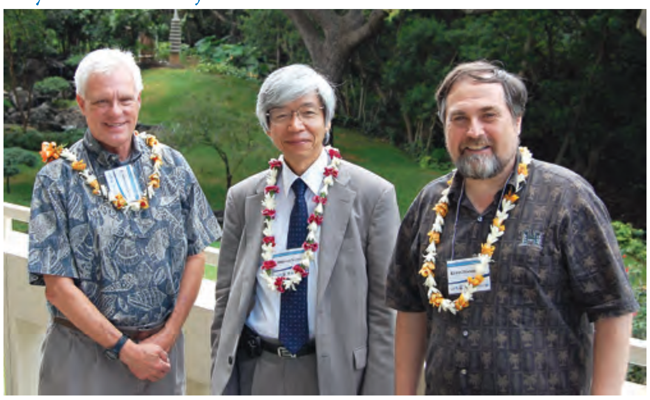
MEETINGS

Joint Symposium with the University of Tokyo

The University of Hawai'i's School of Ocean and Earth Sciences and Technology (SOEST) has long-standing links with the University of Tokyo's principal ocean and atmospheric research units: the Ocean Research Institute (ORI) and the Center for Climate System Research (CCSR). ORI and CCSR were combined in 2010 into the Atmosphere and Ocean Research Institute (AORI) with facilities located on the new University of Tokyo Kashiwa campus. Since its earliest days, the IPRC has had close relations with CCSR, ORI, and now with AORI. Former CCSR Director **Akimasa Sumi** was one of the original supporters of the IPRC in Japan and has been a frequent visitor over the years. CCSR professor (and now AORI Vice Director) **Masahide Kimoto** was a long-serving member of the IPRC Science Advisory Committee. In the last three years, IPRC faculty members **Yuqing Wang** and **Niklas Schneider** have each spent a sabbatical term at AORI. Therefore, when AORI Director **Hiroshi Niino** proposed a 2012 joint workshop with SOEST scientists, IPRC was very pleased to act as host and organizer in partnership with SOEST's Sea Grant Program.

The *Joint Symposium on Ocean, Coastal, and Atmospheric Sciences* was held June 13–15, 2012, in the Keoni Auditorium of the East-West Center, with 27 participants from the University of Tokyo and 31 from SOEST. The meeting featured two days of lectures and one day of informal small-group interactions between the AORI scientists and their SOEST counterparts. IPRC presentations at the meeting were as follows: **Kelvin Richards** discussed interactions between small-scale ocean mixing and the larger-scale atmosphere-ocean circulation in the tropics; **Niklas Schneider** described his work on decadal variability of the North Pacific circulation; **Nikolai Maximenko** spoke on ocean surface currents in the western North Pacific; and **Axel Timmermann** and **Oliver Elison Timm** discussed paleoclimate research being conducted at IPRC. IPRC postdoctoral fellows **Ali Belmadani** and **Malte Heinemann** gave poster presentations.

Sea Grant Associate Director **Darren Lerner**, AORI Associate Professor **Susumu Hyodo** and IPRC Director **Kevin Hamilton** organized the meeting. The workshop program and abstracts of all the oral and poster presentations are at tinyurl.com/IPRCjoint.



From left, Gordon Grau (UH Sea Grant Director), Hiroshi Niino (AORI Director), and Kevin Hamilton (IPRC Director).

Participants of the Joint Symposium on Ocean, Coastal, and Atmospheric Sciences.

US-Japan Workshop on the Tropical Upper Troposphere

Planning for a Golden Era of Tropical Pacific Measurements

Above the equator, the coldest air is generally found near 17-km altitude, the "cold-point tropopause." However, the region spanning roughly 14–17 km typically displays a higher vertical stability than does the atmosphere lower down, and most deep tropical convection detrains below about 14 km. Within the tropical troposphere, the upper few km are rather distinct in composition and dynamics from the lower part, and also from the overlying stratosphere. This special region is called the "tropical tropopause layer (TTL)." The TTL is notable for some of the coldest temperatures observed anywhere in the atmosphere and for the presence of very cold cirrus clouds that are important in maintaining the global radiative energy balance. Almost all the air entering the stratosphere is believed to pass through the TTL, making this a key region for determining stratospheric composition. The TTL is also thought to mark the boundary between large-scale net radiative cooling below and net radiative heating above (Figure 1).

