# FEATURES

# **"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  $CO_2$  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.

Manabespent 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  $CO_2$  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." <sup>1</sup>

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 could'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.



Suki (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 Suki 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 Strickler<sup>2</sup> 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 Smagorinsky 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 latitudewesterlies 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.<sup>3</sup> 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.<sup>4</sup> 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 oceanatmosphere 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  $CO_2$ . So, I was changing greenhouse gases, clouds... playing and enjoying myself. I realized that  $CO_2$  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)<sup>5</sup> 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-



Suki 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  $CO_2$  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  $CO_2$ , it is very difficult to reduce rate of  $CO_2$  emission enough to stabilize the  $CO_2$  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 CO<sub>2</sub>. 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 CO<sub>2</sub> 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.

- <sup>1</sup> Smagorinsky, J., 1983: The beginnings of numerical weather prediction and general circulation modeling: Early Recollections. *Advances in Geophysics*, 25, p. 36.
- <sup>2</sup> Manabe, S., and R.F. Strickler, 1964: Thermal equilibrium of the atmosphere with a convective adjustment. *Journal of the Atmospheric Sciences*, 21, 361–365.
- <sup>3</sup> Smagorinsky, J., S. Manabe, and J.L. Holloway, 1965: Numerical results from a nin-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.
- <sup>4</sup> 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.
- <sup>5</sup> 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 temperaturerainfall 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 seasurface 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 highresolution 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** 



### **Collaboration with the Pacific Islands Fisheries Science Center**



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

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.

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. iprc

#### 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** 

