INITIALIZATION

On-orbit adjustment of sensor calibration based on a comprehensive suite of surface measurements (vicarious calibration).

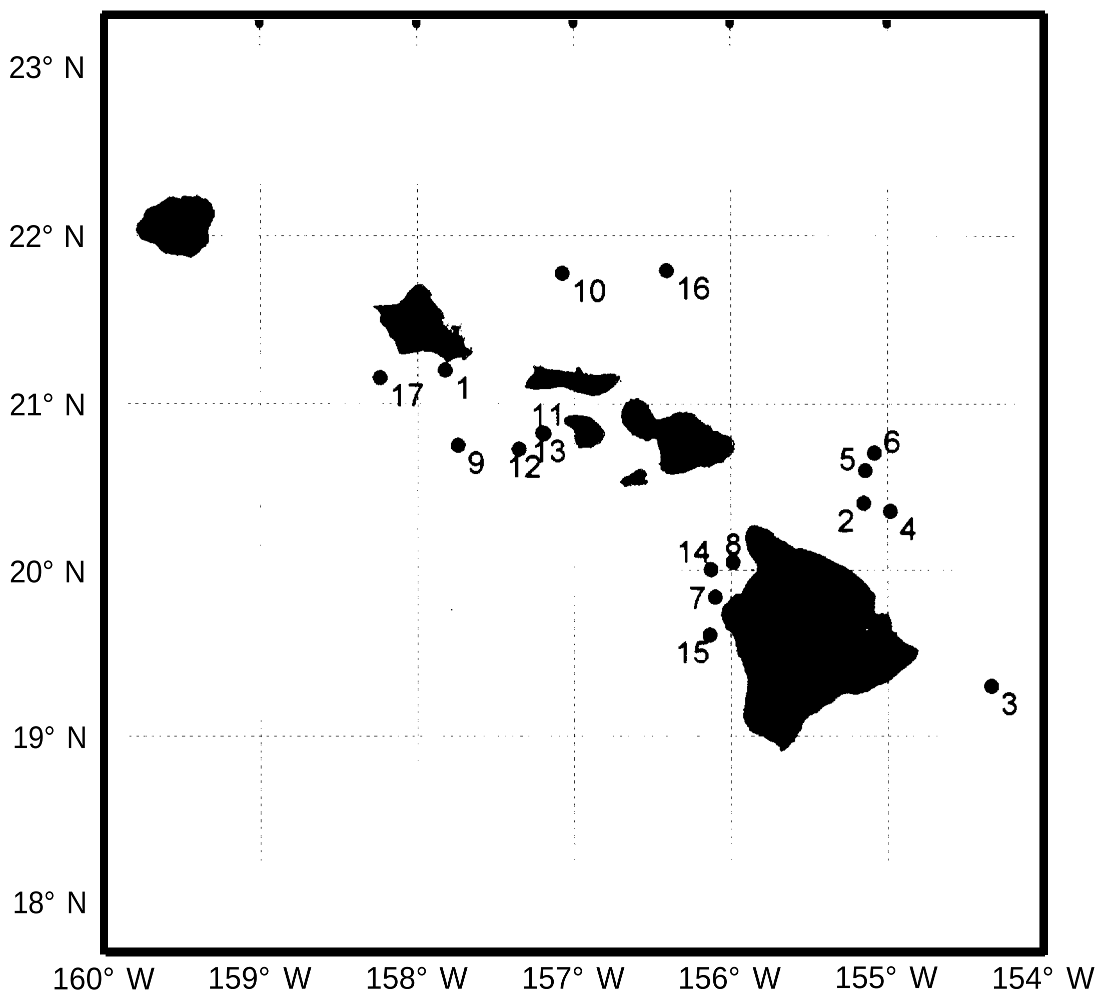
Calibration maintained thereafter by less intensive means.

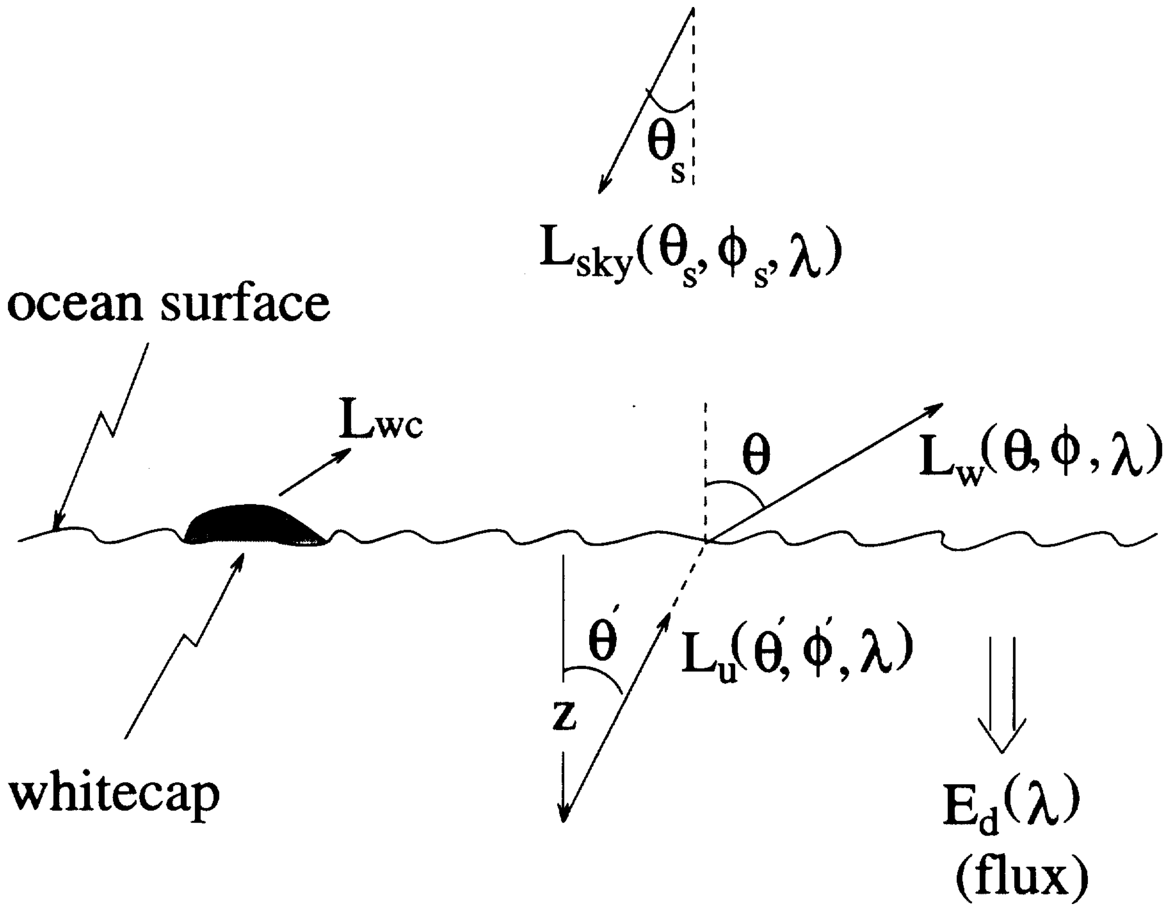
- Solar diffuser
- Lunar views
- MOBY

MOCE 4 - SeaWiFS INITIALIZATION CRUISE PERSONNEL
January 26 - February 12 1998

PERSONNEL	TITLE
NOAA	**Marine Optics Team**
Dennis Clark	Senior Scientist
Marilyn Yuen	Research Associate
Edwin Fisher	Research Technician
Ed King	Research Technician
Eric Stengel	Research Technician
Larisa Koval	Research Associate
Yong Sung Kim	Research Associate
San Jose State University	**Moss Landing Marine Laboratory**
Mark Yarbrough	Research Associate
Mike Feinholz	Research Associate
Stephanie Flora	Student
Brian Schlining	Student - Diver
San Diego State University	**Center for Hydro-Optics & RS**
Chuck Trees	Research Professor
Roberto Millan	Visting Professor
Miami University	**Physics Department**
Ken Voss	Professor
Judd Welton	Graduate Student

MOCE 4 - SeaWiFS Initialization Cruise Stations





MEASUREMENTS

Ship (MOCE)	Buoy (MOBY)
$L_u(0, \phi', \lambda)$, $E_d(\lambda)$, 3 Depths	$L_u(0, \phi', \lambda)$, $E_d(\lambda)$, 3 Depths
$L_u(\theta', \phi', \lambda)$, 1 Depth	—
$\tau_a(\lambda)$ (Sun Photometer)	$\tau_a(\lambda)$ (ASSR)
$L_{\rm Sky}(\theta_s, \phi_s, \lambda)$ (Sky Camera)	$L_{\rm Sky}(\theta_s, \phi_s, \lambda)$ (ASSR)
$L_{wc}(\lambda)$, $\vec{W}$ (Whitecap Rad.)	$\vec{W}$
Solar Aureole (Aureole Camera)	Solar Aureole (ASSR)
$C(x, y)$ (Fluorometric)	—
LIDAR (Ship)	LIDAR (Mauna Loa)
P_0, Ozone	P_0, Ozone

Initialization

Satellite measurement: $+\alpha(\lambda)]\,\rho_t^*(\lambda,\theta_v,\phi_v)$

ERROR TOA REFLECTANCE

Ship measurements: P_0, $\tau_{Oz}(\lambda)$, $\tau_a(\lambda)$, $L_u(\lambda,\theta_v,\phi_v)$, and ρ_{wc}

Correct for Ozone:

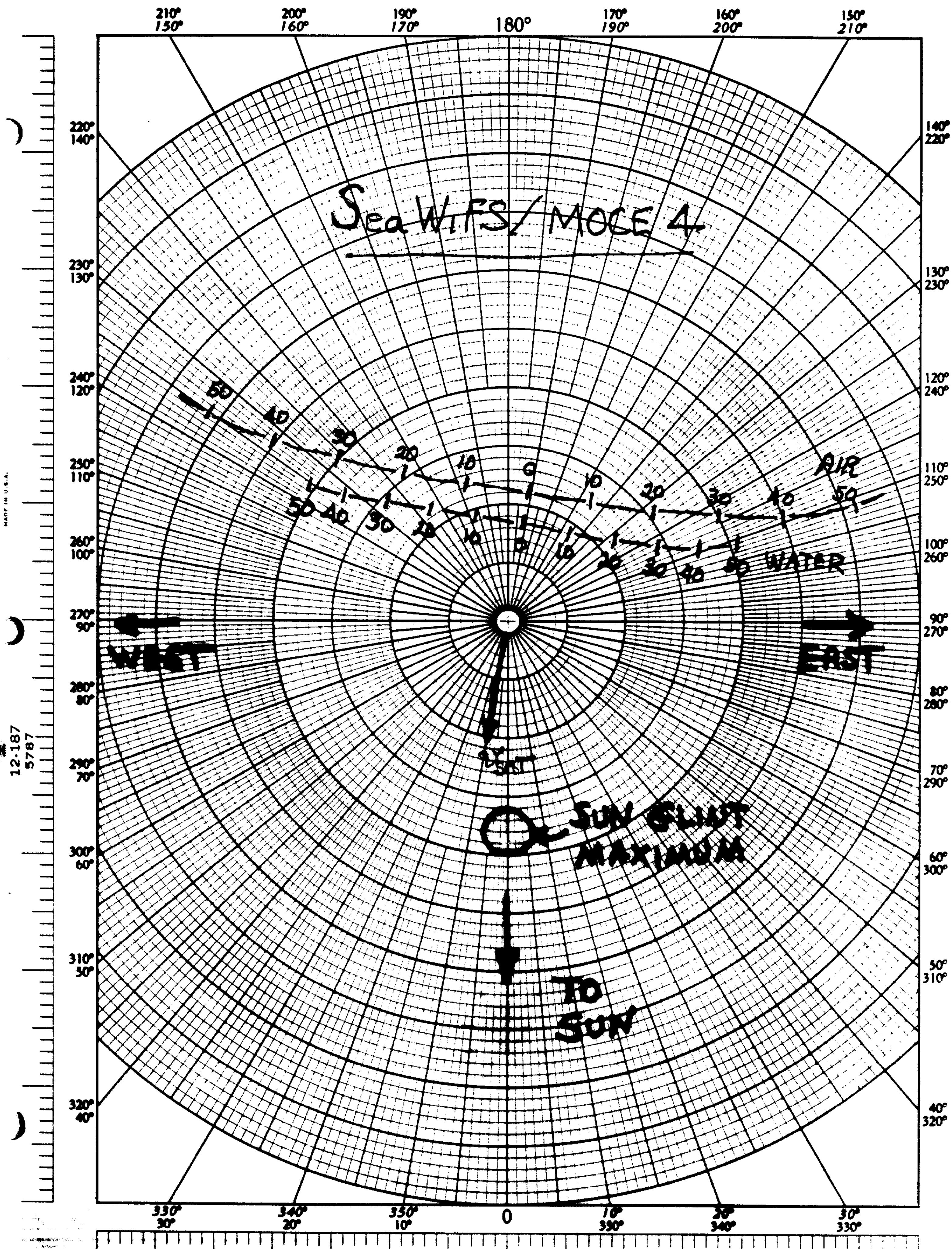
$$[1+\alpha(\lambda)]\,\rho_t(\lambda,\theta_v,\phi_v) = [1+\alpha(\lambda)]\,\rho_t^*(\lambda,\theta_v,\phi_v) \times \exp\left[\tau_{Oz}(\lambda)\left(\frac{1}{\cos\theta_v}+\frac{1}{\cos\theta_0}\right)\right]$$

