

Mesospheric Temperature Observation Using a Michelson Interferometer

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A Michelson interferometer was used to record spectral data of nightglow emissions, and software was written to process the data. The upper mesosphere/lower thermosphere (MLT), approximately 80-105 km above Earth, is a dynamic region of the atmosphere where processes and forces from two layers interact. The MLT is affected by periodic tides, the effects of which can be seen through study of the temperature of the region over time. Due to the altitude of the layer, measurement by long-lived satellite and balloon are impossible, and sounding rockets yield only an instantaneous snapshot. However, with spectral analysis of hydroxyl emissions, remote sensing of temperature over the course of a night is possible. Hydroxyl, found most abundance in this region, exists in a vibrationally excited state (OH*) as well as a ground state (OH). The process which de-excites the OH* to OH results in infrared photon emission. The molecules are in thermodynamic equilibrium with the surrounding atmosphere, so rotational temperature is a reliable measurement of atmospheric temperature. Rotational temperature is calculated using the relationship of photon emission intensity to total upper state angular momentum for a Boltzmann distribution of multiplet rotational levels. To remove noisy data, the spectral data sets are passed through a series of filters before a time vs. temperature graph is created with only valid data. Observations of the 3-1 Meinel band ($6400\text{-}6700\text{ cm}^{-1}$) were made on 5 nights during July 2012 at Center Green Building 1, Boulder, CO in an effort to investigate terdiurnal (thrice-daily) tides at mid-latitudes. An InGaAs detector was used with a Nicolet 6700 spectrometer containing a Michelson interferometer; light entered from a scope attached to the roof. Data collection was limited by malfunctions of the third party software which controls the spectrometer, poor weather conditions, limited ability to align the spectrometer, and the condition of the scope. Variations seen in temperature data from any given night is expected to be approximately 30 K, with an average temperature of 195 K. The valid data collected varied an average of 189.9 K, with an average central point of 271.4 K, and too few valid points were found on all nights to attempt fitting a curve. Error from the spectrometer measurements does not account for the discrepancies. Observations must continue to be taken in hopes of clearer skies, more much work must be done to align the detector of the spectrometer, and additional attention must be given to the scope. Future study also ought to implement a module in the software to calculate total band intensity from the collected spectral data, as time was a constraint this summer.