Identification of odour sources in the Ore Mountains by COSMO-MUSCAT simulations

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Outline

- **Introduction**
- **Methods and used models**
  - Trajectory model (*COSMO-LAGRANTO*)
  - Lagrangian particle model (*COSMO-LaPaSi*)
  - Chemistry transport model (*COSMO-MUSCAT*)
- **Analysis of selected periods**
  - **25./26. January 2018**
  - *14./15. February 2018*
  - *19. + 21. January 2017*
- **Conclusions**

Sändig 2012

Ore Mountains (Erzgebirge)

- Power plants and chemical industry in the Bohemian Basin
- Domestic heating often by wood burning; wood processing (carving, painting, furniture industry) in the Erzgebirge region

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Motivation

- Problem
  - At about 20 days per year the inhabitants of the Ore Mountains suffer under odour nuisance.
  - This odour is very special and penetrant - “Katzendreck”.
- Questions
  - ***What’s the source of the odour?***
  - ***Which substances (mercaptans, thioether, other smelly VOC,…) causes the odour?***
- “Long history”
  - C. Gerlach (Forest journal SILVA, 1922): recognised strong “industrial” odour
  - Several odour programs with selected probands (1988, 2001/2002)
  - Additional measurements (stack emissions, benzol, H2S, …)
  - EU Project OdCom (Geruchsereignisse und Gesundheit im Grenzgebiet Sachsen-Tschechien, 2016-2019): *substances, sources, health effects?*
  - Model studies (FU Berlin, 2003; TROPOS 2012/13 **+ *2018***)

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Motivation

- Search for possible polluters
  - Exclusion of ineligible sources
  - Limitation to possible source regions
- Investigation of the propagation paths in the complex orography of the Ore Mountains
- Investigation of the height dependency of the pollutant propagation
  - Different heights of sources
  - Vertical concentration profiles at the observation sites during odour detection
- Complaints from citizens via hotline of LfULG (odour protocol) and, additionally, reports of trained probands
- Earlier studies: complaints especially during winter inversion weather conditions and low wind from southern directions

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Odour protocol

Nr.	Datum	Zeitraum	Orte mit Geruchsbelastung	Trajektorien, Tracer	Kategorie
1	05.01.10	Vormittag	Zinnwald	BWT	SW
2	06.01.10	Vormittag	Johanngeorgenstadt	BWT	SO
3	20.01.10	Vormittag	Marienberg, Rübenau, Reitzenhain, Kühnhaide, Geringswalde, Pobershau	BWT	SO
4	22.03.10	ca. 21 - 22.00 Uhr	Oberwiesenthal, Hammerunterwiesenthal, Neudorf	BWT, FWT (Höhenschichten)	SO
5	26.03.10	ca. 9 - 14.00 Uhr	Seiffen, Olbernhau, Neuhausen	BWT	SO
6	23.04.10	ca. 3.30 -7.00 Uhr	Neuwernsdorf	BWT	SO
7	06./07.06.10	Nachtstunden	Jöhstadt	BWT	DIFF
8	05.09.10	ab Vormittag	Seiffen	BWT	SO
9	23.09.10	Vormittag	Seiffen, Neuhausen	BWT	SO
10	23.09.10		Schöneck	BWT	SO
11	02./03.10.10	Mitternacht	Zwota, Klingenthal, Plauen	BWT, FWT (flächendeckend)	SO
12	04.10.10	Abend	Auerbach, Rautenkranz	BWT	SO
13	05.10.10	07.00 - 09.00	Zwota	BWT	SO
14	05.10.10	12.00 - 14.00	Auerbach	BWT	SO
15	13.10.10	Vormittag	Seiffen, Neuhausen	BWT	SO
16	19.10.10	ca. 7.00 bis 11.00	Crottendorf, Seiffen	BWT	SW
17	02.11.10		Bad Brambach	BWT	WDIFF
18	09.11.10	ganztägig	Olbernhau, Arnsfeld, Jöhstadt	BWT	DIFF
19	10.11.10	Mittag bis Abend	Neuwernsdorf, Pockau, Halsbrücke, Olbernhau, Marienberg, Lauterbach, Annaberg, Arnsfeld, Sayda, Jöhstadt, Seiffen, Grumbach, Bärenstein, Hammerunterwiesenthal, Crottendorf, Sehmatal, Königswalde, Aue, Schneeberg, Kühnhaide	BWT, FWT (Havarie Vrsova), Tracer	SW
20	11.11.10	Nachmittag	Olbernhau, Jöhstadt, Annaberg, Königswalde, Oberwiesenthal, Sehmatal	BWT	SW
			Scheibenberg, Markersbach		

56	26.05.11	ab 8:00	Seiffen	BWT	DIFF
57	30.05.11	ab 8:00	Seiffen, Neuhausen	BWT	SO
58	31.05.11	08:00	Seiffen	BWT	SO
59	29.06.11	-	Zinnwald	BWT	DIFF
60	12.07.11	08:00	Seiffen	BWT	SO
61	14.07.11	ab 20:00	Seiffen	BWT	SW
62	25.07.11	früh	Seiffen	BWT	SW
63	26.07.11	vormittag	Neuhausen	BWT	SO
64	02.08.11	nachmittags	Schwartenberg/Neuhausen/Seiffen	BWT	SO
65	03.08.11	abends	Seiffen	BWT	SO
66	05.08.11	nachts	Seiffen	BWT	SW
67	06.08.11	früh, vormittag	Seiffen	BWT	SO
68	13.08.11	gegen 01:00	Seiffen	BWT	W
69	14.08.11	früh 5:00	Seiffen	BWT	SW
70	18.08.11	08:00	Seiffen	BWT	SO
71	21.08.11	früh 4:30	Seiffen	BWT	SO
72	01.09.11	früh 3:30	Seiffen	BWT, FWT (Havarie Litvinov), Tracer	SO
73	05.09.11		Erlbach (Markneukirchen)	BWT	W
74	06.09.11	14-15 Uhr	Seiffen	BWT	SW
75	09.09.11	früh	Olbernhau	BWT	W
76	11.09.11	ab 8:00	Seiffen	BWT	SO
77	16.09.11	Mittag	Seiffen	BWT	SO/DIFF
78	17.09.11	Mittag	Seiffen	BWT	DIFF
79	18.09.11	früh	Seiffen	BWT	SO
80	29.09.11		Schwartenberg	BWT	DIFF
81	14.10.11		Seiffen		
82	15.10.11		Seiffen		
83	16.10.11		Seiffen		
84	17.10.11	früh bzw. abends/nachts	Seiffen		
85	19.10.11	früh bzw. abends/nachts	Seiffen, Haselbach		
86	22.10.11	früh bzw. abends/nachts	Seiffen, Olbernhau, Haselbach		
			Seiffen, Olbernhau, Neuhausen		

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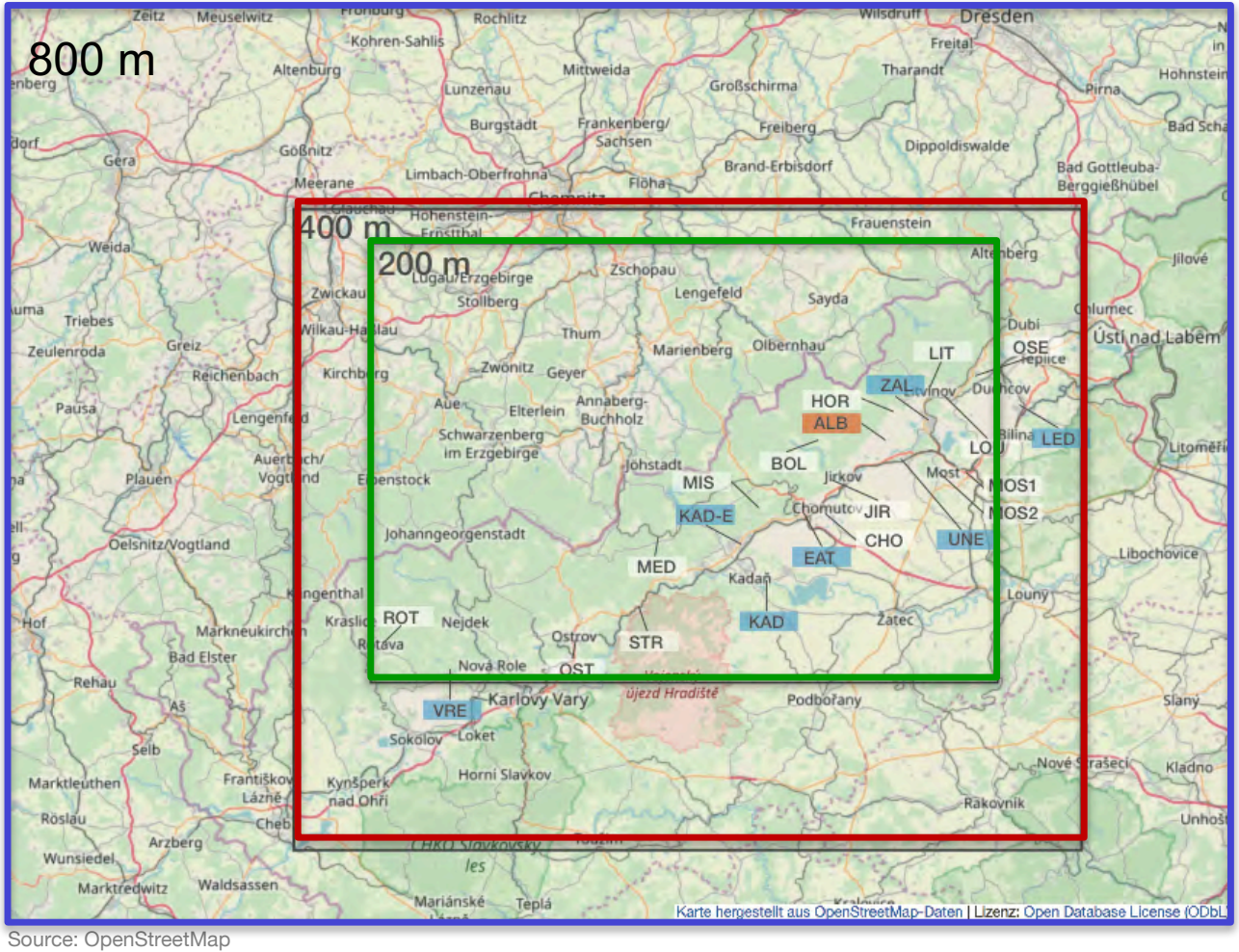
Model domains and tracer sources



