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ESTIMATION OF BIOMASS BURNING EMISSIONS ON SOUTH AMERICA USING FIELD OBSERVATIONS AND REMOTE SENSING

Karla M. Longo* and Saulo R. Freitas

Center for Weather Forecasting and Climate Studies - CPTEC/INPE

1. ABSTRACT

We describe an estimation technique of biomass burning emissions in South America based on a hybrid remote sensing fire products (GOES-8 WF_ABBA, INPE_AVHRR, MODIS) and field observations. For each fire pixel detected by remote sensing the mass of the emitted tracer is calculated trough field observations of fire properties related to the type of vegetation burning. The instantaneous fire size given by WF_ABBA product is used as an estimate of burned area. The sources are then spatially and temporally distributed and daily assimilated by the CATT-BRAMS (Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System, Freitas et al., 2005) which prognoses tracer concentrations. Two others biomass burning inventories (EDGAR 3.2 described at Olivier (2002) and derived from TOMS aerosol index described at Duncan et al., (2003)) are also used and a comparison between the three estimations is shown. Model results present good agreement with MODIS aerosol products and local observations and point out some improvements on the estimation by the technique described in this paper. Operational products are available on a daily basis at www.cptec.inpe.br/meio_ambiente

2. INTRODUCTION

The high concentration of aerosol particles and trace gases observed in the Amazon and Central Brazilian atmosphere during the dry season is associated with intense anthropogenic biomass burning activity (vegetation fires, Andreae, 1991). Most of the particles are in the fine particle fraction of the size distribution, which can remain in the atmosphere for approximately a week (Kaufman, 1995). In addition to aerosol particles, biomass burning produces water vapor and carbon dioxide, and is a major source of other compounds such as carbon monoxide (CO), volatile organic compounds, nitrogen oxides (NO_x=NO+NO_2), and organic halogen compounds. In the presence of abundant solar radiation and high concentrations of NO_x, the oxidation of CO and hydrocarbons is followed by ozone (O_3) formation.

**Corresponding author address:* Karla M. Longo, Centro de Previsão de Tempo e Estudos Climáticos (INPE), Cachoeira Paulista, São Paulo, Brazil. E-mail: longo@cptec.inpe.br.

3. THE BIOMASS BURNING INVENTORY

The biomass burning emission parameterization is based on Freitas (1999) with several improvements. In this work a hybrid remote sensing fire product is used to minimize the missing detections by remote sensing. The biomass burning source emission parameterization is based on the combination of GOES-12 WF_ABBA product (cimss.ssec.wisc.edu/goes/burn/abba.html, Prins et al. 1998), AVHRR from CPTEC-INPE (www.dpi.inpe.br/proarco/bdqueimadas, Setzer and Pereira, 1987) and MODIS fire product (Giglio et al. 2003). Fire detection is merged with a 1 km land use and carbon in live vegetation (Olson et al. 2000) data to provide the associated emission factor (Ward et al. 1992, Andreae and Merlet, 2001, combustion factor and carbon density. For each fire detected by remote sensing, the mass of emitted tracer is calculated and its emission in the model follows a diurnal cycle of the burning. The sources are spatially and temporally distributed and daily assimilated according to the biomass burning spots defined by the satellite observations. Figure 1 shows all sources of information used to estimate biomass burning emissions according to this technique. This approach is called Brazilian Fire Emission Model (BFEMO).
Figure 2 shows the estimation for the months August to November 2002. Three biomass burning inventories are showed. The first column from the left corresponds to the estimation obtained BFEMO model, the second column refers to Duncan et al. 2003 estimation and the last column is the EDGAR 3.2 product. BFEMO has a general agreement with Duncan estimation in terms of order of magnitude for August and September, but not for the others two months. Both estimations show obvious finer scale in comparison with EDGAR 3.2. However, BFEMO resolution can be as fine as of pixel size of the satellite sensor used for the fire detection.

