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Similar freezing spectra of particles in plant canopies and in the air at a high-altitude site

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Table S1: Data acquired from trees sampled in Gempen (FS: *F. sylvatica*, JR: *J. regia*, PA: *P. avium*, TP: *T. platyphyllos*): leaf colour as NCS code, differential INP concentration k(T), spectral type (mon: monotonous increase, brackets for spectra with insignificant peaks), leaf mass per area (LMA). Duplicate measurements of leaf C and N displayed in separate rows.

dd/mm/yyyy	no	tree ID	NCS code	k(T) (cm^{-2} K^{-1})								INP_{-10} (cm^{-2})	spectral type	LMA (g m^{-2})	$\delta^{13}C$ (‰)	N (mg (g dry weight)$^{-1}$)	C:N atomic ratio
				-2.5	-3.5	-4.5	-5.5	-6.5	-7.5	-8.5	-9.5						
09/08/2023	1	FS1	4050 G40Y	0.00	0.00	0.00	0.27	0.54	1.22	2.13	3.51	7.7	mon	84.6	-30.7	29.1	19.4
	2	FS2	3050 G30Y	0.00	0.00	0.00	0.98	2.00	6.28	10.32	16.79	36.4	mon	36.5	-31.9	19.2	28.6
	3	JR1	3050 G30Y	0.00	0.00	0.00	0.00	7.97	5.23	3.78	2.13	19.1	>-7.5	31.4	-33.4	33.1	14.1
	4	JR2	5030 G30Y	0.00	0.00	0.00	0.04	0.29	0.21	0.55	2.39	3.5	(>-7.5)	74.9	-29.8	38.5	14.2
	5	PA1	3050 G30Y	0.00	0.00	0.00	0.03	0.33	0.65	1.43	1.60	4.0	mon	75.7	-29.3	24.8	22.4
	6	PA2	4050 G40Y	0.00	0.00	0.00	0.02	0.09	0.30	0.64	0.71	1.8	mon	89.2	-29.1	19.6	28.0
	6	PA2													-29.3	20.2	27.3
	7	TP1	4050 G40Y	0.00	0.00	0.00	0.04	0.05	0.11	0.30	0.22	0.7	(-8.5)	49.4	-28.5	36.4	15.1
	8	TP2	4050 G40Y	0.00	0.00	0.02	0.03	0.13	0.36	0.42	0.76	1.7	mon	49.7	-28.5	33.9	16.3
22/08/2023	9	FS1	3560 G30Y	0.00	0.00	0.02	0.06	2.04	3.74	4.49	5.32	15.7	mon	79.0	-30.7	21.0	27.1
	10	FS2	3560 G30Y	0.00	0.00	0.06	0.15	1.60	3.82	11.81	18.42	35.9	mon	30.0	-33.6	26.8	20.8
	11	JR1	6030 G30Y	0.00	0.00	0.00	0.09	1.43	2.37	2.33	3.05	9.3	-7.5	31.7	-33.8	35.4	14.3
	12	JR2	5030 G30Y	0.00	0.00	0.00	0.03	0.31	0.69	0.88	2.05	4.0	mon	47.7	-32.2	33.3	16.8
	13	PA1	5040 G40Y	0.00	0.00	0.00	0.41	2.49	1.29	0.00	0.51	4.7	>-7.5	71.5	-29.6	22.0	24.8
	14	PA2	4550 G40Y	0.00	0.00	0.00	0.02	0.11	0.65	1.20	0.70	2.7	-8.5	73.4	-29.5	21.8	25.9
	15	TP1	4550 G40Y	0.00	0.00	0.00	0.00	0.08	0.40	0.68	0.31	1.5	-8.5	46.9	-28.1	32.5	17.0
