



# The Smilodon

The Newsletter of the Southern California Academy of Sciences  
December 20, 2016

## HOW HEALTHY ARE SOCIAL WETLANDS? DEVELOPING STANDARDIZED WETLAND MONITORING STRATEGIES FOR CALIFORNIA

by Karina Johnston, Director of Watershed Programs for The Bay Foundation



Top: Degraded wetland area slated for restoration at Ballona Reserve, Los Angeles.  
Bottom: Higher condition wetland area at Los Cerritos Wetland, Long Beach.

In the next few years, major large-scale coastal wetland restoration projects are being planned throughout the Southern California Bight, including the Ballona Wetlands Ecological Reserve, Ormond Beach Wetlands, and the Los Cerritos Wetland complex, to name just a few. Understanding the current condition of these wetland systems is imperative to the development of restoration planning efforts and informing adaptive management strategies, especially in the context of climate change and sea level rise.

In 2002, wetland scientists and managers from around the state began developing a monitoring and assessment program modeled after USEPA's Level 1-2-3 framework for monitoring wetland resources. The original intent behind this tri-level framework was to explicitly encourage the collection of data such that agencies and managers could more easily compile and more robustly interpret individual wetland site performance as well as broader local and regional trends.

From 2011 to 2015, The Bay Foundation and their partners, California State University Channel Islands, Southern California Coastal Water Research Project, and Loyola Marymount University, contributed substantially to the advancement of restoration planning at wetlands throughout southern California by further developing and then applying the monitoring framework at coastal wetlands in the northern portion of the Bight. This program accomplished two goals – an increase in knowledge of the ecological condition and functioning of regional estuarine wetlands; and field-testing a series of site-intensive protocols to guide the framework development of the California Estuarine Wetland Monitoring Manual.

Trends in data drawn from this multi-year study concluded that, in most cases, hydrology was the best predictor of variability in overall wetland condition. Hydrological impacts such as armored levees, culverts, and fill placement were often the driving mechanisms behind the degradation of the wetlands. Hydrology scores were also highly correlated to other data sets such as vegetative cover and water quality. The wetland sites with the most severe alterations to natural hydrology (e.g. Ballona and Ormond) also had some of the lowest overall condition scores in the state of California and were subsequently the most vulnerable to other impacts such as non-native vegetation invasions.

In addition to the data collection, the Monitoring Manual that the partners developed provides the next step in a framework for wetland scientists throughout California to standardize scientifically-repeatable protocols for site-intensive wetland assessments. The free, downloadable Manual (pdf) provides a suite of protocol recommendations based on factors influencing implementation, such as: resource requirements, quality and importance of data outputs, and site disturbance. These high-resolution evaluations will assist in

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## PRESIDENT'S CORNER...

The Southern California Academy of Sciences is an important part of the scientific community of southern California, and it is an honor and a privilege to serve as its new President. Over the next two years, the Board and I plan to enhance the visibility, membership, and advocacy of the Academy, which is entering its 126th year.

In 2017, SCAS will break from tradition and host its Annual Meeting as a one-day event on the campus of Santa Monica College on Friday, April 28 – save the date! Symposia themes for 2017 are: Freshwater Systems; Rainforest and Tropical Ecology; and Marine Coastal Ecology. As usual, the Contributed Paper presentations will include a variety of topics ranging from Parasitology to Marine and Terrestrial Ecology. We will cap off the meeting with a Poster Session that will include, for the first time, our Junior Academy members.

If you have scientific papers to publish, please remember that the SCAS Bulletin publishes papers by members without page charges. The goal of the Bulletin is to report on research activities of SCAS members, scientific research conducted in southern California, and research that is of interest to the membership.

Thank you to outgoing SCAS President Julianne Passarelli for her hard work and steady leadership. Special thanks also to longstanding Board member Ann Dalkey, who, after many years of service to the Academy, has provided invaluable perspective and structure to the Board. Finally, a big thanks to the entire SCAS membership, which includes Junior Academy participants, university students, environmental professionals, and scholars, whose continued support make it possible to further the goals of our Academy, as well as promote fellowship within the southern California scientific community.

Congratulations and welcome to three newly appointed Board members: Mia Adreani of California State University Northridge, Kristy Forsgren of California State University Fullerton, and Karina Johnston of the Bay Foundation. Kristy and Karina also have agreed to serve as officers (Corresponding Secretary and Treasurer, respectively), as has longtime Board member Lisa Collins (Vice President). We are grateful for their support. Are YOU interested in joining the Board? If so, let me know!

