Aerosol typing in CALIPSO retrieval: an EARLINET/ACTRIS insight

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CALIPSO Version 5 Aerosol Lidar Ratio Workshop March 9-11, 2021

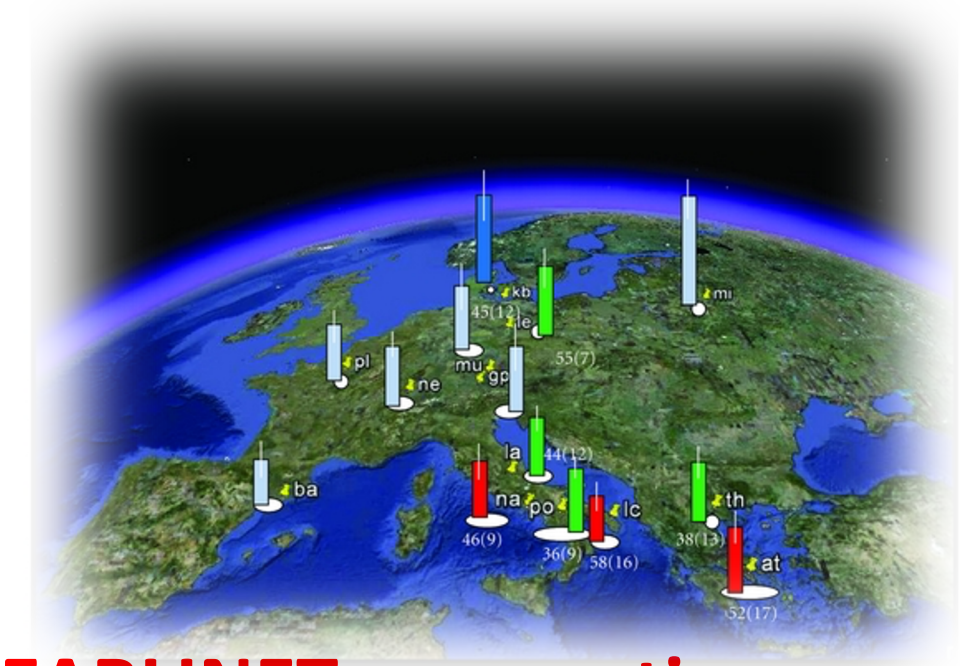
This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 871115

Aerosol typing

- Confusing and misleading **nomenclature**
- Remote-sensing can provide **optical constraints** interpreted as **particle size, shape, and indices of refraction**
- A further **interpretative step**, entailing additional assumptions, reports particle **Source/Chemical Composition**
- **Validation Data** for aerosol type are very **limited**
- **Model** simulations and **in situ** measurements can help

→ *Translating rules and dataset for comparison using model as link are needed….AEROSAT works on this*

Aerosol typing



EARLINET perspective

Observation of optical properties

Air mass origin for interpretating the observation and inferring the typing

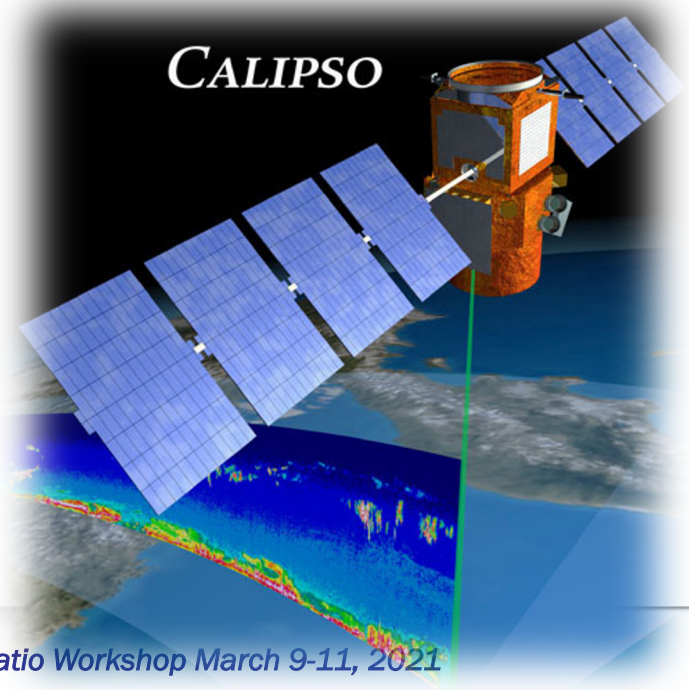
Collection of intensive properties by aerosol types

CALIPSO perspective

Typing needed for obtaining optical properties

Use of lidar ratio table by types

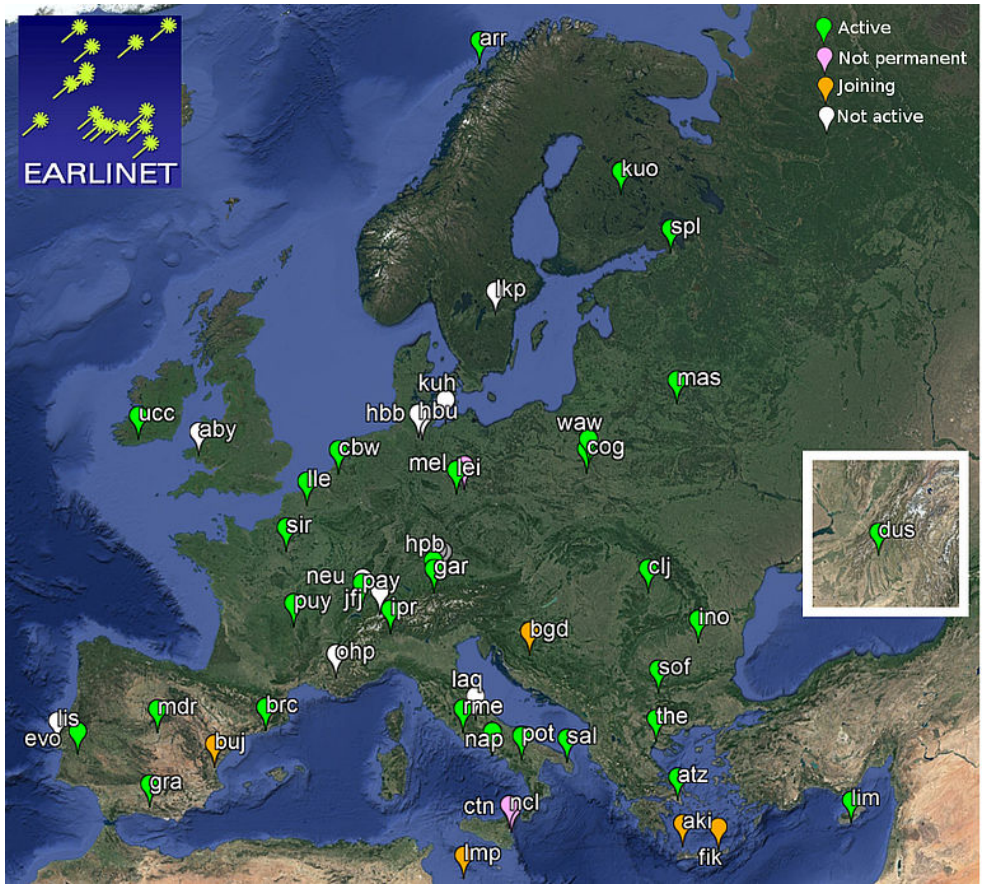
Resulting optical properties depend on typing-lidar ratio assumption



