Quantifying health impacts of air pollution under a changing climate: from a global to the regional and local scales

V. N. Likhvar[1,4], K. Markakis[2], M. Valari[2], A. Colette[3], D. Hauglustaine[4], S. Medina[1], M. Pascal[1], P. Kinney[5]

1/ InVS, French Institute of Public Health Surveillance, Saint Maurice, France – 2/ LMD, Laboratoire de météorologie dynamique, IPSL, École Polytechnique, Palaiseau, France

3/ Ineris, Institut national de l'environnement industriel et des risques, France – 4/ LSCE, Laboratoire des sciences du climat et de l'environnement, Gif-sur-Yvette, France – 5/ Columbia University in the City of New York, NY, U.S.

Introduction

Air pollution (AP) poses a significant public health burden worldwide.

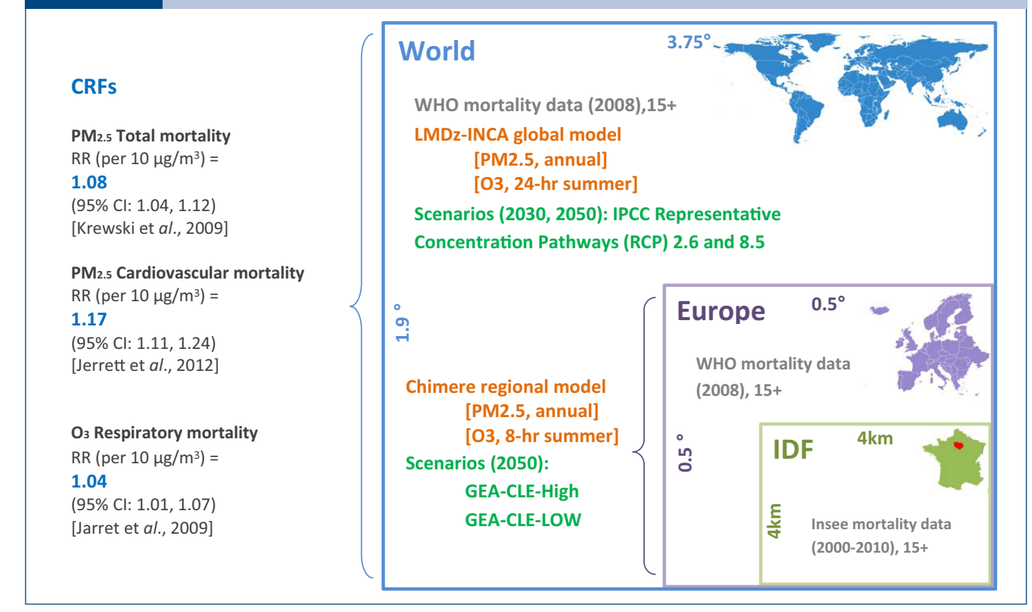
Because air pollution, climate change (CC), and associated policies are deeply connected, The Air Pollution – Climate Change Health Impact Assessment (A-C HIA) project investigates how air pollution and its impact on health would evolve in the future, in a context of changing climate. More specifically, we compared the impacts of $PM_{2.5}$ and ozone on mortality at present and in 2050 under two alternative emission mitigation scenarios.

The project provides results for three geographical scales: global, European and Ile-de-France (IDF).

Methods

We applied the health impact assessment (HIA) method to estimate the long-term impacts of $PM_{2.5}$ and ozone on total, cardiovascular and respiratory mortality using predicted air quality data. The data overview for each scale from our preliminary analysis is presented in figure 1.

FIGURE 1 — A-C HIA PROJECT: DATA OVERVIEW



In this project we investigated the indirect co-benefits of climate policy on health in terms of air pollution. Climate mitigation includes a range of energy efficiency measures that have, in turn, an impact on air quality. The indirect co-benefit of climate policy on air quality is thus assessed by comparing a business as usual (BAU) climate scenario and a mitigation (MIT) scenario aiming at keeping global warming below 2°C by the end of the century.

