THE NATIONAL ACADEMIES

RESEARCH ASSOCIATESHIP PROGRAMS

The Postdoc

Autumn 2011

Table of Contents

Uncertainty of sources of reactive nitrogen

Nitrogen, while among the most common elements on Earth, often limits plant and animal growth in terrestrial and aquatic environments around the world. This paradox results from the chemical forms of nitrogen found on the planet. The vast majority of nitrogen occurs as the unreactive form of N_2 gas, which makes up about 80% of the air we breathe.

Reactive nitrogen, the form of nitrogen available for biological use, makes up a much smaller amount of nitrogen on Earth. In natural ecosystems, specialized microbes slowly regulate the conversion of inert N_2 to reactive nitrogen. This is problematic because, in the absence of human intervention, nitrogen typically limits the production of food. In the past century, technological advances have allowed humans to transform unreactive nitrogen to reactive nitrogen for use as plant fertilizer.

continued on page 3

Dr. Dan Sobota, NRC Associate at EPA, with Dr. Jana Compton, NRC Adviser

"The Postdoc" highlights research and activities of NRC Associates and Advisers who participate in the agency/laboratory programs with the NRC. Our newsletters are available in print and on out website: http://sites.nationalacademies.org/PGA/RAP/PGA_047804. Send all inquiries and submissions to Suzanne White (swhite@nas.edu)

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

NRC Associateship Programs Representation at 2012 Meetings

NAME OF MEETING	DATES	LOCATION	
Joint Mathematics Meetings*	01/04/12-01/07/12	Boston	MA
American Institute of Aeronautics and Astronautics	01/09/12-01/12/12	Nashville	TN
Society of Photo-optical and Instrumentation Engineers*	01/21/12-01/26/12	San Francisco	CA
American Meteorological Society	01/22/12-01/26/12	New Orleans	LA
Biophysical Society*	02/25/12-02/29/12	San Diego	CA
American Physical Society	02/27/12-03/02/12	Boston	MA
National Black Graduate Students Association	03/09/12-03/13/12	Columbia	SC
Society of Toxicology*	03/11/12-03/15/12	San Francisco	CA
Johns Hopkins Medical Institutions/Biomed Career Fair	03/12/12-03/12/12	Baltimore	MD
American Chemical Society - Spring Meeting	03/25/12-03/29/12	San Diego	CA
National Society of Black Engineers*	03/28/12-04/01/12	Pittsburgh	PA
NYC/Louis Stokes Alliance for Minority Participation	04/01/12-04/01/12	New York	NY
Experimental Biology	04/21/12-04/25/12	San Diego	CA
American Association of Petroleum Geologists*	04/22/12-04/25/12	Long Beach	CA
National Conference on Race and Ethnicity in American Higher	05/29/12-06/02/12	New York	NC
American Society for Microbiology	06/16/12-06/19/12	San Francisco	CA
McNair Scholars Conference-Penn State	07/01/12-07/01/12	University Park	PA
McNair Scholars Conference-University of Buffalo	0701/12-07/01/12	Niagara Falls	NY
Ecological Society of America*	08/05/12-08/10/12	Portland	OR
American Fisheries Society*	08/19/23-08/23/12	St. Paul	MN
American Chemical Society - Fall Meeting	09/10/12-09/12/12	Philadelphia	PA
National Organization of Black Chemists and Chemical Engineers	09/25/12-09/28/12	Washington	DC
Florida Education Fund-McKnight Fellows Conference	10/01/12-10/01/12	Tampa	FL
Mexican American Engineering and Science Society	10/05/12-10/08/12	Oakland	CA
Society for the Advancement of Chicanos and Native Americans in	10/11/12-10/14/12	Seattle	WA
Hispanic Association of Colleges and Universities	10/12/12-10/22/12	Washington	DC
Society for Neuroscience*	10/13/12-10/17/12	New Orleans	LA
Human Factors and Ergonomics Society*	10/22/12-10/26/12	Boston	MA
American Indian Science and Engineering Society	11/01/12-11/03/12	Anchorage	AK
Geological Society of America*	11/04/12-11/07/12	Charlotte	NC
Annual Biomedical Research Conference for Minority Students	11/07/12-11/010/12	San Jose	CA
American Society of Tropical Medicine and Hygiene	11/11/12-11/15/12	Atlanta	GA
Society for Environmental Toxicology and Chemistry*	11/11/12-11/15/12	Long Beach	CA
Materials Research Society*	11/26/12-11/30/12	Boston	MA
American Geophysical Union	12/06/12-12/09/12	San Francisco	CA
American Society for Cell Biology*	12/15/12-12/19/12	San Francisco	CA

*** Meetings not attended. Materials sent for distribution and ad submitted**

Information as of the date of printing

continued from cover

Currently, about one third of the global population is alive because of human-created nitrogen fertilizer. Humans have also increased the conversion of N_2 to reactive nitrogen via expanded cultivation of legumes (nitrogen fixing crops), conversion of N_2 into reactive nitrogen for use in synthetic products (e.g., nylon) and increased reliance on fossil fuel combustion, of which reactive nitrogen is an unavoidable byproduct.

As of the year 2000, human activities had roughly doubled the amount of reactive nitrogen input to the Earth's land surface annually. While clearly important to maintain food and energy security, increasing reactive nitrogen input also comes with many human health and environmental consequences. A large fraction, often greater than 50%, of reactive nitrogen used in agricultural systems is lost to air, land and water. All of the reactive nitrogen produced during fossil fuel combustion enters the environment. Nitrogen lost to the environment can affect human health and ecosystem function. For example, air pollution resulting from emission of reactive nitrogen compounds causes a variety of respiratory problems in urban and agricultural areas around the world. In the United States, health related costs of airborne nitrogen pollution amount to over 100 billion dollars per year. Pollution of water resources is another major consequence of reactive nitrogen leakage to the environment. Groundwater supplies in agricultural areas are particularly susceptible to pollution by nitrate, a form of nitrogen that can cause blue-baby syndrome and cancers when consumed in high concentrations. Human-created reactive nitrogen also leaks to river systems and moves downstream to estuaries and coastal marine ecosystems. Nitrogen-fueled harmful algal blooms and hypoxic (low-oxygen) zones have expanded rapidly around the world in the past century, decreasing fisheries production, enhancing spread of disease vectors (e.g., mosquitoes) and reducing biodiversity of aquatic ecosystems. Without significant changes to food and energy systems, loss of reactive nitrogen to the environment will continue to increase for the near future, meaning environmental impacts of nitrogen pollution will also increase and expand.

Particularly intensive use of nitrogen fertilizers, expansive cultivation of legumes (soybeans and alfalfa), and high rates of fossil fuel combustion have modified input of reactive nitrogen to a much greater extent in the United States than in other areas around the world **(Figure 1)**. Consequently, nitrogen pollution problems are widespread throughout the nation, and cost taxpayers billions of dollars each year.

Despite the well-known impacts of environmental loss of reactive nitrogen in the United States, **an NRC Associate, working with the US Environmental Protection Agency, Dan Sobota,** has found that a surprising amount of uncertainty surrounds information on many individual sources of reactive nitrogen to the US. In a new synthesis paper, Sobota and co-authors **Drs. Jana Compton and John Harrison, NRC Advisers,** describe the state of knowledge regarding reactive nitrogen input to the United States. They show that annual reactive nitrogen input is mainly due to inputs from human-created nitrogen fertilizer, cultivation of legumes and deposition of reactive nitrogen from fossil fuel and agricultural sources. They also discover that substantial uncertainty still surrounds many sources reactive nitrogen to the nation. Particularly notable is the lack of information surrounding estimates of reactive nitrogen entering agricultural systems via legume production and entering forests, grasslands and rangelands via natural processes. The amount of reactive nitrogen recycled from livestock waste for use as manure fertilizer is also highly uncertain, necessitating better reporting from feedlot facilities and adjacent farms **(Photos 1 and 2)**. Sobota and co-authors conclude that improving information and reconciling differences among data sets on reactive nitrogen input to the United States will be critical for minimizing the negative ecological and human health effects of nitrogen pollution.

Photos 1 and 2. Livestock manure produced in confined feedlots is collected and often dispersed on adjacent agricultural fields as a fertilizer. Such recycling can improve nitrogen use efficiency in agricultural production systems if done in a way to protect water quality.

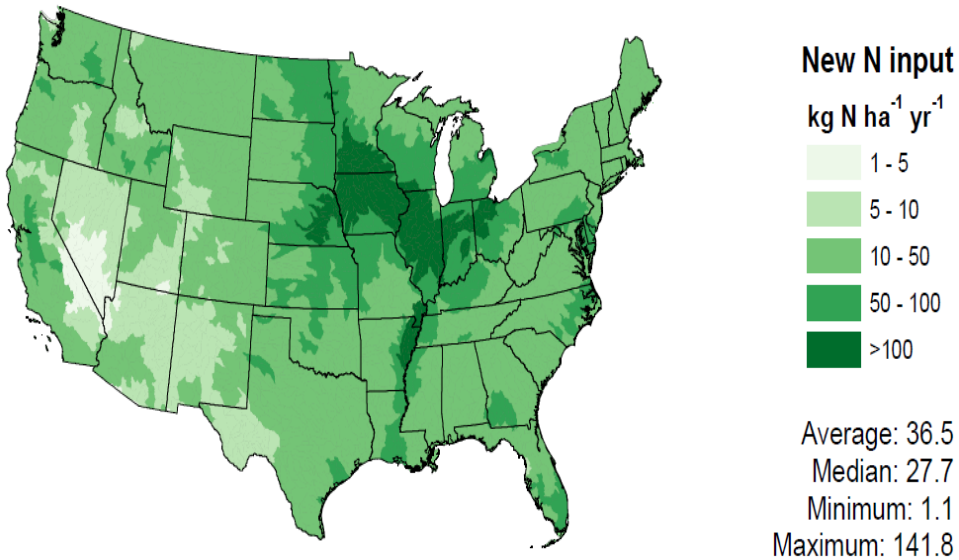


Figure 1. Input of reactive nitrogen (N) to watershed segments (8-digit USGS hydrologic unit codes) in the United States during the 1990s – 2000s. New N refers to reactive nitrogen input from background sources, inorganic fertilizer, legume cultivation and deposition of reactive nitrogen produced during fossil fuel combustion. This map was created for use in a new synthesis paper authored by RAP post-doctoral associate Dan Sobota and Drs. Jana Compton and John Harrison.

