Impact of Aerosols on the Amazon Basin Short-wave Surface and Atmospheric Radiation Balance

Hiroko Kato[1], Fernando Ramos Martins[2] , Hongqing Liu[1] and Rachel T. Pinker[1]

1. Department of Meteorology, University of Maryland, College Park, MD
2. Climate and Environment Division, Center for Weather Forecast and Climate Studies/Brazilian Institute for Space Research (CPTEC/INPE), Sao Jose dos Campos, Brazil

Background

- **Information on large-scale radiative fluxes over the Amazon Basin is needed for modeling and prediction of the surface hydrological balance, for ecological modeling, for evaluation of climate models, and for estimating net primary productivity.**
- **Aerosols are known to impact the accuracy of inferred estimates of such fluxes.**
- **Over the Amazon, aerosols vary seasonally in their optical properties; aerosols from biomass burning have strong absorption and affect the short-wave radiation balance.**
- **Current large scale and long-term information on surface radiative fluxes as available from satellite observations is based on simplified information on aerosol properties.**
- **Relevant information on aerosols at large scale is only recently becoming available.**

Objective

- **To improve the representation of aerosols in the Global Energy and Water Cycle Experiment (GEWEX)/Surface Radiation Budget (SRB) model for the Amazon Basin.**
- **To apply such improvements with high resolution satellite observations as available from:**
  - **a. The University of New Hampshire for the LBA period 1998-2000.**
  - **b. From INPE/CPTEC (Dr. J. Ceballos) for selected time periods.**

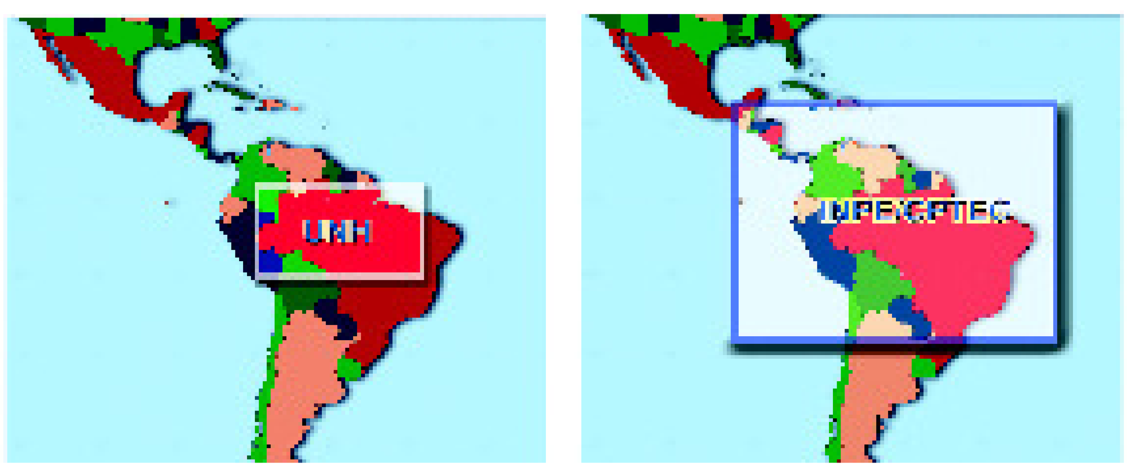
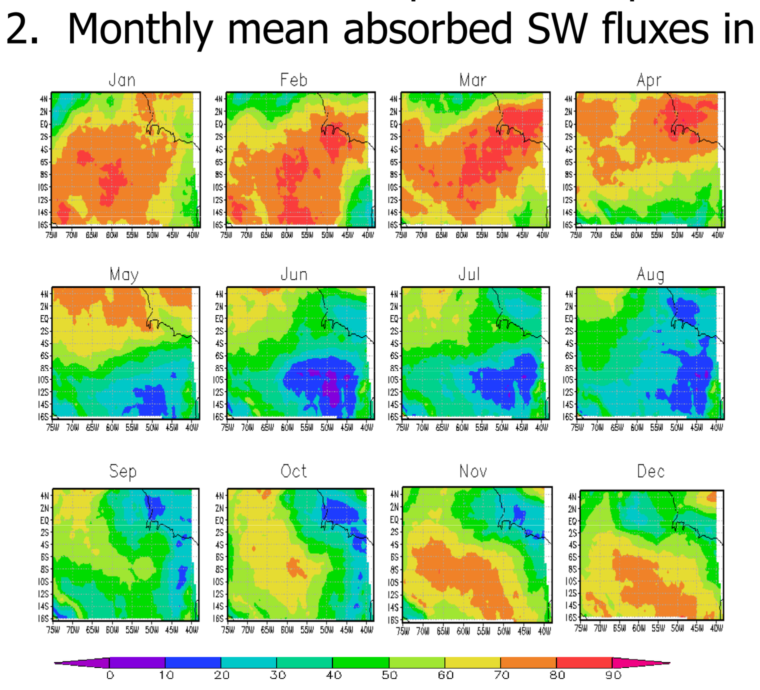


Figure 1. Differences in domain of high resolution satellite data

Steps taken

- **Application of a new cloud screening approach based on CLAVR** (Stowe et al., 1999) **and MODIS (**Ackerman et al., 1998) **to pixel level satellite data**

  Cloud amount as computed from pixel level GOES data for 2000 is illustrated in Figure 2. Monthly mean absorbed SW fluxes in atmosphere are displayed in Figure 3.



Figures 2. Monthly mean cloud amount from GOES-8 for 2000.

