

# In-Situ Stratospheric Size Distribution Measurements from 2008 – 2015: comparisons with OSIRIS and OMPS extinction products

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# Bimodal versus Unimodal Size Distributions

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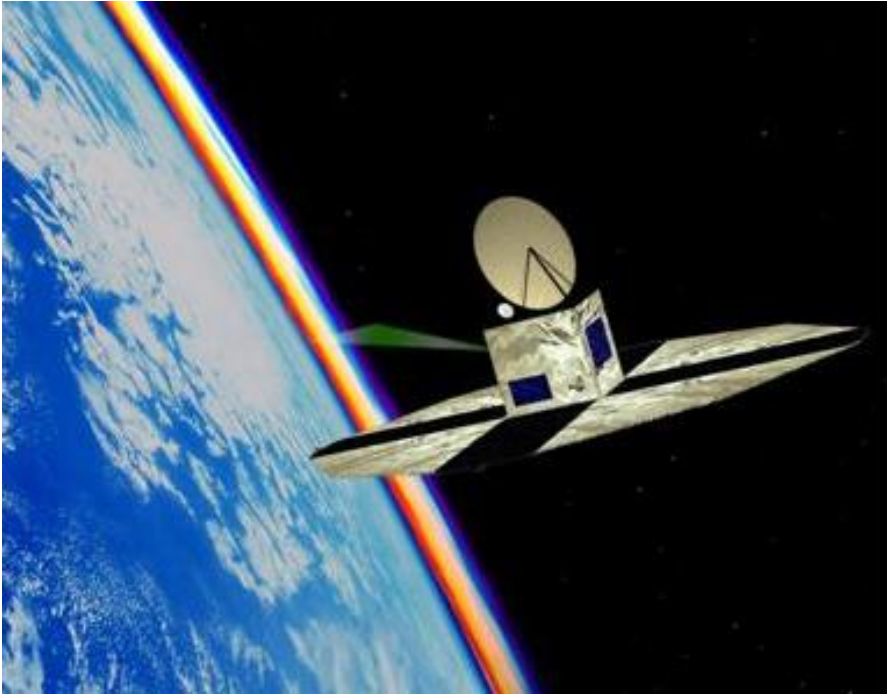
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University of Wyoming Optical Particle Counters (OPCs) –  
continuous measurements of stratospheric aerosol since 1971

Transition in 2006 from white light OPC to laser OPC







Extinction retrieval from limb scattering



$N(r)$  – Concentration as function of radius

# From size distributions to extinction

- OPC measures  $N(r)$  in 8 size bins
- Lognormal size distribution is fit to  $N(r)$  (Deshler, 2003)

$$N(> r) = \sum_i \int_r^\infty \frac{N_i}{\sqrt{2\pi} \ln \sigma_i} \exp\left(-\frac{\ln^2 \left[\frac{a}{r_i}\right]}{2 \ln^2 \sigma_i}\right) d \ln a$$

- Apply Mie theory to calculate extinction coefficient ( $Q$ ) as a function of particle radius, wavelength, and index of refraction

$$m = 1.45 - 0i$$

$$\beta_\lambda = \int_0^\infty \pi r^2 Q(r, \lambda, m) \frac{dn(r)}{dr} dr$$

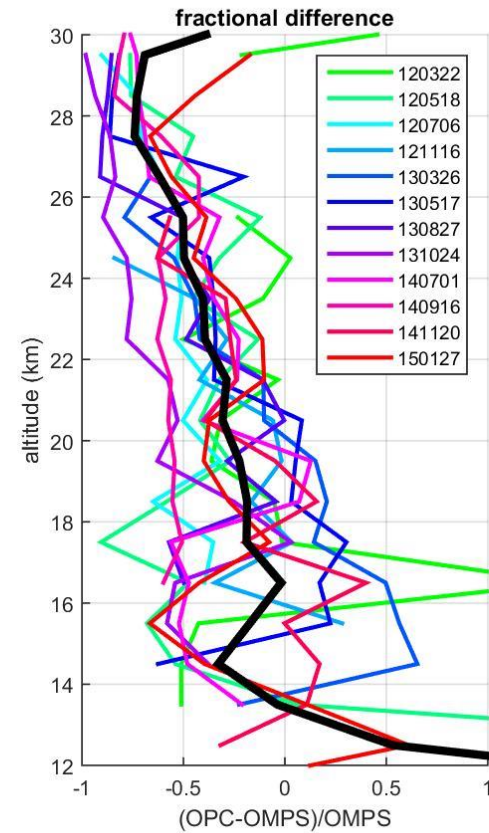
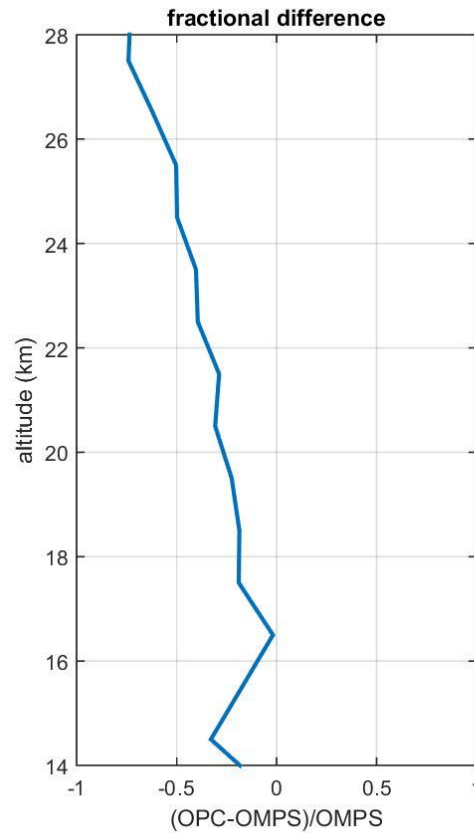
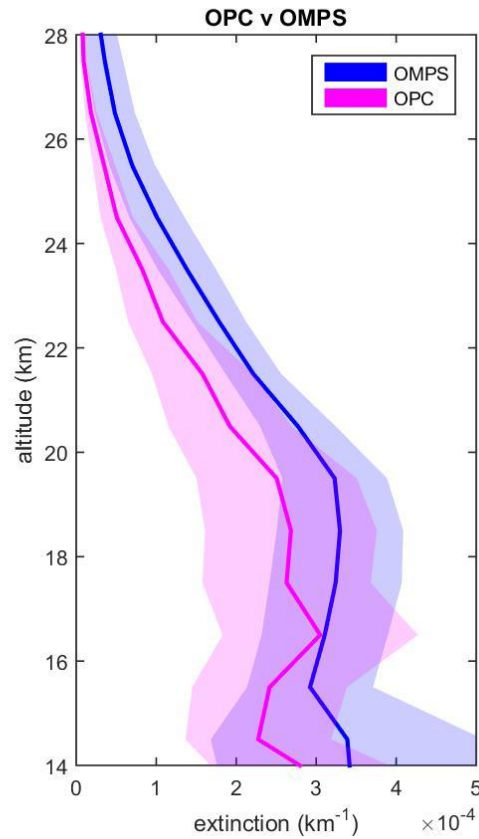
# Comparison to OMPS

