Characterization of the aging process of smoke observed over Austria using organic carbon mixing ratio

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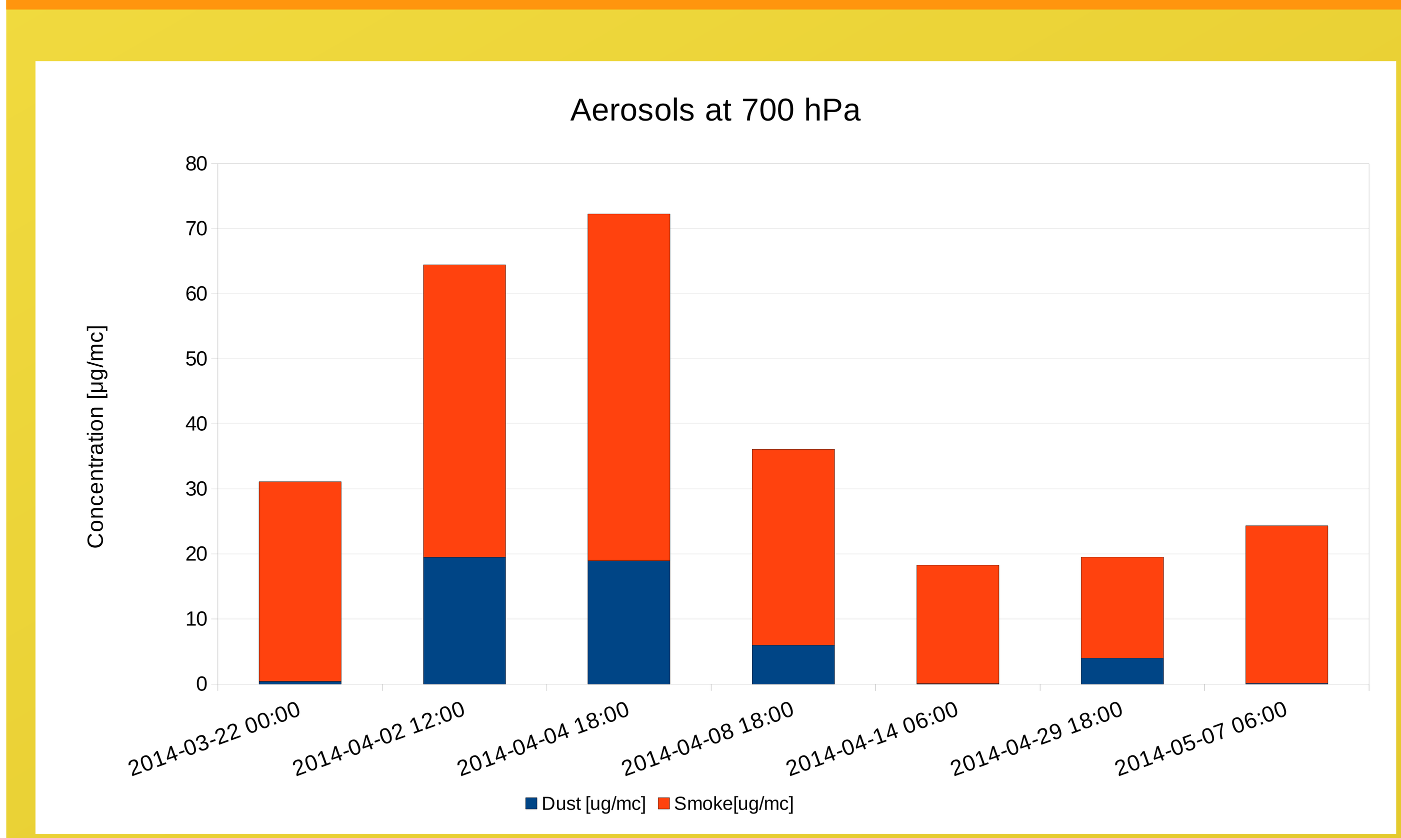
INTRODUCTION

The smoke from anthropogenic and natural sources consists mainly of a mixture of sulphates, black carbon (BC) and organic carbon (OC) [1]. In the atmosphere, most of the smoke is in the optically active accumulation mode.
In this paper, methods to characterize the smoke aging process based on organic carbon mixing ratio are presented.