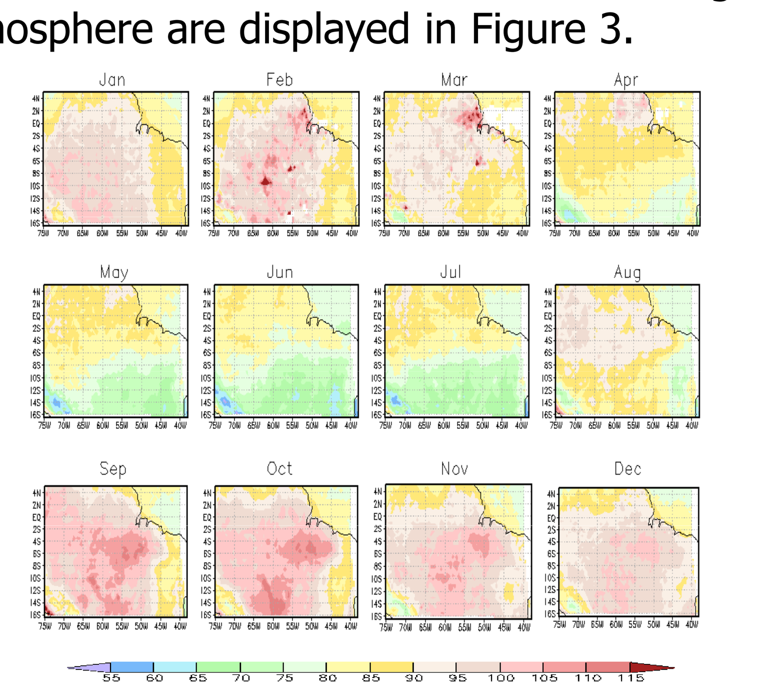


Figure 3. Monthly mean absorbed shortwave flux [W/m²] in the atmosphere using the AOD as derived in Liu et al.(2004).

- **Amalgamation of model input data:**
  - ➢WEB based System for Terrestrial Ecosystem Research (EOS-WEBSTER) at University of New Hampshire for 5°N and 75°W to 16.5°S and 38°W, available half-hourly, hourly, or 3-hourly from March 1998 thru February 2001.
  - ➢Monthly mean Total Column Ozone from Solar Backscatter Ultraviolet Radiometer/Version 2 from NOAA/NESDIS/OSDPD
  - ➢Monthly mean Precipitable Water CDAS-NCEP/NCAR Reanalysis, 6-hourly
- **Development of new aerosol climatology for the Amazon Basin**

  Aerosol Optical Depths (AOD): method of Liu Pinker and Holben (2004). Used are observations from MODIS on Terra (Kaufman et al., 1997; Tanre et al, 1997); observations from AERONET (Holben, et al., 1998); and results from the Global Ozone Chemistry Aerosol Radiation and Transport (GOCART) model (Chin et al., 2000, 2002; Ginoux et al., 2001). Combined are the advantages from each, using the leading EOFs to retrieve the significant variation signals from model and satellite results and fit are the leading EOFs to ground observations to propagate the AERONET information, keeping the amplitude close to the measurements in a least-square sense (Figure 4).

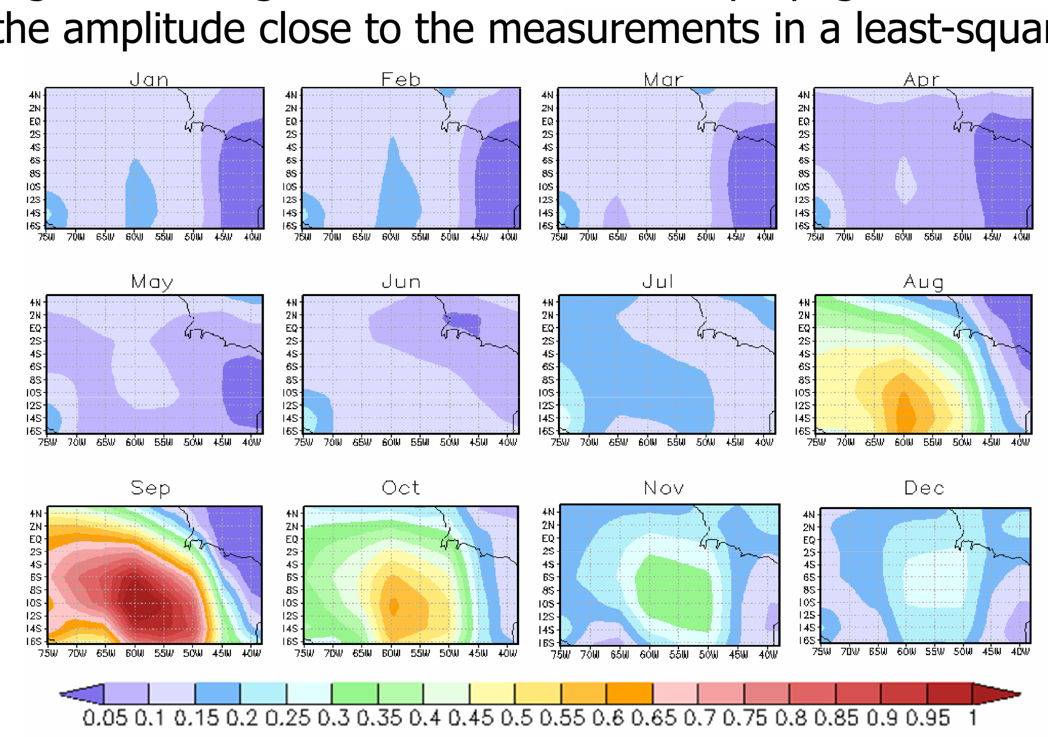


Figure 4. Monthly mean aerosol optical depth over the Amazon region

- **Implementation with GOES-8 Satellite Observations.**

Results

- **The impact of the newly derived aerosol fields on the Surface Radiation Budget is shown in Figure 5.**
  - ➢ Default AOD setting (constant in time and space) Figure 5a.
  - ➢ AOD from Liu, Pinker and Holben (2004).
  - ➢ Reduction in short-wave and visible surface downward flux during biomass burning season (Figure 5b and 5c).

