



# A MODELLING CHAIN FOR ESTABLISHING A LOW EMISSION CORRIDOR THROUGH THE ALPS

Andrea Bisignano, Lorenzo Giovannini

University of Trento - Department of Civil, Environmental and Mechanical Engineering, Italy

Ilaria Todeschini, Gianluca Antonacci

Cisma SRL, Italy

Roberto Cavaliere

NOI Techpark Südtirol/Alto Adige, Italy

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## THE «BRENNER LOWER EMISSIONS CORRIDOR» PROJECT

To develop a «**Low Emissions Corridor**» concept to be applied to the Brenner highway (A22) by means of the experimental and scientific study of an integrated set of dynamic policies (i.e., **variable speed limits**) to manage traffic on the basis of a proactive environmental strategy.

1. Speed reduction to increase the motorway capacity
2. **Speed reduction to improve air quality**
3. Joint management of traffic between traffic control centers to minimize the impact of traffic both on urban areas and on the motorway



Autostrada del Brennero SpA  
Brennerautobahn AG

AUTONOME  
PROVINZ  
BOZEN  
SÜDTIROL



PROVINCIA  
AUTONOMA  
DI BOLZANO  
ALTO ADIGE



PROVINCIA AUTONOMA DI TRENTO



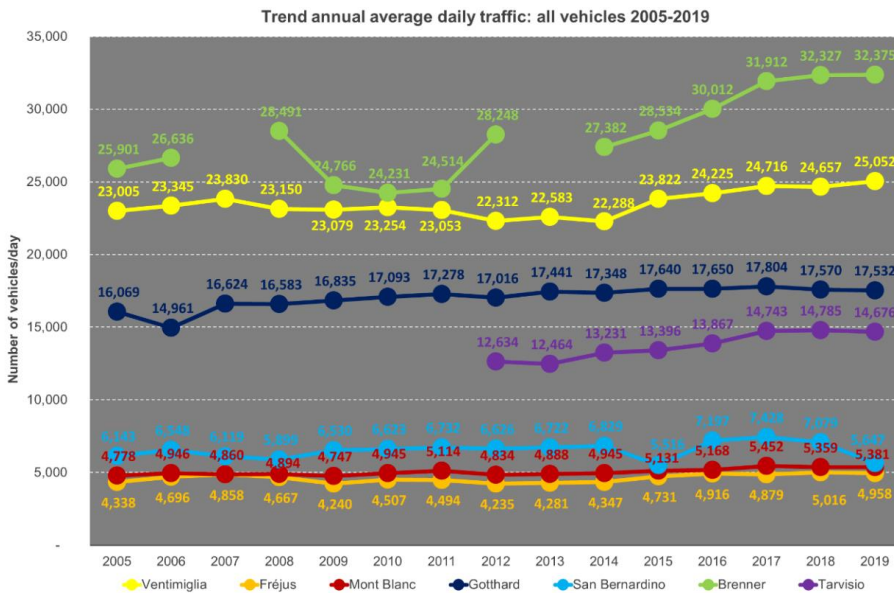
UNIVERSITÀ  
DI TRENTO





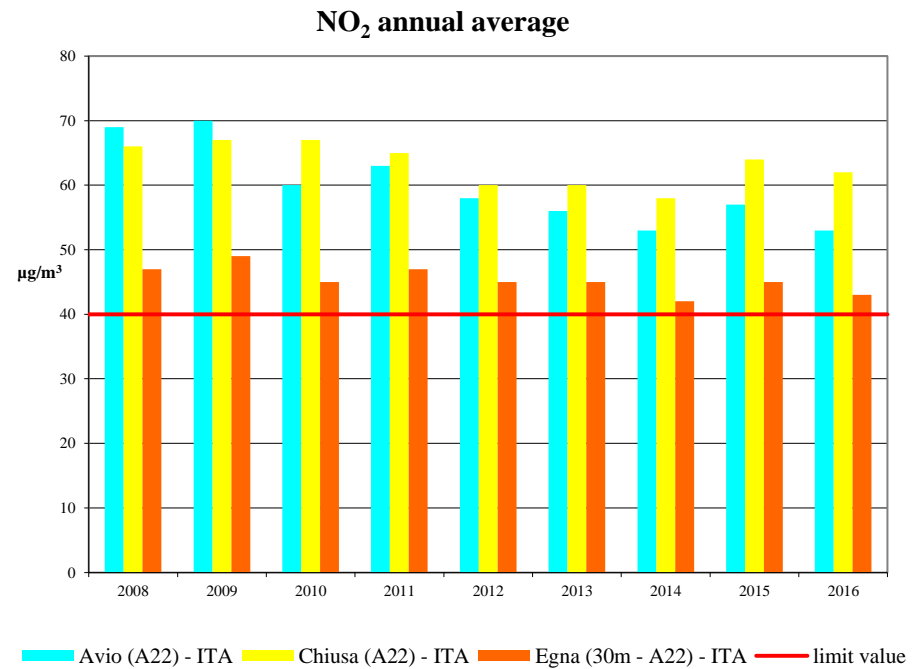
# MOTIVATION

## High volumes of traffic



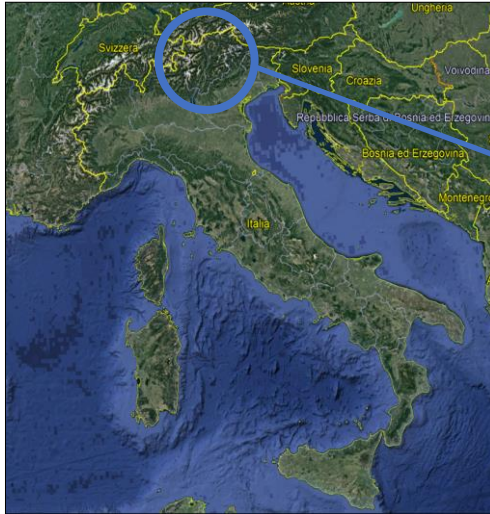
IMONITRAF! Annual Report 2020

## Environmental concern



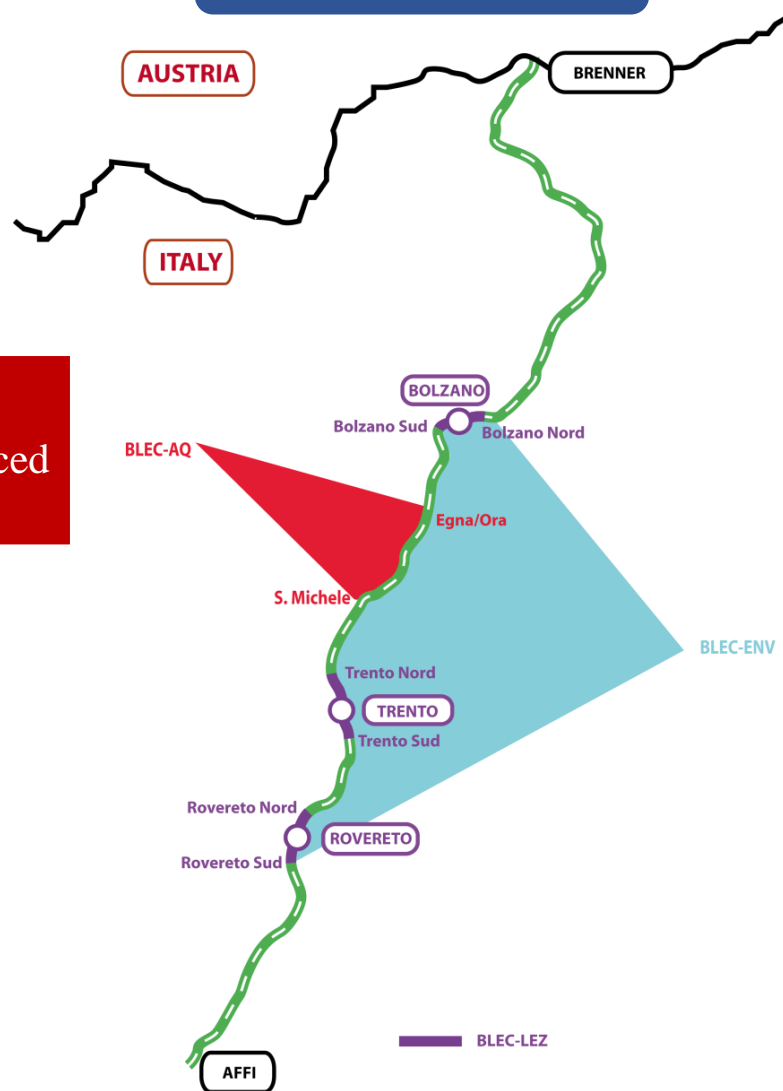


# PROJECT AREA: TRENTO-ALTO ADIGE REGION





# PROJECT AREA



**Approx. 12 km**  
Dynamic air pollution-induced  
policies calibration

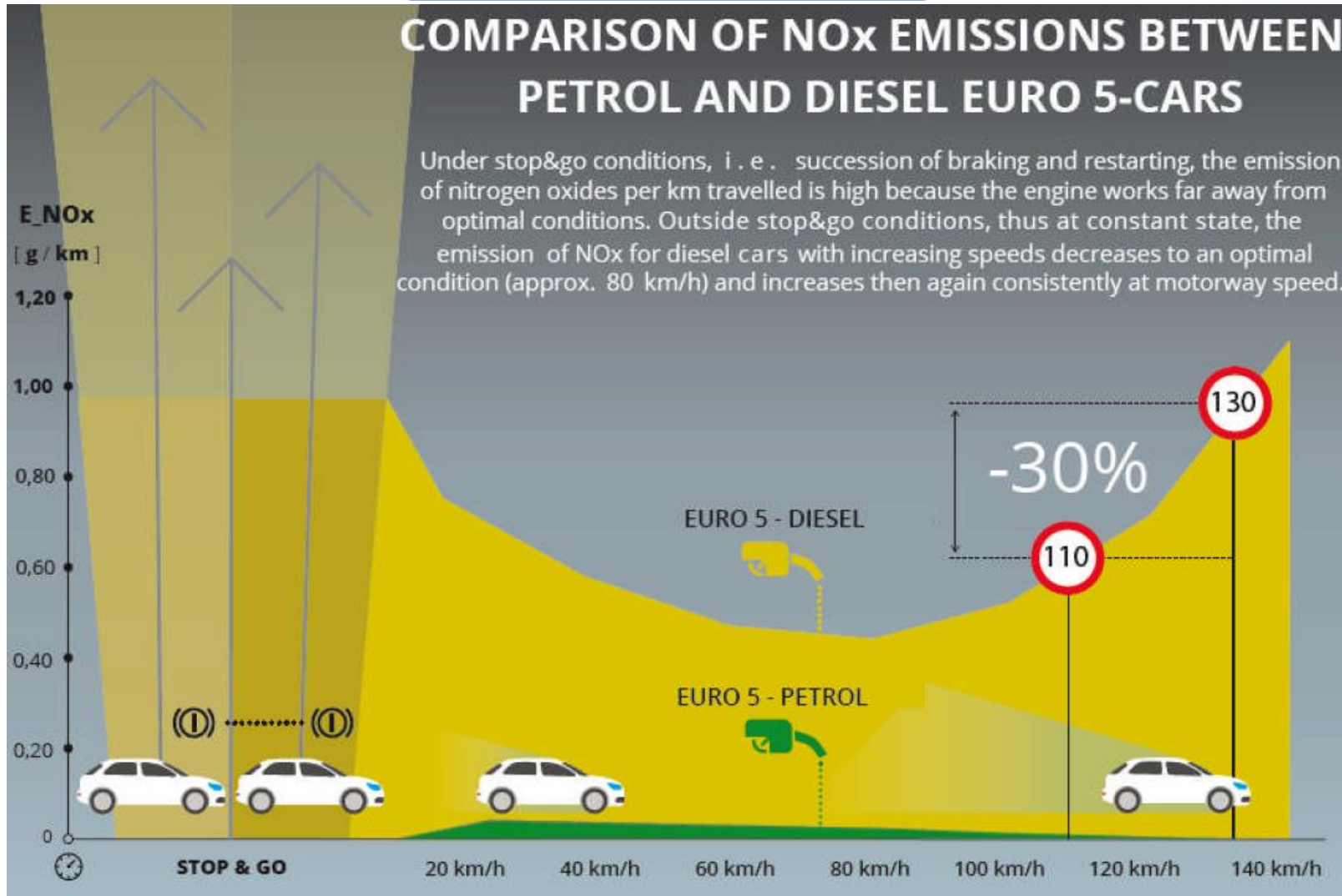
**Approx. 90 km**  
Dynamic traffic-induced  
policies calibration



## SPEED AND EMISSION

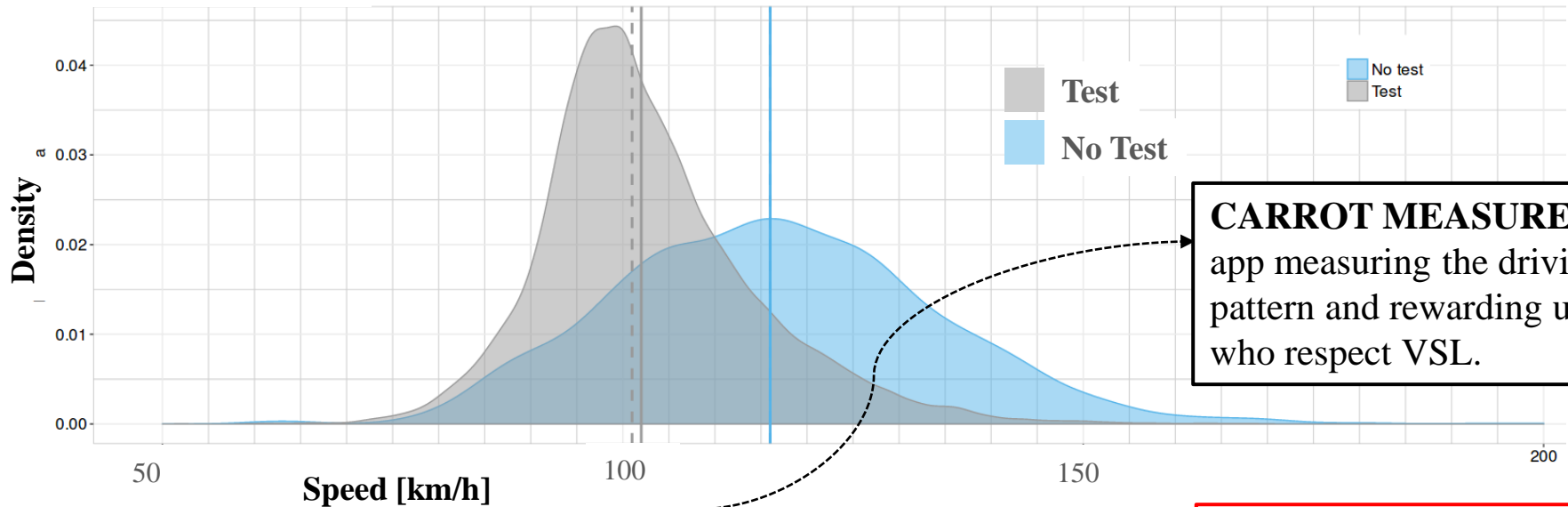
### COMPARISON OF NO<sub>x</sub> EMISSIONS BETWEEN PETROL AND DIESEL EURO 5-CARS

Under stop&go conditions, i . e . succession of braking and restarting, the emission of nitrogen oxides per km travelled is high because the engine works far away from optimal conditions. Outside stop&go conditions, thus at constant state, the emission of NO<sub>x</sub> for diesel cars with increasing speeds decreases to an optimal condition (approx. 80 km/h) and increases then again consistently at motorway speed.





