

A topographic map of Montana, showing the state's outline and internal terrain features. The map is rendered in shades of light brown and tan, with darker brown lines indicating elevation changes and mountain ranges. The state's outline is clearly defined by a thin black line.

# MANAGING FOR CLIMATE VARIABILITY IN MONTANA

Water Policy Interim Committee  
January 7, 2014

Montana Climate Office  
Montana University System  
University of Montana

A topographic map of Montana, showing the state's outline and internal terrain features. The map is rendered in shades of light brown and tan, with darker brown lines indicating elevation changes and mountain ranges. The state's outline is clearly defined by a thin black line.

# OBJECTIVES:

1. Montana's climate and its variability
2. Priorities to enhance agricultural productivity in response to climate

# WEATHER VS. CLIMATE

**Weather:** the condition of the atmosphere at any particular place and time

**Climate:** represents the long-term behavior of the atmosphere at a given region. A description of aggregate weather conditions; the sum of all statistical weather information that helps describe a place or region

# CLIMATE OF MONTANA

East of the continental divide:

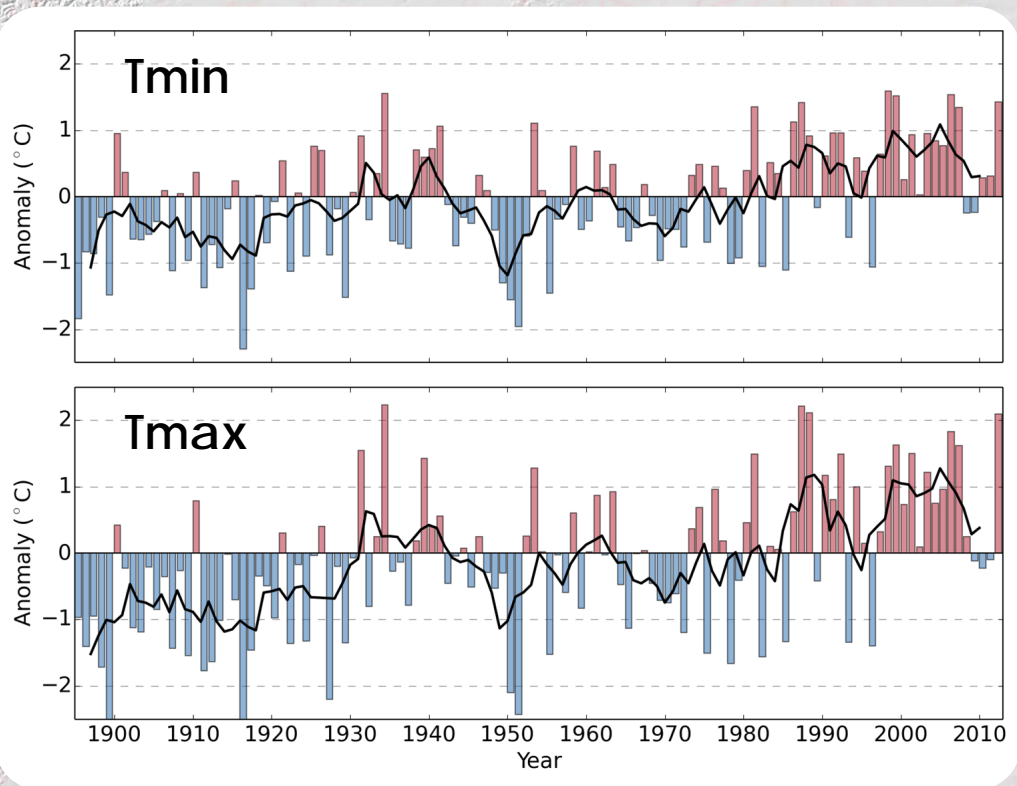
- **continental climate**
- Large annual temperature range
- Cold winters and hot, dry summers, convective summer precipitation

The continental divide forms a transition zone between maritime and continental climates:

- **Maritime** air masses bring storms during the winter with increased precipitation at higher elevations
- More moderate winter temperatures in the valleys
- More stability in July-August with clear and dry conditions

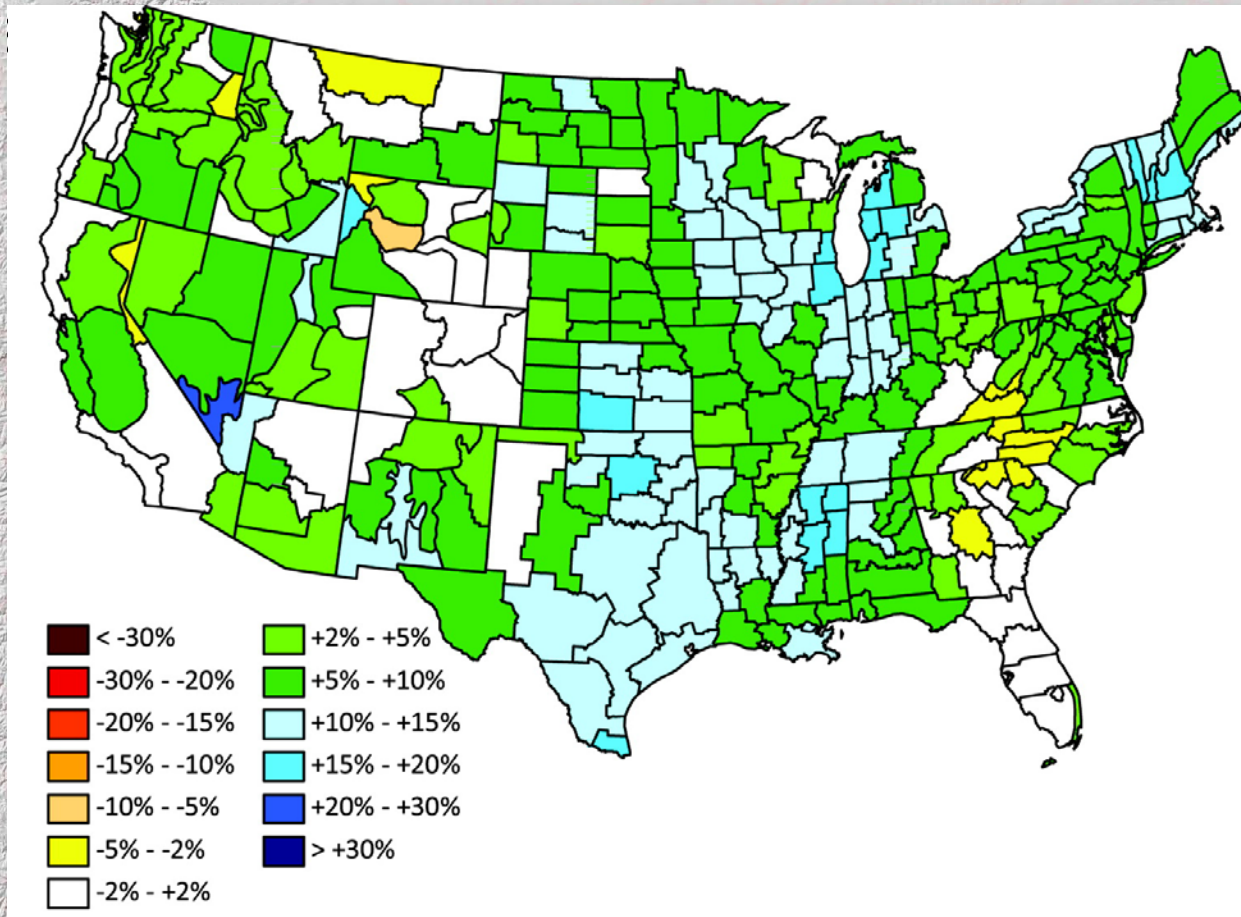
# MONTANA TEMPERATURE TRENDS

Montana Annual Temperature Anomalies  
– U.S. HCN (1961-1990 baseline)



