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WP9 - CONSISTENCY BETWEEN GLOBAL AND REGIONAL SIMULATIONS

MODEL INTERCOMPARISON RESULTS

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Model intercomparison global-regional

Objectives:

- Compare global/regional results

IFS-COMPO – 4 model runs

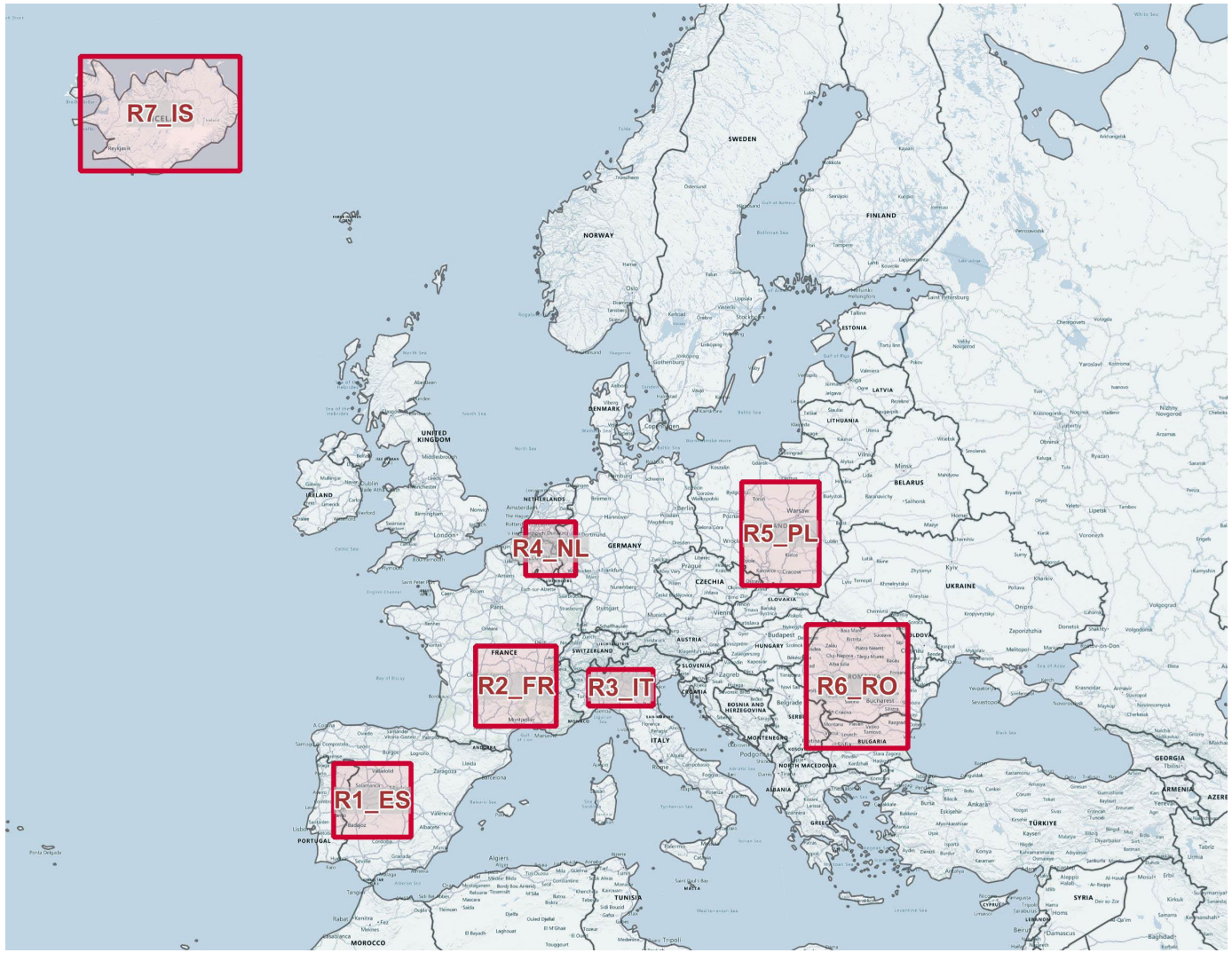
- 0.5x0.5deg vs 0.1x01deg
- Regional emissions over Europe (CAMS-REG-v5.1 REF2 v2.0.1) + global ones elsewhere (CAMS_GLOB_ANTv6.1) vs. global emissions over Europe

Regional models

- **GEM-AQ, MINNI**
- **CHIMERE, LOTOS-EUROPS, MONARCH, SILAM, EMEP, DEHM**

- Year 2018
- Meteorological forcing from the IFS every 3h
- Chemical BC from the IFS-COMPO every 3h
- Target analysis grid : CAMS regional domain 0.1 x 0.1 deg

7 regions with different characteristics



Analysis:

- PM10 and PM2.5
- Maps and difference maps of concentration
- Histograms
- Time series daily and monthly for concentration and error measures
- Error matrices
- Q-Q plots

PM10 annual mean - global vs regional, low resolution

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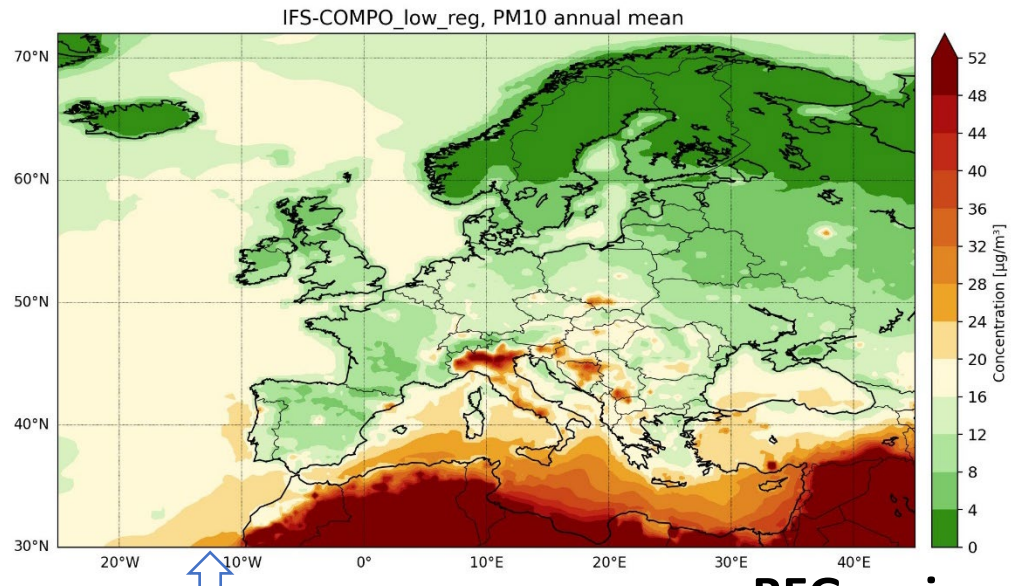
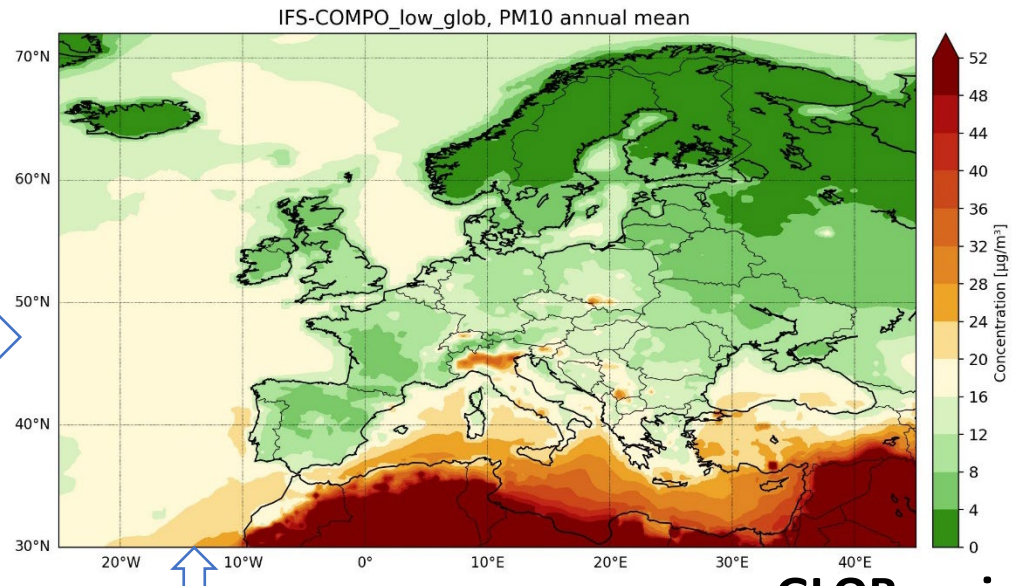
0.5x0.5

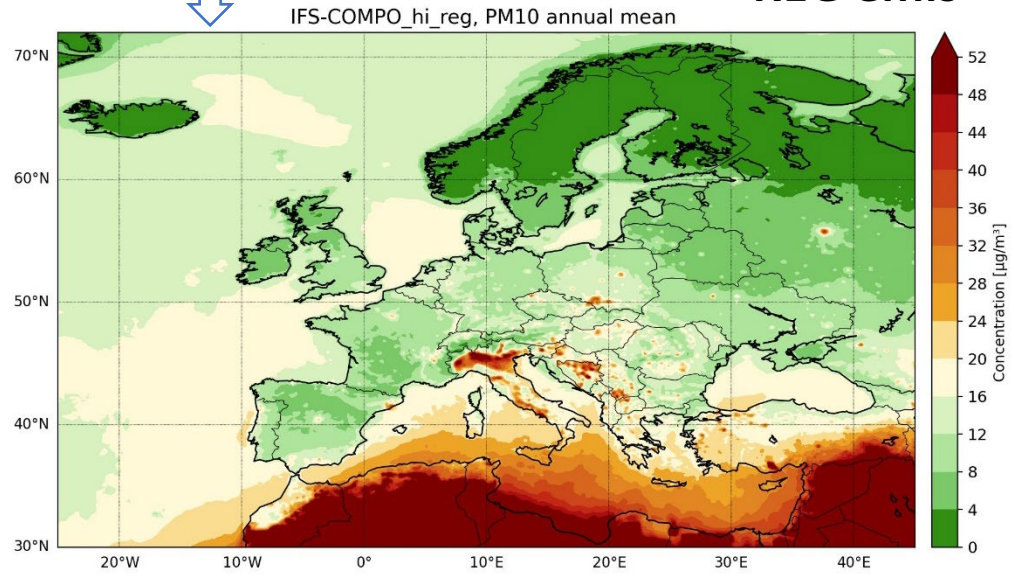
0.1x0.1

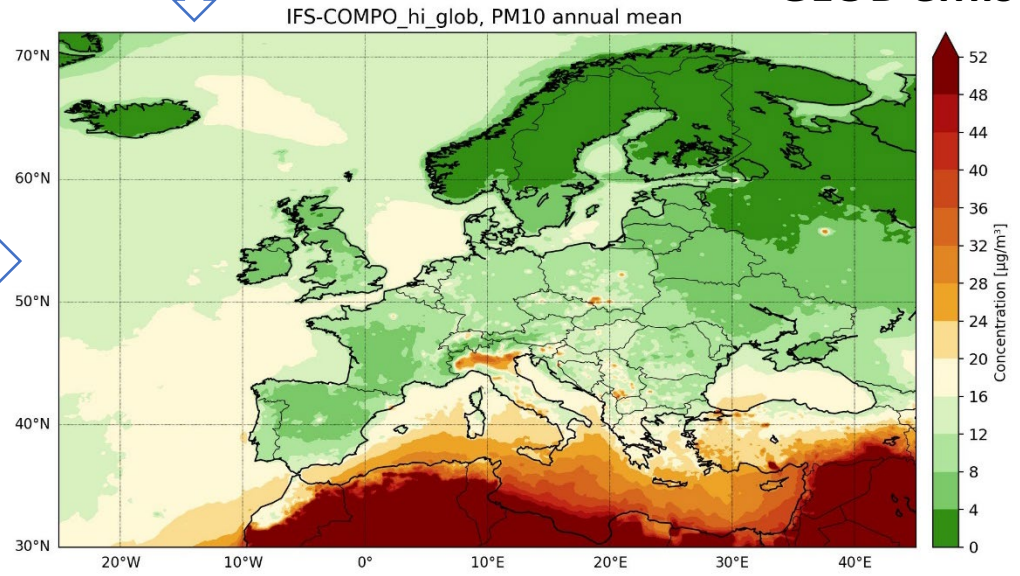




REG emis

GLOB emis





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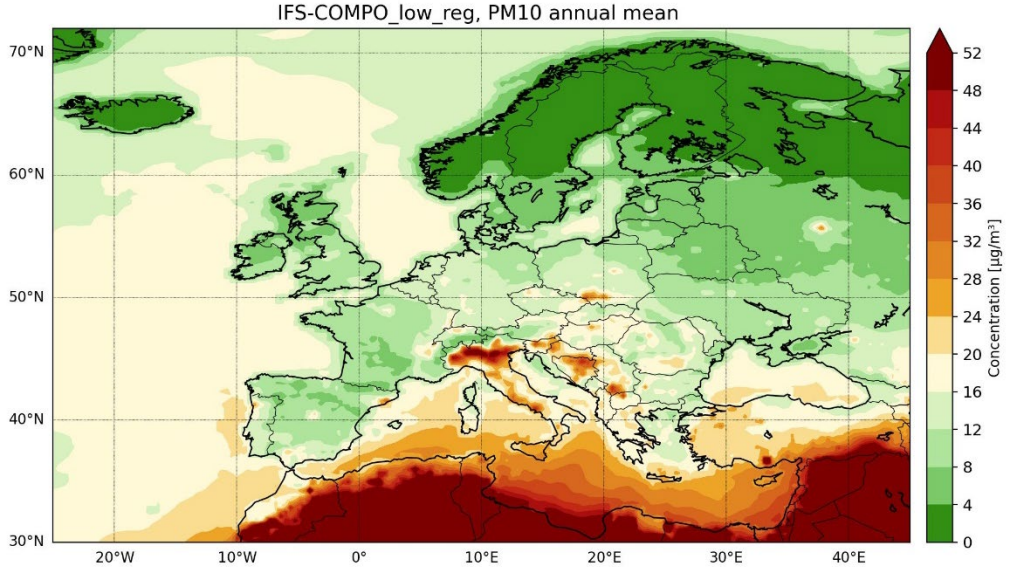
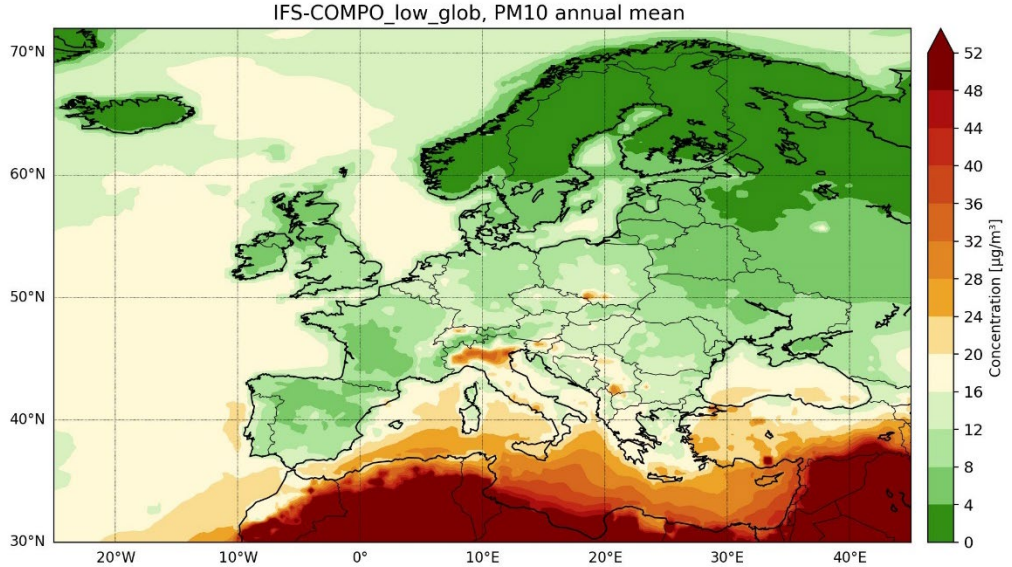
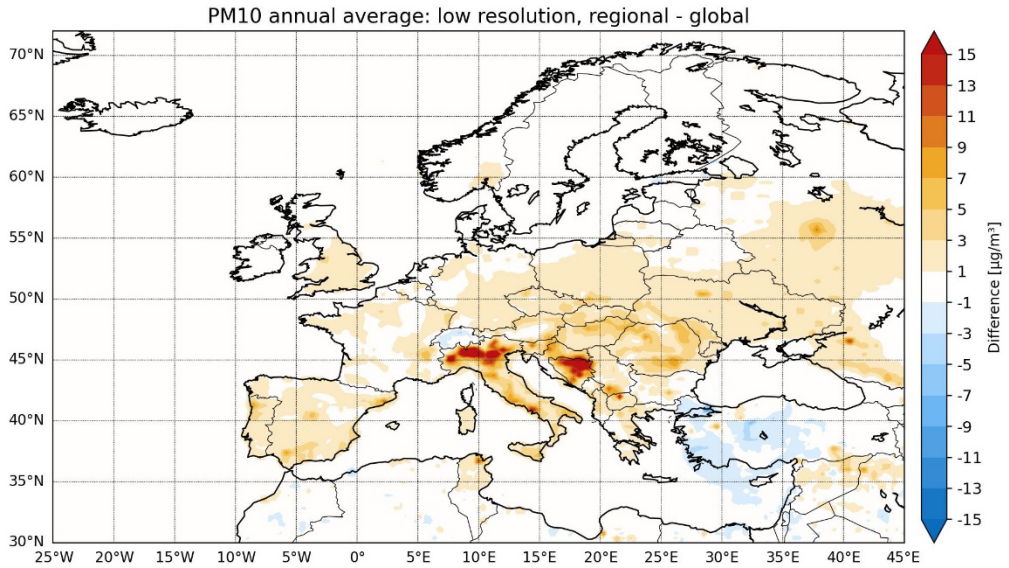
IFS COMPO

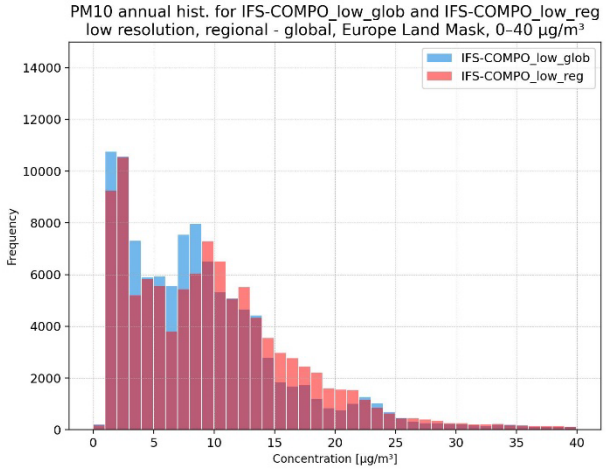
Sensitivity to emissions over Europe

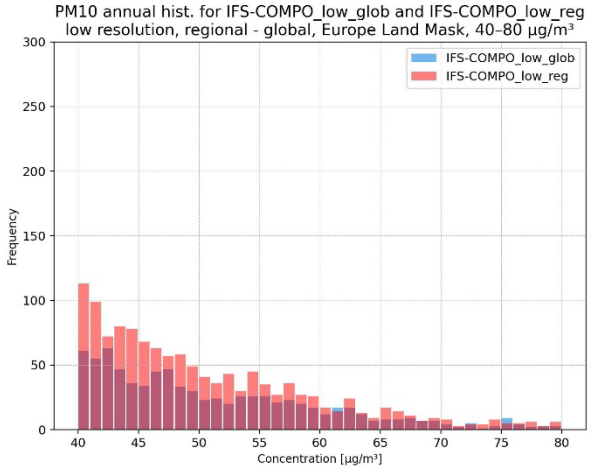
PM10 annual mean – GLOBAL vs. REGIONAL emission, low resolution 0.5deg



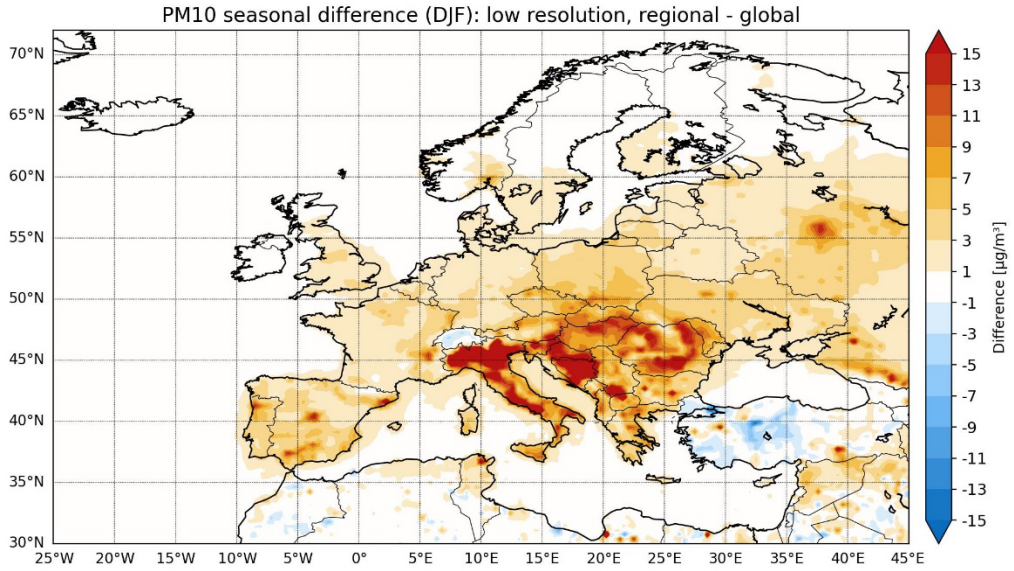


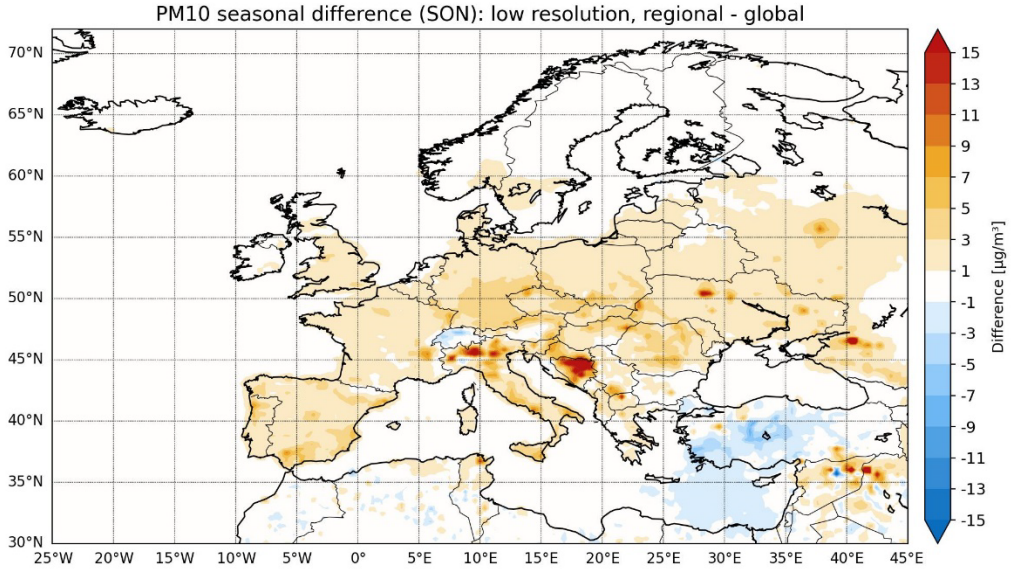


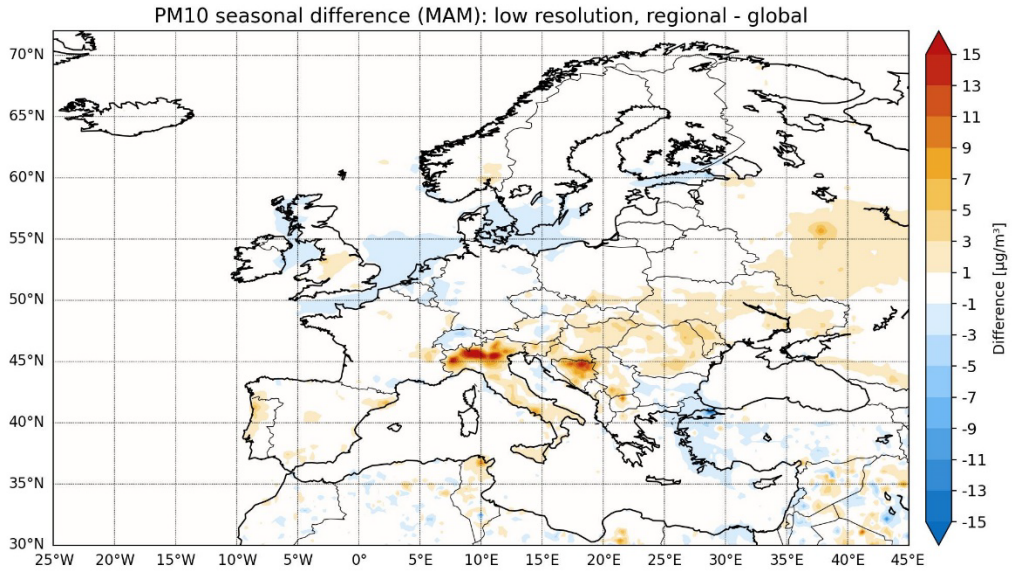


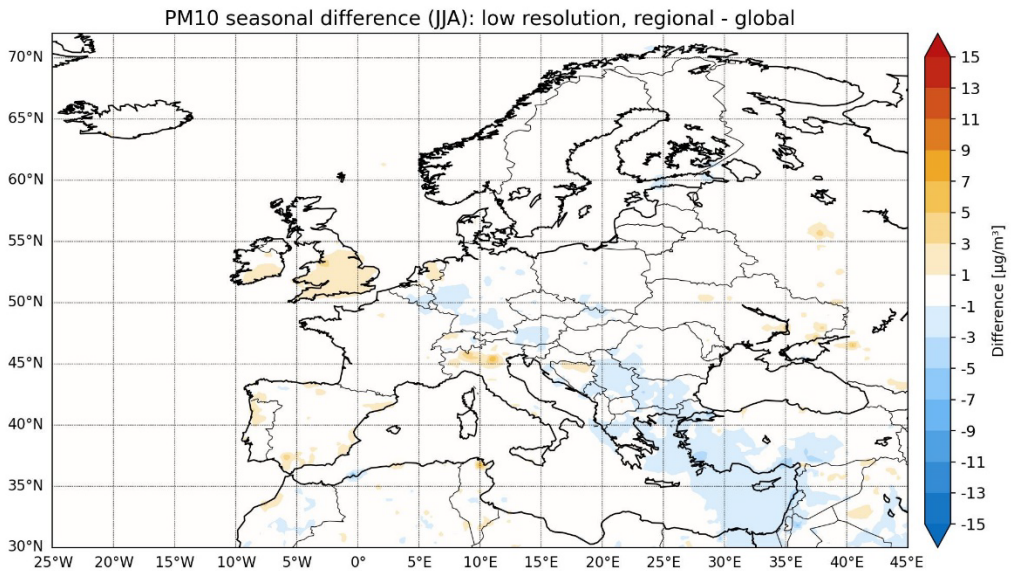


PM10 seasonal differences - all seasons, low resolution → (REG – GLOB)

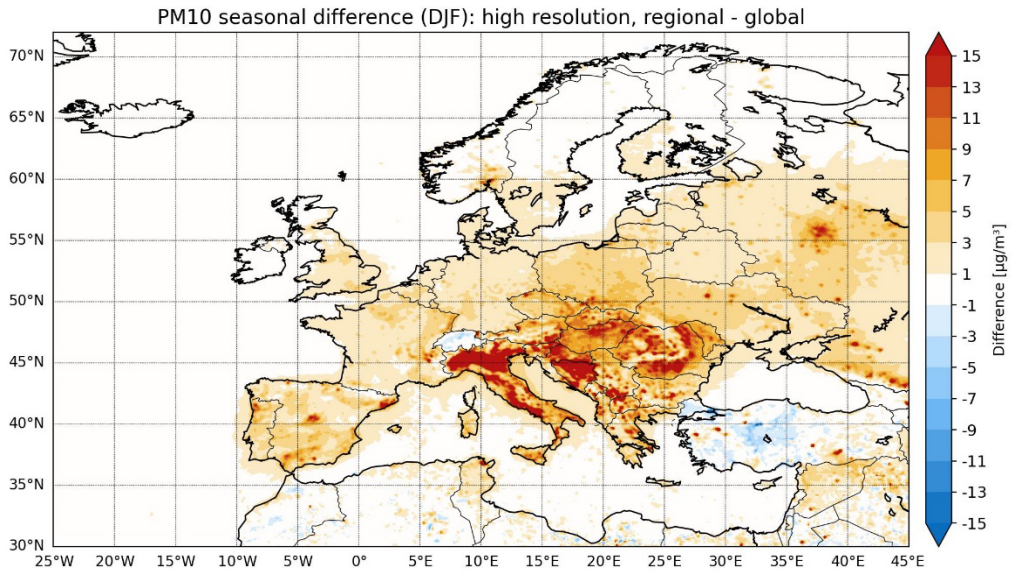


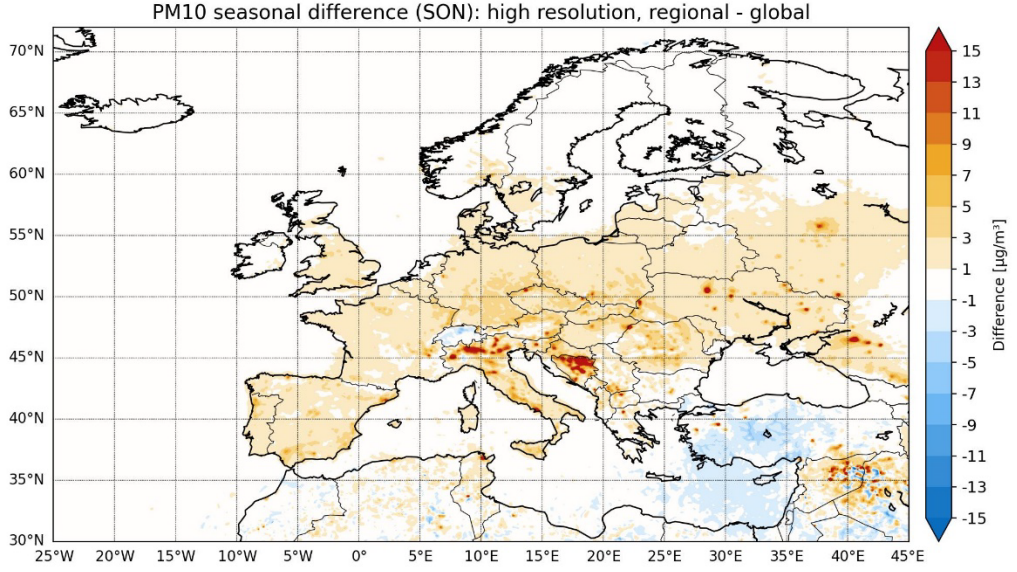


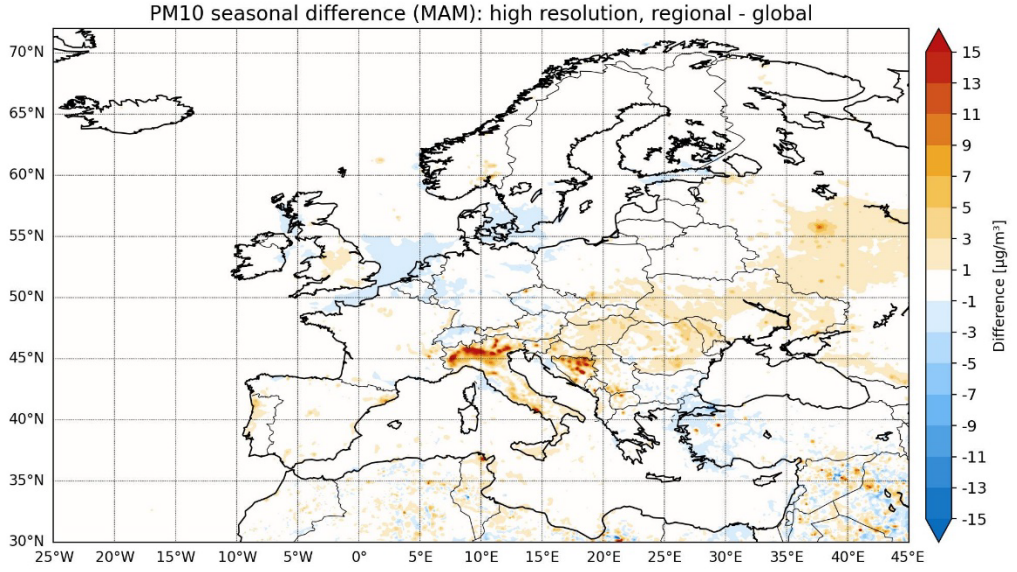


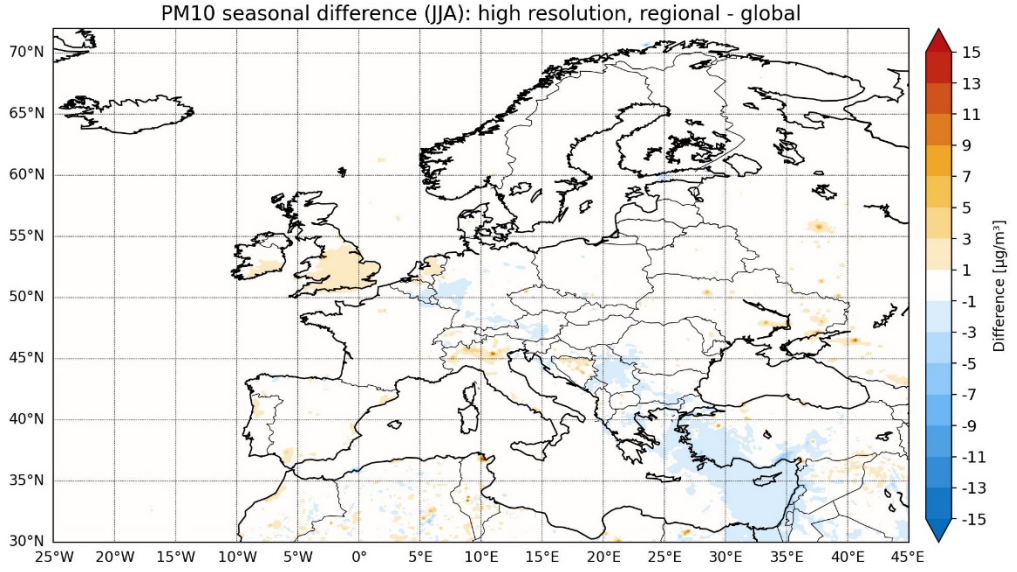


PM10 seasonal differences - all seasons, high resolution → (REG – GLOB)

