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**New Directions: Support for integrated decision-making in air and climate policies – Development of a metrics-based information portal**

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Air pollution and climate change are inextricably linked (Jacob and Winner, 2009). However, they are normally treated separately which can lead to incoherent strategies. An example is domestic biomass heating dubbed as a climate friendly option, however, co-emitted air pollutants, such as black carbon, decrease air quality significantly (Williams, 2012). To support integrated thinking on air and climate policies, that is taking into account co-benefits and avoiding of trade-offs, currently available scientific information needs to be better linked and made available in a more comparable, comprehensive and accessible format at various decision-making levels. Here we report on the plans to develop a framework that will be strongly grounded in the science that would relate disconnected pieces of information for discussions between scientist and policy makers targeted at maximizing co-benefits and avoiding trade-offs in relation to existing policy targets. This proposal is the main outcome of a workshop held in October 2013, where about 30 scientific experts and policy makers invited by the Institute for Advanced Sustainability Studies (IASS) and the European Environment Agency (EEA) discussed how the scientific knowledge base on air-climate interactions can be best made available to policy makers and other stakeholders, as well as the needs of decision-makers in this arena. Participants from Europe, Asia and the USA represented climate, atmospheric, and health sciences, environmental agencies, national and regional policy makers, NGOs, and international organizations.

## Background

The idea of coordinated action on air quality and climate change mitigation policies is no longer new. The relevance and impact of such integration has been suggested and investigated for a numbers of years (e.g., EEA, 2004; EPUK, 2011; IGBP/IGAC, 2012; Raes and Seinfeld, 2009; Shindell et al., 2012). Especially since air pollution and climate change are strongly linked with regard to their causes, effects, and mitigation options (Jacob and Winner, 2009), the assessment and subsequent coordination of relevant policy options that steer air pollutant and greenhouse gas emission reductions (including energy policy) might result in cheaper, more effective and thus more suitable simultaneous tackling of the two environmental problems and their impacts (Nemet et al., 2010; Shindell et al., 2012; West et al., 2013).

One of the challenges is that air pollution and climate change are often treated as separate problems at national and international level under different environmental regulations or conventions (e.g., LRTAP and UNFCCC) and are often covered by different policy departments for a variety of reasons (Sivertsen and Bartonova, 2010). In contrast to this division, although typically considered a local/regional issue, it has been shown that air quality is a global problem because of the transport of air pollutants across the Northern hemisphere (Ramanathan and Feng, 2009; UNECE, 2010). Furthermore, climate change mitigation, typically considered only in the global context, has important regional aspects through the influence of short-lived climate forcing pollutants (Collins et al., 2013; Fry et al., 2012). In both cases, climate change or air quality, mitigation measures intended for one issue can and often do influence the emissions from the other e.g., (Åström et al., 2013; McCollum et al., 2013).

To seize this opportunity for a more integrated approach to air and climate policy, substantial work by science and policy is needed. In the policy domain, to move past thematic thinking, opportunities for joint action need to be identified. Science should play an important role here with the air quality, health, and climate communities working together to link more strongly and coherently the information from metrics currently used to attain different policy goals.

**The role of metrics for decision making**

Metrics serve different purposes and can provide information on emissions, ambient concentrations, exposure, and impacts. Some metrics are designed with specific (policy) goals in mind, such as the protection of human health, or to check compliance with air quality standards (e.g., $PM_{2.5}$ ambient concentration limit values, SOMO35). Others by contrast have been adopted in policy discussions without the original intention for policy use e.g., the global warming potential (GWP) (Shine, 2009). Climate metrics are often based on emissions while air quality metrics often refer to ambient concentrations. Furthermore, many health and ecosystem metrics are impact focussed (mortality, morbidity, crop losses, etc.). Differences such as these make it difficult to compare the implications of a policy on air pollution or climate change in a coherent way.

Some air and climate metrics are debated in the literature regarding their applicability in policy making, an example of which is the discussion around GWP e.g., (Fuglestvedt et al., 2003; O'Neill, 2000; Shine, 2009). In principle the choice of metric is policy-related, often requiring value judgements, and cannot be based on science alone, although it requires strong scientific underpinning. This is illustrated by IPCC AR5 Working Group 1 not making recommendations of a particular metric for climate policy making.

