National Aeronautics and Space Administration

NASA technologies enhance our lives

Environmental Resources

NASA has a unique vantage point from which to observe our world. By employing powerful satellites, imaging devices, and remote sensing technology in space, the Agency studies Earth from a distance. Alongside this remote observation, NASA missions bring about unexpected benefits close to Earth in the form of spinoff technologies. Many of these are environmental technologies, with applications to make and save energy, clean up contaminated land and water, gather environmental data, and improve air quality.

energy conservation

Delivering Clean, Affordable Power

A technology that may one day sustain exploration on Mars is keeping the lights on at Fortune 500 companies across the Nation. Working for Ames Research Center, K.R. Sridhar developed a fuel cell device that used solar power to split water into oxygen for breathing and hydrogen for fuel. Sridhar saw the potential of the technology, when reversed, to create clean energy on Earth. Now Sridhar's Bloom Energy is providing cost-effective, environmentally friendly energy to companies such as eBay, Google, and The Coca-Cola Company.

"NASA is a tremendous environment for encouraging innovation. It's all about solving problems that are seemingly unsolvable." –K.R. Sridhar, Bloom Energy CEO

BLOOM'S NASA-DERIVED TECHNOLOGY GENERATES ENERGY ABOUT 67-PERCENT CLEANER THAN A TYPICAL COAL-FIRED POWER PLANT WHEN USING FOSSIL FUELS AND 100-PERCENT CLEANER WHEN USING RENEWABLE FUELS.

2,000,000,000*

*The approximate number of gallons of fuel saved by winglets, the upturned tips on the wings of many commercial aircraft, as of 2010. This drag-reducing technology was proven through studies by Langley Research Center's Richard Whitcomb and by tests conducted at Dryden Flight Research Center. The benefits abound—not only do the winglets save fuel, they represent a reduction of more than $4 billion in costs and almost 21.5 million tons in carbon dioxide emissions.

AVIATION PARTNERS BOEING MANUFACTURES AND RETROFITS BLENDED WINGLETS FOR COMMERCIAL AIRLINERS. THE TECHNOLOGY TYPICALLY PRODUCES A 4- TO 6-PERCENT FUEL SAVINGS.

Conserving Energy in Homes and Buildings

Flexible aerogel technology developed by Aspen Aerogels under Small Business Innovation Research (SBIR) contracts with Kennedy Space Center is now being employed in a building insulation application by Acoustiblok Inc. The company's Thermablok flexible aerogel strips are applied to wall studs in buildings, boosting the insulation factor by as much as 42 percent. According to Accoustiblok, a typical Midwest home outfitted with Thermablok would save over $700 annually in energy costs.

THERMABLOK CAN ELIMINATE ENERGY LOSS THROUGH A HOME'S EXTERIOR WALLS DUE TO THERMAL BRIDGING—RESPONSIBLE FOR UP TO 35 PERCENT OF A HOME'S HEATING COSTS

wildlife preservation

Tracking Whale Sharks and Other Rare Animals

When a software programmer partnered with a Goddard Space Flight Center astrophysicist, they began to solve a whale of a mystery. Even though whale sharks are the largest fish species, they are listed as "vulnerable to extinction" by the International Union for Conservation of Nature. By employing a star-mapping algorithm originally designed for the Hubble Space Telescope, the duo developed a method for tracking elusive whale sharks by using the unique spot patterns on their skin. In fact, the system can track any animal with unique spotting that does not change as it ages, including other rare and endangered animals, such as polar bears and ocean sunfish.

USING THE ALGORITHM AND A PHOTOGRAPH DATABASE RECEIVING CONTRIBUTIONS FROM SCUBA DIVERS WORLDWIDE, RESEARCHERS IN 2008 DOCUMENTED OVER 2,400 SIGHTINGS OF A RARE ANIMAL WITH ONLY A COUPLE OF HUNDRED PREVIOUSLY DOCUMENTED SIGHTINGS IN TOTAL.

