essd-2024-602 Author response to referee comment 1

Original comments are in black, our responses are in blue, proposed additions and modifications in red, original manuscript text in grey. Line numbers refer to the original manuscript.

**Reviewer 1 Adrià Fontrodona-Bach**

This paper presents a dataset of manual and automated in situ measurements of snow water equivalent (SWE) over the Northern Hemisphere, which is called NorSWE. To the best of my knowledge, there is no in situ global SWE dataset publicly available to date. Currently, researchers need to compile such a dataset from each individual source every time they require it for their applications, and apply their own filters and quality checks, which is time and labour intensive. The scientific community will therefore highly benefit from this dataset, and it fits very well within the scope of the journal. The dataset is excellent, offers a wide range of applications (as the authors very well describe and demonstrate in the paper) and is especially timely as many global products and applications rely on actual SWE measurements and are being increasingly used by the community. The authors did an impressive data compilation and data curation work. The paper is also well written and clear and I hope to see it published soon. However, I have a few minor comments/suggestions and technical corrections that should be addressed before the paper is published.

I only have one rather **major suggestion**, but I call it major just because it may require a bit more time than the rest of minor comments. It regards the spatial coverage of the dataset. The dataset covers a large part of the Northern Hemisphere, but there are some gaps, which the authors recognise in Section 8 (Lines 373-380). It is true that there is a lack of observations in certain areas (e.g. high mountain Asia), and that many other SWE data are just not publicly available. I also acknowledge that it is not possible to find and include every single available dataset and that a line must be drawn somewhere. However, there is some data available over Europe which the authors did not include and which I strongly encourage they do. These include the Global Climate Observing System (GCOS), the Norwegian Water Resources and Energy Directorate, and a few other individual sites over the Alps. The sources are well listed in Table 1 in Fontrodona-Bach et al. (2023), and they are also used and listed by Seo et al. (2025) in Table 1 https://doi.org/10.5194/essd-2024-349 (preprint). This would give some coverage (despite being still limited) to the European Alps and to Scandinavia outside of Finland, and I strongly encourage that these datasets are included. If the authors wish, they can get in touch with me and I will send them some notes on how I downloaded these data.

Thank you for the constructive feedback. NorSWE was original compiled for the purpose of evaluating gridded SWE products. For that reason, we established criteria to only include snow courses and airborne gamma measurements because they are more spatially representative than single point measurements. We later expanded the criteria to also include automated point data because they provide useful information on the seasonal evolution of SWE important for evaluating hydrological models, also an important application of NorSWE data. However, as you and Alexander Gotlieb (Reviewer 3) point out we missed including data from the Norwegian Water Resources and Energy Directorate. We propose to add these data.

We recognize that our criterion omits certain data, for example single point SWE measurements. The Swiss GCOS network (Marty, 2020), highlighted by yourself and Alexander Gotlieb (Reviewer 3), are single point measurements made at snow pits and therefore do not meet our criteria. However, due to the significant data gap in Europe and the wide use of the Swiss data we will make an exception and include these data. These data will be assigned the WMO code 1 (single point manual).

Text describing these networks will be added to the revised manuscript and all Figures revised accordingly.

*Marty, Christoph (2020). GCOS SWE data from 11 stations in Switzerland. EnviDat.doi:10.16904/15.*

I do not know if the authors requested permission to each individual agency to include their data in NorSWE (if they did, maybe they should explain this in the paper). In any case, in my opinion it is necessary to include clear statements that when using NorSWE data, all the original data sources (so all source datasets) must be appropriately cited as well as the citation of this paper and the NorSWE dataset itself (which is on Zenodo). This provides clear and proper acknowledgement to previous data collections that form this compilations dataset.

We made every attempt to identify the licensing and data redistribution policies associated with each dataset either through direct email with data providers or by investigating the corresponding websites. Indeed, this is the main reason this manuscript and dataset took a long time to come to fruition. Data permissions and redistribution information is included in the NetCDF general attribute 'Distribution'. However, we agree with you that this information is not clearly articulated in our text. Our intent with this dataset is certainly not to take ownership or acknowledgement away from the original data sources. We propose to add an acknowledgements section, which should have been included originally.

