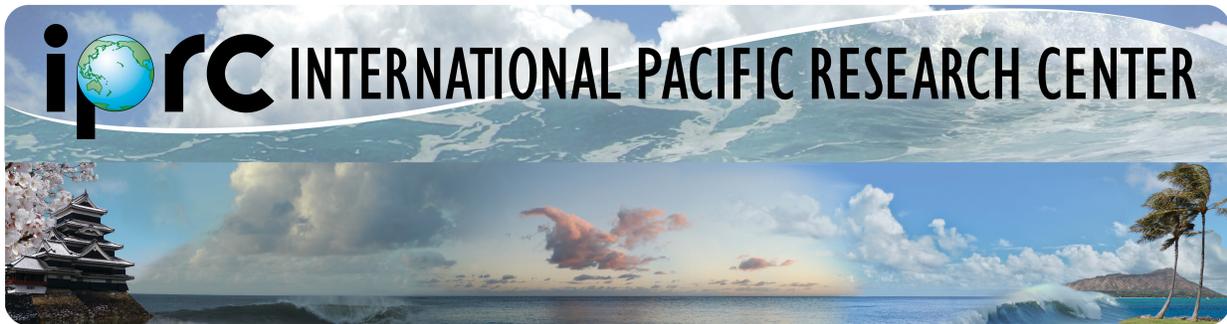


## 12 International Pacific Research Center

*A Japan-US partnership for the study of climate variations and climate change in the Asia-Pacific region*



### Executive Summary

The IPRC is a climate research center within SOEST founded in 1997 as a joint initiative of the Japanese and US governments and the University of Hawai'i. IPRC now receives funding from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) as well as from several US federal science agencies and other sources. Extramural funding over the last five years exceeded \$40 million. The IPRC performs research to enhance understanding of the nature and mechanisms of climate variability and change, and works to improve the tools for modeling and forecasting the climate system. While the range of work is broad in terms of space and time scales of the phenomena studied, the main focus of IPRC activity is in climate diagnostics and modeling of the Asia-Pacific region. A very significant component of IPRC research involves direct collaborations with JAMSTEC colleagues, and IPRC thus has access to JAMSTEC's outstanding facilities and scientific talent. The IPRC now has a Ph.D. level scientific staff of about 50 including 10 tenured UH faculty and about 25 postdoctoral fellows. IPRC faculty also supervise graduate students pursuing M.S. and Ph.D. degrees in the UH Meteorology and Oceanography departments. The IPRC has contributed significantly to the education and professional development of over 100 young scientists mainly from Japan and other Asian nations who have come as graduate students, postdoctoral fellows, researchers, other scientific employees or long-term visitors and who now are "alumni" employed at universities and research institutes in Asia, the US and elsewhere in the world.

The IPRC provides direct service to the specialized scientific research community and the wider public through its Asia-Pacific Data Research Center (APDRC) which maintains a public web interface allowing oceanic and atmospheric data sets to be conveniently analyzed and downloaded.

After a long period of growth and increasing funding, recently some of IPRC's longstanding sources of support have been reduced. Despite these challenges, IPRC expects to continue to thrive as a world-class climate research center with a diversified range of funding sources and some reorientation of research agenda to include more problems with immediate practical application. The IPRC remains a remarkable example of a profound and enduring collaboration between American and Asian partners and may serve as a model for future trans-Pacific endeavors at UH.

## 12.1 Introduction

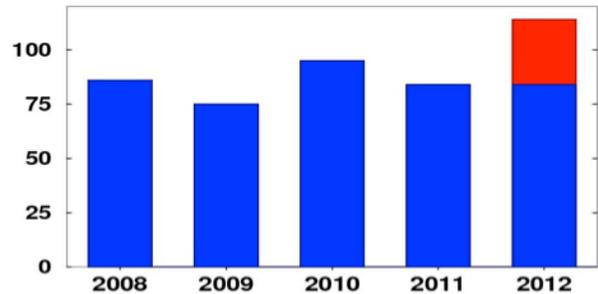
The International Pacific Research Center (IPRC) was established in 1997 within the School of Ocean and Earth Science and Technology (SOEST) of the University of Hawai'i (UH). IPRC performs research on climate variability and change with a focus on the Asia-Pacific region. Conceived under the "U.S.-Japan Common Agenda for Cooperation in Global Perspective", the IPRC represents a very unusual and profound institutional collaboration between the US and Japan. The IPRC has operated under a series of cooperative agreements between Japanese agencies and UH. The most recent agreement is between the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and UH and it covers the period April 1, 2009-March 31, 2014. Under the current cooperative agreement JAMSTEC provides IPRC an annual grant of about 2 million dollars for our collaborative research efforts. NASA and NOAA have been the primary US supporting agencies and, for most of IPRC's history, they have provided a rough match of the JAMSTEC support with funding via unsolicited proposals.

Starting with two employees in October 1997, the IPRC has developed into a powerhouse for climate modeling and diagnostics research, education and service in the Pacific. Ten tenured UH faculty are members of IPRC

### Strengths, Weaknesses, Opportunities and Threats

Among IPRC's many **strengths** are its outstanding faculty and researchers, its strong institutional partnership and scientific collaborations with JAMSTEC, and its established position as a center for international scientific exchange across the Asia-Pacific region. IPRC's **weakness** is a total dependence on extramural funding for operations including basic administrative and computer support. IPRC is now presented with **opportunities** to extend its funding sources due to the increased demand for information about climate change that can be used for practical applications, notably sustainability and climate adaptation planning. In the long term, increasing interest in global environmental change and IPRC's deep connections with Asia are expected to provide new opportunities for international collaborations. IPRC is experiencing serious **threats** to some of its key funding sources. Although IPRC faculty and researchers have an outstanding record of successfully competing for grants from US science agencies and other sources, the IPRC has also relied on generous non-competitive funding that has been provided by Japanese and US agencies, and these sources are increasingly difficult to sustain. See Section 12.10 for a more detailed SWOT analysis.

and about 50 additional research scientists, postdoctoral fellows and scientific and administrative support staff are employed. Over its 15-year lifetime IPRC scientists have published over 900 refereed papers. Total extramural funding over the last 5 years exceeds \$40 million. The IPRC has contributed significantly to the education and professional development of over 100 young scientists mainly from Japan and other Asian nations who have come as graduate students, postdoctoral fellows, researchers, other scientific employees or long-term visitors. The IPRC “alumni” are now populating the universities and research institutes of Asia, the US and elsewhere in the world.