# DRIVERS' RESPONSE



**CARROT MEASURE:**  
app measuring the driving pattern and rewarding users who respect VSL.

**STICK MEASURE:**  
enforcement systems (section control).

“Potentially persuadable” drivers

“Unpersuadable drivers”

**Issue: VSL for air quality reasons (still) not allowed in Italy....**



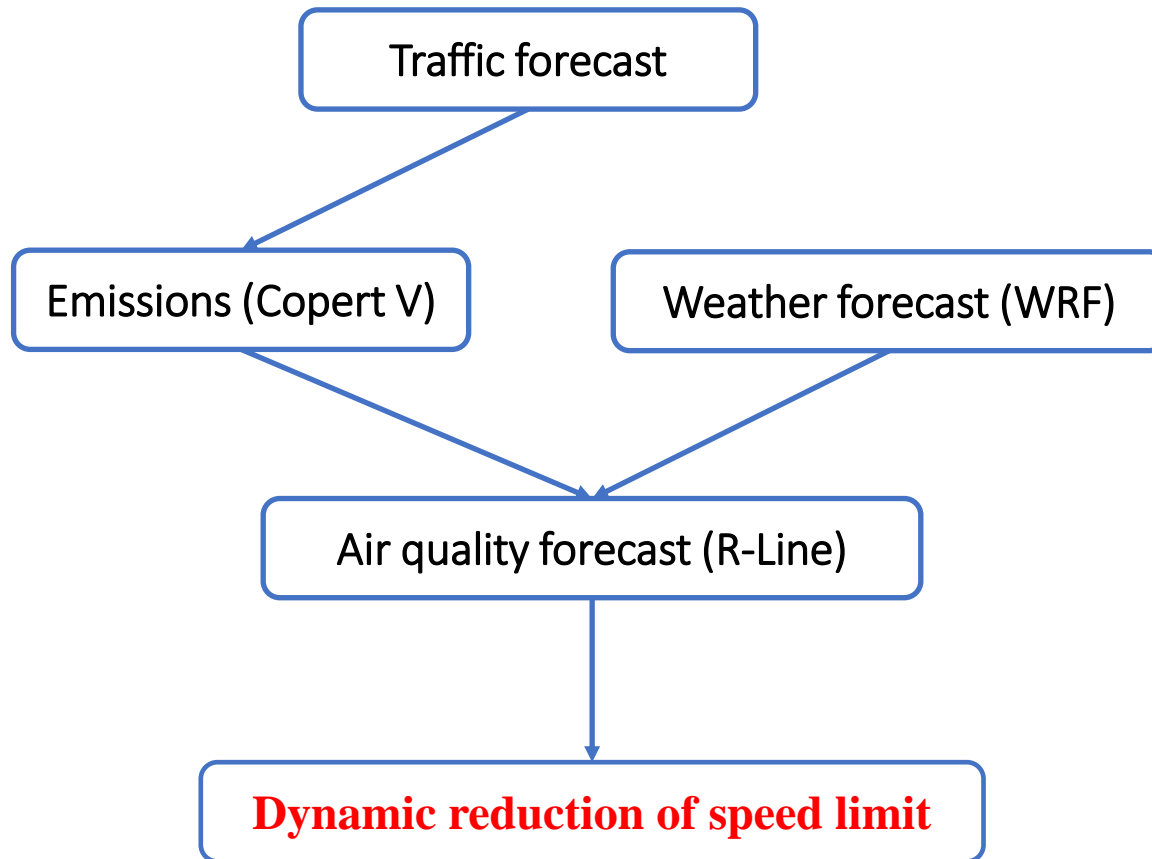
Compulsory



Recommended