3. INVENTORY VALIDATION FOR 2002 DRY SEASON

The three inventories described above were introduced in the CATT-BRAMS model system (Freitas et al., 2005). Simulation for 2002 dry season was performed to compare model results using the three inventories described with observed data. The model configuration had 2 grids. The coarse grid had a horizontal resolution of 140 km covering the South American and African continents. Its main purpose was to simulate approximately the intermittent smoke inflow from the African fires to South America and to coordinate with and compare to the long-range transport of smoke from fires in South America to the Atlantic Ocean. The nested grid had a horizontal resolution of 35 km and covering only South America. The vertical resolution for both grids was between 150 to 850 m, with the top of the model at 23 km (42 vertical levels). The time integration was 135 days, starting on 00Z 15 July 2002. For atmospheric initial and boundary condition we used the 6 hourly CPTEC T126 analysis fields trough 4DDA technique. Three tracers was simulated representing CO emitted according to each inventory with initial the same background values.

Figure 3 shows time series with comparison between surface CO (ppbv) observed (black), BFEMO (red), EDGAR (blue) and Duncan (green) inventories.

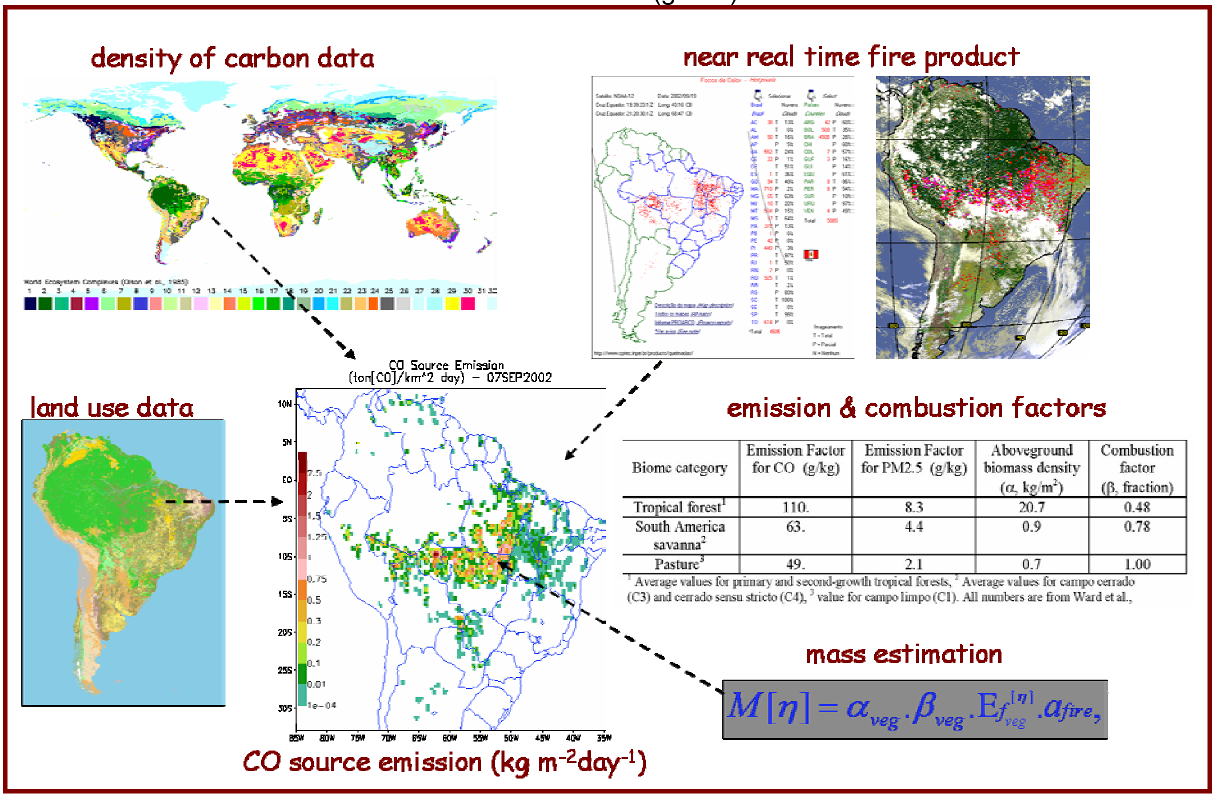

Figure 1. Cartoon describing all sources of information used to estimate biomass burning emissions.

