On the need for assuming imperfect prior knowledge of emissions in regional CO2 inversions

Christoph Gerbig, Panagiotis Kountouris, Fabio Boschetti, Christian Rödenbeck
(MPI-BGC, Jena),
Thomas Koch (DWD),
Ute Karstens (ICOS-CP, Lund)

Max Planck Institute
for Biogeochemistry

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Motivation

- Current regional inverse modeling of CO_2:
  - inverse transport modeling targeted biosphere-atmosphere exchange only
  - fossil fuel emissions assumed much better known than biospheric fluxes
  - uncertainty in transport models more important (Peylin et al., 2011)
  - ICOS atmospheric network not targeted at emissions

Motivation

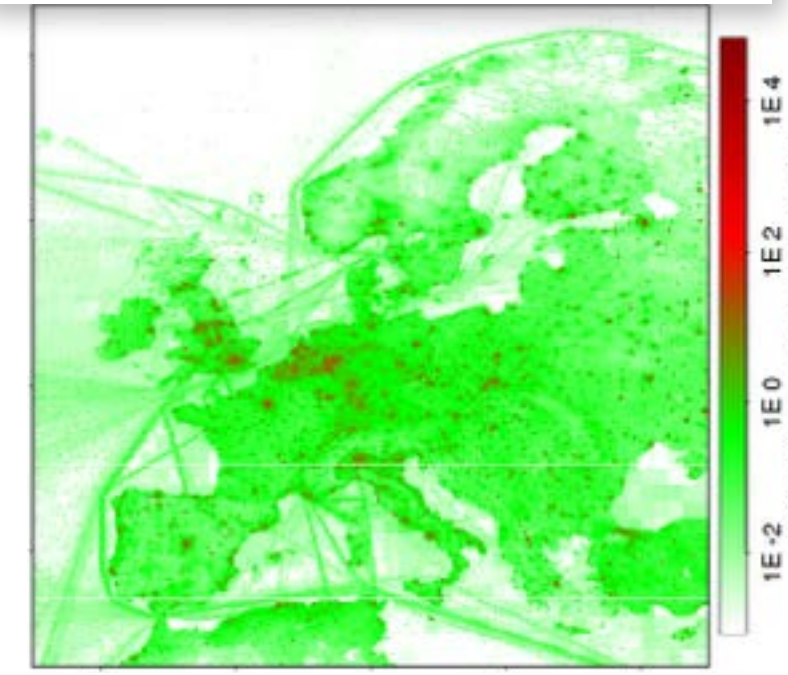
- Future regional inverse modeling of CO_2:
  - political pressure from stakeholders to assess emissions
  - INDCs (Intended Nationally Determined Contributions) need regular verification
  - more ICOS stations with emission influence
  - spatial resolution of inversion transport models increases
  - uncertainty in increases with decreasing scales for spatiotemporal disaggregation
  - observations „see“ these uncertain fluxes

Approach

- Assessment of differences in various emission datasets
- Analysis of resulting emission signals at atmospheric stations
- Inverse transport modeling of biosphere-atmosphere exchange using different emission datasets

Spatial distribution of CO_2 emissions

EDGAR v4.1 + BP2012



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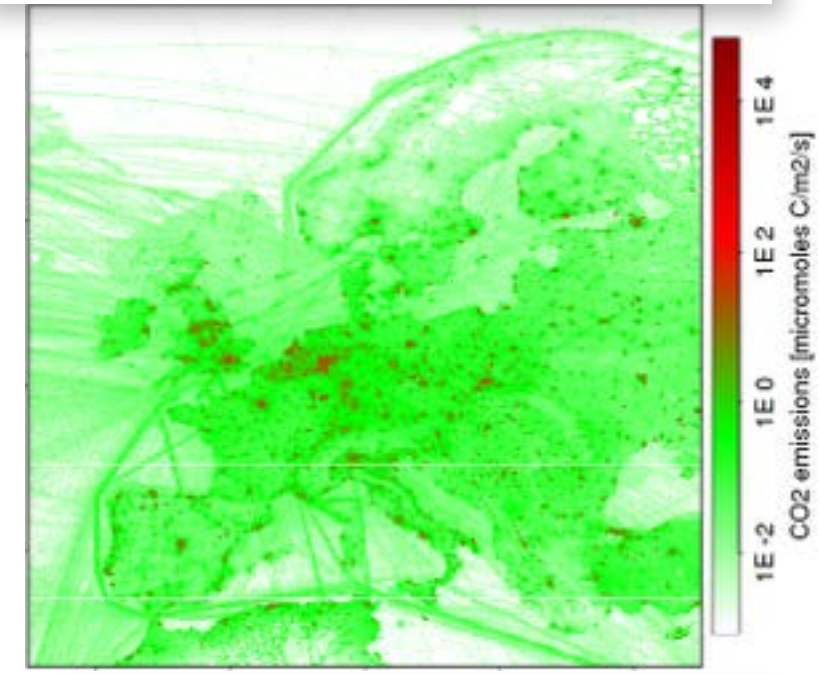
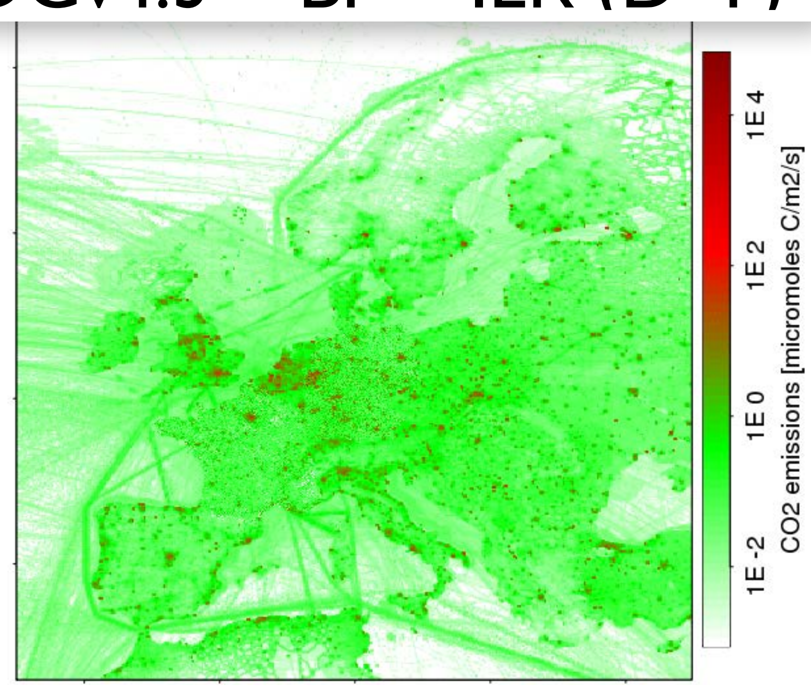
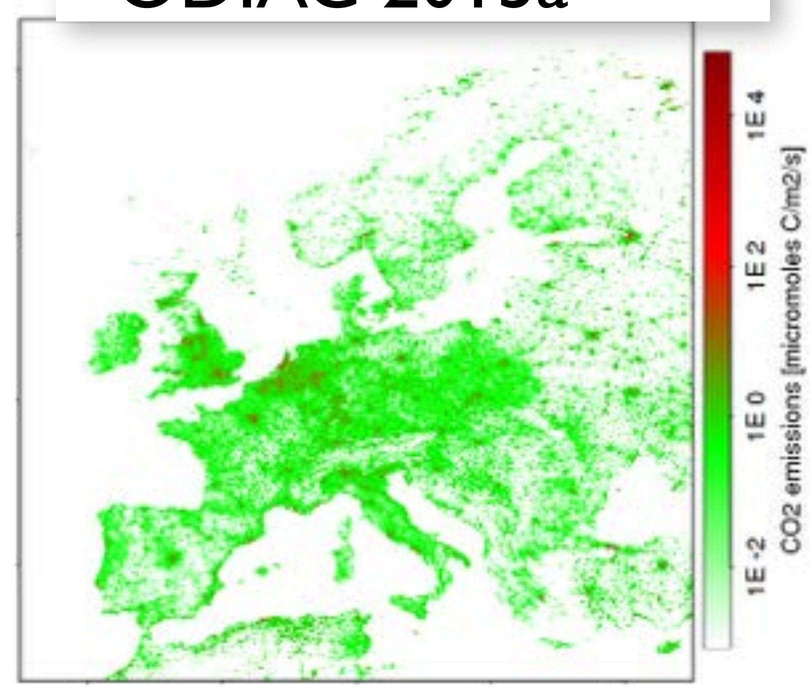


EDGv4.3 + BP + IER (D+F)



ODIAC 2015a



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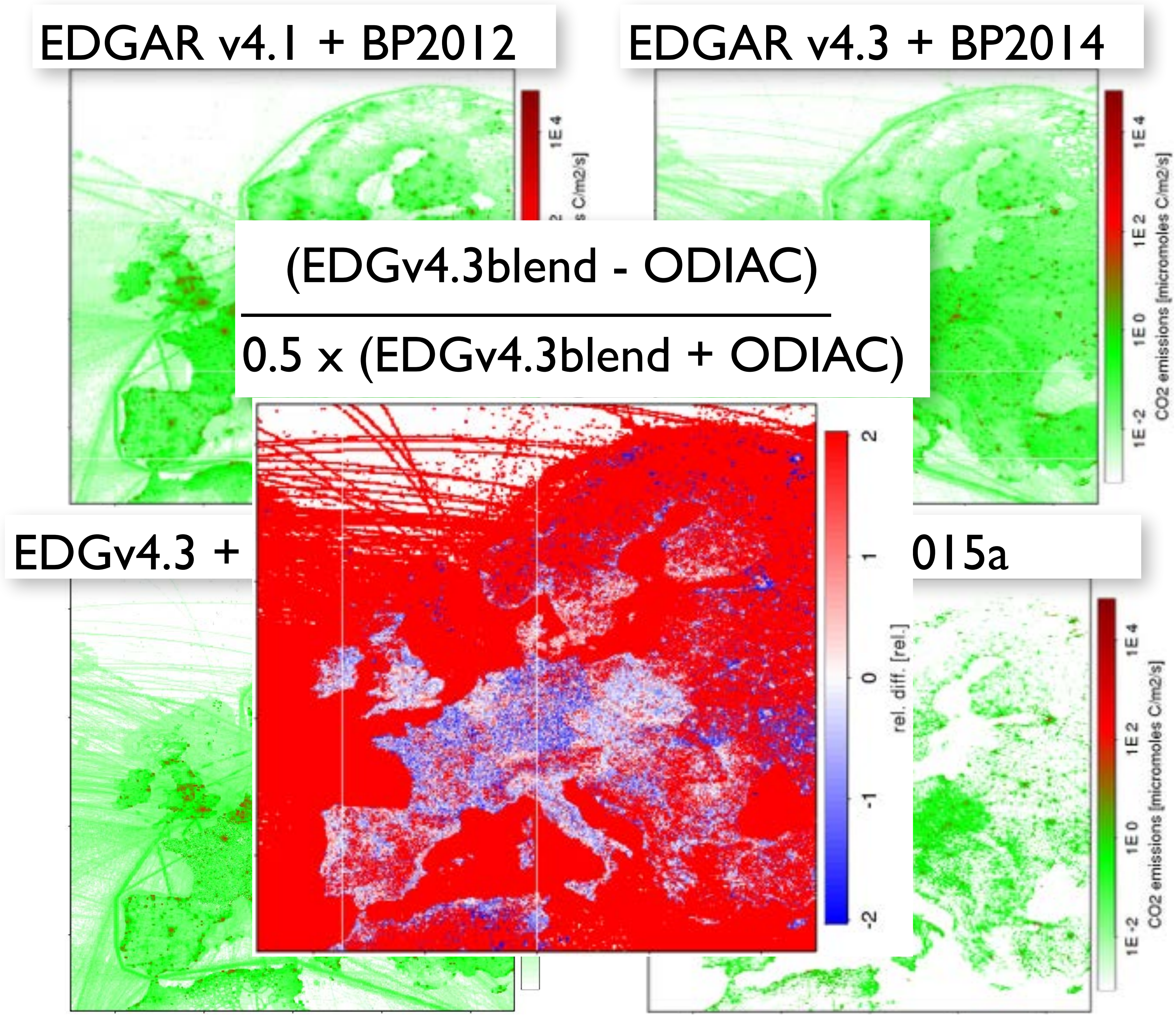

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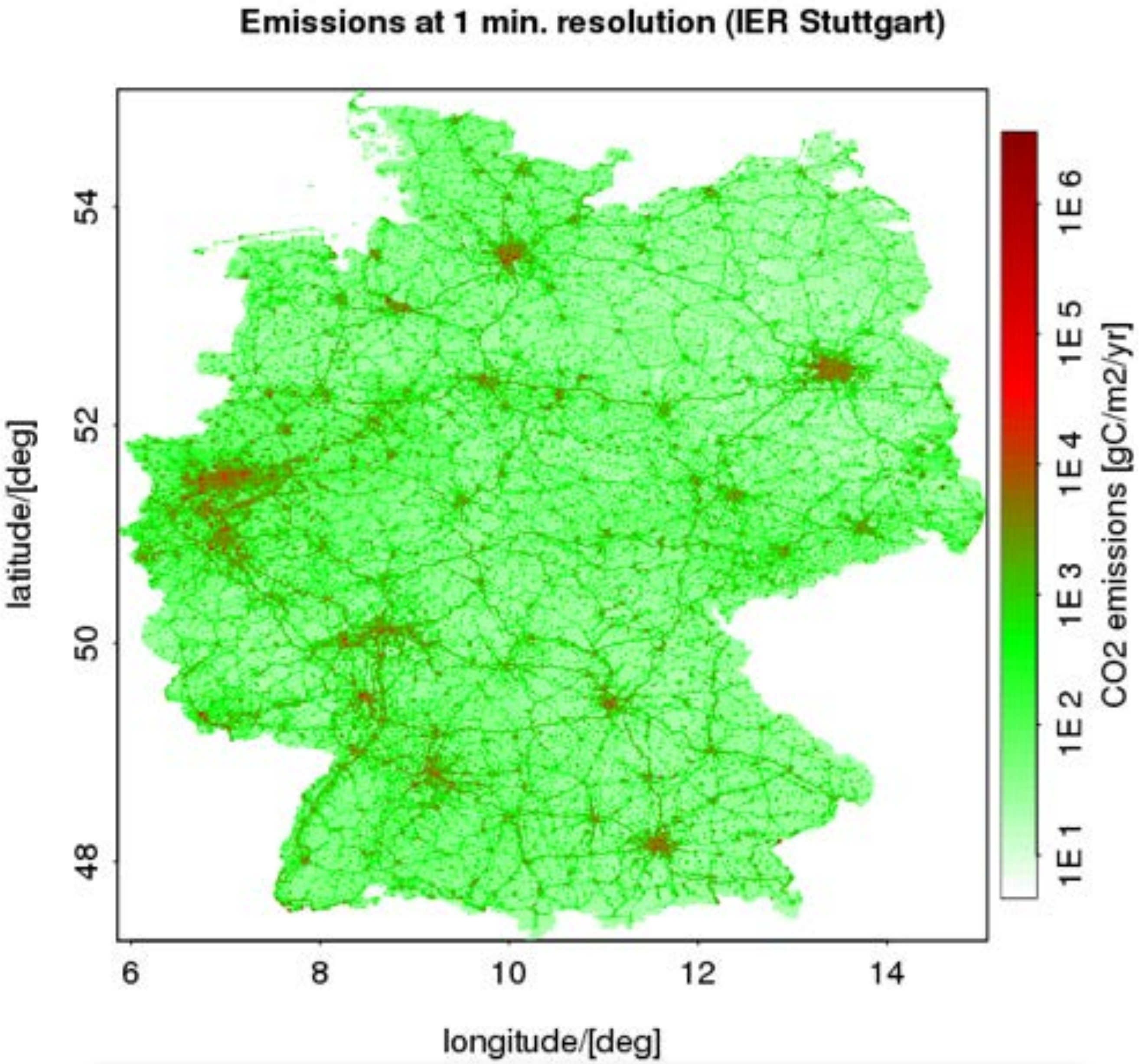
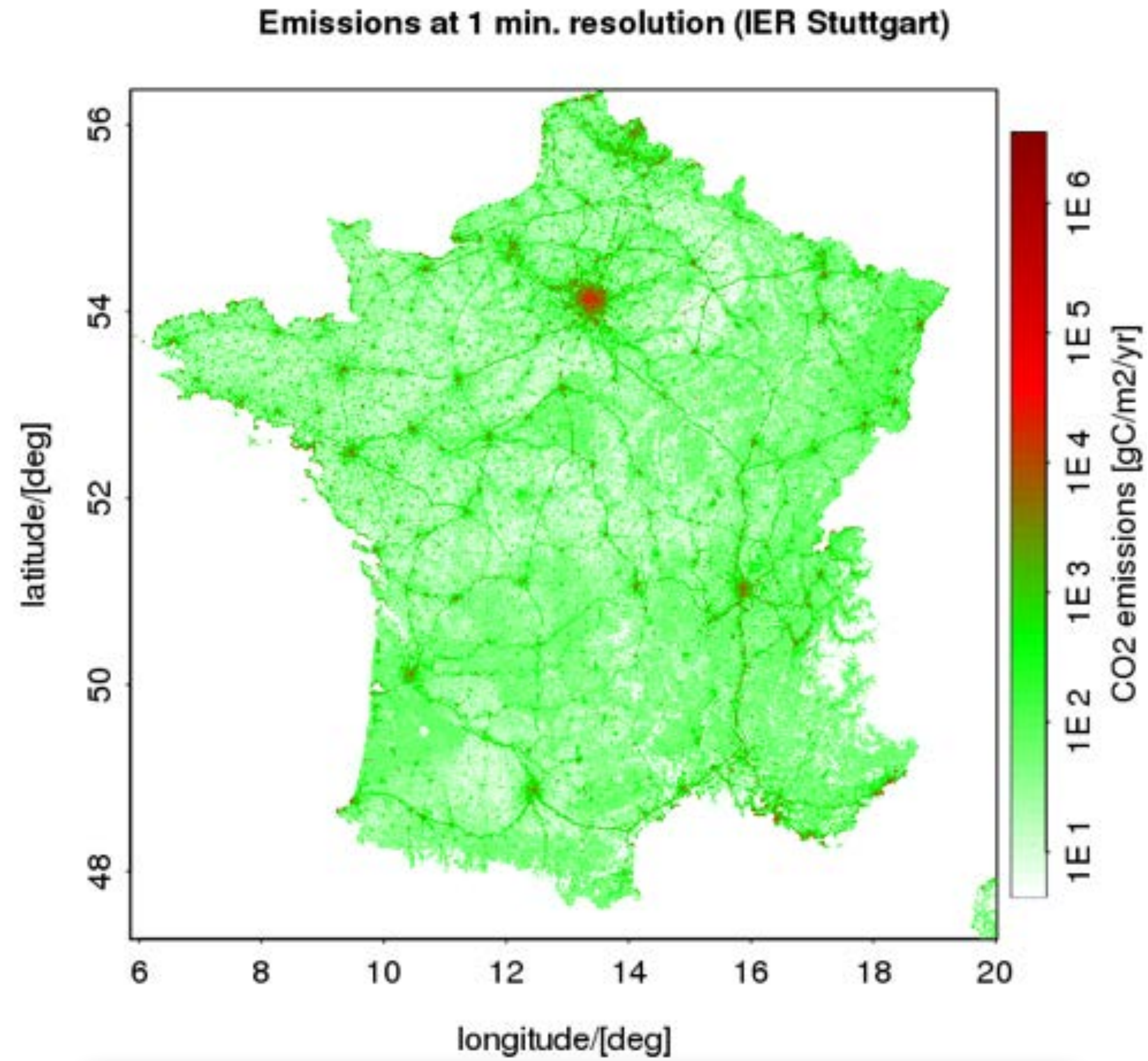


