

# Removal of Glint in Above-Water Radiometry: Computation and Impact on AERONET-OC Retrievals

Barbara Bulgarelli<sup>1</sup>, Giuseppe Zibordi<sup>2</sup>, Davide D'Alimonte<sup>3</sup>, Tamito Kajiyama<sup>3</sup>

<sup>1</sup>JRC – EC; <sup>2</sup>NASA; <sup>3</sup>Aequora

Rome, 30.3-1.4.2026



# Above-Water Radiometry

$$L_w(\theta, \phi; \lambda) = L_t(\theta, \phi; \lambda) - \rho(\theta', \phi' \rightarrow \theta, \phi; \lambda) \cdot L_i(\theta', \phi'; \lambda)$$

via theoretical simulations:

Mobley, 1999

Mobley, 2015

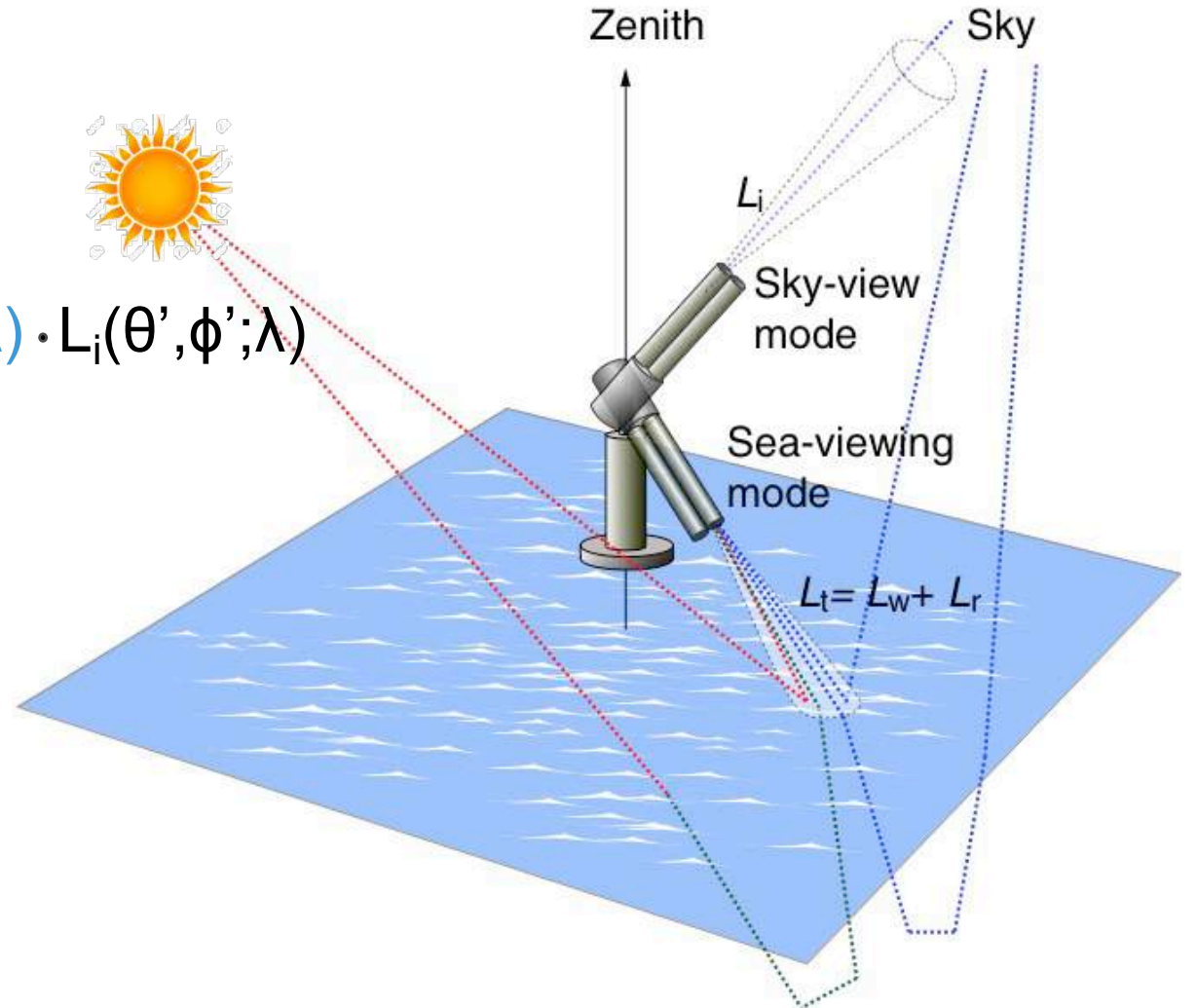
Zhang et al., 2017

Gilerson et al., 2018

