MS. Weather and Climate

MS-ESS2-5. Collect and provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

UCAR – Community Program
Topics in Dynamic Meteorology: Pressure Gradient Force – ***Requires generating a free account***
This module is a learning object on a foundational aspect of dynamic meteorology, the pressure gradient force. As a learning object, it is meant to supplement other teaching material in a course by elucidating a specific concept. The horizontal pressure gradient force is presented through an interactive tool which allows a student to adjust pressures on an idealized surface map and examine the horizontal accelerations produced in response. Three short exercises are provided to reinforce the concepts. This lesson helps explain why air always flows from high to low pressure.
https://www.meted.ucar.edu/

NOAA's National Ocean Service
Synoptic Meteorology
Synoptic means "view together" or "view at a common point". Synoptic meteorology is primarily concerned with large-scale weather systems, such as extratropical cyclones and their associated fronts.
http://oceanservice.noaa.gov/education/yos/resource/JetStream/synoptic/synoptic_intro.htm

NOAA's National Weather Service
NOAA's National Weather Service Introduction to Thunderstorms
This website goes into detail how thunderstorms for by describing in detail the three necessity ingredients for thunderstorms to develop. This link will take you through the stages of a thunderstorm, the different types of thunderstorms and the hazards it creates.
http://www.srh.noaa.gov/jetstream/tstorms/tstorms_intro.html

NSSL - National Severe Storms Laboratory
Severe Weather 101 – Thunderstorms
Thunderstorms are a great way for the atmosphere to release energy. When warm moist air meets colder drier air, the warm air rises, the water vapor condenses in the air, and forms a cloud. As the water vapor condenses it releases heat, which is a form of energy. A large amount of the thunderstorm's energy comes from the condensation process that forms the thunderstorm clouds. As the thunderstorm progresses, eventually the rain cools the entire process down and the energy is gone. This is a great website that describes the different types of thunderstorms, also how thunderstorms form by the interactions of air masses, plus much more.
http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

NSSL - National Severe Storms Laboratory
Severe Weather 101 – Tornadoes
A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust and debris. Tornadoes are the most violent of all atmospheric storms. This is a great website that answers common questions about tornadoes.
http://www.nssl.noaa.gov/education/svrwx101/tornadoes/

NOAA's National Ocean Service
The Atmosphere
This lesson describes the importance of pressure.
http://oceanservice.noaa.gov/education/yos/resource/JetStream/atmos/atmos_intro.htm

NOAA's National Weather Service
What side of a front does precipitation fall?
http://www.wrh.noaa.gov/ggw/newsletter/winter_05/Fronts_w_Figs.pdf

EU Metrain's Synoptic Textbook
This 190-page text, which is based on a series of university lectures, provides comprehensive information on synoptic meteorology. There's a general introduction to synoptic followed by chapters on tropospheric circulation, air masses, boundary layer and weather, wind fields, jet streams, vertical motions, high and low pressure, convective systems, numerical parameters in vertical cross sections, mid-latitude cyclones, the tropopause, and fronts. A number of the examples in the textbook are from Northern Europe.
http://eumetrain.org/synoptic_textbook.html

UCAR – Center for Science Education
Tornado Teaching Box
Students learn how tornadoes form and the atmospheric conditions that are conducive to tornadoes
https://scied.ucar.edu/teaching-box/tornadoes

NOAA's National Weather Service
Learn how to draw your own weather map
http://www.srh.noaa.gov/jetstream/synoptic/ll_analyze.html

NOAA's National Hurricane Service
Blank Hurricane Tracking Charts
http://www.nhc.noaa.gov/tracking_charts.shtml

MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

NOAA's National Weather Service
Tropical Weather
A wonderful website that discusses the Inter-Tropical Convergence Zone, tropical cyclones, El Niño/La Niña/El Niño Southern Oscillation (ENSO) and its weather impacts.
http://www.srh.noaa.gov/jetstream/tropics/tropics_intro.html

NOAA's National Ocean Service
Global Circulations
Global Circulations explain how air masses and storm systems travel over the Earth's surface.
http://oceanservice.noaa.gov/education/yos/resource/JetStream/global/global_intro.htm

NOAA's National Weather Service
Global Circulations
Hadley, Ferrel and Polar Cells
Global circulations explain how air and storm systems travel over the Earth's Surface.
http://www.srh.noaa.gov/jetstream/global/circ.html

NOAA's National Weather Service
The Jet Stream
Jet streams are relatively narrow bands of strong wind in the upper levels of the atmosphere. These streams move from west to east and often shift to the north and south. Jet streams follow boundaries of hot and cold air.
http://www.srh.noaa.gov/jetstream/global/jet.html

