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EXCELENCIA SEVERO OCHOA

Predicción de la Calidad del Aire Multiescala con el modelo MONARCH en el Centro Nacional de Supercomputación

O. Jorba, S. Basart, J. A. Benavides, D. Bowdalo, M. L. Dawson, E. Di Tomaso, M. Gonçalves, M. Guevara, M. Klose, F. Macchia, V. Obiso, M. Olid, M. T. Pay, M. Porquet, K. Serradell, C. Tena, C. Pérez García-Pando

Departamento Ciencias de la Tierra
Centro Nacional de Supercomputación

19/09/2018

VI Simposio Nacional de Predicción - AEMET

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BSC and the Earth Sciences Department

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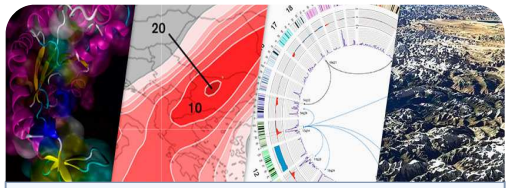
BSC-CNS objectives

Supercomputing services to Spanish and EU researchers



R&D in Computer, Life, Earth and Engineering Sciences

PhD programme, technology transfer, public engagement

BSC-CNS is a consortium that includes

Spanish Government	60%
Catalonian Government	30%
Univ. Politècnica de Catalunya (UPC)	10%

Generalitat de Catalunya
Departament d'Empresa i Coneixement

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

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Earth Science Department

Environmental modelling and forecasting, with a particular focus on weather, climate and air quality

Director: **Francisco Doblas-Reyes**

- 72 people
- Leading: H2020 project, COPERNICUS contract, ERC Consolidator Grant and hosts an AXA Chair

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Overview of MONARCH and HERMESv3 models for Air Quality Applications

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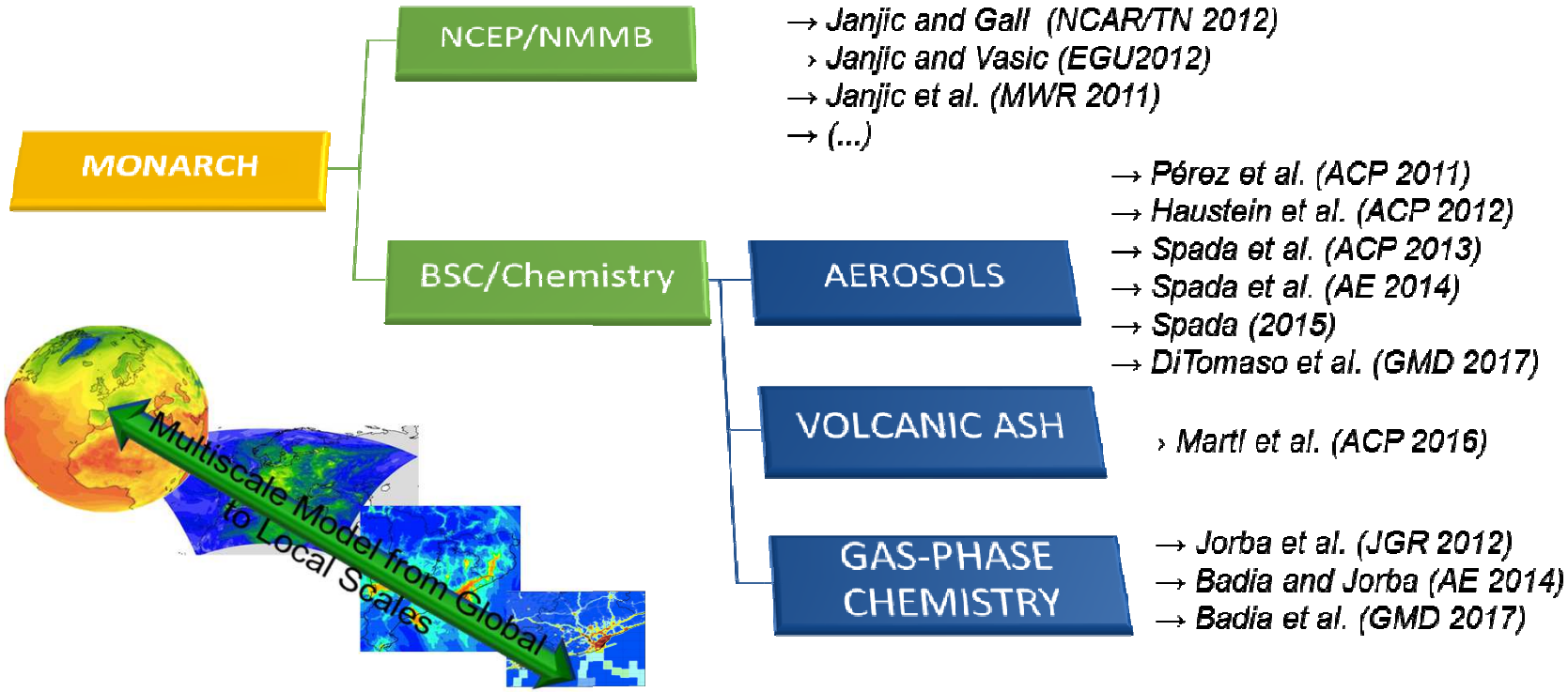
MONARCH: online weather-chemistry model