The scientific context – the EARLINET expertise

EARLINET/ACTRIS

- EARLINET started in 2000
- Based on Raman systems
- Different locations + measurement campaigns
- Working on CALIPSO data evaluation and exploitation



Aerosol typing from lidar optical data

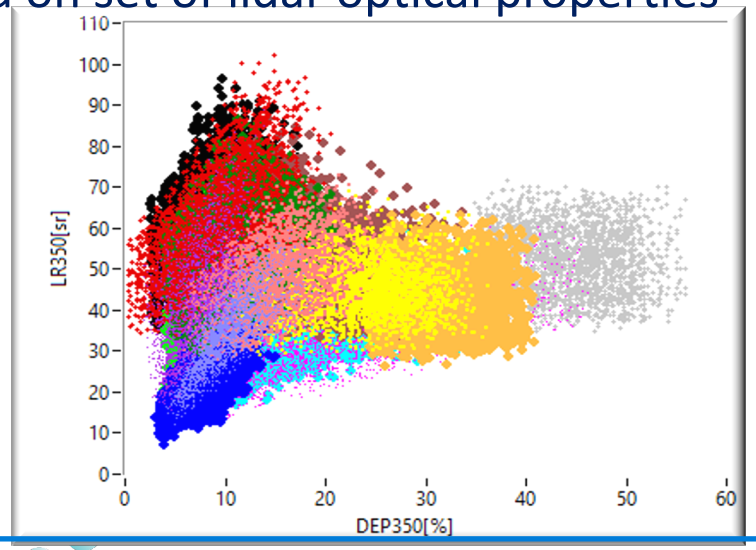
- Lidar optical products have significant uncertainty & microphysical inversions possible only in special conditions, but aerosol typing generally possible
- The physical content of the optical products should include
  - Scattering properties
  - Extinction properties
  - Anisotropy properties
- Aerosol type is defined in relation to its production source
- Up to a certain limit, mixtures can also be resolved

Aerosol typing in EARLINET/ACTRIS

- Aerosol typing is not yet provided in EARLINET data, but in progress
- Mainly 2 algorithms used within the network:

NATALI

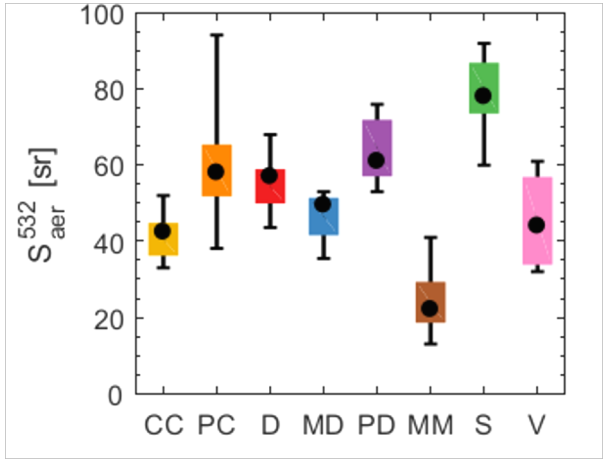
Based on Neural network algorithm
Trained on aerosol model (OPAC+ GDAS+ Tmat)
Tested on set of lidar optical properties



Nicolae, et al., Atmos. Chem. Phys., 2018

MAHANALOBIS distance

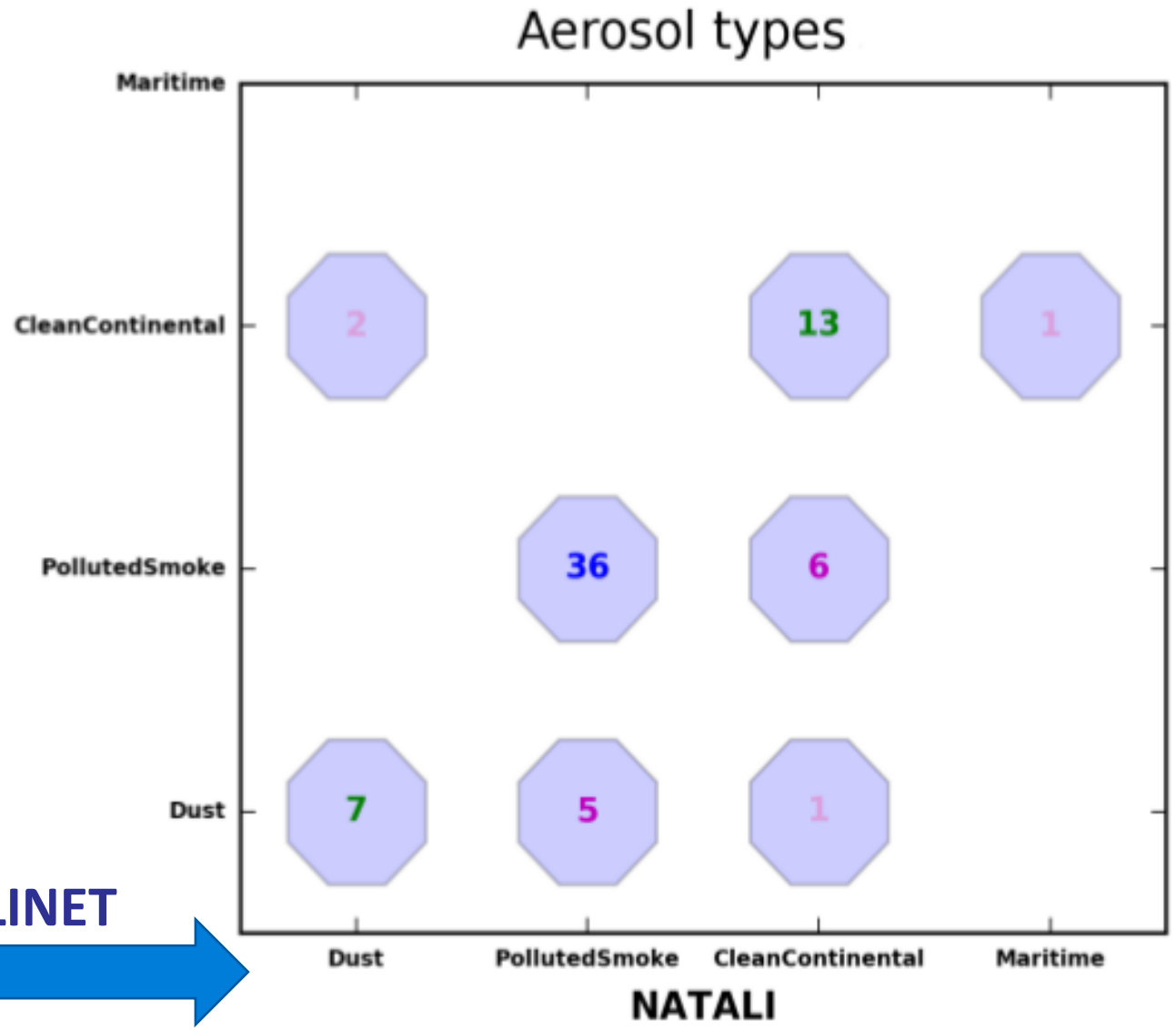
Checking the distance of current obs vs each aerosol class
Trained with 3 years of lidar data
Tested on set of lidar optical properties



