CONTINUOUS *IN SITU* MEASUREMENTS OF ATMOSPHERIC O_2 AND CO_2 AT HARVARD FOREST

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ABSTRACT

Simultaneous and continuous measurements of O_2 and CO_2 made in the air around terrestrial ecosystems have the potential to improve our understanding of the biogeochemistry of the ecosystem, and may reduce uncertainties in estimates of terrestrial carbon uptake derived from atmospheric O_2 measurements. Following the design of Stephens *et al.* [2001], we have constructed an instrument that performs continuous *in situ* measurements of atmospheric O_2 and CO_2 concentrations. We present design and performance data, along with preliminary results from a deployment at the Environmental Measurement Site at Harvard Forest in central Massachusetts.

One of the primary methods used for determining the fate of carbon removed from the atmosphere is the rate at which atmospheric O2 is decreasing [e.g. *Houghton et al.*, 2001]. However, to correctly infer the fate of carbon, we must know the stoichiometric relationships between O_2 and CO_2 in both fossil fuel combustion and terrestrial photosynthesis/respiration. The stoichiometries for fossil fuel combustion are relatively well known [*Keeling*, 1988], but those associated with the land biota carry a larger uncertainty [*Severinghaus*, 1995].

We also expect the terrestrial biotic stoichiometries to vary both spatially and temporally. For example, conversion of carbon to wood has a different value than production of shoots and nitrogen-rich material. Thus, different ecosystems are likely to exhibit different stoichiometries depending on their composition, their age characteristics, and environmental influences. Time series measurements of the stoichiometry should provide insight into the functioning of the ecosystem and the role of external influences on plant physiology.

To measure these stoichiometries, we have combined a fuel-cell based oxygen analyzer (Sable Systems Oxzilla II) and an NDIR CO_2 Analyzer (LiCor LI7000) with a gas handling system that includes active pressure and flow control. A schematic is shown in Fig. 1. We match pressures and flow rates through the two analysis cells of the instruments, make all measurements relative to a suite of independently calibrated sample gases, and switch our sample and reference gas streams frequently using a changeover valve. These protocols afford an instrumental precision of roughly 3 per meg (where 1 per meg is a fractional difference of 0.0001%) on a 2-minute comparison of the sample gas stream and a reference tank, both flowing at 50scc/min.

The instrument is fully automated, and has been recently installed at the Environmental Monitoring Station at Harvard Forest in central Massachusetts (USA). Sample air is drawn in from one of two dedicated intake lines mounted on an instrument tower. The lines originate close to the ground and just above the top of the canopy. We maintain continuous air flow through the unused line in order to maintain the integrity of the gas stream. Preliminary time-series of the covariation of O_2 and CO_2 are presented.

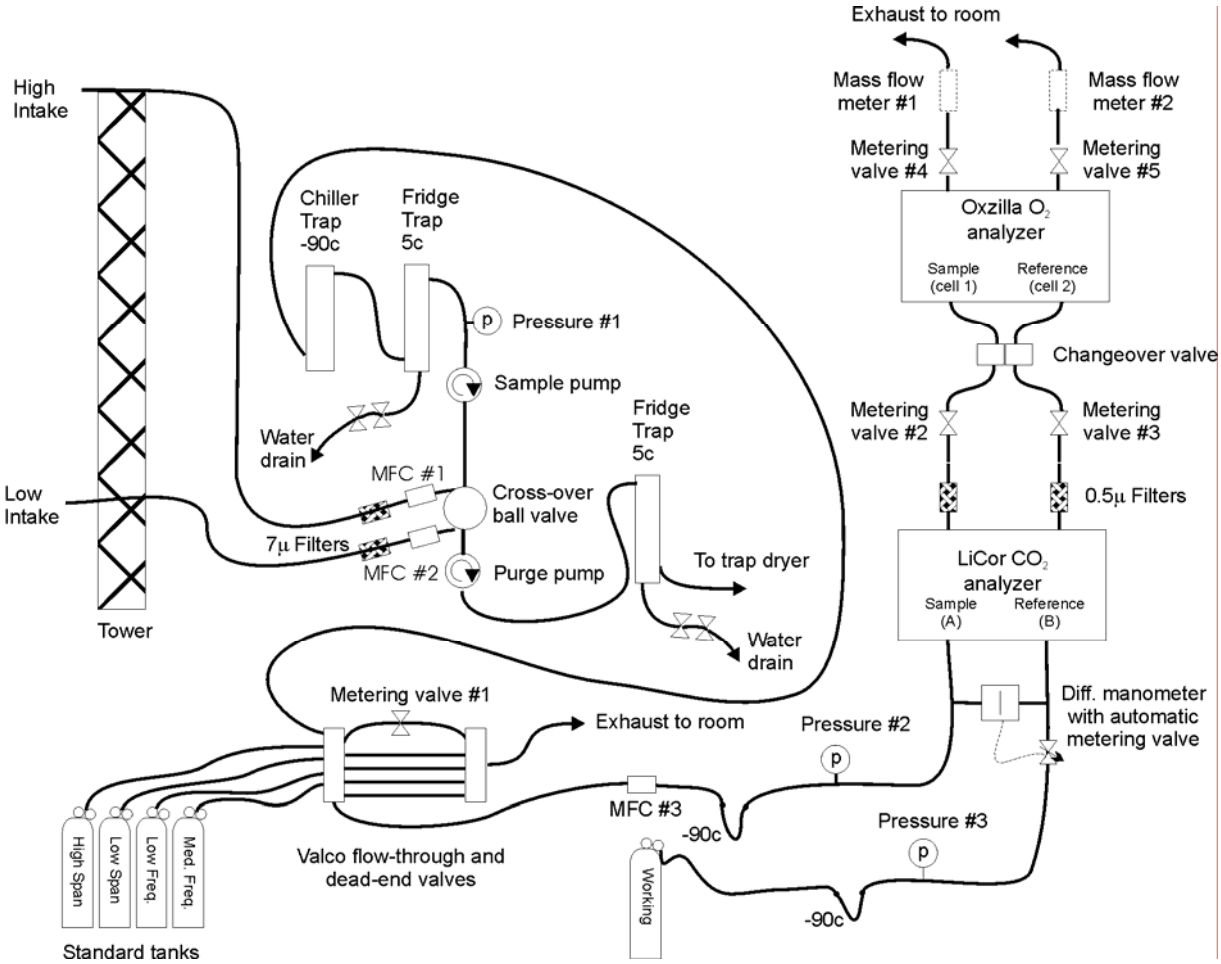

Fig. 1: Schematic diagram of the O_2 & CO_2 analysis system currently installed at Harvard Forest. "MFC" indicates a mass flow controller.

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