Universität Bremen

VOLIMPACT

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Influence of the assumed PSD on the determination of the stratospheric aerosol extinction coefficient from limb scattering observations

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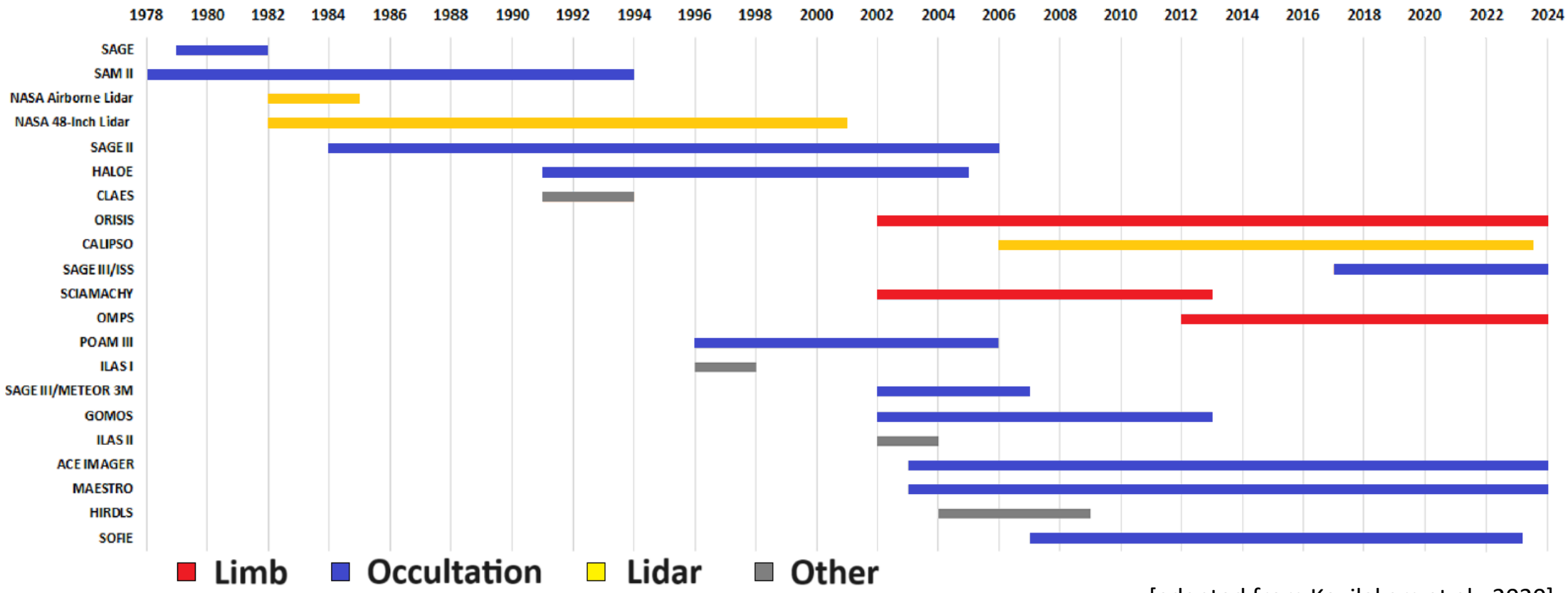
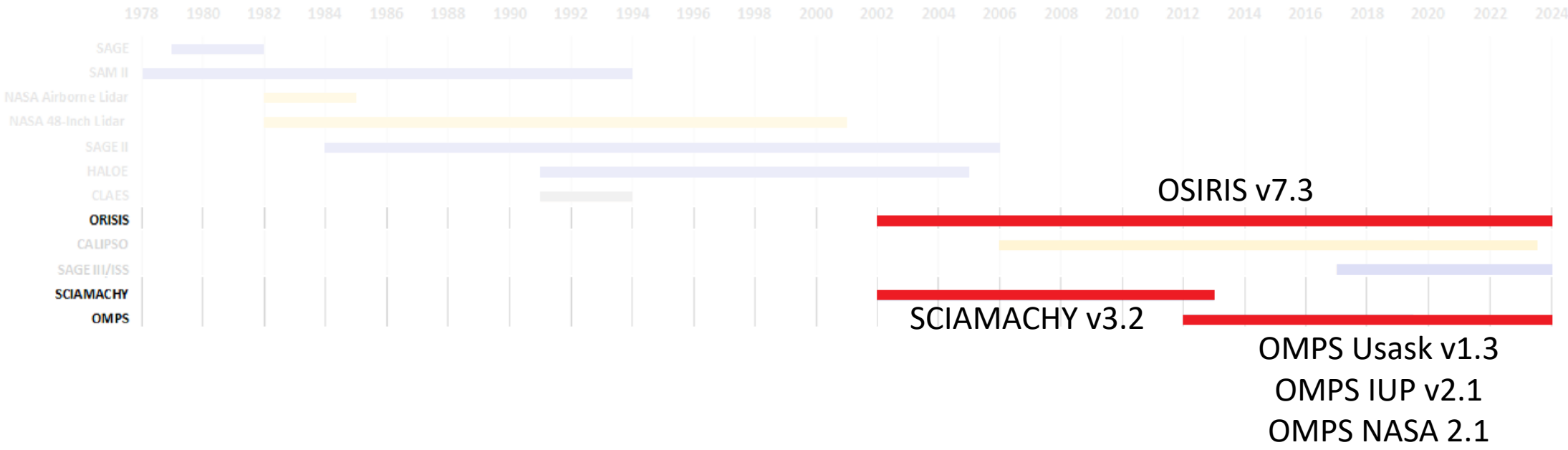
Satellite observations of stratospheric aerosols



