Extending the stratospheric aerosol record with OMPS-LP measurements

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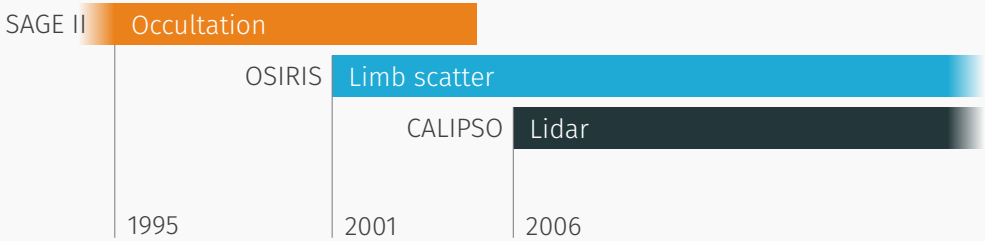

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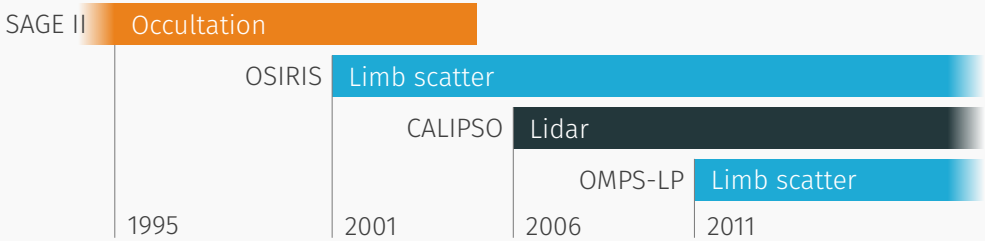


The problem is that limb scattering measurements are tricky...

Limb Scatter

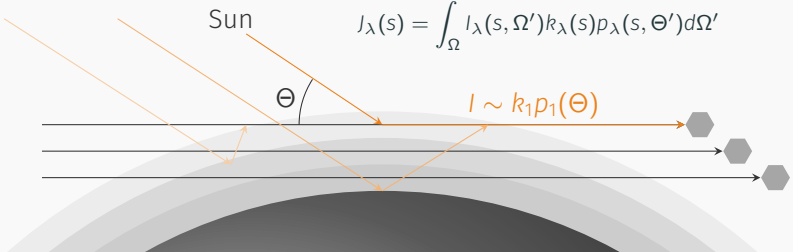
The limb scatter signal is a product of the extinction, as well as the probability of light scattering into the line of sight (determined by particle size)

The general idea is to assume $p(\theta)$ so that k can be retrieved

This means that - unlike for occultation - particle size must be assumed

$$I_\lambda(s) = I_{\lambda 0} e^{-\tau_\lambda(s)} + \int_s J_\lambda(s') e^{-\tau_\lambda(s')} ds'$$

$$J_\lambda(s) = \int_\Omega I_\lambda(s, \Omega') k_\lambda(s) p_\lambda(s, \Theta') d\Omega'$$



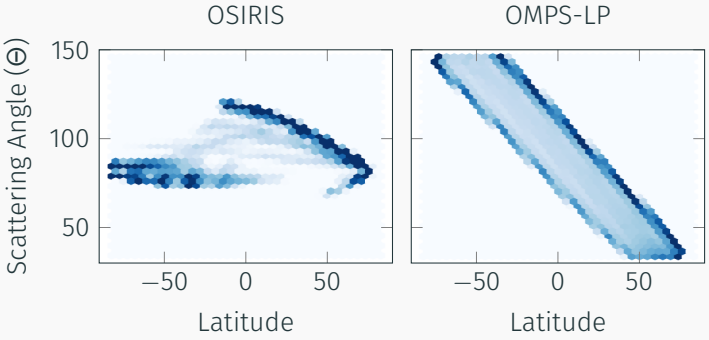
OSIRIS and OMPS-LP

OMPS-LP and OSIRIS have a lot of similarities

- both measure in the UV-vis with aerosol measurements typically around 675-750 nm
- similar vertical resolution of ∼2 km
- several years of overlap for merging

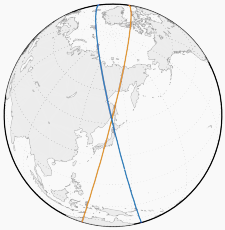
However, their orbits differ substantially, and this matters when we assume $P(\Theta)$

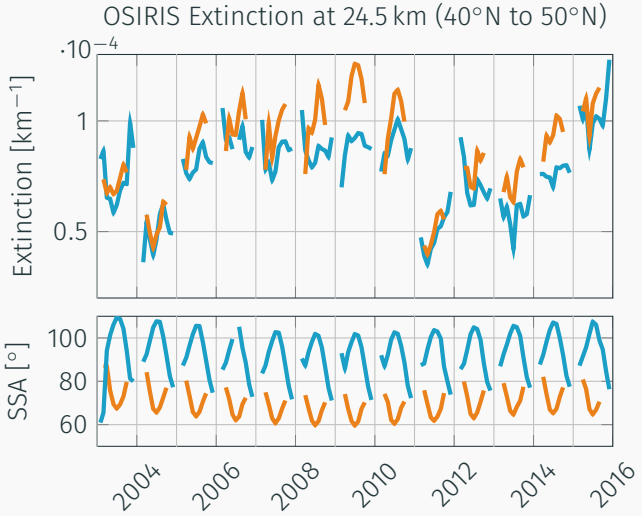
The biases will be different both as a function of latitude and season



