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Lessons from a Lifetime: O(^1D) Emission in Ionospheric Modification

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The principal optical observable emission in ionospheric modification (IM) experiments is the atomic oxygen red line at 630 nm, originating from the O(^1D-^3P) transition. Because the O(^1D) atom has a long radiative lifetime, it is sensitive to collisional relaxation and an observed decay faster than the radiative rate can be attributed to collisions with atmospheric species. In recent work, we showed that in contrast to the common practice of ignoring oxygen atoms in interpreting such observations in the past, O atoms control the atomic oxygen red line emission between approximately 200 and 300 km [1]. Therefore, the observed O(^1D) lifetime in IM experiments provides a measure of the local O-atom density. An analysis of existing IM data yields good agreement between observations and the MSIS model for altitudes above 250 km. In this paper, we present analyses of observations from representative IM experiments and of laboratory data investigating the relaxation of O(^1D) by O(^3P), focusing on the interpretation of the O(^1D) emission's temporal evolution at high and low altitudes. We discuss the relevance to atmospheric observations and ionospheric heating studies.

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