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Hydrology and Earth System Sciences Discussions

Interactive comment on "Does evaporation paradox exist in China?" *by* Z. T. Cong and D. W. Yang

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General Comments

This is an interesting paper that investigates temporal trends in pan evaporation rates from 317 stations in China. Global climate change is expected to increase air temperatures, which should increase the capacity of the air to hold water vapor, and thus would be expected to increase evaporation rates. The evaporation "paradox" is that over much of the land surface of the earth, pan evaporation has been decreasing while air temperatures are increasing.

In this study, the paradox was found to exist, on the whole, for China in the last 50 years. That is, on the whole, temperatures have been increasing, while pan evaporation has

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been decreasing. Furthermore, the authors noted that, in the period from 1956 to 1985, while air temperatures in China were nearly constant, pan evaporation decreased. This is attributed primarily to decreases in radiation and wind speed, with the interpretation that energy is controlling evaporation. However, from 1986 to 2005, pan evaporation increased due to increasing saturation deficits despite decreasing radiation and wind speeds. This was interpreted to imply that water supply controls evaporation.

The topic is suitable for, and of interest to, readers of HESS, and the research is generally of good quality. The paper is well-organized.

Specific Comments

My primary concern in this paper is that insufficient attention is given to:

1. Trends in actual rather than pan evaporation. Conclusion 4 refers to energy control on actual evaporation from 1956 to 1985 and water availability control from 1986 to 2005. What is interesting is that during the first period, if energy controls and pan evaporation (as well as energy) decreased over time, then actual evaporation should be decreasing, too. During the second period, if pan evaporation and humidity deficit are increasing, even though radiation and wind speed are decreasing, the Bouchet complementary evaporation relationship should apply and actual evaporation should be decreasing with the increase in pan evaporation. During both periods actual evaporation could be argued to be decreasing. This point relates closely to point 4 below.

2. The role of moisture availability as given by precipitation data. As far as I could see, precipitation data were not mentioned except in Table 3, and no discussion of the statistics in that table is provided. The overall trend found in Table 3 is that pan evaporation and precipitation trends are opposite. The statistics shown in Table 3 with precipitation should be provided separately for 1956 to 1985 and 1986 to 2005. If energy is limiting during first period as suggested by the authors, there should be very little correlation between pan evaporation and precipitation. If water is limiting (second period), the Bouchet hypothesis should apply, and decreasing precipitation should re-

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sult in decreasing actual evaporation, drying air, and increasing pan evaporation. This would be confirmed in part by a negative correlation between precipitation and pan evaporation during this period.

3. Statistical analysis. In Table 3, further statistical analysis would help greatly in the analysis of the data. For example, a stepwise regression to determine which of the independent variables contributes significantly to the variation of the dependent variable (pan evaporation) would likely indicate that some of the independent variables do not have any statistically significant impact on pan evaporation. Correlation coefficients with only one independent variable cannot do this because they do not account for cross-correlations among the variables.

4. Hydrological implications. While the evaporation paradox is interesting, the real science questions deal with the mechanisms of evaporation changes and their implications for the global water cycle. For example, is the water cycle accelerating? Are runoff and moisture storage in watersheds increasing or decreasing? I suspect the present dataset is not complete enough to answer these questions, but I think these questions need to form the context in which this work is discussed. In its present form, these broader issues are barely mentioned (on page 2112, lines 21-25; page 2114, lines 4-6)). To maximize the impact and relevance of this paper, the discussion and conclusion sections should reflect on the implications of the present results on these issues.

Technical corrections and comments

1. The language needs to be edited by a fluent English speaker.

2. On page 2114, line 15, I think the word “complementary” should be changed to “proportional”.

3. On page 2116, line 11 needs to be re-written. Do the authors mean that daily values were averaged for each year for each of the 317 stations?

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4. On page 2115, line 20, air temperature should specify degrees Celsius.

5. On page 2115, lines 7-9, how were the 317 stations chosen? What was the basis for this choice? Was it entirely random?

6. On page 2116, line 16, it is not clear what the word “they” is referring to. Pan evaporation rates?

7. Table 2 needs to be explained either in the text or in the table heading. Currently, there is no explanation, and the table is not self-explanatory.

8. Section 2.1 should contain a brief description of the measurement methods used to collect the pan evaporation, wind speed, air temperature, and precipitation data.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 2111, 2008.