

Task 5.2 specific slides

- ▶ For discussion during the kick-off of RAPTOR in Paris, 18 November 2019
- ▶ Contents:
 - ▶ Background on national emission inventories
 - ▶ CLEO model
 - ▶ Tasks & planning

National inventory background

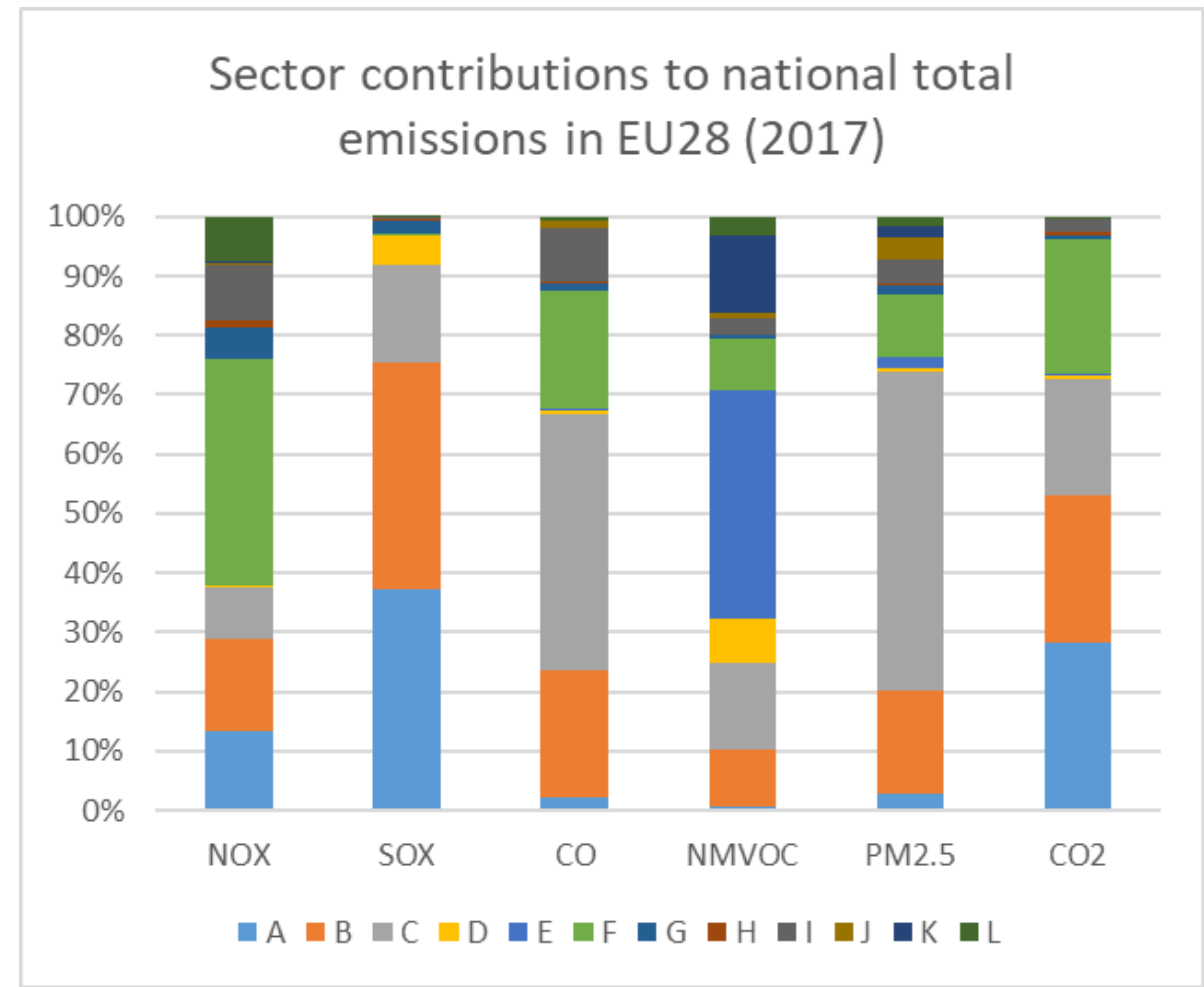
- ▶ For both EU (NEC Directive) and UNECE (LRTAP Convention) each MS shall report its emissions of air pollutants to air on an annual basis
 - ▶ Sector specific, pollutant specific, totals for country as well as gridded (0.1°x0.1°)
 - ▶ For air sector, split between domestic and international aviation but only including the LTO cycles (<3000ft)
 - ▶ Cruise emissions (>3000ft) reported as “memo item”: do not count in national total
 - ▶ Note that for greenhouse gases (UNFCCC) the requirement is not on LTO but on domestic aviation only (meaning: departure & arrival in same country)
- ▶ Reporting requirements for NO_x, NMVOC, SO_x, NH₃, CO, PM_{2.5}, PM₁₀, (TSP), (BC) plus heavy metals and persistent organic pollutant (**UFP not part of this system!**)

