



Daily Planet

University of Michigan College of Engineering

WINTER 2011
 The Department of
 Atmospheric,
 Oceanic and Space
 Sciences Newsletter

Weather monitoring and U-M football

by Sheila Pursglove

In the 2011 opening game of Wolverine football, the action in the sky was as dramatic as on the turf and weather monitoring by a duo from AOSS ensured the safe evacuation of thousands at the Big House.

While fans watched the Wolverines face Western Michigan, AOSS Research Scientist Dr. Frank Marsik and student David Wright looked for tornadoes instead of touchdowns and funnel clouds instead of fumbles.

Marsik was approached at the end of August by the U-M Office of Emergency Preparedness to have AOSS provide weather information



to a stage collapse with multiple deaths, induced the university to formalize hazardous weather planning for major sporting events, Marsik says.

On Thursday before the game against the Broncos, he and Wright gave OEP, Department of Public Safety, and U-M Facilities a weather forecast. Then, during Saturday's game, Wright used a variety of information sources – radar, lightning, watches/warnings, storm motion, and weather spotter reports – to carefully monitor the weather.

"I knew what the score was," Wright said, "but no sense of how the team was playing as I was watching storm cells pop up all afternoon along outflow boundaries."

"I was pleased our work with the U-M Office of Emergency Preparedness through the week paid off on opening day. David did a great job of monitoring the storm activity at the OEP office. I got called out of the stadium shortly after the first game stoppage when the really nasty stuff starting firing to our southwest."



for home football games. While U-M always monitored conditions before sporting events, storm related tragedies at the University of Notre Dame, when strong winds led to a platform collapse and death of a student, and at the Indiana State Fair when thunderstorm winds led

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University of Michigan
1521C SRB
2455 Hayward Street
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(734) 763-7305
(734) 615-4645 fax
aossnews@umich.edu

Daily Planet on the web at
<http://aoss.engin.umich.edu/pages/dailyplanet>

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New Grants

June - September 2011

Principal Investigators are listed first followed by Co-Is

Stephen Bougher, *Structure and Dynamics of the 60 - 120 km Region on Mars*, \$30,000, NASA

Michael Combi, *Determining Water Production Rates with SOHO/SWAN Observations of Cometary Hydrogen*, \$315,000, NASA

Michael Combi, *Hcl, HF And H₂O+ In Comets: Probing Solar Nebula And Coma Chemistry*, \$7,460, NASA-JPL

Charles Edmonson Jr, *Mars Organic Molecule Analyzer MOMA Electrical/Electronic Subsystem Development*, \$64,853, NASA

Lennard Fisk, George Gloeckler, *Seed Particle Populations in the Solar Corona*, \$413,118, NASA

Jason Gilbert, Robert Alexander, *A Methodological Approach for Rapid Auditification in Heliospheric Data Analysis*, \$25,500, NASA-UNCF

Xianglei Huang, Gerald Potter, *Understanding of the Band-by-Band Longwave Radiation Budgets and Cloud Radiative Forcings: A Synergistic Approach with CERES, AIRS, and GCM Simulations*, \$464,575, NASA

Susan Lepri, Jacob Gruesbeck, *Suprathermal Particles Near the Sun*, \$30,000, NASA

Michael Liemohn, Roxanne Katus, *Model Comparisons of the Inner Magnetosphere During Geomagnetic Storms of the IMAGE Mission*, \$30,000, NASA

Michael Liemohn, Natalia Ganjushkina, Darren De Zeeuw, Janet Kozyra, Gabor Toth, Aaron Ridley, Mark Moldwin, *Composition and Feedback in Geospace*, \$1,173,100, NASA

Mark Moldwin, *UM-Detroit Public School Space Science Education Partnership*, \$45,000, NASA

Nilton Renno, *Aerosols-Climate Interactions: Characterization of Saltation, Dust Lifting, and Dust Electrification in Important Dust Source Regions*, \$625,979, NSF

Nilton Renno, Bruce Block, *The Brines of the Phoenix Landing Site, The Potential for Life to Adapt to them, and the Implications for Life Elsewhere*, \$1,054,636, NASA

Aaron Ridley, James Cutler, *CubeSat Investigating Atmospheric Density Response to Extreme Driving (CADRE)*, \$800,000, NSF

Aaron Ridley, *Investigation of Ionospheric Contribution to Geomagnetic Storms*, \$88,742, NSF

Christopher Ruf, Amanda Mims, *Development of Ocean Surface Wind Vector Retrieval Algorithms in Tropical Cyclones*, \$30,000, NASA

Christopher Ruf, *Support for the Hurricane Imaging Radiometer (HIRAD) during GRIP and HS3*, \$312,000, NASA; *PATH/GeoSTAR Risk Mitigation Correlator Development*, \$1,750,000, NASA-JPL

James Slavin, *Multi-Satellite Investigation of Plasma Sheet Flux Rope Formation and Dynamics*, \$291,641, NSF

Shasha Zou, Mark Moldwin, *Multi-Instrument Observation of Dynamics of the Ionospheric Trough During Substorms*, \$312,899, NSF

Thomas Zurbuchen, Susan Lepri, *The Solar Orbiter Heavy Ion Spectrometer Development Extended Phase A III*, \$199,801, NASA-SWRI

Thomas Zurbuchen, Daniel Gershman, *New Operating Mode for a Quadrupole Mass Spectrometer*, \$30,000, NASA

Thomas Zurbuchen, Jim Raines, *Ions from Mercury: Magnetosphere, Sputtering and Transport*, \$30,000, NASA

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AOSS Faculty Accolades



AOSS Assistant Professor **Christiane Jablonowski** was among a select group of researchers who received the nation's highest honor for professionals at the outset of their independent research careers, the Presidential Early Career Award for Scientists and Engineers (PECASE).

