fumigation (L. G. Miller, US Geological Survey). Given these factors, it is clear that more study is needed before estimates of relative emissions from soil can be improved beyond the current range of 20–85% of the amount applied. The most recent studies of biomass burning emissions lower the estimate from the 30 Gg yr^{-1} given in the WMO Scientific Assessment to a probable value of 15–25 Gg yr^{-1}, with no significant emphasis in either hemisphere (D. Blake, Univ. California at Irvine; J. E. Penner, Lawrence Livermore National Lab.).

Until recently, it was generally believed that the only important sinks for atmospheric CH_3Br were reaction with tropospheric OH and irreversible loss to the ocean. But new investigations show soil degradation rates which, when extrapolated globally, represent a large, natural sink (C. E. Kolb, Aerodyne, Maryland; P. M. Crill, Univ. New Hampshire). Apparently due to deposition and rapid biological degradation, this process creates a 42 (±32) Gg yr^{-1} (25%) disparity in the budget. It is also difficult to reconcile with the interhemispheric ratio (north/south) of 1.3 for CH_3Br in the atmosphere, which requires that net emissions in the Northern Hemisphere are double those in the Southern Hemisphere. As the soil sink is likely to be stronger in the north than in the south, the new findings require an equivalent weighting of sources in the Northern Hemisphere, something that is difficult to do in current models.

Estimates of the strengths of all three sinks depend on an accurate determination of the atmospheric burden. Recent intercalibrations between NOAA/CMDL and Scripps Institute of Oceanography suggest that the present atmospheric mole fraction of CH_3Br is about 10% lower than that given in the recent WMO Scientific Assessment (S. A. Montzka, NOAA/CMDL; R. F. Weiss, Scripps Inst. Oceanography). This helps to balance the budget by reducing required sources. Further intercalibrations among laboratories would be valuable. Also, it was pointed out at both meetings that analyses of stored air are often impaired by growth of CH_3Br in the containers, even over a short time, so new measurements of archived air may not reliably detect growth of atmospheric CH_3Br over the past two decades when agricultural uses were increasing, leaded gasoline consumption declining, and atmospheric measurements limited. Recent atmospheric measurements have not spanned sufficient time to detect trends.

Once delivered to the lower stratosphere, CH_3Br is rapidly photolysed to inorganic bromine. Unlike chlorine, much of the inorganic bromine in the lower stratosphere is reactive and even the reservoir species are short-lived. This is largely what makes bromine more efficient at destroying ozone. But there is still uncertainty in the reaction rates of inorganic bromine radicals, particularly for the $BrO+HO_2$ reaction (G. Poulet, Centre National de la Récherche Scientifique; Z. Li, Jet Propulsion Lab.) and for reactions involving $BrONO_2$ or HOBr (ref. 7).

In Monterey, investigators reported BrO data from aircraft (ER-2) and balloon-borne instruments. Reports[8] suggest that BrO abundance in the lower stratosphere ranges from 5 to 8 p.p.t. by volume. This is lower than values calculated with photochemical models that assume total bromine (inorganic plus organic) to be 18–20 p.p.t., and that are consistent with measurements of organic bromine just below the tropopause[9]. ER-2 measurements of BrO from 1994 (R. M. Stimpfle, Harvard Univ.) are higher and predict bromine levels nearer to 25 p.p.t. in the stratosphere. This implies that shorter-lived compounds could be getting into the lower stratosphere through convection of air from the marine boundary layer. Also, measurements taken with the tracer gas SF_6 during ER-2 flights indicate that lower stratospheric air may be less than a year old (J. W. Elkins, NOAA/CMDL). Unfortunately, uncertainties in the measurements of BrO (±30%) and in computations (±80%) are large and more analysis is needed before this issue can be resolved.

As both meetings showed, information on the emission, transport and reaction of atmospheric CH_3Br has been flooding in over the past couple of years, often changing our ideas about the behaviour of this compound in nature. Estimates of the atmospheric burden and lifetime of CH_3Br have improved enormously, as has our understanding of its sources and sinks. Research still continues at a rapid pace. Currently, though, the budget of atmospheric CH_3Br remains uncertain, as do estimates of just how much it contributes to the total destruction of stratospheric ozone. Reducing these uncertainties must lie at the heart of the continuing research effort. □

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DAEDALUS

St Elmo's phone

LAST week Daedalus had a scheme for focusing microwaves high in the air. It exploited the high resolution of a synthetic-aperture receiver made up of widely spaced but interlinked radio telescopes. Daedalus planned to work the whole system in reverse, with the dish aerials of the array operating as coupled microwave transmitters. With correct phasing, the array could concentrate a beam of microwaves at a defined point in space perhaps 10 cm across.

About 100 kW of microwave power, concentrated in a small volume high in the atmosphere, should break down the dielectric resistance of the air, especially if dust or floating particles provided discharge points for an initial corona. The result would be a stable sphere of ball lightning (which, according to one theory, is a spherically symmetrical radio-frequency discharge powered by the intense field gradients of the thundery atmosphere). By changing the phasing of the transmitters in the array, this ball of lightning could be swept around the sky, and raised or lowered on command.

The obvious application is for street lighting, sky-writing and pyrotechnic displays. But Daedalus has higher technology in mind. He recalls an over-the-horizon communication system that bounced its signal off high-altitude meteor tracks. Such tracks can be quite frequent; their hot, ionized air conducts electricity well enough to be a good radio reflector.

So Daedalus wants to establish a stable ball-lightning discharge about 120 km up in the stratosphere, for use as a large-scale communications relay. The microwave beams that maintain it could easily be modulated with telephone, radio, television and digital data. The ionized, conducting ball would reradiate them over an area perhaps 1,200 km in radius. Any other communications system could also beam its signal at the ball and have it reflected evenly over the same area. The ball will probably generate some radio-frequency noise on its own account, but with luck this will be confined to specific bands, or be easy to filter out.

Geosynchronous satellites, with their feeble transmitters, vast expense and limited life, will thus be outmoded. A set of stable ionospheric ball-lightning discharges, closer to Earth and pumping out far more power, will do their job more cheaply and flexibly. The simple receivers needed will be easy to align on the relay, even at extreme range. You will simply look for the bright artificial 'star' glowing fixedly in the night sky, and point the aerial straight at it. David Jones