Stratospheric aerosols from volcanic eruptions and wildfires observed by EarthCARE/ATLID

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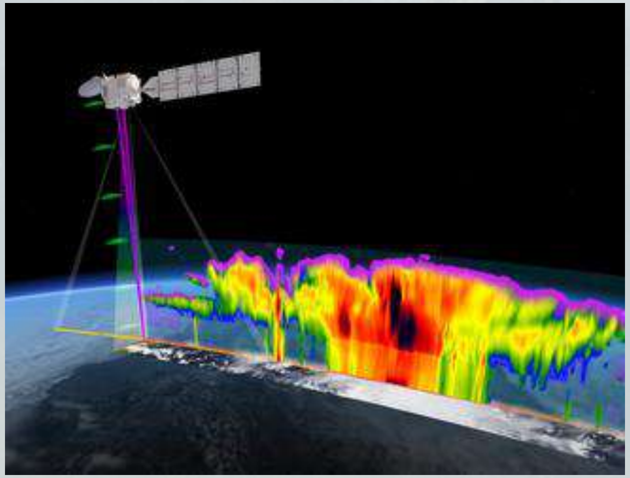
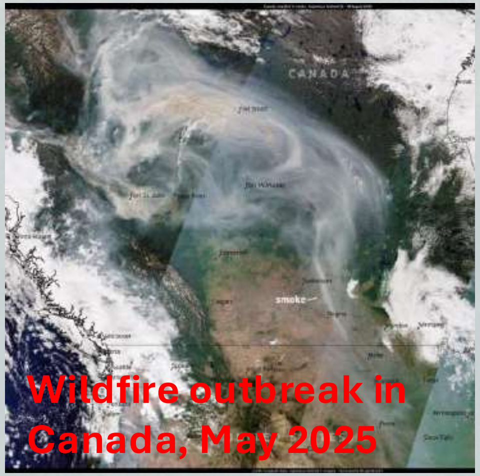




Ruang eruption, April 2024


Wildfire outbreak in Canada, May 2025

Data sets for cal/val and science

ATLID L1B (BA+)

Scattering Ratio (non-attenuated)

$$R = \frac{\left(\beta^{\text{att}}_{\text{M},\parallel} + \beta^{\text{att}}_{\text{M},\perp} + \beta^{\text{att}}_{\text{R}}\right)}{\beta^{\text{att}}_{\text{R}}} = \frac{(\beta_{\text{M}} + \beta_{\text{R}})T^2}{\beta_{\text{R}}T^2} = 1 + \frac{\beta_{\text{M}}}{\beta_{\text{R}}} \quad (1)$$

Mie backscatter coefficient (non-attenuated):

$$\beta_{\text{M}} = (R-1)\beta_{\text{R}}$$

Stratospheric Aerosol Optical Depth

$$\tau_{\text{strato}} = S \int_{z_{\text{trop}+1}}^{z_{30}} \beta_{\text{M}}(z)\,\mathrm{d}z.$$

S *- lidar ratio from L2A EBD, stratospheric layer zonal mean*

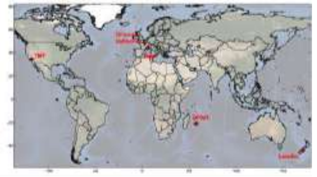
ATLID L2A EBD (BA)

Stratospheric features optical parameters:

- **AOD** (aerosol optical depth)
- **SR** (scattering ratio)
- **PLDR** (particle linear depolarization ratio)
- **LR** (lidar ratio)

Stratospheric aerosol lidars 355 nm (NDACC)

- **OHP** (Observatoire de Haute Provence)
- **OPAR** (Maido, La Reunion island)
- **TMF** (Table Mountain Facility, California)
- **Lauder** observatory (New Zealand) 532 nm