**Number of refereed journal articles by IPRC authors. Papers in press as of October 2012 in red**

As intended by IPRC’s “founding fathers” and our major sponsors, IPRC has become a “crossroads of the Pacific” in climate science by serving as the temporary home of an international group of scientists (graduate students, postdocs, employees, visitors) and by organizing and hosting numerous international meetings that have brought thousands of researchers to Hawai`i for scientific exchanges.

The IPRC is now an important and widely-known international center for climate science. In an ever more globalized scientific community the IPRC has established a unique role as a leader in establishing deep and long-lasting US-Asia research collaborations focusing on issues with practical importance for the people of the entire Asia-Pacific region.



**IPRC’s Trans-Pacific Reach. In 2009 IPRC faculty held a daylong series of meetings in Yokohama with JAMSTEC executives and more than 50 JAMSTEC scientists to map out collaborative**

## 12.2 Mission

The IPRC’s mission is

*To provide an international research environment dedicated to improving mankind’s understanding of the nature and predictability of climate variability and change in the Asia-Pacific sector, and to developing innovative ways to utilize knowledge gained for the benefit of society.*

Asia and the Pacific region are home to over half the world's people, all of whom are affected by variations in the climate system on a range of timescales from intraseasonal to centennial and longer. IPRC researchers conduct modeling and diagnostic studies to document these variations and understand their causes, whether the causes are purely natural or have an anthropogenic component. Through advances in basic research IPRC supports the ultimate practical goal of improving environmental prediction for the Asia-Pacific region. IPRC research leverages the strengths of close partners and collaborators to allow leading edge studies of some of the most important and timely issues in climate science. IPRC also maintains a data center making atmospheric and oceanic data of relevance to the Asia-Pacific region readily available to its own researchers, the broader climate research community, policy makers and the general public. In partnership with departments in SOEST, IPRC makes an important contribution to the international climate research enterprise through training of students and early-career scientists.

## 12.3 Overview of Staff and Facilities

As of the start of the Fall 2012 semester IPRC staff consist of the 10 UH tenured faculty, 23 RCUH employees and 25 postdoctoral fellows. Over a dozen scientific visitors were also in residence for periods ranging up to a full year.

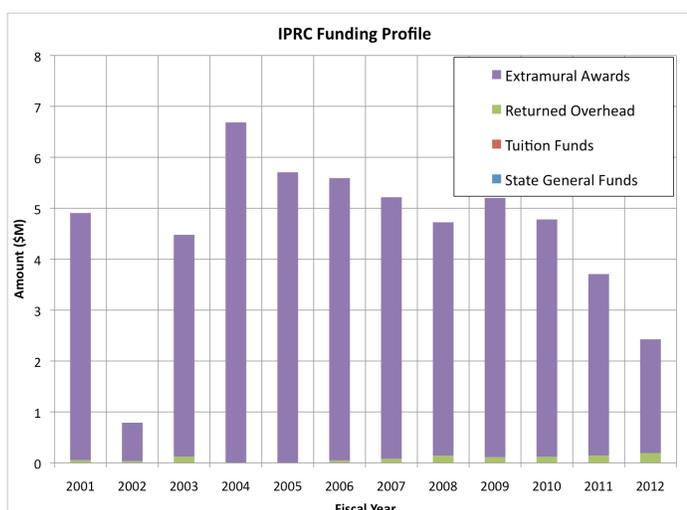
### 12.3.1 UH Faculty

Each of the ten tenured faculty members has a split appointment between IPRC and one of the SOEST academic departments or institutes where they have their locus of tenure. Five of the IPRC faculty have instructional (I) appointments in the Department of Meteorology, four have I appointments in the Department of Oceanography, and one has a specialist (S) appointment in the Hawai'i Institute of Geophysics and Planetology (HIGP). For the I faculty 4.5 month/year of the salaries have been covered by UH general funds and 4.5 months/year from the grant from JAMSTEC.

**Note that the accomplishments of the IPRC faculty (publications, grants, teaching) are included here and *also* in the self-study reports of the departments or institutes where they have joint appointments.**

### 12.3.2 Other Staff

As of Fall 2012, IPRC has 24 RCUH employees, all supported by extramural research funds. Among the RCUH employees are 3 "Senior Researchers", 2 "Associate Researchers", and 8 "Assistant Researchers", who hold non-tenured, soft-money, non-instructional positions roughly equivalent to full professor, associate professor and assistant professor in the UH faculty ranks.



The other RCUH employees consist of 6 scientific and computer support staff, 3 full time and one 20% FTE administrative/office support staff, and a 75% FTE Outreach Specialist.

IPRC's small number of non-scientific support staff are all RCUH employees and are encouraged to take advantage of opportunities for professional development. Office support staff have attended training and information sessions provided by RCUH and UH. The IPRC Outreach Specialist, IPRC's computational and scientific staff are offered opportunities for appropriate professional travel.



**Scientists at Work:** (left) Prof. Anne Mouchet visiting from the University of Liege with IPRC Postdoctoral Fellow Laurie Menviel; (center) IPRC Faculty member Jim Potemra; (right) IPRC Postdoctoral Fellow Yoshiyuki Kajikawa with IPRC Assistant Researcher June-Yi Lee.

### 12.3.3 Facilities

IPRC occupies the entire 4<sup>th</sup> floor of the POST building except for a portion of the inner core space which is controlled by the School of Engineering. On the 4<sup>th</sup> floor IPRC has a conference room, a coffee room/mini-library and a small computer machine room, but virtually all the other IPRC space is used for offices. A total of 86 staff and visitors at any time can be accommodated with at least a desk and internet connection.

## 12.4 Governance and Operation

The overall governance of the IPRC is in the hands of an international Governing Committee with members drawn from the relevant Japanese and US Federal agencies and the University of Hawai'i. Specifically the members of the GC are the Director for Environmental Science and Technology of the Japanese Ministry of Education, Culture, Sports, Science, Sports and Technology (MEXT), the JAMSTEC Executive Director for Research, the Dean of SOEST and program managers from the NASA Earth Sciences Division and the NOAA Climate Program Office. The GC meets at least once each year with the IPRC Director. The GC is also advised by a 10-member external Science Advisory Committee (SAC) consisting of 5 members appointed by JAMSTEC and 5 by the US members of the GC.

