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EXCELENCIA SEVERO OCHOA

Adaptación de inventarios para modelización de la calidad del aire

M. Guevara, Tena, C., Jorba, O., Pérez García-Pando, C.

13/06/2019

Foro tecnológico. Bases científico técnicas para la mejora de la calidad del aire en España. Valencia, 11-13 Junio 2019

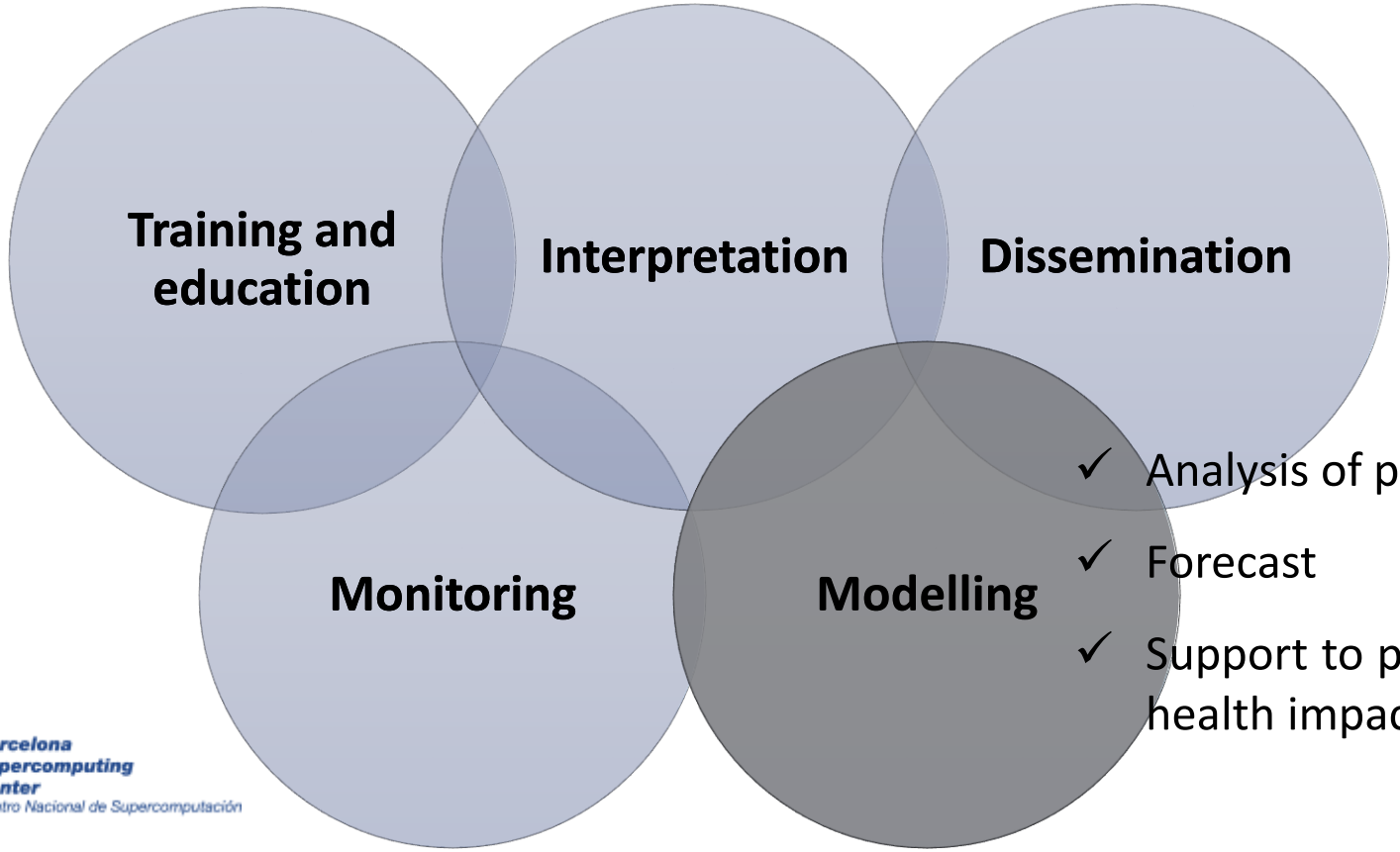
nature
International journal of science

Five steps to improve air-quality forecasts

A worldwide monitoring and modelling network would reduce the dramatic toll of air pollution on health and food production, urge Rajesh Kumar and colleagues.

https://www.nature.com/articles/d41586-018-06150-5

Rajesh Kumar ✉, Vincent-Henri Peuch, James H. Crawford & Guy Brasseur



- ✓ Analysis of past events
- ✓ Forecast
- ✓ Support to planning and health impact studies

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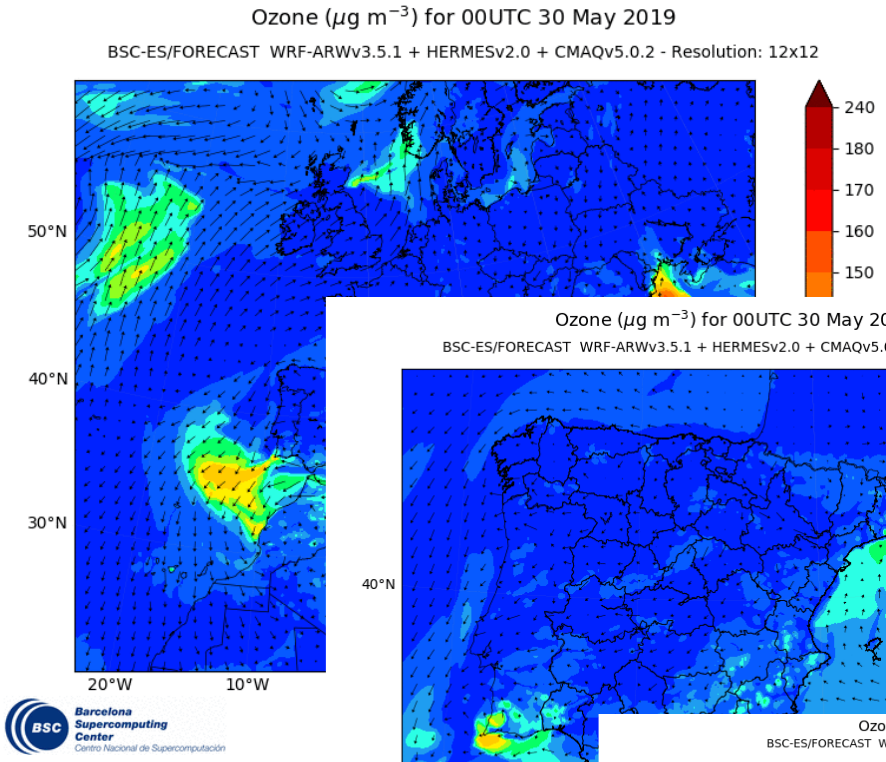
CALIOPE air quality system

Provides air quality information for the coming days and for the application of short term action plans for air quality managers.



Information is delivered using both online or custom applications:

www.bsc.es/caliope

Smart city platform

vodafone IBM

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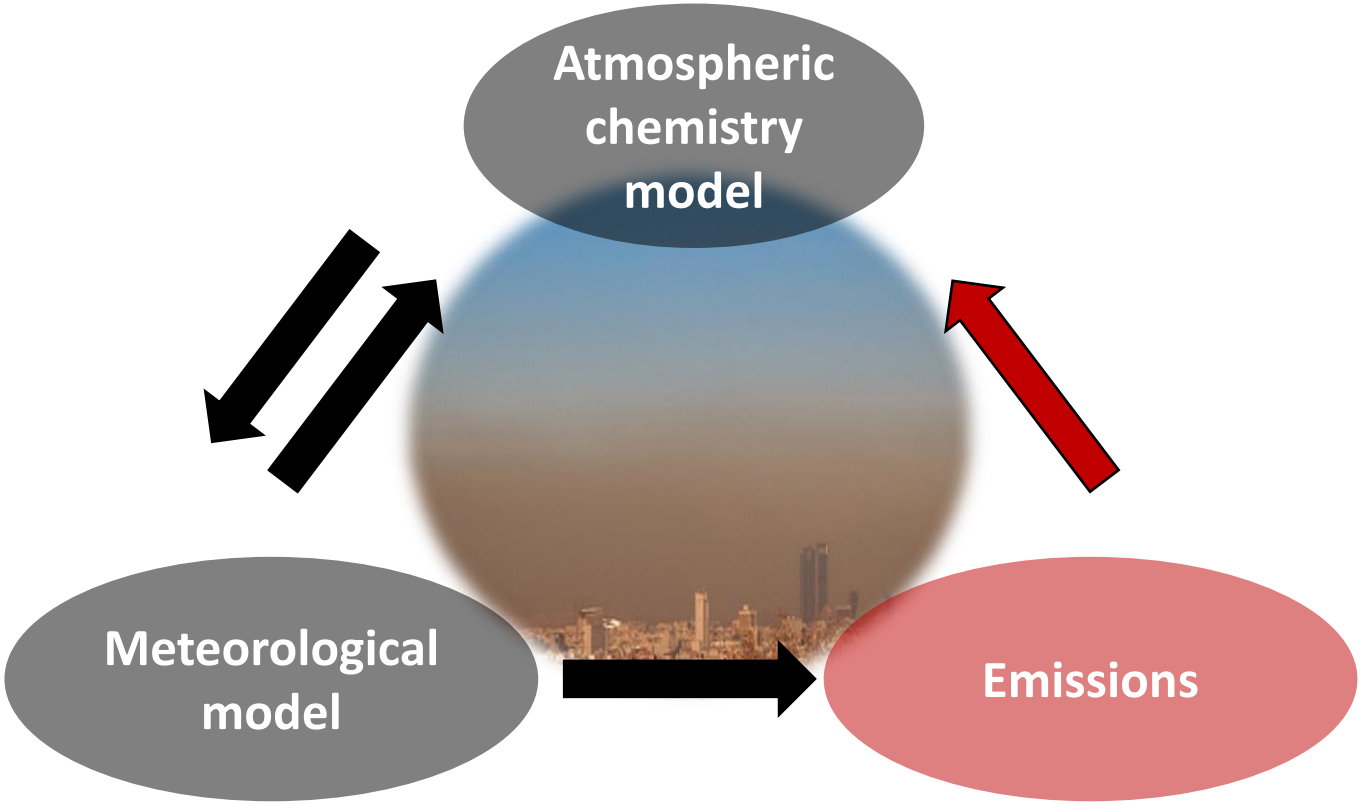
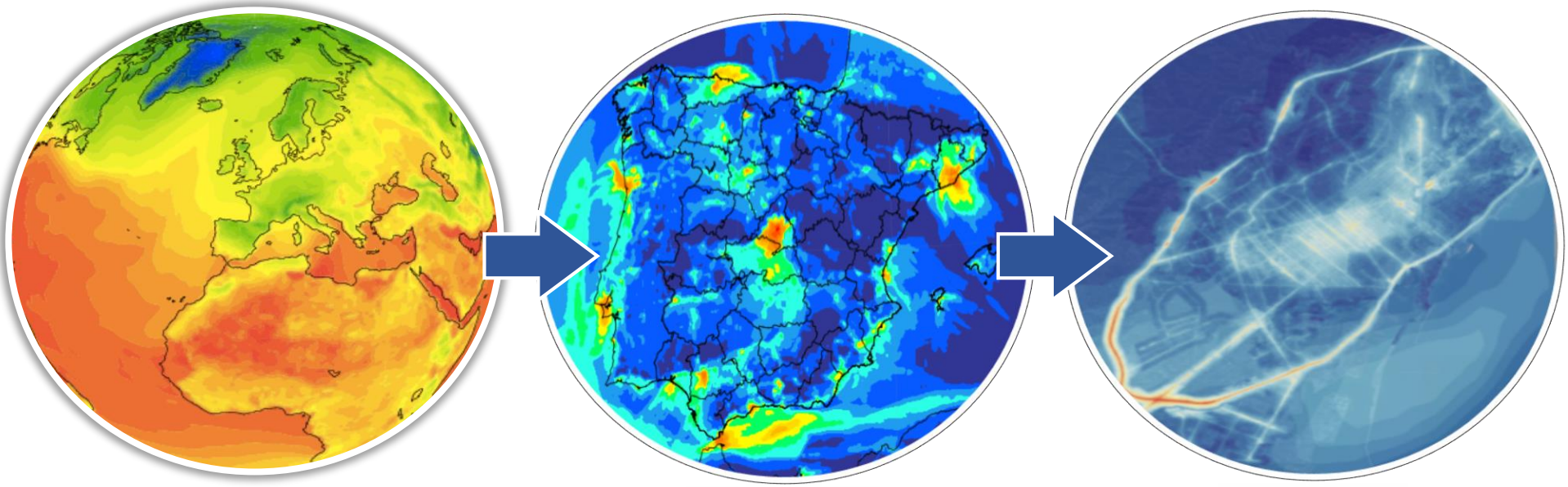
Air quality modelling chain