12 balloon flights from March 2012 – Jan 2015  
(Laramie, WY at 41N, 105W)

65 OMPS profiles within 38-43N, 111-95W

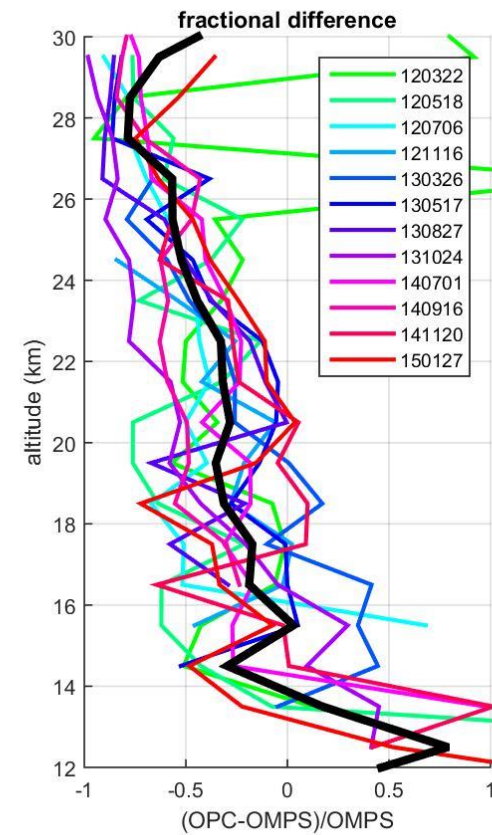
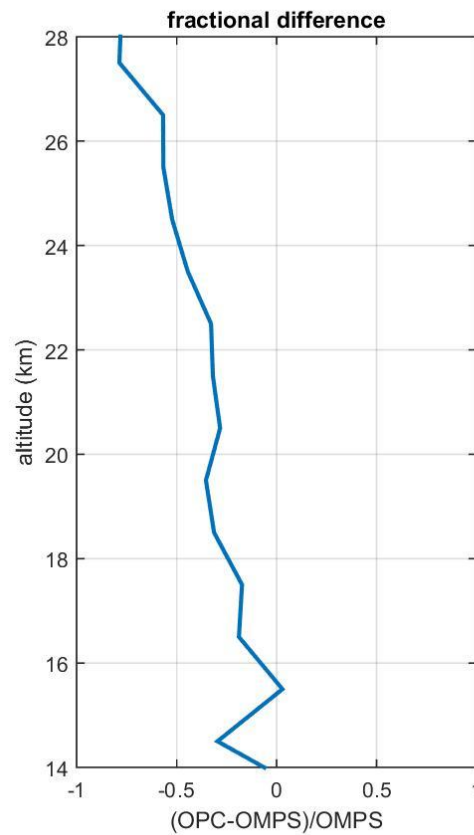
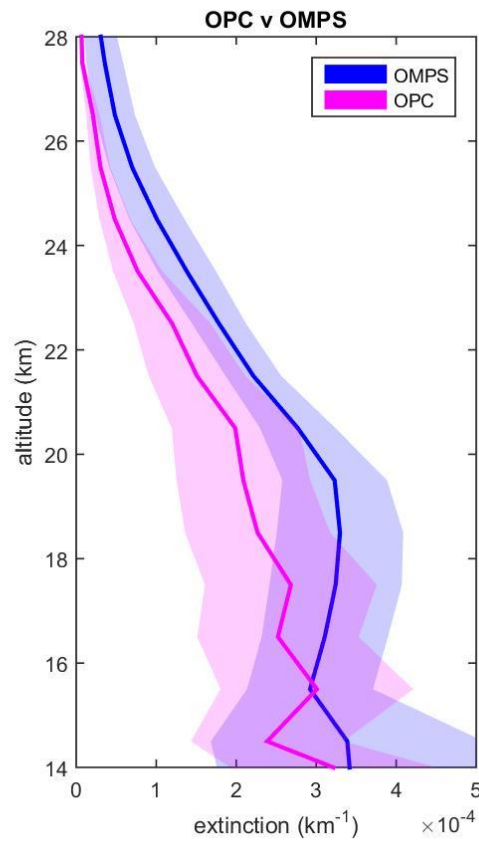
$$\lambda_{\text{OMPS}} = 675\text{nm}$$