METHODOLOGY

The study has been performed for Vienna (48.21°N, 16.36°E), using MACCIII reanalysis data at 700 hPa level from March – May 2014 for OC, BC and Sulphate. Seven cases of smoke were identified using a back-trajectories analysis based on Flexpart aerosol dispersion model [3] and linear particles depolarization (LPD).
The smoke is considered to have a small depolarization (less than 5%).
The optical properties for smoke were calculated using T-Matrix method for two wavelengths: 350 nm and 550 nm.
The aging process was determined using two methods: ratio of OC mixing ratio to BC mixing ratio (OC/BC), respectively ratio of OC mixing ratio to total mixing ratio (OC/T).
In order to estimate the aerosol ages, the result was compared with the ratio (RLR) of lidar ratio at 550 nm to lidar ratio at 350 nm [4]. RLR < 1 means fresh smoke and RLR >= 1 means aged smoke. The age of smoke is proportional to the growth of the RLR.

SELECTED CASES

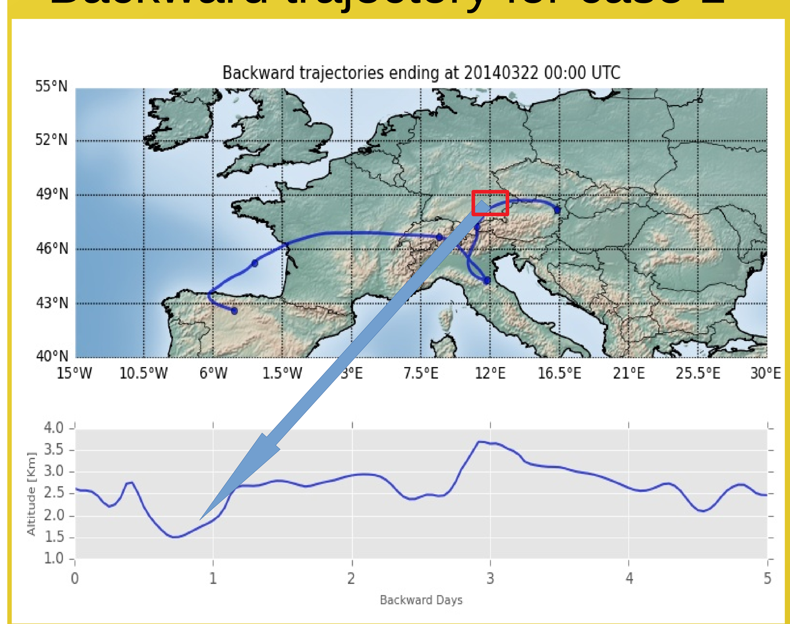


Cases of smoke over Vienna in Spring 2014

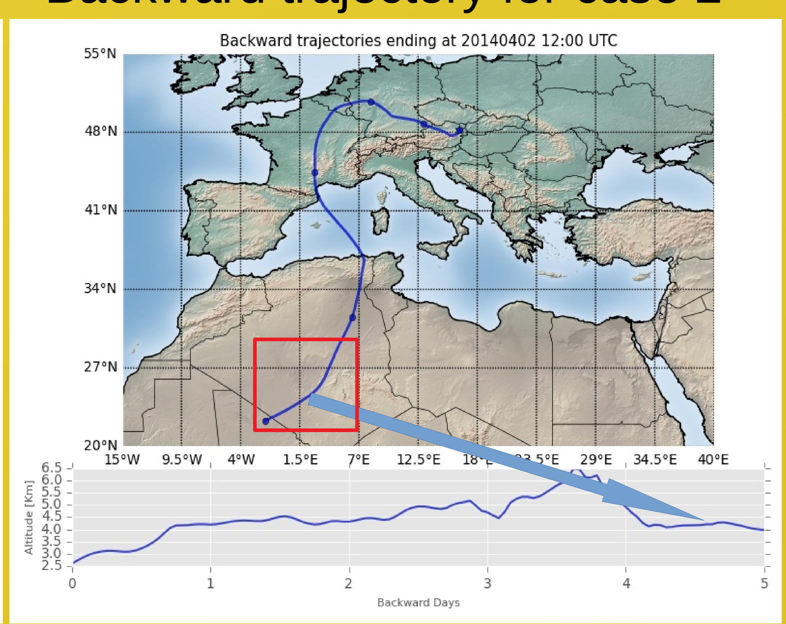
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Date	22 March	02 April	04 April	08 April	14 April	29 April	07 May
Time [UTC]	00:00	12:00	18:00	18:00	06:00	18:00	06:00
AOD	0.31	0.83	0.56	0.74	0.32	0.35	0.44
LPD350 [%]	3.9	4.6	0.1	4.8	4.3	2.5	4.7
LPD550 [%]	1.5	1.7	<0.1	2.8	2.8	1.7	2.6
Source	Austria	North Africa	North America	North America	West Europe	NE Europe	North America
Age	1 Days	4-5 Days	6 Days	4-5 Day	2 Days	2 - 3 Days	> 6 Days

