- RETRIEVAL OF PIGMENT CONCENTRATION WITHOUT EXPLICIT ATMOSPAERIC CORRECTION
- ESTIMATION OF SPECTRAL SOLAR FLUX, PLANAR ABOVE SURFACE AND SPHERICAL BELOW SURFACE

Retrieval of pigment concentration without explicit atmospheric correction

1. TOA reflectance

$$R = R_{atm} + R_w T_{atm} = R_{aer} + R_{mol} + R_w T_{aer} T_{mol}$$

$$R' = (R - R_{mol})/T_{mol} = R_{aer}/T_{mol} - R_w T_{aer} = R'_{aer} + R_w T_{aer}$$

2. Linear combination of reflectance

$$\Sigma_i\, [a_i R'_i] = \Sigma_i\, [a_i R'_{aeri}] + \Sigma_i\, [a_i R_{wi} T_{aeri}]$$

3. Modeling perturbing effects

$$R'_{aeri} = \Sigma_j\, [b_j \lambda_i^{nj}]$$

$$\Sigma_i\, [a_i R'_i] = \Sigma_i\, \{a_i \Sigma_j\, [b_j \lambda_i^{nj}]\} + \Sigma_i\, [a_i R_{wi} T_{aeri}]$$

4. Eliminating perturbing effects

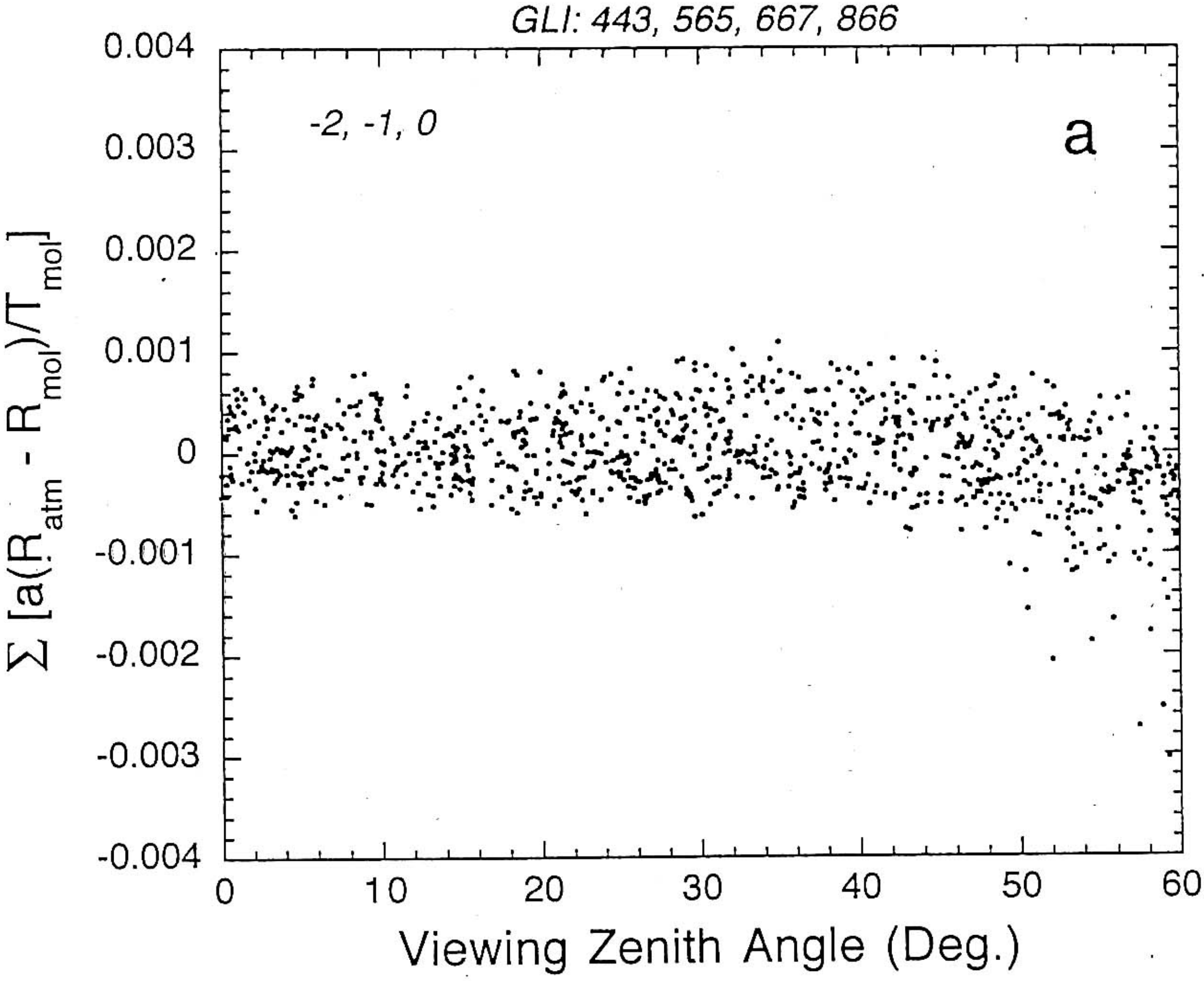
For $\Sigma_i\, \{a_i \Sigma_j\, [b_j \lambda_i^{nj}]\} = 0$, sufficient to have $\Sigma_i\, [a_i \lambda_i^{nj}] = 0$

