Hydrology and
Earth System
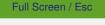Sciences

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Discussions

Interactive comment on "Variability of moisture recycling using a precipitationshed framework" *by* P. W. Keys et al.

Anonymous Referee #1

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In this work the authors use the WAM-2layers model to delineate the precipitationsheds (Keys et al. 2012) that contribute atmospheric moisture to the Western Sahel, Northern China and La Plata regions. They find interesting results including reasonable agreement between the MERRA and ERA-I datasets and a surprisingly persistent "core" precipitationshed region for the three watersheds. . .dominated by terrestrial sources. I really like the concept of precipitationsheds and find that the analysis is robust - except for the EOF analysis (I will elaborate later). The paper is well written, the results are interesting and I recommend for publication after the authors address my following concerns:

1) EOF analysis issues:

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a. In the EOF analysis it is not clear what variable you are analyzing. Is it the seasonal average evaporation within the precipitationshed? Please be more explicit about this.

b. The patterns that you are obtaining are quite strange. The most usual result for an EOF analysis should be a dipole pattern (much like your second EOF of Western Sahel). The fact that most of your EOFs contain a spatial pattern of only one sign leads me to believe that there might be a problem in your analysis. The easiest way to diagnose it is to look at the timeseries of the principal components. This timeseries would enable you to see what years are associated with the patterns that you are seeing in your EOFs. Please show all the PC timeseries for your three modes.

c. When you remove the interannual trend, you first calculate a trend based on the area average and then remove it from each pixel? This might be the problem. It might be best not to remove the trend, and then do the EOF analysis – if the dominant EOF is a trend (this you can diagnose using the principal component timeseries), then don't analyze this mode and move on to the next mode.

d. Also, when you are looking at the PC timeseries, you can evaluate if the EOFs are related to interannual modes of climate variability such as ENSO. This is done by analyzing the correlation between the PC timeseries and the index of ENSO (or other atmospheric patterns that are affecting your region).

e. Finally, I am not sure what you mean in the abstract by "most of the variance in the precipitationshed is explained by a pulsing of more or less evaporation from the core precipitationshed". You have not demonstrated that there is pulsing, it could be an oscillatory pattern, it could be an anomalous year, or even a trend. You must look at the timeseries to figure this out.

f. I recommend Statistical Methods in the Atmospheric Sciences: 2nd Edition by Daniel S. Wilks to improve the analysis.

MINOR ISSUES

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2) In the discussion, I think it is important to reflect on what actually happens when an upwind region is deforested. If region A receives 50% of their moisture from upwind region B, and region B is completely deforested...what actually happens? The answer is complex because the deforestation of region B will likely affect the atmospheric circulation patterns – not only the amount of moisture delivered to region A. I think it is important to realize that the problem is highly nonlinear, and likely a complex interplay between direct effects and non-direct effects (effects on the circulation patterns due to the changes in energy at the surface). A good analysis is the one by Goessling and Reick (2011) What do moisture recycling estimates tell us? Exploring the extreme case of non-evaporating continents. HESS.

3) Page 5145, line 5: Please add the reference "Dominguez, F. and J. C. Villegas and D. D. Breshears, 2009. Spatial Extent Of The North American Monsoon: Increased Cross-Regional Linkages Via Atmospheric Pathways. Geophys. Res. Lett., 36, L07401, doi:10.1029/2008GL037012" Which deals with the impact of drought on terrestrial recycling.

4) Page 5145, line 27 "In the Amazon, advection of oceanic moisture is the dominant source of precipitation, with relatively low interannual variation (e.g., Bosilovich and Chern, 2006)." Is a bit simplistic, as this is a place where local terrestrial recycling is very important, particularly in the southwestern part of the basin. Please add a few references to terrestrial recycling within the basin.

5) 5149, line 10: The reference to the WAM-2 model is incorrect. It is in the 2013, not 2014 paper.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 5143, 2014.