Moreover, it does not provide a spatial pattern of climate change. The analyses from full GCM experiments are therefore eagerly awaited.

### *Challenges of Analyzing Complex Climate Models*

In addition to the evaluation of temperature change, a subset of the complex climate models is being used to attempt to simulate the global carbon cycle. From these models, a diagnosis of the net flux of carbon into the atmosphere needed to achieve the prescribed target greenhouse gas concentrations can be made. This will yield an estimate of uncertainty in allowable carbon emissions, which can next be used as input in integrated assessment models to determine the range of socioeconomic variables that would be consistent with these emissions.

An interesting scientific issue is that the lower warming in the E1 experiment will make it harder to distinguish man-made climate change from natural variations on fine spatial scales. Where there is a climate change signal, the impacts avoided by mitigation—a major research need outlined in Working Group II of the IPCC Fourth Assessment Report—will be looked at.

The value of this experiment increases with each new model that runs the E1 scenario. Some modeling groups outside of the ENSEMBLES project already have committed to following this design, and greater awareness of this project might encourage more to follow. The full set of results will be available several months before delegates to the United Nations Climate Change Conference (COP15) in December 2009 attempt to agree upon international post-2012 climate policy.

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# Anticipating the Next Large Silent Earthquake in Mexico

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Silent earthquakes, or slow slip events (SSEs), in subduction zones [*Schwartz and Rokosky,* 2007] release accumulated strain energy within tens of minutes to a few months, as opposed to a few seconds or minutes for "regular" earthquakes [*Kostoglodov et al.,* 2003]. This phenomenon has important implications for the seismic cycle because SSEs significantly modify the loading-unloading budget of faults; their existence suggests that the buildup and relaxing mechanisms of the earthquake cycle are much more complex than previously thought.

Numerous important questions have to be answered concerning SSEs, in particular, their specific location on the fault, the amount of slip at depth, and their recurrence. Depending on whether they occur on the seismogenic or creeping section of the fault, they may release some accumulated elastic strain or further load the brittle part of the fault, effectively lengthening or shortening the time before the next large regular earthquake. In that framework, assessing the repartition of the displacement on the subduction interface and the frequency of SSEs is of particular importance, because these parameters govern the extent to which SSEs may slow or accelerate the regular earthquake clock.

Forecasting regular earthquakes remains a challenge in spite of important observational efforts in California, Japan, Turkey, and other areas. However, silent earthquakes in the seismic gap of the Mexico subduction zone, located around the state of Guerrero (see Figure 1), have been observed already three times, with large displacements at the surface of up to 6 centimeters [*Kostoglodov et al.,* 2003]. These repeated events provide a unique opportunity to prepare extensive observations of a possible future SSE. Relevant questions include the following: Can the next SSE be forecast? Will it be large? When, where, and how will it occur? How will it modify the earthquake clock in this area?

The Mexican SSEs are the largest ever observed [*Franco et al.,* 2005; *Larson et al.,* 2007] but are well documented only on three occasions, in 1998, 2001–2002, and 2006. Scientists in Grenoble, France, have recently reanalyzed 12 years of continuous Global Positioning System (GPS) data collected by the Universidad Nacional Autónoma de México, using for the analysis a double-difference approach (see http://www-gpsg.mit.edu/~simon/gtgk) and applying the most up-to-date models to remove as much as possible of the nontectonic signals in the time series. Results for the north-south component for three of the 17 permanent GPS stations are shown in Figure 1, with respect to a fixed North America plate. For example, between 1999 and 2002 as well as between 2003 and 2006, north-south displacements are toward the north-northeast and show a linear trend, due to the convergence of the Cocos and North America plates, as represented in Figure 1a by red arrows roughly perpendicular to the trench. SSEs appear in 1998, 2002, and 2006 and last several months with displacements at the surface of opposite direction, toward the south-southwest. Note that the main component is north-south and only displacements along this direction are shown in Figure 1.

According to the graph (Figure 1c), the recurrence times of SSEs are 4–4.5 years. This apparent period of the Guerrero SSE suggests an obvious though still speculative extrapolation of the displacement pattern from which we expect the next large silent earthquake in 2010. The time series covering two full SSE cycles comprise too little data for a reliable statistical conclusion; nevertheless, two different scenarios can be inferred to get a range for the onset time and the displacement at the surface of the next silent earthquake. In Figure 1c, the slopes and time intervals measured between events 1 and 2 (case 1) and between events 2 and 3 (case 2) have been used to extrapolate the time series for the next year. The different displacement rates in these two intervals show that even the "classical" interseismic loading is not constant in

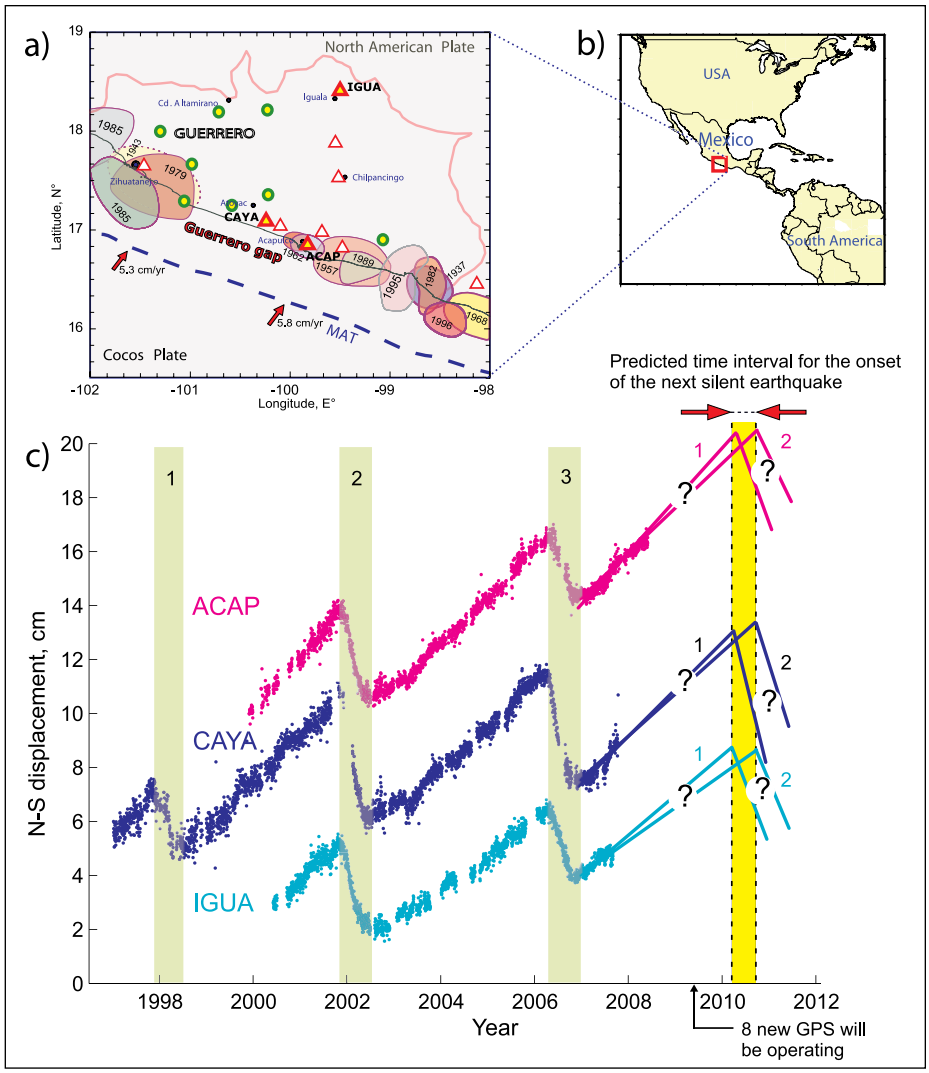


*Fig. 1. (a) Network map with red triangles for existing permanent Global Positioning System (GPS) stations. The three stations marked as bold triangles are used in Figure 1c: IGUA (located in Iguala), ACAP (located in Acapulco), and CAYA (located in Cayaco). Green circles represent the eight GPS stations that will be installed by the summer of 2009. MAT is the Middle America Trench; enclosed regions with dates represent the time and rupture area of large earthquakes that have occurred within 8 decades. (b) Location of Guerrero, in Mexico. (c) Daily north-south position time series (with respect to the North America plate) at GPS stations IGUA, CAYA, and ACAP, located within or close to the seismic gap in Guerrero. Light green vertical bars highlight the last three slow slip events, 1998, 2001–2002, and 2006. The yellow bar represents the time interval of the onset of the next predicted large silent earthquake in Guerrero. This estimation is obtained by extrapolating the interseismic slopes and recurrence times observed (e.g., extrapolating for each station between 1998 and 2001–2002 (marked as 1), and between 2001–2002 and 2006 (marked as 2)).*

time. If the extrapolation in Figure 1 holds, the next Guerrero SSE should begin between March and October of 2010 with displacement on the north-south component ranging from 3.9 to 6 centimeters for the CAYA site (located at Cayaco city, northwest of Acapulco) and of several centimeters for most of the GPS stations along the Pacific coast in the vicinity of Acapulco.