The operation of the IPRC is conducted under a Director who serves as PI of the major grants from JAMSTEC, NASA and NOAA. The Director is drawn from the 10 tenured UH faculty members and is appointed within UH by the SOEST Dean with the agreement of the rest of the

GC. The Director is advised by an internal Steering Committee which is drawn from the UH faculty and senior research staff. Members are appointed by the Director subject to a majority concurrence of the existing Steering Committee membership. As noted below, an important component of the IPRC is the [Asia-Pacific Data-Research Center \(APDRC\)](#) which is overseen by the APDRC Manager who appointed by the IPRC Director with the agreement of the SOEST Dean.

Overall research directions are summarized in the [IPRC Science Plan](#) which is written collaboratively by the faculty and senior research staff. The *Science Plan* is reviewed by the SAC and needs to be approved by the GC. The first *IPRC Science Plan* was completed in 2000 and the second in 2010. The current plan is meant as an overall guide for the period through 2015. A separate process of discussion and negotiation with JAMSTEC scientists produces the *JAMSTEC-IPRC Initiative* (JII) document which is a more detailed 3-year roadmap specifically for IPRC-JAMSTEC collaborations. The first JII plan was completed in 2007, the second in 2010, and a third version will be discussed at a meeting of IPRC leaders and JAMSTEC counterparts in January 2013.

## 12.5 Overview of Research Contributions

IPRC faculty now range between 14 and 34 years past their Ph.D. degrees and all are established researchers, well-known internationally for their scientific contributions. Eight have the rank of full professor and two are associate professors. All are very active in obtaining research funding and in publishing peer-reviewed papers. As discussed in Section 7.3 below, all the faculty are involved in substantial leadership and other service commitments to the scientific community through editorships, committee memberships etc. - details are in the CVs in Appendix 12.1. We include the CVs as well of our three Senior RCUH Researchers who are all established mid-career scientists with international reputations and all of whom have successfully competed for substantial extramural funding.

### 12.5.1 Prizes and Awards to IPRC Faculty and Staff

The IPRC faculty includes 3 Fellows of the American Meteorological Society (AMS) and a Fellow of the American Geophysical Union (AGU). Over their careers IPRC faculty and other staff members have won important awards for their achievements from the AMS, the AGU, the Meteorological Society of Japan, the Canadian Meteorological and Oceanographic Society and the Rosenstiel Foundation, among others – details are in the faculty CVs .

In the five years specifically covered by this report, awards to the faculty included Prof. Bin Wang's election to AMS Fellow in 2009 and his being named the 2012 "Hawai'i Scientist of the Year" by the ARCS (Achievement Rewards for College Students) Foundation. Prof. Jim Potemra was awarded an AGU citation for excellence in reviewing in 2008.

*This period has been particularly notable for important awards received by some of IPRC's more junior scientists.* In particular three IPRC postdoctoral fellows and assistant researchers have won the Meteorological Society of Japan's Yamamoto-Syono award (given for outstanding research achievements by an atmospheric scientist under 36 years of age): Yu Kosaka in 2010, Takeaki Sampe in 2011, and Hiroki Tokinaga in 2012. In addition, in 2009 IPRC Postdoctoral Fellow Fumiaki Kobashi was awarded the Oceanographic Society of Japan's Okada Prize for outstanding contributions to oceanography by a young member of the society. This recognition showing that top young Japanese researchers thrive at IPRC is extremely gratifying for us and for our JAMSTEC sponsors!

### 12.5.2 Publications

IPRC members are all engaged in research projects that typically aim for publications in the mainstream refereed scientific literature as one primary outcome. *IPRC has an excellent record of productivity as measured by the number of such publications and our papers have significant impact as seen in the frequency of their citation.* Appendix 12.2 lists the refereed journal articles from 2008 to October 2012. The following table shows the number of refereed journal articles each year from 2008 to 2012 (including those in press as of October). Shown are the total number, as well as the number that IPRC personnel as first author.

Year	Total	Faculty/RCUH 1 <sup>st</sup> author	Postdoc/student 1 <sup>st</sup> author
2008	86	27	18
2009	75	28	18
2010	95	20	22
2011	84	12	31
2012 & in press	114	15	40

### Kudos for IPRC's young scientists



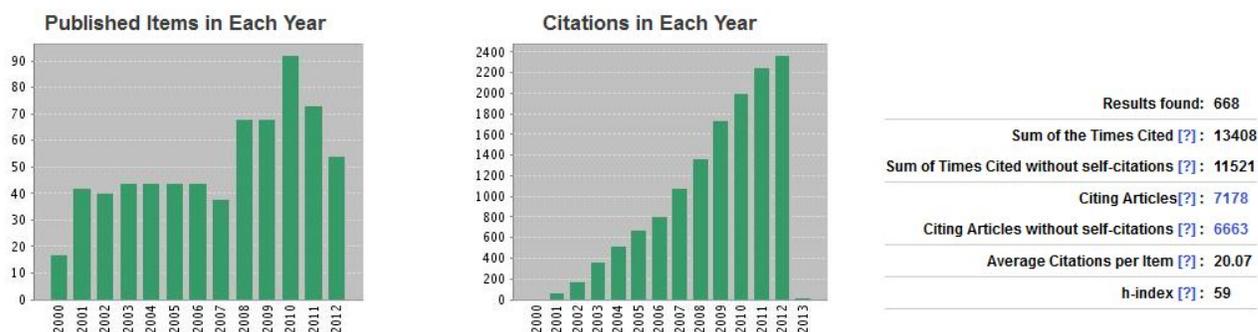
(upper left) Yu Kosaka with her 2010 Yamamoto-Syono Award from the Meteorological Society of Japan; (upper right) Hiroki Tokinaga receiving the 2012 Yamamoto-Syono Award from the President of the Meteorological Society of Japan; (lower left) Fumiaki Kobashi with his 2009 Okada Award from the Oceanographic Society of Japan; (lower right) IPRC Postdoctoral Fellow Takeaki

A citation analysis using [Web of Science](#) for papers since 2000 with authors identified as having IPRC addresses finds 668 papers since 2000, with average of 20.1 citations [about 20% of our papers are not caught by this *Web of Science* search for unknown reasons]. Note that many IPRC faculty and researchers have papers before 2000 that are still being widely cited and this is reflected in the (career) citation counts in their individual CVs.

