

# User Guide

Version: 2.0

Updated: 8 January 2020

Domain: <https://coagmet.erams.com/coagmet/>

## Colorado Agricultural Meteorological Network (CoAgMet) Application



**CATENA**  
ANALYTICS

**One Water Solutions Institute**

Colorado State University

# CONTENTS

Executive Message.....	2
Who Should Use This Guide.....	2
Need Help? .....	2
Introduction .....	3
Purpose.....	3
Description.....	3
About.....	3
Software Availability .....	4
Authorized Use Permission.....	4
System Requirements .....	4
Using the Tool.....	5
Crop Water Use (ET) .....	5
Evapotranspiration Reports.....	6
Monthly Summaries .....	6
Daily Data & Summaries.....	7
Hourly Data & Plots.....	7
5-minute Data & Plots.....	7
Wind Summary.....	8
Climatic Data .....	8
Appendix.....	9
Understanding Plant Water Use: Evapotranspiration (ET) .....	9
Crop ET coefficients.....	11
Raw Data Access .....	13

## EXECUTIVE MESSAGE

Catena Analytics offers powerful platforms for building accessible and scalable analytical tools and simulation models that can be accessed via desktop or mobile devices. Our team has spent that last decade developing the Environmental Resource Assessment and Management System (eRAMS), an open source technology that provides cloud-based geospatially-enabled software solutions as online services and a platform for collaboration, development, and deployment of online tools. Our services are used to assist with strategic and tactical decision making for sustainable management of land, water and energy resources. Thank you for choosing Catena Analytics and the eRAMS platform to meet your data, modeling, analysis and geospatial needs.

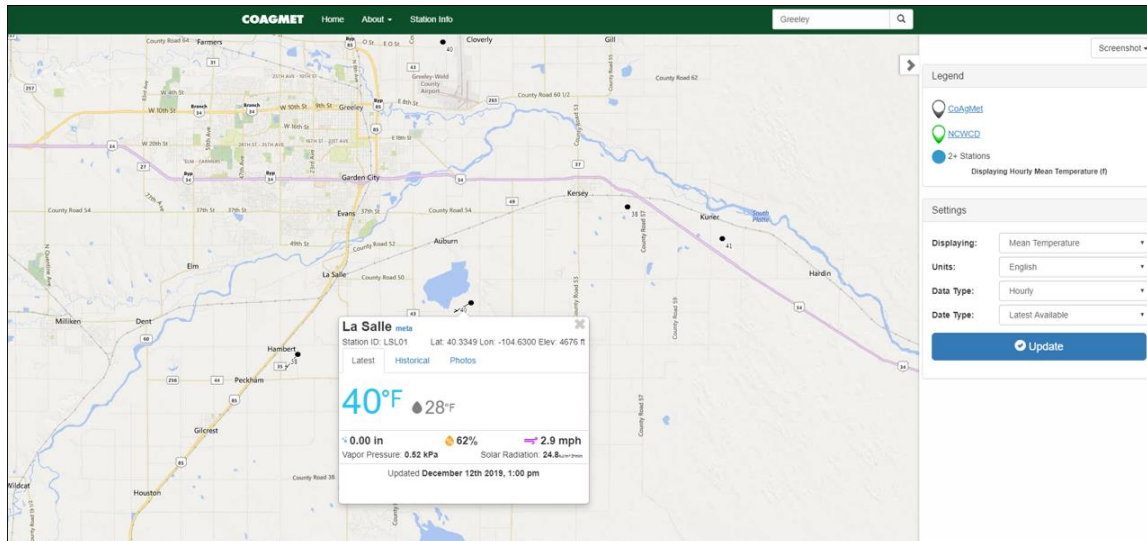
### WHO SHOULD USE THIS GUIDE

This guide is a tutorial to get you started using eRAMS and Colorado Agricultural Meteorological Network Application. The guide provides instructions for commonly performed tasks and uses of the tool. This tool is intended for use by urban planners and water managers, academic groups, regulatory officials, consultants as well as state, local and federal agencies planning for the future of water resources.