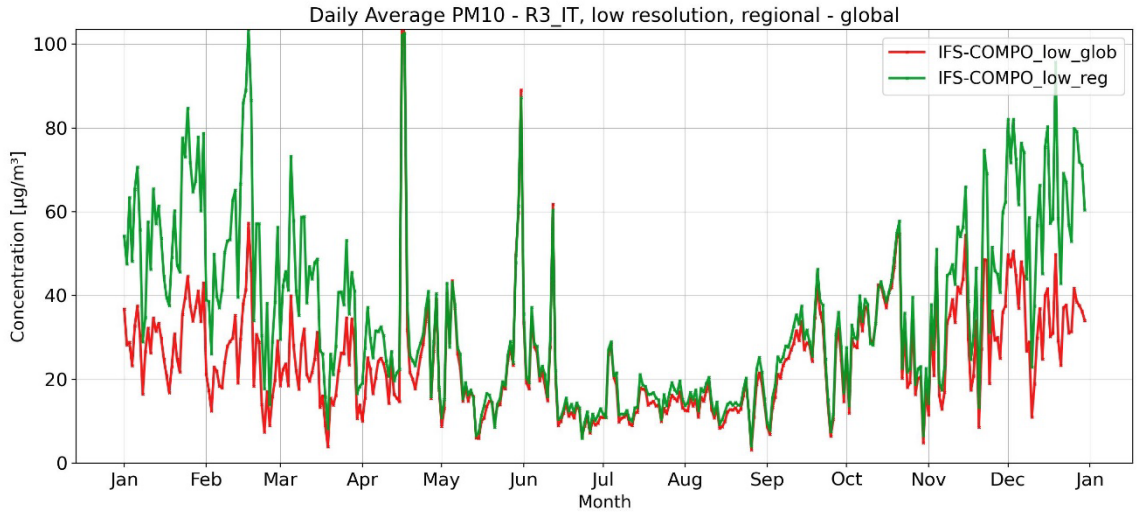


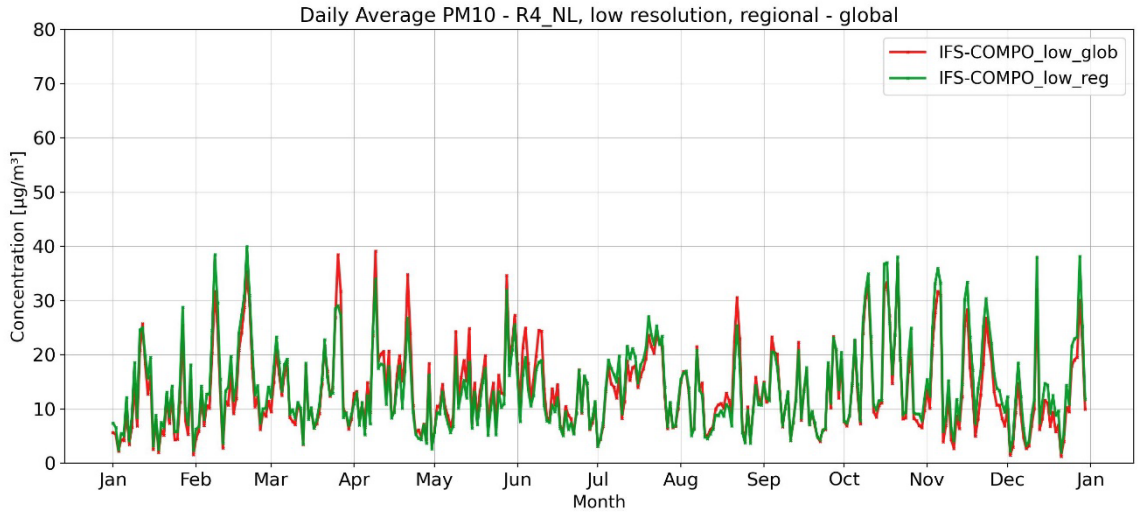


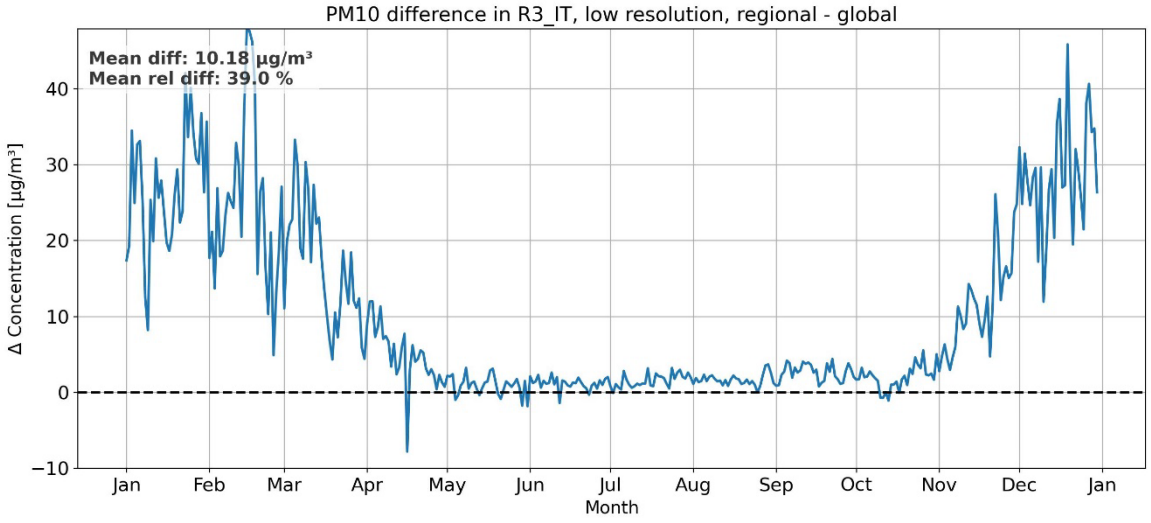


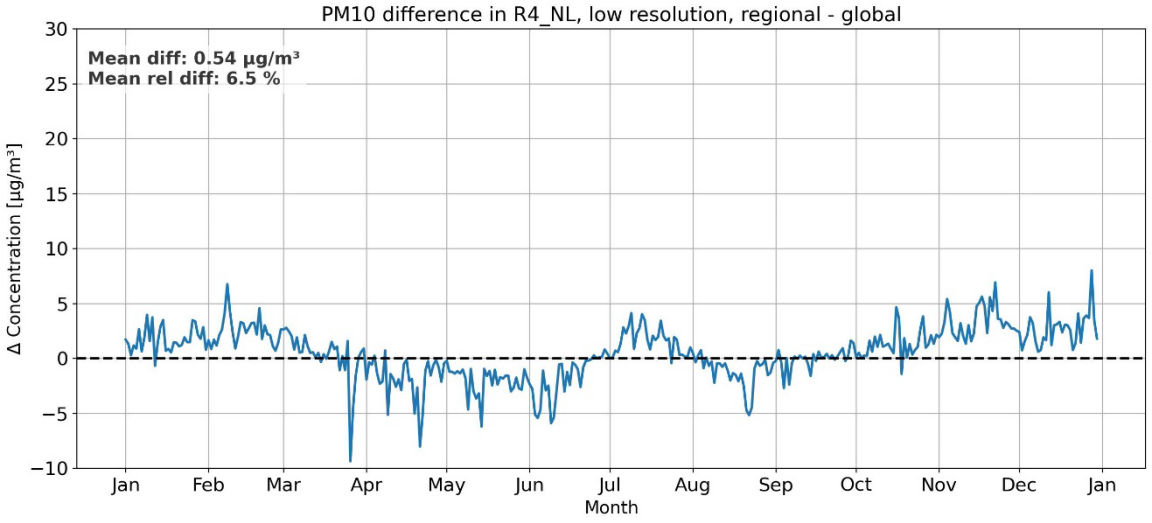


PM10 daily differences - low resolution 0.5deg, GLOB vs. REG by region, daily



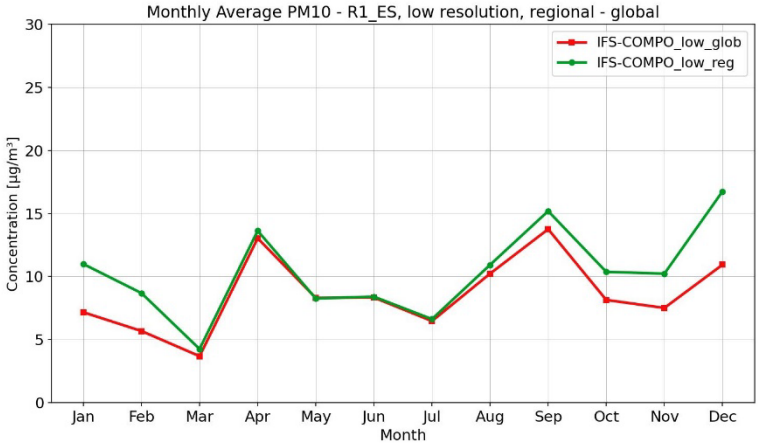






PM10 monthly differences - low resolution 0.5deg, GLOB vs. REG by region, monthly

SPAIN



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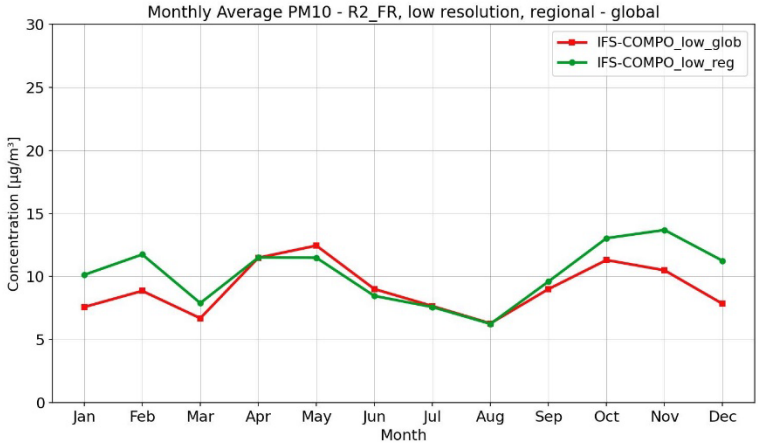

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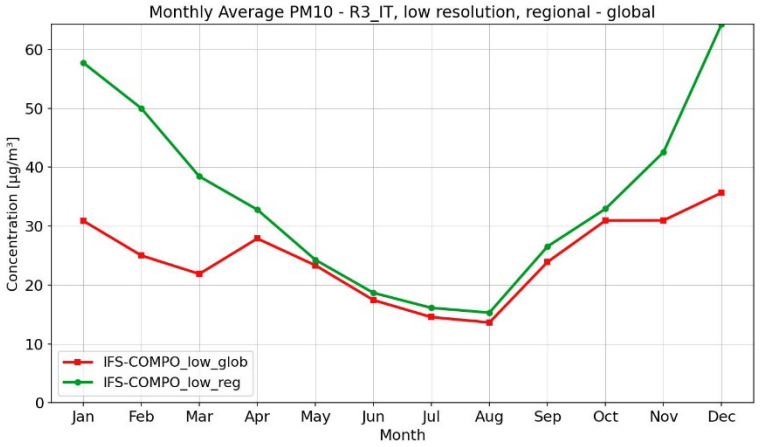
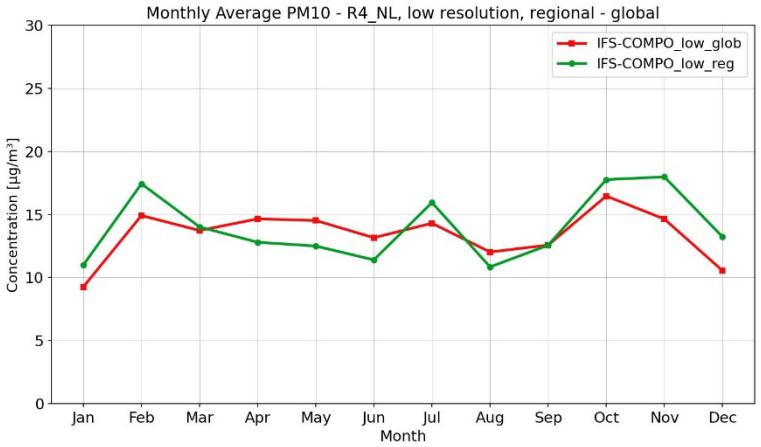
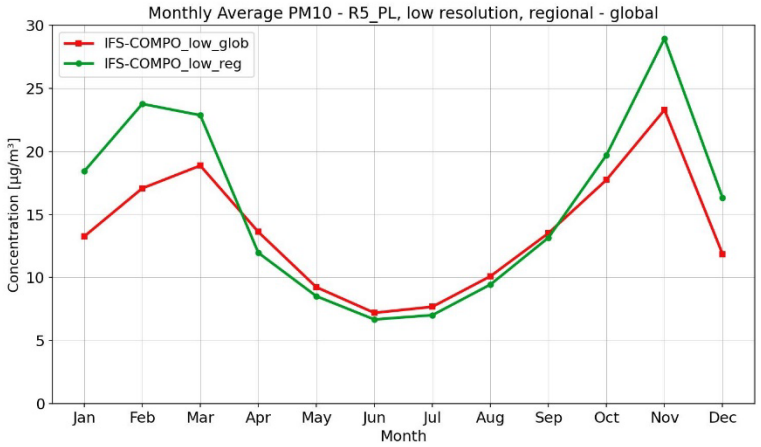
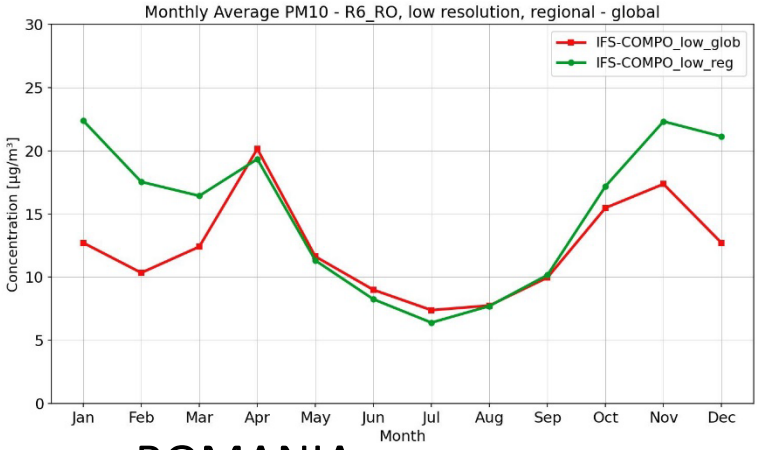




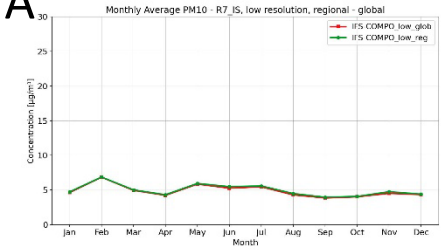
THE NEATHERLANDS



POLAND



ROMANIA



ICELAND

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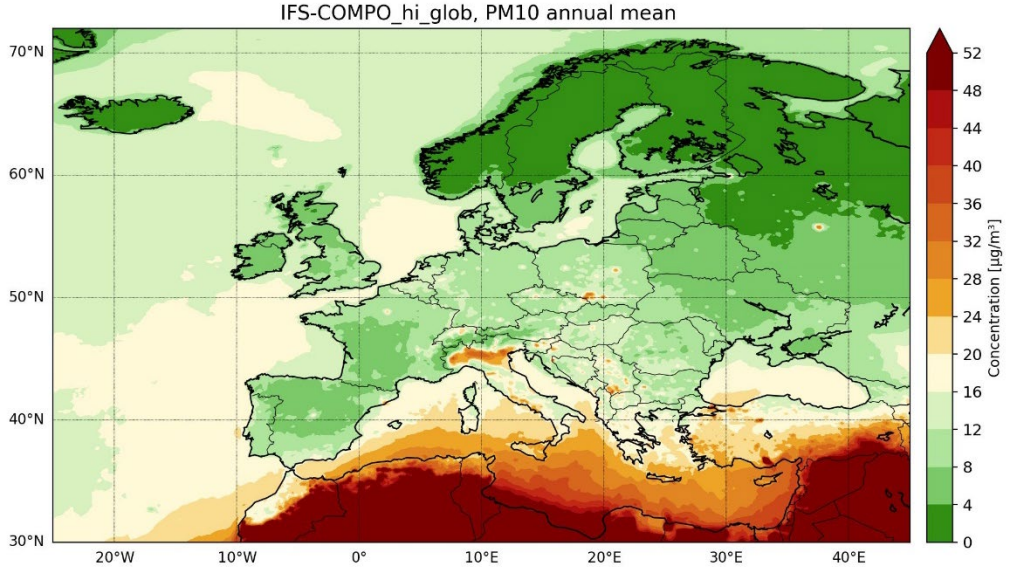
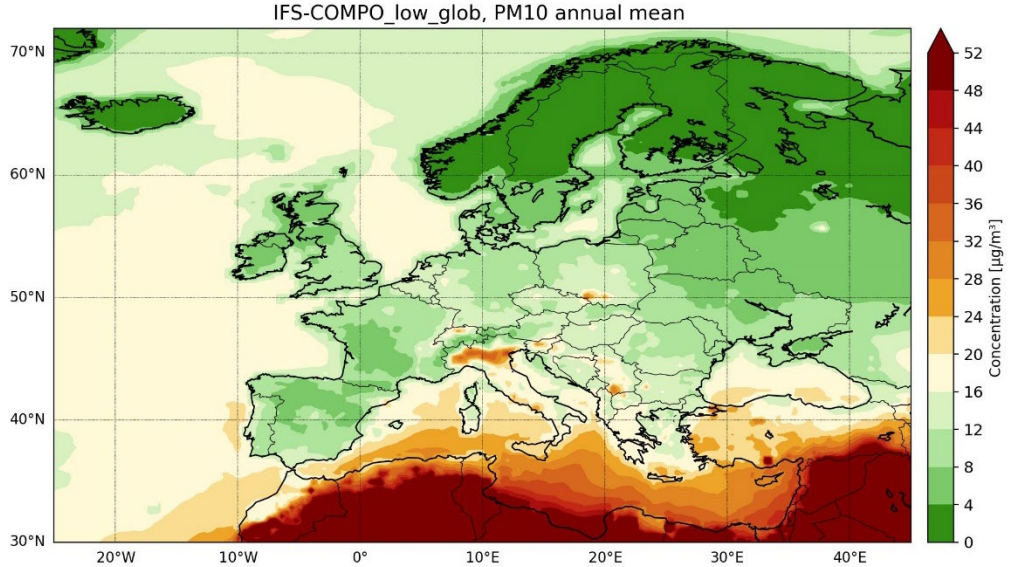
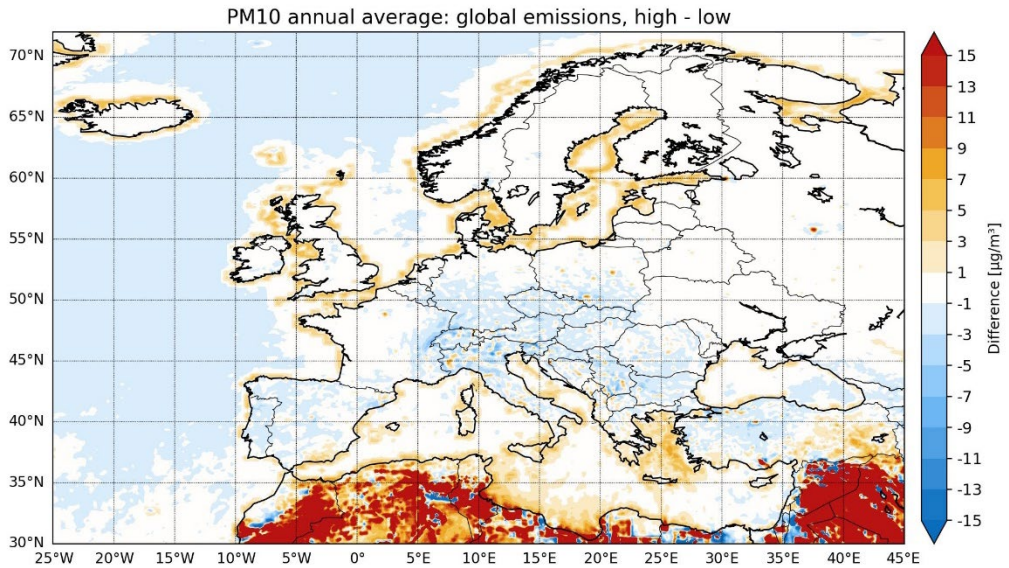
IFS COMPO

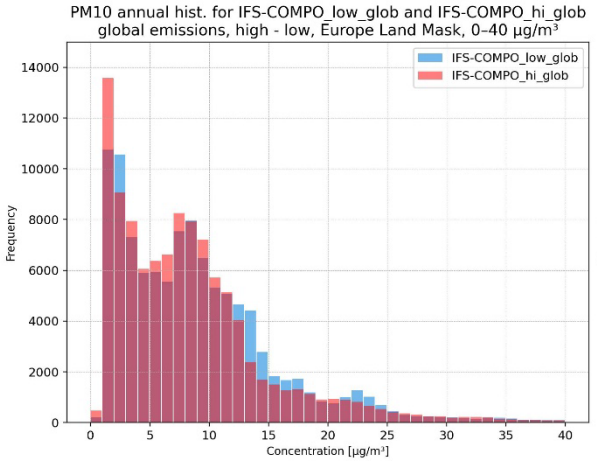
Sensitivity to the grid resolution

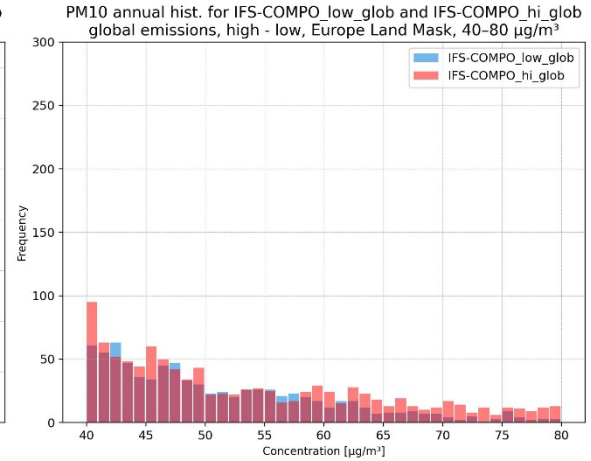
PM10 annual mean - low vs. high resolution (0.5 vs. 0.1), GLOBAL emissions



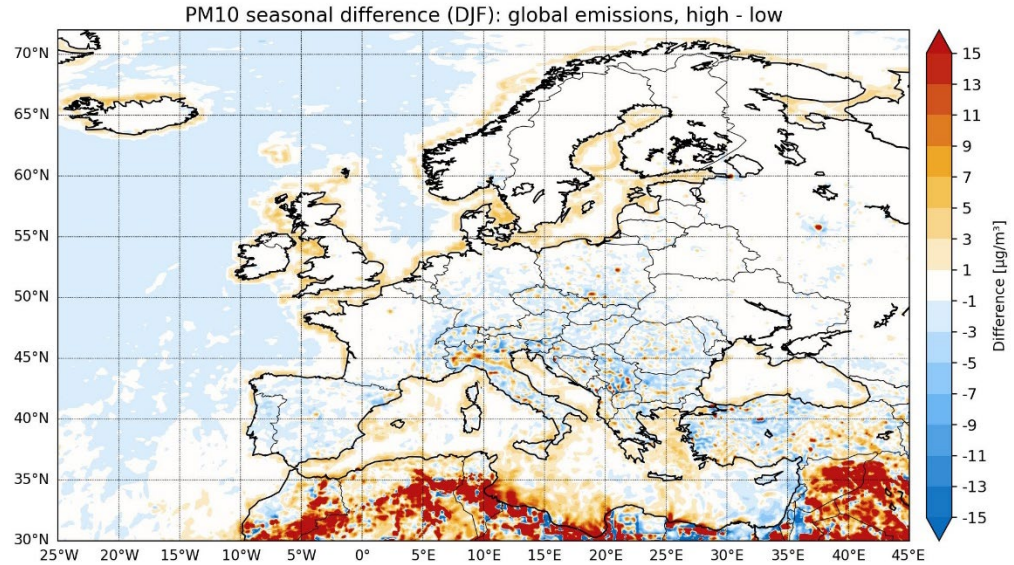


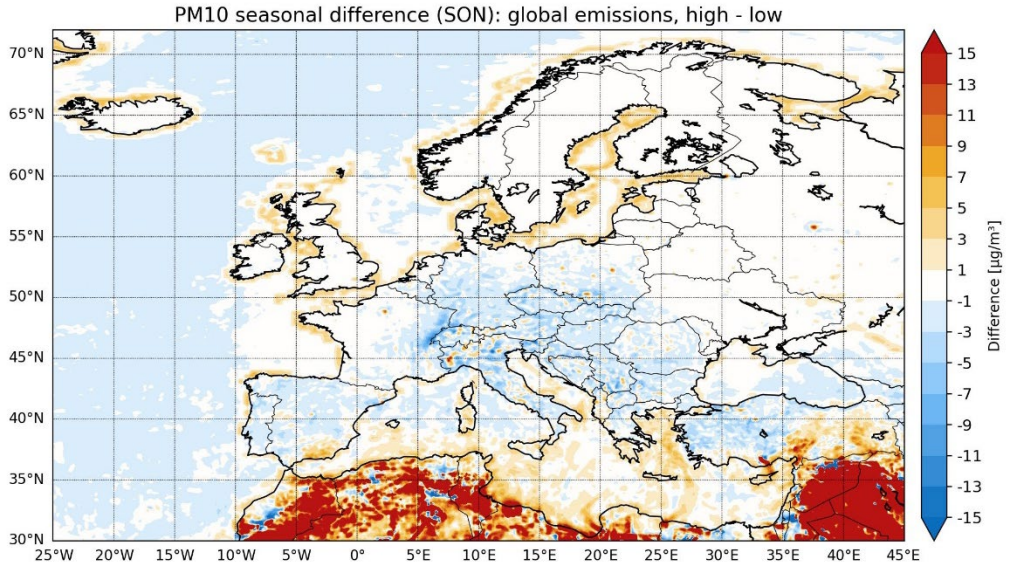


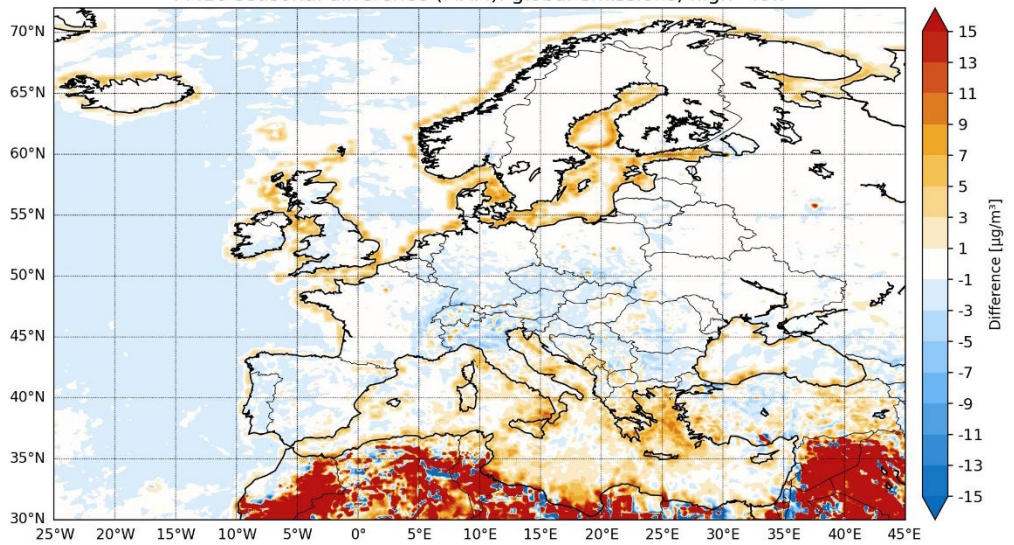


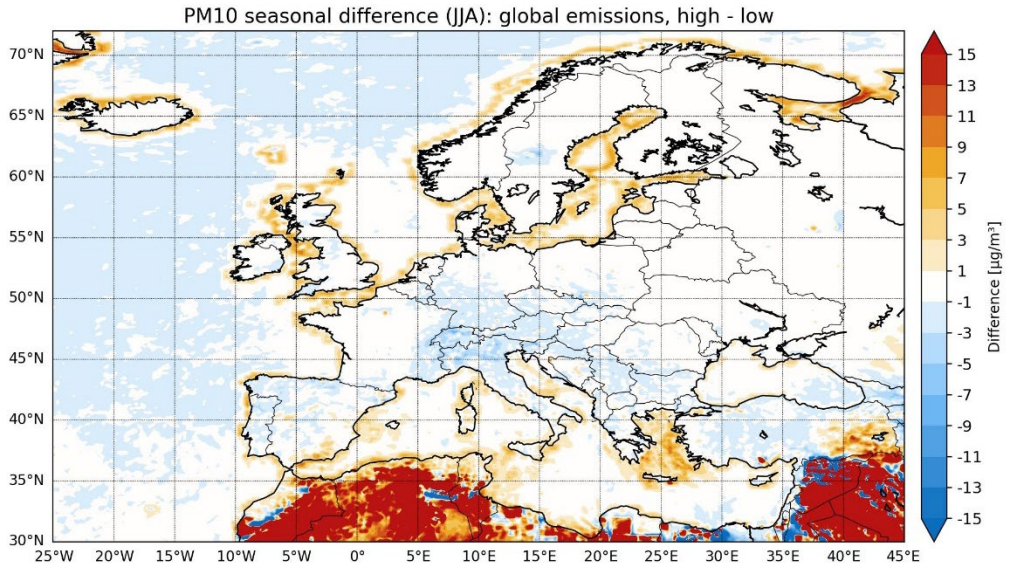


PM10 seasonal differences – high-low resolution (0.1-0.5), GLOBAL emissions

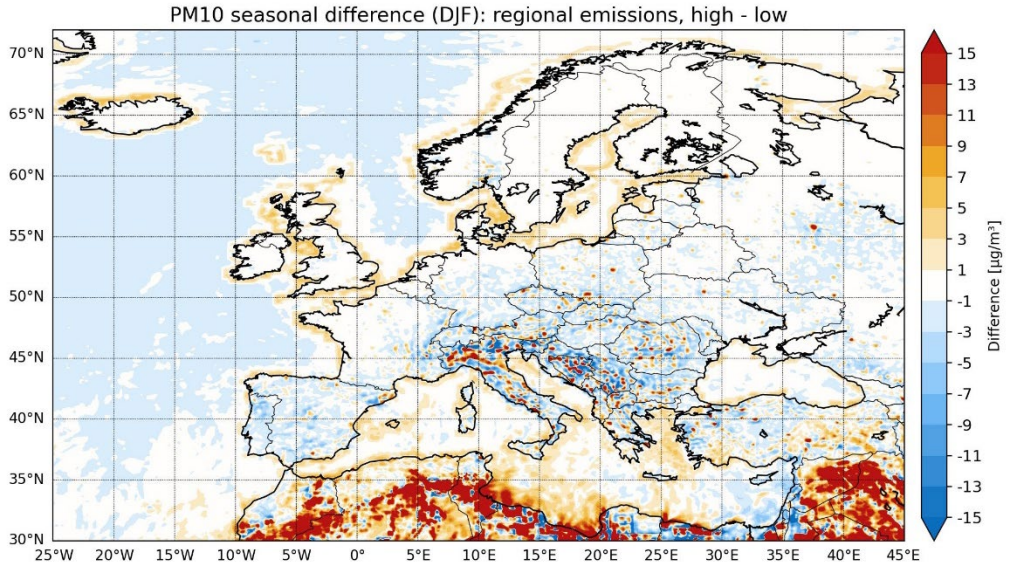


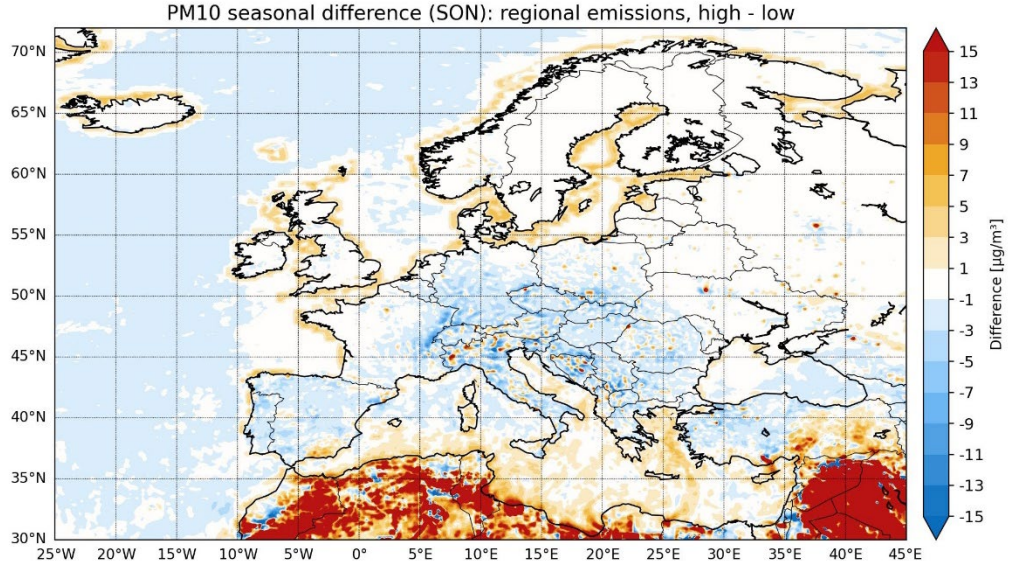


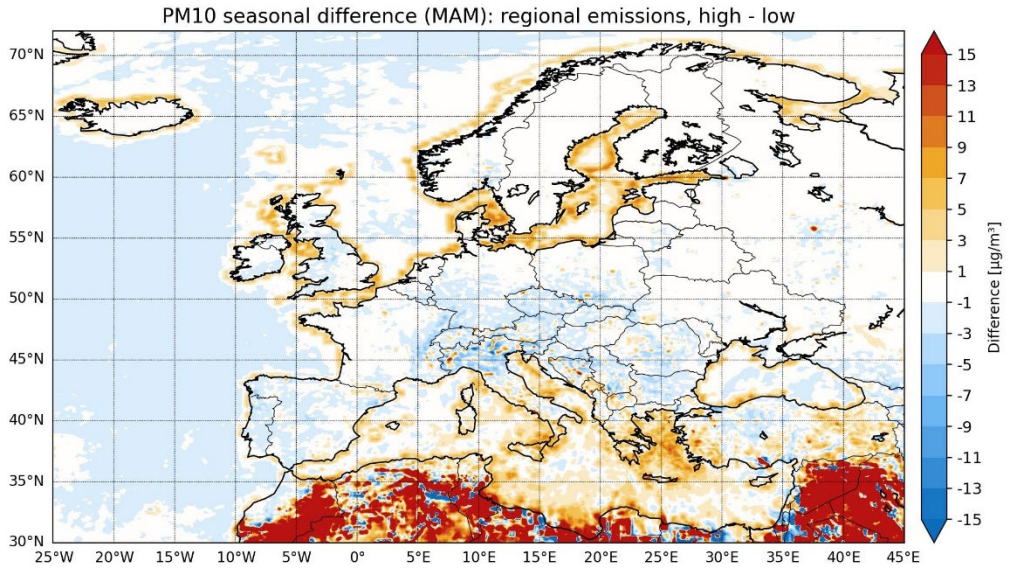


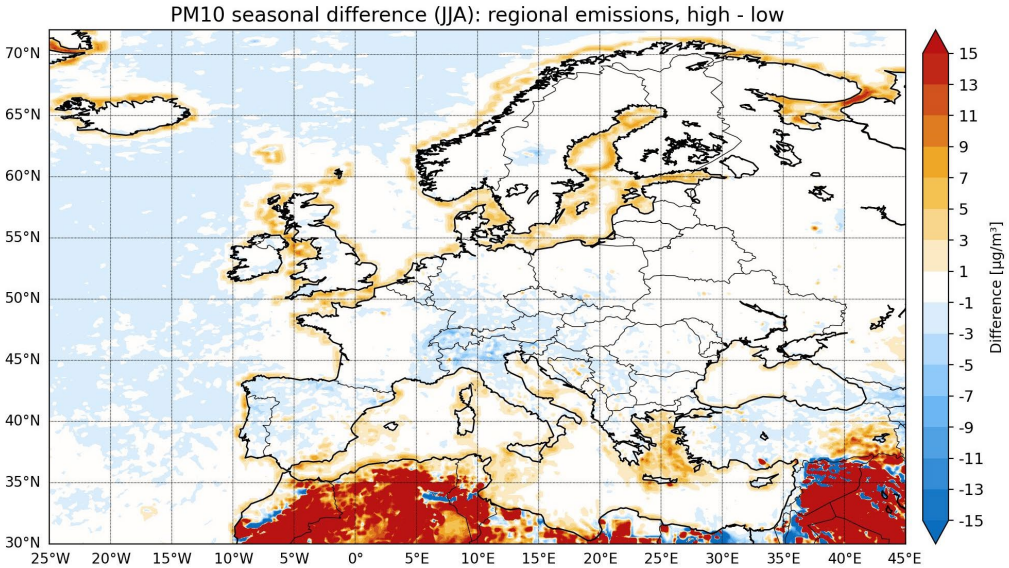


PM10 seasonal differences - high-low resolution (0.1-0.5), REGIONAL emissions



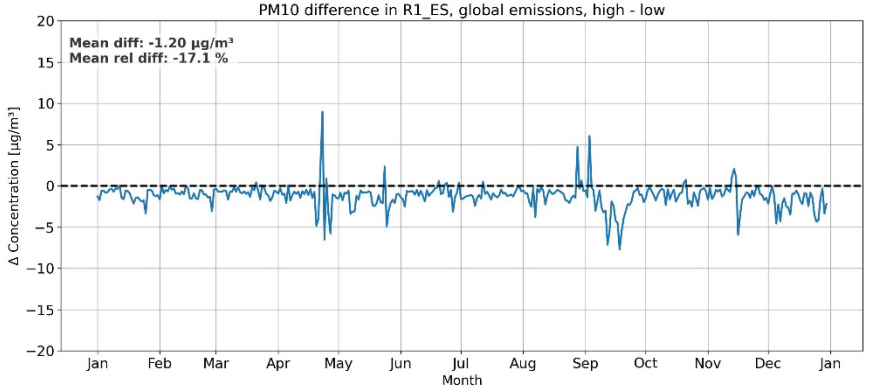




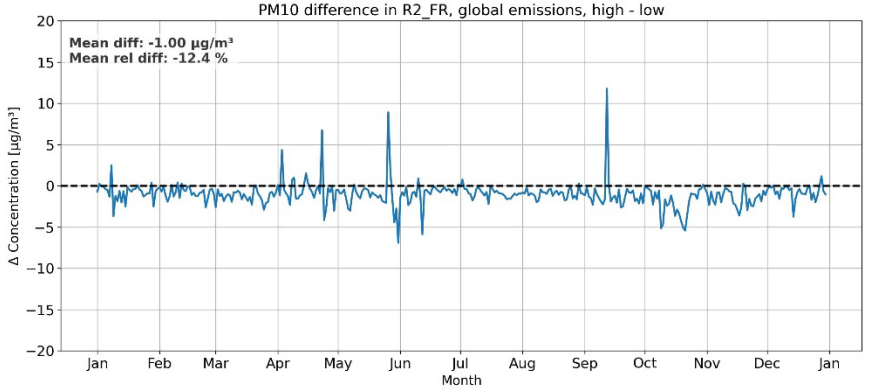


PM10 daily differences - high-low resolution (0.1-0.5), GLOBAL emissions, by region

SPAIN



FRANCE



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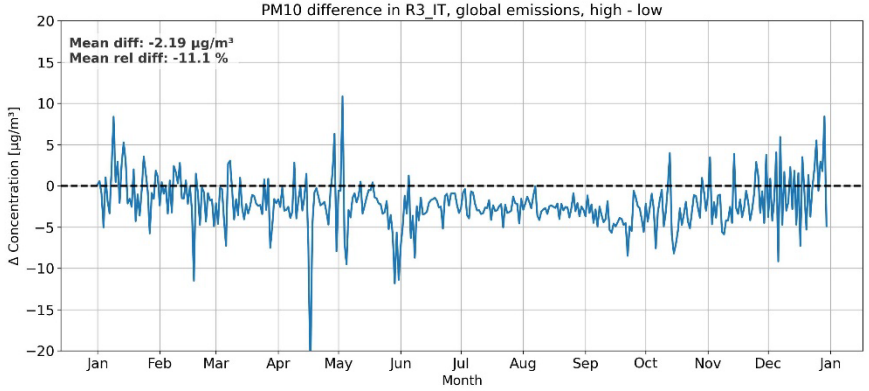
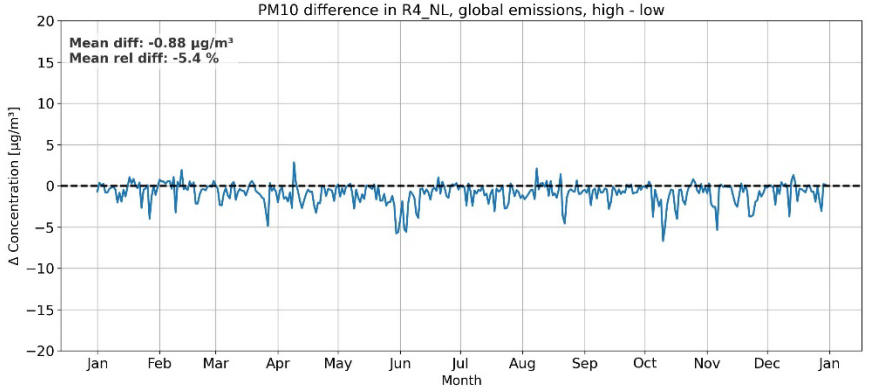
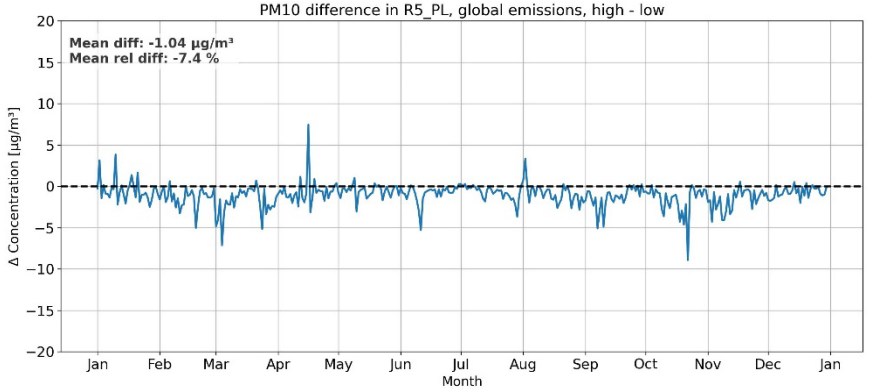


