



Supplement of

A view on recent ice-nucleating particle intercomparison studies: why the uncertainty of the activation temperature matters

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Table S1: Reported temperature uncertainty of instruments participating in the identified intercomparison studies. We refer to the listed studies for full instrument and institute names.

Study	Instrument	ΔT [°C]	Uncertainty reported in
Hiranuma et al., 2015	AIDA	± 0.3	Original Study
Hiranuma et al., 2015	BINARY	± 0.3	Original Study
Hiranuma et al., 2015	CSU-CFDC	± 0.5	Original Study
Hiranuma et al., 2015	CSU-IS	± 0.2	Original Study
Hiranuma et al., 2015	CU-RMCS	± 0.5	Original Study
Hiranuma et al., 2015	EDB	± 0.2	Original Study
Hiranuma et al., 2015	FINCH	± 1.5	Original Study
Hiranuma et al., 2015	FRIDGE-CS	± 0.2	Original Study
Hiranuma et al., 2015	FRIDGE-DC	± 0.2	Original Study
Hiranuma et al., 2015	IMCA-ZINC	± 0.4	Original Study
Hiranuma et al., 2015	LACIS	± 0.3	Original Study
Hiranuma et al., 2015	M-AL	± 0.7	Original Study
Hiranuma et al., 2015	MRI-DCECC	± 1	Original Study
Hiranuma et al., 2015	M-WT	± 1	Original Study
Hiranuma et al., 2015	NC State-CS	$\pm 1^a$	Original Study
Hiranuma et al., 2015	NIPI	± 0.4	Original Study
Hiranuma et al., 2015	PINC	$\pm 0.5^b$	Original Study
Hiranuma et al., 2015	PNNL-CIC	± 0.3	Original Study
Wex et al., 2015	AIDA	± 0.3	Original Study
Wex et al., 2015	BINARY	$\pm 0.3^c$	Budke and Koop, 2015
Wex et al., 2015	FINCH	$\pm 1.5^d$	Hiranuma et al., 2015
Wex et al., 2015	LACIS	± 0.3	Hartmann et al., 2011
Wex et al., 2015	M-AL	± 0.7	Original Study
Wex et al., 2015	M-WT	± 0.75	Original Study
Wex et al., 2015	PINC	$\pm 0.5^b$	Original Study
Burkert-Kohn et al., 2017	LACIS	± 0.3	Original Study
Burkert-Kohn et al., 2017	PIMCA-PINC	$\pm 0.5^b$	Original Study
Burkert-Kohn et al., 2017	PINC	$\pm 0.5^b$	Original Study
Burkert-Kohn et al., 2017	TROPOS-SPIN	$\pm 1^f$	Original Study
DeMott et al., 2017	CSU-CFDC	± 0.5	Original Study
DeMott et al., 2017	CSU-IS	± 0.4	Original Study
DeMott et al., 2017	NC State-CS	± 1	Original Study
DeMott et al., 2017	NIPR-CRAFT	± 0.2	Original Study
DeMott et al., 2017	UBC-MOUDI-DFT	$\pm 0.3^c$	Mason et al., 2015

Table S1: Continued.