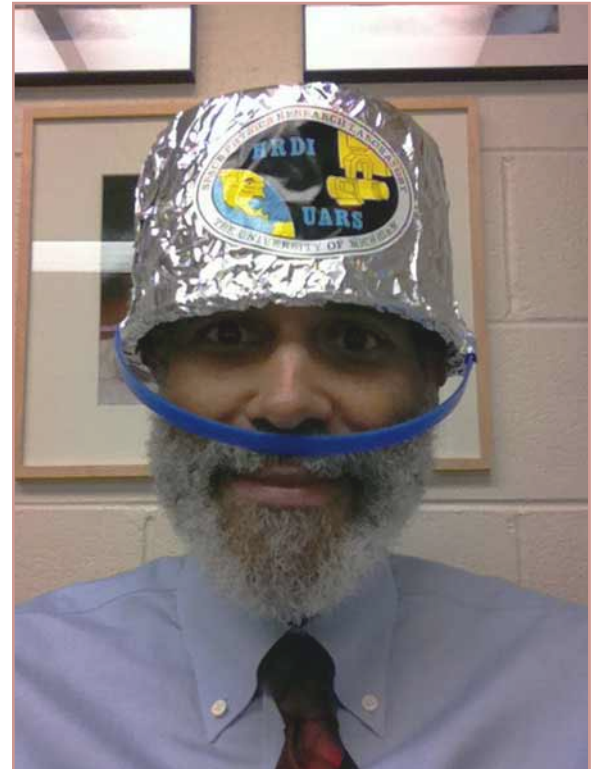
Professor Jablonowski was nominated by the US Department of Energy. The award will support her research on new frontiers in climate and weather modeling. She uses a technique called adaptive mesh refinement to bridge the spatial scales between local, regional and global phenomena in climate models without the prohibitive computational costs of global high-resolution simulations.

"It is inspiring to see the innovative work being done by these scientists and engineers as they ramp up their careers – careers that I know will be not only personally rewarding but also invaluable to the nation," President Obama said in the White House announcement.

Christiane was recognized for exemplary computation science research, advancing the frontier at the interfaces of applied math, computer science, scientific computing, and atmospheric science, and for leadership in connecting diverse communities and bridging the gaps between mathematical and computational developments and the special requirements of climate modeling.



AOSS Assistant Professor **Allison Steiner** was invited by Michele Obama to stand as a representative for female scientists at the White House and National Science Foundation's event on September 26 to announce new workplace flexibility policies to support America's scientists and their families. These policies will help retain women in the Science, Technology, Engineering and Math (STEM) fields.



To find out what Charles Edmonson, the Assistant Director of the Space Physics Research Laboratory is preparing for, see page 8.

ALUMNI OBITUARY

Howard L. McCollister (MSE '64, PhD, '78), February 2, 2011

Jack C. Olson (BSMTL '48) August 8, 2011

Kenneth W. Randle (BSEAA '49) September 9, 2011



CADRE mission will help reduce space collisions

by Sheila Pursglove

The US Air Force monitors more than 13,000 objects larger than a softball in low-Earth orbit, thousands of which can go astray during periods of strong geomagnetic, or auroral, activity.

And some objects – like the International Space Station and advanced telescopes – can be vastly expensive.

Satellite drag knowledge is crucial in predicting when collisions may occur, and taking steps to alter orbit – but such steps can eat up nonreplenishable fuel. AOSS Associate Professor Aaron Ridley is attempting to assist in reducing the possibility of collisions in space.

Ridley recently received a grant from the National Science Foundation for his “CubeSat investigating Atmospheric Density Response to Extreme driving” (CADRE) project, a 3 unit CubeSat that will perform detailed, in-situ measurements of thermospheric properties, such as the temperature and winds.

“The scientific goal is to improve our capabilities for space weather modeling,” Ridley says. “These models will be used to better understand satellite drag and decrease the probability of collisions and the cost of collision avoidance. In many ways these models of the upper atmosphere are similar to weather models that predict when and where hurricanes are going to make landfall, except in our case, the hurricane is a piece of space debris moving at 17,000 miles per hour and Florida is the international space station.”

CADRE, part of a growing collection of NSF-sponsored space weather satellite missions, will be launched into a near-polar orbit with an altitude of approximately 500 km. The project, to run through 2014 under the direction of Ridley, along with Andrew Nicholas (from the Naval Research Laboratory) and James Cutler (U-M Aerospace Engineering), will provide hands-on work for AOSS and CoE students, much like this year’s RAX-II and M-Cubed projects.

“The 2011 winter term Aero 483 senior design team did extensive work on the CADRE baseline design,” Ridley says. A new class, AOSS 605, Nanosat Design, currently has many Master’s level and undergraduate level students working on the CADRE project. The team of students will work with instrument providers at the Naval Research Laboratory, the NASA ELaNa Program (Educational Launch of

Nanosatellites) and through the United States Space Experiments Review Board (SERB).

