Pollution and global warming

Climate change in black and white

When air pollution hurts people's health and heats up the climate it makes sense to do something about it. But what about pollution that cools the planet?

AN IDEAL fossil-fuel power-plant would produce power, carbon dioxide and nothing more. Less-than-ideal ones-not to mention other devices for the combustion of carbon, from diesel generators to brick kilns and stoves burning dung-also emit various gases and gunk. These often cause local environmental problems, damaging lungs, hurting crops and shortening lives. And some of the gunk, notably soot or "black carbon", can warm the planet, too.

Next week ministers attending the governing council of the United Nations Environment Programme (UNEP) in Nairobi will be presented with the summary of a new report on how fighting air pollution can help the global climate (the report itself is due to follow a couple of months later). The summary makes a powerful case for acting on two short-lived climate "forcings", factors that change the amount of energy the atmosphere absorbs, as carbon dioxide does, but stay in it only briefly. One is black carbon and the other is ozone, which is vital for blocking ultraviolet rays in the stratosphere but hazardous in the bits of the atmosphere where plants live and people have to breathe.

According to the UNEP report, implementing measures known to be effective against these two pollutants over the next 20 years would have "immediate and multiple" benefits, including temperatures between 0.2°C and 0.7°C lower than they would otherwise be by 2050 and the saving of between 0.7m and 4.6m lives with improved air quality. For black carbon the measures are largely in the form-of more efficient ways of burning things; for ozone they mostly involve reducing emissions of methane, which encourages reactions in the atmosphere that make ozone. The black-carbon measures save a lot more lives than ozone control, but are trickier to assess in terms of climate.

Clearing the air

UNEP'S interest in black carbon dates back to a plane journey taken a decade ago. Veerabhadran Ramanathan, of the Scripps Institute of Oceanography in La Jolla, California, and Paul Crutzen, a Dutch climate scientist who was one of the first to theorise about "nuclear winter", wanted to find out what aerosols (particles small enough to float in the atmosphere) were doing to the climate. Their campaign, which brought together 150 scientists and a plethora of research aircraft and satellites, revealed the hitherto unappreciated extent of an "Asian brown cloud" thousands of kilometres across and fed by fires, diesel fumes and all manner of other things.

In 2001 Dr Ramanathan took Klaus Töpfer, then UNEP'S executive director, on a flight along the foothills of the Himalayas to see the brown cloud lapping at the mountain range like dirty water at the rim of a bathtub. From that day on UNEP has taken a keen interest in the issue. Now, according to its current executive director, Achim Steiner, the science of short-lived climate changers has matured enough for the issue to deserve a place at the top of the policy agenda.

One aspect of this maturity is that short-lived forcings have become relevant to more people as the scale of their effects has been recognised. This is particularly true for black carbon. Soon after coining the term "Asian brown cloud", Dr Ramanathan realised there were similar if less intense clouds over parts of Africa and elsewhere; the initials ABC, already used by researchers, were retrofitted to stand for "atmospheric brown cloud" (which also appeased some political sensibilities).

Another reason for the increased interest in all this has less to do with science than politics. Negotiations under the UN'S climate-change convention have had some limited success in getting countries to say they will cut emissions of carbon dioxide and other long-lived greenhouse gases. But even if these cuts make the crucial transition from word to deed, they are too small to give the world much of a chance of staying below two degrees of warming, which is the level currently seen, somewhat arbitrarily, as the climate's don't-even-go-there line. Action on short-lived things like black carbon and ozone could help keep the climate on the right ▸▸

side of that line for a few decades longer. That does not do much about the need to cut carbon-dioxide emissions for long-term safety, but it might provide a few decades of grace (see chart).

And doing something about these short-lived forcings is easier than tackling carbon dioxide. Since carbon dioxide is an essential by-product of burning fossil fuels, controlling it is a big economic issue. And because it lasts a long time and is evenly mixed around the planet, action on emissions in, say, America and China is directly comparable. This leads to the sort of burden-sharing negotiations that easily get deadlocked. Short-lived forcings have the advantage of being comparatively cheap to cut: for black carbon tried and true measures include retiring old vehicles, filtering exhausts, getting people better stoves and cleaner fuel to burn in them, stopping widespread burning of agricultural waste, and modernising kilns and coking ovens. The benefits in terms of breathing better and dying later accrue mostly to the country that is doing the cutting.

But some of the effects of things like ABCS tend to be regional. So countries need to work together in a number of different ways-including regional agreements, bilateral aid and comparisons of best practice, UNEP already either facilitates or functions as the secretariat for about a dozen regional pollution agreements. More venues and more instruments to work with should help climate diplomacy move beyond its endless who-should-do-more arguments. David Victor, who works on energy and environmental policy at the University of California, San Diego, argues that seeing positive results relatively quickly from co-operation on things like black carbon could actually increase the levels of trust and ambition seen in negotiations about carbon dioxide—a good thing.

