

# Impacts of pure water absorption to radiometric measurements: a sensitivity study

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# Motivation

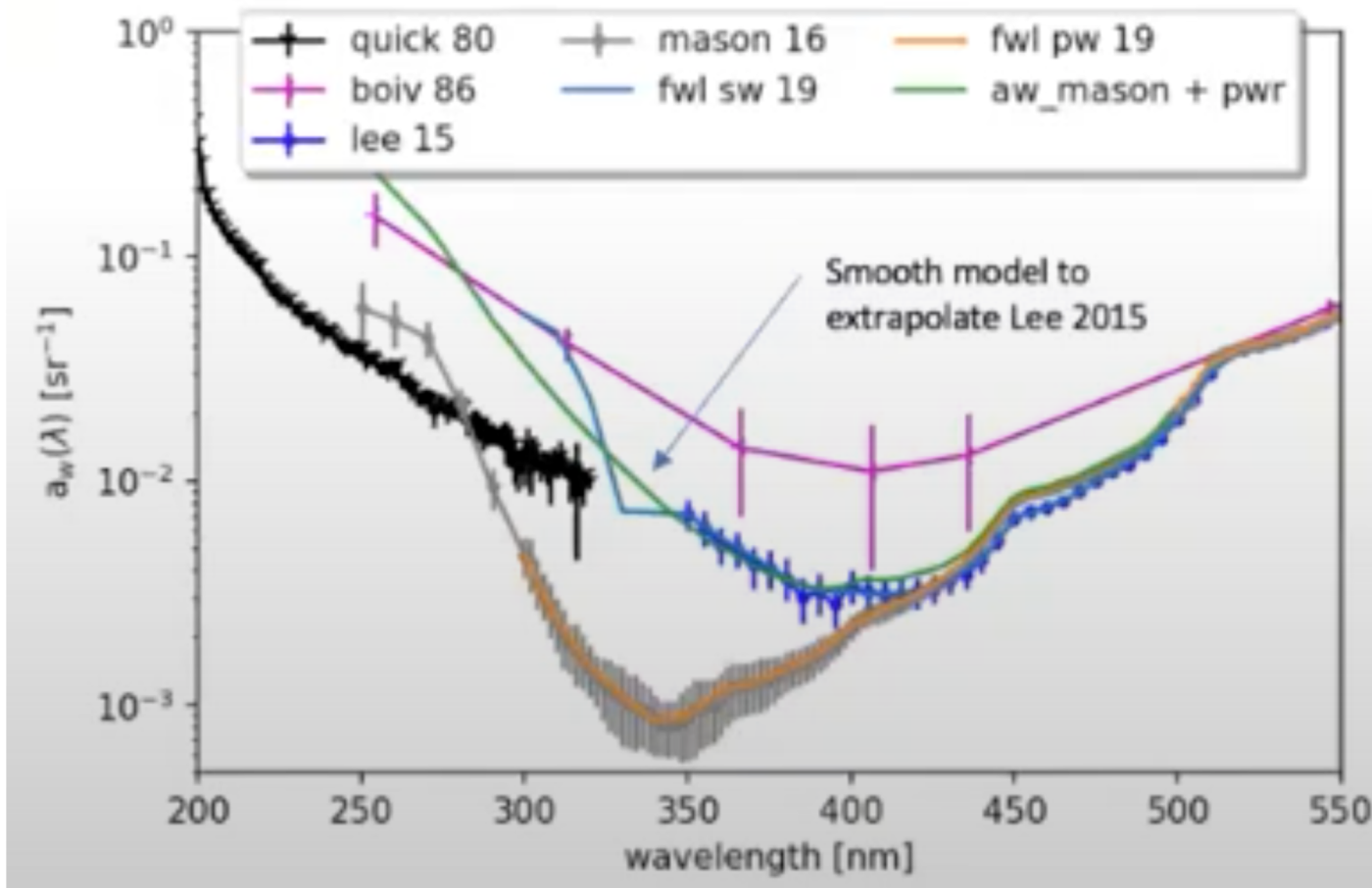


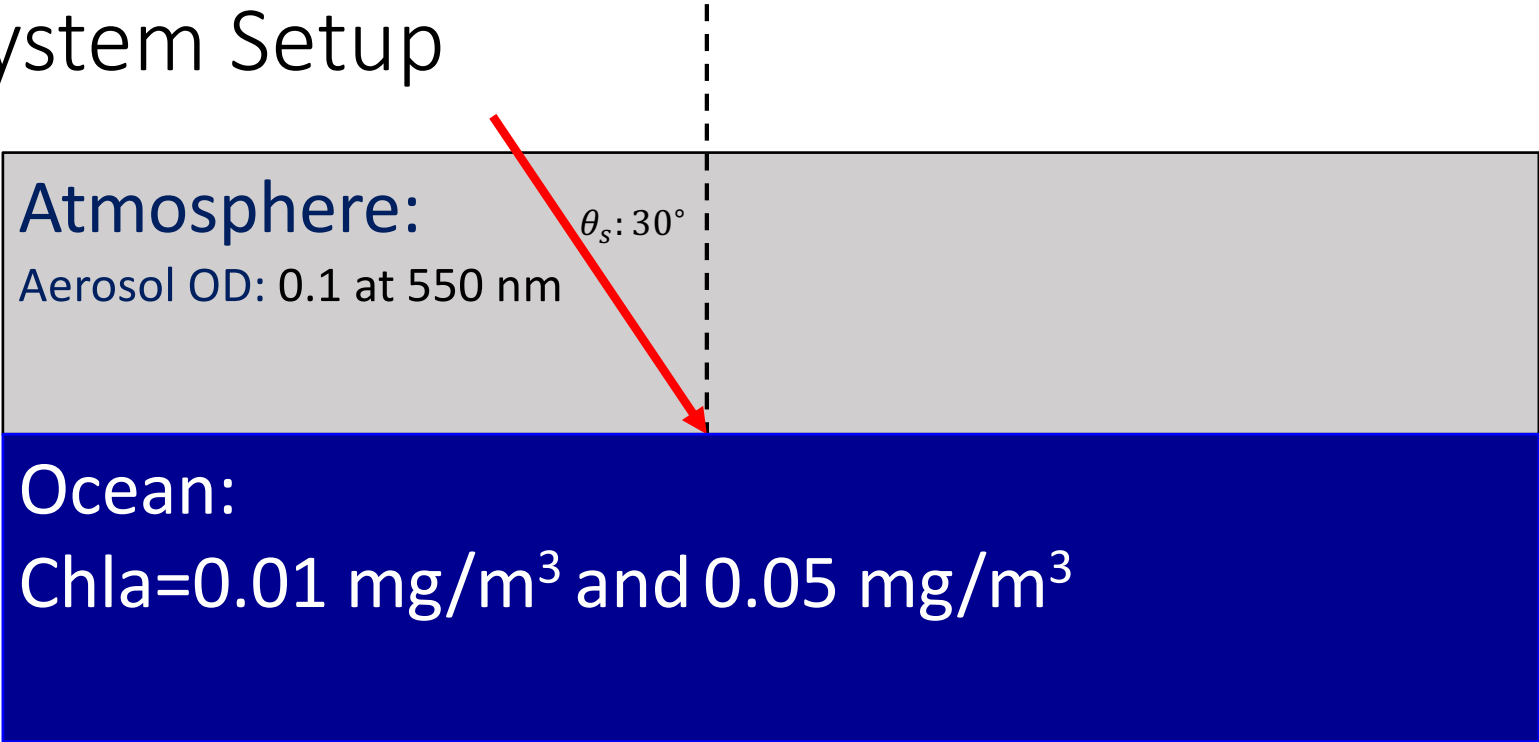
Image credit:  
Lachlan McKinna

# System Setup

Atmosphere:

Aerosol OD: 0.1 at 550 nm

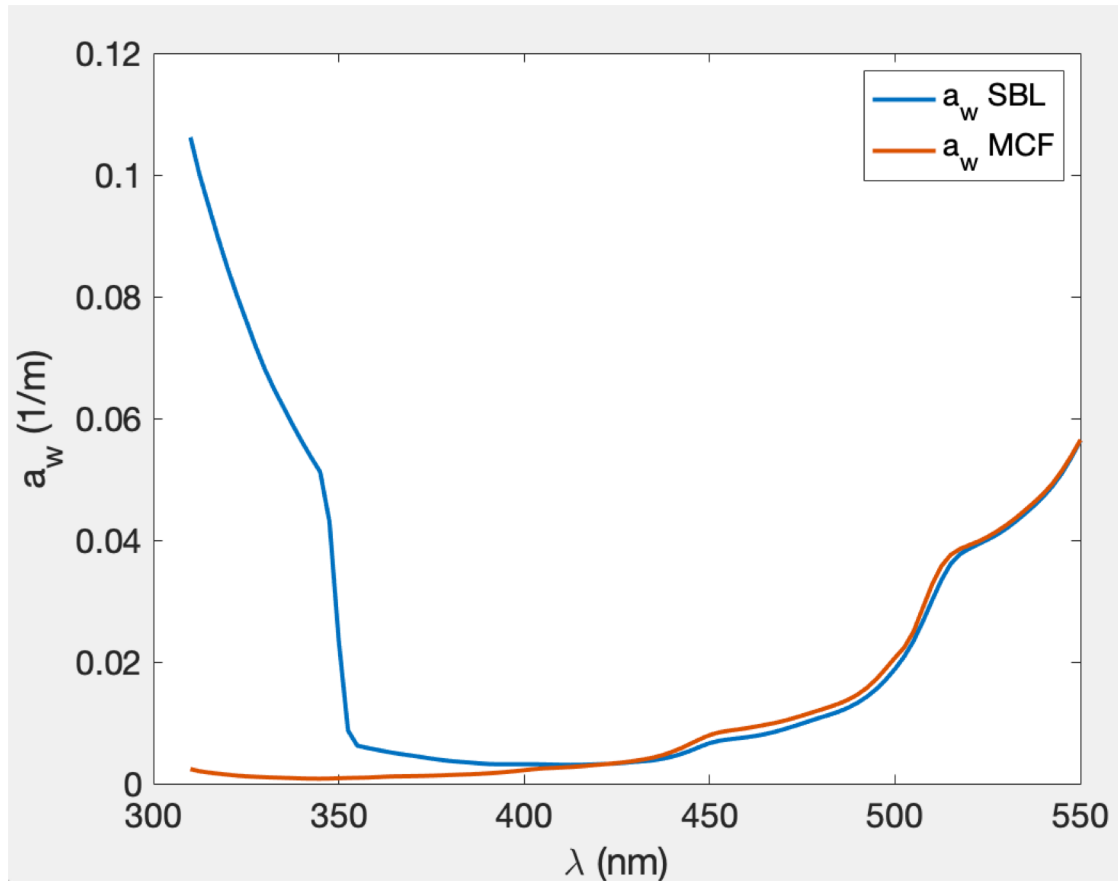
$\theta_s: 30^\circ$

A diagram illustrating the system setup. It consists of two horizontal rectangular regions. The top region is light gray and labeled 'Atmosphere: Aerosol OD: 0.1 at 550 nm'. The bottom region is dark blue and labeled 'Ocean: Chla=0.01 mg/m³ and 0.05 mg/m³'. A vertical dashed line separates the two regions. A red arrow points from the top-left