

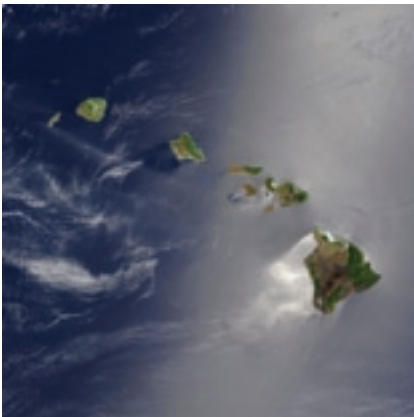
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Newsletter of the International Pacific Research Center

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





Above. The coupled IPRC Ocean–Atmosphere Model (iROAM) will be applied to climate research on the Hawaiian Isles. See page 21 for more.

Cover: The pond at Krauss Hall. The pond at Krauss Hall is an island of tranquility within the bustle of the Mānoa campus. Krauss Hall was a significant site in the evolution of the atmospheric sciences in Hawai‘i. It was here that a cadre of researchers employed by the Pineapple Research Institute (whose logo still graces wrought-iron gates to the facility) collaborated with scientists at the Hawaiian Sugar Planters Association in pioneering research on physics of warm clouds and fundamental weather systems of the Hawaiian Islands.

Thomas Schroeder, Director of Joint Institute of Marine and Atmospheric Research (JIMAR), Associate Professor, Dept. of Meteorology, UH.

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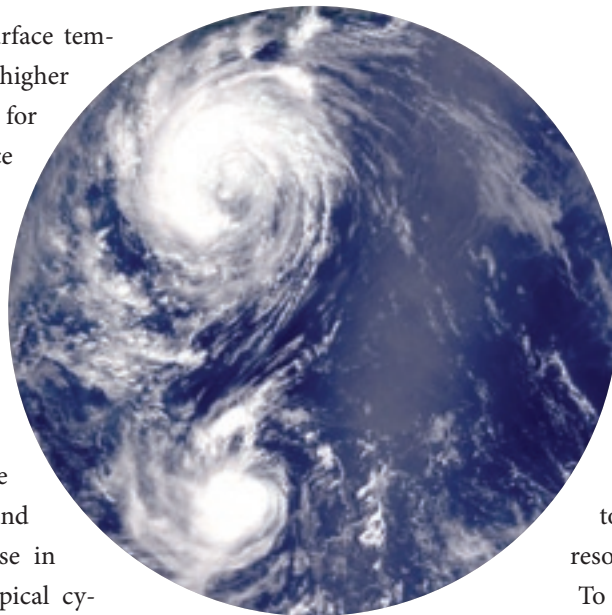
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University of Hawai‘i at Mānoa
School of Ocean and Earth Science and Technology

More Typhoons over the South China Sea?

Warm oceans with surface temperatures of 26°C or higher provide the fuel for tropical cyclones. Since sea surface temperatures in the tropics have risen on average about 0.5°C over the last decades, it is reasonable to ask if this corresponds to any clear trends in tropical cyclone frequency or intensity. In a recent observational study, **Peter Webster** (Georgia Institute of Technology) and colleagues found no statistically significant increase in the world-wide frequency of tropical cyclones over the last 30 years. He did note, though, significantly more storms at category 4 and 5 levels, an indication that storms have become stronger. For the western North Pacific, a region of great relevance to the IPRC focus on Asian-Pacific climate, the number of category 4 and 5 storms has grown from 5.7 per year during the first 15-year period studied, to 7.7 per year during the second period.

We can anticipate further surface warming. This would, by itself, be expected to increase cyclone frequency and intensity. Other factors, however, are known to affect tropical cyclone genesis and development, for example, moisture content, vertical wind shear, and atmospheric convective stability. **Markus Stowasser**, in collaboration with **Yuqing Wang** and **Kevin Hamilton**, has been applying the IPRC Regional



Climate Model (IPRC-RegCM) to studying the effects of global climate change on tropical cyclones in the Pacific. In this project, the IPRC-RegCM is run for a region extending from 100°E to 160°W and from 15°S to 55°N, and with a 0.5° horizontal resolution and 28 vertical levels.

To see how well the IPRC-RegCM is able to simulate present-day tropical cyclone statistics, the model was first run for the July–October period in 10 consecutive years (1991–2000) with horizontal boundary conditions and sea surface temperatures taken from observations. The model simulated 17.9 typhoons per year, which is close to the 20.1 per year recorded in the Joint Typhoon Warning Center (JTWC) best-track data set. The simulated storms have a larger radius (peak winds typically 150 km from the center) than observed typhoons. Other features typically observed in tropical cyclones, however, such as cyclonic inflow in the lower troposphere and anticyclonic outflow above 300 hPa, the pronounced warm core around 350 hPa, and the very high relative humidity (up to 100%) in the inner core of the storm are well simulated. Figure 1a

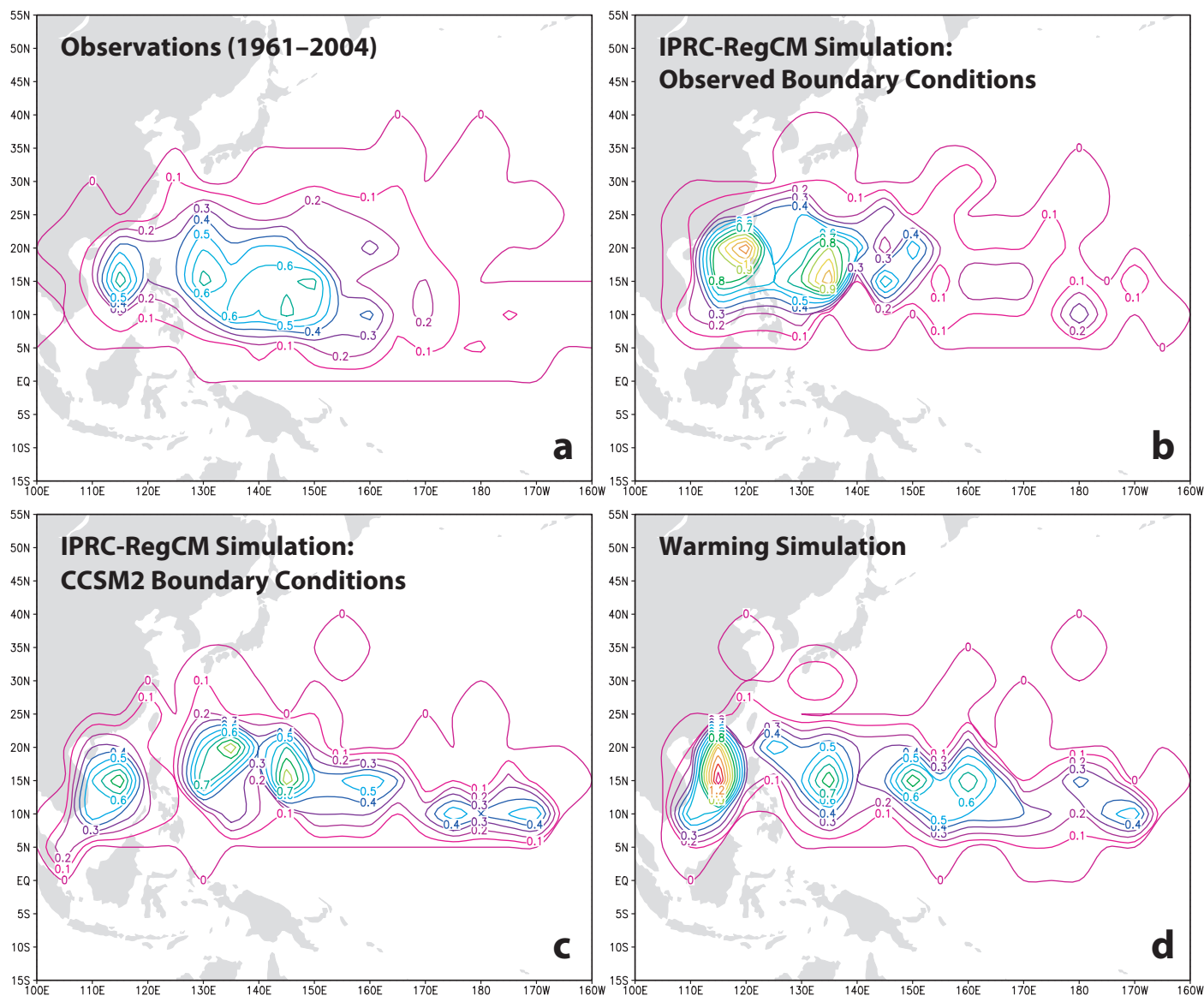


Figure 1. Comparison of tropical storm genesis locations in the western North Pacific during July–October in (a) JTWC best-track data (1961–2004) and the IPRC-RegCM integrations driven by boundary conditions obtained from (b) observed data (1991–2000), (c) CCSM2 present-day control run data, and (d) CCSM2 integration with 6 times present-day CO_2 levels. Results shown as number of storms per 5° latitude–longitude box per year.

shows the number of storms that formed in each 5° box per year computed from the JTWC data; Figure 1b shows the same variable for the simulation. The geographic distribution of the simulated storms is in reasonable agreement with the

data. In both observation and simulation, the region of most frequent tropical storm formation is the South China Sea.

To use the regional model to study the effects of increased levels of CO_2 , the model was nested within the NCAR coupled global climate model CCSM2. First, the regional model was run for ten July–October periods with boundary and sea surface temperature forcing from ten consecutive years of a present-day control run of the CCSM2; the regional model was then forced for ten more July–October periods, in which the forcing fields were taken from ten consecutive years from the end of a long CCSM2 run with six times the present day atmospheric CO_2 concentration. The fairly large increase in CO_2 concentration was chosen because the CCSM2 is one of the climate models with the least sensitivity to increased CO_2 concentration levels.

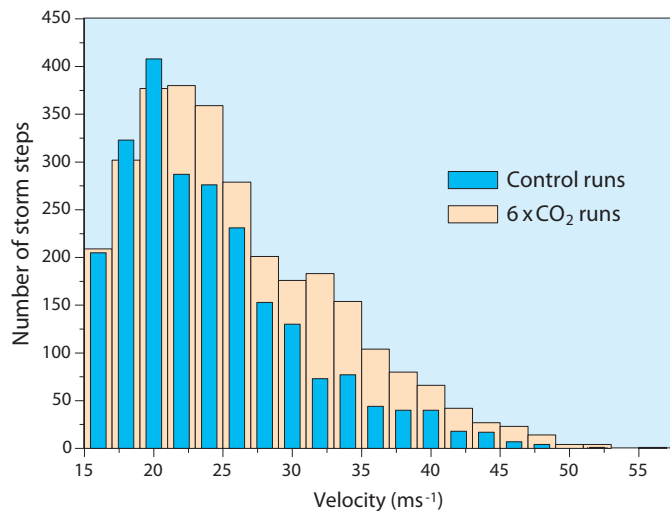


Figure 2. A histogram of western North Pacific tropical cyclone frequency with different maximum surface wind speeds. The frequency is given in numbers of 12-hour time-steps during which a tropical cyclone was present in the domain under present-day levels of CO₂ (blue) and under global warming conditions (6 times present-day CO₂ levels, in yellow). The number of tropical cyclones over the whole domain does not increase significantly in the global warming case; however, the average strength of the storms does increase significantly.