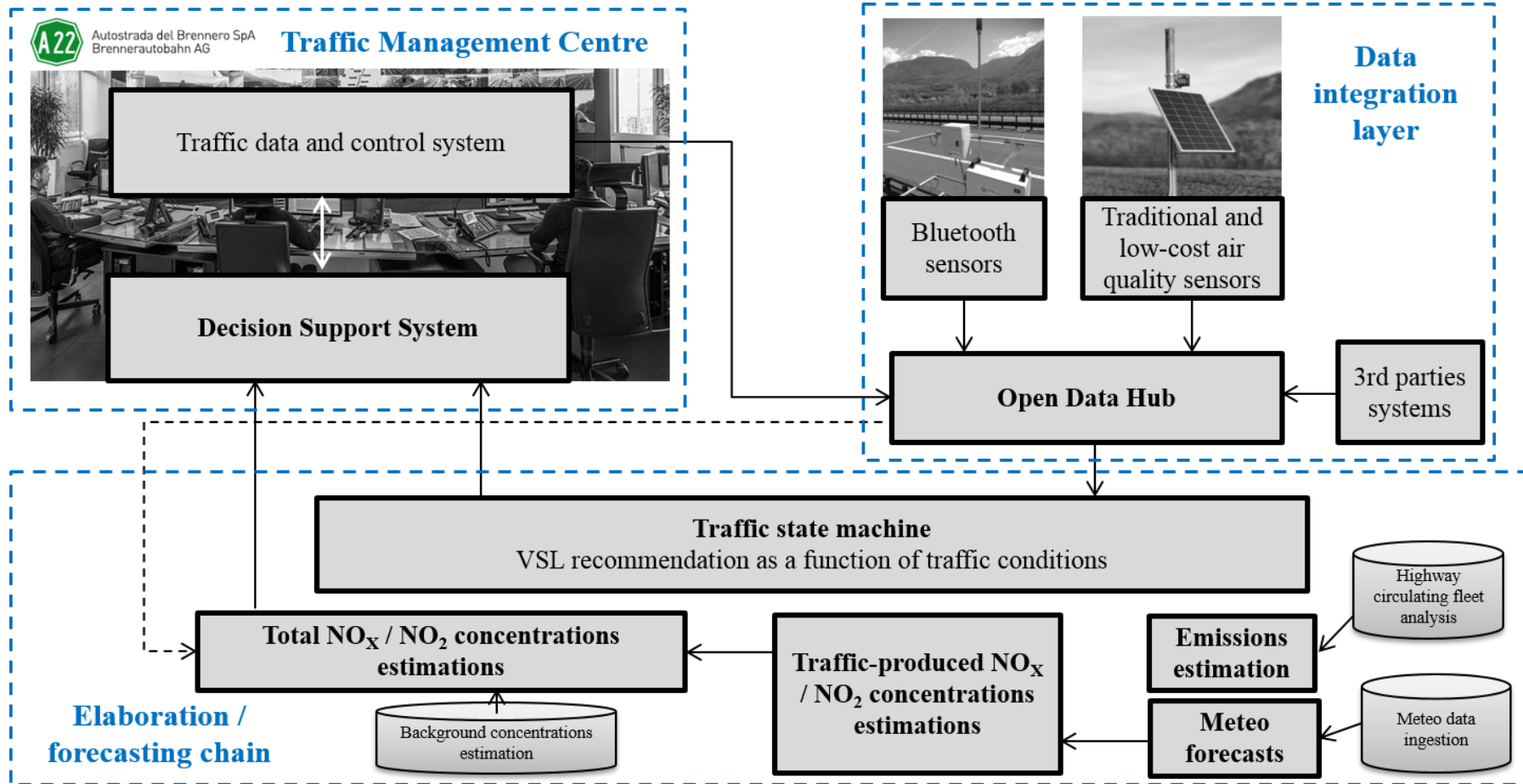
## FORECASTING CHAIN







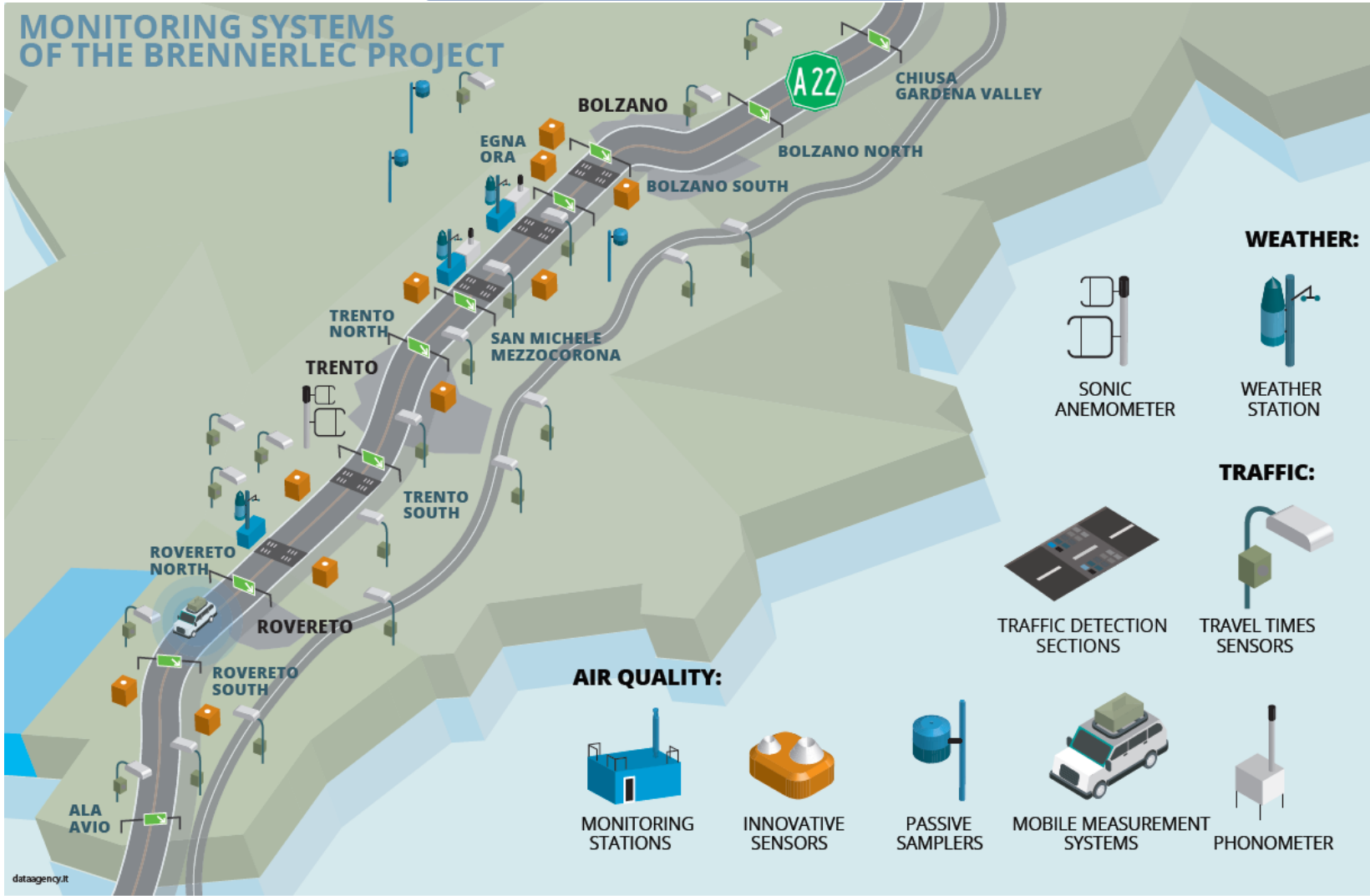
# CENTRAL DATA MANAGEMENT SYSTEM AND REAL-TIME APPLICATION



**The activation of the VSLs must be proportioned to the effective impact that they may generate!**

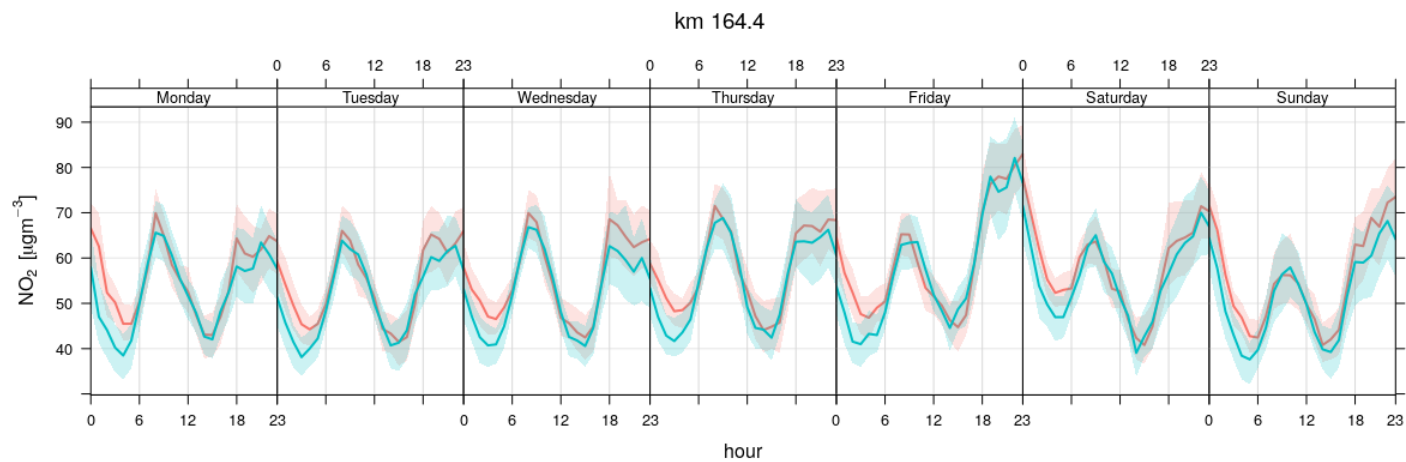


# MONITORING SYSTEM

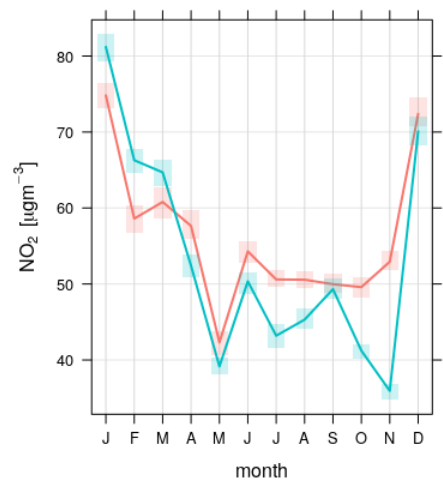
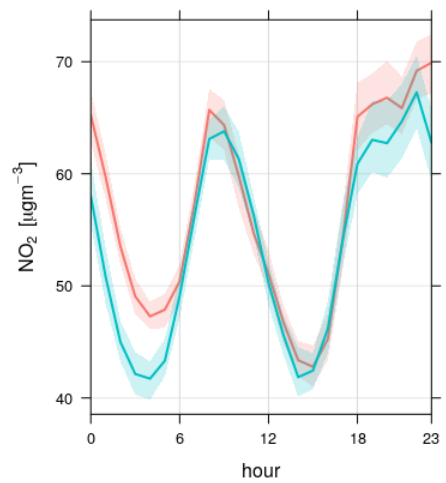