A whole new generation of observations has transformed the study of the TTL in the last decade. One development has been the start of regular extended in situ observational programs, notably the Japanese-led Soundings of Ozone and Water in the Equatorial Region (SOWER) program and the US-led Southern Hemisphere Additional Ozonesonde (SHADOZ) program. SOWER has been running since 1998 on a campaign basis, improving our knowledge of the ozone and water vapor distributions in the tropical Pacific region by making coordinated radiosonde observations at three equatorial sites: the Galapagos Islands, Christmas Island, and Indonesia. Led by NASA and NOAA, in partnership with various national meteorological services, SHADOZ, also initiated in 1998 coordinated balloon soundings of the atmosphere at a number of Southern Hemisphere tropical and subtropical stations. Great advances have also occurred in space-based and ground-based remote-sensing observations. Notable are the research satellites deployed in the first decade of this century, such as those in the NASA "A-train" and the COSMIC array of radio occultation satellites, which have provided unprecedented high-resolution observations of temperatures, trace gases, and clouds in the upper troposphere and lower stratosphere.

Inspired by the significant progress made over the last decade and the prospect of several new field campaigns in the western Pacific region in the next few years, Hokkaido University Professor **Fumio Hasebe** conceived a US–Japan workshop on the tropical upper troposphere to review key science issues and help coordinate mission planning. Joining Hasebe's initiative were US scientists **Andrew Gettelman**

Participants at the NSF US-Japan Workshop.

(NCAR), **Gary Morris** (Valparaiso University), **Henry Selkirk** (NASA) and IPRC's **Kevin Hamilton**.

The US National Science Foundation sponsored the bilateral workshop through its Catalyzing New International Collaborations program. The IPRC was very pleased to host this important US–Japan meeting. The *NSF U.S.-Japan Workshop on the Tropical Tropopause Layer: State of Current Science and Future Observational Needs* was held October 15–19, 2012, at the East-West Center. Eighteen Japanese scientists and graduate students joined about 25 US participants from NASA, NOAA, NCAR and various universities.

The organizing committee from left, Gary Morris, Andrew Gettelman, Kevin Hamilton, Henry Selkirk, and Fumio Hasebe.

The workshop participants discussed open questions in understanding the dynamics and chemistry of the TTL. They found these questions mainly related to one or more key areas: effects of the large-scale atmospheric circulation including the summer monsoon, effects of deep convection, cirrus-cloud dynamics and microphysics, atmospheric wave processes, and long-term trends.

The next few years promise to be an exciting "golden era" for observations of the TTL as the ongoing regular balloon sampling and satellite observations will be supplemented by a series of aircraft campaigns mainly focused on the western Pacific region. These major field campaigns are planned to begin in the summer of 2013 with the Southeast Asia Composition Cloud and Climate Coupling Regional Study (SEAC^{4}RS), which will include observations by two NASA research aircraft (DC8 and ER2) based in Singapore, and will continue over the 2013–2015 period with more campaigns featuring multiple aircraft based in Guam and northern Australia. The workshop participants worked to coordinate the planning of these major initiatives with an eye to reducing the key uncertainties in our knowledge of the tropical upper troposphere.

With the help of Valparaiso University librarian **Jon Bull**, a special effort was made to record completely the workshop presentations and discussions and to document fully the proceedings. All interested colleagues are invited to visit the unusually detailed workshop archive at scholar.valpo.edu/ttlworkshop/2012_proceedings/. A detailed article on the meeting has been published and is at tinyurl.com/IPRClayer.

