Winter Precipitation Type Research Multi-Scale Experiment (WINTRE-MIX) Manual Hydrometeor Photographs Dataset

Version 1.0

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1. Dataset Description

1.1 Introduction

Manual hydrometeor macro photographs were collected during the Winter Precipitation Type Research Multi-Scale Experiment (WINTRE-MIX) between 01 Feb – 15 March 2022. The macro photographs were collected by manual ground observation teams from the University at Albany (UAlbany), University of Colorado Boulder (CU), Université du Québec à Montréal (UQAM), and McGill University (McGill). The following sections provide information on the camera setup, protocol, and dataset file formats, as well as limitations associated with the data. For more information on the meteorological conditions of each IOP, please refer to the mission summaries on the WINTRE-MIX field catalog (http://catalog.eol.ucar.edu/wintre-mix/missions).

1.2 Data Version and Date

Version 1.0, 24 June 2022

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1.3 Observation Locations

Hydrometeor macro photography was conducted at a variety of locations across the Saint Lawrence River Valley in southern Quebec and the Champlain Valley in northern New York throughout the WINTRE-MIX field campaign. A list of the sites used for WINTRE-MIX hydrometeor manual photography is provided below, partitioned by the research teams that operated at each site. A map showing all the locations is provided in Fig. 1.

University at Albany:

- DOW-US-N (Champlain, NY): 44.9554328°, –73.3878575° (elev: 46 m)
- DOW-US-Plattsburgh: 44.684823°, –73.526291° (elev: 109 m)
- ESSX (Essex Farm): 44.308028°, –73.374444° (elev: 67 m)

University of Colorado Boulder:

- DOW-CAN-N (NW of Acton Vale, QC): 45.704814°, –72.644103° (elev: 69 m)
- DOW-CAN-SE (St. Blaise-sur-Richelieu, QC): 45.2129313°, –73.2854085° (elev: 47 m)
- DOW-CAN-S (Noyan, QC): 45.085246°, –73.271936° (elev: 37 m)
- JEAN (St. Jean-sur-Richelieu, QC): 45.324880°, –73.266880° (elev: 37 m)

UQAM:

- Sorel, QC: 46.030244°, –73.110328° (elev: 13 m)
- Trois-Rivières, QC: 46.349836°, –72.581353° (elev: 52 m)
- JEAN (St Jean-sur-Richelieu, QC): 45.324880°, –73.266880° (elev: 37 m)

McGill University:

- Gault (Mont St. Hilaire, QC): 45.535022°, –73.149006° (elev: 132 m)

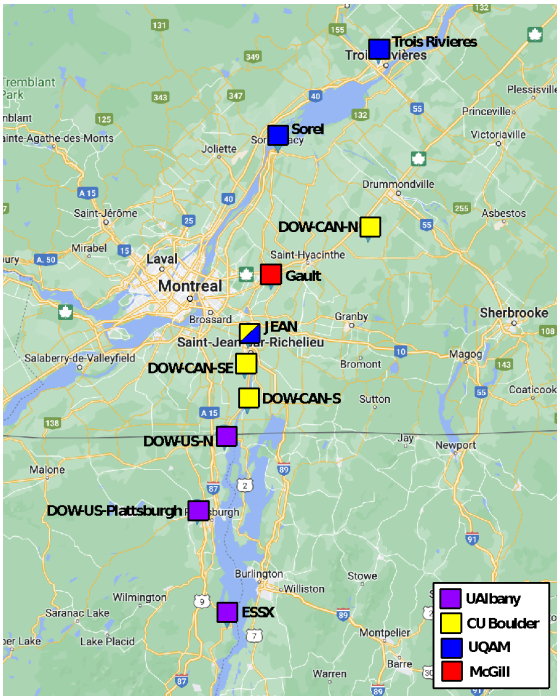

Figure 1. Hydrometeor manual photography locations used throughout the WINTRE-MIX field campaign

1.4 Observation Summary

A total of 11 IOPs were conducted throughout the field campaign. Table 1 summarizes the number of hydrometeor macro photographs taken during each IOP, as well as the precipitation types that can be observed in the photographs. The *# DSLR Photos* column presents the number of photos taken with the DSLR camera and the *# Misc. Photos* column presents the number of photos taken with a non-DSLR camera. Precipitation types (P types) on photos were classified as snow/snow pellets/graupel (SN), ice crystals (IC) and ice pellets (PL).