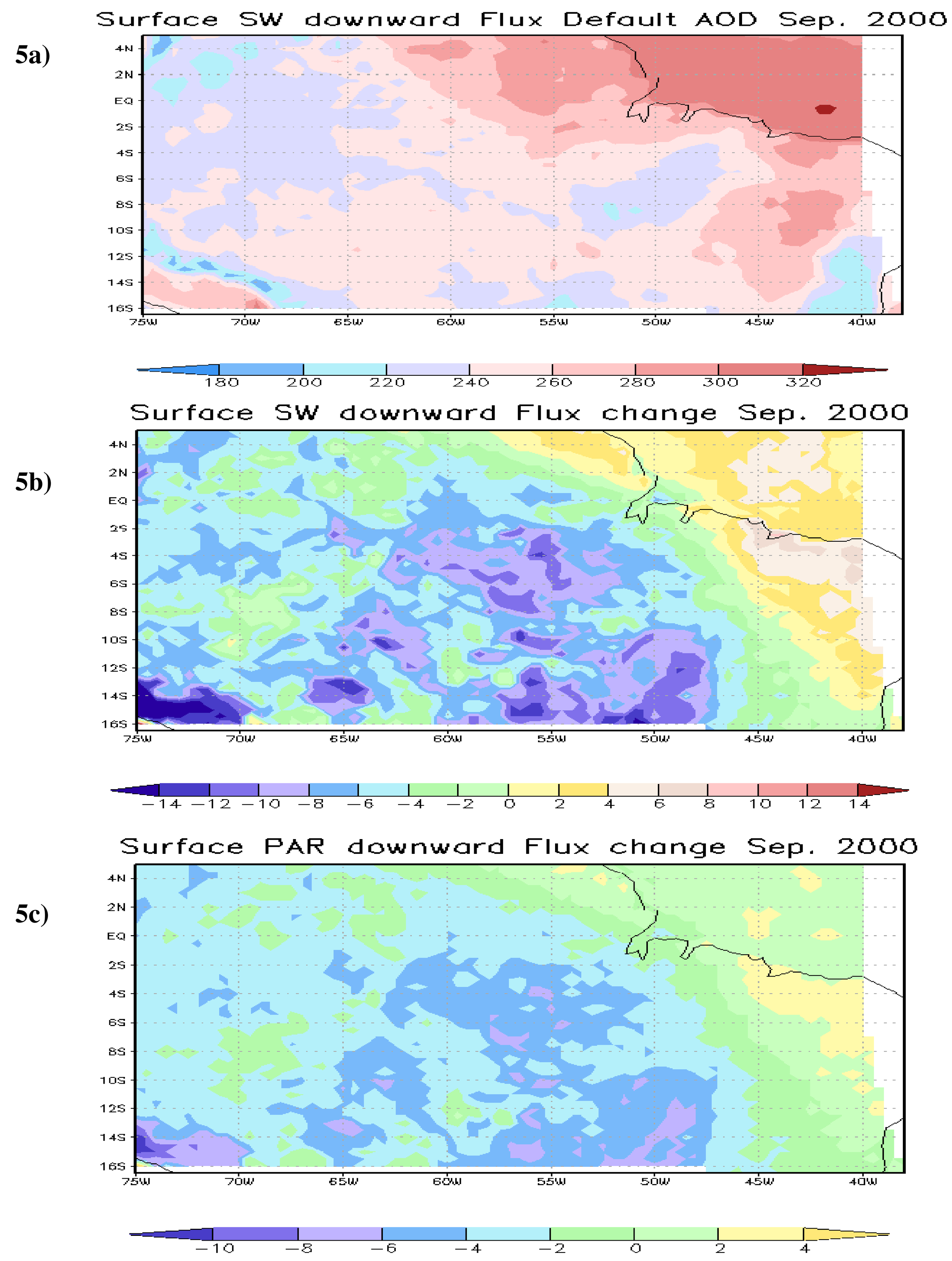
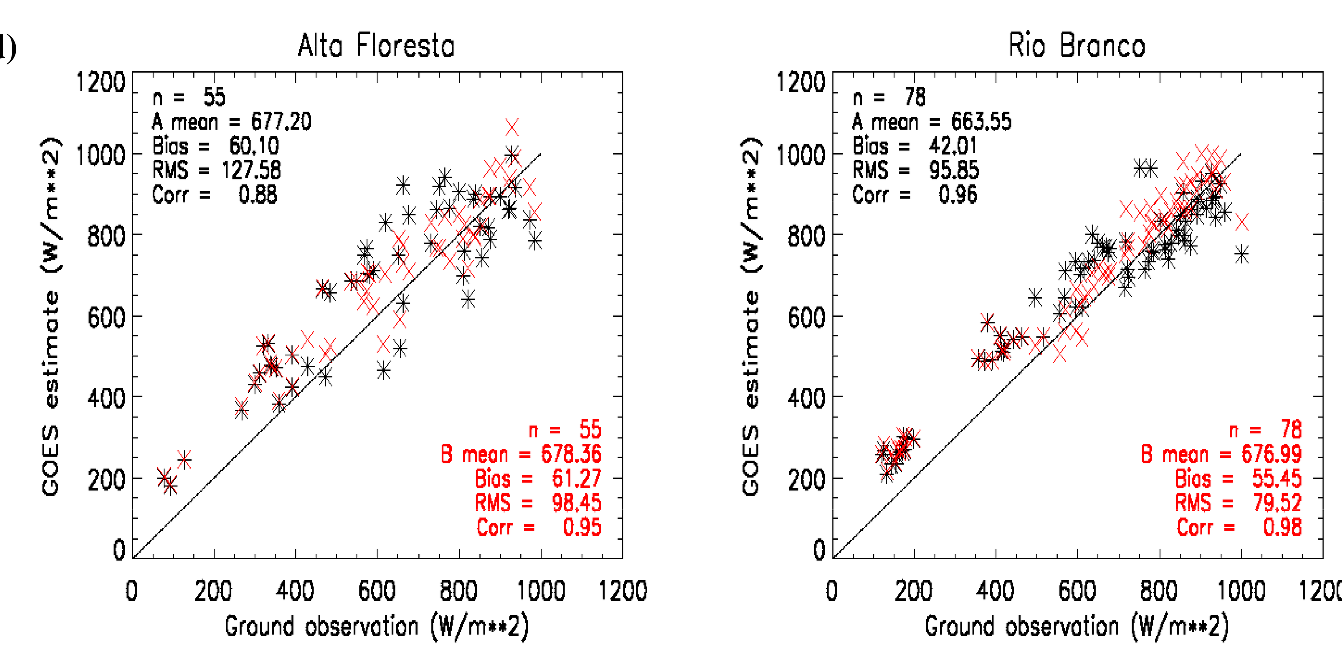


