Term Project
Introduction to Weather and Climate

Stage1 – Time-Series Plots
Due: Wednesday, Oct. 16, 11:59 pm MST

Stage 2 – Weather Diagnosis, Final Draft
Due: Monday, Nov. 18, 11:59 pm MST[1]

PREFACE

The term project constitutes 30% of your final course grade. Its successful completion should be considered a mandatory prerequisite to passing the course. In other words:
Passing the term project very likely positions you to pass the course (earn a grade of D or higher), but failing it (combined score on Stage 1 and Stage 2 of less than 50%) or not submitting it nearly guarantees that you will not pass course, regardless of your scores on quizzes and other assignments.

There are two submission stages to the project. Each stage has its own separate due date and dropbox. The due date for **Stage 1** is **Wednesday, Oct. 16 by 11:59 pm MST**. The due date for the final version of **Stage 2** is **Monday, Nov. 18 by 11:59 pm MST**.

The project is to be done as an individual, not as a member of a group. This means that you neither accept the aid of another nor give aid to another, outside of the bounds of interactions that I deem allowable via writing communication. (See below.) This is your project. It must represent your work, and your work alone.

LEARNING OUTCOMES

1) Accurate collection, organization and processing of current weather data.
2) Presentation of temporal data in graphical form.
3) Time-series analysis (e.g. correlation between fields and identification of extremes/outliers).
4) Diagnosis of synergist weather phenomena in terms of course concepts.
5) Composition of a cogent paper that addresses points 3) and 4) and that follows the concise, precise writing conventions of scientific publications.
6) Experience the process of peer review, revision and submission of a "more polished" final draft.

ANALYSIS OF SURFACE WEATHER OBSERVATIONS

Stage I

Over the next few weeks, you will access hourly weather observations for Minneapolis/St. Paul International Airport (KMSP: 44.9˚N/ 93.2˚W). KMSP is located in the State of Minnesota, which borders Canada. (See Map.) The elevation of KMSP is 256 m (841'); the surrounding terrain is can be considered flat for our purposes.

You are to collect surface weather observations for an hour that is close to local solar noon. That hour for KMSP is 1800 UTC (Coordinated Universal Time)[2], where UTC is standard time in London, United Kingdom. KMSP is located in the Central Time zone, which is UTC-6 or six hours behind London time. 1800 UTC

---

[1] Firm due date.

[2] UTC was formally termed Greenwich Mean Time (GMT). UTC is now commonly called Military Time or "Zulu" Time (or "Z" for short). "Z" often appears on weather products instead of "UTC".

corresponds to 12:00 pm Central Standard Time (CST) or 1:00 pm Central Daylight Time[3] (CDT), which is the GMT hour closest to solar noon at KMSP. The hourly observation is taken a few minutes before 1800 UTC. The typical time is 1753 UTC for KMSP, but you must check every time carefully as the observation time can vary by a few minutes each day. Collect data for every date for the period below.

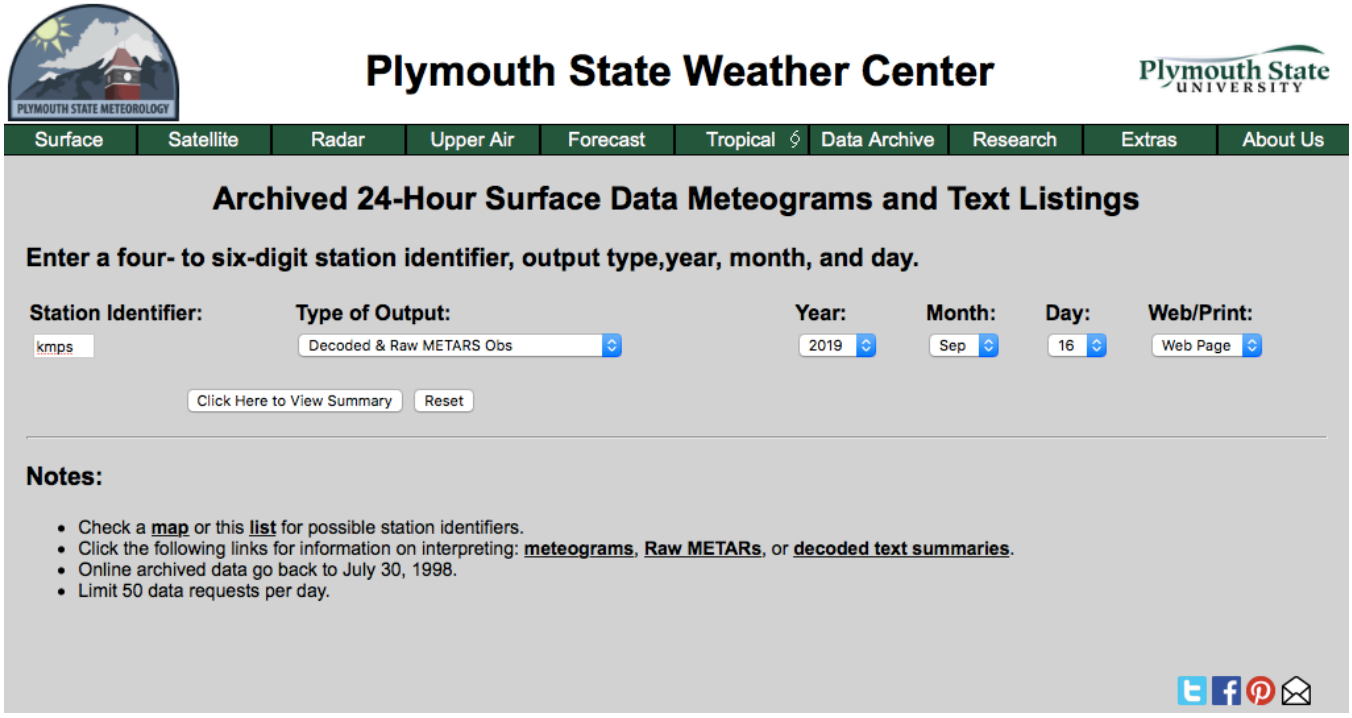
Analysis period: Daily dates from Sept. 16 to Oct. 15, inclusive.
You must collect data for above period. I have done several dates to jumpstart your data collection.

Your archive of surface weather observations for 1800 UTC must include:

- Temperature
- Dew point
- Relative humidity

DATE	TEMP	DEW PT	R.H.	DATE	TEMP	DEW PT	R.H.
16-Sep	83	63	51	**20-Sep**	84	69	61
17-Sep	83	68	61	**21-Sep**	76	69	79
18-Sep	77	65	66	**22-Sep**	66	55	68
19-Sep	82	68	63	**23-Sep**	73	51	46

Weather Data Access: Use the web site http://vortex.plymouth.edu/myo/sfc/statlog-a.html at Plymouth State University to get observations that are 24-36 hours or older. I show the web site below.

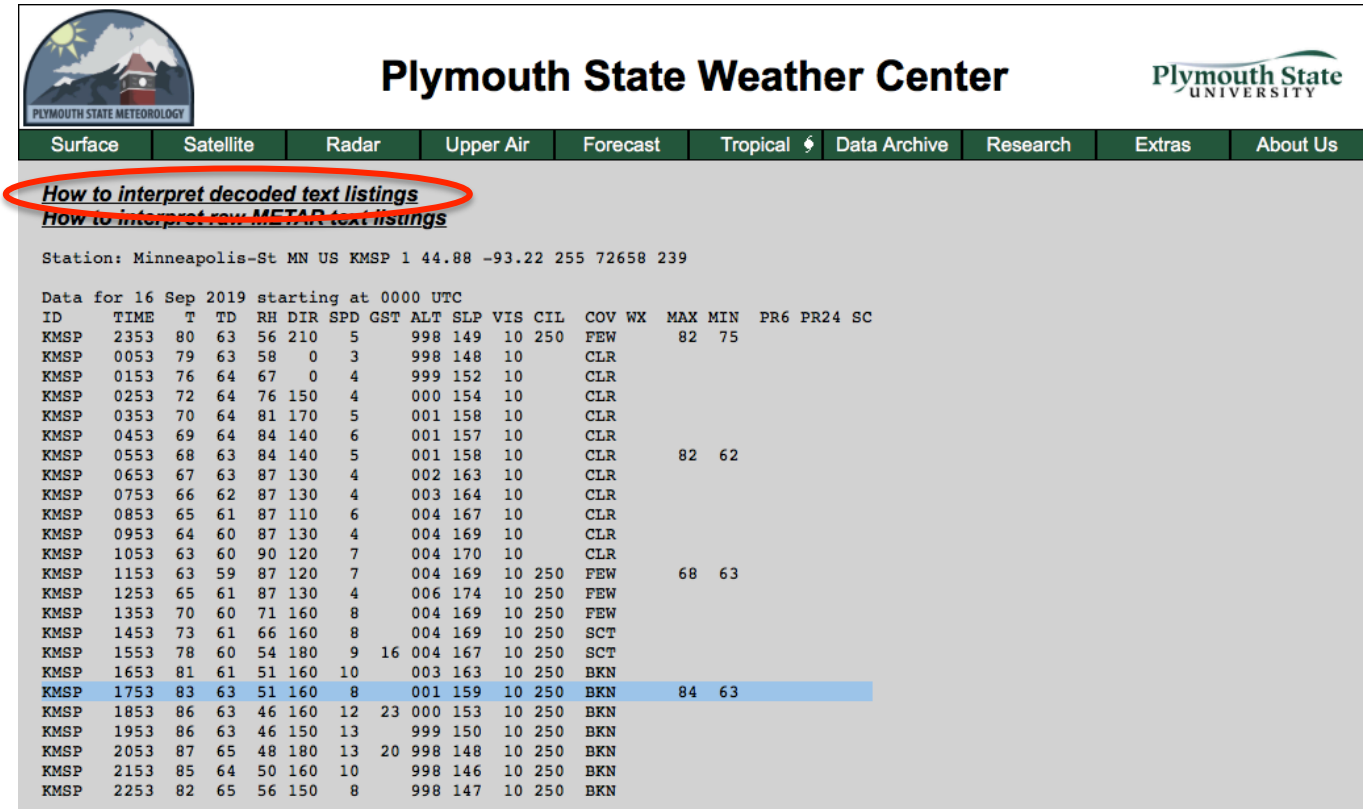


The Plymouth State Weather archive has coded and decoded "METAR" (Meteorological Terminal Aviation Routine Weather Report) data, where METAR is the international code to report routine, hourly weather conditions at air terminals. You will select a "Type of Output" option that allows you to access data without learning the nuances of deciphering METAR code, as I describe next.

[3] Daylight Time begins on the second Sunday in March and ends on the first Sunday in November in the United States. The states of Arizona (outside of the Navajo Nation) and Hawaii do not observe Daylight Time.

Do the following to get the data that you need: Enter the station identifier (KMSP fall semester; KDFW spring semester) and select “Decoded Hourly & Special Obs Listing”. Set “Year”, “Month” and “Day” to their correct values, being extra careful that the time values are set correctly. When you click the "Click Here to View Summary" button, it will produce a list of observations.

I show in the figure that follows what the Plymouth State Weather Archive site returns for *Sept 2, 2018.* You need to read the column TIME to find the report closest to local noon. I shade in blue observations for the time that is closest to *1800 UTC (1753)*. **Always record the 1753 report!** Record the temperature (T), dew point (TD) and relative humidity (RH). The other columns have sea-level pressure (SLP), wind direction (DIR) and speed (SPD), cloud cover (COV) for the time and date. (The link inside the red circle provides help on decoding the text listings.)



Plymouth State Weather Center

Surface | Satellite | Radar | Upper Air | Forecast | Tropical | Data Archive | Research | Extras | About Us

How to interpret decoded text listings

How to interpret raw METAR text listings

Station: Minneapolis-St MN US KMSP 1 44.88 -93.22 255 72658 239

Data for 16 Sep 2019 starting at 0000 UTC

ID	TIME	T	TD	RH	DIR	SPD	GST	ALT	SLP	VIS	CIL	COV	WX	MAX	MIN	PR6	PR24	SC
KMSP	2353	80	63	56	210	5		998	149	10	250	FEW		82	75			
KMSP	0053	79	63	58	0	3		998	148	10		CLR						
KMSP	0153	76	64	67	0	4		999	152	10		CLR						
KMSP	0253	72	64	76	150	4		000	154	10		CLR						
KMSP	0353	70	64	81	170	5		001	158	10		CLR						
KMSP	0453	69	64	84	140	6		001	157	10		CLR						
KMSP	0553	68	63	84	140	5		001	158	10		CLR		82	62			
KMSP	0653	67	63	87	130	4		002	163	10		CLR						
KMSP	0753	66	62	87	130	4		003	164	10		CLR						
KMSP	0853	65	61	87	110	6		004	167	10		CLR						
KMSP	0953	64	60	87	130	4		004	169	10		CLR						
KMSP	1053	63	60	90	120	7		004	170	10		CLR						
KMSP	1153	63	59	87	120	7		004	169	10	250	FEW		68	63			
KMSP	1253	65	61	87	130	4		006	174	10	250	FEW						
KMSP	1353	70	60	71	160	8		004	169	10	250	FEW						
KMSP	1453	73	61	66	160	8		004	169	10	250	SCT						
KMSP	1553	78	60	54	180	9	16	004	167	10	250	SCT						
KMSP	1653	81	61	51	160	10		003	163	10	250	BKN						
KMSP	1753	83	63	51	160	8		001	159	10	250	BKN		84	63			
KMSP	1853	86	63	46	160	12	23	000	153	10	250	BKN						
KMSP	1953	86	63	46	150	13		999	150	10	250	BKN						
KMSP	2053	87	65	48	180	13	20	998	148	10	250	BKN						
KMSP	2153	85	64	50	160	10		998	146	10	250	BKN						
KMSP	2253	82	65	56	150	8		998	147	10	250	BKN						

Moving from left to right, the observations that you would need to record for 1753 UTC are:
Temperature (T)=83˚F.
Dew point (TD)=63˚F.
Relative humidity (RH)=51%

You do not need to collect observations in real-time. That said, I highly recommend that you do just that because you learn weather by following weather…every day. If you want observations for the current day, then go to http://vortex.plymouth.edu/myo/sfc/statlog.html. As before, enter the station identifier (KMSP) and select “Decoded Hourly & Special Obs Listing”, and the available observations up to the current hour are displayed in the same form as the above figure. A valuable learning experience is following weather maps in real-time as you gather data. Simultaneous data collection and monitoring of the maps enables you to associate trends and fluctuations in the time-series with surface weather features. To view or download animations of 3-days worth of prior surface maps, you can go to http://www.wpc.ncep.noaa.gov/html/sfcloop/namusloop_wbg_3day.html for analyses that have station plots and http://www.wpc.ncep.noaa.gov/html/sfcloop/radsfcus_exp_3day.html for maps that have radar imagery superimposed.

Time Series Plots: You are to plot temperature, dew point and relative humidity on a graph for the dates in question. Plot temperatures in degrees Fahrenheit on the left axis and relative humidity in percent on the right axis. I encourage you to put all of the curves on the same plot. If you decide to put temperatures and RH on the same graph, you will need to use a different vertical axis scale for RH and to arrange the plot so the temperature curves and RH curves lines do not intersect. The end of this document has Excel plots of daily time-series for KMSP from the fall 2017 semester. Note how RH is scaled so it does not intersect the dew point curve. .

I urge that you use a spreadsheet program like Excel. I give a link to an Excel program (see Appendix) that you can use to produce your graph; you just input the correct data. Less desirable options are using online plotting tools such as Google Sheets (https://www.google.com/sheets/about/, which can be clunky to set up) or the web-based ChartGo (http://www.chartgo.com/en/chartline.jsp, which is even clunkier to set up) to produce your graphs if you are comfortable using such software since the teaching team can offer no individualized help on the use of plotting software. For help with getting started on using plotting software, read the Appendix at the end of this document where you will finds links to canned programs that plot time-series graphs. Otherwise, scanned copies of *accurate and neatly drawn plots on old-fashion graph paper* are your only option. Whatever option you chose, you must show the data value on your graph at all of your data points. (See the example graph from Excel.)

The temperature/dew point/RH graph with data labels completes **Step 1**. Your graph must be submitted as a single pdf file. No other file type is acceptable. Upload your pdf to the dropbox before the deadline**.** Make certain your graph is properly oriented with its top at the top of the page. This may require that you rotate the pdf file, which is simple to do if you have Adobe Acrobat Reader DC (free from http://www.adobe.com) on your system. Plots that are not properly oriented will receive a deduction.

Stage 2

Overview of the Weather and Climate for the Data Collection Period: Use the time series plots to determine whether there is a general upward or downward trend in data through the period. Write a brief (one but no more than 1½ pages double-spaced text) summary of the trends in the data. Did the temperatures tend to fall/rise as we might expect during fall/spring season? Was there an apparent trend in the dew point or the relative humidity with time? How do the variables seem to correlate with each other? Comment on any interesting maxima and minima in the time series. Note periods of extended above or below average temperatures, and abrupt changes in the weather. Were there any record high or low temperatures? Were there any extreme weather events or extended periods of anomalous weather?

Detailed Diagnosis of Significant Weather: I will identify for you (at a later date) period(s) of "interesting weather" that will serve as the focus (foci) for your diagnosis. Broadly speaking, we can consider "interesting weather" to correspond to abrupt changes in surface conditions; record breaking events (always possible but not likely during our 6-week observation period); highly anomalous weather (an extended heat wave or cold snap of a few days); strong winds (sustained winds faster than 20-25 mph or gusts faster than 35-40 mph); severe thunderstorms with hail or heavy rain (and especially tornadoes); flooding events; snow; etc. You will use course materials and other online weather resources to answer a few (typically 3 to 5) specific questions that I pose about the weather situation(s). The diagnosis portion of the project should not exceed 1½ to 2 pages.

