H12L-0840: Climate Driven Changes in Snow Regime Classifications of the Continental United States (AGU 2022, Poster Session H12L)

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Abstract

Much of the world's water resource infrastructure is experiencing rapid shifts in climate and snowmelt. Changing snowmelt regimes are responsible for rain-on-snow river flooding, putting communities at risk. Our study uses a new Snow Regime Classification system as a proxy for tracking climate driven changes in hydrology across the contiguous US over 40 years (1981-2020). Snow regimes are calculated annually, with changes evaluated across decadal and 30-year time scales. Our Snow Regime technique designates areas across CONUS as: (1) rain dominated (***RD***), (2) snow dominated (***SD***), (3) transitional (transient mix of rain and snow; ***R/S***), or (4) as perennial snow cover (***PS***). Class thresholding ratios involve snow water equivalent (SWE) over cumulative cool-season precipitation (October through March).

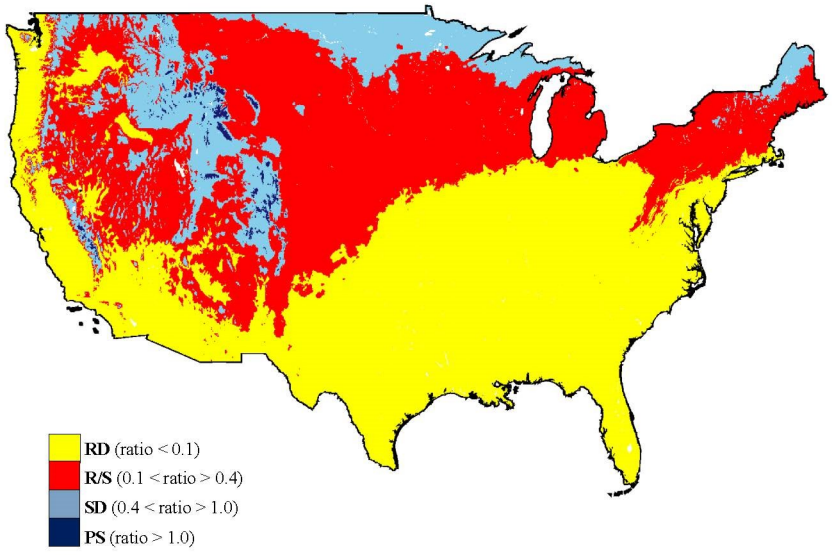

Figure 1: Snow Regime Classifications showing thirty-year normals (1991-2020) derived from a ratio of maximum snow water equivalent (SWE) over cumulative cool season precipitation (October through March). Per pixel ratios were used for thresholding the regime classes of rain dominated (RD), transitional (R/S), snow dominated (SD), and perennial snow (PS).

Climate Driven Changes in Snow Regime Classifications of the Continental United States

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ABSTRACT

Much of the world's water resource infrastructure is experiencing rapid shifts in climate and snowmelt. Changing snowmelt regimes are responsible for rain-on-snow river flooding, putting communities at risk. Our study uses a new Snow Regime Classification system as a proxy for tracking climate driven changes in hydrology across the contiguous US over 40 years (1981-2020). Snow regimes are calculated annually, with changes evaluated across decadal and 30-year time scales. Our Snow Regime technique designates areas across CONUS as: (1) rain dominated (***RD***), (2) snow dominated (***SD***), (3) transitional (transient mix of rain and snow; ***R/S***), or (4) as perennial snow cover (***PS***). Class thresholding ratios involve snow water equivalent (SWE) over cumulative cool-season precipitation (October through March).

BACKGROUND

- Snowmelt is a significant portion of streamflow across the U.S.
- Rain-on-Snow (RoS) events occur when warm storm systems deposit substantial rain on extensive snow cover.
- RoS events are responsible for some of the largest and most devastating floods in the US (e.g., 2019 Missouri River flood).
- Flood regimes in historically snow dominated watersheds are predicted to shift away from spring snow-melt and toward more rain-dominated winter floods (*Mussleman et. al., 2018; Arnell and Gosling, 2016; Freudiger et. al., 2014*).

METHODS

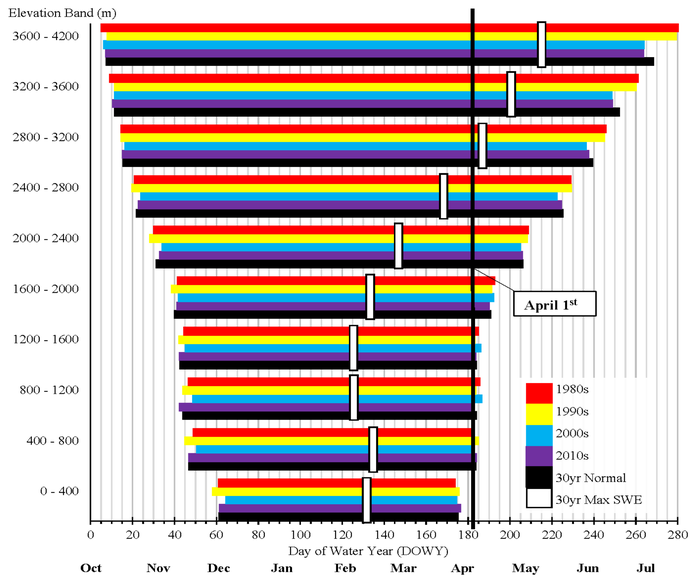
- Used daily PRISM precipitation and University of Arizona's Snow Water Equivalent (SWE) datasets
- Calculations and analysis using Google Earth Engine
- Inspected maximum SWE values and dates, start of snow accumulation, end of ablation (snowmelt), and snow cover duration
- Determined Snow Regime Classifications based on methodology from *Tohver et al. (2014)*

$$\textbf{Regime Ratio} = \frac{\textit{Maximum SWE}}{\textit{Cool Season Precipitation}}$$

