Geophysical Research Abstracts,
Vol. 11, EGU2009-9390, 2009
EGU General Assembly 2009

Space-nadir observations of formaldehyde columns in the 1995-2008 period and their use for inferring NMVOC emissions through inverse modelling.

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Non-methane volatile organic compounds (NMVOCs) of both natural and anthropogenic origin play an important role in the formation of tropospheric ozone. Despite recent efforts to improve existing databases of NMVOC emissions, large uncertainties still remain mainly due to the diversity of the sources and the complexity of the mechanisms involved. Satellite observations of formaldehyde (CH2O) provide useful information to test and improve bottom-up inventories of NMVOC emissions because CH2O is an intermediate product in the oxidation of a large number of NMVOCs and its lifetime is only a few hours. Since 1995, global distributions of CH2O columns have been retrieved from the GOME, SCIAMACHY, OMI and GOME-2 UV-Vis nadir sounders. The retrieval of CH2O by differential absorption spectroscopy (DOAS) is challenging mainly due to the overall faintness of the CH2O signal, but also due to uncertainties in the calculation of air mass factors. To ensure the coherence of long time series of observations based on the combination of different satellite sounders, retrieval settings must be homogenized while taking into account instrumental specificities and eventual limitations of each sounder. Currently, one of the main limitations of the CH2O retrieval from UV-Vis satellites is the random error of the slant column. For single pixels, this error dominates the other sources of uncertainty. It can be reduced by averaging a large number of observations and to this regard, new instruments like OMI and GOME-2, which offer a much better global coverage of the earth, have the capacity to improve the statistics on the CH2O columns and to allow for more selective cloud screening. Recent achievements but also problems and limitations of the currently available sounders are highlighted. This points to the need for improved satellite instruments, both from LEO and GEO orbital configurations. We finally illustrate the potential of satellite CH2O observations for the inverse modelling of NMVOCs emissions, based on the use of the IMAGESv2 global tropospheric chemistry transport model. Results are shown for biogenic and pyrogenic emissions of VOCs. Anthropogenic emissions are currently more difficult to constrain because of the low signal to noise ratio of the CH2O columns in polluted regions. We discuss the interest and potential of combining CH2O observations with glyoxal measurements from the same sensors.