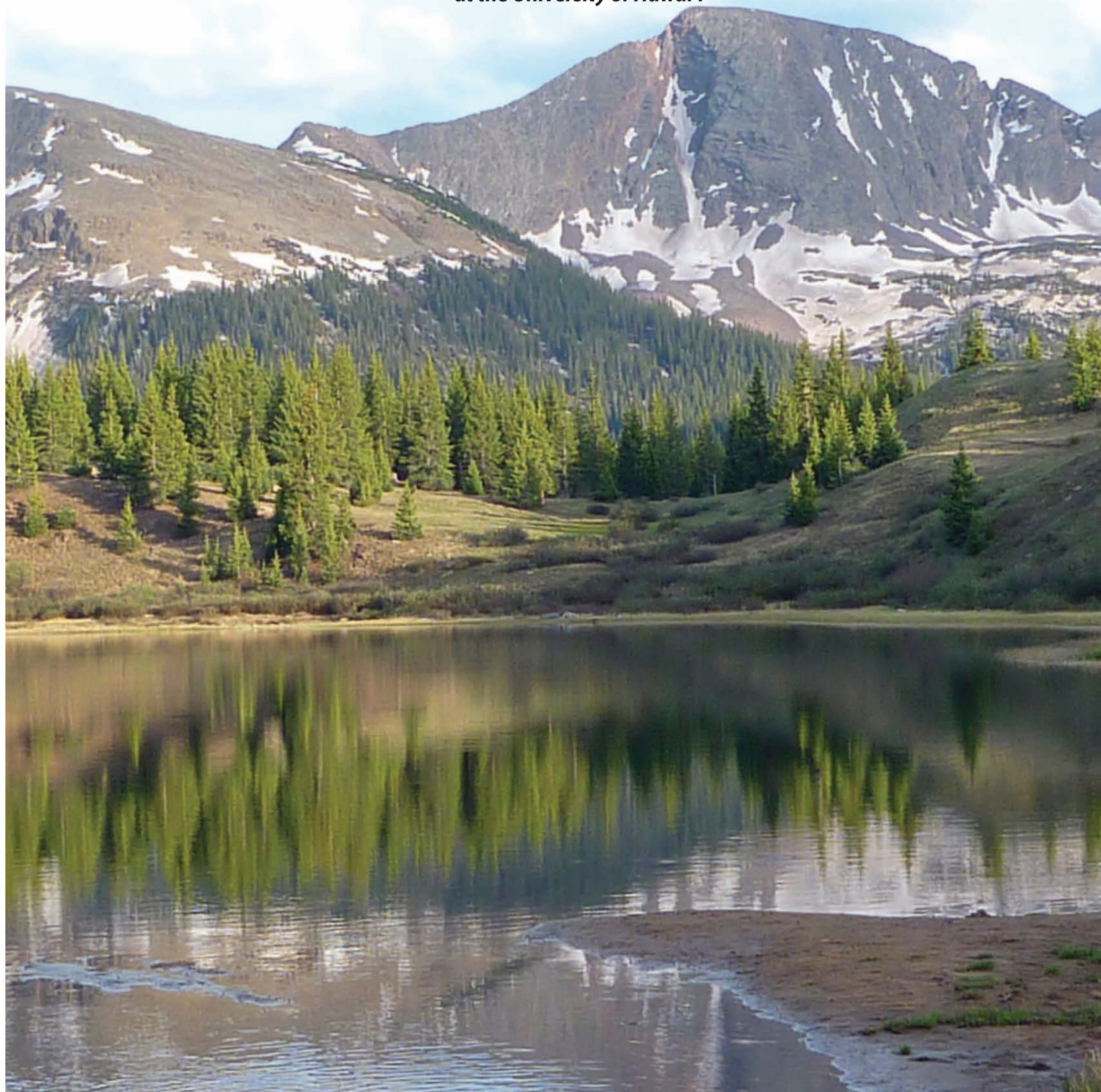


# i<sup>prc</sup> climate

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Newsletter of the International Pacific Research Center

*The center for the study of climate in Asia and the Pacific  
at the University of Hawai'i*





Cover photo: Little Molas Lake, Colorado.  
During the last ice age, many mountain  
ranges in Colorado were covered by glaciers.  
Credit: Gisela Speidel.

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University of Hawai'i at Mānoa  
School of Ocean and Earth Science and Technology



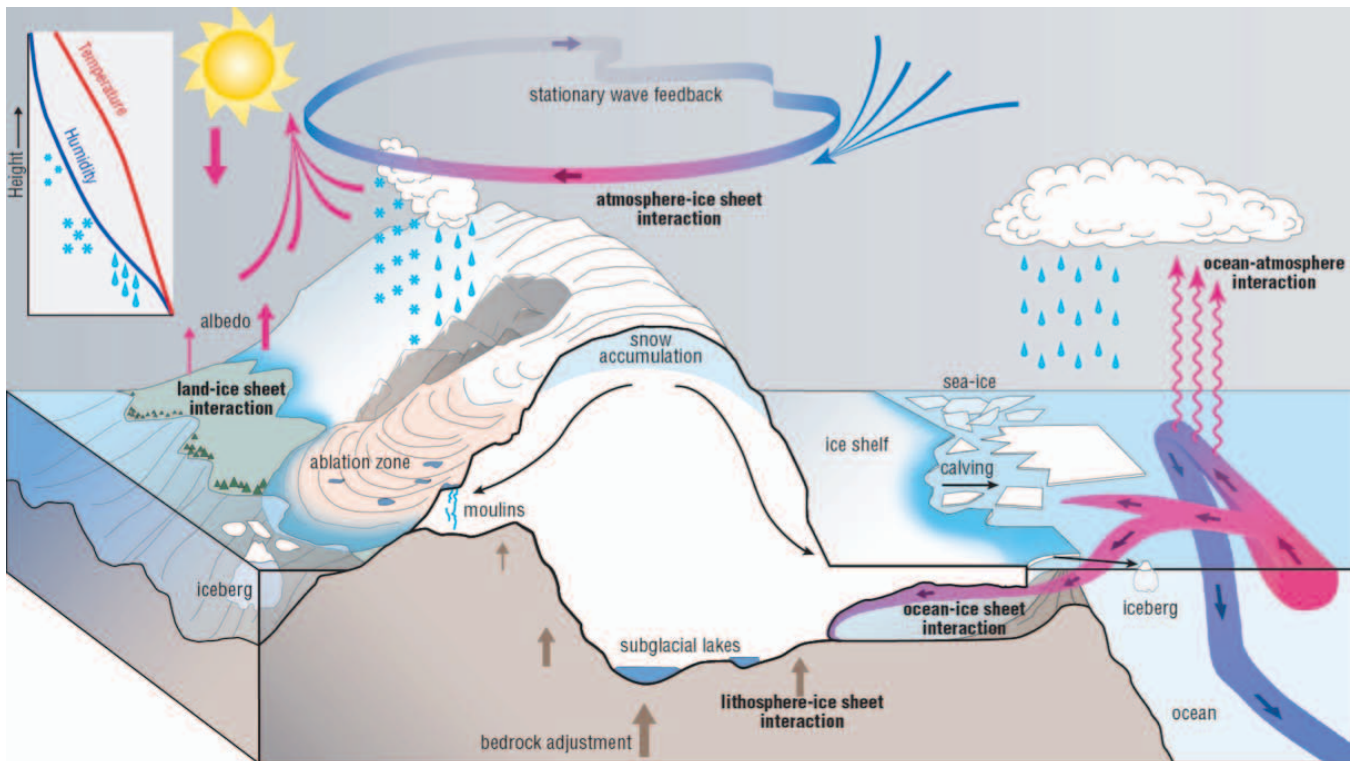
# Leaving the Last Ice Age

The slow but relentless buildup of ice for about 100 thousand years in the Northern Hemisphere stopped abruptly around 20 thousand years ago. Over the next 10 thousand years, global-mean surface temperature rose by 4°C, the ice sheets receded quickly, and sea level rose by over 120 meters, ending the latest ice age cycle.

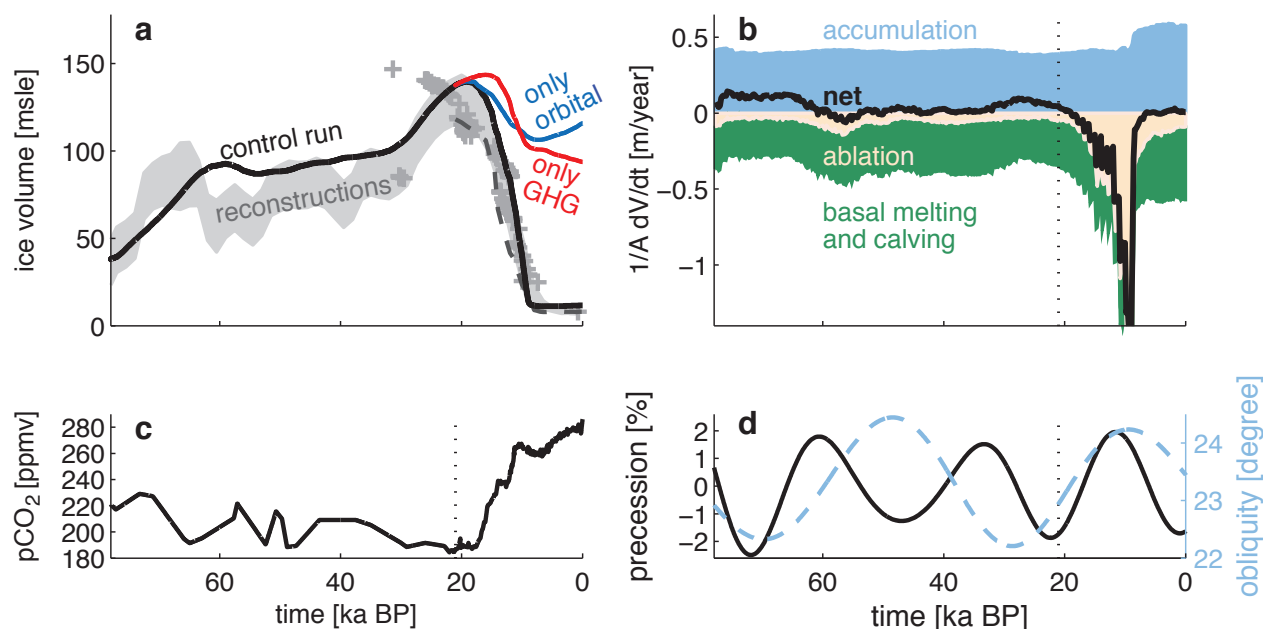
The waxing and waning of the ice sheets has been the hallmark of climate variability over the past 2 to 3 million years. The now widely accepted astronomical theory of ice ages holds that glacial cycles are caused by variations in the amount and

distribution of incoming solar radiation due to Earth's varying orbit. Were the variations in Earth's tilt and orbit, however, sufficient for this last meltdown, which yielded a climate for mankind to settle in North America and northern Europe? Or was CO<sub>2</sub> an essential player, and if yes, what paced the glacial CO<sub>2</sub> variation?

Ice sheets form as a result of a delicate balance between ice loss through melting and calving, and ice gain through snow and rainfall. Both gains and losses are determined by how components of the Earth system respond to variations in Earth's



Ice sheet interacting with the lithosphere, ocean, atmosphere, and land surface (illustrated by Nancy Hulbert, SOEST Publication Services after a sketch by Axel Timmermann).



