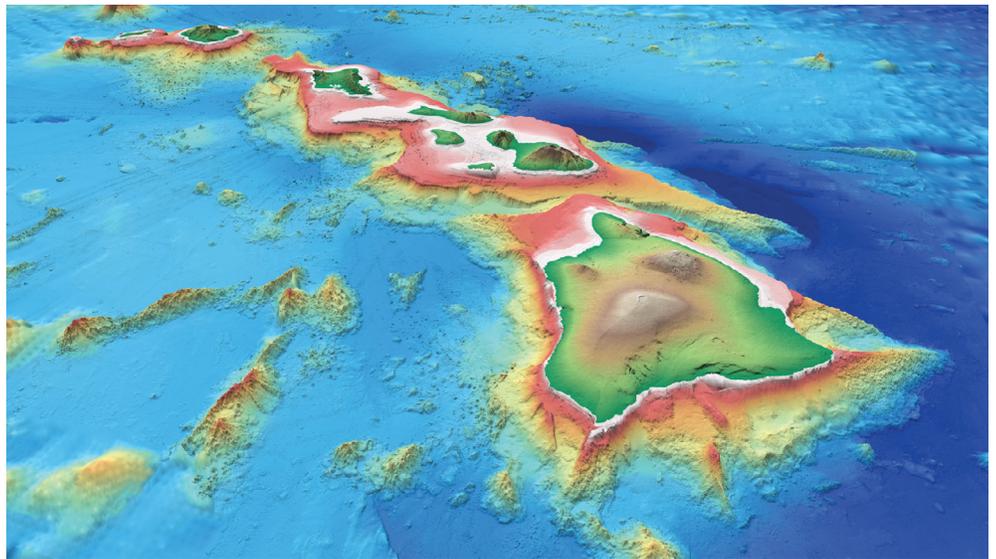


**SOEST**

**SCHOOL OF OCEAN AND EARTH  
SCIENCE AND TECHNOLOGY**  
UNIVERSITY OF HAWAI'I AT MĀNOA

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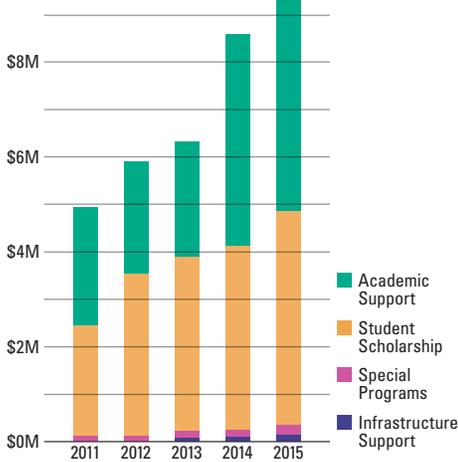
Extramural and private revenue since the school was established:  
over **\$1.6 billion** with  
**more than \$100 million** from private donors

Global School Ranking in Geosciences: **13**  
*NTU 2015*

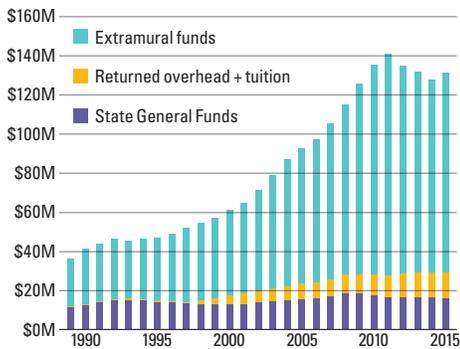


# The Dean's Introduction

## Endowment value



## Funding by year



Over the past three decades the School of Ocean and Earth Science and Technology (SOEST) has grown to be the largest research unit within the University of Hawai'i, with annual expenditures of \$125 million and over 1000 employees. It is a driving engine for business development and fundamental research that matters to the people of the islands. Our staff live and work in each district, on each island, throughout the State — and across the Pacific. We strive to innovate and discover new knowledge, while educating and training the next generation of high-tech professionals.

The vision of the School's founding 27 years ago called for the development of new centers and the combination of previously stand-alone units within UH Mānoa, to create a whole greater than the sum of its parts — a School of geosciences that today stands among the top twenty in the world. Notable areas of excellence include oceanography, climate, volcanology, renewable energy, coral reefs, remote sensing, conservation biology, and planetary exploration.

Our mission is to enhance the quality of life in our state and nation by creating new knowledge, providing world-class undergraduate and graduate education, contributing to a high-tech economy, and promoting the conservation and sustainable use of the environment.