In the global model, these scenarios are the Representative Concentration Pathways (RCP) developed for the IPCC AR5 (RCP8.5 for the BAU and RCP2.6 for the MIT). Here air quality policies are parameterized as a function of wealth.

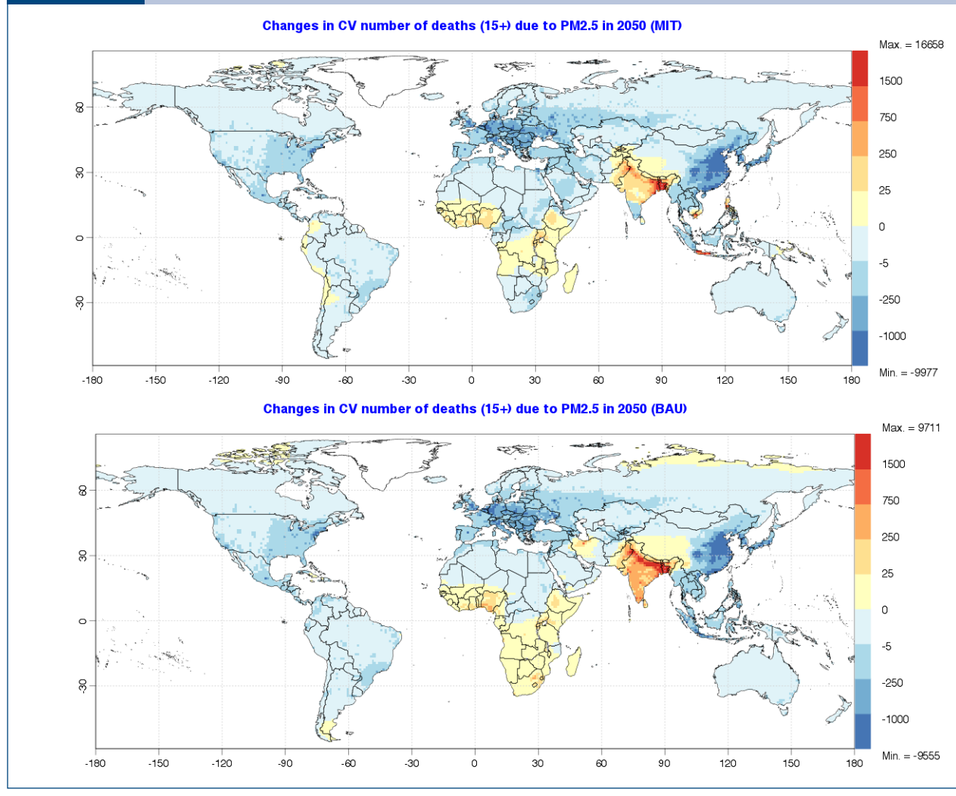
In the European and IDF models, these scenarios are obtained from the Global Energy Assessment (GEA). The climate policy storylines are identical to the RCPs, but air quality policies are explicitly resolved over Europe. For the local model, long term projections use the nationwide GEA trend of emissions applied to the refined local inventory.

Results

We illustrate the project's findings with the long-term impact of $PM_{2.5}$ on cardiovascular (CV) mortality in 2050.

At the global scale, the burden of $PM_{2.5}$ on cardiovascular mortality is predicted to decrease by 4.9% in 2050 under the MIT scenario, and by 3.9% under the BAU scenario (figure 2).

FIGURE 2 — A-C HIA PROJECT: PREDICTED CHANGES IN CARDIOVASCULAR MORTALITY DUE TO CHANGES IN $PM_{2.5}$ WITH MIT AND BAU SCENARIOS - GLOBAL SCALE, 2050



A similar trend is observed at the European scale, but with a larger difference between the MIT and BAU scenarios, that is 14.1% and 10.6% respectively (figure 3).

