Pan-Eurasian Experiment
PEEX

FOCI

PEEX Seminar at the ACCC Impact Week (April 2026)
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Regional scale modelling for Europe: towards climate and air quality modelling convergence

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Air Pollution and Climate interactions

"**Air quality and climate change represent two sides of the same coin**, addressing both issues together could lead to significant synergies and economic benefits while avoiding policy actions that mitigate one of the two issues but worsen the other" (IPCC AR6)

- **Most pollutants** (including aerosols (SOA, SIA, BC, mineral dust and sea spray) and chemically reactive gases (O_3, NO_2, CO, VOCs, SO_2, NH_3)) **are also short-lived climate forcers** that can have warming or cooling effect.

- **Climate can impact local air quality**, e.g. higher temperatures impact on atmospheric dispersion, deposition and chemistry of pollutants.

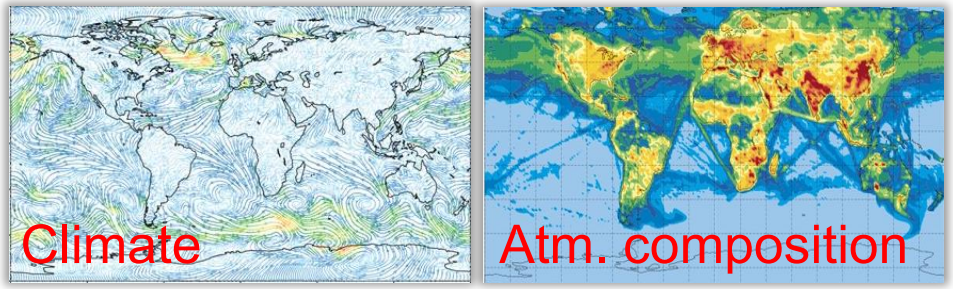
- Climate and air quality policies need a better interconnection:
  - **The evaluation of air quality measures should consider the climate change impact** on their effectiveness together with their feedback on climate change mitigation
  - **GHGs emission reduction actions should consider** their impact on **pollutants' emission**

It didn't happen in the recent past

FOCI coherent coupled multiscale modelling framework

FOCI project: short-lived climate forcers effects on climate and air quality

Global climate predictions



Forcings

- Anthropogenic emissions
- Wildfires emissions
- Land cover

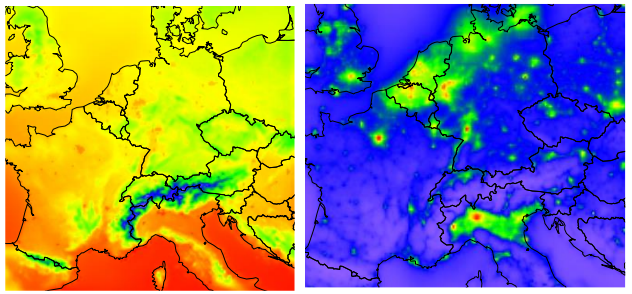
Coherent with Climate CMIP6/CMIP7

Integration needed for downscaling:

- CEDS -> PM2.5, PM10
- GFED -> daily wildfire emissions
- LUH2 -> LUCAS

BCs from driving ESM

RCMs



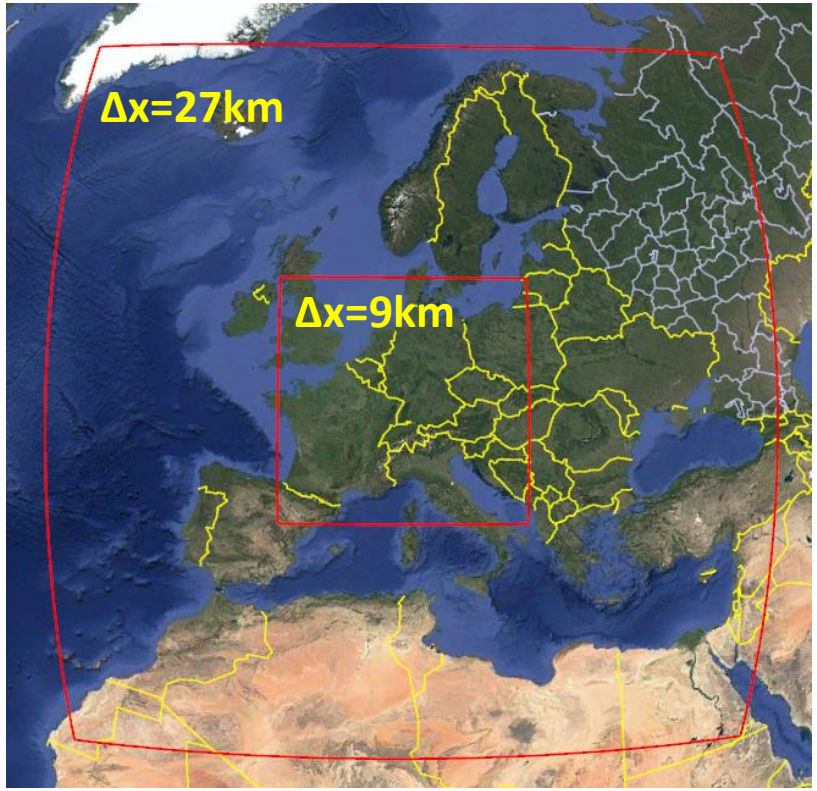
Regional climate & atm. Comp predictions

Inline forcings computation

- Biogenic emissions
- Dust
- Sea Salt

Driven by downscaled climate and related inputs (land cover)

WRF historical simulation 2005-2019: configuration



WRF + FARM domains and configuration

outer domain (nearly coincident with CORDEX Europe), grid spacing **27km**, nx=ny=195, nz=35, dt=120s

Inner domain, grid spacing **9km**, nx=187, ny=184, nz=35, dt=40s

Simulation length: 15 year (2005-2019), 2004=spin-up

LandCover: LUCAS (harmonised with LUH2)

