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Supplementary material

Per and polyfluoroalkylated substances (PFAS) target and EOF analyses in ski wax, snowmelts, and soil from skiing areas

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Sample preparation

Preconcentration and extraction

Snowmelt samples (around 200 g each) were directly put through solid phase extraction (SPE) with Oasis WAX cartridges (150mg, 30µm, Waters) for preconcentration and sample clean-up purposes. SPE process was adapted from Taniyasu et al.(2) with slight modifications: Oasis WAX cartridges were conditioned with 4 mL 0.1 % (*v/v*) ammonia (NH_4OH) in methanol, 4 mL methanol and 4mL ultrapure water (Milli-Pore, 18 M Ω cm) in this order. The extracts and snowmelts were loaded onto the cartridges then the cartridges were washed with 4 mL 25 mmol L^{-1} ammonium acetate (CH_3COONH_4) in ultrapure water. The cartridges were eluted into small solvent washed glass vials with 4 mL methanol and 4 mL 0.1 % (*v/v*) ammonia in methanol. The eluents were evaporated to dryness using N_2 gas without heating, then reconstituted into solvent washed Eppendorf vials with 2 x 0.5 mL 50 % (*v/v*) methanol water mixture. The Eppendorf tubes were centrifuged at 13000 rpm for 5 min then the samples were divided. The top 450 µL was taken into muffled HPLC vials and 50 µL of 50 µg L^{-1} isotopically labelled PFAS internal standard were added for targeted analysis with HPLC-MS/MS. 150 µL of the samples were taken into HPLC vials with conical inserts for total extractable F determination with CIC.

Soil samples were extracted as described previously by Higgins et al. (3)with slight modifications: follows: 2 g soil sample was weighed in solvent washed centrifuge tube. 10 mL of 90:10% (*v/v*) methanol: acetic acid solution 1 % (*v/v*) was added. The sample was sonicated for 20 mins in sonication bath, then centrifuged for 5 min at 3000 revolution per minute (rpm) and the supernatant was collected. This process was repeated 3 more times to result in a total of 40 mL extract. The extract was then cleaned up and preconcentrated using SPE and reconstituted as described above.

Extraction of wax samples were adapted from Plassmann & Berger (4), with slight modifications: 200 mg sample was weighed into solvent washed centrifuge tubes. 5 mL methanol was added, and the sample was sonicated for an hour in sonication bath then left at 4 °C overnight. The samples were then centrifuged at 4000 rpm for 5 min and the supernatant was collected into another solvent washed centrifuge tubes. This process was repeated 1 more time to give a total of 10 mL extracts which were evaporated to dryness with N_2 gas. The samples were then reconstituted into solvent washed Eppendorf tubes with 2 x 0.5 mL methanol. The Eppendorf tubes were centrifuged at 13000 rpm for 5 min then divided as described above. For EOF analysis, where the packaging label on the wax stated that it contained F, 10 µL of the extract was taken, diluted to 200 µL with methanol and measured with CIC and HR-GF-MAS.

Additionally, to check the effect of different solutions have on EOF, 5 mL hexane was added to 10 mg wax samples into pre solvent washed centrifuge tubes. Sonicated for an hour in sonication bath, centrifuged at 4000 rpm for 5 min. An aliquot was taken for total extractable F quantification with CIC and HR-GF-MAS.

Microwave-induced combustion

Microwave-induced combustion (MIC) was used the total fluorine content analysis of solid wax samples. The method used was based on the previous paper (5), approximately 80 mg of sample were weighed and wrapped in a low-density polyethylene film. The films were heat sealed and the excess film was removed. After that, the wrappers were placed on quartz holders containing a disc of filter paper previously moistened with 50 µL of 6 mol L^{-1} ammonium nitrate (NH_4NO_3) (ignition solution). The quartz holders were placed into quartz vessels, in which was previously added 6 mL of absorbing solution (150 mmol L^{-1} of NH_4OH). The vessels were closed, positioned in the rotor and pressurized with 20 bar of O_2. Then, the following irradiation program was applied: *i*)1400 W for 5 min (combustion

and reflux steps), *ii*) 0 W for 20 min (cooling step). Subsequently, the pressure was released, and the solutions were collected in volumetric flasks. The volume was adjusted to 25 mL with ultrapure water for further analysis by IC. To be able to digest a larger sample mass and, consequently, to obtain lower limits of detection and quantification, successive digestions were carried out. For this, three sequential burns (using 50 mg of sample in each one) were performed using the same absorbing solution for all rounds, totalling approximately 150 mg of sample mass, as proposed in previous study (6). For the liquid sample the procedure was based on previous study (7). The wraps were prepared by adding 90 µL of the liquid sample over 100 mg of cellulose (used as a combustion aid) before sealing the wrapper. The other conditions used for MIC method were the same as previously described. To assess the repeatability and to check for losses during sample preparation, 25 µL of a 64 mg mL^{-1} F standard was spiked to a sample previously the sample preparation by MIC.

Instrumentation

Targeted analysis. Agilent 1200 infinity HPLC (Agilent Technologies, Germany) combined with a BrownLee SPP C18 column (2.7 µm, 3 x 100 mm, PerkinElmer, UK) and a BrownLee SPP guard column (2.7 µm, 3 x 5 mm, PerkinElmer, UK) were used for the separation of the analytes by LC. A gradient was used for the separation of target PFAS, consisting of 5 mmol L^{-1} CH_3COONH_4 in ultrapure water and 100% LCMS grade ACN were used as mobile phase A and B. The LC system was coupled to an Agilent 6465 Triple Quadrupole MS/MS (Agilent Technologies, Germany). The MS was used in multiple response monitoring (MRM) mode. Two transitions were monitored (quantifier and qualifier ions) for the analytes except PFBA, PFPA, PFdDA, PFOSA, FOSEs where only one transition was monitored. Transitions and LC method are listed in Table S4 in SI. Due to the large number of transitions, the transitions were monitored only around their retention times. Negative ESI mode was used for the determination of different PFAS. Nitrogen was used as a collision gas.

Total extractable organic fluorine (EOF) and total fluorine (TF)

Combustion ion chromatography (CIC). EOF measurement were carried out using a Thermo-Mitsubishi Analytech CIC. Sample extracts (100 µL) were placed in a ceramic sample boat containing glass wool for better dispersion of the fluids. Sample boats were pre-baked 3 times prior to sample combustion to minimize background contamination (8). Samples were introduced into a combustion oven (HF-210, Mitsubishi Analytech) heated to 1100 °C with argon (200 mL min^{-1}), argon with water (100 mL min^{-1}) and oxygen (400 mL min^{-1}) flow rate. All combustion gases were collected in ultrapure water (GA-210, Mitsubishi Analytech), and the absorption solution (ultrapure water) was adjusted to 10 mL. 1.3 mL were injected onto a Hamilton PRP X100 anion exchange column (10 µm, 4.6 × 250mm) equipped with a guard column (Dionex IonPac AS19 (2 × 50 mm). Chromatographic separation was achieved using isocratic elution of 70 mmol L^{-1} hydroxide mobile phase with 0.6 mL min^{-1} flowrate. The acquisition time was 27 min.

High-resolution graphite furnace molecular absorption spectrometry (HR-GF-MAS). The method used for total fluorine in EOF was described previously in Akhdhar et al (9). A high-resolution continuum source atomic absorption spectrometer (contrAA 700, Analytik Jena, Germany) was used for all measurements. The spectrometer was equipped with a xenon short-arc lamp with a nominal power of 300 W operating in a hot-spot mode, which emits a spectral continuum between 190 and 900 nm and a charge-coupled device (CCD) array detector with 588 pixels, 200 of which are used for analytical purposes. The double monochromator consists of a prism pre-monochromator and an echelle grating monochromator for high resolution. All measurements were performed using the wavelength of

highest sensitivity for CaF at 606.429 nm, using the sum of the integrated absorbance of three pixels (peak volume selected absorbance, PVSA, AΣ3, int). Pyrolytically coated graphite tubes with PIN platform (Analytik Jena, Germany) and with transversal heating were used in all experiments (9).

Ion chromatography for total fluorine in wax samples. Total fluorine in wax samples was determined using an ion chromatograph (ICS-5000, Dionex/Thermo Fisher Scientific, USA) equipped with an IonPac AS11-HC analytical anion exchange column (4 µm, 2 x 250 mm) and an IonPac AG11-HC guard column (4 µm, 2 x 50 mm), at a controlled temperature of 36 °C. A Dionex ERS 500 anion electrolytically regenerated suppressor (2 mm, using the auto suppression external water mode at 0.18 mL min^{-1}, and current from 2 to 80 mA), and an eluent source EGC 500 KOH generator cartridge with continuously regenerated anion-trap column (CR-ATC) were also used. The mobile phase used for the elution of the analyte was a KOH gradient from 1 to 80 mmol L^{-1} at a flow rate of 0.28 mL min^{-1}, and the injection volume used was 50 µL. The detection was performed using a conductivity cell at a controlled temperature (36 °C). The acquisition time was 33 min.

