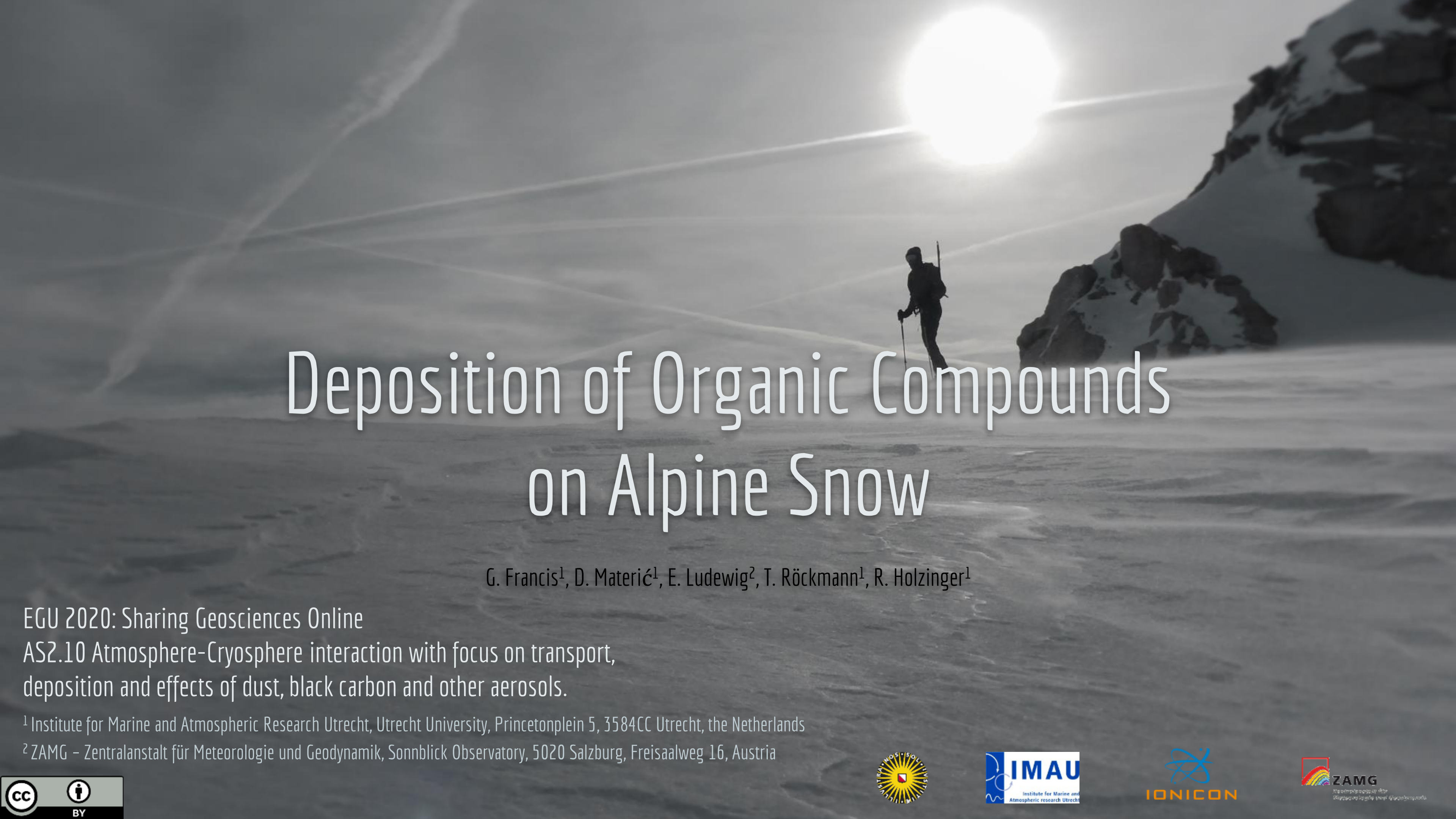

Deposition of Organic Compounds on Alpine Snow

G. Francis[1], D. Materić[1], E. Ludewig[2], T. Röckmann[1], R. Holzinger[1]

EGU 2020: Sharing Geosciences Online
AS2.10 Atmosphere-Cryosphere interaction with focus on transport, deposition and effects of dust, black carbon and other aerosols.

