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Interactive comment on "A new technique using the aero-infiltrometer to characterise the natural soils based on the measurements of infiltration rate and soil moisture content" *by* M. A. Fulazzaky et al.

Anonymous Referee #2

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It is interesting to relate soil-air dynamics with soil-water dynamics, and potentially of value because both concern the flow of fluids with known properties within porous media, but there are serious complexities that must be addressed and that are not adequately treated here, as per examples described below. Serious problems include: 1) Lack of testing with independent sites and media, and 2) Too few samples used in development of empirical relationship.

In soil, water is usually a wetting phase and air is a nonwetting phase. With lesser water

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content, there is higher air content, which means the air will predominantly occupy large pores and large spaces within those pores. Meanwhile, water occupies small pores and narrow crevices. This situation generally remains the case as the soil gets wetter, though with the air confined to shrinking spaces while water occupies increasingly large ones. At any given water content, the water and air occupy portions of the pore space with notably different characteristics. Therefore their individually measured transport properties, such as the hydraulic and pneumatic conductivity, will not have a simple systematic relation to each other.

The rate of diffusion of air pressure through the soil will be less in wetter soil. Likewise the rate of infiltration, if it is controlled by capillary gradients (which usually occurs at the beginning of infiltration into dry soil), can be less in wetter soil. There are many complexities here, for example when infiltration is dominated by gravity, the response to wetness is not the same. With that condition (which usually occurs during late stages of infiltration), water infiltration will be faster in wetter soil, while air pressure still diffuses more slowly in wetter soil. A relation between air diffusion rate and either water infiltration rate or water content depends on factors that vary from soil to soil, such as pore structure and pore-size distribution, and also on factors that vary with the ever-changing conditions, such as water content and the distribution of water within the mass of soil. Because of these various sensitivities and their complex relation to wetness and other factors, it is not feasible with present theory or measurement techniques to formulate a generally applicable quantitative relationship. The authors seem to recognize this because they realize the basis must be empiricism rather than theory. The key problem is that an empirical representation of the complex interrelationships of the pneumatic and hydraulic phenomena (which should be discussed here more thoroughly also) would have to be based on a huge database of diverse soils and conditions. Calibration and testing with data from only three sites does not make a convincing case for the utility of the models presented here.

Therefore I do not see the value of publishing a paper that attempts these objectives

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in this way. The air infiltrometer described could well be useful for purposes related to the flow and diffusion of air in soils, and I would recommend that the authors pursue that sort of application rather than attempting to use it for investigation of hydraulic properties.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 2515, 2014.

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