

ATLID and ground based lidar synergy for tracking stratospheric aerosol composition and transport from volcanic and wildfire events

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EarthCARE Science and Validation Workshop 2025

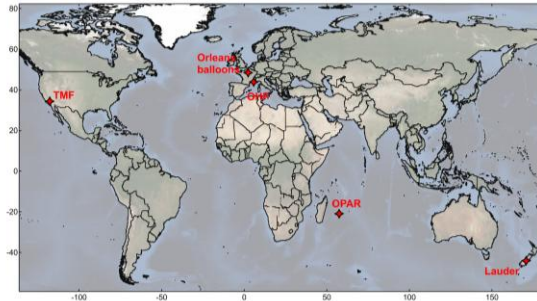
1-5 December 2025 | The University of Tokyo | Tokyo, Japan





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 Orleans

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

Satellite limb-viewing instruments (extinction profiling)

- **ISS SAGE III** 384 nm (solar occultation)
- **OMPS-LP** 869 nm (limb scattering)

ATLID L1B (BA)

Scattering Ratio (non-attenuated)

$$SR(z) = \frac{\beta_{\text{tot}}^{\text{att}}(z)}{\beta_R^{\text{att}}(z)} = \frac{[\beta_R + \beta_p]T^2}{\beta_R T^2} = 1 + \frac{\beta_p}{\beta_R}$$

Stratospheric Aerosol Optical Depth (attenuated)

$$SAOD = LR^* \times \int_{z_{\text{trop}+1}}^{30 \text{ km}} \beta_{\text{Mie}}^{\text{att}} dz$$

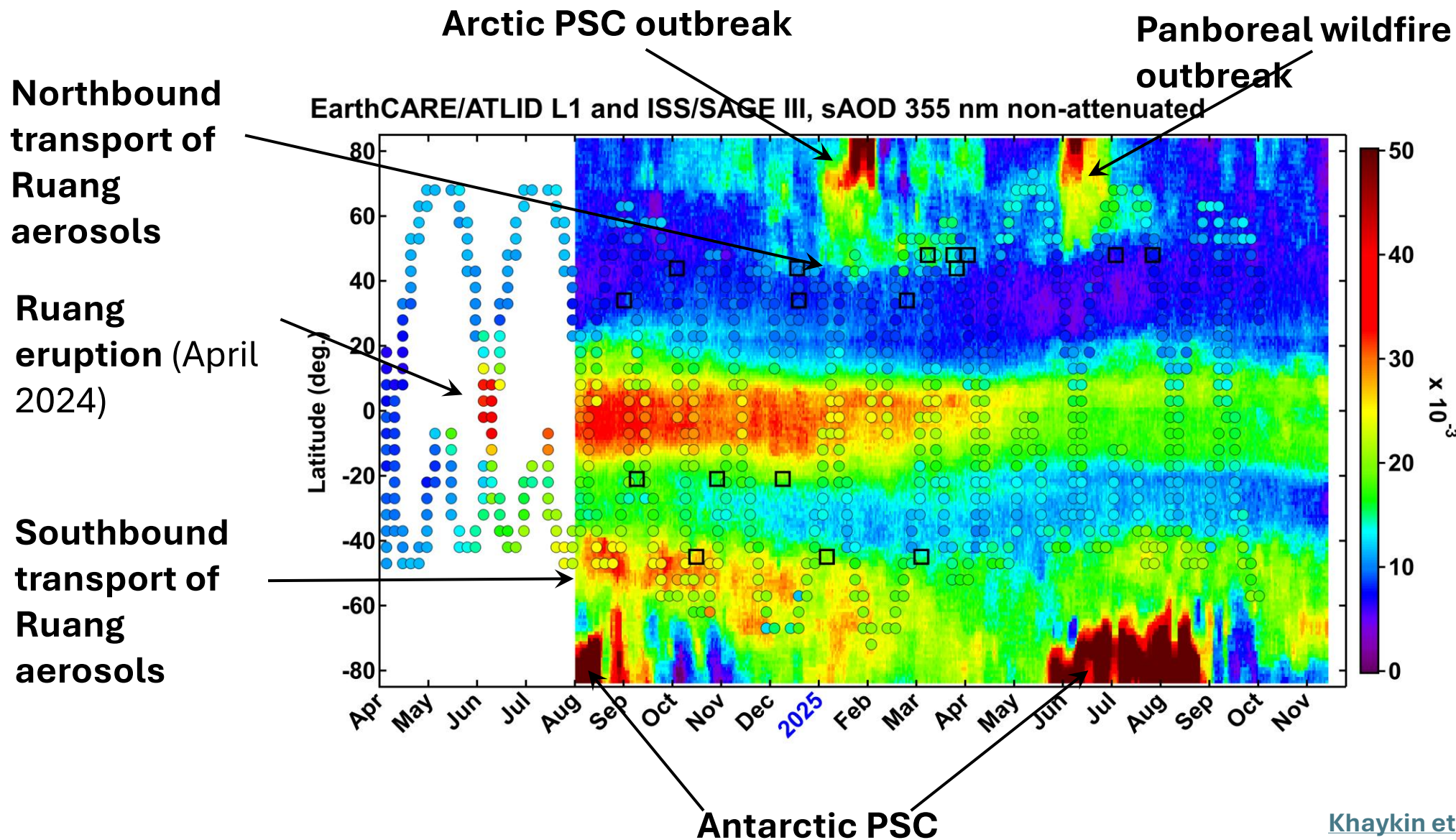
**Lidar ratio from L2A, stratospheric layer mean*

ATLID L2A EBD (BA)

Derived optical/microphysical parameters:

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

Global variation of SAOD from ATLID

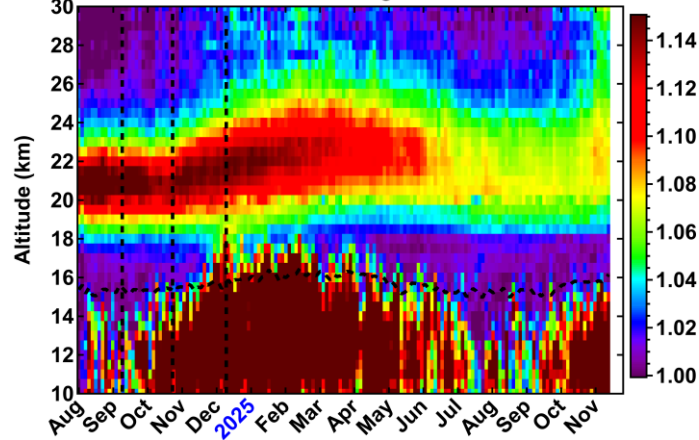


ATLID Cal/Val in the Southern hemisphere

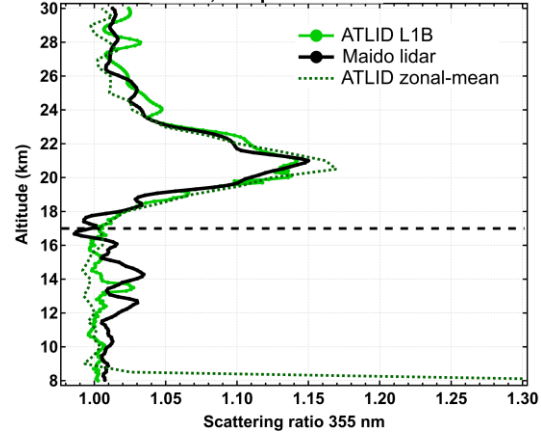


OPAR-Maïdo (La Reunion 21° S)