IER Stuttgart Germany



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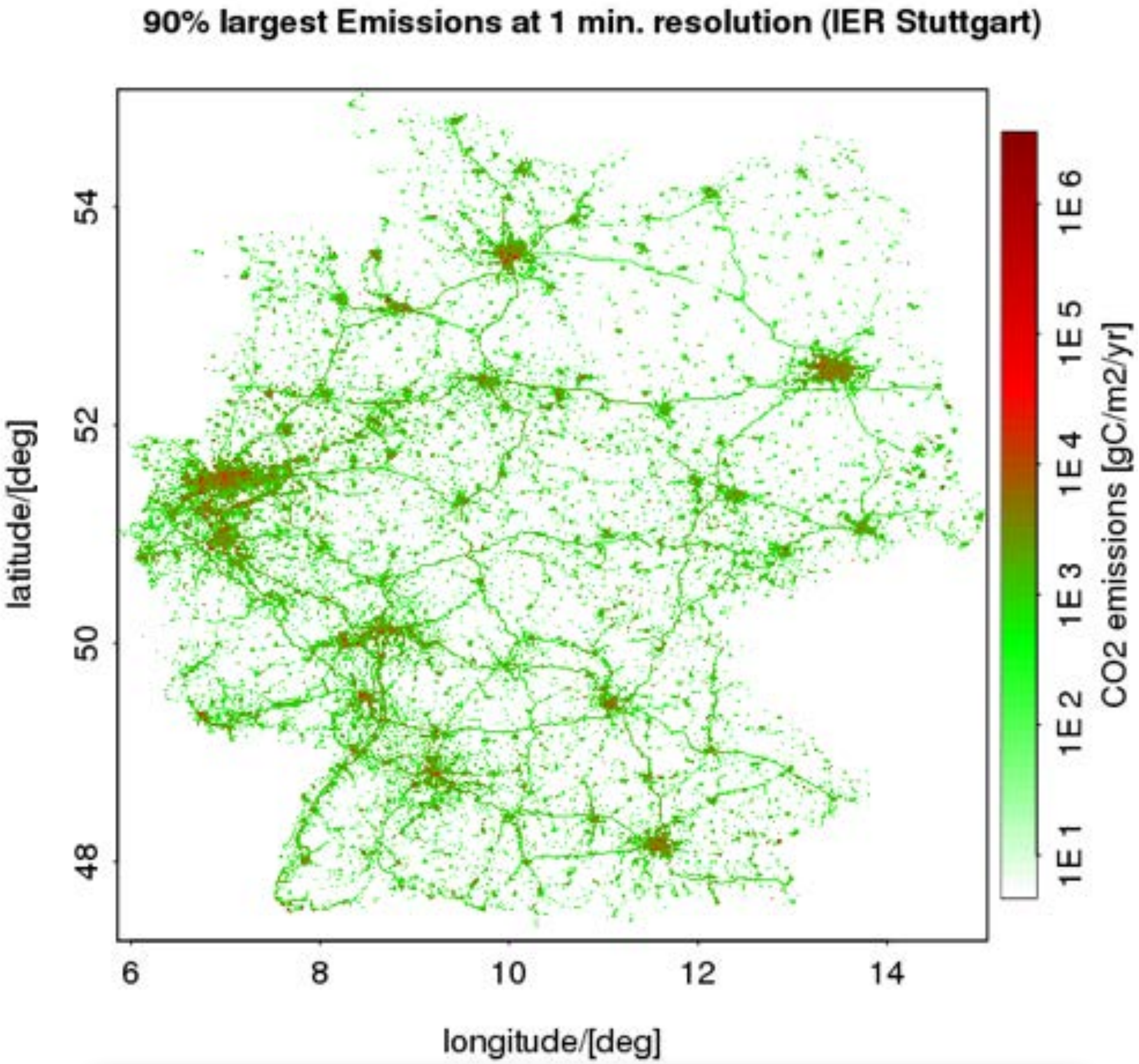

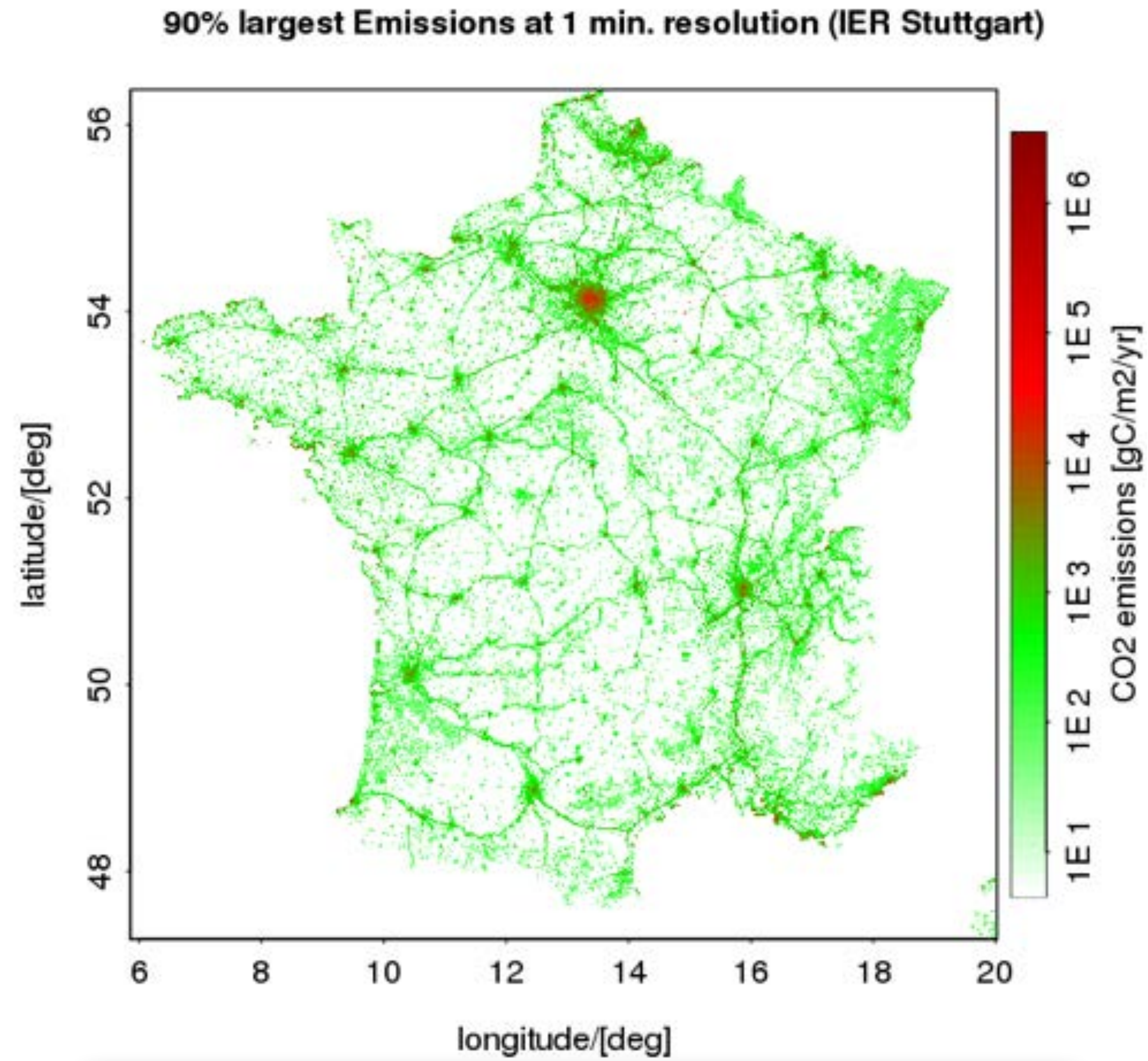

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90% largest emissions

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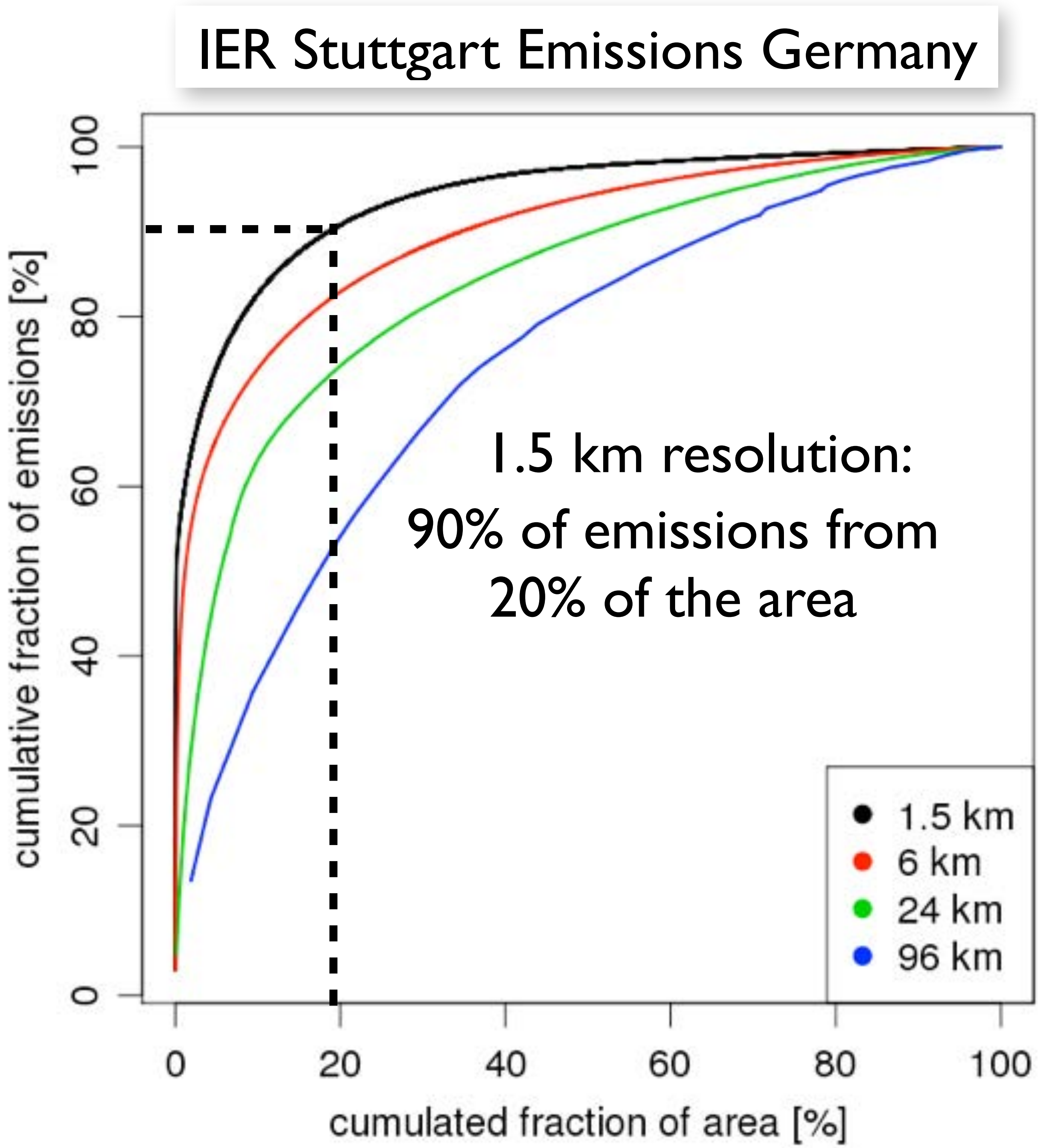