Predicting Phototoxicity of TiO_2 Nanoparticles

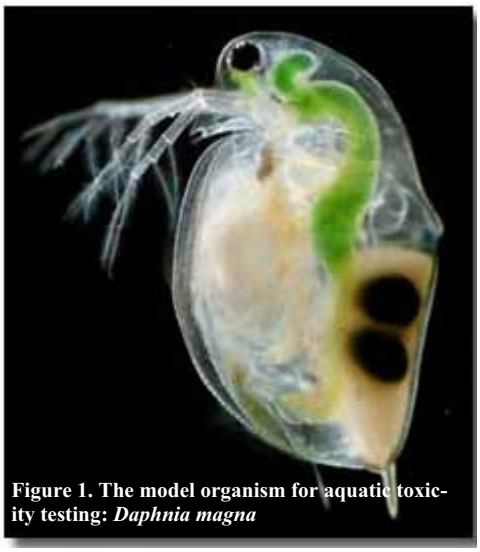


Figure 1. The model organism for aquatic toxicity testing: *Daphnia magna*

Scientists at the EPA's Mid-Continent Ecology Division in Duluth, MN have demonstrated that TiO_2 nanoparticles (nano-TiO_2) cause significant phototoxicity to higher organisms under natural sunlight irradiation, and this can be predicted by a quick and simple chemical assay.

The relatively high-volume production of nano-TiO_2, its incorporation into numerous consumer products (such as, sunscreens and cosmetics), and its ongoing development as a photocatalytic agent suggest the need to understand all aspects of its potential hazard and risk in natural environments. Most of the ecotoxicological studies of nano-TiO_2 have been conducted under ambient laboratory lighting and reported no or low acute toxicity in higher organisms. However, **Dr. Hongbo Ma, NRC Associate, and Dr. Steve Diamond, NRC Adviser**, demonstrated for the first time that toxicity of nano-TiO_2 to a model aquatic organism – *Daphnia magna* - is dramatically enhanced in the presence of sunlight, with 48-h LC50 in µg/L level, which is of four orders of magnitude relative to toxicity under typical laboratory lighting.

TiO_2 is a semiconductor with band-gap energies of 3.26 (anatase) and 3.06 (rutile) eV, which are equivalent to radiation wavelengths of 389 and 405 nm, respectively. According to the band-gap theory, UV radiation at or below these wavelengths can promote electrons in valence band to conduction band of this material, generating "electron-hole pair". This system interacts strongly with oxygen or water in the environment resulting in efficient production of reactive oxygen species (ROS) such as hydroxyl radicals (OH·) and/or superoxide anion ($\cdot O_2^-$). These ROS are highly reactive and can interact with almost any biological molecules and cause damage. Regular laboratory lighting contains negligible UV radiation, and thus exposures under laboratory lighting do not perceive the full hazard and risk of the nanomaterial. The dramatic increase in TiO_2 toxicity under sunlight irradiation, as compared to laboratory lighting, confirmed this concern and led the scientists to further investigate the underlying mechanism of this phototoxicity.

Using a fluorescent dye-based ROS assay, **Dr. Ma** was able to measure the *in situ* ROS generation in media by nano-TiO_2 under simulated solar radiation. The ROS generation was found to be well-correlated with TiO_2 concentration as well as toxicity (immobilization) in *D. magna*. The role of ROS in phototoxicity was further confirmed by intracellular ROS assays which measure oxidative stress within *D. magna* tissues. Significant ROS generation (oxidative stress) was detected in organisms exposed to nanoparticles under solar radiation compared to those exposed under laboratory lighting or in dark. These results strongly suggest that the phototoxicity is ROS-mediated, and photocatalytic ROS production measured using chemical assays may be predictive of whole-organism phototoxicity.

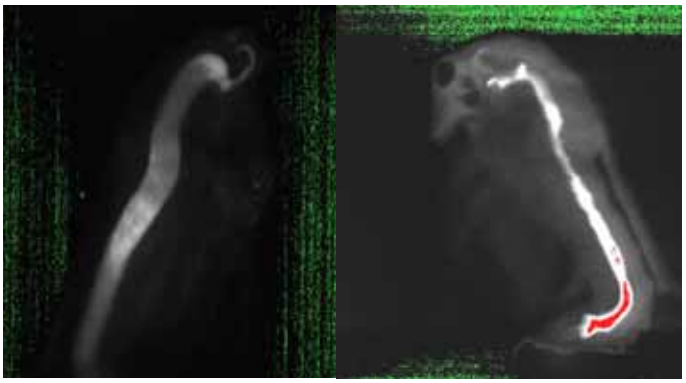


Figure 3. Intracellular ROS production (oxidative stress) in *D. magna* is dramatically enhanced in organisms exposed to TiO2 (1 mg/L) under SSR (right) as compared to under laboratory lighting (left). Brighter color indicates greater ROS production.

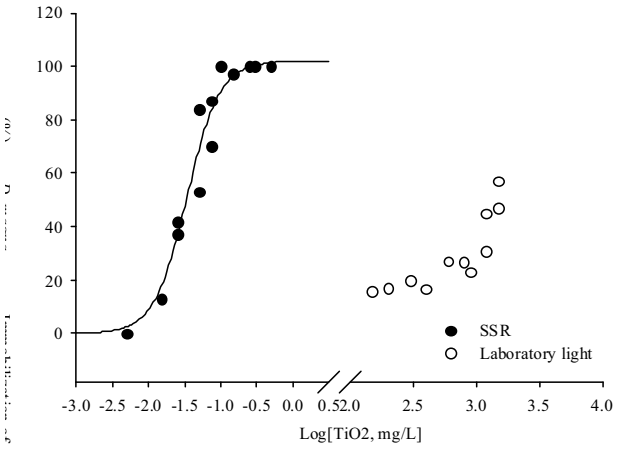


Figure 2. Concentration-response curves of *D. magna* exposed to TiO_2 nanoparticles under simulated solar radiation (SSR) and ambient laboratory light: 48-h LC50 (SSR) = 30 µg/L, 48-h LC50 (Lab light) > 300 mg/L.

The finding that nano-TiO_2 at µg/L levels can cause significant acute phototoxicity to aquatic organisms under natural solar radiation has considerable environmental implication, as similar levels of nano-TiO_2 in a natural environment have been recently documented. These results suggest the need to incorporate this mechanism into future risk assessment for nano-TiO_2.

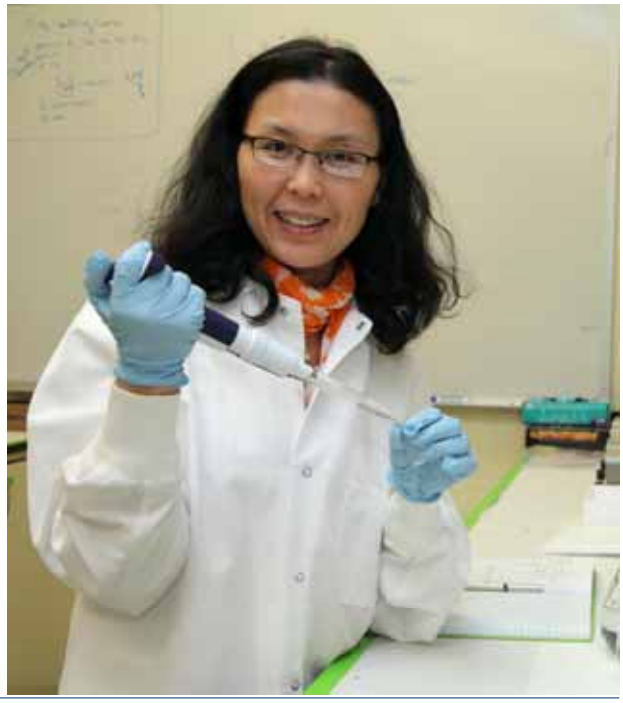
To estimate or predict levels of potential phototoxicity of the nanomaterial in natural environments, it is critical to understand the spectral effectiveness of solar radiation in photoactivating the nanoparticles, as spectral distribution and intensity of solar radiation can vary dramatically both spatially and seasonally. The researchers further investigated the relationship between spectral distribution of solar UV radiation and photoactivation and toxicity of nano-TiO_2

in *D. magna*, using an acute toxicity assay, ROS production in media, and ROS-related damage within tissues. Spectral distributions were manipulated using a series of optical filters that alter the spectrum of radiation reaching exposure vessels.

Phototoxicity of nano-TiO_2 and photocatalytic ROS production under various solar radiation spectra are strongly correlated. The results also confirm that the wavelength threshold for whole-organism phototoxicity, as well as ROS production, corresponds closely to band gap energy – the energy required to excite electron from valence bands to conduction bands. Good correlation between ROS production and phototoxicity demonstrates that photochemical production of ROS as measured using chemical assays, accurately predicts whole organism toxicity.

Findings from this work have immediate application in risk assessment of nano-TiO_2 in natural environments. The confirmation that band gap energies are predictive of whole-organism phototoxicity may enable hazard assessment based on photochemical properties (which can vary among crystal forms and composition of nano-TiO_2) rather than whole-organism testing. The demonstration that relatively simple and rapid chemical assays for ROS production are predictive of whole-organism toxicity provides an additional approach to assessing hazard, and also confirming the predictive value of physico-chemical properties.

Dr. Hongbo Ma, NRC Associate at EPA



Recent creation - Council of NOAA Fellows

The CNF will provide superior scientific advice and support as needed by NOAA leadership with regard to the many scientific challenges that NOAA addresses on a daily basis. The Council is consultative and advisory in nature and has no execution responsibilities. The Council's inaugural meeting during the Senior Executive Service (SES) Summit in September was excited about the potential of the CNF to advance the science and research at NOAA that underpins our services and stewardship.

The CNF consists of all NOAA employees who occupy Senior Scientist (ST) or Senior Leader (SL) positions — these are leading research scientists and advisors at NOAA who have demonstrated a career of dedication to the advancement of science. They are not only NOAA's scientific elite, but they also are recognized around the world as leaders in their respective fields.

Similar to SES positions in management, ST and SL positions are the highest ranks attainable for active NOAA scientists and advisors. Specifically:

- STs and SLs are primarily involved in research and the provision of high-level scientific advice. STs/SLs are distinct from their counterparts in SES, who are involved predominantly in program management and administrative responsibilities.
- STs conceive and direct research projects that are long-term in nature, produce new science that alters our fundamental understanding of the natural world, develop new tools, and inform policy. NOAA's investment in research projects of this nature is substantial and essential to our mission.
- While NOAA does not employ any social scientists at this level, we hope to in the future.

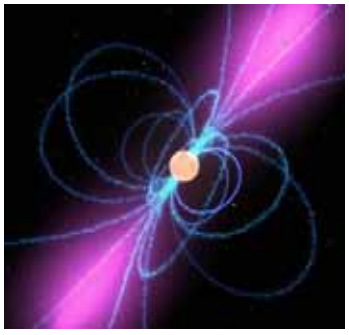
SLs provide leadership by integrating, translating, framing and communicating NOAA's science across multiple domains, often in highly sensitive policy and advisory settings. They focus on high-level scientific engagement in the public arena, rather than producing original research. *continued on page 6*

Largest gamma-ray pulsar discovered

LONDON: An uncharacteristically strong magnetic field in a globular cluster has been detected, confirming the presence of a previously unknown, extremely powerful luminous gamma-ray pulsar.

Publishing today in *Science*, researchers using the Fermi Large Area Telescope (LAT) in the U.S. said the detection of this millisecond pulsar (MSP), which whirls at 43,000 revolutions per minute, will improve our understanding of the physics of hard-to-detect dense matter and magnetic forces in the galactic field. The new MSP has been named PSR J1823-3021A.

