The Atmosphere as Laboratory: Aeronomy by Astronomy

T. G. Slanger, P. C. Cosby, and D. L. Huestis
Molecular Physics Laboratory, SRI International, Menlo Park, CA

Astronomical sky spectra are proving to be a rich source of data on emissions in the terrestrial atmosphere over a broad range of altitudes (85-250 km). The high resolution (0.01-0.02 nm) and CCD detection associated with these spectra has led to much new information on species as diverse as the electronically- excited states of O₂, many O-atom Rydberg levels, weak OH lines, potassium, N₂⁺, He, and Ca⁺, over the 330-1000 nm spectral region. From nightglow emission, we have been able to characterize the O₂ states in vibrational levels not previously observed, and have detected O₂(b) state emission from levels v = 0-15, emission to the O₂(a) state in levels v = 1-11, and emission to the ground state in levels v = 0-15. In addition, we are able to see the fully-resolved O₂ UV emissions in the Herzberg I and Chamberlain transitions. There is considerable synergy when we observe the new atmospheric emissions while simultaneously studying the same emitters in the laboratory [1]. In related astronomically-oriented work, we have also made measurements of the Venus nightglow with the Keck and Apache Point (APO) telescopes, confirming older results which identified O₂(c) state emission, and establishing for the first time that the oxygen 557.7 nm green line is an important Venus nightglow feature. Examples of the terrestrial spectra are available at http://www-ml.sri.com/NVAO/download/Osterbrock.html

References:
[1] K. S. Kalogerakis, A. Tóth, P. C. Cosby, T. G. Slanger, and R. A. Copeland, Laboratory Studies of the Production of Highly vibrationally Excited O₂(a) and (b) from O₂(A) Relaxation, Eos, Trans. Amer. Geophys. Union 81, F944 (2000).

Acknowledgments:
This work has been supported by the NSF Aeronomy and the NASA Planetary Astronomy programs.