Thirty Years and Counting

Harvard SEAS and Applied Technologies, Inc.

Micrometeorological research has been undertaken at the Harvard Forest for decades. The eddy-covariance flux tower (Figure 1) at the Harvard Forest Environmental Measurements Site (HFEMS) was installed in 1989 and provides the world's longest continuous record of net ecosystem CO_2 exchange, evaporation, and energy flux between a forest and the atmosphere, at hourly time resolution[1].

Figure 1: The EMS Tower as viewed from Walkup.

Maintained since 1990 by Harvard researchers Steve Wofsy and Bill Munger, the Environmental Measurement Station Eddy Flux Tower (EMS) is fitted with sensors essential for atmospheric flux studies in addition to the continuous CO_2 exchange. One sensor that has been present since the tower's initial deployment is Applied Technologies, Inc. (ATI) sonic anemometer (Figure 2).

[1] https://harvardforest.fas.harvard.edu/other-tags/eddy-flux

Figure 2: ATI K-Style sonic anemometer mounted to the end of the arm on the EMS tower.

“ATI sonics have been a mainstay at the Harvard Forest research site for over 30 years,” says Bill Munger, Senior Research Fellow in Atmospheric Chemistry, Harvard School of Engineering and Applied Sciences (SEAS). “I think in terms of the long-term historical significance, the Harvard Forest site is the vanguard for research of this nature. It's certainly the longest running CO_2 flux observation site. With this 30 year record (Figure 3) you can see how important ATI has been to us in our research.”

