Brief notes about the world of science and technology at Southwest Research Institute

Stratospheric airship reaches near-space altitude during demonstration flight

An SwRI-led team has successfully demonstrated powered flight of the HiSentinel stratospheric airship at an altitude of 74,000 feet. The development team of Aerostar International, the Air Force Research Laboratory (AFRL) and SwRI launched the airship on November 8 from Roswell, N.M., for a five-hour technology demonstration flight. The 146-foot-long airship carried a 60-pound equipment pod and propulsion system. Sponsored by the U.S. Army Space and Missile Defense Command, the flight was the culmination of a six-month preparation effort.

"There are a number of stratospheric airship programs being promoted around the world, but this is the first of these programs to successfully fly a real airship in near-space," said William Perry, assistant director of Space Systems in the SwRI Space Science and Engineering Division.

SwRI designed the airship and provided the telemetry, flight control, power and propulsion systems. Aerostar International fabricated the hull and participated in the integration and test flight. AFRL developed the innovative launch system, provided facilities, and supported the launch and recovery. Each of the organizations contributed funding, manpower, equipment and facilities for the collaborative effort.

HiSentinel is the first airship developed under the Composite Hull High Altitude Powered Platform (CHHAPP) program. CHHAPP is a spiral development program for a family of long-endurance autonomous solar-electric, stratospheric airships. These low-cost systems will be capable of lifting small to medium payloads (20 to 200 pounds) to near-space altitudes for durations of longer than 30 days for communications, military and science applications.

Designed for launch from remote sites, these airships will not require large hangars or special facilities. Unlike most stratospheric airship concepts, HiSentinel is launched flaccid with the hull only partially inflated with helium. As the airship rises, the helium expands until it completely inflates the hull to the rigid aerodynamic shape required for operation.

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SwRI to help U.S., Chinese agencies with Beijing bus retrofit

The U.S. Environmental Protection Agency, the Beijing Environmental Protection Bureau (EPB) and China's State Environmental Protection Administration (SEPA) kicked off a diesel retrofit demonstration project in Beijing on November 10. The project will entail installation of emissions control equipment on 25 to 30 city buses in Beijing, many of which will use low-sulfur fuel in combination.

Through a cooperative agreement, SwRI will manage the project in Beijing, working closely with EPA, Beijing EPB, the bus company and the emissions control vendors. EPA has committed $200,000 and staff time to the diesel retrofit demonstration project. SwRI also is contributing matching funds.

Air pollution in China is increasing rapidly, much of it due to the rising number of vehicles. In Beijing alone, close to 1,000 vehicles are being added to the roads each day. The fine particulate matter and other emissions from existing diesel-powered trucks and buses contribute to air pollution in Beijing and other large cities and pose serious public health impacts.

At least two different technologies will be demonstrated: one that can reduce particulates by as much as 30 percent; and a second that, when used with low-sulfur fuel, can reduce particulates by 90 percent or more. A successful retrofit demonstration project will lay the groundwork for expanded retrofits of heavily polluting vehicles in Beijing. This will have a positive impact on air quality in Beijing, and thus public health, as the city prepares for the Olympics in 2008 and beyond.

Because new vehicle technologies and the most effective retrofit technologies depend on clean fuels, EPA and SEPA agreed to work together to reduce fuel sulfur levels as one of an integrated array of projects in China for clean fuels and vehicles. Other projects under this agreement include compliance management, training and advanced vehicle technologies.

Several other partners have also committed to join in one or more of these collaborative projects in China, including the Energy Foundation China, Harvard University, Tsinghua University, Cummins, Corning, and others.

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Wyrick paper on Mars pit crater chains honored

Danielle Y. Wyrick, a scientist in the Geosciences and Engineering Division, has received the 2004 Pellas-Ryder Award for the Best Student Paper in Planetary Science by the Meteoritical Society and the Planetary Geology Division of the Geological Society of America.

She is the principal author of the paper, "Distribution, Morphology, and Origins of Martian Pit Crater Chains," published in the June 2004 issue of *Journal of Geophysical Research* while she was pursuing a master's degree in geology at The University of Texas at San Antonio and working as a student assistant at SwRI.

"The article provides a new understanding of pit crater chains on Mars that has relevance to interpreting crustal processes on other terrestrial planetary bodies," said Dr. David Ferrill, director of the SwRI Earth, Material and Planetary Sciences Department and a co-author of the paper. With funding from SwRI's internal research program, Wyrick sorted and organized the huge image data set for Mars, assisted by fellow SwRI Scientist Shannon Colton, who extracted data from various space instruments.