**~L396: *"11 Acknowledgements***

*We gratefully acknowledge the field observers collecting manual snow observations and maintaining automatic stations as well as the agencies and personnel who maintaining these records. The authors of NorSWE do not own any of these data. Data are redistributed under the following licences without guarantee of the quality/accuracy of the data: NorSWE contains data under the Norwegian licence for Open Government data (NLOD) distributed by The Norwegian Water Resources and Energy Directorate and modified as described herein. CanSWE data are redistributed under the Open Government Licence - Canada. (https://open.canada.ca/en/open-government-licence-canada). Hydro-Quebec data (http://www.hydroquebec.com/) are available under the terms of a Creative Commons Attribution - Non Commercial - Share A Like 4.0 International (https://creativecommons.org/licenses/by-nc-sa/4.0/) (CC BY-NC-SA 4.0). Finnish Environmental Institute (SYKE) data are redistributed under Creative Commons Attribution 4.0 International (CC BY 4.0). US data (NOHRSC, NRCS, Maine Geological Survey, NH DES) are redistributed under the 'US-PD' license (Creative Commons Zero Public Domain Dedication (CC0)),* 'GCOS SWE data from 11 stations in Switzerland' are redistributed under the Open Database License (ODbL) 'Attribution Share-Alike for Databases'.

*The authors of NorSWE have modified the original data as outlined in the manuscript. We recommend users of NorSWE reference the data providers of the relevant agencies as outlined in Table 4."*

I think this dataset will be very useful and I look forward to seeing this paper published and the dataset in use. The rest of comments are listed in the attached pdf.

Thank you for your positive and constructive feedback.

**List of minor comments and technical corrections, with line number (L):**

L 8-9: Revise sentence, I suggest "Here we present the Northern Hemisphere in situ snow water equivalent dataset (NorSWE), consisting …"
Suggestion implemented.

L 13: Perhaps a little unimportant, but since you reference the guide to methods and observations from the WMO (2018) in line 25 for the definition of SWE, then I think the acronym HS should be used for snow depth instead of SD throughout the paper and in the dataset, as stated in this same manual.
We recognize that the formal WMO acronym for snow depth is HS. However, since SD is more commonly used we will keep it in our paper. Upon the first use of snow depth in the main body of the text we will add explicit mention that HS is the formal abbreviation according to WMO.
*"…situ snow depth (SD), formally abbreviated as HS (WMO, 2018),"*

L 22: I do not understand how the references "National Academies of Sciences, Engineering, and Medicine, 2018; GCOS, 2022" support the statement of "the seasonal snowpack being critical for ecosystems and climate monitoring". Please be more specific or add more relevant references.
We will replace those references with Meredith et al. (2019), Thornton et al. (2021), and Gottlieb and Mankin (2024).

Added references
Thornton, J. M., Palazzi, E., Pepin, N.C., Cristofanelli, P., Essery, R., Kotlarski, S., Giuliani, G., Guigoz, Y., Kulonen, A., Pritchard, D., Li, X., Fowler, H.J., Randin, C.F., Shahgedanova, M., Steinbacher, M., Zebisch M., and Adler, C.: Toward a Definition of Essential Mountain Climate Variables, *One Earth* 4(6): 805–27, https://doi.org/10.1016/j.oneear.2021.05.005, 2021.

Meredith, M., Sommerkorn, M., Cassotta, S., Derksen, C., Ekaykin, A., Hollowed, A., Kofinas, G., Mackintosh, A., J. Melbourne-Thomas, J., Muelbert, M.M.C., Ottersen, G., Pritchard, H. and Schuur, E.A.G.: Polar Regions. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [Pörtner, H.-O., Roberts, D.C., Masson-Delmotte, V., Zhai, P., Tignor, M., Poloczanska, E., Mintenbeck, K., Alegría, A., Nicolai, M., Okem, A., Petzold, J., Rama, B., Weyer, N.M. (eds.)], https://www.ipcc.ch/site/assets/uploads/sites/3/2019/12/SROCC_FullReport_FINAL.pdf, 2019.

L26: Missing a reference for SWE in Global Climate Models.
Will add Mudryk et al. (2020) which is concerned with snow in CMIP6.

