In this paper the authors analyze annual storage – discharge hysteresis loops observed in a French headwater catchment. They do so to determine if one of four hydrological models can reproduce this behaviour. Testing the ability of a model to do so, the authors argue, is indicative of how well the model may represent the internal system dynamics of the watershed. The authors found that a more thorough representation of the variety of catchment storages (i.e., upper hillslope, lower hillslope and riparian) best simulated the storage – discharge hysteresis loops. I might argue that many model structures will reproduce storage – discharge hysteresis loops. What would be interesting to know is how the model can reproduce the state variables. Presumably there is a curve or loop observed when comparing hillslope and riparian storages. This would be very interesting to see, and it and some discussion around it would make a nice addition to the paper. The only other major comment I have is in regards to the orientation of the storage-discharge graphs. Storage – discharge hysteresis curves are being presented quite regularly in recent literature. However, there seems to be no convention on which term is plotted on the ordinate or y-axis. For instance Gabrielli et al (2012) plot water table fluctuations (i.e., storage) on the y-axis, but Ewen and Birkinshaw (2007) plot storage on the x-axis. Presumably it should be streamflow on the y-axis, as the dependent term. The authors plot streamflow on the abscissa or x-axis. This is a crucial point, as it influences the direction of the hysteresis. I suggest the authors double check to make sure they are interpreting comparable curves. Agreed upon standards for plotting storage-discharge curves would be beneficial to our community as they become more common.

Some specific comments:

Page 2 Line 23 – 29: There are a lot of different ideas in this sentence; perhaps try rewriting it.

Page 4 Line 17 – 18: It would be good if the authors were to add a couple of sentences that tie together the thoughts in these two paragraphs. It might improve the structure of the introduction.

Page 5 Line 13: There is a reference to Figure 2 and streamflow, but Figure 2 does not show streamflow data.

Page 5 Line 27: Perhaps the authors need to be explicit in what the final selection of the study and model period was at this point in the paper.

Page 6 Line 7: Because of the methodology that includes normalizing storage over the study period, it is important to have some statement about how representative these locations and this time period are. The authors assume that the sample period covers the entire range of absolute storage. That would mean the measurements span record highs and lows. A figure would best illustrate this. If the study period did not span this range, then some statement about the broader applicability of the results needs to be made.

Page 6 Line 24: I'm sorry, I don't follow, to which years are you referring when you say "almost all the years".

Page 6 Line 32: The authors are clearly discussing streamflow – chemistry concentration hysteresis loops, and should explicitly say so. The processes driving these types of curves are very different than the ones controlling storage – streamflow curves.

Page 7 Line 25: The sentence that begins "Water storage dynamics ….." perhaps should come earlier in the section.

Page 8 Line 9: This is not a paragraph as it does not convey a single complete idea, but could easily be attached to the previous paragraph.

Page 8 Line 30: Just curious, why add a threshold that controls movement into a deeper groundwater store.

Page 9 Line 4: Perhaps similarly, I was a bit surprised that the authors built a model that included only parallel reservoirs. Given the description of the system they wish to simulate (i.e., hillslope – riparian – stream) would a serial system not be more appropriate? The authors built their own virtual experiment, so a parallel system is fine, but I wonder if some content as to why a serial system was not selected might be helpful.

Page 9 Line 28: I do not see how the information in Table 4 indicates performance.

Page 10 Line 3: Where are the data that show that the model failed to reproduce flow in wet periods?

Page 10 Line 12: This seems to be a pervasive problem with the paper; not providing data or information in figures and tables to back up some of the statements that are being made. I can't glean performance details from Figure 3b.

Page 12 Line 14: In stating that there are "fast responding flow pathways", the authors are interpreting what is going on. What evidence - even from the literature – do they have of this behaviour?

Page 12 Line 28: If you put this last sentence near the beginning of the paragraph, the ideas would flow better.

Page 12 Line 31: "illustrated" instead of "confirmed" perhaps?

Page 13 Line 25: Similar to the earlier point about flow pathways, some evidence that shows the reader the flow was generated in the riparian zone would improve the authors' argument.

Page 13 Line 32: Is this the authors' Figure 7 or Hrachowitz et al.'s?

Page 14 Line 4: The flow of the paper would be better if the content in this paragraph were integrated into the previous paragraph.

Page 14 Line 17: Maybe add "in 2011 – 2012" after "unsaturated zones ….."

Page 14 Line 27: I have to admit, I am not familiar with how to reference data and supplementary material in HESS, but certainly it requires more than the word "Data".

Page 15 Line 13: The two sentences that begin after "The Figure 11a …." can both be removed and the beginning of the next paragraph relocated to after "….. stream dynamics."

Page 16 Line 15: Could these errors be due to the difference between a serial and parallel reservoir model structure?

Page 17 Line 16: I agree. The authors could explain why they chose to build models M3 and M4 this way.

Page 19 Line 15: While the content of this paragraph is interesting, I think it takes away from the focus of the paper. I suggest removing it.

Figure 1: The legend makes it difficult to discern some of the details of the map (e.g., soil moisture sensors vs. buildings). Where in France is this, near Quimper? Perhaps the map of France could be made larger. I think you have the space. Where is the climate station?

Figure 2: Maybe state in the caption that the two profiles are sB1 and sB2.

Figure 6: In the middle panel – c) I believe – streamflow goes up faster than saturated storage. So where is the streamflow coming from? What does the streamflow vs. riparian storage curve look like? In order to glean from which storages the streamflow is originating (hillslope unsaturated zone, saturated zone, riparian, surface, etc.), all these curves should be provided. This will help explain which runoff processes and sources are predominant at which times.

Figure 7: In the third panel from the left, does the hillslope cross section not imply the conceptual model should be include serial reservoirs? Also, how is HUS going up as HSS goes up? Does this imply that the increase in unsaturated storage does not offset the loss of thickness in the vadose zone as the water table rises? Is this realistic?