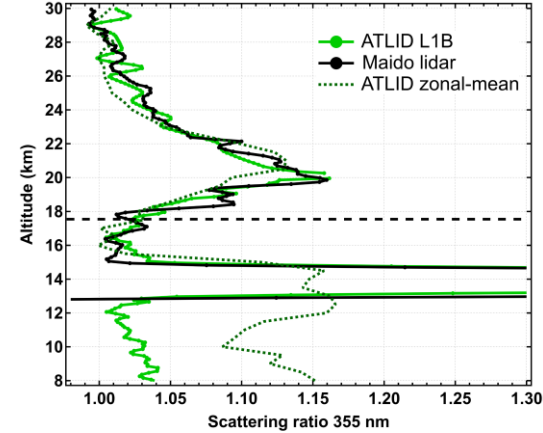
ATLID L1B Scattering ratio, 23° S - 19° S



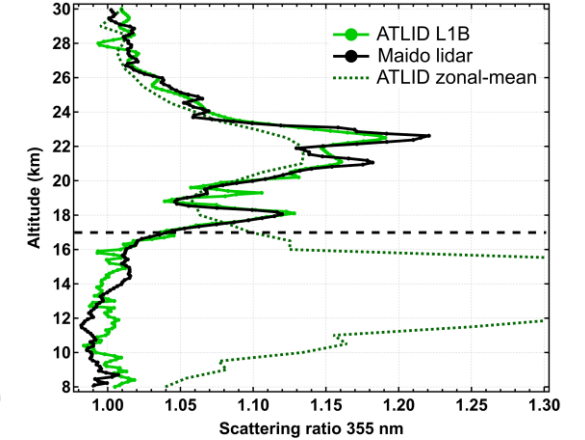
Maïdo, 9 September 2024



Maïdo, 29 October 2024



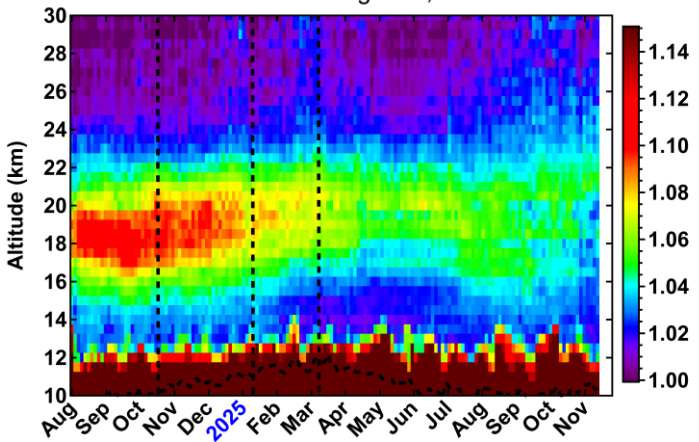
Maïdo, 9 December 2024



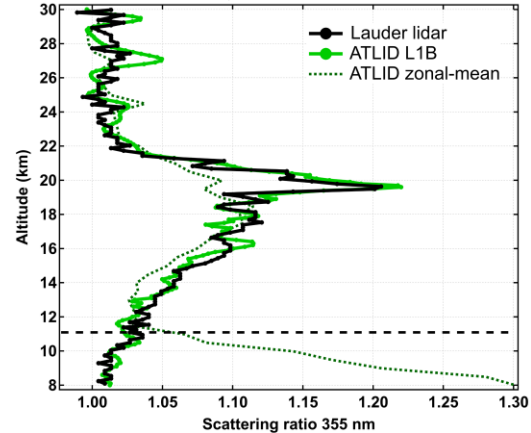
Lauder (New Zealand 45° S)

Khaykin et al., ACPD, 2025

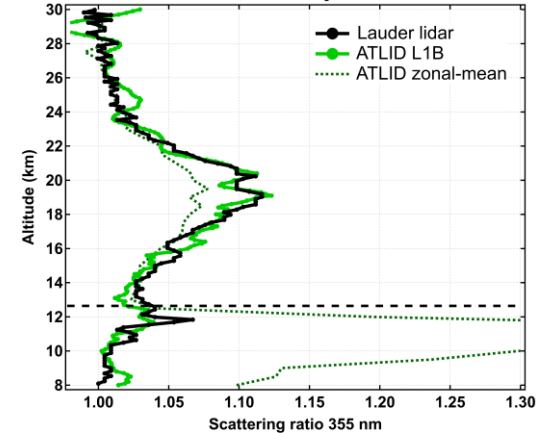
ATLID L1B Scattering ratio, 47° S - 43° S



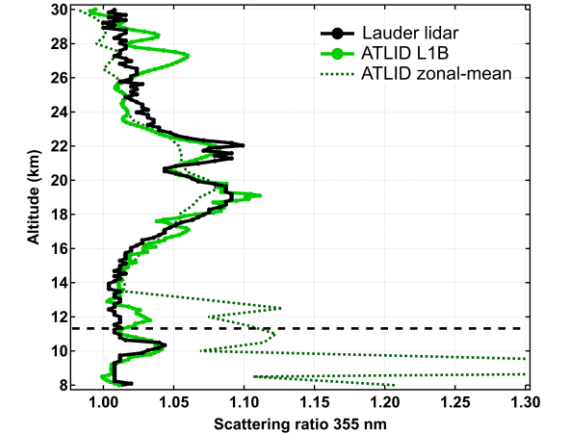
Lauder, 16 October 2024



Lauder, 6 January 2025



Lauder, 6 March 2025

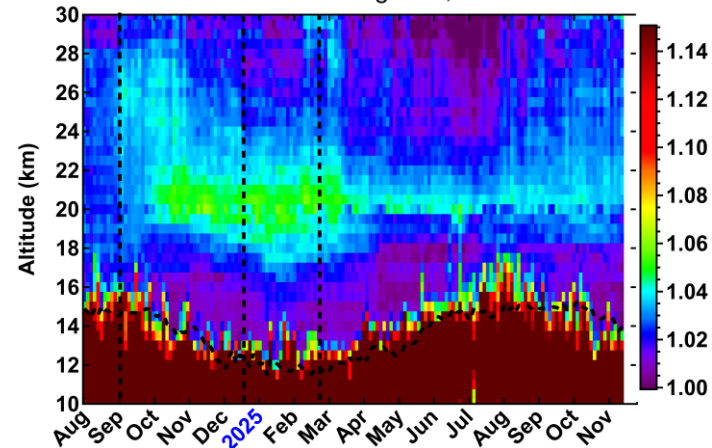


ATLID Cal/Val in the Northern hemisphere

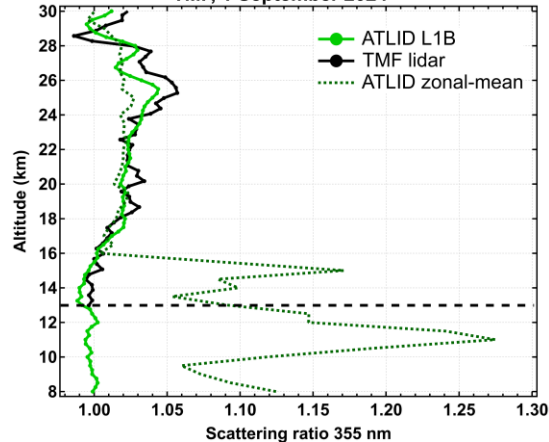


Table Mountain Facility (California 34° N)