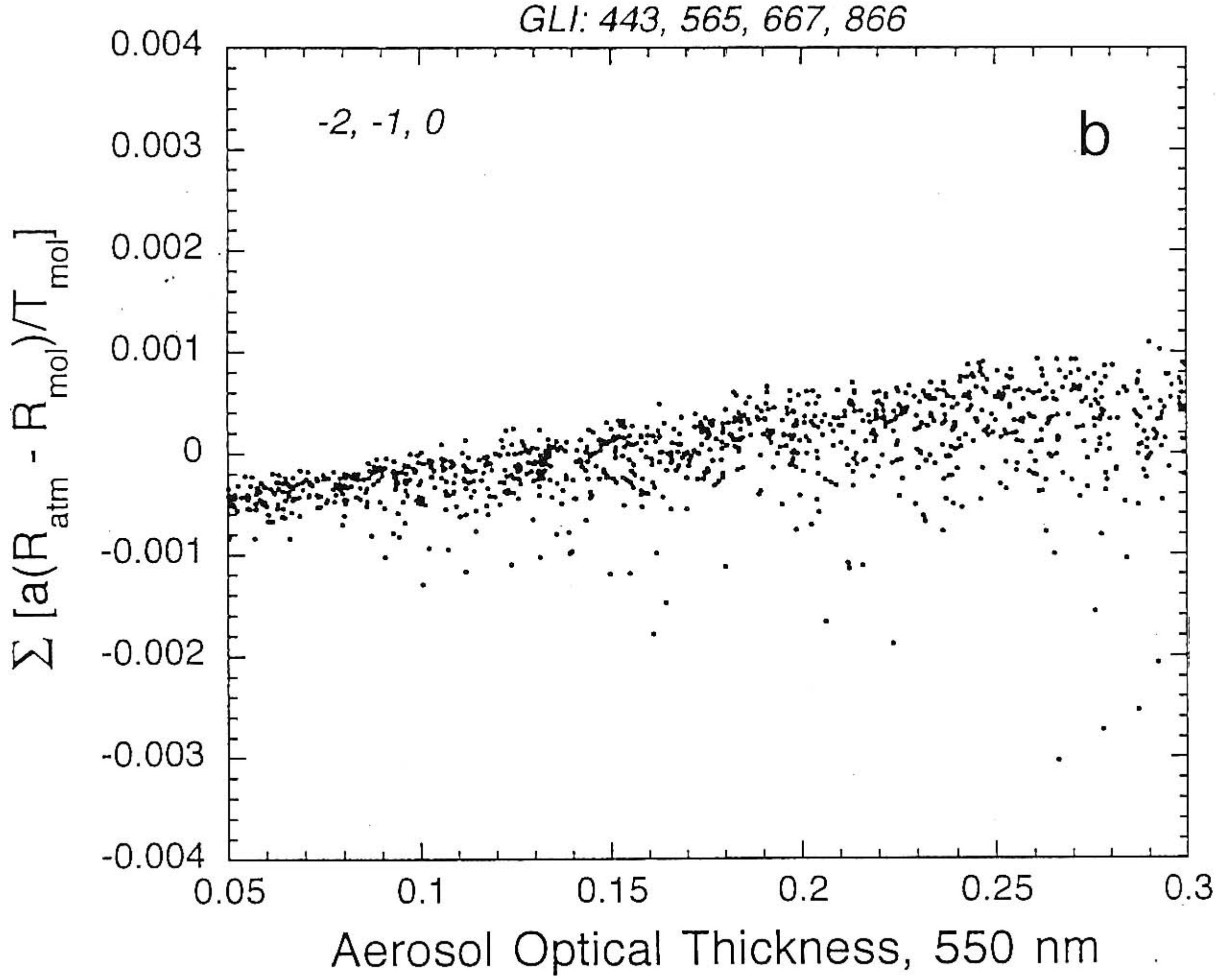
5. Application

λ_i (nm): *443, 565, 667, 866*

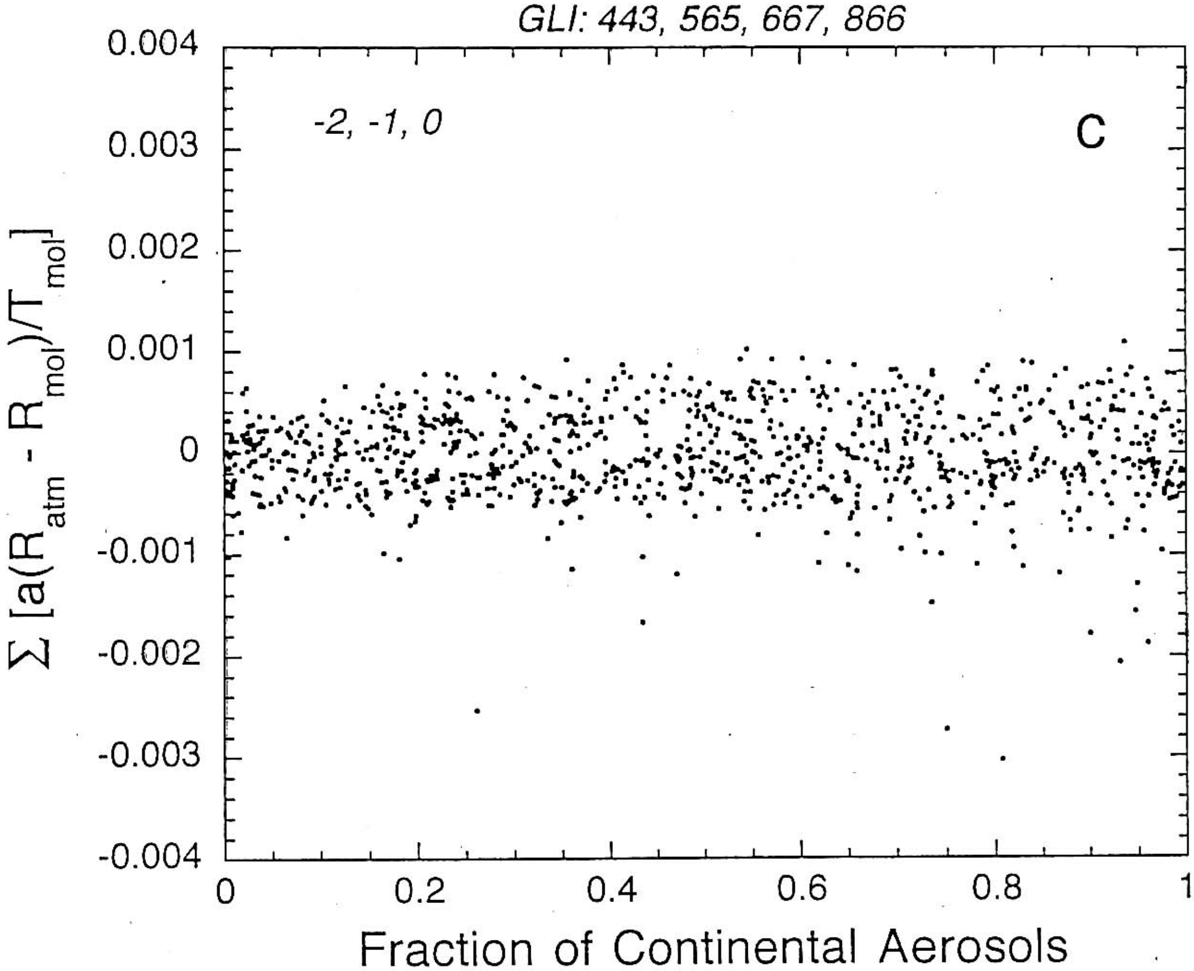
$nj = -2, -1, 0$

$a_1 = 1$

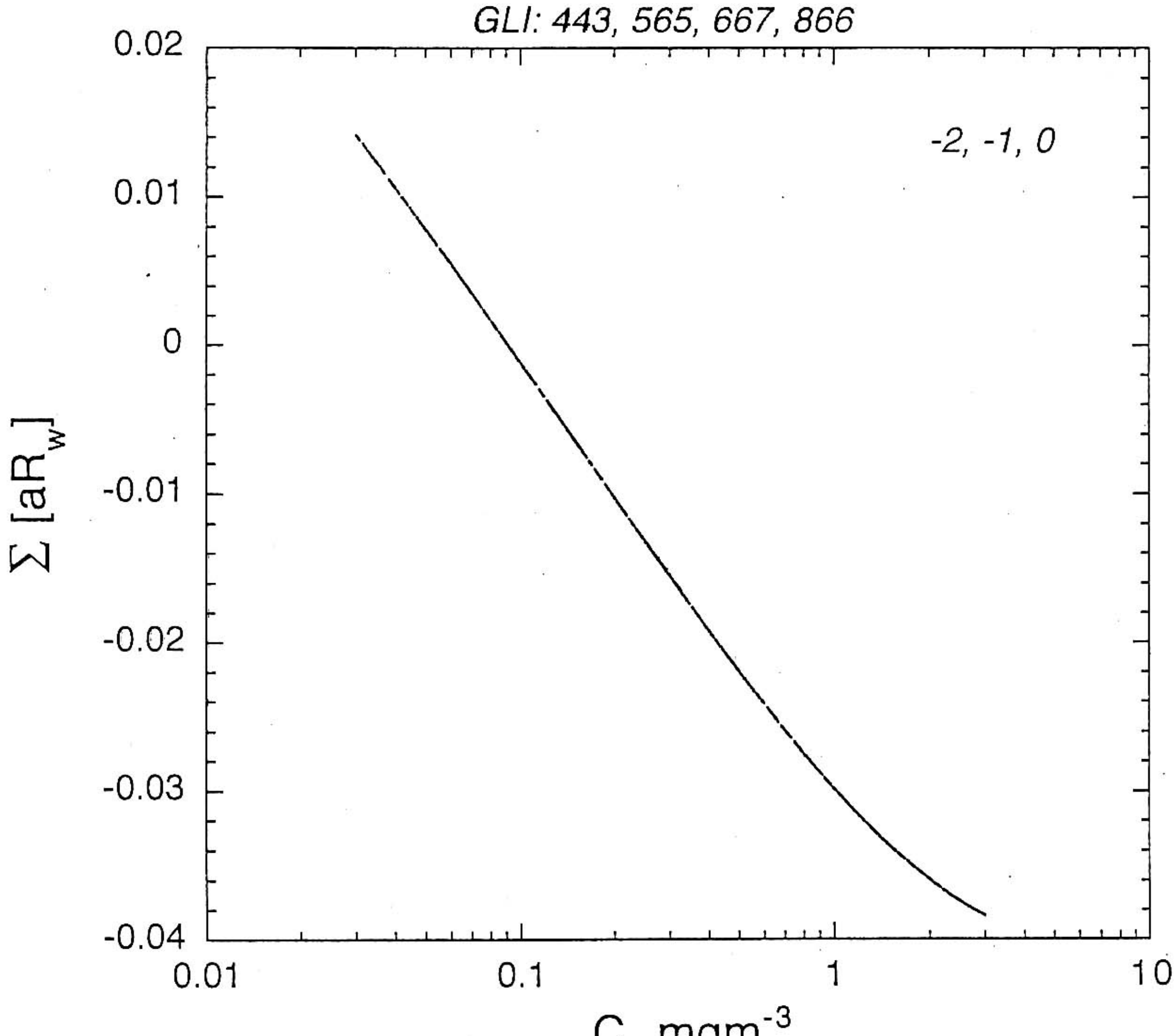

GLI: 443, 565, 667, 866
-2, -1, 0
a
0.004
0.003
0.002
0.001
0
-0.001
-0.002
-0.003
-0.004
$\Sigma\ [a(R_{atm} - R_{mol})/T_{mol}]$
0
10
20
30
40
50
60
Viewing Zenith Angle (Deg.)



GLI: 443, 565, 667, 866
-2, -1, 0
b
0.004
0.003
0.002
0.001
0
-0.001
-0.002
-0.003
-0.004
Σ [a(R_atm - R_mol)/T_mol]
0.05
0.1
0.15
0.2
0.25
0.3
Aerosol Optical Thickness, 550 nm



GLI: 443, 565, 667, 866
