Smoke Radiative Forcings over South America and Africa in 1998

R.M. Welch, X. Li, S.A. Christopher

Department of Atmospheric Science
University of Alabama in Huntsville
Huntsville, AL 35806

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Objective

. Analyze biomass burning season over Africa and South America in 1998 using measurements from TRMM platform

. Estimate smoke radiative forcings both at TOA and at surface

Satellite Data

. Level 1B VIRS, 08/98

. CERES ES8 product, 08/98

Study Areas

South America:
30S – 0, 70W – 40W

Africa:
30S – 5S, 10E – 40E

Methodology

. Identify smoke pixels from VIRS images using spectral multi−thresholding technique

. Using τ from sunphotometers, ω_0 values of smoke are retrieved from AVHRR during SCAR−B. The results are in good agreement with those from aircraft and ground−based measurements. ω_0 values range 0.83−0.92

. Assuming ω_0 of 0.89, τ is retrieved from VIRS for smoke

. A smoke ADM is constructed using discrete−ordinate model. The RMS error between SW fluxes from CERES ES−8 product and those converted from CERES radiances using smoke ADM is about 12 W/m^2

- **Calculate TOA SW fluxes for smoke from CERES radiances using smoke ADM. Estimate TOA smoke radiative forcing**

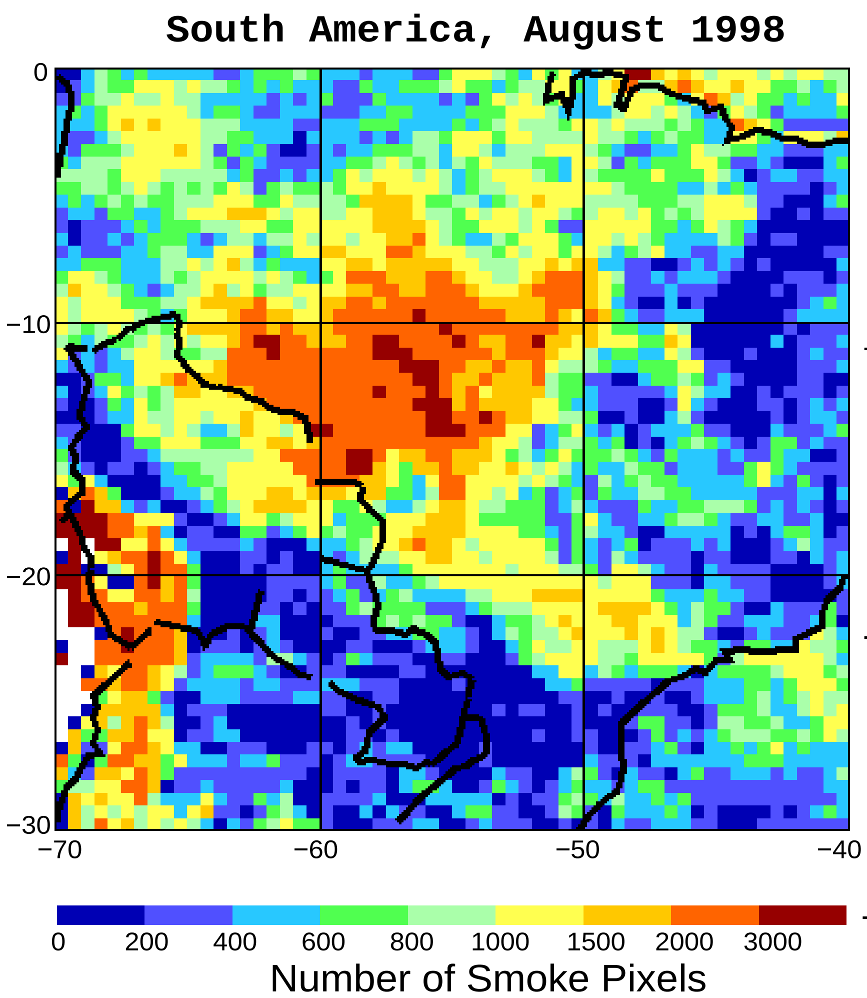
- **Modified Fu−Liou model for smoke aerosols. Calculate SFC downward SW flux over smoke using measured τ and ω_0. Compared to pyranometer measurements; the RMS errors are within 30 W/m^2**

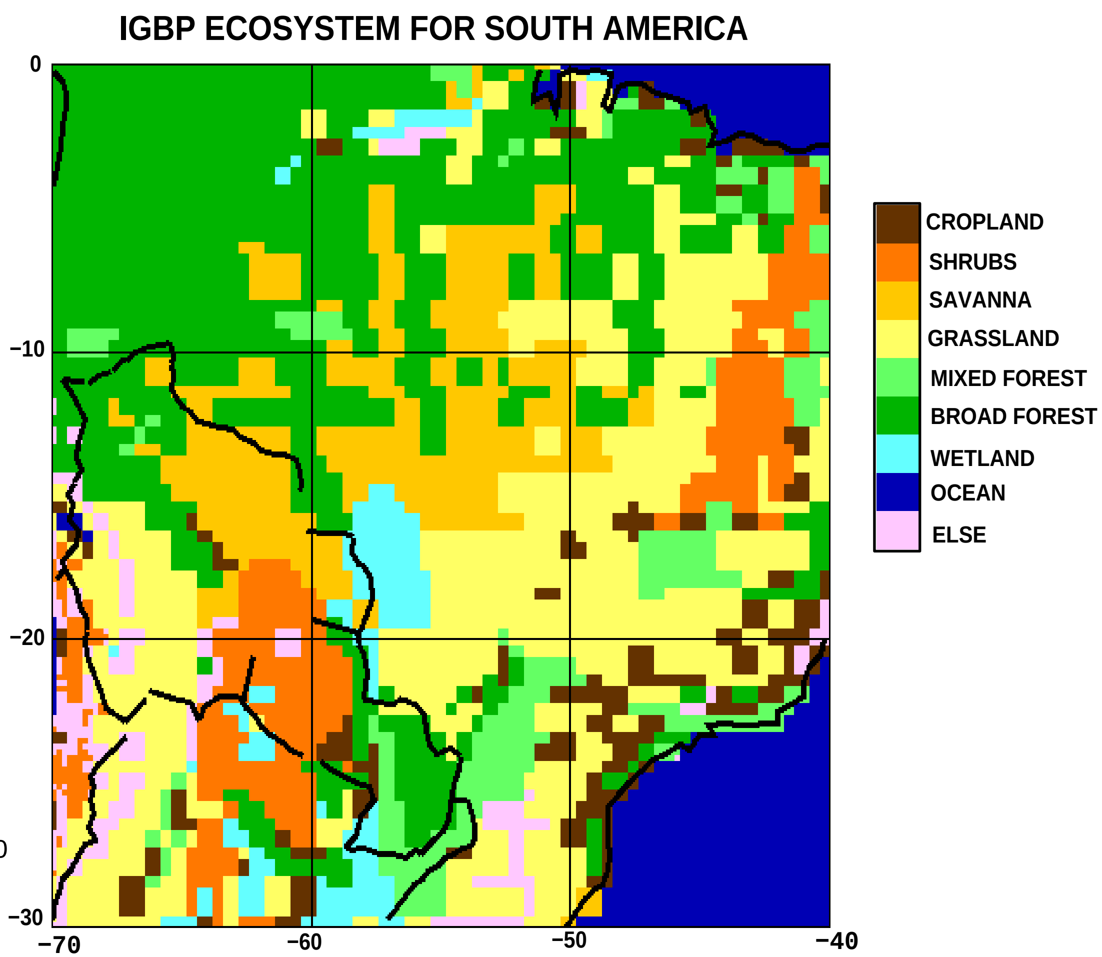
- **Using Fu−Liou model, calculate SFC and TOA SW fluxes with ω_0 and retrieved τ**