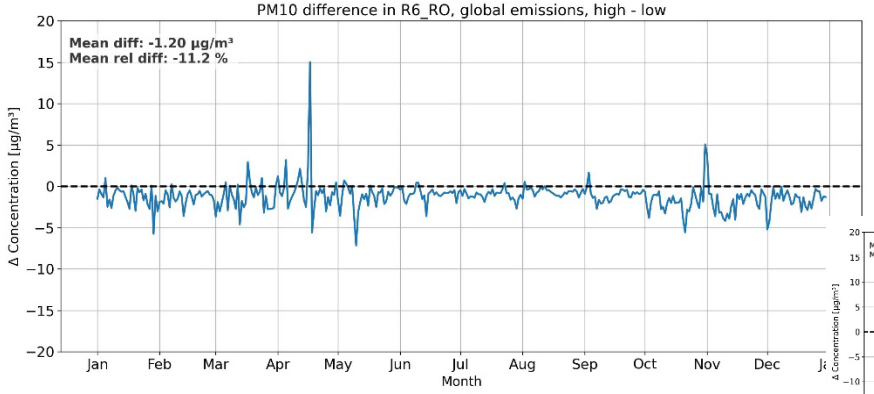
The Neatherlands



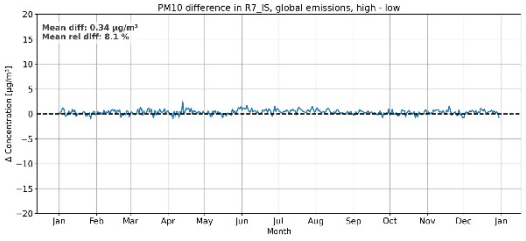
POLAND



ROMANIA

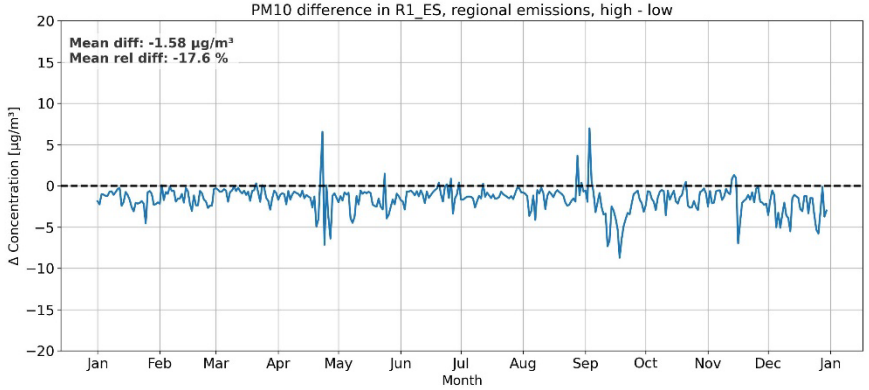


ICELAND



PM10 daily differences - high-low resolution (0.1-0.5), REGIONAL emissions, by region

SPAIN



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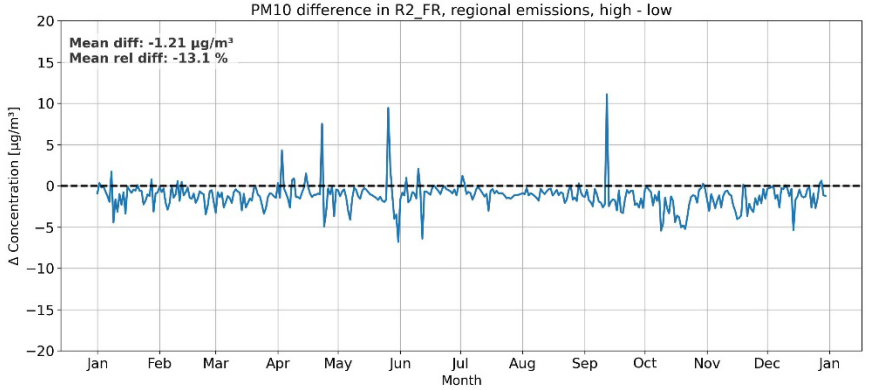

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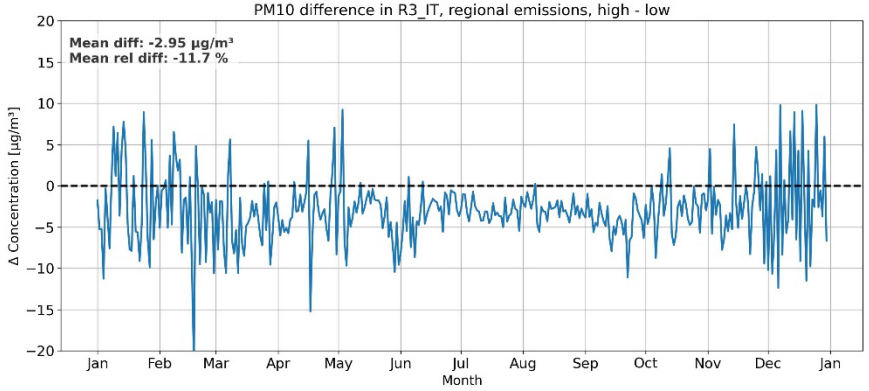
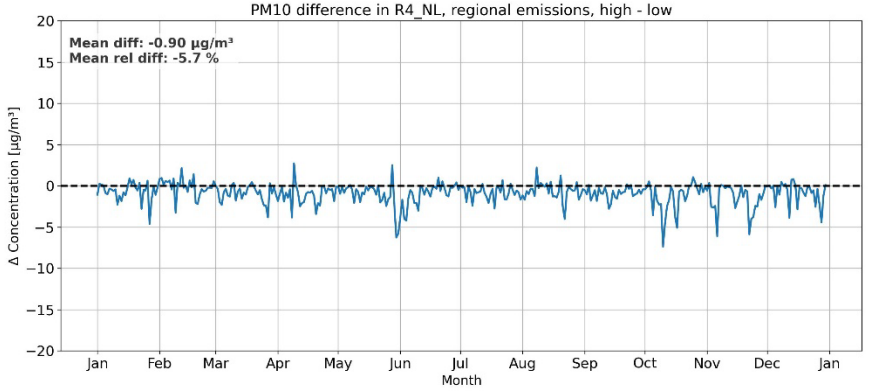
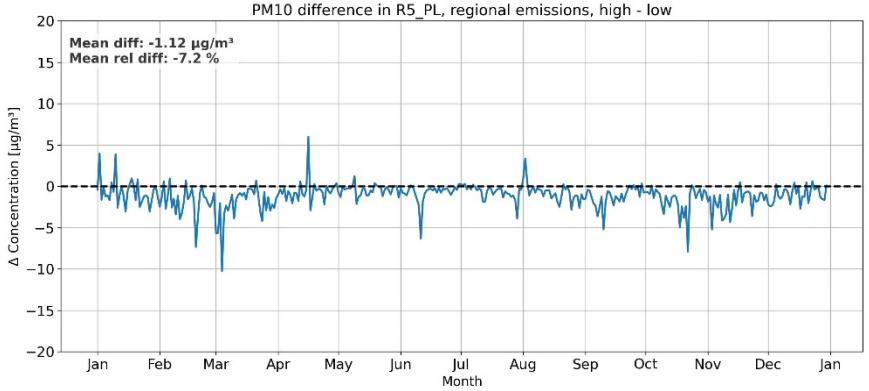


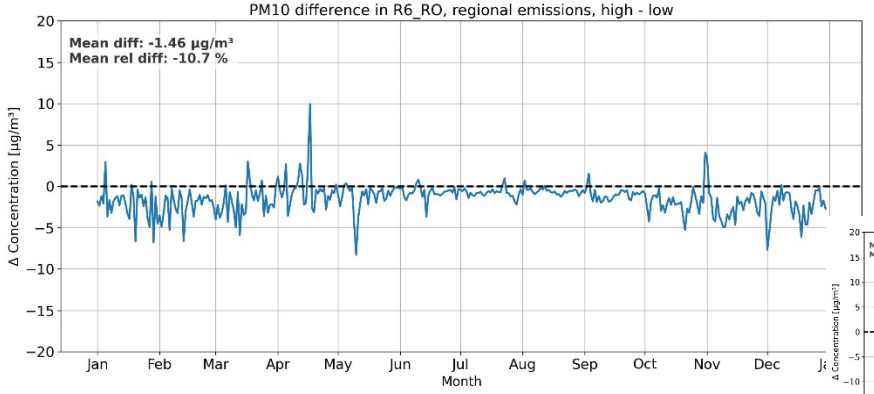
The Neatherlands



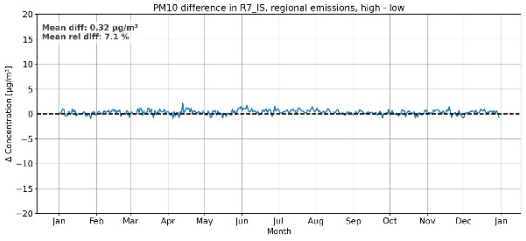
POLAND



ROMANIA



Iceland

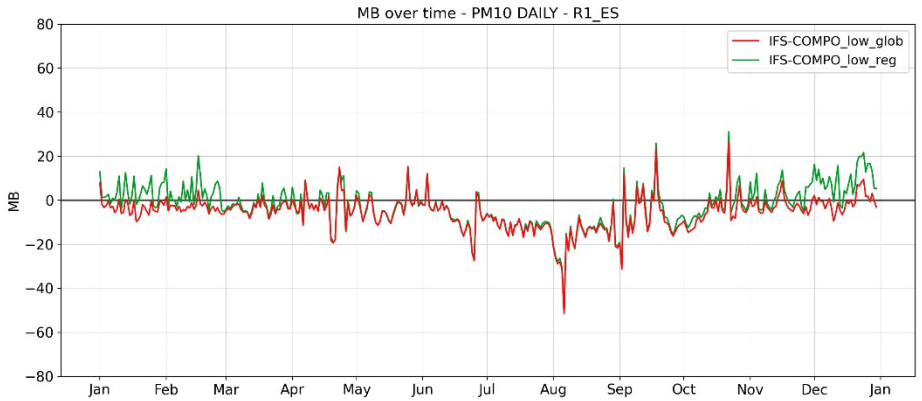


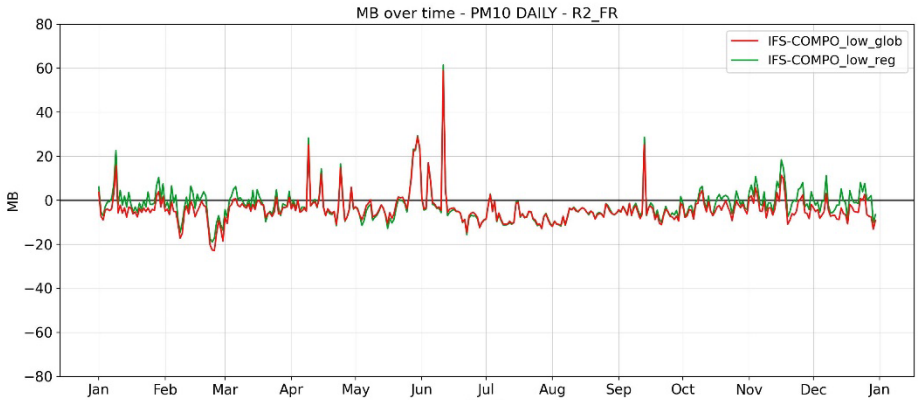
CAMAERA

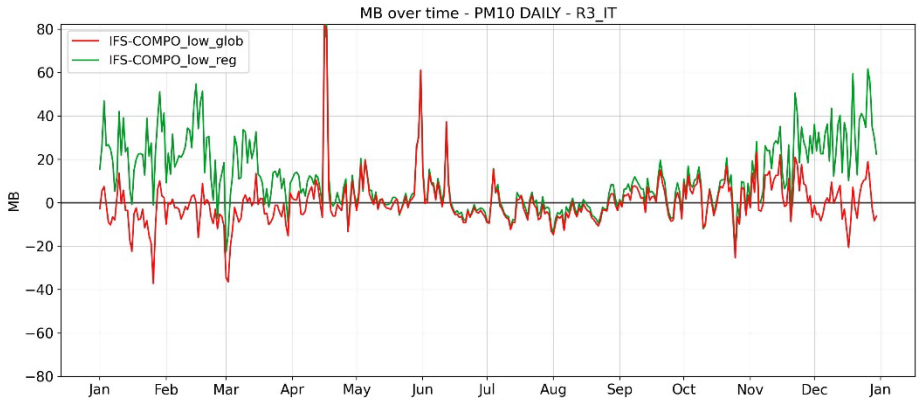
IFS COMPO

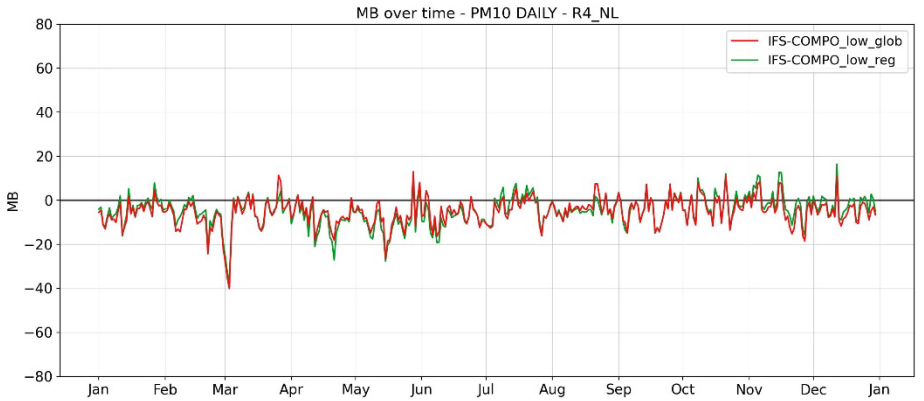
Evaluation of four versions

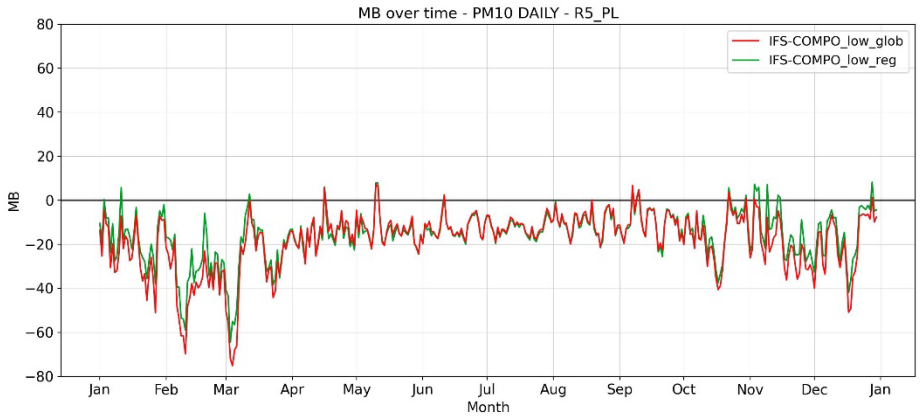
PM10 evaluation - Mean Bias Error (low res 0.5, GLOBAL vs. REGINAL)

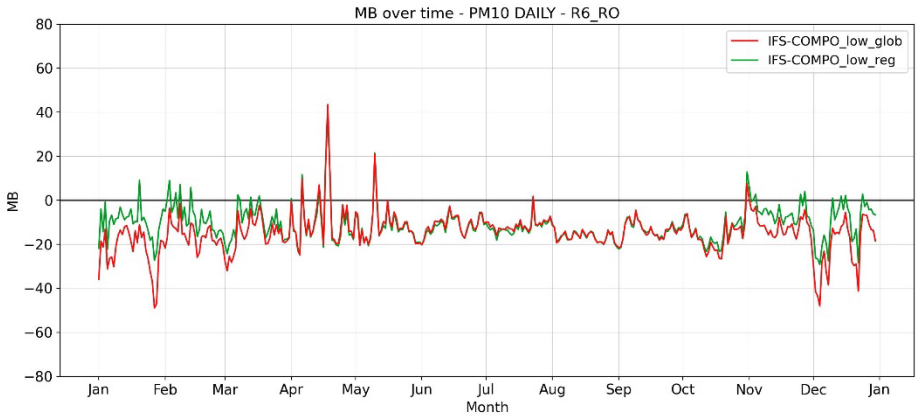




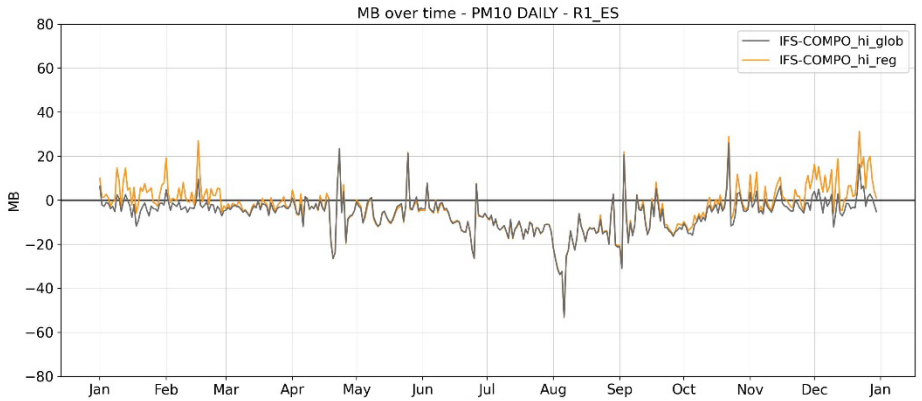


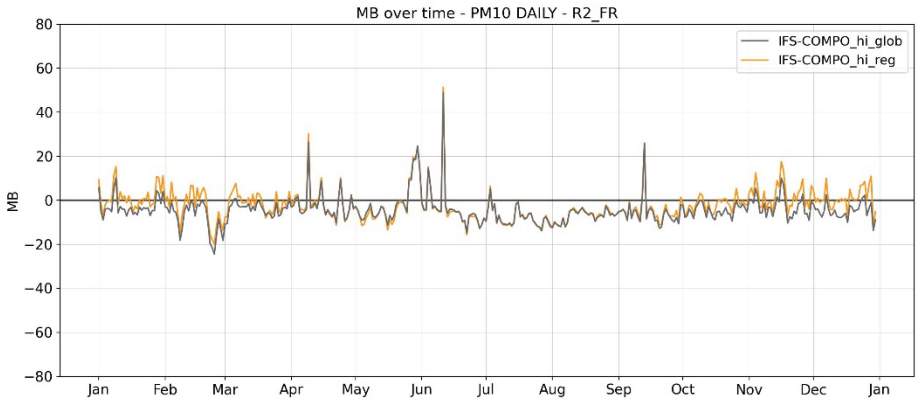


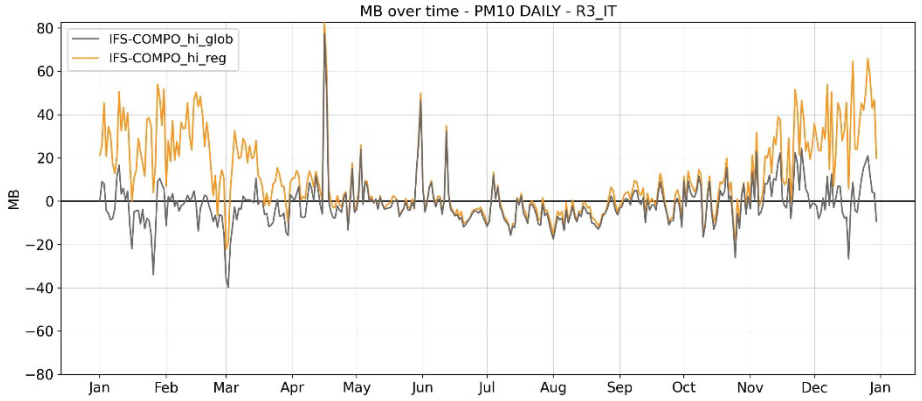


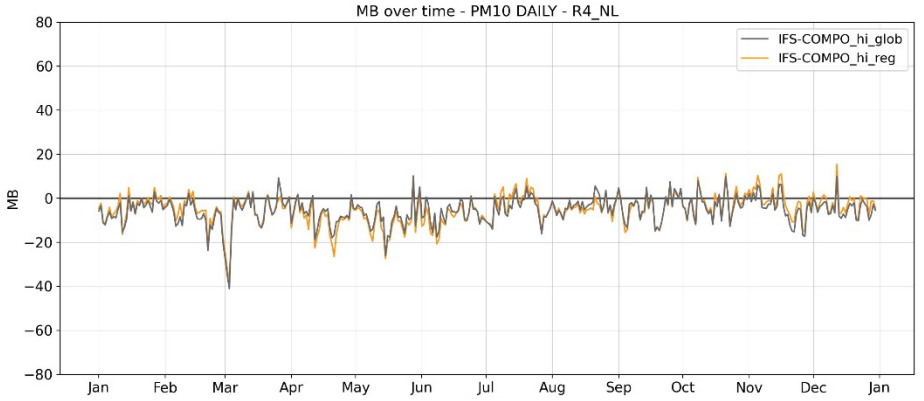


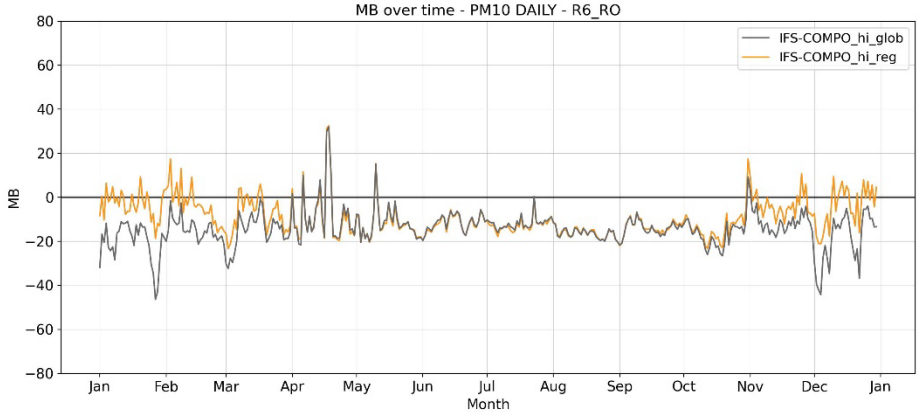
PM10 evaluation - Mean Bias Error (high res 0.1, GLOBAL vs. REGIONAL)

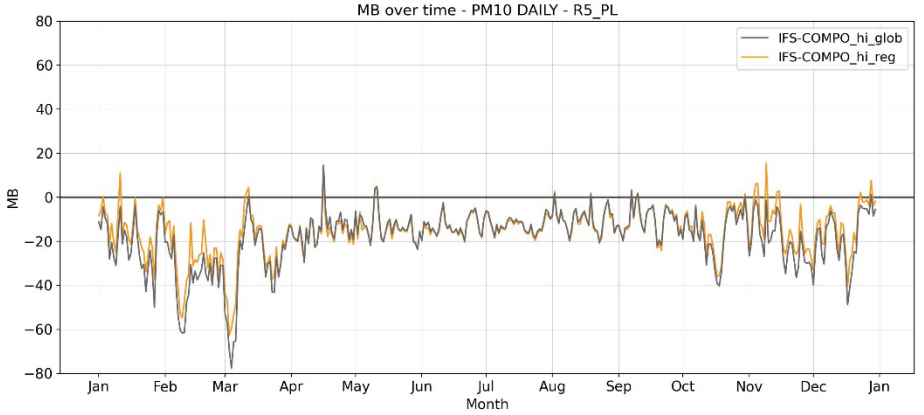




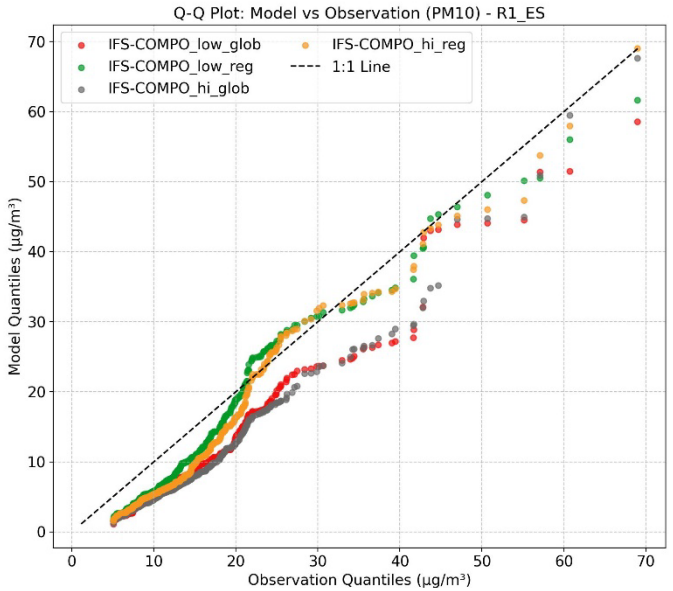


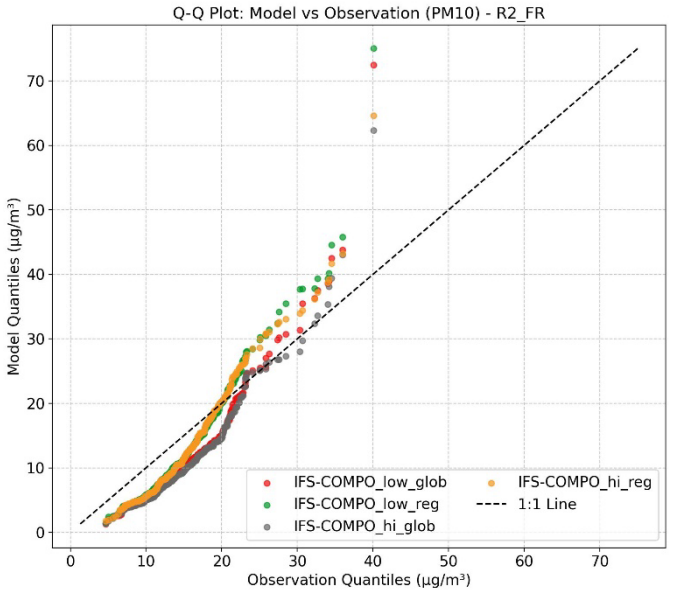


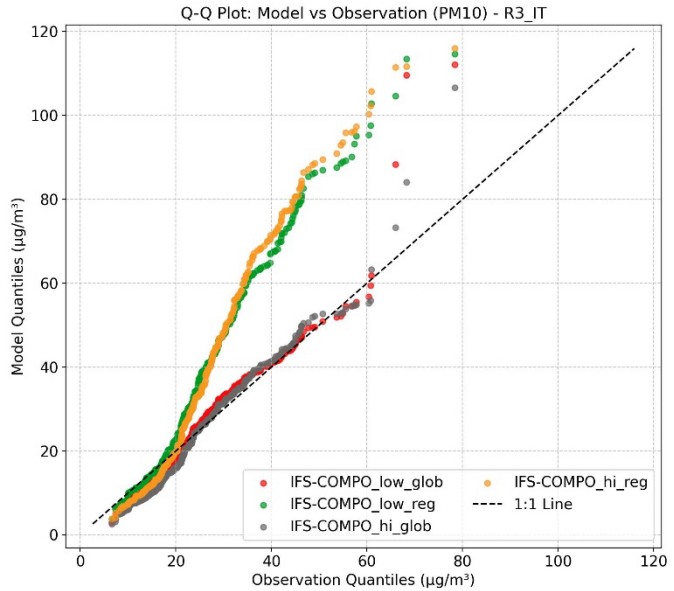


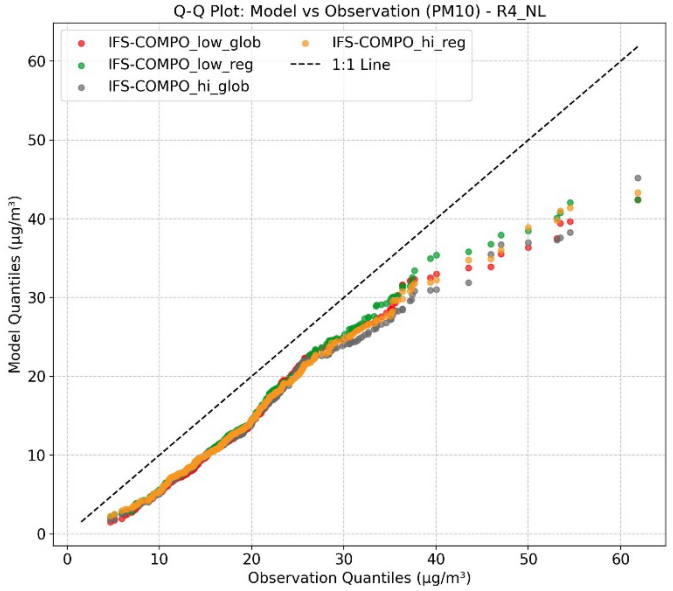


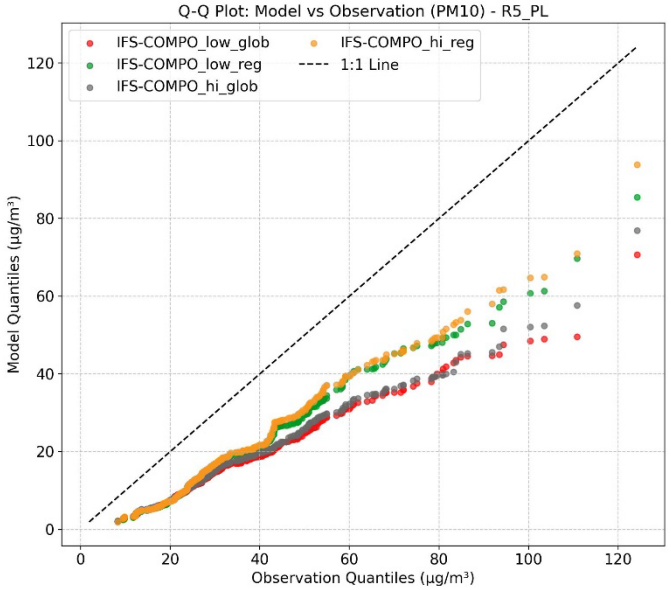
Q-Q plot PM10 - IFS-COMPO vs Regional Models

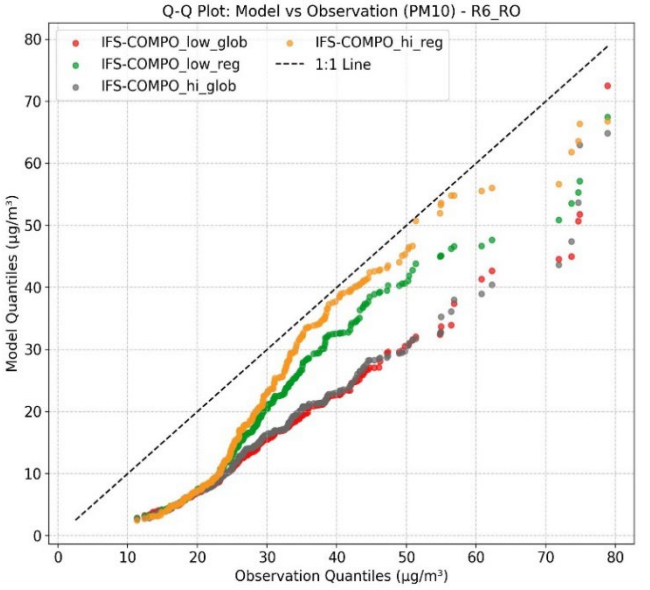






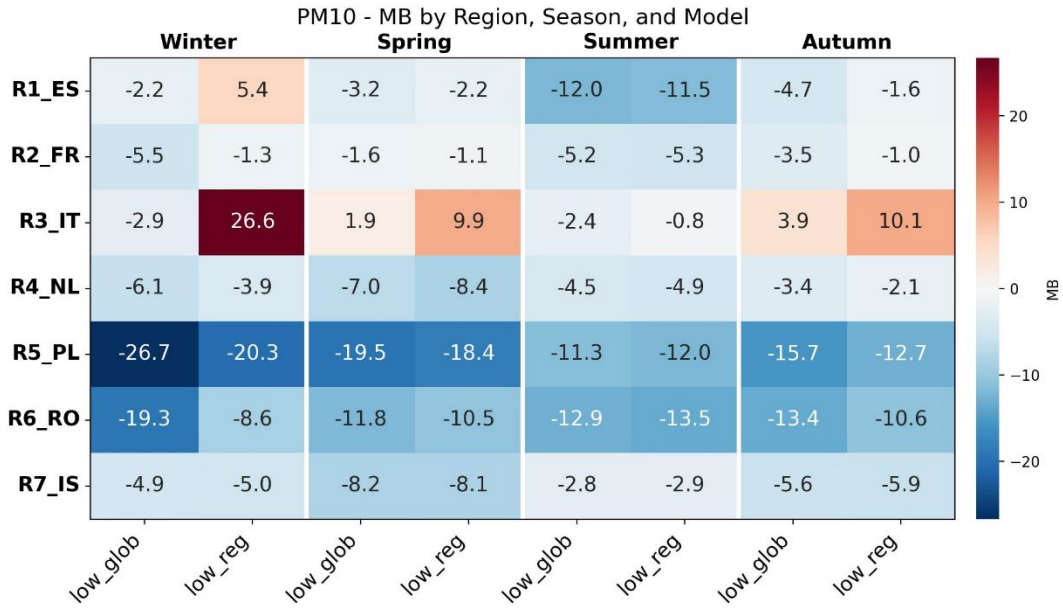


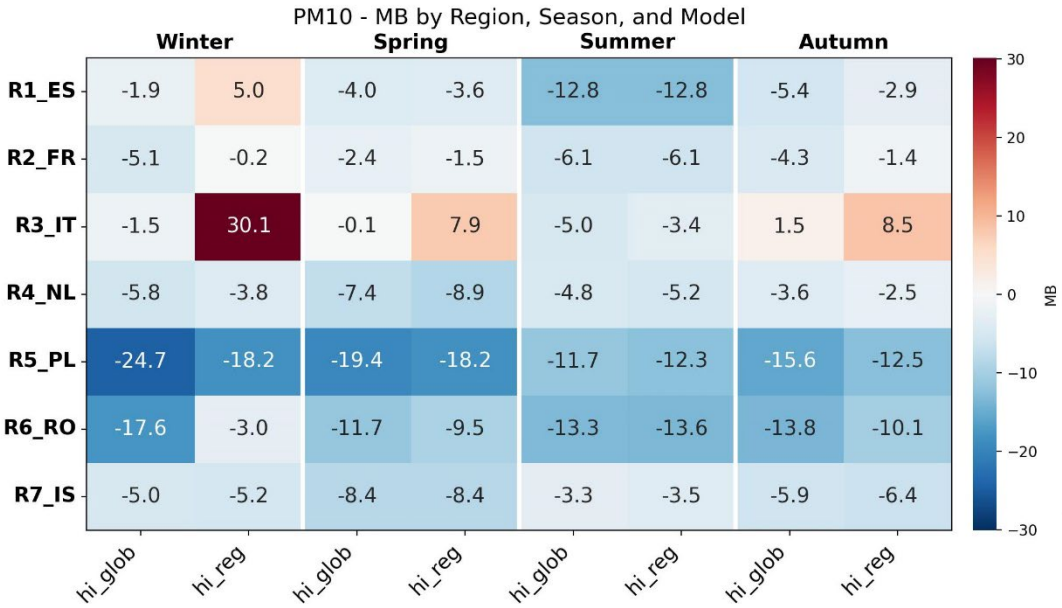




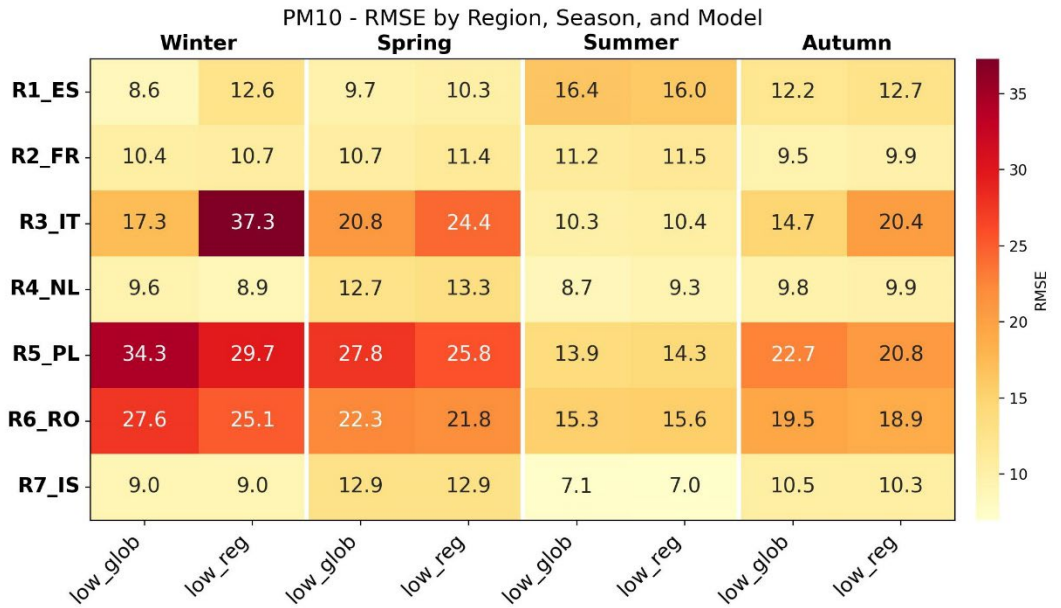
PM10 evaluation - summary (global vs regional emissions)

