Air Pollution and Climate Change

Progress Toward Integrated Strategies and Co-Benefits

by Kevin Hicks and Johan Kuylenstierna

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Drawing on presentations made to the 15th International Union of Air Pollution Prevention and Environmental Protection Associations' (IUAPPA) World Clean Air Congress in Vancouver in September 2010, this article briefly reviews the scientific and policy drivers that are critical in developing plans to improve air quality while simultaneously reducing greenhouse gas (GHG) emissions.

The relationship between air pollution and climate change—and the financial savings that integrated strategies could deliver—has become one of the central issues of air quality in recent years. IUAPPA and the Stockholm Environment Institute (SEI) have been closely involved in developing the issue at every stage.

IUAPPA's 13th World Clean Air Congress in London in 2004, which took as its theme the interaction of climate and pollution, was among the first major international meetings to highlight the issue. In 2008, the Global Atmospheric Pollution (GAP) Forum organized an international conference on "Air Pollution and Climate Change: Developing a Framework for Integrated Co-benefits Strategies" that took place in Stockholm, Sweden. The meeting, hosted by Sweden and funded by Sida, the Swedish International Development Cooperation Agency, was attended by a range of stakeholders from 30 countries, including representatives from the United Nations Environment Programme (UNEP), the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat, the Secretariat of the Convention on Long-Range Transboundary Air Pollution (LRTAP), and the Joint Research Centre of the European Commission and the French Presidency of the European Union. The conference, organized jointly by IUAPPA and SEI, brought the issue of co-benefits to prominence and resulted in a coherent policy framework focused on the critical role of the short-lived climate forcers

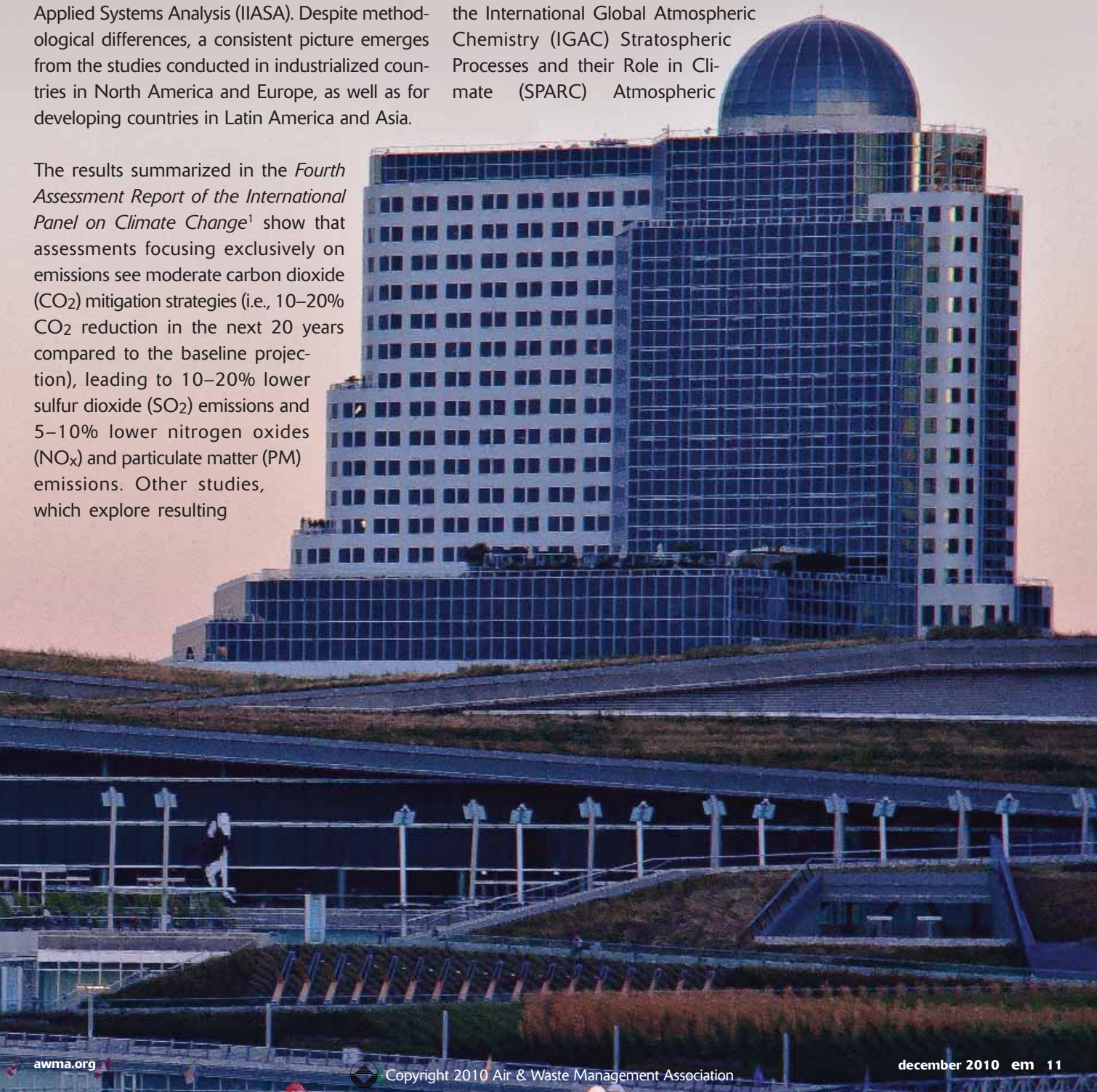
Vancouver's Inner Harbour. Photo is courtesy of Laurie Bates-Frymel and was taken during the IUAPPA Habour Cruise.