AT: 5.2.2023: 2005	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)
				NO _x (as NO ₂)	NMVOC	SO _x (as SO ₂)	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Long name	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt
H_Aviation	1A3ai(i)	International aviation LTO (civil)										
H_Aviation	1A3aii(i)	Domestic aviation LTO (civil)										

Emissions for some key pollutants

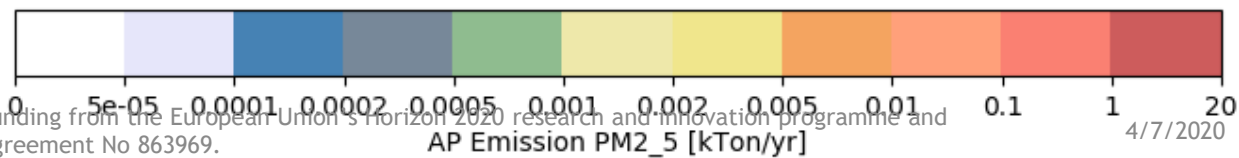
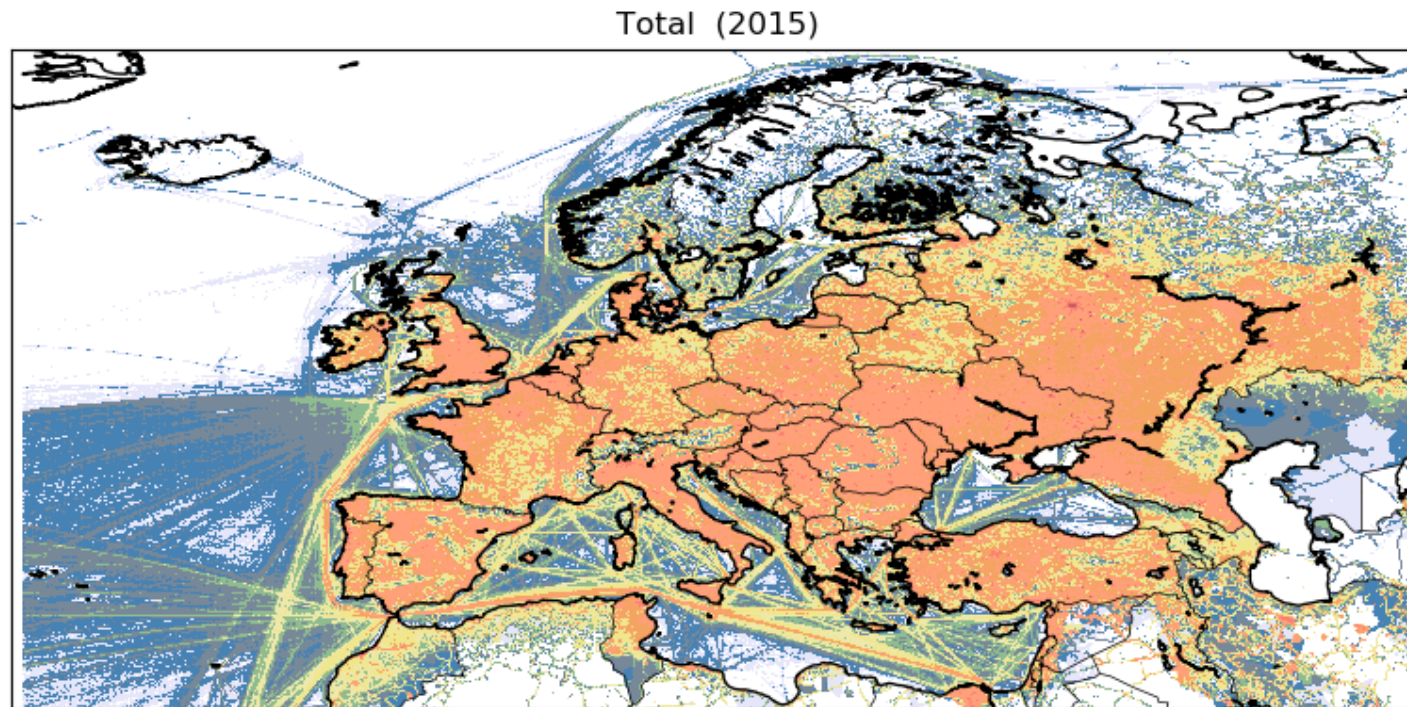
- ▶ Aircraft emissions constitute only a small fraction of national total emissions for all pollutants (~1% for NO_x, <0.5% for others*)
- ▶ Locally however, near major airports, aircraft may be a major source of emissions

