

Water-leaving reflectance errors due to factors other than aerosols

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Simple radiative transfer model

$$\rho_{TOA} = \rho_{path}^{Rayleigh} + \rho_{water-leaving} e^{-\tau_{Rayleigh} \left(\frac{1}{\cos \theta} + \frac{1}{\cos \theta_0} \right)}$$

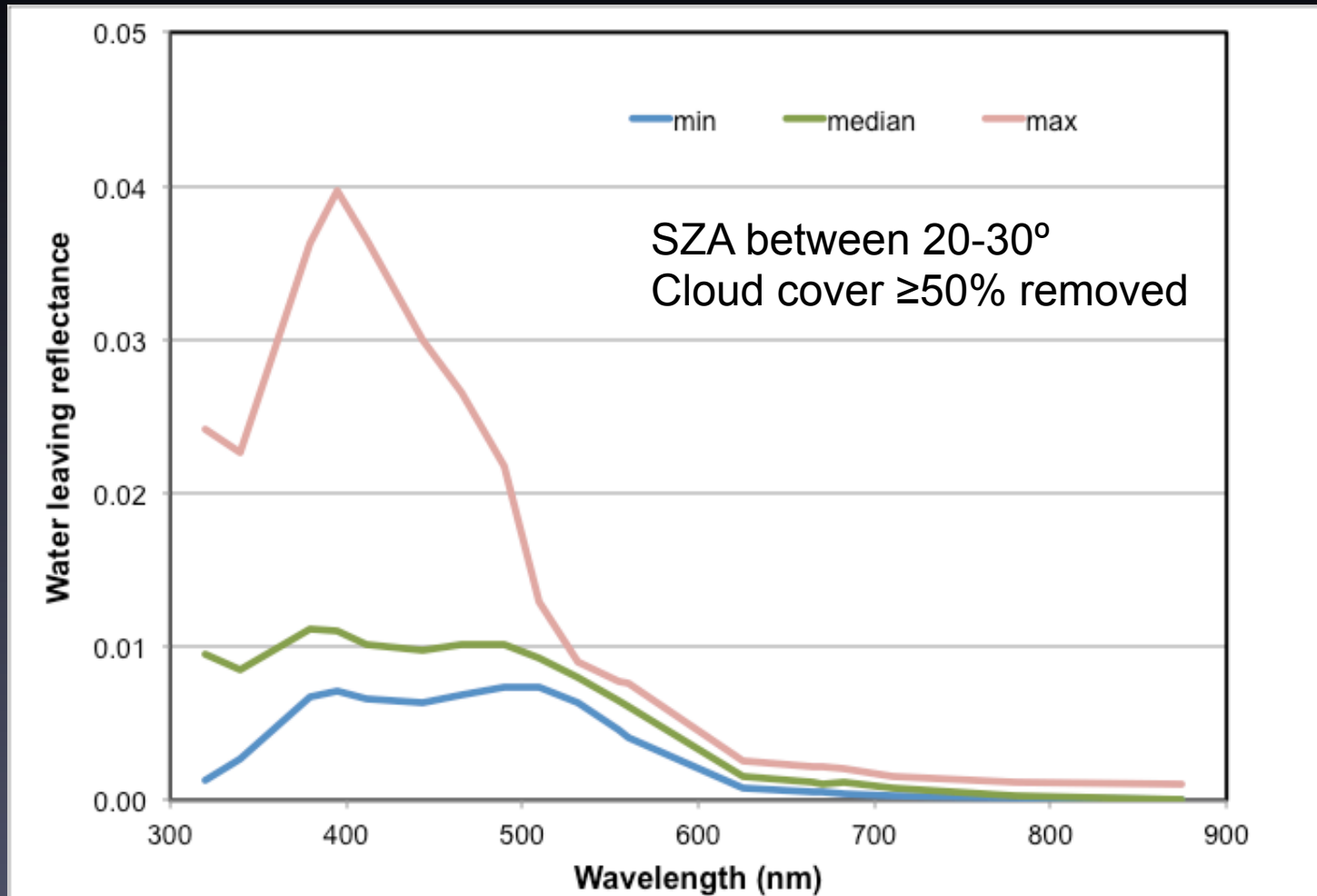
Optimistic assumptions:

- No aerosols, no absorbers – Rayleigh scattering only
- Diffuse atmospheric transmittance neglected
- Nadir view, $\theta = 0^\circ$
- Near-overhead Sun, $\theta_0 = 25^\circ$

Sources of error in top of atmosphere (TOA) reflectance

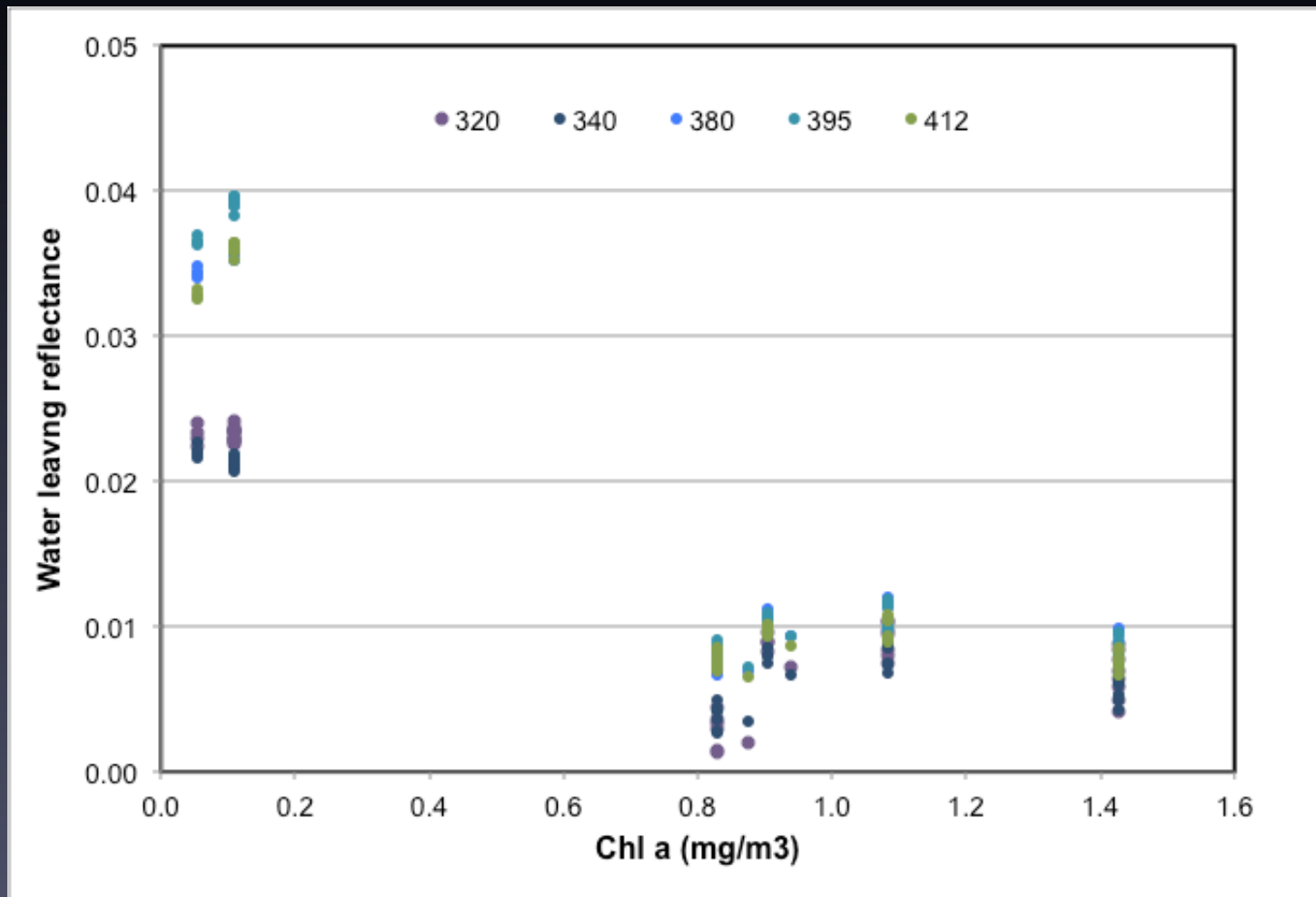
- Atmospheric pressure uncertainty 0.2%
- Day-to-day solar irradiance variability 0.1%
- Calibration stability uncertainty 0.1%
- SNR 0.1%
- RSS error 0.25%