- **Calculate surface downward and TOA smoke radiative forcing**

- **Assuming τ constant, calculate daily−mean smoke forcings at TOA and at surface**

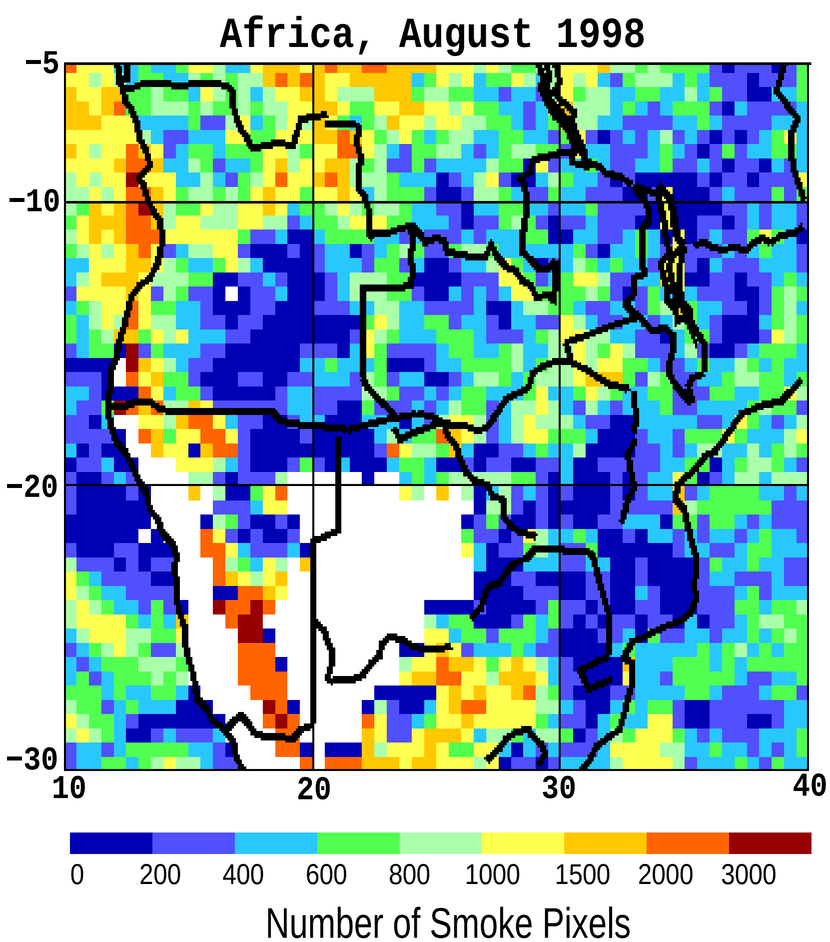
South America

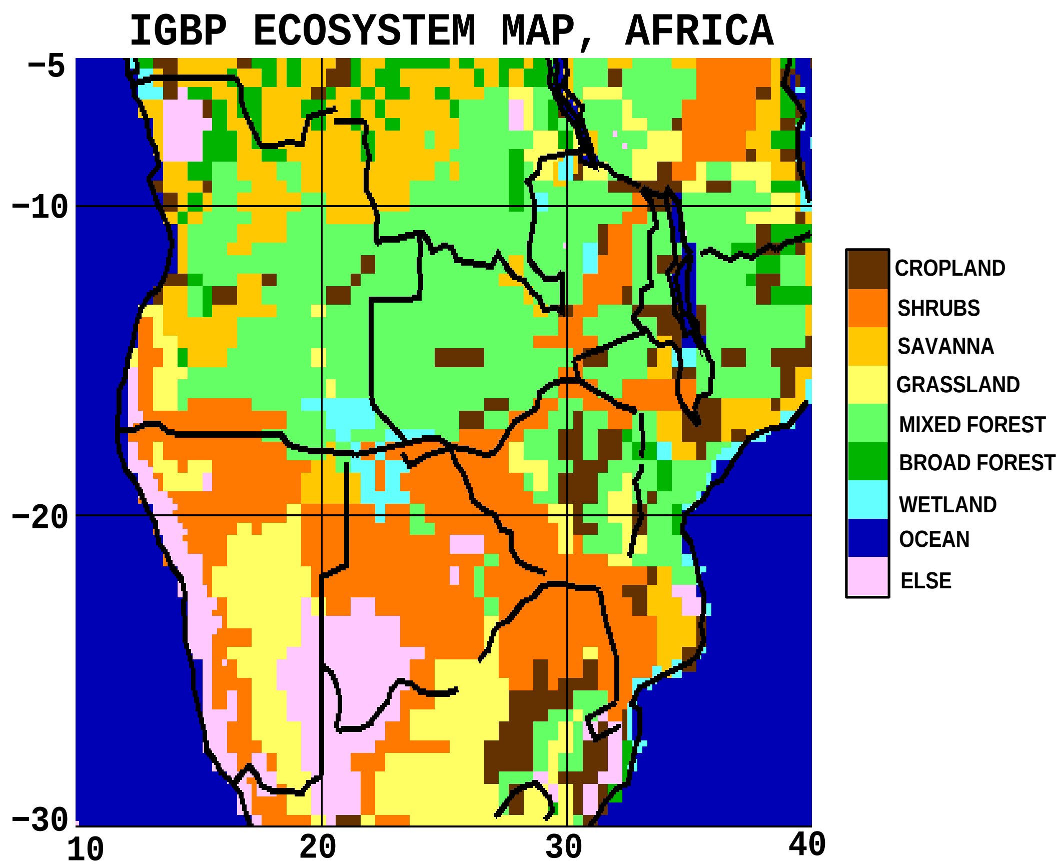




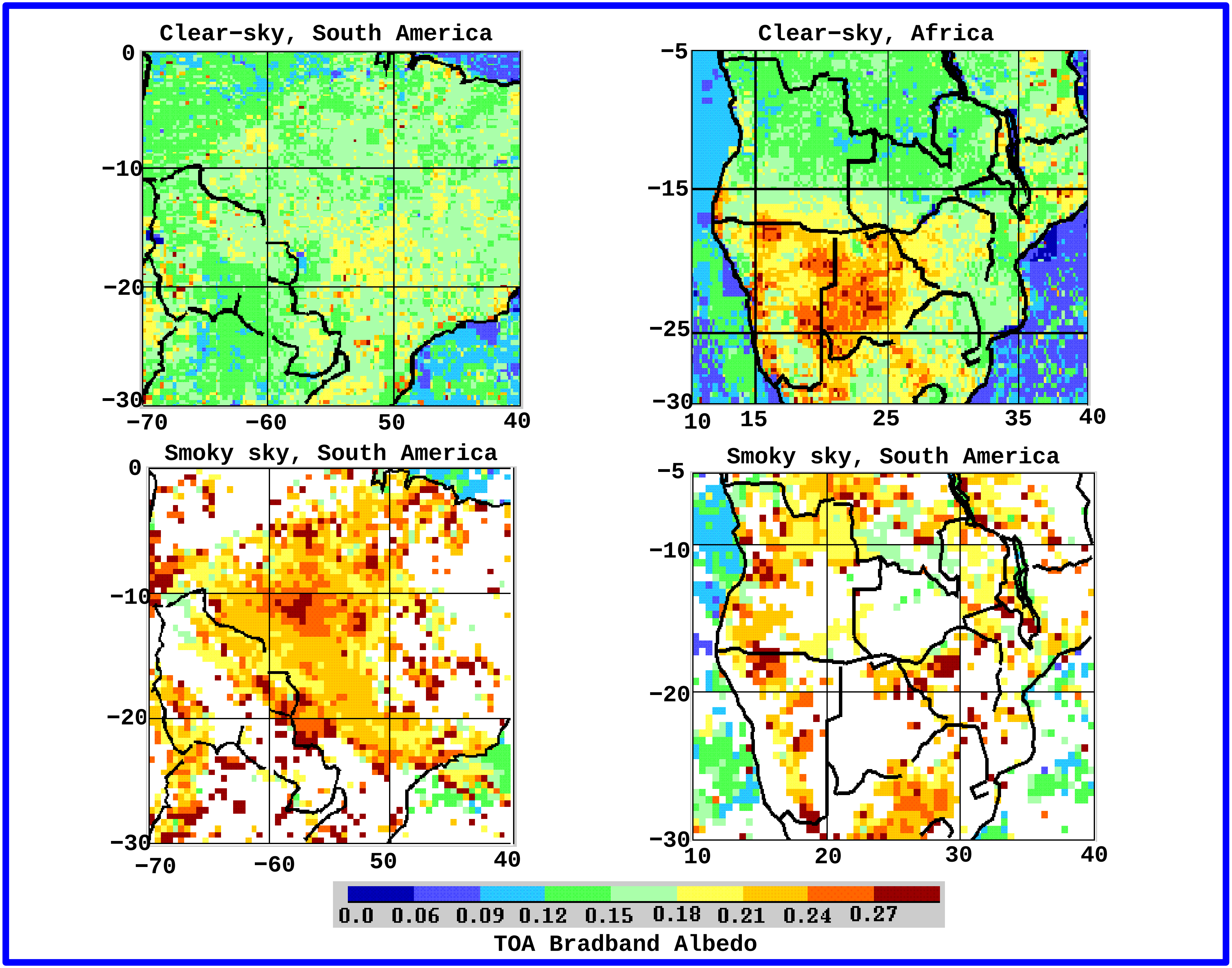
Major ecosystems where smoke prevails:
Forest, Savanna, Grassland

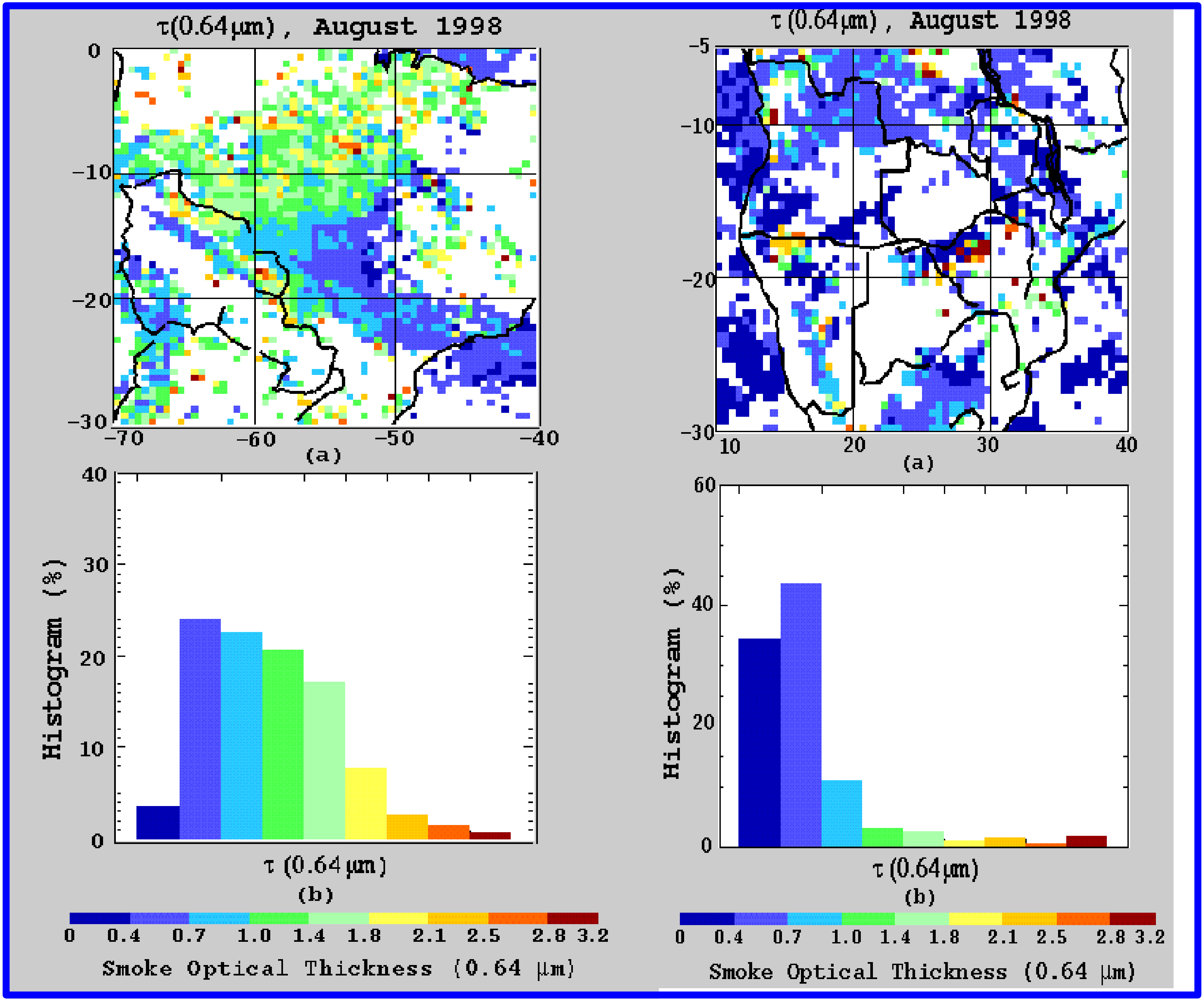
Africa





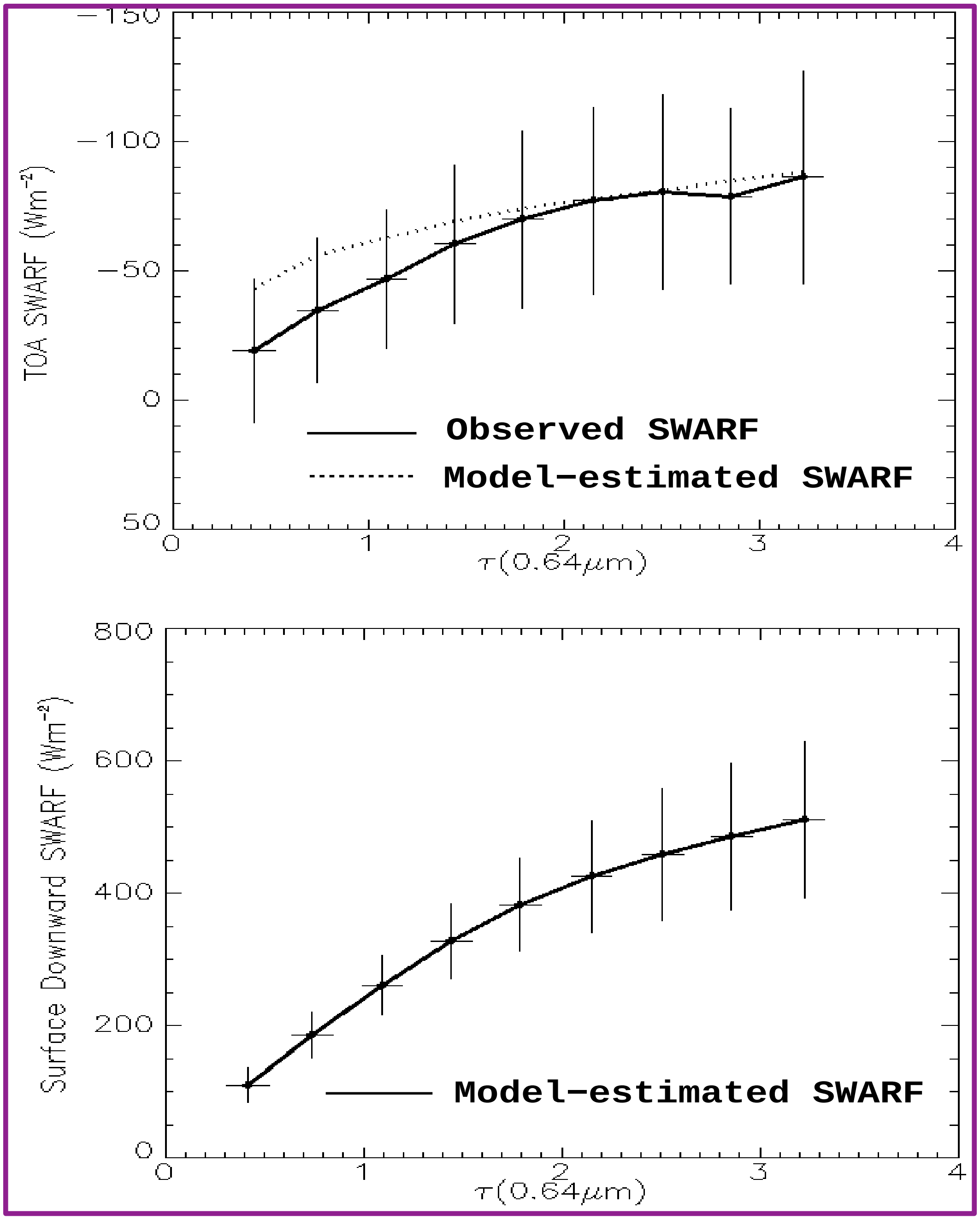
Major ecosystems where smoke prevails: Grassland, Savanna, and Forest


Clear-sky, South America
Clear-sky, Africa
Smoky sky, South America
Smoky sky, South America
0
-10
-20
-30
-70
-60
50
40
-5
-15
-25
-30
10
15
25
35
40
0
-10
-20
-30
-70
-60
50
40
-5
-10
-20
-30
10
20
30
40
0.0 0.06 0.09 0.12 0.15 0.18 0.21 0.24 0.27
TOA Bradband Albedo



