Bias corrections

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- There is no satisfactory way of including bias corrections for projections, or for any other application, because we are correcting for something that is unknown

- We can be correcting in the wrong way or correcting the wrong thing

- A bias correction can be improved if some indication of the cause of the bias is known

From: Technical Guidance in the field of Air Quality Modelling

Causes of bias can be many and include:

- Bias in model formulation, e.g. transport/dispersion formulations, chemistry.
- Bias due to model conceptual formulation, e.g. depth of lowest model layer, non-obstacle resolving models in complex situations.
- Bias due to model and station spatial representativeness.
- Bias due to meteorology, e.g. bias in wind speed or atmospheric stability.
- Bias due to emission uncertainty in known emission sources.
- Bias due to missing emission sources.
- Bias due to background concentrations.

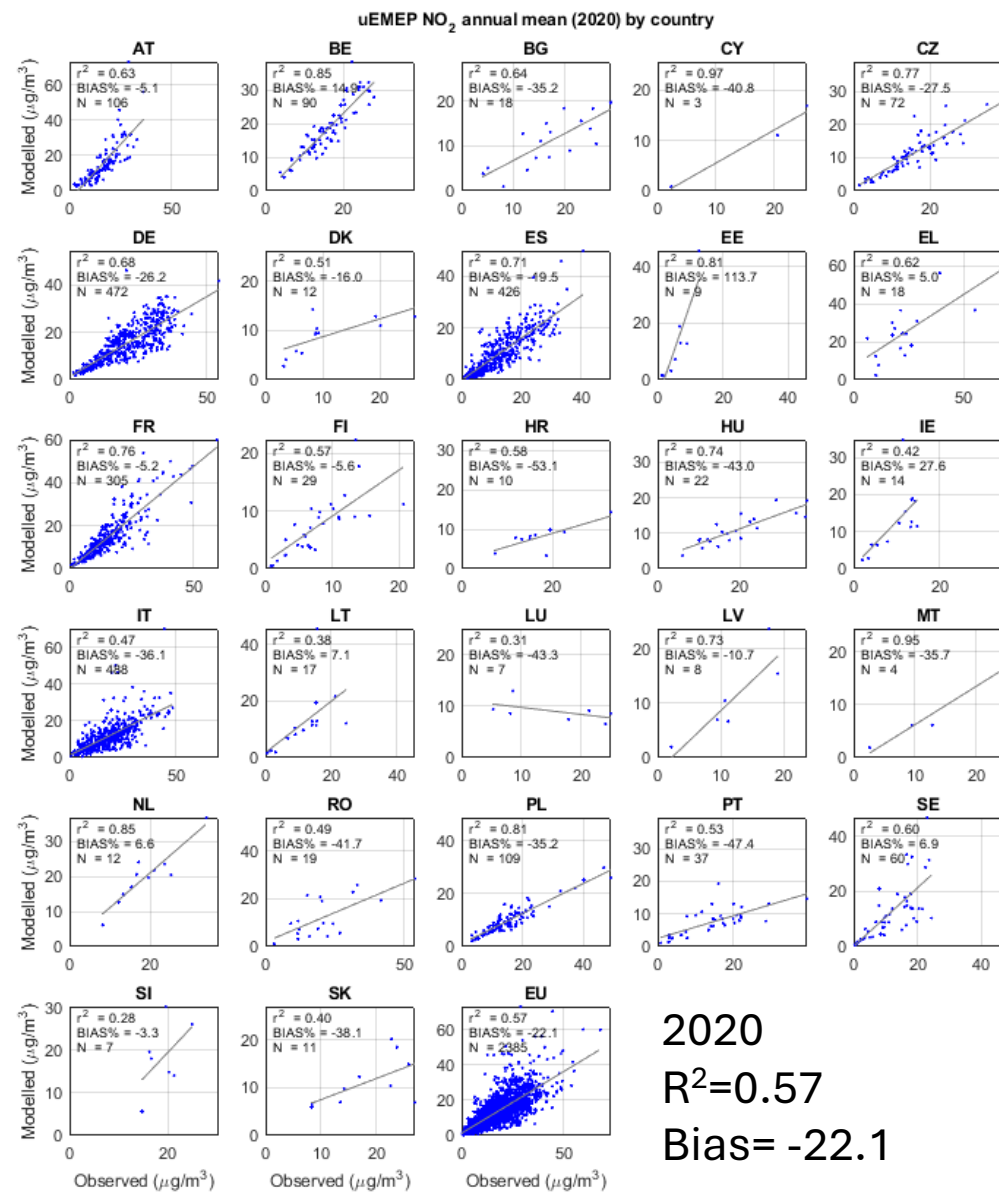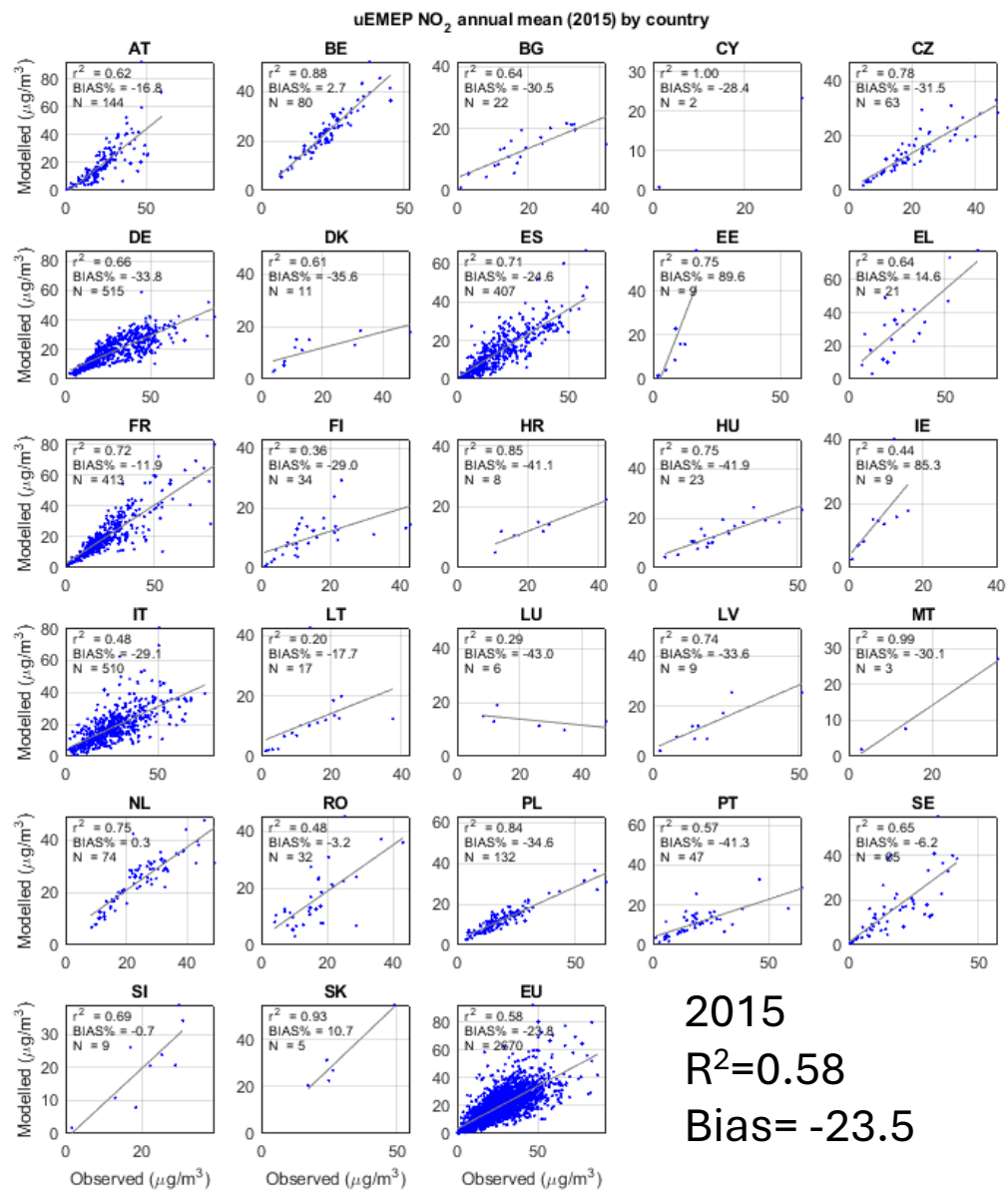# From: Technical Guidance in the field of Air Quality Modelling

