

## Uncertainty Analysis of CO<sub>2</sub> Standard Transfer in CMDL from 1979 to 2004

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At present, state-of-the-art, nondispersive infrared (NDIR) analyzers offer the most precise method of CO<sub>2</sub> detection. However, this technique requires very accurately calibrated standard gases. On the basis of the World Meteorological Organization (WMO) CO<sub>2</sub> Expert Meeting in 1975, the CO<sub>2</sub> standards are classified as WMO primary, secondary, tertiary, and working standards according to intended use. The primary standards are used to assign precise CO<sub>2</sub> concentration values to the secondary standards maintained by each country as national standards. From 1979 through 2000 the CMDL secondary standards were calibrated by the Scripps Institution of Oceanography (SIO) against the WMO primary standards approximately every 3 years. From mid-1996 to 2001, the assigned CO<sub>2</sub> values of the primaries have been jointly based on the SIO and the CMDL manometric measurements and completely on the CMDL manometric measurements alone from 2001 to present. The secondary standards are transferred via NDIR analyzers to all other reference gas tanks used routinely for measuring atmospheric CO<sub>2</sub> concentrations in the CMDL cooperative air sampling network, the CMDL tall tower sites, and at the CMDL observatories. In this presentation the uncertainties for each reference tank calibration by NDIR analyzers against the secondary standards from 1979 to present are evaluated. Figure 1 shows the calibration uncertainties are about 0.03  $\mu\text{mol mol}^{-1}$  from September 1979 to March 1986, 0.007  $\mu\text{mol mol}^{-1}$  from April 1986 to August 2000, and 0.01  $\mu\text{mol mol}^{-1}$  from September 2000 to present. On the basis of these analyses the total measuring uncertainties versus the WMO primary standards in the CMDL air sampling network, the CMDL tall tower sites, and the CMDL observatories are estimated. These estimates can be considered as the upper limit of the precisions to measure atmospheric CO<sub>2</sub> concentrations during the period.

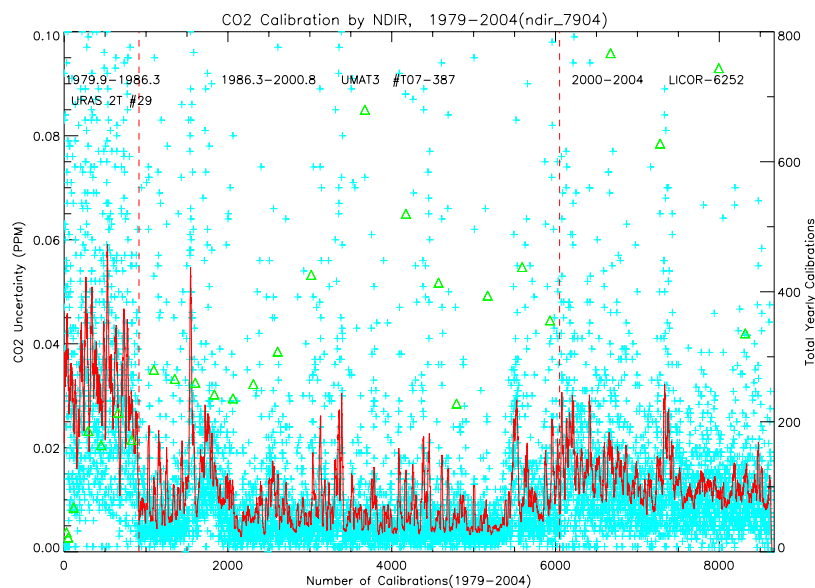


Figure 1. Uncertainty of CO<sub>2</sub> calibration by NDIR for each reference tank is shown by a plus. The red line indicates a weekly average of uncertainties. Triangles show the total yearly calibrations from 1979 through 2004.