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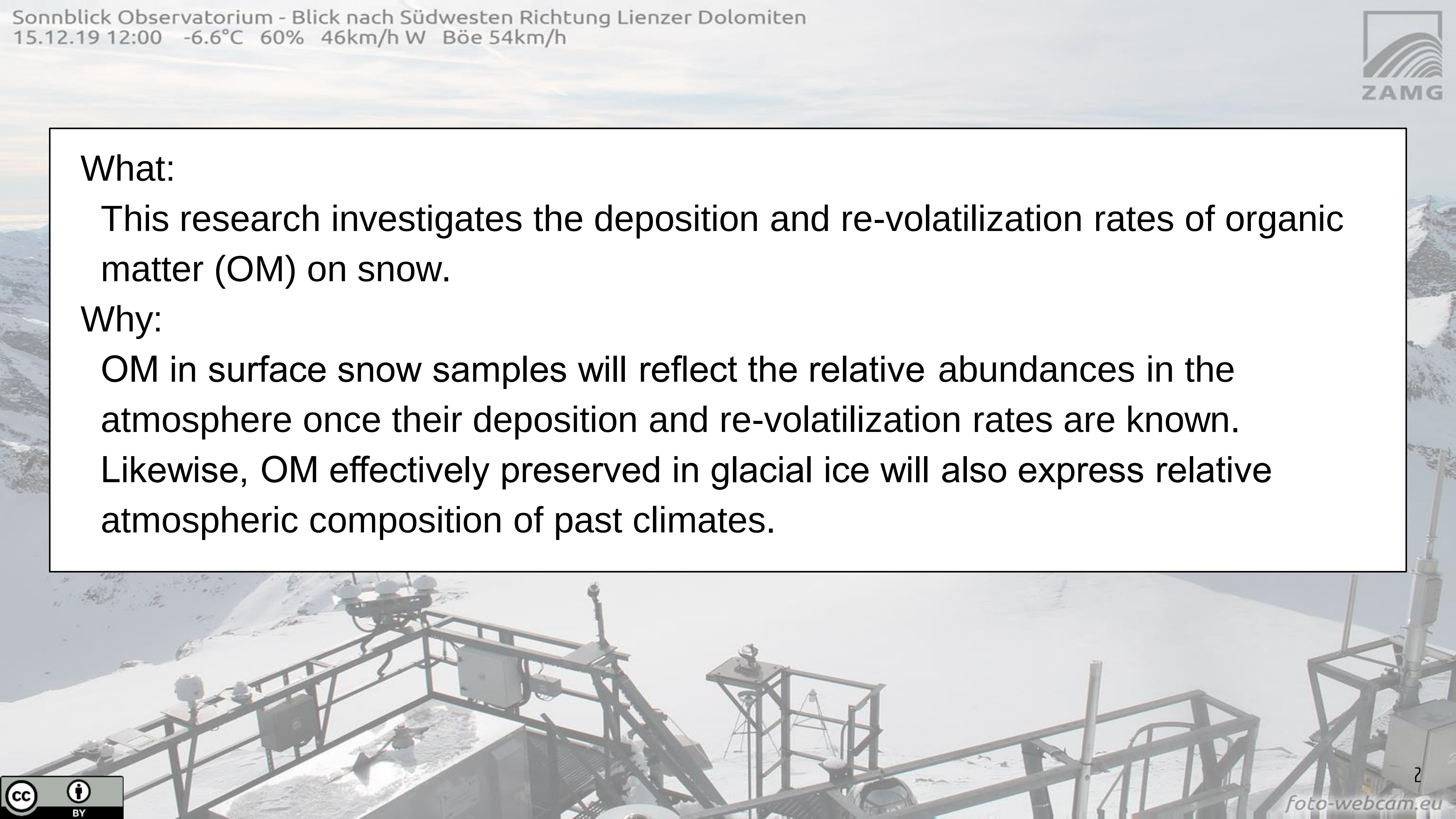
[2] ZAMG – Zentralanstalt für Meteorologie und Geodynamik, Sonnblick Observatory, 5020 Salzburg, Freisaalweg 16, Austria



What:

This research investigates the deposition and re-volatilization rates of organic matter (OM) on snow.

Why:

OM in surface snow samples will reflect the relative abundances in the atmosphere once their deposition and re-volatilization rates are known. Likewise, OM effectively preserved in glacial ice will also express relative atmospheric composition of past climates.

Sonnblick Observatorium - Blick nach Südwesten Richtung Lienzer Dolomiten
15.12.19 12:00 -6.6°C 60% 46km/h W Böe 54km/h

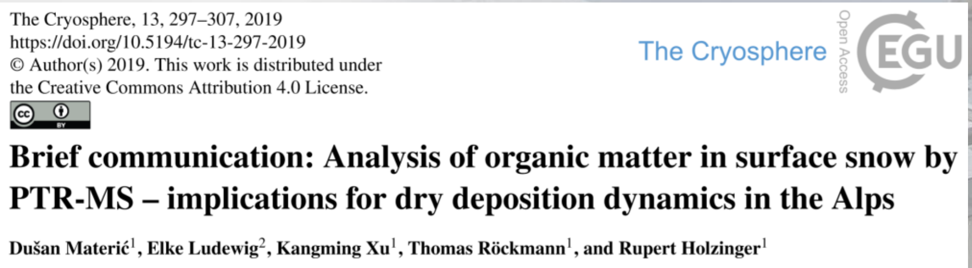
ZAMG

How:

Organics in the atmosphere were measured using Proton Transfer Reaction Mass Spectrometry (**PTR-MS**).

