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Measurement report: Contribution of atmospheric new particle formation to ultrafine particle concentration, cloud condensation nuclei, and radiative forcing – results from 5-year observations in central Europe

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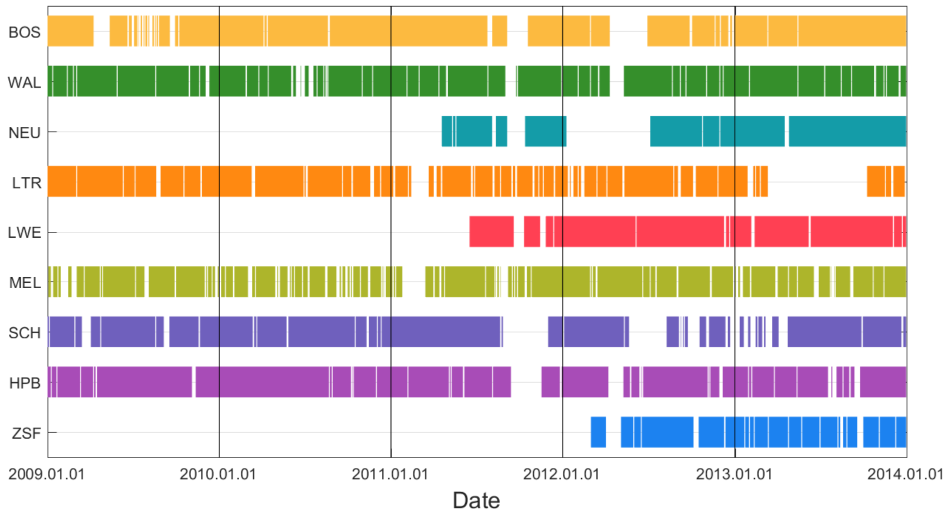

Figure S1. Data coverage of PNSD data in the evaluated GUAN sites.