The brown cloud in action over India and Pakistan

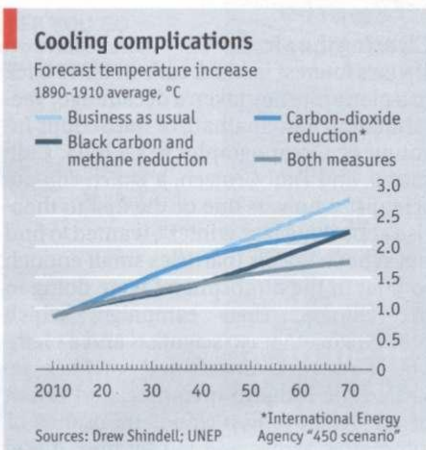
Clouding the issues

The science may have matured, but the role that black carbon and other aerosols play in the changing climate is still rife with nuance, uncertainty and doubt. Durwood Zaelke, president of the Institute for Governance and Sustainable Development and an adviser to UNEP, says these are normally things which frighten policymakers. But he believes the new report lays out the uncertainties clearly while still making a compelling case for action.

Climate forcings are, for the sake of comparison, expressed in terms of watts per square metre: more watts, more warming. The forcing due to the carbon dioxide added to the atmosphere by people over the past few centuries is put at 1.7 watts per square metre. Other greenhouse gases add another watt. Dr Ramanathan puts the figure for black carbon at something like 0.9 watts per square metre, on the basis of observations, with a range of possible values that goes from 0.4 watts per square metre to 1.2. Climate modellers tend to find values near the bottom of that range; this may mean the models are underestimating the amount of black carbon being emitted, or that Dr Ramanathan's figure is too high.

The effect may be amplified, or reduced, by many factors. Black carbon is not emitted alone, but mixed with other things—organic molecules and various oxides of sulphur and nitrogen. These can form less-black particles that reflect, rather than absorb, the sun's energy. These paler aerosols, and to some extent the blacker ones too, can provide sites for water to condense. That promotes the formation of clouds, which reflect sunlight back into space. These are some of the reasons why, though the black carbon in brown clouds has a warming effect, the clouds' net effect is to cool the planet beneath them.

When such a layer of pollutants warms the atmosphere (because of its black-carbon content) but cools the surface, it can have effects well beyond any net warming or cooling. If the surface is cooled and the air above it warmed, there is less tendency for air from near the surface to rise; reduced convection will tend to lead to fewer clouds and reduced rainfall. This sort of change matters more, for a lot of purposes, than the surface temperature. It was an extreme version of this rainless cold-below, warm-above stability that made early models of nuclear winter so disturbing.



All this means that no one can say exactly how much warming will be avoided by acting on black carbon. If it were not for the clouds, says Tami Bond of the University of Illinois, most experts would expect a cooling from steps to reduce black carbon even if those steps also reduced emissions of organic compounds and other cooling aerosols. But given the effects on cloud formation and dissipation (a cloud laced with black carbon does not last as long) the potential for error in estimating the final effects is large. Dr Bond is one of the lead authors of an ambitious attempt to assess observations and models of black carbon, and quantify their uncertainties, that should be published shortly.

The UNEP report puts the average global cooling that could be achieved with black-carbon control measures at 0.3 watts per square metre, taking into account all the cloud effects and other complications. But Drew Shindell, who works on aerosols and climate at NASA and is the chair for the UNEP report, cautions that the range of possible effects runs from twice that much to nothing at all. There is even an outside chance that the proposed black-carbon action could lead to a little warming, though if that were the case the actions on ozone would still provide a net cooling for the package of actions as a whole.

This is why, Mr Zaelke says, it is important to appreciate the regional and local effects too. Dr Ramanathan has amassed a range of evidence that ABCS, the regional effects of which are far greater than global averages, have depressed rainfall in the Indian monsoon over the past decades. Other researchers think the presence of the pollution has an effect within individual monsoon seasons, too, changing patterns of rainfall.

Black carbon has particularly pernicious effects on frozen regions. When it falls on snow it greatly increases the amount of sunlight absorbed. Black carbon slopping over India's bathtub rim represents a threat to Asia's high glaciers. Studies of an ice core from Mount Everest show that from 1975 to 2000 the black carbon rose threefold. The Arctic has been warming faster than other places, and faster than models tend to predict. Black carbon from America, Asia and, predominantly, Europe is likely to be one of the reasons. The Arctic Council, which brings together the eight nations with Arctic territories and representatives of indigenous people, has had a working group on short-lived forcings for some time. The council's foreign ministers may announce some sort of action on black carbon when they meet in Nuuk, Greenland, in May.

Double effects

If the Arctic is warming faster than might be expected, other parts of the world are warming slower. One reason for this, widely accepted by scientists but little appreciated by policymakers, is the sulphur given off by coal-fired power stations and some other industrial fossil-fuel use. Sulphur is very good at forming reflecting aerosols that can also make natural clouds both whiter and possibly longer-lasting, which provides an added cooling effect.

