

11th International Aerosol Conference

 iAC 2022
4-9 SEPT / ATHENS GREECE



*Artwork by Rania Dede,
in the frame of the
international painting
competition*

*“Empowering Children
to Act on Climate
Change through Art”*

Session: Day 5 | AH-8: Human exposure in urban environments

Title: Intra-urban aerosol predictions under future Representative Concentration Pathways: modeling experiments for Athens

Presenter: Eleni Athanasopoulou (eathana@noa.gr) National Observatory of Athens (NOA), Greece

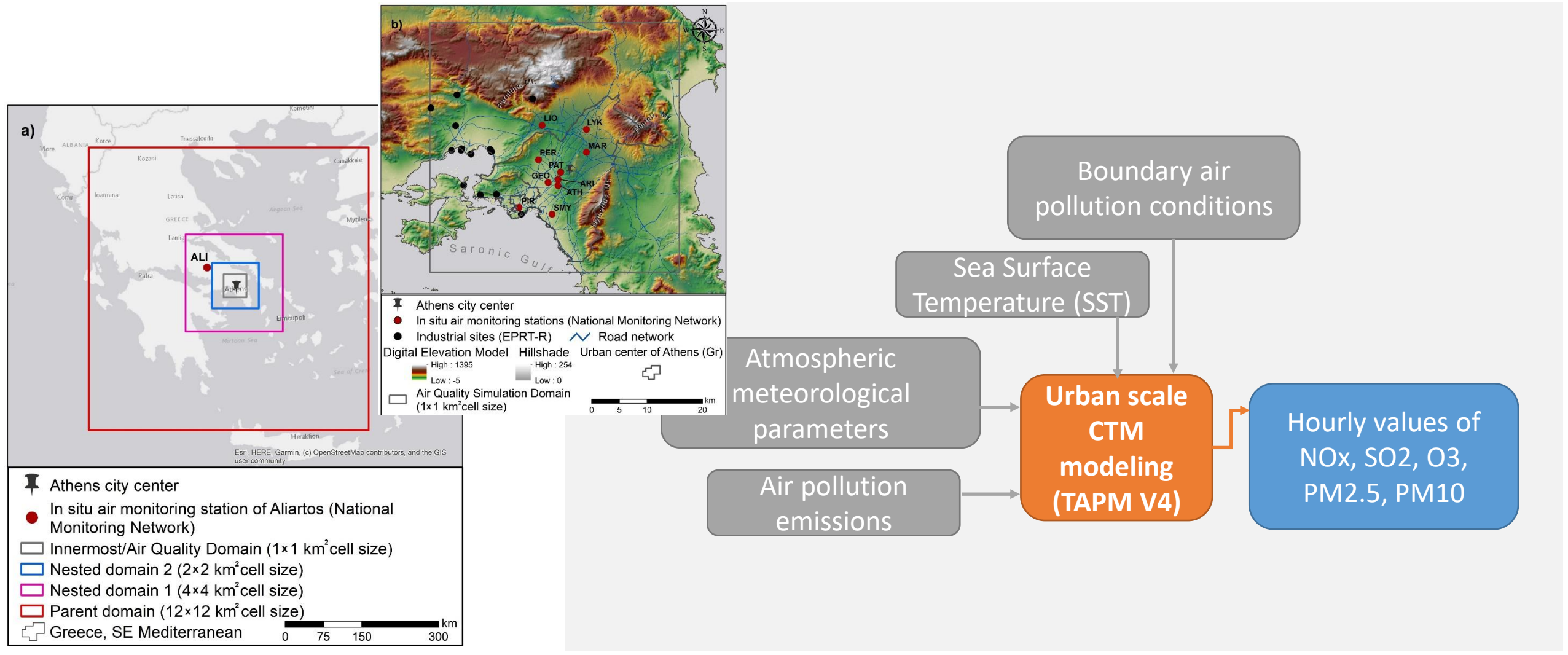
Co-authors: Dimitris Karagiannis, Nasia Kakouri, Giorgos Grivas, Evangelos Gerasopoulos (NOA)

Background

- ❑ **“The Mediterranean region is a global climate change hot-spot... is among the most responsive regions to global climate change.”** (van der Schriek, Atmosphere 2020)
- ❑ **“Fine resolution models (be they physically or statistically based) are necessary to provide more detailed future climate change information for impact assessment studies.”** (Gao et al., Geophysical Research Letters, 2006) Or **“High resolution modeling is necessary to simulate surface climate change over the Mediterranean for use in impact assessment studies”** (Giorgi and Lionello, Global and Planetary Change, 2008)
- ❑ **“The spatial resolution of concentration and population distribution in the city should be 1 km × 1 km or finer to obtain appropriate estimates of total population exposure and health-related externalities”.** (Santiago et al., Science of The Total Environment, 2022)
- ❑ **ΠΕΣΠΚΑ — The establishment of the regional plan for climate change adaptation for the region of Attica**



Model system description



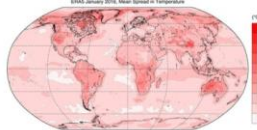
Model system description (present - 1995)

ERA5 hourly data on pressure levels from 1959 to present

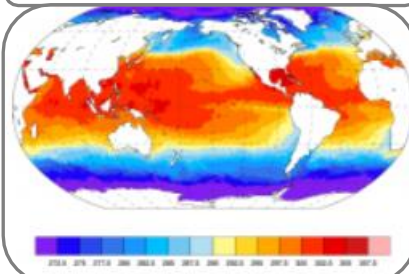
Overview Download data Quality assessment Documentation

ERA5 is the fifth generation ECMWF reanalysis for the global climate and weather for the past 4 to 7 decades. Currently data is available from 1950, with Climate Data Store entries for 1950-1978 (preliminary back extension) and from 1959 onwards (final release plus timely updates, this page). ERA5 replaces the ERA-Interim reanalysis.

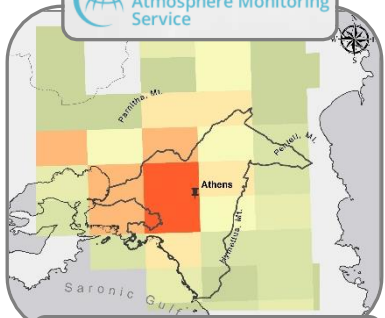
Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. This principle, called data assimilation, is based on the method used by numerical weather prediction centres, where every so many hours (12 hours at ECMWF) a previous forecast is combined with newly available observations in an optimal way to produce a new best estimate of the state of the atmosphere, called analysis, from which an updated, improved forecast is issued. Reanalysis works in the same way, but at reduced resolution to allow for the provision of a dataset spanning back several decades. Reanalysis does not have the constraint of issuing timely forecasts, so there is more time to collect observations, and when going further back in time, to allow for the ingestion of improved versions of the original observations, which all benefit the quality of the reanalysis product.



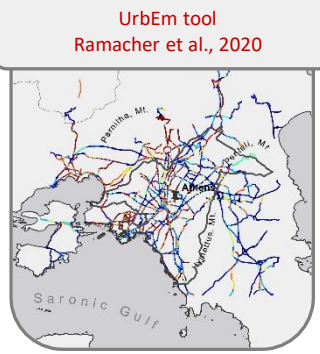
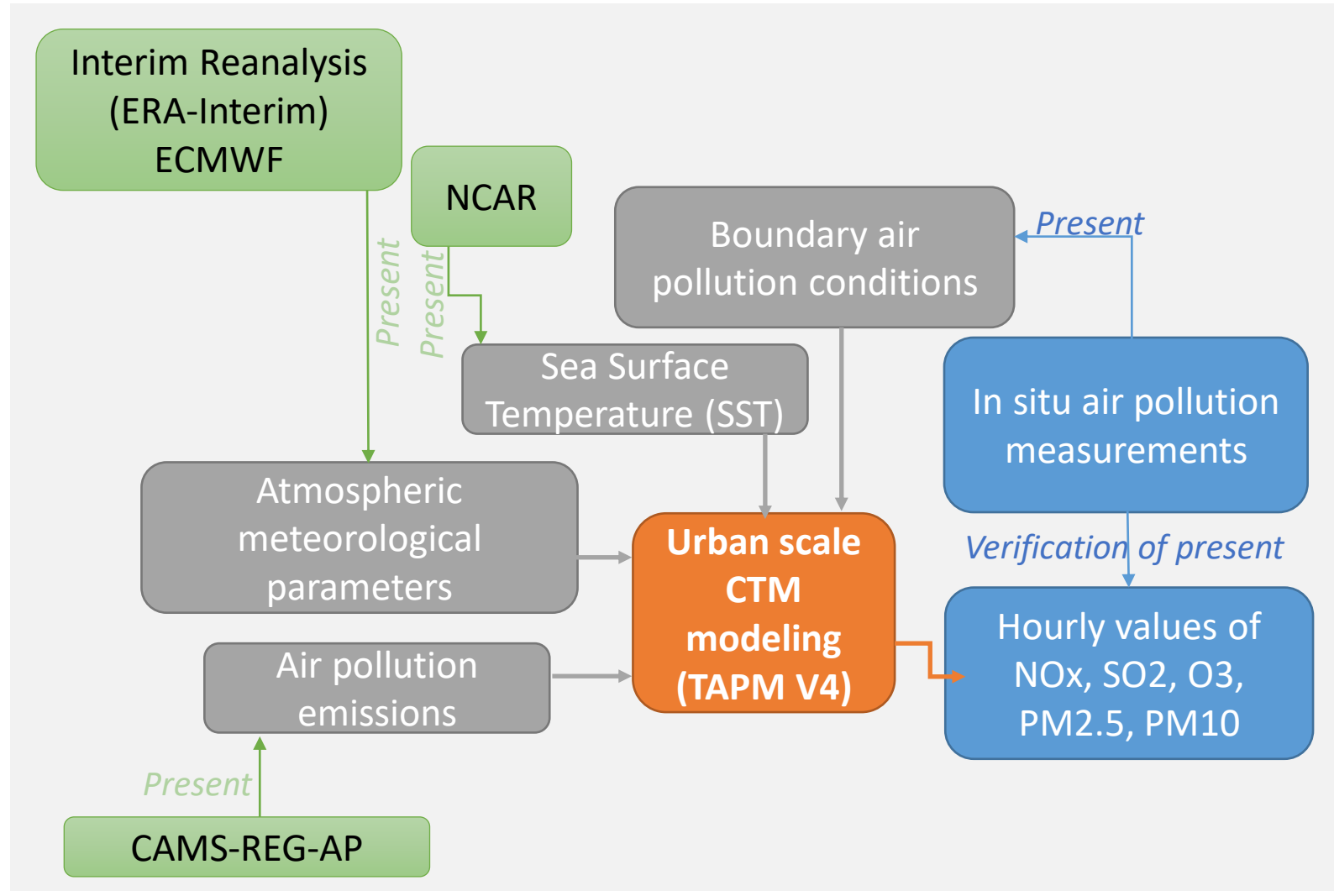
NCAR | CLIMATE DATA