Study	Instrument	ΔT [°C]	Uncertainty reported in
DeMott et al., 2018	AIDA	± 0.3	Original Study
DeMott et al., 2018	BINARY	± 0.3	Original Study
DeMott et al., 2018	CIC-PNNL	± 1	Original Study
DeMott et al., 2018	CMU-CS	$\pm 0.5^c$	Polen et al., 2016
DeMott et al., 2018	CSU-CFDC	± 0.5	Original Study
DeMott et al., 2018	CSU-IS	$\pm 0.5^e$	Lacher et al., 2024
DeMott et al., 2018	DFPC-ISAC	$\pm 0.1^d$	Hiranuma et al., 2019
DeMott et al., 2018	FRIDGE-CS	± 0.2	Original Study
DeMott et al., 2018	FRIDGE-DC	± 0.2	Original Study
DeMott et al., 2018	INKA	± 1	Original Study
DeMott et al., 2018	KIT-CS (INSEKT)	± 0.1	Original Study
DeMott et al., 2018	M-AL	± 0.5	Original Study
DeMott et al., 2018	MIT-SPIN	$\pm 0.5^{d,f}$	DeMott et al., 2024
DeMott et al., 2018	NC State-CS	$\pm 1^d$	Hiranuma et al., 2015
DeMott et al., 2018	NIPI	± 0.4	Original Study
DeMott et al., 2018	PIMCA-PINC	$\pm 0.5^b$	Original Study
DeMott et al., 2018	PINC	$\pm 0.5^b$	Original Study
DeMott et al., 2018	TAMU-CFDC	$\pm 1.5^{c,g}$	Zenker et al., 2017
DeMott et al., 2018	TROPOS-SPIN	$\pm 1^f$	Original Study
DeMott et al., 2018	VODCA	$\pm 0.5^h$	Original Study
DeMott et al., 2018	WISDOM	± 0.3	Original Study
Hiranuma et al., 2019	AIDA	± 0.3	Original Study
Hiranuma et al., 2019	BINARY	± 0.3	Original Study
Hiranuma et al., 2019	CMU-CS	± 0.5	Original Study
Hiranuma et al., 2019	CSU-CFDC	± 0.5	Original Study
Hiranuma et al., 2019	DFPC-ISAC	± 0.1	Original Study
Hiranuma et al., 2019	EDB	± 0.2	Original Study
Hiranuma et al., 2019	FRIDGE-CS	± 0.2	Original Study
Hiranuma et al., 2019	FRIDGE-DC	± 0.2	Original Study
Hiranuma et al., 2019	INKA	± 1	Original Study
Hiranuma et al., 2019	LACIS	± 0.3	Original Study
Hiranuma et al., 2019	LINDA	± 0.2	Original Study
Hiranuma et al., 2019	M-AL	± 0.7	Original Study
Hiranuma et al., 2019	MRI-DCECC	± 1	Original Study
Hiranuma et al., 2019	M-WT	± 0.5	Original Study
Hiranuma et al., 2019	NC State-CS	$\pm 0.2; \pm 1^i$	Original Study
Hiranuma et al., 2019	NIPI	± 0.4	Original Study
Hiranuma et al., 2019	NIPR-CRAFT	± 0.2	Original Study

Table S1: Continued.

Study	Instrument	ΔT [°C]	Uncertainty reported in
Hiranuma et al., 2019	PNNL-CIC	± 1	Original Study
Hiranuma et al., 2019	WISDOM	± 0.3	Original Study
Hiranuma et al., 2019	WT-CRAFT	± 0.5	Original Study
Knopf et al., 2021	CSU-CFDC	± 0.5	Original Study
Knopf et al., 2021	CSU-IS	$\pm 0.5^e$	Lacher et al., 2024
Knopf et al., 2021	DRUM-CP	$\pm 1.25^{c,j}$	Creamean et al., 2019
Knopf et al., 2021	MINT (CMU-CS)	$\pm 0.5^c$	Polen et al., 2018
Knopf et al., 2021	MOUDI-DFT	± 0.3	Original Study
Knopf et al., 2021	PINE-c	± 1	Original Study
Brasseur et al., 2022	INSEKT	$\pm 0.3^c$	Schiebel, 2017
Brasseur et al., 2022	NIPI	$\pm 0.4^d$	Hiranuma et al., 2019
Brasseur et al., 2022	PINC	$\pm 0.5^{b,d}$	DeMott et al. 2018
Brasseur et al., 2022	PINCii	$\pm 0.35^{c,k}$	Casterede and Brasseur et al., 2023
Brasseur et al., 2022	PINE	$\pm 1^c$	Möhler et al. 2021
Brasseur et al., 2022	UEF-SPIN	$\pm 1^{d,f}$	Burkert-Kohn et al., 2017
Lacher et al., 2024	CSU-CFDC	± 0.5	Original Study
Lacher et al., 2024	CSU-IS	± 0.5	Original Study
Lacher et al., 2024	FRIDGE-CS	± 0.2	Original Study
Lacher et al., 2024	INDA	$\pm 0.5^c$	Chen et al. 2018
Lacher et al., 2024	INSEKT	± 0.2	Original Study
Lacher et al., 2024	LINA	$\pm 0.5^c$	Chen et al. 2018
Lacher et al., 2024	LINDA	$\pm 0.2^d$	Hiranuma et al., 2019
Lacher et al., 2024	MIT-SPIN	$\pm 0.5^f$	Original Study
Lacher et al., 2024	PINE-1A	± 1	Original Study
Lacher et al., 2024	UNAM-MOUDI-DFT	± 0.1	Original Study
DeMott et al., 2024	CSU-CFDC	± 0.5	Original Study
DeMott et al., 2024	CSU-IS	± 0.2	Original Study
DeMott et al., 2024	FRIDGE-CS	± 0.5	Original Study
DeMott et al., 2024	FRIDGE-DC	± 0.5	Original Study
DeMott et al., 2024	MIT-SPIN	$\pm 0.5^f$	Original Study
DeMott et al., 2024	NC State-CS	$\pm 1^l$	Original Study