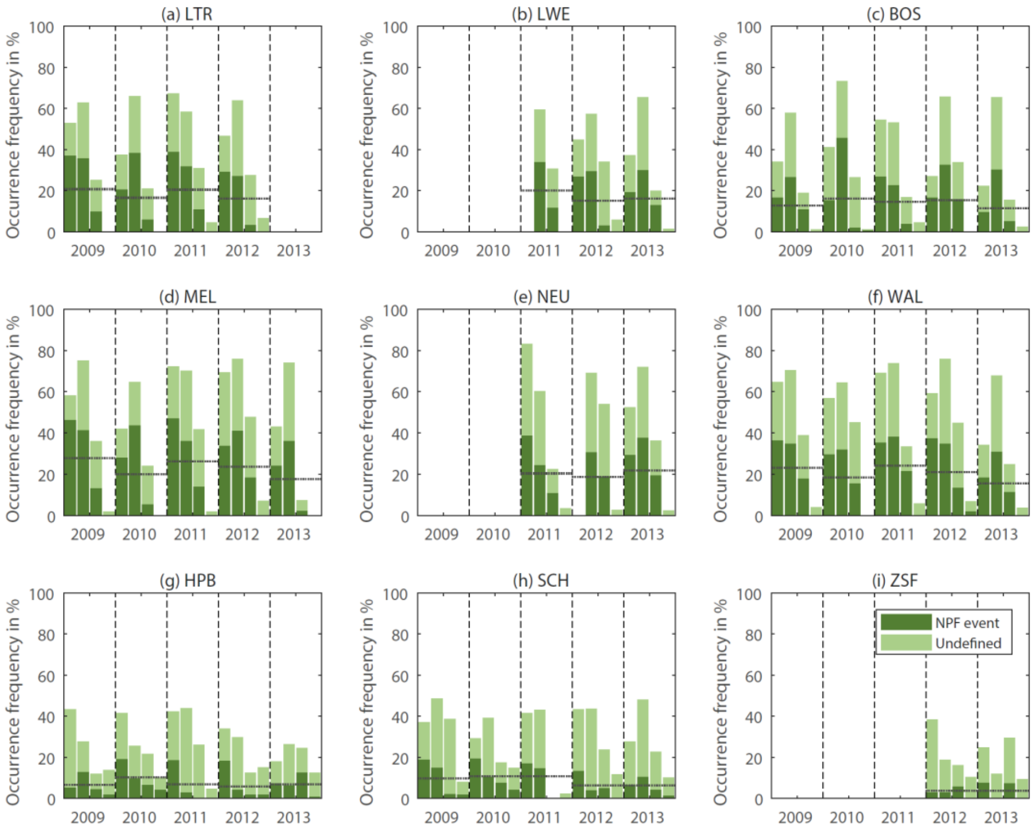

Figure S2: NPF occurrence frequency at the nine GUAN sites for each season in every year. The values in each year are, in turn, the frequencies of spring (MAM), summer (JJA), autumn (SON) and winter (DJF). The gray dotted line denotes the annual mean occurrence frequency.

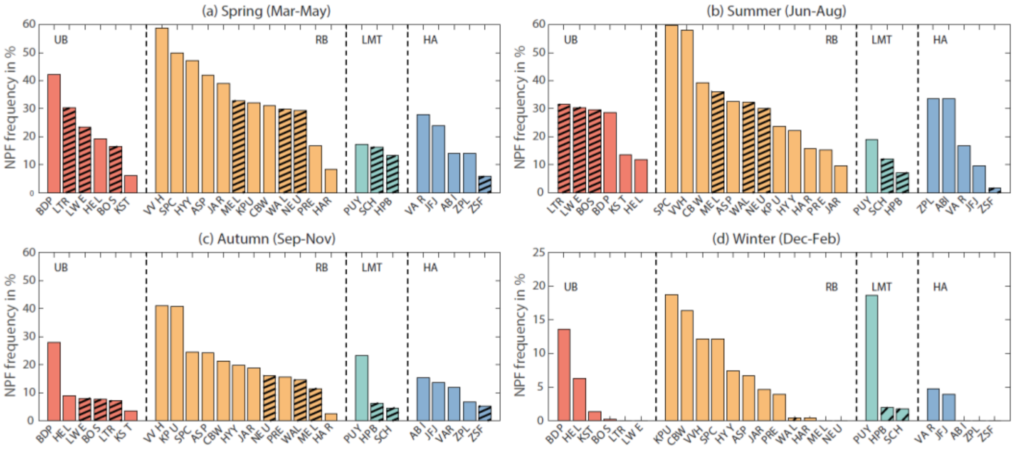

Figure S3. Comparison in seasonal NPF occurrence frequency between GUAN sites (hatched pattern) and other European sites (Baalbaki et al., 2021; Boulon et al., 2011; Bousiotis et al., 2019; Bousiotis et al., 2021; Brines et al., 2015; Dameto De España et al., 2017; Herrmann et al., 2015; Hofman et al., 2016; Joutsensaari et al., 2018; Lee et al., 2020; Manninen et al., 2010; Németh et al., 2018; Nieminen et al., 2014; Plauskaite et al., 2010; Salma and Németh, 2019; Sellegri et al., 2019; Smejkalova et al., 2021; Vaananen et al., 2013; Vana et al., 2016).