Source: officially reported emissions by countries to EU, UNECE and UNFCCC in their 2019 submissions (www.ceip.at, www.unfccc.int)



* For CO₂ emissions represent domestic aviation (LTO + cruise) rather than all LTO's

PM2.5 - emissions (mass)

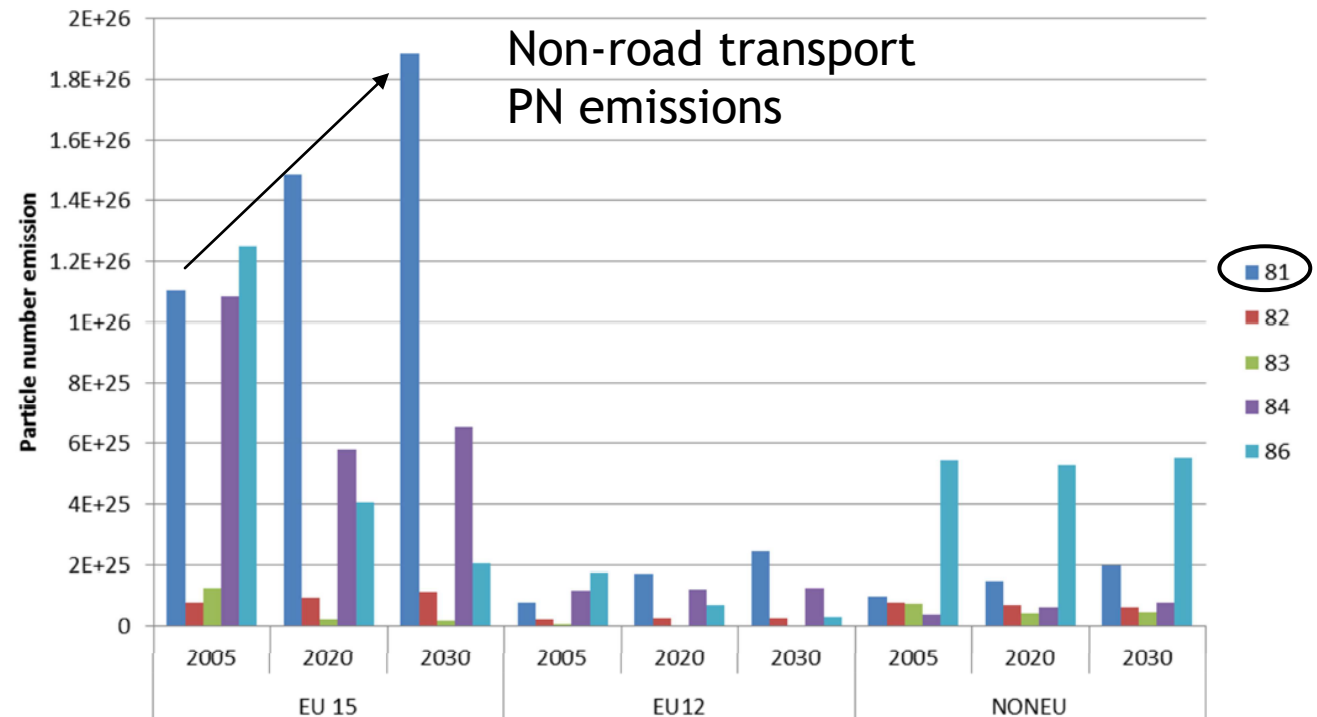
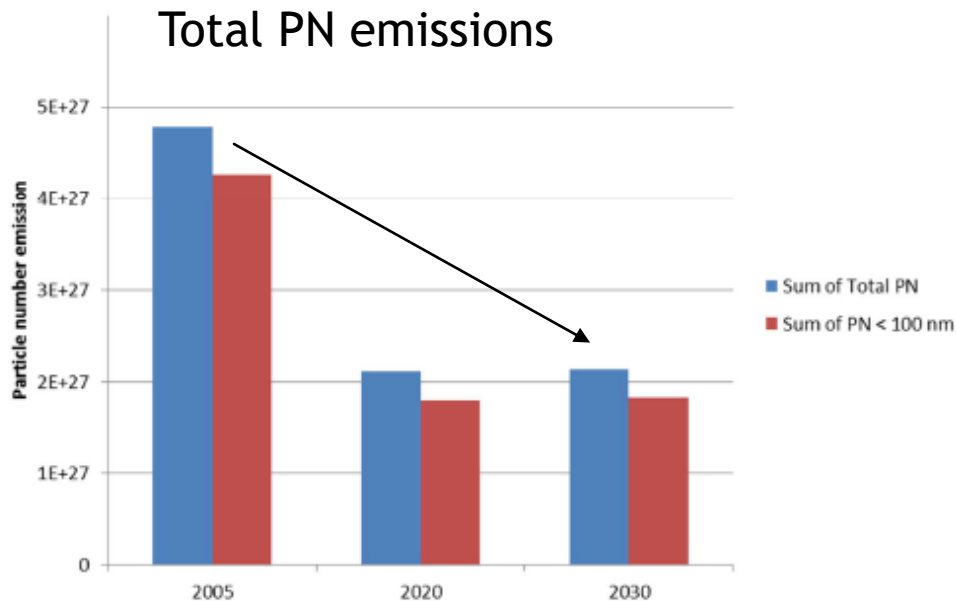


