What Gridded Snow Water Equivalent Dataset Should I Use?

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Introduction

Gridded snow water equivalent (SWE) datasets are critical for accurate and efficient runoff modeling. Snowmelt modeling for hydrologic analysis has greatly improved in recent years and the need for reliable gridded SWE datasets is paramount in evaluating dam safety and flood risk among many other purposes. There are numerous gridded SWE datasets across the United States and these datasets are created in a variety of ways. This analysis focuses on two of the most used gridded datasets: Snow Data Assimilation System (SNODAS) and University of Arizona (UA) and includes a comparison of data coverage (spatial, temporal) as well as a comparison of SWE in the Big Horn Basin in a wet, dry, and average year.

The purpose of the analysis is to present a comparison of the two gridded SWE datasets and methodology for the same analysis at other locations. A final, generalized recommendation cannot be made without more basin-specific comparisons across a wide variety of areas of the United States and specific purpose for use of the gridded SWE product (e.g., forecasting, model calibration, etc.).

Data Overview

SNODAS and UA gridded SWE datasets are widely used across many agencies because of their broad spatial and temporal coverage. Both products are assimilated datasets and have similar spatial coverage over the entire contiguous United States. A comparison of other data properties is summarized in Table 1. Note the significantly longer temporal coverage of UA data. This makes UA data particularly valuable for model development when calibrating to events prior to SNODAS availability.

Table 1. SNODAS and UA Data Comparison.

Dataset	Spatial Resolution	Temporal Coverage	Temporal Resolution
SNODAS	1 km x 1 km	2003-present	1-day
UA	4 km x 4 km	1981-2022	1-day

SNODAS is near real-time data that posts new grids each time a script detects them (NOHRSC, 2004). This is advantageous for real-time modeling for forecasters; however, challenges are presented when ground-truthing changes the assimilated SWE depths and the dataset is not corrected for prior miscalculations. UA data are assimilated over longer periods, meaning it is not available for real-time use in forecasting, but it is corrected for assimilation errors (Broxton, et. al., 2019).

Basin Comparison

On a large scale the two datasets compare favorably (Broxton, et. al., 2019); however, this analysis compares the datasets for a smaller area, the Big Horn basin in Montana and Wyoming. This basin was selected because of its location in a mountainous region with reliable, well-calibrated snowpack, several snow telemetry (SNOTEL) gages for point comparison, and good variety of mountainous and plains regions.

A visual comparison is presented below for the Big Horn Basin in Figure 1 showing SWE depths on 01May2017, which was a relatively high accumulation year in the basin. Immediately noticeable is the difference in spatial resolution with more detail in the SNODAS map due to higher resolution. The basin average SNODAS is also slightly higher than that of UA by about 10%. However, in general, the two datasets compare favorably by visual inspection.