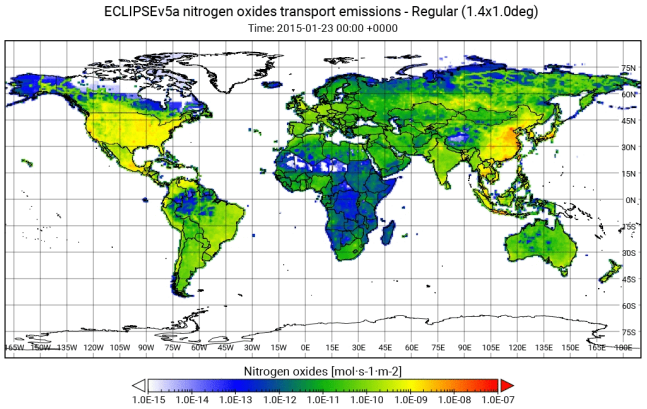
Emissions requirements:

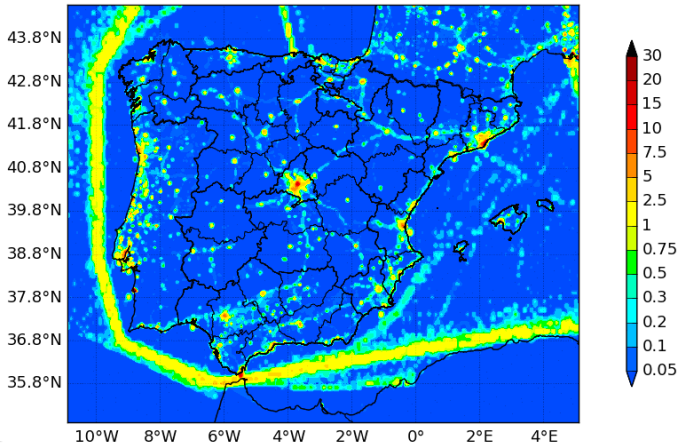
- Spatially distributed over a gridded domain
- Temporally resolved with (typically) an hourly resolution
- Mapped to the species defined in the atmospheric chemistry model (e.g. VOC, NOx)

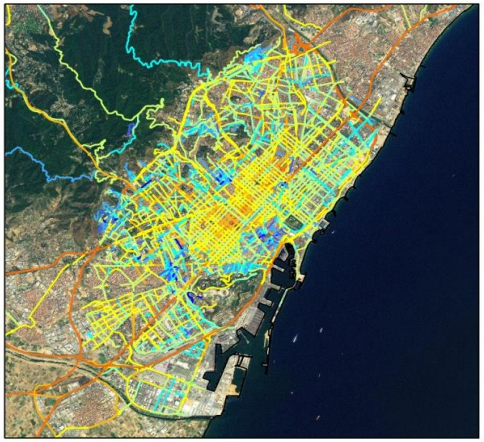
From global to local scales



EMISSIONS: DIFFERENT NEEDS FOR DIFFERENT SCALES

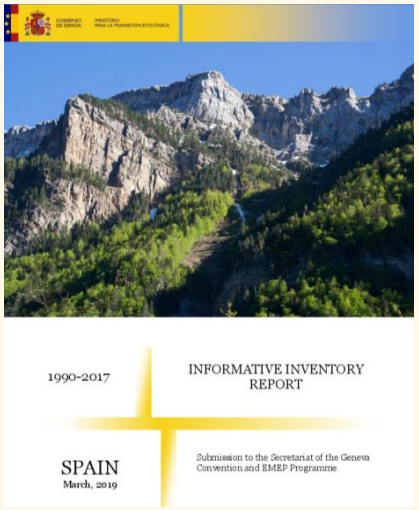






Emission inputs

National emission inventories

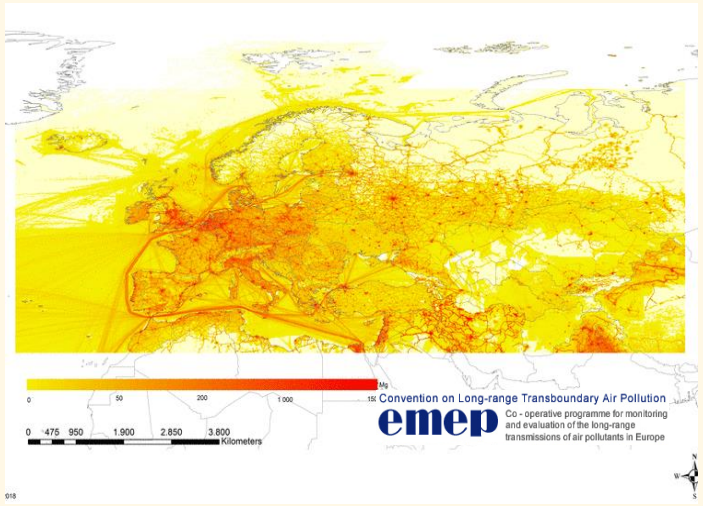


X Not gridded (total national)

X Not hourly (annual)

X Not speciated

Gridded emission inventories

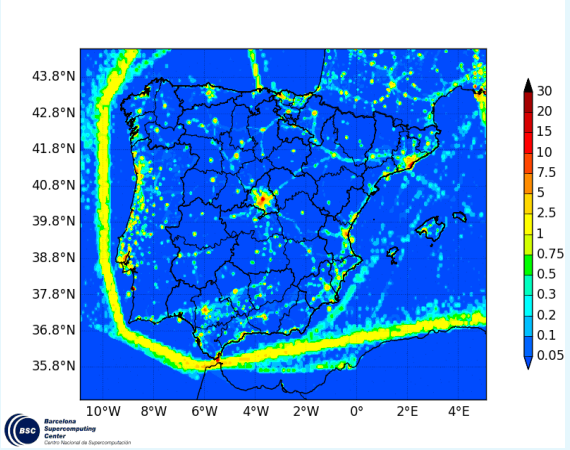


√ Gridded (fixed grid)

X Not hourly (annual, monthly)

X Not speciated

Modelled emissions



√ Gridded (any grid)

√ Hourly

√ Speciated

Emission processing systems: Adapt the emission data to the air quality model's requirement

Emission models: Combine activity and emission factors to estimate hourly, gridded emissions

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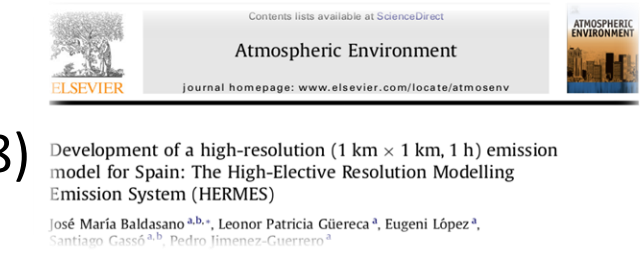
HERMES: The high-Elective Resolution Modelling Emissions System

HERMES

(Baldasano et al., 2008)


Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Development of a high-resolution (1 km × 1 km, 1 h) emission model for Spain: The High-Elective Resolution Modelling Emission System (HERMES)

José María Baldasano [a,b,*], Leonor Patricia Güereca [a], Eugeni López [a], Santiago Gassó [a,b], Pedro Jiménez-Guerrero [a]

HERMESv2

(Guevara et al., 2013)


Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

An improved system for modelling Spanish emissions: HERMESv2.0

Marc Guevara [a,*], Francesc Martínez [a], Gustavo Arévalo [a], Santiago Gassó [a,b], José M. Baldasano [a,b]

HERMES-Mex

(Guevara et al., 2017)


Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

An emission processing system for air quality modelling in the Mexico City metropolitan area: Evaluation and comparison of the MOBILE6.2-Mexico and MOVES-Mexico traffic emissions

M. Guevara [a,*], C. Tena [a], A. Soret [a], K. Serradell [a], D. Guzmán [b], A. Retama [b], P. Camacho [b], M. Jaimes-Palomera [b], A. Mediavilla [b]

HERMESv3

(Guevara et al., 2019)


Geosci. Model Dev., 12, 1885–1907, 2019

https://doi.org/10.5194/gmd-12-1885-2019

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Geoscientific Model Development

HERMESv3, a stand-alone multi-scale atmospheric emission modelling framework – Part 1: global and regional module

Marc Guevara, Carles Tena, Manuel Porquet, Oriol Jorba, and Carlos Pérez García-Pando

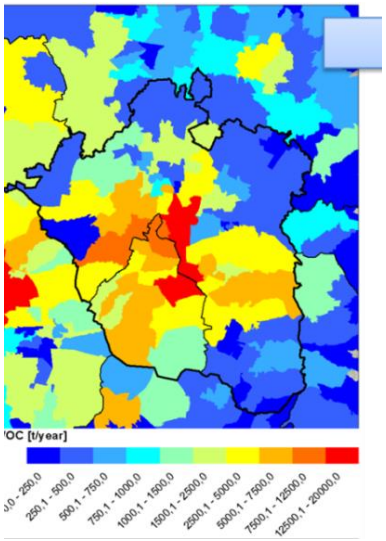
Earth Sciences Department, Barcelona Supercomputing Center, Barcelona, 08034, Spain

