79th LCA Discussion Forum:

Making large data sources available for LCI and LCIA

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Fundamental approaches in creating large LCIs

Based on measured data

- typically high data quality
- misreporting
- background information (e.g. calibration/ reference state) necessary
- gaps for small facilities and regions with limited enforcement

How to combine at large scale?

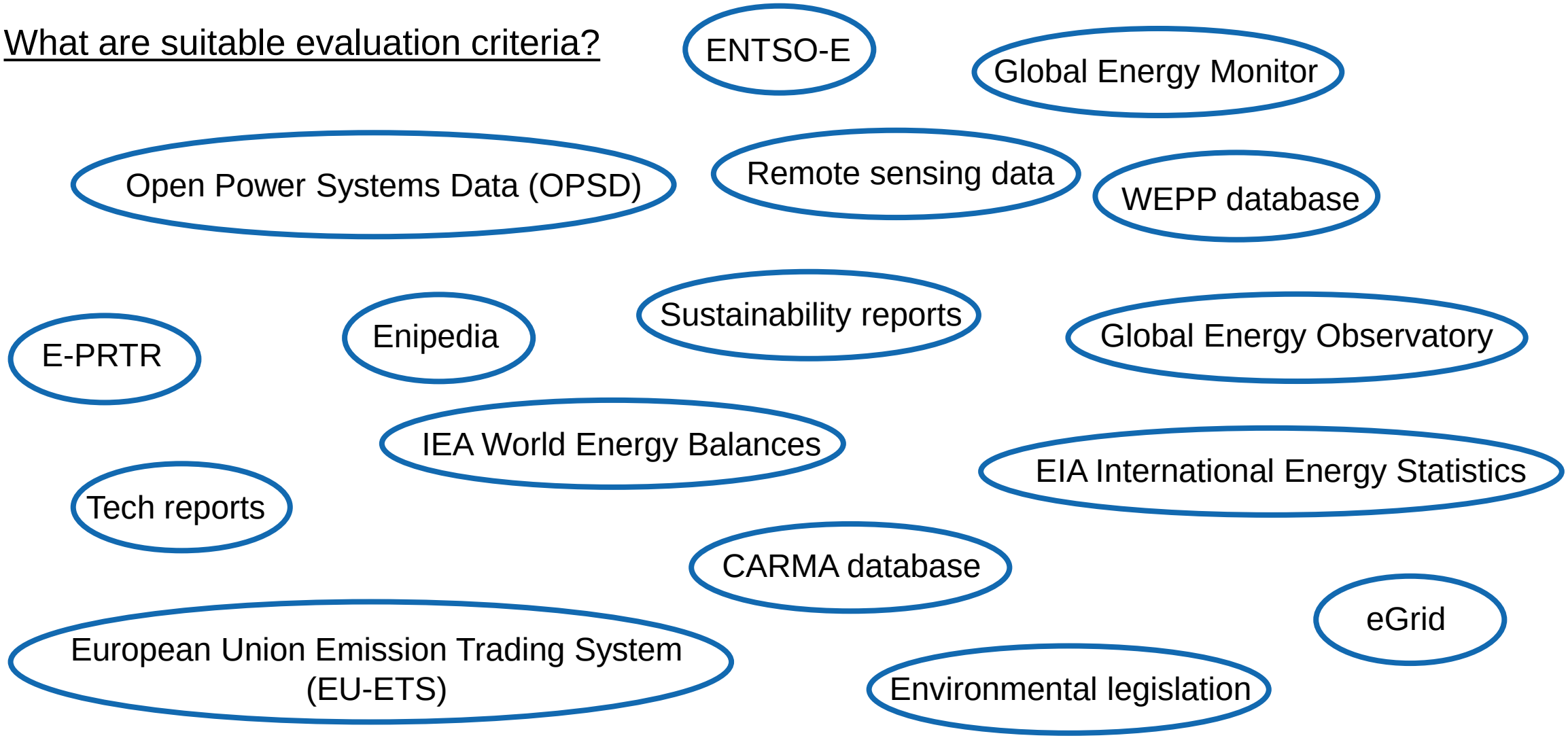
Based on modelled data

- completeness
- full cause-effect chain coverage
- options for predictions and analysis
- influence of operational practices unclear
- (typically) less accurate than measured data

Example here: Emission inventory of all global fossil power plants, refineries, steel mills and cement plants