Mudryk, L., Santolaria-Otín, M., Krinner, G., Ménégoz, M., Derksen, C., Brutel-Vuilmet, C, Brady, M., and Essery, R.: Historical Northern Hemisphere snow cover trends and projected changes in the CMIP6 multi-model ensemble, The Cryosphere, 14(7), 2495–2514, https://doi.org/10.5194/tc-14-2495-2020, 2020.

Caption Table 1: Here you are calling the dataset "NH in situ SWE" instead of "NorSWE". This also occurs on Table 5 and 7, and line 232, and maybe elsewhere, please check and modify.
Thank you for catching this and we apologize for these sloppy errors. Instances of "NH in situ SWE" replaced with "NorSWE".

Table 1: On MGS entry, remove "is" from "Bulk density is derived …" for consistency with other entries.
Again, thank you for catching this inconsistency. Change implemented.

Table 2: Footnotes (1,2,3) are missing. I guess those would explain the difference between each quality flag?
Footnotes added. We also propose adding text to Section 3 to clarify the difference between agency and QC flags and to provide more information about the agency flags. Table added (Table 6) to describe the QC flags applied immediatly following Table 5 (~L165).

Table 2 footnotes (~L75)
1: see Table 3
2: see Table 5
3: see Table 6

L144: *"Each site, identified by a unique station ID, is permitted only one set of snow observations (snw/snd/den) per day; duplicate observations are removed during data processing*. *NorSWE includes two types of flags describing the data quality: agency quality flags and qc flags. QC flags indicate where an observation did not pass our quality control (See Sect. 4) and was set to nan. Agency quality flags (Table 5) incorporate information from the original observations from the data provider. These can be flags assigned by the agency to indicate certain snow conditions, for example patchy or wet snow, or to flag observations that were modified or removed during their internal QC procedures, for example revised data. Some agencies include one or more comments along with each observation instead of data flags. We coded these comments into flag values using keywords and phrases. For example, records with comments 'skiff' or 'patchy' were assigned a 'T' flag. An exception to the use of the agency quality flag field is the airborne gamma SWE data which did not have corresponding agency quality information, and we instead use this variable to store information about the soil moisture estimation method (Sect. 3.5)."*

**Table 6: Quality control (QC) flags in NorSWE. NaN stands for not a number.**

| QC flag | Definition |
|---|---|
| H | SD > 3m (> 8m in mountains). SD set to *NaN*. |
| M | Data masked (set to *NaN*) in a previous CHSSD update. |
| V | Automatic SD-SWE measurement identified as outlier using robust Mahalanobis distance. SD and SWE set to *NaN*. |
| W | SWE > 3000 kgm-2 (> 8000 $kgm^{-2}$ in mountains). SWE set to *NaN*. |
| D | Derived bulk snow density failed 25–700 $kgm^{-3}$ threshold. SD, SWE and bulk snow density set to *NaN*. |

Table 3: I think “64” should be removed from the caption.
Table 3 (~L78) caption revised to: *“Table 3: WMO SWE measurement codes (WMO, 2019) and non-WMO code for airborne gamma SWE.”*

Table 3: What does “7-62 Reserved mean”?
Table 3, except value 64, is taken directly from the WMO SWE measurement codes (WMO, 2019). Our understanding is that numbers 7 – 62 are reserved for future use – i.e. future methods requiring specific codes. Code 3 ‘passive gamma’ does not differentiate between automated gamma measurements from airborne measurements, but these are very different implementations of ‘passive gamma’ methods, so we added a ‘new’ (non-WMO) code for airborne gamma specifically. Because 7 – 62 are ‘reserved’ and 63 is intended for missing measurement type values we assigned airborne gamma the next available numeric code – 64.

L89: Not sure the abbreviation cf. is properly used here? I had not seen this before, but while searching what it means I found that it is sometimes wrongly used in science.
https://scientistseessquirrel.wordpress.com/2016/06/13/friends-dont-let-friends-use-cf/
‘cf.’ removed

Lines 94-105: Does this paragraph belong here? It is in section 2.1 on Manual gravimetric snow surveys but the paragraph is about flight surveys and the gamma radiation method.
Indeed, Section 2.2 subheading was missing. Will add subheading *2.2 Airborne gamma SWE*.

