
XII giornata sulla modellistica in ARIA(NET)
Milano, 25-26 marzo 2025

Progetto HORIZON FOCI: clima e qualità dell'aria

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Project FOCI

Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts

Coordinators: Tomas Halenka (CU), Ranjeet S. Sokhi (UH)

<https://www.project-foci.eu/>



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European Union



UK Research
and Innovation

Motivation

IPCC AR6 WGI:

- Well mixed CO₂ and its impacts on global to continental scales well understood with a high level of confidence
- knowledge gaps concerning the impact of non-CO₂ radiative forcers leading to low confidence in the conclusions
 - a) anthropogenic and natural precursor emissions of short-lived forcers
 - b) effects on atmospheric chemistry and climate, through direct emissions dependent on changes in e.g., agriculture and technologies based on scenarios for future development, as well as feedbacks of global warming
 - c) albedo changes connected to land-use and land-cover, depending on the adaptation or mitigation measures included in different scenarios

WP5: Multiscale emissions processing and development of scenarios for model projections

- **Adaptation of CEDS emissions to regional scale atmospheric composition modelling**
- **Task 5.3: Effect of species-specific emission modelling on BVOC emission estimate (historical and future conditions) -> PSEM vs MEGAN v2.04 vs MEGAN v2.1 vs MEGAN 3.2**
- **Task 5.5: Evaluate the impact of agriculture emissions reduction measures on non-CO2 GHG**

WP4: Regional model improvement and evaluation with observations for quantifying multiscale impacts of non-CO2 radiative forcers

WP6: Multiscale projections to quantify contributions, impacts and uncertainties (on climate, weather, air quality and health)

- **Task 6.1: High-resolution Climate Projections for near and mid future**
- **Task 6.4: Regional and urban multiscale climate impact**

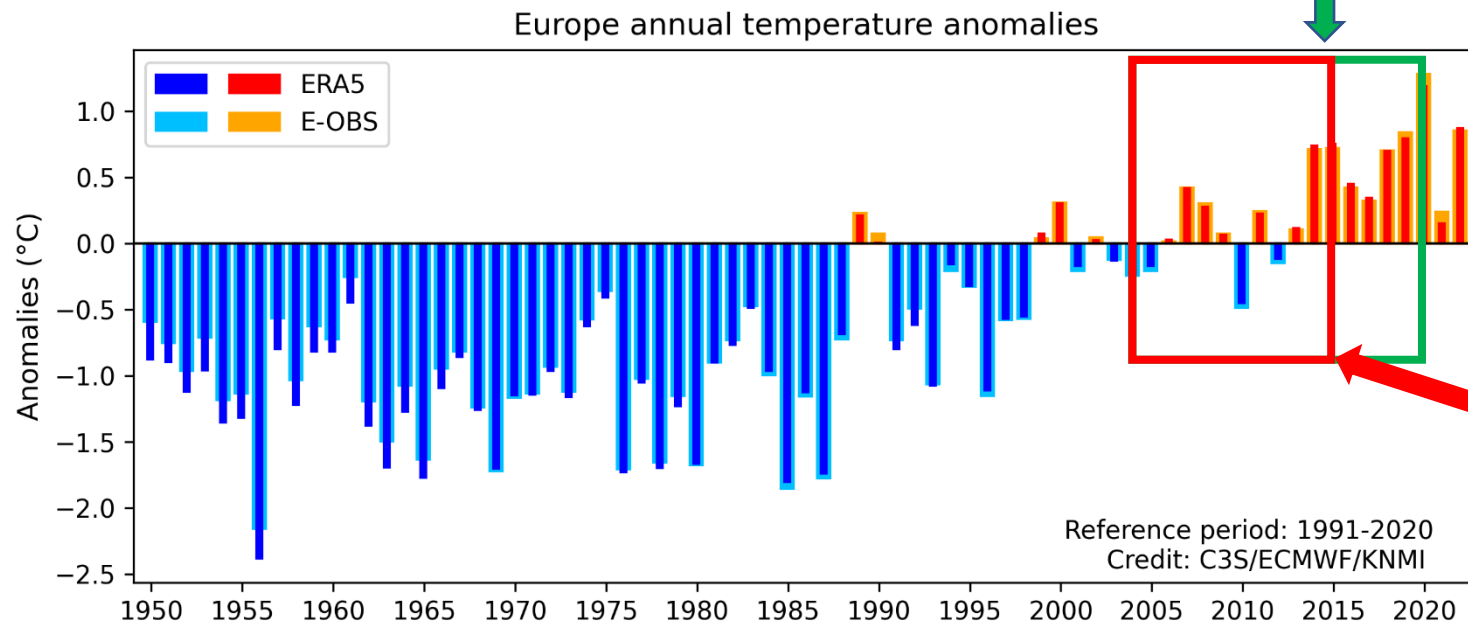
Scenario	Models	Time window	Met. driver	Atmospheric composition driver	Emissions	Land Cover
Historical driven by reanalyses (2004-2019)	WRF+FARM	2004-2019	ERA5	CAMS global Reanalyses	CEDS	LUCAS (LH2 compatible)
Historical driven by EC-Earth3 (historical 2004-2014 and SSP3.7.0 2015-2019)	WRF+FARM	2004-2019	EC-Earth3	EC-Earth3	CEDS	LUCAS (LH2 compatible)
CMIP6 SSP3.7.0 scenario (2045-2055)	WRF+FARM	2045-2055	EC-Earth3	EC-Earth3	CEDS	LUCAS (LH2 compatible)
CMIP6 SSP3.7.0-low NTCF scenario (2045-2055)	WRF+FARM	2045-2055	EC-Earth3	EC-Earth3	CEDS	LUCAS (LH2 compatible)

SSP3-7.0 scenario is a medium-high reference scenario within the “regional rivalry” socio-economic family
 SSP3-7.0-LowNTCF variant of the SSP3-7.0 scenario with reduced near-term climate forcer (NTCF) emissions

