

MOHAWK VALLEY COMMUNITY COLLEGE
UTICA and Rome, NEW YORK

COURSE NUMBER WE101

Introduction to Weather Studies
(4 CREDITS)

Reviewed by Dr. Robert Jubenville March 2019

Course Number: WE101

C-3, P-2, Cr-4

Course Title: Introduction to Weather Studies

Catalog Description: This course introduces students to the science of weather, while highlighting the important concepts behind that science. Prepared by nationally recognized atmospheric scientists and educators at the American Meteorological Society, it provides the opportunity for students to access and work with current weather data and graphics which have been specifically designed for the course. Fundamental scientific principles are studied through their application to everyday weather events. Meteorology in action and the workings of the dynamic atmosphere are observed by following weather as it happens, in near real-time and/or by using recent real-world data and case studies. There is an emphasis on using the analysis and decision-making skills employed by meteorologists to diagnose weather patterns, understand air motions, and predict future atmospheric conditions.

Course Prerequisite: Placement test score in ACT4 above 35 or completion of MA 090 or 091.

Recommended Text: *Weather Studies: Introduction to Atmospheric Science* text covers the basic understandings of meteorology. The primary author of the text is through the American Meteorological Society (AMS) A Laboratory Investigations Manual through AMS is also required.

Major topics:

1. Historical Perspective and Monitoring the Weather
2. Atmosphere: Origin, Composition, and Structure
3. Solar and Terrestrial Radiation
4. Heat Temperature and Atmospheric Circulation
5. Air Pressure
6. Humidity, Saturation, Stability
7. Clouds, Precipitation, and Weather Radar Break
8. Wind and Weather
9. Atmosphere's Planetary Circulation
10. Weather Systems in Middle Latitudes
11. Thunderstorms and Tornadoes
12. Tropical Weather Systems
13. Weather Analysis and Forecasting
14. Light and Sound in the Atmosphere*

*Optional chapter if time allows

Timetable for Lecture and Laboratory Investigations

Week	Current Weather Studies A (Posted about Monday noon ET)	Current Weather Studies B (Posted about Wednesday noon ET)
Text Readings		
1 Historical Perspective and Monitoring the Weather	Air Pressure and Wind	Surface Air Pressure Patterns
2 Atmosphere: Origin, Composition, and Structure	Air Pressure and Wind	Surface Air Pressure Patterns
3 Solar and Terrestrial Radiation	Surface Weather Maps	The Atmosphere in the Vertical
4 Heat Temperature and Atmospheric Circulation	Weather Satellite Imagery	Sunlight Throughout the Year
5 Air Pressure	Temperature and Air Mass Advection	Heating Degree-Days and Wind Chill
6 Humidity, Saturation, Stability	Air Pressure Change	Atmospheric Pressure in the Vertical
7 Clouds, Precipitation, and Weather Radar	Clouds, Temperature, and Air Pressure	Rising and Sinking Air
<i>Break</i>	-----	-----
8 Wind and Weather	Precipitation Patterns	Doppler Radar
9 Atmosphere's Planetary Circulation	Surface Weather Maps and Forces	Upper-Air Weather Maps
10 Weather Systems in Middle Latitudes	Westerlies and the Jet Stream	-El Niño
11 Thunderstorms and Tornadoes	The Extra-Tropical Cyclone	Extra-Tropical Cyclone Track Weather
12. Tropical Weather Systems	Thunderstorms	Tornadoes
13. Weather Analysis and Forecasting	Hurricanes	Hurricane Wind Speeds and Pressure Changes
14. Light and Sound in the Atmosphere*	Weather Analysis/Forecasting	Weather Instruments and Observations
*optional if time allows		

Student Learning Outcomes:

Chapter Learning Outcomes:

Chapter 1:

After reading this chapter, the student should be able to:

- distinguish between weather and climate.
- list some sources of daily weather information.
- identify the principal weather systems that are plotted on surface weather maps.
- describe some of the properties of weather systems including highs, lows, and fronts.
- define the common parameters used to describe the state of the atmosphere.
- distinguish between geostationary and polar-orbiting satellites.
- distinguish between visible and infrared satellite images.
- explain the advantages of satellite observation of the atmosphere.
- present the basic principle of weather radar.
- provide some examples of how observations of the sky provide indications of future weather.