a: The stated tolerance of ± 1 °C of the thermistor is used as uncertainty here, while repeatability tests showed a precision of ± 0.1 °C.

b: The uncertainty listed here is the sum of the sensor accuracy stated as ± 0.1 °C and temperature variation across the sample laminar of ± 0.4 °C.

c: The temperature uncertainty was not indicated in the original study, therefore a referenced instrument paper was scanned for this information.

d: The temperature uncertainty was not indicated in the original study, therefore another here identified intercomparison study was scanned for this information.

e: The temperature uncertainty was not indicated in the original study and there were multiple deviating assessments in different studies. Therefore, the highest uncertainty given in the most recent publication was selected.

f: MIT-SPIN uncertainties are reported as $\pm 0.5^\circ\text{C}$, while TROPOS-SPIN states an uncertainty of $\pm 1^\circ\text{C}$ in Burkert-Kohn et al. (2017), although both assessments are likely based on the same results presented in Garimella et al. (2016). Further, UEF-SPIN temperature uncertainty is not indicated, we select to list the conservative uncertainty of $\pm 1^\circ\text{C}$ in this case of deviating assessments.

g: In Zenker et al. (2017) an exemplary measurement from FIN-02 (i.e. DeMott et al., 2018) of Snomax is discussed. Therein, it is stated that the CFDC was operated at $-15^\circ\text{C} \pm 1.5^\circ\text{C}$. From the text it is not clear if this is indicative of the temperature uncertainty, which we assume, or the temperature variation during an individual experiment.

h: Earlier studies of Pummer et al. (2012) and Zolles et al. (2015) report the temperature uncertainty as $\pm 1^\circ\text{C}$. A later study of Häusler et al. (2018) states the temperature accuracy as $\pm 0.5^\circ\text{C}$ though. In the original study 0.5°C is indicated as the standard deviation of the temperature measurement, therefore we list $\pm 0.5^\circ\text{C}$ as uncertainty here.

i: For parts of the measurements a temperature uncertainty of $\pm 1^\circ\text{C}$ is indicated (Cellulose MCC and FC), for other parts $\pm 0.2^\circ\text{C}$ is stated (Cellulose NCC).

j: Creamean et al. (2019) report a sensor accuracy of $\pm (0.4\% + 1)^\circ\text{C}$ in addition to a $\pm 0.15^\circ\text{C}$ accuracy uncertainty due to a correction factor. At an exemplary temperature of -25°C this adds up to $\pm 1.25^\circ\text{C}$.

k: Castarède and Brasseur et al. (2023) report that the standard error in the laminar temperature can exceed $\pm 0.35^\circ\text{C}$. Further, they state that this error only encapsulates the spatial temperature variability in the chamber and does not account other measurement uncertainties. Therefore, they note that the actual measurement uncertainty is higher, but since the authors do not give any other estimate we use $\pm 0.35^\circ\text{C}$ as temperature uncertainty.

l: The typical mean temperature uncertainty of measurements is reported as $\pm 0.5^\circ\text{C}$ to $\pm 1^\circ\text{C}$. In this study we used the conservative assessment of $\pm 1^\circ\text{C}$. Furthermore, temperature measurement precision is stated as $\pm 0.1^\circ\text{C}$.