D'Alimonte et al., 2021

Bulgarelli et al., 2022, 2024

Harmel, 2023



# FEM-MOX diffuse component of the $\rho$ -factors

Sky-radiance:

FEM plane-parallel numerical code

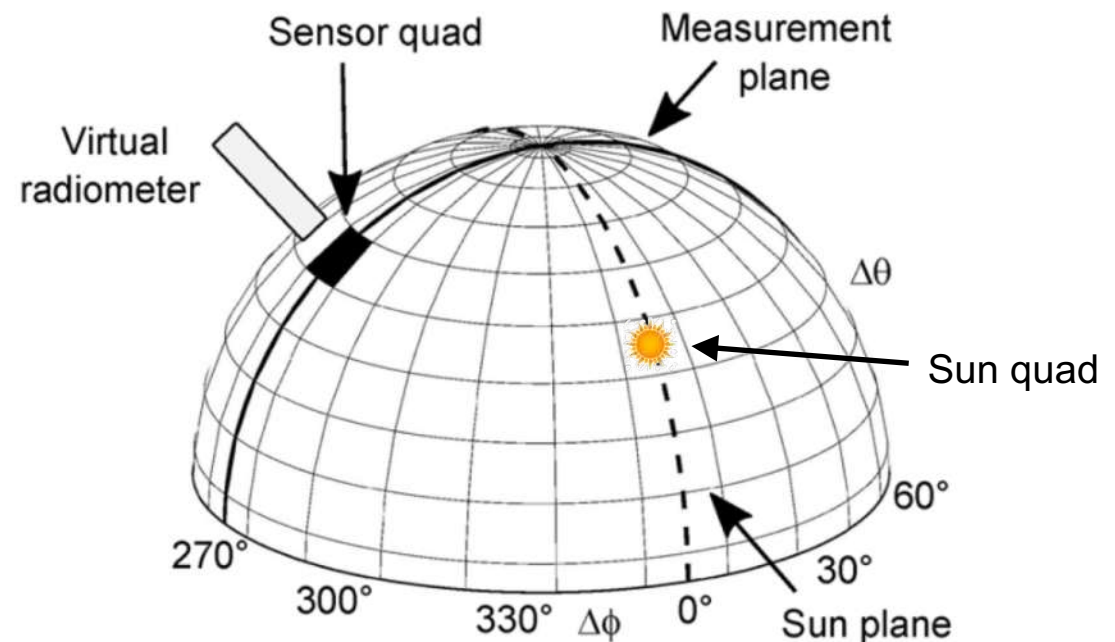
[Bulgarelli et al., 1999]

Sea-surface reflectance:

MOX 3D backward MonteCarlo

[D'Alimonte et al., 2021]

- Multiple scattering
- Full phase function representation
- No polarization
- Water-surface roughness [Cox and Munk, 1954]
- AERONET-OC measurement geometry (supported by the OC data validation protocols):  
 $\phi = 90^\circ$ ;  $\theta = 140^\circ$  and  $\theta' = 40^\circ$  with respect to zenith



