L-vehicles Emissions and Noise mitigation Solutions

Addendum to Deliverable D6.3 Eco-mobility app for best practices on LV use

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056777

Deliverable No.	D6.3	
Deliverable title	Eco-mobility app for best practices on LV use	
Deliverable type	APP	
Dissemination level	Public	
Deliverable leader	IFPEN	
Contractual due date	31.05.2025	
Actual submission date	15.09.2025	
Version	1.0	
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Approved by		

Revisions table

Version	Date	Change
1.0	28.09.2025	First submission to the EC

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Executive summary

This document is an addendum to deliverable D6.3. This deliverable focuses on the content used to upgrade the L-category knowledge of the Geco air app thanks to the LENS project. Within the scope of this deliverable, Geco air app has been challenged with the latest results from WP3 and WP4 regarding the emissions collected in the LENS Database and also the first deliverables of WP6, using the Geco air user database to assess usage. This document is intended to highlight the use of the data and knowledge gathered in the LENS project that has been beneficial for the development of Geco air.

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1 Introduction

Description of the Geco air app

Geco air is a mobile phone application developed by IFP Energies nouvelles (IFPEN) with the support of the French Agency for Ecological Transition (ADEME). This app is available for free on the iOS and Android stores covering most of the transportation modes. Its purpose is to provide an assessment of the impact that each user can have on air quality through a better understanding of their mobility. The approach promoted is that atmospheric pollution and CO_2 emissions can be mitigated by the transportation mode chosen, i.e. your car, your motorbike, your bike or public transportation even walking, and its subsequent use, i.e. the driving behavior. The app provides an insight on the ecological footprint of personal transportation and aims to guide the user to adopt friendlier habits for the environment in terms of mobility. This smartphone app helps to reduce, on a daily basis, pollutant emissions of our journeys by:

- Estimating the pollutant emissions of all the trips that are recorded,
- Analyzing pollutant emissions of journeys, whatever the type of transport (car, bicycle, public transport, walking).
- Classifying the polluting nature of the trips with a “mobility score”, delivered each day and after each trip.
- Helping to improve driving behavior with simple, practical and personalized tips after each trip.
- Recommending the use of soft transportation modes such as cycling when possible.

Geco air takes into account vehicle characteristics such as power, fuel, engine displacement, etc. to generate a model for the emissions specific to each vehicle. The algorithms automatically detect each trip and differentiate whether the user is driving, cycling, or walking. The trips are then analyzed on the server, and pollutant emissions are estimated for each of them.

To keep the analysis as simple as possible, a unique metric is used: the mobility point. All pollutant emissions are combined into a single, simple indicator, the mobility score (Figure 1). A mobility score is computed for each trip, taking into account local pollutant, such as nitrogen oxides (NOx), carbon monoxide (CO) and unburned hydrocarbon (HC) as well as green house gases emission and fuel consumption and synthetizing them into a single and simple value. By following their mobility score within the app, the users can estimate the environmental impact of each of their trips /journeys. For instance, taking a car for a short course will greatly decrease the mobility score of the day and encourage, if possible, the use of a less polluting transportation mode. At the end of each journey, the result is accompanied by simple and practical advices to improve the driving behavior (if the trip is made by a personal vehicle) and thus contribute to improve air quality.