Using field measurements and models, SOEST provides daily forecasts of vog, beach safety, and surf and ocean conditions, and creates products that inform our health, support our recreation, and protect our safety. Partnering with industry and the Public Utilities Commission, we've added megawatt battery systems to the island power grids on Molokai'i, Hawai'i, and O'ahu to improve electric grid stability and the penetration of solar and wind energy. We search for and discover new sources of underground water and geothermal energy; we design, build and launch satellites to observe our planet; and we work to enhance local food supplies through aquaculture and sustainable fishing.

Over the past quarter century, SOEST has delivered on the promise of its creation. Our reach and renown is global but we remain firmly rooted in the Hawaiian Islands, where every day the products of our research, training, and discovery impact lives and livelihoods.

*Brian*

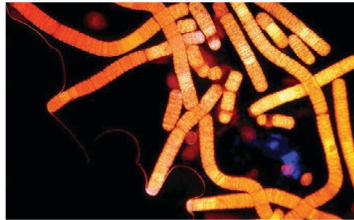
**Brian Taylor**  
Dean of SOEST

# RESEARCH

Total extramural funding in 2015:  
**\$100,796,658**

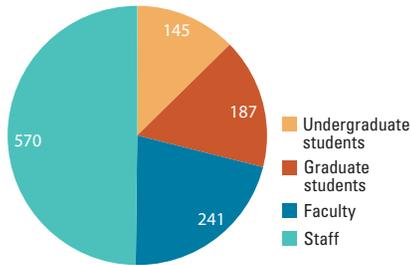


Research Vessel *Kilo Moana*



Microbial oceanography

## Total students, faculty, and staff



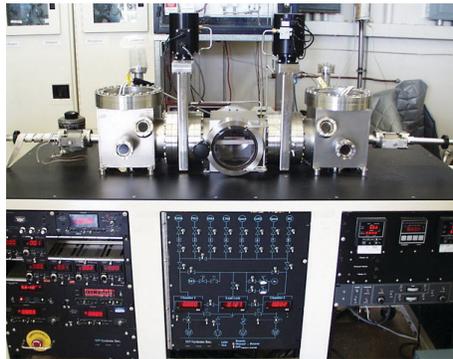
Located in the heart of the Pacific Ocean, SOEST research facilities provide convenient access to active volcanoes, deep ocean habitats, vibrant coral reefs, and some of the most isolated terrestrial ecosystems in the world.

SOEST faculty and staff are recognized as international research leaders on topics as varied as renewable energy, oceanography, coral reef ecology, volcanology, remote sensing, cosmochemistry, tropical meteorology, and climate modeling. SOEST is the research powerhouse of the University, generating fully one third of the total extramural funding received by UH Mānoa — more than any other unit in the University system. The School is operational 24/7/365, with programs and people across all the Hawaiian Islands and around the globe.

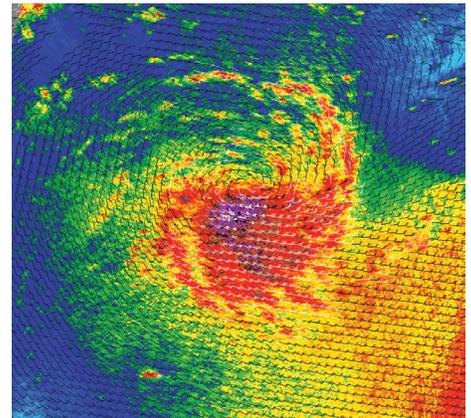
Total number of publications (2000–2014): **4359**

SOEST faculty work with community groups and agencies at local, state, and federal levels to perform the fundamental research that underlies policy development in water quality, renewable energy, natural hazard management, climate change impacts, sustainable ecosystems and train the next generation of State professionals in these fields.