DOM from collected snow samples were measured using a technique combining Thermal Desorption with PTR-MS (**TD-PTR-MS**)[1].

[1] Materi´c, Du˘san. et al. Jan. 30, 2019: Brief communication: Analysis of organic matter in surface snow by PTR-MS - implications for dry deposition dynamics in the Alps. The Cryosphere, 13, 297–307, 2019 https://doi.org/10.5194/tc-13-297-2019


The Cryosphere, 13, 297–307, 2019
https://doi.org/10.5194/tc-13-297-2019

The Cryosphere Open Access EGU

Brief communication: Analysis of organic matter in surface snow by PTR-MS – implications for dry deposition dynamics in the Alps

Dušan Materić[1], Elke Ludewig[2], Kangming Xu[1], Thomas Röckmann[1], and Rupert Holzinger[1]

Sonnblick Observatorium - Blick nach Südwesten Richtung Lienzer Dolomiten
15.12.19 12:00 -6.6°C 60% 46km/h W Böe 54km/h

Where:

Sonnblick Observatory, Hoher Sonnblick Austria

When:

Air measurements – Dec. 11th → Dec. 18th (continuous)

Snow Samples – Dec. 14th, 16th & 18th

Air Measurements

Observatory

PTR-MS instrument with inlet fed from outside

Snow Samples

Snow Field

6 sampling sites:

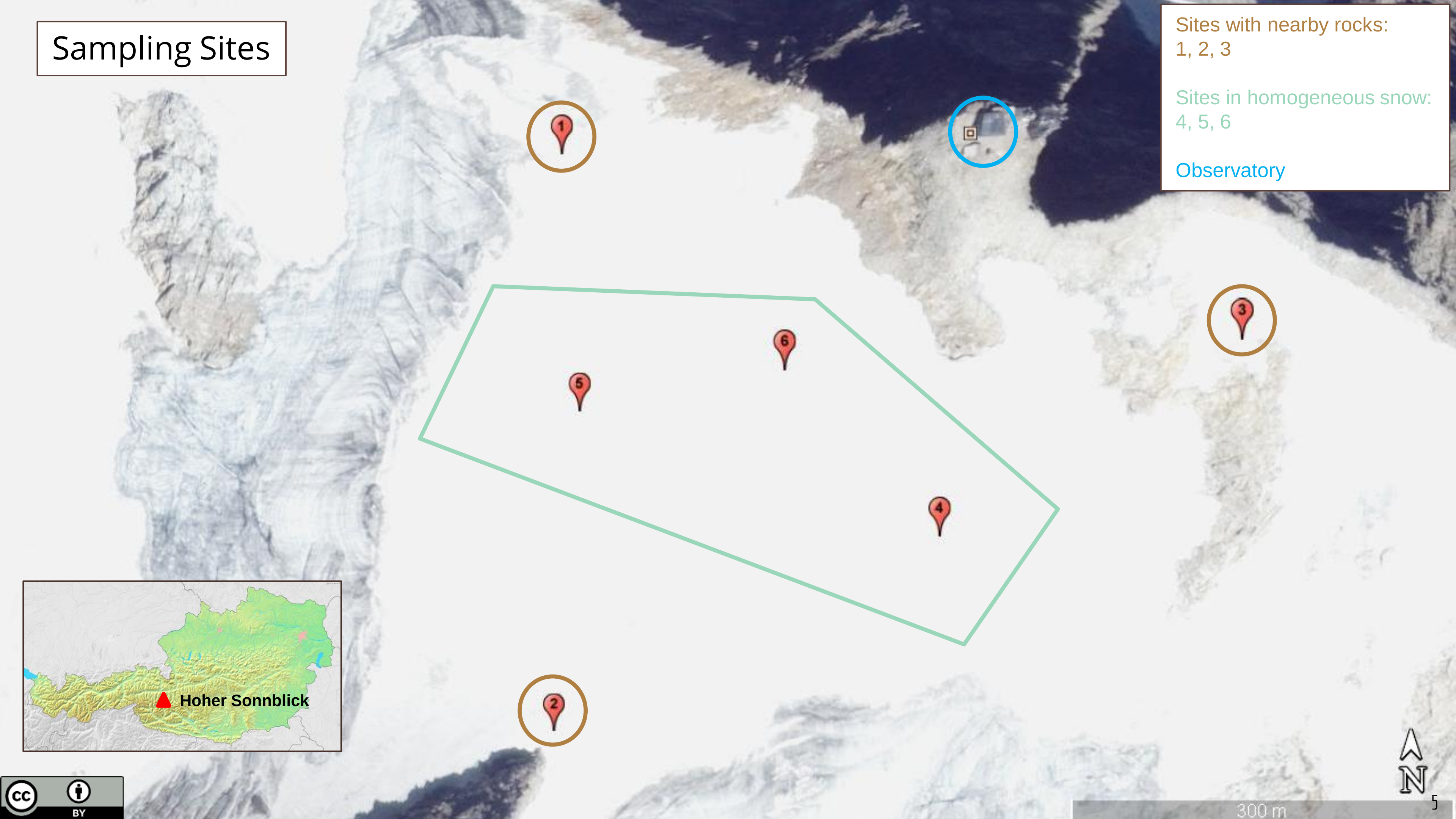
- 1, 2, 3 noticeably near rocks
- 4, 5, 6 homogeneous plateau

