LETTERS

The SST and Ozone Depletion

As president of the Solar Planetary Relations Section of the American Geophysical Union (AGU), I agreed last year, in cooperation with the American Meteorological Society, to sanction, in the name of the AGU, a scientific review of draft monographs 1, 3, and 4 yet to be published by CIAP (Climatic Impact Assessment Program). I not only suggested names of referees but, upon request, participated in the process myself. The Executive Summary of the Report of Findings by CIAP (*1*), in my opinion, conceals the logical conclusions of the study as they were presented in the monographs we saw and criticized: it introduces new concepts concerning ultimate SST (supersonic transport) fleet sizes, flight times, and emission standards without candidly stating the ultimate effect on the stratosphere of such fleets by the early 21st century; and it, together with uncorrected stories based on it and press interviews accompanying its release, have caused a serious loss of credibility to atmospheric scientists. Because of these considerations, I realize that I made a serious mistake in allowing the AGU to be associated with this exercise and I wish to apologize. It was certainly a violation of sound editorial standards to review documents clearly labeled as drafts, preliminary, and subject to arbitrary change after the review process was completed. Having done so, we find it difficult not to *seem* to have endorsed the summary of the Report of Findings unless we explicitly disclaim that endorsement. The principal public result of this report so far has been to cast doubt on the serious nature of the questions now being raised by atmospheric scientists concerning threats to the stratosphere by anthropogenic pollutants other than nitrogen oxide (NO_x) emissions from SST's.

The Associated Press (AP) wire story resulting from CIAP manager Alan J. Grobecker's news conference and the tone of the document released at that time had the effect of concealing, and even negating, the fact that CIAP actually supported the predictions made by McDonald (*2*), Crutzen (*3*), and Johnston (*4*) in the early 1970's of the effects that would be produced by 500 Boeing SST's flying 7 to 10 hours each day over the airlanes of the Northern Hemisphere. A valid first conclusion of the study should have read as follows: "If 500 Boeing SST's had been built as planned and equipped with the engines they were expected to use before this study was undertaken, and if each had flown an average of between 7 and 10 hours per day at an altitude of 20 kilometers as planned, their effect would very probably have been to reduce the average global content of the ozone layer by between 10 and 20 percent with most of the effect occurring in the Northern Hemisphere. The result of this ozone reduction would have been an increase in erythemal solar ultraviolet radiation by approximately 20 to 40 percent and consequently a serious threat to the biosphere in the worst case, or an extremely great increase (by about 20 percent per year) in effects such as incidence of skin cancer among the Caucasian population of the world."

The summary report might have concluded also "that the future fleet of SST's predicted for the year 2020 (5000 large SST's) would have reduced ozone by more than a factor of 3; and that a reduction in NO_x emissions per engine by a factor of 60 would have been required to hold the reduction in the Northern Hemisphere to 5 percent."

No such clearly stated specific conclusions are found in the Report of Findings, although they can be deduced by someone familiar with the history of the study or a perceptive person who goes to the trouble of reading fine print, footnotes to tables, or who pursues some of the statements in the report to their logical ends. Grobecker has twice refused my appeal to correct the impression created by the AP wire story. This impression was that the originally planned SST fleet would not have seriously depleted the ozone shield and that alarm created by fears of such an effect was an important consideration in causing cancellation of U.S. plans to build an SST fleet. Thus those who raised the alarm have been effectively discredited and stand accused of providing damaging counsel to this country. I hope that this letter will repair a little bit of the damage that has been done.

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References

1. A. J. Grobecker, S. C. Coroniti, R. H. Cannon, Jr., *The Effects of Stratospheric Pollution by Aircraft. Report of Findings. Executive Summary* (National Technical Information Service, Springfield, Va., 1974).
2. J. E. McDonald, "Assessment of possible SST effects on the incidence of skin cancer" (paper presented at an informal meeting of the Conference on the Climatic Impact of Supersonic Aviation, National Center for Atmospheric Research, Boulder, Colo., 1971).
3. P. J. Crutzen, *J. Geophys. Res.* **76**, 7311 (1971).
4. H. S. Johnston, *Science* **173**, 517 (1971).