Now,

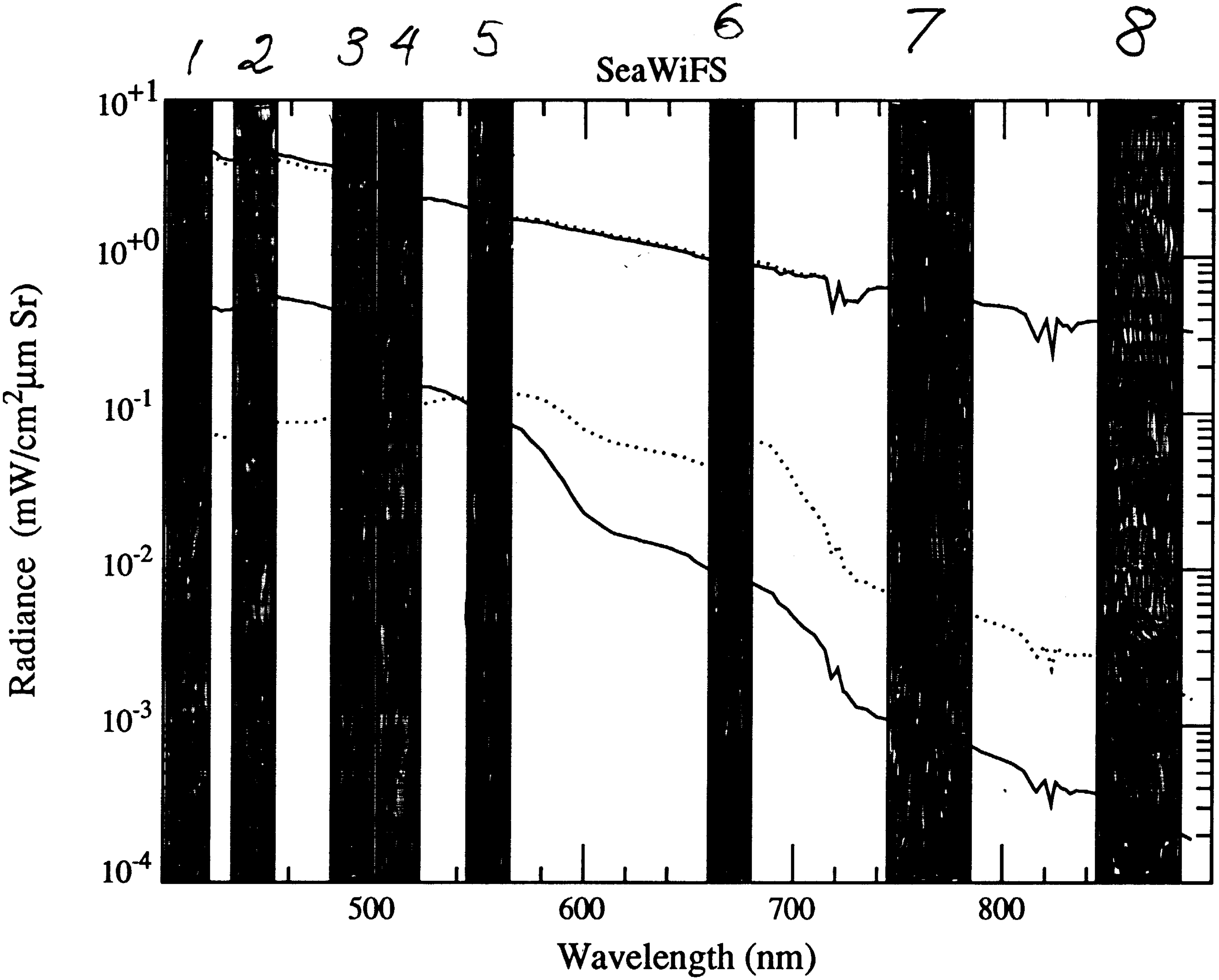
$$\begin{aligned}\rho_t(\lambda,\theta_v,\phi_v) = {} & \rho_r(\lambda,\theta_v,\phi_v) && : P_0\\ & + \rho_a(\lambda,\theta_v,\phi_v) + \rho_{ra}(\lambda,\theta_v,\phi_v) && : \tau_a(\lambda) \text{ \& MODELS}\\ & + t(\lambda)\rho_w(\lambda,\theta_v,\phi_v) && : L_u(\lambda, \theta_v, \phi_v)\\ & + t(\lambda)\rho_{wc}(\lambda,\theta_v,\phi_v) && : \rho_{wc}\\ & + T(\lambda)\rho_g(\lambda,\theta_v,\phi_v), && : \approx 0\end{aligned}$$

and this $\Longrightarrow \alpha(\lambda)$.

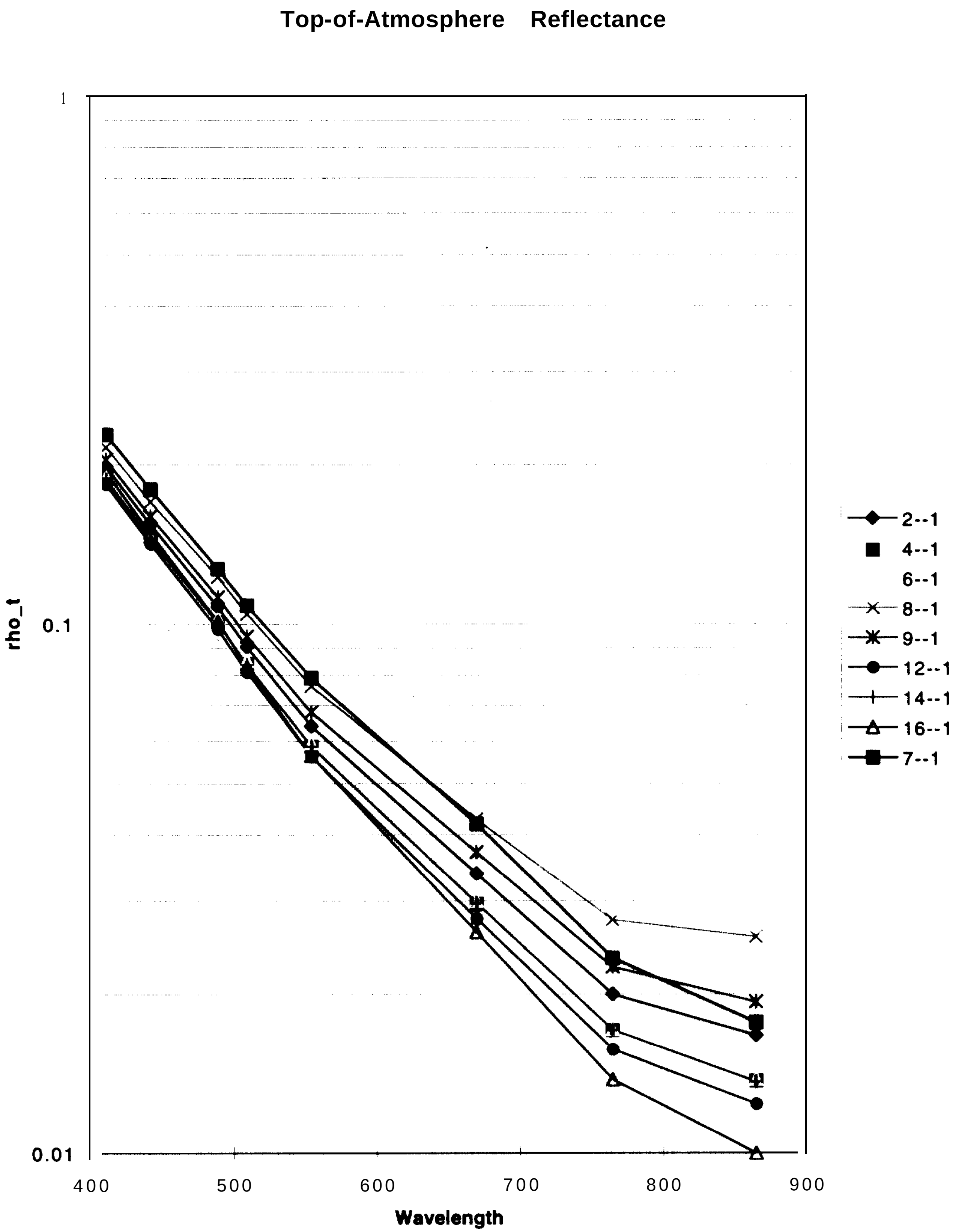
Actually, for more accuracy, we use $\tau_a(\lambda)/\tau_a(\lambda_0)$ to suggest a model for determining $[\rho_a(\lambda)+\rho_{ra}(\lambda)]\,/\,[\rho_a(\lambda_0)+\rho_{ra}(\lambda_0)]$, where $\lambda_0 = 865$ nm. This allows computation of $\alpha(\lambda)$ assuming that $\alpha(865) = 0$.