Observatory

2 sampling sites:

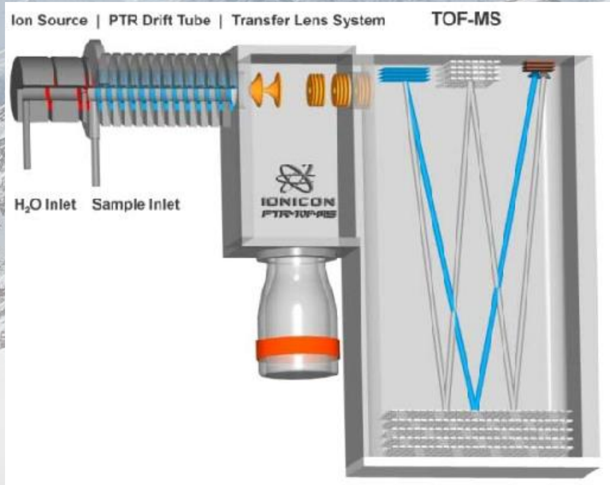
- Roof (duplicates)
- Northside walkway

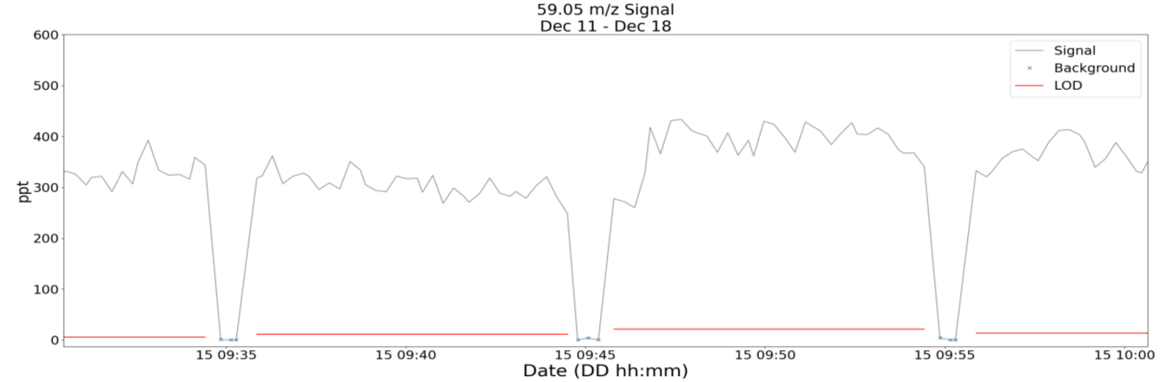
Sampling Sites



PTR-MS (for air measurements)

- Continuous measurements from Dec. 11th → Dec. 18th
- 1 second time resolution
- Cycling between 9min and 1min intervals for atmospheric and background measurements respectively
- Data was condensed using 15 second averages