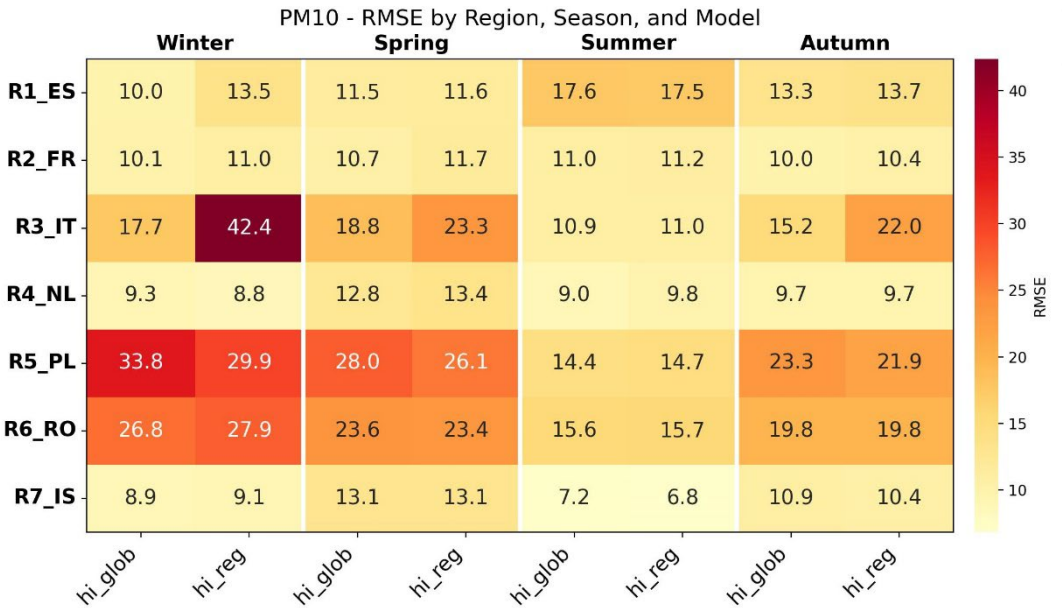
low resolution



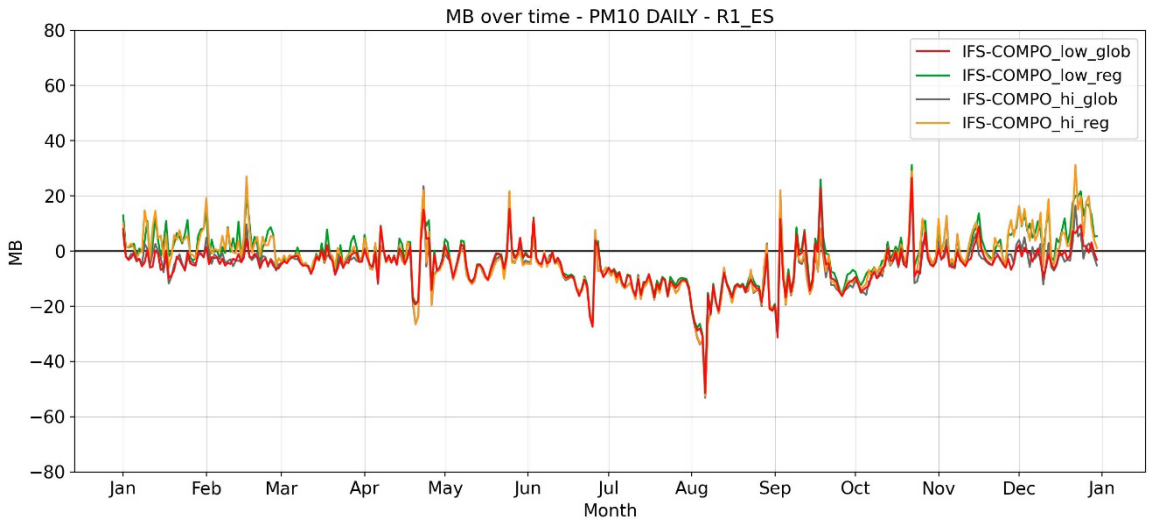


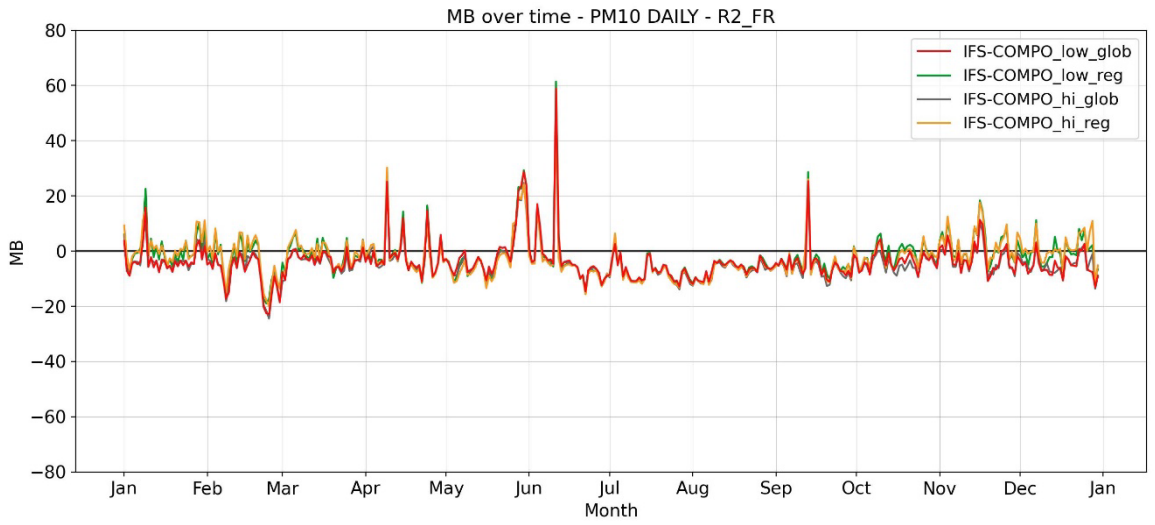
high resolution

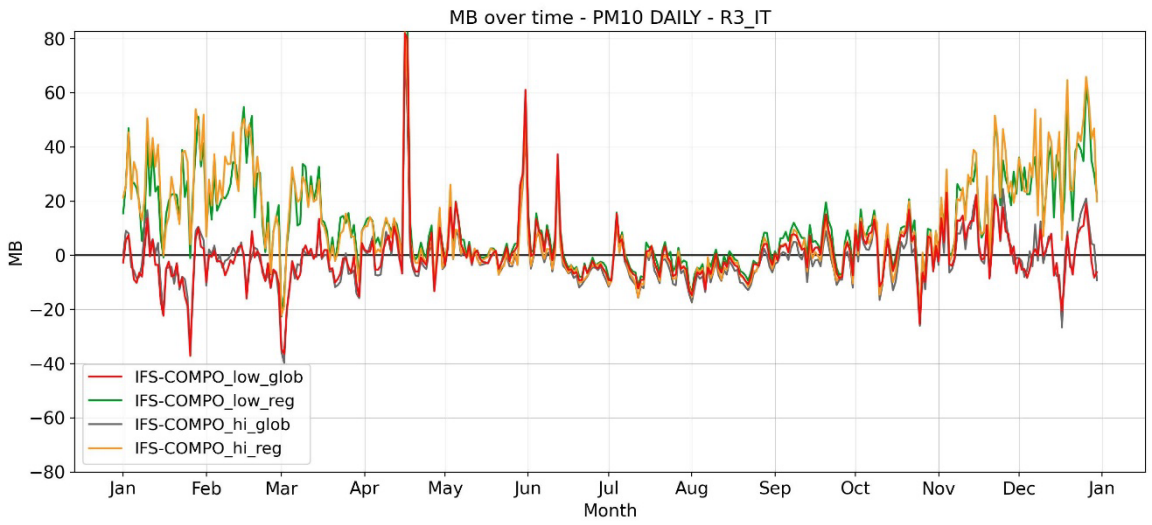


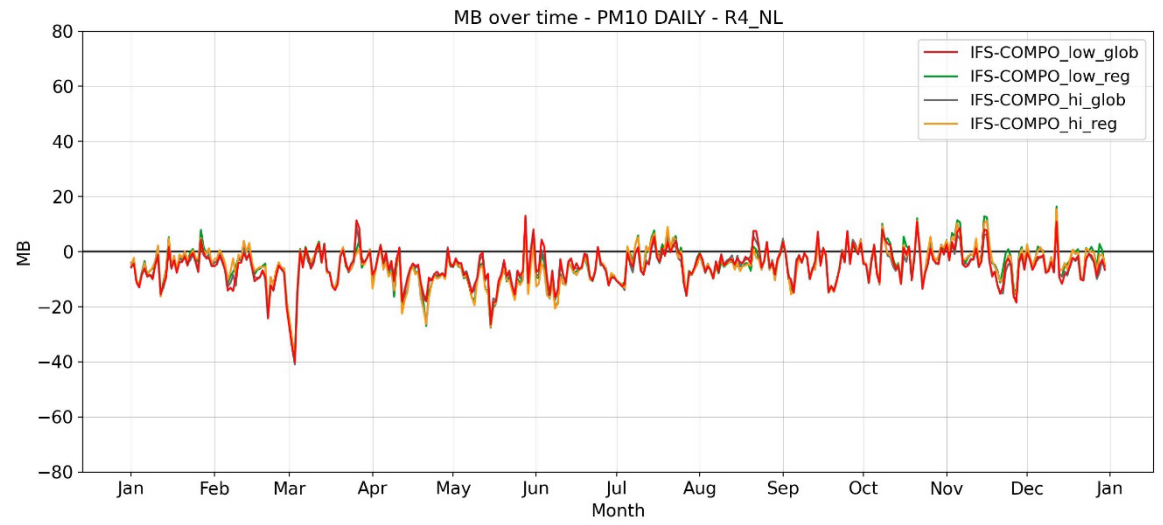


Emission and Resolution Sensitivity - PM10 Evaluation Summary (MBE)

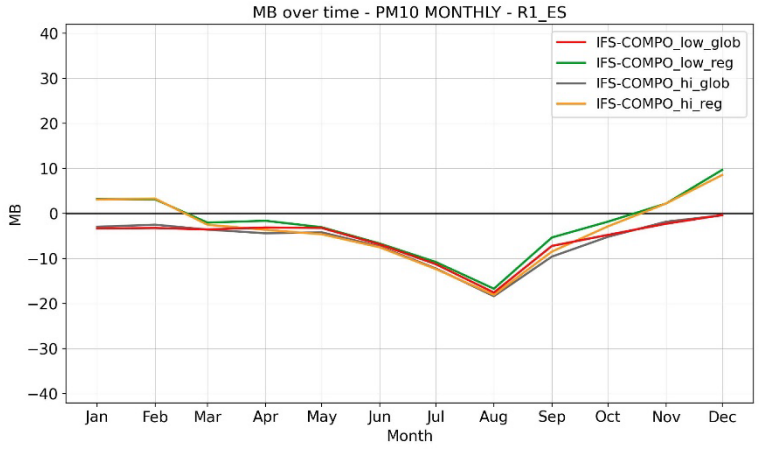


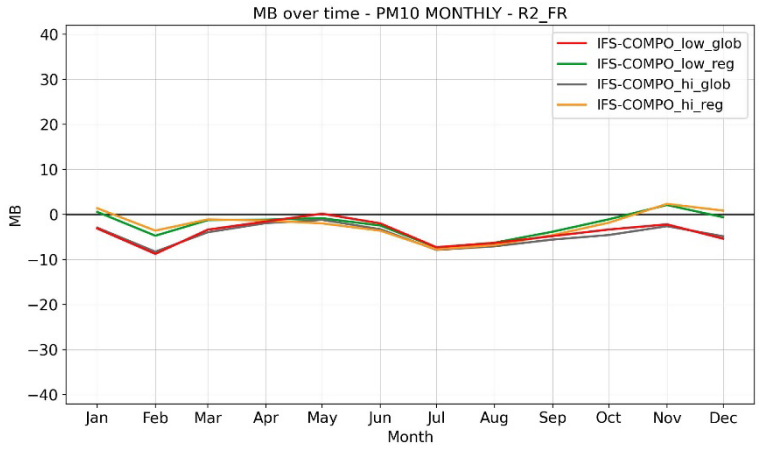


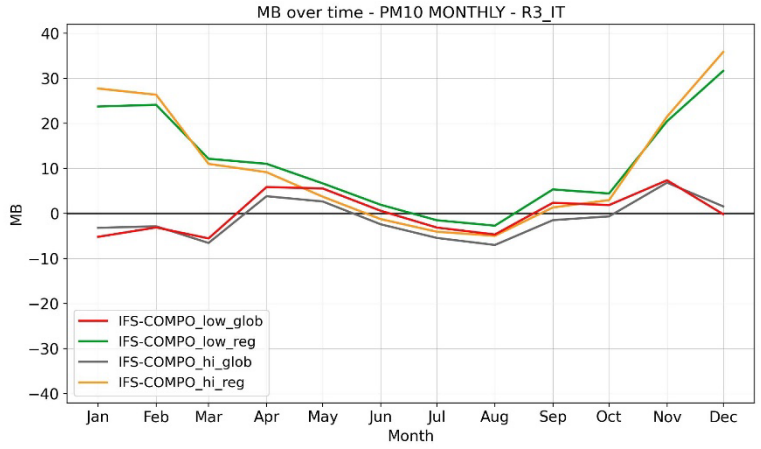


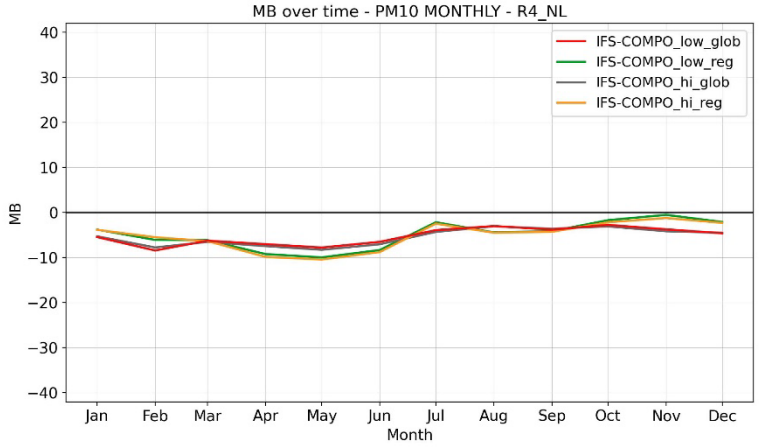


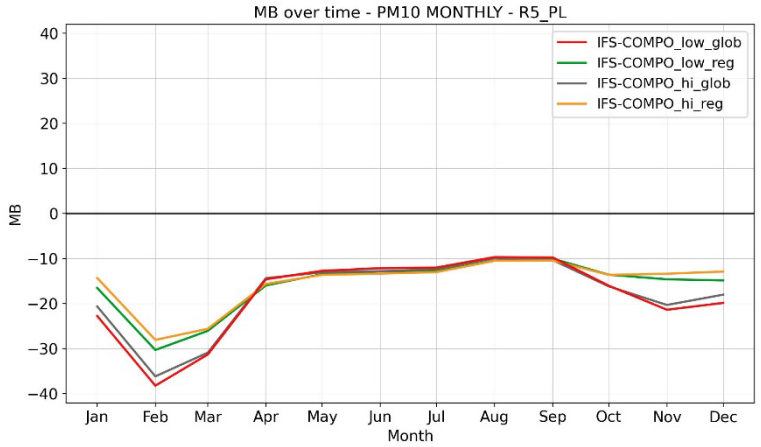
Emission and Resolution Sensitivity - PM10 Evaluation Summary (MBE)

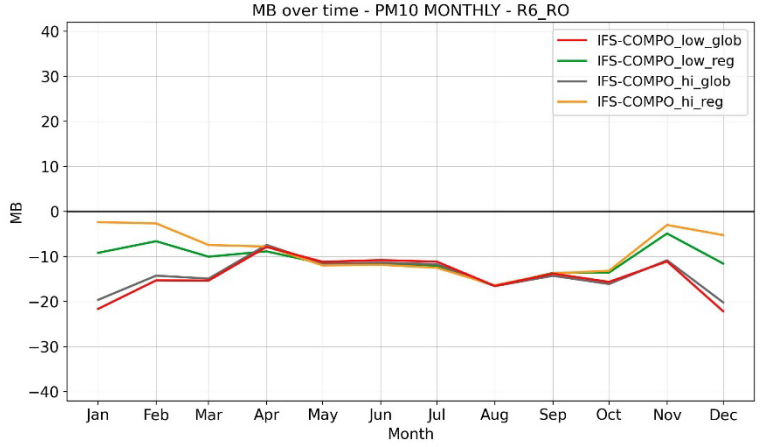


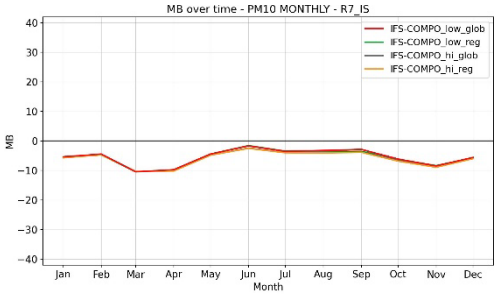








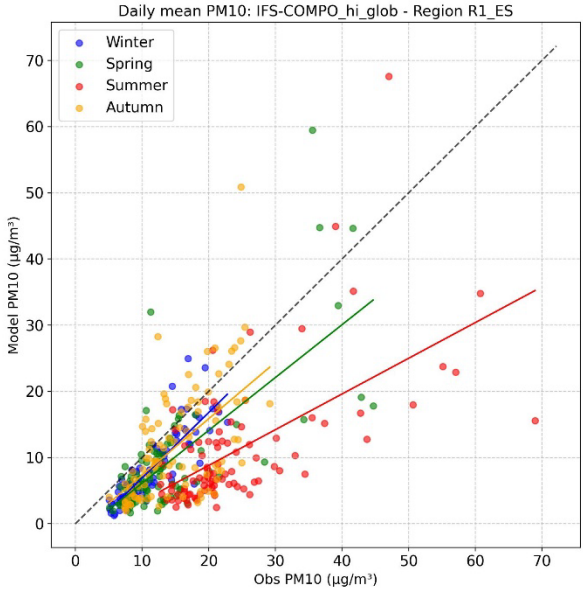




PM10 Evaluation, IFS-COMPO - high resolution, global vs regional

CAMAERA

global emissions

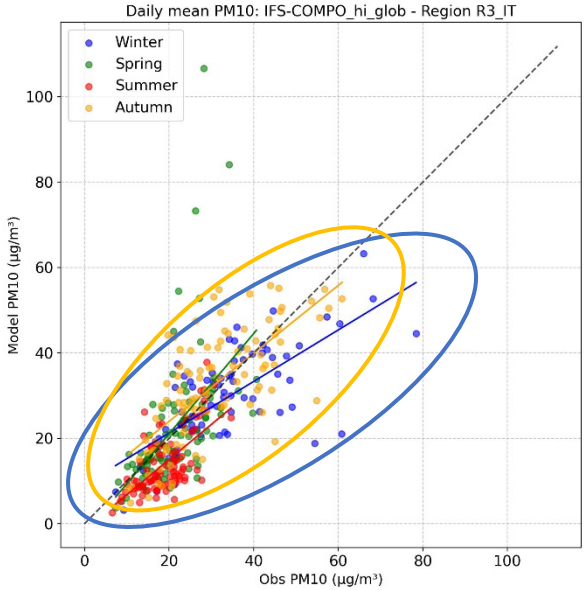


Winter:
Mean Obs: 11.5
Mean Model: 8.3
MB: -3.0
RMSE: 8.3
Corr Coef: 0.60

Spring:
Mean Obs: 13.7
Mean Model: 9.2
MB: -4.6
RMSE: 11.9
Corr Coef: 0.54

Summer:
Mean Obs: 24.1
Mean Model: 11.1
MB: -13.1
RMSE: 18.7
Corr Coef: 0.52

Autumn:
Mean Obs: 14.8
Mean Model: 11.5
MB: -3.4
RMSE: 12.0
Corr Coef: 0.46

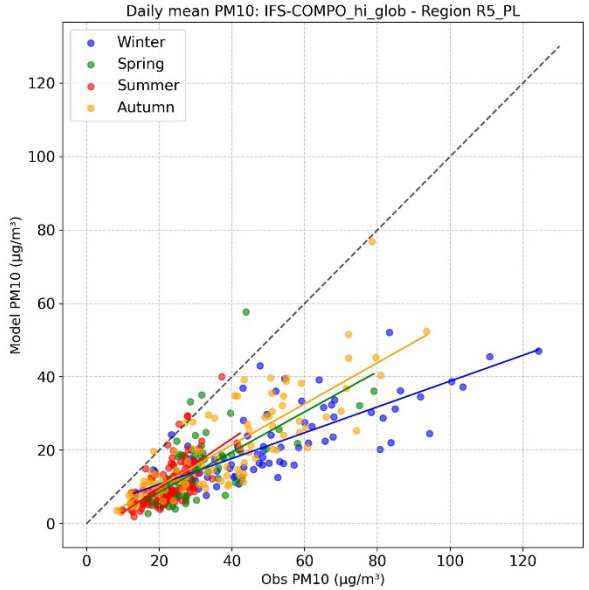


Winter:
Mean Obs: 32.8
Mean Model: 29.0
MB: -3.8
RMSE: 17.0
Corr Coef: 0.55

Spring:
Mean Obs: 21.0
Mean Model: 22.2
MB: 1.2
RMSE: 17.9
Corr Coef: 0.42

Summer:
Mean Obs: 19.1
Mean Model: 14.2
MB: -4.8
RMSE: 10.3
Corr Coef: 0.44

Autumn:
Mean Obs: 30.3
Mean Model: 32.2
MB: 1.9
RMSE: 17.4
Corr Coef: 0.53



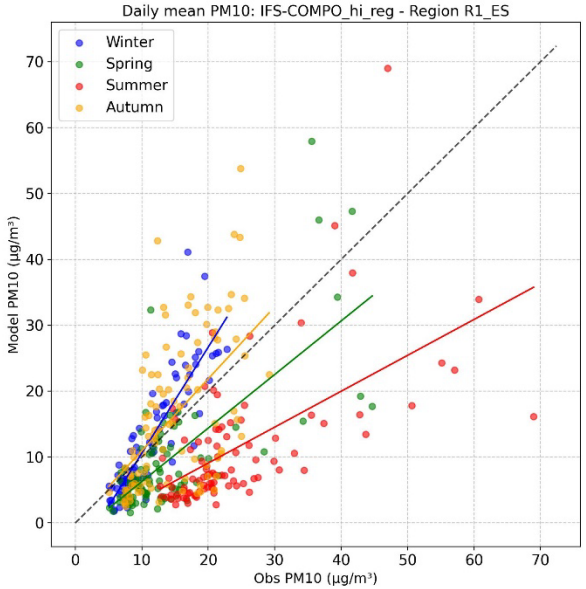
Winter:
Mean Obs: 50.4
Mean Model: 21.4
MB: -29.0
RMSE: 38.8
Corr Coef: 0.61

Spring:
Mean Obs: 29.0
Mean Model: 13.5
MB: -15.5
RMSE: 20.4
Corr Coef: 0.51

Summer:
Mean Obs: 22.4
Mean Model: 11.4
MB: -11.0
RMSE: 14.3
Corr Coef: 0.51

Autumn:
Mean Obs: 37.5
Mean Model: 20.2
MB: -17.4
RMSE: 25.5
Corr Coef: 0.65

regional emissions

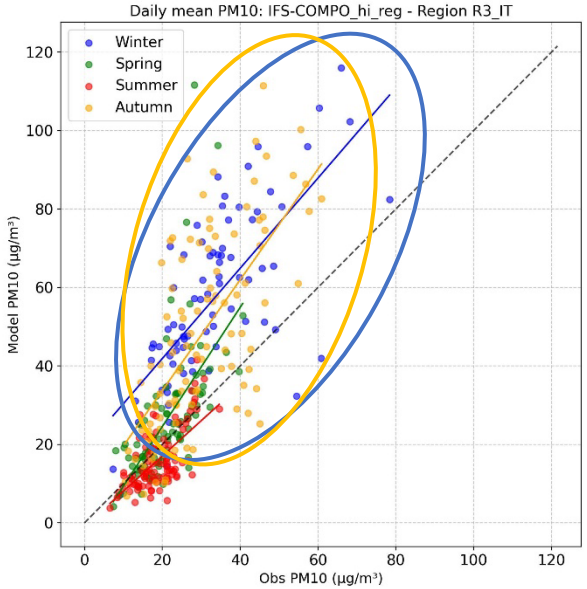


Winter:
Mean Obs: 11.5
Mean Model: 12.8
MB: 1.6
RMSE: 10.6
Corr Coef: 0.61

Spring:
Mean Obs: 13.7
Mean Model: 9.4
MB: -4.4
RMSE: 12.0
Corr Coef: 0.53

Summer:
Mean Obs: 24.1
Mean Model: 11.4
MB: -12.8
RMSE: 18.6
Corr Coef: 0.52

Autumn:
Mean Obs: 14.8
Mean Model: 16.3
MB: 1.4
RMSE: 14.2
Corr Coef: 0.45

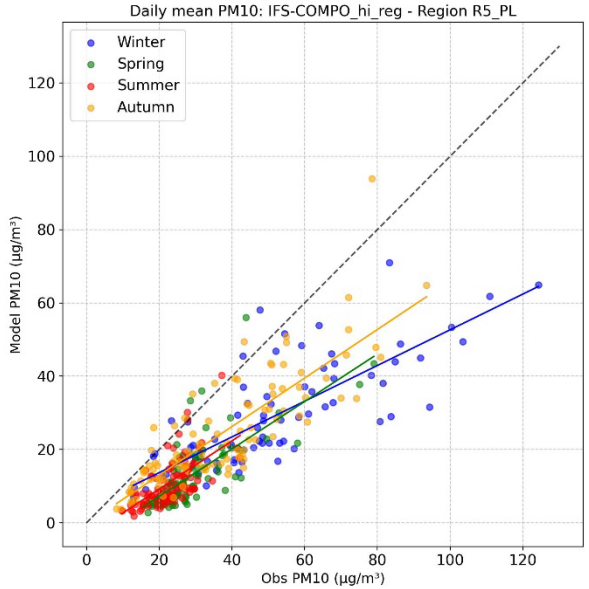


Winter:
Mean Obs: 32.8
Mean Model: 56.6
MB: 23.8
RMSE: 37.0
Corr Coef: 0.53

Spring:
Mean Obs: 21.0
Mean Model: 26.1
MB: 5.1
RMSE: 20.0
Corr Coef: 0.48

Summer:
Mean Obs: 19.1
Mean Model: 16.2
MB: -2.9
RMSE: 10.5
Corr Coef: 0.44

Autumn:
Mean Obs: 30.3
Mean Model: 48.3
MB: 18.2
RMSE: 33.2
Corr Coef: 0.53



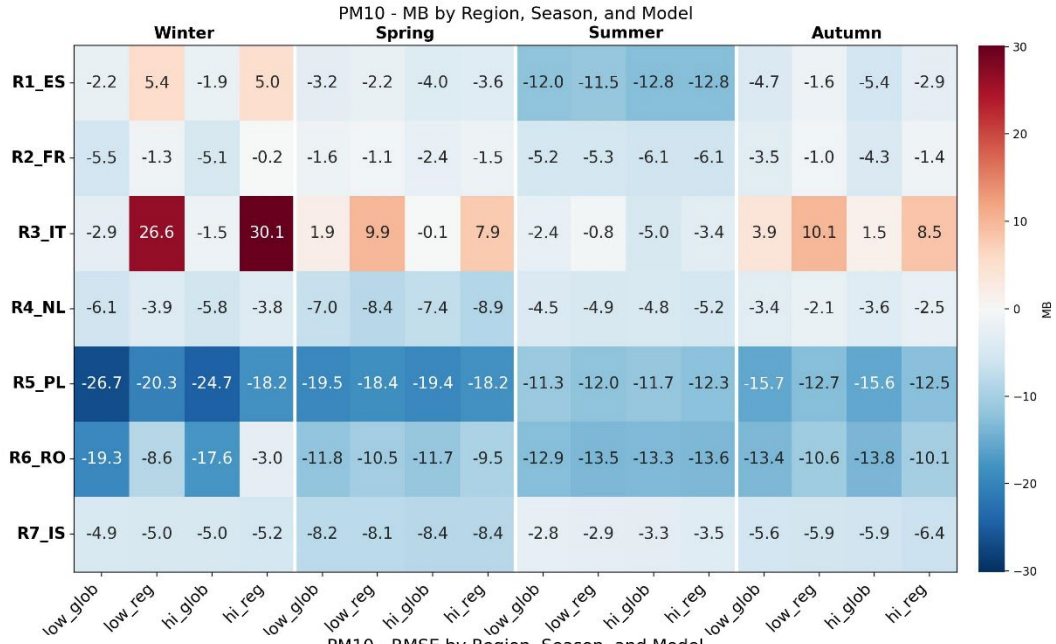
Winter:
Mean Obs: 50.4
Mean Model: 28.5
MB: -21.9
RMSE: 34.3
Corr Coef: 0.64

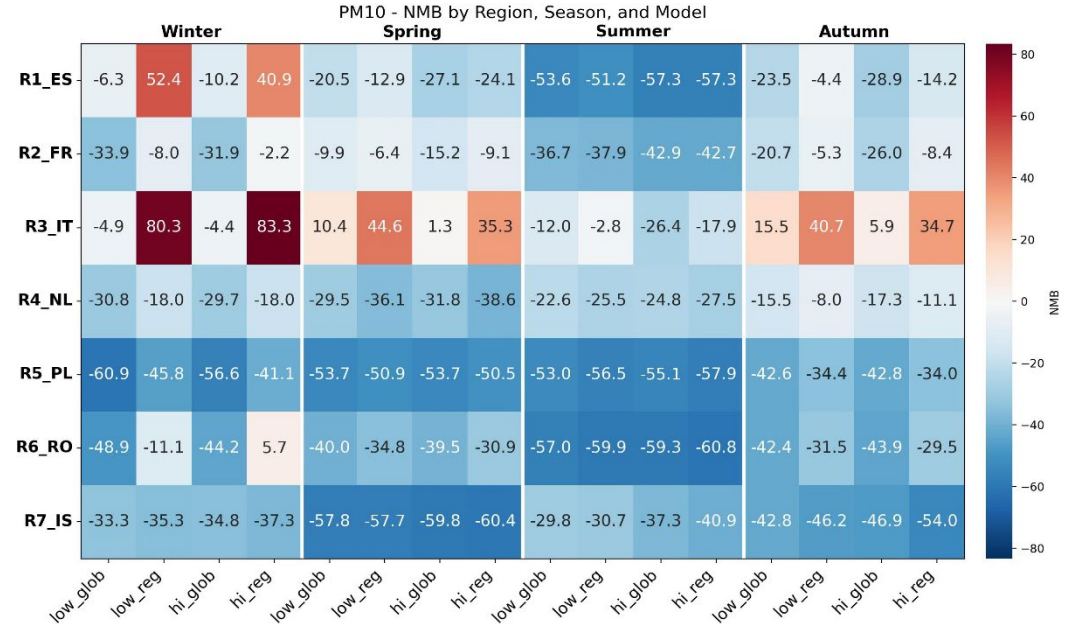
Spring:
Mean Obs: 29.0
Mean Model: 13.1
MB: -15.9
RMSE: 20.4
Corr Coef: 0.57

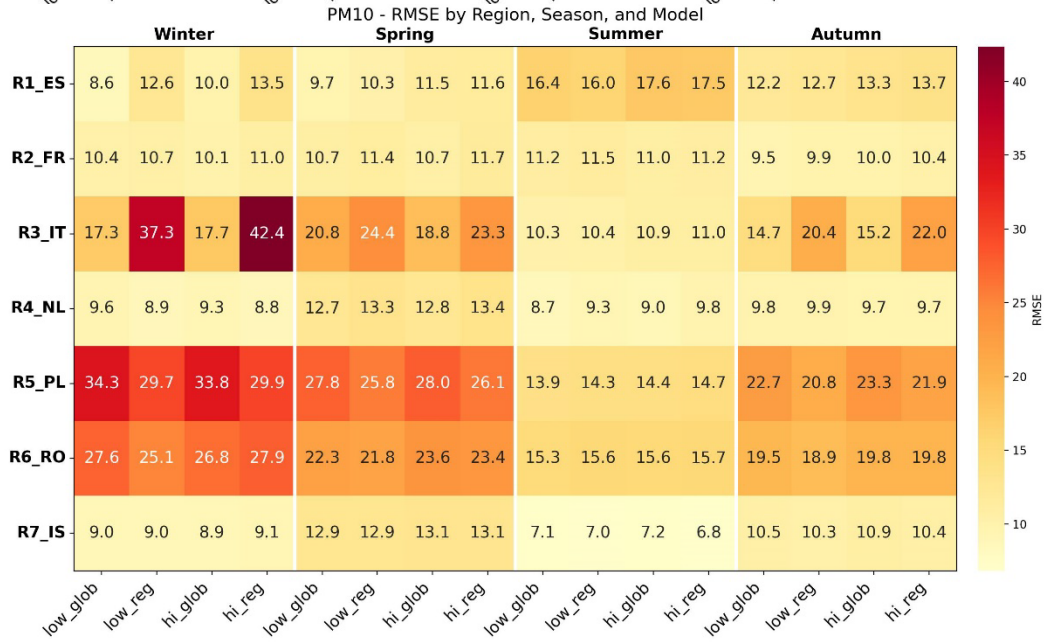
Summer:
Mean Obs: 22.4
Mean Model: 10.9
MB: -11.6
RMSE: 14.6
Corr Coef: 0.50

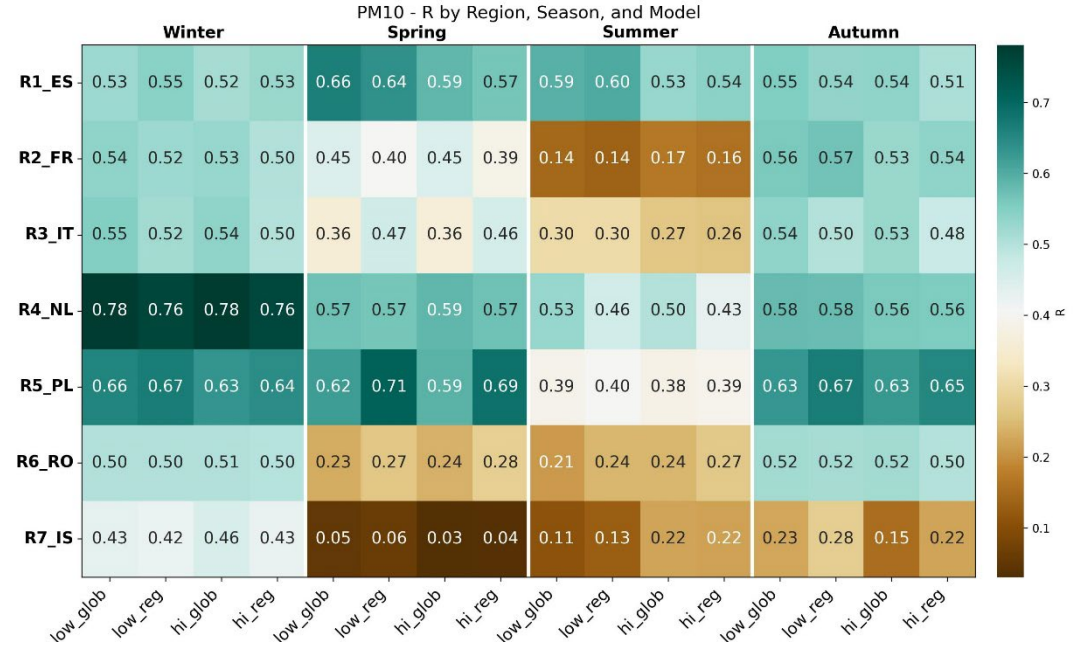
Autumn:
Mean Obs: 37.5
Mean Model: 24.7
MB: -12.9
RMSE: 23.2
Corr Coef: 0.66

