

## ***Interactive comment on* “Estimation of permafrost thawing rates in a sub-arctic catchment using recession flow analysis” by S. W. Lyon et al.**

### **Anonymous Referee #3**

Received and published: 6 March 2009

### COMMENT

Lyon et al. present a method for estimating long-term trends in permafrost thickness that is certainly worthy of investigation. However, their current methodology merits scrutiny.

The plots in Figure 2 in Lyon et al. suffer from the same discretization pattern seen in the recession slope plots of Brutsaert and Lopez (1998) and others. The apparent slope of the  $-dQ/dt$  vs.  $Q$  relation for most of the lower values of  $-dQ/dt$  suggested by visual examination of Figure 2 is likely an artifact of data precision and not a manifestation of a physical process. Rupp and Selker (2006) showed how reported data precision in stage height accounted for the apparent slope of the lower envelope in the

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



plots of Brutsaert and Lopez (1998). Lyon et al. should apply some method for estimating  $-dQ/dt$  that consider data precision and noise similar to that proposed by Rupp and Selker (2006).

The lower envelope method introduced by Brutsaert and Nieber (1977) is consistent with the hydraulic theory that Lyon et al. rely on to estimate temporal variation in permafrost thickness. It is important to recall that the parameters in Eq. (2) and (3) arise from eliminating all but one of the terms in the summation series solution to the linearized Boussinesq equation. At some late time, this single term dominates all others. However, prior to arriving at this "late time", the other terms contribute to increase  $-dQ/dt$  for a given  $Q$ . Prior to arriving at late time, the slope of the recession slope plot is not unity in log-log space. At what precise discharge  $Q$  the "late-time" begins will depend upon initial conditions at the onset of the recession period.

On the other hand, the regression procedure used by Lyon et al. to estimate "a" is not precisely consistent with the theory they invoke. However, this author appreciates the practical drawbacks of the lower envelope, namely the subjective nature (given the current state of understanding) of applying the lower envelope method and, therefore, the appeal of using linear regression to estimate "a".

Lyon et al. do not explicitly state what method of regression they use to arrive at the intercept "a", though I expect most readers would assume they used standard least-squares regression. However, this method of regression may not be the most appropriate given the uncertainty in  $Q$  (and therefore  $-dQ$ ). Brutsaert and Lopez (1998), in fact, also apply the "organic correlation" (OC) method for this reason. From my experience, OC results in a higher value for the slope "b" and, at least visually, provides for a better representation of the trend in the data. Note, for example, how the line in Figure 2a does not follow the trend of the primary cloud of points and how it appears to underestimate the slope of the primary cloud.

If a fitting of a line (or curve) through all the points is the chosen method, then Lyon et

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

al. should consider the arguments made by Kirchner (2009) against fitting a function to all the data points plotted as  $\log(-dQ/dt)$  vs  $\log(Q)$  (for example, how zero and negative values of  $-dQ/dt$  are omitted after the log transformation, therefore biasing the results).

Brutsaert, W., Lopez, J. P. 1998. Basin-scale geohydrologic drought flow features of riparian aquifers in the southern Great Plains, *Water Resour. Res.* (34), 233-240.

Brutsaert, W., Nieber, J. L. 1977. Regionalized drought flow hydrographs from a mature glaciated plateau, *Water Resour. Res.* (13), 637-643.

Rupp, D. E., J. S. Selker. 2006. Information, artifacts, and noise in  $dQ/dt$ - $Q$  recession analysis, *Adv. Water Res.* (29), 154-160.

Kirchner J. W. 2009, Catchments as simple dynamical systems: Catchment characterization, rainfall-runoff modeling, and doing hydrology backward, *Water Resour. Res.* (45), W02429, doi:10.1029/2008WR006912.

---

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, 6, 63, 2009.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper