Understanding North Pacific Sea Level Trends

Rising sea level poses significant challenges to coastal communities, particularly for coastal [Mehlenbacher et al., 2003] and island communities. [Wolff and Krueger, 2010] in the North Pacific where population density at or near coastal waters is high. Recognizing the links with the United Nations’ sea level rise (SLR) is a fundamental consideration, regional mean sea level (RSL) height variability within ocean basins and along their boundaries can be more critical, particularly in the North Pacific where the amplitude of interannual variability is high.

Causes of Global and Regional Sea Level Rise

The main causes for global MSL rise (Figure 1) are added water from the melting of ice sheets and glaciers and thermal expansion of the oceans [Ganopolsky et al., 2008], both driven by global warming [Bussard et al., 2007]. Regional sea level variations appear to fluctuate about the globally averaged trend, which has increased from the tide gauge estimate of about 1.7 ± 0.5 millimeters per year over the twentieth century [Mehlenbacher et al., 2007] to the satellite altimetry estimate of about 3.1 ± 0.7 millimeters per year since 1993 [e.g., Bromirski et al., 2011; Timmerman et al., 2010]. However, recent studies show that regional sea level trends are affected by local and remote wind forcing (Figure 1), which can cause sustained changes in ocean circulation and sea level height [Bromirski et al., 2011; Merrifield, 2011; Stinnes, and Douglas, 2011; Timmermann et al., 2010].

Along the U.S. Pacific coast, tide gauges suggest that regional sea level rise is approximately equal to global MSL rise over most of the twentieth century, but local and remote wind forcing (Figure 1) can cause sustained changes in ocean circulation and sea level height [Bromirski et al., 2011; Merrifield, 2011; Stinnes, and Douglas, 2011; Timmermann et al., 2010]. These studies cover different regions, indicating that RSL along most ocean boundaries can be strongly affected by remote wind forcing (Figure 1), which can cause sustained changes in ocean circulation and sea level height [Bromirski et al., 2011; Merrifield, 2011; Stinnes, and Douglas, 2011; Timmermann et al., 2010].

RegionalSeaLevelTrends

Persistent regional wind stress patterns spanning a few decades [Bromirski et al., 2011], as well as basin-wide wind-driven circulation changes and strong El Niño-related fluctuations on shorter timescales [e.g., Bromirski et al., 2011], strongly affect sea level trends along the Pacific coast of North America, exemplified by the San Francisco record (Figure 2). The recent U.S. West Coast “RSL less than MSL” rise rates are attributed to a dramatic change in eastern boundary and basin-wide wind stress patterns that occurred after the mid-1970s climate regime shift [Miller et al., 1994]. This change in wind stress patterns has reversed regional sea level rise along the West Coast, both in an absolute sense as well as relative to what is expected during a warm phase of the Pacific Decadal Oscillation (PDO) [Mentor et al., 1997]. Similar near-zero RSL trends since 1980 are also observed at San Diego and Seattle [Bromirski et al., 2011], which is consistent with altimetry observations. A similar retracted westernmost coast RSL epoch occurred from 1880 to 1950 (Figure 2), potentially also related to North Pacific wind stress patterns. Persistent wind stress regimes over the entire North Pacific basin have recently exhibited patterns and amplitudes not observed since before the mid-1970s regime shift, likely causing basin-scale thermocline adjustments. This change in broad-scale wind stress patterns may have foreshadowed a climate regime shift. The recent apparently associated shift of PDO to its cold phase during the 2000s will further serve to suppress regional sea level rise along the West Coast if it persists.

In contrast to stationary eastern boundary sea level trends, the strong regional sea level rise in the western tropical Pacific is related to a steady increase in the trade winds since the early 1950s [Merrifield, 2013]. Increasing trade winds are possibly associated with an intensification of the subtropical atmospheric Hadley circulation, which has been linked to an associated increase in mid-latitude westerlies and equatorward winds along the Pacific coast of North America.