Emission and Resolution Sensitivity - PM10 Evaluation Summary









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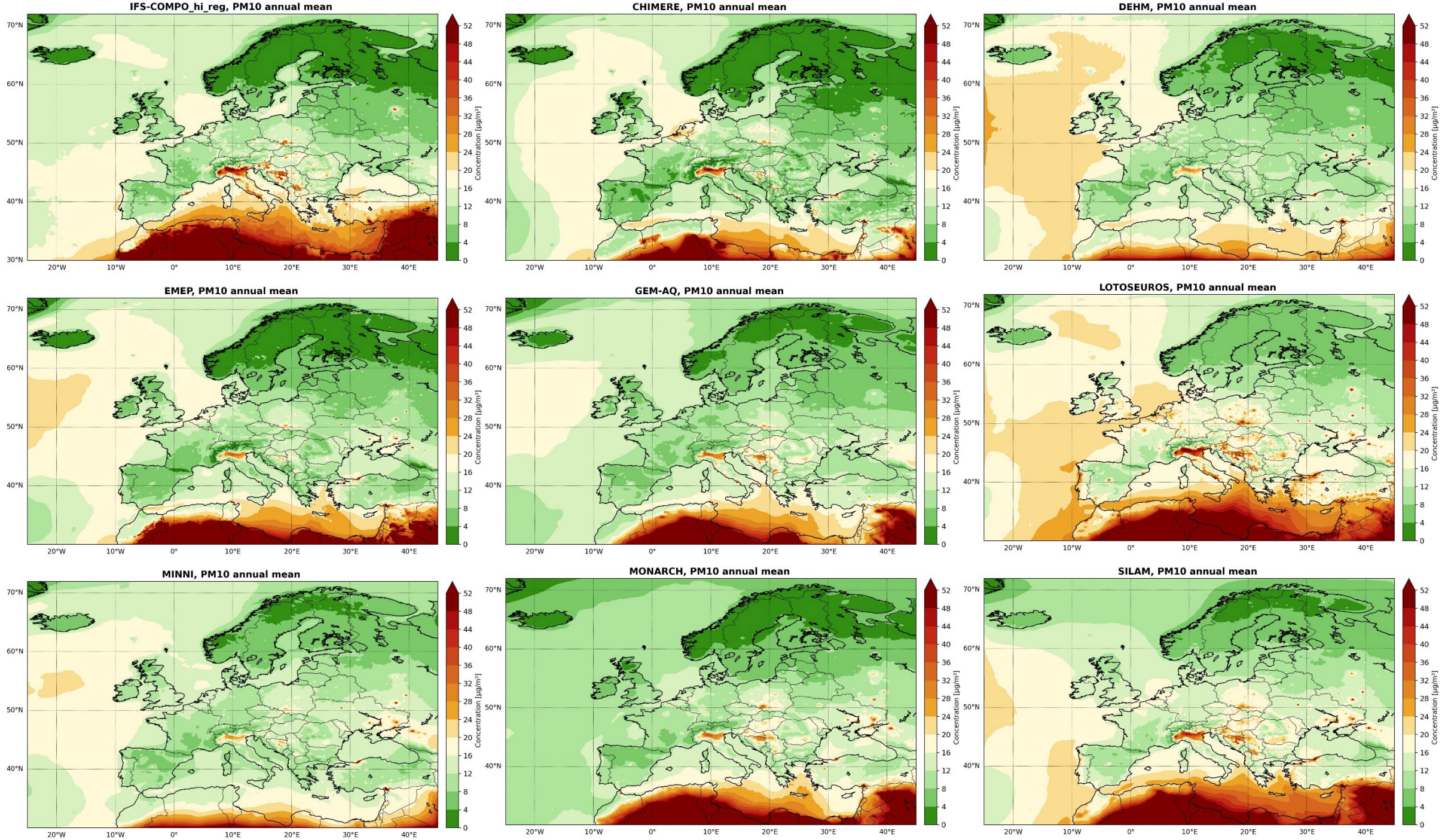
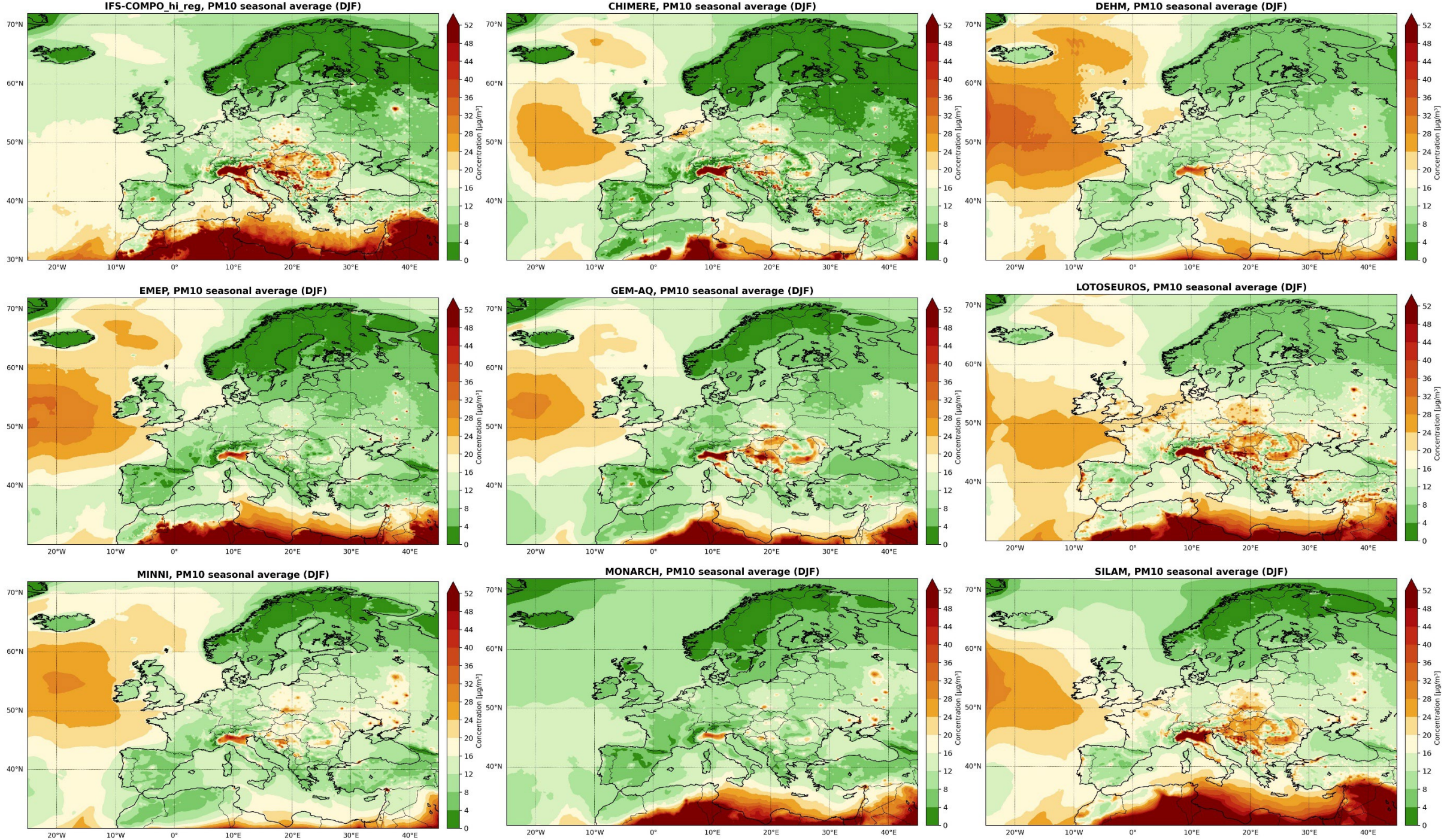
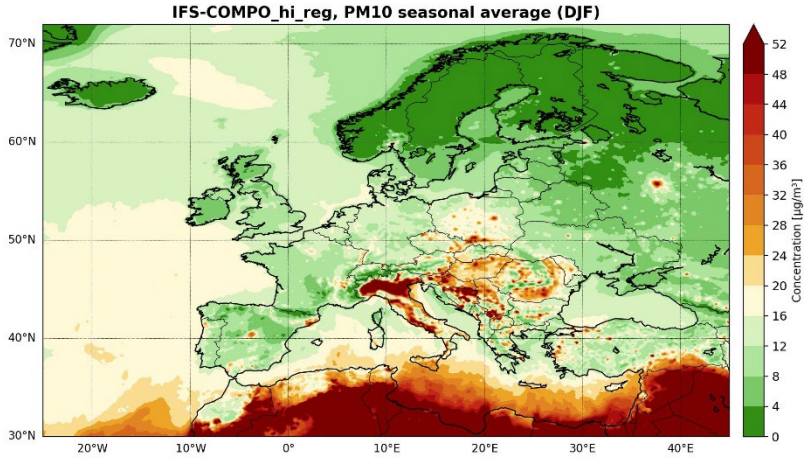
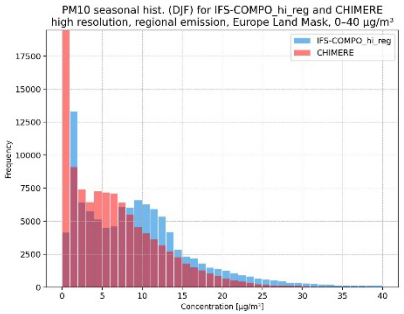
Regional models intercomparison (including IFC COMPO at high resolution with the regional emissions)

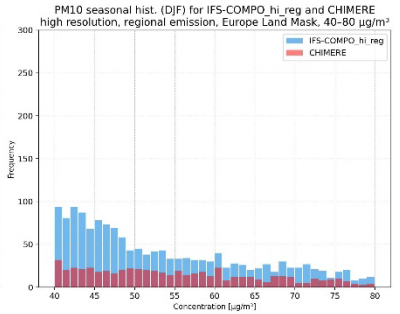

IFS-COMPO_hi_reg, PM10 annual mean
CHIMERE, PM10 annual mean
DEHM, PM10 annual mean
EMEP, PM10 annual mean
GEM-AQ, PM10 annual mean
LOTOSEUROS, PM10 annual mean
MINNI, PM10 annual mean
MONARCH, PM10 annual mean
SILAM, PM10 annual mean
Concentration [µg/m³]
70°N
60°N
50°N
40°N
30°N
20°W
10°W
0°
10°E
20°E
30°E
40°E


IFS-COMPO_hi_reg, PM10 seasonal average (DJF)
CHIMERE, PM10 seasonal average (DJF)
DEHM, PM10 seasonal average (DJF)
EMEP, PM10 seasonal average (DJF)
GEM-AQ, PM10 seasonal average (DJF)
LOTOSEUROS, PM10 seasonal average (DJF)
MINNI, PM10 seasonal average (DJF)
MONARCH, PM10 seasonal average (DJF)
SILAM, PM10 seasonal average (DJF)
70°N
60°N
50°N
40°N
30°N
20°W
10°W
0°
10°E
20°E
30°E
40°E
Concentration [µg/m³]
0
4
8
12
16
20
24
28
32
36
40
44
48
52

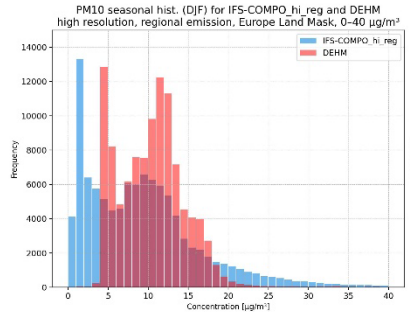


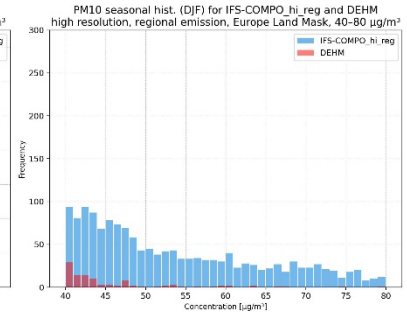
CHIMERE



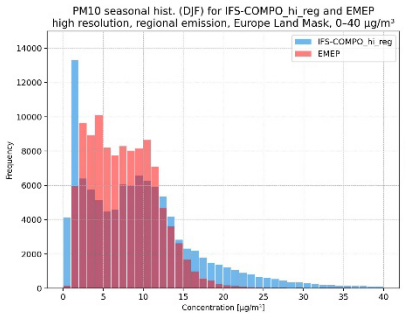


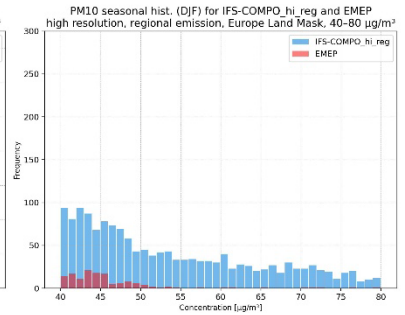
DEHM





EMEP





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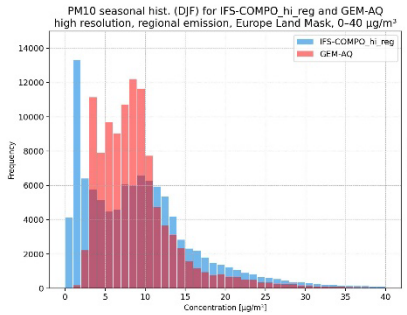

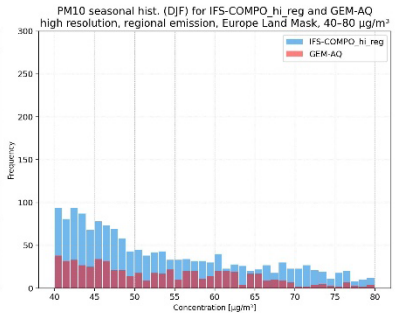

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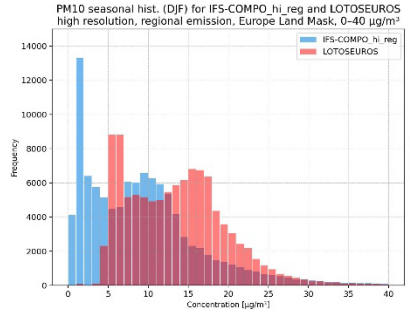

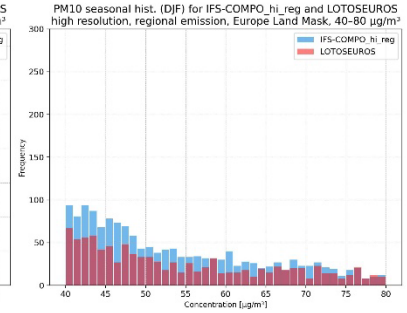

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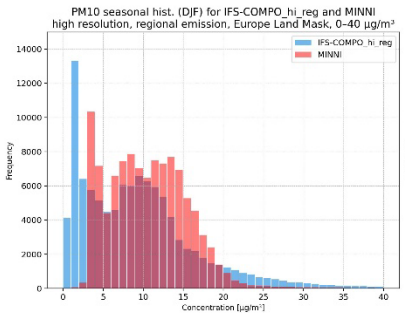

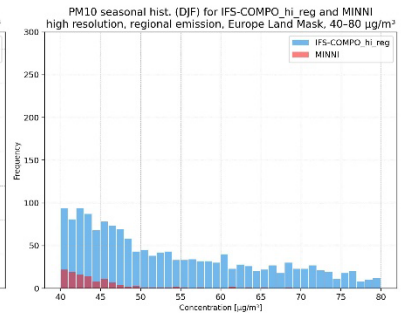

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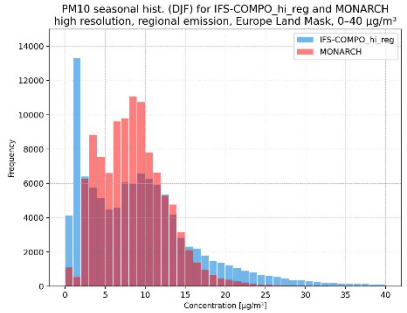

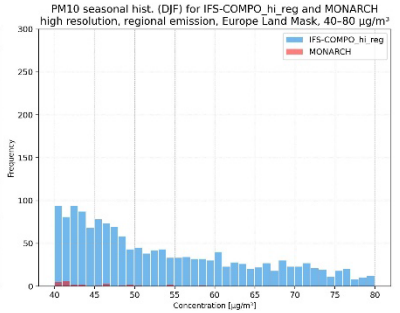

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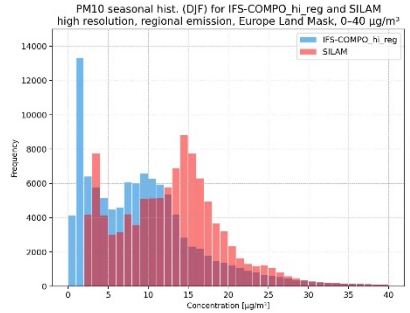
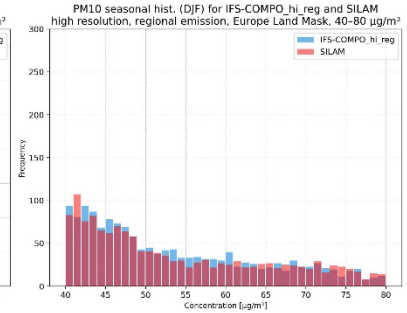
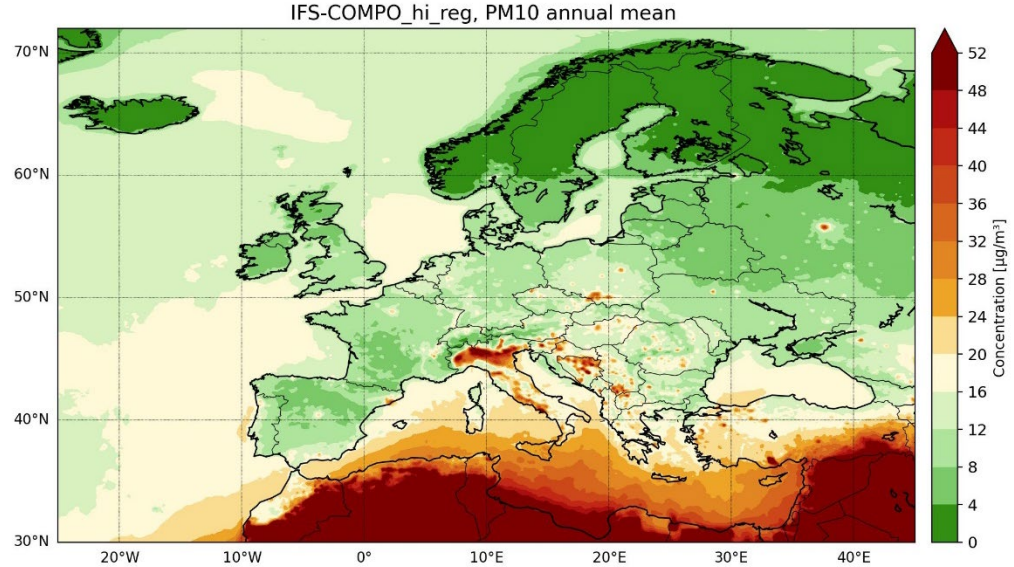
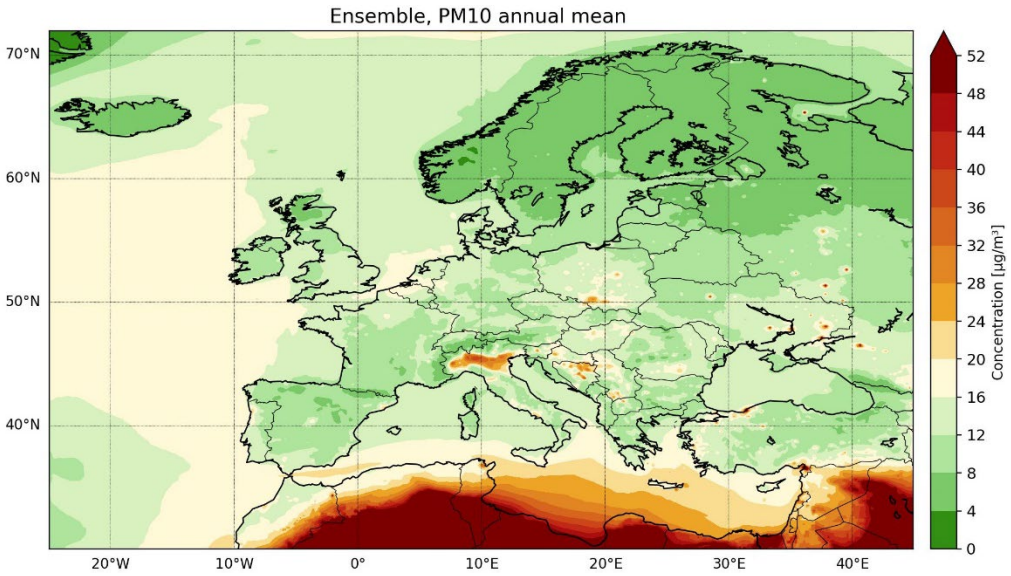
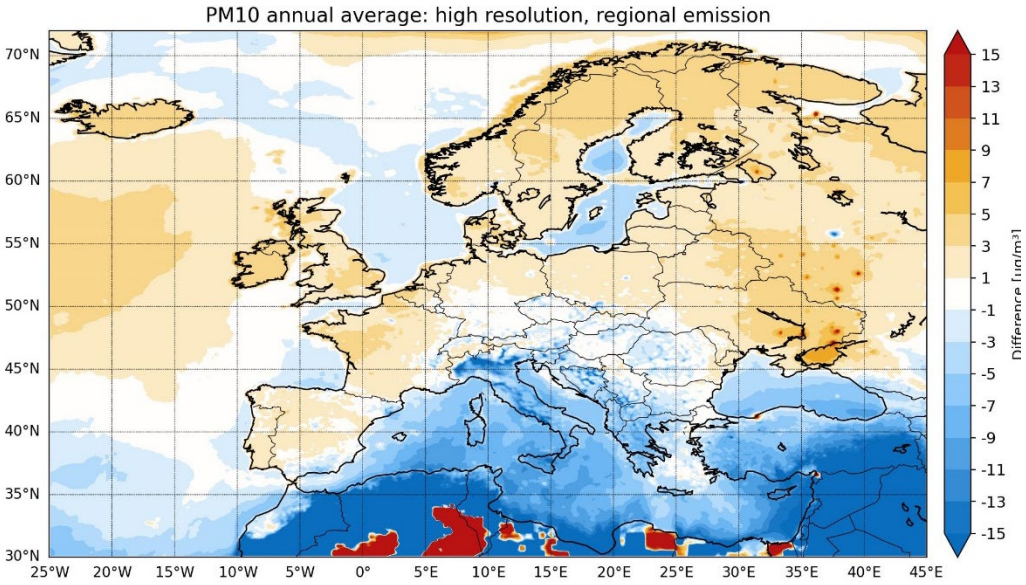


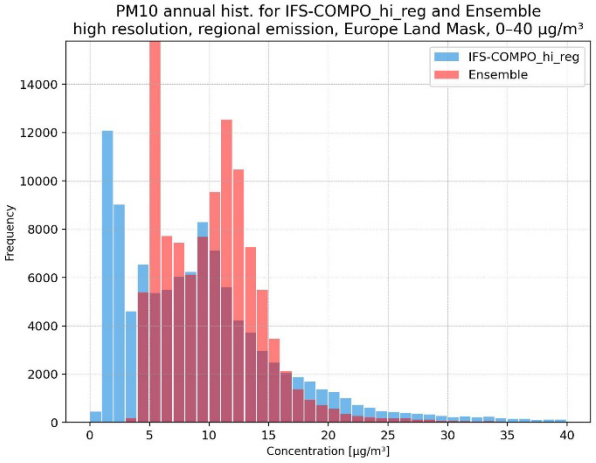


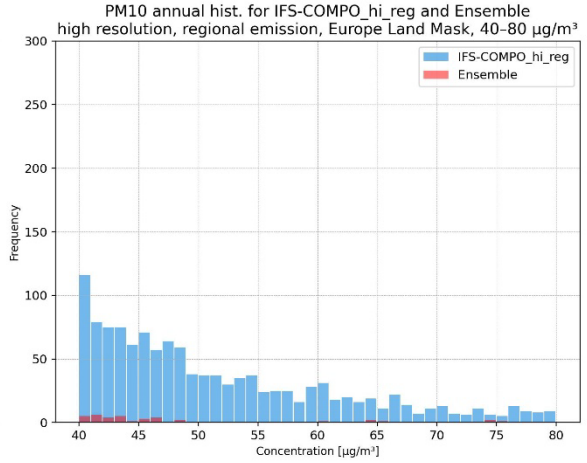
IFS-COMPO (Hig res-REG) vs Reg_Ensemble - PM10 annual mean



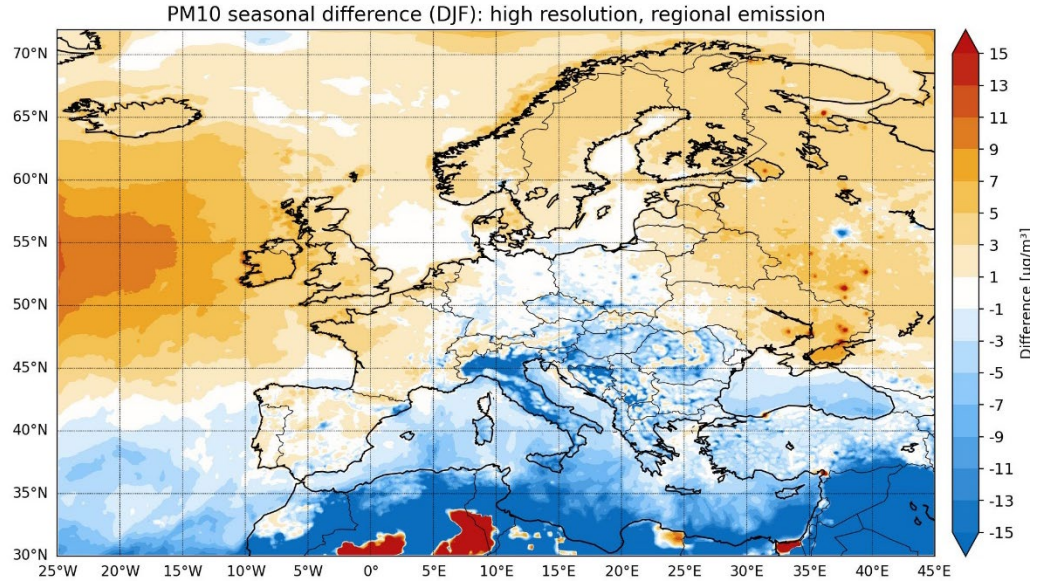


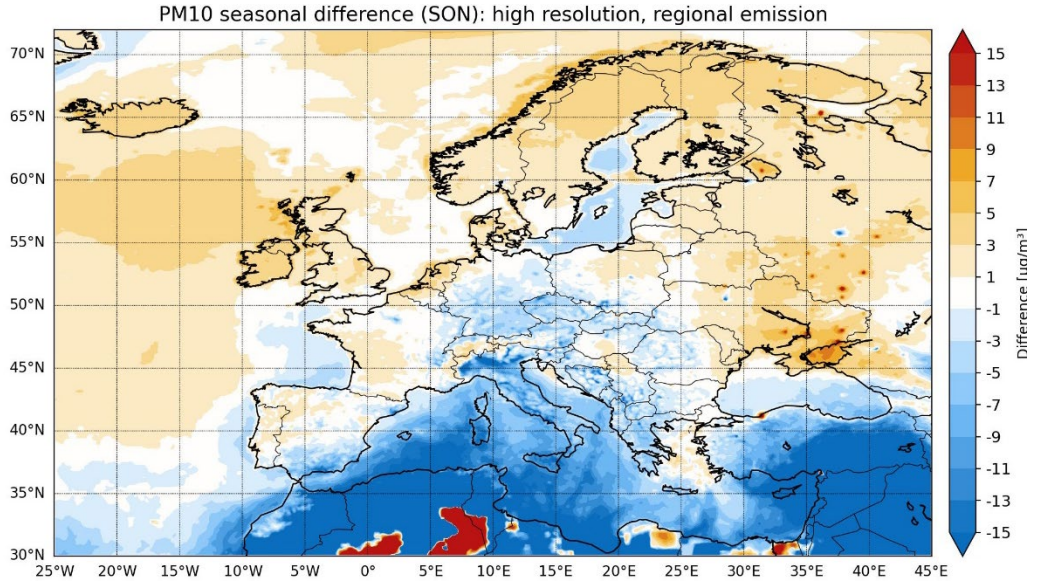


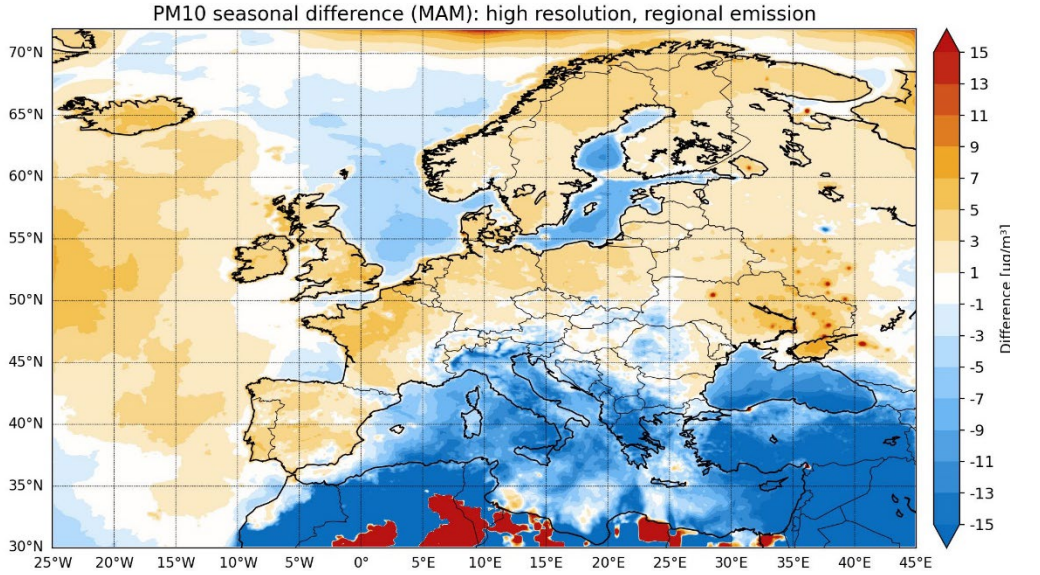


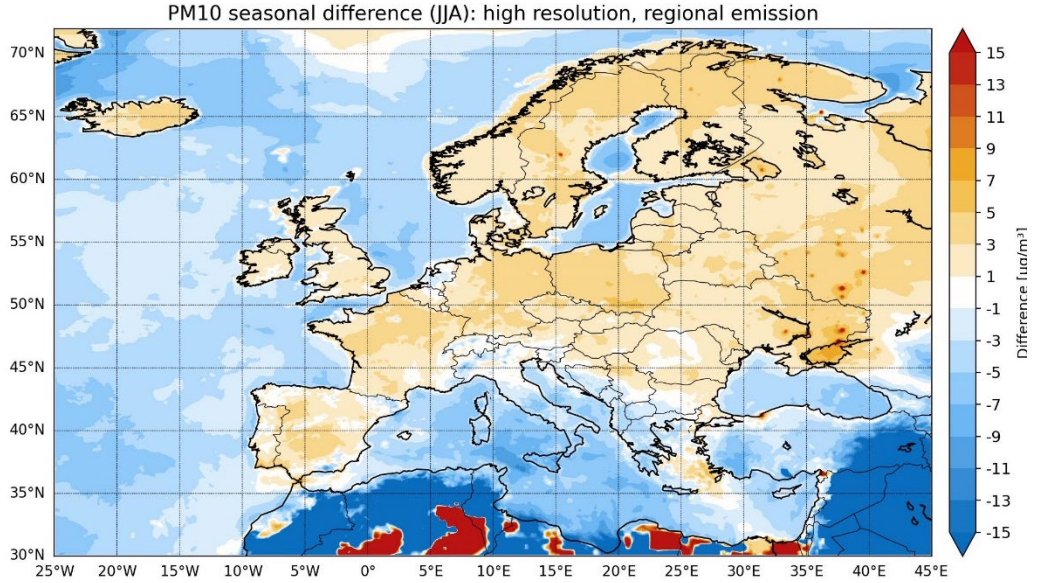


IFS-COMPO vs Ensemble - PM10 seasonal differences (ENSEMBLE – IFS COMPO)

