International Pacific Research Center

IPRC NEWS

IPRC Governing Committee Meets

The IPRC Governing Committee held its 2010 annual meeting on April 7 and 8 at the Tokyo Office of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). JAMSTEC Executive Director Shiro Imawaki served as Japanese co-chair and NASA Program Scientist Eric Lindstrom served as US co-chair. This year, Hirota Tani, Director for Environmental Science and Technology of Japan’s Ministry of Education, Culture, Sports, Science and Technology (MEXT), participated in the meeting. The meeting reviewed governance issues and the overall progress of the IPRC.

IPRC Leadership

Kevin Hamilton has been appointed IPRC Director. Hamilton, who had served as Interim Director from April 2008, has been a faculty member at the IPRC since October 2000 and served as Meteorology Department Chair from 2004 to 2007. Before joining the IPRC, Hamilton was for twelve years a research meteorologist at the NOAA Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, and a visiting professor at Princeton University. He has been honored for his research achievements by the award of the Canadian Meteorological and Oceanographic Society President’s Prize and the American Meteorological Society (AMS) Meisinger Award. He was the 2000 American Geophysical Union Jule Charney Lecturer, and has been a Fellow of the AMS since 2001.

IPRC Takes Part in Aerospace in Hawai’i Week

Established by the United Nations in 1999, World Space Week celebrates the contributions of space science and technology to improving the human condition. Hawai’i participated during this year’s week in October by hosting statewide a series of public events that highlight Hawai’i’s achievements, current activities, and future possibilities. Among happenings at the Hawai’i State Capitol was a panel “Mission to Planet Earth.” Members of the panel included IPRC Director Kevin Hamilton, who spoke on satellite observations and global climate change, and Senior Researcher Nikolai Maximenko, who spoke about the synthesis of satellite and in situ observations to study ocean currents.
Monsoon Modeling for Sustainable Rice Production

IPRC Senior Researcher H. Annamalai travelled to Hyderabad and Coimbatore, India, in November 2009 for the second meeting of the ClimaRice project (see IPRC Climate, vol. 8, no. 2). The project aims to assess effects of climate change on agriculture and water availability and to make recommendations to farmers, local government, and other stakeholders on how to mitigate consequences of future climate change. It is a partnership among the Norwegian Institute for Agricultural and Environmental Research (Bioforsk), the Tamil Nadu Agricultural University in Coimbatore, and the IPRC. The Norwegian Ministry of Foreign Affairs is funding the project through the Royal Norwegian Embassy in New Delhi.

“The most interesting part for me on this trip was that I got to talk with the farmers and the water resource engineers and heard first-hand from them about their experiences with climate change over the last 30 to 40 years,” says Annamalai. “The farmers are very sensitive to the changes that have happened to agriculture and have already seen the effects of warming. They have to use more chemicals because insect pests have increased. The failing monsoons are bringing less water, and so they have turned to rice varieties that need less water, take shorter time to ripen, and can resist the higher temperatures better. The chief water engineer for the Cauvery Basin has seen the groundwater table fall. He says the intrusion of saline water is reducing the amount of land suitable for farming. Because of the uncertainty of viable farming in the future, the number of young people going into farming is plummeting, and a shortage of farmers is looming.”

Annamalai’s contribution to the project is his expertise in numerical modeling of climate, especially of the monsoon. He has adapted the IPRC Regional Climate Model to the region and is driving the model with warming signals from those IPCC AR4 models that are able to simulate the monsoon well, such as the GFDL model. “Based upon these simulations, I will make projections about regional temperature rise and changes in rainfall patterns, especially the frequency of extreme droughts and flooding over this century. An important part will be to assess the level of uncertainty of my projections,” explains Annamalai.

Phase 1 of the project is coming to a close. The Norwegian Ministry of Foreign Affairs has already funded three more years for a second project phase. Project members are writing a book intended for policymakers, non-governmental offices, agriculture and water managers, as well as scientists. The book hopes to contribute to the development of adaptation measures and to recommend management strategies and policies that are based on input from both stakeholders and scientists.

For details of the project and the meeting, please visit http://www.tnau.ac.in/climarice/
Will Ancient Trees in Hawai‘i Tell Stories of Past Climates?