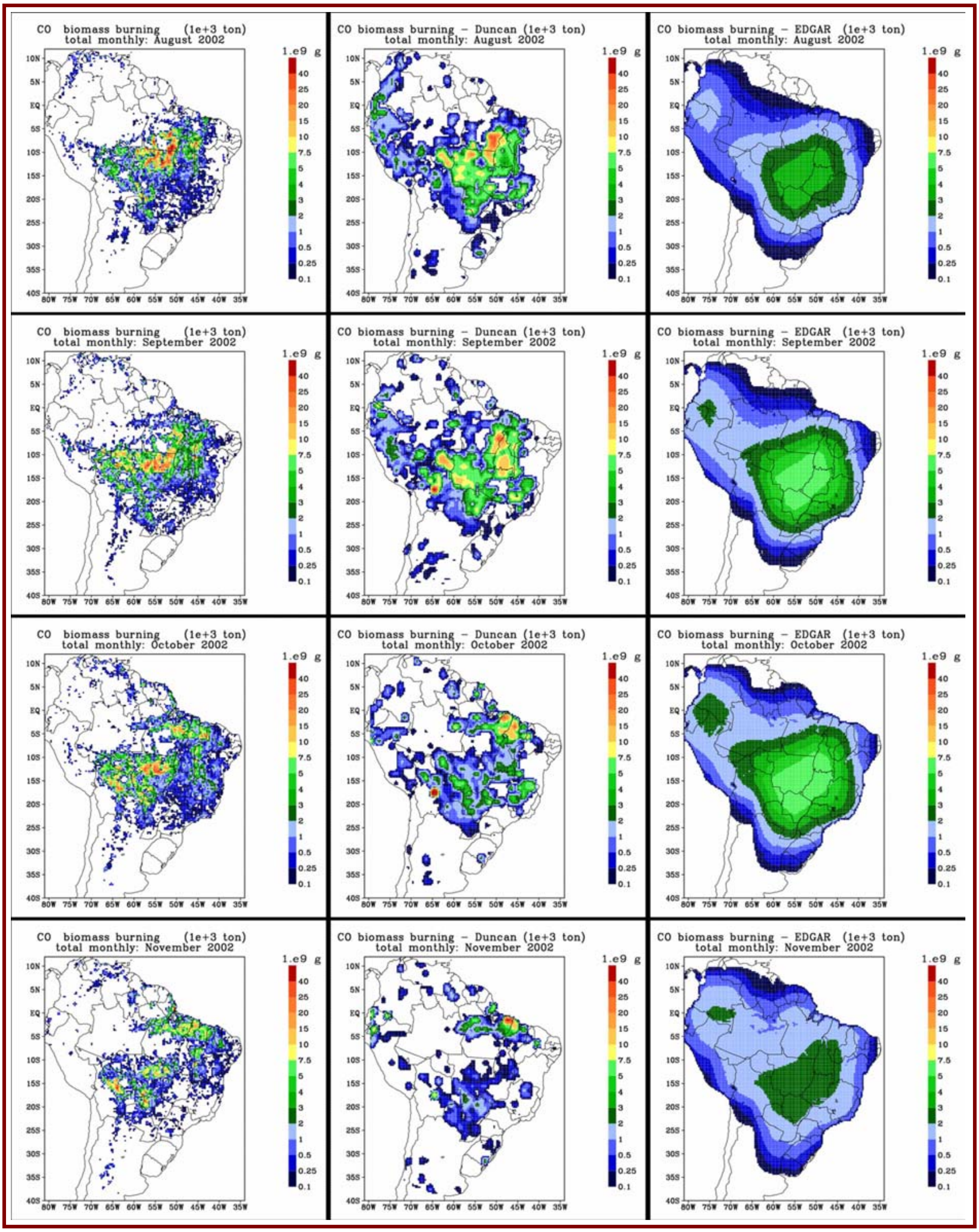

Figure 2. Three biomass burning inventories: the first column from the left shows the estimation obtained with the technique described in this paper, the second column refers to Duncan et al. (2003) estimation and the last column is the EDGAR 3.2 product.