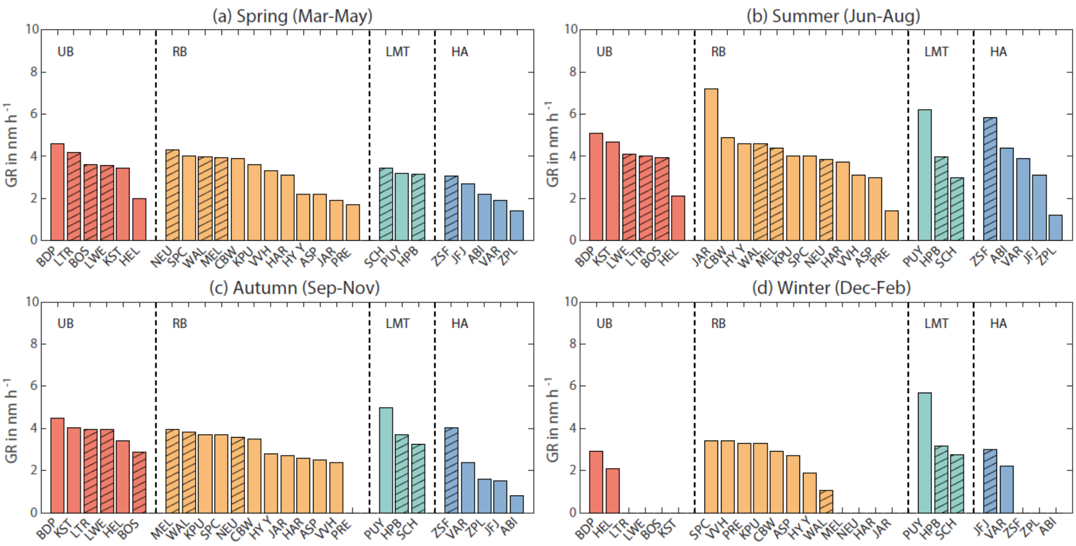

Figure S4: Seasonal GR within the size range 10−25 nm collected from the present dataset and other studies in Europe (Boulon et al., 2011; Bousiotis et al., 2019; Bousiotis et al., 2021; Herrmann et al., 2015; Joutsensaari et al., 2018; Lee et al., 2020; Manninen et al., 2010; Németh et al., 2018; Nieminen et al., 2014; Plauskaite et al., 2010; Salma and Németh, 2019; Vaananen et al., 2013; Vana et al., 2016).

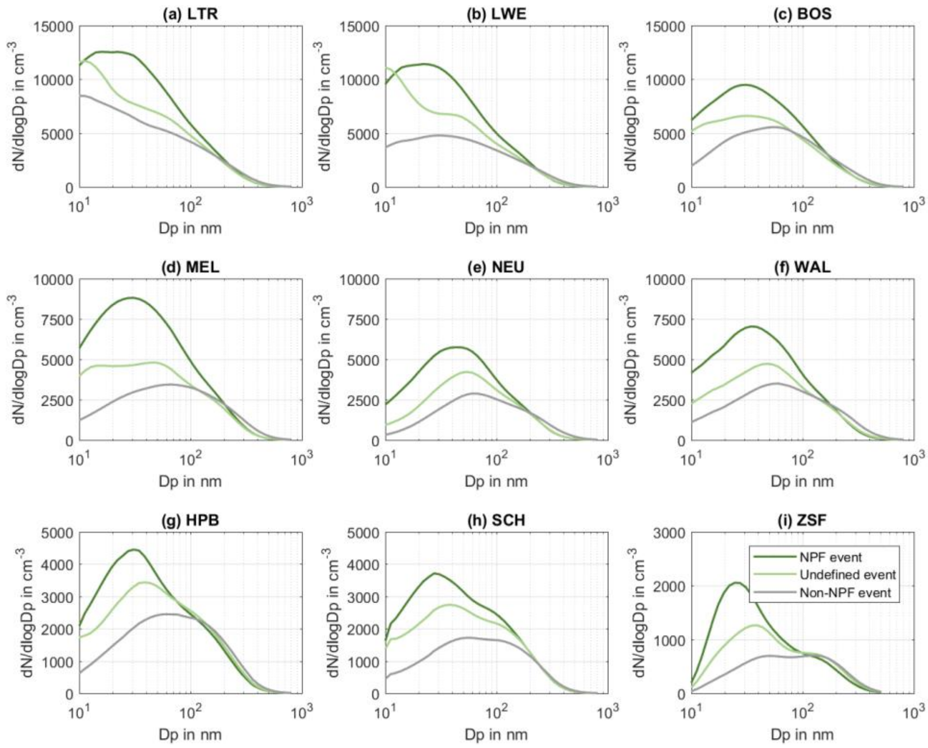

Figure S5: Mean PNSD with respect to NPF days/undefined days/non-event days for each GUAN site.