#### Citation Report Address=(International Pacific Research Center)

Timespan=2000-01-01 - 2012-07-01. Databases=SCI-EXPANDED.

This report reflects citations to source items indexed within Web of Science. Perform a Cited Reference Search to include citations to items not indexed within Web of Science.



### 12.5.3 Research Funding

IPRC receives extramural grant and contract funding from numerous sources. One category of grants we refer to as “project grants”, i.e. grants from our principal supporting agencies (JAMSTEC, NASA and NOAA) with the IPRC Director as PI. These grants have been provided via a cooperative agreement with JAMSTEC and in response to unsolicited proposals to NASA and NOAA, and have provided support for a variety of expenses at IPRC including faculty salaries, and administrative and computer support. A second category of grants and contracts we refer to as “individual PI awards” are sought by faculty or researcher staff at IPRC and mainly are obtained via agency open competitions. A listing of grants and contracts awarded since 2008 is provided in the supporting documents to this document. The table below shows the funding awarded each calendar year since 2008.

Year	Project Grants	Individual PI Awards	Total
2008	4,584,000	3,463,494	8,047,494
2009	5,090,160	4,477,912	9,568,072
2010	4,661,789	6,608,666	11,270,455
2011	3,562,000	3,280,994	6,842,994
2012 (to October)	2,234,000	3,778,112	6,012,112
total	20,131,949	21,609,178	41,741,127

We can expect some “sampling noise” in the year-to-year variations in the individual PI awards. However, a clear trend to lower total funding in “project grants” from our principal supporting agencies is apparent. The forces behind this trend and the implications for the future are

discussed in Section 10 below. The sources of the funds awarded during 2008-2012 are summarized in the following table (subcontracts to UH are attributed to the original agency source of the funds):

Agency	Fraction of Project Grants	Fraction of Individual PI Awards
JAMSTEC	54.8%	< 0.1%
NOAA	22.4%	16.1%
NASA	22.8%	17.4%
NSF		33.5%
Dept. Interior (USGS & FWS)		13.3%
Dept. Defense (mainly ONR)		6.1%
Dept. Energy		6.0%
Other US		0.2%
Non-US (ex JAMSTEC)		7.4%

### Highlights of Non-US Funding Sources

The [ClimaRice](#) program has provided substantial funding to IPRC from the Norwegian Ministry of Foreign Affairs (see Section 7.2). Also IPRC had a notable success recently with the award of a six-year grant under the [Korea's Global Research Laboratory \(GRL\) program](#). GRL is a program of the Korean Ministry of Education Science and Technology (MEST) and supports collaboration between Korean universities and foreign partner universities, with 1/3 of the funding going to the foreign partner. IPRC's award (PI Prof. Bin Wang) is in collaboration with Pusan National University (PSU, Prof. Kyung-Ja Ha, PI) and focuses on predictability of the East Asian monsoon. The IPRC-PSU proposal was one of only 5 funded out of over 100 submitted to the 2011 GRL competition. Other avenues of support being investigated include the Asia Development Bank which has interest in research to inform

IPRC scientists are working hard to diversify their "traditional" sources of funding. On the US side there is growing interest in "climate services" and particularly research supporting practical climate adaptation issues (see Sections 7.2 and 10). A notable development has been the award of the Pacific Islands Climate Science Center (PICSC) to a consortium led by UH. The IPRC is taking the lead in administering this new Department of Interior program for stakeholder-driven science

of the tropical atmosphere, and tropical cyclones. Other examples of important issues for IPRC study include the nature of decadal variability in the extratropical North Pacific Ocean, the dynamics of the very strong Kuroshio and Oyashio ocean currents in the western North Pacific and the role of marginal seas in the climate system. Concerns about human induced climate change are addressed through modeling studies of the

concerning the effects of climate change on terrestrial and coastal ecosystems in the insular Pacific.

## 12.6 Major Research Activities

In this section we will describe the main areas of research at IPRC. A more extensive description of IPRC's research activities in recent years can be found in the [IPRC Annual Reports](#), our semiannual [IPRC Climate](#) newsletter, and the [IPRC Japanese-language Newsletter](#) ([日本語ニュースレター](#)). In addition, each quarter the IPRC prepares captioned powerpoint slides as brief reports of [research highlights](#) for each of our three main supporting agencies (JAMSTEC, NASA and NOAA). Some recent [Quarterly Research Highlights](#) since 2010 are reproduced here in Appendix 12.6. General descriptions of our main research areas are given below.

### Large-Scale Indo-Pacific Climate

The large-scale climate of the Indo-Pacific region involves the ocean circulation, the coupling of the ocean and atmosphere, the natural climate variability, and the emerging impact on these of anthropogenic climate change. IPRC scientists are investigating the role of the ocean in the climate system to increase fundamental understanding of the ocean circulation, air-sea interaction, climate modes and climate change. A theme running through many of the issues considered is the impact of processes at mesoscales on the large-scale climate variations. These concerns are timely as novel opportunities are now afforded by developments in remotely sensed observations from satellites, in situ observing systems, and high resolution modeling. This unprecedented data stream calls for exploration of new climate phenomena that span wavenumber-frequency space that were previously inaccessible. A further key motivation is the increasing signal of anthropogenic climate change and its interaction with natural climate modes. To take advantage of these scientific opportunities, IPRC scientists are analyzing data from state-of-the-art observing systems, and applying a hierarchy of models ranging from highly simplified mechanistic systems to high-resolution, comprehensive, global general circulation models.

### Regional and Small-Scale Climate Processes and Phenomena

IPRC research aims to advance our understanding of the climate state and its variability in specific regions within the Asia Pacific domain. Various IPRC projects are investigations of the synoptic and climatic effects of small and regional-scale oceanic, atmospheric and land surface processes, and IPRC scientists are working to improve the representation of such processes in regional and global climate models. IPRC scientists also devote significant effort in the study of very high-impact atmospheric phenomena, notably tropical cyclones, and the synoptic and climate controls over such events.

