Characterization of Aerosol Optical Properties and Solar Flux for LBA-ECO- An Overview

Brent Holben, Joel Schafer, Tom Eck: NASA/GSFC
Paulo Artaxo, Alberto Setzer, Alejandro Duarte: Brazil

March 2004, NASA/GSFC

LBA-related Publications

JS Schafer, BN Holben, TF Eck, MA Yamasoe, and P Artaxo, **"Atmospheric Effects On Insolation In The Brazilian Amazon: Observed Modification Of Solar Radiation By Clouds And Smoke And Derived Single Scattering Albedo Of Fire Aerosols"**, J. Geophys. Res., 10.1029/2001JD000428, 11 September 2002.

JS Schafer, TF Eck, BN Holben, P Artaxo, MA Yamasoe, and AS Procopio **"Observed Reductions of Total Solar Irradiance by Biomass-Burning Aerosols in the Brazilian Amazon and Zambian Savanna"**, Geophys. Res. Lett., 10.1029/2001GL014309, 05 September 2002.

A. S. Procopio, P. Artaxo, Y. J. Kaufman, L. A. Remer, J. S. Schafer, B. N. Holben, "**Multiyear Analysis of Amazonian Biomass Burning Smoke Radiative Forcing of Climate**", *Geophys. Res. Lett.*, Vol. 31, L03108, doi:10.1029/2003GL018646, 2004.

TF Eck, T.F., B.N. Holben, J.S. Reid, N.T. O'Neill, J.S. Schafer, O. Dubovik, A. Smirnov, M.A. Yamasoe, and P. Artaxo, '**High aerosol optical depth biomass burning events: A comparison of optical properties for different source regions'**, *Geophys. Res. Lett.,* 30(20), 2035, doi:10.1029/2003GL017861, 2003.

Colleagues Using Flux and Aerosol Data

Dr. Márcia Yamasoe, *University of São Paulo*-

Influence of smoke on the transmission of PAR inside the canopy.

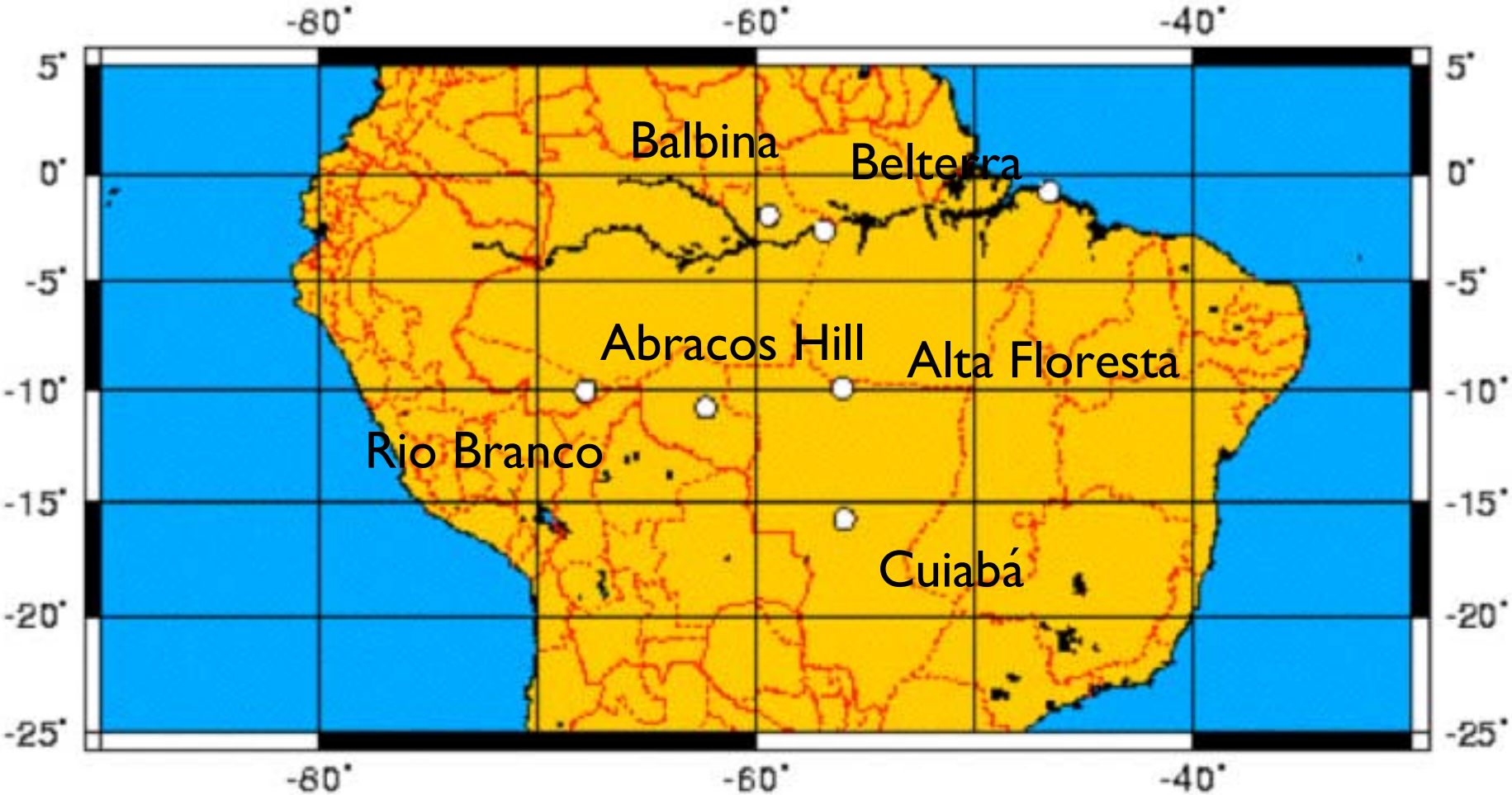
Alejandro Fonseca, *Federal University of Acre* -

Solar energy losses due to smoke for solar panels resources in rural Acré

Assessing aerosol effects upon:

- Plant photosynthesis / productivity
- Climate models / radiative forcing
- Human health

AERONET LBA Sites (Brazil)



NETWORK DETAILS

Six sites in operation (four since 1999)

CIMEL sunphotometer data

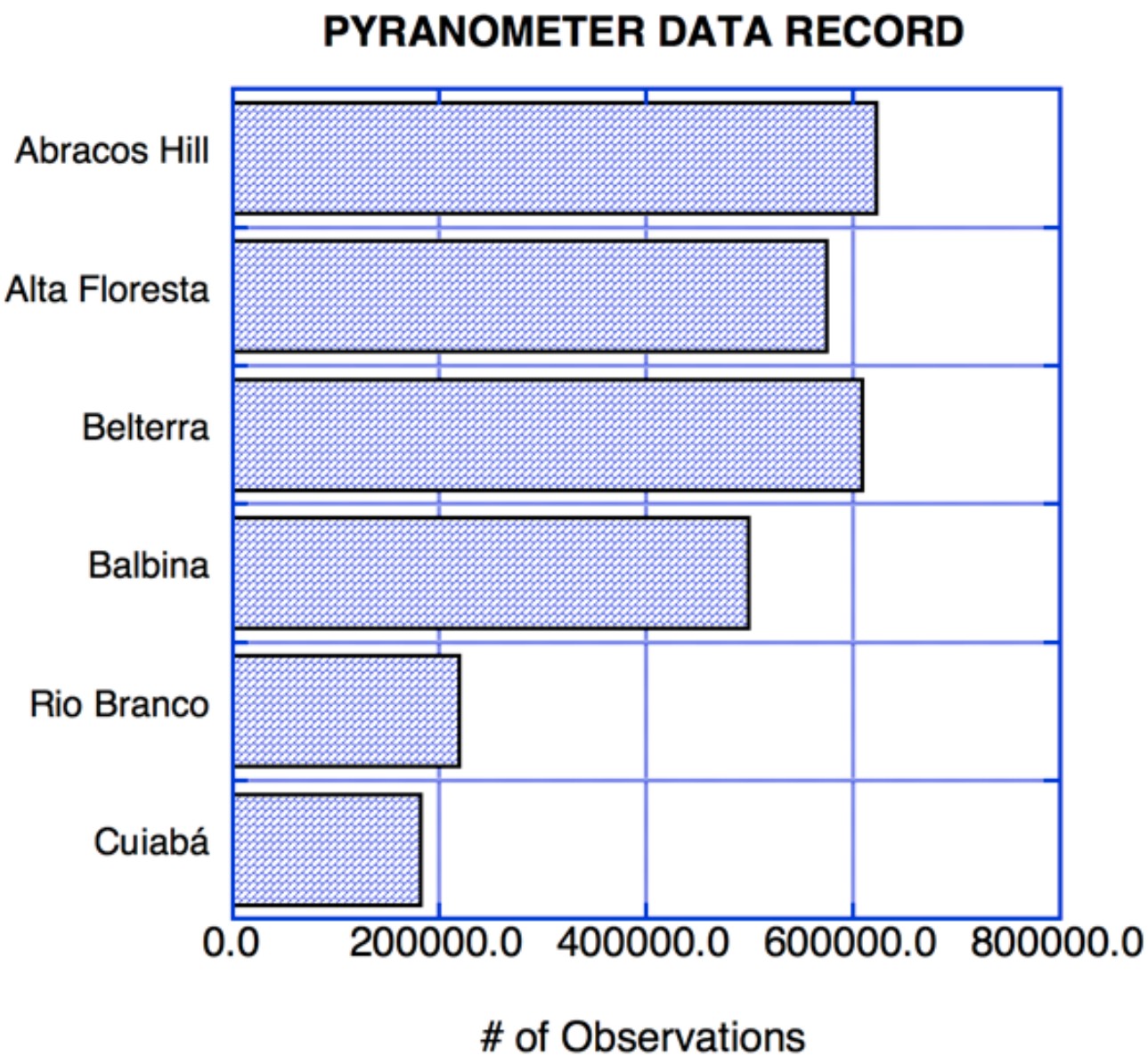
[AOT, WV,g, SSA, n_i, n_r dV/d(ln r)]

2-min instantaneous flux measurements

PAR(400-700nm)

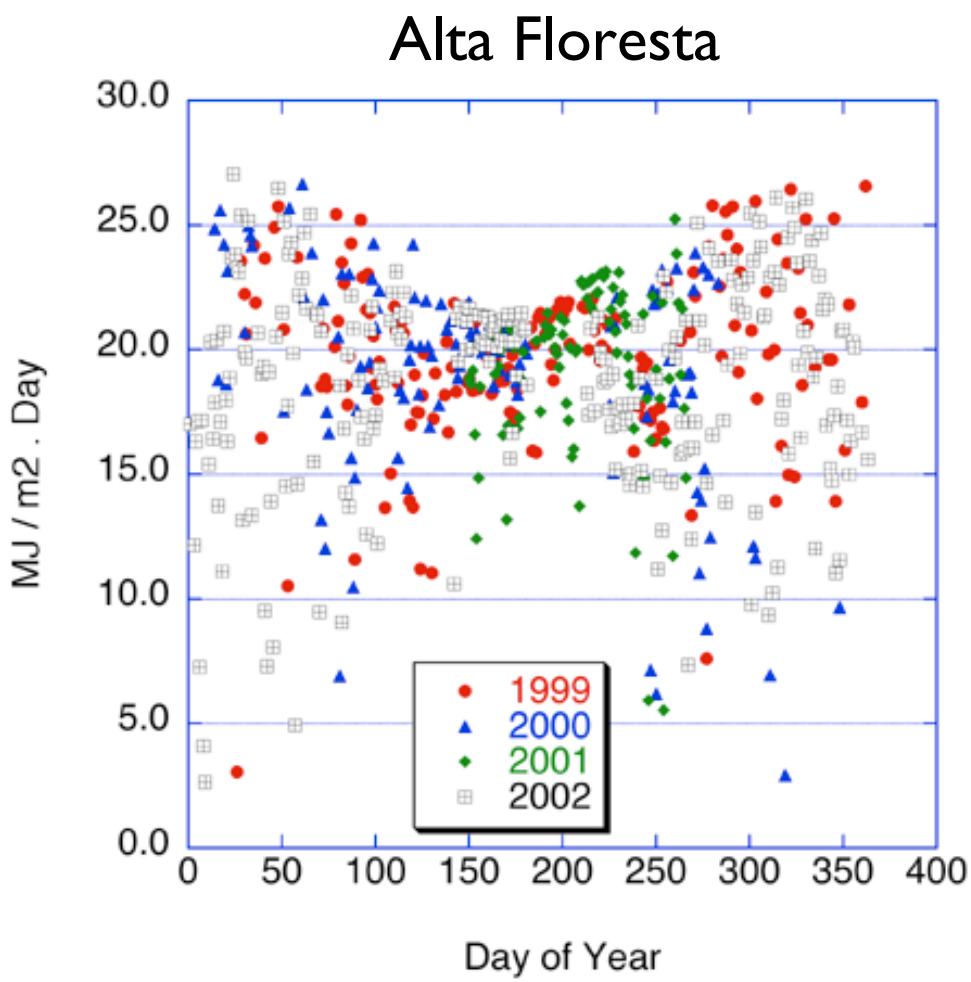
filtered pyranometer (695-2800nm)

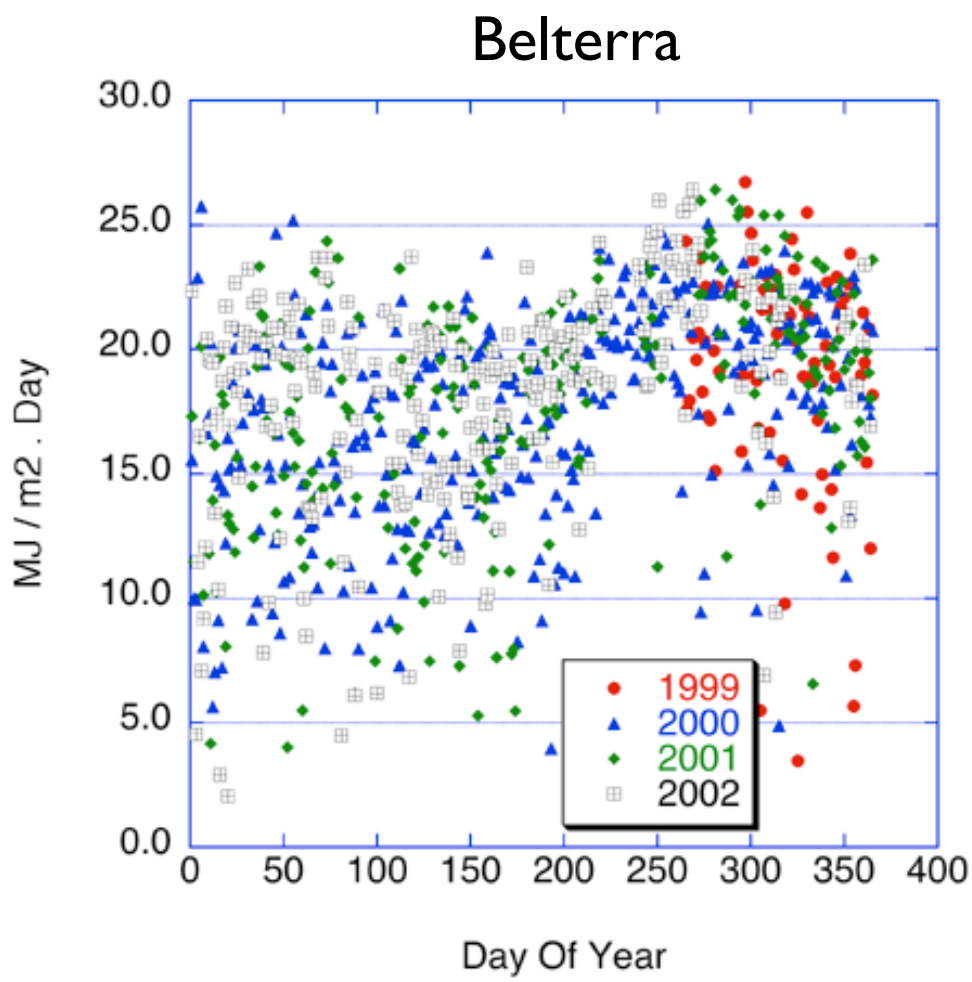
pyranometer (285-2800nm)


PYRANOMETER DATA RECORD
Abracos Hill
Alta Floresta
Belterra
Balbina
Rio Branco
Cuiabá
0.0
200000.0
400000.0
600000.0
800000.0
# of Observations

Challenging Climate

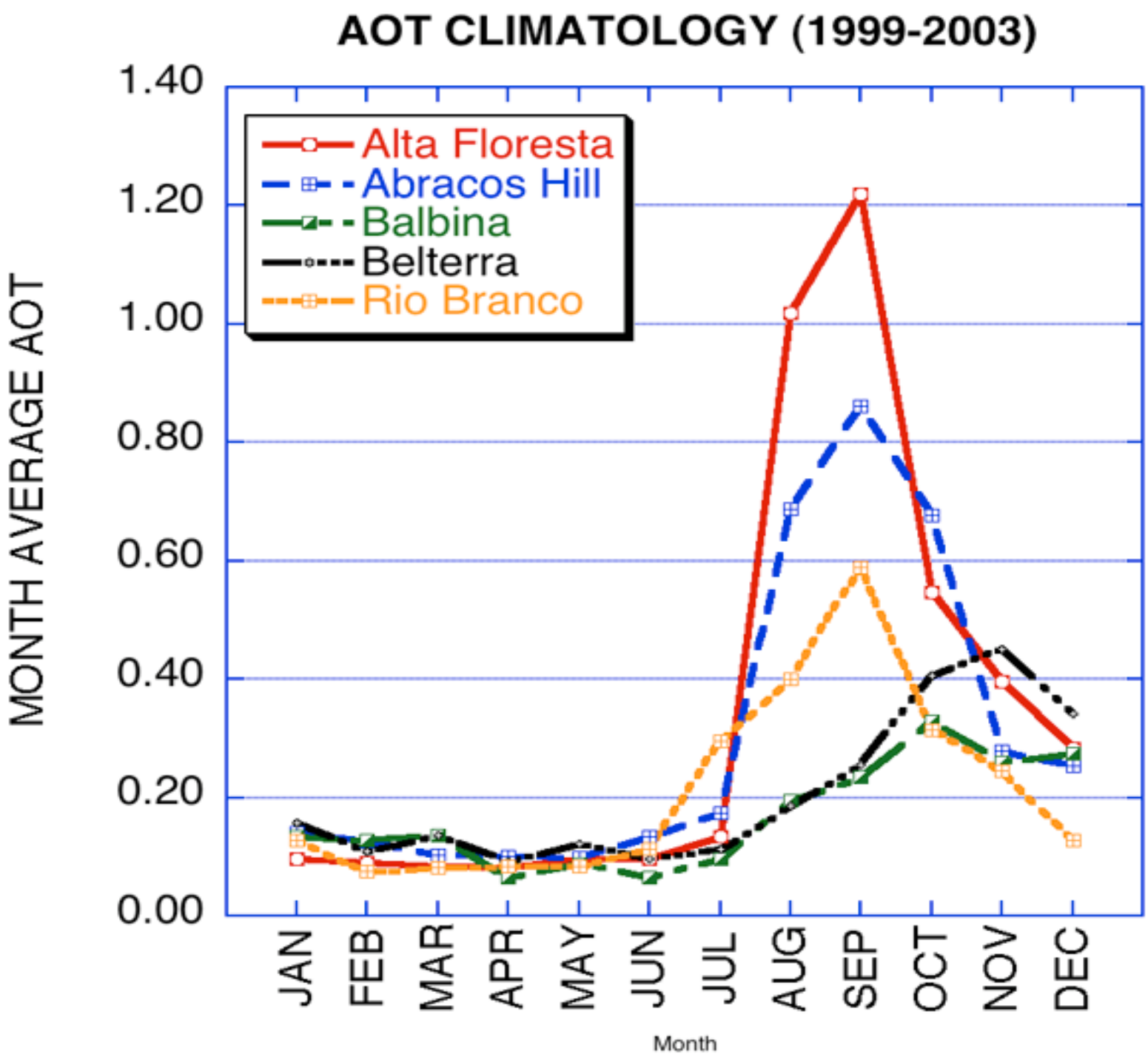
Daily Pyranometer Insolation

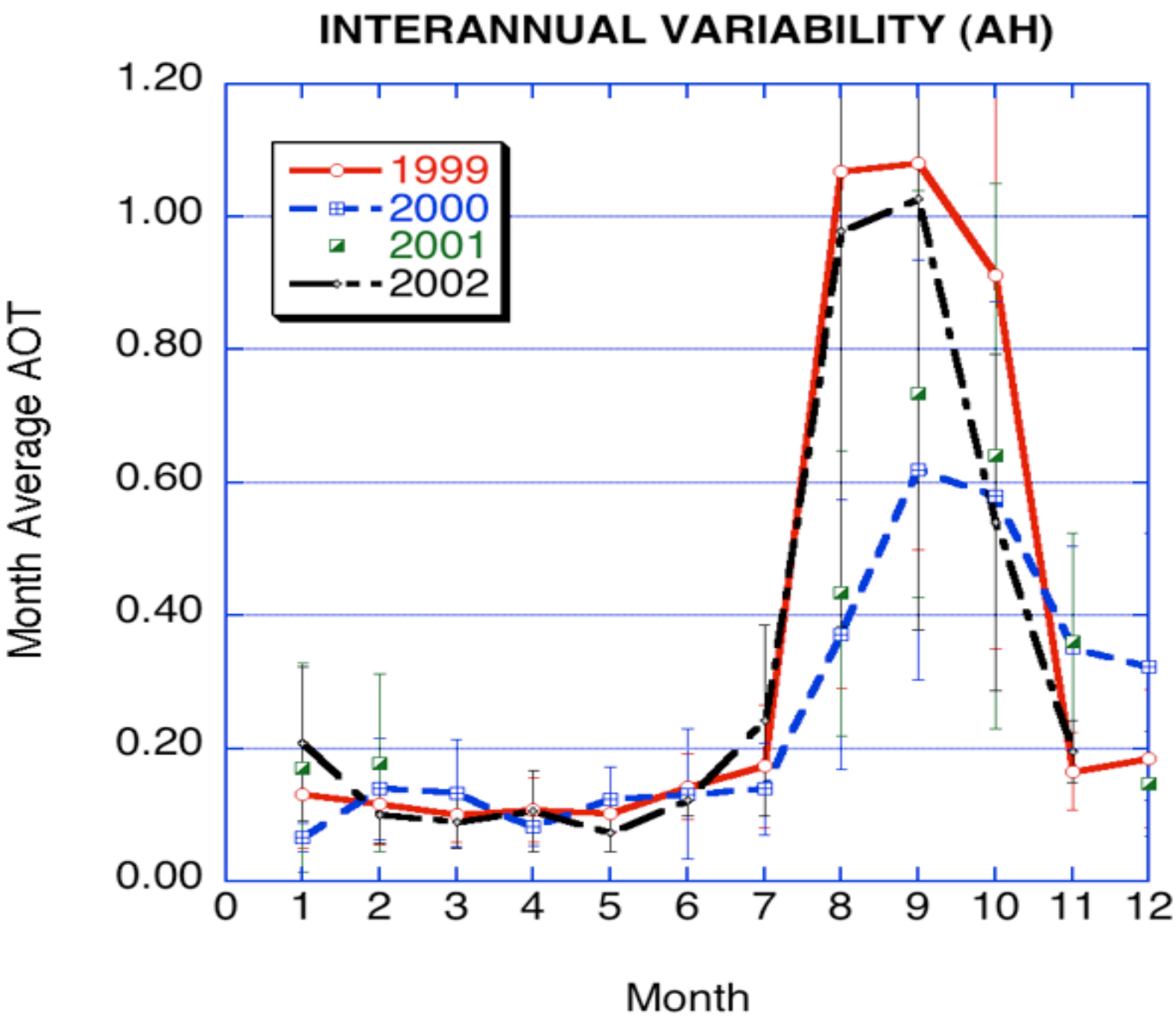


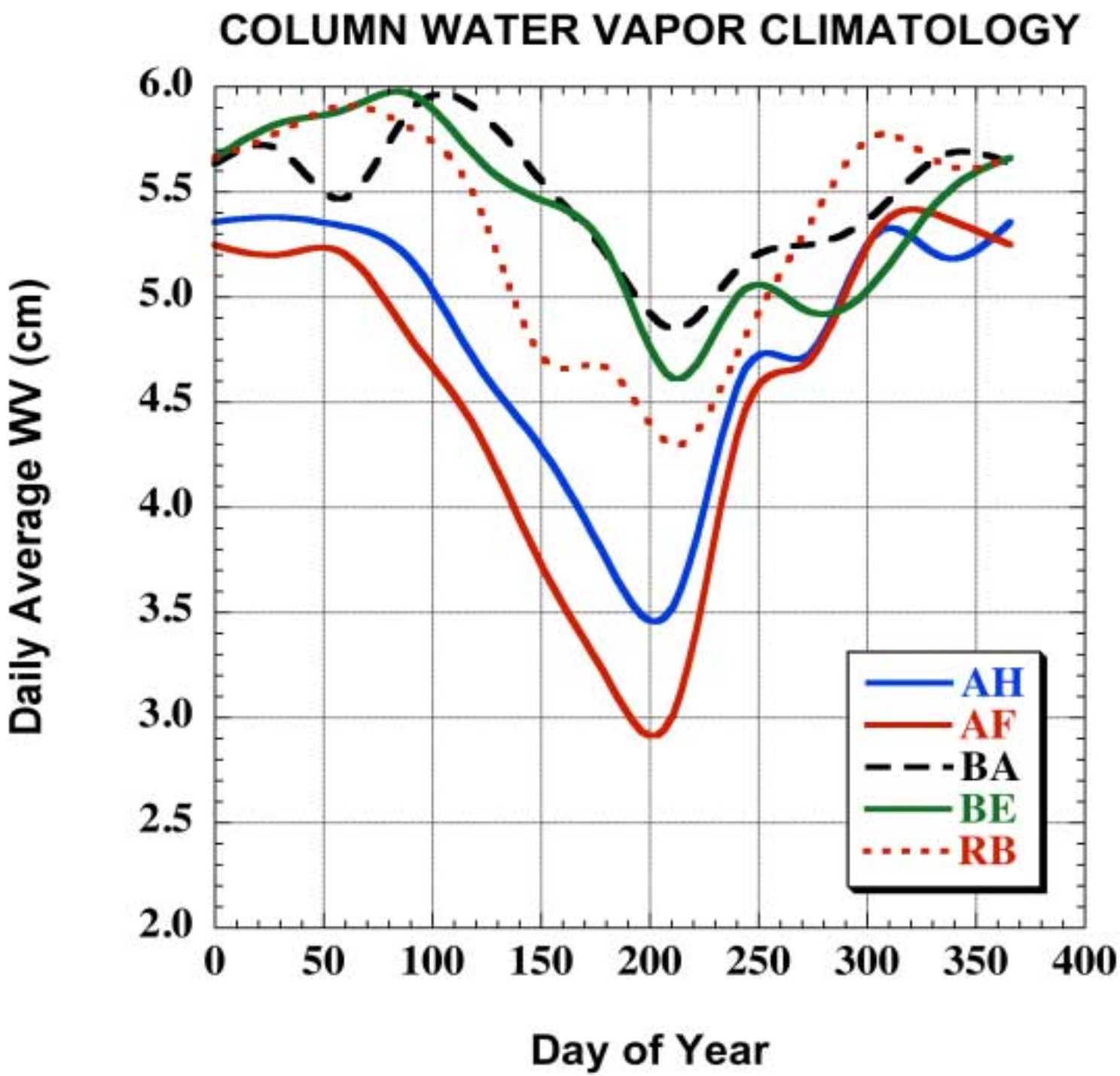


Rolim de Moura, Rondônia
September 30, 2003

Rio Branco, Acre


AOT CLIMATOLOGY (1999-2003)
Alta Floresta
Abracos Hill
Balbina
Belterra
Rio Branco
MONTH AVERAGE AOT
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month

