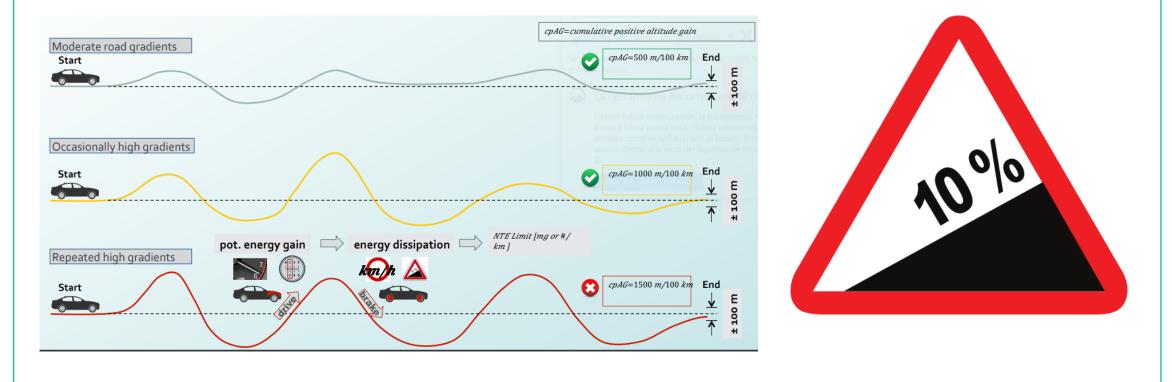
Center for Energy, Environmental and Technological Research



Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Influence of altitude beyond the boundary conditions of the RDE cycle, on the emissions of nanoparticles from a TSI E6 vehicle



OICA (International Organization of Motor Vehicle Manufacturers) DGT (Dirección General de Tráfico) Tawfiq Al-Wasif Ruiz Tawfiq.AlWasif@ciemat.es

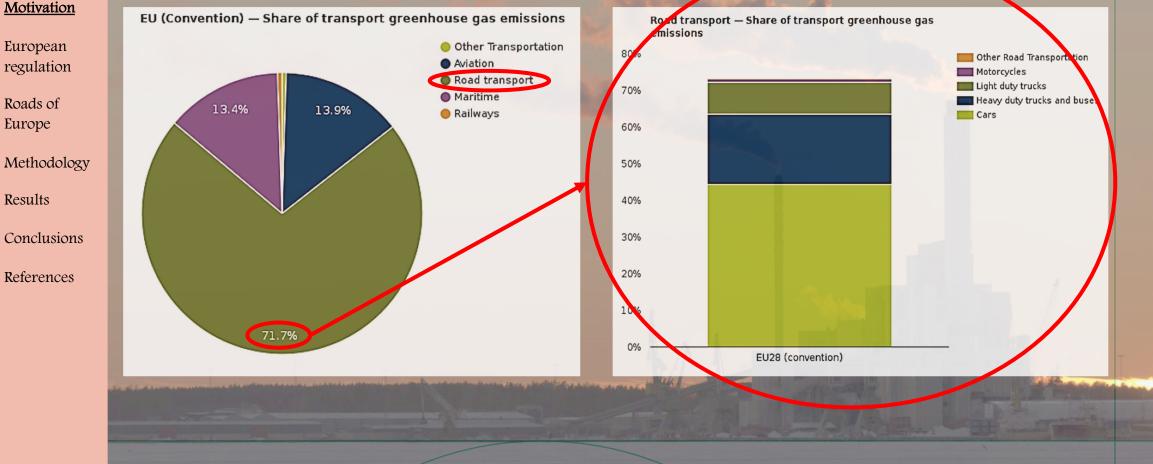
21/06/2022 Environmental Department



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## The emission of greenhouse gases



# Real Driving Emissions (RDE)

#### Motivation

European regulation

Roads of

Methodology

Conclusions

References

Europe

Results

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Approved in 2015 as part of the Euro 6 regulation legislation.

RDE arises from the need to evaluate nitrogen oxides and particulate matter.

The trip requirements for the cumulative positive altitude gain are limited to 1,200m/100km.