# MONTANA PRECIPITATION TRENDS

Linear trends of annual precipitation from the 1895–2009 (% per century)



# PRIORITIES TO ENHANCE AGRICULTURAL PRODUCTIVITY IN RESPONSE TO CLIMATE

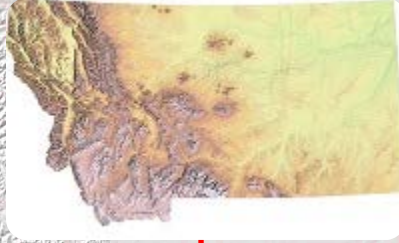
- Quantification of the spatial and temporal climate trends across Montana
- A dialogue between climate product developers and the user community to create new climate tools
- Distribute climate information and forecasts to growers in a timely and easy to access manner

# How to manage agriculture for climate variability?

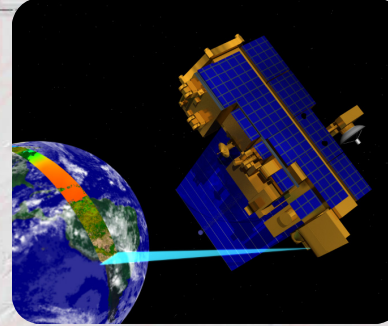
Weather Station Data



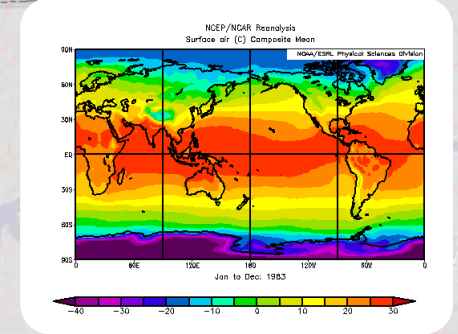
Topographic and LULC data



Satellite Data



Large-scale Atmospheric Data

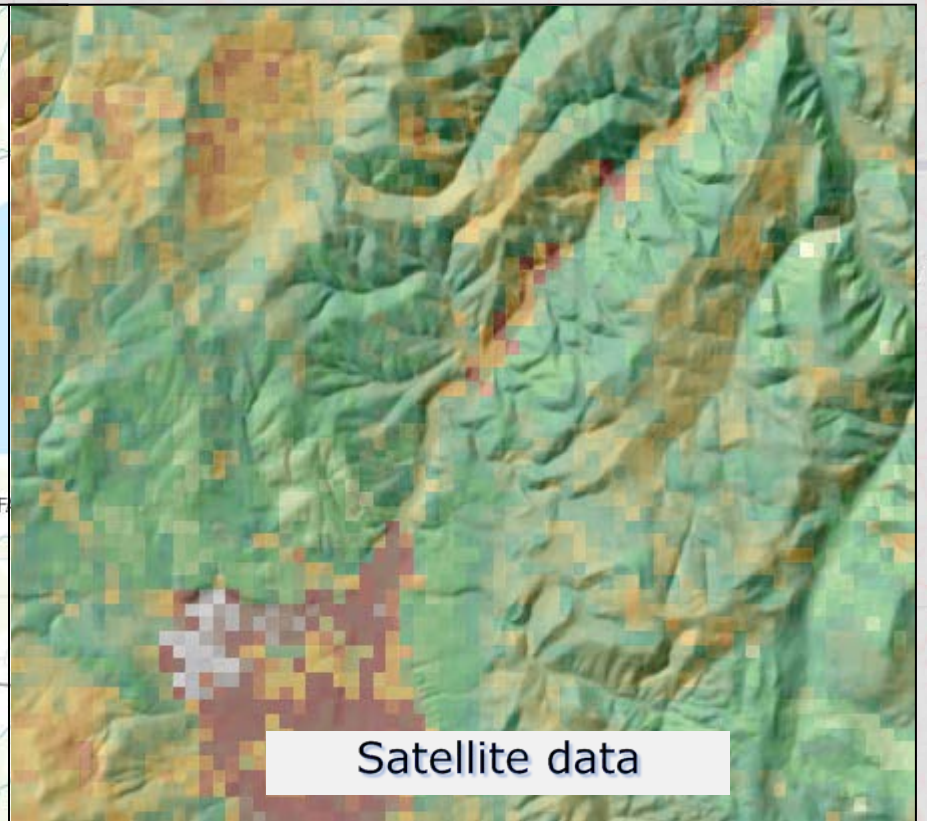
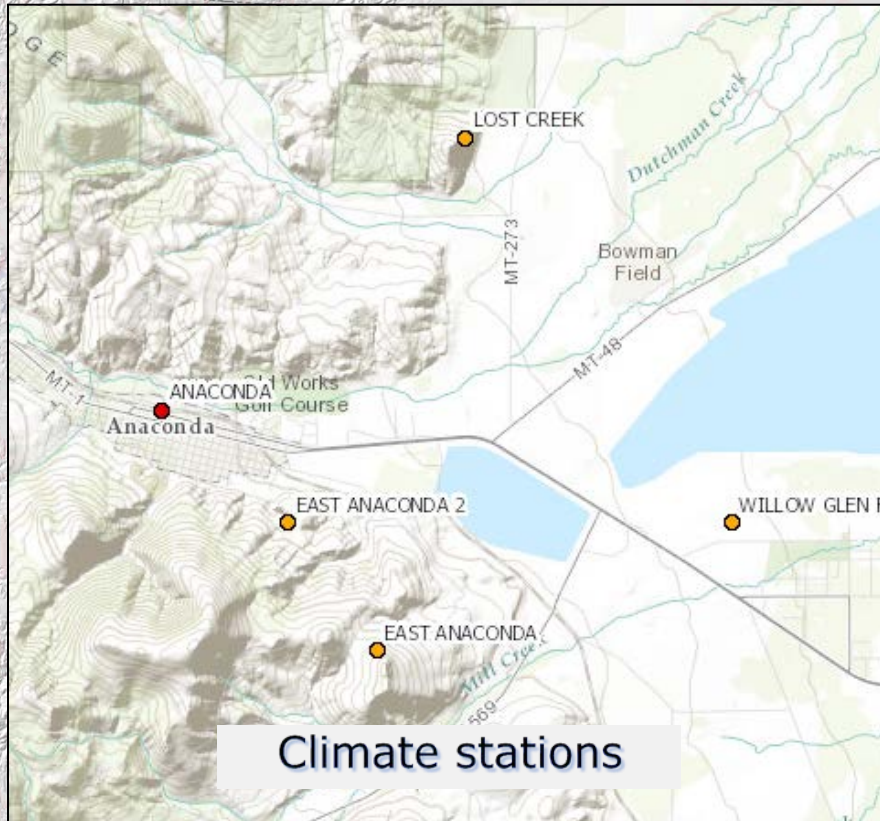


First we must know where and when to manage!