Fluorine mass balance analysis. Individual PFAS concentrations from target analysis, above the LOQ was converted into the corresponding concentration in fluorine in ng F g^{-1} . Fluorine mass balance analysis was carried out by comparing the sum of converted PFAS to that obtained from EOF analyses with CIC. Limit of detection and quantification (LOD and LOQ) through the whole study were calculated from the standard error of the y intercept of the linear regression line. LOD and LOQ were determined as 3 x and 10 x the error of the y intercept, respectively.

Equation 1. Calculation of identified PFAS from target PFAS and EOF.

$$\%\ F\ as\ PFAS = \frac{\sum target\ PFAS\ as\ F}{EOF\ as\ F} x\ 100$$

Quality controls of the used analytical methodologies

Method blanks.

Soil method blanks contained PFBA, PFPA, PFOA, PFdDA, PFOS, PFOSA and N-EtFOSA. Their concentrations were <LOQ. During data analysis, the average areas of these analytes were subtracted from the samples, before processing them further, while snowmelt and wax method blanks contained no PFAS >LOD.

Instrumental quality control.

Instrumental quality controls were between 80-120% for all PFAS found in the samples, measured with HPLC-MS/MS. Recovery of BCR-461 reference material using CIC was 95 ± 3%. These show that the instruments worked fine.

Wax.

Analyte recoveries for PFCAs and PFSAs were between 42 ± 9 and 90 ± 4 %. For precursor PFAS the recoveries were between 10 ± 4 and 60 ± 3% depending on the analyte (table S6a). The only precursor compound found, 2-perfluorooctyl ethanoic acid (FOEA), had a recovery of 10 ± 4 %. Because of the low recovery for this analyte, the results obtained is semi-quantitative only. Recoveries of isotopically labelled PFAS (MPFAC-C-IS) is found between 49±2 and 54±4% which is consistent with the analyte recoveries (table S6b). Spiked wax extracts were measured with CIC and HR-GF-MAS as well. With CIC, wax methanol extracts had 63 ± 26% recovery while recovery of hexane extracts was 9 ± 2%. The lower recovery using hexane as extraction solution is to be expected, because the PFAS spiking solution contains mostly polar compounds. Only wax methanol extracts were measured with HR-GF-MAS, due to the insolubility of the Ca standard solution in hexane that is used for generating the CaF ions. Wax methanol extracts had 63 ± 21% recovery, which agrees with the recovery observed with CIC. Recovery of TF analysis was found to be 109 ± 7%, showing that MIC-IC combust the waxes completely.

Soil.

Analyte recoveries for PFCAs and PFSAs were between 30 ± 12 and 62 ± 16%. The recoveries decreased with C length. For precursor PFAS the recoveries were ranging from not being able to recover (0%) to 88 ± 17% (table S6a). Recoveries of isotopically labelled PFAS (MPFAC-C-IS) is found between 81 ± 6 and 98 ± 5% (table S6b), hence the reliability of the quantitative analysis was adequate. Soil extracts, like wax extracts, also showed high variability in recoveries with CIC. The recovery was found to be 191 ± 70%. As it was stated above, the recovery of BCR-461 reference material had excellent recovery using CIC, showing that CIC operates well. The high variability between the method recoveries is possibly due to high organic F content in the soil themselves, or analyte loss during combustion (volatilisation).

Snowmelts.

Analyte recoveries (%) for PFCAs and PFSAs were between 70 ± 0 and 113 ± 9%. except for PFhxDA (17 ± 1%) and PFoDA (2 ± 0%) (Table S6a). For precursor PFAS the recoveries were ranging from not being able to recover (0%) to 100 ± 15% (table S6a). Recoveries of isotopically labelled PFAS (MPFAC-C-IS) were between 89 ± 5 – 96 ± 5%, which is consistent with the analyte recoveries (table S6b).

Table S1. List of analytes and their acronyms

Name	Acronym	Carbon number
PFAS carboxylic acids	**PFCAs**	
Perfluorobutanoic acid	PFBA	C_4
Perfluoropentanoic acid	PFPA	C_5
Perfluorohexanoic acid	PFHxA	C_6
Perfluoroheptanoic acid	PFHpA	C_7
Perfluorooctanoic acid	PFOA	C_8
Perfluorononanoic acid	PFNA	C_9
Perfluorodecanoic acid	PFDA	C_{10}
Perfluoroundecanoic acid	PFuDA	C_{11}
Perfluorododecanoic acid	PFdDA	C_{12}
Perfluorotridecanoic acid	PFtrDA	C_{13}
Perfluorotetradecanoic acid	PFteDA	C_{14}
Perfluorohexadecanoic acid	PFhxDA	C_{16}
Perfluorooctadecanoic acid	PFoDA	C_{18}
PFAS sulfonic acids	**PFSAs**	
Perfluoro-1- butanesulfonic acid	PFBS	C_4
Perfluoro-1-pentanesulfonic acid	PFPS	C_5
Perfluoro-1-hexanesulfonic acid	PFHxS	C_6
Perfluoro-1-heptanesulfonic acid	PFHpS	C_7
Perfluoro-1-octanesulfonic acid	PFOS	C_8
Perfluoro-1-nonanesulfonic acid	PFNS	C_9
Perfluoro-1-decanesulfonic acid	PFDS	C_{10}
Perfluoro-1-dodecanesulfonic acid	PFDoS	C_{12}
PFAS sulfonamides and sulfonamidoacetic acids		
Perfluoro-1-octanesulfonamide substances	PFOSA	
Perfluorooctanesulfonamidoacetate	PFOSAA	
N-ethyl perfluorooctyl sulfonamide	*N*-EtFOSA	
2-(*N*-Methylperfluoro-1-octanesulfonamido)-ethanol	*N*-MeFOSE	
2-(*N*-ethylperfluoro-1-octanesulfonamido)-ethanol	*N*-EtFOSE	
Others		
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	
Hexafluoropropylene oxide dimer acid	GenX	
Perfluorooctylphosphoric acid	PFOPA	
2-Perfluorooctyl ethanoic acid	FOEA	
Na 8-Chloroperfluoro-1-octansulfonate	8Cl-PFOS	
Sodium 1H, 1H, 2H, 2H-perfluorodecane sulfonate	8:2 FTS	
Na 1H, 1H, 2H, 2H-perfluorododecane sulfonate	10:2 FTS	

Table S2. List of chemicals, consumables and instruments used

Chemicals and consumables	Supplier
Acetonitrile, Chromasolv for HPLC >99.9%	Bartelt
Methanol, Chromasolv for HPLC >99.9%	Bartelt
Ultrapure water, 18 M Ω cm	Milli-Pore
Ammonium acetate, Optima, LC/MS grade	Fisher Chemicals
Ammonium nitrate	Fluka
Acetic acid, glacial	Fisher Chemicals
Ammonia solution, Rotipuran >25%	Roth
Zirconium single element ICP standard from $ZrOCl_2$ in HCl 7% for coating the graphite tube	Merck
F single element IC standard from NaF 99.999%	Fisher Chemicals
Hexane, Chromasolv for HPLC >97.0%	Fisher Chemicals
KOH eluent, Dionex EGC III KOH	Thermo Scientific
Calcium single element ICP standard from $Ca(NO_3)_2$ in HNO_3	Merck
Native perfluorinated compound mix (PFAC-MXC) 2000 ng/mL	Wellington laboratories
Mass labelled perfluorinated compound extraction solution (MPFAC-C-ES) 2000 ng/mL	Wellington laboratories
Mass labelled perfluorinated compound injection solution (MPFAC-C-IS) 2000 ng/mL	Wellington laboratories
Perfluoro-1-octanesulfonamide (PFOSA), 50000 ng/mL	Wellington laboratories
N-ethylperfluoro-1-octylsulfonamide (N-EtFOSA), 50000 ng/mL	Wellington laboratories
Sodium 1H, 1H, 2H, 2H-perfluorodecane sulfonate (>98%) (8:2 FTS) 50000 ng/mL	Wellington laboratories
Na 1H, 1H, 2H, 2H-perfluorododecane sulfonate (>98%) (10:2 FTS) 50000 ng/mL	Wellington laboratories
Perfluorooctylphosphoric acid (>98%) (PFOPA) 50000 ng/mL	Wellington laboratories
2-Perfluorooctyl ethanoic acid (FOEA) 50000 ng/mL	Wellington laboratories
Na 8-Chloroperfluoro-1-octansulfonate (8Cl PFOS) 50000 ng/mL	Wellington laboratories
Perfluoro-1-octanesulfonamidoacetic acid (FOSAA) 50000 ng/mL	Wellington laboratories
2-(N-methylperfluoro1octanensulfonamido)-ethanol (>98%) (N-MetFOSE) 50000 ng/mL	Wellington laboratories
2-(N-ethylperfluoro1octanensulfonamido)-ethanol (>98%) (N-EtFOSE) 50000 ng/mL	Wellington laboratories
2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX) 50000 ng/mL	Wellington laboratories
Na dodecafluoro-3H-4,8-dioxannonanoate (NADONA) 50000 ng/mL	Wellington laboratories
Analytical column for target analysis, Brownlee, SPP C 18, 3 x 100 mm	Perkin Elmer
Guard column for target analysis, Brownlee, SPP C 18, 3 x 5 mm	Perkin Elmer
Analytical colunm for ion chromatography, RPR X 100 (10 µm, 4.6 × 250mm)	Hamilton
Anion exchange coulmn IonPac AS11-HC (4 µm, 2 x 250 mm)	Thermo Scientific
Guard coulmn for ion chromatograpy, Dionex IonPac AS11-AG (4 µm, 2 x 50 mm)	Thermo Scientific
Pyrolytically coated graphite tubes with PIN	Analitic Jena
Sonication bath, Transsonic 700/H	Elma
Centrifuge, Rotina 420R	Hettich Zentrifugen
Eppendorf centrifuge, CD2012 plus	Phoenix Instrument