#### RDE boundary conditions PER 2016/427/EC.

Parameter	Requirements per 2016/427/EC		
Altitude	Moderate: 0 to 700 m	(Extended: 700 to	
		1300 m)	
	< 100 m altitude difference between start and finish The cumulative elevation gain is limited to 1200 m/100 km <sup>a</sup>		
Ambient	Moderate: 0 °C to 30 °C	(Extended: -7°C 0°C	
temperature		and 30 °C-35 °C)	
Dynamics <sup>a</sup>	Max: 95th percentile of $v^*a$	Min: RPA (relative	
	(speed*positive acceleration)	positive acceleration)	
Maximum speed	145 km/h (160 km/h for 3% of the motorway driving time)		
Payload	Maximum 90% of the maximum vehicle weight (driver + equipment)		
Stop percentage	Between 6% and 30% of the urban driving time		
Use of auxiliary systems	Operated as in real life (air conditioning etc.), not to be recorded		

<sup>a</sup> Added by means of the 2nd RDE package.

# Roads of Europe

#### Karakaya Hill

• Elevation of 3,148 meters above the sea level.

#### Col de la Bonette

• Elevation of 2,715 meters above the sea level.

#### **Stelvio Pass**

• Elevation of 2,757 meters above the sea level.

### Observatorio del Pico Veleta

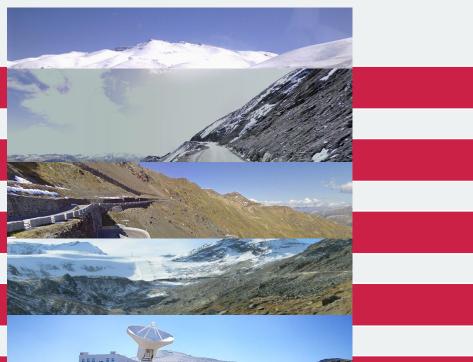
• Elevation of 2,856 meters above the sea level.

#### Testa Grigia

• Elevation of 3,471 meters above the sea level.

### Ötztal Glacier

• Elevation of 2,830 meters above the sea level.





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regulation

Roads of Europe

Results

Methodology

Conclusions

MINISTERIO DE CIENCIA E INNOVACIÓN

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References





### Mobile laboratory



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European regulation

Roads of Europe

Motivation

Methodology

Results

Conclusions

References

**-**« D Turbocharged engine

Skoda Yeti 1.2 TSI 110 CV

Direct stratified injection

4-Cylinder



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Equipment



MethodologyImage: Conclusions

References

Motivation

European

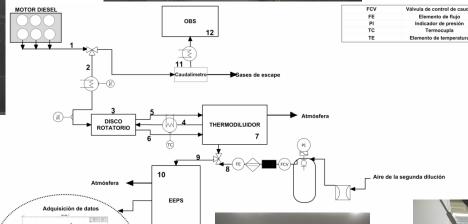
regulation

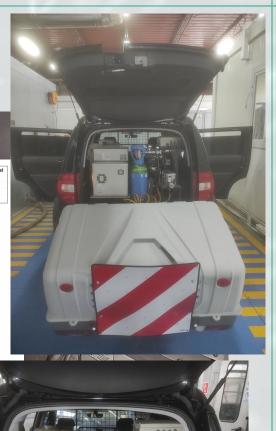
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Contribución al estudio del número y distribución de tamaños de partículas emitidas por motores en tráfico urbano, Aida Domínguez Sáez



