I am very pleased to be partnering with co-author PG&E meteorologist John Lindsey http://www.flickr.com/photos/mikebaird/3304782292/ for this month's Science section featuring a vitally important aspect of space exploration; the study of our Earth. When I make public space exploration presentations I like to explain to audiences that our tiny Earth is actually a huge, yet little known, area of space exploration efforts. We use the Earth to develop theories about how other planets and moons work in our solar system and we use those planets and moons to help us understand how our Earth works. More importantly, we perform this complex long-term investigative work to understand what is happening, or may someday happen, to Earth's processes, especially as they may impact human life.

One of the biggest and fastest growing areas of planetary research is Earth's climate; working to understand more of the inner workings of how Earth's oceans, magnetic field, the Sun and human activity may affect climate activity and change. Climate change is quickly becoming one of the biggest and most important elements of human life on Earth. Humans are actually living in a very fragile atmospheric environment having a very narrow band of habitability, one that we understand very little about. This is where space exploration steps in, in the form of Earth-observing satellites and ocean and climate research.

In one important effort to learn about our atmosphere, what causes weather conditions, and what climate changes may be coming in the future and why, in June 2008 John Lindsey and I participated with educators from around the U.S. and scientists from around the world, including NASA's Jet Propulsion Laboratory, at an Educator Launch Conference at Allan Hancock College sponsored by the Space Endeavour Center located at Vandenberg Air Force Base http://www.endeavours.org/. Joining other speakers that day, John and I provided presentations about JPL public outreach and PG&E ocean monitoring and weather forecasting operations for the benefit of educators who were attending as part of the Ocean Surface Topography Mission (OSTM) Jason-2 satellite launch from Vandenberg http://sealevel.jpl.nasa.gov/mission/ostm.html.

The week following that conference, at 12:46 am on Friday June 20, 2008, my family and I watched breathlessly from 3 miles away as the Delta II rocket lifted off from Space Launch Complex (SLC) 2 carrying the Jason-2 spacecraft http://mediaarchive.ksc.nasa.gov/search.cfm?cat=182. It was a very clear and quiet night with no fog, wind or sounds other than people talking in hushed tones in the small crowd that had gathered to witness the spectacular and exciting launch. Watching the spacecraft leave the launch pad, I was immediately struck by the strange feeling that the powerful rocket lifted off silently without a sound. As it climbed into the black sky, about 14 seconds later the air shock wave and sound from the launch hit us, shaking everything with a very loud roar. My heart raced as I watched it streak into the southern sky and disappear. What a thrill for anyone to see, especially impressionable young children and school students.

The Jason-2 spacecraft joined the Jason-1 spacecraft in orbit 830 miles above the Earth studying global ocean topography for five years, measuring the height of ocean surfaces to within an accuracy of less than 1 inch. The purpose of this vital Earth observing work is to understand the role that Earth's oceans play in generating weather conditions and global climate change. Now, I turn this discussion over to John Lindsey and his expertise in ocean and atmospheric conditions and use of satellites in weather analysis and forecasting.

Satellites revolutionized the way weather forecasts were developed. Many of these satellites were actually launched from our own backyard - Vandenberg Air Force Base. Before 1946, the highest pictures ever taken of the Earth's surface were from the Explorer II balloon, which had ascended 13.7 miles in 1935. This was high enough to discern the curvature of the Earth. Some of the first pictures taken of clouds from above the Earth started in the post-World War II rocket age. In 1946, an unmanned American rocket equipped with a camera reached an altitude of 65 miles and recorded pictures of the Earth's clouds from space. In 1957, Russia's Sputnik orbited the Earth. With the launch of Sputnik, the United States accelerated its space program and the meteorological community benefited since many early satellite photos were used for weather forecasting.

The first satellite dedicated solely to weather observations was TIROS-1, the first in a series of Television Infrared Observation Satellites. It was launched on April 1, 1960 from Cape Canaveral, Florida. Another achievement for weather satellites was the launch of geostationary satellites in 1964. A geostationary satellite is launched into orbit at about 22,300 miles above the Earth. At this height, the satellite appears to hover stationary over a point on the Earth's surface. The benefit of a geostationary orbit is that it allows cloud pictures to be taken from the same reference point and looped to provide an estimated time of arrival of storm systems.

Another type of satellite is the ocean-observing satellite called QuikSCAT. This satellite is a polar-orbiting satellite that can measure a 1,100-mile-wide swath of the Earth's surface. It can estimate the winds over the surface of the ocean to a high degree of accuracy twice daily. One day, this wind data could help to better predict the output of wind farms, and perhaps result in higher amounts of energy from wind. The Jason 1 and 2 satellites are instrumental in determining sea level with their state-of-the-art radar altimeters. These satellites can determine sea level with an accuracy and precision down to a few millimeters.

One way to judge what's going on with the atmosphere and climate is to examine sea levels. The oceans cover 70 percent of the Earth's surface, receive 80 percent of the rainfall and hold 97 percent of the Earth's water. The other three percent is held in land ice, groundwater, and freshwater lakes and rivers. Only a very small percentage of the total water (0.001 percent) is in the atmosphere. I have often wondered why Earth wasn't called "Ocean" instead.

The ocean has a thousand times more heat capacity than the atmosphere. When water warms it expands. During strong El Niño events, when seawater temperatures along our coastline are warmer than normal, water levels can actually be several inches higher than predicted on the tide tables. This is due to the thermal expansion of the water column in the upper-levels of the ocean.

Today, satellites are indispensable in performing weather analysis and forecasting, and are a vital tool used by NASA's Jet Propulsion Laboratory and other organizations in climate change research. As you are learning, space exploration has many facets, requiring a great many scientific and engineering specialties, creating a wide range of educational possibilities for college students as they pursue careers in technical fields.

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