Information content of Rrs spectra using forward and inverse modeling

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Objective (1)

- Identify in Rrs spectra of productive turbid water regions maximally sensitive to variations in Chl, a_{CDOM}, mineral concentration ([min]) and solar zenith angle (SZA).

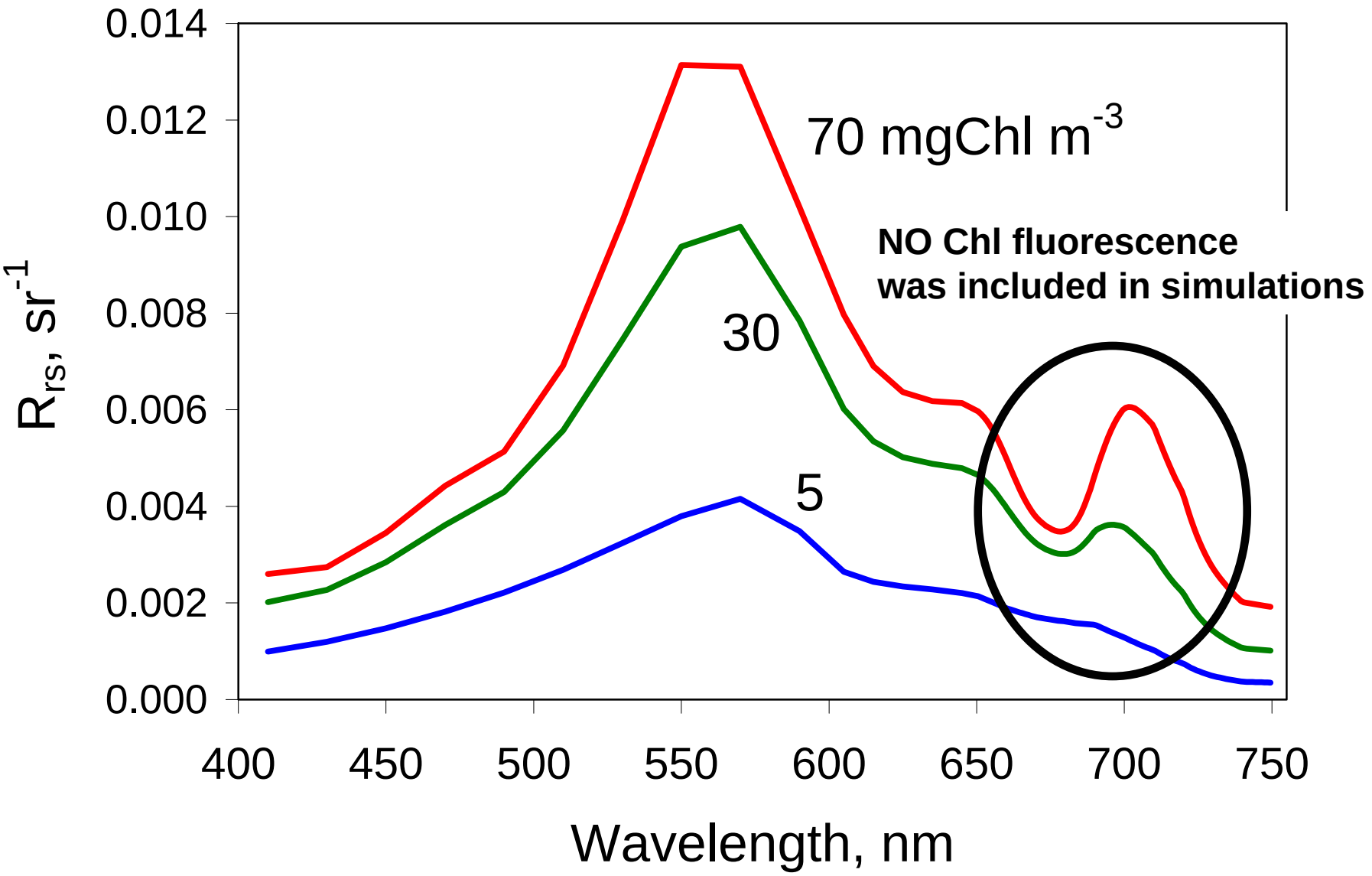
Method

- Hydrolight simulation in three “trophic regimes”