# OPC SD with Bimodal fit





# OPC SD with Unimodal fit





# AOD statistics: OPC vs OMPS

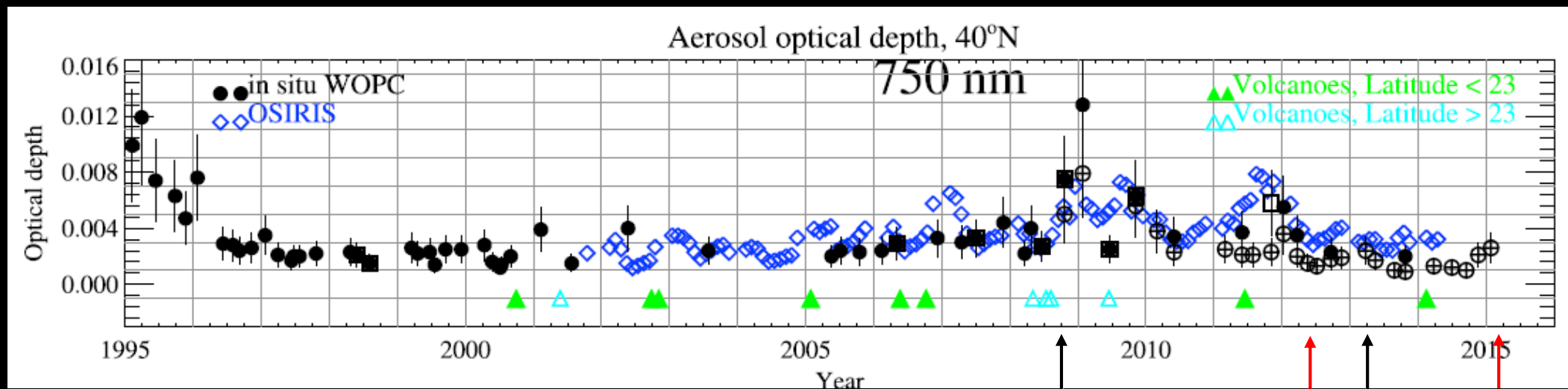
	Avg AOD 14-28 km	OPC AOD/ OMPS AOD	Width of distribution across 12 flights
OMPS	0.0024		$\sigma=5.8\text{e-}4$ ( $\pm 20\%$ )
OPC Bimodal	0.0017	71%	$\sigma=5.6\text{e-}4$ ( $\pm 32\%$ )
OPC Unimodal	0.0016	67%	$\sigma=3.8\text{e-}4$ ( $\pm 24\%$ )