SeaWiFS/MOCE 4
180°
0
AIR
WATER
WEST
EAST
θSAT
SUN GLINT MAXIMUM
TO SUN
12-187
5787

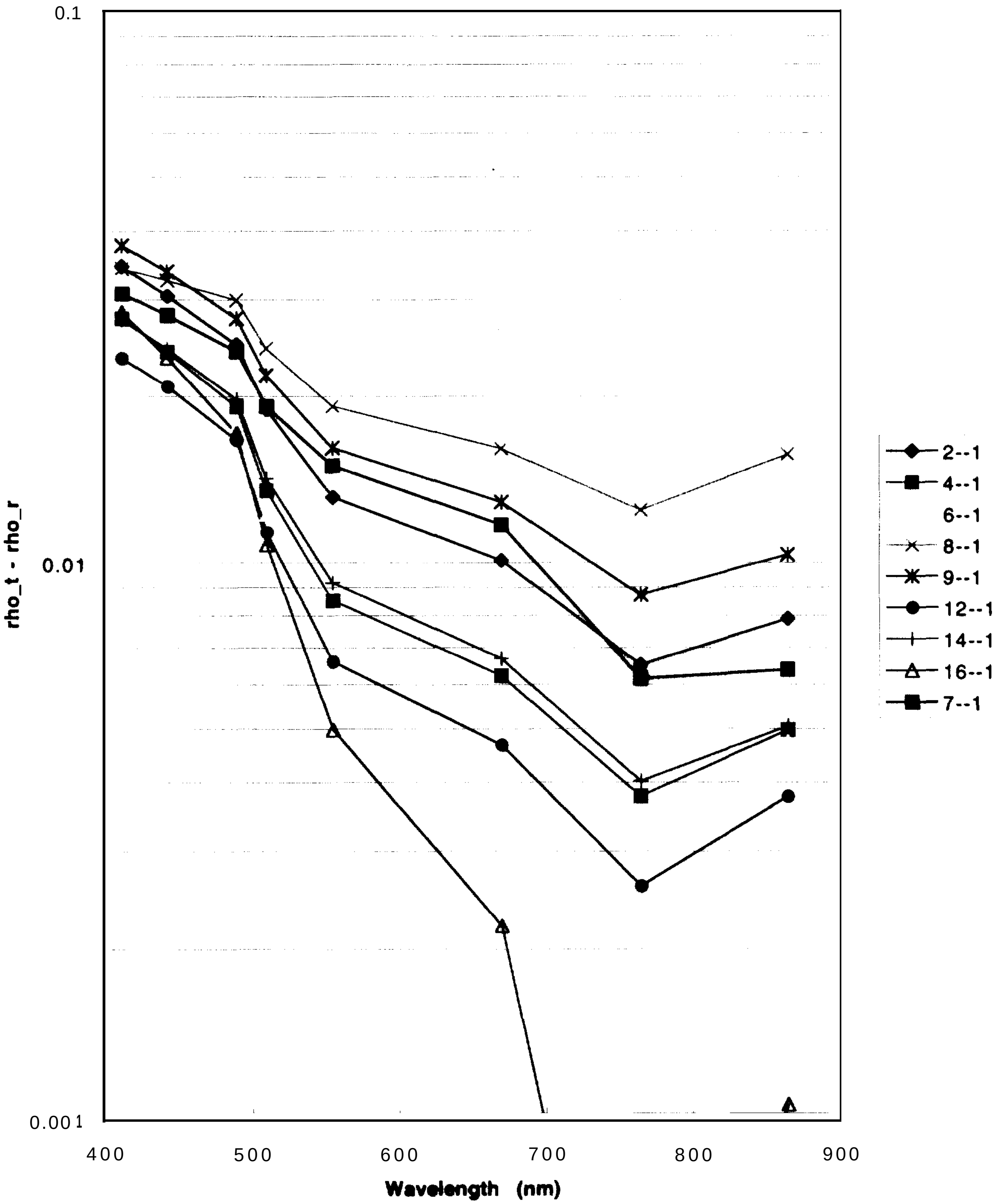


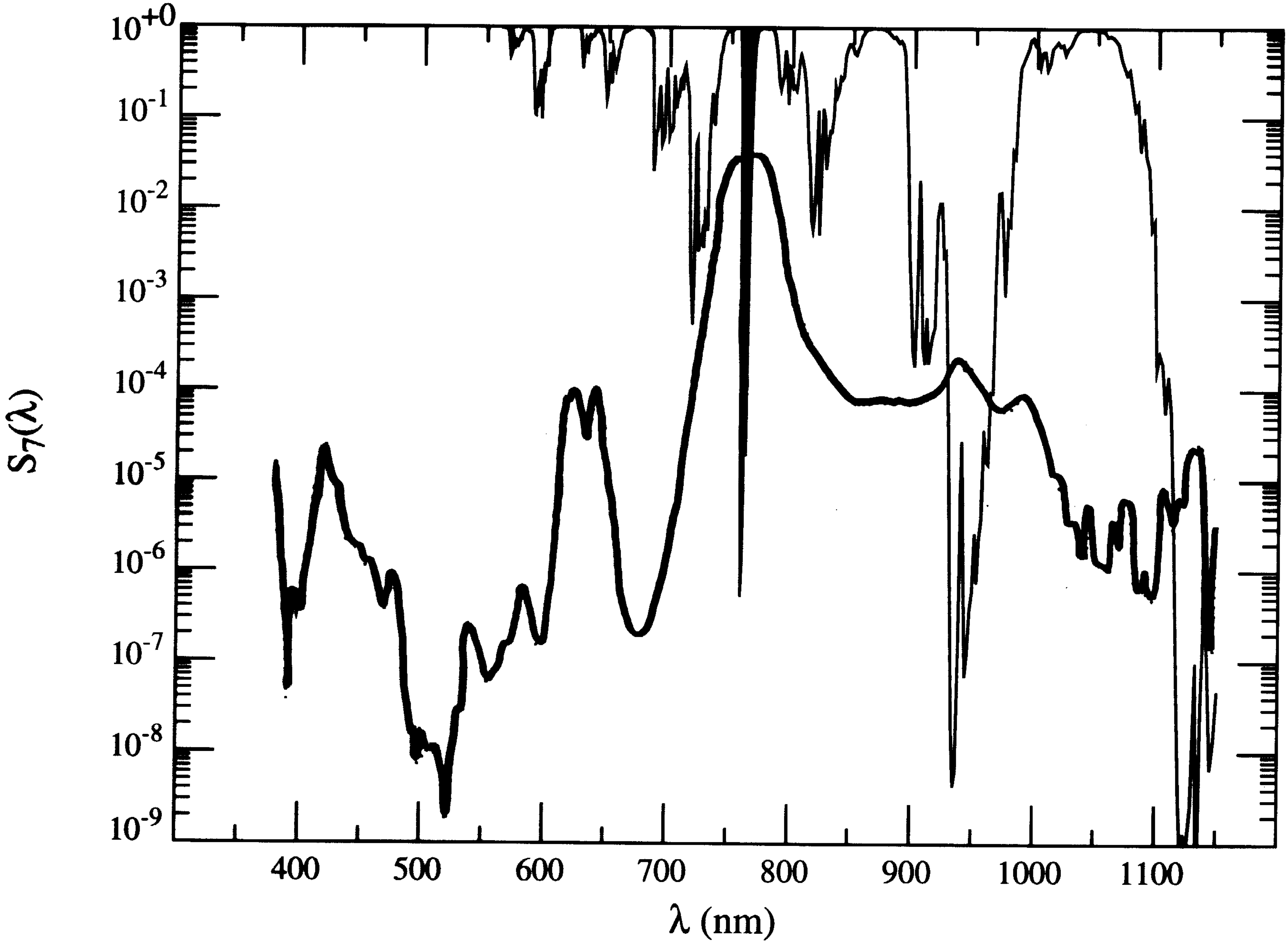
1
2
3
4
5
6
7
8
SeaWiFS
10+1
10+0
10-1
10-2
10-3
10-4
Radiance (mW/cm2µm Sr)
500
600
700
800
Wavelength (nm)



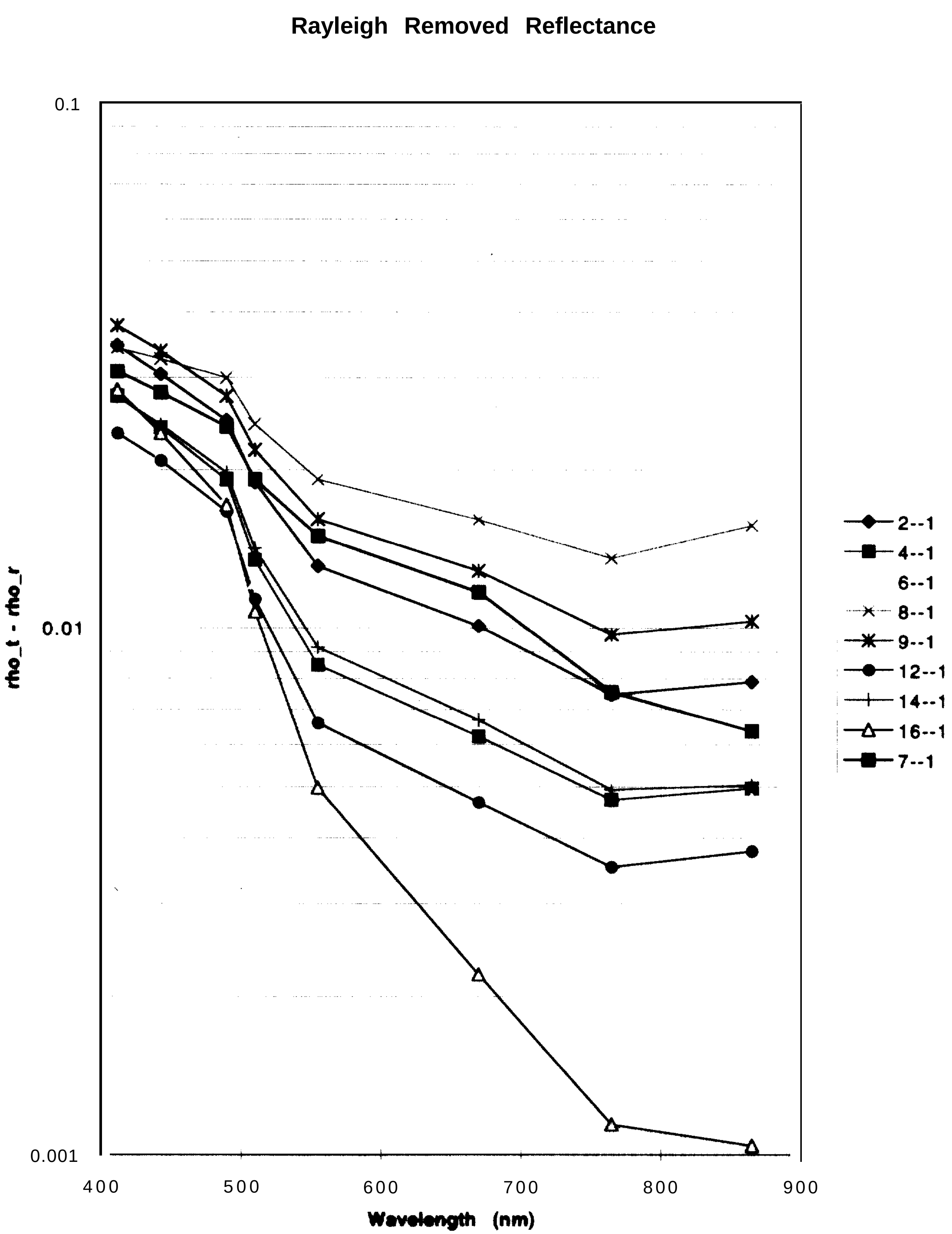
Top-of-Atmosphere Reflectance
1
0.1
0.01
rho_t
400
500
600
700
800
900
Wavelength
2--1
4--1
6--1
8--1
9--1
12--1
14--1
16--1
7--1

Rayleigh-removed Reflectance (No O2 Correction)

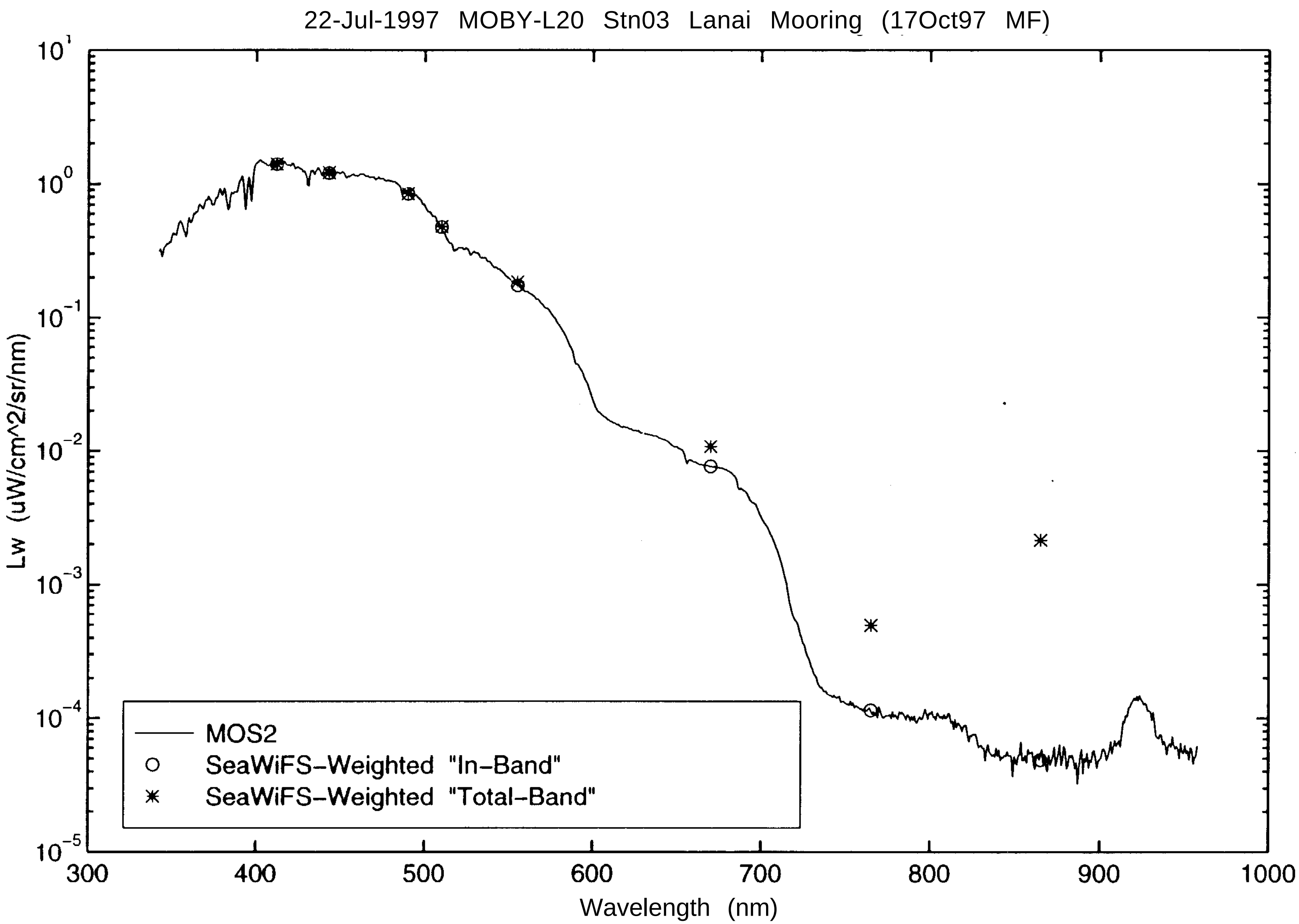




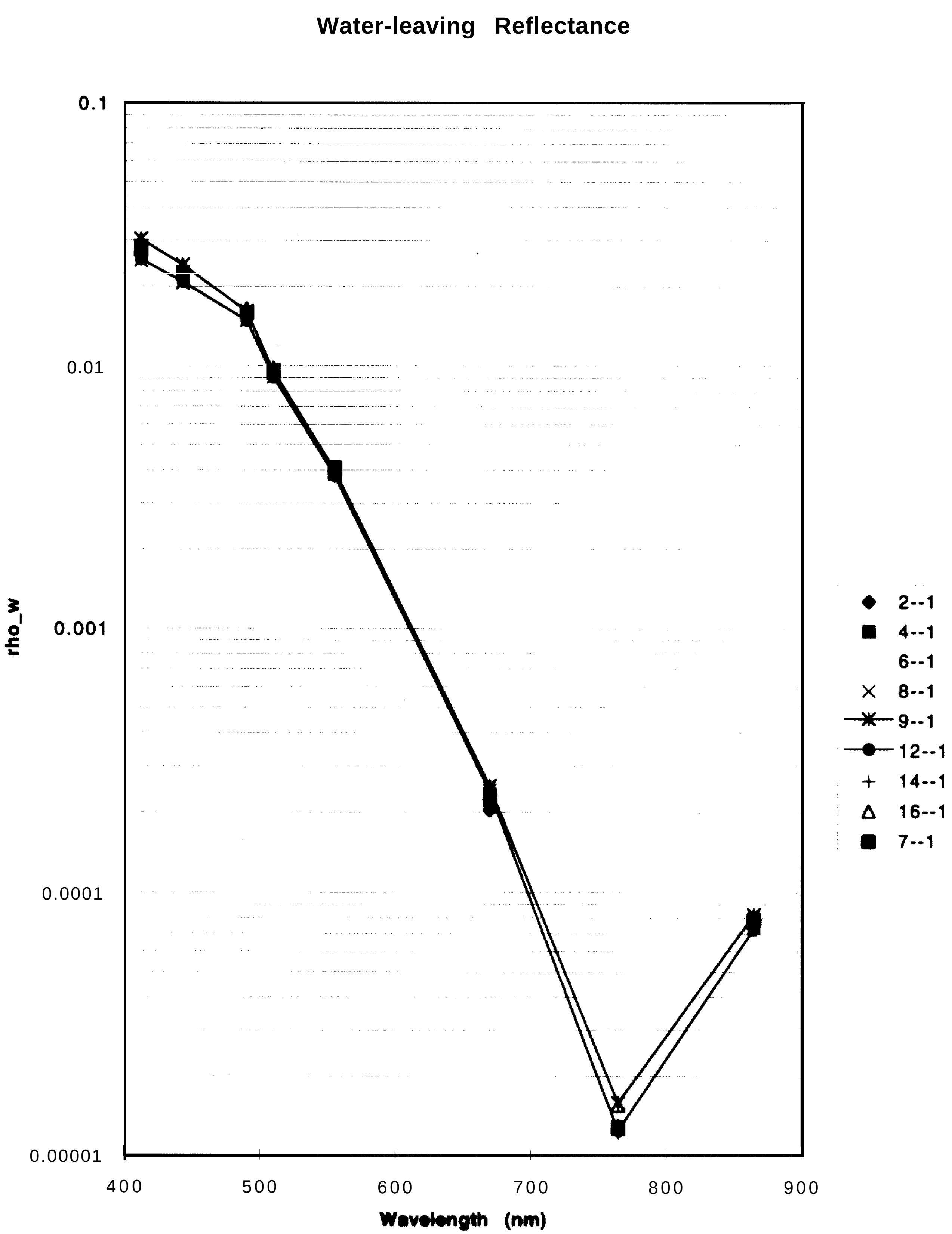
10^{+0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
$S_7(\lambda)$
400
500
600
700
800
900
1000
1100
λ (nm)