	16	TP2	4050 G40Y	0.00	0.00	0.00	0.46	2.75	4.98	13.74	3.68	25.6	-8.5	33.2	-29.9	27.9	18.2
	16	TP2													-30.2	30.4	16.9
12/09/2023	17	FS1	4550 G50Y	0.00	0.00	0.00	0.04	0.16	1.07	1.83	4.90	8.0	mon	82.2	-29.7	24.7	23.1
	18	FS2	4050 G40Y	0.00	0.00	0.04	0.82	2.59	22.70	18.84	25.28	70.3	-7.5	29.7	-34.0	23.2	23.5
	19	JR1	4550 G30Y	0.02	0.03	0.09	0.34	1.20	1.97	4.15	7.47	15.3	mon	26.8	-34.2	33.1	14.9
	19	JR1													-34.2	33.3	14.7
	20	JR2	5540 G30Y	0.00	0.00	0.10	0.02	0.21	1.33	1.69	4.80	8.2	>-7.5	53.7	-30.0	27.8	18.7
	21	PA1	5450 G30Y	0.00	0.00	0.00	0.12	0.28	0.49	3.06	6.84	10.8	mon	69.7	-29.8	20.2	27.0
	22	PA2	4050 G40Y	0.00	0.00	0.00	0.12	0.18	0.55	0.55	1.76	3.1	(-7.5)	85.1	-29.3	15.1	38.3
	23	TP1	5540 G40Y	0.00	0.00	0.00	0.02	0.37	0.90	0.81	1.42	3.5	(-7.5)	48.0	-29.2	31.1	17.1
	24	TP2	4050 G40Y	0.00	0.00	0.02	0.47	2.14	7.91	2.29	9.02	21.8	-7.5	40.5	-30.3	28.8	17.8
26/09/2023	25	FS1	6030 G70Y	0.00	0.00	0.04	0.10	2.68	2.80	20.52	69.09	95.2	mon	65.1	-30.2	21.0	26.0
	25	FS1													-29.9	20.2	26.7
	26	FS2	5040 G40Y	0.00	0.00	0.02	0.66	4.71	7.56	32.68	61.09	106.6	mon	40.3	-33.8	22.6	24.1
	27	JR1	5040 G30Y	0.09	1.34	2.24	0.92	0.97	9.65	22.59	34.77	72.6	>-7.5	62.0	-31.0	30.0	18.4
	28	JR2	5040 G30Y	0.00	0.00	0.02	0.71	2.61	1.88	2.26	4.89	12.4	>-7.5	28.6	-33.8	31.7	15.9
	29	PA1	5040 G40Y	0.00	0.07	0.13	0.14	0.67	2.19	2.24	3.12	8.6	mon	66.5	-30.4	22.5	23.8
	30	PA2	0560 Y	0.00	0.00	0.02	0.04	0.26	1.96	2.66	3.46	8.4	mon	76.3	-30.8	10.0	55.3
	31	TP1	5040 G50Y	0.00	0.00	0.00	0.00	0.08	0.10	0.35	0.47	1.0	mon	54.5	-28.3	24.7	22.7
	32	TP2	5040 G40Y	0.00	0.00	0.03	0.71	1.71	3.85	3.48	10.05	19.8	(-7.5)	40.0	-30.1	26.6	19.6
03/10/2023	33	FS1	6030 G90Y	0.00	0.00	0.00	0.05	1.08	7.99	6.22	13.37	28.7	-7.5	72.7	-29.8	20.1	27.2
	34	FS2	3050 Y20R	0.00	0.00	0.35	5.98	6.55	9.31	13.71	36.78	72.7	mon	24.3	-34.7	8.7	61.5
	35	JR1	5040 G40Y	0.00	0.06	0.06	1.12	5.12	8.19	6.66	12.48	33.7	-7.5	31.7	-34.3	30.9	16.5
	36	JR2	2060 Y10R	0.02	0.10	0.36	0.35	0.53	1.91	8.26	39.60	51.1	(>-7.5)	44.4	-31.6	10.0	53.2
	37	PA1	4050 G40Y	0.02	1.03	1.32	1.41	1.82	4.10	10.33	8.49	28.5	-8.5	80.2	-29.9	17.6	30.8
	38	PA2	1050 Y80R	0.00	0.00	0.04	0.15	0.75	1.81	2.48	3.67	8.9	mon	73.4	-28.9	9.7	57.8

