Simulation for Case 1 Water

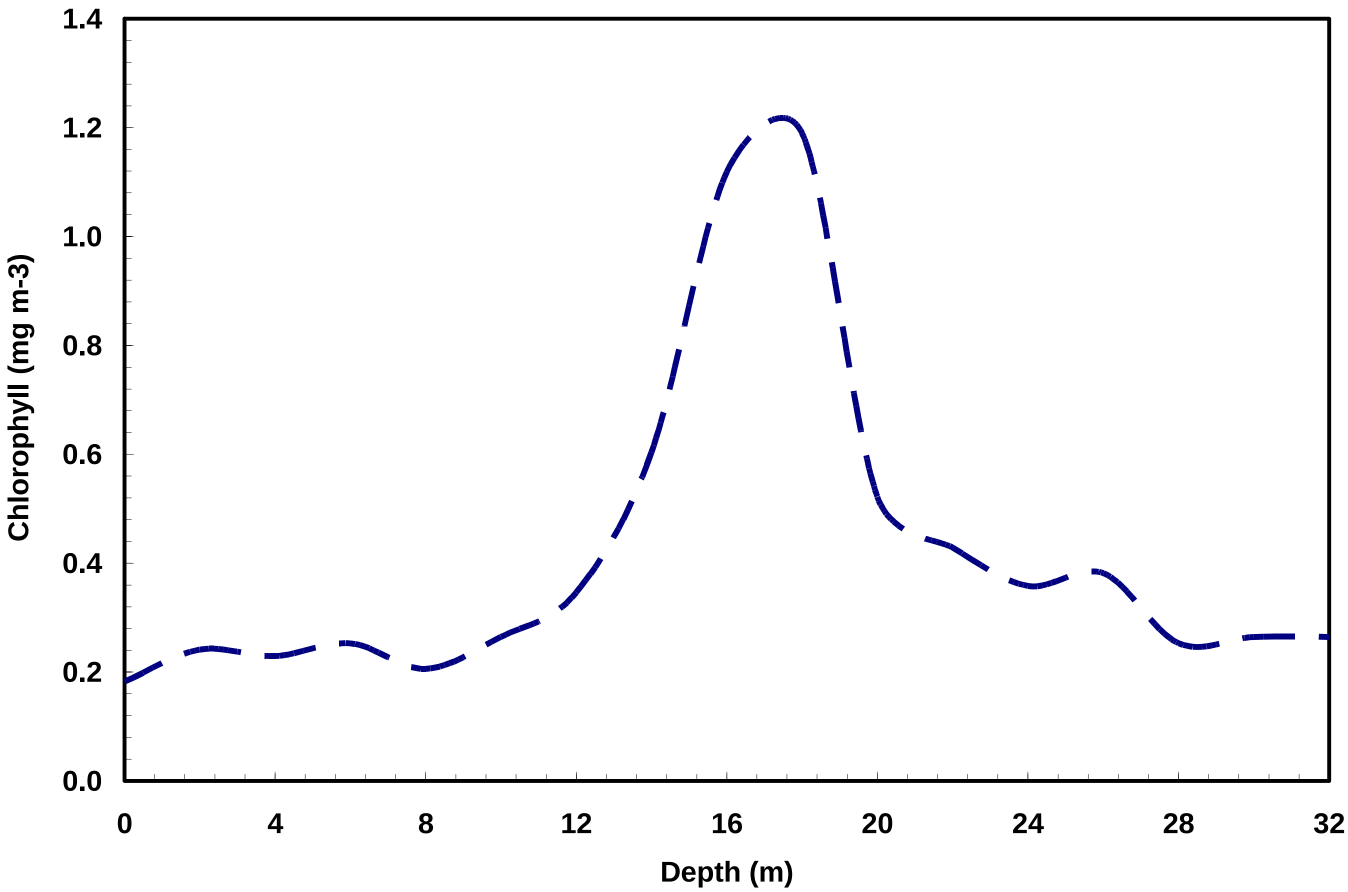
Deepak Mishra

Ocean Optics Course (2004)

Forward Technique

Simulation started by creating a depth profile of chlorophyll and assuming that the water body is Case 1, i.e. chlorophyll bearing phytoplankton and their covarying by-products are dominant in determining the IOPs of the water.

Chlorophyll Profile



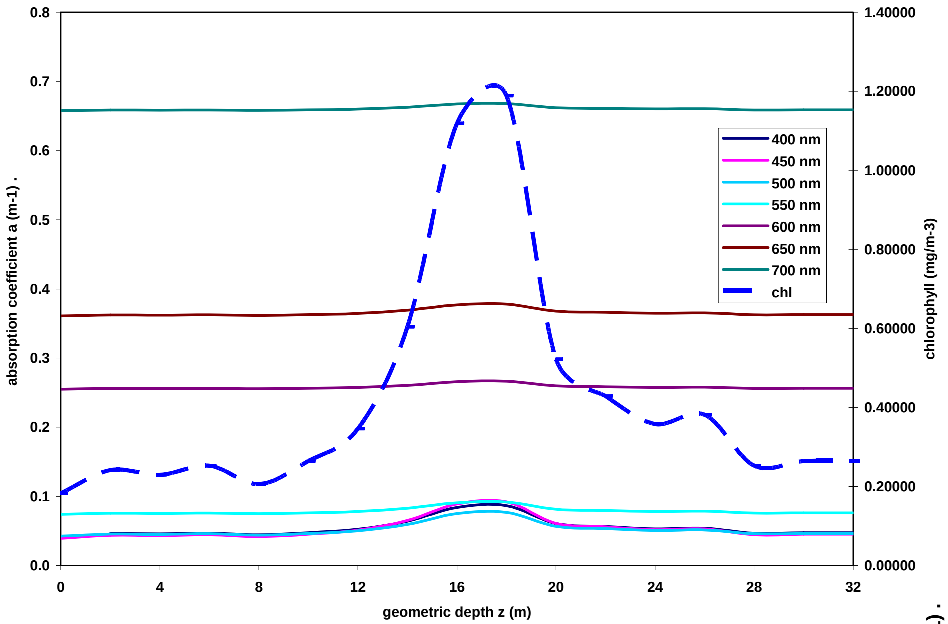
The total absorption coefficient *a*(*z*;*λ*) is obtained from Prieur-Sathyendranath (1981) model upon substitution of the assumed C(z) profile.