Papagiannopoulus, et al., Atmos. Chem. Phys., 2018

Aerosol typing in EARLINET/ACTRIS

- Comparison not trivial
- Mahanalobis method affected by the low number observed cases for maritime and clean continental cases in training dataset
- Typing difficulties in discriminating dust and polluted/smoke



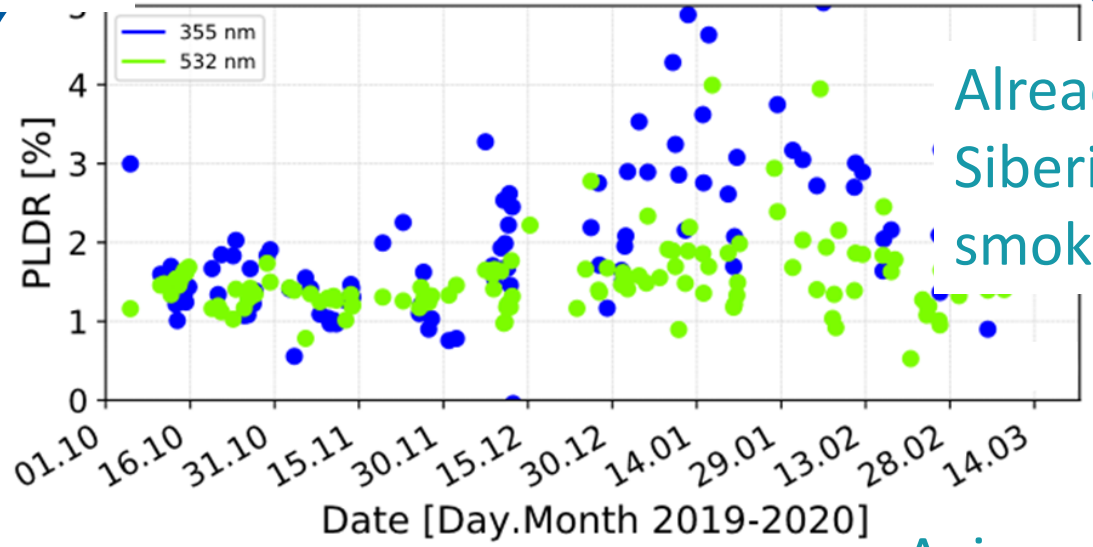
A real case:

Regional performance at an EARLINET urban station over 3y data

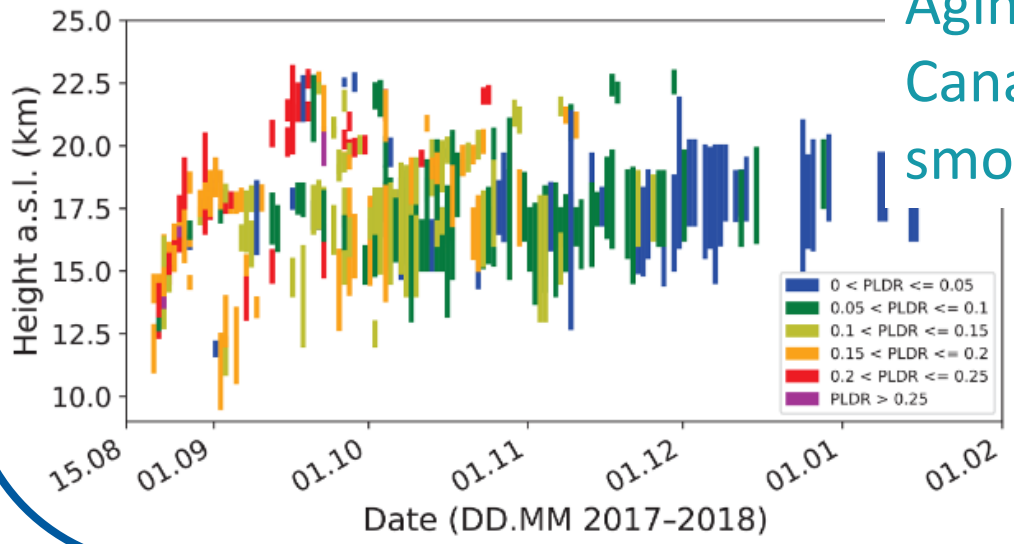
Voudouri, et al., Atmos. Chem. Phys., 2019

