A Statistical Comparison Between MET Station Data and GridMET Data for Calculating Required Storage in Water Balance Cover Systems

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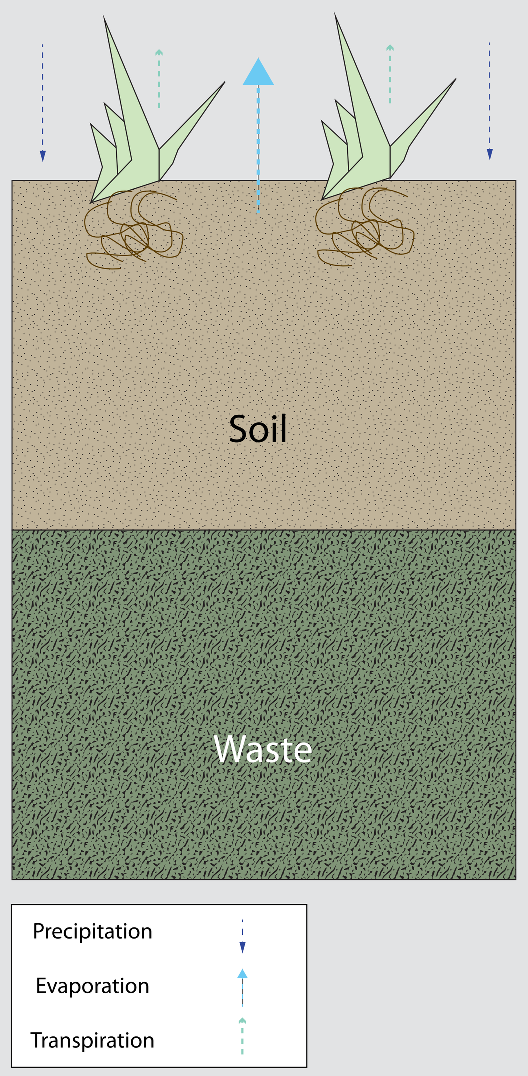
Research Questions

1. What is the difference in required storage using MET station versus ClimateEngnige gridMET data?

2. Are differences in required storage more pronounced in certain locations? If so, what are the specific conditions that affect these differences?

3. What are the implications for sites where local MET data are unavailable?

What is Required Storage?



The primary application of required storage has been for the purpose of designing water balance covers. Water balance covers rely on natural processes to maintain water balance through water storage and release, covers composed of only vegetated soil. The soil acts as a water storage tank and the plants as the tank funnel.

The success of an effective water balance cover relies on the ability of a soil to store water. Percolation occurs as a result of soil storage capacity being exceeded, when precipitation (P) exceeds evapotranspiration (ET). The goal of this research is to apply the science of required storage in water balance covers to alternative applications.

$$\Delta S\ (storage) = P - R - ET - L - Pr \quad (1)$$

↓

$$\Delta S = P - BPET - \Lambda \quad (2)$$

↓

$$Sr\ (required\ storage) = \Delta S fall/winter + \Delta S spring/summer \quad (3)$$

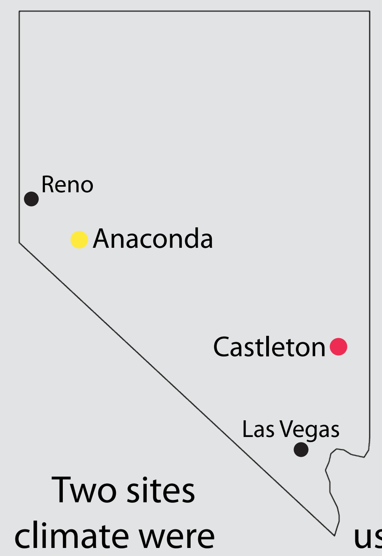
Required Storage Model

Albright, Benson and Waugh (2004) developed an empirical method based on water balance analysis to calculate required storage in soil covers. The basic parameters of the water balance equation (1) were simplified (2), combining ET and PET into one variable (B), and lumping runoff and percolation into a single loss term (Λ). Using the P/PET thresholds defined by water accumulation periods, required storage was computed (3).

Data collected from Alternative Cover Assessment Program (ACAP) sites was used to first, idenify periods of water accumulation within a soil cover, and secondly to identify the amount of water stored during these accumulation periods. Water accumulation periods were identified by graphing. the monthly change in soil water storage versus thresholds of P/PET. (Table 1). Months where the determined threshold was exceeded indicated water accumulation. In the case of northern Nevada, water accumulation increases in the fall-winter season when P/PET exceeds 0.51.