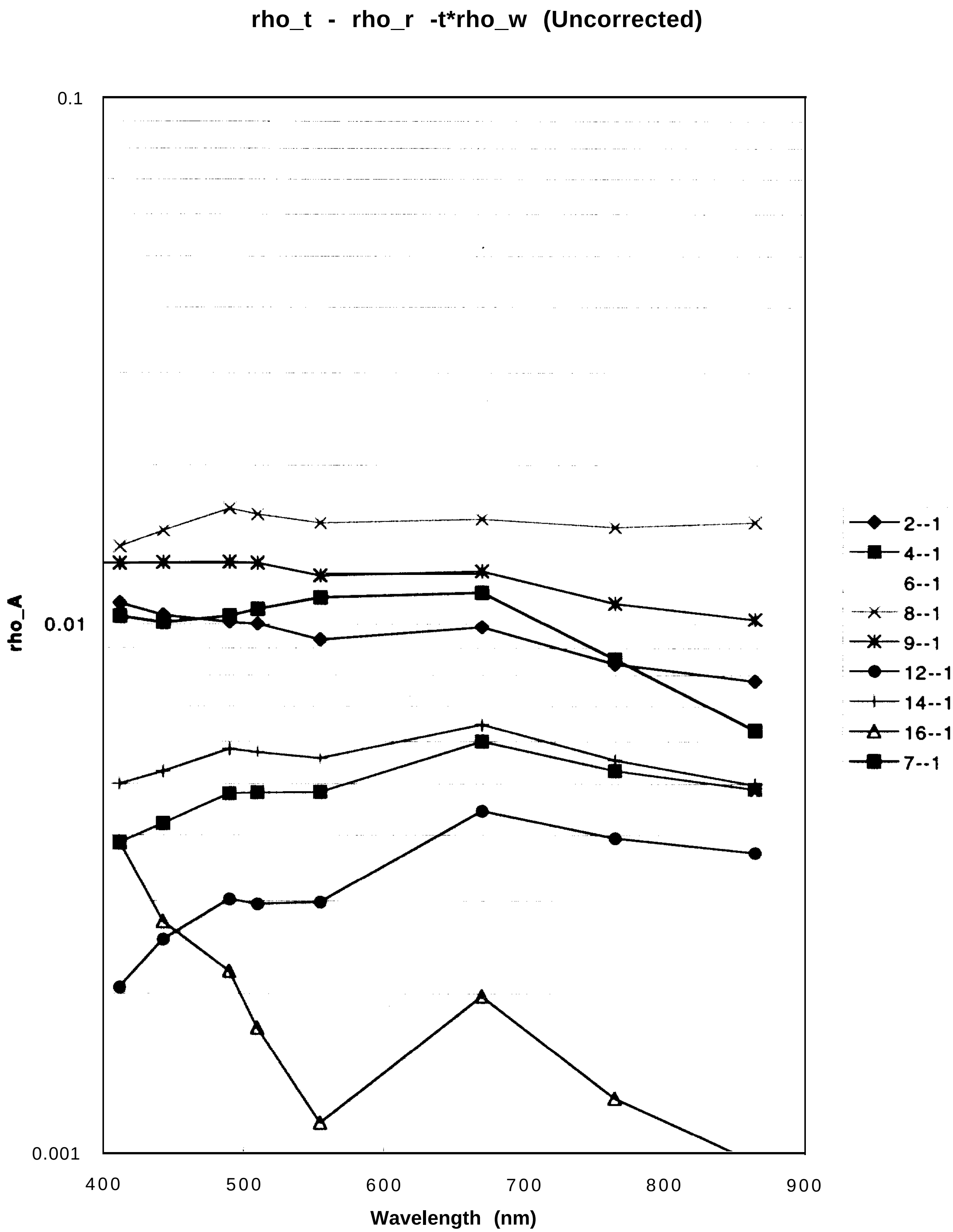
Rayleigh Removed Reflectance
0.1
0.01
0.001
rho_t - rho_r
400
500
600
700
800
900
Wavelength (nm)
2--1
4--1
6--1
8--1
9--1
12--1
14--1
16--1
7--1



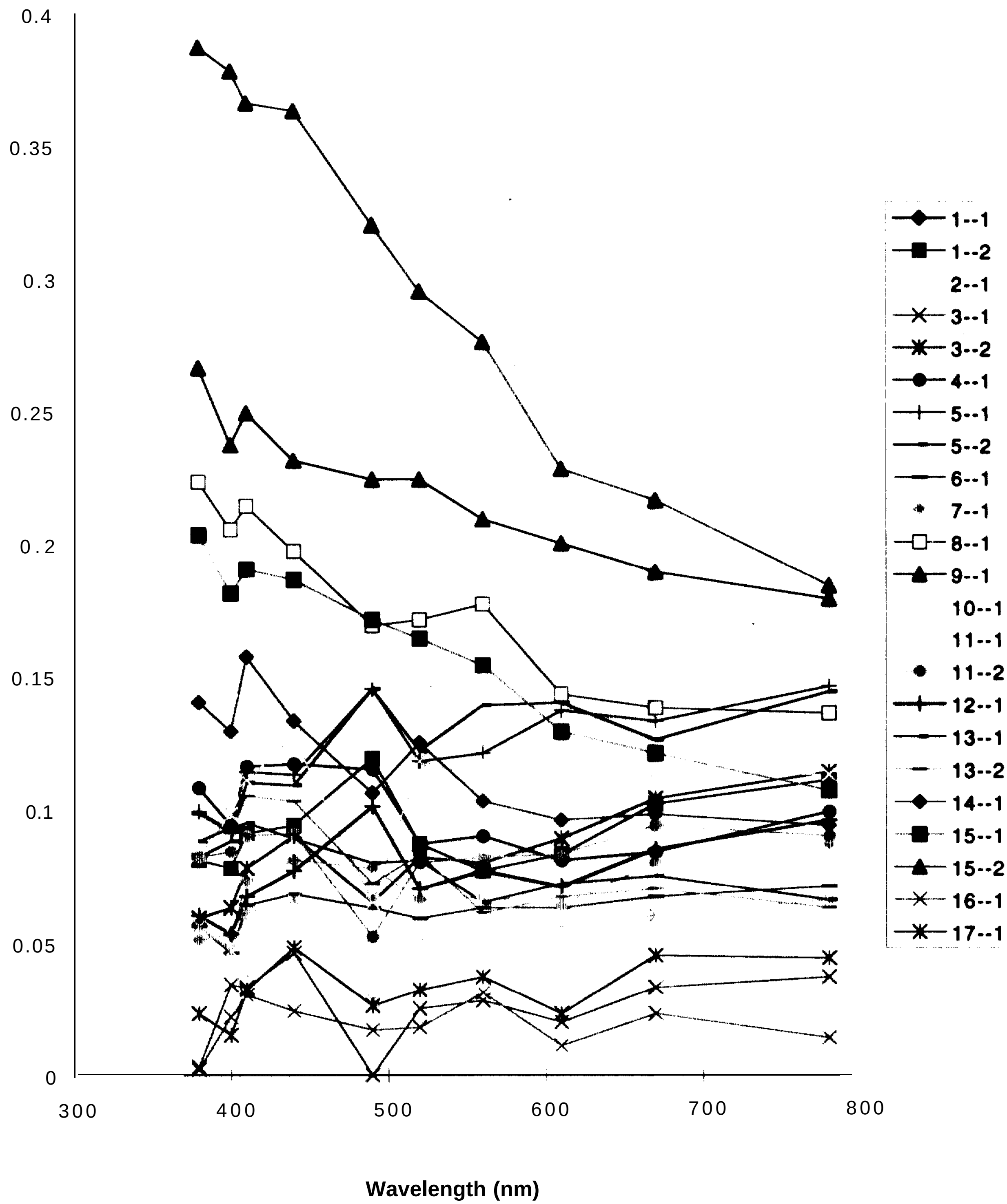
22-Jul-1997 MOBY-L20 Stn03 Lanai Mooring (17Oct97 MF)
Lw (uW/cm^2/sr/nm)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
300
400
500
600
700
800
900
1000
Wavelength (nm)
MOS2
SeaWiFS-Weighted "In-Band"
SeaWiFS-Weighted "Total-Band"

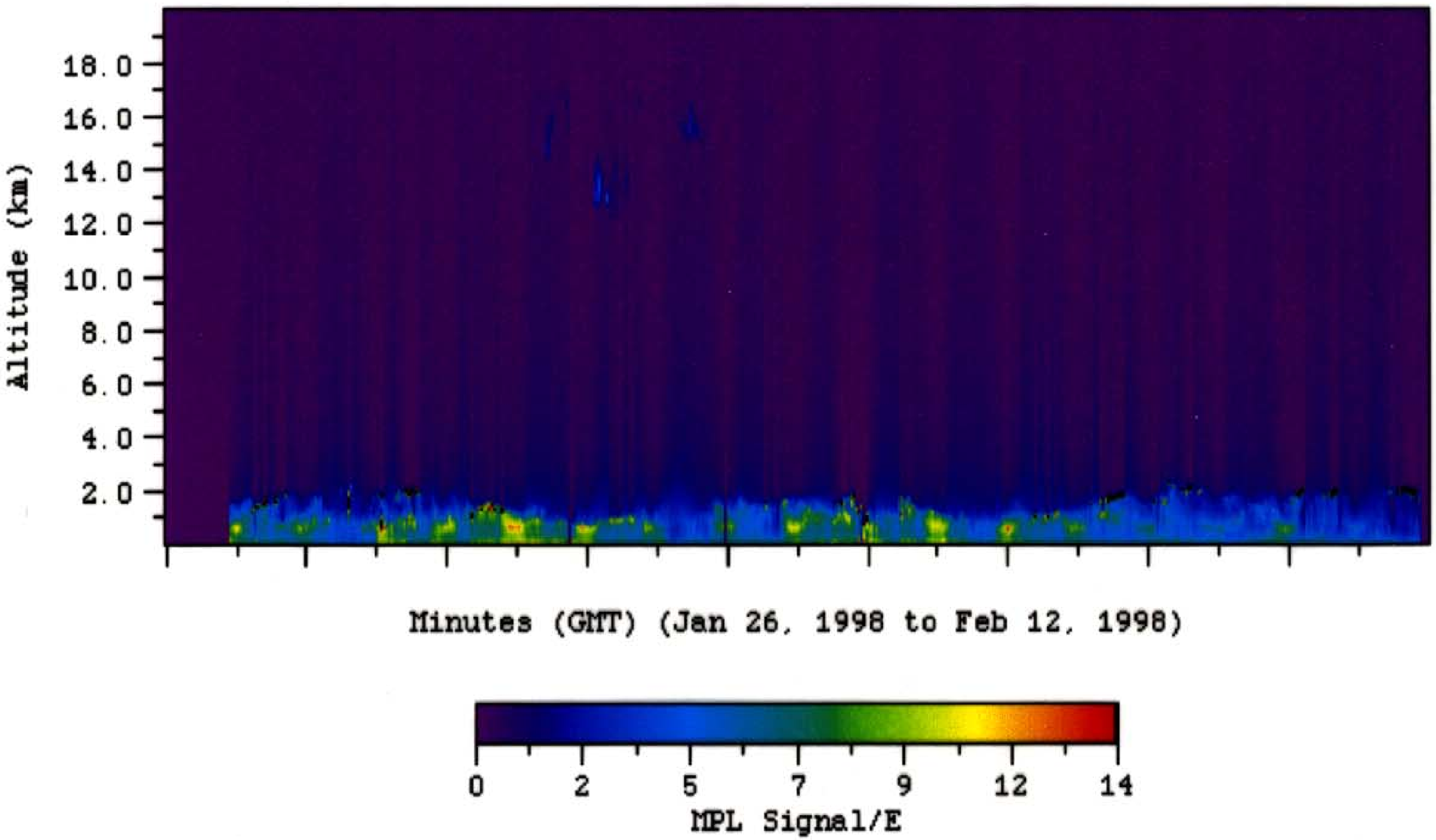


Water-leaving Reflectance
0.1
0.01
0.001
0.0001
0.00001
rho_w
400
500
600
700
800
900
Wavelength (nm)
2--1
4--1
6--1
8--1
9--1
12--1
14--1
16--1
7--1

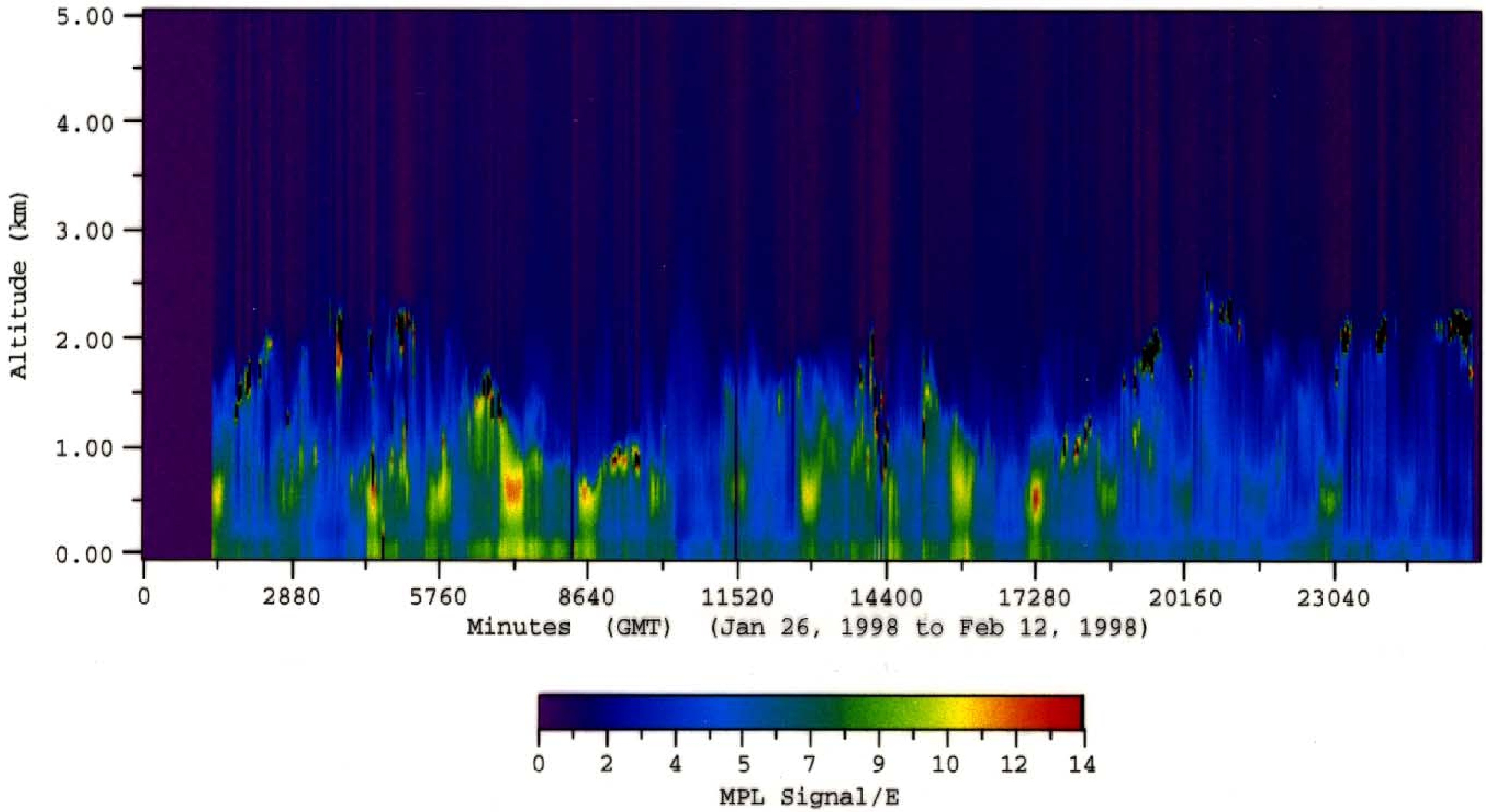


rho_t - rho_r -t*rho_w (Uncorrected)
0.1
0.01
0.001
rho_A
400
500
600
700
800
900
Wavelength (nm)
2--1
4--1
6--1
8--1
9--1
12--1
14--1
16--1
7--1