One type but regional differences and temporal evolution

Depol

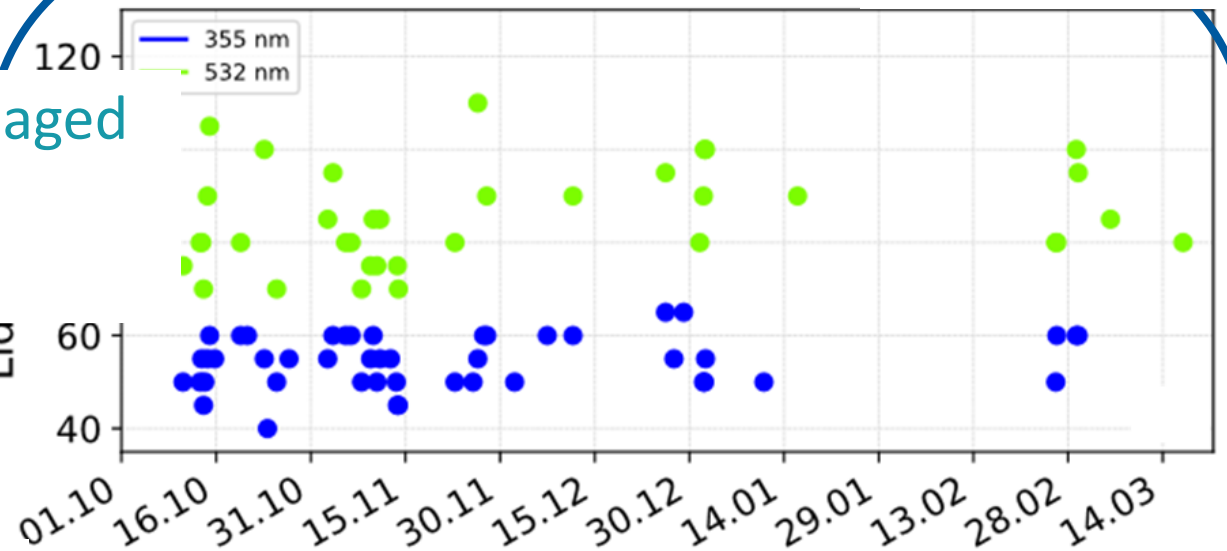


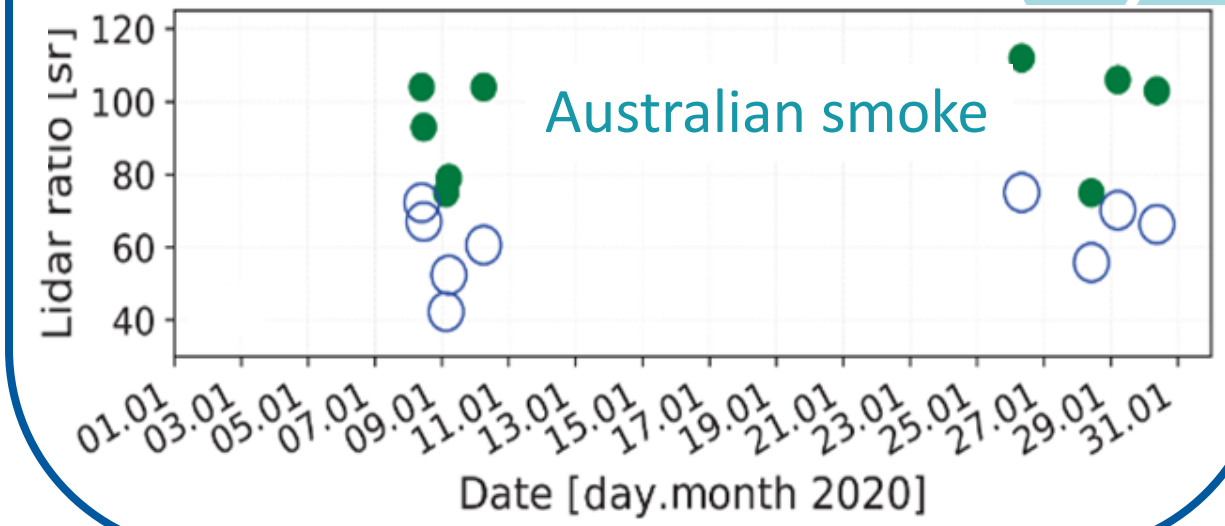
Already aged Siberian smoke



Aging Canadian smoke

Lidar Ratio





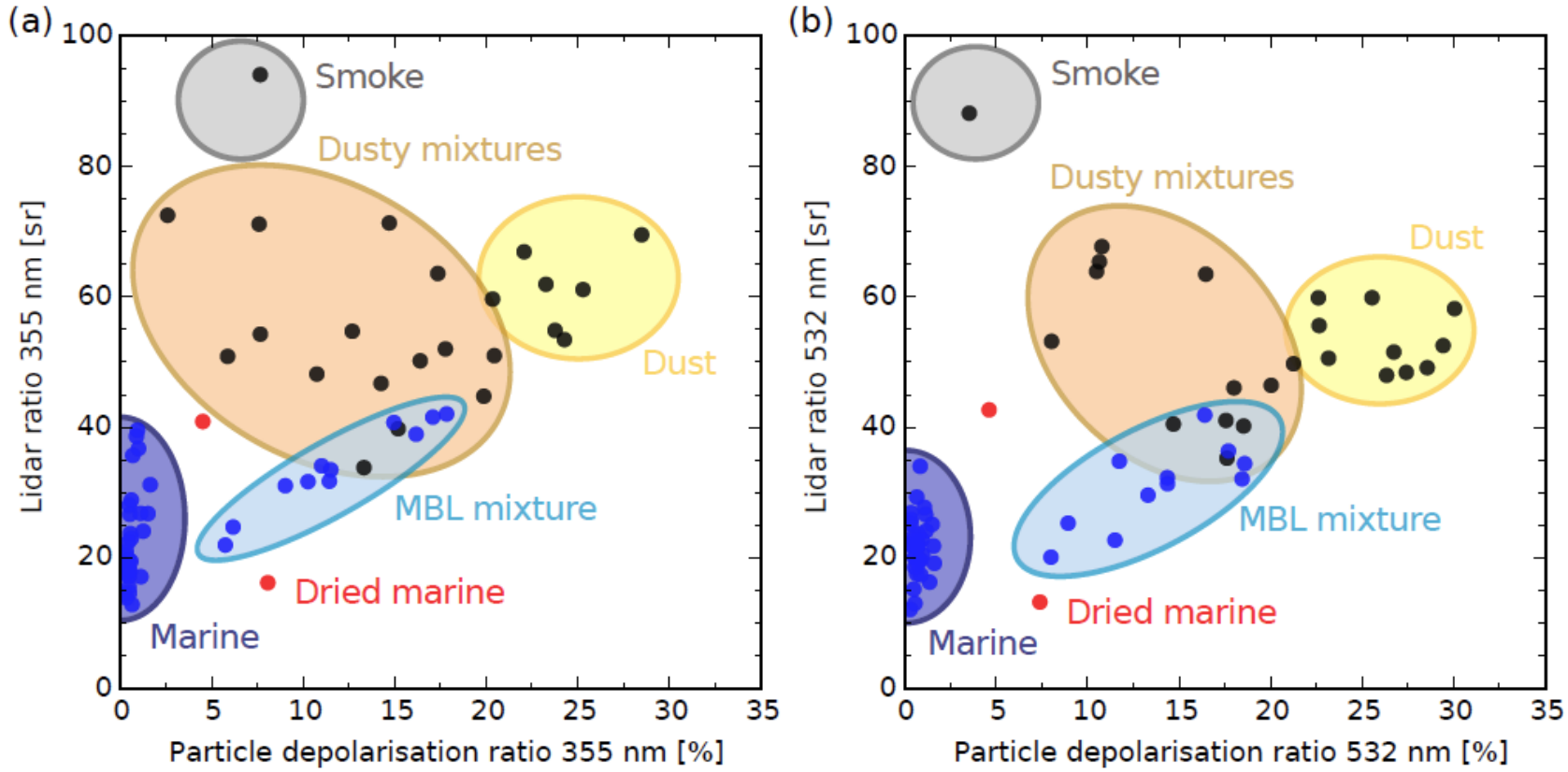
Australian smoke

