Climate Monitoring, Climate Research, and Climate Services for Colorado

Russ Schumacher
Colorado State Climatologist
Colorado Climate Center
Department of Atmospheric Science, Colorado State University

Along with: Becky Bolinger, Noah Newman, Zach Schwalbe, Julian Turner, Peter Goble, Henry Reges, Dani Talmadge, and Nolan Doesken
Brief history of the CCC

• Until 1973, the federal government operated a “state climatologist” program – but in 1973 this was abolished

• Later that same year, Colorado established the Colorado Climate Center at CSU with support through the Colorado Agricultural Experiment Station
Previous state climatologists

Tom McKee, 1974-2000
Nolan Doesken, 2006-2017
(Assistant State Climatologist, 1977-2006)
Roger Pielke, Sr, 2000-2006
Annual average precipitation

Data: PRISM climate group
prism.oregonstate.edu
Colorado’s weather and climate extremes

High Park Fire, June 2012 (from the dept)

“Great Colorado Flood of September 2013”

Nederland, March 2003
From Wesley et al. (2013)

Otero County, May 2018

Fountain, August 2018
Photo from Jennifer Stark, NWS Pueblo

https://twitter.com/ViaeroWXCams/status/1009168644415328258

Photo courtesy of Noel Bryan
Analyzing climate data: both useful and fun!

Month of maximum average precip
Data: PRISM Climate Group, prism.oregonstate.edu

Figure: Russ Schumacher/Colorado Climate Center
Data: PRISM climate group (prism.oregonstate.edu)
Fort Collins, CO
68.5°F
Last Updated on September 16, 15:40 PM MDT

Weather Conditions

Colorado Springs Gaetn interviewed Russ Schumacher to learn more about the recent hot weather and how it's contributing to drought conditions.

Most weather signs are pointing to an El Niño weather pattern this fall and winter.

September 17, 2016

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Record-breaking heat, dry weather increase fire danger, worsen drought conditions across Colorado

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Colorado Climate Ce...
Our mission

The Colorado Climate Center at CSU provides valuable climate expertise to the residents of the state through its threefold program of:

1) **Climate Monitoring** (data acquisition, analysis, and archiving)
2) **Climate Research**
3) **Climate Services** (providing data, analysis, climate expertise, education and outreach)
A small selection of our partners and stakeholders
Our primary activities

• Drought monitoring and early warning
• Community Collaborative Rain, Hail, and Snow network (CoCoRaHS)
• The Colorado Agricultural Meteorological Network (CoAgMET, “Colorado’s Mesonet”)
• Other CCC projects and activities
National Integrated Drought Information System
*Intermountain West Drought Early Warning System*

Becky Bolinger, Assistant State Climatologist

Peter Goble, Climatologist and drought specialist
Implementation of weekly monitoring operations in 2010 led to more timely detection of the 2012 drought.

Yes! Drought can happen in the winter!!

improved monitoring = improved drought depiction
improved monitoring = improved drought depiction
Weekly Drought Monitoring
climate.colostate.edu/~drought

- Conditions
  - Precipitation, snow
  - Evaporative Demand
  - Streams, soils, vegetation

- Impacts Reports
- Outlooks
- Recommendation to USDN

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Summary: February 26, 2019

We've reached the point in our orbit where days begin to last noticeably longer, and temperatures start slowly but surely to tick upward. That said, winter 2019 will not be going anywhere without a fight. The entire western United States saw below average temperatures over the past week. The Intermountain West was anywhere from five degrees below normal in the central Colorado Rockies to 25 degrees below normal east of the Bighorns in Wyoming.

