Characterization of Long-Range Transport of Aerosols over Austria

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FWF Der Wissenschaftsfonds.

INTRODUCTION

The long-range transport of aerosols over Austria is characterized using:

- Lidars
- Sunphotometers
- Aerosol transport models

The analysis is based on selected events of long-range transport of aerosols recorded over Central and South-Eastern Europe:

- Dust, case 1: 31.03.2014 - 4.04.2014
- Biomass burning, case 2: 19.07.2014 - 21.07.2014
- Continental aerosols
- Volcanic ash

using measurements from EARLINET [1] and AERONET [2] stations around Austria:

- Garmisch-Partenkirchen(Germany)
- Munich (Germany)
- Leipzig (Germany)
- Bucharest (Romania)

REMOTE SENSING INSTRUMENTS

Multiwavelength lidar systems (RALI: Bucharest, PollyXT: Leipzig, YALIS: Munich, HSRL: Garmisch)

- 3 elastic channels (nm): 1064, 532, 355
- 2 Raman channels (nm): 607, 387
- 1 depolarisation channel (nm): 532

Parameters:

- Backscatter coefficients
- Extinction coefficient
- Linear particle depolarization ratio profiles
- Mean values of layer intensive optical parameters:
  - Angstrom exponent
  - Color ratios
  - Color indexes

Sun Photometer - CIMEL (all stations, AERONET standard)

- Automatic sun and sky radiometer
- Spectral interference filters centered at wavelengths (nm): 340, 380, 440, 500, 670, 870, 1020 and 1640
- The filter band pass has:
  - 2 nm FWHM for the UV region
  - 10 nm FWHM for the visible region
  - 10 nm FWHM for the infrared region

Parameters:

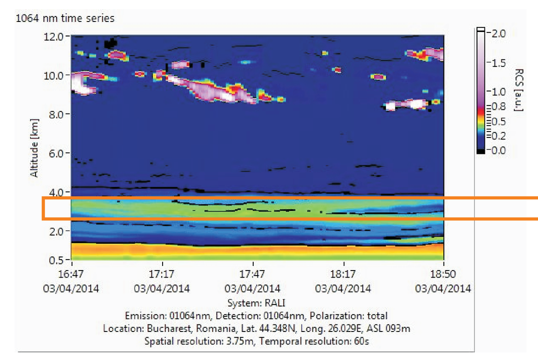
- AOD
- Angstrom exponent
- Aerosols size distribution

METHODOLOGY

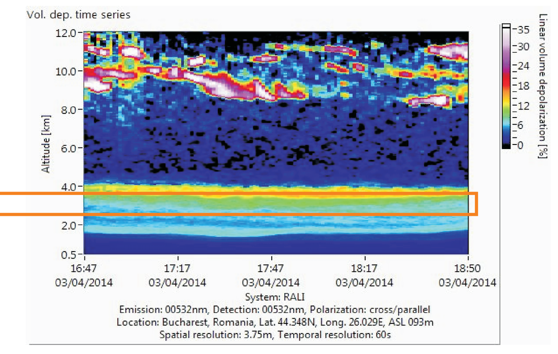
- Aerosol layers have been determined using a wavelet analysis applied to the lidar measurements [3]
- The optical properties of these aerosols have been also determined from lidar [4] and sunphotometer measurements
- The trajectories has been calculated with the FLEXTRA model
- The estimation of the potential areas of aerosols' sources has been performed using FLEXPART transport model [5, 6]
- Based on the spatial and temporal distributions of the trajectories, the main groups of trajectories have been identified using a cluster analysis
- The aerosol type at lidar stations was identified with NATALI algorithm [7]
- For aerosol typing over Austria, the aerosol classification from Calipso satellite data was used.