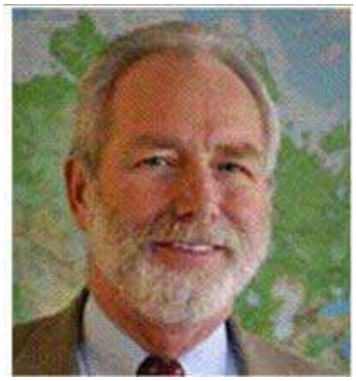
"The glow from a globular cluster is like a chorus of singers each singing a different song in a different key, and we can't pick out the individual voices. But PSR J1823-3021A is different: it's acting more like a solo artist, singing all the gamma-ray songs for its host cluster. The fact that its song can be heard so clearly over such a great distance is amazing," said co-author **Tyrel Johnson, NRC Postdoctoral Research Associate** at the Naval Research Laboratory in Washington, DC. ***"Understanding how this MSP 'diva' was formed, with its uncharacteristically strong magnetic field and bright gamma-ray pulsations, will improve our understanding of the physics of ... magnetic fields in regimes we can't explore in a laboratory on Earth."***



http://www.cosmosmagazine.com/news/4931/largest-ever-gamma-ray-pulsar-discovered

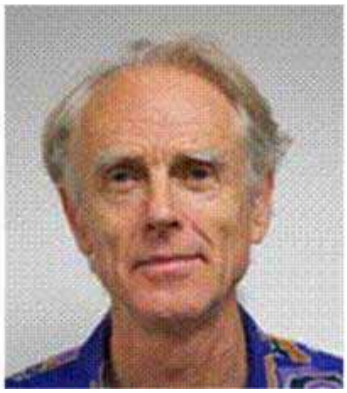
In this artist's impression, clouds of charged particles move along the pulsar's magnetic field lines (blue) and create a lighthouse-like beam of gamma rays (purple).

continued from page 5

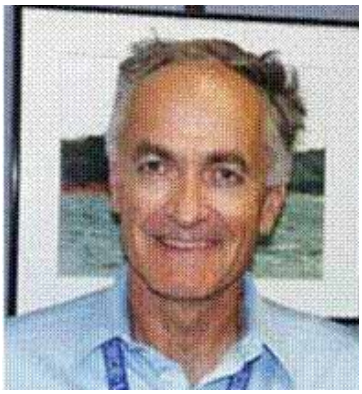


Dr. Michael McPhaden is a senior scientist at NOAA's Pacific Marine Environmental Laboratory in Seattle. His research focuses on large-scale tropical ocean dynamics, ocean-atmosphere interactions, and the ocean's role in climate. Dr. McPhaden has published over 200 articles in the refereed scientific literature and is listed as a "Highly Cited Researcher" by ISI Thomson Scientific. He has received a U.S. Department of Commerce Gold Medal, an American Meteorological Society Special Award for Contributions to Observing El Niño, and a Presidential Rank Award. Dr. McPhaden is a fellow of The Oceanography Society and the American Meteorological Society, and is president of the American Geophysical Union.

Dr. Richard Feely is a NOAA senior fellow at the Pacific Marine Environmental Laboratory in Seattle. He also holds an affiliate full professor faculty position at the University of Washington School of Oceanography. His major research areas are carbon cycling in the oceans and ocean acidification processes. Dr. Feely has authored more than 200 refereed research publications. He was awarded the Department of Commerce Gold Award in 2006 for research on ocean acidification. In 2007, Dr. Feely was elected to be a fellow of the American Geophysical Union. In 2010, he was awarded the Heinz Environmental Award for his pioneering research on ocean acidification.



Dr. Pieter Tans has been actively interested in mankind's influence on climate since he was a student. He obtained a Ph.D. from the University of Groningen, The Netherlands, in 1978 on a study of carbon-14 and carbon-13 in tree rings, which were used to reconstruct the increase of atmospheric carbon dioxide (CO_2) since the late 19th century. Since 1985 he has led the Carbon Cycle Greenhouse Gases group at NOAA's Earth System Research Laboratory. For several decades, Dr. Tans' group has maintained a cooperative global atmospheric observing network producing the most widely used data of atmospheric CO_2, methane (CH_4), carbon monoxide (CO), and several other greenhouse gases and supporting measurements.



Dr. Dusan Zrnic is a senior scientist at the National Severe Storms Laboratory (NSSL), and affiliate professor of Meteorology and Electrical Engineering at the University of Oklahoma. He is a fellow of the Institute of Electrical and Electronics Engineers (IEEE) and of the American Meteorological Society (AMS), and was the chief editor of the *Journal of Atmospheric and Oceanic Technology*. He has published extensively on weather radar signal processing, radar meteorology, and remote sensing. Dr. Zrnic is a co-recipient of the IEEE 1988 Harry Diamond Memorial Award and the 1993 IEEE Donald G. Fink Prize Award. He is also a recipient of the World Meteorological Organization 1996 Vaisala Award and the Presidential Rank Award.

Nanotechnology to Improve Aggregate Performance

It is well recognized that the area of contact between the cement paste and aggregate surface, known as the interfacial region, is one of the most vulnerable areas of concrete. The microstructure of this interface, the nature of its chemistry, its high porosity, coupled with the aggregate's surface and mineralogy, affect the adhesion between the aggregate and cement paste and therefore dictates the strength of the ITZ. Often in the field, the presence of deleterious microfines (particles < 75 µm), such as clay minerals strongly attached to the surface of the aggregate, and/or degradation mechanisms such as alkali-silica or alkali-carbonate reactions can threaten the already "fragile" nature of the ITZ and jeopardize the durability of the whole material.

As suitable aggregates become less common, marginal aggregate situations cannot be readily avoided or restricted without significant economic impact. This leads to an important question: Is it possible to modify the surface mineralogy of the aggregates in order to expand the use of aggregates sources that would otherwise lead to performance problems? Can the ITZ be engineered depending on the nature of the aggregates and the external conditions to which concrete will be exposed?

Nanotechnology can be used to address these issues. The ITZ can be modified by the specific allocation of nanoparticles on the surface of the aggregates to form nanoporous thin films (NPTF). Small quantities of silica and boehmite nanoparticles, introduced as NPTF, are capable of modifying the ITZ and therefore improving the early mechanical properties of mortar specimens. However, the improvements motivated by the presence of these NPTF on the aggregate surface are reduced by the maturation of the hydration reaction in the bulk regions after 14 days of curing, as shown in Figure 1. The challenge is to design new type of NPTF to make an impact not only in the short-term properties of the cementitious materials but also on the long-term ones that significantly enhance the durability.

This study explores the effect of two combinations of nanoparticles, silica/boehmite (SiO_2/AlOOH) and silica/alumino hydroxide [SiO_2/$Al(OH)_3$] on the hydration reaction of cement and the microstructure of interfacial transition zone (ITZ). The sol and zerogel samples were characterized by infrared spectroscopy (FTIR) and their beneficial influence on the cement hydration reaction was tested by isothermal calorimetry measurements. Additionally, a standard ITZ was created to evaluate the induced changes created by the NPTF. The changes in the microstructure and chemical composition of the standard ITZs were tracked by scanning electron microscopy.

The FTIR spectra revealed some indication of the formation of Al-O-Si bond on the zerogel samples analyzed. Both combinations of oxides modified the isothermal calorimetric curve of the cement. The SiO_2/AlOOH mixtures accelerated the hydration reaction to a higher degree than the individual components. The results plotted on Figure 2 indicate that the effect is dependent on the mixture stoichiometry. Mixtures with a Si/Al ratio of 2 have a higher influence on the cement hydration.

continued on page 8

Dr. Jose Munoz, NRC Associate at FHWA

Munoz J.F. , NRC Associate; Youtcheff Jack, NRC Adviser; Yao Y., and Arnold T. Turner- Fairbank Highway Research Center, 6300 Georgetown Pike, McLean, VA 22101

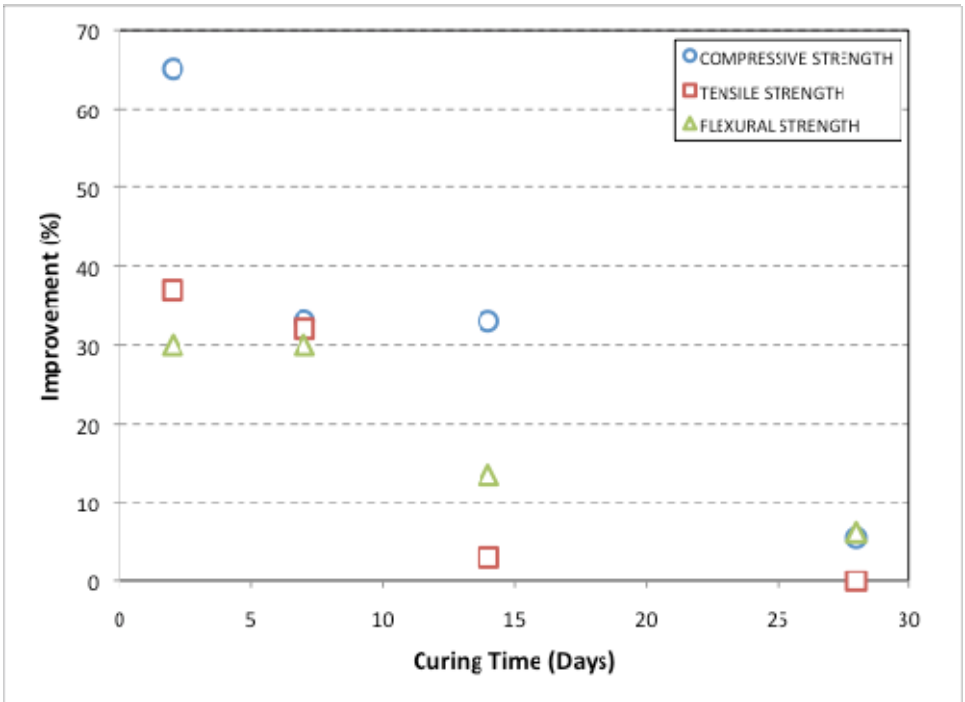


Figure 1. Percentage of improvements observed in the mechanical properties of mortar specimens made with a Nano-silica to Cement Ratio of 0.003. The nano-silica is added as NPTF of the coarser fraction of the sand

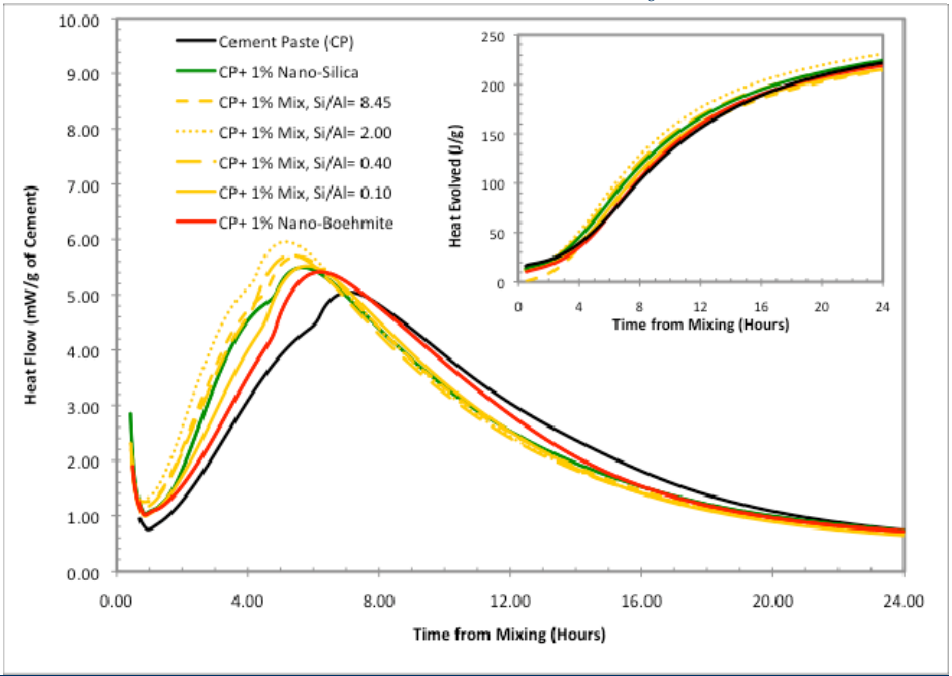


Figure 2 Isothermal calorimetry and cumulative heat release curves vs. time for cement paste samples containing 1% of Nano-silica, Nano-boehmite and mixtures of both at four different proportions.