During the July–October period of the present-day control runs, the model simulated an average of 19.6 tropical cyclones. In the 6-fold CO₂ runs, the sea surface temperature in the tropical western North Pacific run rose roughly 3°C, and the number of average storms per season rose to 23.3, a number not statistically significantly higher than in the unperturbed control simulation. The storm genesis locations simulated by the IPRC–RegCM with control CCSM2 forcing are shown in Figure 1c and for forcing taken from the 6-fold CO₂ run with the CCSM2 in Figure 1d. Although the total number of storms over the region did not increase significantly, the increase in storms in the South China Sea is statistically significant. Moreover, those storms that formed in the warming experiment were, on average, significantly stronger. Thus, in the control run 21% of the storms had wind speeds between 30 and 40 m/s, and 8% had peak winds above 40 m/s. In the global warming runs, 32% had wind speeds between 30 and 40 m/s, and 13% had peak winds above 40 m/s. Figure 2 shows the distribution of the peak surface winds for all the storms (computed at 12-hour intervals during the lifetime of each storm) simulated in the present-day and warming runs.

Analyses of the global-warming runs reveal that the large-scale atmospheric environmental conditions over the South China Sea change to favor more tropical cyclone formation: the relative humidity in the mid-troposphere increases

and the vertical wind shear decreases compared to the present-day runs. Fewer tropical cyclones formed in most other regions of the western North Pacific, a result consistent with lower relative humidity, higher stability and vertical shear found in the warm-climate simulation over these areas.

The results of this study demonstrate the utility of applying the IPRC–RegCM to the tropical cyclone climate sensitivity problem. By using a regional model forced by output from coarse resolution global coupled models, the area to be studied can be represented at fairly high spatial resolution. Different global models produce different changes in the circulation in the tropical Pacific in response to the same large-scale climate forcing, so it will be interesting to repeat the present IPRC–RegCM simulations with boundary forcings taken from other global climate models for which control and global warming simulations are available.

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Capturing the Daily Rain Cycle in the Tropics

Rainfall over the Indonesian region has a pronounced diurnal signature. One test of how well moist convection is represented in models is how well the diurnal rainfall cycle is simulated in this region. In typical atmospheric circulation models, the rainfall over the Maritime Continent peaks too early in the day and the daily range in rainfall rate varies too much, a deficiency that applies over most of the land in the tropics. These difficulties may, at least partly, have to do with the way shallow convection is represented in the models. Shallow cumulus clouds in the morning take moisture from the atmospheric boundary layer at the sea surface and moisten the free atmosphere. This sets the stage for deep convection later in the day.

An adequate representation of shallow convection would seem necessary for capturing the daily rainfall cycle. The strength of shallow convection is largely determined by the rate at which air is mixed from the surrounding environment into clouds as they rise and dilute the original air in the cloud (a process called ‘fractional entrainment’) and the rate at which they transfer moist air inside a cloud to the air outside (called ‘fractional detrainment’). In general circulation model parameterizations, these two processes

have been assumed to occur at fixed rates, and the effect of altering these rates on the simulated daily rainfall cycle has not been studied.

At the IPRC, **Yuqing Wang**, **Kevin Hamilton**, and doctoral student **Li Zhou** have studied how increases in the mixing and diluting rates affect the simulation of the daily rainfall cycle in the Maritime Continent region. They used the IPRC Regional Climate Model with a 0.5°-longitude–latitude grid and 28 vertical levels. The model was run under 3 different conditions for the January 1–March 31 period in 1998, with initial and boundary conditions from ERA-40 reanalysis updated every 6 hours and from Reynolds sea surface temperature updated every week. In the first run, all default parameters in the mass-flux cumulus parameterization scheme were used; in the second run, the mixing and diluting rates were doubled for deep convection; in the third run, the rates for shallow convection were increased 6.7-fold, to a value similar to values inferred from large-eddy simulations for shallow convection.

To obtain a local average daily cycle of the hourly rainfall rate for each model configuration, the hourly rainfall rates were averaged at each grid point and across the 3-month period.

The results were then compared with similar TRMM 3G68 rainfall data averaged over January–March from 1998 to 2004. Since the simulations covered only the 3-month period in 1998, comparisons with the 7-year TRMM observations are not straightforward; nevertheless, the TRMM observation provides a reference for assessing the adequacy of the simulated daily rainfall cycle in the region.

As in previous observational studies, the rainfall over land areas in the TRMM data peaks anywhere from late afternoon to midnight (Figure 1a) depending upon the region, and then shifts to the ocean in the late evening to early morning hours. Over the open ocean there is no consistent peak rainfall time and no consistent migration. The hourly rainfall amount during the daily cycle varies quite a bit over land, but little over the ocean (Figure 2a).

The integration with the default parameters simulates an unrealistic rainfall pattern, but one that is typical of most current atmospheric models: rainfall peaks over most of the land areas about 2–4 hours too early and over the ocean, usually during early to mid-morning (Figure 1b); the rainfall rate varies too much over land and coastal areas, and the proportion of large-scale to stratiform rainfall is too small (not shown).

Doubling the mixing and diluting rates for deep convection delays the peak rainfall by about 1–2 hours over most of the land areas and in some of the coastal regions, but otherwise the rainfall pattern does not become more realistic (Figure 2c).

Increasing the rates for shallow convection, though, improves the simulation in nearly all aspects. It brings

peak rainfall times closer to observations over both the Maritime Continent and the oceans and simulates the peak rainfall shift to offshore during late evening and early morning hours (Figure 1d). Rainfall over the western Pacific warm pool region, moreover, shifts mainly westward, consistent with the generally westward propagating mid-sized convective systems observed in this region. The simulation produces a realistic daily amplitude in rainfall

rate over land (Figure 2d), though it does underestimate the amplitude over the ocean. The shallow convection experiment also produces a more realistic proportion of large-scale stratiform rainfall (not shown).

Analyses of the shallow convection experiment show the reason for the improvements: increasing the mixing and diluting rates slows the destabilizing effect of shallow convection and vertical turbulent mixing in the boundary

layer and slows the moistening of the middle troposphere. All this prolongs the onset of deep convection, delaying and reducing convective rainfall during daytime over land while increasing large-scale, longer-lasting rainfall. The change also increases the day-to-day variability in rainfall amount, something that has been difficult to achieve in many general circulation models.

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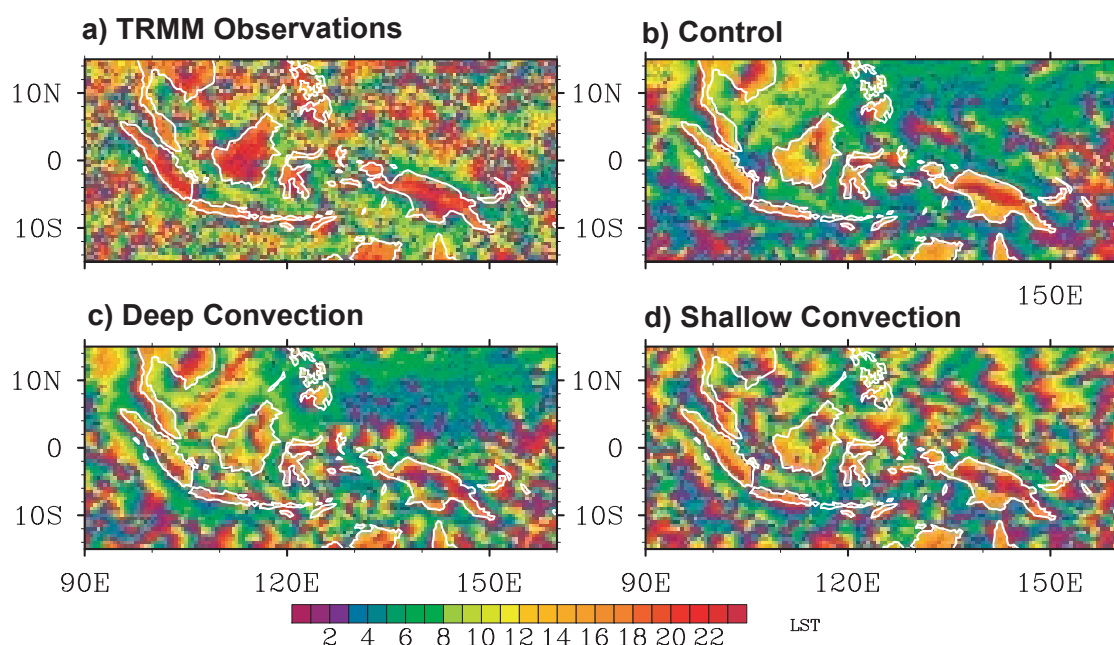


Figure 1. The local time of day (see color bar) of composite peak diurnal rainfall rates from (a) 7 years of TRMM 3G68 products, and from the 3-month model simulations under (b) control, (c) deep convection, and (d) shallow convection modifications.

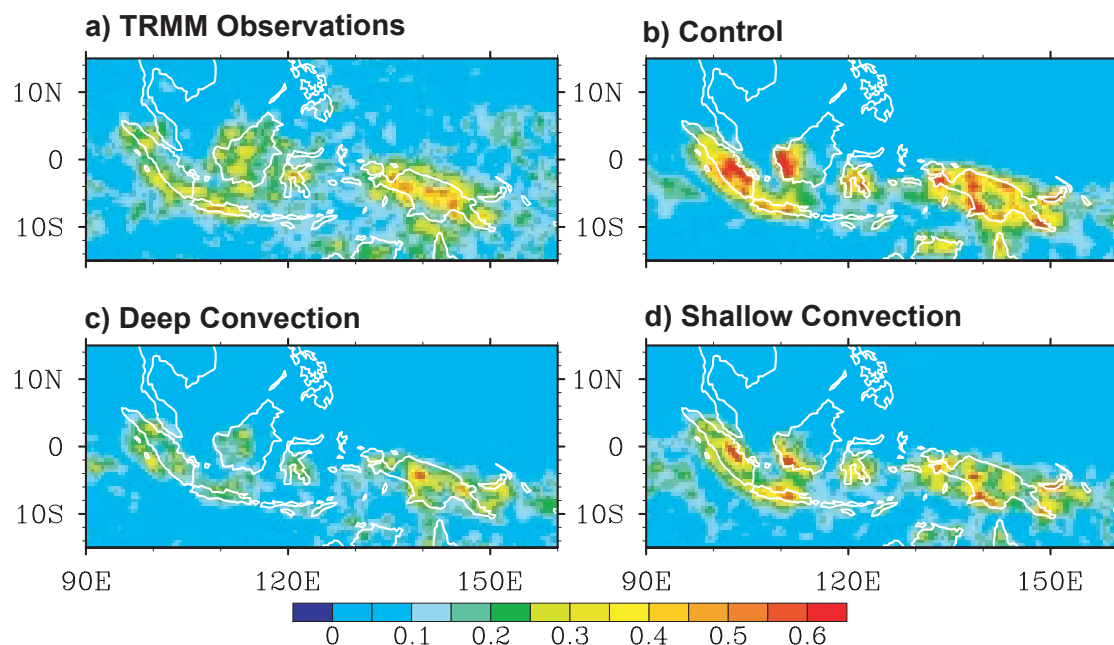


Figure 2. The daily amplitude of the rainfall rate in mm/hr from (a) 7 years of TRMM 3G68 products, and from the 3-month model simulations under (b) control, (c) deep convection, and (d) shallow convection modifications.

ISO Impact on Indian Ocean Depends on Season

An intriguing aspect of the tropical climate system is that the occurrence of weather events is modified by the phase of the intraseasonal oscillation (ISO). The ISO is an atmospheric disturbance with alternating periods of increased and decreased surface westerly winds or convective activity, superimposed on the usual background conditions. Observations show that during a strong westerly wind phase one can expect a greater number of tropical cyclones. The ISO may even trigger or terminate El Niño and Indian Ocean Dipole events. Understanding the ISO is thus crucial for successful prediction of tropical weather and climate.

