

## ***Interactive comment on “Continental moisture recycling as a Poisson process” by H. F. Goessling and C. H. Reick***

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This paper presents an analytical framework to describe the stochastic nature of moisture recycling. The analytical framework is sound and the underlying hypotheses are well discussed. The resulting theoretical results are confronted with previously published numerical results as a first test of the relevance of the mathematical framework to obtain insights into what explains the stochastic nature of moisture recycling events.

The paper is overall well-written but it has only few references to other recycling studies or to studies that might justify some of the invoked numbers about physical processes. The paper is certainly suitable for publication in HESS after some minor revisions. ...

### **Detailed comments:**

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- At the moment, the Poissonian nature of the recycling events is presented only as "falling out" of the analytical framework, as the solution of the differential equations. It would be nice to discuss the relevance of the underlying stochastic process properties (namely the memorylessness, the fact that the recycling events are independent, the exponential distribution of interarrival times). Furthermore, it should be explicitly stated how these stochastic process properties are altered if the number of events are not Poisson distributed. These considerations might not be obvious to many readers but important for the hydrologic interpretation of the results.

- Discussion of the assumptions: it would be nice to have some references for the numbers you use to discuss your assumptions (the moisture content, evaporation rates, transpiration rates etc).

- The paper derives the frequency distribution of the number of recycling events  $n$  but in the comparison with Numaguti 1999 (p. 5070 line 1), the discussion is about the Poisson distribution of  $f_n$ , where  $f_n$  is the ratio of moisture having experienced  $n$  recycling events to total moisture. Why are the two ( $f_n$  and  $n$ ) used interchangeably here?

- p. 5070, line 17: this sentence states that the steady-state assumption given by Eq 6a holds if either the atmospheric moisture composition is constant or if evaporation is fed by precipitation that occurred just before evaporation. Is it not the other way round, i.e. eq. 6a holds if either the system is in steady state or if evaporation is fed by precipitation that occurred just before evaporation?

- p. 5072: "The similarity of the Poisson distributions with the simulated data suggests that violations of the "well-mixed" assumption and the "steady-state" assumption are small." Personally, I would probably rather say that these findings suggest that the developed theory describes well the natural process. Given the many simplifications in an analytical framework, I would not put too much emphasis on these two assumptions (there are of course many more).

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- p. 5072 starting line 14: this is hard to follow; what is "with such a law"? what is the mean value 1.5 as opposed to the fitted value 1.71 (fitted to what)? what is the value 1.68, what are the "corresponding factors"?
- Conclusion: here you insist that only two assumptions (steady-state, well-mixed) are required but the description of a complex natural system with simple equations implies of course many more assumptions.
- In the conclusion, you use once the term "traverse", otherwise you use crossing for two different things i) crossing a boundary, ii) traversing a continent or an ocean. I think that it would help the reader if "crossing" was only used for case i) and traversing otherwise (or perhaps "travelling across").
- It would be nice to have an outlook on how understanding the stochastic nature of recycling events might be useful to gain new insights into the land-atmosphere coupling.
- The recycling ratio "all of a sudden" appears in the discussion. It would be useful to explicitly discuss how it is related to the recycling events. Otherwise it cannot be invoked to explain the physical limits as in the sentence " The fact that the recycling ratio does not stay constant along the westerlies implies that the low intensity limit is not valid."
- As far as I see, the difference between evaporation from intercepted water and transpiration is only introduced on p. 5070. It could be useful to state somewhere right at the beginning that evaporation includes both types of exchanges between the land and the atmosphere.
- Throughout, the paper, the two possible situations are discussed: i) recycling events are Poisson distributed, hence recycling is a Poisson process, ii) recycling events are geometrically distributed. The abstract (and the conclusion) ends however with the statement that continental moisture recycling can be interpreted as a Poisson process. It is not entirely clear how this conclusion is obtained. Is it because recycling on conti-

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nents (as opposed to recycling over oceans) mostly/always satisfies conditions for case i)? Is it because comparison to numerical results (Numaguti, 1999) suggests that case i) always/mostly holds?

*Math notations:*

- I agree with reviewer 1 that it is not clear why exponents are used to distinguish between different variables
- p. 5070, line 1: why distribution of "fn's" instead of fn?

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