The eastern boundary wind stress patterns across the basin. The impacts of these fluctuations on flooding, beach erosion, and shoreline retreat will be amplified under rising coastal RSL because, particularly during high tides, increased water levels allow more wave energy to reach further shoreward. Because ocean wave extremes and storm-forced non-tide fluctuations are not expected to change appreciably over the 21st century [Bromirski et al., 2012], upward trends in regional sea level will be the dominant factor affecting the intensification of coastal erosion processes along the West Coast.

Fig. 1. Processes affecting sea levels along the eastern boundary of the North Pacific. Freshwater flux represents the net volume of added water from ice sheets, glaciers, runoff, and precipitation, which contributes to the global heat and freshwater budget. The effect of regional and global thermal forcing. Alongshore wind stress drives offshore Ekman transport that alters the thermocline depth, with associated changes in sea level. Ekman pumping offshore drives thermocline depth changes, both regionally and basin-wide. Here upwelling is shown raising the thermocline and thus lowering regional sea levels (RSL). Ekman curling produces the opposite effect on thermocline depth and RSL. Remotely forced thermocline adjustment results from basin-scale integrated effects of wind stress curl that are manifested in changes to broad-scale ocean circulation, also affecting RSL height.
Space Station Astronauts Discuss
Life in Space During AGU Interview

Just one day after China’s Shenzhou-9 capsule, carrying three Chinese astronauts, docked with the Tiangong-1 lab on 18 June, Donald Pettit, a NASA astronaut on the International Space Station (ISS), said it is “a step in the right direction” that more people are in space. “Before they launched, there were six people in space,” he said, referring to those on ISS, “and there are 7 billion people on Earth.” The astronauts were “like one in a billion. Now there are nine people in space,” Pettit said during an AGU interview that he and two other astronauts onboard ISS had with AGU. Pettit continued, “So the gradient of human beings going into space is moving in the right direction. We need to change those numbers so that more and more human beings can call space their home so we can expand off of planet Earth and move out into our solar system.”

Pettit, who, at the time of the interview was on his third mission to space—with a scheduled return to Earth on 1 July—said one change he has seen on the planet since his first mission is the number of city lights at night, particularly over South America. “In 2002 and 2003 it was pretty dark, and now it’s pretty lit up. It’s a step forward.” Humanity is expanding and are we advancing with our technology, and electricity is part of that technology. It’s a natural flow for human beings to expand in and the process turn on their lights.”

While onboard ISS, Pettit said, “You learn lessons about yourself, you learn lessons about human behavior, and you learn lessons in science about how things move and operate around you. And you take those lessons back with you.”

During the interview Pettit noted the conservation of angular momentum. He recalled watching a vela- min tablet that rotate end over end and noticing that when the tablet hit a wall it stopped tumbling and moved off from the wall much faster than its center of mass had been moving previously. It had exchanged angular momentum for linear momentum. Pettit explained, “You read about these things in textbooks, but you get to see them here. That imparts your mind, and when I go back to Earth and I start doing engineering that little tidbit is going to stick in my mind and who knows where it might surface for some new kind of invention.”

André Kuipers, a medical doctor and Dutch astronaut with the European Space Agency who is on his second mission to ISS, had contemplated in a prelaunch interview that the space station is serving as preparation for future steps in space exploration. During the interview with AGU, which was broadcasted on NASA television, Kuipers elaborated, “We’re only at the beginning of the discovery of our universe. It’s like the whole ocean that is there to discover and you’re only standing there with your toes in the water. So you still have to go with your feet and your legs and all the way to great depths. And we’ll do the same thing with the universe. I’m very, very privileged that I can be part of this first little step into the water.”

Kuipers, who is scheduled to come back to Earth on 1 July along with Pettit, reflected on the approaching end of his current mission. “Every time I look out of the window, it looks like the first time. Every time, it’s so magnificent that I think this is awesome,” he said, noting that it’s time to keep those moments in his mind. “It’s a fantastic planet but also very fragile. I wish everybody could see this and realise that it’s our planet with limited resources, beautiful but fragile. And I think this is one of the most important things that I can bring back home.”

