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Moving towards ambitious climate policies: Monetised health benefits from improved air quality could offset mitigation costs in Europe

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ABSTRACT

Air quality and related health effects are not only affected by policies directly addressed at air pollution but also by other environmental strategies such as climate mitigation. This study addresses how different climate policy pathways indirectly bear upon air pollution in terms of improved human health in Europe. To this end, we put in perspective mitigation costs and monetised health benefits of reducing $PM_{2.5}$ (particles less than 2.5 μm in diameter) and ozone concentrations.

Air quality in Europe and related health impacts were assessed using a comprehensive modelling chain, based on global and regional climate and chemistry-transport models together with a health impact assessment tool. This allows capturing both the impact of climate policy on emissions of air pollutants and the geophysical impact of climate change on air quality.

Results are presented for projections at the 2050 horizon, for a set of consistent air pollution and climate policy scenarios, combined with population data from the UN's World Population Prospects, and are expressed in terms of morbidity and mortality impacts of $PM_{2.5}$ and ozone pollution and their monetised damage equivalent.

The analysis shows that enforcement of current European air quality policies would effectively reduce health impacts from $PM_{2.5}$ in Europe even in the absence of climate policies (life years lost from the exposure to $PM_{2.5}$ decrease by 78% between 2005 and 2050 in the reference scenario), while impacts for ozone depend on the ambition level of international climate policies. A move towards stringent climate policies on a global scale, in addition to limiting global warming, creates co-benefits in terms of reduced health impacts (68% decrease in life years lost from the exposure to $PM_{2.5}$ and 85% decrease in premature deaths from ozone in 2050 in the mitigation scenario relative to the reference scenario) and

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air pollution cost savings (77%) in Europe. These co-benefits are found to offset at least 85% of the additional cost of climate policy in this region.

1. Introduction

Air pollution has significant negative impacts on human health, in the form of cardiovascular, respiratory and other effects, on mortality, morbidity and well-being (Pope et al., 2002; Curtis et al., 2006; Dockery et al., 1993; Jerrett et al., 2009). A comprehensive body of legislation to reduce air pollution is in place in Europe (EC, 2001a, 2008) and the European Commission, as a long term target, aims at achieving ''a quality of environment where the levels of man-made contaminants do not give rise to significant impacts on, or risks to, human health'' (6th Environment Action Programme, EC, 2001b). Nevertheless, it is estimated that even with effective implementation of current air pollution legislation, fine particulate matter would be responsible for 2.5 million life years lost and ozone for approximately 21,000 premature deaths per year in 2020 in the EU25[1] (EC, 2005). In 2030 in the EU28 fine particulate matter would lead to 2.5 million life years lost and ozone to approximately 17,000 premature deaths (Holland, 2014). These impacts have substantial economic consequences also, in terms of costs of illness to business, additional burdens on healthcare systems, and willingness to pay to avoid pain, suffering, and premature mortality.

At the same time, air quality is sensitive to climate change which affects physical and chemical properties of the atmosphere and thus drives some weather events with favourable conditions to the build-up of pollution episodes (Jacob and Winner, 2009). However, policies combating climate change lead to improved energy efficiency, structural changes towards less fossil fuel based technologies and other technical measures that often, as a side effect, reduce atmospheric emissions, thus improving air quality (McCollum et al., 2013; Rao et al., 2013; Bollen et al., 2009). Indeed, air pollutant and greenhouse gas emissions often share common sources, especially those related to combustion of fossil fuels. While climate mitigation measures are primarily targeted at reducing carbon emission, they also have a collateral impact on co-emitted air pollutants. Reduced energy use due to improved energy efficiency, the use of cleaner energy carriers due to less fossil fuel based technologies, as well as the use of modern technology with higher abatement efficiencies or strict requirements for the cleanness of flue gases[2] all reduce primary air pollutant emissions such as SO_2, NO_x, CO and NMVOCs. As a consequence, climate mitigation policies can also have economic co-benefits in the form of reduced expenditure for air pollution mitigation measures required by legislation (e.g. Rafaj et al., 2013). With NO_x, SO_2 and NMVOCs being precursor emissions to the formation of secondary particles and tropospheric ozone, these health relevant pollution phenomena are equally reduced.

In this context, the questions our paper aims at answering are: (1) how effective are current European air pollution policies to reduce health impacts under different climate and climate policy contexts by 2050? (2) what are the benefits, in terms of air pollution mitigation cost savings and avoided health damage, of ambitious and effective climate policies? (3) how do these benefits compare to climate mitigation costs?

To answer these questions we assess air quality and related health impacts in Europe for different sets of policies addressing air pollution, energy and climate change. We implement an integrated atmospheric modelling chain which is linked with a health impact assessment tool. Climate change and air quality are modelled both at global and European scales. The economic assessment focuses on Europe, i.e. on mitigation costs for European policies and health benefits obtained in Europe. Our study region covers Western Europe and Central & Eastern Europe. To our knowledge this is the first monetised health impact assessment over Europe building upon the recent IPCC AR5 scenarios and taking into account an explicit representation of all currently legislated air quality policies and their costs.

The paper is organised as follows. Section 2 briefly summarises the climate and air quality modelling chain and the emission scenarios used. Section 3 describes the health impact assessment methodology applied. Results are presented in Section 4. Uncertainties are discussed in Section 5, which also sets our results in relation to those of other recent studies. Section 6 concludes. The Appendix gives detailed information on the models used, scenario assumptions and indicators, and on the regional definition.

2. Methods

2.1. *Climate – air quality modelling chain*

The climate and air quality modelling chain is only briefly summarised here, and the reader is referred to Colette et al. (2013a) for further details.

For the assessment of European air quality we use a set of scenarios at the 2050 horizon, with consistent estimates for greenhouse gas and air pollutant emissions at global and regional scales: emission scenarios for Europe developed under the Global Energy Assessment (GEA[3]) in combination with global chemistry simulations and climate fields from the

[1] EU25 designates the 25 EU Member States as of 2004 after the enlargement by 10 new Member States. EU28 designates the EU Member States as of 2013, through the addition of Bulgaria, Romania and Croatia.

[2] Carbon capture and storage technology (CCS), for example, requires sulphur dioxide to be eliminated from flue gas, partly to avoid corrosion of the CCS system, thus resulting in reduced sulphur dioxide emissions.

[3] http://www.iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/Home-GEA.en.html; GEA (2012).