Source: OpenStreetMap

Power plants / industry

Hypothetical Sources

Open pit mining

Domain Resolution

- 800 m
- 400 m
- 200 m

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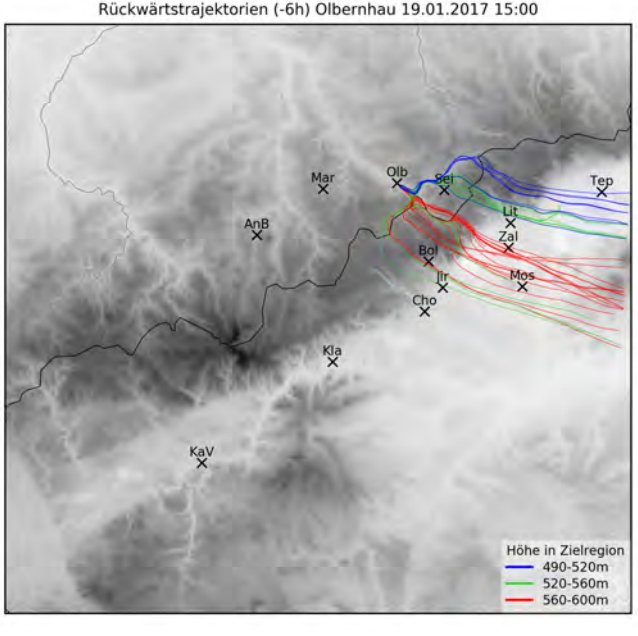
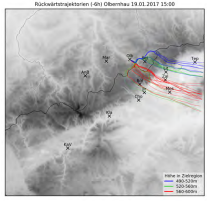
Methods: highly resolved model simulations

- “Usual”: Backward trajectories from COSMO-LAGRANTO (offline) (*Miltenberg et al., 2013*)
  - Runs for all proband reports
  - Narrow down to possible emission regions

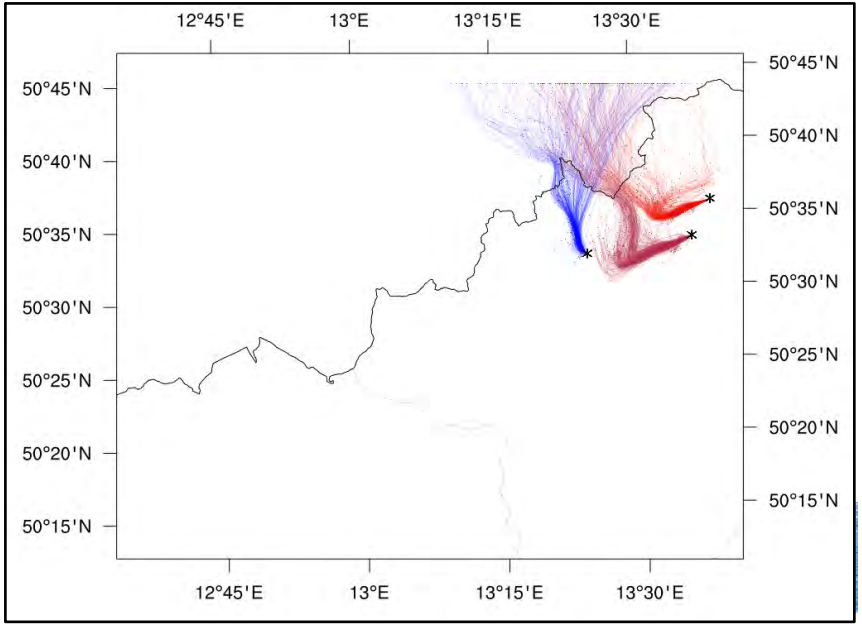


TROPOS

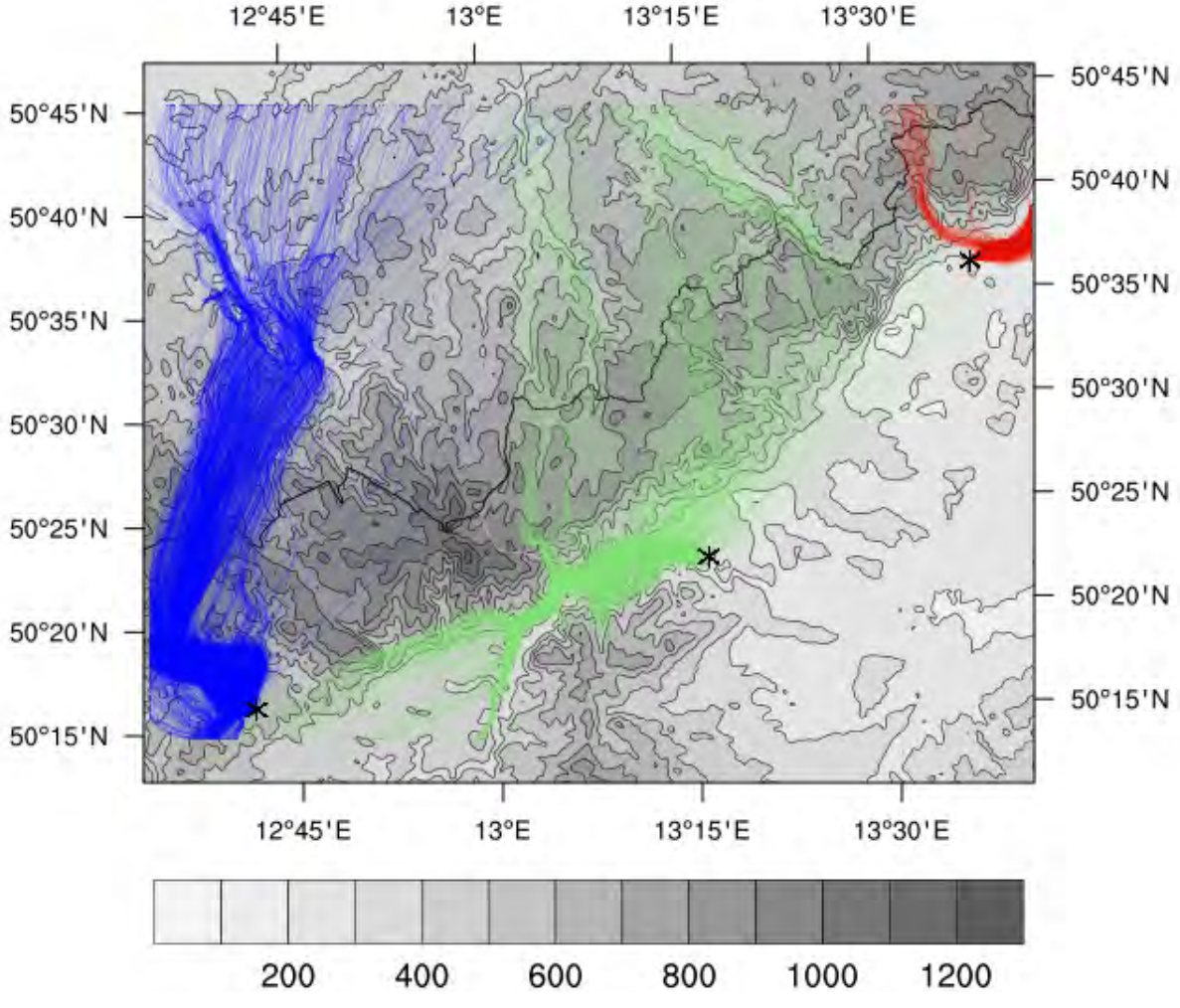
Methods: highly resolved model simulations



- Backward trajectories from LAGRANTO
  - Runs for all proband reports
  - Narrow down to possible emission regions
- Lagrangian particle propagation with COSMO-LaPaSi (*Faust, 2017*)
  - Forward trajectories + random scattering
  - Runs for selected sources