NASA astronaut Joseph Acaba, who is on his second mission to ISS and is slated to stay aloft until September, also commented on the fragility of the planet. “When you come up to space and you look back at the Earth, it’s just a beautiful site and you have a chance for the first time really to look at the big picture. A lot of what we do in geology is look at small pieces and try to build (left to right) International Space Station astronauts Joe Acaba, André Kuipers and Don Pettit answer questions during a live interview with AGU on 19 June. Photo courtesy of AGU/NASA.
Induced Seismicity From Fracking and Carbon Storage is Focus of Study and Hearing

Hydraulic fracturing to recover shale gas does not pose a high risk for inducing felt seismic events, as the method is currently implemented, according to a 15 June report by the U.S. National Research Council (NRC). However, carbon capture and storage (CCS) has the potential to induce larger seismic events because of the large net volume of injected fluids involved in that process, according to the report. Scientists testifying at a 19 June hearing held by the U.S. Senate Committee on Energy and Natural Resources said they largely agreed with the report’s findings. Neither the report nor the hearing focused on potential environmental impacts of hydraulic fracturing, which is commonly known as fracking. “The factor that appears to have the most direct consequence in regard to induced seismicity is the final magnitude of pore pressure changes resulting from the injection of fluid into or removed from the subsurface,” although additional factors may influence the way fluids affect the subsurface, states the NRC report. Reduced Pressure Potentials or Energy Technologies. The report defines induced seismicity as earthquakes that are attributable to human activities. “Projects that inject or extract large net volumes of fluids over long periods of time may have potential for larger induced seismic events, although insufficient information exists to understand this potential because no large-scale CCS projects are yet in operation.”

The injection for disposal of wastewater, generated during oil and gas production (including during fracking), into the subsurface can pose a risk for induced seismicity, according to the report, though there are only a few documented events of this occurring over the past several decades. In addition, the report noted that different forms of geothermal resource development appear to have differing potential for producing seismic events that can be felt. General mechanisms that create induced seismic events are well understood, scientists currently are not able to accurately predict their magnitude and occurrence because of the lack of comprehensive data collected related to induced seismicity. The report notes that such assessments should be undertaken before operations begin in areas with a known fault rupture area, which in turn relates to the magnitude of pore pressure changes and the volume in which it occurs, the committee determined that large-scale CCS may have the potential for causing significant induced seismicity. At the hearing, Mark Zoback, professor of Earth sciences and geophysic at Stanford University, California seismicity risk. Mark Zoback, professor of Earth sciences and geophysics at Stanford University, California, testified that such assessments should be undertaken before operations begin in areas with a known fault rupture area. In addition, the report noted that different forms of geothermal resource development appear to have differing potential for producing seismic events that can be felt.

One of the witnesses at the 19 June Senate hearing was Murray Itzma, a professor of economic geology at the Colorado School of Mines, Golden, and chair of the NRC report committee. He said that while there are about 35,000 fracked shale gas wells in the United States, “only one case of induced seismicity in the United States has been described in which hydraulic fracturing for shale gas development is suspected but not confirmed.” He said that globally there is only one confirmed case, which occurred in Blackpool, UK, of felt seismicity having been caused by fracking. The very low number of felt events relative to the large number of hydraulically fractured wells for shale gas is likely due to the short duration of injection of fluids and the limited fluid volumes used in a small spatial area. On the topic of CCS, Itzma said, “Given that the potential magnitude of an induced seismic event correlates strongly with the fault rupture area, which in turn relates to the magnitude of pore pressure changes and the rock volume in which it occurs, the committee determined that large-scale CCS may have the potential for causing significant induced seismicity.”