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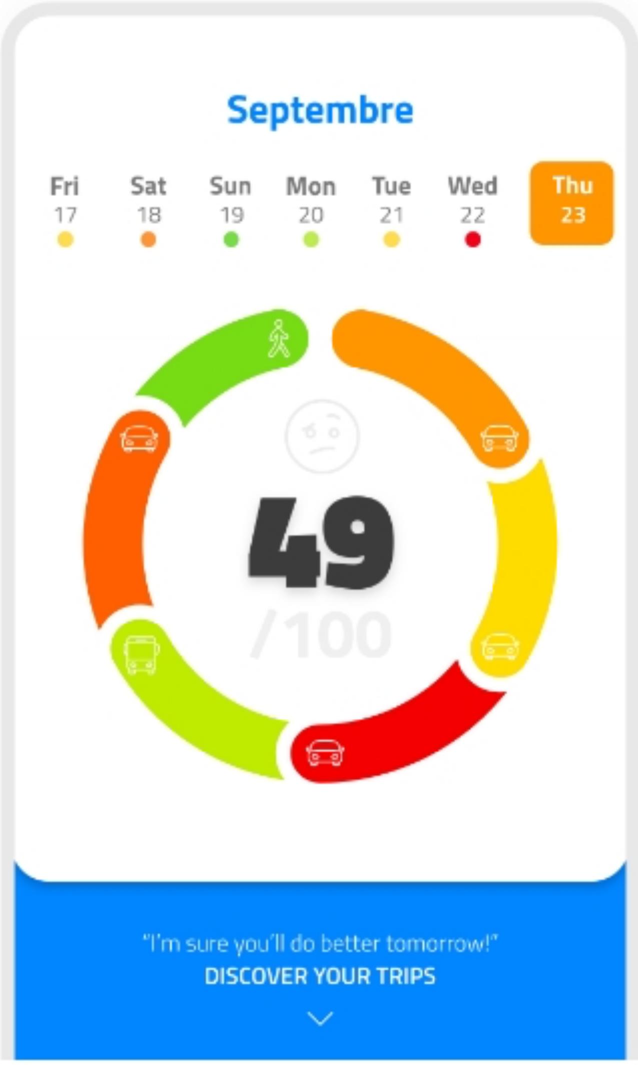

Figure 1: example of mobility score from Geco air

Objective

The EU funded LENS project has been a good opportunity to challenge the Geco air app regarding the L-category vehicles. The models used and their outputs have been assessed thanks to the work performed within the work packages of the LENS project. As part of the assessment of the project set-up, this family of vehicle is poorly covered regarding measurement and especially in real world conditions. While sources of in-use vehicle consumption data are readily available, documentation regarding pollutant emissions remains insufficient. The report aims to describe the inputs from the various LENS work packages into the update of the GECO Air app.

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2 Focus on the L-categroy

User database

L-category users represent a minor share of the regular users of the GECO Air app. For the last 2 years, it covers a hundred of motorcyclists with 260 000 kilometers driven, compared to 26 million kilometers in the Geco air database for about 6 000 regular users, so approximately 1% in distance and 2% in users. Figure 2 illustrates the coverage of the Geco air database over the French territory, most of the main roads are represented as well as usage in suburbs and rural cities. Most of the L cat vehicles from this database are L3e-A2 or L3e-A3, i.e. large displacement and high power/weight ratio. This database remains helpful when it comes to characterize the driving of L category vehicles in real conditions. IFPEN database, from the Geco air users, have been extensively used in the D6.1 to identify real world driving conditions that are critical for pollutants emissions and noise, proving that a database of millions of kilometers driven by non-professional drivers is crucial when it comes to characterize real world use of vehicles. It allowed for example to estimate the average trip duration and distance, the average speed or even the acceleration rate for each subcategories of vehicle for example.

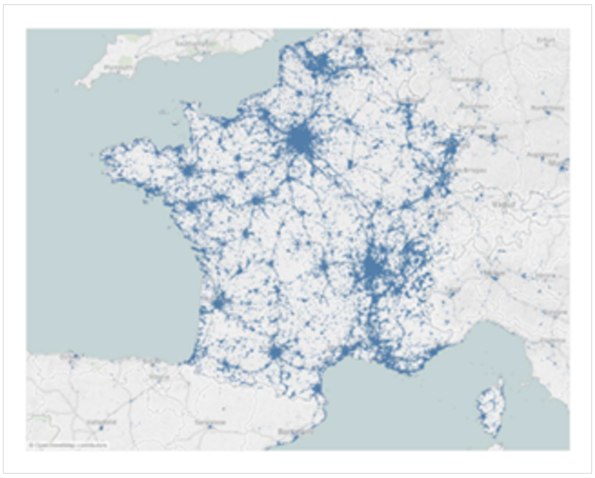

Figure 2: illustration of the coverage of the French roads by the Geco air database

Dedicated recommendations

As part of the promise of the GECO Air app, each trip is analyzed on the server through models that give the amount of CO_2 and atmospheric pollutants (CO, NOx, PN) produced but also some recommendations about the driving situation encountered during the trip. The goal of those recommendations is to raise awareness among users, i.e. drivers, that driving behavior can influence fuel consumption and pollutant emissions with adverse effect on the environment. Figure 3 illustrates the outputs from the app to the users, pop ups along the trip over the map indicate events where the driving could have been smoother.