Specific instructions on the diagnosis component of Stage 2 will come when I announce the focus period(s) and associated questions.

REVISION BEFORE SUBMITTING THE FINAL VERSION OF STAGE 2

Review by a Tutor at the Writing Center and Revision: Finish your penultimate draft of Stage 2 at least one week (preferably two weeks) prior to the due date of Stage 2. Then you are to go to the Writing

Center (see https://thinktank.arizona.edu/writing-center) to have it reviewed by peer tutor. You must have it reviewed at the Writing Center prior to submitting the final version of your term project for grading. If you live too far from Tucson to meet a tutor at the Writing Center, you can still interact with one by arranging for an online session. For information on how to arrange for online tutoring, go to https://thinktank.arizona.edu/online-tutoring.

The process of obtaining independent feedback from an authority with the opportunity to do a revision is a component of what is known as "peer review". Peer review constitutes an essential component of scientific research and its publication. This is your opportunity to receive feedback from a trained and certified writing tutor to improve your term paper…the most important assignment of the course.

A tutor at the Center will go over your penultimate draft and offer suggestions on how to improve your paper. The tutor will NOT rewrite the paper for you though! This means the more polished your penultimate draft is, the more helpful the tutor's suggestions will be, and the better your final draft will be. Be certain you bring a copy of the grading Rubric to share with your tutor.

More detailed instructions about the review process at the Writing Center will be given in a separate document, shortly before the "due date" of your penultimate draft. It is only after you thoughtfully consider and incorporate comments, suggestions and corrections of the tutor into your manuscript that you should submit a final version of the project for grading.

You must submit (to a dropbox to be opened) a copy of the receipt that the Writing Center emails you to demonstrate you met with a tutor to discuss your paper. I recommend that you finish your penultimate draft well in advance of the deadline to allow yourself time to revise the paper.

SUBMISSION OF STAGE 2

All components of Stage 2 must be assembled into a single pdf file. Your complete project (Stage 2) must include each item in the following order:

1) Written analysis of time series.
2) Diagnosis of the weather over the focus period(s) in terms of course concepts.
3) All images (e.g. weather maps, satellite, radar images, etc.) that support your diagnosis. Make certain these plots are properly rotated where north is to the top of the page.
4) References.

Do not include a copy of the graph that you submitted in Stage 1.

Submit your papers in to the D2L Dropbox. Note that all papers are automatically processed by plagiarism detection software (see below).

GRADING RUBRIC

Your grade will be based the following criteria. Criterion 3 is the most important to address and counts 40% of the Stage 2 grade. The other three criteria count 20% each.

(1) Demonstration of a timely, complete and accurate collection of data as judged from your time-series plots. **The evaluation of Stage 1 is independent of the evaluation of Stage 2**.
(2) Succinct overview of the weather and climate for the observation period.
(3) Sound, succinct diagnosis of the weather during the focus period that is based on course concepts. ***Point 3 is the most important component of the project. Submissions that do not address the issue of the underlying physical reasons of "why the weather did what it did" will be subject to a major deduction as large as 25 points.***

(4) Organization, clarity, grammar, punctuation, spelling, appropriate use of terms, and an overall sense of professionalism. For guidance on writing, I recommend https://owl.english.purdue.edu/owl/section/1/ or http://atmo.arizona.edu/~mullen/atmo170A1/project/Grammar_Girl.pdf, but there are dozens of other

online sites with excellent guidance that you may find more useful.

Once I identify the focus topics, you are to write a succinct summary of your diagnosis and conclusions. Your weather synopsis must:
- Contain an overview of the time series plots. Note periods of above or below normal temperatures, precipitation events, strong winds, and of course any record events for the date.
- Give a detailed description of the weather during the focus period(s) that incorporates relevant weather maps, satellite and/or radar imagery, and supplemental surface data beyond the 1800 UTC surface data in your time-series plots. This will satisfy a portion of point (3).
- Use course concepts to diagnose the weather during the interesting period. This will satisfy the bulk of point (3)
- Contain high-quality writing that is coherent, succinct, organized and grammatically proper.