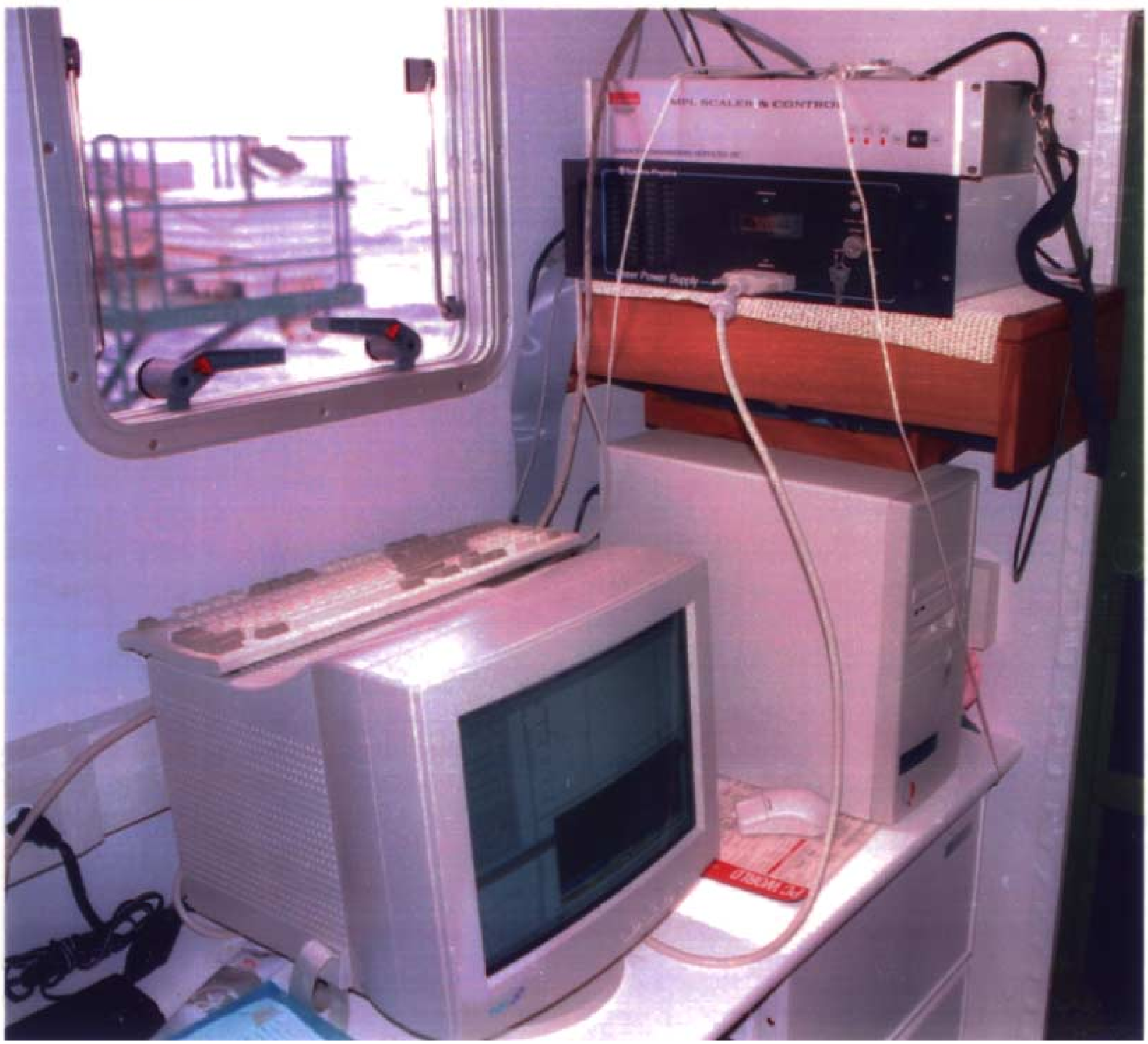

0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
300
400
500
600
700
800
Wavelength (nm)
1--1
1--2
2--1
3--1
3--2
4--1
5--1
5--2
6--1
7--1
8--1
9--1
10--1
11--1
11--2
12--1
13--1
13--2
14--1
15--1
15--2
16--1
17--1



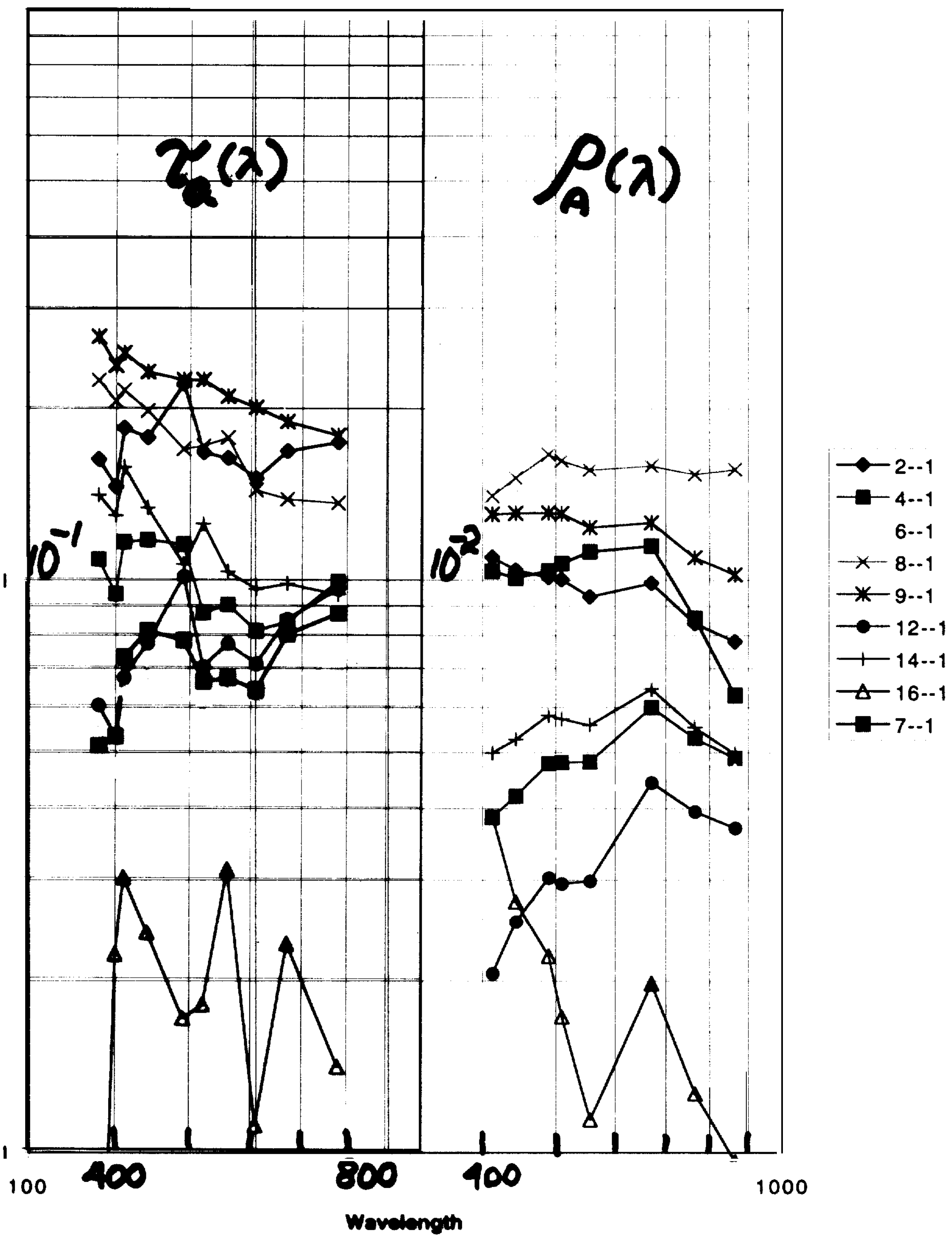
- MOCE-4 MPL data from Jan 26 to Feb 12, 1998. The signals have been divided by the output energy, E.
- Each major and minor tickmark, at 0000 GMT (1400 HST), separates the days.

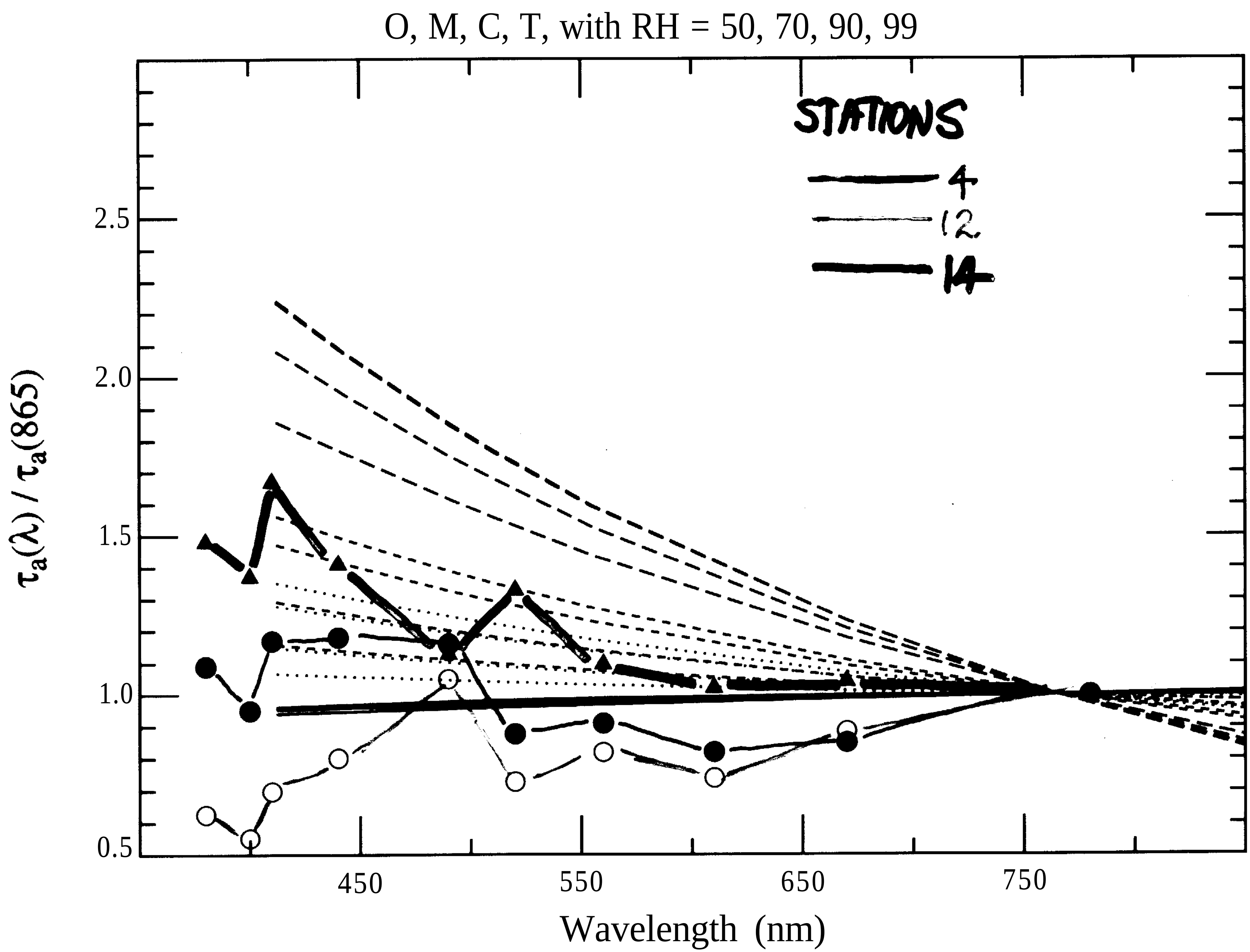


5.00
4.00
3.00
2.00
1.00
0.00
Altitude (km)
0
2880
5760
8640
11520
14400
17280
20160
23040
Minutes (GMT) (Jan 26, 1998 to Feb 12, 1998)
0
2
4
5
7
9
10
12
14
MPL Signal/E


MPL SCALER & CONTRO

rho_A (Uncorrected, O2-Corr, t*-Ray)