Fellows of the National Academy of Sciences: **4**



Thin-film research



Modeling winds in a tropical storm



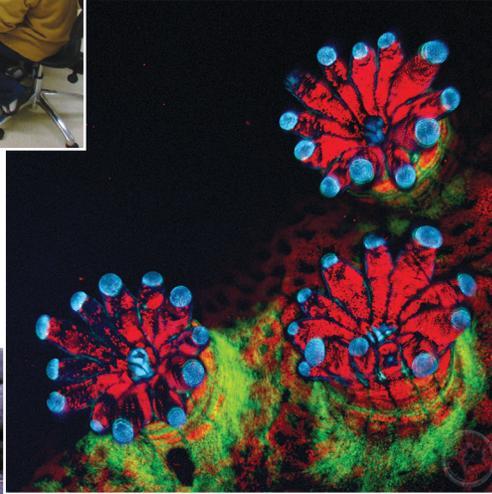
Cosmogeochemical analysis of meteorites

Fellows of the American Association for the Advancement of Science: **3**

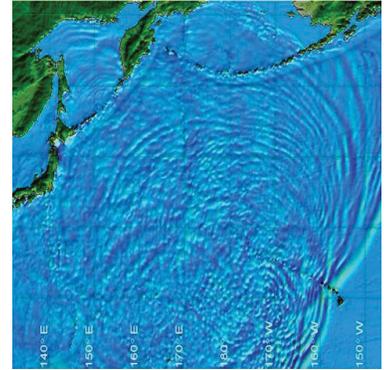


Laboratory analysis of samples

American Academy of Arts and Sciences Members: **5**



Laser confocal microscopy of living coral



Modeling earthquake-generated tsunamis



Geochemistry of the Hawaiian Islands



Collecting open-ocean water samples



Marine ecology (Hawaiian bobtail squid, *Euprymna scolopes*)



Methane hydrate as an alternative fuel

Depth of Aloha Cabled Observatory (ACO): **4728 m**

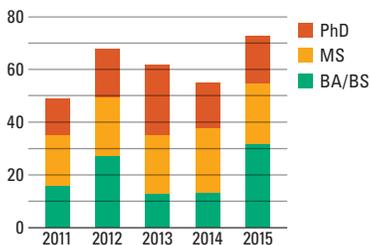
# EDUCATION

Annual visitors to SOEST websites:  
over **700,000**

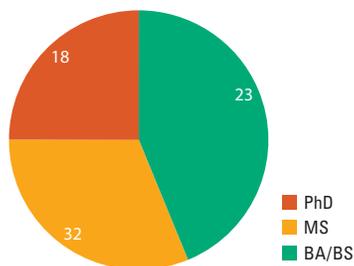


Celebrating graduation

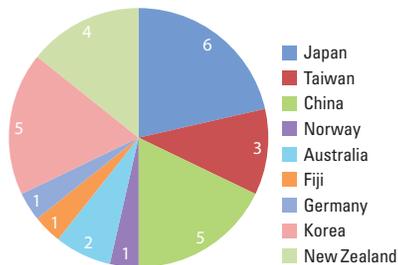
## Degrees awarded by type: 2011–2015



## Degrees awarded by type: 2015



## Academic partner universities by country



Volcanology fieldwork

SOEST faculty teach undergraduate students in atmospheric sciences, geology and geophysics, and global environmental sciences, and master's and doctoral students in atmospheric sciences, geology and geophysics, oceanography, marine biology, and ocean and resources engineering.

With two large research and several coastal vessels, two submersibles, a deep-ocean cabled observatory, a satellite fabrication facility, a private island devoted to marine biology research, and dozens of other specialized laboratories, students within SOEST are trained on state-of-the-art facilities and mentored to "find their passion" by leading researchers and educators as much in the field and lab as in the classroom.



Outreach to high school students statewide

Number of student majors (graduate and undergraduate):  
**332**

In the last decade, the rigorous B.S. degree in Global Environmental Science has developed a national reputation for preparing students for careers in the ocean and earth sciences. Fall 2012 inaugurated the graduate degree program in Marine Biology, joint between SOEST and the College of Natural Sciences. The Department of Geology and Geophysics now offers a Master of Geoscience professional degree to meet demand for expertise in applied geosciences.

Students taught in the Fall 2015 semester:  
**1526**

STUDENT PROFILE

# Haunani Kane

**PhD Candidate**  
*Geology & Geophysics*

I just completed my MS in Geology and Geophysics where I worked with local wetland managers to investigate how coastal wetlands in Hawai'i may be impacted by sea-level rise. I received a BS in Global Environmental Science in the Department of Oceanography, and I am currently pursuing my PhD in Geology & Geophysics.



My undergraduate degree provided a foundation in math and ocean sciences that greatly helped me in graduate school. Although the classes were tough they pushed and challenged me to work hard toward the end goal. I think one of the greatest things about my undergrad years was the relationships I made with both the students and the faculty. A few of my classmates and professors continue to provide support and guidance in my graduate studies.

Graduate degree programs:  
**11**

Through our four departments and in partnership with our own research centers, and other units across the Mānoa campus, SOEST offers undergraduate and graduate degree programs covering a wide range of ocean, earth, and atmospheric science disciplines.



Internships with government agencies



From Death Valley...



... to urban waterways...

