

**SJSU Annual Program Assessment Form
Academic Year 2015-2016**

Department: Meteorology and Climate Science
Program: BS in Meteorology
College: Science
Program Website: www.sjsu.edu/meteorology
Link to Program Learning Outcomes (PLOs) on program website: PLO for Meteorology
Program Accreditation (if any):
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Date of Report: June 1, 2016

Part A

1. List of Program Learning Outcomes (PLOs)

The PLOs for the Meteorology and Climate Science program follow closely the standards accepted by the American Meteorological Society ([AMS: BS in Meteorology recommendations](#)). The roadmap for the BS in Meteorology, following the guidelines from the AMS, includes courses in Mathematics, Physics, and Chemistry in addition to courses in the department that teach computer programming and statistics. The students take required meteorology courses covering atmospheric dynamics, atmospheric physics, and synoptic meteorology.

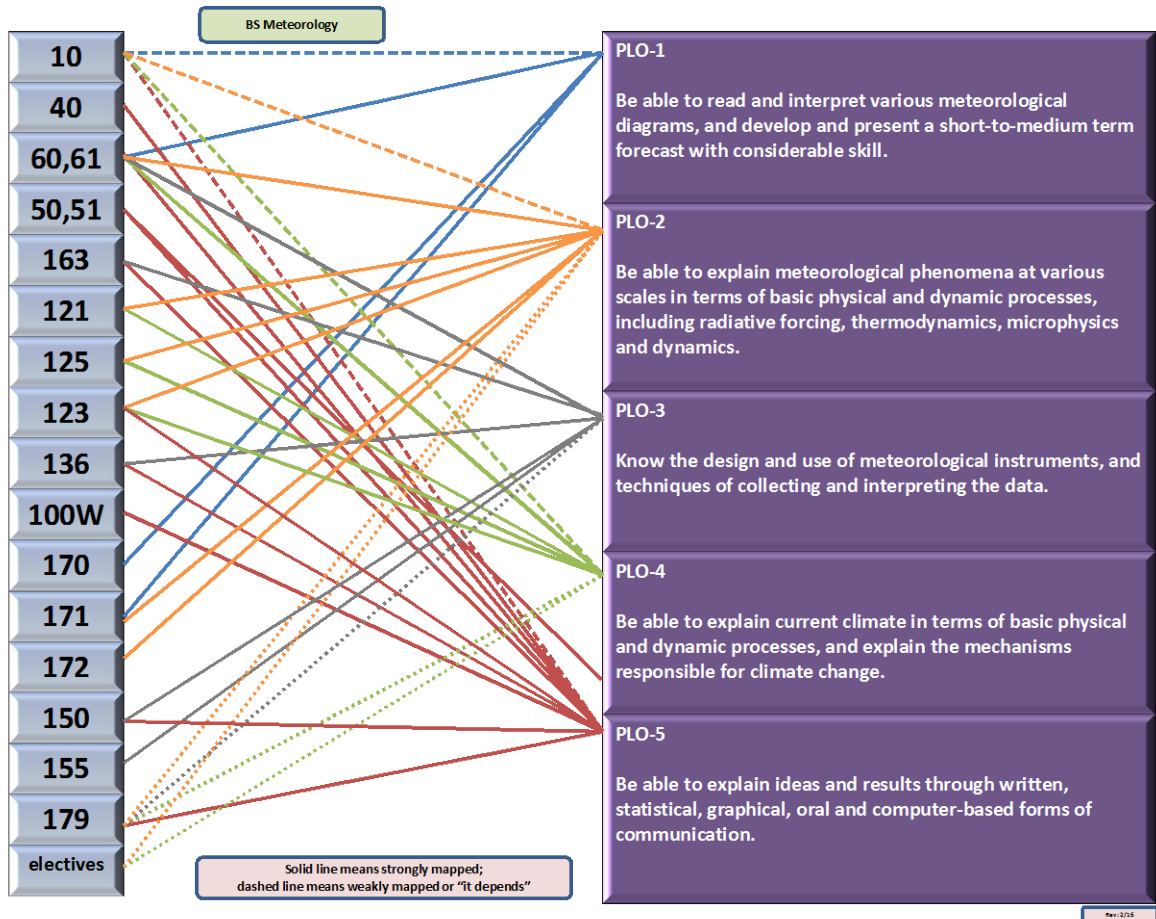
The PLOs for the BS Meteorology include:

1. Be able to read and interpret various meteorological diagrams, and develop and present a short-to-medium-term forecast with considerable skill.
2. Be able to explain meteorological phenomena at various scales in terms of basic physical and dynamic processes, including radiative forcing, thermodynamics, microphysics, and dynamics.
3. Know the design and use of meteorological instruments, and techniques for collecting and interpreting the data.
4. Be able to explain current climate in terms of basic physical and dynamical processes, and explain the mechanisms responsible for climate change.
5. Be able to explain ideas and results through written, statistical, graphical, oral and computer-based forms of communication.

2. Map of PLOs to [University Learning Goals \(ULGs\)](#)

		BS METEOROLOGY				
university	program	PLO-1	PLO-2	PLO-3	PLO-4	PLO-5
		charts & forecasting	explain met phenomena	met instruments & data	climate	communication
ULG-1	1.1	X	X	X	X	X
ULG-2	2.1	X	X	X	X	X
	2.2	X	X	X	X	
	2.3		X		X	
ULG-3	3.1	X	X	X	X	X
	3.2	X	X	X	X	X
ULG-4	4.1	X	X	X	X	
	4.2	X	X	X	X	X
	4.3	X	X	X	X	X
ULG-5	5.1		X	X	X	
	5.2				GE only	
courses		170,171	60,61,121,125,171	163	112	100W,179,170,171
				60,61,71,123,173,174		

3. Alignment – Matrix of PLOs to Courses



PLO3 Know the design and use of meteorological instruments, and techniques for collecting and interpreting data.

4. Planning – Assessment Schedule

(Please provide a reasonable, multi-year assessment plan that specifies when a PLO will be assessed (A), when you might plan to implement changes as a result of your assessment (I), and, if applicable, when you might reassess a given PLO (R) to gauge the impact of the change. All PLOs should be assessed at least once during each program planning cycle (usually 5 years). Add rows and columns as necessary.)

	AY 13-14	AY 14-15	AY 15-16	AY 15-16	AY 17-18
PLO 1					
PLO 2					
PLO 3					
PLO 4					
PLO 5					

5. Student Experience

- a. Most classes in the program maintain a CANVAS Course Management System website where the syllabus is readily available and instructors use the tools to communicate with the students.

- b. The students do not have an opportunity to provide feedback to the PLOs or the assessment activities.

Part B

6. Assessment Data and Results

We assess PLO 3 in this cycle: Know the design and use of meteorological instruments, and techniques for collecting and interpreting the data.

Many of the courses that are taught in Meteorology and Climate Science address this PLO, especially the techniques for collecting and interpreting data. One course in particular, METR 163, is specifically designed to address the design and use of instruments. For AY 2015-2016, we assess this PLO by evaluating METR 163 (Spring 2016) and METR 60 (Fall 2105) .

a. Meteorology 163

Catalog Description: Measurement techniques and instruments used in atmospheric and climate sciences, using lecture, laboratory, and fieldwork. Students will learn techniques of instrument calibration, deployment, and data acquisition.

Meteorology 163 is primarily for junior and seniors, although some graduate students take the course. This course in the SJSU Department of Meteorology and Climate Science is somewhat unique as few Atmospheric Science departments in the country include a course aimed specifically at learning the design, construction, calibration, and deployment of instruments and instrument platforms.