Water-leaving reflectance vs. wavelength

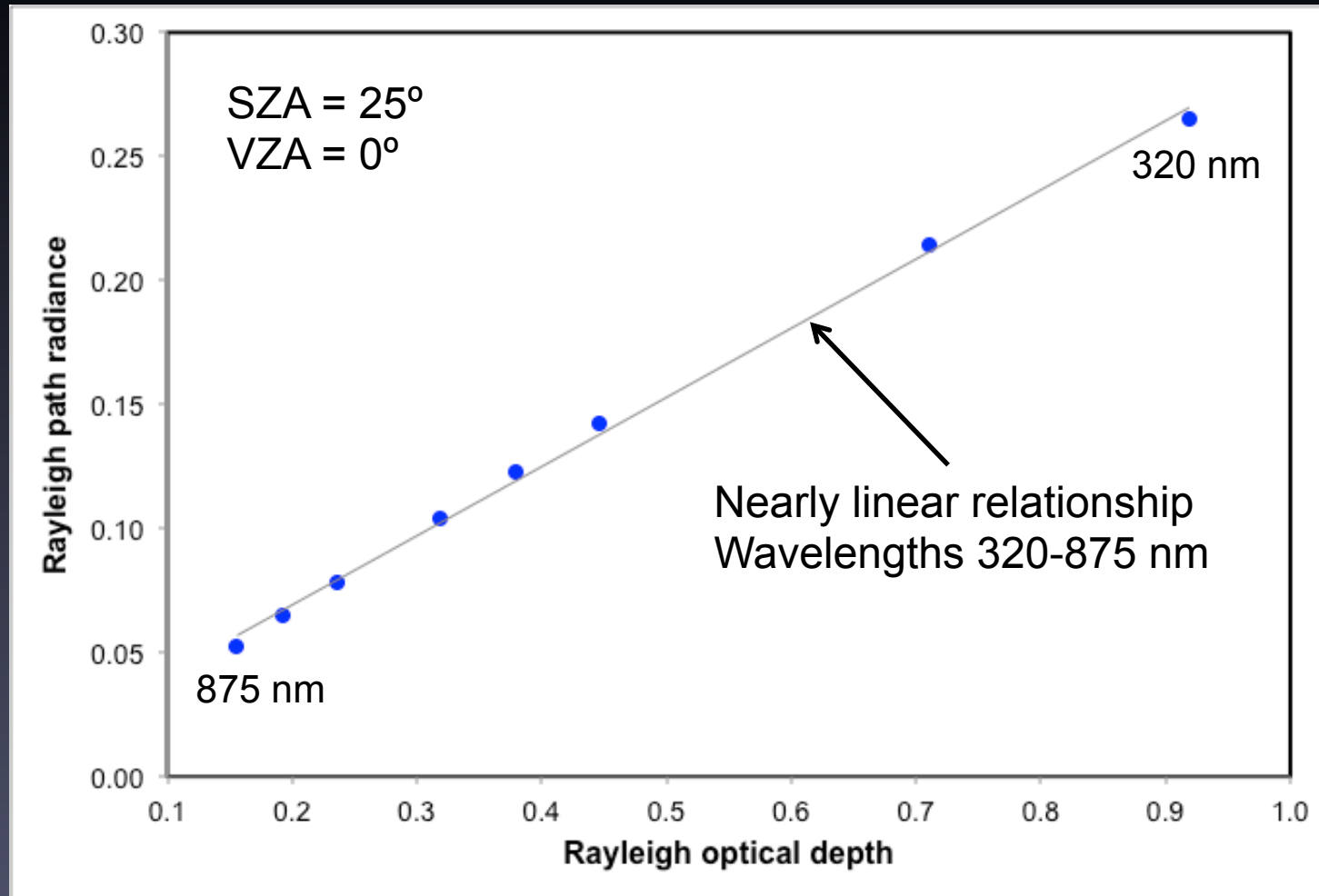


Above-water radiometry from Stan Hooker, 2004 BIOSOPE cruise
Obtained from SeaBASS, thanks to Bryan Franz