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ABSTRACT DEADLINE: 12 July 2012, 23:59 Eastern Time 
This international conference expands upon the focus on longitude and hemispheric dependence of space weather by emphasizing its role in major solar events and by examining the Earth system response. 
For complete meeting details, including information regarding abstract submission, housing, conveners, and more, visit www.agu.org/SpaceWeatherChapman.
An image of the page is not provided, but I can help answer questions or provide context based on the text content. Please let me know what you need assistance with.
The final challenge, and the one for which we were least prepared, was to deal with postevent publicity. While we had effectively used social media tools to organize and communicate within our own community, this campaign had been mounted against a variety of other communicators of climate science as well (e.g., Mann, 2012), and we would have been far better prepared for the postevent publicity if we had anticipated that Twitter and other Internet tools can effectively nationalize awareness of climate science are of little importance to us.

References


—Jeffrey D. Cohen (Department of Biological Sciences, Union College, Schenectady, New York) and Matthew E. Katz (Department of Earth and Environmental Sciences, Rensselaer Polytechnic Institute, Troy, N.Y.)

What’s on the Web

Read the latest offerings from the AGU Blogosphere


Mountain Beltway: “101 American Geo- Sites You’ve or Gotta See, by Albert B. Sicks” (http://bit.ly/MtnBelt)


A close look at amphibole in Bancroft, Ontario, photographed by Magna Cum Laude blogger Jessica Ball.

Enter AGU Student Contest to Win Free Fall Meeting Registration

AGU is excited to announce its first Student Video and Student T-shirt Design competitions. Enter AGU Student Contest to Win Free Fall Meeting Registration and you could win a trip to San Francisco, Calif. Prizes will be awarded to the best submissions in two categories: Best Student Video, Best Student T-shirt Design.

In the Student T-shirt Design Contest, students can show off their graphic design talent by creating a one-of-a-kind T-shirt with an Earth or space science theme. Designs can be humorous, educational, or both. The winning design will appear on T-shirts sold at the Fall Meeting, and proceeds will be donated to AGU’s Student Travel Grants Program. AGU is accepting submissions from 2 July to 13 August. AGU will choose five finalists from each competition, and then the winners will be chosen by AGU’s Facebook and YouTube audiences. T-shirt designs will be posted on AGU’s Facebook page, and AGU Student Contest to Win Free Fall Meeting Registration

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vidos will be posted on the YouTube page. Submissions receiving the most “likes” by 10 September will be the winners. Students who are artistic, innovative, or simply need a diversion from classes and lab reports are encouraged to apply. This is your chance to take part in a fun and creative event and win free student registration to the 2012 AGU Fall Meeting. For more information, see http://membership.agu.org/students/.

—KARA SLEDGE, Student Member Specialist, AGU; E-mail: kslEDGE@agu.org

Outstanding Student Paper Awards

The following members received Outstanding Student Paper Awards at the 2011 AGU Fall Meeting in San Francisco, Calif. Awards for other sections and focus groups will be announced in future issues of Eos.

Atmospheric and Space Electricity (ASE)

Thomas Gjesteland University of Bergen, Bergen, Norway. Are there more TGPs in the NHSE2 data?

Burcu Kasar Florida Institute of Technology, Melbourne, Florida. Spitzer streamer formation in sub-breakdown conditions from an intrasolar disturbance

Atmospheric Sciences (AS)

Alexis Atwood University of New Hampshire, Durham, The effects of mineral dust on the hydrospheric and optical properties of inorganic salt aerosols

Adriana Raudzens Bailey University of Colorado, Boulder, Botanical signatures of mixing processes and cloud detachment in the subarctic

Shannon Capp Georgia Institute of Technology, Atlanta, Quantifying relative contributions of global emissions to PM2.5 air quality attainment in the U.S.