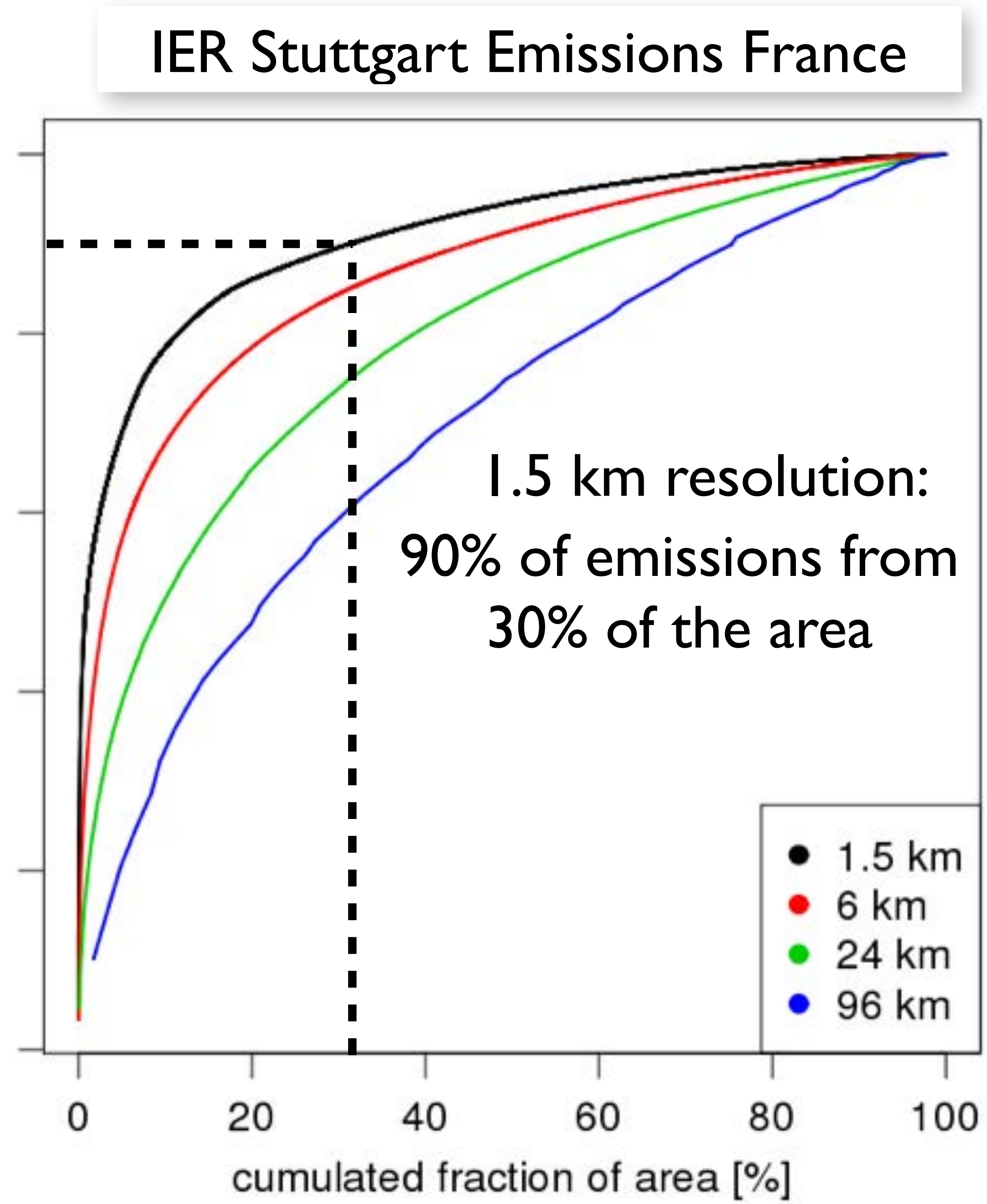

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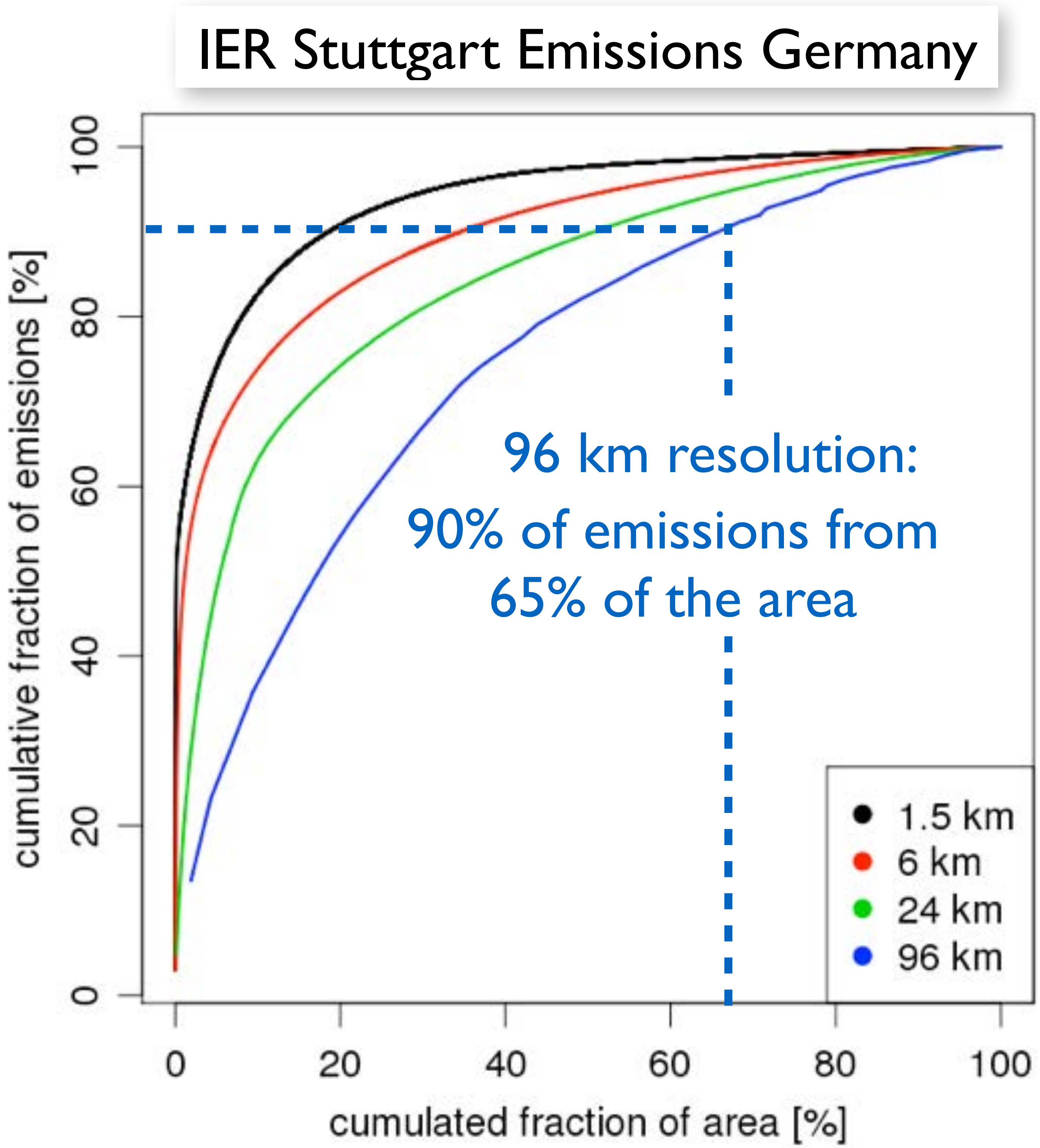
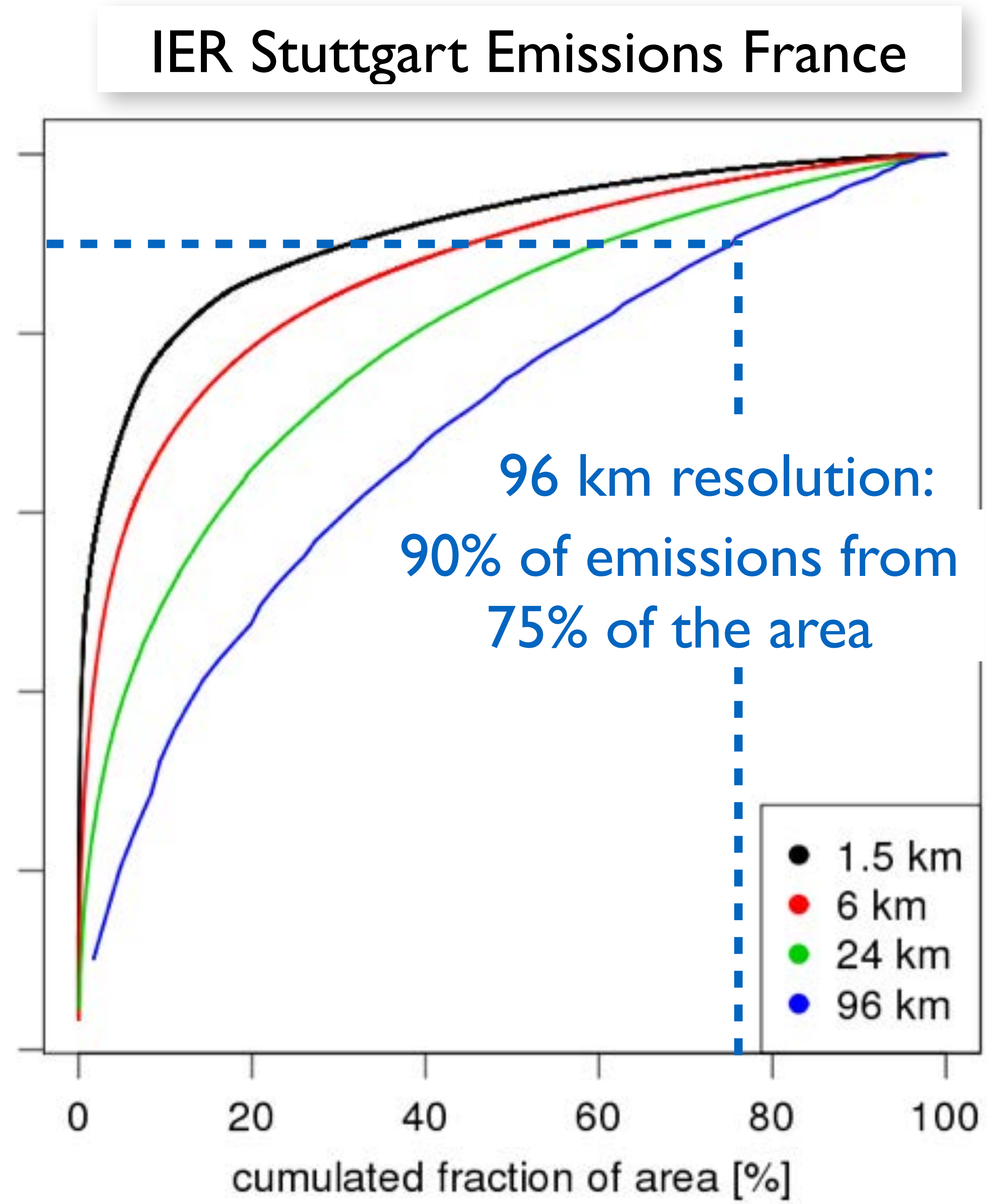
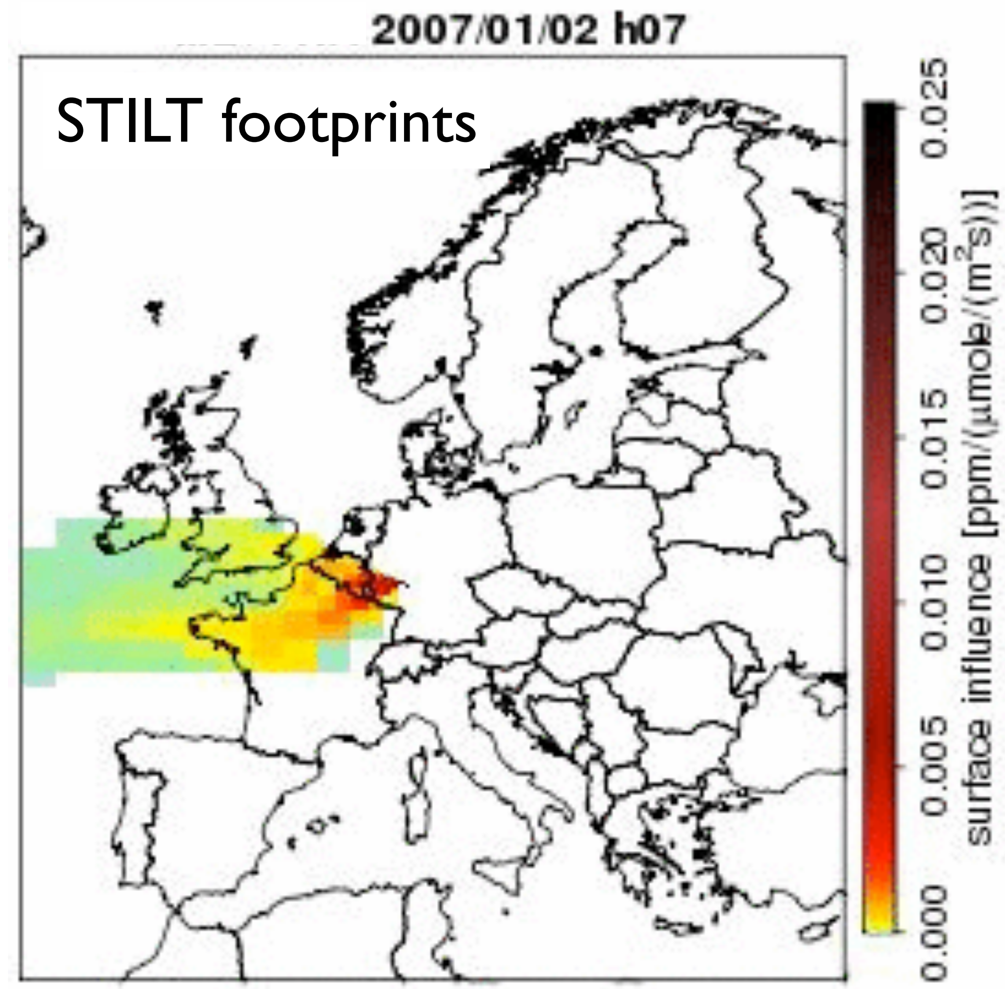
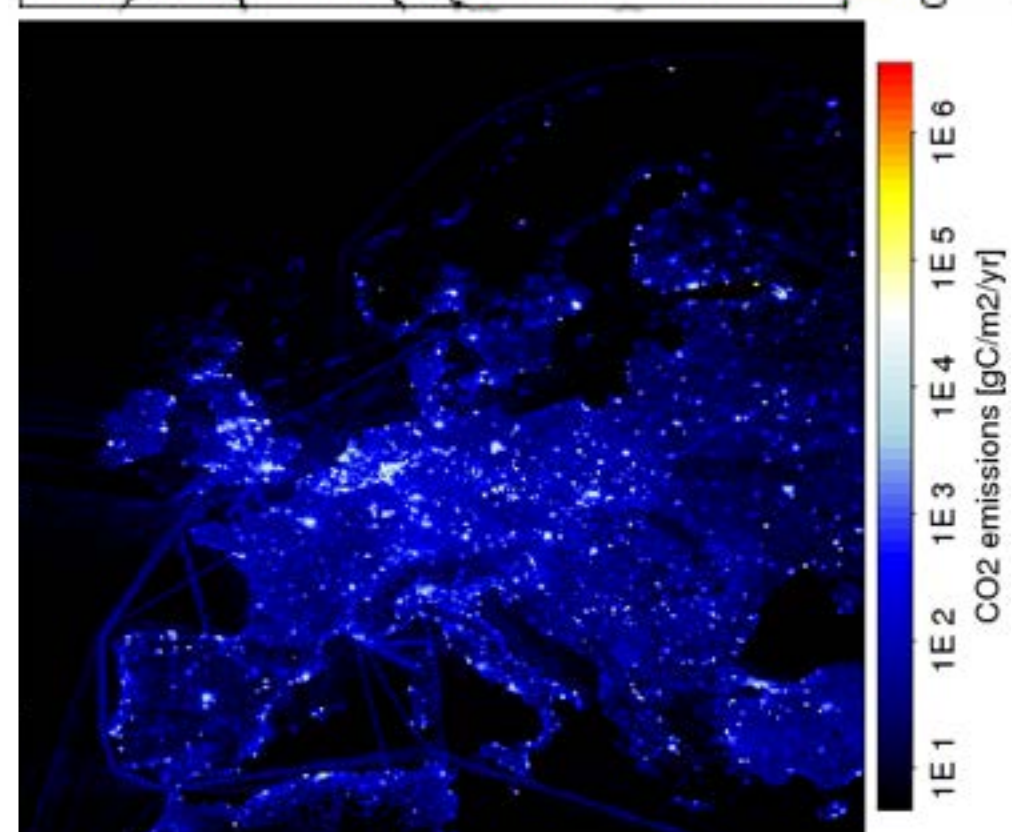




STILT simulations of CO_2 fossil fuel signals

- STILT-ECMWF using 0.25 deg. resolution met fields
- STILT Footprints to provide sensitivity of observations to upstream emissions
- Linking footprints to different emission inventories at different spatial resolution
  - EDGAR v4.3 + IER (D + F) blend @ 80, 10, 6, and 1.5 km
  - ODIAC 2015a @ 0.75 km





