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Interactive comment on "The evolution of process-based hydrologic models: Historical challenges and the collective quest for physical realism" *by* Martyn P. Clark et al.

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An engineer's retrospective

In the eyes of the authors, modern process–based hydrology may have started with the blueprint of Freeze and Harlan (1969). But applied hydrology, of which I've had some familiarity, also had similar process-based beginnings.

One standard text I consulted from time to time was one by Chow (1959). Discussed in this, though strictly not a hydrology text, were some hydrologic techniques still in use

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these days, such as Horton's and Izzard's overland flow, and the Muskingum channel routing (Chow, 1959, pp.543–549, 604–608).

An earliest synthesis or integration of these surface–water processes had led, in 1967, to a nonlinear Muskingum–storage–type response function as follows (Ding, 2011, Eq. (4), and references cited therein):

$$Q = C^N S^N - C_1(dS/dt), \quad N > 0,\ C > 0,\ 1 \geq C_1 \geq 0.$$

in which Q is the discharge (L/T), S is the stored water (L), t is time (T), N is an exponent (–), C is a scale parameter ((L/T)$^{1/N}$/L), and C_1 is a weight (–).

The embedded (dS/dt)–term reflects the mass balance or closure for a control volume. The storage–discharge relation as parameterized above may be considered an energy closure for a subsurface flow system as well (e.g. Ibrahim and Brutsaert, 1965, and discussion by Ding (1966) therein; Hammond and Han, 2006, Eq. (3), and especially it's linearized exact solution, Eq. (7)).

Could this storage–driven response function be the elusive "Holy Grail" of scientific hydrology that Beven (2006) and others have been searching for? (See Page 2, Lines 72–76.)

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