- ***Multiscale***: global to regional (up to 1km) scales allowed
- Fully ***on-line*** coupling: weather-chemistry feedback processes allowed
- Enhancement with a ***data assimilation*** system



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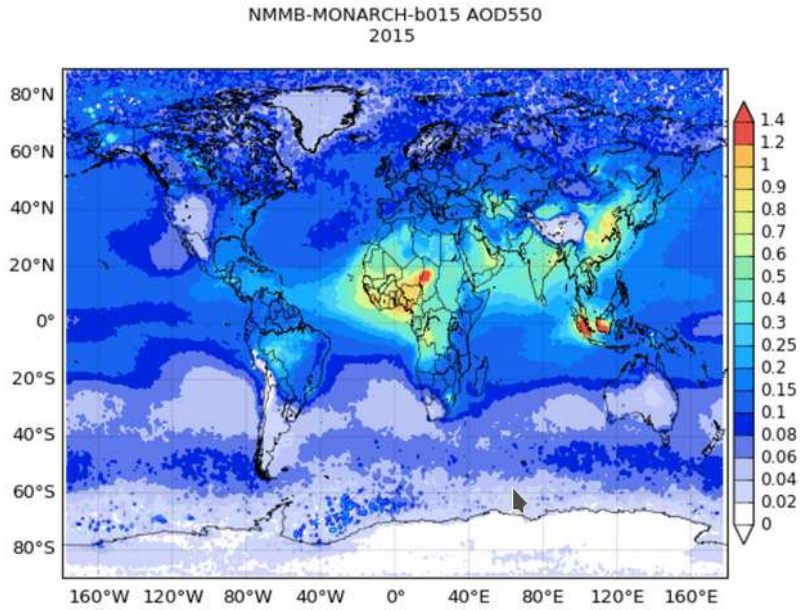
Dust module is known as **NMMB/BSC-Dust**

MONARCH forecasts

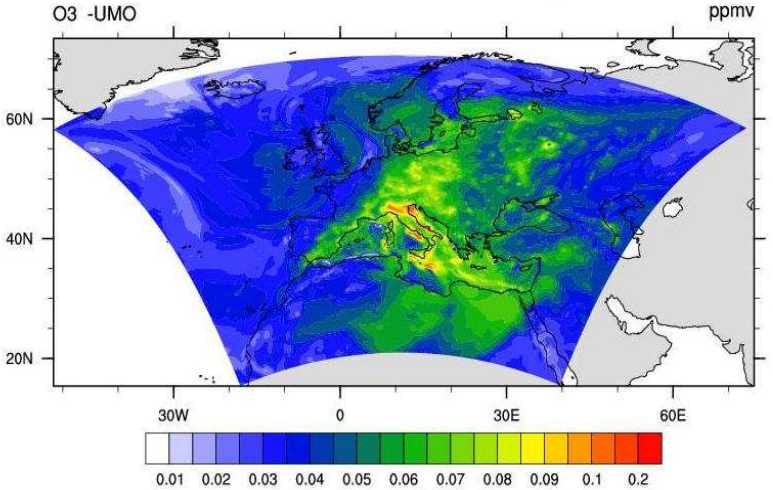
Global



✓ *MONARCH contributes to the* ***ICAP global forecast aerosol*** *multi-model ensemble* http://icap.atmos.und.edu