Recent studies show that the ISO affects both the atmosphere and the ocean. Sparse observations over the open ocean, however, limit our ability to thoroughly explore the oceanic component. Numerical models can be helpful tools in this endeavor. At the IPRC, postdoctoral fellow **Chi-Yung Francis Tam** and **Tim Li**, co-leader of the Asian-Australian Monsoon System Team, used an ocean model to study the interplay between Indian Ocean conditions and elements of the ISO.

The model results for sea surface temperature (SST), outgoing longwave radiation (OLR), and surface wind stress composited by ISO phase are shown in Figure 1 for the Northern Hemisphere winter and summer months. In winter, after a period of strong convection (green contours) and westerly

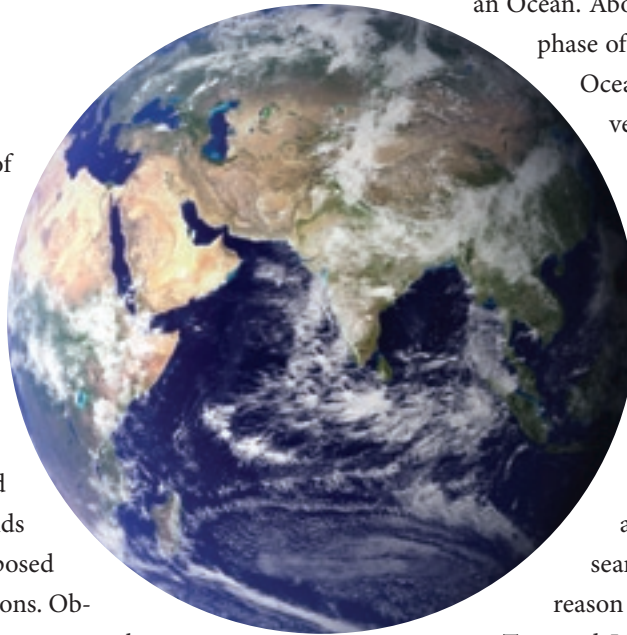
wind stress (arrows) associated with the ISO, anomalously cold SST (shading) appears in a band along 10°S in the Indian Ocean. About 10–15 days after the convective phase of the ISO passes the western Indian Ocean northeast of Madagascar, convection in that region is suppressed (red contours) in response to the cold SST forcing. This evolution suggests that ocean conditions help to start the next phase of the ISO over the western Indian Ocean.

During summer, these signals are almost absent, something already noted in satellite analyses conducted by IPRC researcher **N.H. Saji**. To understand the reason for such large seasonal differences,

Tam and Li compared how certain processes affect the sea surface in winter and in summer during the phase of the ISO with the strongest westerly winds and convection. Figure 2 gives the contribution of incoming solar radiation, evaporation, mixing of cold sub-surface water and horizontal advection to the SST response for winter and summer during this ISO phase.

In northern winter, the dramatic cooling of the sea surface is seen in a band around 10°S. There are several reasons for this cooling. The strong westerly ISO winds strengthen the background surface wind, which during this season is also eastward along 5–10°S; the strong winds increase evaporation and ocean mixing. Moreover, convection, accompanied by clouds, reduces the amount of incoming solar radiation (Figure 2a, 2c, and 2e).

In contrast, in summer during this phase of the ISO, surface easterlies prevail south of the equator, opposing the westerly winds of the ISO and reducing both evaporation and mixing of deeper, colder ocean water with surface water. The sea surface warming that should result is counteracted,



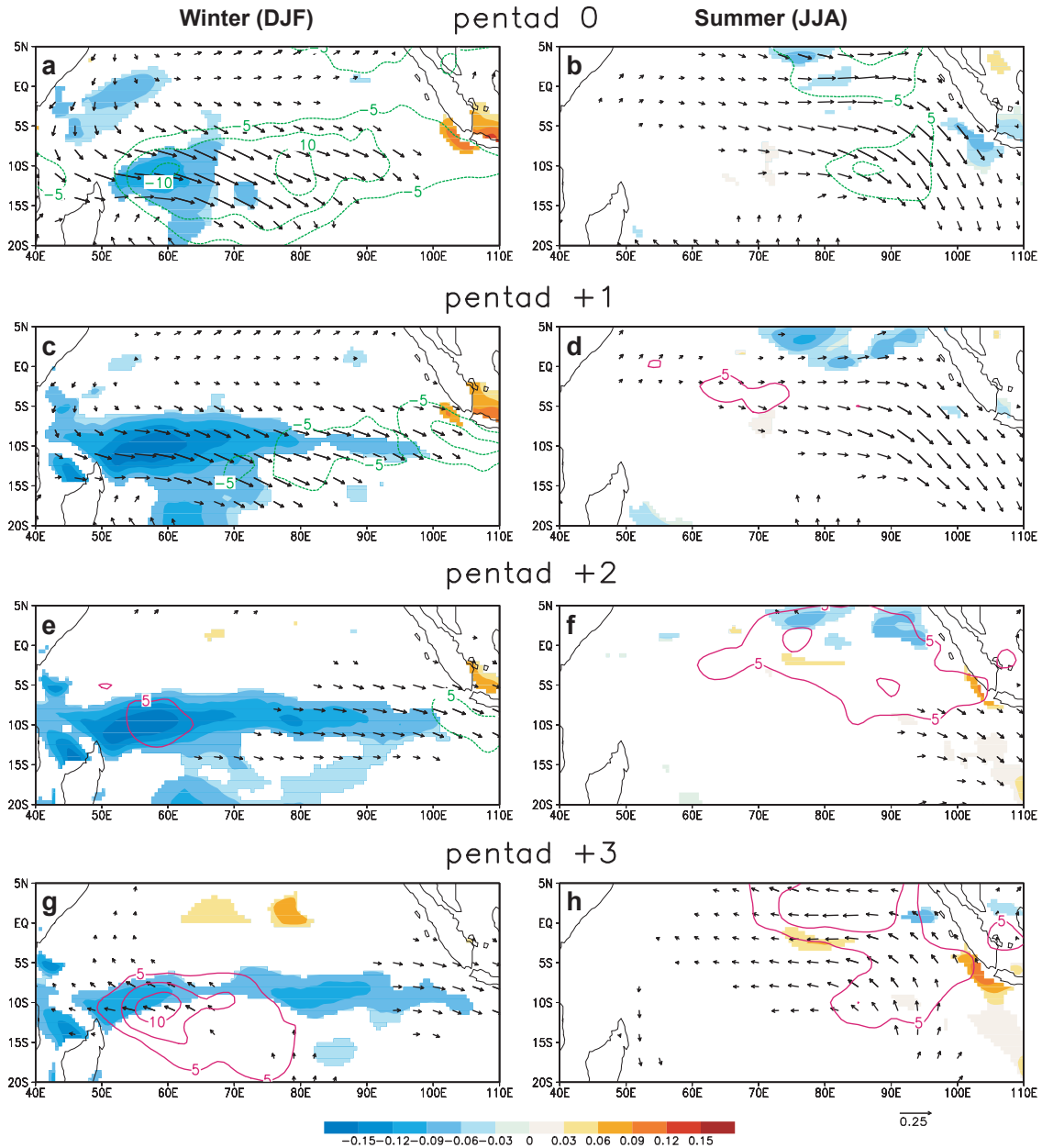


Figure 1. For northern winter (left panels), and northern summer (right panels), model-simulated SST (shading: see scale bar at bottom, in units of °C), wind stress (arrows: see scale at bottom right, in units of dyn/cm²) and outgoing long-wave radiation (red contours for positive and green contours for negative values, in intervals of 2.5W/m²,

starting from 5W/m²) during pentads 0 (panels a and b), +1 (c and d), +2 (e and f), and +3 (g and h). Pentad refers to a 5-day period; pentad 0 refers to the ISO phase when the 25–90 day bandpass filtered zonal wind stress anomaly is most positive over 50–65°E, 5–12.5°S in winter, and over 75–90°E, 2.5–10°S in summer.

however, by less solar radiation in the Indian Ocean along 5–10°S (Figure 2b, 2d and 2f). Furthermore, the strong westerly ISO winds induce a northward Ekman flow that brings cold water from the south, further counteracting the warming. This advection effect is

much stronger in boreal summer than in winter (see also Figure 2g and 2h) because during northern summer the north-south SST gradient is sharper than during winter. The interaction of all these processes explains why the SST in the southern Indian Ocean changes

so little in response to the summertime ISO, further highlighting the sensitivity of the ISO-related SST changes to the mean state of the atmosphere and the ocean.

In summary, the different SST response to the ISO in the southern

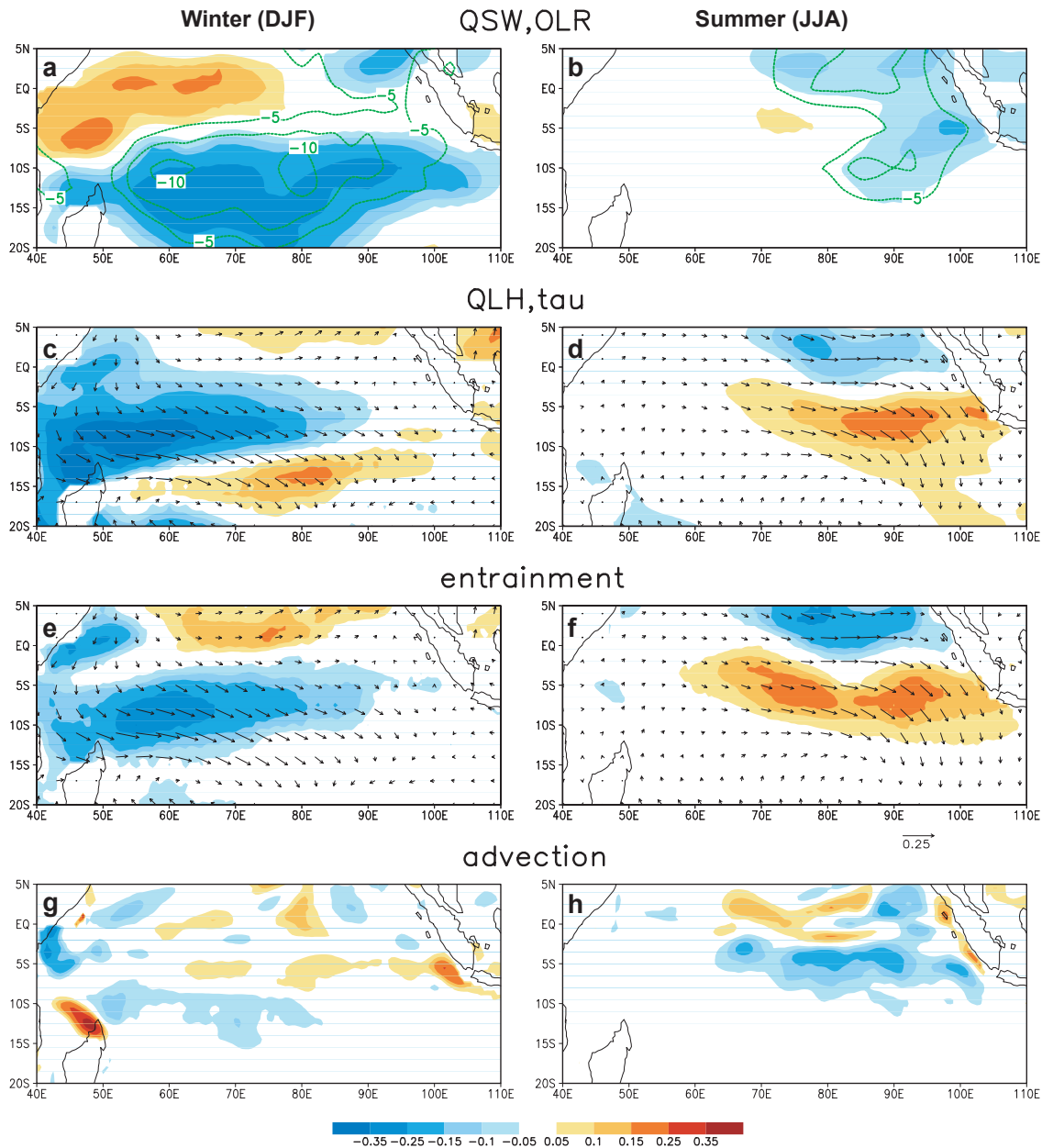


Figure 2. For northern winter (**left panels**) and northern summer (**right panels**), the simulated SST tendency (scale bar unit in °C/month) during pentad -1 to 0 of the ISO phase as a function of solar radiation (panels **a** and **b**), evaporation (**c** and **d**), entrainment (**e** and **f**), and horizontal temperature advection (**g** and **h**). Also shown for this phase of the ISO are in panels **a** and **b**, the anomalous outgoing longwave radiation (contours in intervals of 2.5W/m², starting from 5W/m²), and in panels **c**, **d**, **e**, and **f**, wind stress anomalies (arrows: unit in dyn/cm²).