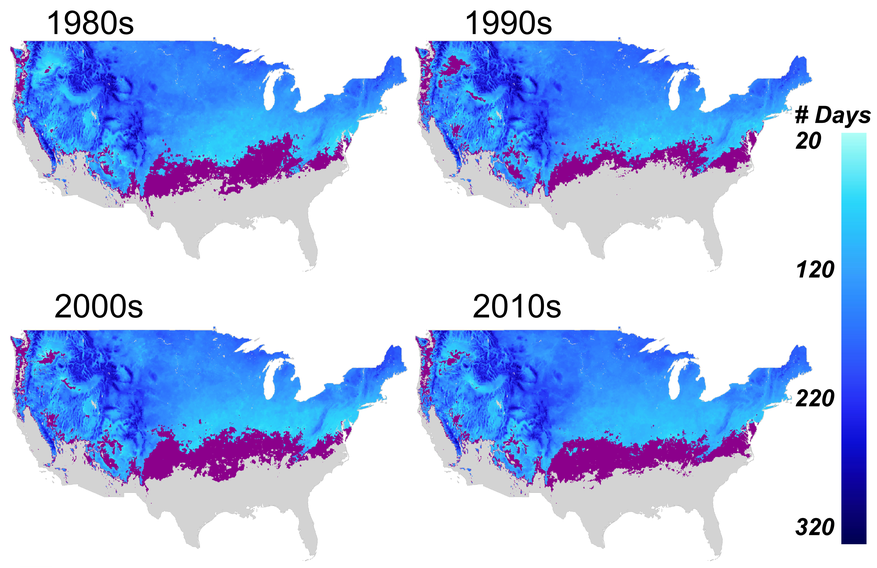
CONCLUSIONS

- Generally, rain-dominated and transitional regimes are moving up in latitude and elevation.
- There is variability both temporally and spatially (i.e., the effects aren't uniform).
- These changes will affect both the timing and magnitude of snowmelt events.

Snow now dominates less of the country for less time than it did in the 20th Century



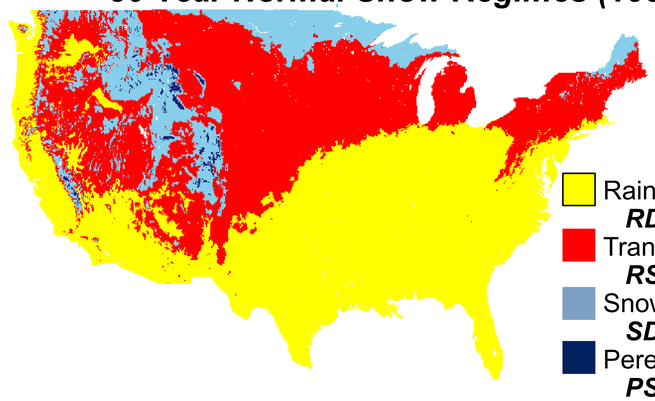
Average Snow Cover Duration



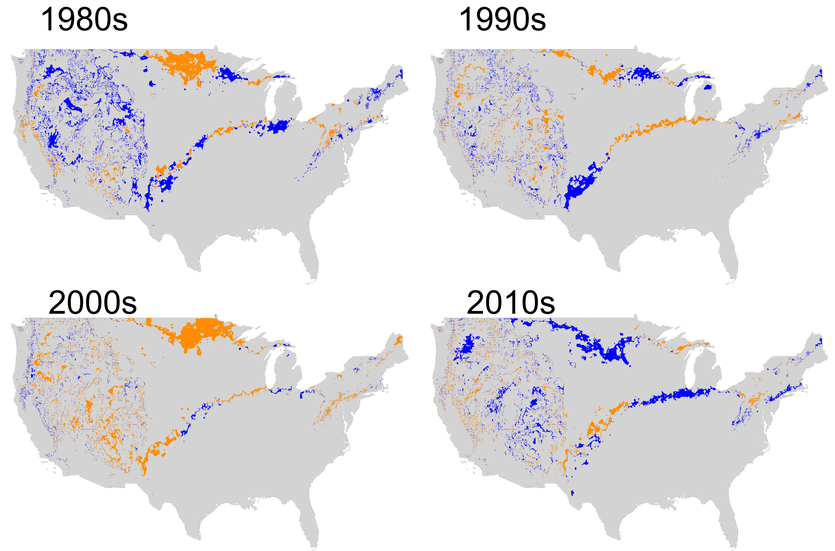
Negligible Snow Cover *(3 weeks or less SWE for all 10 yrs)*

Intermittent Snow Cover *(3 weeks or less SWE for 5-9 yrs)*

30 Year Normal Snow Regimes (1991-2020)



Departures from Normal Regimes



Liquid Precip **>** 30Yr Norm *(ratio decrease 1 or more class)*

Solid Precip **>** 30Yr Norm *(ratio increase 1 or more class)*

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