A Multi-site Comparison Of Aerosol Properties, Including Ice-Nucleating Particles, Measured During Autumn Field Campaigns With Online And Offline Techniques

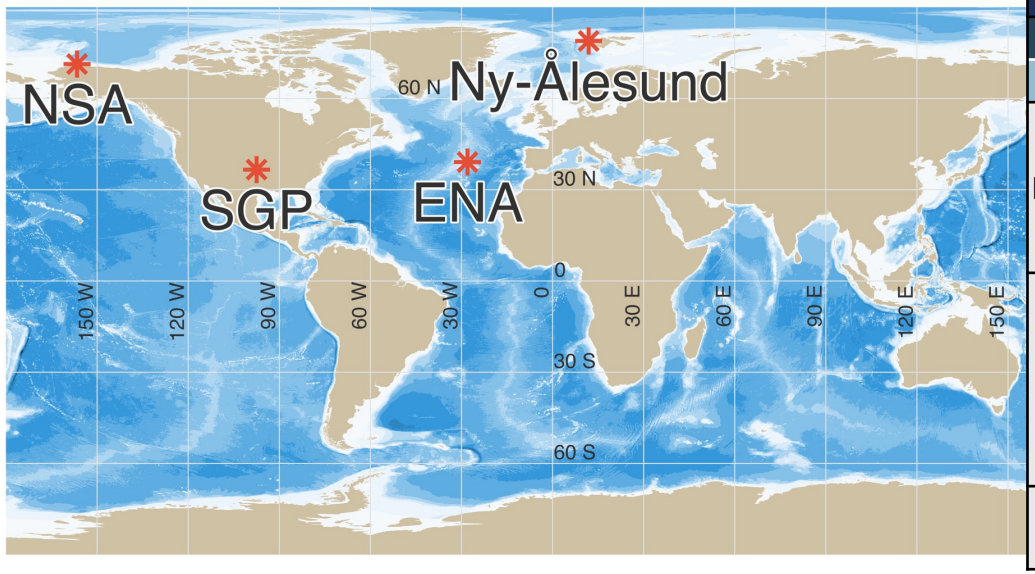
ELISE K. WILBOURN[1], LARISSA LACHER[2], MAURO MAZZOLA[3], OTTMAR MÖHLER[2], AND NARUKI HIRANUMA[1]