The $SiO_2/Al(OH)_3$ combinations not only accelerated the reaction but also increased the degree of cement hydration. In this case, the enhancement is attributed to the seeding effect of the $Al(OH)_3$ particles, being more noticeable at the smaller particle sizes. Lastly, the presence of the nanoparticles decreased the porosity up to 300 mm and depleted portlandite concentration up to 40 mm away from the surface of the rock.

Research into the benefits of NPTF materials in concrete is in an early age. More work is needed to fully understand their fundamental mechanisms and the degree of their benefits. However, it is expected that the use of the NPTF will help to create concrete with improved mechanical characteristics, extended durability and require less maintenance.

WRAIR keynote raises FIST

Dr. Margaret "Maggie" McCoy, [below] **NRC Research Associate at WRAIR,** was the keynote speaker at the November 12, 2011 **Females in Science and Technology (FIST) 23rd annual conference for 7th grade girls in Montgomery County held at Montgomery Blair High School.**

The participants apply through their middle school science teachers and counselors. As part of their application, they read descriptions of different sessions taught by scientists, science teachers, and science magnet students and choose the sessions that interest them the most. The sessions range in topics from learning to build robots with Blair's Robotics club, to examining fossils with a scientist to learning about chemical "magic tricks"! The goal of FIST is to keep girls motivated in science and to inspire them to take more science electives in high school.

Dr. McCoy's presentation was directed to the important of role women have had, and continue to have, in science and technology – and to the importance of today's young women beginning to take responsibility for their future. With 7 billion people now occupying the same blue sphere, it will be the young people and their ideas that will be able to solve the problems of food, water and energy shortages, wildlife disappearance and quality of life; and that it will be their unique contributions that will bring about the changes necessary to revolutionize the future of Science.

Maggie grew up traveling and working overseas in hospitals and refugee camps with her parents, discovering and nurturing her passion to combat infectious diseases. An internship during graduate school at the Institute Pasteur in Paris, France inspired her to pursue a career in malaria vaccinology.

Dr. McCoy is currently a **NRC Associate at Walter Reed Army Institute of Research** where she is characterizing the independently protective cellular and humoral responses induced by a novel self-assembling polypeptide nanoparticle (SAPN) malaria vaccine which expresses peptide sequences of the *Plasmodium falciparum* circumsporozoite protein (CSP). Part of this work is in submission to PNAS and a second manuscript is in progress that will examine, in depth, the mechanisms behind this observed sterilely protective immunity. She is also heading up a non-human primate trial to start in the spring which will test the safety and immunogenicity of *Plasmodium falciparum* and *Plasmodium knowlesi* CSP-based SAPN vaccines in preface to human phase trials in 2013. In addition, she is also investigating alternative delivery methods and other potential factors involved in vaccine efficacy and was awarded runner-up for the National Foundation for Infectious Diseases "Early Career Investigator Award" in 2010.

NRCs receive President's Early-Career Award for Scientists' & Engineers (PECASE)

Two NOAA NRC scientists received the President's Early Career Award for Scientists and Engineers (PECASE). The award is the highest honor given by the U.S. government to outstanding scientists and engineers in the early stages of their careers.

"It is very gratifying that NOAA scientists are honored by this significant award," said Jane Lubchenco, Ph.D., under secretary of commerce for oceans and atmosphere and NOAA administrator. ***"We are immensely proud of these three individuals. They represent the best of NOAA science. While they are being lauded for specific work, this award also recognizes the promise of future contributions to science and the nation."***

Recipients are: **James A. Morris, Jr., Ph.D., NRC Adviser**, ecologist at the National Ocean Service's Center for Coastal Fisheries and Habitat Research in Beaufort, N.C.; and **David Richardson, Ph.D., former NRC Associate**, a fishery dynamics researcher at the National Marine Fisheries Service Northeast Fisheries Science Center in Narragansett, Rhode Island.

Dr. Morris said ***"I've been privileged to have many great advisors and mentors over the years," he said. "This award would not have been possible without their support."*** Dr. David Johnson, director of the NOAA lab, said Dr. Morris is a Carteret County native from a long line of commercial fishermen. ***"He frequently represents not only our laboratory, but also NOAA and the U.S. government, both here and abroad," Dr. Johnson said. "His work on invasive lionfish is recognized internationally and his findings are being utilized by coastal managers in the U.S. and Caribbean."***

Lionfish are a non-native, predatory species that appeared in North Carolina waters in 2000. The fish have been spreading rapidly and have a dense population with no known predators in North Carolina. The fish are also venomous and while not deadly to humans, can deliver a painful sting. Dr. Morris studied the lionfish for several years and gave a presentation in 2009 to the South Atlantic Fishery Management Council on the threat they pose, saying that due to the density of the lionfish population and their varied diet, they can prey on recovering fish stocks and hamper rebuilding efforts.

NOAA said James' studies have helped marine ecologists better understand how lionfish physiology is driving the invasion. It also said his studies have helped define the ecological impact of the species on reef fish communities and better understand the global threat lionfish pose to biodiversity. ***"Dr. Morris has contributed significantly to development and improvement of low-impact aquaculture practices for coastal areas."***

Dr. James Morris, NRC Adviser at NOAA

James has won two other awards for his research on lionfish. On April 27, 2010, he received the 2009 Kenneth R. Keller Award for Excellence in Doctoral Dissertation Research from N.C. State University; and on September 30, 2010 he received the National Ocean Service Employee of the Year Award.

Dr. David Richardson received the award for developing a new method for calculating spawning stock biomass, a critical factor in the fish stock assessments used by fisheries managers to set sustainable levels for fishing. David's method for calculating an index of Atlantic herring spawning stock biomass has since been applied to Atlantic mackerel, silver hake and pollock – a fishery that alone is worth more than $10 million annually. His work also led to the development of a population model that explains historical patterns of population highs and lows in the Atlantic herring fishery.

After earning a Ph.D, in marine biology and fisheries in 2007 from the University of Miami's Rosenstiel School of Marine and Atmospheric Science, Richardson accepted a **National Research Council (NRC) Postdoctoral Associateship at the Northeast Fisheries Science Center's Narragansett Laboratory in Rhode Island**, working with Jon Hare, also a larval fish biologist and head of the Center's Oceanography Branch. When the fellowship ended in 2009, Richardson accepted a position at the lab as a research fisheries biologist.

Richardson grew up in Sierra Madre, California and developed an interest in the marine environment early in life with visits to tide pools and beaches. Snorkeling led to interest in becoming a SCUBA diver in high school. At Cornell University he was a natural resources major, which combines forestry and fisheries, "but definitely gravitated to the fisheries side" before receiving a Bachelor of Science degree in 1999.After working for the California Department of Fish and Game and for the Seminole Tribe of Florida, he enrolled in graduate school at the University of Miami, focused on larval fish studies.

Dr. David Richardson, former NRC Associate at NOAA Northeast Fisheries

NRC Associate developing improved tire model to support crash simulation research at FHWA

Since September 2010, **NRC Associate, Dr. Emmanuel Bolarinwa** has been working to develop an improved finite element model for vehicle tires to support crash simulation efforts at the **Federal Highway Administration's (FHWA) Turner Fairbank Highway Research Center** (TFHRC). The Advanced Crash Analysis Program (ACAP) in the Office of Safety R&D at TFHRC has pioneered efforts to develop and apply finite element (FE) models of vehicles and barriers to analyze crash causation, develop crashworthiness criterion, formulate guidelines for effective barrier placement, and design new safety and security barriers. Over the years, the technology, methods, and models have evolved such that vehicle models consisting of a million elements are being used in simulating crashes with other vehicles and/or barriers. From these physics-based simulation models a wealth of data is derived to allow forces, accelerations, roll-pitch-yaw rates, stress concentrations, occupant risks, and other metrics to be captured and compared for the analyses of safety and security performance.

It was recognized some time ago, that tire behavior in crash simulations (i.e., performance) was not well represented in these models. Rather crude models of the tires were used and consequently, the deformations, failures, and effects were not fully reflected in the simulations. Since tires are critical to the stability of the vehicle, failures can induce roll, pitch, and yaw effects and alter the interface with the object being struck, all of which can alter the outcome and severity of a crash. This phenomenon has been observed often in controlled crash tests as shown in Exhibit 1. While many aspects of a crash event can be accurately represented in simulations (e.g., deformations, forces, stresses, decelerations, and trajectories), tire performance most often was not well predicted. The need for an improved finite element model was apparent. Tires are complex entities (as noted in Exhibit 2) that provide modeling and simulation challenges. The tire industry has used such models in their design and evaluation efforts, but since proprietary features are embodied in their models they have been steadfast in their reluctance to release these models to outsiders (as is the case for the auto industry with vehicle models). The first challenge then becomes "reverse engineering" a tire to define its components, characterize its materials, identify the connections between components, represent the interface with the wheel, and reflect the behavior of the "air" under pressure in the tire. This is also necessary to characterize the nature of operational and crash-induced loading of the tire. For example, in angular crashes with a roadside guardrail, the steel rail or wooden support posts are likely to contact the tire and place a large dynamic load on the side wall. One common result is de-beading, which involves the separation of the tire from the wheel. The subsequent abrupt drop of the vehicle changes the interface with the barrier and can lead to snagging on the post or the inducement of a roll moment that can cause the rollover of the vehicle. Complicating the modeling process is the need to keep the tire model to a reasonable number of elements so that simulation times will be viable (many crash simulations already require many hours of computer CPU time due to their complexity).