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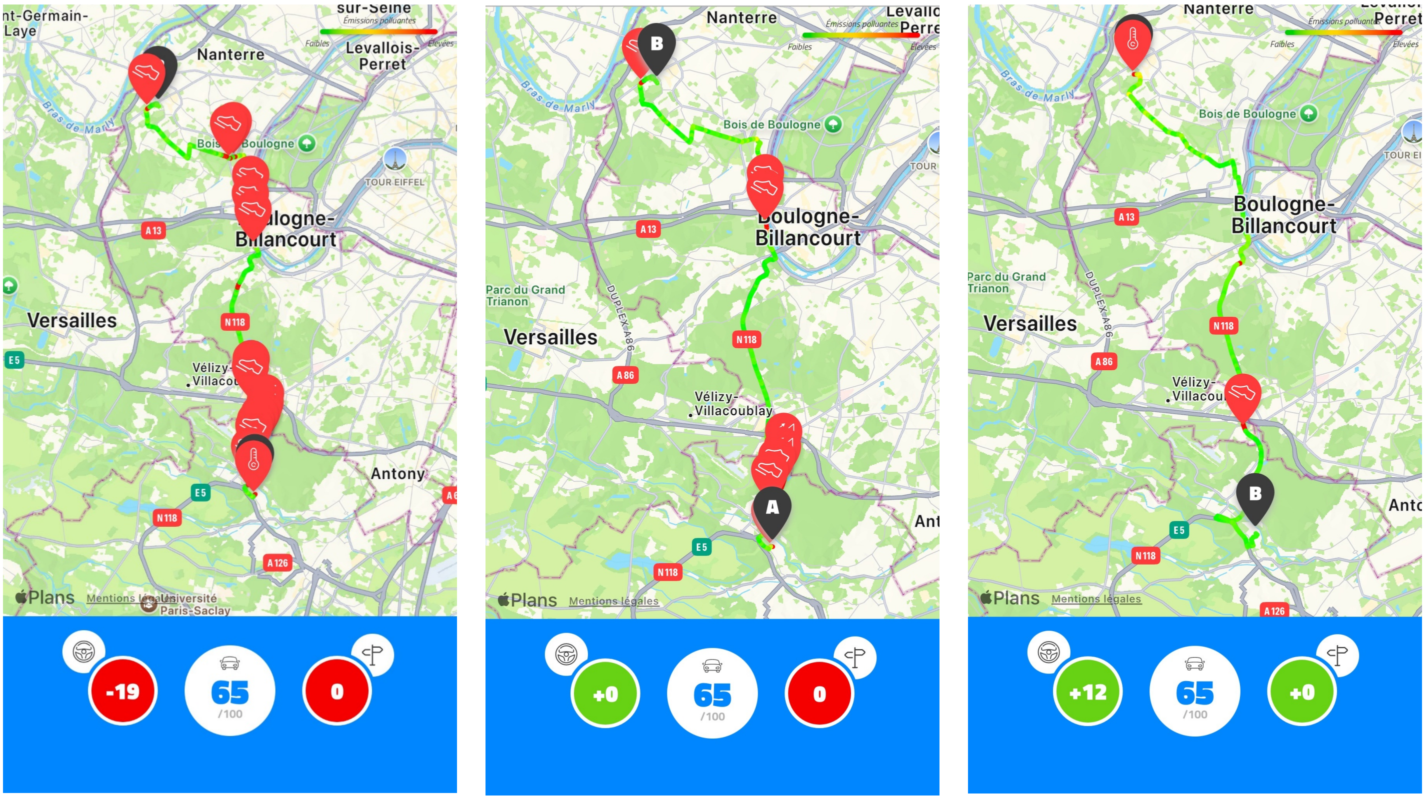

Figure 3: Example of outputs from Geco air on the driving behaviour for three similar trips with different driving behaviour for the same driver using the same motorbike.