CADRE is a follow-on mission to the RAX and M-Cubed (a CubeSat built by the Student Space System Fabrication Laboratory) missions, and will utilize some of the components that were developed for those satellites, such as the power system, the main and back up computer systems and the UHF radio.

“CADRE will allow us to measure both the scale sizes in the ionosphere and in the thermosphere,” Ridley says. “By doing this, researchers will better be able to tell on what scales energy is input into the system.”

One thing that is not really understood about the upper atmosphere is how much energy enters the system during a disturbance and how that energy actually leaves the system. In the lower atmosphere, friction with the surface takes a significant amount of energy out of the system. In the upper atmosphere, there have been very few measurements of the winds, so the amount of friction (or viscosity) is not well understood. CADRE will measure the winds and how those winds change as more and more energy is put into the system.

“While CADRE will not directly solve the operational needs of satellite operators, it will enable better models of the thermosphere and ionosphere to be produced, and improve space weather predictions,” Ridley says.

Student-built satellite to prepare NASA instrument for space missions

by Bill Clayton

EDITOR'S NOTE: M-Cubed, along with RAX-2 and the other CubeSats were successfully deployed on the morning of Oct. 28, and both cubeSats have been heard from and are sending data back to the students. We are including the following story, which ran just prior to the launch, to provide you with additional information about the CubeSat program at the University of Michigan.

When the M-Cubed satellite, built by U-M students, goes into orbit, it will become the first CubeSat to test a NASA instrument for major space missions is scheduled to launch Friday.

A CubeSat is a cubic mini-satellite, about 4 inches per side, with a mass of no more than 3 pounds. CubeSats take little time to design, are inexpensive to build and can be launched as secondary payloads in standardized pods that attach easily to the launch vehicles. These characteristics make CubeSats an inexpensive, efficient way to test space-flight components and software for subsequent major space missions.

James Cutler, assistant professor of aerospace engineering and atmospheric, oceanic and space sciences, said CubeSat technology is “raising the readiness level so that future missions can have confidence in their ability to perform in orbit.”

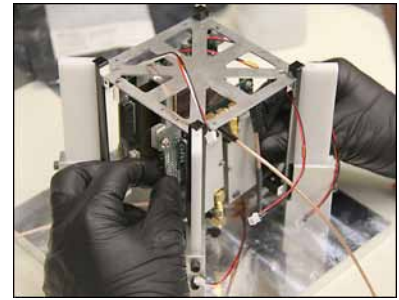
NASA selected M-Cubed to evaluate and certify the Virtex-5 Field-Programmable Gate Array, a new instrument designed

to process images taken by a multi-directional, multi-wavelength camera that has been under development at NASA's Jet Propulsion Laboratory. One of the missions on which the camera will be used is the Aerosol-Cloud-Ecosystem mission, which will take high-resolution images of the Earth. The mission is slated to launch between 2013 and 2016.

M-Cubed will be accompanied by a second U-M student-built satellite, RAX-2, which will study irregularities in the density of plasma in the ionosphere.

Students in the U-M Student Space Systems Fabrication Lab used hardware purchased in local retail stores to build much of M-Cubed.

The students were equally frugal in the development of RAX-2, using spare parts from its forerunner, RAX-1, to build major components. The RAX device is a stack of three CubeSat units, making it about 1 foot high and about 4 inches square at the base. Using one-unit CubeSats to build larger satellites, such as the three-



The M-Cubed CubeSat mini-satellite, built by U-M students, will be used to test high-resolution camera hardware for a future NASA Earth science mission. (Photo courtesy of Michigan Exploration Lab)

unit RAX, has accelerated production dramatically.

The upcoming mission is part of the third NASA Educational Launch of Nanosatellites project. M-Cubed is the first CubeSat funded through the Advanced Technology Initiative in NASA's Earth Science Technology Office. The RAX project has been and continues to be a joint venture between U-M and SRI International, and is the first CubeSat program sponsored by the National Science Foundation. SRI is an independent nonprofit research and development organization.

If the Delta II launch vehicle performs as it should, the mission will mark the first successful launch of CubeSats by a NASA vehicle.



AOS grad students Rachael Kroodsma (left) and Amanda Mims (right) making transect propagation measurements.

Ruf and crew sail the Michigan blue

by Deborah K. Eddy

To the untrained eye, the waters of Lake Michigan seemed glassy calm, at least some days between

May 9 and May 21, 2011, off the coast of Point Betsie, Michigan.

But according to the high-frequency radars deployed by Professor Chris Ruf (AOSS), Lorelle Meadows (CoE Director of Academic Programs), researchers from CODAR Ocean Sensors of Mountain View, CA, and a select cadre of students, beneath the calm surface the currents were aflowing.

The radar backscatter and propagation experiments the group ran this summer aimed to check if the existing approach to coastal current measurements used on the ocean would be valid for the fresh water lakes. What they found was that the present systems, good for up to 150 km over salt water, would only measure 25 km into fresh water lakes. If NOAA wants accurate measurements of the speed and direction of surface currents on fresh water lakes, someone will need to come up with a new type of radar. Any ideas out there?



Getting ready for a transect data run. (Left to right) Unknown non-AOSS undergrad, Guy Meadows (AOSS Professor), Rachael Kroodsma, Zhenfei Weng, and Mat Chase.



Amanda Mims, Rachael Kroodsma, Manju Ganesh (AOSS MEng student), Zhenfei Wang (AOSS undergrad), and Mat Chase (EECS undergrad) in front of one of our antennas.