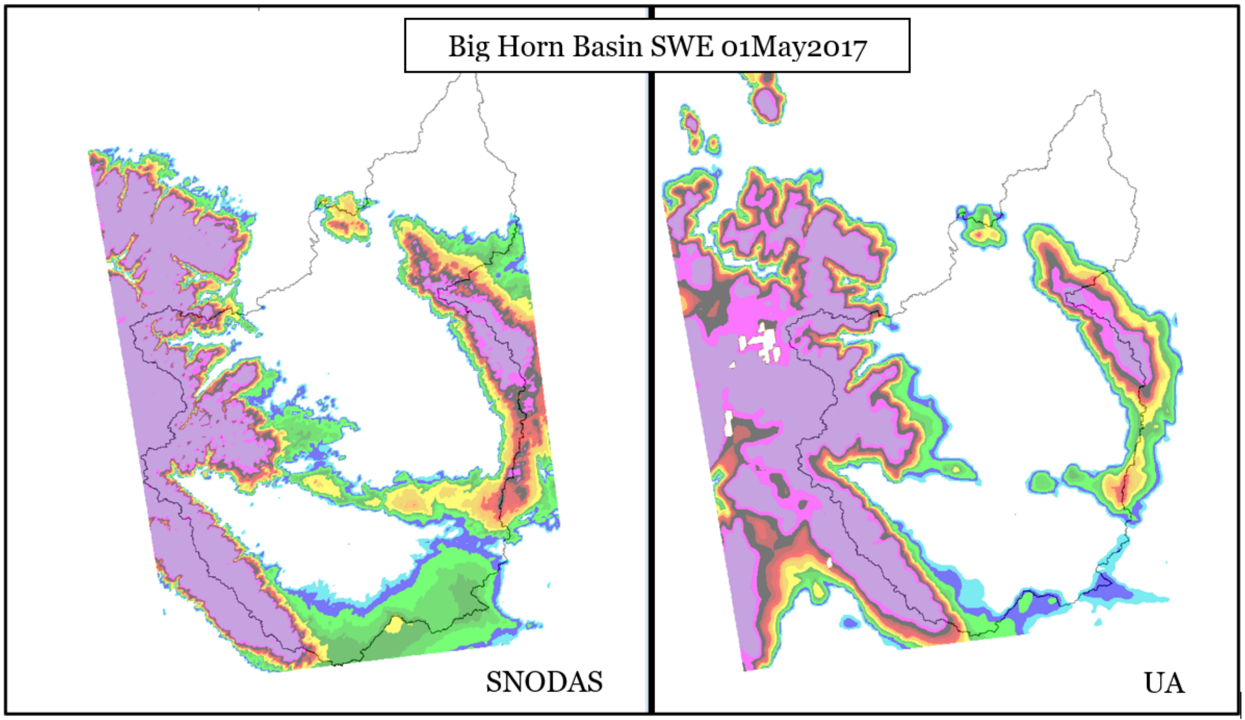

Figure 1. SNODAS and UA SWE data for 01May2017, a high accumulation year in the Big Horn Basin.

A comparison at a single SNOTEL site tells a different story. A timeseries SWE depth was computed from the gridded data and compared to SNOTEL information at the same location. The comparisons vary widely as can be seen in Figure 2 and Figure 3, two representative SNOTEL gages within the Big Horn basin. The inconsistency is apparent and is a major challenge of determining the most valuable dataset for particular methods. At the Blackwater site, UA is higher than SNODAS, and at the Bone Springs site, UA is lower than SNODAS. It is interesting that the SNODAS data at Bone Springs are nearly identical to the SNOTEL data. Also of note is that the melt occurs in a similar pattern for all datasets shown in Figure 2 and Figure 3 and melt rate and pattern is a primary driver of snowmelt runoff modeling.

This comparison represents the primary challenge for recommending the best dataset for all uses and care should be taken to determine the appropriate dataset for each watershed and study type. In this instance, the model is used for real-time forecasting, so the forecaster will likely prefer the use of SNODAS because of its near real-time data collection and the model should likely also be calibrated to SNODAS data for consistency. Further study on other basins with varying characteristics could lead to greater understanding of the differences between the two datasets.