200m


12°45'E
13°E
13°15'E
13°30'E
50°45'N
50°40'N
50°35'N
50°30'N
50°25'N
50°20'N
50°15'N
200
400
600
800
1000
1200

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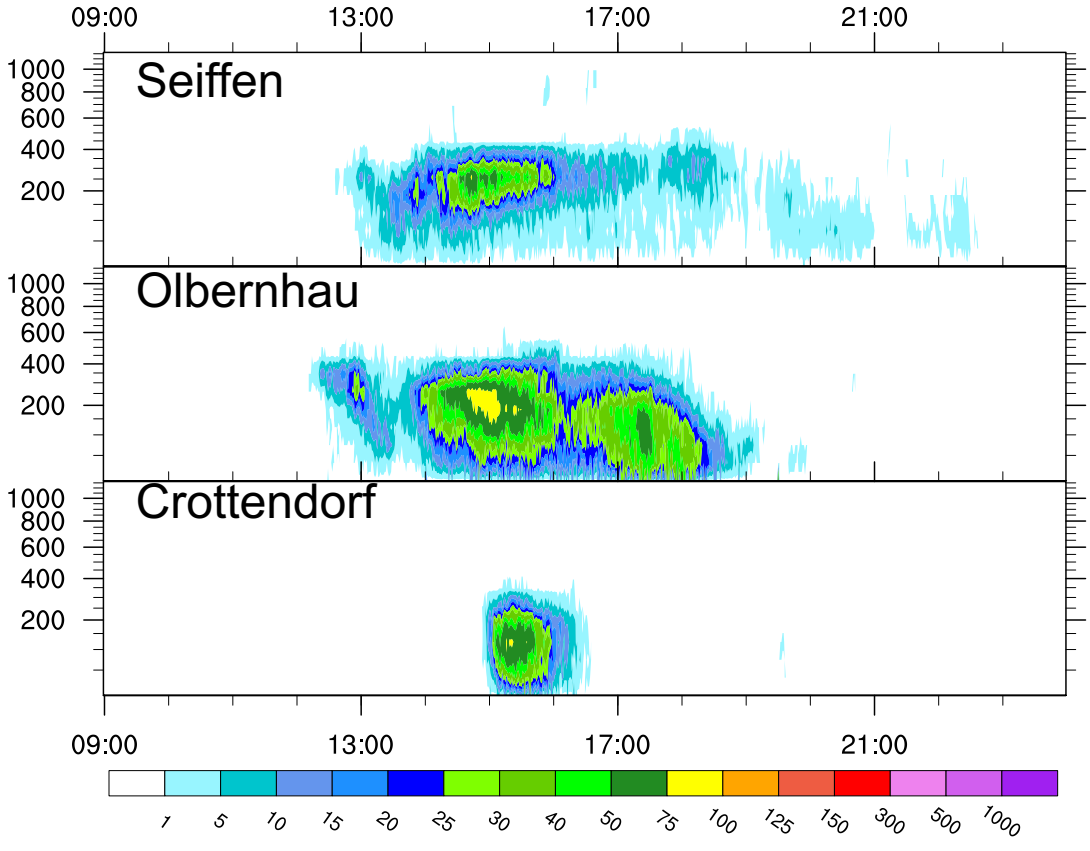
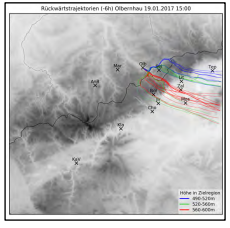
Vertical profiles

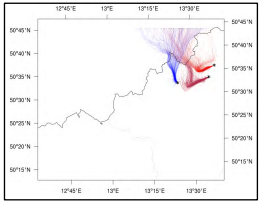


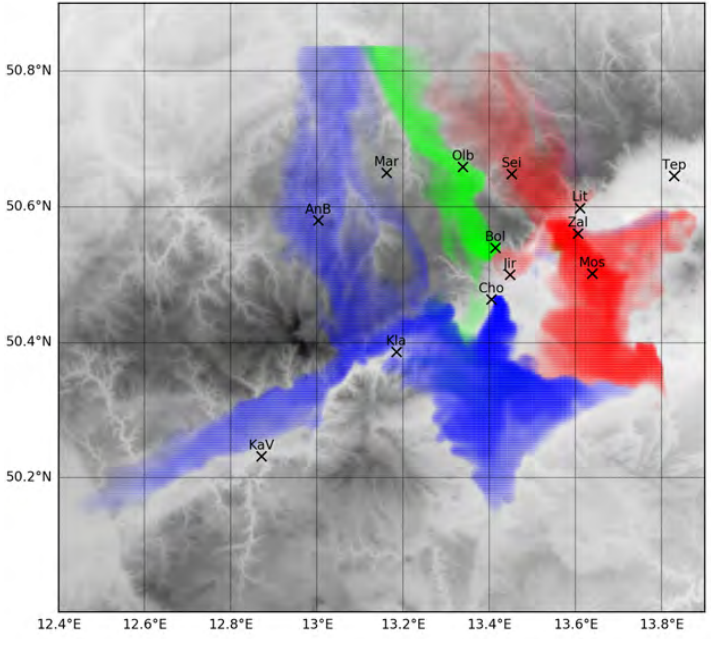
TROPOS

Methods: highly resolved model simulations

- Backward trajectories from LAGRANTO
  - Runs for all proband reports
  - Narrow down to possible emission regions
- Lagrangian particle propagation with COSMO-LaPaSi (*Faust, 2017*)
  - Forward trajectories + random scattering
  - Runs for selected sources
- Tracer simulations with COSMO-MUSCAT
  - Establish source-receptor relationship
  - Investigation of 37 different sources
  - Sources at different heights (e.g. chimneys)

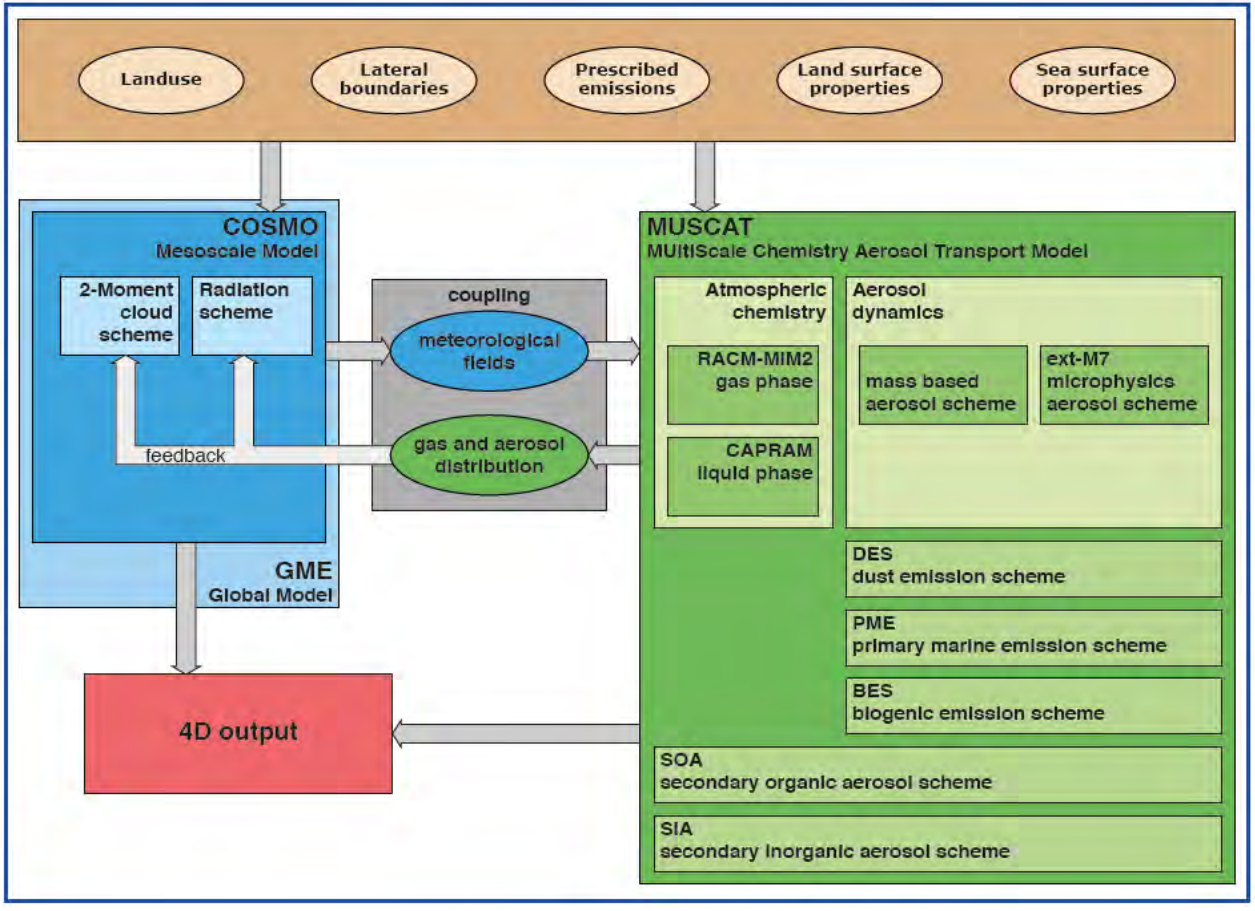






Chemistry Transport Model System COSMO-MUSCAT

- Developed and applied for air quality modelling and process studies at TROPOS
- “Labelling approach” for source appointment of different source regions and emitter groups (*Chen et al., 2018*)
- In addition, the mass flows for selected reaction paths can be visualized and analysed. (*Schrödner, 2016*)



June 2019

https://cosmo-muscat.tropos.de/

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25. & 26. Jan 2018 – Meteorological characterization

- Stable stratification
- Often foggy in the North Bohemian Basin and at high altitudes, sporadic drizzle
- Vertical mixing close to the ground
  - On 25. Jan 2018 often <100m
  - On 26. Jan 2018 to over 300m
- Low wind speed in the valleys of the North Bohemian basin (max. 10 km/h), strong wind at high altitudes (> 40 km/h)
- Wind direction
  - On 25. Jan 2018: initially from SW, after 18:00 from SO
  - Wind turns during the 26. Jan 2018 to N
- Model results are in agreement with available measurements!

