Physics 137, Section 1, Winter Semester
Introduction to the Atmosphere and Weather

OBSERVATIONAL PROJECTS

During the present semester each student will be required to complete and submit a report on one observational project or present one TV-type weather forecast. A list of a few possible observational projects is here provided. Students who desire to do a project of their own design rather than one of the suggested projects are encouraged to do so. However prior approval of the instructor should be obtained for an individually designed project. Use of simple personal instruments such as thermometers, barometers, etc. is permitted, but certainly not required, for many of the suggested projects or for individually designed projects.

Generally the projects are simple enough that they easily can and should be completed individually. However for certain projects, where it is clearly advantageous, collaboration may be allowed in the collection of data if permission to do so is obtained from your instructor in advance. All project reports should be prepared individually!

For many of the projects it is advantageous, or even necessary, to begin working early in the semester since observations are required over an extended period of time. Procrastination will significantly limit the number of projects from which you may choose and may adversely affect your grade.

The Report

Reports should be brief but should include all essential data, results, conclusions, and should show or explain how the results and conclusions were inferred from the data. Depending on the nature of the project, information in the report might include times, dates and places of observations; weather conditions at times of observations, data tables, charts, sketches, graphs, descriptions of what was observed, calculations, and statements and explanations of results and conclusions. Estimates of the errors in both one's data and in one's conclusions should be made. It is appropriate to report what is personally learned from the project, including personal impressions. Extensive background material is neither expected nor desired.

It is expected that besides containing the above information the report will conform to the standards of good writing. It will be graded in accordance with those standards. Thus errors in grammar, punctuation, and spelling as well as lack of clarity and awkward structure will be penalized. If you so choose your report may be handwritten, but, if handwritten, it must be neat enough to be read without difficulty in order to avoid a penalty.

Honesty is valued above impressive data in grading reports. If there is evidence that data have been copied or fabricated (and it is usually more difficult to fabricate convincing data than to obtain it honestly) an appropriately low score, probably zero, will be assessed. If the accuracy of some of your data is questionable, indicate possibly bad data, with an explanation, in your report and assign it an appropriately low weight in drawing conclusions.
A caution: Some of the suggested projects involve making observations at the same time each day or, at least, recording of the time of day. Remember that we switch from Mountain Standard Time (MST) to Mountain Daylight Time (MDT) on the second Sunday of March (March 10, 2013) and that $MDT = MST + 1$ hour. Remember to allow for the change of time, e.g., if you are recording the temperature each day at 6 pm before March 10 you should change your observation time to 7 pm on that date and thereafter.

Suggested Observational Projects

1. Make an accurate sketch (or use a photograph) of the western horizon as seen from some convenient location from which you can observe the setting sun on successive occasions. (Any open location to which you have easy access at the appropriate time of day is suitable.) Mark the due west point on your sketch. Watch the sunset at least once or twice each week of the semester and mark on your sketch the location, the date and the time of each sunset. Over the period of the semester both the north-south motion of the sun and the variation in the time of sunset will be readily apparent. You should also be able to note changes in both the rate of north-south motion of the sun and the rate of change in the time of sunset.

In order to obtain good results you must (1) have an accurate representation of the western horizon as it appears from your observation point, (2) confine your observations to that same point (a displacement of even a few tens of feet could noticeably change the silhouette of the apparent horizon and introduce significant errors into your results) and (3) make regular observations throughout the term. You may obtain, by clicking below, a sketch of the western horizon as it appears from the hilltop above the stairs to the Richards PE Building. However, do not use this sketch if you plan to observe from your apartment or any location other than the one for which it has been prepared! In those cases, if possible, you should photograph the western horizon from your point of observation and use an enlargement of that photograph for plotting the point at which the sun sets. For this purpose, a high resolution photo is not necessary. Even an enlargement of a cell phone photo will be of sufficient quality. If you choose this project, please begin very early, within the first few days, in the semester. Otherwise you will miss much of the total change. If you have accurate data over much of the semester, you should also also be able to make some inferences about the rates at which the daily rates of change of both the time and position of sunset themselves change.