**Figure 1.** a) Simulated Northern Hemisphere (NH) ice sheet volume in meters sea level equivalent (msle) from the control run with both orbital and greenhouse gas (GHG) forcing (thick black), only GHG forcing (red, fixed LGM orbit), and only orbital forcing (blue, fixed LGM GHGs). Reconstructed NH ice volume (dashed line, ICE5G), and reconstructed global sea level changes (grey crosses for coral record from Barbados, light grey shading for reconstructions from foraminiferal oxygen isotopes); b) Simulated ice volume rate of change averaged over the ice sheet area due to accumulation (light blue area), ablation (beige area), basal melting and calving (green area), and their net effect (thick black line) from the control run; c) Proxy-reconstructed atmospheric CO<sub>2</sub> concentration, which was used to drive the model. d) Precessional index (black, high values indicate Northern Hemisphere summers closer to the sun), and obliquity (dashed blue).

orbit. To list a few: winds and their moisture impact the amount of snowfall and thus ice accumulation, while the shape and height of ice sheets, in turn, affect the atmospheric circulation and precipitation. Even if an ice sheet grows at its surface, greater pressure at its base or geothermal heating can cause basal melting. Basal melting can trigger ice sheet calving. Resulting meltwater can contribute to soil moisture, affecting vegetation and evaporation, or to river discharge into the ocean, affecting the ocean circulation. Representing these processes in climate models is challenging.

IPRC's Postdoctoral Fellow **Malte Heinemann**, Faculty **Axel Timmermann**, Assistant Researcher **Oliver Elison Timm** together with and **Ayako Abe-Ouchi** and **Fuyuki Saito** from JAMSTEC set out to meet this challenge by coupling the atmosphere, ocean, sea ice, soil, and vegetation components of LOVECLIM to the Ice Sheet Model for the Integrated Earth System Studies (IcIES) developed at JAMSTEC by Ayako Abe-Ouchi and Fuyuki Saito. The Earth system model iLOVE was born, and with it the first continuous 3-dimensional simulation covering the past 78 thousand years of interactions between ice sheets and climate.

The team initialized iLOVE with the approximate climate conditions and ice-sheet height 78 thousand years before present, prescribing the orbital path and reconstructed greenhouse-gas concentrations since then until the present. The resulting simulated evolution of Northern Hemisphere ice volume agrees well with sea-level reconstructions (Figure 1a).

From 78 thousand years before present through the final stage building up to the Last Glacial Maximum (LGM), a delicate balance—the magnitudes of gain and loss being much larger than the differences between them—characterizes the simulated evolution of the ice sheet. Then around 28 thousand years ago, when obliquity increased from its minimum value, calving accelerated and the rate of the net ice sheet buildup slowed (Figure 1b).

This phase appears to signal the beginning of the end of ice buildup. Ice loss overtakes ice gain with stronger irradiance during Northern Hemisphere summer—first from increasing obliquity and then from increasing precession. The ice-age ending starts *just before* CO<sub>2</sub> increases in the model. That is, the trigger for the meltdown was a change in solar radiation.



Around 11 thousand years ago, the iLove simulation shows an opening between the Cordilleran ice sheet and the retreating Laurentide ice sheet (Figure 2). The emerging land corridor has been thought to be a way for humans to cross from eastern Siberia, across the Bering Strait into North America. By around 10 thousand years ago, the Laurentide ice sheet in iLOVE has retreated beyond Lake Winnipeg and the Great Slave Lake in northwestern Canada, in agreement with global ice sheet reconstructions produced by W. R. Peltier at the University of Toronto.

To determine the roles of greenhouse gas variations and orbital forcing in glacial dynamics, the scientists ran a series of deglacial sensitivity experiments with iLOVE, starting with the initial conditions of 21 thousand years ago. When atmospheric CO<sub>2</sub> concentrations are not increased but kept at LGM values and only Earth's orbit is allowed to vary (blue line in Figure 1 a, c, d), the Northern Hemisphere ice volume decreases from 21 thousand to about 9 thousand years ago. When, however, in this simulation obliquity and summer insolation decrease once again, the ice sheet recovers and reaches at present-day almost the extent it had during the Last Glacial Maximum. Thus, even though changes in insolation triggered the melting, they were not enough to end the ice age. The scientists conclude that without the rise in CO<sub>2</sub>, mile-high ice sheets would still today cover large parts of North America.

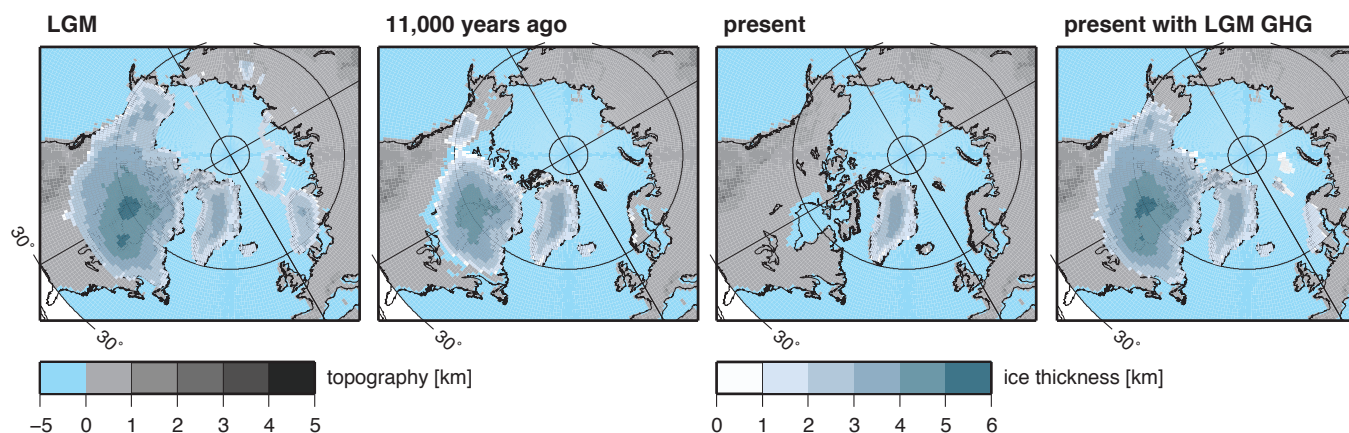
The iLOVE results also show that the global mean temperature rise during the last glacial termination was largely



controlled by the deglacial CO<sub>2</sub> rise and only to a smaller degree by the albedo changes from the retreating ice sheets.

“Our study supports the astronomical theory of ice ages,” concludes Malte Heinemann. “Shifts in Earth’s orbit triggered the initial melting of the North American and Eurasian ice sheets. However, according to our model, CO<sub>2</sub> was a key player during the following deglaciation. Without the rising CO<sub>2</sub>, our present climate would be about 3°C colder, with an ice sheet covering large parts of North America.”

“A puzzle remains,” says Axel Timmermann. “How does orbital forcing influence the carbon cycle and the glacial-scale variability of atmospheric CO<sub>2</sub> concentrations? The IPRC team is currently exploring several options, including sea-ice-induced changes of ventilation in the Arctic Ocean and the Southern Ocean.”



**Figure 2.** Ice sheet thickness and surface height as simulated in iLOVE for the Last Glacial Maximum (LGM, 19,000 years ago in the model), 11,000 years ago, present, and for a hypothetical present assuming that GHG concentrations had not risen by about 100ppm during the deglaciation (GHG concentrations fixed at LGM values).

# Imprint of PDO on South China Sea Throughflow

The highest water temperatures over the large expanse of the global ocean are found at the surface of the tropical “warm pool” that stretches from the eastern Indian Ocean to the western Pacific Ocean. Small changes in the region’s sea surface temperatures (SST) can significantly alter atmospheric circulation, convection and rainfall across the Pacific and the Indian Ocean.

IPRC Senior Researcher **Tangdong Qu** and his colleagues have been studying this region for over a decade. They have discovered that the South China Sea is not a passive body of water as many oceanographers have thought, but contributes significantly to the water exchange between the Pacific and the Indian Ocean.

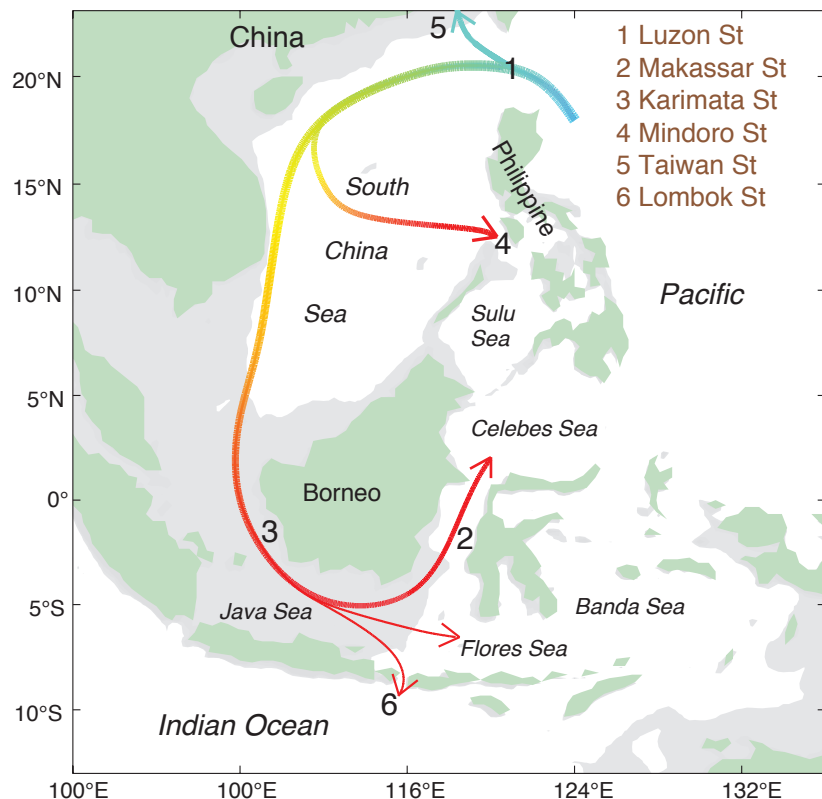
A useful research tool for their studies has been the high-resolution Ocean General Circulation Model For the Earth Simulator (OFES), which they have demonstrated represents the complex topography of the passages through the Indonesian Archipelago and the region’s ocean floor much more realistically than most other ocean models.

Qu, together with former IPRC Postdoctoral Fellow **Yan Du** and JAMSTEC’s **Hideharu Sasaki**, had shown in an OFES hindcast of conditions existing from 1950 to 2003 that a significant amount of Pacific water

flows through the South China Sea into the Indonesian Seas. They called this flow the South China Sea throughflow (SCSTF): Pacific water enters the South China Sea through Luzon Strait and leaves the South China Sea through three straits: Karimata, Mindoro, and Taiwan, each transporting on average approximately 1.3 million cubic meters of water per second. The team’s calculations showed that an appreciable amount of heat, between 0.1 to 0.2 Petawatts, leaves the South China Sea through Karimata and Mindoro

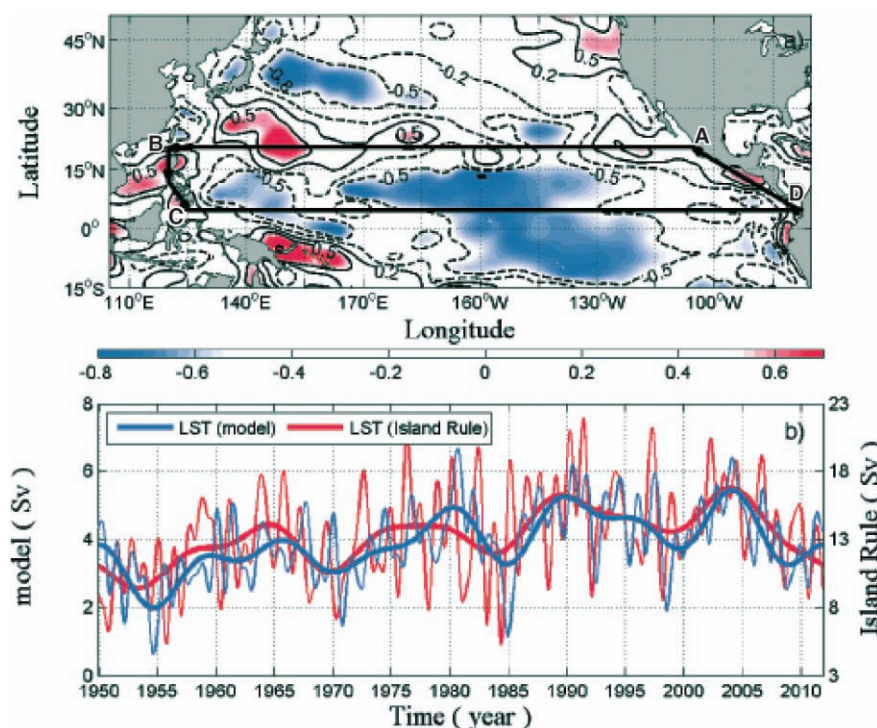
straits. (For comparison, 4 Petawatts is thought to be the total heat flux transported by Earth’s atmosphere and oceans away from the equator towards the poles.) This large transfer of heat into the Indonesian Seas can be expected to have considerable effect on climate in both the Indian and the Pacific Ocean.