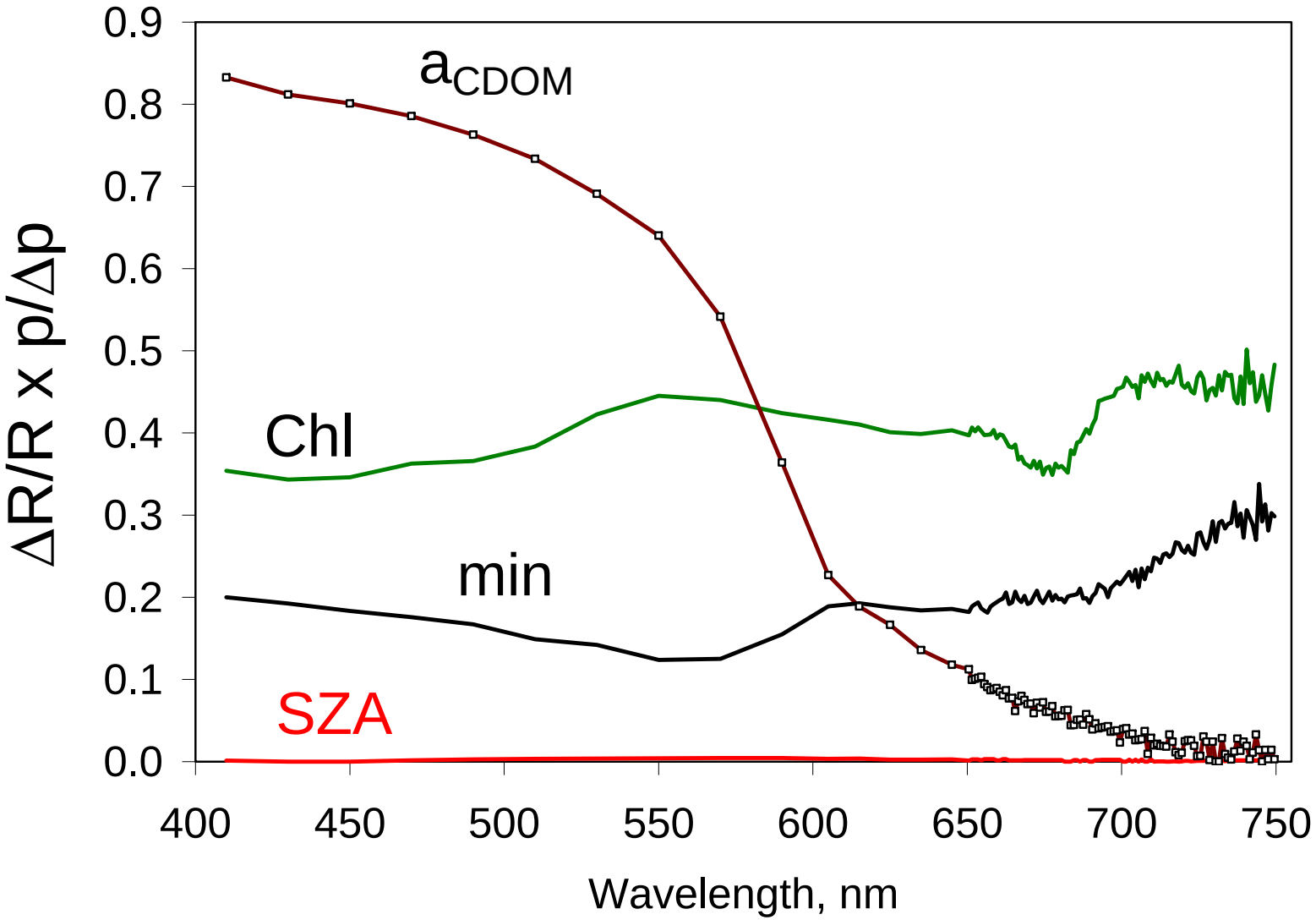
  Chl=5-30-70 mg m^{-3},

  $a_{CDOM}(440)=1\ m^{-1}$
  [min]=1 g m^{-3}
  SZA=30°
  Only elastic scattering

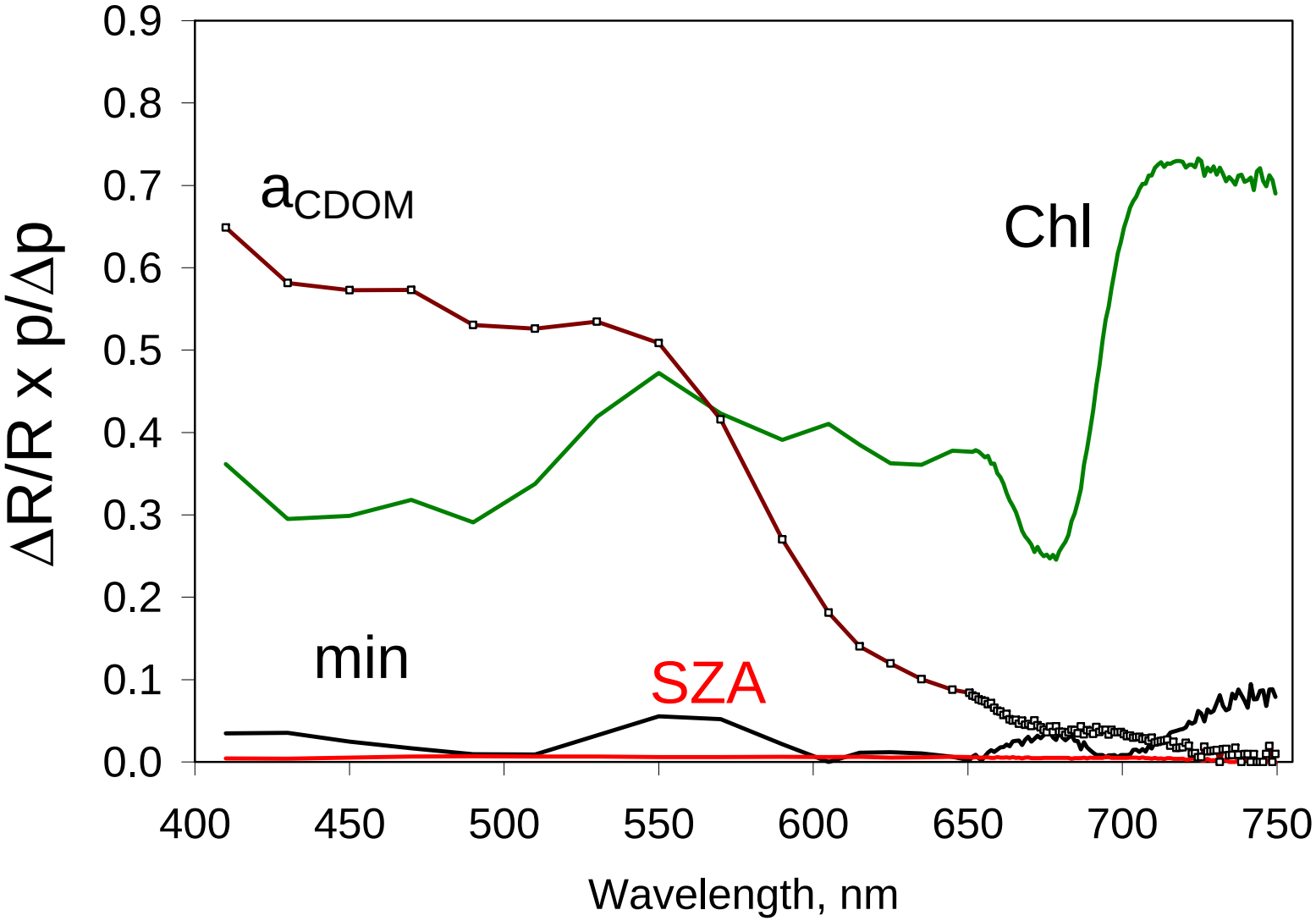
- Calculate $[R(p)-R(p+\delta p)]/R * p/(\delta p)$