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25. & 26. Jan 2018 – Proband reports

Date; Time	Location
25.01.2018 06 – 24 Uhr	Seiffen
25.01.2018 07:40 – 10 Uhr	Steinhübel
25.01.2018 09-21 Uhr	Litvinov
25.01.2018 17-22 Uhr	Olbernhau
25.01.2018 18:15 – 23 Uhr	Sayda
26.01.2018 00 - 10 Uhr & 17 - 24 Uhr	Olbernhau
26.01.2018 05 – 15 Uhr	Seiffen
26.01.2018 06 – 10 Uhr	Sayda
26.01.2018 07 – 08 Uhr	Steinhübel

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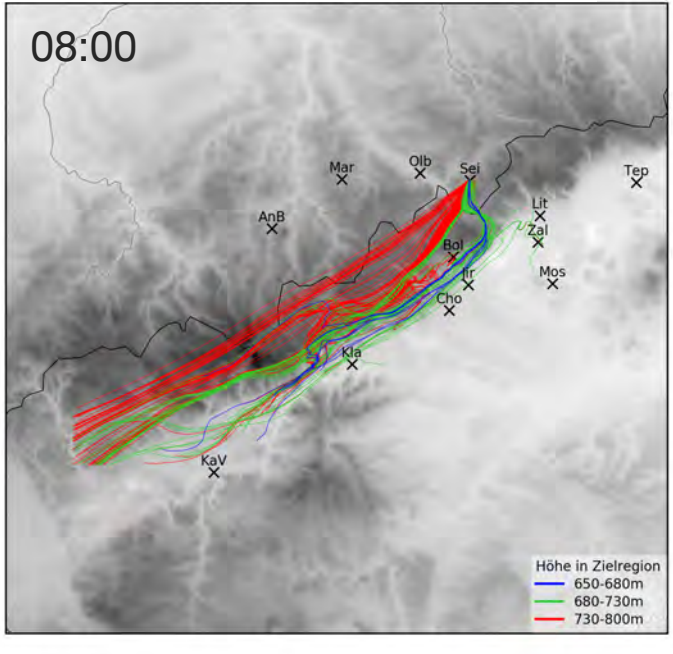
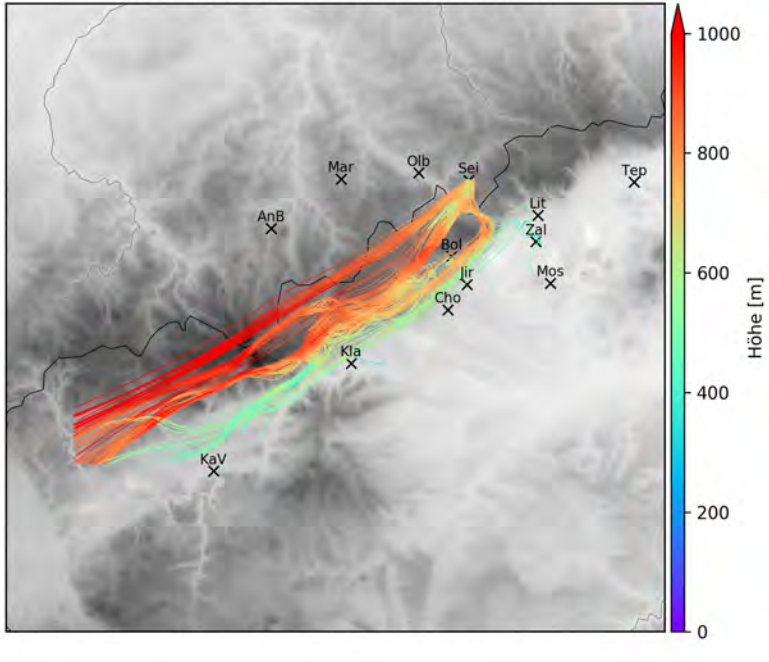
Backward trajectories: Seiffen 25. Jan 2018

Proband reports: 6:00 – 24:00

Altitude at observation site



Current altitude



TROPOS

Backward trajectories: Seiffen 25. Jan 2018

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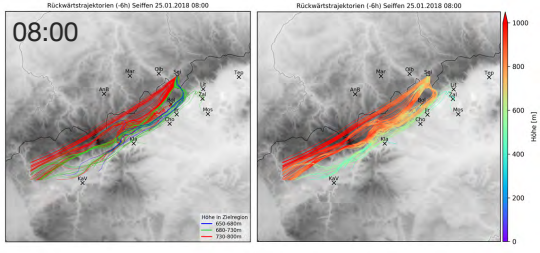
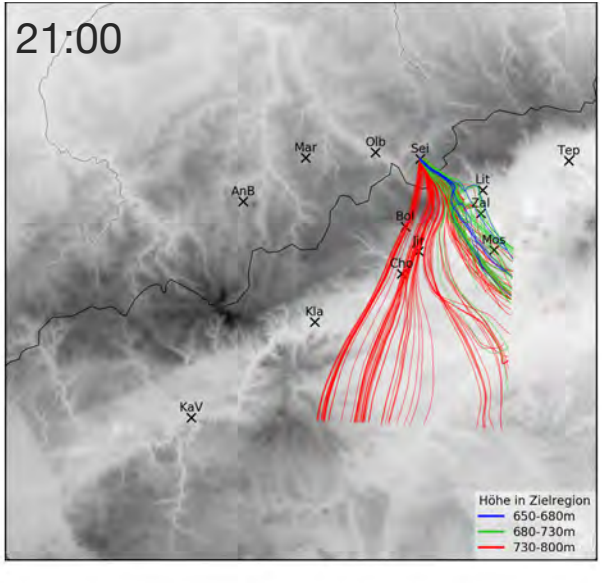
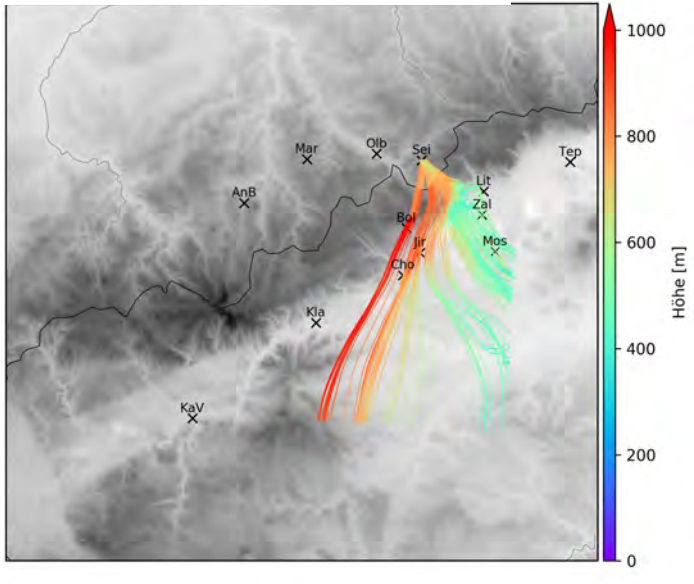