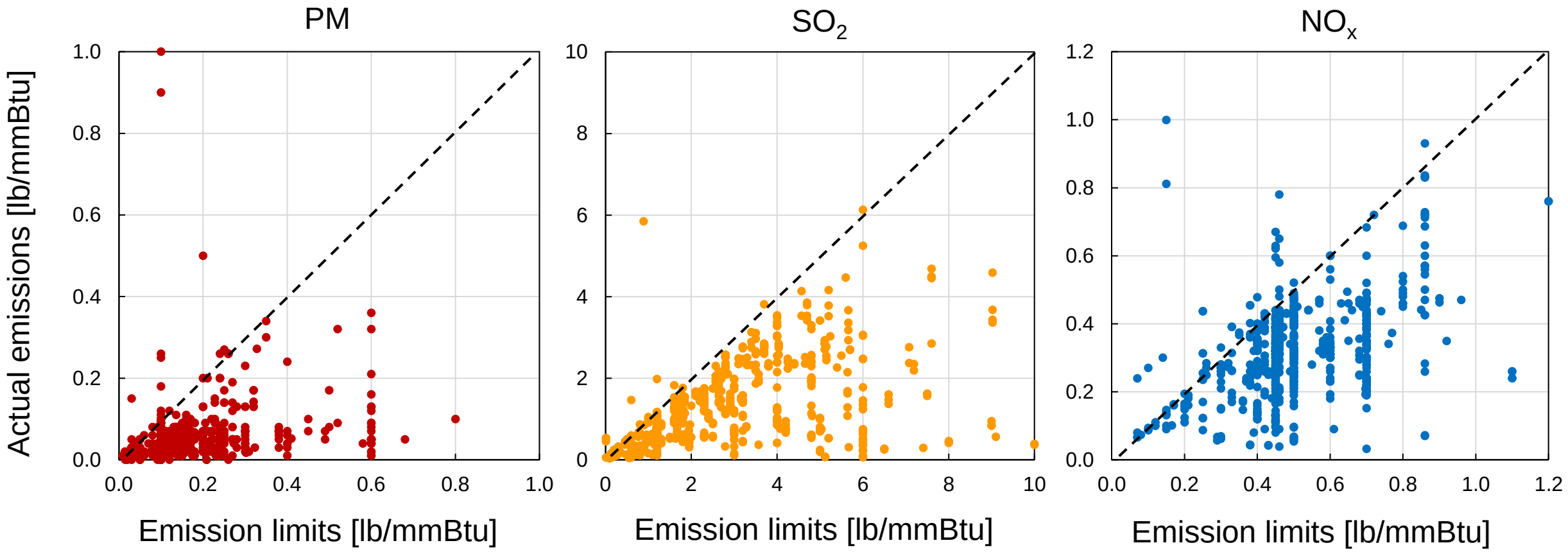
Evaluation of data sources

What are suitable evaluation criteria?



Emission limits as suitable data source?

US coal power pollutant emissions vs. legal limits



based on NETL (2007)

Example for air pollution legislation in India

Emission limits for thermal power plants

	Plants installed before 31 December 2003*		Plants installed 1 January 2004 to 31 December 2016*		New plants installed from 1 January 2017**
Capacity	Smaller than 500 MW	500 MW and above	Smaller than 500 MW	500 MW and above	Any size
Particulate matter, mg/Nm^3	100	100	50	50	30
SO_2, mg/Nm^3	600	200	600	200	100
NOx, mg/Nm^3	600	600	300	300	100
Mercury, mg/Nm^3	-	0.03	0.03	0.03	0.03

* Thermal power plants (units) must to meet the limits within two years from date of publication of this notification