SPE cartridges Oasis WAX, 150mg, 30µm	Waters
Eppendorf vials	Fisher Scientific
Centrifuge tubes (15 and 50mL)	VWR
Beakers (100mL)	Fisher Scientific
Measuring cylinders (10 - 100mL)	Fisher Scientific
SPE vacuum manifold Visiprep	Supelco Analytical
Glass pastour pipettes	Fisher Scientific
Glass TOC vials (40mL) with PP caps	Bartelt
Glass HPLC vials (1.5mL short thread vials)	Agilent tenchnologies
Glass conical inserts (250µL conical inserts)	Bartelt
DS bottles (50mL - 1L)	Fisher Scientific

Instruments	Manufacturer
Horizontal furnace (HF2100)	Mitsubishi Chemical Analytech
Gas absorption unit (GA211)	Mitsubishi Chemical Analytech
Ion chromatogram for EOF Dionex Aquion RFIC	Thermo Scientific
Ion chromatogram for total F ICS-5000	Thermo Scientific
High performance liquid chromatography, Infinity 1200	Agilent Technologies
Electrospray tandem mass spectrometer, ESI MS/MS 6545	Agilent Technologies
High resolution graphite furnace molecular absorption spectrometer, HR-GF-MAS, ContrAA 700	Analytic Jena

Table S3a. Collected snow samples from Teichalm TA samples), Klippitztörl (KP samples), Lachtal (LTSN samples) and Schladming (SD samples).

Sample	Description	Location coordinates	Location
TA_SB	Snow collected from away the skiing slopes.	47.349851, 15.461375	Teichalm
TA_3	Snow from the beginning of cross-country track.		
TA_4	Snow from downhill ski track in front of gates.	47.350036, 15.460056	
KP01	Snow from lower exit to parking place after the hut at upper parking.	46.945955, 14.699006	Klippitztörl
KP02	Snow from the bottom of the 2-seater lift.	46.943917, 14.691219	
KP03	Snow from the top of the 2-seater lift.	46.951578, 14.684604	
KP04	Directly in front of hut (where people park their skis) at upper parking.	46.945557, 14.698110	
KP05	Snow from middle exit to parking place after the hut at upper parking.	46.945804, 14.698882	
KP06	Middle of ski slope (where people either stop to wait for others or go through) next to the hut.	46.945731, 14.698075	
LTSN00	Snow collected from away the skiing slopes.	47.252184, 14.347565	Lachtal
LTSN01	Top of Lachtal chair lift.	47.263350, 14.354001	
LTSN02	Top of Schonberg lift.	47.265584, 14.375252	
LTSN03	Bottom of Schonberg lift.	47.259321, 14.366661	
LTSN04	Lachtal chair lift bottom (in front of gates).	47.251584, 14.365663	
LTSN05	Zinken slope.	47.268590, 14.344388	
LTSN06	bottom of Lachtal chair lift.	47.251584, 14.365663	
LTSN07	Langlauf loipe.	47.253058, 14.350012	
HS00	Hesshütte in Gesäuse.	47.555958, 14.660596	Gesäuse
SD01	Bottom of Hauser Kaibling gondola lift on 21. March 2022.	47.411519, 13.778071	Schladming
SD02	Bottom of Hauser Kaibling gondola lift on 22. March 2022.	47.411519, 13.778071	
SD03	Bottom of Planai I. gondola lift on 22. March 2022.	47.392544, 13.693738	
SD04	Middle of red 37 slope.	47.387051, 13.675479	
SD05	Top area of Rorhmoos I chairlift.	47.383858, 13.668667	

Table S3b. Collected soil samples from Lachtal (LT), Klippitztorl (KPS) and Schladming (SDS).

Sample	Description	Location coordinates	Location
LT1S	Samples taken at 1 m distance	47.1506, 14.2104	Lachtal, transect
LT2S			
LT3S			
LT4S			
LT5S			
LT6S			
LT7S			
LT8S			
LT9S			
LT10S			
LT11S	1m distance from 10S, 2m distance from 12S, and from this onwards, 2m distance		
LT12S			
LT13S			
LT14S			
LT15S			
LT16S	2m distance from 15S, 3m distance from 17S, and from this onwards, 3m distance		
LT17S			
LT18S			
LT19S			
LT20S	Last sample. 7m to the stream		
KPS BS	Soil from playground next to 2-seater lift.	46.943992, 14.692236	Klippitztörl
KPS02	Soil from the bottom of the 2-seater lift	46.943917, 14.691219	
KPS03	Soil from the top of the 2-seater lift	46.951578, 14.684604	
KPS04	Directly in front of hut (where people park their skiis).	46.945557, 14.698110	
KPS06	Middle of ski slope next to the hut	46.945731, 14.698075	
SDS01	Bottom of Hauser Kaibling gondola	47.411519, 13.778071	Schladming
SDS03	Bottom of planet planai gondola	47.392544, 13.693738	
SDS05	From the sport shop at Hochwurzen	47.383858, 13.668667	
SDS05-B	Top of DSL Rohrmoos I lift	47.383858, 13.668667	
SDS BS	Steirischer bodensee parking area from the burn	47.380759, 13.826371	

Table 3c. List of purchased ski waxes.

Name	Code	Manufacturer	Made in
Toko all in one hot wax universal Non Fluoro	1	TOKO	Switzerland
Contour	2	Contour	EU
Toko hot wax high fluoro (HF) (art. No.: 5501023)	3	TOKO	Switzerland
Moly Fluor wax (MB77-60)	4	SWIX	Norway
Ceranovax LF7 (LF07X-6)	5	SWIX	Norway
Ceranovax HF7 (HF07X-4)	6	SWIX	Norway

Table S4a. List of monitored transitions and MS parameters.

Compound Name	Precursor Ion	Product Ion	Ret Time (min)	Fragmentor	Collision Energy	Cell Accelerator Voltage	Polarity
10_2FTS	627	607	14.1	196	52	4	Negative
10_2FTS	627	81	14.1	196	92	4	Negative
8_2FTS	527	507	11.4	176	48	7	Negative
8_2FTS	527	81	11.4	176	80	7	Negative
8Cl-PFOS	515	99	13.3	202	104	4	Negative
d7-N-MetFOSE	623	59	21.2	106	48	4	Negative
FOEA	477	393	10.2	96	56	4	Negative
FOSAA	556	498	11.6	194	44	6	Negative
FOSAA	556	419	11.6	194	52	6	Negative
GenX	285	169	6.1	70	12	5	Negative
GenX	285	119	6.1	70	84	8	Negative
M2PFOA	415	370	9.2	70	16	4	Negative
M2PFteDA	715	670	17.5	122	36	4	Negative
M3PFBA	216	172	1.9	68	12	4	Negative
M3PFBS	302	80	5.6	162	88	4	Negative
M3PFHxS	402	80	9.8	176	108	4	Negative
M4PFHpA	367	322	7.5	74	20	4	Negative
M5PFHxA	318	273	5.3	68	28	4	Negative
M5PFPA	268	223	2.9	70	12	4	Negative
M6PFDA	519	474	12.1	106	16	6	Negative
M7PFuDA	570	525	13.4	82	24	5	Negative
M8PFOA	421	376	9.2	68	8	4	Negative
M8PFOS	507	80	12.9	196	100	6	Negative
M9PFNA	472	427	10.7	84	12	6	Negative
MPFBA	217	172	1.9	64	8	4	Negative
MPFDA	515	470	12.1	72	20	6	Negative
MPFdDA	615	570	14.8	118	24	6	Negative
MPFOS	503	80	12.9	204	112	6	Negative
NaDONA	377	251	8.1	72	20	6	Negative
NaDONA	377	85	8.1	72	72	6	Negative
N-EtFOSA	526	219	20.9	168	72	5	Negative
N-EtFOSA	526	169	20.9	168	108	5	Negative
N-EtFOSE	630	59	20.8	102	36	5	Negative
N-MetFOSE	616	59	20.4	106	48	4	Negative
PFBA	213	19	1.9	72	64	4	Negative
PFBA	213	169	1.9	72	12	4	Negative
PFBS	299	99	5.6	158	88	4	Negative
PFBS	299	80	5.6	158	112	4	Negative
PFDA	513	469	12.1	92	20	6	Negative
PFDA	513	219	12.1	92	24	6	Negative
PFdDA	613	569	14.8	104	24	6	Negative
PFdDA	613	269	14.8	104	52	6	Negative

Table S4a. Continued.