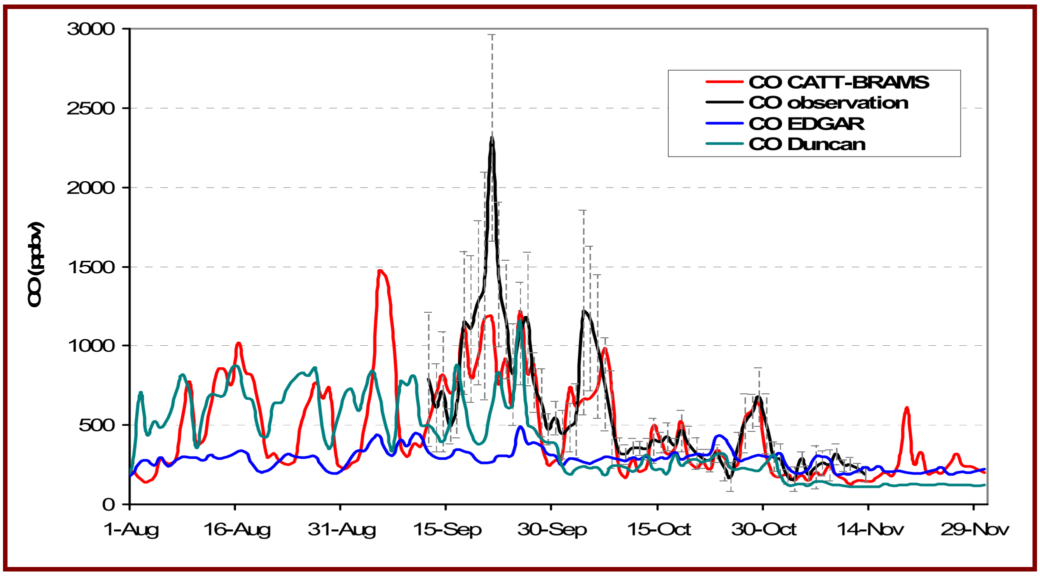

Figure 3. Time series with comparison between surface CO (ppbv) observed (black), BFEMO (red), EDGAR (blue) and Duncan (green). The measurements were daily averaged and centered at 12Z. The error bars are the standard deviations of the mean values. The model results are presented as instantaneous values at 12Z.

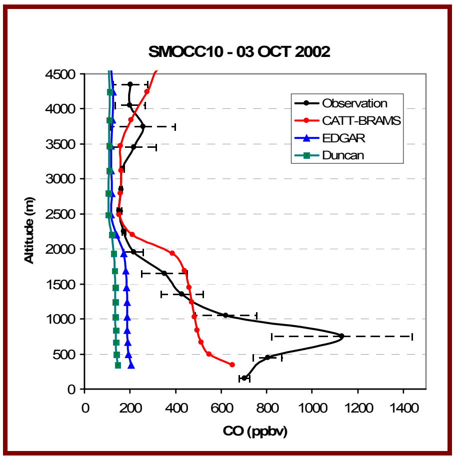

Figure 4. CO vertical profiles from the model (red, blue and green colors) and comparison with observed CO during SMOCC flight 10.

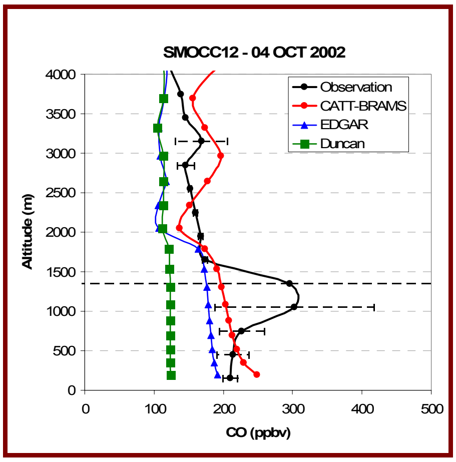

Figure 5. CO vertical profiles from the model (red, blue and green colors) and comparison with observed CO during SMOCC flight 12.

4. CONCLUSIONS

The biomass burning inventory technique developed for South America shows realistic emission estimation and introduces new features like the diurnal and daily variability and higher spatial resolution, being adequate to use in regional and large scales atmospheric transport models. The CATT BRAMS model results showed good agreement with surface and aircraft observations of CO. This technique is implemented in an operational system for monitoring the transport of biomass burning emissions in South America (www.cptec.inpe.br/meio_ambiente).

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