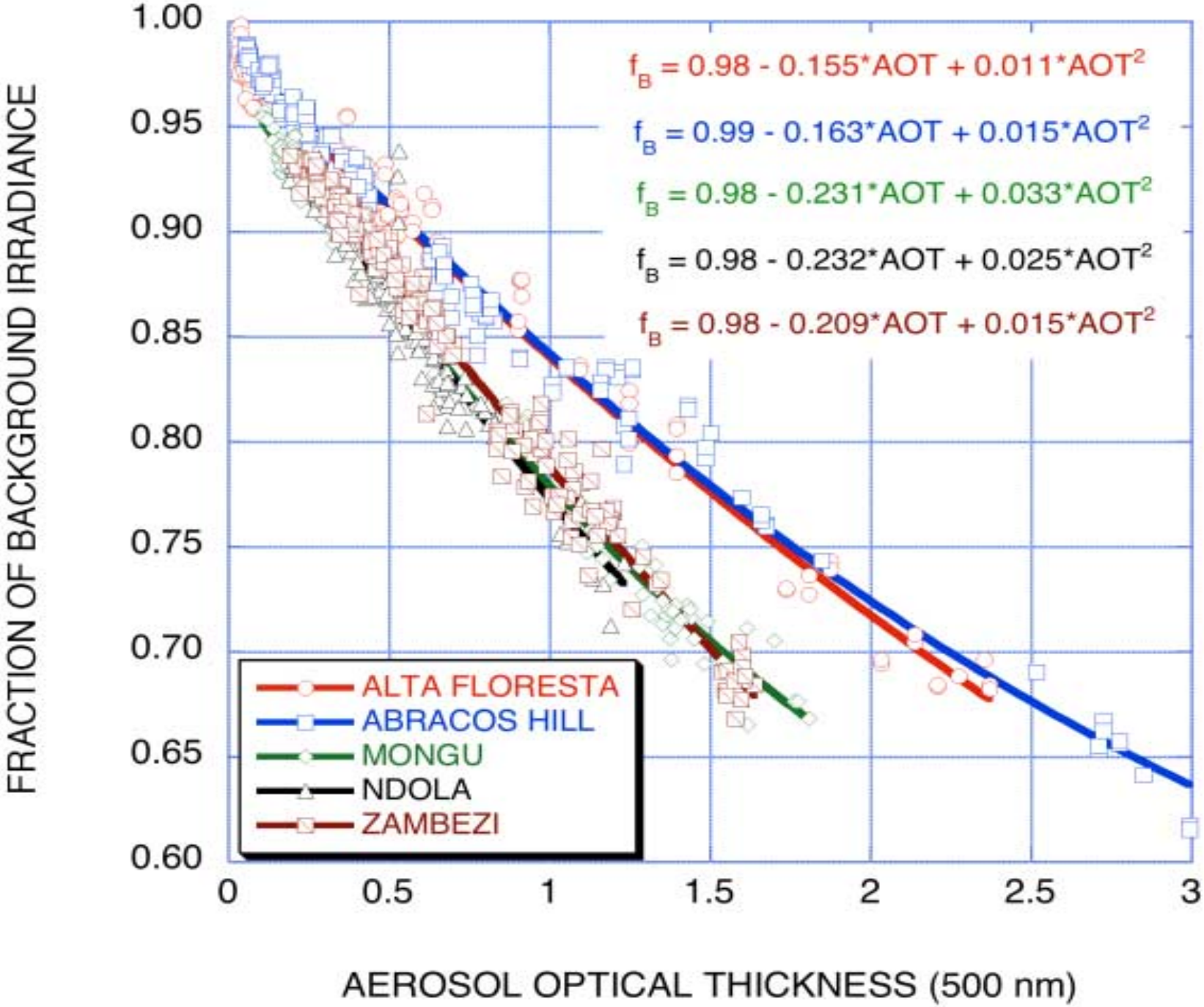

INTERANNUAL VARIABILITY (AH)
1999
2000
2001
2002
Month Average AOT
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

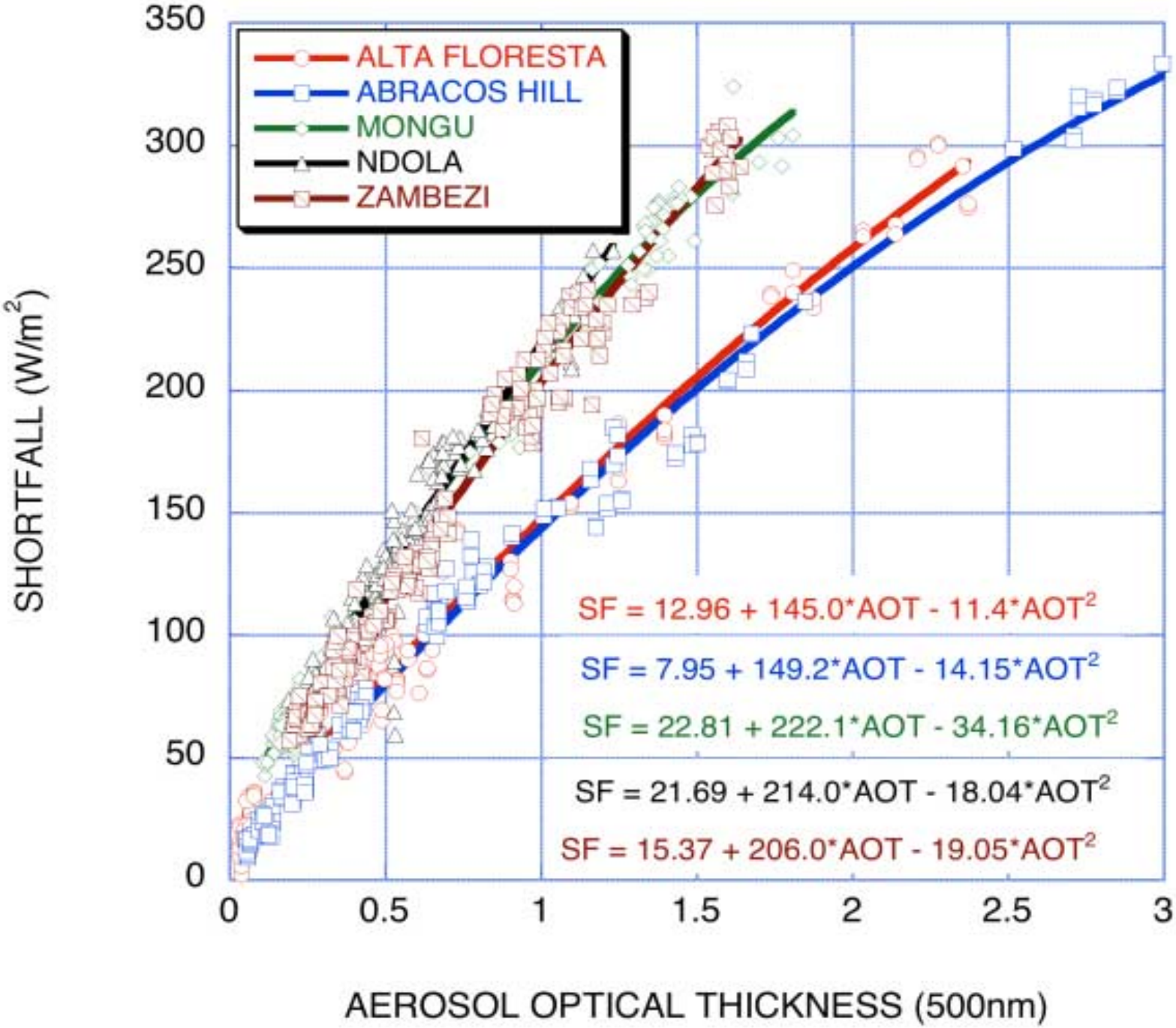

COLUMN WATER VAPOR CLIMATOLOGY
Daily Average WV (cm)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
50
100
150
200
250
300
350
400
Day of Year
AH
AF
BA
BE
RB

Fractional and absolute reductions in flux due to smoke were calculated for total broadband irradiance.

The fractional reduction was computed as the ratio of received irradiance to the modeled clear-sky irradiance for background (low) aerosol conditions.

$$f_B = \frac{Irradiance[AOTx; SSAx; WVx]}{Irradiance[AOT = 0.05; SSA = 0.97; WVx]}$$