[1] WEST TEXAS A&M UNIVERSITY, CANYON, UNITED STATES

[2] KARLSRUHE INSTITUTE OF TECHNOLOGY, KARLSRUHE, GERMANY

[3] ITALIAN NATIONAL RESEARCH COUNCIL, BOLOGNA, ITALY

SAMPLING LOCATIONS

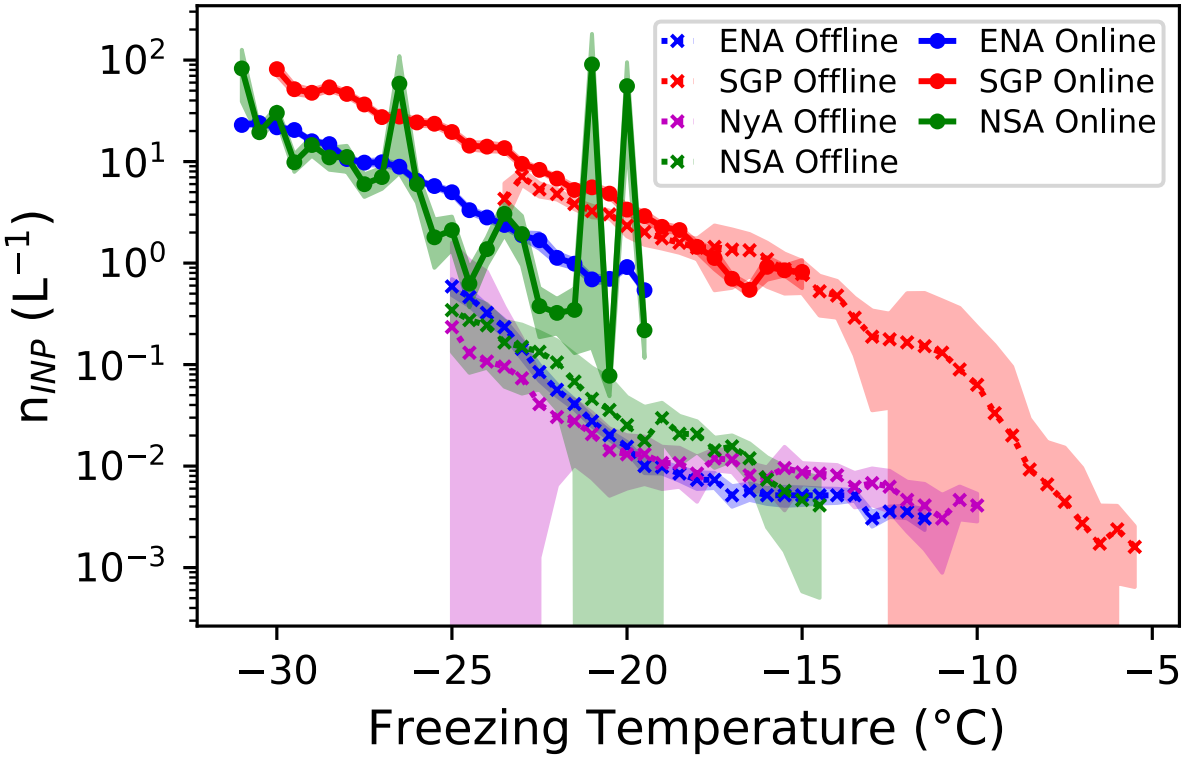


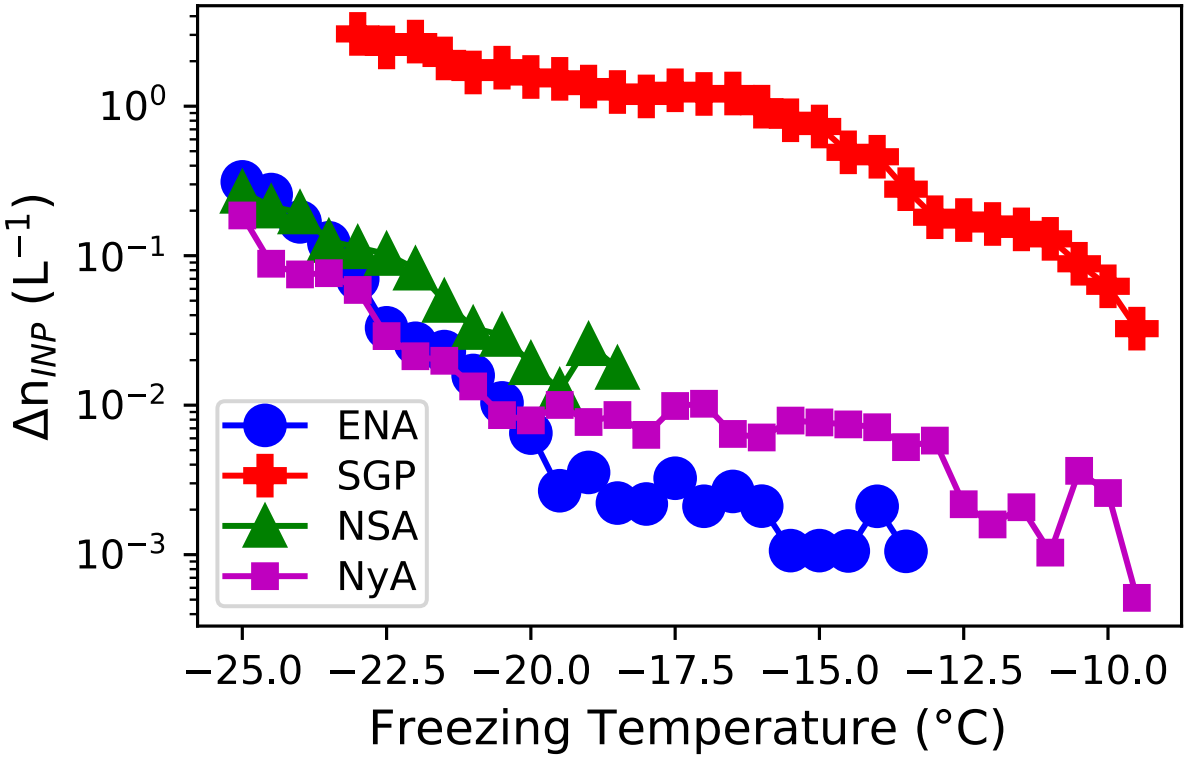
		ENA	SGP	Ny-A	BRW
Time Period		Oct-Nov 2020	Oct-Nov 2019	Oct-Nov 2019,2020	Oct-Nov 2021
Total Aerosols (cm^-3)		338.97 ± 1.40	2896.65 ± 0.90	54.84 ± 1.87	96.4 ± 2.81
N_INP L^-1 Filters	-10 °C	-	0.06 ± 0.17	0.003 ± 0.001	-
	-15 °C	0.007 ± 0.001	0.78 ± 0.27	0.009 ± 0.002	0.003 ± 0.0008
	-20 °C	0.020 ± 0.002	2.33 ± 0.50	0.013 ± 0.007	0.02 ± 0.005
	-25 °C	1.025 ± 0.105	-	0.234 ± 1.35	0.26 ± 0.07
N_INP L^-1 PINE	-10 °C	-	0.24 ± 0.03	-	-
	-15 °C	-	0.25 ± 0.13	-	-
	-20 °C	0.71 ± 0.04	2.03 ± 0.25	-	0.00 ± 0.27
	-25 °C	4.26 ± 0.31	15.61 ± 0.96	-	0.00 ± 0.32
	-30 °C	16.43 ± 1.53	47.74 ± 5.36	-	2.18 ± 0.62
CCN cm^-3	0.1 %SS	40.68 ± 1.79	137.86 ± 7.58	-	-
	0.2 %SS	81.81 ± 3.96	407.96 ± 25.04	-	-