-2, -1, 0
C
0.004
0.003
0.002
0.001
0
-0.001
-0.002
-0.003
-0.004
$\Sigma\,[a(R_{atm} - R_{mol})/T_{mol}]$
0
0.2
0.4
0.6
0.8
1
Fraction of Continental Aerosols



GLI: 443, 565, 667, 866
-2, -1, 0
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
0.01
0.1
1
10
Σ [aR_w]
C, mgm^-3

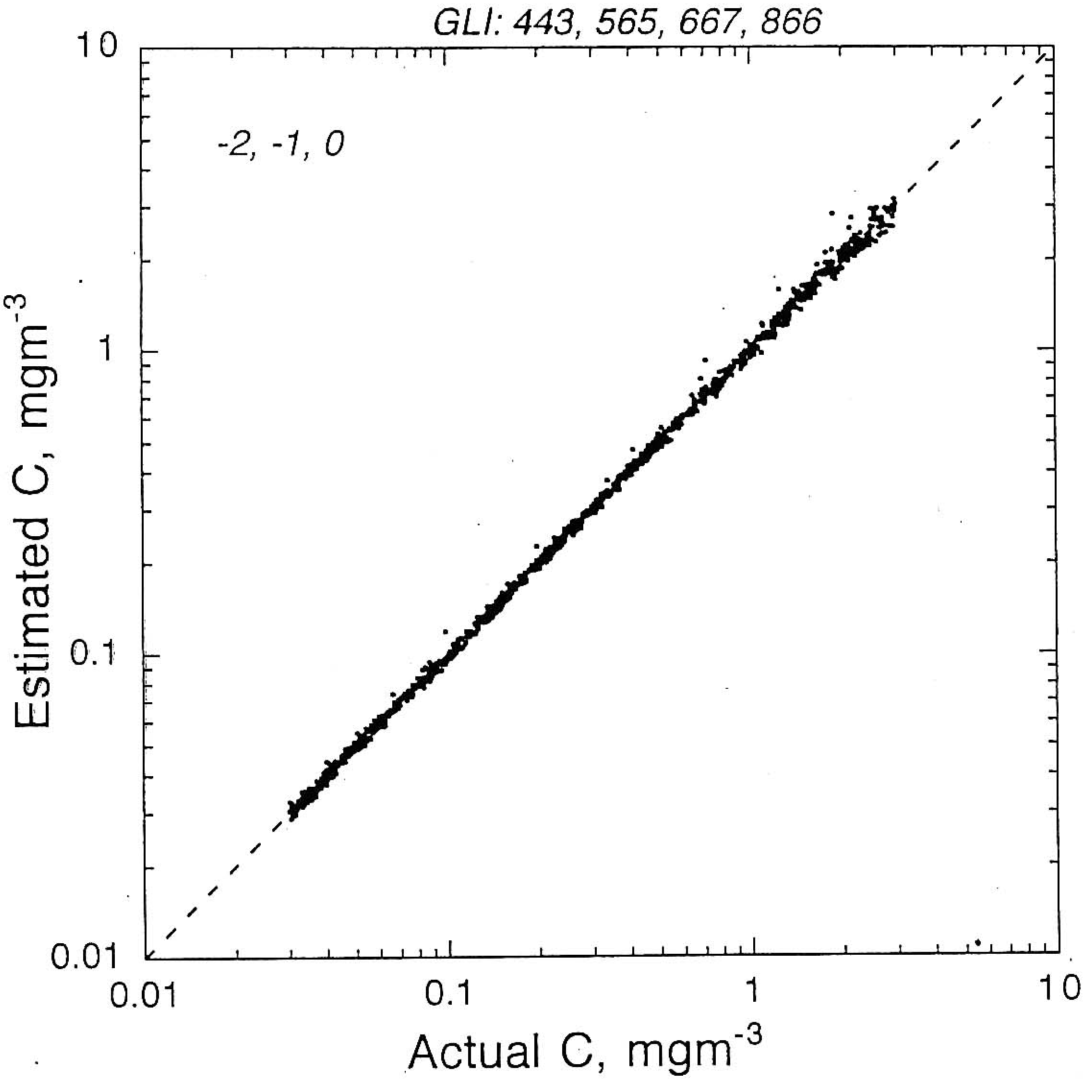

GLI: 443, 565, 667, 866
-2, -1, 0
10
1
0.1
0.01
0.01
0.1
1
10
Estimated C, mgm-3
Actual C, mgm-3

Figure 1: SeaWiFS and ISCCP Global PAR Images, Daily Average.

a. SeaWiFS PAR, Daily Average, December 10, 1997.

b. ISCCP PAR, Daily Average, December 10, 1997.