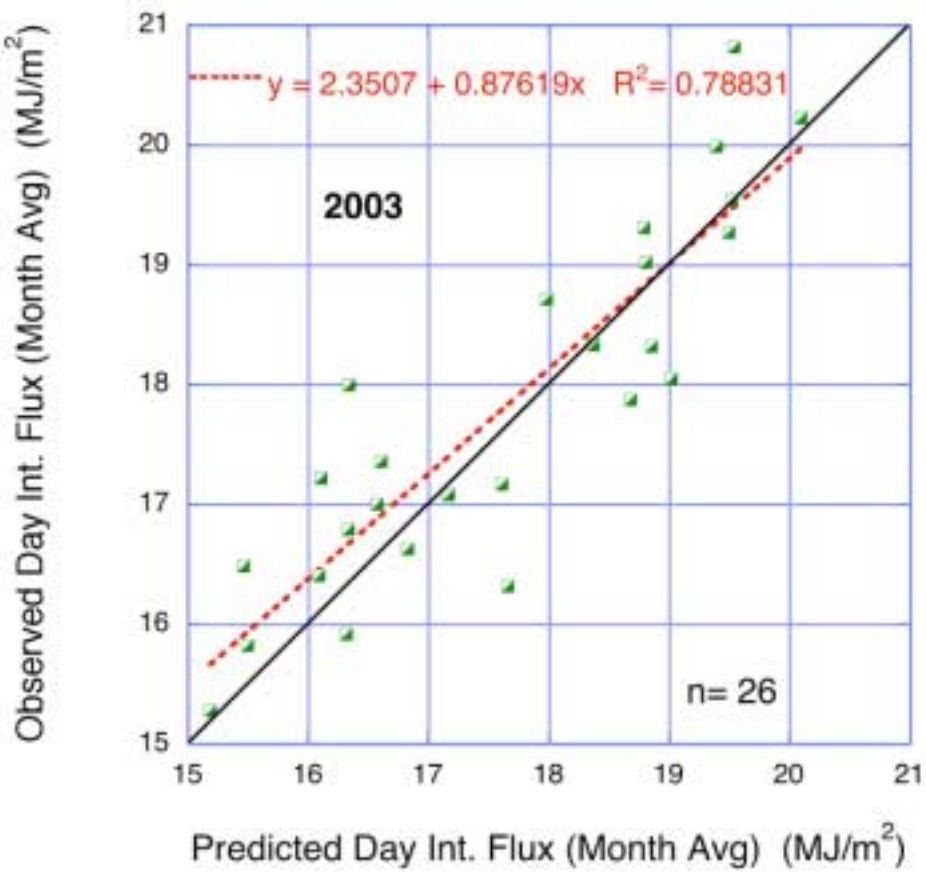

FRACTION OF BACKGROUND IRRADIANCE
AEROSOL OPTICAL THICKNESS (500 nm)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0
0.5
1
1.5
2
2.5
3
$f_B = 0.98 - 0.155*AOT + 0.011*AOT^2$
$f_B = 0.99 - 0.163*AOT + 0.015*AOT^2$
$f_B = 0.98 - 0.231*AOT + 0.033*AOT^2$
$f_B = 0.98 - 0.232*AOT + 0.025*AOT^2$
$f_B = 0.98 - 0.209*AOT + 0.015*AOT^2$
ALTA FLORESTA
ABRACOS HILL
MONGU
NDOLA
ZAMBEZI

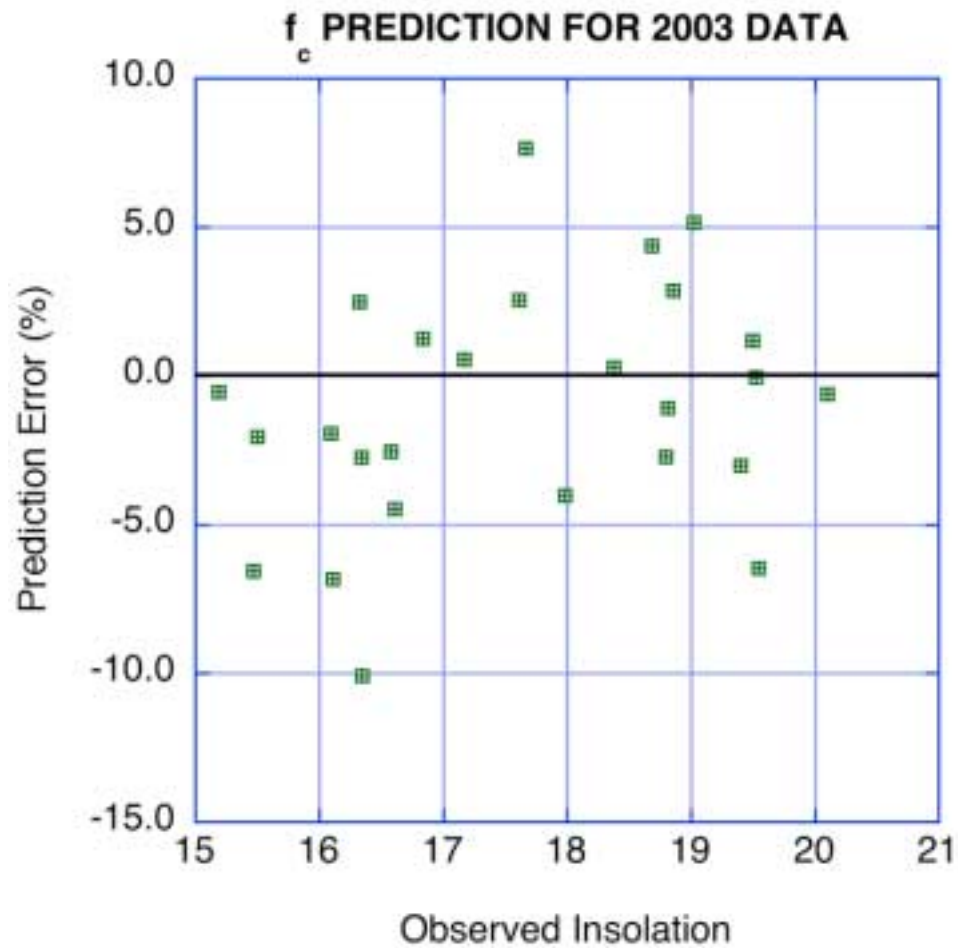

ALTA FLORESTA
ABRACOS HILL
MONGU
NDOLA
ZAMBEZI
SF = 12.96 + 145.0*AOT - 11.4*AOT2
SF = 7.95 + 149.2*AOT - 14.15*AOT2
SF = 22.81 + 222.1*AOT - 34.16*AOT2
SF = 21.69 + 214.0*AOT - 18.04*AOT2
SF = 15.37 + 206.0*AOT - 19.05*AOT2
SHORTFALL (W/m2)
AEROSOL OPTICAL THICKNESS (500nm)
0
50
100
150
200
250
300
350
0
0.5
1
1.5
2
2.5
3

