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**COVER:** Our bodies evolved to handle sounds necessary for survival in nature. But levels of noise in man's modified environment may be not only deafening but also capable of inducing illness. See story p. 377. (Cover art is a composite of EPA photos)

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# LETTERS

## CIO confirmation

In a letter to the editor (SN: 3/20/82, p. 195), Robert deZafra unintentionally confirmed the correctness of SCIENCE NEWS in reporting our upper limit for stratospheric chlorine monoxide (SN: 12/26/81, p. 392). Determination of the correct abundance for this important molecule has vital and far-reaching implications for the importance of chlorofluorocarbons on the destruction of stratospheric ozone. Our results, reported at the San Francisco meeting of the American Geophysical Union, are surprising, even shocking, and are certainly newsworthy.

Several excellent experimental groups have reported measuring CIO. However, contrary to deZafra's claim, the earlier measurements are not incontrovertible. For example, the "direct in-situ measurements from a sensor dropped by parachute through the stratosphere" are not direct measurements of CIO at all. The reported measurements are of free chlorine atoms, purportedly produced chemically from ambient CIO by bleeding NO gas into the instrument air stream. Laboratory measurements by the same group (J. Anderson et al., Harvard University) seem to show that CIO is the only plausible precursor to the observed free chlorine. However, there will always be a lack of completeness since not all possible trace precursors are known and some cannot be easily reproduced in the laboratory.

An independent measurement is based on the detection of one reported rotational line in emission using ground-based and balloon-borne millimeter-wavelength spectrometers. For example, the balloon-borne spectra of Waters et al. (JPL) clearly show a weak emission line at the correct frequency and with the correct strength and width to be caused by CIO. If interpreted as CIO, the retrieved mixing ratios of 30 and 35 km are in agreement with some but not all of Anderson's results. However, this observation is a necessary but not sufficient condition to prove the abundance estimates of CIO. In order to improve the identification based on a single line it is necessary to eliminate all other stratospheric molecules which might possibly cause this emission. For example H<sub>2</sub>O and O<sub>3</sub> are each roughly 10<sup>4</sup>-10<sup>5</sup> times more abundant than CIO in this region of the stratosphere, meaning that rotational transitions within excited vibrational levels and of rare isotopic forms of these molecules must be eliminated as possible progenitors of this spectral line. Another way of improving the identification of CIO would be to measure several lines having the correct frequencies and internally consistent intensities and widths, but such measurements have not been reported.

A third independent measurement is obtained from infrared spectroscopy of CIO in its vibrational fundamental band near 12 μm. The expected absorption line depths, based on known molecular parameters and currently ac-

cepted stratospheric CIO abundances, are ~0.2 percent at five air masses. Detection of atmospheric lines at this strength in solar absorption would satisfy a necessary but again not sufficient condition to confirm the currently accepted CIO abundances. Since we routinely observe sources which are 10<sup>6</sup> weaker than the sun, and since the CIO line frequencies are precisely known, we expected to confirm the conclusions of earlier researchers almost routinely. However, we failed to detect any CIO in our experiments even though we searched for several lines at several seasons. Furthermore, our spectra do show lines of stratospheric HNO<sub>3</sub> at the 0.3 percent absorption level with a signal-to-noise ratio of ~50 on their measured absorption profiles. Since our results did not satisfy a necessary condition for CIO to be present at the currently accepted abundances, we concluded that its abundance was greatly reduced at the times of our observations. Detailed analysis showed that its mixing ratio could not have exceeded 0.12 parts per billion at 40 km, assuming that the shape of Anderson's CIO profile is correct.

Contrary to deZafra's implication, ours is not a new experimental system subject to considerable uncertainty in instrumentation or interpretation. We have investigated numerous problems over the past five years and have published results on studies of stratospheric O<sub>3</sub> and CO<sub>2</sub>, CO<sub>2</sub> on Mars and Venus, and currently have publications in preparation on Jovian C<sub>2</sub>H<sub>6</sub>, and stellar NH<sub>3</sub>.

A full discussion of our CIO results has been submitted to a referred journal, which we hope will stimulate modellers and experimentalists to re-examine the various theoretical predictions and experimental results, for this important trace molecule.

*Michael J. Mumma  
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## Perfect apportionment

Your article on the inaccuracies of our apportionment system (SN: 5/8/82, p. 317) rekindled an idea I had several years ago. The failings of the current system could easily be overcome by simply weighting the value of each seat's vote as necessary so that the total vote for a given state is equal to its apportionment (to any desired accuracy). For example, given a total U.S. voting population of, say, 62,500,392 and a desired number of, say, 460 seats in the House, there should be 135,870.41 voters represented per seat vote. A state with, say, 2,794,620 voters should be apportioned 20.5683 votes in the House. This can be done by allotting the state 21 seats — each with the "weight" of .97944 votes. For convenience, the state could be given 20 seats — each with a "weight" of 1.0284 votes. I suspect that our lawmakers would find it far too great an inconvenience to deal with decimals and have accurate apportionment than to do it as they now do in spite of our Constitution.

*Matt Patterson  
Redondo Beach, Calif.*

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