



Lower Tropospheric Measurements of Water Vapor and Carbon Monoxide during CRYSTAL-FACE

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Open-Path Tunable Diode Laser Absorption Hygrometer



Path length (folded cavity): 37 cm
 Linear Range: 0.005 - 20 g/kg
 Accuracy: 5-10 %
 Sampling Rate: 15-20 Hz
 Weight (with mount plate): 20 lbs
 Power: 4 A (28VDC)

Introduction

The NCAR open-path tunable diode laser hygrometer deployed on the CIRPAS Twin Otter is nearly identical to the JPL hygrometer (May, JGR, 103(D15), 19161-19172, 1998). The NCAR instrument employs a shorter path length than the higher altitude versions for reliable performance in the lower troposphere. The hygrometer was modified prior to this mission for 15-20 Hz sampling rates, enabling flux measurement capability. Laboratory calibrations developed by Bruce Gandrud and Randy May were conducted to characterize instrument response as a function of pressure, temperature and water concentration. The output of a pressure controlled dew point generator was introduced into a sealed flow cell at a controlled temperature. To quantify the water vapor mixing ratio in this calibration gas, a General Eastern chilled mirror hygrometer was inserted in series. For low anticipated mixing ratios, this approach may be extended to include controlled dilution with dried air. A photograph of the instrument is shown at left. Performance specifications are also shown in the left text box.

The CO instrument operates on the principle of vacuum UV resonance fluorescence, as published by Gerbig, et al. (Journal of Geophysical Research, Vol. 104, No. D1, 1699-1704, 1999). Single point calibrations and zeroes were taken periodically during each flight to characterize instrument performance. Ambient air was sampled from the CIRPAS community inlet. A photo of the instrument and pump are shown at right, along with a box summarizing of system performance. Intercalibration activities with the WB-57 Argus group are ongoing.

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Vacuum UV Resonance Fluorescence CO Analysis



Linear Range: 3 ppbv - 100 ppmv
 Detection Limit: 3 ppbv
 Accuracy: 4 ppbv + 10 %
 Frequency Response: 1 Hz
 Weight: 120 lbs.
 Power: 8 A (28 VDC)
 Space Requirement: 21 vertical inches
 Non-toxic Support Gases: 3



Below are Twin Otter CO data from three flights: 21, 23, and 28 July. The time series include altitude and CAPS data as indicators of vertical heterogeneity and times of cloud penetrations. Below the time series are plots of the latitudinal variation in the CO data. The data are also color coded according to rough altitude bins provide some indication of vertical mixing within sampled areas.

Water Vapor Instrument Performance

At left is a plot of the NCAR and CIRPAS hygrometer data from the 7 July flight. The NCAR data have been averaged into 1-s bins. The time series shows reasonably good agreement between the two instruments. The pink trace depicts the ratio of the two signals, and indicates the two measurements typically agree to within 10%, with the NCAR instrument tending toward slightly higher mixing ratios. The correlation and vertical profile plots provide further evidence of close agreement with some larger differences noted for data at altitudes below 500m.