Schematic illustrating the impact of different bias correction
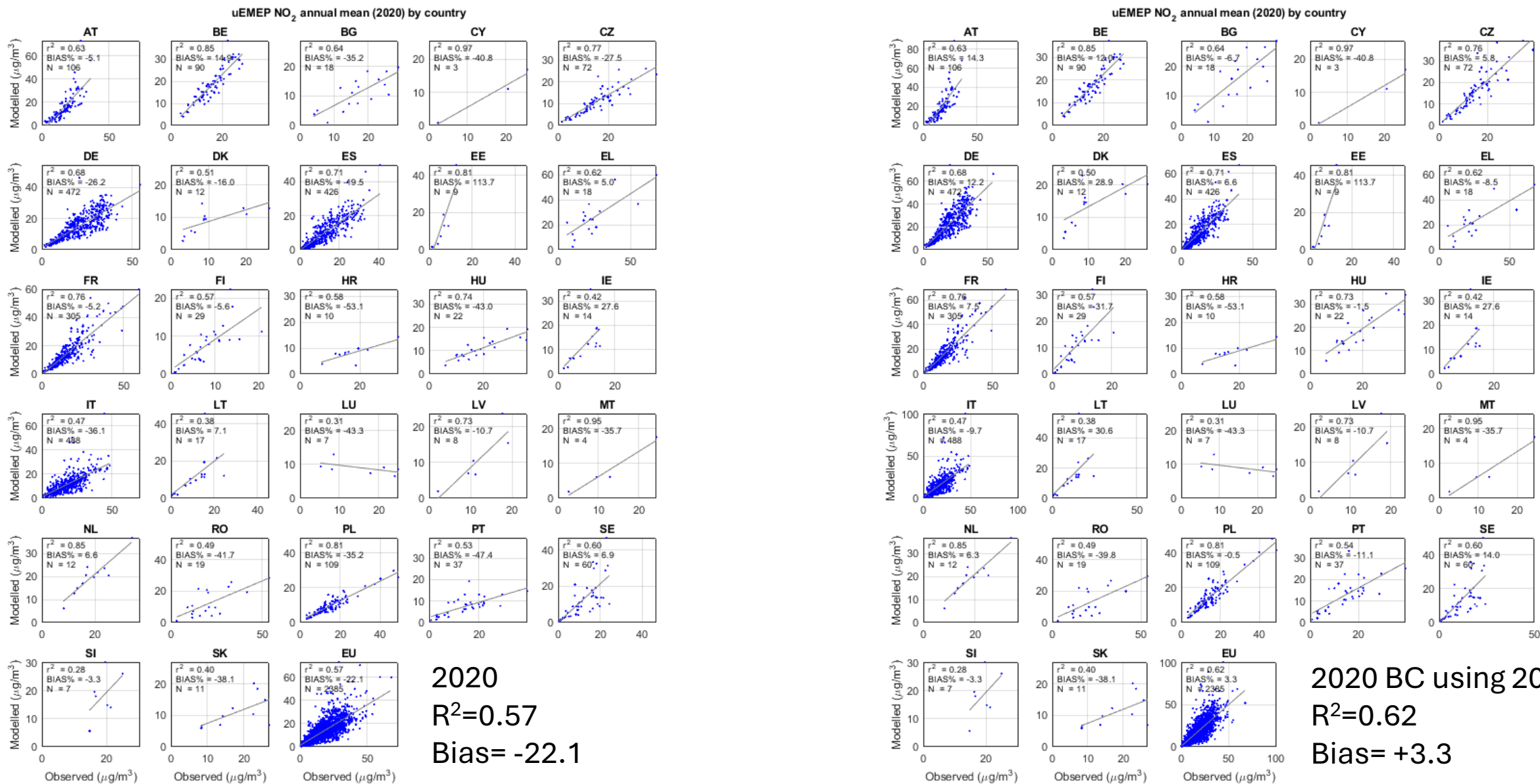methodologies