Time period for model evaluation and historical conditions analysis

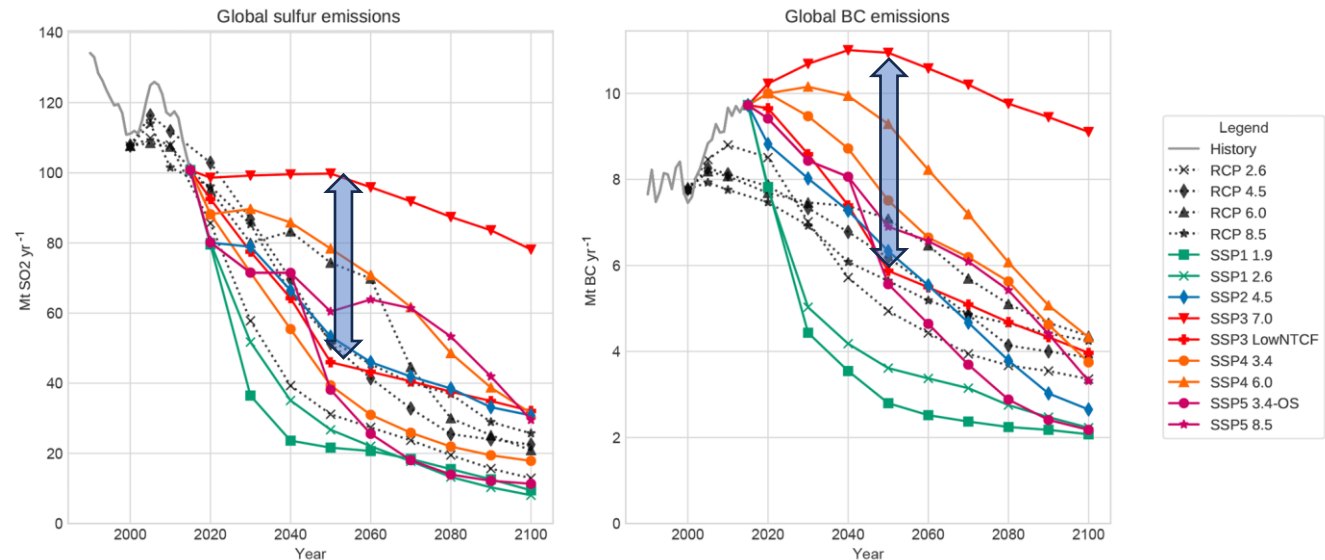
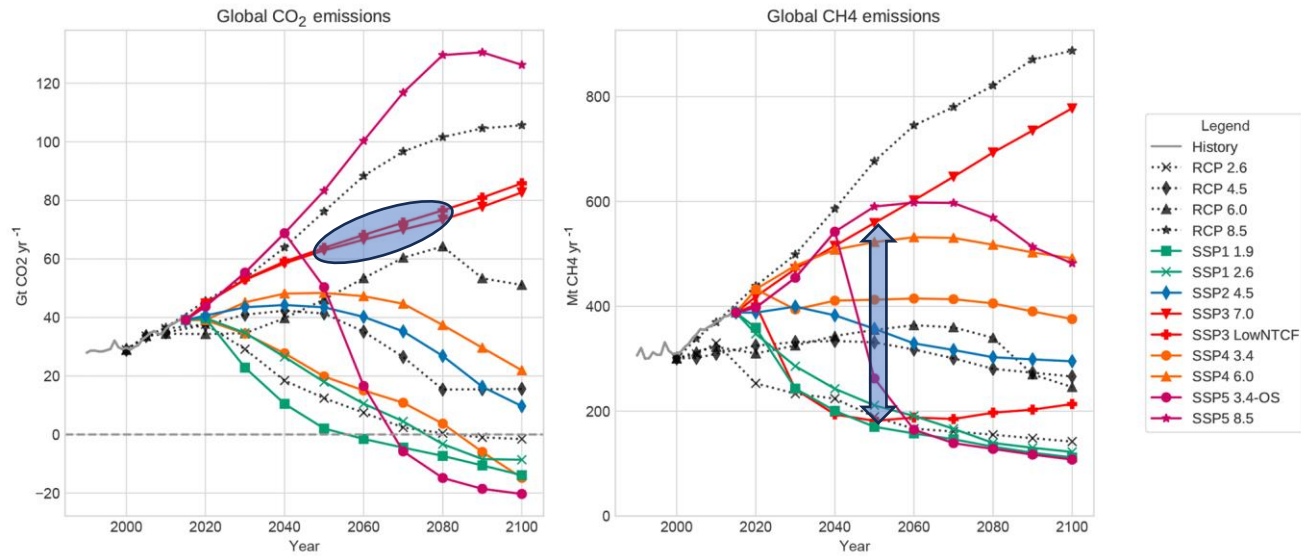
2004-2019

15+1 recent years (before covid-19)



2005-2014

Last 10 years of CMIP6 historical simulations



Gidden et al., Global emissions pathways under different socioeconomic scenarios for use in CMIP6: a dataset of harmonized emissions trajectories through the end of the century, *Geosci. Model Dev.*, 12, 1443–1475, <https://doi.org/10.5194/gmd-12-1443-2019>, 2019.



External domain (nearly coincident with CORDEX Europe),
grid spacing 27km, $n_x=n_y=195$, $n_z=35$, $dt=120s$

Internal domain, grid spacing 9km, $n_x=187$, $n_y=184$,
 $n_z=35$, $dt=40s$, 1st level at ~ 10m height

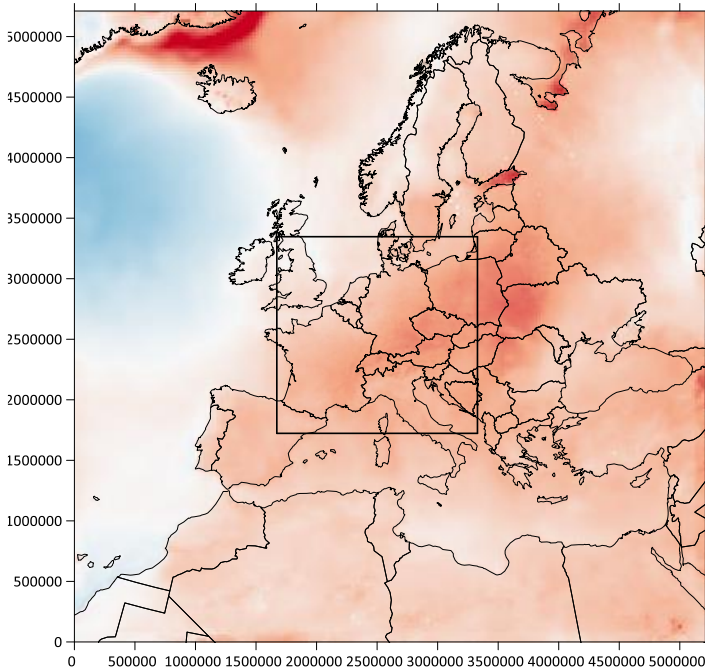
Simulation length: 16 year (2004-2019), 2004=spin-up

LUCAS LandCover

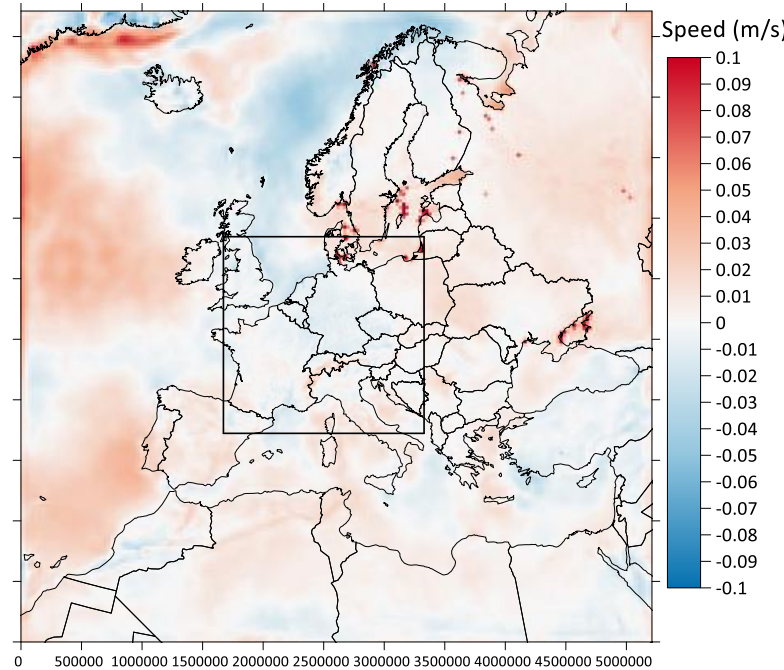
Forcing at BC: ERA5 reanalyses

Spectral nudging inside the outer domain to maintain coherence between downscaled (WRF) and forcing (ERA5) fields.

