

# MULTI-SCALE MODELING OF A SHORT TERM NO<sub>2</sub> ACTION PLAN IN MADRID (SPAIN)

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## Background

European NO<sub>2</sub> standards (=WHO) are currently exceeded in Madrid due to road traffic

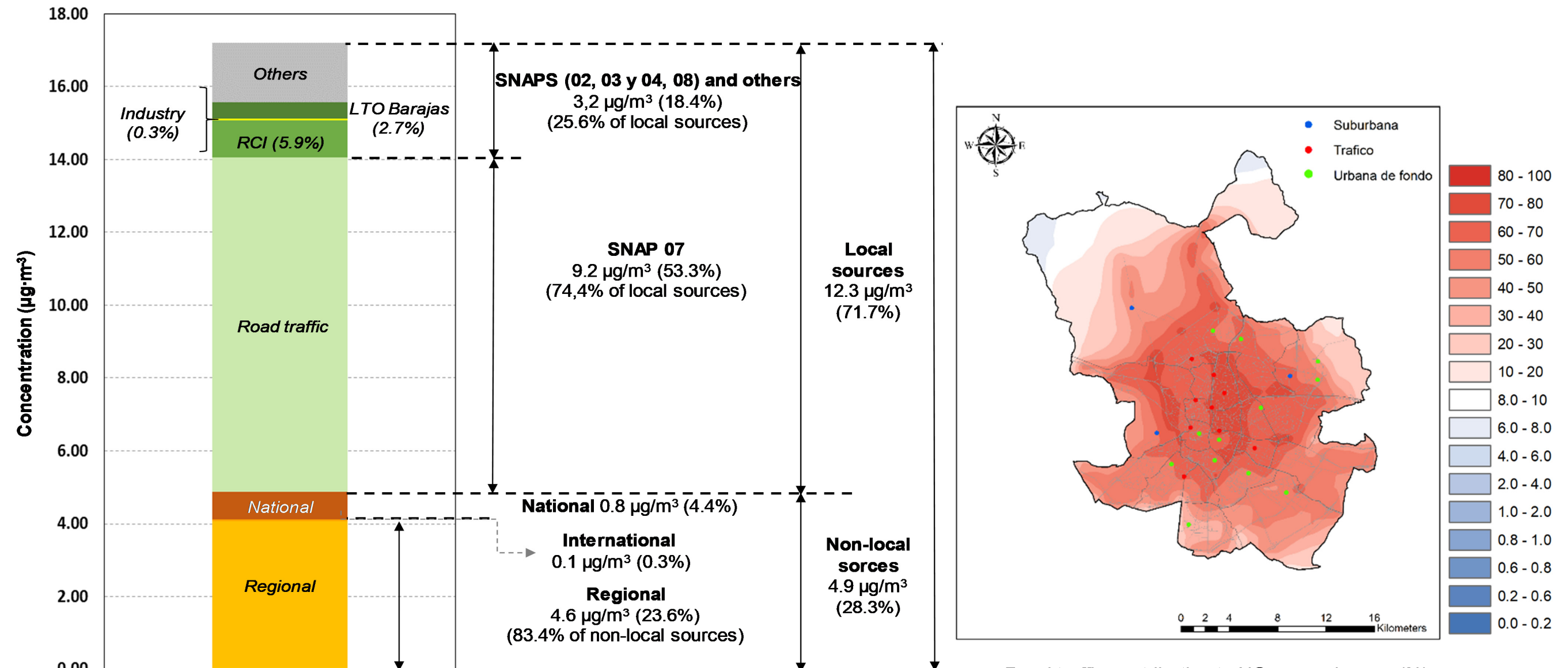
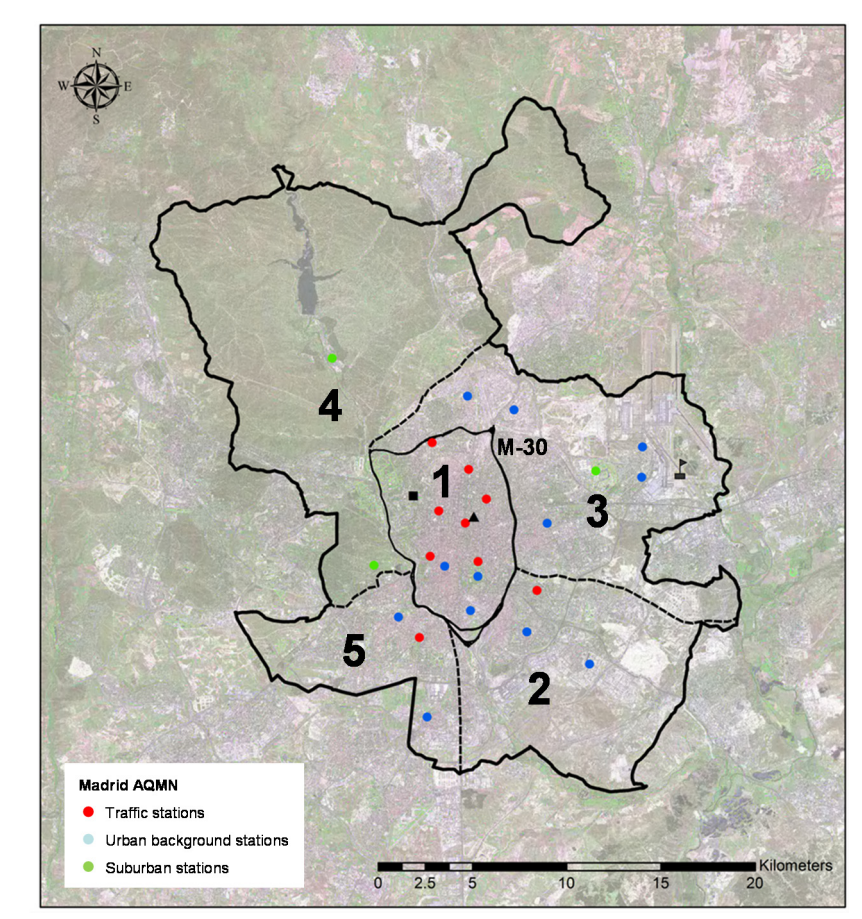


