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Research

Discovering the Secret Gardens in the Mangroves of St. John, U.S. Virgin Islands

By Ann B. Tihansky and Caroline S. Rogers

Caribbean region, showing location of St. John.

When scientists peered into the secret world of mangrove forests fringing the protected coastlines of the Virgin Islands Coral Reef National Monument, in St. John, U.S. Virgin Islands, they discovered vibrant marine gardens growing there. Tucked among the roots and shade of the red mangrove trees is a stunning and colorful array of corals, sponges, anemones, and fish. The communities are remarkably diverse, rich in texture, color, and number of species. The diversity of corals may be unique among mangroves of the Caribbean.

In 2001, approximately 50 km^2 was designated as the Virgin Islands Coral Reef National Monument to protect a wide array of marine habitats, such as coral reefs, seagrass beds, and mangrove forests. An area within the monument known as Hurricane Hole includes some of the least disturbed mangrove ecosystems remaining in the U.S. Virgin Islands. Hurricane Hole is made up of a series of shallow-marine bays with a narrow zone of red mangrove trees fringing the shorelines. The mangroves use long, branching prop roots to extend offshore and anchor themselves to the seafloor. These roots create shelter, providing a safe haven and nursery areas for small fish and many invertebrates. Very little research has been done in Hurricane Hole, and not much was known about the marine communities there. It was not until 2009 that **Caroline Rogers**, a scientist with the U.S. Geological Survey (USGS), discovered the secret coral gardens growing among the prop roots of the red mangrove trees.

"The discovery of all of the corals in the mangroves is very exciting," said **Rogers**. With more than 30 years working in the Caribbean as a coral-reef ecologist, she realized the area was special. "Within Hurricane Hole, there are at least 30 coral species, some of which are rarely seen even in the nearby coral reefs," she said. No other similar mangrove ecosystems, with such a high diversity of corals, are known to exist in the Caribbean.

Bird's-eye view of Hurricane Hole in Virgin Islands Coral Reef National Monument, showing protected bays and coastlines fringed by mangroves.

"There are about 45 coral species identified on coral reefs around St. John, and to date we've identified 30 in the mangrove areas. The diversity is remarkable and is not unique to the corals. We're seeing great diversity in the sponges as well. Many of the sponges are more typically found in coral reefs than in mangroves," said **Rogers**.

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*Prop roots of the red mangrove (*Rhizophora mangle*) tree create thickets that harbor a wide variety of creatures both above and below the water.*

Sound Waves

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(Mangrove Gardens continued from page 1)

It is not clear why the prop-root communities are so diverse, or why the individual bays within Hurricane Hole differ so much from each other with respect to coral abundance and diversity, but the unique assembly of marine creatures offers up a visual feast of subtle textures and rich colors. "There is always something new to see with each visit," said **Rogers**. (For a list of many of the coral species, see the short article by **Rogers** in *Coral Reefs*, v. 28, no. 4, p. 909, **http://dx.doi.org/10.1007/s00338-009-0526-4**.)

Scientists in the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (**http://coralreef.noaa.gov/conservation/**) have identified critical goals that need to be commonly addressed by all regulatory and management strategies to save and sustain coral reefs. The goals are to help coral-reef ecosystems cope with climate change. Scientific research can identify areas that are vulnerable as well as areas that are more resistant to environmental stressors, including stressors associated with climate change. The biological community in the mangroves of Hurricane Hole is important for research because of its richness and its possibly greater tolerance to adverse conditions, such as higher seawater temperatures.

In 2005, a massive coral-bleaching event in the northeast Caribbean and a subsequent severe disease outbreak caused a 60-percent decline in corals in the U.S. Virgin Islands (see publication by National Park Service biologist **Jeff Miller** and others in *Coral Reefs*, v. 28, no. 4, p. 925-937, **http://dx.doi.org/10.1007/s00338-009-0531-7**). Surprisingly, the corals living among the mangrove roots seem to be in better condition than many corals on the reefs. Some of the colonies are so large

(Mangrove Gardens continued on page 3)

*Pale-blue sponges and multiple coral colonies (*Agaricia agaricites*) grow on mangrove prop roots.*

Corals that typically build the structural framework of coral reefs grow in the mangroves in Hurricane Hole. The rich colors of the corals, sponges, and feather duster worms are reflected in the shallow-water surface.

(Mangrove Gardens continued from page 2)

that they clearly survived the 2005 bleaching event and disease outbreak. Many others are small enough that they may have settled and recruited to the mangrove roots since 2005.

The name "Hurricane Hole" describes the protective function the mangrove-lined bays provide during hurricanes. When a hurricane threatens the area, boaters seek shelter in the protected waters. Sometimes in the past, before the monument was established, they even tied their boats directly to the mangrove tree trunks and roots. This practice can significantly injure the mangroves and their associated ecological communities. The boats can break loose and run aground in shallow water, damaging the mangroves and destroying the fragile communities that grow on them.

In 2005, the National Park Service and the Friends of Virgin Islands National Park began installing a storm-mooring system in these bays to give boaters a secure alternative that would reduce damage to the mangroves. Other protective regulations include bans on fishing, water skiing, and jet skiing; these bans will help reduce wave action that stirs up sediment and dislodges organisms from the submerged prop roots. The improved mooring method and the added protective measures may be having a positive effect on the coral communities by reducing disturbance to the overall ecosystem.

Scientists are just beginning to understand and characterize the physical and chemical parameters that afford resilience to coral reefs in the face of climate change. Although it is not clear why corals in the mangroves are thriving and those on the coral reefs are not, such critical areas as Hurricane Hole may ultimately preserve coral species while more vulnerable reef habitats succumb to the effects of climate change. Understanding what factors contribute to the health and diversity of corals in these areas will help us develop strategies to protect other coral communities that are more vulnerable.

Rogers hopes to conduct future research in these fascinating bays, with a particular focus on the roles that seawater chemistry and patterns of water circulation may play in maintaining the high species richness of the corals and in their relative resistance to bleaching and disease.

Some of the corals in these bays are so large that they must have been growing here before the bleaching event in 2005. The mountainous star coral Montastraea faveolata *(background) is one of the largest colonies in these mangroves. In the foreground is the flower coral* Eusmilia fastigiata.