Chapter 2:

After reading this chapter, the student should be able to:

- describe the principal events and processes in the evolution of Earth's atmosphere.
- explain the important role of the ocean in the evolution of the atmosphere.
- distinguish between the homosphere and the heterosphere.
- explain the significance of minor components of the atmosphere.
- explain how meteorologists monitor surface and upper-atmospheric conditions.
- sketch the average vertical temperature profile of the atmosphere.
- distinguish between the troposphere and the stratosphere.
- describe the origin and significance of the ionosphere.
- explain how solar activity influences the ionosphere.

Chapter 3:

After reading this chapter, the student should be able to:

- identify the principal characteristics of radiation and the electromagnetic spectrum.
- distinguish among the various forms of electromagnetic radiation.
- explain how solar altitude influences the intensity of solar radiation received at Earth's surface.
- explain the significance of the stratospheric ozone layer for life on Earth.
- identify the principal threat to the stratospheric ozone shield.
- describe the interactions that take place when solar radiation strikes Earth's surface.
- explain the role of the ocean in the global solar radiation budget.
- identify the gases responsible for the greenhouse effect.
- explain how the continued buildup of greenhouse gases is likely to cause further global warming.

Chapter 4:

After reading this chapter, the student should be able to:

- distinguish between temperature and heat.
- compare and contrast the various temperature scales.
- describe how temperature is measured.
- explain how heat is transported via conduction and convection.
- explain how heat is transported via phase changes of water.
- contrast a continental climate with a maritime climate.
- describe the imbalances in radiational heating and cooling within the Earth-atmosphere system.
- identify the various processes responsible for poleward heat transport.
- explain the seasonal and diurnal lag between radiation and temperature.
- describe how properties of Earth's surface influence air temperature.

Chapter 5:

After reading this chapter, the student should be able to:

- define air pressure.
- explain the significance of air pressure tendency for local weather forecasting.
- describe how air pressure and air density change with altitude.
- explain how and why meteorologists adjust air pressure readings to sea level.
- describe how air temperature and water vapor concentration influence the density of air and air pressure at the Earth's surface.
- show how divergence and convergence of horizontal winds can cause changes in air pressure.
- discuss how surface air pressure varies with different types of air masses.
- explain why ascending air cools whereas descending air warms.
- describe the adiabatic process

Chapter 6:

After reading this chapter, the student should be able to:

- identify the principal reservoirs in the global water cycle.
- distinguish among the various phase changes of water.
- describe the role of latent heat in phase changes of water.
- list some of the implications of the global water budget.
- compute the relative humidity from either the mixing ratio or the vapor pressure.
- explain why and how relative humidity is temperature dependent.
- explain why the average precipitable water value generally decreases with increasing latitude.
- describe the operation of a sling psychrometer to determine relative humidity.
- explain how atmospheric stability is determined.
- plot a sounding on a Stüve thermodynamic diagram.
- describe how atmospheric stability affects vertical motion of air and cloud formation.
- list the various lifting processes that operate within the atmosphere.
- describe how a mountain range can influence the pattern of clouds and precipitation.

Chapter 7:

After reading this chapter, the student should be able to:

- explain the role of nuclei in cloud development.
- list the sources and types of cloud nuclei.
- describe how clouds are classified.
- distinguish among the principal cloud types.
- identify the various fog-forming processes.
- list conditions required for extreme nocturnal radiational cooling. .
- distinguish between warm clouds and cold clouds.
- describe the Bergeron-Findeisen process.
- distinguish among the various solid and liquid forms of precipitation.
- explain how weather radar detects precipitation.
- distinguish between the reflectivity and velocity modes for weather radar.
- describe how rain and snow are measured directly and remotely.

Chapter 8:

After reading this chapter, the student should be able to:

- identify the forces that initiate and govern the circulation of air.
- present the origins of horizontal air pressure gradients.
- explain the source of the centripetal force.
- describe how the Coriolis Effect varies with latitude.
- explain how friction influences the magnitude and direction of surface winds.
- describe the circulation in cyclones and anticyclones.
- explain why stormy weather is associated with cyclones and fair weather with anticyclones.
- describe how winds are monitored.