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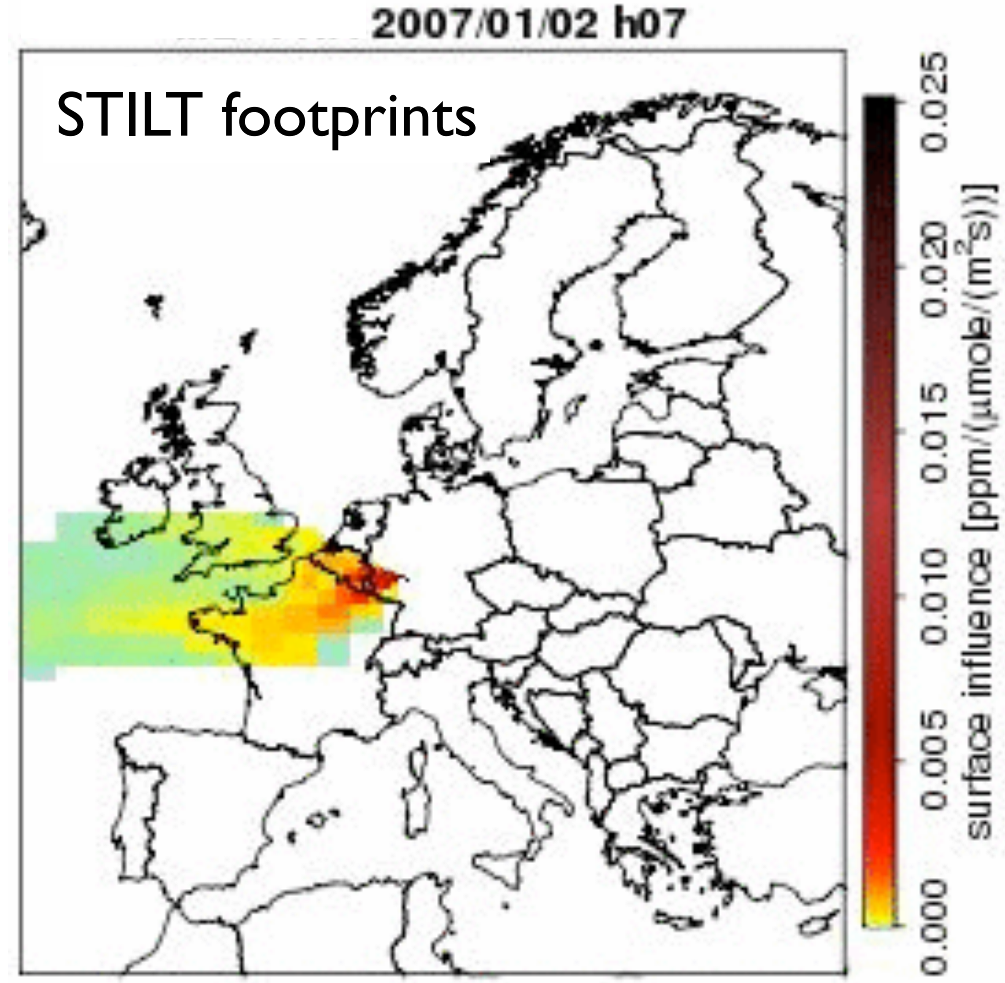
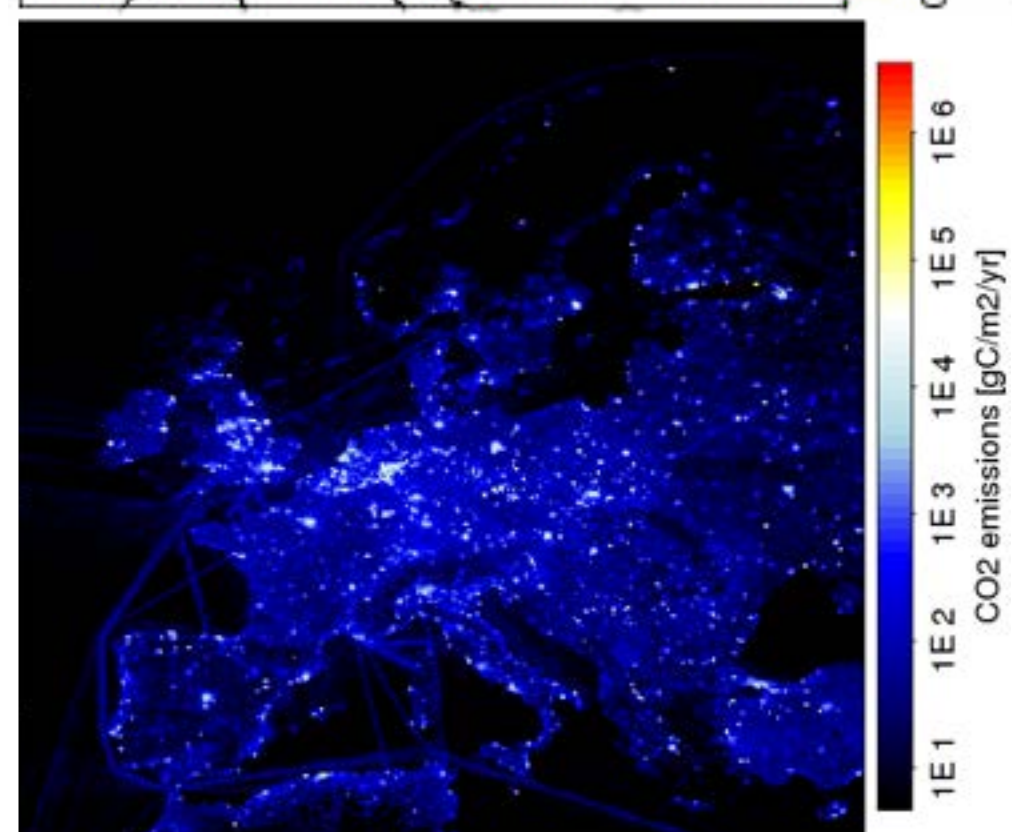
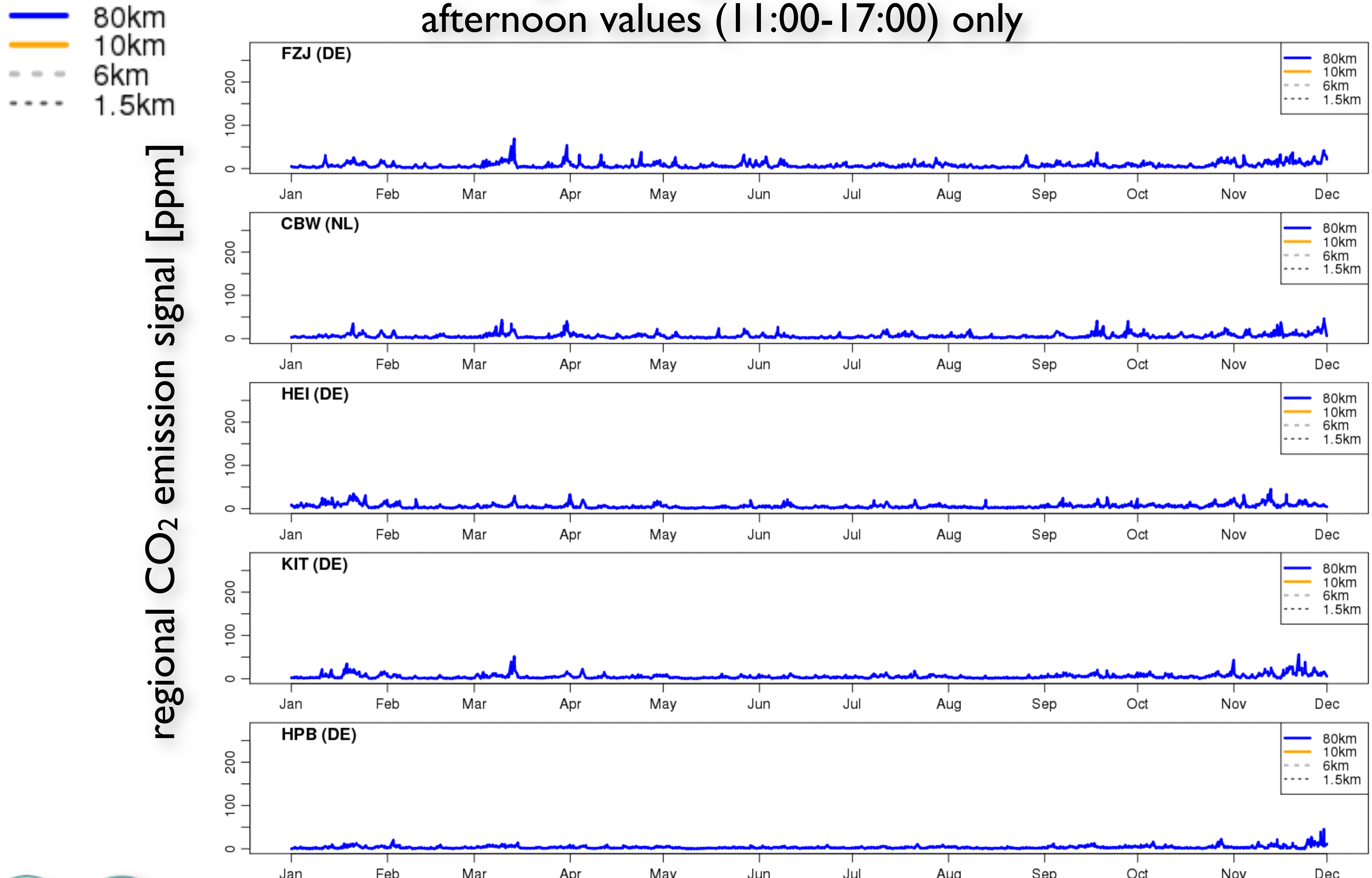




CO_2 fossil fuel signals @ different resolutions

afternoon values (11:00-17:00) only



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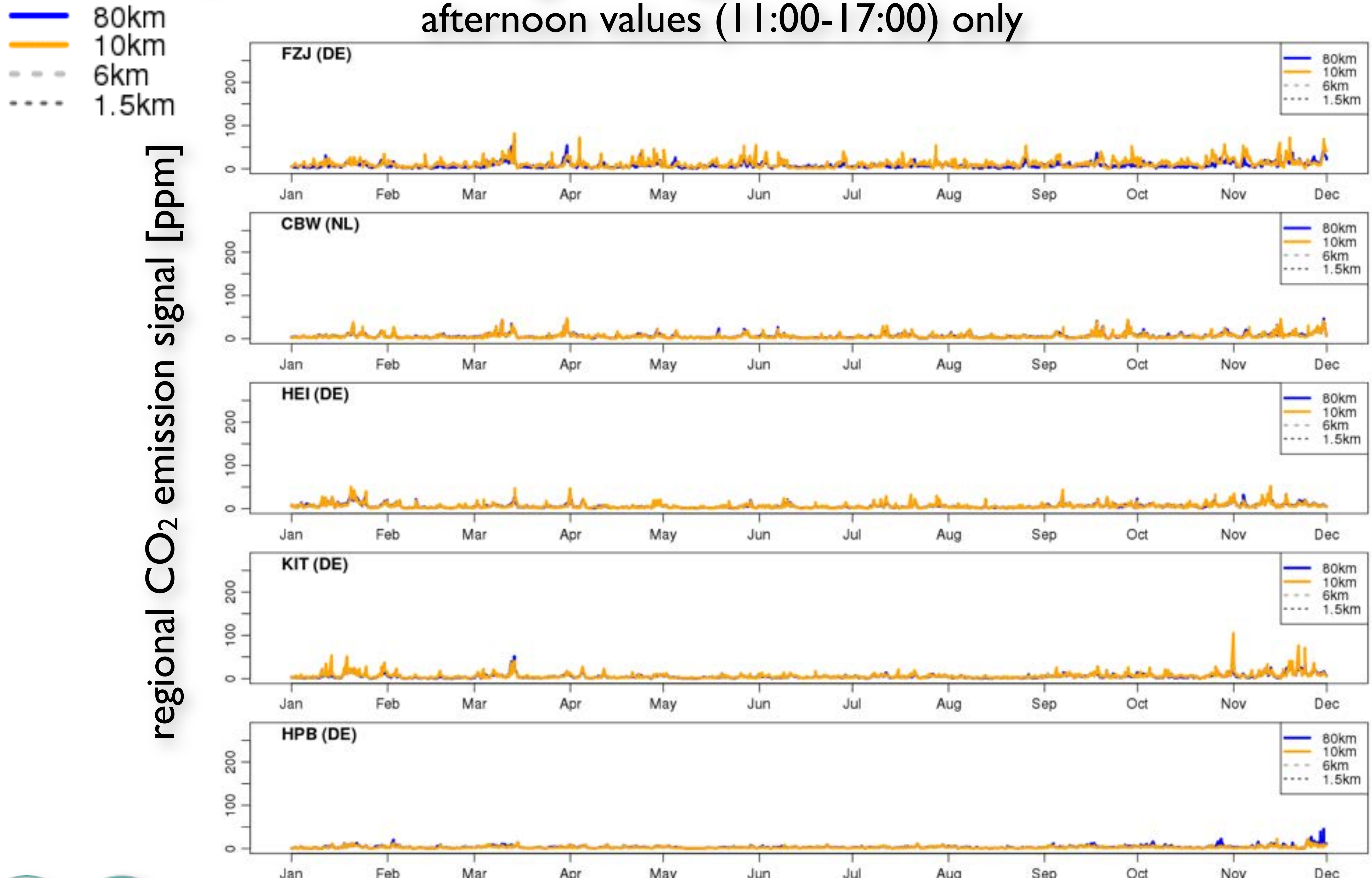

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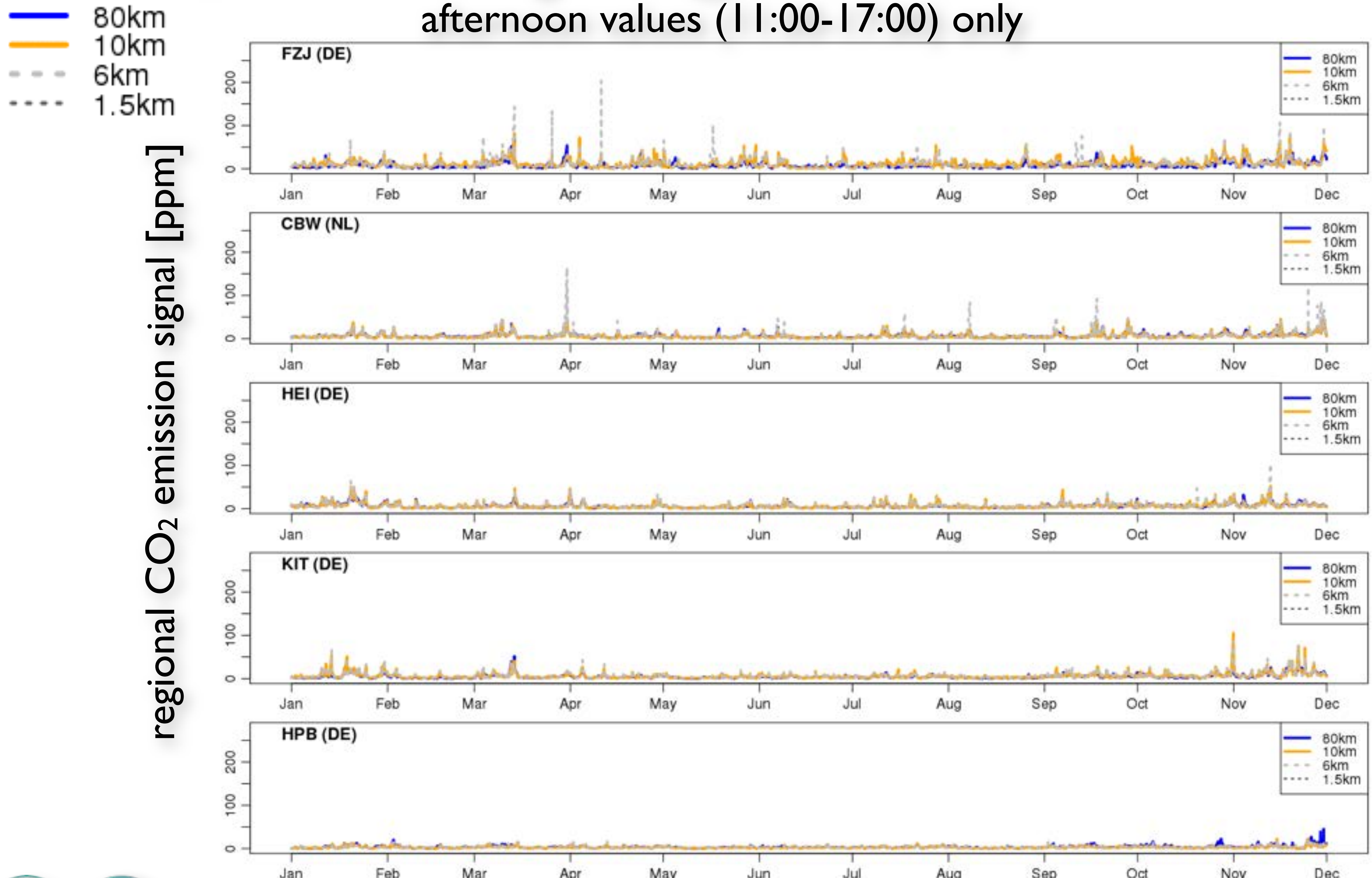

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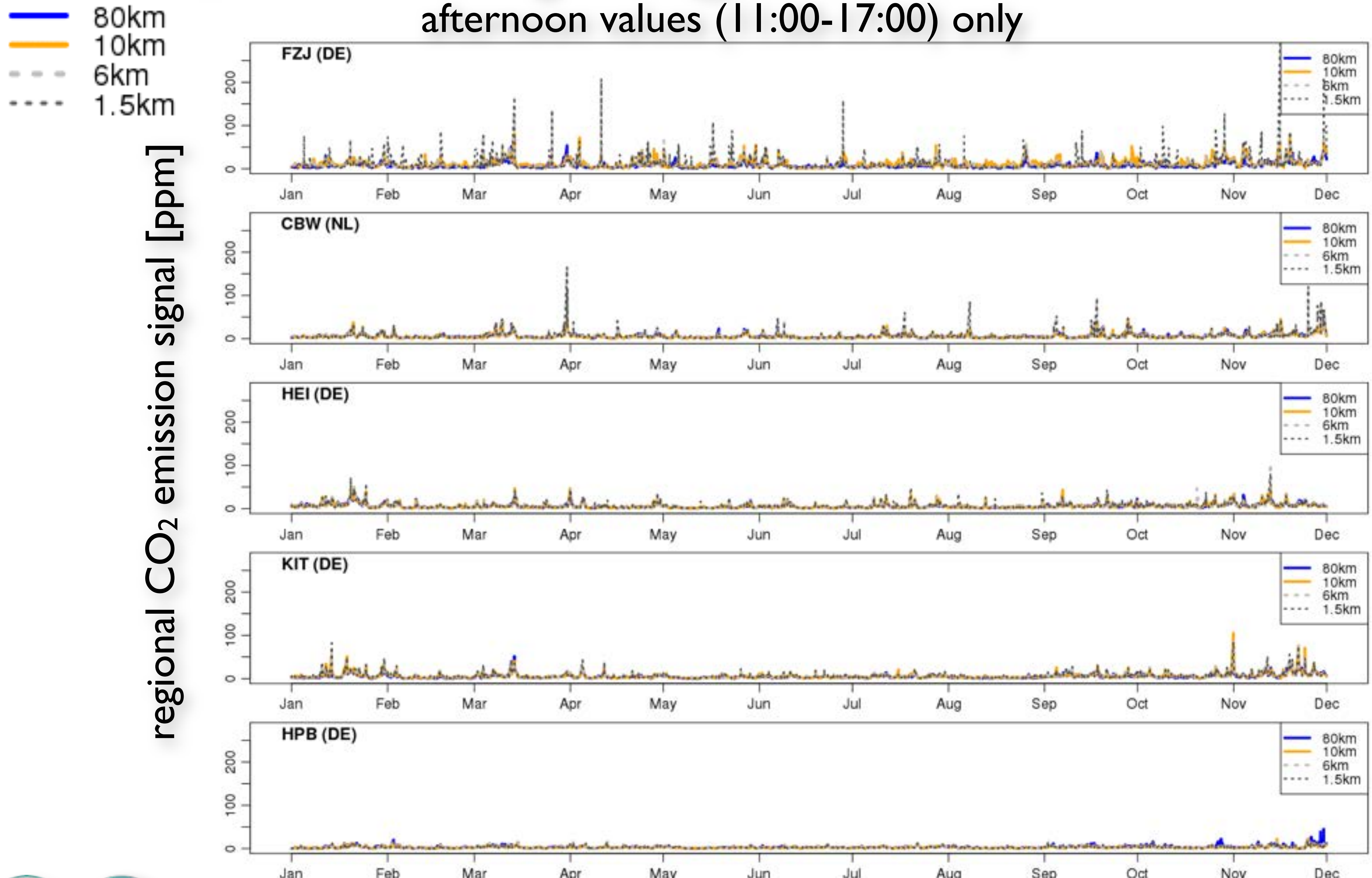