That climate and air quality metrics can be applied simultaneously to identify trade-off and co-benefit options for air pollution and climate change mitigation has been recognized, for example, by European institutes like the Joint Research Centre (JRC) and the International Institute for Applied Systems Analysis (IIASA) that run integrated assessment studies at international and national level. The Joint Research Centre has explored trade-offs and co-benefits by world region (van Aardenne et al., 2010) and recently developed the Fast Scenario Screening Tool (FASST) to explore health, ecosystem and climate impacts (as used in (UNEP, 2011)). IIASA developed the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model used for assessing strategies that reduce air pollutant and greenhouse gas emissions at country level at least cost and to minimize negative effects on human health, ecosystems, and climate change (Amann et al., 2011).

Current international and national thematic environment policies are relatively well served by the available models and the metrics they apply, and once targets are fixed, the policy information needs are especially focused on compliance and not so much on taking new metrics-based information into account in the ongoing policy process. There are, however, two areas where new approaches are needed in the policy cycle that would benefit from scientific support. First, the upcoming transition to a low carbon society (e.g., (Fisher, 2013; Government, 2009)) requires air and climate policies to go beyond mere technical measures taking into account systemic changes as well as potential climate feedbacks and resulting environmental impacts. Secondly, on the smaller, more local, city level, where initiatives knowingly exist that are ready to simultaneously consider air quality and climate (e.g. the city of Durban, Republic of South Africa (Thambiran, 2011)), and possibly other issues (e.g., noise), there is a need for information to support strategic decision-making (Anguelovski and Carmin, 2011). Here the resources and/or data needed to conduct integrated assessment modeling do not exist, but the independently motivated action does. Cities are particularly relevant actors for mitigating both greenhouse gases and air pollution, since more than half of the world's population lives in urban centers, they are economic engines with substantial emissions of greenhouse gases and air pollutants (Anguelovski and Carmin, 2011; Blok et al., 2012; Carter, 2011; EEA, 2013; Liu and Deng, 2011). In the European Union for example, about 80 % of the $CO_2$ emissions stem from urban activities (Cerutti et al., 2013) and roughly 88 % of the urban population is exposed to air pollution levels exceeding the recommendations by the WHO (EEA, 2013).

**The Framework**

All these points considered, the workshop participants concluded that the best way forward is the development of an information framework, applying a suite of metrics supporting simultaneous consideration of various environmental (and potentially economic) impacts of air quality and climate change policies at regional and local scales. The framework would facilitate discussion between science and policy at different levels regarding co-benefits and trade-offs in relation to existing policy targets. The aim is not to reproduce or replace more detailed efforts, as described above, but aims to combine the relevant information in such a way as to enable a dialogue about the options that could be implemented and what synergies or trade-offs these measures would have for the different areas making use of the lesson learned – not in the form of one meta-metric, but a framework that includes information from multiple metrics. By providing access to qualitative and quantitative information in a useable and comparable way, guidance can be provided and awareness improved, especially at city and regional level not always covered by integrated assessments. For example, information such as the impact of switching from traditional fossil fuel cars to electric cars, where data from London show that this would reduce $NO_x$, $PM_{10}$ and $CO_2$ emissions by 9%, 5% and 15% in 2020, respectively, compared to a baseline scenario (Oxley et al., 2012).

The tool would hence illustrate the relative improvements for air quality and GHG emissions allowing comparison between different practices/policy choices. Where possible the figures could be translated in air quality limit values and avoided tonnes of $CO_2$ emissions for direct comparison with legal limit values and potential climate objectives. By bringing the discussion to a different decision making level of more local users and local action, approaches to jointly consider air pollution and climate change mitigation measures might make its entry into everyday decision-making and long-term planning. To support this process, the EEA and IASS are developing a prototype for such an information portal in collaboration with the various scientific disciplines and specifically call for new approaches linking climate change and air quality metrics. For saliency the design will be co-developed with the different communities of end-users. For more information and/or to engage in the process, please contact the authors or go to http://climpol.iass-potsdam.de/about/working-group/metrics-workshop.

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