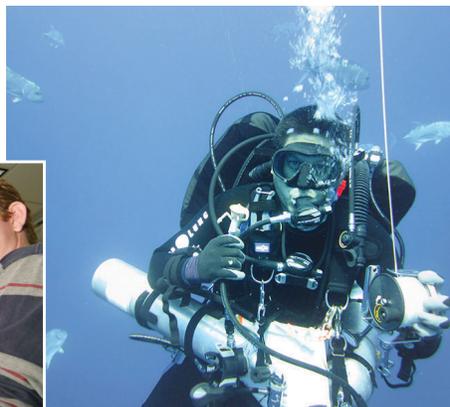


... to Antarctica



Over 6000 students and community members visited SOEST's 2013 Open House

Foreign partner universities students can attend: **28**



Oceanography fieldwork

Undergraduate degree programs:  
**4**

STUDENT PROFILE

# Elinor Lutu-McMoore

**Meteorologist**  
*National Weather Service*

As a meteorologist at the Weather Service Office in Pago Pago, American Samoa, I am responsible for issuing daily weather forecasts for all of the American Samoan islands and coastal waters and issuing timely weather watches, warnings and/or advisories to alert residents and mariners of any hazardous weather that may affect life and property. I also work on marine and climate programs and perform outreach activities that contribute toward American Samoa's continuous goal of being a "Weather-Ready Nation."



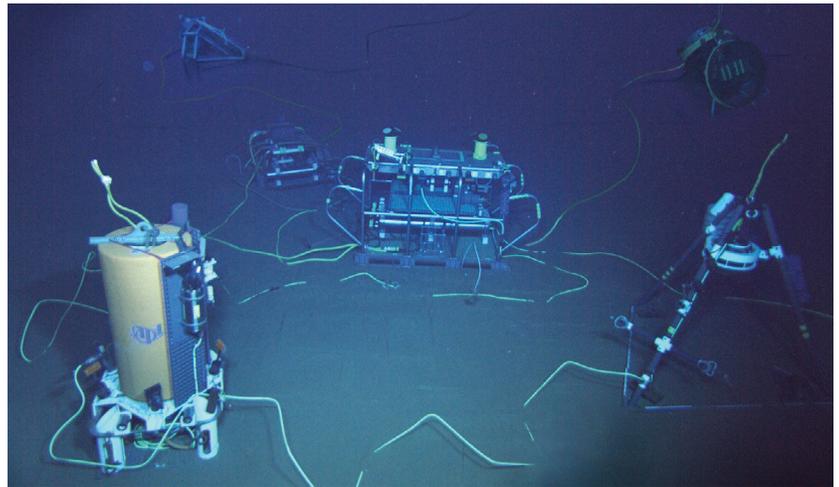
My degree program in meteorology definitely prepared me for my career. The lessons learned from courses were invaluable as were the helpful professors and staff whose goal is student success. The strong partnership with the NWS Honolulu Forecast Office was a vital component toward my transition to becoming a meteorologist for the National Weather Service.



# OCEAN

National Department Ranking:  
**7**

As a wholly coastal state, with an economy that is dependent upon safe and efficient marine transfer of goods and services, the ocean is Hawai'i's lifeline.



ALOHA Cabled Observatory is the world's deepest cabled observatory at 4728 m

From the seafloor to the ocean surface, and from the coast to the open ocean, SOEST researchers are global leaders — advancing knowledge of the physical forces, complex chemistry, and extremely diverse biology that exist in the ocean near Hawai'i and around the globe.

Using ships, submersibles, satellite, remote vehicles and a range of oceanographic sensing systems, students and faculty study circulation, nutrient cycles, and marine organisms large and small — from microbes to whale falls.

Our scientists explore coral reefs, hydrothermal vent systems on the ocean floor, examine the interplay between complex planktonic, fishery, and microbial food webs; and lead the global research community in microbial ecology and biology. Discoveries at SOEST enhance our understanding of the role of the ocean in driving local weather and global climate, and the human impact on ocean chemistry and ecosystem productivity.

Oceanographic research pursuits are both theoretical and applied at SOEST, with efforts ranging from modeling ocean circulation and tsunami inundation, to the provision of coastal ocean wave, pollution, and safety information to members of the general public.

Further, the ocean presents huge potential for yielding energy sources. Research within SOEST investigates the harvest of deep water methane hydrates, the generation of electricity from wave energy systems and ocean thermal energy conversion (OTEC), and the cooling of metropolitan areas using seawater air conditioning (SWAC).



Pisces V submersible discovers sunken WWII Japanese mini-sub off Pearl Harbor

Manned submersible dives since 1980:  
**over 1900**



Sea glider: drones of the sea



Fisheries and resource management



Flora and fauna native to Hawai'i



Collecting deep-ocean fish

# LIFE

The largest ocean on the planet, the Pacific Ocean is home to the world's largest collected biomass of marine life.

Hawai'i is situated within one of the richest marine ecosystems on earth. From the tops of volcanic mountains to the deepest ocean trenches, students and researchers in SOEST are performing world-class research within ocean and terrestrial ecosystems around the globe.