The model is given by:

$$a(\lambda) = [a_w(\lambda) + 0.06 a_c^{*'}(\lambda) C^{0.65}][1 + 0.2 \exp(-0.014(\lambda - 440))]$$

where,

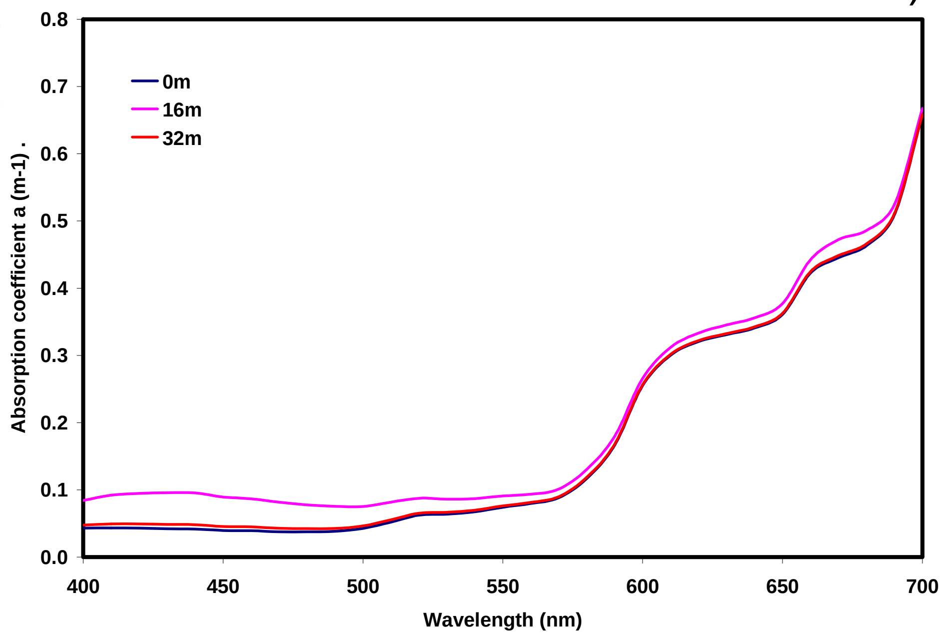
a_w and $a_c^{*'}$ are absorption by pure sea water and chlorophyll specific absorption coefficient respectively. (Taken from Prieur and Sathyendranath, 1981) a)



a) $a(z;\lambda)$ as a function of depth for selected wavelength

b) $a(z;\lambda)$ as a function of wavelength for selected depth

b)

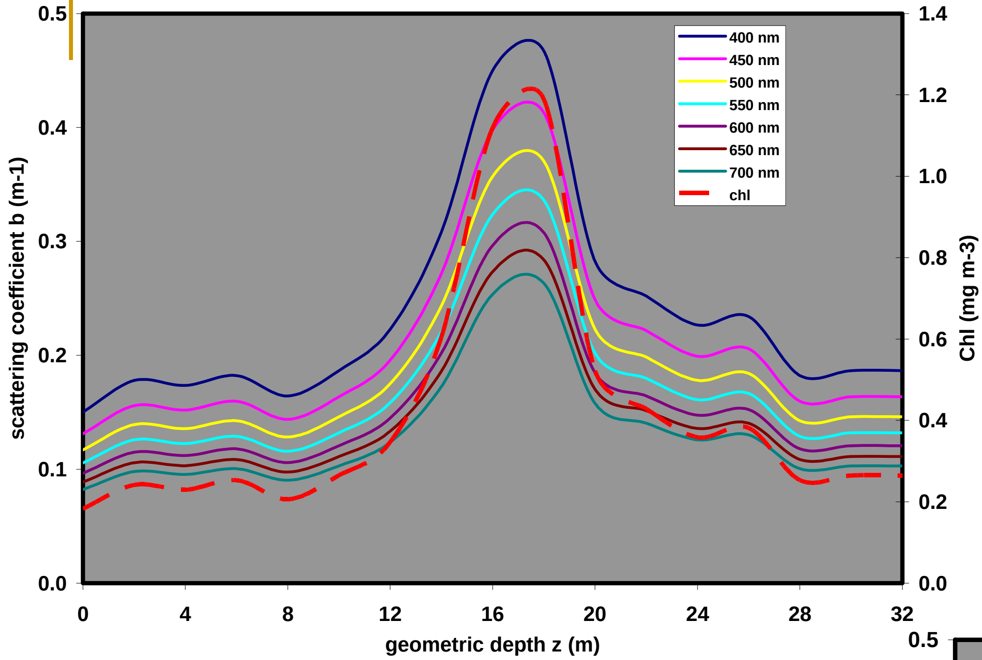


The total scattering coefficient $b(z;\lambda)$ is obtained from Gordon-Morel (1983) model upon substitution of the assumed C(z) profile.

The model is given by:

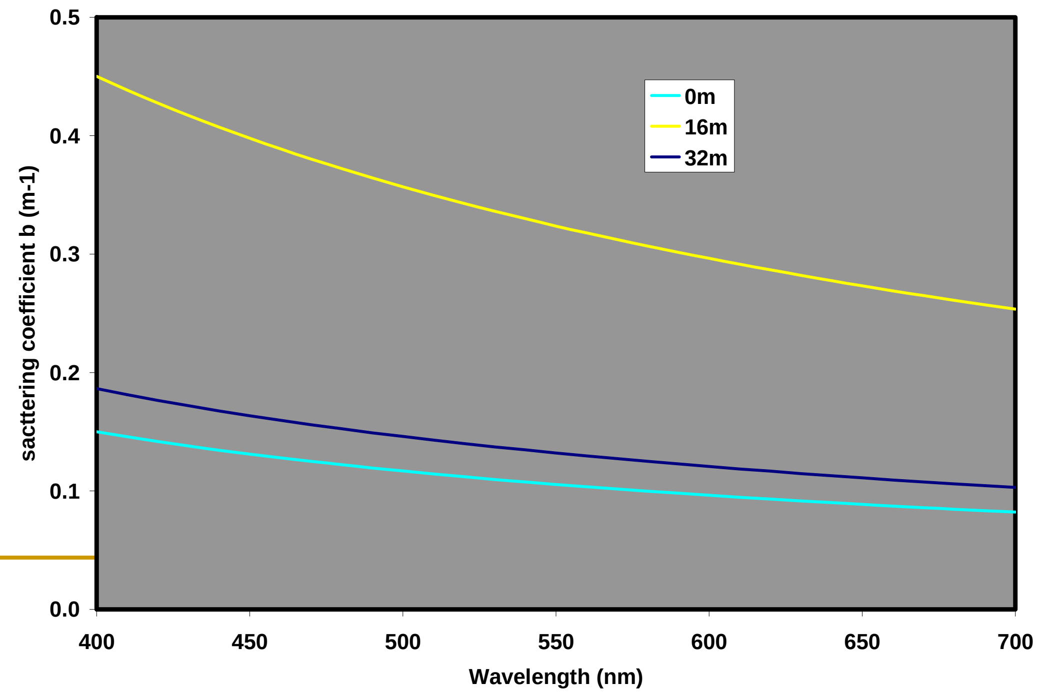
$$b(\lambda) = \left(\frac{550}{\lambda}\right) 0.30 C^{0.62}$$

a)



a) $b(z;\lambda)$ as a function of depth for selected wavelength

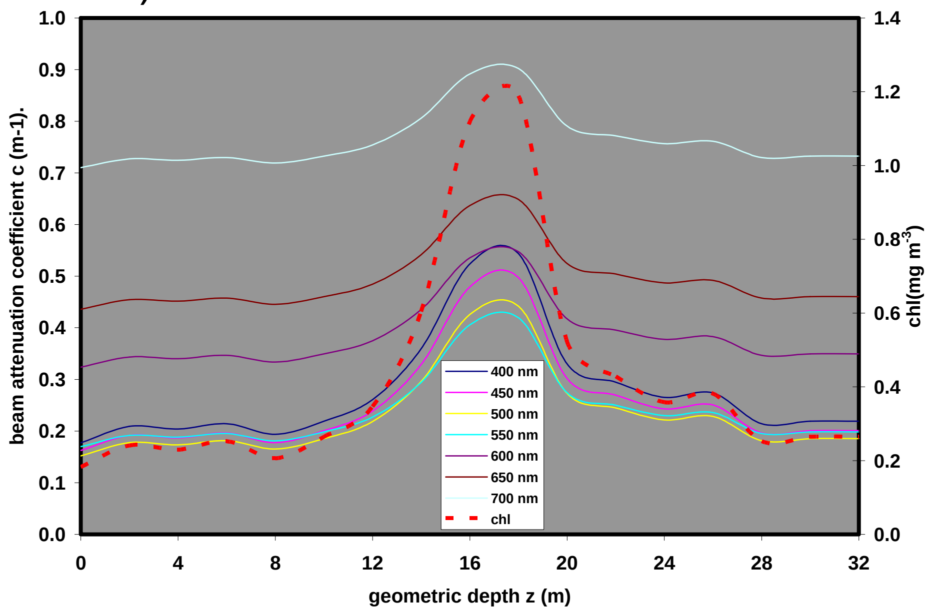
b)



b) $b(z;\lambda)$ as a function of wavelength for selected depth

Beam attenuation coefficient c(z;λ)