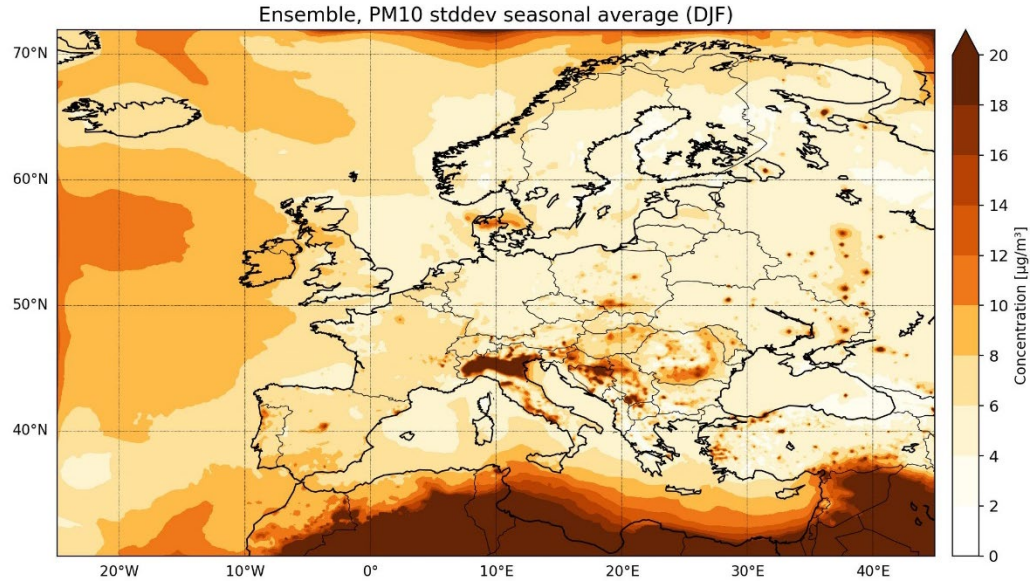


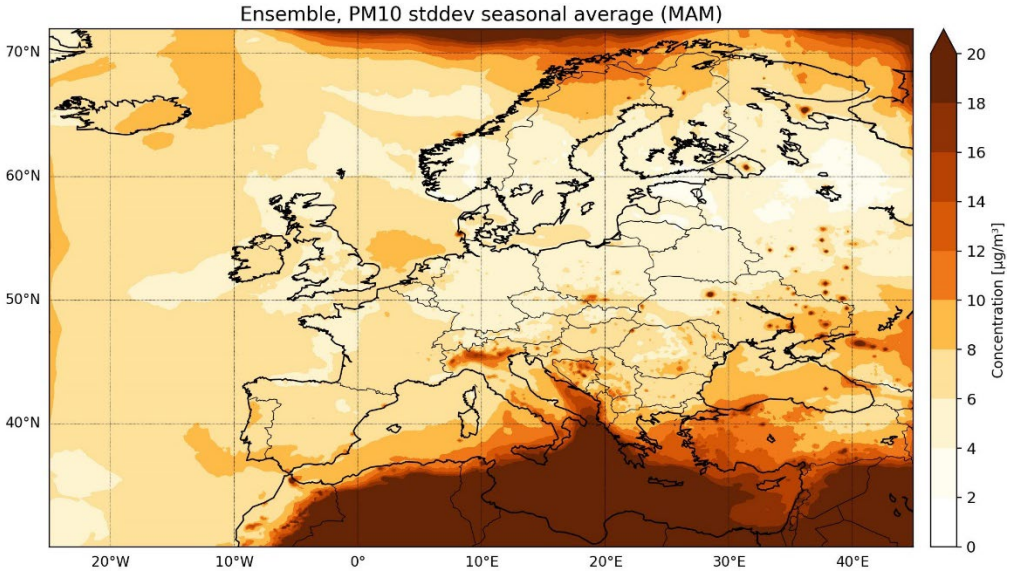


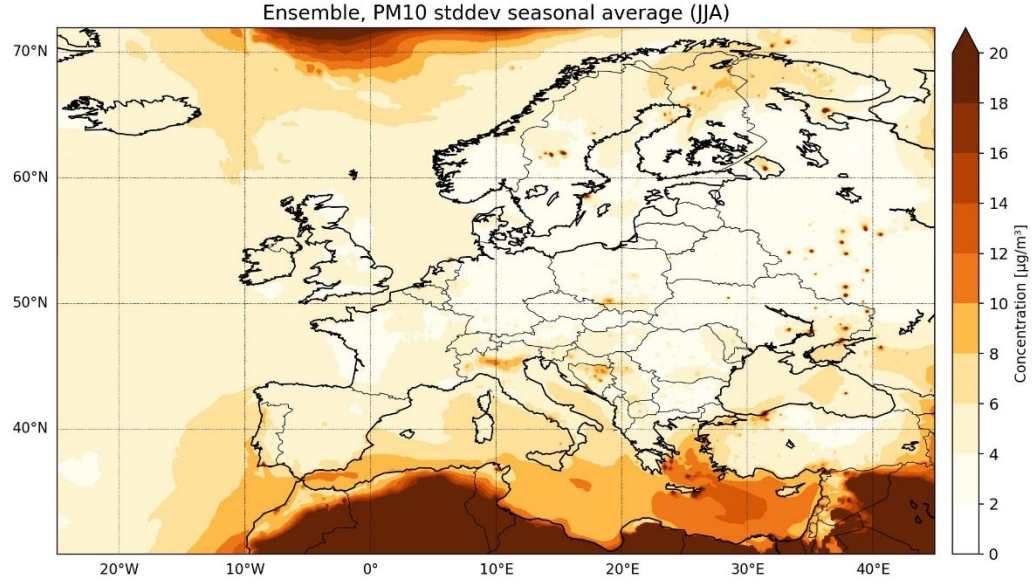


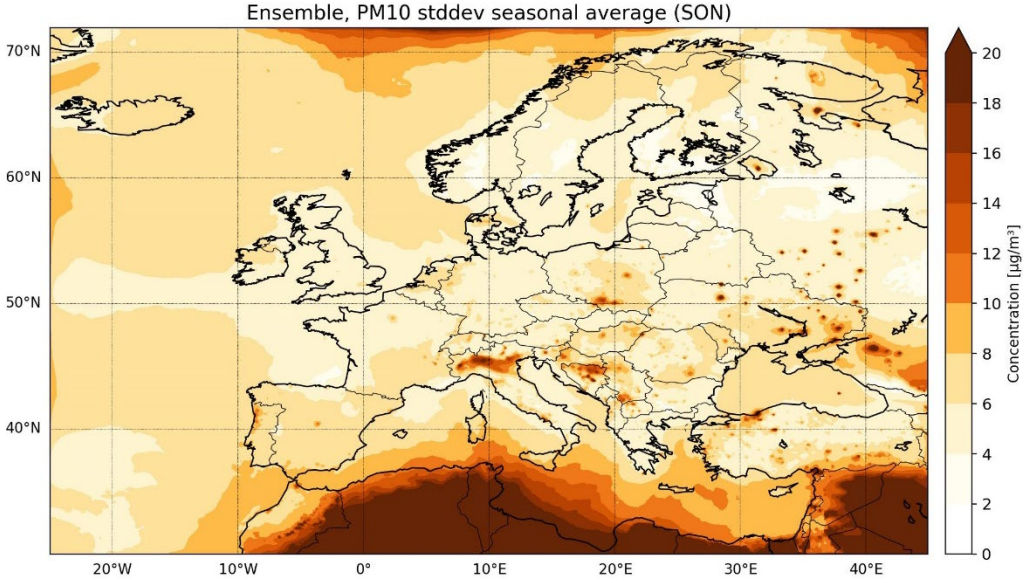


Regional models - PM10 standard deviation

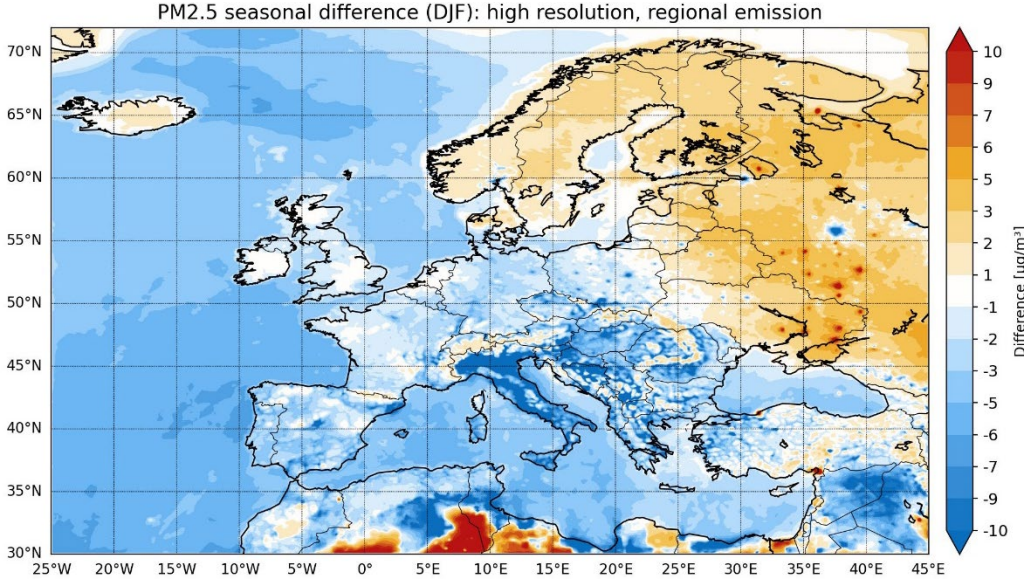


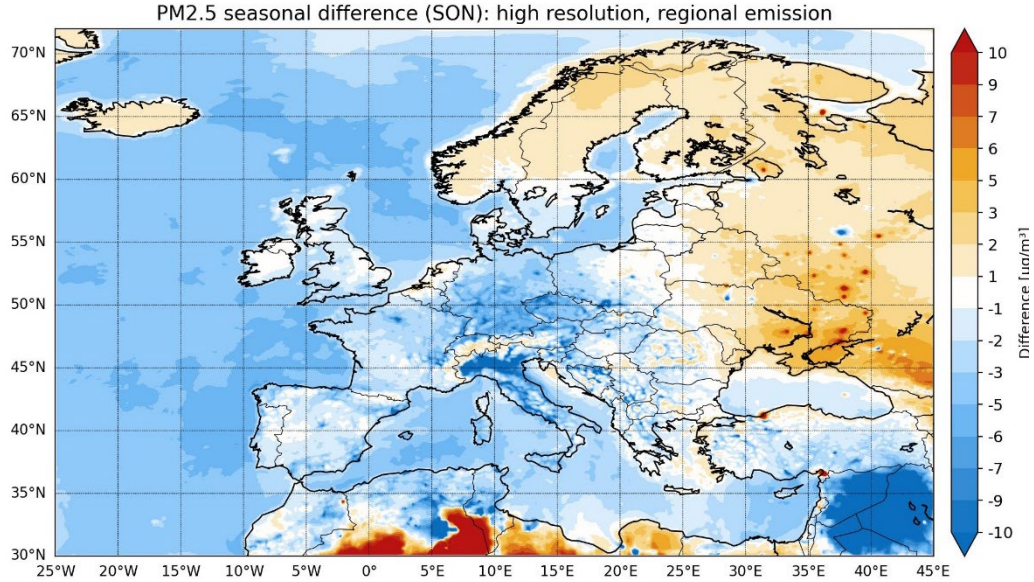


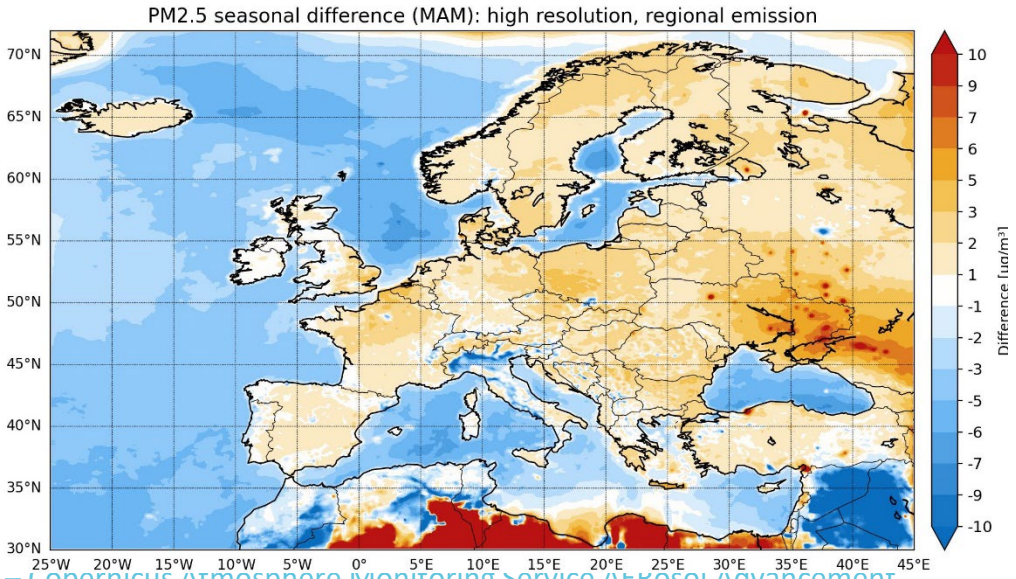


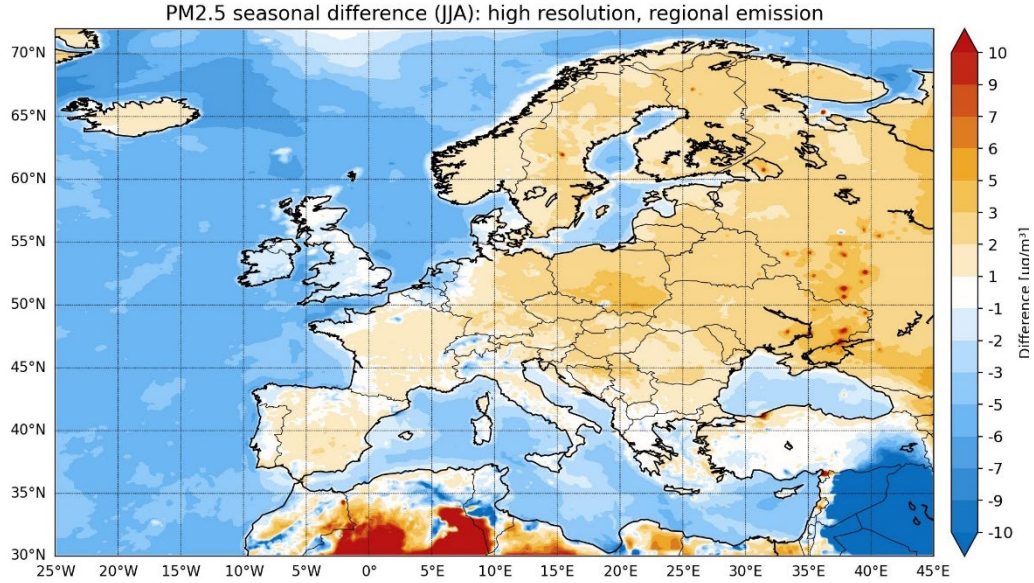


IFS-COMPO vs Ensemble - PM2.5 seasonal differences (ENSEMBLE – IFS COMPO)