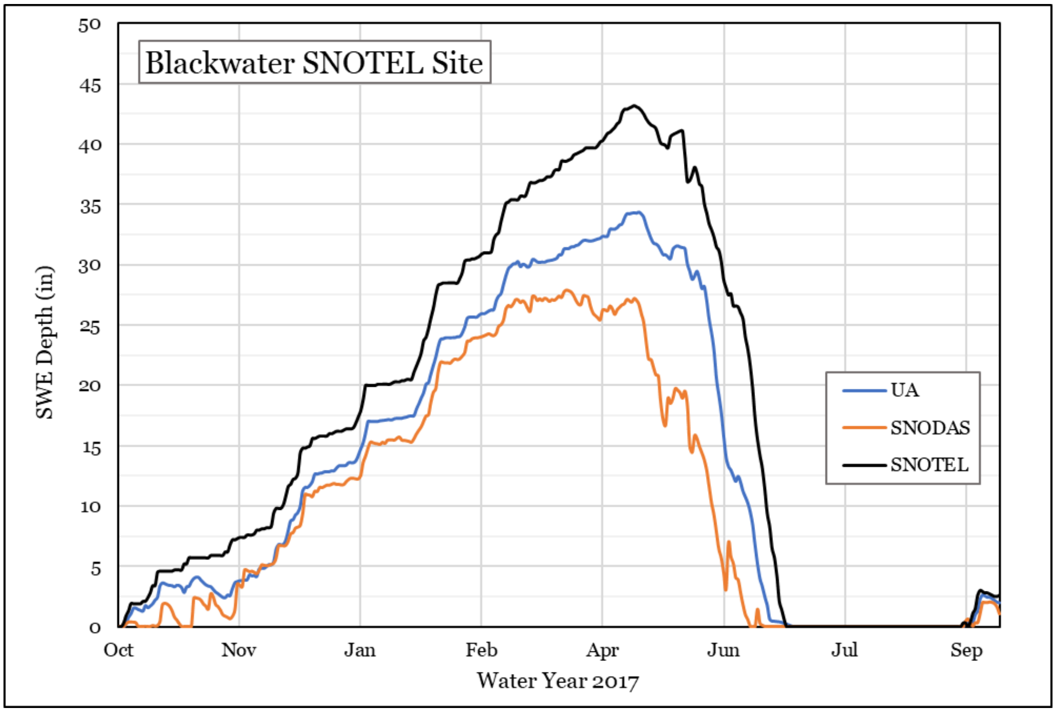

Figure 2. Blackwater SNOTEL site comparison to SNODAS and UA SWE.

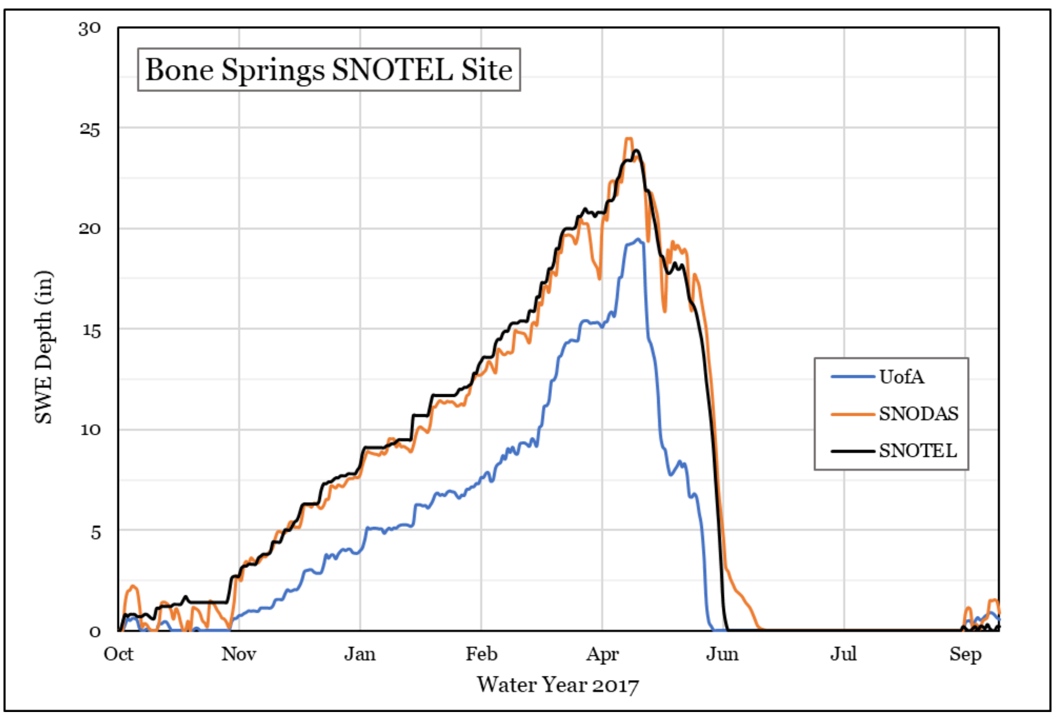

Figure 3. Bone Springs SNOTEL site comparison to SNODAS and UA SWE.

References

Broxton, P., X. Zeng, and N. Dawson. 2019. Daily 4 km Gridded SWE and Snow Depth from Assimilated In-Situ and Modeled Data over the Conterminous US, Version 1. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/0GGPB220EX6A. [14Dec2022].

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