LEGO-BEL-AQ

Low-Earth and Geostationary Observations of Belgian Air Quality

DURATION
15/12/2019 - 15/03/2024

BUDGET
375 951€

PROJECT DESCRIPTION

Any policy or decision, whether local and stand-alone or global and integrated, that aims to ensure a sustainable consumption of fossil and other organic fuels, needs to consider appropriately issues of air pollution, in particular with NOx and particulate matter. A fundamental prerequisite to effective policymaking is the availability of an observing system that gives access to quantification and mapping of the current air quality and of the impact of past and future regulations.

Air quality monitoring has hitherto been relying mostly on measurement networks of in-situ atmospheric composition, complemented with chemical transport modelling (CTM) to fill in the gaps between measurements. The advent of hyperspectral satellite sounders at high-resolution (typically 5 x 5 km² on ground) has enabled global mapping of atmospheric pollutants at regional and even nearly local scales, however, only once per day and in cloud free weather, without access to the diurnal cycle of pollutants and of their emissions. In the next step the international community has elaborated a strategy for integrated observation of air quality with a constellation of these satellites: the CEOS LEO+GEO AQ Constellation, gathering Low Earth Orbit instruments (LEO) with global mapping once per day, and Geostationary instruments (GEO) limited to a geographical area like Europe or North America but also with hourly sampling and thus access to the diurnal cycle. The European programme Copernicus contributes to this LEO+GEO AQ constellation with the Sentinel-5 Percorsor (S5P) satellite since 2017 and the launch of several Sentinel-4 (GEO) and Sentinel-5 (LEO) after 2023.

To make these new data sets truly fit-for-purpose in the context of air quality policy making, several challenges need to be addressed, among others:

(1) Improve even further the horizontal resolution to map and monitor pollution on the scale of local policies (e.g. the Low Emission Zones established in several large Belgian cities),
(2) Determine the non-trivial relation between the (tropospheric) pollutant column measured by satellite instruments and the surface concentration measured by in-situ networks,
(3) Evaluate to what extent differences in measurement geometry and sensitivity between LEO and GEO observations lead to a different perception of atmospheric details (e.g., through spatial blurring and obscuration effects), hence, to an internal incoherence of the satellite constellation.

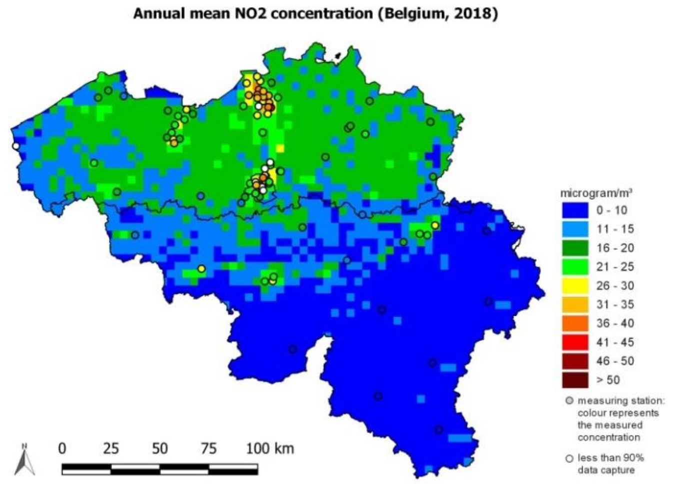
The project aims to explore these three topics, with applications specific to Belgium, its regions and cities, by bringing together the expertise in satellite-based monitoring of tropospheric composition at BIRA-IASB with the in-situ and modelling expertise and the relation with key stakeholders makers at IRCEL-CELINE. For challenges (1) and (2), a mostly observational approach is adopted which is meant to be complementary to the CTM method adopted in the Copernicus Atmosphere Monitoring Service (CAMS). More specifically, the work plan targets advances:

- On the first challenge by developing oversampling tools for satellite data, based on selective aggregation (trading temporal for horizontal resolution) and geostatistical interpolation techniques (WP1 of the project), and by applying these on S5P observations of tropospheric NO_2 over Belgium, with a focus on key cities such as Brussels, Antwerp, Ghent, and Liège (WP2). The results, both the high-resolution maps and the analyses of the temporal evolution (with reference to the policy in effect), will be made available online.
- On the second challenge by comparing the high-resolution S5P maps over Belgium with the in-situ measurements and derived gridded products (e.g. the RIO data set) to assess under which conditions the high-resolution satellite maps of the NO_2 column can be considered as representative for the distribution of the NO_2 surface concentration (also in WP2);

LEGO-BEL-AQ

- On the third challenge by extending the OSSSMOSE observing systems metrology simulator at BIRA-IASB with dedicated 3D GEO observation operators and applying these on representative atmospheric model fields, digital elevation models and orbital parameters of S5P, Sentinel-4 and Sentinel-5, in order to quantify the significance of these effects on the internal coherence of the CEOS LEO+GEO AQ Constellation (WP3).

To ensure uptake by key stakeholders, a separate work package (WP4) is dedicated to user interaction: collecting requirements, ensuring availability of outcomes, and designing a roadmap for the future to take this work to an operational level.



CONTACT INFORMATION

Coordinator

Tijl Verhoelst
Royal Belgian Institute for Space Aeronomy (BISA)
tijl.verhoelst@aeronomie.be

Partners

Frans Fierens
Belgian Interregional Environment Agency (IRCEL-CELINE)
fierens@irceline.be