Some parts of the Intermountain West (IMW) received major snowfall too. Payson, AZ recorded 31.8” of snow in 48 hours. Totals in the Colorado San Juans were impressive. CoCoRaHS stations in the Durango area recorded as much as 23” in 24 hours. The Wolf Creek Ski area recorded 86” of snowfall in a seven-day period. That's an average of over one foot/day. While these are extreme examples, Pacific Moisture did grace a large portion of the region.
San Miguel, Dolores, Animas & San Juan River Basins Time Series Snowpack Summary

Based on Provisional SNOTEL data as of Feb 28, 2019

Current as Pct of Normal: 123%
Current as Pct of Avg: 118%
Current as Pct of Last Year: 223%
Current as Pct of Peak: 99%
Normal as Pct of Peak: 81%
Pct of Normal Needed to Reach Peak: 3%
Normal Peak Date: Apr 06

Snow Water Equivalent (inches)

Oct 01  Nov 01  Dec 01  Jan 01  Feb 01  Mar 01  Apr 01  May 01  Jun 01  Jul 01  Aug 01  Sep 01

Median  WY2016  WY2017  WY2018  Average  WY2019
Ground validation of the Evaporative Demand Drought Index (EDDI) product using CoAgMET data.
Our Current NIDIS Objectives

✓ enhancing engagement and interaction
✓ communication and dissemination
✓ value added information and products
enhancing engagement and interaction

works for Durango-Silverton Railroad (suspected cause of the 416 Fire)

Soliciting Condition Monitoring reports from CoCoRaHS observers in D2 counties

one week later

Rizza,John
To: Bolinger, Becky
Re: Conditions in west and southwest CO

February 20, 2018 at 4:48 PM

I think this is a good approach, plan for the worst and hope for the best rather than be behind the eight ball.

Thank you for your efforts. Maybe this is a good time to revisit the conversation about the short webinars directed towards producers? I can follow up on that email from the other week and Maybe we can set something up for a week or two away?

working with CSU Extension to keep engaged with the ag community
communication and dissemination

webinars and videos

Ranching in Drought
A Workshop by USDA & CSU Extension Range School

Thursday, August 9th
10 am - 3 pm, lunch provided!
Otero Junior College
Student Center (Rm 116), 1802 Colorado Ave, La Junta, CO

- Discuss drought issues & ideas with other ranchers from the area
- Latest weather & climate outlooks
- Flexible grazing strategies
- Animal health concerns in drought
- Drought assistance programs
- Drought planning & goal-setting

social media

promotional materials

website updates

media interviews

COLORADO CLIMATE CENTER
value added information and products

What’s the likelihood of staying above normal?

how “important” is each month to the annual contribution of precipitation?
Understanding the relationship between precipitation and evaporation and how the drought responds to water balance.
The Community Collaborative Rain, Hail and Snow Network

https://www.cocorahs.org
CoCoRaHS headquarters team
CoCoRaHS was born in response to the 1997 Fort Collins, Colorado Flood
Simple low-cost measurement tools

- 4-inch diameter High capacity rain gauges
- Aluminum foil-wrapped Styrofoam hail pads
- Snow rulers marked in tenths of an inch
Easy Training

- Written Instructions
- Slide Shows
- Videos and Animations

COLORADO CLIMATE CENTER
Data used by national entities
CoCoRaHS For Schools

• All 50 states
  – Colorado, Florida, Maine Coastal Islands, Hawaii school network, and more

• Connections with Scientists
  – UNC Chapel Hill and schools in Washington isotope analysis

• “Rain Gauge Week” bi-annual campaign

Rockies Weather and Science Day, Coors Field
CoCoRaHS Observation Protocols

- Daily Precipitation
- Multi-day Precipitation
- Hail
- Significant Weather
- Condition Monitoring
- Soil Moisture
- Evapotranspiration
- Frost
- Optics
- Snowflake
- Thunder
- Ice Accretion (Coming 2019?)

https://pmm.nasa.gov/education/sites/default/files/article_images/Water-Cycle-Art2A.png
Precipitation Reports Make Up the Bulk of the Observations
Significant Weather and Hail Reports are sent to the NWS in Real-time.
Observation Protocols Used in Drought Monitoring
Mobile Apps