Scientific understanding will give us the tools to tend our ecosystem gardens for the future. The coral communities thriving in the mangroves in Virgin Islands Coral Reef National Monument show excellent potential for helping scientists unlock their secrets.

(The photographs shown here are among the many that **Rogers** has taken while exploring the mangrove ecosystems around St. John. These and more can be viewed in an online slide show at **http://fl.biology.usgs.gov/Science_Feature_Archive/2010/mangrove_secret/mangrove_secret_slideshow.html**.) ☸

*This coral (*Mycetophyllia *sp.) is not abundant in coral reefs of the Virgin Islands. It most commonly grows in water deeper than 40 ft. Thus, it is surprising to find it growing in the shade of the mangroves in 3 ft of water.*

The 2010 Chilean Tsunami and Uncertainty in Tsunami Modeling

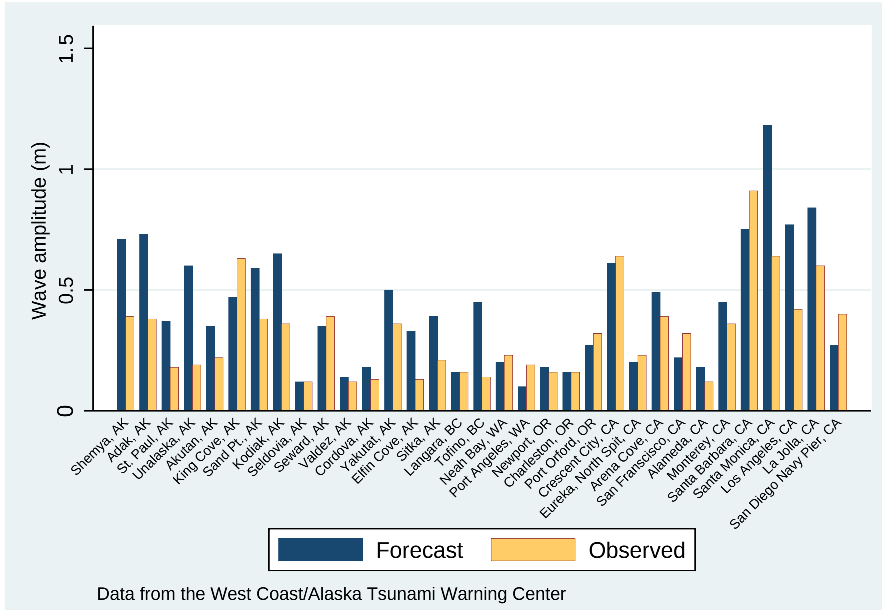
By Eric Geist

A magnitude 8.8 earthquake—the fifth-largest instrumentally recorded earthquake in history—struck off the central coast of Chile at 3:34 a.m. local time on February 27, 2010, causing deaths and widespread damage (**http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2010tfan.php**). In addition to the deadly shaking, the earthquake triggered a tsunami that devastated several villages on the Chilean coast. Together, the earthquake and tsunami killed nearly 500 people in Chile. The tsunami radiated to shores throughout the Pacific Ocean basin, where it was widely recorded by tide gauges.

This earthquake and tsunami are not without precedents: the world's largest instrumentally recorded earthquake (magnitude 9.5) occurred just to the south in 1960, triggering a massive tsunami and leading to the loss of approximately 2,000 lives in southern Chile. The tsunami spread across the Pacific Ocean, killing 61 people in Hawai‘i, 138 in Japan, and 32 in the Philippines. The 1960 tsunami had an 11-m maximum runup in Hawai‘i—that is, it reached an elevation on land of 11 m (36 ft) above sea level. In addition, a smaller (M~8.0-8.5) earthquake in 1837, also just south of the 2010 epicenter, resulted in a destructive tsunami with a reported 6-m (20 ft) maximum runup in Hawai‘i.

Soon after the 2010 Chilean earthquake, the Pacific Tsunami Warning Center (part of the National Weather Service of the National Oceanic and Atmospheric Administration [NWS/NOAA]) issued a tsunami warning for the State of Hawai‘i and most of the countries surrounding the Pacific. Fortunately, the 2010 tsunami did not prove to be nearly as destructive on distant shores as past tsunamis. At tide gauges in Hawai‘i, for example, the tsunami's maximum amplitude (height from sea level to crest of wave) was less than 1 m (3 ft); runup figures have not been reported but would likely be comparable to the tide-gauge amplitudes.

For the U.S. west coast and Alaska, the West Coast/Alaska Tsunami Warning Center (also part of NWS/NOAA) issued a tsunami advisory to inform emergency managers and the public that "a tsunami capable of producing strong currents or waves dangerous to persons in or very near the water is imminent or expected." The advisory was quite accurate: strong currents were reported at many harbors, with several instances of broken mooring lines and minor damage reported at harbors in southern California. The West Coast/Alaska Tsunami Warning Center's Web site (**http://wcatwc.arh.noaa.gov/chile/chileamp.php**) compares forecasted (that is, estimated) tsunami amplitudes at specific tide-gauge stations with observed amplitudes. In Washington, Oregon, and northern California, the forecasted amplitudes were very close to the observed amplitudes. Elsewhere, the forecasted values were greater than the observed values, although in some places, such as Santa Barbara, the observed values were greater. It always needs to be emphasized that even low-amplitude tsunamis are capable of generating strong (and therefore dangerous) currents in harbors over many hours.



Comparison of forecasted and observed maximum Chilean 2010 tsunami amplitudes (heights above sea surface) at tide-gauge sites along the west coast of North America. Data from ***http://wcatwc.arh.noaa.gov/chile/chileamp.php****.*

Tsunami Models and Uncertainty

The massive amount of tide-gauge data recording the 2010 Chilean tsunami around the Pacific Ocean makes it possible to better understand the sources and types of uncertainty associated with computational models of how tsunamis are generated, how they travel through the open ocean, and what happens when they hit coastlines. (For an introduction to these processes, see "Life of a Tsunami" at **http://walrus.wr.usgs.gov/tsunami/basics**.) Such models, along with near-real-time tsunami measurements from deep-ocean buoys, are increasingly used to forecast tsunamis soon after an earthquake. (See related *Sound Waves* articles at **http://soundwaves.usgs.gov/2005/10/meetings.html** and **http://soundwaves.usgs.gov/2007/04/research2.html**.) To improve these models, and thus the accuracy of tsunami forecasts, it is critical that uncertainty analyses be conducted when new data become available.