WRF

Spectral nudging inside the outer domain

Forcing at BC: ERA5 reanalyses; EC-Earth3

FARM

Forcing at BC: CAMS global reanalyses (EAC4); EC-Earth3

Emission inventory: CEDS + GFED5

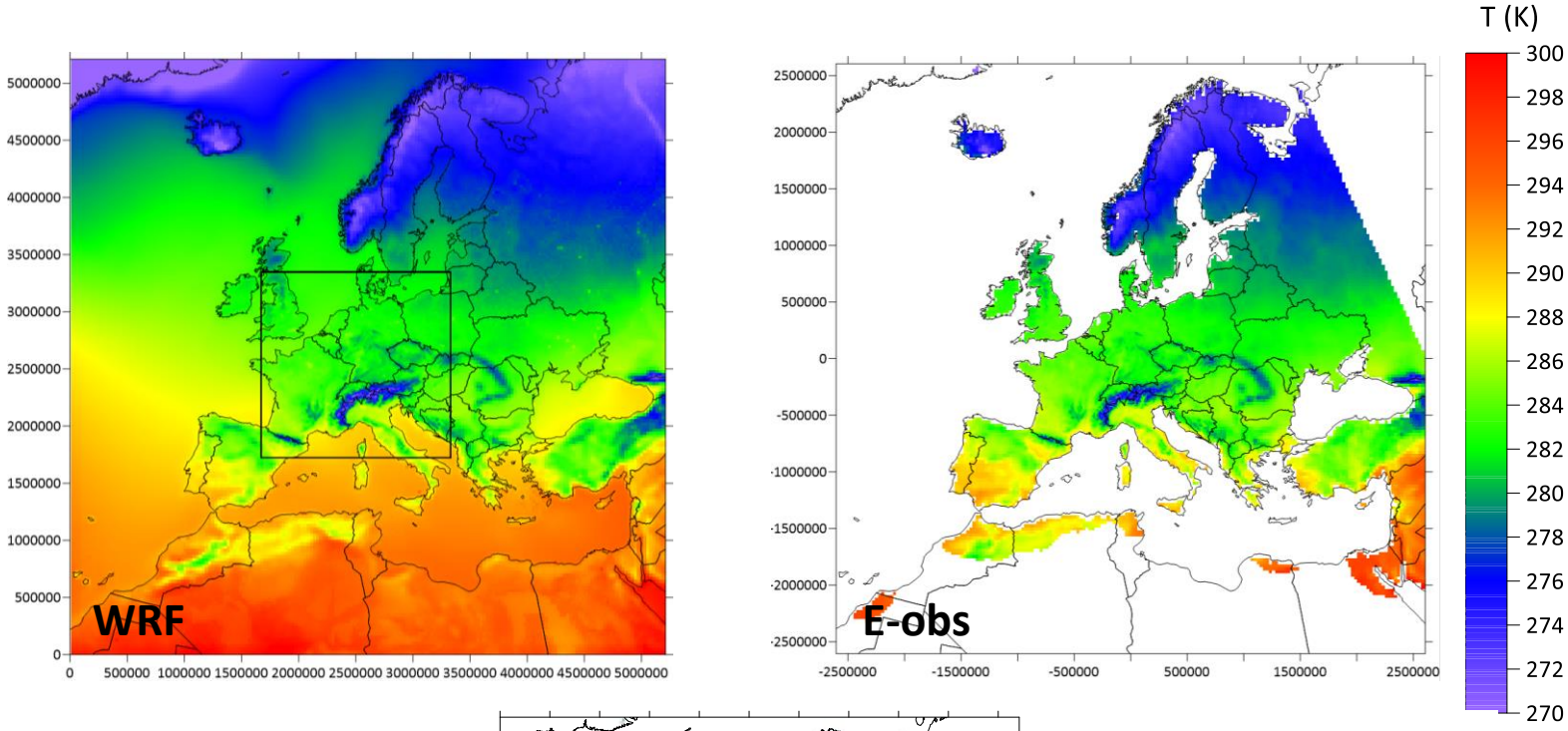
Biogenic emissions: PSEM

Chemical scheme: SAPRC99

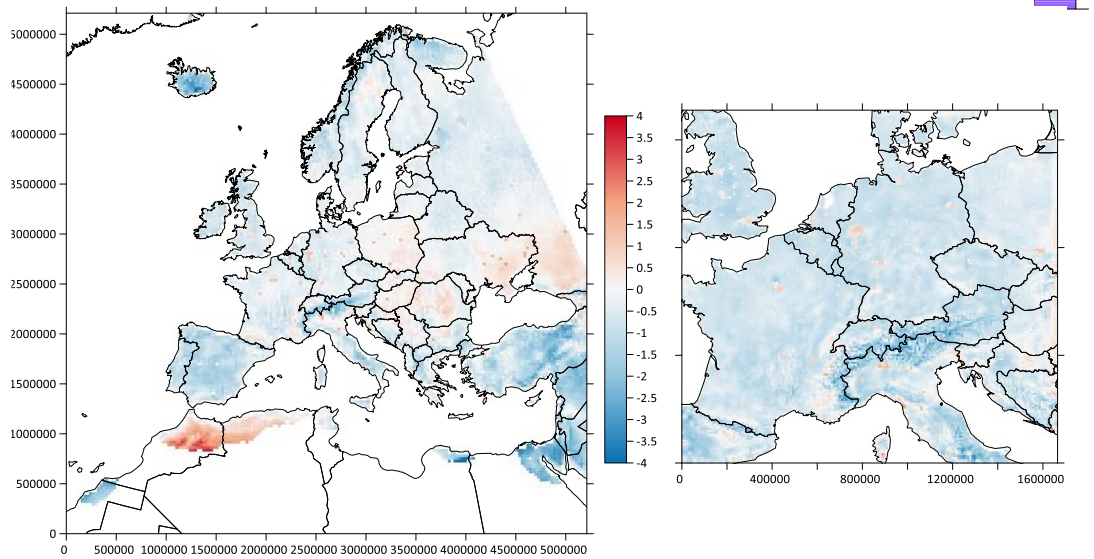
Aerosol scheme: modal, AERO3

WRF ARW 4.5.2 physical scheme	Description
Microphysics	Morrison double-moment scheme (10)
Long wave radiation	RRTMG (Rapid Radiative Transfer Model) (4)
Short wave radiation	RRTMG (4)
Cumulus convection	Grell-Freitas (GF) scheme (3)
Surface model	Noah Land Surface Model
Surface Layer	MYNN surface layer. Nakanishi and Niino PBL's surface layer scheme (5).
Boundary layer	Mellor-Yamada Nakanishi and Niino Level 2.5 PBL (5)
Urban parameterization	None