“It all began with an analysis of climate model simulations that showed over decades a strong connection between the concentration of an oxygen isotope in precipitation over Hawai‘i and the El Niño-Southern Oscillation,” says IPRC oceanography professor Axel Timmermann. Would anything on the Hawaiian Islands store this information on a yearly basis, he wondered, and thereby help to reconstruct past El Niño occurrences? Trees probably would, but an accurate dating of oxygen isotope variations in tree cellulose requires the trees to have annual bandings. Because the annual cycle in the tropics is weak, tropical trees usually don’t have clearly marked tree rings.

But Timmermann thought, “Hawai‘i has tall mountains, and maybe trees higher up might supply the key.” He decided to explore this with a team of scientists.

He first turned to Patrick Hart, a biology professor at the University of Hawai‘i at Hilo. Hart is an expert on trees that grow at high elevations in Hawai‘i because they are an important habitat for native birds. Hart came up with two candidate trees, the mamane and the ōhi‘a. These trees can reach an age of 600 years and may have tree rings or store isotope information that reflects the oscillation between wet La Niña and dry El Niño periods. Since their wood is so hard and nearly indestructible, ancient dead trees might be used to splice together information extending back even further than live trees.

Timmermann also asked Edward R. Cook, senior scholar at the Tree-Ring Laboratory, Lamont-Doherty Earth Obser-
Climate Research, Environmental Sustainability, and Finance

“In Nature’s casino the insurance companies had set themselves up as the house, and yet they didn’t know the odds......potential losses from various catastrophes are too great and too complicated to be judged by human intuition.”

Michael Lewis, In Nature’s Casino

Research in the science of climate variability and change ultimately is driven by a desire to inform practical decisions that impact society. One increasingly important connection between climate science and real-world decision-making is provided by financial markets. Such recent innovations as weather derivatives and catastrophe bonds, together with conventional insurance and reinsurance markets, provide ways to manage the financial component of the risks associated with climate variability and change. The emergence of markets for carbon emission credits is also beginning to impact business decisions that may affect the long-term sustainability of our society. Optimal pricing of environmentally related market securities depends on having the best possible understanding of, and projections for, climate trends and variability. More generally, climate information is needed to inform both regulatory and market decisions related to financing mitigation and adaptation efforts.

In Fall 2009 the Shidler College of Business of the University of Hawai’i Mānoa, with the generous support of Hawai’i businessman Jay Shidler, started a new program, a Master’s of Science in Financial Engineering (MFE). This is an ambitious effort to teach state-of-the-art quantitative finance at the graduate level. The importance of environmental finance was recognized by having one of the eight new courses in the program devoted to this topic.
Spurred in part by the developments at the Shidler College, the IPRC has become increasingly interested in contributing in the area of environmental finance. IPRC Director and Meteorology Professor Kevin Hamilton taught part of the course on environmental finance in this inaugural year of the MFE program, together with Business Professor and MFE Program Director Gunter Meissner and Meteorology Professor Steven Businger. In his lectures Hamilton explained the nature of weather observations, described available climate data bases, introduced the principles of climate modeling and discussed the basis for climate prediction on various timescales.

This spring the IPRC hosted an international leader in the field of climate change and finance, Richard Murnane, Program Director for the Risk Prevention Initiative at the Bermuda Institute of Ocean Sciences. Murnane’s seminar, co-sponsored by the IPRC, the Shidler College of Business, the International Center for Climate and Society (ICCS), and the Meteorology Department, was titled “Natural Hazards and the Catastrophe Reinsurance Industry.” In conjunction with Murnane’s visit, the IPRC organized a panel discussion on “Some Issues Related to Weather Risk Mitigation,” which included Meteorology Professor Thomas Schroeder and Brendan Larson, a Honolulu-based entrepreneur in weather information services.

Given its focus on Asia-Pacific issues and strong connections with Japan, the IPRC is naturally interested in exploring common interests with relevant Japanese businesses. In April Hamilton visited the Tokyo headquarters of Tokio Marine Nichido, the oldest casualty insurance company in Japan and one that is developing a progressive approach to incorporating climate information in its business operations. Hamilton enjoyed discussions with members of the Tokio Marine Research Institute (the company’s “think tank”), including Managing Director Terumasa Miyoshi, and researchers Hiroo Shimada, Kei Masuyama and Akira Juri. The Tokio Marine researchers have a particular interest in projections of how global warming will affect western Pacific tropical cyclones, an issue that is also a focus of IPRC research (e.g., IPRC Climate, vol. 5, no. 2), and the IPRC is looking ahead to sharing results in this area.