Various aspects of the waves that make up a tsunami—sometimes referred

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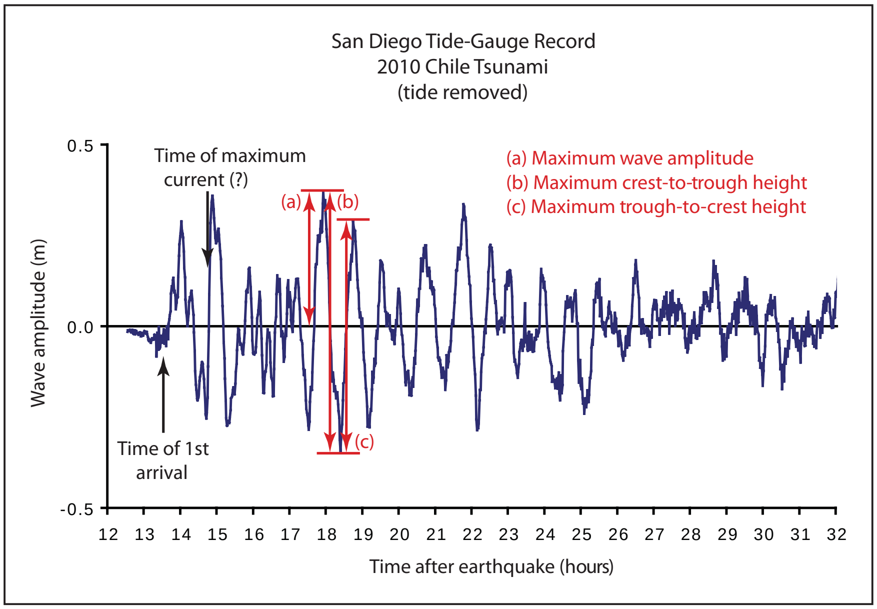
to as the tsunami wavefield—are easier to model than others. For example, the time it takes for the first tsunami wave to travel from the earthquake source region to any coastal site (termed the "first arrival time") can be modeled with great accuracy because the speed at which a tsunami wave travels depends only on the water depth along its propagation path. The first tsunami wave, however, may not be the most dangerous; the wave with the greatest amplitude can occur hours after the first arrival. Because more factors are involved, tsunami amplitude is more difficult to model than first arrival time. In general, the amplitude of the tsunami scales with the magnitude of the earthquake—the higher the magnitude, the greater the amplitude—but estimating the open-ocean tsunami amplitude with any precision depends on several assumptions, each with varying levels of uncertainty. Much of the total uncertainty in estimating tsunami severity is related to the tsunami-generation process, particularly the location of the earthquake rupture, how much the seafloor is uplifted and downdropped, and how deep the overlying water column is.



Record of the 2010 Chilean tsunami from a tide gauge in San Diego, California, showing the long duration of tsunami wave activity (the tsunami "coda"), which extended over 20 hours. Note that the tsunami waves with the largest amplitude and wave heights (a, b, and c) occurred more than 4 hours after the first arrival of the tsunami. Diagram shows how tsunami modelers define wave amplitude, wave height from trough to crest (related to runup, or the elevation to which the water surface rises during tsunami wave activity), and wave height measured from crest to trough (related to drawdown, or the amount by which the water surface is lowered during tsunami wave activity). Also shown is the inferred time of maximum current (associated with the steepest slope in the graph, indicating the fastest change in water elevation); even low-amplitude tsunamis can generate strong, dangerous currents.

Earthquakes with the same magnitude can produce tsunamis of different sizes, depending on the location of the rupture. Shown in the figure on page 6 are three possible rupture locations along the interplate thrust fault of a subduction zone, each with the same amount of slip (and therefore the same earthquake magnitude). This fault marks the boundary between tectonic plates, separating the downgoing plate (for example, the Nazca plate at the Chile subduction zone) from the overriding plate (for example, the South American plate). The top panel shows an earthquake rupture beneath a continental shelf. The rocks surrounding the rupture zone quickly deform, resulting in the vertical displacement graphed in the top half of the panel. In this case, most of the vertical displacement occurs offshore and is transferred to the tsunami. In the middle panel, the rupture occurs slightly deeper in the subduction zone, much of it beneath land rather than water. Only a small part of the vertical displacement is transferred to the ocean, and the resulting tsunami is small relative to the magnitude of the earthquake. In the bottom panel, the rupture occurs closer to the oceanic trench and at a shallow depth below the seafloor. Virtually all the vertical displacement caused by the earthquake is transferred to the water above, and because the water is deep at such a site, a relatively large mass of water is displaced. As the resulting tsunami travels into shallow water—at either a nearby or a distant shore—it becomes amplified to a much greater extent than in the other two cases.

The February 27, 2010, Chilean earthquake had aspects of both a continental-shelf tsunami (top panel of illustration) and a coastal tsunami (middle panel) and was therefore of moderate amplitude relative to a magnitude 8.8 earthquake, but scientists could not know this until enough time had elapsed to allow an accumulation of the relevant data. In the minutes following an earthquake, such information as magnitude and epicenter are readily available; however, it is difficult to ascertain the detailed slip pattern along the interplate thrust fault, particularly for very large earthquakes. After sufficient data are recorded at seismic stations around the world, these details gradually emerge. The updated 2010 Chile Finite Fault Model computed by seismologists at the National Earthquake Information Center (NEIC; **http://earthquake.usgs.gov/earthquakes/eqinthenews/2010/us2010tfan/finite_fault.php**; see map on page 7) shows that the rupture zone extended nearly 500 km (300 mi) along the coast, with large vertical displacements occurring offshore in some areas and just onshore in others. In general, most of the slip (and accompanying vertical displacement) occurred offshore and so was transferred to the tsunami, but primarily in shallow water. Both seismological and water-level data from the tsunami suggest that this was a "typical" magnitude 8.8 interplate thrust earthquake, in terms of where slip