Compound Name	Precursor Ion	Product Ion	Ret Time (min)	Fragmentor	Collision Energy	Cell Accelerator Voltage	Polarity
PFdDS	699	99	18.3	208	112	4	Negative
PFdDS	699	80	18.3	208	116	4	Negative
PFDS	599	99	15.7	214	116	4	Negative
PFDS	599	80	15.7	214	104	4	Negative
PFHpA	363	319	7.5	74	16	4	Negative
PFHpA	363	169	7.5	74	28	4	Negative
PFHpS	449	99	11.4	200	120	4	Negative
PFHpS	449	80	11.4	200	92	4	Negative
PFHxA	313	269	5.3	72	12	4	Negative
PFHxA	313	119	5.3	72	88	4	Negative
PFhxDA	813	769	19.1	136	40	4	Negative
PFhxDA	813	169	19.1	136	64	4	Negative
PFHxS	399	99	9.8	186	76	4	Negative
PFHxS	399	80	9.8	186	108	4	Negative
PFNA	463	419	10.7	84	16	6	Negative
PFNA	463	219	10.7	84	28	6	Negative
PFNS	549	99	14.2	214	120	5	Negative
PFNS	549	80	14.2	214	108	5	Negative
PFOA	413	369	9.1	76	16	4	Negative
PFOA	413	169	9.1	76	28	4	Negative
PFoDA	913	869	20	142	52	4	Negative
PFoDA	913	169	20	142	96	4	Negative
PFOPA	499	79	18.2	164	108	5	Negative
PFOS	499	99	12.9	208	104	6	Negative
PFOS	499	80	12.9	208	108	6	Negative
PFOSA	498	78	18.2	174	92	5	Negative
PFPA	263	219	2.9	56	8	4	Negative
PFPS	349	99	7.9	164	84	4	Negative
PFPS	349	80	7.9	164	108	4	Negative
PFteDA	713	669	17.5	94	32	4	Negative
PFteDA	713	169	17.5	94	116	4	Negative
PFtrDA	663	619	16.2	104	32	4	Negative
PFtrDA	663	169	16.2	104	68	4	Negative
PFuDA	563	519	13.4	52	16	5	Negative
PFuDA	563	169	13.4	52	92	5	Negative

Table S4b. LC method

Time (min)	A (%)	B (%)
0.0	75	25
1.0	75	25
15.0	40	60
19.0	0	100
24.0	0	100
24.1	75	25
28.0	75	25

Table S5. Concentration of target PFAS in soil and wax samples in ng/g and snowmelt in ng/L.

Origin	Sample name	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFuDA	PFdDA	PFtrDA	PFteDA	PFhxDA	PFoDA	PFBS	PFPS	PFHxS	PFHpS	PFOS
Lachtal soil	**MB_1**	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	***<LOQ***
	LT1S	0.27	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	0.49	0.23	0.19	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT2S	0.22	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	0.59	0.68	0.46	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT3S	***<LOQ***	<LOD	<LOD	***<LOQ***	***<LOQ***	0.69	0.64	0.49	0.18	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT4S	0.40	***<LOQ***	***<LOQ***	0.35	***<LOQ***	0.83	0.72	0.58	0.18	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT5S	<LOD	<LOD	<LOD	<LOD	<LOD	0.23	0.19	0.12	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LT6S	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	***<LOQ***	0.52	0.43	0.38	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT7S	***<LOQ***	<LOD	<LOD	***<LOQ***	***<LOQ***	0.33	0.18	0.14	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	MB_2	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD
	LT8S	0.31	***<LOQ***	***<LOQ***	0.33	***<LOQ***	0.52	0.33	0.33	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT9S	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	0.35	0.22	0.25	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT10S	0.36	***<LOQ***	***<LOQ***	0.36	***<LOQ***	0.61	0.35	0.32	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT11S_1	<LOD	<LOD	***<LOQ***	***<LOQ***	***<LOQ***	0.38	0.27	0.22	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT11S_2	***<LOQ***	<LOD	<LOD	***<LOQ***	1.04	0.49	0.32	0.30	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT11S_3	<LOD	<LOD	<LOD	<LOD	<LOD	0.41	0.26	0.23	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT12S	***<LOQ***	<LOD	***<LOQ***	0.34	***<LOQ***	0.75	0.31	0.26	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	MB_3	***<LOQ***	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD
	LT13S	1.0	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	0.42	0.29	0.32	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	0.46
	LT14S	1.6	0.207	***<LOQ***	0.57	***<LOQ***	0.90	0.63	0.67	0.21	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.60
	LT15S	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	0.63	***<LOQ***	0.31	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT16S	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	0.77	0.69	0.72	0.23	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT17S	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	0.72	0.36	0.28	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LT18S	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	0.37	0.29	0.24	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Table S5. Concentration of target PFAS in soil and wax samples in ng/g and snowmelt in ng/L.

Origin	Sample name	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFuDA	PFdDA	PFtrDA	PFteDA	PFhxDA	PFoDA	PFBS	PFPS	PFHxS	PFHpS	PFOS
Lachtal soil	**LT19S**	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	0.29	0.19	0.17	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LT20S_1	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	0.32	0.17	0.16	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LT20S_2	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	0.30	0.18	0.14	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Klippitztorl soil	**KPS soil from non-skiing area**	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	0.070	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.95
	KPS02	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	0.86	***<LOQ***	<LOD	0.077	0.11	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	2.9
	KPS03	<LOD	<LOD	<LOD	<LOD	***<LOQ***	0.37	1.18	***<LOQ***	***<LOQ***	0.17	0.21	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.85
	KPS04-1	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	KPS04-2	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	KPS04-3	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	KPS06	<LOD	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	***<LOQ***
Teichalm and Klippitztorl snowmelt	**KP MB**	<LOD	<LOD	<LOD	<LOD	15	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD
	TASB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	KP01	***<LOQ***	***<LOQ***	10	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	KP02	***<LOQ***	<LOD	8.8	***<LOQ***	***<LOQ***	***<LOQ***	20	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.3
	KP03	113	<LOD	10	***<LOQ***	***<LOQ***	***<LOQ***	16	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	3.3
	KP04	51	<LOD	10	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	KP05	40	<LOD	9.2	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	KP06	69	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	TA03	***<LOQ***	6.7	61	***<LOQ***	***<LOQ***	16	24	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.1
	TA04	29	***<LOQ***	23	5.0	***<LOQ***	***<LOQ***	12	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Table S5. Concentration of target PFAS in soil and wax samples in ng/g and snowmelt in ng/L.

Origin	Sample name	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFuDA	PFdDA	PFtrDA	PFteDA	PFhxDA	PFoDA	PFBS	PFPS	PFHxS	PFHpS	PFOS
Lachtal snowmelt	**LTSN MB**	<LOD	<LOD	<LOD	<LOD	16	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN00	***<LOQ***	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN01	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN02	***<LOQ***	<LOD	***<LOQ***	<LOD	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN03	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN04	***<LOQ***	<LOD	***<LOQ***	<LOD	***<LOQ***	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN05	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	LTSN06	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***
	LTSN07	***<LOQ***	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Schladming snowmelt	**SD MB**	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	SD01	2.0	10	28	3.4	<LOD	3.1	<LOD	<LOD	0.3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	SD02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	SD03	<LOD	<LOD	1.7	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	SD04	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	SD05	<LOD	5.9	13	<LOD	<LOD	6.4	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	HS00	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Table S5. Concentration of target PFAS in soil and wax samples in ng/g and snowmelt in ng/L.