[adapted from Kovilakam et al., 2020]

Limb observations of stratospheric aerosols



Aerosol extinction coefficients (Ext) from SCIAMACHY, OSIRIS, OMPS

- Provide a high spatial sampling, advantageous for observations of wildfires / volcanic eruptions
- are used in climate data records CREST / GLOSSAC
- **Ext retrievals assume a constant PSD** (except OMPS NASA)

SCIAMACHY retrieval versions

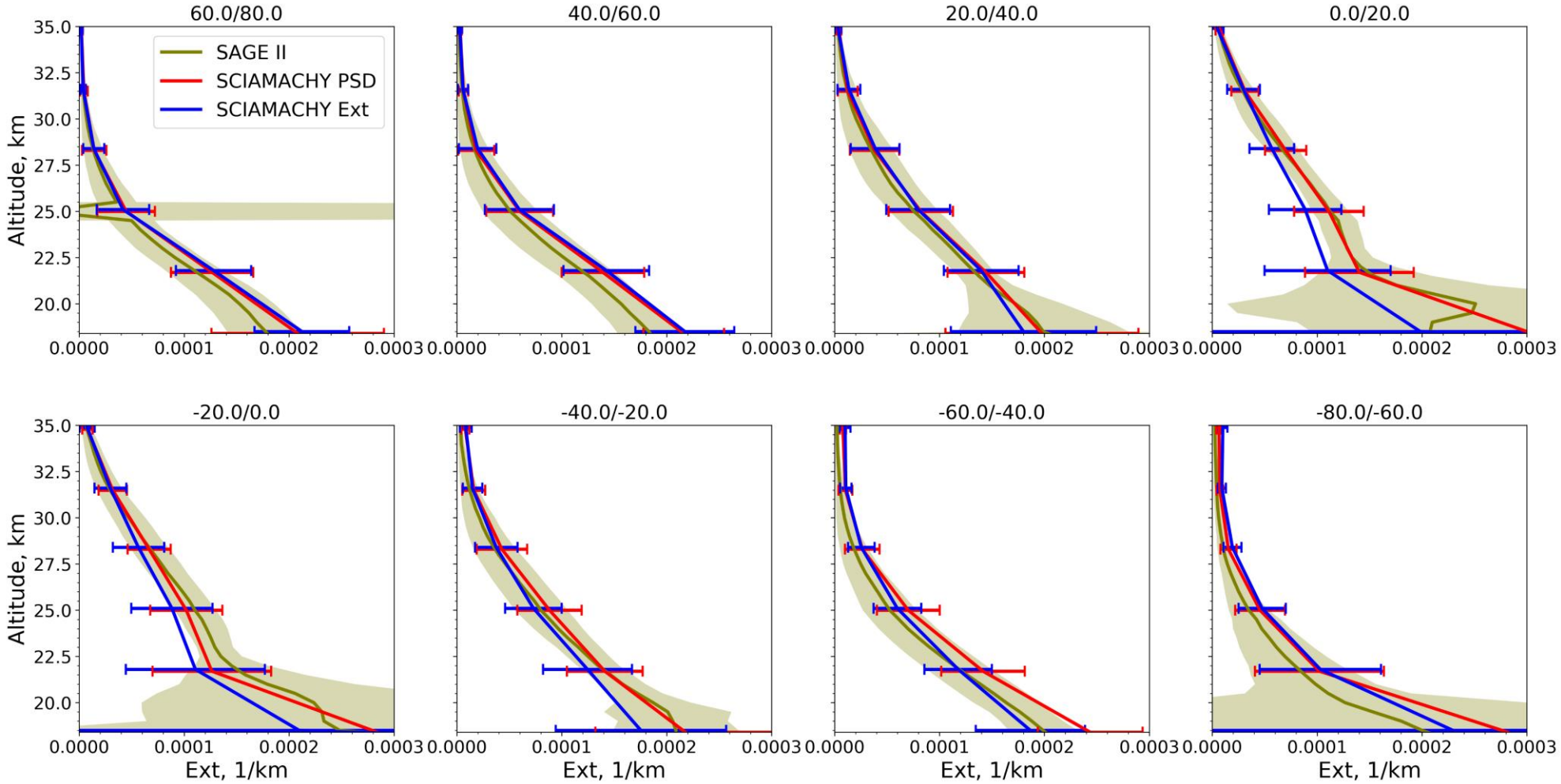
[popsci.com]

SCIAMACHY PSD retrieval [1]	SCIAMACHY Ext retrieval [2]
Weighted-regularization approach based on 0th order Tikhonov	Levenberg-Marquardt approach
Sun-normalized radiance	Sun-normalized radiance
Pre-retrieved surface albedo	Pre-retrieved surface albedo
Altitude: 18 – 35 km	Altitude: 9 – 38 km
Fixed N	Fixed PSD
r_g, σ_g – retrieval → calculation of Ext	Ext - retrieval
6 wvls (750 – 1300 nm)	1 wvl (750 nm)