Helping to Remove Ocean Debris

As part of its ocean-observing work, NASA partnered with the National Oceanic and Atmospheric Administration (NOAA) and private industry to develop remote sensing devices to protect the North Pacific seas—and its inhabitants—from abandoned fishing gear. As a result, Airborne Technologies Inc., developed satellite-respondent buoys to monitor currents and to track sea debris. The company also produced an unmanned aircraft system and complementary software package to process images of the ocean for debris detection and subsequent collection.

A COLLABORATION AMONG NASA, NOAA, AND INDUSTRY USES SATELLITES AND A SYSTEM OF BUOYS TO LOCATE DANGEROUS DEBRIS THAT CAN THREATEN MARINE MAMMALS, SEA TURTLES, BIRDS, AND FISH.

Protecting People and Animals

More than 35 years after Skylab launched into orbit, the same radiant barrier insulation technology used on Skylab is now employed by Advanced Flexible Materials (AFM) Inc. The company offers wraps to keep marathon runners safe from hypothermia, lining for mittens and vests, and insulation to keep manatees warm as they are lifted from the water as part of a tag-and-release program.

clean water

Eliminating Harmful Contaminants

With support from Small Business Innovative Research (SBIR) funding from Johnson Space Center, Argonide Corporation tested and developed its proprietary nanofiber water filter media. Capable of removing dangerous particles like bacteria, viruses, and parasites, the media was incorporated into the company's commercial NanoCeram water filter. In addition to its drinking water filters, Argonide produces large-scale nanofiber filters used for industrial and municipal water purification.

ARGONIDE FILTERS REMOVE GREATER THAN 99.99 PERCENT OF 0.025 MICRON PARTICLES IN WATER. (A HUMAN RED BLOOD CELL IS ABOUT 5 MICRONS WIDE.)

Restoring Groundwater at Polluted Sites

During the Apollo Program, NASA workers used chlorinated solvents to clean rocket engine components at launch sites. Dr. Jacqueline Quinn and Dr. Kathleen Brooks Loftin of Kennedy Space Center partnered with researchers from the University of Central Florida's chemistry and engineering programs to develop a technology capable of remediating the area without great cost or further environmental damage. Called Emulsified Zero-Valent Iron (EZVI), the groundwater remediation compound now cleans up polluted areas around the world.

EZVI CAN BE APPLIED TO A WIDE VARIETY OF AREAS CONTAMINATED WITH INDUSTRIAL SOLVENTS, INCLUDING 60 TO 70 PERCENT OF THE SITES ON THE SUPERFUND NATIONAL PRIORITIES LIST.

IN ADDITION TO CONTAINING A SPILL, THE BIO-BOOM WILL BIODEGRADE A CONTAMINANT AND THEN BIODEGRADE ITSELF. IT IS 100 PERCENT NATURAL AND NONTOXIC.

Cleaning Up Hazardous Spills

In the early 1990s, industry scientists worked with researchers at the Jet Propulsion Laboratory and Marshall Space Flight Center to develop something called Petroleum Remediation Product (PRP). Years later, Universal Remediation Inc. expanded the uses of the microencapsulation technology to clean up water with spills of fuel, motor oil, or petroleum hydrocarbons. Basically, thousands of microcapsules—tiny balls of beeswax with hollow centers—absorb contaminants and leave the water behind. Today, PRP is packaged and sold in products such as the Bio-Boom, Bio-Sok, Well Boom, and Oil Buster. One of the most popular is the Bio-Sok, which allows boaters to clean up small spills.

Removing Oil from the Gulf of Mexico

Through Small Business Innovation Research (SBIR) contracts with Marshall Space Flight Center, Micro-Bac International Inc., developed a phototrophic cell for water purification in space. Inside the cell were millions of photosynthetic bacteria. Micro-Bac proceeded to commercialize the bacterial formulation, which is now used for the remediation of wastewater systems and waste from livestock farms and food manufacturers. Strains of the SBIR-derived bacteria also feature in microbial solutions that treat environmentally damaging oil spills, such as the catastrophic 2010 Deepwater Horizon oil rig explosion in the Gulf of Mexico.

