On the Ground at the AGU, Dec. 5-9, San Francisco

The American Geophysical Union held its annual fall meeting Dec. 5-9, 2011 in San Francisco, where 20,000 attendees from around the world presented research on everything from deep earth processes to the physics of the outer reaches of the heliosphere. Peter Martinson, Alexandra Peribikovsky, and Oyang Teng from 21st Century *attended, with a focus primarily on current developments in space weather and earthquake forecasting, which will be the subject of upcoming articles.*

Here are some highlights of other research from the poster sessions and oral presentations, compiled by Oyang Teng.

NASA

NASA

Artist's depiction of CloudSat, the most advanced radar designed to measure the properties of clouds, is part of the "A-Train" constellation of three other Earth Observing satellites including Aqua, Aura, and the French CNES's PARASOL. Inset: Dr. Graeme Stephens.

CLOUDS AND CLIMATE CHANGE

For all the attention climate scientists pay to global mean surface temperature, it is virtually irrelevant when it comes to clouds and cloud dynamics. Such was the message of Graeme Stephens's standing-room-only lecture on "Climate Change: A Very Cloudy Picture," which addressed the complexities of cloud properties and their varying influences on the climate as a whole, in particular through the hydrological cycle. These complexities have bedeviled climate models as the single greatest source of uncertainty, and "muddled up" water vapor feedback in the reports of the Intergovernmental Panel on Climate Change.

Stephens, director of the Center for Climate Sciences at NASA's Jet Propulsion Laboratory, said that rather than attempting to tweak current climate models into submission, "the way forward is to dig into the key processes and try to understand them at the building-block level, the process level," which is only possible through such dedicated multi-sensory platforms as NASA's A-Train constellation of Earth-observation satellites.

THE EARLY MAGNETIC FIELD AND LIFE

In spite of several billion years of upheavals that have erased most of the record of Earth's infancy, traces of the planet's most ancient magnetic field live on in microscopic magnetic particles lodged inside of millimeter-sized quartz crystals. In discussing his poster titled, "Magnetic Field Strength, Water, and Life on the early Earth," John Tarduno of Rochester University explained that because such inclusions have escaped the ravages suffered by most larger rock samples over time, they have allowed him and his associates to establish the oldest record of the existence and strength of the geomagnetic field, which 3.47 billion years ago was approximately 25 percent its current strength.

One of the consequences of such a weak field at a time when it is believed the young Sun was spinning more rapidly, and therefore producing a more intense solar wind, is that much of the initial supply of water vapor in the Earth's atmosphere would have been blown away—implying that the planet was much wetter to begin with, and perhaps shedding light on conditions necessary for the appearance of the first living organisms.

University of Rochester

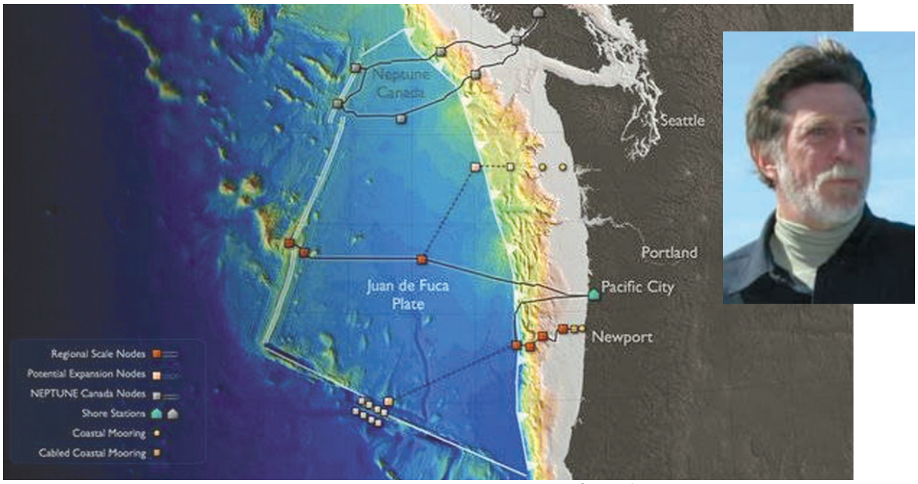
Dr. John Tarduno is Professor of Geophysics at the University of Rochester, here in a clearing sandstorm in the Sahara (northeastern Mauritania).

Tarduno noted, that the oldest microfossil evidence of life coincides in time with the earliest evidence of the geomagnetic field. He said he is now studying zircon inclusions in rock conglomerates that are older than 4 billion years, for even more ancient signs of the geomagnetic field. (Such work could also serve as a constraint on current geophysical models for the generation of the geomagnetic field itself.)