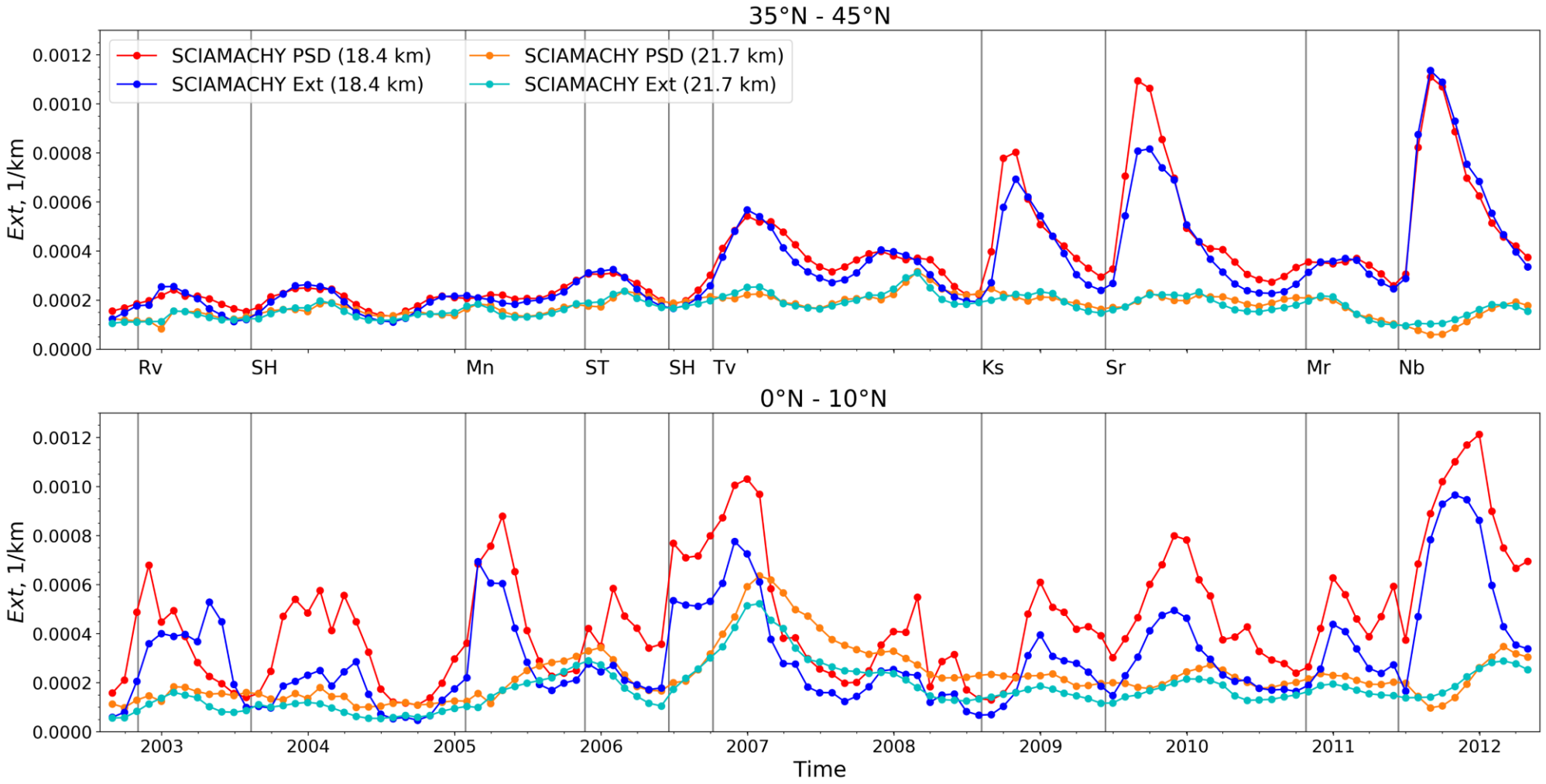
[1] Pohl et al.: Stratospheric aerosol characteristics from SCIAMACHY limb observations: 2-parameter retrieval, Atmos. Meas. Tech. Discuss. accepted, 2024

[2] Sofieva et al.: A Climate Data Record of Stratospheric Aerosols, Earth Syst. Sci. Data Discuss., in review, 2024

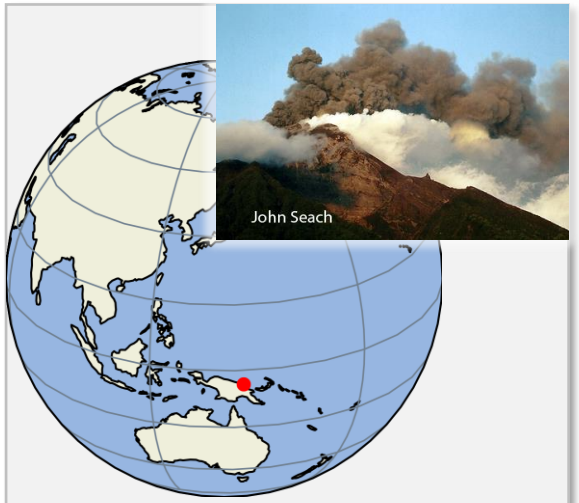
Aerosol ext. coefficient: SCIAMACHY vs SAGE II (2002-2005)