Example of 59.05 m/z signal between 09:30 and 10:00 on Dec. 15th 2019

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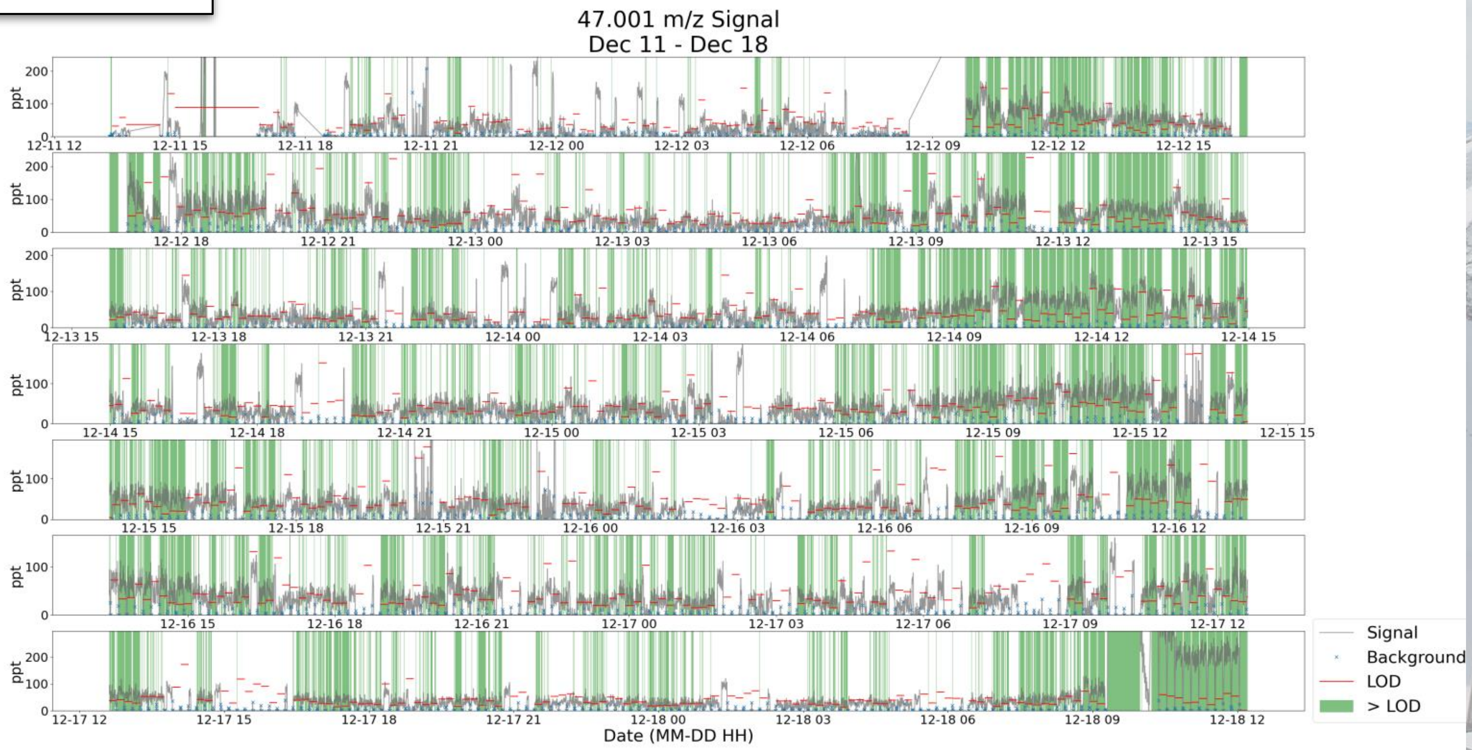
15.12.19 12:00 -6.6°C 60% 46km/h W Böe 54km/h

PTR-MS (for air measurements)



Example of full timeline (Dec. 11th → Dec. 18th) for 47.001 m/z (likely formic acid).
Statistically significant periods are highlighted in green.

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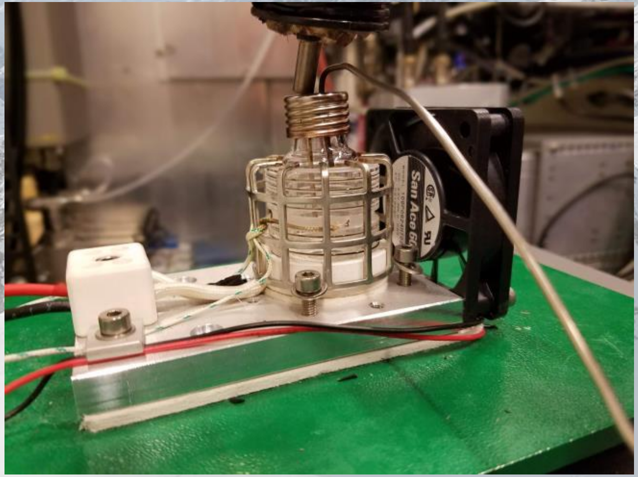
TD-PTR-MS (for snow samples)

Replica ‘X’

Blank ‘X’



For Each Snow Sample:

- 6 replicates (1ml each) (3 filtered, 3 unfiltered)
- replicates were compared with corresponding blanks prepared from ultrapure water

- liquid was evaporated away from all replicates using a low pressure desiccator, and flushed with N_2.