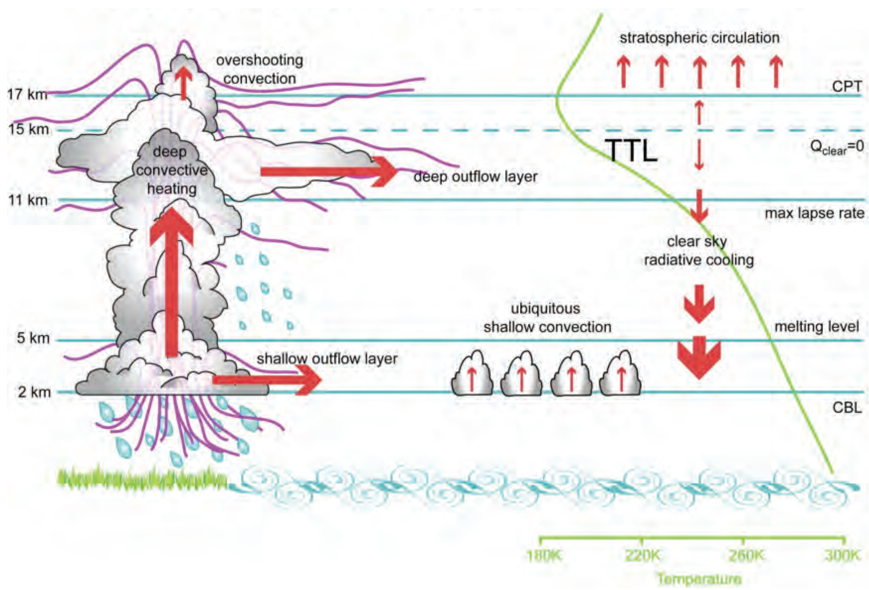


Figure 1. Schematic diagram showing some key processes in the tropical atmosphere (adapted by Laura Pan, NCAR, from an original prepared by Diane Pendlebury and the SPARC office).

Kazuyuki Miyazaki at the IPRC.

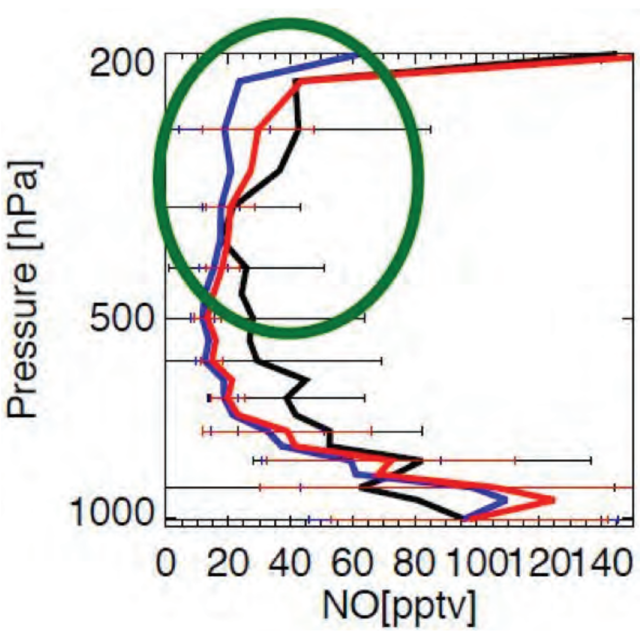


Figure 2. Concentration (parts per trillion) of nitric oxide in the atmosphere over a tropical location in direct observations (black) and in two global assimilation data sets (red and blue). The red curve is for an assimilation that includes input of satellite observations of atmospheric composition.

Putting Chemistry into Global Analyses

The tropical upper troposphere is a region with relatively sparse in situ observations. Making the best use of the available satellite data, including satellite observations of atmospheric composition, is important for advancing our knowledge of this region. JAMSTEC's **Kazuyuki Miyazaki** is a leader in assimilating chemical data into sophisticated global analyses using dynamical-chemical atmospheric models. The *Tropical Tropopause* workshop occurred during Miyazaki's six-month visit to the IPRC. In his invited tutorial talk at the workshop, he reviewed the emerging field of chemical data-assimilation for global analyses and discussed results from a major Japanese initiative.

"The Japan Meteorological Agency's Meteorological Research Institute (MRI), the National Institute for Environmental Studies (NIES), JAMSTEC, and Tohoku University have developed chemical data assimilation systems for monitoring the atmospheric environment in East Asia and over the whole globe. The data assimilation systems developed by the four research institutes use the ensemble Kalman filter scheme. The approach allows simultaneous optimization of forecast variables (i.e., concentrations of particular chemicals) and other parameters, notably emission rates into the atmosphere," said Miyazaki.

One result that shows promise for obtaining a more complete picture of the circulation and chemistry of the TTL is given in Figure 2. The figure compares the atmospheric profile of nitric oxide (NO) concentration at a tropical location determined in a special aircraft observation campaign (black curve) and the predictions of a chemical model-run with atmospheric circulation from analyses with (red), and without (blue), assimilation of chemical observations. The improvement in the model's upper troposphere that includes assimilated satellite chemical measurements is quite significant, despite the fact that observations of NO were not actually used in the assimilation.