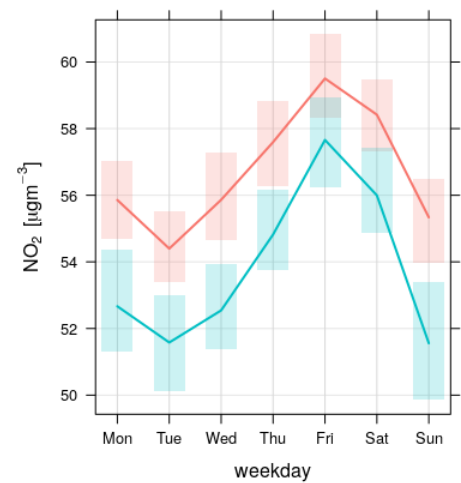
# LOW-COST SENSORS



■ AQ3 (S)    ■ BL164 (S)



mean and 95% confidence interval In mean

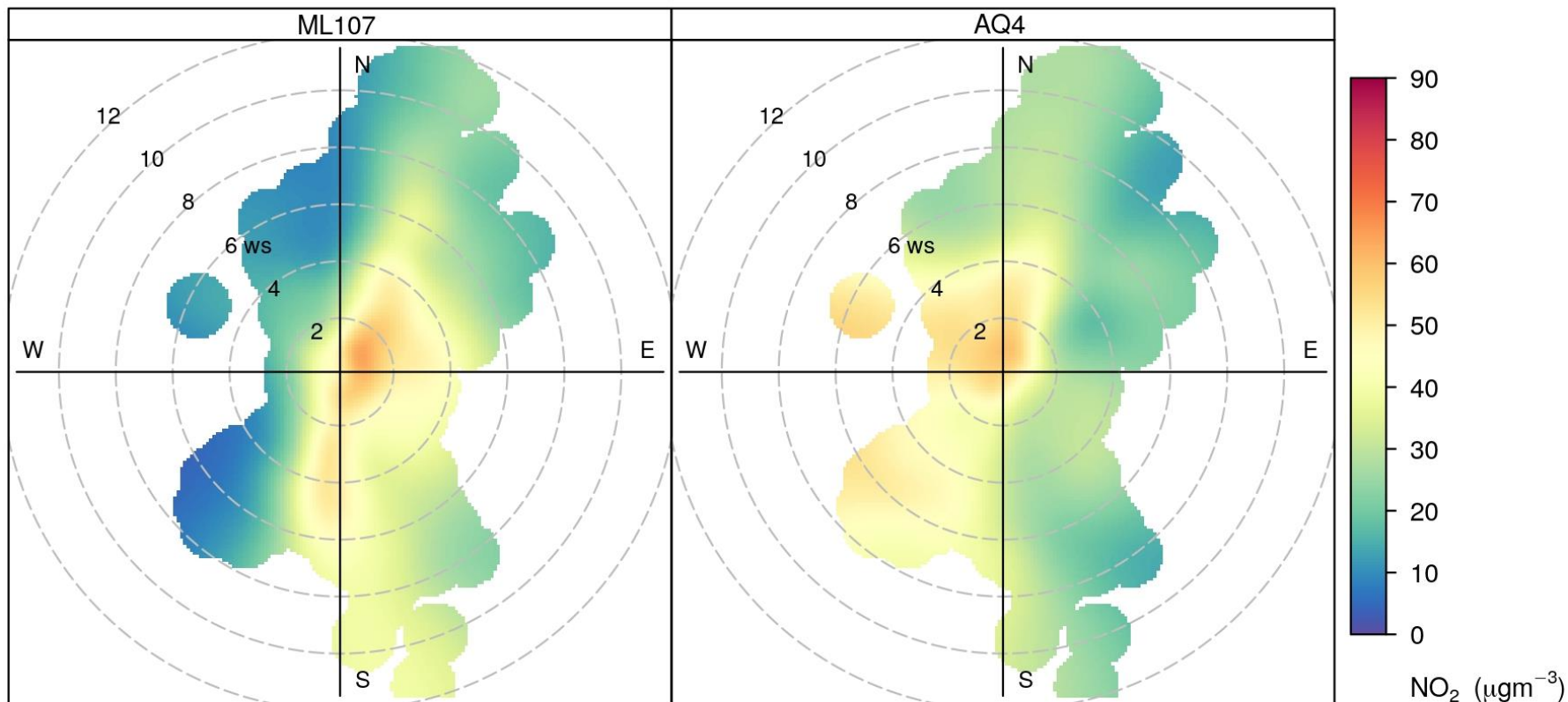




# LOW-COST SENSORS

## South carriageway

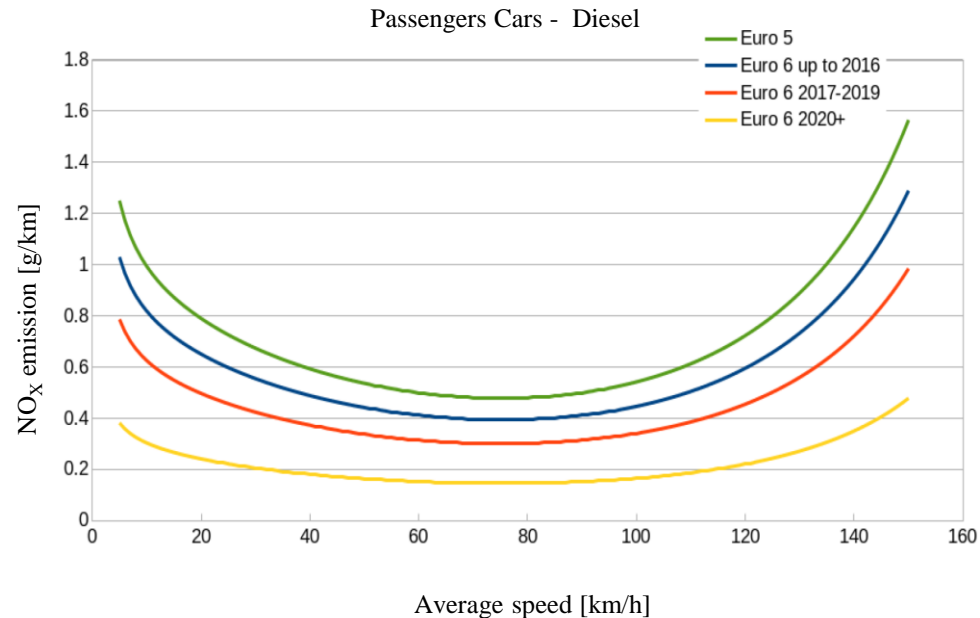
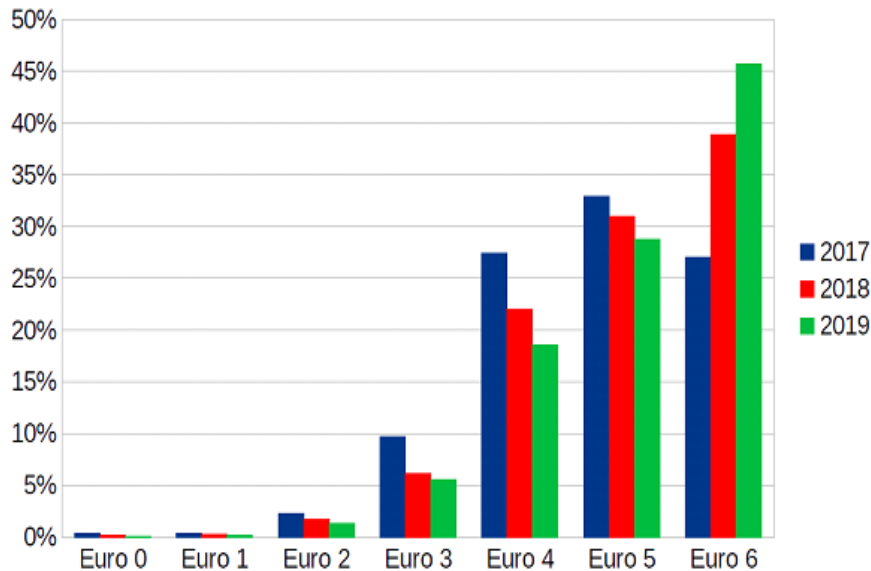
## North carriageway