The indicators at the bottom of the app screen are split in three sub notes: the driving note, the transportation/vehicle note and the trip note. The transportation note is based on the type of vehicle used, for example a recent Euro 5 vehicle will have a better note than an old Euro 2 vehicle, and electric vehicle will have a better note than a thermal one. The trip note is based on the distance of the trip between the starting point and the arrival point, if the distance is too short, a bad note can be given because the trip could have been done by feet or bike. The driving note will vary based on the quantity of events observed during the trip. Comparing the 3 visualizations, the first trip on the left represents a driving behavior with many harsh acceleration events, those events reduce the note, resulting in a negative note. The driving behavior from the trip in the middle has less harsh acceleration events but the first part of the driving as well as the middle part are driven to dynamically, resulting in a neutral note. The last driving behavior represented as almost no detection of events that could be avoided resulting in a positive note.

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3 Update from LENS

Vehicle database

Thanks to WP3 and WP4, a database of more than 150 vehicles tested has been built, including type approval (TA) and real world driving conditions tests. This database is useful to assess the results from the models regarding consumption estimation and pollutant emissions for each vehicle trip.
Such data are invaluable because pollutant emissions from L-cat vehicles are both poorly documented and difficult to measure, as assessed in the WP3 and WP4 deliverable, very limited equipment for road measurement exists and are costly.
Geco air models regarding L-cat vehicles were formerly assessed on user fuel consumption databases and limited data for emissions, mainly related to gasoline powered passenger cars behavior.

Models

In order to correctly estimate the pollutant emissions linked to each user trip, it is imperative to be able to correctly capture the driving behavior and the resulting fuel consumption with the help of dedicated models. Particularly in gasoline vehicles, sudden acceleration events that can cause fuel enrichment which can be crucial for pollutant emissions need to be reproduced. The models behind Geco air are based on a simple vehicle construction based on its generic information (vehicle category, fuel, mass, engine displacement, etc.). A 0D vehicle dynamic model is then applied on the trip using its characteristics (speed, slope) to obtain an estimation of fuel consumption and consequently pollutant emissions.

The use of the LENS database helped calibrate and tailor, as much as possible, the pre-existing models to the different types of L-category vehicles and to their particularities, especially in real world conditions. The LENS database helped to refined the virtual driver behaviour with gearshifting range adapted to different L-vehicle subcategories, it also helped to better understand where the fuel consumptions maps had to be improved, specifically for small displacement vehicles. The following figures (Figure 4, Figure 5 and Figure 6), provide a look on the model's capabilities in different real world test for different motorcycle categories (L1eB, L3e-A1 an d L3e-A3).