Origin	Sample name	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFuDA	PFdDA	PFtrDA	PFteDA	PFhxDA	PFoDA	PFBS	PFPS	PFHxS	PFHpS	PFOS
Ski wax	**MB_Wax1**	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	MB_Wax2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	MB_Wax3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_1_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_1_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_1_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_2_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_2_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_2_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_3_1	<LOD	***<LOQ***	<LOD	<LOD	<LOD	25	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_3_2	<LOD	***<LOQ***	<LOD	<LOD	<LOD	24	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_3_3	***<LOQ***	***<LOQ***	<LOD	***<LOQ***	***<LOQ***	28	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_4_1	5.6	12	175	518	<LOD	6.2	2.4	2.9	***<LOQ***	***<LOQ***	0.77	***<LOQ***	<LOD	<LOD	<LOD	148	<LOD	3.1
	Wax_4_2	***<LOQ***	13	186	488	<LOD	5.7	2.1	2.6	***<LOQ***	1.7	0.74	***<LOQ***	<LOD	<LOD	<LOD	77	<LOD	***<LOQ***
	Wax_4_3	***<LOQ***	***<LOQ***	76	222	<LOD	***<LOQ***	0.88	***<LOQ***	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOD	<LOD	24	<LOD	***<LOQ***
	Wax_5_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_5_2	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_5_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_6_1	37	41	173	82	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_6_2	27	33	128	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
	Wax_6_3	24	26	116	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Table S5. Concentration of target PFAS as well as the sum of target PFAS in soil and wax samples in ng/g (EOF in ng F/g) and snowmelt in ng/L (EOF ng F/L) and % of target PFAS in EOF.

Origin	Sample name	PFNS	PFDS	PFdDS	PFOSA	N-EtFOSA	8Cl PFOS	PFOPA	GenX_2	Nadona	8:2 FTS	10:2 FTS	PFOSAA	N-MetFOSE	N-EtFOSE	FOEA	∑ PFAS	EOF	%
Lachtal soil	**MB_1**	<LOD	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	<LOD	<LOQ	<LOQ	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	0	309	N.A.
	LT1S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.2	68	1.2
	LT2S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.9	102	1.3
	LT3S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.0	143	0.99
	LT4S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	3.1	283	0.75
	LT5S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.54	117	0.33
	LT6S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.3	170	0.55
	LT7S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.66	92	0.50
	MB_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	<LOD	N.A.
	LT8S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.8	<LOD	N.A.
	LT9S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.83	84	0.69
	LT10S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.0	109	1.2
	LT11S_1	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.87	146	0.42
	LT11S_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.1	102	1.5
	LT11S_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.90	152	0.41
	LT12S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.7	118	0.99
	MB_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	283	N.A.
	LT13S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.5	<LOD	N.A.
	LT14S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	5.4	<LOD	N.A.
	LT15S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.95	<LOD	N.A.
	LT16S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.4	<LOD	N.A.
	LT17S	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.3	313	0.30
	LT18S	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.90	<LOD	N.A.

Table S5. Concentration of target PFAS as well as the sum of target PFAS in soil and wax samples in ng/g (EOF in ng F/g) and snowmelt in ng/L (EOF ng F/L) and % of target PFAS in EOF

Origin	Sample name	PFNS	PFDS	PFdDS	PFOSA	N-EtFOSA	8Cl PFOS	PFOPA	GenX	Nadona	8:2 FTS	10:2 FTS	PFOSAA	MetFOSE	EtFOSE	FOEA	∑ PFAS	EOF	%
Lachtal soil	**LT19S**	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.65	<LOD	0
	LT20S_1	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.64	<LOD	0
	LT20S_2	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.62	67	0.65
Klippitztorl soil	**KPS soil from non-skiing area**	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.0	N.A.	N.A.
	KPS02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	4.0	N.A.	N.A.
	KPS03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2.8	N.A.	N.A.
	KPS04-1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	N.A.	N.A.
	KPS04-2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	N.A.	N.A.
	KPS04-3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	N.A.	N.A.
	KPS06	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	N.A.	N.A.
Teichalm and Klippitztorl snowmelt	**KP MB**	<LOD	<LOD	<LOD	1.4	***<LOQ***	<LOD	<LOD	***<LOQ***	***<LOQ***	<LOD	1.3	***<LOQ***	***<LOQ***	***<LOQ***	<LOD	18	<LOQ	N.A.
	TASB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0	<LOD	N.A.
	KP01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	10	<LOD	N.A.
	KP02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	42	<LOD	N.A.
	KP03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	143	<LOD	N.A.
	KP04	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	62	<LOD	N.A.
	KP05	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	49	<LOD	N.A.
	KP06	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	69	<LOD	N.A.
	TA03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	109	<LOD	N.A.
	TA04	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	81	<LOD	N.A.

Table S5. Concentration of target PFAS as well as the sum of target PFAS in soil and wax samples in ng/g (EOF in ng F/g) and snowmelt in ng/L (EOF ng F/L) and % of target PFAS in EOF.

Origin	Sample name	PFNS	PFDS	PFdDS	PFOSA	N-EtFOSA	8Cl PFOS	PFOPA	GenX	Nadona	8:2 FTS	10:2 FTS	PFOSAA	MetFOSE	EtFOSE	FOEA	∑ PFAS	EOF	%
Lachtal snowmelt	**LTSN MB**	<LOD	<LOD	<LOD	1.4	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.2	<LOD	<LOD	<LOD	<LOD	18	0.87	1.4
	LTSN00	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	LTSN01	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	LTSN02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	LTSN03	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	LTSN04	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	LTSN05	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.0	<LOQ	N.A.
	LTSN06	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	***<LOQ***	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	LTSN07	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
Schladming snowmelt	**SDMB**	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	SD01	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	47	<LOD	N.A.
	SD02	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	SD03	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.7	<LOD	N.A.
	SD04	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.
	SD05	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	25	<LOD	N.A.
	HS00	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.0	<LOD	N.A.

Table S5. Concentration of target PFAS as well as the sum of target PFAS in soil and wax samples in ng/g (EOF in ng F/g) and snowmelt in ng/L (EOF ng F/L) and % of target PFAS in EOF.

Origin	Sample name	PFNS	PFDS	PFdDS	PFOSA	N-EtFOSA	8Cl PFOS	PFOPA	GenX	Nadona	8:2 FTS	10:2 FTS	PFOSAA	MetFOSE	EtFOSE	FOEA	∑ PFAS	EOF	%
Ski wax	**MB_Wax1**	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	MB_Wax2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	MB_Wax3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_1_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_1_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_1_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_2_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_2_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_2_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	N.A.
	Wax_3_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	307	<LOD	518000	0.04
	Wax_3_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	324	<LOD	558000	0.04
	Wax_3_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	390	<LOD	540000	0.05
	Wax_4_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	921000	0.06
	Wax_4_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	519000	0.10
	Wax_4_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	567000	0.04
	Wax_5_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	662000	N.A.
	Wax_5_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	689000	N.A.
	Wax_5_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	296000	N.A.
	Wax_6_1	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2320000	0.01
	Wax_6_2	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1850000	0.01
	Wax_6_3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	2180000	0.01

MB: method blank. N.A.: not applicable. <LOQ: below limit of quantification. <LOD: below limit of detection.

Table S6a. Average recoveries ± standard deviation (n=3) of PFAS from different sample media (%) using target analysis.

Sample matrix	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFuDA	PFdDA	PFtrDA	PFteDA	PFhxDA	PFoDA	PFBS	PFPS	PFHxS	PFHpS
Wax	42 ± 9	50 ± 7	72 ± 10	69 ± 6	61 ± 6	65 ± 4	72 ± 4	73 ± 5	73± 4	70 ± 3	72 ± 4	86 ± 3	90 ± 4	57v± 7	54 ± 5	47 ± 26	70 ± 4
Snowmelt	99 ± 8	98 ± 10	111 ± 11	113 ± 9	106 ± 11	101 ± 8	105 ± 10	97 ± 7	88± 4	98 ± 3	70 ± 0	17 ± 1	2 ± 0	80v± 6	102 ± 9	103 ± 26	98 ± 12
Soil	57 ± 11	57 ± 10	59 ± 14	61 ± 12	56 ± 8	58 ± 10	57 ± 11	56 ± 15	51± 11	33 ± 17	38 ± 9	30 ± 12	31 ± 14	62 ± 11	59 ± 11	62 ± 16	59 ± 12

Sample matrix	PFOS	PFNS	PFDS	PFdDS	PFOSA	FOEA	8Cl PFOS	PFOPA	GenX	Nadona	8:2 FTS	10:2 FTS	PFOSAA	N-MetFOSE	N-EtFOSE	N-EtFOSA
Wax	82 ± 6	72 ± 5	80 ± 3	76 ± 3	23 ± 6	10 ± 4	60 ± 3	20 ± 5	42 ± 5	56 ± 4	48 ± 3	53 ± 2	59 ± 3	43 ± 3	15 ± 5	26 ± 6
Snowmelt	110 ± 12	97 ± 11	99 ± 11	76 ± 9	67 ± 11	100 ± 15	68 ± 9	62 ± 8	76 ± 9	76 ± 9	69 ± 11	67 ± 7	59 ± 5	N.R.	N.R.	N.R.
Soil	59 ± 12	62 ± 13	63 ± 16	65 ± 13	1 ± 0	46 ± 28	60 ± 2	N.R.	63 ± 5	62 ± 7	75 ± 10	88 ± 17	65 ± 28	N.R.	N.R.	N.R.
N.R.: not recovered																

Table S6b. Average recoveries ± standard deviation (n=3) of isotopically labelled PFAS from different sample media (%) using target analysis.

