

**Term Project**  
**Introduction to Weather and Climate**  
**Due: 01 April, 2013**

The term project<sup>1</sup> constitutes 30% of your final course grade. Its successful completion is mandatory of all students. Stated simply:

*Doing and passing the project does not guarantee that you pass the course (grade of D or higher).*

*However, not doing the project or failing it (lower than 50%) guarantees that you do not pass (grade of E).*

## **Analysis of Surface Weather Observations**

### **Part I**

Collect daily surface weather observations at Tucson International Airport (TUS), which are recorded by the National Weather Service, Tucson Office at approximately 5 pm local standard time. Note that 5 pm MST is 00:00 UTC. UTC (Universal Time Coordinated) time is London U.K. standard time. You need to pick the available observation for the time that is closest to 00:00 UTC. Generally speaking, this will be about 7 minutes before the hour. (e.g. 23:53 UTC; you must check every time as the observation time can vary by a few minutes.) Do this everyday for a three-workweek period, including the intervening weekend days. Candidate periods are:

**Analysis period #1: February 11 (Monday) to March 01 (Friday)**

**Analysis period #2: February 18 (Monday) to March 08 (Friday)**

You must do one of the analysis periods above. The advantage of the choosing an earlier period is that you can finish your project earlier in term and not have to worry about it competing for time with projects in other classes toward the end of the semester (i.e. after Spring Break). Another advantage is that the likelihood of “interesting” weather occurring in Tucson is higher earlier in the winter (rain; frontal passages; abrupt temperature or abrupt moisture changes; anomalous cold snap). Note that whatever three-week period you pick, the due date is **April 01 @5:00 pm**, which is a two weeks after Spring Break ends. Choose your period accordingly.

Your surface weather observation should include the following:

- Temperature
- Wind speed and direction

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<sup>1</sup>This project closely follows ones given by Prof. Christopher Castro and Prof. Elizabeth Ritchie in their sections of *Introduction to Weather and Climate*. Your instructor acknowledges their generosity to share ideas.

- Sky conditions: Cloud coverage
- Pressure
- Dew point
- Significant weather at the time of observation (e.g. thunderstorm)
- Total accumulated precipitation during the 24-hour period that ends at 5 am MST (12:00 UTC) the next local calendar day.

Daily surface observations at TUS (Tucson International Airport) for the prior 960 hours (28 days) can be obtained directly from NWS Tucson forecast office at... <http://www.wrh.noaa.gov/mesowest/getobext.php?wfo=twc&sid=TUS&num=960&raw=0> <http://www.wrh.noaa.gov/mesowest/getobext.php?wfo=twc&sid=KTUS&num=960&raw=0> Note that some days/times may be missing owing to hardware failure and power outages. Instruments can fail too. And they can go offline. Stuff happens.

Weather Underground <http://www.wunderground.com/history/> also maintains a *deep archive* of hourly reports. How one gets data for Tucson International Airport should be self-evident via the dropdown menus. Just make certain that you get data for TUS and not DMA or another Tucson site. A shortcut to get hourly data for February 3<sup>rd</sup>, for example, is cut-n-paste the following link into your browser's menu bar... [http://www.wunderground.com/history/airport/KTUS/2013/02/6/DailyHistory.html?req\\_city=NA&req\\_state=NA&req\\_statename=NA](http://www.wunderground.com/history/airport/KTUS/2013/02/6/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA) The string "2013/02/6" would change accordingly for a different date. For example, you would change the string to "2013/02/4" to get hourly data for February 4<sup>th</sup> 2013. Standard caveats and disclaimers apply to data availability at <http://www.wunderground.com/> .