Figure 1. NO<sub>2</sub> ambient concentration source apportionment



- 70 Stage 1: 70 km/h speed limitation in M30 ringroad
- 70 Stage 2: stage 1 + no parking inside (9 AM - 9 PM)
- 70 Stage 3: stage 2 + access restrictions to the city centre for private cars (even/odd plate numbers – except low emission technologies according DGT scheme-) (6:30 AM - 9 PM)



Figure 2. The Madrid City Council reviewed its protocol to disseminate information to the public and to implement short term measures to reduce road transport emissions and population exposure over certain NO<sub>2</sub> concentration (NO<sub>2</sub> protocol) in 2016

## Motivation

Stage 3 of the protocol was trigger for the first time. It was controversial but the effect was not evident.

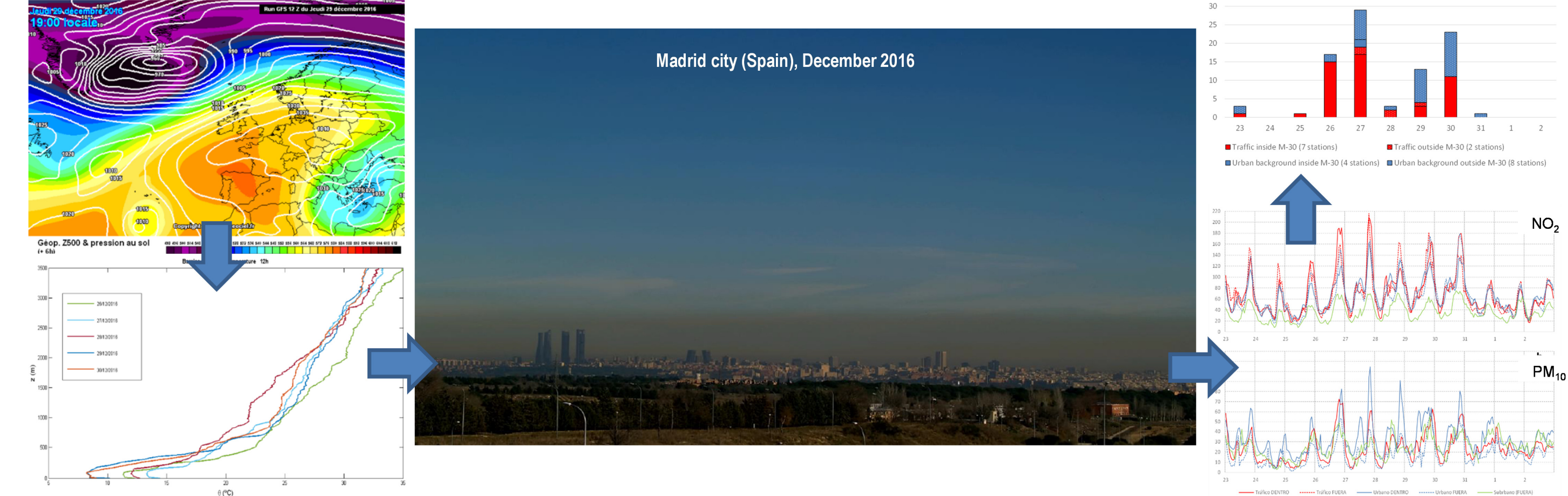


Figure 3. 86 hourly exceedances of 200 µg/m<sup>3</sup> were recorded in 13 air quality monitoring stations of the municipal network during 2016 Christmas period