Regional

20100715 at 12UTC

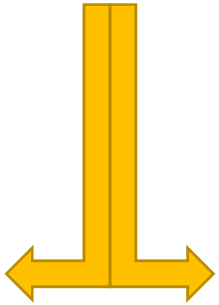


✓ *BDFC and SDS-WAS dust forecast*
✓ *Candidate model CAMS-50*
✓ *It will be implemented in*

CALIOPE *(www.bsc.es/caliope)*
AQ Forecast System for ***EU*** *and* ***Spain***

HERMESv3: emission model

An **open source, parallel and stand-alone multiscale** atmospheric emission model that **processes and estimates gas and aerosol emissions** for use in chemistry transport models



global-regional module (HERMESv3_GR)	bottom-up module (HERMESv3_BU)
A highly customizable processing system that calculates emissions through an automatic combination of existing inventories and user defined vertical, temporal, speciation scaling and masking factors	A Spanish emission model to estimate emissions at the source level (e.g. road link, industrial facility, crop type) combining state-of-the-art bottom-up methods with local activity and emission factors

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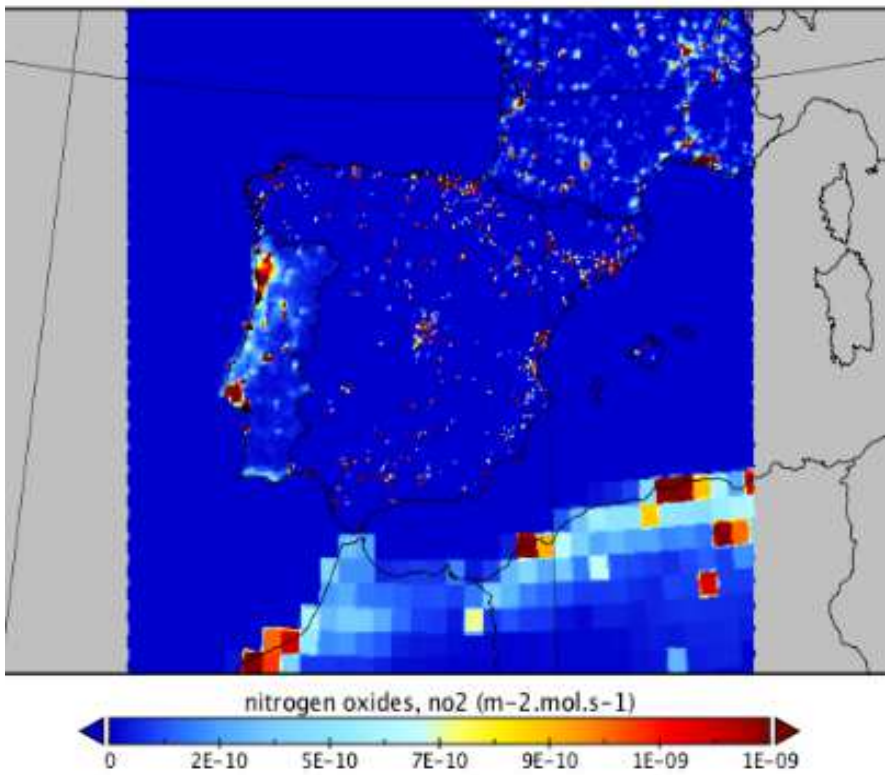
Emission Combination and Spatial regridding

Widely applicable framework for designing and adjusting the emission modelling experiment:

- Combination of multiple emission inventories
- Country-specific scaling factors
- Country-specific masks
- Flexibility on chemical speciation

Name	Sources	Spatial res/cov	Temporal res/cov	Reference
EDGARv4.3.2	Anthropogenic	Global (0.1x0.1)	Annual (1970 – 2012) Monthly (2010)	Cripa et al. (2018) Huang et al. (2017)
CEDS	Anthropogenic	Global (0.5x0.5)	Monthly (1851 – 2014)	Hoesly et al. (2018)
ECLIPSEv5.a	Anthropogenic	Global (0.5x0.5)	Monthly (1990 - 2050)	Klimont et al. (2017)
HTAPv2.2	Anthropogenic	Global (0.1x0.1)	Monthly (2008 and 2010)	Janssens-Maenhout et al. (2015)
GFASv1.2	Biomass burning	Global (0.1x0.1)	Daily (2012-present)	Kaiser et al. (2012)
Carn	Volcanoes (degassing)	Point sources	Annual (2005 – 2015)	Carn et al. (2017)
Wiedinmyer	Open air trash burning	Global (0.1x0.1)	Annual (2010)	Wiedinmyer et al. (2014)
TNO_MACC-iii	Anthropogenic	Regional (0.0625*0.125)	Annual (2000 – 2011)	Kuenen et al. (2014)
EMEP	Anthropogenic	Regional (0.1x0.1)	Annual (2000 – 2016)	Mareckova et al. (2017)