OSIRIS and OMP-LP

We can see this effect when comparing measurements taken at similar locations but different scattering angles

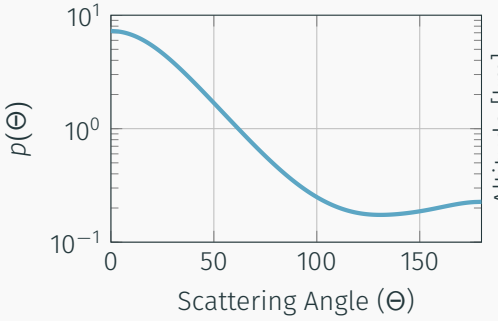


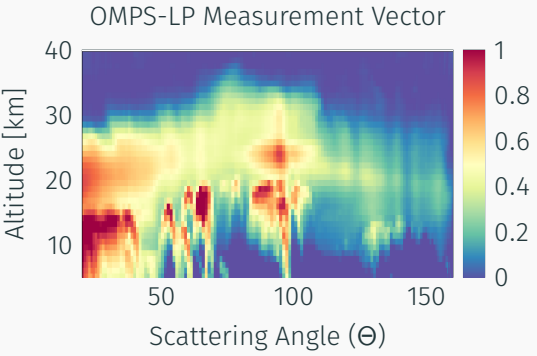


But wait, there's more...

Aerosol retrievals in the Southern Hemisphere are more difficult with OMPS-LP due to the backscattering conditions

This is particularly true at lower altitudes where Rayleigh and multiple scattering contributions are large





Algorithm updates

This leaves us with two improvements to make:

1. Minimize the retrieval sensitivity to particle size ($\mathbf{GS}_{\mathrm{PSD}}\mathbf{G}$)
2. Improve the retrieval precision ($\mathbf{GS}_{\epsilon}\mathbf{G}$)

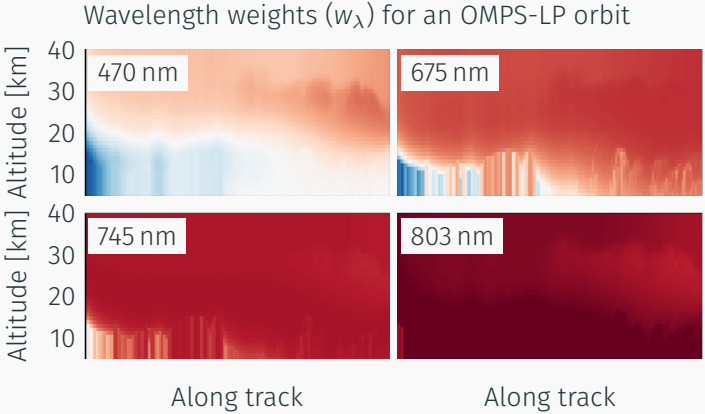
To do this use a new measurement vector that uses wavelengths at 470, 675, 745 and 803 nm

$$y(j) = \sum_{\lambda} w_{\lambda}(j)\tilde{I}_{\lambda}(j) \qquad \tilde{I}_{\lambda} = ln(I_{\lambda}(j)) - ln(I_{\lambda}(j = \text{ref alt}))$$

Choose w_{λ} such that the diagonal elements of $\mathbf{GS}_{\mathrm{PSD}}\mathbf{G} + \gamma\mathbf{GS}_{\epsilon}\mathbf{G}$ are minimized

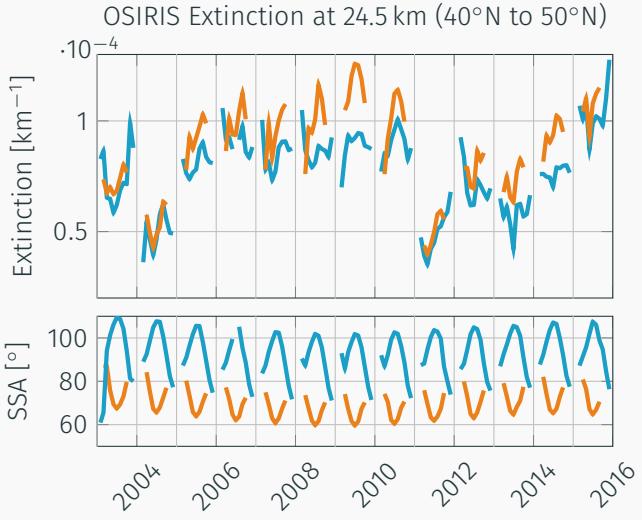
Algorithm updates

This produces a shift to longer wavelengths under higher loading conditions, but also uses a short wavelength normalization in backscatter to increase sensitivity