(SLCFs; tropospheric [or ground-level] ozone, aerosols [including black carbon] and methane), which are both major pollutants and important climate change agents.

Between these two landmark meetings, a decisive step was the development of integrated assessment models for optimized strategies for air pollution and climate, such as the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model developed by the International Institute for Applied Systems Analysis (IIASA). Despite methodological differences, a consistent picture emerges from the studies conducted in industrialized countries in North America and Europe, as well as for developing countries in Latin America and Asia.

The results summarized in the *Fourth Assessment Report of the International Panel on Climate Change*[1] show that assessments focusing exclusively on emissions see moderate carbon dioxide (CO_2) mitigation strategies (i.e., 10–20% CO_2 reduction in the next 20 years compared to the baseline projection), leading to 10–20% lower sulfur dioxide (SO_2) emissions and 5–10% lower nitrogen oxides (NO_x) and particulate matter (PM) emissions. Other studies, which explore resulting health impacts, demonstrate substantial benefits for human health. The inescapable conclusion for IUAPPA and its partners was that co-benefits should be a primary concern, and this has been increasingly reflected in recent IUAPPA programs.

Since 2008, there has been a significant increase in international activity in the area. Several international assessments are now in progress, including the UNEP Integrated Assessment of Black Carbon and Tropospheric Ozone, and Its Precursors; the International Global Atmospheric Chemistry (IGAC) Stratospheric Processes and their Role in Climate (SPARC) Atmospheric



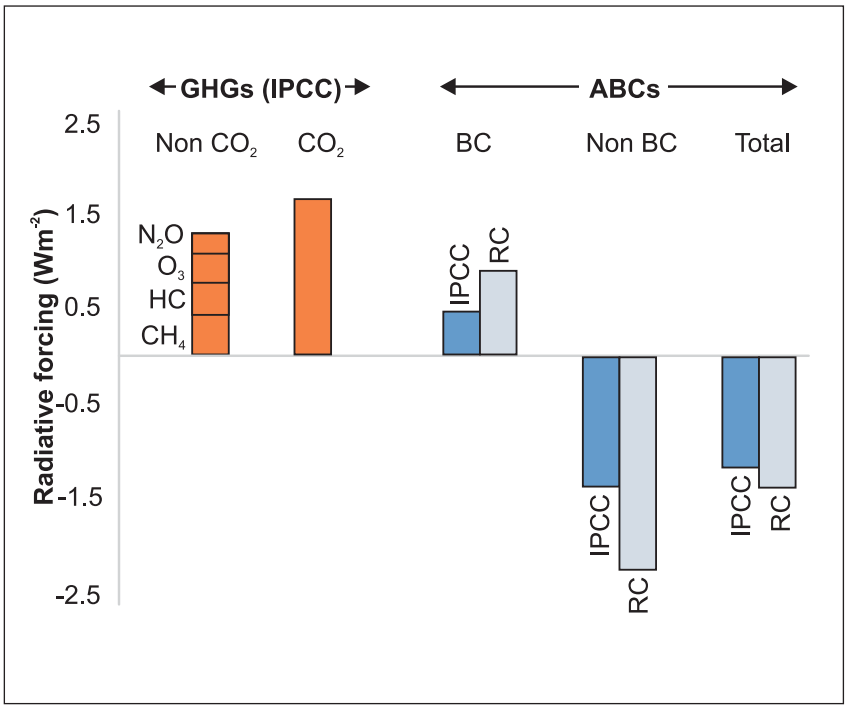


Figure 1. *Global radiative forcing due to greenhouse gases and atmospheric brown clouds (ABCs).*[2]

Chemistry and Climate Initiative on Bounding the Role of Black Carbon in Climate, which will report to the Fifth Assessment of the Intergovernmental Panel on Climate Change (IPCC); and the ad hoc expert group on Black Carbon of the Convention on Long-Range Transboundary Air Pollution (LRTAP).