Baars et al., ACP, 2019 *Ohneiser et al., ACP, 2020* *in preparation Ohneiser et al., ACP, 2021*

Atlantic Ocean observations

- **Marine boundary layer**
- **Elevated layers**

Bohlmann, et al., Atmos. Chem. Phys., 2018

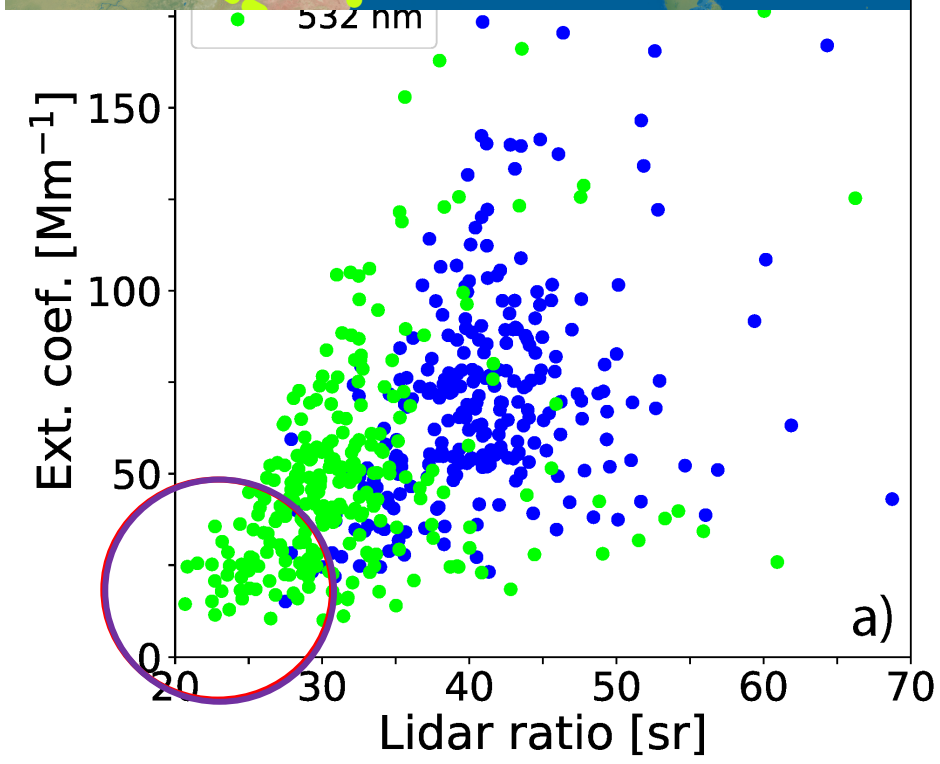


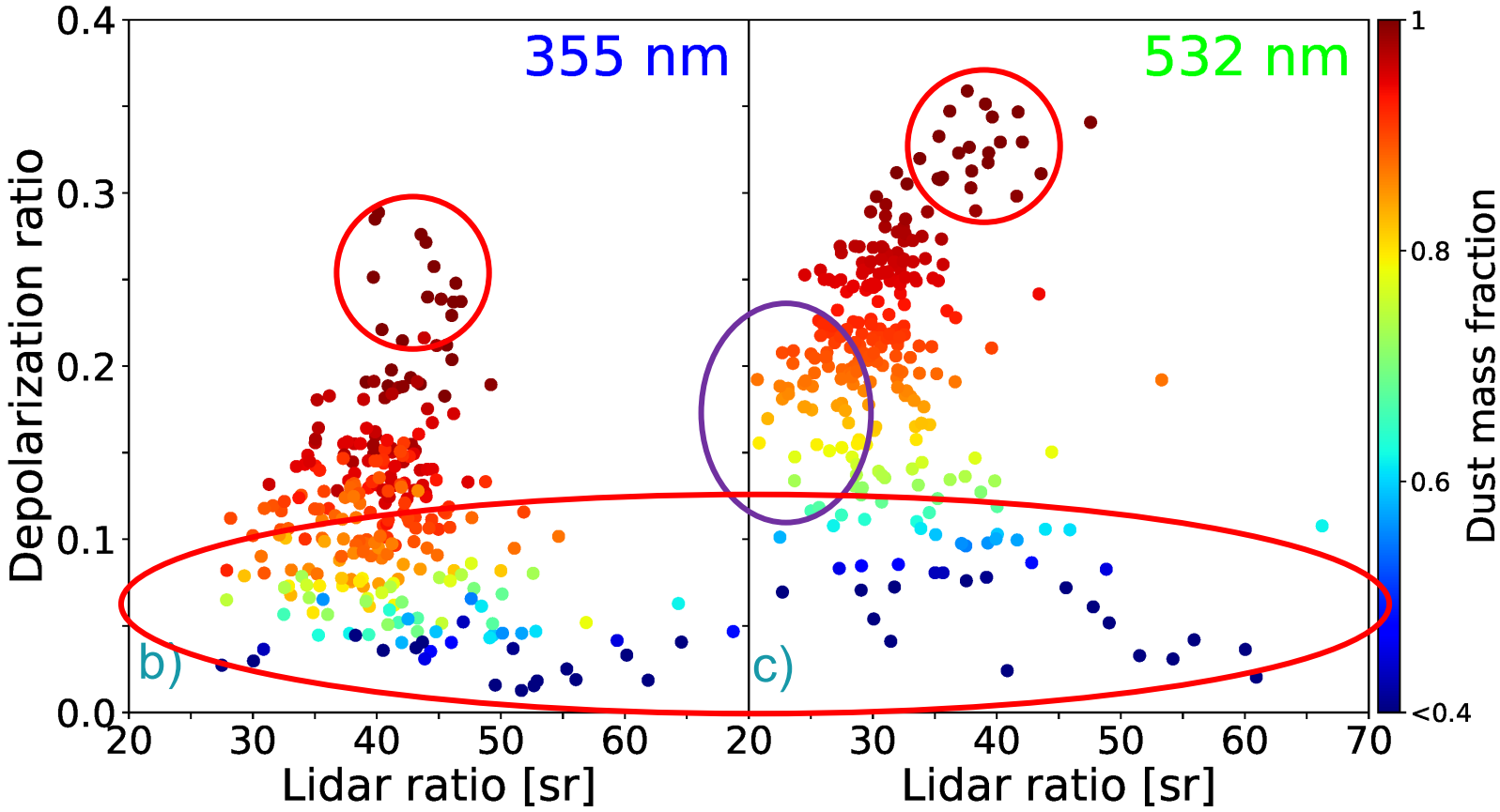
Mixture is relevant also in marine boundary layer