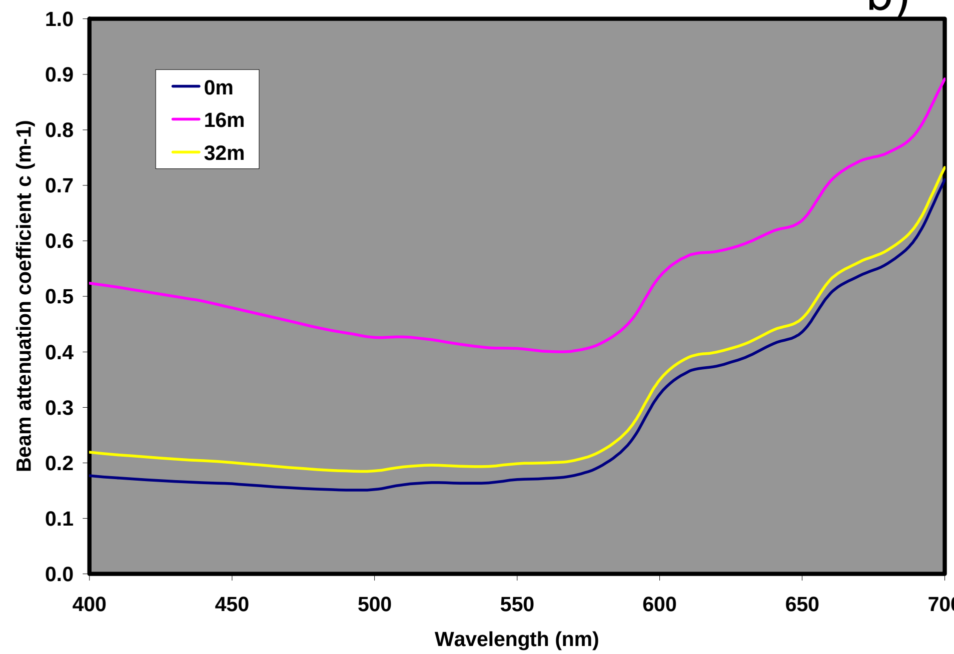
a)



a) $c(z;\lambda)$ as a function of depth for selected wavelength

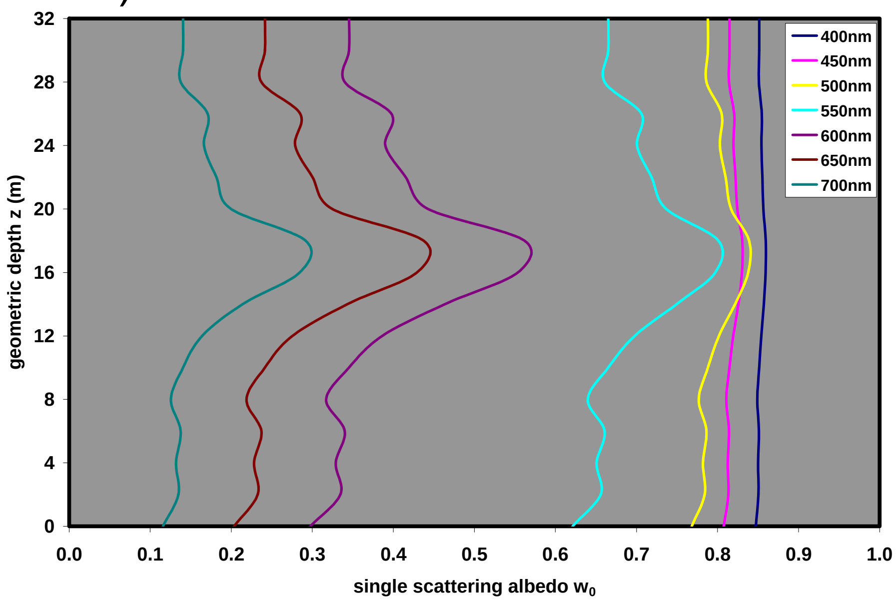
b) $c(z;\lambda)$ as a function of wavelength for selected depth

b)



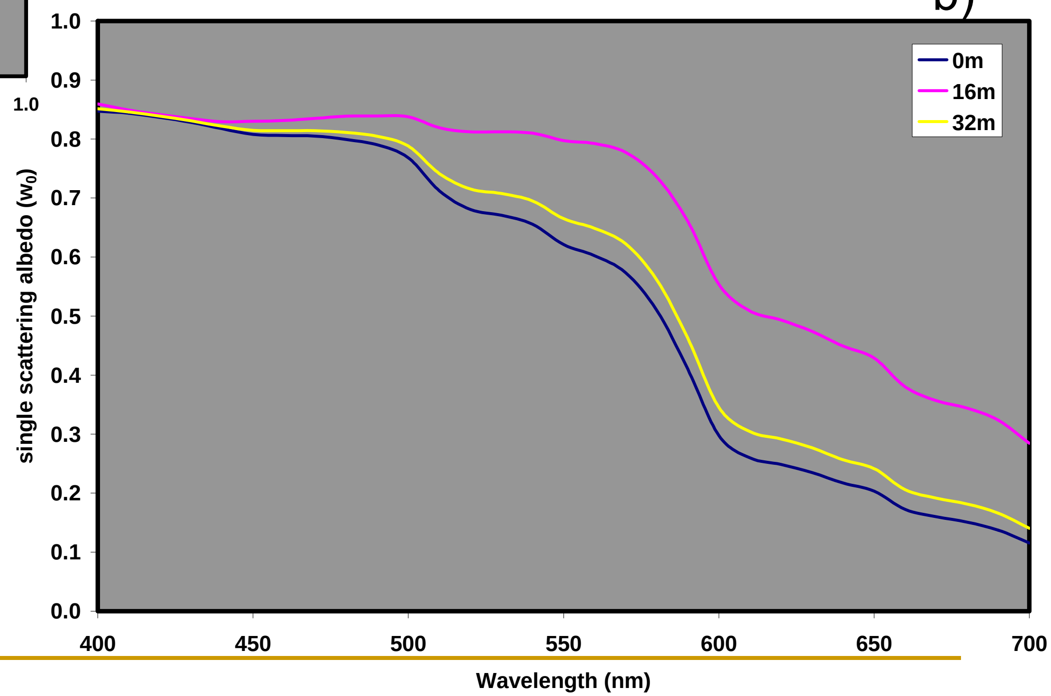
Albedo of single scattering $\omega_o(z;\lambda)$

a)



