PERGAMON

Atmospheric Environment 37 (2003) 3757–3770

ATMOSPHERIC ENVIRONMENT

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Localization of source and sink regions of carbon dioxide through the method of the synoptic air trajectory statistics

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Received 9 September 2002; received in revised form 16 May 2003; accepted 28 May 2003

Abstract

The main purpose of this paper is to contribute to the improvement of the present knowledge concerning the transient components of the global carbon cycle, superimposed to the periodic seasonal oscillation and to the yearly trend. This purpose has been achieved through the comparison among the calculated concentration fields of atmospheric CO_2 and its comparison with the sea-surface temperature patterns, forestation maps, forest fires, and the anthropogenic emissions extracted from Edgar V.2.0 database. In order to identify with high spatial resolution the most relevant areas of CO_2 sources and sinks, we have applied a methodology based on a statistical analysis of simulated back-trajectories related to atmospheric concentration values measured at some receptor sites where the back-trajectories originate.

In particular, we have used a 2-year time series (1996 and 1997) of CO_2 concentration data observed in three receptor sites located in high mountain areas, in order to reduce significantly the effects due to local influences (such as emissions from industries and urban areas or the absorption processes due to the vegetation). The back-trajectories were computed by means of the wind fields provided by the ECMWF analysis (T213/L31 model) on a regular grid. The area investigated was from 11°W to 36°E in longitude and from 30°N to 57°N in latitude. The final concentration field was computed by means of a statistical source–receptor model, based on a methodology developed by Stohl (Atmos. Environ. 30 (1996) 579) and adapted here with some modifications in the pre- and post-processing phases.

Before applying the model, a careful evaluation of its sensitivity to the input data has been performed, followed by an analysis to identify the optimal configuration of the model.

The results have shown a satisfactory accuracy in the identification of the major sources and sinks considered.

Keywords: Long-range transport; Backward trajectories; Carbon dioxide; Seasonal cycle; Source-oriented relationship

1. Introduction

The growth of the atmospheric concentration levels of greenhouse gases such as carbon dioxide, methane, nitrous oxide, halocarbons (so-called CFCs) and tropospheric ozone since the industrial period (1750) has been identified as one of the major causes of the general warming of the Earth's surface. Recent studies (IPCC WGI, 2001) have demonstrated that, in 1999–2000, the CO_2 alone has been responsible for about 60% of the increase in radiative forcing due to the emissions of all greenhouse gases.

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1352-2310/03/$ - see front matter
doi:10.1016/S1352-2310(03)00505-3