IPRC’s developing interest in environmental finance is a step towards applying basic climate science to pressing, real-world issues of managing the risk of climate change to society and enhancing sustainability. IPRC scientists look forward to bolstering their capabilities in this area through further connections within the University of Hawai’i and beyond.

“The risks surrounding our customers have become increasingly complex and diversified due to issues such as the escalation of global environmental problems and rapid changes in the social structure.... Tokio Marine Nichido established ...a comprehensive program concerning global warming in November 2007, which holds up our policy of a comprehensive and aggressive commitment to the global warming issue through risk research....”

Shuzo Sumi, President, Tokio Marine Nichido Group
Can Ocean Drifters Help Solve Historical Puzzles?

"America Before Christopher Columbus: Who really discovered the New World?" is the title of a two-hour special program aired on the History Channel (http://www.history.com/) as this issue of the IPRC Climate is going to press. In a 5-hour interview, IPRC Senior Researcher Nikolai Maximenko talked about ocean circulation to Maria Awes of Committee Films. The company is producing a video that explores possible ocean voyages to the New World before Christopher Columbus.

The program features, among other stories, that of Japanese fishermen from Kyushu sailing in Jomon fishing boats to coastal Ecuador and Chile as early as 3044 BC; a Chinese explorer reaching Southern California around 458 AD on a Chinese junk; and ancient Hebrews from the Mediterranean reaching between the 1st and 8th century AD the east coast of America, where some members of the Cherokee tribe today believe they are descendants.

Committee Films had heard about Maximenko and his work on charting ocean currents using drifters. Awes interviewed him for the film to see whether ocean currents and winds would help to support or to disprove the stories of these early voyages.

Maximenko made calculations for 7 of the possible ancient travels the program is exploring. For the Jomon story, for instance, he calculated that the fastest path for a passively floating object from Kyushu to Ecuador is 240 days (figure below).

"While the suggested ‘fastest’ path is not impossible for one-time travel, it is largely provided by anomalous currents and the winds that drive the currents but that cannot be relied upon for regular navigation," Maximenko cautions.

With the help of Jan Hafner at the IPRC, Maximenko generated animations of the possible drifter paths on IPRC’s Magic Planet. "These animations give a colorful, visual demonstration of how things move and drift in the ocean from one continent to the next,” says Maximenko.

Current-favored pathways from Kyushu to Ecuador of 240, 290, and 320 days duration are represented by yellow, purple, and blue arrows respectively. Ocean colors (in days) represent the fastest drift between Kyushu and Ecuador through the particular locations.
**Plastic Oceans**

The plastic garbage dumped directly or swept by rivers into the ocean is accumulating in huge "garbage patches." IPRC Senior Researcher Nikolai Maximenko has developed a statistical model of ocean currents, based on actual drifter observations, that is applicable to tracking ocean plastic pollution.

At the 2010 AGU Ocean Sciences meeting in February in Portland, Oregon, Maximenko gave a talk on his work and also participated in the press conference “Plastic Oceans” with Kara Lavender Law and Giora Proskurowski, oceanographers with the Sea Education Association of Woods Hole Oceanographic Institution. During the press conference, Maximenko explained how his research on surface currents and ocean mixing helps to understand where the plastic debris comes from and where it goes once it enters the oceans.


Maximenko’s modeling work on ocean currents is featured extensively in Edwin Schiele’s article describing how atmospheric and oceanographic processes lead to the accumulation of plastic in certain regions of the ocean. Schiele’s article is found on the Ocean Motion NASA-funded website produced by Eric Lindstrom. The website covers everything a layperson might want to know about ocean currents (http://www.oceanmotion.org).

Maximenko’s work is also contributing to a story about plastics in the ocean by Amanda Martinez, a student in the MIT Graduate Program in Science Writing. She interviewed Maximenko in January about his research on currents and the convergence regions where garbage collects. The description of Maximenko’s research is a crucial installment of a larger article that is to be her master’s thesis.

Maximenko is at present investigating why so much debris washes up on certain beaches in Hawai’i and not others. One beach that collects a particularly large amount of marine debris is Kamilo Beach on the Island of Hawai’i.