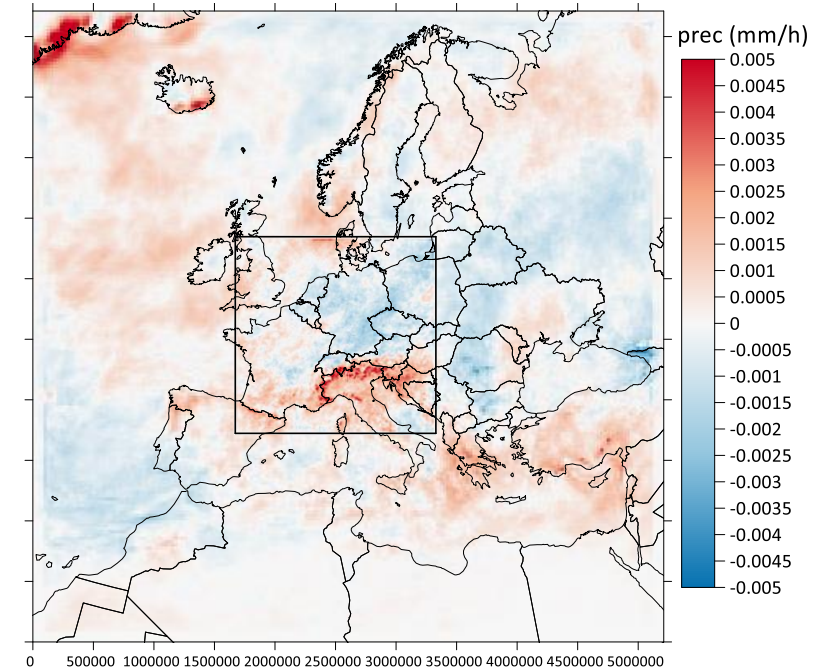
2005-2019 linear trends: rate of change per year