RESULTS

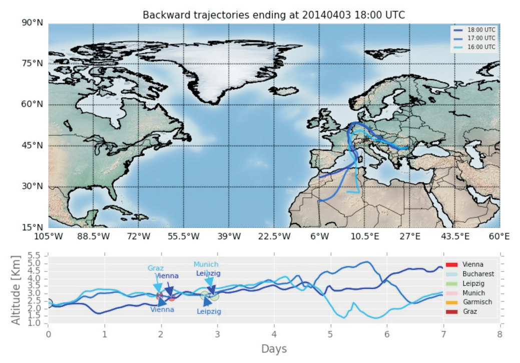
Case 1: 1 - 4 April 2014



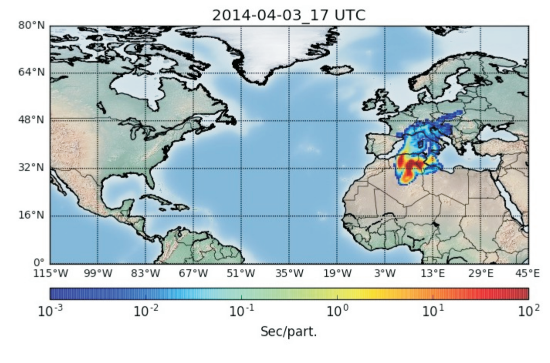
Lidar RALI Bucharest
time series of range corrected signal
aerosol layer: 2.5 - 4.0 km



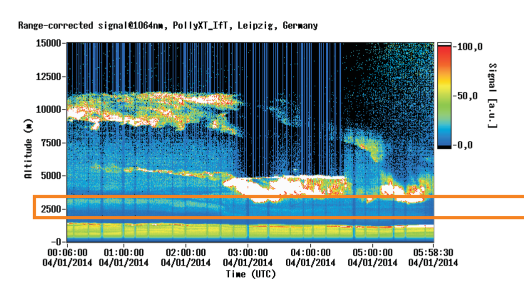
Lidar RALI Bucharest
time series of volume depolarisation ratio



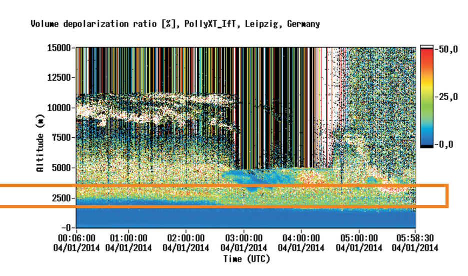
Flextra model: 7 days backward trajectories
starting from Bucharest station
time: 16:00 - 18:00 UTC



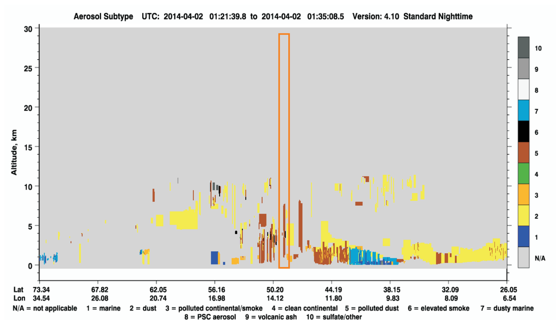
Flexpart column integrated (up to 25 km) of
source-receptor sensitivity, 17:00 UTC
aerosol layer: 2.5 - 3.5 km



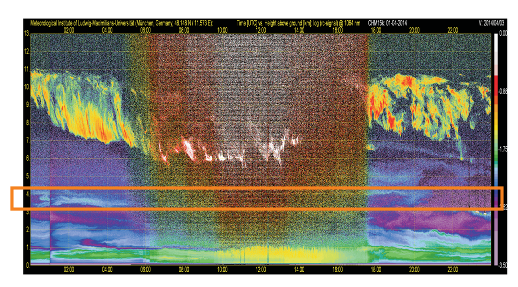
Lidar PollyXT Leipzig
time series of range corrected signal
aerosol layer: 2.5 - 3.5 km