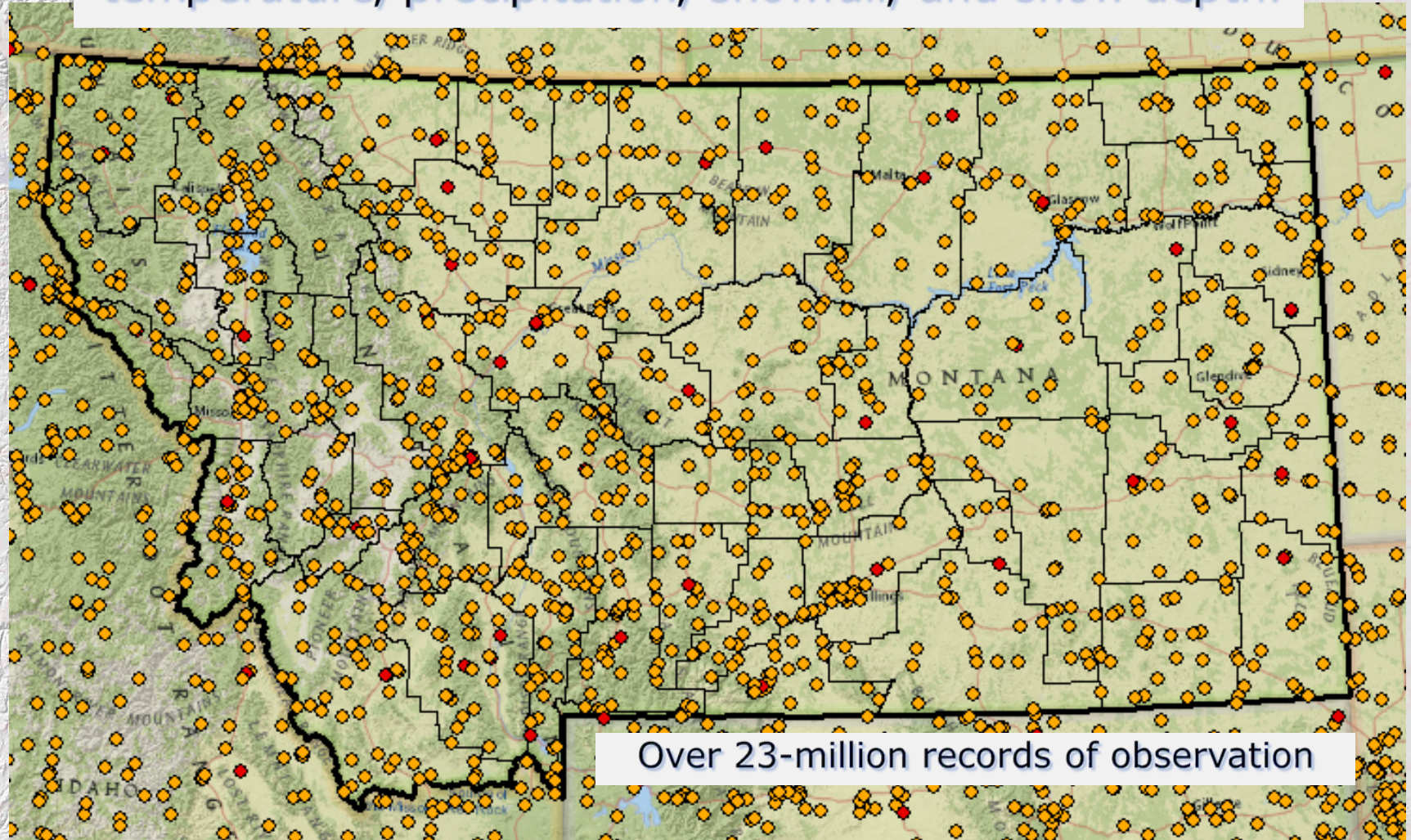


Climate data consists of statewide science-based climate information with two primary data types – point and raster (gridded) data



"Developed, Integrated, and Maintained"

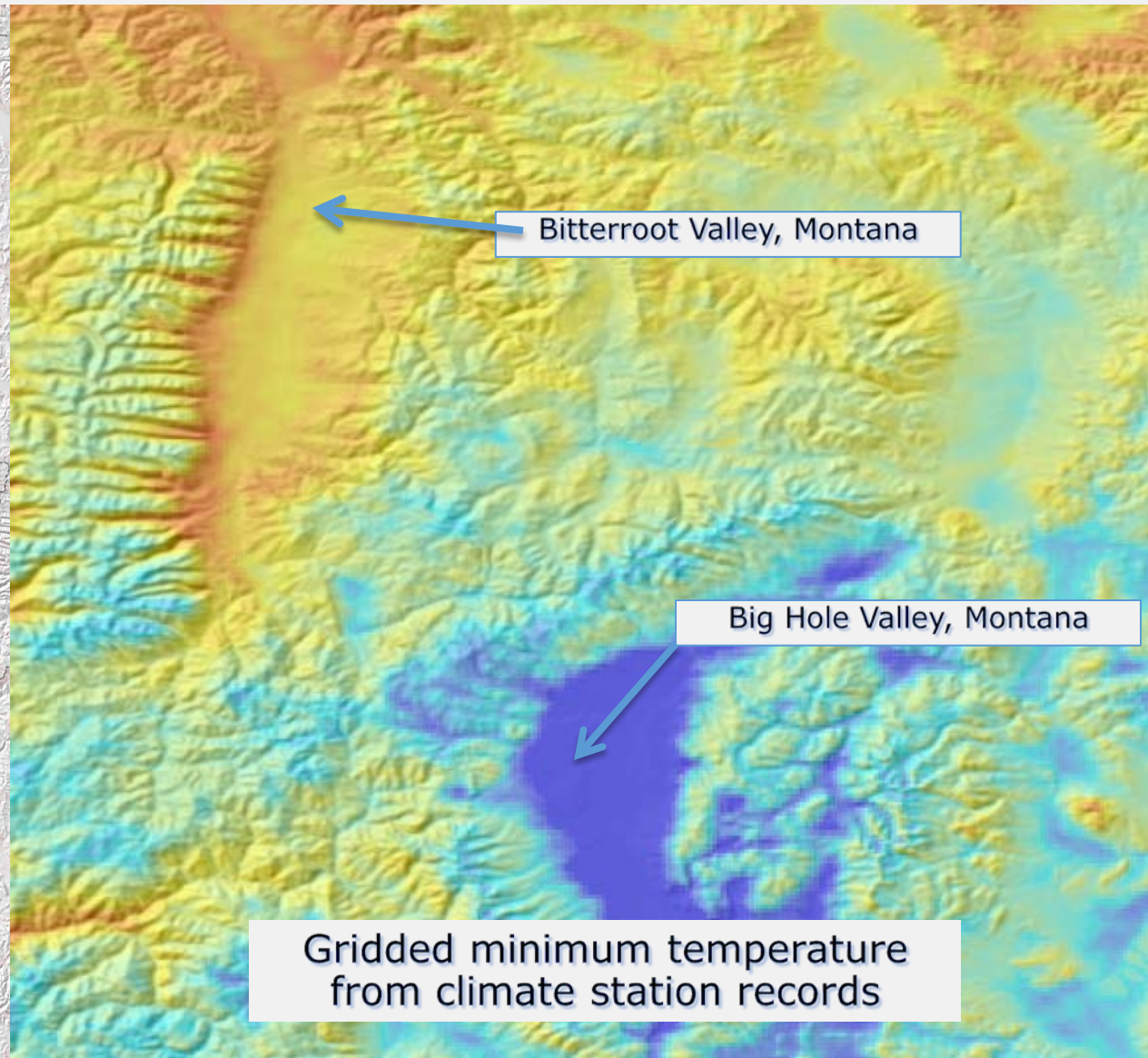
The most common measured elements for climate stations include minimum temperature, maximum temperature, precipitation, snowfall, and snow depth.