Chapter 9

After reading this chapter, the student should be able to:

- list the principal components of the atmosphere's planetary-scale circulation.
- compare and contrast the planetary winds at the surface with those in the mid and high troposphere.
- describe the seasonal changes in the planetary-scale circulation.
- demonstrate how the prevailing planetary-scale circulation influences climate.
- describe how prevailing winds set up ocean surface currents
- describe the linkage between the polar front and the middle latitude jet stream.
- describe the connection between sea-surface temperature anomalies and changes in the planetary circulation.
- identify the changes that take place in the tropical Pacific ocean and atmosphere during El Niño and La Niña.

Chapter 10

After reading this chapter, the student should be able to:

- identify the various air masses that regularly form over or invade North America.
- describe how and why air masses modify as they travel away from their source regions.
- identify and distinguish among the various types of fronts.
- distinguish between warm frontal weather and cold frontal weather.
- explain why fronts are associated with extra-tropical cyclones but not with anticyclones.
- sketch and describe the stages in the life cycle of an extra-tropical cyclone.
- explain the linkage between a surface cyclone and the westerly flow aloft.
- identify the principal storm tracks across North America.
- describe the air mass advection associated with an anticyclone.
- compare and contrast sea (or lake) breezes with land breezes.
- explain the diurnal variation of winds in deserts and mountainous areas.

Chapter 11

After reading this chapter, the student should be able to:

- describe each stage in the life cycle of a thunderstorm cell.
- describe the role of atmospheric stability in thunderstorm development.
- explain how and why thunderstorm frequency varies across North America.
- list the characteristics of a severe thunderstorm.
- sketch the synoptic weather pattern that favors severe thunderstorms.
- explain why lightning is dangerous.
- distinguish between a microburst and a macroburst.
- explain why urban areas are particularly vulnerable to flash flooding.
- describe the origin and characteristics of hail.
- distinguish between a tornado and a funnel cloud.
- identify the principal force operating within a tornado.
- explain why tornadoes are most frequent in tornado alley.
- explain why tornadoes are most frequent in spring.
- identify and describe the hazards of tornadoes.
- present the basis for the EF-scale of tornado intensity.
- describe the linkage between severe thunderstorm cells and tornadoes.

Chapter 12

After reading this chapter, the student should be able to:

- describe the basic structure and characteristics of a hurricane.
- compare and contrast a hurricane with a typical extra-tropical cyclone.
- identify the oceanic and atmospheric conditions required for hurricane formation.
- locate the major hurricane breeding grounds.
- explain why hurricanes rarely strike the west coast of North America.
- explain why hurricanes are most common in late summer and autumn.
- describe the basis of the Saffir-Simpson Hurricane Intensity Scale.
- present the life cycle of a tropical cyclone.

- explain why the southeastern United States is particularly vulnerable to a destructive hurricane.
- describe the basis for long range forecasting of Atlantic hurricanes.

Chapter 13

After reading this chapter, the student should be able to:

- explain the difference between surface weather maps and upper-air weather maps.
- describe the complementary roles of meteorologists and computers in weather data analysis and forecasting.
- identify the various components of NCEP and their responsibilities.
- explain how and why forecast skill changes with length of the forecast period.
- explain how meteorologists prepare long-range (e.g., seasonal) weather forecasts.

Chapter 14

After reading this chapter, the student should be able to:

- define scattering, reflection, refraction, and diffraction.
- explain why the daytime sky is blue.
- explain how halos and rainbows form.
- describe the optics of corona or a glory.
- explain twilight and twilight optical phenomena.
- distinguish between light and sound waves.
- explain how and why sound waves undergo refraction.
- identify some of the consequences of sound wave refraction.