Indian Ocean during summer and winter can be explained by the interplay among the various ISO forcing components and the different background

states during the two seasons. Many coupled general circulation models do not simulate the impact of the ISO well. A reason is that they do not have the correct background climate state, such

as the surface wind condition near the intertropical convergence zone. This study, demonstrating the sensitivity of the ocean to the mean climate, sheds light on ways to improve simulation of the ISO in general circulation models.

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“Suki” Manabe Pioneer of Climate Modeling

Professor Syukuro Manabe is generally regarded as the world's foremost scientist in the field of computer modeling of Earth's climate and climate change. In the 1960s, he made pioneering breakthroughs that lie at the very foundation of the subject. He made the first credible calculations of the climate effects of increasing atmospheric CO₂ concentration. With his colleagues Joseph Smagorinsky and Leith Holloway, he created the first true “comprehensive” global climate model with explicit treatments of atmospheric dynamics, radiation, and the hydrological cycle. This and subsequent work by Manabe and his colleagues in the 1970s, launched the modeling study of global environmental change.

He has continued his world-class scientific contributions to climate modeling through the last three decades. His published papers include the first comprehensive simulation of the climate and hydrologic cycle with a coupled global atmosphere-ocean model, the first simulation of stratospheric circulation, the first simulation of long-period changes in the overturning of the Atlantic Ocean, and some of the first comprehensive paleoclimate simulations.

Manabe spent most of his career at the NOAA Geophysical Fluid Dynamics Laboratory in Princeton, helping to build it into the world's premier laboratory for numerical simulation of the atmosphere and ocean. He also served on the Princeton University faculty. From 1997 to 2001, he directed the Global Warming Research Program at the Frontier Research System for Global Change in Japan.

Suki, as Professor Manabe is known among friends and colleagues, visited the IPRC in May 2005. He gave two lectures: “Early Development of Climate Modeling and Prospects for the Future” and “Simulated ENSOs with Interannual and Decadal Time Scales: Amplitude Modulation and CO₂ Sensitivity.” During this time, he also met with the IPRC Climate editor. These pages attempt to recapture Suki's delightful recollections and comments.



The first fully coupled general circulation model

As Syukuro Manabe was finishing his dissertation in meteorology at Tokyo University, he received a letter from Joseph Smagorinsky inviting him to join his research group at the U.S. Weather Bureau in developing a general circulation model of the atmosphere. It was early 1958, and significant breakthroughs were being made in the field.

Manabe recalls, “I accepted the invitation from Smagorinsky... It was a good time... lots of money for research [in the U.S.]. Smagorinsky was a pioneer... he had a grand vision. He wanted to build an Earth System Model, a global numerical model that had a troposphere and stratosphere and had large-scale circulation, radiative heat transfer, convective heat transfer, and heat and water balance at the surface.” Smagorinsky wrote about this time: “In September 1958, Syukuro Manabe joined our group. He was to become my close collaborator in this massive enterprise, eventually becoming the leader of our growing general circulation modeling group.”¹

Manabe came to Washington to work at the General Circulation Research Section of the U.S. Weather Bureau, which was renamed the Geophysical Fluid Dynamics Laboratory (GFDL) in 1963 and was later moved to Princeton. Of this first period in Washington, Manabe recalls, “Smagorinsky's and my role were complementary. He had the ambitious plan, and my job was to make it work. The computer was so feeble at the time... if we put everything into the model at once, the computer couldn't handle it. I was there and was watching the model blow up all the time. So, I had to break it down into bits, and first test individual components of the model separately. Initially, I focused on land-surface processes and on radiative transfer... I chose these because Smagorinsky wasn't working on them. I didn't know anything about these things then, so I had to work very hard, visiting frequently the Library of Congress to get information.



Sugi (center, with present) at the Haneda International Airport, September 1958, is leaving for the United States and is given his sendoff by staff members of the Meteorology Section, Geophysical Institute, University of Tokyo. Yoshio Kurihara, who later joined Sugi at GFDL stands to his immediate right.

“For instance, we didn’t know if we could couple successfully radiative transfer and the equations of motion together into a three-dimensional model, whether we can get a temperature distribution that resembles the real atmosphere, whether we get a stratosphere, or even a troposphere where moist convection takes place... there was no guarantee at that time. So I created a vertical one-dimensional column model, a global horizontally averaged model, with radiative transfer to see whether this model alone can produce a realistic vertical distribution of temperature before it is incorporated into the three-dimensional model. And this became my 1964 paper with Bob Strickler² on the thermal equilibrium of the atmosphere with convective adjustment.

“One of the challenging questions we had to answer was how to treat moist convection, such as cumulus convection and large-scale convective rainfall. Smagorinsky had a very sophisticated parameterization of moist convection, but when we put water vapor into the GCM, the model just blew up. Reason we got so much trouble is that the unstably stratified atmosphere tends to develop very small-scale convection, which becomes more and more unstable. You begin to get a very small-scale updraft in the model, then it grows to grid-box scale, and the model just can’t handle it numerically. When I analyzed the actual data, I saw this thing happening many times.

“I thought a lot about the problem, and developed a parameterization for moist cumulus convection: I neutralized the lapse rate. This solved the problem. A very simple idea, people don’t like it, some think I still haven’t solved the problem. During a time when Sma-

gorinsky was traveling, I simplified the model, so when he came back the model was running. He couldn’t complain about success.

“To compute soil moisture, I initially developed a one-dimensional model, in which water diffused vertically. Unfortunately, information on soil property such as vertical diffusivity of water in soil was not available on the global scale. So, we developed a very simple ‘bucket model’, which has worked very well in my opinion.

“The original 1956 model by Norman Phillips is a two layer, mid-latitude zonal belt model. Smagorinsky came up with an ingenious idea for treating the entire globe by combining Northern and Southern Hemispheres. Unfortunately, the model did not work because computational leakage of air developed at the equator, where the two hemispheres meet. Because of the systematic loss of angular momentum due to the leakage, middle latitude-westerlies weakened, and eventually transformed into highly unrealistic easterlies. As a stop-gap measure and out of desperation, I just put a ‘Great Wall’ on the equator. Instead of having a global model, I changed it into a hemispheric model. This resulted in the two 1965 papers.³ At that time, we couldn’t satisfy our dream to create a global model with geographically realistic climate distribution, but we put in the hydrological cycle and we already had an interactive stratosphere-troposphere... so these things were a very satisfactory contribution.

My GFDL colleague and old classmate Yoshio Kurihara introduced a spherical coordinate system to treat the entire globe. We put in realistic distribution of continents, oceans, and gave

realistic sea surface temperature, and came up with the 1974 paper.⁴ That paper has a very successful simulation of global rainfall, both geographical and seasonal. The contents are still not outdated, in my opinion. I'm very proud of this paper. I was really amazed at how good the simulation is. Now everybody says, when you get high sea surface temperatures you get more rain. But they don't understand why. This 1974 paper explains it.

"The numerical experiment for the '74 paper was actually carried out around 1970. At that time, the computer was so slow. We were using 60% of GFDL computer time, and it took one year to integrate one year of model time. It was end of 1971 when we finished the runs. The 2½-year-integration produced thousands of tapes. The tape reading machine was huge... 27 tape reading machines... put in reel, push button here and there... much more impressive than the computer itself. When you wanted to read the tapes, they were so bad... many tapes were in storage... the operator blows dust out and then puts tape back in, and after you try several times, two out of three tapes start reading, but the last one still goes bad. Then you send it to cleaning. It took 2½ years to run and two to three years to analyze.

"In mid-1960s, I started working collaboratively with Kirk Bryan in putting his ocean model into a coupled ocean-atmosphere model, which was used later for projecting future climate change. About the coupled model, people said, 'Oh, they construct this complicated model and write this very lengthy boring paper, but we really don't understand the atmosphere very well yet, nor the ocean. It appears premature to build such a complicated model. They are spoiled by computer.' Thirty years later, everybody else's model has become much more complicated than mine. I hardly changed my model over time; it was still working reasonably well, and I was applying it to solve many interesting problems. But, I find myself with everybody saying to me, 'Your model is too simplistic.'

"Many people think you have to build a model that mimics nature as realistically as possible. But nature has so many things, you can't include everything. The more complicated you make a model, the harder it is to find out why it malfunctions. I'm not against this Earth System Modeling, but for training graduate students and for problem-solving, there is a need for a model like mine, a model of intermediate complexity with realistic equations of motion, realistic physics, but simplified parameterization of subgrid-scale pro-



October 21, 1970, Kirk Bryan and Syukuro Manabe receive the Gold Medal Award from Department of Commerce, NOAA. From left to right: Kirk Bryan, Suki Manabe, Secretary of Commerce Maurice Stans, and NOAA Administrator Robert White, "For an outstanding contribution to the problem of mathematically modeling the joint atmosphere-ocean system and its implication for the service of humanity."

cesses. What I want to say is that with such a model, you can conduct many numerical experiments with relatively small expenditure of computer time, and unravel the mystery of climate.

Hitting the Jackpot: Global Warming Research

"When I published the radiative convective equilibrium paper back in 1964, I was pleased to get a nice stratosphere and near-perfect surface temperature all in the one-dimensional column model. Before I coupled this simple model with the three-dimensional one, I wanted to see how sensitive the model is to cloudiness, water vapor, ozone and to CO₂. So, I was changing greenhouse gases, clouds... playing and enjoying myself. I realized that CO₂ is important, and as it turned out, I changed the right variable and hit the jackpot. I think now this paper (Manabe and Wetherald, 1967)⁵ is cited over 1000 times. The Institute for Scientific Information chose this paper as a citation classic.

"Probably this is the best paper I wrote in my whole career. I used just a simple, one-dimensional model, but in terms of originality, no other paper I wrote can beat this one. We assumed that the vertical distribution of relative humidity remains unchanged; we discussed water vapor feedback. At that time, I didn't get any accolades and didn't know I hit the jackpot. I was busy working on developing a nice three-



Sugi during his lecture at the University of Hawai'i, May 2005, "Early Development of Climate Modeling and Prospects for the Future."

dimensional model... and just had a small detour... doing some research because I was curious.

"This was my first study on global warming. I had learned a lot about radiation from Fritz Möller. He visited our lab in early 1960. He was a pioneer of radiative transfer calculations. When he improved the infra-red radiation absorption in his model of radiative transfer, he discovered to his great surprise that all estimates of global warming that had been done before him were flawed. Möller and I felt that using my one-dimensional radiative convective model and treating properly the convection component of the heat transfer, we would be able to resolve

the flaw in the studies conducted earlier. But I didn't think that I hit a home run. At that time, no one cared about global warming. Only gradually people began to realize that global warming is really an issue... with far-reaching, societal impact.