Altitude at observation site



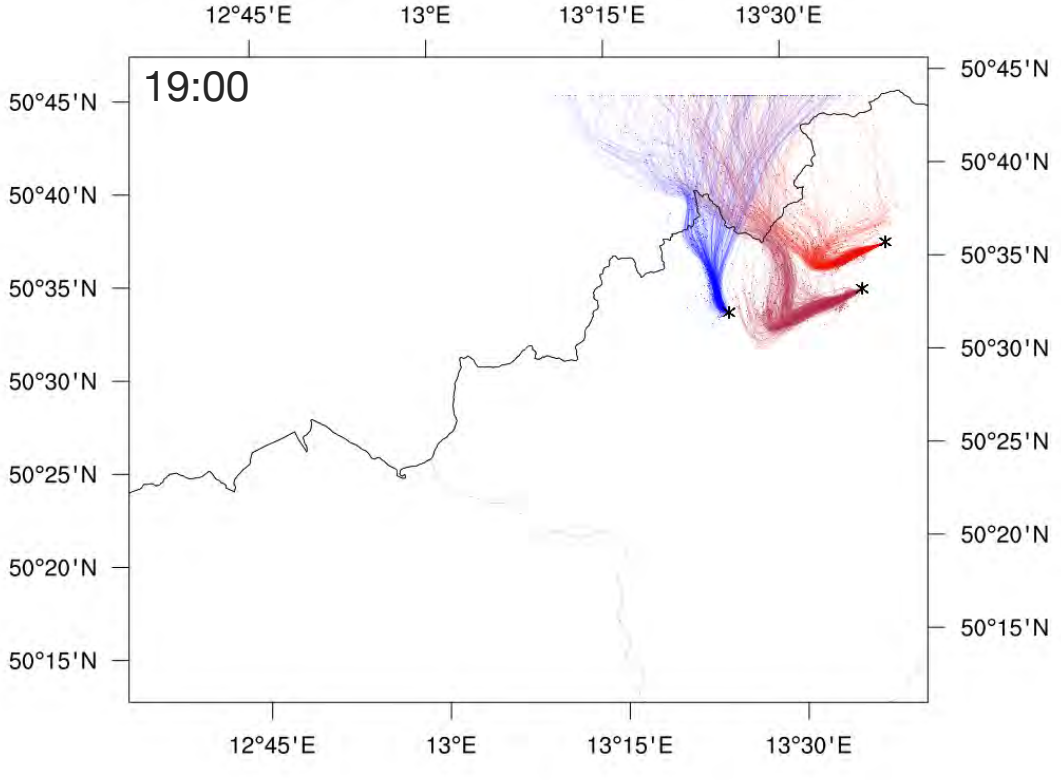
Current altitude

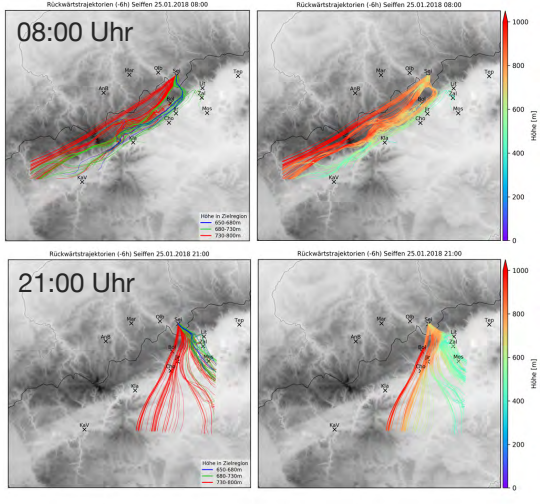


TROPOS

Particle model (LaPaSi): 25. Jan 2018

Proband reports (Seiffen): 6:00 – 24:00





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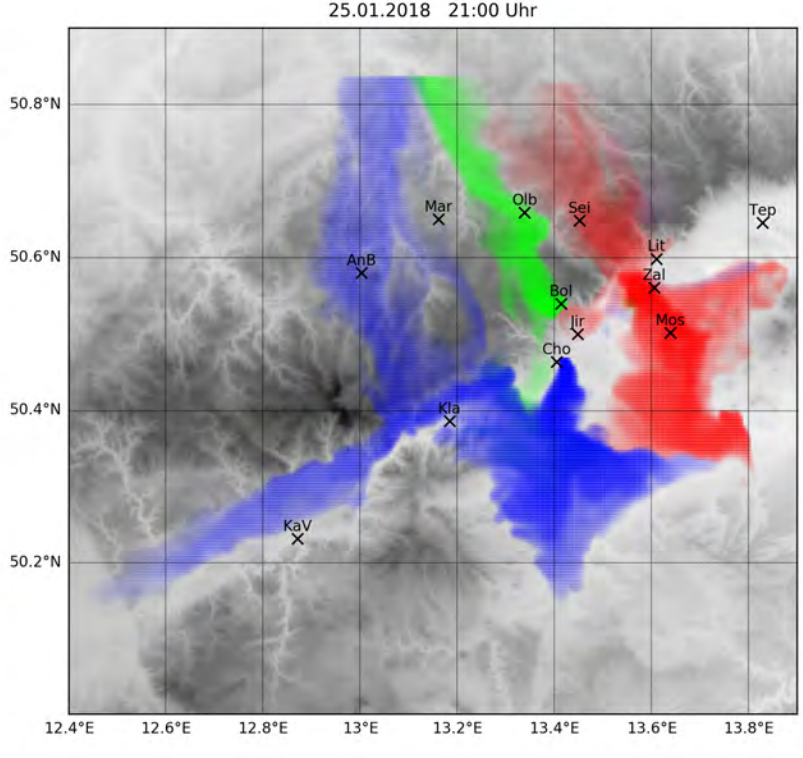
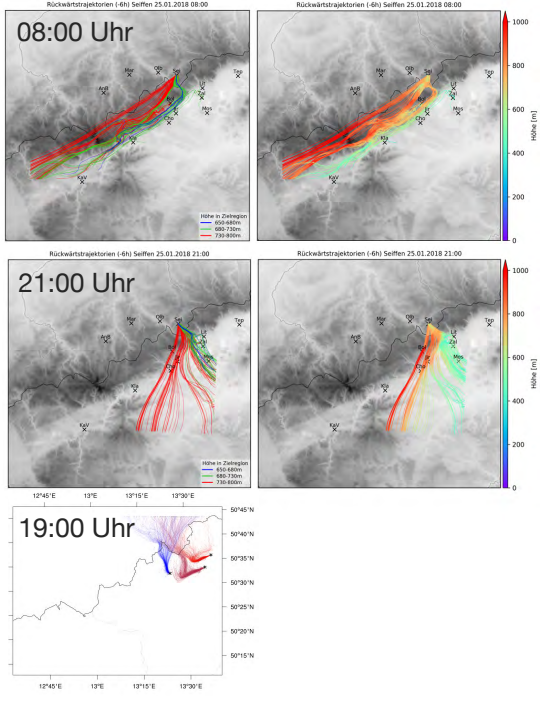
Tracer simulation (MUSCAT): 25. Jan 2018

Proband reports Seiffen): 6:00 – 24:00



ZAL BOL UNE



TROPOS

Tracer simulation (MUSCAT): Seiffen 25. Jan 2018

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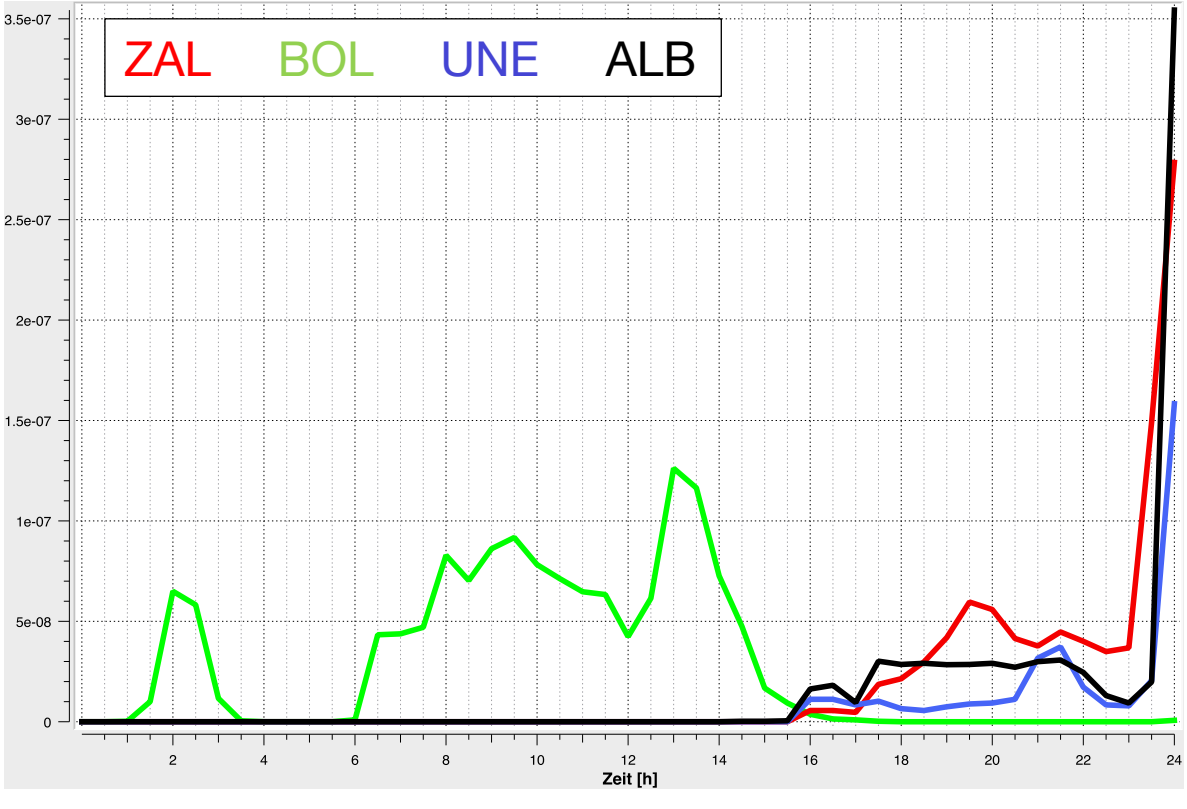
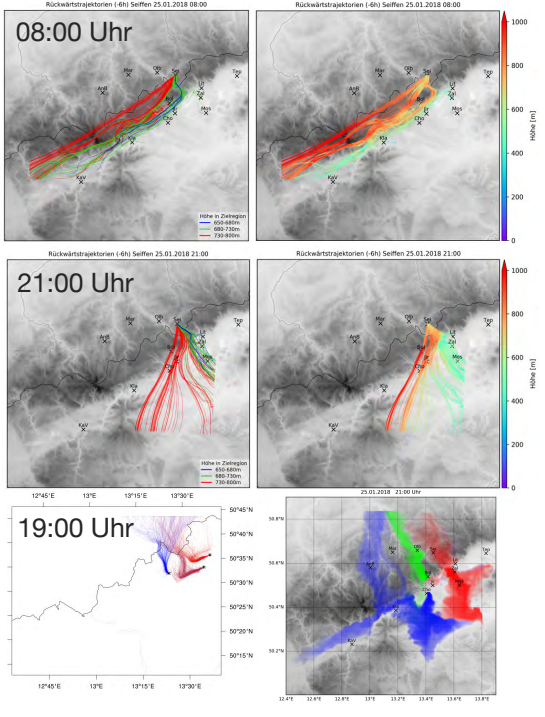
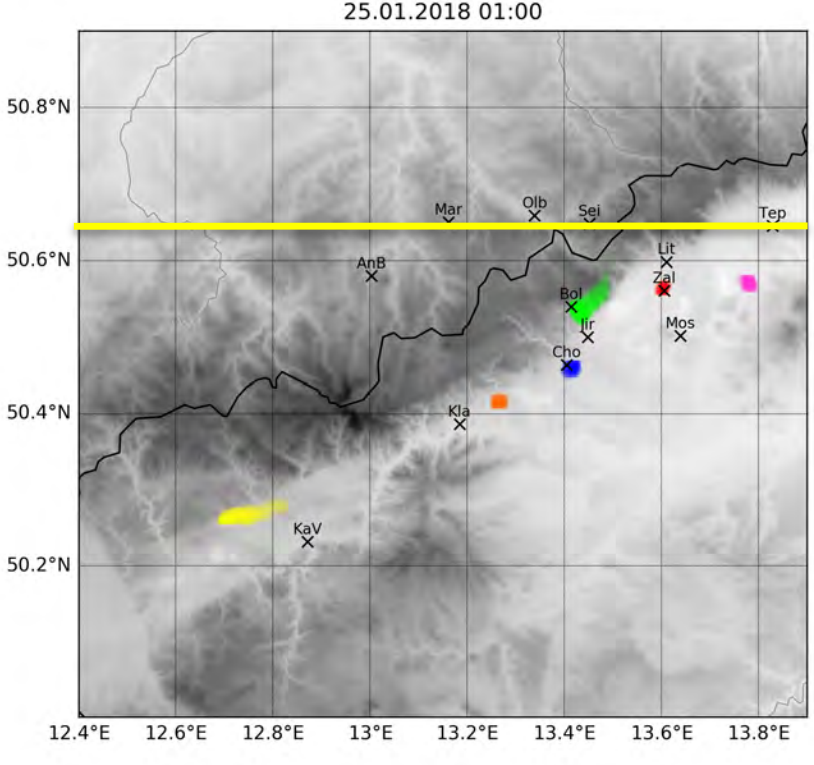


