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Trend Detection in Satellite Observations of Formaldehyde Tropospheric Columns Using GOME, SCIAMACHY and GOME-2 Spectrometers

Isabelle De Smedt, Jenny Stavrakou, Jean-François Müller, and Michel Van Roozendael
Belgian Institute for Space Aeronomy (BIRA-IASB), Brussels, Belgium (isad@aeronomie.be)

Being a short-lived intermediate product in the oxidation of a large number of Non-Methane Volatile Organic Compounds (NMVOCs), formaldehyde (H2CO) constitutes a useful indicator of anthropogenic, biogenic and biomass burning hydrocarbons emissions in the troposphere. Therefore, over recent years, satellite observations of H2CO have been increasingly used in combination with tropospheric chemistry transport models for constraining emission inventories of NMVOC, through top-down inversion approaches. With satellite measurements being available since the launch of ERS-2 GOME in 1995, the eventual trend in NMVOCs emissions might be investigated. Trend analysis based on satellite data sets have been successfully applied for NOx (and more recently SO2) emissions over Eastern China. However, according to the current knowledge, the contribution of anthropogenic NMVOCs to the total H2CO column is relatively small and therefore, the expected trend in H2CO is smaller than the trend in NO2 columns. Added to the fact that H2CO column measurements have larger uncertainties than corresponding NO2 data, this has so far prevented any significant trend detection from H2CO satellite data sets.

In this work, consolidated global distributions of formaldehyde columns derived from GOME, SCIAMACHY and GOME-2 instruments are used to analyze the temporal evolution of H2CO over industrialized areas in the period 1996-2009. A linear model with seasonal components has been used to fit the time series, taking into account the errors on the satellite observations as well as uncertainties related to possible biases between the different instruments. Results show that Asia, and more particularly Eastern China and the city of Shanghai, are the only regions in the world where statistically significant positive trends in H2CO columns are found. The satellite-based trends in H2CO columns are compared to reported trends in the REAS bottom-up inventory of NMVOCs emission in Asia.