plants in Europe will become even more competitive, locking in carbon-intensive infrastructure for decades to come.

To address these concerns and reinforce the credibility of long-term targets, de Perthuis and Trotignon[2] call for a fundamental reform of the EU ETS. They propose an Independent Carbon Market Authority (ICMA) to manage — and adjust when needed — the long-term supply of emissions allowances and the timing of the auctions through which allowances are sold in the short term. Long-term supply adjustments would imply a reduction of the cap, for example, when renewables are pushed into the market through additional subsidy schemes by some EU member states. It also means a reduction of the long-term cap when international carbon credits are flooding the market. This proposal aims at establishing an independent body with a well-defined mandate and clear rules of accountability that are intended to enhance long-term commitment and credibility, eventually leading to efficient price signals in the short term.

However, the idea of an independent body tasked with adjusting long-term emissions caps is the Achilles heel of the proposal because it is improbable that politicians will delegate decisions about the ambitiousness of climate policy to an independent body of experts. As already highlighted, the mandate of ICMA would require adjusting the cap if and when the deployment of renewables is increased through additional subsidies, thereby leading to a decline of allowance prices. But a country (for example, Poland) would hardly accept a tighter cap because of the increasing share of renewables in a neighbouring country (such as Germany). Therefore, the proposal by de Perthuis and Trotignon[2] faces substantial practical and political difficulties. Not only will it be difficult to establish the institution because of prevailing fundamental political controversies, but there will always be the risk that future policymakers will change its mandate, undermining its credibility[5].

Despite the potential barriers, the idea of establishing an independent body has merit. The researchers analyse the challenges of defining the mandate of the proposed body with sufficient detail to possibly dissuade some of the political hurdles. Still, a much broader and open discussion of the EU ETS reforms is required, which include the expansion of sectoral coverage, the recycling of the revenues obtained by auctioning the allowances, the potential role of a price collar setting a minimum and a maximum carbon price and burden-sharing schemes. There are currently only a few comprehensive proposals that address all of these problems with the aim of establishing the long-term credibility of European climate and energy policy.

It is encouraging that the correct topics are being discussed. Without intelligent proposals for institutional design that include courageous steps for implementation, and a general openness to new ideas by all stakeholders, the EU ETS is at risk to fail permanently. If the EU intends to continue acting as a leader in climate and energy policy, failure of the ETS is not an option. ❒

Ottmar Edenhofer is at the Technische Universität Berlin, Department of Economics of Climate Change, EB 4-2, Strasse des 17. Juni 145, D-10623 Berlin, Germany, and at the Mercator Research Institute on Global Commons and Climate Change (MCC), Torgauer Strasse 12-15, D-10829 Berlin, Germany, and at the Potsdam Institute on Climate Impact Research (PIK), Telegraphenberg A 31, D-14473 Potsdam, Germany.
e-mail: Ottmar.Edenhofer@pik-potsdam.de

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ATMOSPHERIC SCIENCE

Quiet weather, polluted air

Severe air pollution episodes are caused by certain types of weather. Now, research suggests these meteorological conditions will become more common due to climate change.

John Dawson

Most of the discussion about climate change and climate extremes focuses on dramatic events, such as floods, droughts and record high temperatures. Stagnant, fair-weather conditions are not usually thought of as extreme — after all, warm, stable atmospheric conditions generally lead to pleasant weather. However, a different viewpoint is required when considering the meteorological drivers of pollution episodes, including stagnation. A warm, stagnant high-pressure system may not fit most definitions of hazardous weather, yet stagnation leads to air pollution extremes. As they report in *Nature Climate Change*, Daniel Horton *et al.*[1] suggest that changes in the climate over the twenty-first century will lead to a considerable global increase in the stagnation events that are partially responsible for air pollution episodes.

Although emissions are the most important determinant of air pollution concentrations, meteorology plays a major role in determining whether or not an air pollution episode occurs. For example, a strong correlation has been established between the stagnant atmospheric conditions associated with the Bermuda High weather pattern and high ozone concentrations in the eastern US[2]. Similarly, ambient concentration of $PM_{2.5}$ — particulate matter with diameter 2.5 μm or less — was calculated to be 2.3 μg m^{-3} greater on stagnant days than on non-stagnant days in the US[3]. This effect would presumably be even more pronounced in areas with less robust emissions control programs. Additionally, analysis of historical meteorological data from several decades suggests that the increasing frequency of stagnation in the

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US may have already negated part of the benefits to ozone air quality resulting from reductions in emissions of nitrogen oxides[4].

The impact climate change will have on stagnation has been investigated by a handful of studies focussing on the US. It has been suggested that increased stagnation would exacerbate the severity and length of air pollution episodes in the northeastern and midwestern US[5]. Calculations show that stagnation would change under a future climate[6], though the projected spatial pattern of changes differed from that of an earlier study[5]. In previous work, Horton *et al.*[7] examined global changes in stagnation in the CMIP3 (phase 3 of the Coupled Model Intercomparison Project) set of global climate models and revealed that increases in stagnation were the dominant response to climate change in the three regions studied (eastern US, Mediterranean, and eastern China/Korean Peninsula).

In their latest work, Horton and colleagues[1] investigate changes in stagnation across the globe over the twenty-first century. They use simulations of the RCP8.5 (high emissions) future scenario for the middle and late twenty-first century in the CMIP5 suite of general circulation models to examine how pollution-relevant stagnation is expected to change globally. Their analysis is based on the Air Stagnation Index (ASI), which was developed by Wang and Angell[8]. The relevance of the index for air pollution and health is extended by formulating a population-weighted ASI.

A major result of the study by Horton *et al.*[1] is the prediction that increases in stagnation will affect 55% of the global population by the late twenty-first century, with the population in areas of increasing stagnation a factor-of-ten greater than the population in areas where stagnation is expected to decrease. The frequency of stagnation events is expected to increase considerably over much of the globe — with some of the largest increases occurring over northern India, western US and Mexico — whereas the frequency of stagnation events over China was projected to change little.

The study by Horton *et al.*[1] makes an important contribution to our understanding of the meteorology of air pollution episodes and how they may change in a future climate. Most of the research on changing stagnation and its consequences for air quality has focused on North America, so the global focus of this work is a welcome addition. The introduction of a new population-weighted ASI to quantify stagnation changes could provide a useful metric for comparison with future studies. Additionally, the vast number of climate models used and the explicit examination of increases and decreases (rather than just averages) combine to make this currently the most thorough study on this topic. Strong evidence is presented to support the suggestion that the future atmosphere will be more conducive to air pollution events than the present atmosphere.


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Smog air pollution in Mexico City, Mexico.

There are a few limitations to consider when weighing up the ramifications of this study. Only one climate scenario (RCP8.5) was used, so caution must be exercised when generalizing beyond this scenario; although current greenhouse gas emission levels suggest that a high-end future scenario may not be unrealistic. Additionally, modelling of atmospheric chemistry or changing air pollution precursor emissions is not included, so there are no actual pollution predictions. There are opportunities for researchers to refine and build on this work. However, the approach used by Horton and colleagues also means that changes in one phenomenon — namely, stagnation events — can be isolated. This work highlights the need to consider air pollution, and its meteorological drivers, when appraising strategies for climate change adaptation and the benefits of climate change mitigation. ❐

John Dawson is at the US Environmental Protection Agency, Office of Research and Development, Washington DC 20460, USA.
e-mail: dawsonjp@gmail.com

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Additional information

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