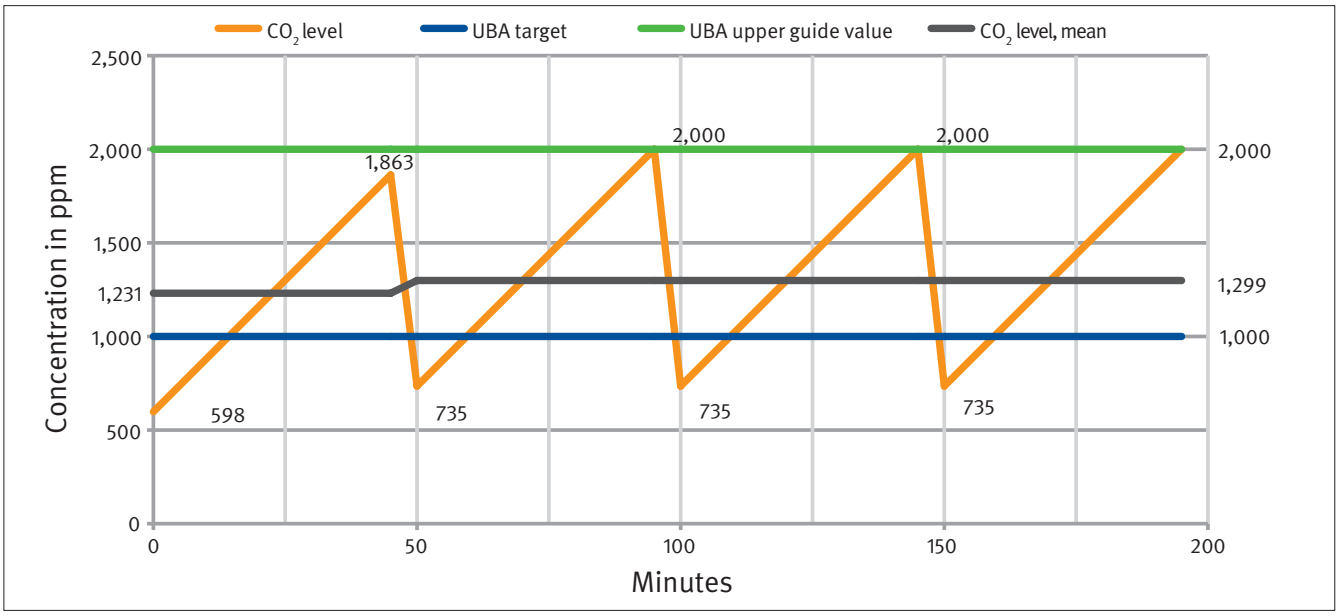
Figure 27:
Mean CO_2 pollution in classrooms aired briefly and thoroughly after each lesson; UBA = Umweltbundesamt (Federal Environmental Agency)



12.4.2 Ozone

The main source of indoor ozone pollution is contamination through outdoor air as a result of ventilation (e.g. open windows). Ozone formation caused by operating laser printers and copiers is no longer a problem today (see Section 7.2.3).

Ozone is produced in the outdoor air by means of solar irradiation and photochemical smog reactions. Ventilation, especially in the form of open windows and doors, enables it to make its way from the outdoor air into the indoor air. Ventilation systems, on the other hand, break down part of the ozone as it travels through the filter and the pipes towards the work area. Indoors, ozone decomposes with a half-life of approximately 30 minutes, partly by reacting with other volatile substances.

Directive 2008/50/EC of the European Parliament and the Council on ambient air quality and cleaner air for Europe [6] stipulates an ozone value of 120 µg/m³ as the maximum eight-hour average for one day in order to protect human health. This value may be exceeded on no more than 25 days per year. For the one-hour value, the directive also lays down an information threshold of 180 µg/m³ (the public must be informed when this value is exceeded) and an alert threshold of 240 µg/m³.

High concentrations, resulting in the assessment values being exceeded, are particularly likely during sunny weather at the height of summer. On such days, it is advisable to keep windows and doors closed as far as possible to prevent too much ozone entering indoor rooms. The preferred option should always be to air rooms briefly and thoroughly and then close the doors and windows again.

12.4.3 Formaldehyde

Formaldehyde is a basic chemical that serves as an inexpensive precursor for a variety of chemical products. For instance, it is used in the production of phenol formaldehyde resins and aminoplasts, which in turn are used, for example, to glue chipboard, plywood and edge-glued panels (see Section 6.4.3).

Other formaldehyde sources of relevance in indoor spaces include in situ foams made from urea formaldehyde resin, varnishes (mainly acid-catalysed coatings for wooden floors and furniture), veneers, textiles, carpets and fibre mats containing binders. Aqueous solutions used as disinfectants and preservatives also contain formaldehyde and it can also be detected in personal care and cleaning products.

In 2004, a working group at the International Agency for Research on Cancer (IARC) classified formaldehyde as category 1, carcinogenic to humans [7; 8]. Germany's Bundesinstitut für Risikobewertung (BfR; Federal Institute for Risk Assessment) responded in the spring of 2006 by suggesting an air concentration level of 0.1 ppm (0.12 mg/m³) as a safe level in view of the carcinogenic effect of formaldehyde on human beings [9]. The Ad Hoc Working Group on Indoor Guide Values followed step in the autumn of 2006 [10].

The WHO proposes a 30-minute average of 0.1 mg/m³ (0.08 ppm) as a precaution against sensory irritation in the general public [11]. Where exposure is prolonged, the recommendation is not to exceed a concentration of 0.06 mg/m³ (0.05 ppm) [12].

12.4.4 Volatile organic compounds

Volatile organic compounds (VOCs) can be classified as shown in Table 30. The very volatile and volatile organic compounds are almost exclusively found in the ambient air. The semi-volatile organic compounds, such as biocides and phthalates, and the organic compounds associated with particulate organic matter (POM) are mostly found in sedimented house dust and attached to airborne dust. These cases can only be assessed adequately by examining the dust deposits.