Integrated Effects of Air Pollution and Climate Change on Northern Forests

Although there are complex chemical and physical interactions between greenhouse gases (GHG) and air pollutants (AP), they are usually considered as separate issues. In a recent study, an international team of scientists reviewed the links between GHG and AP and assessed their interactive effects on northern hemisphere forests. The authors suggest that the combined effects can significantly differ from the sum of the separate effects and call for AP and GHG to be addressed simultaneously in order to maximise research, monitoring and policy efficiency.

Many air pollutants (AP) and greenhouse gases (GHG) not only share common sources but may also interact physically and chemically in the atmosphere. For example, carbon dioxide (CO$_2$) is mainly produced by the burning of fossil fuels and so are a large number of pollutants. Due to a large array of synergistic and antagonistic interactions, the combined effects of AP and GHG may differ significantly from the sum of the separate effects. For instance, some air pollutants such as methane (CH$_4$), nitrous oxide (NO$_2$) or halocarbons contribute to global warming while aerosol and particulate matters may have warming or cooling effects depending on local conditions and their interactions with other air pollutants. A better understanding of the interactions between air molecules is therefore of significant importance in order to maximize policy efficiency.

In a recent study, an international team of scientists reviewed the interactions between AP and GHG and assessed the interactive effects they might have on northern hemisphere forests. The authors studied the impacts of a combined exposure to GHG and AP on various parameters such as soil processes, tree health and growth, biodiversity changes or susceptibility to natural disturbance. Their main results are as follows:

- By affecting rain patterns, GHG may increase the redeposition of some AP and cause eutrophication (excess of nutrients). Climate change also tends to worsen acidification issues by enhancing the production and redeposition in the soil of acidifying compounds. At the same time, increased acidification can enhance the release of GHG, hence creating a vicious circle.

- Increased temperature due to climate change can increase the sensitivity of certain trees to air pollutants by triggering stomata opening (pores used for gas exchanges) hence increasing the exposure to some toxic air pollutants such as ozone (O$_3$).

- Species composition is mainly driven by climate, soil and forest type, but nitrogen and sulphur deposition, which may be severely modified by air pollutant redeposition, also have a significant impact. Moreover, as some crops and trees need low temperatures for their buds to open in spring, increased temperatures induced by climate change can significantly alter the distribution of such species.

- Sensitivity to natural disturbances such as insects, drought or disease is affected by nutrient balance. Therefore excessive nitrogen loads due to AP redeposition could enhance the severity of extreme climatic events such as frost, drought or fires, which are in turn expected to increase under prospective climate change scenarios.

These results strongly support the need for a better integration of air pollution policies as there are important opportunities for capturing synergies and avoiding overlaps between two lines of traditional research. The authors also emphasise that there is an increasing need for a better understanding of the mechanisms used by forests and other ecosystems to adapt to climate change.


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