O, M, C, T, with RH = 50, 70, 90, 99
STATIONS
4
12
14
2.5
2.0
1.5
1.0
0.5
$\tau_a(\lambda) / \tau_a(865)$
450
550
650
750
Wavelength (nm)

wavelength = 412 nm

Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	0.02	-0.06	-0.25	-0.36	-0.10	-0.42	-0.77	-0.91
12	-0.37	-0.47	-0.70	-0.78	-0.41	-0.67	-1.04	-1.16
14	0.88	0.68	0.25	0.14	0.80	0.40	-0.27	-0.44

wavelength = 443 nm

Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	0.17	0.02	-0.31	-0.48	-0.01	-0.42	-0.92	-1.11
12	-0.20	-0.38	-0.73	-0.84	-0.28	-0.62	-1.13	-1.29
14	1.22	0.89	0.28	0.13	1.09	0.55	-0.33	-0.55

wavelength = 490 nm

Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	0.61	0.33	-0.25	-0.54	0.33	-0.26	-1.02	-1.32
12	0.00	-0.30	-0.86	-1.09	-0.12	-0.63	-1.37	-1.62
14	2.01	1.47	0.55	0.24	1.81	1.02	-0.21	-0.57

wavelength = 510 nm

Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	0.61	0.23	-0.48	-0.82	0.19	-0.53	-1.43	-1.78
12	-0.21	-0.60	-1.29	-1.56	-0.45	-1.07	-1.94	-2.24
14	2.13	1.43	0.34	-0.02	1.79	0.83	-0.59	-1.02

wavelength = 555nm

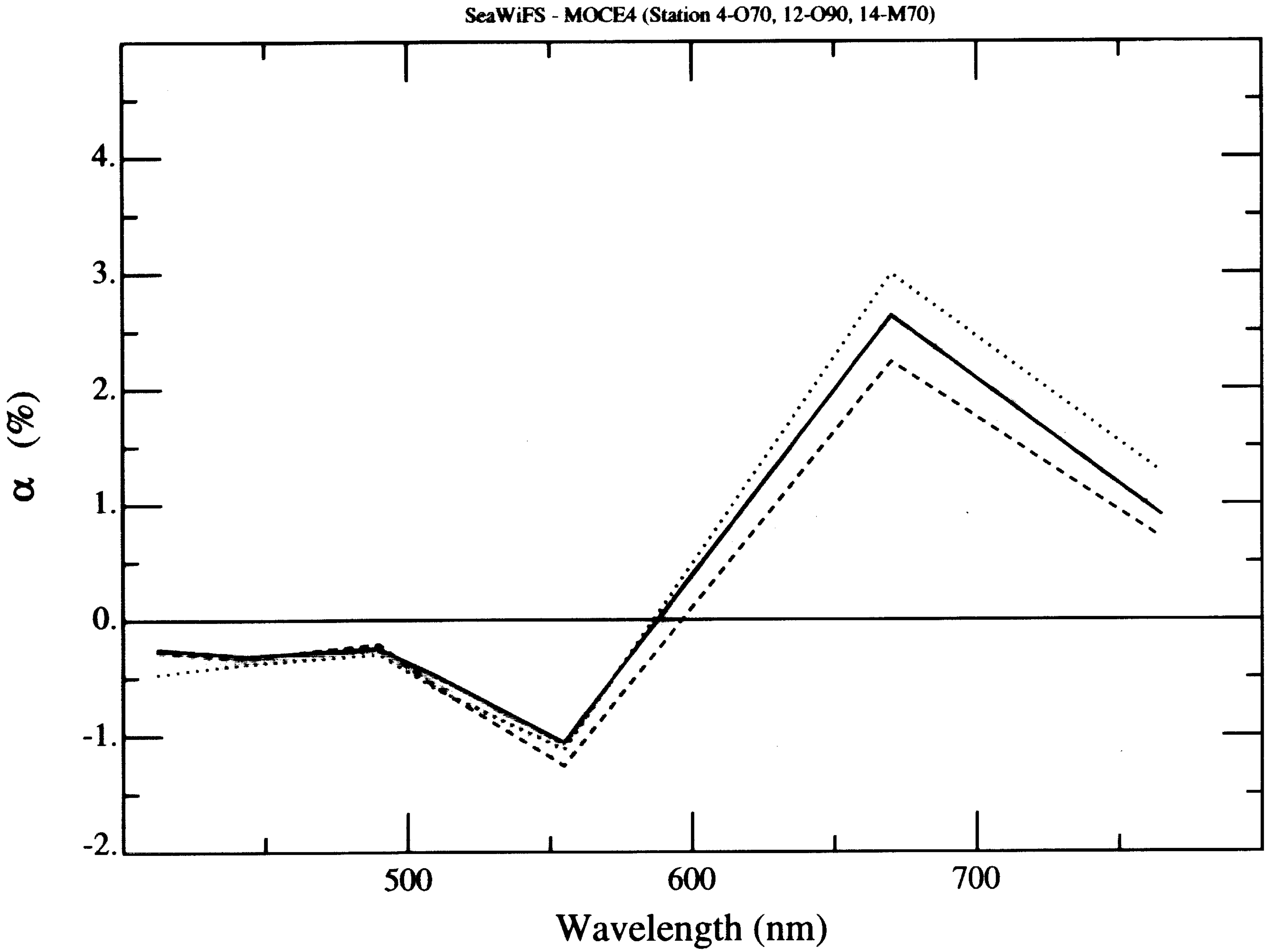
Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	0.51	0.01	-1.06	-1.50	-0.10	-0.98	-2.21	-2.64
12	-0.59	-1.12	-2.10	-2.46	-1.00	-1.77	-2.92	-3.30
14	2.29	1.36	-0.13	-0.62	1.78	0.56	-1.26	-1.81

wavelength = 670 nm

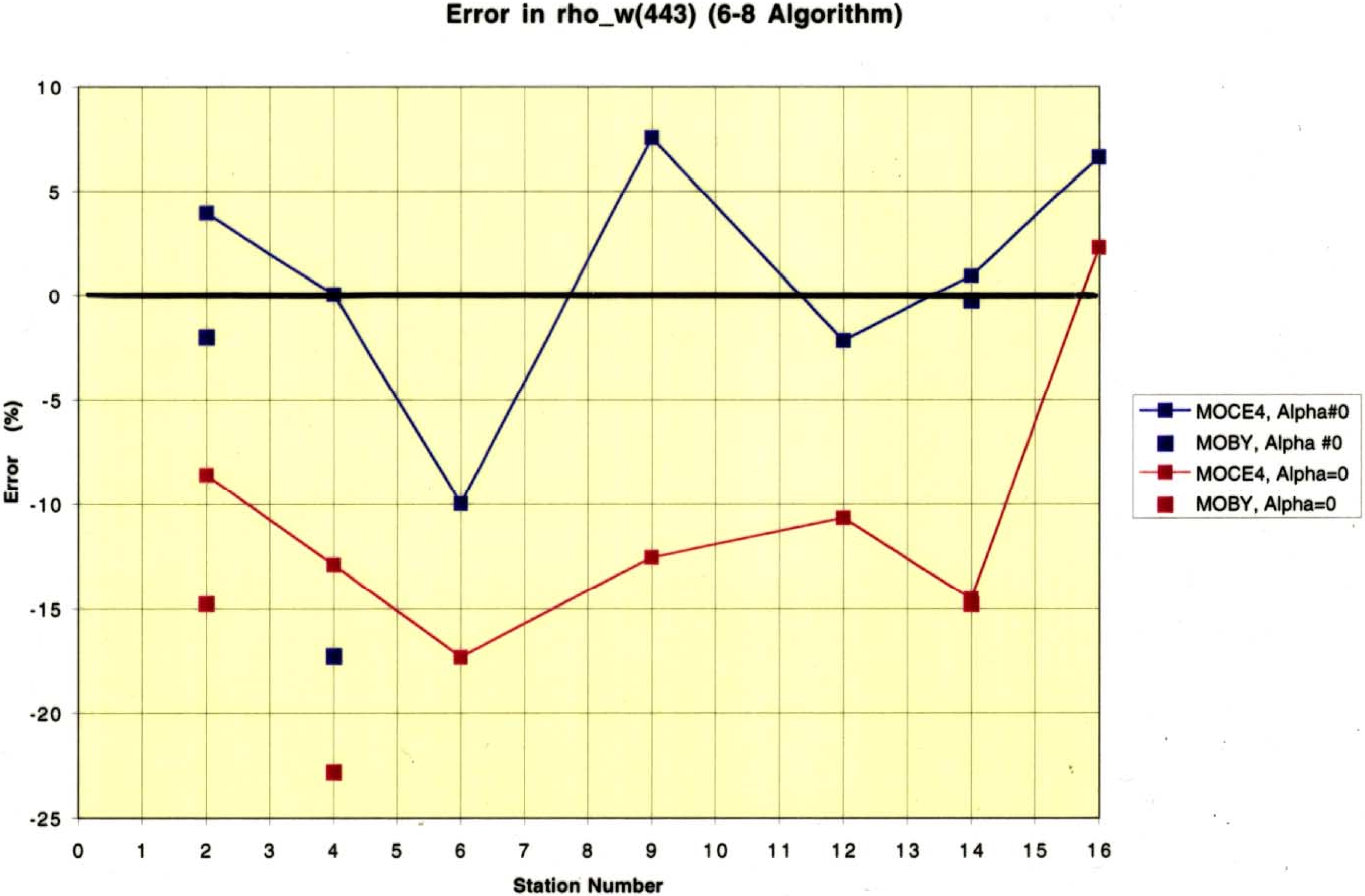
Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	4.97	4.14	2.63	2.08	4.11	2.90	1.26	0.73
12	3.86	2.99	1.63	1.17	3.23	2.11	0.59	0.12
14	6.96	5.52	3.58	3.01	6.22	4.51	2.23	1.60

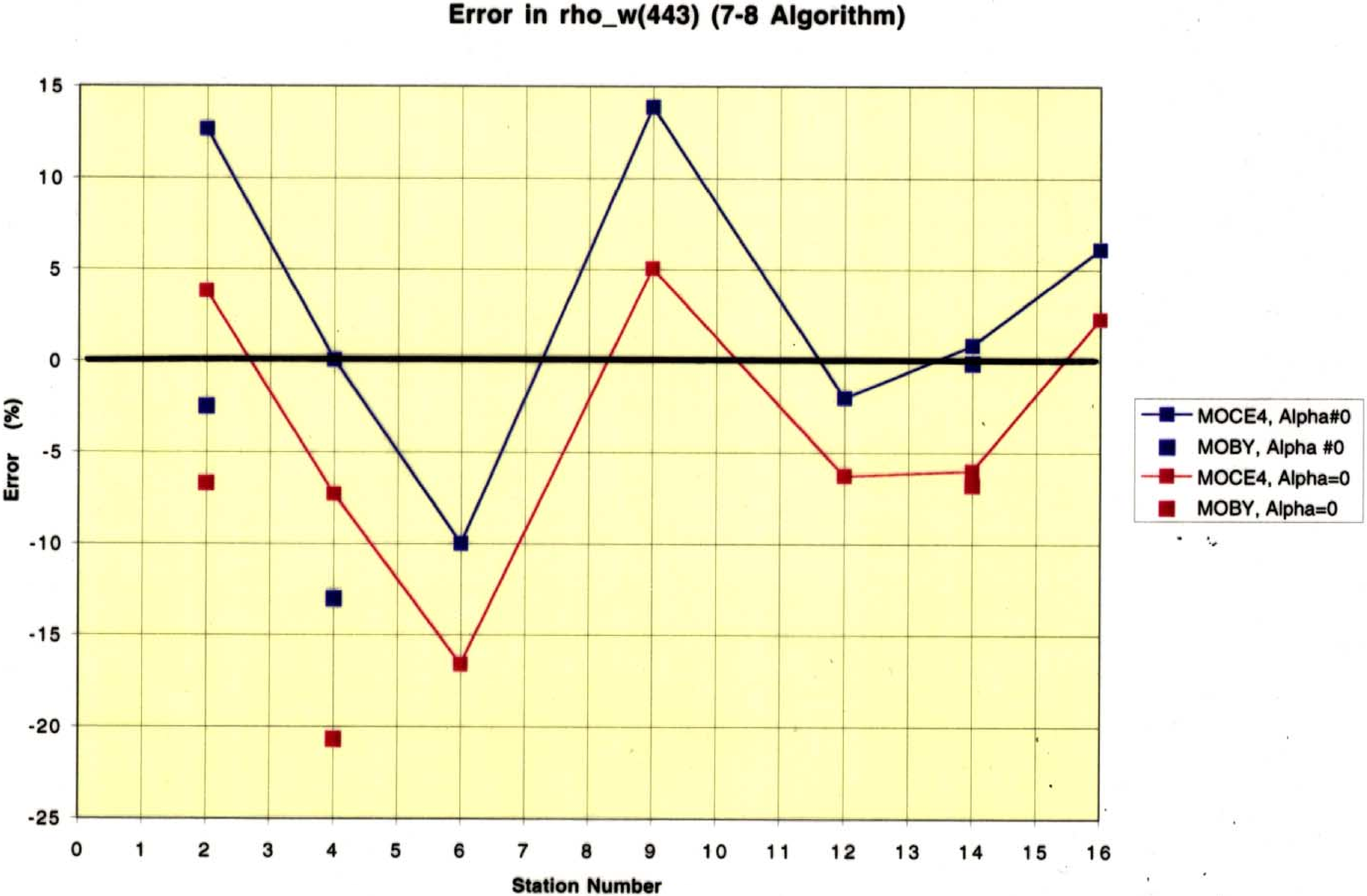
wavelength = 765 nm

Sta.	O99	O90	O70	O50	M99	M90	M70	M50
4	2.55	1.90	0.90	0.48	2.00	1.13	0.07	-0.34
12	1.96	1.27	0.35	-0.01	1.54	0.71	-0.30	-0.66
14	3.83	2.76	1.51	1.06	3.36	2.13	0.70	0.22