T

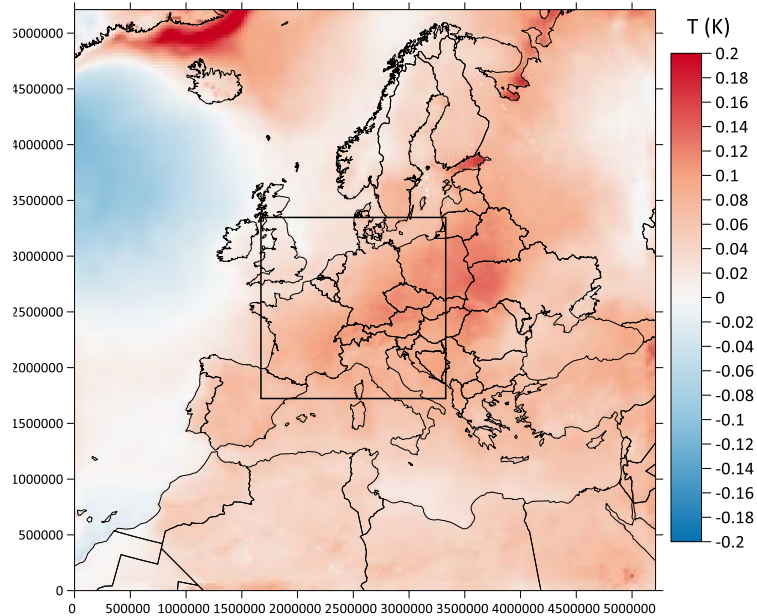


Wind speed



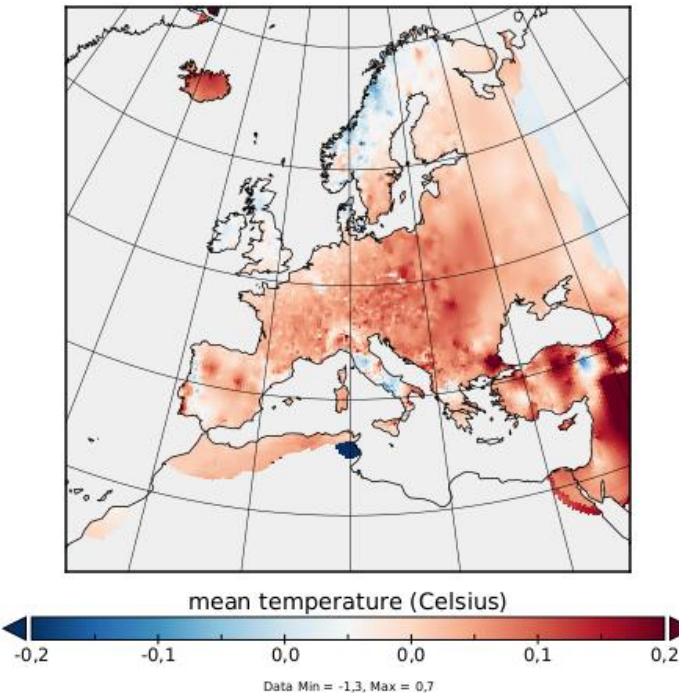
Prec

2005-2019 T trend deg/year



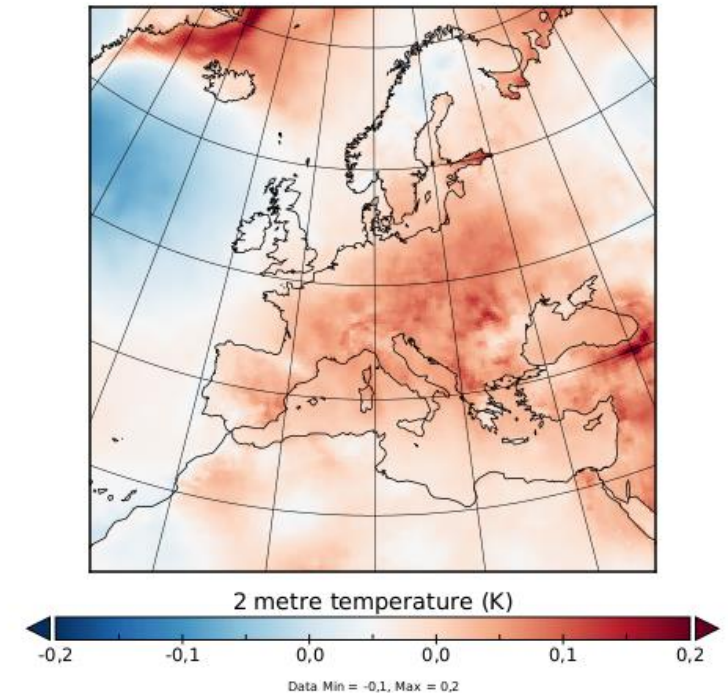
WRF

e-obs mean temperature trend



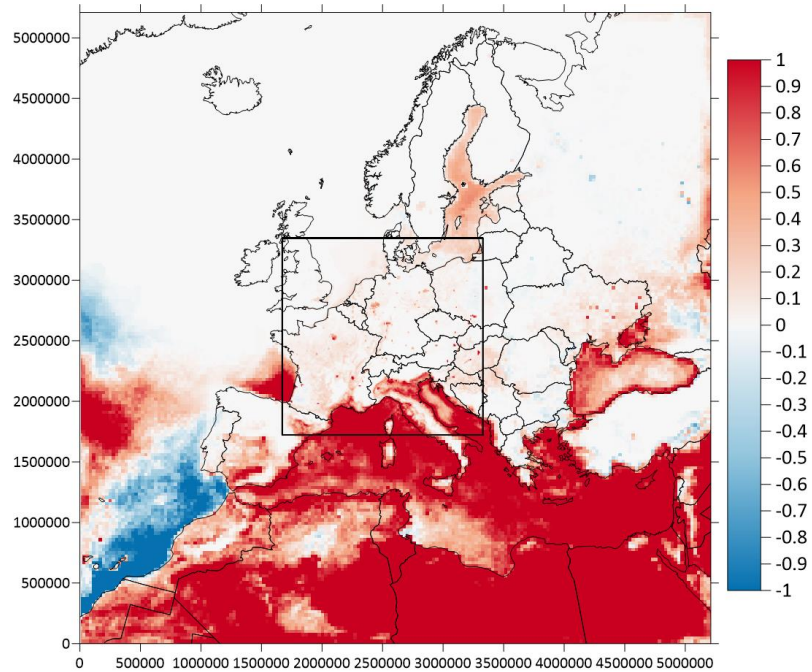
E-obs

ERA5 2 metre temperature trend

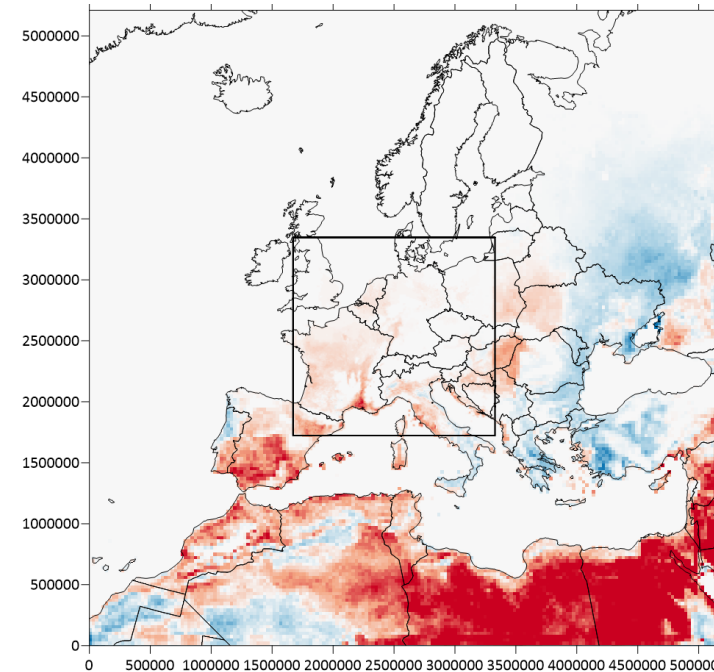


ERA5

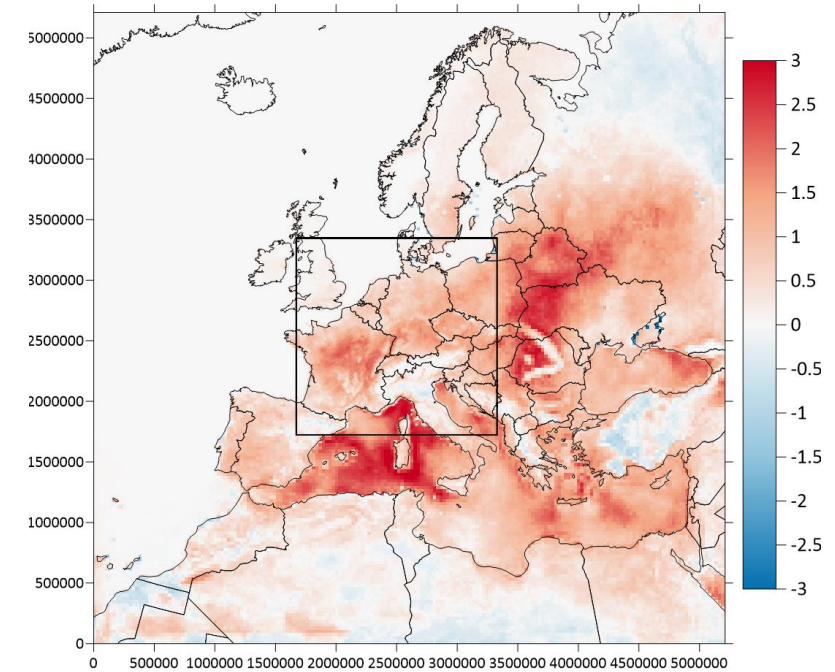
Tropical nights



Hot days Tmax >30C

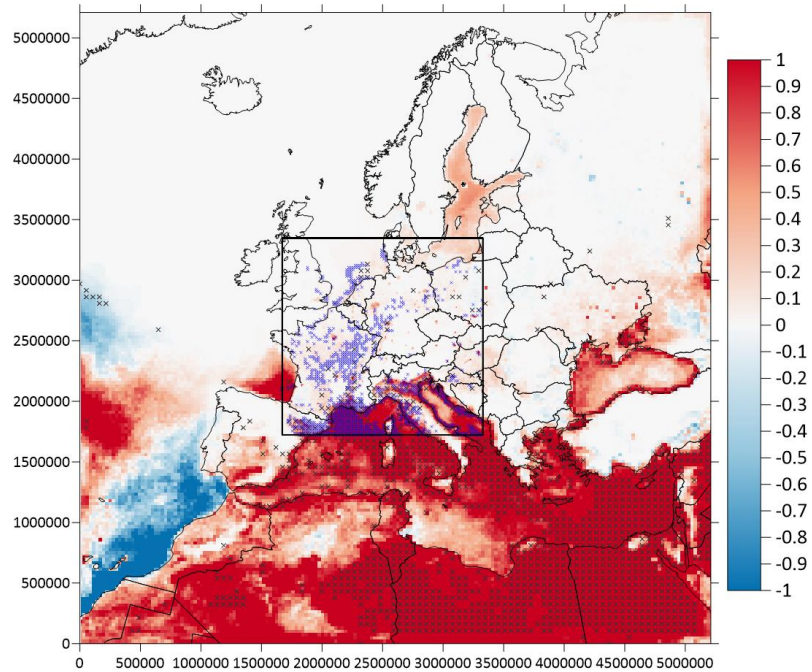


Summer days