FIGURE 3 — A-C HIA PROJECT: PREDICTED CHANGE IN CARDIOVASCULAR MORTALITY DUE TO CHANGES IN $PM_{2.5}$ WITH MIT AND BAU - EUROPEAN SCALE, 2050

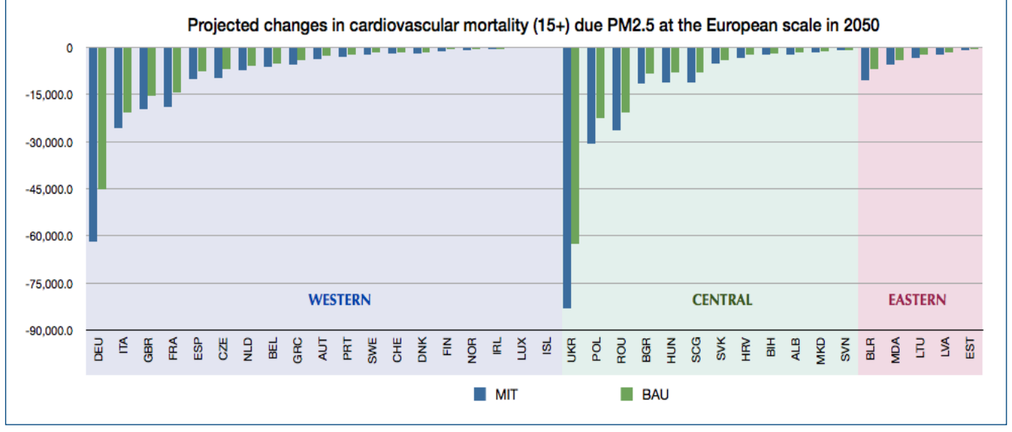
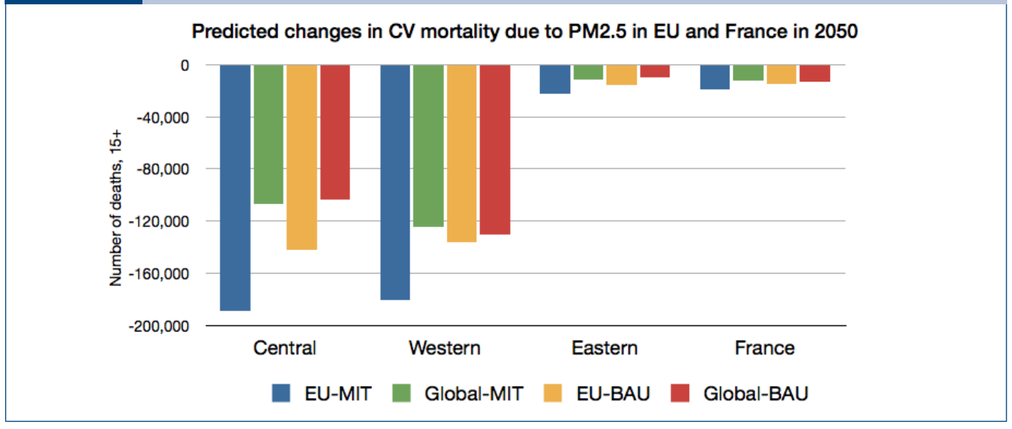


