of SCA with time scale up to about 10 days are the consequence of weather cyclones. Some short-term variations of NO_2 and O_3 SCA are a result of intensive stratospheric-tropospheric exchange. Other residual time series periods are caused by Rossby waves or by over-passing of the polar vortex filaments. An ozone mini-hole was detected over the Balkan Peninsula in March 2005. Applying wavelet analysis of the obtained NO_2 slant column amount data series, and the total O_3 amount obtained by the GOME instrument, during the 23-rd solar cycle maximum, periods of 27 days are found. The development of a secondary ozone layer just above the tropopause at high European latitudes was approved using lidar and ozone sounding balloon data.

Under the QUILT program Stara Zagora NO_2 data were used for validation of the SCIAMACHY (spectrometer on board the ESA-ENVISAT Satellite) data.