Reply

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We appreciate the comments provided by Fishman (1991) concerning our paper (Rodgers et al. 1990). We had not realized the extent of tropospheric ozone that had been produced by biomass and pollution episodes that was distributed over the open ocean regions. Obviously, there is a need to determine what influence tropospheric ozone has on the distribution of total ozone in tropical cyclones as observed from the Nimbus-7 Total Ozone Mapping Spectrometer (TOMS).

There are no current observational techniques to isolate the tropospheric distribution of ozone within a tropical cyclone circulation from the TOMS-observed total ozone distribution (Fishman 1991). Therefore, it will be difficult to determine quantitatively what influence tropospheric ozone has on the distribution of total ozone in a tropical cyclone that is observed from TOMS. However, the TOMS-measured total ozone distributions in the western North Atlantic tropical cyclones consistently reveal a total ozone pattern that corresponds more to the three-dimensional transport processes that are associated with the circulation near the tropopause than the circulation found in the lower troposphere. If the TOMS-observed total ozone were substantially influenced by tropospheric ozone, the observed total ozone distribution would reflect the cyclonic circulation around the tropical cyclone. If this were true, the TOMS would most likely delineate a ozone-rich region north and a ozone-poor region south of the tropical cyclone, which would spiral cyclonically inwards towards the center. However, it is observed from the nonrotated mean Nimbus-7 TOMS-measured total ozone anomalies for 28 nonintensifying and 25 intensifying western Atlantic tropical cyclones seen, respectively, in Figs. 23 and 24 of our paper (Rodgers et al. 1990) that the mean total distribution does not reflect such a ozone distribution. There are no strong latitudinal mean total ozone gradients that resemble the mean tropospheric ozone gradients shown in Fig. 1 of Fishman's (1991) comment. Also, the mean TOMS-observed total ozone minimum region found east of the tropical cyclone center could not be generated by the tropical cyclones' lower-tropospheric cyclonic flow, if the TOMS total ozone measurements were influenced by tropospheric ozone. The data analysis and numerical simulations that were performed by Rodgers et al. (1990) suggest that the region of minimum mean total ozone is most likely generated by the secondary circulation associated with the tropical cyclones' outflow jet.

As part of our future research with the TOMS total ozone data, an effort will be made to examine landfall tropical cyclones over the United States, so that the data source will be sufficient to allow for a more accurate diagnostic analysis of the tropospheric and lower-stratospheric transport processes in and around the tropical cyclones. These analyses will then be compared to the TOMS total ozone observations. Perhaps these analyses will provide more information on whether the spatial distribution of total ozone observed from TOMS is influenced by the lower-tropospheric circulation and, therefore, tropospheric ozone.

REFERENCES

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