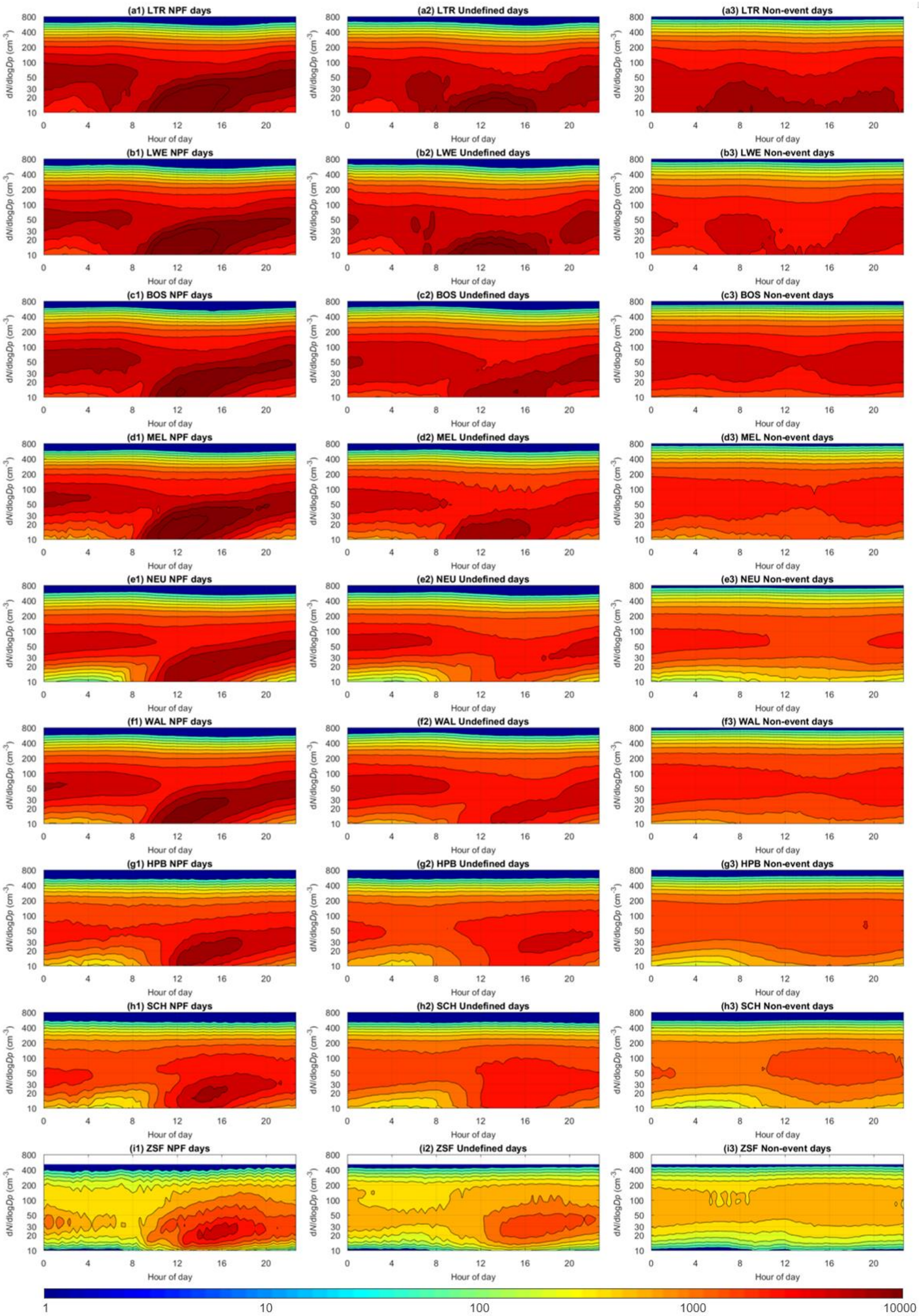

Figure S6: Mean PNSD with respect to NPF days/undefined days/non-event days for each GUAN site.