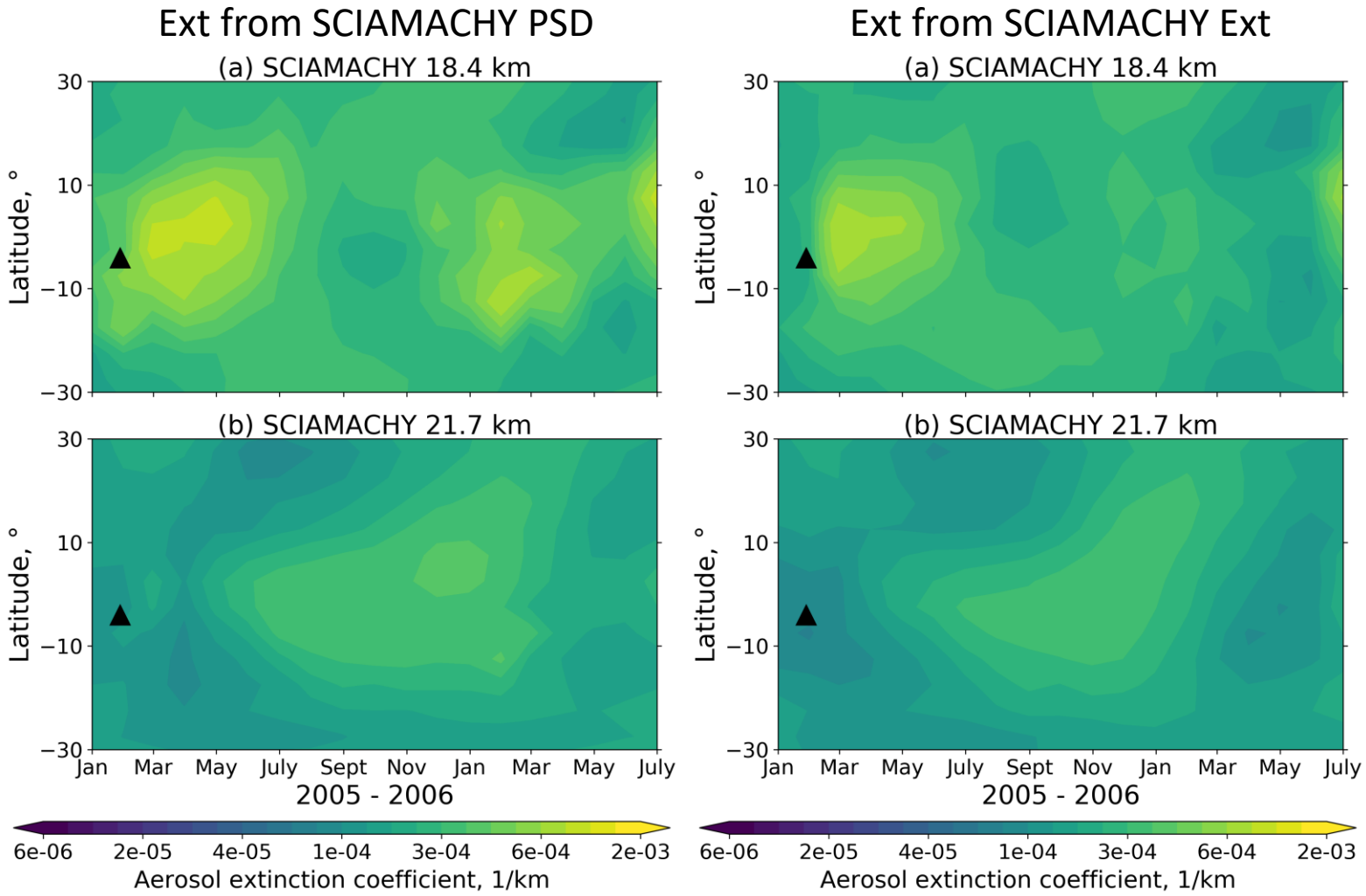
SCIAMACHY aerosol extinction coefficient time series



SCIAMACHY observations after the Manam eruption 2005



Manam
Papua New Guinea
4°S, 145°E
Oct 2004 – Jan 2005



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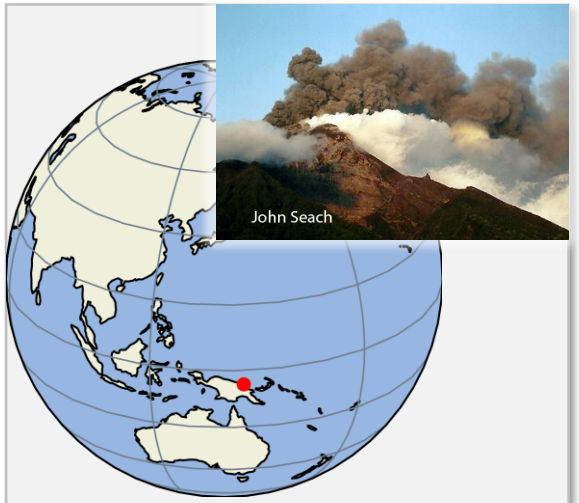