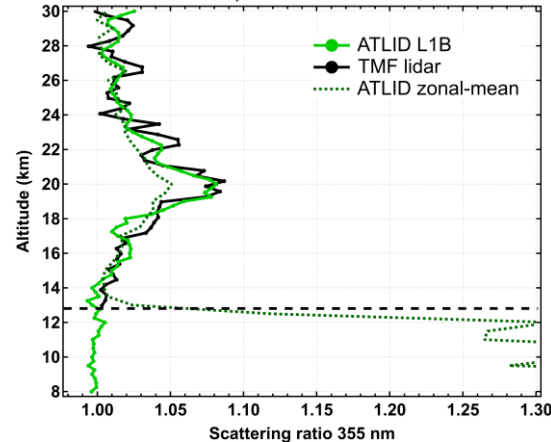
ATLID L1B Scattering ratio, 32° N - 36° N



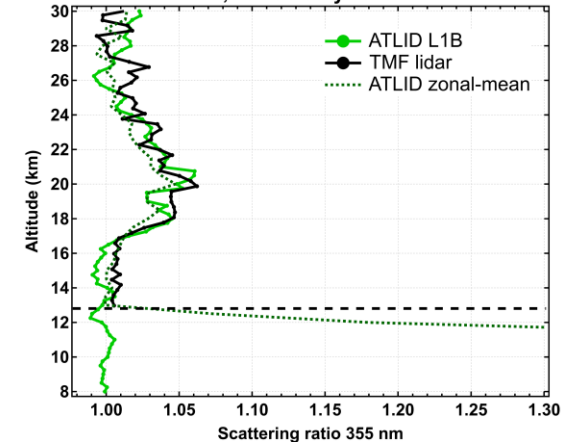
TMF, 1 September 2024



TMF, 19 December 2024

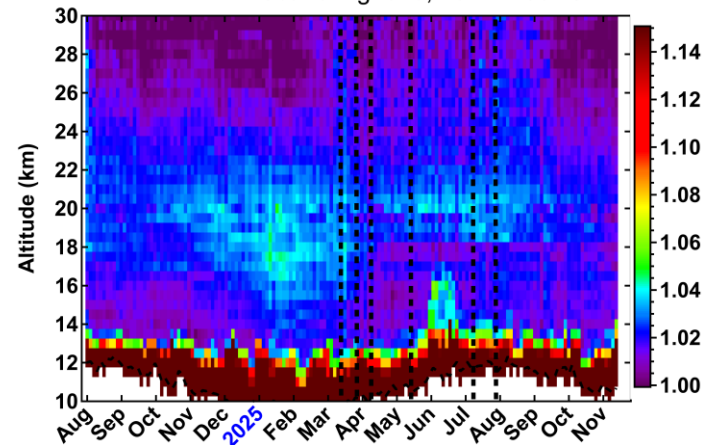


TMF, 25 February 2025

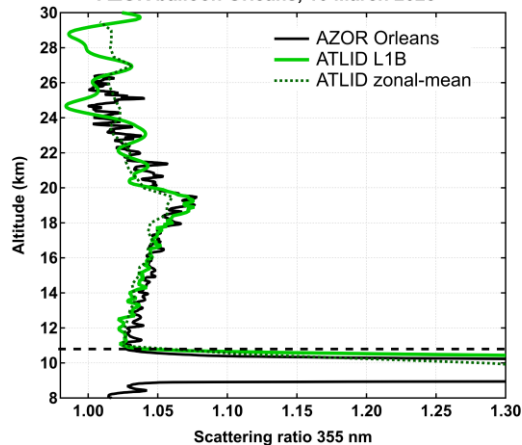


OHP (44° N) and Orleans balloons (48° N)

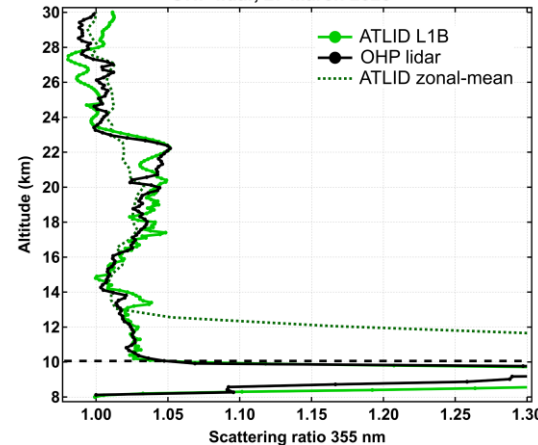
ATLID L1B Scattering ratio, 46° N - 50° S