In his most recent work, Qu together with **Kai Yu**, a long-term IPRC visitor from the Ocean University of China, studied the variability of the strength of the South China Sea



Map of the South China Sea throughflow.





**Figure 1.** (a) Correlation between the upper-layer (0–745 m) Luzon Strait transport (LST) and zonal wind stress anomalies (contour) on the decadal timescale, and (b) time series of LST from the model (blue) and the “island rule” (red) smoothed by a 13-month (thin) and 84-month low-pass (thick) filter. The shading in (a) indicates the area satisfying the 95% significance level by t-test. The path ABCD in (a) is the path along which wind stress is integrated in applying the “island rule” to the LST. See Yu and Qu, *J. Climate*, for details.

throughflow in an OFES hindcast from 1950 to 2011. Since the Luzon Strait is the only inflow from the Pacific into the SCS, variations in transport through this strait determine much of the variations in the SCSTF. As expected, analysis of the OFES hindcast showed that the greatest variability in Luzon Strait transport (LST) comes from the seasonal cycle, which accounts for about 68% of the total variation in the flow.

Removal of the impact of the seasonal cycle revealed two time scales that captured most of the remaining 32% variation in transport strength in the upper-layer of Luzon Strait: a 3.3-year interval and a 14.2-year interval, each period accounting for about 11% of the total variation in the transport.

Since Qu and his colleagues had already studied causes of the higher-frequency interannual variability in the transport, they focused in this latest

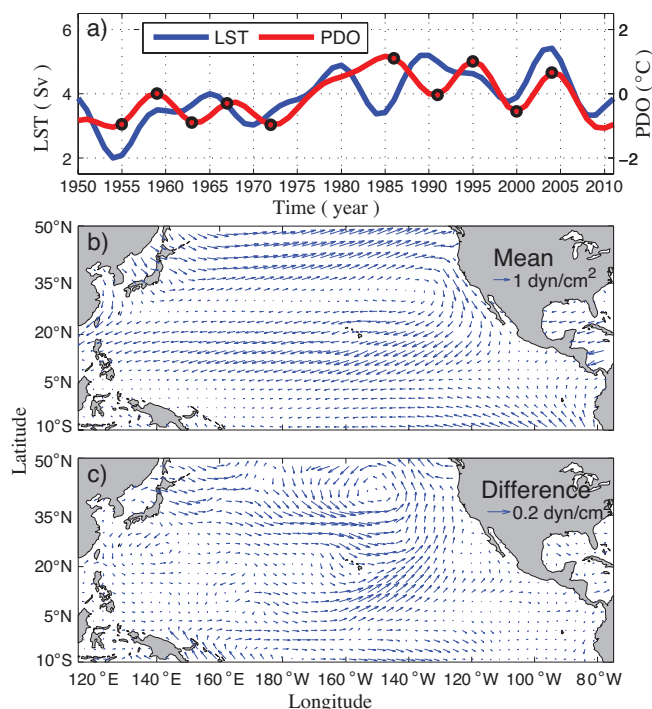
study on what causes the decadal variability. OFES results showed that the decadal inflow into the Luzon Strait is highly correlated with the outflow from the South China Sea through the three straits. Moreover, transport through Mindoro Strait, which varies the most among the three straits, correlates nearly perfectly with the upper-layer inflow through Luzon Strait ( $r=+0.95$ ).

Where is the source of this decadal variability of inflow into Luzon Strait? Previous studies have pointed to the basin-wide winds. The OFES zero-lag correlation between LST and NCEP zonally integrated wind stress along  $4.75^\circ\text{N}$  is  $-0.87$ , confirming the existence of a link between variations in Luzon Strait transport and variations in the westerly winds across the central Pacific: the stronger the westerly winds, the greater the transport through the upper-layer of Luzon Strait (Figure 1).

Given these findings, the scientists suspected that the Pacific Decadal Oscillation (PDO) modulates LST by affecting the strength of the North Pacific Tropical Gyre: during warm or positive phases of the PDO, the western Pacific is unusually cool and part of the



The Earth Simulator. Credit: JAMSTEC.



**Figure 2.** (a) Time series of the upper-layer (0–745 m) Luzon Strait transport (blue) and PDO index (red), (b) long-term (1950–2011) mean wind stress, and (c) its difference between the strong (1959, 1967, 1986, 1995, and 2004) and weak (1955, 1963, 1972, 1991, and 2000) PDO years as marked by the black circles in (a). A 7-year low-pass filter has been applied before plotting.

eastern Pacific unusually warm, resulting in stronger westerlies; during cool or negative phases the opposite happens.

Their hunch was right: further analysis showed that LST is related to the PDO, the correlation being +0.60. In other words, during warm PDO phases, the flow into the upper-layer Luzon Strait tends to be stronger and during cold phases weaker (Figure 2).

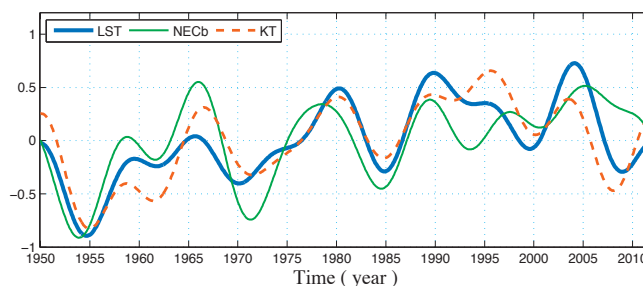
To trace the source of this link even further, the scientists filtered their data to include only variations with periods longer than 7 years and then compared composites of positive and negative PDO phases. This revealed that during positive PDO phases an unusually strong Aleutian Low develops and intrudes southward with a positive wind stress curl near 40°N. This intrusion results in the following sequence of events: the northeasterly trades weaken, leading

to stronger westerly winds over a large part of the central tropical Pacific; the North Equatorial Current bifurcation (NECb) shifts northward, leading to weaker Kuroshio flow and stronger LST. See Figure 3. (On decadal timescales, the OFES correlation between the NECb latitude and LST is +0.72 and between Kuroshio transport and LST –0.82.)

From 1980 to 1993, the PDO and LST, though, were not in phase. The reason was the effect of the remarkable regime shift observed in the North Pacific during the 70s. Examination of wind-stress anomalies in OFES showed that the center of the Aleutian Low did not move as far south during this period as during other periods, preventing the PDO signals from penetrating into the tropics and from affecting the trade winds.

“In addition to the atmospheric teleconnections described in our study, variability in ocean temperatures and spiciness very likely also impact the decadal variations in Luzon Strait transport,” concludes Qu. “These are features we are now beginning to study.”

This study is based in part on Kai Yu and Tangdong Qu: Imprint of the Pacific Decadal Oscillation on the South China Sea throughflow variability, *J. Climate* (in press).



**Figure 3.** Normalized decadal variability of the upper layer (0–745 m) Luzon Strait transport (blue) and Kuroshio transport (KT: dashed line) compared with the latitude of the North Equatorial Current bifurcation (NECb) (green). Positive values indicate westward transport in the LST, southward transport in the Kuroshio, and northward movement of the NECb.



# Detecting Ocean Salinity from Space

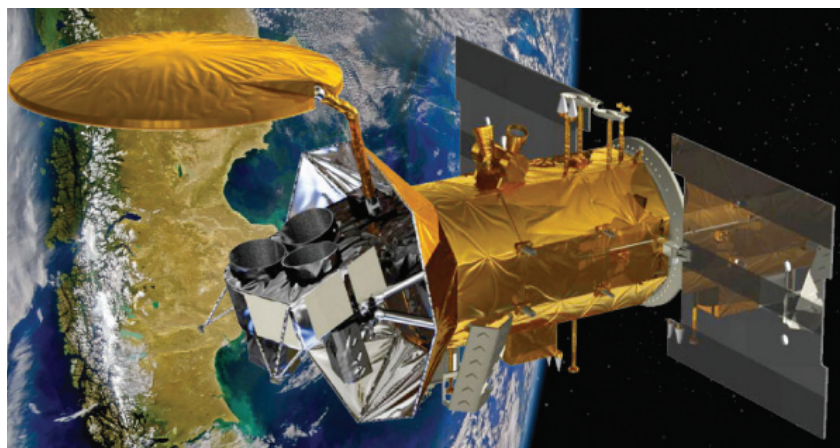


Illustration of Aquarius/SAC-D above Earth. Credit: NASA Aquarius Mission.

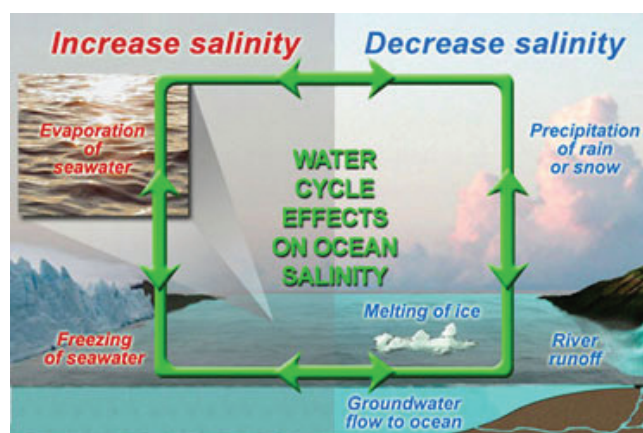
Ocean salinity reflects key processes in ocean circulation, the hydrological cycle, and climate. By defining its density, salinity combined with temperature determine ocean circulation including the large-scale overturning referred to as the thermohaline circulation. Past climate shifts have been accompanied by significant changes in salinity and the thermohaline circulation. Recent studies suggest that abnormal surface salinity in the far North Atlantic and unusual weather in Europe may be linked.

Evaporation and precipitation over the vast oceans, river runoff in coastal regions, and ice melt at high latitudes affect the time and geographical variations in ocean salinity as illustrated in the water cycle schematic. Scientists have seen indications that with global warming the water cycle has been speeding up over the past 50 years, and as a result the ocean's surface is getting saltier in salty regions and fresher in fresh regions. If this trend continues, the ocean circulation could be significantly affected.

Up until the last decade, measurements of sea surface salinity (SSS) have been relatively sparse despite their relevance, because they had to be collected from ships and buoys and therefore they lacked adequate resolution to study important oceanic features. This situation has improved over the past decade with the implementation of the Argo network of profiling floats and is changing dramatically with the launches of European Space Agency's SMOS Mission and the recent NASA Aquarius instrument on the Argentine Space Agency's SAC-D satellite. The Aquarius instrument can detect changes in SSS as tiny as one-eighth of a teaspoon per gallon of water. It now provides weekly, nearly global SSS information with a space and time resolution never achieved before.

Because Aquarius derives ocean salinity from measurements of the brightness and temperature of the ocean surface, numerous corrections for geophysical effects must be made—effects such as solar and galactic radiation, atmospheric gases, water vapor, rain, cloud liquid water, Faraday rotation, the ionosphere temperature, ocean surface temperature and the roughness of the ocean surface. The two years of data collected have allowed the calibration and validation team, including IPRC scientist, to begin to refine these measurements.