Over 23-million records of observation

"Developed, Integrated, and Maintained"

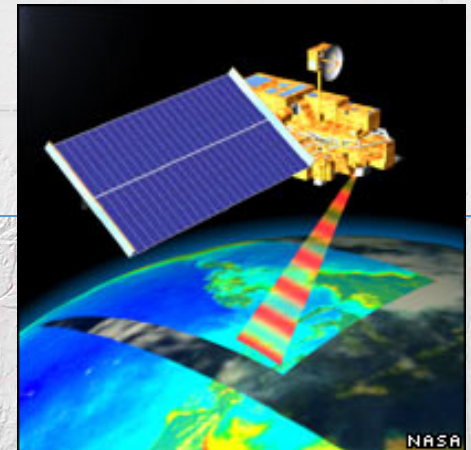
Daily statewide product for temperature and precipitation  
with measures of quality and uncertainty  
(1948-2012 results in over 25,000 rasters)



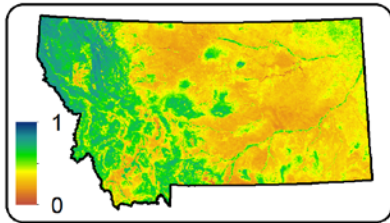
# GRIDDED (RASTER) DATA

## Satellite-based products:

- Normalized Difference Vegetation Index (**NDVI**) as a proxy of vegetation health and productivity.
- Evapotranspiration (**ET**) as a measure of evaporation from the ground or vegetated surfaces combined with plant transpiration.
- A new drought severity index (**DSI**) to accurately quantify the spatial and temporal persistence of drought.

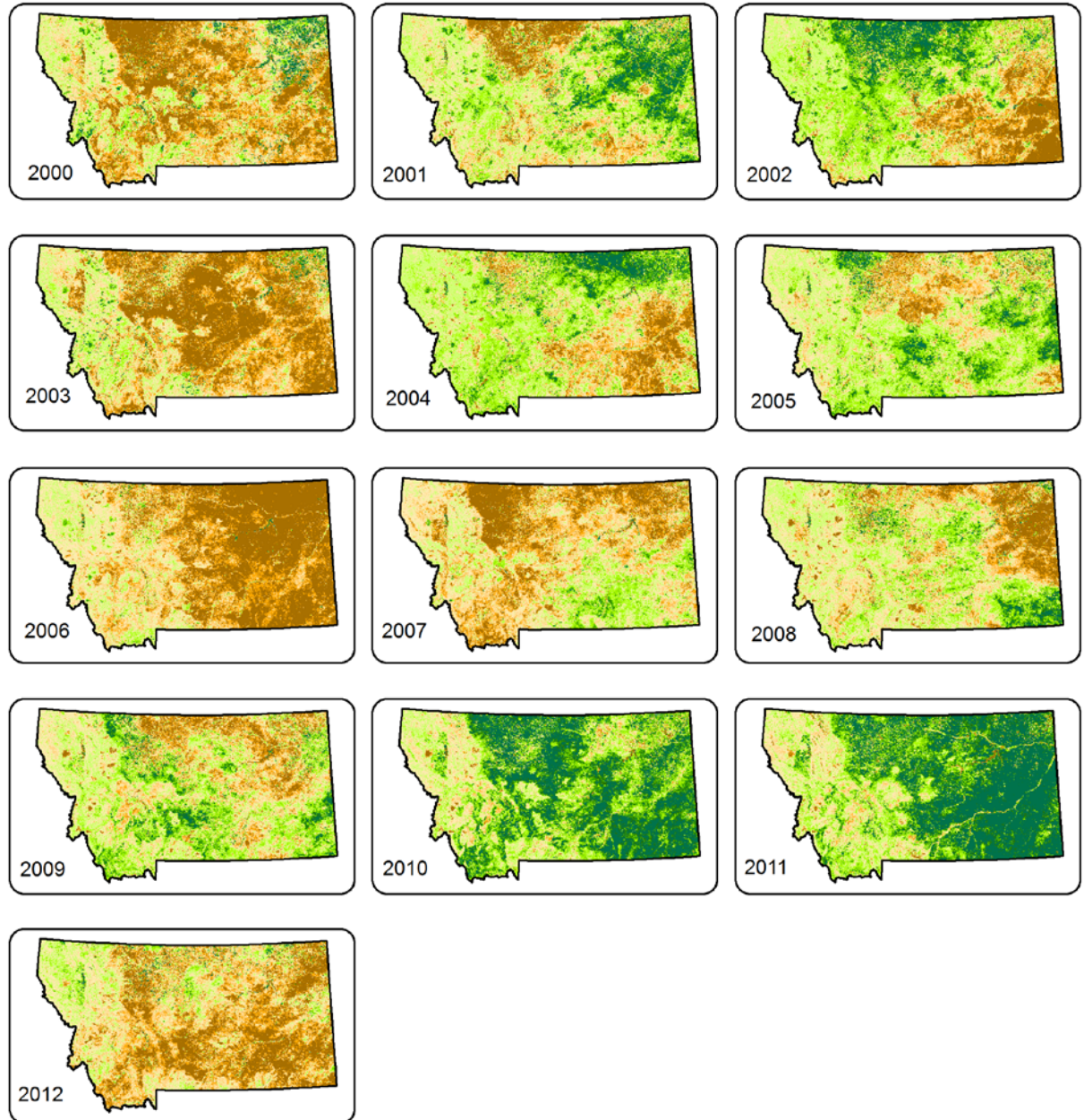


2000 - 2012  
Avg. August NDVI

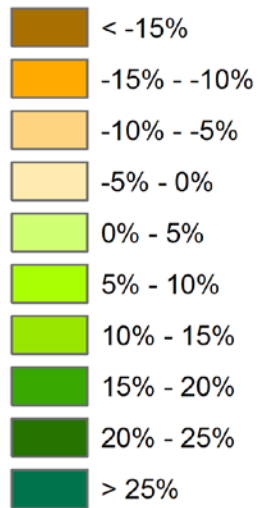


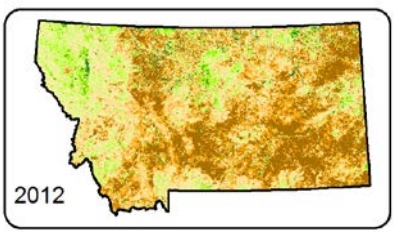
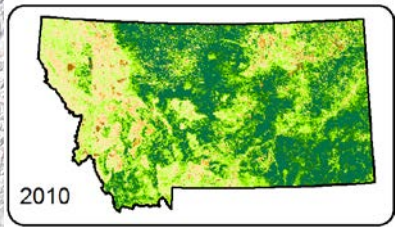
2000 - 2012  
Annual August NDVI Anomalies