"I did this work on CO₂ not because I worried about global warming and its societal impact but to evaluate the three-dimensional model we were constructing. In the Northern Hemisphere, temperature decreased slightly between 1940 and 1975. Some people thought maybe an ice age is coming. Then, around 1975, temperature started to go up again and warming to accelerate, and people started getting concerned about global warming. Throughout that period, I kept studying global warming using the three-dimensional model to satisfy my curiosity.

"A drought spread over North America in summer 1988. Congress suddenly worried that the drought may be a consequence of global warming. Our numerical experiment shows that, in summertime, the soil gets drier as global warming proceeds. So, I gave testimony at a Congressional hearing that global warming can make droughts more frequent. At the hearing, Jim Hansen of NASA did what you might call a prediction of future climate change based upon the result obtained from his model. He made an excellent presentation, concluding that he is 99% certain that a major part of the warming during this century is attributable

to the increase in greenhouse gases. His testimony was extensively cited in the *New York Times* and other major newspapers, and had a large impact. In contrast, my testimony was not interesting enough to be cited by the media. I said, 'It is impossible to say whether this drought can be regarded as a consequence of global warming, because you can get a big drought in the absence of global warming, like in the 1930s... Steinbeck's novels... we had a big dust bowl... hardly any global warming then. Probably this is a natural variability. But if it goes on (temperature rises) over a long time, then this kind of drought is likely to become more frequent.' They asked me: 'Is entire North America going to become a desert?' I said, 'No, it will not!'

"They weren't too impressed by this Japanese guy who has this accent; whereas Jim Hansen made a bombshell impression. This was the first time politicians really began to take seriously that there is global warming and that it may impact our life, not just some kind of theoretical projection.

"I never became a crusader. Realizing that I am not good at communicating my ideas to the general public, I decided early on to focus my energy and attention on research. I've continued the modeling study of drought and the impact of global warming on river discharge and found that it's far from uniform. Some rivers will have more discharge... the arctic rivers, the Ganges. However, in the semiarid regions of the world, such as the southwestern part of North America, the Sahel, South Africa, and the Middle East, where they are already suffering from water shortages, in these areas the soil

will get drier with warming. Water shortage is going to be one of the most important negative impacts of global warming, in my opinion.

“The issues of global warming are different from the ozone hole problem. People get skin cancer. When you stop CFC emissions, you know ultraviolet radiation will eventually be reduced and rate of skin cancer will be less. The CFC emission has been reduced successfully. In case of CO₂, it is very difficult to reduce rate of CO₂ emission enough to stabilize the CO₂ concentration of air at a safe level. I can tell how climate will change, but not whether it is worthwhile to do things to mitigate the effect.

“In the late 1980s, the Intergovernmental Panel on Climate Change (IPCC), held a meeting in Princeton and invited me to participate in the meeting. They saw our coupled ocean–atmospheric model study, published in *Nature* in 1989. From 1989 through 1992, we had several articles that used coupled ocean–atmosphere GCMs, and showed how the climate responds to a gradual increase in CO₂. We analyzed very carefully the results from coupled ocean–atmosphere simulations and investigated what is happening in the ocean and how it affects the pace of climate change. The role of oceans in climate change is articulated in those studies, probably better articulated than in many papers published since. Though people are still using a similar coupled model methodology, they have developed more detailed models, and have included not only the changes in CO₂ and other greenhouse gases but also in aerosols. It is great that they compare very carefully simulated and observed changes in global climate. I am encouraged that they have begun to obtain more consistent results on regional climate.

“Regional climate change is more relevant to our daily life than global-mean temperature change. To determine regional climate change, you need many experiments, every time with slightly different initial conditions... because of the natural variability. By superposing the results from all of the members, you can extract the systematic change and the regional climate change. I found, for example, that almost all models show that semiarid regions become drier with global warming. This is a robust finding.

“I’m no longer active in the IPCC, but I think the IPCC is very important and doing wonderful business.”



Suki with his former GFDL colleague, IPRC Co-team Leader Kevin Hamilton.

¹ Smagorinsky, J., 1983: The beginnings of numerical weather prediction and general circulation modeling: Early Recollections. *Advances in Geophysics*, **25**, p. 36.

² Manabe, S., and R.F. Strickler, 1964: Thermal equilibrium of the atmosphere with a convective adjustment. *Journal of the Atmospheric Sciences*, **21**, 361–365.

³ Smagorinsky, J., S. Manabe, and J.L. Holloway, 1965: Numerical results from a nine-level general circulation model of the atmosphere. *Monthly Weather Review*, **93**, 727–768; and Manabe, W. J. Smagorinsky, and R.F. Strickler, 1965: Simulated climatology of a general circulation model with a hydrologic cycle. *Monthly Weather Review*, **93**, 769–798.

⁴ Manabe, S., D.G. Hahn, and J.L. Holloway, Jr., 1974: The seasonal variation of the tropical circulation as simulated by a global model of the atmosphere. *Journal of the Atmospheric Sciences*, **31**, 43–83.

⁵ Manabe, S., and R.T. Wetherald, 1967: Thermal equilibrium of the atmosphere with a given distribution of relative humidity. *Journal of the Atmospheric Sciences*, **24**, 241–259.

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Forecasting Monsoon Rainfall

The large variability in rainfall during the Asian summer monsoon greatly affects the economies of densely populated Asia. Periods of less than 2 mm rain a day may be followed by periods with up to 14 mm a day. The physical mechanisms regulating these intraseasonal oscillations have been a major IPRC research focus. The intent is to establish procedures to predict these “active” and “break” rainfall periods.

The predictability research has mostly used atmospheric general circulation models (GCMs) that are not coupled to ocean models but constrained by realistic sea surface temperature and sea ice. This avoids the complexity of ocean–atmosphere feedbacks.

Bin Wang, co-leader of IPRC’s Asian-Australian Monsoon System research, however, conducted a collaborative study with other scientists at IPRC and at the Center for Ocean-Land-Atmosphere Studies, Seoul National University, and the European Center for Medium-Range Weather Forecasts. The study showed that the uncoupled approach does not work for dynamical simulation and prediction of the Asian yearly summer monsoon rainfall, “stand-alone” models being unable to simulate realistically the average annual rainfall over Asia during the monsoon. Wang and his colleagues, for instance, noted that the uncoupled atmospheric model ECHAM yielded positive sea surface temperature–rainfall correlations, a relationship opposite to observations. When ECHAM, however, is coupled with an intermediate ocean model, allowing feedback between the ocean and the atmosphere, a realistic relationship develops.

Xiouhua Fu and Bin Wang found similar outcomes when simulating the dry and rainy spells during a single monsoon season, or the intraseasonal rainfall. When ECHAM is coupled to an intermediate ocean model, allowing feedback between the ocean and the atmosphere, the system reproduces a realistic sea surface temperature–rainfall relationship, but when the model is used by itself, the rainfall is not simulated correctly, even though the model is run with the daily sea-surface data from the coupled model solutions.

In their most recent work, Fu and Wang, in collaboration with **Li Tao** at the IPRC and **Duane Waliser** at the Jet Propulsion Laboratory, demonstrated that the ECHAM, coupled to an intermediate ocean model (the IPRC hybrid coupled



Ingo Kirchner with Xiouhua Fu.

model), can predict the dry and rainy periods over northern Indian nearly one month ahead.

The next step is to perform experimental real-time intraseasonal rainfall predictions with the IPRC hybrid coupled model. This project is part of a major task of the newly launched international project, Climate Prediction and Application to Society (CliPAS) of the APEC Climate Center in Korea. Bin Wang is a principal investigator of this international project.

The development of such a coupled-model prediction system is challenging. As a step in this endeavor, CliPAS and IPRC invited this fall **Ingo Kirchner**, senior scientist at the Institute for Meteorology, Free University, Berlin, in order that he could implement initialization packages for the IPRC hybrid coupled model. During his visit, Kirchner worked with Xiouhua Fu, **Qing Bao**, and Bin Wang to adapt the NCEP reanalysis data so it is usable by ECHAM. He developed a simple nudging scheme to initialize the coupled model without complex data assimilation. The technique will also help to evaluate the parameterization schemes in the coupled model.

The intraseasonal monsoon-rainfall prediction team at the IPRC has now started the first set of experimental runs with their new tools. In these runs, the forecasts are actually hindcasts that compare the model predictions with actual observations on past monsoons. Once the problems and bugs have been worked out, simulations with the IPRC hybrid coupled model will be compared to simulations with other models to assess how well the model forecasts intraseasonal rainfall. Such multi-model runs will help to detect systematic model errors and to determine the best strategy for predicting rainfall a few weeks in advance during the summer monsoon. **iprc**

What's Happening at the Asia-Pacific Data-Research Center?

Two-Million-Dollar NOAA Grant for the APDRC

The Asia-Pacific Data-Research Center (APDRC) of the IPRC received a grant of nearly 2 million dollars from NOAA through the National Environmental Satellite, Data, and Information Service and its National Climate Data Center. The funds are to help advance NOAA's objectives in meeting regional needs for information on the ocean, climate, and ecosystems in order to protect lives and property, support economic development, and enhance the resilience of Pacific Island communities in the face of changing environmental conditions.

The APDRC will use the funds to operate and to continue to develop its data server system, data sets, and data management for climate data and products. This work includes serving Global Ocean Data Assimilation Experiment (GODAE) satellite- and model-derived products, which are useful for a broad range of research activities and societal applications. The funds will also support activities of the recently established Pacific Region Integrated Data Enterprise (PRIDE), especially the development of high-resolution versions of operational models that can be applied to the Pacific Islands region, and data analysis of the Atmospheric Brown Cloud project.

[iprc](#)

More Upgrades to the APDRC Website

Computer Systems Engineer **Sharon DeCarlo** continues to upgrade the APDRC website. She has placed a new text search box at the bottom left of all APDRC pages. The box allows key-word searches of the entire APDRC site, including the data archive and documentation. She has also

added a "Projects" page, which briefly describes the support the APDRC gives to various projects and which has links to these projects, for example the Atmospheric Brown Cloud, the Pacific Argo Regional Center, Japanese Earth Simulator model outputs, PRIDE, and the information and data center on the Hawaiian region. The link "New" on the home page leads to a page with all the recent updates to the website. [iprc](#)

apdrc Welcome to the Asia-Pacific Data-Research Center

New The APDRC is building towards a vision of one-stop shopping of climate data and products for our users.

Data Our mission is to increase understanding of climate variability in the Asia-Pacific region by developing the computational, data management, and networking infrastructure necessary to make data resources readily accessible and usable to researchers and general users; and by undertaking data-intensive research activities that will both advance knowledge and lead to improvements in data preparation and data products.

Partners

Projects

Servers

Tutorials

Easy Access to Data and Products via the APDRC Servers (atmospheric, oceanic, air-sea flux, and terrestrial)

Search for datasets EPIC for non-gridded products

APDRC Datasets

- Argo
- SeaWiFS
- ISCCP D2 satellite cloud
- J-OFURO
- Jeaeger precipitation
- Japan GODAE, NGSST
- Legales precipitation
- Levitus Climatology
- LB-OTD Lightning
- WINDIAN TOPEX

SEARCH Gridded access to Products

APDRC SERVERS

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OPENDAP Direct Client Access to Products

LAS Gridded Products

LAS for gridded products GDS server, Aggregation server

Questions or Comments?