# Comparisons to OSIRIS: 9 flights from 2008 - 2013

Larger variability in extinction during this time

$$\lambda_{\text{OSIRIS}} = 750\text{nm}$$



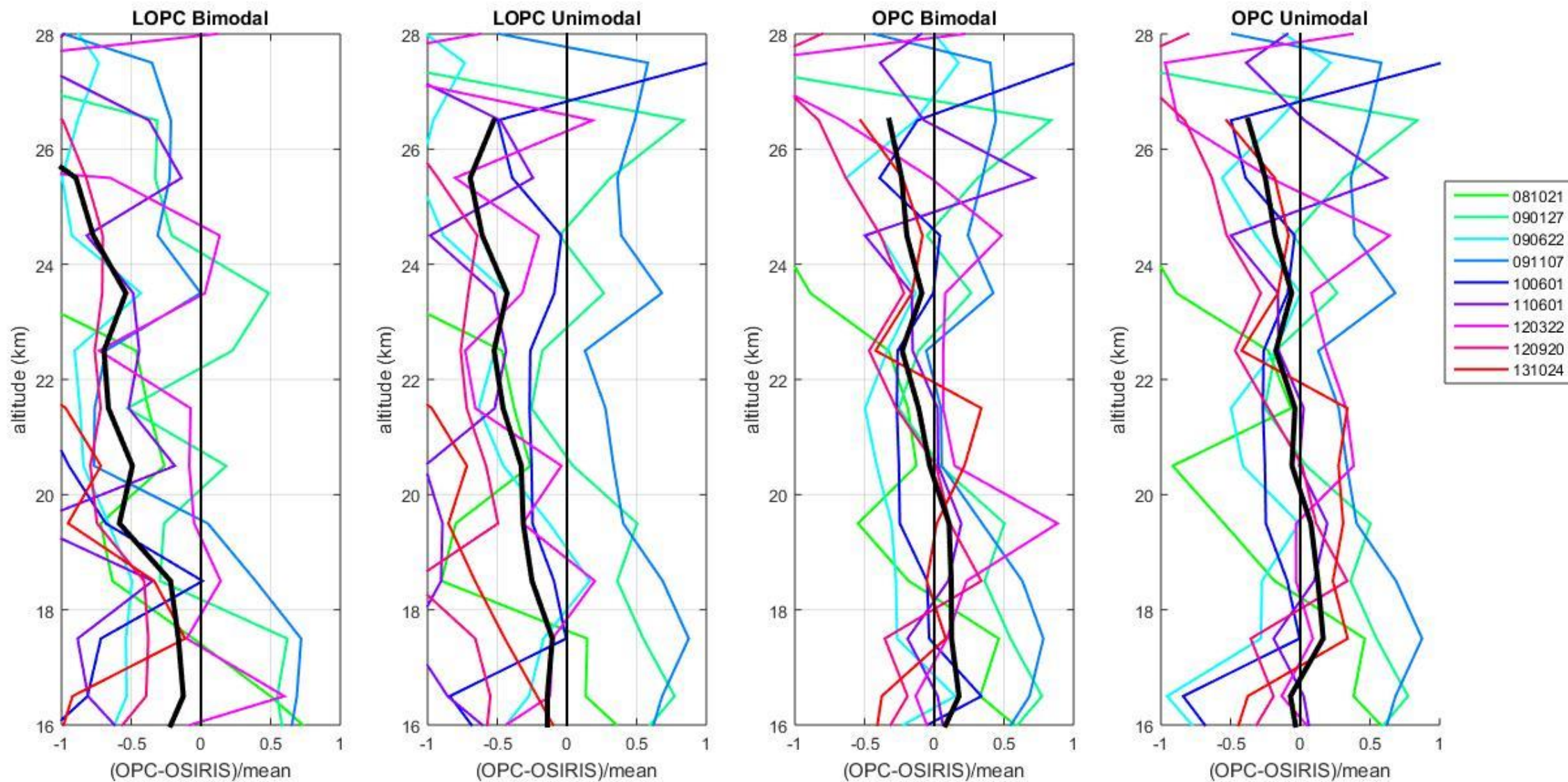


Kremser et al., 2016

OSIRIS  
comparison  
period

OMPS  
comparison  
period

## Difference between OPC and OSIRIS extinction across 9 flights

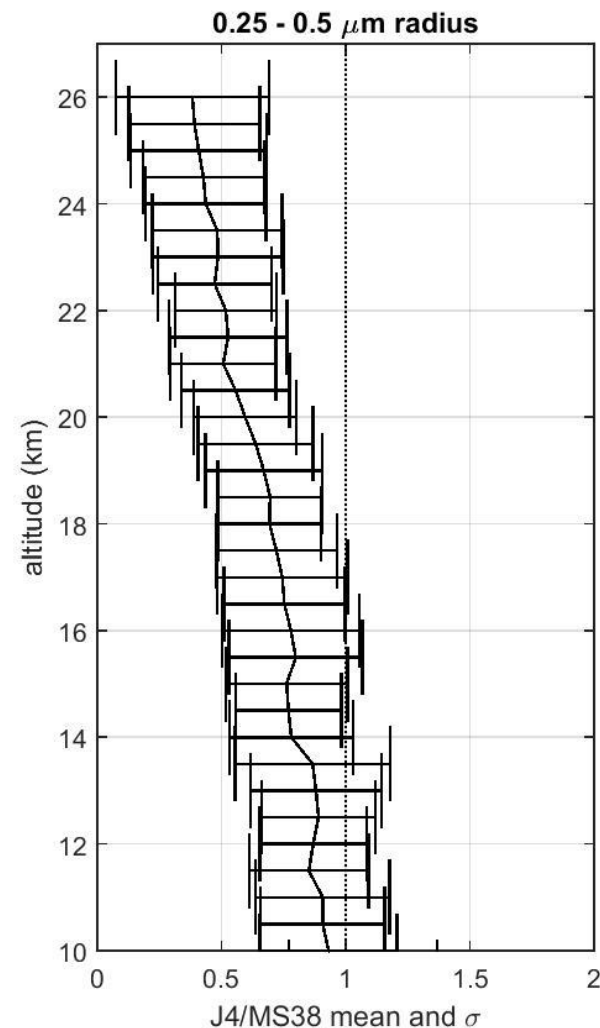
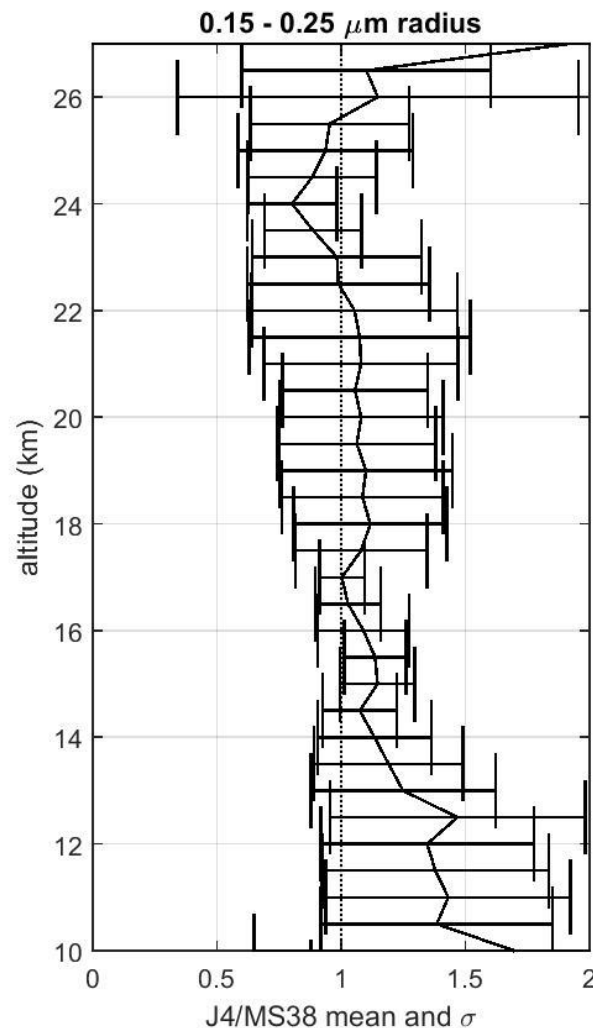