Uncertainty about how strong these effects are is one reason why it is frustratingly hard to use the 20th century's climate trends to predict those of the 21st: no one knows how much greenhouse warming in decades past was masked by the cooling effects of sulphate and other aerosols. It is telling, say some scientists, that global warming was at its most marked from the 1970s to the 1990s, roughly the time when Europe and North America got serious about cleaning up smokestack sulphur. Year-on-year warming slackened in the 2000s—at a time when China's burning of coal for electricity, and its emissions of sulphur, went through the roof, reversing the downward global trend of the previous decades. Coincidence is not causation. But an analysis by Dr Shindell and his colleague Gregory Faluvegi suggests that a typical coal-fired power station in China will take three decades to produce enough carbon dioxide to overpower the initial cooling effects of its sulphates.

This may sound like a free solution to global warming—but not if you have to breathe China's air. Pollution is leading to hundreds of thousands of premature deaths a year. The Chinese government is at the same time dtrigtste and susceptible to some sorts of public pressure: it has programmes for reducing pollution and has more sulphur scrubbers installed on its plants than America does, though it is not clear how many are in use (they reduce a plant's efficiency). In an ever richer China greater action on sulphur seems all but inevitable, and some sort of air-pollution equivalent of 2008's tainted-milk crisis might bring it about precipitously. At that point the warming effects of recent fossil-fuel emissions will be unmasked.

Something similar is going on at sea. After decades of increasing sulphur emissions by ships, the International Maritime Organisation is reversing the trend by regulating the sulphur content of fuels. Analysis by independent scientists suggests this will save tens of thousands of lives in coastal areas, but could add something like 0.3 watts per square metre of warming—a significant amount. All told, action to get sulphur out of the atmosphere, which is justified on health grounds, could easily warm the world as much, or more, than removing black carboncools it.

So, what to do about such conundrums? Regulators mostly ignore them; reducing pollution by things like sulphates has been the goal of clear-air legislation around the world for decades, and finding a downside now would not be helpful. Even if one could compare the number of lives lost through action or inaction, a Kantian squeamishness about means and ends might properly stop people acting on the conclusions. For the present, then, the issues are mostly passed over in silence.

One voice that has been raised, though, is that of Dr Crutzen, who worked with Dr Ramanathan on that first study of brown clouds. Now and then volcanoes produce sulphate aerosols in the stratosphere which last far longer than those created by industrial pollution lower down in the atmosphere-they have lifetimes of years, rather than days or weeks. This longer life means that in terms of cooling per gram, sulphur in the stratosphere outdoes the lower-down stuff by about 25 to1. So if you were to inject a comparatively small amount of sulphate into the stratosphere while phasing out all industrial emissions lower down, Dr Crutzen noted in a paper published five years ago, you could keep today's cooling levels while getting huge health benefits.

Icebreaker or icemaker?

The technical, environmental, political and moral pros and cons of such "geoengineering" have been widely discussed since. The idea gained a lot of credibility from the fact that although Dr Crutzen is one of the people who first warned of man-made damage to the stratosphere's ozone layer—work which won him a Nobel prize-he is not overly worried that added sulphates would add significantly to the damage. But little of the discussion has focused on one of the two key ideas on which Dr Crutzen's argument was built: that geoengineering could solve the problem of pollution-control measures that save people but warm the planet.

The other key foundation was desperation. Despite years of warning, Dr Crutzen saw action on carbon-dioxide emissions getting nowhere; it seemed as if something else was necessary. A similar analysis underlies moves to step up action on short-lived forcings, though here the fresh approach is intrinsically attractive, rather than scary. In fact, geoengineering and action on short-lived forcings have a lot in common. Both might sap urgency from efforts to control carbon dioxide; both raise large uncertainties; both can come about through the work of just a few nations; both throw a light on the nature of human responsibility for the climate. Most people see climate change as an incidental side-effect when caused by burning fossil fuels. If it were engineered by intentionally putting sulphate into the stratosphere they would judge it to be deliberate. But what of reducing the level of sulphates emitted by ships, knowing it is likely to warm the planet? Is that deliberate or incidental?

It is no coincidence that a non-governmental organisation active in the fight against air pollution, America's Clean Air Task Force, now strongly advocates more research into the pros and cons of geoengineering. Jason Blackstock, at the Centre for International Governance Innovation in Waterloo, Canada, points out that black carbon, sulphates and geoengineering are all neglected by the institutions that govern climate policy. He is looking at ways to bring the topics together in the broader context of how nations make choices about the climate. If human action on the climate is ever to be properly deliberate, it must first be properly deliberated. •

Fonte: The Economist, London, v. 398, n. 8721, p. 89-91, 19 February 2011.