0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
R_{rs}, sr^{-1}
70 mgChl m^{-3}
30
5
NO Chl fluorescence
was included in simulations
400
450
500
550
600
650
700
750
Wavelength, nm

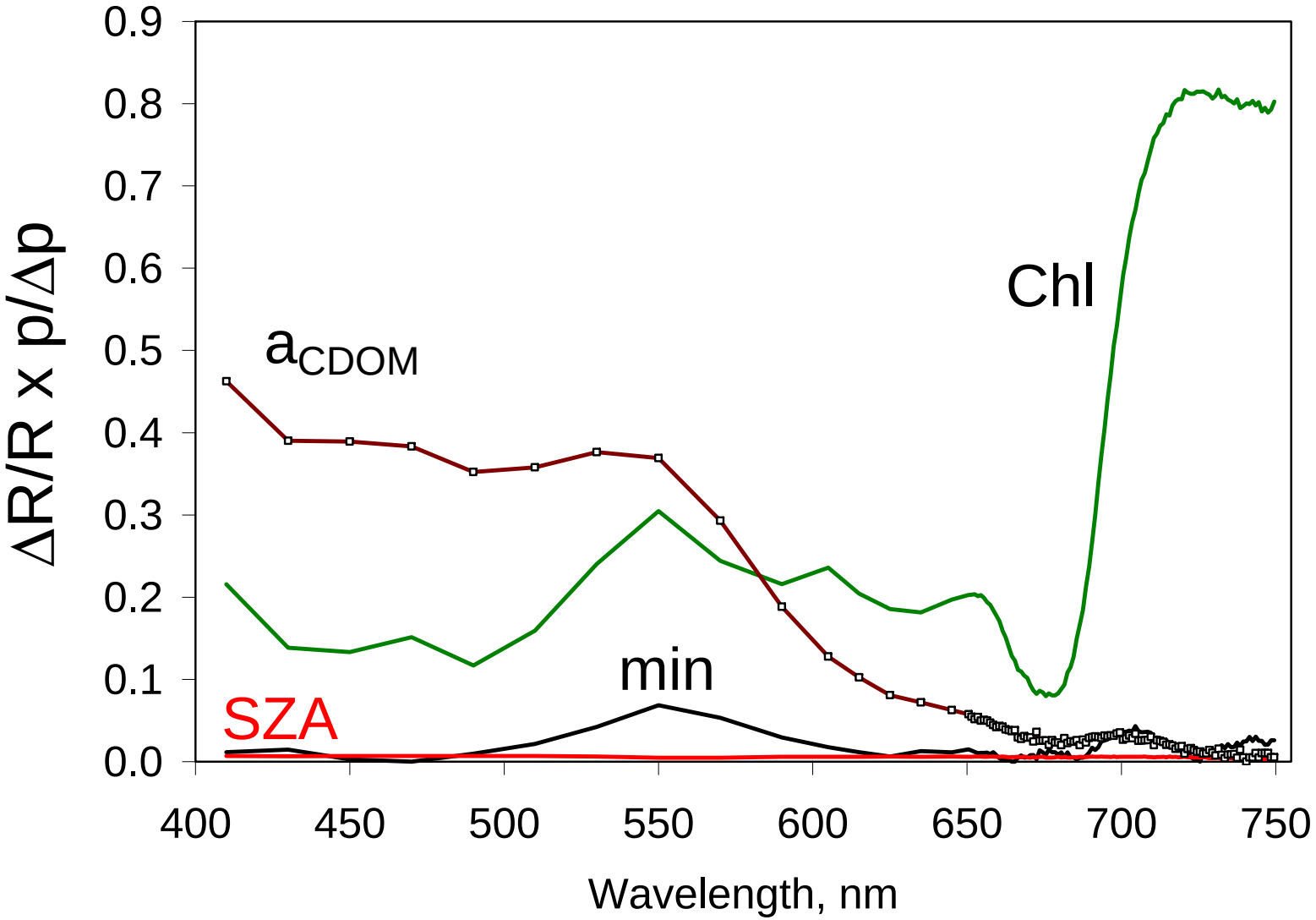
Chl=5 mg m^{-3}


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
ΔR/R x p/Δp
a_{CDOM}
Chl
min
SZA
400
450
500
550
600
650
700
750
Wavelength, nm

Chl=30 mg m^{-3}


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
ΔR/R x p/Δp
a_{CDOM}
Chl
min
SZA
400
450
500
550
600
650
700
750
Wavelength, nm

