A Progress Update on the Montana Mesonet and its Applications

Kelsey Jencso
Montana State Climatologist
W.A. Franke Endowed Professor of Hydrology

Zachary Hoylman – Asst. Climatologist
Kevin Hyde – Mesonet Site Coordinator
Colin Brust - Data Scientist
Kyle Bocinsky – Dir. Climate Extension
Toby Dunn – Mesonet Soil Analysis

UNIVERSITY OF MONTANA | W.A. FRANKE COLLEGE OF FORESTRY AND CONSERVATION

Staff at the Montana Climate Office

KELSEY JENCSO
STATE CLIMATOLOGIST

ZACH HOYLMAN
ASSISTANT STATE CLIMATOLOGIS

KYLE BOCINSKY
DIRECTOR OF CLIMATE EXTENSIOI

KEVIN HYDE
MONTANA DEVELOPMENT MANAGE

JOEL MARTIN
LEAD HYDROLOGIC TECHNICIAN

ANNIE MCVAY
PROGRAM & FISCAL COORDINATOI

COLIN BRUST
CLIMATE DATA SPECIALIST

MAUREEN I. MCCARTHY, PHD

WES SHORT
HYDROLOGIC TECHNICIAN

ADAM COOK
HYDROLOGIC TECHNICIAN

JOHN STAPLETON
HYDROLOGIC TECHNICIAN

WILL KERSEY
HYDROLOGIC TECHNICIAN

GUY MARSHALL
HYDROLOGIC TECHNICIAN

DREW PAINTER
MESONET ASSISTANT

DAVID KETCHUM
HYDROLOGIST

FIN MALONE
MASTER'S STUDENT/RESEARCH ASSISTANT

CHRISTINE LAYEUX
EXTENSION

ETHAN JONES
MESONET ASSISTANT

ALEX MAUSSHARDT
MESONET ASSISTANT

KENZYE SPEARS
MESONET ASSISTANT

TOBY DUNN
UNDERGRADUATE RESEARCH ASSISTANT

RYAN FLEETWOOD
UNDERGRADUATE RESEARCH ASSISTANT

DANIEL MARTIN
UNDERGRADUATE RESEARCH ASSISTANT

PAIGE JOHNSON
NATIVE CLIMATE INTERN

Why install more weather and soil moisture stations in Montana?

Flood Prediction and Early Warning

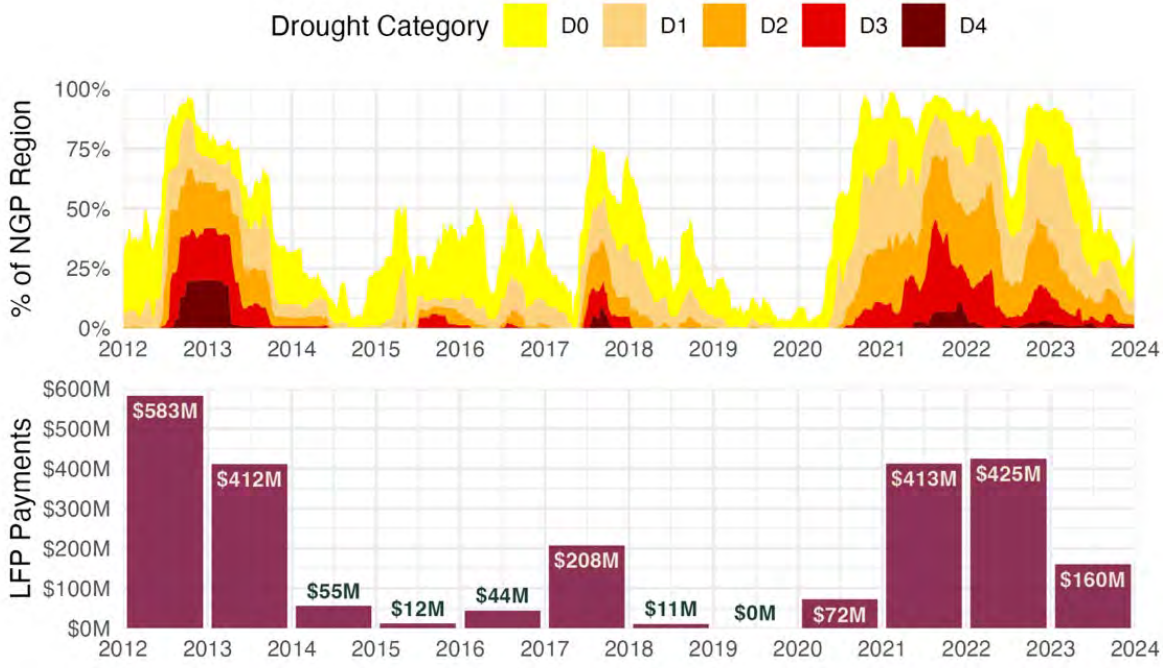
- Improved knowledge of precipitation and antecedent moisture conditions for modeling of flood potential
- Timing and amounts of reservoir releases to mitigate downstream flooding

Drought Monitoring and Prediction

- Improved knowledge of water availability in agricultural, range, and forest settings
- Triggers state and federal emergency response
- Documentation of conditions leading to crop loss