Dependence on Chl a concentration

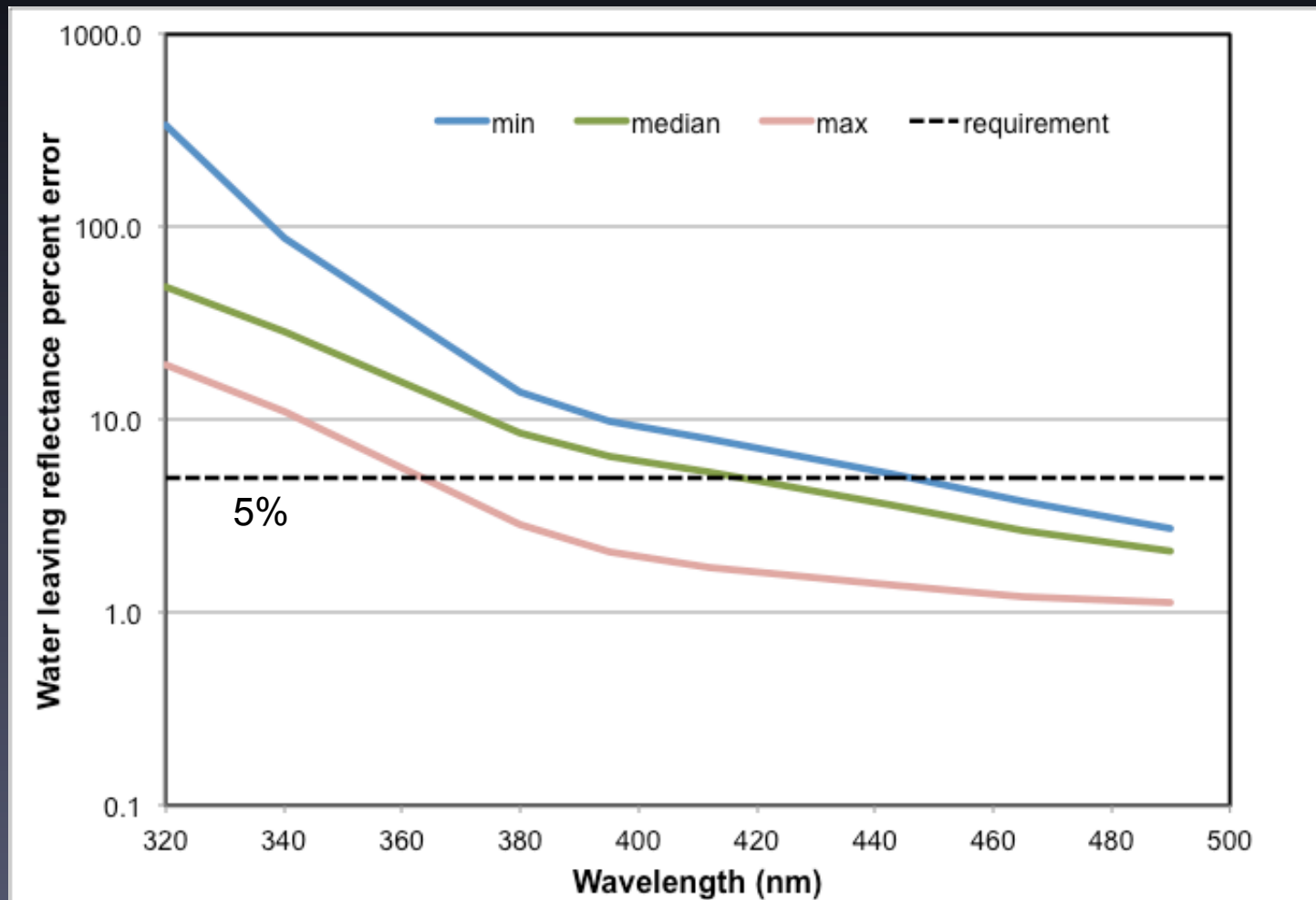


TOA reflectance from Rayleigh path radiance



Path radiance calculations from John Martonchik

Error in water-leaving reflectance due to 0.25% uncertainty in TOA reflectance



Conclusions

- 5% uncertainty in water-leaving reflectance is problematic
 - at wavelengths below 420 nm if Chl a $> 0.8 \text{ mg m}^{-3}$
 - at wavelengths below 360 nm if Chl a $< 0.2 \text{ mg m}^{-3}$