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A satellite-based analysis of temporal dynamics in tropospheric nitrogen dioxide levels over large urban agglomerations worldwide

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Satellite observations allow for a consistent perspective on tropospheric nitrogen dioxide at a global scale and their operational status facilitates studies on multi-annual to decadal temporal dynamics. Utilizing close to a decade of data from the SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY (SCIAMACHY) and the Ozone Monitoring Instrument (OMI) sensors, we present in this contribution a global analysis of the temporal dynamics in tropospheric nitrogen dioxide over the worlds' major urban agglomerations during the last 10 years.

The results indicate that while levels of nitrogen dioxide have been slowly declining in most areas of the United States and Europe over the last decade, very rapid increases in tropospheric nitrogen dioxide can be observed over many megacities and other large urban agglomerations throughout most of Asia, often with highly significant trends. Particularly in Eastern China, increases of 10 to 20 percent per year are quite widespread. Some of the large urban agglomerations with the most rapid increase in nitrogen dioxide pollution are Dhaka in Bangladesh, Kabul in Afghanistan, and Tianjin in China, and these are investigated in more detail. An inter-comparison of trends derived separately from SCIAMACHY and OMI shows that in terms of spatial patterns the resulting trends agree quite well between the two instruments, particularly in the more polluted areas. However, at the individual grid cell level substantial differences can be found. In addition, the satellite-based trends in tropospheric nitrogen dioxide levels were compared to those obtained from the European Monitoring and Evaluation Programme (EMEP) chemical transport model over the same time period, and furthermore sampling the model at the same time of day as the satellite overpass, thus eliminating the impact of the distinct diurnal cycle of nitrogen dioxide. While generally a good correspondence in the trends has been found between the two data sources, significant differences occur at the individual grid cell level and in Eastern Europe.