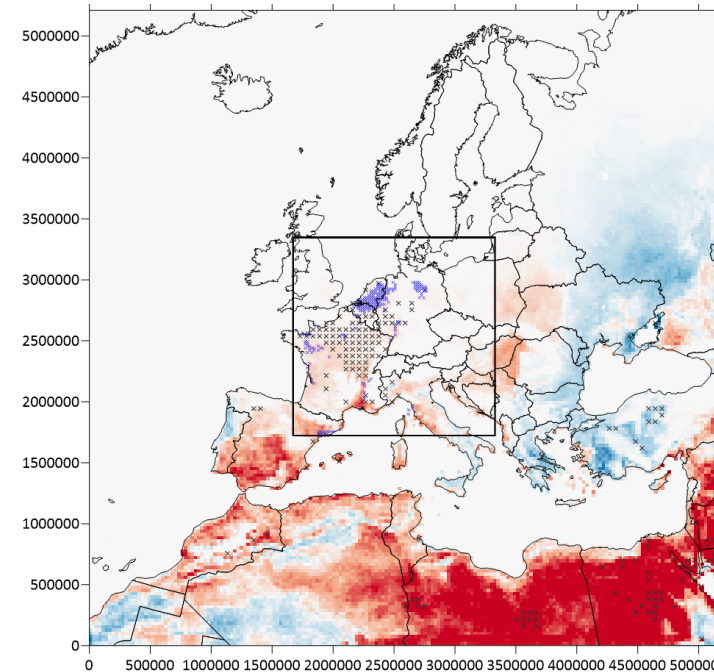


Tropical nights = days when the temperature does not fall below 20°C during the nighttime
summer days = days when the maximum air temperature is at least 25°C

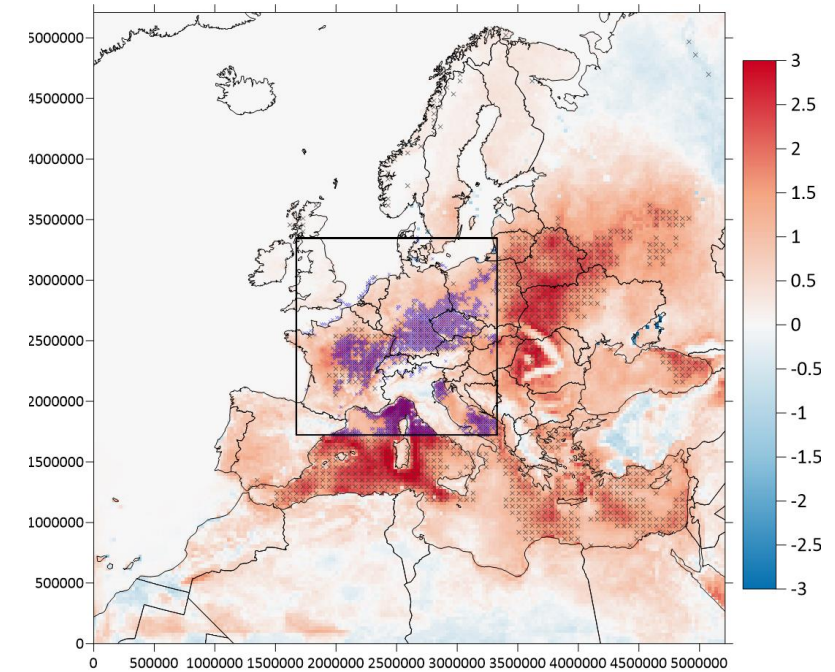
Tropical nights



Hot days Tmax >30C

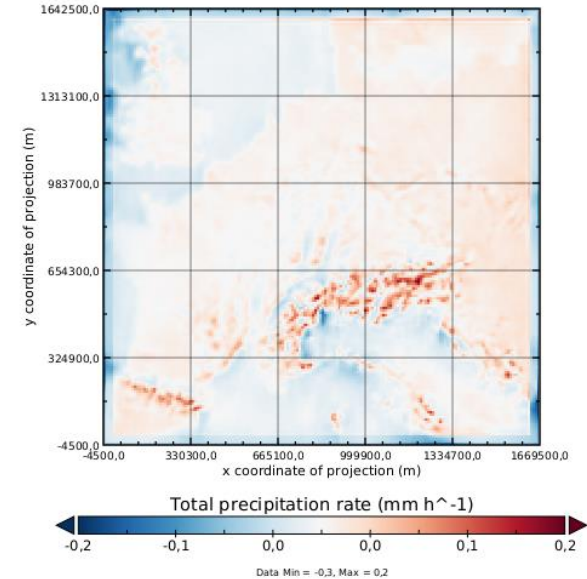
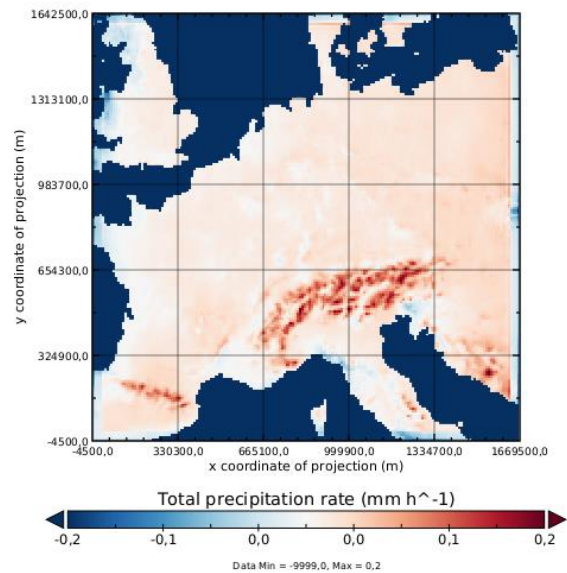
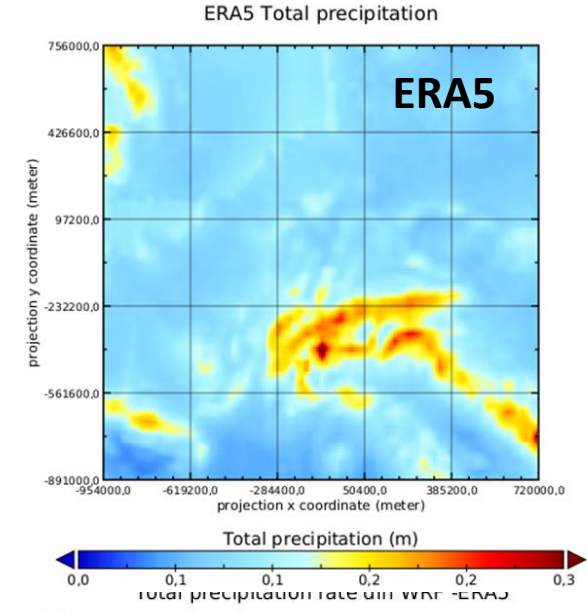
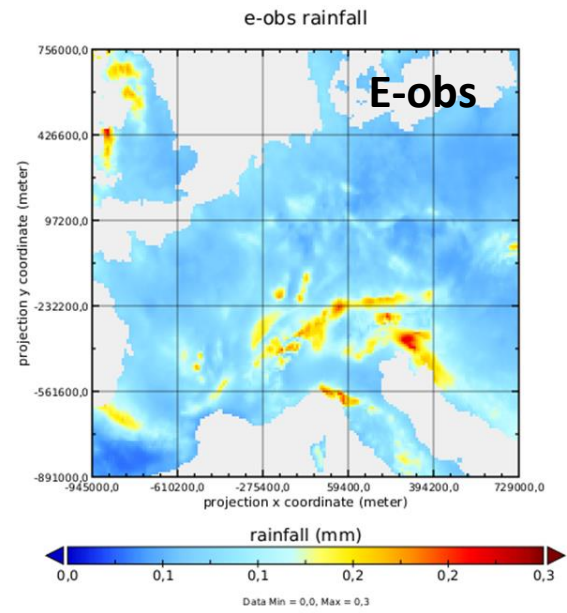
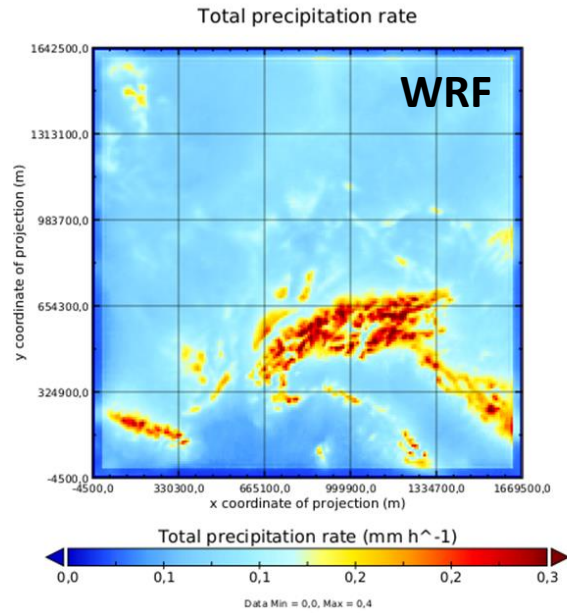