MICRO-BAC PRODUCTS HAVE SAFELY TREATED MORE THAN 100 HAZARDOUS WASTE SITES AND NUMEROUS BODIES OF WATER.

Processing Data to Respond to Environmental Conditions

NASA's award-winning Earth Resources Laboratory Applications Software (ELAS) package was developed at Stennis Space Center. Since 1978, it has been used worldwide for processing satellite and airborne sensor imagery data of the Earth's surface. Today, DATASTAR Inc. uses ELAS in its Image Processing Exploitation (DIPEx) software to provide information for the agriculture and forestry industries—including citrus growers—to track and respond to factors such as water, stress, and disease that affect natural assets.

BY COMBINING AERIAL IMAGERY WITH MEASURED DATA, DATASTAR PROVIDES HIGHLY ACCURATE ANALYSES ON THE BASELINE STATE OF AN AREA'S ENVIRONMENT AND CAN ALSO TRACK ONGOING CHANGES WITHIN AN AREA.

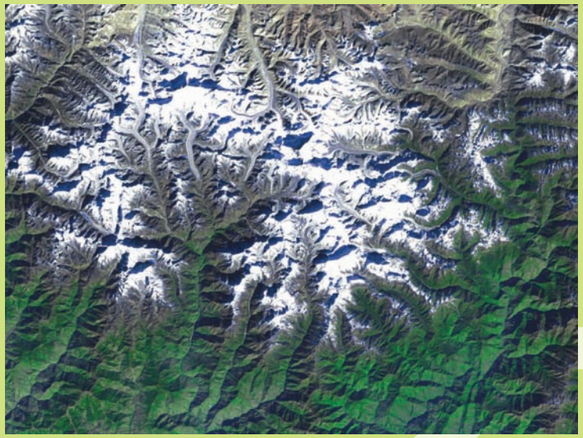
Providing Data to Monitor Natural Resources

In early 2005, researchers at the National Biocomputation Center, a joint partnership between Stanford University and NASA's Ames Research Center, formed a company called Intelesense Technologies to use telemedicine sensors—originally designed to help deliver medical care to remote locations—to provide integrated global monitoring systems. Intelesense uses the systems to remotely monitor and protect natural resources, predict and adapt to environmental changes, and provide for sustainable development.

INTELESENSE STARTED WORKING WITH THE NATURE CONSERVANCY IN 2010 TO DEVELOP AND DEPLOY A REMOTE MONITORING SYSTEM IN THE WAINIHA PRESERVE AND ALAKAI PLATEAU—6,500 ACRES OF INTACT NATIVE-DOMINATED LOWLAND AND WET FOREST ON THE HAWAIIAN ISLAND OF KAUAI.

Enhancing Satellite Imagery for Climate Research

Supported by Small Business Innovative Research (SBIR) contracts with Stennis Space Center, Geospatial Data Analysis Corporation (GDA) invented software to automatically identify clouds in satellite imagery, without the use of thermal data. The Cloud and Cloud Shadow Assessment software provides highly accurate cloud identification for private remote sensing imagery firms, and the technology's feature detection capabilities are being applied to a range of land features, helping researchers study the effects of population growth and climate change on crop field acreage, flood zones, and plant cover.



"To have the research and development funding and the backing of NASA to go out into the commercial market has been key for us." –Stephanie Hulina, GDA president and senior scientist

Detecting Atmospheric Pollutants

Under Small Business Innovation Research (SBIR) contracts from Glenn Research Center, Aerodyne Research Inc. (ARI) created spectrometers for use in mobile laboratories to study ground-based air pollution. The spectrometers detect a range of the most important greenhouse gasses and air pollutants, including carbon dioxide, nitrogen dioxide, and methane. In addition to mobile measurements from van, aircraft, and ship platforms, ARI and its customers use the instruments to determine the magnitude of pollutant emissions.

AERODYNE'S PRODUCTS ARE CURRENTLY IN USE IN NUMEROUS CLIMATE CHANGE LABORATORIES ON FIVE CONTINENTS, DETECTING MORE THAN 15 ATMOSPHERIC POLLUTANTS.