Figure 5a. Monthly mean surface short-wave downward flux from default AOD at 0.5º deg
5b. Monthly mean surface short-wave downward flux change (new AOD – default AOD).
5c. Monthly mean surface visible downward flux change (new AOD – default AOD).

- ➢ Runs of SRB model with different aerosol information (climatology vs. observed values).
- ➢ Scatter plots of model results and ground measurements at three stations (Figure 5d).

stations	Aerosol climatology			AERONET measurements		
	AOD	Single Scattering Albedo	Asymmetry Parameter	AOD	Single Scattering Albedo	Asymmetry Parameter
Abracos Hill	0.928	0.893	0.637	0.563	0.898	0.657
Alta Floresta	1.02	0.893	0.637	0.660	0.925	0.665
Rio Branco	0.783	0.893	0.637	0.452	0.910	0.701

5d)



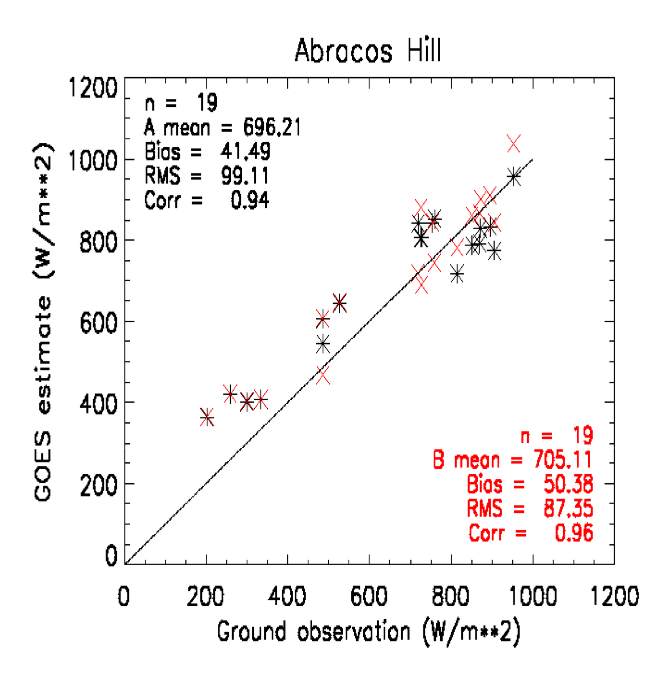


Figure 5d. Scatter plots of satellite estimates of surface short-wave flux against AERONET measurements using model built-in aerosol climatology (*, black) and aerosol information from AERONET measurements (x, red) at Alta Floresta, Abracos Hill and Rio Branco.

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Work in progress

Relationship between aerosol properties and number of fires was investigated.

Methodology

1. Based on eight AERONET sites (Table 1), small annual variability is observed in the single scattering albedo and asymmetry factor (Figure 6).

