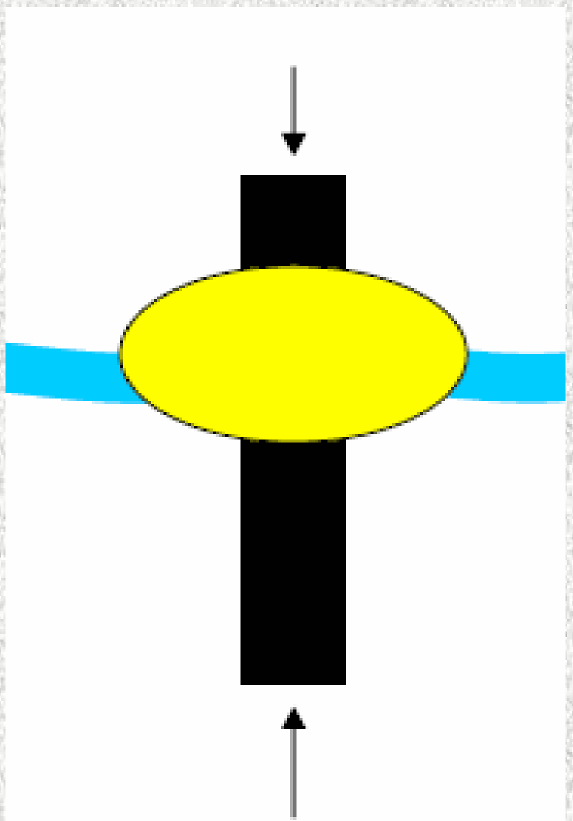
IOP inversion from shallow waters

Peng Wang

$$R_{rs} = f(a, b_b)$$



$L_u(0^-)/E_d(0^+)$

$L_u(0^-)$: upwelling radiance

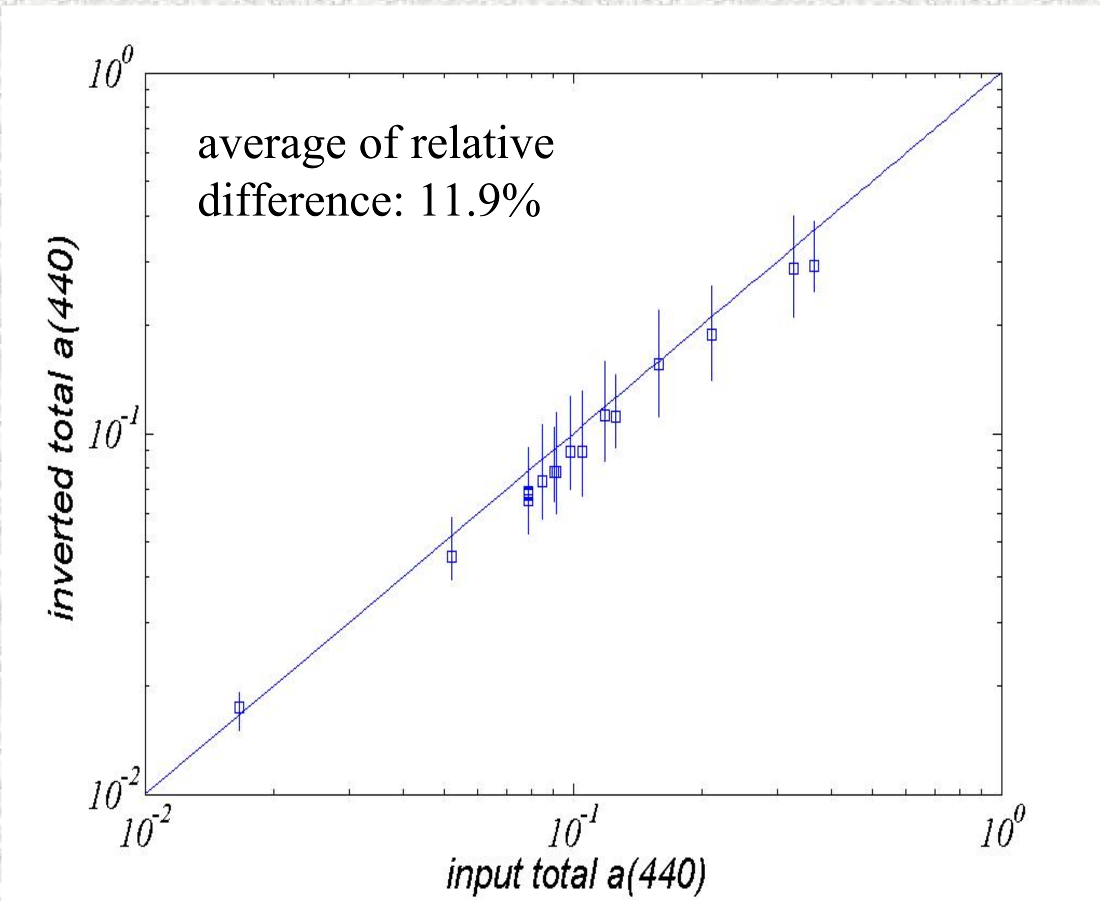
$E_d(0^+)$: downwelling irradiance

PBR approach:

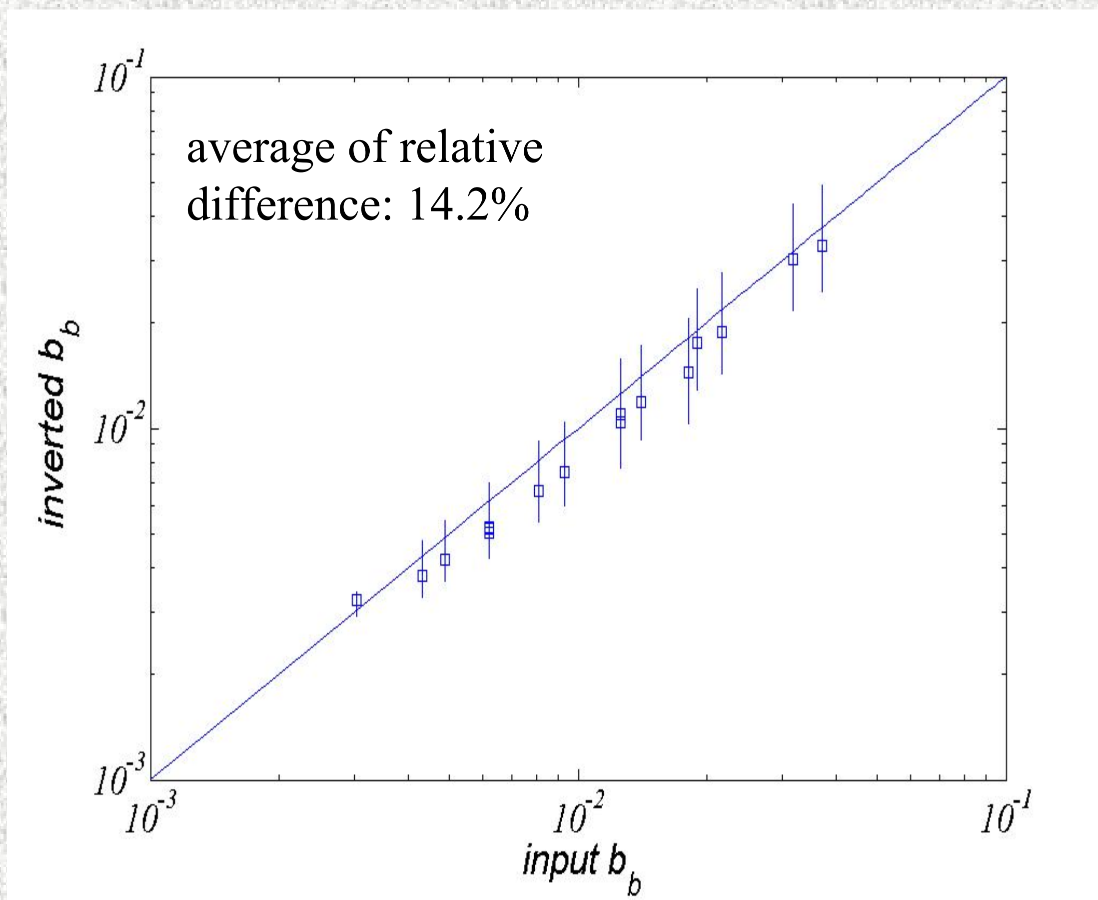
- Basis vectors
- absorption
- $a_\varphi(\lambda) = a_\varphi(\lambda_0)$ [S_f*$a_{micro}(\lambda_0)$+(1-S_f)$a_{pico}(\lambda_0)$]
- $a_{dg}(\lambda) = a_{dg}(\lambda_0)\ \exp(-S(\lambda-\lambda_0))$
- backscattering
- $b_{bp}(\lambda) = b_{bp}(\lambda_0)\ (\lambda/\lambda_0)^{-Y}$
- Radiance Reflectance equation [400:10:650]
- $Rrs = 0.0949(\ b_b/(b_b+a)) + 0.0794\ (b_b/(b_b+a))^2$
- Linear regression method
- Data set: simulated by hydrolight (Rrs, a and b_b)