** Includes all thermal power plants (units) which have been accorded environmental clearance and are under construction

IEA CCC (2017)
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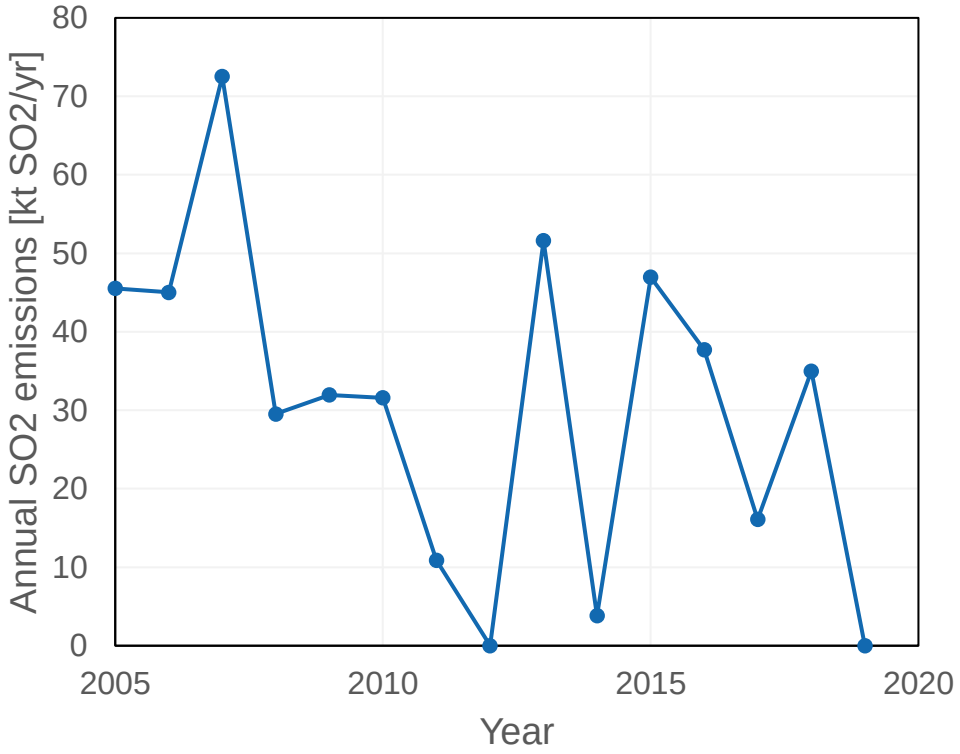
Suitability of remote sensing data



Refinery identified near Marseille as SO_2 emission source, but:

- amounts and time series do not match reporting
- other emission sources (steel mill/ power plants) are missed

Still: Validation option?

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Example for an emission modeling hierarchy

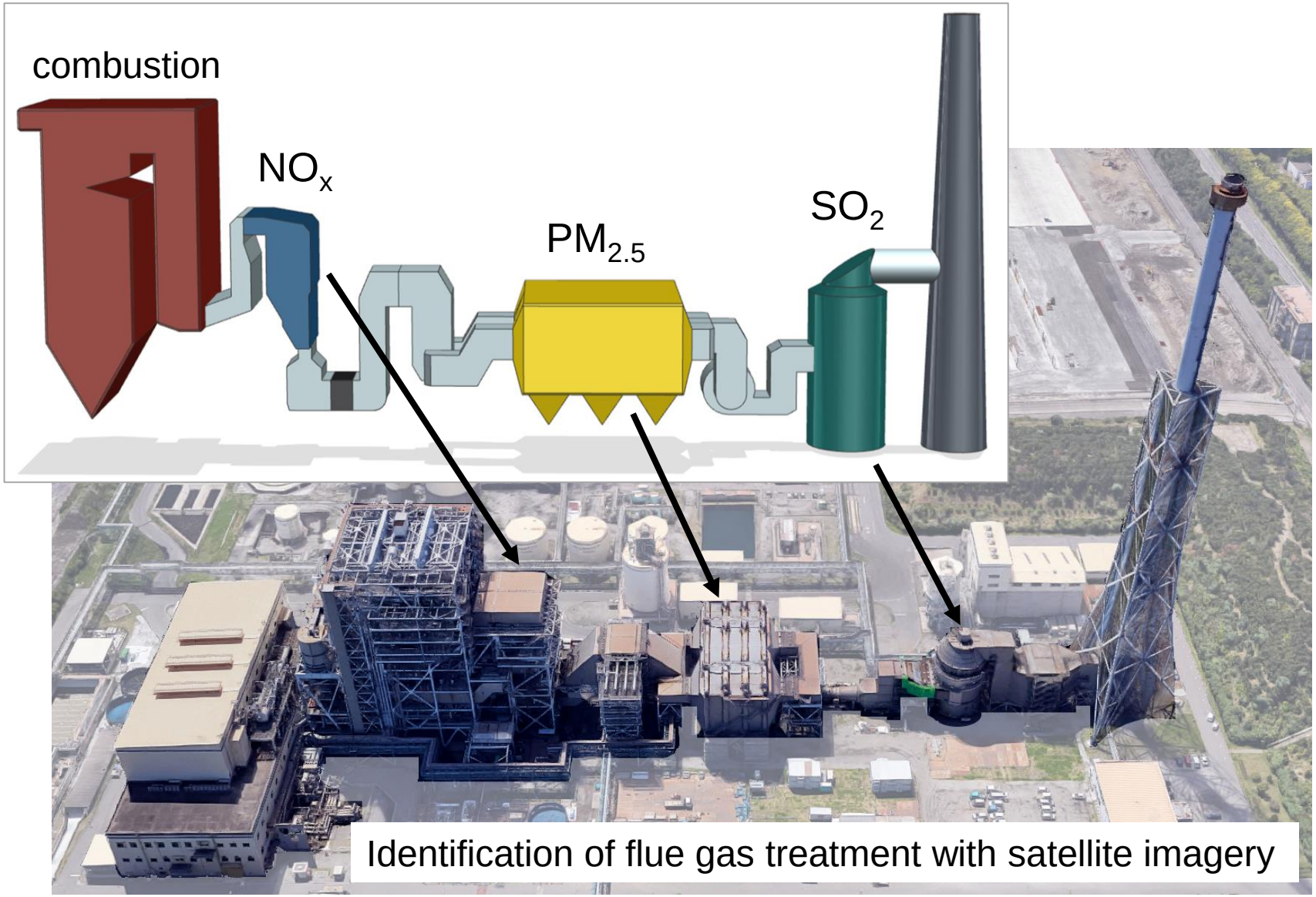
Case A: All emissions reported
→ take reported emissions

