Lesson Title	Planetary Climates
Length of Lesson	1 class period (50 min)
Created By	Charles Vaughan
Subject	General Science
Grade Level	8
State Standards	1d, 4e
DOK Level	DOK 3 (Hypothesize, Compare)
DOK Application	Apply a concept in other contexts.
National Standards	5-8: D: Earth and Space Science
Graduate Research Element	My research involves the study of comets, which have a very thin atmosphere called a coma. Although the coma is very thin, events on the surface of the comet (such as gas jets) will easily affect the "climate" of the coma.

Student Learning Goal:

MS 8th Grade:

1d (Inquiry): Analyze evidence that is used to form explanations and draw conclusions.

4e (Earth and Space Science): Explain how the tilt of Earth's axis and the position of the Earth in relation to the sun determine climatic zones, seasons, and length of the days.

National Standards for Grades 5-8:

D: Earth and Space Science: Earth in the Solar System:

- The sun is the major source of energy for phenomena on the Earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the Earth's rotation on its axis and the length of the day.

Materials Needed (supplies, hand-outs, resources):

Plain white paper, colored pencils, PowerPoint (file name: INSPIRE_Vaughan_10_15_12_Powerpoint.ppt)

Lesson Performance Task/Assessment:

Students will learn how the physical characteristics of a planet affect its climate. The teacher is expected to demonstrate how parameters such as mass, axis tilt, planet-sun distance, etc., are the factors that determine climate, and the students will then create their own imaginary planet with parameters of their choice. The students will be expected to describe its climate and tell whether or not the climate changes significantly from one region to the other on the planet.

Lesson Relevance to Performance Task and Students:
Understanding why we have climates helps understanding of day-to-day weather, along with why climate change happens. If a student can figure out what climates might occur on a different planet, then the student can likewise understand what happens on Earth.

Anticipatory Set/Capture Interest:
Earth is not the only planet with an atmosphere, seasons, and stormy weather. What factors contribute to our long-term climates on Earth?

Guided Practice:
This lesson would be better if presented after basic lessons on weather and climate. The teacher should initially explain what factors affect the climate on a planet:

- Distance to the sun obviously affects temperature overall, but this distance also contributes to the energy of day-to-day weather (i.e., closer planets could potentially have more severe storms).
- A planet's mass determines how much atmosphere it can have. Massive, rocky planets can have thicker atmospheres, whereas smaller rocky planets (such as Mars or Mercury) have little to no atmosphere. More atmospheric pressure means more potential for noticeable weather. Gas giants are known to have incredibly large storms.
- Axis tilt will allow planets to have seasons. Greater tilts generally mean more extreme season changes. Earth's tilt is about 23.5°.
- Atmospheric composition will affect how much energy is trapped from sunlight. Venus, for example, has a large amount of carbon dioxide in its atmosphere. Thus, it will easily trap solar energy and create terrible storms (in fact, the surface of Venus is hotter than that of Mercury).
- Length of day will affect how the weather and temperatures vary across the surface. Planets with shorter days will have more uniform climates, and planets with longer days will have more extreme variations between nighttime and daytime sides.

Independent Practice:
After the guided practice, have students imagine a planet and draw it on their paper. They should describe how this planet compares to Earth in terms of mass, distance to sun, axis tilt, atmospheric composition, and length of day (for example, 2x Earth mass, 1/2 Earth distance, 15° tilt, mostly oxygen atmosphere, 12 hour day). They should then guess what kind of climate this planet has, as well as describing some possible day-to-day weather on its surface. For simplicity, assume that the star about which it revolves is the same as our sun.

Remediation and/or Enrichment:
Remediation – IEP

For more advanced classes, require the students to consider fluid flow (e.g., ocean currents or jet streams) and mass outflow (regular volcanic activity or gas jets) on the planet. Have them describe how this affects climate. My personal research involves the study of comet comae, which are strongly influenced by gas jets.

If you prefer a longer lesson, National Geographic also has a planetary climates lesson that can supplement this one:
http://education.nationalgeographic.com/education/activity/extreme-weather-on-other-planets/?ar_a=1

Check(s) for Understanding:
Students should be able to guess what kind of climate a real planet has if they know its basic physical characteristics. The teacher can describe a real planet without revealing the name (Venus is a great example) and ask the students to describe its climate.

Closure:
Important questions they should be able to answer for their planet:

- Is the planet you drew relatively hot or cold compared to Earth?
- Does this planet have seasons? If so, are they more or less extreme than Earth's?
- Can this planet have storms? What kind, and how severe?
- Can the climate vary drastically from one region to the next on the surface of your planet?
- If the Earth had less mass, how would this affect our climate?

Possible Alternate Subject Integrations:
Astronomy

Teacher Notes:
Personal research on the planets of our solar system may be required if you're a bit rusty on astronomy. Fortunately, most pertinent information can be easily found online. As mentioned above, this lesson would be better if presented after basic lessons on weather and climate. The PowerPoint provided is not completely necessary for the lesson.