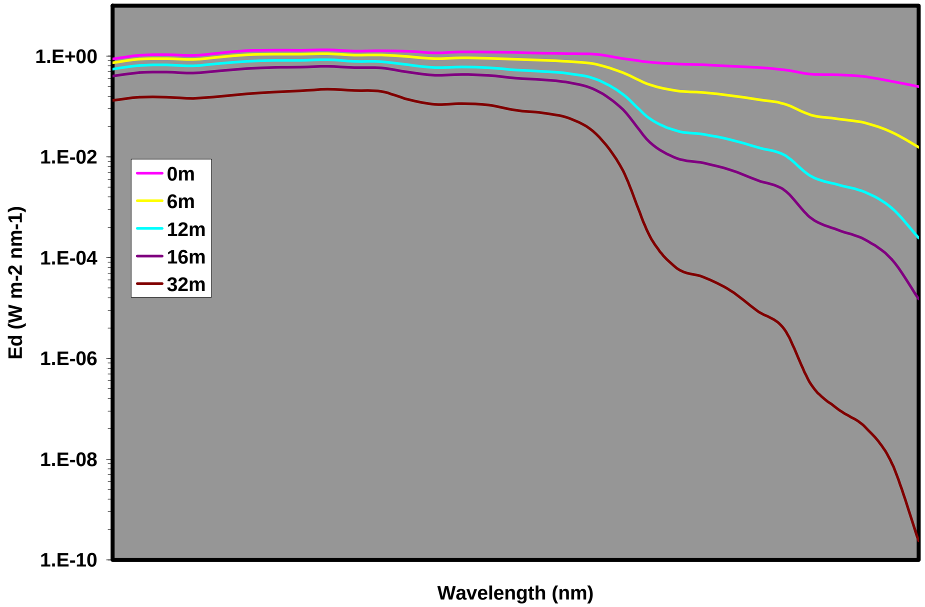
a) $w_0(z;\lambda)$ as a function of depth for selected wavelength

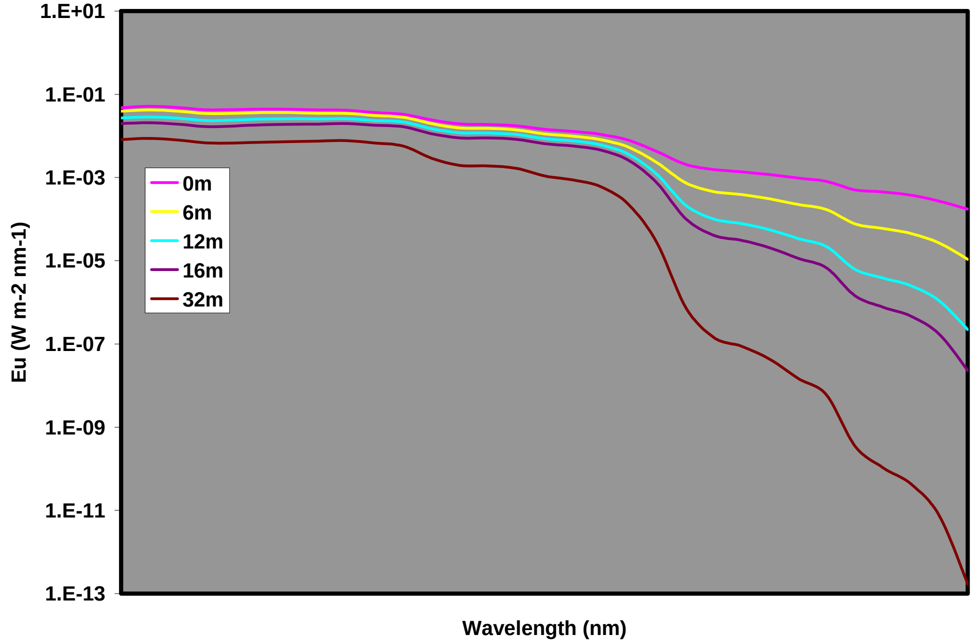
b)



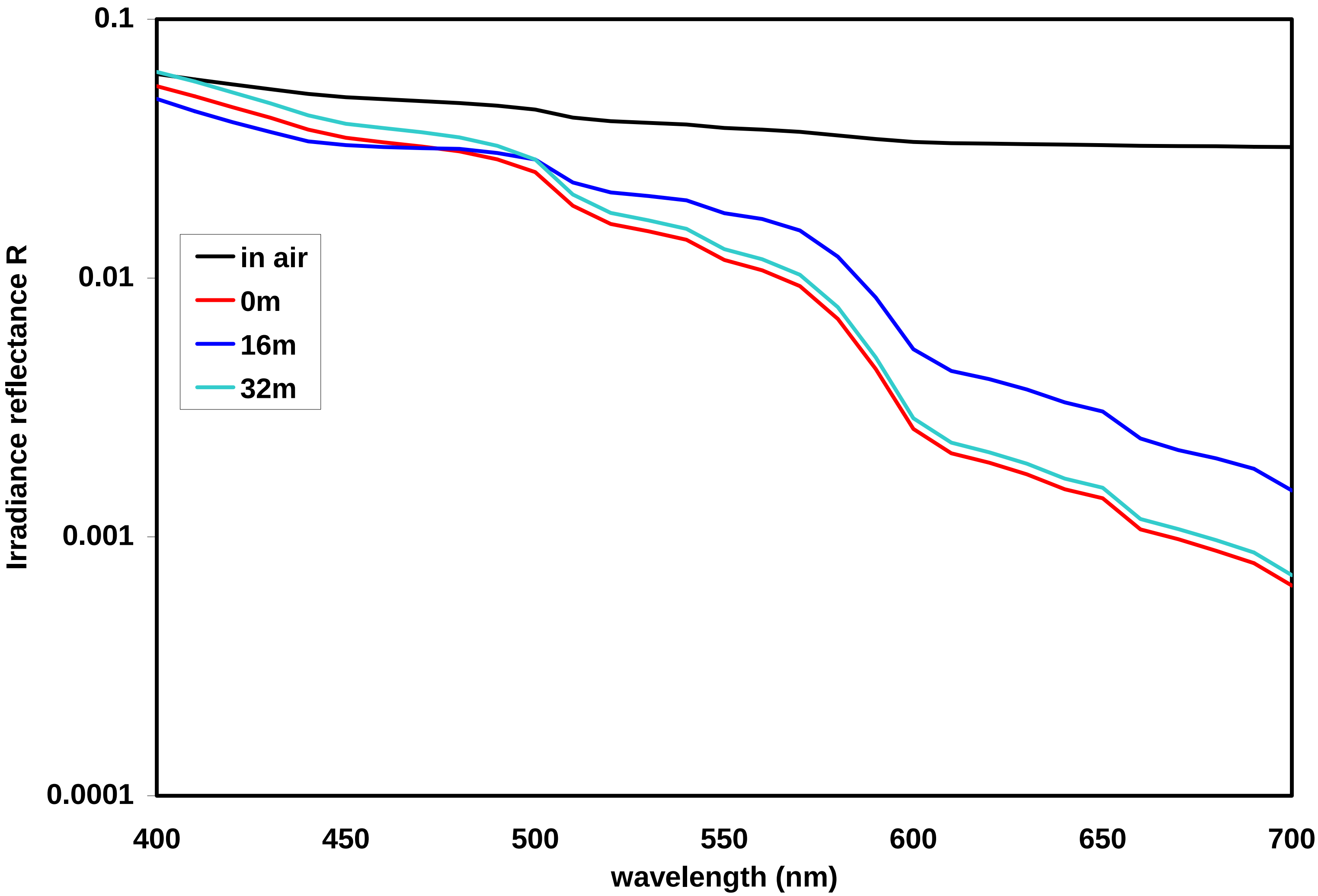
b) $w_0(z;\lambda)$ as a function of wavelength for selected depth