The IPRC team of researchers **Oleg Melnichenko**, **Peter Hacker**, **Nikolai Maximenko** (principal investigator), and **Jim Potemra** creates salinity maps by synthesizing Aquarius swath data with information from the array of Argo floats, which until now has been providing the largest volume of salinity data. While over 3600 Argo floats distributed throughout the world ocean provide information about the water column at a cycle of about 10-day and 3-5 degree



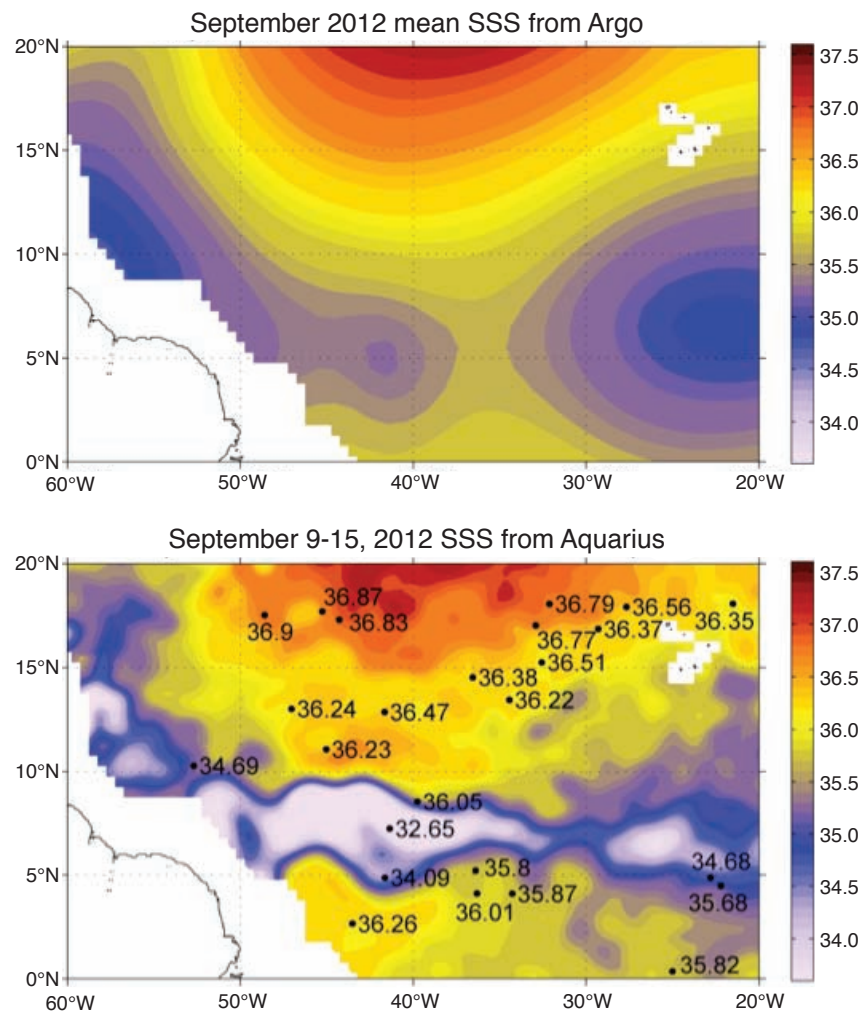
Credit: NASA Aquarius Mission.

resolution, Aquarius adds great detail at the surface, resolving major oceanic fronts and other mesoscale features.

Because patterns of the Aquarius SSS errors can be expected to occur over large areas, the IPRC team developed a method to detect such error patterns using the data from the Argo array. By synthesizing the large-scale signals sampled at float locations with the mesoscale signal from the along-track satellite measurements, the team is successfully producing meaningful SSS maps based on Aquarius. The maps have reduced the biases present in the original Aquarius data and allow space/time estimates of the signal and noise.

The value of these new Aquarius maps became evident when Melnichenko sent weekly salinity maps from such syntheses to **Raymond Schmitt** who coordinates a project of the Salinity Processes in the Upper Ocean Regional Study (SPURS) on board of R/V *Knorr*. The Aquarius maps showed a region in the North Atlantic where sea surface salinity was so high that some SPURS scientists thought the maps were wrong. The R/V *Knorr* working in the North Atlantic at the time collected on-site samples, which confirmed the extremely high salinity region.

An example of the wide-ranging use of Aquarius data in regional climate studies is seen in Figure 1, which compares the tropical North Atlantic SSS field as reconstructed from IPRC's Argo-calibrated Aquarius data with the mean SSS field obtained from in-situ Argo float data. Among the many features in the Aquarius SSS map is a plume of low-salinity water that extends from the Amazon River outflow



**Figure 1.** Comparison between the September mean tropical North Atlantic SSS field obtained from in-situ Argo float data (top) and the SSS field for September 9–15, 2012 as reconstructed by IPRC scientists from the Aquarius swath data (bottom). The Aquarius map clearly shows more fine-grained salinity structures than the Argo map; especially noteworthy is the plume of low-salinity water flowing out of the Amazon River and extending far into the Atlantic. (Bold numbers in panel 2 represent points of Argo observations.)

far into the tropical Atlantic. The plume, which is visible during summer and fall, but weakens or disappears in other months, is characterized by very low salinity with sharp boundaries setting it off from surrounding salty waters.

It is noteworthy that the plume stretches into an area where many of the tropical cyclones in the North Atlantic form during the peak hurricane season. The hypothesized connection is as follows: due to its lower density, the low

SSS plume is kept from mixing downward into the cold subsurface waters, creating a so-called barrier layer and a region of high sea surface temperature and deep atmospheric convection, conditions favorable for hurricanes.

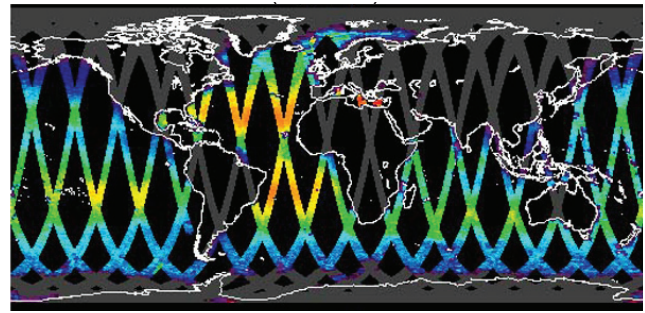
IPRC scientists are using these new high-resolution SSS maps to study the formation of subtropical salinity maxima and their connection with the equatorial oceans. As already known, each subtropical ocean has a region



where the surface is the saltiest. These regions, seen below on the global salinity map from Aquarius, are part of the subtropical overturning circulation. The salty, dense water in these regions subducts into the thermocline, contributing to the subtropical overturning circulation and transporting excess salt out of the subtropics toward the equator. Hydrographic observations show that these SSS maxima vary from year to year in location and magnitude and are greatly influenced by natural and anthropogenic processes. Through the ocean's shallow overturning circulation, such variations affect the atmosphere and thereby longer climate fluctuations.

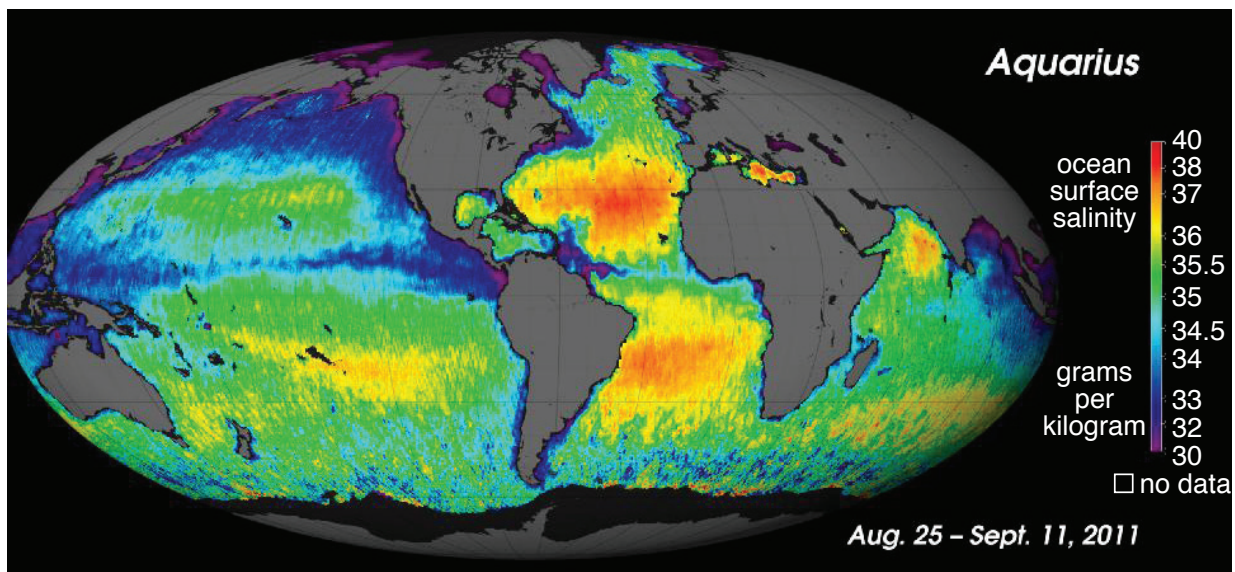
As part of the Aquarius Science Team, **Tangdong Qu** is leading a project with **Niklas Schneider** at the IPRC and **Ichiro Fukumori** at the Jet Propulsion Laboratory that aims to understand the formation and variation of these salinity maxima. The project's objectives include: (1) identifying the ocean processes governing the subtropical salinity maxima, (2) examining the transport of subtropical salinity maximum waters and their impact on the global thermohaline circulation, and (3) determining the variability and time scales of subtropical salinity maxima and the large-scale forces that shape them.

Aquarius salinity maps will also be used to constrain the "next-generation" long-term integration of JAMSTEC's Ocean Model for the Earth Simulator (OFES). Schneider



Aquarius sea surface salinity swaths on January 4, 2011. Credit: NASA/GSFC/JPL-Caltech.

plans to use the results of this integration to study the role of long-term salinity variations and their relation to the formation of mode water in the North Pacific. A recent analysis of decadal variations in water properties in coupled models run by IPRC and JAMSTEC scientists suggests that wind-driven meridional shifts in the sharp temperature and salinity gradients at the fronts between subtropical and subpolar water impact North Pacific mode-water formation. These results however are at odds with observational estimates that show the decadal variations in eddy-fields modulate mode-water formation. Aquarius salinity data together with OFES simulation results should help to untangle the dynamics of the region's mode-water formation.