on a bias corrected projection
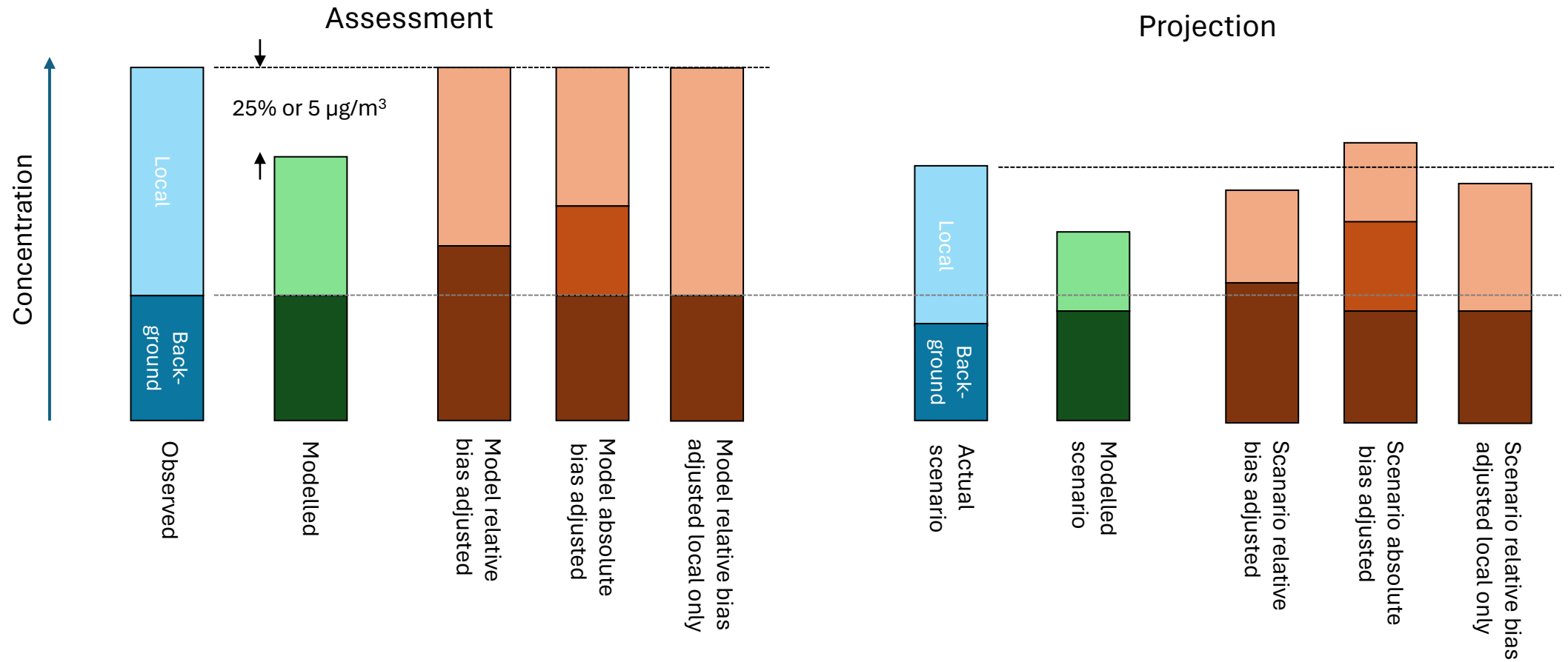
Bias correction for AAQD revision