## The Asian and Global Monsoon Systems

The monsoon system involves complex atmosphere-ocean-land-ice interactions. In the past two decades monsoon science has progressed dramatically, yet our knowledge and understanding of monsoon climate variability and change remain limited. Most state-of-the-art coupled atmosphere- ocean-land climate models still have great difficulty in simulating the mean state and variability at intraseasonal-to-interannual and longer time scales. IPRC scientists are studying the variability, predictability, and past and future long-term changes of the Asian-Australian monsoon. A large effort is devoted to improving and assessing practical extended-range prediction systems for monsoon variability. Also, while the principal focus of IPRC's efforts remains on monsoons in the Asia-Pacific region, IPRC researchers are using the insights gained in studying the Asian-Australian monsoon system to help understand issues concerning global monsoon circulations.

## Paleoclimate

The climate of the past may hold important clues to understanding its future evolution. Recent discoveries on past ice-sheet instabilities have prompted a surge of activities to monitor, understand and predict the response of the Greenland and Antarctic ice-sheets to greenhouse warming. A partial rapid meltdown of these ice-sheets would lead to a global sea-level rise of several meters with catastrophic effects for low-lying countries and islands in the Pacific. Moreover, meltwater from the disintegrating Greenland ice-sheet could trigger a substantial weakening of the Atlantic Meridional Overturning Circulation (AMOC), with climate-effects that would be felt worldwide: relative cooling of the Northern Hemisphere, weakened Indian summer monsoon, increased El Niño variability and reduced upwelling and marine productivity in the major southeastern basin upwelling regions.

Assessing the sensitivity of the major ice-sheets and the ocean's thermohaline and wind-driven circulation to perturbations, such as an increase in carbon dioxide concentrations, requires an understanding of their past behavior. Paleo-data have provided a unique means to decipher important aspects of abrupt climate change. With the discovery of Heinrich and Dansgaard-Oeschger events in the late 1980's and early 1990's evidence emerged that under glacial conditions the climate system is capable of generating spontaneous rapid transitions from one state to another. What caused such abrupt transitions remains elusive. Possible threshold behavior has been suggested for the AMOC, ice-sheets and the carbon cycle. Moreover, on millennial to orbital timescales these climate components seem to interact with each other vigorously.

Paleoclimate research is being conducted at IPRC to (i) assess the stability of the major ice-sheets using paleo-climate data and coupled ice-sheet climate models, (ii) identify the climate and biogeochemical impacts of reorganizations of the

### Very Fine Global Model Simulations

Fine-resolution modeling of the atmosphere and ocean is a major focus for collaboration between IPRC scientists and their JAMSTEC colleagues. With the advent of the [Earth Simulator](#) in 2002, JAMSTEC

became a world leader in developing international Pacific Research Center and applying very high-resolution models of the atmosphere and

AMOC, (iii) elucidate the mechanisms that drive glacial cycles and millennial-scale glacial climate variability, (iv) develop a better understanding of climate-carbon cycle interactions under past and future climate conditions and (v) quantify ENSO's sensitivity to past and future climate change using paleo-proxy archives from the Pacific and state-of-the art forced climate models

## 12.7 Service and Outreach Contributions to the Community

IPRC contributes to the international scientific community and to the broader community in Hawai'i and elsewhere through many channels. A particularly significant effort at IPRC is devoted to the [Asia-Pacific Data-Research Center \(APDRC\)](#) which is both IPRC's local data center and a public web portal that provides support to our own researchers, our domestic and international collaborators, some specific international programs, the overall global scientific research community, and the general public. IPRC partners in programs designed to build capacity and provide practical support for climate services to stakeholders in developing countries - a category of activity that we expect to grow in the future (Section 7.2). IPRC faculty and staff play an important role in leadership and service in the international science community (Section 12.7.3). Finally IPRC faculty, staff, postdocs and students engage in local outreach to disseminate our expertise to young scholars and the general public in Hawai'i (Section 7.4).

### IPRC's Asia-Pacific Data Center (APDRC)

- Development and operation of a web-based, integrated data server system
- Global data base and data management for climate data and products
- New climate related products for research and applications users

### 12.7.1 Asia-Pacific Data Research Center (APDRC)

The goal of the APDRC is to link data management and preparation activities to research within a single center, and to provide "one-stop shopping" for climate data and products to local researchers and collaborators, the international climate research community, and the broader public. The APDRC is supported by all our principal supporting agencies but has benefitted particularly from NOAA support as a project of the Pacific regional component of US Global Climate Observing System (GCOS). The APDRC is organized around three main activities: providing integrated data server and management systems for climate data and products; developing and serving new climate-related products for research and applications users; and conducting climate research in support of the IPRC and NOAA research goals.

The linkage of research activities with data management in one center is novel, and it has led to increased data usage, to improvements in data products, and hence to more rapid scientific progress. The APDRC has developed into a powerful research resource, not just for IPRC scientists, but for the international climate community as well

Activities within the APDRC can be divided into three thrusts discussed below:

### A. Development and Operation of a Web-based, Integrated Data Server System

APDRC has developed and adapted tools for web-based browsing and viewing of both gridded and non-gridded (in situ) data sets and products. These provide easy access for downloading data in their original formats and in user-friendly and assimilation-friendly formats, including the handling of metadata and quality flags; and easy access to desktop tools for powerful display and analysis of data and products on the client's computer.

To achieve this APDRC staff has closely coordinated its development activities with: the evolving plans of the National Virtual Ocean Data System (NVODS), which was considered a central element for the planning and implementation of the Global Ocean Observing System (GOOS) by its sponsor, the National Oceanographic Partnership Program (NOPP); and, currently, with the Data Management and Communication (DMAC) requirements of the Integrated Ocean Observing System. The APDRC collaborates closely with the NOAA Pacific Marine Environmental Laboratory (PMEL) on technical aspects of server development, taking advantage of their substantial expertise.