D'Alimonte et al., 2021

Bulgarelli et al., 2022, 2024

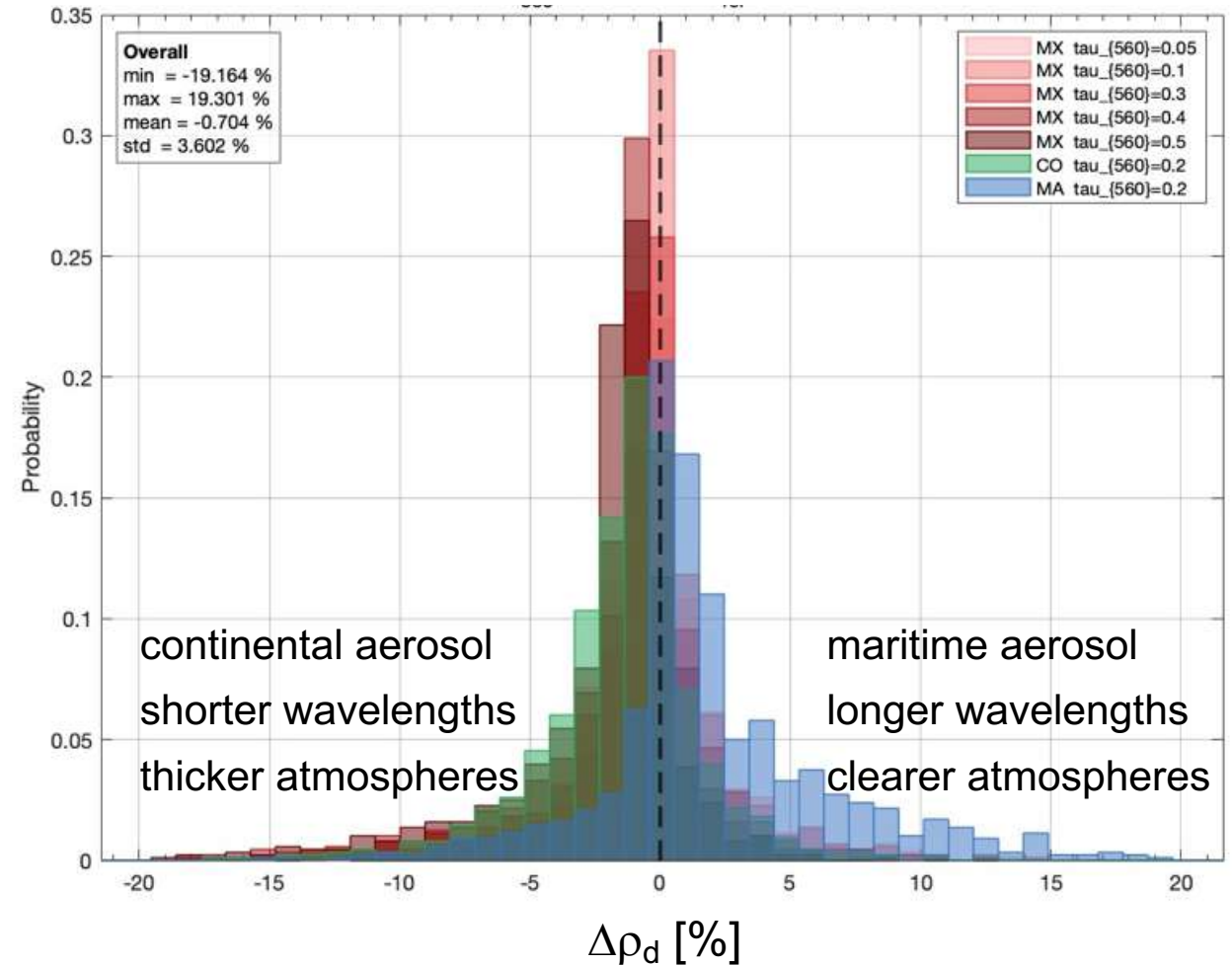
# FEM-MOX diffuse component of the $\rho$ -factors