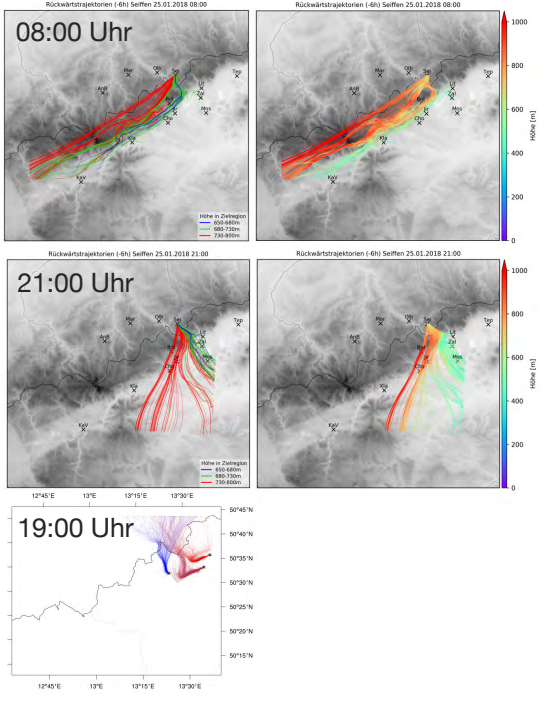


TROPOS

Tracer simulation (MUSCAT): 25. Jan 2018

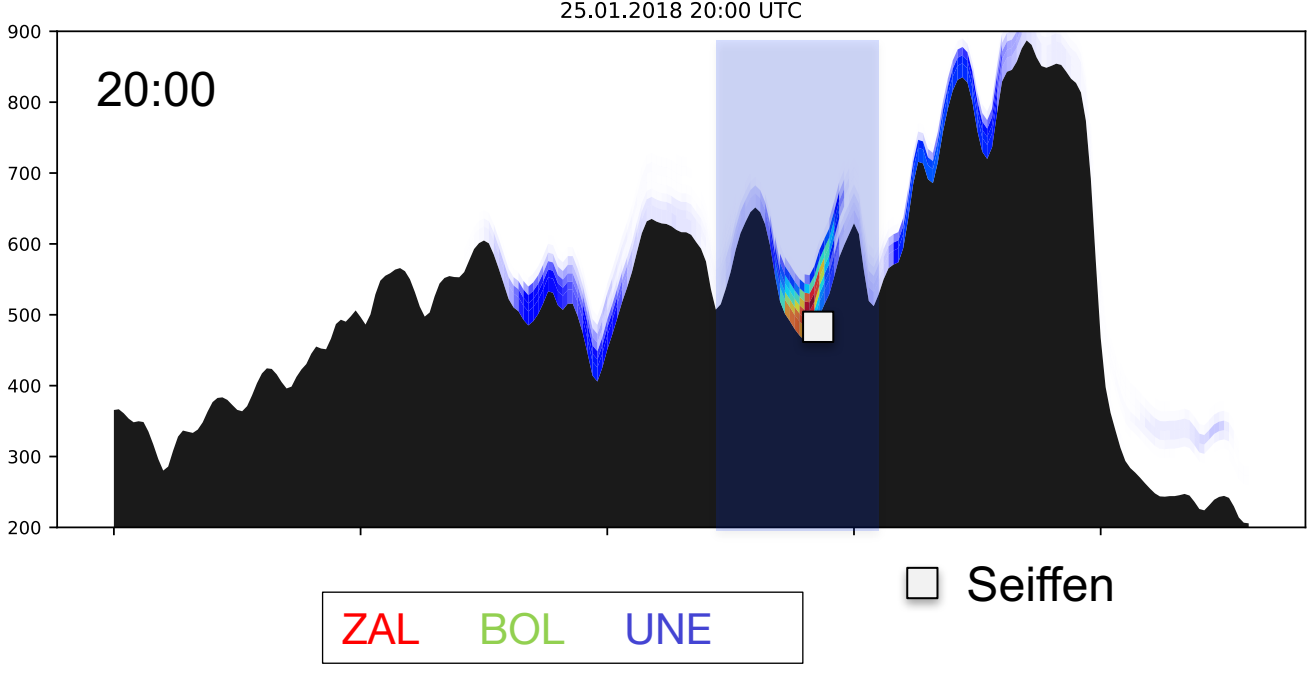
Proband reports (Seiffen): 6:00 – 24:00

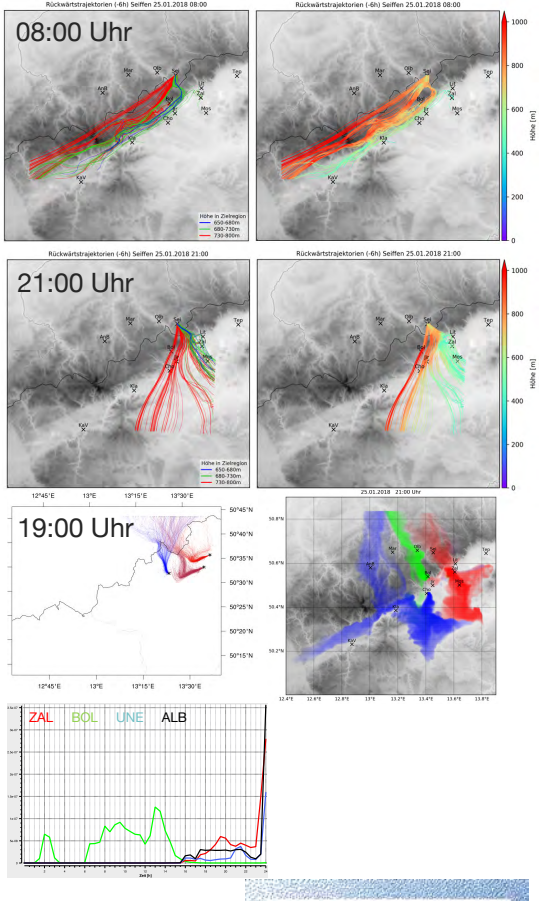




Tracer simulation (MUSCAT): 25. Jan 2018

Proband reports (Seiffen): 6:00 – 24:00

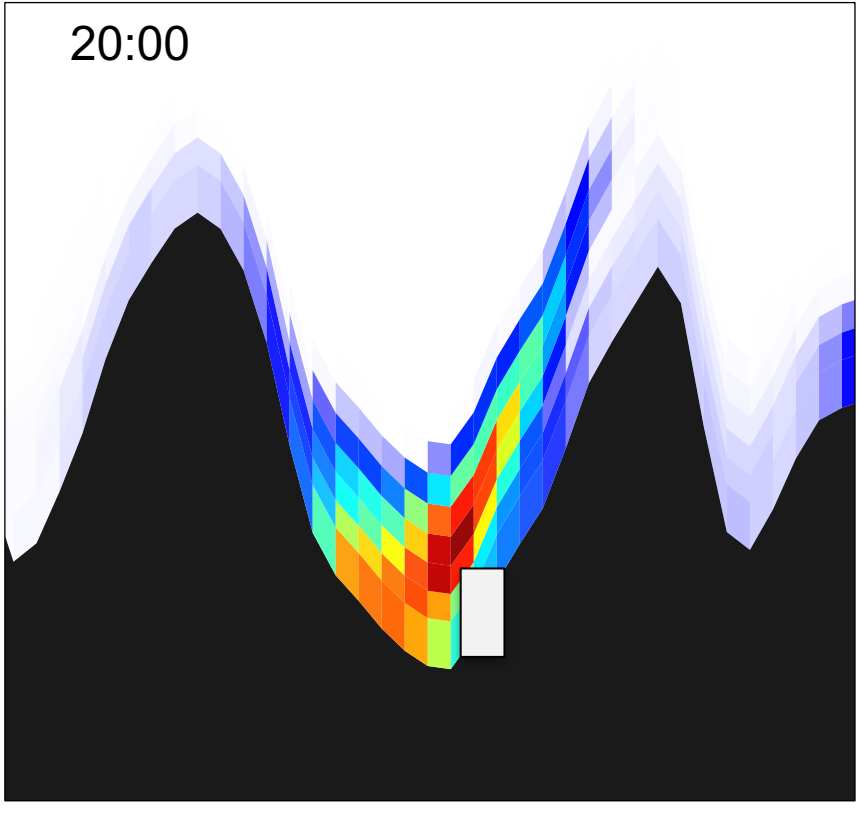




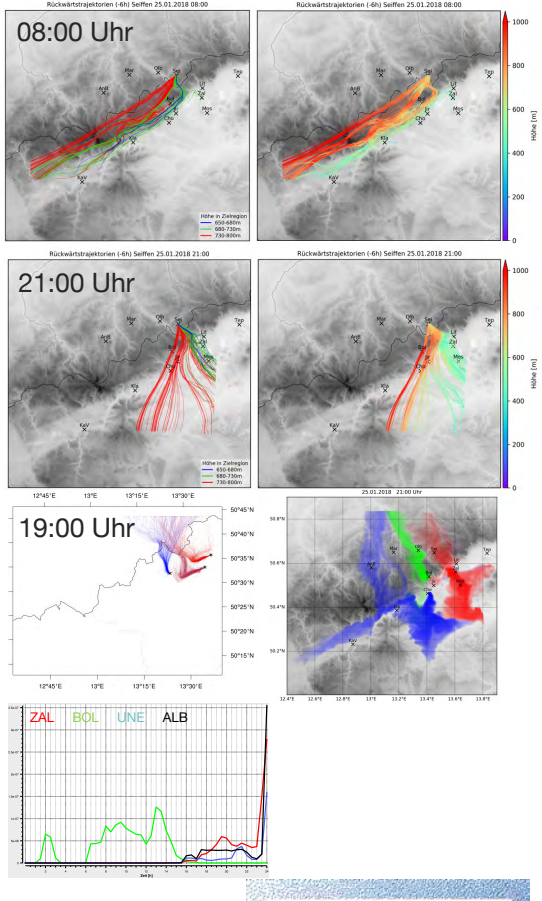
TROPOS

Tracer simulation (MUSCAT): 25. Jan 2018

Proband reports (Seiffen): 6:00 – 24:00



Seiffen



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25. & 26. Jan 2018 – agreement with proband reports

	25.01.18					26.01.18				
	Sei 6-24	Ste 7:40-10	LIT 9-12	OLB 17-22	SAY 18:15-23	OLB 0-10	OLB 17-24	Sei 5-15	Say 6-10	STE 7-8
ZAL_0	t		x	x	x	x		t	x	x
ZAL_1	t		x	x	x	x		t	x	x
ZAL_2	t		x	x	x	x		t	t	x
UNE_0	t		x	t	x	x		g	g	
UNE_1	t		x	t	x	x		t	x	
