SCIENCE

Published by the **American Association for the Advancement of Science (AAAS),** *Science* serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Membership/Circulation

Director: Michael Spinella
Fulfillment: Marlene Zendell, *Manager*; Gwen Huddle, *Assistant Manager*, Mary Curry, *Member Service Supervisor*, Pat Butler, Helen Williams, Robert Smariga, *Member Service Representatives*
Promotions: Dee Valencia, *Manager*, Laurie Baker, Hilary Baar, *Assistants*
Research Manager: Kathleen Markey
Financial Analyst: Jacquelyn Roberts
Administrative Assistant: Nina Araujo de Kobes

Advertising and Finance

Associate Publisher: Beth Rosner
Advertising Sales Manager: Susan A. Meredith
Recruitment Sales Manager: Janis Crowley
Adverising Business Manager: Deborah Rivera-Wienhold,
Financial: Julie Eastland, *Manager*, Andrew Joyce, *Analyst*
Marketing Manager: Laurie Hallowell
Traffic Manager: Tina Turano
Recruitment: Michele Pearl, *Operations Manager*, Dan Moran, *Traffic Manager*, Debbie Cummings, Millie Muñoz-Cumming, *Assistants*
Reprints Manager: Corrine Harris
Permissions Manager: Arlene Ennis
Advertising Assistants: Allison Pritchard, Kelly Nickerson
Send materials to *Science* Advertising, 1333 H Street, NW, Washington, DC 20005, or FAX 202-682-0816.

SALES: Northeast/E. Canada: Fred Dieffenbach, 802-867-5581, FAX 802-867-4464 • **Mid-Atlantic:** Richard Teeling, 201-904-9774, FAX 201-904-9701 • **Southeast:** Mark Anderson, 305-856-8567, FAX 305-856-1056 • **Midwest:** Donald Holbrook, 708-386-6921, FAX 708-386-6950 • **West Coast/W. Canada:** Neil Boylan, 415-673-9265, FAX 415-673-9267 • **Germany/Switzerland/Austria:** Ric Bessford, World Media Services, Germany; +49-089-39-00-55, FAX +49-089-39-00-15 • **Japan and Far East:** Mashy Yoshikawa, Orient Echo, Inc., Japan; +3 3235-5961, FAX +3 3235-5852 • **UK, Scandinavia, France, Italy, Belgium, The Netherlands:** Andrew Davies, Great Britain; +44-457-838-519, FAX +44-457-838-898 • **Other:** Contact *Science* Advertising: 202-326-6544, FAX 202-682-0816.

■

Information for Contributors appears on pages 36–38 of the 3 January 1992 issue. Editorial correspondence, including requests for permission to reprint and reprint orders, should be sent to 1333 H Street, NW, Washington, DC 20005. **Science Telephone:** 202-326-6500, TDD 202-408-7770. London office: 071-435-4291. **Subscription/Member Benefits Questions:** 202-326-6417. **Other AAAS Programs:** 202-326-6400.

LETTERS

Stratospheric Ozone Trends

The article "Measured trends in stratospheric ozone," by Richard Stolarski *et al.* (17 Apr., p. 342), represents an enormous amount of international cooperative research and analysis. Unfortunately, it creates a misleading impression through its title that *measured* trends in stratospheric ozone are described and discussed. Even though the text makes it clear that the downward trends described since 1970 are, in fact, calculated and derived from a statistical model, the reader is left with the impression from figure 3 of the article that actual total column ozone levels have been decreasing worldwide in the northern midlatitudes. As in earlier assessments, Stolarski *et al.* calculated the ozone trend series by taking seasonal, solar, and quasibiennial oscillation components, plus data from atmospheric nuclear tests ("where appropriate"), and subtracting these factors from the ozone series measured at each station. The actual measured ozone levels, unadjusted for these factors, were not shown. The measured Dobson total ozone monthly averages are shown in Fig. 1. To my untrained eye, these 32-year time series in the Northern Hemisphere reveal no obvious trends one way or the other through 1986. These measurements made in three different latitudinal zones are, however, consistent with *global* average ozone levels that have remained very near 300 Dobson units since then (*1*). Global average ozone levels were also near 300 Dobson units in the early 1970s (*2*) before rising to 311 in 1979 (*1*).

One important implication of the statistical model approach is that the derived trend estimates could be the net result of other influences, presumably "human activities" such as chlorofluorocarbon emissions. However, it seems important to distinguish what has actually happened from what would have happened were it not for other offsetting factors. Adjusting observed ozone levels downward with statistics for "seasonal, solar, and so forth components" does not mean an actual ozone-related increase in the ultraviolet flux to the earth's surface any more than adjusting salaries downward to remove the effects of inflation will mean an actual decrease in the income taxes due on them. Both are adjustments made "on paper." Except for the clear, measured seasonal depletion of ozone in Antarctica, all of the varied effects appear, over time, to have offset one another elsewhere.