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**Climate and Mode Water**

As part of the Spring Meeting of the Oceanographic Society of Japan in Tokyo, Shang-Ping Xie organized the “Symposium on New Developments in Mode-Water Research: Dynamics and Climate Effects” with Atsushi Kubokawa (Hokkaido University) and Fumiaki Kobashi (Tokyo University of Marine Science and Technology). Mode waters are thick layers of water mass with rather uniform temperature, density, and potential vorticity. In the North Pacific, such a mass anchors the eastward subtropical countercurrent (STCC), flowing near the sea surface, to the westward flow in the lower thermocline. The symposium presentations and discussions dealt with new developments in mode-water research, mostly in relation to the North Pacific.

“Argo observations, for instance, show that interannual Rossby waves, meanders, and eddies modulate mode-water formation in the Kuroshio Extension,” explains Xie. “Through subsurface stratification and advection, the STCC impacts sea surface temperature and thereby affects precipitation and wind stress curl.”

The symposium participants plan to summarize the recent studies in a special journal issue and to pursue funding toward multi-disciplinary research in this new area. Among the presenters from Hawai’i were, in addition to Xie, Bo Qiu (University of Hawai’i) and Ryo Furue (IPRC).
In Search of Small-Scale Ocean Features

Oceanographer Kelvin Richards went data gathering on a 37-day-long cruise of JAMSTEC’s Research Vessel Mirai in November–December 2009. It was his third trip on the ship, which was on a Triton mooring-maintenance cruise this time. Richards and his colleague Yuji Kashino (RIGC, JAMSTEC) are interested in ocean turbulence measurements taken near the equator with a microstructure profiler (MSP) and a high-frequency Acoustic Doppler Current Profiler (LADCP). Sampling at high vertical resolution, the LADCP shows that features with a vertical scale of a few tens of meters dominate the vertical shear of the currents in the thermocline. The combined LADCP and MSP measures reveal that these features, though small in scale, control much of the mixing in the equatorial thermocline.

“Since ocean mixing is known to greatly influence the state of the equatorial ocean and ocean-atmosphere interactions,” says Richards, “these small-scale features may well impact such climate phenomena as the El Niño–Southern Oscillation.”

Richards is now using the data sets to study the dynamics of the small-scale features in numerical experiments with Andrei Natarov (IPRC) and Hidenori Aiki (RIGC), and their impact in a coupled ocean-atmosphere model with Jing-Jia Luo and Wataru Sasaki (RIGC).

The Story of Chlorofluorocarbons: A Possible Disaster Averted

Kevin Hamilton was invited by Leticia Colmenares, Professor of Chemistry at Windward Community College in Kaneohe, to talk at the American Chemical Society Community Forum in Chemistry. The Forum builds bridges between the classroom and real-world applications for students and the community. Hamilton reviewed the powerful effects of man-made chlorofluorocarbon compounds (CFCs) on the atmosphere and the climate system. Calculations suggest that the introduction of CFCs into the atmosphere since about 1960 has resulted in a significant forcing of anthropogenic global warming. Some CFC molecules are 10,000 times more effective in trapping heat than a CO₂ molecule and can survive in the atmosphere for over a century.

“Had it not been for the Montreal Protocol in 1987, which restricted the use of CFCs, the annual growth rate of CFCs could have been 7%,” says Hamilton, “and this could have led to dangerous levels of global warming.”

Some Coolness on a Weather Modification Scheme

IPRC’s Kevin Hamilton was interviewed for a story in the October 19, 2009, Honolulu Advertiser that discussed a patent application for a hurricane suppression method filed recently by a group of businessmen and scientists including Microsoft’s Bill Gates: “Billionaire’s plan strikes familiar chord” http://the.honoluluadvertiser.com/article/2009/Oct/19/ln/hawai’inews910190329.html. The idea is to pump cold water from the ocean depth to the surface in a region over which the hurricane is projected to pass.

Hamilton dumped some “cold water” on the proposal, noting the difficulty in creating a practical demonstration-scale project: “If you only make the ocean surface a little colder, it won’t weaken the hurricane enough to make much of a difference. Even as an experiment, you have to go the whole way, and that’s a pretty big investment.” Hamilton also warned of the legal, philosophical, and ethical issues, for example, “What happens if you divert a hurricane away from Florida, and it hits Cuba?”