Focused on scales ranging from individual genes to entire ecosystems, SOEST researchers are gaining new insights into the vital role of healthy ecosystems in sustaining our planet, and pioneering approaches to conserve their biodiversity. Our scientists and students maintain extensive field operations, utilize genetic and chemical analyses, and develop laboratory experiments to reveal the hidden worlds of marine and land-based life.

As a global leader in microbial oceanography, we have helped clarify the importance of marine microbes, which dominate our planet and inhabit every drop of seawater.

We are pioneering efforts to save coral reefs, pristine forests, and native fauna from the impact of global climate change, developing methods to manage invasive species, and conducting research to support management of coral reefs, fisheries, and forests that support tourism, underpin local island economies, provide food and protection to communities, and serve as enduring conservation zones in areas of the planet inaccessible to humankind.

Invasive species monitoring sites in Hawai'i: **7**

Coral reef monitoring sites around the islands: **36**



Video camera and data recorder are attached to the fin of a sixgill shark



Microbial oceanography

Marine microbes, which make up most of the biomass in the ocean, contribute half of the Earth's daily production of oxygen.

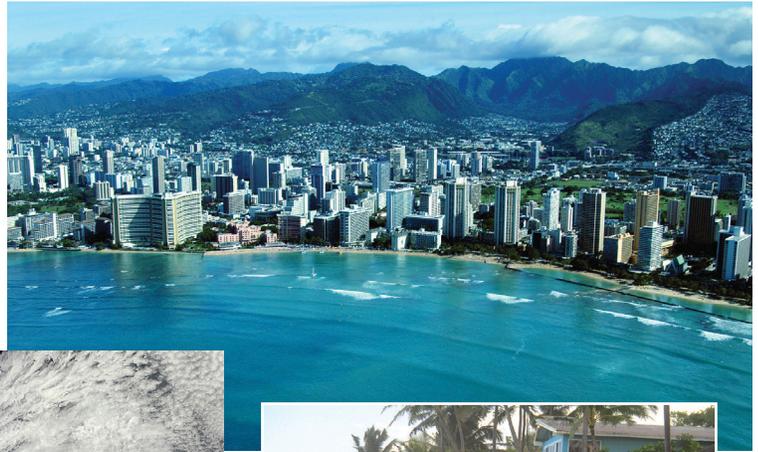


Echolocation of toothed whales

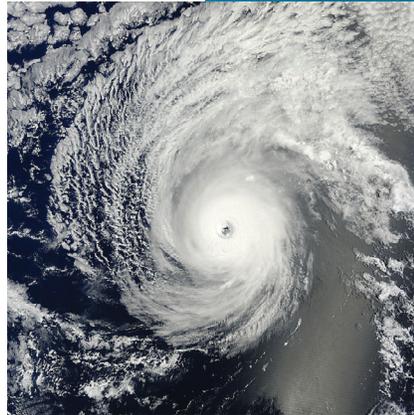


Ecology of whale carcasses

# CLIMATE



Finding stress-resistant corals



Effects of climate change on tropical storm strength and frequency

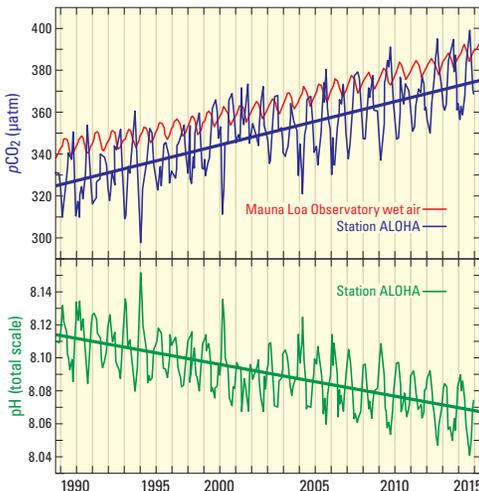


Sea level rise and threats to coastal property

Coastal erosion in the state of Hawai'i is predicted to double by 2050.

Climate change will impact the social, environmental, economic, and political infrastructures of nearly every nation on Earth. Understanding the complexities of the global climate system and predicting future changes requires detailed knowledge of large-spatial data sets and a robust numerical modeling capability that can accurately detail the interplay between the world's oceans, atmosphere, polar regions, ecosystems, and land masses.

## The Station ALOHA Curve



The longest continuous record of oceanic pH shows a clear and compelling acidification of the ocean as atmospheric carbon dioxide levels grow virtually unabated.

The long and distinguished history within SOEST in modeling climate variability has led to greater understanding of probable longer-term climate trends and how that may affect the occurrence of extreme events such as monsoons, tropical cyclones, storms, droughts and floods.

