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COMMENTS ON THE POSSIBLE EFFECT OF NO_x INJECTION
IN THE STRATOSPHERE DUE TO ATMOSPHERIC NUCLEAR WEAPONS TESTS

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Recently it has been pointed out^{1,2} that the atmospheric nuclear weapons tests in the 50's and early 60's injected significant amounts of NO_x into the stratosphere. Based on this observation it was suggested that past ozone measurements be examined to determine whether the hypothesized NO_x catalytic cycle^{3,4} had produced a detectable effect on stratospheric ozone content. From such an examination it was claimed that past ozone data showed "no evidence of ozone decrease in the months following the test explosions" (p. 15, ref. 1). We believe that interpretation of this result as invalidation of the NO_x catalytic destruction of O₃ is premature and unjustified. We believe that Foley and Ruderman were misled by several often misquoted numbers and were too simplistic in their consideration of the physical process involved. Finally, this unfortunate series of events was compounded by a very cursory examination of the available ozone data.

We shall not go into the details of NO production rate from nuclear weapons. It is sufficient to note that the total yield estimate as given by Foley and Ruderman is really an upper bound and that the net NO production per explosion is an over estimate which realistically should be reduced by a factor of 2-10.⁵ Nevertheless, given the numbers from ref. 1 one should

*This work was performed under the auspices of the U.S. Atomic Energy Commission

first establish the effects to be expected in O_3 distribution and then go to the data and seek corroboration or refutation. Foley and Ruderman fail to make clear the type and magnitude of change in O_3 they expected to find and yet they concluded they did not see it. One may assume that they used the estimates of ref. 3 as the basis of comparison, since these are most widely circulated. But a careful reading of ref. 3 will reveal that the estimated NO_x catalytic effects on O_3 ranges from 3% to 50% reduction depending on the equilibrium (fixed) NO distribution and concentration (pp. 87-92, ref. 3). It should be pointed out that these results are steady state calculations, i.e. after the system has fully reacted. The highly important downward transport of O_3 from the chemically active upper stratosphere has been neglected completely. This is a crucial omission in that the highly perturbed O_3 profiles in ref. 3 are not in dynamical equilibrium. In fact the dynamical interaction between the transport mechanism and chemical kinetics resulting in a large reduction in the observable effect of the NO_x catalytic process has already been pointed out.⁶ One should also recognize the differences between the solutions calculated from continuous injection of NO due to SST's and from the "delta function" injections of nuclear tests. In the former case a steady state calculation is possible while in the latter case one must deal with a time dependent problem. None of these considerations seem to have been treated by Foley and Ruderman. This may have led to expectations of an unrealistically large perturbation in the O_3 observations.

We have made some preliminary computations with a 1-D model combining diffusion and the NO_x catalytic cycle. These indicated that the maximum reduction in O_3 would occur approximately 250 days after NO injection and would amount to <15% reduction in total O_3 . If these effects of the NO injection are valid one would not have expected them to be detectable by the cursory examination of the O_3 observations reported by Foley and Ruderman. They reported no analysis

of the O_3 data other than a visual examination of the reproduced curves of total O_3 at selected stations. Superpositions of O_3 annual curves (traced from ref. 1) for 1960-1964 for the stations reported by Foley and Ruderman appear in Fig. 1. These make it clear that year to year random variations in mean monthly total O_3 are of the order of 10-20%. Yet for Kodaikanal and Marcus Island Foley and Ruderman claimed "Even a five percent effect would be apparent in this very reproducible data" (Ref. 1, p. 16). (In fact the diameter of their plotted data points exceeded 5% of the mean ordinate values.)

Our present position is that the Foley and Ruderman study¹ is very inconclusive. It does not establish that NO injected into the stratosphere by nuclear weapons tests had no detectable effect on O_3 observations. We feel and urge that a more careful study should be carried out.