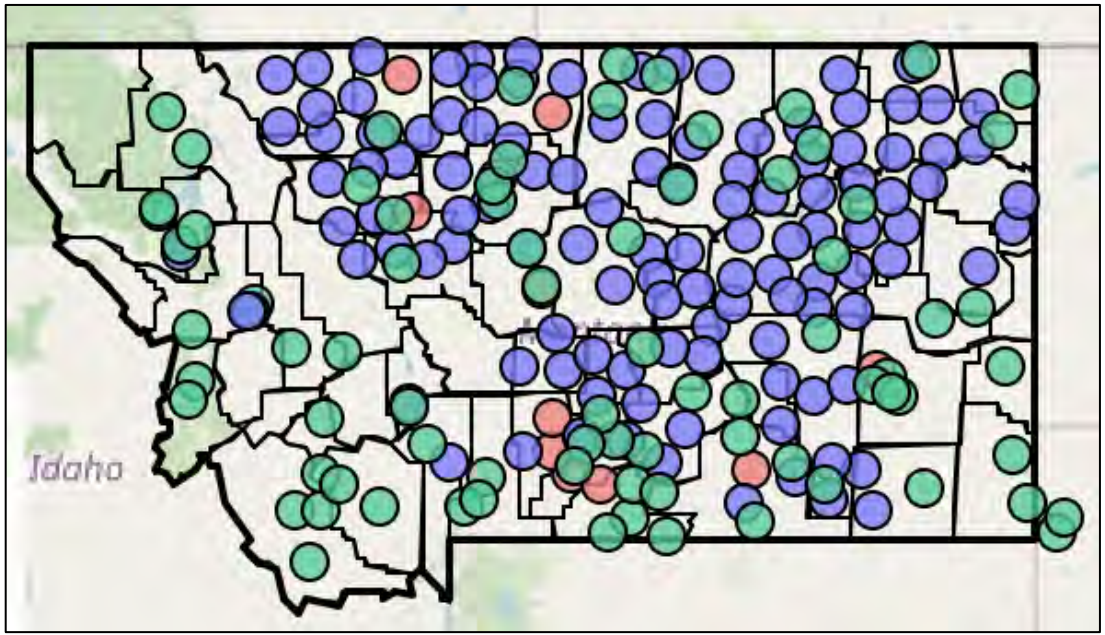
Infrastructure that forms the basis for additional measurements and tools - eg. precision agriculture, fire weather and natural resource management

Why do valid data matter?



Ensuring the appropriate allocation of funds to support our food systems and rural communities across Montana!

MT Mesonet - A Collaborative Framework



Agrimet Stations Hydromet Stations Both

220 stations

climate.umt.edu/mesonet

Federal, State, and Private Partnerships

- United States Army Corps of Engineers
- National Oceanographic and Atmospheric Administration (NOAA)
- DOI Bureau of Land Management
- USDA Forest Service
- MT Department of Agriculture
- Montana Department of Natural Resources and Conservation
- MSU Ag Research Centers
- Stillwater County
- Montana Bureau of Mines and Geology
- Crow Agency
- Lolo Watershed Group
- Blackfoot Challenge
- Trout Unlimited
- National Drought Resilience Partnership
- Community Collaborative Rain, Hail and Snow Network (CoCoRahs)
- **Private landowners**

Expansion & Improvements to Drought Infrastructure

TOM BAUER, MISSOULIAN

Carly Andlauer, a University of Montana senior finishing up a bachelor's degree in ecology restoration, processes soil samples Thursday from across the state for a climate monitoring project. UM researchers recently received a $21 million government contract for the project to better monitor soil moisture, snowpack, weather hazards and climate conditions.

UM awarded $21M contract

Researchers given Army Corps contract to expand climate monitoring network

LAURA SCHEER
laura.scheer@missoulian.com

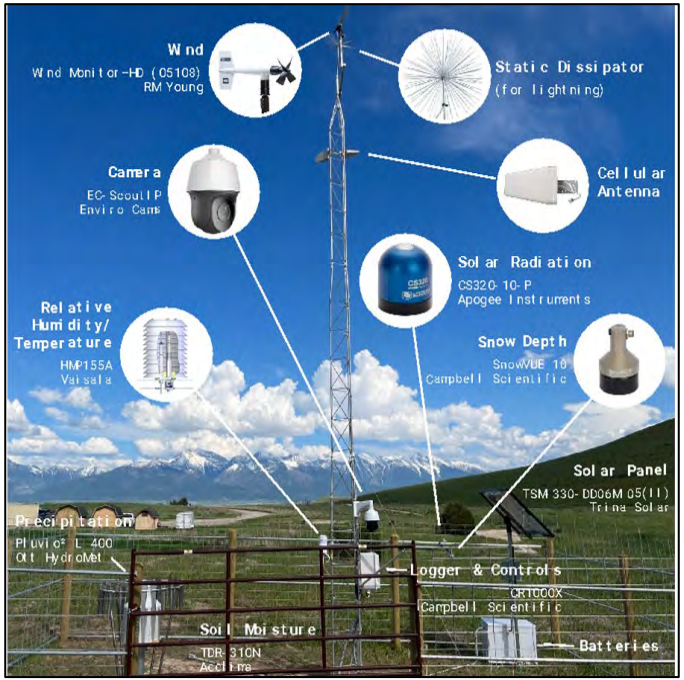
University of Montana researchers recently received a $21 million government contract, bringing more support and longevity to what has been a grassroots effort to build a better climate monitoring network across the state.