### NEED HELP?

After reviewing the guide if you need additional assistance we are here to help! This guide is designed to provide instruction on commonly performed operations and answers to many frequently asked questions. If you find any aspect of the tool challenging or missing information from this guide, please engage an eRAMS expert to guide you through any hurdles. Contact us at: [eramsinfo@gmail.com](mailto:eramsinfo@gmail.com)

# INTRODUCTION



## PURPOSE

This application provides access to a wide variety of Colorado climate station data.

## DESCRIPTION

The [Colorado Agricultural Meteorological Network \(CoAgMet\) Application](#) allows users to access a wide variety of data and information from Colorado’s network of automated weather and environmental monitoring stations including minute and hourly plots, water use and evapotranspiration reports, daily and monthly statistics and summaries as well as direct access to raw data. Services provided by the CoAgMet Application include:

- [Crop Water Use \(ET\)](#)
- [Evapotranspiration Reports](#)
- [2017 Growing Season Report](#)
- [Monthly Summaries](#)
- [Hourly Data Access](#)
- [Raw Data Access](#)
- [Wind Summaries](#)
- [ET Coefficients](#)
- [Other Climatic Data](#)

## ABOUT COAGMET

### COlorado AGricultural Meteorological nETwork — COAGMET

In the early 1990's, two groups on the Colorado State campus, the Plant Pathology extension specialists and USDA's Agricultural Research Service Water Management Unit, discovered that they had a mutual interest in collecting localized weather data in irrigated agricultural area. Plant

### Application

#### User Guide

pathology used the data for prediction of disease outbreaks in high value crops such as onions and potatoes, and ARS used almost the same information to provide irrigation scheduling recommendations.

To leverage their resources, these two formed an informal coalition, and invited others in the ag research community to provide input into the kinds and frequency of measurements that would be most useful to a broad spectrum of agricultural customers. A standardized set of instruments was selected, a standard datalogger program was developed, and a fledgling network of some eight stations was established in major irrigated areas of eastern Colorado. As interest grew and funds were made available, primarily from potential users, more stations were added.

Initially, stations were located near established phone service to allow daily collection of data. Soon, cellular phone service began to become widely available, and the group determined that this methodology was a reliable and inexpensive method of data recovery. Commercial software was used to download data from the growing list of stations shortly after midnight to a USDA-ARS computer, from which it was then distributed to interested users via answering machine, automated FAX and satellite downlink (Data Transmission Network).

As the network grew, Colorado Climate Center at Colorado State became interested in these data, and subsequently took over the daily data collection and quality assessment. CCC added internet delivery and a wide range of data delivery options and continues to improve the user interface in response to a growing interest in these data.

## SOFTWARE AVAILABILITY

### Domain

<https://coagmet.erams.com/coagmet>

### Documentation URL

<https://erams.com/catena/tools/colorado-collaborative/climate-stations/>

## AUTHORIZED USE PERMISSION

The information contained in the [Colorado Agricultural Meteorological Network \(CoAgMet\) Application](#) (the "Service") is for general information purposes only. Colorado State University's One Water Solutions Institute ("CSU-OWSI") assumes no responsibility for errors or omissions in the contents of the Service. In the Service, you agree to hold neither the creators of the software platform nor CSU-OWSI liable for any action resulting from use or misuse of the Service. In no event shall CSU-OWSI be liable for any special, direct, indirect, consequential, or incidental damages or any damages whatsoever, whether in an action of contract, negligence or other sort, arising out of or in connection with the use of the Service or the contents of the Service. CSU-OWSI reserves the right to make additions, deletions, or modification to the contents of the Service at any time without prior notice.

## SYSTEM REQUIREMENTS

## Application

### User Guide

A modern web-browser is required to connect and run this tool. Browser options include: Google Chrome v.69, Mozilla Firefox v.62, Safari v.11.1, and Microsoft Edge v.17.

# USING THE TOOL

Users can interact with the [Colorado Agricultural Meteorological Network \(CoAgMet\) Application](#) in several ways, each of which is described in greater detail below. Each method can be accessed from the corresponding section of the homepage: <http://coagmet.com/>

## CROP WATER USE (ET)

This page provides crop and turf water use information (i.e. evapotranspiration or "ET").