EUMetrain's Synoptic Textbook
This 190-page text, which is based on a series of university lectures, provides comprehensive information on synoptic meteorology. There's a general introduction to synoptics followed by chapters on tropospheric circulation, air masses, boundary layer and weather, wind fields, jet streams, vertical motions, high and low pressure, convective systems, numerical parameters in vertical cross sections, mid-latitude cyclones, the tropopause, and fronts. A number of the examples in the textbook are from Northern Europe.
http://eumetrain.org/synoptic_textbook.html

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

NOAA
Climate monitoring
Step outside and you can learn a lot about your local weather, but what does it tell you about your climate?
http://www.noaa.gov/resource-collections/climate-monitoring

UCAR – Community Program
Climate Change and Regional Impacts– ***Requires generating a free account***
This short module is an overview of the different effects climate change produces in different regions of the United States. In addition to discussing impacts already being experienced, the module presents information on how climate scientists use specialized models and statistical techniques to estimate how regional climates are likely to change in the future.
https://www.meted.ucar.edu/

UCAR – Community Program
Climate Change and Sea Level Rise – ***Requires generating a free account***
This module looks at how increasing temperatures due to climate change have affected sea level rise and what effects scientist expect in the future, given rising greenhouse gas emissions. The various mechanisms of sea level rise are discussed, as well as the tools and research used to study this topic. The module also discusses how countries and communities are preparing for future increases in sea levels.
https://www.meted.ucar.edu/

UCAR – Community Program
Climate Change: Fitting the Pieces Together – ***Requires generating a free account***
This module discusses climate change, particularly as it is currently being affected by increasing concentrations of greenhouse gases emitted by human activities. It also covers signs of climate change, how scientists study climate, the current thinking on future changes, and what can be done to minimize the effects.
https://www.meted.ucar.edu/

UCAR – Community Program
Climate Change and Extreme Weather– ***Requires generating a free account***
This module discusses how a changing climate can also lead to changes in extreme weather events on the local scale. The role of natural variability is also explained. The module describes how climate change can have both positive and negative effects, depending on the situation, location, and the vulnerability of the population. While research on climate change and extreme events is still relatively new, the module discusses what changes scientists think are likely if greenhouse gas emissions continue to rise.
https://www.meted.ucar.edu/

UCAR – Community Program
Interpreting Climate Outlooks: An Australian Example – ***Requires generating a free account***
Climate outlooks provide probability-based information about expected rainfall and temperatures at timescales of months or longer. This lesson demonstrates how monthly and seasonal outlooks issued by the Australian Bureau of Meteorology can be combined with other information for use in decision-making by persons in climate-sensitive sectors.

The lesson explains the main drivers affecting Australia's climate—ENSO, Indian Ocean Dipole, Southern Annular Mode, and the subtropical ridge—and explores how the status of the climate drivers can affect the outlook maps as well as confidence in the outlook information. Case examples (for Wagga Wagga in eastern Australia and Merredin in western Australia) provide a context for interpreting the different types of outlooks using past accuracy maps, climate driver information, and antecedent conditions to arrive at a decision based on the projections and overall confidence.
https://www.meted.ucar.edu/

UCAR – Community Program
Weather and the Built Environment – ***Requires generating a free account***
This short course provides broadcast meteorologists, educators, and the public with an overview of the evolution of our modern urban environment with a focus on impacts on the urban watershed, air quality, and climate. This course complements the course Watersheds: Connecting Weather to the Environment and both are part of the Earth Gauge™ environmental curriculum for weathercasters and educators. This curriculum is being developed by the National Environmental Education Foundation (NEEF). [See http://www.earthgauge.net/wp/] Unit 1, Where We Live, takes a look at past and current U.S. growth patterns and the way our urban areas have evolved from compact population centers to automobile-dependent sprawl. Unit 2, Impacts on the Watershed, explores how the built environment affects the water that moves through an urban watershed. Unit 3, Impacts on the Atmosphere, highlights the way our urban landscape and industrial activities impact the air we breathe and the local climate. Each unit includes information on ways to reduce our impact on our water and air with ideas ranging from simple changes in our commuting and housekeeping habits to changes in how we build houses and roads.
https://www.meted.ucar.edu/

UCAR – Community Program
Weather and Health– ***Requires generating a free account***
This course will help meteorologists and others broaden their understanding of the impacts of weather and climate on public health, including the impacts of heat waves and cold temperatures, winter storms and thunderstorms, flooding, drought, poor air quality, tornadoes, hurricanes, wildfire, UV radiation, and others. This course is directed to broadcast meteorologists, in particular, who play a critical role in the community by helping the public to protect against weather-related health threats and by promoting good health. The course also describes the public health communication system, providing information about reliable public health services, tools, and resources.
https://www.meted.ucar.edu/