In case we haven't yet met, I have been an active member of the Academy and joined the Board in 2012. As an Associate Professor (Teaching) of Environmental Studies in the USC Dornsife College of Letters, Arts and Sciences, my teaching is focused on marine environmental science and sustainability, and includes hands-on learning and research experiences in the classroom and field.

I believe the research, scholarship, and professional development opportunities offered by SCAS can greatly enhance the future career choices of students at all levels of their academic career.

Thank you for your continued participation in and support of SCAS! We hope to see you at the April 2017 Annual Meeting!

David W. Ginsburg, President

## ANNOUNCING SCAS' 2017 ANNUAL MEETING April 28, 2017 Santa Monica College ONE DAY ONLY!!!

**Symposia themes for 2017 are:**  
Freshwater Systems  
Rainforest and Tropical Ecology  
Marine Coastal Ecology

## WHAT SATELLITES CAN TELL US ABOUT HOW ANIMALS WILL FARE IN A CHANGING CLIMATE

by Maria-José Viñas, NASA's Earth Science News Team (originally published December 12, 2016)

From the Arctic to the Mojave Desert, terrestrial and marine habitats are rapidly changing. These changes impact animals that are adapted to specific ecological niches, sometimes displacing them or reducing their numbers. From their privileged vantage point, satellites are particularly well-suited to observe habitat transformation and help scientists forecast impacts on the distribution, abundance and migration of animals.

In a press conference Monday at the American Geophysical Union meeting in San Francisco, three researchers discussed how detailed satellite observations have facilitated ecological studies of change over time. The presenters discussed how changes in Arctic sea ice cover have helped scientists predict a 30 percent drop in the global population of polar bears over the next 35 years. They also talked about how satellite imagery of dwindling plant productivity due to droughts in North America gives hints of how both migratory herbivores and their predators will fare. Finally, they also discussed how satellite data on plant growth indicate that the concentration of wild reindeer herds in the far north of Russia has not led to overgrazing of their environment, as previously thought.

### Long-term polar bear declines

Polar bears depend on sea ice for nearly all aspects of their life, including hunting, traveling and breeding. Satellites from NASA and other agencies have been tracking sea ice changes since 1979, and the data show



A young polar bear sitting on the shore in southern Beaufort Sea, Alaska. In some parts of the Arctic, sea ice loss is causing polar bears to spend longer periods on shore each summer. Credits: U.S. Fish and Wildlife Service/Eric Regehr

that Arctic sea ice has been shrinking at an average rate of about 20,500 square miles (53,100 square kilometers) per year over the 1979-2015 period. Currently, the status of polar bear subpopulations is variable; in some areas of the Arctic, polar bear numbers are likely declining, but in others, they appear to be stable or possibly growing.

"When we look forward several decades, climate models predict such profound loss of Arctic sea ice that there's little doubt this will negatively affect polar bears throughout much of their range, because of their critical dependence on sea ice," said Kristin Laidre, a researcher at the University of Washington's Polar Science Center in Seattle and co-author of a study on projections of the global polar bear population. Eric Regehr of the U.S. Fish and Wildlife Service in Anchorage, Alaska, led the study,

which was published on December 7 in the journal *Biology Letters*.

"On short time scales, we can have variable responses to the loss of sea ice among subpopulations of polar bears," Laidre said. "For example, in some parts of the Arctic, such as the Chukchi Sea, polar bears appear healthy, fat and reproducing well — this may be because this area is very ecologically productive, so you can lose some ice before seeing negative effects on bears. In other parts of the Arctic, like western Hudson Bay, studies have shown that survival and reproduction have declined as the availability of sea ice declines."

Regehr, Laidre and their colleagues' results are the product of the International Union for Conservation of Nature's (IUCN) Red List assessment for polar bears. To determine the level of threat to a species, IUCN requests scientists to project what the species population numbers will be after three generations. Using data collected from adult females in 11 subpopulations of polar bears across the Arctic, Regehr and Laidre's team calculated the generation length for polar bears—the average age of reproducing adult females—to be 11.5 years. They then used the satellite record of Arctic sea ice extent to calculate the rates of sea ice loss and then projected those rates into the future, to estimate how much more the sea ice cover may shrink in approximately three polar bear generations, or 35 years.