Setting up the radar transmitter antenna: (left to right) Calvin Teague (CODAR), Guy Meadows, Suwen Wang (CODAR), Amanda Mims.



Setting up our custom receive antenna array. (Left to right) Manju Ganesh (AOSS MEng student) and Chris Ruf (AOSS Professor).

Conducting Great Lakes Restoration Initiative (GLRI) research through AOSS

by Sheila Pursglove

If AOSS Professor Guy Meadows can't be found in his office, you might track him down out on the water or by the lakeshore.

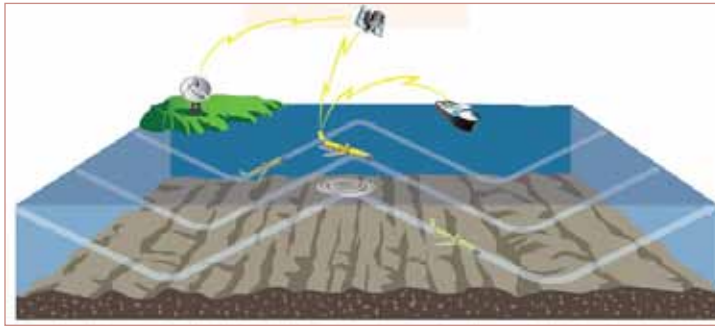
Meadows' laboratory – the Ocean Engineering Lab – is in its second year of funding for the Great Lakes Restoration Initiative (GLRI), the largest investment in the Great Lakes in two decades. The Great Lakes form the largest surface freshwater system on the Earth, with more than 30 million people living in the Great Lakes basin. The daily activities of these people, from the water consumed to the waste returned, directly affects the Great Lakes environment.

“The GLRI has allowed new, state-of-the-art oceanographic research tools to be brought to bear on Great Lakes issues,” he says. “These new tools include two, fully autonomous underwater vehicles (AUVs), one configured as a water quality monitoring ship and the other as a bottom survey ship. Both are capable of pre-programmed, 6 to 8 hour duration, three-dimensional surveys covering up to 32 km of distance.”

In addition, Meadows' lab is also operating a new ocean glider, capable of long, slow transits of the Great Lakes on timescales of a few weeks by repeatedly diving deep and gliding to the surface. At each surfacing, the glider “phones home” via satellite link.

“For me, the Great Lakes are a new frontier, here in our own backyard,” he says. “These new ‘space age’ tools will allow us to explore this frontier in ways never before possible. The understanding we will gain will help us preserve this tremendous resource for future generations.”

Meadows also is involved with Grand Valley State University in a three-year feasibility analysis of offshore wind energy harvesting on the Great Lakes. He and a team of U-M researchers from the College of Engineering and the School of Natural Resources and Environment will study the nature of Lake Michigan's offshore wind and weather, the structural effects of wind and icing on a turbine system, the potential environmental impact and issues related to site placement. The study is a partnership led by the U-M's



Michigan Memorial Phoenix Energy Institute (MMPEI) and GVSU's Michigan Alternative and Renewable Energy Center (MAREC).

Team members have anchored a WindSentinel buoy/research platform – weighing nearly 6 tons – about four miles off the coast of Muskegon. WindSentinel uses an advanced Vindicator® laser sensor developed by Virginia's Catch the Wind, Inc. that can measure wind speed and properties up to 150 meters above the water level – roughly the height of a large, commercial wind-turbine tower.

Meadows and his U-M team have also used underwater vehicles capable of extracting samples from the lakebed. They are part of a set of environmental monitoring devices, including eight surface buoys.

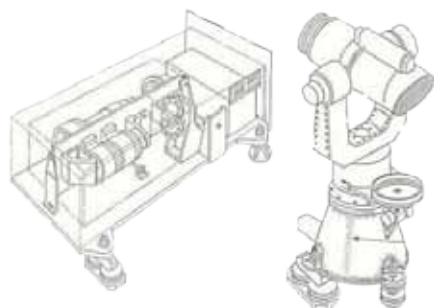
“We're using hard science and the latest technology to provide an unbiased assessment of the true potential of offshore wind in the Great Lakes,” Meadows says. “The Great Lakes impose an extremely harsh environment on engineering structures.

“The joy of watching students become immersed in this type of work almost overcomes the wind, wet, cold and ice associated with making real measurements on the open waters of the Great Lakes.”

SPRL instrument returns to earth after two decades

by Sheila Pursglove

In 1991 the Giants won the Super Bowl, the Minnesota Twins won the World Series, Arkansas Governor Bill Clinton announced his bid for the 1992 democratic nomination for U.S. president, and the Space Shuttle Columbia carried the Spacelab into orbit. That same year, the six-ton NASA Upper Atmosphere Research Satellite (UARS) was launched into space.



Schematic of the High Resolution Doppler Imager (HRDI), a SPRL build instrument.

After gathering data for 14 years, and orbiting for another six, the decommissioned UARS crashed over a broad, remote ocean area in the Southern Hemisphere at about midnight EDT Saturday, Sept. 24, 2011. Teams in SPRL/AOSS played a large role in the success of UARS, which carried the U-M built HRDI (High Resolution Doppler Imager).