- Calculations made with uEMEP/EMEP
- For mapping and stations:
  - Bias correction applied to 'local' contributions from within ±40 km
  - Bias correction per country, intended to reflect differences in country emissions and bias in the downscaling dispersion model. One scaling factor per country for the local contributions
  - Correction of only local contributions also reduced border effects
  - Many variations tried, including different years, combinations of years, station selection, model and emission inventory versions.
  - Verified by applying 2015 scaling to 2020 calculations and compare to2020 observations

- Additionally a station scaling method was implemented. Observed concentrations scaled by the change in modelled concentrations
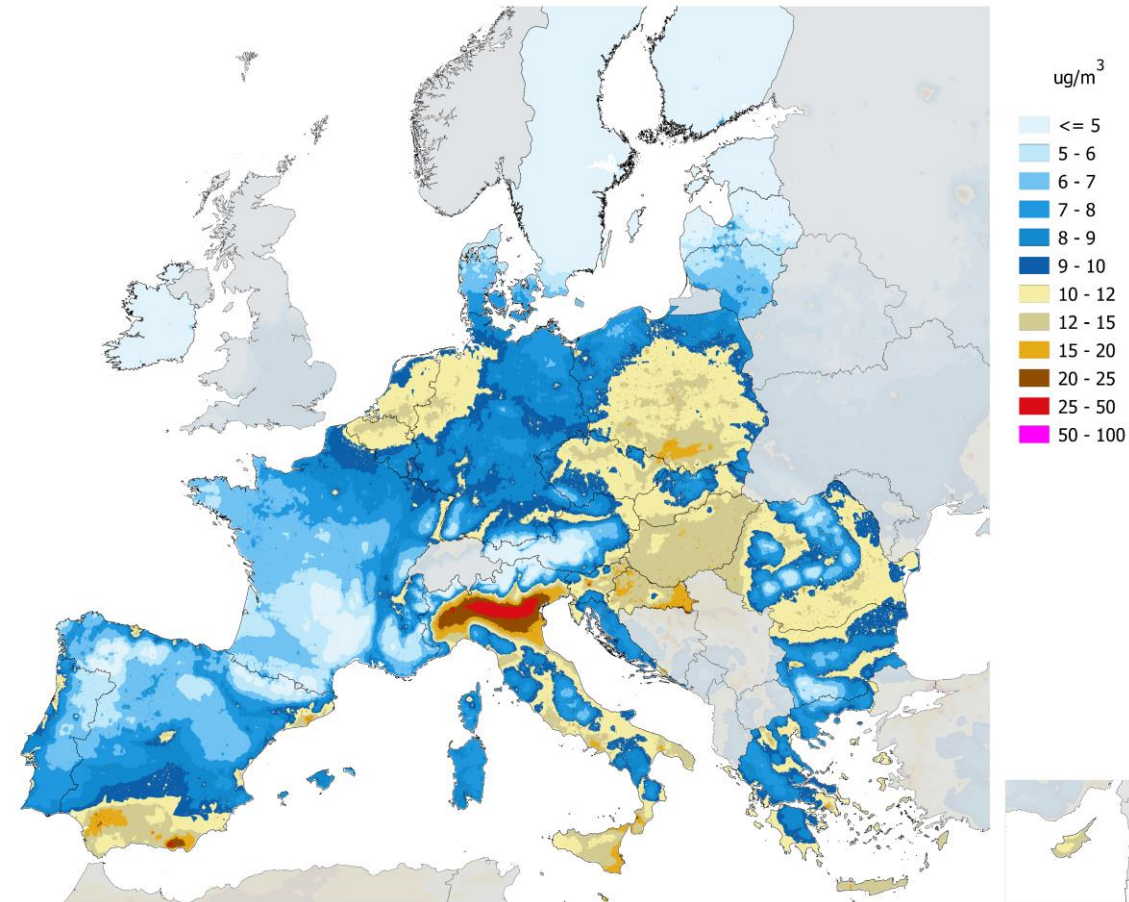
Station calculations for 2015 and 2020 NO2