Lastly, the scientists evaluated different scenarios for the relationships between polar bear abundance and sea ice. In one of them, the bear numbers declined directly proportionally with sea ice. In the other scenarios, the researchers used the existing, albeit scarce, data on how polar bear abundance has changed with respect to sea ice loss, using all available data from polar bear subpopulations in the four existing polar bear eco-regions, and projected forward these observed trends. They concluded that, based on a median value across all scenarios, there's a high probability of a 30 percent decline in the global population of polar bears over the next three to four decades, which supports listing the species as vulnerable on the IUCN Red List.

"It is difficult to predict what population numbers will be in the future, especially for animals that live in vast and remote regions," Regehr said. "But at the end of the day, polar bears need sea ice to be polar bears. This study adds to a growing body of evidence that the species will likely face large declines as loss of their habitat continues."

### Drought and mountain lions

The southwestern United States is expected to become more prone to drought with climate change. The resulting loss of vegetation

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## SO CAL WETLANDS, CONTINUED...

the development of restoration trajectories, success criteria, and adaptive management thresholds.

This collaboration has allowed us to look at coastal wetlands both in a regional context and individually – benefitting our efforts to understand, preserve, and restore wetlands in Southern California for years to come.

Please visit *The Bay Foundation* at [www.santamonicabay.org](http://www.santamonicabay.org) for more information. *Karina Johnston* ([kjohnston@santamonicabay.org](mailto:kjohnston@santamonicabay.org)) is the Director of Watershed Programs for *The Bay Foundation* and a member of the SCAS Board of Directors.

## WARM 2015-'16 WINTER CYCLONE WEAKENED ARCTIC SEA ICE PACK

by *Maria-José Viñas, NASA's Earth Science News Team* (originally published November 14, 2016)

A large cyclone that crossed the Arctic in December 2015 brought so much heat and humidity to this otherwise frigid and dry environment that it thinned and shrunk the sea ice cover during a time of the year when the ice should have been growing thicker and stronger, a NASA study found.

The cyclone formed on Dec. 28, 2015, in the middle of the North Atlantic, and traveled to the United Kingdom and Iceland before entering the Arctic on Dec. 30, lingering in the area for several days. During the height of the storm, the mean air temperatures in the Kara and Barents seas region, north of Russia and Norway, were 18 degrees Fahrenheit (10 degrees Celsius) warmer than what the average had been for this time of the year since 2003.

The extremely warm and humid air mass associated with the cyclone caused an amount of energy equivalent to the power used in one year by half a million American homes to be transferred from the atmosphere to the surface of the sea ice in the Kara-Barents region. As a result, the area's sea ice thinned by almost 4 inches (10 centimeters) on average.

At the same time, the storm winds pushed the edges of the sea ice north, compacting the ice pack. "During the cyclone, the sea ice retreated northward, causing a loss in coverage equaling the area of the state of Florida," said Linette Boisvert, lead author of the study and a sea ice scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

Boisvert and her colleagues used data from NASA's Atmospheric Infrared Sounder (AIRS) instrument aboard the Aqua satellite to study the atmospheric effects of this storm on the sea ice, specifically the evolution of air temperature and humidity during the storm. They also compared the cyclone to other extreme events from past winters since 2003, the year AIRS began to collect data.

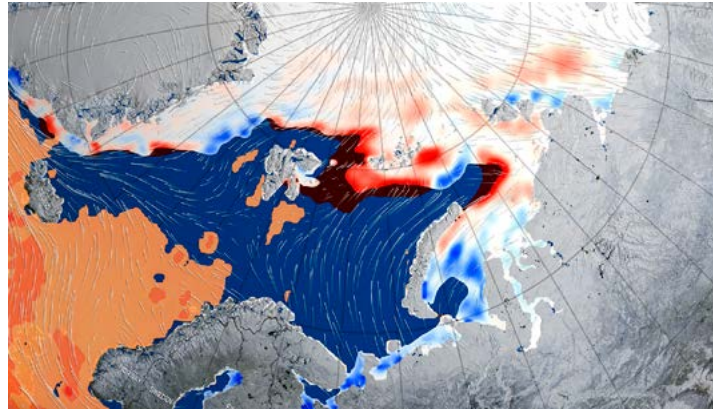
"Measured against other extreme winter events that have happened in the Kara-Barents seas region over the AIRS period, this one was the warmest," Boisvert said. "The AIRS time period also coincides with the warmest decade on record, so this storm being the hottest is a big deal."

The researchers also used a reanalysis of wind speeds, satellite passive microwave data of Arctic sea ice concentration and a sea ice thickness model to study how the storm impacted the sea ice cover.