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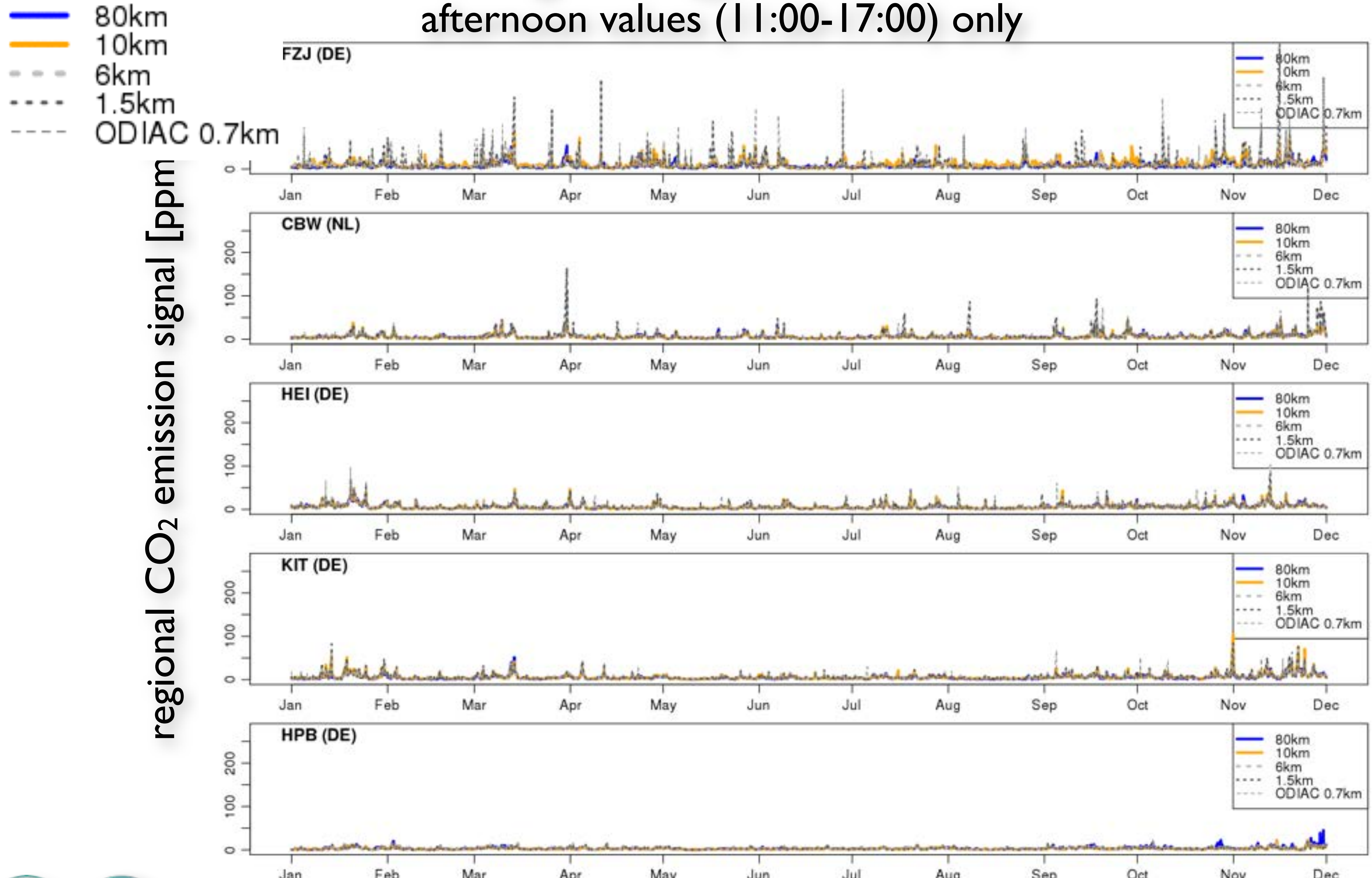

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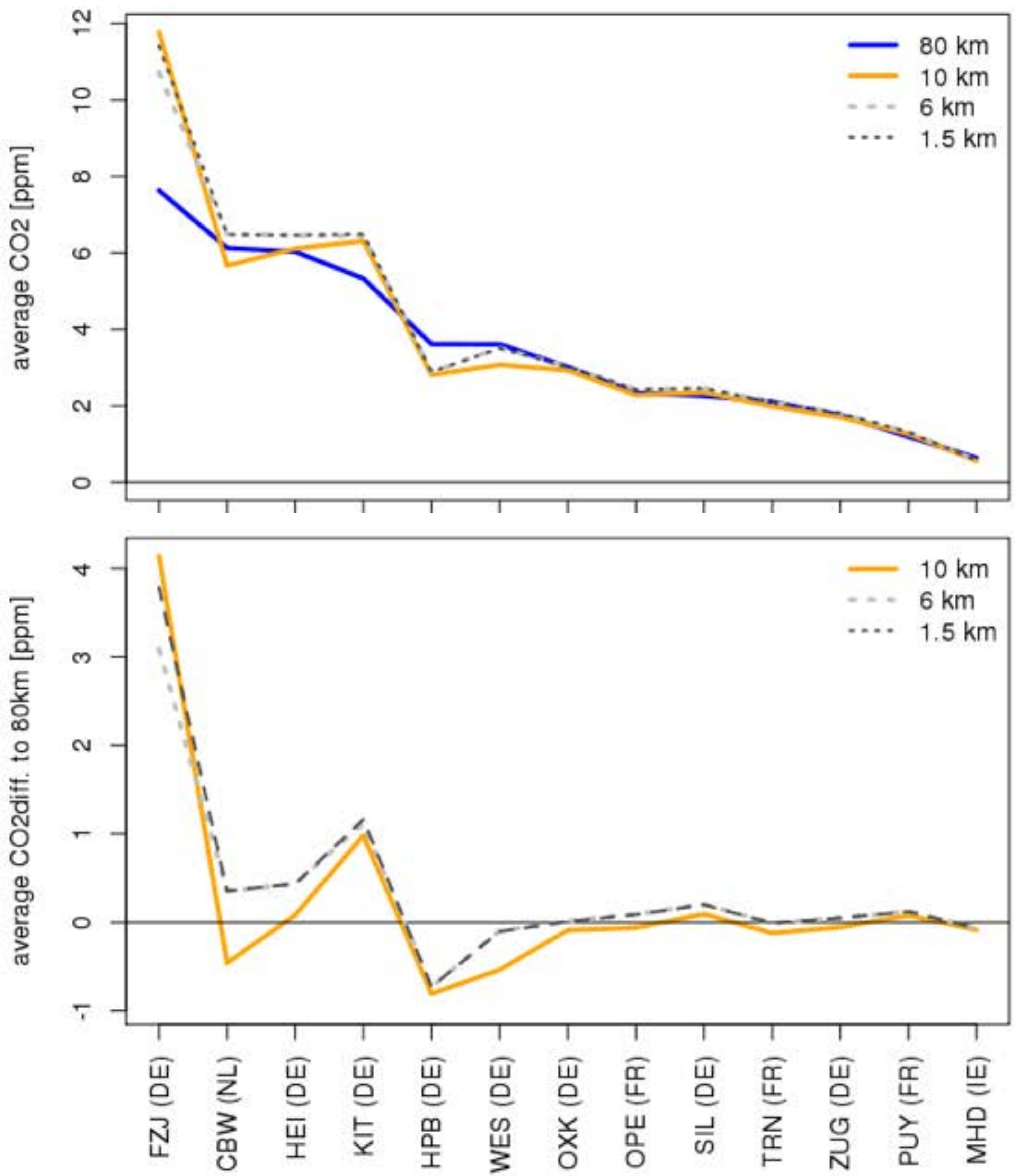

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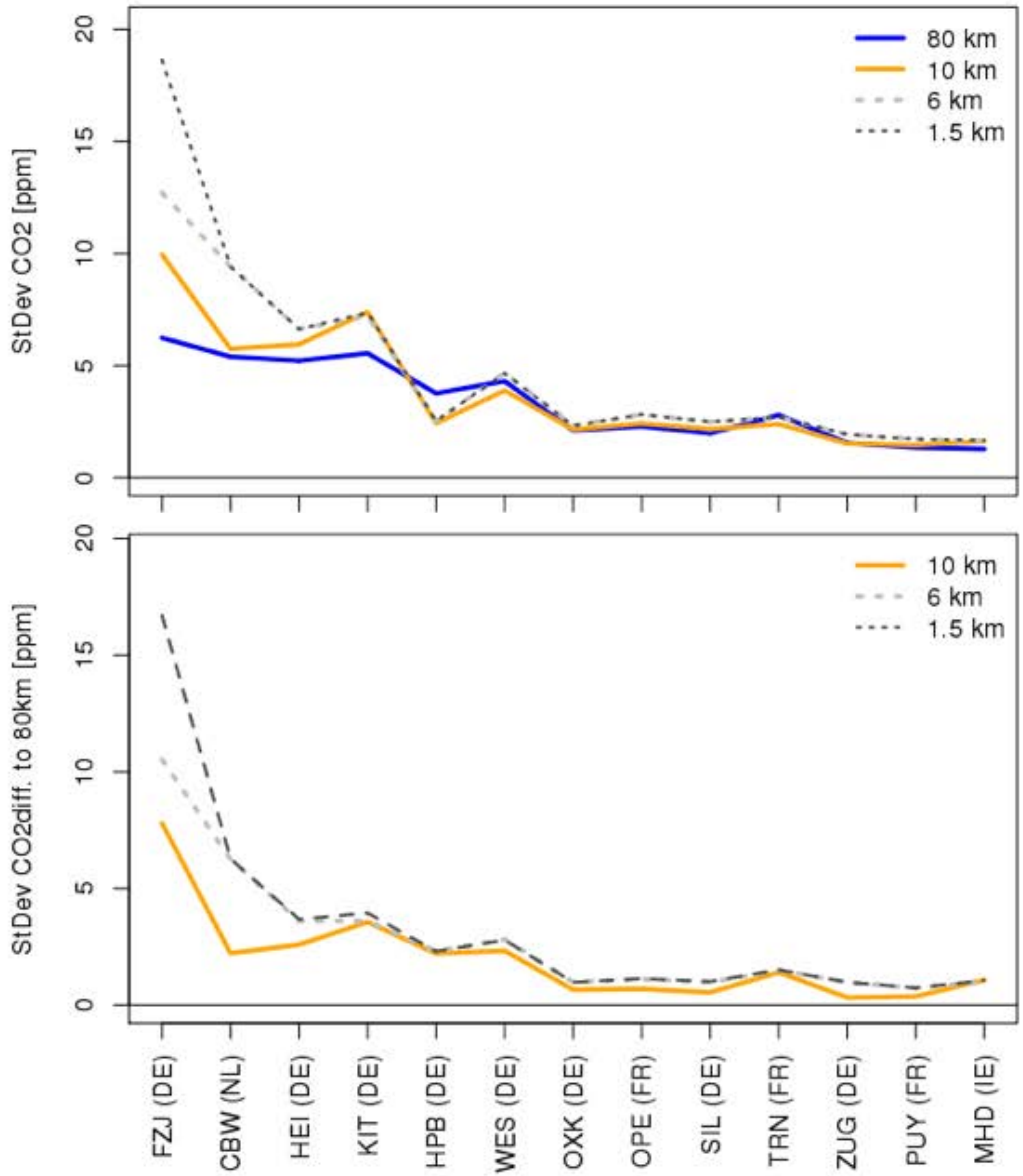

CO_2 fossil fuel signals @ different resolutions

Future ICOS station Juelich

CO_2 emissions in 2009 : (www.carma.org)
Weissweiler 19.200.000 Tons CO2/yr
Niederaussem 26.300.000 Tons CO2/yr
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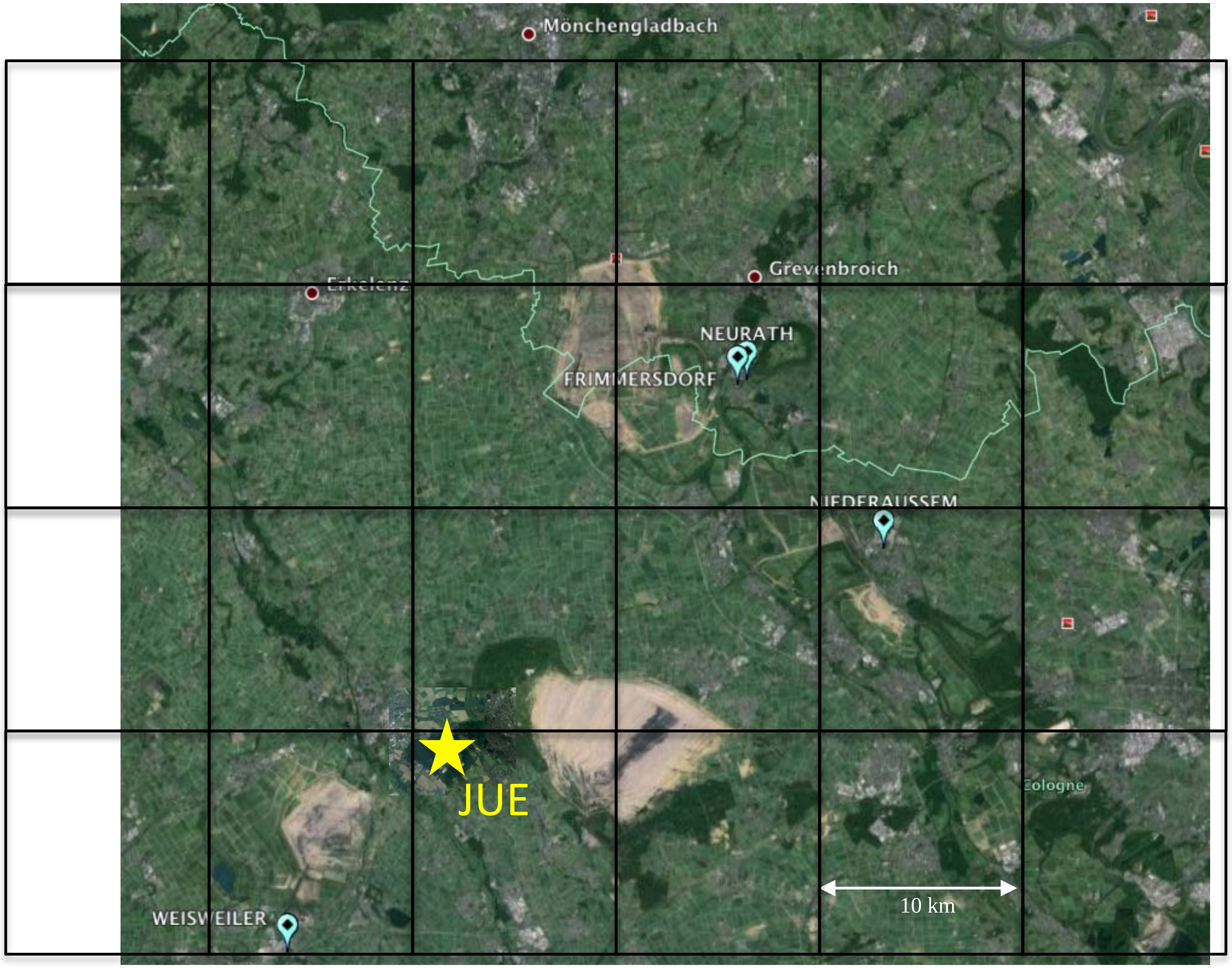

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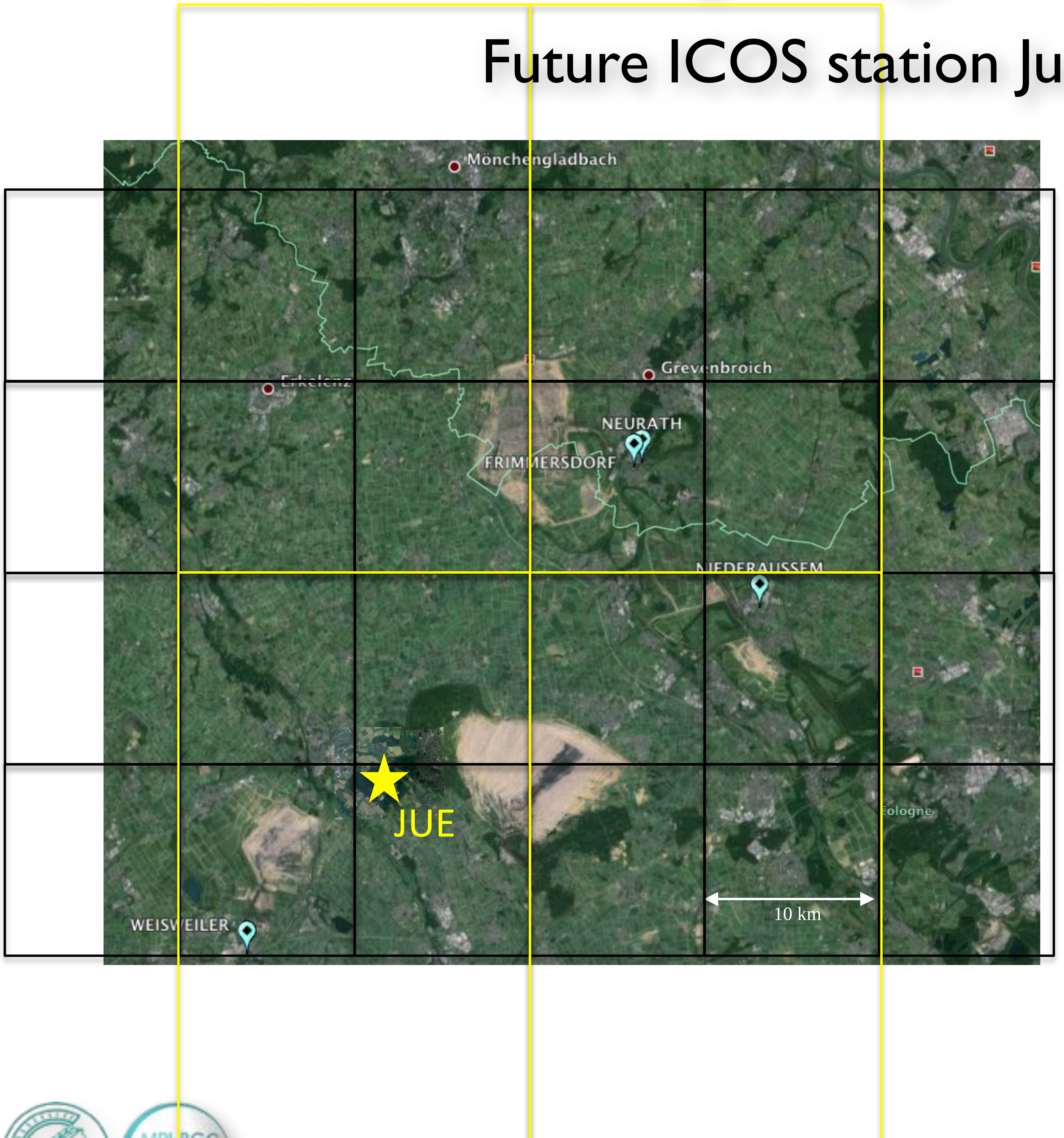