### Modeling the Spread of Tsunami Debris

The great East Japan tsunami of March 2011 washed an estimated 20 million tons of debris from the shoreline into the ocean. Detailed observations of the spread of the debris patch soon became impossible and we have had to rely on a combination of numerical modeling and anecdotal reports of sightings in the ocean and on shorelines. IPRC has taken the lead in tracking the debris using our own unique high resolution global ocean surface current analysis. Dr. Nikolai Maximenko is leading this effort and he was able to correctly anticipate the first observations of tsunami debris on the West Coast of North America and now on Hawaii's shores.



**This work has brought IPRC unprecedented media attention. Shown above is a screen capture from an early report in April 2011 on the CBS national TV news. IPRC's work has been featured in many hundreds of media reports including several national TV broadcasts in the US and Japan.**

### B. Provide a Global Data Base and Data Management for Climate Data and Products

APDRC works to provide the required data-management and metadata infrastructure for easy usability of data and products. The data management group within the APDRC identifies important datasets from each of three sub-disciplines: oceanographic data, atmospheric data and air-sea flux data. IPRC scientists identify data and products that may be useful for climate

research efforts (but not necessarily maintained on local machines). This information is passed to the data management group who either directly acquire, or link to, the data.

### C. Develop and Serve New Climate Related Products for Research and Applications Users

The APDRC works to link IPRC research with the development of new climate related products for research and applications users. Typically, researchers focus on the publication of new research results. In some cases, though, these new results can result in a useful climate product, such as an index or a regularly updated atmospheric or oceanographic analysis, and this APDRC thrust assists in the development of such legacy products. An important component of this activity supports national and international activities to meet critical regional needs for ocean, climate and ecosystem information for applications users, particularly those in the Asia-Pacific region. Specifically, activities support GEOSS through the Integrated Ocean Observing System (IOOS) and the regional Pacific organization PacIOOS, the Global Ocean Data Assimilation Experiment (GODAE/GODAE Ocean View, and the Pacific Climate Information Service (PaCIS).

The **Pacific Argo Regional Center (PARC)** is an important example of IPRC international collaboration supporting key regional data needs. IPRC and JAMSTEC are the lead partners in PARC. PARC is one of five regional Argo centers worldwide, and it validates all the Argo profiling float data in the Pacific through rigorous scrutiny and derives regional products based on these raw data. This provides useful, high-quality information to the worldwide research and applications community on a near real-time basis. In this very important project JAMSTEC takes the lead on data quality control and IPRC on producing derived products on regular grids. More details are available on the [JAMSTEC home page for PARC](#) and the [IPRC home page for PARC](#).



**Argo float activities:** (left) Banners from the JAMSTEC (top) and IPRC (bottom) web pages for the Pacific Argo Regional Center (PARC); (right) monthly mean sea surface salinity computed from a gridded analysis made at IPRC based on the Argo data

#### 12.7.2 Support for Stakeholders in the Insular Pacific and the Developing World

The islands in the Pacific Ocean encompassed by Polynesia, Micronesia and Melanesia are spread over an enormous region and represent a unique physical and human environment. The inhabited islands range from the large, heavily-populated and topographically prominent main Hawaiian Islands to small atolls such as those that make up the nation of Tuvalu. The IPRC is the premier climate modeling and diagnostics research institution located within this region and so has a natural focus on the issues relating to the Pacific island environment. This is a specific focus as well for IPRC's funding from NOAA, and connects IPRC to NOAA programs such as the Pacific Regional Integrated Science and Assessment (RISA), and the Pacific Climate Information Service (PaCIS). IPRC faculty have participated in training exercises to assist Pacific islanders to access and use climate data. Also in response to a request from the [Secretariat of the Pacific Regional Environment Programme](#) (SPREP) IPRC established a mirror site of the APDRC data portal at SPREP headquarters in Fiji, which is now being customized for SPREP's own uses. Starting in 2012 IPRC's role in such capacity building for the insular Pacific has been recognized with support from the Agency for International Development (USAID) for IPRC's contribution to GCOS data activities for the Pacific region.

IPRC's expertise in regional climate modeling and diagnostics can be applied to inform adaptation to climate change in many areas throughout the Asia-Pacific region, and we are pursuing such opportunities. For several years IPRC has been a key partner in the [ClimaRice Project](#) focused on the needs of agricultural producers in South Asia. This project aims to assess effects of climate change on agriculture and water availability and to make recommendations to farmers, local government, and other stakeholders on how to mitigate consequences of future climate change. It is a partnership among the [Norwegian Institute for Agricultural and Environmental Research \(Bioforsk\)](#), the Tamil Nadu Agricultural University in Coimbatore, and the IPRC. The Norwegian Ministry of Foreign Affairs provides the funding.

### 12.7.3 Service to the International Science Community

IPRC faculty and research staff are very active in leadership and service roles within the geosciences community in the United States and internationally. Our faculty have served, and

#### Pacific Islands have major climate related concerns



(left) surveying destruction after a wildfire on Guam; (center) warning sign in Guam connecting wildfire damage with increased runoff and effects on coastal ecosystems; (right) sign on Pohnpei in the Federated States of Micronesia announcing “El Niño is here” and urging water conservation measures.

currently serve, as editors or associate editors/editorial board members for important professional journals published in the US and other countries. During at least part of the five year period of this report, IPRC faculty served as editors or associate editors for American Meteorological Society journals *Journal of Climate*, *Journal of the Atmospheric Sciences* and *Weather and Forecasting*; the *Journal of the Meteorological Society of Japan*; and the European Geophysical Union's *Atmospheric Chemistry and Physics*, among many others. Our faculty and scientific staff are well represented as leaders and members of national and international scientific committees. Recent highlights of such service include two IPRC faculty who are serving as Lead Authors for chapters of the Working Group 1 report of the IPCC AR5.

A full list of significant service activities during the period of this report is presented in the faculty and senior researcher CVs in Appendix 12.1.

#### 12.7.4 Local Outreach

IPRC faculty and staff work with partners in SOEST and elsewhere to engage and inform school children and others in our local community. IPRC staff, students and postdoctoral fellows have enthusiastically participated in SOEST's Open House which brings over 5000 school children to our campus for a day of engagement with SOEST staff and students. IPRC scientists have also participated in outreach activities at the Bishop Museum (Honolulu's major natural and cultural history museum). Our faculty have a long history of involvement with the *Pacific Symposium for Science and Sustainability* (sponsored by the Hawai'i Academy of Science) which brings high school students from across the insular Pacific to Honolulu each year for a science fair featuring student reports on their research projects. An IPRC faculty member is now chief judge for this major trans-Pacific science fair.