$\rho_d$  values have been computed for

- $\theta_0 = 0-80$  deg
- Wind speed =  $0-10 \text{ ms}^{-1}$
- $\tau_a = 0.05-0.5$
- OPAC atmosphere
- aerosol type = continental – mix – maritime

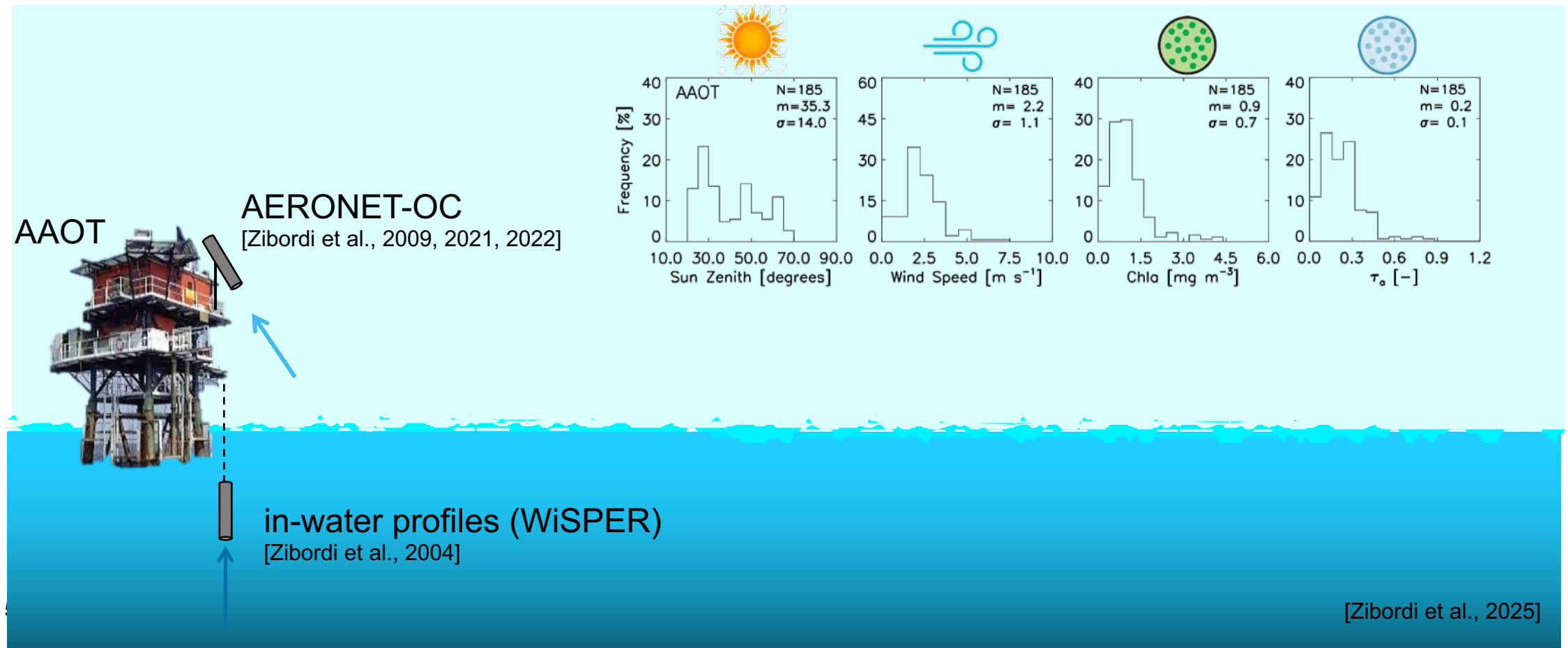
Histogram distribution of  $\Delta\rho_d$  [%] with respect to reference values for