Atmosphere Monitoring Service

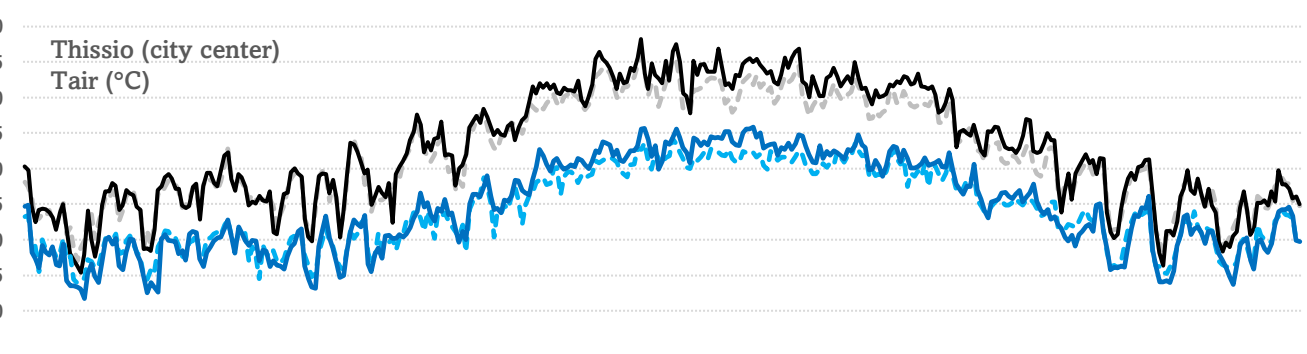
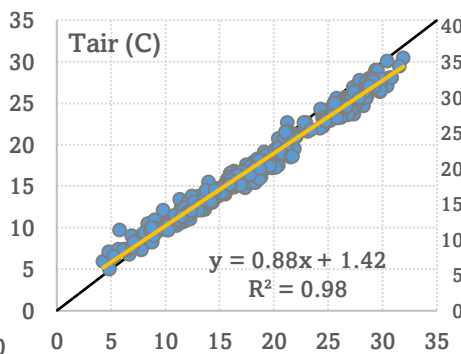
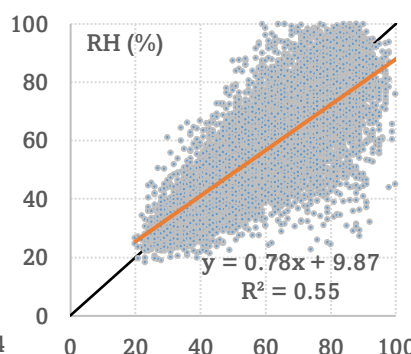
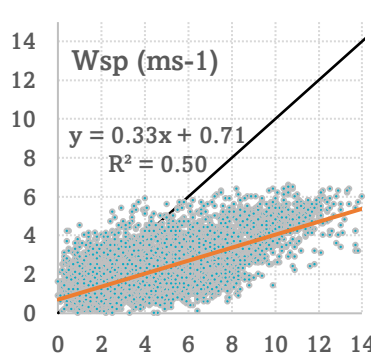
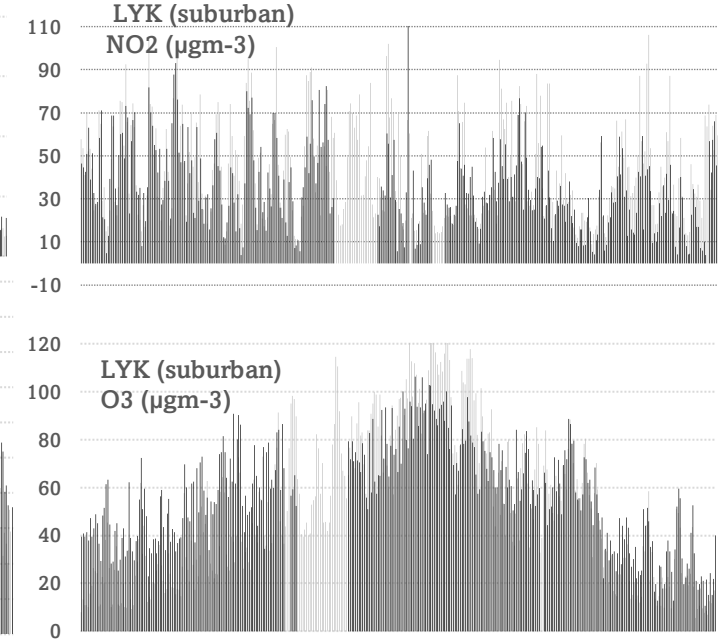
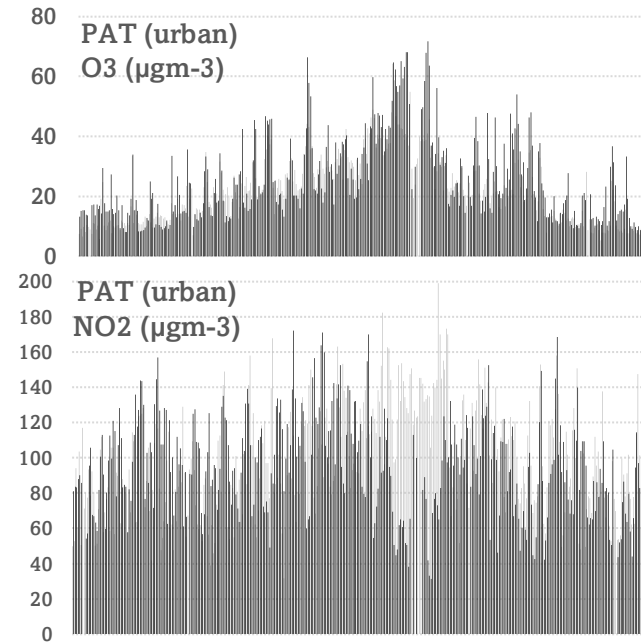


UrbEm tool
Ramacher et al., 2020

Model system evaluation

Param.	Obs (std)	Mod (std)	MB	NMB	r2	N
NO2	60.8 (20.8)	71.6 (26.5)	11.4	49.7	0.23	3275
O3	52.4 (22.9)	40.4 (23.3)	-13.6	-25.9	0.68	2729
Tmean	18	17.8	-0.2		0.99	8758
Tmin	14.7	14	-0.6		0.96	365
Tmax	22	22	-0.2		0.98	365
RH	61.4	57.8	-3.6	-5.8	0.6	8758
Uair	3.9	2	-1.9	-48	0.68	8758
PM2.5	16.1	22.9	6	44.3	0.37	8215