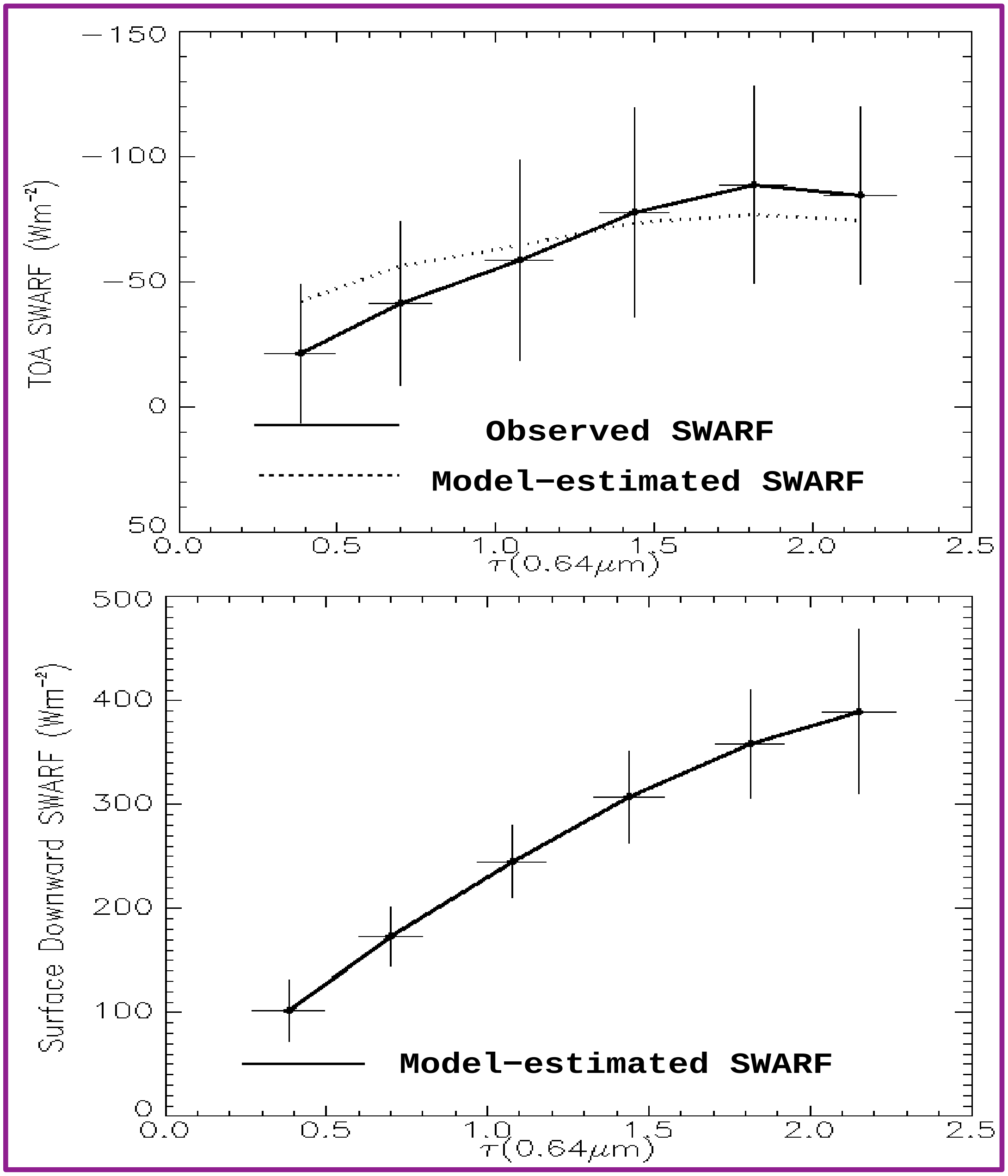
τ(0.64μm), August 1998
(a)
Histogram (%)
τ (0.64 μm)
(b)
0 0.4 0.7 1.0 1.4 1.8 2.1 2.5 2.8 3.2
Smoke Optical Thickness (0.64 μm)
τ (0.64μm), August 1998
(a)
Histogram (%)
τ (0.64μm)
(b)
0 0.4 0.7 1.0 1.4 1.8 2.1 2.5 2.8 3.2
Smoke Optical Thickness (0.64 μm)

Instantaneous Shortwave Aerosol Radiative Forcing(SWARF)as a function of τ over South America



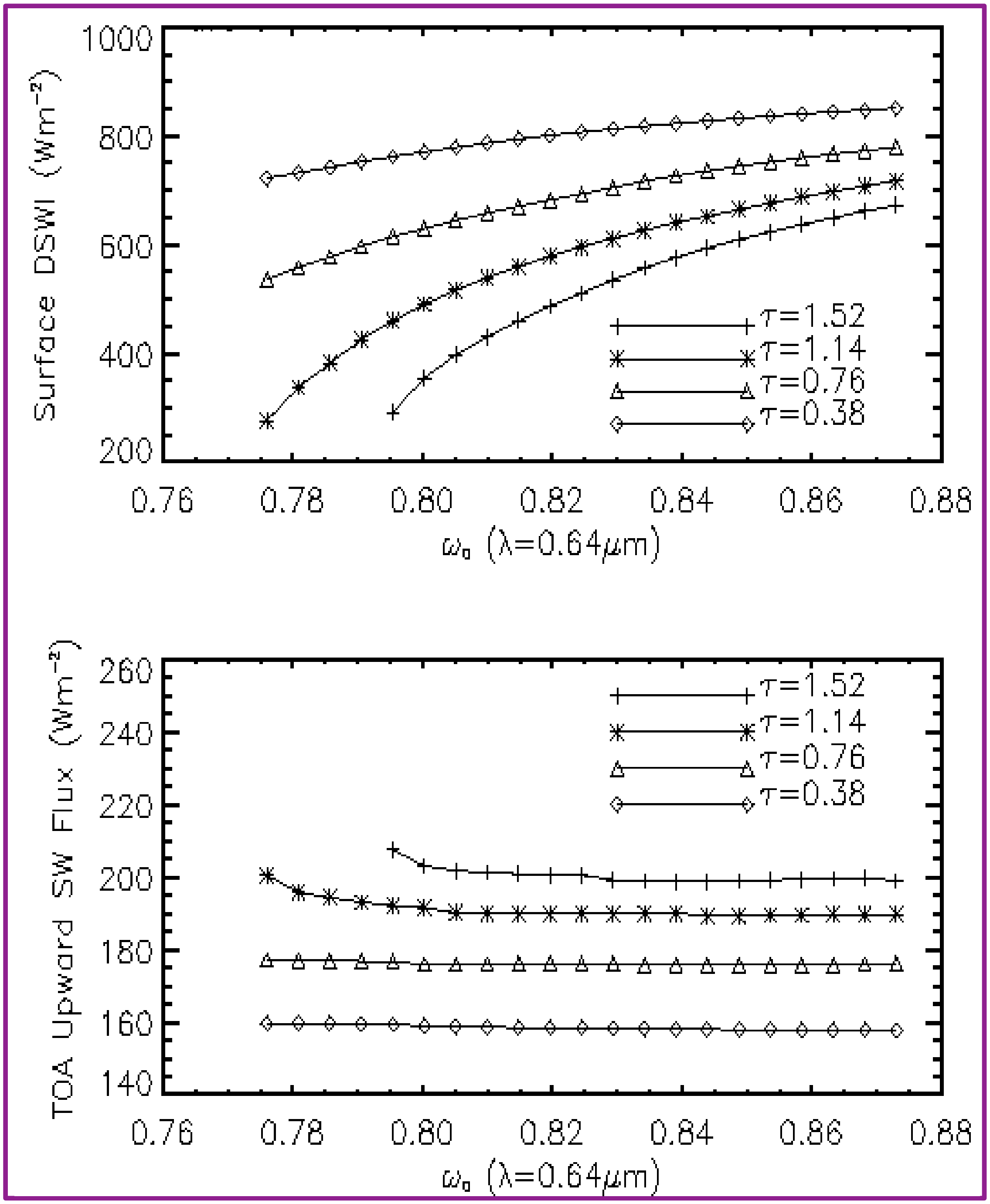
τ(0.64 μm) : 0.4 − 1.8
TOA SWARF : −19 − −70 Wm−2
TOA SWARF / τ : −36.4 Wm−2
SFC downward SWARF: 110 − 380 Wm−2
SFC downward SWARF/τ: 190 Wm−2