You may include up to 4 supplementary figures to support your diagnosis of the weather during the focus period. Be certain that each figure has a caption (a tight description of the figure) and is assigned a figure number, where the number is determined by the order in which the figure is first referenced in the text. Pick your figures wisely; the teaching team will view unfavorably an excessive number of figures, ones of marginal value, or ones not referenced in the text.

Your write-up is to be **no longer than three double-spaced pages of text using #12-point, Times New Roman font.** The limit excludes references, tables, figures and figure captions. Three pages is very little space (about 1/3 of the words in this document) to write a summary of the time-series and present a detailed diagnosis of a weather event. But it is enough. Hence, it is critical that you make every word count. I suggest that you target one page but no more than 1.5 pages for the time-series analysis, and at least 1.5 pages but no more two for the weather diagnosis.

I have posted in the D2L Content section the file "Example Term Project" from a prior class (when the project differed somewhat from yours). It is not a file for you to cut-and-paste portions thereof into your document, even if the specifics differ. I offer it as an example of "what" that I am confident you are capable of doing. Do take note how succinct the presentation is. Note how the paper satisfies the key criteria of the assignment in only two pages.

DUE DATES
The due date for Stage 1 (completed graph only) is **Wednesday, Oct. 16 by 11:59 pm MST**. In view of the purpose of Stage 1, namely "a timely, complete and accurate collection of data as judged from your time-series plots", late submissions of the graphs will not be accepted, regardless of circumstances.

The due date for final version of Stage 2 (completed project) is **11:59 pm MST, Monday, Nov. 18**.

All components of Stage 2 must be assembled into a single pdf file. Your complete project (Stage 2) must include item in the following order:

1) Analysis of the time series, after you incorporate comments of the Writing Center reviewers.
2) Diagnosis of the weather during focus period(s) in terms of course concepts.
3) All images (e.g. weather maps, satellite, radar images, etc.) that support your diagnosis of the focus period. Make certain these plots are properly rotated.
4) References
Do not include a copy of the graph that you submitted earlier. I will post a correct version of the time-series graphs immediately after the due date for Stage 1 passes.

Assignments can only be submitted to the appropriate D2L dropboxes. This means that hand drawn plots must be either digitally photographed or "scanned" into a digital format (.jpeg, .png) that can be imported into your word processing program. You should plan to complete the final version of

your project at least two days prior to the due date to give yourself ample of time to make certain your materials are complete, thoroughly proofed, properly ordered and rotated, and can be uploaded to the D2L dropbox successfully. You are responsible for checking that you final submission is uploaded to D2L

Late Stage 2 submissions will accumulate a subtractive penalty of -10% per calendar day late. For example, if your project is 3 days late, 30% is subtracted from your score. That means if your project is 5 days late, an “E” mark will be assigned to your project and course grade too. Extensions of the due date will not be granted under any circumstances beyond extenuating ones specified in the syllabus. I recommend that you finish Stage 2 long before the deadline. Besides, think how nice it would be to finish the project early so it does not conflict with end-of-semester requirements in other courses.