Case B: Emissions missing, activity data reported
→ estimate from activity and fuel/ process properties

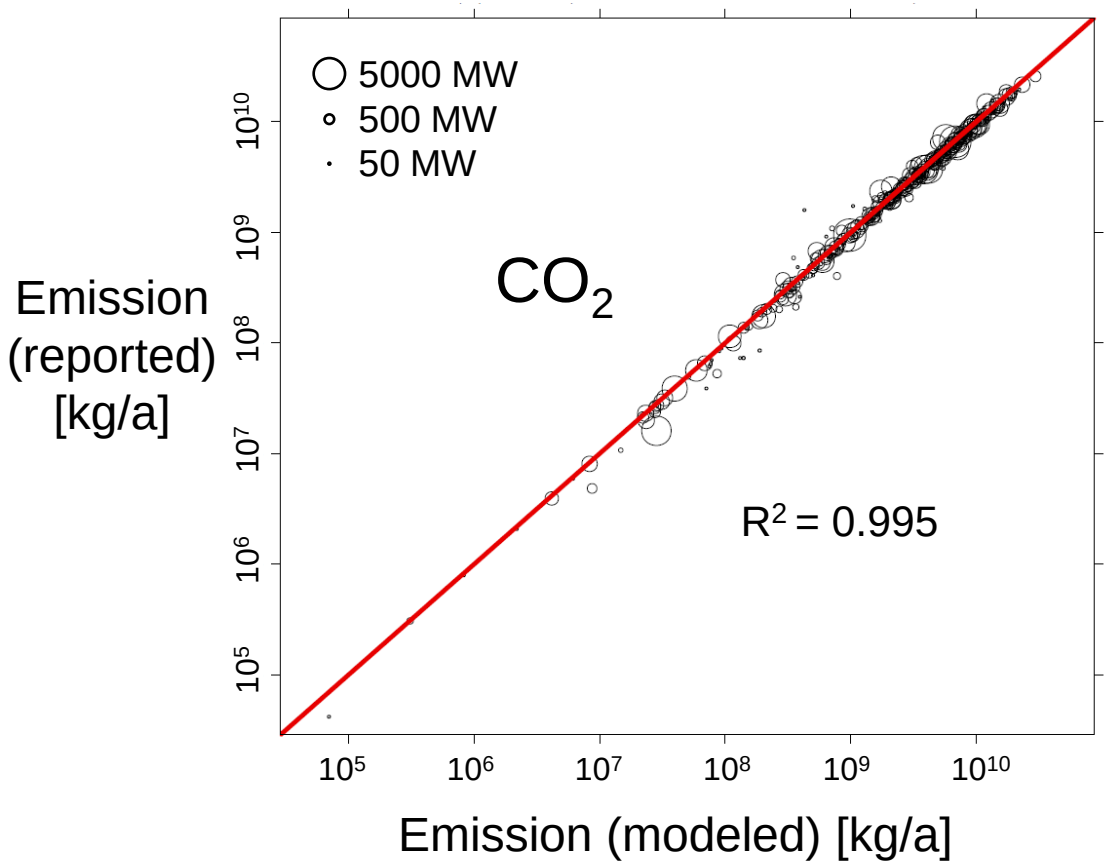
Case C: Some emissions missing, at least CO2 emission reported
→ Estimate activity with CO2, then like case B