Usually, during the Arctic winter the atmosphere and surface of the ice are very cold, while the exposed ocean waters are warmer, so there's a heat transfer from the ocean to atmosphere. During the cyclone, the pattern was inverted and heat traveled from the atmosphere to the surface of the ice. After the storm, the weather in the Kara-Barents seas region remained warmer than average for January, leading scientists to believe this cyclone prevented the sea ice from recovering.

During the months of January, February and March of this year, Arctic sea ice presented the lowest monthly extents in the satellite record, which were largely driven by abnormally low ice levels in the Kara and Barents seas.

Model projections of Arctic sea ice show that ice thickness will continue to decline over the next decades, making the sea ice cover even more vulnerable to winter storms. "In our study, we found that the thinnest ice was completely melted out by the storm," said Alek Petty, a co-author of the study and a sea ice researcher at Goddard. "Maybe in the coming years, if we start with a thinner winter ice pack we'll see extreme events like these cause even bigger melt-outs across the Arctic."



A large, warm cyclone that crossed the Arctic in December 2015 thinned and shrunk the sea ice cover during a time when the ice should have been growing. Credits: NASA's Goddard Space Flight Center/Kathryn Mersmann, producer.

## WHAT SATELLITES CAN TELL US, CONTINUED...

will not only impact herbivores like mule deer; their main predator, mountain lions, might take an even larger hit.

To estimate the numbers and distribution of mule deer and mountain lions in Utah, Nevada and Arizona, David Stoner, a wildlife ecologist at Utah State University in Logan, Utah, used imagery of plant productivity from the Moderate Resolution Imaging Spectroradiometer, flown on NASA's Terra and Aqua satellites, plus radio-telemetry measurements of animal density and movements. He found that there is a very strong relationship between plant productivity and deer and mountain lion density.

"Measuring abundance of mule deer in the western United States is logistically difficult, hazardous and very expensive. For mountain lions, it's even worse," Stoner said. "But measuring changes in vegetation is



This collared adult female mountain lion, pictured in the Oquirrh Mountains, Utah, was part of a 1997-2013 population study. Credits: Utah State University/David Stoner

relatively easy and more affordable. With this research, we've provided a model that wildlife managers can use to estimate the density of deer and mountain lions, two big game species of great economic importance."

Using maps of vegetation productivity during a severe drought that occurred in the southwestern United States in 2002, Stoner modeled what would be the deer and mountain lion distribution and abundance, should extreme drought become the norm.

"During 2002, there was a 30 percent decrease from the historical record mean in precipitation," Stoner said. "Using measurements of vegetation stressed by drought, our model predicted a 22 percent decrease in deer density. For mountain lions, the decline was 43 percent. Mountain lions occur at far lower densities than deer, and so any loss of their prey can have disproportionate impacts on their reproductive rates and overall abundance."

Mule deer are popular game animals, bringing in hundreds of millions of dollars to rural areas through recreational hunting and tourism. But deer can also have adverse economic impacts; they cause vehicle collisions, devour crops and damage gardens.

"Droughts will make human landscapes more attractive to deer, because farms and suburban areas are irrigated and would remain fairly green," Stoner said. "And mountain lions will go wherever the deer are. We're going to lose some of the economic benefits of having those animals, because they'll be fewer of them, but the costs are going to increase because the remaining animals will be attracted to cities and farms."

### Longer journeys for wild reindeer

The Taimyr reindeer herd in the northernmost region of Russia is the largest wild reindeer herd in the world and a key of source of food for the indigenous population of the Taimyr Peninsula.

"Reindeer populations are declining all over the world, in some places catastrophically; in Taimyr, there has been an about 40 percent drop since 2000 and the herd is now at 600,000 animals," said Andrey Petrov, an associate professor at the University of Northern Iowa, in Cedar Falls. Petrov examined historical data going back to 1969 and determined that there are ongoing changes in the distribution and migration patterns of the wild reindeer due to climate change and human pressure. The reindeer have moved east, away from human activity. At the same time, the herd is now traveling farther north and higher in elevation during the summer, possibly to avoid increasing temperatures and more abundant mosquitoes.

"Taimyr reindeer now have to travel longer distances between their winter and summer grounds, and this is causing a higher calf mortality," Petrov said. "Other factors contributing to the higher mortality are the increased mosquito harassment and the fact that rivers are opening earlier than before and the animals have to cross them during their migration."

Petrov also used imagery from the NASA/United States Geological Survey Landsat satellite program to determine how the presence of reindeer in their summer grounds impacts vegetation. He found that, as expected, plant



Taimyr reindeer in northern Russia, summer of 2003. Credits: Leonid Kolpashchikov

biomass decreased while the reindeer were grazing, but it bounced back a few weeks after the animals left the area. This finding argues against overgrazing as a possible factor for the Taimyr reindeer population decline that occurred after 2000.

