

# ***Meet Me in the Mesosphere:***

## ***Investigation of Atmospheric Processes for Classroom Studies***

### **Introduction**

As people endeavor to learn more about global climate change, there is a need to better understand the various processes taking place in Earth's atmosphere. To enable students to gain knowledge of the composition and interaction processes at work in the atmosphere, the teachers taking part in the 2009 RET program at MIT's Haystack Observatory have explored Earth's atmosphere to create the unit entitled, "Meet Me in the Mesosphere: Investigation of Atmospheric Processes for Classroom Studies." This unit utilizes data collected by the Mesospheric Ozone System for Atmospheric Investigations in the Classroom (MOSAIC) system to reinforce framework concepts within high school courses such as Earth Science, Chemistry, Physics, Astronomy, and Environmental Science. Lesson plans have been created in support of understanding the science underlying the MOSAIC system, with topics including the layers of the atmosphere, Earth's energy balance, the Greenhouse Effect, ozone creation in the atmosphere, noctilucent clouds, heat transfer, heat versus temperature, the laws of thermodynamics, radio waves in nature, and the significance of radio waves to the study of the atmosphere, astronomy, and geodesy. Exercises using the web-based MOSAIC interface step students through the analysis of spectral plots and the diurnal and annual variation of mesospheric ozone.

### *What is MOSAIC?*

In very broad terms, a MOSAIC system consists of a DirectTV®-style satellite dish antenna with a receiver designed to capture European satellite signals, and some specialized electronics. This instrument functions as a small radio telescope that continually monitors 11.07 GHz line of ozone located within the mesosphere at altitudes of between 70 and 100 km above Earth. Currently, there are five MOSAIC systems collecting data: one each at MIT's Haystack Observatory in Westford, Massachusetts; Chelmsford High School in Chelmsford, Massachusetts; Bridgewater State University in Bridgewater, Massachusetts; Union College in Schenectady, New York; and Southeast Missouri State University in Cape Girardeau, Missouri. Real-time and saved data from each of these units is publicly available through an online portal located at:

<http://www.haystack.mit.edu/ozone/>

Instructions for using the online portal are included within Unit #6 ("Seeing the Ozone") of this package.

### *Why Ozone in the Mesosphere?*

The variability of ozone concentrations in the mesosphere is a topic of current interest to atmospheric scientists. Ozone concentrations within the troposphere and stratosphere have been well documented and the causes of the stratospheric "ozone hole" are largely agreed upon, but mesospheric ozone has been little studied. Traditionally, Earth based observation systems have been limited in their ability to investigate the mesosphere because of interference from lower atmospheric phenomena. Balloon-borne instruments cannot reach the mesosphere and rocket-borne instruments are expensive and short-

lived. Looking down, some satellite-borne instruments are collecting mesospheric data, but these are also expensive and relatively new to the scene.

The MOSAIC system provides a unique opportunity for students to participate in the analysis of ozone within the mesosphere, a very current topic, with an innovative and inexpensive Earth-based system. In this endeavor students will also learn about radio telescopes. This collection of lessons is designed to provide the introductory background material students will need in order to understand basic processes occurring within Earth's atmosphere (Units #1 through #5) as well as more advanced material to provide students with an in depth understanding (Units #6 through #9.) Provided with each unit is some suggested background reading for educators and interested students as well as classroom activities designed to enhance the understanding of selected topics.