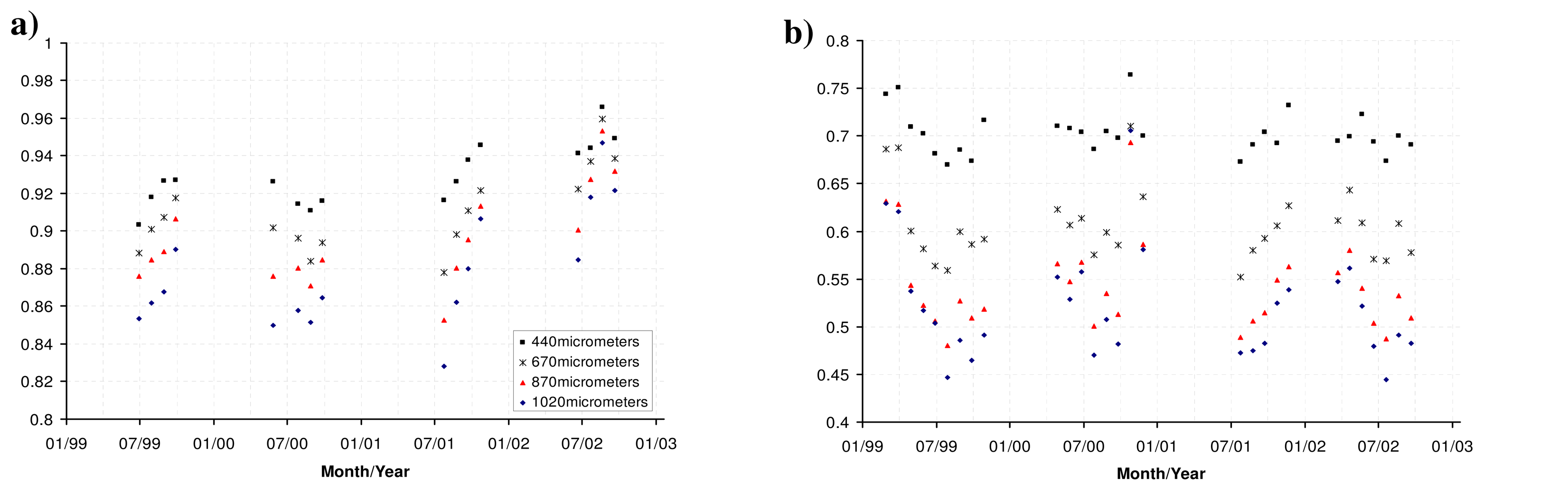

Figure 6. Aerosol optical properties measured at the AERONET site of Abracos Hill: (a) asymmetry factor (b) single scattering albedo

Site	Latitude	Longitude	Description
Abracos Hill	-10.76	-62.36	Amazonas/Brazil
Alta Floresta	-9.87	-56.11	Rondonia/Brazil
Balbina	-1.92	-59.49	Amazonas/Brazil
Belterra	-2.65	-57.95	Amazonas/Brazil
Rio Branco	-9.96	-67.87	Acre/Brazil
Cuiabá	-15.73	-56.02	MatoGrosso/Brazil
Los Fieros	-14.55	-60.62	Bolivia
Concepcíon	-16.14	-62.03	Bolivia

2. Monthly means AOT during the burning season are within one standard deviation of the longer term monthly means for each month as shown for Alta Floresta (Figure 7). Largest variability is observed during the burning season peak of September.