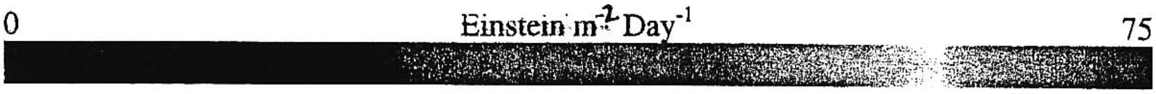
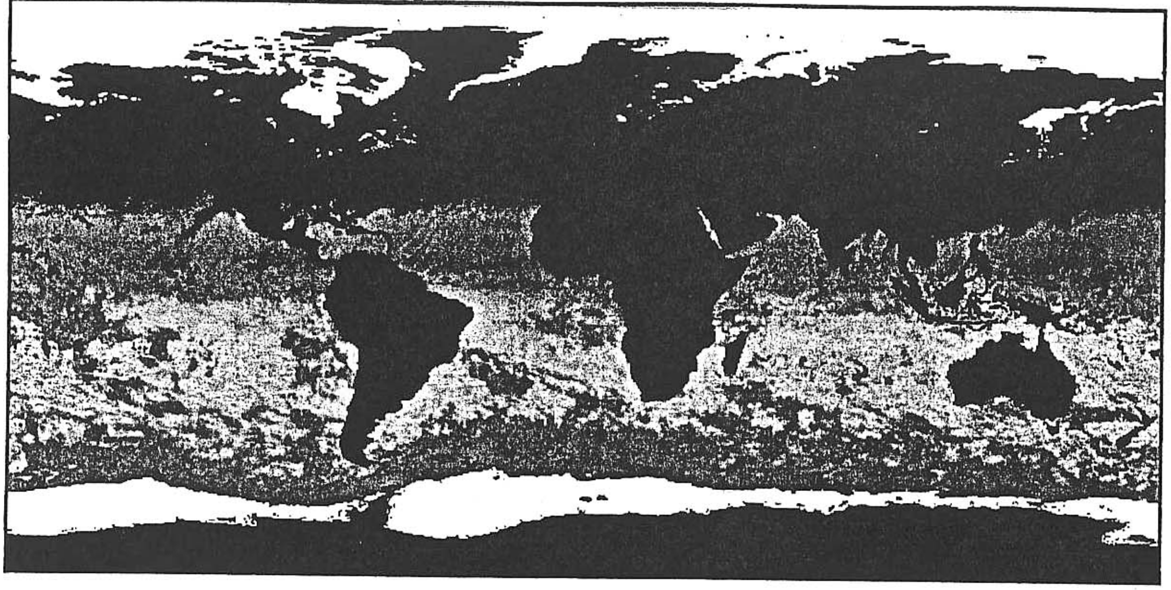
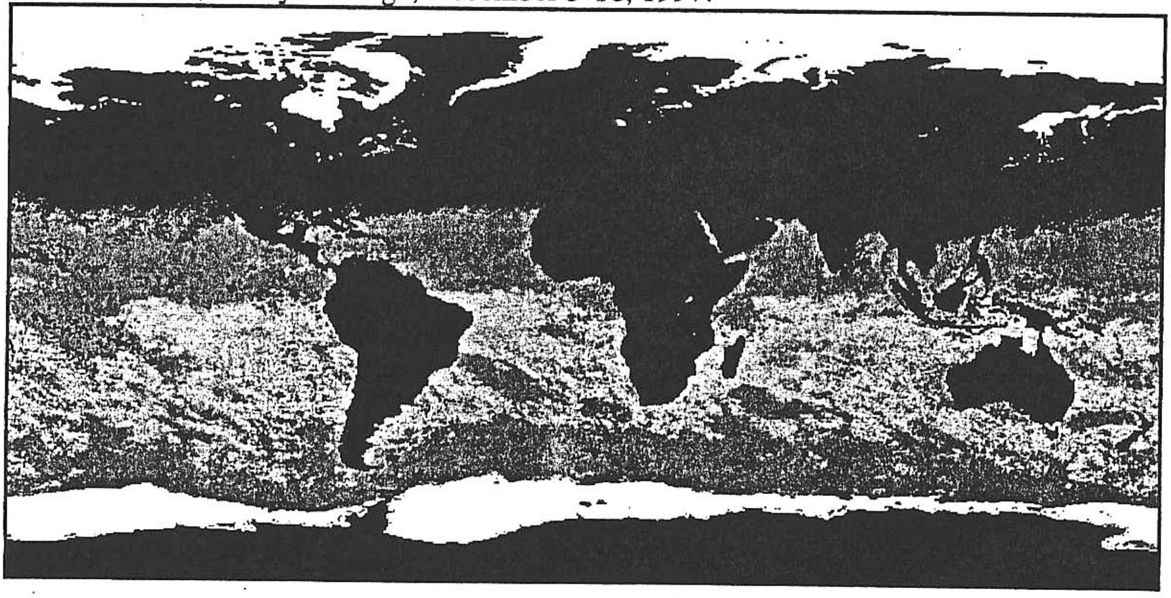


Figure 2: SeaWiFS and ISCCP Global PAR Images, 8-Day Average.

a. SeaWiFS PAR, 8-Day Average, December 3-10, 1997.



b. ISCCP PAR, 8-Day Average, December 3-10, 1997.



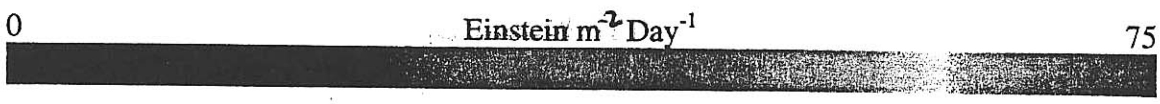
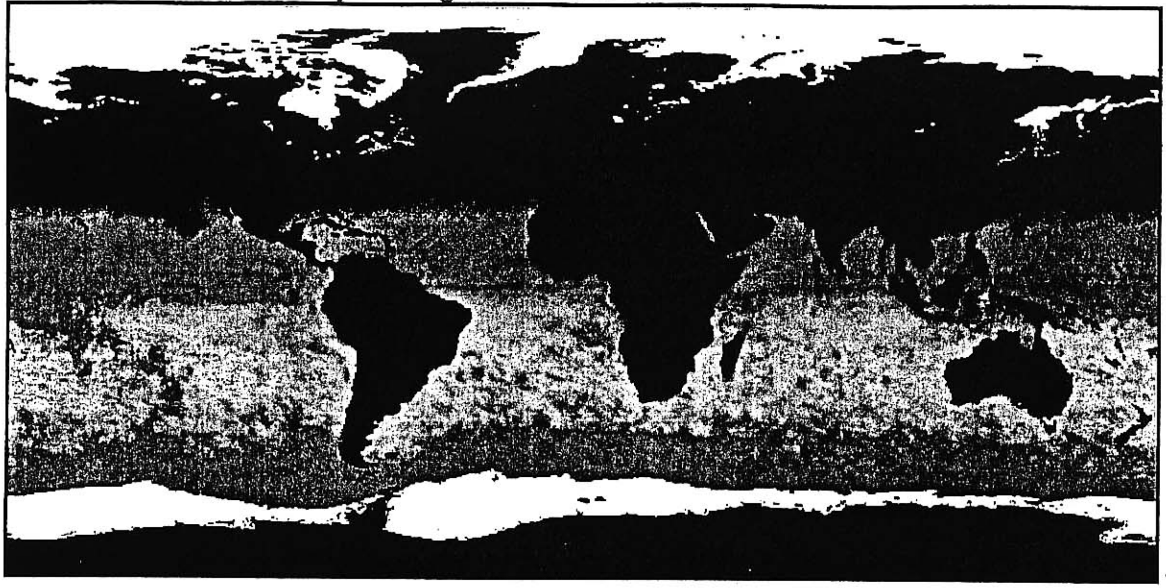