The funding from the U.S. Army Corps of Engineers will pay to expand and enhance a collaborative project spearheaded by UM's Montana Climate Office in 2016 that aims to fill in gaps in weather and soil moisture data throughout the state.

"This project is very unique," said Kelsey Jencso, a lead researcher and associate professor of watershed hydrology at UM. "This is a very applied project. It has a particular goal, which is to better monitor soil moisture, snowpack, weather hazards and climate conditions."

Through partnerships with government agencies, including the Montana Department of Agriculture and Bureau of Land Management, Montana State University, watershed groups, and private farmers and ranchers, the Montana Climate Office, part of the W.A. Franke College of Forestry and Conservation, has installed 80 weather stations

Please see CONTRACT, Page A3

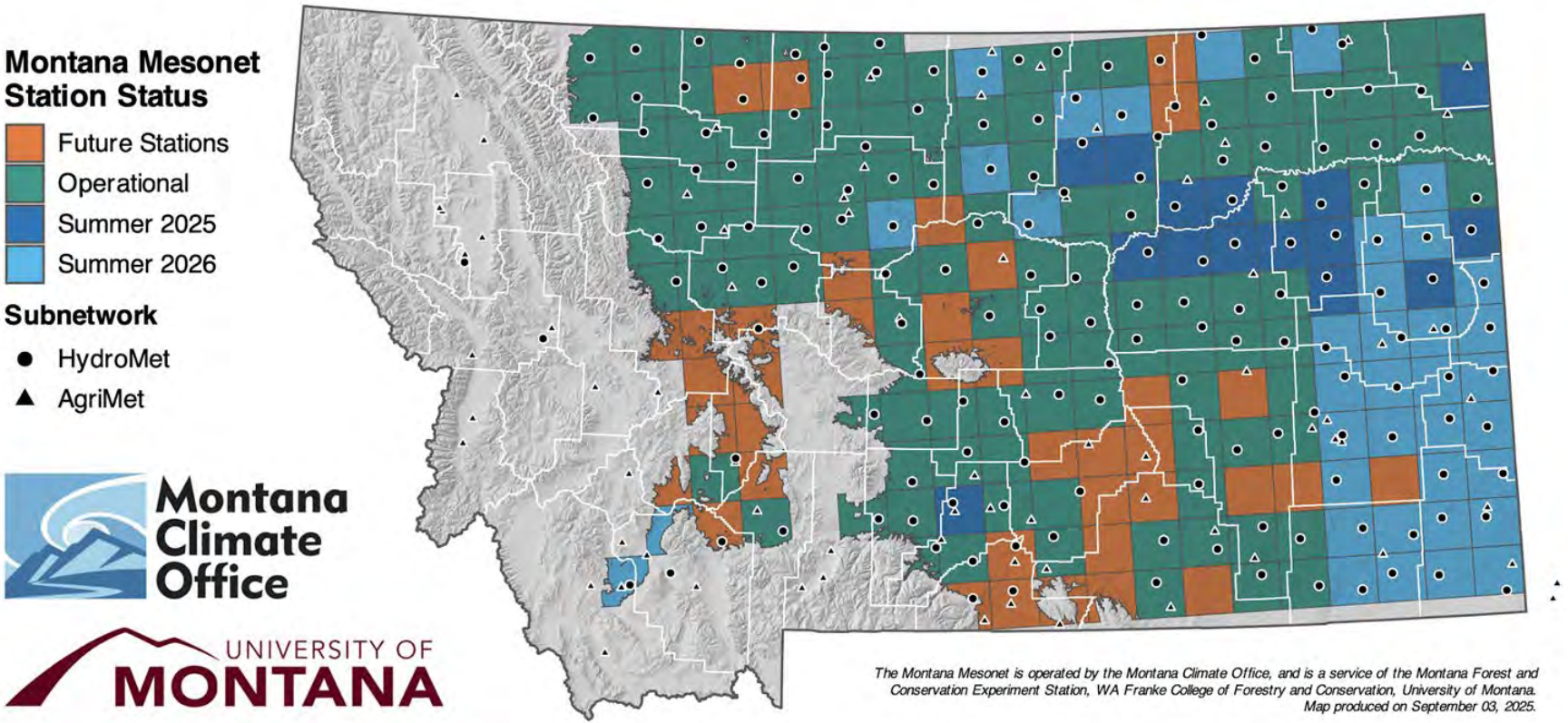


CSKT Bison Range Station

U.S. Army Corps

- S.4444 - Missouri River Basin Drought and Snowpack Monitoring Act
- Introduced by Senator Thune (SD) with bi-partisan support
- Upper Missouri River Basin and elevations below 5,500 feet
- 205 more stations in MT and 500 total across the five-state region.

