Semi-Annual-Oscillation in Mesospheric Temperatures at Low-Latitudes

The Maui-MALT program is a joint research initiative between the US Air Force Office of Scientific Research (AFOSR) and the National Science Foundation. Measurements are obtained using a cluster of instruments operated at the Air Force AMOS facility at the summit of Haleakala Crater, Maui (20.8°N, 156.2°W). These instruments include a powerful Na wind/temperature lidar (operated on a campaign basis), a meteor radar, and several passive imaging instruments designed for long-term unattended measurements of the MLT nightglow emissions. One of the primary goals of this program is the investigation of the thermal structure and variability in the MLT at low-latitudes.

As part of this program, novel measurements of seasonal variability in mesospheric temperature have been obtained using the USU CEDAR Mesospheric Temperature Mapper (MTM) during a 25-month period from Oct. 2001 - Jan. 2004. Autonomous observations of the OH (6, 2) Meinel band (peak height ~87 km) and the O₂ (0, 1) Atmospheric band emission (~94 km) were made ~22 days per month centered on the new moon period. Over 467 nights of quality data (4-10-hr duration) have been collected to date. The two figures below show the OH and O₂ emission intensities and the derived rotational temperatures folded into a 1-year interval. The “error bars” show the standard deviation in the mean of the nightly relative intensity and temperature distribution for each emission, which, is mainly due to geophysical variability (caused by gravity waves and tides) in the high precision data recorded during each night.

Both figures show a coherent oscillation in the OH and O₂ emission intensity and rotational temperature with a well-defined periodicity of 181 ± 7 days. The amplitude of this oscillation was determined to be ~5-6 K in temperature (fitted curves) and ~8-9% in intensity for both the OH and O₂ data sets. In addition, a strong asymmetry in the shape of the oscillation was also observed with the spring maximum significantly larger than the fall peak. These data provide new evidence in support of a semi-annual oscillation in mesospheric temperature at ~ 20° N (and airglow emission intensities) and help quantify its seasonal characteristics.