Laboratory Evaluation of the (355, 532) Depolarization Ratio of Pure Pollen

Danaël CHOLLETON, Patrick RAIROUX, Alain MIFFRE

Institute of Light and Matter (iLM), ATMOS Research group, Lyon University, France

03. Atmospheric aerosol and clouds properties

Tuesday June 28th, 12:00 UTC

P24

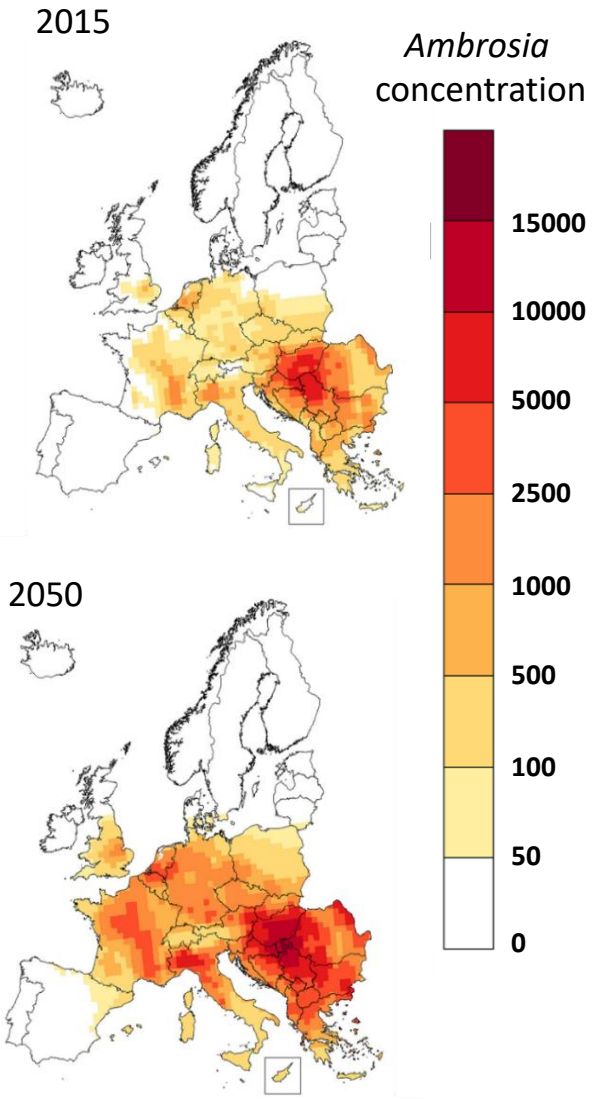
The 30th International Laser Radar Conference (ILRC) virtual conference, June 26th – July 1st, 2022.

Impact of pollen and need for monitoring

- **Health and economical impact**
  - Allergic reactions (asthma, rhinitis)
  - 1/3 of the population in France (ANSES, 2021)
  - Health cost of pollen : 151 billion €/year in Europe (Lake et al. 2017)

- **Climatic impact**
  - Regional warming through scattering and absorption (Spänkuch et al., 2002)
  - Cloud and ice condensation nuclei (Pope et al., 2010; Wozniak et al. 2018)