Click here for a BYU Campus horizon sketch.

2. Keep a daily log of one or more weather elements from the beginning of the semester to the project report deadline. Possible elements include (1) temperature at a particular time of day, or daily maximum, minimum, mean or range; (2) barometric pressure, (3) humidity, (4) cloud cover, (5) precipitation, (6) visibility and (7) wind speed. You may record these elements at any location you choose but that location should be the same every day. You may use personally owned instruments to make observations at a location of your choice (preferred option) or you may make observations at BYU using the data available in the office of the Geography Department, 690E Kimball Tower (SWKT). You may also acquire your (somewhat limited) data from the display on the north side of the Eyring Science
Center foyer or from the charts posted in the ground floor hallway, southeast section, of the Kimball Tower. Be sure to state in your report the exact location of the instrument(s) used for observations.

If you use a personally owned thermometer to make observations make sure that that instrument is located out of the sun, about 5 feet above the ground, preferably over grass, and away from buildings so that it will give as accurate a reading of air temperature, consistent with the adopted standards for meteorological measurement, as possible. (An interesting variation on this project is to use two instruments, one positioned in accordance with Weather Service standards, and the second positioned very nearby in violation of at least one of those standards to see what effect these modifications have on the recorded temperature, but, if you compare readings from two different instruments, correct for any systematic differences in the readings yielded by those two instruments. Another interesting variation is to use multiple instruments in relatively nearby locations and compare and explain the results, e.g., BYU campus versus the Provo Airport or Orem, or even the ESC rooftop instruments versus the official BYU weather station instruments which are located below the bench location of most of the campus or the SWKT rooftop instruments.)

What systemic changes do you see in your chosen element(s) over the course of the semester?

3. An interesting variation on project #2 is to compare some weather element, e.g., the daily maximum or minimum temperature, with the forecast value for that element taken from the previous day's weather forecast. If you do this project the results will be most meaningful if you always get your weather forecasts from the same source at the same time of day. What kinds of weather are associated with the most and least accurate forecasts of meteorologists?

3.5 A interesting variation on the project of recording the maximum temperature each day is to also record the time of the day's maximum temperature. You can easily determine this by regularly visiting the website http://marvin.byu.edu/Weather/cgi-bin/textbritish24hr. (Caution, some days may require you to visit the website more than once to capture all of the necessary data.) Plot the time of temperature maximum versus date. What trends do you see. Try to explain your observations.

4. How accurate are the Weather Service's precipitation forecasts? Keep a log comparing the number of precipitation forecasts at each percentage level with the number of times measurable precipitation actually occurred, e.g., what percentage of the time, on days when a 40-percent probability of precipitation was forecast, did measurable precipitation actually occur? (If you do this project, make sure your observations extend over the entire semester to maximize your data base. Even then your conclusions may not be statistically well-supported if we have an unusually dry semester. You could get better statistical support by choosing to do the project for a city with a wetter climate than Provo. However your results would probably not hold true locally.)

5. Use a daily log of weather elements to look for correlations between various weather elements or correlations involving relationships between those elements. For example, the daily temperature range (the difference between the daily maximum and minimum temperatures) could be related to the
relative humidity, the amount of cloud cover and even the time of year. Investigate such a relationship
then attempt to explain what you learn.

6. Abrupt changes in weather are often associated with frontal passages. Use daily logs to look for such
correlations, e.g., keep track of how many times during the semester the daily temperature change (the
temperature difference on successive days obtained by comparing highs, lows or means) is . . . ., -3°F, -
2°F, -1°F, 0°F, +1°F, +2°F, +3°F, . . . . How many times for each of those changes was there a frontal
passage during the intervening day?

