# Evaluating and Improving Snow in the National Water Model, using Observations from the New York State Mesonet (dataset archive user guide)

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## 1 Overview

This document describes the dataset archive for the study of Minder et al. (2024): *Evaluating and Improving Snow in the National Water Model, using Observations from the New York State Mesonet*. The datasets in this archive include output from distributed simulations of the WRF Hydro model, output from point simulations with the Noah-MP land surface model, and manual and automated snow water equivalent (SWE) observations at New York State Mesonet (NYSM) station locations. The formatting and file naming conventions for each dataset are described below. Information on how these datasets were generated is found in the text of the study (and references cited therein). Datasets used in the study but not archived here can be found at the locations referenced in the text of the study.

### 1.1 Citation

RafieeiNasab, A., T.W. Letcher, J.R. Minder, P.W. Naple, and J. Wang, 2024: Evaluating and Improving Snow in the National Water Model, using Observations from the New York State Mesonet. Version 1.0. UCAR/NCAR – GEDX. https://doi.org/10.5065/s0d2-3z51

## 2 Datasets

### 2.1 WRF Hydro distributed simulations

All datasets described in this subsection are stored in the folder `/WRFhydro_dist/`. These include data related to WRF Hydro distributed simulations conducted with a configuration based on the National Water Model (NWM) operational configuration used in the CONUS

analysis and assimilation, short-range, and medium-range forecast (Cosgrove et al., 2024) and forced with meteorology from the Analysis of Record for Calibration dataset (Fall et al., 2023).

#### 2.1.1 Calibration basin shapefiles

The shape file `/WRFhydro_dist/Final_V21_HydroInspector.shp` includes geospatial information on the NWM v2.1 calibration basins. A subset of 21 of these basins were used for streamflow evaluation in the study.

#### 2.1.2 Geographic input file

The netcdf file `geo_em.d0x.nc` includes WRF Hydro gridded geographic forcing information (e.g., land use, terrain height, etc.) used in the simulation. Variables and are described with metadata within the file.

#### 2.1.3 Simulation output at NYSM station locations

The netcdf file `distributed_runs_obs_locations.nc` contains hourly simulation output for model grid points corresponding to NYSM station locations. The locations are identified with the *station* dimension, using their 4-letter station identifier. The specific simulations are indexed by the *run_ID* dimension. The specific runs presented in this study are: *Jordan_TAU_1000000, T0, T0_TAU_100000*. Variables are described with metadata within the file.

#### 2.1.4 AORC meteorological forcing at NYSM station locations

The netcdf file `AORC_all.nc` contains the hourly AORC meteorological forcing used in the WRF Hydro distributed runs for model grid points corresponding to NYSM station locations. The locations are identified with the *station* dimension, using their 4-letter station identifier. Variables and are described with metadata within the file.

#### 2.1.5 Simulated basin discharge

Three files names with the convention `RUN_[simulation name]_basin.nc` contain hourly simulated basin discharge at the NWM v2.1 calibration basins for the three WRF Hydro runs presented in the study. The basins are indexed by their USGS station ID numbers. Variables and are described with metadata within the file.

### 2.2 Noah-MP point simulations

All datasets described in this subsection are stored in the folder `/NoahMP_point/`. These include output from point simulations conducted with a configuration based on the Noah-

MP land surface model (Niu et al., 2011; He et al., 2023), with a baseline configuration emulating the configuration in the NWM. These simulations were conducted only at locations corresponding to NYSM stations, with NYSM station observations used as meteorological forcing, as described in the study. The simulation output is grouped into two subdirectories, one for the default simulation and snow accumulation sensitivity experiments (`OPT_accum`), and one for the revised baseline simulation (using HRRR precipitation phase partitioning) and snow ablation sensitivity experiments (`OPT_abla`). Within each folder, there are further subdirectories for the two study years (`2019-20` and `2021-21`). There is one netCDF output file with 30-min output for each simulation. Files all follow this naming convention `[yyyymmddHHMM].LDSAOUT_DOMAIN1_[run name]`. Tables relating the run names to the descriptions used in the manuscript are provided below.