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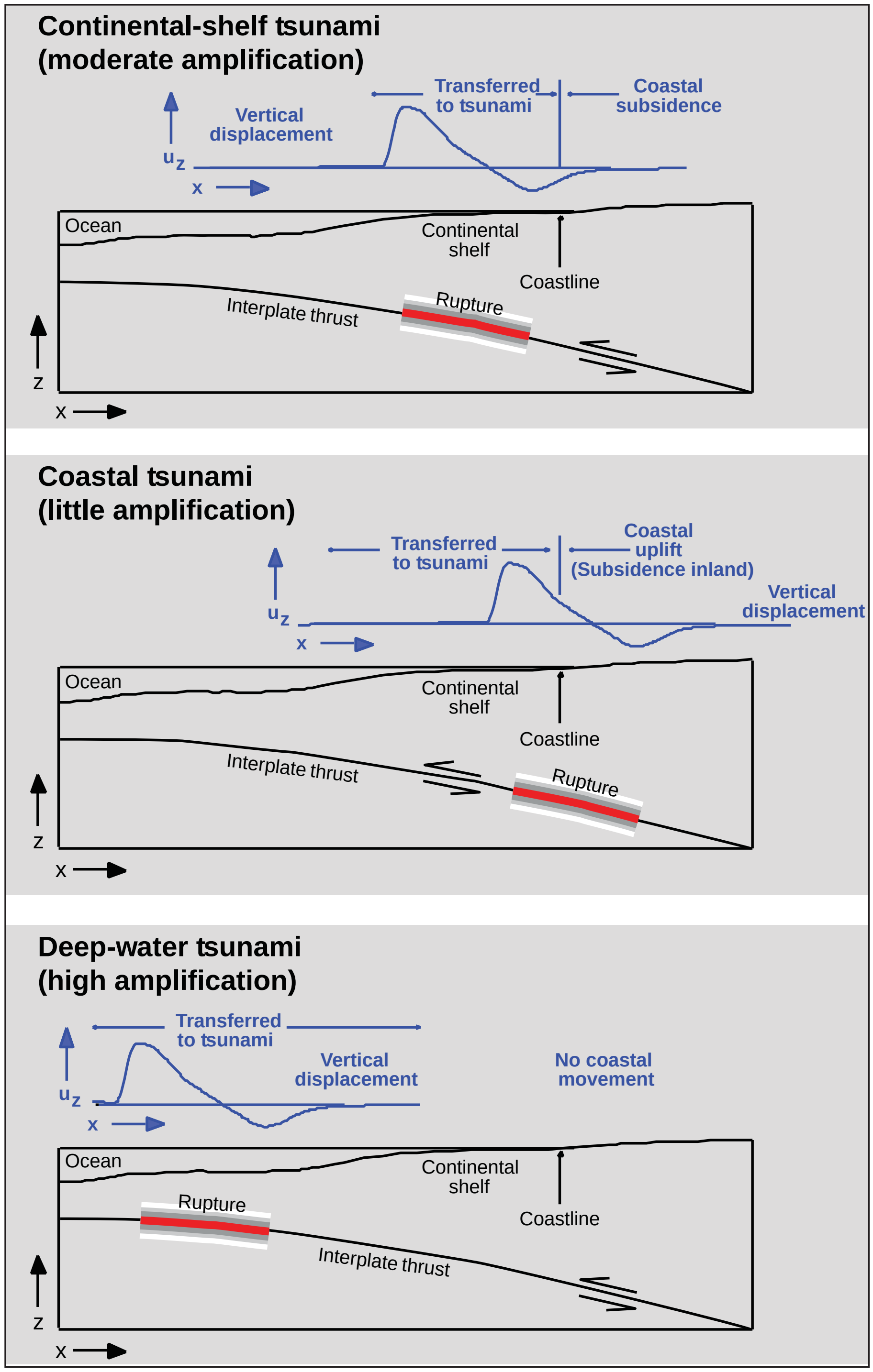
(Chilean Tsunami continued from page 5)

occurred and the size of the tsunami that was produced.

Even if tsunami amplitudes in the open ocean are accurately known from data about the tsunami-generation process, additional uncertainty arises when a tsunami arrives at the coast. Tsunami waves reflect and scatter off submerged bathymetric features as they travel toward the coast, and off headlands and other coastline features as they begin to come ashore. Interactions between the tsunami and coastal features generate secondary waves that are “trapped” along coastlines. These waves, called edge waves, propagate parallel to the coastline and themselves can be scattered by shoreline irregularities (see *Sound Waves* articles at **http://soundwaves.usgs.gov/2009/12/** and **http://soundwaves.usgs.gov/2007/04/research2.html**). In harbors and bays, tsunamis can resonate, setting up a tsunami-induced seiche. Theoretically, all of these waves in the tsunami “coda” (the long-lasting wave activity after the first arrival) can be accurately modeled if the nearshore bathymetry is known at high enough spatial resolution. (See tide-gauge record from San Diego, page 5, for an example of the waves in a tsunami coda.) High-resolution bathymetric maps for tsunami modeling have recently become available for selected sites (**http://www.ngdc.noaa.gov/mgg/inundation/**), but only low-resolution bathymetric maps exist for many areas vulnerable to tsunamis. Modeling the coastal response of tsunami waves by using low-resolution nearshore bathymetry introduces some uncertainty into estimates of wave height and current velocities. Turbulence in the nearshore regime, either from wave breaking or from seafloor roughness, introduces additional uncertainty.



Three schematic examples showing how the location of earthquake rupture affects tsunami generation. See text (page 5) for discussion. x, horizontal distance; z, vertical distance; uz, change in vertical distance. The oceanic trench, where the interplate thrust intersects the ocean floor, is outside the figure, to the left of each panel.

Classifying Uncertainty

In assessing and forecasting natural hazards, different sources and types of uncertainty are commonly classified as being either epistemic or aleatory. Epistemic uncertainty, or “knowledge uncertainty,” is related to a lack of (or inaccurate) data on which the models are based. The acquisition of additional and more accurate data reduces epistemic uncertainty. Aleatory uncertainty, or “natural uncertainty,” is related to the physical process itself and typically is not reduced by the collection of additional data.