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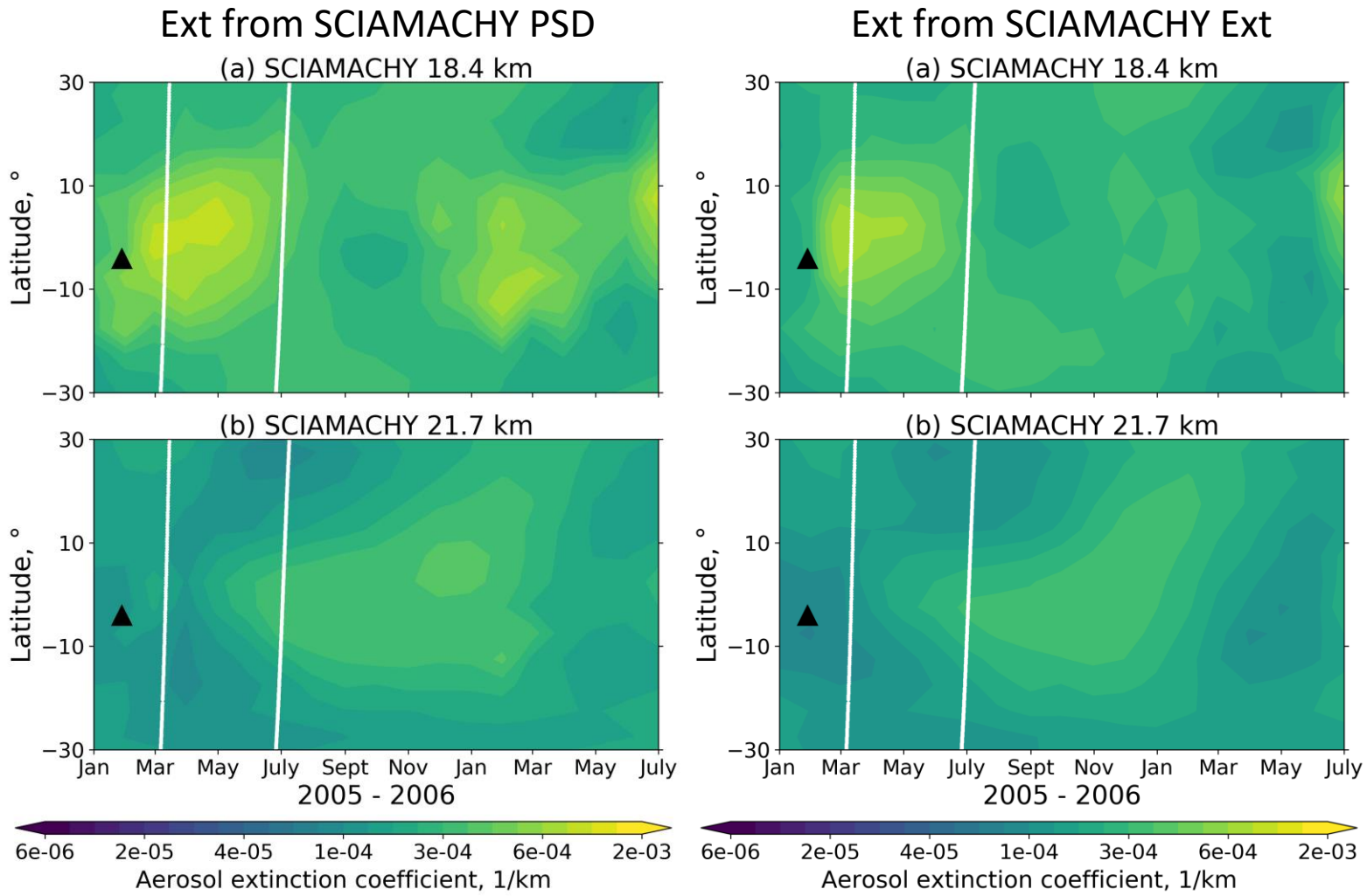
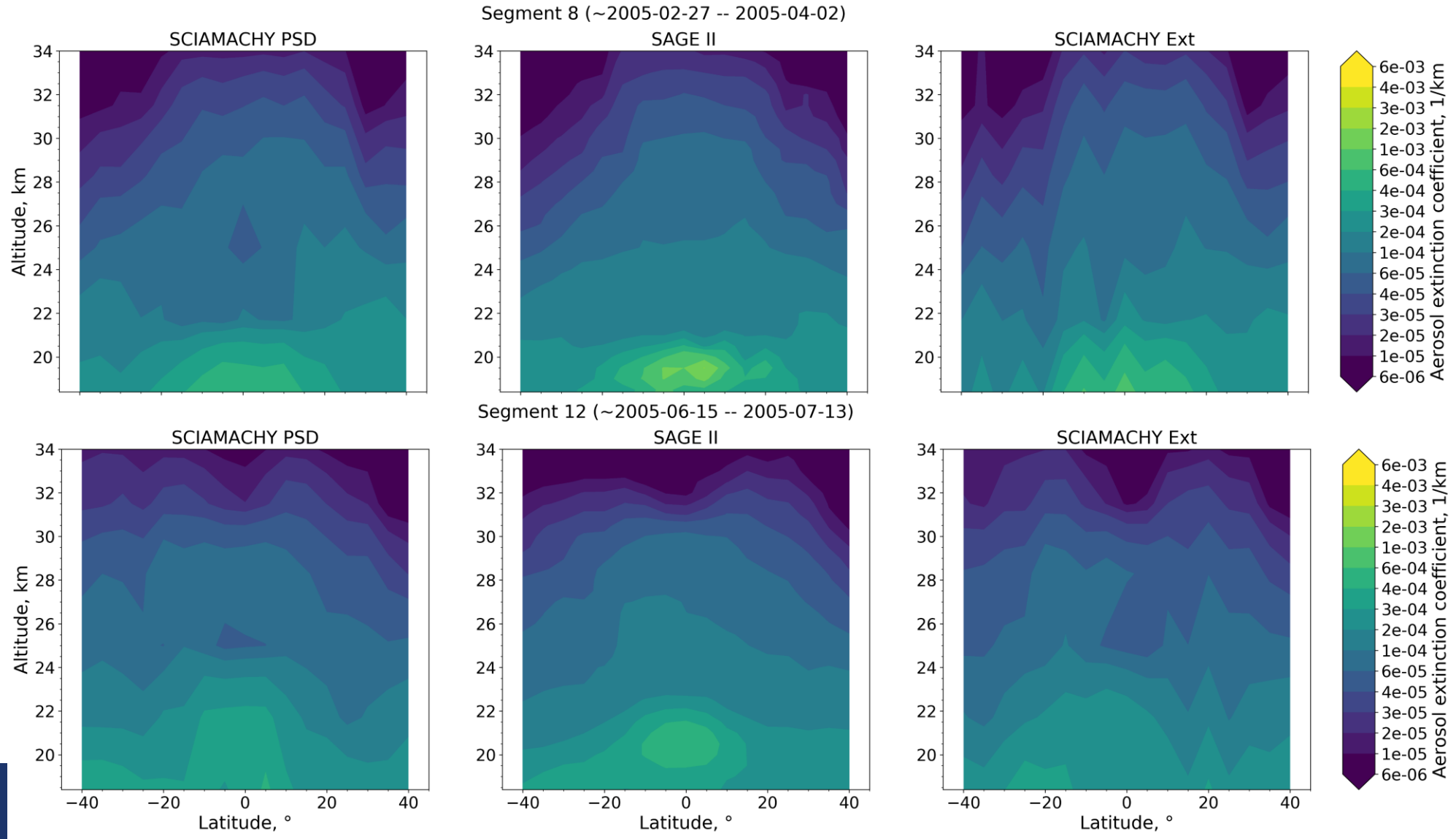