WRF evaluation with reanalyses for historical simulation (2005 to 2019)



Mean difference = WRF – e-obs



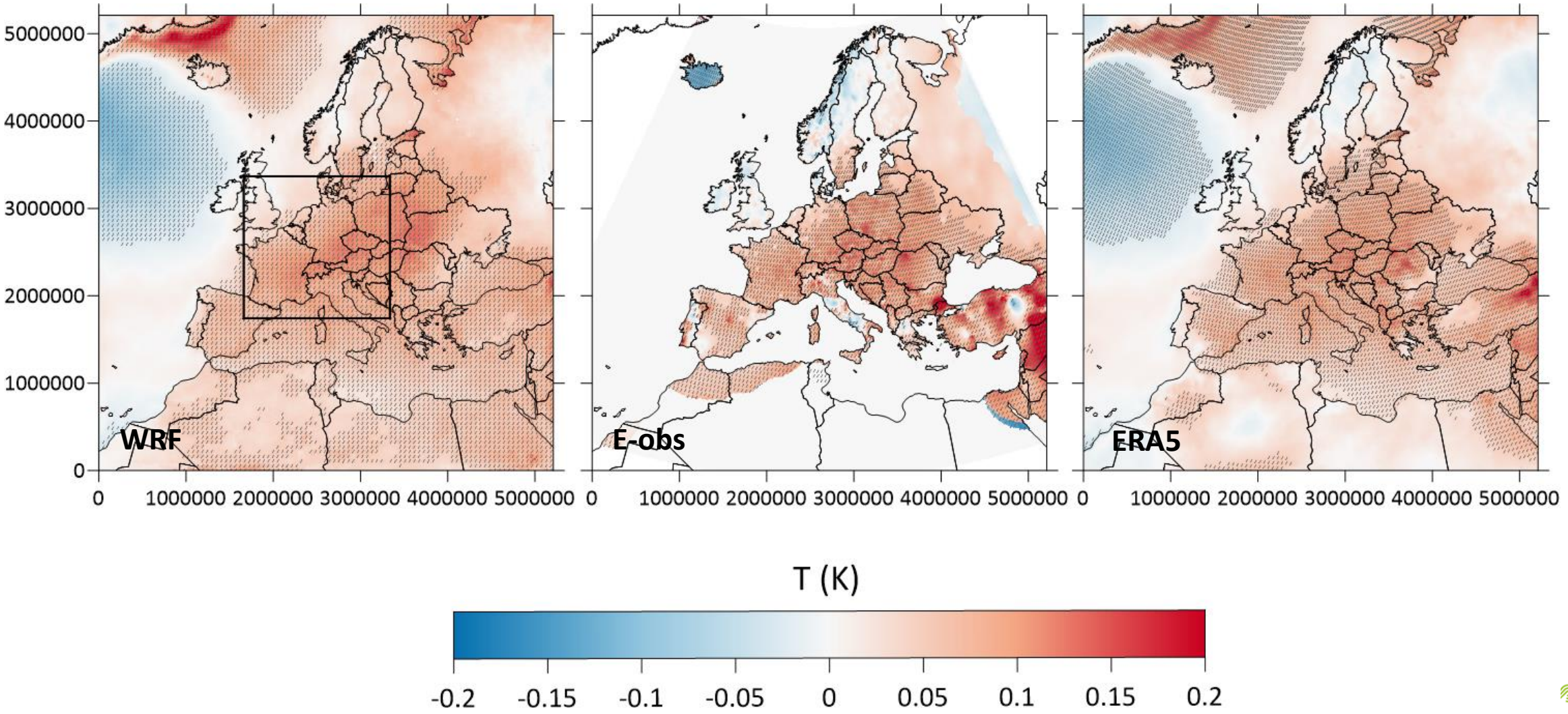
T2m

Comparison with:

- E-obs (v30)