Matthew Christensen Colorado State University, Fort Collins, Aromatic precursors to aromatics from ship tracks as observed by CloudSat

Evon Cowan University of North Carolina at Chapel Hill, A regulatory model’s ability to simulate large-scale spatial heterogeneity in observed severe in Houston, Texas

Stepha ne Griffin Indiana University, Bloomington, Hydroxyl and hydrogen peroxide chemistry at the CalNex- LA 2010 site. Measurements and modeling

Will Johnson Montana State University, Bozeman, Development of an eye-safe micro- wave differential absorption lidar (DMAL) for carbon dioxide profiling

Changsong Lu, Ning University of Information Science and Technology, Nanjing, China, and Brookhaven National Laboratory, Upton, Long Island, New York, Observational study of different entrainment mixing mechanisms in cumulus during RACORO. An impli- cation for parameterization

Kirsten Bergmann, California Institute of Technology, Pasadena, The clamped isotopic record of Neoproterozoic carbonates, Suharni of Oman

Corey Markwort University of Minnesota, Twin Cities. Effects of scales on katabatic- atmosphere fluxes

Scott Miller University of Maryland, College Park. A combined kinetic and volatility basis set approach to model secondary organic aerosol from biomass and diesel exhaust/motor mixtures

Brando Strelia, Georgia Institute of Technology, Atlanta, The influence of light absorbing aerosols on the radiation balance over ocean and land

Michael Zacher University of Colorado, Boulder, Atoiront passive microwave measurements from the MODIS 2008 science campaign for modeling of Arctic sea ice heating

Biogeosciences (BG)

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casidy Schmidt, University of Florida: Gladys Knight Granddaughter bioremediation for long term nitrogen reductions in agricultural effluents.

Nguyen Son, University of Wisconsin-Madison: Use of nitrate and ammonia and acid aerosol products by a native grassland plant are altered by experimental warming and elevated atmospheric CO₂.

Jonathan Duncan, University of North Carolina: We examine large-scale variability in precipitation and how this controls summer nitrate export: A multi-scale approach.

Emily Knowles, University of Colorado, Boulder: A geochemical analysis of the formation and preservation of biogas seeps in subfloor beach gneiss.

Rebecca Lybrand, University of Arizona, Tucson: Ophiolite-hosted potential formations of primary minerals from granitic rocks and局限于 the Santa Catalina Mountain Chain as observed through basement mapping.

Carlo Rosendo, Pennsylvania State University: We present results of our role in a multidisciplinary project focusing on dissolution of Cd containing iron oxides.

Eric Thomas, University of Texas: Development of new methods for detecting and quantifying elemental compositions in sediments using ground-based remote sensing of snow depth.

Rebecca Caldwell, Boston College, Boston, Massachusetts: The effect of gas/size distribution on river delta morphology and sediment transport patterns.

Anna Crowell, University of North Dakota: Grand Forks, Re-evaluating geothermal potential with GIS methods and new data: Williston Basin, North Dakota.

Katharine Huppert, Massachusetts Institute of Technology, Cambridge, Morphotologies of stream lakes in the Great Lakes.

Alan Richardson, Massachusetts Institute of Technology, Cambridge, Scalable, massively parallel approaches to upstream drainage area computation.

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The total duration of an individual's postdoc- toral service at no time will exceed five years, including interdisciplinary research, post-doctoral research investments in the ECI including new resources for interdisciplinary research and education in the environmental sciences at Brown. The University is making investments in the ECI including new resources for interdisciplinary research, post-doctoral research appointments, graduate education and a cooperative graduate program with the Marine Biological Laboratory (MBL) at Woods Hole. The candidate should be a core faculty member of the ECI with an appointment at a tenure-track level. Opportunities exist for an Assistant Professor to a full Professor level. Applications should be submitted as soon as possible after October 15, 2012, for early consideration.

commensurate with the tenuring department’s stan-
dards for a tenure-track appointment.

Requirements include a Ph.D. in an environ-
mentally-related discipline, a record of achievement in the use of remotely sensed data in environmental science-focused research, and a commitment to graduate and undergraduate teaching.

Applications must be postmarked no later than 15th April 2013. The position will be filled September 2013, or until a suitable candidate is found. Further information on current research and facilities at the LPI may be found on our website: http://www.lpi.usra.edu.

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