LESSON 3:

ANALYZING AND INTERPRETING CLIMATE DATA

Driving Question:

How do you read and analyze weather data, and how can that be used to understand climate of a particular region and to find how climate is changing?

Sub-questions:

- Where do weather observations come from? What and where are the NWS-COOP and SNOTEL stations in the San Juans?
- What are climate trends and how can they be identified from climate data?

Goal:

For students to be able to interpre and analyze climate data in the form of charts and graphs and be able to recognize climate averages and anomalies.

Grade Level:

9th Grade

Lesson time: 1.25 hours

Climate literacy principle addressed:

- Principle 4 - Climate varies over space and time through both natural and man-made processes.
- Principle 7 - Climate change will have consequences for the Earth system and human lives.

Learning Objectives:

- Students will become aware of different agencies involved in weather and climate observations through an interactive lecture.
- Students will understand where historical climate data comes from, as well as problems associated with these data.
- Students will interactively learn where to find reliable climate data and use online tools to interpret data for a particular region.

Colorado State Standards & 9R Dashboards for Earth Systems Science - High School:

- Earth Sciences Standard #4: Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere
- HSS 4b: Analyze and Interpret data on Earth's Climate.
- HSS-4e. Analyze the evidence and assumptions regarding climate change (DOK 1-3) (E)
- HSS 4f: Interpret evidence from weather stations, buoys, satellites, radars, ice and ocean sediment cores, tree rings, cave deposits, native knowledge, and other sources in relation to climate change.

Prior Knowledge Required:

- Students must be aware of what factors control climate.
- They should be able to connect this with material from the previous lesson which described how climate is a function of latitude, longitude, elevation, distance from the ocean and the large scale atmospheric and oceanic circulation.
- Ability to understand time series plots.
- Understanding of averages, slopes, and variability or errors.

Common student misconceptions and prior understandings:

- Students may not realize the important difference between weather (short term conditions- weeks to months) and climate (long term conditions – decades to centuries).

Lesson 1 Materials and Handouts:

- Homework: Climate Data Analysis and Interpretation Worksheet
- Materials:
  - Weather Station PowerPoint
  - Climate Analysis and Interpretation Worksheet

Background Information:

- SNOTEL background information at: http://www.stevenswater.com/articles/snotel.aspx
- National Weather Service: http://www.weather.gov
- Local Tree ring study: http://www.mountainstudies.org/sites/default/files/pdf/education/Animas_treering_brochure_RevC.pdf
- Paleoclimatology proxy data information: http://www.ncdc.noaa.gov/paleo/globalwarming/proxydata.html
- Other weather station data: http://data.giss.nasa.gov/gistemp/station_data/
- Create your own time series website: http://www.cefa.dri.edu/Westmap/Westmap_home.php?page=mapplot.php
- Colorado State University Climate Trend Graphs: http://climatetrends.colostate.edu/

Lesson 3 (1.25-1.5 hours)

1. Information on weather stations. Where does weather data come from? What are some good sources? PowerPoint is available explaining weather station data, and to be easily shown to students or used to assist teacher. (30 minutes)
    - NOAA National Weather Service (http://www.weather.gov/)
        - Brief history
        - Length of observation
        - Long-term mean-define climotology (information on climographs, which are one of the ways to plot climatology of a place (e.g. see this climograph for Minneapolis: http://education.nationalgeographic.com/archive/xpeditions/lessons/15/g912/pgafrica4.html?ar_a=1
    - SNOTEL
        - Brief history and why these sites were established. (SNOTEL sites were primarily put up to help with stream flow predictions by monitoring Snow Water Equivalencies at high elevation sites, as well as have weather station components. These became functional since the 1980s)
        - Bring up: (http://www.wcc.nrcs.usda.gov/snotel/Colorado/colorado.html) and look at SNOTEL sites around Durango and ask students to identify which stations could be useful in making stream flow predictions for the Animas River in Durango.
    - How was climate data acquired before weather stations?
        - Go over proxy data and paleoclimatology and define both terms.
        - Go over historic data, corals, tree rings, and ice cores. Develop pros and cons for each.
        - Show graphs from local study and explain the importance of tree rings in water management. (http://www.mountainstudies.org/sites/default/files/pdf/education/Animas_treering_brochure_RevC.pdf)
    - Problems with station and proxy data:
        - Problems with instrumentation not working well (e.g. snow deposits on instruments)
        - Changes in station location

- Changes around the station resulting in inconsistent results (e.g. urbanization, changes in vegetation and shading)
- Problems with collecting data (e.g. human errors, missing data)
- Uncertainty with proxy data- sometimes more than one factor could be responsible in producing a particular proxy signal (e.g. tree ring width in some regions could be affected by both temperature and precipitation.

2. Analyzing weather station data. Weather station activity. (45 min.)
   - As a class, bring up the website http://climatetrends.colostate.edu/ which is a website that holds weather data that has been judged as offering the most consistent long-term temperature and precipitation data.

Weather Station Long-Term Trends:

- First, click on station map link at the top of the page.
- Find the weather station Hermit 7 ESE at 9000 ft. on the drop down menu above the map.
- Click on the house icon on the map and select get RAW Data & Graphical Plots link. Take note of the short description of the station.
- First, briefly discuss the first mean temperature graph that appears: why are some areas of the graph missing? What year does data begin?
- To get monthly mean minimum temperature select the data type without changing any of the parameters. Ask the students what trend they see in temperature.
- Select data type and select total monthly precipitation link to get total annual precipitation. What trends do you see? What are the years with the highest amount of precipitation? What are years with the lowest?

Weather Station Data: Long term vs. Short term

- Now, go back to the station map page and select the Telluride station from the drop-down list.
- Compare and take note of the missing information to the Hermit station vs. the Telluride station at 8700 ft.
- When does weather data begin in this plot?
- Change the time period shown to 1990-2009. How do the trends differ? What sense of average do you get with the short-term average vs. the long-term?

Weather Station Data: When do minimum and maximum temperatures occur?

- Navigate to the Cochetopa Creek station at 8000 ft; compare the average maximum summer temperature and the average maximum winter temperature. What trends do you see?
- Show the RAW data link and identify high and low temperatures.

3. Wrap up and discuss homework: Fill out the Climate Data Analysis and Interpretation sheet for homework attached in homework section which is an extension of the graph interpretation activity. (10 min.)