Figure 3: SeaWiFS and ISCCP Global PAR Images, Monthly Average.

a. SeaWiFS PAR, Monthly Average, December 1997.



b. ISCCP PAR, Monthly Average, December 1997.

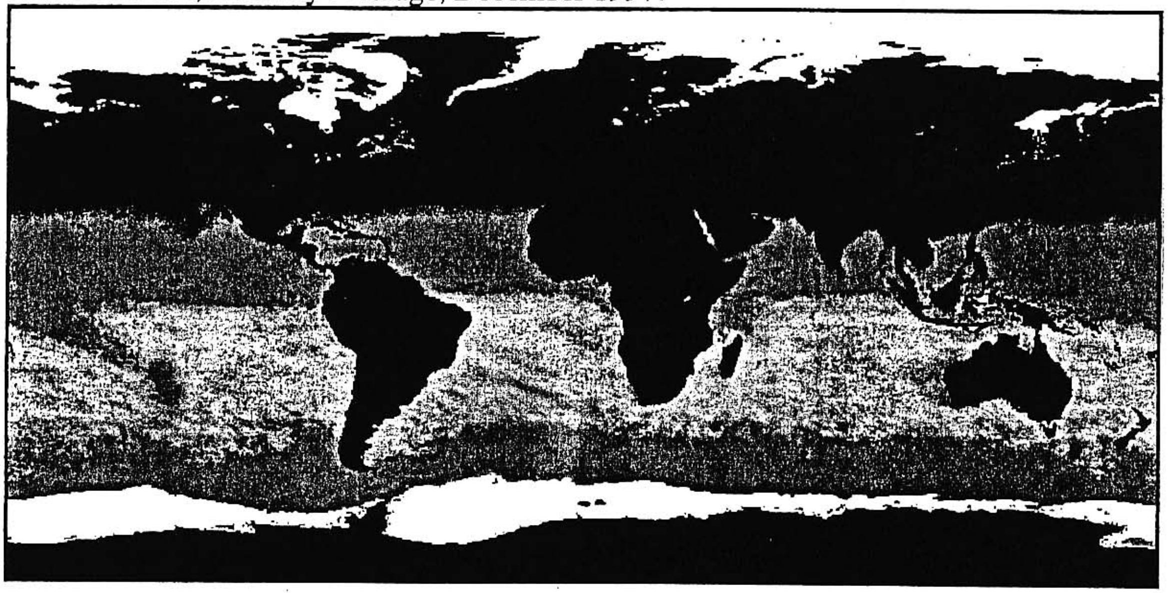
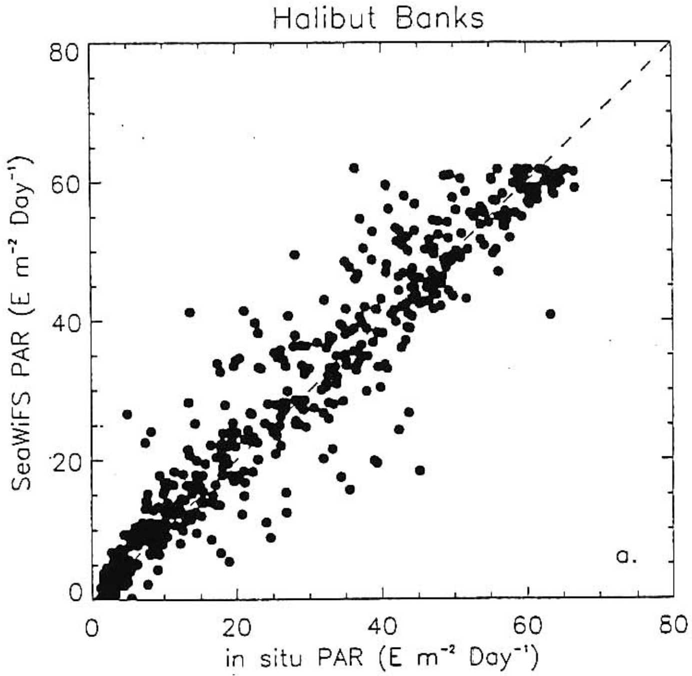