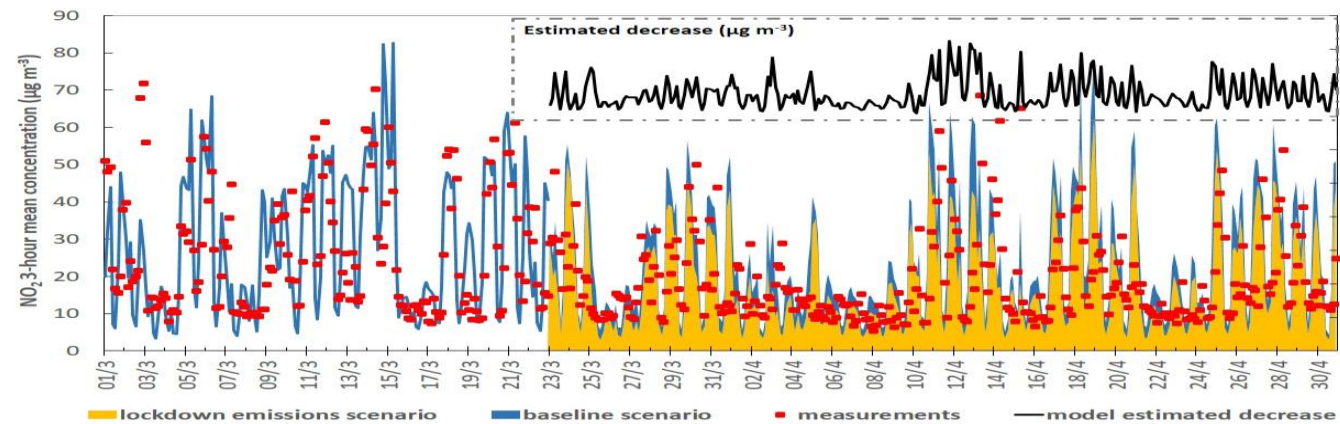
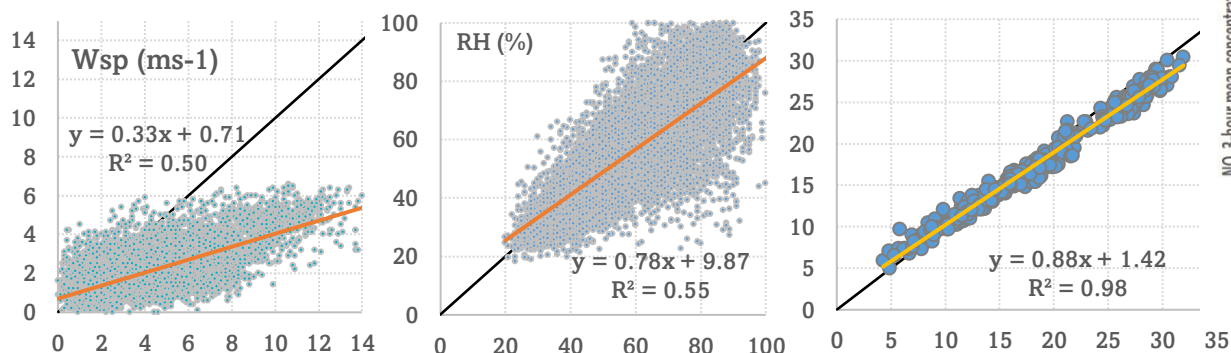
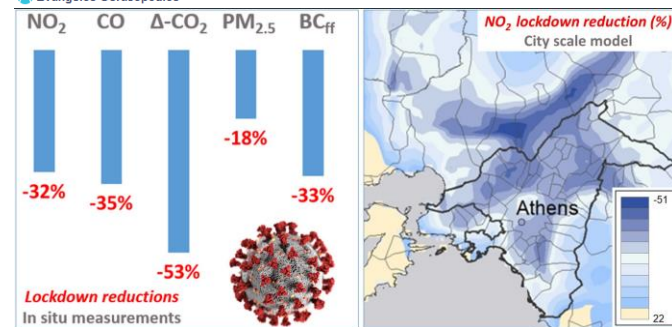
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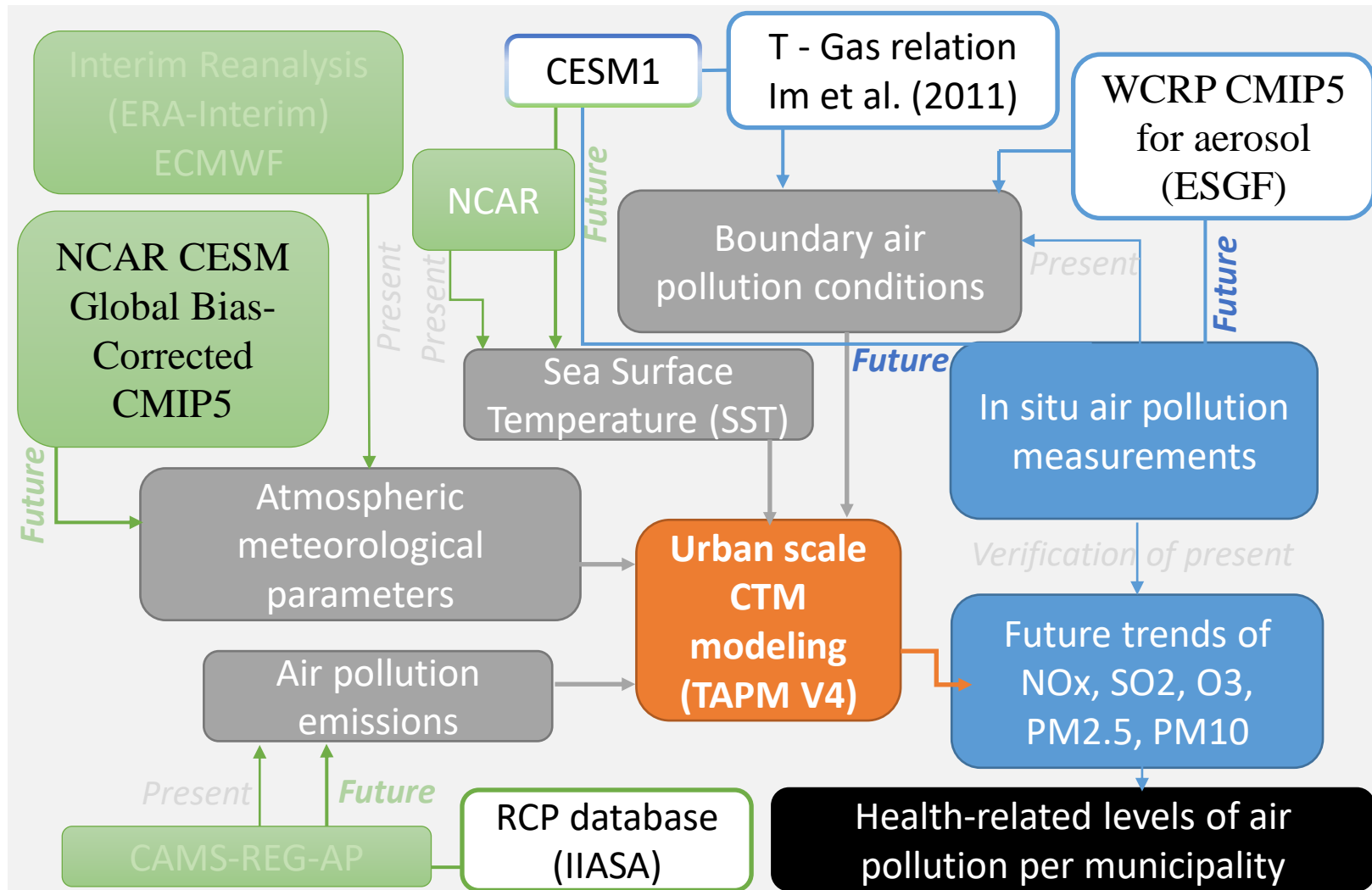
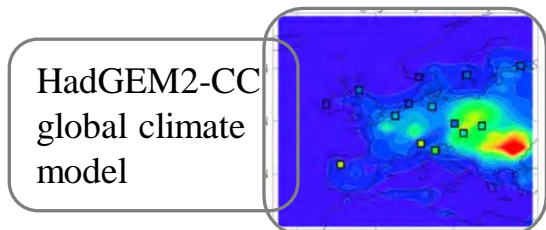
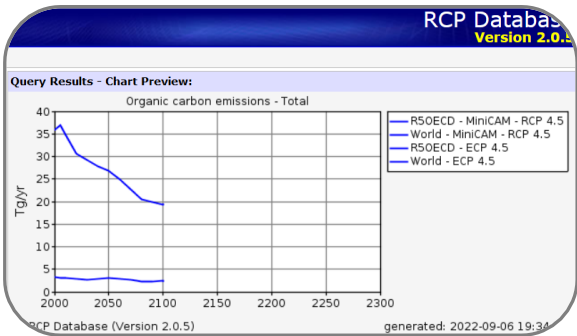
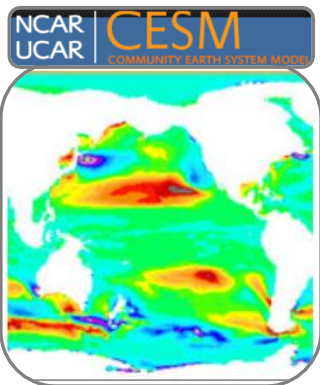
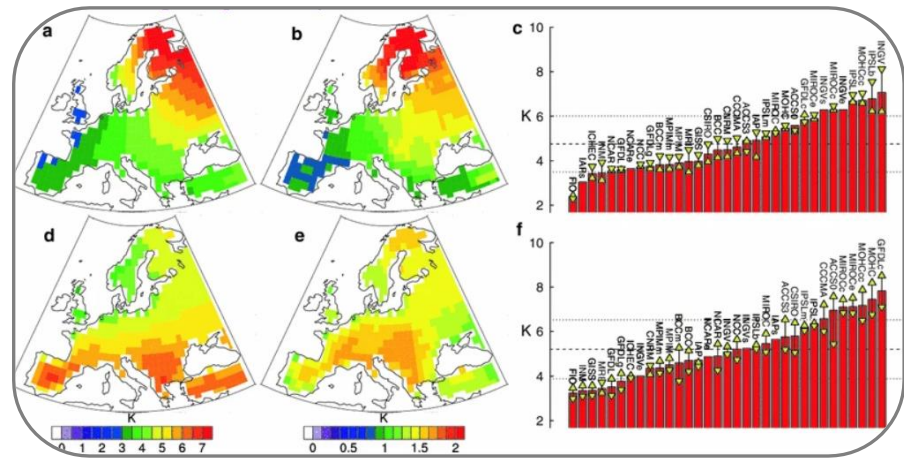
Open Access Editor's Choice Article

Integrating in situ Measurements and City Scale Modelling to Assess the COVID-19 Lockdown Effects on Emissions and Air Quality in Athens, Greece

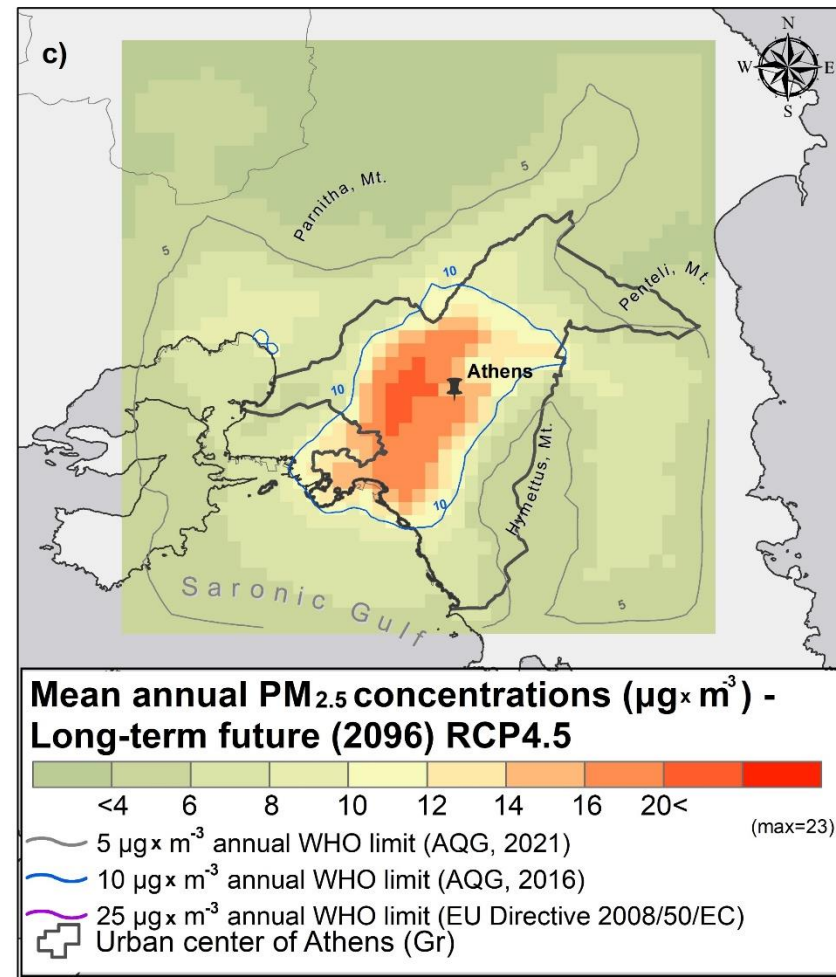
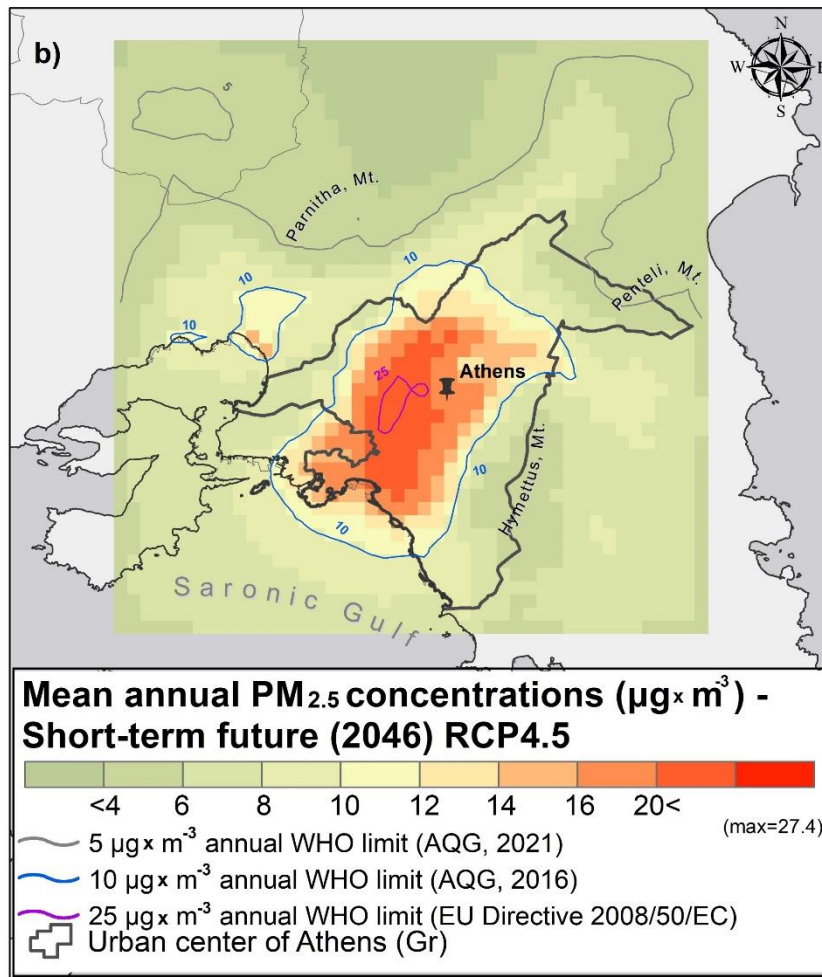
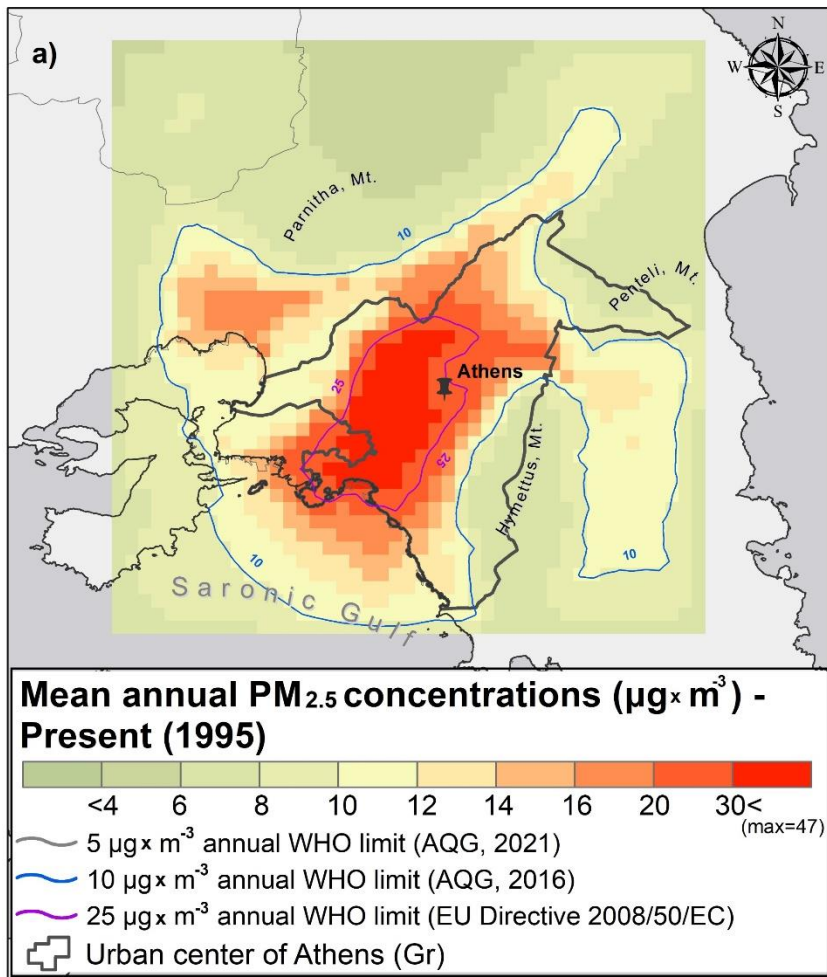
by Georgios Grivas^{1,*}, Eleni Athanasopoulou¹, Anastasia Kakouri¹, Jennifer Bailey¹, Eleni Liakakou¹, Iasonas Stavroulas¹, Panayiotis Kalkavouras¹, Aikaterini Bougiatioti¹, Dimitris G. Kaskaoutis^{1,2}, Michel Ramonet³, Nikolaos Mihalopoulos^{1,2} and Evangelos Gerasopoulos^{1,*}