# ESTIMATION OF POLLUTANTS EMISSIONS FROM TRAFFIC

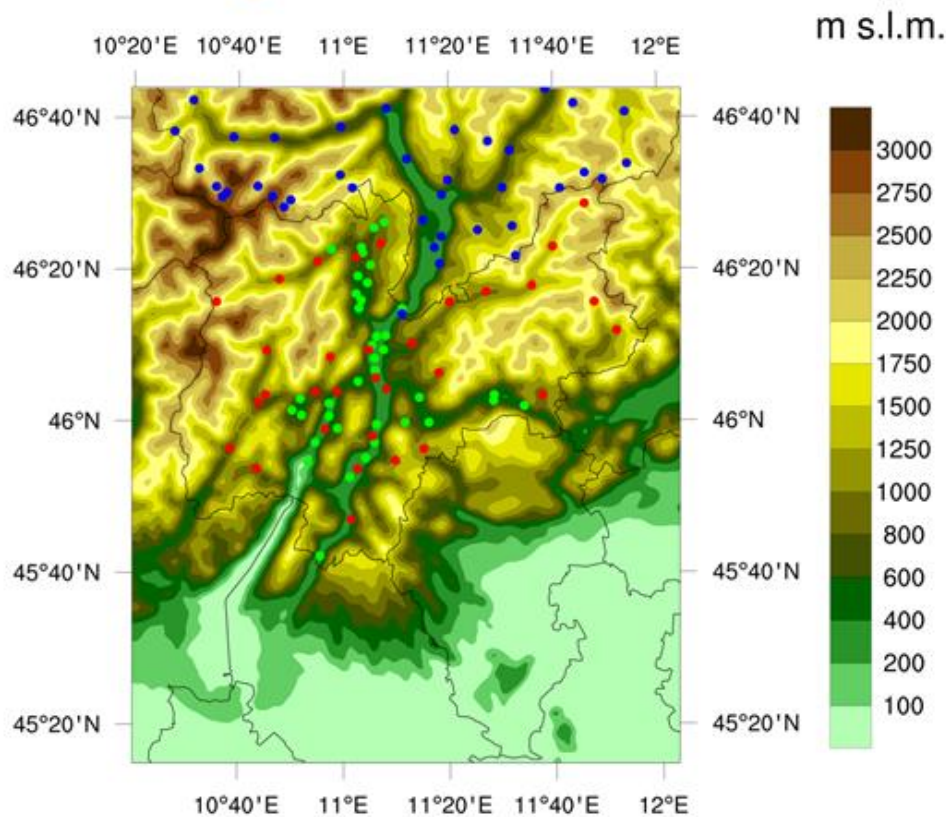
- The **estimation of effective circulating fleet** on the A22 highway is based on a comprehensive data-driven analysis.
- The **estimation of traffic volumes and traffic behaviour** is based on the analysis of historical data, collected from different inductive loops located inside the test stretch.



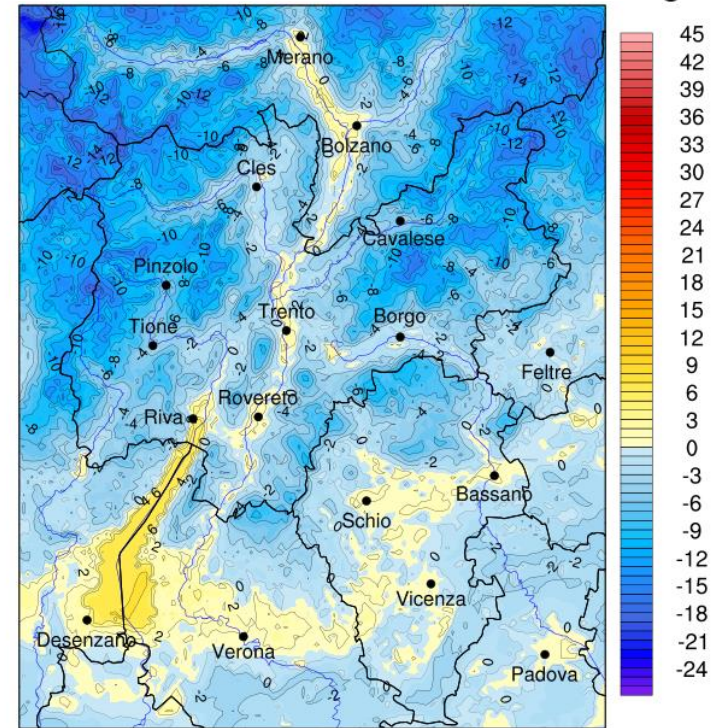


# METEOROLOGICAL FORECASTING

- Edmund Mach Foundation
- Meteotrentino
- Meteorological Office Province of Bolzano