Figure 5: SeaWiFS PAR versus *in situ* PAR, Daily Average



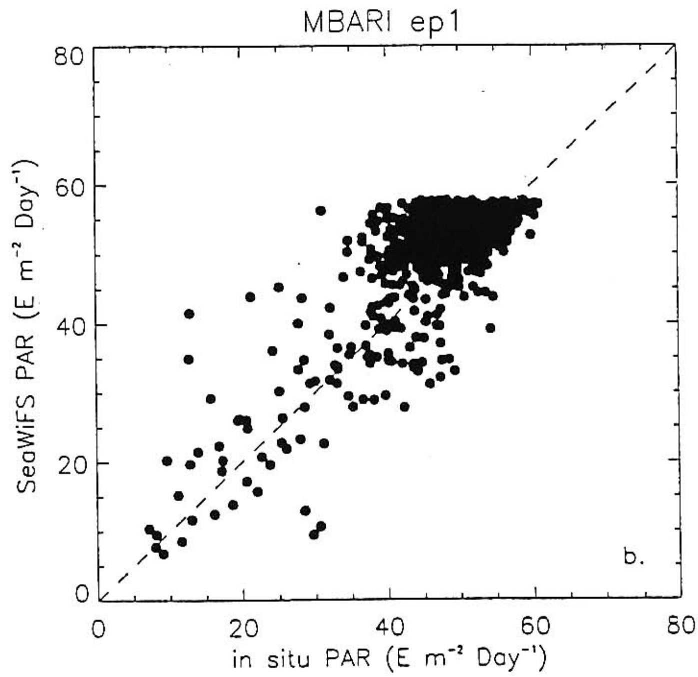


Figure 6: SeaWiFS PAR versus *in situ* PAR, 8-Day Average

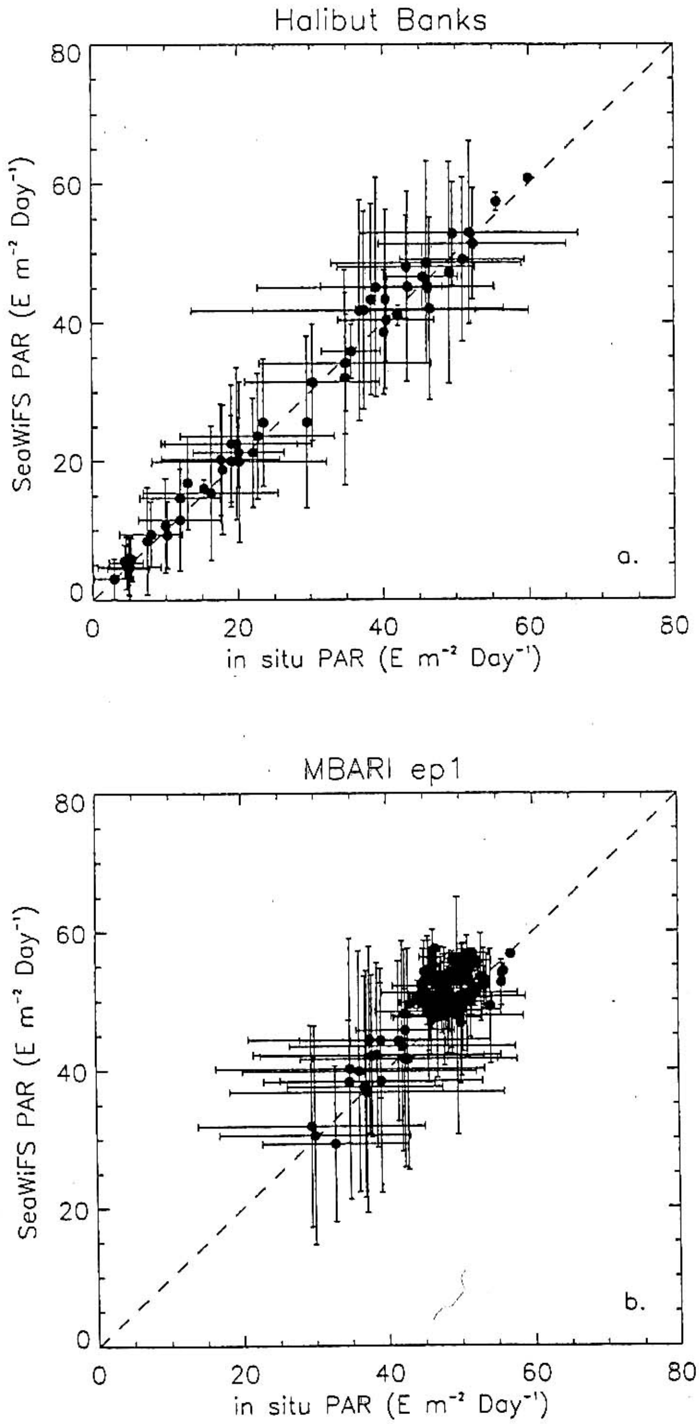


Figure 7: SeaWiFS PAR versus *in situ* PAR, Monthly Average

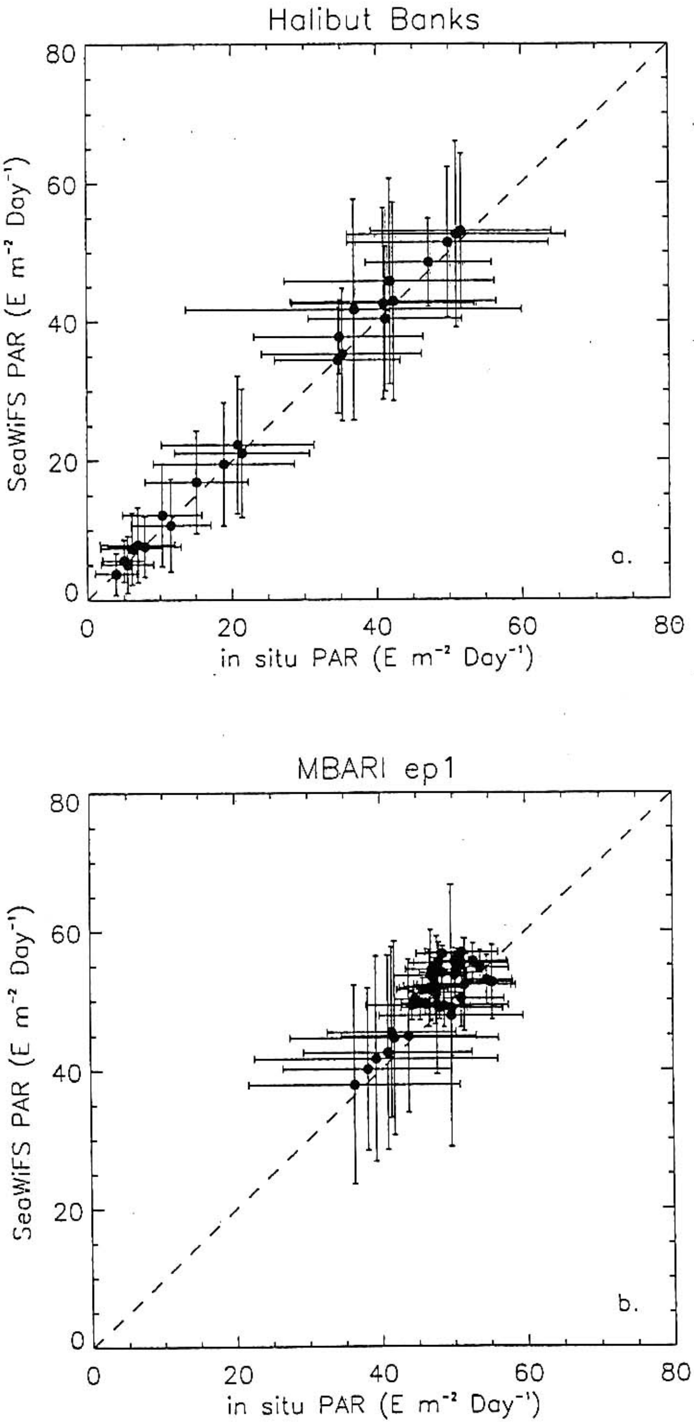


Table 1: SeaWiFS PAR versus ISCCP PAR

Averaging Period	Daily	8-Day	Monthly
correlation coefficient, r^2	0.587	0.881	0.954
bias, E m^{-2} Day^{-1}	-0.6 (-1.3%)	-0.8 (-1.9%)	-0.7 (-1.8%)
r.m.s. difference, E m^{-2} Day^{-1}	13.6 (32.6%)	5.70 (13.4%)	3.57 (8.4%)
mean, E m^{-2} Day^{-1}	41.6	42.7	42.3
number of points	89810	123015	123149