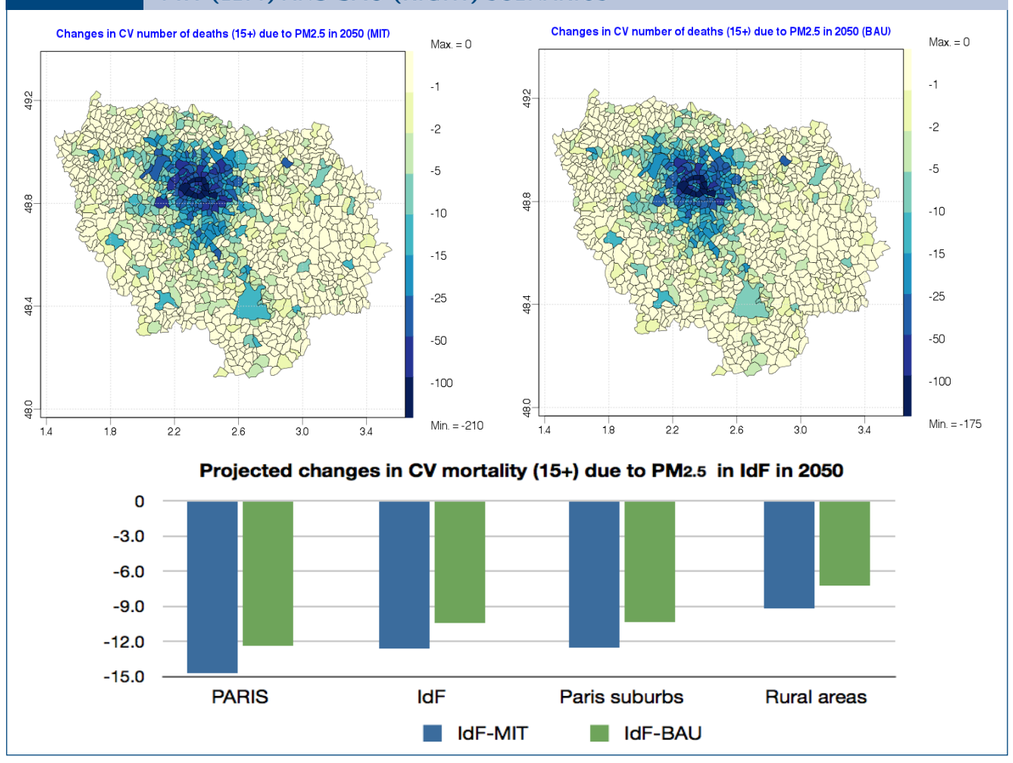
Figure 4 compares estimates for Europe and France obtained with the global model and with the European regional model. The patterns are quite consistent across the scales despite the differences between scenarios, modeling set-up and health data sources. The results are sensitive to the emission projection, however these are provisional results and we will attempt a more definitive comparison at a later stage in the project.

FIGURE 4 — A-C HIA PROJECT: PREDICTED CHANGES IN CARDIOVASCULAR MORTALITY IN EUROPE AND FRANCE IN 2050 AT THE EUROPEAN AND GLOBAL SCALES WITH MIT AND BAU SCENARIOS



We obtained more details when working at a finer scale (IDF) (figure 5). In IDF the number of deaths from cardiovascular diseases decreases by 12.6% with MIT scenario and by 10.4% with BAU. The larger reductions occur in the city area of Paris (14.7% and 12.4% respectively) compare to rural areas. The pattern is consistent with the global and regional scales: more reductions are obtained with the MIT scenario.

FIGURE 5 — A-C HIA PROJECT: PREDICTED CHANGE IN CARDIOVASCULAR MORTALITY DUE TO CHANGES IN $PM_{2.5}$ IN 2050 RELATIVE TO 2005 FOR ILE-DE-FRANCE WITH MIT (LEFT) AND BAU (RIGHT) SCENARIOS



Discussion

Results show that policies mitigating climate change would have positive impacts on mortality through an improved air quality at the global, regional and local scales independent on the scenario used.

The next step in the A-C HIA project is to perform a new set of simulations based on consistent emissions projection across the three scales which will investigate the possibility to use local scale information to inform the results of the larger scales.

Studies of this type are challenged by the lack of appropriate scenarios for changing air pollutants emissions. Interdisciplinary is an asset to tackle this issue. That's why A-C HIA is based on a strong collaboration between climate scientists, air pollution modelers, epidemiologists and public health scientists.

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Contact : Victoria Likhvar (v.likhvar@invs.sante.fr) - French Institute for Public Health Surveillance - Environmental Health Department - 12, rue du Val d'Osne 94415 Saint-Maurice Cedex - Tél. : +33 (0)1 41 79 69 41 - Fax : +33 (0)1 41 79 67 68