Some results:
IOP comparison (a and b_b)

Total Absorption Comparison

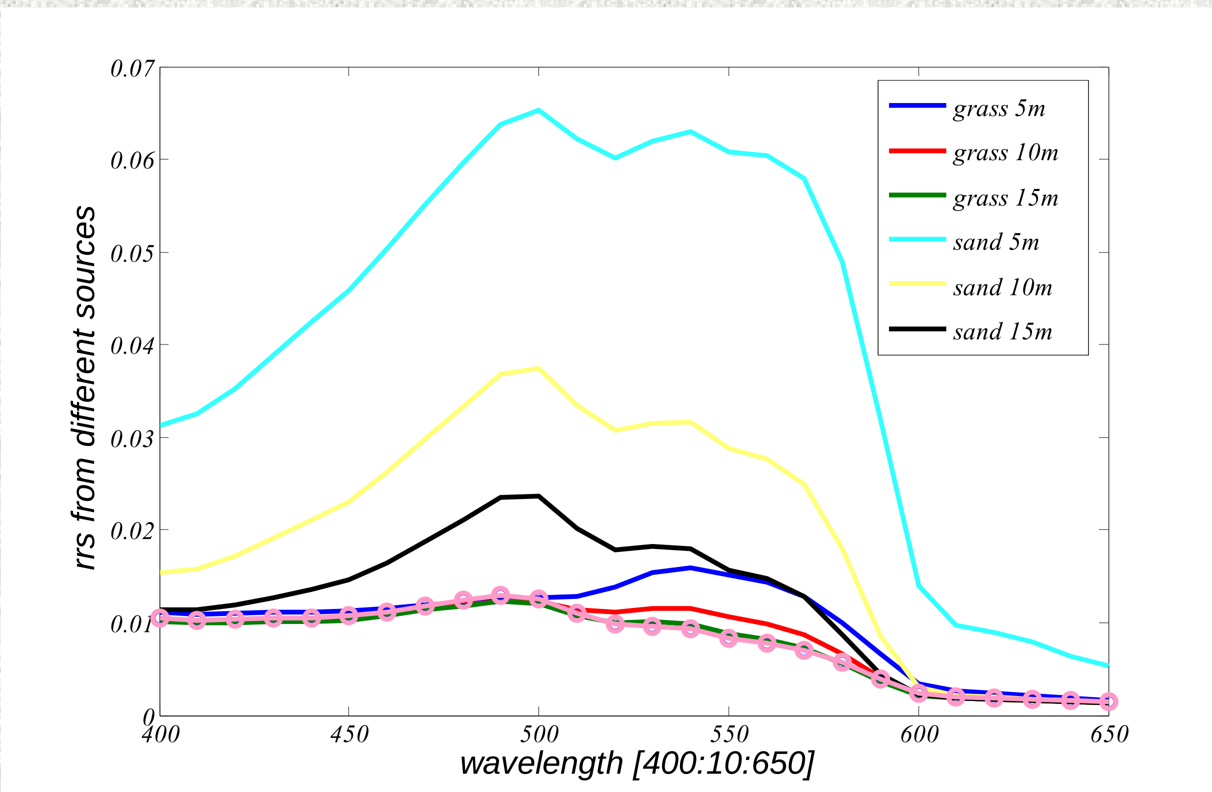


total backscattering comparison



Now story changed……

Rrs from shallow waters:



Strange rrs

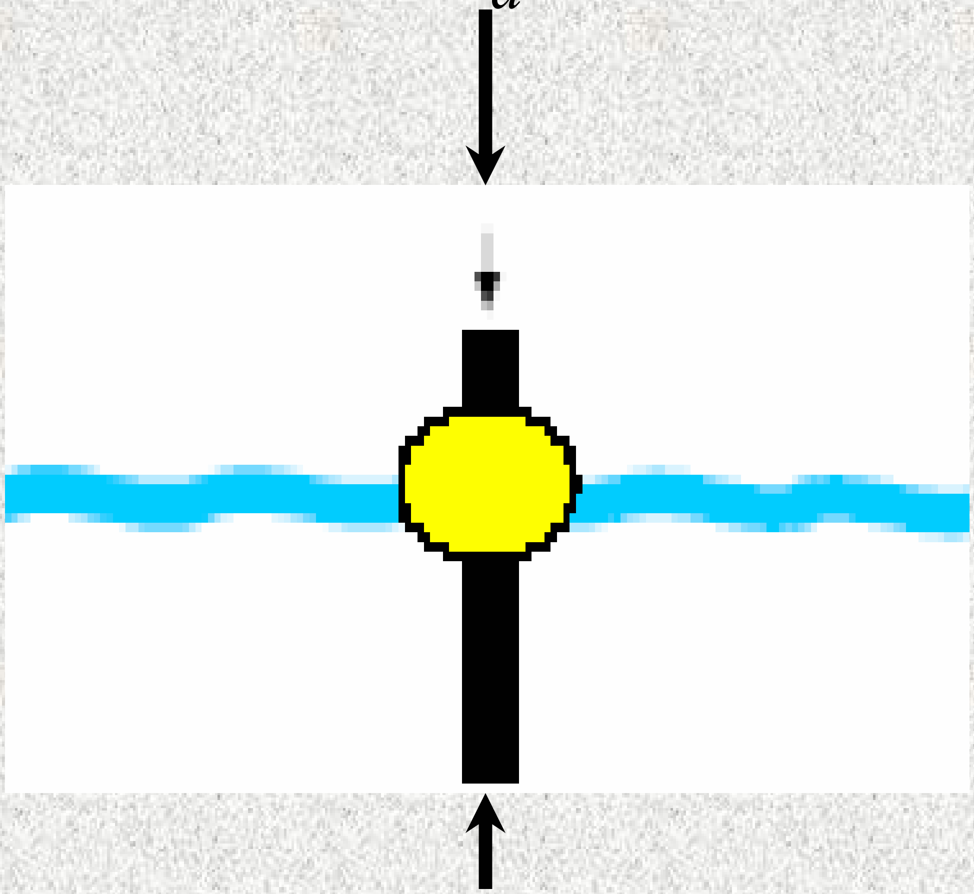
↓

Matlab complain

↓

No solutions !!!

E_d



L_u

L_u^{dp} $\quad$ L_u^{B}

$$Rrs = L_u/E_d = (L_u^{dp} + L_u^{B})/E_d$$

$$= L_u^{dp}/E_d + L_u^{B}/E_d = R_{rs}^{dp} + R_{rs}^{B}$$

downwelling irradiance, upwelling radiance from water column and bottom

simple idea, hard application; fortunately……

Semi-Analytical Hyperspectral Model of Lee, et al, 1998

basically:

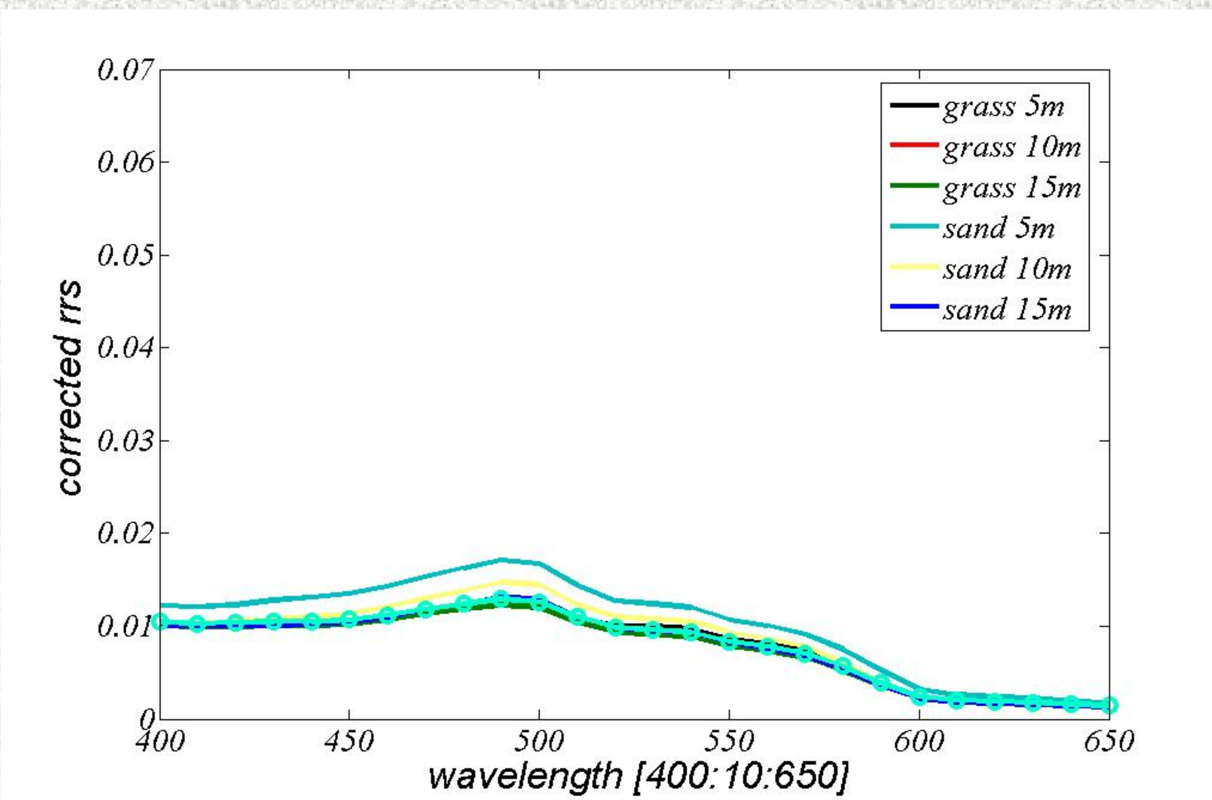
$$r_{rs} \approx r_{rs}^{dp}[1\text{-exp}(-2KH)] + r_{rs}^{B}\text{exp}(-2KH) \approx$$

$$r_{rs}^{dp}(1\text{-}A_0\text{exp}\{-[(1/cos\theta_w)+D_0(1+D_1u)^{0.5}]\alpha H\}) +$$

$$A_1\rho\text{exp}\{-[(1/cos\theta_w)+D'_0(1+D'_1u)^{0.5}]\ \alpha H\}.$$

r_{rs}: subsurface remote-sensing reflectance, sr^{-1}
r_{rs}^{dp}:subsurface remote-sensing reflectance for deep waters, sr^{-1}
r_{rs}^{B}: subsurface remote-sensing reflectance for the bottom, sr^{-1}
K: diffuse attenuation, m^{-1}
H: bottom depth, m
θ_w:subsurface solar zenith angle, rad
u: $b_b/(a + b_b)$
α: attenuation coefficient ($=a+b_b$), m^{-1}
ρ: bottom albedo
$A_{0,1}$ $D_{0,1}$ $D'_{0,1}$: from Lee et al, 1998

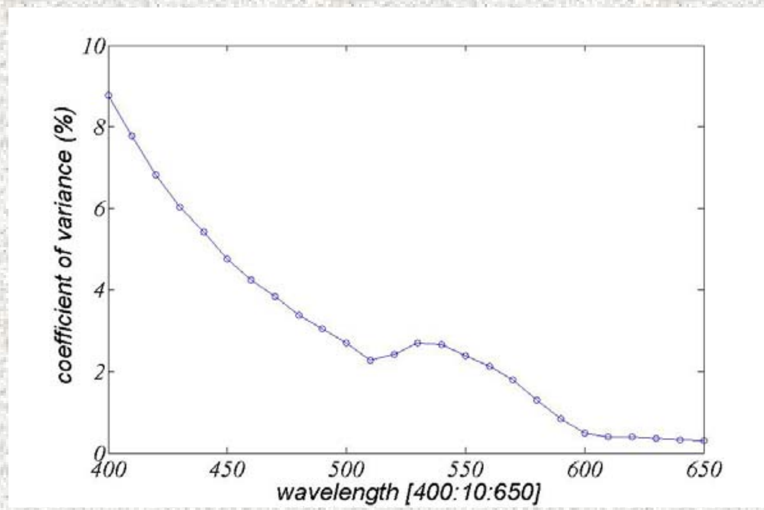
After subtracting the bottom influence, we get…