Android and iOS apps currently support entry and editing of daily and multi-day precipitation observations with more observation types and features to come.
Viewing the Data
Water Year Summary Reports
Growth in the Network
Daily Precipitation Observations for July 1st 1998
Daily Precipitation Observations for July 1st 2000

[Map image showing precipitation levels across the USA on July 1, 2000]
Daily Precipitation Observations for July 1\textsuperscript{st} 2002
Daily Precipitation Observations for July 1st 2004
Daily Precipitation Observations for July 1st 2005
Daily Precipitation Observations for July 1st 2006
Daily Precipitation Observations for July 1st 2008
Daily Precipitation Observations for July 1\textsuperscript{st} 2009
Daily Precipitation Observations for July 1st 2010
Daily Precipitation Observations for July 1st 2011
Daily Precipitation Observations for July 1st 2012
Daily Precipitation Observations for July 1\textsuperscript{st} 2013
Daily Precipitation Observations for July 1\textsuperscript{st} 2014

[Map showing daily precipitation observations across the USA for July 1\textsuperscript{st} 2014]
Daily Precipitation Observations for July 1st 2015
Daily Precipitation Observations for July 1st 2016
Daily Precipitation Observations for July 1\textsuperscript{st} 2018
Number of Daily Precip Obs and Active Stations by Month with the Running Daily Precip Archive Count

- Number of Daily Precip Obs
- Number of Active Stations
- Total Daily Precip Obs Count
Condition Monitoring
My Data Entry: Condition Monitoring Report Form

Condition Monitoring Report Form
Station Number: CO-LR-687
Station Name: Fort Collins 3.8 SSW

Condition monitoring reports are submitted on a regular (weekly, biweekly, monthly) basis to share information about the effects of local precipitation on the environment and society. By submitting reports on a regular basis, you create a baseline to see change through time, such as seasonal differences or changes caused by more or less precipitation. Please refer to the Condition Monitoring training slide show for more information.
* indicates required field

Report Date: 9/25/2018

Condition Scale Bar
- More information on the scale bar
- Clear Scale Bar

Severity
- Dry
- Moderately Dry
- Mildly Dry
- Near Normal
- Mildly Wet
- Moderately Wet
- Severely Wet

Description
Please provide a description of how dry, normal or wet conditions are affecting you, your livelihood, your activities, etc.

Report Categories
- General Awareness
- Agriculture
- Business & Industry
- Energy
- Fire
- Plants & Wildlife
- Relief, Response & Restrictions
- Society & Public Health
- Tourism & Recreation
- Water Supply & Quality

Submit Data Reset

Condition Monitoring Summary Report

Filter Condition Monitoring Data
- By Location:
  - United States
  - North Carolina
  - Entire State
- By Station Field:
  - Station Number or Name
  - Station Number
  - Station Name

About the summary
The summary charts display information provided in condition monitoring reports to document changing on-the-ground conditions that are affected by precipitation, or a lack thereof. The data in the charts represent observers' scale bar and condition monitoring category selections.

Location: North Carolina, United States
Station: Any Station
Period of Record: From the week starting on Oct 11, 2016 through the week ending on Oct 01, 2018

Generate Report

Submit Data Reset
Hope Mills 6.3 SE

Station Number: NC-CM-42

Report: With the 20+" of rain we received with Florence, it is severely wet. My house had a lake about 1 ft. deep around it on Sunday. None entered the house and garage thankfully. Rivers and creeks are still high and some are above flood stage.