Summer days

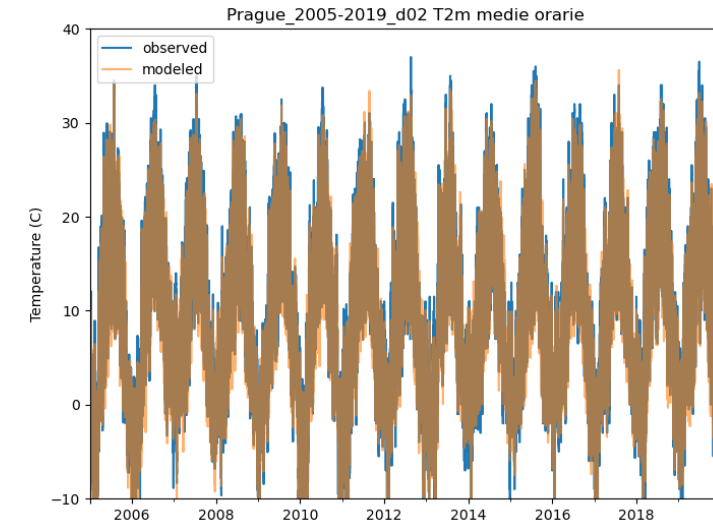
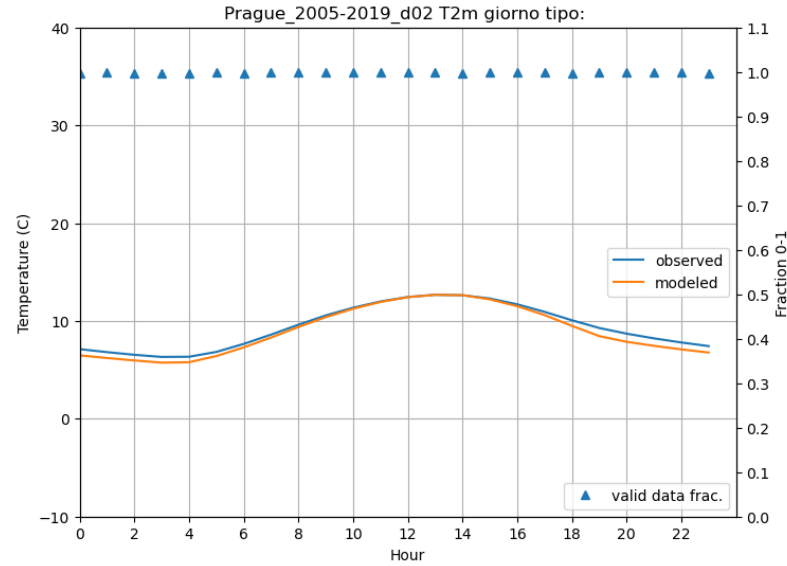


