INDAIRPOLLNET
IMPROVING INDOOR AIR QUALITY

# WORKING GROUP 2

# What can the indoor and outdoor air chemistry communities learn from each other?

## Recommendations

**COST Action 17136 Indoor Air Pollution Network**

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EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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## The network

**INDAIRPOLLNET** (INDoor AIR POLLution NETwork) is a network of experts on indoor air, working together to solve issues related to indoor air quality and planning an optimal way of studying indoor air pollution and its effects on health of the occupants. The overarching aim of this network is to define a blueprint for the optimal indoor air chemical characterisation campaign, which is relevant for the buildings we use and for the way that we use them.

**This report constitutes** the recommendations of INDAIRPOLLNET COST Action 17136 Working Group 2 to Working Groups 3, 4 and 6, based on review of recent literature to gather the existing information and expertise in outdoor air studies to be used in the development of planning indoor air campaigns.

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# Recommendations drawn from the literature review on outdoor air chemistry

The work within WG2 was performed to identify the areas and processes, based on our own (the WG2 group) knowledge of and experience in atmospheric chemistry in ambient air in general, that could be useful for the indoor community. The work was organized to provide information and input to other WGs, WG3 "What to measure", WG4 "How to measure" and partially WG6 "Blueprint of a field campaign for characterization of indoor air chemistry". Recommendations for WG5 are out of scope of WG2 and thus not included here.

The indoor air chemistry research has advanced on its own during the past couple of years. It also has a history of the measurements and assessments of indoor air quality issues with respect to what compounds to measure and why, what measurement techniques to use, what kind of buildings to be measured. The remaining issue is to define the perfect field campaign for complex characterisation of indoor air chemical processes.

With regard to indoor air chemistry, the outdoor community can make recommendations for indoor community in respect of recently identified approaches, methodologies and evaluation schemes, instrumentation and modelling tools, rather than suggestions on the individual pollutants and their concentrations in indoor air.

## Recommendations for deciding key species and relevant parameters (WG3)

In addition to the extensive list of recommendations provided by WG1, the outdoor community would suggest the following:

- Real-time measurements of the concentrations of the main atmospheric **oxidants** hydroxyl radical (OH), ozone ($O_3$), nitrate radical ($NO_3$), and chlorine atom (Cl); peroxyradicals $HO_2$ and $RO_2$ and **their precursors** (NOx, $N_2O_5$, $ClNO_2$, HONO as well as peroxynitrates, aldehydes or other photochemically or thermally labile species) in indoor environments. The measurements will be useful as input in indoor air chemistry models, to explain or predict the outcomes of indoor air measurements of other species.
- Perform studies on measured and modelled **oxidant reactivity** – overall loss rate, mainly of OH radicals but also $NO_3$ radicals. Missing reactivity, the difference between the measured reactivity and that calculated from the identified and quantified components, and their know reaction rates in the investigated indoor space, will provide guidance on the extent of missing/unknown indoor air pollutants.
- Investigate formation and concentrations of **highly oxygenated** organic **molecules** (**HOM**). The HOM-compounds are formed by both OH- and $O_3$-initiated oxidation of both anthropogenic (BTEX – Benzene, Toluene, Ethylbenzene, Xylenes) and biogenic (terpenes – mainly $\alpha$-pinene and limonene) substances abundantly present in indoor air. Published studies from both field campaigns and simulation chambers can serve for guidance and expertise.
- **Simultaneous measurement of outdoor air pollutants** as it creates a link between the indoor and outdoor air quality and chemistry and can be successfully approached by modelling. The models can then help with specific indoor-relevant questions such as 1) refinement of indoor-to outdoor ratio variability (e.g., as a factor of outdoor weather and pollutant concentrations, climate change, indoor ventilation and infiltration rates, source strength, and human activities), 2) ) better assessment/identification of indoor sources, and 3) estimation of a true individual (personal) pollutant exposure level, focusing on a better discrimination between indoor and outdoor air pollutant exposure.

## Recommendations for considering how to measure (WG4)

There are existing conventional techniques for measurement of the concentrations of a number of various (indoor) air pollutants. The traditional techniques rely often in sampling on sorbent media or filters with subsequent off-line analysis using instruments with a large variety and complexity of possibilities for identification and quantification of the species and time resolution of the measurements. Considering the analytical tools available, these are the recommendations:

- Use the existing, rapid **on-line monitoring** equipment with high sensitivity for monitoring of gaseous organic compounds such as Time-of-Flight Proton Transfer Reaction Mass Spectrometer(s) (ToF-PTR-MS) for VOC, and Time-of-Flight – Chemical Ionisation Mass Spectrometer(s) (ToF-CIMS) for specific organic compounds such as carboxylic acids.
- Use on-line monitoring instruments for measurements of particles properties: mass and number concentrations and size distributions. For chemical characterisation of particles, use Aerosol Mass Spectrometer and/or ToF-PTR-MS and ToF-CIMS with the FIGAERO (Filter Inlet for Gases and AEROsols) inlet.
- Consult relevant publications for a **selection of an appropriate instrument** when several options are available. Instruments for a measurement of the same species may differ in terms of size, robustness and easiness to operate (and calibrate). Published intercomparison data of instruments for the measurement of formaldehyde, oxygenated organic compounds, OH radical concentrations and reactivity, nitrate radicals, peroxyradicals, HONO, $N_2O_5$ and black carbon are summarised in the report of WG2.
- **Complement** the on-line measurements using the monitoring instruments **with off-line monitoring** (sampling and consequent analyses) using sorbent media or filters. Especially non-target analyses can help to identify species that on-line monitoring instruments missed or were not able to quantify because of interferences or non-specificity of the method.

## Recommendations for planning a blueprint of a field campaign for characterization of indoor air chemistry (WG 6)

WG6 will build on the results from the work all the preceding WGs. In addition to the extensive list of suggestions the 'perfect field camping' provided by WG1, the outdoor group would like to make these recommendations:

- Arrange the campaign in a way that covers measurement of organic substances with a wide range of **volatility**. Categorisation of the organic compounds in indoor environments according to their volatility is a complement to traditional classifications according to the origin (primary or secondary) or the distinction between gaseous and particulate indoor air pollutants. In connection to other indoor parameters (indoor climate, ventilation rates, occupant number and behaviour, etc.), it may reveal unexpected correlations.

- Consider the use of **novel interpretative methods** (e.g., data mining and/or machine learning algorithms, Principle Component Analysis, Positive Matrix Factorisation) for simplification, reduction and interpretation of the complex chemical data generated in the field campaign. Such methodologies can be applied to understand the relative contributions of sources beyond the historical simplifications by use of surrogates, representative compounds and tracers/markers for individual processes towards a more complete appreciation of their complexity.

- Arrange the campaign in close cooperation with the modellers who can provide information about necessary inputs for the models and desired parameters/measurements for model development and validation.