“HRDI was the largest and most expensive space flight instrument ever built at SPRL/AOSS,” says AOSS research scientist Wilbert Skinner. “Most of the engineers and technicians in the building, as well as many of the administrative staff, were involved. There was a small army of

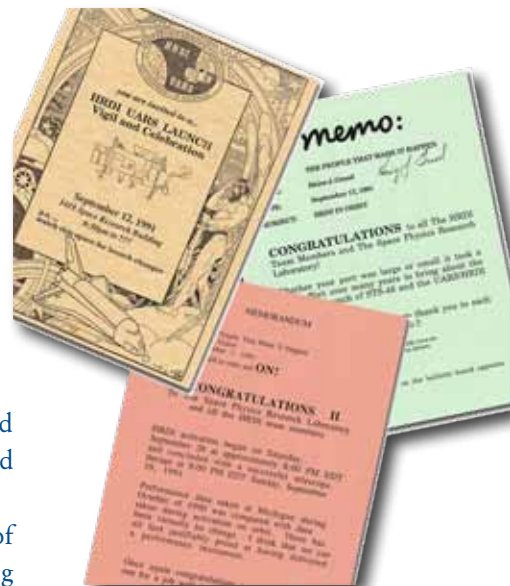
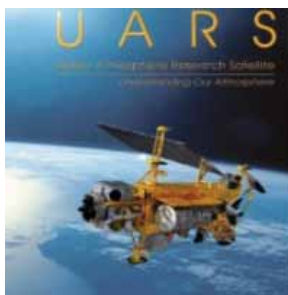
research scientists, programmers, and students – both undergraduate and graduate – contributing.”

Skinner spent a significant part of his career working on HRDI starting immediately after finishing his PhD work in November 1983. “For the first several years I was deeply involved with the construction, characterization, and calibration of HRDI,” he says.

Shortly after launch in early 1992, two of the most senior research scientists involved with HRDI departed for other career opportunities and Skinner became the science manager. In 2000, AOSS Emeritus Professor Paul Hays, the original HRDI Principal Investigator (PI), retired and Skinner became the PI, remaining in that role until the end of the mission in 2005.

AOSS associate research scientist Rick Niciejewski, who came to U-M in 1986, says his role 20 years ago was limited to one post-launch activity: correlative measurements of winds from ground-based observatories to aid in the absolute calibration of two remote wind-measuring experiments flying aboard UARS.

“The experiments provided a rare synoptic view of neutral winds ranging in altitude from the



stratosphere to the upper thermosphere,” Niciejewski says. “One can imagine using a thermometer to measure a child’s fever but not being able to read the scale on the thermometer – you would be able to tell whether the fever was lessening, but not whether the child’s temperature was back to normal.

“SPRL provided me with the talent and the resources to construct various high-resolution optical experiments, spectrometers, interferometers, and imagers to monitor natural but extremely feeble airglow emission from our Earth’s upper atmosphere,” he says. “These diagnostic tools were used to generate some of the only direct long-term records of winds and temperatures in the upper atmosphere.

“Statistical analysis of these long term records are beginning to illustrate some of the connections between different regions of the atmosphere, such as thunderstorms in the tropics and composition changes in the mesosphere and lower thermosphere,” Meadows went on to say.

“Depending on one’s viewpoint, UARS fell later than expected, as the extreme length of the just-concluded solar minimum phase extended the life of UARS and other satellites by several years,” Niciejewski said.

Mercury meanders museum mesmerizing minors

by Deborah K. Eddy

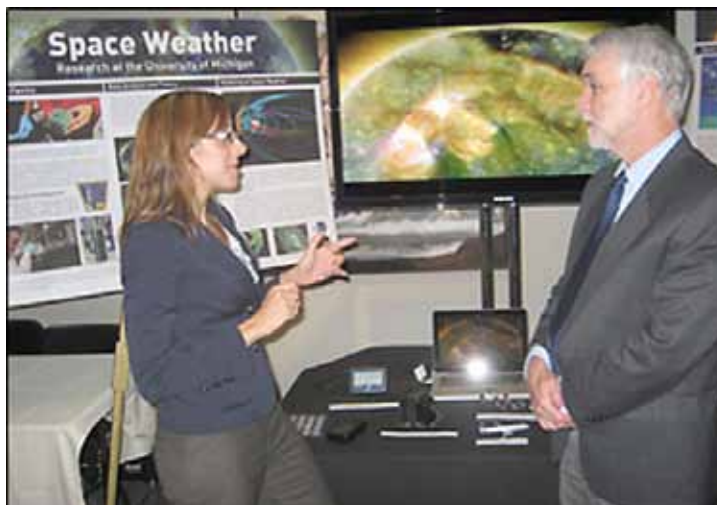
When the MESSENGER (MErcury Surface, Space ENvironment, GEOchemistry, and Ranging) Science Team decided to hold their August 2011 meeting in Ann Arbor, AOSS Professor Thomas Zurbuchen (lead scientist for the MESSENGER FIPS instrument) seized the opportunity to spread the word of all the wonders being discovered about the mysterious planet Mercury. With an exciting presentation by the project lead, Dr. Sean Solomon (Carnegie Institute), an interactive workshop, and the enthusiastic antics of AOSS grad students Gina DiBraccio and Dan Gershman, over 200 kids, parents, and other Earth inhabitants were inspired to begin their own explorations of the thrills of space science.



