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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 airplanes 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 of the damage that has been done.

THOMAS M. DONAHUE
Department of Atmospheric and Oceanic Science, University of Michigan, Ann Arbor 48105

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SCIENCE, VOL. 187
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 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 NOx 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.

**Alan J. Groeberer**

**Climatic Impact Assessment Program, Department of Transportation, Washington, D.C. 20590**

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)]

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>Fuel burned per year* (kg/year)</th>
<th>Altitude (km)</th>
<th>NO.x emission index (EI)</th>
<th>Percentage of ozone reduction in Northern Hemisphere</th>
<th>Without controls</th>
<th>EI controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Without controls</td>
<td>EI controls</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 day</td>
<td>2 day</td>
</tr>
<tr>
<td>Subsonic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>707 DC-8</td>
<td>1 x 10⁶</td>
<td>11</td>
<td>6</td>
<td>0.0034</td>
<td>0.000070</td>
<td>0.0000070</td>
</tr>
<tr>
<td>704-10 L-1011</td>
<td>1.5 x 10⁶</td>
<td>11</td>
<td>15</td>
<td>0.010</td>
<td>0.0020</td>
<td>0.0020</td>
</tr>
<tr>
<td>747</td>
<td>2 x 10⁶</td>
<td>11</td>
<td>15</td>
<td>0.014</td>
<td>0.0025</td>
<td>0.0025</td>
</tr>
<tr>
<td>747-SP</td>
<td>2.0 x 10⁶</td>
<td>13.5</td>
<td>0.079</td>
<td>0.014</td>
<td>0.0014</td>
<td>0.0014</td>
</tr>
<tr>
<td>Supersonic</td>
<td>3 x 10⁶</td>
<td>16.5</td>
<td>18</td>
<td>0.39</td>
<td>0.0688</td>
<td>0.0068</td>
</tr>
<tr>
<td>Concorde-TU-144</td>
<td>3 x 10⁶</td>
<td>16.5</td>
<td>18</td>
<td>1.74</td>
<td>0.32</td>
<td>0.032</td>
</tr>
<tr>
<td>Advanced SST</td>
<td>6 x 10⁶</td>
<td>19.5</td>
<td>18</td>
<td>1.74</td>
<td>0.32</td>
<td>0.032</td>
</tr>
</tbody>
</table>

---

*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.
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Mass, Force, and Weight

R. J. Temple’s comment (Letters, 21 Feb., p. 598) that the SI (International System of Units) is illogical because “in the SI, . . ., weight is measured in kilograms.”

The facts are, that, in the SI, mass is measured in kilograms, and force in newtons. Weight is a general word that is widely used for both force and mass, but as a force it can be defined precisely only for the special case of bodies at rest on the surface of a heavenly body. The dual usage of the term weight has led to a National Bureau of Standards editorial guideline statement (1):

Considerable confusion exists in the use of the term weight as a quantity to mean either force or mass. In commercial and everyday use, the term weight nearly always means mass. . . . Because of the dual use of the term weight as a quantity, this term should be avoided in technical practice except under circumstances in which its meaning is completely clear.

Chester H. Page
Institute for Basic Standards,
National Bureau of Standards,
Washington, D. C. 20234

References

Merit and Discrimination

Brewster C. Denny’s editorial (6 Dec. 1974, p. 875) rightly stresses the importance to society of rewarding merit. Unfortunately, a presently popular ideology opposes rewarding superior performance and penalizing bad performance. This leads to policies that maximize the short-term comfort of the populace, but also slowly cause all social systems to sink into a slumber of inefficiency and sloppy performance. In fact, the fundamental thermodynamic principle of strictly egalitarian systems states that, “In the long run, all men and all institutions sink into a state of uniform dynamic incompetence.” In the words of Kenneth Boulding, “Radical egalitarianism may be a good way of legalizing stagnation” (1). The canonical example of dynamic incompetence is the U.S. Postal Service.

C. A. Desoer
2589 Hilgard Avenue,
Berkeley, California 94709

References

Denny’s editorial asserts that there has been a decline in the use of merit as a principle for selection, promotion, and reward. Frankena, in a discussion (1) of moral and nonmoral virtue as possible criteria of merit, concludes:

. . . . before virtue can reasonably be adopted as a basis of distribution, there must be prior equal distribution of the conditions for achieving virtue, at least insofar as this is within the control of human society.