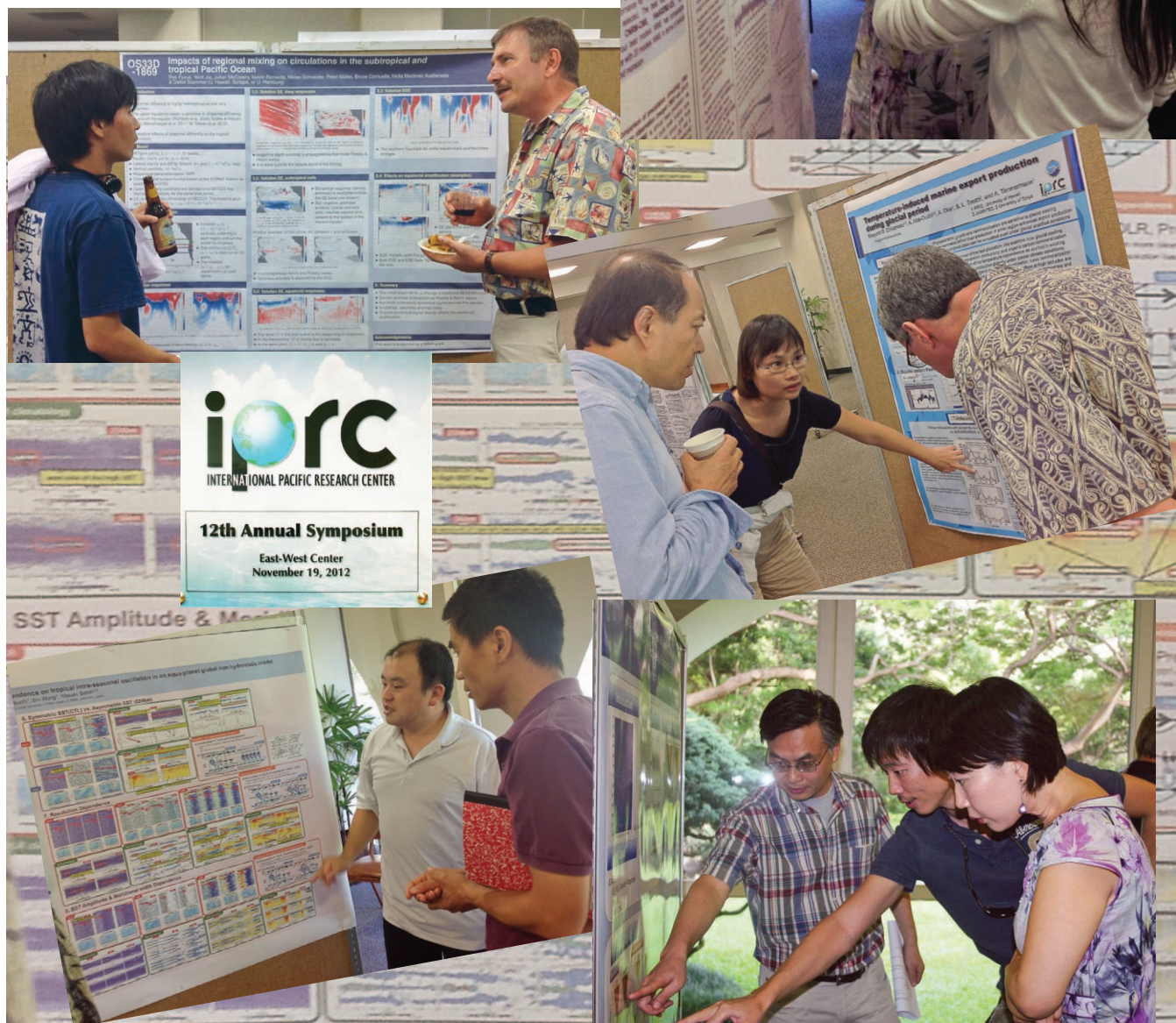
The first Aquarius global map of ocean saltiness, a composite of the first two and a half weeks of data since the instrument became operational on August 25, 2011. Credit: NASA/GSFC/JPL-Caltech.



# M E E T I N G S

## IPRC Annual Symposium

The IPRC held its 12<sup>th</sup> Annual Symposium at the East-West Center on November 19, 2012. At the “all poster” symposium, IPRC’s scientists presented 29 excellent posters ranging over all the major themes of IPRC research. In addition to the posters, the staff of the Asia-Pacific Data-Research Center showed off their data server and products on a large-screen video display. The format made for energetic discourse and animated exchange of research ideas among the IPRC and other UH Mānoa scientists who attended. The stimulating discussion concluded in the early evening with *pupus* and refreshments.





## The 5<sup>th</sup> OFES International Workshop

Since the establishment of the Earth Simulator in 2002, our colleagues at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) have been conducting unprecedented high-resolution ocean, atmosphere, and atmosphere–ocean coupled general circulation model simulations. The development and application of OFES (Ocean General Circulation Model For the Earth Simulator) has been one of the great successes of the Earth Simulator enterprise. Results from the very fine resolution OFES global simulations have been analyzed by scientists worldwide, resulting in important research outcomes.

IPRC scientists have worked closely with their JAMSTEC colleagues on analyses of OFES simulation results, leading to joint sponsorship of a series of international workshops devoted to OFES and related numerical climate modeling efforts. Following the success of the first four *OFES International Workshops* (in 2008, 2009, 2010 and 2011), the fifth workshop was organized as a special meeting that celebrated the tenth anniversary of the Earth Simulator and featured both a look at past modeling achievements made possible by the computational power of the Earth Simulator (ES) and a look at future possibilities of fine-resolution climate modeling.

*The 5<sup>th</sup> OFES International Workshop: 10-Year Progress of GCMs for the ES and Future Strategic Perspective* was sponsored and organized by the IPRC, the JAMSTEC Earth Simulator Center (ESC), the JAMSTEC Research Institute for Global Change (RIGC), and the JAMSTEC Data Research Center for Marine-Earth Science. The meeting was held January 24–25 at the JAMSTEC Global Oceanographic Data Center in Nago on the island of Okinawa. Six IPRC scientists attended, joining our JAMSTEC colleagues as well as other participants from Japan, China, Hong Kong and India. Presentations included projects on analyses of results from OFES, AFES (Atmospheric General Circulation Model For the Earth Simulator) and CFES (Coupled General Circulation Model For the Earth Simulator), as well as other modeling and observational studies. The final workshop session consisted of a general discussion of prospects for further development and applications of OFES, AFES, and CFES and of related data-management challenges.

**Hideharu Sasaki** of the ESC served as lead convener and **Yukio Masumoto** (RIGC) and **Kevin Hamilton** (IPRC) as co-conveners of the workshop. The meeting agenda is available at [tinyurl.com/IPRCofes5](http://tinyurl.com/IPRCofes5).



Participants at the 5<sup>th</sup> OFES International Workshop in Nago.

## Minisymposium on Climate Variability, Predictability, and Change

The IPRC has a tradition of holding “minisymposia” during visits of distinguished scientists. These half-day or day-long meetings feature mainly talks by IPRC’s younger scientists. The *Minisymposium on Climate Variability, Predictability, and Change* was held during **Robert Dickinson’s** and **Rong Fu’s** visit from the University of Texas. Dickinson, a member of both the National Academy of Sciences and the National Academy of Engineering, is a leader in dynamical meteorology and climate modeling, with seminal contributions to such subfields as stratospheric dynamics, thermospheric science and modeling, planetary atmospheres and modeling of earth surface processes. Rong Fu, since 2008 a

faculty at the Jackson School of Geosciences at the University of Texas at Austin, has expertise in satellite remote sensing applications, convection, cloud- and precipitation-processes, and atmosphere-ocean-land interaction. Fu has served for some years on the IPRC Science Advisory Committee.

The minisymposium featured 11 talks from IPRC faculty, researchers, postdoctoral fellows, visitors, and graduate students on such topics as monsoon predictability, the structure of global warming in the troposphere, and effects of climate change on tropical cyclones. The IPRC participants appreciated the helpful comments from the Texas visitors. Associate Researcher **June-Yi Lee** and UH Meteorology graduate student **Owen Shieh** organized the symposium. The meeting agenda is at [tinyurl.com/IPRCdrf](http://tinyurl.com/IPRCdrf).



Participants at the minisymposium with Robert Dickinson and Rong Fu at the right wearing leis.

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## Final Meeting of NASA Ocean Mixing Project

In 2010 a joint UH/IPRC–University of Hamburg–Scripps partnership was funded by NASA to study detailed ocean-mixing processes and their parameterization in ocean models. The key scientists from the three centers have held several workshops at the IPRC, and in March 2013 they held their final meeting. The participants discussed the manuscripts completed and to be written on the project by the research teams.

**Chuanyu Liu**, **Armin Koehl**, and **Detlef Stammer** of the Hamburg team have completed a paper on the global optimization of mixing parameters in a coarse-resolution model. They found that the estimated distributions of mixing parameters are dynamically sound.

**Bruce Cornuelle** and **Nidia Martínez Avellaneda** of Scripps Institution of Oceanography (SIO) have been writing

about short-term optimization of mixing parameters in an eddy-permitting model. Their adjoint sensitivity analysis gives a dynamical interpretation to the Hamburg team’s result on vertical diffusivity. They have demonstrated that changes in vertical mixing in the western equatorial Pacific affect the thermocline in the eastern Pacific by advection and wave propagation.

The IPRC–University of Hawai‘i Team (**Ryo Furue**, **Jay McCreary**, **Peter Müller**, **Kelvin Richards**, and **Niklas Schneider**) conducted a forward sensitivity study with the SIO team’s model and demonstrated the same sensitivity to vertical mixing as in the adjoint runs of the SIO results. The team also explored long-term signal propagation and decided to write about using Green’s functions to obtain optimal vertical mixing coefficients.



## 2013 IPRC PUBLIC LECTURE



Meeting Hawai'i colleagues interested in the climate science/policy interface. From left, Victoria Keener (East-West Center), IPRC Director Kevin Hamilton, William Chameides, Zena Grecni (East-West Center), Richard Wallsgrave (Blue Planet Foundation).

For the last several years, the IPRC has sponsored an annual public lecture on climate science and its implications for humanity. Held in the evening on the University of Hawai'i (UH) Mānoa campus, the lecture draws an audience from the local community as well as students and staff from a broad cross section of UH.

The 2013 IPRC Public Lecture in Climate Science featured **William Chameides**, Dean of the Nicholas School of the Environment at Duke University. A member of the National Academy of Sciences, Chameides has had a career of more than 30 years in academia, and for several years was Chief Scientist at the Environmental Defense Fund. With a long-standing interest in communicating the results of environmental science to the broader public, Chameides has become a prolific blogger at numerous sites, including *Scientific American*, *The Huffington Post*, and *Popular Science*.

Chameides' lecture "Dealing with Climate Change: Are We Flying Blind?" took place on March 11. The lecture opened with a brief history of the concept of greenhouse-gas-induced global

warming as the science developed through the 19<sup>th</sup> and 20<sup>th</sup> centuries. The science behind the expectation that global mean temperatures will rise has become more complete and reliable and has naturally stimulated a broad global debate on strategies for coping with global warming and its consequences.

Uncertainties, of course, remain in our understanding and our capacity to project accurately future climate changes. Chameides noted the tendency for some people to use the remaining scientific uncertainties to question the basic premise behind man-made global warming. His response was to suggest that the science of global warming should be viewed not as a rickety building that may collapse if one brick is removed, but rather as a jigsaw puzzle. As we solve a jigsaw

puzzle, we reach a point where enough pieces of the puzzle are in place so that the overall picture is already clear even though a number of individual pieces are still not placed.

"We may not yet have all the pieces to the global warming puzzle," Chameides said, "but that Earth's temperatures are rising due to greenhouse gas emissions is a fact to which we must adapt." Chameides concluded with a brief discussion of options for mitigating global warming and adapting to effects of anticipated climate change.

A lively and wide-ranging discussion followed the lecture, with the audience providing interesting perspectives on the issue of individual responsibility and the role of individual action in dealing with the consequences of global change.

### *Previous IPRC Public Lectures in Climate Science*

#### **2009** *A Tale of Environmental Change*

By Dr. Susan Solomon, Senior Scientist, National Oceanic and Atmospheric Administration

#### **2010** *Changing World, Changing Ocean*

By Dr. Susan Avery, President and Director of Woods Hole Oceanographic Institution

#### **2011** *Climate Change and Development: Avoiding the Unmanageable and Managing the Unavoidable*

By Dr. Rosina Bierbaum, Professor, University of Michigan

# WHAT'S NEW AT THE APDRC

IPRC's Asia-Pacific Data-Research Center (APDRC) acquires and serves a wide variety of products from *in-situ* platforms, satellites, and numerical models. We report here on some developments during the last year.

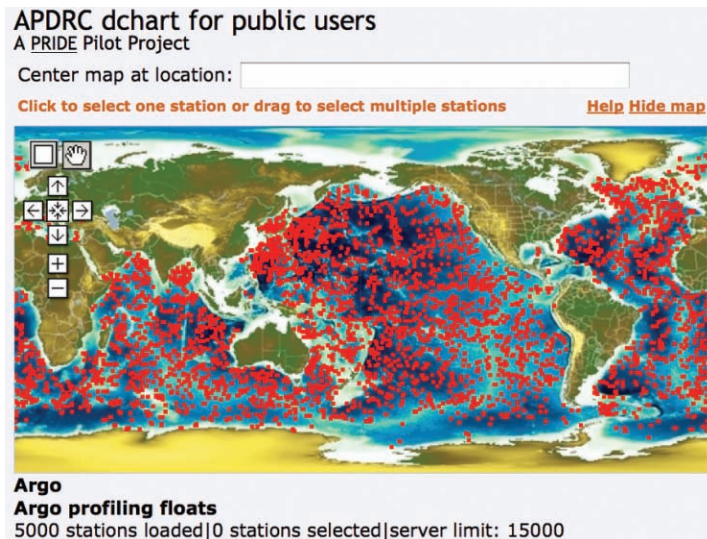
The APDRC now provides access to Argo-float data (including temperature and salinity) through DChart, allowing browsing and downloading capability: near-real time data are available from Global Data Assembly Centers or GDACs. Until recently, the NOAA Pacific Marine Environmental Laboratory provided this service. The DChart browsing tool is a core data-service of the APDRC and access with DChart of near-real time Argo profiles significantly broadens our capabilities.

