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A PROPOSED NEW METRIC FOR QUANTIFYING THE CLIMATIC EFFECTS OF HUMAN-CAUSED ALTERATIONS TO THE GLOBAL WATER CYCLE

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1. INTRODUCTION

Extensive recent work has documented the major role of human-caused landscape change on altering the earth's climate system (Kabat 2002). Based on work such as Chase et al. (2000), the effect of landscape change has been shown to teleconnect globally, and to alter the hydrologic system thousands of miles from where the landscape change occurred. That land-use change and other interacting effects are not yet incorporated into climate change studies such as the IPCC (2001) and the U.S. National Assessment (http://www.usgcrp.gov/usgcrp/nacc/) may help explain the failure of the GCM-generated climate change scenarios to replicate the observed tropospheric temperature changes from 1980 to the present (see Witness Testimony from the Committee Hearing on The U.S. National Climate Change Assessment: Do the Climate Models Project a Useful Picture of Regional Climate?, The House Committee on Energy and Commerce, W.J. 'Billy' Tauzin, Chairman, http://energycommerce.house.gov/107/hearings/07252002Hearing676/Pielke,Sr.1144.htm)

In Pielke et al. (2002), a new metric was defined to characterize climate change. Using heat, expressed as Joules, the proposal involves the assessment of the absolute value of surface changes in the Earth's surface heat budget associated with human disturbance of the environment. By weighting the changes by the area over which they occur, a globally-averaged value can be obtained.

Using a set of GCM sensitivity experiments, Pielke et al. (2002) reported on a global average influence of land-use change on the surface heat budget of 0.7 W m^{-2} for January and 1.08 W m^{-2} for July for those locations where land-use change occurred. When teleconnection effects were included, 9.47 and 8.90 W m^{-2} were obtained for January and July, respectively. These globally-averaged values of influence are on the same order as other human influences on the earth's climate system (IPCC 2001).

In this preprint, we extend this concept to the water budget.

2. ANALYSIS TECHNIQUES

The surface water budget over land can be represented as

$$P - E - T + RO_s + RO_{ss} = 0 \qquad (1)$$

when P is precipitation, E is physical evaporation and sublimation, T is transpiration, RO_s is surface runoff, and RO_{ss} is subsurface runoff. An analogous budget could also be written for water bodies, however, except where river discharges occur and are modified by human influences, we are assuming the main direct disturbance of the water budget is over land.

The individual terms in (1) are modified by humans (Pielke 2001). In the context of the heat budget, this approach was used to create the heat metric reported in Pielke et al. (2002).

Equation (1) can be written as absolute value changes due to human disturbance as

$$|\delta P| - |\delta E| - |\delta T| + |\delta(RO)| = 0 \qquad (2)$$

Values can be expressed in terms of mm day^{-1}. When globally-averaged, and contrasted with globally-averaged values of Eq. (1), a relative effect of human disturbance to the water cycle can be assessed, in the same manner as applied in Pielke et al. (2002).

Using the model results reported in Pielke et al. (2002), which is based on the general circulation model results given in Chase et al. (2000), values of the terms in Eq. (2) can be obtained. The results will be presented in our oral presentation in Long Beach.

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