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The role of climate variability in the inter-annual variation of terrestrial net primary production (NPP)

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Abstract

Eleven years data set of global net primary production (NPP) and long-term climatic and land use data were used to explore the patterns of inter-annual variability of terrestrial NPP in relation to potential causal factors. Global anomalies in temperature, precipitation and cloud cover were found to significantly contribute in different ways and magnitudes to the variability of NPP of global ecosystems particularly forests and grasslands. El Niño/La Niña events represented an important factor affecting forests, woodlands and grasslands while deforestation was found to largely contribute to the NPP variability of tropical forests. Regionally, NPP variability is related to variation of precipitation in the tropics but is related to both variation and annual mean of temperature and cloud cover in the mid-northern latitudes. We hypothesized that the increase in variability of potential causal factor(s) will provoke more declines of NPP in the tropics but will yield more pulses or at least maintain a mean NPP in the mid-northern latitudes.

Keywords: NPP variation; Climate factors; El Niño; Tropical region; Mid northern latitudes region

1. Introduction

Since the industrial revolution the atmospheric CO_2 concentration had exceptionally increased from the pre-industrial steady state concentration of 280–368 ppm in the year 2000 (IPCC, 2001). The current atmospheric CO_2 concentration is caused by anthropogenic emissions of CO_2 from fossil fuel burning, cement production and land use change which are estimated to be approximately 6.3 Pg C/year (Pg = 10^{15} g) during the 1990s. However, only 3.2 Pg C/year is annually accumulating in the atmosphere and another 2 Pg C/year is dissolved into the ocean (Keeling et al., 1989, 1995; Schimel et al., 1996). The 'missing carbon' fraction remaining from balancing the carbon cycle was therefore, suggested to be hosted by terrestrial vegetation (Ciais et al., 1995; Keeling et al., 1996). However, conflicting results originated from attempts to allocate this terrestrial carbon sink to which part of the globe; the tropical region, the northern mid and high latitude region or both (e.g. Dai and Fung, 1993; Ciais et al., 1995; Lal et al., 1995; Keeling et al., 1996; Fan et al., 1998; Rayner et al., 1999).

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