The APDRC has been partnering with the Pacific Climate Information System (PaCIS), a NOAA effort to provide climate-related information and data to users in the US-Affiliated Pacific Islands. The APDRC now hosts, develops, and maintains the PaCIS home web site (<http://www.pacificcis.org/>).

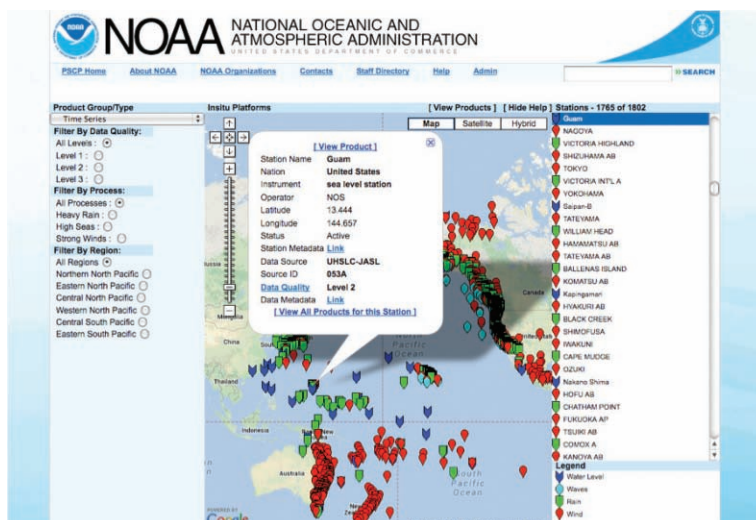
org/) and the linked pages for PaCIS projects. The projects include various databases, tools, and information about climate variability and outlooks for the Pacific.

An example is the Pacific Storms Climatology Products site (<http://pacificstormsclimatology.org/>), which provides straightforward analyses of

past high sea-level, rain and wind events to help communities mitigate impacts of future weather extremes. Another web-based resource (PacificIslandsClimate.org, known as PICO), served now by the APDRC, is a searchable archive of climate-related information and events specific to Pacific Islands. Other components of the APDRC/PaCIS partnership are found on the PaCIS site.



The APDRC provides access to all Argo float data with DChart, a web-based data-browsing tool. The figure shows a screen-shot of an example search DChart of all floats at their locations for the period selected: July 1 through July 31, 2013.



Pacific Storm Climatology website.



IPRC's Senior Computer Systems Engineer Sharon DeCarlo and John Marra, NOAA Pacific Regional Climate Services Director and PaCIS Chair, are working together on climate services to the Pacific Islands.





From left, Brian Taylor, Toru Kimoto (JAMSTEC Intl. Affairs Division), Aska Solange Vanroosebeke (JAMSTEC Intl. Affairs Division), Kevin Hamilton (IPRC Director), Yukio Masumoto (JAMSTEC Research Institute for Global Change), Tetsushi Komatsu (Manager, JAMSTEC Intl. Affairs Division), Masao Fukasawa (Research Director, JAMSTEC Research Institute for Global Change), Yoshihisa Shirayama, and Eric Lindstrom.

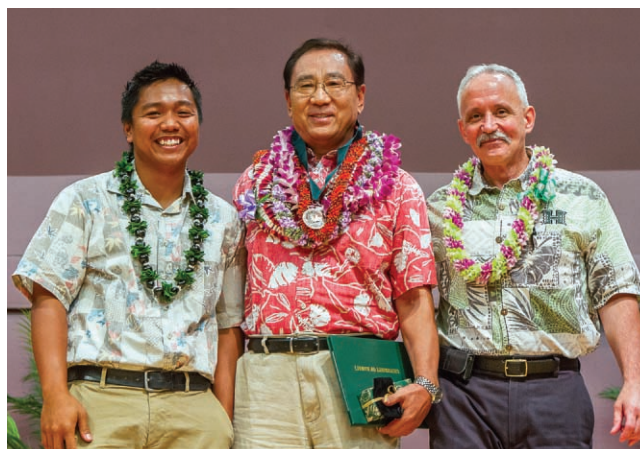
## IPRC Governing Committee Meets

The IPRC Governing Committee (GC) held its 2013 annual meeting on May 9 at the IPRC. The meeting was co-chaired by GC members **Yoshihisa Shirayama** (JAMSTEC Executive Director) and **Eric Lindstrom** (NASA Physical Oceanography Program Scientist). Also present was GC member **Brian Taylor** (SOEST Dean and Interim Vice Chancellor for Research, University of Hawai'i at Mānoa). GC member **Howard Diamond** (NOAA Program Manager for the Global Climate Observing System) joined via telephone from Washington; GC member **Takashi Kiyoura** (Director for Environmental Science and Technology of the Japan Ministry of Education, Culture, Sports, Science and Technology) could not attend and sent a written message for the participants. The meeting participants reviewed overall progress at IPRC and considered IPRC's current and future relationships with its Japanese and US supporting agencies.

## IPRC's Bin Wang Wins Prestigious Awards

IPRC faculty member **Bin Wang** received two exceptional awards for his scientific achievements spanning his career in meteorology. In April he was honored with the University of Hawai'i Board of Regents' Medal for Excellence

in Research. This award recognized Wang's scientific contributions over his 25 years as a faculty member at UH. More recently Wang has been elected as a 2013 Fellow of the American Geophysical Union (AGU) for "seminal contributions to the advancement of scientific understanding of the dynamics and predictability of monsoon and tropical climate." Attaining the rank of Fellow is a very high recognition for outstanding research in the geosciences as the AGU accords this honor to only 0.1% of the members each year.



Bin Wang at the 2013 UH Mānoa Awards Ceremony with UH Regent Jeffrey Acido (left) and UH Mānoa Chancellor Tom Apple (right).

## Okada Prize Awarded to Hiroki Tokinaga

IPRC Assistant Researcher **Hiroki Tokinaga** received in March the prestigious Okada Prize of the Oceanographic Society of Japan during its Annual Spring Meeting at Tokyo University of Marine Science and Technology. The prize commemorates the late Professor **Takematsu Okada** and is awarded to a young member of the Society who has contributed significantly to the progress of oceanography. Tokinaga

received the prize for his work on detecting long-term tropical ocean climate change accompanied by ocean-atmosphere interaction. As reported in *IPRC Climate* vol. 12, no. 2, in 2012 Tokinaga won the Meteorological Society of Japan Yamamoto-Shyono Medal for research achievement by an early-career meteorologist. He is the first scientist to receive both prizes.



Hiroki Tokinaga presents his winning work on tropical ocean climate change.

## Japanese Agencies Partner with Hawai'i on Tsunami Driftage

Concerned about the 2011-tsunami driftage washing up on US beaches, representatives of Japanese governmental and non-governmental agencies—including the Japanese Ministry of Environment, the Japan Environmental Action Network (JEAN) and the Sea Beautification Program—visited Hawai'i in January 2013. With

Chris Woolaway, Director of the Hawai'i International Coastal Cleanup, as their guide, the visitors inspected the presence of likely tsunami driftage that had already arrived on several Hawai'i beaches.

In line with their mission to research, gather and publish reports on marine debris, JEAN members organized a meeting on January 10, 2013, at the Ala Moana Hotel in Honolulu. At the meeting, the Japanese visiting agencies shared their experiences in monitoring and cleaning up tsunami driftage.

IPRC Senior Researcher **Nikolai Maximenko** described the timelines and pathways of different debris types based on the model he has developed at the IPRC. The International Coastal Cleanup groups in Hawai'i and other Hawai'i governmental and non-governmental groups dealing with marine debris gave overviews of their work on coastal cleanup and monitoring.

The groups discussed strategies for monitoring and responding to arrival of tsunami driftage and to the general marine debris problem.



Participants of the Tsunami Driftage meeting in Honolulu.



## IPRC–PNU Partnership Continues with the 12<sup>th</sup> East Asia Climate Workshop

The fruitful IPRC–Pusan National University (PNU) Partnership, described in *IPRC Climate* vol. 12, no. 1, continued this summer with the 12<sup>th</sup> East Asian Climate Workshop, held during the first three days of July in Busan. The workshop “New Perspectives and Challenges in East Asian Climate Science” was characterized by lively exchange of ideas among scientists on the workshop’s theme and by forging scientific collaborations.

Workshop host was Professor **Kyung-Ja Ha**, the Korean principal investigator of the PNU–IPRC project, a 6-year program of Korea’s Global Research Laboratory designed to promote international collaborative research between Korean and foreign laboratories.

In his welcoming address, PNU Vice-President Prof. **Ho-Hwan Chun** stressed that the Northwest Passage will soon be open. “This will change trade patterns, and special attention is needed on arctic climate research.” Professor **Soon-Chang Yoon** from Seoul National University and Chairman of the Asia-Pacific Climate Center Board charged the participants with decreasing the large uncertainty remaining in forecasts of climate change and its environmental impact.

The workshop had four major topics: Aerosol–Cloud–Precipitation; Atmosphere–Ocean–Land Interaction; Mon-

soon Variability; and Climate Changes, Modeling, and Prediction. Over 120 international guests participated and gave 53 talks. The 19 poster presentations given by junior scientists and graduate students point to the successful education of young climate scientists, a mission of the PNU–IPRC partnership.

The IPRC was well represented, with several talks by Profs. **Bin Wang** (the IPRC principal investigator of the PNU–IPRC project) and **Tim Li**, and also by associate researchers **Xiouhua Fu** and **June-Yi Lee**. IPRC long-term visitors **Andrea Alessandri** from Italy and **Soon-Yon Kim** from Korea also presented. The papers by the IPRC participants dealt mostly with promising advances in monsoon prediction: Alessandri reported on using ensemble dynamical seasonal forecasts to refine prediction of the Indian monsoon onset; Fu spoke about how air-sea coupling in the University of Hawai’i model extends skillful forecasting of monsoon wet and dry spells as validated against CINDY/DYNAMO field observations; Lee and Wang introduced the “predictable mode analysis,” a new method that includes information about atmospheric patterns for more accurate Asian summer monsoon forecasts. Wang also talked about advancing East Asian monsoon rainfall and tropical cyclone forecasts by taking advantage of the predictability of the western Pacific Subtropical High.

The agenda is at <http://gmcl.pusan.ac.kr/EAC12/>.



## UH Hosts Pacific Islands Climate Science Symposium

The US Department of Interior (DOI) has recently created regional partnerships with academic institutions and community stakeholders as a strategy to include the effects of climate variation and change in its mission to protect the nation's natural and cultural resources. Specifically, a network of 22 Landscape Climate Cooperatives and 8 regional Climate Science Centers was established across the US. Hawai'i and the US affiliated Pacific islands are served by the Pacific Islands Climate Science Center (PICSC) and the Pacific Islands Climate Change Cooperative (PICCC).

The PICSC and PICCC fund several projects of IPRC scientists. Founded last year, the PICSC is a partnership among the DOI, the University of Hawai'i at Mānoa and at Hilo, the University of Guam, and several other institutions. The IPRC is closely connected with the PICSC as IPRC Director **Kevin Hamilton** is University Director of the PICSC.



The PICSC and PICCC held the *First Annual PICSC/PICCC Science Review Symposium* on July 15 on the UH Mānoa campus. World-renowned biogeochemist and ecologist **Peter Vitousek** of Stanford University gave the opening keynote address titled "Atmospheric and Geological Sources of Nutrients for Forests and for Traditional Agriculture: Thresholds and Irreversibilities Associated with Climate and Climate Change."