Stockholm Conference: Key Conclusions

The key outcome of the Stockholm Conference was the recognition by a wide range of stakeholders that, although the GHGs that have accumulated in the atmosphere over the last 150 years have committed the planet to a warming of over 2 °C, air pollution—in the form of aerosols (and aerosol-cloud interactions)—is reflecting enough sunlight to mask this committed global warming by approximately 40%. Air pollution aerosols can have different effects; it is the net effect that is important. For example, black carbon warms the atmosphere, while aerosols such as sulfate particles exert a cooling effect.

Radiative forcing is the term used to describe these effects and it is defined as the net change in the energy balance of the Earth with space (i.e., change in incoming solar radiation minus outgoing terrestrial radiation). At the global scale, the annual average radiative forcing at the top-of-the-atmosphere or the "tropopause" is generally a good indicator of global mean temperature change.

Figure 1 shows that estimates of the magnitude of the radiative forcing of aerosols are potentially greater than reported by the IPCC in its fourth assessment report in 2007. According to the IPCC, the mean anthropogenic radiative forcing resulting from all GHGs is estimated to be +3.05 Wm^2 of which methane accounts for +0.48 Wm^2 and tropospheric ozone for +0.35 Wm^2. In addition, it is estimated that black carbon accounts for +0.34 Wm^2 in the atmosphere and an additional +0.1 Wm^2 on snow. Regionally, black carbon heating effects can rival that due to CO_2 increases, for example, in the Arctic and the Himalayan-Tibetan glacier regions.

This underlines the potential for addressing air pollutants comprehensively as part of the efforts to address global warming, which has stimulated the current international assessments that aim to improve the estimates shown in Figure 1.

As well as acting as warming agents, ground-level ozone and black carbon aerosols are also air pollutants (as is methane, which is a precursor of ozone formation). Ozone affects crop yield, and therefore, food availability, and also human health. Black carbon is a key component of PM, which is the main contributor to the health impacts of air pollution, causing the premature deaths of hundreds of thousands of people each year. Compared to CO_2, these substances live for a relatively short time in the atmosphere, anything from a few days or weeks for ozone and black carbon, to a decade for methane.

The main conclusion of the Stockholm Conference was, therefore, that urgent action to decrease the concentrations of the key SLCFs in the atmosphere will improve air quality (reducing risks to health and crop yields) and combat short-term accelerated warming (reducing risks of crossing critical temperature and environmental thresholds).

It was stressed that some air pollution policies required to reduce aerosols to protect human health and the environment (e.g., low sulfur fuels) will lead to the unwanted effect of accelerated

warming in the short-term. Because of the importance of protecting human health, this leads to a necessity for the reduction of all GHG emissions, not only of long-lived (e.g., CO_2), but also of short-lived substances (e.g., black carbon, methane, and ozone), to compensate the loss of aerosols that exert a cooling effect. In this way, integrated co-benefit strategies can optimize GHG and air pollution mitigation benefits whilst minimizing unwanted tradeoffs.

Science Drivers

Since 2008, there has been significant international effort to understand more fully the science of SLCFs and their potential as tools to combat climate change and air pollution issues simultaneously. The effects of black carbon and ozone on human health are well established, as is the potential for ozone impacts to sensitive crop varieties, especially in Asia. However, there is still debate as to the actual climate-forcing effects of SLCFs.

A key area of debate is the magnitude of the net warming effect of black carbon once factors such as aerosol-cloud interactions are taken into account. The outcome of current assessments being conducted by the international community is eagerly awaited on this issue and will ultimately determine how successfully co-benefit strategies for black carbon can be implemented around the world. For example, black carbon is a particular issue for the developing world because of the prevalence of biomass burning for domestic cooking and heating.

Methane is the second most significant driver of climate warming after CO_2 and recent research has shown that its warming impacts occur through a variety of pathways, and suggests that methane warms approximately two thirds as much as CO_2 (see Figure 2). However, unlike CO_2, which lasts for centuries in the atmosphere, methane lasts only about a decade. So, to achieve quick cooling in sensitive regions like the Arctic, methane reductions may be a more powerful tool, even though CO_2 reductions are needed over the long run.

Policy Drivers

It has often been said that, in an ideal word, science and policy development should go hand in hand, as there is often no time to wait for the science to provide all the answers, and decisive actions need to be taken by policy-makers. Climate change is no exception and SLCFs could potentially make a big contribution to the stabilization of the climate in the short-term, especially in sensitive regions.

Contributors to the Stockholm Conference emphasized that the current priority for developing countries is poverty eradication and sustained economic development, and in support of this, improved air quality. Countries that do not yet have well-established systems of air quality regulation have the opportunity to develop groundbreaking integrated systems more efficiently and cost-effectively than countries where well-established air pollution control systems are already in place. Existing regional air pollution networks can play an important role in linking the climate and air pollution communities at different scales and in sharing expertise.