Sample matrix	M3PFBA	M2PFOA	MPFDA	M3PFOS		
Soil	98 ± 5	87 ± 6	81 ± 6	92 ± 5		
Water	93 ± 1	96 ± 5	91 ± 6	89 ± 5		
Wax	49± 2	54 ± 2	54 ± 4	51 ± 3		

Table S7. Average recoveries ± standard deviation (n=3) of EOF analysis with CIC and with HR-GF-MAS*

Sample matrix	Recovery (%)
Wax methanol (spiked before extraction)	63 ± 26
Wax hexane (spiked before extraction)	9 ± 2
Soil (spiked before extraction)	191 ± 70
Snowmelt (spiked before extraction)	NA
Wax methanol (spiked before extraction)*	63 ± 21
Methanol spiked with inorganic and organic F	105 ± 19
BCR-461 (clay reference material)	95 ± 3

Table S8. Average recoveries ± standard deviation (n=3) of TF analysis (%).

Sample matrix	Recovery (%)
Wax	109 ± 7

Table S9. Concentration of EOF in wax samples extracted with hexane in µg F/g.

Name	EOF (µg F/g)	Average EOF µgF/g	Standard deviation	RSD (%)
Wax_1_Hexane_1	<LOQ	<LOQ	N.A.	N.A.
Wax_1_Hexane_2	<LOQ			
Wax_1_Hexane_3	<LOQ			
Wax_2_Hexane_1	<LOQ	<LOQ	N.A.	N.A.
Wax_2_Hexane_2	<LOQ			
Wax_2_Hexane_3	<LOQ			
Wax_3_Hexane_1	1018	1973	685	35
Wax_3_Hexane_2	2590			
Wax_3_Hexane_3	2312			
Wax_4_Hexane_1	2461	2615	109	4
Wax_4_Hexane_2	2687			
Wax_4_Hexane_3	2698			
Wax_5_Hexane_1	3469	3775	588	16
Wax_5_Hexane_2	3259			
Wax_5_Hexane_3	4597			
Wax_6_Hexane_1	19178	18928	2035	11
Wax_6_Hexane_2	16319			
Wax_6_Hexane_3	21285			

N.A.: not applicable

Table S10. EOF concentrations in wax samples, extracted with MetOH, measured with HR-GF-MAS

Name	EOF (µgF/g)	average conc (µgF/g)	sdev conc (µgF/g)	rsd (%)	measured with CIC (µgF/g)	how much more?	p of t test
waxE_MB_1	<LOQ	<LOQ	N.A.	N.A.	<LOQ	N.A.	N.A.
waxE_MB_2	<LOQ						
waxE_MB_3	<LOQ						
waxE_2_1	<LOQ	<LOQ	N.A.	N.A.	<LOQ	N.A.	N.A.
waxE_2_2	<LOQ						
waxE_2_3	<LOQ						
waxE_1_1	<LOQ	<LOQ	N.A.	N.A.	<LOQ	N.A.	N.A.
waxE_1_2	<LOQ						
waxE_1_3	<LOQ						
waxE_3_1	959	1327	322	24	518	2	0.03
waxE_3_2	1278				558	2	
waxE_3_3	1742				540	3	
waxE_4_1	2118	2098	157	7	921	2	0.001
waxE_4_2	2278				519	4	
waxE_4_3	1896				567	3	
waxE_5_1	2717	2788	365	13	662	4	0.001
waxE_5_2	2380				689	3	
waxE_5_3	3267				296	11	
waxE_6_1	15992	13405	1830	14	2319	7	0.001
waxE_6_2	12187				1851	7	
waxE_6_3	12036				2175	6	

Table 11 Enrichment factor.

Sample name	Mass (g)	End volume (mL)	enrichment factor	average enrichment factor
LT1S	2.0747	1	2.07	2.043
LT2S	2.0991	1	2.10	
LT3S	2.0169	1	2.02	
LT4S	2.0794	1	2.08	
LT5S	2.0301	1	2.03	
LT6S	2.0133	1	2.01	
LT7S	2.0052	1	2.01	
LT8S	2.0700	1	2.07	
LT9S	2.0236	1	2.02	
LT10S	2.0473	1	2.05	
LT11S_1	2.0536	1	2.05	
LT11S_2	2.052	1	2.05	
LT11S_3	2.0528	1	2.05	
LT12S	2.0277	1	2.03	
LT13S	2.200	1	2.20	
LT14S	1.990	1	1.99	
LT15S	2.160	1	2.16	
LT16S	2.080	1	2.08	
LT17S	2.050	1	2.05	
LT18S	2.0115	1	2.01	
LT19S	2.0226	1	2.02	
LT20S_1	2.0612	1	2.06	
LT20S_2	2.0529	1	2.05	
KPS blank soil	1.9999	1	2.00	
KPS 02	1.9949	1	1.99	
KPS 03	2.0025	1	2.00	
KPS 04-1	2.0213	1	2.02	
KPS 04-2	2.0167	1	2.02	
KPS 04-3	1.9965	1	2.00	
KPS 06	1.994	1	1.99	
TASB	212	1	212	
KP01	206	1	206	
KP02	208	1	208	
KP03	157	1	157	
KP04	209	1	209	
KP05	208	1	208	
KP06	209	1	209	
TA03	201	1	201	
TA04	214	1	214	
LTSN00	205	1	205	
LTSN01	139	1	139	
LTSN02	204	1	204	

Table S11. Enrichment factor continued

Sample name	Mass (g)	End volume (mL)	enrichment factor	average enrichment factor
LTSN03	80	1	80	245
LTSN04	199	1	199	
LTSN05	205	1	205	
LTSN06	209	1	209	
LTSN07	211	1	211	
SD01	500	1	500	
SD02	500	1	500	
SD03	500	1	500	
SD04	500	1	500	
SD05	150	1	150	
HS00	200	1	200	
Wax_1_1	0.2075	1	0.21	0.21
Wax_1_2	0.2009	1	0.20	
Wax_1_3	0.2067	1	0.21	
Wax_2_1	0.2047	1	0.20	
Wax_2_2	0.2061	1	0.21	
Wax_2_3	0.2116	1	0.21	
Wax_3_1	0.2042	1	0.20	
Wax_3_2	0.1997	1	0.20	
Wax_3_3	0.2053	1	0.21	
Wax_4_1	0.207	1	0.21	
Wax_4_2	0.2099	1	0.21	
Wax_4_3	0.2086	1	0.21	
Wax_5_1	0.204	1	0.20	
Wax_5_2	0.1987	1	0.20	
Wax_5_3	0.2056	1	0.21	
Wax_6_1	0.2079	1	0.21	
Wax_6_2	0.2010	1	0.20	
Wax_6_3	0.2006	1	0.20	

Table S12. Instrumental and averaged method limit of quantifications for target PFAS analysis.

	PFBA	PFPA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFuDA	PFdDA	PFtrDA	PFteDA	PFhxDA	PFoDA	PFBS	PFPS	PFHxS	PFHpS	PFOS
Instrumental LOQ for Lachtal soil (µg/L)	**0.114**	**0.134**	**0.102**	**0.153**	**0.332**	**0.115**	**0.056**	**0.044**	**0.090**	**0.237**	**0.133**	**8.0**	**8.6**	**0.085**	**0.187**	**0.175**	**0.086**	**0.391**
Method LOQ for Lachtal soil (ng/g)	0.062	0.073	0.056	0.083	0.181	0.062	0.030	0.024	0.049	0.129	0.073	4.367	4.670	0.046	0.102	0.095	0.047	0.212
Instrumental LOQ for snowmelt (µg/L)	**0.714**	**0.351**	**0.499**	**1.1**	**60.8**	**0.372**	**4.156**	**0.170**	**0.122**	**0.087**	**0.144**	**0.883**	**2.0**	**0.609**	**0.405**	**0.308**	**0.197**	**0.354**
Method LOQ for snowmelts (ng/g)	0.0032	0.0016	0.0023	0.0050	0.2764	0.0017	0.0189	0.0008	0.0006	0.0004	0.0007	0.0040	0.0090	0.0028	0.0018	0.0014	0.0009	0.0016
Instrumental LOQ for wax (µg/L)	**1.0**	**1.4**	**11.7**	**12.7**	**6.9**	**1.00**	**0.15**	**0.48**	**0.39**	**0.32**	**0.11**	**0.23**	**0.21**	**2.67**	**0.38**	**0.64**	**0.45**	**0.35**
Method LOQ for wax (ng/g)	5.60	7.60	63.47	68.67	37.51	5.40	0.84	2.61	2.11	1.72	0.60	1.27	1.12	14.49	2.07	3.49	2.43	1.89