This project has received funding from the European Union's Horizon 2020 research and innovation programme and Clean Sky JU under grant agreement No 863969.

CAMS-REG-v2.2.1
TNO (2018)

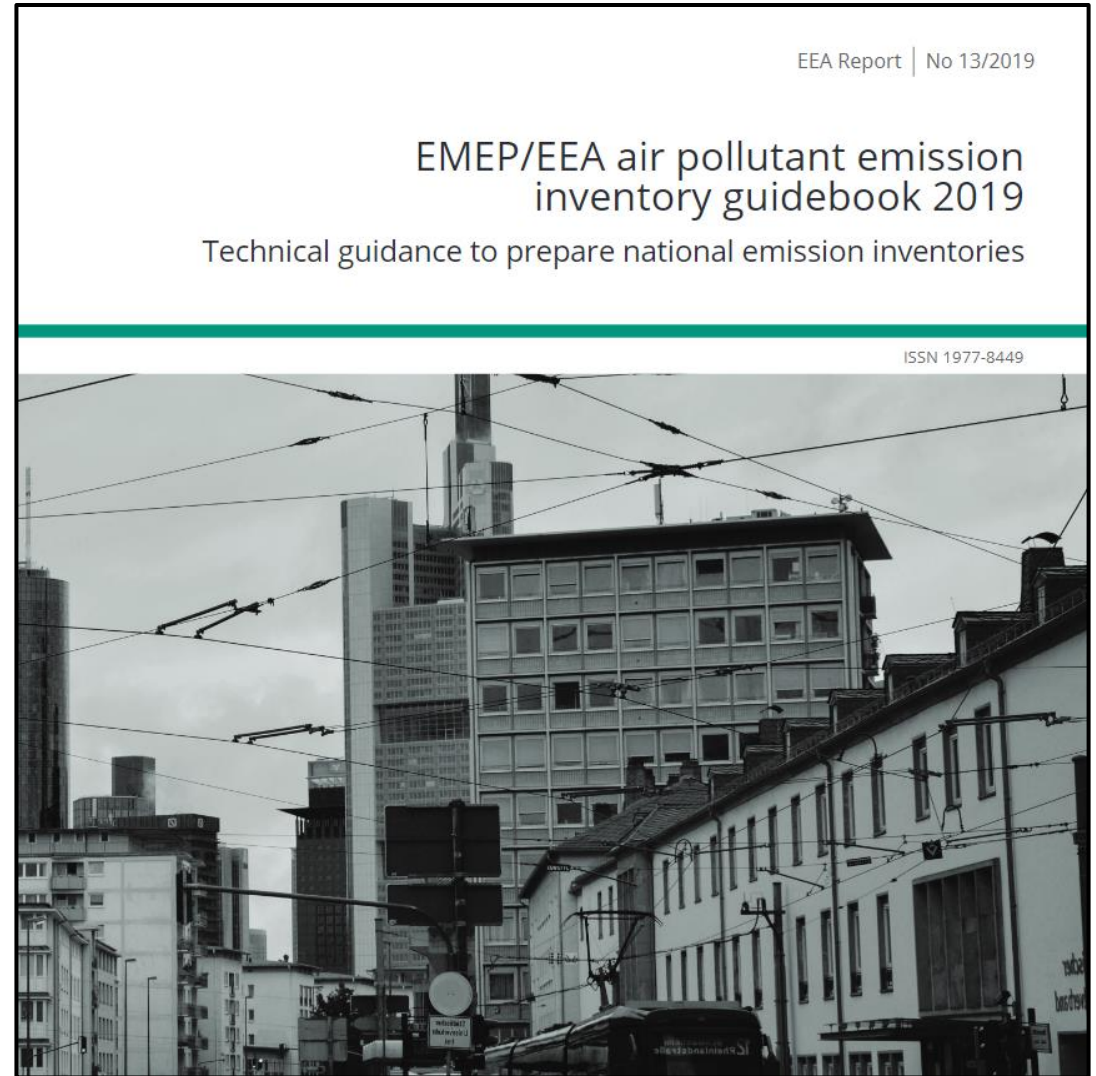
UFP emissions

- ▶ UFP releases from aircraft may be more important than “traditional” air pollutants
- ▶ Earlier work (EU FP7 project TRANSPHORM, 2010-2014) shows aircraft to be a major source of particle numbers in non-road transport
 - ▶ Estimated ~2% of national total PN in 2005, increasing to ~10% in 2030
- ▶ Relatively high uncertainty



How to report emissions

- ▶ EEA Emission Inventory Guidebook is main tool
 - ▶ Provides default guidance for all countries how they can calculate national emissions for each relevant sector
 - ▶ Sector based Tiered approach: from simple to detailed
 - ▶ Yet many countries have developed their own methodologies (incl. models)



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Methodologies for aircraft emissions

- ▶ Methodology for aircraft emissions has been recently upgraded (by EEA in collaboration with EUROCONTROL)
- ▶ Tier 1: simple approach based on fuel statistics only
 - ▶ “Average” emission factors per unit of fuel used
- ▶ Tier 2: emission calculator
 - ▶ Based on number of LTOs, LTO fuel consumption and emission factors per aircraft type and for most common engine types