Left, cruise track of the Mirai, right, deployment of the microstructure profiler.
Mid-Pacific Islands and the Copenhagen Climate Change Conference

Kevin Hamilton participated in a discussion on the relevance of the Copenhagen Climate Change Conference for mid-Pacific Islands on Hawai’i Public Radio’s Energy Futures program with host Doug Carlson on December 7, 2009, the opening day of the Copenhagen Conference. In addition to providing a general background, Hamilton talked about IPRC’s climate modeling work. “Simulations with our regional climate model,” he noted, “suggest that the overall intensity of cyclones and hurricanes is likely to increase in response to the warming of the ocean and atmosphere as greenhouse gases accumulate. Combined with sea level rise, future storms could be all the more destructive when they crash into our islands and coastal regions.” Joining the conversation by phone was John Barnes, principal investigator of the Mauna Loa Observatory. Hamilton and Barnes also answered phone-in questions from the public during the show.

IPRC Director Gives TV Interview on Global Warming

On February 24, IPRC Director Kevin Hamilton was interviewed about global warming by Justin Fujioka, the broadcast meteorologist for Honolulu’s KITV television station. The interview was aired in two stories the next day on KITV evening news.

High School Students Film at IPRC

A group of students from Waipahu High School on O‘ahu descended on Kevin Hamilton’s office with TV camera and microphone in November. The students are in a high school career path for humanities, performing, visual, literary, and the media arts, and interns at ‘Olelo Hawai‘i Community television network. They were making a video for a symposium on climate change held at their school. Student Sharmaine Tiburcio reported, “Our symposium went very well. Our advisor commented on how excellent the video was and how well we used our interviewee, Dr. Hamilton.”
Pacific Climate Change during the “Mystery Interval”

During the “Mystery Interval” from 18,000 to 10,000 years ago, melting ice-sheets dumped freshwater into the North Atlantic, triggering a collapse of the Atlantic Meridional Overturning Circulation. This brought on a major climatic reorganization. As part of the JAMSTEC-IPRC partnership, a team of researchers from JAMSTEC (Yusuke Okazaki, Megumi Chikamoto, Naomi Harada, Ayako Abe-Ouchi) and the IPRC (Laurie Menviel and Axel Timmermann) is trying to uncover how these massive changes in North Atlantic climate affected the North Pacific Ocean circulation, the climate over Japan, and also the global carbon cycle. Using latest results from a combination of deep-sea sediment core and climate model simulations, the team has found striking evidence that from about 17,500 to 15,000 years ago, a deep Pacific overturning circulation formed, as if it were replacing the collapsed North Atlantic overturning circulation.

To throw more light on the mechanisms that led to the climate shift in the North Pacific, Chikamoto and Okazaki visited the IPRC this winter. Chikamoto is comparing the Pacific Meridional Overturning Circulation in MIROC with LOVECLIM, the model that Timmermann’s team is using at the IPRC. Okazaki is analyzing patterns of deep-sea ventilation during the Mystery Interval in his paleo sediment data of the Pacific and comparing it with climate model simulations.

An MJO Prediction System

In-Sik Kang, professor at the School of Earth Environmental Sciences at Seoul National University, visited the IPRC in January–February 2010 to work with IPRC’s Bin Wang on the predictability of the seasonal and intraseasonal forecasting of major weather and climate disturbances, such as the Madden-Julian Oscillation (MJO), the El Niño-Southern Oscillation, and the Asian monsoon. The prediction tools they are assessing are ensemble forecasts of major climate models such as those from National Centers for Environmental Prediction, NASA, Geophysical Fluid Dynamics Laboratory, and other institutions.

A Unique Regional Atmospheric Model

Masaru Inatsu, associate professor at the Department of Natural History Sciences, Hokkaido University, visited the IPRC in March 2010. He gave a seminar on a two-way regional-global atmospheric general circulation, which is nested within the MIROC coupled general circulation model and which he developed with scientists at the University of Tokyo. Inatsu is looking into working with IPRC scientists on research projects that would tap into the strengths of his unique model.
Probing Small-Scale Coastal Processes in the Black Sea

Viacheslav Kremenetskiy, senior researcher at the P.P. Shirshov Institute of Oceanology in Moscow, visited the IPRC from December 2009 to February 2010. On a joint grant from the US Civil Research and Development Foundation and the Russian Foundation for Basic Research, he came to the IPRC to work on the dynamics of the Black Sea with senior researcher Nikolai Maximenko. The Black Sea is of special interest to oceanographers because the coastal processes in that inland sea are of unusual complexity, taking place on small space- and time-scales over intricate shoreline topography.