Search APDRC

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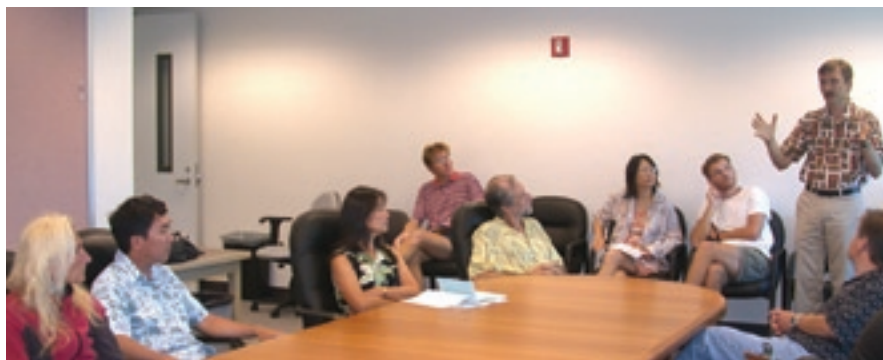
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Address: Pacific Ocean Science and Technology Bldg., Room 401, 1680 East-West Road, University of Hawaii, Honolulu, Hawaii 96822 ([see map](#))
Phone: (808) 956-5019; Fax: (808) 956-9425.

Questions, Comments? Contact Us

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Collaboration with the Pacific Islands Fisheries Science Center



Meeting with staff from the Pacific Islands Fisheries Science Center. From left, Reka Domokos, Don Kobayashi, Yanli Jia, Justin Small, Jeffrey Polovina, Zuojun Yu, Paulo Calil, Nikolai Maximenko, and Tommy Jensen.

Scientists from the NOAA Pacific Islands Fisheries Science Center in Honolulu visited the IPRC last June. **Jeffrey Polovina**, Chief of the Ecosystems and Oceanography Division at the NOAA center, opened the meeting that explored how the high-resolution Hawai'i Regional Ocean Model, developed at the APDRC, could be applied to projects at the Fisheries Science Center.

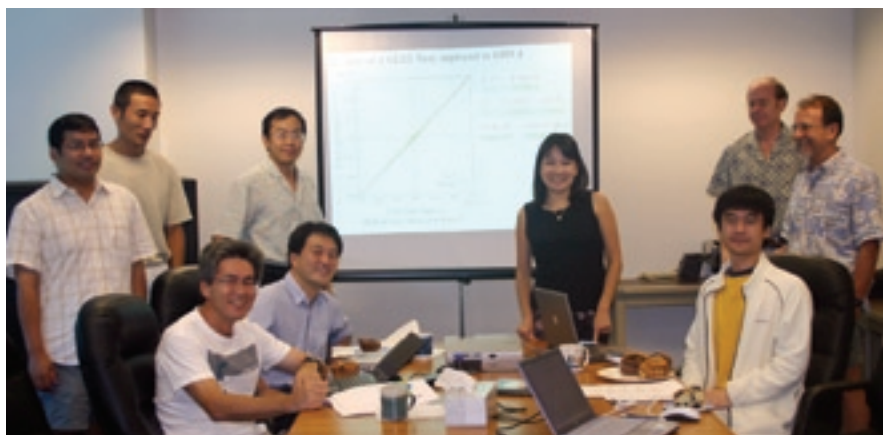
The NOAA scientists described their work, giving the APDRC staff an idea how their modeling skills and the regional model might contribute to the NOAA studies. Research Fishery Biologist **Don Kobayashi** is looking at the 45-day colonization pathway of fish larvae from the Johnston Atoll to the Hawaiian Archipelago. Mortality of the larvae is very high, and most

larvae die within the first week of life. The currents, sea surface temperature, and phytoplankton concentration on the colonization pathway are therefore critical to larval survival. It appears that the nature of the path from Johnston atoll may make the atoll a poor recruitment region. A high-resolution ocean model that represents well the bathymetry, currents, sea surface temperature, and chlorophyll is needed to understand the transport and recruitment issues better. **Reka Domokos**, oceanographer at the Ecosystems and Oceanography Division, is investigating marine life around seamounts, especially, how the location of the different species shifts during the daily 24-hour cycle. Is this variation due to changing sunlight, currents, or internal waves? Domokos would like a model

that simulates these variables at the complex seamount bathymetry so that she can understand their impact on seamount life. **Rusty Brainard**, Chief of the Coral Reef Ecosystem Division, described the coral monitoring, mapping, and research work of his division. The mapping of bathymetry, including fine details of the ocean floor and its slope, is a project that will be very important for the regional application of ocean modeling at the IPRC. The records of living, dead, and fossil corals that are being collected in this project can provide valuable information about climate variability over both recent periods and paleoclimates.

Plans are now underway for **Yanli Jia**, visiting scientist at the APDRC, to import codes for particle tracking (in order to simulate fish larval recruitment) into the Hawai'i Islands Regional Ocean Model and to extend the model domain to the date line, thereby including the larval recruitment region for the Hawaiian Archipelago. [iprc](#)

Pacific Argo Regional Center (PARC)



PARC participants, from left, sitting: Shinya Minato, Shigeki Hosoda, and Hiroshi Yoshinari; standing, Shuiming Chen, Yingshuo Shen, Gang Yuan, Sharon DeCarlo, Jim Potemra, and Peter Hacker.

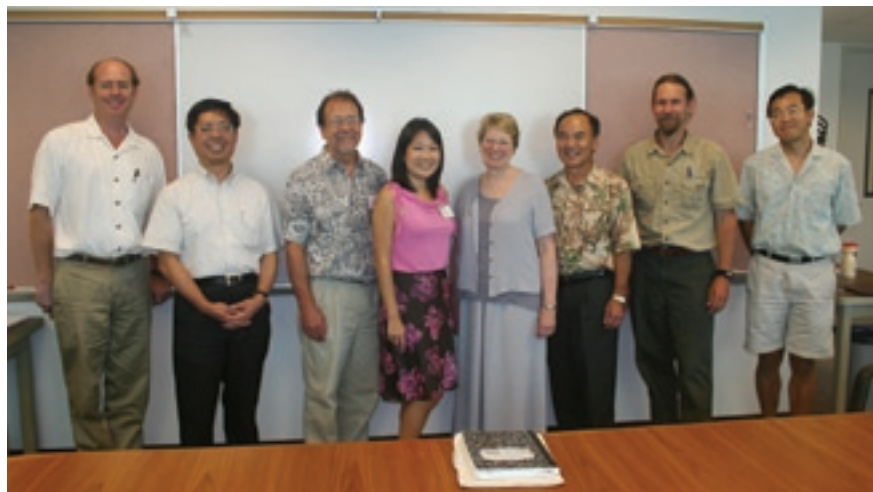
Argo is a multinational effort to measure the world oceans with autonomous drifting floats. Nations contribute to this program by supplying ship time, floats, and expertise in deploying floats. Not all countries have the

resources to collect, quality control, and distribute the data, nor to make such products from the Argo network of measurements as, for example, gridded, near real-time temperature and salinity maps to depths of 1500 meters. The Argo program is therefore establishing regional centers to help with these activities.

The APRDC, in collaboration with the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and the Australian Commonwealth Scientific and Research Organization (CSIRO), is working toward the development of the Pacific Argo Regional Center (PARC), which will be responsible for Argo data and products for the Pacific region. (The precise area coverage for the center is still to be determined.) To continue planning for this center, the APDRC hosted an organizational meeting August 31–September 2, 2005. The participants included **Shinya Minato** and **Shigeki Hosoda** from JAMSTEC, **Shuiming Chen** from the Oceanography Department at the University of Hawai‘i, and representatives of the APDRC and the IPRC. Plans call for a “virtual center”, *i.e.*, a web-based site on which the main participants (APDRC, JAMSTEC and CSIRO) exchange information. At the meeting, the design of the virtual center and its web pages were discussed at length. Future work and research relevant to the Pacific Argo Regional Center were presented and reviewed together with current research projects, particularly those that are focused on determining deep-ocean velocities from Argo data.

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IPRC Assists with the Second Annual PRIDE Meeting



Jim Potemra, Charles Sun, Peter Hacker, Sharon DeCarlo, Nancy Soreide, Mark Mekaru, Steve Hankin, and Gang Yuan after APDRC server “tour.”

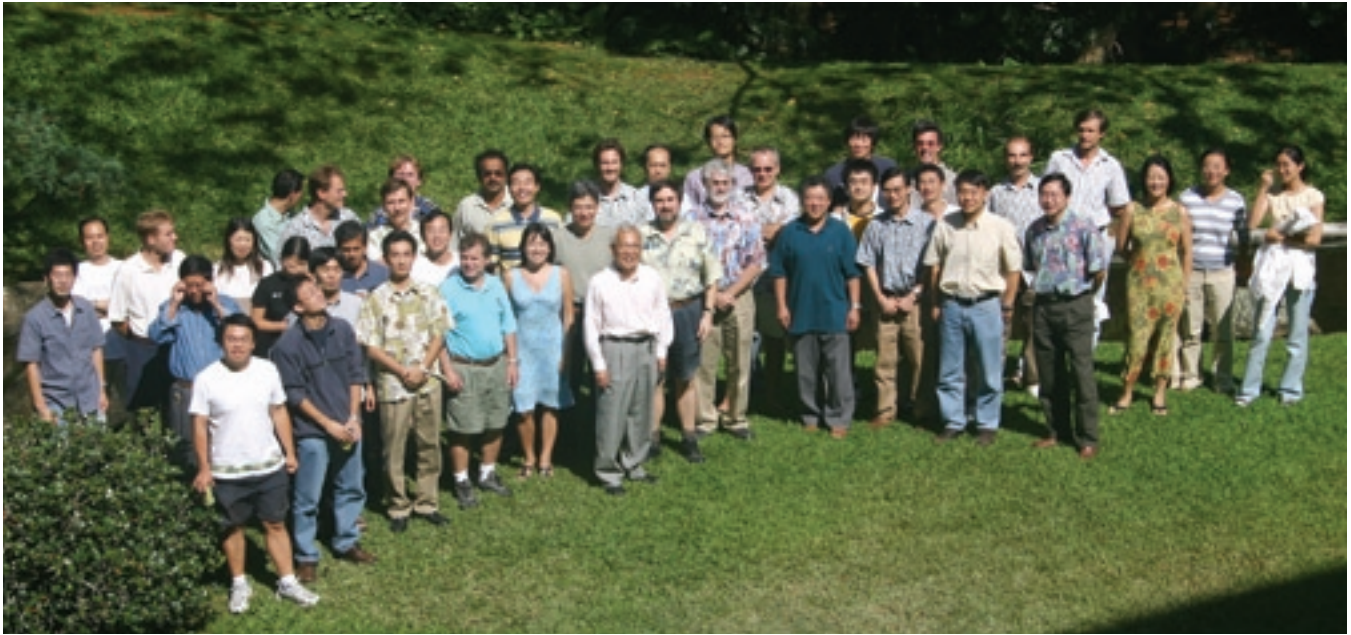
The Pacific Region Integrated Data Enterprise (PRIDE), the recently formed NOAA effort to integrate its Pacific services and activities, held its second annual meeting at the East-West Center in Honolulu on August 9–10, 2005. Investigators from the 14

PRIDE-funded projects (5 of which are IPRC projects) gave short presentations about their progress to date. The talks from the meeting are posted at the PRIDE projects page on the APDRC server. At the end of the meeting, a group of PRIDE participants were given a “tour” of the APDRC server systems. [iprc](#)



M E E T I N G S

Fifth Annual IPRC Symposium Held May 4–6, 2005



The Fifth Annual IPRC Symposium was held May 4–6 at the East-West Center in Honolulu. At this event, IPRC scientists present the highlights of their research for the year. This annual sharing is a time to pause and reflect upon the progress that has been made in understanding climate phenomena, particularly those affecting the Asia-Pacific region. It is an occasion to solicit comments and suggestions from peers and to detect common research threads.