 - ▶ Based on average taxi times (provided by EUROCONTROL)
- ▶ Tier 3: flight- and aircraft type methodology
 - ▶ Based on actual flight movement data, based on only origin or full flight trajectory information

Model CLEO (Calculus Luchtvaart Emissies Onder 1000m)

- ▶ Essentially a Tier 3 approach
- ▶ Primarily based on US EPA/ICAO methods for aircraft engines
- ▶ Covering four flight modes in LTO (taxiing, take-off, climb out, approach) with each their specific power settings
- ▶ Besides direct engine emissions, also other sources of emissions in airports are included
 - ▶ APU emissions, GSE emissions, fuelling/fuel handling emissions, tyre & brake wear
- ▶ Model calculates annual emissions 1990 to present day (t-1)
- ▶ Report describing the model available online:

[http://www.emissieregistratie.nl/erpubliek/documenten/Lucht%20\(Air\)/Verkeer%20en%20Vervoer%20\(Transport\)/Overig%20Verkeer%20en%20Vervoer/Dellaert%20&%20Huls%20kotte%20-%202017%20-%20Emissions%20of%20air%20pollutants%20from%20civil%20avi....pdf](http://www.emissieregistratie.nl/erpubliek/documenten/Lucht%20(Air)/Verkeer%20en%20Vervoer%20(Transport)/Overig%20Verkeer%20en%20Vervoer/Dellaert%20&%20Huls%20kotte%20-%202017%20-%20Emissions%20of%20air%20pollutants%20from%20civil%20avi....pdf)