**IPRC engagement with school students: (left) IPRC Postdoctoral Fellow Tobias Freidrich lecturing to local high school students at SOEST Open House; (right) IPRC Postdoctoral Fellow Ingo Richter with enthusiastic local public school children.**

In recent years IPRC has reached out to the general public in Honolulu with an annual, high profile *IPRC Public Lecture in Climate Science*. This brings an outstanding climate scientist each year to present an evening lecture on our campus. Our inaugural speaker in 2009 was famed atmospheric chemist Susan Solomon, followed by Woods Hole Oceanographic Institution Director Susan Avery (2010) and University of Michigan Dean and former Director of the White

House Office of Science and Technology Policy (OSTP) Rosina Bierbaum (2011). The IPRC's semiannual newsletter *IPRC Climate* is distributed to over 1000 individuals worldwide including many in Hawai'i - legislators, government officials and other important local stakeholders. Feedback on the newsletter from many readers, including several State legislators, indicates that this is another effective and widely-appreciated contribution to outreach.

## 12.8 International Science Meetings

The Japanese scientists who first conceived and supported the idea of the IPRC envisaged a "Hawaiian village" where researchers from around the Pacific and all over the world would gather for scientific exchanges. IPRC has lived up to this vision and plays a very active role as a host and organizer of international meetings related to climate science as well as host for a large number of scientific visitors from around the world. As shown in Appendix 12.5, during 2007-2012 IPRC hosted 31 international meetings including small informal workshops, training workshops, bilateral meetings with Japanese or Korean colleagues, international science panel meetings and major widely-publicized conferences. Notable among the major conferences are a 2011 AGU Chapman conference (~100 participants) and two major meetings associated with the development of the IPCC Fifth Assessment Report (AR5) – a scoping meeting (~150 participants) and the first major meeting dedicated to analyzing the global model intercomparison results for the AR5 (~200 participants). IPRC scientists took the lead as local organizers for all these meetings and, in most cases, were leaders in the scientific organization as well. Not included in Appendix 12.5 are several local workshops that IPRC organized primarily for our own scientists and our SOEST colleagues.



***IPRC hosts many international meetings:*** (top left) Participants at a bilateral meeting with Korean scientists focused on monsoon studies; (top right) small workshop on modeling ocean mixing processes; (lower left) major meeting in March 2012 devoted to analysis of global model results to be used for the next IPCC assessment report; (bottom right) informal interactions at a poster session.

### IPRC Faculty in the Classroom



(left) Prof. Yuqing Wang lecturing about cloud physics in a Meteorology graduate course; (center) the attentive students in Prof. Wang's lecture; (right) Prof. Kevin Hamilton lecturing about seasonal climate forecasting in a graduate course on environmental finance in the UH College of Business

## 12.9 Teaching and Mentoring Contributions

IPRC has nine tenured Instructional (I) faculty and they, along with our one specialist (S) faculty, are all engaged in classroom teaching and student supervision. (Note that only 4.5 months/year of the I faculty salaries are covered by UH general funds and so classroom teaching expectations are somewhat lower than for most regular I faculty). Over the five academic years covered in this report IPRC faculty have taught MET101, MET302, MET303, MET402, MET600, MET610, MET620, MET704, MET706, MET752, MET/OCN666, OCN620, OCN661, OCN760, OCN780, GES363, and GES496.

The student–semester-hours (SSH) taught within SOEST by IPRC faculty during F07-S12 were

Fall 07	178	Spring 08	164
Fall 08	132	Spring 09	153
Fall 09	170	Spring 10	158
Fall 10	213	Spring 11	145
Fall 11	175	Spring 12	196

for a total of 1684 SSH. In addition, IPRC faculty taught part of a course in the UH Business School in Fall 2010 and Summer 2011 and Summer 2012 which would account for about another 75 SSH.

IPRC faculty supervise graduate students enrolled in M.S. and Ph.D. programs in the Meteorology and Oceanography departments. Over the five academic years considered here, ten Ph.D. and two M.S. degrees were awarded to students supervised by IPRC faculty. A list of these alumni and their current employment is given in Appendix 12.3. All IPRC faculty serve as members of the Ph.D. and M.S. committees of several (typically 5-10 at any time) students in the Meteorology and Oceanography departments.

IPRC hosts a large number of postdoctoral fellows who, while contributing to our research projects, are primarily trainees pursuing their professional development. We have a long record now of postdoctoral scientists who have become “alumni” and these young scientists represent a very important contribution of IPRC to the broader science community. Notably there are a large number of young scientists from Japan, China and Korea who were postdocs at IPRC and are now in research and teaching positions at major institutions in Asia. Appendix 12.4 lists the 55 scientists who have passed through the IPRC postdoctoral program. Eight of our postdoc “alumni” currently are employed in more senior positions at IPRC and almost all the others are in professional positions in universities and research institutes throughout the world.

## 12.10 Strengths, Weaknesses, Opportunities and Threats (SWOT)

### Strengths

By virtue of its international institutional foundations, its location, its assembled expertise, and its scientific focus, the IPRC plays a uniquely valuable role in the climate research community. The JAMSTEC-UH institutional arrangements encourage and sustain the Japan-US collaboration that is at the core of IPRC’s activities, and provide IPRC staff with access to the world class collaborators and facilities of JAMSTEC. IPRC’s location in the mid-Pacific significantly facilitates the practical aspects of collaborating with Japan and other Asian nations. The IPRC has assembled an international group of faculty and researchers with outstanding expertise in aspects of the meteorology and oceanography of the Asia-Pacific region. IPRC’s explicit scientific focus on the Asian-Pacific region is unique for a US institution. The IPRC also draws on the expertise of our UH-SOEST colleagues who also generally have a Pacific focus to their research interests and expertise. The multicultural nature of society in Hawaii, the international background of the IPRC faculty, and the particular IPRC science focus all combine to make the IPRC an ideal institution for younger scientists from Asia to be exposed to, and develop lasting connections with, the US research community.