The new records - OSIRIS

The updated algorithm substantially improves comparisons between ascending/descending nodes



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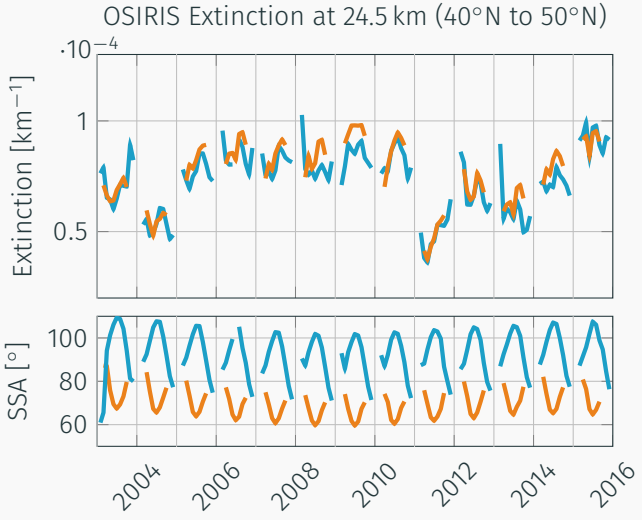
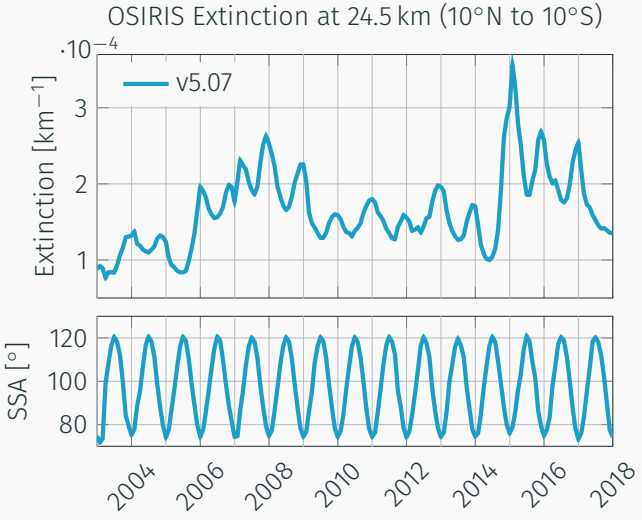


The new records - OSIRIS

The seasonal cycle in the tropics is also reduced



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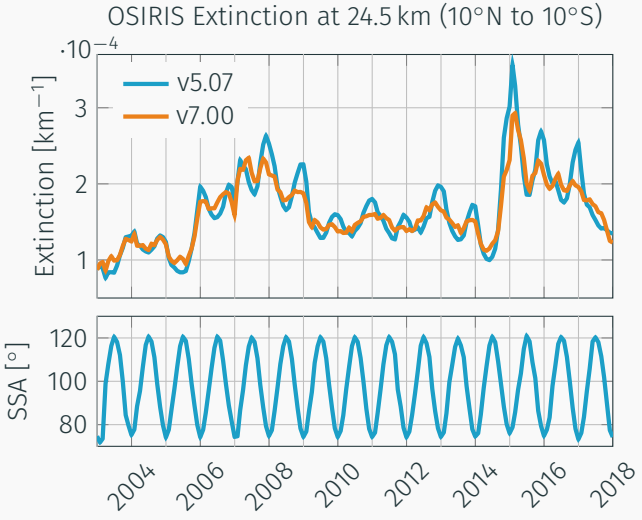
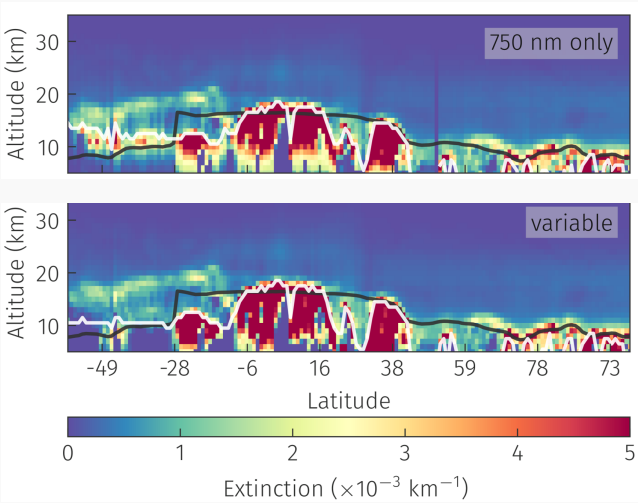


The new records - OMPS-LP

Not enough data has been processed to tell if scattering angle biases have been improved

However sensitivity in the Southern hemisphere is promising



Conclusions

Merging limb scattering records is difficult due to geometry dependent biases and backscattering conditions

New algorithm was developed to reduce these errors

Processing status:

- OSIRIS dataset ∼90% complete
- OMPS-LP dataset ∼10% complete

Validation work still to be completed

Thanks!