Condition: Severely Wet

Date: 2018-09-20T00:00:00Z

Summary Data: CoCoRaHS summary data by week for this station.
Overview of CoCoRaHS Mapping Requirements

- Ability to map tens of thousands of data points without crashing the browser
- Make every data point interactive
- Ability to provide maps for the entire CoCoRaHS archive of over 40 million daily precip observations
- Provide accumulation maps over entire archive of daily and multi-day observations for dynamic (user-defined) date ranges
- Ability to map the observer contributed data in near real-time
- Support for a multitude of stakeholder filtering and visualization requirements
Prototype Solution is a custom Angular App that utilizes Carto mapping services via their SQLAPI and Mapping API.
CoCoRaHS Observations of Hurricane Harvey
CoCoRaHS Observations of Hurricane Maria
What you don’t see
CoCoRaHS Cyber-Infrastructure Data Flow Context

Data Aggregators that Incorporate CoCoRaHS Data
- Global Historical Climatology Network (GHCN)
- Applied Climate Information System (ACIS)
- Meteorological Assimilation Data Ingest System (MADIS)

Institutional Data Users
- NWS
- NASA GPM
- National Operational Hydrologic Remote Sensing Center (NOHRSC)

Precipitation Networks Aggregated by CoCoRaHS
- CHARM
- RiverWatch
- NERain

CoCoRaHS Staff, Volunteers, and the Public
- CoCoRaHS Staff
- CoCoRaHS Coordinators
- Observers
- Public

Android and iOS Apps
- SignificantlyWx & Hail Observations

DATA Aggregators that Incorporate CoCoRaHS Data
- CoCoRaHS Staff
- Volunteers
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Institutional Data Users
- NWS
- NASA GPM
- NOAA

Private Companies
- Municipal Governments
- Universities

CoCoRaHS Cyber-Infrastructure

Bulk data access:
- bulk.cocorahs.org
- year-to-date/nightly
- entire-archive/weekly

SignificantlyWx & Hail Observations
- significantwx.com
- Hail Observations

Manage observations
- Manage stations & observers

Get observer data
- Import CoCoRaHS observations into RiverWatch

Submit observations
- Android and iOS Apps

SignificantlyWx & Hail Observations
- significantwx.com

NASA GPM
- Global Precipitation Measurement mission

River Forecast Centers
- River Forecast Centers

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Private Companies
- Municipal Governments
- Universities

Applied Climate Information System (ACIS)

Meteorological Assimilation Data Ingest System (MADIS)
- MADIS

Import CHARM stations & observations
- Import CoCoRaHS observations into RiverWatch
- Import RiverWatch stations & observations
- Import NERain stations & observations

Manage stations & observers
- Manage stations & observers

QC Data
- Manage data & maps

View data & maps
- View data & maps

Data Aggregators that Incorporate CoCoRaHS Data
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Private Companies
- Municipal Governments
- Universities

Get observer data
- Import CoCoRaHS observations into RiverWatch

SignificantlyWx & Hail Observations
- significantwx.com
- Hail Observations
Why use the data
Canadian Regional Deterministic Precipitation Analysis System (CaP A-RDPA RDPA)

- Product of Environment and Climate Change Canada
- Is a regional deterministic precipitation analysis system that provides objective estimates of precipitation amounts for a specific domain by combining readings from precipitation gauges, radar and a trial field generated from RDPS -V6
- As of September 18, 2018 is incorporating CoCoRaHS data into the analysis after testing its impact on the data product
- “The addition of the CoCoRaHS network combined with the change in trial field brings value to the 24-hour analysis in summer across the entire CaPA domain. It is clearly seen by the gain in skill.”

From CAPA-RDPA_4_5_0_Tech_note_e.pdf
Inter-comparison of gauge data quality
National Severe Storms Laboratory - Jian Zhang, Steve Martinaitis, Micheal Simpson

Gauge data in MRMS

- **MADIS**
  - Hourly
  - Contains many networks including ASOS, Mesowest, DOT, etc.
  - 
    ~15,000 each hour at the top of the hour (+/- 4min)
    - ~1,000 after QC
  - Used in MRMS local gauge corrected QPE and Mountain Mapper

- **CoCoRaHS**
  - Daily
  - ~13,000 at the top of the hour (+/-15min)
  - 450 (102) +2800 (112) +3700 (122)+2500 (132)+2000 (142) +1000 (152) +350 (162) +60 (172)
  - Not used in any MRMS products
  - For evaluations only

- **CRN**
  - Hourly
  - ~150
  - Considered the most reliable rain gauges
  - Included in MADIS (different ID, slightly different lat/ion and amounts due to truncation errors?)