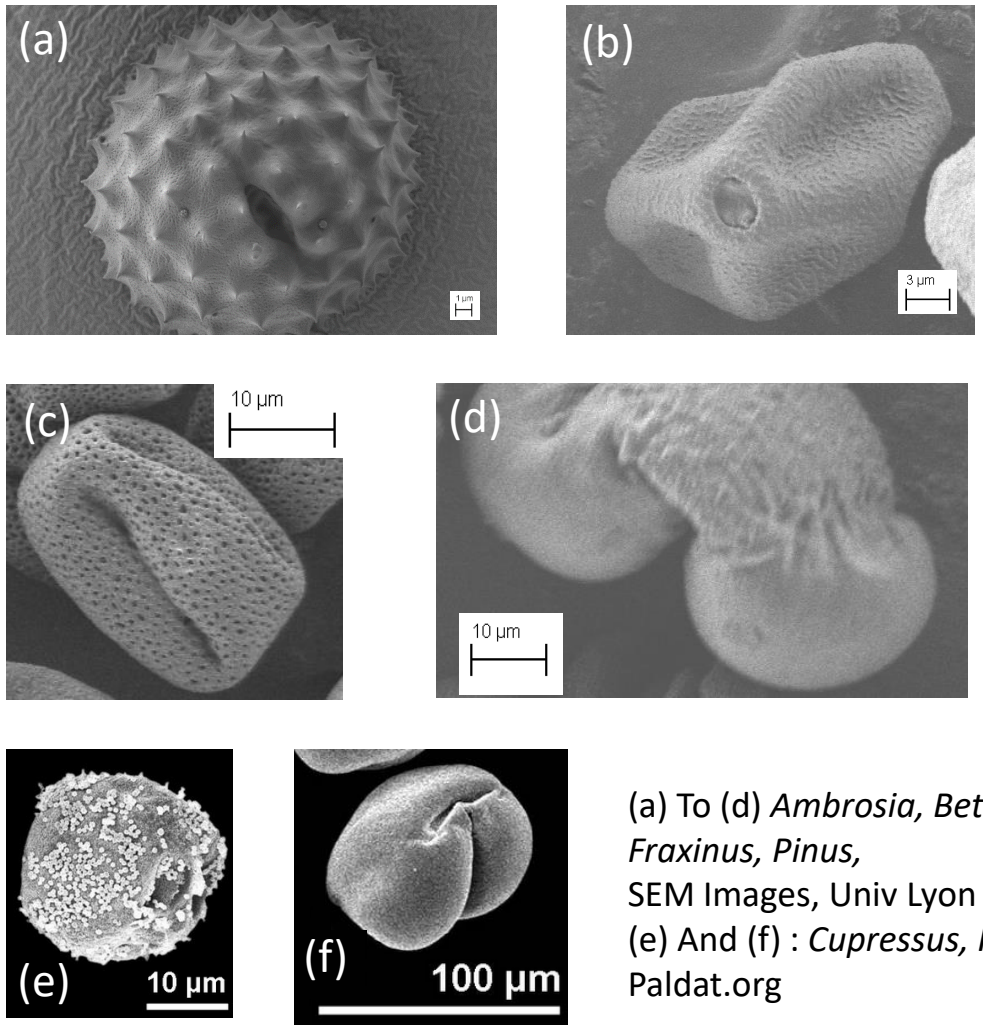
- **Evolution in future years**
  - Higher pollen concentrations
  - Longer pollen season
  - Larger geographical locations



(Lake et al. 2017)

Pollen: large and complex-shaped aerosols

- **Pure pollen samples**



(a) To (d) *Ambrosia, Betula, Fraxinus, Pinus,*
SEM Images, Univ Lyon 1
(e) And (f) : *Cupressus, Picea*
Paldat.org

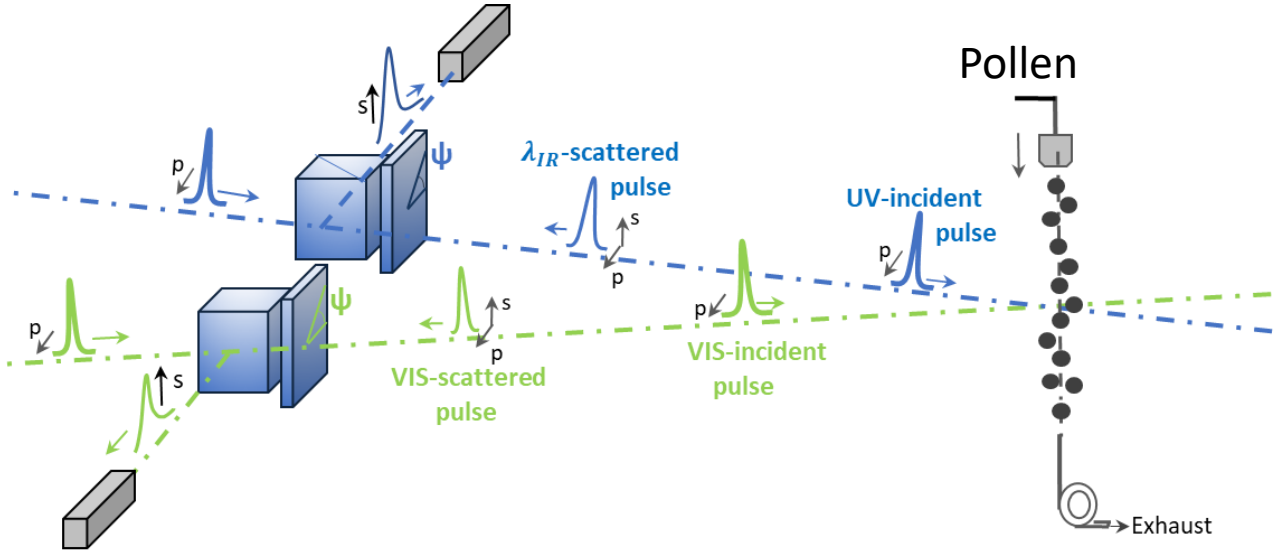
- **State of the art on pollen lidar remote sensing**
  - Depolarization lidar profiles of pollen mixtures : Sassen 2008, Noh et al. 2013, Sicard et al. 2016, Shang et al., 2022.
  - First evaluation of the pollen PDR by Cao et al. 2010 at close but not exact backscattering angle.
  - No accurate light-scattering numerical simulation for such large and complex-shaped particles.

