Evaluating and Improving Northeastern US Snow in the National Water Model by Leveraging Advanced Mesonet Observations: Retrospective Run and Meteorological Forcing Analysis

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ABSTRACT

The NOAA National Water Model (NWM) is used for operational forecast of hydrology, including surface snowpack, across the continental United States (US). It initializes surface snowpack conditions using a simple deterministic analysis cycling every hour and represents snowpack physics using the Noah-MP land surface model. However, performance of the NWM at simulating snow over the northeastern United States is poorly characterized, in part due to limitations in the observational network. Our group is working to improve snow state initialization and prediction within the NWM by leveraging observations from the advanced New York State Mesonet (NYSM; *http://nysmesonet.org/*), which includes 126 stations with detailed meteorology measurements and sub-networks with additional snowpack water equivalent (SWE) and surface energy flux measurements.

As part of this larger effort, we are quantifying biases in NWM-simulated snow and evaluating the link between snow and meteorological forcing biases. This presentation evaluates two versions (v2.0 and v2.1) of NWM retrospective runs, forced by meteorological analyses, against NYSM station observations and New York Snow Survey manual snow course data (*https://www.nrcc.cornell.edu/regional/snowsurvey/snowsurvey.html*). Simulated snow depth for the 2017-2018 snow season is evaluated against NYSM measurements. Simulated SWE from 2010-2018 is evaluated against New Your Snow Survey manual snow course measurements to validate biases found in simulated snow depth. Precipitation, temperature, and incoming shortwave radiation from forcing datasets are evaluated against NYSM observations to determine the effects of meteorological forcing biases on snow biases.

NWM v2.0 shows substantial negative snow depth biases and v2.1 shows moderately negative snow depth biases compared to NYSM observed values. Modeled SWE shows similar biases when compared with New York Snow Survey measurements. Meteorological forcing shows negative precipitation, positive temperature, and positive incoming shortwave radiation biases with larger magnitude biases seen in the forcing for NWM v2.0. These forcing biases decrease modeled snow depth by reducing accumulation and increasing ablation. Snow depth biases and precipitation forcing biases show statistically significant positive correlations, especially during accumulation events. Our results indicate that, despite being forced by analyses of meteorological observations, meteorological forcing biases contribute significantly to biases in NWM retrospective runs, complicating efforts to isolate biases in model physics.

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