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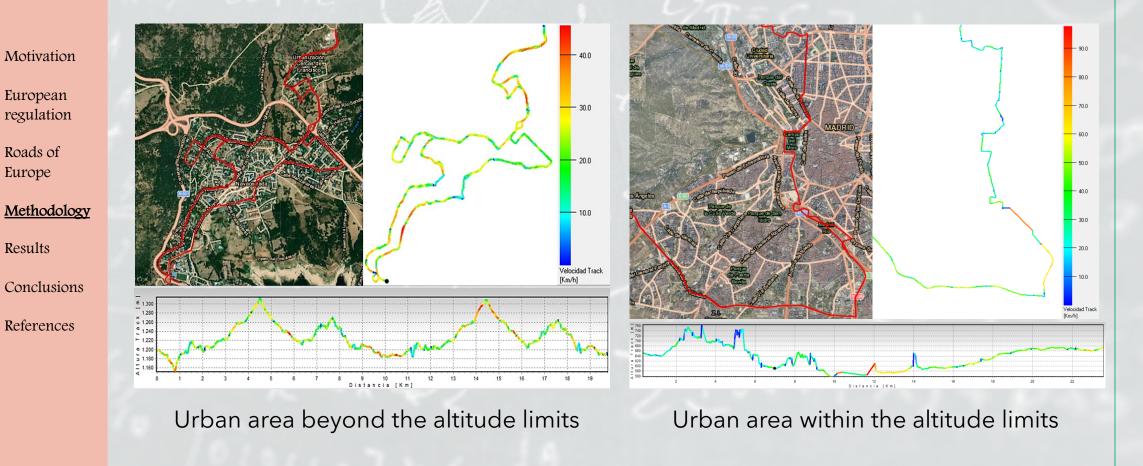
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### Urban area



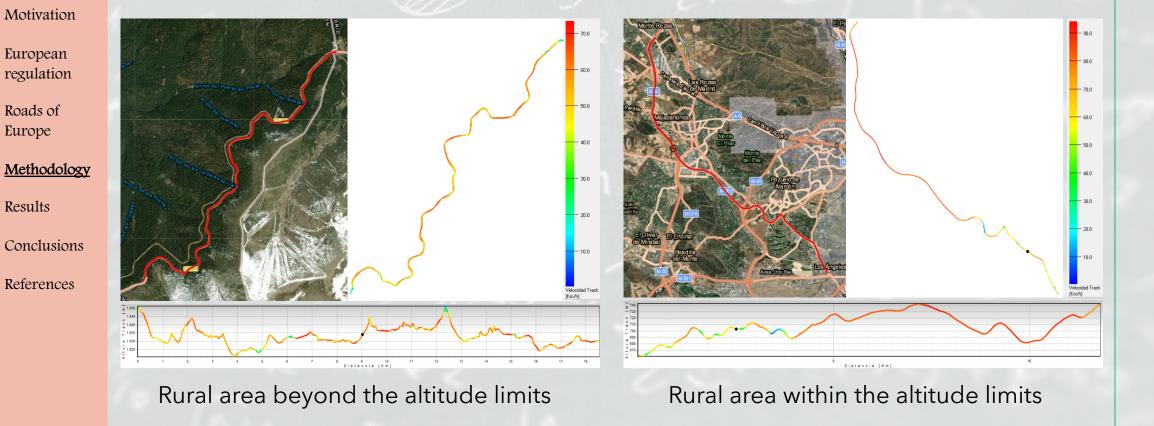


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Rural area





Results

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### Motorway area

- 120.0 Motivation - 110.0 European - 100.0 El Velló LEÓN regulation UNIDAD DE MADRID 90.0 80.0 Roads of 70.0 Europe 60.0 50.0 Methodology 40.0 30.0 20.0 Conclusions 10.0 Velocidad Track References [Km/h] Distancia [Km]

Motorway area beyond the altitude limits

Motorway area within the altitude limits

- 120.0

- 110.0

- 100.0

- 90.0

70.0

60.0

- 30.0 Velocidad Track [Km/h]

### Torque and fuel consumption

iemat	Centro de Investigaciones inergéticas, Medioambientales y Tecnológicas
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Motivation

European regulation

Roads of

Methodology

Conclusions

References

Europe

Results

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Within the a	titude limits		
Area	Torque (Nm)		
Urban	52.03		
Rural	65.84		
Motorway	121.03		
Beyond the a	ltitude limits		
Area	Torque (Nm)		
Urban	48.41		
Rural	61.75		
Motorway	138.96		
		Within the altitude limits	
		Area	Fuel consumption (l/
		Urban	3.07
		Rural	5.06
		Motorway	10.42
		Beyond the altitude limits	
		Area	Fuel consumption (l/
		Aled	i dei consumption (i/
		Urban	2.64



