DOAS measurements from Kinshasa: Context and First results

Rodriguez YOMBO[1], Gaia PINARDI[2], Alexis MERLAUD[2], Caroline FAYT[2], Michel VAN ROOZENDAEL[2], Jean-Pierre MBUNGU[1]

1. Université de Kinshasa, Faculté des Sciences, Département de Physique (UNIKIN)
2. Institut Royal d'Aéronomie Spatiale de Belgique (BIRA-IASB)

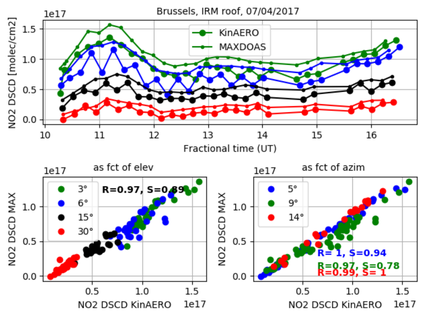
rodriguez2yombo@gmail.com, gaia.pinardi@aeronomie.be, alexis.merlaud@aeronomie.be, Caroline.Fayt@aeronomie.be , Michel.VanRoozendael@aeronomie.be, jmbungu2001@yahoo.fr

Context/interest of Kinshasa

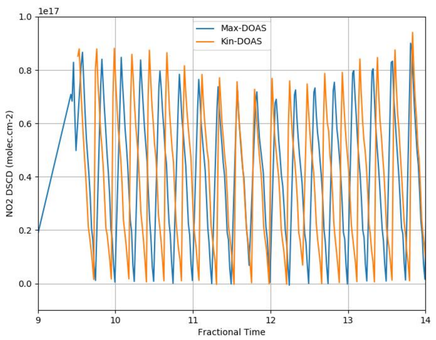
Several groups have spectral measurements (UV/VIS) of scattered sunlight (MAXDOAS and/or ZenithSky) measuring around the globe trace gases like nitrogen dioxide (NO_2), formaldehyde (HCHO), sulphur dioxide (SO_2), but the African continent is under-sampled compared to other regions of the world, with only regular measurements in Nairobi and Bujumbura. There is a need within the scientific community to develop more stations on the African continent, and promote projects in order to set up collaborations with local universities. Any mid-to-long term measurements in Africa is thus of great interest, e.g. in term of satellite validation or model evaluation. Biogenic emissions (measurable e.g., through the formaldehyde content) related to annual cycles of tropical forest are indeed among the highest in the world (De Smedt, et al., 2015). The air quality is also an issue in rapid developing urban areas (such as in the Kinshasa megacity with its 11 million inhabitants), and measurement of nitrogen dioxide and aerosols are crucial to measure the predicted deterioration of the air quality in the next decade if no emission regulations are taken (Liousse et al., 2014).
BIRA-IASB and UniKin have thus set up a collaboration to create a cheap and portable MAXDOAS instrument, that have been tested against BIRA-IASB MAXDOAS in Uccle (Belgium) in beginning of 2017 and set up at the Kinshasa University (RD Congo) in May 2017. The instrument is based on a AVANTES spectrometer (290-450nm), connected through a fiber to a commercial Nextstar motorized support. A GPS is also integrated to the instrument, allowing measurements onboard of a car.

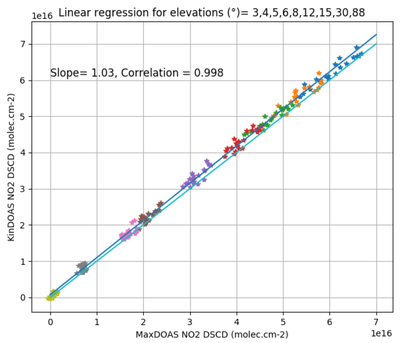
1. Tests in Brussels

The new system (AVANTES spectrometer and NextStar) has been tested against BIRA-IASB MAXDOAS in Uccle (Belgium) in beginning of 2017.

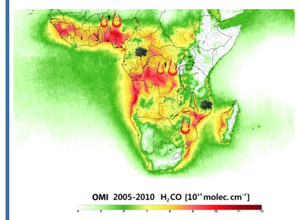


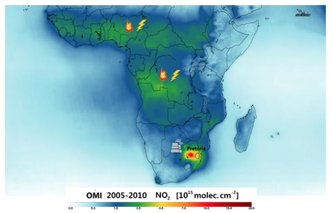
Another intercomparison was performed in April 2018 with another compact Avantes spectrometer and a similar telescope mount. The field-of-view was reduced to better match the large MAX-DOAS and improve the profiling capabilities.