Lidar PollyXT Leipzig
time series of volume depolarisation ratio



Calipso overpass Austria
aerosol typing: polluted dust and dust

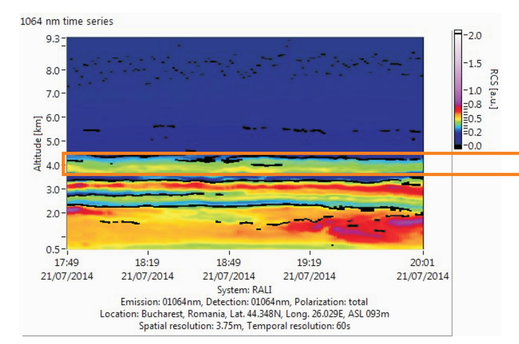


Ceilometer YALIS Munich
time series of range corrected signal
aerosol layer: 3.0 - 4.0 km

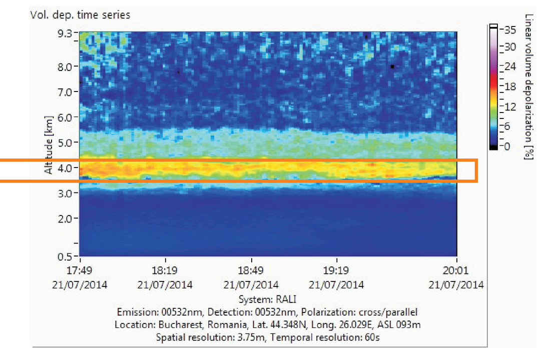
	Date	Hour	Layer [m]	AE_440-870	AOD	VolDep [%]	Type
Bucharest	2014-04-03	17:00	2500	0.56	0.42	20	Polluted dust
Vienna	2014-04-01	18:00	2800	NA	0.57	NA	Polluted dust
Leipzig	2014-04-01	01:00	2870	NA	NA	18	Polluted dust
Bucharest	2014-04-03	16:00	2500	0.59	0.42	15	Polluted dust
Munich	2014-04-01	00:00	3360	0.45	0.78	20	Dust
Graz	2014-04-01	17:00	2970	NA	0.57	NA	Dust

Aerosol type for selected EARLINET stations using NATALI algorithm
Aerosol type for Austria, using Calipso algorithm

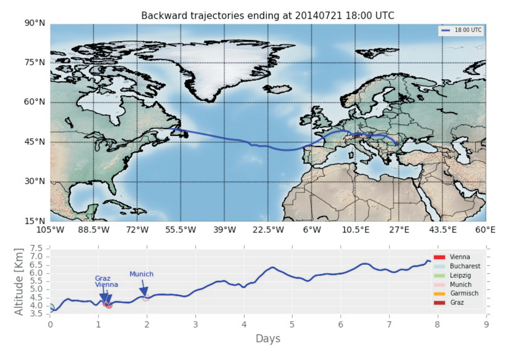
Case 2: 19 - 21 July 2014



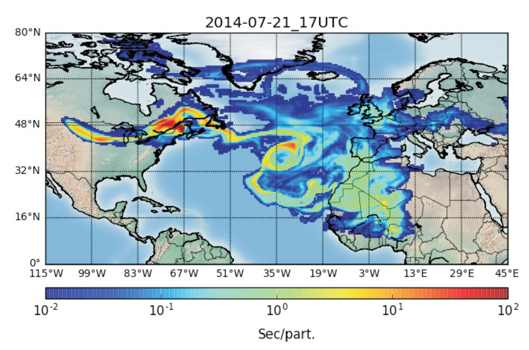
Lidar RALI Bucharest
time series of range corrected signal
aerosol layer: 3.5 - 4.5 km



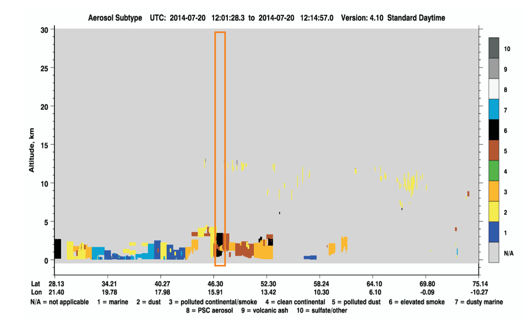
Lidar RALI Bucharest
time series of volume depolarisation ratio