The Pellas-Ryder Award, named for Paul Pellas and Graham Ryder, recognizes the best student paper in planetary science published in a peer-reviewed scientific journal. Wyrick continues to work in the SwRI Geosciences and Engineering Division and is pursuing a doctorate in geology from UTSA. Her current work focuses on understanding faulting and fracturing processes on Earth, Mars and Ganymede.

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Study suggests Titan may hold keys for exotic brand of life

Saturn's moon Titan has long been a place of interest to astrobiologists, primarily because of its apparent similarities to the early Earth at the time life first started. A thick atmosphere composed primarily of nitrogen and abundant organic molecules (the ingredients of life as we know it) are among the important similarities between these two otherwise dissimilar planetary bodies.

Scientists have considered it very unlikely that Titan hosts life today, primarily because it is so cold (-289 degrees Fahrenheit, or -178 Celsius) that the chemical reactions necessary for life would proceed too slowly. Yet previously published data, along with new discoveries about extreme organisms on Earth, raise the prospect that some habitable locales may indeed exist on Titan.

In a paper presented at the Division for Planetary Sciences 2005 Meeting in September, a team of researchers from SwRI and Washington State University said that several key requirements for life now appear to be present on Titan, including liquid reservoirs, organic molecules and ample energy sources.

Methane clouds and surface characteristics strongly imply the presence of an active global methane cycle analogous to Earth's hydrological cycle. It is unknown whether life can exist in liquid methane, although some such chemical schemes have been postulated. Further, abundant hints of ice volcanism suggest that reservoirs of liquid water mixed with ammonia may exist close to the surface.

"One promising location for habitability may be hot springs in contact with hydrocarbon reservoirs," said lead author Dr. David H. Grinspoon, a staff scientist in the SwRI Space Science and Engineering Division. "There is no shortage of energy sources [food] because energy-rich hydrocarbons are constantly being manufactured in the upper atmosphere, by the action of sunlight on methane, and falling to the surface."

"Possible Niches for Extant Life on Titan in Light of Cassini-Huygens Results" was presented by Grinspoon, Dr. Mark A. Bullock and Dr. John R. Spencer of SwRI, and D. Schulze-Makuch of Washington State University. Funding came from the NASA Exobiology Program using published results from the Cassini-Huygens mission. This project is not otherwise affiliated with Cassini-Huygens.

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SwRI®-CATARC joint venture in China opens for business

A joint venture between SwRI and the state-owned China Automotive Technology and Research Center (CATARC) has officially opened for business in the People's Republic of China.

The joint venture, called Tianjin SwARC Automotive Research Laboratory Co., Ltd., appointed Li Jun as general manager during its first board meeting on October 21.

SwARC provides independent and impartial evaluation of automotive products, powertrain components and automotive system designs. It also develops protocols for evaluating exhaust aftertreatment devices and systems and organizes and conducts consortia and evaluations for the Chinese government and transportation and energy industries.

Li previously served as chief engineer of the CATARC Intelligent Transport Systems Research Institute. He is proficient in engine bench testing and has experience in project management and marketing.

SwARC, owned equally by SwRI and CATARC, has five fully equipped cells for performing engine dynamometer testing and emissions measurement and analysis.

CATARC, also based in Tianjin, is a state-owned technical and administrative entity of the Chinese automotive industry. It provides standardization and technical regulation, product certification and testing research, quality system certification, information and databases for the auto industry, engineering management and design, enterprise management science research, and automotive high-technology development and applications. It leases the laboratory building to SwARC, and both CATARC and SwRI furnish equipment for SwARC.

SwRI, which currently operates a representative business office in Beijing, has established a technical presence in China and is furthering its scientific purposes through its participation in SwARC, which draws on SwRI's expertise in automotive emissions research and its leadership role in developing protocols for diesel aftertreatment evaluations in the U.S.

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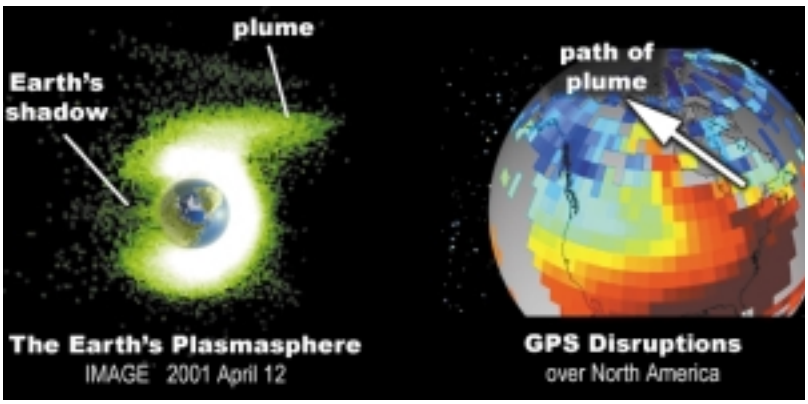
New findings could allow scientists to predict bad space weather