"The work discussed at today's press conference is emblematic of the many ways in which satellite remote sensing supports our efforts at natural resource management and wildlife conservation," said Woody Turner, program scientist for NASA's Biological Diversity Program at NASA Headquarters in Washington.



## SCAS JUNIOR ACADEMY FALL 2016 NEWS

by Gloria Takahashi

The Southern California Academy of Sciences 2016-17 high school Research Training Program (RTP) is well underway! The Junior Academy (SCJAS) had its first of three group Saturday meetings at Loyola Marymount University in September. The group numbering over 100, included enthusiastic young high school science students and parents representing four southern California area counties and 28 high schools. They have begun their nearly year long journey of discovery, creativity and hard work with their Mentors in local laboratories, wetlands and environmental areas. Their efforts and results will be shared next year at the SCAS Annual Meeting, set for April 28, 2017 at Santa Monica College. Students will present their research during the SCAS Poster Session and Reception. This will be the first time all of their posters will be presented with the graduate, undergraduate, and professional submissions. The SCJAS Committee members, SCAS Board and members in attendance have much to look forward to.

Brrrrr...Boston Bound! Eight Junior Academy students from eight different high schools will present their research in poster and oral format at the AJAS/NAAS meeting with AAAS in Boston, February 15-19, 2017. Makena Low (now a freshmen at Stanford), plus three seniors (Jinwoo Park, Jennifer Choi, Ashley Abing), three juniors (Matthew G. Tang, Sydney Marler, Uniss Tan), and one sophomore (and AJAS Fellow Benjamin C. Liu) will represent SCJAS. Most are continuing science research while attending southern California area high schools. All were chosen for their scientific paper and oral presentations at the 2016 SCAS Annual Meeting held in May at the University of Southern California, Los Angeles. Mrs. Gloria Tang, parent and Lead Chaperone, and Dr. Jonathan Baskin, SCAS Past President will accompany them.

Every year, a group of very dedicated parents have been instrumental in contacting and encouraging parental involvement and financial support of the Junior Academy program. This year our parent leaders are: Mrs.

Gloria Tang, Mr. Robin Liu, and Mrs. Jenny Lei. Jenny's Lei's daughter Bonnie and son Kenny were each in RTP for four years; both are now Harvard graduates. Bonnie will continue her studies at Oxford. Robin's son Vick (SCJAS'16) is an engineering major at MIT, and his younger sons Benjamin and Stanley both conducting RTP research at the University of California, Irvine (UCI).

We encourage all SCAS members and their colleagues to be Mentors and guide a generation of high school students through experiencing the beneficial works of science (discovery) and engineering (invention). Become part of our informal STEM education RTP! Contact Gloria Takahashi at: [scas.nhm@gmail.com](mailto:scas.nhm@gmail.com) and learn more about the Junior Academy Programs and additional Meetings at host institutions Cabrillo Marine Aquarium and UCI APHEL. Additional information is available at the SCAS website: <http://scas.nhm.org/>

### RTP MEMBER RESEARCHES OTC CAFFEINE CONTENT

by Jessica Nunez, RTP Participant

My name is Jessica Nunez, and I am a junior at Academy of the Canyons. I found out about the opportunity to conduct research after attending the National History Museum in April 2015. Because my school is close to College of the Canyons, I was able to easily find a chemistry professor that would serve as my mentor. My research was conducted on the basis of analyzing the amount of caffeine in over the counter drugs and coffee. The examination was done in a span of six months at College of the Canyons, Valencia Campus with the help of Dr. Flynn and Maya Galloway. Learning about organic chemistry through an experiment that allowed me to enrich my understanding in organic chemistry was extremely rewarding. In the future, I hope to continue with my analysis on medicinal drugs and develop a new idea that pertains to the cardiovascular system. I enjoy the fact that I am able to explore various areas of research through different lenses.

## A CHAPERONE'S PERSPECTIVE ON THE 182ND AAAS/AJAS CONFERENCE

by Christina Ng, Head Chaperone

The bright lights, video cameras, and gorgeous banquet on the second night after our arrival made us feel like we were part of an elite squad walking on the red carpet –just like at the Oscars, except this meeting was for the heavyweights of the science world.

It was a wonderful experience for our six delegates to represent SCAS and attend the 182nd AAAS/AJAS meeting at Washington DC this year. We started our trip with an early weekday flight, and even at 6:30 in the morning, LA traffic was still horrible!