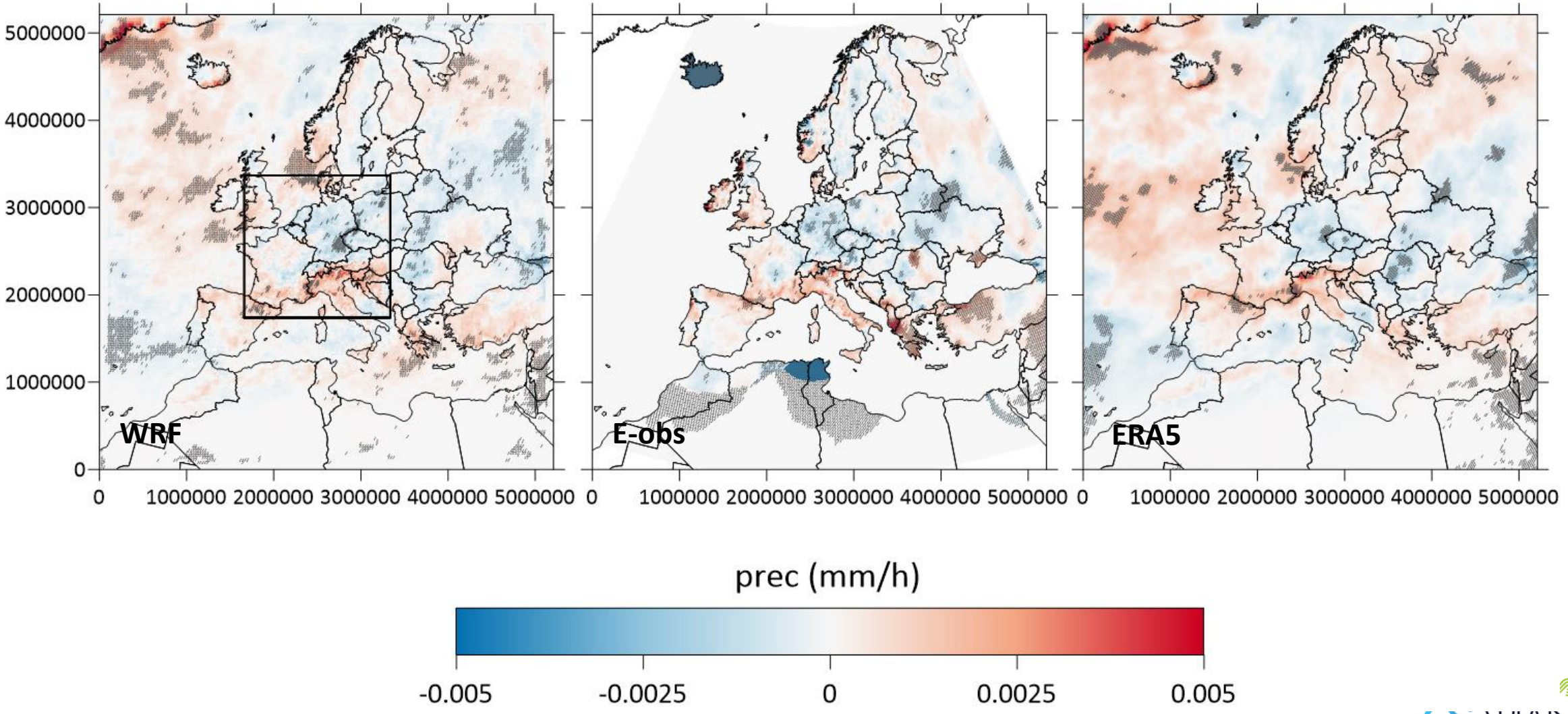
WRF evaluation with reanalyses for historical simulation (2005 to 2019)

2005-2019 T linear trend (C/year)

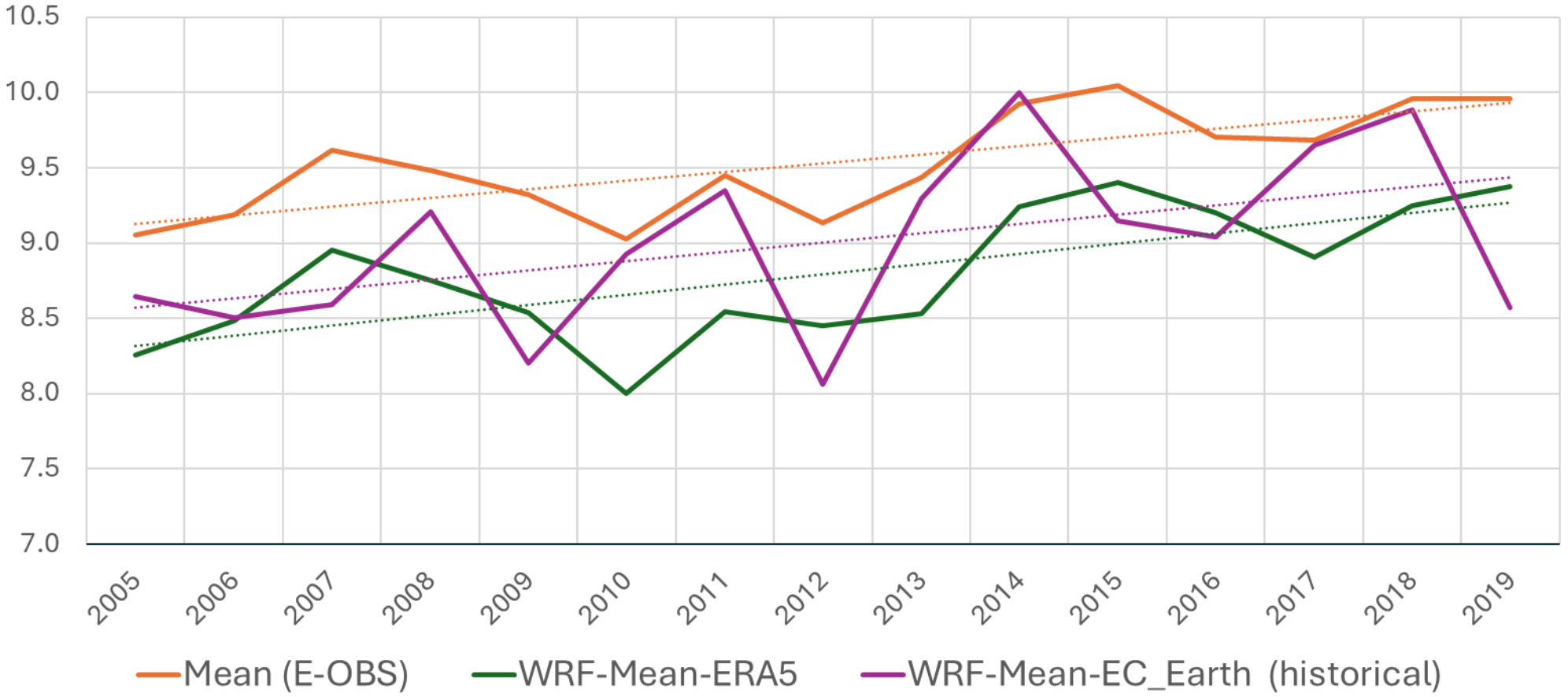


WRF evaluation with reanalyses for historical simulation (2005 to 2019)

2005-2019 precipitation linear trend (mm/h/year)



Annual means of T2m from historical period 2005-2019 (WRF vs e-obs)



Linear trend slope (2005-2014):

