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Hydrology and Earth System Sciences Discussions

Interactive comment on "Measurement and estimation of the aerodynamic resistance" *by* S. Liu et al.

Anonymous Referee #1

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General comments:

Remote sensing of surface energy budget needs calculating heat/ evaporation transfer resistance. This paper reported measurements of the aerodynamic resistance over a bare soil surface and a maize field using both eddy correlation system and evaporation pan respectively, and some comparisons of measurements and models are shown. The paper is well organized, and it includes three parts. Part I reported measurement results, and stated that the distribution of the aerodynamic resistance takes a "U" type in the daytime and inverse "V" type at night; Part II compared the resistance measured by eddy-correlation method and pan-evaporation; and Part III compared several models and tried to suggest better models for estimation of aerodynamic resistance. However, the analysis in the latter two parts (particularly Part III) is superficial and full of uncertainties, and its content needs substantial improvements before considering its publication. Their conclusions are faint and do not advance our understanding of boundary layer processes or model/algorithm development.

Major comments:

(1) Data processing. It is important to remove some low-quality data for boundary-layer studies. In Figure 1, many data for nighttime were removed, but there are no details of data filtering criterion.

(2) In Part II, the paper stated that the aerodynamic resistance measured by EC method is higher than the one measured by pan-evaporation, but there is not any explanation to this phenomenon. Actually, this is related to the size of the pan. A pan plays a role in retarding wind and changing wind direction, and thus enhancing nearby turbulent intensity and evaporation. Such an effect decreases with the increase of the pan-size. So evaporation from a smaller pan is usually larger than from a larger-pan. In other words, it is reasonable that the resistance measured by a 15-cm diameter pan, which was used by the authors, is smaller than an EC measured one.

(3) Part III may need a complete reconstruction. In this part, the paper compared seven models, which actually could be grouped in two types. One follows Monin-Obukohv similarity theory, such as Thom, Xiexianqun, and Choudhury-I, which are essentially identical. The other is much simplified from this theory, such as Verma-Rosenberg, Monteith-Hatfield, Mahrt-Ek, and Choudhury-II. It is not surprising that the first type performs better than the second, because the similarity theory is still the best theory until now. Almost all current remote sensing and atmospheric models adopt it. Current major concern is how to determine some critical parameters such as emissivity, z0m, zoh (See specific comments below). Therefore, the simple model comparison in this paper is not so scientifically meaningful. Instead, I would like to ask the authors to focus on investigating differences in parameter values and energy partition between the bare soil surface and the maize, which should be more important for remote sensing.

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Interactive Comment

(4) It is somehow surprising that the authors didn't show any comparisons of heat fluxes.

Specific comments:

(1) Throughout the paper. Aerodynamic resistance can be either for momentum transfer or heat transfer. It is better to use symbol "rah" instead of "ra" for heat transfer resistance.

(2) p681. Abstract: The aerodynamic resistance is a power function of wind speed. I guess it is more like a hyperbolic function, since its definition is rah=1/(Ch*U) . Anyway, ra strongly depends on wind speed and ground-air temperature difference, rather than a simple function of a single variable. Such an empirical formula presented in the paper does not help model development.

(3) P686. L in Eqs. (7-12) is measured or calculated from Ts, u, Ta?

(4) P690: The solution for stable case in the original Choudhury-I model (Eqs (27-31)) is not correct. See the correct solution in Byun (1990) and Lee (1997) for z0m = z0h cases and in Yang et al. (2001) for z0m != z0h cases.

(5) P691. In the paper, ln(z0m/z0h)=0.17u(Ts-Ta), which follows Kustas et al. (1989). Since the authors observed the flux data, they should derive the value from their own observation and verify this formula.

(6) The authors give z0m = 0.01, and ln(z0m/z0h) = 2 for the bare soil surfaces. Originally, ln(z0m/z0h) = 2 is applied to a dense canopy. For a bare soil surface, the value of ln(z0m/z0h) can be quite different. As far as I know, there are a limited number of experiments for bare soil experiments. Stewart et al. (1994) found z0m = 0.013 m and the mean values of ln(z0m/z0h) = 4.5 for a near-bare soil site. Verhoef et al. (1997) gave z0m = 0.0001 m and the mean value of ln(z0m/z0h) = -0.9 for a smooth bare soil surface. Yang et al. (2003) found z0m = 0.001 ˜ 0.01 m and the mean value of ln(z0m/z0h) = 3 ˜ 6 for several bare soil sites. The latter two works also suggested

a diurnal cycle of ln(z0m/z0h). Uncertainties in determining these parameters may make different conclusions when you evaluate a model. Therefore it is really crucial to determine ln(z0m/z0h) from your experimental data.

(7) P692. How did you determine surface emissivity that is required for converting TIR (IR temperature) to surface skin temperature? As stated in Kohsiek et al. (1993), the quantity of surface temperature has to be known with a precision better than ś2°C. This error can easily occur if the emissivity is not carefully determined.

(8) P696. The sensitivity study should be improved. Eq. (41) is questionable for some variables. I suggest the following range: 2 K for Ts (following Kohsiek et al., 1993), 1 for ln(z0m) and ln(zm0/zh0) . Sensitivity analysis for other parameters is not so important.

Minor comments:

(1) P693. “Ra” should be “ra”.

In summary, I hope the authors show how they processed their data, carefully determine parameter values and investigate the change of these parameters and energy partition with respect to surface characteristics, and submit the paper again.

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