RESULTS

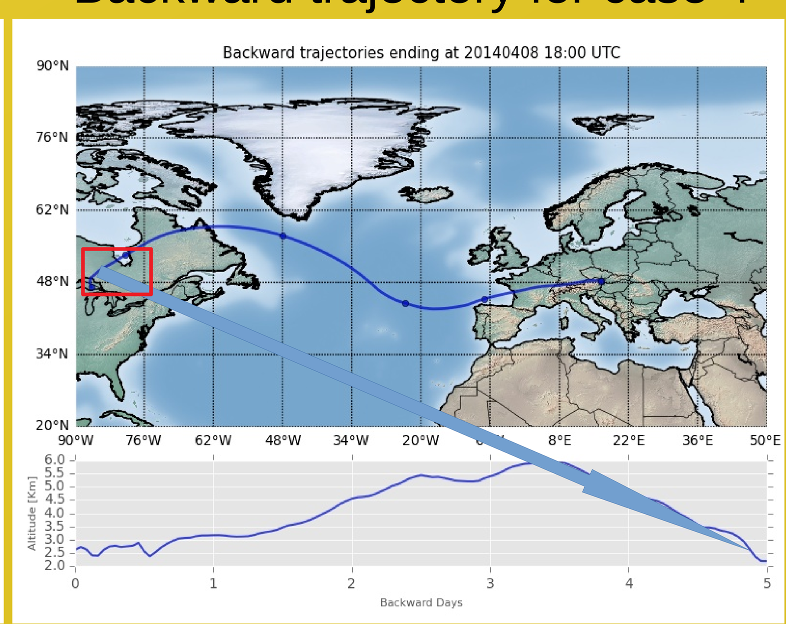
Backward trajectory for case 1



Backward trajectory for case 2



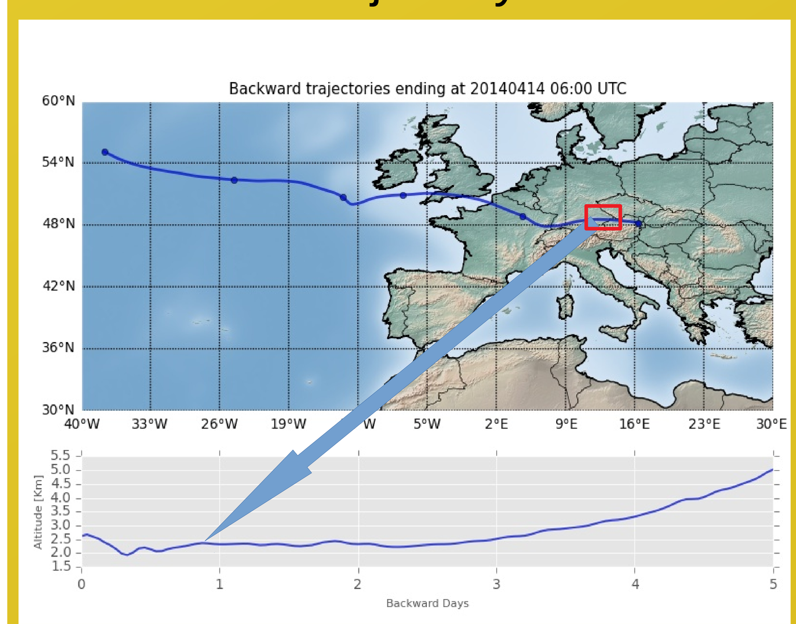