corner of the atmosphere region down to the interface between the atmosphere and ocean. The angle between this red arrow and the vertical dashed line is labeled as  $\theta_s: 30^\circ$ .

Ocean:

Chla=0.01 mg/m<sup>3</sup> and 0.05 mg/m<sup>3</sup>

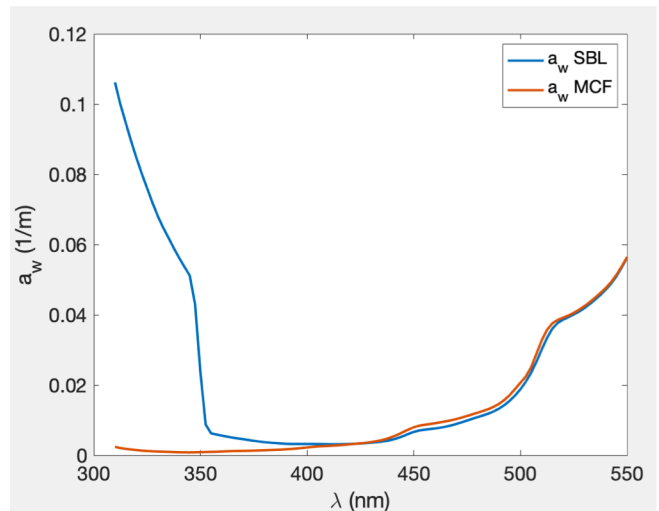
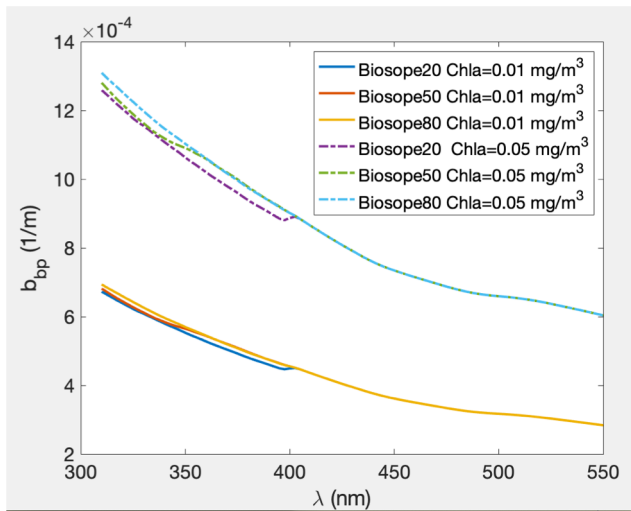
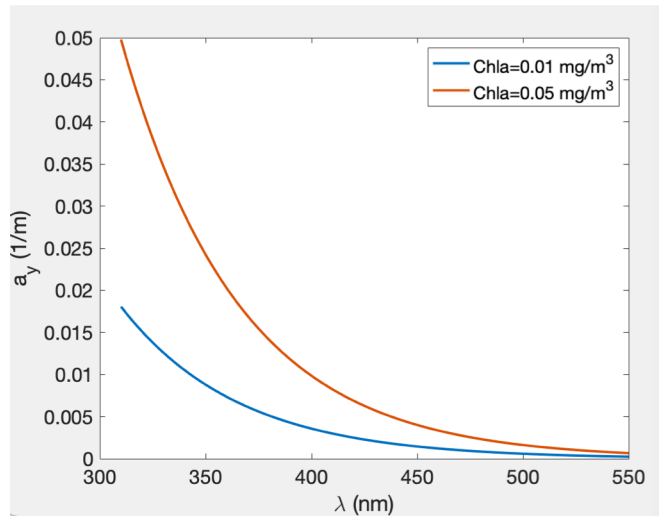
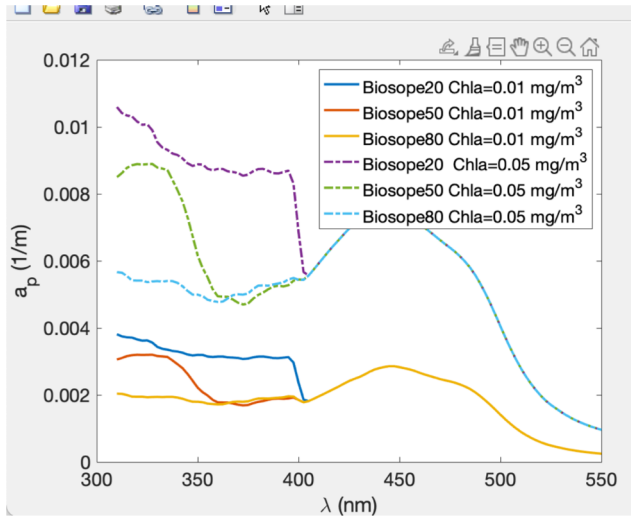
# Water IOPs