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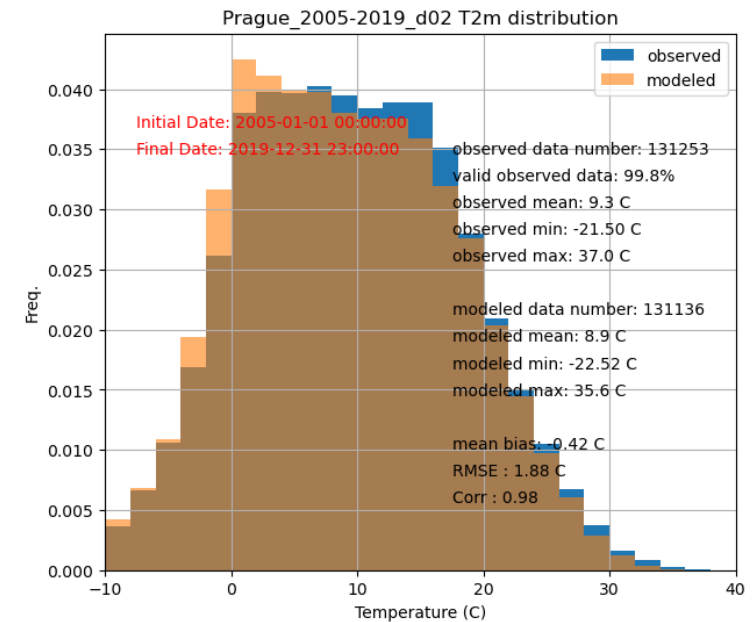
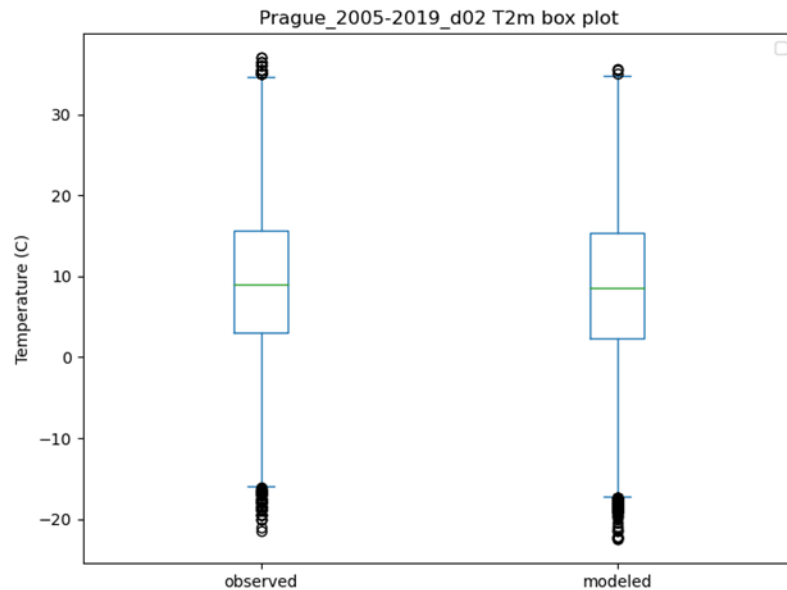
WRF vs reanalyses: annual mean precipitation (2005-2019)



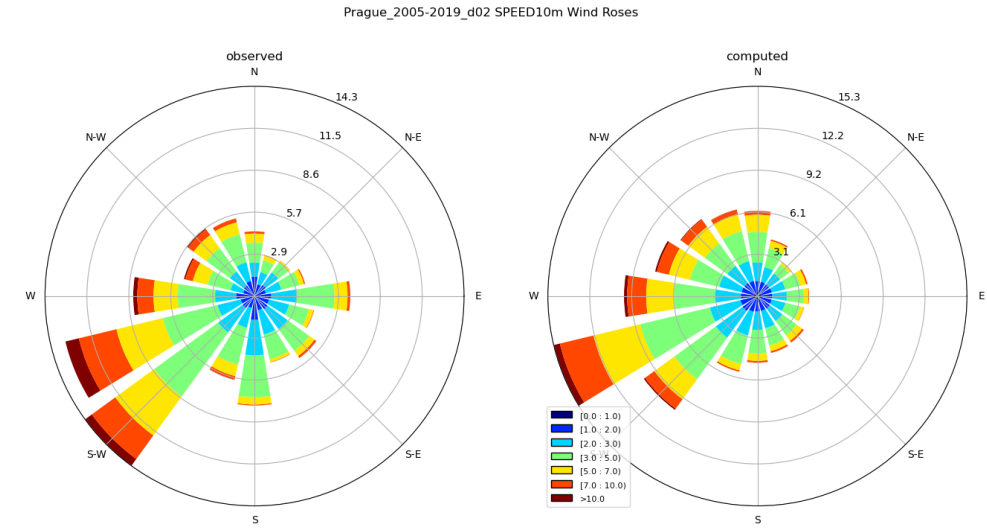
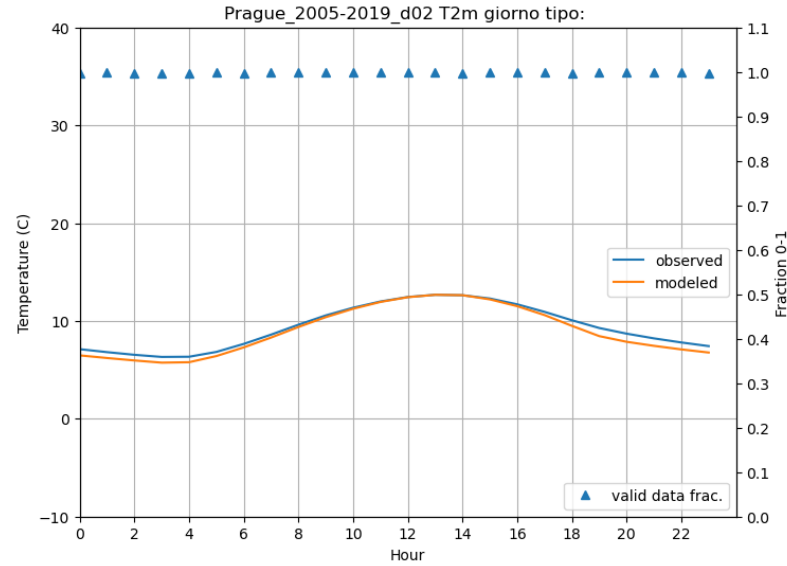
WRF verification vs surface stations (2005-2019): temperature



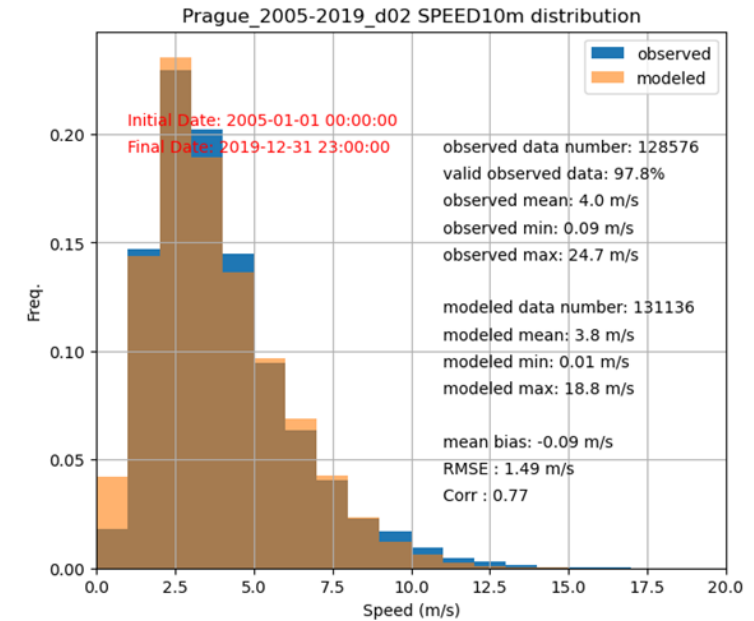
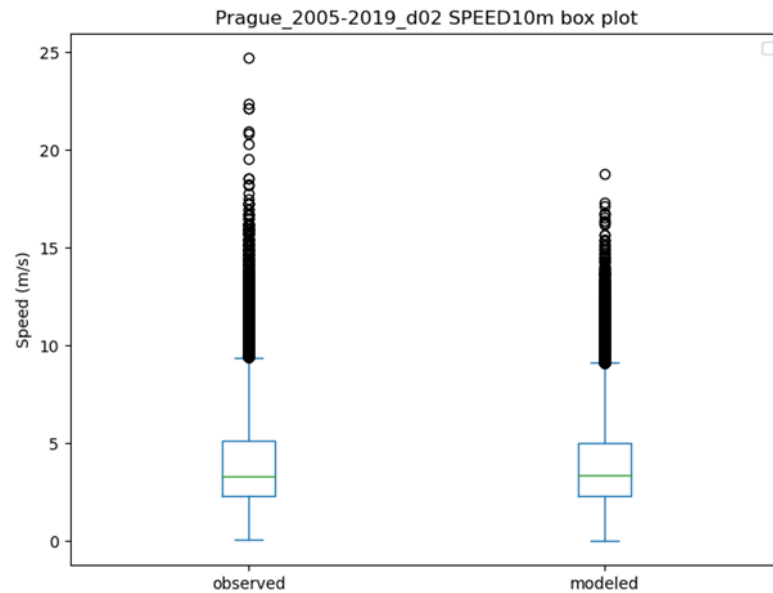
Prague