## Methodology

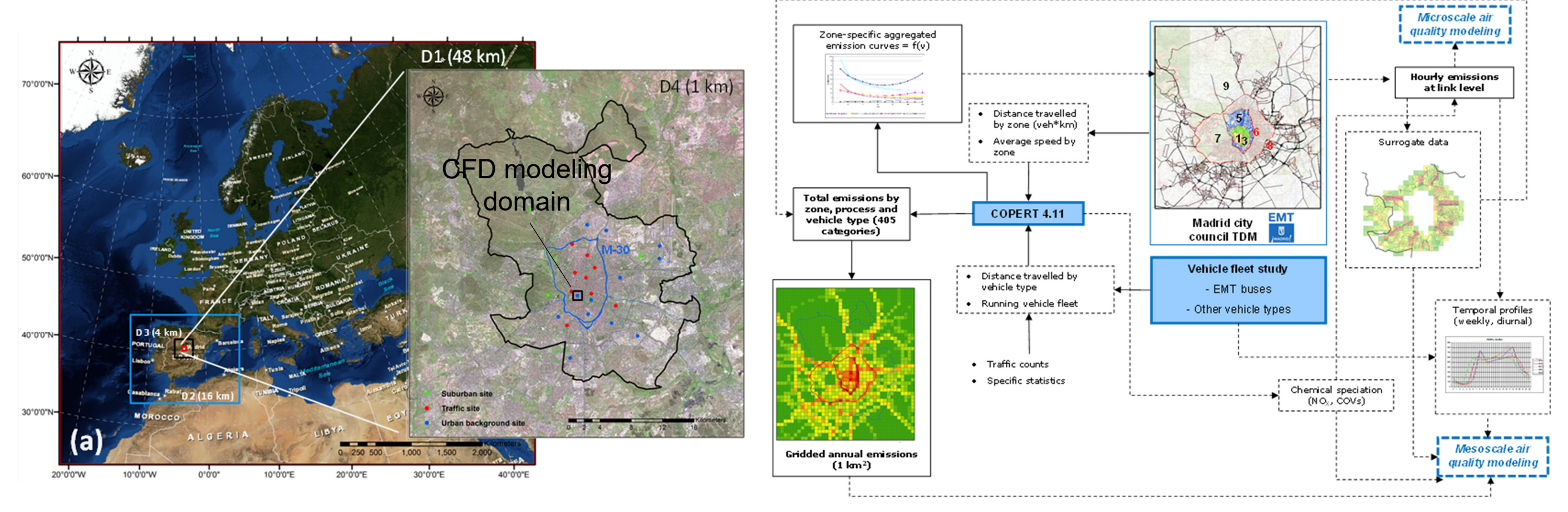


Figure 4. WRF-SMOKE-CMAQ was used to assess the impact of the protocol at city scale (1 km<sup>2</sup> resolution) and the Star-CCM+ (RANS CFD model) for fine-scale assessment in a 1 km<sup>2</sup> area downtown. Emissions were consistently supplied using a street-level traffic emission computation model that incorporated real traffic data in the period of study

The impact of the application of the protocol was estimated from the difference of 2 model runs:

- Emissions from measures taken
- Hypothetical baseline –no action- scenario

## Results

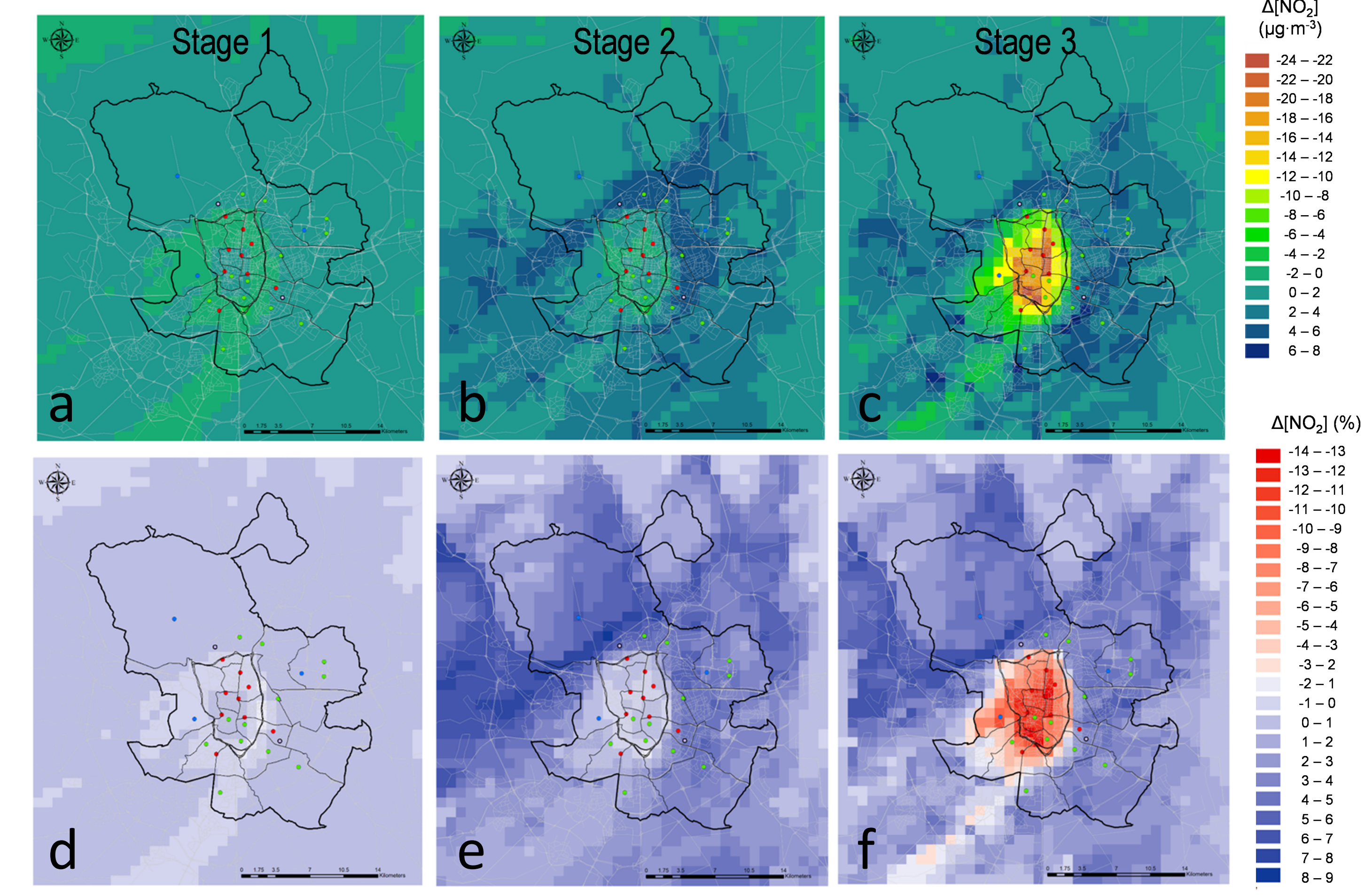


Figure 5. Variation on 1-h maximum NO<sub>2</sub> ambient concentration: absolute and relative values for stage 1, a), d), stage 2, b), e) and stage 3, c), f)

Relevant effects only inside M-30 for stage 3: NO<sub>2</sub> daily peak reduced up to 24 µg·m<sup>-3</sup> (up to 14%)

