Improving Emissions of Condensable Particulate Matter in the Context of the LRTAP Convention

Description of the issue:

- The condensable component of Particulate Matter (PM_{10} and $PM_{2.5}$) is released as a gas but upon dilution and cooling it forms particles shortly after the release. In current emission reporting, there is no clear definition of whether Particulate Matter includes/excludes the condensable component.
- Across different source sectors, different PM measurement techniques are being used, and consequently the emission factors (EFs) that result can include or exclude the condensable component. For example:
    - In road transport, all emission measurements include the condensable component.
    - For industrial sources, all emission measurements exclude the condensable component.
    - For small-scale combustion using coal or wood, a mixture of methods is currently being used resulting in some emission factors that include the condensable component and others which do not.
- Small-scale combustion sources are of particular concern because they make a relatively large contribution to PM emission totals, are a large source of condensable PM, and currently some Parties report on the basis of filterable PM (excluding the condensable component) while other Parties report including the condensable component. This inconsistency in reporting across Parties creates a major problem for the assessment of air pollution exposure.
- For small-scale combustion, the EFs excluding and including the condensable fractions may differ by up to a factor of 5 depending on the appliance type. This can have a large impact on total primary PM emission estimates (see Annex).
- Condensables are considered secondary aerosols which are formed directly after the release. It is therefore logical that these are treated by models rather than included in emission estimates. However, the amount of condensable material strongly depends on the appliance type, which is information held in the emissions inventories and not necessarily readily available to modelers or easily incorporated into models.
- Condensable PM that is not included in PM emissions reporting are not included in VOC emissions - they are excluded due to their low volatility. Therefore, some condensable PM is completely missing in current emission reporting, and in particular the contribution of wood combustion to PM exposure is underestimated.
- As well as being a concern for accurately modelling overall exposure to PM, these discrepancies are also of concern for issues associated with Parties demonstrating compliance with $PM_{2.5}$ emissions reduction commitments.

Proposed solutions

- Current situation
    - Modelers use officially reported emissions from Parties, therefore using inconsistent and underestimated PM emissions in their analyses.
    - TFEIP has indicated that it intends to aim for consistent reporting of PM in a sector specific way, i.e. condensables are consistently included from some source sectors and consistently excluded from other source sectors.

- Short-term actions (planned for 2018-2022):
    - 2018: We ask that the EMEP SB at their 2018 meeting agree to request to Parties that they explain in their IIR whether they are reporting emissions that include or exclude the condensable component for each source (for example by presenting this information in a table).
    - 2018: We ask that the EMEP SB at their 2018 meeting agree that for the purposes of input into modelling studies, TFMM/MSCW may use an expert estimate of condensable emissions in place of PM emissions reported by Parties[1]. The methodology that is used will be agreed between the TFMM, MSC-W, MSC-E and the TFEIP. The method will be transparent, and will use publicly available information. This approach will only be undertaken if it is clear that a Party is not including the condensable component in its PM emissions estimates. This will be deduced from the corresponding IIR, or results from a specific Stage 3 review.
    - 2019: Subject to securing funding[2], the TFEIP will oversee an update to the EMEP/EEA Guidebook chapters on small-scale combustion so that only emission factors including condensable component are included in the "normal" emission factor tables. EFs that do not include the condensable component will be added to a separate table for reference. This will be done both for wood and coal combustion. Clear guidance will be added to the Guidebook chapter, indicating that best practice is for Parties to report PM emissions that include the condensable component for small combustion to the extent that this is possible.
    - 2019: At the 2019 TFEIP meeting, the updated Guidebook chapters will be presented for endorsement. information will be disseminated to Parties, explaining that best practice is to report PM emissions from small-scale combustion with the condensable component of PM included, and that the information in the Guidebook has been updated to specifically support this.
    -
- Long-Term (2022 onwards):
    - Following the Guidebook update, Stage 3 checks can be used to support the long-term aim of all Parties standardizing their reporting of PM emissions according to best practice, and in particular that they will include the condensable component for estimating PM emissions from small-scale combustion, road transport and non-road mobile machinery. This may be challenging for Parties that currently use country-specific PM EFs.

Annex

Background

Over the last years, scientific studies using modelled PM concentrations and comparing those with measured values have shown rather strong discrepancies, suggesting that some emission sources could be missing from the existing inventories. It was found that one of the key factors in this story is the

[1] For example estimating emissions by using: EFs from the Guidebook that include the condensable component, appliance information from the GAINS model and wood consumption from the IEA.