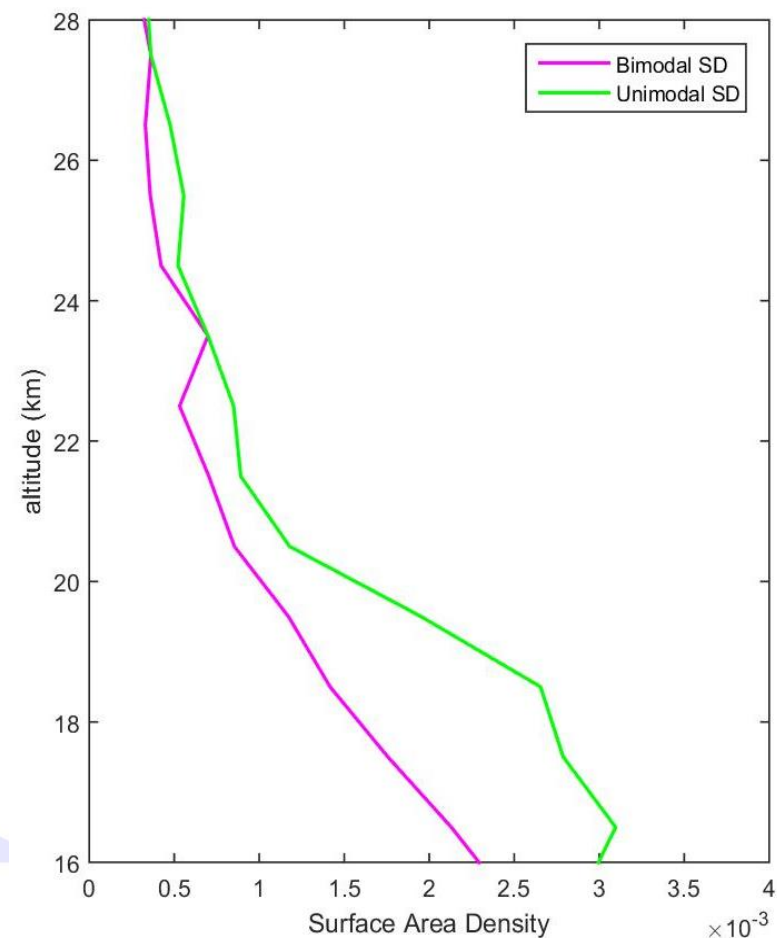
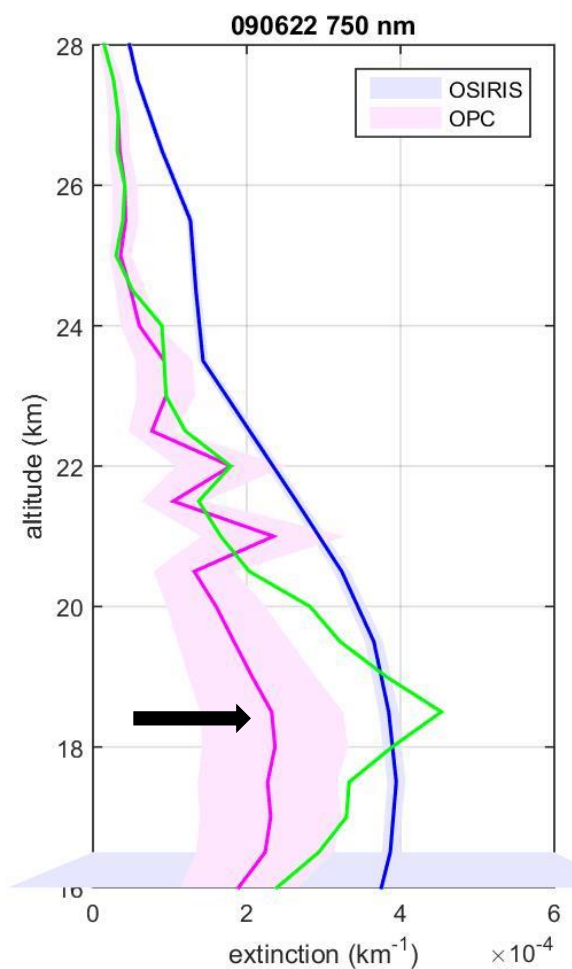
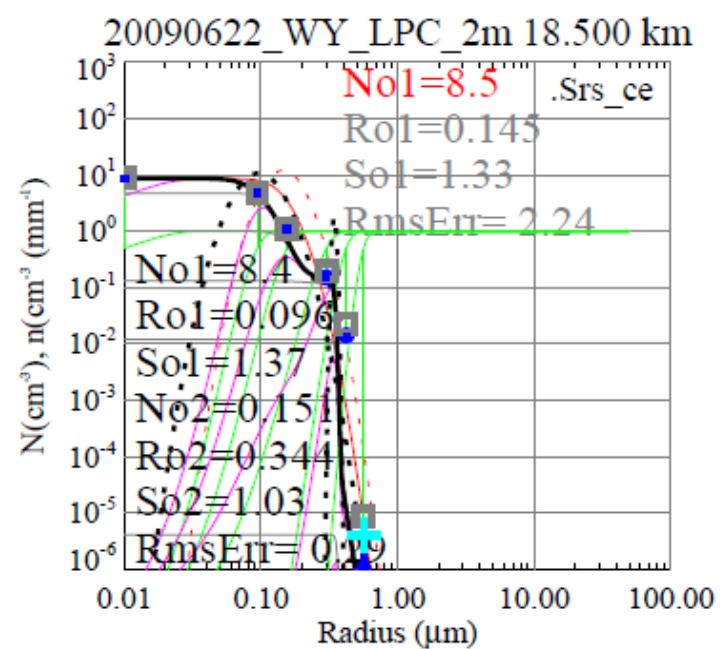
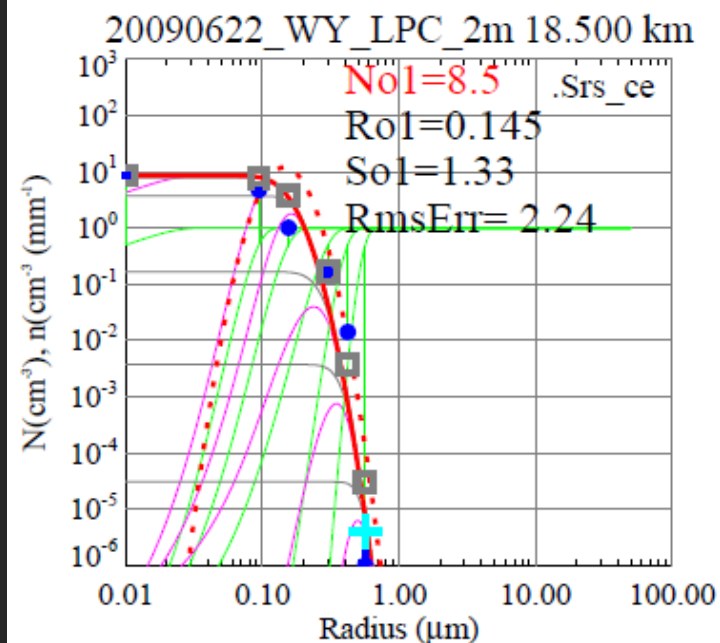