Chl=70 mg m^{-3}


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
ΔR/R x p/Δp
400
450
500
550
600
650
700
750
Wavelength, nm
Chl
a_{CDOM}
min
SZA

Conclusions

- 400-500 nm region is maximally sensitive to a_{CDOM}
- 600-750 nm region is maximally sensitive to Chl

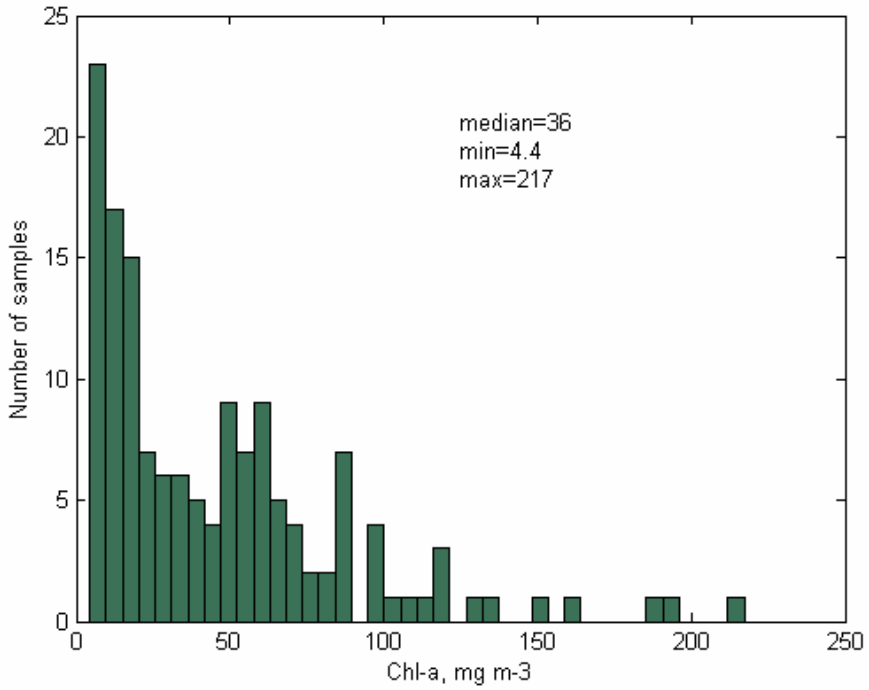
- As Chl increases, the sensitivity to a_{CDOM} decreases in the blue-green region and the sensitivity to Chl increases in the NIR

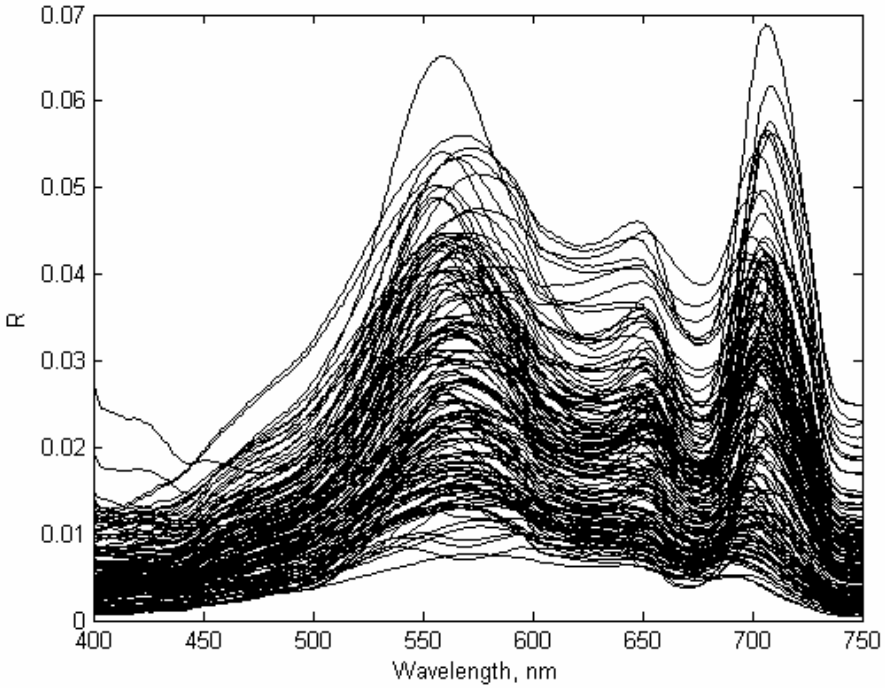
- Variations in SZA and mineral concentration appear to be negligible