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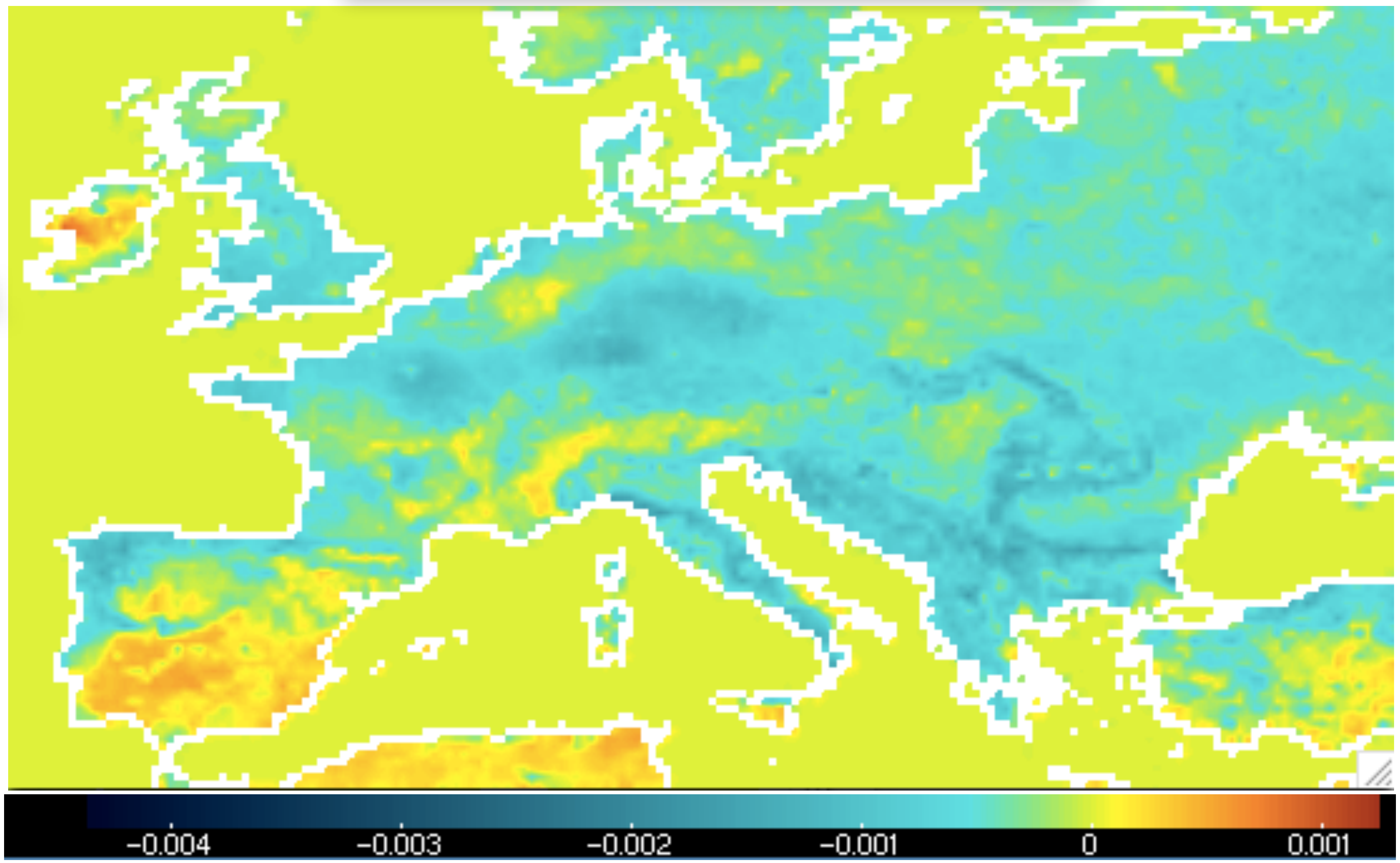
STILT-TM3 inversions using different emission inventories

Posterior fluxes June 2014

using EDGAR v4.1 + BP2012



biosphere-atmosphere flux [PgC/a]

Inversion system:

P. Kountouris et al. 2016a and 2016b (ACPD)

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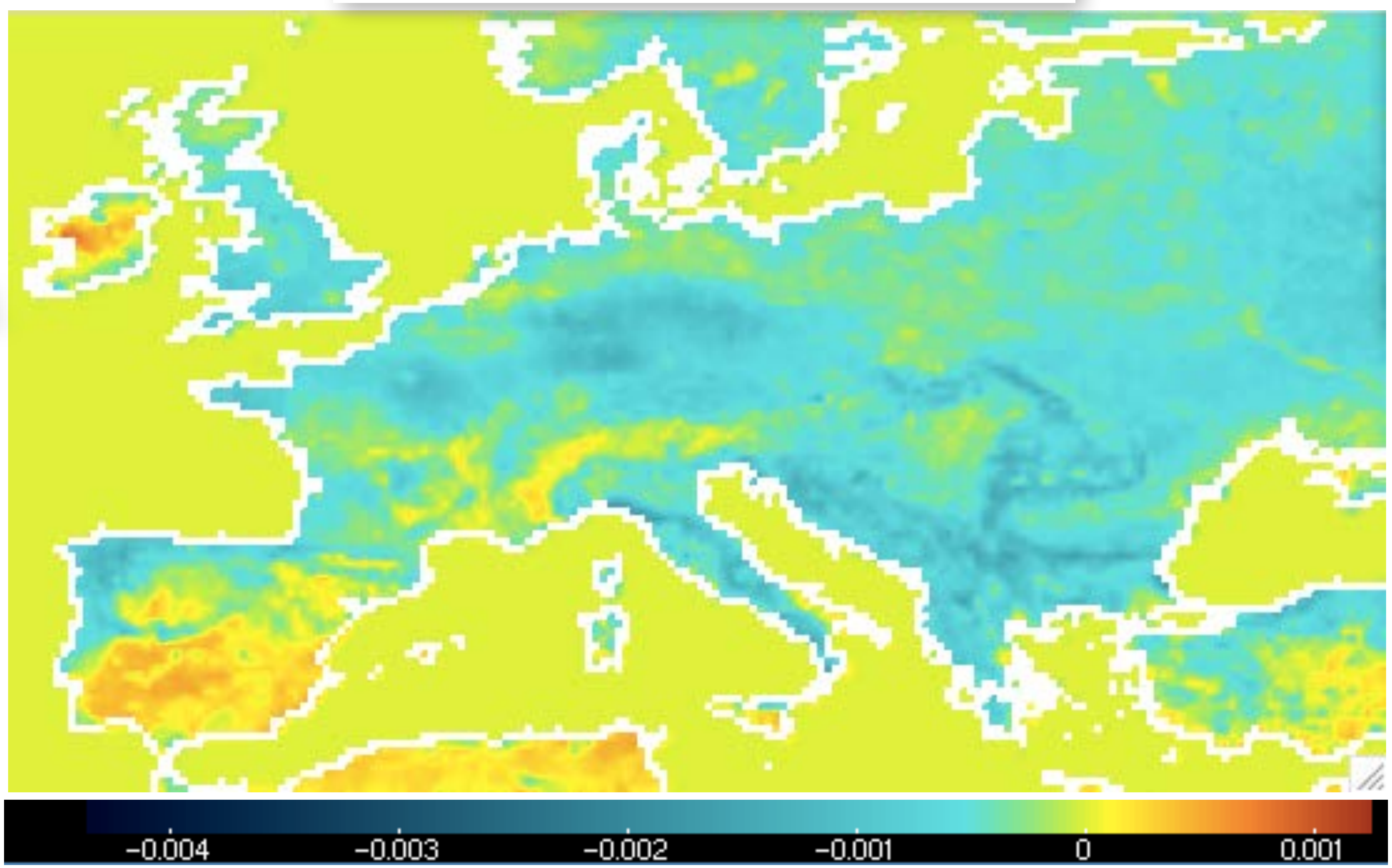

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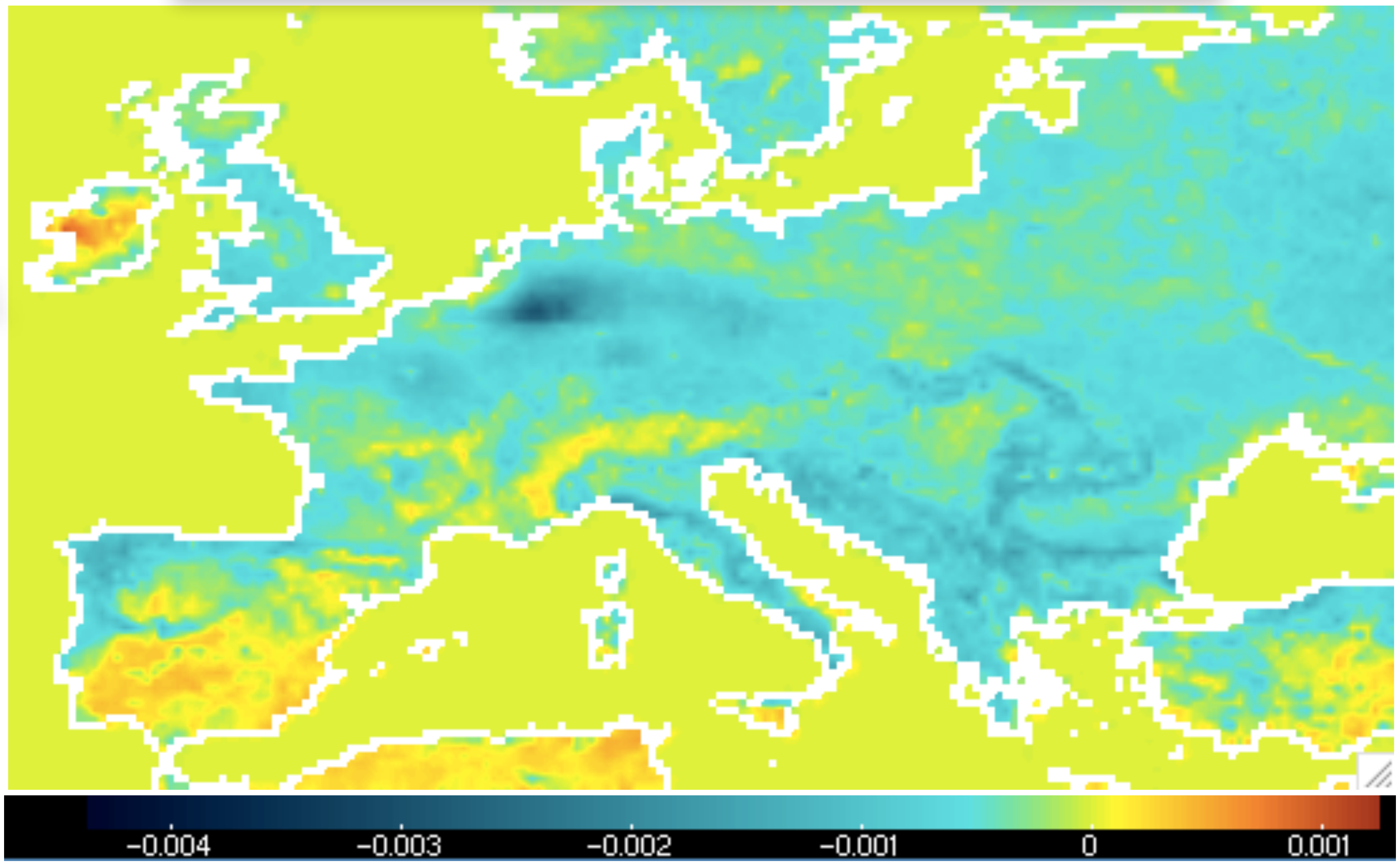

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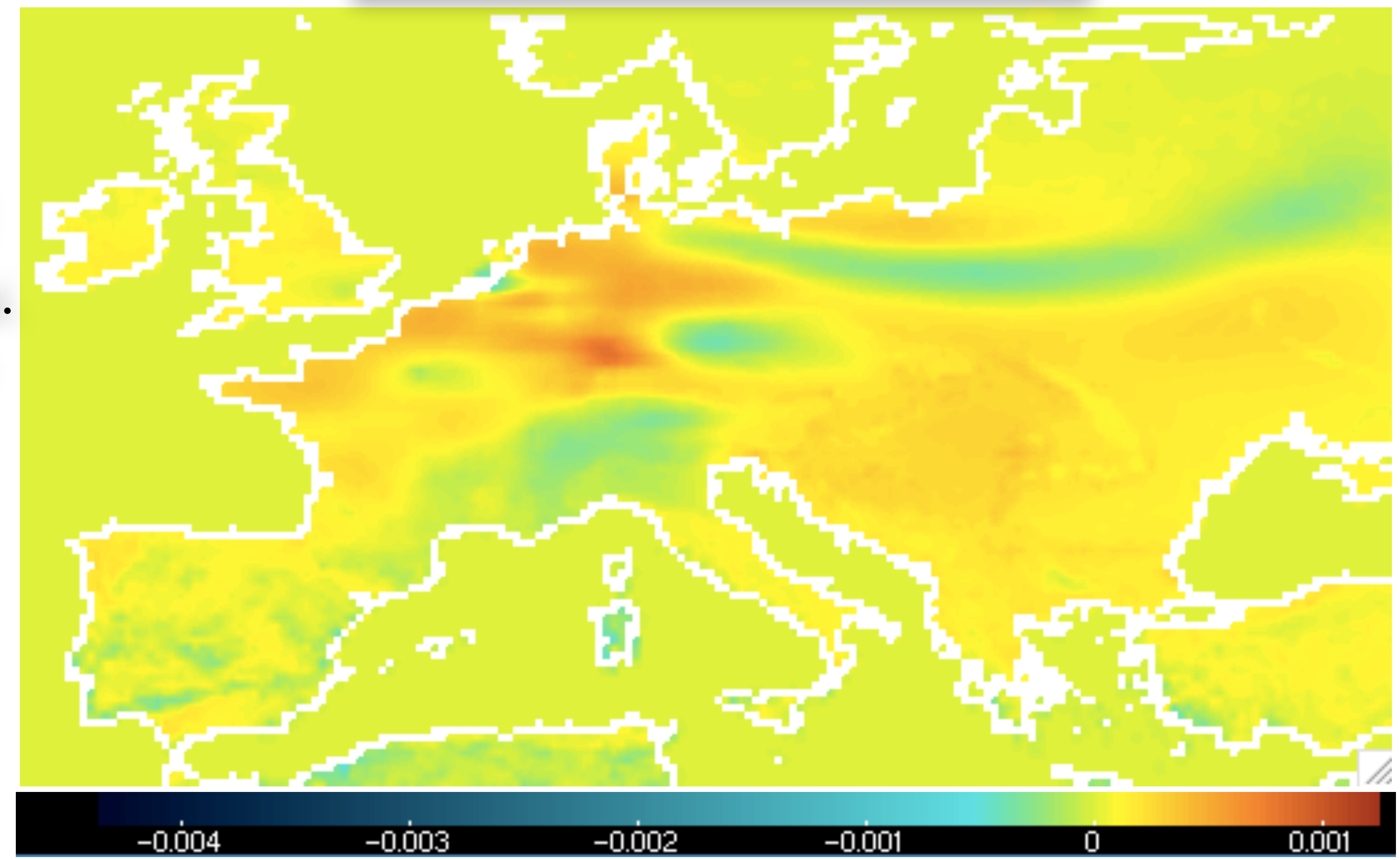