# Departure from average "greenness"

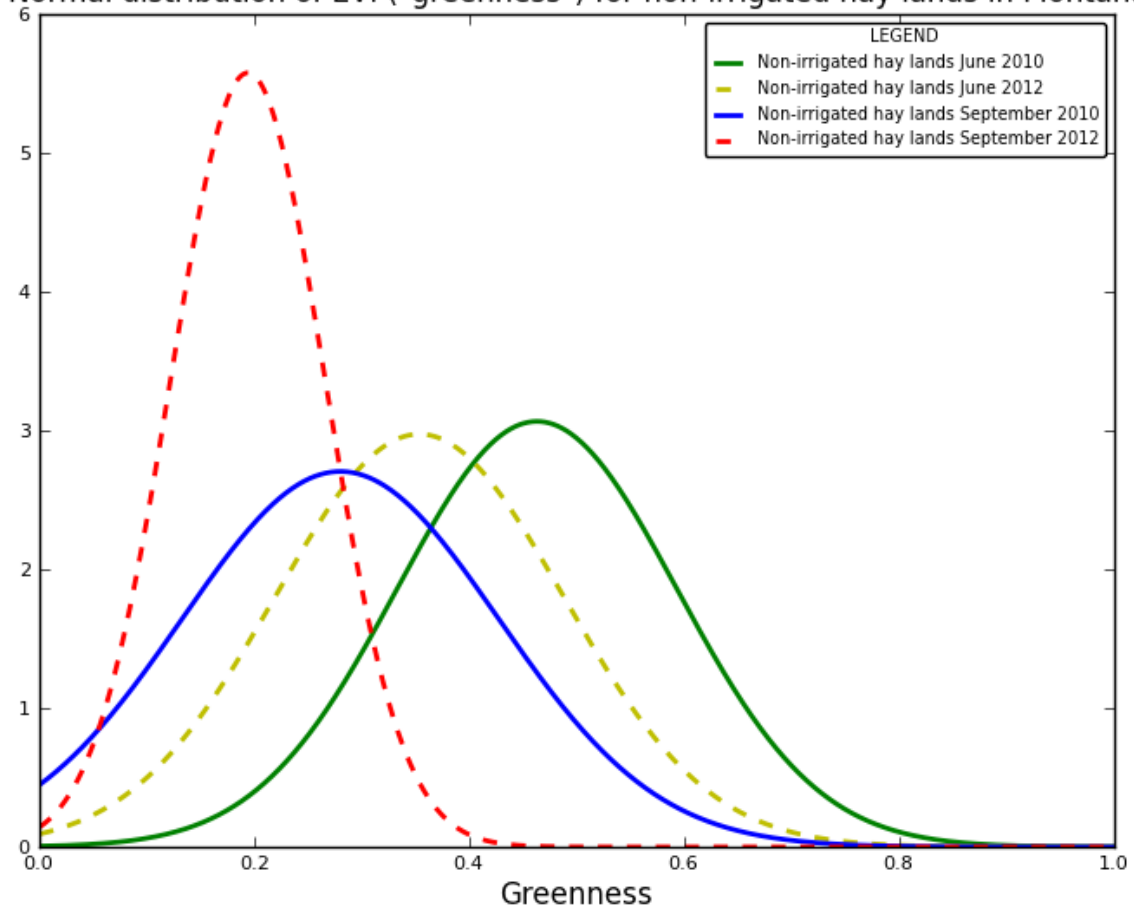


**NDVI Aug. Anomaly**  
**% Above/Below Normal**



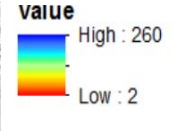
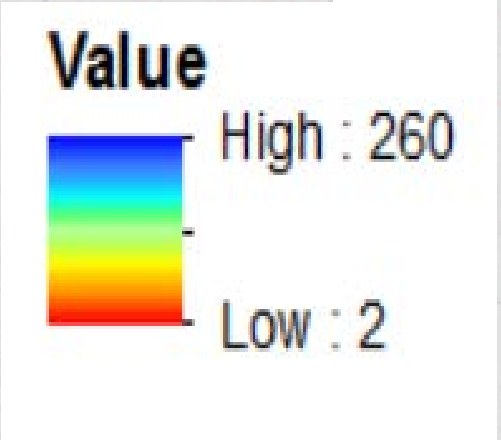
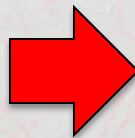
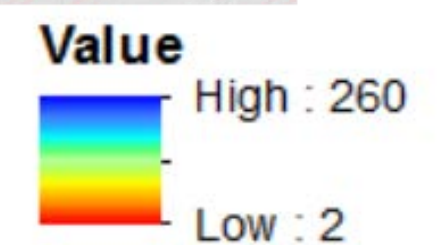
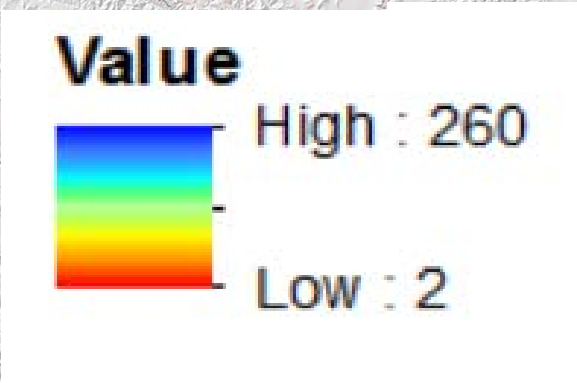