This Year's Hydromet Construction



Mesonet Data Availability

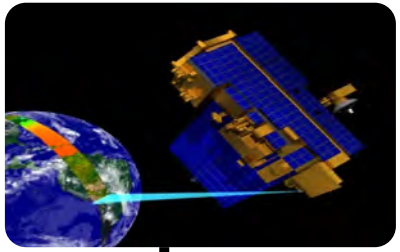
- Publicly available
- Map based and graphical summaries
- Updated every 5 minutes
- **Data used by NOAA and USACE for weather forecasting, flood prediction, and reservoir management**

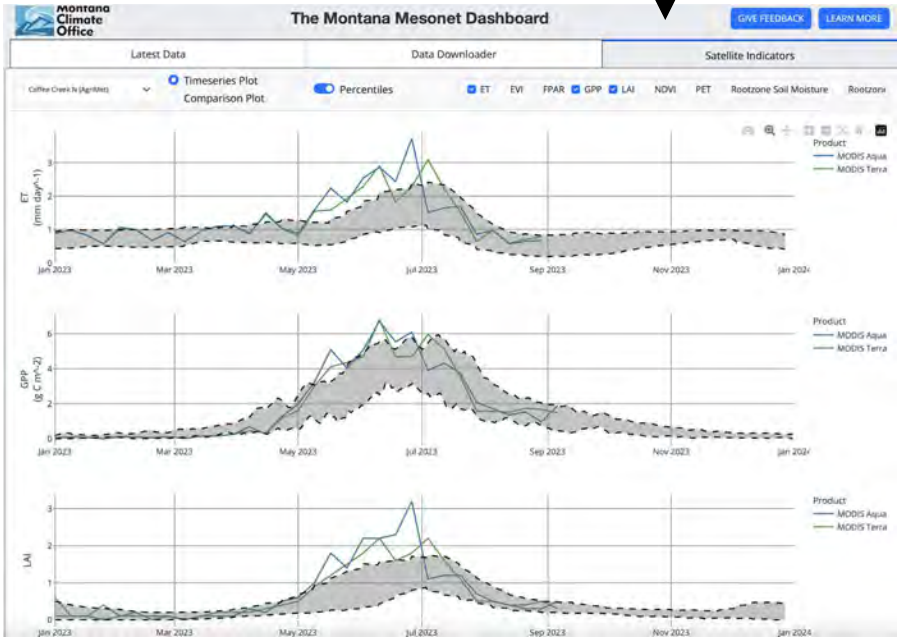
Colin Brust (MCO)

mesonet.climate.umt.edu/dash

NATIONAL MESONET Program Partner

Mesonet Data – Operational Agriculture & Rangeland Tools to Enhance Decision Making

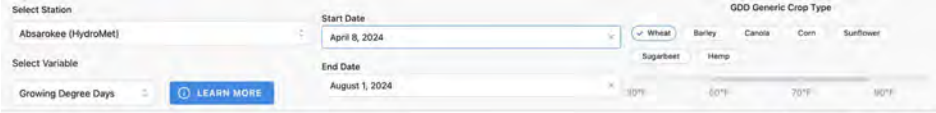




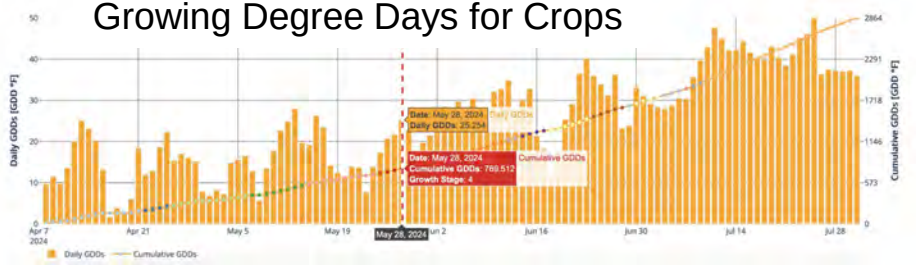
Tureck Ranch – Denton, MT

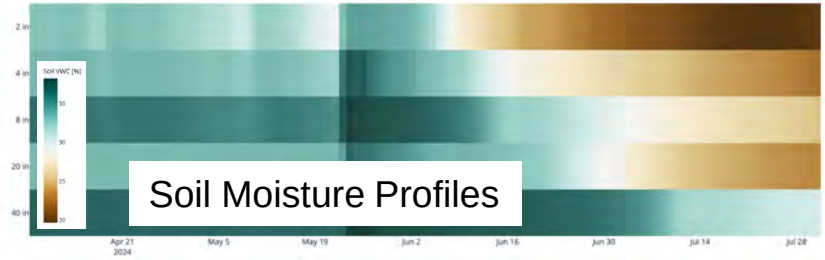
”It’s been one of the most productive years (2023) that I can remember” – Judy Tureck

Mesonet Data – Precision Agriculture & Rangeland Tools to Enhance Decision Making