Dr. Bolarinwa has successfully generated what is believed to be an improved model by incremental additions of detail about the tire and its components. He began with an analysis of a typical tire FE model being used in FHWA crash simulations. That model was compared to the actual design features of the tires and the characterizations of crash impacts. The improved tire finite element model utilizes a rubber material matrix for the sidewall and the tread where the elements are closed shell elements made from hyper-elastic materials. The model also includes the reinforcement materials in the tire that form the bead core, and sidewall & belt plies as a series of beam elements. A representation of this model is shown in Exhibit 3 a)-e). The interface between the tire and wheel is a critical element relative to failure (e.g., de-beading). To represent the connection between the tire and the wheel at the rim, the connection was modeled as a spot weld. In the simulation software, spot welds can separate as a function of the type and strength of the weld. The improved model consists of more than 10,000 elements, more than five times the number of elements in the current model.

Data to formulate the improved model and provide a basis for validating it were obtained from repeated static and dynamic testing in TFHRC labs. One set of tests involved the dynamic loading of the tire sidewall with the Federal Outdoor Impact Lab (FOIL) pendulum to determine the forces needed to cause de-beading (shown in Exhibit 4). These dynamic tests of sidewall loading were conducted for varying angles and object shapes to determine the types of deformations and forces necessary to cause tire de-beading. At each stage the tests were simulated to allow comparisons of observed loading and behavior to the simulation predicted values. Exhibits 5 and 6 respectively show the test and associated simulation for this failure mode. The results are promising. Efforts will continue to look at other normal tire impacts as well as crash impacts to assess the viability of the improved tire model.

Over the next year the research agenda will involve additional tests, simulations, and comparisons to determine whether the improved tire model better represents the behavior in crash impacts. Efforts will eventually involve replacing the tire model on the vehicle model for the 2007 Chevrolet Silverado pick-up truck to assess the implications of using a more complex tire on the overall crash simulation processing. This model has been used extensively since its release in 2009 and there have been several full scale crash tests that will allow direct comparisons of behavior and modes of failure. Likewise, the developed tire model will be used to conduct tire pavement interaction studies for assessing vehicle/tire pavement friction threshold values. These are expected to provide useful insights about tire behavior in crash events as well as set the stage for further research on tire interactions.

Exhibit 1 – Tire Interaction with Guardrail & Post during Crash Event

Exhibit 2 – Typical Tire Structure

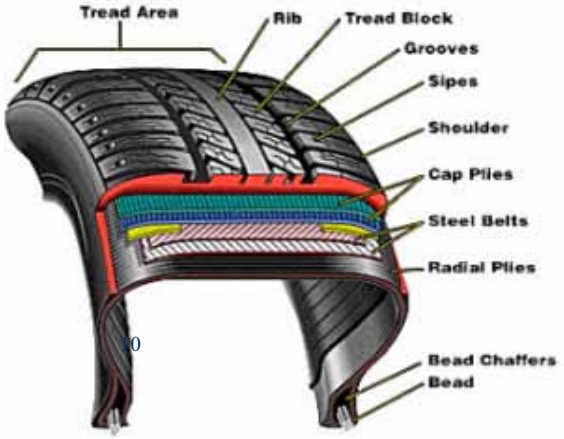
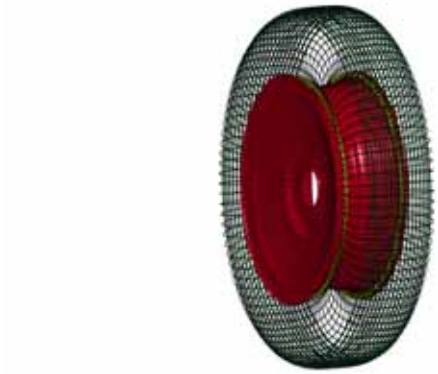
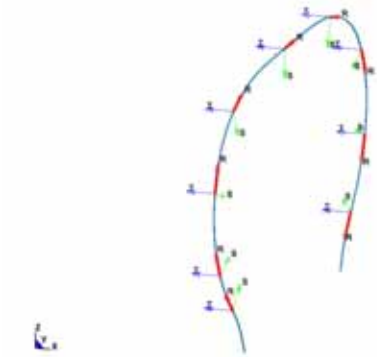


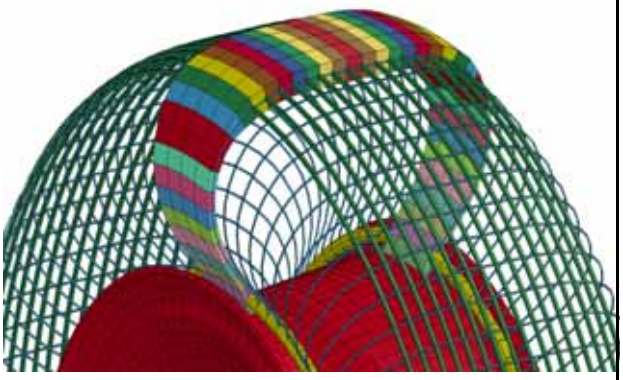
Exhibit 3: Representations of Improved Tire Finite Element Model



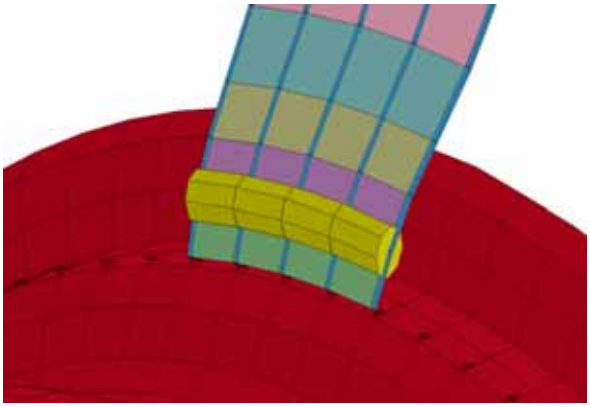
a: Tire Reinforcements: Body plies, Belt Plies and Bead Cores



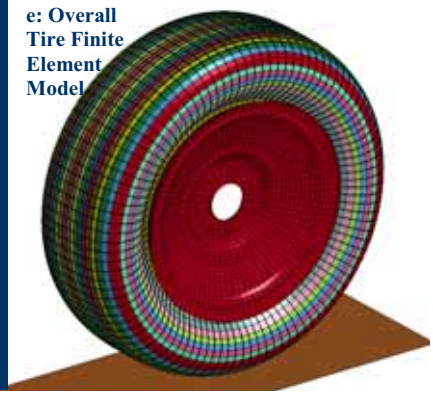
b: Sidewall Beam Element Orientation Vectors



c: Tire Reinforcements with Sidewall and Tread Rubber Matrix



d: Tire to Rim Modeling Detail



e: Overall Tire Finite Element Model

NRC Associate, Dr. Emmanuel Bolarinwa

Mr. Eduardo Arispe, Dr. Ken Opiela, NRC Adviser, Dr. Emmanuel Bolarinwa, NRC Associate at FHWA

Exhibit 4: Federal Outdoor Impact Laboratory (FOIL) Pendulum Rig

Exhibit 5: Data Derived from Dynamic Tire Sidewall Impact Testing

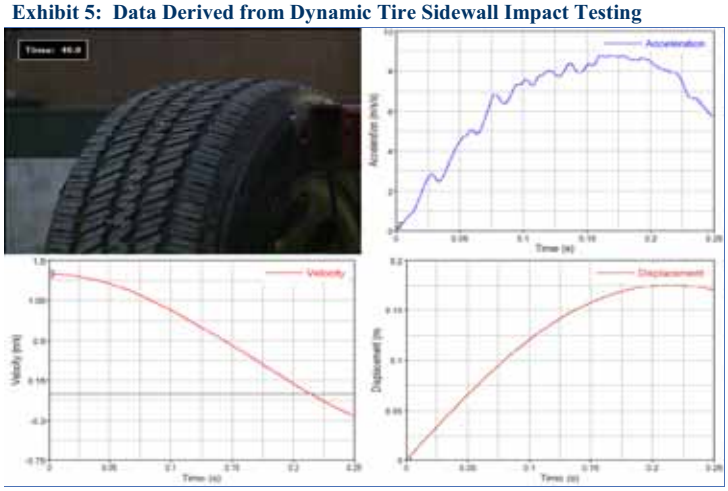
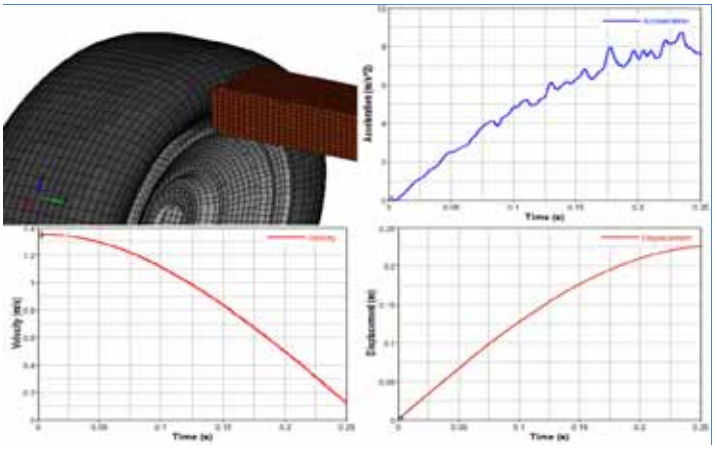


Exhibit 6: Data Derived from Simulation of Dynamic Tire Sidewall Impacts



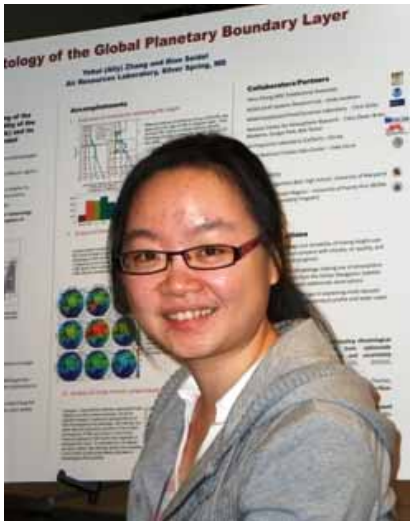
For more information contact Dr. Emmanuel Bolarinwa, NRC Research Associate Office of Safety R&D, TFHRC, and/or Dr. Kenneth S. Opiela, NRC Adviser, FHWA Highway Research Engineer, Office of Safety R&D, TFHRC.

Acknowledgement: This research has been supported by the FHWA and its contractor, the National Crash Analysis Center at The George Washington University. Contractor staff including Dr. Dhafer Marzougui, Dr. Umashankar Mahadevaiah, and Mr. Fadi Tahan of GWU have provided technical insights in creating the enhanced tire model and running the simulations and FOIL technicians including Chris Story and Scott Mosher have assisted in conducting tire testing. Dr. Kenneth S. Opiela of FHWA serves as the project advisor and Mr. Eduardo Arispe of FHWA has facilitated testing and analyses arrangements.