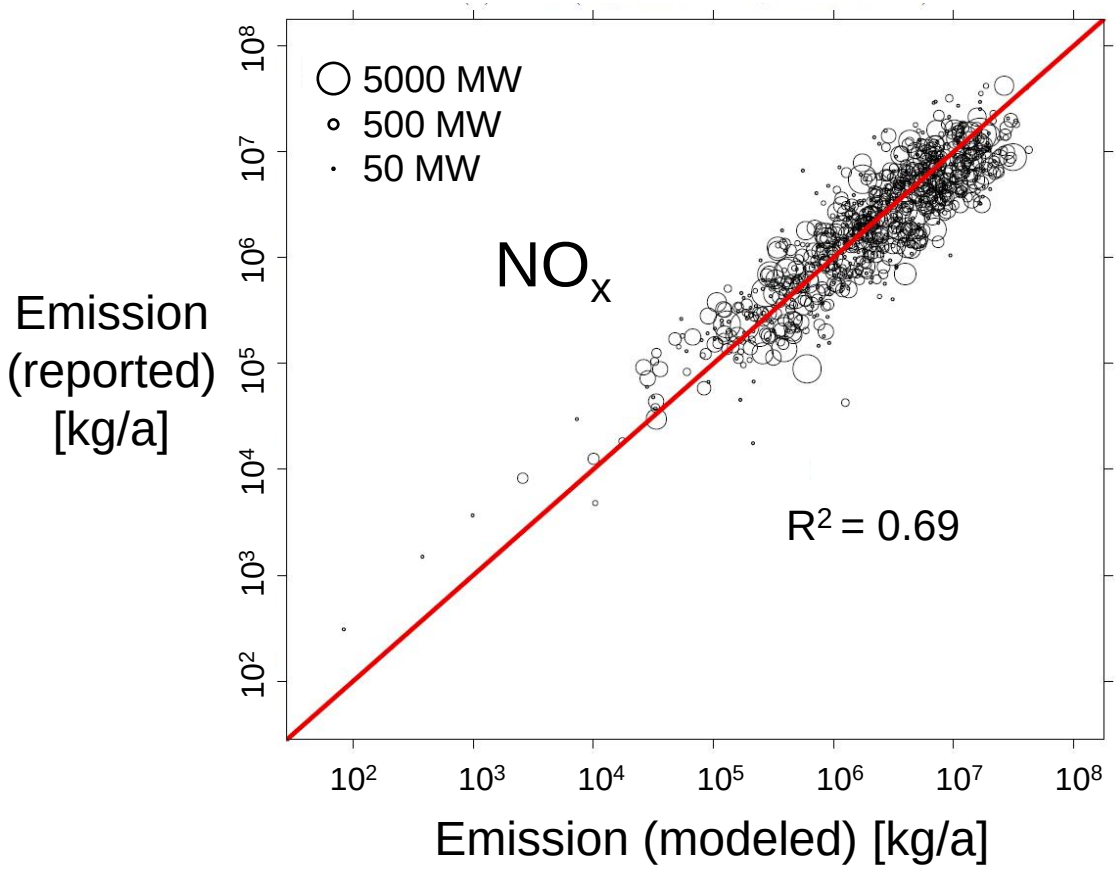
Case D: Everything missing
→ Estimate generation from capacity factor, then case B

The importance of the specific emission abatement



Model validation (example: CO_2 and NO_x emissions for coal power)