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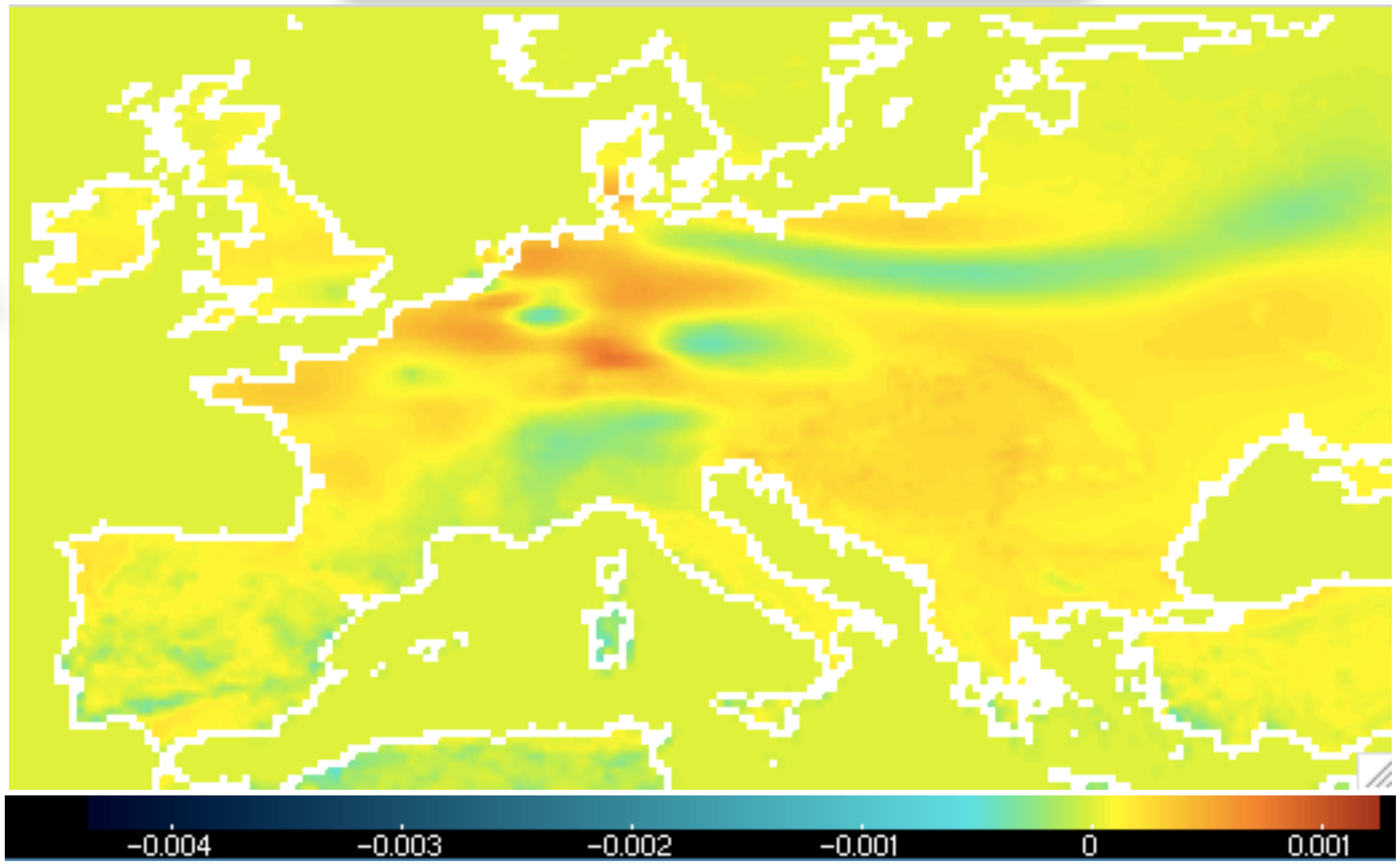

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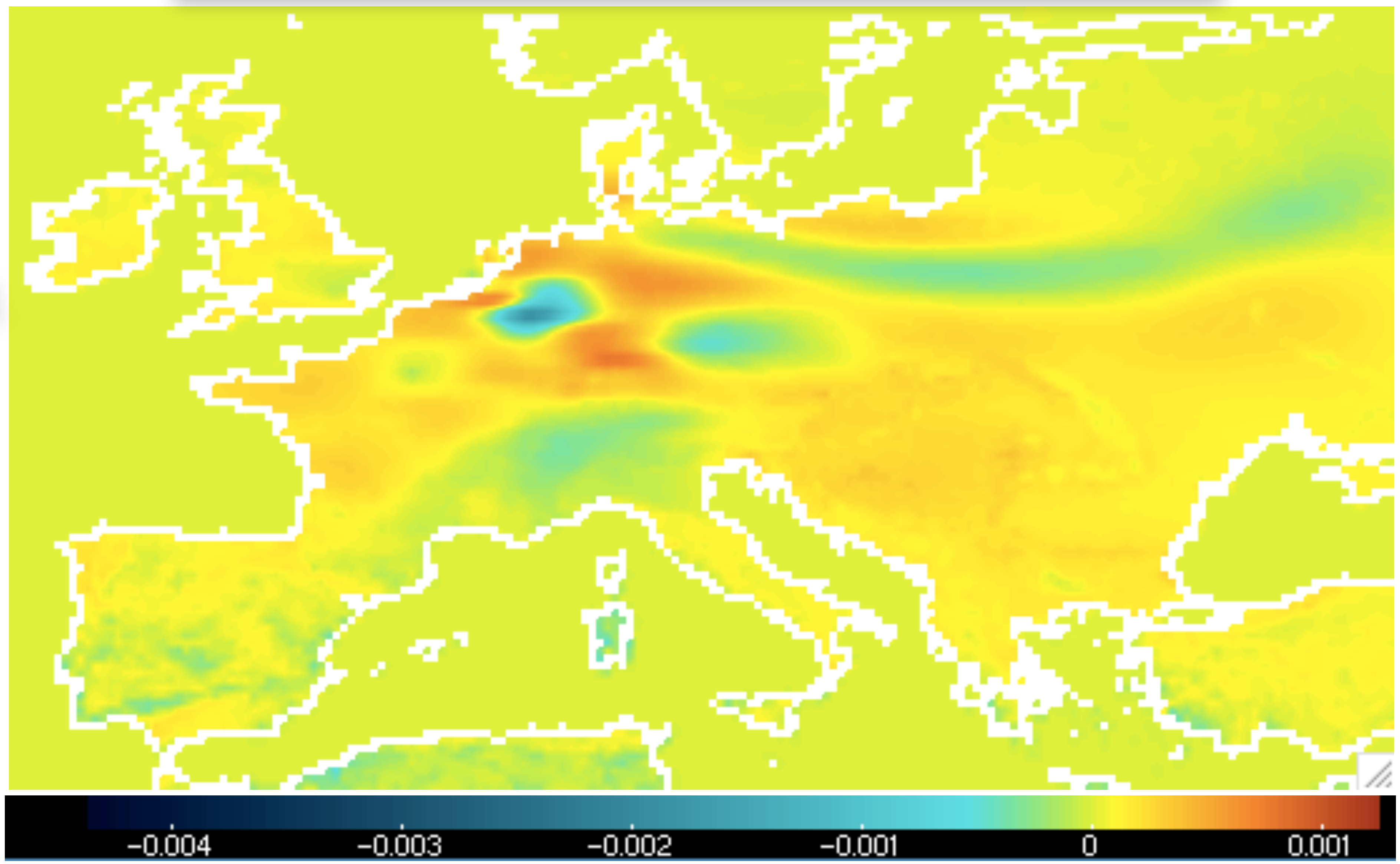

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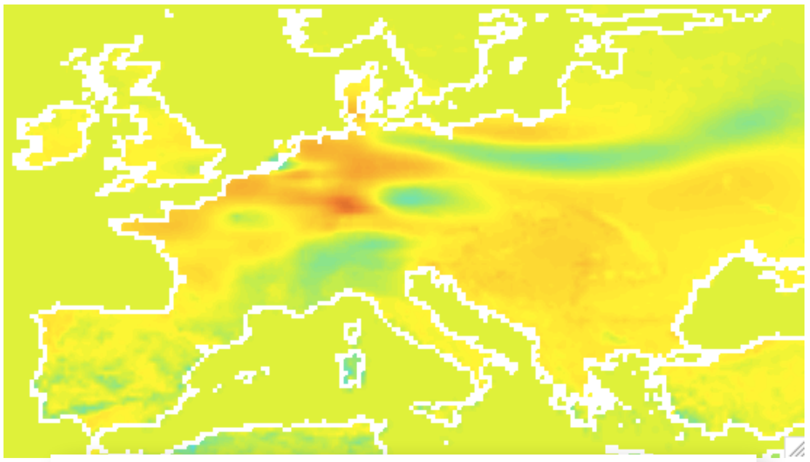

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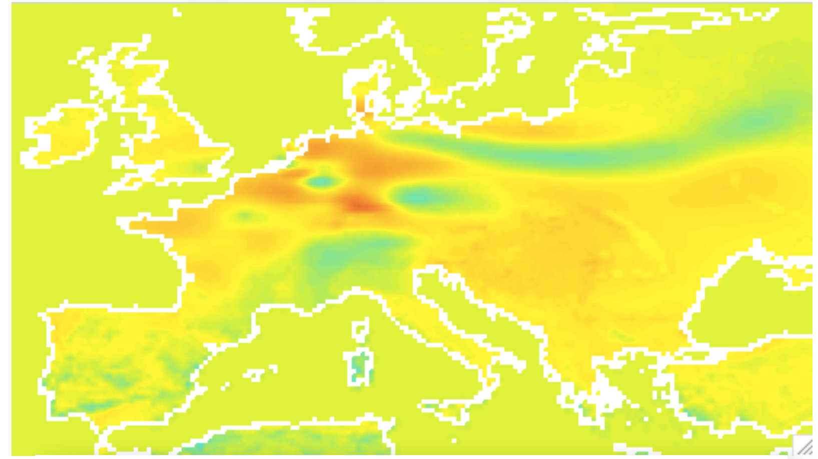

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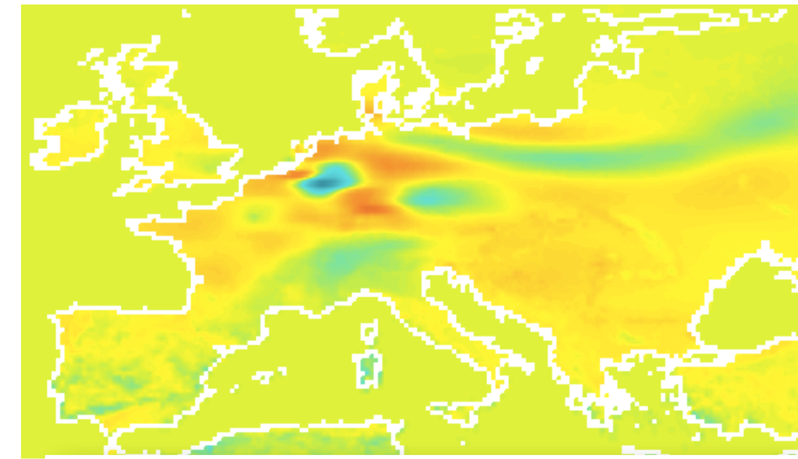
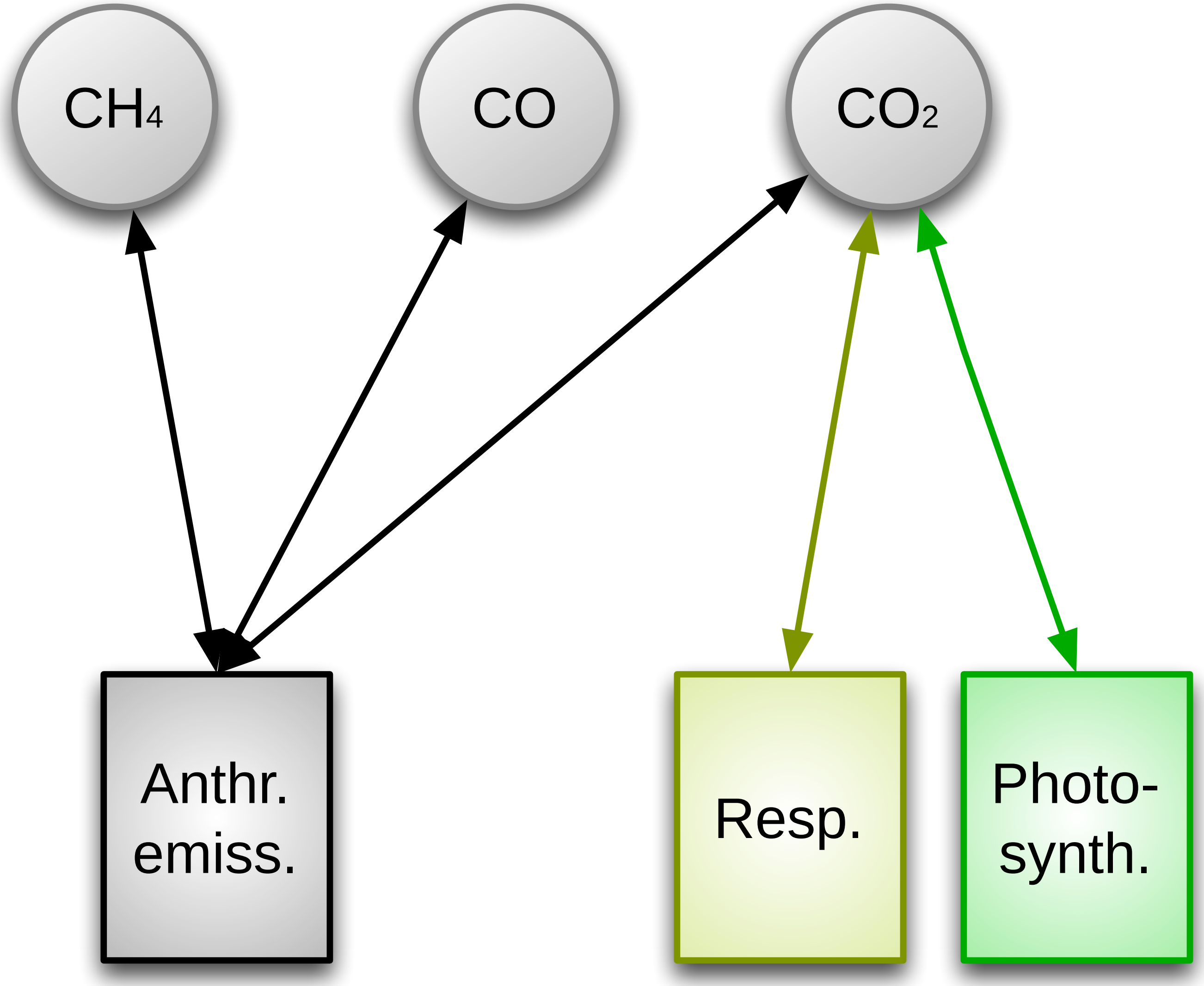


using EDGAR v4.3 + BP2014 + IER (D + F)

PRIOR annual NEE (GtC/a):	-1.24	-1.24	-1.24
POSTERIOR annual NEE (GtC/a):	-0.49	-0.53	-0.74
annual fossil fuel emissions (GtC/a):	1.374	1.416	1.416
Fraction of ΔFF „recovered“ as NEE:		95%	595%