SBL: Smith-Baker-Lee  
300-350 nm: Smith-Baker 1981  
350-550 nm: Lee et al. 2015.

MCF: Mason-Cone-Fry 2016

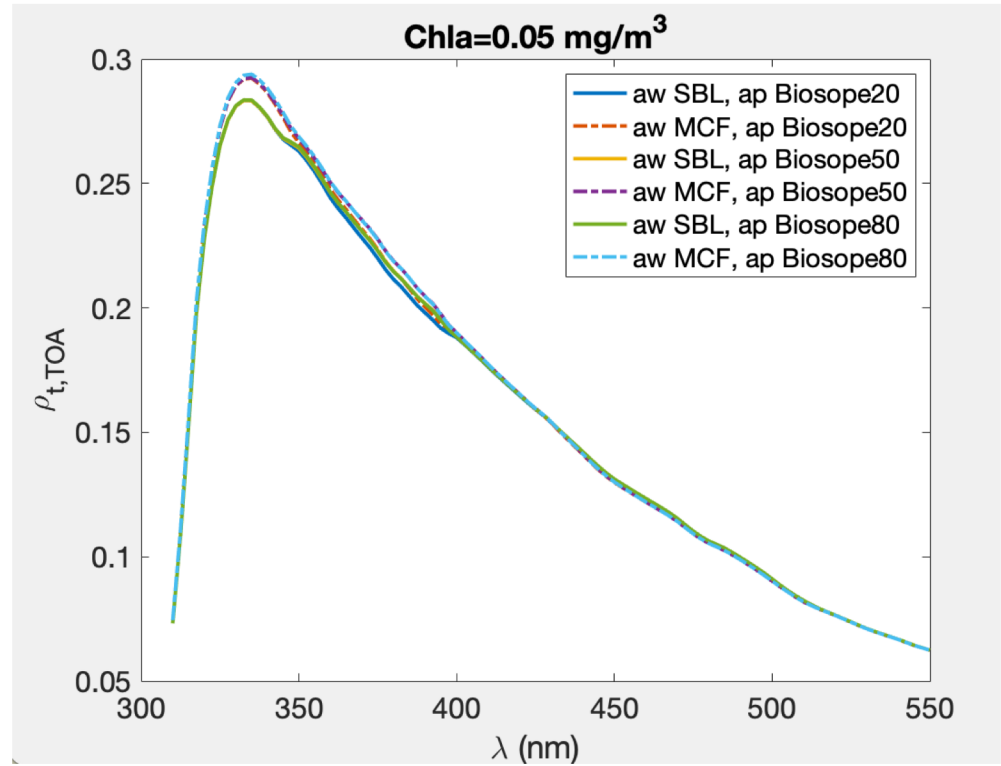
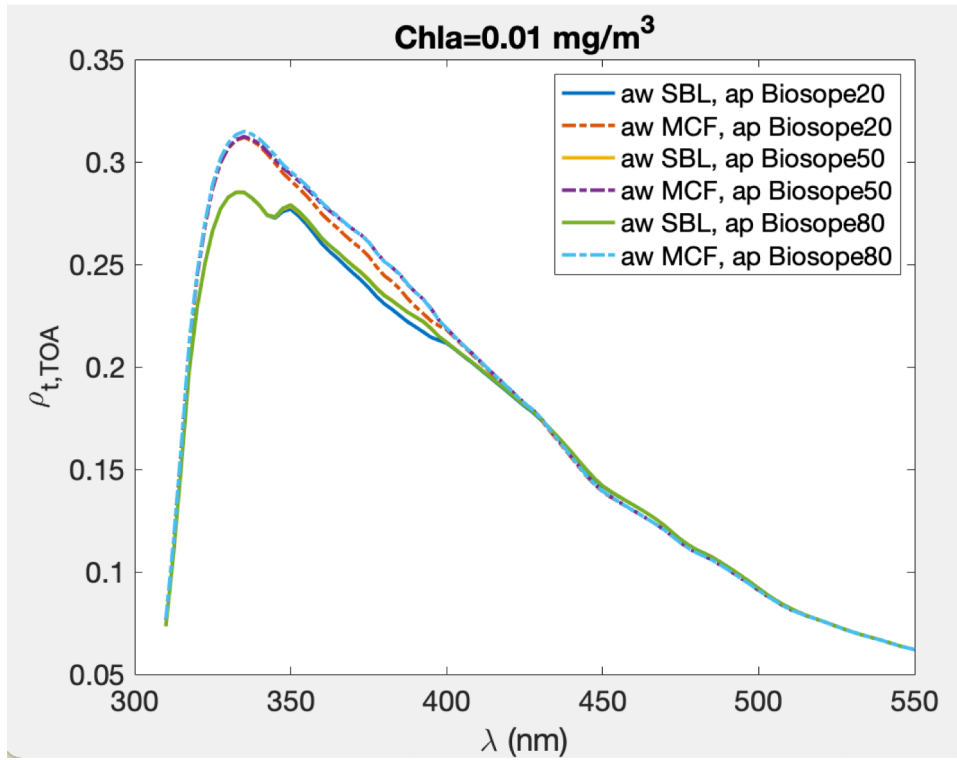
# Other water constituents