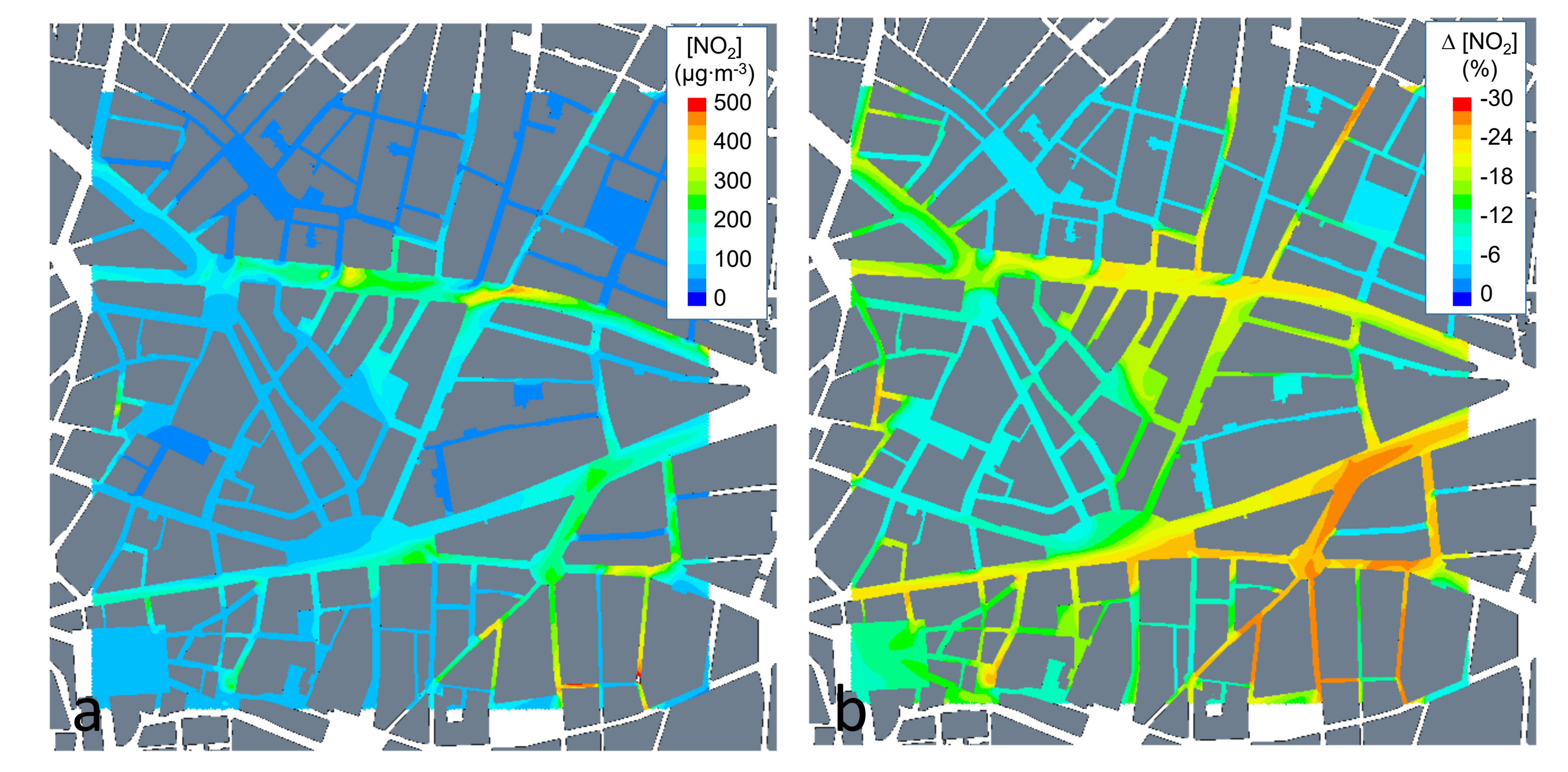


Figure 6. NO<sub>2</sub> predicted on December 29<sup>th</sup> 2016 (stage 3) (20-21 hours) in the Gran Vía area a) and modeled reductions relative to baseline scenario b) Average reduction of 18% (up to 25%; around 100 µg·m<sup>-3</sup> in specific areas, such as Gran Vía Avenue)

## Conclusions and implications

- Limited effect under strong stability conditions: only drastic reductions (stage 3) have a relevant effect → need to implement permanent measures to cut down traffic emissions throughout the year
- Consistent buy complementary view from the mesoscale and microscale models → need for multi-scale analysis and potential of complementary local measures
- Options to improve Madrid's NO<sub>2</sub> protocol identified → it was recently reviewed

## References

- Borge, R., Artñano, B., Yagüe, C., Gomez-Moreno, F.J., Saiz-Lopez, A., Sastre, M., García-Nieto, D., Narros, A., Cristóbal, A., 2018. Application of a short term air quality action plan in Madrid (Spain) under a high-pollution episode - Part I: Diagnostic and analysis from observations. Science of the Total Environment 635, 1561-1573.
- Borge, R., Santiago, J.L., de la Paz, D., Martín, F., Domingo, J., Valdés, C., Sánchez, B., Rivas, E., Rozas, M.T., Lázaro, S., Pérez, J., Fernández, A., 2018. Application of a short term air quality action plan in Madrid (Spain) under a high-pollution episode - Part II: Assessment from multi-scale modelling. Science of the Total Environment 635, 1574-1584