- Four sites to represent:
  - A predominately marine site (Eastern North Atlantic, ENA)
  - A mid-latitude terrestrial site (Southern Great Plains, SGP)
  - Two arctic sites (North Slope Alaska, NSA; Ny-Alesund, Svalbard)
- Aim was to quantify INPs at a variety of contrasting sites and to determine information about the INPs at the sites (eg., heat sensitivity)

- Two offline and one online $n_{INP}(T)$ measurement methods
  - Online method provided high time resolution measurements
    - Portable Ice Nucleation Experiment chamber, Mohler et al., 2021
  - Offline methods provided $n_{INP}(T > -15°C)$ and INP heat sensitivity information
    - West Texas A&M Cryogenic Refrigerator Applied to Freezing Technique (WTCRAFT) and Ice Nucleation Spectrometer of Karlsruhe Institute of Technology (INSEKT)

RESULTS





- INPs show less variability between sites than expected based on previous studies
- Terrestrial $n_{INP}(T)$ and heat sensitivity is much higher than sites with stronger marine influence
- Samples from ENA show the least heat sensitivity, especially at temperatures above -20°C
  - Below -20°C the heat sensitivity of the three coastal sites is similar
- Suggests the need for studies using the same methods at contrasting sites to better understand INPs globally

ACKNOWLEDGEMENTS

- This research was supported by the US Department of Energy, Office of Science, Office of Biological and Environmental Research (grant no. DE-SC-0018979). The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and/or READY website (https://www.ready.noaa.gov) used in this publication. Data were obtained from the Atmospheric Radiation Measurement (ARM) Program sponsored by the U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research, Climate and Environmental Sciences Division.

- Thanks to all our collaborators:
  - Current and former members of the Hiranuma research group at WTAMU
  - Ottmar Möhler, Larissa Lacher, Jens Nadolny, Franziska Vogel, Romy Fösig, Nicole Büttner, Alex Böhmländer
  - Members of the PINE development community
  - Technicians at each of the sample sites

WEST TEXAS A&M UNIVERSITY™

U.S. DEPARTMENT OF ENERGY

ARM CLIMATE RESEARCH FACILITY

KIT Karlsruher Institut für Technologie