Coupled Simulations of Physical Climate and CO_2 Exchange in Rondonia

Elicia Eri Inazawa, A. Scott Denning, Melville Nicholls, and Niall Hanan
Department of Atmospheric Science, Colorado State University, Fort Collins, CO USA

Abstract

Exchanges of water, energy and carbon between Amazonian ecosystems and the atmosphere is investigated using a numerical model (SiB2).

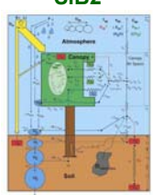
The model is tested and calibrated by comparing simulations at a forest site (Reserva Biologica do Jaru) and a pasture site (Fazenda Nossa Senhora) with eddy covariance data collected during ABRACOS.

Canopy processes and fluxes agree well with the flux data during both dry and wet season.

The model was also coupled to a mesoscale model (CSU-RAMS) and used to investigate the diurnal evolution of CO_2 and other scalars in the planetary boundary layer.

Model Descriptions

SiB2

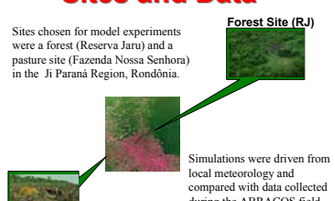


SiB2 simulates exchanges of energy, moisture momentum, and CO_2 between the atmosphere and the vegetated land surface (Sellers et al, 1996a). Assimilation of CO_2 by photosynthesis is calculated according to biochemical processes and diffusive transport. Stomatal conductance is linked to photosynthesis and the physical environment (Denning et al, 1996). Model parameters are derived from satellite imagery and other spatial data (Sellers et al, 1996b).

The CSU Regional Atmospheric Modeling System (RAMS, Pielke et al, 1992) was coupled to SiB2, and run for several case studies. These simulations used a grid spacing of Δx=100 m, Δz=30 m. Subgrid-scale turbulence was parameterized using a Deardorff TKE formulation. Surface parameters were identical to those used in the stand-alone SiB2 simulations. These simulations were initialized from a sounding obtained during the LBA WetAMC campaign in February 1999.

Sites and Data

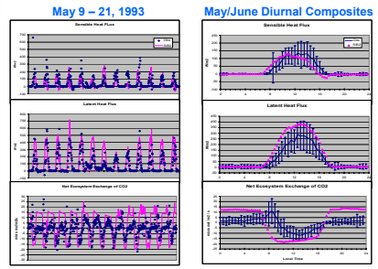
Sites chosen for model experiments were a forest (Reserva Jaru) and a pasture site (Fazenda Nossa Senhora) in the Ji Paraná Region, Rondônia.



Simulations were driven from local meteorology and compared with data collected during the ABRACOS field campaigns (Gash et al, 1996).

Forest Site
ReBio Jaru

SiB2 with observed meteorology

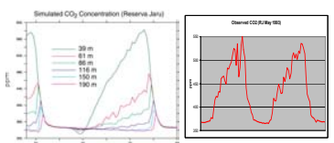


Simulations with SiB2 were performed from Jan 1992 to Dec 1993, for each site.

Diurnal composites were obtained calculating mean averages at each time. Error bars correspond to the standard deviation of the observational data.

Mean diurnal cycles of latent and sensible heat fluxes compare well with data collected during the ABRACOS field campaign. Simulated NEE is stronger than the eddy covariance data during both day and night.

Coupled SiB2-RAMS

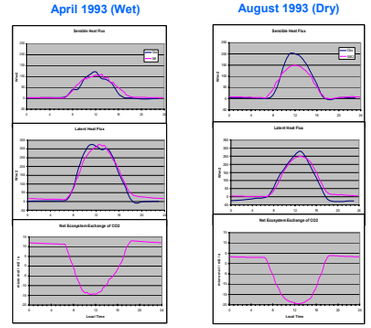


The coupled SiB2-RAMS model was integrated for 5 days on a periodic domain of 60 columns with SiB2 boundary conditions representing the forest at Reserva Jaru.

Results show very strong trapping of nighttime CO_2 evolved from soil respiration under the stable inversion. Concentrations aloft receive a "pulse" of elevated CO_2 in the early morning when the stable layer mixes out. Simulated diurnal cycle in the lowest RAMS levels agrees well with the observed diurnal variation on the 52 m tower.

Pasture Site
Fazenda Nossa Senhora

Monthly Diurnal Composites



The model captures the changes in the diurnal cycles of the surface energy budget between wet and dry conditions reasonably well at NS. No eddy covariance data for CO_2 flux were available at this site, but the simulated fluxes appear quite strong in both seasons.

References

Denning, A. S., J. G. Collatz, C. Zhang, D. A. Randall, J. A. Berry, P. J. Sellers, G. D. Colello, and D. A. Dazlich, 1996. Simulations of terrestrial carbon metabolism and atmospheric CO_2 in a general circulation model. Part 1: Surface carbon fluxes. *Tellus*, **48B**, 521-542.

Gash, J.H.C., C. A. Nobre, J. M. Roberts, and R. L. Victoria (Eds), 1996. *Amazonian Deforestation and Climate*, J. Wiley and Sons, 611 pp.

Pielke, R. A., W. R. Cotton, R. L. Walko, C. J. Tremback, W. A. Lyons, L. D. Grasso, M. E. Nicholls, M. D. Moran, D. A. Wesley, T. J. Lee, and J. H. Copeland, 1992. A comprehensive meteorological modeling system - RAMS. *Meteor. Atmos. Phys.*, **49**, 69-91.

Sellers, P. J., D. A. Randall, G. J. Collatz, J. Berry, C. Field, D. A. Dazlich, C. Zhang, and L. Bounoua, 1996*a*: A Revised Land-Surface Parameterization (SiB2) for Atmospheric GCMs. Part 1: Model formulation. *J. Clim.*, **9**, 676-705.

Sellers, P. J., S. O. Los, C. J. Tucker, C. O. Justice, D. A. Dazlich, G. J. Collatz, and D. A. Randall, 1996*b*: A Revised Land-Surface Parameterization (SiB2) for Atmospheric GCMs. Part 2: The generation of global fields of terrestrial biophysical parameters from satellite data. *J. Clim.*, **9**, 706-737.

Acknowledgement:

Data were collected under the ABRACOS project and made available by the UK Institute of Hydrology and the Instituto Nacional de Pesquisas Espaciais (Brazil). ABRACOS is a collaboration between the Agencia Brasileira de Cooperacao and the UK Overseas Development Administration.

For more information, please visit http://biocycle.atmos.colostate.edu
or email elicia@atmos.colostate.edu