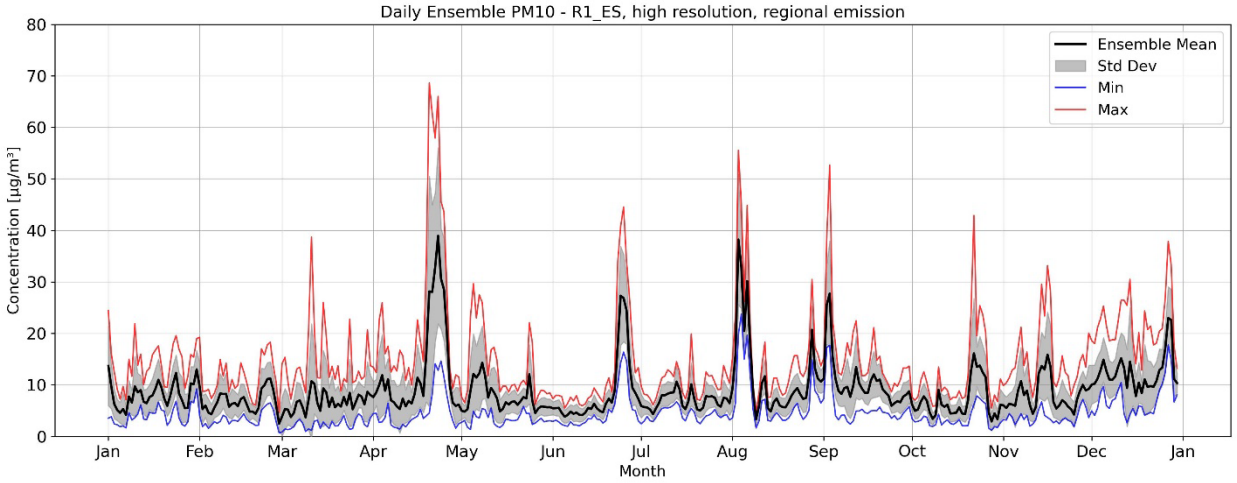


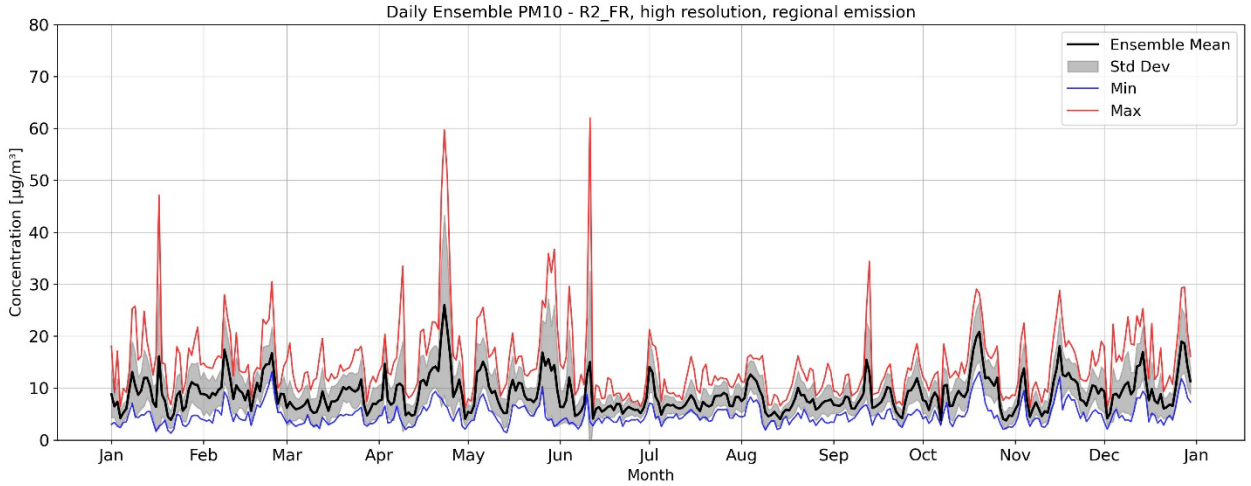


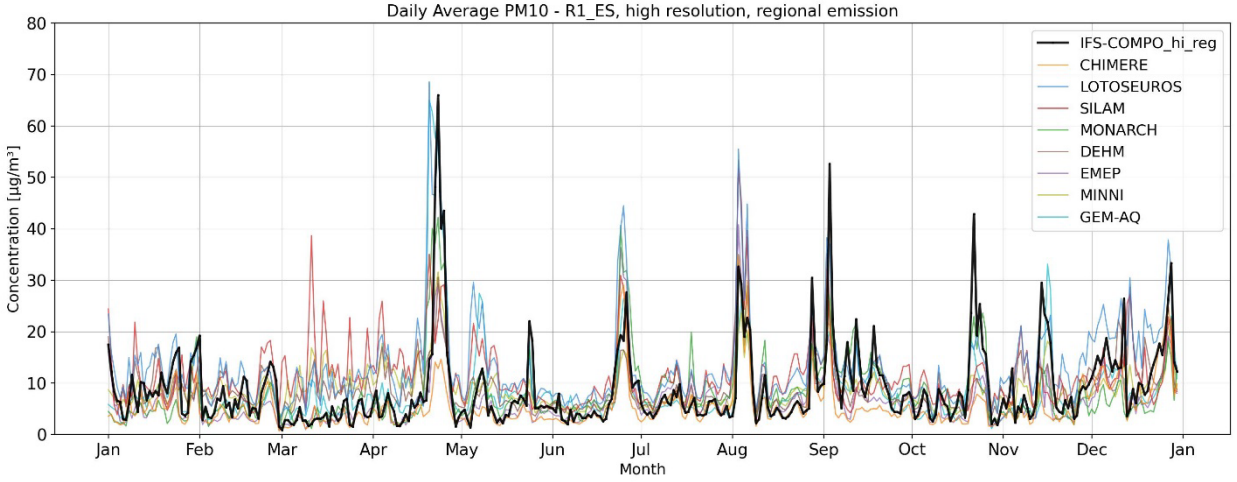


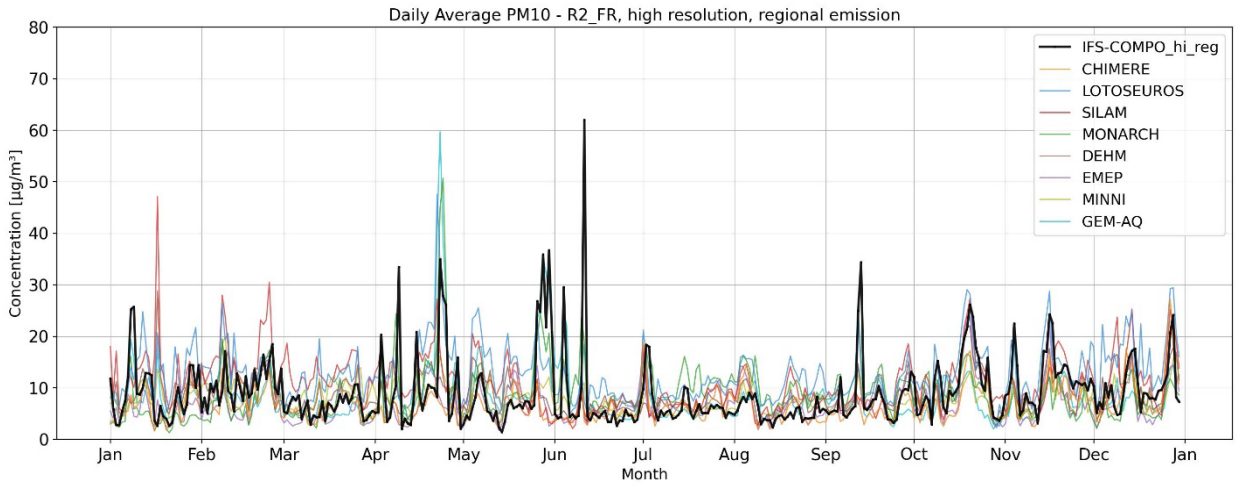


IFS-COMPO vs Regional Models - PM10 time series over regions

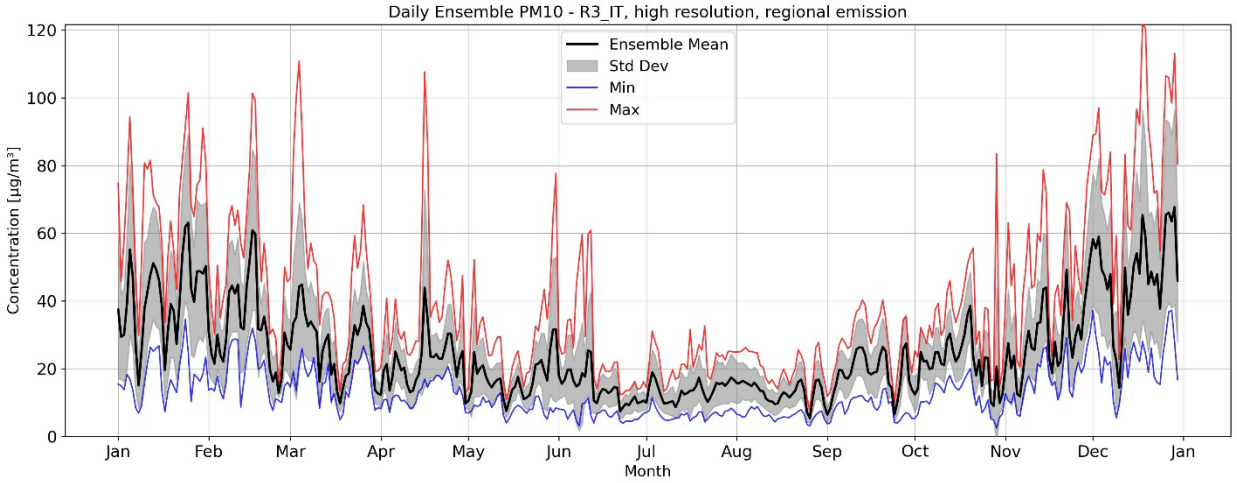


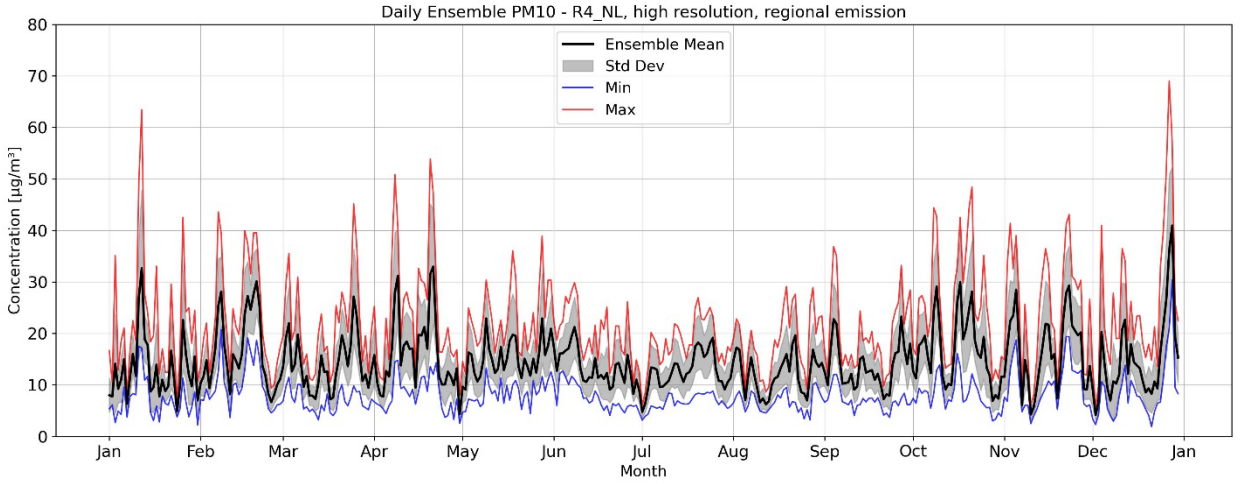


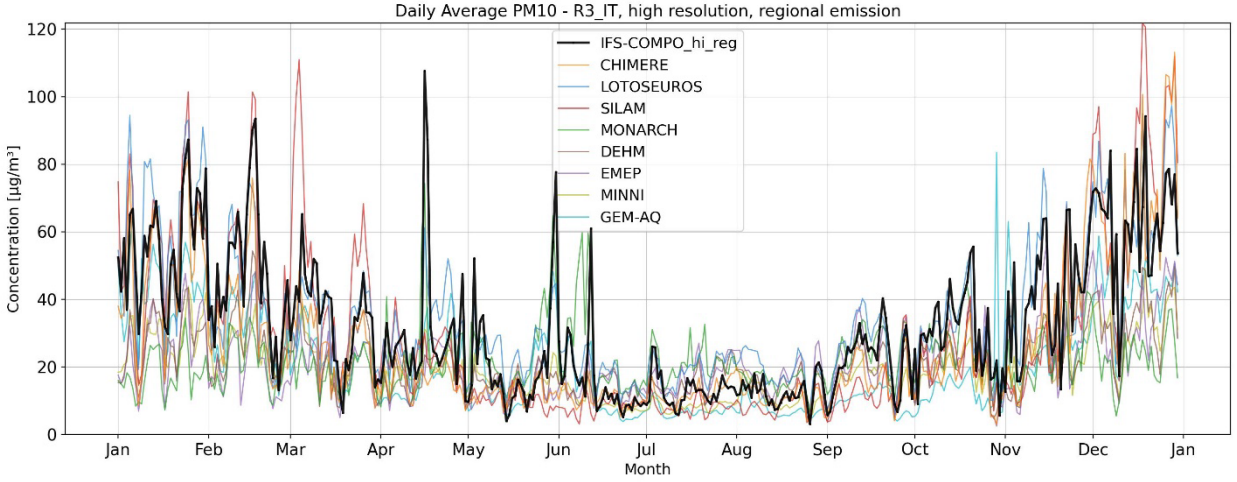


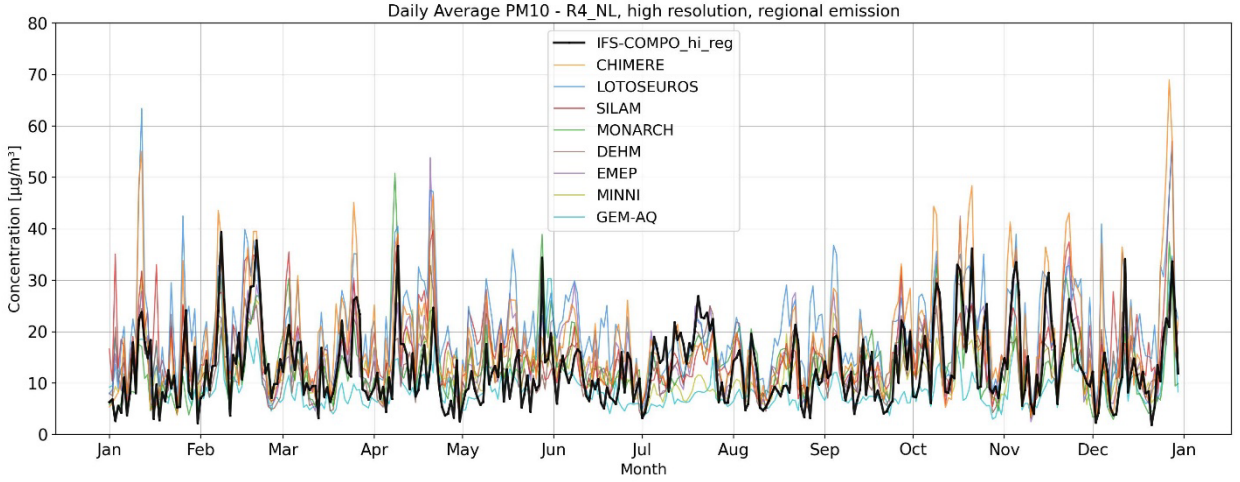


IFS-COMPO vs Regional Models

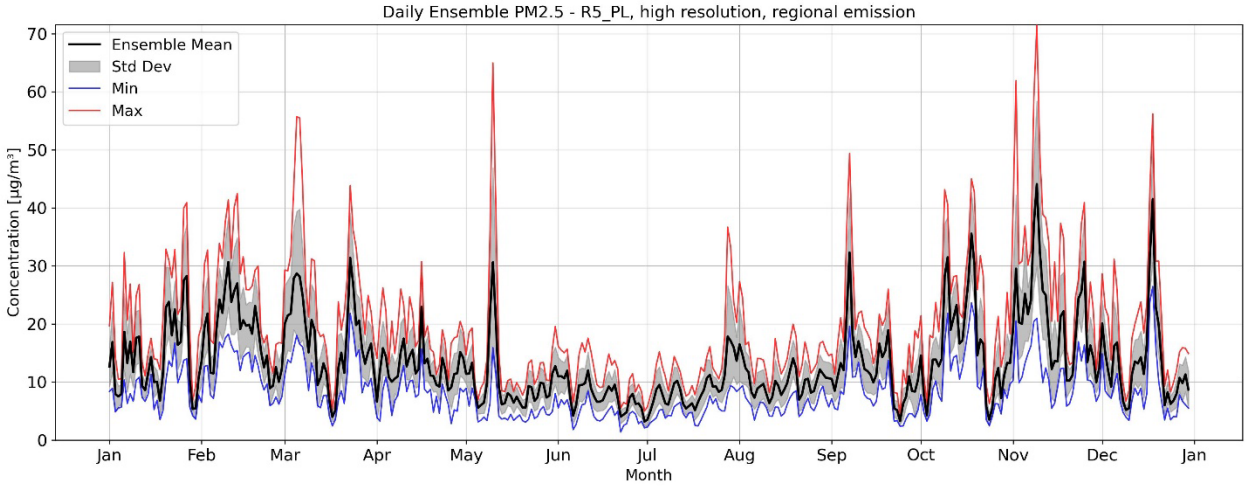


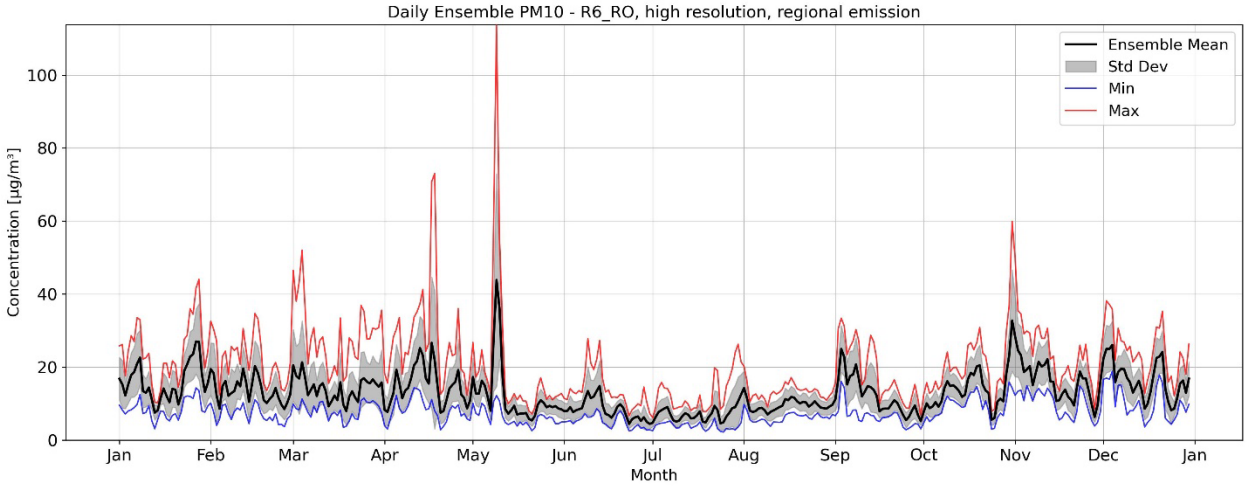


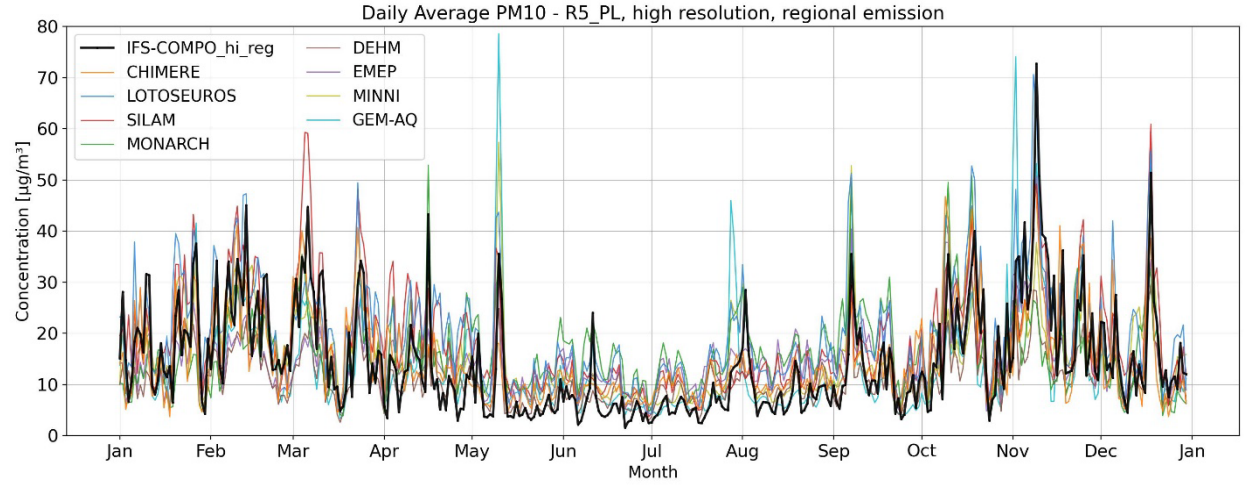


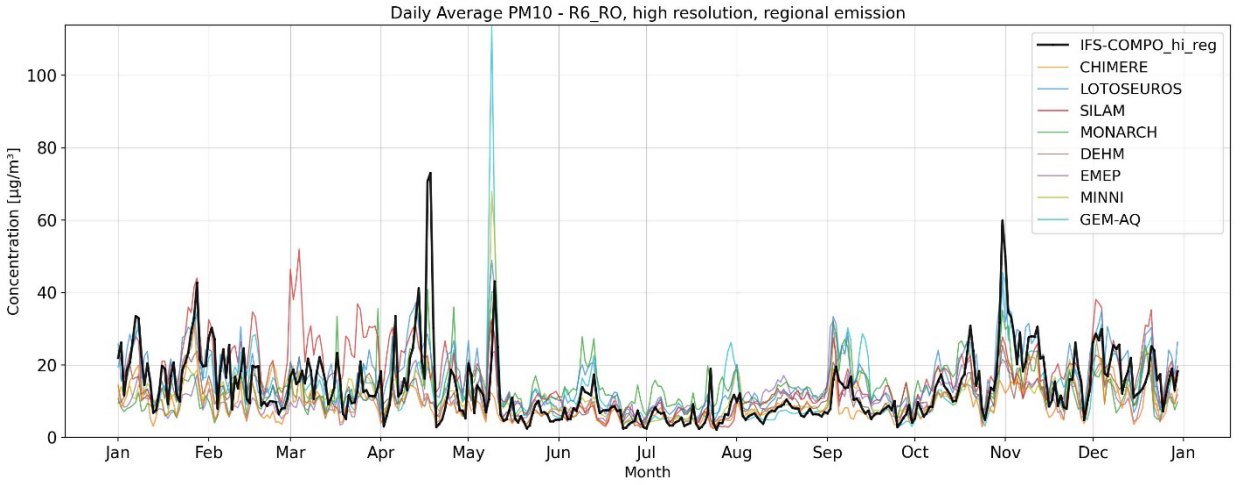


IFS-COMPO vs Regional Models

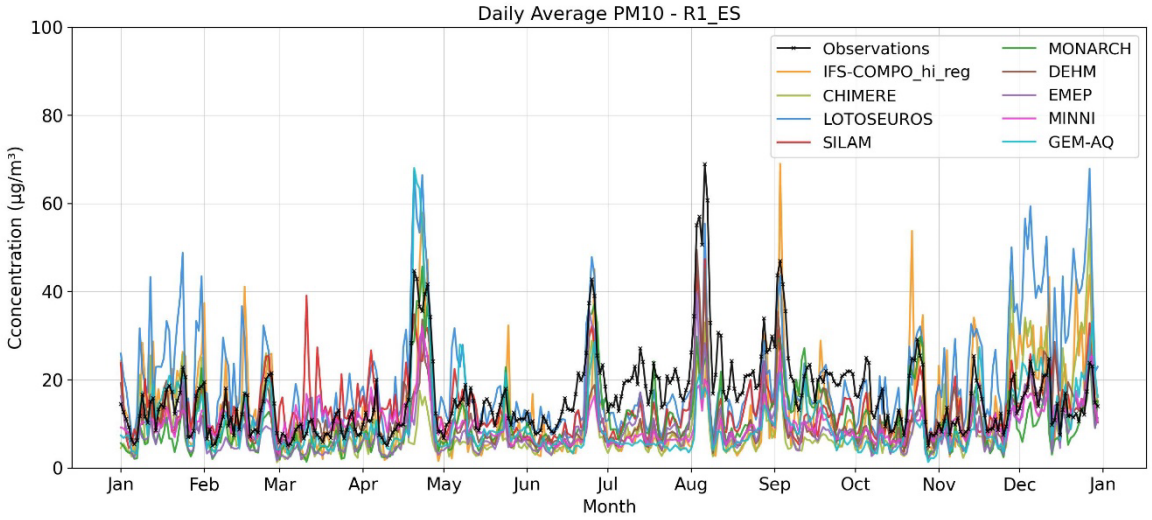


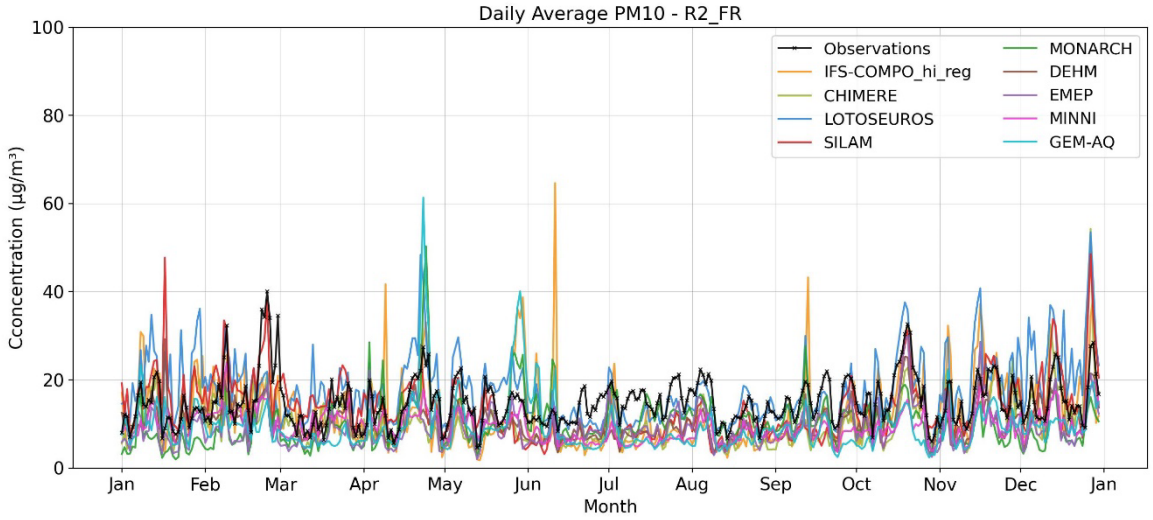


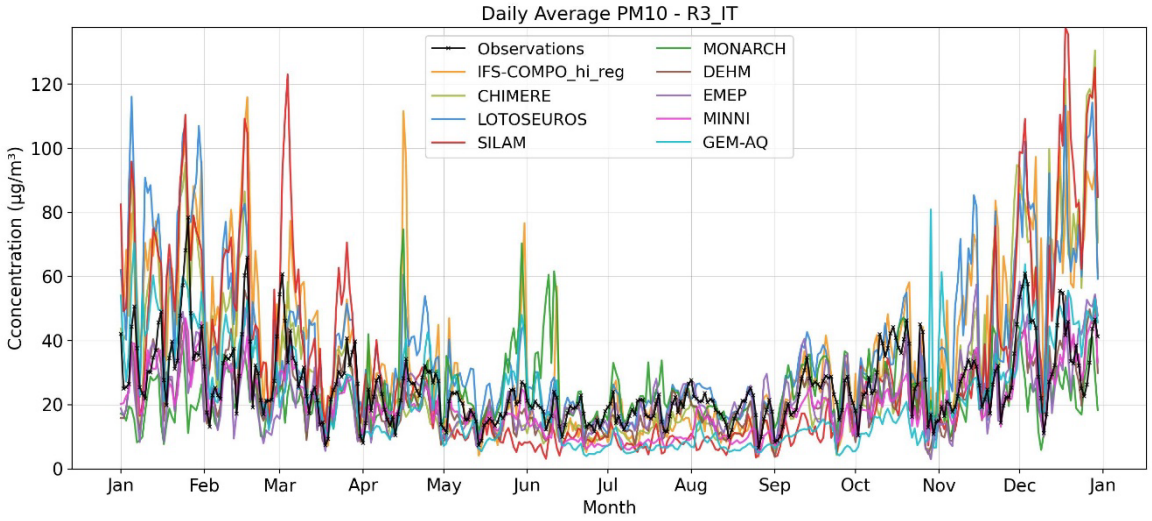


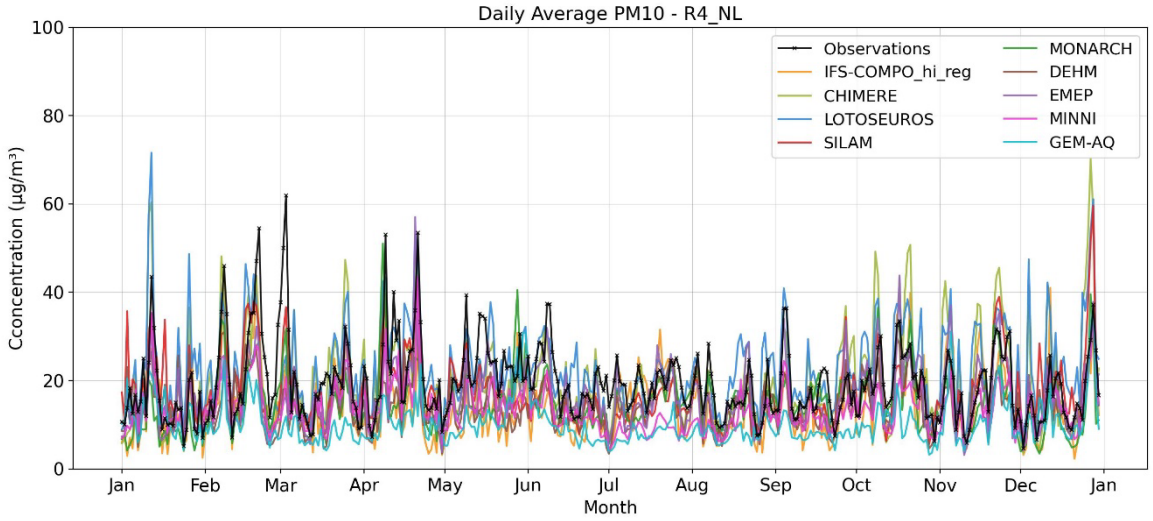


PM10 Evaluation - IFS-COMPO vs Regional Models

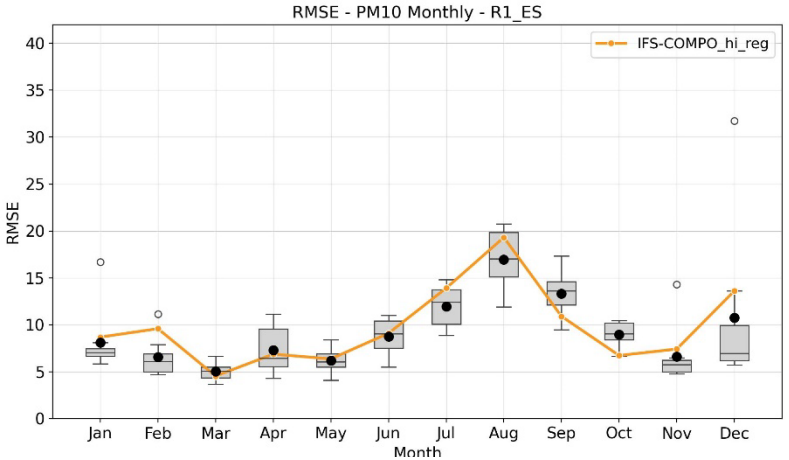


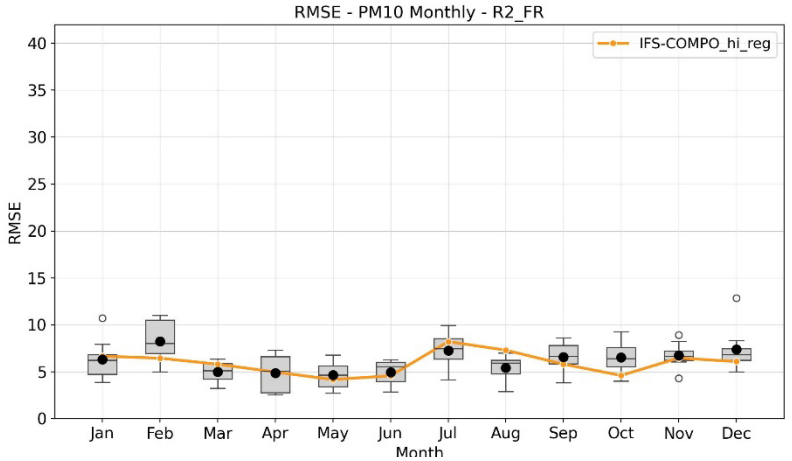


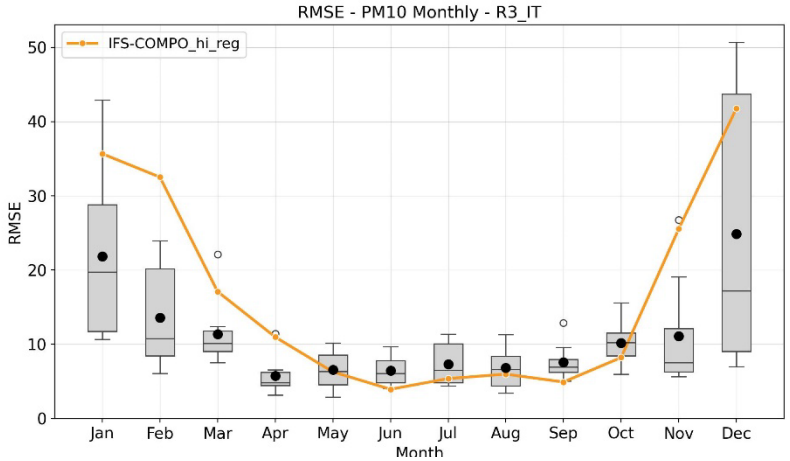


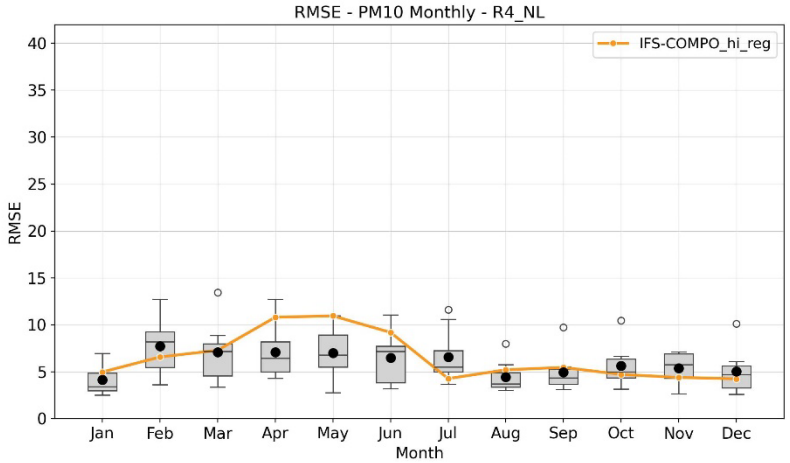


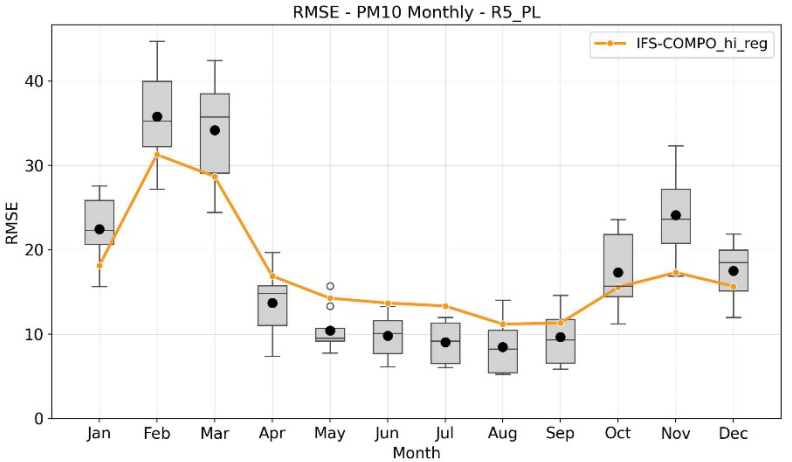
PM10 Evaluation (RMSE) - IFS-COMPO vs Regional Model Ensemble

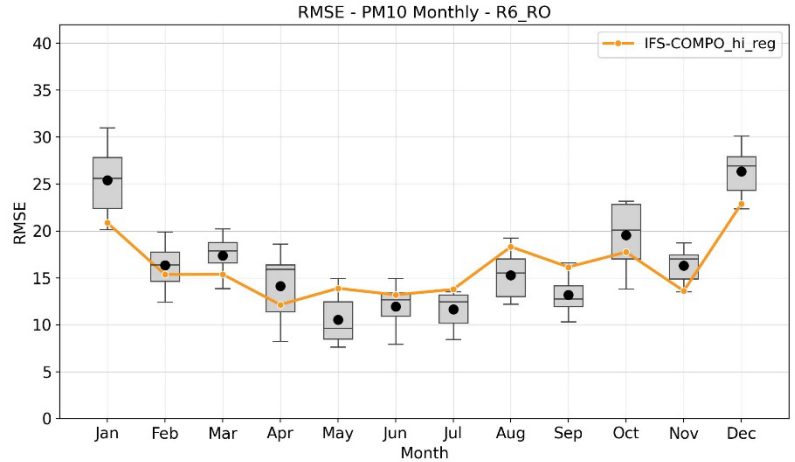


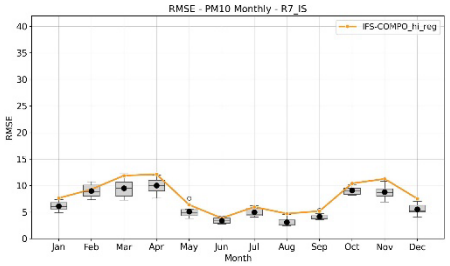




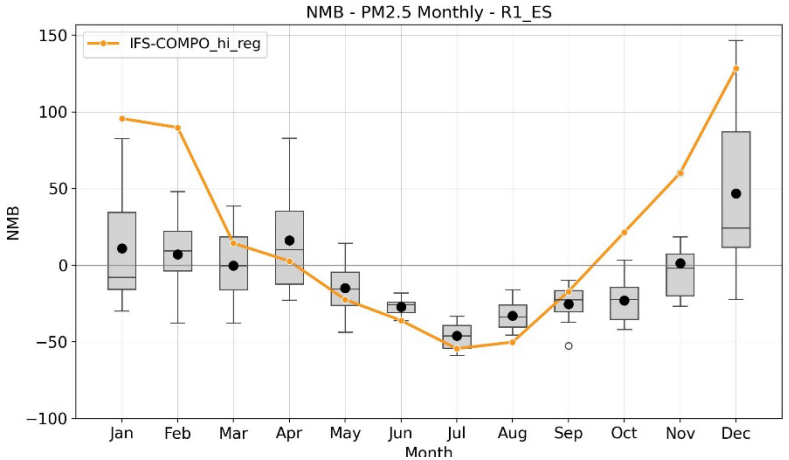


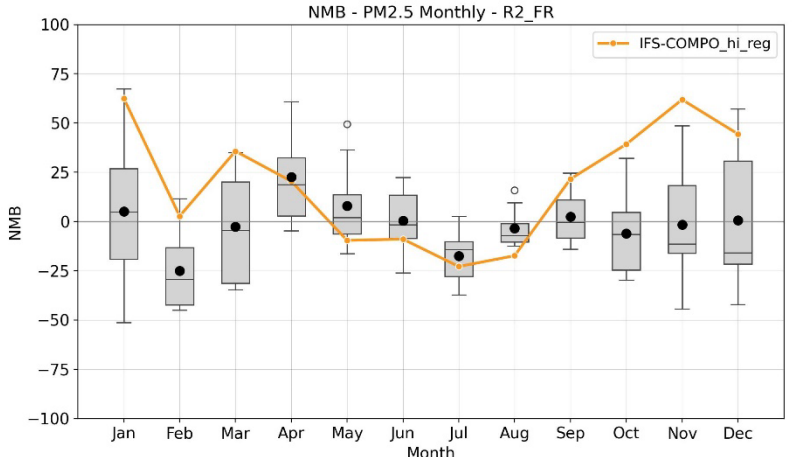


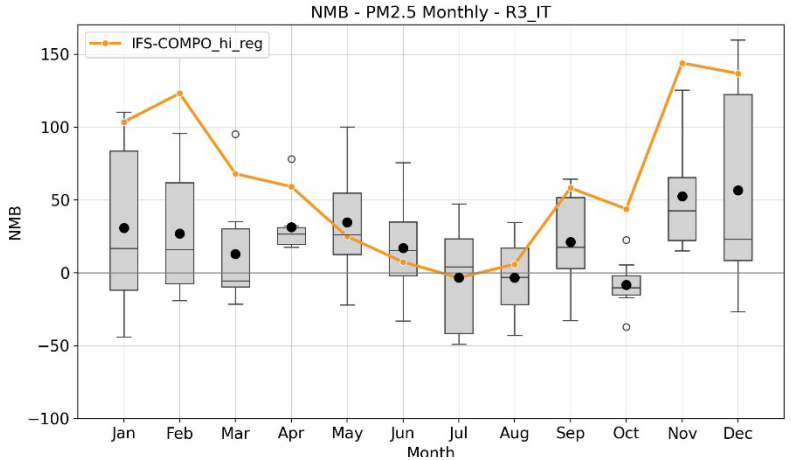


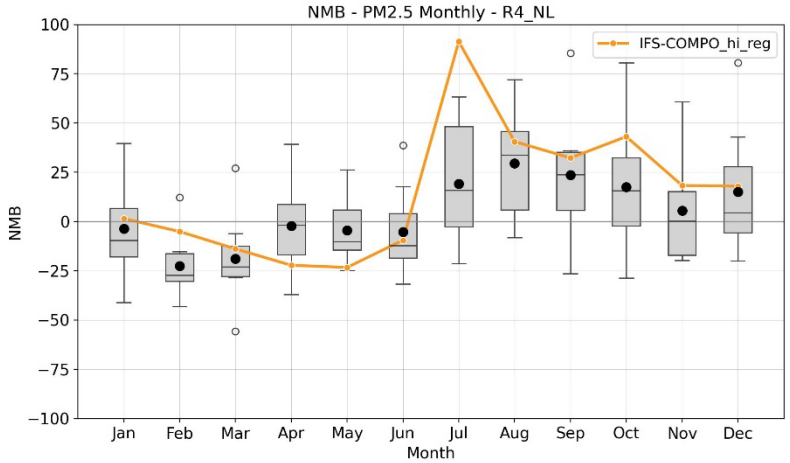


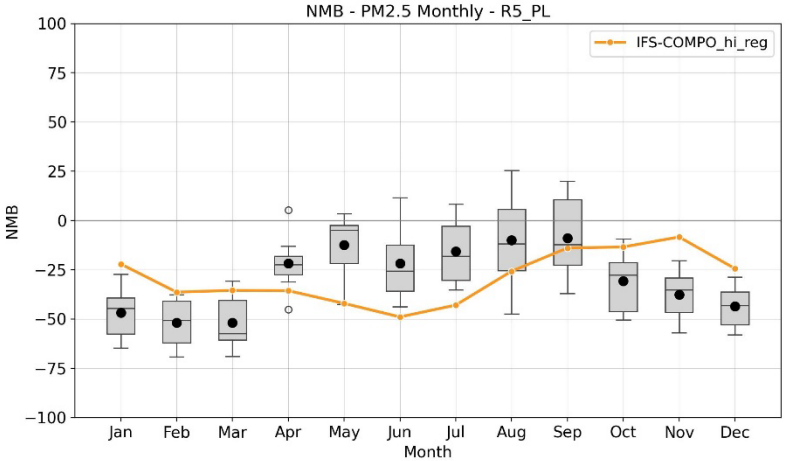
PM2,5 Evaluation (NMB) - IFS-COMPO vs Regional Model Ensemble

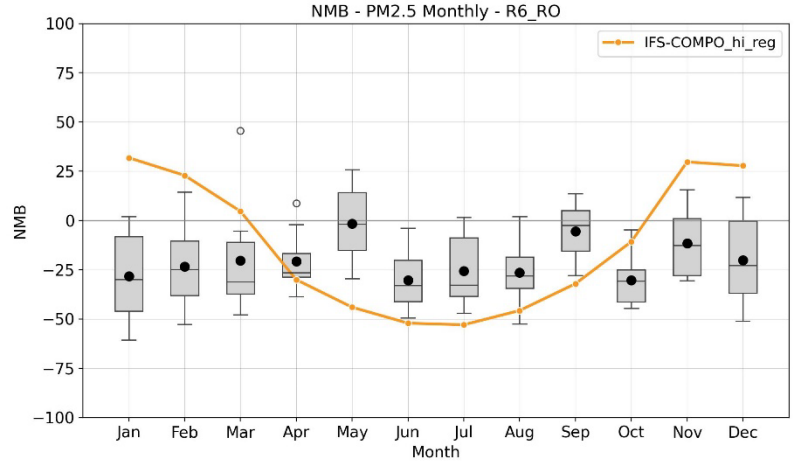


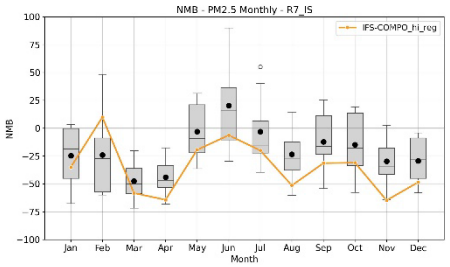






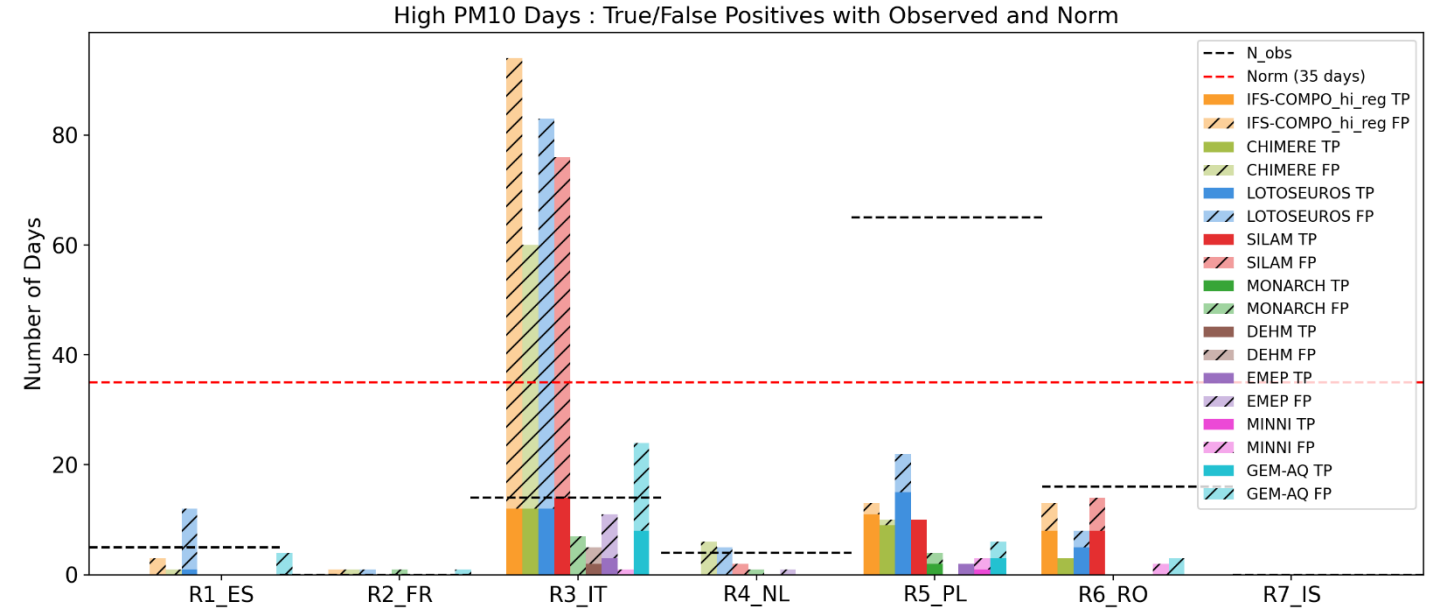


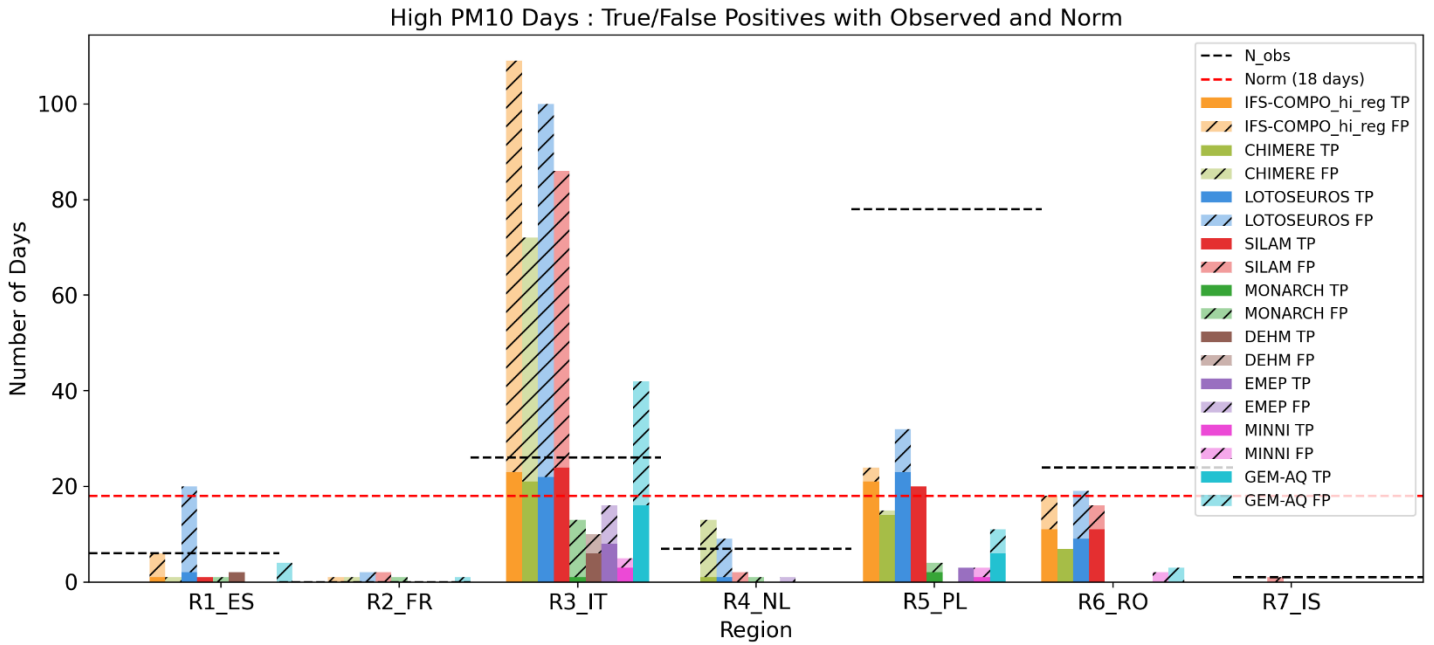




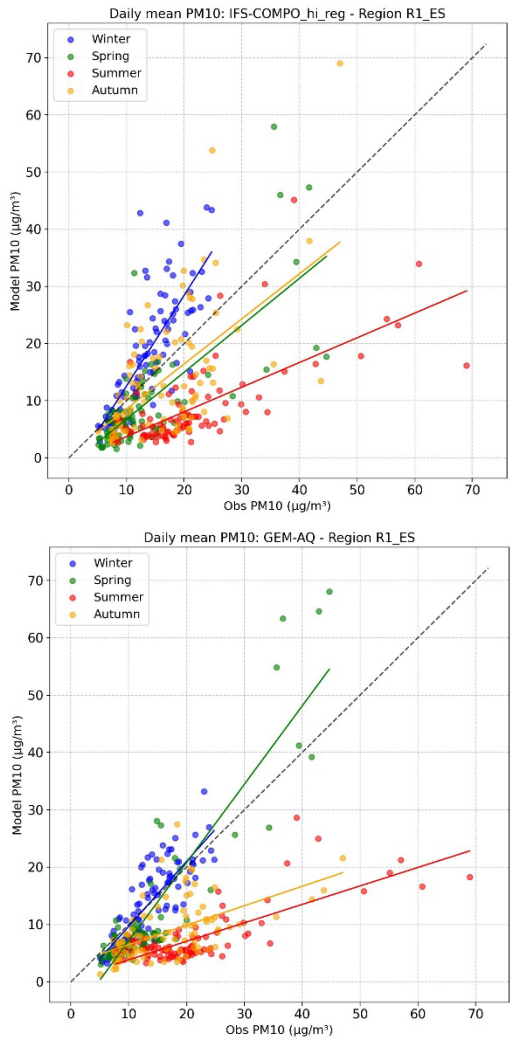
Regional models evaluation

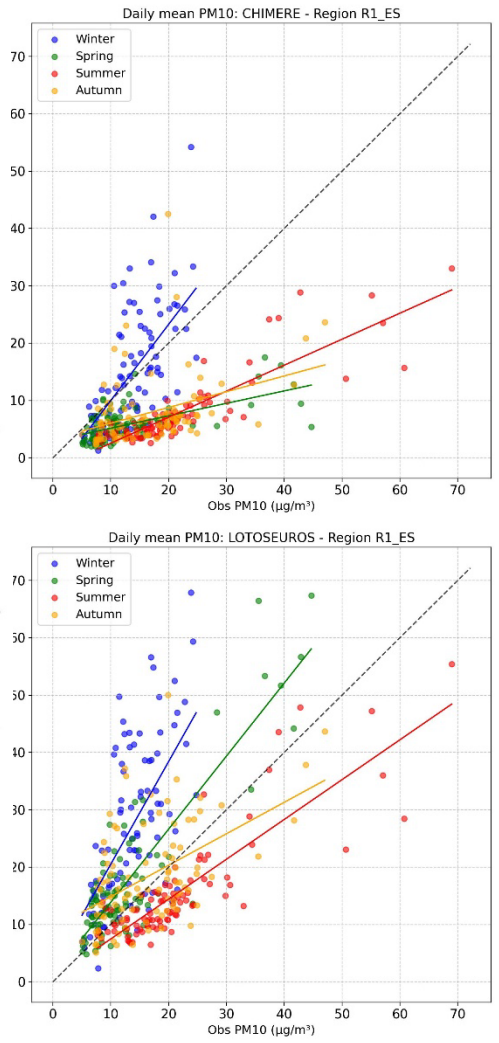
PM10 Evaluation - IFS-COMPO vs Regional Model

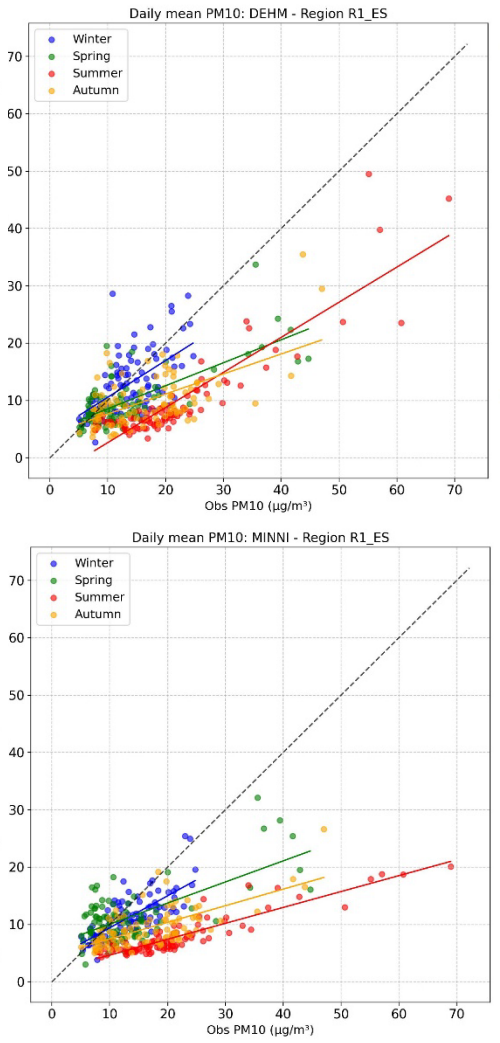


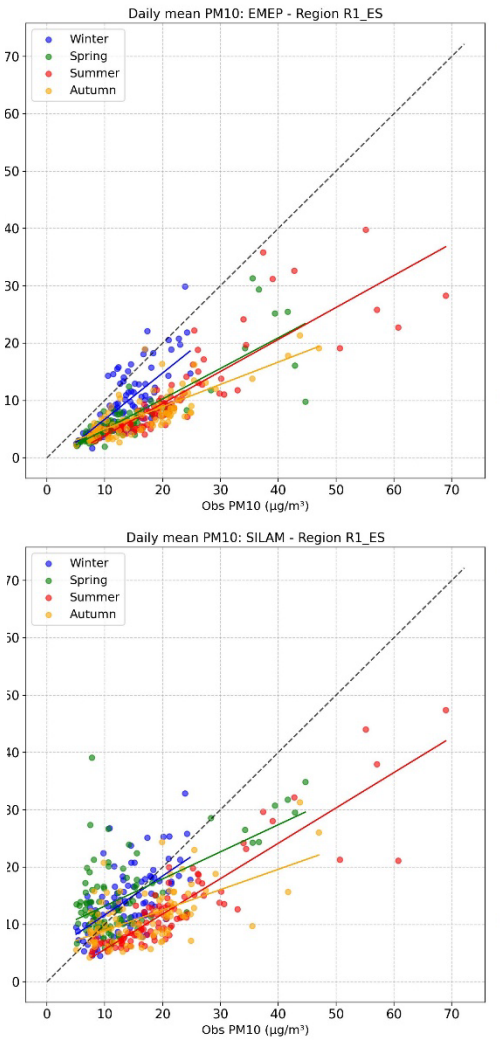


PM10 Evaluation - IFS-COMPO vs Regional Models, Region1_ES

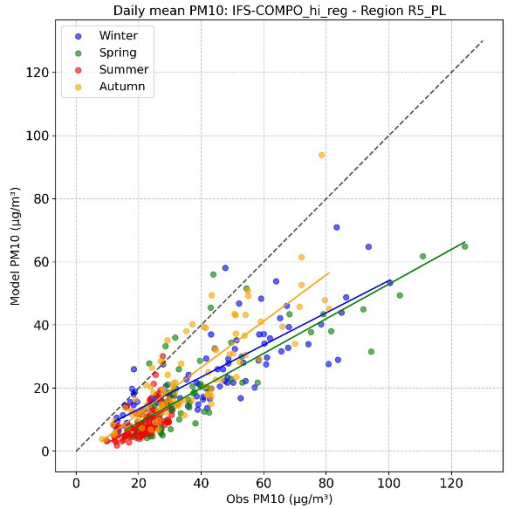








PM10 Evaluation - IFS-COMPO vs Regional Models, Region5_PL

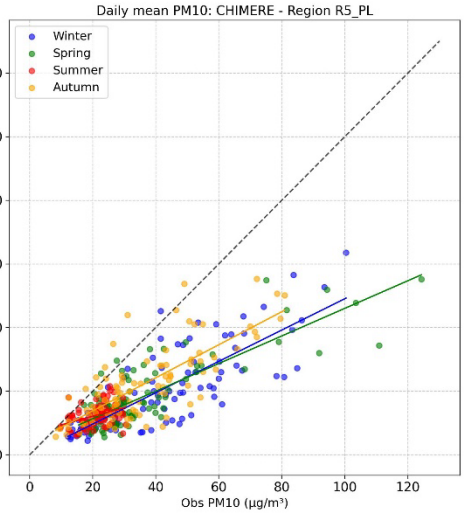


Winter:
Mean Obs: 43.4
Mean Model: 25.2
MB: -18.2
RMSE: 29.9
Corr Coef: 0.64

Spring:
Mean Obs: 36.2
Mean Model: 18.0
MB: -18.2
RMSE: 26.1
Corr Coef: 0.69

Summer:
Mean Obs: 21.3
Mean Model: 9.0
MB: -12.3
RMSE: 14.7
Corr Coef: 0.39

Autumn:
Mean Obs: 36.6
Mean Model: 24.1
MB: -12.5
RMSE: 21.9
Corr Coef: 0.65

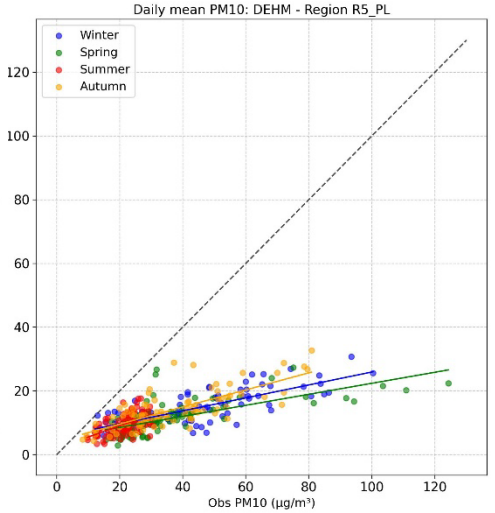


Winter:
Mean Obs: 43.4
Mean Model: 21.1
MB: -22.2
RMSE: 31.9
Corr Coef: 0.63

Spring:
Mean Obs: 36.2
Mean Model: 18.4
MB: -17.8
RMSE: 25.6
Corr Coef: 0.69

Summer:
Mean Obs: 21.3
Mean Model: 12.5
MB: -8.8
RMSE: 11.3
Corr Coef: 0.34

Autumn:
Mean Obs: 36.6
Mean Model: 22.4
MB: -14.1
RMSE: 22.0
Corr Coef: 0.62

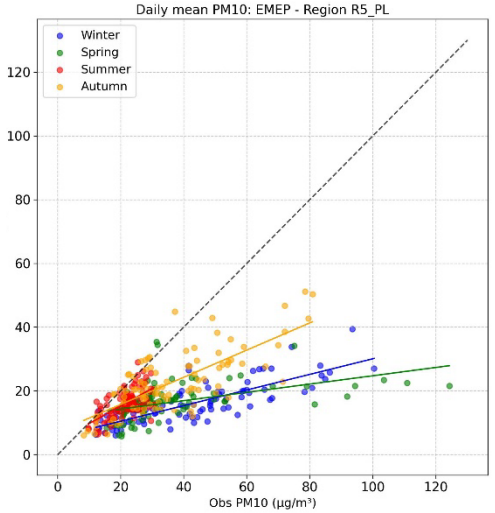


Winter:
Mean Obs: 43.4
Mean Model: 14.4
MB: -28.9
RMSE: 37.1
Corr Coef: 0.66

Spring:
Mean Obs: 36.2
Mean Model: 11.4
MB: -24.8
RMSE: 32.7
Corr Coef: 0.62

Summer:
Mean Obs: 21.3
Mean Model: 9.5
MB: -11.8
RMSE: 13.3
Corr Coef: 0.45

Autumn:
Mean Obs: 36.6
Mean Model: 14.1
MB: -22.5
RMSE: 27.9
Corr Coef: 0.65

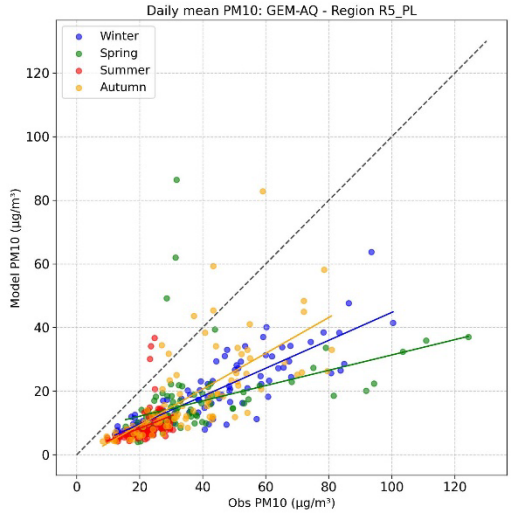


Winter:
Mean Obs: 43.4
Mean Model: 16.2
MB: -27.2
RMSE: 35.5
Corr Coef: 0.65

Spring:
Mean Obs: 36.2
Mean Model: 16.5
MB: -19.7
RMSE: 29.7
Corr Coef: 0.44

Summer:
Mean Obs: 21.3
Mean Model: 16.0
MB: -5.3
RMSE: 9.0
Corr Coef: 0.49

Autumn:
Mean Obs: 36.6
Mean Model: 22.8
MB: -13.7
RMSE: 21.4
Corr Coef: 0.60

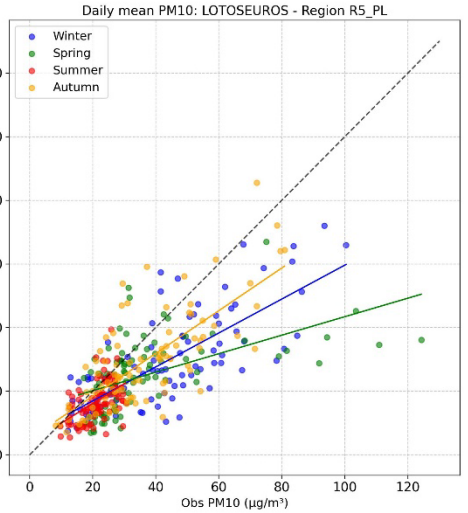


Winter:
Mean Obs: 43.4
Mean Model: 19.9
MB: -23.5
RMSE: 30.9
Corr Coef: 0.72

Spring:
Mean Obs: 36.2
Mean Model: 16.0
MB: -20.2
RMSE: 30.5
Corr Coef: 0.40

Summer:
Mean Obs: 21.3
Mean Model: 8.8
MB: -12.5
RMSE: 14.9
Corr Coef: 0.29

Autumn:
Mean Obs: 36.6
Mean Model: 18.7
MB: -17.8
RMSE: 24.7
Corr Coef: 0.61

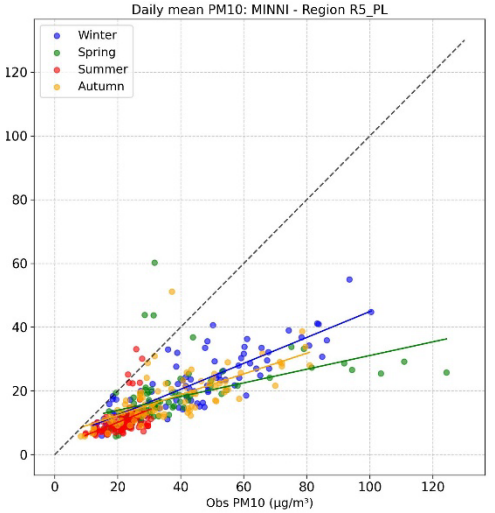


Winter:
Mean Obs: 43.4
Mean Model: 29.4
MB: -14.0
RMSE: 27.8
Corr Coef: 0.63

Spring:
Mean Obs: 36.2
Mean Model: 24.9
MB: -11.3
RMSE: 25.4
Corr Coef: 0.46

Summer:
Mean Obs: 21.3
Mean Model: 17.0
MB: -4.3
RMSE: 10.0
Corr Coef: 0.40

Autumn:
Mean Obs: 36.6
Mean Model: 29.6
MB: -6.9
RMSE: 20.3
Corr Coef: 0.62

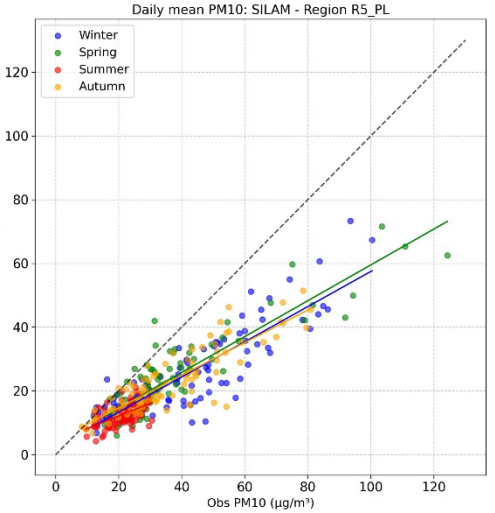


Winter:
Mean Obs: 43.4
Mean Model: 21.9
MB: -21.5
RMSE: 29.3
Corr Coef: 0.74

Spring:
Mean Obs: 36.2
Mean Model: 17.4
MB: -18.8
RMSE: 28.4
Corr Coef: 0.50

Summer:
Mean Obs: 21.3
Mean Model: 10.7
MB: -10.7
RMSE: 12.7
Corr Coef: 0.36

Autumn:
Mean Obs: 36.6
Mean Model: 17.7
MB: -18.8
RMSE: 24.7
Corr Coef: 0.65



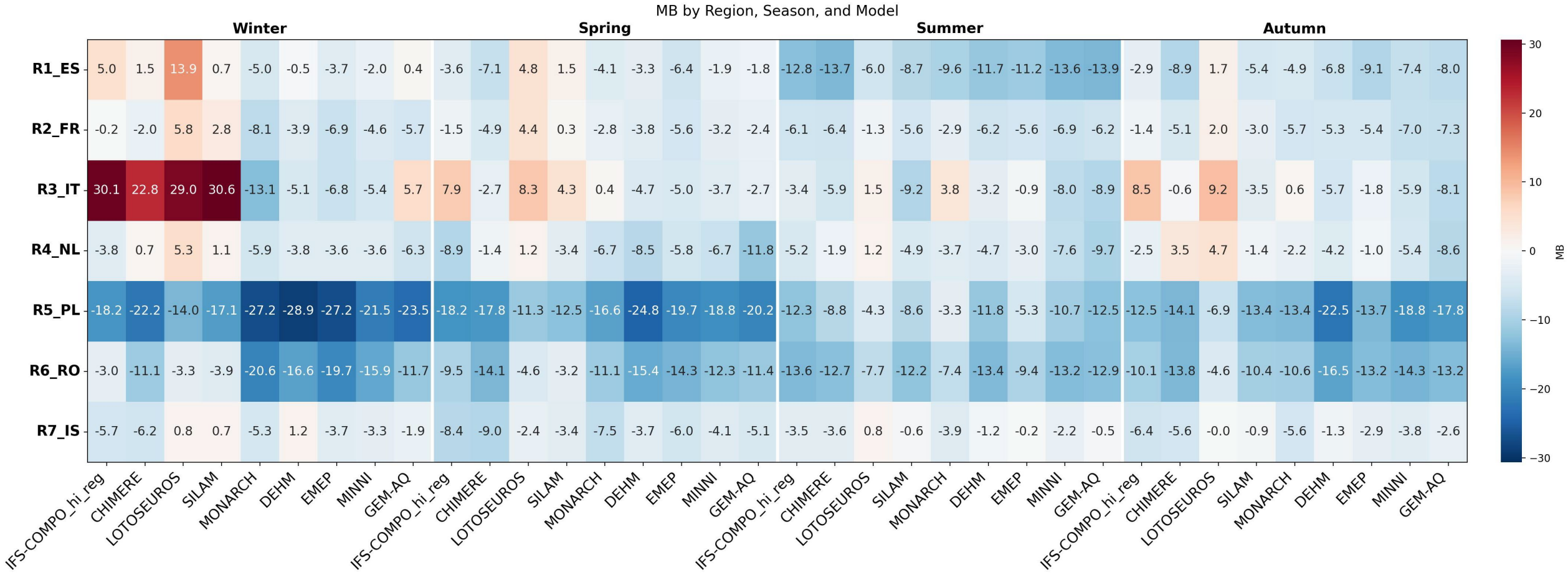
Winter:
Mean Obs: 43.4
Mean Model: 26.2
MB: -17.1
RMSE: 26.3
Corr Coef: 0.72