Climate Type	Season	P/PET Threshold	B (-)	Λ (mm)
Snow/frozen ground	Fall-Winter	0.51	0.37	-8.9
	Spring-Summer	0.32	1.00	167.8

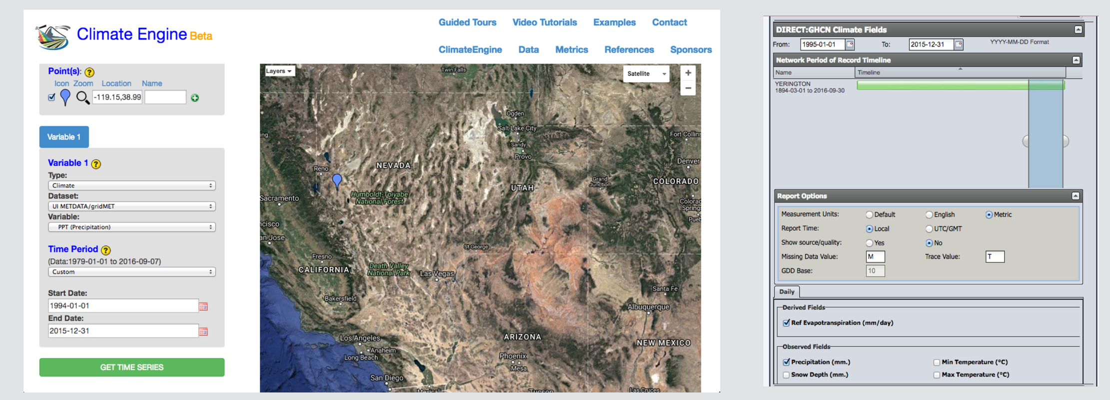
Sites Location



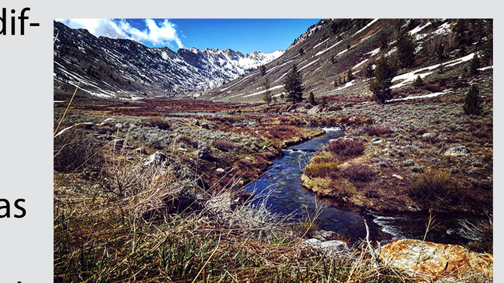
Two sites exhibiting different elevation, geographic locations, and climate were used for statistical comparison. Several statistical analyses comparing overall precipitation, witner precipitation, potential evapotranpiration (PET), and required storage were conducted using MiniTAB to determine the statistical significance in the differences in required storage between gridMET and site-specific MET data.

The MET station data was collected using weather stations monitored by Utah State University's Utah Climate Center. The Climate Center estimates ET using the Oenman Monteith equation, thus theoretically approximating ET. It does not reference a specific crop or ground cover. Gridmet data also utilizes MET data (University of Idaho) for precipitaiton, wind speed, etc., however, the data is encompassed in a 4 km grid. Unlike Utah Climate Center, ClimateEngine's gridMET estimates PET using a ground cover reference (grass).

	Anaconda Mine	Castleton Tailings
MET Coordinates	38.98 N, -119.19 W	37.91 N, -114.49 W
gridMET Coordinates	38.99 N, -119.15 W	37.49 N, -114.24 W
Elevation	4300 ft	5856 ft
Average Yearly Precipitation	5.14 in	13.21 in



Implications & Further Research



Although the PET values indicate significant statistical differences, the other T-values show that MET and gridMET data are equally reliable and comparable. Either source has the potential to calculate required storage with a relatively small margin of error.

What can we do differently?

- Determine the maximum distance MET station data is reliable
-Calculate a correction factor to decrease the variability in PET