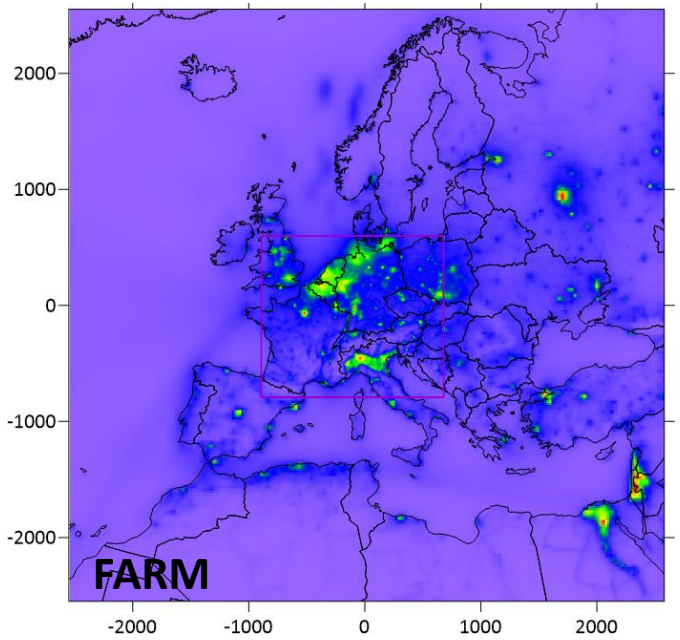
E-OBS: 0.058 C/y
WRF (ERA5): 0.068 C/y
WRF (EC_Earth): 0.062 C/y

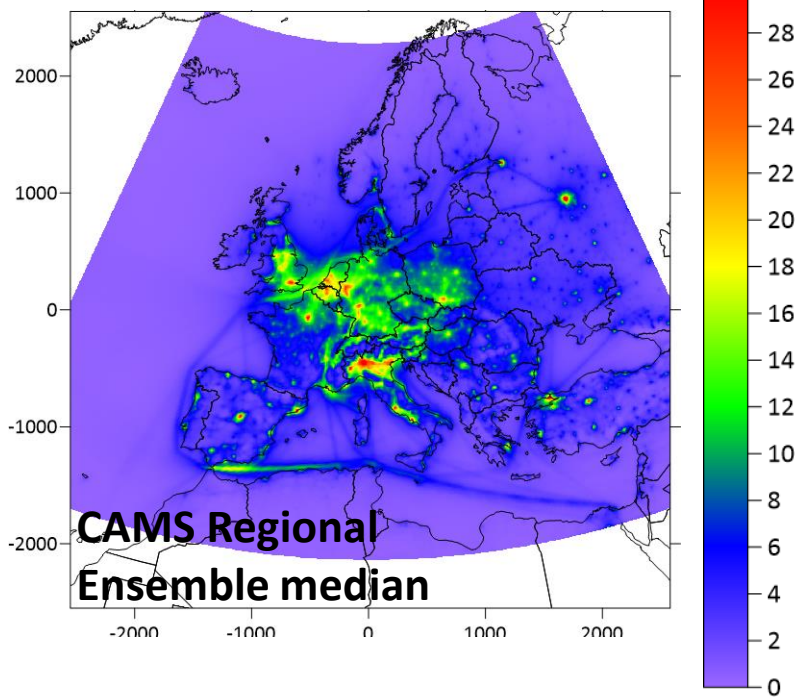
Mean BIAS (2005-2014):

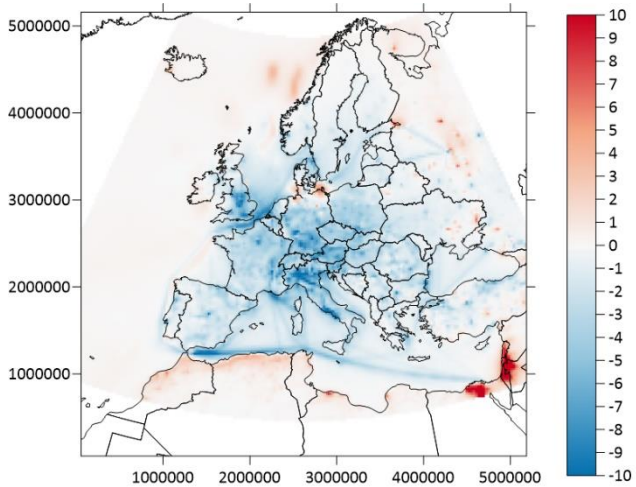
WRF (ERA5) - E-OBS: 0.6 C
WRF (EC_Earth) – E-OBS: 0.3 C

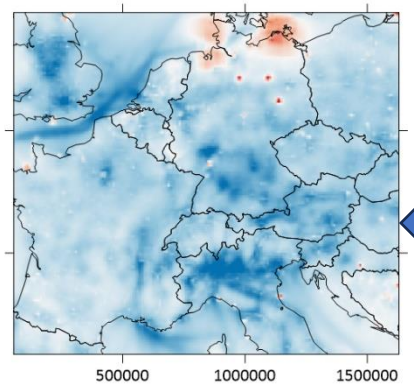
Spatial mean computed over E-OBS and WRF coarser domain intersection

FARM evaluation with reanalyses for historical simulation (2013 to 2019)





