New space science courses cover planetary physics and the perils of space weather

How does the sun's atmosphere and magnetic field interact with the earth's atmosphere and magnetic field? How does this interaction impact modern electrical technologies?

Why does Jupiter look so different from Earth? Why is Earth's atmosphere different from that of Mars and Venus? What electrical engineering principles are used to observe such differences?

With the knowledge students have from sophomore and junior engineering and physics classes, they can work through and calculate the answers to these questions, according to ECE's Scott Bailey and Bob Clauer. Bailey and Clauer used these questions and solutions as the framework for new courses taught last academic year.

Bailey's course, "Introduction to Space Science II," concentrates on the upper atmosphere and gives a quantitative treatment of ionospheric physics and aeronomy (the science of the upper atmosphere), based on our solar system. "If you think about the physics and work through the questions, you can get a long way towards understanding why the planets have their characteristics. We all started the same, but have different locations relative to the sun," he says.

Location from the sun determines a planet's temperature, which leads to different evolutions, he explains. The planets then develop different atmospheres; Mars developed a thin atmosphere, Venus developed a thick one, and Earth developed an atmosphere with oxygen. "My goal in the class, was to show students that with the mathematics and engineering and physics courses they had already taken, they could reason out these differences."

The course covers ion and neutral chemistry, ionization by solar Extreme Ultraviolet (EUV) photons and charged particle radiation, heating and cooling processes, diffusion, neutral upper atmospheres, exospheres and ionospheres, and solar wind/ionosphere interactions. "We are trying to teach the students problem-solving and at the same time get them fired up about space science and engineering," Bailey says. Although it's a graduate-level course, it is open to the best undergraduates. "We are trying to get undergraduates more confident about their own ability and be able to jump in and try their hand in this field," he said.

Two other new courses in the series, "Introduction to Space Science I" and 'The Perils of Space: An Introduction to Space Weather', were developed by Bob Clauer. The introduction course covers the electrodynamics, plasma physics, and chemistry of the near-earth space environment from the sun to the earth's upper atmosphere. The space weather course is a 4000-level course emphasizing the practical consequences of space weather on modern electrical technologies, such as solid state devices, satellite technology, communication, and global navigation systems.

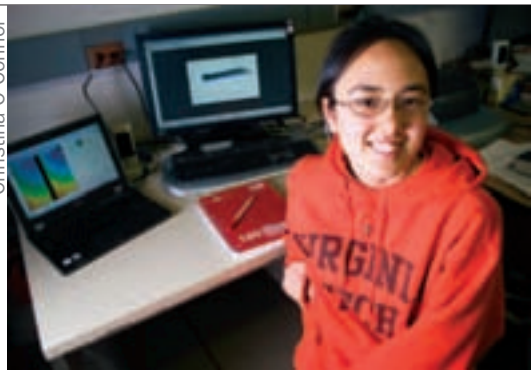
Undergraduate reaches for the edge of space

An instrument designed and built to observe polar mesospheric clouds (night shining clouds) from space can also measure ozone, according to results verified by the research of undergraduate Heather Hunter (ECE '08). Hunter is working in the Aeronomy and Remote Sensing Laboratory, analyzing data from the NASA AIM satellite that launched last April.

She presented her results in a poster session at the American Geophysical Union conference in San Francisco, Calif., in December 2007.

The cloud imaging and particle size (CIPS) instrument is observing the clouds and determining particle sizes and the proportion of the incident light that is reflected. "When the clouds are not present," she explains, "CIPS observes only the sunlit Rayleigh-scattered background brightness, which is controlled by ozone present above 40 km from the earth's surface."

She created a model of the atmosphere from existing data and compared it to the satellite data, following a technique developed for solar backscattered ultraviolet instruments. "Our results show that CIPS can reasonably measure ozone column density and the ratio of the ozone and neutral air scale heights."


Christina O'Connor

Hunter, who started working in the laboratory last May, says she was initially surprised by the amount of space science research and the complexity of the projects. "I was also very surprised that there were so many opportunities emerging in space science research for students. I'm glad to see the department encouraging students in this area."

Before joining the laboratory, she had decided she most enjoyed the area of electromagnetics. She had a strong interest, but no previous course work in space or atmospheric science and had much to learn. Her experience has convinced her to follow a career in the field. She wants to work in RF propagation engineering, then return to school for more education in atmospheric science. "This is an exciting area of study with a very promising future. This isn't 'mainstream EE', but I'm eager to see more students get involved."