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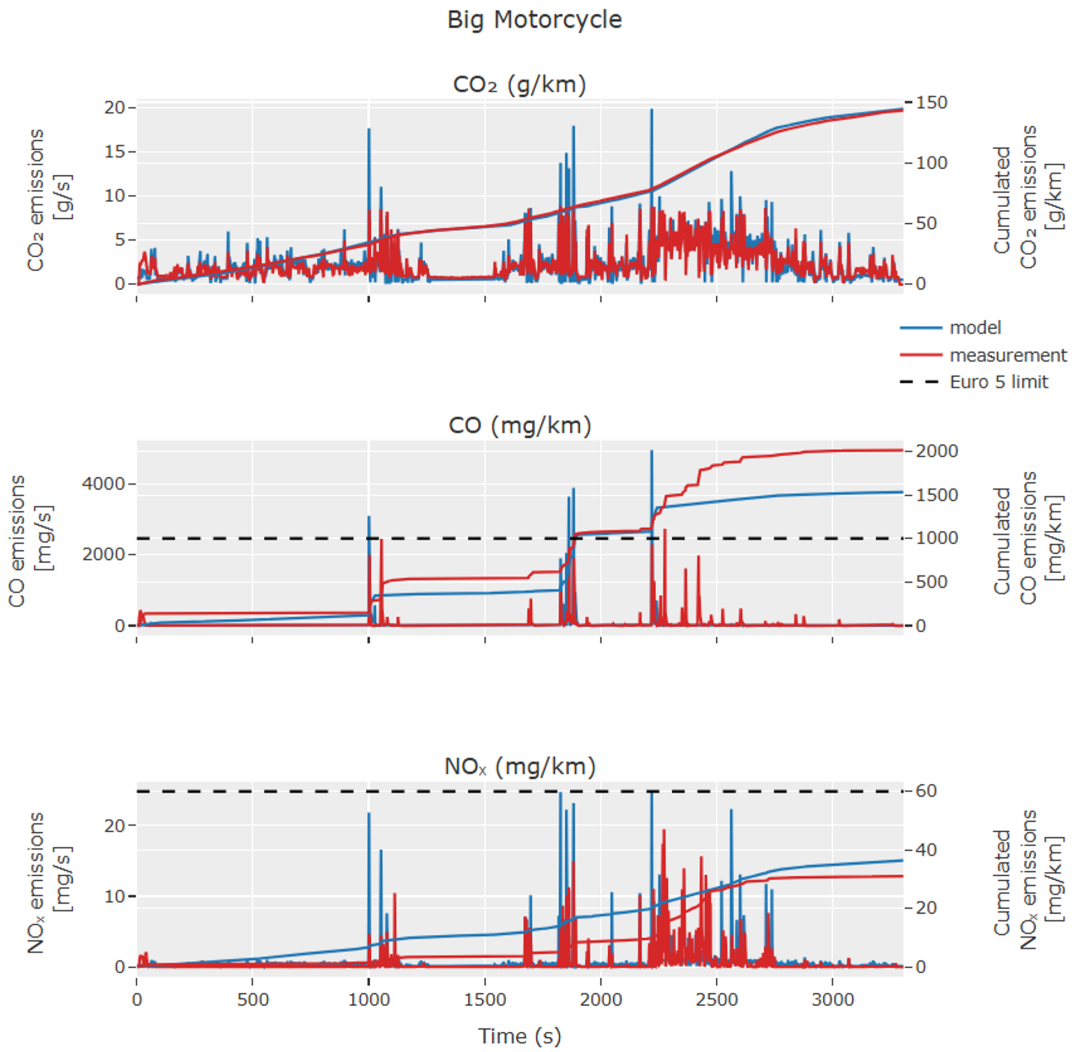

Figure 4: Instantaneous and cumulative traces of CO2, CO and Nox for a EU5 motorcycle of L3e-A3 category