Assessments of natural hazards are conducted before disasters strike to help managers plan for them. Tsunami-hazard

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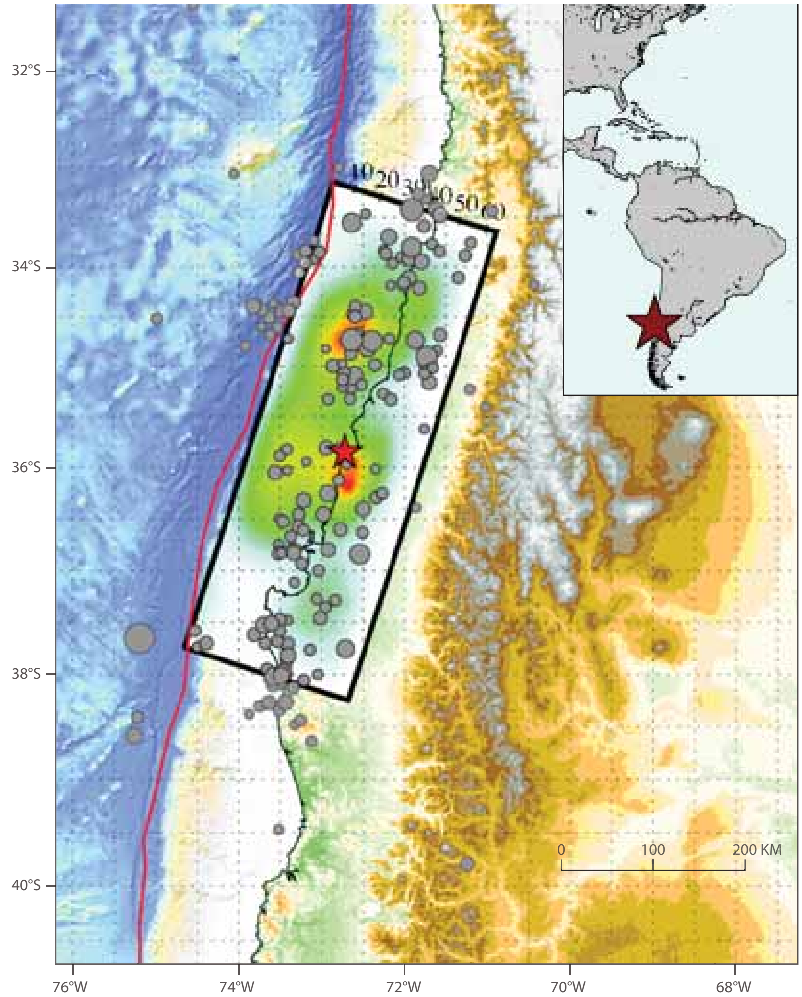
(Chilean Tsunami continued from page 6)

assessments, for example, identify areas vulnerable to tsunami indundation, and managers use this information to plan evacuation routes and conduct public education. Because such assessments are made before a tsunamigenic earthquake occurs, they encompass a great deal more uncertainty than the real-time tsunami forecasts made immediately after an earthquake. For example, the time when a specific earthquake might occur cannot be predicted, and so the tidal stage during which a tsunami arrives at the coast also cannot be predicted. This uncertainty is treated as aleatory uncertainty. Once an earthquake occurs, this uncertainty is greatly reduced, and travel times and tsunami-coda duration can be predicted with relatively high accuracy. As another example, before an earthquake occurs, the detailed slip pattern of a future rupture cannot be predicted and is also treated as aleatory uncertainty. After an earthquake occurs and sufficient seismic waveform data have become available, the slip pattern can be estimated; in this case, the uncertainty switches from being aleatory to epistemic—it depends on the amount and accuracy of the data used to estimate the slip pattern. In the minutes, hours, and days after the earthquake, as more and different types of data are obtained (including Global Positioning System [GPS], near-field strong-motion, and tsunami-waveform data), epistemic uncertainty is reduced in subsequent analyses, though never completely eliminated.



Slip pattern for the 2010 Chilean earthquake. Black rectangle encloses area on the Earth's surface directly above the section of the interplate thrust fault that ruptured during the February 27 earthquake; green shading, low to moderate slip; red shading, high slip of as much as 14 m (46 ft). Red line offshore is fault's surface trace, the line along which the fault intersects the seafloor. (The fault dips east below Chile.) Red star is the earthquake's epicenter (point on the Earth's surface directly above the earthquake's focus, or point where rupture began); gray dots are aftershock epicenters, with size proportional to magnitude. Offshore bathymetry (blue-white) and onland topography (green-tan) shown in background. Inset map shows general location of earthquake (star). Modified from Finite Fault Model from the USGS National Earthquake Information Center (NEIC): ***http://earthquake.usgs.gov/earthquakes/eqinthenews/2010/us2010tfan/finite_fault.php****. See text (page 5) for discussion.*

"Probabilistic" techniques that incorporate both types of uncertainty are increasingly being used in hazard assessments. (See, for example, a pilot study focused on Seaside, Oregon: **http://pubs.usgs.gov/of/2006/1234/** and **http://pubs.usgs.gov/ds/2006/236/**). In the past, tsunami-hazard-assessment models have been primarily "deterministic": they assume an earthquake with a specific set of parameters that lead to a single scenario for the resulting tsunami. Probabilistic models test numerous possible sets of earthquake parameters, generate numerous possible tsunami scenarios, and report their probabilities. Probabilistic techniques have been used for a long time in weather forecasting and are recently being expanded to forecast specific real-time hazards, such as hurricane storm surge (for example, see NOAA's National Hurricane Center Web site at **http://www.nws.noaa.gov/mdl/psurge/**). Analysis of the tremendous amount of data from the 2010 Chilean tsunami will allow researchers to better quantify uncertainty in tsunami models, with an eye toward possibly developing probabilistic forecasting methods for tsunamis in the future.