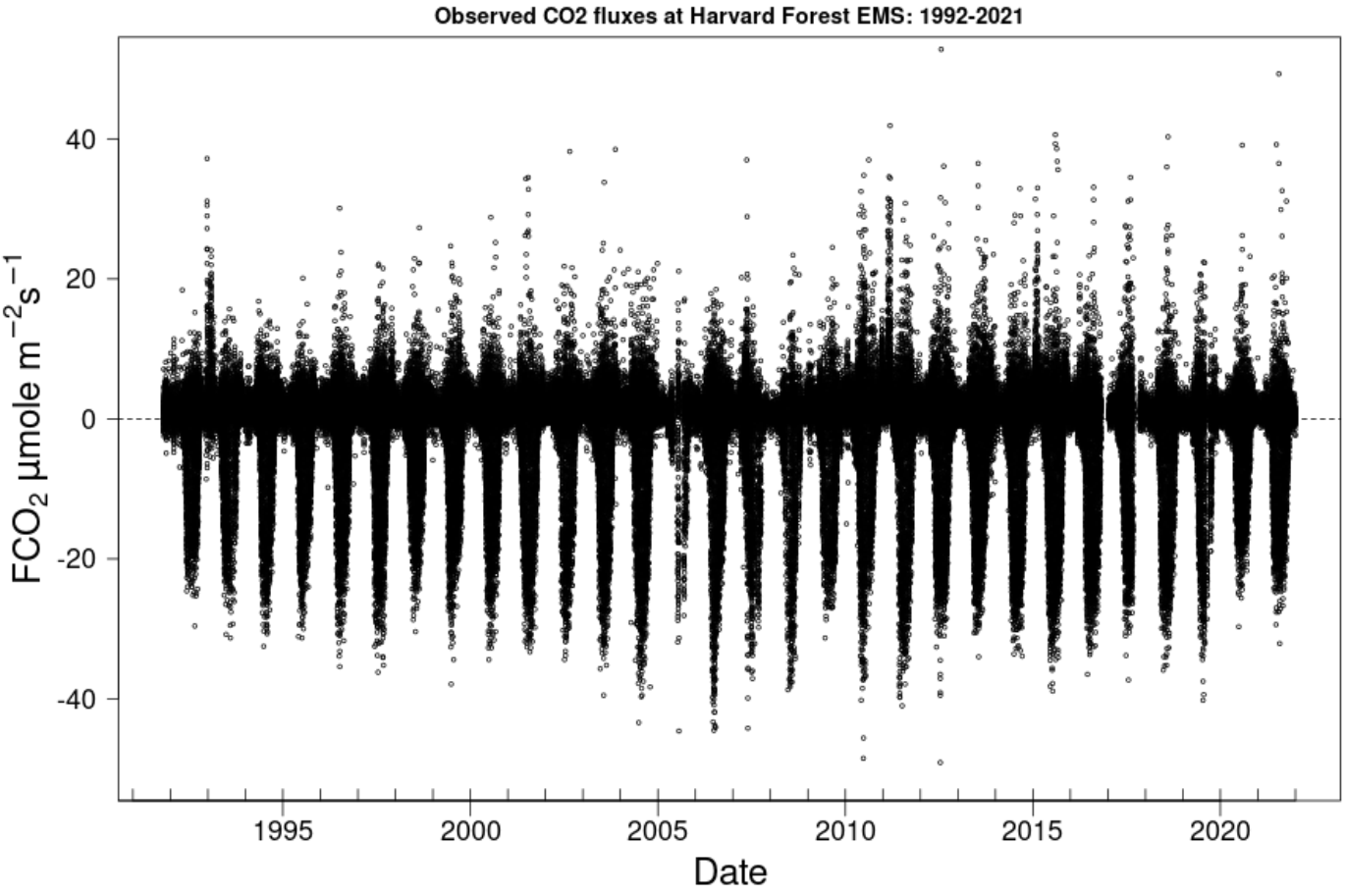

Figure 3: Observed CO2 fluxes at Harvard Forest EMS: 1992-2021

Initial introduction to ATI sensors resulted from a collaboration with Dr. Dave Fitzjarrald, Senior Research Associate, SUNY Albany, on a NASA-led research study in the Alaska Tundra. “Fitzjarrald steered us towards the ATI sensors as he had found them to be the only sensor at the time that could run unattended continuously,” Munger recalls. “At our Harvard Forest site and some other installations, we have stuck with those and have been really pleased with the way they've performed and evolved. They have become more user friendly over time.”

The evolution that Munger references relates to the on-board electronics of the sensor. Initially, the device came attached to a rather large (2’ x 2’ x 2’) box containing all essential electronics. It also required fine tuning with an oscilloscope. With the advent of microprocessors, not only did the probe become more compact (10cm - 15cm paths versus 25cm), but all the essential electronics are now incorporated into the probe bar of the device itself.

Another long-term project where the ATI sonics are deployed is called BOREAS (BOReal Ecosystem-Atmosphere Study), a large-scale international interdisciplinary experiment in the boreal forests of central Canada. Its focus was improving our understanding of the exchanges of radiative energy, sensible heat, water, CO2 and trace gases between the boreal forest and the lower atmosphere[2]. It was here that other members of Munger's team were introduced to ATI sensors and learned first-hand the importance of timely product support.

"I remember having an issue at a CO_2 flux site in the middle of northern Manitoba," said John Budney, Research Technician, Harvard SEAS. "I was in the field, with winter setting in and we're having issues with a sonic. Herb Zimmerman (ATI owner and president) rapidly sent us a loaner to help us get over the hump up there. Herb has always been very helpful, very accommodating, quick to help us solve issues—either quick fixes or even loaning us sonics if we need them. He's just been really easy to work with."

Harvard SEAS has numerous ATI K-Style probes in their research portfolio. These probes are three axis, three-dimensional orthogonal ultrasonic anemometers designed for atmospheric boundary layer studies. Its array design (Figure 4) assures minimum flow distortion errors in measuring turbulence statistics. These instruments have been established for use in Eddy Covariance work, which includes Momentum Fluxes, Latent Heat Fluxes and Sensible Heat Fluxes.

[2] https://daac.ornl.gov/cgi-bin/dataset_lister.pl?p=2

Figure 4: ATI K-Style Ultrasonic Probe

When asked how he sees his research evolving, Munger replies, “The basic research questions about heat and momentum and carbon fluxes and how those change over time will remain our focus. That won’t change. We're always interested in how to make those measurements more robust and require less maintenance to maintain the same level of accuracy level with less steps in the workflow to acquire and process data”.

Munger summarizes, “There are a lot of sonics available on the market now, yet we have not seen any reason to switch at Harvard Forest or any of the other projects we’ve deployed ATI sensors at.”

Thirty years and counting. That is a quite an accomplishment. Wouldn’t you agree?