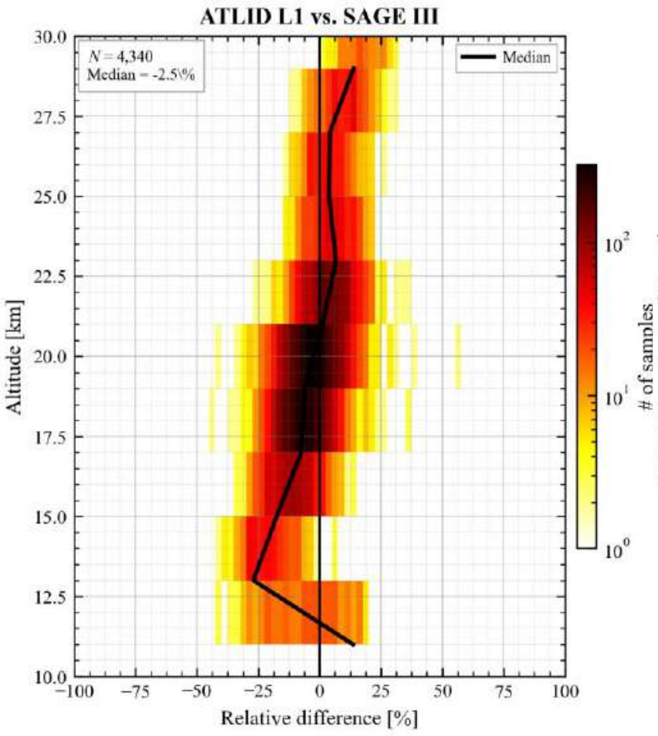
Suborbital balloon flights from Orlean

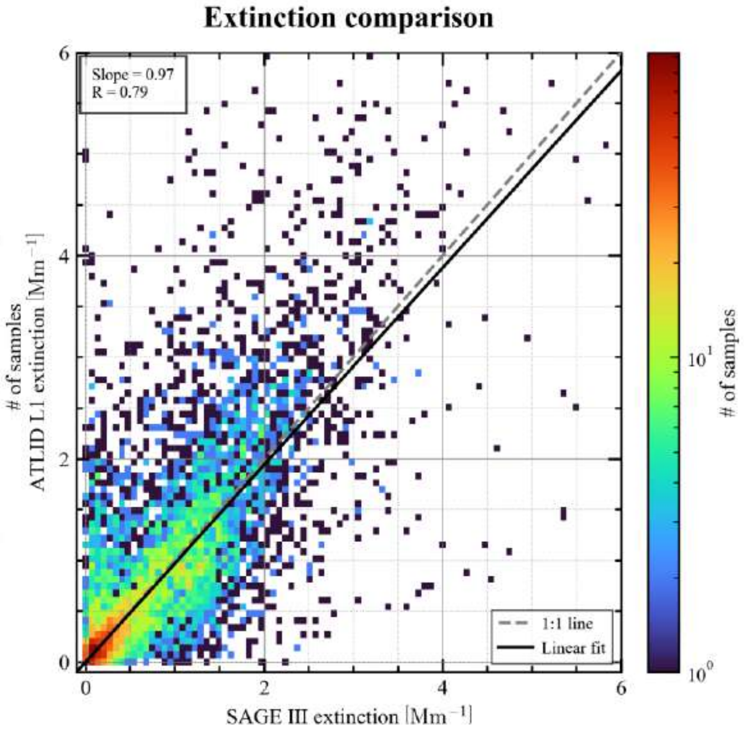
- **AZOR** aerosol backscatter sonde (528/940 nm)
- **POPS** optical particle counter

ISS SAGE III 384 nm
solar occultation extinction profiling

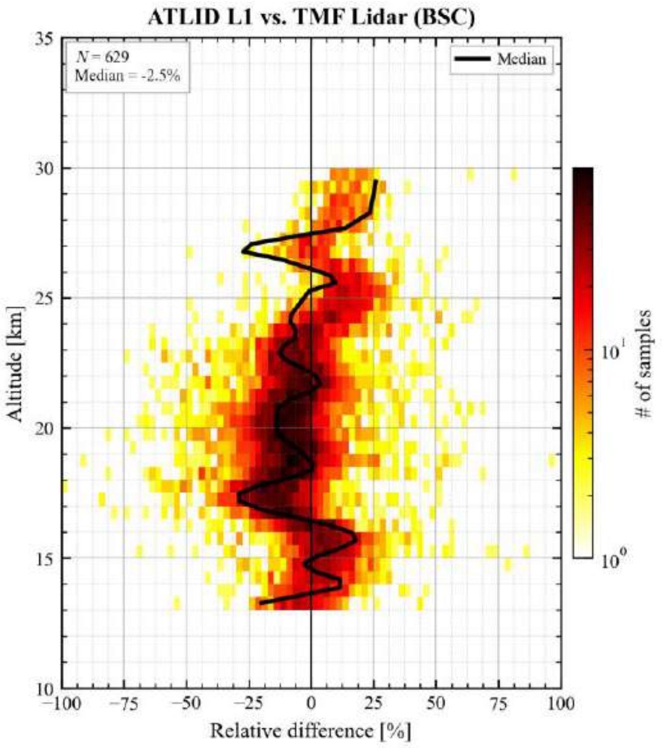
ATLID validation

Comparison with ISS/SAGE III extinction
~900 collocations (50 km, 12 h)



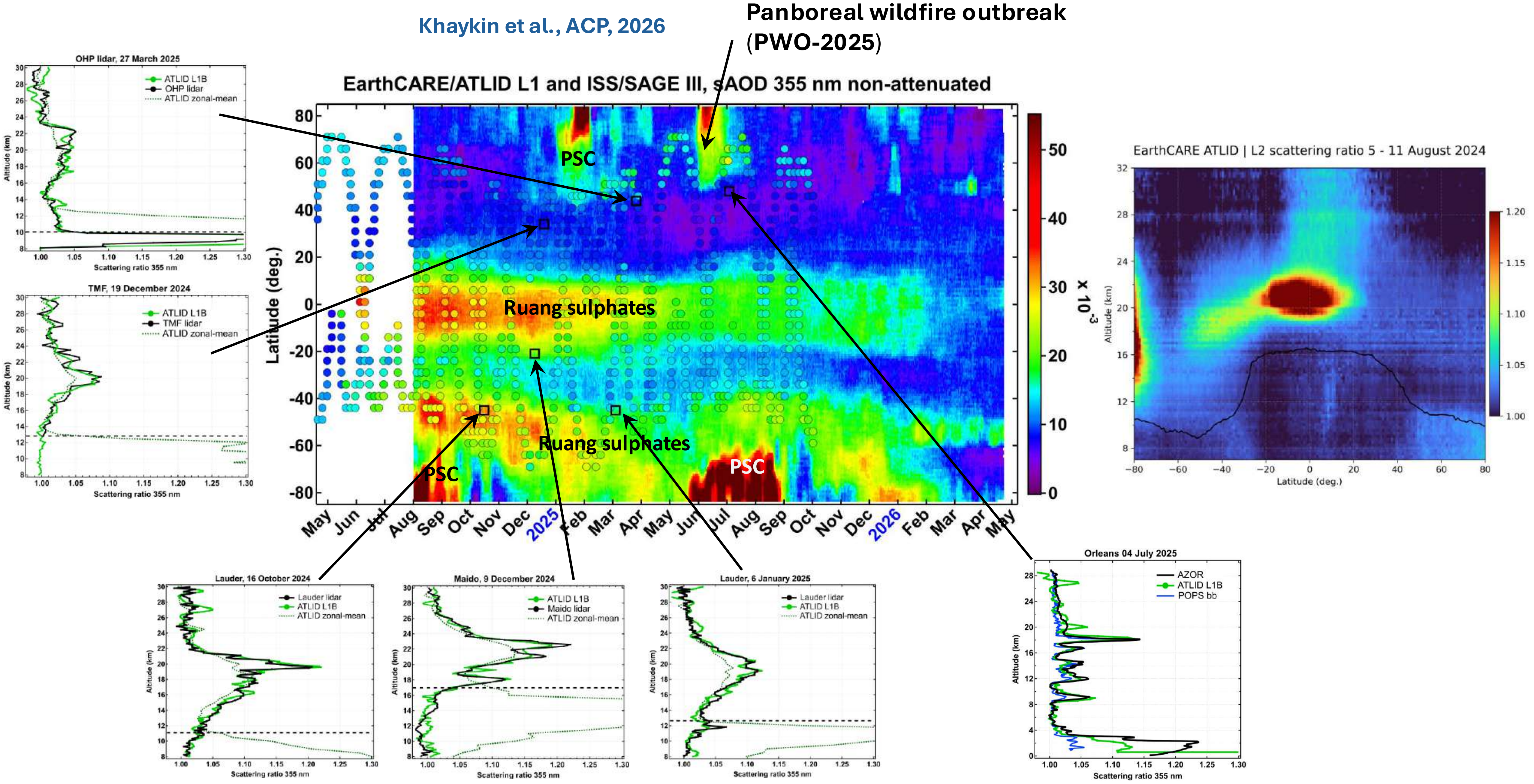


Comparison with TMF lidar
47 collocations (50 km, 12 h)