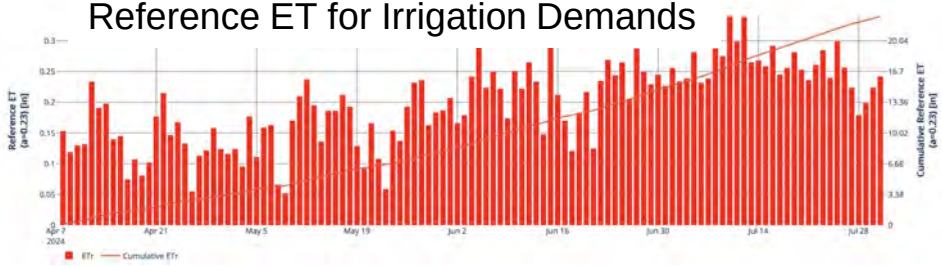


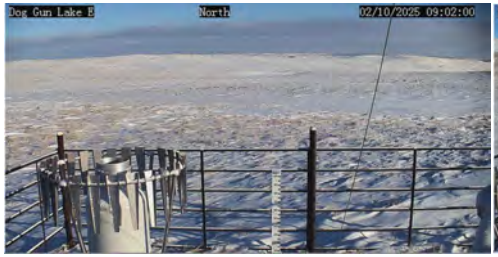
Growing Degree Days for Crops

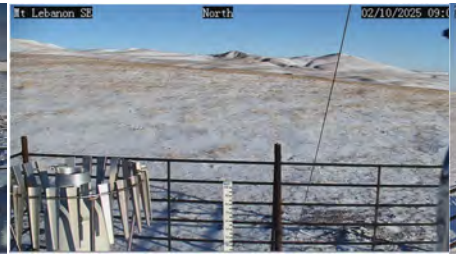


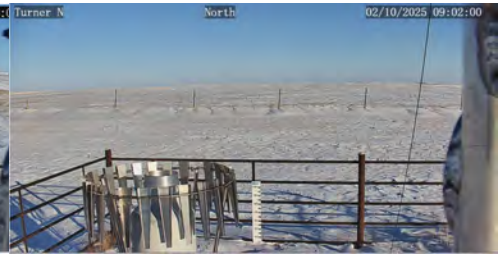


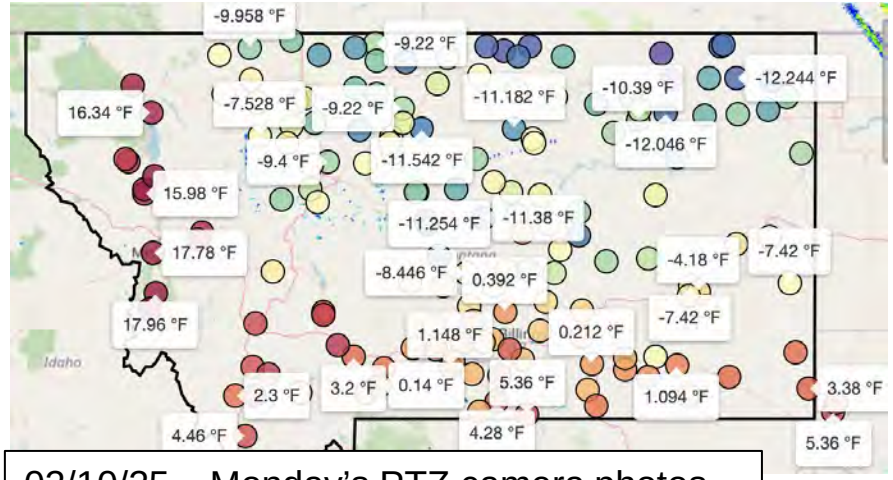
Reference ET for Irrigation Demands

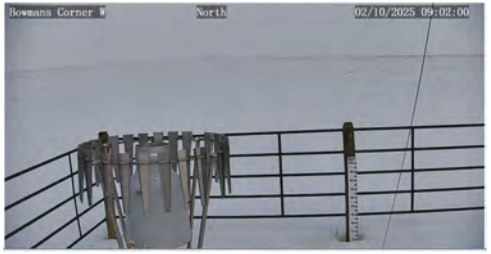




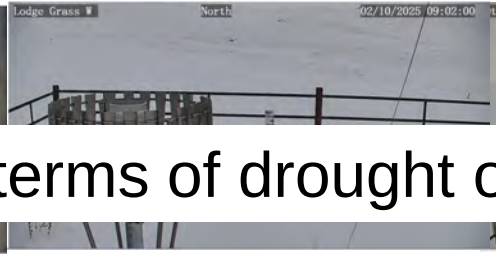


