Lesson 1 - Skydiving Through the Layers of the Atmosphere

Astronauts aboard the International Space Station captured this photograph of Earth's atmospheric layers on July 31, 2011, revealing the troposphere (orange-red) to the stratosphere and above. Earth-observing instruments in space allow scientists to better understand the chemistry and dynamics occurring within and between these layers. Credit: NASA/JSC Gateway to Astronaut Photography of Earth.

Summary: This lesson engages students in learning about the different layers of the atmosphere. Students are asked to observe and graph the changing characteristics of the atmosphere following Felix Baumgartner's skydive from the stratosphere. Then, students are encouraged to present their findings in an info-graphic. The lesson uses real NASA data on ozone levels and temperature, relating both to altitude. The lessons will teach students about the relationship between altitude and temperature; temperature initially decreases with altitude in the troposphere, at the tropospause temperatures remain constant and then temperatures increase in the stratosphere. Scientists use temperature as one of the main characteristics to define the different layers of our atmosphere. The lessons will also teach students about the relationship between altitude and ozone concentrations; ozone levels increase in the stratosphere, creating the ozone level. It will also introduce the importance of the ozone layer.

Time: Two 45-minute class periods

Science standards Addressed:

MS-Earth Systems

MS-ESS2-1.	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
MS-ESS3-1.	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

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Engagement

A) Discussion (5 minutes):

- What does a skydiver need to jump from an airplane?
- What makes a jump from almost 128,000 feet (~39km) different than jumping from an airplane?
- What does he or she need? *(possible answers: parachute, special suit, training)*

> Teacher note: Discussion is intended to jumpstart students into thinking critically about the video they are about to watch

B) Felix Baumgartner's fall from the Stratosphere Video (10 minutes):

- Hand out L1A Skydiving Through the Atmosphere Notes to each student to fill out as they watch the video
- http://www.redbull.com/en/adventure/stories/1331615604283/fly-with-felix-red-bull-stratos-pov-video - *128,000 foot skydive (from the stratosphere) by Felix Baumgartner in 2012. Video is 10 minutes and has an altitude meter (and some other information including: g-force, biomed and velocity*)

Exploration - After watching the video divide students into small groups of 3 or into pairs. Ask them to discuss the questions in the following sections

A) *Visual observations* – students should share their notes recorded on L1A Skydiving Through the Atmosphere Notes and discuss.

B) *Using Data to Make Observations*

Hand out L1B Ozone vs. Altitude Graphing Assignment to half of the class.
Hand out L1C: Altitude vs. Temperature Graphing Assignment to the other half of the class.

Before they start graphing their individual data, have the whole class mark these points on their graph, to connect to prior knowledge and give perspective as to where we are talking about in the atmosphere.

1) Height of airplane (32,000 feet)
2) Weather balloon (~40km)
3) Baumgartner's jump 128,000 feet (~39km)
4) The death zone (~8km) - an area where mountaineers believe that no human body can acclimatize

Observing **Temperature** 33Using Data - Altitude vs. Temperature group

- Students will create a graph of the atmosphere, using temperature as a variable dependent on altitude.

- After graphing the information on the worksheet. Student groups or pairs should explore the graph and answer the questions on the back of the graphing assignment, which include tracing the temperature changes that Felix Baumgartner went through as he traveled from 128,000 feet (39 km) to Earth's surface.

Observing **Ozone** Using Data (Ozone vs. Altitude group)

- Students will create a graph of the atmosphere, using ozone levels as a variable dependent on altitude.
- After graphing the information on the worksheet. Student groups or pairs should explore the graph and answer the questions on the back of the graphing assignment, which include tracing the ozone level changes that Felix Baumgartner went through as he traveled from 128,000 feet (39 km) to Earth's surface.

When students are finished with their graph, they should find another student who completed the other graph and discuss any connections they can find and discuss their answers from the second page of the activity.

Explanation – Student's graphs should have 2 layers, the troposphere and the stratosphere. They will not know the technical names of the layers, but will be able to see in their graphs that there is a distinct area where temperatures change, dividing the atmosphere into two areas. This is the point where the temperatures reverse direction, known as the tropopause. This divides the troposphere from the stratosphere.

- Watch following video about Leon Teisserenc De Bort, who was the first person to use weather balloons to study Earth's atmosphere. https://www.youtube.com/watch?v=X4SJZZLOwmA

Elaboration

Watch the Science on a Sphere movie, UV-Ozone Connection available on you tube at: https://www.youtube.com/watch?v=BIREDNU-7cA, based on the information in the video students should revise their answers as necessary.

Evaluation - Students pretend to be scientists.

- Hand out L1D Create an Info-Graphic, which asks students:
  - If you were a scientist, what information would you use to determine where atmospheric layers change?
  - Students draw a picture of the layers of the atmosphere, include temperature and ozone levels, using information based on the graphs they made.
  - What do you notice about Ozone specifically?

- Completed L1D Create an Info-Graphic can be turned in for credit and graded with the following ***rubric*** for the drawing.

Rubric – Create an Info-graphic				
Points Possible	0 points	1 point	2 points	3 points
Layers of the Atmosphere: Layers and transition zone noticeable from data given (Students are not required to know the names of the layers, just that there are 3 areas to depict).	Did not label any layers	Labeled one layer	Labeled two layers	Labeled 2 layers and a transition zone
Temperature: Temperatures decrease with altitude until ~ 11 or 12 km where temperatures remain constant until near 24 km when temperatures begin to increase with altitude.	Temperature trends were not labeled	Temperature trends were correct in one of the 3 atmospheric layers	Temperature trends were correct in two of the three atmospheric layers	Temperature trends were correct in all three atmospheric layers
Ozone Levels: Ozone decreases from ground level and then stabilizes, it increases between 16 km and 22 km (the ozone layer in the stratosphere), then decreases as altitude increases	Ozone level trends were not labeled	Ozone level trends were correct in one of the 3 atmospheric layers	Ozone level trends were correct in two of the 3 atmospheric layers	Ozone level trends were correct in all three of the 3 atmospheric layers