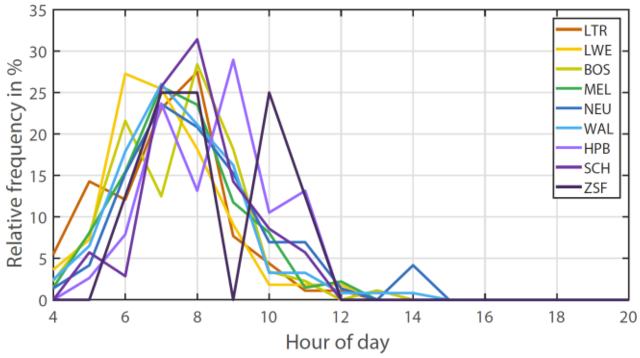

Figure S7: Starting time distribution of NPF events at each site.

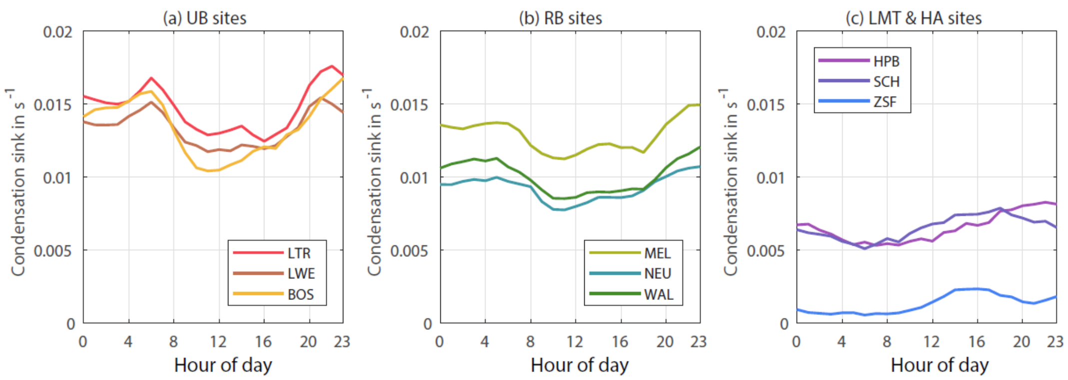

Figure S8: Mean diurnal cycle of condensation sink during NPF days at GUAN sites.

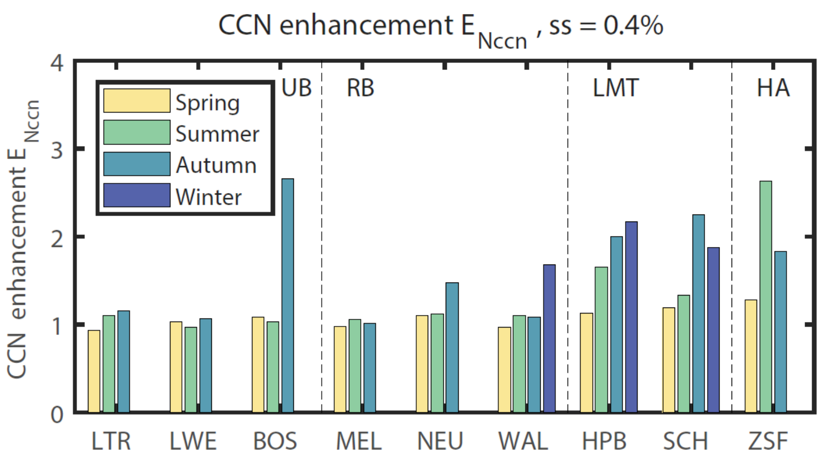

Figure S9. The seasonal variation of relative contribution of NPF to N_{ccn}, taken the results with ss=0.4%.

Table S1. Annual frequency of NPF events in the present study and other studies in Europe, listed with the detailed information of the corresponding studies.