	PFNS	PFDS	PFdDS	PFOSA	N-EtFOSA	8Cl PFOS	PFOPA	GenX	Nadona	8:2 FTS	10:2 FTS	PFOSAA	N-MetFOSE	N-EtFOSE	FOEA
Instrumental LOQ for Lachtal soil (µg/L)	**0.147**	**0.163**	**1.1**	**0.034**	**0.066**	**0.127**	**2.642**	**0.057**	**0.137**	**0.306**	**0.162**	**0.291**	**0.054**		
Method LOQ for Lachtal soil (ng/g)	0.080	0.089	0.592	0.019	0.036	0.069	1.437	0.031	0.074	0.166	0.088	0.158	0.030	0.000	0.000
Instrumental LOQ for snowmelt (µg/L)	**0.299**	**0.247**	**0.340**	**0.527**	**0.443**	**1.45**	**N.M.**	**0.905**	**0.296**	**5.3**	**1.7**	**0.779**	**0.289**	**0.820**	**5.1**
Method LOQ for snowmelts (ng/g)	0.0014	0.0011	0.0015	0.0024	0.0020	0.0066	N.M.	0.0041	0.0013	0.0239	0.0079	0.0035	0.0013	0.0037	0.0233
Instrumental LOQ for wax (µg/L)	**0.22**	**0.34**	**1.2**	**1.4**	**1.7**	**0.27**	**3.9**	**2.1**	**1.5**	**0.58**	**1.4**	**1.1**		**1.5**	**2.9**
Method LOQ for wax (ng/g)	1.20	1.84	6.65	7.57	9.40	1.47	21.06	11.20	8.17	3.14	7.35	6.15		8.17	15.83

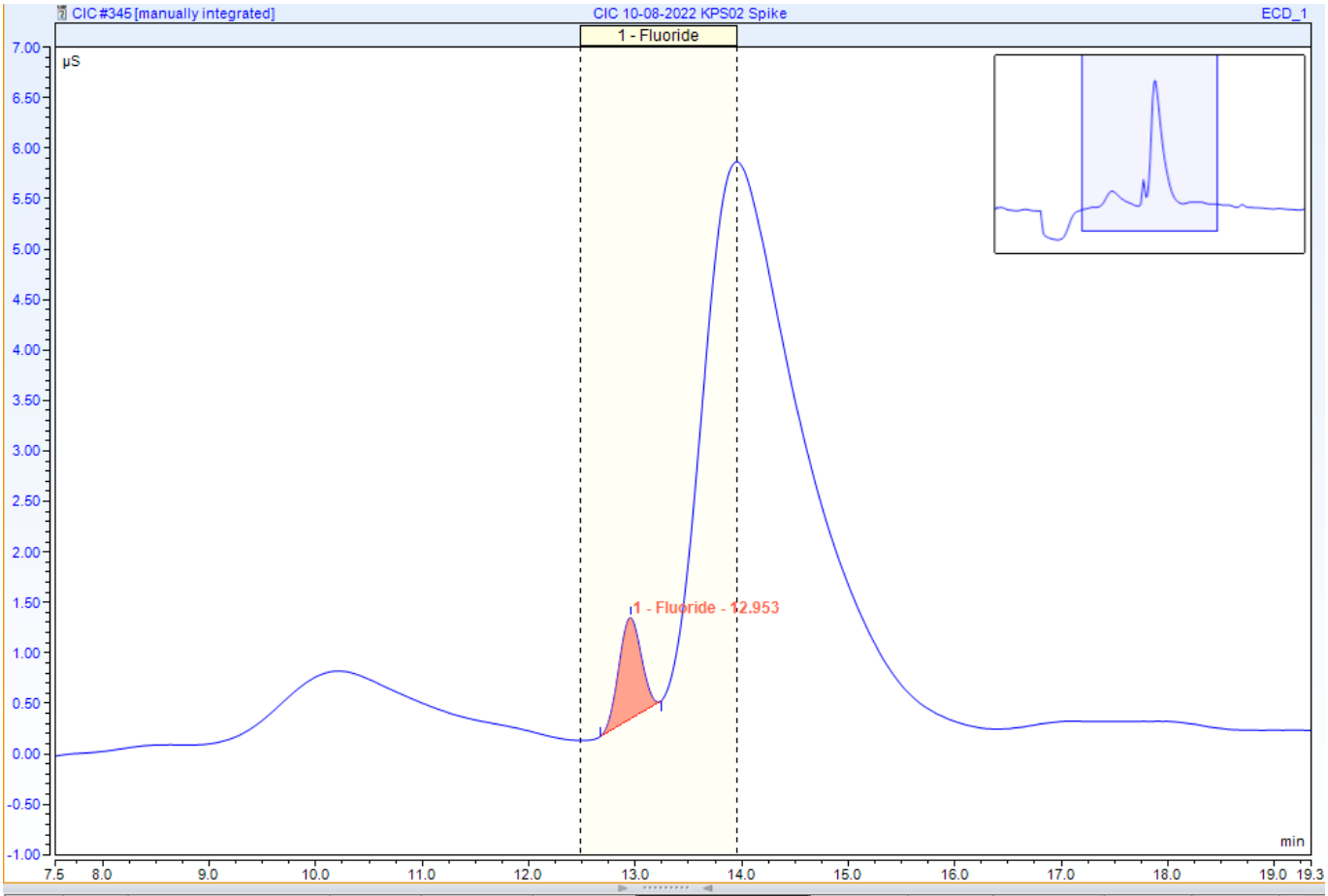
Table S13. Averaged method limit of quantifications for EOF analysis (with CIC and HR-GF-MAS).

	CIC	HR-GF-MAS
Method LOQ for Lachtal soil (ng/g)	35	N.A
Method LOQ for snowmelts (ng/g)	0.81	N.A
Method LOQ for wax (ng/g)	1039	1414

N.A: not applicable

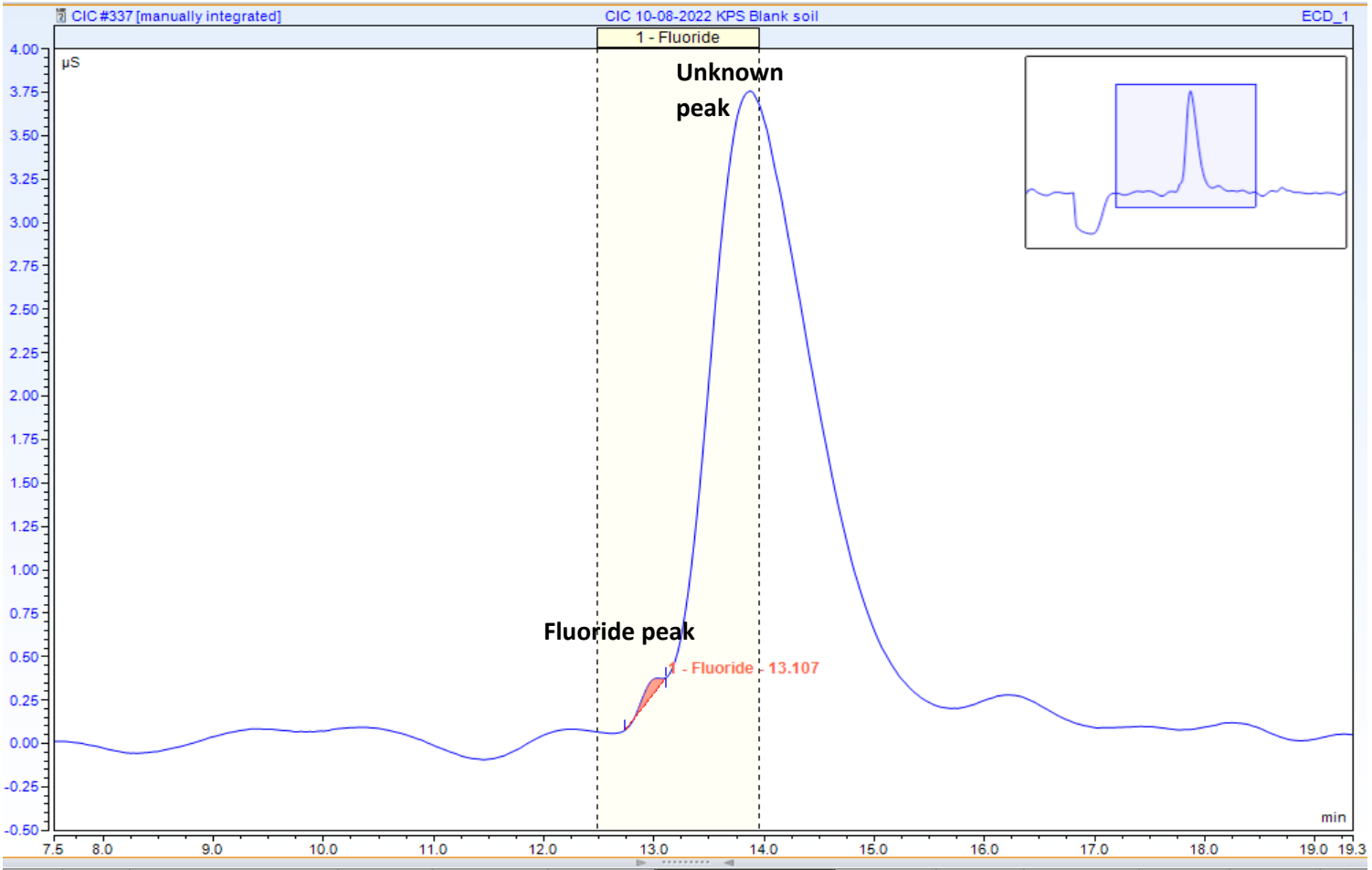
Table S14. Total fluorine concentration in wax samples.