To learn more about the exact timing and characteristics predicted for the next slow slip event, it is important to densify the GPS network no later than the summer of 2009. Lacking are the stations needed to establish precisely how much of the slow slip is localized on the seismogenic section as opposed to the creeping section of the fault, which would thus indicate either a decrease or an increase of the time before the next large regular earthquake. Therefore, eight new permanent GPS stations will be deployed close to the Pacific coast in Guerrero during summer 2009 (Figure 1a). With the densified GPS network, a detailed surface displacement pattern will be used to determine the partial strain release on the seismogenic zone when SSEs occur. Displacement maps will also help monitor continuous strain buildup if no SSE occurs. In any case, GPS position time series will provide important clues to understanding the stress buildup on a subduction interface and how it may be released through the slow slip event.

A better description and understanding of silent earthquakes will improve our view of the seismic cycle. The ability to obtain new dense observations in the right place and at the right moment is crucial for improving the seismic hazard assessment in the Guerrero gap. This is of particular importance for Mexico City, where the seismic hazard is high [*Ordaz and Singh,* 1992; *Singh et al.,* 1988] and directly concerns a population of more than 20 million.

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# NEWS

## Budget Increases Proposed for NOAA and Energy Department

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In addition to the Obama administration's proposed budget increases for NASA, the Environmental Protection Agency, and the U.S. Geological Survey (see *Eos*, *90*(10), 83, 2009, and *90*(20), 175, 2009), other federal Earth and space science agencies also would receive boosts in the proposed fiscal year (FY) 2010 budget. The proposed budget comes on top of the 2009 American Recovery and Reinvestment Act's (ARRA) US$18.3 billion in stimulus spending for research and development that can be apportioned between the FY 2009 and FY 2010 budgets. This news item focuses on the budget proposals for the National Oceanic and Atmospheric Administration (NOAA) and the Department of Energy (DOE). Next week, *Eos* will look at the budget proposal for the National Science Foundation.

### *Modest Increase Proposed for NOAA*

In the proposed FY 2010 budget, NOAA would receive $4.48 billion, an increase of $110 million (2.5%) above the FY 2009 Omnibus Appropriation. The agency also received $830 million in ARRA funding; Congress approved NOAA's stimulus spending plan on 7 May.

At a 12 May briefing, NOAA administrator Jane Lubchenco said the proposed FY 2010 budget would enable the agency to make significant progress toward addressing a number of goals, including improving weather forecasting and disaster warnings, providing credible information about climate change and ocean acidification, protecting and restoring coastal waters and ecosystems, reviving fisheries, and helping the economy.