Intercomparison of gauge data

- Using CRN as reference to assess the quality of MADIS and CoCoRaHS data

- Criteria for “co-located” CRN-CoCo (MADIS) gauges: 3km radius

- CRN vs. CoCoRaHS: Jan 2017 – Jul 2018
  - Warm season: Apr – Oct 2017, Apr-Jul 2018

- CRN vs. MADIS: Sep 2017 – Jul 2018
  - Cool season: Nov – Dec 2017, Jan – Mar 2018,
  - Warm season: Sep – Oct 2017, Apr-Jul 2018
CRN vs. CoCoRaHS and MADIS gauges

- CoCo matches CRN much better than does MADIS.
- MADIS amounts are often lower than CRN indicating undercatch issue?
- Abnormal high amounts in MADIS indicating malfunctioned sites?
CRN vs. CoCoRaHS and MADIS gauges: enlarged view

- CoCo matches CRN much better than does MADIS
- MADIS amounts are often lower than CRN indicating undercatch issue?
- A few outliers in warm season CRN-CoCo pairs (see arrows) are investigated further (next slide)
Four CoCo vs. CRN data pairs with large differences were analyzed, and all were real and attributed to large precipitation gradients between the gauge pairs.

<table>
<thead>
<tr>
<th>Date-hr</th>
<th>CRN</th>
<th>CoCo</th>
<th>Lat/Ion</th>
<th>remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>170607-12</td>
<td>2.19</td>
<td>0.11</td>
<td>94078 42.6800 -108.6700</td>
<td>radar QPE@CRN: 1.2in</td>
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<td></td>
<td></td>
<td>WY-FM-39 42.70168 -108.67567</td>
<td>radar QPE@CoCo: 0.13in</td>
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<tr>
<td>170607-12</td>
<td>1.2</td>
<td>3.44</td>
<td>63869 30.5500 -87.8800</td>
<td>Radar QPE @CRN: 1.63in</td>
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<td>AL-BW-13 30.56674 -87.90053</td>
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<tr>
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<td>0.42</td>
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<td>63869 30.5500 -87.8800</td>
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<td></td>
<td></td>
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<td></td>
<td>AL-BW-13 30.56674 -87.90053</td>
<td>radar QPE @CoCo: 2.8in</td>
</tr>
</tbody>
</table>
The CoAgMET Network

Zach Schwalbe
CoAgMET Manager
zach.schwalbe@colostate.edu
970-491-8140
CoAgMET = Colorado Agricultural Meteorological Network

also known as “Colorado’s Mesonet”
History

► In the early 1990’s, CSU extension plant pathologists and ARS scientists decided to collaborate efforts to collect detailed agricultural weather data.

► Standard instruments and data collection platform were selected and a small network of stations were deployed in fully irrigated agriculture.

► As the network grew, the Colorado Climate Center became increasingly interested in using the data, began daily data collection, quality control and built a web interface to distribute data and products to users across the state.
Colorado Climate Center’s role

► Coordination, data management, web support

► We hosted annual meetings of key partners and data users – set priorities, secure commitments, prepare proposals (rarely funded but we persisted)

► We now run the network including station maintenance, product development, funding, etc.
Overview of CoAgMET Network

► Currently there are 85 stations

► Data are collected hourly, daily and 60 stations with 5-minute data

► Data include: temperature, humidity, solar radiation, wind speed and direction, and soil temperatures.
Anemometer and wind vane: Wind speed, direction and gusts

Pyranometer: Solar radiation

Tipping bucket rain gage

Soil temperatures

2 and 6 inches below ground

2 m

Solar panel powers the station when the sun shines

Temperature/Humidity sensor in radiation shield

Above all else facing South

Data logger

About the stations
Why these measurements?

► The main goal of CoAgMET is to calculate evapotranspiration (ET) from meteorological measurements.