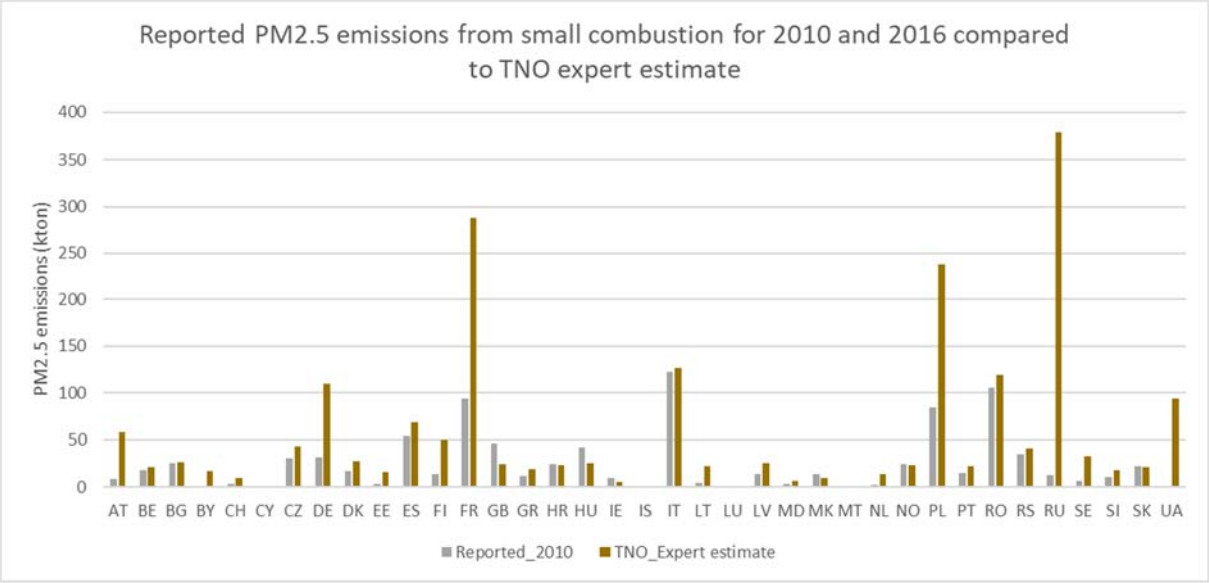
[2] There currently no secured funding for this work. We have assumed here that it will be possible to undertake the work in the Spring of 2019. All actions that follow are dependent on this step.

condensable component of particulate matter, that PM emissions in Europe are currently underestimated by comparing modelling results with measurements, and the residential combustion sector, in particular wood burning, is a key source for these condensable emissions.

Most emission factors in the EMEP/EEA Guidebook, as well as most of the country specific methodologies that have been developed by Parties, are based on a filterable only approach. This means that the condensable component is missing from many emission estimates.

Analysis of the issue

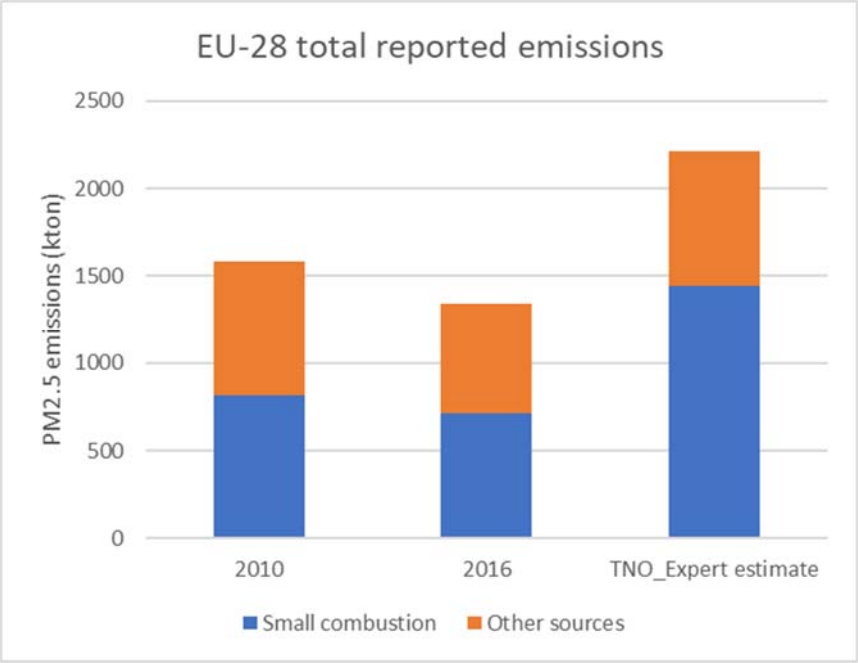
The Figure below presents the emissions of $PM_{2.5}$ for 2010 from all small combustion sectors (comprising of categories NFR 1A4ai, 1A4bi, 1A4ci, 1A5a), as reported by selected Parties in 2018. In addition, an expert estimate for 2010 is shown which has been calculated by estimated wood consumption figures in the residential sector (from Eurostat or alternative sources) with emission factors including the condensable component (from Denier van der Gon et al., 2015).



The Figure shows that in many counties significant underestimations are found in the reporting compared to the expert estimate including condensables, e.g. AT, DE, FI while for some other countries this is not the case (e.g. BE, BG, IT). An investigation into the methodologies applied by each country (in the IIRs available via the Centre on Emission Inventories and Projections, http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2018_submissions/) shows that the largest difference between reported data and the expert estimate is found in those cases where Parties do not include the condensable component in their PM emission estimates from this sector. For instance, reporting from BE, BG, DK, ES, IT, RO includes the condensable component. For these countries, the difference between reported data and expert estimate is significantly smaller compared to countries where the condensable component is excluded in reporting (these countries include for instance AT, DE, EE, FR, PL, NL). While it is recognized that it is not only the inclusion/exclusion of the condensable component which can cause differences between the reported value and the expert estimate, it is clear that the different approaches used by Parties are a key factor in ensuring consistent and comparable PM emissions across the EMEP region.

Applying the consistent expert estimate across Europe could increase total primary $PM_{2.5}$ emissions in the EU-28 alone by more than 50%, as shown by the Figure below, which compares current reporting

in small combustion to the TNO expert estimate for small combustion (based on 2010), with for both the same reported emissions for other sources in 2010 on top. The Figure shows that for 2010, when using the expert estimate total $PM_{2.5}$ emissions for the EU-28 Member States could increase by around 40%. With $PM_{2.5}$ emissions from other sources decreasing with time (in particular road transport), the relative underestimate in later years may even be larger.



Using the TNO expert estimate in different modelling exercises showed that the calculated concentrations of different PM components correspond better to the measured concentrations (Denier van der Gon et al. 2015). This confirms that the condensable component of PM is one of the factors explaining the current gap between modelled and observed concentrations of $PM_{2.5}$.