Axel Timmermann, co-leader of the Impacts of Global Environmental Change Research Team, organized this fifth symposium.

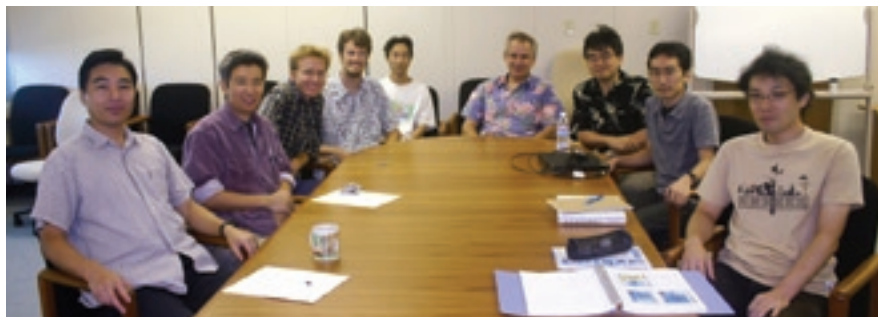
The *Atmospheric Dynamics and Modeling* section featured work on modeling hurricanes, improvements in simulating the daily tropical rainfall cycle over the ocean by altering the convective entrainment and detrainment parameterizations, and the use of simulations with high-resolution general atmospheric models as a source of information for low-resolution models. The *Climate Change* section featured research dealing with global warming effects on tropical storms in the western North Pacific and paleoclimate studies, including the global response to a shutdown of the thermohaline circulation. *Climate Variability* presentations ranged from a description of a link between the Pacific North American atmospheric pattern and Southwest Indian Ocean sea

Participants of the 2005 Annual IPRC Symposium in the Japanese Gardens of the East-West Center.

surface temperature to the modeling of North Pacific decadal variability, to a study of eastern Pacific climate with the recently developed IPRC Regional Ocean–Atmosphere Model (iROAM). The *Ocean Circulation and Modeling* presentations included studies of the influence of the Indonesian Throughflow on the circulations in the Indian and Pacific Oceans, a description of the source and nature of the upwelling off Java and Sumatra and its influence on the region's sea surface temperature, the successful numerical modeling of the important Southern Tsuchiya Jet, and the discovery of alternating zonal jets in the upper ocean.

For the agenda, visit the IPRC website at iprc.soest.hawaii.edu/meetings/workshops.html/. **iprc**

IPRC Regional Ocean–Atmosphere Model Meeting



The iROAM Team, from left, Yuqing Wang, Shang-Ping Xie, Justin Small, Simone de Szoeke, Hideki Okajima, Kelvin Richards, Toru Miyama, Takashi Mochizuki, and Minoru Chikira.

The IPRC Regional Ocean–Atmosphere Model (iROAM) is the most recent model developed at the IPRC. Currently the model is running on Japan's Super Computer, the Earth Simulator, as part of a collaboration between the IPRC and JAMSTEC on the Kyosei-7 Project, an ambitious project to develop a system for seasonal to interannual climate forecasts. To discuss the current status of model development and experiments to be conducted with iROAM, **Toru Miyama** and **Takashi Mochizuki** from Frontier Research Center for Global Change and JAMSTEC met with IPRC team members

in October 2005. Planned projects with the model include further study of the effects of the Andes, ocean mixing, and boundary layer clouds on the coupled eastern Pacific climate system. The goal of these studies is to understand the air–sea coupled processes in the eastern Pacific in order to improve coupled climate models, which tend to simulate a cold tongue that stretches too far to the west, an eastern Pacific coastal region that tends to be too warm, and a climate that is too symmetrical with respect to the equator. iROAM will also be used to study the climate of the Hawaiian Islands. [iprc](#)

IPRC Hosts NASA Science Team for Earth Observing System



IPRC's Xiouhua Fu (left front) with the NASA AMSR-E Science Team at Jefferson Hall, East-West Center.

The IPRC co-hosted a meeting on September 13–15, 2005, at the East-West Center for the science team of the NASA Advanced Microwave Scanning Radiometer for the Earth Observing System, or AMSR-E. This very important observing system, which is flying on NASA's Aqua polar orbiting satellite, can see through clouds and has good global coverage. The system yields the following advanced products: for the ocean—surface wind speed, sea surface temperature, atmospheric water vapor, cloud liquid water; for land—surface soil moisture, vegetation water content, surface temperature; for sea ice—sea-ice concentration and surface temperature,

snow over sea ice, and also global rainfall and snow-water equivalent. At the workshop, recent database developments, procedures for data assimilation, various applications of the data, and validation studies were presented.

IPRC researchers are heavy users of NASA satellite data products and the Asia-Pacific Data-Research Center serves part of the AMSR-E datasets at apdrc.soest.hawaii.edu/. The detailed description of AMSR and available datasets can be found at the AMSR-E official website www.ghcc.msfc.nasa.gov/AMSR/. [iprc](#)

Visit by Director-General of the Frontier Research Center for Global Change



From left, sitting: Tatsushi Tokioka, James Gaines, Klaus Keil, and Toshio Yamagata; standing: Tetsuro Isono, Vassilis Syrmos, Judith Rubano, Saichiro Yoshimura, Julian McCreary, Katsuhiko Masuda.

Tatsushi Tokioka, the Director-General of the Frontier Research Center for Global Change (FRCGC), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), visited the IPRC on December 2, 2005, together with Program Director of the

Climate Variations Research Program **Toshio Yamagata**, Advisor **Saichiro Yoshimura**, Director of the Research Promotion Office **Katsuhiko Masuda**, and Chief Administrative Officer **Tetsuro Isono**.

A luncheon was given in honor of

the visitors at Hawai'i Hall, the oldest building of the University of Hawai'i (UH), where the group from FRCGC and JAMSTEC were welcomed by UH Interim Vice President for Research **James Gaines**, the chief research policy advisor to UH Interim President **David McClain**. Vice President Gaines expressed his appreciation to Director-General Tokioka for the valuable support given by JAMSTEC and FRCGC to the IPRC climate research.

At the IPRC, the visitors discussed funding for the IPRC with Interim Dean of SOEST **Klaus Keil**, Acting Director of Administration for SOEST **Judith Rubano**, and IPRC Director **Julian McCreary**. They also met with IPRC research team leaders, who gave summaries of their most recent research projects. [iprc](#)

IPRC Scientific Advisory Committee Meeting



Scientific Advisory Committee members, from left, sitting: Julian McCreary, Kensuke Takeuchi (Co-chair), Antonio Busalacchi (Co-chair); standing: Atsushi Kubokawa, Gary Meyers, Roberto Mechoso, Gerald Meehl, Masahide Kimoto, Peter Cornillon, and Humio Mitsudera.

The IPRC Scientific Advisory Committee met in November 2005 to review research progress at the IPRC. The committee noted a rise in the quality, consistency, and collaboration of IPRC science activities; the progress in the APDRC; the reorganization of the annual report; and the IPRC's hosting of internationally recognized meetings. [iprc](#)

IAMAS 2005 Presidential Lecture Given by IPRC's Kevin Hamilton



Kevin Hamilton gives IAMAS Presidential Lecture in Beijing, China.

IPRC's **Kevin Hamilton** gave the Presidential Lecture at the Plenary Opening Session of the Ninth Scientific Assembly of the International Association of Meteorology and Atmospheric Science (IAMAS), which was held August 2–11, 2005, in Beijing, China.

His lecture, “Ultrafine Resolution Global Atmospheric Modeling,” included discussion of the results on high-resolution atmospheric modeling obtained in a collaboration between the IPRC and Japanese colleagues at the Earth Simulator Center and at Hokkaido University (see *IPRC Climate*, Vol. 3, No. 2, “Atmospheric Modeling on the Earth Simulator”).
[iprc](#)

Participants of the Regional Climate Workshop in Beijing. Workshop Chair Yuqing Wang is the sixth from right in the back row.

IPRC Service to the Climate Research Community

Shang-Ping Xie Appointed as an Editor of *Journal of Climate*

Shang-Ping Xie, co-leader of the Indo-Pacific Climate Research Team has been appointed by the Council of the American Meteorological Society as an editor of the *Journal of Climate*. His editorship begins January 1, 2006, and is for a three-year term. With this appointment, Xie regrettably steps down from the editorship with the *Journal of the Meteorological Society of Japan*, a position in which he has served since 2000.

Impact indices show that the *Journal of Climate* has grown into one of the most influential journals in atmospheric and ocean sciences since its inception in 1988. A semi-monthly publication, the journal published in 2004 about 350 papers with a total 4,909 pages. [iprc](#)

Yuqing Wang Chairs Regional Climate Modeling Workshop

The 4th Workshop on Regional Climate Modeling for the Monsoon System was held at the Beijing Climate Center (a regional climate center of the World Meteorological Center) of the

China Meteorological Administration in Beijing on August 12–13, 2005. IPRC's **Yuqing Wang**, who helped to organize the very first workshop at the IPRC in 2001 (*IPRC Climate*, Vol. 1, Fall), chaired this workshop. Wenjie Dong (National Climate Center, China Meteorological Administration), Fujio Kimura (University of Tsukuba), Takehiko Satomura (Kyoto University), and Wei-Chyung Wang (State University of New York at Albany) were on the organizing committee. The Beijing Climate Center sponsored the workshop.

Presentations ranged from regional coupled ocean–atmosphere model development and regional climate process studies, to operational seasonal climate prediction. Encouraging was the report that the China National Climate Center's use of a regional climate model improved seasonal climate prediction over a coupled general circulation model. Progress is seen also in such modeling issues as the time-lagged effects of spring Tibetan Plateau soil moisture on the early summer East-Asian monsoon; the effects of runoff and spin-up time on regional climate-



model performance; the sensitivity of East-Asian summer monsoon rainfall simulations to convective parameterization schemes; and the behavior of cloud processes and the water and energy cycles in regional climate simulations.

Discussed at length were issues in simulating the diurnal cycle of tropical precipitation: the diurnal cycle of clouds and precipitation will be a focus of the Regional Atmospheric Inter-Model Evaluation (RAIME) Project (of which Yuqing Wang is the coordinator). Discussed were also the effects of domain size, lateral boundary conditions, driving fields, and deep soil temperature anomalies on regional model performance.

Studies in the planning are as follows: climate processes—land surface processes in the diurnal cycle and monsoon evolution, the hydrological cycle in the monsoon system, and the effect of air-sea interaction on summer precipitation and East-Asian monsoon onset; simulation and prediction—extending simulations to include the winter monsoon, intraseasonal oscillations, subseasonal and interannual variability, and extreme climate events; and projections of global warming scenarios of extreme climate events. The 5th Regional Modeling Workshop will be held at the IPRC in Spring 2007. [iprc](#)

IPRC-Sponsored Student from Japan Receives Ph.D.

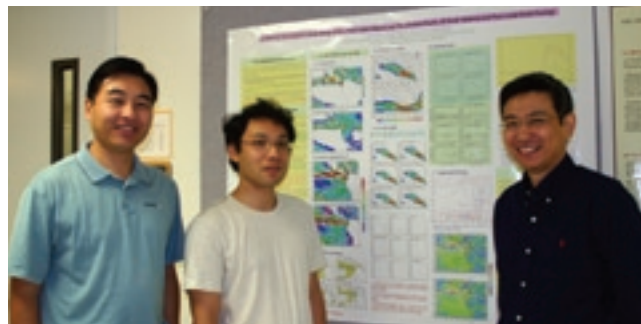


Yuko Okumura with her adviser, Shang-Ping Xie.