- $\lambda = 551$  (as for Mobley, 1999)
- average aerosol climatological conditions ( $\tau_a = 0.2$  - mix aerosol model)



# Impact of Alternative Processing on AERONET-OC $L_{WN}$ : benchmark with independent in-water profiles

Comparison between  $L_{WN}$  from collocated AERONET-OC and in-water profile measurements



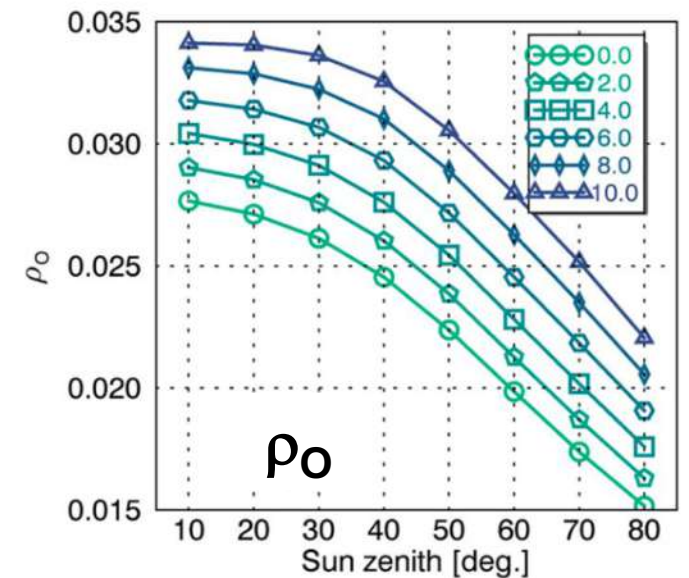
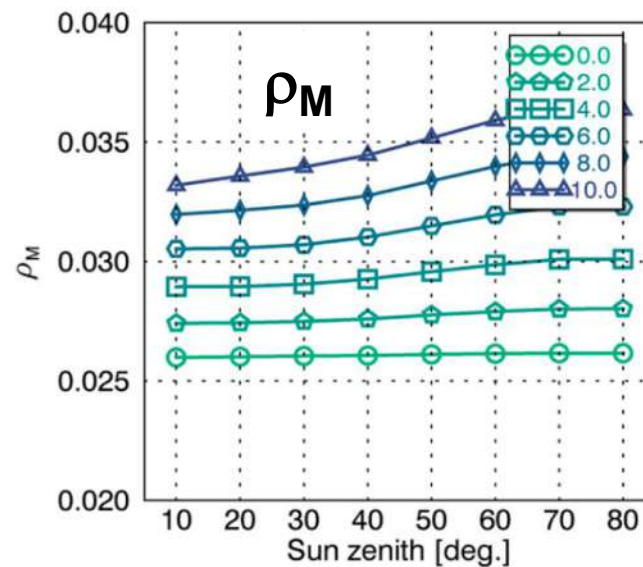
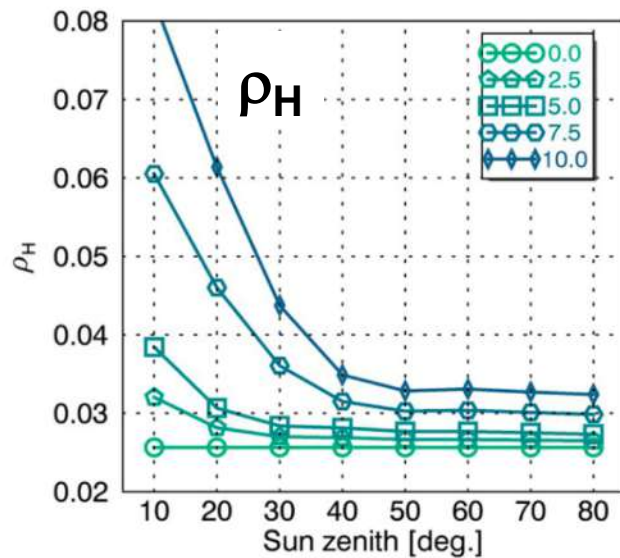
# Impact of Alternative Processing on AERONET-OC $L_{WN}$ : alternative processing solutions