1. Select the desired date for an ET rate report date. This may be either the start date or the end date.
  - a. **Note:** If you only need yesterday's ET rate, you can skip this step because the default date is the previous day.
  - b. ET rates are based upon weather data that logs from 12 midnight to 12 midnight. Therefore, the correct ET rates are not available for a given date until the following day. For example, if today's date is June 10, the most recent ET available would be June 9.
2. Choose the number of days needed for your ET report. CoAgMet will use the date you selected and return ET rates for the number of days selected.
  - a. For example, if you want ET rates for June 1 – 7, 2007; you select June 1, 2010 as the start date and the number 7 in the "# to do" column.
3. Select the weather station(s) that will be used for the ET report. In most cases the nearest weather station (see linked map) is the best choice unless you have specific knowledge that another station is more representative of your area. If your location for ET rate is between two stations, consider using an average of both. To select multiple stations, hold down the control key and click on the stations you are interested in.
4. Click on the desired crop(s) for ET rates.
5. Select the planting date for the crop(s) of interest.
  - a. Be aware that if crop emergence was delayed due to cool weather or other reasons, you may need to adjust the planting date back accordingly.
  - b. For alfalfa, change the green-up date with each new cutting.
6. Select Reference ET Model (Penman-Kimberly recommended)

Application

User Guide

- a. 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.
7. Select results preference, either htm webpage (Figure 1) or CSV file
8. Click Submit
  - a. Bookmark your ET output to avoid having to re-enter your preferred crop(s), station(s) and planting dates.

**Note:** Some stations are located in areas that are predominantly 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.

Station: Durango  
 Location: 11 mi S of Durango  
 Elevation: 6203  
 Longitude: 107.8810  
 Latitude: 37.1125

Crop Evapotranspiration in Inches

Date	Alfalfa	Corn	ETr	ETo	Precip
07/23/2018	0.34	0.29	0.34	0.27	0.17
07/24/2018	0.29	0.26	0.29	0.23	0.00
07/25/2018	0.28	0.25	0.28	0.22	0.00
07/26/2018	0.27	0.24	0.27	0.21	0.00
07/27/2018	0.27	0.24	0.27	0.21	0.10
07/28/2018	0.28	0.26	0.28	0.22	0.00
07/29/2018	0.32	0.29	0.32	0.25	0.00
07/30/2018	0.32	0.30	0.32	0.25	0.00
07/31/2018	0.32	0.30	0.32	0.26	0.00
08/01/2018	0.28	0.26	0.28	0.22	0.00
08/02/2018	0.27	0.26	0.27	0.22	0.00
08/03/2018	0.25	0.23	0.25	0.20	0.01
08/04/2018	0.29	0.27	0.29	0.23	0.00
08/05/2018	0.32	0.31	0.32	0.26	0.00
08/06/2018	0.35	0.34	0.35	0.27	0.00
08/07/2018	0.33	0.32	0.33	0.26	0.00
08/08/2018	0.34	0.33	0.34	0.27	0.00
08/09/2018	0.28	0.27	0.28	0.23	0.00

Figure 1: Extended crop evapotranspiration

EVAPOTRANSPIRATION REPORTS

This page provides regional Evapotranspiration (ET) summaries. These reports contain daily reference 3-day ET average crop-specific ET estimates based on a modified Penman method. They also contain month-to-date precipitation totals and Corn Growing Degree Day totals since March 1st.

1. Select Year (defaults to current date if left unselected), month, day and region
2. Click Submit
3. Review Results (Figure 2)

CoAgMET/NCKCD Meteorological Data for 12/11/2019

	FtColl	ARDEC	HortFm	LovInd	Cherpk	Lngmnt	ChrCrk	
HiTemp	42	45	m	m	52	m	53	degF
LoTemp	14	17	m	m	20	m	26	degF
Precip	0.00	0.00	m	m	0.00	m	0.00	in
P/Month	0.20	0.29	0.00i	m	0.53	0.00i	0.15	in
P/Year	11.84i	11.16	10.27i	0.50i	11.22	10.72i	2.14i	in
WindGst	15.7	18.5	m	m	21.9	m	10.6	mph
Ref ET	0.03	0.03	m	m	0.06	m	0.05	in
ETo	0.03	0.04	m	m	0.07	m	0.06	in
GrowDD	2860	2923	m	m	2698	m	1742	degF
Scm Soil	32.8	30.9	m	m	31.8	m	m	degF

Evapotranspiration data will return next growing season.