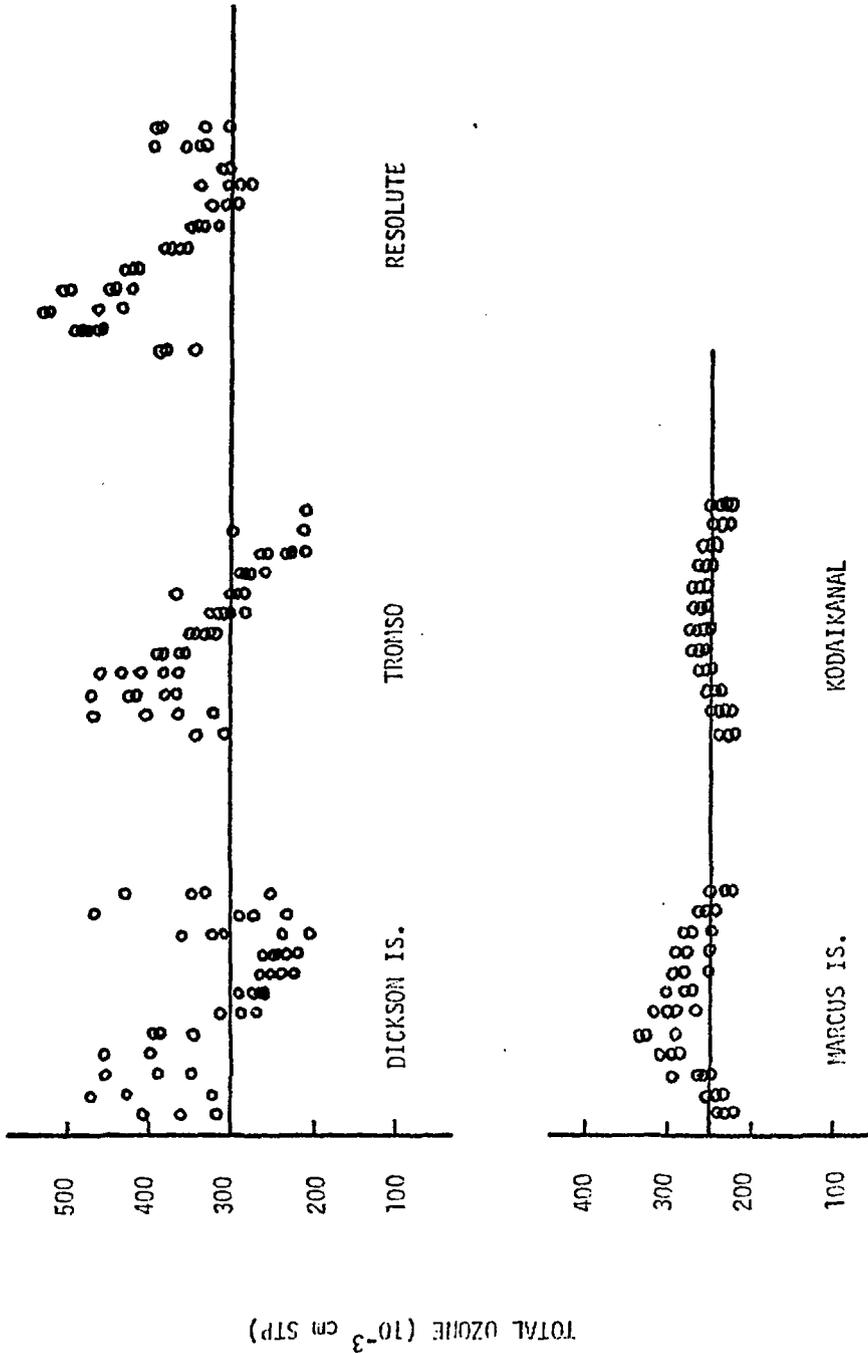


FIG. 1 FIVE YEAR SUPERPOSITION OF MONTHLY OZONE MEASUREMENTS (1960-1964)

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