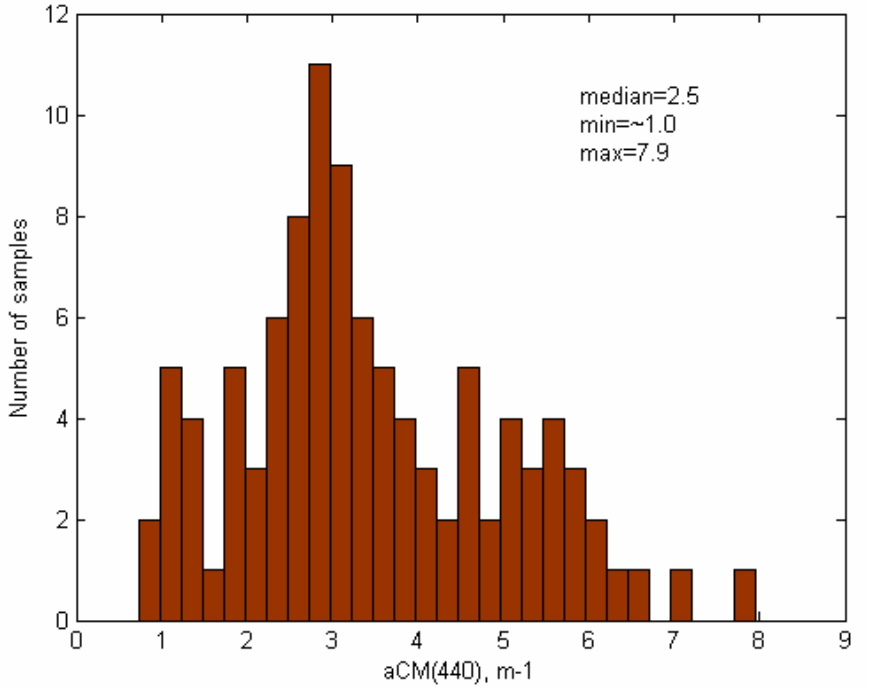
Inverse problem

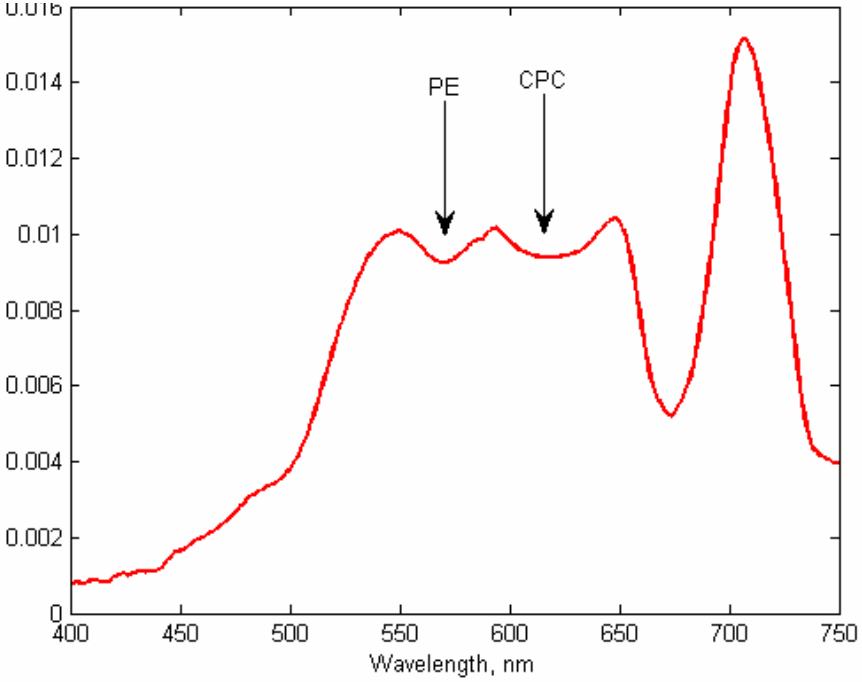
OBJECTIVE (2):

- Apply the Roesler and Perry (1995) technique to fit R spectra collected in NE productive lakes
- Compare the retrieved Chl and aCM(440) with measured values using different spectral ranges

