Geophysical Research Abstracts
Vol. 13, EGU2011-3133, 2011
EGU General Assembly 2011

The Sodium Nightglow

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The Na emission at 589 nm in the earth's nightglow consists of two closely spaced lines, the so-called D lines. This doublet arises from spin-orbit coupling in the excited (2P) state of the Na atom. It was discovered relatively recently [Slanger et al, JGR 2005] that the ratio between the D lines is not constant (unlike other airglow features involving multiplets). The most likely explanation for this is that the emission is produced by the reaction of two different electronic states of NaO with atomic O, which yield Na(2P) with different spin-orbit propensities. In this paper we describe a comprehensive set of measurements of the D line ratio, at various locations and seasons. The average ratio is 1.66. We show that this ratio of 5/3 is in fact the statistical ratio expected by considering the projection of angular momentum in the O-Na-O internuclear plane. This statistical analysis is fitted to the laboratory measurements reported in Slanger et al. [2005], and then used in an atmospheric model to predict the variation in the D line ratio as the Na layer is perturbed by gravity waves. These variations are shown to be consistent with simultaneous observations of the Na atom density (by lidar) and the D line ratio.