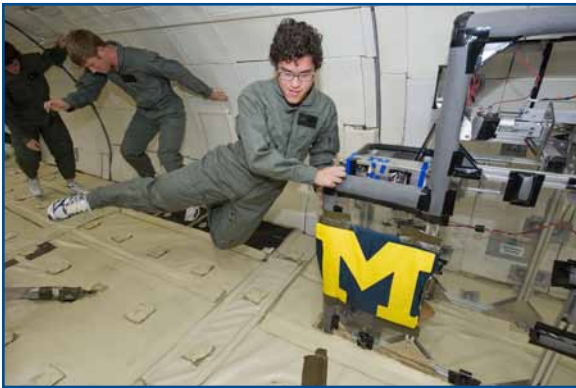
AOSS grad students Gina DiBraccio (a.k.a. Mercury) and Dan Gershman (a.k.a. the Sun).



Dr. Stan Solomon enthalls eager listeners with MESSENGER's mission to solve Mercury's mysteries at the Ann Arbor Hand's On Museum, August 16, 2011



AOSS Associate Research Scientist **Susan Lepri** enlightens NSF Assistant Director for Geosciences (and former AOSS faculty member) Tim Killeen on the dangers of Space Weather and the volatility of the Sun's atmosphere at the Sept. 6, 2011, NSF Space Weather Expo in Washington, D.C.



Students float aboard “Weightless Wonder”

by Stephanie Gowell and Daniel Callaghan

Have you wanted to float in space? Do you envy the astronauts on the space station? Six hardworking U-M students can now describe the amazing experience of weightlessness. This past summer, the GOTHAM Boom Team of current and recently graduated U-M students, including five from AOSS, was one of 14 undergraduate teams that ventured to NASA Johnson Space Center’s Ellington Field in Houston to conduct experiments aboard the agency’s “Weightless Wonder” aircraft. AOSS Professor Mark Moldwin was the team’s advisor.

The GOTHAM Boom Team, through the Student Space System Fabrication Laboratory (S3FL), was given the task of designing a deployable boom for a CubeSat mission by Professor Moldwin during the summer of 2010. Previous S3FL teams have tested projects such as the eXtendable Solar Array System (XSAS) and Zero-g ElectroStatic Thruster Testbed (ZESTT). For the microgravity flight, Professor Moldwin asked the students

to design, build, and test a boom that fits within a 10 cm cube of the 10 cm x 10 cm x 30 cm CubeSat satellite.

GOTHAM stands for GPS Occultation Tomographer & High Accuracy Magnetometer, which is a project started in the University’s space system engineering masters program as a final design project. The original graduate student team, who developed the mission concept, implemented a boom to extend the mission magnetometer away from the electromagnetic noise generated by the CubeSat electronics. The goals of the GOTHAM mission were to take measurements of Ultra-Low Frequency waves and magnetic field-aligned currents in the Earth’s ionosphere with a constellation of three 3-Unit (3U) CubeSats. The GOTHAM Boom team was tasked with developing the boom for the final GOTHAM space mission.

Each year, the Reduced Gravity Education Flight Program (RGEFP) gives undergraduate students the opportunity to propose, build and fly a reduced gravity experiment. The teams perform the experiments aboard a microgravity aircraft, which produces weightlessness for 18 to 25 seconds at a time by executing a series of approximately 30 parabolas – a steep climb followed by a free fall – over the Gulf of Mexico. During the free falls, the students are able to gather data in the unique environment and experience near-weightlessness.

U-M’s opportunity to participate

was the result of the hard work and commitment of AOSS students Daniel Callaghan, Brad Costa, Alex Fox, Tom Heine, Matthew Mueller, and CoE students Shane DeMeulenaere, Justin DeSousa, Robert Forsyth, Stephanie Gowell, Nathan Heidt, Catherine Keys, Annie Marinan, and Fernando Saca. The U-M project was selected from more than 20 proposals based on scientific merit and educational outreach potential. (See accompanying story about the Team's outreach program.)

Doug Goforth, the RGSFOP Program Manager at NASA, is a vocal cheerleader for the program. "We were excited that our program provides once-in-a-lifetime opportunities for aspiring scientists and engineers to study and understand their craft. The students gained useful skills by participating in the program through collaborative planning and teamwork."

The U-M team arrived at Ellington Field, where astronauts do their T-38 training, in July and went through physiological training before flying their experiment, which required spinning and releasing a CubeSat into microgravity on board the "Weightless Wonder". When the satellite was floating in the plane's cabin, the CubeSat deployed a boom, an extendable arm out of the satellite that holds sensitive electronics away from the CubeSat structure. The experiment measured the deflection of the boom's free end to determine the feasibility of the design for future CubeSat missions. Following their flight, the team evaluated findings, drew conclusions and provided the results to NASA.

GOTHAM Boom Team Outreach



The GOTHAM Boom Team did more than design, build and test the boom. They also organized a four-session outreach program for an Ann Arbor middle school class of sixth graders interested in engineering and space. Each workshop had a theme and goal, which included the basics of circuits, building light sensor circuits, building temperature sensors, and, finally, building the students' own payload to be flown on a high-altitude balloon flight.

The first session covered atmospheric layers and what happens to a balloon as it rises. Then the students had a chance to build their own light sensing circuit using a resistor and a photoresistor.

In the second session, the Team showed the students how a magnetometer worked, using one to determine which direction the magnetic field was strongest and which way was north. The students also made compasses of magnets and string as well as temperature sensing circuits, which they tested using ice and hot water.

During the third session, the students asked very interesting and insightful questions about space, and built a sound sensor.

The High Altitude Solution (HAS) balloon team, another S3FL team, hosted the flight for the sixth grade students' circuits to be flown. In the last session the students viewed the flight video and designed their own lunar mission.