Recent station plots for the Southwest U.S. with TUS data can be obtained from a copy and paste of the following link IF the data remain in the NCAR archives... almost one week under ideal circumstances. For example, to obtain the map for a local time that is closest to Wednesday, February 6<sup>th</sup>, 2013 for 5 pm MST (which is actually midnight London time for the following calendar day: 00:00 UTC YYYYMMDD=20131007), navigate to... <http://weather.rap.ucar.edu/surface/displaySfc.php?region=las&endDate=20130207&endTime=00&duration=0> Note how I put the proper UTC date/time of endDate=20130307 and endTime=00... that corresponds to the MST date of 20130206... February 7<sup>th</sup> ...that is closest to 5 pm MST to obtain the desired map. *Do not let the label of 00:43 fool you. The map with the 5 pm MST reports is labeled at the UTC time that the computer generates the plot, 00:43 UTC or 5:43 pm MST, so you would set endDate=20130207 and endTime=00 as described.*

*To obtain plots for other days, you must edit the above link before running it. For example, to obtain the surface plot closest to Monday, 4 pm MST for February 4<sup>th</sup> 2013 (if the date has not been purged or has not come yet!) or the first day of Analysis period #1, you would change the endDate string to 20130205" as*

shown:

<http://weather.rap.ucar.edu/surface/displaySfc.php?region=las&endDate=20130205&endTime=00&duration=0>. Note that some days/times may be missing owing to power outages or purging of old data.

High-quality, daily surface maps and upper-air maps for 1200 UTC can be obtained at <http://www.hpc.ncep.noaa.gov/dailywxmap/index.html>. The maps generally run 24 hours behind real-time.

Hourly surface maps with superimposed GOES satellite imagery and Doppler radar imagery can be obtained at <http://www.mmm.ucar.edu/imagearchive/>. The archives of surface, satellite and radar maps are generally posted online within 12 hours of analysis time. Its menu is straightforward and intuitive to use. I highly recommend that you explore the <http://www.mmm.ucar.edu/imagearchive/> link. It can be a valuable resource of weather maps for your project.

Another site to obtain historic surface weather maps (and upper-air maps too) with station model plots for the Southwest or other regions of the world is Plymouth State College at URL <http://vortex.plymouth.edu/u-make.html>. The menu is powerful and flexible, but it complex to set to get what you want; I only recommend its use for the most patient of webbies and most passionate of weather weenies. Unfortunately, I am not in a position to field individual's questions or offer tutoring on how to use the site.

## Part II

Construct the following diagrams:

1. The station model for TUS at 5 pm MST for each day. You will have a total of 19 station models (5 days for three workweeks; 2 days for two intervening weekends). I suggest using a calendar form for your presentation. See page 6 for the scanned calendar with station model plots from the spring 2011 semester. A blank form for your time period is at the end of this write-up. I show an example plot from the [www.weather.ucar.edu](http://www.weather.ucar.edu) and the raw surface report from [www.wunderground.com](http://www.wunderground.com) for February 6 and 7, 2013, 5:00 pm MST, which are two days just prior to your period.

Red characters denote data that are plotted on your the station model. Note that cloud cover is not clearly delineated on the plots from [www.weather.ucar.edu](http://www.weather.ucar.edu).

Observation closest to *February 6, 2013 5:00 pm MST (20130207 0000 UTC)*  
 4:53PM 69.1 °F - 34.0 °F 27% 29.89 in 10.0 mi WNW 11.5 mph – N/A Clear  
 METAR KTUS 062353Z 30010KT 10SM CLR 21/01 (*T and Td in Celsius*) A2996  
 RMK AO2 SLP120 T02060011 10217 20172 53003



Observation closest to *February 7, 2013 5:00 pm MST (20130208 0000 UTC)*  
 4:53PM 70.0 °F - 25.0 °F 18% 29.95 in 10.0 mi Calm Calm - N/A Clear  
 METAR KTUS 072353Z 0000KT 10SM CLR 21/M04 A3001 RMK AO2 SLP140  
 T02111039 10211 20150 56010



If interested in learning how to decode the entire METAR string, see <http://www.wunderground.com/metarFAQ.asp> or search `METAR`.