Backward trajectory for case 4



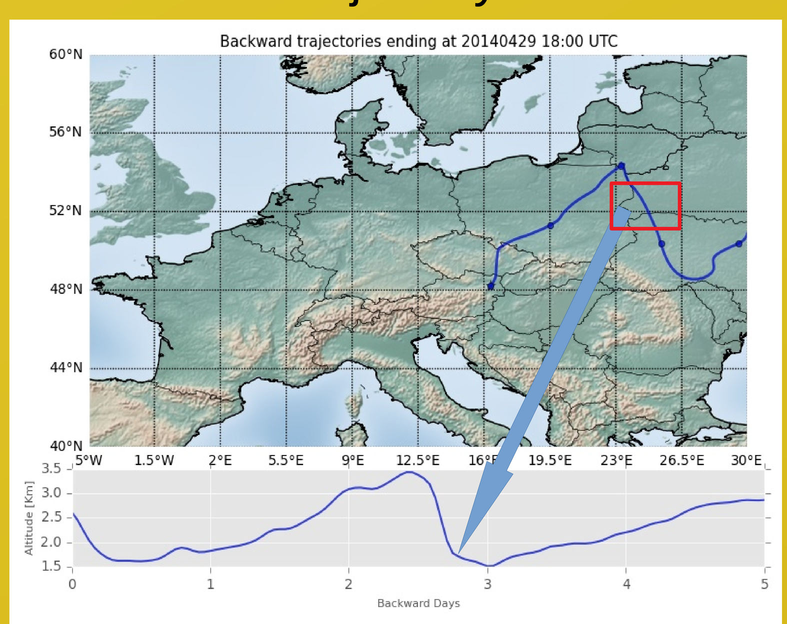
Aerosols properties at 50% relative humidity

