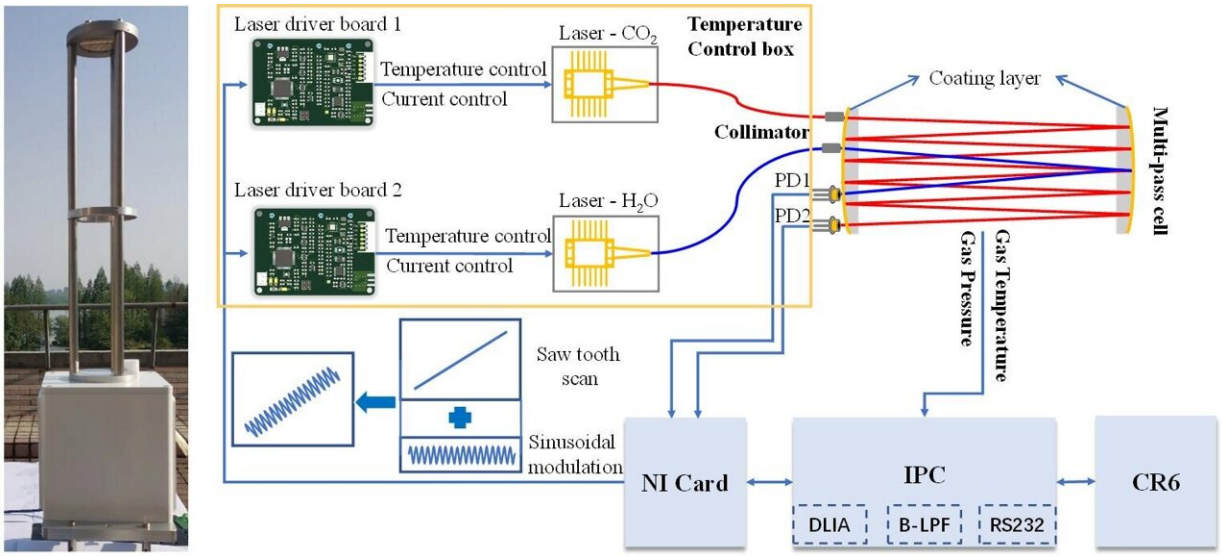
Open-path multi-pass cell helps measure atmospheric H2O and CO2 fluxes online

December 7 2022, by Zhang Nannan



Photograph of the TDLAS sensor and schematic of the open-path TDLAS system used for measuring atmospheric H_2O and CO_2 concentrations. Credit: Gu Mingsi

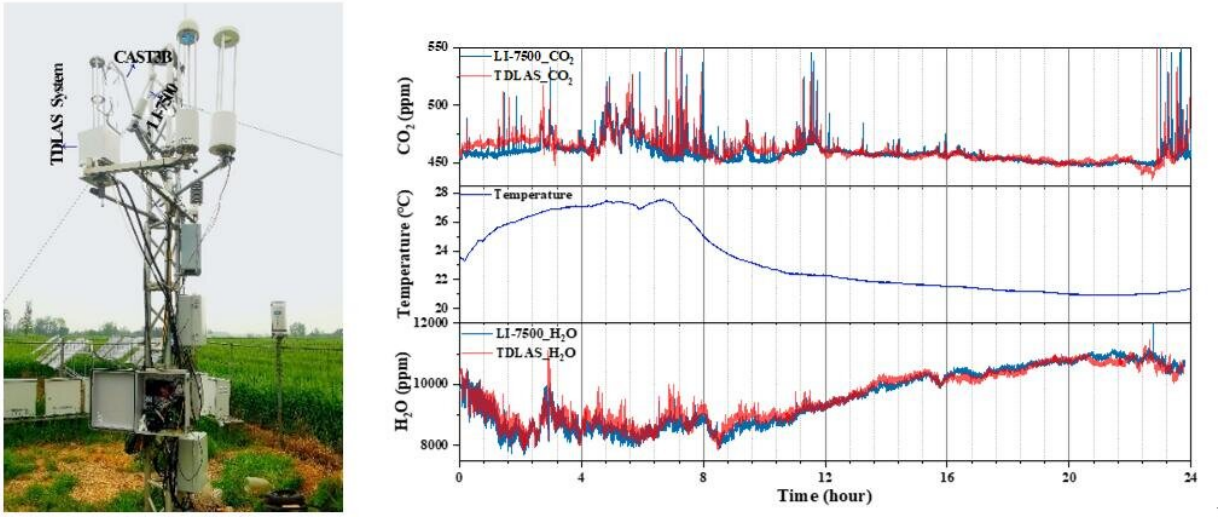
According to a study published in *Optics Express*, a research team from the Hefei Institutes of Physical Science of the Chinese Academy of Sciences proposed a new design for online measurement of atmospheric H_2O and CO_2 fluxes.