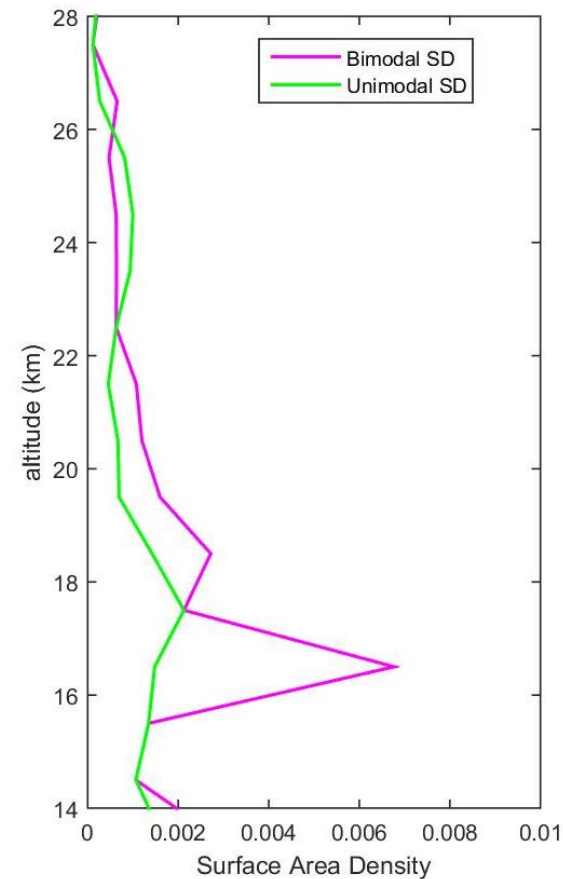
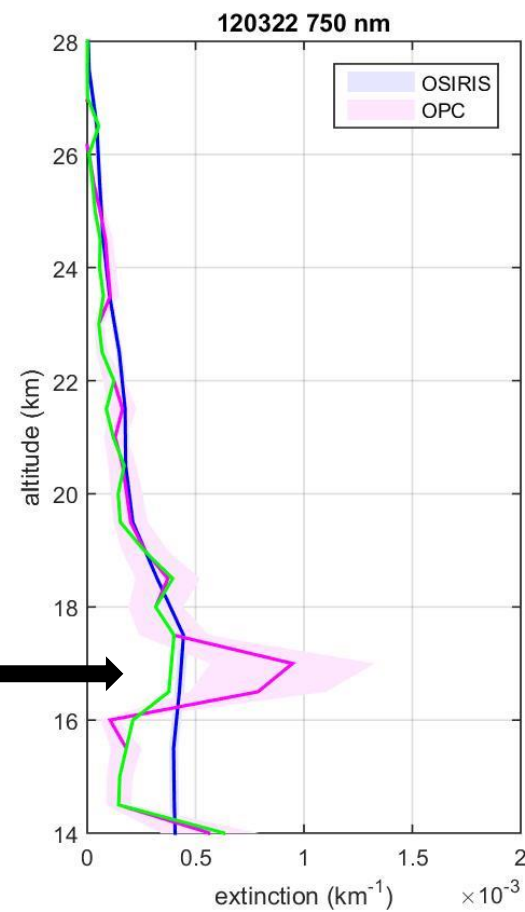
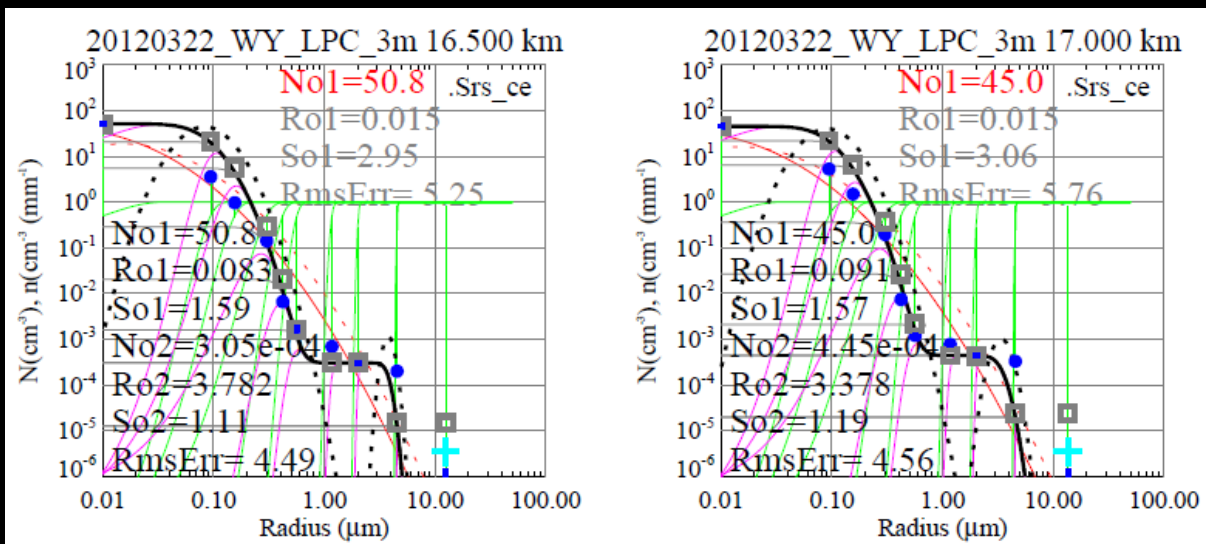
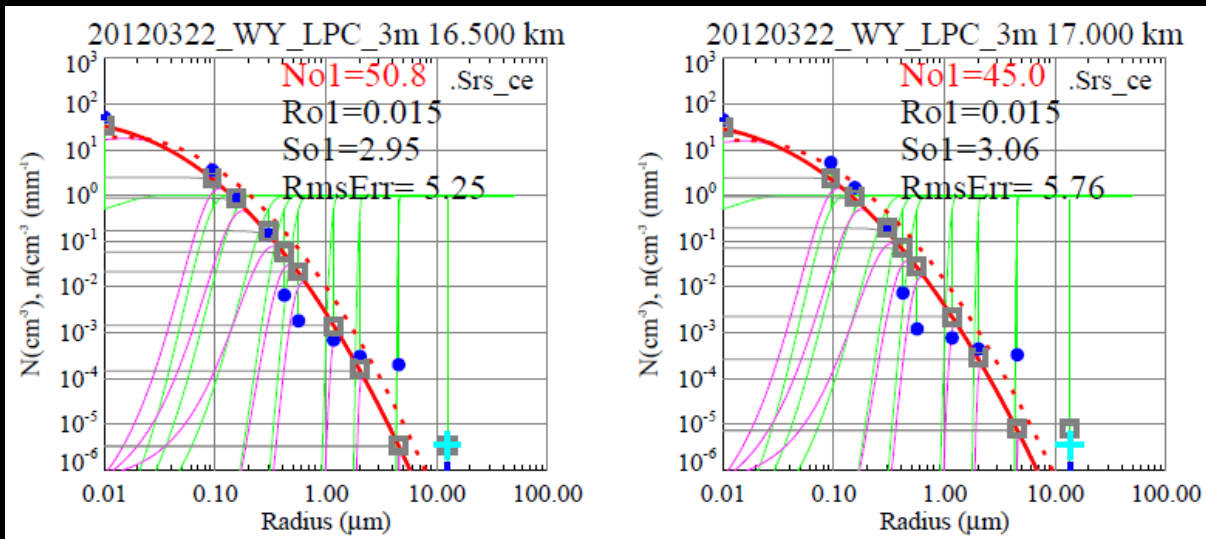
# Newest OPC compared to previous generation