Additionally, SOEST has world-renown expertise related to a number of urgent issues associated with climate change:

- The International Pacific Research Center is producing forecasts of likely changes to rainfall patterns and strength necessary in forward planning of water resources, as well as changes to tropical cyclone frequency and intensity likely to impart the islands.
- The Hawai'i Ocean Time-Series at Station ALOHA, the longest continuous record of oceanic pH, shows a clear and compelling acidification of the ocean as atmospheric carbon dioxide levels grow virtually unabated. This has implications for a variety of marine life — from coral reefs to globally-important fisheries.
- As sea-level rises around Hawai'i and the Pacific, communities and infrastructure (hospitals, schools, roads, public utilities, communication systems) are increasingly vulnerable to coastal flooding and erosion. Across SOEST, students and faculty are exploring solutions to mitigate climate impacts in the islands and increase adaptive ability to sea level rise and coastal hazards.



Research into alternate fuels for automobiles

Advancing solutions to solve current and future energy needs of the State and the nation is both an urgent requirement and a complex task. Development of technologies and policies that will have significant positive impact on the State of Hawai'i's energy mix requires the integration of analysis, research, engineering, economics, and policy. Experts from across SOEST, and staff teams within the Hawai'i Natural Energy Institute (HNEI) develop, test, and evaluate novel renewable energy solutions and build public-private partnerships to demonstrate real-world integration of solutions onto energy grids.

The Hawai'i Natural Energy Institute (HNEI) within SOEST has established a major fuel cell research and development program – building on HNEI's highly successful research on hydrogen production from renewable resources. Further, SOEST departments and centers conduct research and testing of alternative fuels including biomass and biofuels, solar fuels, and methane hydrates; while also assessing the potential for alternative fuels, including the use of liquefied natural gas (LNG), to meet Hawai'i's energy needs.

SOEST works with local utilities and commercial partners across the globe to safely and effectively integrate renewable energy systems onto existing island-scale electric grids. SOEST staff and students are addressing the challenges associated with this integration and formulating potential solutions, including use of renewable energy storage systems and implementation of smart grid technology.



Wave energy device off Kāne'ohe Bay, O'ahu



Wind farm at Hawi, Hawai'i Island

The Hawai'i Sustainable Energy Research Facility is a partnership with Hawaiian Electric Company to accelerate acceptance and deployment of fuel cells for commercial and military applications.

# ENERGY



"Smart building" design and construction

HNEI operates the Hawai'i Hydrogen Power Park, wherein electrolyzers operating on solar and wind energy generate hydrogen, which can be stored and then used to drive fuel cells for generating energy.



Flash Carbonization™ producing charcoal from biowaste



# ATMOSPHERE

SOEST has maintained the vog prediction model for the Hawaiian Islands since 2010.



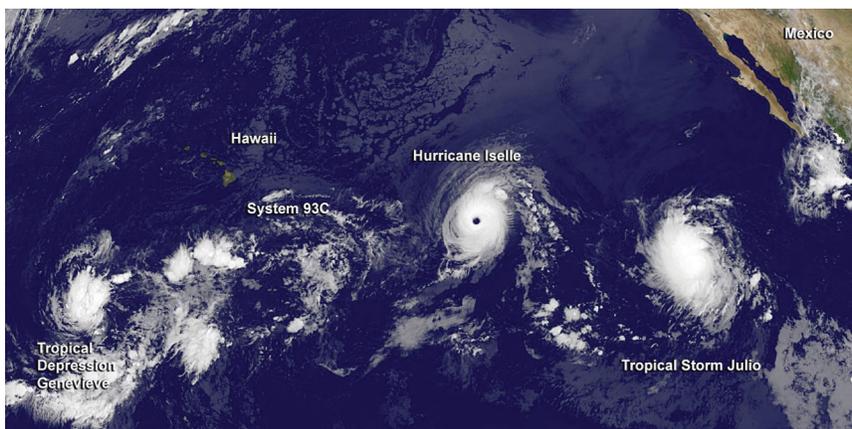
Monitoring and modeling vog — fumes from volcanic vents — across the state



Installing a weather station on O'ahu



Releasing a weather balloon from a ship at sea



Two tropical storms and a hurricane near the Hawaiian Islands on 04 August 2014

**Pao-Shin Chu**, professor of Atmospheric Sciences, is Hawai'i State Climatologist.

Research and education in atmospheric sciences is entering its second half-century at the University of Hawai'i. Scientists and staff at SOEST work to understand and predict weather phenomena and climate trends in the Pacific and across the globe.