Manufacturing industrial NOx emissions:

- North Africa
  (HTAPv2.2 0.1x0.1deg)
- Portugal
  (ECLIPSEv5.a, 0.5x0.5deg),
- France
  (TNO_MACC-iii, 0.0625x0.125deg)
- Spain
  (bottom-up inventory, Guevara et al. 2013)

Multiscale capability of MONARCH model

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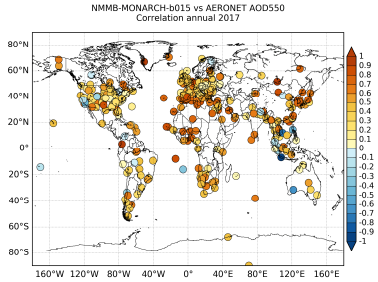
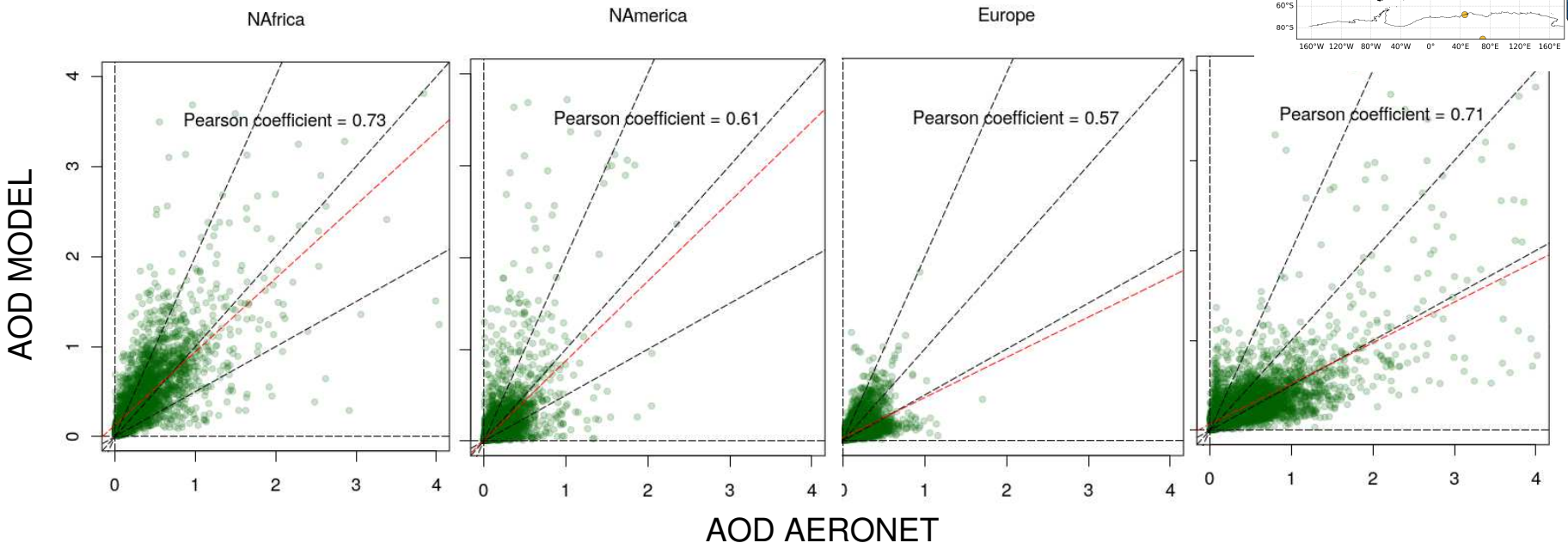
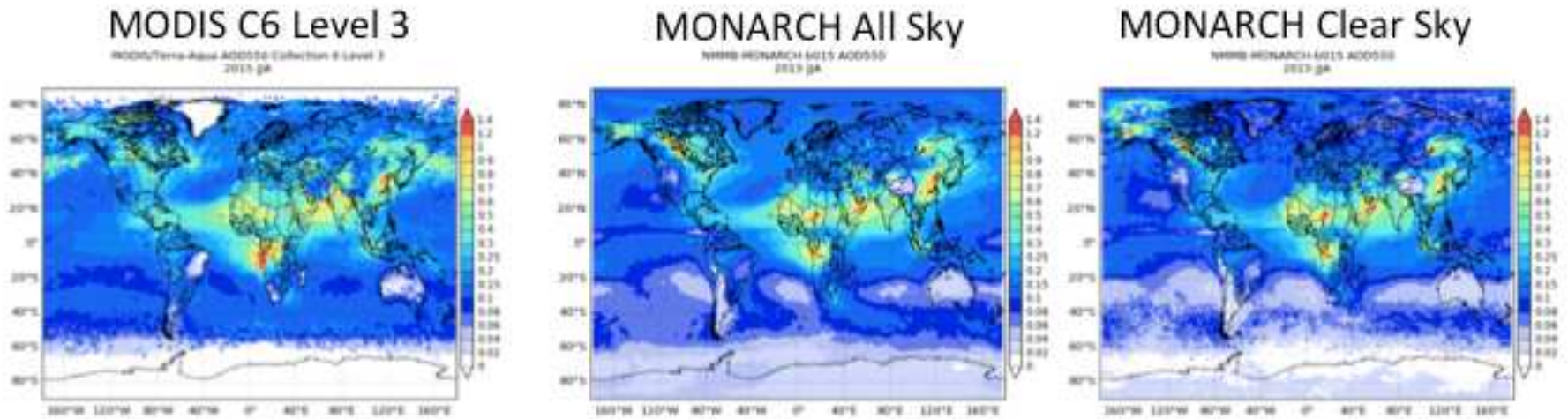
Aerosol forecasting at global scale: International Cooperative for Aerosol Prediction