Barcelona Supercomputing Center

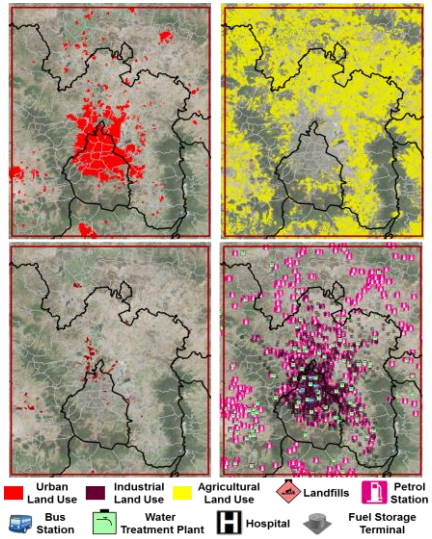
Centro Nacional de Supercomputación

HERMES-Mex:
An emission processing tool for Mexico

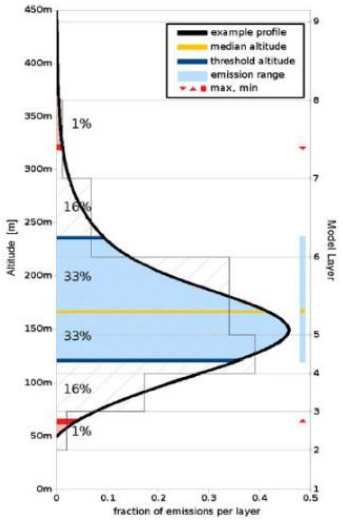
Official Emission Dataset



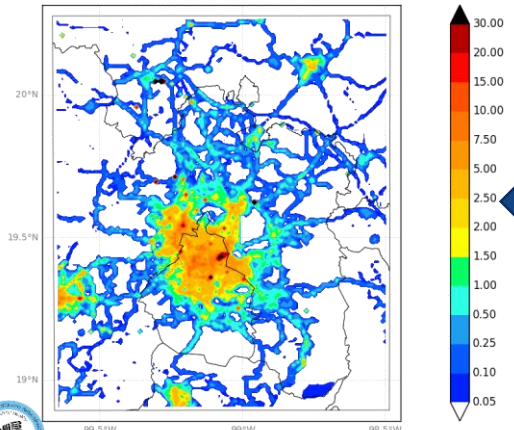
Spatial Allocation



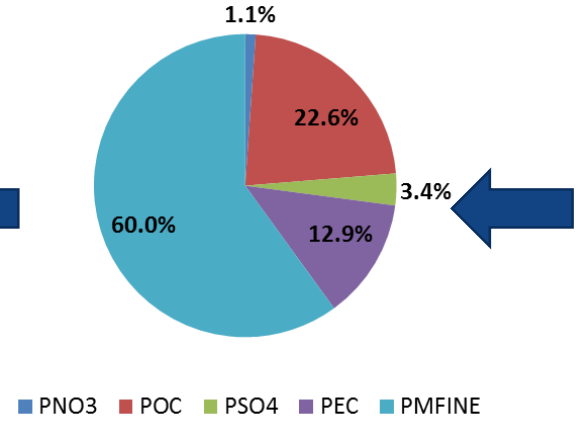
Vertical Allocation



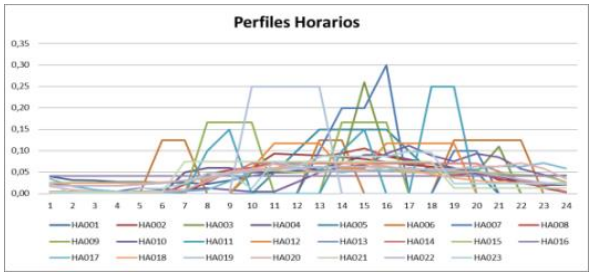
CMAQ ready emission data



Chemical Speciation



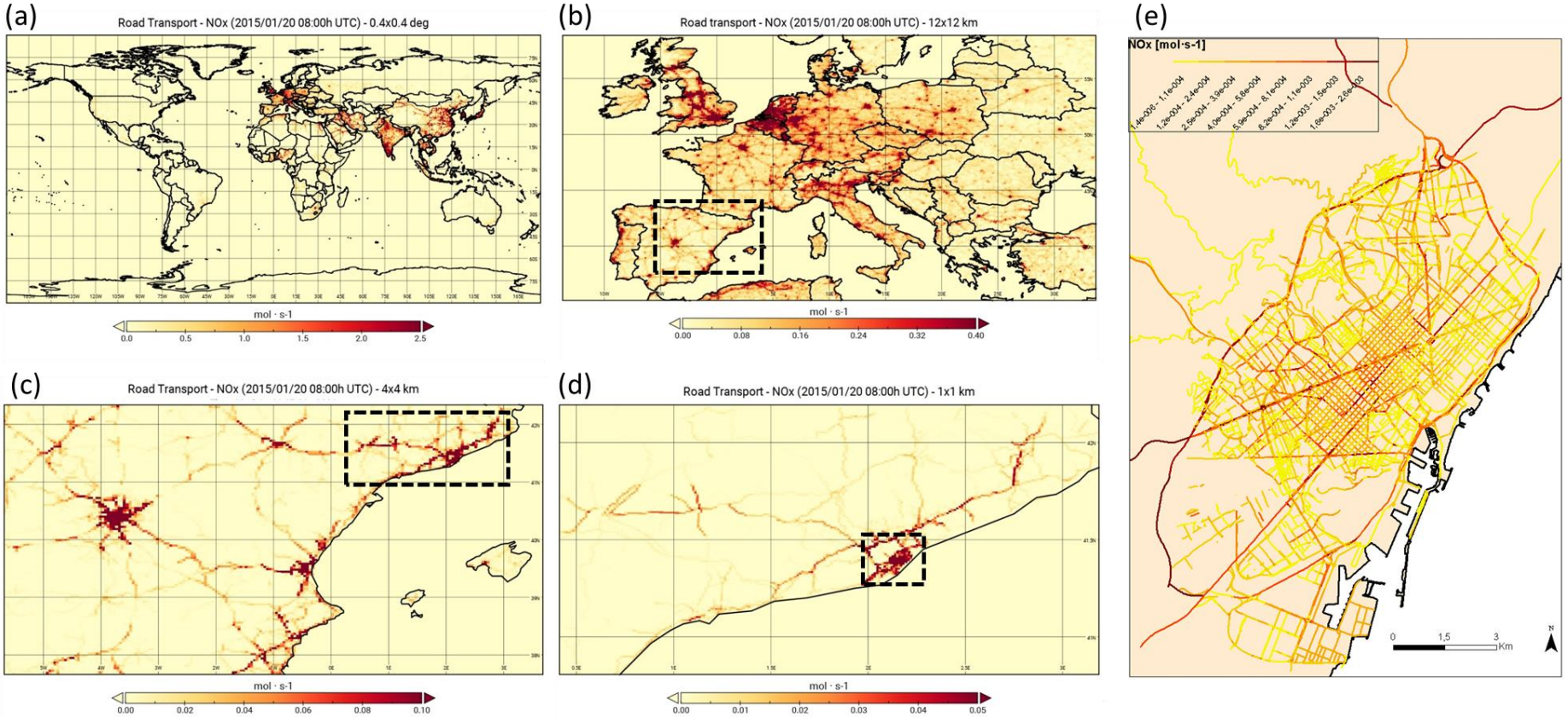
Temporal Allocation



GOBIERNO DE LA CIUDAD DE MÉXICO

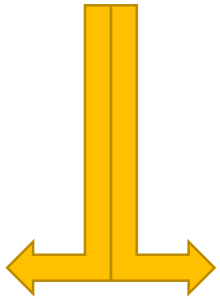
HERMESv3

A **python-based, open source and multiscale** emission modelling framework that **processes and estimates gas and aerosol emissions** for use in atmospheric chemistry models.



HERMESv3

A **python-based, open source and multiscale** emission modelling framework that **processes and estimates gas and aerosol emissions** for use in atmospheric chemistry models.



global-regional module (HERMESv3_GR)	bottom-up module (HERMESv3_BU)
A **processing system** to calculate emissions through an automatic **combination of existing inventories** and user defined vertical, temporal and speciation profiles	An **emission model** to estimate emissions at the source level (e.g. road link) combining state-of-the-art **bottom-up methods** with **local activity and emission factors**
Guevara et al. (2019a, GMD)	*Guevara et al. (2019b, in preparation)*

HERMESv3_GR: global-regional module

Emission data library

Convention on Long-range Transboundary Air Pollution emep

EDGAR EMISSION DATABASE FOR GLOBAL ATMOSPHERIC RESEARCH

ECLIPSE

Atmosphere Monitoring Service

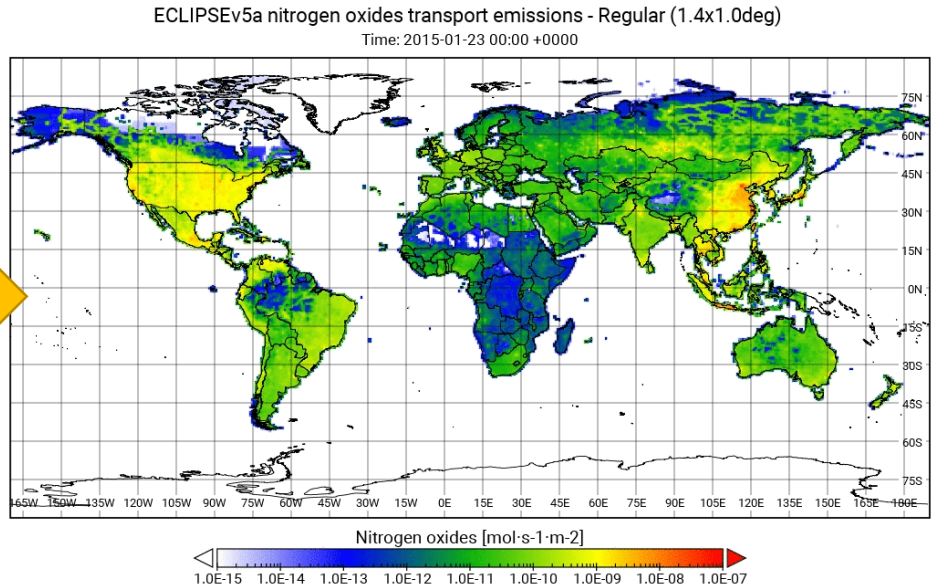
macc

University of Maryland

Pacific Northwest National Laboratory

TNO innovation for life

HERMESv3_GR output

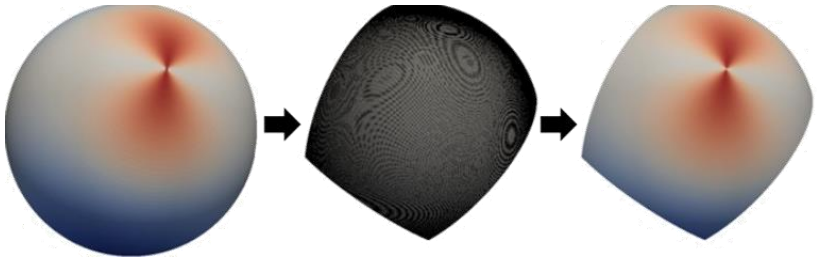


- Combination of multiple up-to-date gridded emission inventories
- User defined destination working domain (multiple projections)
- Application of country-specific scaling and masking factors
- Temporal profiles per sector and pollutant
- Speciation profiles for multiple chemical mechanisms (CB05, RADM2, AERO5, AERO6)
- Outputs for multiple atmospheric chemistry models (CMAQ, WRF-Chem, MONARCH)
- Available at the BSC git repository: https://earth.bsc.es/gitlab/es/hermesv3_gr

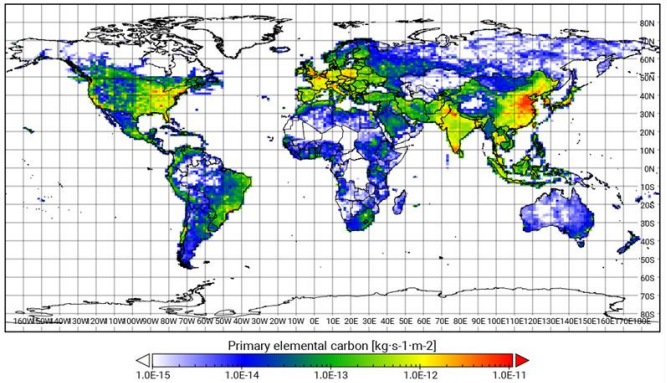
HERMESv3_GR: Spatial remapping

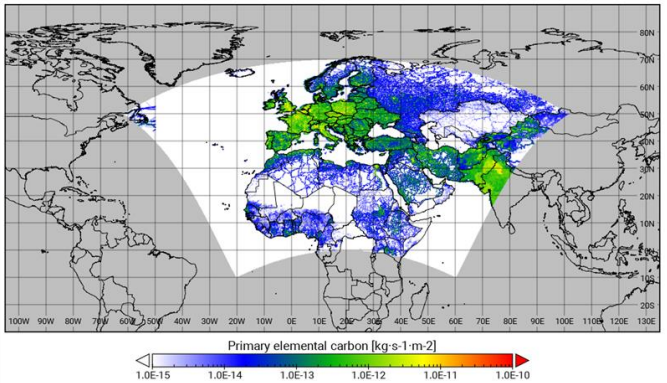
User defined destination working domain:

- Conservative remapping (ESMF)
- Multiple spatial resolutions
- Multiple projections: regular lat-lon, rotated lat-lon, mercator, lambert conformal conic



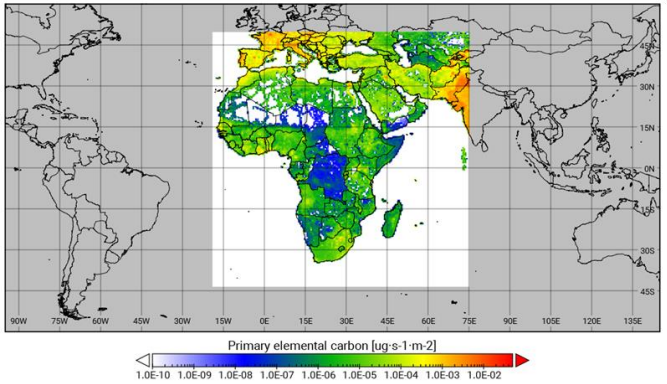
Regular lat-lon (1.4*1.0 deg)

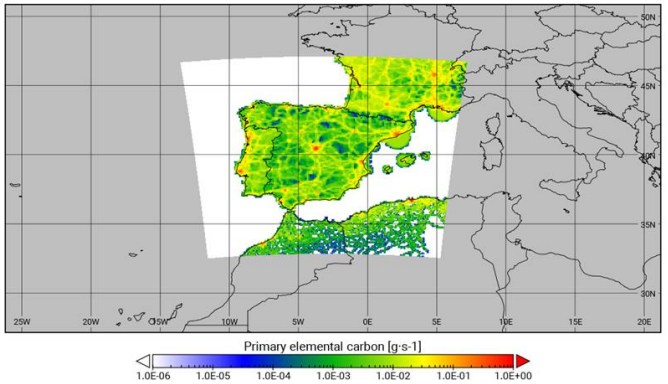




Rotated lat-lon (0.1*0.1 deg)

Mercator (50kmx50km)