Instantaneous Shortwave Aerosol Radiative Forcing(SWARF)as a function of τ over Africa



τ(0.64 μm) : 0.4 – 1.8
TOA SWARF : −20 – −90 Wm−2
TOA SWARF/τ : −50 Wm−2
SFC downward SWARF: 100 – 360 Wm−2
SFC downward SWARF/τ: 186 Wm−2

Sensitivity



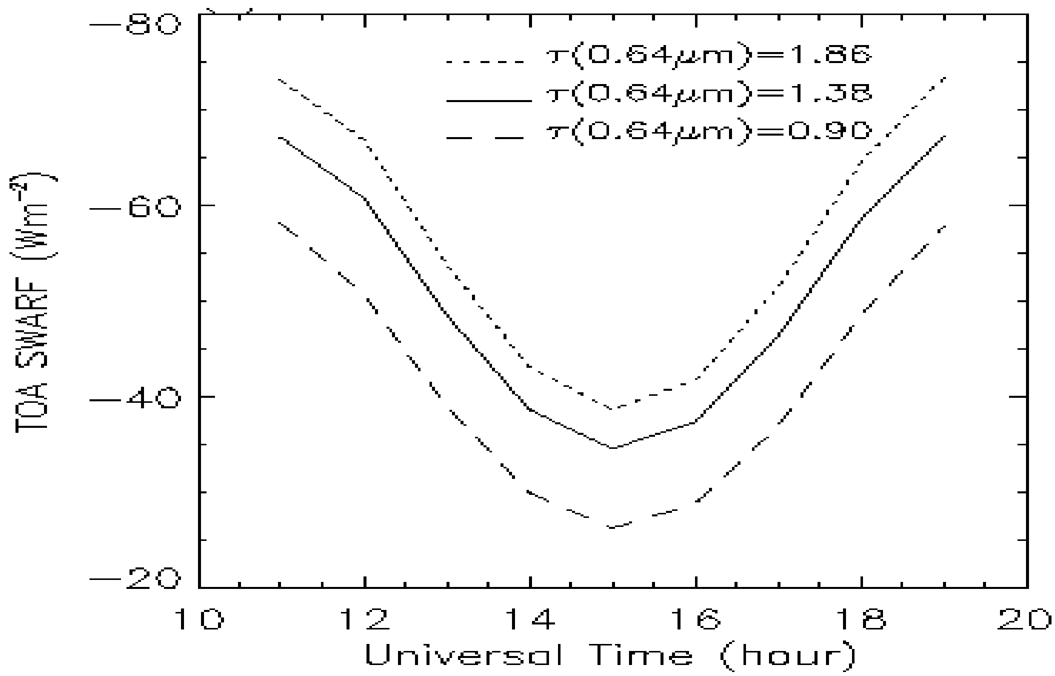
ω=0.825, τ=0.78,
F_{toa}=176 W/m2, F_{sfc_dn} =693 W/m2

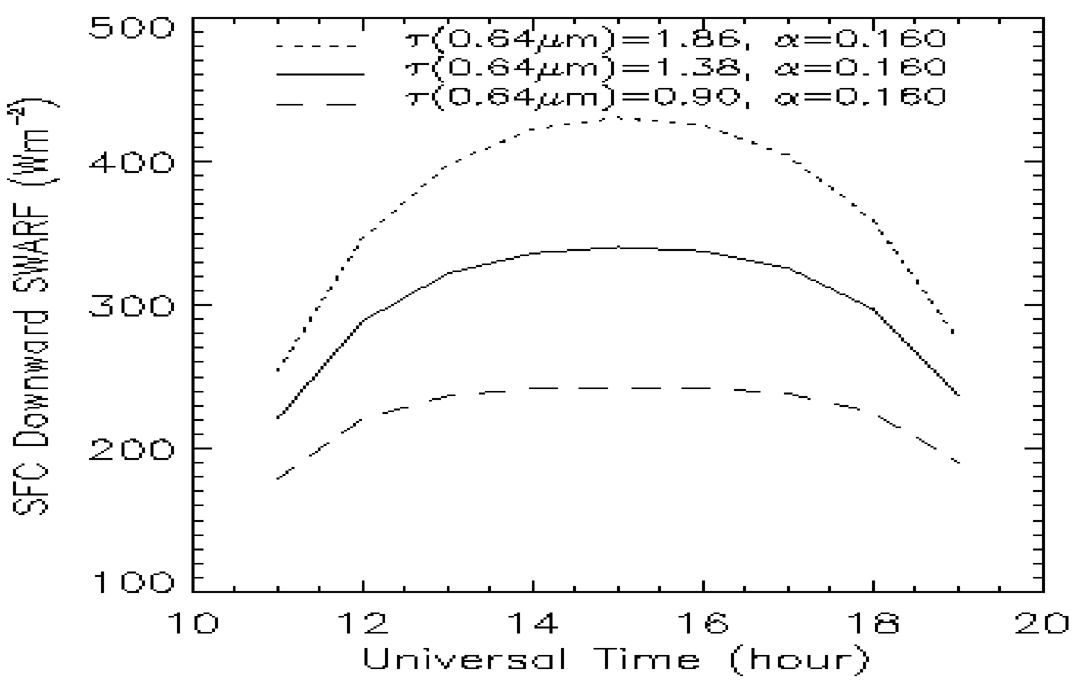
ω increases to 0.854, τ decreases to 0.60
F_{toa}=176 W/m2, F_{sfc_dn} =752 W/m2