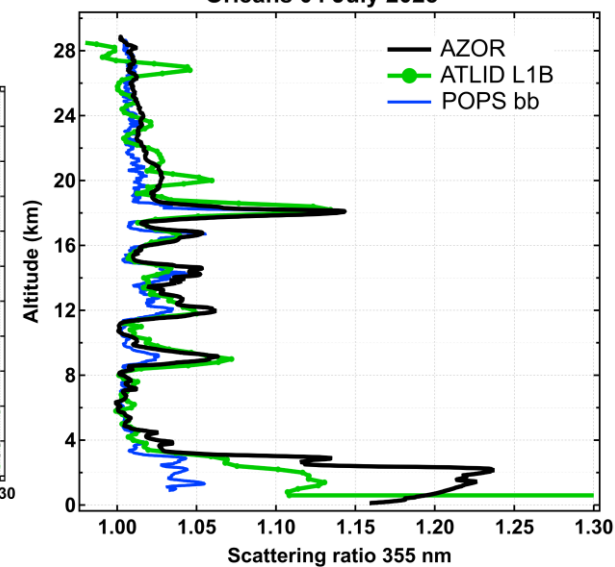
AZOR balloon Orleans, 10 March 2025



OHP lidar, 27 March 2025



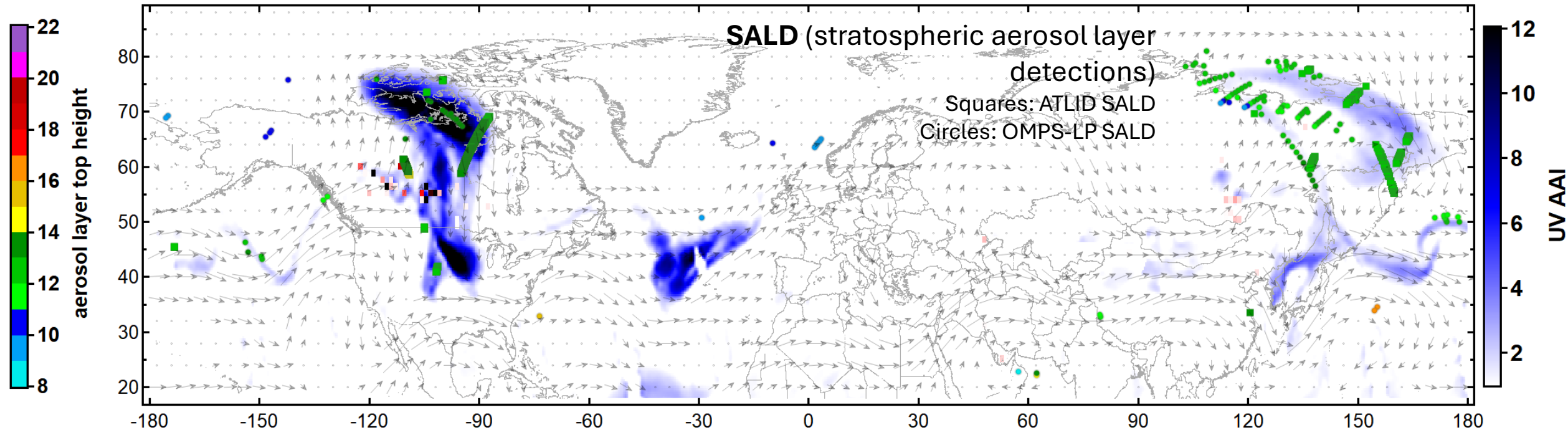
Orleans 04 July 2025



Panboreal wildfire outbreak in May 2025



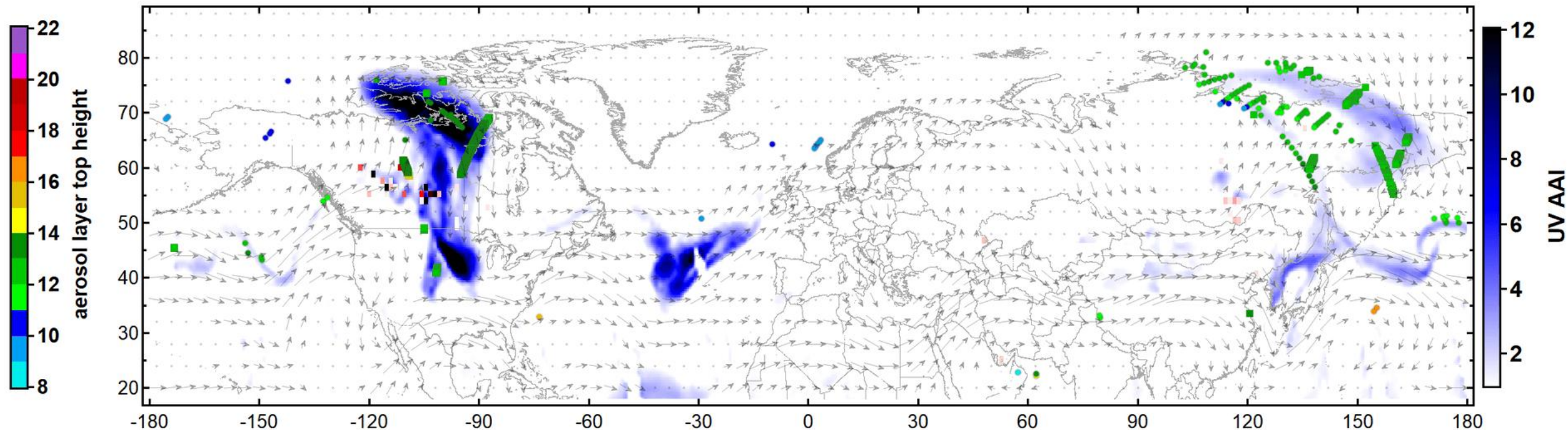
OMPS-NM Absorbing Aerosol Index 2025 05 30



Panboreal wildfire outbreak in May 2025

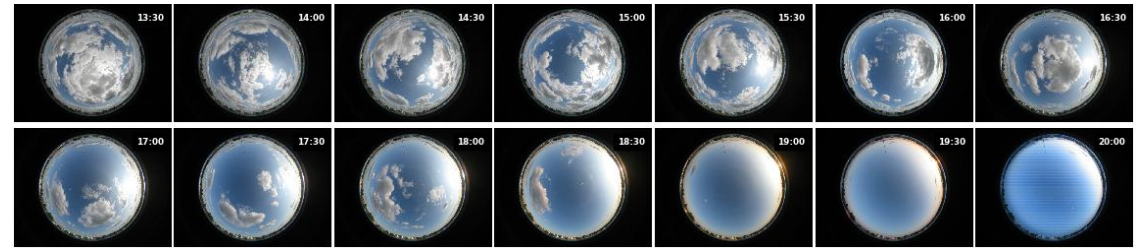
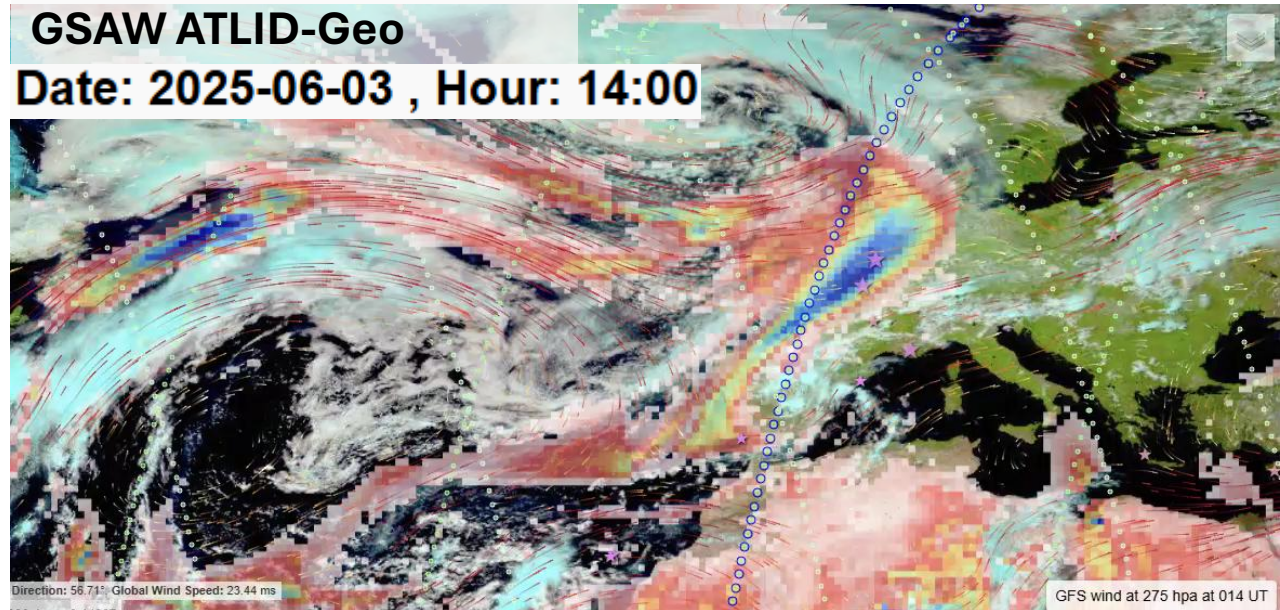


