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Air quality and climate change: Designing new win-win policies for Europe

Michela Maione^{a,b,*}, David Fowler^c, Paul S. Monks^d, Stefan Reis^{c,g}, Yinon Rudich^e,
Martin L. Williams^f, Sandro Fuzzi^b

^a DiSPeA, Università degli Studi di Urbino "Carlo Bo", Urbino, Italy

^b Istituto di Scienze dell'Atmosfera e del Clima, Consiglio Nazionale delle Ricerche, Bologna, Italy

^c Centre for Ecology & Hydrology, Edinburgh, United Kingdom

^d Department of Chemistry, University of Leicester, Leicester, United Kingdom

^e Department of Earth and Planetary Sciences, Weizmann Institute of Science, Rehovot, Israel

^f Environmental Research Group, King's College London, London, United Kingdom

^g University of Exeter Medical School, Knowledge Spa, Truro, United Kingdom

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ABSTRACT

Anthropogenic activities are responsible for the emission of gaseous and particulate pollutants that modify atmospheric composition. Such changes are, in turn, responsible for the degradation of air quality at the regional/local scale as well as for changes of climate. Air pollution and climate change are two intimately connected environmental issues. However, these two environmental challenges are still viewed as separate issues, which are dealt with by different science communities and within different policy frameworks. Indeed, many mitigation options offer the possibility to both improve air quality and mitigate climate change but, at the same time, mitigation options that may provide benefits to one aspect, are worsening the situation in the other. Therefore, coordinated actions taking into account the air quality-climate linkages are required. These actions need to be based on strong scientific grounds, as recognised by the European Commission that in the past few years has promoted consultation processes among the science community, the policy makers and the relevant stakeholders. Here, the main fields in which such coordinated actions are needed are examined from a policy perspective.

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1. Introduction

Climate change and air pollution are both critical environmental issues that humanity is facing. On the one hand, air pollution is globally the second leading risk factor for the global burden of diseases, and the premature deaths due to air pollution are estimated globally as 3.4 million, 480,000 in Europe only (Lim et al., 2012). On the other hand, the 5th IPCC Assessment Report has clearly stated that "warming of the climate system is unequivocal and, since the 1950s, many of the observed changes are unprecedented over decades to millennia" (IPCC, 2013).

The concept that air pollution and climate change are two environmental issues intimately connected is not new and a publication of the Swedish Environmental Protection Agency in 2009 (Swedish EPA, 2009) had the foretelling title "Air pollution and

climate Change: two sides of the same coin?". However, even now, in many areas of both science and policy, these two environmental challenges are viewed as separate issues, which are dealt with by different science communities and different policy departments.

A recent overview paper (von Schneidemesser et al., 2015) summarises the many linkages between air quality and climate change (Fig. 1) and evidences that any policy actions intended to mitigate one of these two issues must necessarily take into account the feedbacks with the other, to avoid that benefits to one sector, will worsen the situation in another.

2. Linkages between air quality and climate change

All anthropogenic activities (e.g. energy production, transportation, industrial processes, agriculture, waste management) are responsible for the emission of gaseous and particulate pollutants that modify atmospheric composition. The atmosphere has, on the other hand, a high self-cleansing capacity, and most pollutants are rapidly removed from the atmosphere by wet and dry deposition

* Corresponding author at: DiSPeA, Università degli Studi di Urbino "Carlo Bo", Urbino, Italy.

E-mail address: michela.maione@uniurb.it (M. Maione).

