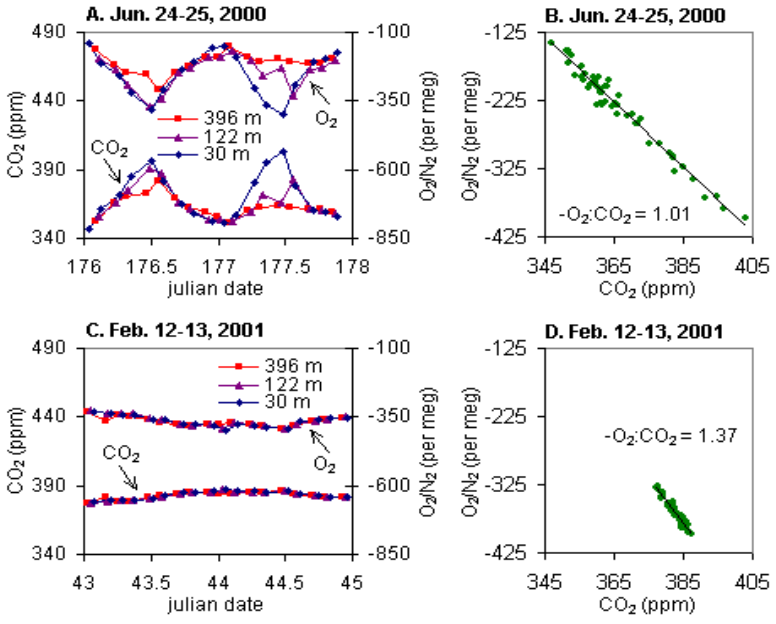
Results From the First Year of Atmospheric O_2 Measurements at the WLEF Tall-Tower Site

B. B. Stephens[1,2], P. Bakwin[2], P. Tans[2], R. Teclaw[3]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, 80309-0216; (303) 497-6999, Fax: (303) 497-5590, E-mail: britt@cmdl.noaa.gov
[2]NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, CO 80305
[3]Forest Sciences Laboratory, USDA Forest Service, Rhinelander, WI 54501

Marine boundary-layer atmospheric O_2 measurements have proven to be valuable constraints on the global partitioning of terrestrial and oceanic CO_2 sources, seasonal net production by the marine biosphere, hemispheric gas-exchange rates, and interhemispheric oceanic transport. We have recently adapted a commercial fuel-cell detector to make the first atmospheric O_2 measurements from the interior of a continent and to collect the first extended O_2 record in and above a forest ecosystem. The fuel-cell analyzer has successfully measured O_2 concentrations at the WLEF tall-tower research site continuously since June 2000. The system analyzes air from one of three heights (396 m, 122 m, and 30 m) every 30 minutes with a precision comparable to existing laboratory techniques. These measurements have a bearing on the use of O_2 to constrain the global carbon cycle, the physiological behavior of forest plants, the vertical mixing of air as it moves across the continent, and our potential to verify industrial emissions through atmospheric measurements.

The first 10 months of data reveal lower-than-expected oxidative ratios in terrestrial respiration (figures A and B). Though still unexplained, the observed diurnal and seasonal variations in O_2 provide some clues to explain this apparent anomaly. By combining the O_2 and concurrent CO_2 and CO measurements, we can derive a tracer that is conservative with respect to terrestrial processes but very sensitive to oceanic gas exchange. The vertical gradients and seasonal cycle in this tracer then provide information on aspects of continental boundary-layer mixing that can be used as validation tests for atmospheric transport models. Finally, O_2:CO_2 ratios in a number of pollution events from midwestern cities (figure C and D) have been detected . These ratios are consistent with what we expect from the corresponding mix of reported combustion sources, suggesting a potential tool for emission verification in areas where this mixture is not known.



Two-day timeseries and correlation plots for atmospheric O_2 and CO_2 variations measured at the WLEF tall tower site. Data from June of 2000 (A and B) show a strong diurnal cycle, with O_2 and CO_2 anticorrelated at somewhat lower than the expected oxidation ratio. Data from February 2001 (C and D) show no diurnal cycle, but reflect the passage of an urban air plume traceable to Chicago with an O_2:CO_2 ratio consistent with industrial emissions. The data also show a seasonal cycle with O_2 lower and CO_2 higher during winter.