Table 1: Number of photography for every IOP

IOP	IOP Duration	Locations	# DSLR Photos	# Misc. Photos	P types on photos
1	2100 UTC 2 Feb – 0900 UTC 3 Feb 2022	Sorel Gault DOW-CAN-S DOW-US-Plattsburgh	0 0 0 0	8 0 0 0	SN - - -
2	0800 UTC 10 Feb – 1330 UTC 10 Feb 2022	Sorel Gault DOW-CAN-N DOW-US-N	0 0 0 0	11 0 0 0	SN, PL - - -
3	2200 UTC 11 Feb – 0630 UTC 12 Feb 2022	Sorel Gault DOW-CAN-N DOW-US-N	0 0 0 0	0 0 0 0	- - - -
4	2300 UTC 17 Feb – 1000 UTC 18 Feb 2022	Sorel Gault	464 335	18 0	SN SN,IC,PL

		DOW-CAN-S DOW-US-Plattsburgh	112 20	0 0	SN,IC,PL SN,IC,PL
5	2000 UTC 22 Feb – 0530 UTC 23 Feb 2022	Sorel Trois-Rivières Gault DOW-CAN-N DOW-US-N	329 279 0 0 0	89 0 0 0 0	PL,IC PL,IC - - -
6	0900 UTC 25 Feb – 2000 UTC 25 Feb 2022	ESSX	73	0	SN
7	1600 UTC 01 Mar – 0200 UTC 02 Mar 2022	Sorel Gault DOW-CAN-SE DOW-US-N	476 465 12 19	0 0 0 0	SN SN SN SN
8	0600 UTC 06 Mar – 1730 UTC 06 Mar 2022	Sorel Trois-Rivières Gault DOW-CAN-N DOW-US-N	156 0 0 0 0	0 0 0 0 0	SN, PL - - - -
9	1400 UTC 07 Mar – 0200 UTC 08 Mar 2022	Sorel Gault DOW-CAN-SE DOW-US-Plattsburgh	378 126 0 0	77 0 0 0	PL,SN SN,PL - -
10	0000 UTC 12 Mar – 0900 UTC 12 Mar 2022	Sorel Gault JEAN DOW-US-Plattsburgh	298 211 16 0	0 0 0 0	SN SN,PL SN,PL -
11	0000 UTC 15 Mar – 0700 UTC 15 Mar 2022	Gault JEAN DOW-US-Plattsburgh	77 11 0	0 13 0	SN SN -

1.5 Web Address

https://doi.org/10.26023/D0SE-720B-K60J

1.6 Data Restrictions

Please refer to the websites below for more information regarding the dataset restrictions and dissemination.
WINTRE-MIX data policy:
https://www.eol.ucar.edu/content/wintre-mix-data-policy
WINTRE-MIX data management plan:
https://www.eol.ucar.edu/system/files/Data_Management_Plan-1Dec2021.pdf

2. Instrument Description

2.1 Camera setup

All the teams used a Nikon Digital Single Lens Reflex (DSLR) camera, equipped with a 60-mm macro lens and a ring flash. Similar DSLR camera models were used by the different teams: CU, UQAM-Sorel and McGill used a Nikon D3500, UAlbany used a Nikon D3600 and

UQAM-Trois-Rivières used a Nikon D3200. During precipitation events, the camera was installed on a vertical mount with a large metal base (Figure 2.1). A plastic pad covered with a black velvet fabric was used to collect solid precipitation. The pads measured between 13 x 13 cm and 15 x 15 cm.