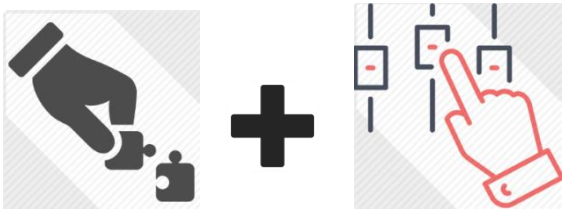


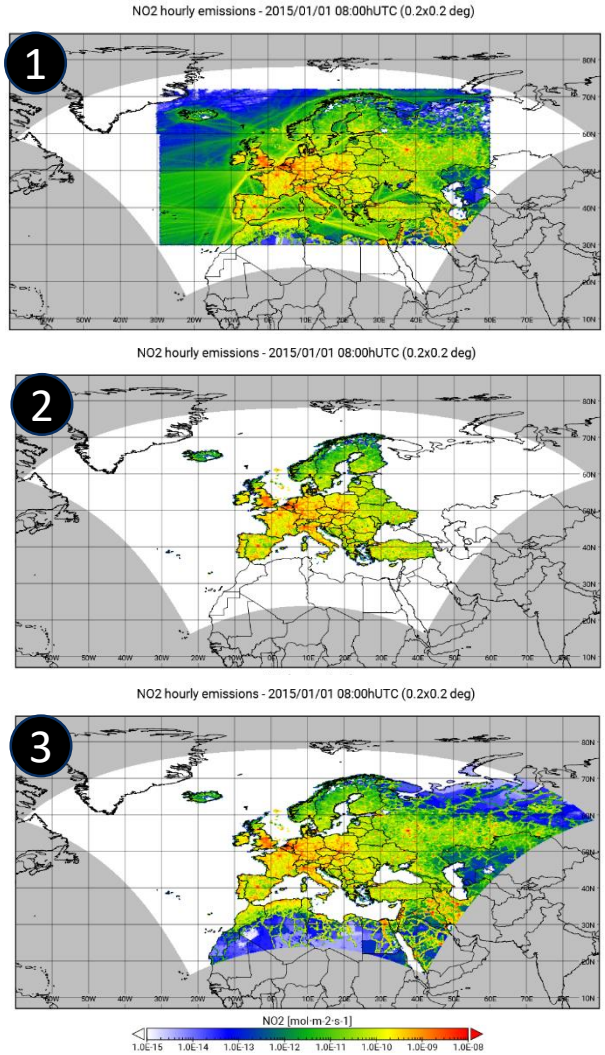


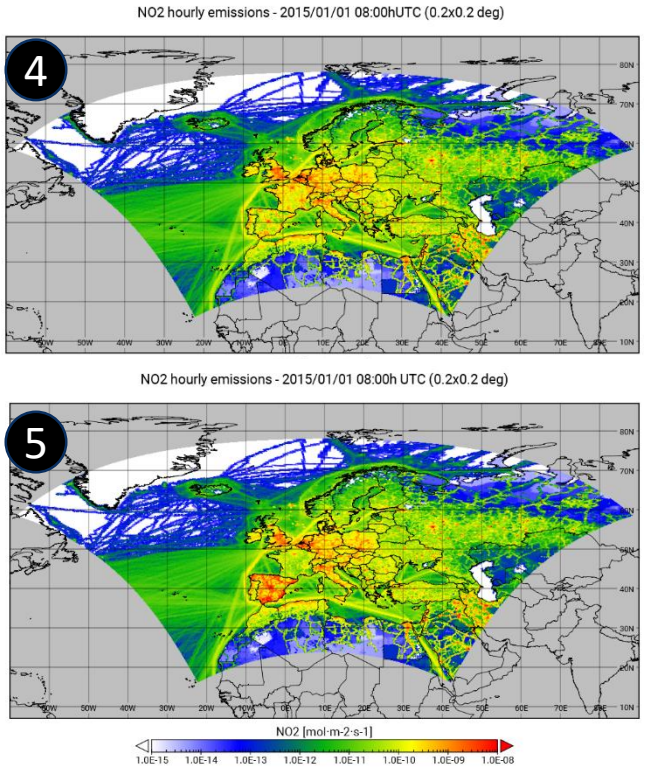
Lambert conformal conic (4kmx4km)

HERMESv3_GR: Designing your experiment

- Combination of multiple emission inventories
- Application of country-specific scaling factors/masks





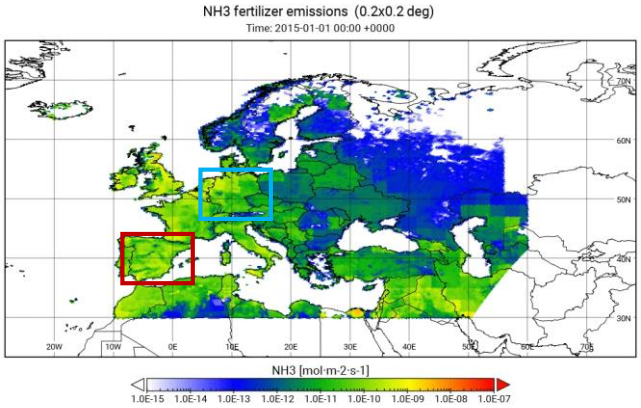


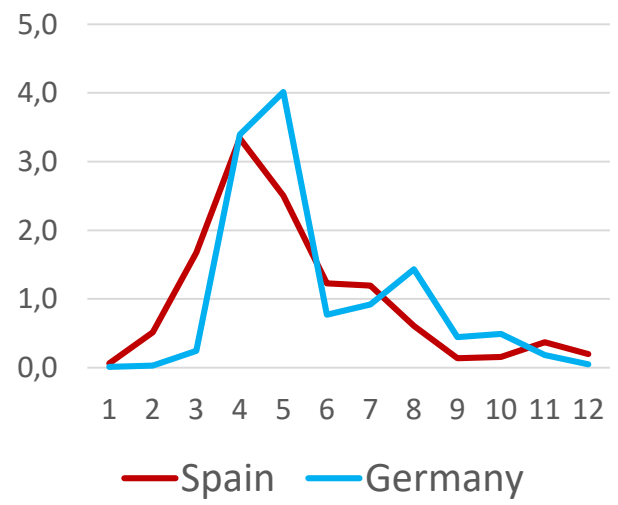
1. **CAMS_REG_APv2.2.1**
2. **CAMS_REG_APv2.2.1 (EU)**
3. **CAMS_REG_APv2.2.1 (EU) + CAMS_GLOB_ANTv2.1 (rest)**
4. **CAMS_REG_APv2.2.1 (EU) + CAMS_GLOB_ANTv2.1 (rest) + CAMS_GLOB_SHIPv1.1**
5. **CAMS_REG_APv2.2.1 (ESP*10, FRA*0.1) + CAMS_GLOB_ANTv2.1 + CAMS_GLOB_SHIPv1.1**

HERMESv3_GR: Temporal distribution

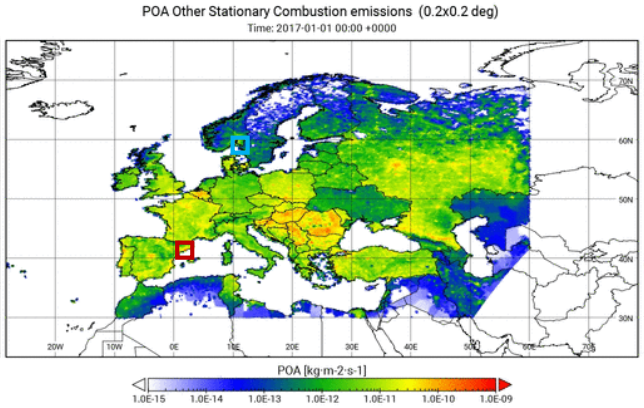
- Specific monthly, weekly and diurnal profiles per sector and pollutant
- Use of gridded profiles (variation not uniform across the space)