L 102: What are GM and GI? Should it be “or” instead of “of”?
Corrected. Should be ‘or’.

L 104: Is the uncertainty of the estimates so precise (23 mm)? But I also wonder how reliable these uncertainty ranges are applied to nowadays, considering the papers cited are from 1983 and 1984.

The majority of the literature regarding airborne gamma SWE is from the 1980s. Recent work by Eunsang Cho has demonstrated good agreement with the University of Arizona SWE dataset and also included some comparisons with ground observations. We propose to expand the discussion of uncertainties related to airborne gamma SWE. We acknowledge many of the added references are still quite old.

Expanded text:

L102: *“Error simulations and comparisons with coincident ground-based observations have reported accuracies of 4% to 10% in prairie and agricultural environments (Carroll et al. 1983) and up to ~12% in forested areas (Carroll and Vose, 1984; Vogel, 1985; Carroll and Carroll 1989a), although some studies have reported larger errors Glynn 1988; Cho et al. 2020a Figure 9). A comprehensive accuracy assessment of NOHRSC airborne gamma SWE showed strong correlation with the University of Arizona SWE product across all land covers and forest fractions (Cho et al. 2020b). Underestimation often occurs when there is significant SWE variability along a flight line (Cork and Loijens, 1980; Carroll and Carroll 1989b). Inaccurate characterization of the soil moisture, often due to changes in the soil moisture after the fall reference flight, is a common source of error (Carroll and Carroll 1989b; Cho et al. 2020a). Other known sources of error include*

*biomass, rock outcrops, navigation, and gamma count statistics (Glynn et al. 1988; Cork and Carroll and Carroll 1989a; Carroll and Carroll 1989b).”*

*Added references*

*Carroll, T. R., Glynn, J.E., and Goodison, B.E.: A comparison of U.S. and Canadian airborne gamma radiation snow water equivalent measurements, Proc. West. Snow Conf., 51, 27-37, 1983.*

*Carroll, S.S., Carroll, T.R.: Effect of uneven snow cover on airborne snow water equivalent estimates obtained by measuring terrestrial gamma radiation, Water Resour. Res., 25 (7), 1505 -1510,* https://doi.org/*10.1029/WR025i007p01505, 1989b.*

*Carroll, S.S. and Carroll, T.R.: Effect of forest biomass on airborne snow water equivalent estimates obtained by measuring terrestrial gamma radiation. Remote Sens. Environ. 27 (3), 313 -319. https://doi.org/10.1016/0034-4257(89)90091-6, 1989a.*

*Cho, E., Jacobs, J.M., Schroeder, R., Tuttle, S. E. and Olheiser, C.: Improvement of operational airborne gamma radiation using SMAP soil moisture, Remote Sens. Environ., 240, 111668, https://doi.org/10.1016/j.rse.2020.111668, 2020a.*

*Cho, E., Jacobs, J.M., and Vuyovich, C.: The value of long-term (40 years) airborne gamma radiation SWE record for evaluating three observation-based gridded SWE datasets by seasonal snow and land cover classifications, Water Resour. Res., 56, e2019WR025813, https://doi.org/10.1029/2019WR025813, 2020b.*

*Cork, H. F. and H. S. Loijens, H.S.: The effect of snow drifting on gamma survey results, J. Hydrol., 48(1-2), 41-51, https://doi.org/10.1016/0022-1694(80)90064-5, 1980.*

*Glynn, J.E., Carroll, T.R., Holman, P.B., Grasty, R.L.: An airborne gamma ray snow survey of a forested covered area with a deep snowpack, Remote Sens. Environ., 26 (2), 149 -160, https://doi.org/10.1016/0034-4257(88)90093-4, 1980.*

*Vogel, R. M., Carroll, T. R., and Carroll, S. S.: Simulation of airborne snow water equivalent measurement errors made over a forest environment, Proceedings of the American Society of Civil Engineers Symposium, Denver, CO, p. 9, 1985.*

L 114: “can **be** much larger”
Correction made.