References

- Brasseur, Z., Castarède, D., Thomson, E. S., Adams, M. P., Drossaert van Dusseldorp, S., Heikkilä, P., Korhonen, K., Lampilahti, J., Paramonov, M., Schneider, J., Vogel, F., Wu, Y., Abbatt, J. P. D., Atanasova, N. S., Bamford, D. H., Bertozzi, B., Boyer, M., Brus, D., Daily, M. I., Fösig, R., Gute, E., Harrison, A. D., Hietala, P., Höhler, K., Kanji, Z. A., Keskinen, J., Lacher, L., Lampimäki, M., Levula, J., Manninen, A., Nadolny, J., Peltola, M., Porter, G. C. E., Poutanen, P., Proske, U., Schorr, T., Silas Umo, N., Stenszky, J., Virtanen, A., Moiseev, D., Kulmala, M., Murray, B. J., Petäjä, T., Möhler, O., and Duplissy, J.: Measurement report: Introduction to the HyICE-2018 campaign for measurements of ice-nucleating particles and instrument inter-comparison in the Hyytiälä boreal forest, *Atmos. Chem. Phys.*, 22, 5117–5145, <https://doi.org/10.5194/acp-22-5117-2022>, 2022.
- Burkert-Kohn, M., Wex, H., Welti, A., Hartmann, S., Grawe, S., Hellner, L., Herenz, P., Atkinson, J. D., Stratmann, F., and Kanji, Z. A.: Leipzig Ice Nucleation chamber Comparison (LINC): intercomparison of four online ice nucleation counters, *Atmos. Chem. Phys.*, 17, 11683–11705, <https://doi.org/10.5194/acp-17-11683-2017>, 2017.
- Budke, C. and Koop, T.: BINARY: an optical freezing array for assessing temperature and time dependence of heterogeneous ice nucleation, *Atmos. Meas. Tech.*, 8, 689–703, <https://doi.org/10.5194/amt-8-689-2015>, 2015.
- Castarède, D., Brasseur, Z., Wu, Y., Kanji, Z. A., Hartmann, M., Ahonen, L., Bilde, M., Kulmala, M., Petäjä, T., Pettersson, J. B. C., Sierau, B., Stetzer, O., Stratmann, F., Svenningsson, B., Swietlicki, E., Thu Nguyen, Q., Duplissy, J., and Thomson, E. S.: Development and characterization of the Portable Ice Nucleation Chamber 2 (PINcii), *Atmos. Meas. Tech.*, 16, 3881–3899, <https://doi.org/10.5194/amt-16-3881-2023>, 2023.
- Chen, J., Wu, Z., Augustin-Bauditz, S., Grawe, S., Hartmann, M., Pei, X., Liu, Z., Ji, D., and Wex, H.: Ice-nucleating particle concentrations unaffected by urban air pollution in Beijing, China, *Atmos. Chem. Phys.*, 18, 3523–3539, <https://doi.org/10.5194/acp-18-3523-2018>, 2018.

Creamean, J. M., Mignani, C., Bukowiecki, N., and Conen, F.: Using freezing spectra characteristics to identify ice-nucleating particle populations during the winter in the Alps, *Atmos. Chem. Phys.*, 19, 8123–8140, <https://doi.org/10.5194/acp-19-8123-2019>, 2019.