SwRI's IMAGE spacecraft shows an ultraviolet image of the plasmasphere (shown left in false color), a cloud of plasma surrounding the Earth. Space storms eroded the plasmasphere, causing long "plumes" of plasma to be pulled outward into space. These plumes are magnetically connected to the Earth's ionized upper atmosphere, where they cause disruptions in GPS signals (right) that affect navigation of airplanes, boats, and cars.

It may soon be possible to predict the electromagnetic disturbances in the upper atmosphere that disrupt the satellite signals we use to communicate, navigate and defend our country.

Scientists from SwRI, the Massachusetts Institute of Technology Haystack Observatory, and the Jet Propulsion Laboratory combined ground and space observations, creating an unprecedented view of the Earth's upper atmosphere. They discovered large, global-scale disturbances not unlike the cold fronts that govern weather conditions on the ground. These "space fronts" cause storms in the Earth's upper atmosphere, creating plumes of electrified plasma in the ionosphere that delay and scintillate GPS signals. These problems cause location errors that affect air, ground and marine navigation technology as well as military defense and precision surveying and farming systems.

"When the blobs of plasma pass overhead, they wreak havoc with low- and high-frequency radio communications and delay Global Positioning System navigation signals," said Dr. Jerry Goldstein, principal scientist in the Space Science and Engineering Division. "The communications disruptions seemed like random events because the plumes were invisible to human eyes and passed unnoticed overhead until recent technology allowed us to image them. Then we still didn't understand what was controlling their movement, occurrence or appearance."

The answers to these questions came from space, from data collected by NASA's Imager for Magnetopause to Aurora Global Exploration (IMAGE) satellite, conceived and built at SwRI, led by Dr. Jim Burch, vice president of the Space Science and Engineering Division. Since 2000, IMAGE has routinely obtained ultraviolet images of the plasmasphere — a plasma cloud surrounding Earth in space. Plasmaspheric images have revealed a predictable pattern of behavior during space storms. Just as storms on Earth can cause erosion of coastlines, storms in space erode the outermost part of the plasmasphere. This plasmaspheric erosion produces plumes, elongated strands of plasma torn from the plasmasphere, that extend into space at least 36,000 km and may stretch as far as 60,000 km.

These large space plasma features turned out to have a crucial impact on the local conditions in the ionosphere that so critically affect the reliability of GPS navigation. The plasma plume is magnetically linked to the ionosphere by the Earth's intrinsic geomagnetic field. So when the plume is dragged outward farther into space, a corresponding motion occurs in the ionosphere: blobs of dense plasma dragged northward disrupt GPS signals at latitudes over North America where, ordinarily, lower-density ionospheric plasma occurs.

"In other words, space-based imaging showed that the apparently random GPS disruptions were caused by the formation of plasmaspheric plumes tens of thousands of kilometers in space," said Goldstein. "Discovering this link is like discovering that the movement of cold fronts is responsible for sudden squalls.

"The good news is that the plumes are predictable," he continued. "IMAGE data show that plumes are a consistent, systematic response to perturbations in the solar wind. This predictability may translate one day into an early warning system for GPS disruptions.

"Like storms on Earth, plumes are not preventable," said Goldstein. "But advance warning can make a huge difference in their impact."

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Nesvorny awarded Urey Prize

The Division for Planetary Sciences of the American Astronomical Society (AAS) has awarded its Urey Prize in Planetary Sciences to Dr. David Nesvorny, a senior research scientist in the Space Studies Department of SwRI's Space Science and Engineering Division. Nesvorny was selected as the 2005 recipient of the award, named in honor of the late Nobel laureate Harold C. Urey, who made significant advances in the fields of physical chemistry, geochemistry, lunar science and astrochemistry.

Nesvorny was noted for his research contributions to the dynamical evolution of small bodies in the solar system. His recent efforts focused on precisely dating asteroid breakup events and determining how sunlight affects asteroid spin rates.

Nesvorny holds a master's degree in astronomy from Charles University, Czech Republic, and a doctorate in astronomy from the University of São Paulo, Brazil. He joined SwRI in 2003. Nesvorny will receive the Urey Prize and a cash award at the annual meeting of the AAS Division for Planetary Sciences in Cambridge, England, in September 2005.

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