



Comparison of tropospheric ozone trends from European mountain stations

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In spite of air quality regulations in Europe since the 1990s, tropospheric ozone concentrations have not decreased as strongly as the decline in ozone precursor emissions would suggest. There is considerable debate about a continued increase in background ozone levels at least until the year 2000. In order to investigate the consistency of tropospheric ozone trends over Europe, we analyzed hourly measurements from several European mountain sites. The three Alpine mountain sites with the longest data record are Jungfraujoch, Sonnblick and Zugspitze. For the period 1990 to 2009, Zugspitze and Sonnblick show statistically insignificant increase while the Jungfraujoch trend is also positive, but with a stronger and significant increase between 48.4 and 54.1 ppb (growth rate ~ 0.28 ppb per year). Due to the higher altitude of Jungfraujoch its ozone data reveal quite different behavior than the other mountain sites demonstrating the stronger influence of the free troposphere on Jungfraujoch.

The annual 5-percentiles show slightly stronger rises, while the 95-percentiles do not exhibit a significant trend at any of the three stations. Zugspitze and Sonnblick show no changes or slight decline of the 95-percentiles trend, while Jungfraujoch shows an increase. Daytime-nighttime differences at the three stations are almost zero in winter and largest in July. Zugspitze and Sonnblick exhibit maximum daily amplitudes of 3 and 4 ppb, respectively, while Jungfraujoch's maximum daily amplitude is less than 1.5 ppb.

For other stations, which do not have a similarly long record, we compare the seasonal and diurnal cycles and the interannual variability.