DeMott, P. J., Hill, T. C. J., Petters, M. D., Bertram, A. K., Tobo, Y., Mason, R. H., Suski, K. J., McCluskey, C. S., Levin, E. J. T., Schill, G. P., Boose, Y., Rauker, A. M., Miller, A. J., Zaragoza, J., Rocci, K., Rothfuss, N. E., Taylor, H. P., Hader, J. D., Chou, C., Huffman, J. A., Pöschl, U., Prenni, A. J., and Kreidenweis, S. M.: Comparative measurements of ambient atmospheric concentrations of ice nucleating particles using multiple immersion freezing methods and a continuous flow diffusion chamber, *Atmos. Chem. Phys.*, 17, 11227–11245, <https://doi.org/10.5194/acp-17-11227-2017>, 2017.

DeMott, P. J., Möhler, O., Cziczo, D. J., Hiranuma, N., Petters, M. D., Petters, S. S., Belosi, F., Bingemer, H. G., Brooks, S. D., Budke, C., Burkert-Kohn, M., Collier, K. N., Danielczok, A., Eppers, O., Felgitsch, L., Garimella, S., Grothe, H., Herenz, P., Hill, T. C. J., Höhler, K., Kanji, Z. A., Kiselev, A., Koop, T., Kristensen, T. B., Krüger, K., Kulkarni, G., Levin, E. J. T., Murray, B. J., Nicosia, A., O'Sullivan, D., Peckhaus, A., Polen, M. J., Price, H. C., Reicher, N., Rothenberg, D. A., Rudich, Y., Santachiara, G., Schiebel, T., Schrod, J., Seifried, T. M., Stratmann, F., Sullivan, R. C., Suski, K. J., Szakáll, M., Taylor, H. P., Ullrich, R., Vergara-Temprado, J., Wagner, R., Whale, T. F., Weber, D., Welti, A., Wilson, T. W., Wolf, M. J., and Zenker, J.: The Fifth International Workshop on Ice Nucleation phase 2 (FIN-02): laboratory intercomparison of ice nucleation measurements, *Atmos. Meas. Tech.*, 11, 6231–6257, <https://doi.org/10.5194/amt-11-6231-2018>, 2018.

DeMott, P., Mirrieles, J., Petters, S., Cziczo, D., Petters, M., Bingemer, H., Hill, T., Froyd, K., Garimella, S., Hallar, G., Levin, E., McCubbin, I., Perring, A., Rapp, C., Schiebel, T., Schrod, J., Suski, K., Weber, D., Wolf, M., Zawadowicz, M., Zenker, J., Möhler, O., and Brooks, S.: The Fifth International Workshop on Ice Nucleation Phase 3 (FIN-03): Field Intercomparison of Ice Nucleation Measurements, *EGUsphere* [preprint], <https://doi.org/10.5194/egusphere-2024-1744>, 2024.

Garimella, S., Kristensen, T. B., Ignatius, K., Welti, A., Voigtländer, J., Kulkarni, G. R., Sagan, F., Kok, G. L., Dorsey, J., Nichman, L., Rothenberg, D. A., Rösch, M., Kirchgäßner, A. C. R., Ladkin, R., Wex, H., Wilson, T. W., Ladino, L. A., Abbatt, J. P. D., Stetzer, O., Lohmann, U., Stratmann, F., and Cziczo, D. J.: The SPectrometer for Ice Nuclei (SPIN): an instrument to investigate ice nucleation, *Atmos. Meas. Tech.*, 9, 2781–2795, <https://doi.org/10.5194/amt-9-2781-2016>, 2016.

Hartmann, S., Niedermeier, D., Voigtländer, J., Clauss, T., Shaw, R. A., Wex, H., Kiselev, A., and Stratmann, F.: Homogeneous and heterogeneous ice nucleation at LACIS: operating principle and theoretical studies, *Atmos. Chem. Phys.*, 11, 1753–1767, <https://doi.org/10.5194/acp-11-1753-2011>, 2011.

Häusler, T., Gebhardt, P., Iglesias, D., Rameshan, C., Marchesan, S., Eder, D., and Grothe, H.: Ice Nucleation Activity of Graphene and Graphene Oxides, *J. Phys. Chem. C*, 122, 15, 8182–8190, <https://doi.org/10.1021/acs.jpcc.7b10675>, 2018.