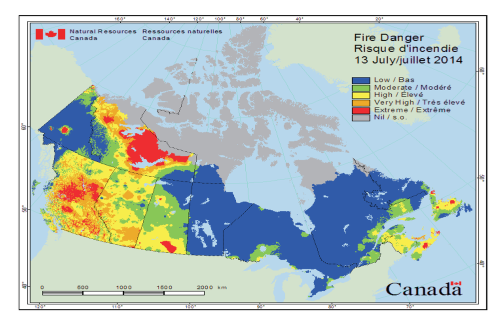
Flextra model: 8 days backward trajectories
starting from Bucharest station
time: 18:00 UTC



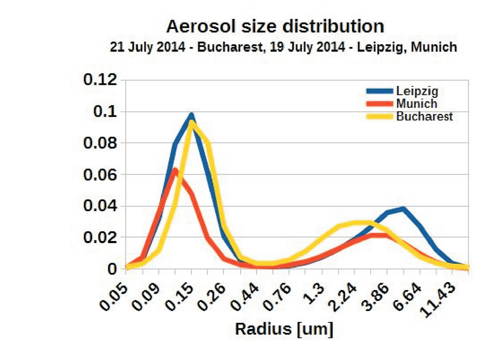
Flexpart column integrated (up to 25 km) of
source-receptor sensitivity, 17:00 - 18:00 UTC
aerosol layer: 3.5 - 4.5 km



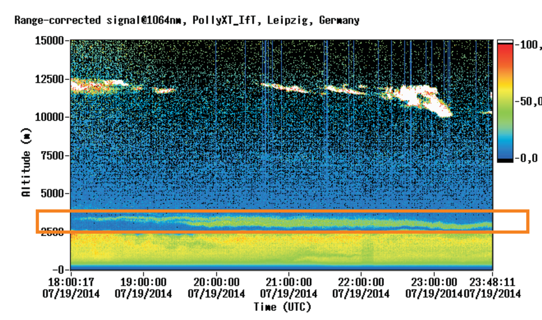
Calipso overpass Austria
aerosol typing: smoke and dust



Natural Resources Canada: Fire map



Bucharest, Munich, Leipzig AERONET stations:
Aerosols size distribution



Lidar PollyXT Leipzig
time series of range corrected signal
aerosol layer: 2.5 - 3.0 km

	Date	Hour	Layer [m]	AE_440-870	AOD	VolDep [%]	Type
Bucharest	2014-07-21	18:00	3884	1.77	0.31	15	Mixed smoke
Vienna	2014-07-20	16:00	4300	NA	0.26	NA	Smoke+Dust
Graz	2014-07-20	15:00	4350	NA	0.51	NA	Smoke+Dust
Munich	2014-07-19	18:00	4835	1.74	0.2	NA	Mixed smoke
Leipzig	2014-07-19	15:00	2500	1.74	0.37	12	Mixed smoke
Bucharest	2014-07-21	18:00	3000	1.77	0.31	8	Mixed smoke

Aerosol type for selected EARLINET stations using NATALI algorithm
Aerosol type for Austria, using Calipso algorithm

CONCLUSIONS

- The long-range transported aerosols over Austria in the two cases shown here originate mainly from Sahara (dust) and Canada (smoke), coming over Germany
- Case 1, Saharan dust: the aerosol layers and type determined from remote sensing measurements agree with layers computed with cluster analysis of Flextra back-trajectories and Flexpart source-receptor sensitivity (SRS) started from the last lidar station on the trajectory
- Case 2, smoke transported from Canada, eventually mixed with Saharan dust, is also well traced by the combination of remote sensing measurements and aerosol transport model (Flextra and Flexpart)
- The analysis of aerosols optical parameters determinated from remote sensing measurements confirms the presence of the dust aerosols for first case and the smoke aerosols mixed with dust for the second case

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