Presentations summarizing the achievements of 24 individual projects funded by the PICSC or PICCC then followed. All talks dealt with climate change and variability and its effects on the Pacific islands, spanning a broad range of physical and biological science issues. Organized by IPRC Director Kevin Hamilton, PICSC federal Interim Director **David Helweg** and PICCC Science Coordinator **Jeff Burgett**, the meeting attracted an audience of nearly 100.

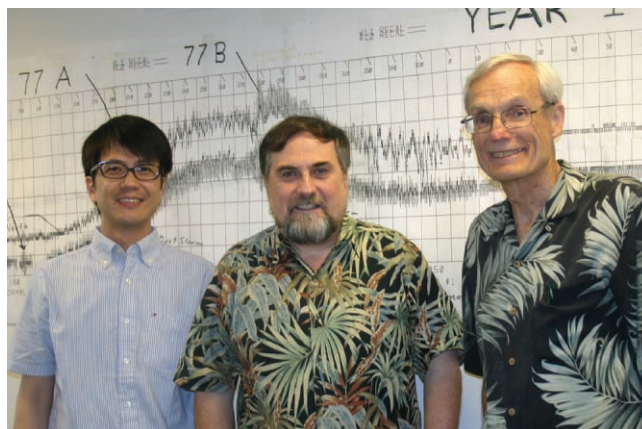


PACIFIC ISLANDS  
CLIMATE CHANGE COOPERATIVE

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## Tropical Weather Prediction Pioneer Visits

**Russell Elsberry**, Distinguished Research Professor at the Department of Meteorology of the Naval Postgraduate School in California, visited the IPRC on April 12. During his nearly half-century scientific career, Elsberry has been a leader in developing and applying numerical models for tropical cyclone forecasting. Elsberry was accompanied by National Research Council Postdoctoral Fellow **Hsiao-Chung Tsai**. Elsberry and Tsai held discussions with several colleagues at the IPRC and the UH Meteorology Department and presented a joint seminar "Progress in Tropical Cyclone Forecasting and Research (1963-2013)."



From left, Hsiao-Chung Tsai, IPRC Director Kevin Hamilton and Russell Elsberry.



## Toshio Yamagata Visits

In April, the IPRC welcomed University of Tokyo Emeritus Professor **Toshio Yamagata**. Yamagata was the leader among the Japanese scientists who conceived of a joint US–Japan research enterprise to study climate and climate change. His efforts were crucial to the founding of IPRC in 1997. From 1997 to 2004 Yamagata was the JAMSTEC Program Director responsible for the IPRC.

Yamagata retired from the University of Tokyo in 2012 as Professor of Earth and Planetary Sciences and Dean of Science after a distinguished career spanning Kyushu University, Princeton University and the University of Tokyo. Currently he is Director of the Application Laboratory at JAMSTEC. An innovator in the field of large-scale atmosphere–ocean interaction and tropical interannual variability, Yamagata has won the highest award of the Japan Meteorological Society, the Sverdrup Medal of the American Meteorological Society, and the Medal with Purple Ribbon from the Emperor of Japan.

During his visit, Yamagata gave a seminar titled “Predictability of the Subtropical Dipole Modes in the Atlantic

and Indian Oceans.” He took this opportunity to describe results of a multiyear project led by the University of Tokyo and JAMSTEC with South African partners. The project is conducted under the aegis of Japan’s Science and Technology Research Partnership for Sustainable Development.

During Yamagata’s visit an informal session of presentations by some of IPRC’s more junior scientists was arranged which led to lively discussions.

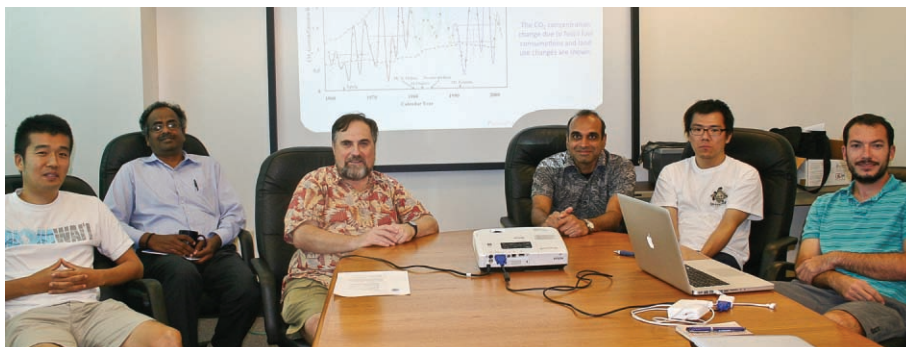


IPRC Postdoctoral Fellow Baoqiang Xiang with Toshio Yamagata.

## JAMSTEC Atmospheric Chemists Visit

Three colleagues from the Atmospheric Geochemical Cycle research team of JAMSTEC’s Research Institute for Global Change gathered at the IPRC in December 2012, when **Ryu Saito** and **Prabir Patra** joined **Kazuyuki Miyazaki** in the middle of his six-month visit. During their visit, the three experts made presentations and discussed with IPRC colleagues their project on representing the observed carbon cycle in the atmosphere. Recent advances in

global observations (notably the Japanese Greenhouse gases Observing SATellite or GOSAT) and in data assimilation techniques open the possibility of using atmospheric data to infer accurately the detailed map of CO<sub>2</sub> surface fluxes over the globe. Such a product could have wide ranging implications for understanding the oceanic and terrestrial carbon cycles and even for formulating strategies to mitigate global CO<sub>2</sub> emissions.

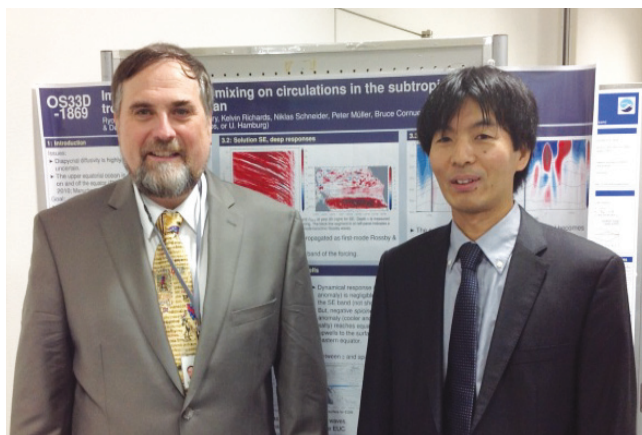


From left, Kazuyuki Miyazaki, IPRC Senior Researcher H. Annamalai, IPRC Director Kevin Hamilton, Prabir Patra, Ryu Saito, and IPRC Postdoctoral Fellow Matthew Widlansky.

## IPRC Scientists Active in the Research Community

### IPRC at the RIGC Annual Symposium

Masao Fukasawa, Research Director of JAMSTEC's Research Institute for Global Change (RIGC) invited IPRC participation in the *RIGC Annual Review Symposium* held at Yokosuka headquarters on March 28. Director **Kevin Hamilton** and Assistant Researcher **Ryo Furue** represented the IPRC, summarizing highlights of IPRC–JAMSTEC collaborative research during the 2012–2013 period. Furue also presented two posters describing his work on ocean mixing and ocean current structure near Australia.



Kevin Hamilton and Ryo Furue in front of one of Furue's posters at the *RIGC Annual Review Symposium*.

### IPRC Participates in the Fifth Climate Assessment Report of the IPCC

As the writing of the Fifth Assessment Report (AR5) of the International Panel on Climate Change entered its final stage, **Axel Timmermann** worked long hours as a lead author of the chapter, "Information from Paleoclimate Archives" in *Climate Change 2013: The Physical Science Basis*, the report of Working Group 1. The chapter describes the current state of our knowledge of the past climate system, going back 55 million years, with a focus on the last 2 million years. The chapter includes the newest information about how the climate system has responded to external forcing such as greenhouse gases as reflected in ice- and sediment-cores, tree-rings, and other proxy records. The Working Group 1 Report was published on September 30, in Stockholm, Sweden.

## Scientific Appointments

IPRC faculty member **Yuqing Wang** has recently been appointed an editor of *Advances in Atmospheric Sciences*, a journal of Springer Publishing. He joins these new duties to continuing service as an editor of *Weather and Forecasting*, published by the American Meteorological Society, and as an editor of the *Journal of the Meteorological Society of Japan*.

IPRC Director **Kevin Hamilton** has been appointed to the inaugural Editorial Advisory Board for *Progress in Earth and Planetary Science* (PEPSci), a new journal of the Japan Geoscience Union. Hamilton joins this new duty to his service on the editorial board for the American Geophysical Union's *Journal of Advances in Modeling Earth Systems* and as an associate editor of the Canadian journal *Atmosphere-Ocean*.

Senior Researcher **H. Annamalai** has been appointed by the CLIVAR Scientific Steering Group to the Asian-Australian Monsoon Panel, where he will contribute to the direction of future monsoon research across the projects of the World Climate Research Programme.



## IPRC Scientists Active in the Community

### IPRC Scientists Participate in Science Fairs

The *Pacific Symposium for Science and Sustainability* (PSSS) is a trans-Pacific science fair and serves as a regional competition of the national *Junior Science and Humanities Symposium*. IPRC faculty member **Jim Potemra** has assisted for several years with the PSSS and this past year served as Chief Judge. Also acting as judges were IPRC faculty **Niklas Schneider** and **Kevin Hamilton**. The fair, which was held from November 30 to December 2, 2012, on the UH Mānoa campus, drew 87 high school students from Hawai'i, American Samoa, and the Federated States of Micronesia. The top four students from the PSSS received invitations and travel funds to participate in the national competition held in May 2013 in Dayton, Ohio.

Potemra also acted as a judge during the Hawai'i State Science Fair held April 7–9, 2013, at the Hawai'i Convention Center in Honolulu. This statewide event attracted over 200 high school and middle school students.



## *IPRC Scientists Contribute to Earth Week Celebrations*

Joining in the 2013 Earth Week celebrations, IPRC's **Axel Timmermann** gave a talk, answering "Fifteen Frequently Asked Questions on Climate Change," such as how much of the recent warming can be attributed to human activities? what are the biggest uncertainties in scientists' predictions of Global Warming? and how will the Hawaiian Islands be impacted by future climate change, sea level rise and ocean acidification? Timmermann presented on three consecutive days at the Hawai'i State Capitol Auditorium, University of Hawai'i (UH) Mānoa Campus, and UH West Oahu. The Mānoa Campus talk was broadcast to all UH campuses.



**Axel Timmermann answers frequent climate-change questions during Earth Week. Credit Richard Figliuzzi.**

Scientific Computer Programmer **Jan Hafner** represented the IPRC at the US Navy's Earth Day celebration, which took place on the Navy Exchange Mall in Pearl Harbor.



**Jan Hafner displays IPRC research efforts on tracking marine debris.**

Hafner set up a display to educate the public on the huge marine debris problem in Hawai'i. Among his display items, he had debris samples from Kamilo Beach on the Island of Hawai'i and an oyster buoy that is almost certainly from the 2011 tsunami in Japan. The public was fascinated by his display, learning about marine debris and about IPRC research activities. The event was broadcast on the Navy's TV channel.

## *IPRC at the Pacific Islands Climate Services Forum*

The *Pacific Islands Climate Services Forum* took place January 21–25, 2013, at the University of the South Pacific (USP) Laucala Campus in Suva, Fiji. Organized by the Pacific Climate Information System through the National Oceanic and Atmospheric Administration (NOAA) and by the USP Pacific Centre for Environment and Sustainable Development, the Forum brought together over 200 participants from the Pacific islands and the world. The organizing committee included IPRC faculty member **Jim Potemra** as well as IPRC Governing Committee member and NOAA Program Manager **Howard Diamond**.