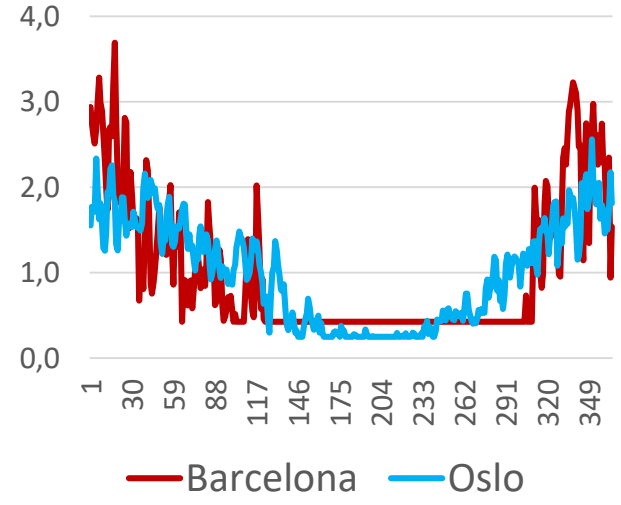
Monthly – NH_3 fertilizers



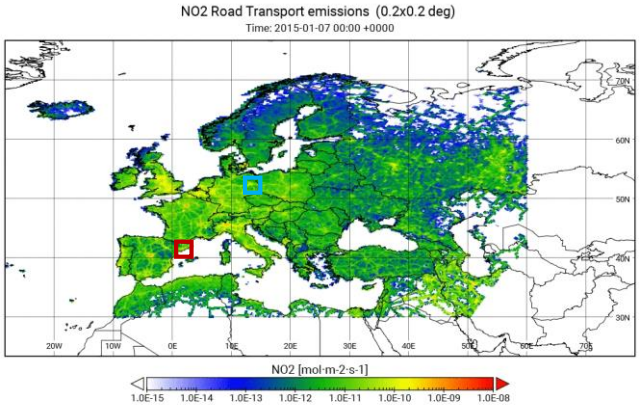


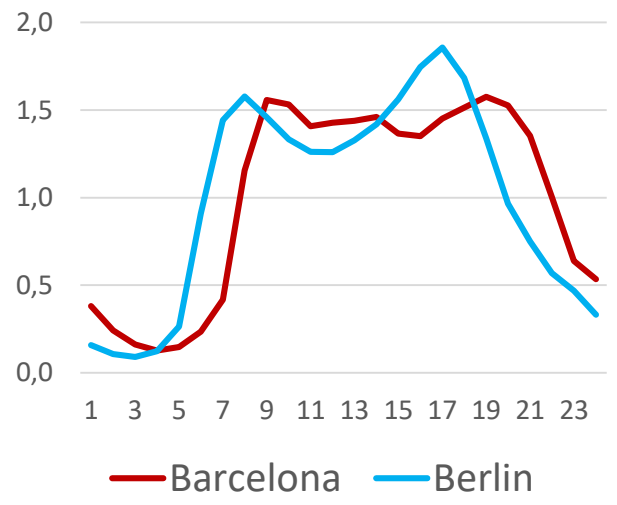
Daily – $PM_{2.5}$ residential



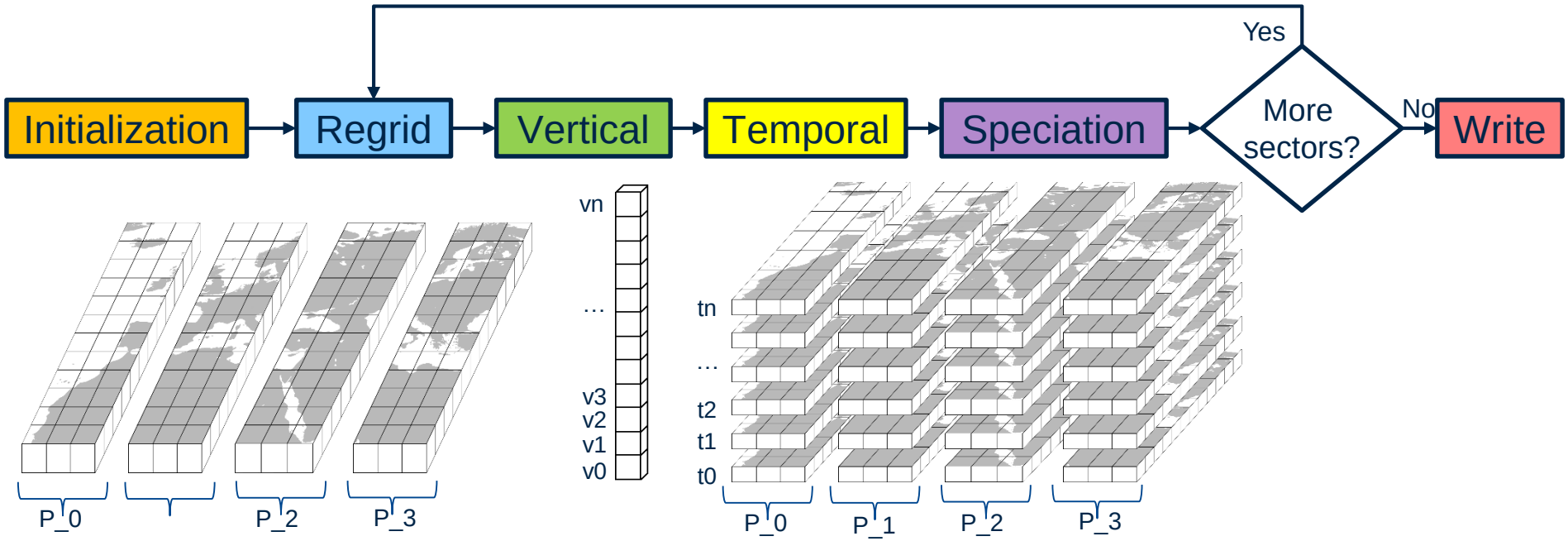


Hourly – NO_2 traffic



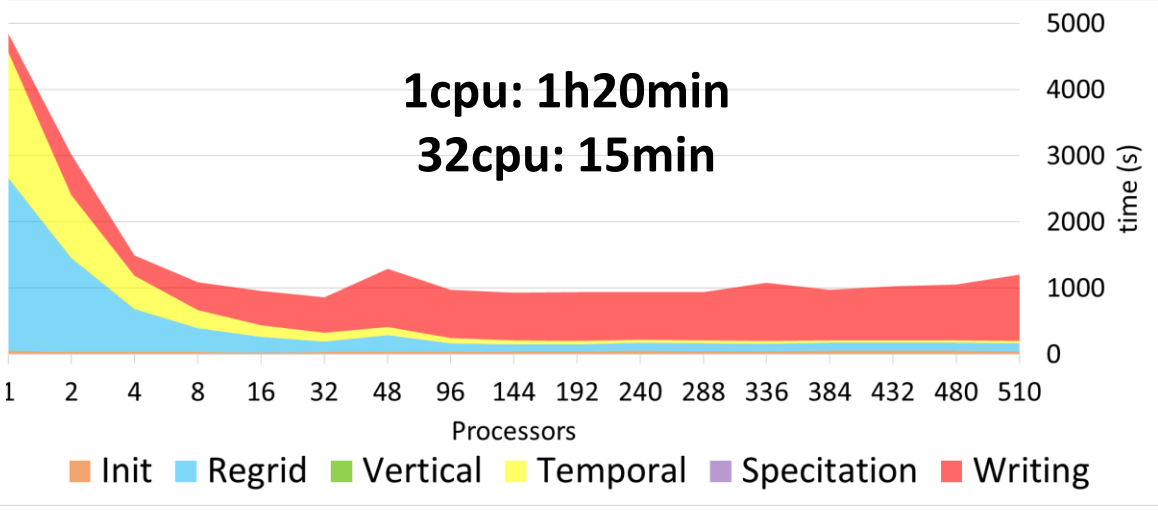


HERMESv3_GR: Technical Implementation



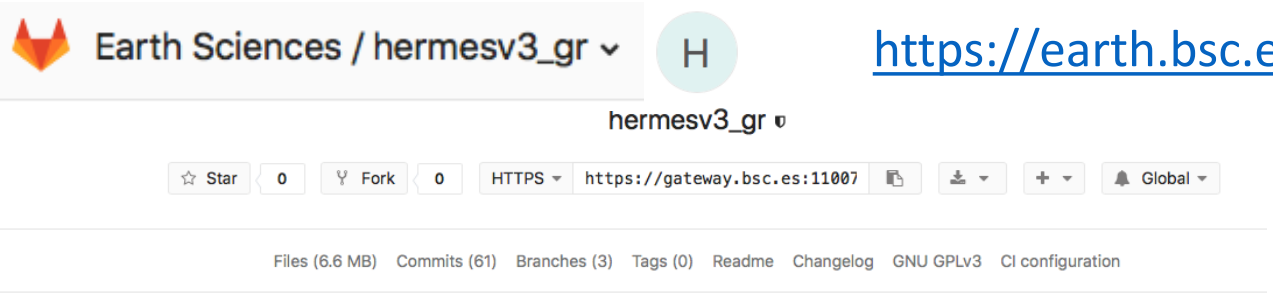
Test case:

- **Domain:** Europe-North Africa-Middle East (1021 x 721 cells)
- **Spatial resolution:** 0.1x0.1deg
- **Vertical resolution:** 48 layer
- **Emissions:** TNO_MACC-iii (EU) + HTAPv2 (others)
- 24-h simulation

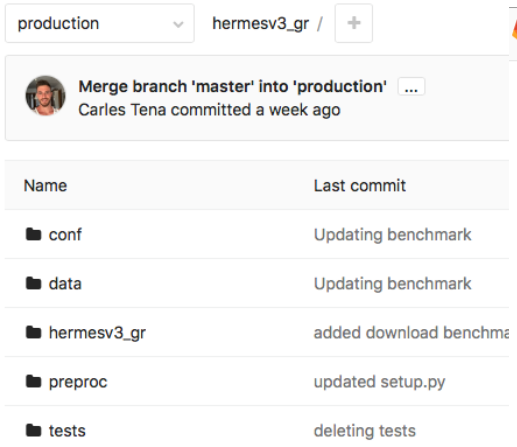


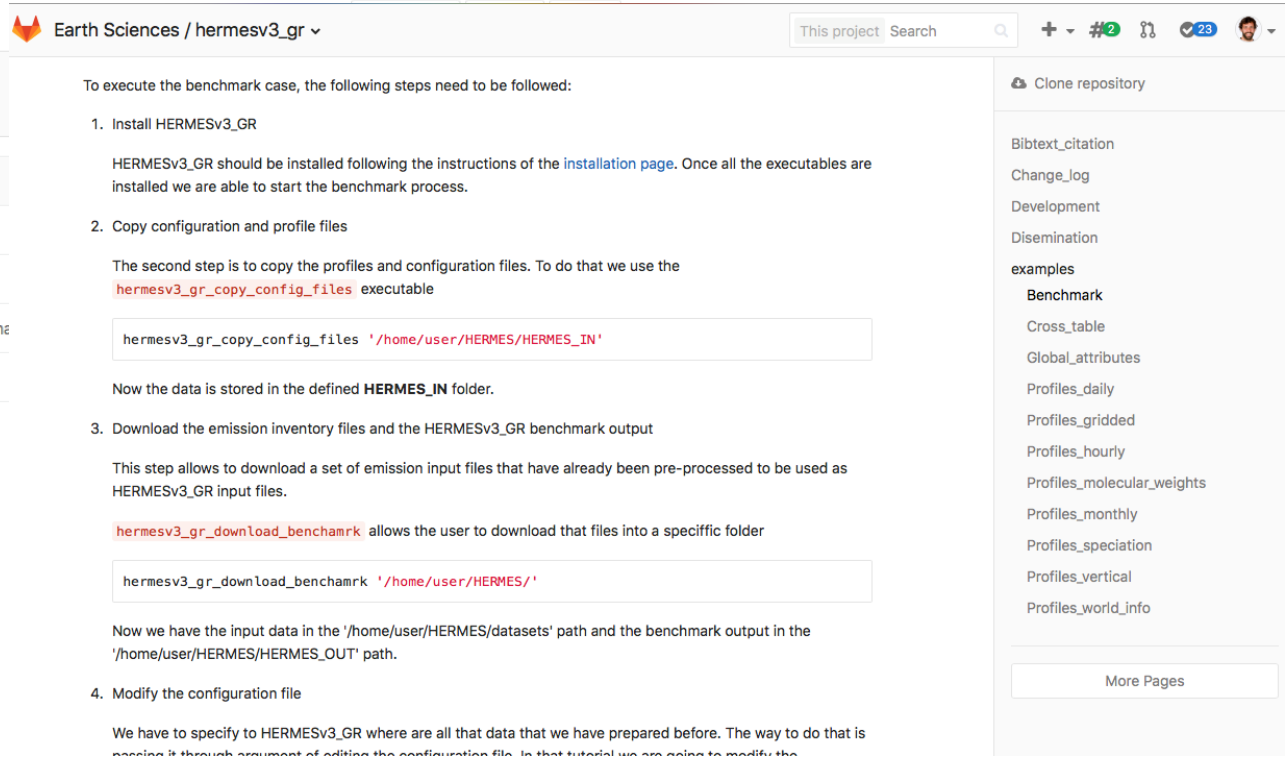
HERMESv3_GR: Code Availability

HERMESv3_GR code, test case and user guide available at BSC gitlab repository



https://earth.bsc.es/gitlab/es/hermesv3_gr





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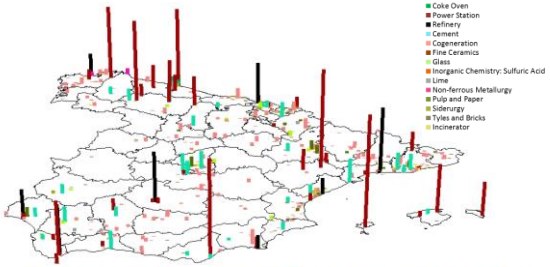
HERMESv3_BU: Bottom-up module

Point Source

P ● (x, y)

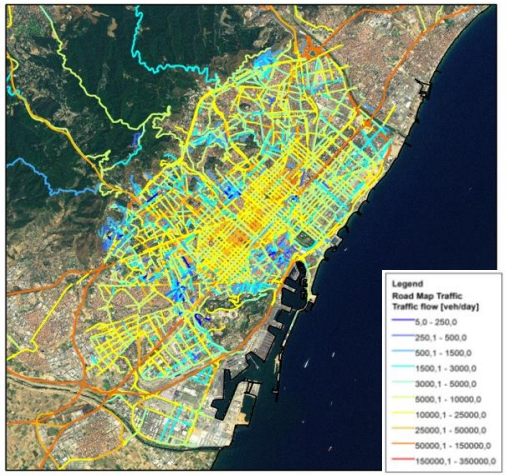


Line Source

S

a

$\{P_1, \ldots, P_n\}$

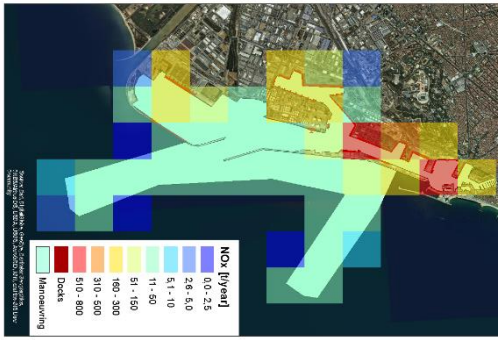


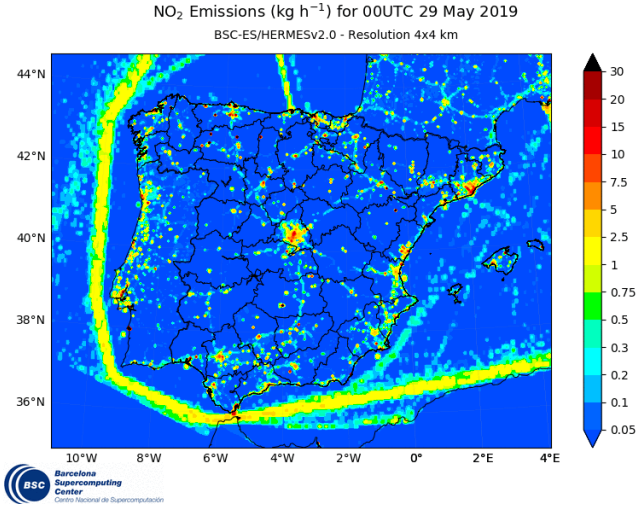
Area Source

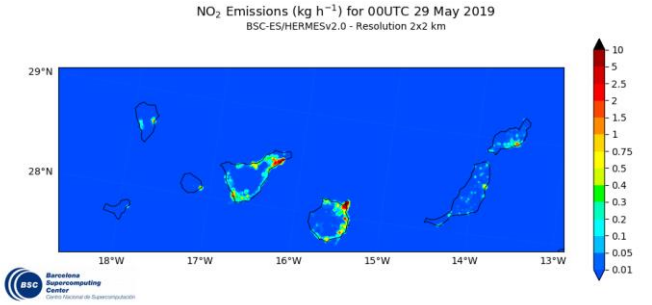
F

A

$\{S_1, \ldots, S_n\}$







Criteria pollutants:

NO_x, CO, SO_2, NMVOC, NH_3, PM_{10}, $PM_{2.5}$

Greenhouse gases:

CO_2, CH_4

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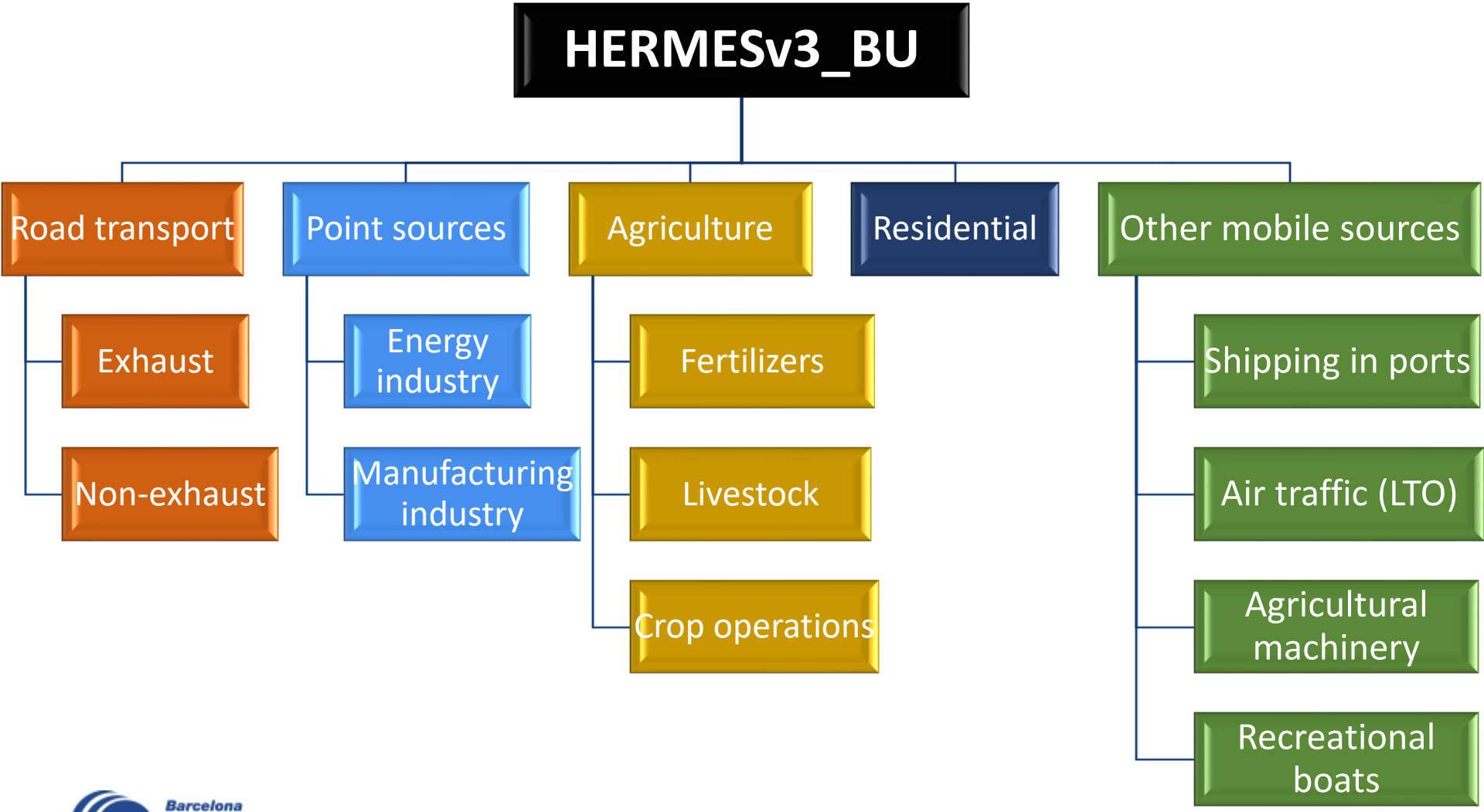
HERMESv3_BU: Bottom-up module

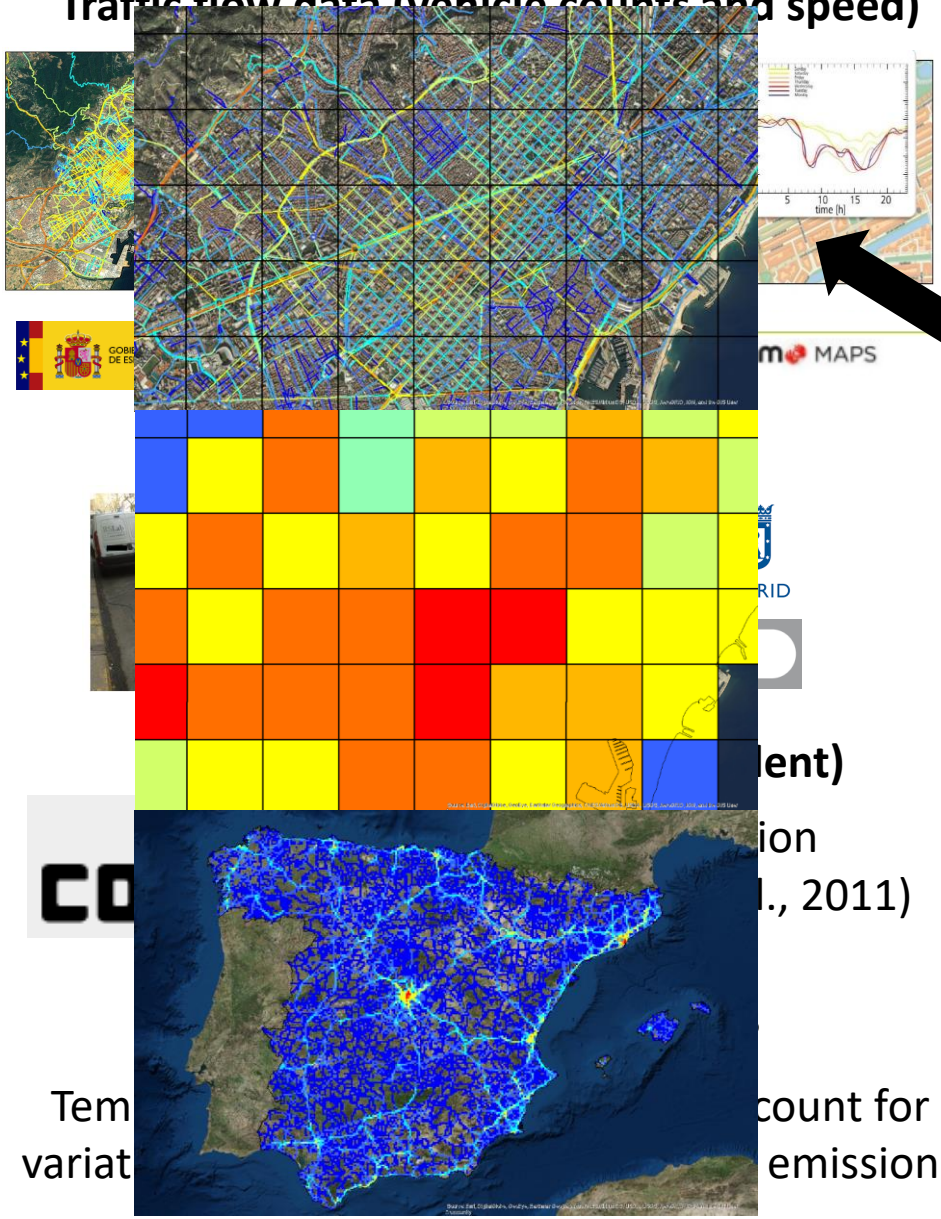


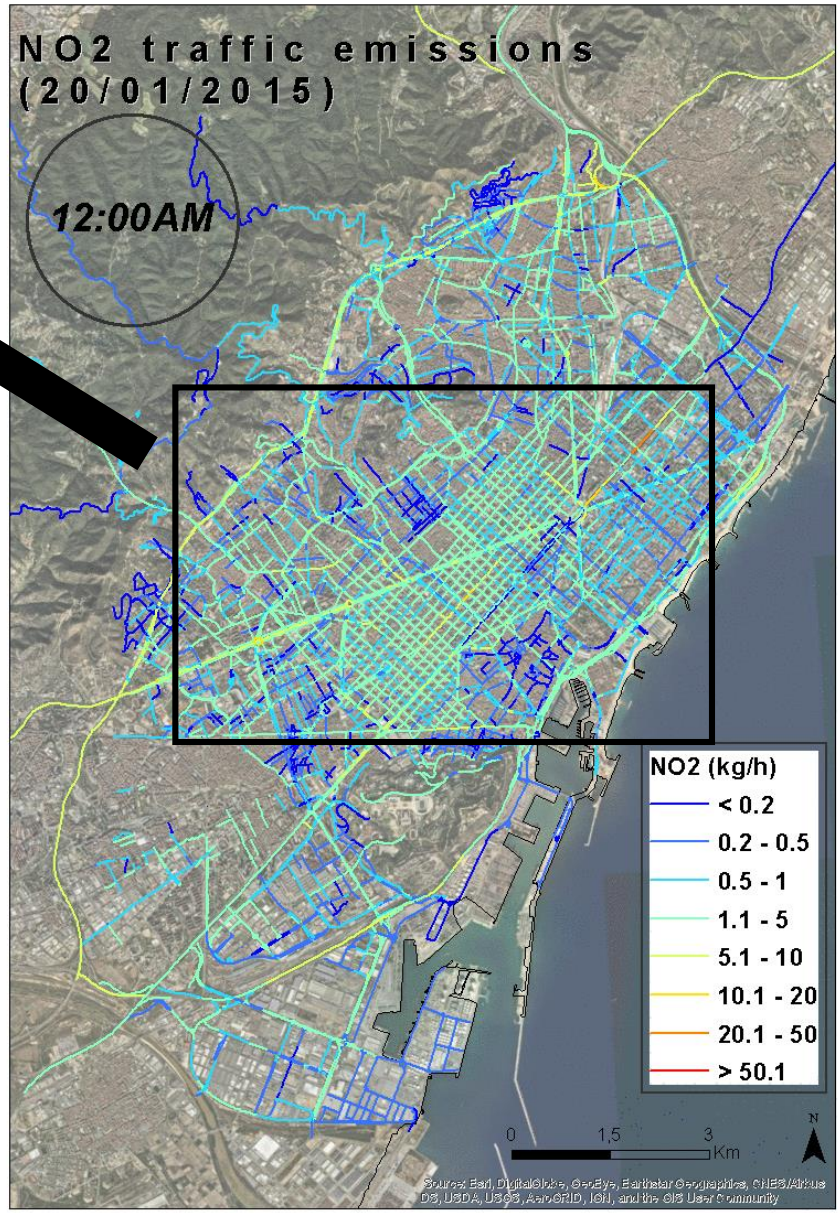
HERMESv3_BU: Input data

More than 75% of the time spent building up an emission inventory is devoted to compile and homogenise all the input data.
There is a need to centralise all this information.