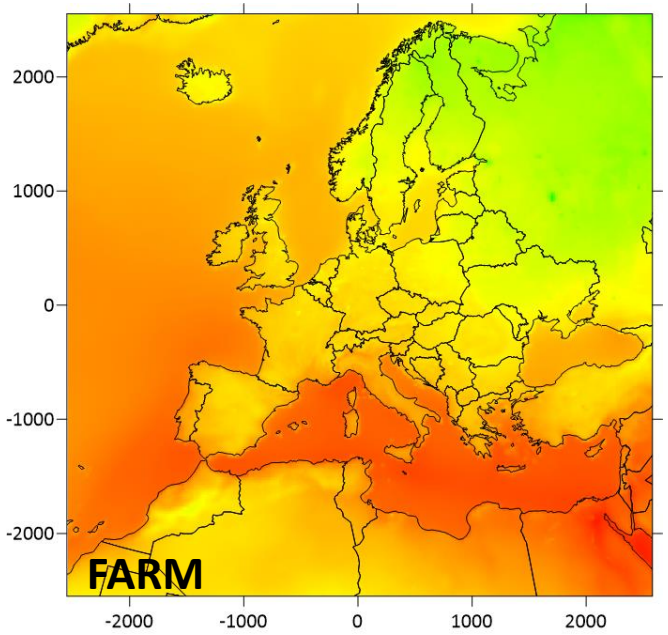


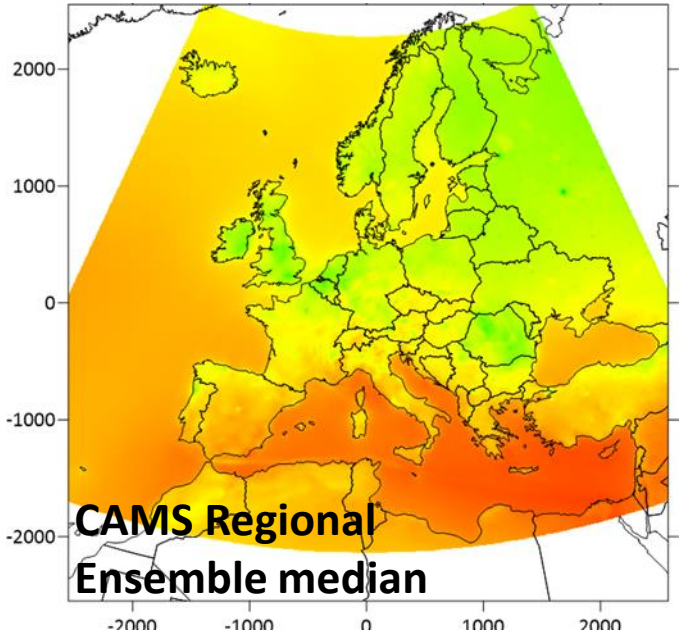


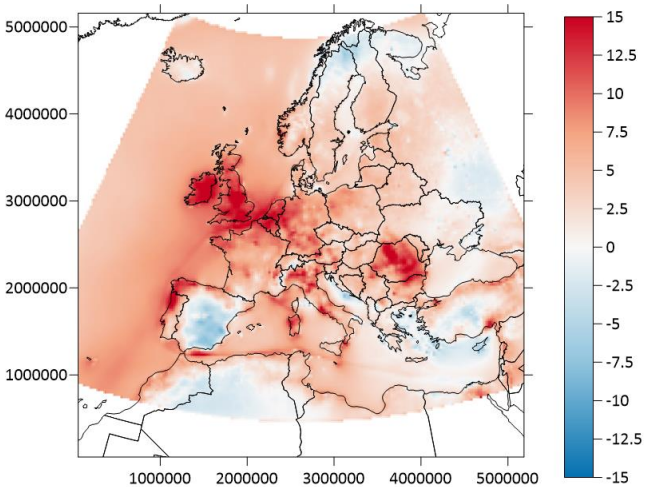
NO2

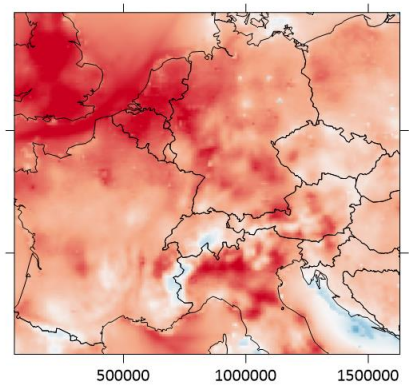
Comparison with:
CAMS regional

FARM evaluation with reanalyses for historical simulation (2013 to 2019)