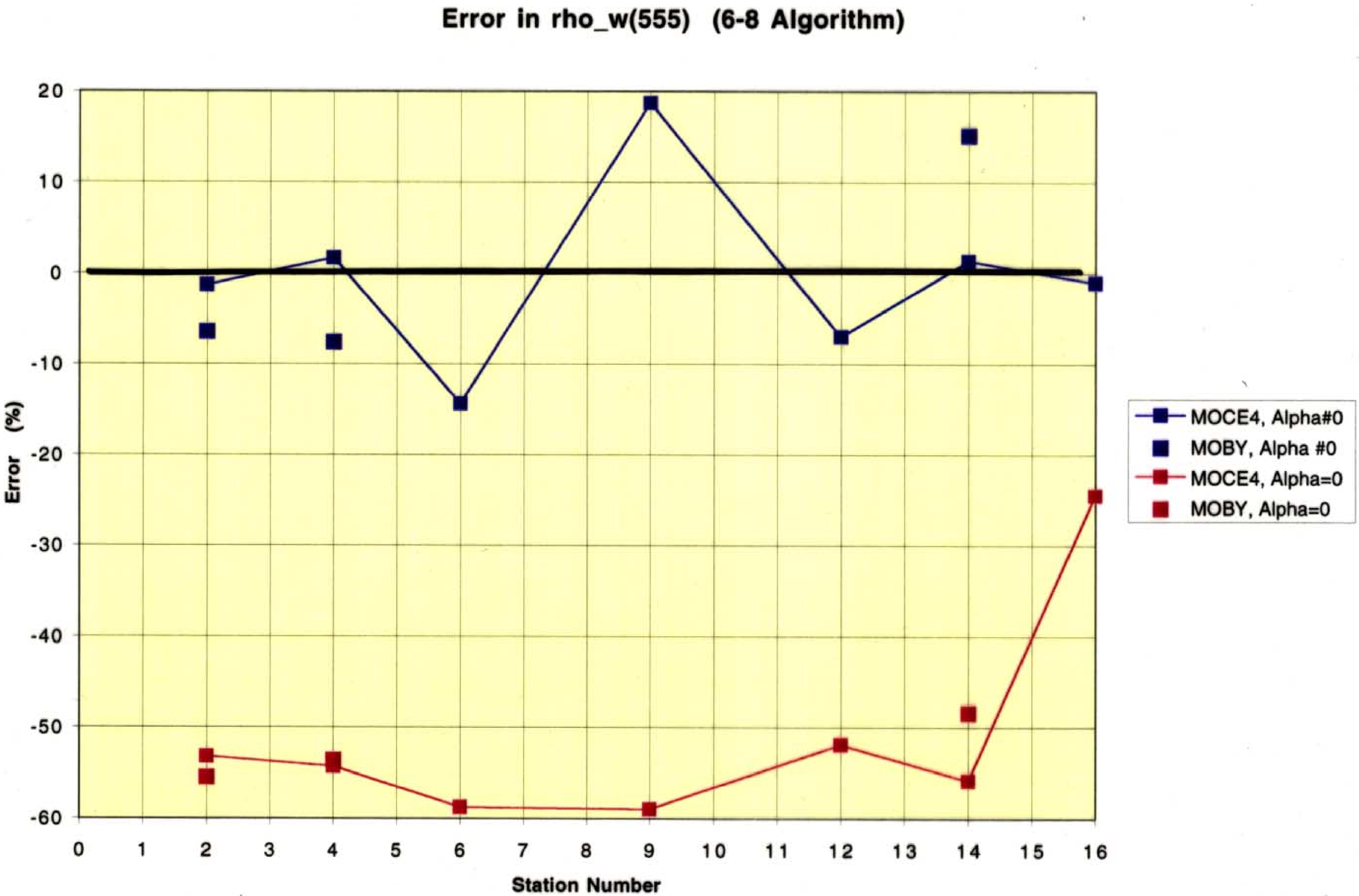


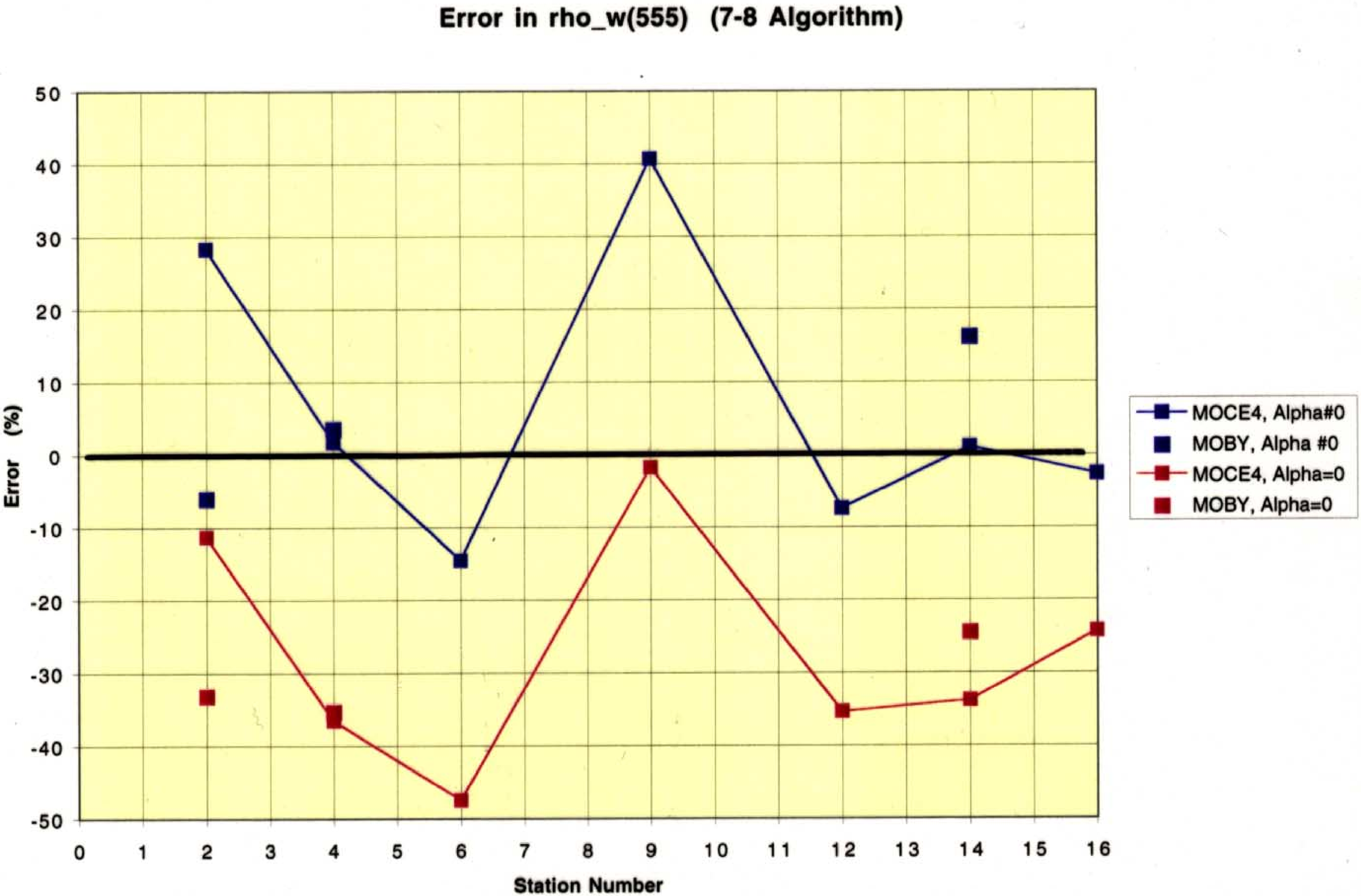
SeaWiFS - MOCE4 (Station 4-O70, 12-O90, 14-M70)
4.
3.
2.
1.
0.
-1.
-2.
α (%)
500
600
700
Wavelength (nm)


Error in rho_w(443) (6-8 Algorithm)
10
5
0
-5
-10
-15
-20
-25
Error (%)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Station Number
MOCE4, Alpha#0
MOBY, Alpha #0
MOCE4, Alpha=0
MOBY, Alpha=0

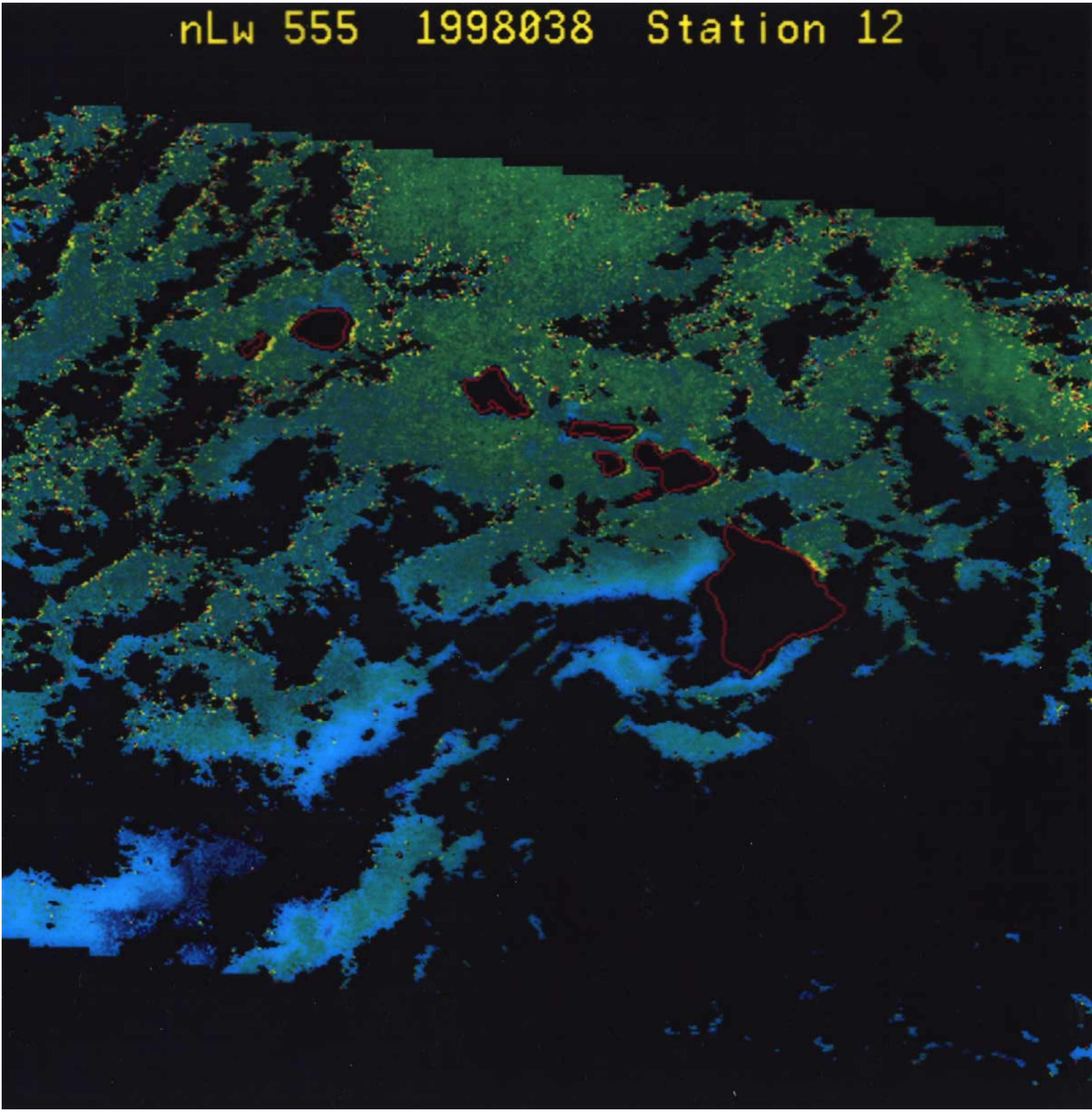


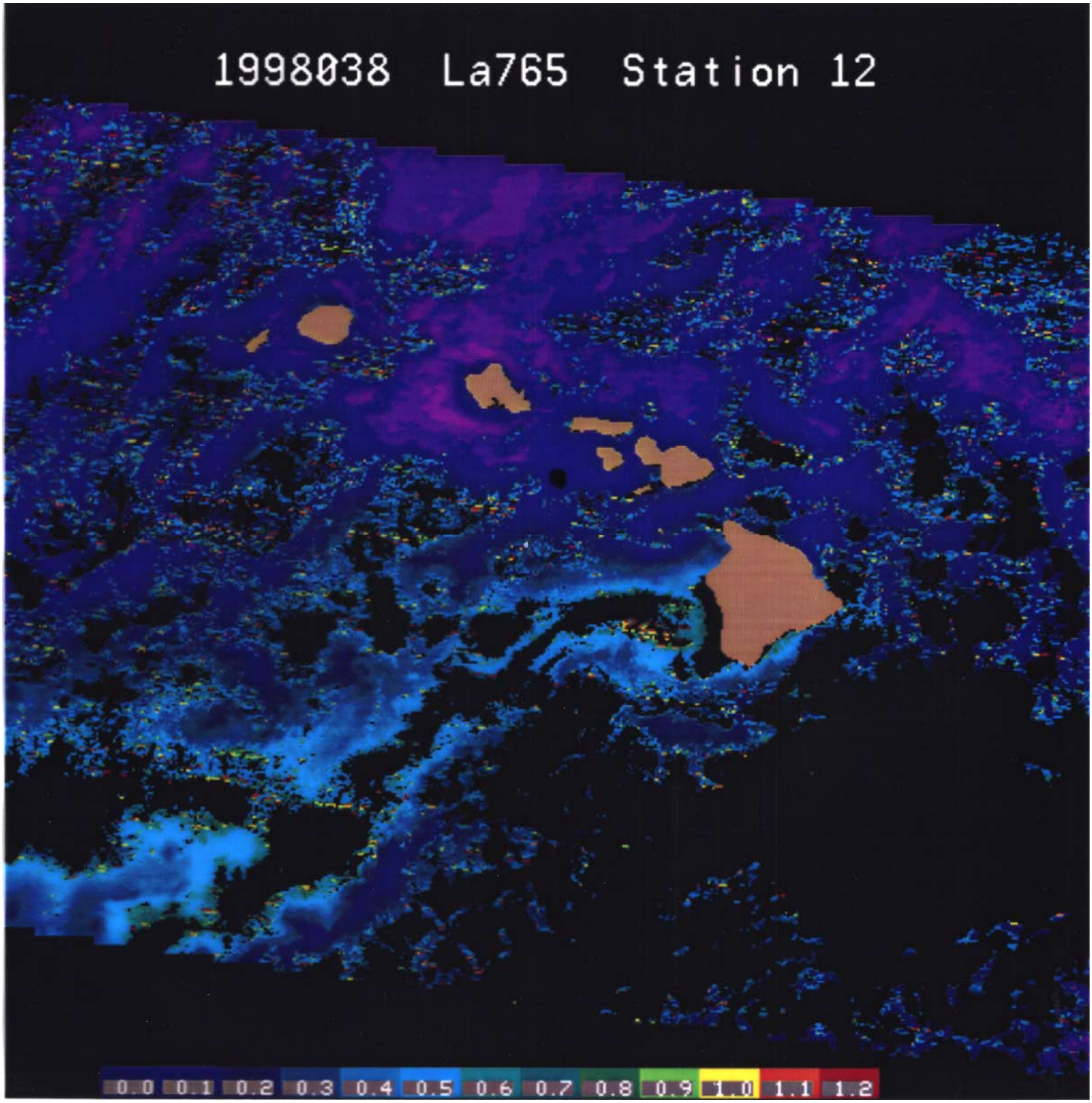
Error in rho_w(443) (7-8 Algorithm)
15
10
5
0
-5
-10
-15
-20
-25
Error (%)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Station Number
MOCE4, Alpha#0
MOBY, Alpha #0
MOCE4, Alpha=0
MOBY, Alpha=0