The intent of the Pacific Islands Climate Services Forum was to advance the use of climate services among Pacific Islanders by familiarizing and engaging Forum participants in a dialogue about available regional climate services. The Forum was also intended to strengthen and build new relationships between producers and users of climate services and included training sessions on using the existing online climate information resources. Potemra led one of these training sessions. A final report of the meeting is available at <http://tinyurl.com/IPRCpacis>.



**Students at a training session in the Pacific Islands Climate Services Forum.**

## IPRC Research in the News

The media frequently feature scientific studies published by IPRC scientists. Below is a selection of such work. More information is available on the IPRC News webpage at [tinyurl.com/IPRCnews](http://tinyurl.com/IPRCnews).

### More Hurricanes for Hawai'i?

Hawai'i, fortunately, has been largely free of hurricanes in the recent past. Now a study by IPRC's **Hiroyuki Murakami** and **Bin Wang**, and by **Akio Kitoh** at the Japan Meteorological Research Institute projects a two-to-

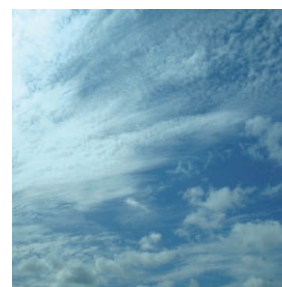
threefold increase in tropical cyclones approaching Hawai'i in the last quarter of this century. The study, published in the May 5, 2013, online issue of *Nature Climate Change*, was featured on *Hawai'i News Now*.



### Global Monsoon Rainfall Intensifies

An international team of scientists around **Bin Wang** at the International Pacific Research Center found that natural swings in the climate have significantly intensified Northern Hemisphere monsoon rainfall in recent years. These swings must there-

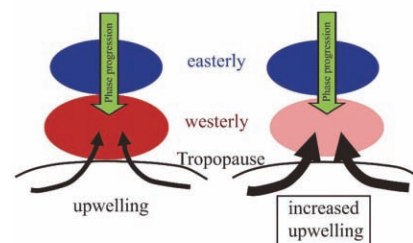
fore be taken into account in climate projections. Published in the March 18 online *Proceedings of the National Academy of Sciences*, the findings were featured in the Dot Earth blog of the *New York Times*.



### The Tropical Upper Atmosphere "Fingerprint" of Global Warming

The winds of the quasibiennial oscillation in the tropical upper atmosphere have greatly weakened at some altitudes over the last six decades, according to a study by IPRC's **Kevin Hamilton** and JAMSTEC's **Yoshio Kawatani**. Published in *Nature* on May

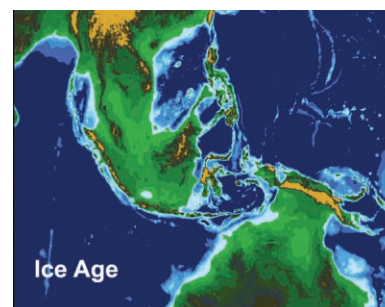
23, 2013, the finding agrees with computer model projections of how the upper atmosphere responds to global warming induced by increased greenhouse gas concentrations, and was featured in several Japanese national newspapers including the *Asahi Shimbun*.



### Sea Level Impact on Indo-Pacific Climate during Glacial Times

Young Investigator **Pedro DiNezio** at the IPRC and **Jessica Tierney** at Woods Hole Oceanographic Institution studied preserved geological clues (called "proxies") of rainfall patterns during the last ice age when the planet was dramatically colder than today.

Comparing these patterns with computer model simulations, they found that the exposed Sunda Shelf during the last ice age shifted rainfall and convection westward. The study, published in the May 19 online issue of *Nature Geoscience*, was featured in *redOrbit*.





## El Niño Unusually Active in the Late 20<sup>th</sup> Century

How El Niño responds to global warming has been difficult to forecast reliably because El Niño varies naturally over decades and centuries. Instrumental records, thus, are too short to determine whether recent changes are natural or attributable to increased greenhouse gases. An international team of scientists, spearhead-

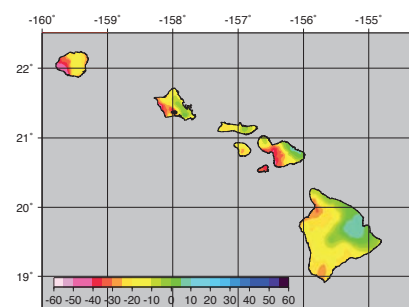
ed by **Jinbao Li** and **Shang-Ping Xie** while at the IPRC, now has shown that recent El Niño activity is the highest for the past 700 years, possibly in response to global warming. Their work, published in the June 30, 2013, online issue of *Nature Climate Change*, was featured in the *Christian Science Monitor*.



## Less rainfall expected for the Hawaiian Islands

Almost imperceptibly, rainfall over the Hawaiian Islands has been declining since 1978, and this trend is likely to continue with global warming through the end of this century, according to a team of scientists led by IPRC's **Oliver Ellison Timm** and colleagues at the

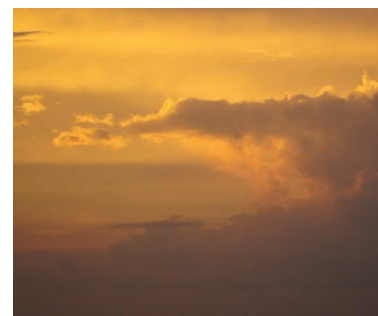
University of Hawai'i at Mānoa and the University of Colorado at Boulder. The study, published in the March 13, 2013, online issue of the *Journal of Geophysical Research*, was featured on the KITV evening news.



## Change in Seasonal Patterns of Tropical Rainfall from Global Warming

Projections of rainfall changes from global warming have been very uncertain because scientists could not determine how two different mechanisms will impact rainfall. The two mechanisms turn out to complement each other and together shape the spatial dis-

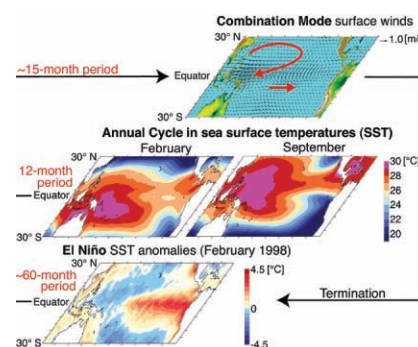
tribution of seasonal rainfall in the tropics, according to IPRC's **Shang-Ping Xie** and Chinese colleagues. Published in the April 14 online issue of *Nature Geoscience*, their study was featured in the *Summit County Citizens Voice*.



## New Research Could Lead to Improved El Niño Forecasting

Why El Niño peaks in boreal winter and ends quickly in February to April has been a long-standing mystery. The answer is that El Niño conditions and the annual cycle act upon each other to generate an unusual wind pattern in the tropical Pacific with a 15-month period, according to

a study by IPRC's **Axel Timmermann** and **Malte Stuecker** and **Fei-Fei Jin** at the UH Mānoa Meteorology Department. The study, which could lead to improved El Niño forecasting, was published in the May 26 online issue of *Nature Geoscience* and featured in *TopNews Arab Emirates*.



# V I S I T I N G   S C H O L A R S

## *Extended Visits by JAMSTEC Experts in Atmospheric Chemistry and Climate Modeling*

In recent years, the IPRC has hosted several scientists from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) for extended periods through a special JAMSTEC fund for such exchanges. During the previous two years, seven scientists from the Research Institute for Global Change (RIGC) and the Earth Simulator Center spent a total of 22 months at the IPRC. In continuing this program, which has the interest and support of JAMSTEC Executive Director **Yoshihisa Shirayama**, IPRC hosted this year two outstanding young atmospheric scientists from RIGC.

**Kazuyuki Miyazaki**, during his stay from October 2012 through March 2013, worked with IPRC's **Yuqing Wang** on model parameterizations of the vertical transfer of air associated with moist convection and parameterizations of the chemical changes induced by lightning in deep convection. Miyazaki analyzed results of cloud-resolving model simulations conducted at the IPRC and assessed the uncertainties stemming from the use of current cumulus-convection parameterizations in global models. This joint JAMSTEC–IPRC work should help to improve parameterizations of lightning-induced chemical processes in climate models.

**Tomoe Nasuno**, visiting the IPRC from December 2012 through March 2013, worked with IPRC's **Tim Li** on finding what triggered the strong Madden-Julian Oscillation (MJO) during the CINDY/DYNAMO field campaign (October 2011–January 2012). Finding the triggers for deep convection associated with the beginnings of MJO events in



From left, **Tim Li**, **Tomoe Nasuno**, **Kazuyuki Miyazaki**, and **Yuqing Wang**.

the western Indian Ocean remains a formidable challenge. The CINDY/DYNAMO field campaign, led by JAMSTEC and US agencies, exemplifies the kind of large-scale international collaborative effort that is needed to understand the MJO more fully: an effort that combines in-situ observations, high-resolution reanalysis, and global cloud-resolving models.



From left, **Takuya Hasegawa**, **Chunxi Zhang**, **Yuqing Wang**, and **Toru Miyama**.

## *Expanding IPRC Regional Climate Modeling Efforts*

**Toru Miyama**, a former IPRC visiting assistant researcher, and his colleague **Takuya Hasegawa**, both now at RIGC, worked extensively with **Yuqing Wang** on the development and applications of the IPRC regional climate model, which has been used in various JAMSTEC projects to study atmospheric climate features from the tropics to the midlatitudes. In one such project, Miyama and Hasegawa are using the IPRC regional atmospheric model to understand how the sharp sea surface temperature gradient, stemming from upwelling along the New Guinea coast, strengthens the westerly surface winds in the western equatorial Pacific. Such winds are possible El Niño triggers.

The IPRC and JAMSTEC scientists are also developing a new version of the regional ocean-atmosphere coupled model (iROAM), combining the IPRC regional atmospheric model and the ocean model HYCOM.



### *Developing Regional Ocean Models for “Ocean Weather” Prediction*

**Yasumasa Miyazawa**, Leader of the Ocean Downscaled Prediction Research Team at JAMSTEC, visited the IPRC in March 2013 to discuss opportunities for joint research on ocean modeling. During his seminar, Miyazawa presented impressive results of his work with other scientists of the Japan Coastal Ocean Predictability Experiment (JCOPE) group. The group is developing a system for predicting shifts in the Kuroshio path and in mesoscale eddies, which greatly influence Japan’s coastal ocean and regional climate. The downscaled model simulations now include internal-tide processes and their complex interaction with the Kuroshio and with mesoscale eddies, yielding realistic wave-induced mass fluxes. An outcome of the visit is that Miyazawa and IPRC’s **Nikolai Maximenko** and **Oleg Melnichenko** have started exchanging ideas in order to formulate research tasks as part of future JAMSTEC–IPRC collaboration.



Nikolai Maximenko with Yasumasa Miyazawa.



### *Tracking Marine Debris on Coastlines with Cameras*

**Tomoya Kataoka** from the National Institute for Land and Infrastructure Management in Ibaraki, Japan, visited the IPRC in February 2013 to discuss with **Nikolai Maximenko** the movement of marine debris washing onto shorelines. Kataoka gave a seminar on his study on coastline monitoring of remote beaches in Japan with high-resolution webcams. In close partnership with **Atsuhiko Isobe**, professor at Ehime University, he has developed the technology to identify, count, and trace how objects move along a shoreline. First results show that even in places known for marine debris to pile up, objects may float in and out many times—pushed and pulled by high waves, tides, or winds—before staying on shore or floating back into the ocean again. The study shows that no simple model will describe the complexity of debris movement along shorelines.

Kataoka’s talk was broadcast by the WebEx system to the “marine debris” community. With the help of Hawai‘i State International Coastal Cleanup Coordinator **Chris Woolaway**, Campbell Wildlife Refuge Manager **David Ellis**, and Hanauma Bay Manager **Tara Hirohata**, Kataoka had the opportunity to survey with Maximenko marine debris and possible tsunami driftage on the windward shores of Oahu. The visit is expected to start a long partnership between the scientists in Japan and the IPRC.



Tomoya Kataoka, inspecting oyster buoys very likely from the 2011 tsunami, with Nikolai Maximenko and the oyster buoy “owner” on windward Oahu.

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