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# Impacts of land use land cover on temperature trends over the continental United States: assessment using the North American Regional Reanalysis

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**ABSTRACT:** We investigate the sensitivity of surface temperature trends to land use land cover change (LULC) over the conterminous United States (CONUS) using the observation minus reanalysis (OMR) approach. We estimated the OMR trends for the 1979–2003 period from the US Historical Climate Network (USHCN), and the NCEP-NCAR North American Regional Reanalysis (NARR). We used a new mean square differences (MSDs)-based assessment for the comparisons between temperature anomalies from observations and interpolated reanalysis data. Trends of monthly mean temperature anomalies show a strong agreement, especially between adjusted USHCN and NARR ($r = 0.9$ on average) and demonstrate that NARR captures the climate variability at different time scales. OMR trend results suggest that, unlike findings from studies based on the global reanalysis (NCEP/NCAR reanalysis), NARR often has a larger warming trend than adjusted observations (on average, 0.28 and 0.27 °C/decade respectively).

OMR trends were found to be sensitive to land cover types. We analysed decadal OMR trends as a function of land types using the Advanced Very High Resolution Radiometer (AVHRR) and new National Land Cover Database (NLCD) 1992–2001 Retrofit Land Cover Change. The magnitude of OMR trends obtained from the NLDC is larger than the one derived from the 'static' AVHRR. Moreover, land use conversion often results in more warming than cooling.

Overall, our results confirm the robustness of the OMR method for detecting non-climatic changes at the station level, evaluating the impacts of adjustments performed on raw observations, and most importantly, providing a quantitative estimate of additional warming trends associated with LULC changes at local and regional scales. As most of the warming trends that we identify can be explained on the basis of LULC changes, we suggest that in addition to considering the greenhouse gases–driven radiative forcings, multi-decadal and longer climate models simulations must further include LULC changes. Copyright © 2009 Royal Meteorological Society

KEY WORDS land use land cover change; reanalysis; temperature trends; observed minus reanalysis approach; US historical climate network

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## 1. Introduction

Temperature trends result from natural and anthropogenic factors; the latter (especially $CO_2$ resulting from human activities) has been mainly seen as the result of increasing concentrations of greenhouse gases (IPCC 2001; Trenberth *et al*., 2007). Recent investigations have also shown that climate forcing from land use/land cover (LULC) change also significantly impacts temperature trends (e.g. Bonan, 1997; Gallo *et al*., 1999; Chase *et al*., 2000; Feddema *et al*., 2005; Christy *et al*., 2006, Roy *et al*., 2007; Wichansky *et al*., 2008). Some studies suggest that new metrics should be considered for characterizing climate changes (e.g. Pielke *et al*., 2002a, 2004, 2007b; Joshi *et al*., 2003; NRC, 2005; Williams *et al*., 2005). Consequently, attention has been increasingly given to the impact of LULC change on climate. For example, it has been reported that land use changes due to agriculture lead to decreased surface temperatures (Mahmood *et al*., 2006; Roy *et al*., 2007; Lobell and Bonfils, 2008). LULC change can significantly influence climatological variables such as maximum, minimum and diurnal temperature range (Gallo *et al*., 1996; Hale *et al*., 2006, 2008). The effects of urbanization on climate trends have been analysed using classifications of meteorological stations as urban or rural based on population data (Karl *et al*., 1988; Easterling *et al*., 1997) or satellite measurements of night lights (Gallo *et al*., 1999; Peterson *et al*., 1999;

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