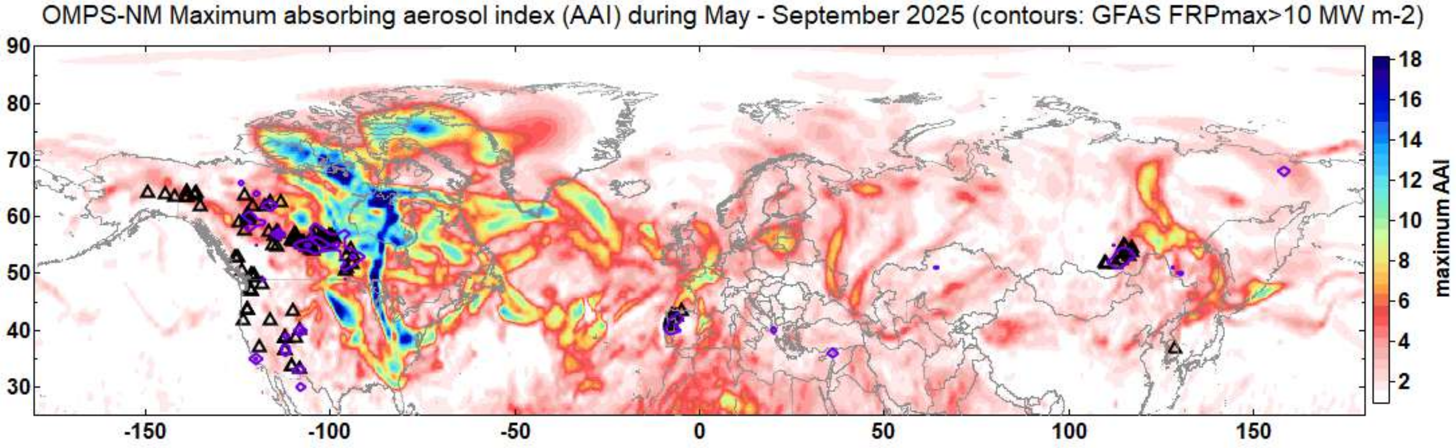
Poncet et al., in prep. for AMT

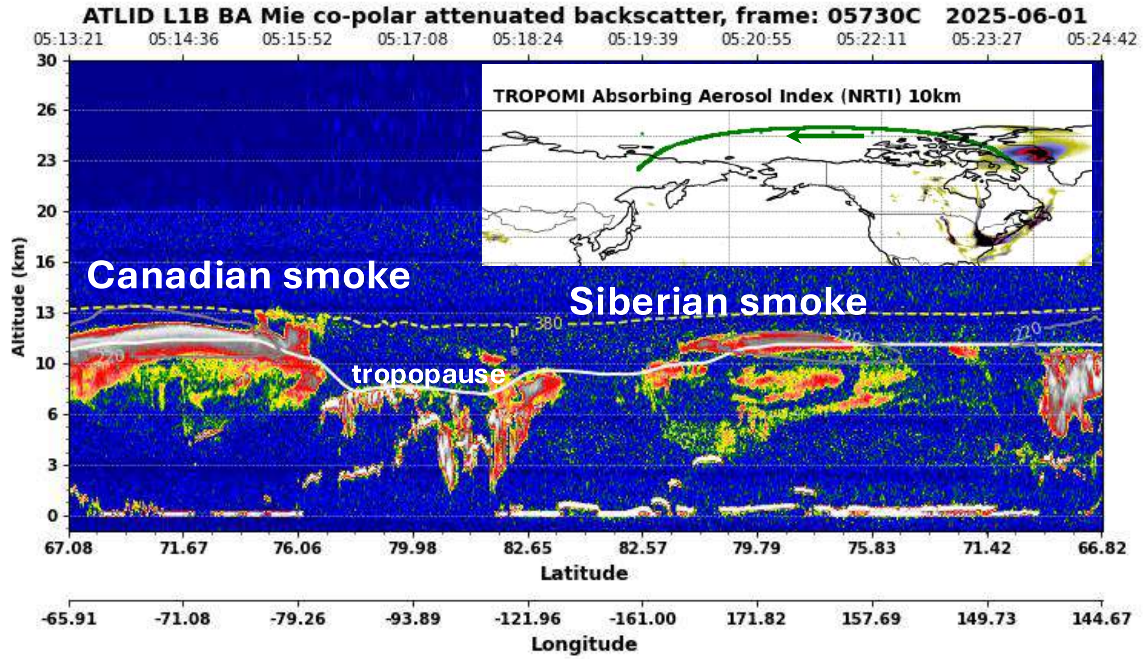
ATLID observations of stratospheric aerosols and cal/val



Panboreal wildfire outbreak (PWO-25)