To view computer animations of the 2010 Chilean tsunami, visit **http://walrus.wr.usgs.gov/tsunami/chile10/**. For an indepth discussion of observations of tsunamis and their often unexpected behavior, see a recent paper by the author in *Advances in Geophysics*, 2009, v. 51, p. 107-169, **http://dx.doi.org/10.1016/S0065-2687(09)05108-5**. ☸

Ice Shelves Disappearing on the Antarctic Peninsula— Glacier Retreat and Sea-Level Rise Are Possible Consequences

By Jane Ferrigno and Jessica Robertson

Ice shelves are retreating in the southern section of the Antarctic Peninsula owing to climate change. Continued warming could result in glacier retreat and sea-level rise, threatening coastal communities and low-lying islands worldwide. The ice-shelf retreat is documented in a U.S. Geological Survey (USGS) report, "Coastal-Change and Glaciological Map of the Palmer Land Area, Antarctica: 1947-2009," released in late 2009.

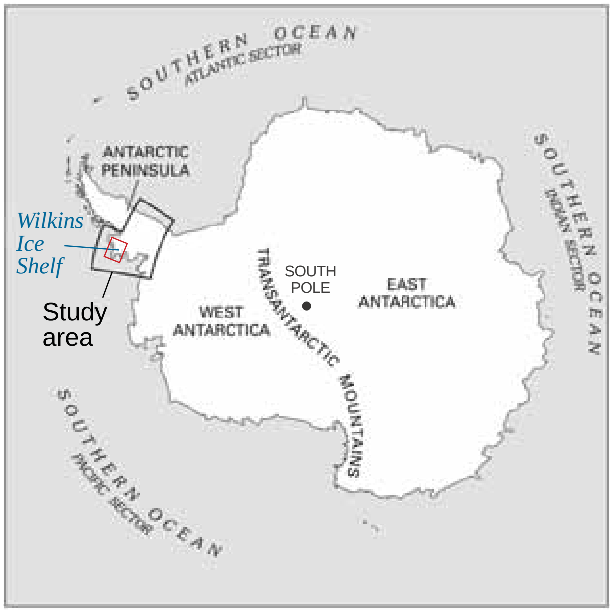
Research by the USGS is the first to document that every ice front in the southern part of the Antarctic Peninsula has been retreating overall from 1947 to 2009, with the most dramatic changes occurring since 1990. The USGS previously documented that most of the ice fronts on the entire peninsula have also retreated during the late 20th century and into the early 21st century.

The ice shelves are attached to the continent and already floating, holding in place the Antarctic ice sheet that covers about 98 percent of the Antarctic continent. As the ice shelves break off, outlet glaciers and ice streams from the ice sheet can more easily flow into the sea. The transition of that ice from the land to the ocean is what raises sea level.

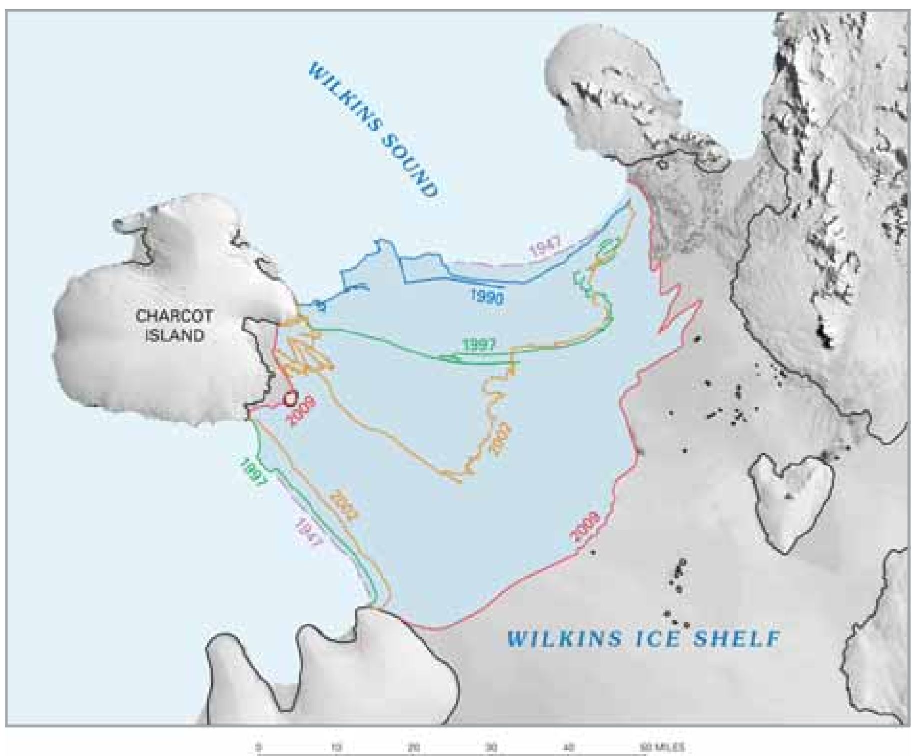
"This research is part of a larger ongoing USGS project that is for the first time studying the entire Antarctic coastline in detail, and this is important because the Antarctic ice sheet contains 91 percent of Earth's glacier ice," said the report's lead author, USGS scientist **Jane Ferrigno**. "The loss of ice shelves is evidence of the effects of global warming. We need to be continually on the alert to observe and evaluate, so that we may understand how and why our climate system is changing."

The peninsula is one of Antarctica's most rapidly changing areas because it is farthest from the extremely cold, main part of the Antarctic continent that surrounds the South Pole. The peninsula's ice-shelf loss may be a forecast of changes in other parts of Antarctica, and the world, if warming continues.

(Disappearing Ice continued on page 9)



*USGS scientists are studying coastal and glacier change along the entire Antarctic coastline. Research on the southern part of the Antarctic Peninsula (polygon labeled "Study area") is summarized in the USGS report "Coastal-Change and Glaciological Map of the Palmer Land Area, Antarctica: 1947-2009" (**http://pubs.usgs.gov/imap/i-2600-c/**). Small red rectangle is area of excerpted map depicting retreat of the Wilkins Ice Shelf (below).*



*Retreat of the Wilkins Ice Shelf on the southern part of the Antarctic Peninsula from 1947 to 2009. Excerpt from USGS map "Coastal-Change and Glaciological Map of the Palmer Land Area, Antarctica: 1947-2009" (**http://pubs.usgs.gov/imap/i-2600-c/**).*

(Disappearing Ice continued from page 8)

Retreat along the southern part of the peninsula is of particular interest because, in combination with earlier observations, it demonstrates that global warming is affecting the entire length of the peninsula.