UNE_2	t		x	t	x	x		t	x	
UNE_3	t		t	t	x	x		g	x	x
EAT_0			t			t		t		
EAT_1	g		t			t		t		
KAD_0			t			g		g		
KAD_1	g					g		t		
KAD-E_0	g	g	t			g	g	g		
KAD-E_1	g	g	t			g	g			
KAD-E_2	g	g	t			g	g			
VRE_0										
VRE_1										
ALB	t		x	x	x	x		x	x	x

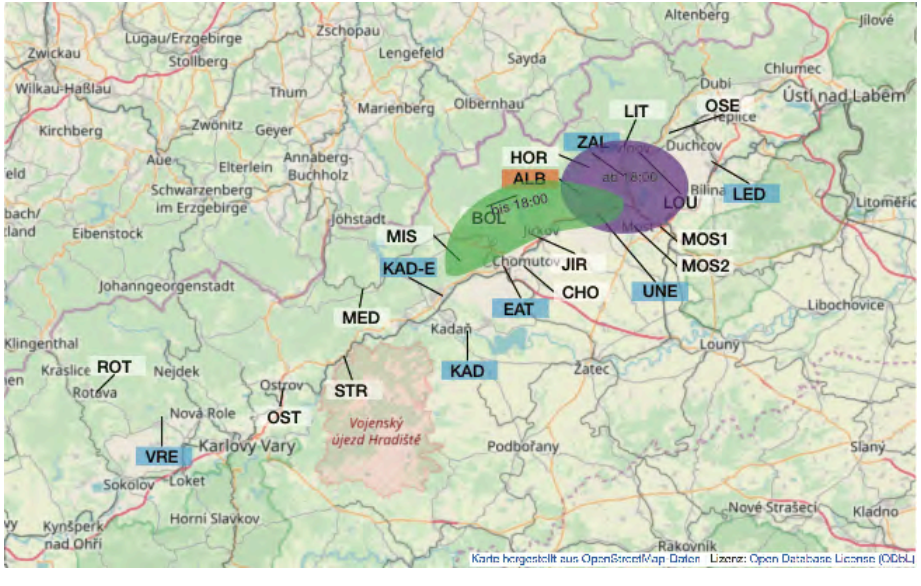
OSE_0	t		t	g	t	t		t	x	x
OSE_1	t		t	g	t	t		t	x	x
LOU_0	t		t	x	t	t		t	t	x
LOU_1	t		t					t	t	x
LIT_0	t		x	t	x					
LIT_1	t		x							
HOR_0	t		x	x	x	g		t	t	x
HOR_1	t		x	x	x	g		t	t	x
MOS1_0										
MOS1_1	t			g	t	g		t		
MOS2_0	t		t	t	x			g		
MOS2_1	t		t	t	x	t		t	t	
BOL_0	t	x	t	x		x	g	t	x	
BOL_1	t	x	t	x		x	g	t	x	
JIR_0	g		x	g		t	g	t		
JIR_1	g		x	x		t	g	t		
CHO_0			t			g		t		
CHO_1	g		t	x		t		t		
MIS_0	g	x	t			t		g		
MIS_1	g	x	t			t		g		
MED_0	t	x	t					g		
MED_1	g	x	t					g		
STR_0										
STR_1										
OST_0	g	x	t							
OST_1			g							