2025 Boreal wildfire hotspots

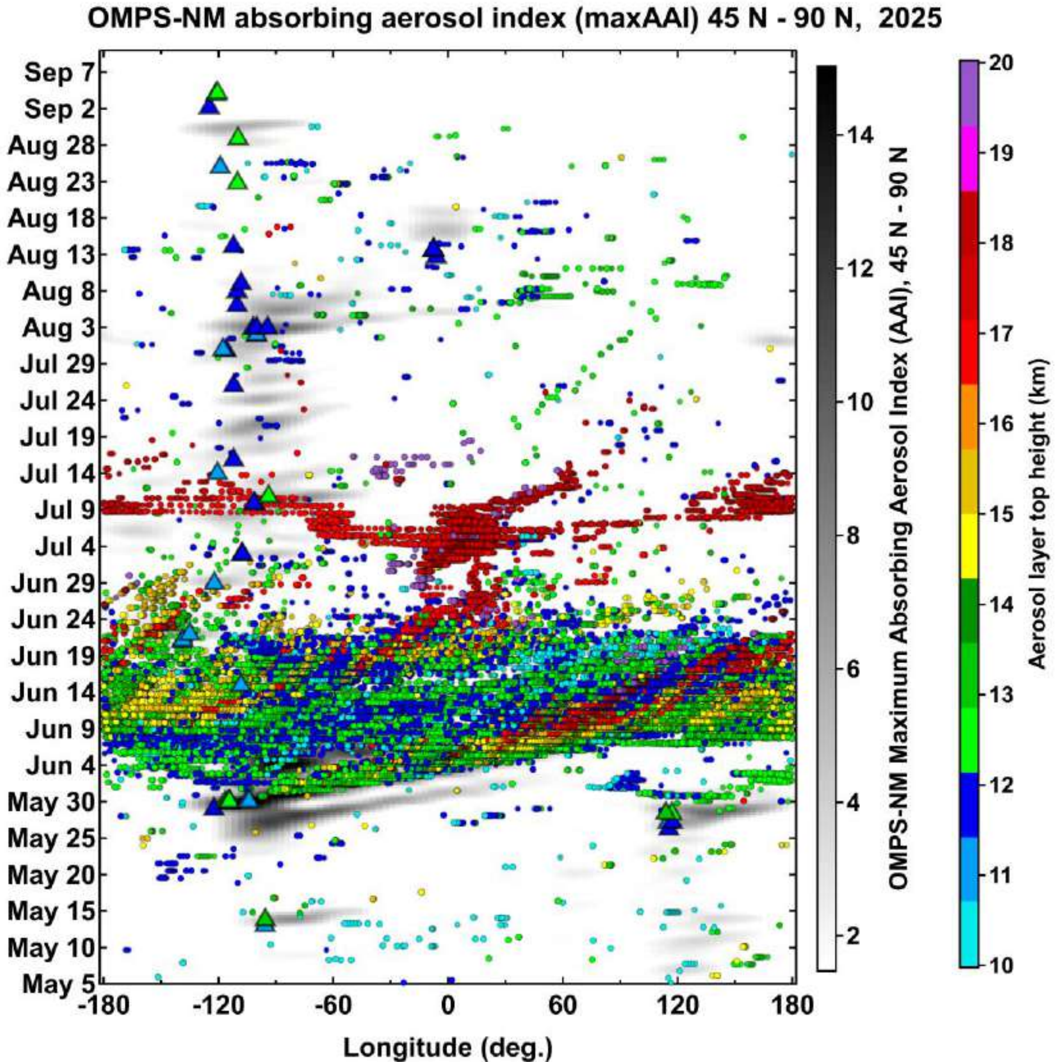




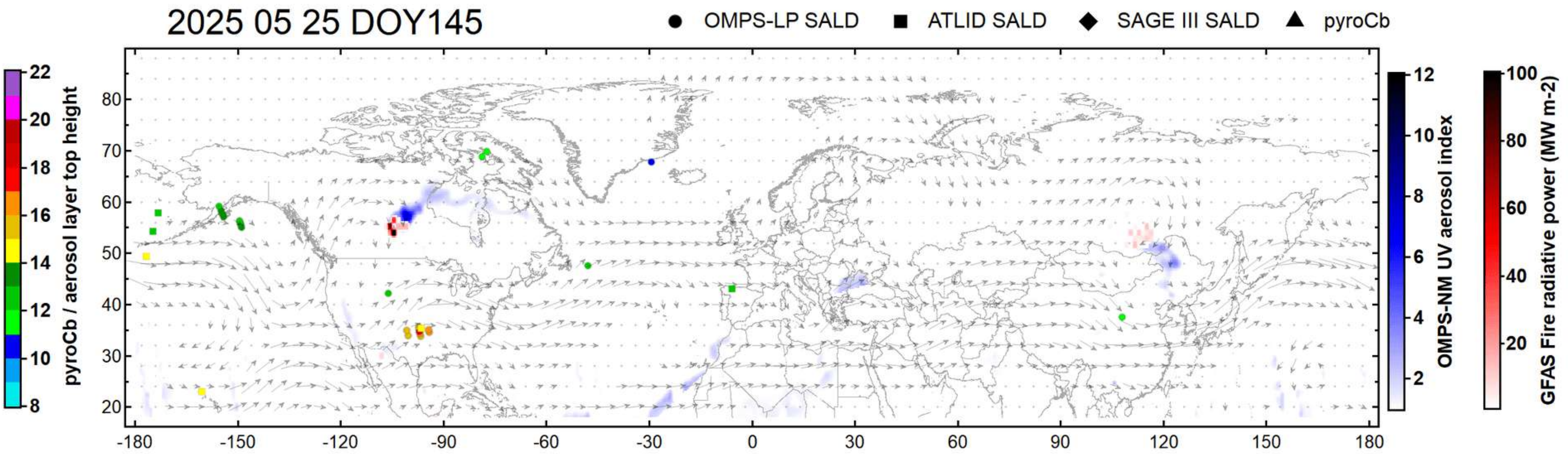
123 confirmed pyroCbs of which 77 in Canada, 11 in Russia

(Servanckx and Fromm, personal communication)