Laboratory Investigations Learning Outcomes:

Investigation/Application 1a/2a: Air Pressure Patterns and Winds:

After the investigation and application processes the student should be able to:

- Draw isobar lines to show the patterns of surface air pressures across the nation at a particular time
- Locate regions of relatively high and low pressures on the surface map produced
- Go to a specifically directed website and attempt analysis of a real-world weather map

Investigation/Application 1b/2b: Surface Air Pressure Patterns:

After the investigation and application processes the student should be able to:

- Describe the relationship between the patterns of high and low pressure areas on a surface weather map and the direction of surface wind using the hand-twist model of wind direction /and circulation
- Predict the wind direction and speed of individual locations on the coded format called the “station model”

Investigation/Application 3a: Surface Weather Maps

After the investigation and application processes the student should be able to:

- Decode the symbols appearing on a surface weather map and hypothesize weather conditions at various locations
- Identify fronts and predict the weather likely to be occurring on either side of the front, and the motion of fronts

- Relate the general relationships between wind patterns and the high and low air pressure centers shown on weather maps

Investigation/Application 3b: The Atmosphere in the Vertical

After the investigation and application processes the student should be able to:

- Describe the vertical temperature of the atmosphere in the troposphere and in the lower stratosphere
- Compare the temperature profile specified by the US Standard Atmosphere with the actual surroundings of the lower atmosphere.
- Plot given data point on the vertical atmospheric chart (Stüve diagram) and evaluate what happens with increased temperature relative to pressure in millibars.

Investigation/Application 4a: Weather Satellite Imagery

After the investigation and application processes the student should be able to:

- Summarize the different types of weather-satellite imagery and describe the information they can provide.
- Interpret probable atmospheric conditions from different weather-satellite imagery provided.

Investigation/Application 4b: Sunlight throughout the year

After the investigation and application processes the student should be able to:

- Describe the variation of solar radiation received in different latitudes for a period of one year.
- Estimate and compare the quantity of sunlight received at different latitudes during the different seasons of the year.
- Construct an annual solar radiation curve for locations provided by the instructor.
- By visiting a specific website, estimate amounts of solar radiation received at your location for a variety of dates provided.

Investigation/Application 5a: Temperature and Air Mass Advection

After the investigation and application processes the student should be able to:

- Draw isotherms to reveal patterns of air temperatures for evaluation across the nation at a given time.
- Locate regions on a weather map where cold and warm air advection is likely to be occurring.
- Relate warm and cold air advection patterns to circulations of weather systems using local weather information.

Investigation/Application 5b: Heating Degree Days and Wind Chill

After the investigation and application processes the student should be able to:

- Calculate the number of heating or cooling degree-days accumulated on a given day and demonstrate the use of current data to determine the number of heating or cooling degree days in selected locations.
- Describe the pattern of average annual heating-degree totals of the coterminous United States.
- Determine the wind chill temperature based on temperature and wind observations.
- Demonstrate proficiency in using the NOAA Windchill Calculator.

Investigation/Application 6a: Air Pressure Change

After the investigation and application processes the student should be able to:

- Identify air pressure changes and other local weather conditions with the passage of a cold front.

- Relate local air pressure changes and weather conditions to the presence of different air masses after the passage of a cold front.
- Estimate the speed of movement of a strong, well defined cold front.
- Acquire a meteogram for the closest NWS and interpret the relationship between the data regarding air pressure changes.

Investigation/Application 6B: Atmospheric Pressure in the Vertical

After the investigation and application processes the student should be able to:

- Explain what air pressure is.
- Explain how variations in air temperature cause differences in air pressure.
- Describe how density contrasts between warm and cold air produced horizontal variations in air pressure at different altitudes in the atmosphere.
- Compare and contrast data from two stations provided and plot and compare the two temperature curves via Stuve printouts and relate to pressure (mb)

Investigation/Application 7a: Clouds, Temperature, and Air Pressure

After the investigation and application processes the student should be able to:

- Describe how air temperature changes as air pressure change.
- Analyze the science of a cloud chamber relative to temperature and cloud formation.
- Describe the role that condensation nuclei play in enhancing cloud formation.
- Bases on information above, indicate how contrails.

Investigation/Application 7b: Rising and Sinking Air

After the investigation and application processes the student should be able to:

- Analyze the figure presented regarding a major winter storm on the east coast and correlate the satellite image with the surface weather map provided.