## Tool: PACE simulator

- A monochromatic multiple scattering model based on successive order of scattering method
  - Atmosphere-ocean coupling;
  - Polarization;
  - Flexible atmospheric and ocean scattering properties;
  - Pseudo-spherical treatment of spherical shell.
- Atmospheric gas absorption:
  - H<sub>2</sub>O, CO<sub>2</sub>, O<sub>2</sub>, CH<sub>4</sub>: ARTS + HITRAN;
  - Ozone and NO<sub>2</sub>: databases from Serdyuchenko et al. (2013); Bogumil et al. (2003).
- Flexible on wavelength ranges and relative spectral response functions.
- Inelastic scattering: Raman scattering and Fluorescence.

# TOA Reflectance $\pi I / E_d$



Solar zenith angle: 30 degree.

Atmosphere:

$\tau_{a,550\text{ nm}}=0.1$

Gas absorption: H<sub>2</sub>O, Ozone, CO<sub>2</sub>, CH<sub>4</sub>, O<sub>2</sub>, NO<sub>2</sub>.

Ocean water model:

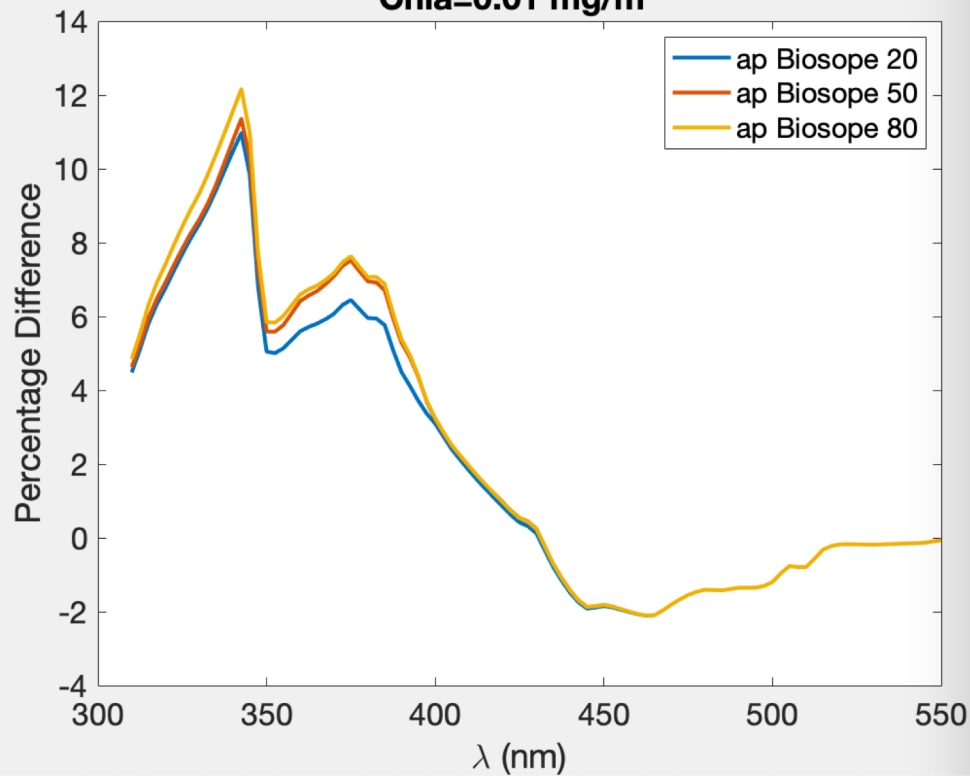
pure sea water,

phytoplankton covariant particle,

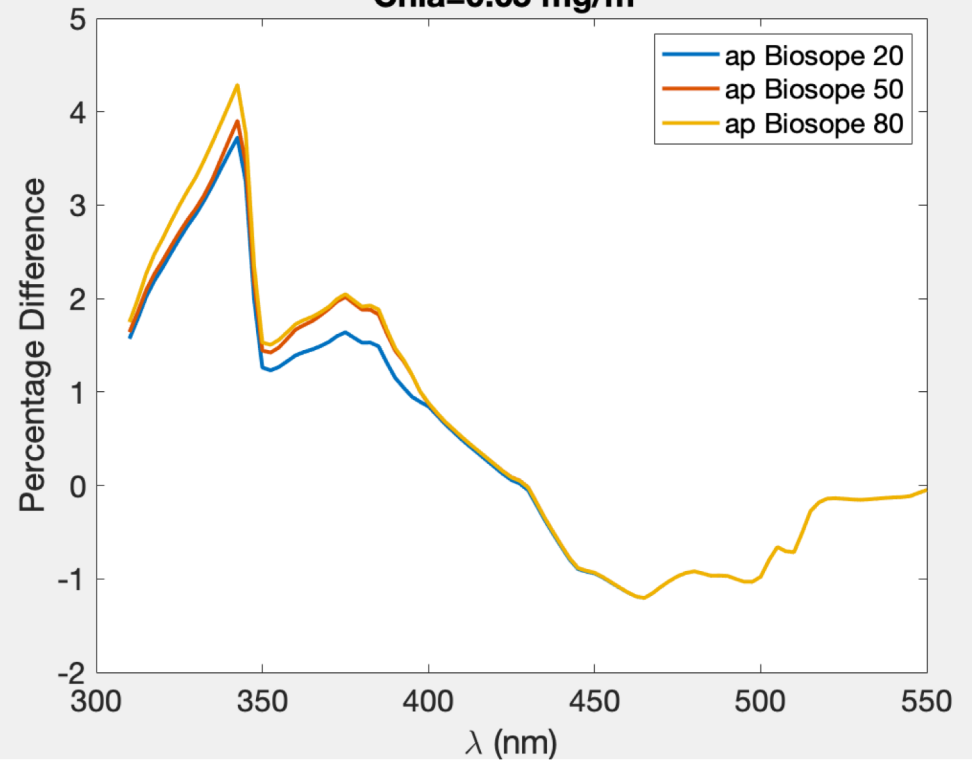
CDOM

# Relative Difference at TOA between SBL and MCF

Chla=0.01 mg/m<sup>3</sup>

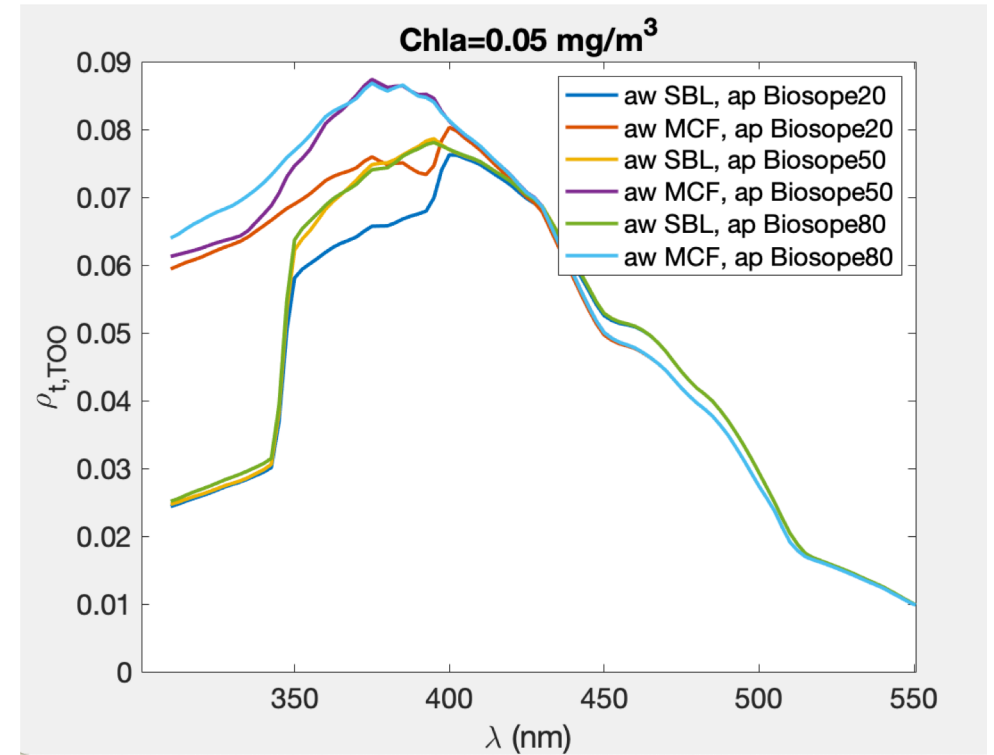
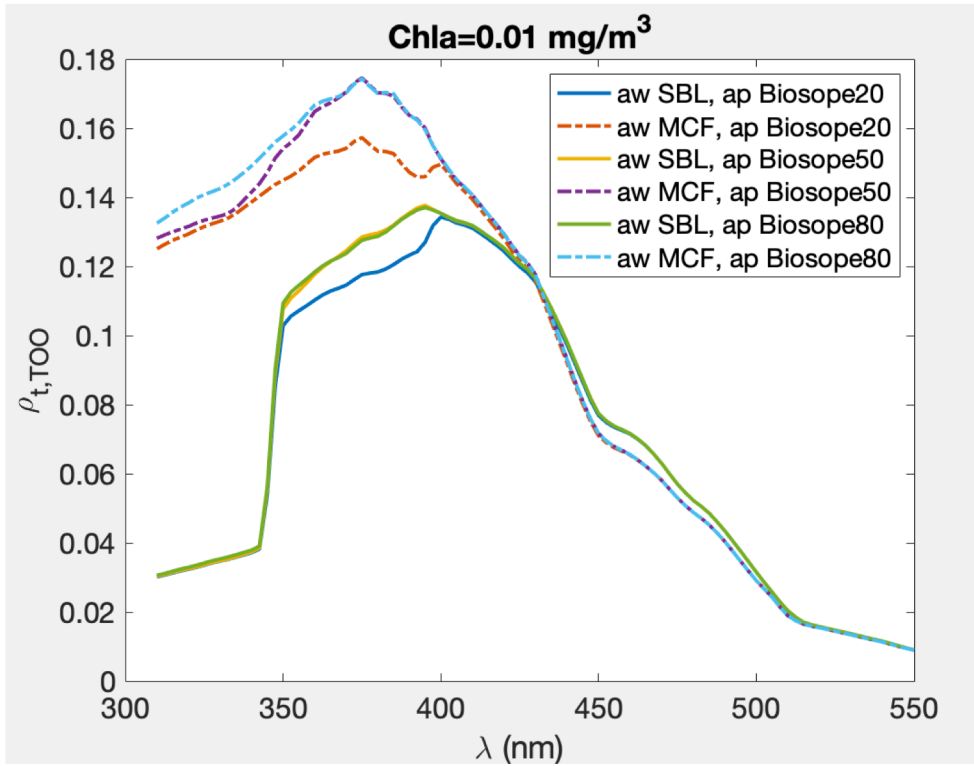


Chla=0.05 mg/m<sup>3</sup>





# TOO Reflectance $\pi I / E_d$



Solar zenith angle: 30 degree.

Atmosphere:

$\tau_{a,550 \text{ nm}}=0.1$

Gas absorption: H<sub>2</sub>O, Ozone, CO<sub>2</sub>, CH<sub>4</sub>, O<sub>2</sub>, NO<sub>2</sub>.