→ Laboratory evaluation of pure pollen Lidar PDR at 180.0° lidar backscattering angle.

Laboratory evaluation of the lidar PDR of pure pollen

- Unique laboratory polarimeter at 180.0 lidar backscattering angle (Miffre et al. 2016, 2019)

  ☞ **See A. Miffre's talk tomorrow at 15:45 !**



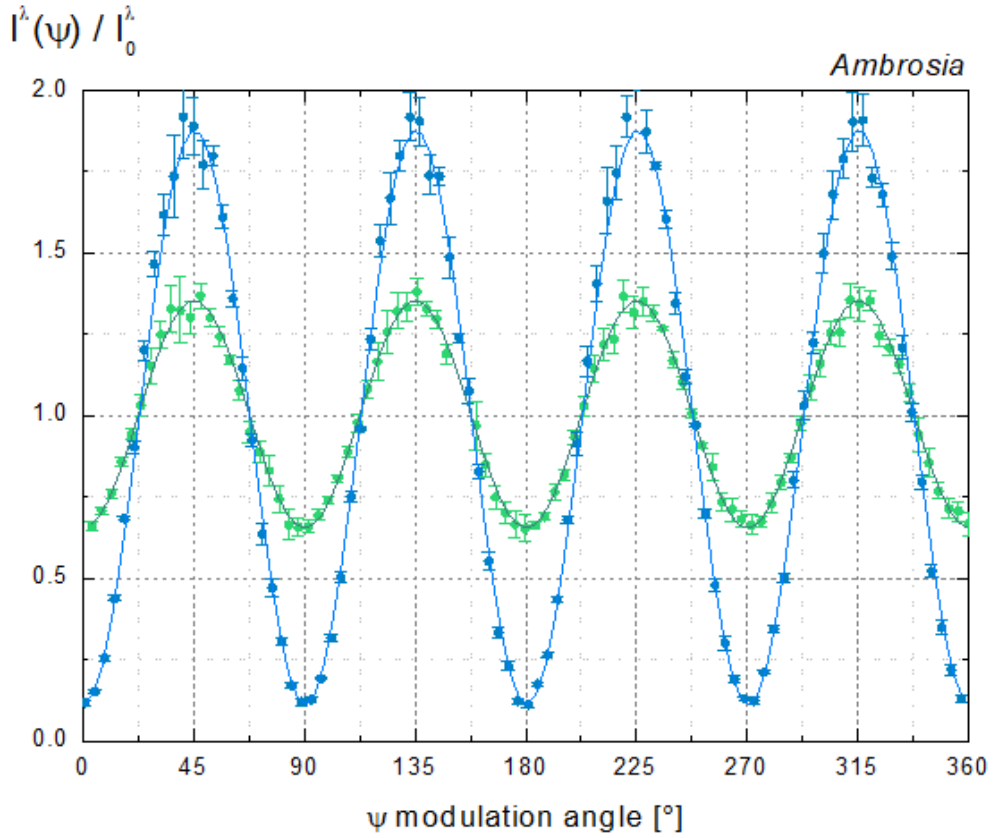
$$PDR_\lambda = \frac{1 - F_{22}^\lambda / F_{11}^\lambda}{1 + F_{22}^\lambda / F_{11}^\lambda}$$

- **Time-resolved**: ns-pulsed laser source (as in lidar applications)
- **High sensitivity**: polarization cross-talks are fully negligible (as low as 10^{-7}).
- **Multi-spectral**: 355 and 532 nm lidar wavelengths.
- **Accurate (1%) spectroscopic evaluation of the PDR of pure pollen.**