Hiranuma, N., Augustin-Bauditz, S., Bingemer, H., Budke, C., Curtius, J., Danielczok, A., Diehl, K., Dreischmeier, K., Ebert, M., Frank, F., Hoffmann, N., Kandler, K., Kiselev, A., Koop, T., Leisner, T., Möhler, O., Nillius, B., Peckhaus, A., Rose, D., Weinbruch, S., Wex, H., Boose, Y., DeMott, P. J., Hader, J. D., Hill, T. C. J.,

Kanji, Z. A., Kulkarni, G., Levin, E. J. T., McCluskey, C. S., Murakami, M., Murray, B. J., Niedermeier, D., Petters, M. D., O'Sullivan, D., Saito, A., Schill, G. P., Tajiri, T., Tolbert, M. A., Welti, A., Whale, T. F., Wright, T. P., and Yamashita, K.: A comprehensive laboratory study on the immersion freezing behavior of illite NX particles: a comparison of 17 ice nucleation measurement techniques, *Atmos. Chem. Phys.*, 15, 2489–2518, <https://doi.org/10.5194/acp-15-2489-2015>, 2015.

Hiranuma, N., Adachi, K., Bell, D. M., Belosi, F., Beydoun, H., Bhaduri, B., Bingemer, H., Budke, C., Clemen, H.-C., Conen, F., Cory, K. M., Curtius, J., DeMott, P. J., Eppers, O., Grawe, S., Hartmann, S., Hoffmann, N., Höhler, K., Jantsch, E., Kiselev, A., Koop, T., Kulkarni, G., Mayer, A., Murakami, M., Murray, B. J., Nicosia, A., Petters, M. D., Piazza, M., Polen, M., Reicher, N., Rudich, Y., Saito, A., Santachiara, G., Schiebel, T., Schill, G. P., Schneider, J., Segev, L., Stopelli, E., Sullivan, R. C., Suski, K., Szakáll, M., Tajiri, T., Taylor, H., Tobo, Y., Ullrich, R., Weber, D., Wex, H., Whale, T. F., Whiteside, C. L., Yamashita, K., Zelenyuk, A., and Möhler, O.: A comprehensive characterization of ice nucleation by three different types of cellulose particles immersed in water, *Atmos. Chem. Phys.*, 19, 4823–4849, <https://doi.org/10.5194/acp-19-4823-2019>, 2019.

Knopf, D. A., Barry, K. R., Brubaker, T. A., Jahl, L. G., Jankowski, K. A., Li, J., Lu, Y., Monroe, L. W., Moore, K. A., Rivera-Adorno, F. A., Saucedo, K. A., Shi, Y., Tomlin, J. M., Vepuri, H. S. K., Wang, P., Lata, N. N., Levin, E. J. T., Creamean, J. M., Hill, T. C. J., China, S., Alpert, P. A., Moffet, R. C., Hiranuma, N., Sullivan, R. C., Fridlind, A. M., West, M., Riemer, N., Laskin, A., DeMott, P. J., and Liu, X.: Aerosol–Ice Formation Closure: A Southern Great Plains Field Campaign, *B. Am. Meteorol. Soc.*, 102, 10, E1952–E1971, <https://doi.org/10.1175/BAMS-D-20-0151.1>, 2021.

Lacher, L., Adams, M. P., Barry, K., Bertozzi, B., Bingemer, H., Boffo, C., Bras, Y., Büttner, N., Castarede, D., Cziczó, D. J., DeMott, P. J., Fösig, R., Goodell, M., Höhler, K., Hill, T. C. J., Jentzsch, C., Ladino, L. A., Levin, E. J. T., Mertes, S., Möhler, O., Moore, K. A., Murray, B. J., Nadolny, J., Pfeuffer, T., Picard, D., Ramírez-Romero, C., Ribeiro, M., Richter, S., Schrod, J., Sellegri, K., Stratmann, F., Swanson, B. E., Thomson, E. S., Wex, H., Wolf, M. J., and Freney, E.: The Puy de Dôme ICe Nucleation Intercomparison Campaign (PICNIC): comparison between online and offline methods in ambient air, *Atmos. Chem. Phys.*, 24, 2651–2678, <https://doi.org/10.5194/acp-24-2651-2024>, 2024.