Temperature at 2 m 06/02/2002 01:00 °C

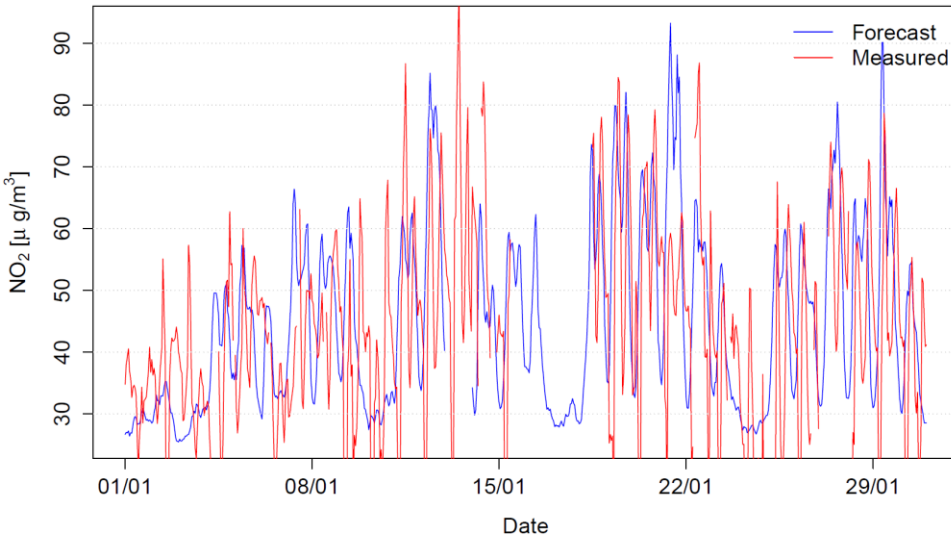


Init: GFS 00z

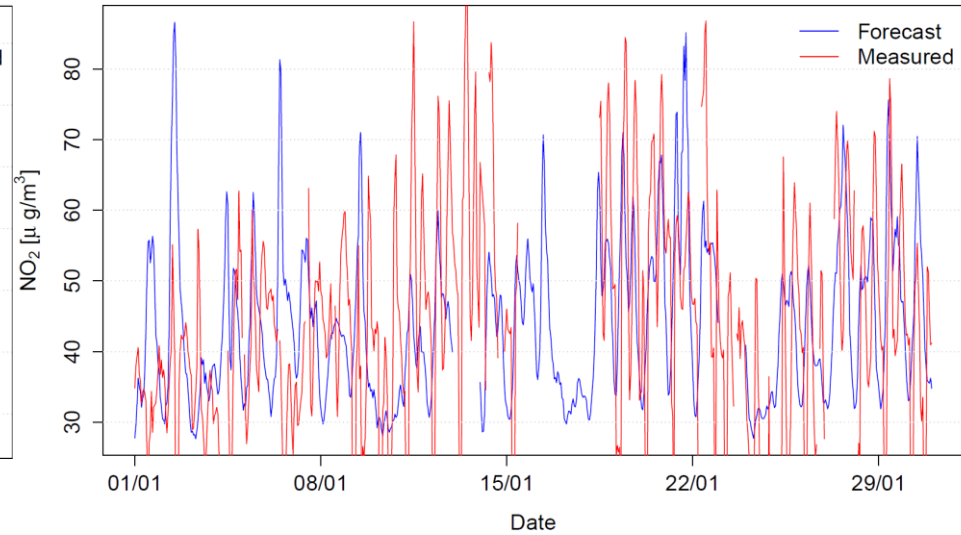


# AIR QUALITY FORECASTING

NO<sub>2</sub> forecast with measured traffic data



NO<sub>2</sub> forecast with predicted traffic data



The activation of VSLs is suggested to the TMC 24 hours in advance and is based on a comparison between concentrations' forecasts and a reference threshold.

VSLs are not activated if traffic volumes or NO<sub>2</sub> concentrations from sensors are significantly lower than the forecasts for a certain time (3 consecutive hours).



## RESULTS: ENVIRONMENT BENEFITS IN TERMS OF NO<sub>x</sub> CONCENTRATION

1470 hours of test: homogeneous distribution over seasons, days of the week, hours the of day.

Average reduction of speed: **14 km/h**

Speed reduction [km/h]	NO <sub>2</sub> concentration reduction [µg/m <sup>3</sup> ]	NO concentration reduction [µg/m <sup>3</sup> ]
0-5	-1.8	4.6
5-10	0.3	5.5
10-15	2.6	9.2
15-20	5.1	11.8
>20	4.7	7.1

Light vehicles per hour	NO <sub>2</sub> concentration reduction [µg/m <sup>3</sup> ]	NO concentration reduction [µg/m <sup>3</sup> ]
0-500	0.7	2.1
500-1000	2.3	8.5
1000-1500	4.0	8.3
1500-2000	6.9	15.8
2000-2500	5.8	18.2
2500-3000	6.1	18.0
> 3000	5.2	14.6

