Satellites improve air quality monitoring in South Africa

Information from ESA

Economic development often means an increase of harmful gases into the atmosphere. The European Space Agency’s (ESA) GlobEmission project uses satellite data to monitor atmospheric pollution from emissions.

South Africa’s economy is growing rapidly. From 2002 to 2012, its gross domestic product grew by about US$ 270-billion. Unfortunately, a strong economy often leads to high levels of air pollutants which can influence regional air quality and have an impact on global climate change.

Over the industrialised Highveld region, satellites show concentrations of the air pollutant nitrogen dioxide comparable to those observed in Europe, eastern North America and south-east Asia. With such high levels of air pollution, it is important to monitor the emissions that cause them.

Emission inventories are used to describe the location and magnitude of emissions from various origins, such as traffic, forest fires or industry. These inventories are then used for scientific atmospheric models, as well as by policy makers to evaluate the effectiveness of air quality improvement initiatives and decide on future strategies.

Emission inventories are usually compiled from large amounts of statistical data, but are limited by the lack of continuity. Furthermore, events such as forest fires or extreme weather are not taken into account. In addition, economic developments – such as recession or the closing of factories – directly affect atmospheric composition but are not accounted for by common emission inventories.

Earth observation satellite observations, however, can provide consistent data on atmospheric composition for improved emissions inventories. For a closer look, ESA began the GlobEmission project to focus on emissions for four specific regions: China, India, Europe and South Africa.

Dr. Ronald van der A, leader of the GlobEmission project, says that state-of-the-art satellite measurements and computer models are used to calculate the measured air pollutant concentrations back to their origins. The advantages of these emission estimates are their spatial consistency and high temporal resolution. Above all, they are rapidly available because there is no more need to wait for the newest release of statistical data.

At the Dutch meteorological institute KNMI, Dr. Bas Mijling works on improving regional emission estimates using nitrogen dioxide observations from the GOME-2 instrument on Eumetsat’s MetOp satellite and the OMI instrument on NASA’s Aura. He was surprised to see such a large difference between the estimated emissions values for South Africa’s Highveld region and actual values from the satellites.

He explained that the old inventory was especially wrong about the location and strength of emissions by power plants and heavy industry. Using satellite data, however, the researchers can correct the location data and update the emission data to actual values.

A next step in the GlobEmission project is being taken by the Belgian company VITO, which will refine the South African emission values by using statistical information on population density, traffic and land use. Furthermore, emissions from wildfires, forests and agricultural land use will also be taken into account. All information will be made available on the GlobEmission website.

Fig. 1: Measurements of nitrogen dioxide (NO₂) concentrations by the GOME-2 instrument on board the MetOp-A satellite from 2011. High values are found in the Highveld region – the economic centre of South Africa, where large cities and heavy industry are concentrated. Due to prevailing westerly and north-westerly winds, the air pollution is transported over a large area.
Fig. 2: Nitrogen oxide emissions for the South African Highveld region. The grey outline indicates the densely populated Gauteng province, containing the cities of Johannesburg and Pretoria. Blue circles indicate the location of coal-fired power stations, important hot spots of nitrogen oxide emissions. The upper panel shows the emission strength of the model-based emission inventory, based on 2008 data. The lower panel shows the emission estimates from the spaceborne OMI instrument for 2009–10. The use of satellite data improves the identification of the emission hot spots.

Fig. 3: MetOp-A was launched on 19 October 2006 from the Baikonur Cosmodrome in Kazakhstan, on a Soyuz ST rocket with a Fregat upper stage.

The Department of Environmental Affairs of South Africa is already planning to use this new emission inventory to improve their emission monitoring programme.

Results of emission inventories derived from satellite observations will be presented to users and potential users in December 2013 at ESA’s ESRIN centre in Frascati, Italy. The goal of this third User Workshop of GlobEmission is to present the services developed in the first two years of the GlobEmission project and to present the assessment of the users of these services. The following services will be presented:

- Global emission estimates for isoprene and VOCs (including verification of EDGAR or REAS inventory).
- High resolution regional emission estimates for NOx for China, India and South Africa, including spatial disaggregation.
- European emission estimates for NOx and SOx.
- Global emissions related to forest fires (trace gases and aerosols).
- Regional aerosol emissions and estimation of effects on PM for Europe.

Both developers and (potential) users will have the opportunity to present their work at this workshop. There will also be discussion on improvements to the emission service.

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