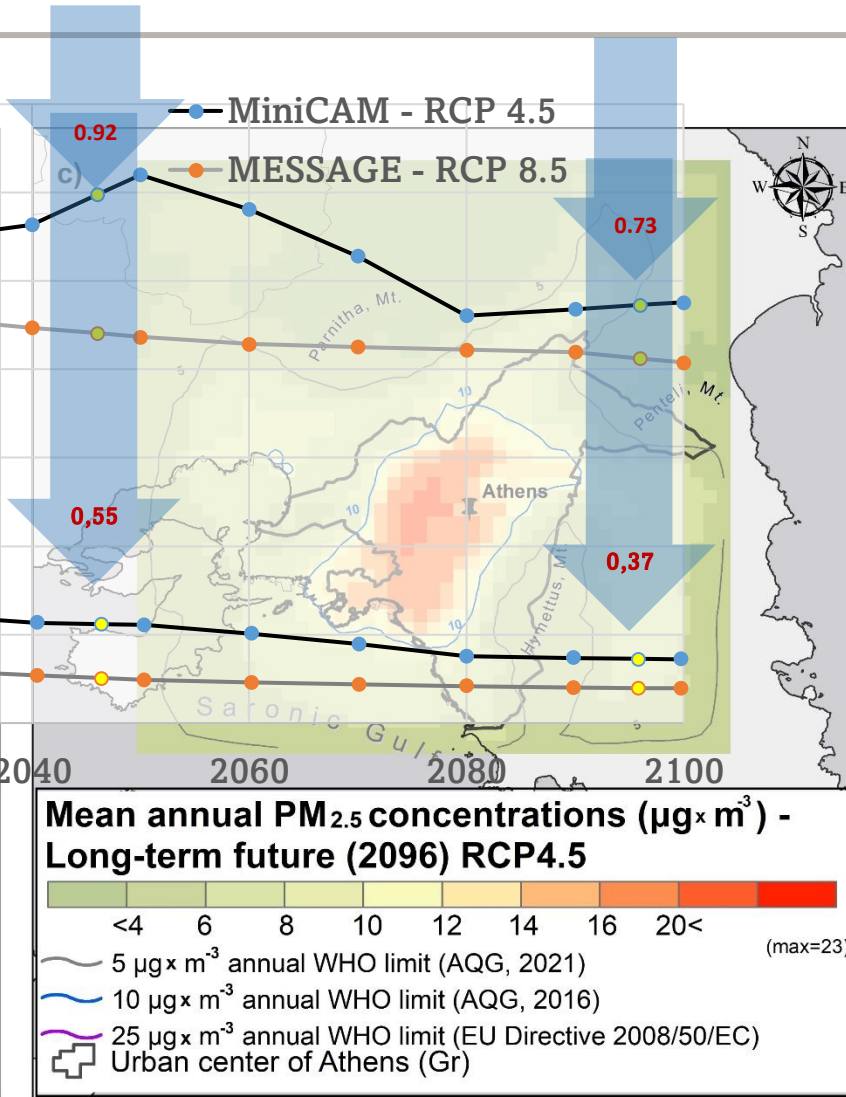
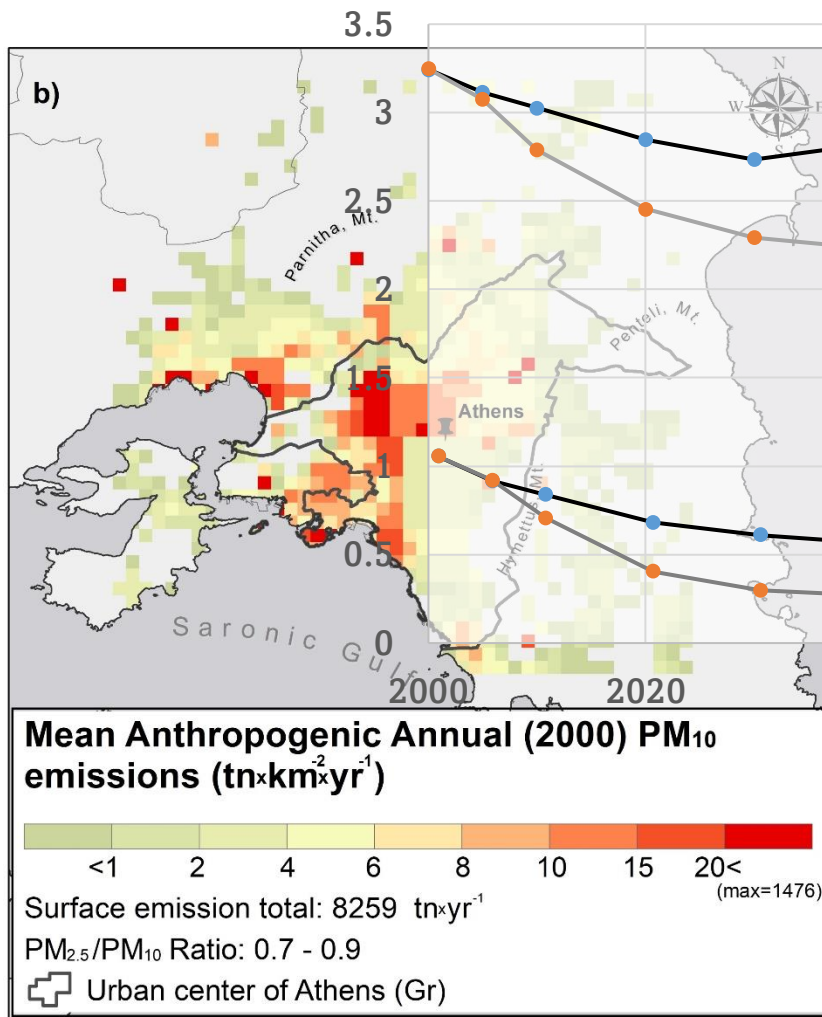
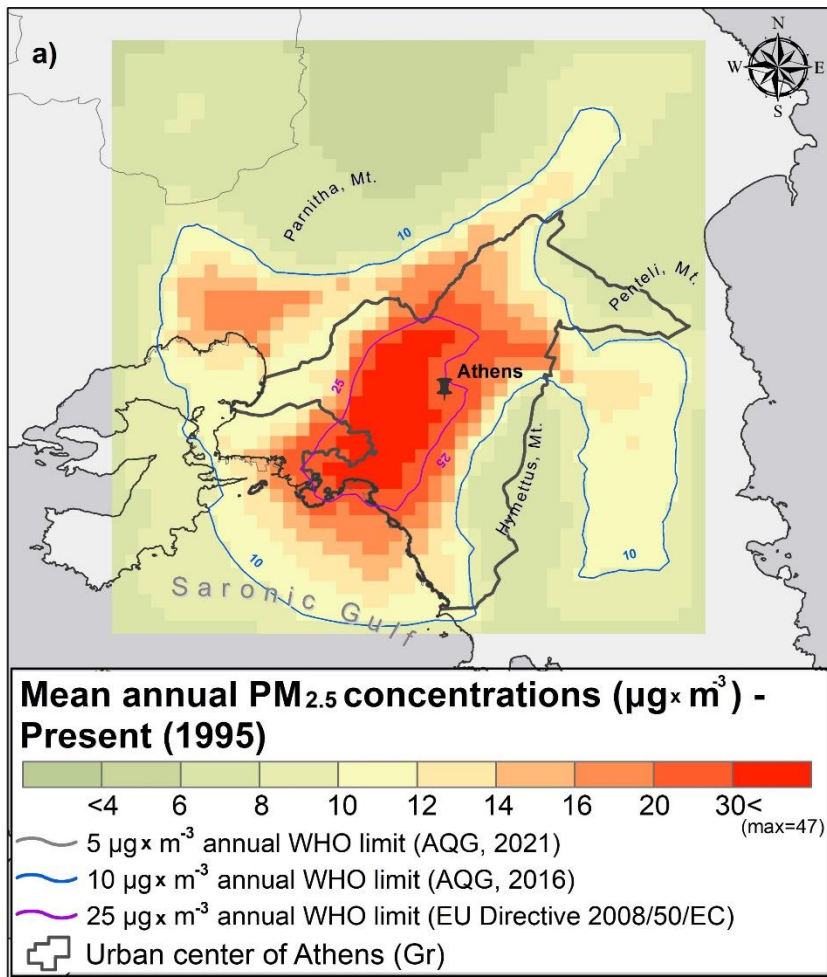
Model system description (future: RCP4.5 & RCP8.5, 2046 & 2096)