WIRING THE OCEAN FLOOR TO MONITOR VOLCANOES

As humanity has steadily expanded its sensorium into space through an increasing array of Earth-orbiting satellites, we are only now beginning to reach into the depths to probe the deep seafloor, which covers some 60 percent of Earth's surface. Under the National Science Foundation's Ocean Observatories Initiative, an integrated network of advanced *in-situ* monitoring instruments is being constructed around the volcanically active seafloor spreading region of the Juan de Fuca tectonic plate, situated several hundred miles off the coast of the Pacific Northwest.

The University of Washington's John Delaney, discussed the prospects in his talk on "Active Submarine Volcanoes and Electro-Optical Sensor Networks: The Potential of Capturing and Quantifying an Entire Eruptive Sequence at Axial Seamount, Juan de Fuca Ridge." Delaney explained that this will allow scientists to study, for the first time, the full sequence of an underwater volcano, its biogeochemical consequences for the marine environment, as well as clues about the nature of the deep biosphere, which periodically vents microorganisms into the ocean during such eruptions.



Center for Environmental Visualization
and OOI-RSN program, University of Washington

Dr. John Delaney (inset) and a University of Washington research team are implanting robotic sensor arrays along the Juan de Fuca Ridge and elsewhere on the ocean floor and water column, which link to the Internet using submarine electro-optical cables.

"We're not just talking about Axial Seamount—we're talking about a global system," Delaney stressed, pointing out that the Juan de Fuca Ridge is representative of the global dynamics of ocean crust. Although not explicitly mentioned in his presentation, the Juan de Fuca Ridge is also the origin of the Cascadia Subduction zone, which has the potential to unleash a mega-earthquake and tsunami that could devastate both the Pacific Northwest as well as Japan, as it has in the past.

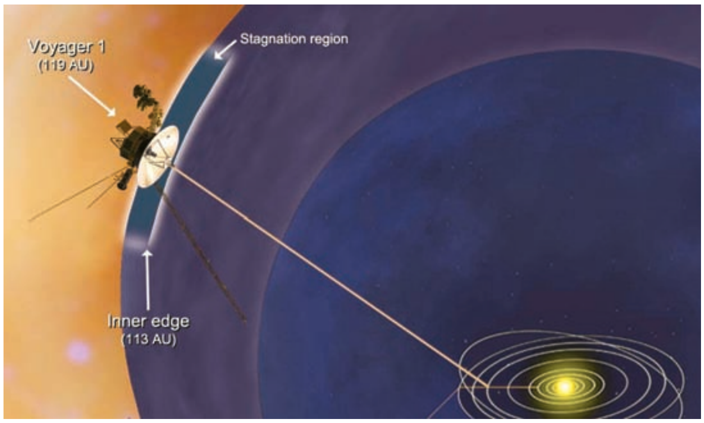
Advanced, real-time monitoring of this area, once the system comes online in the next couple of years, could be key for developing an early warning system.

EXPECT THE UNEXPECTED: UPDATE ON VOYAGERS 1 AND 2

Voyagers 1 and 2, launched in 1977 and now roughly 11 and 9 billion miles from Earth, respectively, continue their encounter with the weird outer edges of the Solar System. In a talk on "Voyager Observations in the Heliosheath: An Overview," project scientist Ed Stone discussed the so-called stagnation zone Voyager 1 has entered, in which the solar wind has apparently slowed to a halt in the outer fringes of the heliosphere. Stone, former director of JPL lab, is now a professor of physics at Caltech.

It is expected that the spacecraft could punch through to interstellar space within several months or years. In a following presentation on "The Dynamics of the Heliosphere from 1961 to Voyagers 1 and 2 in 2011," Eugene Parker, the astrophysicist who first theorized the existence of the solar wind in the mid 1950s, described the excitement of the near-term prospects for directly sampling the interstellar environment.

"The spacecraft are plunging into unknown, uncharted regions of space with the usual unexpected surprises. It reminds me of the early days of space exploration studying the solar wind, when practically any measurement would turn up something interesting," Parker said.



NASA/JPL-Caltech

Artist's illustration of NASA's Voyager 1 spacecraft entering a new region between our Solar System and interstellar space, called the stagnation region. There the wind of charged particles streaming out from the Sun has slowed and turned inward for the first time, the Solar System's magnetic field has piled up, and higher-energy particles from inside the Solar System appear to be leaking out into interstellar space.

Dr. Ed Stone with a model of Voyager.

Dr. Eugene Parker, a solar astrophysicist, is a professor emeritus at the University of Chicago.