Sources
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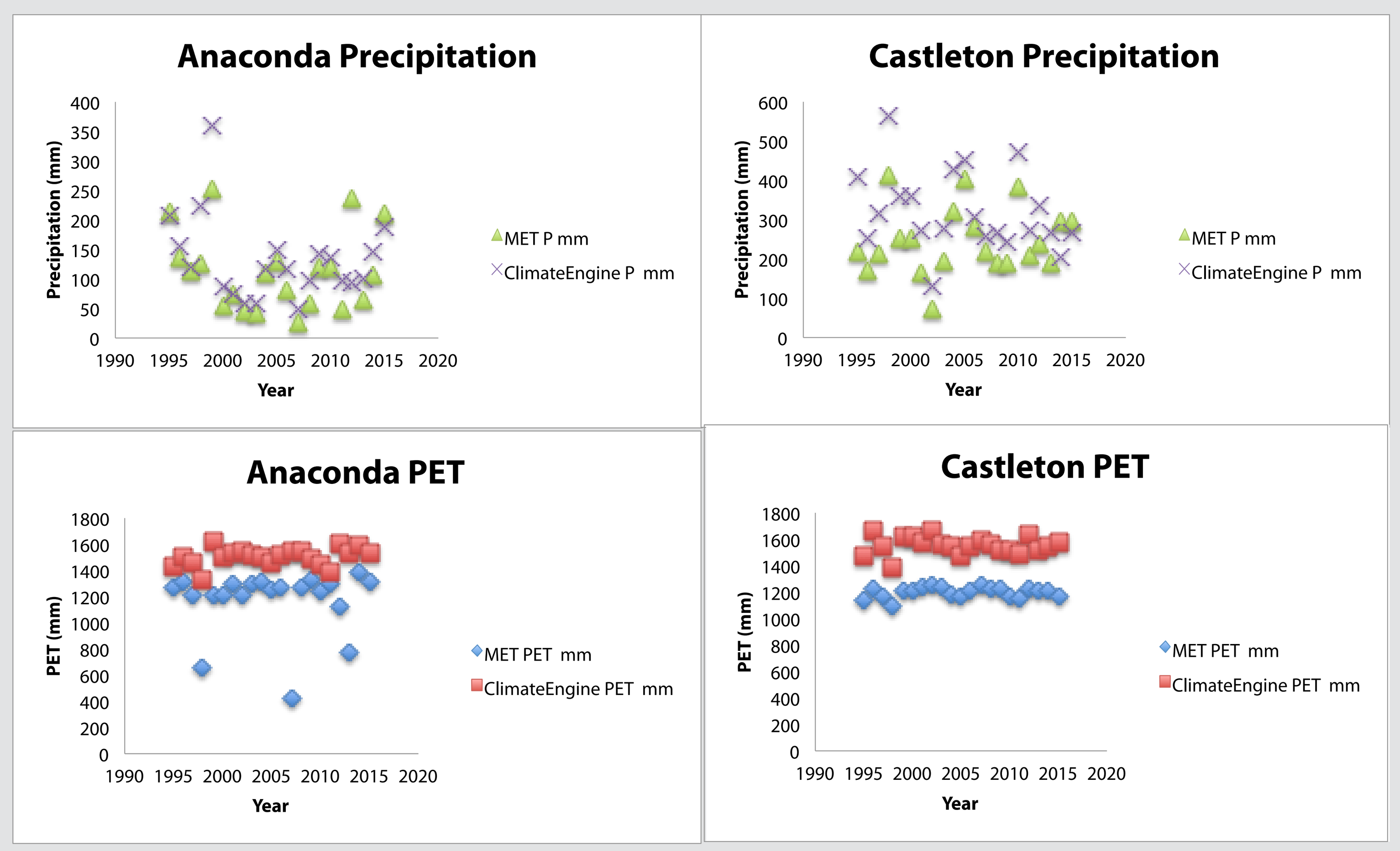
Location Comparison



Site	Precipitation	Evapotranspiration	Required Storage	Winter Precipitation
Anaconda	-0.91	-5.95	0.85	-0.68
Castleton	-2.57	-20.61	-1.78	-3.36
	2.5X	*4X*	*2X*	*3X*

Precipitation and PET estimates from both gridMET and MET were compared (see left). Precipitation values for both sites show that estimates are fairly similar, however PET estimates show that gridMET consistently overestimates PET. The accuracy of required storage input parameters, precipitation and PET, affects the calculation of required storage. The figure to the right compares estimates of required storage using MET station data versus gridMET data. Generally, ClimateEngine overestimates required storage; however it doesn't always overestimate. Comparing estimates of required storage at each site, the storage estimates are more similar at Anaconda than at Castleton.

The histograms (below) show the distribution of each data source for both sites. the MET station and gridMET data have remarkably different distributions patterns: the MET station data follows an irregular pattern with the highest frequencies bordering the center value, whereas the gridMET data resembles a normal distribution with the highest frequency at the median of the data. Table 3 compares the T-values of each site. Castleton shows no significant differences between MET and gridMET data for sotrage and precipitation; however, winter precipitation and PET T-values are extraordinarily high. Anaconda has comparable T-values to Castleton, however the winter precipitation T-value has a values less than -2.0, and all of the Anaconda T-values are more than half the magnitude of those of Castleton.