x – full period t – in part g – from time to time

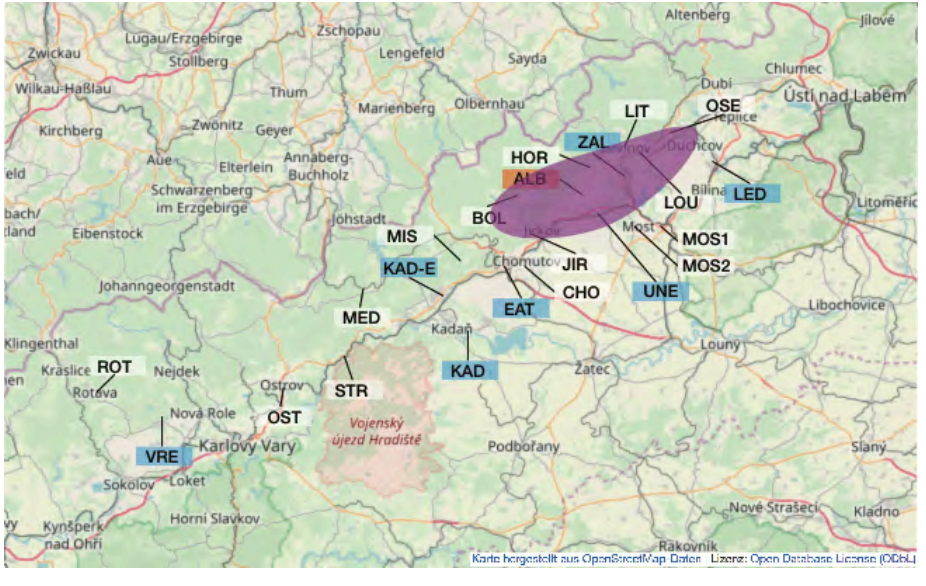
TROPOS

25. & 26. Jan 2018 – Summary

25. Jan before18:00 after 18:00

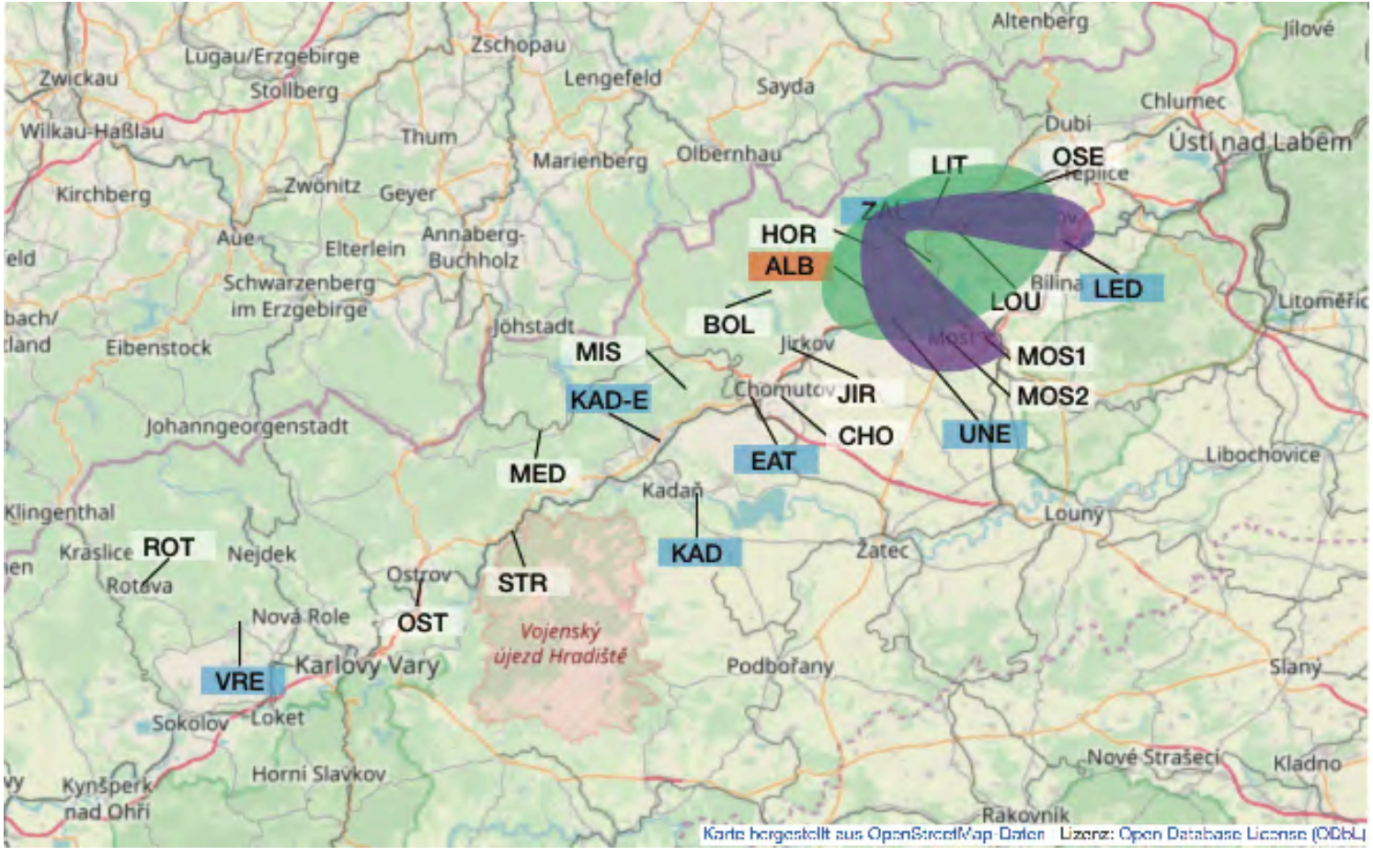


26. Jan 2018



TROPOS

19. & 21. Jan 2017 – Summary

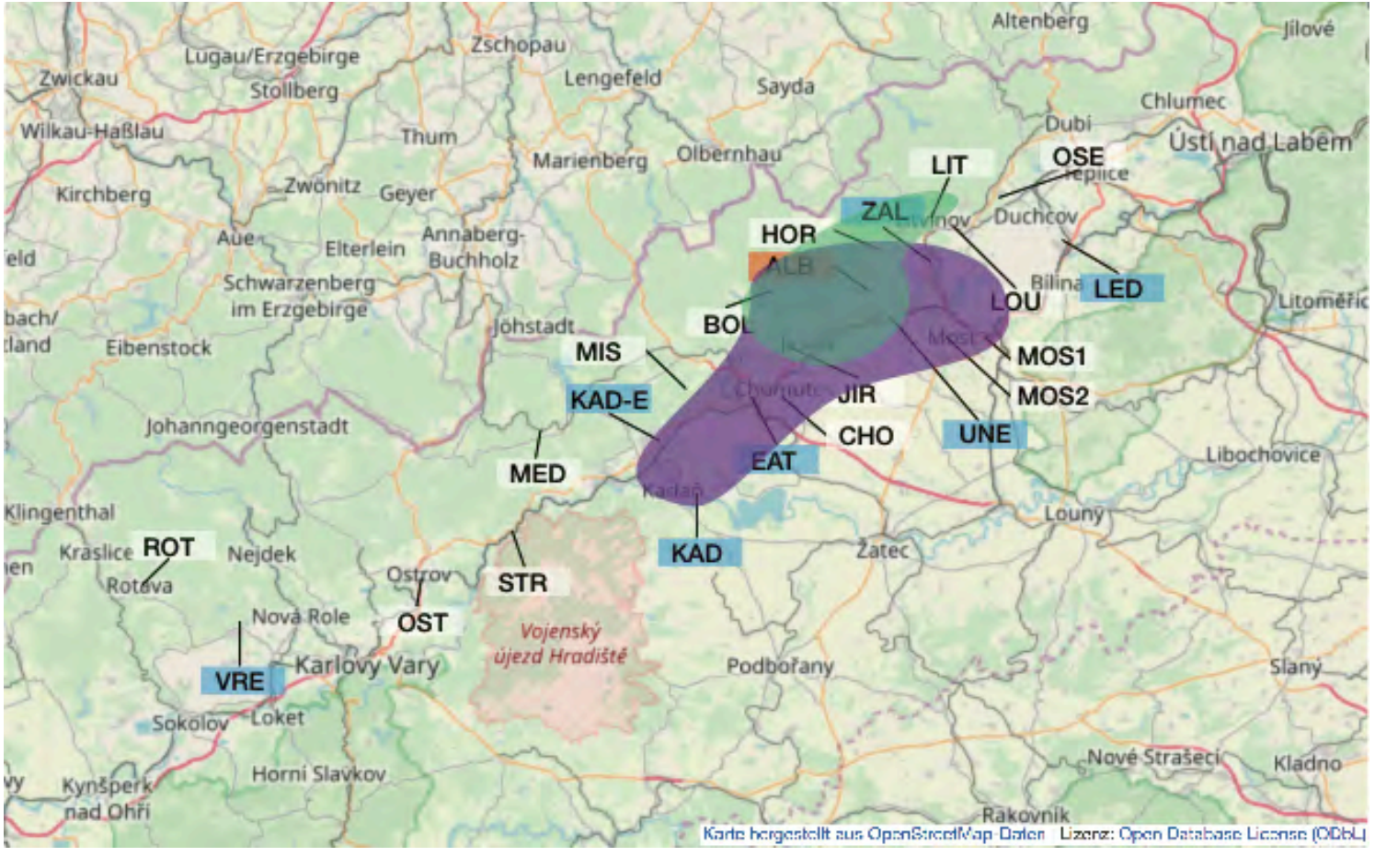


19. Jan

21. Jan

TROPOS

14. & 15. Feb 2018 – Summary



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Conclusions

- No clear source attribution
  - None of the sources investigated can explain all the reports.
- Sources west and southwest of Chomutov can be excluded.
- Further location of regions for single episodes is possible.
- Most frequent match in the area between Most, Jirkov, Horni Jiretin.
- Seldom match only with tracers emitted in higher altitudes
  - Exception 14.Feb 2018
- What is still possible?
  - Several similar and/or widely distributed sources?
  - Chemical formation during atmospheric transport?
  - ***OdCom***: Several local sources (wood burning, …)?
  - Health effects are found only for high BC concentrations!

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Thank you very much for your attention!

ACKNOWLEDGMENT
The authors would like to thank the Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (LfULG) for funding of this project and good cooperation. Furthermore, we gratefully acknowledge the ZIH Dresden, the JSC Jülich and the DWD Offenbach for the support of this work.

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