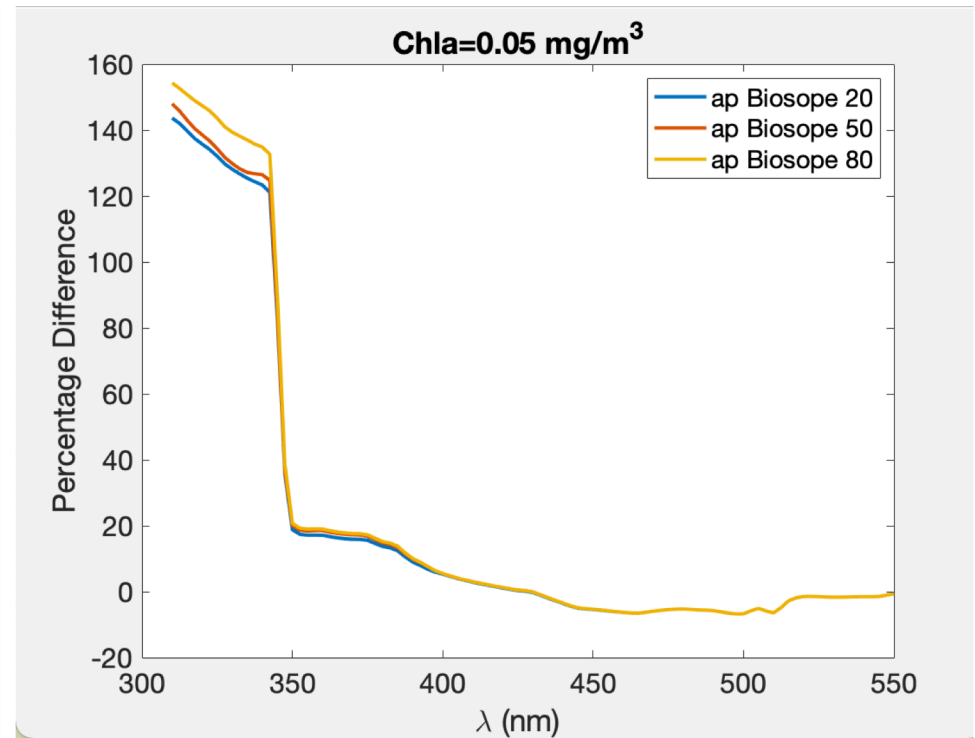
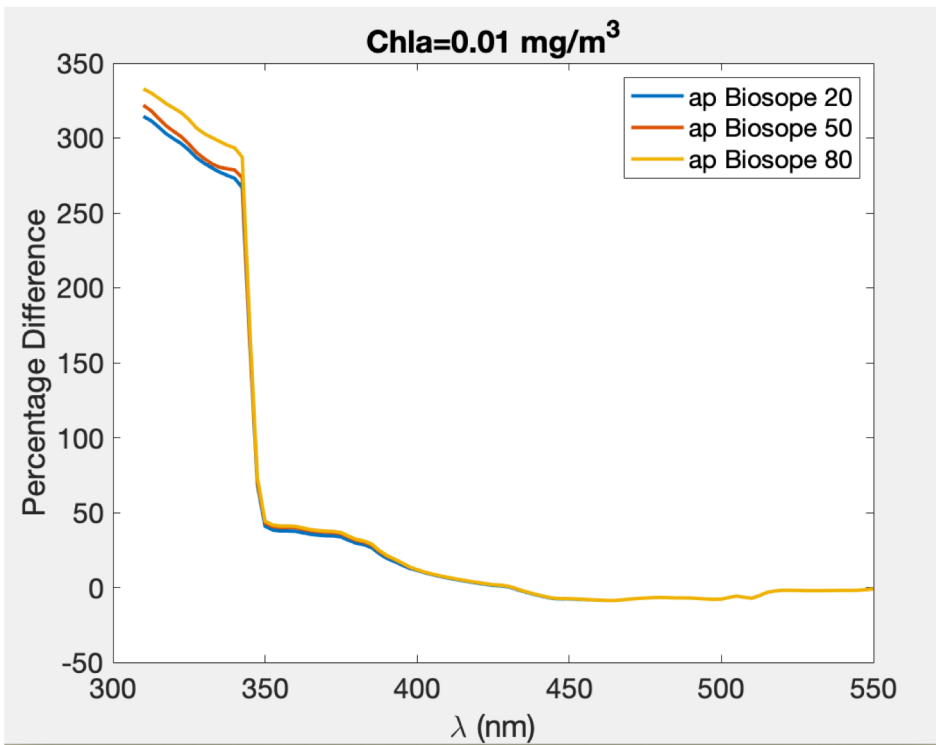
Ocean water model:

pure sea water,

phytoplankton covariant particle,

CDOM

# Relative Difference at TOO between SBL and MCF



# Summary

- A series of tests have been done to test the sensitivity of TOA and TOO sensors to the choice of the water absorption coefficient spectra.
- The relative difference of sensor measurements for different water absorption coefficients depends on the choice of other constituents.
- At TOA, the relative difference is 6% near 350 nm for  $\text{Chla}=0.01 \text{ mg/m}^3$ ; This number is 2% for  $\text{Chla}=0.05 \text{ mg/m}^3$ , the differences are due to Lee et al.(2015) and MCF (2016).
- At TOO, the relative difference is 40% near 350 nm for  $\text{Chla}=0.01 \text{ mg/m}^3$ ; This number is 20% for  $\text{Chla}=0.05 \text{ mg/m}^3$ .
- For shorter wavelength, the difference is even larger as the difference between the Smith-Baker (1981) and MCF (2016) is larger.
- Alex Lyapustin's Quest: Can current spaceborne UV sensors be used to help quantify water absorption coefficients?