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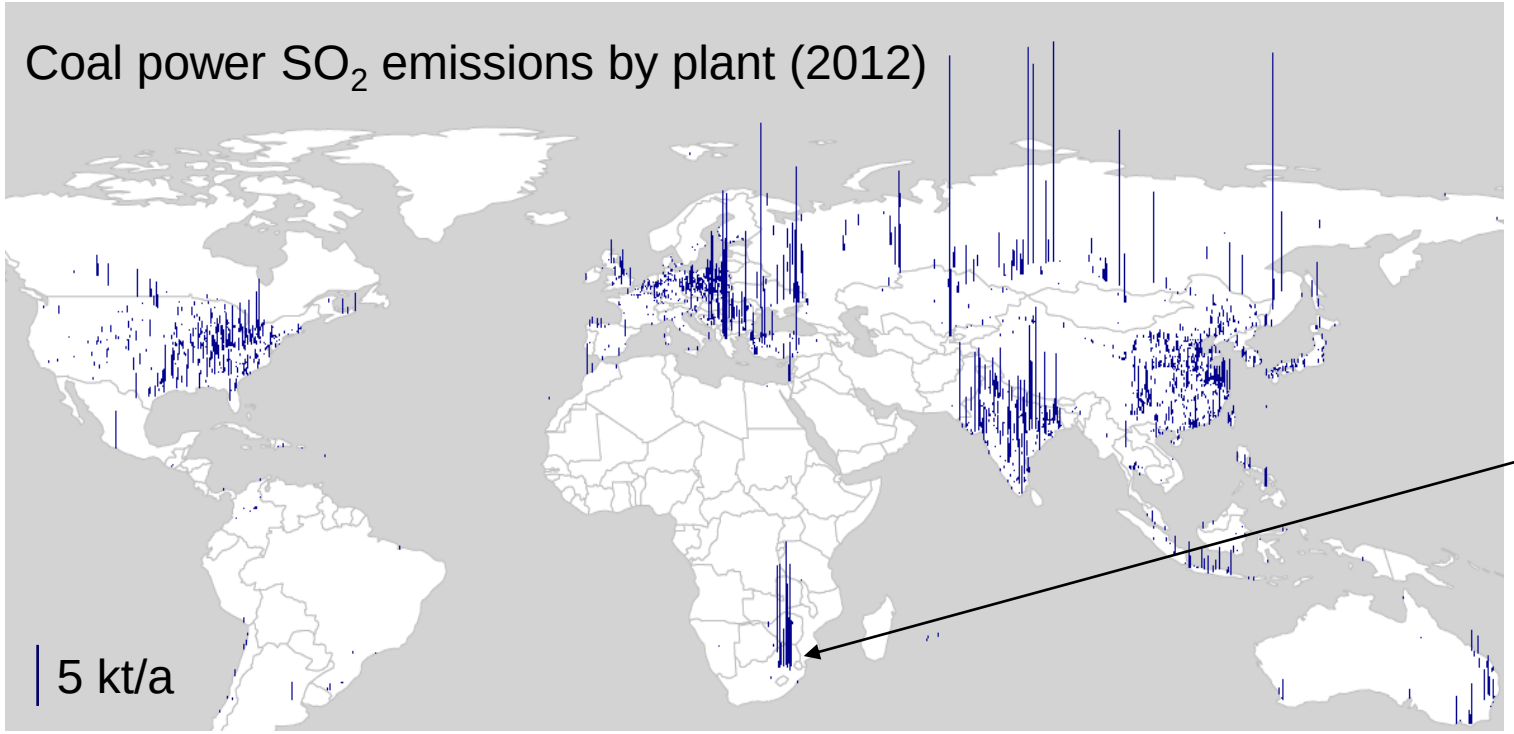
Additional data needs for connecting LCI and LCIA



Oberschelp et al. (2019)
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LAT = -23.704°
LONG = 27.561°

T = 217°C
v = 22.3m/s
$\dot{m}_{SO2}$ = 0.104kg/s

height = 137m

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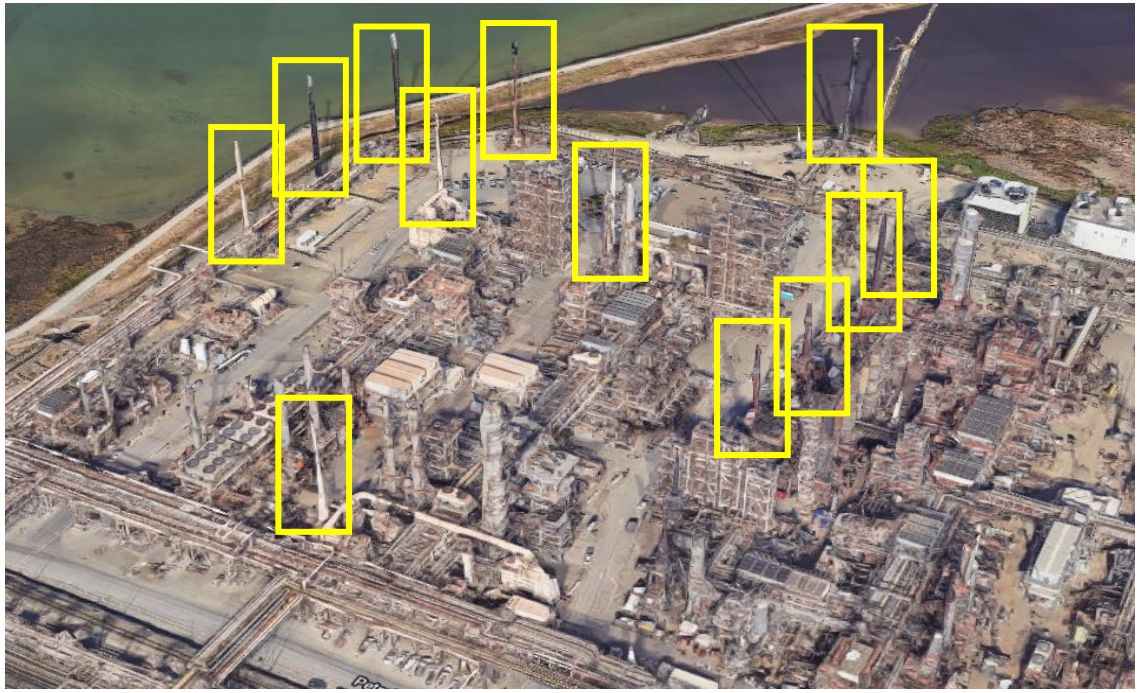
Some additional data on flue gas characteristics had to be added to combine emission inventories and impact assessment.