► The standard CoAgMET station collects the elements needed to calculate evapotranspiration.

► These are also very important data for real-time weather monitoring.
CoAgMET web access:
http://coagmet.colostate.edu/
Data are free and available to the public
| Sta | Mon | Day | Tmax | Tmin | Vapor | Solar | Prec | Wind Gust | Wind Run | Soil Temp | Min | Grow | P-Kim | ASCE E | HLY ET |
|-----|-----|-----|------|------|-------|-------|------|----------|----------|-----------|-----|------|-------|--------|--------|------|
| akr02 | 7   | 1   | 73.1 | 59.7 | 17.75 | 248   | 0.64 | **229**  | **66.2**  | 1270      | 0.161 | 0.123 |
| alt01 | 7   | 1   | 78.5 | 60.4 | 17.62 | 391   | 0.04 | 27.9     | 127      | 70.0      | 49.0 | 1157  | 0.193 | 0.162  |
| avn01 | 7   | 1   | 81.8 | 62.6 | 19.95 | 345   | 0.05 | 18.3     | 51       | 70.6      | 51.5 | 1510  | 0.163 | 0.132  |
| bld01 | 7   | 1   | 74.4 | 55.5 | 12.93 | 373   | 0.00 | 30.4     | 117      | 62.1      | 36.3 | 957   | 0.196 | 0.168  |
| bnv01 | 7   | 1   | 69.4 | 52.1 | 13.14 | 264   | 0.05 | 17.3     | 66       | 56.0      | 44.4 | 882   | 0.120 | 0.107  |
| brg01 | 7   | 1   | 80.6 | 58.2 | 18.83 | 336   | 0.14 | 22.7     | 162      | 68.0      | 52.1 | 1243  | 0.200 | 0.140  |
| brk01 | 7   | 1   | 72.8 | 62.3 | 16.63 | 224   | 0.05 | 13.5     | 58       | 74.2      | 59.9 | 1486  | 0.140 | 0.106  |
| brj02 | 7   | 1   | 72.9 | 61.5 | 20.64 | 298   | 0.07 | 16.2     | 149      | 65.2      | 77.1 | 1342  | 0.131 | 0.103  |
| brj03 | 7   | 2   | 72.2 | 61.5 | 20.18 | 325   | 0.31 | 15.8     | 153      | 67.7      | 78.6 | 1035  | 0.135 | 0.109  |
| cbl01 | 7   | 1   | 68.5 | 57.8 | 17.07 | 251   | 0.01 | 9.7      | 38       | 59.8      | 68.1 | 1044  | 0.102 | 0.091  |
| cckp01| 7   | 1   | 76.9 | 56.4 | 15.70 | 376   | 0.76 | 17.2     | 72       | 64.8      | 49.2 | 997   | 0.166 | 0.140  |
| cnn01 | 7   | 1   | 80.5 | 61.6 | 17.69 | 384   | 0.56 | 24.4     | 68        | 66.9      | 45.0 | 1420  | 0.185 | 0.161  |
| cow01 | 7   | 1   | 69.5 | 50.0 | 12.71 | 415   | 0.00 | 17.2     | 49        | 60.5      | 43.0 | 589   | 0.148 | 0.149  |
| cto01 | 7   | 1   | 71.1 | 52.5 | 13.83 | 326   | 0.36 | 14.7     | 55       | 60.7      | 59.7 | 887   | 0.135 | 0.114  |
| cto02 | 7   | 1   | 73.9 | 53.4 | 13.60 | 378   | 0.12 | 21.0     | 94       | 67.1      | 43.2 | 943   | 0.171 | 0.145  |
| ctz01 | 7   | 1   | 68.3 | 59.3 | 15.91 | 198   | 0.09 | 10.1     | 50       | 65.7      | 59.9 | 1261  | 0.111 | 0.081  |
| clt01 | 7   | 1   | 72.4 | 60.5 | 16.78 | 262   | 0.09 | 10.1     | 55       | 64.1      | 59.3 | 1400  | 0.132 | 0.106  |
| dvc01 | 7   | 1   | 67.9 | 55.9 | 14.93 | 226   | 0.09 | 13.3     | 79       | 66.7      | 60.8 | 981   | 0.126 | 0.093  |
| eac01 | 7   | 1   | 75.5 | 57.6 | 17.92 | 351   | 1.08 | 32.7     | 237      | 64.1      | 61.7 | 1250  | 0.198 | 0.138  |
| ekt01 | 7   | 1  | 71.2 | 60.0 | 16.75 | 243   | 0.08 | 10.5     | 35       | 63.0      | 56.0 | 1241  | 0.121 | 0.097  |
| fmt02 | 7   | 1  | 72.6 | 61.3 | 18.92 | 223   | 0.07 | 11.7     | 78       | 67.1      | 63.3 | 812   | 0.094 | 0.099  |
| ftc01 | 7   | 1  | 76.4 | 58.9 | 17.84 | 294   | 0.02 | 12.2     | 42       | 66.0      | 58.7 | 1087  | 0.130 | 0.112  |
| ftc03 | 7   | 1  | 76.7 | 59.3 | 17.54 | 247   | 0.02 | 15.1     | 102      | 68.7      | 57.4 | 1126  | 0.138 | 0.111  |
| ftt01 | 7   | 1  | 79.6 | 60.9 | 17.27 | 411   | 0.02 | 23.5     | 92       | 70.6      | 41.0 | 1176  | 0.198 | 0.176  |
| tbl01 | 7   | 1  | 82.3 | 63.9 | 18.78 | 341   | 0.20 | 15.2     | 55       | 76.1      | 47.0 | 1526  | 0.191 | 0.156  |
| gly04 | 7   | 1  | 80.6 | 60.5 | 18.19 | 415   | 0.20 | 17.8     | 111      | 69.2      | 47.6 | 1191  | 0.201 | 0.167  |
Daily data for a month