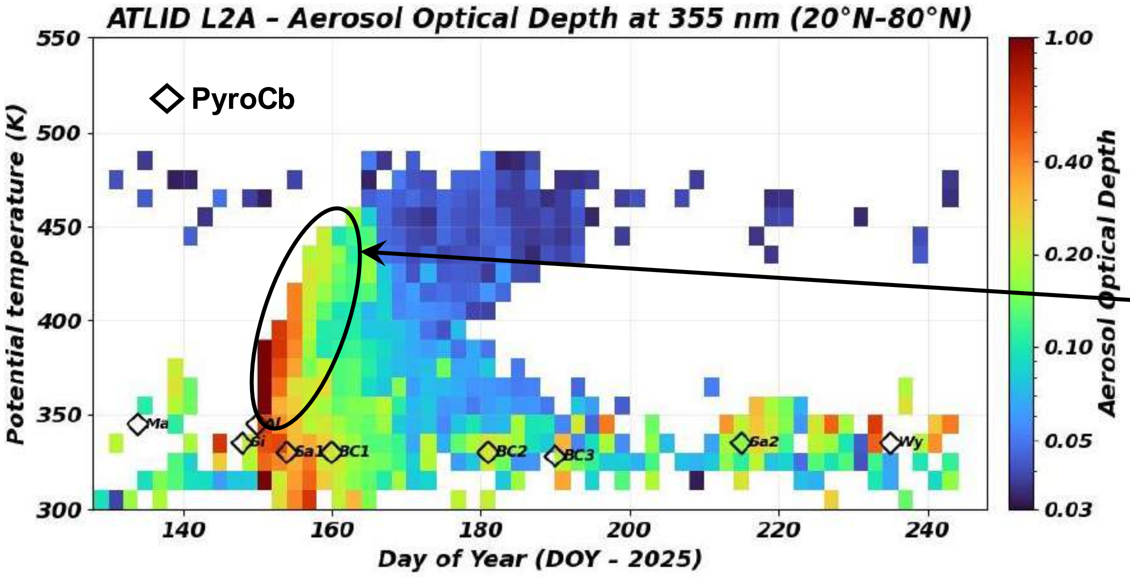
Preliminary pyroCb inventory

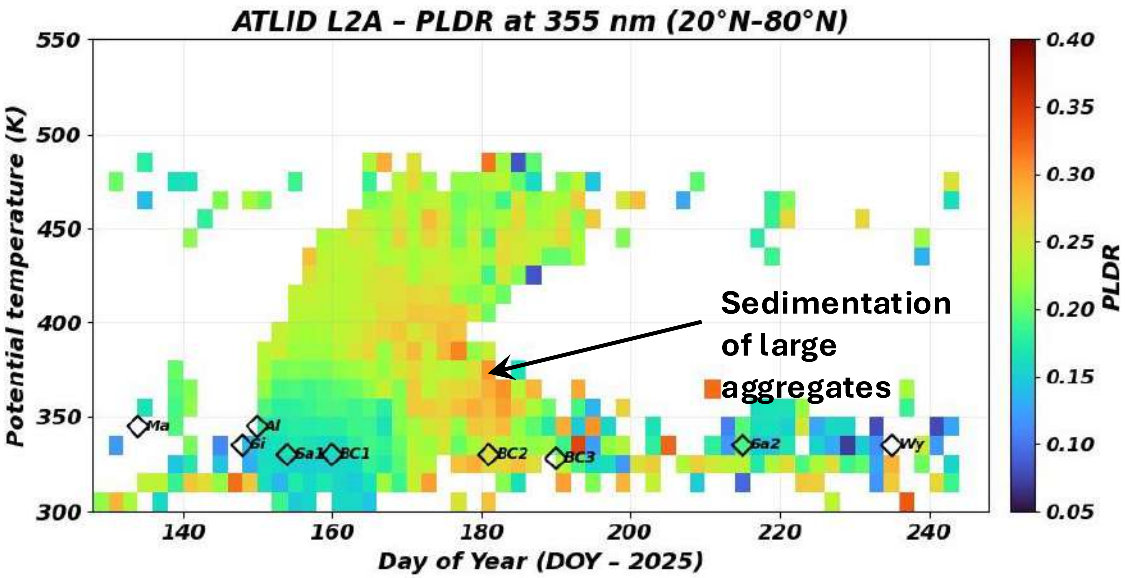


Spatiotemporal evolution of stratospheric smoke



Evolution of smoke plumes' optical properties from ATLID



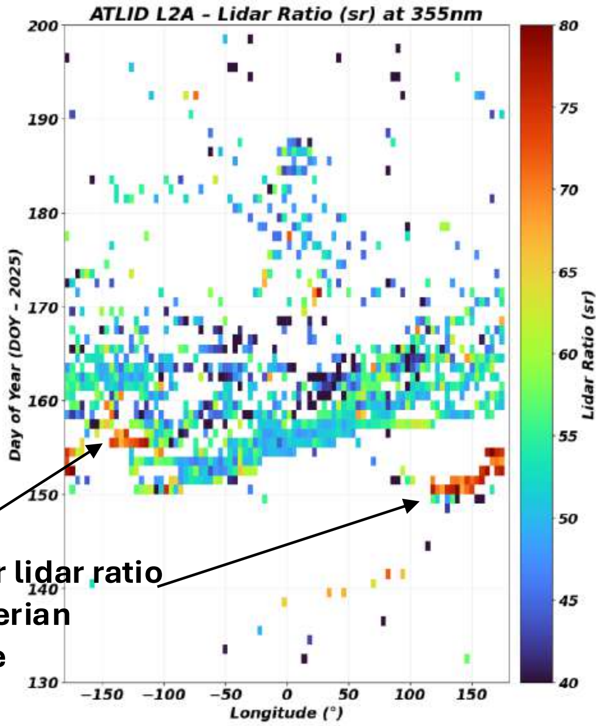


EBD data on stratospheric layers

- ✓ Filtering on AOD>0.03, SR>2 and quality flag
- ✓ Aggregation into 1 day/500 m bins
- ✓ Correction of -16% applied to daytime PLDR

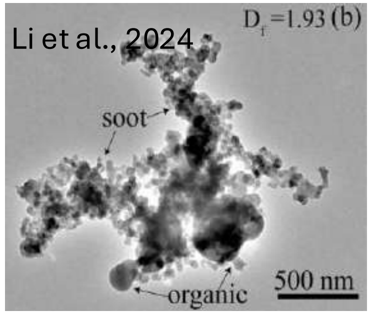
Self-lofting of high-concentrated plume up to 22 km

