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Trends in NO_2 and the Effects of the Economic Crisis Observed by OMI over Europe

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Tropospheric NO_2 plays an important role in air pollution and atmospheric chemistry, particularly O_3 chemistry. Air quality thresholds for O_3 and NO_2 set by the European Comission to protect human health are still frequently exceeded in EU member states. The primary anthropogenic sources of NO_x ($NO + NO_2$) are combustion processes, namely motor vehicle emissions, power generation, and industrial activities. Emissions from these sectors are controlled by legislation and economic growth or recession. We examine the effect of the 2009 economic crisis on European NO_x emissions with observations of NO_2 tropospheric columns from the Ozone Monitoring Instrument (OMI) from 2004 to 2010. We use the Kolmogorov-Zurbenko (KZ) filter to isolate long term NO_2 variability from seasonal fluctuations. We perform Empirical Orthogonal Function (EOF) analysis on the filtered OMI NO_2 data to determine the most significant spatial and temporal variations. We reduce the dimensionality of the data to three components. The NO_2 long term trend over Europe is predominantly driven by declining NO_2 at a rate of 2-5% per year before 2008, followed by a 10-25% per year decrease in NO_2 until the middle of 2009 in industrialized areas in Germany, Poland, Belgium, the United Kingdom, the Po River Valley, and the major cities in southern Europe. The pre 2008 decline is in line with trends in the high resolution bottom up European emissions inventory developed by TNO for the MACC project. The remaining two components from the EOF analysis are compared to interannual variability in ECMWF data fields. We compare OMI NO_2 to NO_2 columns simulated with the regional air quality model CHIMERE for periods before and after the economic crisis assuming 2010 emissions ceiling levels for EU member states after 2008. Thereby, we obtain an independent estimate of the contribution of the 2009 ecomonic crisis to declining NO_x emissions in Europe.