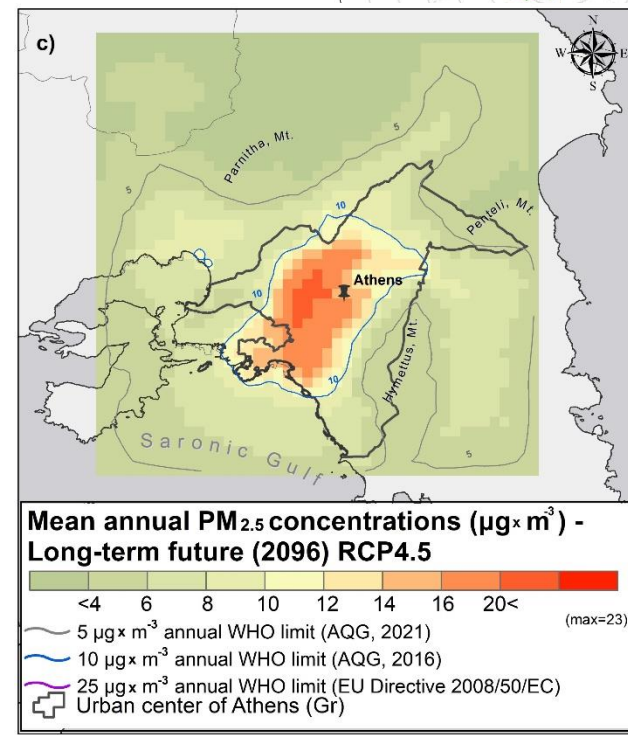
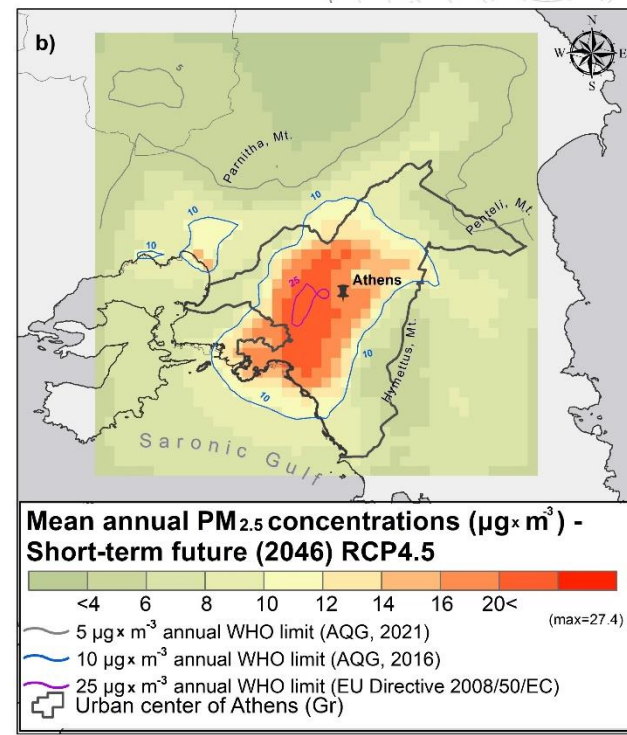
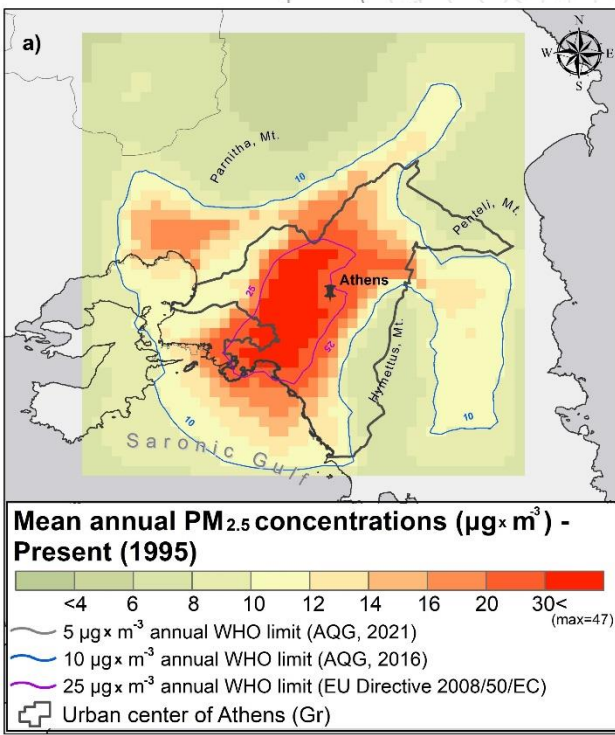
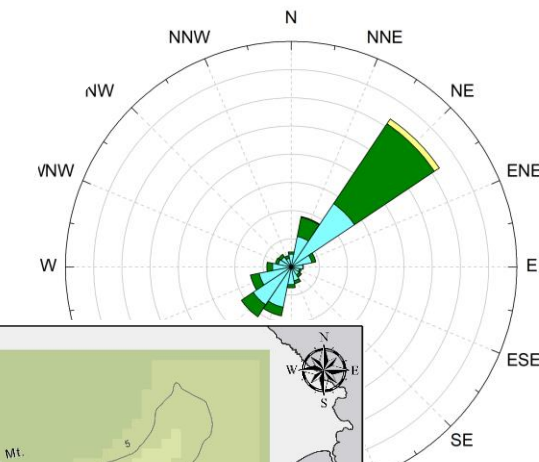
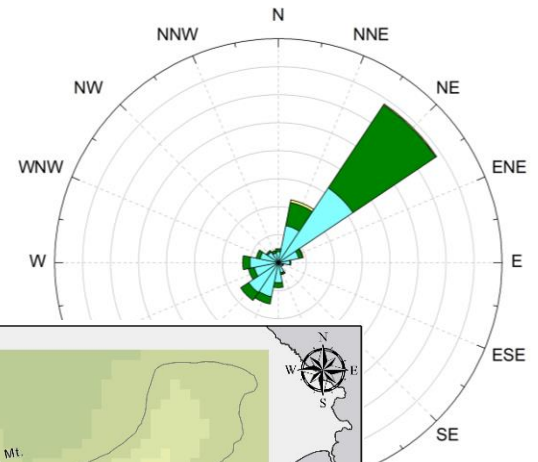
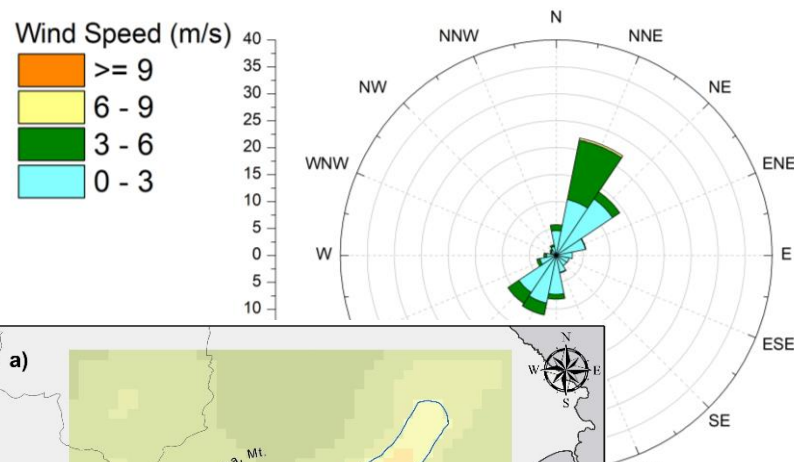
Model outputs – present and projected estimations (1x1 km²)