## Weaknesses and Threats

The IPRC has thrived under very unusual institutional arrangements. Through the generosity of our primary Japanese and US supporting agencies UH was able to create IPRC from scratch with a commitment from the university of only 4.5 month/year of 9 faculty salaries (which are for instructional faculty who are contributing to the teaching in the Meteorology and Oceanography departments). All support staff and scientific staff salaries, furniture, equipment, faculty startup costs, and stipends for graduate students and postdoctoral fellows have been paid entirely from extramural grants or from a small return of indirect grant costs back to the IPRC Director. Japanese agencies (currently JAMSTEC) have paid 4.5 months/year of the IPRC “I” faculty salaries for 15 consecutive years – a very generous and unusual arrangement. There have been no base-funded UH positions created for secretaries, computer support staff etc. This arrangement worked well until recently when stresses on our extramural funding have appeared and the consequences of a lack of base funding have become apparent.

Key threats to IPRC have emerged with new pressures on our primary funding agencies and particularly their ability to continue what have been somewhat unconventional arrangements that have supported core IPRC operations. It is clear from interactions with JAMSTEC and MEXT executives that the Japanese evaluate IPRC’s scientific contributions very highly and that they strongly support the continuation of the JAMSTEC-UH partnership. In the last year both JAMSTEC President Asahiro Taira and Kanji Fujiki (now Deputy Minister in MEXT) have expressed their appreciation of the success of IPRC in mentoring young Japanese scientists. However JAMSTEC and MEXT both face the realities of overall budget pressures and a reduction in the priority of climate research in the national Japanese science agenda, and these factors will lead to a significant reduction in the future JAMSTEC financial contributions to IPRC.

On the US side our primary supporting agencies are under new pressures. In particular the ability of NASA to continue their support of IPRC’s basic operations via non-competitive grants has ended, and future NASA support will be only through IPRC scientists’ success in regular Research Opportunities in Space and Earth Sciences (ROSES) competitions. NOAA support for our data and research activities continues through the US GCOS program, but at a lower level than in the past.

IPRC senior scientific leadership has been remarkably stable. IPRC reached its 15<sup>th</sup> anniversary without any turnover among the faculty or Senior RCUH Researcher ranks. This enviable record has been broken by the recent move of Prof. Shang-Ping Xie to the Scripps Institution of Oceanography on November 1, 2012, where he became the inaugural Roger Revelle Professor of Environmental Sciences. Prof. Xie remains officially as UH faculty in leave status, but is not expected to return. While IPRC takes some pride in the fact that one of our long-standing faculty members was selected for this extremely prestigious position, the departure of Prof. Xie and his group from IPRC is a serious loss.

## Opportunities

Interest in the practical applications of climate information, particularly for adaptation planning in Hawai'i and in the wider Pacific region, has led to new demands for IPRC's expertise. In recent years IPRC has participated with partners at UH and elsewhere in a number of new (and some still-proposed) initiatives focused on practical concerns. IPRC is one of 5 main partners in the NOAA [Pacific RISA](#) (Regional Integrated Science and Assessments) center, one of 11 RISA centers nationwide. The [RISA program](#) supports research that addresses climate sensitive issues of concern to decision-makers at a regional level. NOAA had planned to begin a National Climate Service (NCS) in FY2011, but Congress did not support this initiative. One surviving element of the (NCS) plan was the appointment of six regional Climate Services Directors, including one for Hawaii and the US affiliated Pacific islands (USAPI). This is important recognition that the Pacific region should have its own NOAA climate services footprint. We are hopeful that this may lead to more NOAA-related opportunities for IPRC's expertise. An upcoming test case will be the recompetition for NOAA's [Regional Climate Centers](#), in which we anticipate that a university or consortium in Hawai'i and the USAPI will now be offered the chance to host a separate NOAA Regional Climate Center for the insular Pacific.

The IPRC is now participating in a study by the US Department of Agriculture (USDA) and the Department of Defense that is evaluating the feasibility and sustainability of a long-term plan to grow crops on Maui for production of biofuels to power US Navy ships. With partners at UH and other US affiliated Pacific islands universities with agriculture schools (organized as the Pacific Land Grant Association), IPRC is working to build on this initial climate-related USDA interest to scope out a possible project to support agricultural adaptation to climate change in the Pacific region.

Even the [UH Shidler College of Business](#) has sought IPRC expertise in helping to teach a course there and as a partner in a (ultimately unsuccessful) proposal for a USAID-funded center devoted to assisting development in the Philippines and Southeast Asia. The Hawai'i-based [Pacific Disaster Center](#) has sought out IPRC as a partner in a possible proposal for European funding related to sustainable development in Viet Nam and the Philippines. The Asian Development Bank has also reached out to IPRC for research expertise related to their sustainable development issues.

This interest in climate change and broader sustainability issues in the world at large is being echoed within UH, and significant new initiatives related to sustainability can be anticipated. As the leader in climate modeling and diagnostics at the university and in the Pacific, the IPRC is well positioned to contribute to any broader UH efforts.

## 12.11 Conclusion and Outlook

While the IPRC is threatened by the short-term vagaries of funding from our traditional supporting agencies, our center is remarkably well positioned to take advantage of two

predictable long-term trends in the world at large. One is a continuing growth in interest in high quality climate research to inform key policy decisions related to global change. Policy makers facing ever more urgent and difficult decisions will need to have (i) reliable information on attribution of observed changes to natural and anthropogenic causes, and (ii) credible forecasts of the future climate response to specific regulatory actions. Public concern about these key environmental issues will also ensure a continuing student interest in studying these topics at both the undergraduate and graduate levels. So we confidently predict increasing demand for the research, instructional and service contributions from IPRC faculty and staff.

The second major trend is the rise of Asia as an increasingly dominant economic and scientific center in the world. The IPRC, despite its relative youth and modest size, is a remarkable example of a profound and enduring collaboration between American and Asian partners. IPRC faculty and staff have developed very strong collaborations with colleagues in Japan, China, Korea and Taiwan, and IPRC's former graduate students, postdoctoral fellows and scientific staff now represent a large "alumni" network in major institutions in Asia. Our activities thus far have laid the basis for potentially even broader and deeper collaborations with Asian partners and, despite our current challenges, we envision a bright future for the IPRC at UH. The IPRC experience may even serve as a model for a growing engagement of UH in scientific research with Asian institutions.