

January 27, 2001

U.S. Nuclear Waste Technical Review Board
2300 Clarendon Blvd., Suite 1300
Arlington VA 22201

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RE: Comment for your next public meeting

Ladies and Gentlemen,

I wish this comment to be included in both the presentation and record of your next public meeting.

As you may recall, I have had severe criticism for the review of my work in numerical methods for unsaturated flow models given by Drs. Liu and Bodvarsson of Lawrence Berkeley National Laboratory. You may find a copy of their 1999 review on my web site: <http://www.aquarien.com/peerev/lbnlcm1.pdf>. Among other misrepresentations, they falsely claimed that my approach to intergrid conductivity means would not be valid in the case of pure gravity flow in a vertical soil column. They claimed, "Obviously, Dr. Baker's conclusions regarding the accuracy of flow prediction, drawn from the two-node system, is not valid here. In other words, the use of interblock hydraulic conductivity in the two-node system may not be appropriate for evaluating prediction errors of flow flux in real systems."

One wonders what they have against using Darcy's law between grid points. Let us briefly consider the fact that the example they gave cannot be used to determine the general validity of any intergrid conductivity mean. In such flow, the unsaturated conductivity is constant throughout the soil column. The correct intergrid conductivity mean could be artificially constructed from any mean formula that gives back $(1+1)/2 = 1$, even if determined by the phases of the moon.

The more important thing is that the Honorable Doctors give the impression that the math in my work is so bad that it could not be used in any case where the upper inflow boundary condition is one of constant flow. As it happens, I have recently derived a quasi-analytic general exact solution to Richards' equation, as part of an exercise in generating web-based tutorial information for soil physics students. It is based on fractional-flow approach, and has been verified to work for the cases of horizontal and vertical flow with constant-head and constant-flow inflow boundary conditions. You can find drafts of the work on my web site, <http://www.aquarien.com>, along with source code for the programs. Please be aware that this is draft work, placed on the net to establish precedence, and the program errors were being corrected as they were found. That only means that some of the programs may not work properly when used out of the context of their examples.

Whereas a finite difference model of Richards' equation spreads the points out in space, this approach spreads them out across the wetting front, in steps of water content or saturation. As such, it defines the wetting front to almost any degree of resolution desired. I used an independent method to confirm the results of the exact solution. That method was a finite difference model using a simple approximation of the same Darcian intergrid conductivity means that Liu and Bodvarsson found so invalid and objectionable. Since neither method is predicated on the other, the test is as legitimate as the agreement is close.

Furthermore, the unsaturated hydraulic relations directly needed to solve the new exact solution are diffusivity and conductivity, expressed as functions of saturation. The pressure-saturation relation comes in only if diffusivity or conductivity is defined in terms of it, or one needs to know

the pressure heads involved. The constant-head boundary condition is actually expressed as constant water content. If I remember correctly, unsaturated diffusivity and conductivity were not measurement priorities at YMP, were they?

It's not nice to screw with Mother Nature. And that includes her avatar, The Math. You see, one really doesn't need the permission of any titular gods at national laboratories to get it right. So whenever any of them stomp all over the legitimate, contributory work of an independent investigator, there is always the risk of future embarrassment. There is always the possibility that even a disabled investigator, who somewhat depends on the research money they were able to squelch, could come back with the exact solution and ask, "If they are going to use their considerable muscle to defame and deny even the least of us when we disagree with them, what are they going to do with a larger problem, like a nuclear waste leak?"

This wasn't just the appearance of collusion and impropriety. This was the deliberate falsification of mathematical principles to generate the impression that "Nothing's wrong here!". Two scientists in positions of responsibility and authority for assuring the eternal safety of a nuclear waste dump used their positions and credentials to assure an innumerate program manager that someone suggesting a need to take more measurements had no case. It would seem in the highest levels of government science, even in the agencies responsible for review and control, that prestige and credentials trump the math.

I wonder, is that the kind of message about the quality and accountability of education that the new President of the United States wants to send? What students of math and science are going to take seriously the responsibility of learning to do it right when the message from the top is "He with the biggest bluster wins"? Is this an exercise in nuclear science or fraternity science?

Sincerely,



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