Normal distribution of EVI ("greenness") for non-irrigated hay lands in Montana

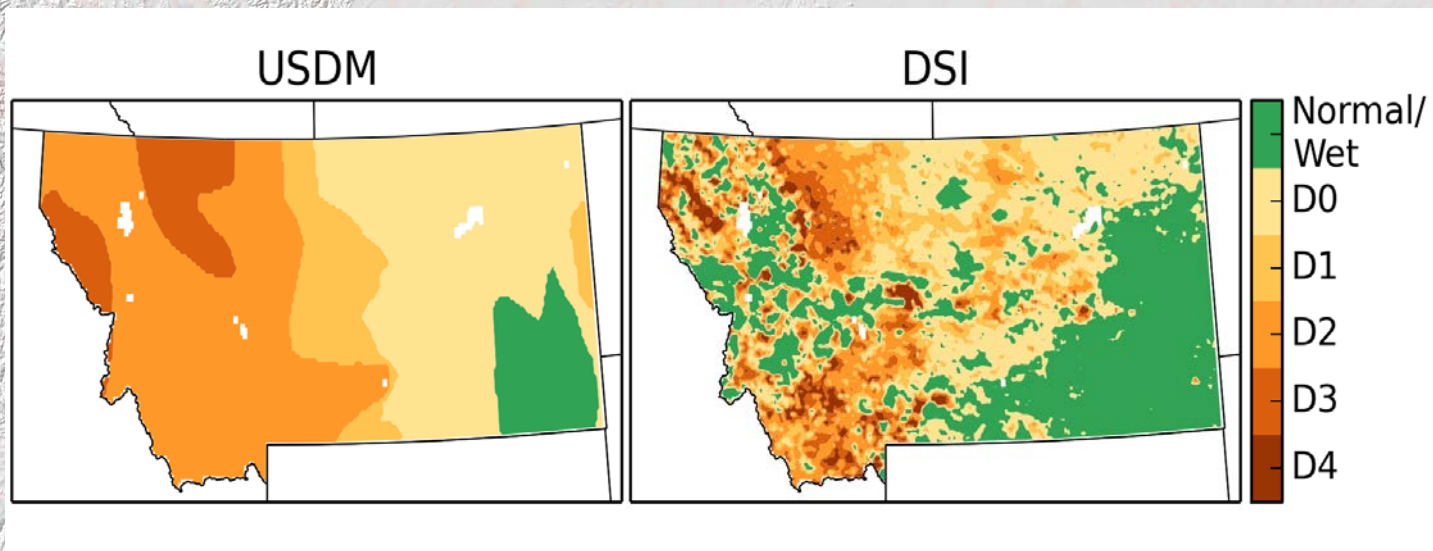


Characterization of croplands between different time periods.

# SATELLITE MEASURES OF EVAPOTRANSPIRATION

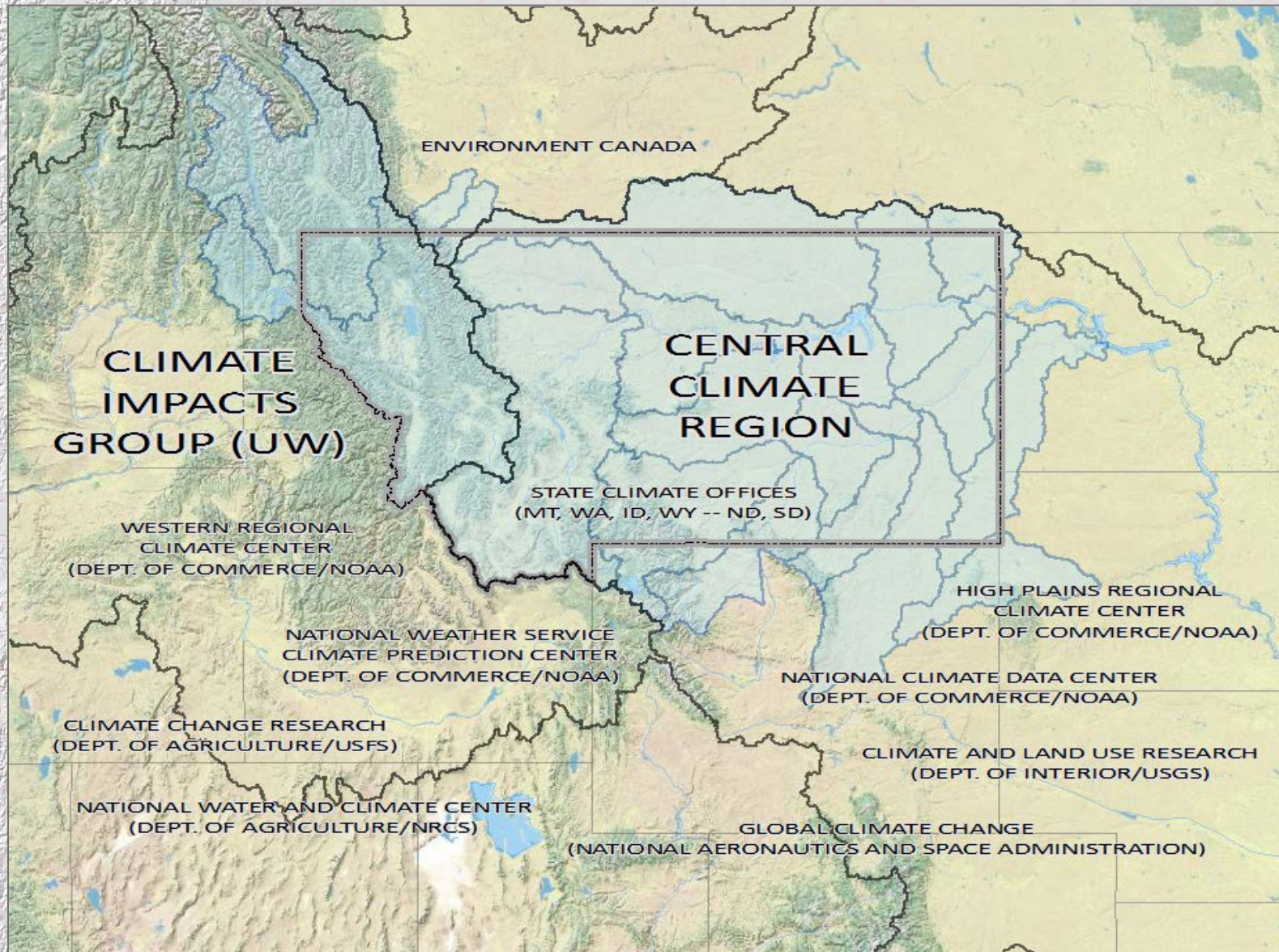


# SATELLITE MEASURES OF DROUGHT SEVERITY





# MONTANA AT THE HEADWATERS



"Coordinated"

# Montana Climate Office

Home Data and Products Working On Extras About Contacts

## Climate by Use

**About the Montana Climate Office**  
The Montana Climate Office has been an entity within Montana since the mid-1970's. In 2006 Governor Schweitzer designated the Montana Climate Office as the official state climate office.

**Satellite data published**  
The Montana Climate Office has published greenness, enhanced greenness, evapotranspiration, and potential evapotranspiration for the years 2000 to present.

**Climate station data published**  
The Montana Climate Office has published daily climate records for over four thousand climate stations covering Montana and surrounding areas.