10 coincident flights between 2006 – 2013 to characterize performance of latest OPC

$$\frac{\text{new OPC}}{\text{old OPC}} = \frac{J4}{MS38}$$







# Conclusions

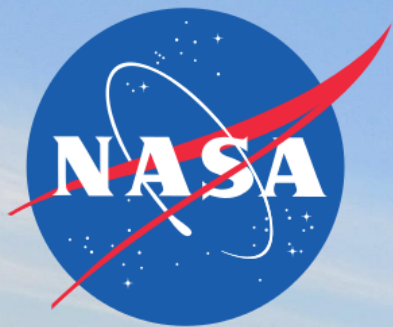
On average, the “new” Laser OPC size distributions produce extinction that is ~30% lower than satellites OMPS or OSIRIS

Unimodal fit gives similar extinction to Bimodal fit

Caution! Playing with the fit is slippery business and SAD can be very different between the two

Laser OPC extinction < White light OPC extinction  
this discrepancy worsens at higher altitudes





# Thank You

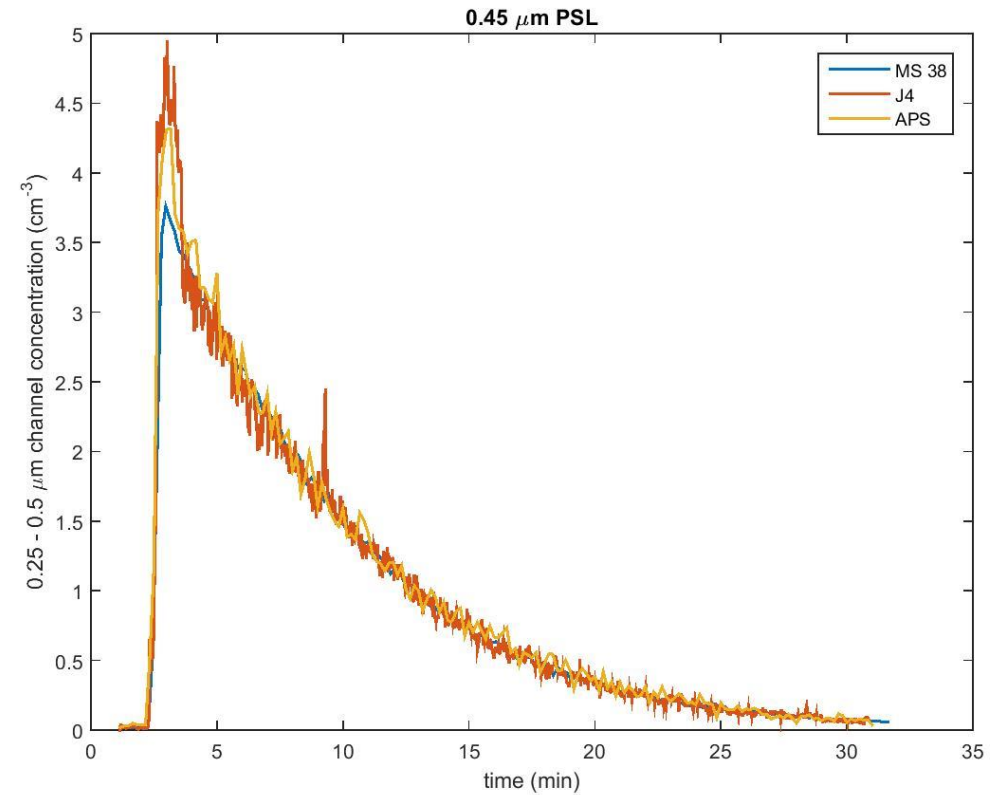
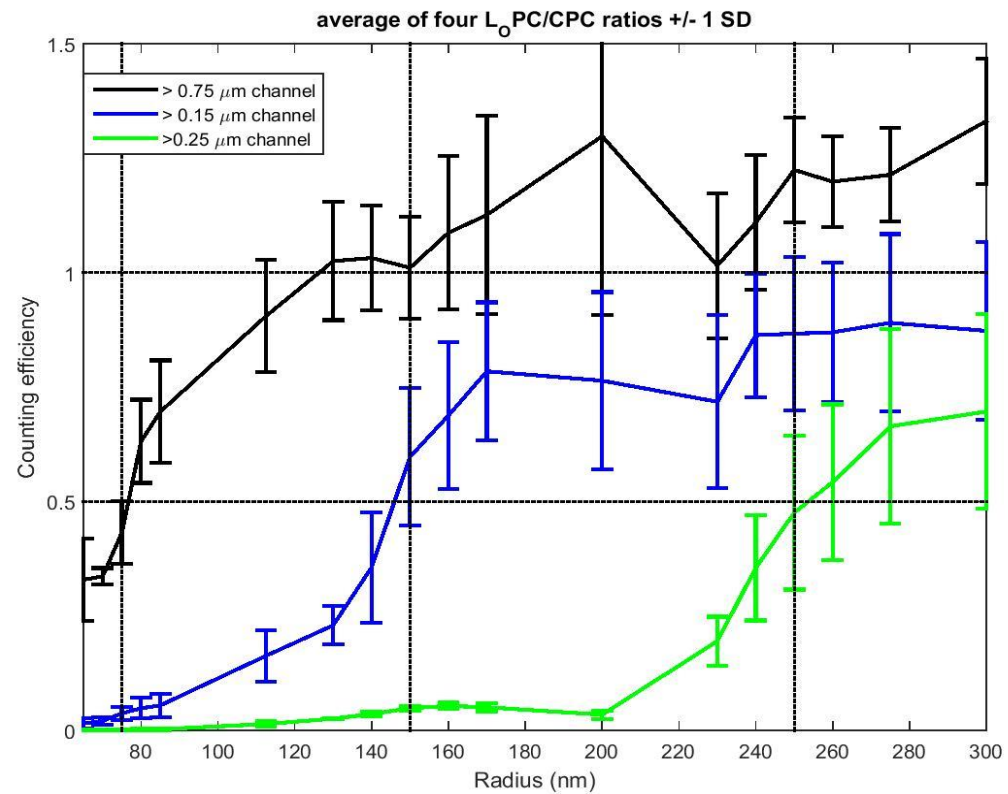