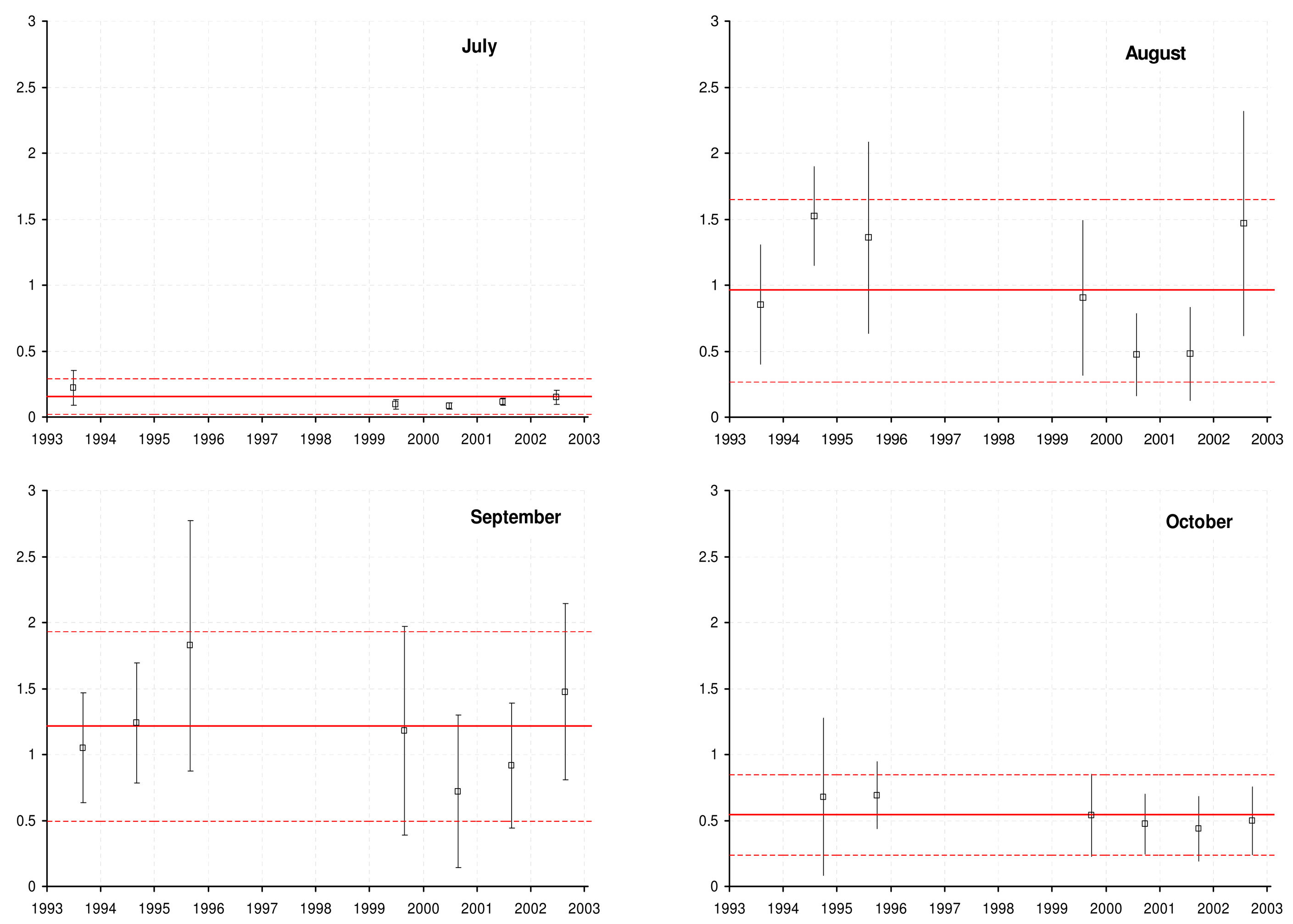

Figure 7. Monthly mean AOT measured at Alta Floresta at 500 nm during the burning season (July to October). Red lines show the period mean; red dotted lines represents one standard deviation interval around overall mean.

3. Analyzed relationship between aerosol optical thickness and fire spots, as available on a weekly time scale at 0.5 deg grids from CPTEC/INPE using AVHRR (http://www.cptec.inpe.br/products/queimadas/quadriculas.html). During the dry season, high correlation found between weekly AOT and mean number of fire spots in 3X3 cells around AERONET sites (Figure 8). Study to be extended to include burned area data from the Wildfire ABBA and aerosol optical properties provided by MODIS. Fire information will be used to distribute available point measurements of aerosol optical parameters to the larger scale of the Amazon Basin.

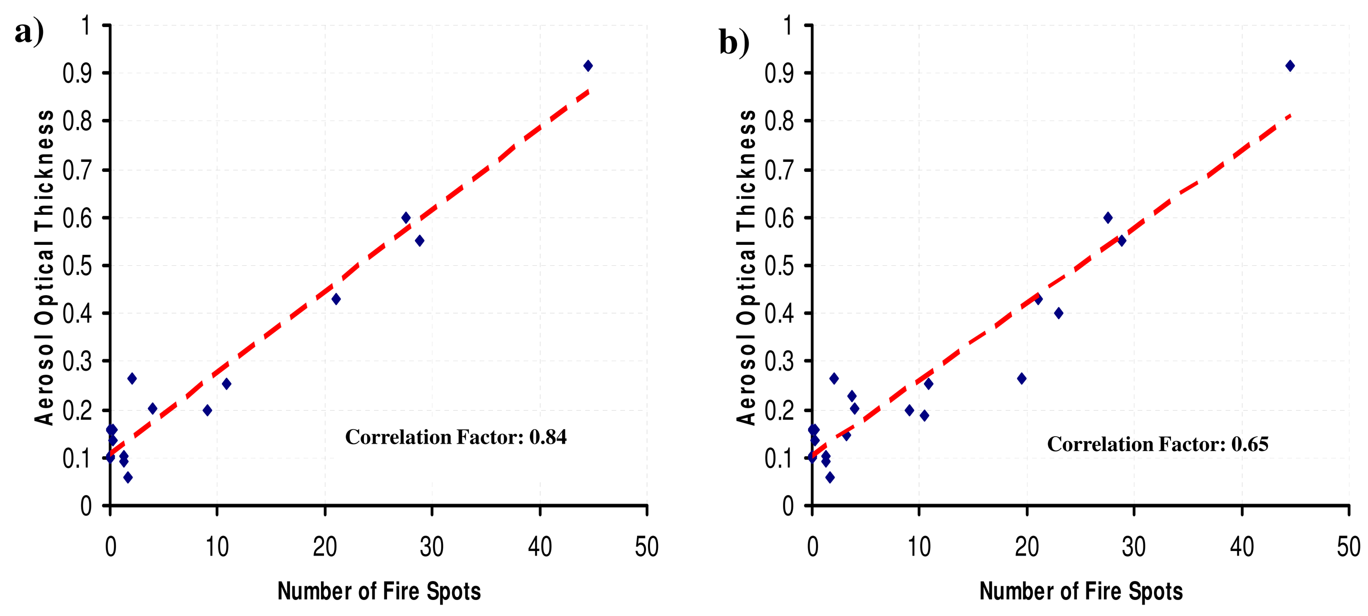

Figure 8. Correlation between AOT and number of fires spots (in 3x3 cell arrays around site location) obtained from AVHRR:
a) only measurements from forest sites (Alta Floresta, Abracos Hill, Balbina and Belterra) used
b) measurement from all 8 sites used