Main features of the basic and alternative processing solutions

Processing solution	Regular Quality Control	Correction for bidirectional effects	$L_T$ determination	$\rho$ -factors	Spectral and atmospheric dependence	Polarization effects
ST-P basic	Yes	Chla-based [Morel et al., 2002]	Mean of a percentage of the lowest values	$\rho_H$ [Mobley, 1999]	No	No
AM-P alternative	Yes	IOP-based [Lee et al., 2011]	Average of all values	$\rho_M$ [Bulgarelli et al.]	Yes	No
AO-P alternative	Yes	IOP-based [Lee et al., 2011]	Average of all values	$\rho_O$ [Harmel, 2023]	Yes	Yes

# Impact of Alternative Processing on AERONET-OC $L_{WN}$ : alternative $\rho$ -factors

Values of  $\rho_H$ ,  $\rho_M$ , and  $\rho_O$  at  $\lambda=560$  nm (550 for  $\rho_H$ ) for  $\tau_a=0.2$  (0.26 for  $\rho_H$ )



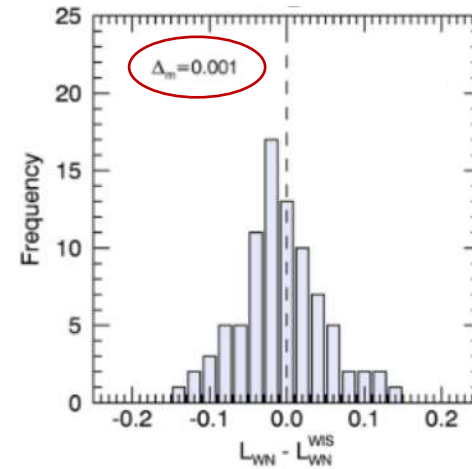
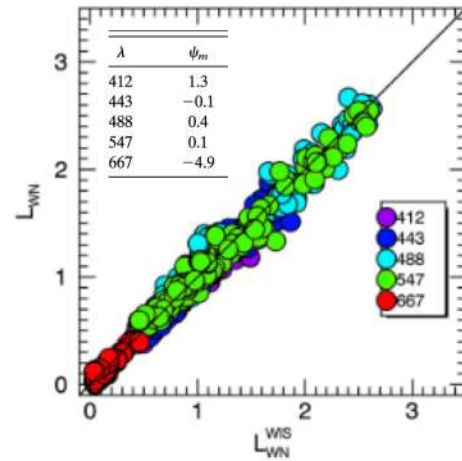
● [Mobley, 1999] Hydrolight  
total – scalar – non-spectral

● [Bulgarelli et al.] FEM-MOX  
diffuse – scalar – spectral

● [Harmel, 2023] OSOAA  
diffuse – vectorial – spectral

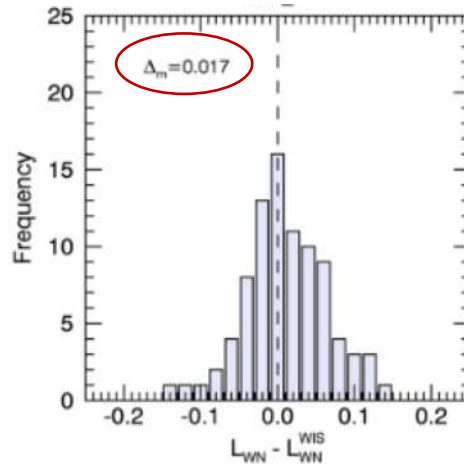
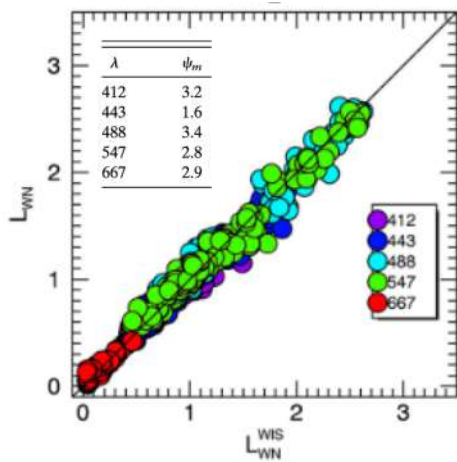
# Impact of Alternative Processing on AERONET-OC $L_{WN}$ : benchmark results