HERMESv3_BU: Road transport

Traffic flow data (vehicle counts and speed)





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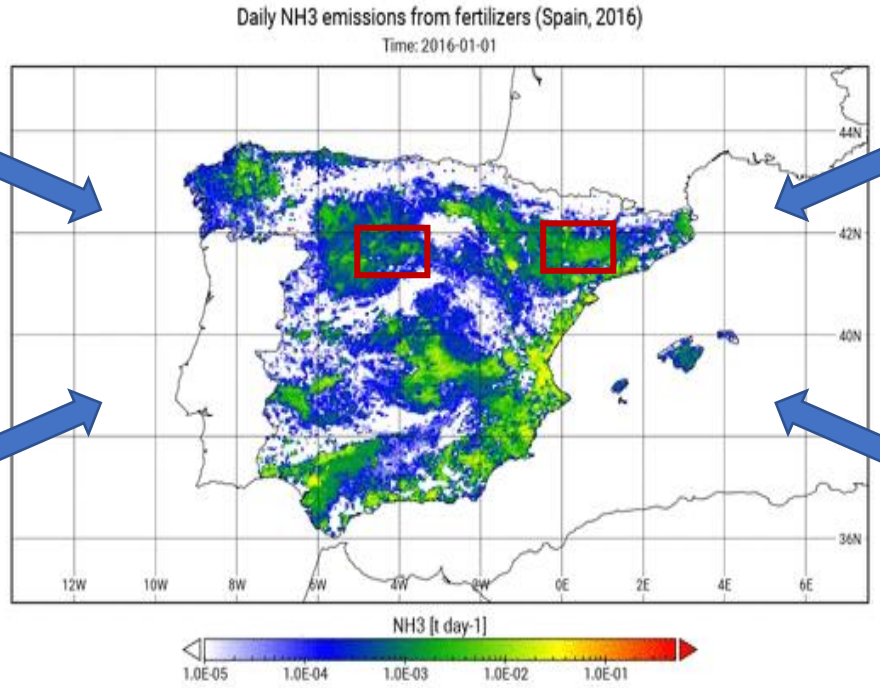
Tem count for

variat emissions

HERMESv3_BU: Fertilizers

General information
- Crop hectares
- Land uses

Cultural techniques
- N application rate
- Crop calendars
- Type of fertilizers
- Type of application