MSL: Launched with Curiosity onboard

When the Mars Rover, Curiosity, lands on Mars this coming August, at least two AOSS Professors will begin their scientific endeavor on the planet. Professors Sushil Atreya and Nilton Renno are members of the science team of the Mars Science Laboratory (MSL), which will study whether the Red Planet was ever capable of harboring microbial life. MSL, with the latest Mars Rover, Curiosity, was successfully launched on November 25, 2011.

Professor Atreya has been involved in the planning and execution of many of NASA's milestone planetary missions from Voyager on. An expert on the solar system's chemistry and evolution, he is a co-investigator on the MSL's cornerstone lab, the Sample Analysis at Mars (SAM). He will be involved in the study of climate evolution and the search for organics—the building blocks of life.

Professor Renno will be involved in monitoring Martian weather and assessing whether the environmental conditions are suitable for life. During the 2008 Mars Phoenix mission, Renno was the first to theorize that the globules photographed on the lander's leg were actually beads of liquid saltwater. Liquid water is an essential ingredient for life.

U-M's Space Physics Research Lab built the computer controls of the SAM instruments that Atreya will utilize.

"This mission is extremely important to me, and to all of us who seek to understand more about the habitability of Mars, which comes closest in our solar system to an Earth-like environment,"

Atreya said. "It is designed to answer some of the biggest and longest-standing questions we have about Mars."

Could Mars have ever harbored microbial life? Are organics preserved there today? How much liquid water did the planet hold in the past – perhaps



an ocean's worth? This mission aims to give scientists answers to these and other questions.

Among the tasks before Atreya and the SAM suite of instruments is to search for organics, carbon-based molecules that are the building blocks of life as we know it. Curiosity will use SAM's mass spectrometer, gas chromatograph, and tunable laser spectrometer to analyze samples from air, soil and rock.

When the data from SAM is combined with that from other MSL instruments, scientists should be able to tell not just whether a molecule is organic, but if it came from a living or non-living source. Atreya expects the rover to find organics.

"Organics have been raining down

on Mars from meteorites, comets and interplanetary dust particles for 4.5 billion years," Atreya said. "And Mars probably has its own indigenous organics, whether they're connected with life or not."

"Mars Science Laboratory can investigate those habitable environments that might also preserve organics. However, preservation of organics on Earth is very uneven, so if they are not found at Curiosity's Gale Crater landing site, it might not necessarily indicate an absence elsewhere in the geologic record of Mars. But Gale Crater is a very attractive site to begin the search."

Renno is a co-investigator on the Rover Environmental Monitoring System, which is the mission's weather station. The instrument will measure the air and ground temperatures, wind speed and direction, atmospheric pressure, humidity, and ultraviolet radiation around the rover. This information will help scientists understand how the planet's ground and atmosphere interact, which could provide insights into whether Mars could support microbial life beneath thin layers of salts on its surface.

While it's not part of the official mission, Renno will be watching for any signs of subsurface ice, salts or brines at the landing site today or in the distant past. Certain salts would enable brines to form and stay liquid at the low Martian temperatures and atmospheric pressures.

"This is the most capable rover ever sent to Mars," Renno said. "It has extremely sensitive instruments capable of making unexpected discoveries."

Looking for life on Mars

by Nicole Casal Moore

How common are droplets of saltwater on Mars? Could microbial life survive and reproduce in them? A new million-dollar NASA project led by the University of Michigan aims to answer those questions.

This project began three years after beads of liquid brine were first photographed on one of the Mars Phoenix lander's legs. [*See Spring 2009 Daily Planet for story.*]

"On Earth, everywhere there's liquid water, there is microbial life," said Nilton Renno, a professor in the Department of Atmospheric, Oceanic and Space Sciences who is the principal investigator. Researchers from NASA, the University of Texas at Dallas, the University of Georgia and the Centro de Astrobiologia in Madrid are also involved.

Scientists in the United States will create Mars conditions in lab chambers and study how and when brines form. These shoe-box-sized modules will have wispy carbon dioxide and water vapor atmospheres with 99 percent lower air pressure than the average pressure on Earth at sea level. Temperatures will range from -100 to -80 Fahrenheit and will be adjusted to mimic daily and seasonal cycles. Instruments will alert the researchers to the formation of brine pockets, which could potentially be habitable by certain forms of microbial life.

Their colleagues overseas will seed similar chambers with salt-loving "extremophile" microorganisms from deep in Antarctic lakes and the Gulf of Mexico. They will observe whether these organisms survive, grow and reproduce in brines just below the surface of the soil. All known forms of life need liquid water to live. But microbes don't need much. A droplet or a thin film could suffice, researchers say.



"If we find microbes that can survive and replicate in brines at Mars conditions, we would have demonstrated that microbes could exist on Mars today," Renno said.

With his colleagues on the Mars

The secret life of dust

What does dust have to do with finding life on Mars?

U-M professor Nilton Renno is an expert in the unlikely field of dust and dust storms, he was instrumental in the discovery of liquid water on Mars and might just solve a multi-billion dollar problem for the electronics industry. Find out more in this video from *Out of the Blue*, a series by Michigan Productions for the Big Ten Network.

<http://michigantoday.umich.edu/story.php?id=8062>

Phoenix mission in 2008, Renno theorized that globules that moved and coalesced on the spacecraft's leg were liquid saltwater. Independent physical and thermodynamic evidence as well as follow-up experiments have confirmed that the drops were liquid and not frost or ice. The Phoenix photos are believed to be the first pictures of liquid water outside the Earth.