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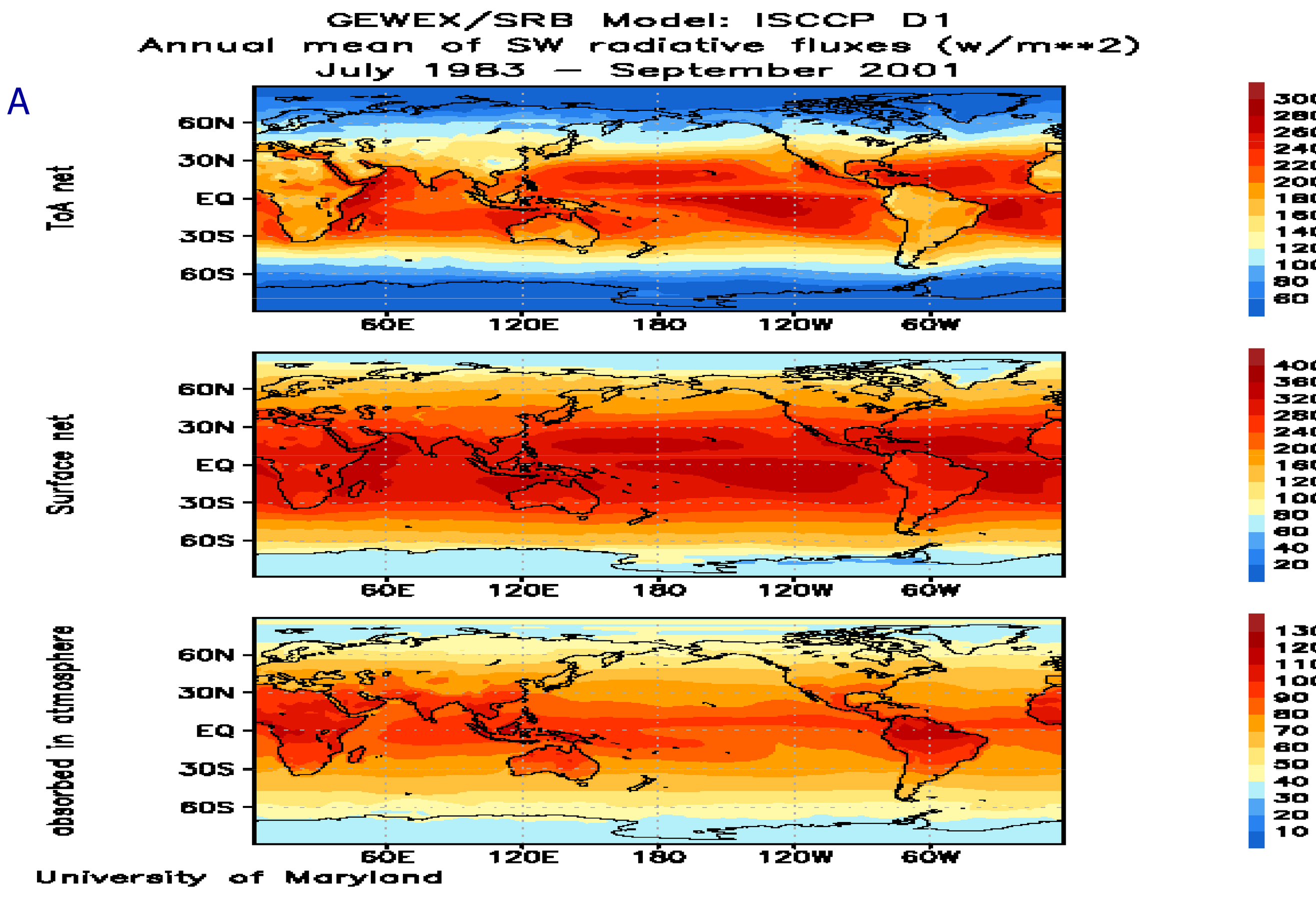
Examples of available products

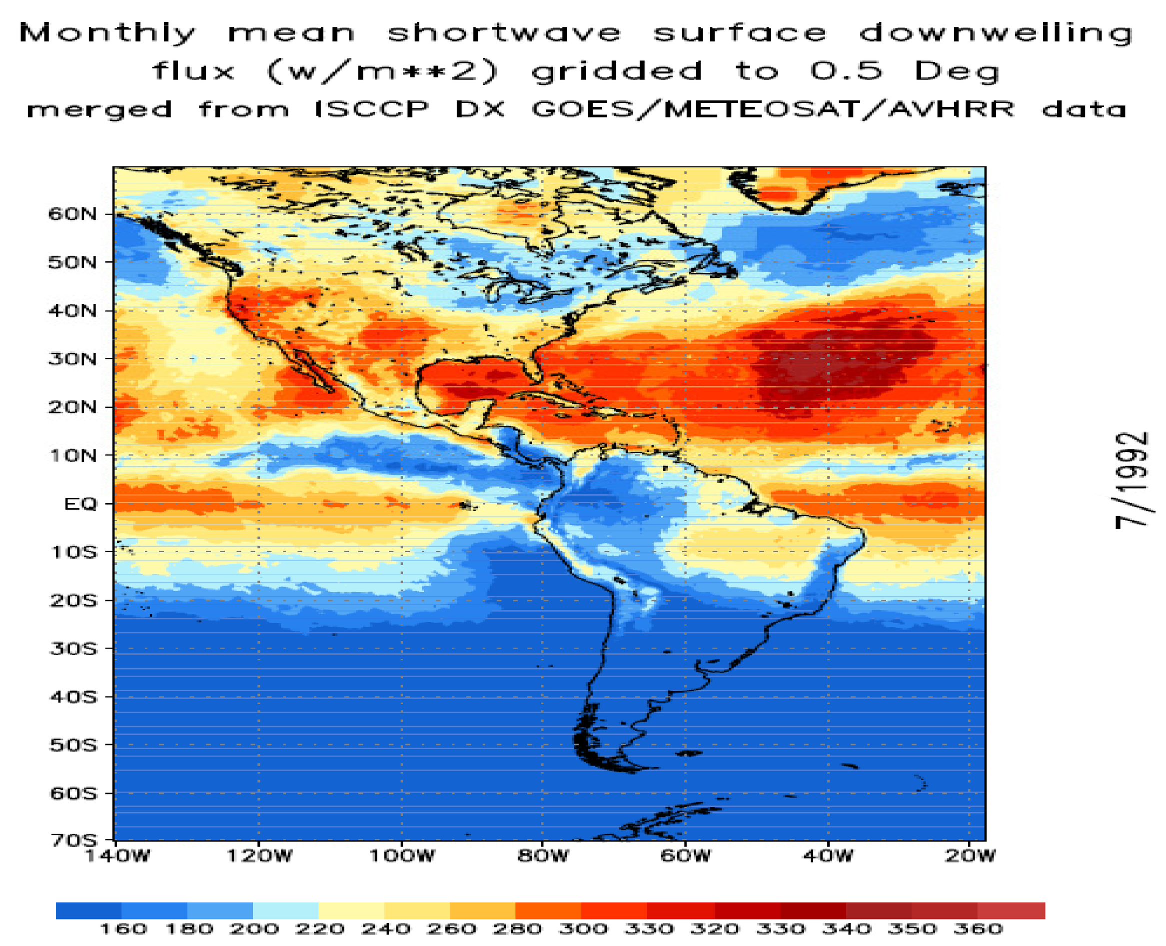
About twenty years of historical satellite observations from PATHFINDER data are used to infer radiative fluxes at 2.5-degree resolution on global scale (Figure A). Data available at: http://www.atmos.umd.edu/~srb/pathfinder/webpath.htm

