Snow ice particle microphysical properties and fall speed from particle images taken with the Dual Ice Crystal Imager (D-ICI) in Kiruna (Sweden) 2014–2018

SND-ID: 2021-125-1. **Version**: 2. **DOI**: https://doi.org/10.5878/2dnq-5x15

Download data

particle_data.txt *(320.14 KB)*

Side.zip *(1.32 GB)*

Top_particle_cutout.zip *(107.76 MB)*

Top.zip *(1.95 GB)*

Associated documentation

Description_of_dataset_v2.txt *(4.23 KB)*

Shape_groups.txt *(424 bytes)*

Shapes.txt *(808 bytes)*

Download all files

2021-125-1-2.zip *(~3.38 GB)*

Citation

Kuhn, T., & Vázquez-Martín, S. (2021) Snow ice particle microphysical properties and fall speed from particle images taken with the Dual Ice Crystal Imager (D-ICI) in Kiruna (Sweden) 2014–2018 (Version 2) [Data set]. Luleå University of Technology. Available at: https://doi.org/10.5878/2dnq-5x15

Creator/Principal investigator(s)

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Research principal

Luleå University of Technology - Department of Computer Science, Electrical and Space Engineering

Description

Accurate predictions of snowfall require good knowledge of the microphysical properties of the snow ice crystals and particles. Shape is an important parameter as it strongly influences the scattering properties of the ice particles, and thus their response to remote sensing techniques such as radar measurements. The fall speed of ice particles is another important parameter for both numerical forecast models as well as representation of ice clouds and snow in climate models, as it is responsible for the rate of removal of ice from these models. The particle mass is also a key quantity as it connects the cloud microphysical properties to radiative properties.

The ground-based in-situ instrument Dual Ice Crystal Imager (D-ICI) has been used in Kiruna, Sweden, to determine snow ice particle properties and fall speed simultaneously. D-ICI takes two highresolution images of the same falling ice particle from two different viewing directions, a top view and a side view. Both images have a pixel resolution of approximately 4 µm/pixel and an optical resolution of approximately 10 µm.

The top-view image with its close to vertical viewing direction is used to provide particle size (maximum dimension), cross-sectional area, and shape of the ice particle. This viewing geometry is chosen instead of a horizontal one because shape and size of ice particles as viewed in the vertical direction are more relevant than these properties viewed horizontally as the vertical fall speed is more strongly influenced by the vertically viewed properties. In addition, a comparison with remote sensing instruments that mostly have a vertical or close to vertical viewing geometry is favoured when the particle properties are measured in the same direction.

The side-view image with its horizontal viewing direction is used both to aid shape determination as well as to determine fall speed by means of a double exposure. Two bright flashes of a light-emitting diode behind the camera illuminate the falling ice particle and create this double exposure, from which the vertical displacement of the particle is measured and used to determine its fall speed.

To add ice particle mass to the data from D-ICI, an empirical relationship between the dimensionless Reynolds and Best numbers can be used. Then, mass of individual ice particles can be derived from measured fall speed, particle size, and cross-sectional area.

During four winter seasons, 2014/2015–2017/2018, D-ICI was employed in Kiruna, northern Sweden (67.8N, 20.4E). The dataset presented here has resulted from the D-ICI measurements during this period and consists of the determined snow ice particle properties and the dual images of the same particles.

The dataset is the basis of the articles:
Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021): Shape dependence of snow crystal fall speed, Atmospheric Chemistry and Physics, 21(10), 7545–7565. https://doi.org/10.5194/acp-21-7545-2021
Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021). Mass of different snow crystal shapes derived from fall speed measurements, Atmospheric Chemistry and Physics, 21(24), 18669–18688. https://doi.org/10.5194/acp-2021-203

The following description can also be found in the documentation file "Description_of_dataset.txt".

Data in Version 2 are identical to the data in Version 1, but they also contain ice particle mass as new variable.

The dataset is the basis of the articles:
Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021): Shape dependence of snow crystal fall speed, Atmospheric Chemistry and Physics, 21(10), 7545–7565. https://doi.org/10.5194/acp-21-7545-2021
Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021). Mass of different snow crystal shapes derived from fall speed measurements, Atmospheric Chemistry and Physics, 21(24), 18669–18688. https://doi.org/10.5194/acp-2021-203

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Description of the dataset

During four winter seasons, 2014/2015-2017/2018, a Dual Ice Crystal Imager (D-ICI) was employed in Kiruna, northern Sweden (67.8N, 20.4E), to record dual images of naturally falling snow ice particles.

For each detected particle, the maximum dimension, cross-sectional area, area ratio, and aspect ratio are determined from the top-view image. The particle fall speed is determined from the side-view image, which is for this purpose exposed twice. Additionally, the particle's shape is determined by looking at both top-view and side-view images. Details of the methods can be found in Kuhn et al. (2020) and Vázquez-Martín et al. (2020). Furthermore, an empirical relationship between the dimensionless Reynolds and Best numbers is used to derive mass of individual ice particles from measured fall speed, maximum dimension, and cross-sectional area (Vázquez-Martín et al., 2021a).

