Towards Snowpack Runoff Decision Support

Anne Heggli[1], Benjamin Hatchett[1*], Andrew Schwartz[2], Tim Bardsley[3] and Emily Hand[4]
1. Division of Atmospheric Sciences, Desert Research Institute, 2. University of California, Berkeley, Central Sierra Snow Laboratory,
3. National Weather Service, Reno , 4. Department of Computer Science, University of Nevada

Overview

Rain-on-snow (ROS) events are commonly linked to large historic floods in the United States. Projected increases in the frequency and magnitude of ROS multiply existing uncertainties and risks in operational decision making. Here, we introduce a framework for quality-controlling hourly data to guide the development of an empirically-based snowpack runoff decision support framework at the Central Sierra Snow Laboratory for water years 2006-2019. Our work demonstrates how (1) present weather and (2) antecedent snowpack risk can be "learned" from hourly data to support eventual development of basin-specific snowpack runoff decision support systems aimed at providing real-time guidance for water resource management.

Introduction

This project demonstrates how hourly data aids understanding of event-based changes and helps to improve decision support through

(1) the dissemination of runoff-relevant changes in the snowpack in real-time,

(2) pattern recognition of present weather and antecedent snowpack conditions that contribute to midwinter TWI, and

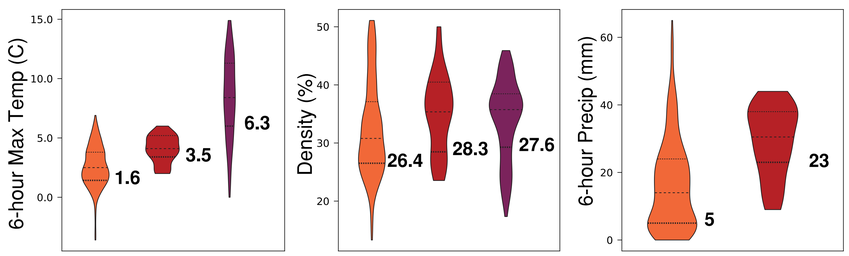
(3) the provision of higher confidence validation data to advance the development of operational snowpack or hydrologic models.

Method

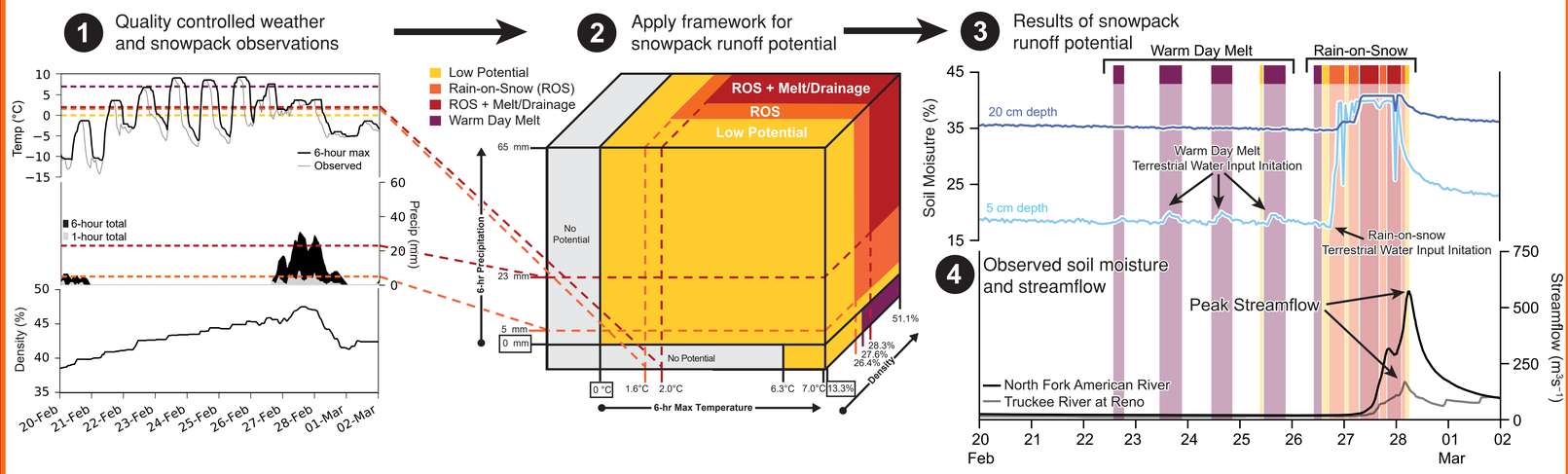
1. QA/QC of hourly data
2. Apply TWI identification alogirthm
3. Manually classify TWI as warm day melt or ROS
4. Split test and train data to build decision tree classification model