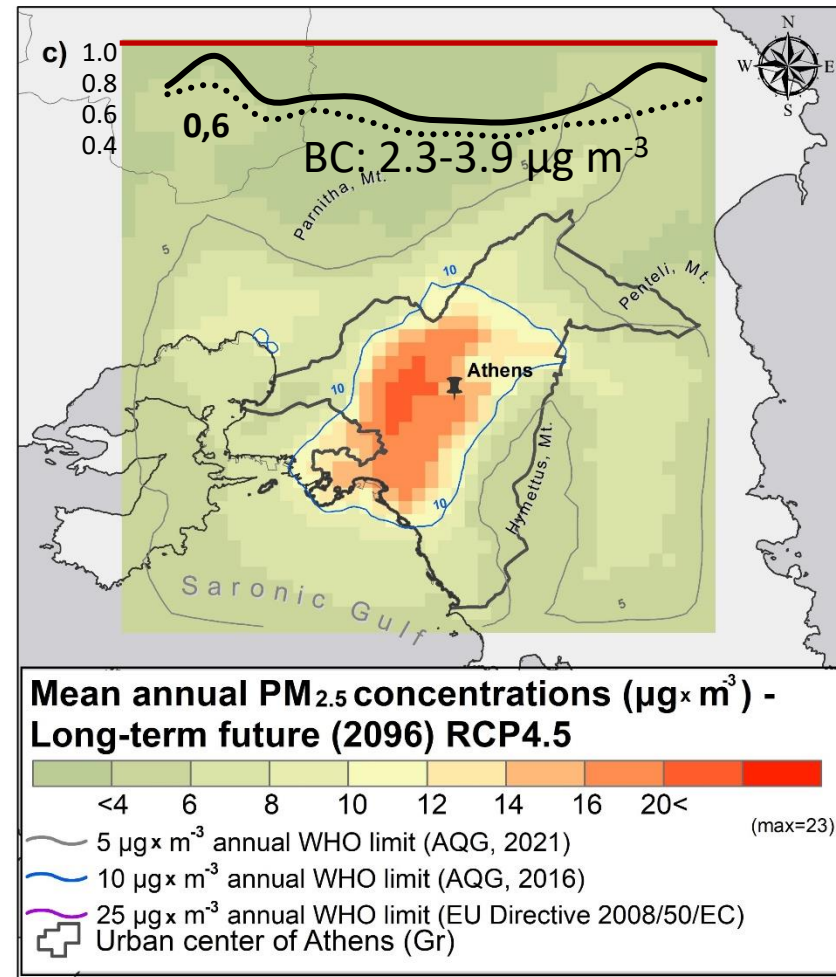
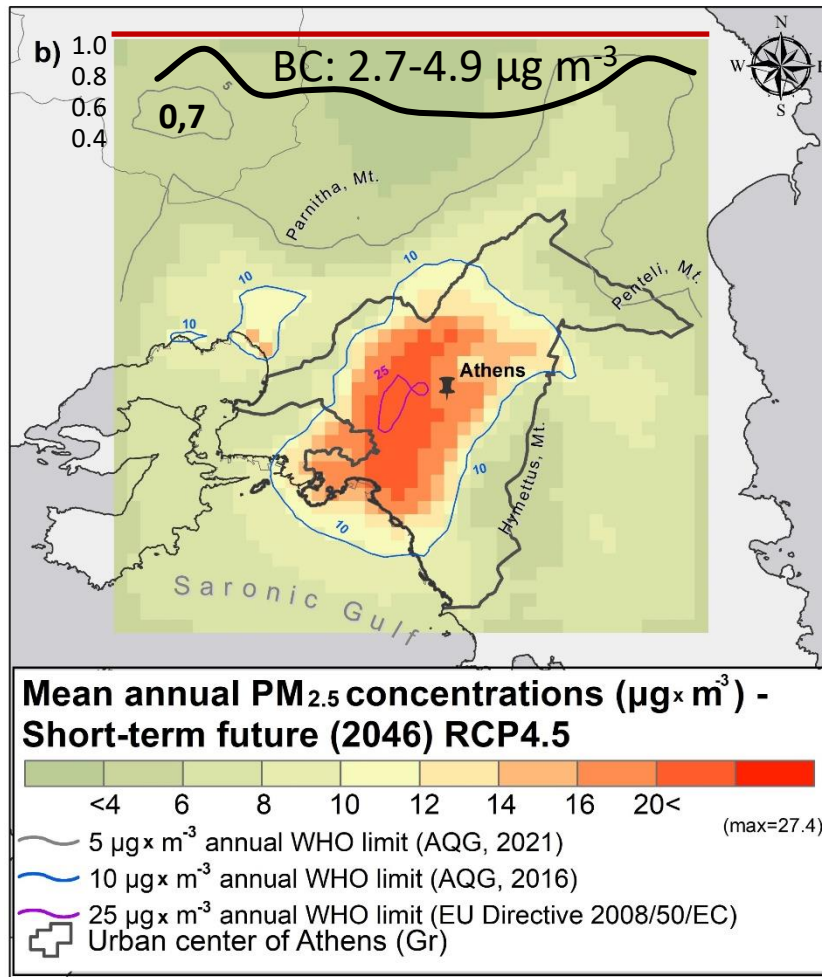
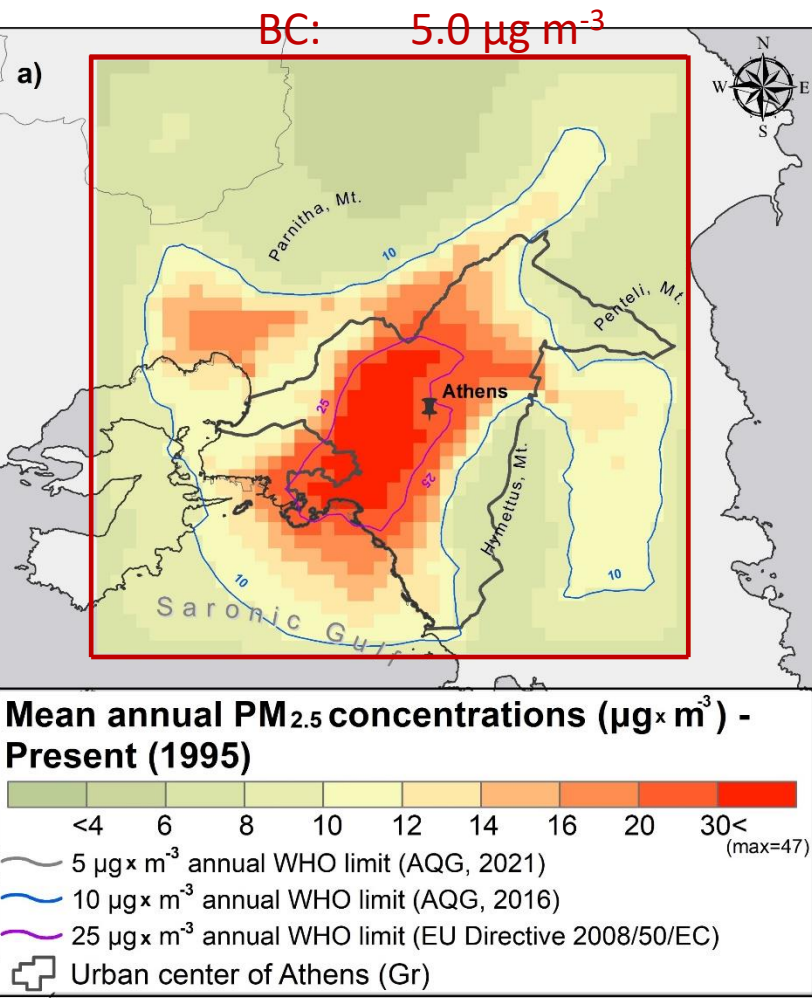
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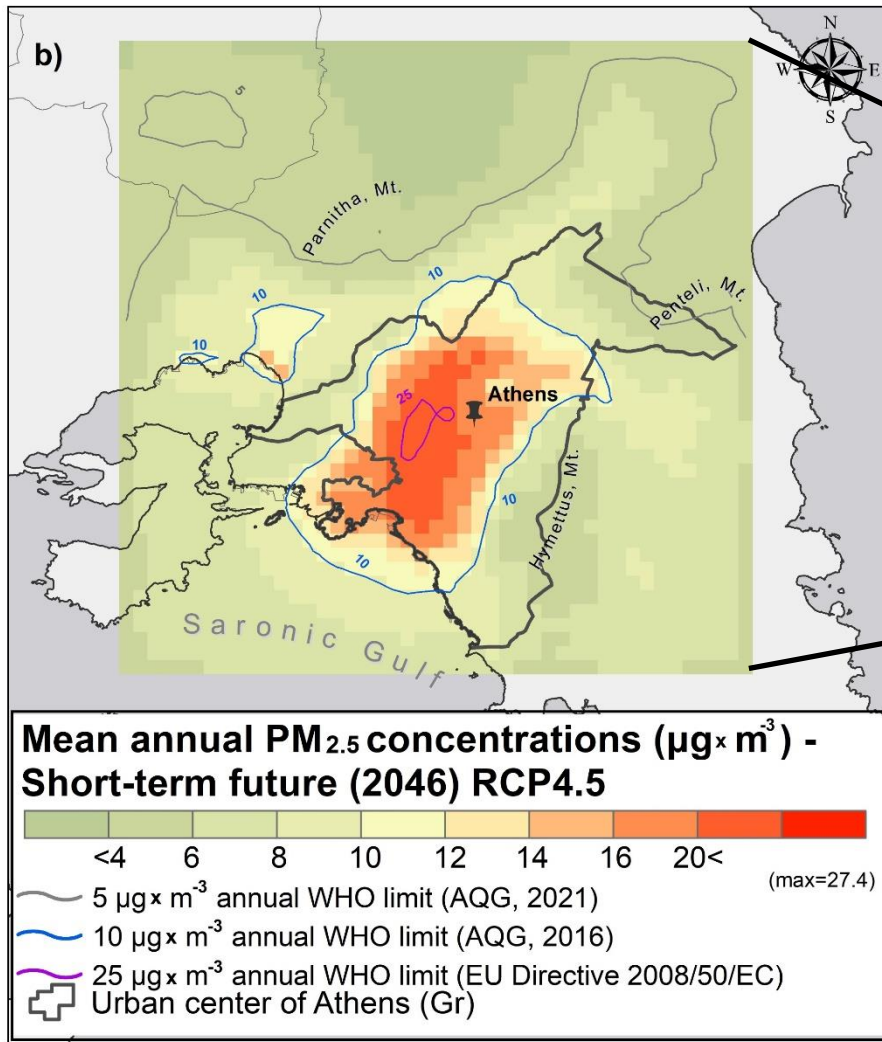
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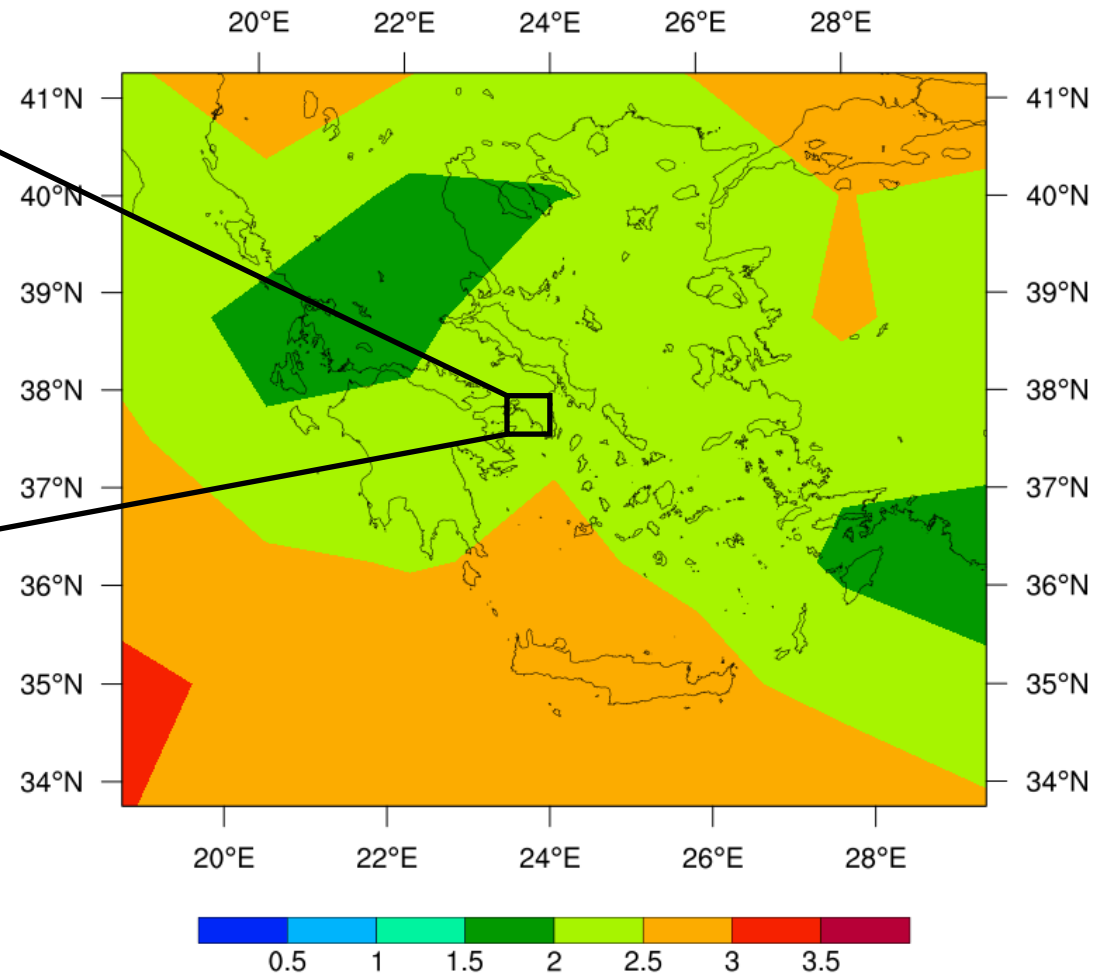
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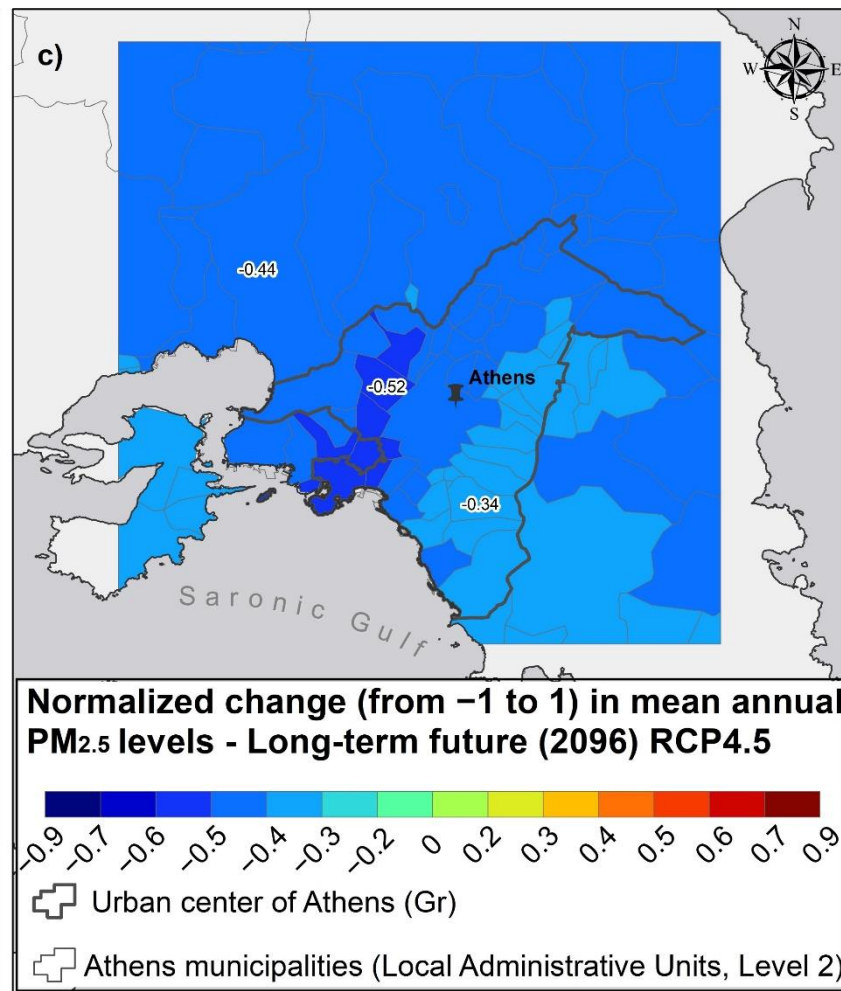
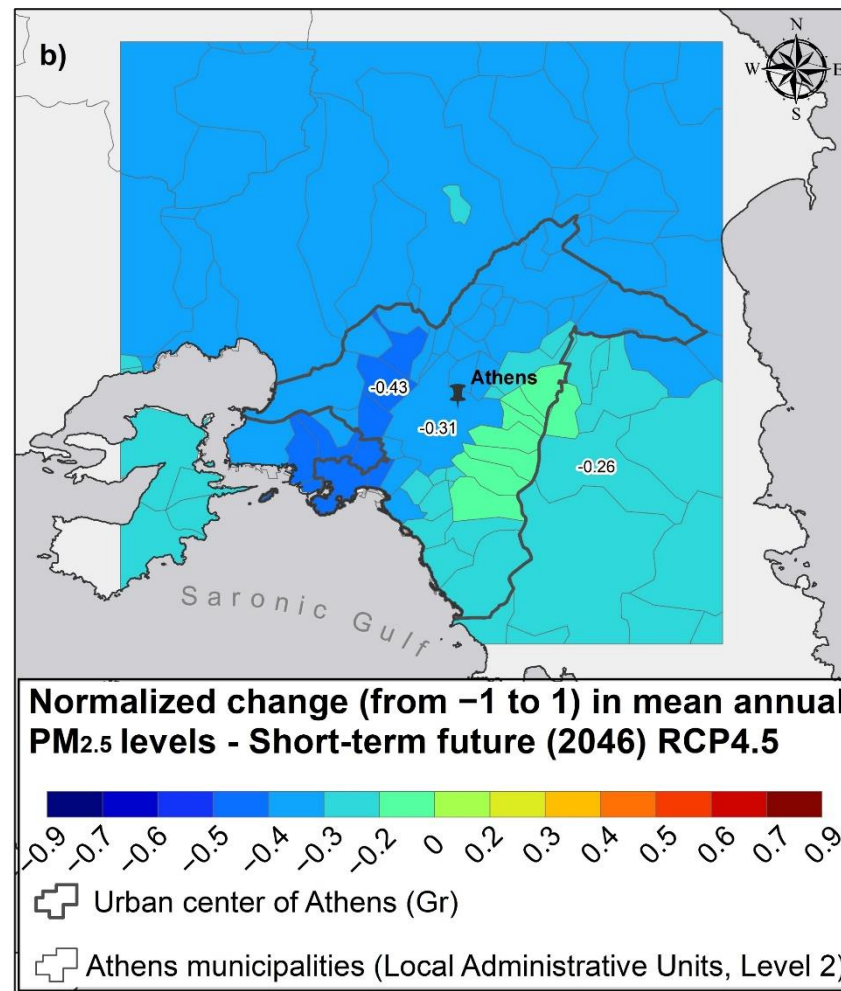
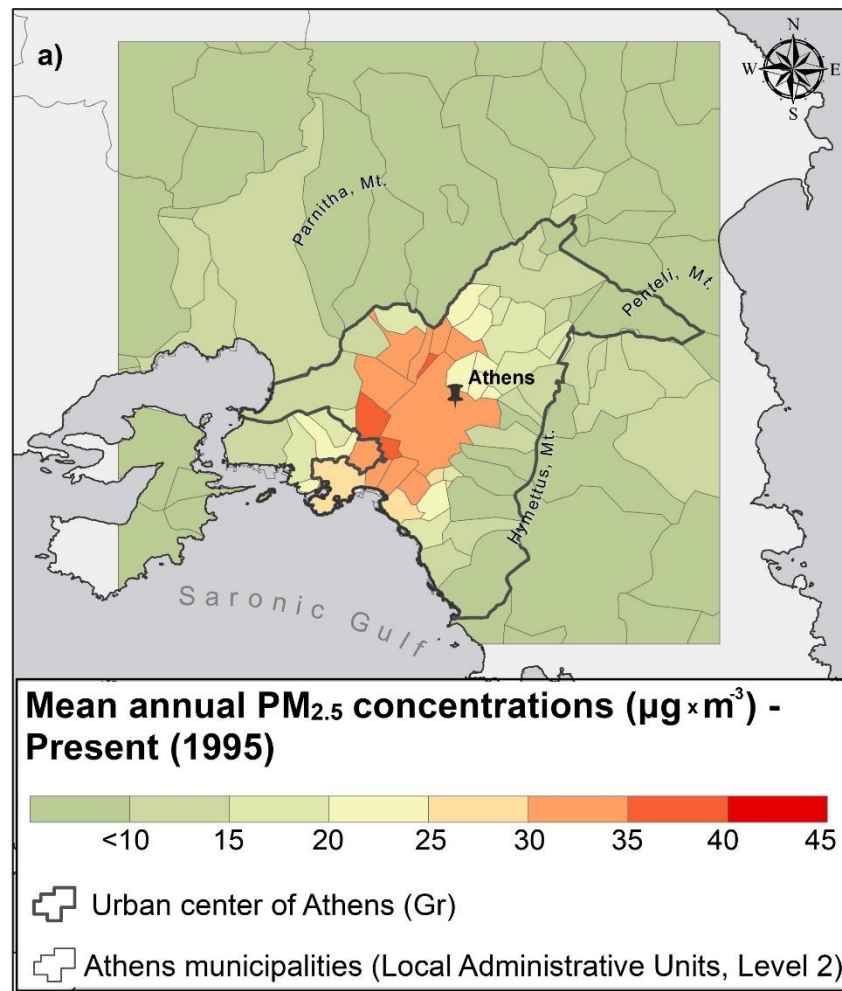
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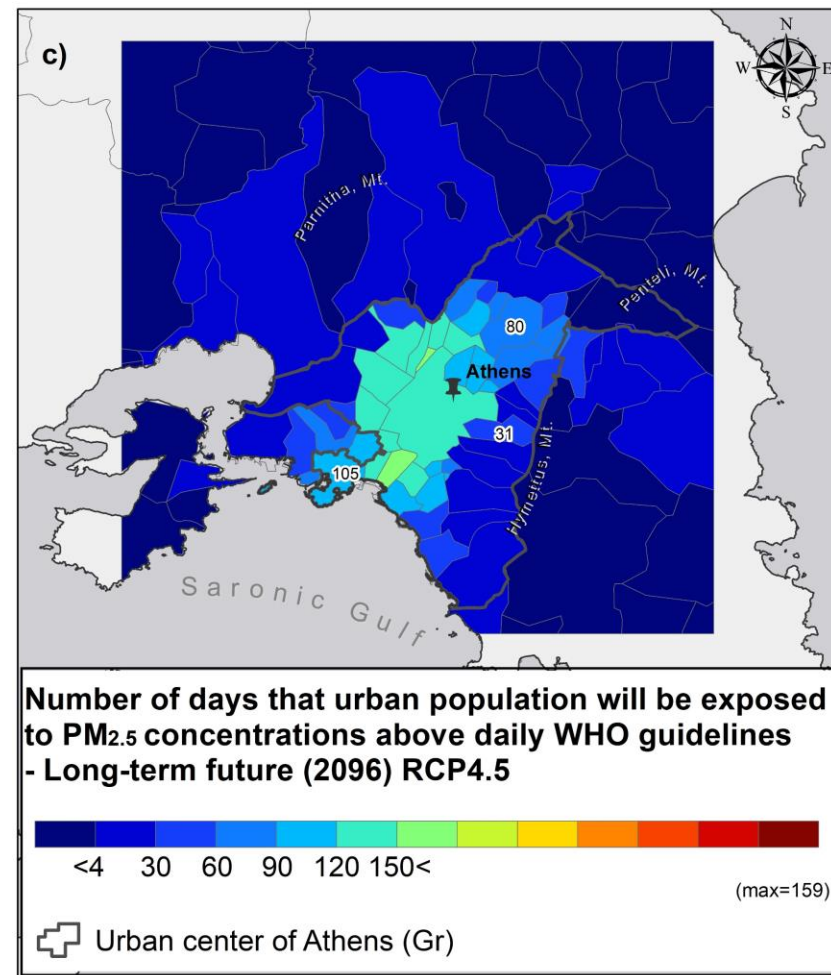
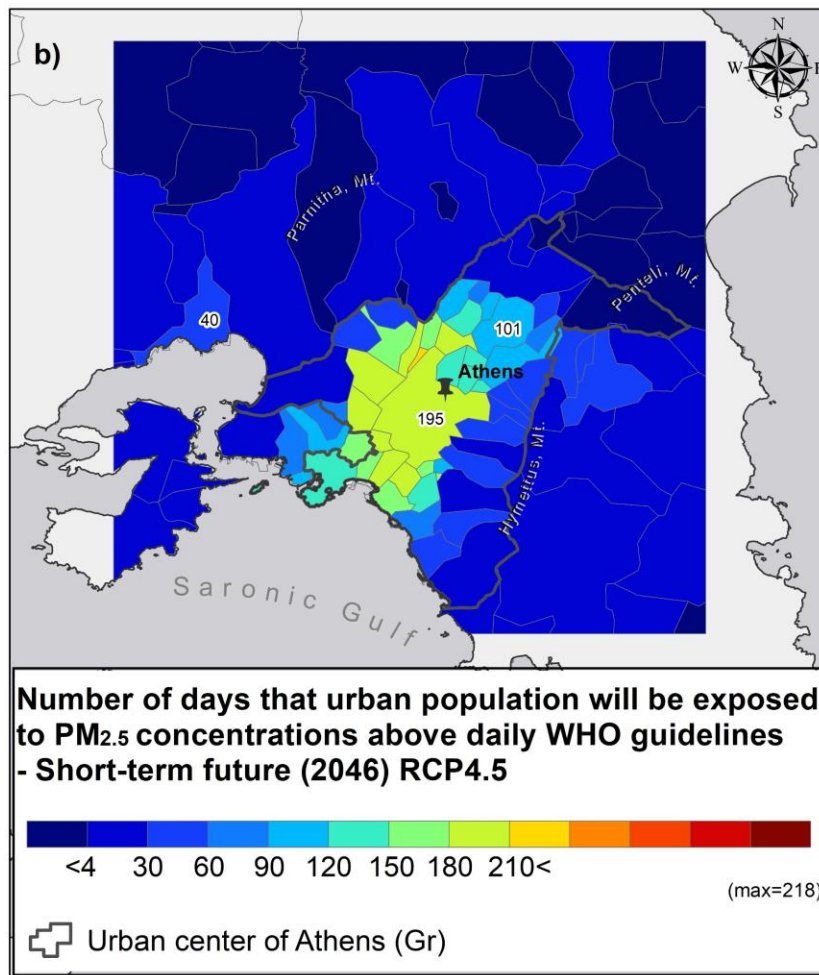
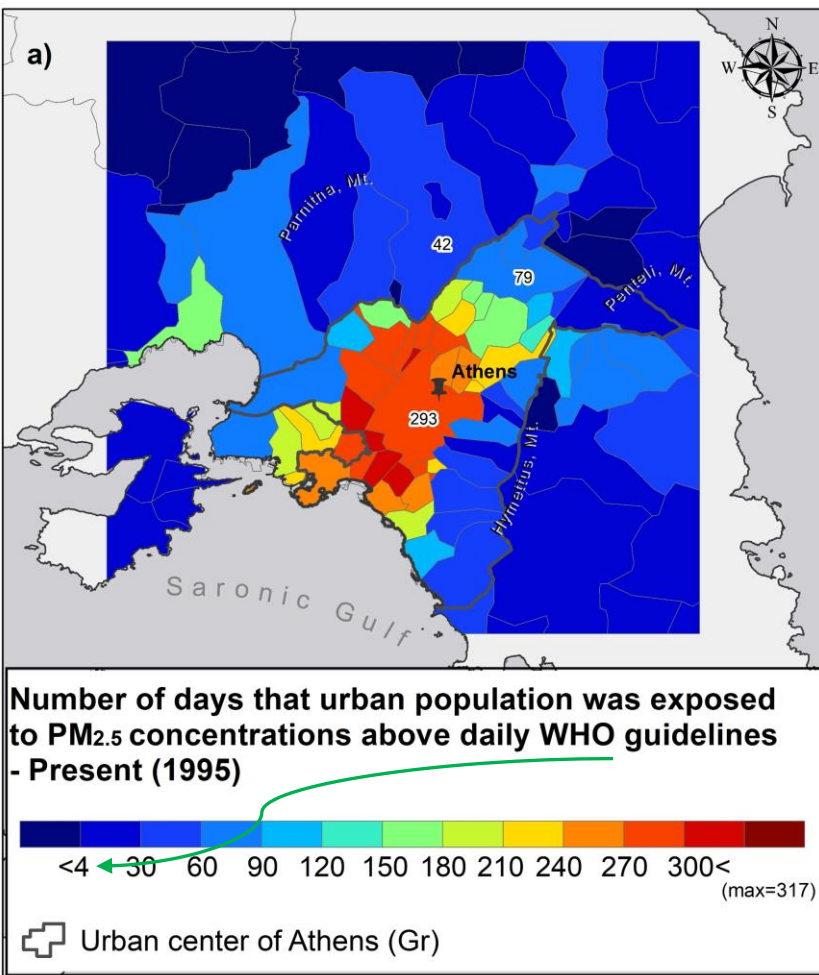
Annual average PM_{2.5} (BC, SOA & SO₄) concentration for RCP4.5 2046



