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Geoscientific Instrumentation Methods and Data Systems Discussions
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Interactive comment on "A low-cost acoustic permeameter" *by* S. A. Drake et al.

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Thank-you Dr. Kinar for your thoughtful review.

A. Response to general comments:

The "general comment" questions of this review regard field deployment of the acoustic permeameter in snow. Although the acoustic permeameter is designed for field deployment in snow, the purpose of this paper is to explore the utility of the presented design to acoustically acquire volume-averaged permeability measurements of standard media to test the methodology. In-snow field measurements acquired with this device cannot be validated without extensive independent measurements using a currently verified method such as the flow-through permeameter referenced in Hardy and Albert (1993). We consider verification of in-snow permeability measurements by an independent device has yet more complications that are beyond the scope of this pa-

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per. For example, acoustic permeameter measurements apply to a much larger volume than flow-through permeameter measurements invoking issues with inhomogeneities such as snow layering and representative sample size that would also need to be addressed. We therefore narrowed the focus of this paper to a uniform standard media rather than snow as indicated by the title, (which does not contain the word “snow”). To underscore this point, on page 1 at line 12 we added the sentence: “In this paper, we compare acoustically-derived permeability with results derived from a standard flow-through permeameter using reticulated foam samples.”

B. Response to specific comments:

Page 2, Lines 2-3: Moved equation (1) to page 2, line 5 and described Darcy’s Law.

Page 2, Lines 16, 23, 27: Added Fig (2) showing a picture of the system deployed for EM calibration and renumbered subsequent figures. Added discussion relating volumetric flux and intrinsic permeability.

Page 2, Line 27: Many enhancements could be made with the parts that were used and thereby improve measurement error. We report but do not recommend particular electronic parts utilized to assemble the acoustic permeameter. One of the points of this paper is that, because the measurements are relative, frequency inaccuracy associated with drift is minimized so lower cost components can be utilized. The critical measure of the quality of the signal generator is that the imposed and modified waveforms are sufficiently robust to extract a single-valued sine wave.

Page 3, Line 1: A photograph of the setup was added as Fig. 2 that should inform this comment.

Page 3, Lines 3-4: Phantom power was used to power the microphone. Microphone sensitivity varied with frequency. Since measurements were relative the impact of frequency-dependent sensitivity was minimized.

Page 3, Line 10: Added Figure 2 showing the EM calibration configuration.

Page 3, Line 15: Rationale for using the EM method is given in the “Theory” section as well as the referenced M91 paper.

Page 3, Lines 16-17: As explained in the “Theory” section, this method precludes the necessity of employing a numerical scheme (unlike the M91 methodology).

Page 3, Line 27: Added “maximum” to discriminate it from RMS amplitude.

Page 3, Line 31: Changed “initial amplitude” to “amplitude of the imposed waveform”.

Page 4, Line 2: Complete model numbers for foam types were included in Table 1. The manufacturer does not give reference permeability information.

Page 5, Line 6: Changed “two parameters” to “three parameters”. Added some explanation of the assumptions used by M91. A more comprehensive explanation of assumptions would require repeating the derivation in Attenborough (1983), obfuscating the narrative.

Page 5, Line 17: Added an explanation of the need for an empirical calibration. The empirical calibrations are discussed in the section titled, “Results for the EM Method”.

Page 5, Line 24: replaced “white” with “both environmental and microphone-derived”.

Page 5, Line 26: Appended: “a mid-point value for the low-frequency approximation”.

Page 5, Line 29: This section describes the EM theory so it is not appropriate to give calibration values here. The EM calibration is given in Eq. 11 and the IM calibration is given in the Fig. (6) caption.

Page 6, Line 6: Added, “(up to 2 kHz)” as given in Moore et al. (1991) for the valid range of frequencies for the low-frequency approximation.

Page 6, Line 15: Calibration equation and coefficients are given in Eq. 11.

Page 6, Line 17: I don’t understand the first part of this question. The RMS voltage is a single value measured by the oscilloscope whereas the sound power level is the ratio of input voltage to output voltage.

Page 6, Line 26: Issues related to non-linearity of the loudspeaker response are a valid concern but were minimized by acquiring data at only 3 frequencies.