Note: Precipitation is measured with a tipping bucket gauge. Many of these gauges are inactive during the winter season and those that remain active will not accurately report snow events.

Figure 2: Regional ET summary

MONTHLY DATA & SUMMARIES

Monthly data and summary reports contain selected meteorological elements for a single CoAgMet station. Enter desired start date, station and required growing degree parameters and click "Submit".

Application

User Guide

DAILY DATA & SUMMARIES

Daily data and summary reports contain selected meteorological elements for all CoAgMet stations on a single day. Enter desired date and click "Submit".

HOURLY DATA & PLOTS

These reports contain hourly meteorological elements for selected CoAgMet station(s) (Figure 3). Enter desired date and click "Submit". Graphical plots of temperature, humidity and wind for all CoAgMET stations are also available by selecting "Hourly Plots" from the home page.

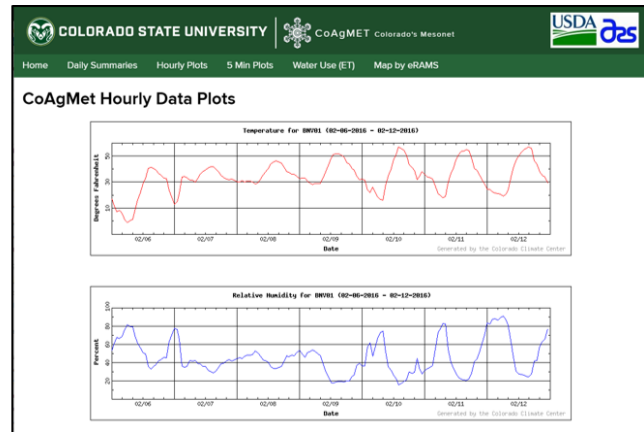
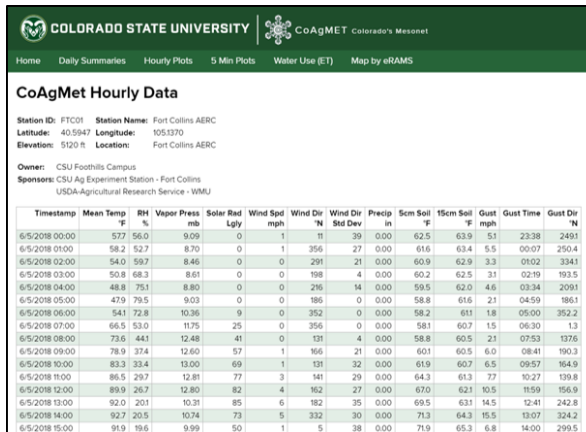


Figure 3: Hourly meteorological data and graphical plots

5-MINUTE DATA & PLOTS

Interactive access to the five-minute data set for a specified station and selected days. Plots of parameters observed at 5-minute intervals are also available (Figure 4).

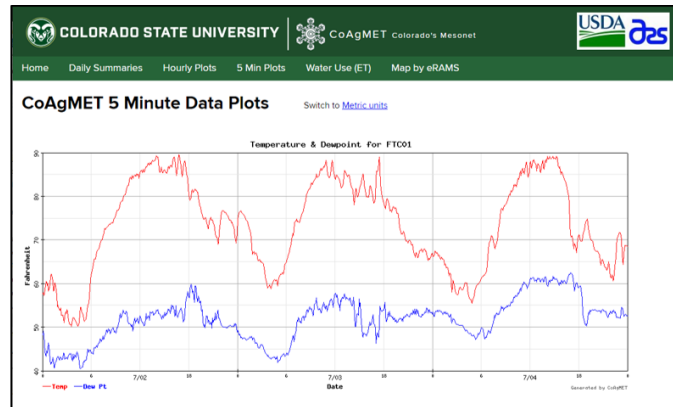
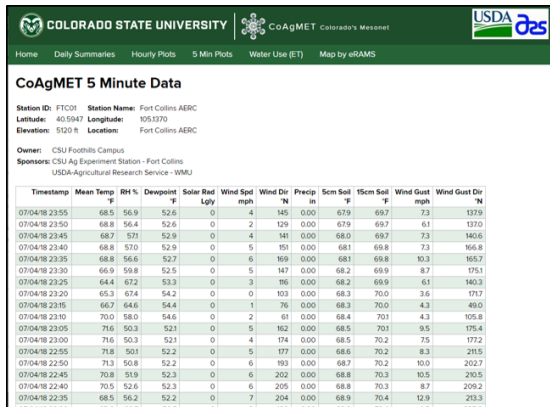