### 2.2.1 Accumulation sensitivity experiments

Table 1 relates the run names used in the naming of the accumulation experiment output files to the associated precipitation phase partitioning methods described in the manuscript.

Table 1: Precipitation phase partitioning methods corresponding to file run names.

| run name | Precipitation phase method |
|---|---|
| PCP1 | Jordan (default) |
| PCP2 | $T = 2.2$°C |
| PCP3 | $T = 0$°C |
| PCP5 | $T_w = 0$°C |
| PCP6 | HRRR |

### 2.2.2 Ablation sensitivity experiments

Table 2 relates the run names used in the naming of the ablation experiment output files to the associated snow ablation parameter sensitivity experiments described in the manuscript. Each row represents a suite of experiments where *XXX* is a placeholder for the various parameter values used for the specific parameter being tested. The default parameter value, and range of values tested, are listed in the table.

## 2.3 NYSM SWE evaluation

The study evaluated the automated SWE measurements collected by the NYSM's CS725 sensors by comparing them with co-located manual snow core measurements of SWE, as described in Naple (2021). The data used for this comparison are provided in:

Table 2: Snow ablation parameter sensitivity tests corresponding to file run names. *XXX* is a placeholder for the various parameter values used for the specific parameter being tested. The default and range of tested parameters is listed.

| run name | Ablation sensitivity experiment | parameter default (range) |
|---|---|---|
| CONTROL | Revised baseline exp. (HRRR phase partitioning) | n/a |
| NIR_NEW_*XXX* | New snow albedo (NIR) | 0.65 (0.59–0.75) |
| RSURF_SNOW_*XXX* | Aerodynamic resistance for snow | 50 (0.1–100) s $m^{-1}$ |
| SSI_*XXX* | Snowpack liquid water holding capacity | 0.03 (0.015–0.06) |
| TAU0_*XXX* | Snow albedo decay timescale | $10^6$($10^4$–$10^8$) $s^{-1}$ |
| Z0_*XXX* | Snow surface roughness length | 0.002 (0.001–0.01) m |

`/NYSM_SWE_eval/NYSM_CS725_eval_2020to2023.csv`. In this .csv file, each row corresponds to a paired CS725 automated SWE observation ($SWE\_CS725$) and manual SWE observation ($SWE\_Man$), recorded in inches. For each measurement, the UTC date, time, and NYSM station identifier ($stn\_num$) is also provided.

## References


Cosgrove, B., and Coauthors, 2024: NOAA's National Water Model: Advancing operational hydrology through continental-scale modeling. *JAWRA Journal of the American Water Resources Association*, **JAWR-23-0005-P**, https://doi.org/10.1111/1752-1688.13184.

Fall, G., and Coauthors, 2023: The Office of Water Prediction's Analysis of Record for Calibration, version 1.1: Dataset description and precipitation evaluation. *JAWRA Journal of the American Water Resources Association*, **59 (6)**, 1246–1272, https://doi.org/10.1111/1752-1688.13143.

He, C., and Coauthors, 2023: Modernizing the open-source community Noah with Multi-parameterization Options (Noah-MP) land surface model (version 5.0) with enhanced modularity, interoperability, and applicability. *Geoscientific Model Development*, **16 (17)**, 5131–5151, 10.5194/gmd-16-5131-2023.

Naple, P. W., 2021: Evaluating the performance of National Water Model snow simulations in the Northeastern United States using advanced mesonet observations. M.S. thesis, Univerity at Albany, 98 pp., https://libproxy.albany.edu/login?url=https://www.proquest.com/dissertations-theses/evaluating-performance-national-water-model-snow/docview/2566245160/se-2.

Niu, G.-Y., and Coauthors, 2011: The community Noah land surface model with multiparameterization options (Noah-MP): 1. Model description and evaluation with local-scale measurements. *Journal of Geophysical Research: Atmospheres*, **116 (D12)**, 10.1029/2010JD015139.