Site category	**Site name**	**City & country**	**NPF occurrence frequency**	**Time period**	**Reference**
Urban background	LON	London, UK	36.0 %	2014-2015	Hofman et al., 2016
	PRA	Prague, Czech Republic	30.0 %	2013-2017	Németh et al., 2018
	THI	Thissio, Greece	21.4 %	2017-2018	Joutsensaari et al., 2018
	BDP	Budapest, Hungary	21.0 %	2008-2019 & 2013-2018	Salma and Németh, 2019
	MAD	Madrid, Spain	19.0 %	2007-2008	Brines et al., 2015
	LTR	Leipzig, Germany	17.4 %	2009-2013	This study
	ANT	Antwerp, Belgium	17.0 %	2013-2015	Hofman et al., 2016
	AMS	Amsterdam, Netherland	16.0 %	2013-2015	Hofman et al., 2016
	LWE	Leipzig, Germany	15.5 %	2009-2013	This study
	BOS	Bösel, Germany	13.3 %	2009-2013	This study
	BCL	Barcelona, Spain	13.1 %	2012-2015	Bousiotus et al., 2021
	VIE	Vienna, Austria	13.0 %	2014-2015	Dameto de España et al., 2017
	LCT	Leicester, UK	13.0 %	2014-2015	Hofman et al., 2016
	ATH	Athens, Greece	8.5 %	2015-2018	Bousiotus et al., 2021
	KST	Kensington, UK	6.2 %	2009-2015	Bousiotus et al., 2019
	ROM	Rome, Italy	6.0 %	2007-2009	Brines et al., 2015
	COP	Copenhagen, Sweden	5.8 %	2008-2017	Bousiotus et al., 2021
	HEL	Helsinki, Finland	5.0 %	2008-2011 & 2015-2018	Bousiotus et al., 2021
Rural/regional background	AMX	Agia Marina Xyliatos, Cyprus	56.7 %	2018-2019	Baalbaki et al., 2021
	SPC	San Pietro Capofiume, Italy	36.0 %	2002-2016	Joutsensaari et al., 2018
	CBW	Cabauw, Netherland	34.0 %	2008-2009	Manninen et al. 2010

	VVH	Vavihill, Sweden	29.0 %	2008-2009	Manninen et al. 2010
	KPU	K-puszta, Hungary	27.7 %	2012-2013	Salma and Németh, 2019
	HYY	Hyytiälä, Finland	23.0 %	1997-2012	Nieminen et al., 2014
	MEL	Melpitz, Germany	20.9 %	2009-2013	This study
	JAR	Järvselja, Estonia	20.5 %	2013-2014	Vana et al., 2016
	NEU	Neuglobsow, Germany	19.5 %	2009-2013	This study
	WAL	Waldhof, Germany	19.1 %	2009-2013	This study
	PRE	Preila, Lithuania	15.0 %	2009-2013	Plauskaite et al., 2010
	MON	Montseny, Spain	12.0 %	2012-2015	Bousiotus et al., 2021
	LLV	Lille Valby, Denmark	7.9 %	2008-2017	Bousiotus et al., 2021
	HAR	Harwell, UK	6.9 %	2009-2015	Bousiotus et al., 2019
Low mountain range	PUY	Puy de Dome, France	35.7 %	2007-2010	Boulon et al., 2011
	OPM	Opme, Grance	20.8 %	2007-2010	Boulon et al., 2011
	SCH	Schauinsland, Germany	8.8 %	2009-2013	This study
	HPB	Hohenpeiβenberg, Germany	7.2 %	2009-2013	This study
High altitude & remote	CMN	Monte Cimone, Italy	28.0 %	2009	Sellegri et al., 2019
	ABI	Abisko, Sweden	24.0 %	2005–2007	Väänänen et al., 2013
	ZPL	Mt. Zeppelin, Norway	23.0 %	2016-2018	Lee et al., 2020
	JFJ	Jungfraujoch, Switzerland	14.5 %	2008-2014	Herrmann et al., 2015
	VAR	Värriö, Finland	8.5 %	2013-2014	Vana et al., 2016
	ZSF	Zugspitze, Germany	3.3 %	2009-2013	This study

Table S2. Annual growth rate (GR) and formation rate (*J*) of NPF events in the present study and other studies in Europe, listed with the detailed information of the corresponding studies.