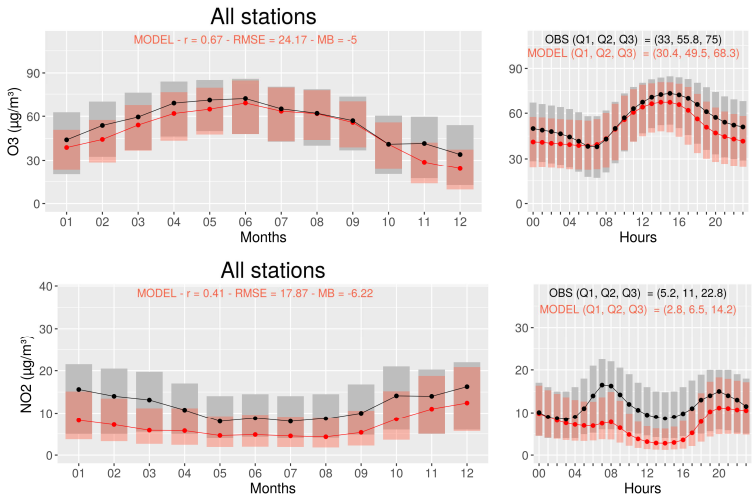


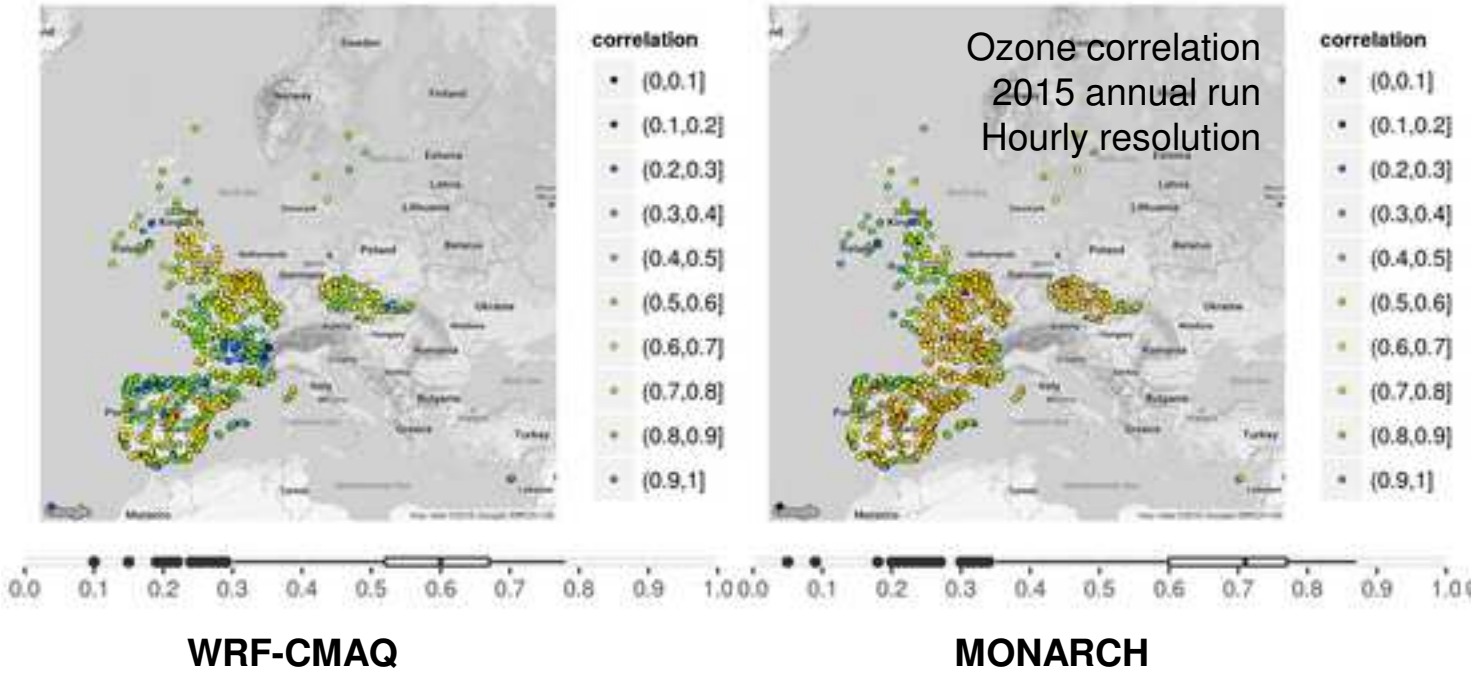
JJA



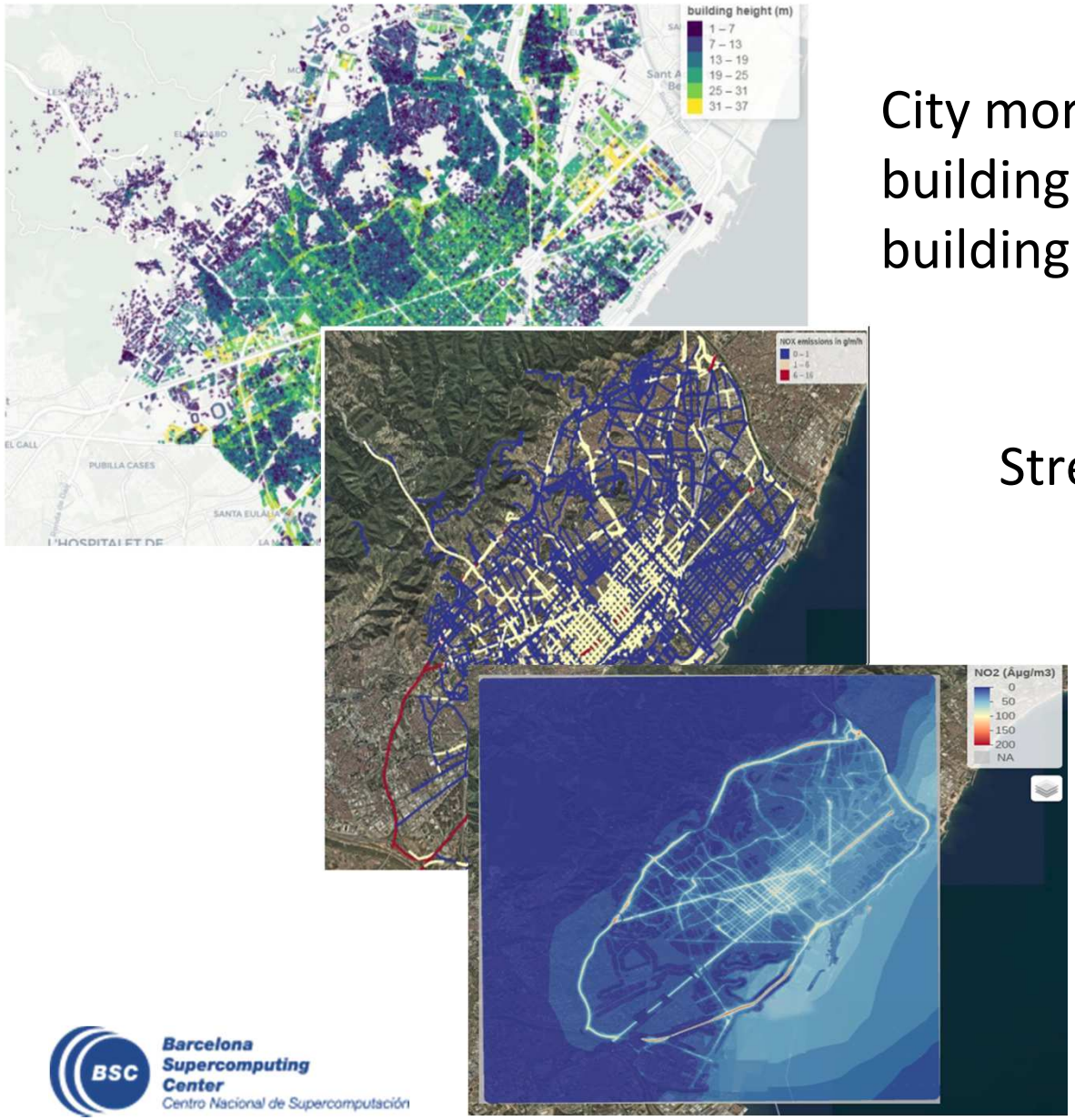
Regional Air Quality

- Model results evaluated with EIONET and EBAS gas-phase and aerosol surface concentration measurements
- European domain at 12 km
- Comparison with current CALIOPE system based on WRF-CMAQ shows good improvements