2. Measurements in Kinshasa

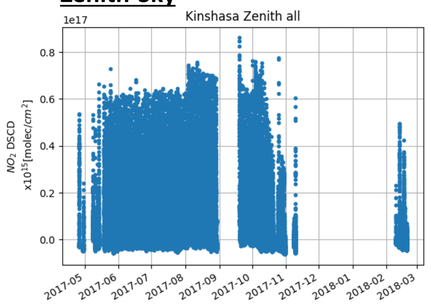




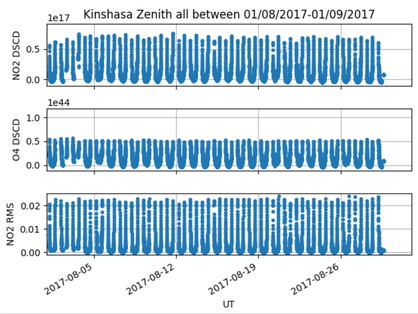
Set-up at the University of Kinshasa

The KIN-AERODOAS station is located on the roof of the UNIKIN Faculty of Science building and has been operational since May 2017. It operates daily and provides continuous measurements in ZenithSky mode and punctual MAXDOAS measurements during clear-sky days. Clear signals of NO_2 in the troposphere and stratosphere have been highlighted, as well as HCHO and aerosols signals in the troposphere.

Zenith-Sky

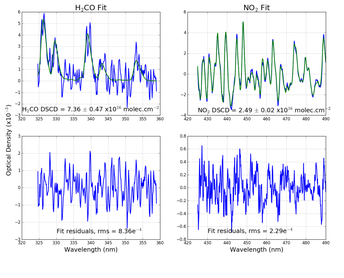


Zenith time series since May 2017

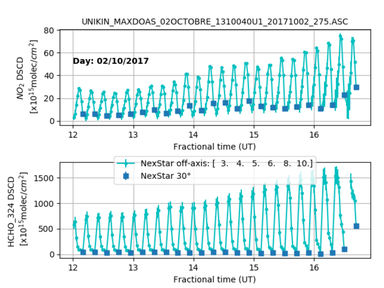


Example of one month of zenith data

MAXDOAS

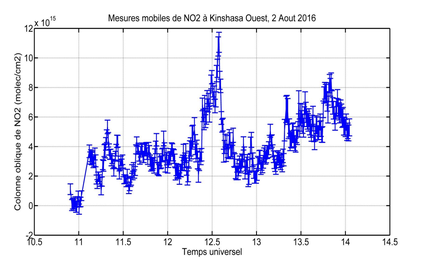


Example of DOAS fits



Example of a MAXDOAS time series

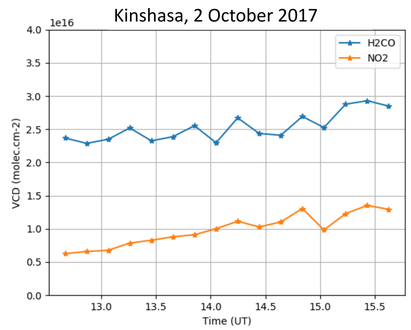
Mobile-DOAS

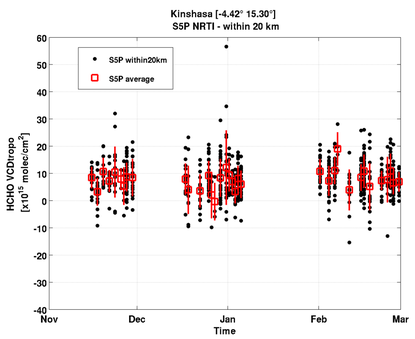


Example of Mobile-DOAS measurements

3. Future plans

- Analysis of zenith-only time series (e.g. for NO_2, Tack et al. AMT, 2015)
- Analysis of MAX-DOAS measurements
- Comparisons with space-based data, in particular TROPOMI/S5P
- Comparisons with Bujumbura data and IMAGE models (Gielen, ACPD, 2017)
- Updated instrument will be installed in June 2018 (automatized MAXDOAS)





Acknowledgements: the KINAERO project is supported by the Belgian Science Policy (BELSPO). The authors also thank Nuno José dos Santos Pereira for his valuable help on site with the MAX-DOAS measurements.