standard procedure with  $\rho_H$

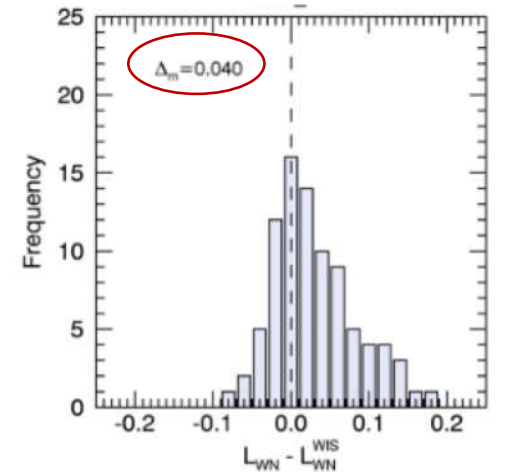
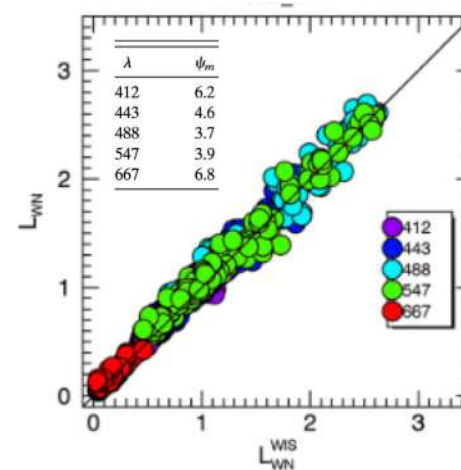


$\Delta_m$  = median of differences  
 $\psi_m$  = median of relative differences