Figure 1: add “a,b,c” panels, and perhaps add “Surveys” or “Manual” in panel a?
Will add ‘a’, ‘b’, ‘c’ added to panels. Will rename panel ‘a’ to ‘Manual’ and distinguish between surveys and single point (Swiss GCOS).

L 129: “Data from each of source”.
Corrected to ‘Data from each source listed …’

L 136: What does “Harmonizing agency-specific quality flags” mean? I got a little confused, because as I understand from Table 2, agency specific quality flags are kept as in the original format in the dataset, in the field “data_flag_snw” and “data_flag_snd”, but then in Table 5 the flags

are “harmonized”, so it is not clear if flags are modified or used as they are. Furthermore, you provide additional quality control flags (Section 4), but these are not specified in Table 2 or 5 (e.g. quality flag “H” in line 235 or “D” in line 236), unless by “CanSWE quality control flag” in Table 2 you mean “NorSWE quality control flag”?. Is there a table or variable missing with your own quality control flags? And how are these distinguished from the original flags from the agencies?

Thank you for this comment. It is clear we did not adequately explain the difference between agency and QC flags, and our text discussing ‘agency quality flags’ is insufficient.
We propose to add the following text to Section 3 to better provide a better explanation of ‘agency quality flags’ and to offer better distinction between them and QC flags. We will also add a table describing the QC flags (new Table 6).

L146: “*NorSWE includes two types of flags describing the data quality: agency quality flags and qc flags. QC flags indicate where an observation did not pass our quality control (See Sect. 4) and was set to NaN. Agency quality flags (Table 5) incorporate information concerning the original observation as detailed by the data provider. These can be flags assigned by the agency to indicate certain snow conditions, for example patchy or wet snow, or to flag observations that were modified or removed during their internal QC procedures, for example revised data. Some agencies include one or more comments along with each observation instead of data flags. We coded these comments into flag values using keywords and phrases. For example, records with comments ‘skiff’ or ‘patchy’ were assigned a ‘T’ flag. An exception to the use of the agency quality flag field is the airborne gamma SWE data which did not have corresponding agency quality information; instead we use this variable to store information about the soil moisture estimation method (Sect. 3.5).”*

**Table 6: Quality control (QC) flags in NorSWE. NaN stands for not a number.**

| QC flag | Definition |
|---|---|
| H | SD > 3m (> 8m in mountains). SD set to *NaN*. |
| M | Data masked (set to *NaN*) in a previous CHSSD update. |
| V | Automatic SD-SWE measurement identified as outlier using robust Mahalanobis distance. SD and SWE set to *NaN*. |
| W | SWE > 3000 kgm-2 (> 8000 $kgm^{-2}$ in mountains). SWE set to *NaN*. |
| D | Derived bulk snow density failed 25–700 $kgm^{-3}$ threshold. SD, SWE and bulk snow density set to *NaN*. |

L139: What does “using unique agency-specific Python scripts” mean? Please specify.
‘using unique agency-specific Python scripts’ removed.

L139: coordinate**s**
Corrected

Table 5: What does “revised data” mean? And what is the difference between Traces and Patches?

Thank you for the question regarding ‘Trace’ versus ‘Patches’. We propose to consolidate these into a single ‘Trace’ flag. The ‘Patches’ line will be removed from Table 5 and P flags replaced with T flags (697 snow course instances). Revised data means the data were revised by the original providing agency. This is now clarified in the expanded Section 3 text (above), relevant excerpt: “*…to flag observations that were modified or removed during their internal QC procedures, for example revised data.”*

Section 3: I find the titles of the subsections a little inconsistent, as some subtitles refer to specific datasets (3.1, 3.2, 3.4), one to a region (3.3) and another one to a method (3.5). I suggest to harmonise them by naming Subsection 3.3 as "Northeast US (MGS, NRCC, NHDES)" and Subsection 3.5 as "Airborne gamma SWE (NOHRSC)", so that at least all datasets are mentioned. Or any other harmonisation that makes the subsectioning clearer.