uEMEP NO$_2$ annual mean (2015) by country

2015
R^2=0.58
Bias= -23.5

uEMEP NO$_2$ annual mean (2020) by country

2020
R^2=0.57
Bias= -22.1

Applying country bias correction from 2015 to 2020 NO$_2$

uEMEP NO$_2$ annual mean (2020) by country

2020
R^2=0.57
Bias= -22.1

2020 BC using 2015
R^2=0.62
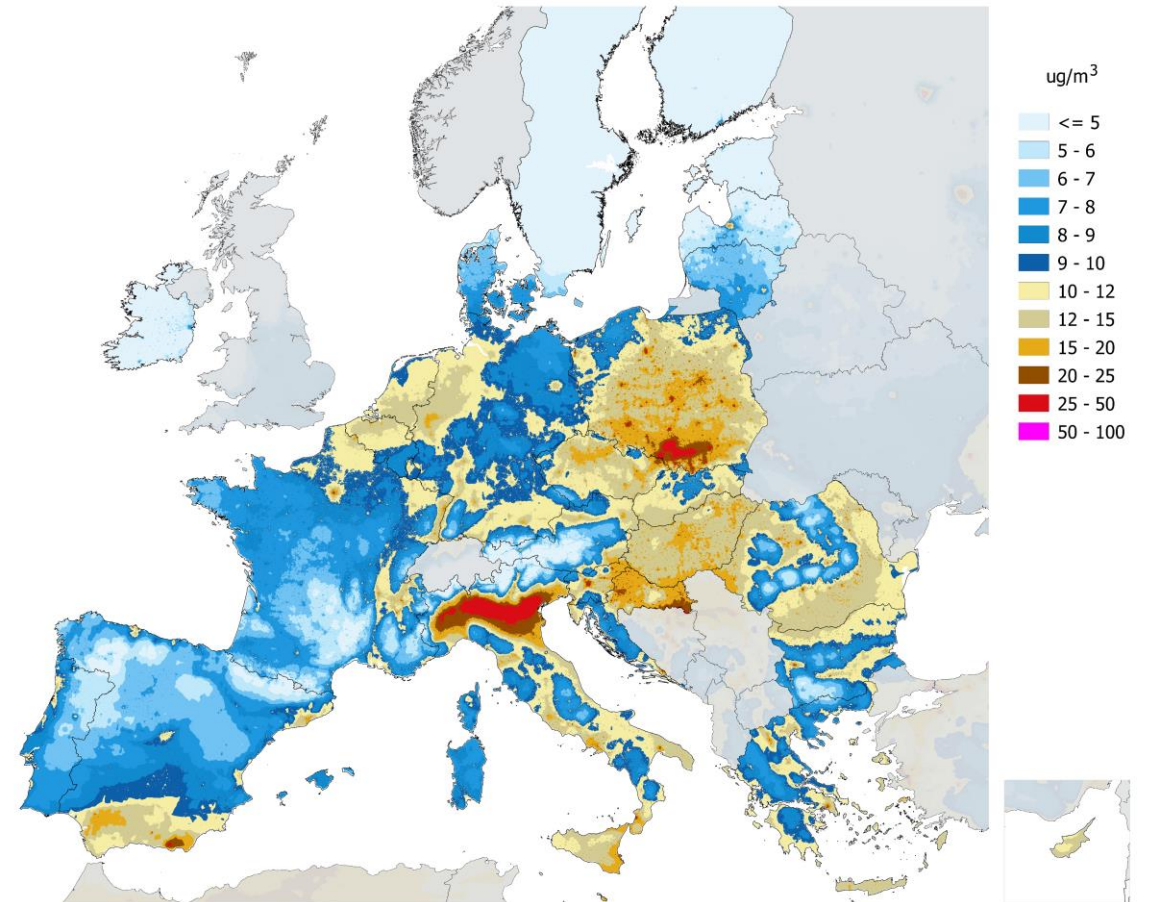Bias= +3.3

Countries with < 10 stations not corrected

Bias corrected map of PM2.5 for 2015
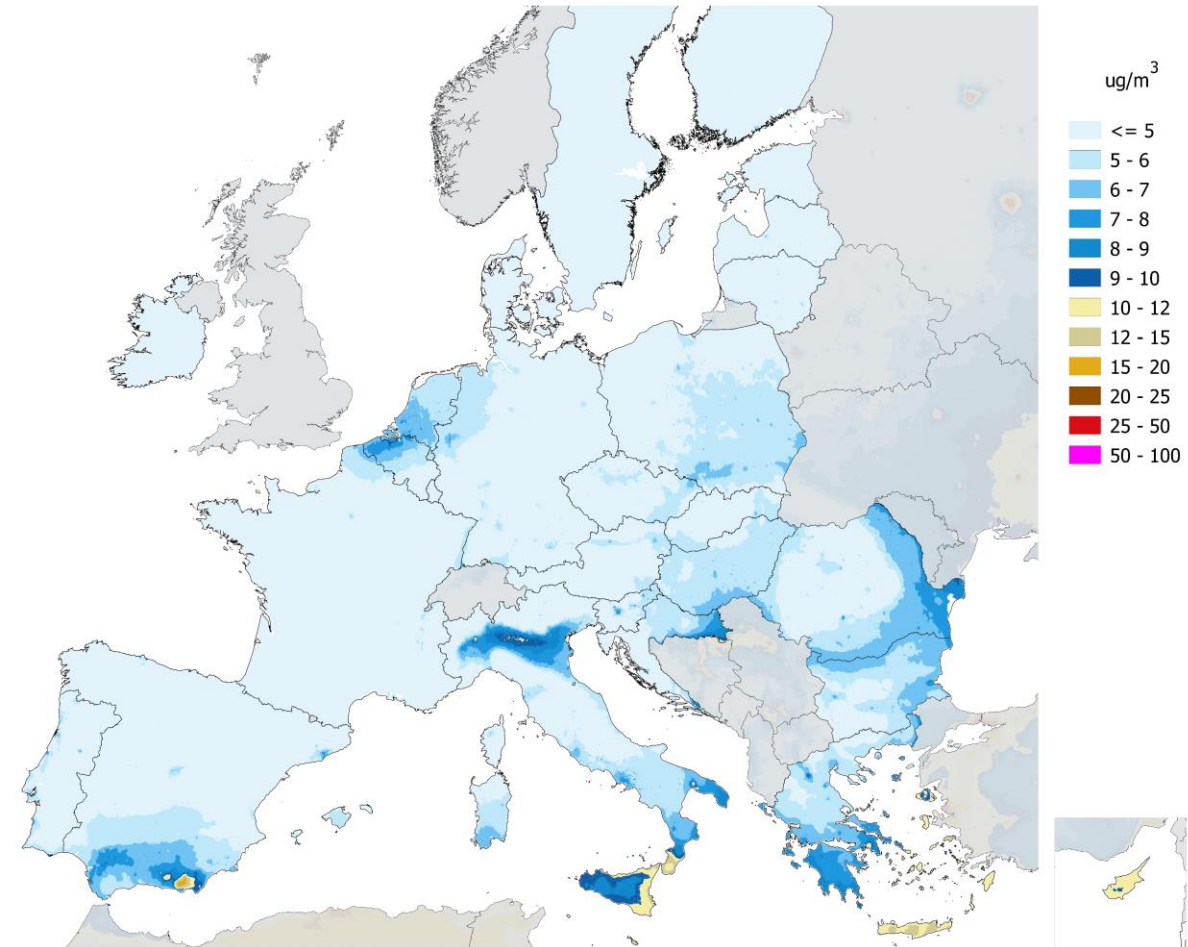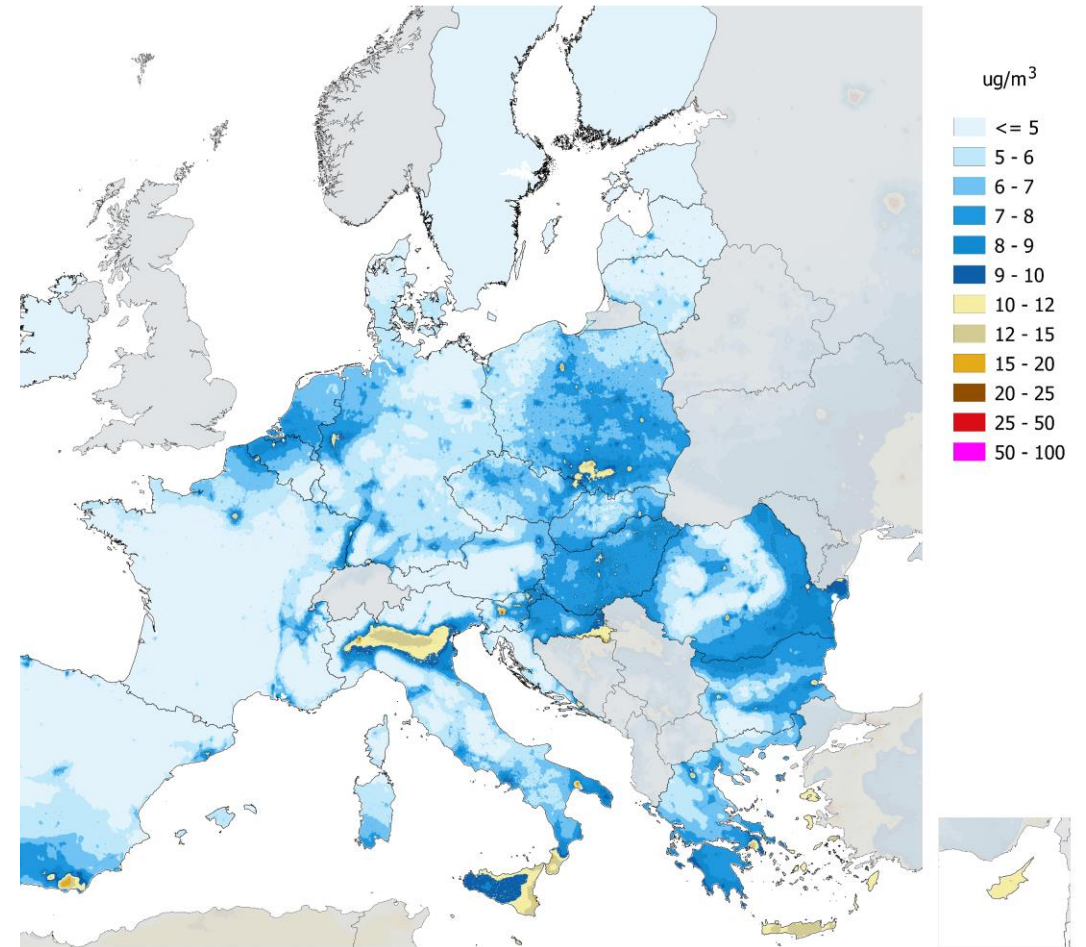
Not corrected