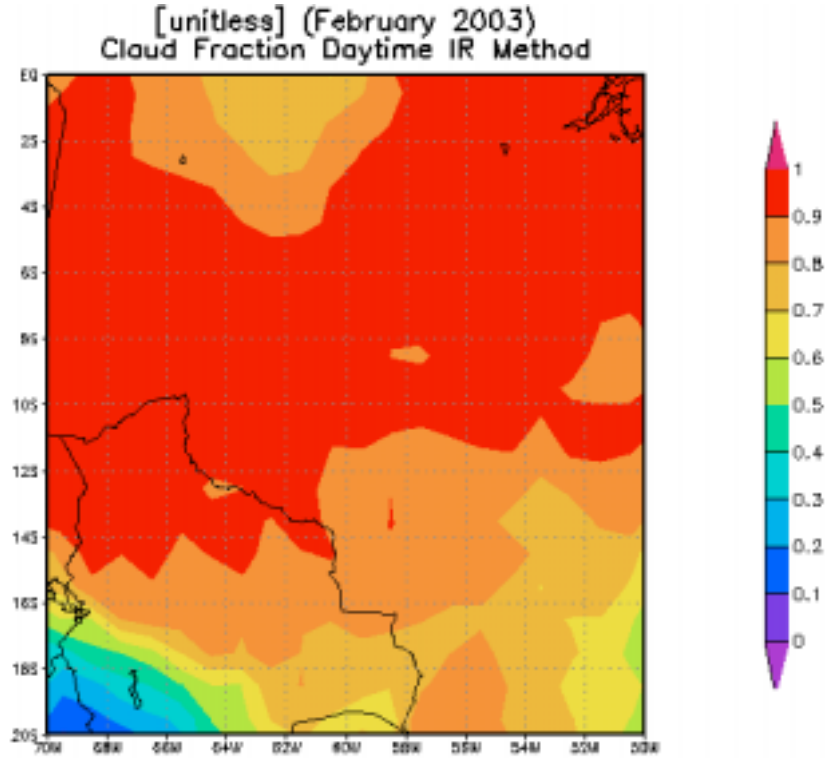
Estimated Cloud Transmission Maps

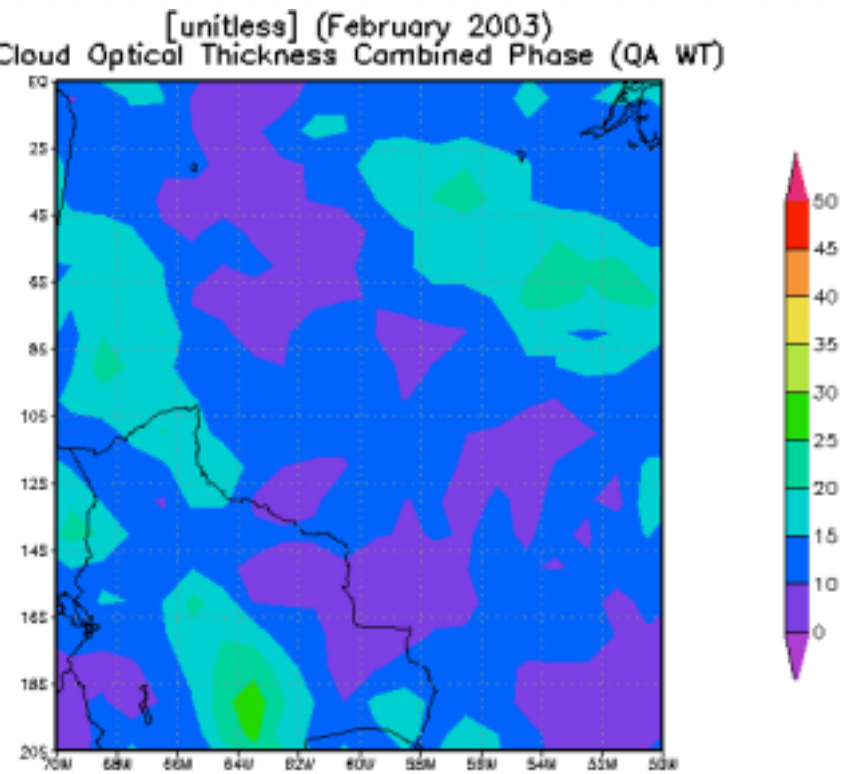
- Reductions by clouds are strongly correlated with satellite cloud products (cloud optical thickness and daytime cloud fraction from MODIS)
- Relationship based on data from 2000-2002 could predict f_C at all sites for the 2003 observations using only MODIS parameters

Adequate prediction for low to moderate AOT
Max error: 10%; rms error 0.7 MJ m^{-2} (~4%)