Agreed. We propose the following harmonized subsections:

3.1 Canada (CanSWE)
3.2 Russia (RIHMI-WDC)
3.3 Northeast US (MGS, NHDES, NRCC)
3.4 Western and Alaska US (NRCS)
3.5 Airborne gamma SWE (NOHRSC)

L148-149: Please explain why SYKE (Finland) did not require any additional processing steps.
The data from SYKE was clean and did not include any agency data flags so extra processing steps were required. Only the general processing steps were applied.

L169: Why is the land cover type not supported by NetCDF? Please explain.
Text in question removed.

Table 6: "Station coordinates ~~as~~ **are** the same …" and "RIHMI instead of RHIMI.
Corrected

L 234: I think this should be Table 5 and not 7?
Revised to refer to new Table 6 (other Tables renumbered accordingly).

**Table 6: Quality control (QC) flags in NorSWE. NaN stands for not a number.**

| QC flag | Definition |
|---|---|
| H | SD > 3m (> 8m in mountains). SD set to *NaN*. |
| M | Data masked (set to *NaN*) in a previous CHSSD update. |
| V | Automatic SD-SWE measurement identified as outlier using robust Mahalanobis distance. SD and SWE set to *NaN*. |
| W | SWE > 3000 kgm-2 (> 8000 $kgm^{-2}$ in mountains). SWE set to *NaN*. |
| D | Derived bulk snow density failed 25–700 $kgm^{-3}$ threshold. SD, SWE and bulk snow density set to *NaN*. |

L 243: qg_fladg_snd
Corrected

L 250 and 253: Please specify what "similar coordinates" means.
Text revised for clarity.
L250: *"Duplicate sites were defined as those with similar locations, snow observations, station names or IDs as follows. First, we identified all sites from neighbouring agencies with matching station names and inspected those matched sites within 5 km of each other. If the paired sites had matching coordinates and snow records (within rounding precision), we retained the site from the agency whose jurisdiction it intersects…"*

L 259: “This step removed 63 sites: 62 + 7”? Shouldn’t it be 69?
According to Table S1 it should read “*This step removed 63 sites: 56 from CanSWE and 7 from Maine GS (**Table S1**).”*

L 264: I suggest to be specific with the exact number of observations in this section, and the exact number of sites.
As per your suggestion we will provide exact numbers for the revised dataset.

L 273: I think it should be Fig. 3 or Fig. 5 but not Fig. 4?
Corrected to Fig. 3.

Figure 3: I suggest to rephrase the caption, the first three lines are long and without a comma.
Proposed revision:
*Figure 3. **(Left):** NorSWE site distribution by **snow class (Sturm and Liston, 2021)** snow class for the complete dataset **(solid bars)** and a **temporally consistent** subset **(hatched bars) versus the proportional land area by snow class (dashed black line). The temporally consistent subset consists of** sites with at least one measurement in each pentad starting in 1980 and having measurements in at least 30 different years between 1979 and 2021. The ephemeral snow class is excluded from the land area calculations because it does not differentiate between no snow and ephemeral. Permanent land ice is also excluded. **(Right): Map showing the geographical extent of Sturm and Liston (2021) snow classes.** Montane: montane forest, Boreal: boreal forest.*

L 338: I suggest to remove “briefly”, as it is not very brief. Great section though! It is very strong describing so many data usages, well done.
Suggestion implemented.

L 344: “uses **to** parameterize”
Corrected.

L 355-357: Yes absolutely! That is why this dataset is great, when I did the data collection myself, I missed these eastern US datasets. Great job!
Your dataset is great. We just thought the differences in North America were quite interested. As you know, data collation is challenging and takes a village, so we greatly appreciate your suggestions about additional European data.

L 379: Not sure how, but it would be great to include a reference/link for this https://mountainresearchinitiative.org/flagship-activities/joint-body-on-the-status-of-mountain-snow-cover/
Agreed. We propose to add the link to the activity.

Table A1: Perhaps specify for each entry if it is CanSWE or NorSWE that they used? Assuming some of those already used NorSWE. It was not entirely clear to me if the table is about showing examples of “potential uses”, or studies that have already used these specific datasets.

Table A1 is intended to show the ranges of uses of this type of dataset. Title renamed accordingly and dataset used added.