OMPS-NM Absorbing Aerosol Index 2025 05 30

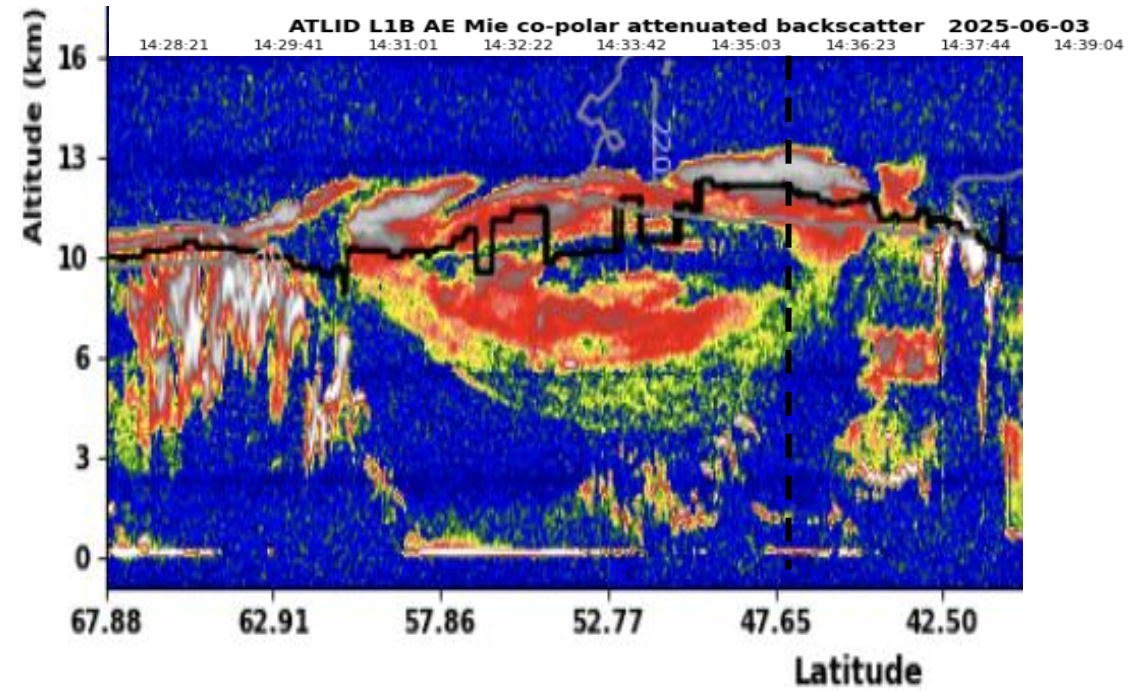
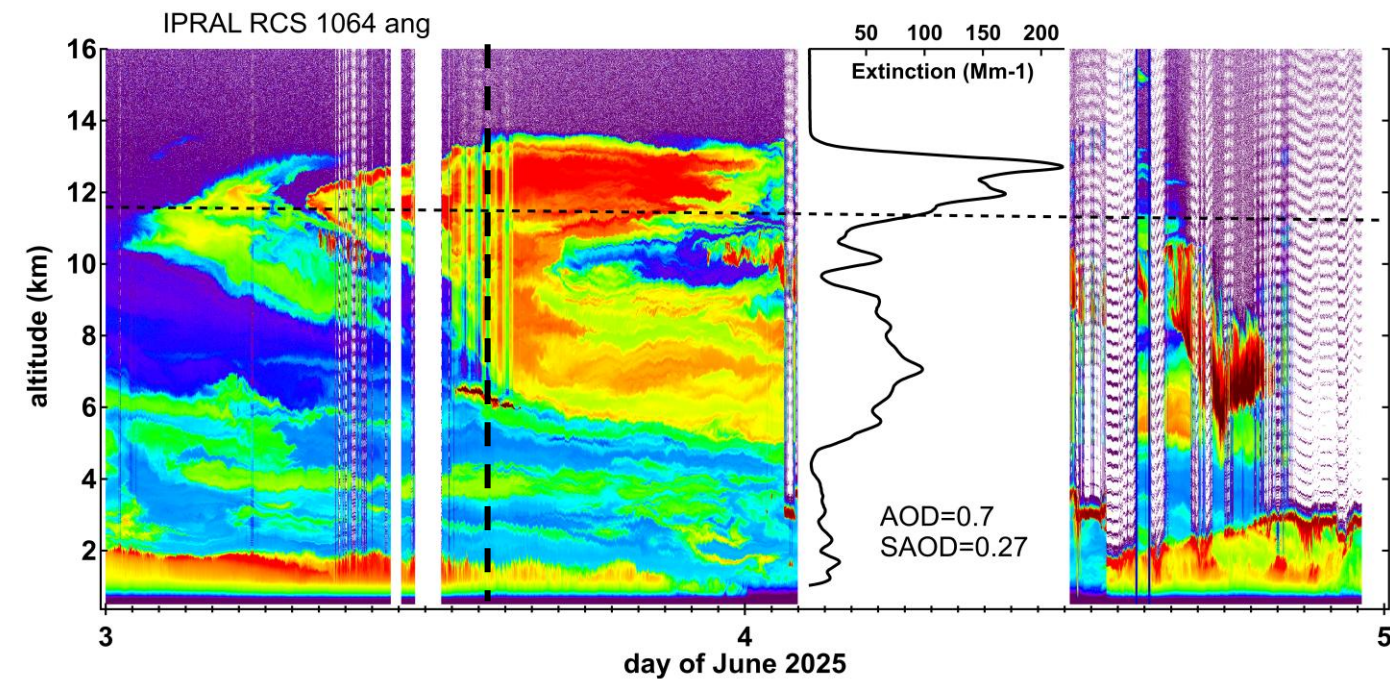
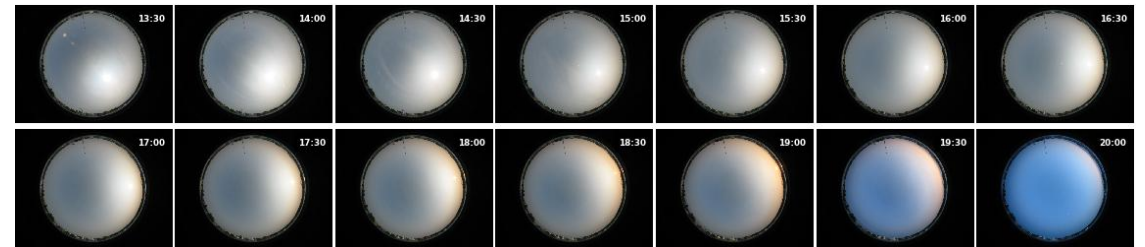