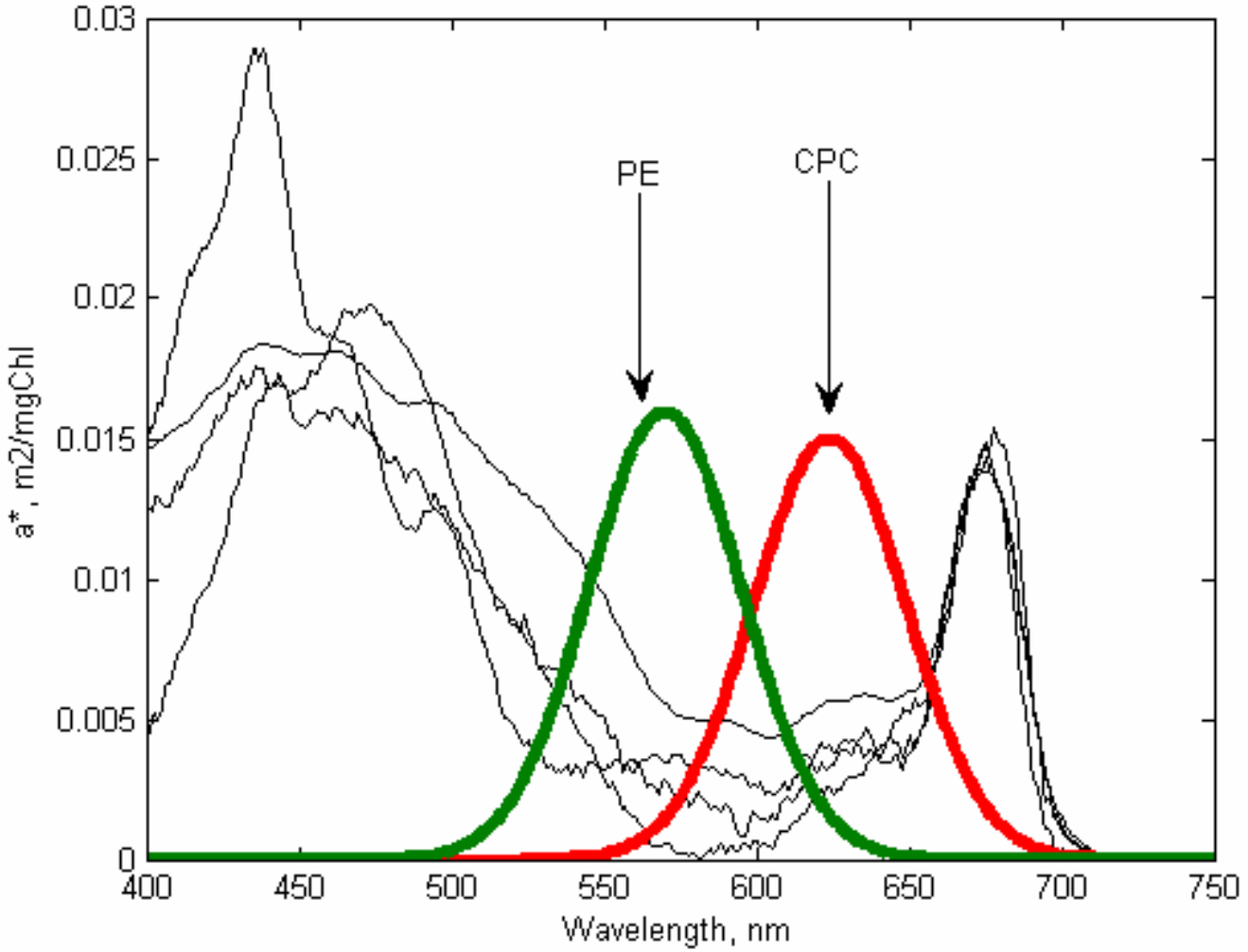

median=36
min=4.4
max=217
Number of samples
Chl-a, mg m-3


R
Wavelength, nm

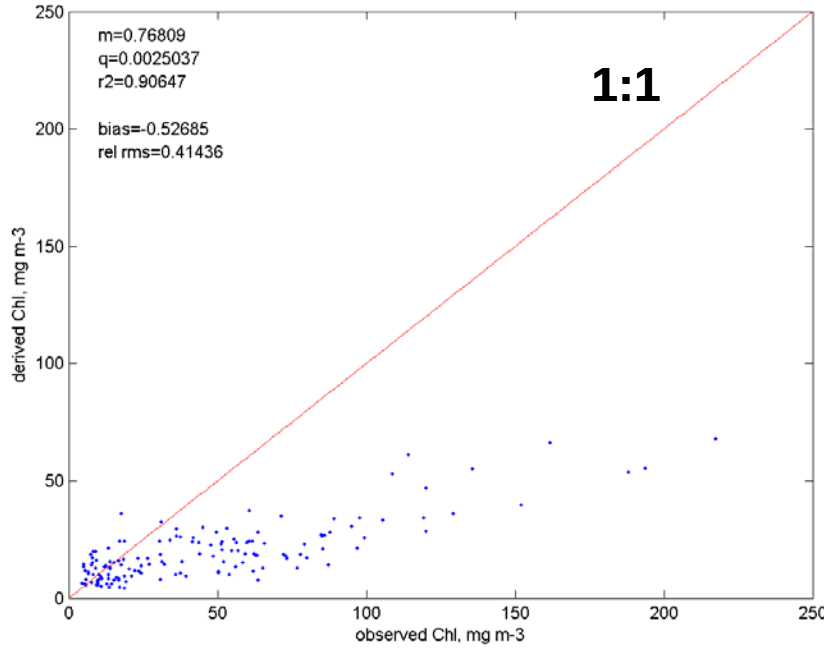

median=2.5
min=~1.0
max=7.9
Number of samples
aCM(440), m-1


PE