Rainfall and snow associated with storms, monsoons, and longer term processes such as El Niño impact the social, environmental, economic, and political infrastructures of nearly all nations on Earth. SOEST students and staff study changes in the Asian monsoon, the physics governing storm generation, and the impact of climate change on rainfall, droughts, and floods.

Students and staff at SOEST develop and maintain a wide range of climate, weather, and atmospheric forecast models to advance understanding of climate variability; assist the National Weather Service with providing accurate extended range weather forecasts; and assist emergency managers with assessing brush/forest fire risk, health impacts of volcanic gas, and flooding potential from monsoons and storms.

Further, SOEST researchers are improving predictions of the creation, movement, and intensity of tropical cyclones (known as typhoons, cyclones, and/or hurricanes), among the most destructive natural hazards in the world.

SOEST researchers and students advance the scientific understanding of climate dynamics through sustained and detailed data collection, analysis, and modeling of climate systems – projecting climate change and associated impacts from the global to the local scale.

National department ranking: **12**

From volcanic mountaintops to the deepest submarine trenches, SOEST's earth scientists seek to understand the complex physical, chemical and biological processes shaping our planet, both at the surface, and deep within.

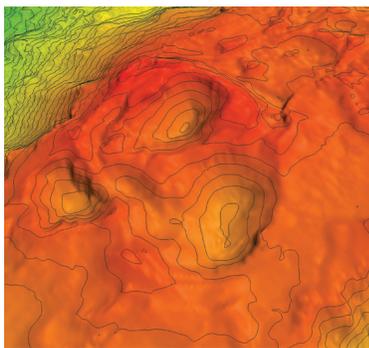
Within the School, students and faculty pursue research topics such as volcanoes, coastal to deep-ocean geochemistry, and global tectonic activity. SOEST scientists seek to understand the processes responsible for the creation and destruction of important natural resources including groundwater and geothermal energy. Earth science research is advanced using SOEST's ship and submersible capabilities, experimental and theoretical developments, field-based observations, and computer simulations.

Studies of the physical structure and dynamic forces of Earth provide students with a background that combines both geology and geophysics for technical and professional work at industrial, governmental, and academic institutions. Further, the study of high-pressure mineral physics and materials science (e.g., synthesis of diamonds, mineral transformation in Earth's interior) are key subjects of scientific research and have great potential for application in high-tech industries in Hawai'i.

Hawai'i's beaches and reefs are recognized around the world for their beauty; understanding the processes that shape them helps us preserve their splendor. Coastal geology research within SOEST focuses on coastal erosion, geologic history of Hawaiian reefs, and Pacific basin sea level history – providing crucial knowledge to aid mitigation and adaptation to future climate changes.



Field work in the American Southwest...



The submarine summit of Lō'ihi



Collecting lava samples on land...



... and rock samples on the sea floor



... and on Hawai'i Island

# EARTH

Global School Ranking: **15**  
Nature Index for Earth & Environment

Kīlau'ea, on the slopes of Mauna Kea on the Island of Hawai'i, is one of the most active volcanoes on Earth.



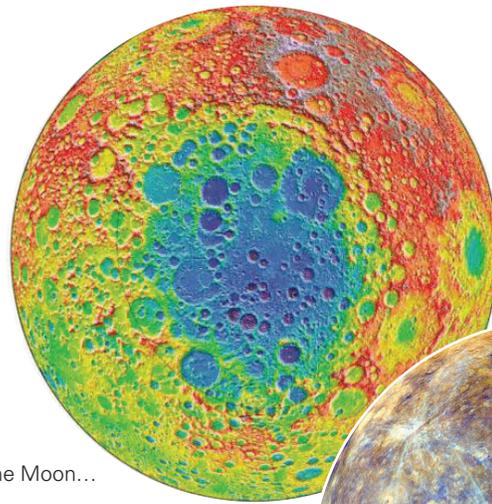
The land-sea interface

**Bruce Houghton**, Gordon A. Macdonald Professor of Volcanology in the Dept of Geology & Geophysics, is Hawai'i State Volcanologist.



# SPACE

Interplanetary dust particles could have delivered water and organics to Earth.



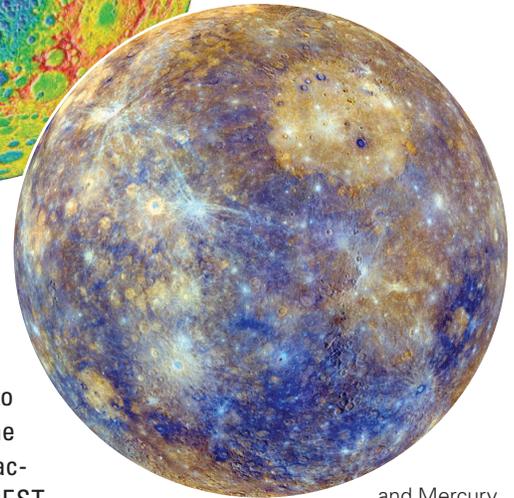
Mapping the Moon...