Figure 4: Five-minute data and plots



## WIND SUMMARY

Wind summaries are provided for CoAgMET station(s) by selecting station, report format, tables size and time (Figure 5).

## CLIMATIC DATA

In addition to the information provided by CoAgMet, The Colorado Climate Center maintains a database of historical climatic data for many weather stations throughout Colorado. Learn more by visiting: <http://ccc.atmos.colostate.edu/>

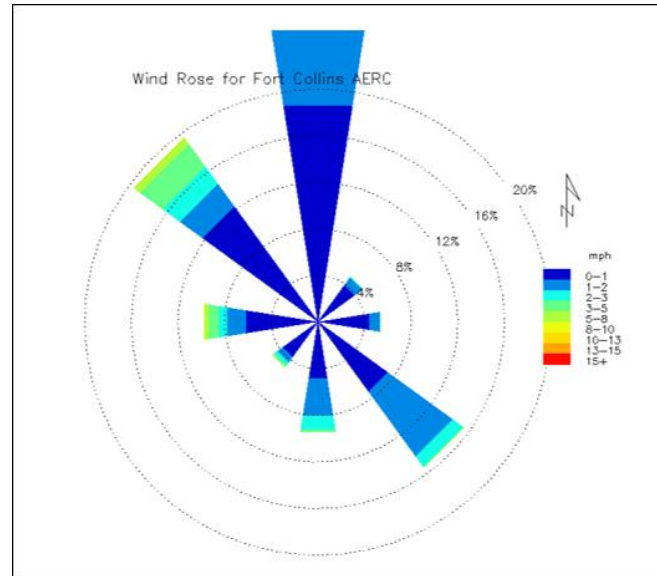


Figure 5: Wind summary

# APPENDIX

## UNDERSTANDING PLANT WATER USE: EVAPOTRANSPIRATION (ET)

### ET Facts

More than 99.9% of the water used by an irrigated crop or turf is drawn through the roots and transpires through the leaves. Only small amount (0.1%) of the water taken up by plants is actually used to produce plant tissue.

The overall amount of ET for a crop or landscape over an entire growing season is about the same as the seasonal water requirement.

Keeping track of ET in your local area can help you more efficiently irrigate your crops and landscapes.

### What is ET?

Evapotranspiration (ET) is a term used to describe the water consumed by plants over a period of time. Evapotranspiration is the water loss occurring from the processes of evaporation and transpiration. Evaporation occurs when water changes to vapor on either soil or plant surfaces. Transpiration refers to the water lost through the leaves of plants.

### How does ET occur?

For irrigated crops and landscapes that provide complete ground cover for most of the growing season, the majority of the seasonal ET is from transpiration. Transpiration losses are usually high and are directly linked to plant growth and productivity. This is because the pathway for transpiration in plants is the same one that allows for plant intake of carbon dioxide. Both exchange processes occur through pores called stomates on the leaf surface. Stomates are fully open when plants receive enough water through the soil and when both transpiration and photosynthesis are occurring at maximum rates. If soil water becomes limiting, stomates begin to close causing a decrease in transpiration and photosynthesis.

### How is ET Estimated?

The most important factors needed to estimate ET are: 1) the local weather conditions and 2) the cropping system for which estimates are needed (type of crop, planting date, crop development).

Local weather conditions are important because ET is driven by weather factors that determine the drying power of the air. We can accurately predict ET losses in a given area from the measurements of four local weather variables:

1. solar radiation
2. temperature
3. humidity
4. wind

**Application**

User Guide

The data from these measurements is then plugged into equations that accurately predict the daily rate of ET for those conditions. These values are called reference ET and refer to the ET of the reference crop.