**Table A1: Demonstration of uses of NorSWE and its precursor CanSWE. NorSWE includes v1 and its unpublished precursors. Uses of Snotel data are detailed in Flemming et al. 2023.**

| Benchmarking gridded SWE products | Dataset |
|---|---|

| | | |
|---|---|---|
| **Mortimer et al. 2022** https://doi.org/10.1016/j.rse.2022.112988 | Benchmarking EO SWE product (Snow CCI+) | NorSWE |
| **Luojus et al. 2021** https://doi.org/10.1038/s41597-021-00939-2 | Validation of GlobSnow v3 product and older CHSSD dataset (Brown et al., 2019) used as input to monthly bias correction. | NorSWE |
| **Gao et al. 2023**. https://doi.org/10.3390/rs15082065 | Evaluation of snow densities derived from SMOS over Quebec, Canada. | CanSWE |
| **Mortimer et al. 2024** https://doi.org/10.5194/tc-18-5619-2024 | Impact of in situ method on benchmarking gridded SWE products. | NorSWE |
| **Mudryk et al. 2024** https://doi.org/10.5194/egusphere-2023-3014 | Benchmarking of 23 gridded products from the SnowPex+ intercomparison project. | NorSWE |
| **Elias Chereque et al. 2024** https://doi.org/10.5194/tc-18-4955-2024 | Evaluation of simple temperature index model with different meteorological forcings. | NorSWE |
| **Sun et al. 2024** https://doi.org/10.5194/egusphere-2024-3213 | Evaluation of a mountain SWE reanalysis with snow cover fraction data assimilation. | NorSWE |
| **Hydrological model development and evaluation** | | |
| **Garnaud et al. 2021** https://doi.org/10.3390/rs13245022 | Evaluation of snow analyses in hydrological models for forecasting. | CanSWE |
| **Arnal et al. 2024** https://doi.org/10.5194/hess-28-4127-2024 | Seasonal hydrological forecasting. | NorSWE |
| **Mai et al. 2022** https://doi.org/10.5194/hess-26-3537-2022 | Evaluation and selection of reference datasets for Great Lakes Runoff Intercomparison Project. | CanSWE |
| **Marsh et al. 2024** https://doi.org/10.1029/2023WR036948 | Evaluation of simulated snow drifting patterns with the Canadian Hydrological Model across the Canadian cordillera and adjacent regions. | CanSWE |
| **Shrestha et al. 2022** https://doi.org/10.3389/frwa.2022.801134 | Evaluation of a functional hydrological model of the Great Lakes Basin. | CanSWE |
| **Vionnet et al. 2022** https://doi.org/10.1029/2021WR031778 | Evaluation of the ability of precipitation phase information to improve mountain snowpack prediction. | CanSWE |
| **Model input, parameterization, retrieval schemes** | | |
| **Fontrodona-Bach et al. 2023** https://doi.org/10.5194/essd-15-2577-2023 | CanSWE (and Snotel) data used to develop snow density model to go from SD to SWE. (NH-SWE). | CanSWE |
| **Venäläinen et al. 2023** https://doi.org/10.5194/tc-17-719-2023 | Interpolated in situ snow density information for use in GlobSnow SWE retrieval. | NorSWE |
| **Dulfer et al. 2022** https://doi.org/10.1016/j.quascirev.2022.107465 | CanSWE (SD and density) used to calculate snow shielding factors. | CanSWE |
| **Tian et al. 2024** https://doi.org/10.1016/j.scs.2024.105660 | Training data for machine learning model to investigate the reliability of rapid public transit in the Toronto region under various climate change scenarios. | CanSWE |
| **Snow status and trends** | | |
| **Gottlieb and Mankin 2024** https://doi.org/10.1038/s41586-023-06794-y | Observational data (CanSWE) used to in attribution study of impact of human influence on NH snow loss. | CanSWE |
| **Hale et al. 2023** https://doi.org/10.1038/s43247-023-00751-3 | Changes in snow water storage. CanSWE data from 1 April used to evaluate snow storage index output from Snow Storage Index. | CanSWE |

| Other | | |
|---|---|---|
| **Pokorny et al 2023**<br>https://doi.org/10.1061/JHYEFF.HEENG-5833 | Uncertainty analysis – model uncertainties | CanSWE |