EMPIR Call 2020 – Fundamental, Industry and Normative

Selected Research Topic number: **SRT-n06**
Version: 1.0

Title: Improved uncertainties for monitoring diffuse pollutant and greenhouse gas emissions from distributed sources

Abstract

The monitoring of diffuse pollutant and greenhouse gas emissions from distributed sources is underpinned by flux data, which is obtained by combining open path optical concentration measurements with wind field measurements. This approach is used for periodically validating the diffuse emissions that are reported by site operators, based on emission factor calculations. However, there is no standardised approach to interpolating wind profiles to the locations of the open path optical concentration measurements, and the uncertainties associated with this, have not been characterised. Consequently, validated protocols should be developed for determining the uncertainty of the flux emitted from distributed diffuse pollutant and greenhouse gas emission sources. CEN/CENELEC identified this topic as one of their priorities [1]. Therefore, these protocols should be provided as a contribution to standards developing organisations, such as CEN 264 “air quality”, for incorporation into standards, such as those under CEN/TC 264/WG 38.

Keywords

Computational fluid dynamics, diffuse emissions, distributed sources, greenhouse gases, lidar, pollutants, standardisation, uncertainties, wind field, wind sensors

Background to the Metrological Challenges

Pollutant (e.g. NH_3) and greenhouse gas (e.g. CH_4, N_2O) emissions cause well documented socioeconomic and environmental impacts. As part of this, their diffuse emission from distributed sources (e.g. refineries, landfill, agriculture) significantly contributes to national emissions inventories. For example, waste contributes 30 % of European methane emissions, refineries contribute 19 % through leaks alone, and agriculture contributes 14.5 % of the world-wide total. The measurement of these emissions from distributed sources is understandably more difficult than measuring emissions from point sources (e.g. stacks). Nonetheless, and given the magnitude of these sources, these measurements are important because this data is needed for the monitoring, reporting and verification of diffuse emission sources. This is a critical issue for national regulators and policy makers, as without these capabilities, it will not be possible to regulate, to track reduction strategies or to formulate future legislation across all of these sectors.

New computational fluid dynamics (CFD) models need to be developed for the monitoring, reporting and verification of diffuse pollutant and greenhouse gas emissions from distributed sources. However, CFD models of the atmospheric boundary layer are not currently available. Therefore, new CFD wind field models, based on existing OpenFOAM codes, need to be developed that are representative of diffuse emissions from distributed sources.

New CFD models will need to be validated against the techniques that are currently used for determining the wind field (i.e. wind sensors on masts or wind lidar). Measurement sites typically determine wind profiles using ~4 sensors that are equally spaced along ~10 m high fixed masts. In addition, some measurement sites project wind lidar lasers in a conical orientation to determine turbulence and the horizontal and vertical wind speed. Consequently, wind lidar is a superior technique as it provides more data than mast-based wind sensors. For both approaches, the wind field measurements are then combined, by measurement service providers, with the location of each open path optical concentration measurement. The resulting flux data underpins diffuse emissions monitoring across all sectors and species and this method is used for validating (or in some cases directly monitoring) diffuse emissions. In most sectors the regulatory requirement is to calculate chronic emissions using emission factors, which are periodically validated by comparison to such measurements. Therefore, new CFD models will also need to be suitable for coupling with open path optical measurements in order to provide flux data from these sources. For the validation of new CFD models, the wind field will need to be accurately determined under a range of meteorological conditions, at a site with representative topography, using wind sensors on masts, lidar, and CFD modelling.

The uncertainties of individual wind sensors, and of wind lidar measurements, are both ~1 %. However, there is no standardised approach to interpolating wind profiles to the locations of the open path optical concentration measurements, and the uncertainties associated with this, have not been characterised. Consequently, the lack of characterisation of wind field uncertainties raises serious questions over the validity of the uncertainties assigned to flux emission quantities. Therefore, the uncertainties associated with determining the wind field need to be propagated with example concentration uncertainties of diffuse pollutant and greenhouse gas emission sources, in order to determine the impact on the final flux uncertainty. The uncertainty target for the wind field is 1 %.

Validated protocols, for determining the uncertainty of the flux emitted from distributed diffuse pollutant and greenhouse gas emission sources, are needed as a function of the wind field uncertainty (which is a larger contributor to the flux uncertainty than the concentration). These protocols need to be taken up by standards developing organisations, such as CEN 264 “air quality”, and incorporated into standards, such as those under CEN/TC 264/WG 38, at the earliest opportunity. This will enable regulators to have flux emissions data that are comparable between sectors and they will be able to differentiate real step-changes and trends from random variance. In addition, this will enable them to correctly target the operators which need to explain changes in their emissions profiles. It will also improve the quality of the data, from a raft of sectors, which is compiled into national emission inventories.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on metrology research necessary to support standardisation in monitoring diffuse pollutant and greenhouse gas emissions from distributed sources.

The specific objectives are

1. To develop a computational fluid dynamics (CFD) wind field model for representative diffuse pollutant (e.g. NH_3) and greenhouse gas emissions (e.g. CH_4, N_2O) from distributed sources (e.g. refineries, landfill, agriculture). This model should be suitable for coupling with open path optical measurements of the concentration of these emissions in order to provide flux data from typical distributed diffuse sources.
2. To accurately determine the wind field, under a range of meteorological conditions (e.g. rain, snow, wind), at a site with representative topography using wind sensors on masts, lidar, and the CFD model developed in objective 1.
3. To estimate the uncertainties associated with determining the wind field using the measurement data from objective 2. The uncertainty target for the wind field is 1 %. The wind field uncertainties should be propagated with example concentration uncertainties of diffuse pollutant and greenhouse gas emission sources to determine the impact on the final flux uncertainty.
4. To facilitate the take up of methods and technology developed in the project by standards developing organisations such as CEN 264 “air quality”, including the provision of validated protocols for determining the uncertainty of the flux emitted from distributed diffuse pollutant and greenhouse gas emission sources as a function of the wind field uncertainty. To ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form (e.g. Technical report) that can be incorporated into the standards (e.g. those under CEN/TC 264/WG 38) at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.8 M€, and has defined an upper limit of 1.0 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the oil and gas, agriculture, landfill, iron, steel, etc. sectors.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects (JRPs)"

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] CEN/CENELEC identified this topic as one of their priorities. Details are available at: https://msu.euramet.org/current_calls/pre_norm_2020/documents/cen_priority_004.pdf