alternative procedure with  $\rho_M$



alternative procedure with  $\rho_O$



# Impact of Alternative Processing on AERONET-OC $L_{WN}$ : Implications

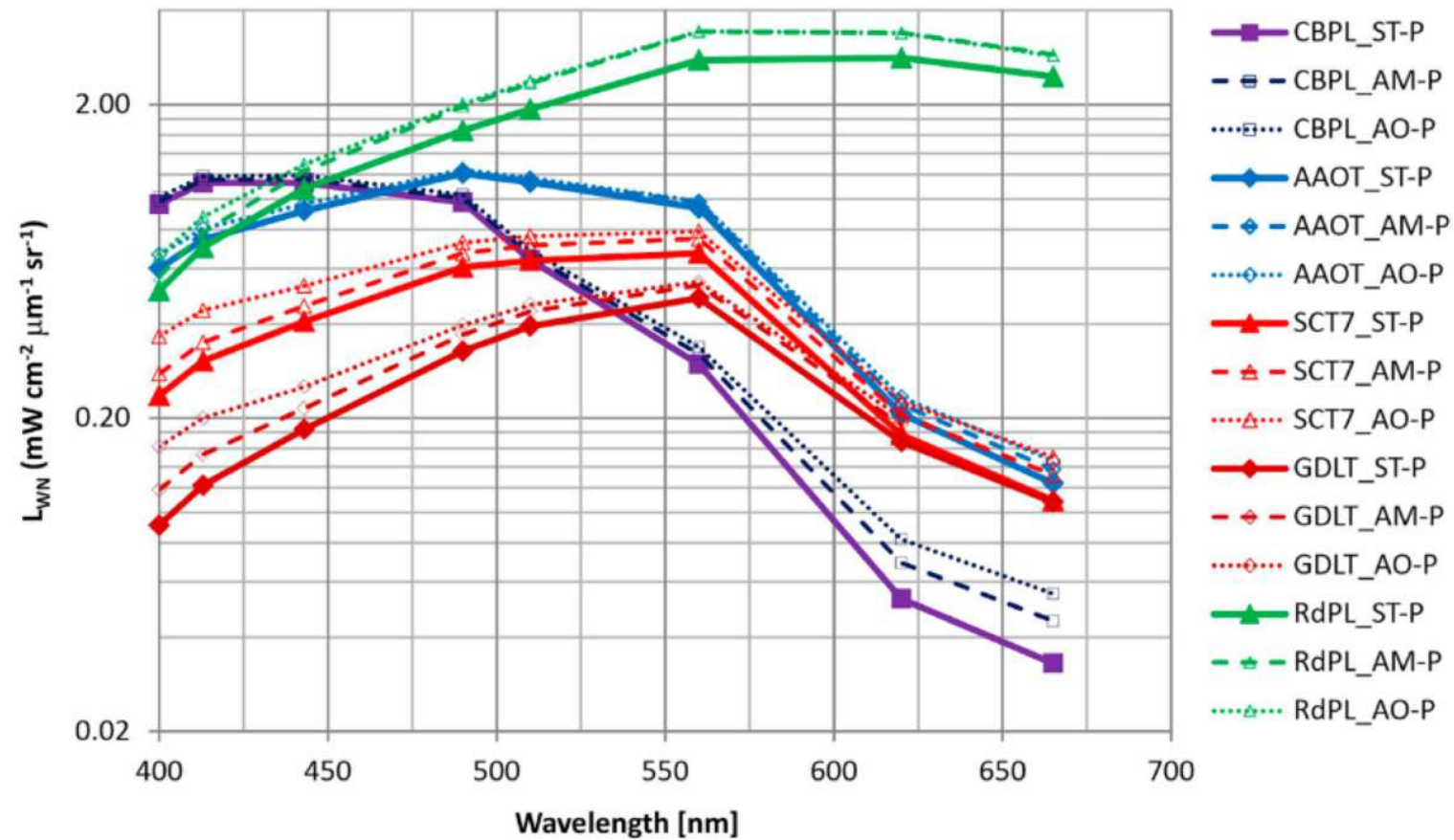


FIG. 5. Median  $L_{WN}$  spectra obtained from the ST-P, AM-P, and AO-P processing for the CBPL, AAOT, SCT7, GDLT, and RdPL AERONET-OC sites representative of diverse water types.

# Summary and Conclusions

- Acknowledging the accurate AERONET-OC filtering of measurements affected by sun-glint contamination, the sole diffuse component of the  $\rho$ -factor has been computed with FEM-MOX. The diffuse component of the  $\rho$ -factor shows more limited dependence on illumination, spectral and atmospheric conditions, as compared to the total  $\rho$ -factors.
- The analysis of the impact of alternative processing solutions on AERONET-OC  $L_{WN}$  highlighted:
  - The optimal performance of the basic AERONET-OC processing
  - A good performance of alternative processing solutions, with a slightly better agreement with independent measurements when the scalar FEM-MOX  $\rho$ -factors are applied
  - A more significant impact of alternative processing solutions in regions exhibiting optically complex waters, with  $L_{WN}$  generally increasing in highly absorbing or scattering waters, and with differences generally enhanced by applying OSOAA  $\rho$ -factors accounting for polarization effects
- This highlights the need for further comprehensive assessments of the impact of polarization effects in above-water radiometry across diverse optically complex waters and illumination conditions

# Thank you