Regional patterns of technical specifications

Refineries in the US: many low stacks



Google Maps (2020)
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Refineries in Japan: few very high stacks

Google Maps (2020)
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Some additional data on flue gas characteristics have to be added to combine emission inventories and impact assessment.

Global industrial emission inventories

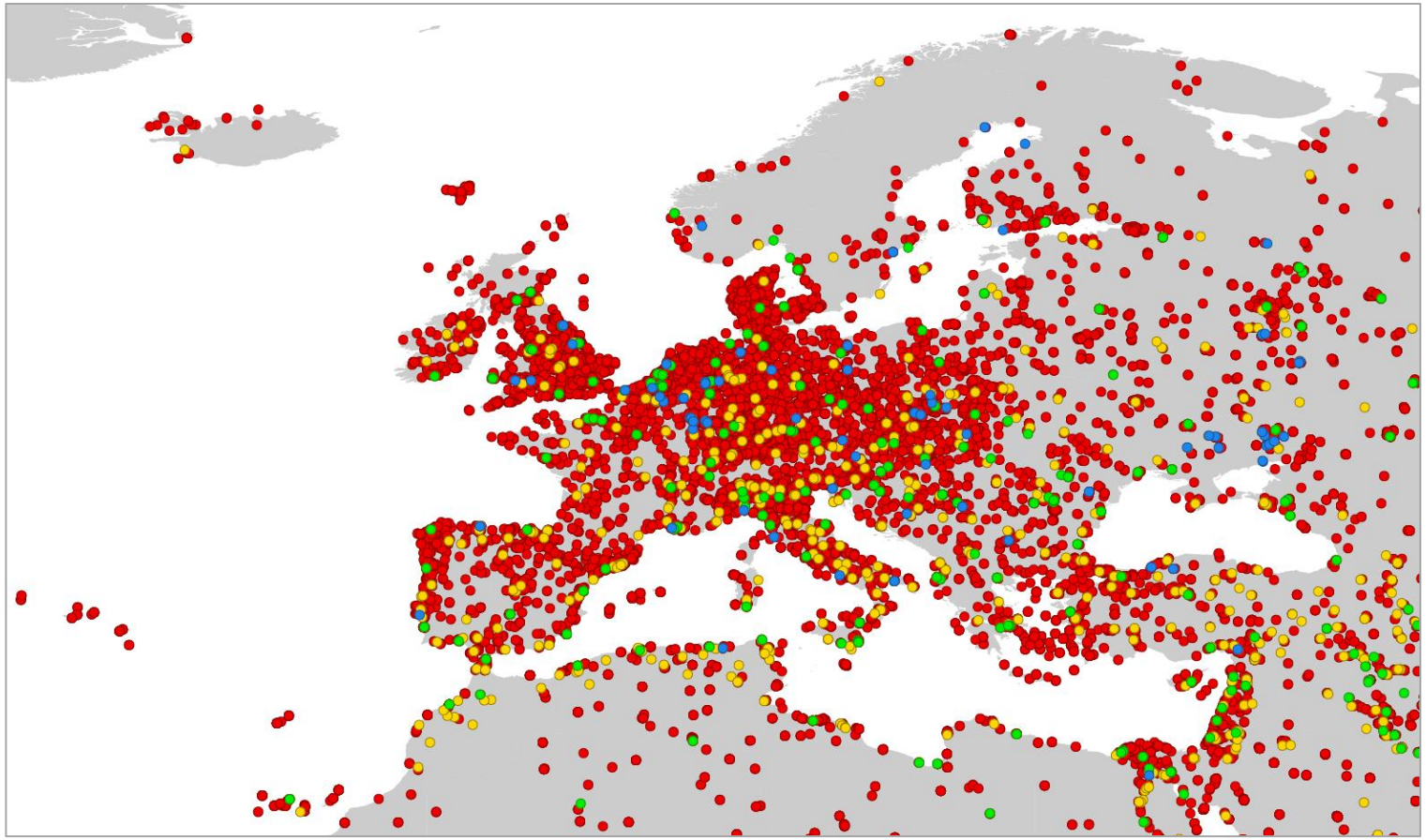
Result: Emission inventories that combine emission measurements and mechanistic models globally.

