

***Interactive comment on “Effects of land cover change on temperature and rainfall extremes in multi-model ensemble simulations” by A. J. Pitman et al.***

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Received and published: 22 July 2012

This is an excellent paper and should be accepted. I have just a few comments

1. The authors write

"Our LULCC perturbation focused on conversion of forests to crops and pasture and ignores other types of land use change such as urbanization and irrigation that could also strongly affect regional climate (Pielke et al., 2011) but tend to be more localized."

However, irrigation also affects large areas.

Examples of papers that discuss this effect include

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DeAngelis, A., F. Dominguez, Y. Fan, A. Robock, M. D. Kustu, and D. Robinson (2010), Evidence of enhanced precipitation due to irrigation over the Great Plains of the United States, *J. Geophys. Res.*, 115, D15115, doi:10.1029/2010JD013892.

Puma, M. J., and B. I. Cook (2010), Effects of irrigation on global climate during the 20th century, *J. Geophys. Res.*, 115, D16120, doi:10.1029/2010JD014122.

Douglas, E.M., D. Niyogi, S. Frolking, J.B. Yeluripati, R. A. Pielke Sr., N. Niyogi, C.J. Vörösmarty, and U.C. Mohanty, 2006: Changes in moisture and energy fluxes due to agricultural land use and irrigation in the Indian Monsoon Belt. *Geophys. Res. Letts*, 33, doi:10.1029/2006GL026550.

Pielke, R.A. Sr., J. Adegoke, A. Beltran-Przekurat, C.A. Hiemstra, J. Lin, U.S. Nair, D. Niyogi, and T.E. Nobis, 2007: An overview of regional land use and land cover impacts on rainfall. *Tellus B*, 59, 587-601.

Lobell, D. B., Bala, G. Bonfils, C. and Duffy, P. B. 2006. Potential bias of model projected greenhouse warming in irrigated regions. *Geophys. Res. Lett.*, 33, L13709, doi:10.1029/2006GL026770.

The authors should, in my view, discuss this LULCC type and present examples of its influence somewhere in the paper.

In terms of urban effects, while the areal coverage might be relatively small, this is where much of the world's population lives. Moreover, this urban LULCC is expanding. I suggest citing and briefly discussing some of the papers that show an important climate effect due to its land use type; e.g. s

Grossman-Clarke et al, 2010: Contribution of Land Use Changes to Near-Surface Air Temperatures during Recent Summer Extreme Heat Events in the Phoenix Metropolitan Area. *J of Applied Meterology and Climatology*. DOI: 10.1175/2010JAMC2362.1

Fragkias, F. and K.C. Seto, 2012: The rise and rise of urban expansion - Urban land area has expanded globally during the past few decades – a trend that looks set to

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continue in the foreseeable future. IGBP Newsletter, 78. March 2012

The Fragkias and Seto paper, for instance, report that

"Cities Expand By Area Equal To France, Germany And Spain Combined In Less Than 20 years".

2. I suggest the authors also compute the effect on surface air moist enthalpy from LULCC. The value of this approach was introduced in

Pielke Sr., R.A., C. Davey, and J. Morgan, 2004: Assessing "global warming" with surface heat content. *Eos*, 85, No. 21, 210-211.

and used to study its relationship to land use type in

Davey, C.A., R.A. Pielke Sr., and K.P. Gallo, 2006: Differences between near-surface equivalent temperature and temperature trends for the eastern United States - Equivalent temperature as an alternative measure of heat content. *Global and Planetary Change*, 54, 19–32.

Fall, S., N. Diffenbaugh, D. Niyogi, R.A. Pielke Sr., and G. Rochon, 2010: Temperature and equivalent temperature over the United States (1979 – 2005). *Int. J. Climatol.*, DOI: 10.1002/joc.2094.

and as a global scale issue in

Peterson, T. C., K. M. Willett, and P. W. Thorne (2011), Observed changes in surface atmospheric energy over land, *Geophys. Res. Lett.*, 38, L16707, doi:10.1029/2011GL048442

Moist enthalpy is very relevant to the assessment of extreme temperature events as shown in Section 3 Figure 11 in

Pielke, R.A. Sr., K. Wolter, O. Bliss, N. Doesken, and B. McNoldy, 2007: The July 2005 Denver heat wave: How unusual was it? *Nat. Wea. Dig.*, 31, 24-35.

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3. The paper concludes that

"In general, changes in both high and low temperature extremes are similar to the simulated change in mean temperature caused by LULCC and are restricted to regions of intense modification."

However, do the individual model runs show effects on temperatures at locations that are distant from the LULCC? If not, than the paper's finding in terms of the LULCC they examined would be correct. However, if the models each produce an effect at distance, but the locations are not coherent among the models, it may just be showing a very nonlinear teleconnection response from LULCC that is significant (i.e. it alters large scale circulation features) but is not the same for each model run.

One way to examine this is to place boxes of increasing size around each LULCC and analyze the differences in lateral heat, moisture and momentum fluxes across the perimeter of these boxes. What is the size of this box, for example, that needs to be attained before the difference in the model runs with and without LULCC becomes negligible?

In conclusion, Andy Pitman and his collaborators are leading a world-class research study on the role of land use change on climate. This paper is yet another critically important contribution. I recommend adoption of the information as listed in my review as a way to strengthen the paper under review.

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Interactive comment on *Earth Syst. Dynam. Discuss.*, 3, 597, 2012.

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