Bias corrected

Bias corrected map of PM2.5 for 2030 OPT10 scenario

Not corrected

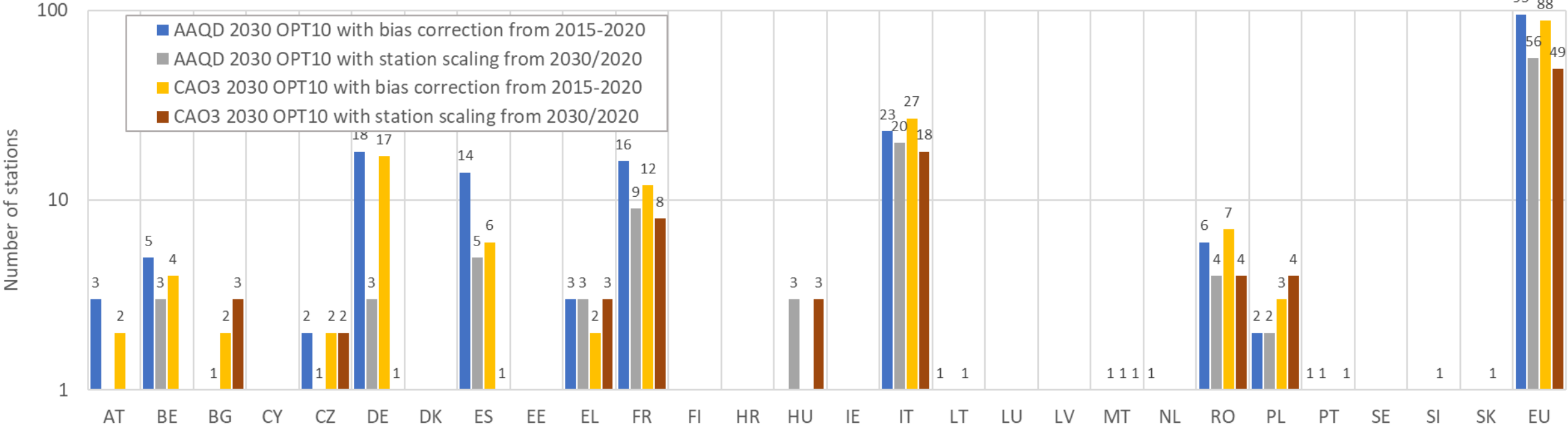Bias corrected

Different bias corrections for NO$_2$ 2030 OPT10 scenario

Number of station sites with annual mean NO$_2$ concentrations > 20 μg/m^3 per country using 2030 OPT10 emissions from CAO3 and AAQD for the average bias correction and station scaling methods

Legend:
- AAQD 2030 OPT10 with bias correction from 2015-2020
- AAQD 2030 OPT10 with station scaling from 2030/2020
- CAO3 2030 OPT10 with bias correction from 2015-2020
- CAO3 2030 OPT10 with station scaling from 2030/2020

Summary

- Bias correction, or projection correction, is necessary
- Though not undisputabley proven, applying bias correction to projections gives better projections
- Station scaling gives a consistent BC method at stations
- Spatial bias corrections are still in need of attention
- It is possible to 'verify' bias corrections, building confidence