<u>Results</u>

Conclusions

Methodology

Motivation

European

regulation

Roads of Europe

References



### Air-Fuel Ratio

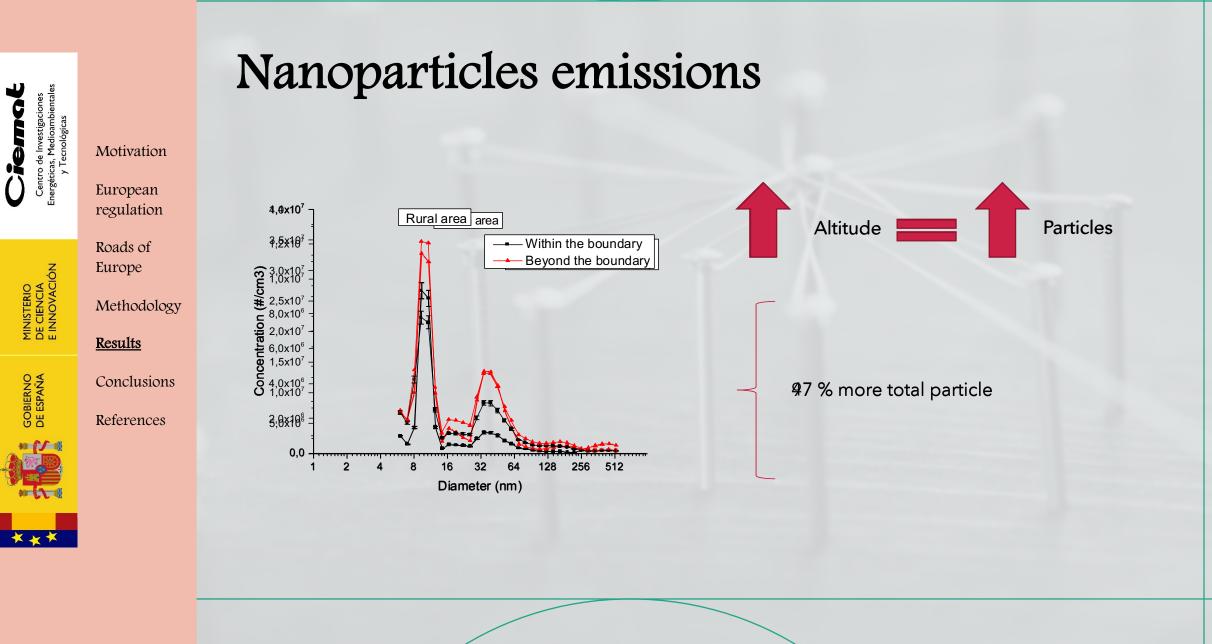
>14,7 Lean mixture

= 14,7 Stoichiometric mixture

< 14,7 Rich mixture

Within the altitude limits				
Area	A/F			
Urban	15.9			
Rural	14.8			
Motorway	15.5			
Beyond the altitude limits				
Area	A/F			
Urban	16.1			
Rural	16.4			
Motorway	13.8			

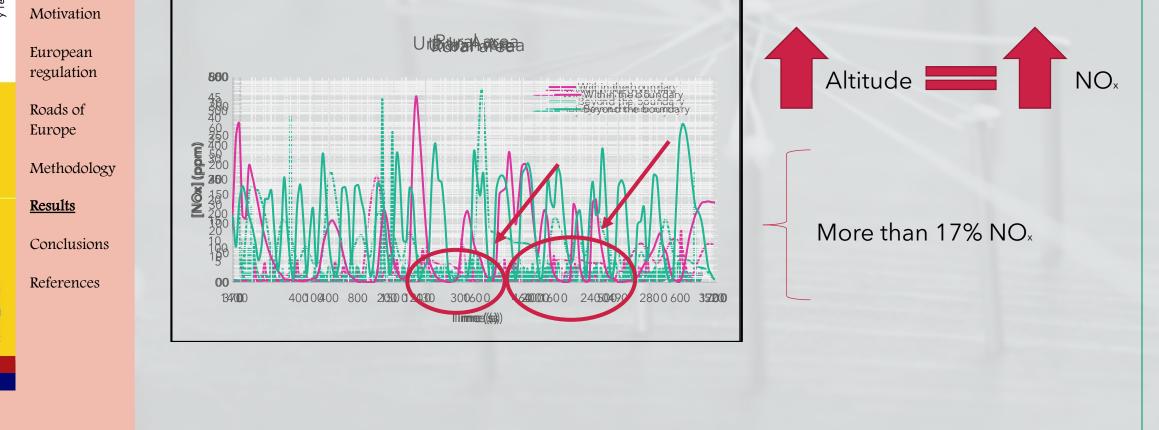
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### NO<sub>x</sub> emissions

