Biogeosciences Discuss.,
doi:10.5194/bg-2016-102-RC2, 2016

Biogeosciences Discussions

Interactive comment on "Ideas and perspectives: Heat stress: more than hot air" *by* Hans J. De Boeck et al.

Anonymous Referee #2

Received and published: 9 May 2016

In their paper "Ideas and perspectives: Heat stress: more than hot air" De Boeck et al. emphasize the importance of leaf temperature rather than air temperature as the fundamental driver of heat stress in plants. Using an energy balance model along with field data they attempt to identify the drivers for differences between leaf and air temperature. Their ultimate goal is to educate ecologists and agronomists to improve their understanding of how heat waves can induce plant heat stress.

I agree with the authors that this is a relevant topic and that the importance of leaf temperature deserves more attention. However, I do not feel that the paper provides sufficient insights to actually inform scientists concerned with the analysis of heat waves. My concerns are:

1. The fundamental problem that the paper wishes to address is that many studies of

heat stress rely on air temperature rather than leaf temperature as a measure for heat stress, and therefore fail to reproduce or correctly attribute the impact of heat waves. While this is probably true, the use of just three references to underline this point is not particularly striking. In order to highlight the relevance of the issue, the paper should demonstrate that the use of air temperature is a common problem in ecological and agronomic studies across all scales, whether they analyze data or apply modeling. I don't think a thorough literature review is needed here. But a brief concise overview with examples from a wide range of applications is a minimum requirement.

2. The paper relies on an energy balance model described in another paper (De Boeck et al., 2012) to demonstrate the influence of various environmental variables on the difference between leaf and air temperature. The observed patterns are then discussed in the context of the physical processes that govern the heat and mass exchange in the soil-plant-atmosphere system. The authors thereby also resolve "counterintuitive" results such as the influence of wind speed and humidity. However, all this has been established textbook knowledge for nearly half a century, and there certainly isn't anything surprising or counterintuitive about it! The whole problem can basically be described by just four simple equations that not surprisingly are also used in the applied energy balance model (eqs. 1, 8, 9, and 12 in De Boeck et al., 2012). A thorough inspection of these fundamental equations rather than a superficial analysis of casually obtained results from the energy balance model (which essentially remains a black box to the reader), would be a far more educative exercise. For example, one could easily combine these four equations into something like Tl = Ta + X – Y and demonstrate how the variables in X and Y determine whether leaf temperature is above or below air temperature. A series of contour plots of Tl–Ta for different combinations of environmental variables and stomatal control could be used to quantify their relative importance and highlight important interactions. Such a more fundamental treatment of the issue would help the reader to develop a basic understanding of the physical laws determining leaf temperature, eventually stimulating the improvement of studies on plant heat stress.

3. Using some field data to demonstrate that theory holds true in practice is an excellent way to strengthen the argument of the paper. Unfortunately, the effect of only one variable is investigated although the data presumably would support a much wider range of relationships. The paper would gain a lot if the data were used to further explore the influence of other variable in the field. Additional important insights might be gauged from the analysis of diurnal variations.

4. Accurate analysis and proper use of statistical methods is crucial, even if the data is just used to illustrate a theoretical argument! Using the slight visual separation of data points obtained at days without irrigation in Figure 2 to support the argument that stomatal closure reduces transpiration cooling is farfetched, if not entirely wrong. While the statistical significance of the difference remains unknown, the attribution to stomatal closure simply has no basis. The difference could well be caused by slight variations in environmental conditions.

5. The description of the field experiment lacks detail. Information about the type and timing of irrigation is required to understand the potential influence by a wet canopy. Also, information on vegetation cover and the potential impact of bare soil on measurements is missing. At least the measurement principles and some basic specifics of "custom made" sensors should be mentioned. The rationale for mounting the radiation sensors unusually close to the surface and the potential impacts on measurements should be discussed.

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-102, 2016.