Figure 2.1 The metal base and the DSLR camera installed as they are used during precipitation events (adapted from Lachapelle & Thériault, 2022).

Other cameras were sometimes used to complement the macro photography collected with the DSLR camera. At the Sorel and Jean sites, all non-DSLR photos were taken using an Olympus Tough TG-5 camera.

2.2 Camera settings

DSLR cameras were used in manual mode (**M**). The photography resolution was set to Fine. ISO was set to manual and kept to low values (100-200). The shutter speed was set to a low value (1/4 s - 1/16 s). The aperture was kept small to increase the depth of field (F18 - F32). The ring flash was set to maximum brightness. The macro lens was used with the closest focus. Resulting photos are in JPEG format with a shape of 6000 x 4000 pixels.

Photos of rulers were taken throughout the field campaign to calculate a photographic scale. With all the cameras used during the field campaign, the resulting scale is 265 (+/- 2) pixels/mm. Table 2 presents details about the photographic scale calculation.

Table 3. Photographic scale calculation

Team	Site	Camera model	File Name	Calculated ratio [pixel/mm]
UQAM	Sorel	D3500	UQAM_Sorel_IOP04_ruler.JPG	263
UQAM	Sorel	D3500	UQAM_Sorel_IOP05_ruler.JPG	263
UQAM	Sorel	D3500	UQAM_Sorel_IOP10_ruler.JPG	266
UQAM	TroisRivieres	D3200	UQAM_TroisRivieres_IOP05_ruler.JPG	265
UAlbany	-	D3600	UAlbany_post_campaign_ruler.JPG	264
McGill	Gault	D3500	McGill_Gault_IOP07_ruler.JPG	265
McGill	Gault	D3500	McGill_Gault_IOP09_ruler.JPG	265
McGill	Gault	D3500	McGill_Gault_IOP10_ruler.JPG	266
McGill	Gault	D3500	McGill_Gault_IOP11_ruler.JPG	267
CU	DOW-CAN-S	D3500	CU_DOW-CAN-S_IOP04_ruler.JPG	266

2.3 Protecting the camera from precipitation

All photography was conducted outside, or in an unheated shelter, at near ambient temperature, to minimize hydrometeor melting. To conduct the hydrometeor macro photography protocol, the camera setup was protected from precipitation. Teams of UAlbany and UQAM used fishing tents to install their camera setup (Figure 2.2) while McGill and CU used a large plastic box.

Figure 2.2. UQAM-Sorel manual observation and macro photography site. The fishing tent on the left was protecting the camera during precipitation events.

Figure 2.3. UAlbany manual observation and macro photography site. The fishing tent in the middle was used to protect the camera during precipitation events.

3. Data Collection and Processing

During each IOP, observers were responsible to start following the photography protocol when solid precipitation was observed. The photography protocol followed Gibson & Stewart (2007) and Lachapelle & Thériault (2022). Ideally, solid precipitation was collected every 10 min on a collection pad covered with a black velvet fabric. Manual observers made sure that precipitation particles did not touch one another on the pad so that future analysis does not overestimate snow aggregation. Collection time depended on the precipitation rate, but was never above 1 minute. After collection, the pad was placed below the camera and a series of nine macro photographs of distinct areas on the pad was systematically taken. After taking the photographs, the observers entered information about the hydrometeor photographs in the manual observation spreadsheet. The following fields were selected from the Manual Observation Dataset (preliminary link: http://catalog.eol.ucar.edu/wintre-mix/reports) and included in the Hydrometeor Macro Photography Dataset :

- **Hydrometeor photos taken?** : Yes or no
- **DSLR camera settings** : DSLR camera aperture, the shutter speed and the ISO.
- **Photo comments** : Other pertinent comments (e.g. quality of photographs, melting of hydrometeors, etc.).

Hydrometeor melting is limited by always leaving the collection pad outside at ambient temperature.