	39	TP1	4040 G50Y	0.00	0.00	0.00	0.14	2.70	3.00	2.06	2.68	10.6	-7.5	52.7	-28.9	21.6	25.3
	40	TP2	2060 G90Y	0.00	0.08	0.12	3.67	3.86	3.52	3.27	4.01	18.5	(>-7.5)	35.1	-29.5	12.2	42.3
17/10/2023	41	FS1	5040 G50Y	0.00	0.00	0.02	0.02	0.23	1.28	2.85	5.64	10.0	mon	92.1	-30.4	15.4	31.4
	42	FS2	4050 G40Y	0.00	0.00	0.06	3.01	6.25	10.37	11.27	17.47	48.4	mon	31.7	-34.0	20.7	25.9
	43	JR1	4550 G30Y	0.00	0.00	0.00	0.13	0.73	2.74	4.26	6.02	13.9	mon	24.4	-34.6	26.1	18.9
	44	JR2	5020 Y30R	0.00	0.07	0.13	0.10	0.33	2.97	13.65	11.02	28.3	-8.5	53.7	-30.9	9.7	57.2
	45	PA1	4050 G40Y	0.00	0.00	0.00	0.09	1.20	7.59	10.68	9.74	29.3	-8.5	81.9	-30.6	19.6	27.2
	46	PA2	1060 Y10R	0.00	0.00	0.12	0.31	0.86	3.43	5.67	4.72	15.1	(-8.5)	74.5	-29.9	9.9	56.1
	46	PA2													-29.3	11.0	51.4
	47	TP1	4040 Y30R	0.00	0.00	0.00	0.01	0.23	0.86	1.75	2.20	5.1	mon	40.4	-28.3	10.8	49.3
	48	TP2	2050 Y10R	0.00	0.00	0.00	0.59	2.71	10.45	6.22	6.06	26.0	-7.5	38.9	-29.6	9.2	56.8
30/10/2023	49	FS1	1070 Y10R	0.00	0.00	0.07	0.15	0.52	3.05	6.00	36.43	46.2	mon	85.2	-31.5	11.1	50.9
	50	FS2	4050 Y40R	0.00	0.02	0.51	2.36	3.05	14.79	23.12	32.01	75.9	mon	28.6	-34.6	7.1	74.4
	51	JR1	1060 Y	0.00	0.00	0.04	0.12	0.50	1.21	2.53	5.21	9.6	mon	20.7	-34.4	10.2	47.2
	52	JR2	5030 Y20R	0.03	1.77	1.84	2.05	1.70	8.74	29.52	41.16	86.8	(>-7.5)	53.4	-30.3	9.9	55.1
	52	JR2													-30.0	9.6	56.8
	53	PA1	0570 Y10R	0.00	0.02	1.01	4.29	9.32	9.71	9.68	13.40	47.4	(-7.5)	78.5	-30.6	12.0	44.7
	54	PA2	1040 Y60R	0.00	0.17	0.25	0.27	1.19	6.26	22.21	19.70	50.1	-8.5	78.0	-28.6	9.3	60.0
	55	TP1	3040 Y30R	0.00	0.12	0.10	0.15	0.67	1.46	3.07	1.43	7.0	-8.5	46.8	-29.0	10.8	49.9
	56	TP2	2040 Y	0.00	0.00	0.30	2.88	4.94	6.00	2.98	4.81	21.9	-7.5	36.0	-30.6	13.5	39.0
15/11/2023	57	FS1	6030 Y50R	0.00	0.00	0.02	0.02	0.16	1.00	2.37	7.59	11.1	mon	57.6	-31.6	9.5	59.9
	58	FS2	5040 Y50R	0.00	0.02	0.33	2.67	4.58	7.73	10.80	16.22	42.3	mon	34.6	-34.3	7.4	73.4
	58	FS2													-34.0	6.6	81.6
	59	JR1	2060 Y10R	0.01	0.28	0.60	0.39	0.66	1.74	5.33	2.47	11.5	>-7.5	27.2	-34.5	12.5	39.0
	60	JR2	5030 Y20R	0.73	7.46	6.47	10.87	7.15	10.53	60.51	62.49	166.2	(>-7.5)	50.8	-32.1	11.2	48.7
	61	PA1	1060 Y10R	0.00	0.07	0.19	0.75	2.21	8.15	11.28	11.05	33.7	-8.5	64.7	-30.9	9.1	59.9
	62	PA2	1070 Y10R	0.00	0.00	0.10	0.14	0.97	3.32	4.44	7.20	16.2	mon	88.3	-29.4	6.9	80.2
	63	TP1	2060 G90Y	13.14	82.52	48.26	24.33	16.83	30.21	97.29	60.75	373.3	>-7.5	36.1	-28.9	10.6	49.8
	64	TP2	3040 G70Y	0.00	0.00	0.82	7.38	15.87	39.53	9.04	30.15	102.8	-7.5	35.5	-31.6	16.3	32.1