**What is Reference ET?**

The term "reference" refers to the ET equations calibrated to estimate the water use of a well-watered alfalfa or grass field under a set of local weather conditions. The reference ET value provided in CoAgMet outputs are computed using an Alfalfa reference equation (1982 Kimberly Penman). To use  $ET_{ref}$  values for other crops the  $ET_{ref}$  values must be adjusted by using a crop coefficient or multiplier. The daily ET for a specific crop is the product of the  $ET_{ref}$  multiplied by the crop coefficient for that same date.

Reference ET values are for conditions where soil moisture is not limiting (greater than 50% field capacity). If moisture does become limiting, a soil coefficient value can be applied in addition to the crop coefficient.

**How to Use ET Provided on CoAgMet**

Consider the soil water in your field or landscape as a bank account. In the soil, daily ET amounts are withdrawals from the account of soil storage. Any rainfall or irrigation is a deposit to soil storage. When an initial soil water value is determined, the water balance can be estimated by subtracting ET daily or over a period of time. Should the water balance calculations project soil water to drop below some minimum level, the irrigation is needed. The following is an example of a soil water balance:

Date	Crop ET	Irrigation	Rain	Plant Available Soil Moisture Balance	Cumulative Soil Moisture Depletion
	----- inches -----				
6/14		2.5	0	2.50	
6/15	0.25	-	0	2.25	0.25
6/16	0.20	-	0	2.05	0.45
6/17	0.15	-	0.25	2.15	0.35
6/18	0.15	-	0	2.00	0.50

ET can also be used to estimate the next irrigation by comparing to system capacity. For example, your system irrigated a net application of 1.5 inches to your field four days ago. The average ET rate since this irrigation has been 0.25 inches / day and there has been no rain. It will take two days to irrigate this field and you are anticipating a similar ET rate during that time. Therefore, you need to begin irrigating today to maintain your soil moisture and keep up with crop demand.  $\{(4 \text{ days since last irrigation} + 2 \text{ days to irrigate field}) \times 0.25 \text{ inches /day} = 1.5 \text{ inches}\}$ .

**Application**

User Guide

The CoAgMet outputs provide reference ( $ET_{ref}$ ) and daily ET values for nine potential crops. The crop ET values are calculated for you automatically by multiplying the  $ET_{ref}$  and a crop coefficient, determined by using the default or user entered planting date. For crops not provided in CoAgMet outputs, consult with your local Natural Resources Conservation Office (NRCS) or water conservancy district for crop coefficients appropriate for your area. The provided  $ET_{ref}$  can then be used by multiplying it by the appropriate coefficient.

ET-based scheduling using the water balance approach should be verified periodically by checking soil moisture in the field with a probe or shovel. Refer to the fact sheet, [Estimating Soil Moisture](#), 4.700 for help in this process.

CROP ET COEFFICIENTS

We compute crop ET with the following algorithm. For each day of the season:

1. Start with stage = 1 and  $etr\_sum = 0$ .
2. Add the day's  $ET_r$  to  $etr\_sum$ .
3. If  $etr\_sum$  is greater than the stage's threshold, go to the next stage.
4. Use the stage's coefficients to calculate the crop coefficient  $k$ :
  1. If the stage is 1,  $k$  is stage 2's  $K_{min}$
  2. Calculate  $frac\_sum = etr\_sum / threshold * 100$
  3. Otherwise,  $k = frac\_sum * C3^3 + frac\_sum * etr\_sum * C2^2 + frac\_sum * C1 + C0$
  4. If  $k$  exceeds  $K_{min}$  or  $K_{max}$ , clamp it to one of those values.
5.  $ET = k * ET_r$

The following are the coefficients, thresholds, etc. we use with the above algorithm. The crop coefficients used to generate crop ET reports were developed for the Penman-Kimberly model.