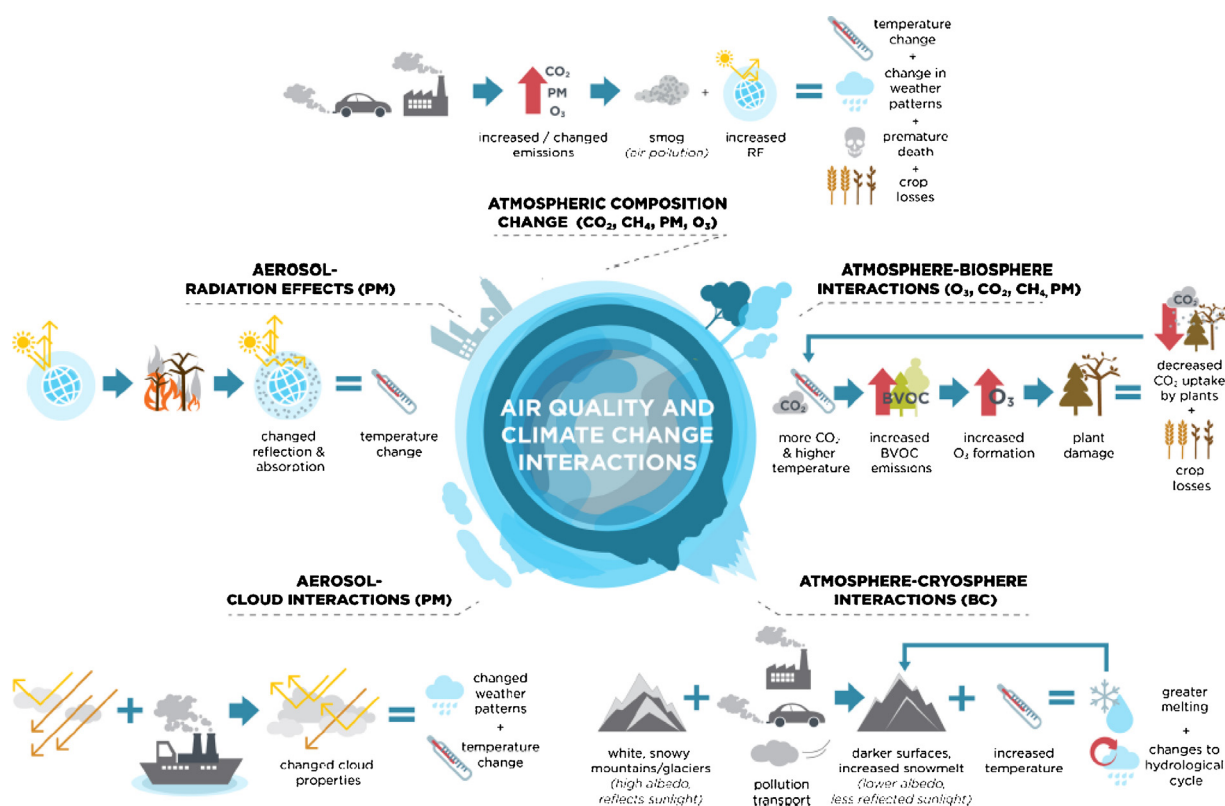


Fig. 1. An overview of the main categories of air quality and climate change interactions. The most relevant components are listed in the brackets following the category (Reprinted with permission from von Schneidemesser et al., 2015).

or through atmospheric reactions (short-lived compounds, persisting in the atmosphere for times roughly from a few days to a month).

The self-cleansing capacity of the atmosphere is much smaller for other less reactive atmospheric compounds emitted by anthropogenic activities such as carbon dioxide, which remain in the atmosphere for much longer times (long-lived compounds). Carbon dioxide, the main greenhouse gas (GHG) is not considered an atmospheric pollutant since it does not affect human health. On the other hand, also some of the traditional short-lived air pollutants interact with climate. In particular, ozone (Monks et al., 2015) and particulate matter (PM) (Fuzzi et al., 2015) have a strong impact on the Earth radiation balance and thus on climate.

Methane, which has a residence time in the atmosphere of the order of 8 years, lies in an intermediate situation: is a greenhouse

gas but also interacts with the atmospheric oxidant cycle and with air pollution in general (Monks et al., 2015).

It is therefore not possible to unambiguously separate anthropogenic emissions in two distinct groups: atmospheric pollutants and climate-forcing species, as evidenced in Table 1. In addition, many of the same sources emit both climate-forcing species and air pollutants.

The anthropogenic activities influence climate both directly, emitting GHGs and PM, and indirectly emitting short-lived pollutants that are either climate forcing agents themselves or precursors of them. Fig. 2 shows an evaluation of the radiative forcing for the period 1750–2011 of the main trace compounds derived from anthropogenic activities (Myhre et al., 2013).

As Fig. 2 clearly shows, policy measures to mitigate air quality and climate change must necessarily be integrated, since climate-

Table 1

Residence time, pollutant properties and climate effects of the main atmospheric trace compounds deriving from anthropogenic activities.

Compound	Approx. atmospheric residence time	Pollutant effect(s) on health and/or ecosystems	Climate effects
Carbon dioxide (CO_2)	150 years	Ocean acidification, affects photosynthesis	Long-lived climate-forcer
Methane (CH_4)	8 years	Precursor of tropospheric ozone	Medium-lived climate-forcer
Ozone (O_3)	1 month	Health and vegetation damages	Short-lived climate-forcer
Sulphur dioxide (SO_2)	1 week	Health damages, ecosystem acidification	Precursor of PM sulphate, cooling climate
Nitrogen oxides (NO_x)	1 week	Health damages, precursor of tropospheric ozone, ecosystem acidification, water eutrophication	Precursor of PM nitrate, cooling climate
Ammonia (NH_3)	1 week	Ecosystem acidification, water eutrophication	Precursor of PM ammonium, cooling climate
Black carbon (BC)	1 week	Health damages	Absorbs solar radiation, warming climate
Volatile organic compounds (VOCs)	variable	Health damages, precursors of tropospheric ozone	Precursors of tropospheric ozone

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