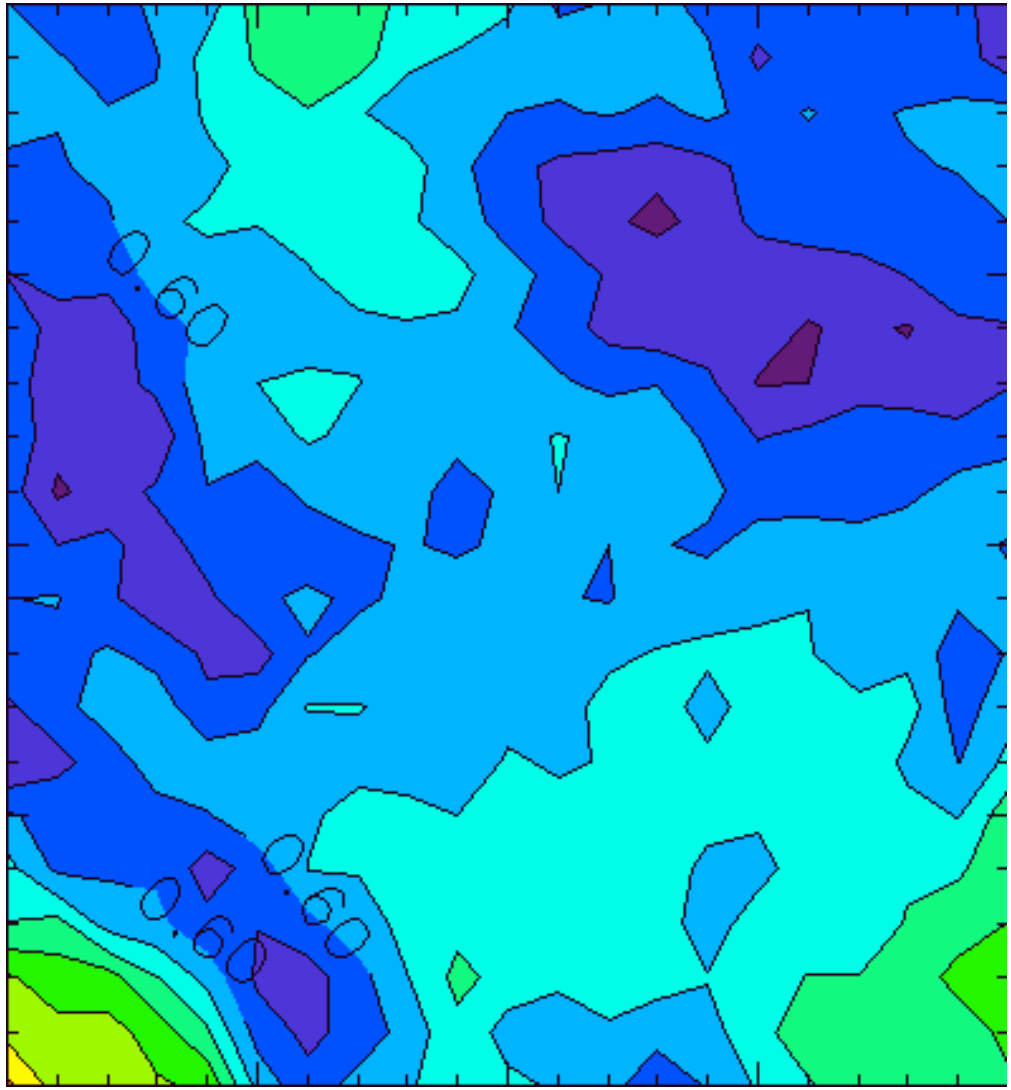


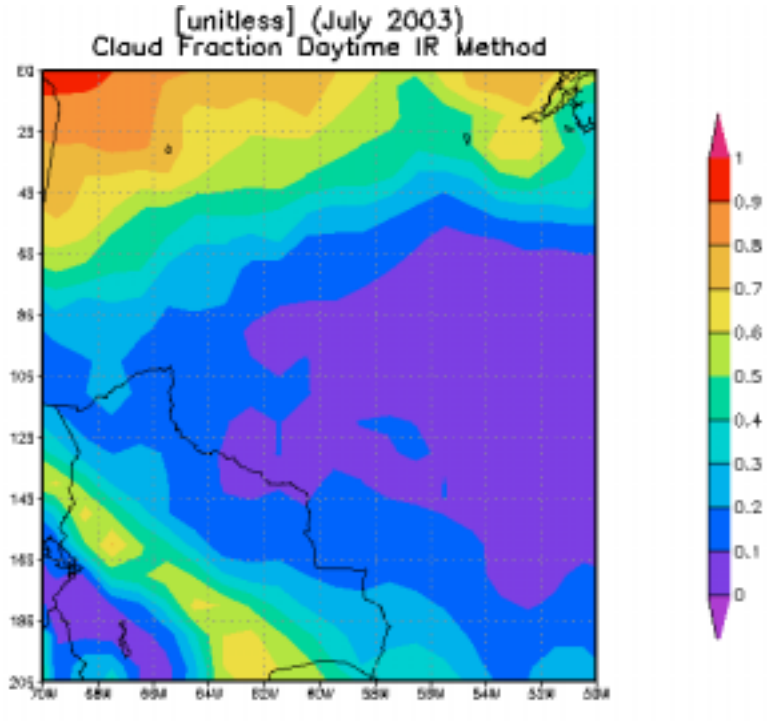


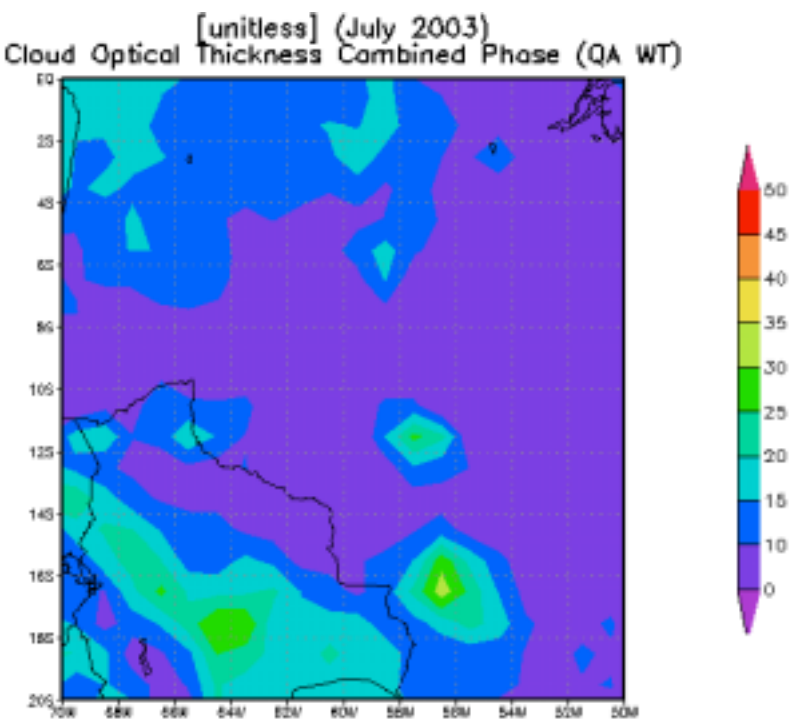




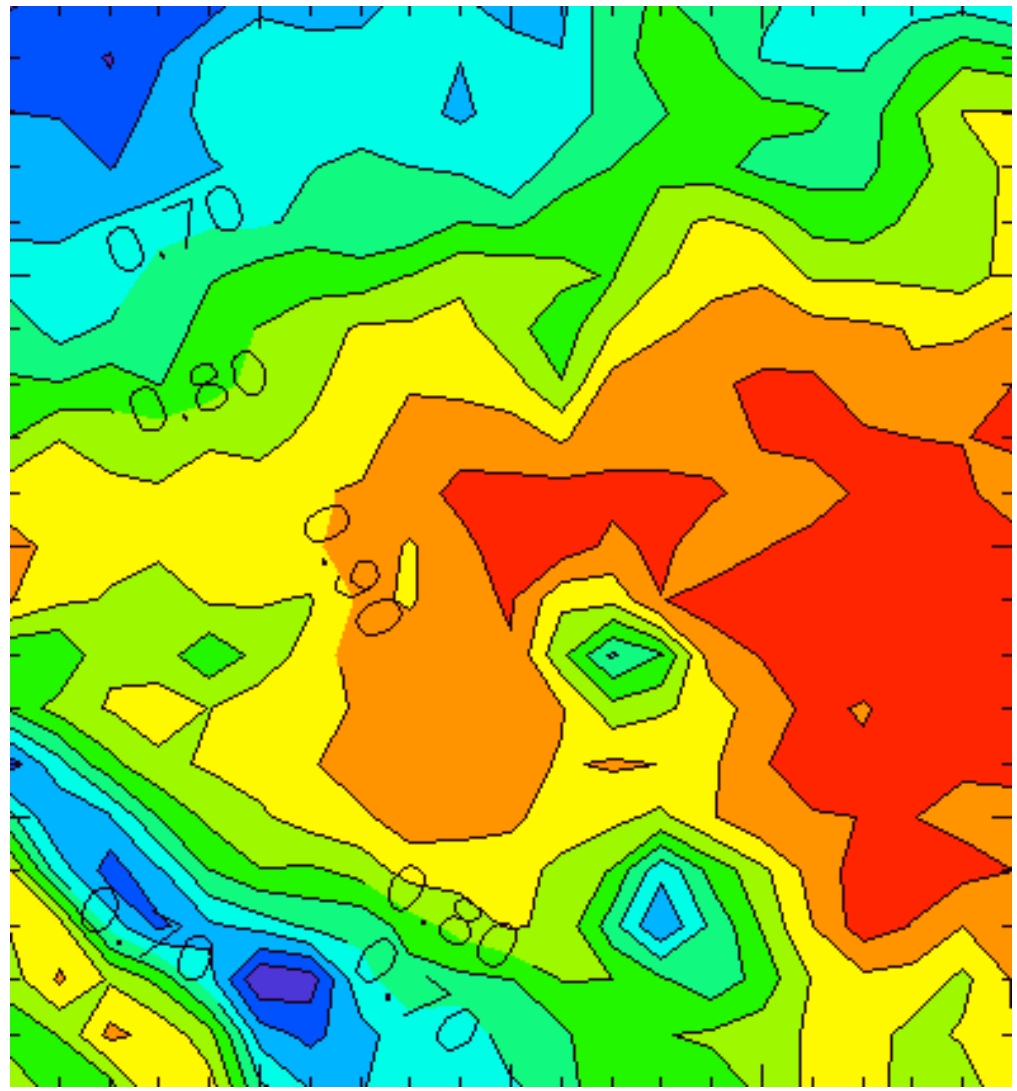
Predicted f_c map over LBA study region (Feb. 2003)







Predicted f_c map over LBA study region (Jul. 2003)



Ongoing Issues

Import/Export

- ☹ 2-3 month delay (cals are time sensitive)
- ☹ Extremely $$ relative to other countries

Future LBA Plans

- Aerosol climatology paper
- Flux tool (calibration and data access)
- PAR flux final calibration

Climatology of Aerosol Optical Properties in Amazonia

- We plan to analyze multi-year data sets from 1993-2004 at southern Amazonian sites and from 1999-2004 at northern sites
- Aerosol optical depth inter-annual variability will be investigated in relation to GOES satellite fire counts, seasonal

Climatology of Aerosol Optical Properties in Amazonia, cont.

- Regional (N. versus S. Amazon) differences in aerosol composition will be investigated by analysis of Angstrom exponents and retrievals of size distributions and SSA
- Analysis of diurnal trends in aerosol optical depth especially in the burning season, for various sites, and as a function of AOD

Flux Data Base Tool

- Interactive in-situ calibration (PAR)
- Descriptive flagging of quality issues
- Analysis/diagnostic tools (derived products)
- Web-based simple interface for public users to view and download Level 2.0 flux data