Spring:
Mean Obs: 36.2
Mean Model: 23.7
MB: -12.5
RMSE: 20.3
Corr Coef: 0.78

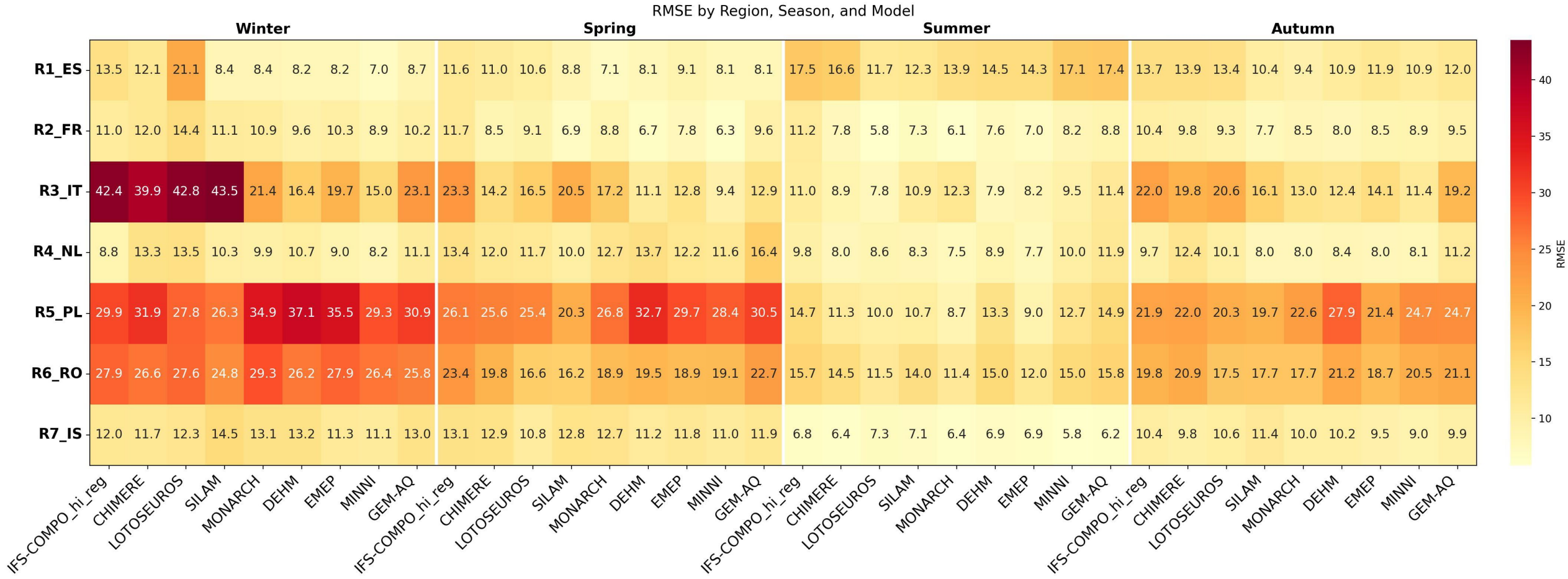
Summer:
Mean Obs: 21.3
Mean Model: 12.7
MB: -8.6
RMSE: 10.7
Corr Coef: 0.48

Autumn:
Mean Obs: 36.6
Mean Model: 23.2
MB: -13.4
RMSE: 19.7
Corr Coef: 0.73

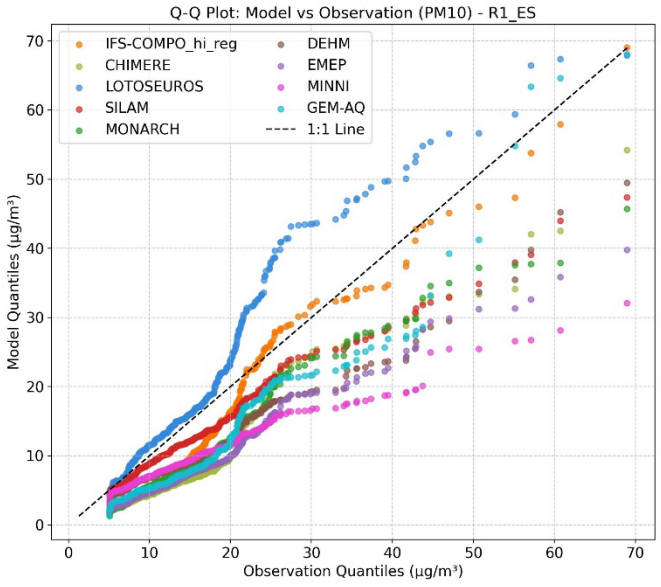
PM10 Evaluation - Mean Bias

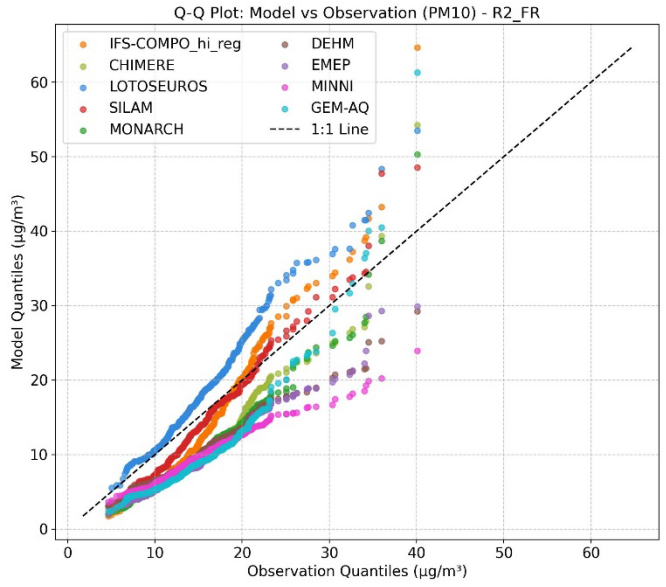


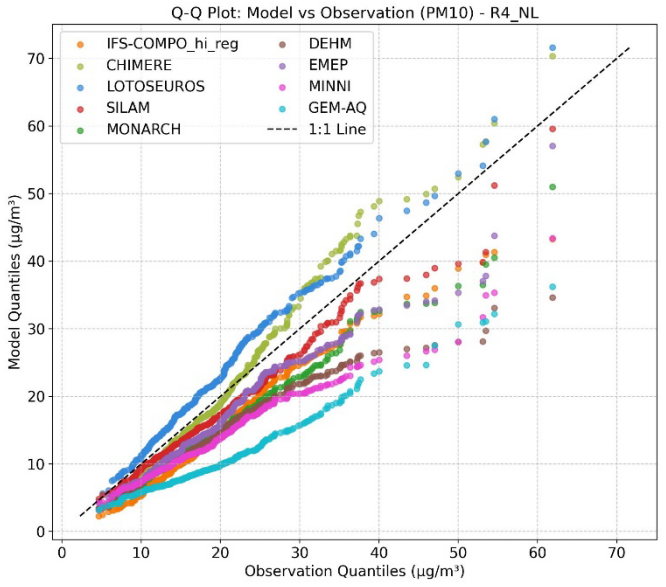
PM10 evaluation - RMSE

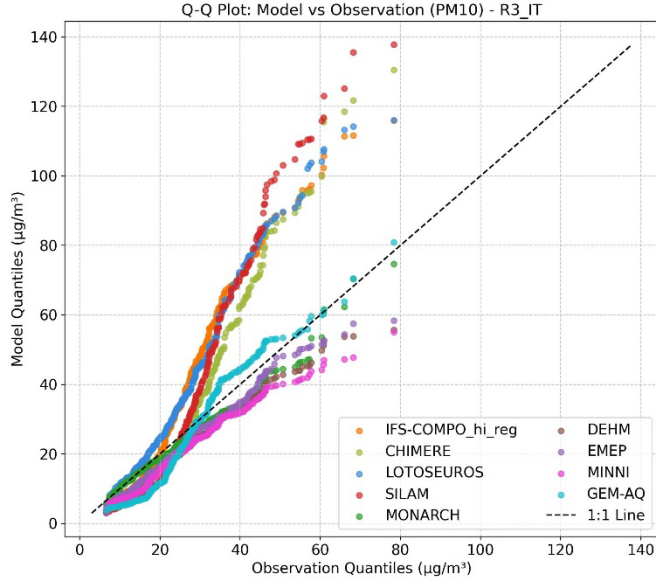


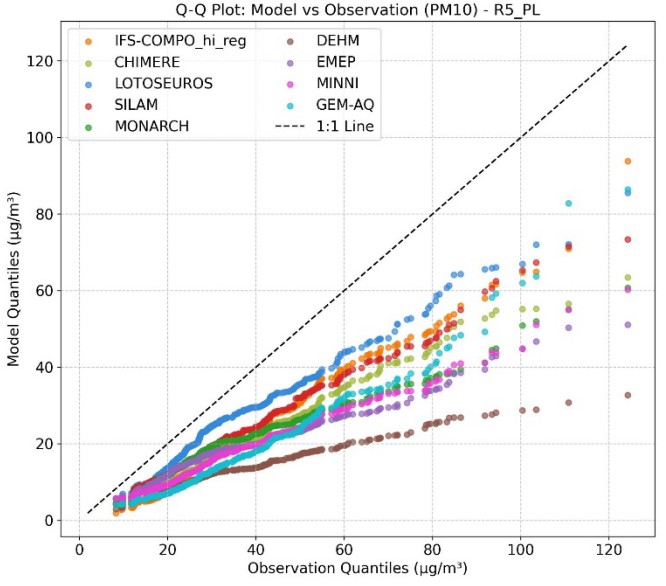
Q-Q plot PM10 - IFS-COMPO vs Regional Models

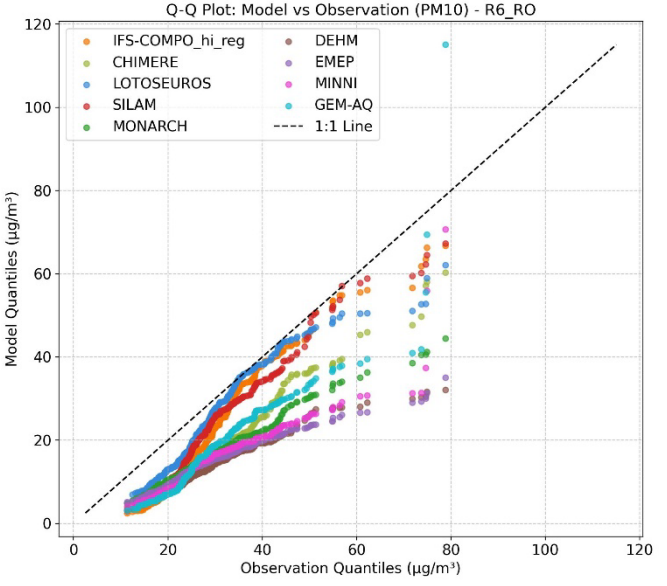




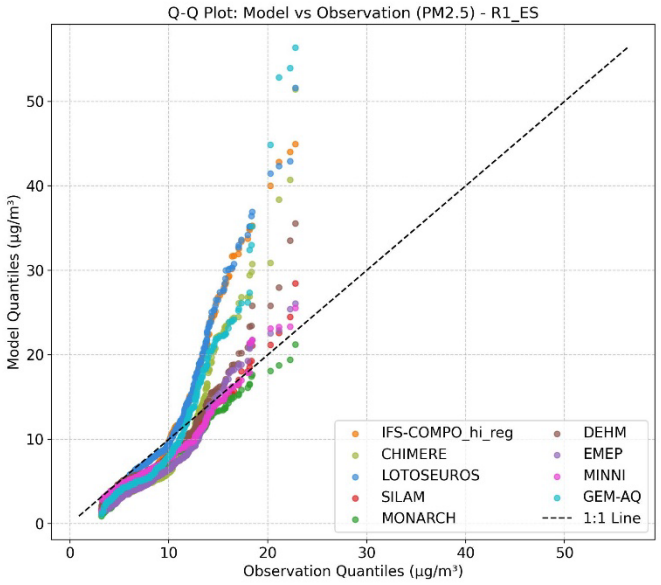


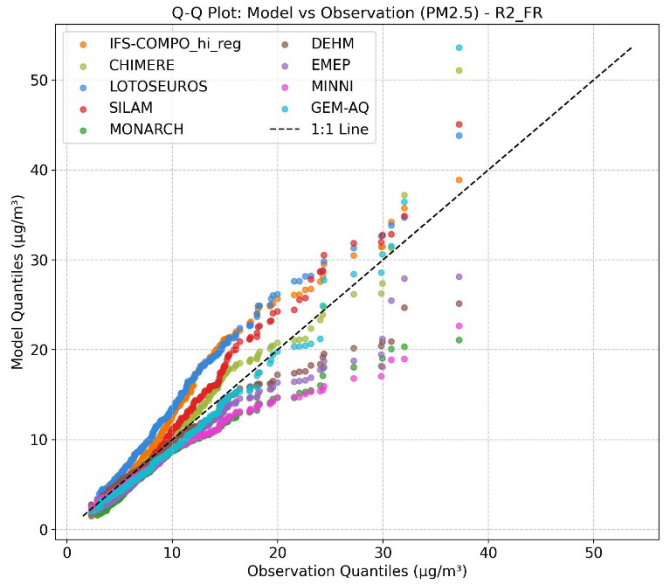


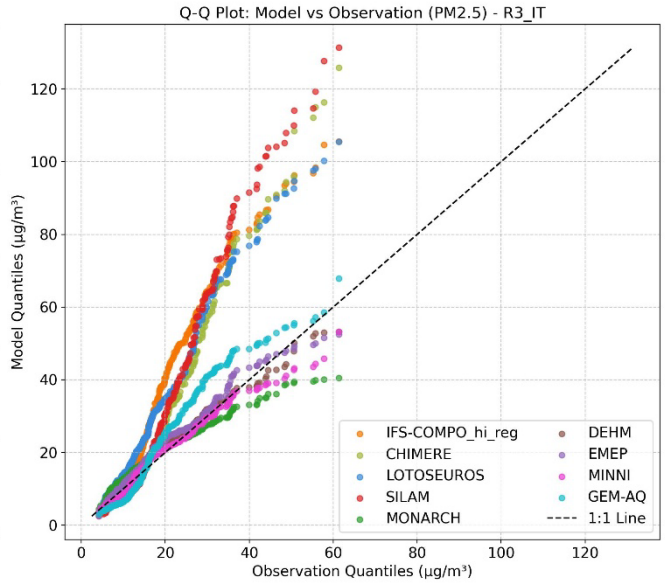


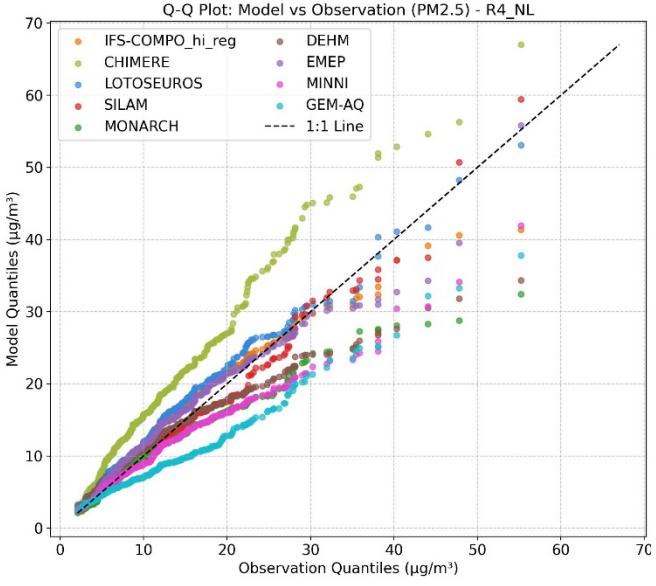


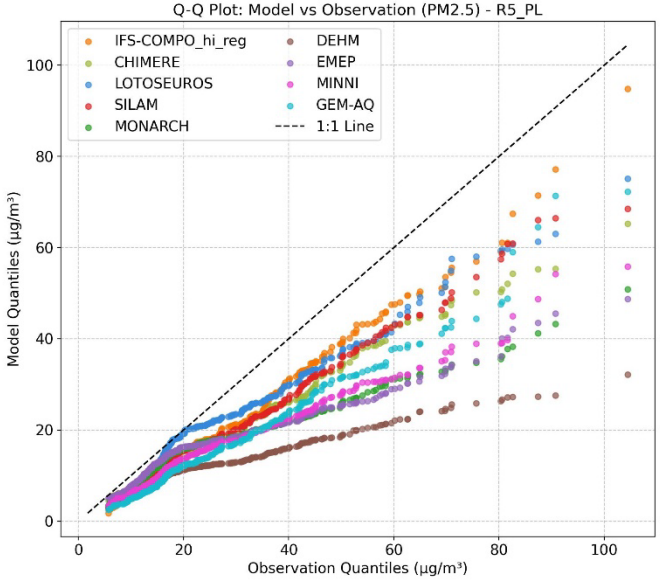
Q-Q plot PM2.5 - IFS-COMPO vs Regional Models

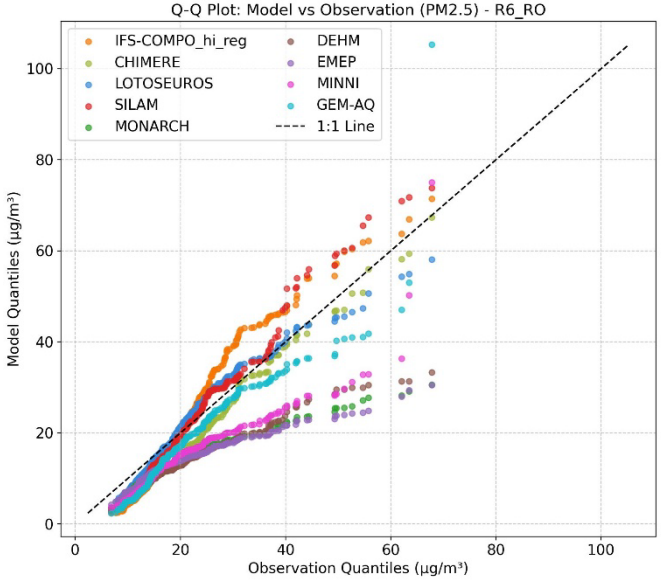












Summary and next steps

IFS COMPO (Source and sink processes)

Emission sensitivity:

- regional emissions concentration are higher in the hotspots especially during winter season and lower over water.
- annual mean is biased by winter season. No difference due to natural emissions

Resolution sensitivity:

- higher his res values over hotspots and cities but overall lower (efficiency of deposition?).
- Visible impact of uptake processes of natural seas pray and dust (sea spry lower and dust mostly higher, also higher values in coastal regions (land sea mask – lower deposition over water?) Interesting – no differences in northern and eastern EU

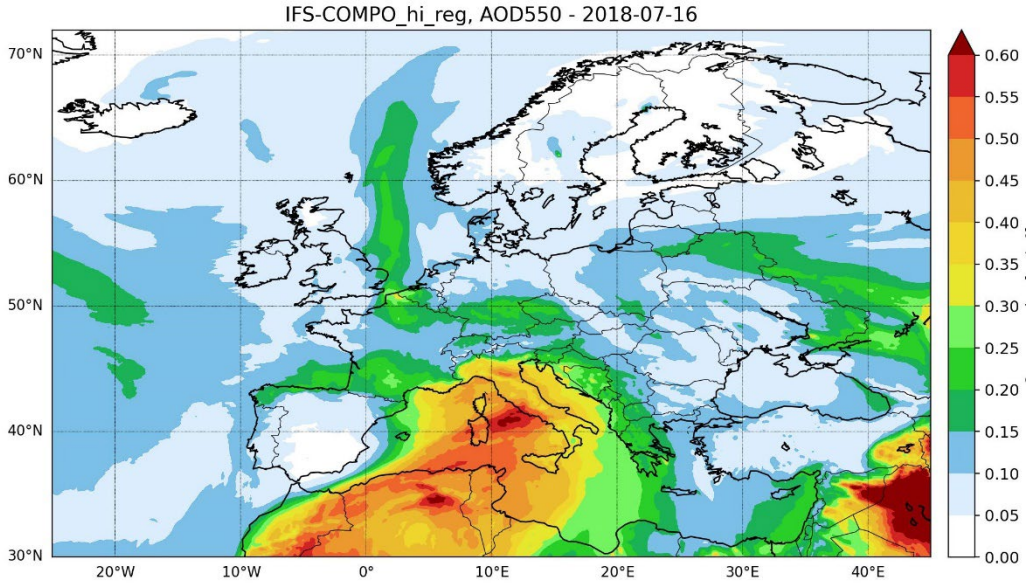
Evaluation – with the same emission the difference between high and low resolution relatively small. Need for revision of the temporal profiles

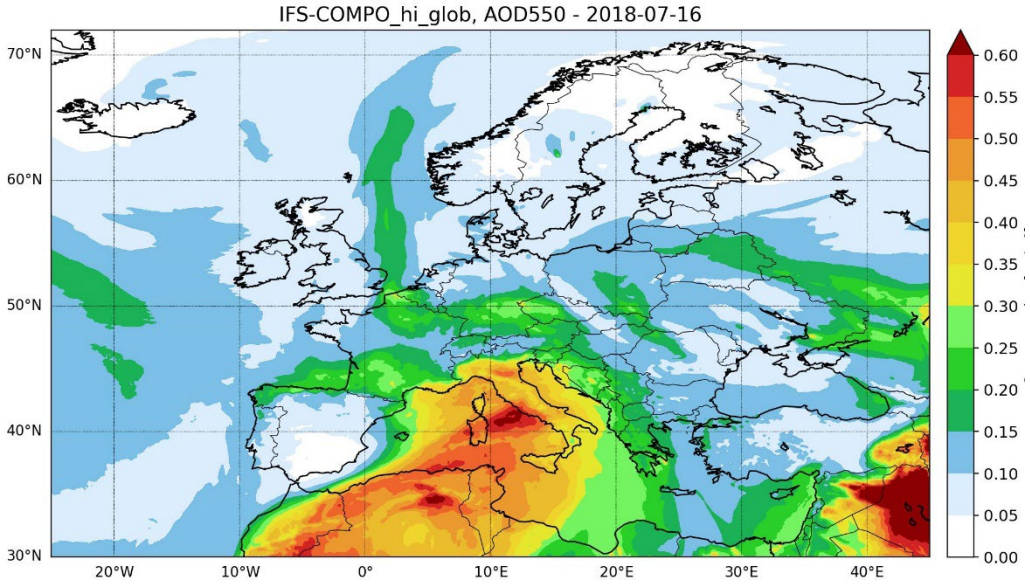
Summary and next steps

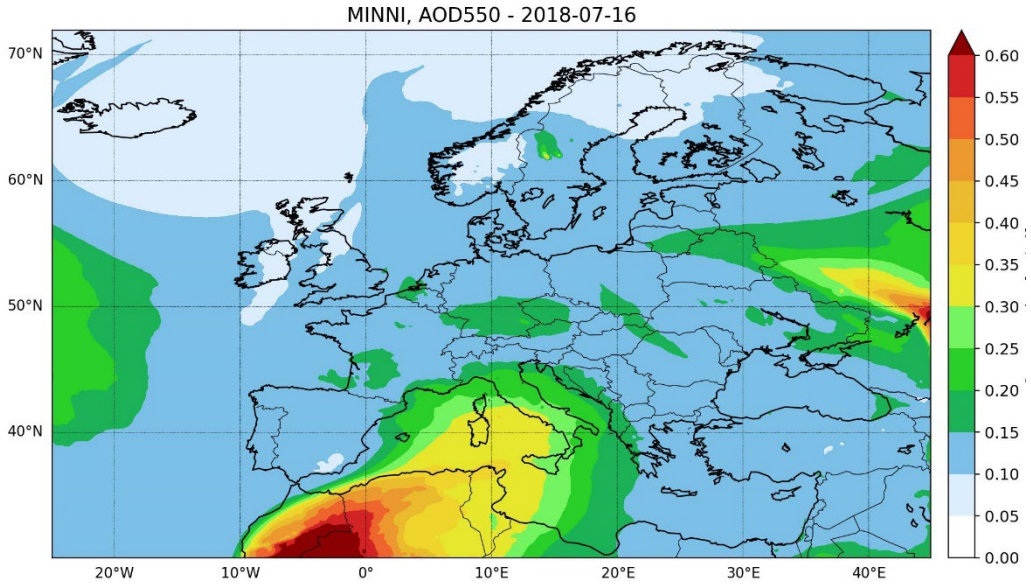
Regional models intercomparison

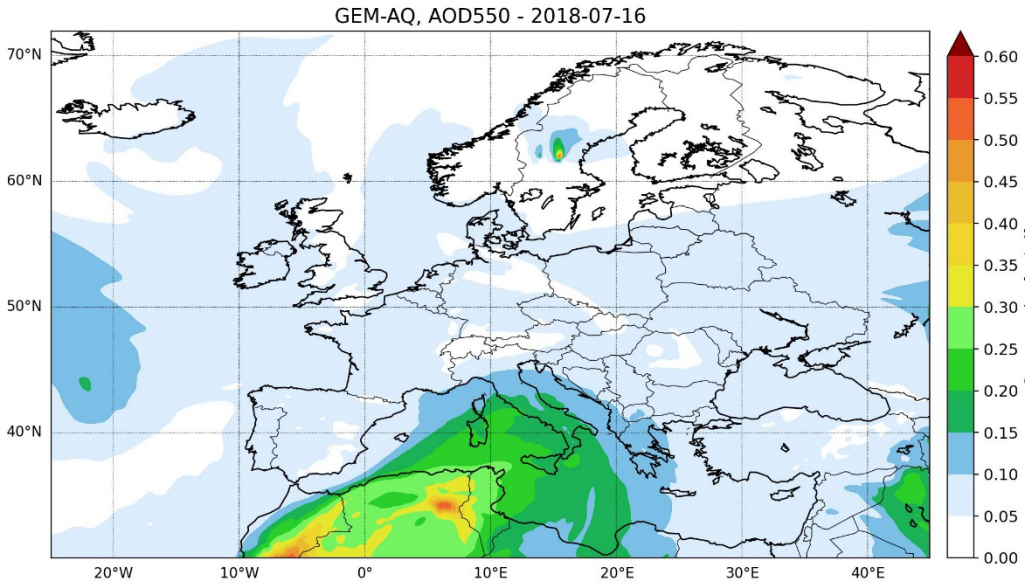
- Different patters – sometimes different source regions (secondary production? life time? dry/wet deposition efficiency)
- In most cases a range of concentration reproduced by the regional models is narrower thar IFS Compo high resolution with REG emissions (not necessarily bad – but this are the same emissions)
- Seasonally, significant differences over Atlantic Ocean and over North Africa
- Standard deviation of the regional ensemble highest over North Africa, north of the domain and locally over hot spots
- For PM10 IFS COMPO is relatively simitar to the regional models while for PM2.5 there are quite substantial differences
- Regional models' performance is region dependent (IT – overestimation, RO and PL underestimation – not necessarily due to too low country emission as 50% comes from transboundary contribution)

IFS-COMPO vs Regional Models - AOD550 (2018.07.16)

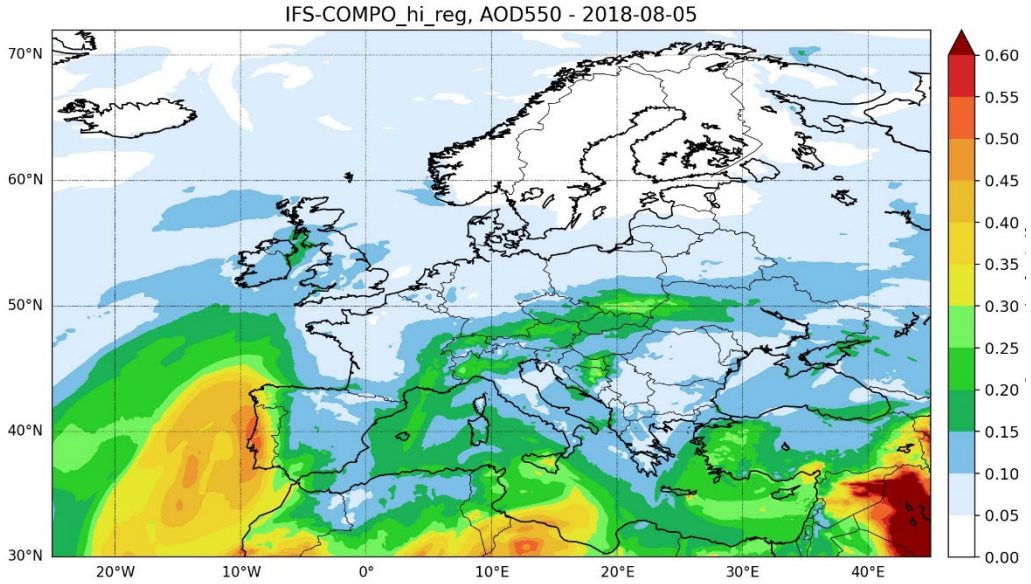


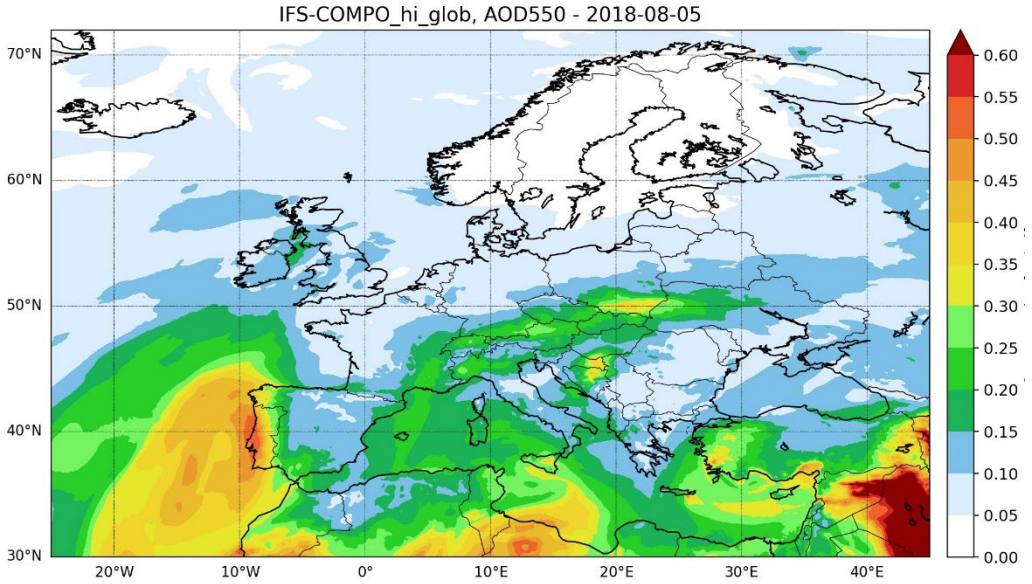


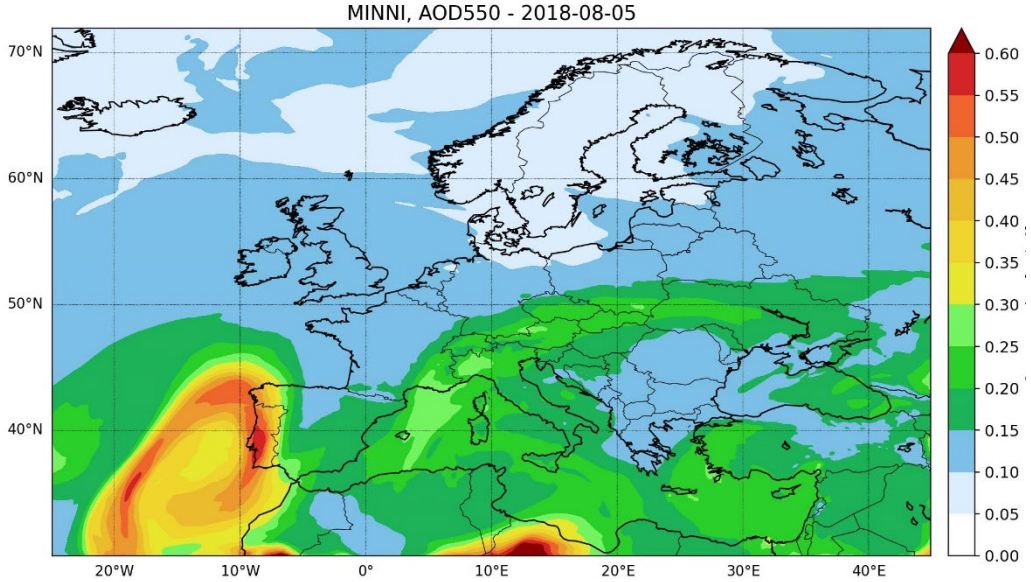


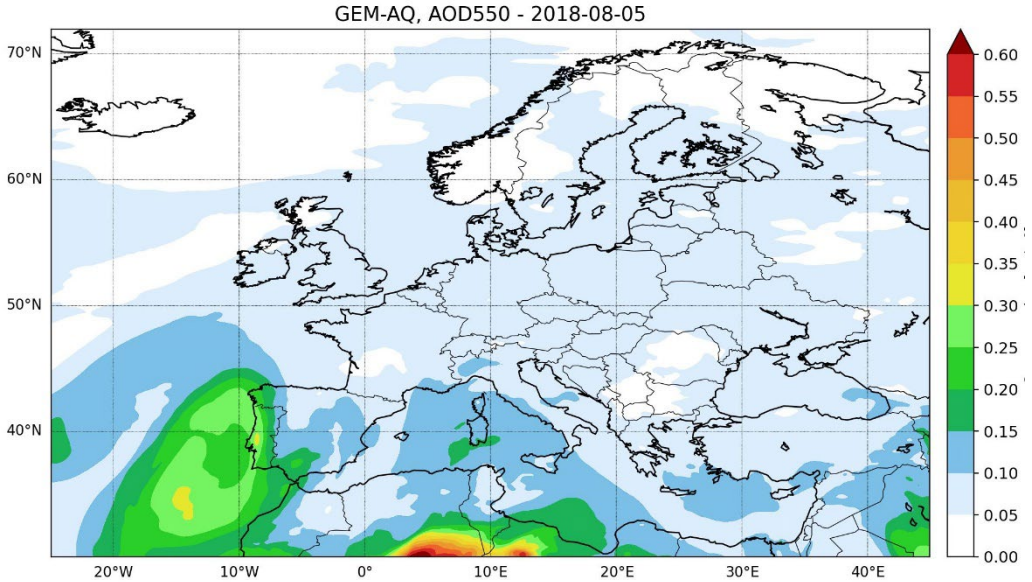


IFS-COMPO vs Regional Models - AOD550 (2018.08.05)









Next steps

- AOD analysis (July and August 2018)
- Integrated concentrations instead of AOD@550 to avoid differences in the optical module?
- PM10 and PM2.5 profile analysis
- PM2.5/PM10 ratio analysis