**Line Contents**

1	crop name
2	stage 2 coeffs (4)
3	stage 3 coeffs (4)
4	stage 2 $K_{min}$ and max, stage 3 $K_{min}$ and max
5	Planting date (mm,dd)
6	Stage sum thresholds (3)

**Alfalfa**

0.33748, -0.0024345, 0.00026031, -0.0000016861  
 1.0, 0.0, 0.0, 0.0  
 0.35, 1.00, 1.0, 1.0  
 4, 24  
 0.0, 6.0, 6.0

**Corn**

0.18684, 0.0023555, 0.00016093, -0.0000010779  
0.98014, 0.0043027, -0.00013037, 0.00000011096  
0.2, 0.96, 0.22, 0.96  
4, 20  
2.4, 18.8, 17.7

**Drybeans**

0.19715, 0.00088840, 0.00017947, -0.0000010136  
1.0503, -0.00010989, -0.0000037637, 0.000000024275  
0.20, 1.00, 0.68, 1.00  
5, 31  
1.0, 12.9, 11.0

**GrassHay**

0.28138, 0.021053, -0.000065, 0.0  
0.87, 0.0, 0.0, 0.0  
0.28, 0.87, 0.87, 0.87  
3, 15  
0, 2, 43.3

**Smallgrn**

0.13877, 0.0058077, 0.00018732, -0.0000015644  
1.0247, 0.0038453, -0.00017294, 0.00000054111  
0.20, 1.00, 0.22, 1.00  
3, 23  
1.0, 10.9, 13.6

**Sgrbeets**

0.19291, 0.0018086, 0.000080571, -0.00000015235  
1.0038, 0.0016168, -0.000046807, -0.000000034258  
0.20, 1.00, 0.66, 1.00  
4, 8  
1.4, 22.7, 21.0

**Potatoes**

0.19731, 0.00019446, 0.00017014, -0.0000010004  
0.9000, 0.0000, 0.0000, 0.0000  
0.20, 0.90, 0.90, 0.90  
6, 3  
1.3, 16.7, 8.1

## Application

User Guide

### Onion

0.39042, -0.00064841, 0.00015373, -0.0000010567  
0.88965, 0.0011674, 0.0000092657, -0.00000064297  
0.40, 0.80, 0.45, 0.80  
3, 22  
1.1, 27.0, 10.1

### WntrWheat

0.1276, 0.0161, -0.0000228, -0.000000479  
1.0263, 0.00373, -0.000182, 0.000000647  
0.20, 1.0, 0.22, 1.0  
3, 1  
0.0, 10.5, 13.0

## RAW DATA ACCESS

An easy way to get started is to go to the [Raw Data Form](#) and set up a query similar to what you want. After you submit the query, you can copy the query specification from your browser's address bar and edit it from there.

This documentation is for developers interested in pulling data from the CoAgMet website. Below is an example of a data query:

[https://coagmet.colostate.edu/rawdata\\_results.php?station=FTC01&start\\_date=1999-01-01&end\\_date=2000-01-02&daily=1&qc=1&etr=1](https://coagmet.colostate.edu/rawdata_results.php?station=FTC01&start_date=1999-01-01&end_date=2000-01-02&daily=1&qc=1&etr=1)

A breakdown:

**[https://coagmet.colostate.edu/rawdata\\_results.php](https://coagmet.colostate.edu/rawdata_results.php)**

Our script that dispenses raw data. The URL for this shouldn't change, but if it does it'll be the same script called on by the [Raw Data Access Page](#). HTTPS is recommended but HTTP will still work fine.

**?**

Tells the webserver that arguments are being passed.

**station=FTC01**

The station you wish to retrieve data from. This must be a 5 character long identifier. Consult the [list of stations and their IDs](#).

**&**

This must be appended after every argument if there is a argument following it.

**start\_date=1999-01-01**

## Application

### User Guide

The beginning date of your query. This must be in the format YYYY-MM-DD to work. 1999-1-1 will not work.

### **end\_date=2000-01-02**

The end date of your query. This must be in the format YYYY-MM-DD to work. 2000-1-1 will not work.

### **daily=1** and/or **hourly=1** and/or **5min=1**

You must append one or more of daily=1 or hourly=1 or 5min=1 depending on the time interval(s) you want. You may ask for multiple data intervals, but it is up to you to determine what's what.