Dust belt

276 Layer-mean values in **Dushanbe**
Optical properties similar to dried sea salt (Haarig et al., 2017)
Salt dust? Remains open discussion!

Hofer et al., Atmos. Chem. Phys., 2020



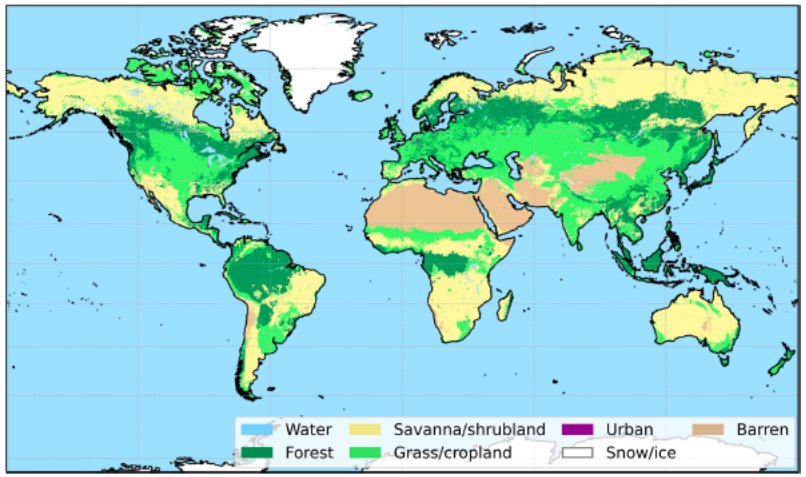


Backtrajectories for source identification

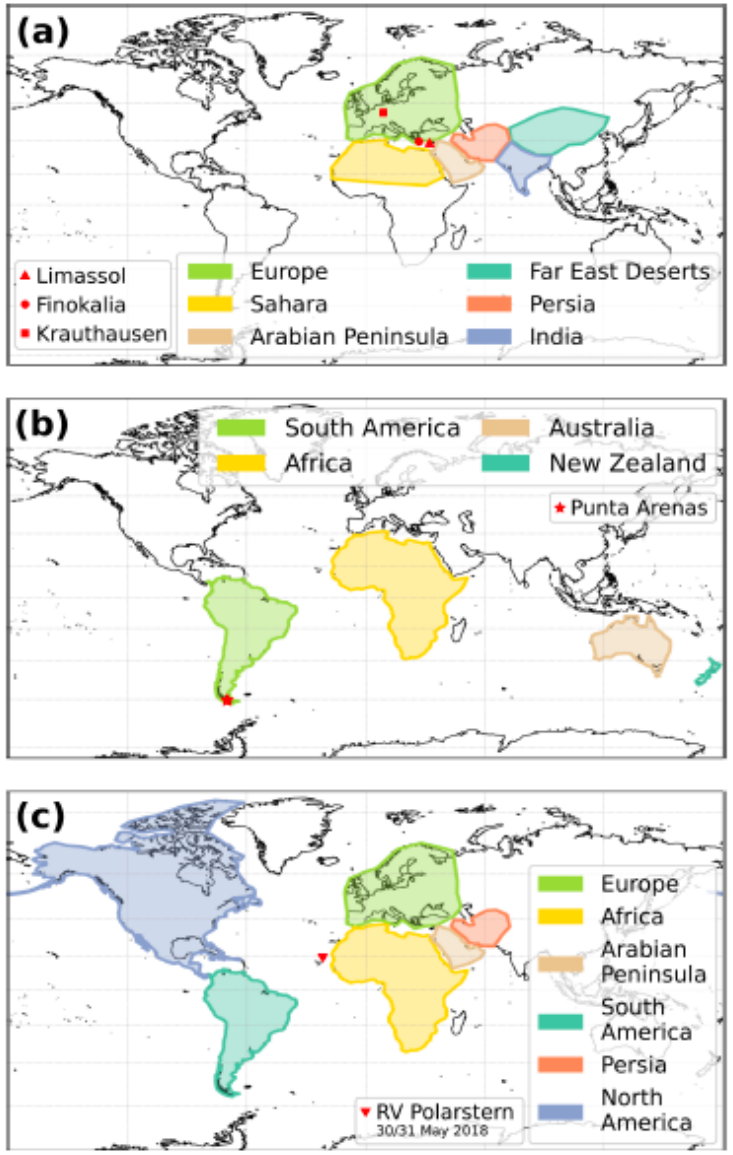
Typically used for observation interpretation and typing