Lectures are designed to cover the theory and operation of instruments and the concepts and design of instrument layout. During laboratory work, students learn calibration and routine maintenance of instruments. Fieldwork includes overnight camping trips where students learn how to install in-situ instruments, such as surface based weather stations, and deploy remote sensing platforms, such as sodar and lidar.

We used a mid-term exam to evaluate student achievement. The exam indicates how comprehensive the course is and is attached as an appendix. The course covers basic concepts like terminology and standards established to ensure consistent observing techniques regardless of location. More advanced concepts include the physical basis for instrument design, the need for automation, and the deployment of instruments. Finally, the design of the layout of instrument networks for field experiment the value of the data that would be obtained.

b. Meteorology 60

Catalog Description: A quantitative introduction to Atmospheric Science for Meteorology majors.

Meteorology 60 is an introductory course where students learn the basics of obtaining and analyzing meteorological data, primarily at the synoptic scale, i.e. variability on a spatial scale of 300 to 3000 km or temporal scale of one day to one week. Most of the students are sophomores or transfers and this course is the first meteorology course for majors that is not a general education course (e.g. METR 10). To assess this PLO, we assessed the ability of the students to recognize and label major features on weather maps and their ability to interpret satellite data and relate it to the features they see on the weather maps

As part of one lab, students were given weather maps at three levels, i.e. the surface and two pressure levels in the free atmosphere: 700 hPa (about 3000 meters above sea level), and 500 hPa (about 5500 meters above sea level). The students were then asked to identify key features at each of the three levels that are typical reasons why the three levels are used. For instance, they identified cyclones (lows) and anticyclones (highs) at the surface and asked to identify areas where the horizontal winds would be strongest and in what direction the wind would blow.

Features at the surface are related to the dynamics through the entire troposphere. For example, at 700 hPa, they were asked to identify areas with positive (upward) and negative (downward) vertical velocity, areas where clouds would generally form or dissipate respectively. Similarly, at 500 hPa, they were asked to identify the troughs and ridges in the long wave pattern that influences the movement and development of the lows and highs.

Students were taught the basic physical concepts behind satellite instrumentation used to observe the atmosphere. In another lab, students were asked to define what physical principles that satellites use to observe clouds and describe the differences between visible and infrared (IR) satellite images. As part of the exercise, the students were asked to compare the advantages and disadvantages of the two techniques. Additionally, the students were asked to relate what they observed on the satellite images to what they saw on the weather maps that they used in the earlier maps, including regions with cyclonic flow, and regions that were cloudy and regions that were cloud-free.

7. Analysis

Several courses in the BS with Meteorology concentration address this PLO. Two courses, an introductory course for sophomores and transfers into the program, and a more advanced course for juniors and seniors (and some grad students) were chosen to evaluate the PLO. We believe that these courses represent the entire program quite well regarding this PLO.

METR 163

The students in general showed a reasonable grasp of the material and an understanding of how instruments work. There were nine undergraduate students in the class: three received grades equivalent to A, two in the B+ to A- range, three in the C+ to B- range and one C. Six or seven of the students received a grade of B or above on the midterm, indicating that the PLO was satisfied. We can infer from that range of scores that the material is being covered well and grasped reasonably by the students.\

Additionally, the student who received the lowest grade on the midterm improved and earned an A on the final exam. The PLO is satisfied when the students invest the required time and effort.

METR 60

The questions were asked in the laboratory portion of the class and students were allowed to use books and computers to complete the lab. All of the students did quite well. In the lab

We used two lab exercises to evaluate student achievement. One of the labs introduces students to the analysis and use of weather maps. The other lab introduces students to the instruments deployed on satellites used to observe the atmosphere from space. The two labs

run consecutively and introduce students to the three-dimension nature of the atmosphere. The two lab assignments are attached as appendices.

All seven students got perfect scores on the first lab, and five received perfect scores on the second lab. Of the two who did not receive a second perfect score, one turned in the lab report late, and the second stopped attending class.