Spectral downward and upward plane irradiances at selected depth

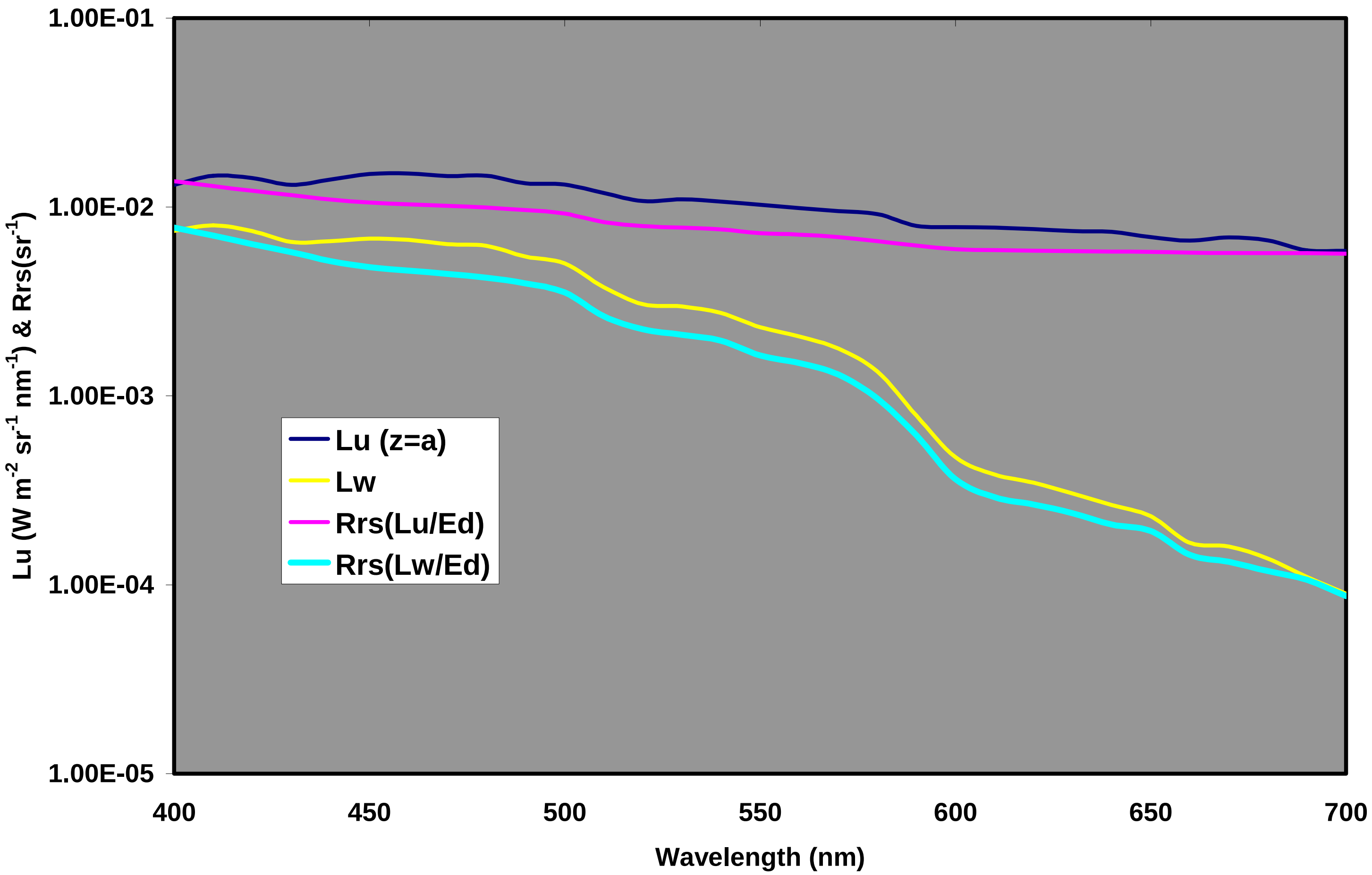




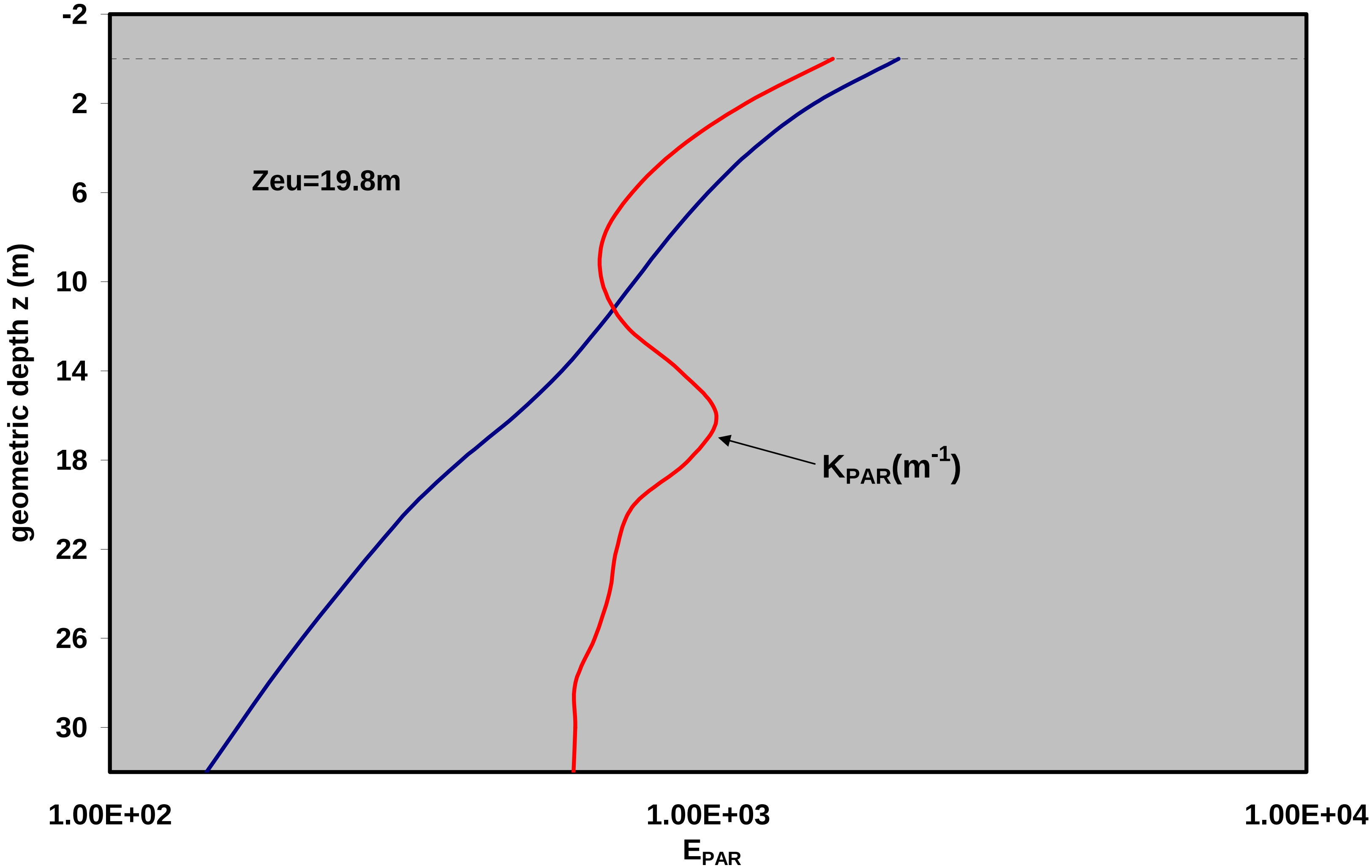
Irradiance Reflectance



Water leaving radiance and Remote sensing reflectance



PAR



-2
2
6
10
14
18
22
26
30
geometric depth z (m)
Zeu=19.8m
K_PAR(m^-1)
1.00E+02
1.00E+03
1.00E+04
E_PAR