Automatic tool reported in **Radenz et al., ACPD, 2021**

MODIS land cover classification

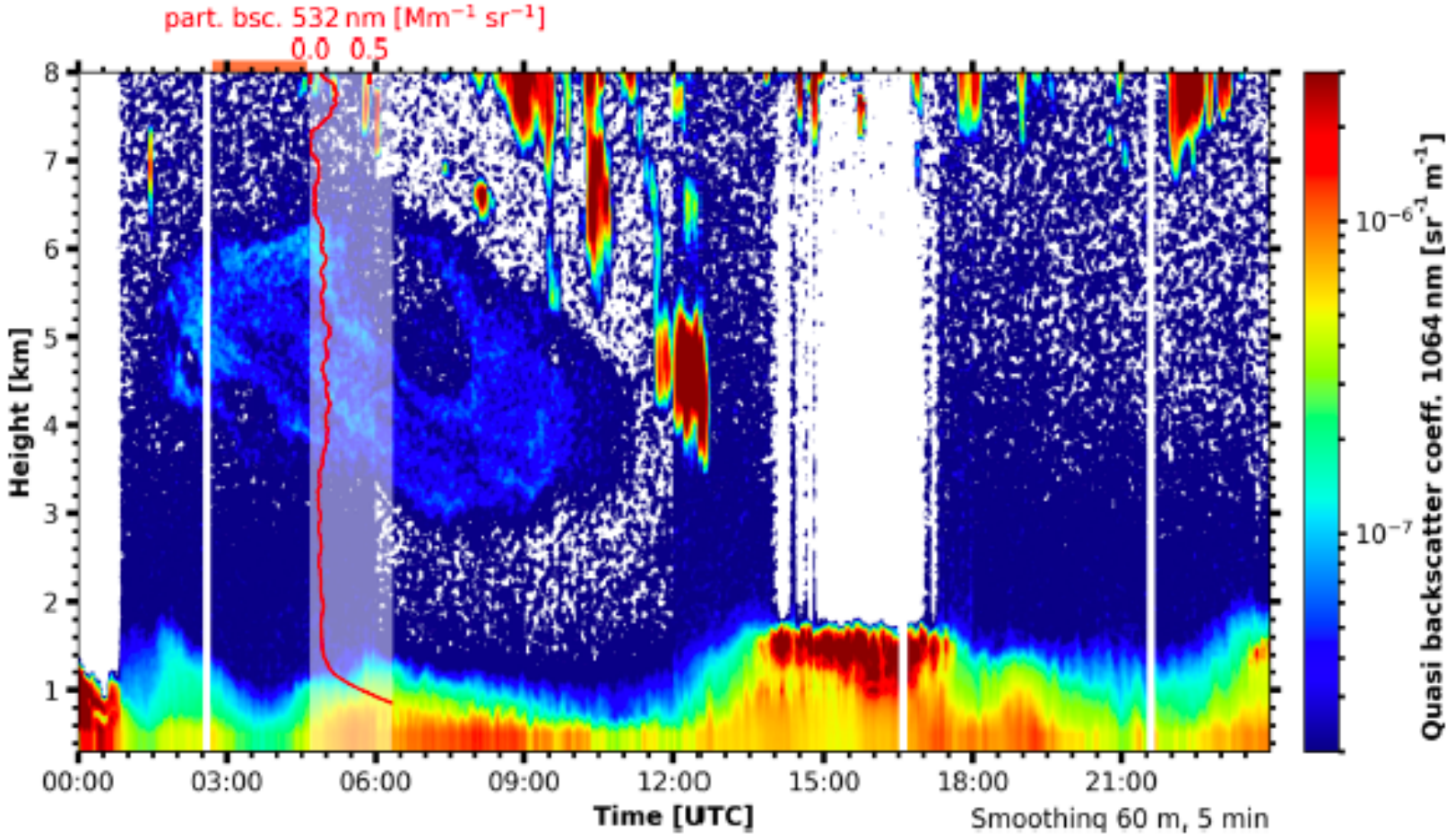


Custom defined geographical areas



Backtrajectories for source identification

Lidar obs 20 May 2019 in Punta Arenas (Chile)



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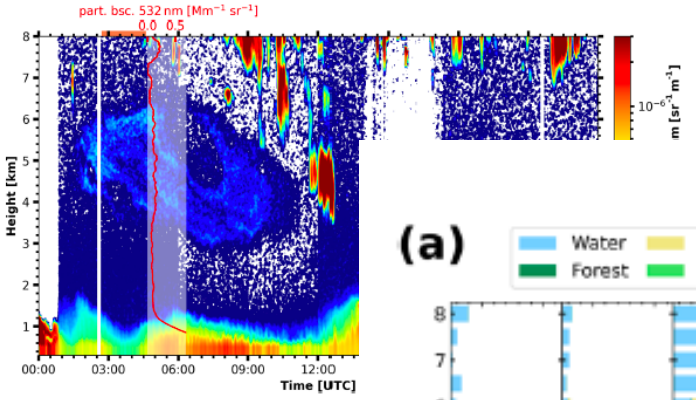