Ally Zhang-team member of the month

Congratulations to **Dr. Yehui (Ally) Zhang, NRC Postdoctoral Research Associate at NOAA,** for being recognized as the NOAA Team Member of the Month-August! Ally's innovative studies of the global climatology of the atmospheric boundary layer have helped NOAA break new ground in atmospheric research, bridging a sub-disciplinary divide between boundary layer meteorology (traditionally focused on small space and time scale processes in the lowest layer of the atmosphere) and climate science (which generally deals with larger space and time scale phenomena).

Through careful and creative analysis of both upper-air observations and climate model simulations, Ally's work has shed new light on features of the boundary layer over the Arctic and Antarctica, and over Europe and North America. Ally's cooperative and engaged way of working with colleagues, and her productivity and responsiveness, have contributed to the creation of a new and highly effective collaborative research team that brings together scientists in three NOAA Research Laboratories (the Air Resources Lab, the Earth System Research Lab, and the Geophysical Fluid Dynamics Lab) and at the National Center for Atmospheric Research.



Dr. Ally Zhang, NRC Associate at NOAA

During her tenure Ally has presented her work at two ARL seminars and at two national conferences (the American Meteorological Society's 2010 Conference on Boundary Layers and Turbulence and the American Geophysical Union Fall 2010 Meeting). She also submitted two papers (co-authored with NOAA and NCAR colleagues) to peer-reviewed journals. Ally Zhang is an outstanding example of the potential for innovation and collaboration that can be achieved when postdoctoral associates team with NOAA scientists to explore new areas of environmental research relevant to NOAA's mission goals.

Data assimilation improves ocean wave forecasts

Dr. Mark Orzech, NRC Postdoctoral Research Associate at the Naval Research Laboratory Stennis Space Center, Stennis, Mississippi.

Ocean waves directly affect the lives of millions of Americans and others who visit or live near the coast. Tourism to beaches and other coastal areas provides an important source of income to many states. Amphibious naval landing craft must often transit a poorly known surf zone in order to carry out their mission. Large storms can flood coastal communities and erode beaches and cliffs, and waves can pose hazards to beachgoers, swimmers, and small boats. Accurate prediction of waves near the shoreline plays an important role in mitigating hazards, reducing or countering erosive effects, and, of course, picking the best surfing spot.

The SWAN computer model ("Simulating Waves Nearshore"; Booij et al., 1999) has been widely used for shallow water wave prediction by the ocean modeling community for more than a decade. It includes all significant processes of wave generation, propagation, reflection, and decay. Waves are represented in a spectral form, with the wave energy distributed over different wave periods and directions. Following initialization at its offshore boundary (usually with estimates from other, larger-scale models), SWAN computes the wave spectrum at all grid locations in a specified nearshore domain. If given accurate boundary data, SWAN's performance is generally very good; however, the use of incorrect boundary data can lead to significant errors in wave predictions throughout the model grid.

Dr. Mark Orzech, NRC Research Associate at the Naval Research Lab at Stennis Space Center, Mississippi, is working to improve SWAN's performance by adapting the model to assimilate measured nearshore wave data. With guidance from advisors Dr. Rick Allard and Dr. Jay Veeramony, Dr. Orzech is building a numerical data assimilation system, including both tangent-linear (TL) and adjoint versions of the original SWAN code (Fig. 1). Data assimilation techniques essentially use measured data to ground truth a model's predictions against reality. The system allows users to compare the model's wave predictions to observed wave spectra where they are available, then back-propagate these errors out to the model region's boundary and adjust the initializing boundary conditions to minimize overall error throughout the entire model grid.

The numerical adjoint approach is superior to analytically based approaches, because a numerical adjoint can include all wave processes present in SWAN while analytical adjoints are limited to only stationary, linear processes. Dr. Orzech's project is the first attempt to construct such a numerical adjoint for SWAN. The project's first stage, encompassing the creation of adjoint subroutines for all of SWAN's basic linear propagation processes, has been completed, and a variety of simulations have been conducted to validate the simplified adjoint.

References

Booij, N., R.C. Ris, and L.H. Holthuijsen, 1999. A third-generation wave model for coastal regions: 1. Model description and validation. Journal of Geophysical Research 104 (C4), 7649-7666.

Walker, D.T., 2006. Assimilation of sar imagery in a nearshore spectral wave model. Tech. Rep. 200236, GDAIS.

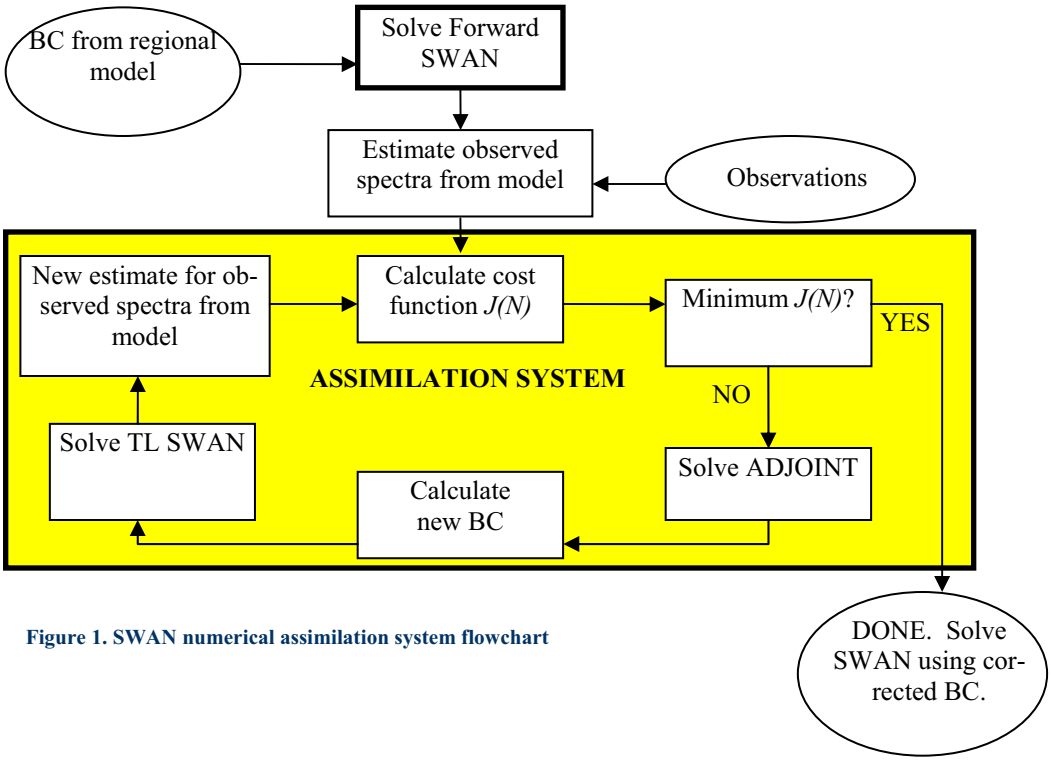


Figure 1. SWAN numerical assimilation system flowchart

In parallel twin experiments, Dr. Orzech found that the stage-one numerical adjoint (without sources and sinks) performed as well as an earlier analytical adjoint developed by Walker (2006). In tests with observed data, the simplified assimilation system predicted wave height, period, and direction very well under mild wave conditions, but its performance was somewhat worse for larger waves, and it was unable to accurately estimate directional spreads of the wave spectra (Fig. 2).

"I expect that the numerical adjoint model will significantly improve the accuracy of most SWAN model nearshore wave simulations," says Dr. Orzech. ***"The adjoint will still be subject to measurement and model error and will be limited to the physical processes that are included in SWAN, so it will never be 'perfect'. However, by providing sensitivity maps, the adjoint will also help users to obtain even better forecasts by targeted deployments of wave-measuring instruments in the nearshore."***

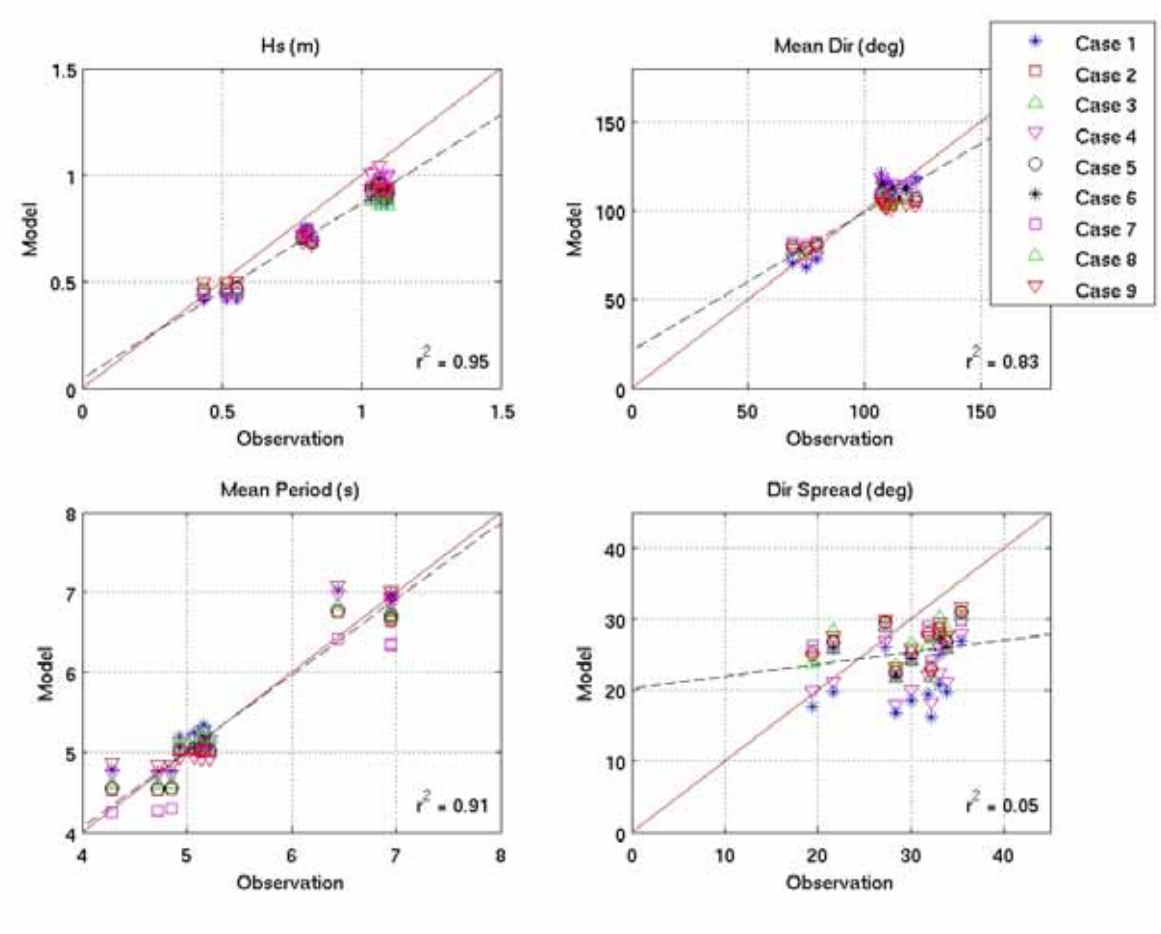


Figure 2. Predictions of significant wave height (Hs), mean wave direction, mean wave period, and directional spread by the SWAN adjoint system, plotted versus observed data in a set of nine twin experiment cases from Duck, NC. Solid line in each panel shows a one-to-one correspondence, while dashed line is best linear fit to plotted values. Correlation r-squared value is provided in each panel.