Purifying Air by Eliminating Pathogens

A NASA-developed ethylene reduction device for a plant growth unit is now in widespread use, helping preserve fresh produce at grocery stores, food storage facilities, and in the medical and dental fields. Licensed by KES Science and Technology Inc., the company partnered with Akida Holdings, which now markets the NASA-developed technology as AiroCide. According to the company, it is the only air purifier that completely destroys airborne bacteria, mold, fungi, mycotoxins, viruses, volatile organic compounds (like ethylene), and odors. What's more, the devices have no filters that need changing and produce no harmful byproducts, such as the ozone created by some filtration systems.

THE AIROCIDE AIR SANITATION SYSTEMS ARE AVAILABLE IN THREE ENERGY-EFFICIENT MODEL SIZES, AVERAGING LESS THAN $1 PER DAY TO OPERATE IN THE UNITED STATES.

"The images show the size and the shape of the particles, which gives us an idea of how light reflects or refracts through the particles…a very important quantity to measure if we're trying to get an idea of whether sunlight is warming the Earth's surface or if it's bouncing off and cooling the Earth." –Paul Lawson, SPEC president and CEO

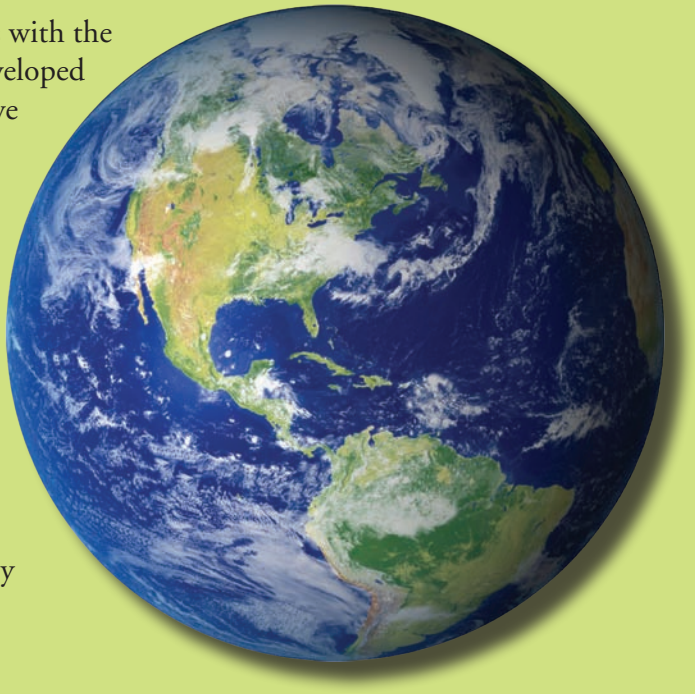
Offering New Insights on the Earth's Health

Stratton Park Engineering Company Inc. (SPEC) has won numerous Small Business Innovation Research (SBIR) contracts to develop atmospheric instrumentation, including a Phase II SBIR from NASA's Jet Propulsion Laboratory for cloud particle imagers. The SPEC Cloud Particle Imager (CPI) has been installed on NASA's high-altitude research aircraft and has been sold to universities and agencies around the world. Mounted to airplane exteriors, the CPI system captures images of cloud particles, enabling further analysis for climate predictions and research.

300+

THE NUMBER OF ENVIRONMENTAL RESOURCES SPINOFFS DOCUMENTED SINCE 1976.

Since its founding, NASA has nurtured partnerships with the private sector to facilitate the transfer of NASA-developed technologies. The benefits of these partnerships have reached throughout the economy and around the globe, as the resulting commercial products contributed to the development of services and technologies in the fields of health and medicine, transportation, public safety, consumer goods, environmental resources, computer technology, and industry. Since 1976, more than 1,700 of the most compelling partnerships and innovations have been documented in NASA's *Spinoff* publication. Building on this dynamic history, NASA partnerships with the private sector continue to seek avenues by which aerospace technologies can be brought down to benefit our lives on Earth. You can learn more by visiting us online at **www.sti.nasa.gov/tto**, or:



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