Site category	Site name	City & country	GR in nm h^{-1}	*J* in cm^{-3} s^{-1}	Time period	Reference	GR size range in nm	*J* size range in nm
Urban background	LTR	Leipzig, Germany	4.37	2.83	2009-2013	This study	10 − 25	10 − 25
	LWE	Leipzig, Germany	4.42	2.89	2009-2013	This study	10 − 25	10 − 25
	BOS	Bösel, Germany	4.1	1.90	2009-2013	This study	10 − 25	10 − 25
	COP	Copenhagen, Sweden	3.19	0.23	2008-2017	Bousiotus et al., 2021	5.8 − 30	10 − 25
	HEL	Helsinki, Finland	2.87	0.03	2008-2011 & 2015-2018	Bousiotus et al., 2021	3.4 − 30	10 − 25
	KST	Kensington, UK	4.4	--	2009-2015	Bousiotus et al., 2019	16.6 – 50	--
	BCL	Barcelona, Spain	3.38	0.02	2012-2015	Bousiotus et al., 2021	10 − 30	10 − 25
	ATH	Athens, Greece	3.68	0.05	2015-2018	Bousiotus et al., 2021	10 − 30	10 − 25
	THI	Thissio, Greece	4.2	1.60	2017-2018	Kalkavouras et al., 2020	10 − 25	10 − 25
	PRA	Prague, Czech Republic	3.98	--	2013-2017	Smejkalova et al., 2021	10 − 100	--

	UST	Ústí, Czech Republic	3.85	--	2013-2017	Smejkalova et al., 2021	10 − 100	--
	BUD	Budapest, Hungary	5.1	2.1	2012-2013	Salma et al., 2016	6 − 25	6 − 25
Rural/regional background	MEL	Melpitz, Germany	4.70	1.98	2009-2013	This study	10 − 25	10 − 25
	NEU	Neuglobsow, Germany	4.30	1.16	2009-2013	This study	10 − 25	10 − 25
	WAL	Waldhof, Germany	4.13	1.59	2009-2013	This study	10 − 25	10 − 25
	LLV	Lille Valby, Denmark	3.19	0.03	2008-2017	Bousiotus et al., 2021	5.8 − 30	10 − 25
	MON	Montseny, Spain	3.62	0.02	2012-2015	Bousiotus et al., 2021	9 − 30	10 − 25
	FKL	Finokalia, Greece	3.78	0.005	2012-2018	Bousiotus et al., 2021	9 − 30	10 − 25
	HAR	Harwell, UK	3.4	--	2009-2015	Bousiotus et al., 2019	16.6 – 50	--
	HYY	Hyytiälä, Finland	2.5	0.84	1997-2012	Nieminen et al., 2014	3 − 25	3 − 25
	PRE	Preila, Lithuania	3.9	0.4	2009-2013	Nieminen et al., 2018	10 − 25	10 − 25
	JAR	Järvselja, Estonia	4.6	0.81	2013-2014	Vana et al., 2016	3 − 25	3 − 25
	KPU	K-puszta, Hungary	4.2	1.8	2012-2013	Salma et al., 2016	6 − 25	6 − 25

	CBW	Cabauw, Netherland	6.63	32.4	2008-2009	Manninen et al., 2010	7 − 20	2 − 3
	VVH	Vavihill, Sweden	3.94	--	2008-2009	Manninen et al., 2010	7 − 20	10 − 25
Low mountain range	HPB	Hohenpeiβenberg, Germany	3.67	0.62	2009-2013	This study	10 − 25	10 − 25
	SCH	Schauinsland, Germany	3.82	0.52	2009-2013	This study	10 − 25	10 − 25
	PUY	Puy de Dome, France	8.86	1.6	2007-2010	Boulon et al., 2011	7 − 20	2 − 3
	OPM	Opme, France	6.2	1.38	2007-2010	Boulon et al., 2011	7 − 20	2 − 3
High altitude or remote	ZSF	Zugspitze, Germany	3.81	0.43	2009-2013	This study	10 − 25	10 − 25
	JFJ	Jungfraujoch, Switzerland	3.6	1.0	2008-2014	Tröstl et al., 2015	5 − 15	3.2 − 1000
	ZPL	Mt. Zeppelin, Norway	2.85	0.1	2016-2018	Lee et al., 2020	7 − 25	3 − 7
	VAR	Värriö, Finland	2.7	0.15	2013-2014	Kyrö et al., 2014	8 − 25	8 − 25

	ABI	Abisko, Sweden	3	0.05	2005–2007	Väänänen et al., 2013	10 − 25	10 − 25

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