Thermal gradients drive errors in gas exchange measurements

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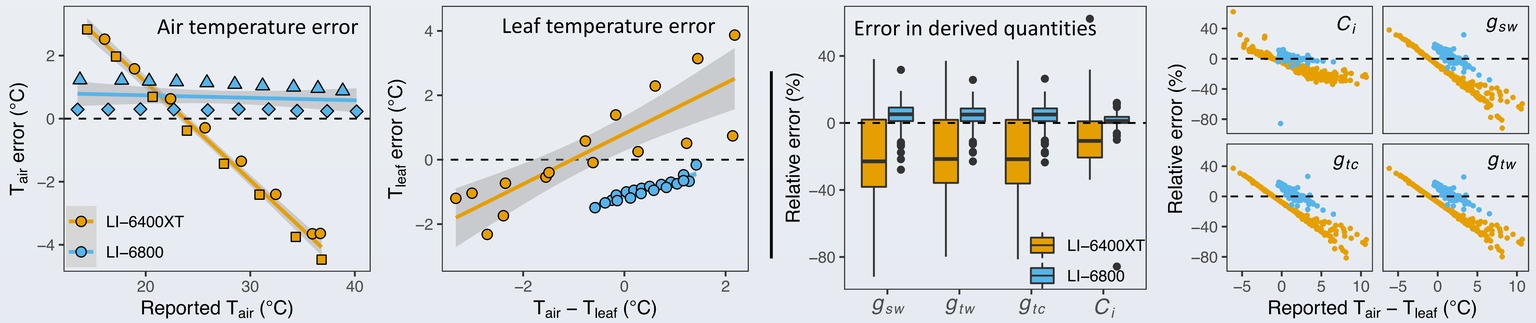
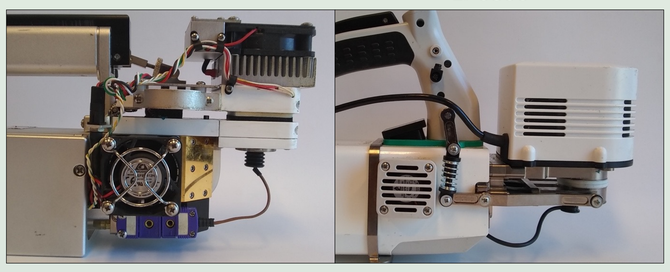
Errors in leaf and air temperatures and derived quantities



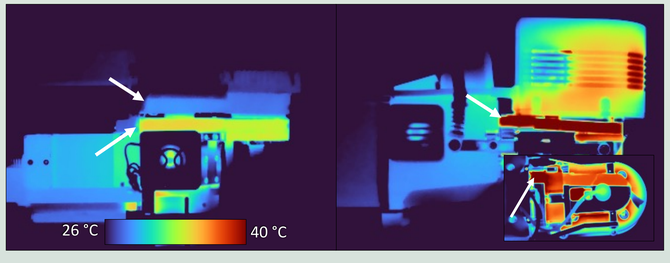
Leaf and air temperature errors increase as the LI-6400XT departs from ambient temperatures. Errors are much reduced in the LI-6800.

Errors in derived quantities depend on the leaf-to-air temperature difference and are much larger in the LI-6400XT than the LI-6800.

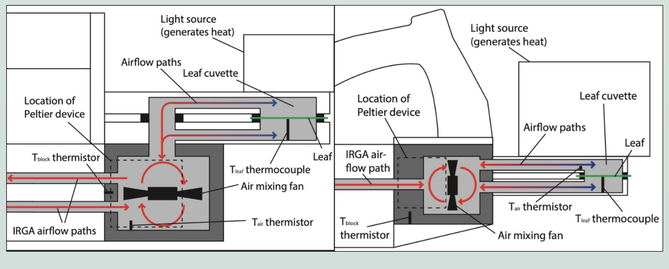
What drives temperature errors?



Sideview photographs of the LI-6400XT and the LI-6800.



Temperature gradients in airflow conduits (white arrows).



In the LI-6400XT, air thermistor position biases reported temperatures.

Objectives

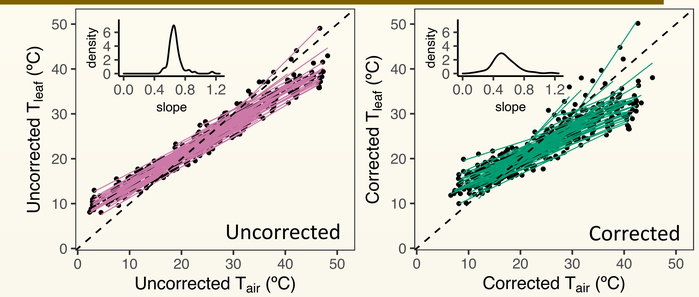
Quantify error in leaf and air temperatures measured by the LI-6400XT and LI-6800 and estimate resulting errors in leaf H_2O conductance (g_{tw}), stomatal H_2O conductance (g_{sw}), leaf CO_2 conductance (g_{tc}), intercellular CO_2 concentration (C_i)

Determine the cause of leaf and air temperature bias in the LI-COR LI-6400 and LI-6800

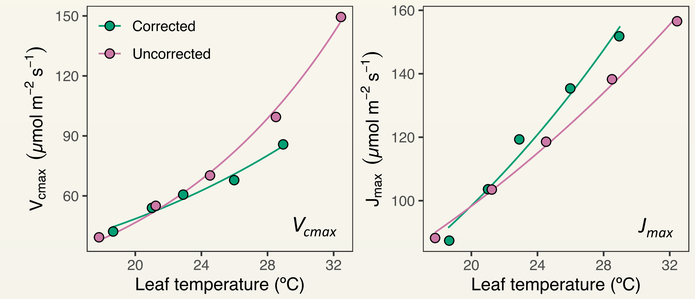
Determine the effect of LI-6400XT errors on common types of ecophysiological analyses

Develop methods for preventing or correcting errors when collecting gas exchange data

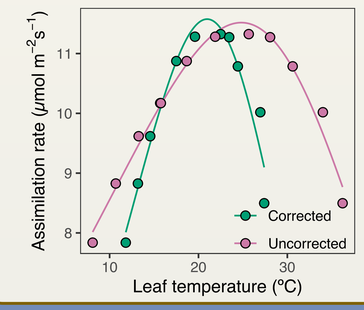
LI-6400XT data are strongly affected



Correcting leaf and air temperatures amplifies patterns of limited homeothermy (slope of leaf vs. air temperature < 1) by decreasing slopes



Correction reduces temperature sensitivity of maximum carboxylation rate (V_{cmax}) and increases that of maximum RuBP regeneration rate (J_{max}).



Correcting *A-T* data results in a narrowed curve, increased activation energy, and decreased thermal optimum.

How can I prevent errors in my data?

Errors occur when:

- Using the LI-COR LI-6400 or LI-6400XT gas exchange analyzers
- Forcing leaves toward high or low temperatures, relative to ambient temperature, using internal Peltier devices
- Greater departures from ambient temperatures resulted in larger errors in leaf and air temperatures
- Half of all V_{cmax} and J_{max} data used to parameterize Earth System Models may be affected by these errors

Errors can by avoided by:

- Using the LI-COR LI-6800, or possibly other gas exchange analyzers
- Taking measurements at ambient temperatures; i.e. do not use Peltier devices to force leaf temperatures
- Control ambient temperature using a growth chamber or similar device
- Correcting for temperature bias after measurement - scan QR code for scripts