The first thing we experienced when we stepped out from the Ronald Reagan International Airport was the freezing cold weather –a dramatic change from the summer-like temperature in Southern California! The first night started with a dinner reception at the hotel and since five of our six delegates were veterans of the conference, they had a great time catching up with their acquaintances from the other delegation.

The following day's group tour was to NASA's Goddard Space Flight Center, home to the control center for the Hubble Space Telescope and James Webb Space Telescope. We were given a tour of the control center where all the data from several orbiting satellites were relayed back to Earth; we were also given a peek into the facility where the final parts of the James Webb Telescope were being engineered and put together. The night concluded with a meet-and-greet for all the AAAS attendees, and our delegates took the initiative to start conversations with many adult scientists, researchers, educators, and professionals in different fields from all around the nation.

Needless to say, our delegates had a very rewarding time meeting and talking with top researchers and educators at the "Breakfast with Scientists" hosted at American University. Each delegate presented with elegance and eloquence at their afternoon poster session as well. We had a chance to read and learn about the other students' research, and I am proud to say that our next generation of scientists is full of talented individuals filled with an overwhelming drive to improve society as a whole –students were researching new biometric security systems for electronic devices as well as new antibiotics and cancer treatments to improve and replace existing ones.

The AJAS group was blessed with the generosity of an unnamed U.S. Senator who requested and reserved the US Botanic Garden for us all to enjoy a nice dinner and tour –it was a wonderful and unexpected surprise for us. While the Garden may have looked spectacular in the daytime, at night it was simply gorgeous. Having the whole place to ourselves while also snacking on hors d'oeuvres was a beautiful and breathtaking experience. Afterwards, we toured the National Mall and visited the Lincoln and Vietnam Memorials as well as the Washington Monument. It was brutally cold, and I was so glad that we were able to enjoy our dinner in the warm Botanic Garden and that none of us caught hypothermia on that disrespectfully cold night!

The next morning was truly a surprise as we found the ground covered in snow when we looked out of our hotel windows. The forecast had predicted clear skies, and it was a treat to see the snow fall.

During the oral presentation scheduled for that afternoon, each of our delegates was assigned to a different room according to their own research category. I was truly impressed by the depth of research projects and quality of presentation skills by each of the young presenters! They all did a professional job!

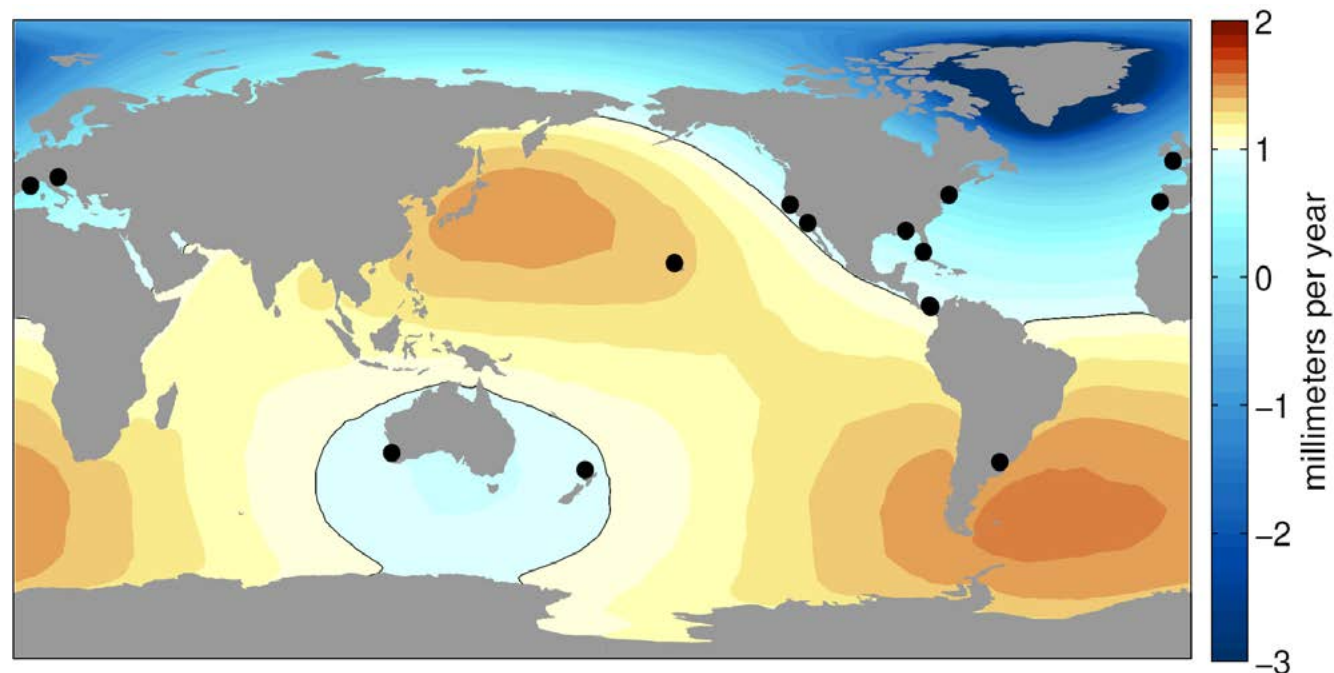
The conference was concluded with a beautiful dinner reception at the atrium of the American Indian National Museum, which generously opened their place exclusively just for our delegates for the night.