From space flight to instrument development to chemical analyses of extraterrestrial material, SOEST scientists and students are enabling new understanding of the origin and evolution of our solar system.

Hawai'i is located in a unique position to become a low-cost gateway to space and to place the University of Hawai'i as the only university in the world to have both satellite fabrication capabilities and unique, direct access to orbital space. Through the Hawai'i Space Flight Laboratory, SOEST students and staff are engaged in ongoing satellite fabrication, launch, and mission operations of satellite systems.

The origin and evolution of our solar system has preoccupied human observers for centuries. SOEST personnel design and build instruments for remote sensing systems for Earth and planetary exploration; and study Solar System objects with a variety of approaches including spacecraft data analysis, theoretical and computational modeling, and laboratory analysis of presolar grains from meteorites, interplanetary dust particles, and comet samples returned by the Stardust mission.

The discoveries to be made in studying meteorites and the chemistry of the cosmos are fundamental to understanding planetary evolution and exploring the processes linking the distribution of water and life in the Universe.

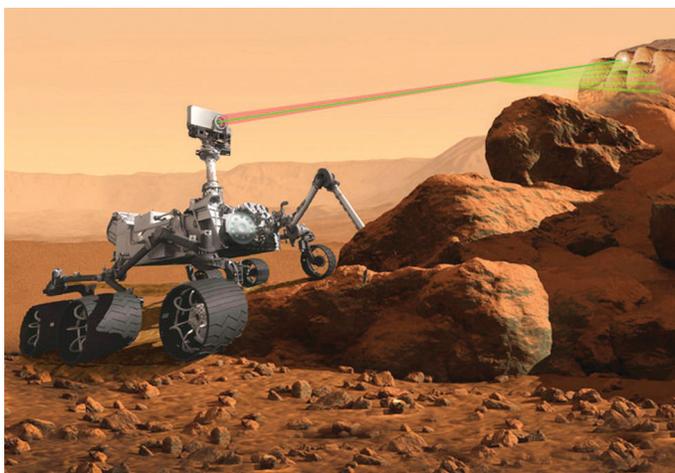


... and Mercury



Using meteorites to determine the age of the Moon

UH has a rocket launch pad and rail launcher; clean-room facilities and test equipment for small-satellite production; satellite tracking, communications and mission control.



SOEST researchers are on the team designing the Mars 2020 Rover



Super Strypi launch from Kaua'i, November 2015

## Academic Departments

**Atmospheric Sciences**  
[www.soest.hawaii.edu/MET](http://www.soest.hawaii.edu/MET)



**Geology and Geophysics**  
[www.soest.hawaii.edu/GG](http://www.soest.hawaii.edu/GG)



**Ocean and Resources Engineering**  
[www.ore.hawaii.edu](http://www.ore.hawaii.edu)



**Oceanography**  
[www.soest.hawaii.edu/oceanography](http://www.soest.hawaii.edu/oceanography)



## Research Centers and Institutes



**Center for Microbial Oceanography: Research and Education (C-MORE)**  
[cmore.soest.hawaii.edu](http://cmore.soest.hawaii.edu)



**Hawai'i Institute of Geophysics and Planetology (HIGP)**  
[www.higp.hawaii.edu](http://www.higp.hawaii.edu)



**Hawai'i Institute of Marine Biology (HIMB)**  
[www.hawaii.edu/HIMB](http://www.hawaii.edu/HIMB)



**Hawai'i Natural Energy Institute (HNEI)**  
[www.hnei.hawaii.edu](http://www.hnei.hawaii.edu)



**Hawai'i Sea Grant College (UH Sea Grant)**  
[seagrant.soest.hawaii.edu](http://seagrant.soest.hawaii.edu)



**Hawai'i Undersea Research Laboratory (HURL)**  
[www.soest.hawaii.edu/HURL](http://www.soest.hawaii.edu/HURL)



**International Pacific Research Center (IPRC)**  
[iprc.soest.hawaii.edu](http://iprc.soest.hawaii.edu)



**Joint Institute for Marine and Atmospheric Research (JIMAR)**  
[www.soest.hawaii.edu/jimar](http://www.soest.hawaii.edu/jimar)



**Pacific Biosciences Research Center (PBRC)**  
[www.pbrc.hawaii.edu/](http://www.pbrc.hawaii.edu/)



# SOEST

SCHOOL OF OCEAN AND EARTH  
SCIENCE AND TECHNOLOGY

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