Mason, R. H., Chou, C., McCluskey, C. S., Levin, E. J. T., Schiller, C. L., Hill, T. C. J., Huffman, J. A., DeMott, P. J., and Bertram, A. K.: The micro-orifice uniform deposit impactor–droplet freezing technique (MOUDI-DFT) for measuring concentrations of ice nucleating particles as a function of size: improvements and initial validation, *Atmos. Meas. Tech.*, 8, 2449–2462, <https://doi.org/10.5194/amt-8-2449-2015>, 2015.

Möhler, O., Adams, M., Lacher, L., Vogel, F., Nadolny, J., Ullrich, R., Boffo, C., Pfeuffer, T., Hobl, A., Weiß, M., Vepuri, H. S. K., Hiranuma, N., and Murray, B. J.: The Portable Ice Nucleation Experiment (PINE): a new online instrument for laboratory studies and automated long-term field observations of ice-nucleating particles, *Atmos. Meas. Tech.*, 14, 1143–1166, <https://doi.org/10.5194/amt-14-1143-2021>, 2021.

Polen, M., Lawlis, E., and Sullivan, R. C.: The unstable ice nucleation properties of Snomax® bacterial particles, *J. Geophys. Res. Atmos.*, 121, 11,666–11,678, <https://doi.org/10.1002/2016JD025251>, 2016.

Polen, M., Brubaker, T., Somers, J., and Sullivan, R. C.: Cleaning up our water: reducing interferences from nonhomogeneous freezing of “pure” water in droplet freezing assays of ice-nucleating particles, *Atmos. Meas. Tech.*, 11, 5315–5334, <https://doi.org/10.5194/amt-11-5315-2018>, 2018.

Pummer, B. G., Bauer, H., Bernardi, J., Bleicher, S., and Grothe, H.: Suspendable macromolecules are responsible for ice nucleation activity of birch and conifer pollen, *Atmos. Chem. Phys.*, 12, 2541–2550, <https://doi.org/10.5194/acp-12-2541-2012>, 2012.

Schiebel, P.: Ice Nucleation Activity of Soil Dust Aerosols, Ph. D. thesis, Institute of Meteorology and Climate Research – Atmospheric Aerosol Research, Karlsruhe Institute of Technology, Germany, 131 pp., 2017.

Wex, H., Augustin-Bauditz, S., Boose, Y., Budke, C., Curtius, J., Diehl, K., Dreyer, A., Frank, F., Hartmann, S., Hiranuma, N., Jantsch, E., Kanji, Z. A., Kiselev, A., Koop, T., Möhler, O., Niedermeier, D., Nillius, B., Rösch, M., Rose, D., Schmidt, C., Steinke, I., and Stratmann, F.: Intercomparing different devices for the investigation of ice nucleating particles using Snomax® as test substance, *Atmos. Chem. Phys.*, 15, 1463–1485, <https://doi.org/10.5194/acp-15-1463-2015>, 2015.

Zenker, J., Collier, K. N., Xu, G., Yang, P., Levin, E. J. T., Suski, K. J., DeMott, P. J., and Brooks, S. D.: Using depolarization to quantify ice nucleating particle concentrations: a new method, *Atmos. Meas. Tech.*, 10, 4639–4657, <https://doi.org/10.5194/amt-10-4639-2017>, 2017.

Zolles, T., Burkart, J., Häusler, T., Pummer, B., Hitzenberger, R., and Grothe, H.: Identification of Ice Nucleation Active Sites on Feldspar Dust Particles, *J. Phys. Chem. A*, 119, 11, 2692–2700, <https://doi.org/10.1021/jp509839x>, 2015.