Aerosol extinction coefficient: SCIAMACHY vs SAGE II after the Manam eruption 2005



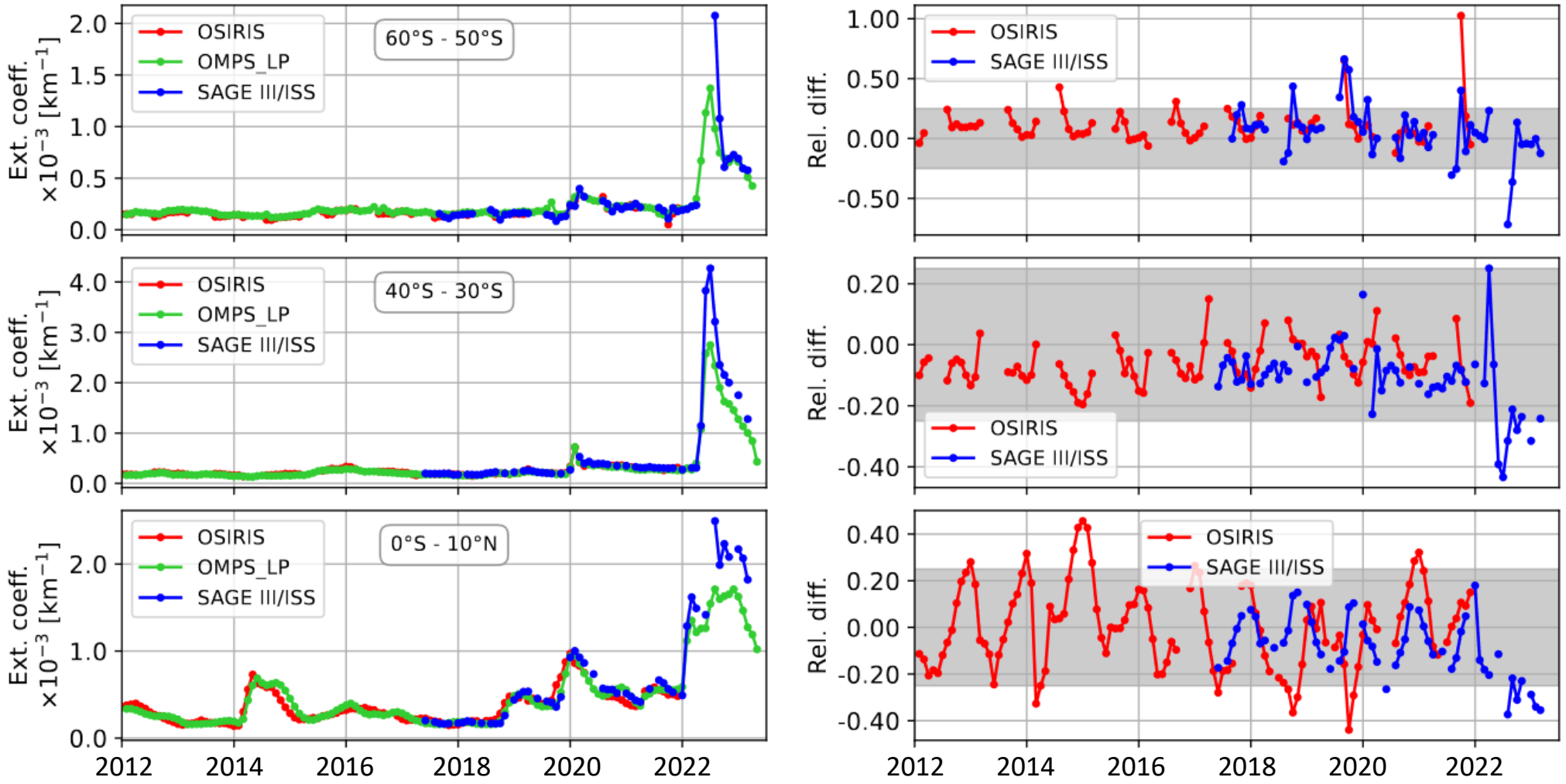
OMPS-LP retrieval algorithm

OMPS Ext retrieval [1]	
Regularized non-linear inversion using Levenberg-Marquardt	
Sun-normalized radiance	
Pre-retrieved surface albedo	
Altitude: cloud top – 45.5 km	
Fixed PSD	
Aerosol extinction retrieval at 869 nm	
1wvl (869 nm)	