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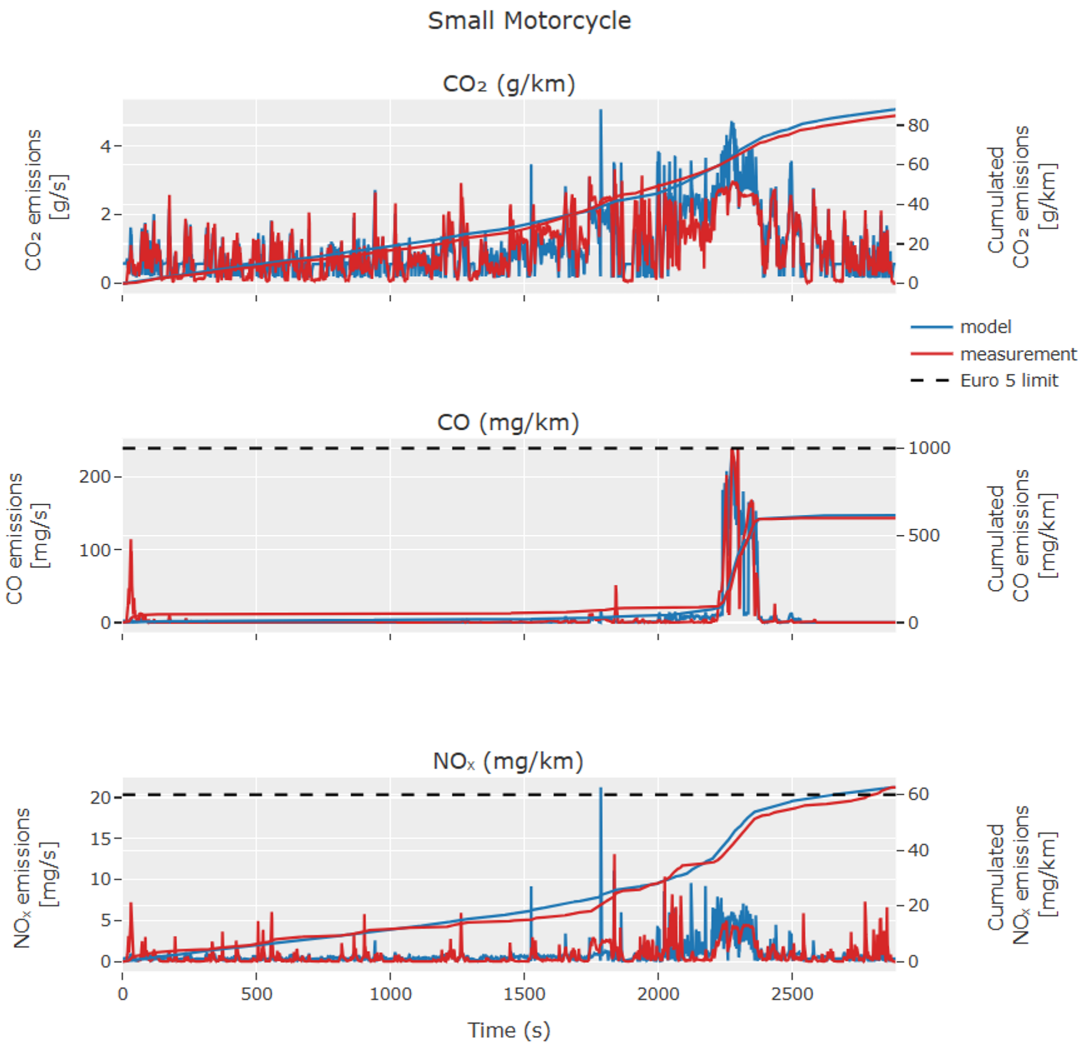

Figure 5: Instantaneous and cumulative traces of CO2, CO and NOx for a EU5 motorcycle of L3e-A1 category