<table>
<thead>
<tr>
<th>Station</th>
<th>Mon</th>
<th>Day</th>
<th>Temp</th>
<th>Temp</th>
<th>Vapor</th>
<th>Solar</th>
<th>Prec</th>
<th>Wind Gust</th>
<th>Wind Run</th>
<th>Soil Temp</th>
<th>Min</th>
<th>Grow</th>
<th>P-Kim</th>
<th>ASCE</th>
<th>ET</th>
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Five minute data
Hourly Data


Soil Temperatures

Can you see the difference between when the ground was snow covered and when it was free of snow?
EVAPOTRANSPIRATION DATA
CoAgMET Homepage

News

- Becky Bollinger has created a 2017 Growing Season Report, giving a nice overview of Evapotranspiration and what factors go into it.
- Our website has a new look! We hope you find it enjoyable and easier to navigate.
- A growing number of stations have 5 minute data available. You can view plots or read tabular data. In addition, our web services provide a machine-readable form of the data.

Services

- CoAgMET Crop Water Use (ET)
  Page for obtaining crop and turf water use information (Evapotranspiration).
- Evapotranspiration Reports
  ETREs are daily reports for selected stations by region.
- 2017 Growing Season Report
  An interactive web-based report for the 2017 growing season at our 7 long-term CoAgMET sites where we monitor ET accumulations.
- Monthly Summaries
  Interactive access to the daily data set for a particular station and selected months.
- Daily Summaries (all stations)
  Daily summary files are formatted to display selected parameters for all stations.
- Hourly Data Access
  Interactive access to the hourly data set for a particular station and selected days.
- Hourly Data Plots
  Plots of temperature, humidity and wind for all CoAgMET stations.
- Five Minute Data Access
  Interactive access to the five minute data set for a particular station and selected days.
- 5 Minute Data Plots
Select from a number of crop types.