The dataset consists in these particle properties together with the acquired dual images. The particle properties are listed in a text file called "particle_data.txt". This file also contains the filenames of the dual images. The two filenames refer to a cut-out of the particle in the top view and the entire side-view with the double-exposed falling particle. The filenames are constructed from the date and time (including ms) of acquisition. The cut-out top-view filenames have an additional particle index, which numbers particles consecutively in case several particles were found on the same top-view image. An example cut-out top-view filename is "20141019_070207_020_1.tiff", an example side-view filename is "20141019_070207_028.tif".

The particle shape in the file "particle_data.txt" denotes a unique numeric shape identifier. Each shape identifier corresponds to one shape from the classification scheme described by Vázquez-Martín et al. (2020) as listed in the file "shapes.txt". The shape dependence is analysed by Vázquez-Martín et al. (2021b) using 15 different shape groups. Each shape, and consequently each particle, belongs to one of these shape groups as shown in the file "shape_groups.txt".

The two folders "Top" and "Side" contain all top- and side-view image files, respectively. The folder "Top_particle_cutout" contains the cut-out top-view files.

References:

Kuhn, T. and Vázquez-Martín, S. (2020). Microphysical properties and fall speed measurements of snow ice crystals using the Dual Ice Crystal Imager (D-ICI), Atmospheric Measurement Techniques, 13, 1273–1285, https://doi.org/10.5194/amt-13-1273-2020

Vázquez-Martín, S., Kuhn, T., and Eliasson, S. (2020). Shape Dependence of Falling Snow Crystals' Microphysical Properties Using an Updated Shape Classification, Applied Sciences, 10, 1163, https://doi.org/10.3390/app10031163

Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021a). Mass of different snow crystal shapes derived from fall speed measurements, Atmospheric Chemistry and Physics, 21(24), 18669–18688. https://doi.org/10.5194/acp-2021-203

Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021b). Shape dependence of snow crystal fall speed, Atmospheric Chemistry and Physics, 21(10), 7545–7565. https://doi.org/10.5194/acp-21-7545-2021

Data contains personal data

No

Language

English

Time period(s) investigated

2014-10-19 – 2018-05-11

Variables

12

Data format / data structure

Numeric

Still image

Geographic spread

Geographic location: Sweden, Norrbotten County, Kiruna Municipality

Geographic description: Measurement site in Kiruna, northern Sweden (67.8°N, 20.4°E).

Responsible department/unit

Department of Computer Science, Electrical and Space Engineering

Research area

Earth and related environmental sciences (Standard för svensk indelning av forskningsämnen 2011)

Natural sciences (Standard för svensk indelning av forskningsämnen 2011)

Meteorology and atmospheric sciences (Standard för svensk indelning av forskningsämnen 2011)

Climatology / meteorology / atmosphere (INSPIRE topic categories)

Keywords

Atmospheric conditions, Snow fall speed, Snowfall, Snow crystals, Snow

Publications

Vazquez-Martin, S., Kuhn, T., & Eliasson, S. (2020). Shape Dependence of Falling Snow Crystals' Microphysical Properties Using an Updated Shape Classification. Applied Sciences, 10(3), Article 1163. https://doi.org/10.3390/app10031163
DOI: https://doi.org/10.3390/app10031163
URN: urn:nbn:se:smhi:diva-5682

Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021). Shape dependence of snow crystal fall speed. Atmospheric Chemistry and Physics, 21(10), 7545–7565. https://doi.org/10.5194/acp-21-7545-2021
URN: urn:nbn:se:ltu:diva-82170
DOI: https://doi.org/10.5194/acp-21-7545-2021

Kuhn, T., & Vázquez-Martín, S. (2020). Microphysical properties and fall speed measurements of snow ice crystals using the Dual Ice Crystal Imager (D-ICI). Atmospheric Measurement Techniques, 13, 1273–1285. https://doi.org/10.5194/amt-13-1273-2020
DOI: https://doi.org/10.5194/amt-13-1273-2020
URN: urn:nbn:se:ltu:diva-78097

Vázquez-Martín, S., Kuhn, T., & Eliasson, S. (2021). Mass of different snow crystal shapes derived from fall speed measurements, Atmospheric Chemistry and Physics, 21(24), 18669–18688. https://doi.org/10.5194/acp-2021-203

DOI: https://doi.org/10.5194/acp-21-18669-2021

If you have published anything based on these data, please notify us with a reference to your publication(s). If you are responsible for the catalogue entry, you can update the metadata/data description in DORIS.

Polygon (Lon/Lat)

20.409069162726, 67.840976013854

20.409069162726, 67.833875463539

20.41485151854, 67.833875463539

20.41485151854, 67.840976013854

20.409069162726, 67.840976013854

Accessibility level

Access to data through SND
Data are freely accessible

Use of data

Things to consider when using data shared through SND

License

Versions

Version 2. 2021-12-20
Version 1. 2021-05-17

Contact for questions about the data

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Related research data in SND's catalogue

Dual Ice Crystal Imager (D-ICI): images of snow particles from Kiruna on 2014-10-19 with size, area, and fall speed measurements

Snow ice particle microphysical properties and fall speed from particle images taken in Kiruna (Sweden) 2014–2018 - Data 2

Download metadata

DataCite

DDI 2.5

DDI 3.3

DCAT-AP-SE 2.0

JSON-LD

PDF

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