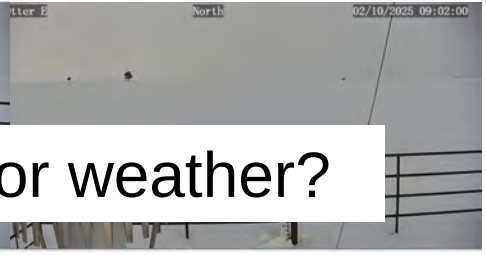






02/10/25 – Monday's PTZ camera photos

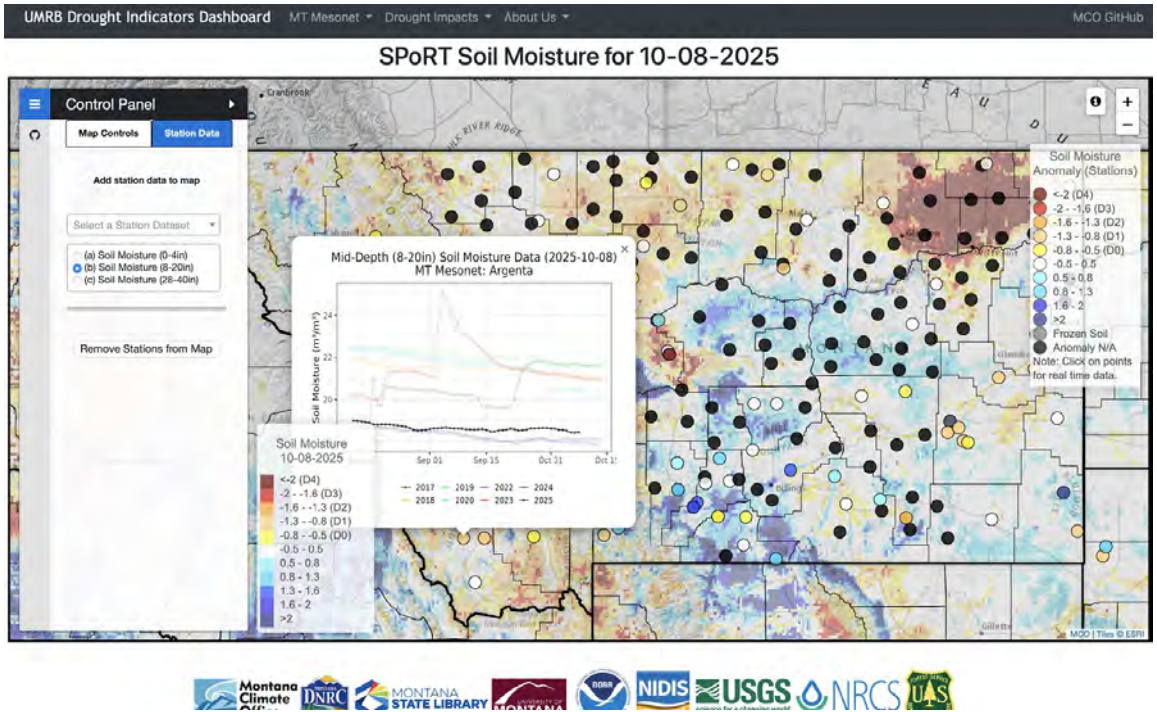




How does the state **look** in terms of drought or weather?

Better characterizations of drought & water supply conditions

“No one trusts a model except the person who wrote it; everyone trusts an observation, except the person who made it.”

