

Hydrol. Earth Syst. Sci. Discuss., 8, C5866–C5868, 2012

[www.hydrol-earth-syst-sci-discuss.net/8/C5866/2012/](http://www.hydrol-earth-syst-sci-discuss.net/8/C5866/2012/)

© Author(s) 2012. This work is distributed under the Creative Commons Attribute 3.0 License.



**HESSD**

8, C5866–C5868, 2012

Interactive  
Comment

## ***Interactive comment on “Applying a simple water-energy balance framework to predict the climate sensitivity of streamflow over the continental United States” by M. Renner and C. Bernhofer***

**M. Renner and C. Bernhofer**

[maik.renner@mailbox.tu-dresden.de](mailto:maik.renner@mailbox.tu-dresden.de)

Received and published: 25 January 2012

### **Author reply to the first reviewer**

We thank the reviewer for his constructive comments on our manuscript.

[Full Screen / Esc](#)

[Printer-friendly Version](#)

[Interactive Discussion](#)

[Discussion Paper](#)



The manuscript is linked with the more theoretical manuscript Renner et al. (2011) which is also published in HESSD. Based on the critiques stated in the interactive discussion <http://www.hydrol-earth-syst-sci-discuss.net/8/8793/2011/hessd-8-8793-2011-discussion.html> we revised that manuscript and it is currently under review.

The referee criticised that we suggested that the CCUW hypothesis is of different conceptual basis than the Budyko type of approaches. This was actually not intended, but we wanted to highlight the apparent differences between both approaches.

We understand, that both frameworks are based on long term average data, which are components of the water and energy balance equations. Also both sensitivity approaches describe how actual evapotranspiration  $E_T$  is changing with a change in precipitation, i.e. the partial differential term  $\frac{\partial E_T}{\partial P}$ . To determine this term one needs a functional description of how a basin moves through different climatic conditions, which is e.g. available through the Budyko type of functions. As the referee correctly states, also the CCUW hypothesis can be expressed as a Budyko function, see Renner et al. (2011, Section 2.3, Eq. (28)). In that respect both approaches are indeed similar.

The difference is in the derivation of these Budyko type functions. For example, Yang et al. (2008) show how the Mezentsev function can be derived by the coupled consideration of the water and energy balance equation and including the water and the energy limits as boundary conditions. In contrast, the CCUW hypothesis, makes an assumption on how the relative partitioning of water fluxes is linked to the relative partitioning of energy fluxes under a change in either  $P$ ,  $E_p$  or both. Using this, we illustrate in Renner et al. (2011) how to derive the analytical solutions for the sensitivity of  $E_T$  and streamflow  $Q$  under a change in climate.

Therefore, we withdrew the claim of a better theoretical basis in the revision of the first manuscript and as well in the revision of this manuscript. Additionally, we tried to state our arguments more precisely.

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

## Further remarks

The referee also suggested to improve the manuscript by calculating the change in the catchment parameter  $n$  between both periods. We incorporated this idea in the revised manuscript.

We also agree to focus our analysis on the scheme of Roderick and Farquhar (2011) using a parametric Budyko function approach. Thus, the non-parametric Budyko functions will be removed.

In point 5 of his review the referee asks which value of the catchment parameter  $n$  of the parametric Budyko function of Mezentsev has been used to compute the right panel of Figure 4, P33. The graph shows the sensitivity of streamflow to precipitation  $\varepsilon_{Q,P}$  for a multitude of catchments. Thereby, we computed the catchment parameter for each catchment based on long-term averages of  $P$ ,  $E_p$ , and  $E_T = P - Q$ .

## References

- Renner, M., Seppelt, R., and Bernhofer, C.: A simple water-energy balance framework to predict the sensitivity of streamflow to climate change, *Hydrology and Earth System Sciences Discussions*, 8, 8793–8830, doi:10.5194/hessd-8-8793-2011, <http://www.hydrol-earth-syst-sci-discuss.net/8/8793/2011/>, 2011.
- Roderick, M. and Farquhar, G.: A simple framework for relating variations in runoff to variations in climatic conditions and catchment properties, *Water Resources Research*, 47, W00G07, doi:10.1029/2010WR009826, 2011.
- Yang, H., Yang, D., Lei, Z., and Sun, F.: New analytical derivation of the mean annual water-energy balance equation, *Water Resources Research*, 44, W03410, doi:10.1029/2007WR006135, 2008.

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 10825, 2011.

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