[science.nasa.gov]

[1] Rozanov et al.: Retrieval of stratospheric aerosol extinction coefficients from OMPS-LP measurements, EGUsphere, in review, 2024

Aerosol extinction coefficient time series



[Rozanov et al., in review]

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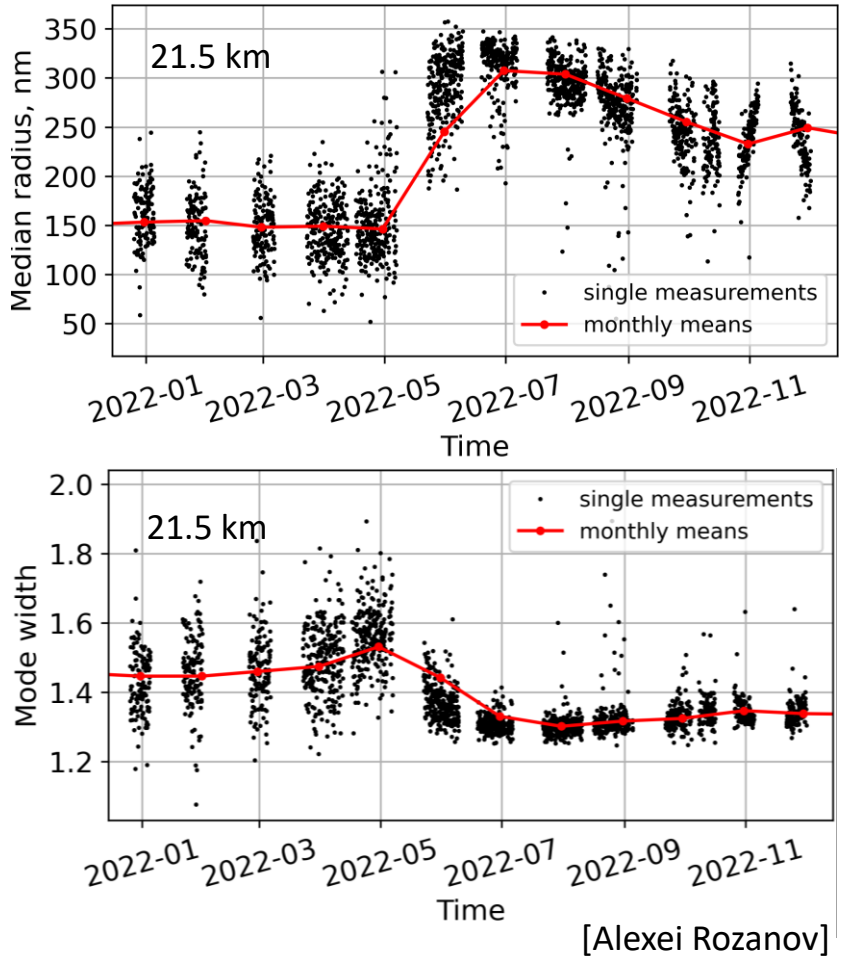
SAGE III PSD parameters (45-65°S)



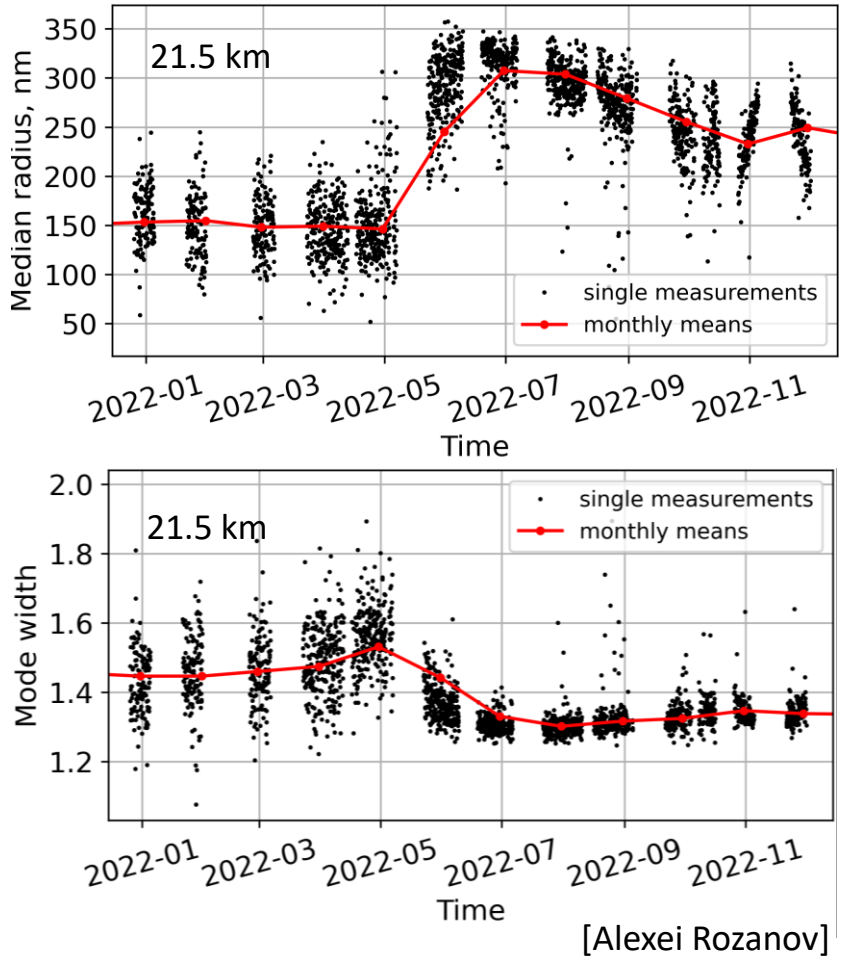
[Alexei Rozanov]

