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Abstract

Near UV OH(A→X) and NH(A→X) emission bands at ~3100 and 3360 Å, respectively, have been observed from the far-field radiance from the Shuttle Vernier Reaction Control System (VRCS) engine exhaust using the GLO imager spectrograph located in the payload bay during the STS-74 mission. Spectra were collected at a resolution of 4 Å for daytime solar illumination conditions during low-Earth orbit (LEO) maneuvers. A temporal analysis (2 s temporal resolution) of spectral features is presented for an extended VRCS burn. The spectrum is dominated by the narrow NH(A-X) band. Both NH(A-X) and OH(A-X) features are shown to be proportional to the engine mass flow, and thus are produced by a single collision or solar-induced mechanism. While a pure chemical, yet unknown chemical mechanism has been established for the NH(A-X) feature, the weaker OH(A-X) band is demonstrated to be primarily produced by the chemical reaction of atmospheric O with exhaust H_2O, with minor solar-induced contributions. The high signal-to-noise ratio for both bands allowed a more precise determination of excited state rovibrational populations compared with previous efforts. The present analysis is complemented with direct simulation Monte Carlo calculations of the engine exhaust flow field and proposed radiation excitation mechanisms for the NH(A-X) and OH(A-X) emissions. The results for both are consistent with a one-step reaction mechanism of atmospheric O with an engine-exhaust precursor.