Table 2: SeaWiFS PAR versus *in situ* PAR

Averaging Period	Daily	8-Day	Monthly
Halibut Bank			
correlation coefficient, r^2	0.904	0.984	0.994
bias, E m^{-2} Day^{-1}	0.932 (3.3%)	0.863 (3.1%)	1.10 (4.1%)
r.m.s. difference, E m^{-2} Day^{-1}	6.2 (21.7%)	2.3 (8.2%)	1.8 (6.5%)
mean, E m^{-2} Day^{-1}	28.4	28.2	27.2
number of points	505	54	24
ep1			
correlation coefficient, r^2	0.613	0.680	0.673
bias, E m^{-2} Day^{-1}	2.9 (6.0%)	2.8 (5.8%)	2.8 (5.8%)
r.m.s. difference, E m^{-2} Day^{-1}	6.2 (12.8%)	4.3 (8.9%)	3.9 (8.0%)
mean, E m^{-2} Day^{-1}	48.7	48.3	49.0
number of points	882	103	38
Halibut Bank and ep1 Combined			
correlation coefficient, r^2	0.883	0.957	0.978
bias, E m^{-2} Day^{-1}	2.2 (5.3%)	2.1 (5.2%)	2.2 (5.4%)
r.m.s. difference, E m^{-2} Day^{-1}	6.2 (15.0%)	3.7 (9.1%)	3.3 (8.0%)
mean, E m^{-2} Day^{-1}	41.3	41.4	40.6
number of points	1387	157	38

Estimation of solar planar flux above the surface and solar spherical flux below the surface

- Plane-parallel theory
- Clear atmosphere above cloud layer

1. Planar flux above the surface

$$E_p = E_0 \int_{day} dt[\cos(\theta_s)T_g T_d(1 - A)(1 - A_s)^{-1}(1 - S_a A)^{-1}]$$

$$A = R(t^*)F(t^*, t)$$

$$R(t^*) = (R_{sat}/T_g - R_a)[T_d(\theta_s^*)T_d(\theta_v) + S_a - R_a)]^{-1}$$

2. Spherical flux below the surface

$$E_s = E_0 \int_{day} dt[\cos(\theta_s)T_g T_d(1 - A)(1 - A_s)^{-1}(1 - S_a A)^{-1}\gamma)]$$

- Clear sky

$$\gamma = \gamma_0 T_w/\cos(\theta_{sw})$$

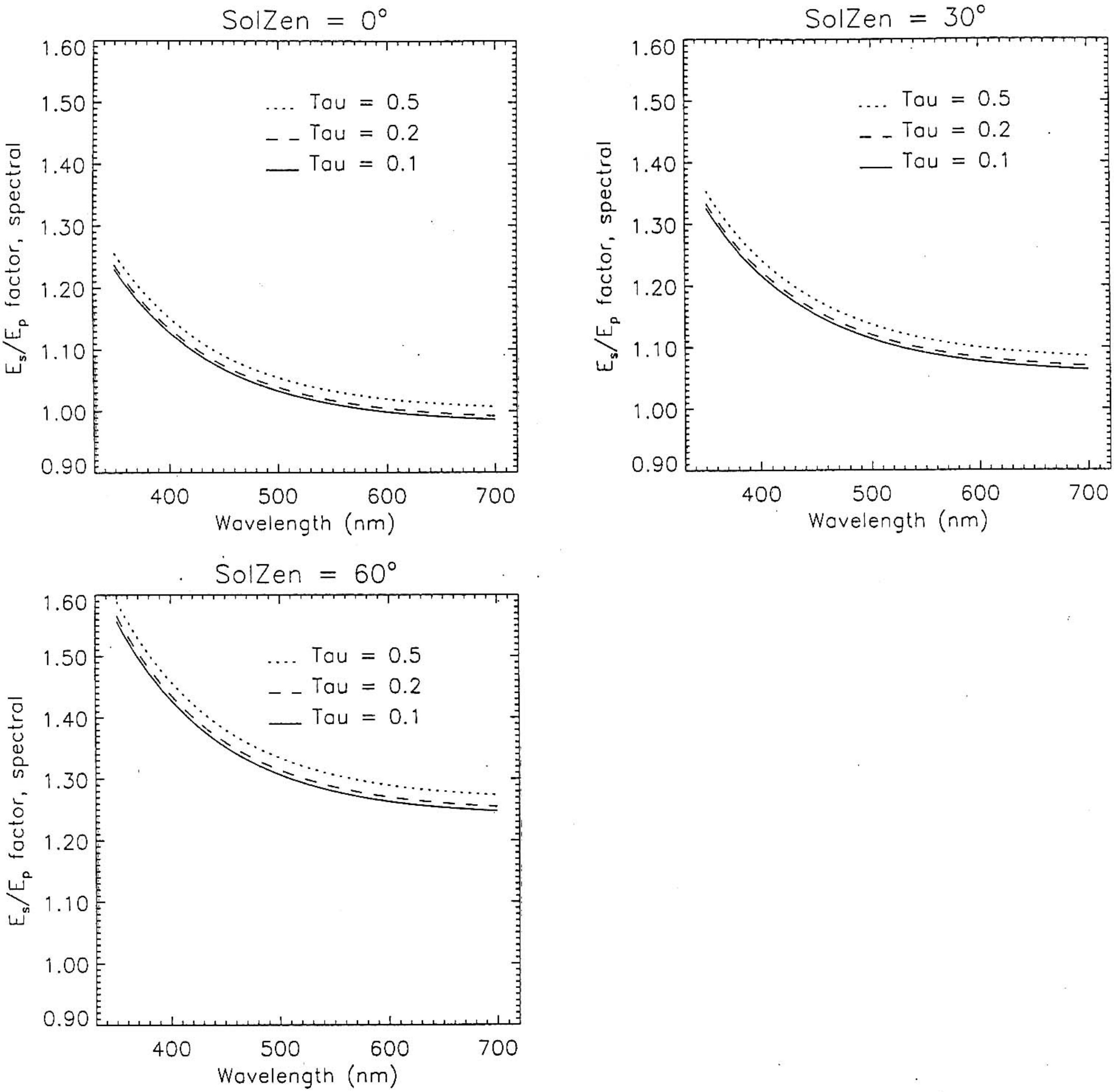
$$\gamma_0 = [1.122 - 0.102exp(-0.635\tau_{aer550})]$$

$$[9.200exp(-10.308\lambda + 0.974], \lambda \text{ in } \mu m$$ (spectral)