2. Time series plots of temperature, pressure, dew point, and total 24 h precipitation; the 24-hour accumulation period for precipitation is the interval 5 am to 5 am MST that surrounds your station plot for 5 pm MST. You may plot these as you wish. I suggest that you use a program such as Excel...if you are experienced using the program. See page 8 for Excel plots of time-series plots from the spring 2011 semester. Otherwise, scanned copies of carefully drawn hand charts are your only option.

Identify ONE period of two or three **consecutive** days with “interesting” weather for Tucson. Collect complementary data or analyses (surface maps, satellite or radar imagery, hourly surface reports) to help you diagnose the weather at a detail beyond the TUS 24-hourly surface observation. If you examine the intervening hourly reports, it might help you identify and diagnose an “interesting” period. Other complementary evidence could include, for example, satellite or radar imagery, upper air data, a local or national weather map, or the local National Weather Service forecast discussion.

Use the related links posted on the class website, the above links and *awareness of the weather around you* as a starting point. I leave it to you to define what constitutes an interesting weather day. Broadly speaking, you need to be looking for things like an abrupt change in surface conditions; record breaking temperatures (always possible but not likely to occur during any random 3 week period); strong winds (faster than 20-25 mph); occurrence of precipitation; snow and/or severe weather (for we dreamers). **Once again, you identify just ONE period of at no more than three consecutive days of observations.**

“Interesting” weather events generally stand out in the data. An examination of the station plots and time-series for February 2011 (see below) shows two periods of abrupt change that might be consider “extreme” by TUS standards.

1) Feb01-Feb03: Tucson experienced a 20°F cooling from Feb01 to Feb02,

and set record cold MIN temperatures for mornings of Feb03 and Feb04. Surface weather maps and hourly surface data for Tucson reveal a rare incursion of polar air spilling over the Continental Divide into the Sonoran Desert. Go to hourly data at The Weather Underground at <http://www.wunderground.com/history/airport/KTUS/2011/2/3/DailyHistory.html> .

- 2) Feb26-Feb27: Tucson recorded an 18°F cooling, wind shift and sharp pressure rise over the Feb26-Feb27 period while measuring 0.21" rain. This is a classic signature of a wintertime cold front from the Pacific passing through Tucson, which a review of the weather maps and hourly Tucson data confirms. In fact, the hourly plots indicate that snow occurred at the airport just before sunrise on the 27<sup>th</sup>! Go to hourly data at wunderground <http://www.wunderground.com/history/airport/KTUS/2011/2/27/DailyHistory.html> . See my diagnosis of the weather of these dates in the pdf file titled "Example Term Project" in the Content section.

### Part III

Write a tight summary of your findings. Your weather briefing should include:

- 1) An analysis of the time series plots.
- 2) An explanation of how you identified interesting weather days.
- 3) A description of the weather during the interesting period, using the additional collected data beyond the surface observations.
- 4) Use of course concepts to diagnose the weather during the period. That is, why the weather did what it did.

I consider the last point critical to the project (see grading algorithm), so be certain that you do the diagnosis and do an excellent job on it. Include 2 to 3 supplementary figures from additional data or analyses collected for the interesting days, but no more than 4 figures under any circumstances. (Figures not counted against the page limitation.) The teaching team will view a deficient or excessive number of figures, or figures of marginal value, unfavorably. Your write-up must be **no longer than two double spaced pages using #12 Times font**; again the limit does not include figures. That is very little space (about 25% of the words in this description), so no fluff and no filler. Make every word count and choose your words judiciously.

I have posted in the d2I Content section the file "Example Term Project". I offer it as an unfinished example (References lack requisite detail.) of "what" I am looking for. It is *NOT a file for you to cut-and-paste* large portions of passages into your document, even if the specific descriptors (e.g. dates) differ. Such acts will be considered plagiarism and addressed accordingly.

### GRADING STANDARDS

Your grade will be based on the following criteria, in no order of importance for

points 2 through 4.