Laboratory evaluation of the lidar PDR of pure ragweed pollen

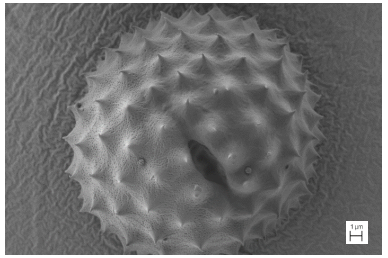
- Polarimeter validated on spherical particles → $PDR_\lambda = 0$ as expected by Lorenz-Mie theory

- Evaluation of the PDR by modulating the backscattered intensity with a retarder plate (angle ψ) :



$$PDR_{355} = 5.2 \pm 0.5\ \%$$

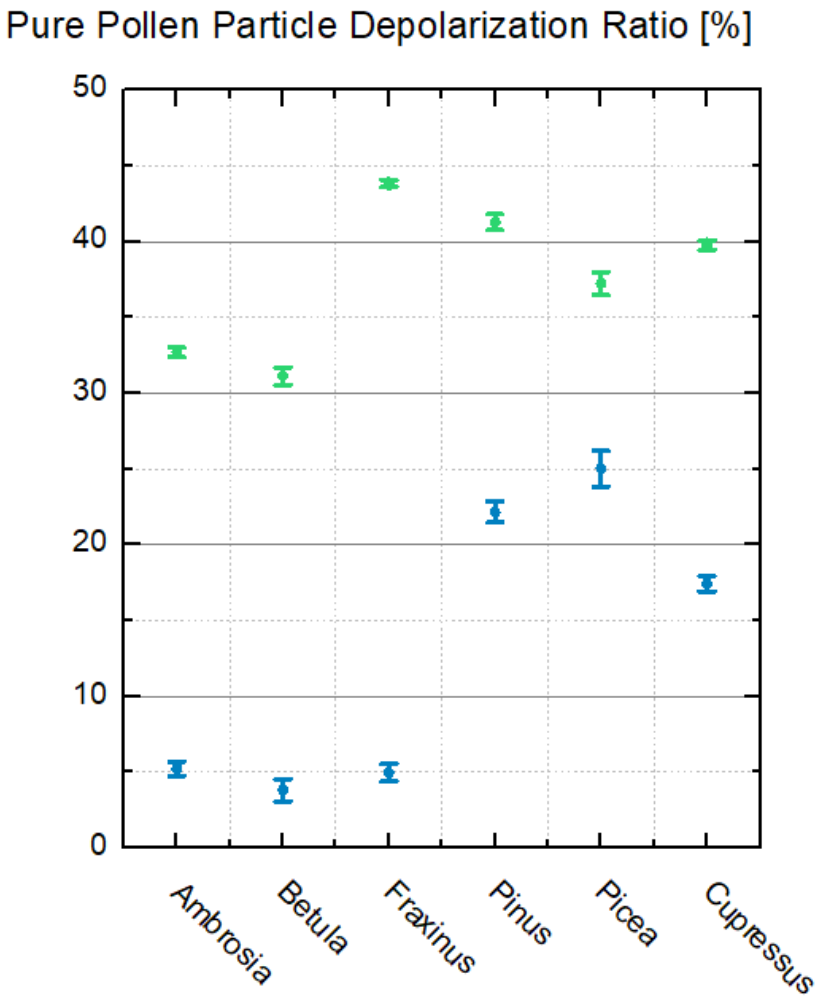
$$PDR_{532} = 32.7 \pm 0.3\ \%$$



Output : Lidar Particle Depolarization Ratio of Pure Pollen

Pure pollen taxon	PDR_{355} [%]	PDR_{532} [%]
Ragweed	5.2 ± 0.5	32.7 ± 0.3
Birch	3.8 ± 0.7	31.1 ± 0.6
Ash tree	5.0 ± 0.6	43.8 ± 0.2
Pine	22.2 ± 0.7	41.3 ± 0.5
Spruce	25.0 ± 1.0	37.2 ± 0.8
Cypress	17.4 ± 0.5	39.8 ± 0.3

Precision on lidar PDR of pure pollen : helps interpreting lidar observations of pollen mixtures (Sassen 2008, Noh et al. 2013, Sicard et al. 2016), and discussing the validity of inversion methodologies (Shang et al., 2022).



To be submitted to Remote Sensing Special Issue 2022 ELC Conference