If there has been discrimination and if the condition of equality is necessary for the distribution of rewards according to merit to exist, then a reward system based primarily on merit has not existed during the time when discrimination was present. The people employed, promoted, and rewarded before 1968 were drawn from a favored 30 to 40 percent of the population. This group cannot claim that they are the most virtuous or meritorious members of their generation: they will never know if they are, since most of the population (minority and female members) were excluded before the selection for recognition began.

Following this line of reasoning one can conclude that the employment, promotion, and reward systems of the past favored “mediocrity.” The so-called merit system of the past was “hollow mockery,” and those who wish to use a “crowbar” to further discrimination are using the words “merit” and “mediocrity” for this purpose. (The word excellence is used in this way also.)

The leadership of the academic community was not actively promoting equality of opportunity before the civil rights legislation of the late 1960’s. Faculty composition reflects this discrimination. The civil disturbances in 1967 led to the legislation that has promoted equal employment opportunities, not only for minorities, but also for women. There is little evidence that university officials have willingly made many of the changes required by law. The civil rights agencies are swamped with complaints.

I realize that it requires some humility for the members of the academic community to admit the possibility that they could not be judged meritorious in a meaningful way, but humility
THE BIOLOGICAL AND CLINICAL BASIS OF RADIOSENSITIVITY edited by Milton Friedman. Instituto Regina Elena, Rome, Italy. (55 Contributors) To reduce the gap between laboratory and clinical schools, authorities from the fields of radiobiology, radiation pathology, preclinical radiobiology and experimental clinical radiotherapy have related their investigations concerning the common denominators of radiosensitivity and chemosensitivity. The perimetus is clarified, the unproven is deduced, and irrelevant concepts are eliminated. Many topics on radiosensitivity are discussed. 74, 592 pp., 5 x 10, 675 ill., 67 tables, $49.50

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sively with brains and performance may be valuable in developing technology, but the new problems of today require new definitions of excellence and new people to make the judgments.

Furthermore there is a concern that, even using classical definitions, merit systems have worked and will continue to work against excellence. Most of us are aware that "merit" systems have been used in the past to exclude women and minorities, especially some of the most able ones who seemed the most threatening to our stereotypes. Under so-called merit systems, we in academe for years have hired not the most qualified people, but rather friends and friends of friends. We never heard about rigidly enforced merit decisions in those days. Even now, the merit issue is only raised when we are talking about women and minorities.

It seems strange to argue with the notion of merit. But merit, as it has been defined and applied, has had the effect of limiting the range of solutions available for our problems. We can't afford this luxury any longer. I doubt that we ever could.

Sidney Roth
Department of Psychology,
California State University,
Los Angeles 90032

McMeekin and Roth correctly point out that discrimination, favoritism, mediocrity, and just plain bad judgment have historically hidden behind personnel processes called merit systems, often incorrectly. In fact, despite the many instances of blatant, overt, racial, religious, and sexual discrimination in our society, the majority of such discriminations, particularly in this century, have probably occurred covertly in the name of rules and procedures giving the appearance of fairness, like seniority, or the appearance of scientifically determined merit, like civil service examinations with their expeditiously precise scores based on unvalidated test instruments. Affirmative action rather than a status quo neutrality is needed for precisely this reason, since the work forces of our society now in place are neither fully representative of the society nor determined wholly on merit. I agree fully with Roth's insistence that merit must include much more than brains and regret and retract any implication to the contrary in my brief editorial. Merit includes all those qualities which enable and inspire a person to do an outstanding job and which assure a moral and humane perform-
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Green Revolution: Just or Unjust?

Nicholas Wade's report on high-yielding varieties of rice and wheat "Green revolution (I): A just technology, often unjust in use" (News and Comment, 20 Dec. 1974, p. 1093), while it can hardly be called biased, can't be called balanced either. I suppose every one of the thousands of new technological innovations in agriculture that have occurred since man emerged from his hunting status in the forest has tended to favor those who already have in hand the most capital to make the innovations. To argue on these grounds that the innovations should not be made leads to the absurd conclusion that Homo sapiens should never have evolved, for technological innovation is what distinguishes man as a species.

Of course the distribution of income is a major problem. But perhaps social scientists need to give more attention to solving that problem and less to lamenting the social-justice consequences of increasing productivity. The problem has been around a long time; it's not unique to the green revolution. I haven't run a poll, but I doubt if very many economists would agree that the green revolution is bad.

Dean F. Peterson
Division of Research,
Utah State University,
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