Model accurately classified 97.6% of data.

5. Frequency Analysis for Pattern Recognition



Results

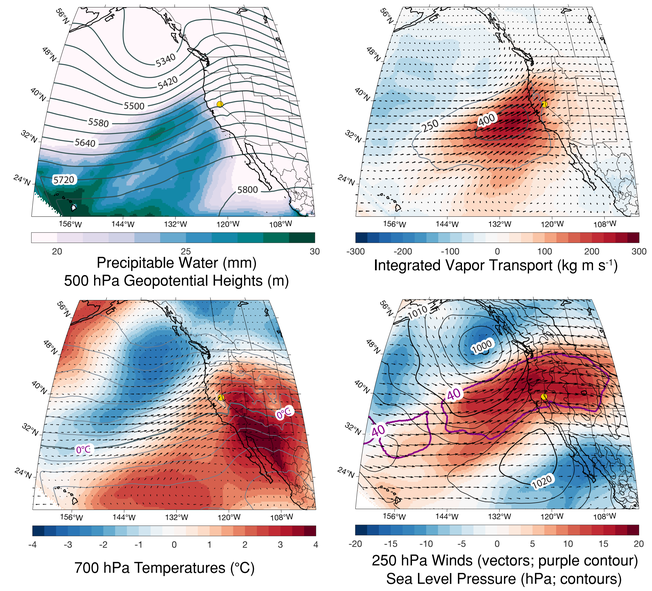


Identifying ROS events with the greatest hydrologic impact enables pattern recognition of synoptic conditions and improve situational awareness at longer lead times.

Key Findings

Testable and scalable framework to build snowpack runoff decision support

- Soil moisutre used to identify snowpack TWI
- Automated TWI driver classification as ROS or warm day melt
- Clean data improved model accuracy up to 25.4%
- Snowmelt is not a primary source of runoff during ROS
- 22 mm of ranfall always produced TWI at study location
- 17 unique ROS events with at least six hours of TWI



Composite synoptic conditions for events with at least six hours of TWI from ROS. Composite synoptic conditions from the North American Regional Reanalysis[1] for 17 unique events that produced at least six hours of TWI.

Conclusion

Our efforts represent a first step towards operational snowpack runoff decision support applicable across management scales. and is aligned with NASA's Science Mission Directorate (H.3) Earth Science Division by integrating observations of precipitation and seasonal snowpack for improved hydrological forecasts, which could guide water resource planning through integrated decision support system emphasized in the Earth Science Decadal Survey[2].

This research was published to the iScience Journal from Cell Press: https://doi.org/10.1016/j.isci.2022.104240

This material is based upon work supported in part by the National Aeronautics and Space Administration under Cooperative Agreement No. 80NSSC20M0043.

Read More

References
1. Mesinger, F. et al. North American Regional Reanalysis. Bulletin of the American Meteorological Society vol. 87 343–360 (2006). https://doi.org/10.1175/bams-87-3-343
2. National Research Council. (2007). Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond. Washington, DC: The National Academies Press. https://doi.org/10.17226/11820.