ω decreases to 0.795, τ increases to 1.06
F_{toa}=177 W/m2, F_{sfc_dn} =615 W/m2

Diurnal variation of TOA and SFC downward SWARFs

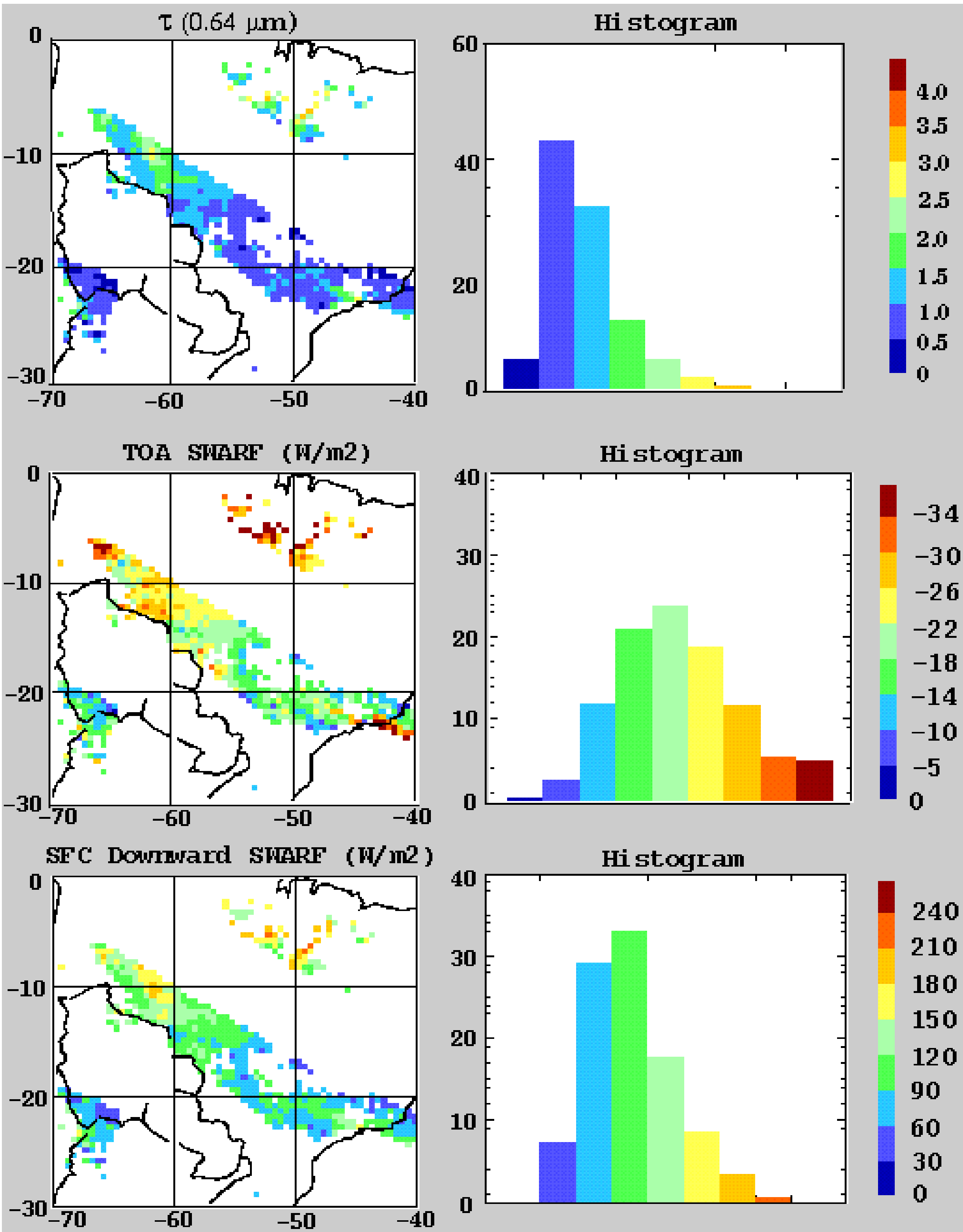
(Assuming constant τ during a day)