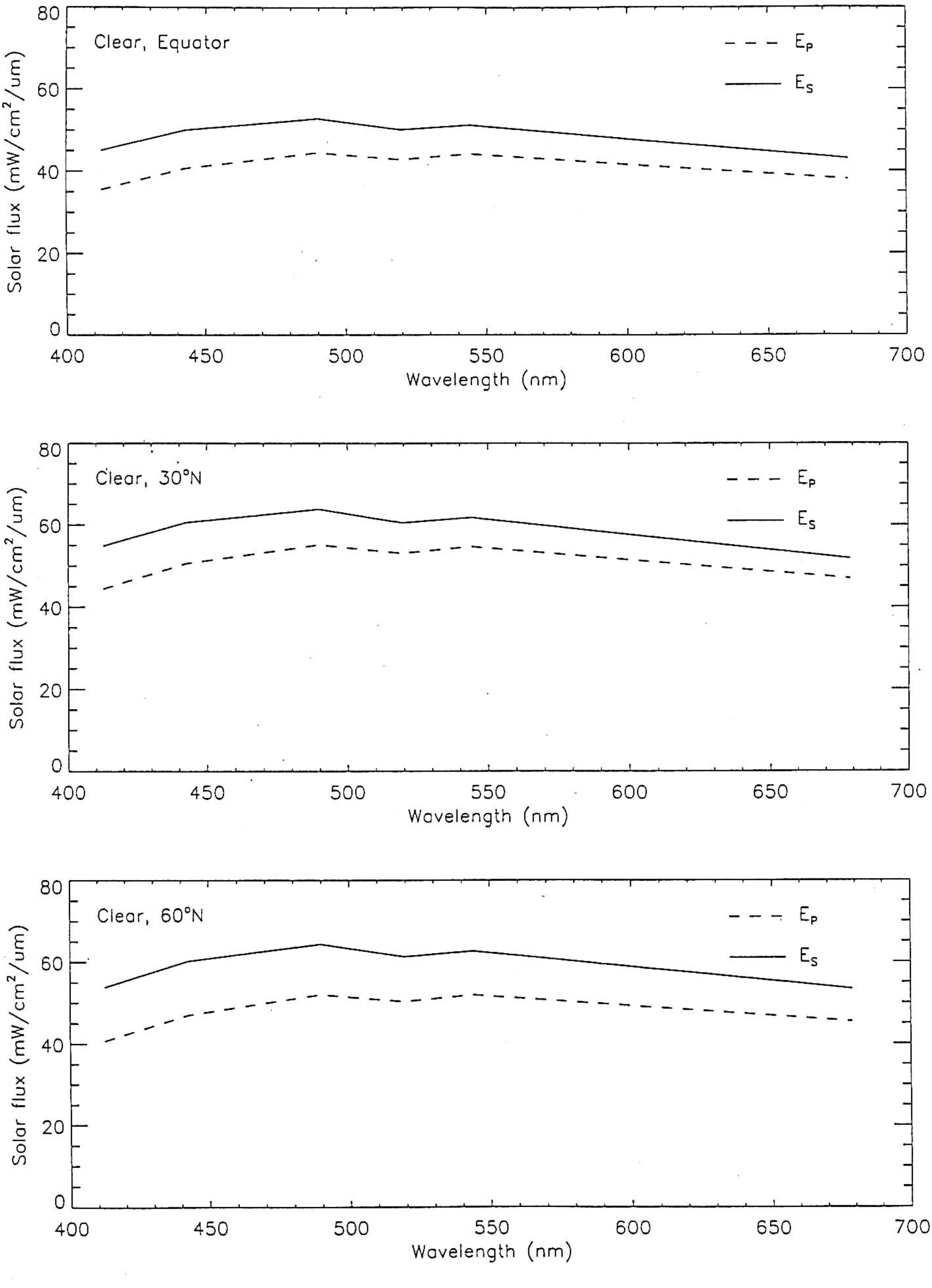
$$\gamma_0 = [1.122 - 0.102exp(-0.635\tau_{aer550})]$$ (400-700 nm)

- Cloudy sky

$$\gamma = 1.12$$

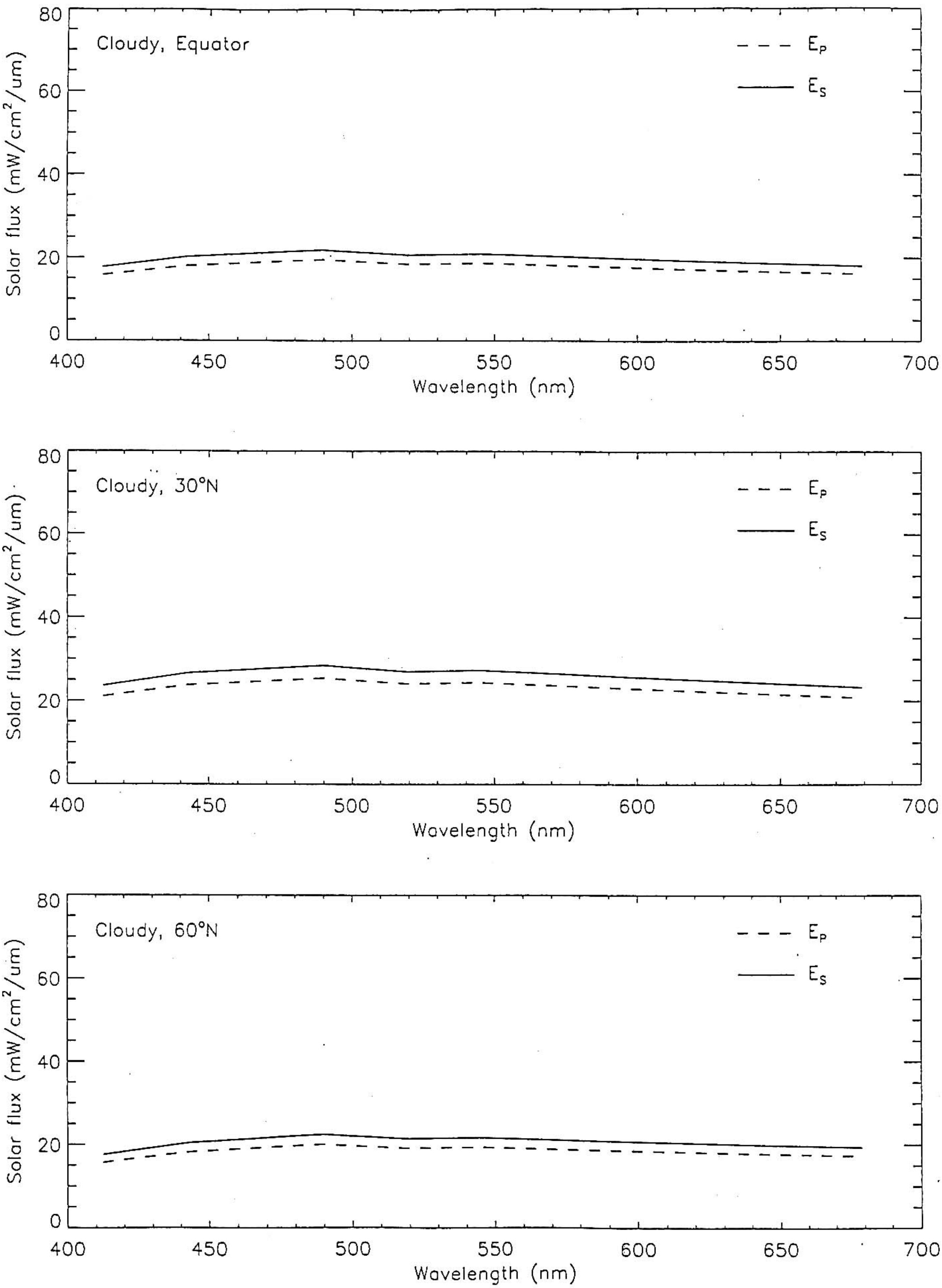

SolZen = 0°
SolZen = 30°
SolZen = 60°
Tau = 0.5
Tau = 0.2
Tau = 0.1
E_s/E_p factor, spectral
Wavelength (nm)
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
400
500
600
700

01 July



Clear, Equator
Clear, 30°N
Clear, 60°N
E_p
E_s
Solar flux (mW/cm²/um)
Wavelength (nm)
0
20
40
60
80
400
450
500
550
600
650
700

01 July


Cloudy, Equator
E_P
E_S
Solar flux (mW/cm^2/um)
Wavelength (nm)
Cloudy, 30°N
E_P
E_S
Solar flux (mW/cm^2/um)
Wavelength (nm)
Cloudy, 60°N
E_P
E_S
Solar flux (mW/cm^2/um)
Wavelength (nm)