- each replicate was then heated with a temperature controlled ramp to re-volatilize any remaining particles.
- gasses emitted were measured using PTR-MS

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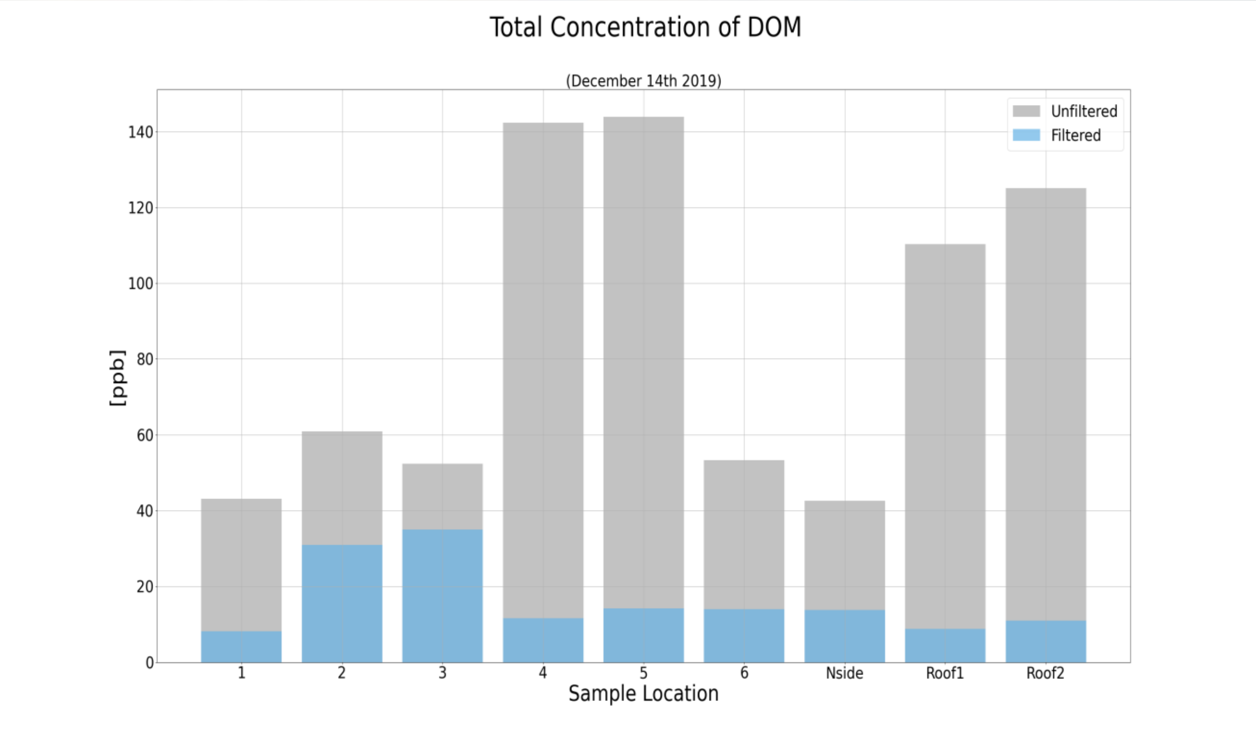
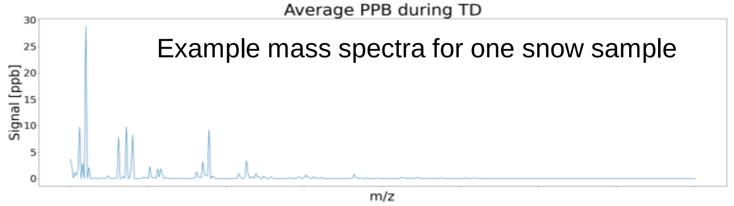
TD-PTR-MS (for snow samples)

Totals for each sample location on December 14th. We can see that filtering the samples before measurement not only reduces the bulk total concentration of OM found, but also results in less variability between similar samples (i.e. roof duplicates or homogeneous snow locations 4, 5, 6). This is important because larger particles may be less homogeneously distributed in the local environment and can reveal a completely different story whether or not a particle was captured in a sample.