The adjoint model's performance is expected to steadily improve as nonlinear effects like bottom friction, wind forcing, wave breaking, and triad/quadruplet interactions are added to the stage-two code. At present, adjoint subroutines for wave triads and shallow-water breaking have been built and validated, and results of preliminary simulations with observed data are very promising. The stage-two adjoint system is also being adapted to handle nonstationary cases where wave conditions vary over time, as might be seen during a storm or hurricane.

When the improved SWAN model is ultimately transitioned to operational form, it will benefit the entire coastal research community. More accurate predictions of surf-zone waves and currents will help to make amphibious naval operations both safer and less costly, contribute to better estimates of coastal erosion and flooding from storms, and empower scientists around the world to further advance our understanding of the complex nearshore environment.

Reminder to Advisers:

The 2012 Research Opportunity Update process is underway— the third year of our online revision management tool to help you keep your opportunities current. You have already received a link to the data base, along with your username, password, and a link to step-by-step instructions on how to revise your Research Opportunities.

Here are a few tips for a smoother process: (1) make a note of your password since you will also need it to update your contact information, (2) revise your opportunities within four weeks of receiving the E-mail; and (3) mark your opportunities as "complete" so your Laboratory Program Representative will know they're ready for his/her review. Even if you have no changes, you still need to view your opportunities, mark them as "complete", and then save.

Our goal is to keep the Web site up to date and this online tool should enhance that process. We appreciate all the work you do to help us make this new procedure a success.

NRL hosts first annual Karles Invitational Conference

NRL hosted the first annual **Karles Invitational Conference**, named in honor of **Drs. Jerome and Isabella Karle**, on August 15 and 16. The professional contributions of Dr. Jerome Karle, 1985 Nobel Laureate in Chemistry, and Dr. Isabella Karle, a 1993 Bower Award Laureate and 1995 recipient of the National Medal of Science, were critical in enabling the resolution of the molecular structure and function of complex macromolecules.

While fundamental in nature, the Karles' contributions continue to have a significant impact on the basic and applied physical, chemical, metallurgical, geological and biological sciences. In commemoration of the Karles' achievements and broad scientific impact, NRL initiated the annual invitational conference to convene the leading authorities and innovators from scientific disciplines that are on the verge of producing contributions with similar reach and impact. In recognizing the rapid progress of two fields that are helping the research community realize the promise of the post-genomics era, NRL selected "Microbial Systems and Synthetic Biology" as the topic for the first conference.

The completion of the first decade of research in both fields has resulted in the development of the tools and methods necessary to make global cellular measurements, integrate these data to map, model and predict cellular function, and use this systems-level understanding to guide the rational design, construction and optimization of novel genetically engineered circuits and organisms.

As a result of this considerable progress, both fields now lie on the verge of combining to develop transformative bioengineered solutions for recalcitrant problems in energy and biofuel synthesis, environmental remediation, chemical and biological sensing, pharmaceutical synthesis and materials science. It is this potential that has elicited considerable interest and investment, and resulted in the prioritization of systems and synthetic biology research in academia, industry and government.

Members of the Scientific Committee for the Karles Invitational Conference — NRC Advisers Dr. Bhakta Rath, Ms. Anne Kusterbeck, Dr. Banahalli Ratna, and Dr. Gary Vora.

Dr. Subra Suresh, National Science Foundation.

The goal of the conference was to bring together those who are involved in systems and synthetic biology research to discuss the history, progress and recent breakthroughs in these fields. NRL conference planners also hoped that the event would provide an intimate atmosphere to promote the exchange of ideas and address current limitations and potential end user needs.

The two-day program included presentations by leading authorities and innovators and represented the diversity of ideas, approaches and microbial systems used in both of these fields. At its conclusion, the conference had successfully provided a forum for approximately 150 invited multidisciplinary scientists, sponsors, policy makers, industrialists and technical society leaders to discuss the current state, challenges and future of microbial systems and synthetic biology research.

The NRL scientific committee members for this first annual conference were **Dr. Gary J. Vora**, **Dr. Banahalli Ratna** and **Dr. Bhakta Rath**. "As anticipated, a well-planned assemblage of key speakers and invited attendees has resulted in a number of planned research collaborations and coordination's between several academic, government, and industrial institutions," said Dr. Rath.

Drs. Isabella and Jerome Karle (seated center of the table), Dr. John Montgomery and Dr. Bhakta Rath (standing just behind them), and other members of the Karle family.

Conference Speakers

Keynote Addresses

Dr. David Honey, *Director of Research of the Office of the Secretary of Defense, Department of Defense*
"Department of Defense Science & Technology Planning and Synthetic Biology"
Dr. Subra Suresh, *Director of the National Science Foundation* "Probing Human Diseases Across Disciplinary Boundaries"

Left: Karle Conference draws high attendance, enthusiastic reception

Right: NRL's Dr. Bhakta Rath, Associate Director of Research, Materials Science and Component Technology Directorate; Dr. David Honey, Deputy Assistant Secretary of Defense for Research; and Dr. John Montogmery, NRL's Director of Research.

Featured Speakers
Dr. Leroy Hood, Institute for Systems Biology
Dr. Bhakta Rath, Naval Research Laboratory
Dr. Hiroaki Kitano, The Systems Biology Institute
Dr. Pamela Silver, Harvard Medical School
Dr. Bernhard Palsson, University of California, San Diego
Dr. Gary Vora, Naval Research Laboratory
Dr. John Glass, J. Craig Venter Institute
Dr. Drew Endy, Stanford University
Dr. Christopher Voigt, Massachusetts Institute of Technology
Dr. Steven Benner, Foundation for Applied Molecular Evolution
Dr. John Montgomery, Naval Research Laboratory
Dr. Adam Arkin, University of California, Berkeley
Dr. Zach Serber, Amyris
Dr. Arthur Grossman, Solazyme, Carnegie Institution for Science
Dr. Andreas Schirmer, LS9, Inc.

NRL / multi-national team launching Herschel space observatory

Naval Research Laboratory scientists are part of a team working on the Herschel Space Observatory, which was successfully launched by the European Space Agency (ESA) from French Guiana on May 14, 2009. Herschel is the first observatory to cover the full far-infrared to submillimeter spectral range (55 - 670 microns in wavelength / 0.5 - 5 terahertz in frequency) and it hosts a 3.5 meter diameter telescope, the largest single mirror telescope ever launched to space.

The Herschel Space Observatory is the next of ESA's scientific missions and houses a suite of instruments built by a multi-national team which includes partners from Europe, the United States (NASA), and Canada. Herschel opens a new terahertz window on the cold and dusty Universe, enabling its scientific objective: to investigate how planets, stars and galaxies formed and continue to evolve. Terahertz photons are the dominant photons emitted by cold material. They can penetrate through dusty regions that obscure the optical and ultraviolet radiation emitted by young stars and accreting black holes. Also, because our Universe is expanding, the radiation from the very distant galaxies of earlier epochs is Doppler shifted to the lower energy terahertz range.

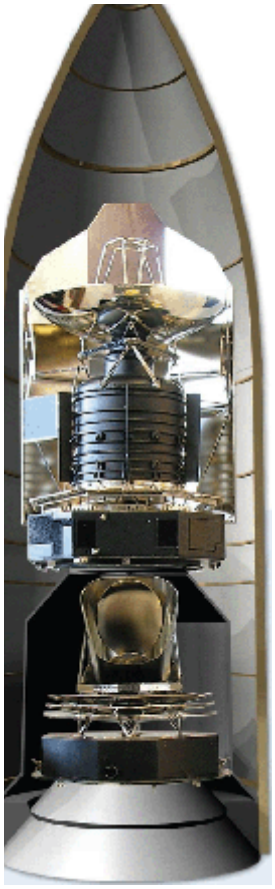
Herschel telescope: The Herschel telescope is almost entirely made of silicon carbide, a highly polishable, stable, and lightweight ceramic material and coated with a very thin layer of aluminum, for reflectivity. (Credit: ESA)

NRL's Dr. Jackie Fischer, **NRC Adviser,** head of NRL's Infrared - Submillimeter Astrophysics & Techniques Section in the Remote Sensing Division, is the Herschel Optical System Scientist and a member of the Herschel Science Team. She has worked on Herschel for the past eight years. She and her colleagues, including Dr. Robert Lucke of the Remote Sensing Division, have carried out laboratory measurements and modeling efforts to better understand how the telescope will perform. Dr. Fischer will use the Herschel Space Observatory to study mergers of galaxies that emit most of their immense luminosity in the terahertz spectral range, and are therefore known as the ultraluminous infrared galaxies (ULIRGs). These galaxy mergers are hypothesized to be responsible for the evolution of galaxies from gas-rich spiral galaxies to gas-poor elliptical ones. Dr. John Carr, also of the NRL Infrared - Submillimeter Astrophysics & Techniques Section, will observe conditions in the cold outer regions of the dusty disks around young stars from which planetary systems are formed.

The Observatory is named after Sir Frederick William Herschel, who discovered at the beginning of the 19th century that there is electromagnetic radiation at wavelengths longer than those visible to the human eye. Herschel placed a thermometer beyond the red part of the spectrum of sunlight dispersed by a prism and observed a rise in temperature due to heating of the thermometer by longer wavelength, infrared radiation. Although infrared radiation is invisible to the human eye, all objects "glow" in the infrared, and the quantity and wavelength distribution of the radiation depend on the temperature, area, and emissivity (surface emitting efficiency) of the object. For objects that are much colder than room temperature, such as the outer planets or interstellar ice and dust, the peak of this thermal radiation shifts from the mid-infrared peak at room temperature, into the far-infrared / terahertz range. Herschel's telescope and instruments are designed to detect and characterize the "cool" Universe.

The Earth's atmosphere both absorbs and emits terahertz radiation. For this reason, the best location for an infrared telescope is in space. The Sun, the Earth, and the Moon are strong terahertz emitters, and this must be taken into account in choosing the Observatory's location in space in order to shield the Observatory. In addition, the colder the telescope and its surroundings, the lower the background radiation and the more sensitive the instruments can be. The Herschel telescope's 3.5 meter-diameter mirror will gather terahertz radiation from some very cool and some very distant objects in the Universe. The Herschel Space Observatory is a successor to several earlier small cryogenic observatories that covered parts of the terahertz range, including ESA's Infrared Space Observatory (ISO), on which NRL scientists were co-investigators on the Long Wavelength Spectrometer, and NASA's Spitzer Space Telescope, a mission whose cryogens are now depleted. Both hosted small superfluid-helium cooled telescopes, 0.6 and 0.85 meter in diameter respectively. Herschel's three instrument focal plane units will also be cooled by superfluid-helium to temperatures ranging from 1.7 - 10 degrees Kelvin (zero degrees Kelvin is -273 degrees Celsius). However, because of its large size, required to increase the angular resolution and sensitivity of the Observatory, the Herschel telescope was designed for passive (radiative) cooling in space to an operating temperature of approximately 80 K, near the temperature of liquid nitrogen and still relatively cold. Thus, only enough superfluid-helium to cool the instruments and detectors over the lifetime of the mission needs to be carried to space in the cryostat.