Ocean Mixing Group Meets Again

From left, Ryo Furue, Yanli Yia, Niklas Schneider, Bruce Cornuelle, Kelvin Richards, Peter Hacker, Armin Köhl, Nidia Martinez Allevaneda, Jennifer MacKinnon and Detlef Stammer.

Ocean models in climate research have greatly advanced in recent years. A major challenge, however, remains: representing realistically ocean mixing, which significantly impacts the large-scale ocean circulation and surface fluxes.

"The processes directly responsible for mixing occur at such small spatial and temporal scales that they must be parameterized by representing small-scale effects on large scales in terms of large-scale variables," wrote IPRC's assistant researcher **Ryo Furue** after an IPRC miniworkshop on ocean mixing in March 2009 (*IPRC Climate,* vol. 9, no. 1).

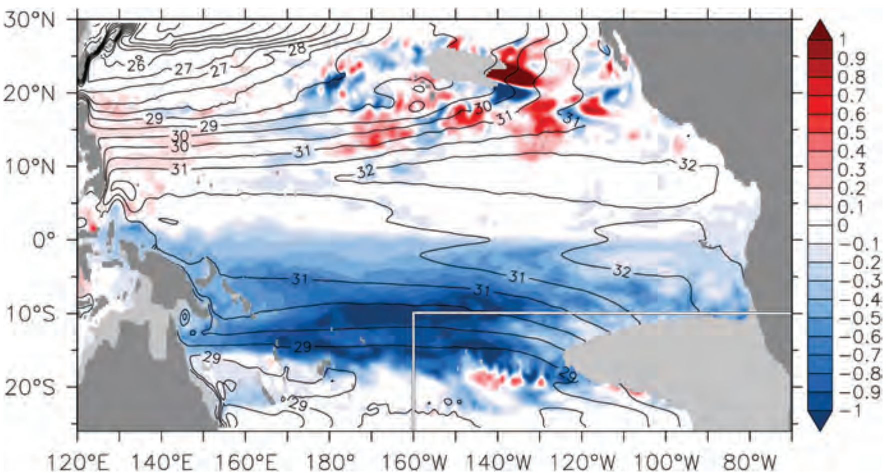
From that meeting emerged a project, funded by NASA, to investigate ocean-mixing processes more closely, and the group has been meeting annually since then. The latest meeting was held September 10–11 at the IPRC to review progress and to plan further research.

This year's group consisted of Ryo Furue, **Yanli Jia**, **Kelvin Richards**, and **Niklas Schneider** from the IPRC; **Bruce Cornuelle** and **Nidia Martinez Allevaneda** from Scripps Institution of Oceanography; **Armin Köhl** and **Detlef Stammer** from the University of Hamburg; and **Peter Müller** from the University of Hawai'i at Mānoa (UHM).

The participants reported major progress in understanding the following issues: (1) the modifications needed to mixing parameters for data assimilation and the reasons for these modifications; (2) the reasons why, and the ways in which diapycnal diffusivity affects the upper tropical Pacific Ocean; and (3) the difficulty of using Green's function to optimize diapycnal diffusivity because it results in overfitting and negative (unrealistic) diapycnal diffusivity values.

To learn more about the complexities of diapycnal diffusivity and to help plan future possible extensions to the project, the group had invited to the meeting **Jennifer MacKinnon**, Scripps Institution of Oceanography, who summarized the work of the US CLIVAR Climate Process Team (CPT) on ocean diapycnal mixing; and **Thomas Decloedt** (UHM Oceanography Department), who reviewed various parameterizations of diapycnal mixing used in ocean general circulation models. They had also invited **Peter Hacker** from NASA headquarters to hear more about the research directions NASA plans to pursue.

On the basis of these presentations and discussions, the group is considering to focus on diapycnal diffusivity near the equator, which would complement CPT's work, which does not concentrate on this region.



Results of an experiment in which vertical diffusivity is increased from the sea surface to the sea bottom in the box in the figure (south of 10°S and east of 160°W). This increase results in a negative temperature anomaly (blue) that is advected on isopycnal surfaces to the equator, where it changes the temperature of the thermocline and the sea surface.