WHEN TO EXPECT TO GET YOUR GRADE

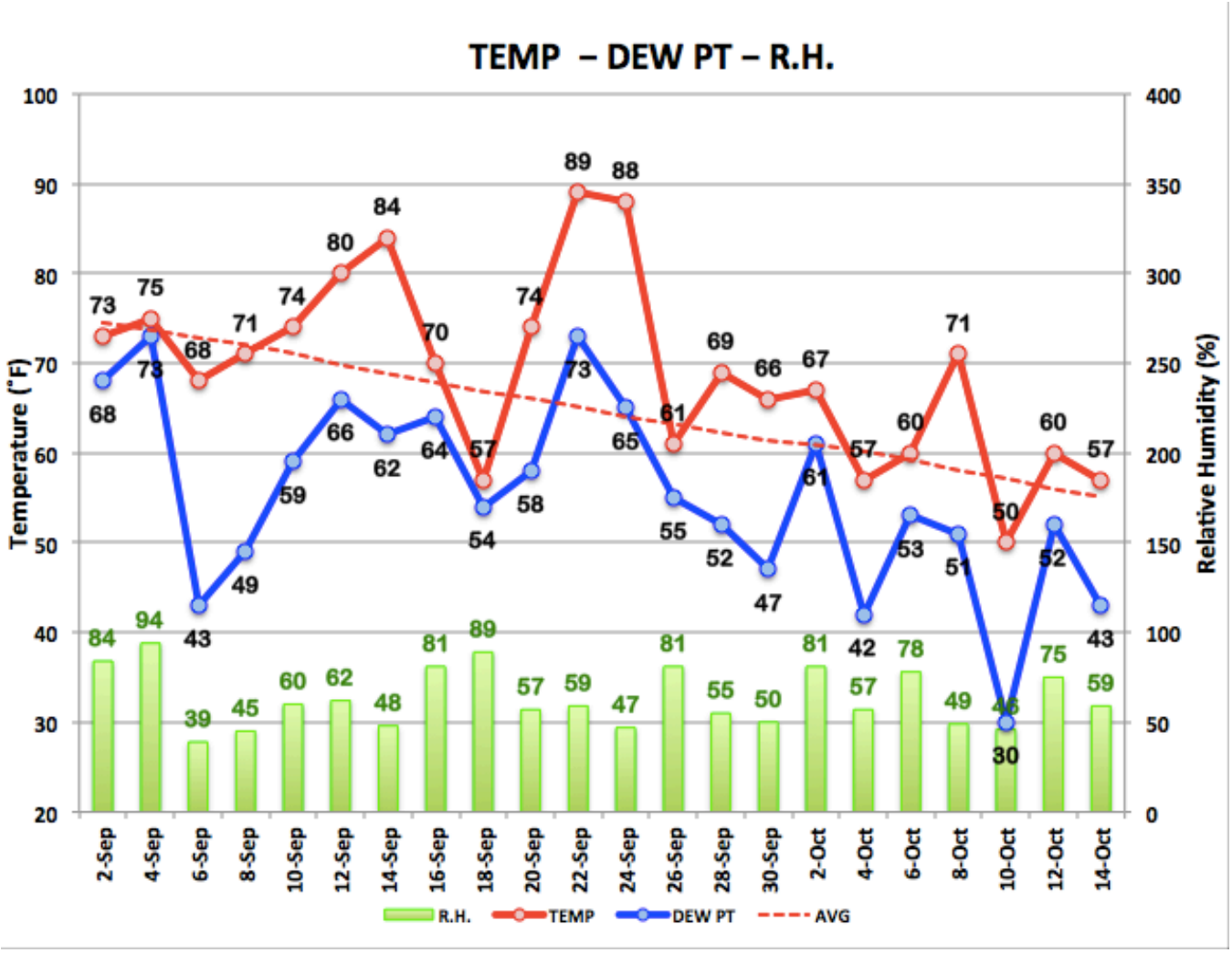
You should not expect to see your total score on the term project any earlier than the last week that classes meet. Please keep in mind that it takes time to assess carefully more than 100 submissions. It takes a grader many hours to evaluate their share of the submissions, and their grading for our class must be worked into their graduate courses, research obligations and grading for other sections of ATMO 170A1. The teaching team is committed to complete the grading of project by “Dead Day”.

I close with a last request: please do not send emails of the ilk, “Where is the grade on my term project?” before I announce all of the projects are graded and the scores are posted. Such emails will not be acknowledged since replies only serve to slow down the grading process.

APPENDIX: HELP WITH PLOTTING

I urge every student to use a spreadsheet program like Excel or an online plotting tool like Google Sheets to produce their plots.