### **qc=1**

Now that we do quality control on our data, you may request our QC'd data by adding qc=1 to the query string. If you want to keep retrieving the raw (i.e. not QC'd) data, use qc=0 or just leave it off the query parameters.

### **etr=1**

If you want to retrieve Reference ET values you may append etr=1 to the query string. Note that this is only available for daily and hourly data. ET values will appear at the end of each line of data; see below for details. Either use etr=0 or just leave this parameter off the query string if you do not want to retrieve ET parameters.

Please try to make as few queries on our database as possible. If you must grab 100 days worth of data for example, try do it in one request, not multiple ones.

## CoAgMet Daily Data Format

1. Datetime (in the format YYYY-MM-DD)
2. Mean Temperature (Celsius)
3. Maximum Temperature (Celsius)
4. Time of Maximum Temperature (HH:MM:SS)
5. Minimum Temperature (Celsius)
6. Time of Minimum Temperature (HH:MM:SS)
7. Vapor Pressure (kPa)
8. Maximum Relative Humidity (Fraction)
9. Time of Maximum Relative Humidity (HH:MM:SS)
10. Minimum Relative Humidity (Fraction)
11. Time of Minimum Relative Humidity (HH:MM:SS)
12. Solar Radiation (MJ/m<sup>2</sup>)
13. Wind\_Run (km/day)
14. Precipitation (millimeters)
15. Maximum Soil Temperature at 5cm (Celsius)
16. Time of Maximum Soil Temperature at 5cm (HH:MM:SS)
17. Minimum Soil Temperature at 5cm (Celsius)

## Application

### User Guide

18. Time of Minimum Soil Temperature at 5cm (HH:MM:SS)
19. Maximum Soil Temperature at 15cm (Celsius)
20. Time of Maximum Soil Temperature at 15cm (HH:MM:SS)
21. Minimum Soil Temperature at 15cm (Celsius)
22. Time of Minimum Soil Temperature at 15cm (HH:MM:SS)
23. Battery Voltage
24. Year of data
25. Maximum daily wind gust (m/s)
26. Time of maximum daily wind gust (min into day NOT HH:MM as other max/min)
27. Direction of maximum daily wind gust (deg)
28. ASCE Reference Evapotranspiration Model (mm)\*
29. Penman-Kimberly Ref. Evapotranspiration Model (mm)\*
30. Summed hourly ASCE Ref. ET (mm)\*

\* = only when ET has been requested

### CoAgMet Hourly Data Format

1. Datetime (in the format YYYY-MM-DD HH:MM:SS)
2. Mean Temperature (Celsius)
3. Relative Humidity (Fraction)
4. Vapor Pressure (kPa)
5. Solar Radiation ( $\text{kJ/m}^2 \cdot \text{min}$ )
6. Mean Wind Speed (m/s)
7. Vector Average Wind Direction (in Degrees, 0 and 360 being north)
8. Standard Deviation of Wind Direction (Degrees)
9. Precipitation (millimeters)
10. Mean Soil Temp at 5cm (Celsius)
11. Mean Soil Temp at 15cm (Celsius)
12. Wind Gust (m/s)
13. Wind Gust Time (minutes into day)
14. Wind Gust Direction (Degrees)
15. ASCE hourly Reference Evapotranspiration Model (mm)\*

\* = only when ET has been requested

### CoAgMet Five Minute Data Format

1. Datetime (in the format YYYY-MM-DD HH:MM:SS)
2. Battery Voltage\*
3. Mean Temperature (Celsius)
4. Relative Humidity (Fraction)
5. Vapor Pressure (kPa)
6. Solar Radiation ( $\text{kJ/m}^2 \cdot \text{min}$ )
7. Mean Wind Speed (m/s)
8. Vector Average Wind Direction (in Degrees, 0 and 360 being north)



**Application**

User Guide

9. Standard Deviation of Wind Direction (Degrees)
10. Precipitation (millimeters)
11. Mean Soil Temp at 5cm (Celsius)
12. Mean Soil Temp at 15cm (Celsius)
13. Wind Gust (m/s)
14. Wind Gust Time (minutes into day)
15. Wind Gust Direction (Degrees)

\* - deprecated

Evapotranspiration is not available for 5-minute data.