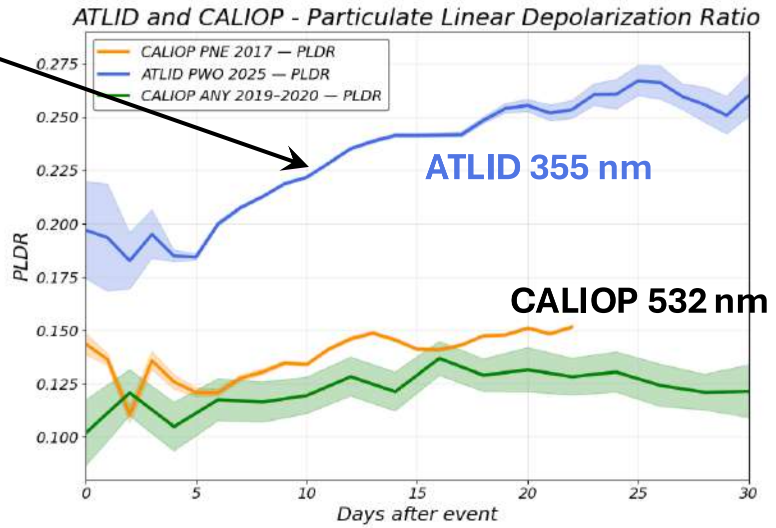
Sedimentation of large aggregates



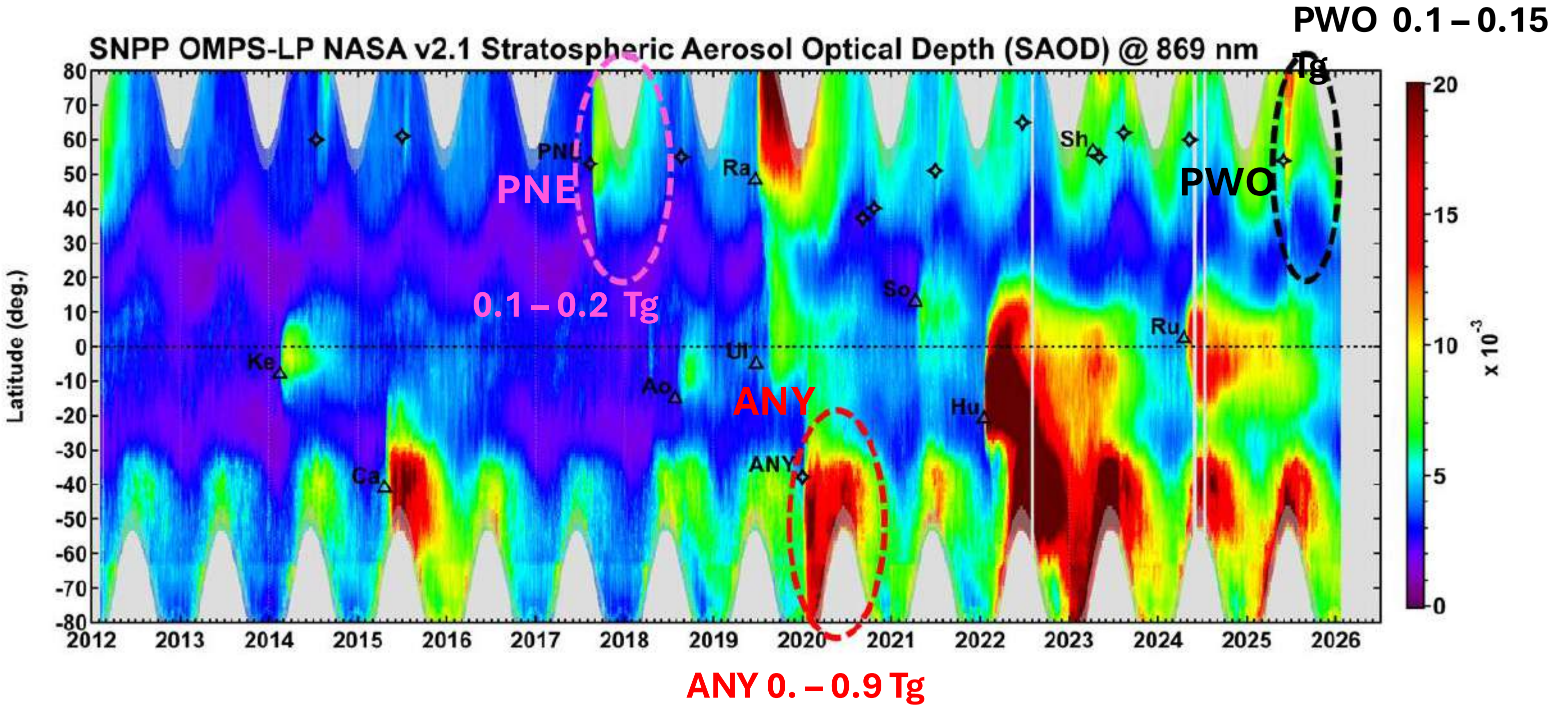
Higher lidar ratio of Siberian smoke

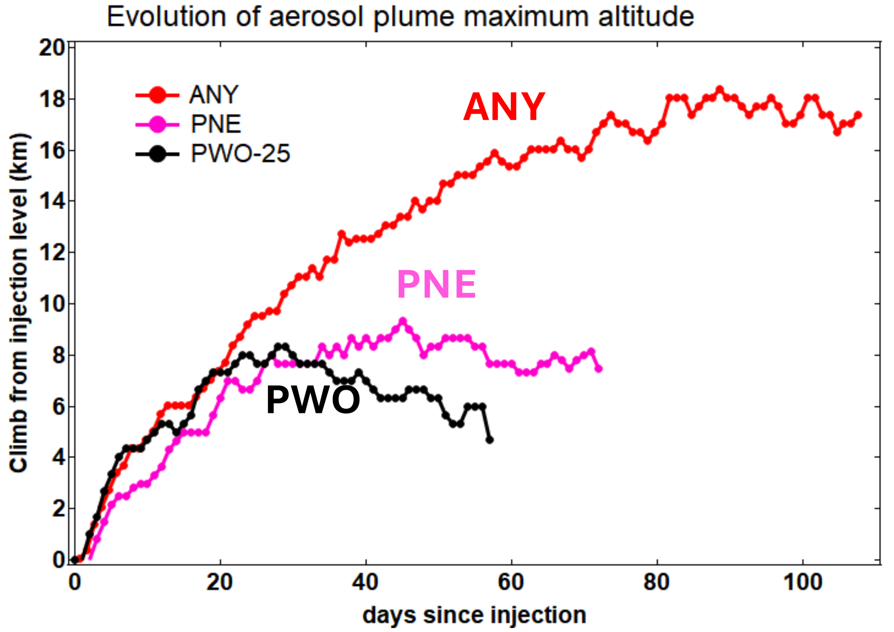
Depolarization growth due to aggregation