The median temperature at the Phoenix landing site was -70 degrees Fahrenheit during the mission—too cold for liquid fresh water. But "perchlorate" salts found in the site's soils could lower water's freezing point dramatically, so that it could exist as liquid brine. The salts are also capable of absorbing water from the atmosphere in a process called deliquescence.

Welcome Back, Guy

After 25 years across the street at the Department of Naval Architecture & Marine Engineering, Professor Guy Meadows has returned to the hallowed halls of the Space Research Building. Though



he has had a joint appointment with AOSS, Professor Meadows has been spending his time and the majority of his considerable energy as Director of the Marine Hydrodynamics Laboratories.

Professor Meadows' return to AOSS contributes to the department's efforts to repopulate and reinvigorate the oceanic part of Atmospheric, Oceanic and Space Sciences. With over 34 years of research on marine environmental hydrodynamics, numerous outstanding teaching awards, and three nationally televised documentaries for the History and Discovery Channels under his ball cap, Professor Meadows is a welcomed back to the department.

AOSS Happenings



Grinning grandpa Steve Bougher (AOSS Prof.) greets new grandson Benjamin Wesley Bougher. Ben was born Nov. 2, 2011, at 3:08 pm, 8 lbs 5 oz. Mom Jessica and Poppa Jonathan are just as proud as Grampa Steve.



It was a beautiful day, this past August 4, 2011, at Weller's Carriage House in Saline, Michigan, when Sarah Tremont (2009 UM Law School Grad) wed Jacob Gruesbeck (AOSS grad student).



AOSS professor Christiane Jablonowski and hubby Rainer Leuschke proudly present their brand new daughter, Alexa Natalia Leuschke, born at 4:27 am on Oct. 24, 2011. Alexa joined us at 20.5 inches tall and 7.2 lbs.

Alumna Spotlight:

Jessica Parker, Weather Underground meteorologist

by Sheila Pursglove

When Jessica Parker, a meteorologist with the Weather Underground in San Francisco, set her sights on attending the University of Michigan, it was the AOSS department that attracted her to the maize and blue.

“The programs in the department were well rounded and allowed students to study both the science and engineering sides of Earth Sciences with world renowned faculty,” she says.

“The program also offered just enough flexibility and hands-on experience to really make studies unique to each student.

“I love U-M because it’s a diverse school with amazing students, faculty, and research opportunities.”

Parker completed her Earth Systems Science and Engineering studies at U-M, concentrating on Meteorology/Atmospheric Science, and “dabbling” in Climate Change Studies.

Some of her favorite adventures as a Wolverine included learning about instrumentation and data sampling in Greenland with Professor Perry Samson, and learning about smokestack sampling in Pensacola, Florida, with the late Professor Gerald Keeler.

After U-M, Parker turned down an opportunity to be a tornado chaser on reality TV, and headed to California where she joined the Weather Underground in San Francisco.

“I wanted to join the Weather Underground team of meteorologists because the company allows ‘mets’ to indulge in the many facets of meteorology, similar to the AOSS dept. – programming, research, outreach, broadcast, and more – and encourages continued education conferences and workshops,” she says.

“While I enjoy working with new data sets and programming, forecasting storms, and making recent storm assessments, I have the most fun participating in various outreach projects, including weather talks with students, radio and broadcast about weather and travel, and national and international conferences and events.”

In her leisure time, Parker enjoys exploring the many districts of San Francisco and the cities of the Bay Area. “There’s always some new and exciting restaurant, shop, or event.”

For a quick escape from the city, she hikes in the Marin Headlands or the nearby National Parks. Her newest hobby is learning how to snowboard and she is looking forward to visiting Lake Tahoe in the Sierra Nevada this winter.

She also enjoys kickboxing and traveling. “My favorite places to visit in the states include New York, Miami, and back home to Chicago to visit family – and my favorite international city is London.”



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Extensive pre-game planning by OEP was ultimately responsible for the safe evacuation of the stadium, Marsik says. “I believe our biggest contribution was not so much in the detection of the existence of thunderstorms, but our ability to recognize, anticipate and project the growth and/or decay of storms that appeared on radar.”

“The decision to end the game was prompted by the existence of a third, more structured convective system to our west that would have arrived at the stadium about the time the teams would have returned to the field following the second evacuation,” he says. “That third storm resulted in numerous reports of wind damage.”

Wright, who has done weather forecasting/monitoring for the Jackson Hot Air Balloon Festival, and who, as a member of the AOSS Tornado Camp, went storm chasing with Professor Perry Samson and Texas Tech, has made calls to OEP every Saturday morning to give an update on the weather forecast.

“While our other forecasts have not been for conditions as dramatic as that first game, they’ve had their own important elements,” Marsik says. “For example, the weather hazard for one particular Saturday was high winds, a particular concern for the many vendors that ring the stadium, many of whom use portable tents for structures.”

“The most fascinating thing about monitoring the weather is trying to visualize what the storm is doing – how is the storm evolving, where is it moving to, why is it moving that direction, what sort of dangers are associated with this storm,” Wright says. “My whole reason for studying meteorology originated from my love of analyzing data and drawing conclusions. Monitoring weather just feeds that passion.”

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Questions? Contact Mary Nehls-Frumkin at maryln@umich.edu