It has been a great privilege for me to spend those few days with our bright delegates. After all, they represent the future powerhouse of the science and research community of our nation!



## HISTORICAL RECORDS MAY UNDERESTIMATE SEA LEVEL RISE

edited by Tony Greicius, NASA Earth Sciences Team (updated October 18, 2016)



Sea level change resulting from Greenland ice melt, derived from NASA GRACE measurements. Black circles show locations of the best historical water level records, which underestimate global average sea level rise due to Greenland melt by about 25 percent. Credits: University of Hawaii/NASA-JPL/Caltech

A new NASA and university study using NASA satellite data finds that tide gauges -- the longest and highest-quality records of historical ocean water levels -- may have underestimated the amount of global average sea level rise that occurred during the 20th century.

A research team led by Philip Thompson, associate director of the University of Hawaii Sea Level Center in the School of Ocean and Earth Science and Technology, Manoa, evaluated how various processes that cause sea level to change differently in different places may have affected past measurements. The team also included scientists from NASA's Jet Propulsion Laboratory, Pasadena, California, and Old Dominion University, Norfolk, Virginia.

"It's not that there's something wrong with the instruments or the data," said Thompson, "but for a variety of reasons, sea level does not change at the same pace everywhere at the same time. As it turns out, our best historical sea level records tend to be located where 20th century sea level rise was most likely less than the true global average."

One of the key processes the researchers looked at is the effect of "ice melt fingerprints," which are global patterns of sea level change caused by deviations in Earth's rotation and local gravity that occur when a large ice mass melts. To determine the unique melt fingerprint for glaciers, ice caps and ice sheets, the team used data from NASA's Gravity Recovery and Climate Experiment (GRACE) satellites on Earth's changing gravitational field, and a novel modeling tool (developed by study co-author Surendra Adhikari and the JPL team) that simulates how ocean mass is redistributed due to ice melting.

One of the most fascinating and counter-intuitive features of these fingerprints is that sea level drops in the vicinity of a melting glacier, instead of rising as might be expected. The loss of ice mass reduces the glacier's gravitational influence, causing nearby ocean water to migrate away. But far from the glacier, the water it has added to the ocean causes sea level to rise at a much greater rate.

During the 20th century, the dominant locations of global ice melt were in the Northern Hemisphere. The results of this study showed that many of the highest-quality historical water level records are taken from places where the melt fingerprints of Northern Hemisphere sources result in reduced local sea level change compared to the global average. Furthermore, the scientists found that factors capable of enhancing sea level rise at these locations, such as wind or Southern Hemisphere melt, were not likely to have counteracted the impact of fingerprints from Northern Hemisphere ice melt.

The study concludes it is highly unlikely that global average sea level rose less than 5.5 inches (14 centimeters) during the 20th century. The most likely amount was closer to 6.7 inches (17 centimeters).

"This is really important, because it provides answers to the question about how melt fingerprints and the influence of wind on ocean circulation affect our ability to estimate past sea level rise," said Thompson. "These results suggest that our longest records are most likely to underestimate past global mean change and allow us to establish the minimum amount of global sea level rise that could have occurred during the last century."