Inversion Technique

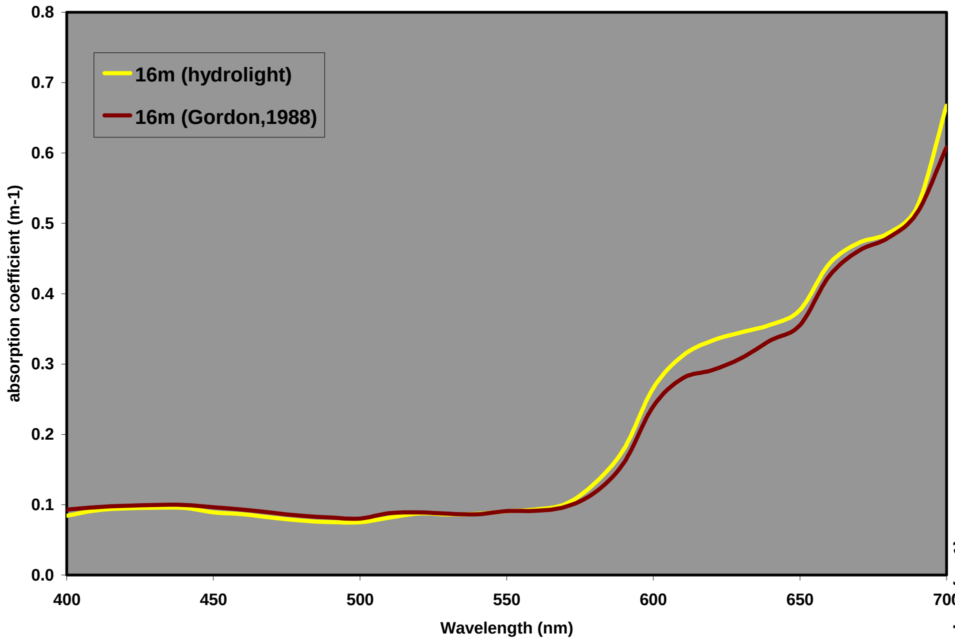
- IOPs (absorption and backscattering coefficients) from AOPs (K_d an d Rrs)
- Gordon, *et al*. (1988) showed that for Case 1 waters, R/Q ratio can be useful to exploit the theoretical relationship between the Rrs and the inherent optical properties, specifically b_b and a.
- R = Irradiance reflectance
- Q = Eu/Lu, provides information about the angular distribution of the upwelling light field