Terry Deshler

OSIRIS team: Landon Rieger, Adam Bourassa

OMPS contact Ghassan Taha

# Comparisons between 2 different UW OPCs

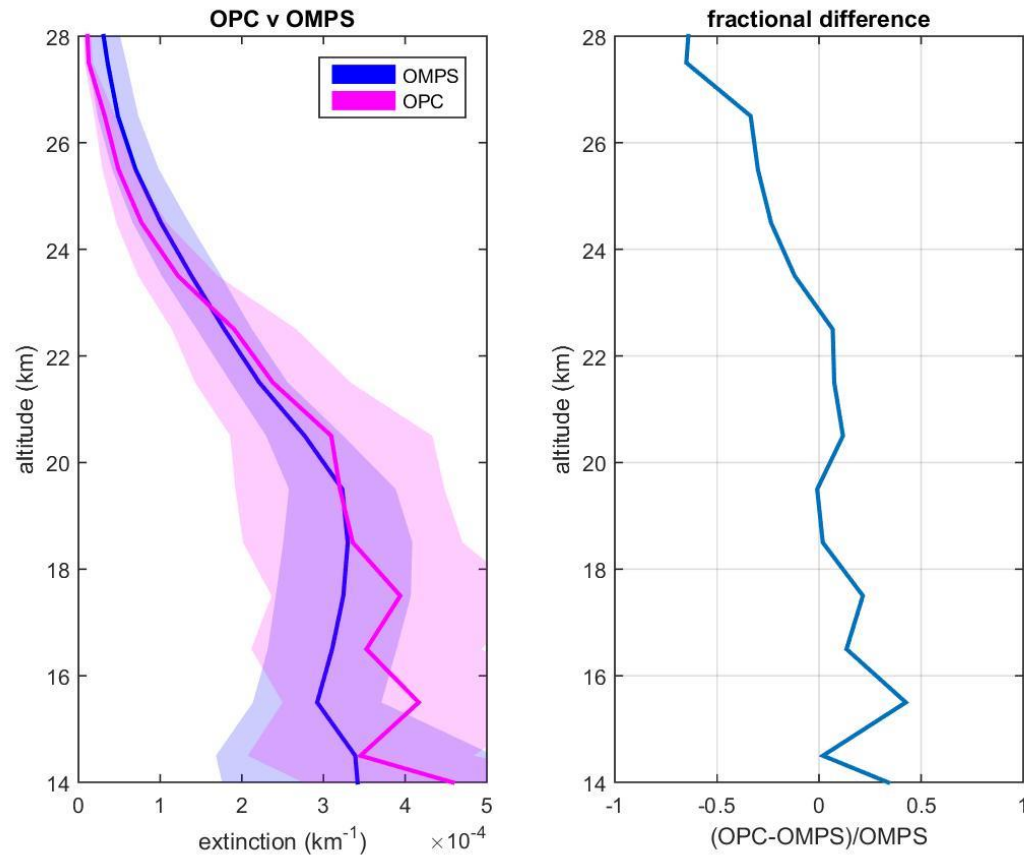


# 10% increase to OPC mode Radius

Unimodal SD from OPC

OMPS AOD 14-28km = 0.0030

OPC AOD 14-28 km = 0.0030



# Comparisons between 2 different UW OPCs

0.45  $\mu\text{m}$  radius PSL

This is upper end of the channel with a discrepancy  
(0.25 – 0.5  $\mu\text{m}$ )

Aerodynamic Particle Sizer as ground truth