- 1) Sound, succinct diagnosis of the weather during your period of interest that is based on course concepts. *This is the most important component of the project, and it correspondingly accounts for a large portion of the project grade.*
- 2) Sensible and defensible reason(s) for choosing your weather event as interesting or significant weather during the 3-week period.
- 3) Demonstration of complete, accurate data collection.
- 4) Organization, clarity, grammar, punctuation, and overall professionalism. For writing guidance see [http://hbpub.vo.llnwd.net/o16/video/olmk/Grammar\\_Girl.pdf](http://hbpub.vo.llnwd.net/o16/video/olmk/Grammar_Girl.pdf) among many online guides.

### **DUE DATES**

The due date is before **5:00 pm on April 01, 2013**. The assignment must be in pdf format (i.e. a .pdf file) and self-contained into a single file; no other form is acceptable without penalty. Assignments can only be submitted through d2l. This means that you must “scan” or take a digital picture of any hand drawings into a digital format (.gif, .jpeg, .png) that can be imported into your word processing program. *You should complete your project at least two or three days prior to the due date to give yourself plenty of time to make certain your materials are properly uploaded.* Stuff happens, and not all good, when d2l is involved.

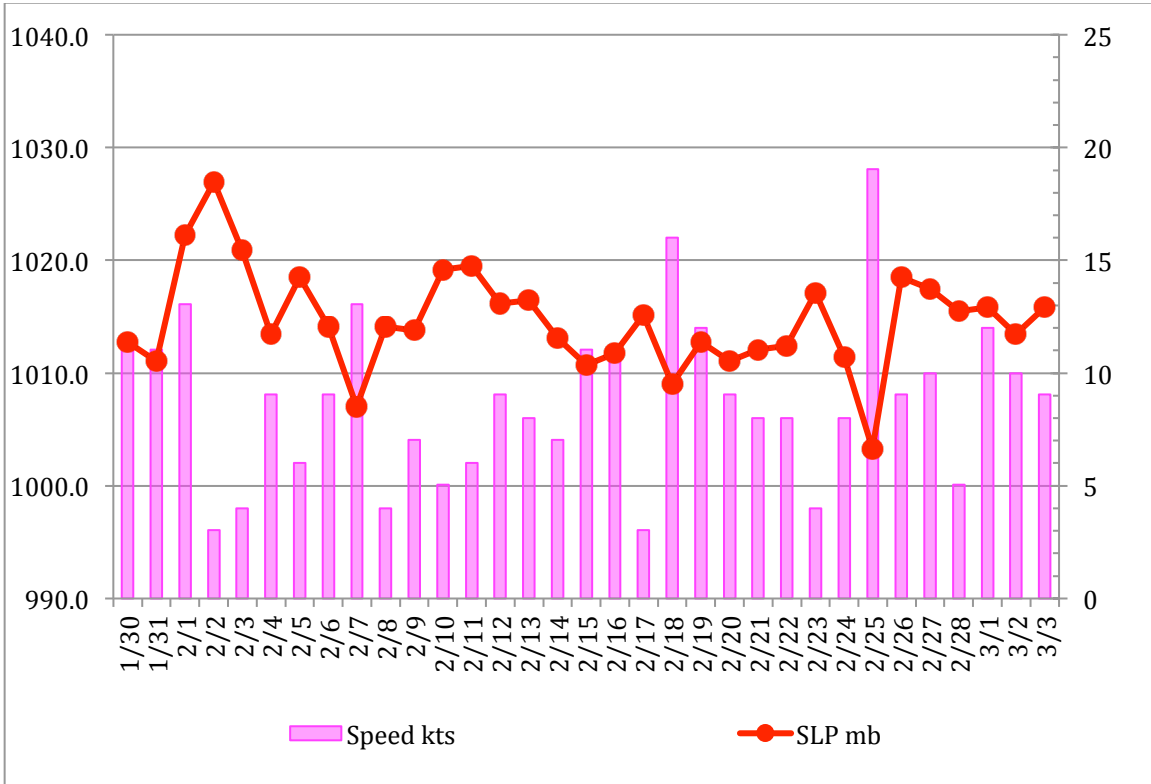
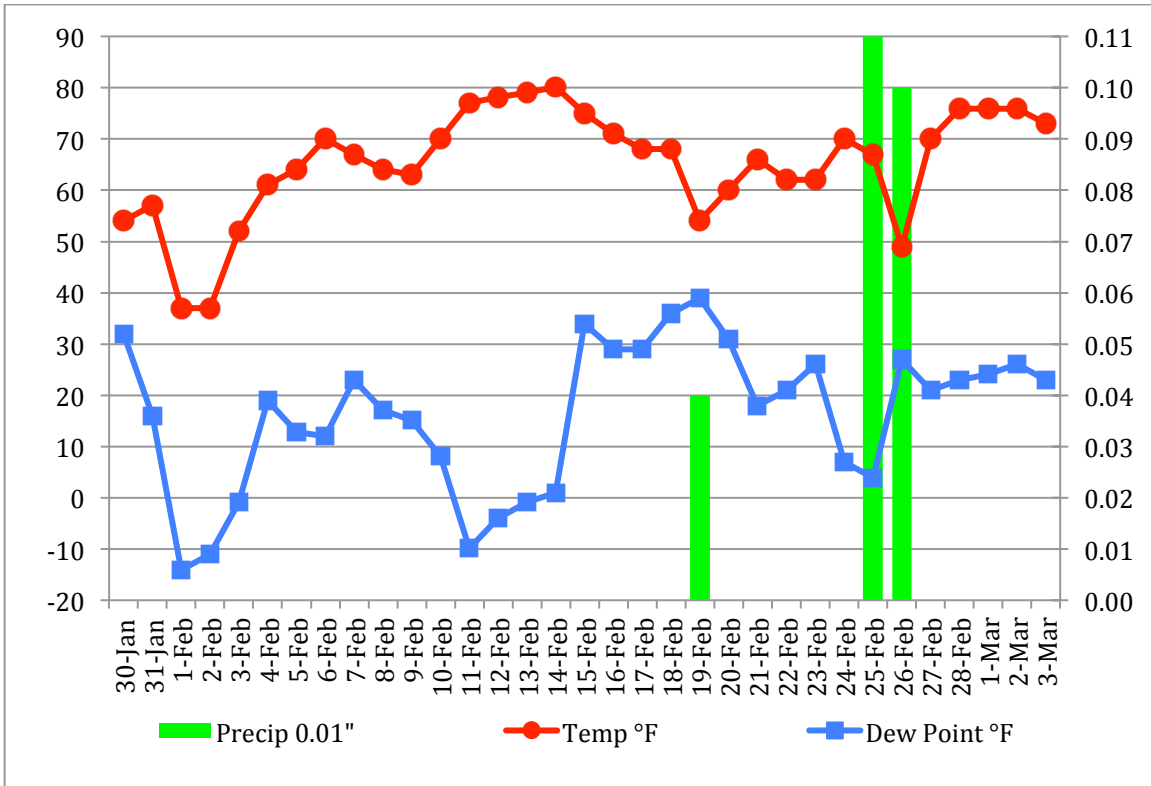
Late assignments, if I decide to accept them, accumulate a 10-point deduction per calendar day late. If your project is more than 5 days late, an “E” mark will be assigned to your project and course grade. Extensions of the due date will not be granted under any circumstances. If you fear some catastrophe event is going to happen to you (e.g. the next doomsday based on the end of a calendar for some extinct civilization), start the project now and finish it long before the deadline...besides, think how nice it would be to finish the project early in the term so the it does not conflict with projects, term papers or final exams in other courses!