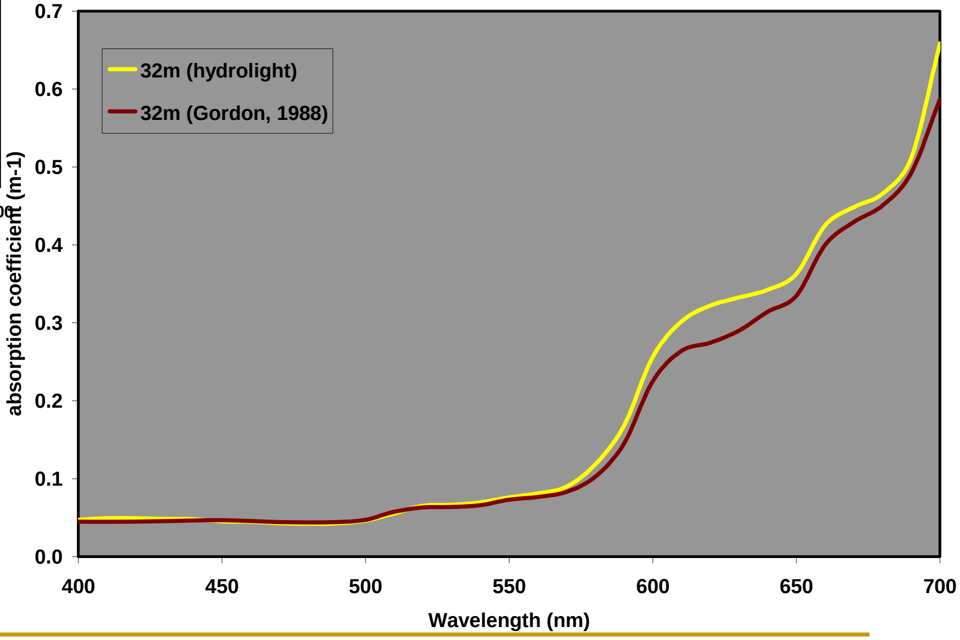
Gordon's approximation

- For Case 1 waters

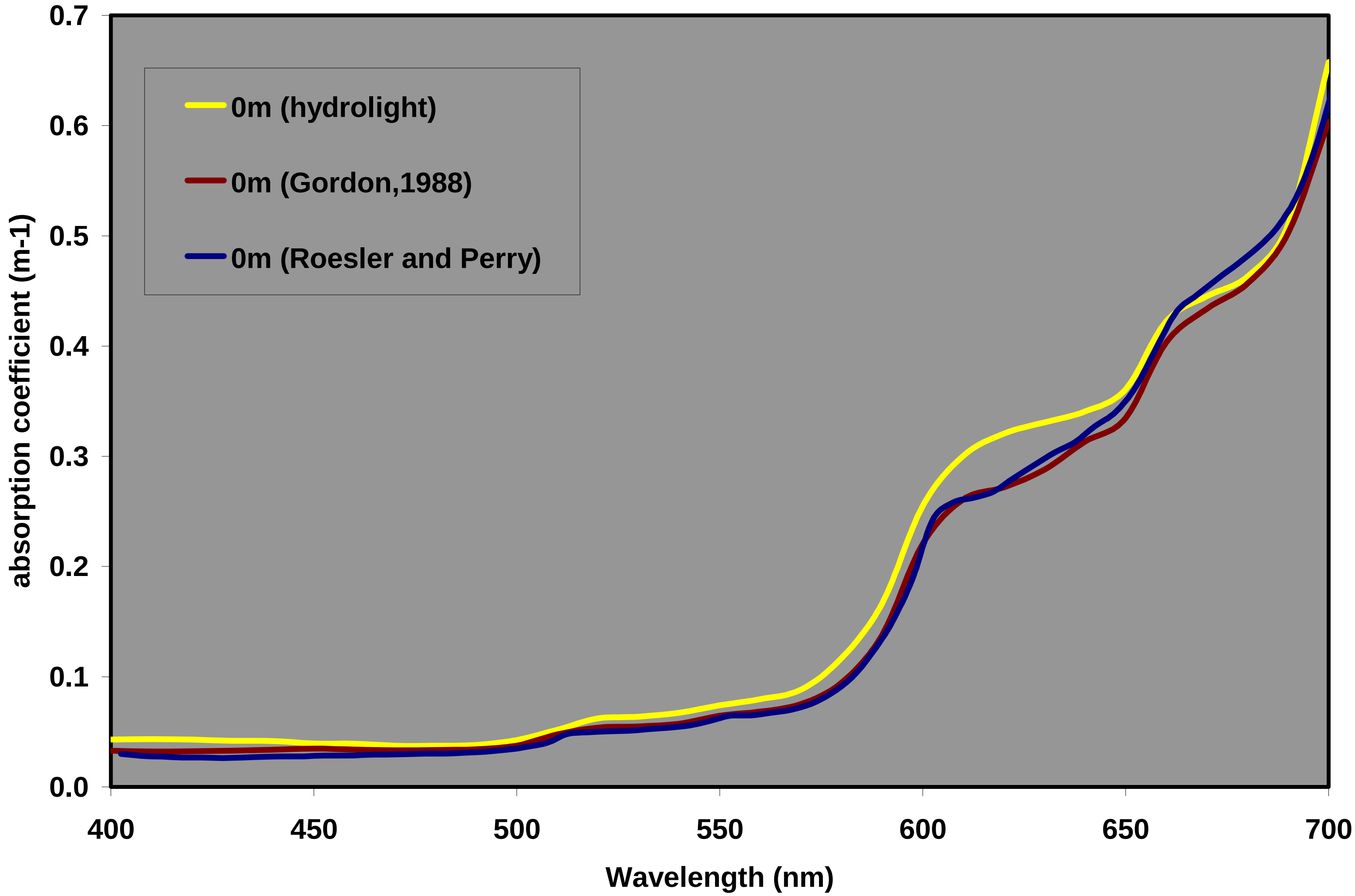
- $Rrs \approx 0.54(R/Q)$
- $R/Q \approx 0.095\ (b_b\ /(a+b_b))$
- $R/Q \approx 0.11(b_b/K_d)$

IOP retrieval (absorption coefficient)

