

# A NEW PERSPECTIVE ON CLIMATE CHANGE AND VARIABILITY: A FOCUS ON INDIA

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Our paper overviews the global context of climate change in terms of the Earth's heat budget. It is shown that the Earth's climate system, as the major store for heat, has warmed less than suggested by the IPCC reports. In terms of top of the atmosphere radiative heating, the globally-averaged radiative imbalance between 1955-1995 is about  $0.3 \text{ W m}^{-2}$ .

Then we focus on India and discuss the role of land-use change, vegetation dynamics, and aerosols in altering the regional climate on India. The current and natural landscape of the region is illustrated with 50 km horizontal grid scales and the effect on India's weather and climate is simulated using the NCAR CCM3 GCM.

Using NDVI satellite data, vegetation growth is shown to be closely correlated with precipitation that fell two months earlier. Aerosols are shown to significantly alter the direct and diffuse sunlight that reaches vegetation, which subsequently has an effect on carbon assimilation and transpiration. Population increases are presented as a primary driver of these regional climate changes in India.

**Key Words:** Regional Climate; Earth's Heat Budget; Climate Change; Indian Climate; Regional Aerosol Effects; Regional Land-use Change Effects; Regional Vegetation Dynamics

## 1 Introduction

This article begins with a discussion of climate in the context of Earth system heat storage changes. It builds on the discussion in Pielke<sup>1</sup>, in which heat is shown to be an appropriate metric to assess the climate system. When the term "global warming" is used, for example, heat in units of Joules is the appropriate metric to use. Among the conclusions is that the Earth system has not warmed as much as implied by the IPCC<sup>2</sup>. Indeed it is spatial redistribution of heat by such effects of land-use change and anthropogenic aerosols which appear to exert a larger human influence on the Earth climate system than the radiative effect of doubling of carbon dioxide concentrations, as recently summarized in Pielke *et al.*<sup>3</sup>. This issue is illustrated in this article, with a particular emphasis on India.

## 2 Global Perspective

This section describes how an examination of the global heat budget allows a straightforward explanation for understanding one of the consequences of human changes in the composition of the Earth's atmosphere. Data and analysis provided in Levitus *et al.*<sup>4,5</sup> on increases in heat stored within the world's oceans provide a unique opportunity to explore this perspective. The use of a global heat budget to assess this consequence of human perturbations of the Earth system was also introduced by Pielke<sup>1</sup>.

This section expresses the Levitus *et al.*<sup>4,5</sup> data in terms of long-term, globally-averaged values of heat flux ( $\text{W m}^{-2}$ ), and relates the fluxes to the radiative forcing of the Earth's climate system. These fluxes provide a constraint on estimates of radiative forcing such as provided by the Intergovernmental Panel on Climate Change (IPCC). Such an assessment of the global heat budget was provided in Peixoto and Oort<sup>6</sup>, based on the study of Ellis *et al.*<sup>7</sup>, but this perspective is not appropriately utilized in the IPCC reports.

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