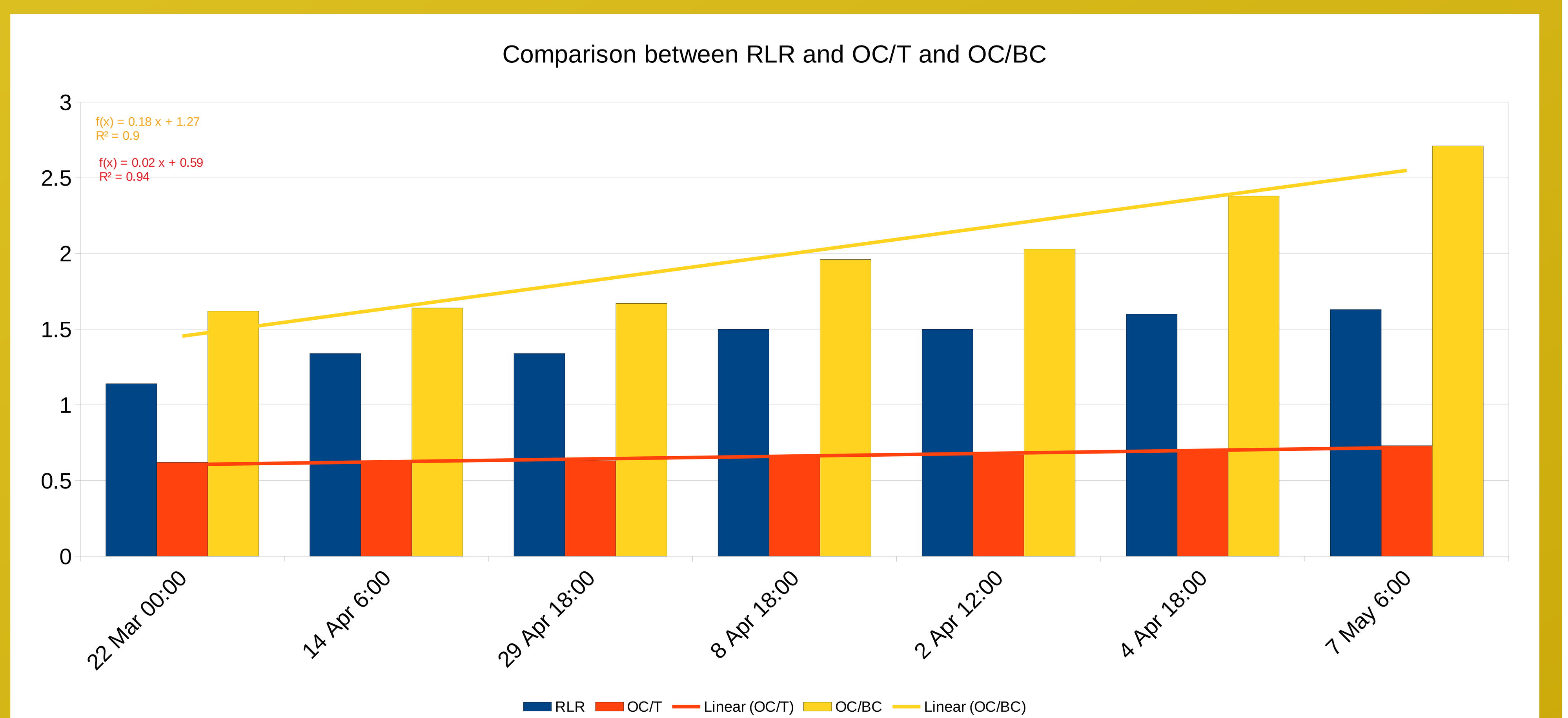
Case	LR350 [sr]	LR550 [sr]	Radius [µm]	AE
1	42 ± 9	48 ± 10	0.38 ± 0.09	1.4 ± 0.2
2	36 ± 8	54 ± 11	0.39 ± 0.09	1.3 ± 0.1
3	45 ± 9	72 ± 15	0.33 ± 0.05	1.1 ± 0.1
4	50 ± 10	75 ± 15	0.41 ± 0.11	1.8 ± 0.2
5	53 ± 11	71 ± 14	0.37 ± 0.09	1.4 ± 0.1
6	91 ± 18	122 ± 20	0.40 ± 0.10	1.2 ± 0.1
7	50 ± 10	79 ± 16	0.40 ± 0.10	1.1 ± 0.1

Backward trajectory for case 5



Backward trajectory for case 6





CONCLUSIONS

1. Two methods to characterize the smoke aging process based on mixing ratio were presented: OC/BC and OC/T
2. The results shows that the age of aerosols liniar increases with increasing content of OC.
3. We obtained a good correlation between RLR method and both methods:
   - 0.91 corelation factor for OC/BC method
   - 0.87 corelation factor for OC/T method

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