7. Keep track of the elevation of the individual-storm snowline as it fluctuates from storm to storm.
After each storm record the date and the approximate elevation of the lowest snowline associated with
that particular storm. (The "individual-storm snowline" refers to the snowfall from that particular storm
only, not to the elevation of residual snow which may persist on the mountains from previous storms.)
To do this project you will need to consult some local topographical maps (or use the data in Appendix A
of the Course Outline) to determine the elevation of the snowline. Why doesn't the snowline (usually)
ascend smoothly in elevation as winter turns to spring?

8. Use data as in project #7 to calibrate a crude local temperature-snowline relationship. What is the
temperature on campus when the snowline during an ongoing storm is right at the summit of
Timpanogos, at the summit of Y Mountain, at the summit of Squaw Peak, at the block "Y", just at the
level of campus, etc.? (When the cloud bases are above the snowline as is sometimes the case during
our storms one can tell where the snowline is from the opacity of the precipitation.) Do these questions
always have the same answer or just approximately so? If there is variation, about how much does that
appear to be?

9. During the course of the semester observe as many types of atmospheric optical phenomena as
possible (at least 6 different kinds of phenomena are required in order to be eligible for the maximum
possible 50 points on the report of this project). A partial list of such phenomena includes crepuscular
rays, unusual coloration of the sun or moon, variations in the color of the clear sky, stellar twinkling or
scintillation, the green flash, a superior mirage, an inferior mirage, a solar halo, a lunar halo, an upper
tangent arc, a lower tangent arc, a sundog, a sun pillar, rainbows (primary and/or secondary; be sure to
note the relative brightness of the sky inside the primary, between the bows and outside the secondary),
a circumzenithal arc, a solar or lunar corona, cloud iridescence, the glory, the brocken bow and the
heiligenschein. Describe your observations in as much detail as possible. Be sure to give the places,
times and dates of your observations, the location of each phenomenon in the sky with respect to the
sun and/or moon, sky conditions, weather conditions, approximate temperatures, and any other data
you believe might be relevant to your observations. Attempt to explain, in each case, the physical causes
of the phenomenon observed. Sketches or diagrams, including estimates of angular scale, should be
used to the extent possible. When possible observe each type of phenomenon on two or more
occasions, note differences in the observations, and attempt to explain those differences.

10. Compare the behavior of some weather element(s) at various sites, e.g., how does the average daily
temperature range for Winter Semester compare at Provo, and a selected group of other sites. Such
comparisons are interesting whether the comparative sites are highly local, restricted to Utah, national or international. (It would be interesting to compare the seasonal progression of temperature in Provo with a southern hemisphere site, where the trend should be in the opposite direction.) In any case, make your best attempt to explain your observations, *i.e.*, explain why the element(s) you have chosen exhibit the differences in behavior you have observed at the sites you have selected.

11. Observe the nocturnal radiation inversion by using two or more thermometers set at different heights. (Beware of systematic differences in the readings of the two instruments.) There are several different possibilities here, *e.g.*, (a) Take simultaneous measurements at several heights to get the vertical temperature profile. (b) Observe the correlation between the strength of the inversion and other relevant weather variables such as wind or cloud cover. (c) Observe the strength of the inversion on the same mornings at different sites (which cannot be widely separated unless someone assists you). (One past student was sufficiently enthusiastic about this project, that he made eight early morning hikes to the "Y" to record the temperature difference between there and the valley floor!)

12. Monitor the temperature change in some body of water such as Utah Lake or Deer Creek Reservoir over the duration of the semester. (If you choose this project, measure the water temperature at least weekly, taking each measurement at the same site, at a constant depth and at the same time of day. An interesting variation of this project would be to measure the vertical temperature profile in a body of water at two or three widely separated times during the semester.)

13. Take a long mountain hike or a drive with a contour map or elevation enabled GPS, an accurate, appropriately calibrated thermometer, a backpack stove and a container of water to measure how the boiling point of water depends upon elevation. Be sure to span a sufficient range of elevations to get easily measurable results.

*Be creative! The last three projects were invented by students in recent classes!*