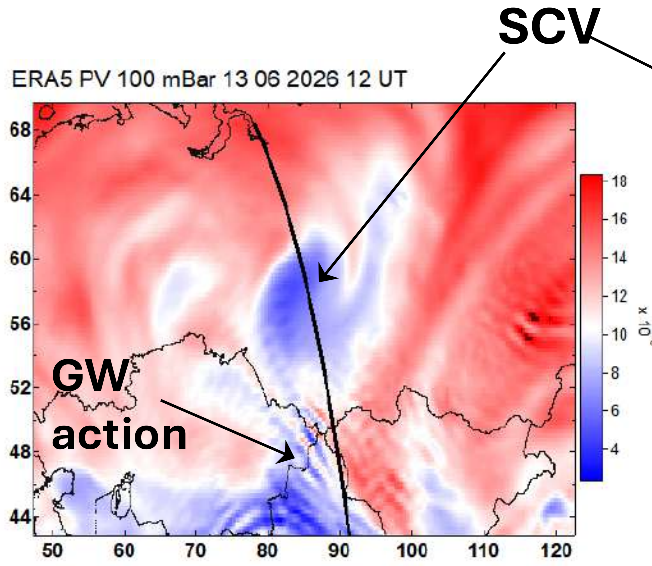


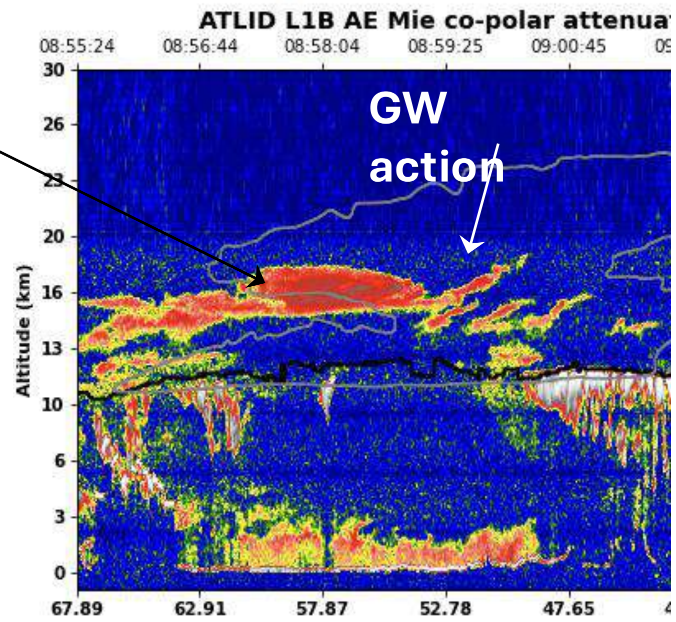
Large-scale impact and self-lofting of PWO-25 smoke





- **PWO-25: among the three largest wildfire-induced stratospheric perturbation**
- **Formation of smoke-charged vortex (SCV) is the key condition for self-lofting**
- **SCV lifetime likely reduced by gravity wave activity**





Summary

Image: *Burned forest near Candle Lake, Saskatchewan.* © S. Khaykin

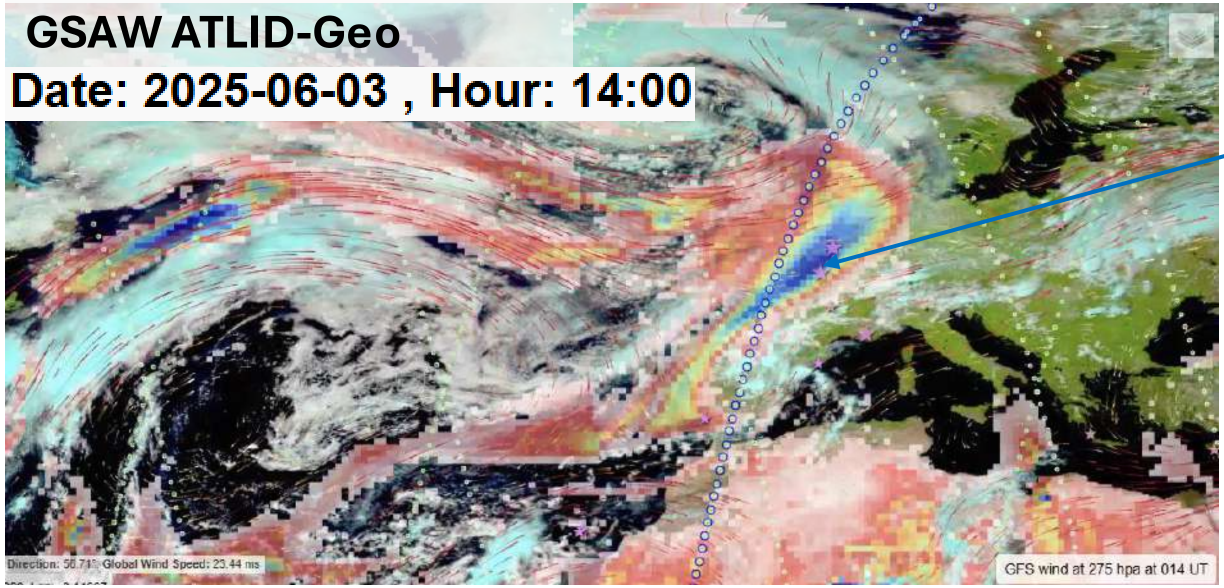
- **ATLID shows excellent performance in the stratosphere** as inferred from comparison with suborbital GB lidars, balloon soundings and passive satellite instruments
- **ATLID has witnessed two significant stratospheric aerosol perturbations: 2024 Ruang eruption and 2025 Panboreal wildfire outbreak**
- **PWO-25 is among the three largest wildfire outbreak in terms of stratospheric impact**
- **ATLID provided new and exclusive information on stratospheric smoke properties and their rapid evolution**