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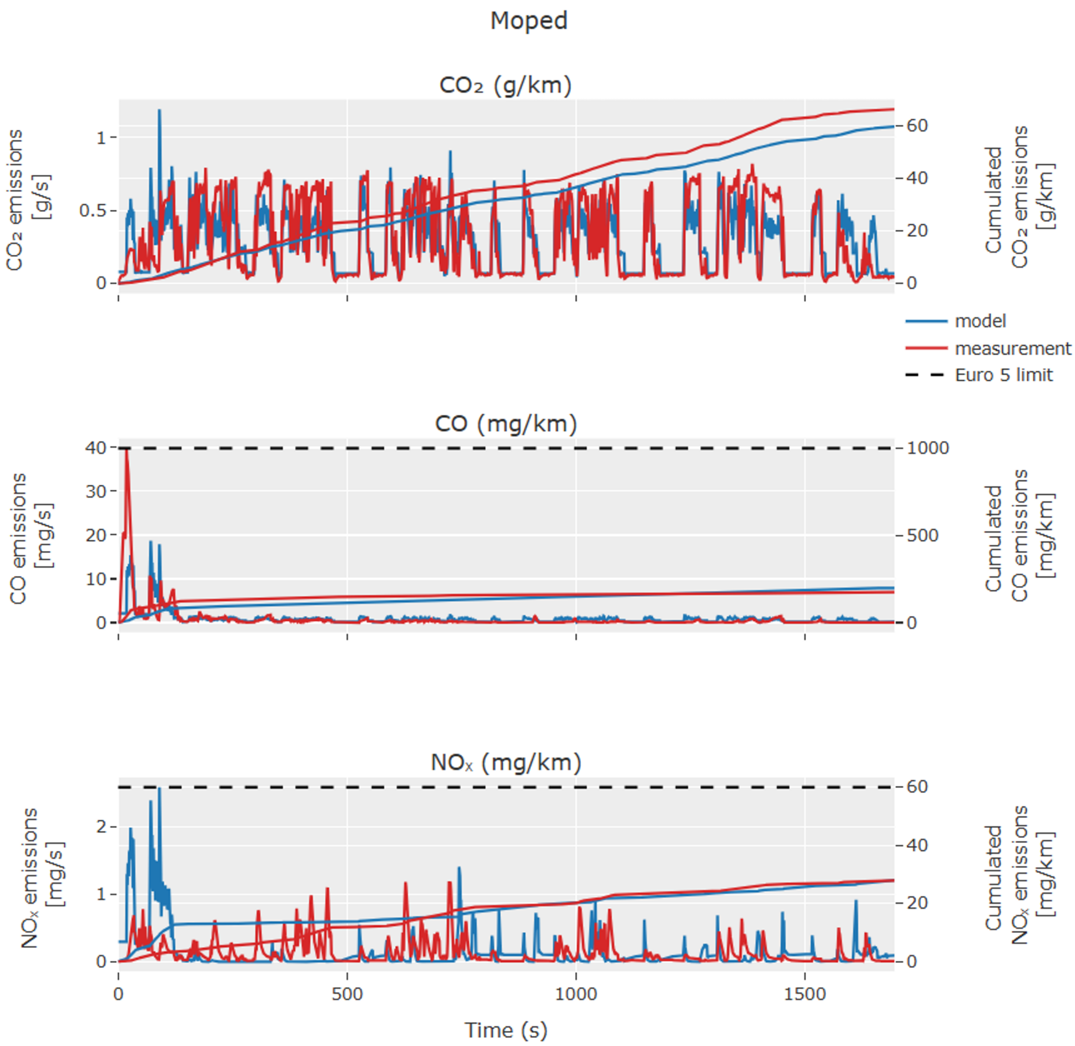

Figure 6: Instantaneous and cumulative traces of CO2, CO and NOx for a EU5 motorcycle of L1eB category

It can be seen from the figures presented above that the model has a good capacity to reproduce the measured emissions for different types of vehicles. The range of applications for the L-category vehicles (from small mopeds to sport motorcycles) makes it challenging to achieve a perfect match in all conditions for all the subcategories of vehicles but the current state of the model is satisfactory.

Figure 7 illustrates the behavior of the updated models compared to the previous models integrated in the server for Geco air.