WRF verification vs surface stations (2005-2019): wind

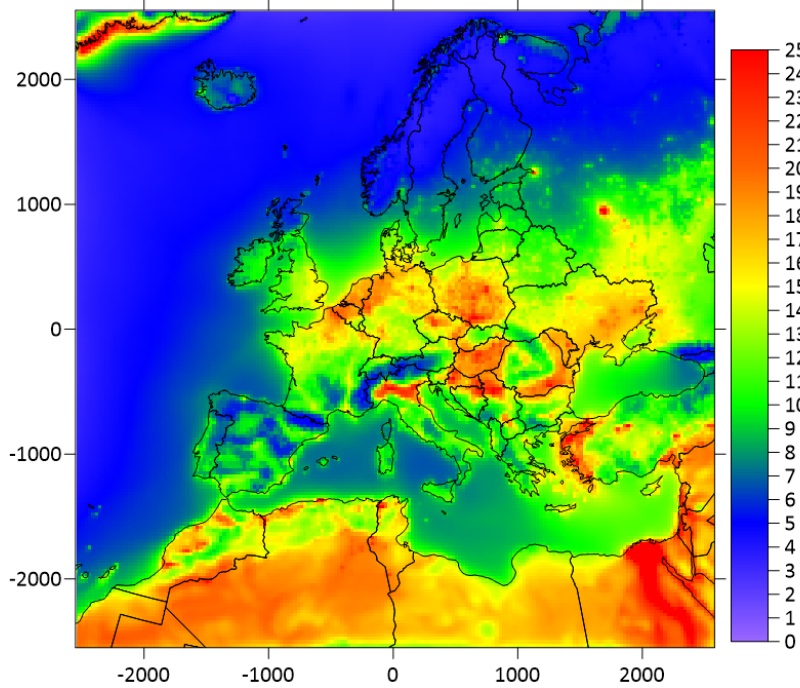


Prague

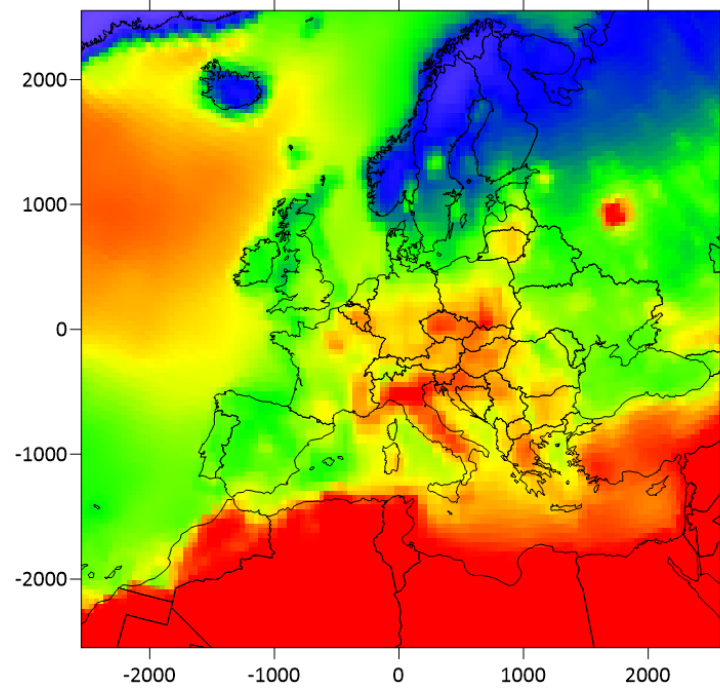


PM_{2.5}: 2018 annual mean concentrations (µg/m³)

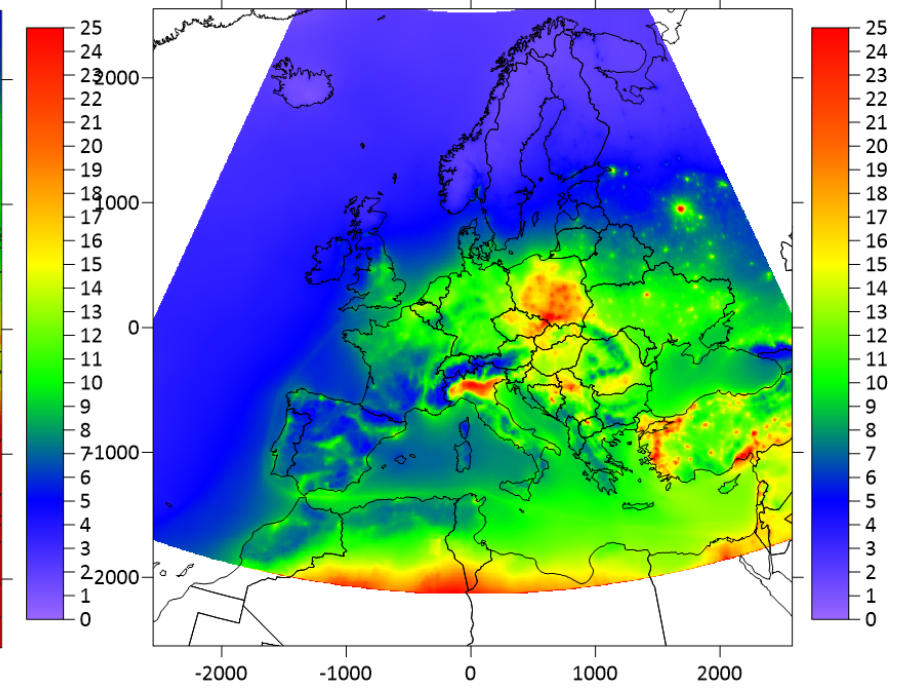
FARM



CAMS Global



CAMS Regional Ensemble median



Thank you for your attention!

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Wish us good luck!