PWO observations by IPRAL and ATLID

2 June



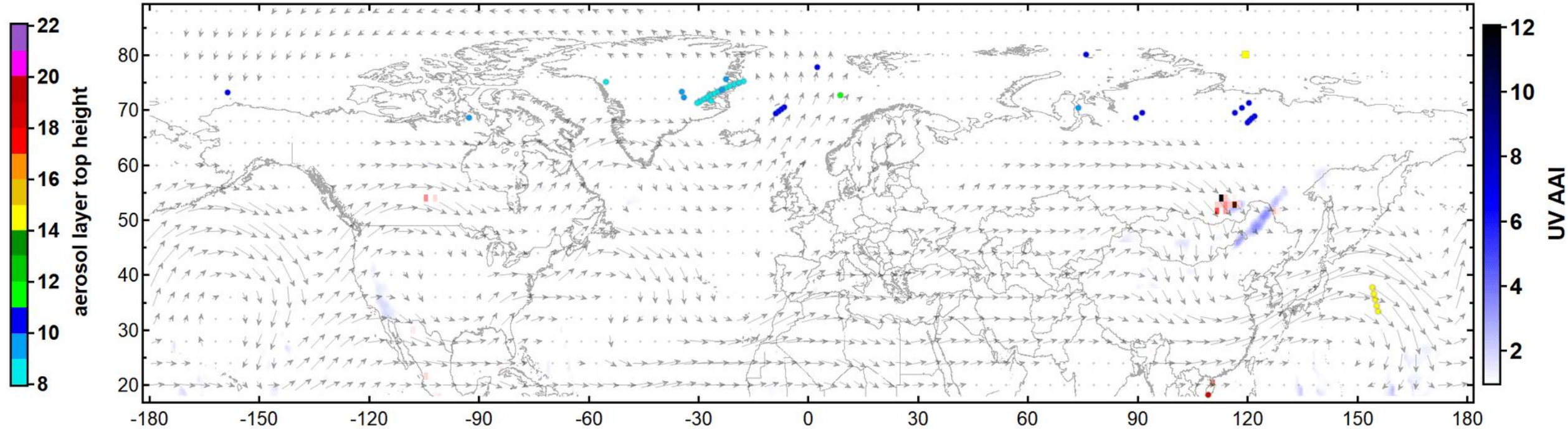
3 June



Panboreal wildfire outbreak in May 2025



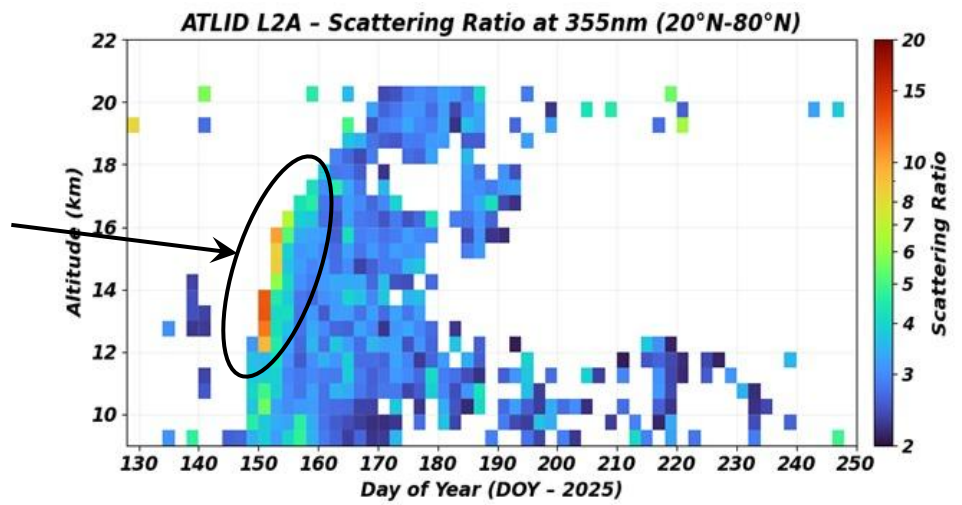
OMPS-NM Absorbing Aerosol Index 2025 05 10



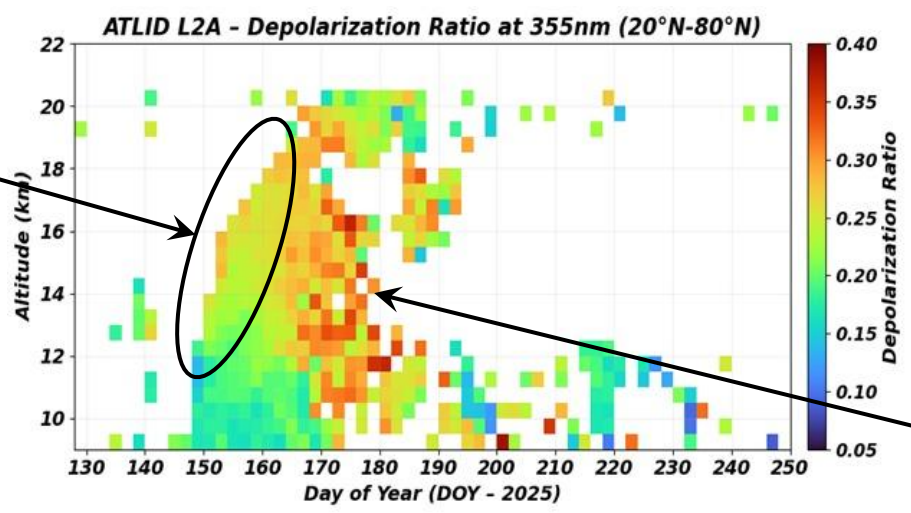
Microphysical evolution of smoke particles from ATLID



Self-lofting of high-concentrated plume up to 21 km



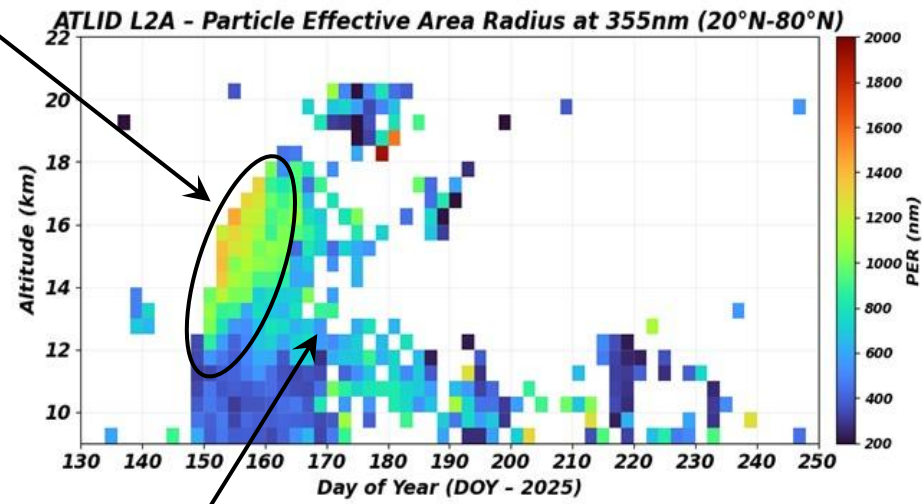
Depolarization growth due to aggregation



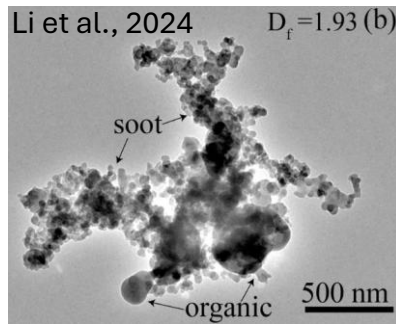
EBD data on stratospheric layers (night & day)

- ✓ Filtering on AOD>0.03, SR>2 and quality flag
- ✓ Aggregation into 1 day/500 m bins

Rapid particle growth through aggregation



Sedimentation of large aggregates



Soares et al., in prep.

Summary and outlook



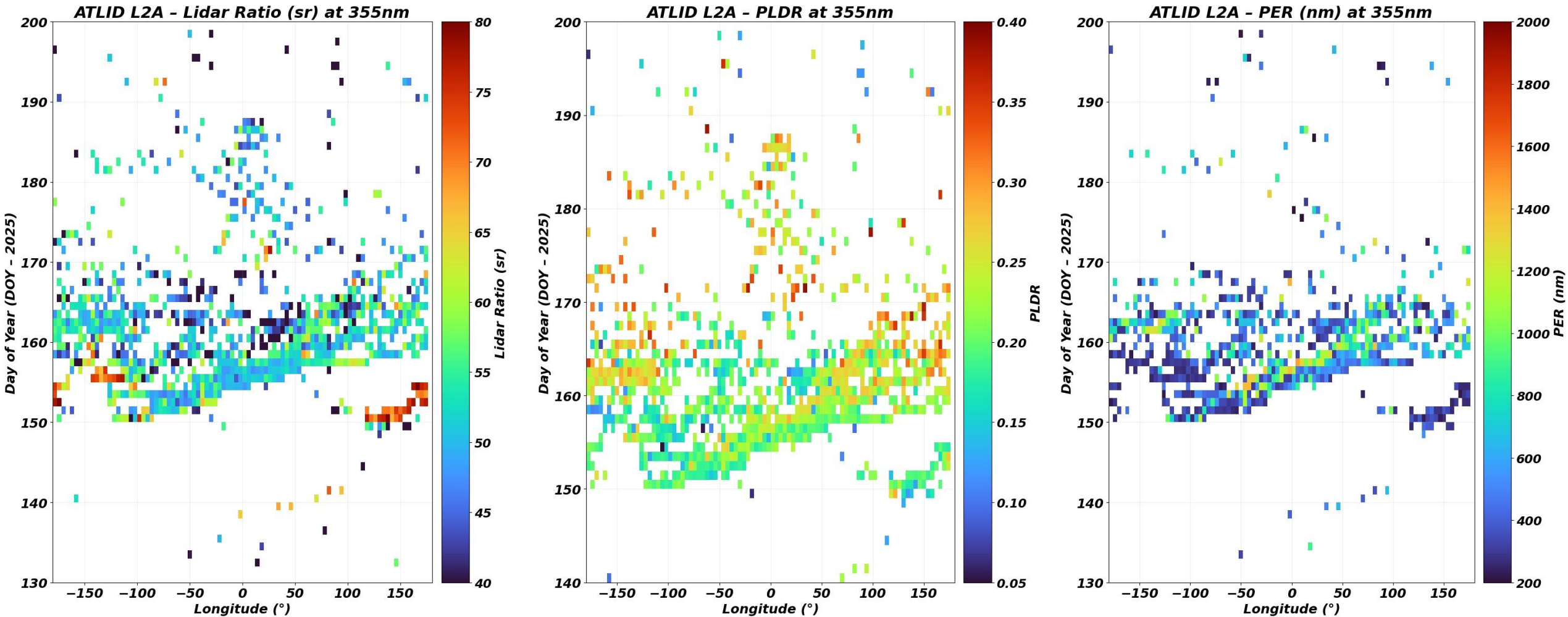
- **ATLID shows remarkable performance in the stratosphere** as inferred from comparison with suborbital GB lidars, balloon soundings and passive satellite instruments
- **ATLID has witnessed several significant stratospheric aerosol perturbations**
- **ATLID observations of the PWO-2025 stratospheric smoke particles advance the current understanding of their microphysical habits**