The Antarctic Peninsula's southern section as described in this study contains five major ice shelves: Wilkins, George VI, Bach, Stange, and the southern part of the Larsen Ice Shelf. The ice lost since 1998 from the Wilkins Ice Shelf alone totals more than 4,000 km^2, an area larger than the State of Rhode Island.

The USGS is working collaboratively on this project with the British Antarctic Survey (**http://www.antarctica.ac.uk/**), with the assistance of the Scott Polar Research Institute (**http://www.spri.cam.ac.uk/**) and Germany's Bundesamt für Kartographie und Geodäsie (**http://www.bkg.bund.de/EN/**). The research is also part of the USGS Glacier Studies Project (**http://www.glaciers.er.usgs.gov/**), which is monitoring and describing glacier extent and change over the whole planet by using satellite imagery.

The new report, "Coastal-Change and Glaciological Map of the Palmer Land Area, Antarctica: 1947-2009" (USGS Scientific Investigations Map 2600-C) and its accompanying map are available online at **http://pubs.usgs.gov/imap/i-2600-c/**.

A USGS report released in 2008 (USGS Scientific Investigations Map 2600-B, **http://pubs.usgs.gov/imap/2600/B/**) documented the complete disappearance of the Wordie Ice Shelf and the northern part of the Larsen Ice Shelf (see article in *Sound Waves*, May 2009, **http://soundwaves.usgs.gov/2009/05/research4.html**).

The other completed reports in the Coastal-Change and Glaciological Maps of Antarctica series can be viewed at **http://pubs.usgs.gov/imap/2600/**.

Listen to a USGS CoreCast about this project at **http://www.usgs.gov/corecast/details.asp?ep=121**. ❆

Meetings

Workshop Considers Alaskan Earthquakes as Possible Triggers of Hypothetical Tsunami for 2013 Preparedness Drill

By Stephanie Ross

On February 9, 2010, U.S. Geological Survey (USGS) scientists **Holly Ryan** and **Stephanie Ross** led an all-day workshop as part of initial planning for a tsunami-preparedness exercise to be run in 2013. This exercise will be a follow-on to the USGS Multi-Hazards Demonstration Project's Great Southern California ShakeOut of 2008, the largest earthquake-preparedness event in U.S. history.

The February workshop brought together members of the Multi-Hazards Demonstration Project's tsunami-scenario team and the USGS Tsunami Source Working Group, along with participants from academia, industry, and other government agencies. Thirty-three scientists met at the USGS center in Menlo Park, California, to consider a plausible source for a hypothetical tsunami that would threaten shores in southern California and around the Pacific Ocean. Specifically, they focused on the possibility of a large-magnitude earthquake in Alaska's eastern Aleutian or Shumagin Islands acting as a trigger for such a tsunami.

Diego Arcas *(NOAA PMEL) explains NOAA's tsunami model, including scenarios of tsunami-generated currents in Los Angeles Harbor. Screen capture from video footage shot by* ***Mike Moore****, USGS.*

Overview talks covered past and likely rupture areas in Alaska (**Roland von Heune**, USGS emeritus), historical seismicity (**Steve Kirby**, USGS, Menlo Park), geodesy (**Ken Hudnut**, USGS, Pasadena, California), the gravity signature of seismic sources (**Ray Wells**, USGS, Menlo Park), and evidence for hydrated mantle beneath the subduction zone (**Rick Blakely**, USGS, Menlo Park). The California Geological Survey's **Rick Wilson** discussed their second-generation tsunami-inundation maps and the impact on California from tsunamis generated by earthquakes in the Alaska-Aleutian subduction zone. **Rich Briggs** (USGS, Golden, Colorado) talked about this summer's planned fieldwork to study prehistoric megathrust tsunami deposits in Alaska—deposits left by tsunamis triggered by large-magnitude earthquakes

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along the Alaska-Aleutian subduction zone. **Diego Arcas** (Pacific Marine Environmental Laboratory [PMEL] of the National Oceanic and Atmospheric Administration [NOAA]) presented NOAA's tsunami model, including scenarios of tsunami-generated currents in Los Angeles Harbor; and **Hong Kie Thio** (URS Corp.) discussed probabilistic tsunami-hazard analysis for southern California.

Arcas and **Thio** also joined a panel of tsunami modelers who showed their models, discussed similarities and differences in their approaches, and fielded questions from the rest of the participants. The other modelers on the panel were **Aggeliki Barberopoulou** (University of Southern California) and **Eric Geist** (USGS, Menlo Park).

***Ken Hudnut** (right) talks about the Great Southern California Shakeout, while workshop co-convener **Holly Ryan** (standing) and attendees **Rich Briggs** (left) and **Guy Gelfenbaum** (center) listen. Screen capture from video footage shot by **Mike Moore**, USGS.*

Additional USGS participants included **George Choy** and **Alan Nelson** (Golden); **Dale Cox** (Sacramento, California); **Amy Draut** (Santa Cruz, California); **Peter Haeussler** (Anchorage, Alaska); and **Ginger Barth**, **Sean Bemis**, **Jamie Conrad**, **Guy Gelfenbaum**, emeritus **Homa Lee**, emeritus **Willie Lee**, **Tom Parsons**, emeritus **George Plafker**, emeritus **Jim Savage**, emeritus **Dave Scholl**, **Ray Sliter**, **Steve Walter**, and emeritus **Tracy Vallier** (Menlo Park).

Additional participants from partner organizations included **Gary Greene** (Moss Landing Marine Lab, Moss Landing, California), **Roger Hanson** (University of Alaska, Fairbanks), and **Kevin Miller** (California Emergency Management Agency [Cal EMA]). **Mike Moore** (USGS) video-streamed the talks, allowing **Kate Long** (Cal EMA) and **Uri ten Brink** (USGS, Woods Hole, Massachusetts) to listen in. Many thanks to **Mike** for providing that service! Videos of the talks will soon be available at the Multi-Hazards Demonstration Project Web site (**http://multi-hazards.usgs.gov/**).