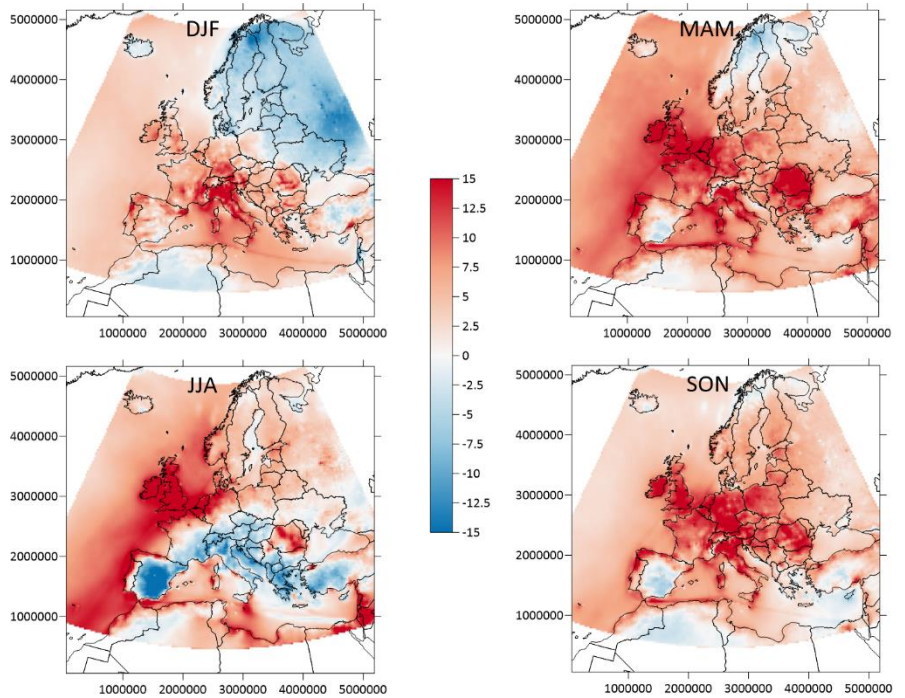




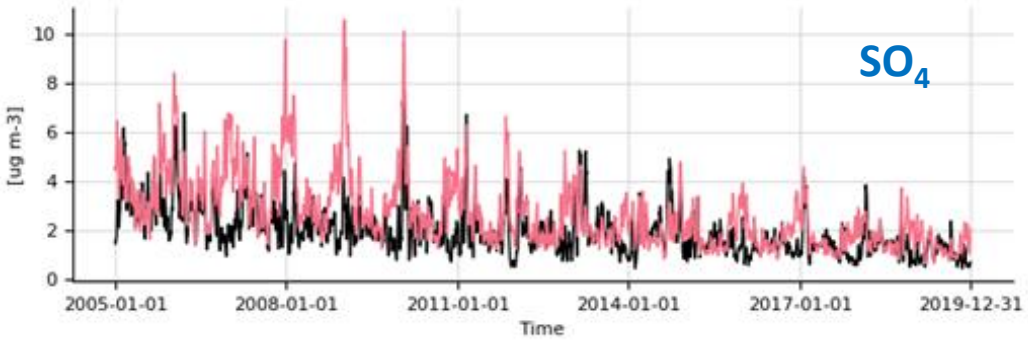


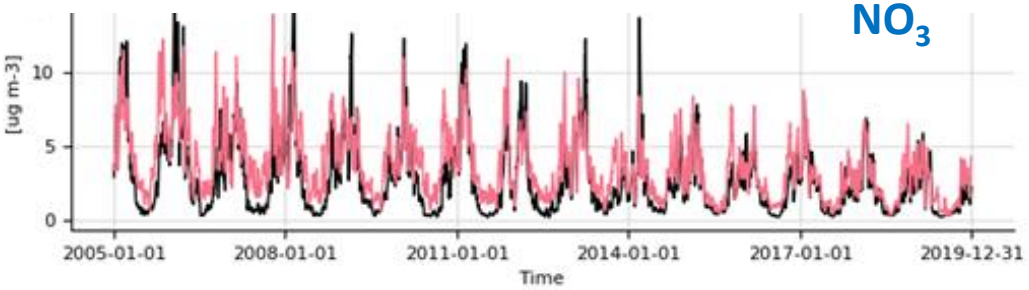
O3 mda8h

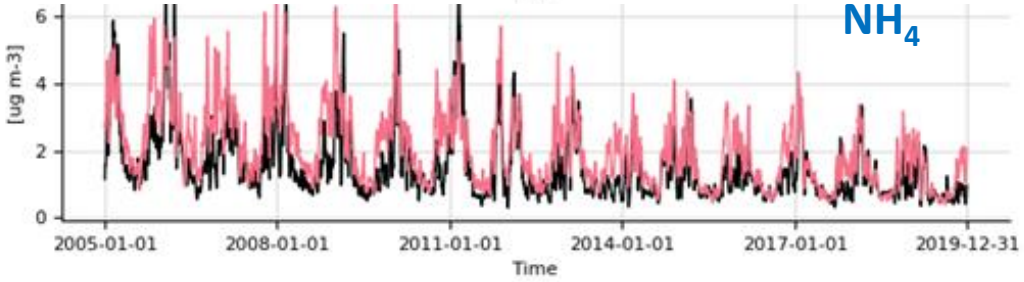
Comparison with:
CAMS regional

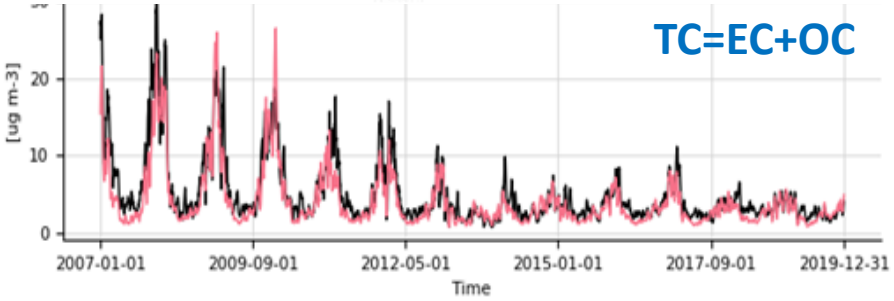


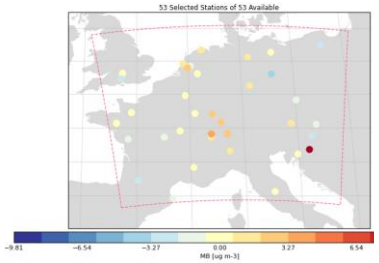
PM2.5 components (μg m^{-3}) FARM vs EMEP network 2005-2019