CPC
Wavelength, nm

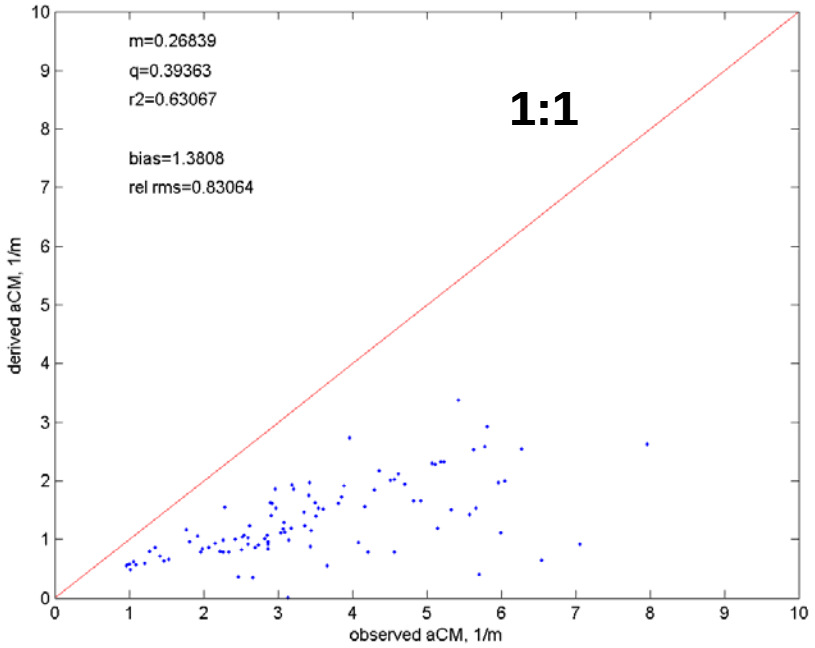
a_ϕ basis vectors



From 400 to 700 nm R&P a_ϕ basis vectors

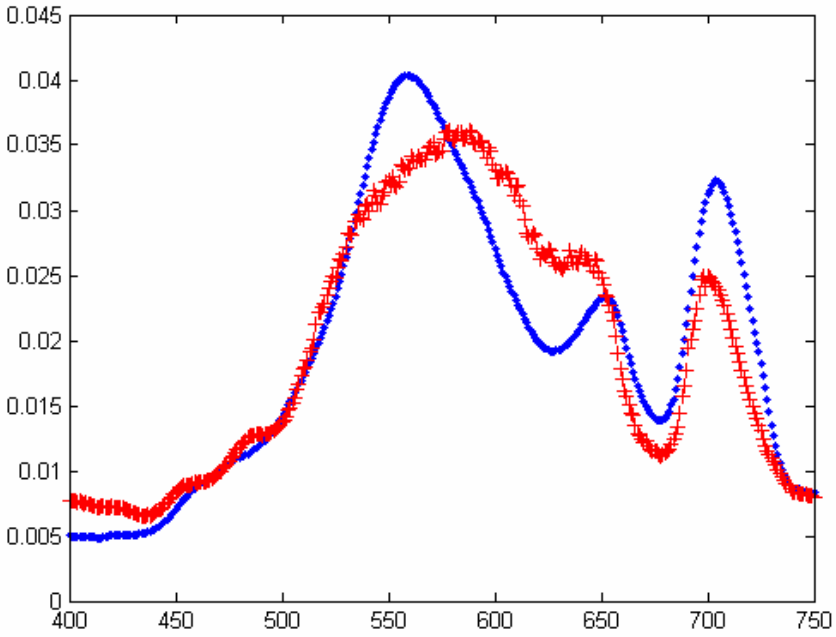


Chl

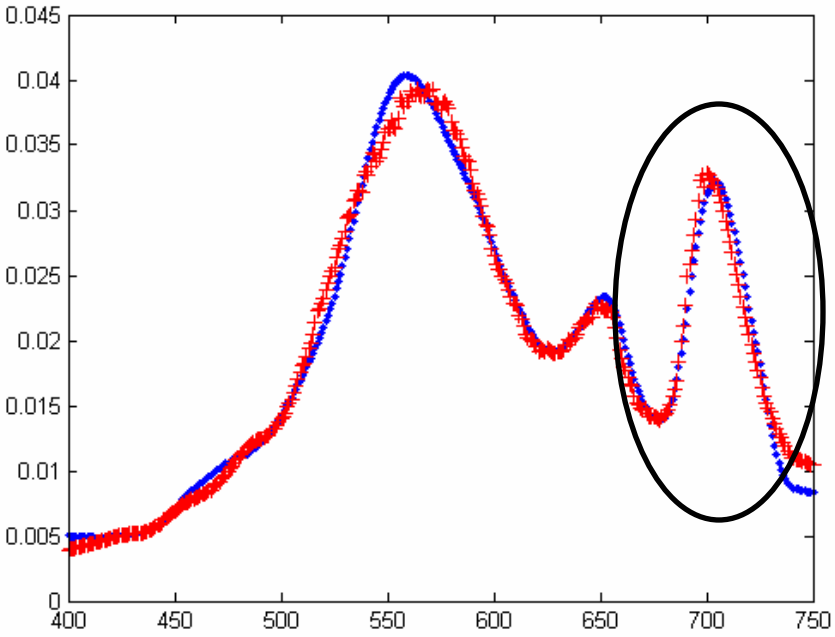


aCM(440)