Figure A



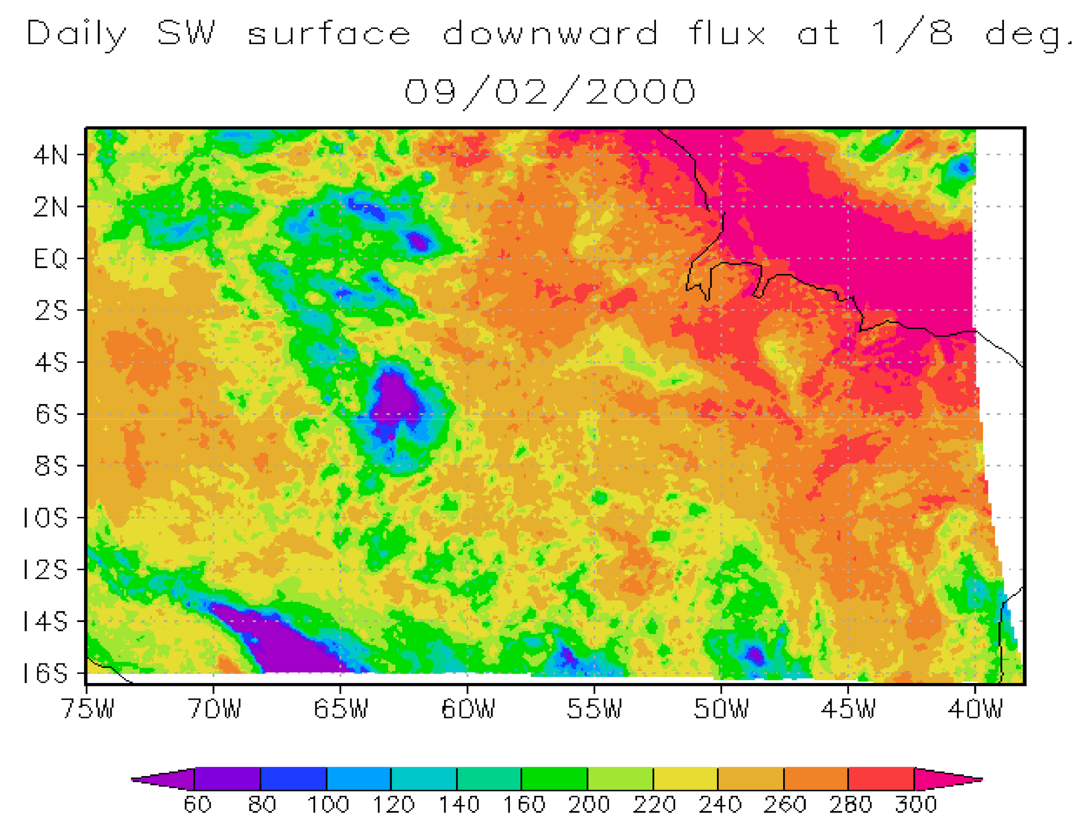
- **About ten years of GOES and METEOSAT data used to infer fluxes at 0.5 degree over North and South America, using optimal interpolation techniques to merge observations (Figure B). Data distributed via the Global Land Cover Facility (GLCF), Earth Science Information Partnership (ESIP) Federation, University of Maryland: http://glcf.umiacs.umd.edu/data/serf/**

Figure B



- **Pixel level data from GOES used to obtain radiative fluxes for the Amazon Basin at a 1/8-degree resolution for a period spanning three years during the LBA project (Figure C)**

Figure C



- **The time scale for first two products is 3- hourly; the high spatial resolution product is available hourly to three hourly. Instantaneous, hourly averaged, daily, and monthly means are available**

Please Note:

Updates on progress and data status will be posted at: http://www.atmos.umd.edu/~srb/lba/weblba.htm

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