CASE STUDY

Strawberry Fields—The Banning of Methyl Bromide

The problem of the release of chlorine-containing ozone-depleting substances into the air has been largely solved. However, the final chemical to have been brought under Montreal Protocol control, methyl bromide—a pesticide widely used by farmers in both developing and developed countries—is proving to be controversial.

Methyl bromide is a colorless, odorless gas that currently is present in air at the tiny concentration of 8 parts per trillion (ppt). It is a natural constituent of the atmosphere, constantly being emitted into it from sources, especially the oceans, which contain large amounts of dissolved bromide ion, and from biomass burning, both natural and anthropogenic.

The year or less that typical CH_3Br molecules reside in the troposphere is sufficient for a small fraction of them—about 4%—to escape destruction and instead rise slowly to the stratosphere. There, atomic bromine is released by their photochemical decomposition and participates in ozone destruction chains.

Substantial amounts of methyl bromide are produced synthetically, mainly for agricultural uses. Release of the synthetic gas now constitutes a significant—though uncertain and therefore controversial—fraction of the methyl bromide emissions into the air and consequently represents an additional source of bromine to the stratosphere. Anthropogenic methyl bromide was responsible for about 4% of the ozone depletion in recent decades.

The main use of methyl bromide is as a pesticide, for the control of insects, nematodes, weeds, pathogens, and rodents before planting crops such as tomatoes, strawberries, grapes, tobacco, and flowers. In the United States—the world's leading consumer of methyl bromide—its main application (85%) is for soil fumigation, the same use that dominates globally. For this purpose, it is injected into soil 1 to 2 feet below the surface, which is temporarily covered by tarps, and it kills the vast majority of soil insects. Tomatoes in Florida and strawberries in California are the crops that involve heaviest usage of this soil treatment. Methyl bromide is also used to fumigate some crops such as dried fruit and nuts after their harvest. Crops—such as grapes from Chile—that are stored or are shipped long distances are also often treated for post-harvest pest control, though the total amount of CH_3Br consumed in this way is small. Almost all the methyl bromide used to sterilize soils and for other insecticide applications eventually finds its way into the atmosphere. Although it is quite poisonous to humans—a number of deaths have occurred when workers entered buildings fumigated with it—its atmospheric concentration is so small that it is not an air pollutant.

As discussed in the text, according to the Montreal Protocol, developed countries were to have phased out methyl bromide production and importation completely by 2005. Its consumption in all developing countries combined,

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which amounted to less than half the U.S. usage, was to have been frozen at 1995–1998 levels in 2002, was to have been reduced by 20% in 2005, and is to be completely eliminated by 2015.

Methyl bromide is different from the other banned/controlled ODS chemicals in several important ways:

- It is also a natural substance, not a totally synthetic one, as are all the other ODSs. (Tiny amounts of some CFCs are produced naturally, but they constitute a negligible source.)
- Its main use is as an agricultural pesticide, not as a refrigerant or to produce manufactured consumer products. The agricultural products on which it is used in developed countries compete directly with those produced in developing countries, where the substance is subject to less control over the next decade.
- No single, cheap "drop-in" replacement for its pesticide uses exists. Methyl bromide is low in cost to produce and is useful against a wide variety of pests, in contrast to the characteristics of the proposed alternatives. As a fumigant, it works more quickly than its alternatives.
- Its atmospheric lifetime is quite short in comparison to the decades for other ODSs. Consequently, control of its anthropogenic levels in the atmosphere could be achieved in the short term at any time if it proved to be more of a problem to the ozone layer than is anticipated.
- The contribution of anthropogenic CH_3Br to ozone depletion is rather uncertain, since major natural sources of the gas are still being discovered. It is believed that most atmospheric methyl bromide arises from natural sources, but the actual fraction is controversial.

The scheduled 2005 phase-out of methyl bromide use in silos was opposed by some farm groups in the United States on the argument that their competitors in developing countries are not yet required to follow suit and the claim that no safe, effective, and economically viable alternative has been found. In 2004, the United States and ten other developed countries were granted limited "critical use exemptions" by the Ozone Secretariat of the United Nations from the scheduled 2005 Montreal Protocol phase-out of methyl bromide by such nations. The exemptions were intended to give farmers and other users of the gas more time to develop and adopt cost-effective substitutes. For 2005, the United States was allowed to use 9445 tonnes of it, which was about 120% of its level of use in 2003 and 2004, but only 37% of the amount that it used in 1991, before reductions began. For 2006, the U.S. amount was 32%, and for 2008 the request is for 25%, of its pre-1991 usage. The increased use of methyl bromide by the United States is likely part of a worldwide trend that began in 2003.

The use of methyl bromide for killing insects in stored grain and in shipping pallets made from raw wood is not yet covered by the Montreal Protocol. Its employment for such purposes is rising sharply as international trade grows; by 2004 use of the gas for such purposes had risen by about 60% over its 2002 level. Many countries, including the United States, require that raw wood pallets be treated by the gas or by a more expensive heat process.

Measurements of methyl bromide in tropospheric air show that its concentration increased throughout the twentieth century

until about 1998, when it reached a peak level of 9.3 ppt, following which a steady decline began. By 2004, its concentration had decreased to 7.9 ppt, a reduction of 15%. For the first three years of the post-1998 period, the annual decreases amounted to about 4%, which was larger than expected from the mandatory cutbacks that began at that time (see below). Since then (and until 2004 at least), however, the annual reductions in concentration have become much less, averaging about 1.4%. A decline in atmospheric concentration was expected following the first stages of Montreal Protocol reductions in the production of the gas in developed countries (25% minimum reduction in 1999 relative to 1991 amounts, 25% more in 2001, and 20% in 2003). Although it is tempting to speculate that decreases in *natural* sources of methyl bromide might explain part of the initial surge, no recent decline in methyl chloride—an analogous substance with many natural sources in common with the bromide but with no commercial production—was observed over the same period. Thus, as stated in the text, there remain important uncertainties concerning the size of sources and sinks of methyl bromide.

Points to Ponder

Farmers in developed countries will likely continue to press for exemptions from the ban on using methyl bromide as a pesticide. If granted indefinitely, these continuing uses may well halt the decline of methyl bromide levels in the atmosphere. Consequently, more of the gas than expected will migrate to the stratosphere, where the bromine it releases will destroy ozone. As a result, the disappearance of the ozone hole that occurs annually over the Antarctic would likely be delayed a few more years after mid-century. Furthermore, slightly lower levels of protective ozone over the Arctic and perhaps over our heads in temperate regions could result.

On the other hand, if the ban on methyl bromide use is strictly enforced in the future, the production of some agricultural products in both developed and developing countries could be adversely affected as farmers experiment with different and more costly alternatives. Also, there will be a few years in which farmers in developed nations will consider themselves disadvantaged.

The question of whether or not to strictly enforce the ban on methyl bromide in the future is thus a difficult one to answer. It is unfortunate that there is still considerable uncertainty about the ratio of synthetic to natural emissions, so we are unsure about how effective our efforts to control the substance will be.

In addition to the points raised above, there is the larger question of whether tinkering with the world's most successful environmental initiative—the ban on ozone-depleting substances—will open up a Pandora's Box of requests for exemptions on other compounds controlled by the Montreal Protocol.

Question to Discuss

Based on the pros and cons discussed, are you in favor of continuing indefinitely the exemptions granted to farmers in developed countries to use methyl bromide on crops? If so, do you favor eliminating the substance from the ODS list controlled by the Montreal Protocol?