Reviewer #2:

This is a very interesting paper and potentially significant contribution to the hydrology field, particularly semi-distributed rainfall-runoff modeling. The mathematics is quite solid. I do have a few minor comments/questions though.

Dear Reviewer: Thank you. My responses to your comments are listed below.

1. *It is not clear how the author reached the specific probability density function (PDF) (Eqn. 24) since it is not associated with any well-known functions. It'd be better if the author can clarify his reasoning process here.*

This research started with the following research question. If the SCS-CN method is a saturation excess runoff generation model, what is the distribution function of soil water storage capacity? Wang and Tang (2014) shows that equation 37 is derived from the proportionality relationship of SCS-CN method (i.e., equation 38). From the comparison of boundary conditions between SCS-CN method and VIC type of model, we know that equation 37 does not include initial soil water storage, and the derived one from distribution function will include initial soil water storage (e.g., equation 34). However, equation 37 can be viewed as the result of $S_0 = 0$, i.e., W for equation 37 can be written as:

$$W = \int_0^P [1 - F(x)]dx \quad \text{(R1)}$$

From equation 37, we obtain:

$$W = \frac{P+S_b-\sqrt{(S_b+P)^2-2aPS_b}}{a} \quad \text{(R2)}$$

Substituting equation R2 into equation R1, we obtain:

$$\frac{P+S_b-\sqrt{(S_b+P)^2-2aPS_b}}{a} = \int_0^P [1 - F(C)]dC \quad \text{(R3)}$$

From equation R3, we obtain:

$$F(C) = 1 - \frac{1}{a} + \frac{C+(1-a)\mu}{a\sqrt{(C+\mu)^2-2a\mu C}} \quad \text{(R4)}$$

2. *The comparison made between VIC and new distribution have different ranges of C values (Figure 3a and 3b, and Figure 4a and 4b). The C value goes from 0-200 for the new function and 0-50 for VIC.*

   In the revised manuscript, C_m will be changed to 200 in Figure 3 and Figure 4.

3. *Though it can be seen from Figure 4 that for the new PDF the storage capacity curve has S-shape curve, for the same range of C value (0-50) the new distribution function seems to be no different from β= 1.5 and Cm=50.*

   As shown in Figure 3a, when a<1, the peak of f(C) occurs at C=0; when a>1, the peak of f(C) occurs at C>0. With the increase of a (when C>1), the peak of f(C) occurs at higher value of C. The S-shape of CDF (Figure 4a) is more significant with higher value of a (e.g., a=1.9). For a smaller value of a, the difference between the new PDF and VIC-type of model becomes smaller.

References:

Wang, D. and Y. Tang (2014), A one-parameter Budyko model for water balance capture emergent behavior in Darwinian hydrologic models, Geophys. Res. Lett., 41, 4569–4577, doi:10.1002/2014GL060509.