Montana Climate Office

Access through MCO website, and published through the Montana State Library portal

MONTANA.GOV  
OFFICIAL STATE WEBSITE

SERVICES AGENCIES LOGIN SEARCH

### Geographic Information


Providing Montana a sense of place

MSDI Data Geography Web Changes

Home > Data > Montana Spatial Data Infrastructure (MSDI)

#### Montana Spatial Data Infrastructure (MSDI)

**A message from Dr. Kelsey Jencso, State Climatologist**



"Welcome to the Montana Climate Office. We are excited about the opportunity to work with fellow Montanans to advance our collective understanding of climate variability and how it impacts the resources and industries we care about. By understanding climate variability, uncertainty, and leveraging existing information we can work together to build the knowledge and resilience necessary to sustain Montanan's livelihoods into the future."

Verizon 8:54 AM 94%

Weather The difference given place req Weather is the cloudiness, vis of variability an changes in our

**GHCN daily station inventory: BLACKLEAF**

**Station identifier**  
USC00240877

**Station name**  
BLACKLEAF

**Link to more info**  
<http://mco.cfc.umt.edu/gcnc/station/USC00240877.html>

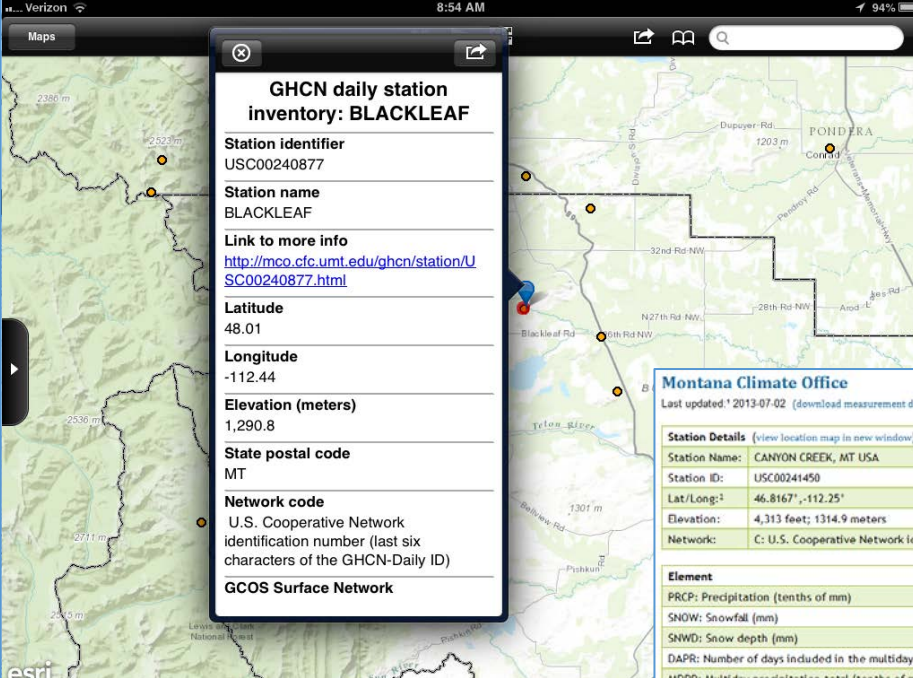
**Latitude**  
48.01

**Longitude**  
-112.44

**Elevation (meters)**  
1,290.8

**State postal code**  
MT

**Network code**  
U.S. Cooperative Network identification number (last six characters of the GHCN-Daily ID)  
GCOS Surface Network



Access via mobile devices

"Distributed"

Access via direct download or through web services

**Montana Climate Office**  
Last updated: 2013-07-02 (download measurement data for this station in CSV format)

**Station Details** (view location map in new window)

Station Name: CANYON CREEK, MT USA  
 Station ID: USC00241450  
 Lat/Long: 46.8167°N, -112.25°W  
 Elevation: 4,313 feet; 1314.9 meters  
 Network: C: U.S. Cooperative Network identification number (last six characters of the GHCN-Daily ID)

Element	Start	End	Years	Observations	Coverage <sup>1</sup>
PRCP: Precipitation (tenths of mm)	1907	1979	72	12,129	46%
SNOW: Snowfall (mm)	1907	1979	72	9,481	36%
SNWD: Snow depth (mm)	1907	1978	71	8,530	33%
DAPR: Number of days included in the multiday precipitation total (MDPR)	1959	1978	19	5	0%
MDPR: Multiday precipitation total (tenths of mm and use with DAPR and DWPR if available)	1959	1978	19	5	0%
WT01: Weather Type fog or ice fog or freezing fog (may include heavy fog)	1950	1960	10	5	0%
WT03: Weather Type thunder	1948	1968	20	227	3%
WT04: Weather Type ice pellets or sleet or snow pellets or small hail	1949	1964	15	15	0%
WT05: Weather Type hail (may include small hail)	1951	1964	13	8	0%
WT06: Weather Type glaze or rime	1948	1953	5	4	0%
WT08: Weather Type smoke or haze	1949	1949	0	0	0%
WT09: Weather Type blowing or drifting snow	1949	1950	1	40	6%
WT11: Weather Type high or damaging winds	1948	1957	9	128	4%
WT14: Weather Type drizzle	1948	1951	3	14	1%

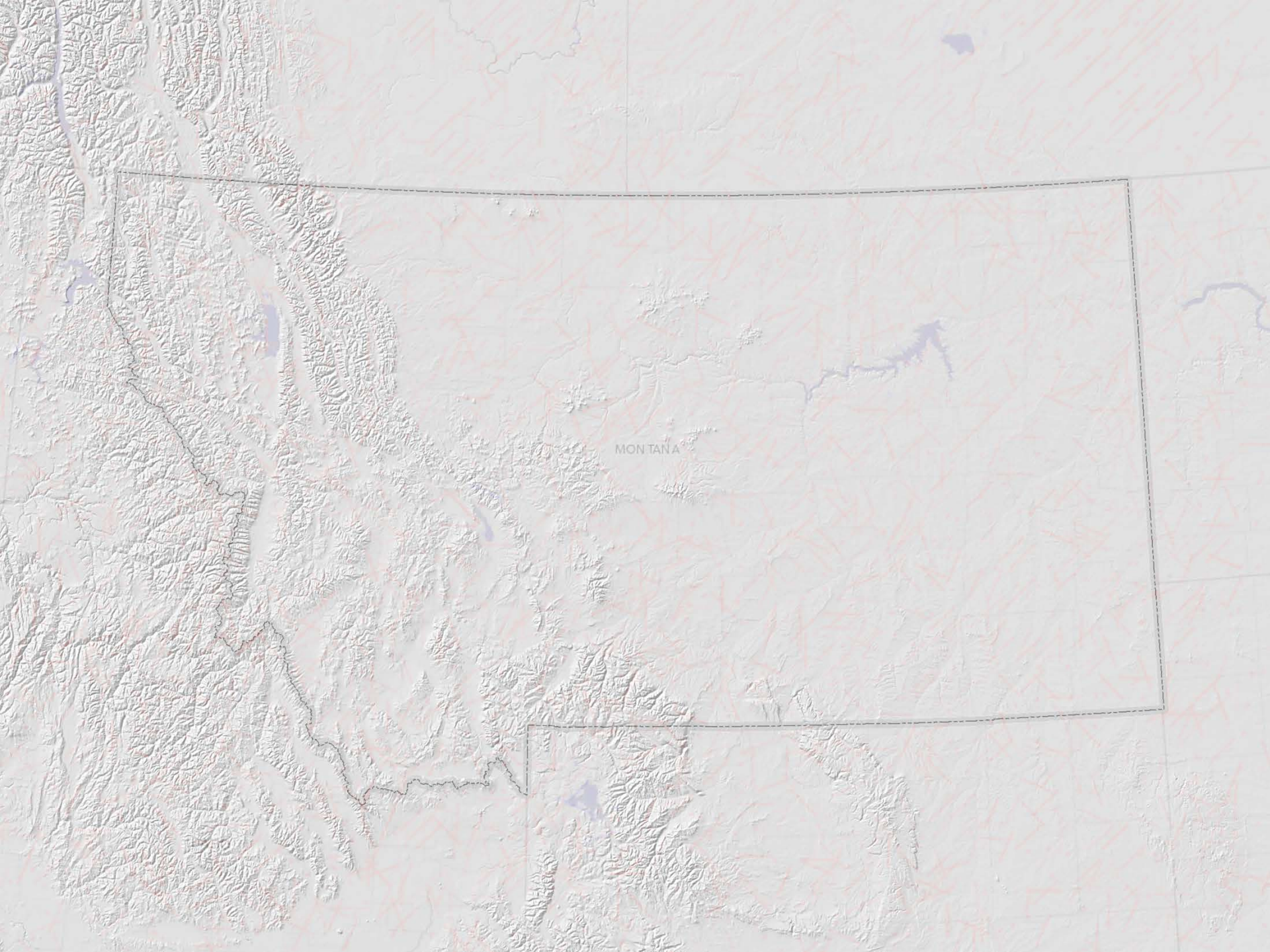
Additional information for this site is available at the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC)