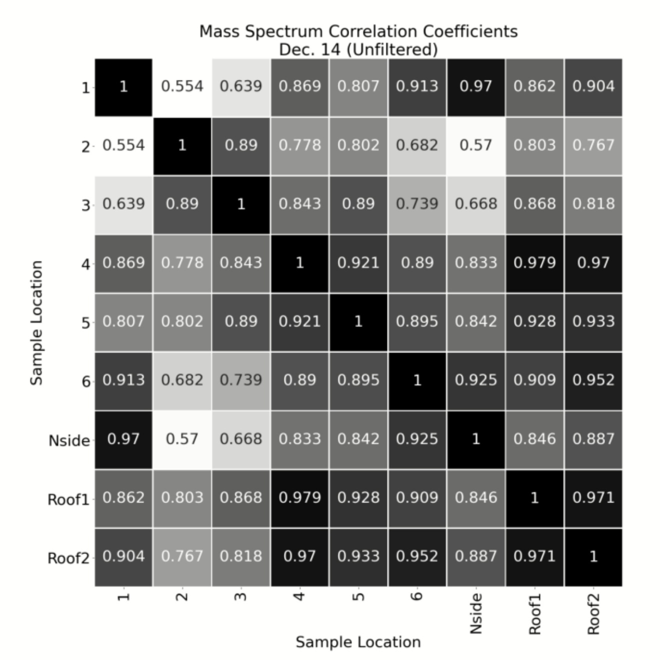


1 through 6 corresponding to the snow field sites, and Nside, Roof1 and Roof2 corresponding to the northside walkway and the roof duplicates respectively.

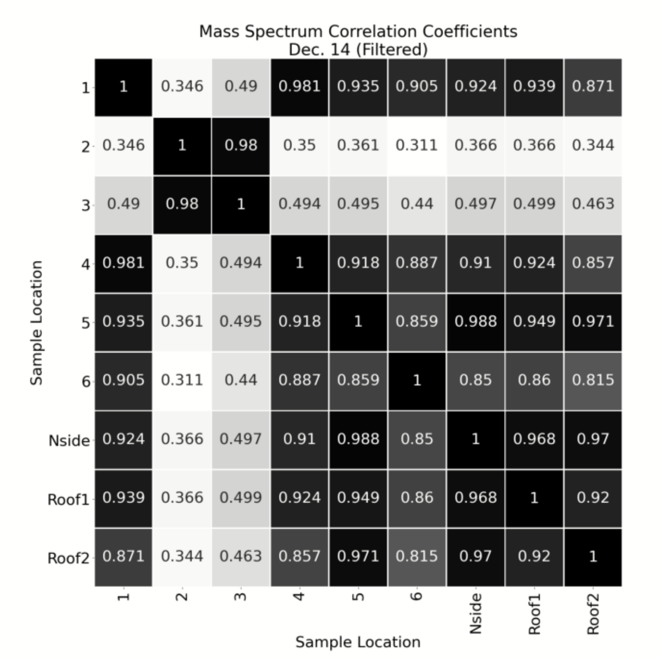
TD-PTR-MS (for snow samples)



While *bulk totals* provide us with an idea of total inventory, the *mass spectra* of each sample provides a unique fingerprint of the specific OM that are present in each sample. Correlating the mass spectra from one sample with that of another indicates how similar the two samples are. On this day we can see sites 2 and 3 standing out from the rest, but with relatively high correlations with each other. This is more apparent when larger particles are filtered out.



Sample Location	1	2	3	4	5	6	Nside	Roof1	Roof2
1	1	0.554	0.639	0.869	0.807	0.913	0.97	0.862	0.904
2	0.554	1	0.89	0.778	0.802	0.682	0.57	0.803	0.767
3	0.639	0.89	1	0.843	0.89	0.739	0.668	0.868	0.818
4	0.869	0.778	0.843	1	0.921	0.89	0.833	0.979	0.97
5	0.807	0.802	0.89	0.921	1	0.895	0.842	0.928	0.933
6	0.913	0.682	0.739	0.89	0.895	1	0.925	0.909	0.952
Nside	0.97	0.57	0.668	0.833	0.842	0.925	1	0.846	0.887
Roof1	0.862	0.803	0.868	0.979	0.928	0.909	0.846	1	0.971
Roof2	0.904	0.767	0.818	0.97	0.933	0.952	0.887	0.971	1



Sample Location	1	2	3	4	5	6	Nside	Roof1	Roof2
1	1	0.346	0.49	0.981	0.935	0.905	0.924	0.939	0.871
2	0.346	1	0.98	0.35	0.361	0.311	0.366	0.366	0.344
3	0.49	0.98	1	0.494	0.495	0.44	0.497	0.499	0.463
4	0.981	0.35	0.494	1	0.918	0.887	0.91	0.924	0.857
5	0.935	0.361	0.495	0.918	1	0.859	0.988	0.949	0.971
6	0.905	0.311	0.44	0.887	0.859	1	0.85	0.86	0.815
Nside	0.924	0.366	0.497	0.91	0.988	0.85	1	0.968	0.97
Roof1	0.939	0.366	0.499	0.924	0.949	0.86	0.968	1	0.92
Roof2	0.871	0.344	0.463	0.857	0.971	0.815	0.97	0.92	1