CLEO model structure

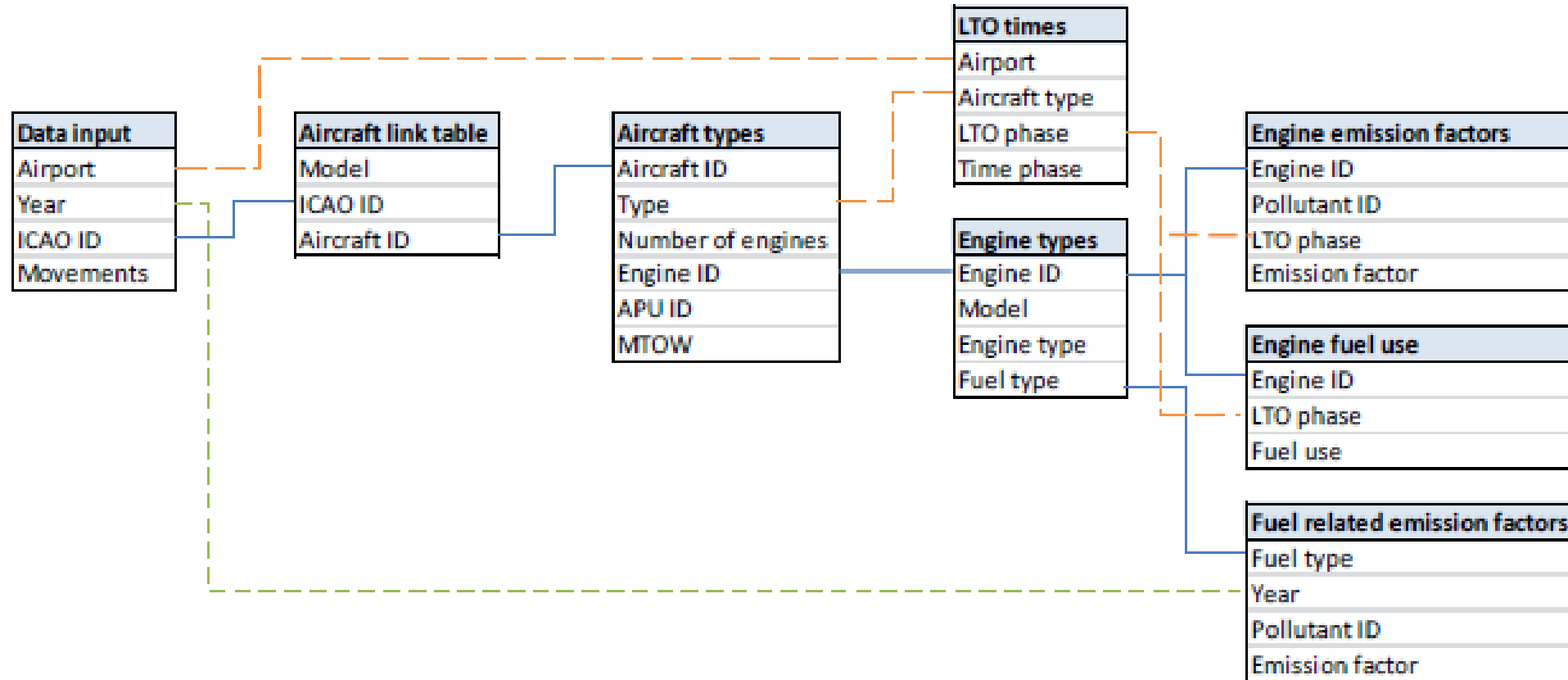


Figure 1: Aircraft LTO emissions and fuel use in the model

Task 5.2 Test case national inventory

► Tasks foreseen

- ❖ Context for aircraft emissions
 - ❖ National emission inventories: what's the contribution of the air sector in Europe?
- ❖ Review CLEO model developed for Netherlands, and used for national inventory. Underlying questions are:
 - ❖ Review CLEO model for PM
 - ❖ Compare with ICAO EEDB approach
 - ❖ EEDB: how to get from smoke to PM?
- ❖ Extend CLEO model with UFP (if possible)

Tasks & planning

- ▶ Specific points to work on:
 - ▶ Review the CLEO model approach against the ICAO EEDB with focus on PM (and components)
 - ▶ Look specifically at how to translate smoke to PM and components (EC, nvPM, vPM, ...) as this is one of the main uncertainties in the CLEO model at the moment
 - ▶ Explore options to extend CLEO model with UFP
- ▶ Timing
 - ▶ Task runs M1-18 (Nov 2019 - Apr 2021)
 - ▶ Late 2019: agree on approaches & clarify discussion points
 - ▶ Actual work to start in early 2020

Discussion points & open questions

- ▶ Emissions vs. concentrations
 - ▶ The work on CLEO is emission modelling, so how to go from the single aircraft measurement to a complete overview of emissions for one or more airport(s).
 - ▶ In order to connect to WP4 - health effects we would also need to discuss AQ modelling (local to regional scale?)
- ▶ CLEO considers only LTO at the moment, planned for 2020 to explore options including cruise (funded by NL) - if available we can pick this up as well