The budget would include $3.21 billion for NOAA's Operations, Research, and Facilities (up 2.2%) and $1.39 billion for Procurement, Acquisition, and Construction (up 11.9%). Within the FY 2010 proposed budget, not many accounts were deleted aside from congressional earmarks that can be built back up, according to NOAA budget director Steve Gallagher.

The NOAA budget is divided by activity categories and by agency line offices. In some instances, an activity category (e.g., satellites and fisheries) relates fairly neatly to an individual line office, while in other instances, activity category funding is distributed among more than one line office.

NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) budget (aligned with the satellites activity category) would be $1.43 billion, up from $1.18 billion in the FY 2009 omnibus budget. The satellites activity is the largest "plus up" in the FY 2010 proposed budget, Lubchenco said. "We are investing in multiple satellite acquisition programs for the continuity of critical weather, climate, and oceanographic data."

For the Geostationary Satellite System (GOES-R series), the request for $737 million would be an increase of $272 million. The Jason 3 altimetry mission to measure sea height would receive $20 million in new funding. The budget for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) would jump to $382.2 million, up from $94.2 million. Lubchenco told *Eos* that the three agencies directly involved in NPOESS (NOAA, NASA, and the Department of Defense) are working together to determine how to address problems in the program. She said the agencies are exploring a range of options about the program and that an independent review team is in the process of finalizing its report.

The National Marine Fisheries Service budget (aligned with the fisheries activity category) would increase to $911.8 million, up from $879 million in the omnibus spending bill. Funding for the reauthorized Magnuson-Stevens Fishery Conservation and Management Act would swell to $98.3 million, up $56.5 million. The funding would help with efforts to end overfishing in federal waters and would include the expanded use of ecosystem-based management approaches and improved data collection measures.

Among other line office budget highlights, the National Weather Service would receive a slight increase to $963.9 million, up $5 million; funding for the National Ocean Service would drop about 10%, to $502.7 million from $558.7 million; and the budget for the Office of Oceanic and Atmospheric Research would dip to $404.6 million from $408.3 million for FY 2009.

Funding in the research and climate activity category would include $12.9 million for the National Integrated Drought Information System. The $4.6 million proposed increase includes $2.6 million for drought early warning system pilot projects and $2 million for a climate forecast system that would lead to improved drought forecasting. Funding in this activity category also would include $4.5 million, up $1.3 million, for completion of the U.S. Climate Reference Network; $5.5 million in new funding for ocean acidification research; and $2.6 million in new funds for a decadal climate prediction program.

The coasts activity category includes proposed funding for the Coastal Task Force and National Coastal Zone Management Program ($10.4 million, up $3.1 million); Ocean Research Priorities Plan Implementation ($6 million in new funding); and geodesy ($30 million, up $4 million).

Proposed funding in the weather activity category includes the Hurricane Forecast Improvement Project ($17 million, up $13 million); the NEXRAD Doppler Radar ($7 million in new funding to address a gap in coverage); Aviation Weather–Next Generation ($11.4 million, up $6.1 million); the Advanced Weather Interactive Processing System ($24.4 million, up $5.3 million); and space weather forecast improvement ($10.9 million, up $2.7 million).

"We believe very strongly in ensuring the integrity of the science," Lubchenco said, noting that the budget is a good one for NOAA. "But it is about more than just doing good science. It's also using that science to inform policy and management decisions, either those decisions made within the agency or decisions that are made by others."

### *Energy Department Budget Up, Yucca Mountain Down*

The administration's $26.4 billion budget request for the Department of Energy is $146 million, or 0.6%, more than the FY 2009 enacted budget. The request is in addition to the department's $38.7 billion in ARRA funding.

The FY 2010 budget for DOE's Science activity would be $4.94 billion, an increase of $184 million, or 4%, above the FY 2009 level of $4.76 billion. The budget would include increases for a number of programs: High energy physics would receive $819 million (up $23 million, 3%); nuclear physics would receive $552 million (up $40 million, 8%); and energy sciences would bump up to $1.69 billion (up $114 million, 7%). Funding for biological and environmental research would be flat (a $604 million request compared with