Investigation/Application 8A: Precipitation Patterns

After the investigation and application processes the student should be able to:

- Describe different mechanisms leading to the formation of clouds and precipitation in low-pressure systems.
- Locate areas of precipitation based on weather radar depictions.
- Indicate the general relationship between the uplift of air and the formation of clouds and precipitation.

Investigation/Application 8b: Doppler Radar:

After the investigation and application processes the student should be able to:

- Be able to interpret Doppler radar weather depictions
- Describe aspects of the actual winds that are detected by Doppler Radar
- Describe the speed of the winds towards or away from the radar site
- Construct the wind pattern as detected by Doppler radar

Investigation/Application 9a: Surface Weather Maps and Forces

After the investigation and application processes the student should be able to:

- Describe the horizontal forces that act on air parcels
- Show the directions toward which these atmospheric forces act
- Relate these horizontal forces to the winds reported on weather maps
- Demonstrate an understanding of the relationships between pressure gradient force, Coriolis effect, Friction, and Weather maps

Investigation/Application 9b: Upper-Air Weather Maps

After the investigation and application processes the student should be able to:

- Describe the topography of upper-air constant-pressure surfaces based on height contours, including the identification of Highs, Lows, ridges, and troughs.
- Identify the general relationship between height contours and the temperature of the underlying atmosphere.
- Describe the relationship between the height contours and wind direction on upper-air weather maps.
- Demonstrate an understanding of the upper air station model legend.

Investigation/Application 10a: Westerlies and the Jet Stream.

After the investigation and application processes the student should be able to:

- Describe the wave patterns exhibited by the meandering upper-air westerlies.
- Determine the location of the polar front jet stream on an upper-air weather map.
- Explain the general relationships between the jet stream in the upper-air westerlies and the paths air masses and storms take.
- Describe how atmospheric temperature patterns are associated with the upper-air circulation and jet stream

Investigation/Application 10b: El Nino

After the investigation and application processes the student should be able to:

- Describe the neutral (long term average) conditions of the tropical Pacific Ocean and atmosphere.
- Compare El Nino conditions to neutral conditions.
- Explain how atmospheric conditions during El Nino are transmitted beyond the tropical Pacific area.
- Demonstrate an understanding of how the TAO/Trinitron Array is deployed and how its data is utilized regarding El Nino.

Investigation/Application 11a: The Extratropical Cyclone:

After the investigation and application processes the student should be able to:

- Describe the pattern of surface winds and weather about the center of an extra-tropical cyclone.
- Specify the type of weather associated with fronts that rotate about an extra-tropical cyclone's pressure center.
- Compare and contrast the weather associated with cold fronts and warm fronts.
- Visit NOAA weather radio and keep track of hourly weather changes on a blank Metgram.

Investigation/Application 11b: Extra-tropical Cyclone Track Weather

After the investigation and application processes the student should be able to:

- Describe the sequence of changes in weather that typically takes place on the right side of a cyclone track
- Describe the sequence of changes in weather that usually takes place on the left side of a cyclone track.
- Based on information, determine the hypothetical tracks for an extratropical cyclone.

Investigation/Application 12 a: Thunderstorms

After the investigation and application processes the student should be able to:

- Describe the appearance of thunderstorm on visible satellite imagery.
- Identify probable locations of thunderstorms on infrared satellite imagery.

- List some of the modes of occurrence of thunderstorms.
- Compare and interpret a surface weather map and regional radar animation images for the same period

Investigation/Application 12b: Tornadoes

After the investigation and application processes the student should be able to:

- List some of the characteristics of the path of an intense tornado.
- Describe the general weather conditions favorable for formation of tornadic thunderstorms.
- Explain why winds on one side of a tornado may be stronger than winds on the other side.
- Predict the damage path of a tornado based on the projections of the general direction of movement of the majority of tornadoes that occur in the United States.
- Be able to read and interpret the Fujita and Enhanced Fujita (EF) scales.

Investigation/Application 13a: Hurricanes

After the investigation and application processes the student should be able to:

- Evaluate the forecast track taken by a tropical cyclone from the western Atlantic and define when it is considered a hurricane based on data given.
- Indicate the probable position of highest storm surge when a hurricane makes landfall.
- Demonstrate an understanding of the color coding and NHCTC graphical advisories and legends.
- Demonstrate an understanding of the map of tracks of Atlantic basin tropical weather systems from 2008 and determine the type of system and how many became major hurricanes.