Results are published in *Geophysical Research Letters*. To read the full paper, visit: <http://onlinelibrary.wiley.com/doi/10.1002/2016GL070552/abstract>

## NASA STUDY ANALYZES FOUR CORNERS METHANE SOURCES

edited by Tony Greicius, NASA Earth Sciences Team (updated August 15, 2016)



The Four Corners region of New Mexico and Colorado. Numerous light-colored spots are sites of gas and oil development. Credits: Flickr user Doc Searls, CC-BY-SA 2.0

In an extensive airborne survey, a NASA-led team has analyzed a previously identified "hot spot" of methane emissions in the Four Corners region of the United States, quantifying both its overall magnitude and the magnitudes of its sources. The study finds that just 10 percent of the individual methane sources are contributing half of the emissions.

Scientists from NASA's Jet Propulsion Laboratory and Caltech, both in Pasadena, California; the National Oceanic and Atmospheric Administration (NOAA), Boulder, Colorado; and the University of Michigan, Ann Arbor, used two JPL airborne spectrometers to identify and measure more than 250 individual sources of methane. The sources emitted the gas at rates ranging from a few pounds to 11,000 pounds (5,000 kilograms) per hour. Results are published this week in the *Proceedings of the National Academy of Sciences* in a paper titled "Airborne methane remote measurements reveal heavy-tail flux distribution in Four Corners region." Christian Frankenberg of JPL and Caltech is the lead author.

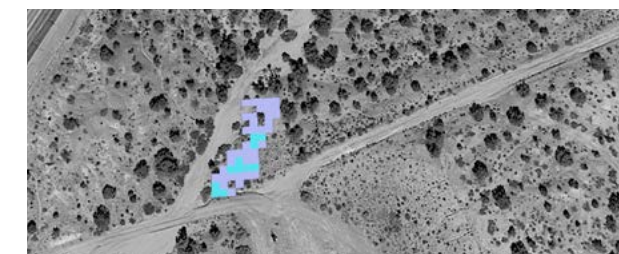
As a greenhouse gas, methane is very efficient at trapping heat in Earth's atmosphere, contributing to global warming. In the Four Corners region, where Arizona, Colorado, New Mexico and Utah meet, methane emissions are primarily associated with the production and transport of natural gas from coal beds. The odorless, colorless gas is difficult to detect without scientific instruments.

The experiment was a proof of concept for airborne detection of methane, according to Frankenberg. "That we could observe this distribution in a widespread geographical area and collect enough plumes to perform a statistical analysis was a pleasant surprise," he said.

A group of researchers including Frankenberg originally detected the Four Corners methane hot spot using past observations from a European satellite. Last year, he and

JPL colleagues joined a campaign, led and funded by NOAA, to investigate the hot spot, called Twin Otter Projects Defining Oil/gas Well emissionNs (TOPDOWN). The campaign also included researchers from the University of Michigan. Each participating institution deployed its own suite of instruments.

The NASA spectrometers used in the study can identify certain atmospheric gases, including methane, by the way the gases absorb sunlight. NOAA provided airborne plume measurements that were used to calibrate and validate the NASA data.



An example of a methane plume observation by NASA's AVIRIS-NG spectrometer instrument. This plume was confirmed by JPL's ground team to be caused by a leaking pipeline. The leak was reported to the pipeline operating company, which shut down the pipeline and repaired it. Credits: NASA/JPL-Caltech

NASA collects data from space, air, land and sea to increase our understanding of our home planet, improve lives and safeguard our future. NASA develops new ways to observe and study Earth's interconnected natural systems with long-term data records. The agency freely shares this unique knowledge and works with institutions around the world to gain new insights into how our planet is changing.

# THE LAST WORD

In an effort to regularize the publication of this organ, the editorial board of the Smilodon (in consultation with the SCAS Board of Directors) have decided to revise the aforementioned publication's production schedule. The Smilodon will be published twice annually:

## April 15 and November 15

To facilitate this schedule, the following deadlines for receipt of articles/input/photographs/etc. will be adhered to.

### Deadlines for April 15 (Spring) issue:

Receipt of articles/input:	March 15
Draft Smilodon to Board for review:	April 1
Board comments on Draft Smilodon to editor:	April 8
Smilodon distributed to membership:	April 15

### Deadlines for November 15 (Autumn) issue:

Receipt of articles/input:	October 15
Draft Smilodon to Board for review:	November 1
Board comments on Draft Smilodon to editor:	November 8
Smilodon distributed to membership:	November 15

If you have any questions or concerns about this schedule, or better yet, if you have content to provide (this can be an abstract of a paper or presentation you are working on, an idea you want to share or receive feedback on, an essay on a field experience that was singular and noteworthy, a particularly good photo you want to share...), please contact [sgraff@psomas.com](mailto:sgraff@psomas.com) or [bblood@psomas.com](mailto:bblood@psomas.com). Thank you!