Synergy of tracers



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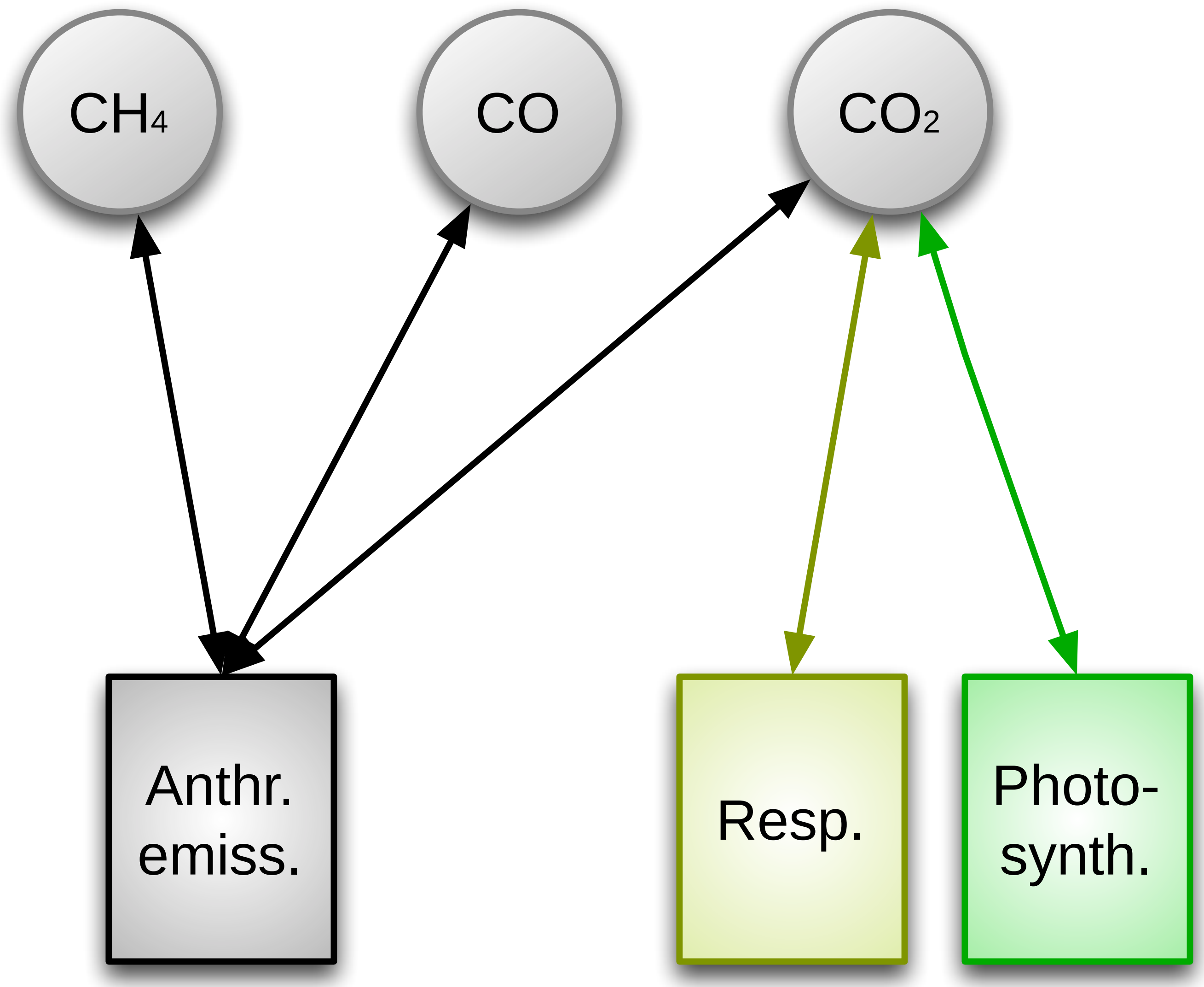
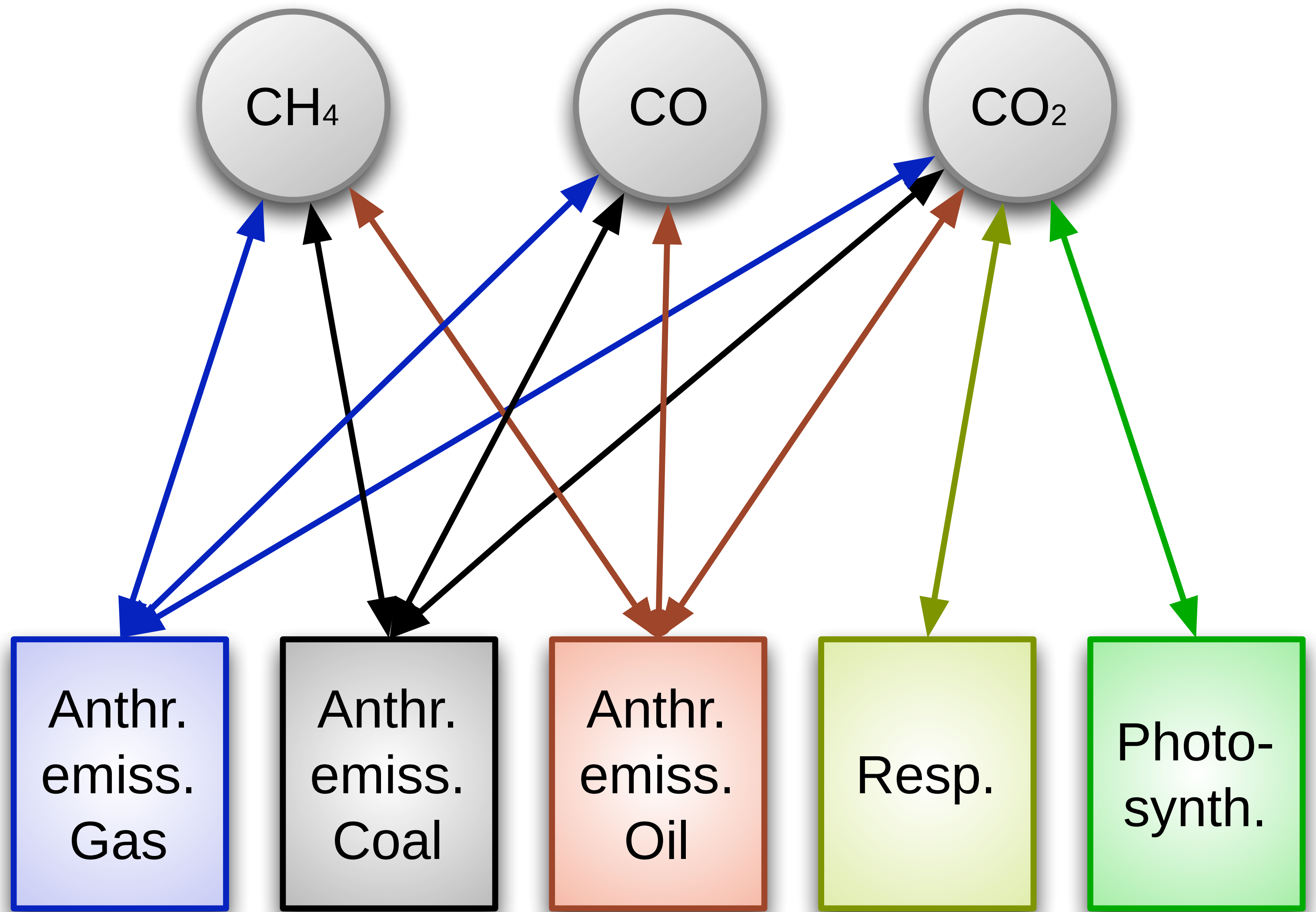


- shared atmospheric transport

Synergy of tracers



- shared atmospheric transport
- shared fuel types

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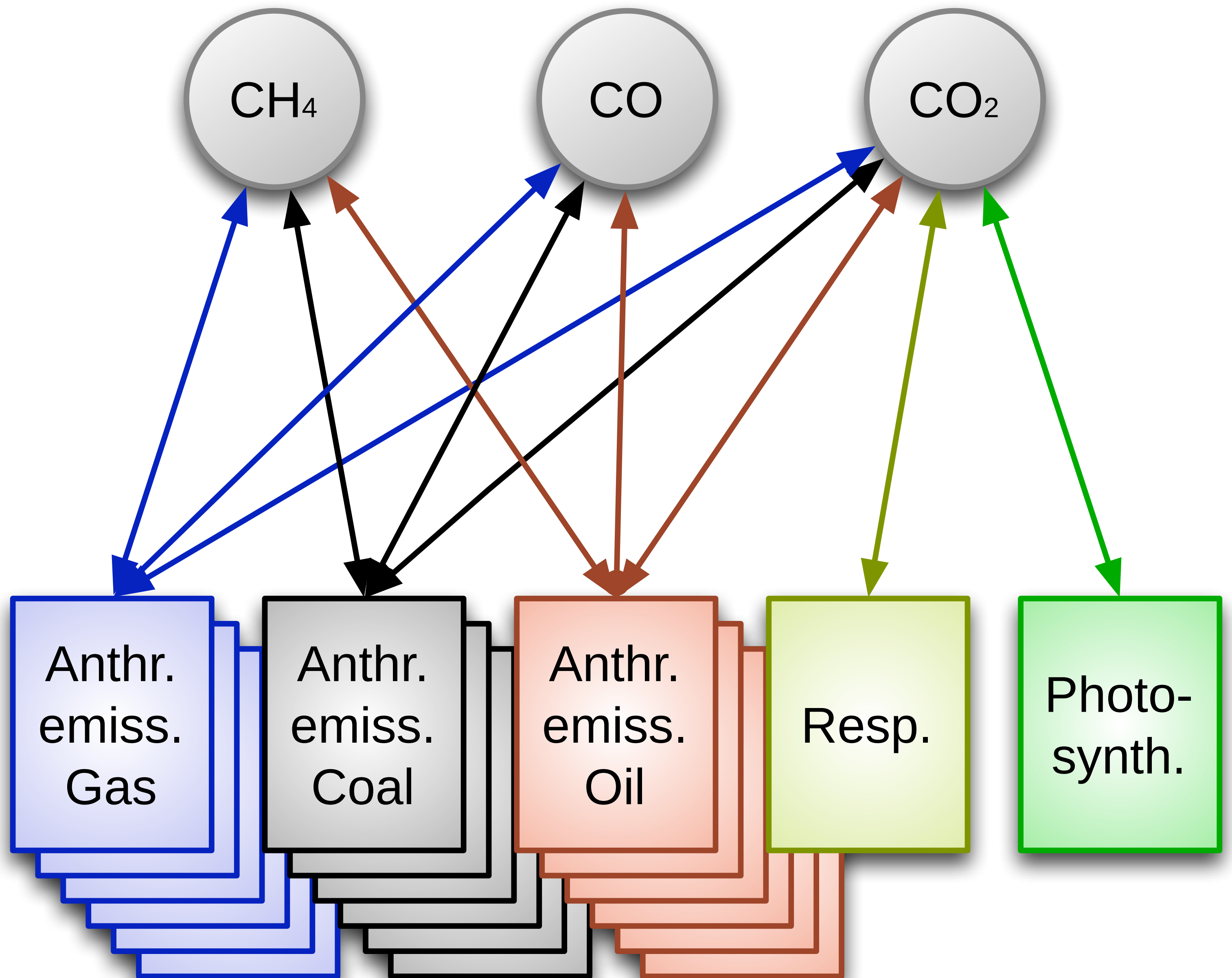
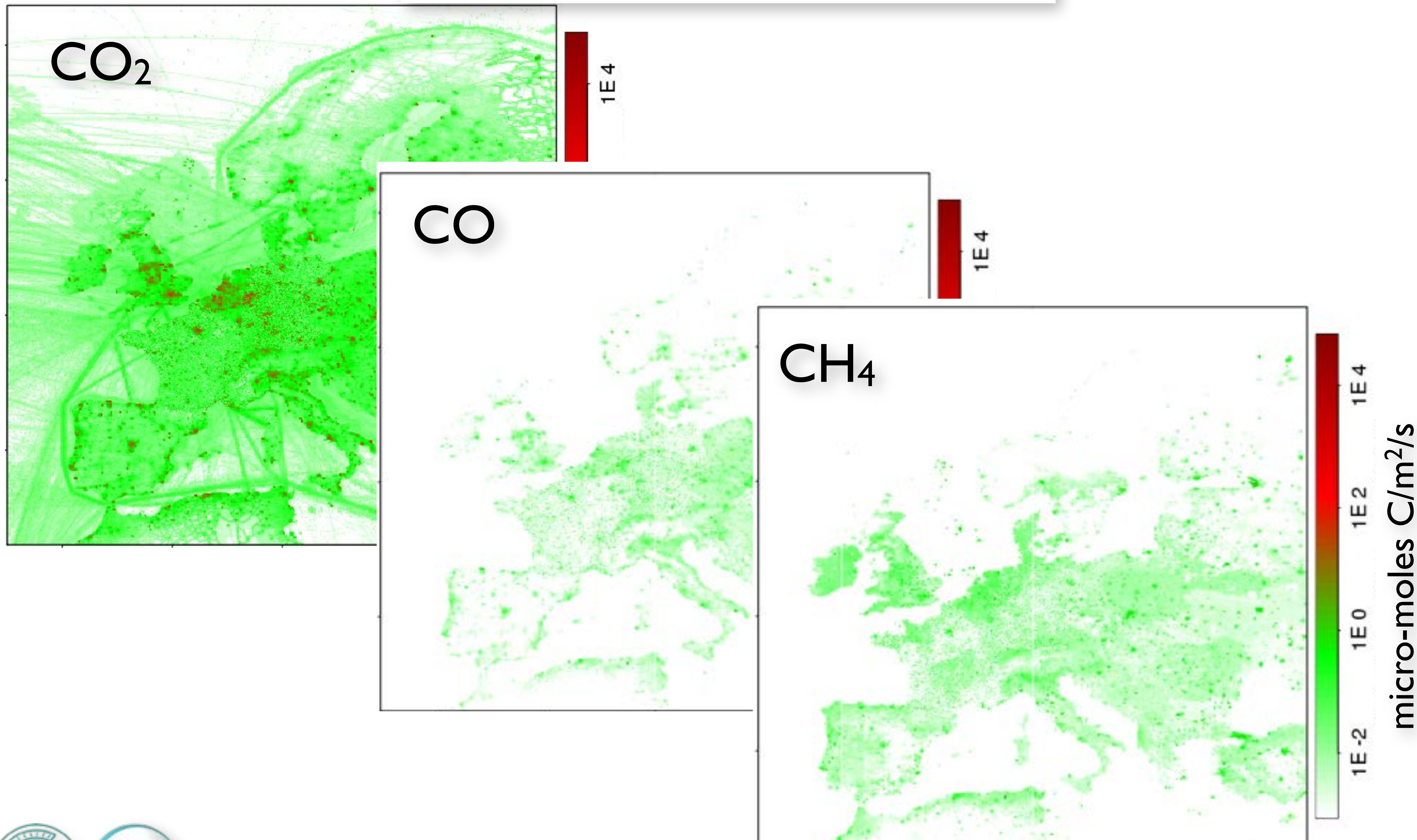


- shared atmospheric transport
- shared fuel types
- shared emission sectors

Synergy of tracers

EDGAR v4.3 + BP2014 + IER (D + F)

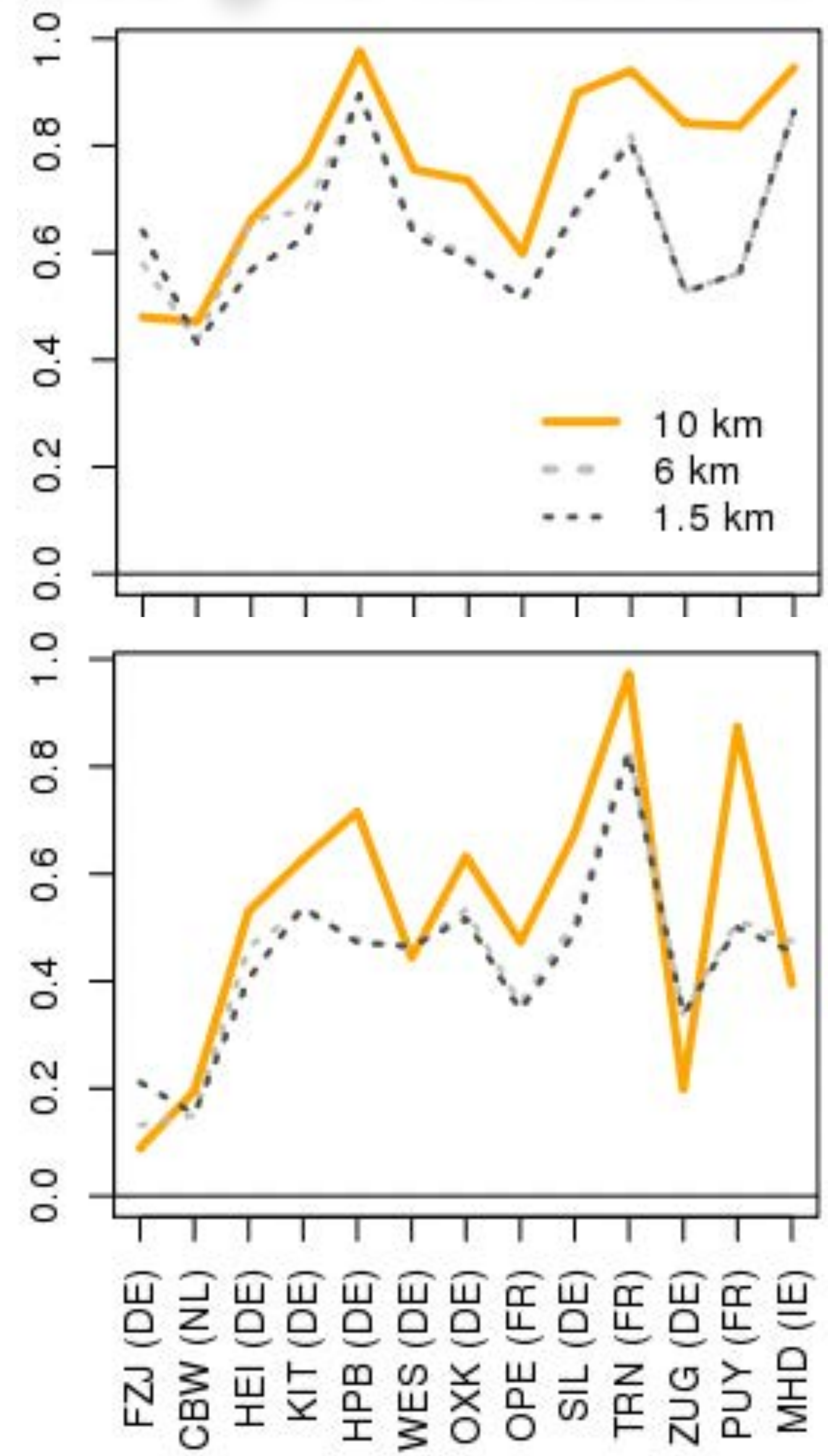


tracer correlations for sub-grid variations

- Linking footprints to emission inventories for CO_2, CO and CH_4
- different spatial resolution 80km, 10km, 6km, 1.5km
- Difference to 80km

correlation CO_2 - CO

correlation CO_2 - CH_4



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Conclusion/Outlook

- Emissions have increasing uncertainty with decreasing spatial disaggregation scale, leading to potential bias in retrieved biosphere-atmosphere exchange
  - in combination with increasing number of stations under influence from emissions
  - in combination with increasing resolution of inverse transport models
- Potential benefit from multi-species inversions
  - provide a clearer link between inverse modeling and UNFCCC reporting (sectors, fuel types)
  - shared uncertainties (shown here: influence from sub grid variability)
- Implementation @ ICOS-CP (Carbon Portal):
  - STILT footprints for ICOS atmospheric stations
  - EDGARv4.3 + BP2015 emission estimates (sector- + fuel-specific)