P1.26 MODELING THE EMISSION AND TRANSPORT OF CO_2 FROM AMAZONIA BURNING AREAS

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1. INTRODUCTION

Each year in the tropics an estimated 1.8-4.7 Pg of carbon are released to the atmosphere by biomass fires (Crutzen and Andreae, 1990). This value can be compared with annual aerosol emission in Tropical America, 2.2 Pg (Penner, Ghan et al, 1991). Globally, biomass burning has now been recognized as a major source of CO_2 (carbon dioxide), important trace gases and aerosol particles to the atmosphere.

Regionally, in the dry season biomass burning areas in Central Brazil and Amazonia significantly contribute to carbon dioxide input into atmosphere.

To estimate the balance of carbon dioxide for this season the numerical experiments with the transport model have been performed. The emission of carbon dioxide was estimated with using distribution of fire centers and their areas.

The transport model has been designed on the basis of semi-Lagrangian technique and includes the numerical procedures for the interpolation and the calculation of the air particle displacement (Trosnikov and Nobre, 1998).

For the simulation of the carbon dioxide transport the wind, temperature, geopotential height, and vertical turbulence parameters fields from the 40-km grid-increment version of the CPTEC-INPE Eta Model were used.

2. TRANSPORT MODEL

For compatibility of the transport model with the Eta Model the same vertical and horizontal coordinates have been used in this models.

The vertical coordinate is the step mountain, η coordinate, with the step-like representation of mountains (Mesinger, 1984).

The model equations are written in a geodesic coordinate. The integration domains of the 40-km grid-increment version of the CPTEC-INPE Eta Model (outer domain) and the transport model (inner domain) are shown in Fig. 1.

The transport model is based on the three-dimensional Lagrangian form of the transport equation for tracers:

$$\frac{d\chi}{dt} = \frac{1}{\rho}\frac{\partial}{\partial\eta}\rho K_H \frac{\partial\chi}{\partial\eta} + \frac{S_\chi}{\rho}$$

where $\chi = \rho_\chi/\rho$ is mixing ratio of the tracer with mass density ρ_χ; ρ is the air mass density, K_H is coefficient of vertical turbulence, and S_χ is a source term.

For calculation of the three-dimensional trajectories of air particles Crank-Nicolson time integration scheme was used (Williamson and Rasch, 1989). The implicit equation for arrival point was solved by iterations. The unknown wind components for arrival points were obtained by quasi-monotone local spline interpolation (Bermejo and Staniforth, 1992).

The model has property to conserve the carbon dioxide mass without sources. The conservative algorithm has been designed by using ideas from flux corrected transport method (Priestley, 1993).

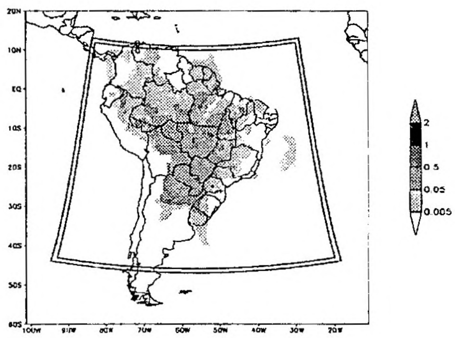

Figure 1: Excess of CO_2 concentration (ppm) at 850 hPa level for August 25, 1995 (00 UTC).

In the transport model boundary conditions are used:

a. In lateral boundary points, where there are influx of the air, a tracer flux is zero;

b. On the bottom surface the CO_2 flux is calculated from distribution of fires and their area.

c. On the top surface the CO_2 flux is zero.

During the synchronous integration with the 40-km grid-increment version CPTEC-INPE Eta Model, which has 96 second time step, transport model has access to predicted wind, temperature, geopotential height fields, and K_H every 48 min

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3. RESULTS

The transport of the CO_2 from Amazonia was simulated for the period from 20 to 29 August, 1995. The distribution and area of fires were obtained from the University of Wisconsin Space Science and Engineering Center SCAR-B web site (Prins and et al., 1998).

The initial conditions for the excess CO_2 were set equal zero and CO_2 was injected during integration from areas with fires in accordance with observed fire distribution.

Fig. 1 shows excess of CO_2 at 850 hPa level for August 25, 1995 after four days model integration.

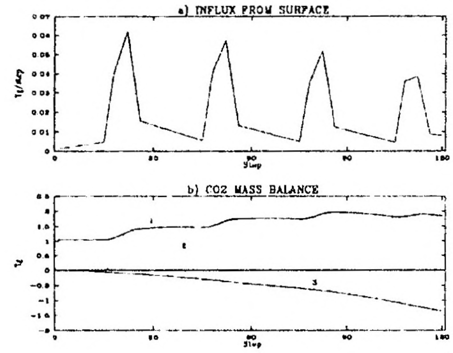

Figure 2: (a) The total surface influx of CO_2 from 25 to 28 August 1995; and (b) the CO_2 mass balance: (1) excess of the CO_2 mass caused by fires, (2) total injected mass of the CO_2 from August 25, 00 UTC, and (3) total the CO_2 flux through lateral boundaries.

The CO_2 injected in burning areas was spread north-westward and southward. In latter case the CO_2 arrived at 40°S. In the noth-westerly direction the excess of the CO_2 moved behind the Andes.

The components of the CO_2 mass balance are represented in Fig. 2. As shown in Fig. 2a, the injected mass of the CO_2 had diurnal course. Figure 2b shows (1) excess of the CO_2 mass caused by fires, (2) total injected mass of the CO_2 from August 25, 00 UTC, and (3) total CO_2 flux through lateral boundaries. The first four days of the integration this flux was negligibly small.

4. CONCLUSIONS

- The semi-Lagrangian transport model have been coupled with the Eta Mesoscale Forecast Model for trace gases and aerosol monitoring.
- The model has the property of tracer mass conservation which allows to calculate budget of the CO_2.
- The developed transport model can be employed as an useful tool for studies of climate change due to CO_2 cycle in the atmosphere.

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