Industrial sites:

- Power plants
- Oil refineries
- Steel mills
- Cement plants

Pollutant coverage:

CO_2, $PM_{2.5}$, SO_2, NO_x, NH_3, partly mercury and methane

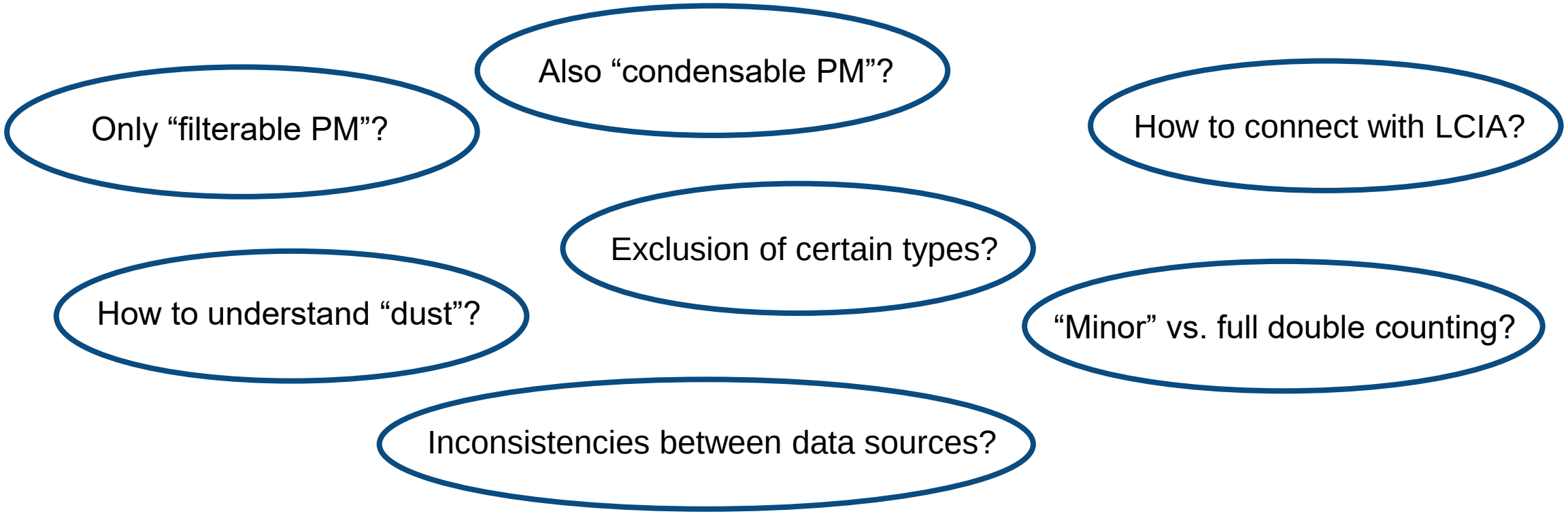


European part of the 130’000 industrial sites

Example for open issues: terminology problems between disciplines

"Particulate emissions are separated according to the diameter class. Three categories are distinguished, namely less than 2.5 micron, between 2.5 and 10 micron, and more than 10 micron […]. Particulate emissions are inventoried as particulates and as specific substance emissions, implying a (minor) double-counting of mass. […]"

Weidema et al. (2013)



Main learnings

- Priority: Resource/ time management!
- Not all available large data sources are suitable
- A clearly defined data hierarchy is necessary to handle data conflicts and set focus
- For long-term data projects, it can be better to avoid one-time data sources (e.g. some academic data)
- Major challenges in terminology remain
- Only relying on well-documented data may not be an option

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Thank you for your attention!

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All data and models are/ will be open source:

1. Coal power emissions and model: https://doi.org/10.17632/dm3rjb9ymc.1
2. PM fate model; detailed + aggregated CFs: http://dx.doi.org/10.17632/8jnj4vzbh6.1
3. Coal/ oil/ gas power, refining, steel, cement emissions and impacts: *tbd*

ESD ecological systems design