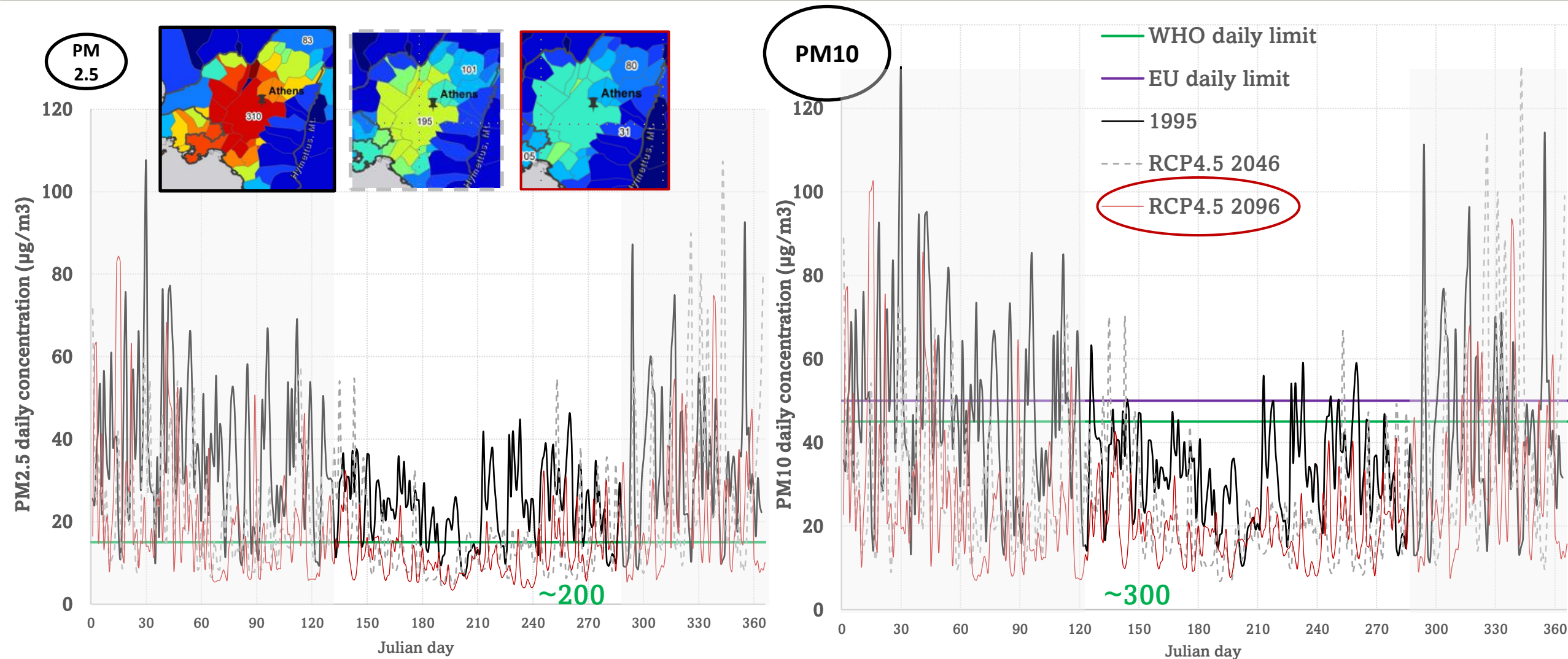
Model outputs – projected changes (%) per municipality