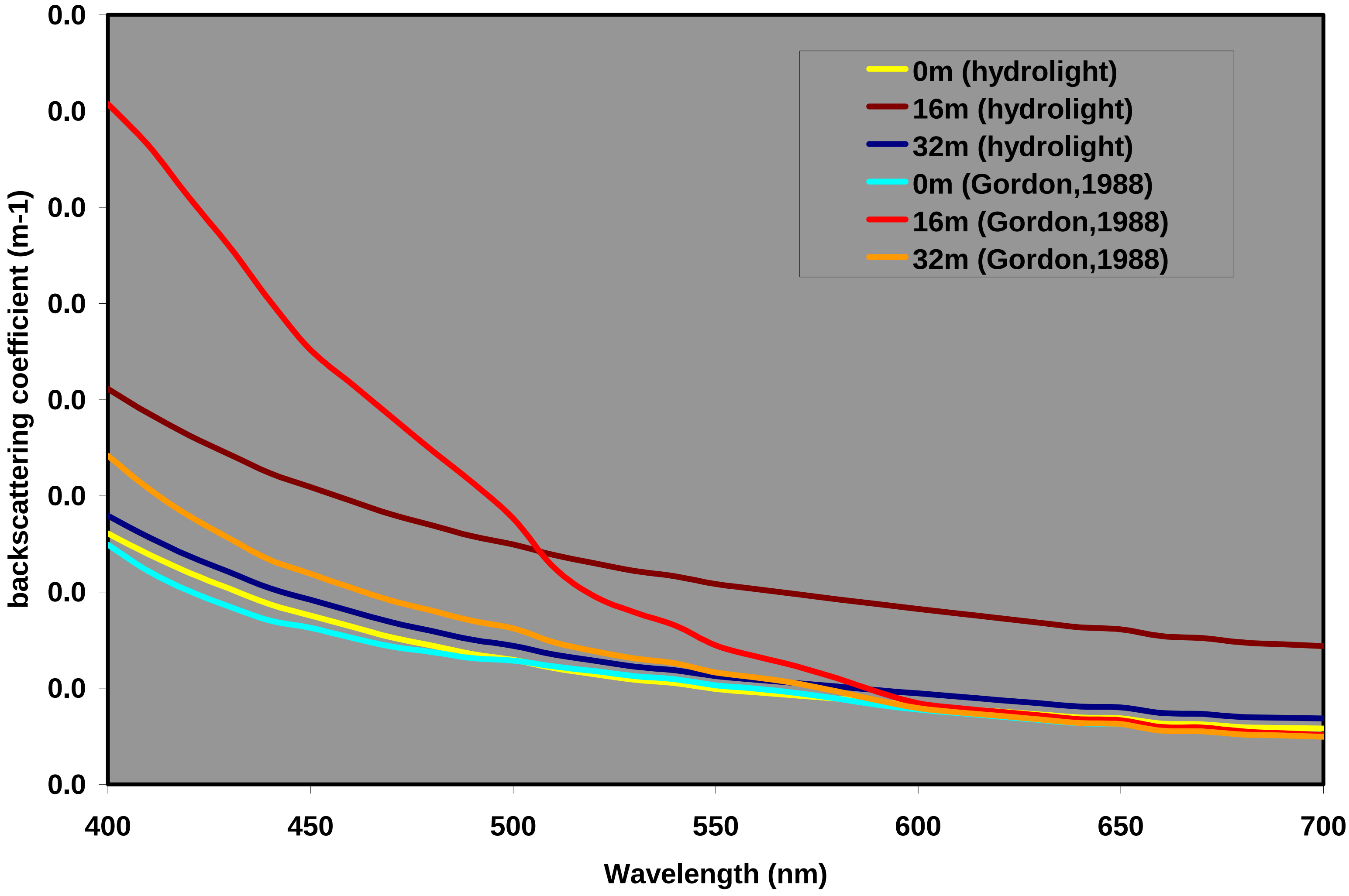




Absorption coefficient comparison



Backscattering coefficient



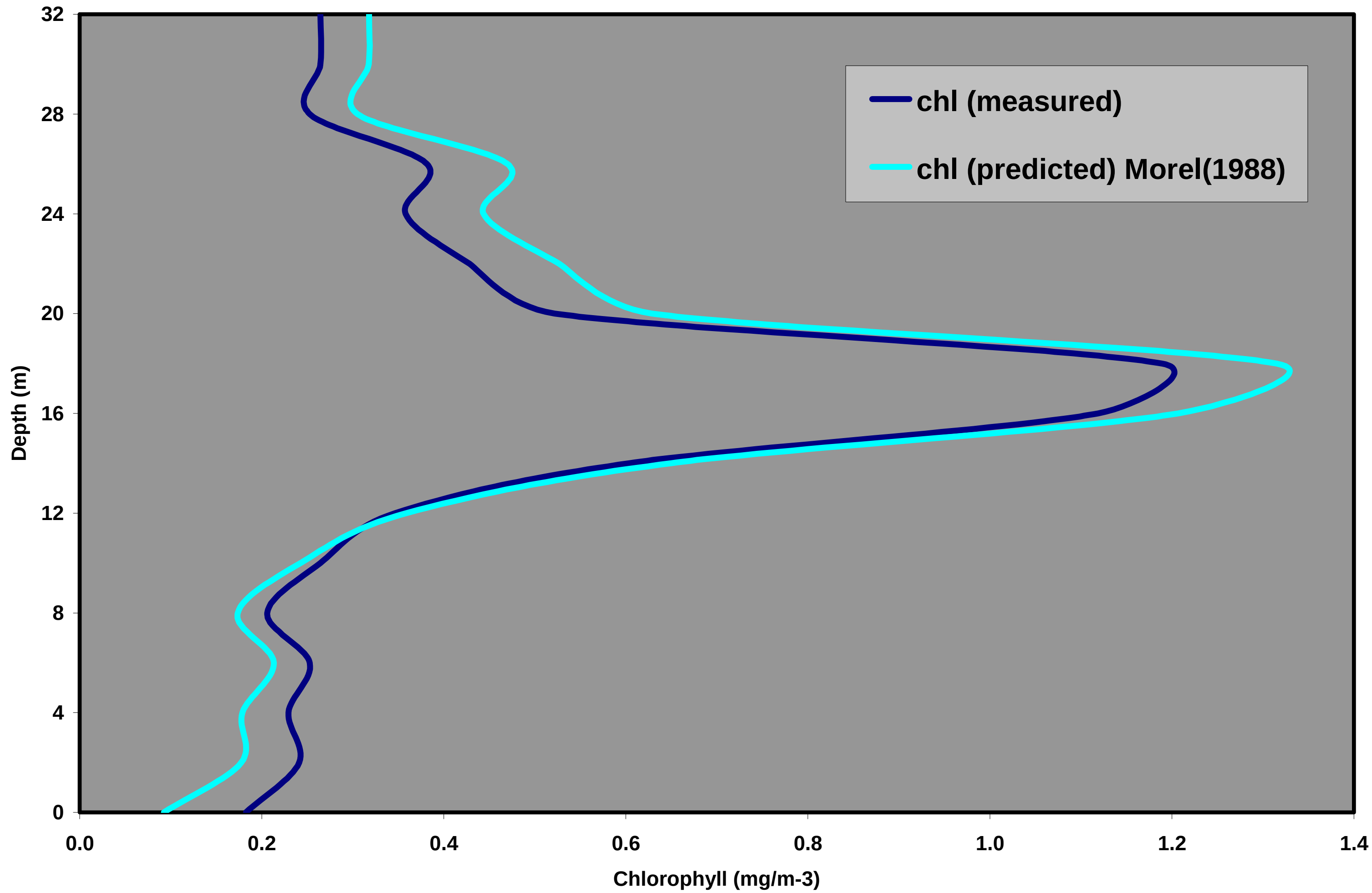
Chlorophyll retrieval

Chlorophyll was retrieved from K_d using a bio-optical model given by Morel (1988):

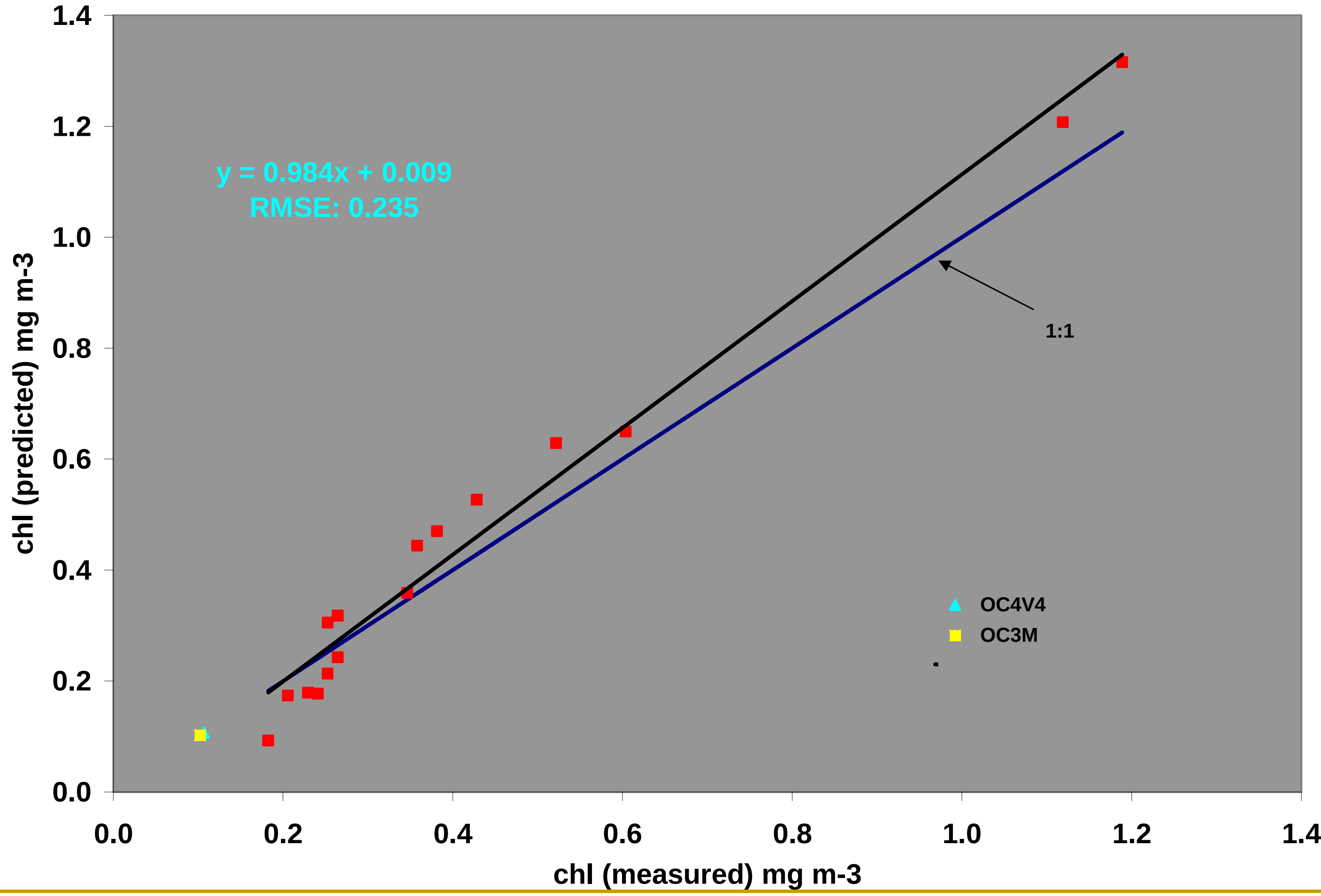
$$K_d(\lambda) = K_{dw}(\lambda) + \chi(\lambda) C^{e(\lambda)}$$

Where $\chi(\lambda)$ and $e(\lambda)$ are statistically derived functions that convert the chlorophyll concentration in mg m^{-3} to K_d values in m^{-1}.

Chlorophyll retrieval



Comparison



y = 0.984x + 0.009
RMSE: 0.235
1:1
OC4V4
OC3M
chl (predicted) mg m-3
chl (measured) mg m-3
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

Summary

- There can be considerable error in Rrs from an improper removal of sea surface reflectance effect.
- Based upon 1% of E_{PAR} surface value depth of euphotic zone was found to be 19.8m.
- Semi-analytical inversion algorithms, applied on Rrs spectra were able to retrieve chlorophyll concentration and IOPs such as absorption coefficient, backscattering coefficient.

Thank you!!