Ocean Research the Focus of USGS Director's Plenary Lecture at the AAAS 2010 Annual Meeting

By Ann B. Tihansky

U.S. Geological Survey (USGS) Director **Marcia McNutt** was the third of four plenary speakers at the American Association for the Advancement of Science (AAAS) annual meeting, held February 18-22, 2010, in San Diego, California. **McNutt's** speech, titled "Science Below the Sea," focused on four major areas of undersea science, using an example from each area to discuss in more detail how USGS scientific expertise supports the Department of the Interior's ocean-management responsibilities and provides critical information for policy and decision making. The primary topics were Climate Change (sea-level rise), Ecosystem Health (hypoxia in the northern Gulf of Mexico), Human Health (mercury contamination of the oceans), and Marine Spatial Planning (geospatial information and decision-support tools). **McNutt** concluded her remarks about the important role the USGS will be playing through interagency cooperation on the Ocean Policy Task Force being led by the White House's Council on Environmental Quality. The USGS is committed to the President's national ocean-policy vision.

AAAS President **Peter C. Agre** opened the conference with his President's Address. Four speakers gave a plenary address on each subsequent day of the meeting: In addition to **McNutt's** address, 2009 Nobel Prize winner **Carol Greider** gave a talk titled "Telomerase and the Consequences of Telomere Dysfunction"; **Eric S. Lander** discussed "Science and Technology in the First Year of the New Administration"; and **Barry C. Barish** spoke about "New Frontiers in Particle Physics." The AAAS Plenary Lectures, along with background information about each of the speakers, can be viewed online at **http://www.aaas.org/meetings/2010/program/plenaries/**.

***Marcia McNutt**, Director, U.S. Geological Survey.*

Jeff Williams Retires from USGS Center in Woods Hole, Massachusetts

By Chris Polloni

On January 17, 2010, approximately 50 family members and colleagues gathered for a luncheon at the Coonamessett Inn in Falmouth, Massachusetts, to help U.S. Geological Survey (USGS) scientist **Jeff Williams** make the transition to "retirement" (he continues to contribute to USGS coastal research). At the head table were his partner **Rebecca Upton**; his brother and sister-in-law, **Buck** and **Carole Williams**; **Bill Schwab** and **Walter Barnhardt**, past and current directors of the USGS Woods Hole Coastal and Marine Science Center; **Jack Kindinger**, director of the USGS St. Petersburg Coastal and Marine Science Center (Florida); and **Mary Foley**, the National Park Service's Senior Scientist for the Northeast Region.

After more than 42 years of research and management in coastal and marine science, **Williams** decided to move to a new phase that will still involve coastal science but will also allow time for travel, spending time with his son's family in Hawai'i, and doing some writing about the effects of climate change on coasts. **Williams** was granted a scientist emeritus position with the USGS and is an affiliate graduate facility member with the coastal geology group in the Geology and Geophysics Department at the University of Hawai'i, Manoa.

At the retirement event, **Mary Foley** presented **Williams** the National Park Service Regional Director's Resource Award, given annually to reward career excellence for science benefiting the national parks. The award included a certificate and a beautiful handmade green glass bowl on a wooden base with inscription.

S. Jeffress Williams served until 2010 as a senior research coastal marine geologist with the USGS at the Woods Hole Coastal and Marine Science Center and focused his career on studying the geologic history and processes of coastal, estuarine, wetland, and inner-continental-shelf regions. He has 40 years of research experience investigating such topics as the geologic origins and development of marine coastal and estuarine systems, as well as Great Lakes coastal systems, Holocene to modern sea-level history, climate-change effects on coasts, and the geologic origins of modern marine sand bodies and their importance to coastal sediment budgets. **Williams** has participated in more than 80 field studies along the Atlantic, Gulf of Mexico, Pacific, and Great Lakes coasts and the United Kingdom's Irish Sea. In June, **Williams** was awarded the 2009 Coastal Zone Foundation Award for Career Achievement (see article in *Sound Waves*, August 2009, **http://soundwaves.usgs.gov/2009/08/awards.html**).

He has authored or coauthored more than 350 publications, including research papers, journal articles, reports, and abstracts; and he has served on more than a dozen high-level national and State science committees, including the National Academy of Sciences, the National Oceanographic Partnership Program, the 1998 National Ocean Conference, the U.S. Coral Reef Task Force, the Louisiana Wetlands Restoration Task Force, and the Louisiana Sand Task Force. He also gave testimony to Congress on the effects of Hurricane Katrina on the Gulf Coast and most recently was a co-lead author on the U.S. Climate Change Science Program SAP 4.1 report assessing the effects of sea-level rise on U.S. coasts. In addition, **Williams** is a frequent lecturer at scientific conferences and is often invited to speak to students, State and local legislators, and civic groups on topics related to coastal and climate change.

Before taking a research position at the USGS center in Woods Hole, **Williams** directed the Coastal and Marine Geology Program from1996 to 2000, at USGS headquarters in Reston, Virginia. During that time, **Williams**, along with USGS research oceanographer **Abby Sallenger**, was responsible for refocusing the program toward coastal and nearshore mapping and research, with the addition of a 25-percent budget increase to address coastal-science needs on the United States' Atlantic, Pacific, Gulf of Mexico, and Great Lakes coasts.

Before joining the USGS, **Williams** was a research marine geologist with the Coastal Engineering Research Center in Washington, D.C., and an invited visiting scientist at the Institute of Oceanographic Sciences, Taunton, U.K. He earned degrees in geology/geophysics and oceanography from Allegheny College and Lehigh University and completed military service as a commissioned officer in the U.S. Army Corps of Engineers.

***Jeff Williams** holds the National Park Service Regional Director's Resource Award presented to him in January at a luncheon to celebrate his retirement from the USGS.*

Williams' research interests are focused on three main topics: (1) mapping and understanding the geology and hard-mineral resources of offshore areas; (2) understanding the risk and vulnerability of U.S. coastal regions to climate change and its effects, such as sea-level rise and increased storm activity; and (3) coastal and wetland ecosystem processes and restoration. Additional information can be viewed at **Williams'** professional page, **http://woodshole.er.usgs.gov/staffpages/jwilliams/**.

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