Global Stratospheric Aerosol Watch (GSAW)

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

See poster by Kadyrov and Khaykin (Annex

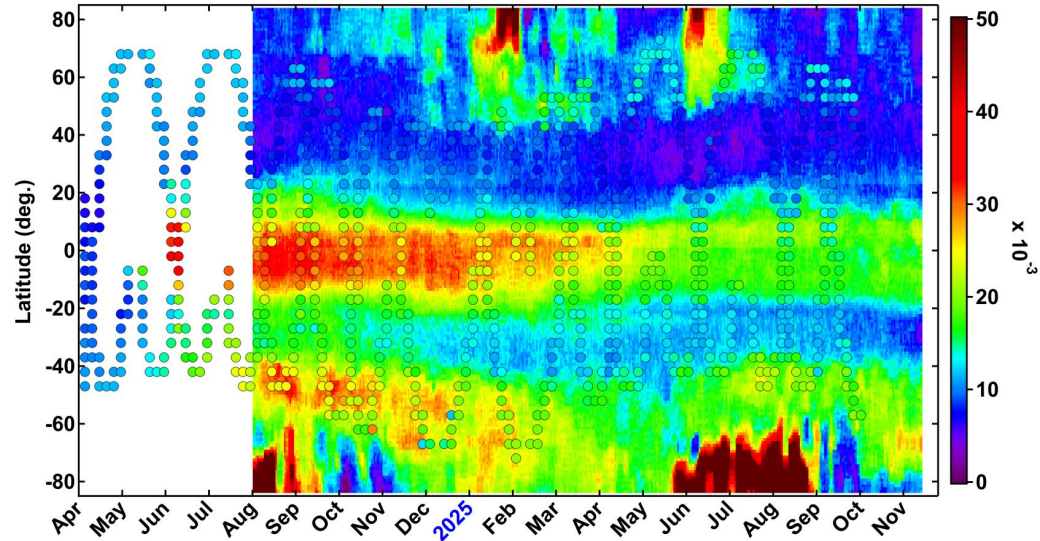
Panboreal wildfire outbreak in May 2025



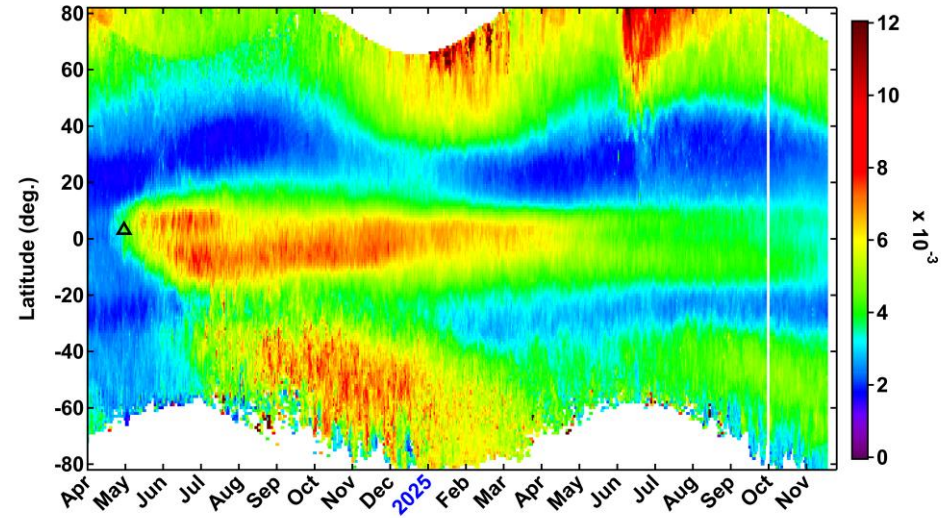
ATLID L1 vs L2 SAOD



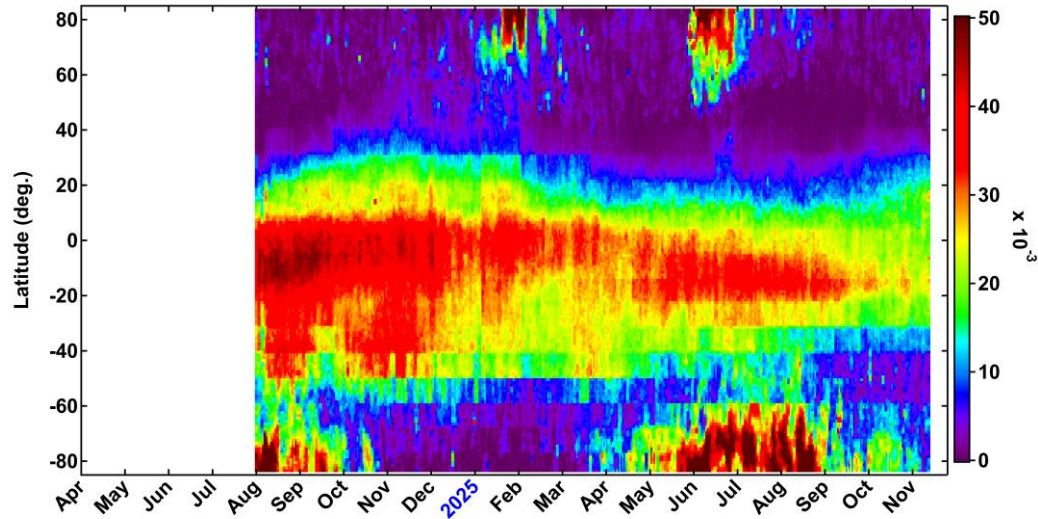
EarthCARE/ATLID L1 and ISS/SAGE III, sAOD 355 nm non-attenuated