Investigation/Application 13b: Hurricane Wind Speeds and Pressure Changes:

After the investigation and application processes the student should be able to:

- Describe the relationship between the maximum wind speeds and central pressure in a hurricane.
- Categorize the damage potential of a hurricane based on wind speeds.
- Explain how wind speeds in hurricanes are affected by landfall.
- Be able to interpret a graph of central pressure and maximum sustained wind speeds.
- Compare the general relationship of central pressure and wind speed curves shown by the graph.
- Become familiar with the Saffir-Simpson scale used to assess the damage potential of hurricanes.

Investigation/Application 14a*: Weather Instruments and Observations

After the investigation and application processes the student should be able to:

- Describe the ASOS and AWOS and indicate the data provided by each.
- Describe how to access weather observations for the US and the world via the Internet.

Investigation/Application 14b*: Weather Forecasts

After the investigation and application processes the student should be able to:

- Describe the general elements of a weather forecast
- Compare the forecasts available to the public by NWS Forecast Offices with resulting weather conditions.
- Be able to read and interpret METARS and TAF's presented to you.
- Be able to read and interpret NWS Watches and Warning maps.

*Optional based on time

Supporting Documentation:

Weather Studies is an introductory college-level meteorology course prepared by nationally recognized atmospheric scientists and educators at the American Meteorological Society with support from the National Science Foundation. The course introduces students to the science of weather as it happens while they learn the important concepts behind the science. Student's access and work with current weather data and graphic products delivered via the Weather Studies website on the Internet which has been specifically designed for the course. A text and a series of investigations lead student learning throughout the course.

A major innovation of the Weather Studies course is the study of fundamental scientific principles through their application to everyday weather events. Students observe the workings of the dynamic atmosphere by following weather as it happens, in near real-time and/or by using recent real-world data and case studies, and observe the principles of meteorology in action. They employ the analysis and decision-making skills used by meteorologists to diagnose weather patterns, understand air motions, and predict future atmospheric conditions.

The Weather Studies course covers topics treated in most weather and climate courses, but is delivered in a sequence that builds on investigations of the real atmosphere. It has been prepared as an integrated, package with a text, investigations manual, and additional faculty material designed to integrate the web-based portion of the course delivered via the website.

The Weather Studies course is organized as fifteen chapters, each corresponding to one week of course work. Chapters consist of a sequential core of twelve chapters plus three chapters which may be offered in any order, at any time during the term, depending on the instructor's preference or institutional needs.

The fifteen sequential core chapters are scheduled to fit the majority of semester systems with the web-based, weather studies delivered accordingly. For each week of this core, the text covers one major topic in one chapter. In addition, the Investigations/Applications exercises have the framework of hands-on investigations that are coordinated with material covered in each chapter. Each investigation initiates the student's exploration of some principle of atmospheric science or method of meteorological analysis in the Introduction section and then uses real-world examples to expand on that introduction in the Applications section. Math skills on the website allow the student to explore chapter concepts from a mathematical perspective.

The Weather Studies Course Website also provides current meteorological products, 24 hours per day, 7 days per week, year round, making possible ongoing individualized atmospheric study and analysis. Analyzed maps, charts, and diagrams provide students with instant confirmation of successful application of the basic understandings developed in the course.

The Course Website also includes the delivery of Current Weather Studies, optional weekly Math Skills, current weather maps, visible, infrared, and water vapor satellite imagery, composite radar displays, and surface and upper-air data, plus forecast maps for the U.S. and southern Canada. Meteorological data, formatted and delivered via NOAA's National Centers for Environmental Prediction (NCEP) are updated hourly, 24 hours a day, and seven days a week, year-round.

The Weather Studies course embodies key elements of critical thinking. According to the National Council of Teachers of English Committee on Critical Thinking and the Language Arts, critical thinking is "a process which stresses an attitude of suspended judgment, incorporates logical inquiry and problem solving, and leads to an evaluative decision or action."