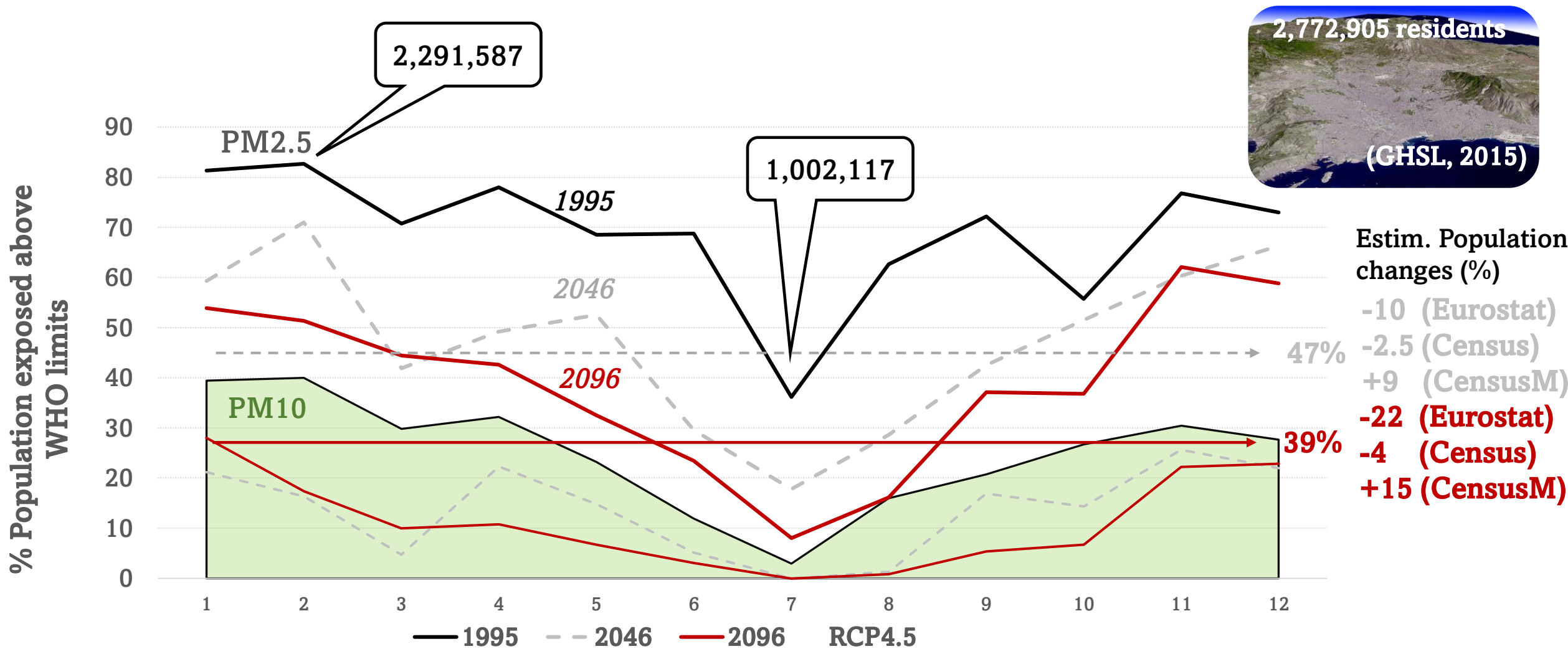
Model outputs – exceedances of the latest daily WHO limit



Model outputs – exceedances of the latest daily WHO limit



Model outputs – Urban Center population exposure



Summary

A high-resolution numerical modeling study of future anthropogenic air pollution over Athens showed:

- ❑ PM_{2.5} decreases under the medium pathway (RCP4.5) that reach 40% in the short- and 60% in the long-term future. They are explained by the emission reductions assumed in this scenario, and the enhanced dispersion due to higher winds from the NNE direction.
- ❑ Comparisons against the latest WHO annual and daily limits for PM align with the necessity for stronger climate protection measures (than 25 to 45% aerosol emission reductions).

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Merci

Gracias

Дякую

Ευχαριστώ

Kiitos

Danke

Thank you

Grazie

Mulțumesc

Tack

Hvala vam

Děkuji

Session: Day 5 | AH-8: Human exposure in urban environments

Title: Intra-urban aerosol predictions under future Representative Concentration Pathways: modeling experiments for Athens

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