I would like to correct some of the statements made by Thomas M. Donahue in his letter concerning the Report of Findings of the Department of Transportation Climatic Impact Assessment Program (CIAP).

The impact of 500 Boeing SST's is implicit in a comparison presented in table 15 (*1*) of the Report of Findings. That table gives Boeing SST emissions as they were estimated in 1970; Boeing SST emissions as they are presently estimated (1974); and Concorde emissions as they are presently estimated (1974). The pollution effect of a 1971 Boeing SST, which flies at 21 kilometers is about six times that of a single Concorde, which flies at 16.5 km. The reader can use this comparison to give the ratio of Boeing SST effects to Concorde effects and then get the effect of 500 Boeing SST's by scaling the effects estimated for 100 Concorde aircraft in table 1 of the Executive Summary (see below). Similarly, the effect of 5000 "large SST's" can be computed by scaling the effects estimated for 100 "advanced SST's" in the same table.

In response to Donahue's appeal, the impression created by the Associated Press story of 15 January—that the originally planned SST fleet would not have depleted the ozone shield—was publicly corrected before an international audience of more than 350 persons in Cambridge, Massachusetts, on 4 February. The correction was given wide coverage in the press and on television.

I regret that a scientist as important to atmospheric science as Donahue should believe that the public result of the CIAP program has been to cast doubt on the serious nature of the questions being raised now by atmospheric scientists concerning threats to the stratosphere by anthropogenic pollutants other than NO_x emissions from SST's. These questions are as serious as the questions of stratospheric pollution by aircraft. They deserve serious worldwide attention and the use of advanced technology so that undesirable consequences may be avoided.

The alarm in 1971 created by fears of such an effect was an important consideration in causing cancellation of U.S. plans to build an SST fleet and has had a useful result in stimulating stratospheric and other researches necessary for such avoidance.

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References

1. A. J. Grobecker, S. C. Coroniti, R. H. Cannon, Jr., *The Effects of Stratospheric Pollution by Aircraft. Report of Findings* (National Technical Information Service, Springfield, Va., 1974), p. 101.
2. ———, *The Effects of Stratospheric Pollution by Aircraft. Report of Findings. Executive Summary* (National Technical Information Service, Springfield, Va., 1974), p. xvi.

I am very pleased to read this reply to my letter. My complaint was certainly not directed at CIAP itself, for I believe that it produced very significant results. It is important that what it accomplished be clearly understood. Its director's letter goes a long way toward achieving that goal.

—THOMAS M. DONAHUE

Table 1. Estimated percent ozone reduction per 100 aircraft. [Adapted from table 1 in (*2*)]

Aircraft type	Fuel burned per year* (kg/year)	Altitude (km)	NO_x emission index (EI) without controls (g/kg fuel)	Percentage of ozone reduction in Northern Hemisphere		
				Without controls	EI controls	
					1/6 today	1/60 today
Subsonic†	1×10^9	11	6	0.0034	0.00070	0.000070
707/DC-8	1.5×10^9	11	15	0.010	0.0020	0.00020
DC-10/L-1011	2.0×10^9	11	15	0.014	0.0025	0.00025
747	2.0×10^9	13.5	15	0.079	0.014	0.0014
747-SP	4×10^9	13.5				
Supersonic	3×10^9	16.5	18	0.39	0.068	0.0068
Concorde/TU-144	3×10^9	16.5				
Advanced SST	6×10^9	19.5	18	1.74	0.32	0.032

* Subsonics assumed to operate at high altitude, 5.4 hours per day, 365 days per year. Supersonics assumed to operate at high altitude, 4.4 hours per day, 365 days per year. † The present subsonic fleet consists of 1217 707/DC-8's, 232 DC-10/L-1011's, and 232 747's flying at a mean altitude of 11 km and is estimated to cause a 0.1 percent ozone reduction.