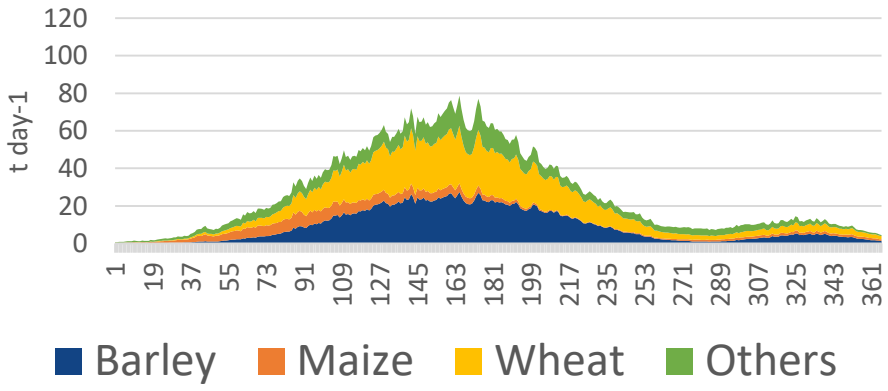


Meteorology
- Temperature
- Wind speed
- Growing Degree Days

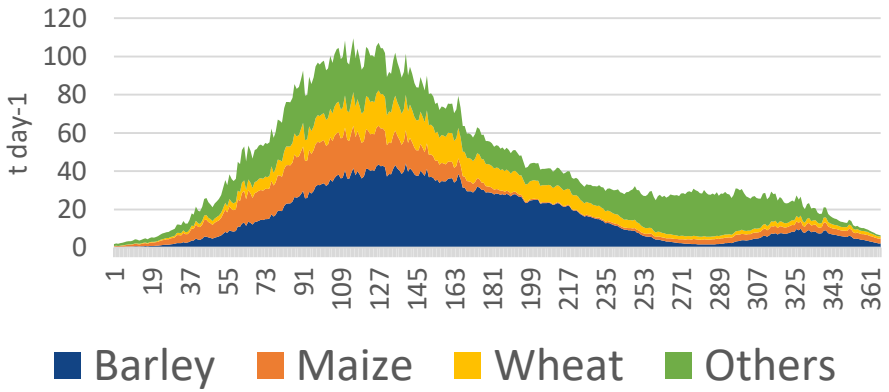
Soil properties
- PH
- CEC

ISRIC World Soil Information

South of Castilla Leon



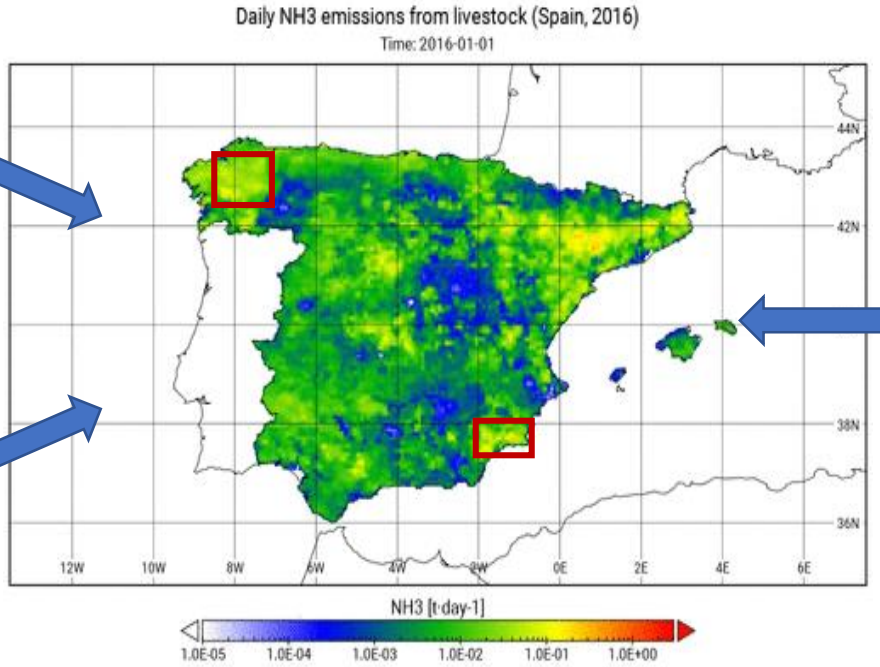
Lleida



HERMESv3_BU: Livestock

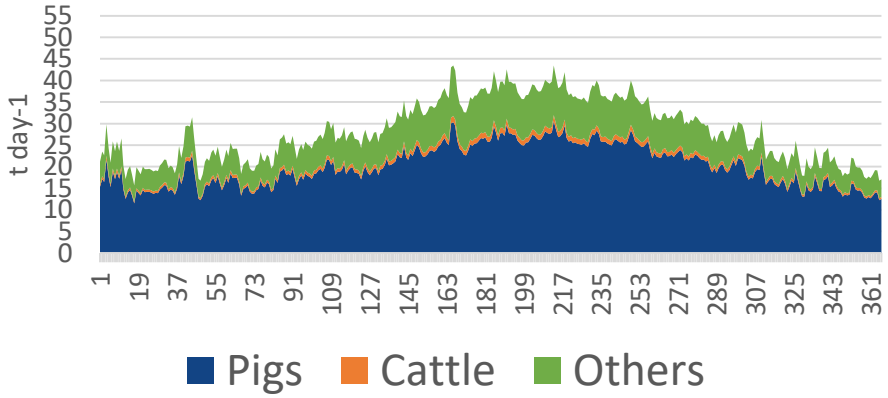
General information
- Number of animals

Cultural techniques
- N excreta rate
- TAN
- Barn type
- Storage type

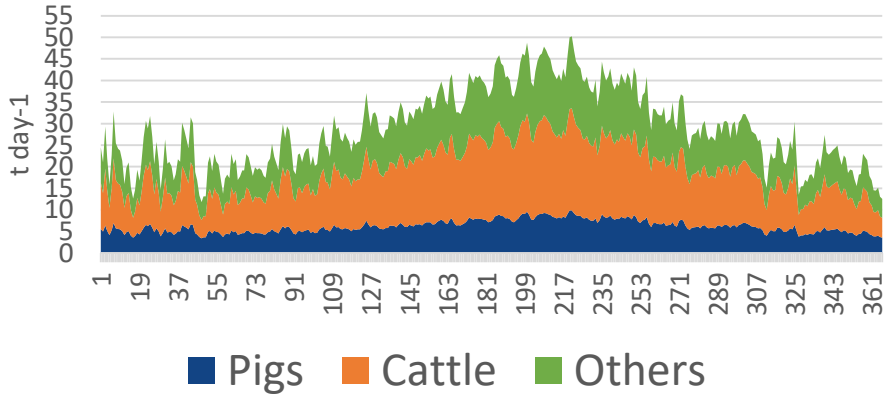


Meteorology
- Temperature
- Wind speed

Murcia

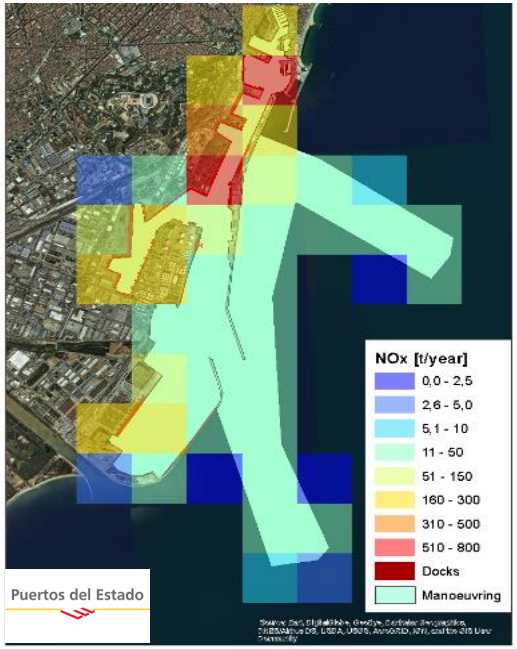


Galicia

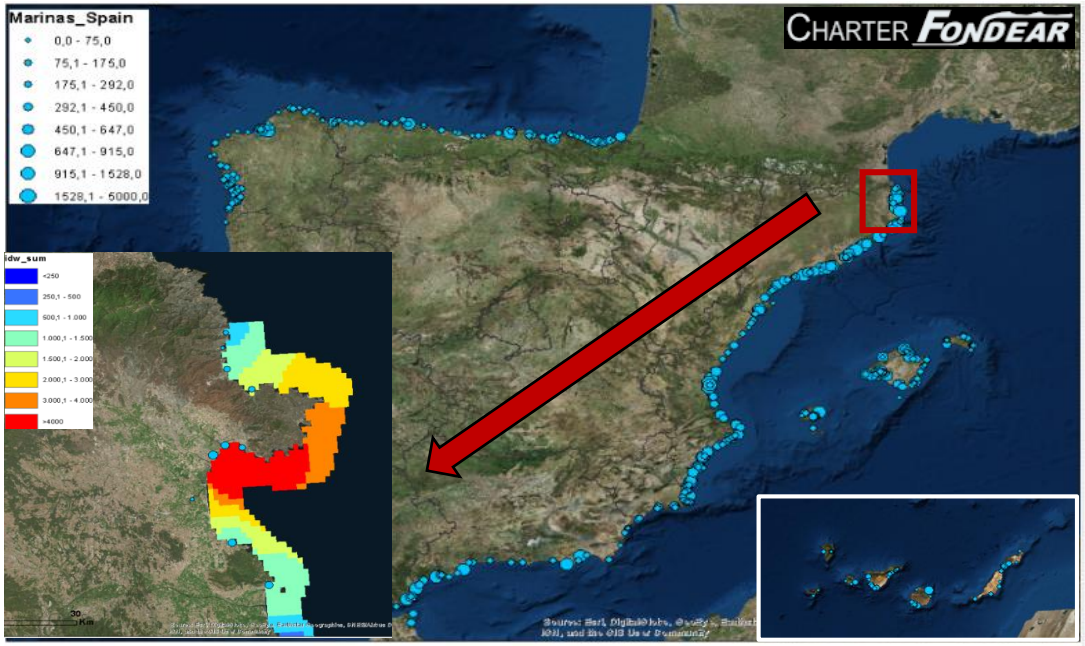


HERMESv3_BU: Other mobile sources

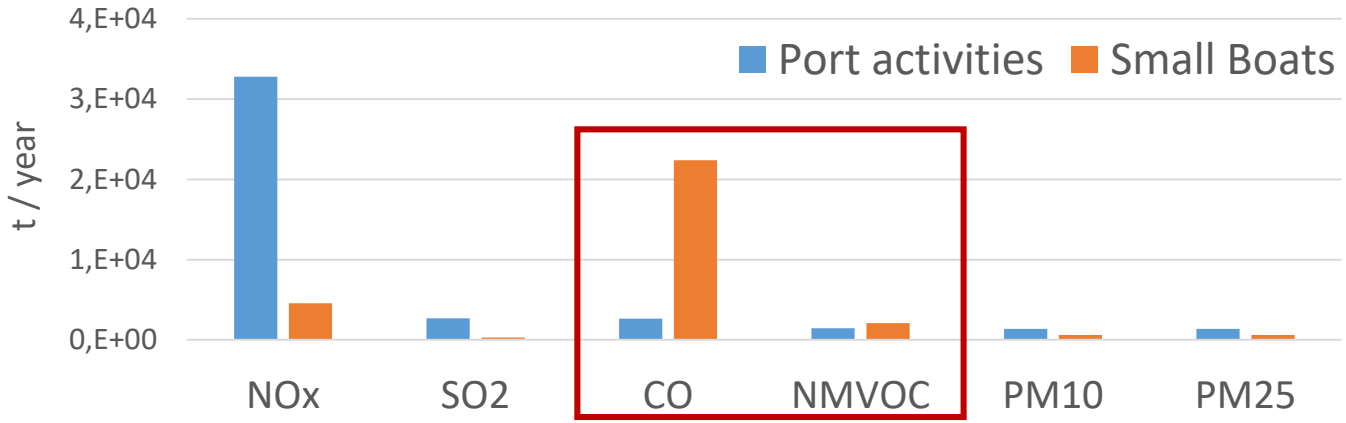
Shipping activities in ports



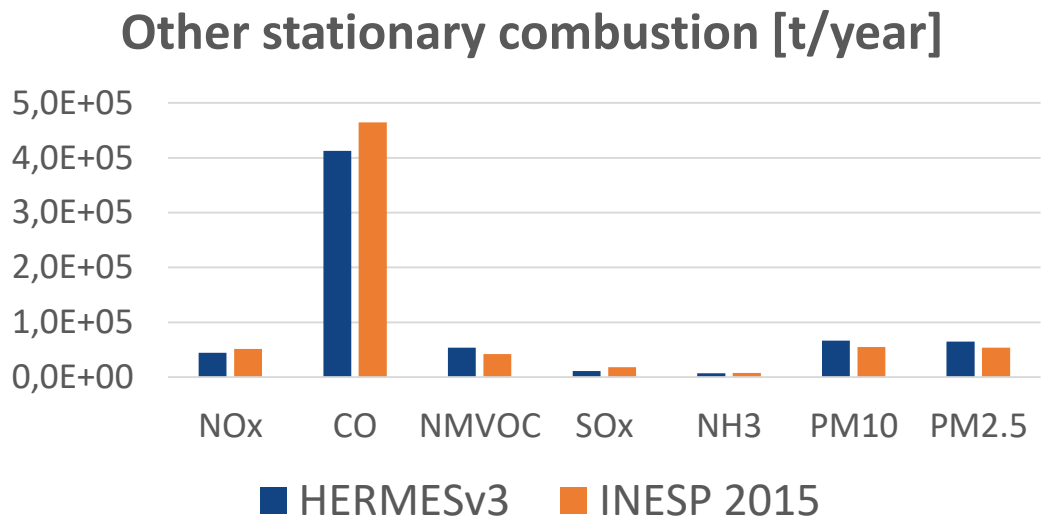
Recreational boats in marinas

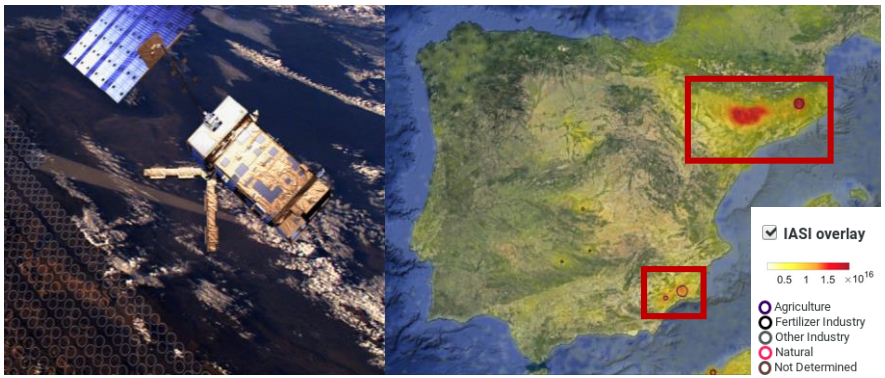


Total annual emissions

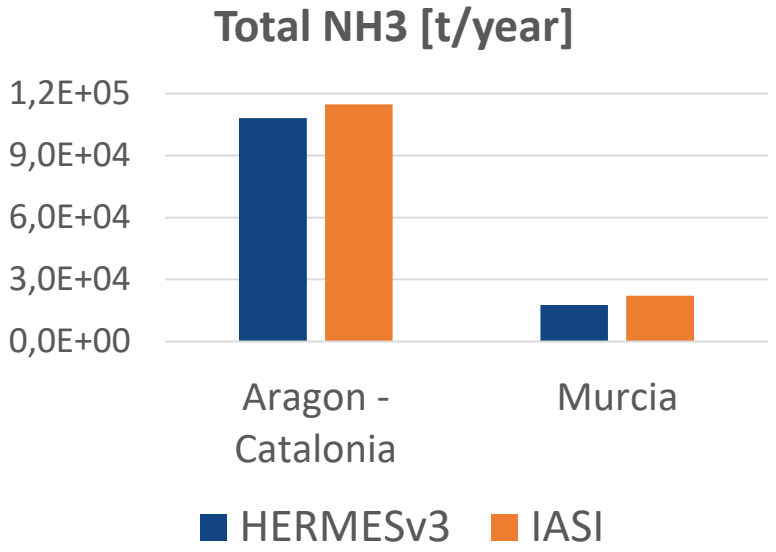


HERMESv3_BU: Inter-comparisons



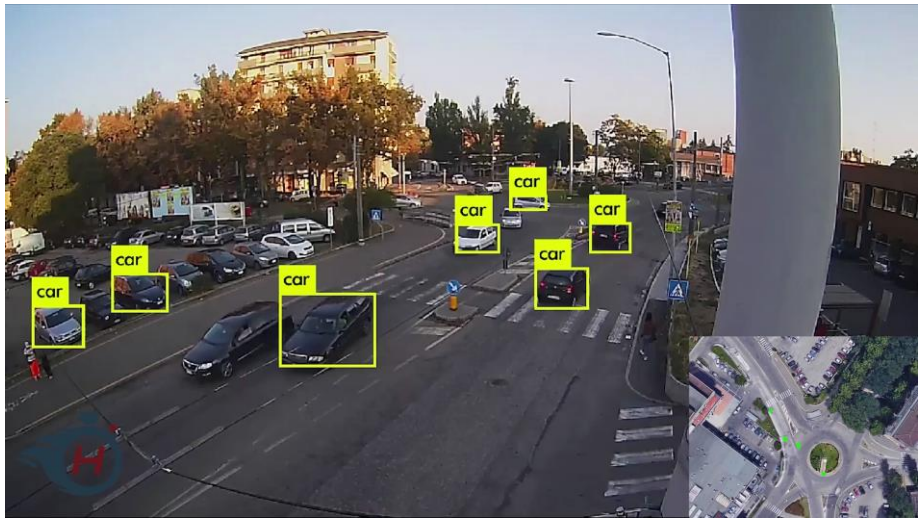


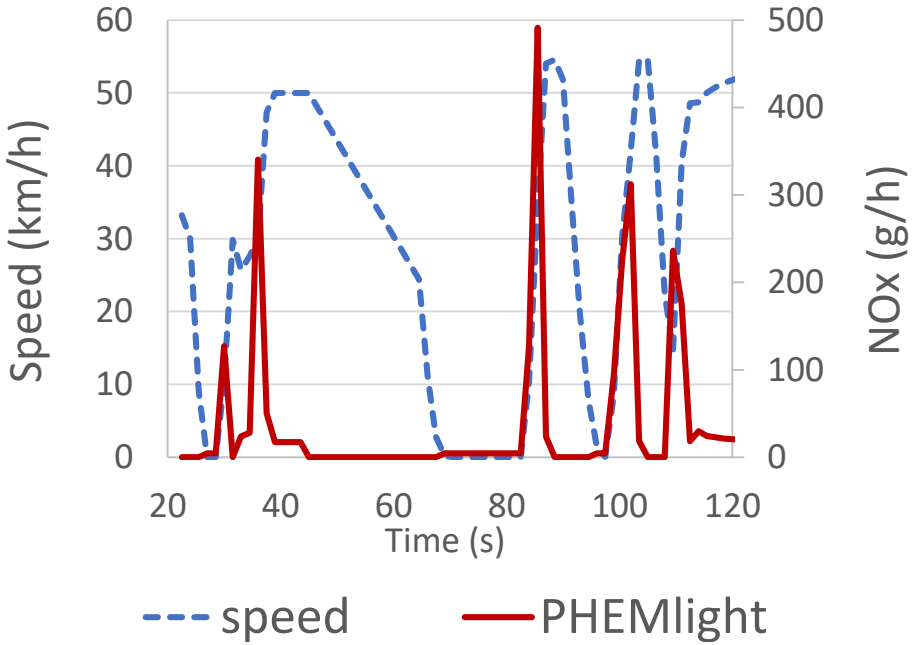
Van Damme et al. (2018, Nature)



Beyond the state-of-the art

Use of **artificial intelligence** to combine high resolution **video-based traffic data** with **instantaneous emission models**





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CLASS
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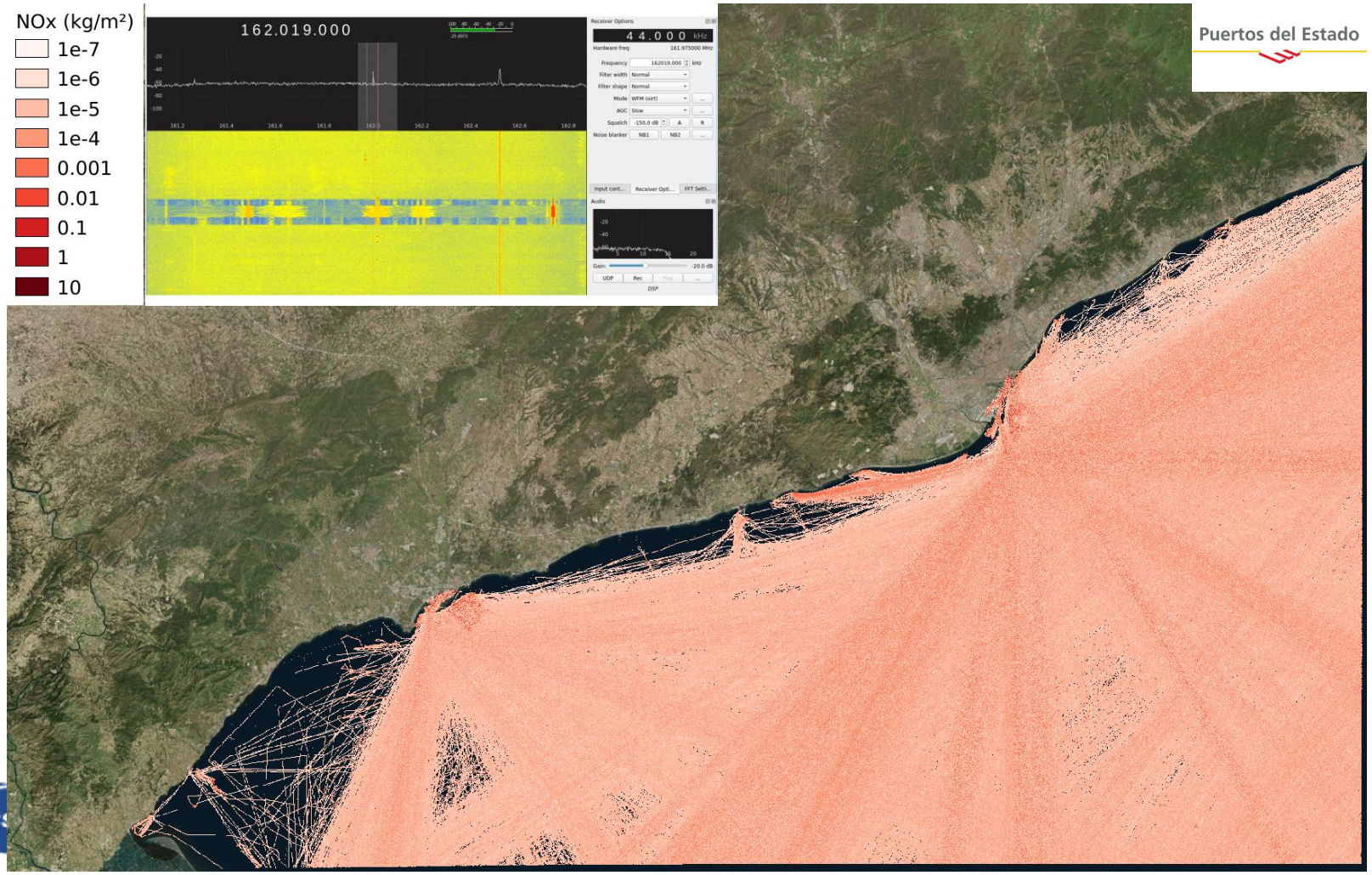
Beyond the state-of-the art

Use of **GPS data from ships** and **data mining and machine learning** techniques to assess very high resolution **shipping emissions**



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EXCELENCIA SEVERO OCHOA

HERMESv3 represents an effort to facilitate the use of emission inventories within the air quality modelling community

Next step: Engage and collaborate with key actors to develop a national emission tool that fulfils the needs of researchers, operational services, administrations and companies

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