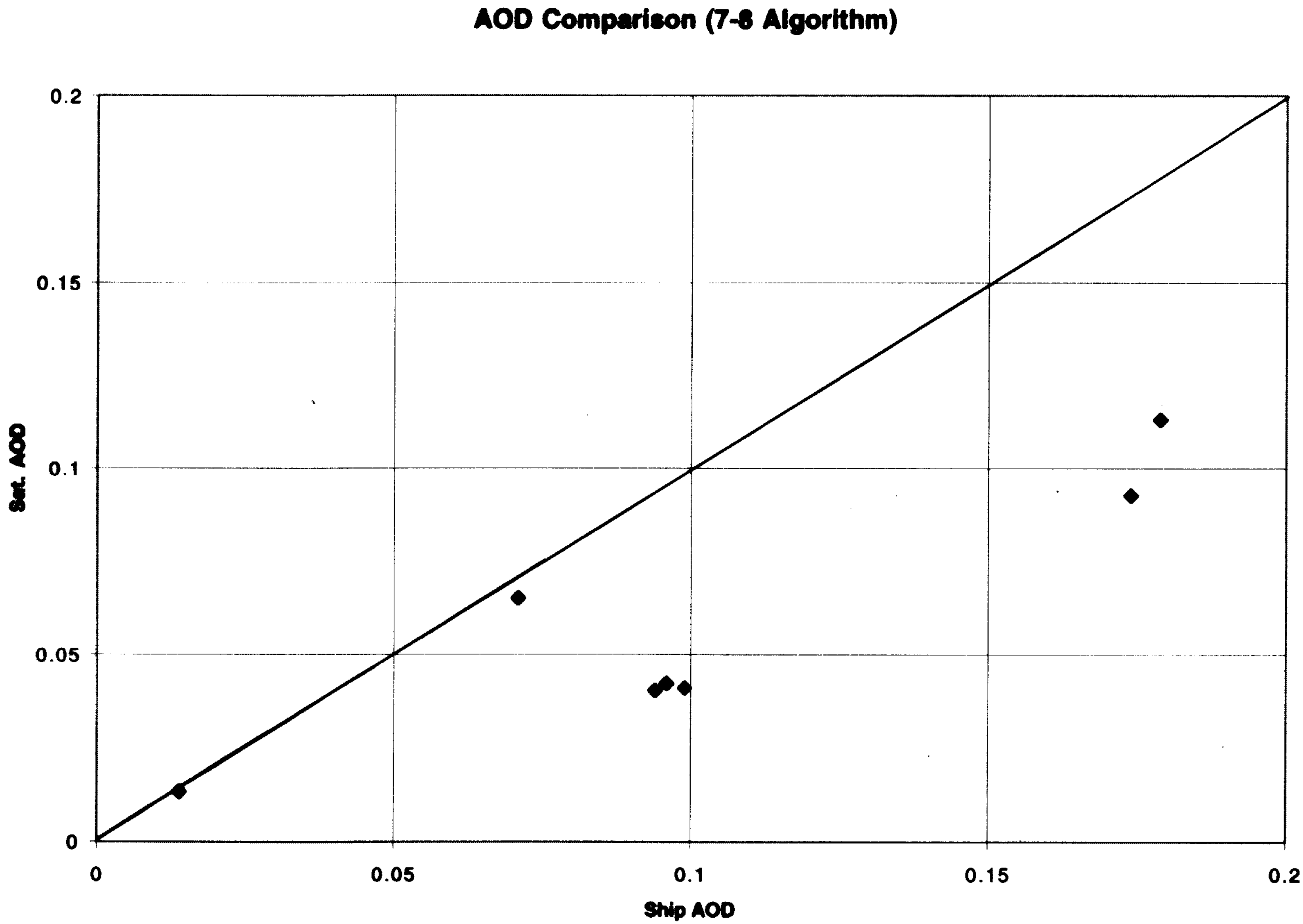

Error in rho_w(555) (6-8 Algorithm)
20
10
0
-10
-20
-30
-40
-50
-60
Error (%)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Station Number
MOCE4, Alpha#0
MOBY, Alpha #0
MOCE4, Alpha=0
MOBY, Alpha=0



Error in rho_w(555) (7-8 Algorithm)
50
40
30
20
10
0
-10
-20
-30
-40
-50
Error (%)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Station Number
MOCE4, Alpha#0
MOBY, Alpha #0
MOCE4, Alpha=0
MOBY, Alpha=0


nLw 555 1998038 Station 12


1998038 La765 Station 12
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2

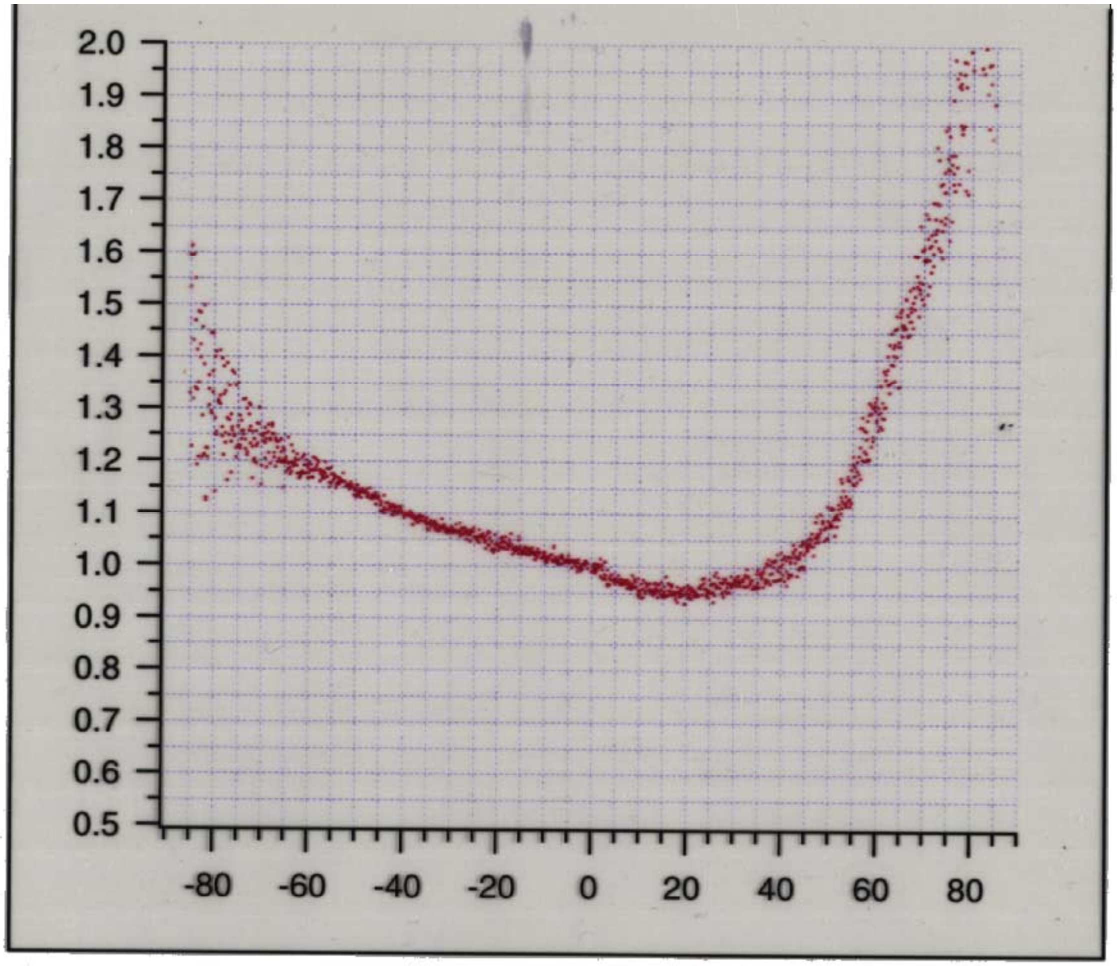

AOD Comparison (7-8 Algorithm)
0.2
0.15
0.1
0.05
0
Sat. AOD
0
0.05
0.1
0.15
0.2
Ship AOD

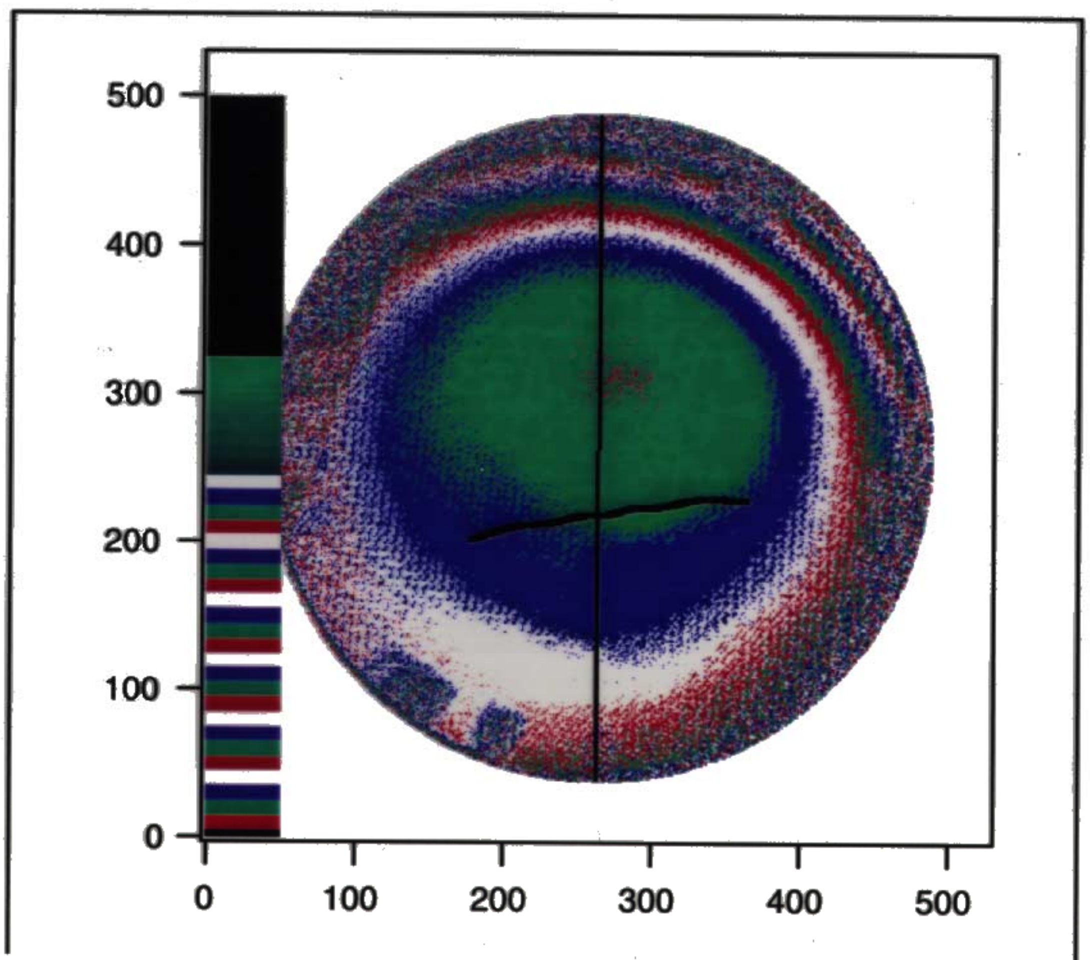
Initialization Summary

- Successful initialization exercise completed.
- Preliminary calibration of all bands relative to 865 nm completed.
- Good agreement with SeaWiFS Project calibration in the blue and blue-green using MOBY (excluding BRDF infIuence).
- Significant error at 670 and 765 nm detected.
- Need to test calibration with higher pigment concentrations.

Remaining Work on MOCE4 Initialization Data Set

- Include the BRDF (significant in the blue).
- Model the BRDF (for other solar angles and C).
- Include *C(x,y)* variation over the 3 x 3 pixels (significant in the blue).
- Try to use $L_{Sky}(q,f)$ to model pt(865) and provide α(865).
- Include stations with whitecaps.
- Understand poor estimate of Ta(865).


2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
-80
-60
-40
-20
0
20
40
60
80


500
400
300
200
100
0
0
100
200
300
400
500

MOCE 4 - SeaWiFS Initialization
Grid 6 Station 14