Table S2: Data acquired from one *F. sylvatica* sampled at about 10 m (bottom), 20 m (middle) and 30 m (top) above ground in Hölstein. Leaf colour as NCS code, k(T): differential INP concentration, leaf mass per area (LMA). Duplicate measurements for leaf C and N displayed in separate rows.

dd/mm/yyyy	level	compass direction	NCS code	k(T) (cm^{-2} K^{-1}) -2.5	-3.5	-4.5	-5.5	-6.5	-7.5	-8.5	-9.5	INP_{-10} (cm^{-2})	LMA (g m^{-2})	$\delta^{13}C$ (‰)	N (mg (g dry weight)$^{-1}$)	C:N atomic ratio
05/09/2023	top	N	4550 G50Y	0.00	0.00	0.00	0.05	0.10	0.80	0.92	1.14	3.0	97.6	-27.4	15.5	37.0
	top	S	5540 G40Y	0.00	0.00	0.00	0.03	0.08	0.36	0.47	2.25	3.2	99.0	-27.6	16.8	34.0
	middle	N	5540 G40Y	0.00	0.00	0.00	0.11	0.46	0.99	1.76	2.56	5.9	84.7	-29.2	18.6	30.6
	middle	N												-28.8	18.1	31.4
	middle	S	5040 G50Y	0.00	0.00	0.00	0.05	0.06	0.33	1.33	2.53	4.3	91.5	-28.5	20.2	28.6
	bottom	SE	5040 G40Y	0.00	0.00	0.24	11.68	20.47	19.55	17.58	3.56	73.1	73.5	-28.7	19.2	29.8

	bottom	N	5030 G30Y	0.00	0.00	0.00	0.10	0.50	0.97	2.39	3.81	7.8	47.8	-30.4	20.5	27.2
11/10/2023	top	N	1070 Y10R	0.00	0.00	0.02	0.06	0.10	1.00	1.90	1.64	4.7	84.5	-28.1	9.0	64.0
	top	S	1070 Y10R	0.00	0.00	0.02	0.02	0.24	1.13	1.81	3.83	7.1	97.8	-28.0	9.9	58.5
	middle	N	2070 Y10R	0.00	0.00	0.00	0.02	0.18	0.99	1.91	3.64	6.7	82.0	-28.9	9.5	60.3
	middle	S	1070 Y10R	0.00	0.00	0.00	0.04	0.24	0.90	2.02	2.56	5.8	84.0	-28.8	9.4	61.0
	bottom	N	3050 G80Y	0.00	0.00	0.00	0.10	0.34	1.40	3.79	1.57	7.2	79.1	-29.4	10.6	54.9
	bottom	SE	4050 G60Y	0.00	0.00	0.02	0.18	1.52	4.27	4.20	5.64	15.8	80.1	-28.7	17.4	32.2
														-28.6	18.1	32.2

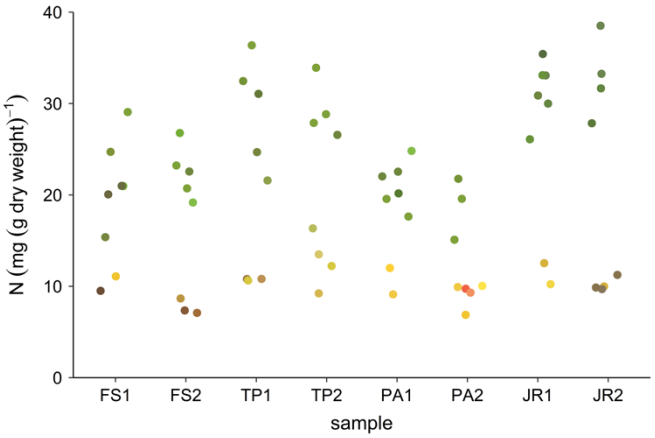

Figure S1: Nitrogen content of foliage from trees sampled in Gempen (FS: *F. sylvatica*, TP: *T. platyphyllos*, PA: *P. avium*, JR: *J. regia*). Colours display leaf colour.