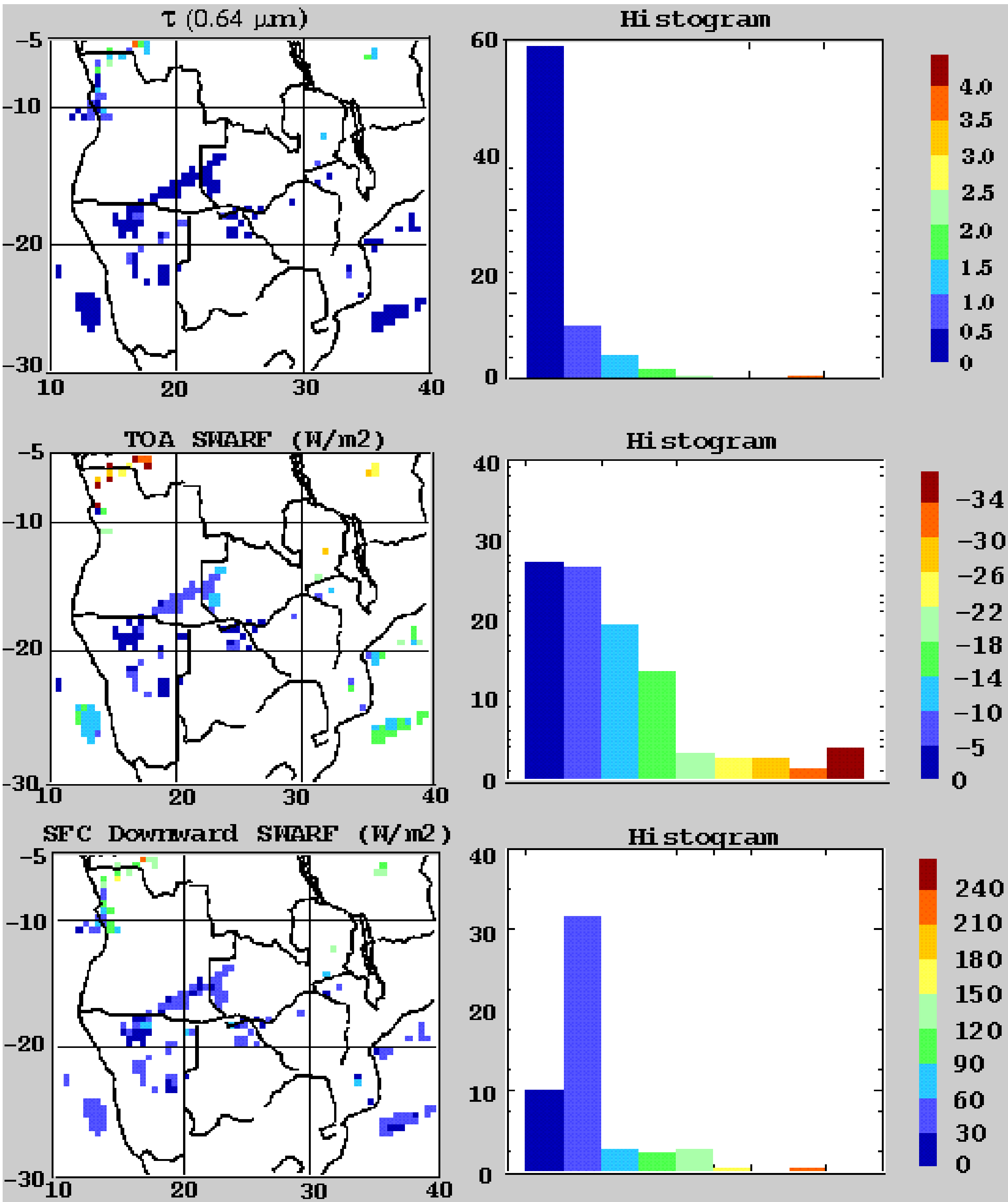


τ=1.38, TOA SWARF: −19.1, SFC SWARF: 112.7
τ=1.86, TOA SWARF: −21.1, SFC SWARF: 138.2
τ=0.90, TOA SWARF: −15.7, SFC SWARF: 84.0

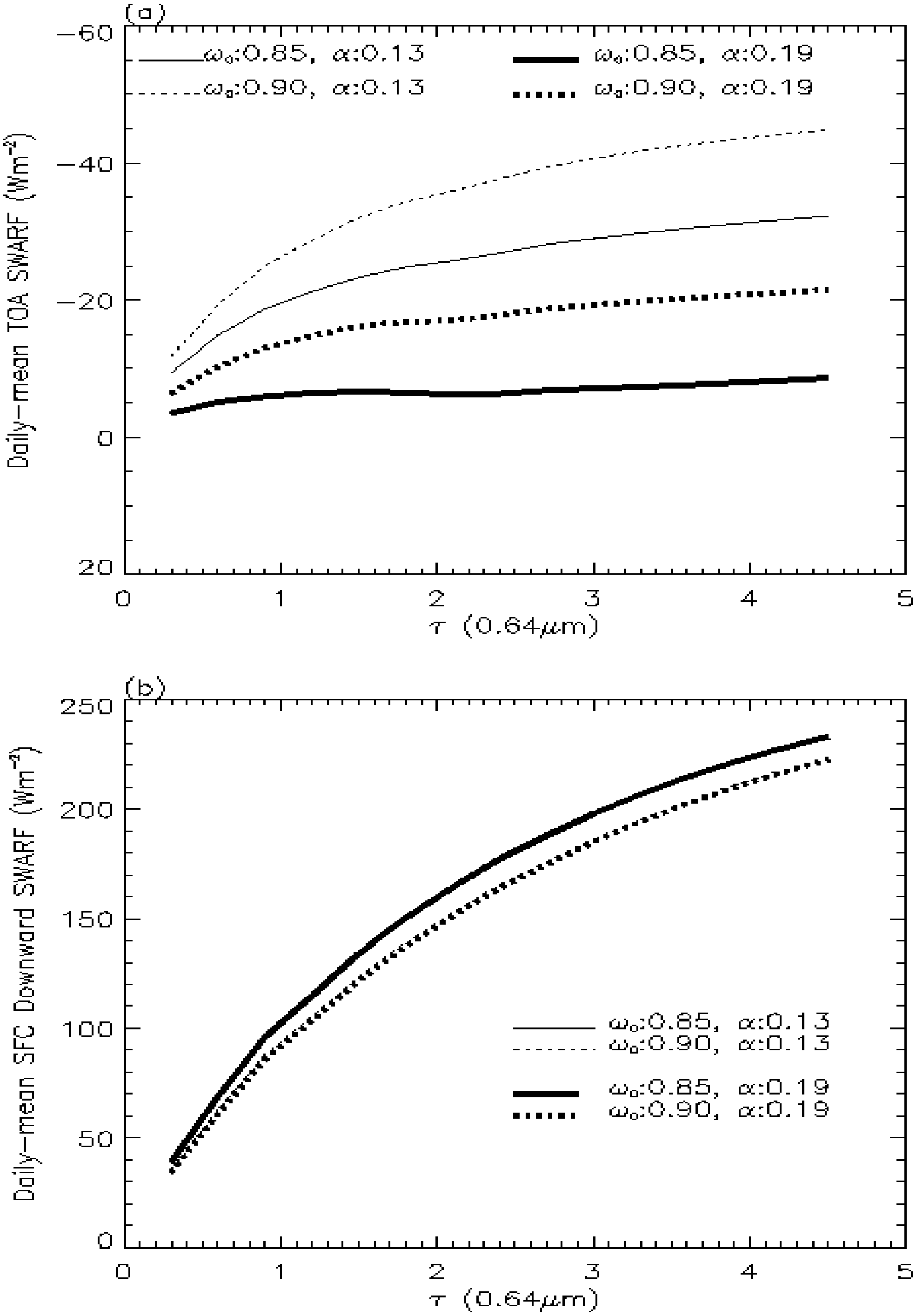
Retrieved τ, daily-mean TOA SWARFs and surface downward SWARF over South America on 08/29



Retrieved τ, daily-mean TOA SWARFs and surface downward SWARF over Africa on 08/10



Daily-mean TOA SWARF and SFC downward SWARF versus τ



- TOA SWARFs increase with increasing τ and ω_0 and with decreasing surface albedo
- SFC downward SWARFs increase with increasing τ and with decreasing ω_0

Summary

. Biomass burning is more intense over South America than over Africa

. Instantaneous TOA SWARF/τ (Wm−2):
South America: −36.4, Africa: −50.0.

Instantaneous SFC downward SWARF/τ:
South America: 190, Africa: 186

. daily−mean SWARFs (Wm−2):
τ = 0.75, TOA SWARF: −13.3
SFC downward SWARF: 71.7
τ = 1.00, TOA SWARF: −15.5
SFC downward SWARF: 88.0

- **On 08/29 over South America,**
  τ ranges: 0.5 – 2.0
  daily–mean TOA SWARF: –10 – –30 W/m2
  daily–mean SFC downward SWARF:
  60 – 180 W/m2

- **In this procedure, SFC SWARF is sensitive to the accuracy of assumed single scattering albedo values.**