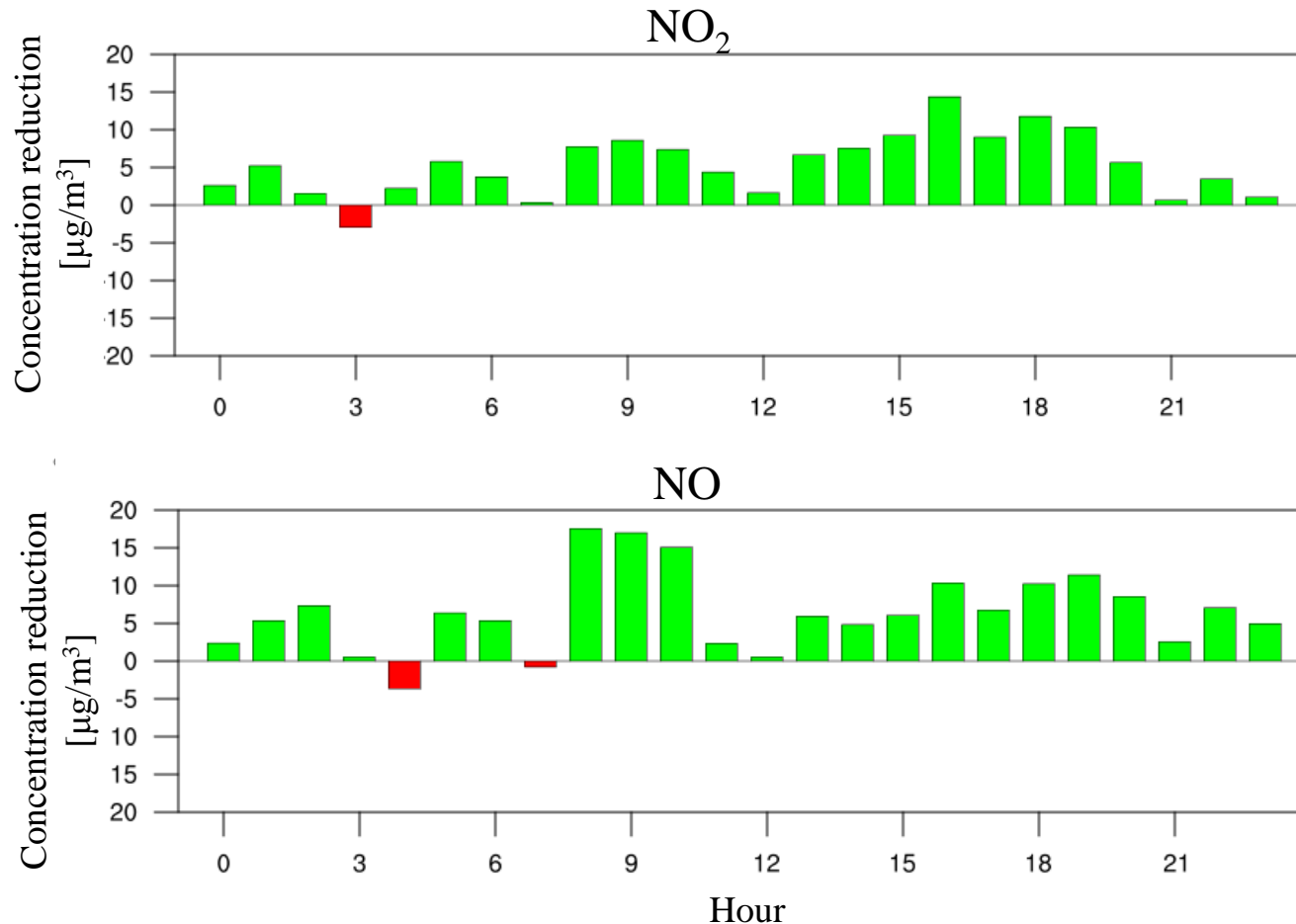




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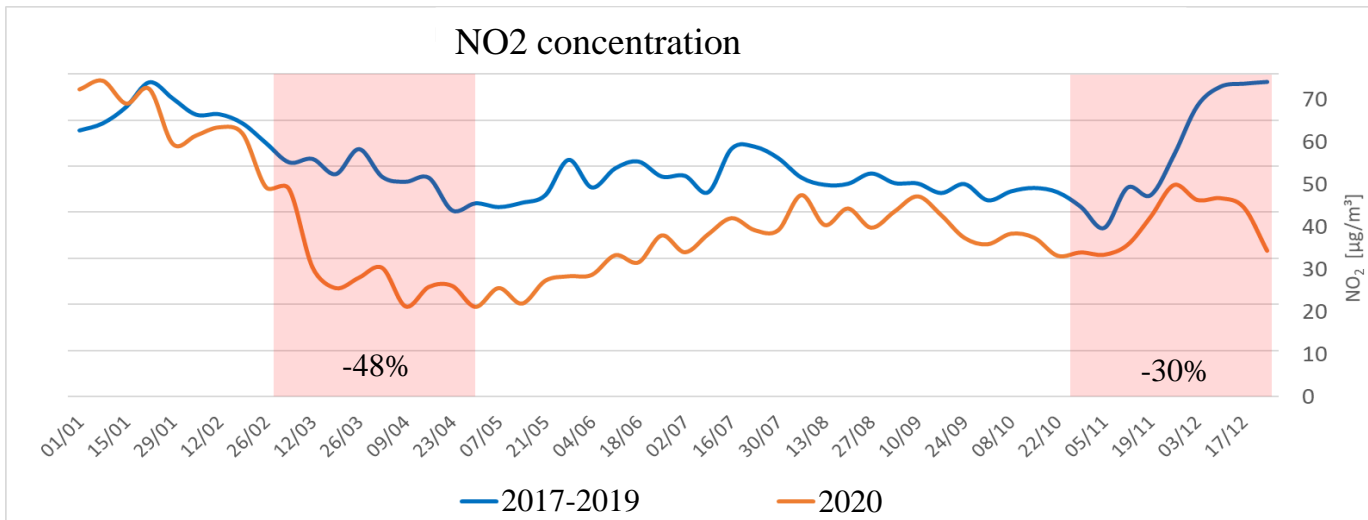
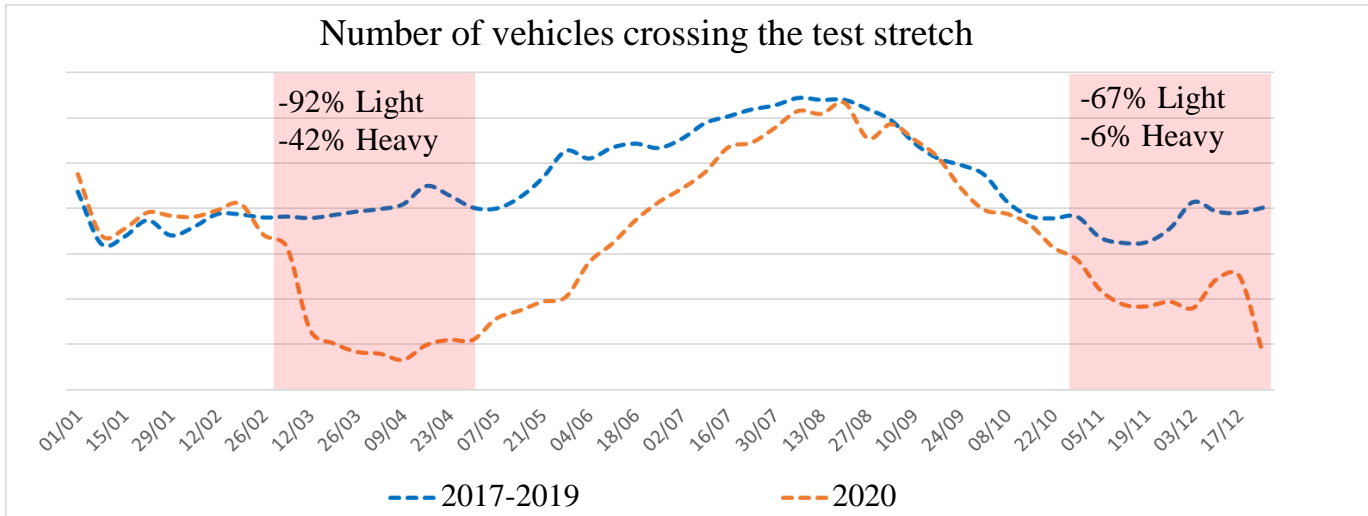
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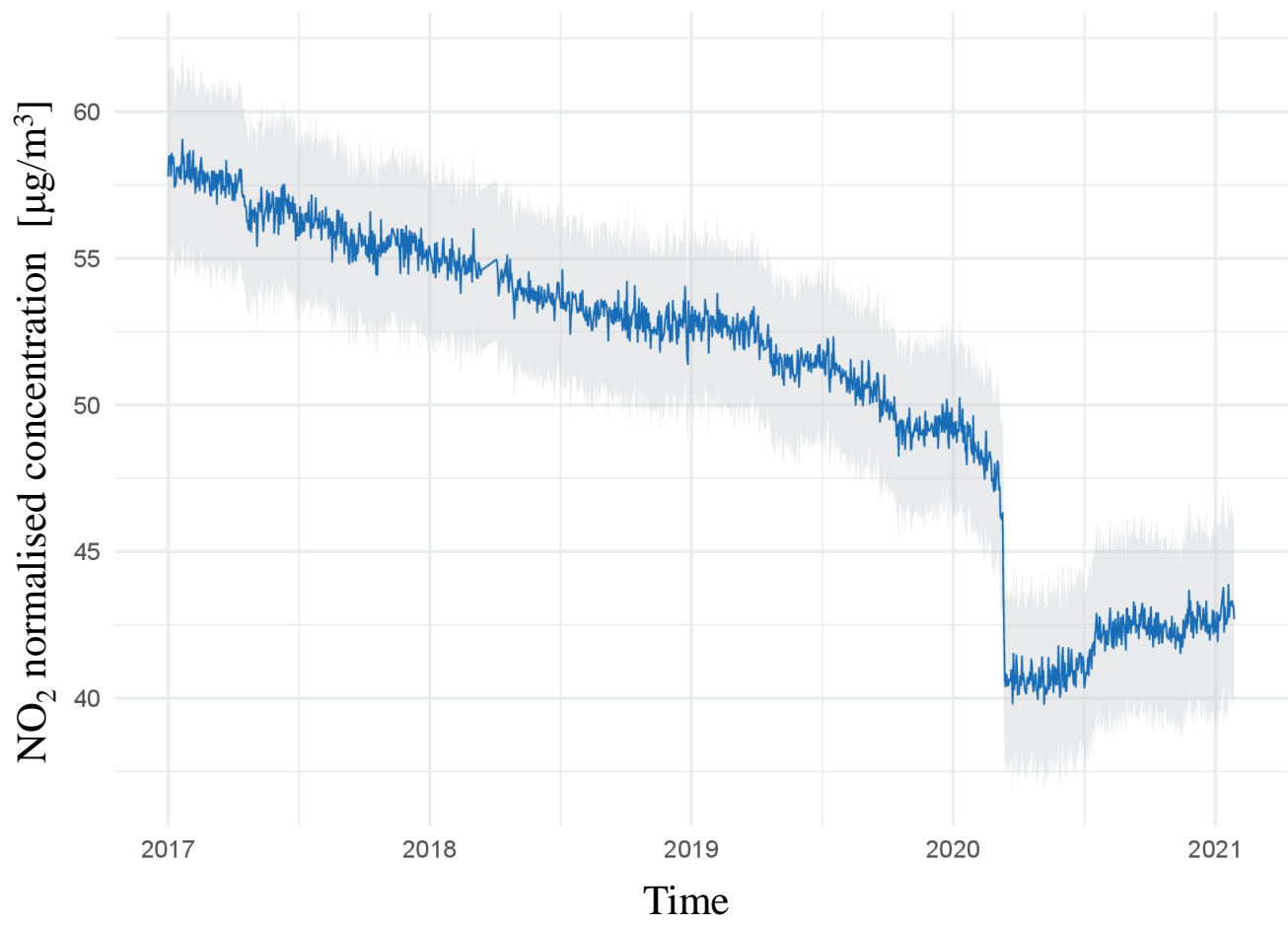


# EFFECTS OF COVID-19 LOCKDOWN MEASURES





# METEOROLOGICAL NORMALIZATION OF NO<sub>2</sub> CONCENTRATION





## CONCLUSIONS

After an intense testing of VSL applications on the A22, it has been possible to collect solid evidences regarding the benefits of this kind of measure on traffic-related air pollution.

THANKS FOR THE ATTENTION!