4. Data Format

Photos are in JPEG format. Photo files are grouped by IOP#, research team and site name in compressed files. The compressed files have the following naming convention : *[IOP#]_[Team name]_[Site name].zip .*

i. *[IOP#]* : IOP01, …, IOP11

ii. *[Team name]* : McGill, UQAM, UAlbany or CU.

iii. *[Site name]* : Gault, Sorel, TroisRivieres, DOW-CAN-N, DOW-CAN-S, DOW-CAN-SE, DOW-US-N, DOW-US-Plattsburgh, ESSX, JEAN.

The individual photo files follow this convention: *[Team name]_[Site name]_[UTC time: YYYYMMDD_HHMM]_[counter].JPG*

i. *[Team name]* : McGill, UQAM, UAlbany or CU.

ii. *[Site name]* : Gault, Sorel, TroisRivieres, DOW-CAN-N, DOW-CAN-S, DOW-CAN-SE, DOW-US-N, DOW-US-Plattsburgh, ESSX, JEAN.

iii. *[UTC time: YYYYMMDD_HHMM]* is the date and approximate time that the hydrometeors were collected for photography. The time is rounded to the nearest 10 min.

iv. *[counter]* is an index to distinguish between multiple photos taken of the same collection pad instance. Letters are used (e.g. a, b, c,...). The counter suffix is replaced by "_ruler" if a photo contains a ruler.

v. If a photo was taken using a camera other than the macro DSLR (e.g., a cell phone, olympus tough tg-5), the same naming convention is used but "misc_" is added to the counter suffix (e.g.. misc_a, misc_b, …).

A file, named "Manual_Hydrometeor_ruler_photos.zip", contains photographs of rulers taken throughout the field campaign. This folder has one subfolder per team and the photos have the following naming convention : *[Team name]_[Site name]_[IOP#]_ruler.JPG*

Files with name *[IOP#]_Camera_Settings.zip* contain CSV files for the sites where manual observation was made. These CSV files have the name : *Camera_Settings_[Team name]_[Site name]_[IOP#].csv.* They contain 6 columns that were filled up by manual observers during the IOPs : Date & time (UTC), Observer initials, Location, Hydrometeor photos taken?, DSLR settings, Photo comments.

5. Data Remarks

Macro photographs have already been validated by the different manual observers. Photographs that provided no information about the precipitation type, or that were duplicates were systematically removed from the dataset. A few limitations of the dataset are listed below.

- Photos can be blurry. This is due to camera vibration during the process of taking a photo or to a wrong position of the camera on the vertical mount.
- The size of particles cannot be precisely measured on blurry photos.
- Wind tends to reduce the number of large particles in comparison with smaller ones by blowing larger particles off the pad.
- Melting of particles on the pad can affect their appearance and shapes on the photos. Melting on the pad can occur even when ambient temperature is slightly below 0°C.
- The pad should have been cleared out of ice before collecting the hydrometeors. However, we noticed during our first assessment that some photos contain residual ice.
- The brightness of the ring flash changes as the batteries are draining. Hence, brightness changes can be observed on the photos.
- The ring flash can be reflected by spherical particles such as rain drops or ice pellets. When it does, a white circle appears in the middle of the particles.
- In practice, photos were not always taken every 10 minutes as manual observers had to do other time-consuming tasks such sounding launches and snow measurements.

6. References

Lachapelle, Mathieu, and Julie M. Thériault. "Characteristics of Precipitation Particles and Microphysical Processes during the 11–12 January 2020 Ice Pellet Storm in the Montréal Area, Québec, Canada." *Monthly Weather Review* 150.5 (2022): 1043-1059.

Gibson, Steven R., and Ronald E. Stewart. "Observations of ice pellets during a winter storm." *Atmospheric research* 85.1 (2007): 64-76.

7. Acknowledgements

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8. Appendix

Suggested GCMD keywords to accompany this dataset are provided below in no particular order:

- Solid precipitation
- Frozen precipitation
- Ice pellets
- Snow
- Ice storms
- Snow storms
- Extratropical cyclones
- Macro photography
- Snowflakes
- Ice crystals
- Manual weather observations