Sample code	Fluorine concentration (µg/g)	average EOF methanol (µg/g)	average EOF hexane (µg/g)	% of methanol	% of hexane
1	< 16				
2	< 16				
3	4280 ± 140	539	1970	13	46
4	4450 ± 360	669	2620	15	59
5	4770 ± 400	549	3780	12	79
6	31200 ± 420	2120	18900	7	61



	A	B	C	D	E	F	G	H	I	J	K
1	Peak No.	Peak Name	Ret.Time min	Amount ppb	Rel.Area %	Area µS*min	Height µS	Type	Width (50%) min	Asym. EP	Resol. EP
4	1	Fluoride	12.953	605.8362	100.00	0.2431981	1.00590	BMB*	0.232	1.00	n.a.

Figure S1. Klippitztörl soil ion chromatogram with CIC in KPS02 sample spiked with 1 ppm PFAS mix.



	A	B	C	D	E	F	G	H	I	J	K
1	Peak No.	Peak Name	Ret.Time min	Amount ppb	Rel.Area %	Area µS*min	Height µS	Type	Width (50%) min	Asym. EP	Resol. EP
4	1	Fluoride	13.107	n.a.	100.00	0.0144879	0.00000	BMB*	n.a.	n.a.	n.a.

Figure S2. Klippitztörl soil ion chromatogram with CIC in KPS blank soil from a non-skiing area.

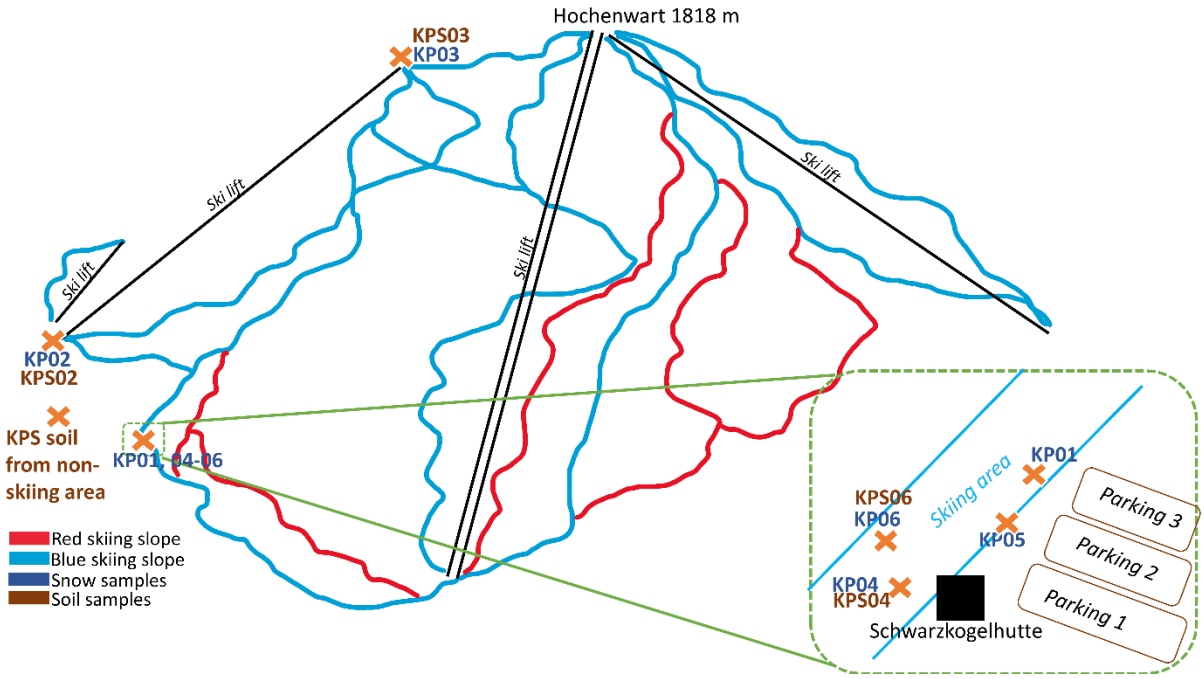


Figure S3a. Sampling area and samples from Klippitztörl site.

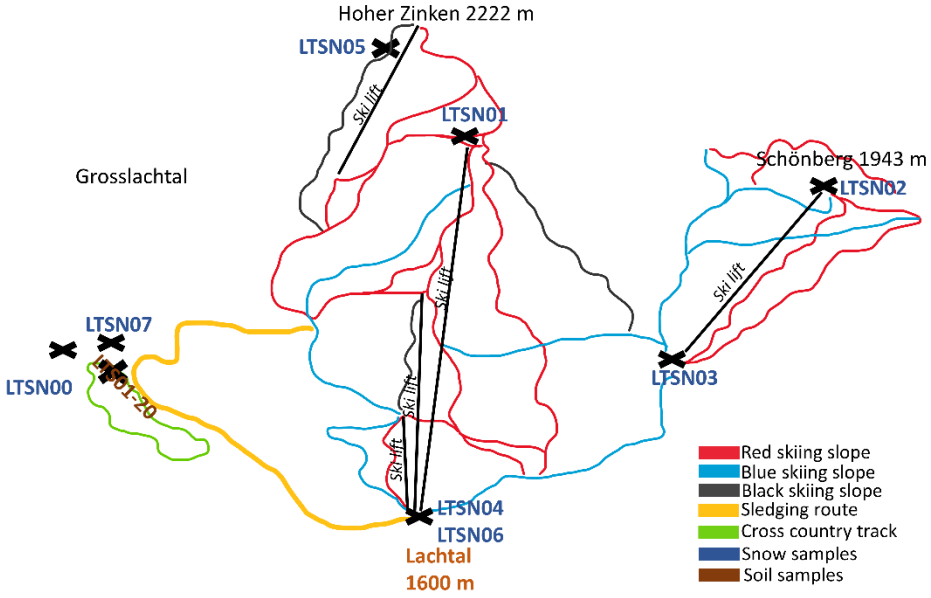


Figure S3b. Sampling area and samples from Lachtal site.

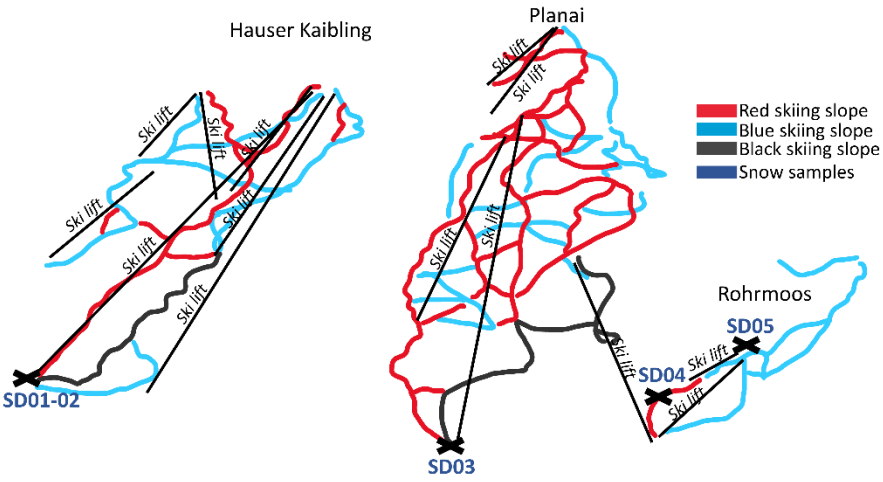


Figure S3c. Sampling area and samples from Schladming site.

Figure S3d. Sampling area and samples from Teichalm site.

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