Geophysical Research Abstracts
Vol. 14, EGU2012-6288, 2012
EGU General Assembly 2012

Determination of the NO_2 concentration and its distribution with different DOAS techniques - a study in the metropolitan area of Hong Kong

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In Hong Kong, like in other urban areas, nitrogen dioxide (NO_2) emissions still remain one of the most problematic pollutions. Even though a lot of effort has already been made towards their reduction, concentrations are often much above the recommended limits. Therefore, the Hong Kong Environmental Protection Department continuously monitors the NO_2 concentration levels. These stations only give in-situ information at a few fixed locations, which are unable to capture the strong spatial gradients that are present in urban areas. These gradients are mainly caused by differences in automobile traffic, the population densities and industries that are found in the individual city areas. The gradients are further enhanced by street canyon effects. Hence, it can be assumed that there are areas with much higher pollution compared to the values at the official measuring sites. At present the uncertainties about the spatial NO_2 distribution place a limitation on the assessment of health risks and on the quality of chemical model calculations.

We applied a new Cavity Enhanced (CE-) DOAS instrument to car based measurements in the city of Hong Kong for eight days in December 2010. Measurements on mobile platforms like cars give the opportunity to create a map of the NO_2 for a whole city area with high spatial resolution. The CE-DOAS instrument is distinguished by its compact and robust setup. It directly measures NO_2 by its optical absorption and therefore it does not have interferences with other trace gas species like O_3 or NO_y. This is a great advantage over other NO_2 instruments (e.g. solid state detectors or chemiluminescence instruments which have such known problems). For our measurements a van travels along carefully selected tracks to give a representative coverage of the area of interest. The mobile measurements are corrected for the varying meteorological conditions and traffic variations during the different measurements by comparing them to a fixed measurement of NO_2 to derive a representative distribution map. This is done by a simultaneously performed Long Path DOAS measurement which gives the average NO_2 concentration along a few kilometer long light path over the area of interest. Our measurements show that NO_2 concentrations in Hong Kong vary by more than an order of magnitude on scales of only few 100m. Concentrations up to several ppmv are observed at various locations, clearly showing that environmental measurement stations with their fixed point measurements do not sufficiently capture these variations and the given results may not be correct for a location close by.

Besides the determination of NO_2 maps the Long Path DOAS measurements since December 2009 are used to validate DOAS based OMI satellite measurements. This is done to assess the usability of satellite based measurements for air quality monitoring in urban areas. Monthly averaged LP-DOAS and OMI measurements correlate well but the satellite measurements significantly underestimate the NO_2 concentration. Furthermore, the mean weekly NO_2 cycles, display different characteristics which will be discussed.