

Error in drainage equation VIC?

The master version of VIC contains the following statement that is used to compute vertical drainage between two model layers:

```
Q12 = init_moist - pow(pow(init_moist - resid_moist, 1.0 - expt) -  
    Ksat / pow(max_moist - resid_moist, expt) * (1.0 - expt),  
    1.0 / (1.0 - expt)) - resid_moist;
```

I translated this to the following equation:

$$Drainage = \theta - \theta_r - \left[(\theta - \theta_r)^{1-c} - \frac{K_s(1-c)}{(\theta_s - \theta_r)^c} \right]^{1/(1-c)}$$

Where c in the equation equals $expt$ in the computer code. I expected the equation of Brooks-Corey but my colleague Lisanne Nauta found the following explanation for the replacement on github (<https://github.com/UW-Hydro/VIC/commit/59c9f5dbcf0835e6a3ee77eb1820f6349228ec27>): “Modify layer drainage Q12 calculation - use exact integral (instead of numerical solution) in order to avoid unreasonably-strong soil moisture oscillation when the Brook & Corey curve is steep”.

There are at least two reasons why I think the modified equation cannot be correct:

- 1) drainage does not become zero if water content equals residual water content, nor is drainage equal to K_s if water content equals saturated water content.
- 2) Dimensions are not correct, e.g. drainage has the dimension of length / time whereas θ on the other side of the equal sign is dimensionless. The two terms between square brackets also have different dimensions since K_s has the dimension of length / time and θ is dimensionless.

Wouter Greuell, Wageningen University & Research

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