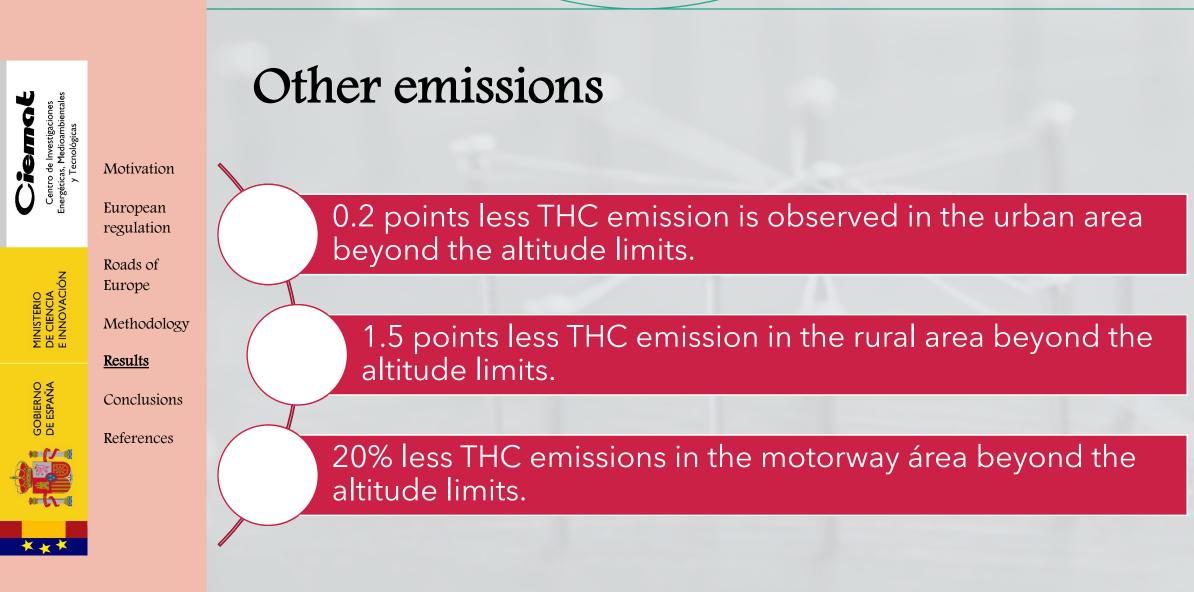




### Other emissions

12% less total particle emission is observed in the motorway area beyond the altitude limits.

More than 17% NOx emission in the motorway area beyond the altitude limits.



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Motivation

European

regulation

Roads of Europe

Results

Methodology

Conclusions

References

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General conclusions

An increase in altitude affects vehicle emissions.

The altitude limits of the RDE cycle are quite restricted, implying the need to be extended.

Nanoparticles are the most affected emissions.

EOBD leans the mixture as altitude increases.

The temperature of the catalyst in post-cold start conditions has a great influence on emissions.

1,000

OICA (International Organization of Motor Vehicle Manufacturers)

DGT (Dirección General de Tráfico)

Agencia Europea de Medioambiente (EEA).

www.dangerousroads.org

5

Contribución al estudio del número y distribución de tamaños de partículas emitidas por motores en tráfico urbano, Aida Domínguez Sáez

Hooftman, N., Messagie, M., Van Mierlo, J., & Coosemans, T. (2018). A review of the European passenger car regulations -Real driving emissions vs local air quality.

Motivation

European regulation

Roads of Europe

Methodology

Results

GOBIERNO DE ESPAÑA

Conclusions

**References** 

References



Thank you very much for your attention