### **A FEW WORDS ON PLAGIARISM**

I value academic integrity. In accordance with University of Arizona policy, plagiarism on this assignment is a violation of the Code of Academic Integrity and penalties described therein will be enforced. Plagiarism is defined as copying (including copying test answers) or paraphrasing someone else’s work without proper citation. Every write-up will be screened by plagiarism software and manually screened to check authorship and to check for similarity with other classmates and papers from prior classes. **Do not do it.** It is becoming boringly easy to identify suspected acts of plagiarism with today’s computerized matching software. ***I am professionally obligated to investigate suspected violations of the Code and to “write up” what appear to be unequivocal ones.*** For further details see: <http://deanofstudents.arizona.edu/academicintegrity> .



	<p>54 128 32 .00</p> <p>Jan 31</p>	<p>57 111 16</p> <p>Feb 01</p>	<p>37 222 -14</p> <p>Feb 02</p>	<p>37 270 -11</p> <p>Feb 03</p>	<p>52 209 -1 V4</p> <p>Feb 04</p>	<p>61 134 19</p> <p>Feb 05</p>
<p>64 185 13</p> <p>Feb 06</p>	<p>70 141 12</p> <p>Feb 07</p>	<p>67 070 23</p> <p>Feb 08</p>	<p>64 141 17</p> <p>Feb 09</p>	<p>63 138 15</p> <p>Feb 10</p>	<p>70 192 8</p> <p>Feb 11</p>	<p>77 195 -10</p> <p>Feb 12</p>
<p>78 161 -4</p> <p>Feb 13</p>	<p>79 145 -1</p> <p>Feb 14</p>	<p>80 131 1</p> <p>Feb 15</p>	<p>75 107 34</p> <p>Feb 16</p>	<p>71 117 29</p> <p>Feb 17</p>	<p>68 157 29 V3</p> <p>Feb 18</p>	<p>68 090 36</p> <p>Feb 19</p>
<p>154 128 39 .04</p> <p>Feb 20</p>	<p>60 111 31</p> <p>Feb 21</p>	<p>66 121 18</p> <p>Feb 22</p>	<p>62 124 21</p> <p>Feb 23</p>	<p>62 172 26</p> <p>Feb 24</p>	<p>170 114 7</p> <p>Feb 25</p>	<p>67 033 4 .11</p> <p>Feb 26</p>
<p>44 185 27 .10</p> <p>Feb 27</p>	<p>70 175 21</p> <p>Feb 28</p>	<p>76 155 23 V5</p> <p>Mar 01</p>	<p>76 158 24</p> <p>Mar 02</p>	<p>76 134 26</p> <p>Mar 03</p>	<p>73 158 23</p> <p>Mar 04</p>	





Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	○ Feb 11	○ Feb 12	○ Feb 13	○ Feb 14	○ Feb 15	○ Feb 16
○ Feb 17	○ Feb 18	○ Feb 19	○ Feb 20	○ Feb 21	○ Feb 22	○ Feb 23
○ Feb 24	○ Feb 25	○ Feb 26	○ Feb 27	○ Feb 28	○ Mar 01	○ Mar 02
○ Mar 03	○ Mar 04	○ Mar 05	○ Mar 06	○ Mar 07	○ Mar 08	

# First Period

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	○ Feb 11	○ Feb 12	○ Feb 13	○ Feb 14	○ Feb 15	○ Feb 16
○ Feb 17	○ Feb 18	○ Feb 19	○ Feb 20	○ Feb 21	○ Feb 22	○ Feb 23
○ Feb 24	○ Feb 25	○ Feb 26	○ Feb 27	○ Feb 28	○ Mar 01	

# Second Period

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	○ Feb 18	○ Feb 19	○ Feb 20	○ Feb 21	○ Feb 22	○ Feb 23
○ Feb 24	○ Feb 25	○ Feb 26	○ Feb 27	○ Feb 28	○ Mar 01	○ Mar 02
○ Mar 03	○ Mar 04	○ Mar 05	○ Mar 06	○ Mar 07	○ Mar 08	