"We designed an open-path and anti-pollution multi-pass cell," said Prof.

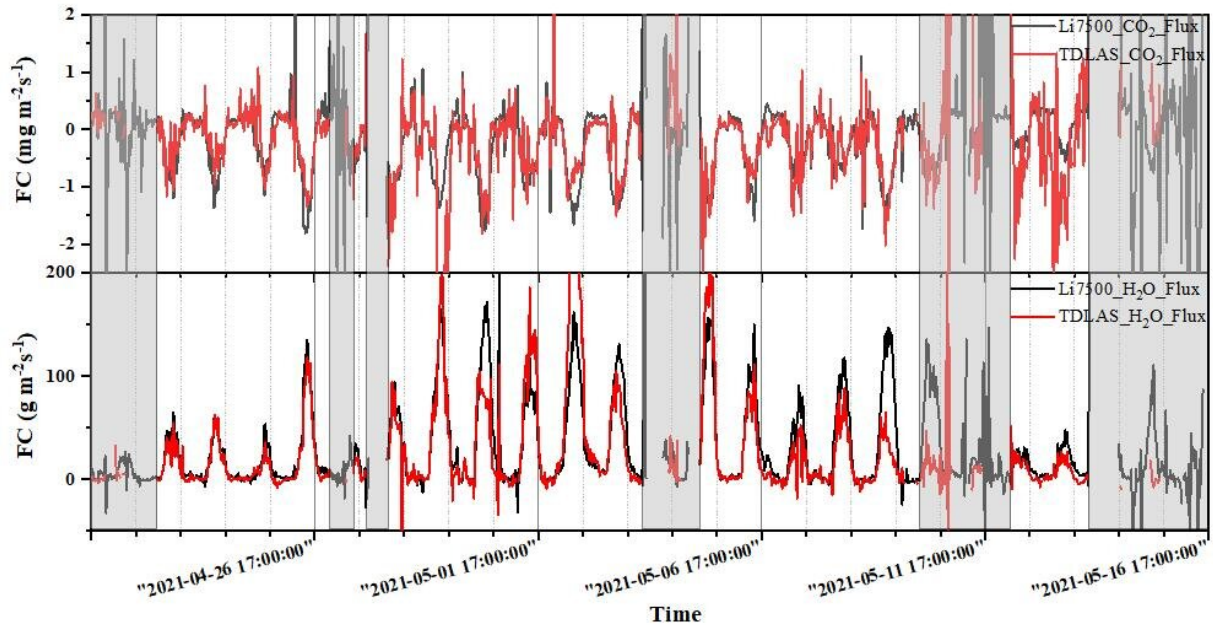
Gao Xiaoming, who led the team, "and applied it on tunable diode laser absorption spectroscopy sensor (TDLAS)."

The new gas analysis instrument exhibited good consistency with commercial instruments, and its accuracy was comparable.

One of the most important ways to reduce greenhouse gas concentrations is to store carbon in soil and vegetation. Scientists suggest using turbulent eddies generated by air flow to measure greenhouse gas emissions.



Photograph of the installation and comparison of the field measurements obtained using TDLAS and LI-7500 for 24 h. Credit: Gu Mingsi



Comparison of (a) CO_2 flux and (b) H_2O flux for approximately a month. Credit: Gu Mingsi

Equipment based on tunable laser absorption spectroscopy combined with eddy covariance technology has many advantages including high sensitivity, high precision, and fast response. There are two gas path methods for measuring gas fluxes: open-path and closed path. However, the traditional open-path multi-pass cell is unsuitable because its optical path is exposed to air, which causes the coating layer of the lens to be corroded in the atmosphere.

Different from traditional multi-pass cells, this novel anti-pollution open-path multi-pass cell is mainly composed of two plano-convex mirrors coated on a convex surface.

"It's coated on the reverse side," said Gao. "The design does not allow a direct contact between the coating layer of the lens and air, that's why it

has the anti-pollution effect."

This design effectively avoids the pollution and corrosion of the lens film layer by the external environment. When it is applied to the flux monitoring equipment of atmospheric greenhouse gases CO_2 and H_2O, the long-term stability and durability of the open-path system is improved.

Researchers setting up self-made instrument for comparative observation experiment. Credit: by Gu Mingsi

The design was further proved in a field comparative observation experiment on the CO_2 and H_2O fluxes of the wheat seasonal farmland ecosystem. The results were in good agreement with those achieved using the non-dispersive infrared-based commercial instrument.

"We see strong application prospects for flux measurements in any ecosystem," said Gao.

More information: Mingsi Gu et al, Open-path anti-pollution multi-pass cell-based TDLAS sensor for the online measurement of atmospheric H2O and CO2 fluxes, *Optics Express* (2022). DOI: 10.1364/OE.474070

Provided by Chinese Academy of Sciences