Page 8, Lines 7-8: This paper does not document snow measurements.

Page 8, Line 22: The 5-cm sample thickness was chosen because it was sufficiently thick to attenuate the measured frequencies and because it was available for all sample models from the manufacturer.

C. Response to technical comments:

Page 4, Line 20: Removed the extra comma.

Figures 3, 4, 5, 6: Regenerated figures without dashes in the x-axis label units.

Figure 3: Added a legend.

Figure 2: Described the "P ATM" sensor and added Hardy & Albert (1993) reference to figure caption.

New Fig. 2 is attached with this response. The complete caption for this figure is: EM calibration setup with the microphone suspended above a foam sample. Foam samples, the oscilloscope and the frequency generator are located on the foldup table. Not shown are a ring weight that was placed around the perimeter of the foam sample to minimize vibration and foam sheets that were placed beneath the acoustic tube to dampen amplitude of reflected acoustic energy.

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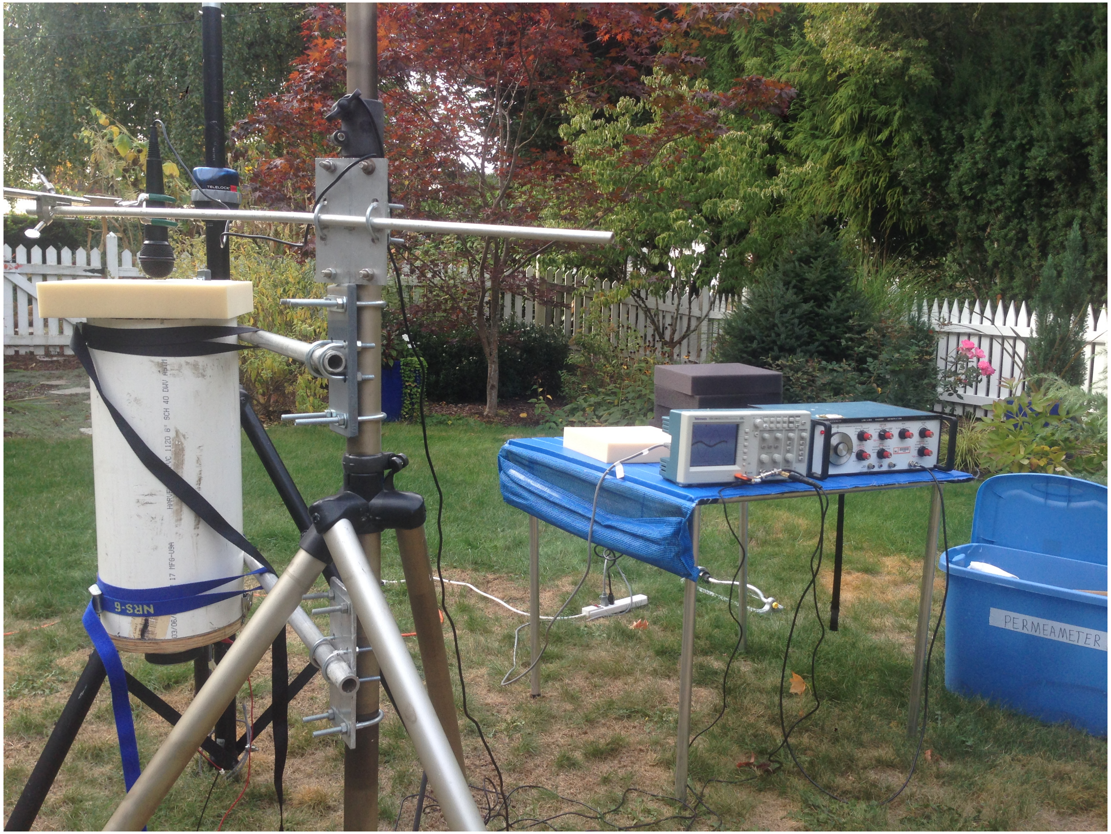

Fig. 1. EM calibration setup with the microphone suspended above a foam sample. Foam samples, the oscilloscope and the frequency generator are located on the foldup table.

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