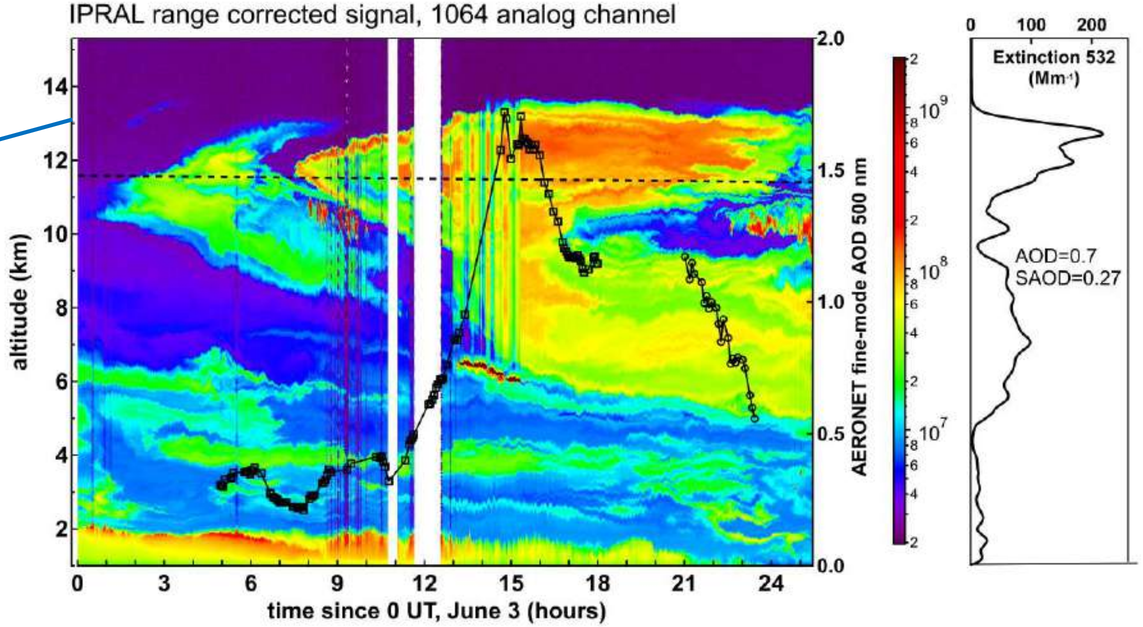
Global Stratospheric Aerosol Watch (GSAW)

https://aerosolstrato.projet.latmos.ipsl.fr

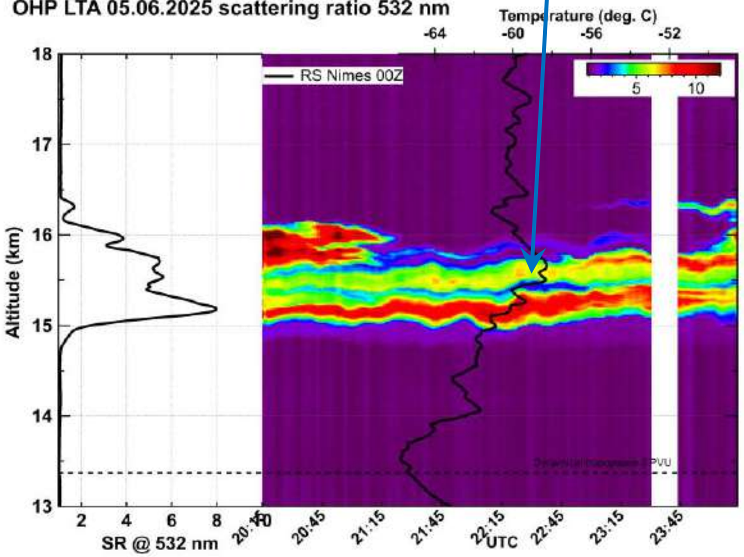
See online poster P066 by Kadygrov and Khaykin

Lidar observations of Alberta smoke

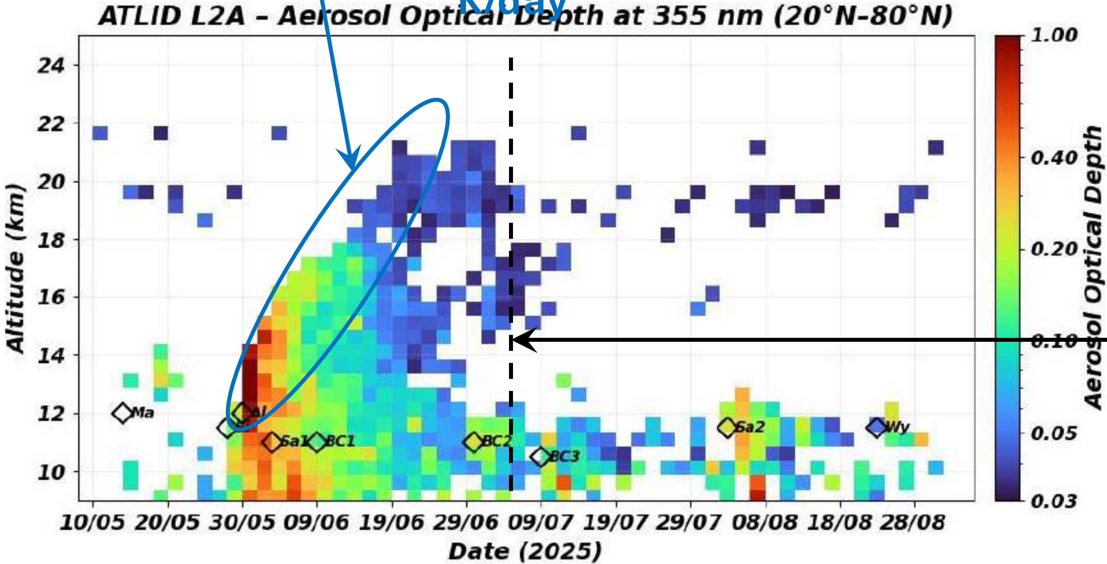




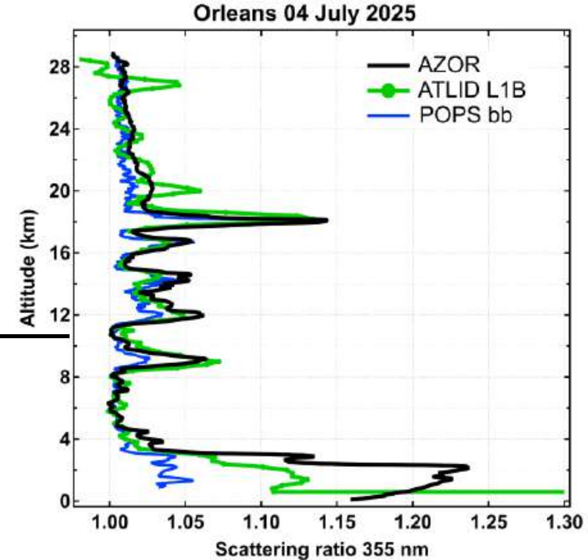
Internal heating of the plume



Self-lofting at ~400 m/day or 5 K/day



Multiple layers throughout LS



Examples of ALTLID vs SAGE III intercomparison

(Poncet et al., in prep.)