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Solar cycle and linear trend analysis of the 15 year hydroxyl rotational temperature record over Davis station, Antarctica.

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A climatology of hydroxyl (6-2) band temperatures has been derived from 15 consecutive years of scanning spectrometer measurements at Davis station (68°S, 78°E), Antarctica.

Hydroxyl emissions originate in a layer about 8km thick near 87km altitude from the exothermic hydrogen-ozone reaction which vibrationally and rotationally excites the molecule. Rotational levels rapidly thermalize, so that the rotational temperatures derived can be considered a proxy for atmospheric temperature near the mesopause. Carbon dioxide radiatively cools in this region and global climate models indicate that the high latitude upper atmosphere is likely to cool significantly in response to global carbon dioxide increases.

Mean winter temperatures over Davis for the last two years are the coldest on record, but occur during solar minimum. In this work, multivariate fitting is used to extract solar cycle and long term linear trend coefficients from a total of 3067 nightly averages between 1995 and 2009 to assess the significance of the recent cold years. Winter average temperatures, calculated from nightly averages between day 108 to 258 each year vary between 199.7 (2009) and 208.9K (1999) with a solar cycle dependence of about 0.05 ± 0.01K/sfu (or 6K per cycle) and long term linear trend of about -0.13K$\pm$0.09K/year. Sliding window analysis to extract the seasonal variation in trend coefficients shows the cooling trend is at a minimum around mid-winter (no trend) and maximum around the september equinox (up to -0.3K/year), which may be associated with the spring ozone depletion.

The successful detection of long term trends in this data set is strongly dependent on the inter-year calibration precision. A recommendation of the NDMC (Network for the Detection of Mesopause Change) was that “an assessment of climate change in OH temperatures requires an inter-year calibration uncertainty of less than 1K". Primary calibrations (three times per year) with annual cross reference of primary sources to international standards and regular secondary reference calibrations have maintained the calibration uncertainty in these data to around 0.3K.