Street Scale NO_2 modelling: Barcelona case



City morphology parameters: building height, street width, building density

Street scale NO_x emissions from HERMESv3

Mesoscale – Street Canyon model coupling: NO_2 concentration

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Data assimilation work

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Ensemble-Based Data Assimilation (DA) at BSC

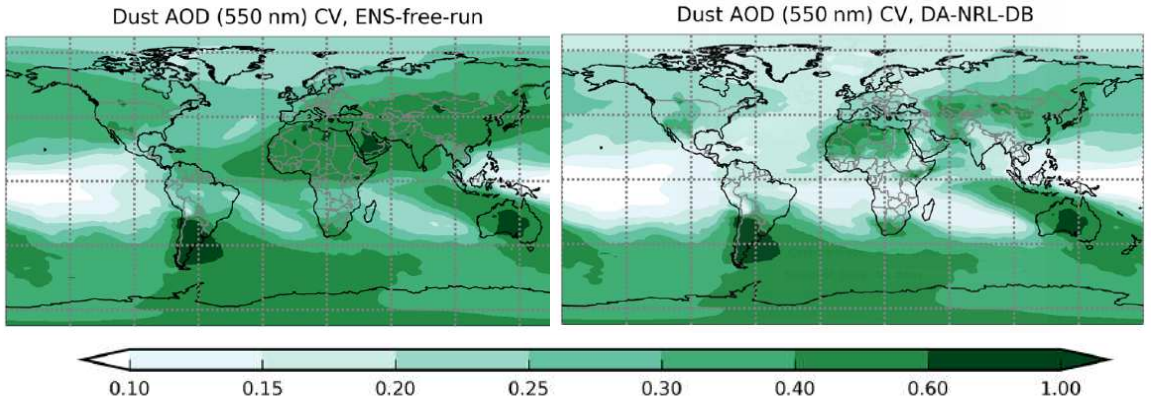
Dust ensemble forecasts are used at BSC to estimate **flow-dependent forecast uncertainty,** which is used by DA to optimally combine forecast with observations

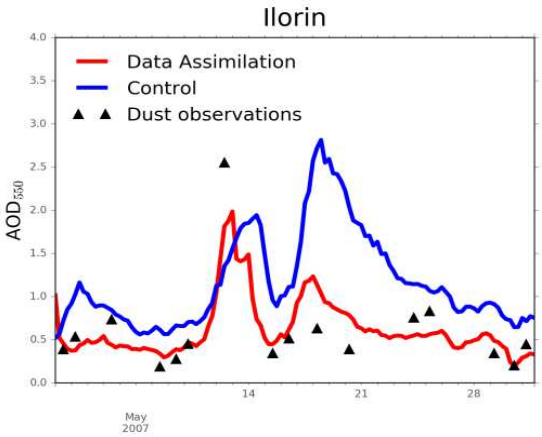
The ensemble forecast has been designed considering model uncertainties with respect to:

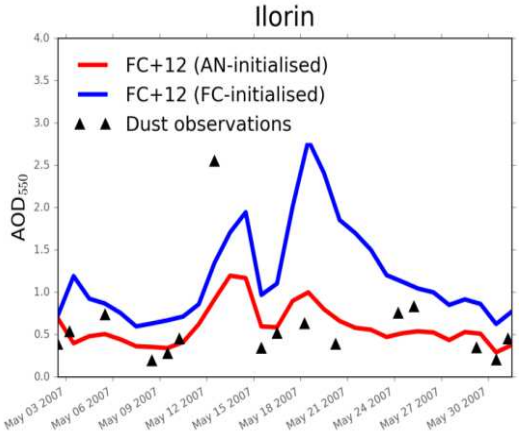
- **surface winds**
- **soil humidity**
- **vertical flux distribution at sources**

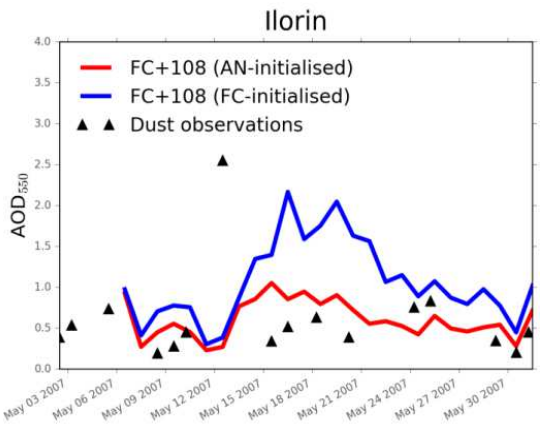
Ensemble free run

Data assimilation run









▲ *AERONET independent observations*

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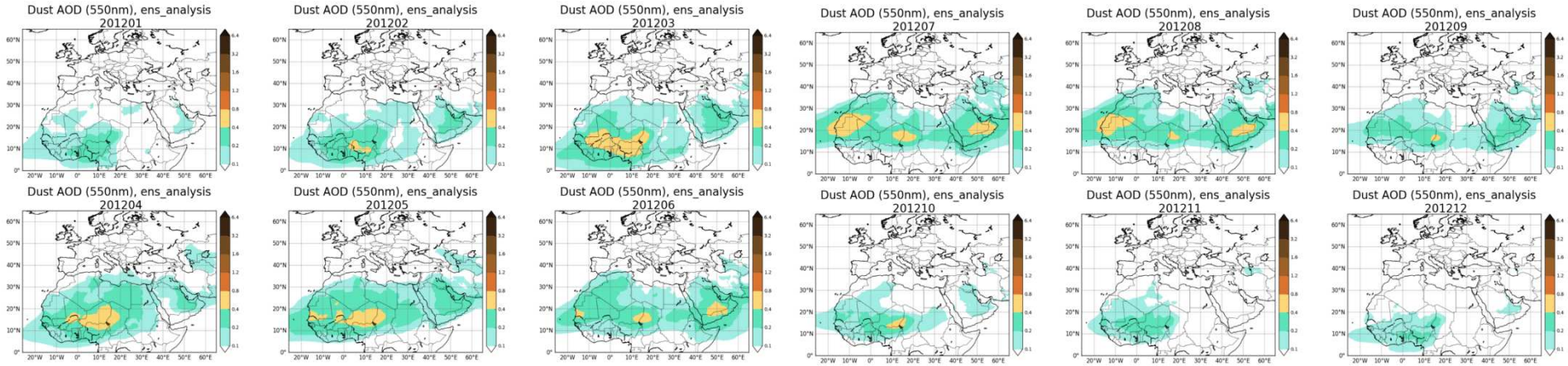
Better description of current and forecast conditions for dust with DA

DustClim Project (2017-2020)

Produce a **high resolution dust reanalysis** for Northern Africa, Middle East and Europe covering the satellite era of quantitative aerosol information, and develop **dust-related services** tailored to specific socio-economic sectors

Monthly dust analyses for 2012



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Conclusions

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Conclusions

- Atmospheric Composition Group of BSC focused on Atmospheric Chemistry model developments
- MONARCH – HERMESv3 systems allow wide range of applications
- Used in SDS-WAS, ICAP, CALIOPE and in the forthcoming Phase-II CAMS-50
- Successful collaboration with AEMET in WMO Dust centers
- Potential further collaborations in air quality with AEMET

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Gracias!

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