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Measurement of reactive nitrogen species inside and outside of the Cologne Cathedral

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Reactive nitrogen compounds have a major impact on the atmosphere since they e.g. influence ozone levels in the atmosphere and lead to acid rain formation. In addition, reactive nitrogen compounds like e.g. HNO_3 may destroy historical buildings:

(1) $CaCO_3 + 2\ HNO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$

Reactive nitrogen compounds are mainly emitted as NO and converted into NO_2, N_2O_5, HONO and HNO_3, etc. Some of the conversion processes occur heterogeneously on surfaces, and may lead to the destruction of e.g. historical paintings through the formation of HNO_3:

(2) $2\ NO_2 + H_2O \rightarrow HONO + HNO_3$

(3) $N_2O_5 + H_2O \rightarrow 2\ HNO_3$.

In addition, nitrous acid (HONO), which is one of the products of reaction (2) is an important OH-radical source:

(4) $HONO + h\nu \rightarrow NO + OH$,

and thus has a direct impact on the oxidation capacity of the atmosphere (Vogel et al., 2003). Furthermore, HONO is of particular interest because of its potential impact on human health due to its reaction with amines leading to nitrosamines, which are known to be carcinogenic (Pitts et al., 1978).

In the present study, reactive nitrogen compounds were measured inside and outside the Cologne Cathedral. In addition, the emission of NO_x and HONO from candles was directly measured, which were of importance for the pollution levels inside the

cathedral. The heterogeneous conversion rate of NO_2 into HONO was determined and the impact of reactive nitrogen species on the destruction of the stones of the Cathedral was estimated.

References:

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