Therefore, we conclude that the students mastered the material and the PLO is satisfied.

8. Proposed changes and goals (if any)

Although the two courses represent the program quite well, other courses may be used in the future to indicate how comprehensively this PLO is attained in the program.

Part C

(This table should be reviewed and updated each year, ultimately providing a cycle-long record of your efforts to improve student outcome as a result of your assessment efforts. Each row should represent a single proposed change or goal. Each proposed change should be reviewed and updated yearly so as to create a record of your department's efforts. Please add rows to the table as needed.)

Proposed Changes and Goals	Status Update
See last year's for (AY14-15)	satisfactory
None (AY 15-16)	

Appendices:

- 1) Midterm Exam, METR 163
- 2) Lab Exercise #8, METR 60
- 3) Lab Exercise #9, METR 60

Name _____

Midterm Exam

5 April 2016

Met 163: Meteorological Instruments
Prof. Clements
115 Points

Complete each question to the best of your ability. Partial credit will be given. Points are given for each question. Use extra paper as needed.

1. (12) Define each term:

a. Observation

b. Measureand

c. Distance Constant

d. Wind run

e. Gust lull speed

f. Hygristor

2. (5) List 5 instrument platforms:

13b. (2) Most anemometers have a threshold speed on the order of _____ m s⁻¹.

14. (5) (a) Describe how a sonic anemometer works and (b) what it measures.

15. (2) What is the advantage of a 2-D sonic anemometer over a cup anemometer?

16 (18). Given the following equation, calculate the *water vapor mixing ratio, r*, for an air temperature of T = 24.5°C, relative humidity of 30%, and at an altitude where P =1000 kPa, where e_o = 0.611 kPa, T_o = 273 K, R_v = 461 J K⁻¹ kg⁻¹ is gas constant for water vapor, L= 2.5x10⁶ JKg⁻¹ latent heat of vaporization, and ε = R_d/R_v = 0.622 g g⁻¹.

(2) Name a type of humidity sensor that will provide the humidity value needed for this calculation: _____

$$e_s = e_o \cdot \exp \left[\frac{L}{R_v} \cdot \left(\frac{1}{T_o} - \frac{1}{T} \right) \right]$$

17. (4) Given the momentum budget equation for a slope wind, name the *type of instrument* best used to measure Term I and Term V.

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + w \frac{\partial u}{\partial z} = -\frac{1}{\rho_r} \frac{\partial p}{\partial x} + g \frac{d}{\theta_r} \sin \alpha - \frac{\partial(\overline{u'w'})}{\partial z}$$

I
II
III
IV
V

where u and w are velocity components in the x and z directions, ρ_r is a reference density, p is the pressure, g is gravitational force, d is the potential temperature deficit in the flow, θ_r is the reference potential temperature, and α is the slope angle.

Term I is the storage of momentum

Term II is advection

Term III is the horizontal pressure gradient force

Term IV is the buoyancy force

Term V is the turbulent momentum flux

Instrument for Term I _____

Instrument for Term V _____

19. (8) Given the following CR1000 data logger program identify the following:

1. (1) The sampling rate of the program (the rate at which the sensors are sampled)
2. (1) The averaging period of the data storage for table 1
3. (1) The averaging period for table 2
4. (1) What type of thermocouple is used
5. (1) What is the offset for anemometer speed?
6. (3) Indicated three errors in the program