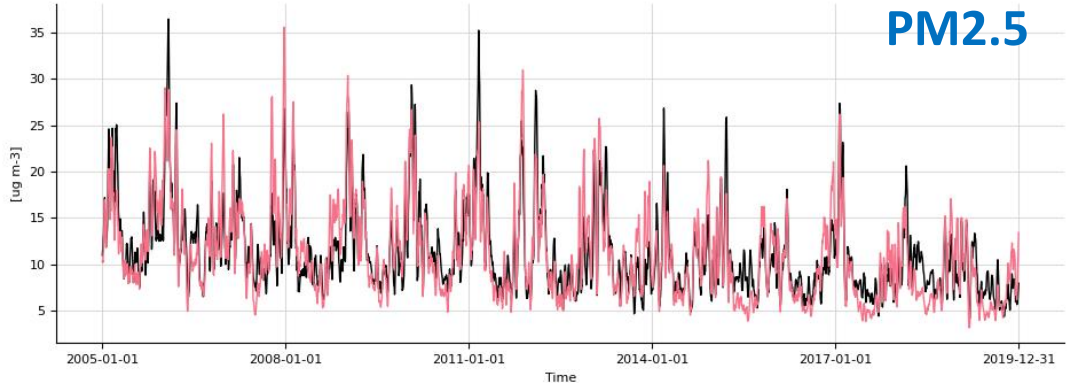


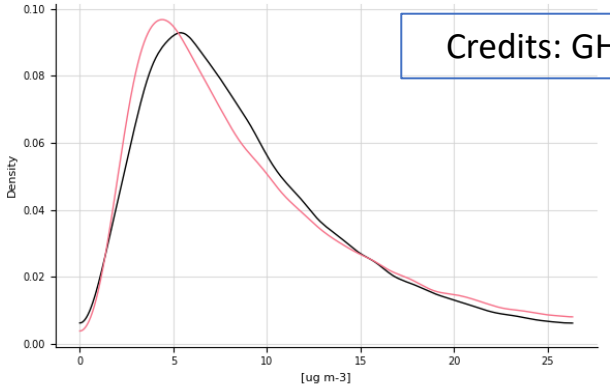




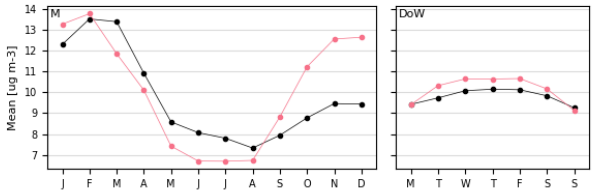


	Mean	StdDev	p5	Median	p95	NStations	Min	Max
observations	9.80	7.50	2.77	7.63	24.14	20.00	0.80	69.34
d02gmt-eu-000	10.14	7.41	2.59	7.88	25.31	20.00	0.98	52.17



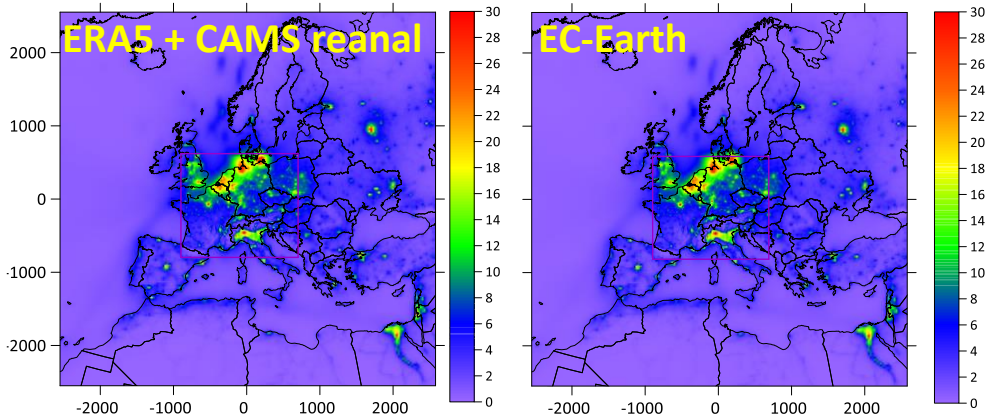


Credits: GHOST dbase and PROVIDENTIA tool (BSC)

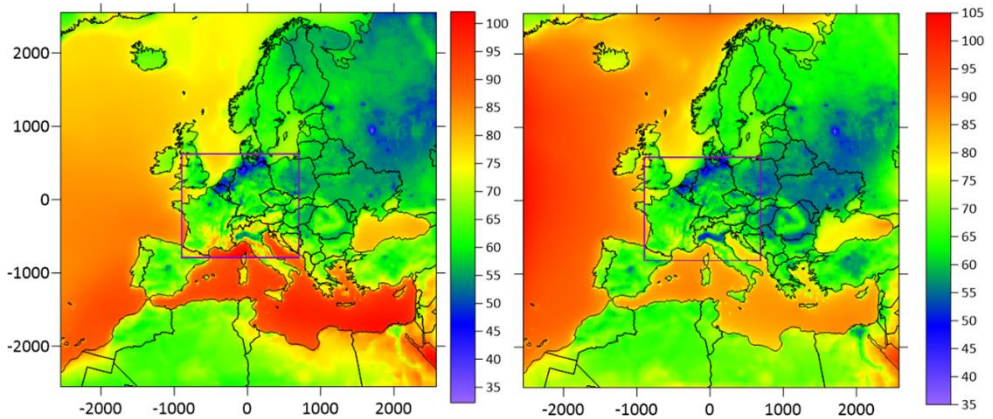


● observations ● d02gmt-eu-000

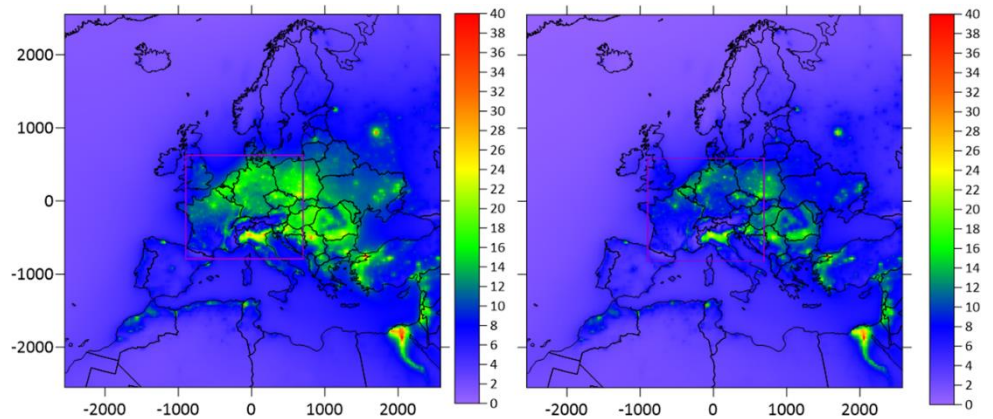
FARM: differences EC-Earth vs ERA5+CAMS driven simulations



NO2



O3



PM2.5

Concluding remarks

- FOCI regional modelling framework has been applied to reconstruct in a coherent way continental scale climate and atmospheric composition variability
- CEDS SLCP emission inventory allows the reconstruction of continental scale air quality over Europe and its changes recorded by background monitoring stations and reanalyses during the last decades
- PM2.5 and PM10 emissions are missing in CEDS inventory and has been integrated by FOCI project. CEDS seems causing NO2 underestimation with respect to regional inventories
- The cross-comparison of regional model results driven by reanalyses and climate models (EC-Earth3) confirms the usability of the tested modelling framework to analyse historical and future climate/air quality interactions
- Results need to be confirmed by (online & offline coupled) multi-model results within FOCI

Thank you for your attention!

More details will be presented at the:

15th International Conference on Air Quality Science and Application
1-5 June 2026, Charles University, Prague, Czech Republic

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