Kremenetskiy described the Black Sea at an IPRC Luncheon Discussion. Fed by rivers and draining through the Bosphorous, the sea is very deep. Below 150 m it is anoxic and virtually dead aside from a few bacteria. The mean current flows clockwise around its rim. Currents near the coast swiftly react to varying winds blowing over coastal terraces. Eddies form frequently along the irregular shorelines and then move offshore, where they fall apart within a few weeks.

“A better grasp of these complicated processes will greatly advance the knowledge of eddy formation, coastal currents, and shelf sea processes. The Black Sea is a gem for such study,” says Maximenko, “because of the dense coverage by drifting buoys that furnish data.”

Modeling the Quasibiennial Oscillation

The Quasibiennial Oscillation (QBO) of the tropical stratosphere is a dominant component of variability in the stratosphere, and may play a role in the interannual fluctuations of tropospheric circulation. JAMSTEC researcher Yoshio Kawatani visited the IPRC from December to March to work with Kevin Hamilton on analysis of simulations of the QBO in a high-resolution general circulation model. The project emphasizes the application of the model to study possible changes in the QBO behavior in response to anticipated global warming.
Alumni Come Home to the IPRC

Four IPRC alumni now at JAMSTEC—Masami Nonaka, Ingo Richter, Shin Kida and Bunmei Taguchi—came back to Hawai‘i and the beautiful University of Hawai‘i Mānoa campus in early December 2009. They each gave a talk at the Second OFES International Workshop (p. 11). They had fun climbing the monkey pod tree, which they used to rush past to attend Oceanography and Meteorology Seminars. And here is what they are doing at JAMSTEC: Masami Nonaka is senior scientist and team leader of the Mid- and High-latitude Climate Predictability Research Team of the Research Institute for Global Change (RIGC); Shin Kida is scientist with the Multiscale Simulation & Modeling Research Group of the Earth Simulator Center (ESC); Bunmei Taguchi is scientist with the Geophysical Fluid Simulation Research Group of ESC; and Ingo Richter is scientist with the Low-latitude Climate Prediction Research Team of RIGC.

Changes in Asian Monsoon Rainfall

Former postdoctoral fellow Yoshiyuki Kajikawa returned to the IPRC for a week in March. During his visit he gave a luncheon discussion about his present work with Professor Tetsuzo Yasunari at the Hydrospheric Atmospheric Research Center, Nagoya University. Yasunari’s group is conducting an all-encompassing study named “Impact of Integrated Effect of Land Cover/Use Change and Aerosol Forcings on Climate Change in Asia.”

Agriculture-induced nitrate aerosols and secondary organic aerosols can impact the formation of clouds and precipitation and therefore the Asian monsoon. The study intends to unravel such processes using a full-aerosol process model coupled with CHASER, an atmospheric chemistry climate model. Kajikawa is part of the team that is analyzing the observational data on the effects of aerosols and land-surface changes on Asian monsoon rainfall and its seasonality from 1950 to 2000. The observational analysis will then be used to validate the model’s results. The project is funded by Japan’s Global Environmental Research Fund.
Hokkaido-IPRC Exchange Program Continues

Yusuke Udagawa visited the IPRC on a Hokkaido University fellowship for 3 weeks in March. He is continuing the exchange program between the IPRC and Hokkaido University Graduate School of Environmental Science, the initiative begun by Hokkaido University’s Youichi Tanimoto (IPRC Climate, vol. 8, nos. 1 and 2). Udagawa had just defended his PhD thesis at Hokkaido University, and during his visit he discussed with IPRC scientists the idea that the Southern Annular Mode might impact the westerly waveguide and thus the tropical forcing of the Pacific–South American teleconnection pattern. In November 2009, Axel Timmermann gave a lecture series on El Niño to graduate students at Hokkaido University.

Aloha and Welcome to the IPRC

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