Impact of Solar Spectral Irradiance Variability on Middle Atmospheric Ozone and Temperature

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Ozone and temperature data collected from several instruments was examined for effects from solar spectral variability in the middle atmosphere. Concentration of ozone measurements collected independently at 9.6μm and 1.27μm from the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument were compared with one another and analyzed for solar irradiance variability effects in the lower mesosphere. SABER temperature data was compared with that of the Microwave Sounding Unit (MSU) Channel 4 and Advanced Microwave Sounding Unit (AMSU) Channel 9. Temperature comparisons were found to be possible only at 86mbar in the lower stratosphere. The difference between the annual mean temperatures of the instruments was consistently 20K through 10 years of overlapping measurements. MSU and AMSU data was found to have extremely low variability both within each year and through its full record. It showed no QBO or solar cycle effects and varied, on average, 0.06 % from its annual mean at solar minimum in 2009. SABER data showed reasonable variability within each year and showed solar cycle and QBO effects. Because of the limitations of comparisons between these two instruments and the variability problems with the MSU and AMSU data set, further comparisons to SABER data would not be particularly useful. Data gathered from the Stratospheric Sounding Unit (SSU) would likely yield more meaningful comparisons to data gathered by SABER.

Ozone measurements at 9.6μm and 1.27μm were found to be equally populated with values for overlapping pressure level measurements. A constant bias between the measurements of the two channels was found that is higher than would be expected from the documented instrumentation bias of the 9.6μm channel. The ozone measurements were found to be significantly affected by solar variability, such that at times of greater UV variability, the difference between the two channel's measurements was greater than it was during times of low solar variability. Further investigation is needed to determine if the photolysis rates used in inferring the ozone measurements at 1.27μm are underestimating contributions from solar variability over the solar cycle, particularly, in the oxygen Schumann-Runge Band and the ozone Hartley Band of absorbance. It is plausible that the solar cycle irradiance changes observed by SORCE could bring the 1.27μm and 9.6μm SABER channels into agreement; however a full reanalysis of the SABER 1.27μm data would be required to make this assessment.