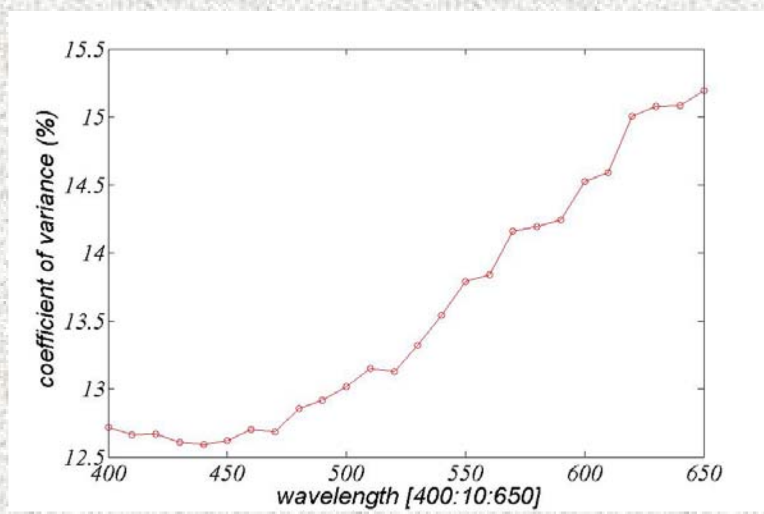
Now matlab smiled and we got solutions !!!

Coefficient of Variance: (express sample variability relative to the mean of the sample)

Total absorption:

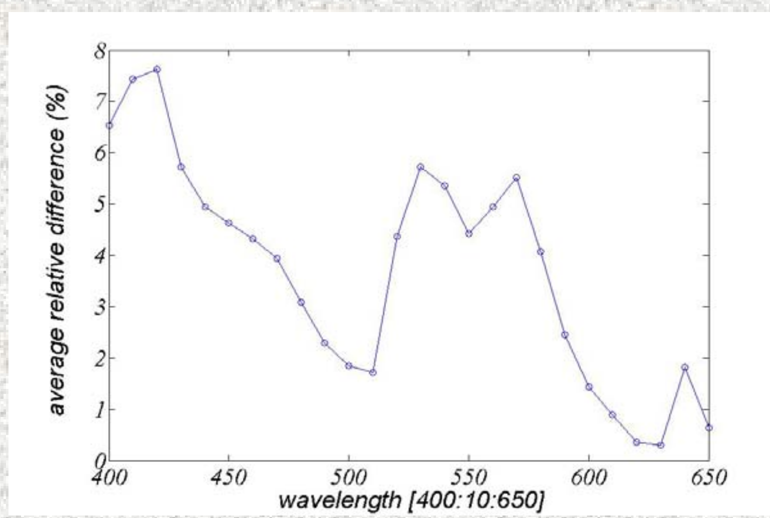


Total Backscattering:

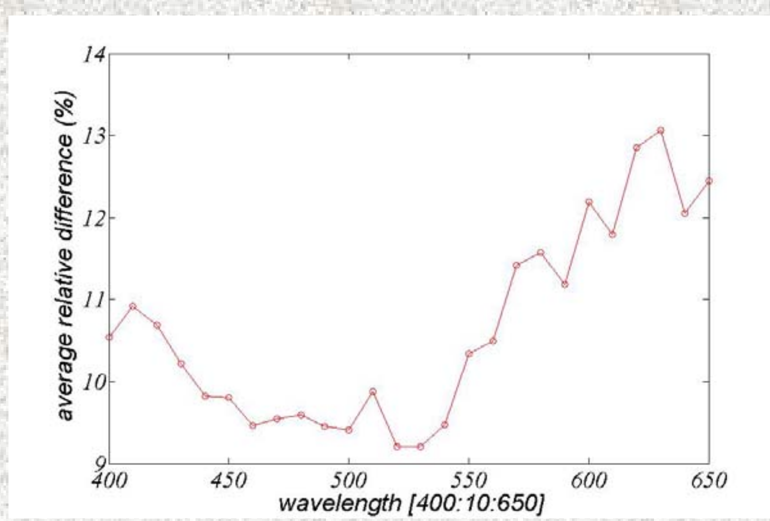


IOP inversion results from shallow waters:

Total Absorption:



Total Backscattering:



Conclusions:

- Bottom reflectance has a huge impact on the remote sensing reflectance;
- Current semi-analytic algorithm can be successfully applied to invert IOPs after bottom correction;
- PBR approach can find strange r_{rs} which is caused by the environment or bad measurements?

Acknowledgements