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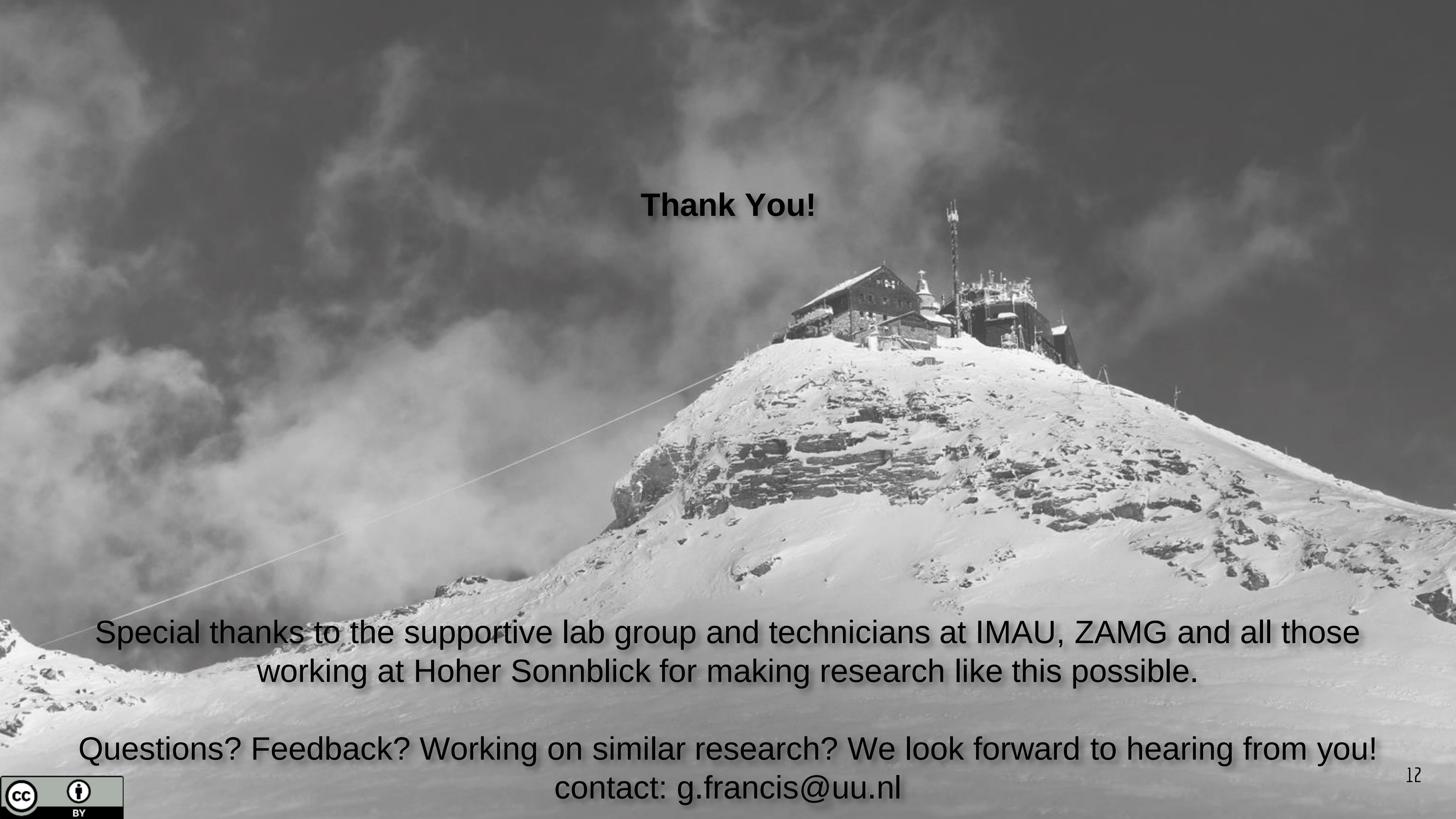
Where do we go from here?

As we continue to analyze the existing data and look for clues that tell us about the relationship between OM in the atmosphere and how it is deposited on snow, sampling is still currently underway thanks to the dedicated team at the Sonnblick Observatory. These snow samples span the melt season from winter into summer, and once analyzed, they will provide insight into the long-term accumulation and re-volatilization trends for different organics in these high alpine regions.



Thank You!

Special thanks to the supportive lab group and technicians at IMAU, ZAMG and all those working at Hoher Sonnblick for making research like this possible.

Questions? Feedback? Working on similar research? We look forward to hearing from you!

contact: g.francis@uu.nl