Kenneth M. Towe
Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560

REFERENCES

1. J. R. Herman, R. McPeters, R. Stolarski, D. Larko, R. Hudson, *J. Geophys. Res.* **96**, 17297 (1991).
2. J. London and J. Kelley, *Science* **184**, 987 (1974).
3. "Scientific assessment of stratospheric ozone: 1989" (*World Meteorological Organization, Global Ozone Research and Monitoring, Report No. 20*, World Meteorological Organization, Geneva, Switzerland, 1990); R. D. Bojkov, L. Bishop, W. J. Hill, G. C. Reinsel, G. C. Tiao, *J. Geophys. Res.* **95**, 9785 (1990).

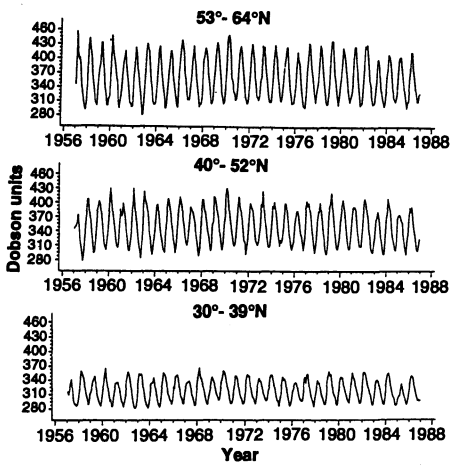

Fig. 1. A plot of Dobson total ozone monthly averages combined into time series for three latitudinal zones. [Adapted from figure 2.2-3 in (*3*)]

Response: Towe points out that the title of our article, "Measured trends in stratospheric ozone," is technically incorrect. We did not measure trends. We took measurements of ozone and deduced trends from those measurements. Perhaps a better title would have been, "Trends in stratospheric ozone deduced from measurements."

Towe implies that, other than the Antarctic ozone hole, these trends may simply be an artifact of the analysis. However, the data in Towe's figure 1 extend only through 1987, and the trends have been most obvious since only about 1980. The extra 4 years from 1987 through 1991 make the trends more significant and more obvious. Also, because of the dominance of the seasonal cycle in the total column of ozone, one can only "see" the trends in the data when the seasonal cycle is removed.

Ozone data from the TOMS satellite instrument and ground-based Dobson instruments that were deseasonalized and then smoothed with a 1-year running mean (Fig. 1) clearly show the downward trend over the last decade. No account was taken of any possible 11-year solar cycle, quasibiennial oscillation, or other natural influence.

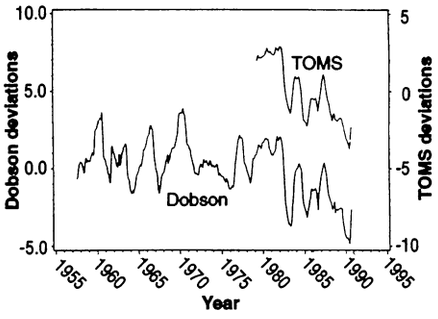

Fig. 1. A comparison of Dobson and TOMS data for northern middle latitudes. Both are presented as percent deviation from the long-term mean (in Dobson units). The Dobson graph shows a composite series constructed from deseasonalized ozone measurements from stations in the latitude range of 40° to 52°N and should be read against the *y*-axis on the left. The TOMS graph shows deseasonalized mean ozone measurements from the latitude range 40° to 50°N and should be read against the *y*-axis on the right. [Adapted from figure 2-10 of (*2*)]

Global ozone trends are significantly smaller than those shown in Fig. 1 because nearly half of the globe in tropical regions displays no trend at all (see figure 4 of our article). The details of the analysis of the global record over the 12 years of TOMS data were published in (*1*). The decrease during that time was a little more than 3%, nearly all of which occurred before 1986. Theory would suggest that this is because the downward trend is superimposed on an 11-year solar cycle variation of about 1 to 2% peak to peak. The magnitude of the solar cycle variation in total ozone is confirmed by analysis of 30-year data records from Dobson stations. This suggests that, if the trends continue, the global total ozone record will show a long-term downward trend that will be large for half the solar cycle and small or near zero for the other half.

Towe is correct that the solar ultraviolet flux at the surface will respond to the actual ozone variability resulting from all causes and not to just the trend component. However, we do not agree with his analogy to salary adjustment for inflation. The trend in the solar ultraviolet should respond to the trend in the ozone. Unfortunately, our database on trends in ground-level ultraviolet radiation is not yet robust enough for us to be able to make any quantitative statements.

Richard Stolarski
Goddard Space Flight Center,
National Aeronautics and
Space Administration,
Greenbelt, MD 20771

REFERENCES

1. J. R. Herman, R. McPeters, R. Stolaski, D. Larko, R. Hudson, *J. Geophys. Res.* **96**, 17297 (1991).
2. R. Stolarski *et al.*, in "Scientific assessment of ozone depletion: 1991" (World Meteorological Organization/United Nations Environment Program Report, World Meteorological Organization, Geneva, Switzerland, 1992), chap. 2.

■

Appraising the Evidence

Sociologist Allan Schnaiberg writes in his review (20 Mar., p. 1586) of *No Safe Place: Toxic Waste, Leukemia, and Community Action*, by sociologist Phil Brown and psychiatrist Edwin J. Mikkelsen

this study notes the rage, the sense of powerlessness, and depression experienced by Woburn [Massachusetts] activists when confronting the self-interested corporate scientists working to protect industrial profits or the government scientists working to vindicate records of government "regulation" (which was often ineffectual if