Select Ref ET Model

Reference ET Model
- Penman-Kimberly
- ASCE Standardized (daily data)
- ASCE Standardized (monthly data)

The crop coefficients used to generate crop ET reports were developed for the Penman-Kimberly model. Selection of another model is only appropriate to obtain reference ET.

* Some stations are located in areas that are predominately non-irrigated (dryland) or partially irrigated. Users should be aware that ET values from these sites will typically be higher than values from sites in fully irrigated areas. More site information can be found on the Station Index page.
## CoAgMET Extended Crop Evapotranspiration

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**Location:** Fort Collins AERC  
**Elevation:** 5120  
**Longitude:** 105.1370  
**Latitude:** 40.5947

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### CoagNet/NG/CD Meteorological Data for 8/29/2017

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CoAgMET Homepage

News

- Becky Bollinger has created a 2017 Growing Season Report, giving a nice overview of Evapotranspiration and what factors go into it.
- Our website has a new look! We hope you find it enjoyable and easier to navigate.
- A growing number of stations have 5 minute data available. You can view plots or read tabular data. In addition, our web services provide a machine-readable form of the data.

Services

- CoAgMET Crop Water Use (ET)
  Page for obtaining crop and turf water use information (Evapotranspiration).
- Evapotranspiration Reports
  ETaR is a daily report for selected stations by region.
- 2017 Growing Season Report
  An interactive web-based report for the 2017 growing season at our 7 long-term CoAgMET sites where we monitor ET accumulations.
- Monthly Summaries
  Interactive access to the daily data set for a particular station and selected months.
- Daily Summaries (all stations)
  Daily summary files are formatted to display selected parameters for all stations.
- Hourly Data Access
  Interactive access to the hourly data set for a particular station and selected days.
- Hourly Data Plots
  Plots of temperature, humidity and wind for all CoAgMET stations.
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CoAgMET Homepage  http://coagmet.colostate.edu/

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Real-time data

Fort Collins AERC
Station ID: FTC01
Lat: 40.5947 Lon: -105.1370 Elev: 5120 ft

Latest | Historical | Photos

48°F
30°F

0.00 in
0.56 kPa
49%
9.7 kJ/m²
5.4 mph

Updated February 28th, 2019, 4:05 pm
Maintaining the data

► Our goal is to visit each station at least once a year to make sure the station is operating properly.
  ▪ Sensor are swapped out once every 2 years.
  ▪ Emergency visits to stations when there is a problem with the station causing bad data or an interruption of data.

► Data are quality controlled daily to catch data errors and catch issues with stations before it becomes a problem.
CoAgMET web access:

http://coagmet.colostate.edu

Web services are available for downloading data

Zach Schwalbe
CoAgMET Manager
zach.schwalbe@colostate.edu
970-491-8140
The Historic Fort Collins Weather Station

First established in 1872, on the CSU campus since 1879, consistent data since 1889
At current location since 1961

Nolan Doesken discussing the history of the station:
https://www.youtube.com/watch?v=c-Za8TPTvIc
Collaboration with Colorado Wine Industry Development Board
• The largest constraint on wine grape growth in Colorado is plant hardiness
• As the climate warms, more pockets of the state become suitable for an increased quantity and diversity of grapes
• Because of the complexity of western Colorado topography, this involves carefully-placed temperature observations
• Dangerous cold winter and spring nights can produce surprising variation in surface temperature
• In general, the coldest nights occur under synoptic high pressure conditions with near-surface inversions where wind patterns are dominated by cold air drainage
• Odds of avoiding freeze damage increase on hill slopes, and near the mouths of canyons where mixing is continuous
Hazard Mitigation Grant Program

- The Colorado Climate Center lead a FEMA-commissioned study to assess the biggest data collection gaps in the state for emergency weather events
- Top recommendations were radar coverage in SW CO, and rain/stream gage flood alert networks for the cities of Colorado Springs and Pueblo
Thank you!

- We welcome collaboration ideas and opportunities – please don’t hesitate to get in touch!

http://climate.colostate.edu/

Follow us on Facebook and Twitter! @ColoradoClimate