From 400 to 700 nm
R&P a_ϕ basis vectors + PE and CPC

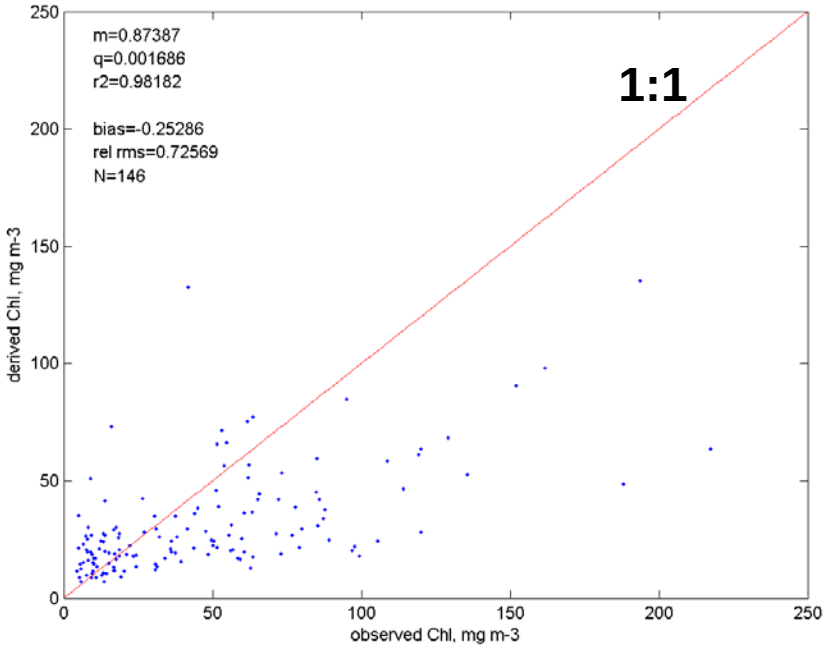


Original aϕ Basis Vectors

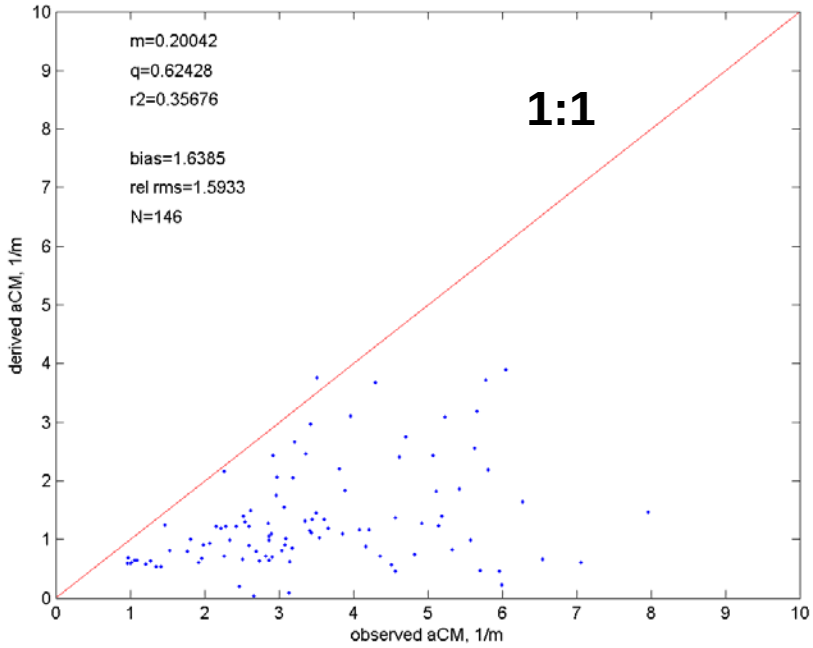


Original aϕ Basis Vectors + CPC + PE

From 400 to 650
R&P a_ϕ basis vectors + PE and CPC

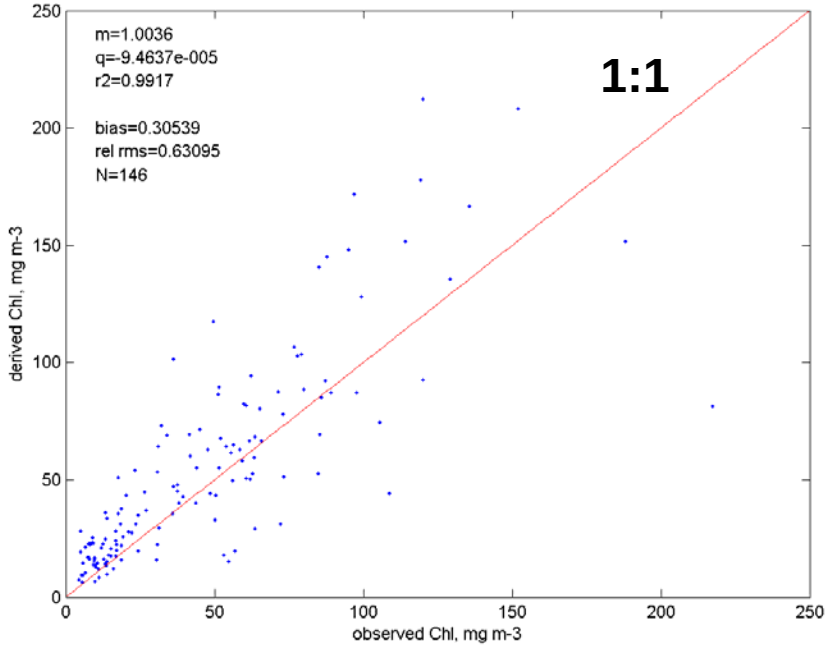


Chl

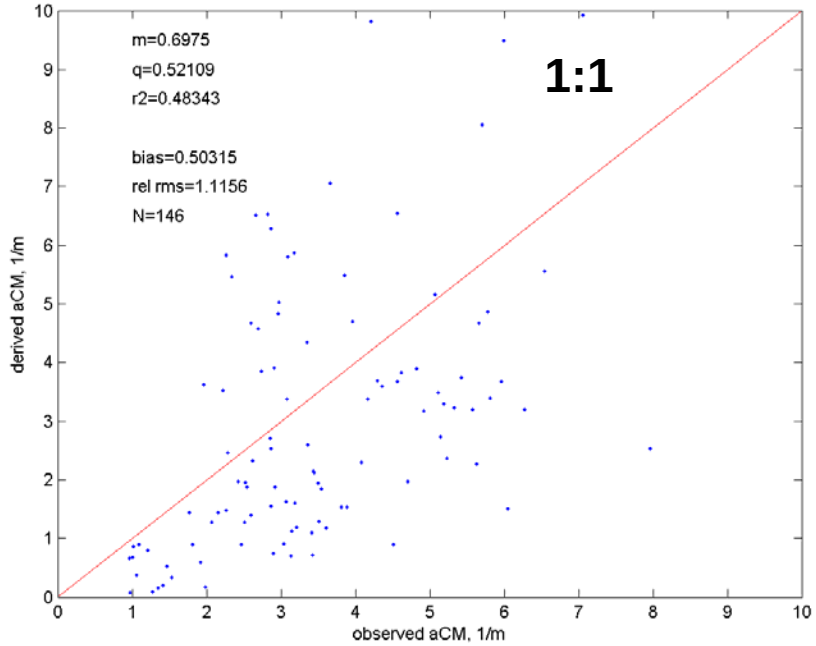


aCM(440)

From 650 to 700 nm
R&P a_ϕ basis vectors + PE and CPC



Chl



aCM(440)

Conclusions

- Original basis vectors are insufficient for fitting spectra from productive freshwater environment
- However, by including additional absorption peaks (independent of Chl) Chl prediction can be improved
- aCDOM+aNAP was poorly fitted due probably to a “transfer of variance” with bb
- The technique can be used to study the information content of R spectra
- A similar method was applied by Gege (1995) to derive from Rrs spectra phytoplankton composition