'CR1000 program for Midterm Exam

'Created by Prof. Clements

' 5 April 2016

'Declare Variables and Units

Public P_Temp, 'panel temp

Public Temp_C 'thermocouple

Public WS_ms '05103 Wind Speed

Public WindDir '5103 Direction

Units PanelTemp=Deg C

Units Temp_C=Deg C

Units WS_ms=meters/second

Units WindDir=Degrees

Units SlrW=W/m²

'Define Data Tables

```
DataTable(Table1,True,-1)
  DataInterval(0,5,Min,10)
  Average (1,Batt_Volt,FP2,False)
  Average (1,P_Temp,FP2,False)
  Average (1,TC,FP2,False)
  Average (1,WS_ms,FP2,False)
  Average (1,WindDir, FP2),False)
  Average (1,SlrW,FP2,False)

DataTable(Table2,True,-1)
  DataInterval(0,1,Sec,10)
  Sample(1,Temp_C,FP2,False)
EndTable

Scan(1,Sec,1,0)

  TCDiff(Temp_C,1,mV2_5C,1,TypeE,P_Temp,True,0,_60Hz,1,0)

  PulseCount(WS_ms,1,1,1,1,0.098,0)
  BrHalf(WindDir,1,mV2500,3,1,1,2500,True,0,_60Hz,355,0)
  If WindDir>=360 Then WindDir=0

  VoltSE(SlrW,1,mV250,4,1,0,_60Hz,1,0)
  If SlrW<0 Then SlrW=0

  CallTable(Table2)
NextScan
EndProg
```

20. (15) You are a consulting meteorologist and are asked by the Bay Area Air Quality Management District to conduct a study on the effects of a new coal fired power plant to be developed in Santa Clara Valley (SCV). The question the BAAQMD is asking you to answer is what would be the dispersion of pollutants in Santa Clara Valley during nighttime conditions and what is the strength of the temperature inversions in the valley. Design a field study to measure the atmospheric temperature inversions of Santa Clara Valley.

1. Summarize your measurement strategy
2. List at least 3 platforms you would use
3. List the instruments to be deployed including their specifications (response time)
4. Discuss the locations of deployments.
5. Discuss the variables you would measure
6. Describe any calculations you would make from your measurements

You can use the space below to draw an idealized map of SCV and where you would place your instruments.

Lab #8 - Introduction To Satellite Imagery

Met 60, Fall 2015

20 Points

Due Thursday 10/22/2015 at 10:00 AM

Name:

Part I General Information

In order to answer the following questions, read the section on satellite imagery in your text, 4.5.5.a (pg 139). Also see the PPT slides with some additional notes.

1) What does geostationary mean? And, what does GOES stand for?

2) How many times does a geostationary satellite orbit earth in one day?

3) What is the principle behind a visible satellite image?

4) What makes a cloud layer appear bright in a visible image?

5) What does a visible image depict well? What not so well?

6) What is the principle behind an infrared satellite image?

7) What makes a cloud layer appear bright in an infrared image?

8) What does an infrared image depict well? What not so well?

9) Go to <http://www2.mmm.ucar.edu/imagearchive/>. Select Jan 4, 2008 from the date dropdown menu, and study the animations for national visible and infrared imagery. On the attached visible and infrared satellite images, label the following

- Low clouds (stratus)
- Snow
- Cold Front
- Center of low
- Open cell cumulus
- Closed cell cumulus
- Cloud band
- Gulf Stream

Go to <http://www.met.sjsu.edu/weather/gfsone-ex.html>

500 mb map:

Label all troughs and ridges using appropriate color conventions. Discuss areas of positive and negative vorticity, and where these are in relationship to trough and ridge axes.

700 mb map (with omega):

Discuss areas of positive and negative vertical velocities. Where are the highest values located? What are typical values of vertical velocity? (rule of thumb: vertical velocity = omega/10).

Surface map:

Describe the location and strength of the cyclones and anticyclones on today's weather map – what are the central pressures? Label area(s) of the weakest + strongest winds (hint: look at the isobar spacing).

Go to <http://www.met.sjsu.edu/weather/models.html>

Forecasting fun:

Take a look at the NAM and GFS Surface Analysis – Precip and 500 mb – temp products. For the west coast (specifically focusing on California), explain the current pattern and then what will happen over the next 5 days (similar to a tv meteorology discussion).