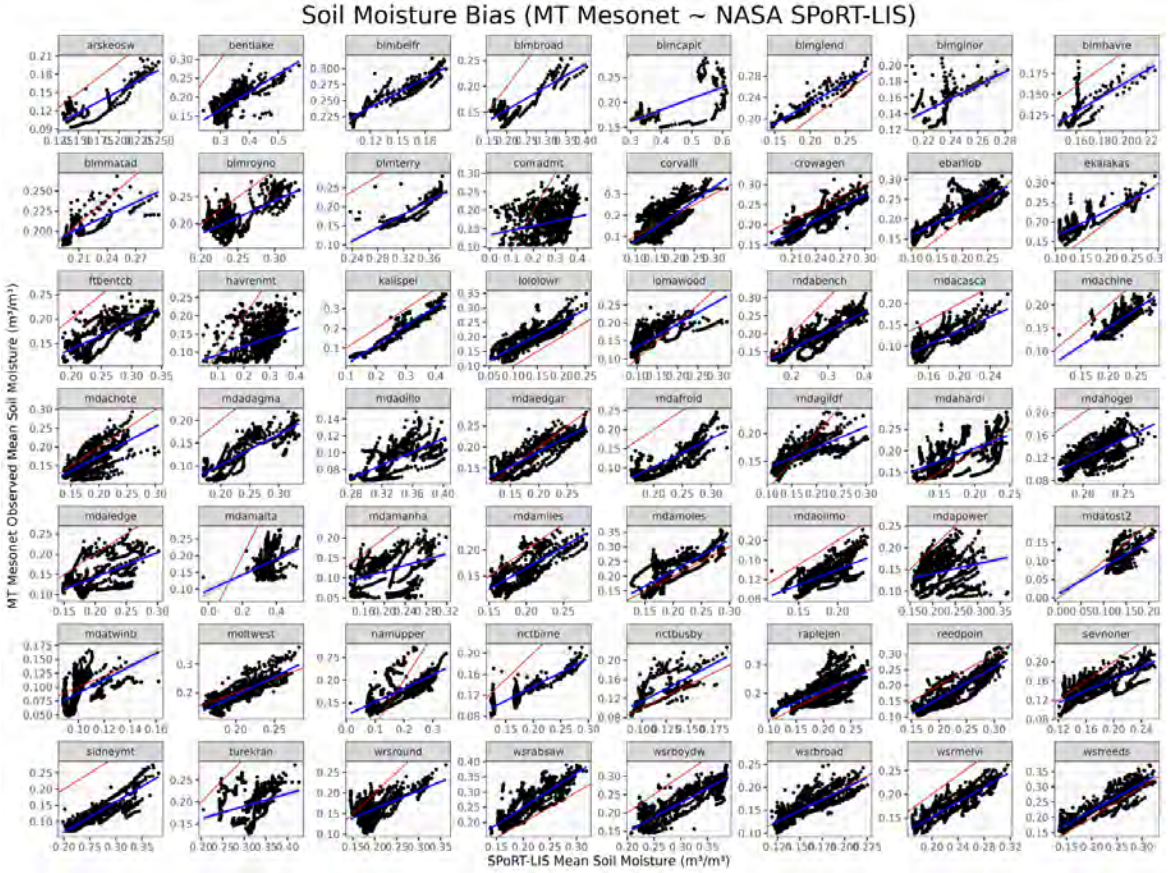


The UMRB Drought Dashboard

- Daily modeling of precipitation, temperature, snow, soil moisture, evapotranspiration and drought models across Montana
- Science based tool for drought mapping by the state of Montana and for evidence-based reporting to the USDM

drought.climate.umt.edu Hoylman et al., In Review, *Nature Water*

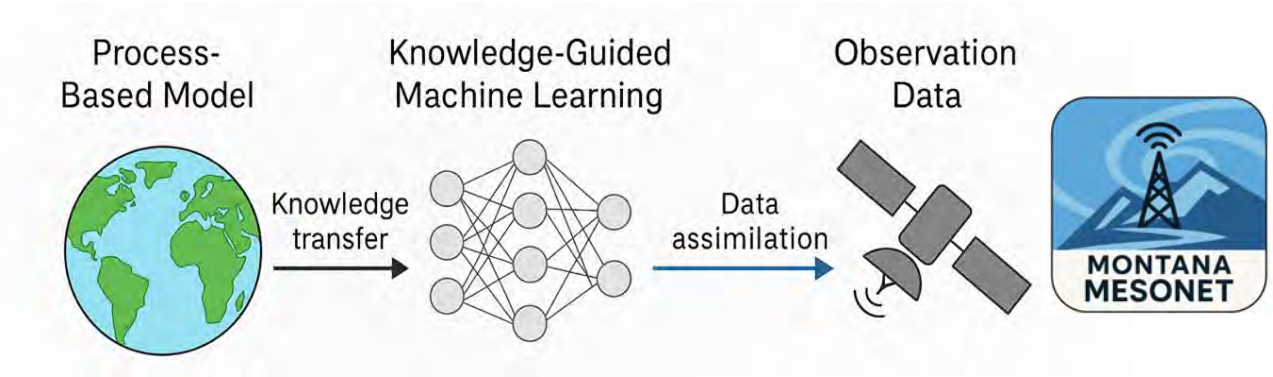
What drives error in modeled soil moisture?