Yuko Okumura received her Ph.D. in meteorology from the University of Hawai'i at Mānoa in December 2005. After completing her master's degree in ocean and atmospheric sciences at Hokkaido University, Okumura came to the University of Hawai'i in 2000 to continue her

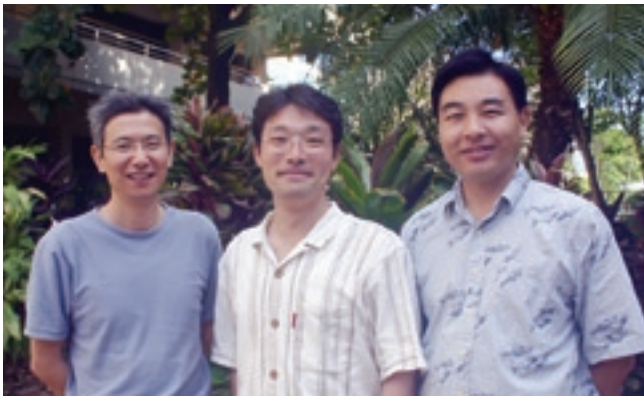
graduate education with **Shang-Ping Xie**, co-leader of the Indo-Pacific Ocean Research Team, as her adviser. In her doctoral research on the seasonal and interannual variations in tropical Atlantic climate, she found a previously unknown mode of equatorial variability for that region—a variability that is similar in spatial structure to the El Niño-Southern Oscillation in the Pacific. She was sponsored by the IPRC and a NOAA research grant to the University of Hawai'i. [iprc](#)

Collaborations



Yuqing Wang, Minoru Chikira, and Shang-Ping Xie in front of the poster depicting the IPRC Regional Climate Model simulation of the stratocumulus cloud deck in the tropical eastern Pacific.

Minoru Chikira, a postdoctoral researcher at the Frontier Research Center for Global Change, JAMSTEC, is visiting the IPRC from October 2005 through March 2006 to work with IPRC's **Yuqing Wang** and **Shang-Ping Xie**. The scientists are engaged in improving the representation of the marine stratus and stratocumulus clouds over the southeastern Pacific in the Frontier general circulation model. Realistic simulation of these clouds should reduce the common biases that coupled air-sea general circulation models have in the tropical eastern Pacific. Chikira is developing a single column model that incorporates the model physics from both the Frontier model and the IPRC Regional Climate Model. The latter model simulates the stratus and stratocumulus clouds in the region reasonably well, especially the boundary layer and the cloud-regime transitions from the coastal stratus to the offshore stratocumulus clouds, to the trade cumuli farther to the west. The column model will be used to identify the processes that are critical for the realistic simulation of marine stratus and stratocumulus clouds. The knowledge gained will then be applied to improving the simulation of these clouds in the Frontier model and their representation in fully coupled climate models.



Shang-Ping Xie (left) with Tomohiro Nakamura and Yuqing Wang.

Tomohiro Nakamura, oceanography lecturer, Institute of Low Temperature Science at Hokkaido University, Japan, visited IPRC in September 2005. During the visit, Nakamura worked with **Yuqing Wang** and **Shang-Ping Xie** to adapt the IPRC Regional Climate Model as the atmospheric component for the regional coupled model that is being developed at Hokkaido University for study of the Ohkotsk Sea.



Wataru Ohfuchi with Kevin Hamilton.

Wataru Ohfuchi, leader of the Atmospheric and Oceanic Simulation Research Group of the JAMSTEC Earth Simulator Center, visited IPRC in June. During his visit at the IPRC, he worked with **Kevin Hamilton** on analysis of results from the high-resolution, global Atmospheric Model for the Earth Simulator (AFES). Ohfuchi also gave a seminar, “Recent Results from the Coupled Ocean Atmosphere Model for the Earth Simulator (CFES).” [iprc](#)



Meteorology graduate students practice launching a weather balloon while IPRC’s Kevin Hamilton (left), Chair of the Meteorology Department, looks on.

IPRC Participates in SOEST Open House



The School of Ocean and Earth Science and Technology held its biennial Open House October 14 and 15, 2005. IPRC researchers put on a great show. They entertained the public with an animation created at the IPRC from satellite rain data over the Island of O’ahu on the terrible day that the main library of the University of Hawai’i was flooded and sustained over 75 million dollars in damages. Using an animation created with the IPRC Regional Ocean Model, they showed how the ocean’s temperature around the Hawaiian Islands changes with the seasons. The audience was also fascinated by satellite-data animations of Hurricane Katrina’s path over the Gulf of Mexico and its landfall. [iprc](#)

Mototaka Nakamura joined the IPRC this fall as a visiting associate researcher from Frontier Research Center for Global Change. Already in high school, Nakamura became aware of possible climate changes. “Back then,” he recalls, “we did see some really odd weather patterns. I became worried about the possibility of major climate changes



Mototaka Nakamura

associated with deep-circulation changes in the oceans.” His career path, though, took some side trips. He worked for a Japanese company before going to North Carolina State University to get his bachelor’s degree in 1989 in meteorology with a minor in oceanography. He spent the next years at MIT working on his doctoral degree and on “whatever interested me.” He explains: “I explored interactions among the atmospheric transports of moisture and heat, the thermohaline circulation, ice-albedo effects, and river runoff. I showed with conceptualized models the existence of complex stabilizing and destabilizing feedbacks among these processes and the masking of them by flux adjustments in coupled GCMs. Also, my work on non-linear behaviors of Rossby waves influenced by the larger-scale flow, particularly on shear and deformation fields, helped explain characteristics of material mixing in the upper troposphere and stratosphere and issues relating to the ozone hole problem.”

After completing his Ph.D. in 1994, Nakamura spent another year at MIT, joined the Georgia Institute of Technology for a year, worked at Goddard Space Flight, returned to MIT, and then joined the Jet Propulsion Laboratory for three years, where he examined the role of eddies (waves) in the large-scale circulation and material mixing and transport in the atmosphere and oceans.

He then left science and lived as a performing jazz musician for almost 2 years until a persistent pain in his left thumb forced him to return to science. He joined Duke University and then moved to Frontier Research Center for Global Change. At Frontier, he conducted research on both atmospheric and oceanic topics, which ranged from improvement of a convective mixing scheme developed by Kerry Emanuel to examination of eddy-mean relationships and their role in the large-scale ocean circulation.

At the IPRC, Nakamura will be investigating mechanisms of the alternating zonal jets with **Kelvin Richards** and **Nikolai Maximenko** and also conduct projects on the dynamics of the mid-latitude atmosphere and oceans.

Yoshiki Fukutomi, a research scientist with the Hydrological Cycle Research Program, Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), joined the IPRC in October 2005 as a Frontier visiting assistant researcher.



Yoshiki Fukutomi

Fukutomi obtained his Ph.D. in 2000 from the Institute of Geoscience, University of Tsukuba. In his dissertation on the early summer tropical-extratropical interaction associated with sub-monthly tropical convection in the western North Pacific monsoon region, he detected that tropical convection had an effect on mid-latitude atmospheric circulation, an effect involving subtropical Baiu frontal activity in the East Asia-Pacific region. After graduation, he worked at the University of Tsukuba’s Terrestrial Environment Research Center, where he constructed, from the NCEP-DOE AMIP-II reanalysis dataset, global atmospheric energy and water budget products for analyzing the continental-scale hydrological cycle. He also participated in the GAME 4-dimensional data assimilation reanalysis project conducted by the Meteorological Research Institute, Japan Meteorological Agency.

At Frontier since 2001, Fukutomi has been studying the causes of the year-to-year summer variations in the northern Eurasian hydrological cycle. He noted in the climate data over the last 30 years an east-west precipitation seesaw across Siberia at timescales of about 6–8 years. The seesaw reflects an east-west displacement of the storm track along the northern Eurasian Arctic frontal zone. Working with **Mototaka Nakamura**, he is now seeking the physical processes underlying this precipitation oscillation.

At the IPRC, Fukutomi is returning to his monsoon research and working with **Bin Wang** and the Asian-Australian Monsoon System Team. He had previously investigated characteristics of low-level southerly surges on sub-monthly timescales over the eastern Indian Ocean.

The surges are caused by the development of a mid-latitude Rossby wave that propagates in the subtropical jet region of the Southern Hemisphere and involves cold, dry air advection, air-sea interaction, tropical convection, and an equatorial wave response. He is now extending this work with 4-dimensional data assimilation and satellite observational data products and studying aspects of the cross-equatorial influence of this transient southerly surge on the south Asian monsoon region and on air-sea coupling processes.

Yoshiyuki Kajikawa, or “Kaji”, joined the IPRC in August 2005, after receiving his Ph.D. in meteorology from Nagoya University in Japan. Kaji tells how, when he was in junior high school and his baseball practice once was cancelled because of rain, his friend took him home and showed him how to draw a weather map of the event. He took



Yoshiyuki Kajikawa

up drawing weather maps from weather radio broadcasts as a hobby, spurring his interest in meteorology. While working as research assistant in the Hydrospheric Atmospheric Research Center at Nagoya University, Kaji was doing his doctoral research on the intraseasonal variations of the summer monsoon over the South China Sea. Analyzing these variations over many years, he noticed that during years that the northward propagating 30 to 60-day disturbances were strong, the westward propagating 10 to 25-day disturbances were weaker, and *vice versa*. This relationship seemed to be connected to the monsoon onset over the South China Sea.

Working at the IPRC with Team Leader **Bin Wang**, co-leader of the Asian-Australian Monsoon Research Team, Kaji is now exploring the mechanism that underlies the relationship between these two disturbances, focusing on the sudden changes in the summer monsoon seasonal cycle. In a second project, he is using output from a coupled general circulation model to clarify the effects of the high Tibetan Plateau on the intraseasonal variations of the Asian summer monsoon. This research is conducted in collaboration with scientists at Nagoya University and the Japan Meteorological Research Institute. His long-term goal is to show how interactions among land, air, and sea over the maritime continent affect global circulation.

David Burns joined the IPRC in Spring 2005 as computer systems engineer. He is working with Computer Systems Manager **Ronald Merrill**, helping IPRC staff solve their many and varied complex computer problems. He is also assisting with the maintenance and upgrading of computer hard- and software, a never-ending task.



David Burns

Burns likes to take stuff apart and put it back together. “Computer software is one of the few things that you can still use (one copy) at the same time you’re taking it apart (another copy). So I was drawn to computer programming as a career,” he recalls. After working for a decade in that field, he became interested in economics and got a Ph.D. in 1997 before discovering that taking the economy apart was really not a good idea. Returning to computers, he earned a master’s degree in Information and Computer Science at the University of Hawai’i in 2002. Now at the IPRC, Burns is interested in automating as many activities as possible so that the scientists can do their science and the IPRC Help Team can concentrate on adding capacity and capability.

IPRC Bids Sayonara

Soon-Il An, who has been a researcher with the IPRC since its inception in 1997, returned to Korea this fall to take a position as an associate professor in the Department of Atmospheric Science at Yonsei University in Seoul. He is continuing his research on the long-term variations of the El Niño–Southern Oscillation (ENSO) and their predictability and how global warming may affect ENSO.

Li Tao ended her 18-month postdoctoral stay at the IPRC in December 2006. She has taken an associate professor position at the Department of Atmospheric Sciences, Nanjing Institute of Meteorology in China.

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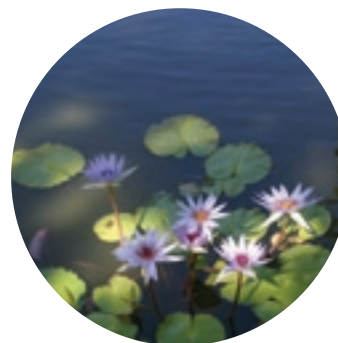
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