[1] Rozanov et al.: Retrieval of stratospheric aerosol extinction coefficients from OMPS-LP measurements, EGUsphere, in review, 2024

OMPS-LP retrieval algorithm

OMPS Ext retrieval [1]	Modified OMPS Ext retrieval
Regularized non-linear inversion using Levenberg-Marquardt	
Sun-normalized radiance	
Pre-retrieved surface albedo	
Altitude: cloud top – 45.5 km	
Fixed PSD	PSD from SAGE III (Monthly means)
Aerosol extinction retrieval at 869 nm	
1wvl (869 nm)	

SAGE III PSD parameters (45-65°S)



[Alexei Rozanov]

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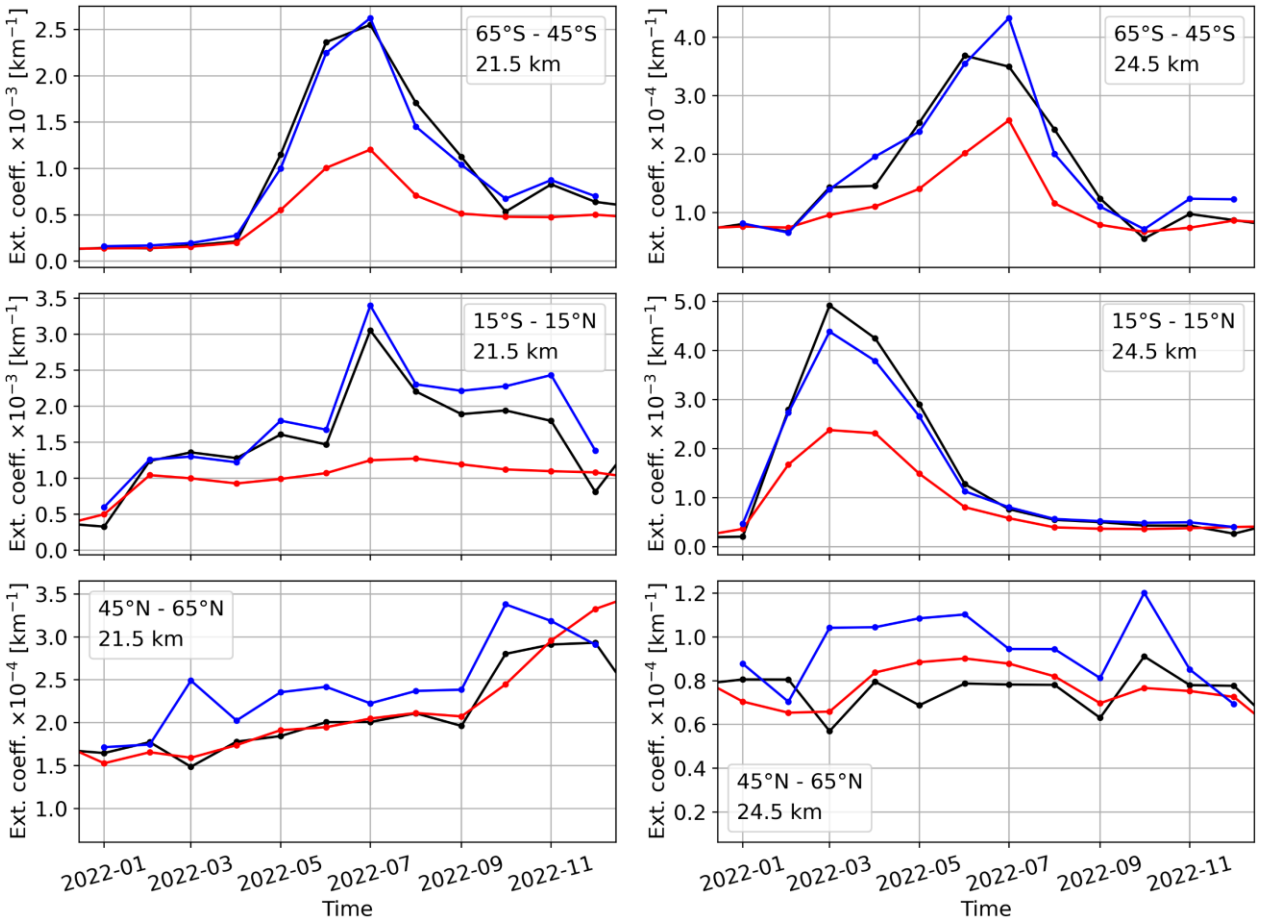
Aerosol extinction coefficient: OMPS-LP vs SAGE III/ISS after the Hunga eruption 2022



[Alexei Rozanov]

Take home messages

- Most Ext-retrievals that use limb scattering measurements (SCIAMACHY, OSIRIS, OMPS, ALTIUS) have to assume a constant PSD
- A constant PSD assumption can lead to underestimations of Ext after volcanic eruptions by more than 40%
- Additional information about the actual PSD, e.g. obtained by measurements in the NIR, can reduce this offset

→ Limb scattering observations in a broader wavelength range (e.g., 700 – 1500 nm) are highly recommended

→ Combination of limb scattering measurements in NIR and emission measurements in TIR could significantly increase the derived information content of stratospheric aerosols