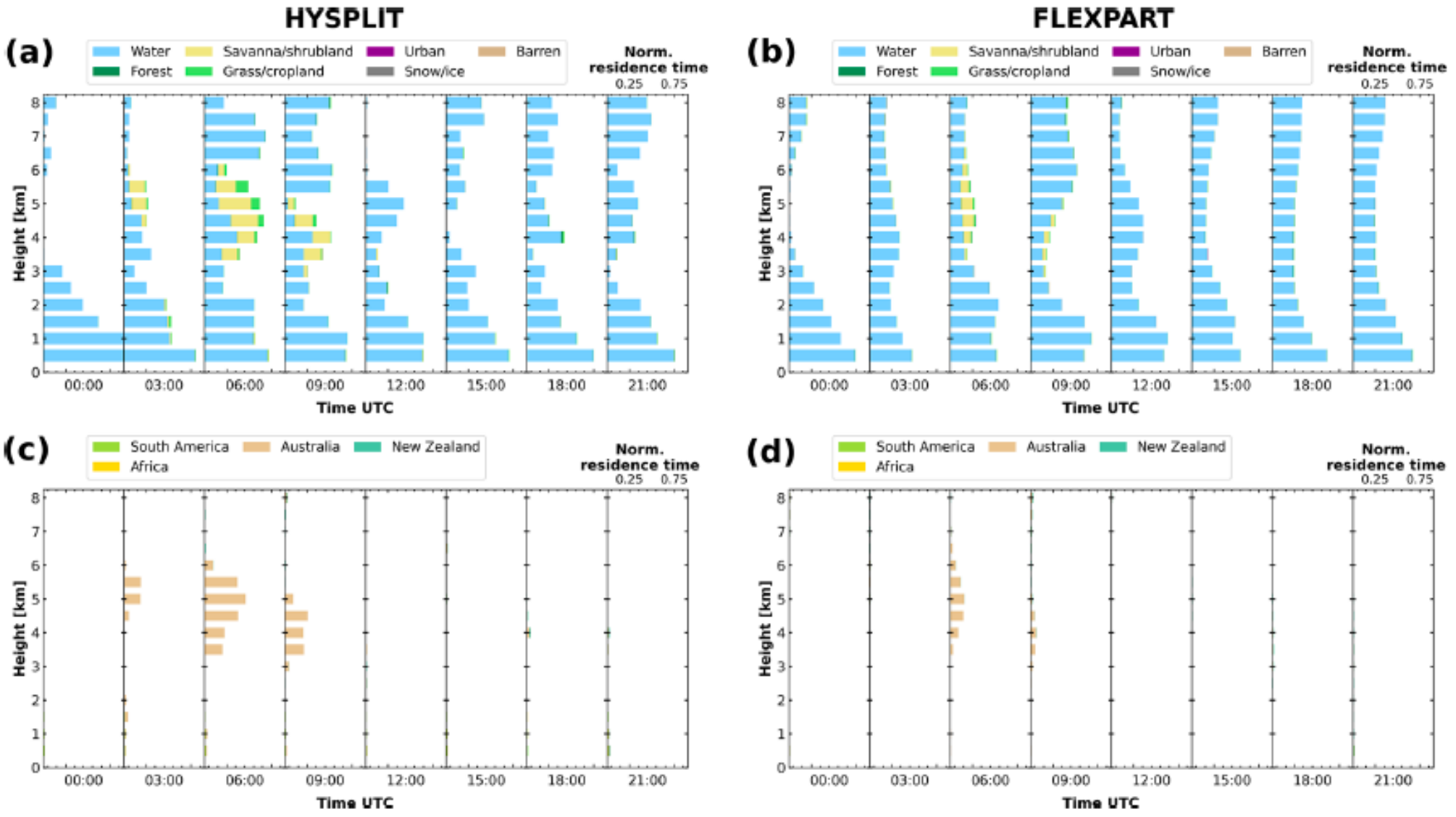

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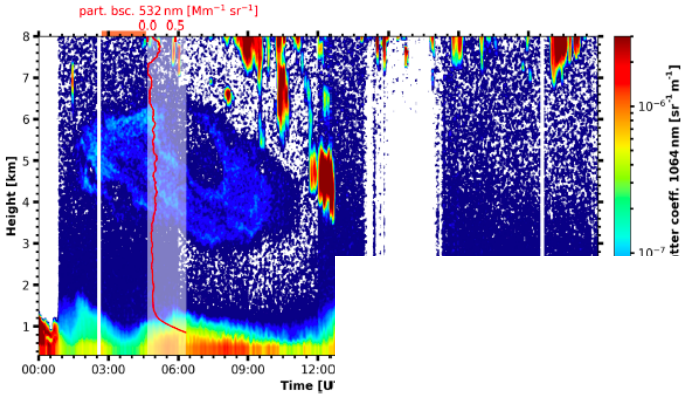

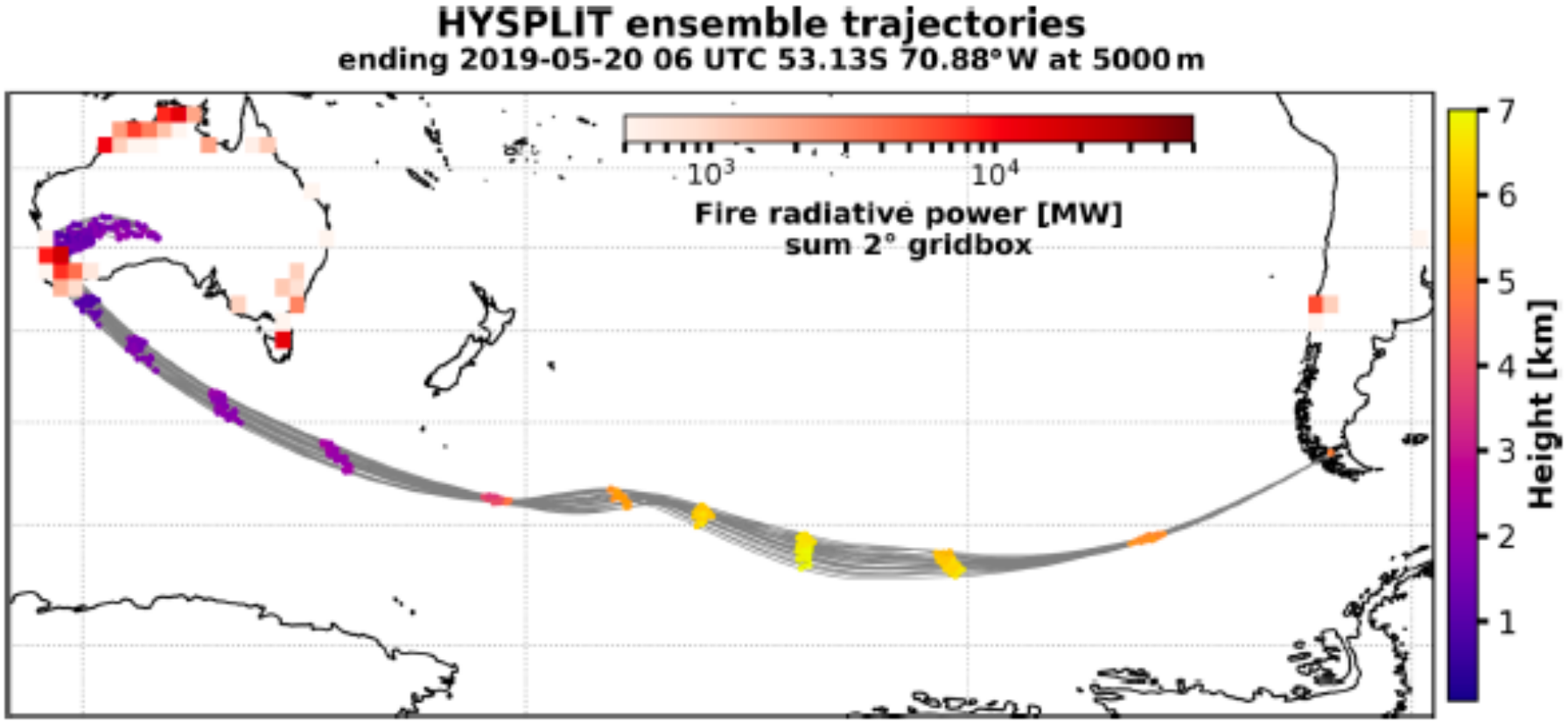

Backtrajectories for source identification

- Source code and data provided
- FLEXPART particle positions and HYSPLIT trajectories as input.
- With that setup, 1 d of air mass source estimate, with the resolution used in this study, can be processed in less than 1 h on a standard desktop computer (2.1 GHz processor; 4GB RAM; single-threaded).

Radenz et al., ACPD, 2021

Take home messages

Aerosol typing “guess” from lidar optical properties depends on: location, aging processes, algorithms relevant

Intensive optical properties have a natural variability because of differences at source, mixing and aging

Mixing has to be taken into account for marine BL

Backtrajectories could be useful for better guessing the type and lidar ratio values to be assumed even for satellite borne measurements.

Thank you for your attention