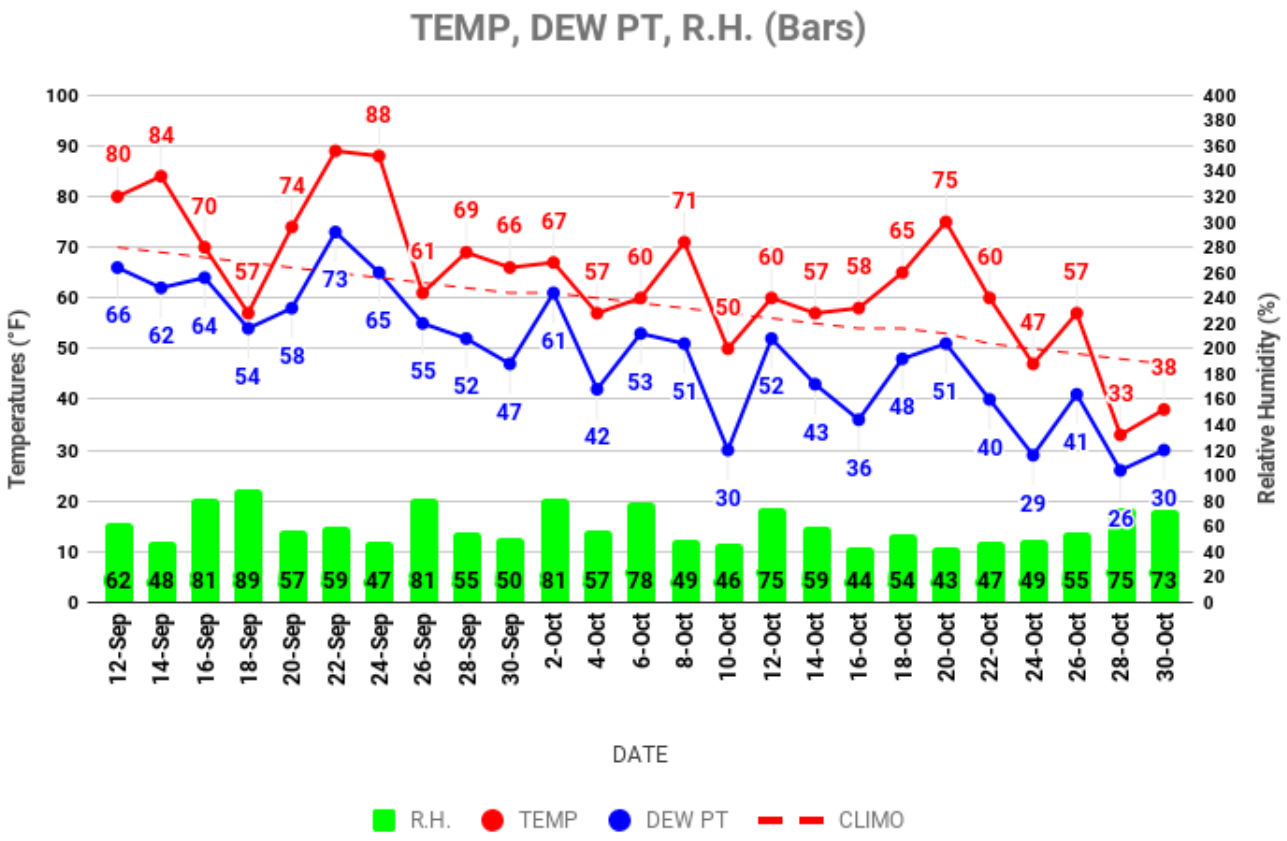
I give a link to an Excel file where you just enter the temperature, dew point and relative humidity data. Click http://www.atmo.arizona.edu/courses/mullen/Graph_KMSP_Students.xlsx. A plot using the program is shown below. If you have Excel on your computer, the file might open automatically. If not, the file should download automatically to your computer where you can open it. Once the file is on your computer, Excel can open it. The left axis has temperature and dew point, and the right axis has relative humidity. Also make note of the "Data Labels" on the dots/bars that give the data values. Data labels for every field are mandatory. For illustrative purposes, I filled the data columns with fake data that you must change, but the average 1800 UTC temperature for the date is correct. Numbers (Apple) and LibreOffice (open source) should open the file too, as can Google Sheets (see next paragraph). *If you have MS Office on your computing platform, or any office software program that can open xlsx files without issues, I recommend that you use the above Excel file.*



I also provide a link to a Google Sheets program at the end of the paragraph that you can use as a template to make graphs. Where you enter the data for a particular date is self-evident. You can enter the link into any mainstream browser (MS Edge, Safari, Firefox, Chrome, Opera). The graph shows the

actual observations for Fall 2017 at KMSP starting 12-Sept. and ending 30-Oct. You would need the dates that correspond to this assignment.
https://docs.google.com/spreadsheets/d/1VTTZJjAUEdY64kKSYZhazOU48Lp2uC_GEU8es93u4gw/edit?usp=sharing

Unfortunately, a shared link in Google Sheets cannot be edited by anyone other than the owner (me) or downloaded to another Google account. You can, however, upload the Excel file of the first paragraph to Google Drive then edit it with Google Sheets. What initially opens in Google Sheets is a much too busy, three-line chart where the RH line crosses the temperature lines, but Google Sheets can be modified to look very similar to the combination lines/bar chart in Excel by plotting RH relative to the right vertical axis and scaling it accordingly. See the settings in my link. Again, note the mandatory data labels that appear near the dots and above the bars. Google Sheets produced the graph below.



Important: Whether you use plotting software (as I strongly urge) to draw the graphs or do them by hand, you must include labeling of every data point. Switching the Data Labels option to “On” enables the teaching team to assess the fidelity of your data accurately. In fact, the display of data values is so greatly faciliated by using plotting software that one benefit *per se* is a sufficiently compelling reason to NOT draw graphs and plot labels by hand.