Analysis of NO2 pollution in megacities by Earth Observation

Thilo Erbertseder(1), Christoph Bergemann(1), Hannes Taubenböck (1), Frank Baier(1),

(1) Deutsches Zentrum für Luft- und Raumfahrt, Deutsches Fernerkundungsdatenzentrum, 82234 Weßling, Germany
thilo.erbertseder@dlr.de

Summary
In this study we investigate the variability and trends of NO2 pollution in 30 megacities by analyzing different Earth Observation data sets. Multi-annual records of tropospheric NO2 from SCIAMACHY (2002-2012) and GOME-2 (2007-2015) are combined with the global urban footprint of each megacity as a proxy for urban growth. The consistent and homogenous data sets enable a global comparison of the findings for the megacities and a classification with respect to their socio-economic development. The possibilities of current and upcoming Earth Observation missions are discussed.

Introduction
Concerning air pollution and its effects on human health and climate, megacities and mega-regions have become the focus in recent years (WMO, 2012) However, from a global perspective, megacities are quiet heteorogeneous in terms of urban growth rates and the resulting spatial pattern. Moreover, their predominant functionalities, ie whether industrially dominated or already taking part in the emerging information society, impact on pollution characteristics as well.

Method and results
A globally systematic multi-sensor approach is applied to analyse NO2 pollution variability in megacities linked to urban growth rates and population development. To quantify the global tropospheric NO2 variability satellite-based observations of GOME-2 (2007-2015) and SCIAMACHY (2002-2010) are examined The linear trend is determined by an approach building upon Weatherhead et al. (1998). The classification of the dynamics of urban development and the spatial pattern for 2002 and 2012 is based on optical Landsat and TanDEM-X radar data (Taubenböck et al., 2014).
Considering the per-capita NO2 pollution, the megacities can clearly be classified into three groups with differentiated pollution characteristics (of increasing magnitude): the cities of the Global South, the cities of Europa and USA, and the cities in China and Korea. With respect to the linear trends, each of these groups shows a typical development. While the NO2 levels in Europe and USA are decreasing, a strong increase can be found throughout the megacities of the Global South. Heterogeneous trends are observed for Chinese and Korean megacities. Here the trends vary spatially and urban growth pattern need to be taken into account to draw the conclusions in line with in-situ measurements. This is demonstrated by the NO2 analysis of the mega-region Guangzhou-Shenzhen-Hong Kong, a dynamic industrial and economic region with globally unprecedented growth rates so far.

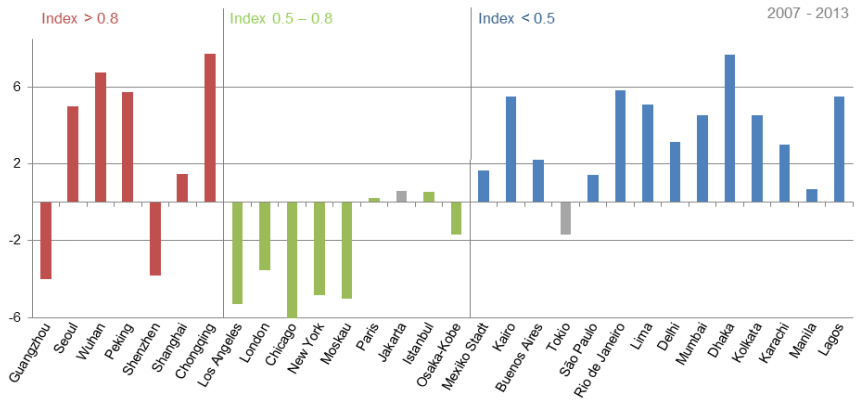

Fig 1: Megacities sorted by per-capita NO2 pollution (decreasing from left to right) and the corresponding relative trends (%/year)

Conclusion
Satellite-based time series of tropospheric NO2 observations and urban settlement pattern have been combined for the first time. The systematic analysis enables to classify megacities with respect to growth, pollution characteristics and significant trends as well as to delineate heterogeneous trends within megaregions.

References
Erbertseder T et al. (2015): Stadtregionen als globale Zentren der Luftverschmutzung – in: Globale Urbanisierung – Perspektive aus dem All, Springer
Taubenböck H et al. (2014): New dimensions of urban landscapes: The spatio-temporal evolution from a polynuclei area to a mega-region based on remote sensing data. In: Applied Geography. Vol. 47, pp. 137-153.
Weatherhead E C et al. (1998): Factors affecting the detection of trends: Statistical considerations and applications to environmental data. Journal of Geophysical Research, 103, 17149-17161.
WMO (2012), WMO/IGAC Impacts of Megacities on Air Pollution and Climate, GAW Report No. 205.