Also different from ISO and Spitzer, which were in highly elliptical Earth orbit and Earth-trailing orbit respectively, Herschel will be launched to orbit around the 2nd (of five) Lagrange (L2) point of the Sun-Earth system. Lagrange points are positions where the combined gravitational pull of two large



Herschel launch rocket: Herschel launched aboard an Ariane 5 rocket from Kourou, French Guiana together with Planck, a mission to map the cosmic microwave background in more spectral bands and with more sensitivity than previous missions. (Credit: ESA (Guarniero))

masses provides precisely the centripetal force required to rotate with them. Thus they allow an object to be in a "fixed" position with respect to the two large masses rather than in a position in which the relative positions of the two large masses change.

Herschel will be in orbit around a point along the Sun-Earth axis, one million miles more distant from the Sun than the Earth. Because an object orbiting L2 always maintains the same approximate relative orientation with respect to the Sun and Earth, thermal shielding is simpler. Herschel is the second observatory to be located at L2, after NASA's Wilkinson Microwave Anisotropy Probe (WMAP) cosmology mission.

Herschel's telescope will feed a science payload consisting of three instruments: (1) Photodetector Array Camera and Spectrometer (PACS), three band camera and a low- to medium-spectral resolution integral field (5 X 5 pixel) spectrometer, covering the 55 - 210 micrometers spectral range. It uses two bolometer detector arrays in the camera and two photo-conductor detector arrays in the spectrometer. The PACS team is led by Germany and includes contributions from Belgium, Austria, France, Italy & Spain; (2) Spectral and Photometric Imaging Receiver (SPIRE), a three band camera with bands centered at 250, 350, and 500 microns, and a low- to medium-resolution imaging Fourier transform spectrometer covering the 200 - 600 micrometers spectral range, using five bolometer arrays. The SPIRE team is led by the United Kingdom and includes contributions from the US, France, Canada, Italy, Spain, Sweden, & China; (3) Heterodyne Instrument for the Far Infrared (HIFI), a very high spectral resolution spectrometer covering the 157 - 670 micrometers. The team is led by the Netherlands, with contributions from the US, France, Germany, Canada, Ireland, Italy, Poland, Russia, Spain, Sweden, Switzerland, & Taiwan.

The Herschel telescope was constructed almost entirely from silicon carbide (SiC), which is a strong and lightweight ceramic that is as polishable as glass. SiC was chosen because it has relatively high thermal conductivity, important for minimizing thermal gradients, and because it is homogeneous and isotropic, and less hygroscopic than other light-weight materials such as composites. For high reflectivity and low emissivity, its surface was coated with aluminum.

As the Herschel Optical System scientist, Dr. Fischer worked with the Herschel telescope engineers to ensure that the telescope's performance would enable it to carry out the science for which the Observatory was intended. She measured the emissivity of Herschel mirror samples at the telescope's operating temperature to quantify the expected telescope background and worked with Dr. Lucke on modeling of telescope secondary mirror reflections of internal instrument radiation causing unwanted baseline ripple for the Herschel heterodyne instrument. She worked with telescope engineers to understand variations in the telescope focus position with temperature, a critically important issue since the Herschel telescope does not have a focus mechanism. She also worked with the engineering team to understand, minimize and finally characterize stray light scattered into and emitted by the optical system surroundings.

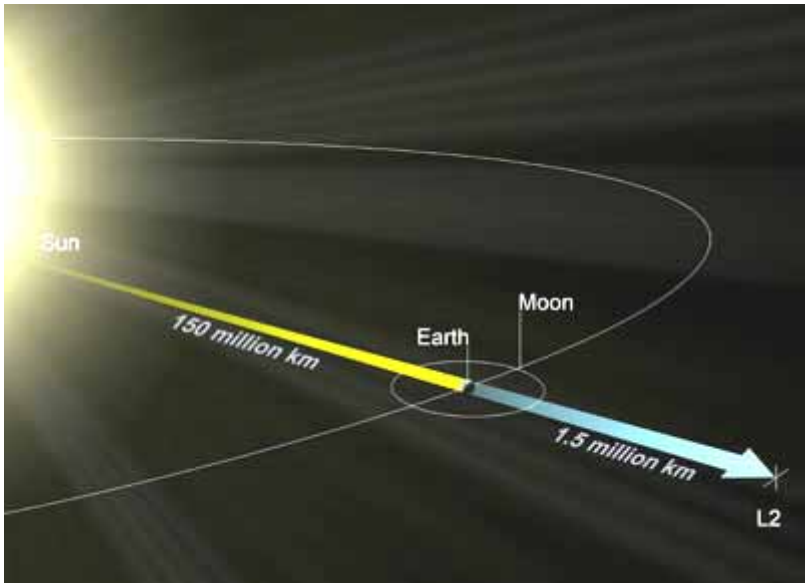
Herschel shared the launch with the cosmology mission, Planck, aboard an Ariane 5 ECA rocket. Herschel will commence preparations for its science mission enroute toward its operational orbit around a point in space situated at one million miles away from the Earth. Herschel has been designed to perform routine science operations for a minimum of three years, starting six months after launch. The mission will end when the helium used to cool the focal planes of the three scientific instruments is depleted.

Main Herschel link: http://sci.esa.int/science-e/www/area/index.cfm?fareaid=16

Simulation movie of galaxy mergers: http://web.phys.cmu.edu/~tiziana/BHGrow/

The SHINING Key Program: http://www.mpe.mpg.de/ir/Research/SHINING/index.php

More on Herschel Key Programs: http://herschel.esac.esa.int/Key_Programmes.shtml



Herschel orbit: Herschel will orbit around the second Lagrange point, L_2, with a relatively constant environment, and where it can be well shielded from emission from the Earth and Sun, and can hover without using too much fuel. (Credit: ESA)

Happy Trails, Lynne!

"August 9, 2011, I celebrated my 40th year with the National Research Council. It is with sadness that I say ...it's time for me to retire, enjoy more time with my family, and do the things I'd like to do while I still have time left on this earth. I have enjoyed working with many of you and will miss you." Lynne Haffner

Lynne Haffner, Financial Associate, NRC Research Associateships Programs

Those who remember the Roy Rogers / Dale Evans era (1952) will recall the theme song, "Happy Trails." About that time, Lynne Haffner's Aunt Mary was beginning what would become a happy 20-year employment at the National Academies, beginning with the Transportation Research Board. 19 years later, Aunt Mary recommended the National Academies as an employer to Lynne, whose career was beginning in the actuarial field. Lynne was hired by the NAS Accounting Office (NAO) in 1971. Her dedication to duty and attention to detail were rewarded by positions of increasing responsibility spanning 12 successful years. Lynne and her future husband, Ed Haffner met as fellow employees in NAO. Ed moved on to employment with the Department of the Army, while Lynne continued employment within the Academies.

In 1983 Lynne transferred to the Associateship Office, managing the Associateships and Fellowships stipend payrolls, insurance coverage, and many, many other assigned and volunteered responsibilities. This year, 2011, Lynne celebrates 28 years of this dedicated service to the Fellowships Office—dedicated to the Associates and Fellows, dedicated to timely payments and coverage, dedicated to efficiency, dedicated to detail, dedicated to customer service.

2011 actually marks several milestones for Lynne. Lynne and Ed have been married for 31 years. Lynne has completed 40 years of service to the National Academies. Lynne and Ed are the proud parents of Shellie, and the glowing grandparents of Anthony. Lynne is looking forward to working with Anthony, and enjoying his new knowledge and fun experiences. She will also remain actively involved in volkssporting, an international recreational activity that includes noncompetitive walking, biking, swimming, and other activities. Volkssporting has been part of Lynne's life since 1993. As a member of the Freestate Happy Wanderers Walking Club of Laurel, Maryland, Lynne's walks have taken her through 24 states. No doubt that number will increase with Lynne's increasingly available free time!

So, in the words of the Dale Evans and Roy Rogers song, ***"…Happy trails, Lynne, until we meet again."***

"I have worked with Lynne for 22 years. As one of the fellow "early birds" in the office, I will miss our early morning chats and the words of wisdom that only Lynne can provide, as well as the interesting stories about her family. In Lynne, the Fellowships Office is losing a dynamic, vivacious employee of 40 years!!! Very few people have that kind of longevity and dedication. Lynne is truly one of a kind and the office won't be the same without her." Marla J. Allentuck

"***Wow, the end of an era of your steady, dedicated work, Lynne. I'm shocked to admit that I remember you as Dan McHugh's assistant, back in the days of TWO people in Payroll. You deserve a change of pace after all these years, a chance to enjoy your family, and begin other adventures closer to home. We'll miss you!"*** Peggy Wilson

"***Thanks, Lynne, for always going the extra mile to accommodate stipend advances, or checks "lost in the mail"! My best wishes for you and your family. Continue to enjoy life and better health"*** Suzanne White

"***Dear Lynne, You have been great to work with and very devoted and dedicated and dependable (3 D's) as long as I have known you which is just short of 40 years! We appreciate you and love you and you know we will miss you. Enjoy every minute of your new lifestyle and, in the meantime, enjoy being surrounded by your loved ones."*** Chris O'Brien

"***Lynne, congratulations to you for 40 years of service to the NAS. I wish you happiness in your retirement!*** Joan Rosenthal

"Linnie, I never thought I'd see the day where one us 'originals' would be at retirement age and ready to leave the nest.....time passes by so quickly but I can't think of anyone who will enjoy retirement more than you! You GO girl! Congratulations!" Maria Crocco

"Dear Lynne, so many of us want to wish you well that I'm not sure this will fit on the page. May your retirement be prosperous, peaceful, and rewarding. Thank you so much for so much excellent work" Peggy Petrochenkov

"Lynne, Congratulations on 40 years with the NAS. That is an incredible milestone. I wish you the best and hope you have a happy and healthy retirement—and more importantly I thank you for staying through the end of the federal fiscal year!! Thank you for all your contributions to the fiscal team. You will be missed." Julie Parker

2012 SCHEDULE

February Review

February 1	**Application deadline**
February 15	**Support doc deadline**
March 12-13	**Panels/Review Board**
March 18	**Results available to applicants**

August Review

August 1	Application deadline
August 15	Support doc deadline
Sept 21	Review Board
Sept 28	Results available to applicants

May Review

May 1	Application deadline
May 15	Support doc deadline
June 21-22	Review Board
June 29	Results available to applicants

November Review

Nov 1	Application deadline
Nov 15	Support doc deadline
January 7, 2013	Review Board
January 14	Results available to applicants

From the NRC new LinkedIn site, we sent you …

…individual e-mail invitations to join your agency's LinkedIn group.

Please join!

http://www.linkedin.com/groups?gid=4109187&trk=hb_side_g