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Reply

CHARLES H. JACKMAN, PAUL D. GUTHRIE, AND JACK A. KAYE

Atmospheric Chemistry and Dynamics Branch, NASA Goddard Space Flight Center, Greenbelt, Maryland

It is disconcerting that the model computations of NO_2 and HNO_3 are a factor of 4 or more different from the Limb Infrared Monitor of the Stratosphere (LIMS) data in the lower stratosphere [*Jackman et al.*, 1987]. We would obviously prefer a disagreement of "only" a factor of 2 at 25 km implied by some balloon-borne measurements [*Roscoe*, this issue]. We are not in a position to decide which data sets are correct: the balloon-borne measurements of NO_2 discussed by *Roscoe* [this issue] or the LIMS NO_2 measurements. We used LIMS NO_2 and HNO_3 data for comparison for two reasons: (1) the LIMS data contained other species as part of the data set, including H_2O which we used in our model calculations, and (2) the LIMS data were part of a nearly global data set over a long (7-month) period. The LIMS NO_2 validation paper [*Russell et al.*, 1984] goes into detail about the sources of errors in the measurements, with the root square sum systematic error being 49% at 30 mbar (about 24 km), and increasing to 84% at 50 mbar (about 20 km) and below. The model results reported by *Jackman et al.* [1987] are not incompatible with the LIMS NO_2 data, given the large uncertainties in the LIMS measurements at 50 mbar and below. We should emphasize, though, that the model and LIMS NO_2 do not disagree in a random manner, but the model results are consistently much less than the LIMS data.

Another global satellite data set is that of the Stratospheric Aerosol and Gas Experiment (SAGE). A cursory inspection of the NO_2 measurements of SAGE in the lower stratosphere, as presented by the *World Meteorological Organization (WMO)* [1986, Figure 10–33], indicates that the SAGE NO_2 data are also a factor of 4 or more larger than model computations. The satellite data sets of LIMS and SAGE, at least in the middle to lower stratosphere, appear to be roughly consistent with one another [see *WMO*, 1986, Figures 10–12 and 10–51]. This good comparison between LIMS and SAGE NO_2 is significant because the two measuring techniques are independent of one another. The SAGE instrument measures atmospheric attenuation of visible radiation during each solar occultation (sunrise or sunset), whereas LIMS measures infrared emission (day or night) in order to determine NO_2.

Roscoe's [this issue] major point is that the LIMS measurements may have even larger uncertainties than those presented by *Russell et al.* [1984]. This is a point worthy of emphasis. NO_2 is one of the most important constituents of the stratosphere, especially with regard to the photochemistry of O_x, HO_x, Cl_x, and, of course, NO_x species. Models need good measurements of NO_2 for validation, especially in the lower stratosphere, where both dynamics and chemistry are important and modelling is difficult. We urge experimentalists to further intercompare and refine their NO_2 measurements in order to determine the most reasonable values for NO_2 in the lower stratosphere.

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P. D. Guthrie, C. H. Jackman, and J. A. Kaye, Atmospheric Chemistry and Dynamics Branch, Code 616, NASA Goddard Space Flight Center, Greenbelt, MD 20771.

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