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# MONTANA CLIMATE OFFICE

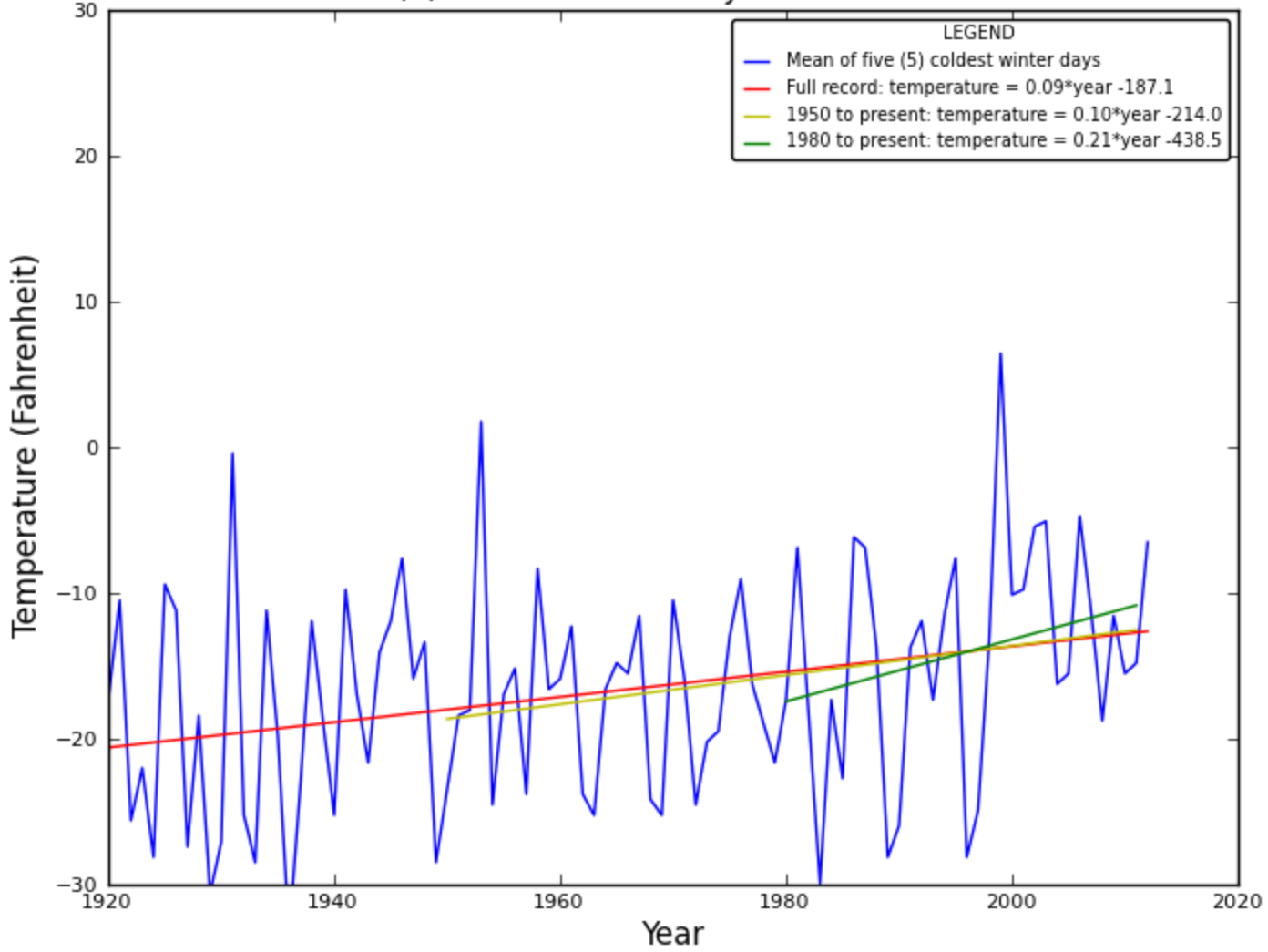
[www.climate.umt.edu](http://www.climate.umt.edu)

Montana Climate Office  
Montana University System  
University of Montana



MONTANA

# Mean of Five (5) Coldest Winter Days for Station USC00240802



Billings, Montana

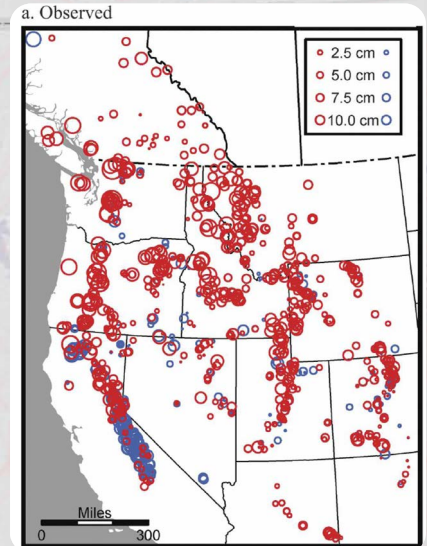
# TRENDS IN SNOWPACK

## The bad news:

- Overall decreases in regional snowpack
- Earlier snowmelt

## The good news:

- Increase in later spring precipitation has likely helped buffer some of the decreases in snowpack
- A decadal shift in large-scale Pacific climate variability around 1976-1984 may account for 30%-50% of:
  - Western North America springtime warming
  - Decreasing winter precipitation in the N.Rockies



Mote, P. (2006) Journal of Climate.