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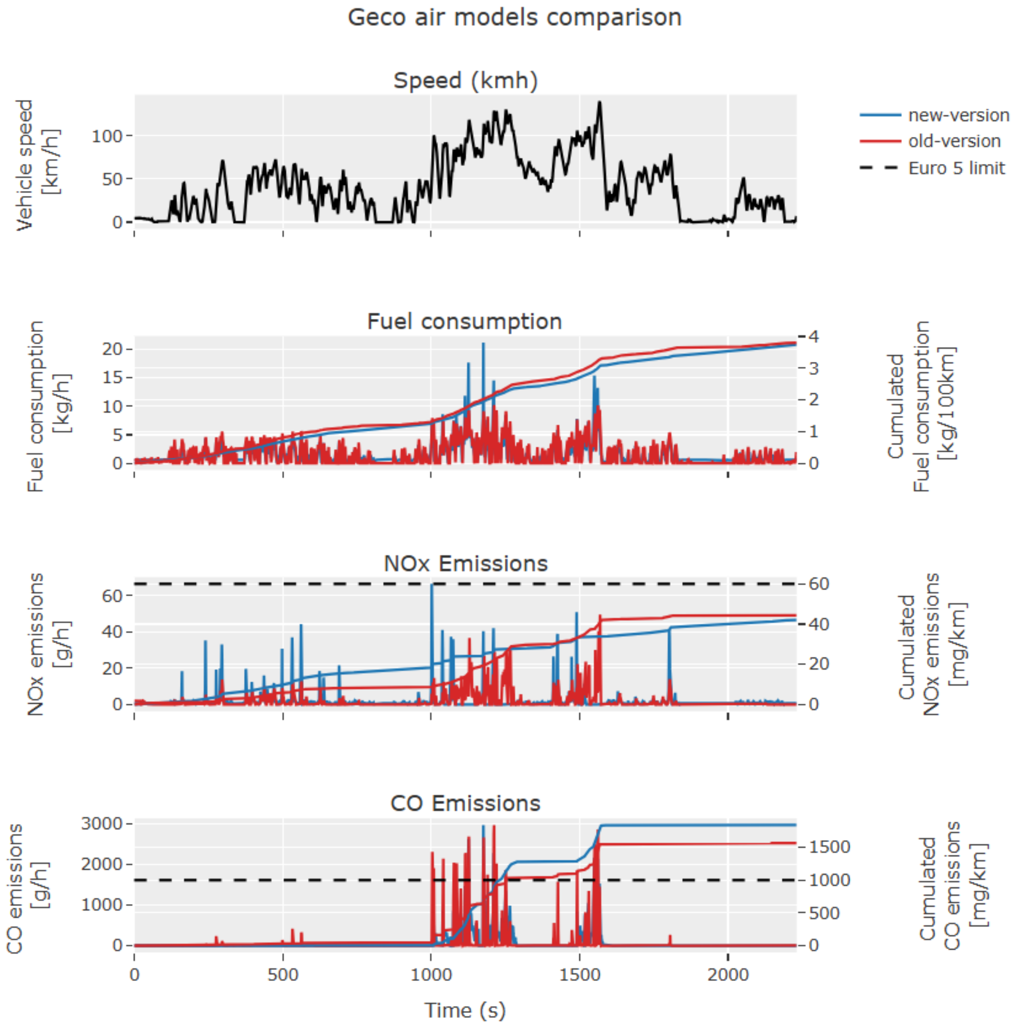

Figure 7: Instantaneous and cumulative traces of fuel consumption, CO and NOx for a motorcycle of L3e-A3 category from the Geco air database

There is some change on the instantaneous profile, particularly of pollutant emissions but cumulated values over the trip remain similar, with the exception of CO which showcases the value of the input that the LENS project has provided.

Nonetheless, it needs to be stated that there are inherent limitations to the function of Geco Air. As only GPS data are available for reproducing the cycle the actual behavior in parts of a trip may not be correctly captured (e.g. gear change on the highway with no severe change in vehicle speed or a modification of the gear shifting behavior within the trip). Using the data from LENS helps ensure that over a substantial range of data the order of magnitude of the pollutant emissions that are estimated are appropriate.

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Recommendations

Thanks to WP5 D5.1 about tampering behaviors and WP6 D6.1, about the influencing parameters for exhaust and noise emissions, pop up recommendations have been made regarding the use and the driving style for L-category vehicles, such as reducing harsh acceleration to reduce emissions and noise or reducing hig revs events. The table 2.2 from D6.1 that refers to the driving conditions for which high pollutant emissions are expected, is a good support to guide the future development and recommendations that the app can detect or at least spread to the L-category users.

Dissemination

Thanks to WP2, the Geco air app has been relayed to a larger public, with people from all over Europe. Also a LENS specific group has been set in the Geco air app in order to regroup all of the users from the LENS project and to simplify analysis between the partners.

4 Conclusion

The European Horizon LENS project has been a boon for validating and improving the understanding of the use of L-category vehicles through simple physical models. Although the number of users is limited via the GECO Air application, it is necessary to ensure that the announced values are as accurate as possible, particularly regarding emissions for very diverse vehicle categories. The work carried out in work packages 2, 3, 4, 5, and 6 has enriched knowledge about the world of L-category vehicles and provided necessary data for validating the models used so far. The LENS database has been extensively used to challenge and validate 0D models that are used for the Geco air app.

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