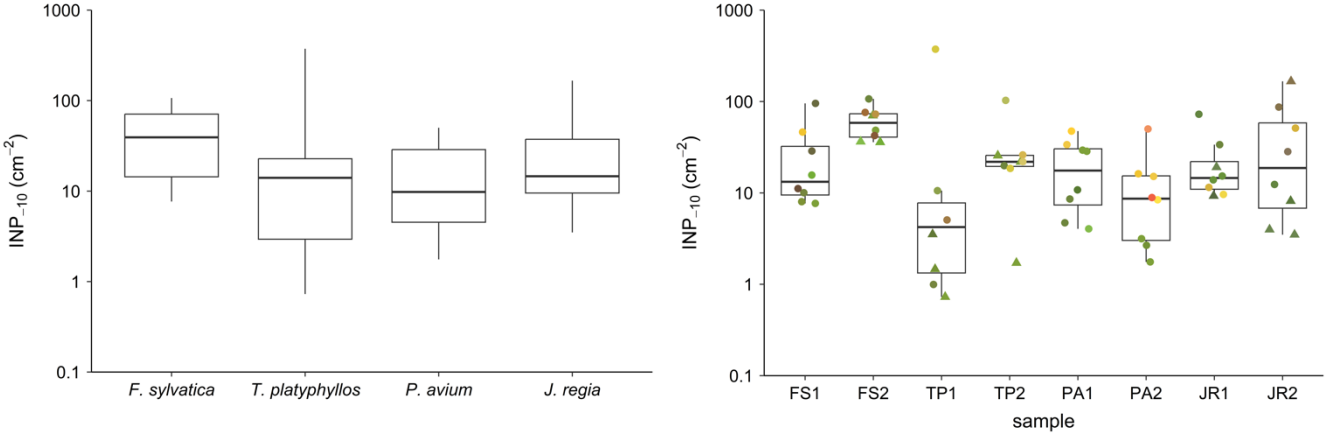

Figure S2: Cumulative concentration of INPs active at temperatures ≥ -10 °C (INP$_{-10}$) quantified in leaf washing water by species (left) and sampled tree (right) for the Gempen sampling site. Colours represent leaf colour, round symbols samples collected from the same tree.

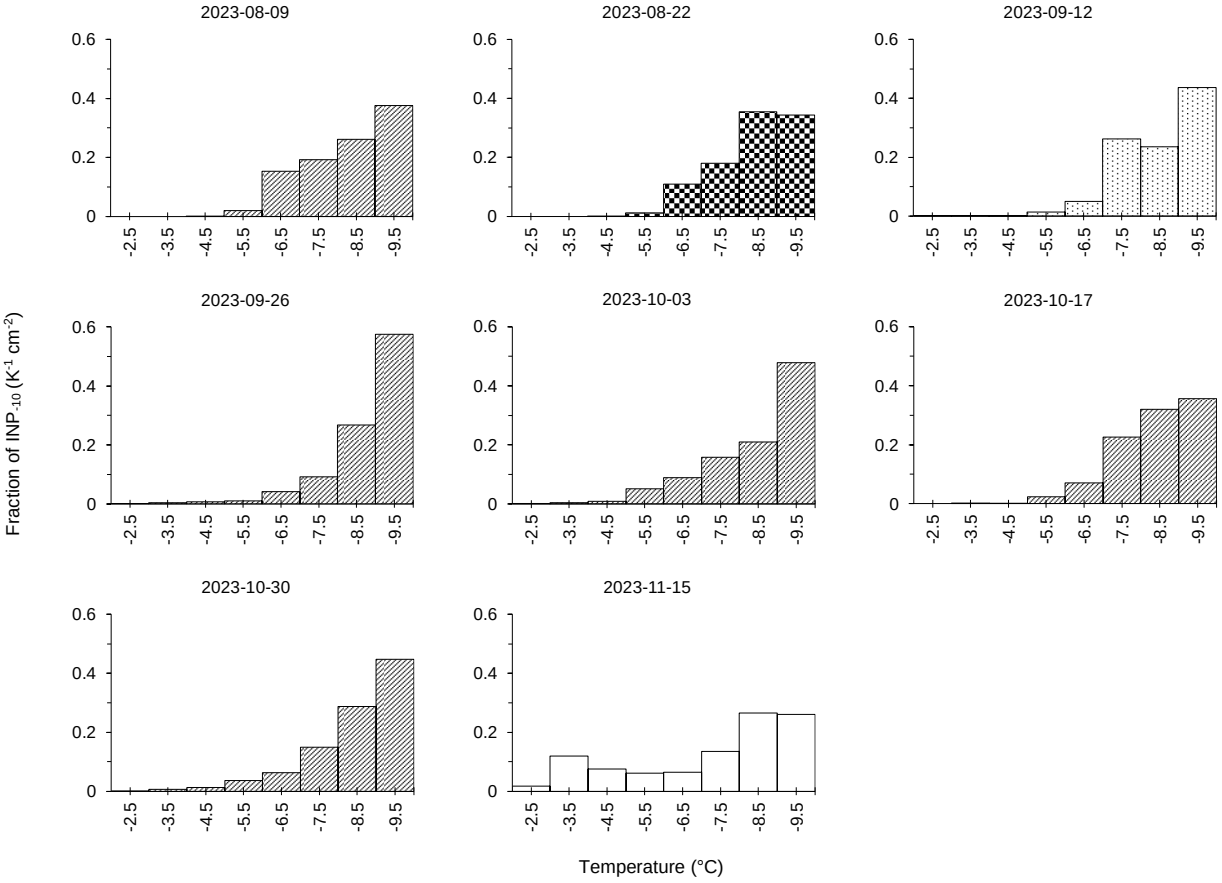

Figure S3: Mean differential INP concentrations of all trees sampled on a particular day, normalized by total daily cumulative INP_{-10} concentration.