NOAA-21/OMPS-LP and ISS/SAGE III, sAOD 869 nm

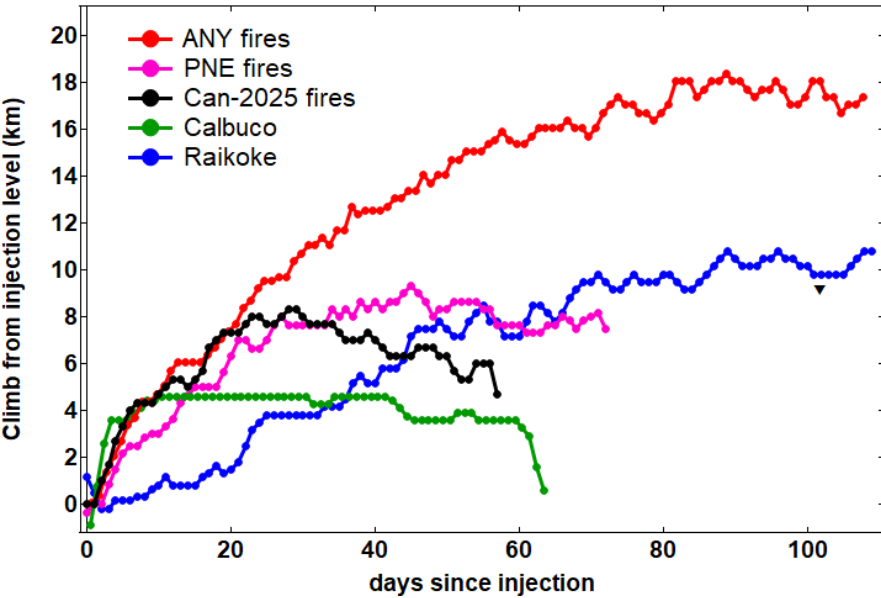


EarthCARE/ATLID L2 EBD and ISS/SAGE III, sAOD 355 nm

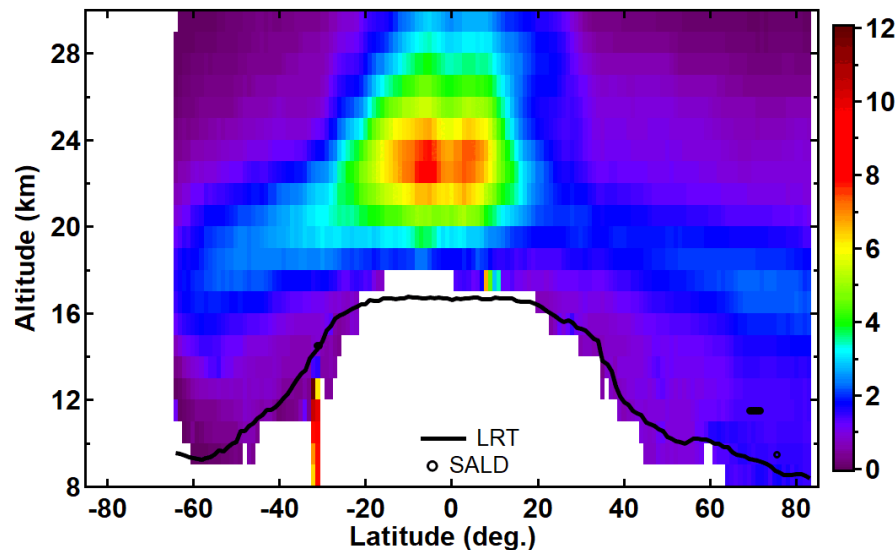


Self-lofting and large-scale impact of PWO-2025 smoke

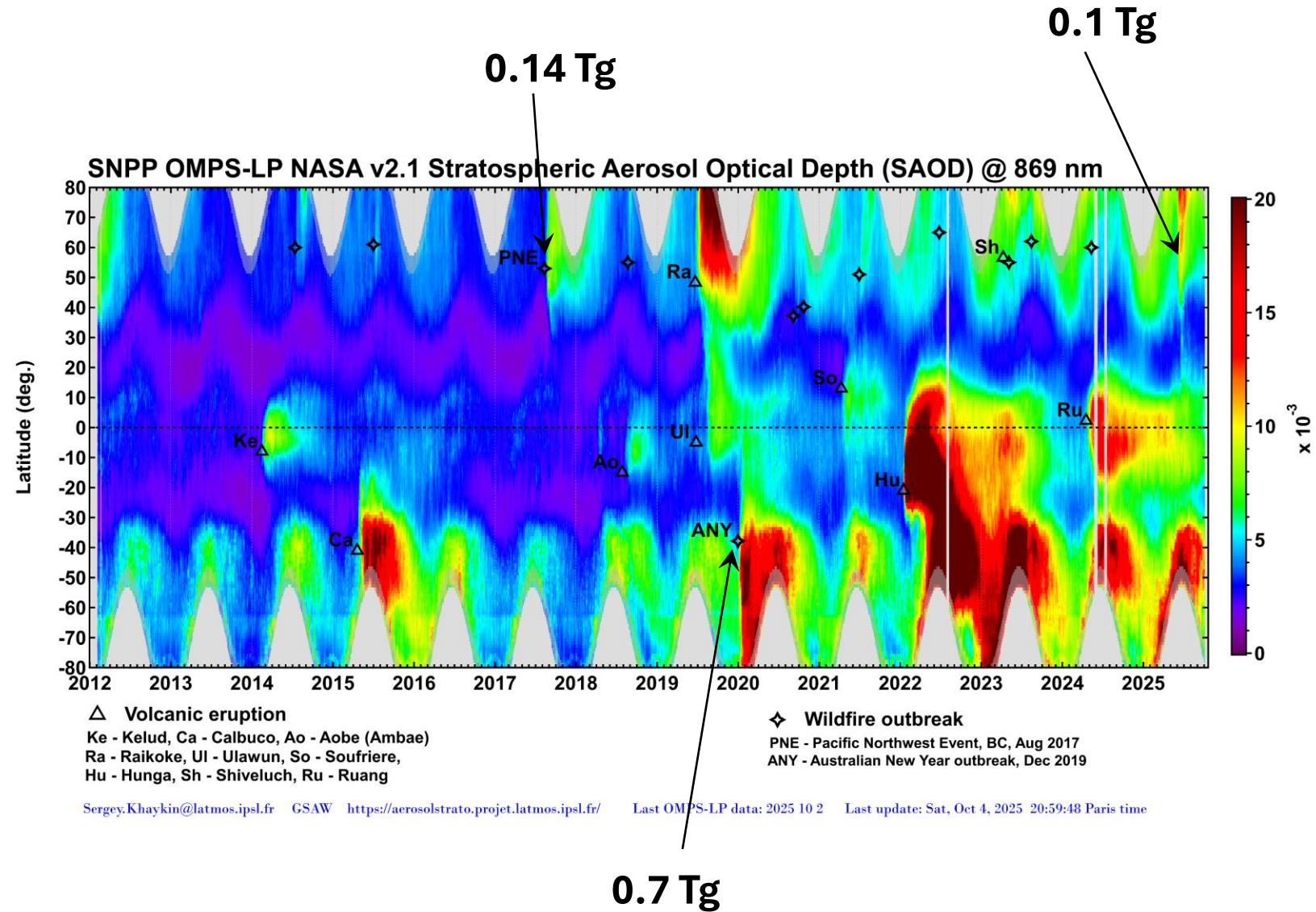
Evolution of aerosol plume maximum altitude



NOAA-21 OMPS-LP Extinction ratio 869 nm 2025 05 20



GSAW <https://aerosolstrato.projet.latmos.ipsl.fr/>



△ Volcanic eruption
Ke - Kelud, Ca - Calbuco, Ao - Aobe (Ambae)
Ra - Raikoke, UI - Ulawun, So - Soufriere,
Hu - Hunga, Sh - Shiveluch, Ru - Ruang

◇ Wildfire outbreak
PNE - Pacific Northwest Event, BC, Aug 2017
ANY - Australian New Year outbreak, Dec 2019

Sergey.Khaykin@latmos.ipsl.fr GSAW <https://aerosolstrato.projet.latmos.ipsl.fr/> Last OMPS-LP data: 2025 10 2 Last update: Sat, Oct 4, 2025 20:59:48 Paris time

Khaykin et al., in prep.

Panboreal wildfire outbreak in May 2025