The Weather Studies Course investigations, which are "hands-on" and inquiry based, implicitly engage students in critical thinking. Students employ critical skills such as evaluation, inference, and prediction as they explore the atmosphere. In addition to the student investigations, the course website, containing daily weather discussions and current weather maps, can be an excellent laboratory for critical thinking.

Assessment of Student Learning:

The Weather Studies program supports a variety of student assessment techniques and instructors teaching the course can choose which method(s) they will use, as well as develop other assessment activities. There are sets of multiple choice questions for each of the course units. Also, students may submit their completed textbook chapter Review and Critical Thinking Questions and Investigations Manual and Current Weather Studies investigations for periodic evaluation during the course. Another approach to student assessment may be to require a portfolio, where students accumulate their completed assignments (e.g., Investigations Manual and Current Weather Studies investigations, textbook chapter questions, and special assignments), periodically review those materials, and provide written reports on their progress in the course. If utilized, the review of portfolio contents during and/or at the end of the course is possible. Posting of answers to Investigations Manual and Current Weather Studies questions allows students to assume responsibility for their own determination of progress. This technique has been used quite effectively for a distance-learning course where instructor-student meetings are infrequent. Assessments may also address student participation in weather briefings or online discussions based on the current weather situation. Assigned student discussions in class or laboratory could be on an individual or team basis.

Websites and other pedagogy to be utilized for the practical applications:

Daily Weather Summary A very useful Website feature is the daily weather discussion, which appears during the fall and spring semesters, describing the current weather pattern nationwide. This weekday summary builds on course content as the semester progresses. It is prepared by Dr. Edward J. Hopkins (University of Wisconsin-Madison).

Weekly Weather/Climate News This weekly feature contains links to the latest weather and climate news items. The news files are prepared by Dr. Edward J. Hopkins.

Math Skills The weekly Math Skills component contains exercises that correspond to each textbook chapter. Each Math Skills has parts A and B. Part A is a quantitative study of important chapter concepts that assumes knowledge of basic algebra. Part B is a more challenging section that explores meteorological concepts such as radiation laws, gas laws, energy conservation, and forces and winds. We recommend that Part B be reserved for use by students with more extensive mathematics backgrounds.

Critical Thinking/Diversity Component This component first defines Critical Thinking and its attributes, and then examines a specific critical thinking cognitive skill and an affective attribute that relate to each week's student learning investigations. The component then describes an activity that models some aspect of critical thinking. Each week's segment ends with the suggestion of ways in which critical thinking can be applied more generally to topics or issues that are not part of the science content of the course. The theme for these applications is diversity, a topic that impacts all of us and in which there are many ideas to explore. We do this because our society is becoming increasingly diverse and our educational process has the potential of benefiting significantly by being more inclusive.

Investigation Manual Images The website contains a link to electronic versions of Investigations Manual images. These will be helpful if the course instructor prefers to have students submit selected images they have marked or processed electronically (e.g., via e-mail or drop box on a course management system website).

Investigation Manual Web Addresses Internet addresses appearing the Investigations Manual can be accessed via the "Learning Files" section of the course website. Click on "Investigations Manual Web Addresses". Then, go to the appropriate investigation and click on the address link. We recommend this approach for its convenience. It also enables AMS to update any website addresses that were changed after the Investigations Manual was prepared.

Links to COMET Modules The Cooperative Program for Operational Meteorology, Education and Training (COMET) was established by the University Corporation for Atmospheric Research (UCAR) and the National Weather Service to promote the teaching of meteorological topics to professionals as well as students. Interactive educational materials dealing with meteorology and related sciences are available through COMET's *MetEd* website. *MetEd* provides online learning materials for students, professionals, professors, and weather enthusiasts in weather and forecasting topics. We have selected several modules to accompany each textbook chapter that can be incorporated into your classroom, or used as an additional learning opportunity for the advanced student. Many of the subjects discussed in the modules take an in-depth look at topics introduced in the text and are presented at an advanced level. Modules appear on the course website homepage, presented in links by chapter. To view and use the COMET modules, you must first register with MetEd. Website registration is free of charge and requires the use of an email address.