Since 2008, the development of initiatives on SLCFs, such as methane and black carbon, has been gaining momentum around the world, driven by the potentially high health and environmental benefits, with GHG mitigation as a co-benefit in "win-win" policies. For example, reducing black carbon emissions in the domestic sector in developing countries is particularly attractive to policy-makers due to the tremendous human health benefits. However, there is, inevitably, still a long way to go

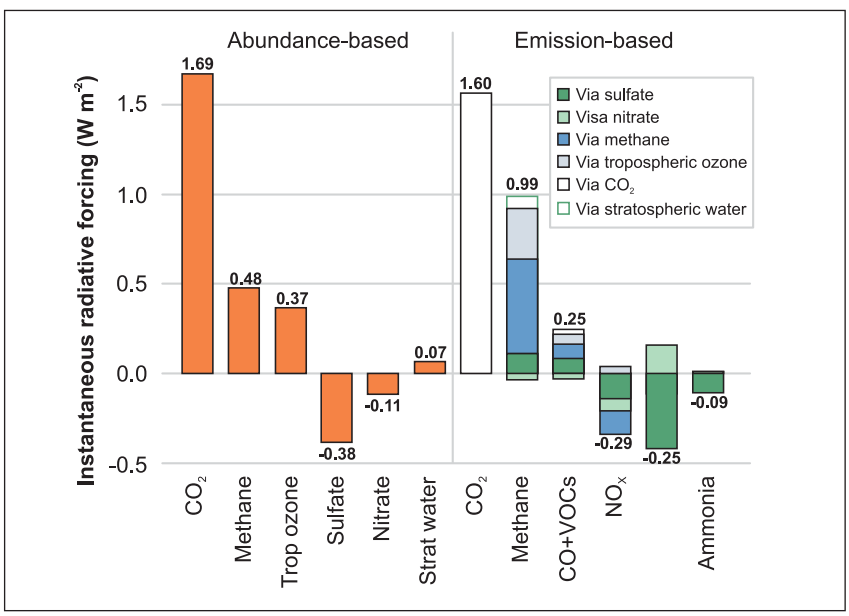


Figure 2. *Relative climate forcing of different emissions, showing that methane warms approximately two thirds as much as carbon dioxide.*[3]

There is still debate as to the actual climate forcing effects of SLCFs.

before integrated co-benefit policies are widely implemented nationally and regionally.

Methane as a precursor of ozone and a GHG in its own right is a prime area where action is already being initiated. Several nations have begun to regulate methane emissions, especially from landfills and coal mines—as much for energy recovery as for environmental reasons. Some methane projects have been financed through the Clean Development Mechanism (CDM) of the Kyoto Protocol, but those projects have stalled with uncertainty over what comes after the Protocol. The global Methane to Markets program (www.methanetomarkets.org) has engaged 30 countries in technical assistance and project development, and is expanding. In December 2009, health and climate experts proposed a Global Methane Fund (www.globalmethanefund.org) to jump-start methane reduction projects by providing carbon-credit guarantees and several countries are discussing its development.

Contribution of IUAPPA and GAP Forum Partners

The conclusions of the Stockholm Conference (see www.gapforum.org) stand as the fullest and most coherent statement of the issues and opportunities, but in the last two years there have been other important initiatives by the GAP Forum and by IUAPPA and its members individually:

- The GAP Forum partners are considering how to encourage outreach to help developing nations implement "best practices" for regulation of methane sources with an initial focus on improving regional air quality, but with the clear co-benefit of climate protection. The national level may be the most important for the development of co-benefit strategies, but the regional air pollution networks in the GAP Forum could potentially play an important role in promoting and disseminating strategies at the national scale.
- The European Federation for Clean Air has produced important recommendations on how the European Union (EU) could integrate its policy-making processes for air quality and climate. A key proposal is that whenever EU Air Quality Directives come up for review there should be an obligation to take account of implications for climate change.
- IUAPPA's French member organization is playing a significant role in promoting the French government's strategy to integrate air pollution and climate policies at the regional and local scales.
- An Asian Co-Benefits Partnership has been established by the Institute for Global Environmental Strategies in Japan, which works closely with the GAP Forum.
- The Stockholm Conference concluded that countries newly introducing Air Quality Management Systems had an opportunity denied those with established systems to move directly and simply to integrated air quality-climate systems. IUAPPA's regional conference in South Africa highlighted how this had been achieved in South Africa.
- The LRTAP Convention is considering how far short-term climate forcers can be incorporated in the review of the Gothenburg Protocol, which currently regulates air pollution across the region. If this could be achieved it would provide an instrument for targeting resources on urgent climate and air pollution priorities, such as slowing the rate at which the Arctic ice cap is melting. **em**

References

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