- Soil properties
- Terrain
- Vegetation
- Climate
- Scaling
- Non-linearity

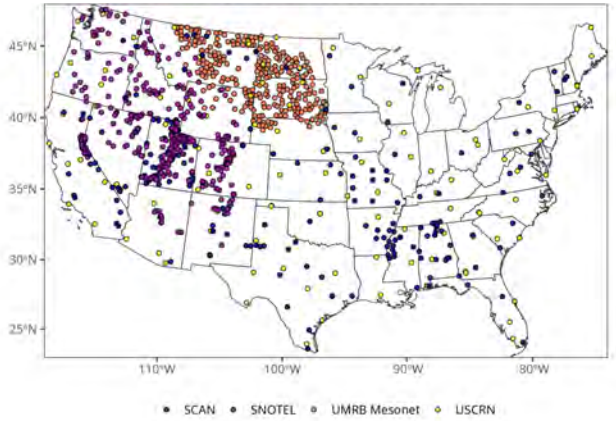
Knowledge Guided Machine Learning

ZACH HOYLMAN
ASSISTANT STATE CLIMATOLOGIST

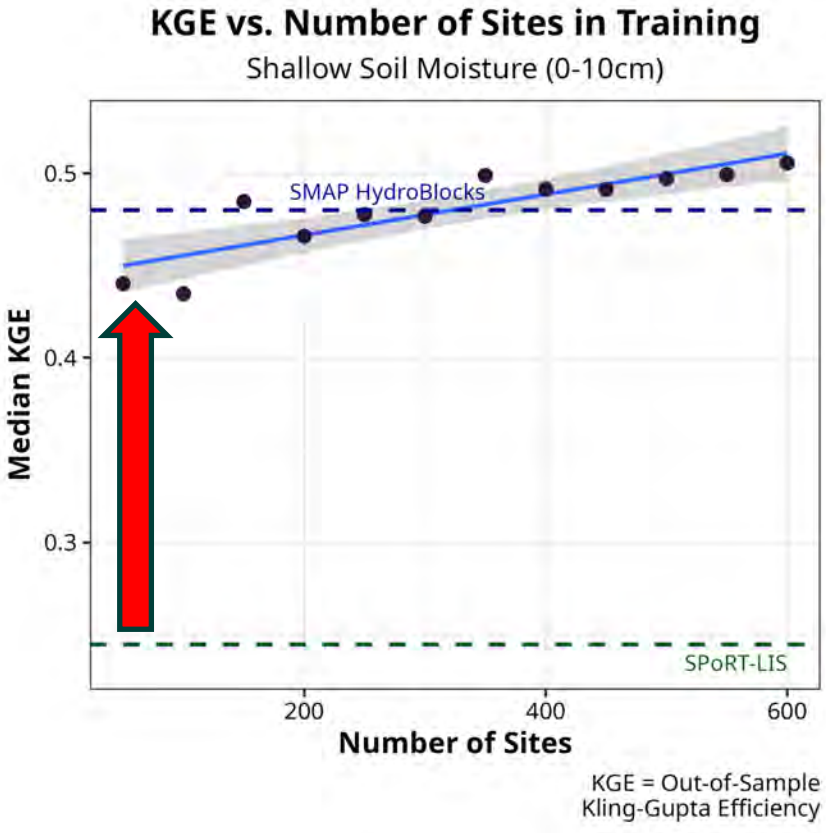


Pretraining - Embedding SPoRT-LIS into the Neural Net

Fine Tuning - Embedding Observations



KGML Soil Moisture Results



- Up to 13x more accurate than SPoRT-LIS at shallow depths

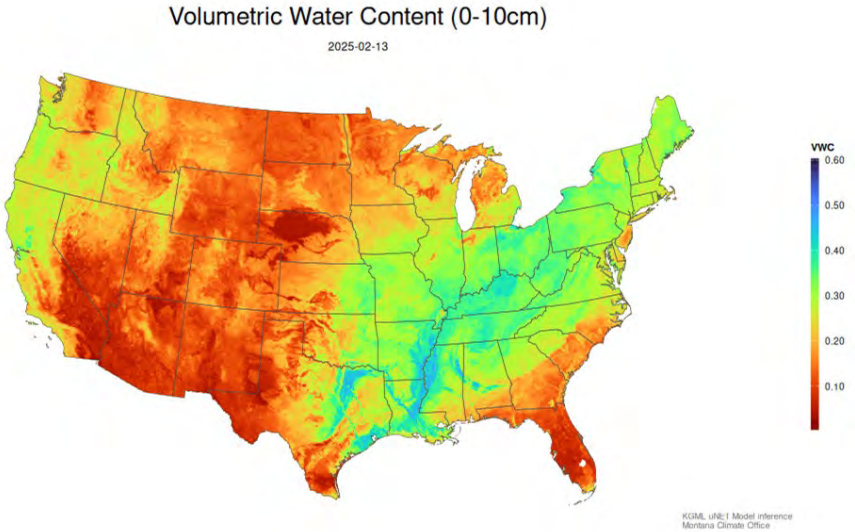
Kling Gupta Efficiency (magnitude of VWC)
KGML = 0.58
SPoRT-LIS = 0.04

Pearson's r (temporal correlation of VWC)
KGML = 0.86
SPoRT-LIS = 0.52

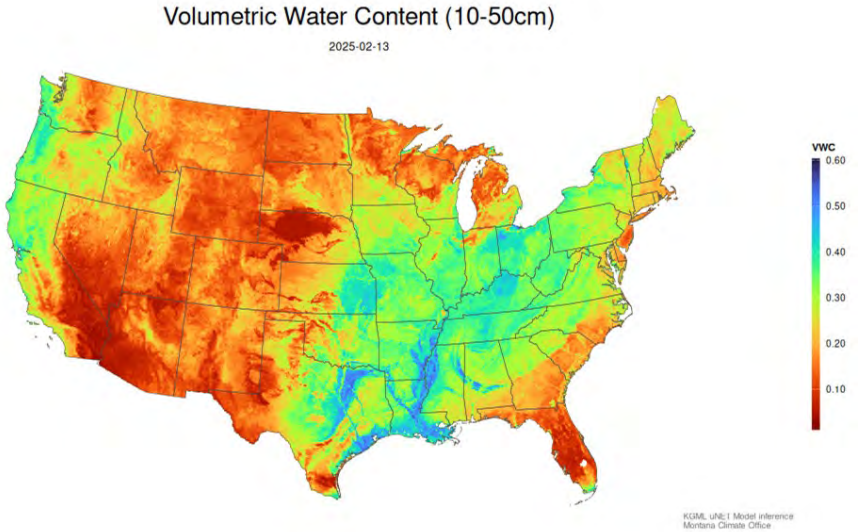
- Linear increase in accuracy with each additional station added

Operational KGML Soil Moisture on the UMRB Drought Dashboard - Soon!

Shallow (0-10cm)



Mid-Depth (10-50cm)



Summary

Our unique geography contributes to spatial differences in where, how often and how fast weather events impact Montanan's livelihoods and our economy – and it's a big state

Accurate monitoring is critical to informing our daily and seasonal response to drought & floods

These frameworks are critical to the allocation of hundreds of millions of dollars for food security, infrastructure, and protection of livelihoods and lives.

Questions?

Montana Climate Office

state.climatologist@umontana.edu

Web Resources:

MCO Web Page: https://climate.umt.edu

Climate Data Explorer: https://mco.cfc.umt.edu/datasets

Drought Tracker: https://drought.climate.umt.edu

Seasonal Newsletters: https://climate.umt.edu/mtdrought

Montana Mesonet: https://climate.umt.edu/mesonet