6th APEC Climate Symposium

Climate Prediction and Its Applications

and

US-Korea Workshop

on Dynamical Seasonal Prediction

Busan, Korea

20-24 June 2010

Note: This document summarizes the discussions at the APEC Climate Symposium on Climate Prediction and Its Applications and the US-Korea Workshop on Dynamical Seasonal Prediction held at the APEC Climate Center, Busan, Korea on 20-24 June 2010.

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APCC would like to extend its sincerest thanks to the funders and all participants for making the events both meaningful and successful.

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Symposium Proceedings

Summary

1. The 6th APEC Climate Symposium (APCS) was successfully held from June 20-24, 2010 at the APEC Climate Center (APCC) building in Busan, Korea in conjunction with the following related meetings and activities: 6th APCC Working Group Meeting, US-Korea Workshop for Dynamical Seasonal Prediction, Forum for Disaster Risk Preparedness with APEC Emergency Preparedness Working Group (EPWG), 6th APCC Science Advisory Committee meeting, and a hands-on Tutorial Session on multi-model ensemble forecast and downscaling.

2. The events were attended by around 100 participants from 18 APEC member economies: Canada, Chile, China, Chinese Taipei, Hong Kong China, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russia, Singapore, Thailand, and USA. Participants included invited speakers, representatives from National Meteorological and Hydrological Services (NHMSs), academics and students. Also in attendance were APEC Secretariat Program Directors for Industrial Science and Technology Working Group (ISTWG) and Emergency Preparedness Working Group (EPWG). The list of participants can be viewed in Annex 1.

6th APCC Working Group Meeting

3. The 6th Meeting of the APEC Climate Center (APCC) Working Group was held at the Cosmos Room, APCC building in Busan on 20 June 2010. The session was attended by 32 participants from 18 out of 21 APEC member economies, who are mostly representatives of National Hydrological and Meteorological Services (NHMS). The meeting commenced at 1:30 p.m.

Working Group Session 1

4. The meeting was formally opened with the transfer of the Working Group Chairmanship from Mr. Foong Chee Leong, Director General of the Singapore National Environmental

Agency (NEA) to Dr. Chin-Seung Chung, Director of APCC. Mr. John Low of the Meteorological Services of NEA represented Mr. Foong Chee Leong.

5. After the transfer of Chairmanship to Dr. Chin-Seung Chung, Dr. R.H. Kripalani was appointed to lead the sessions. Dr. Siegfried Schubert, Dr. Dmitry Kiktev, Dr. Valentina Davydova Belitskaya, Mr. Antoyo Setyadipratikto, Mr. John Low, Mr. Kwan Kok Foo, Ms. Munirah Ariffin, Mr. Kiyotoshi Takahashi and Mr. Jaime Leyton were appointed rapporteurs.

Working Group Session 2

6. Dr. R.H. Kripalani, Acting Head of Climate Research Division, reported on the activities of APCC during the past year. He focused on operations, research and development, and future plans and directions. Issues covered under operations include the rolling 3-month lead monthly multi-model ensemble (MME) forecast, downscaled 3-month lead forecast provision for Korea to Korea Meteorological Administration (KMA), semi-operational extreme hydrological drought and flood monitoring and operationalization of 1-tier MME forecast with 6-month lead. Research and development activities include extreme drought and flood monitoring and MME-based hydrological extreme prediction, improvement of statistical downscaling method with uncertainty estimation, pilot study on dynamical downscaling using a regional climate model, improvement of APCC/CCSM3 in-house coupled model, enhancement of skills of MME seasonal prediction, and model diagnostic research based on APCC participating models.

7. Dr. Kripalani ended his presentation by suggesting the following points for discussion to the Working Group members:

    a. APCC requested longer (up to 2009) hindcast data with more overlapping data periods from Working Group members. SMIP / HFP and CMIP-type experiments in hindcast were suggested.
    b. Model holders are requested to provide forecast on a monthly basis, submitting no later than the 15th of each month.

c. At least 11 variables are required and extended variables at vertical levels are suggested. Daily data was also requested from WG members should they be able to provide this.
d. Currently individual model data sets are open to working group members only and not the general public.
e. APCC opens the invitation for members to participate in the coupled 1-6 month lead predictions.

Working Group Session 3

8. Dr. James Renwick of the National Institute of Water and Atmospheric Research (NIWA) in New Zealand led discussions for the third session. Working Group members gave presentations on the communication of climate information to various user groups in their economies. Before the meeting, the following guide questions were provided as discussion points:

    a. Who are the users of climate information provided by your organization, aside from the general public? (i.e. relevant government ministries, NGOs on health issues, power companies, disaster management organizations, etc.)
    b. How do you communicate with these users? Are there MOUs between the institutions? Do they purchase data from your institution? Are there formal meetings or task forces set up to facilitate information exchange?
    c. What are the gaps and problems that your institution faces in providing climate information to your users?
    d. Can you tell us about the state of inter-agency cooperation on disaster issues in your country? What are the important initiatives on climate change adaptation and risk management? How are your services enlisted in these initiatives?

9. There were obvious differences between the communication of climate products to user groups between National Hydrological and Meteorological Services (NHMSs) and institutions who do not provide information to the general public but to the scientific community, such as NASA. Most NHMSs encounter problems in communicating information such as translating the information to local languages for user groups,

assessing the needs of the user groups, and coming up with accurate climate information in the first place. Most NHMSs had broad links to various user groups such as government ministries in energy, health, agriculture, water management, environment and the private sector as well. This session helped emphasize the social applications of climate information by identifying the gaps of service provision from NHMSs.

10. The following are highlights of the presentations during the third session. Dr. James Renwick from New Zealand began a description of climate services at NIWA. He emphasized the importance of knowing the market and speaking the same language of the users instead of technical jargon. Providers must understand what is most useful to the user and data must be provided in a timely manner. Dr. Hai Lin from the Meteorological Service of Canada proposed the idea of measuring the economic value of seasonal forecasts as a performance measure. He presented the various users in Canada, including wind energy forecasting, sustainable agriculture and the preparation of the 2010 Winter Olympic Games which required installation of new weather radars and nowcasting systems. Mr. Jaime Leyton from Chile spoke of challenges to convince users to use the APCC MME forecasts. Dr. Jyh-Wen Hwu from Chinese Taipei said that users wanted to know quantitative forecasts instead of probabilistic values. Dr. T.C. Lee from the Hong Kong Observatory provided an overview of the observation system and climate change research. Mr. Takahashi from Japan generally agreed that probabilistic forecasts are not well-received in Japan. Mr. Kwan Kok Foo from Malaysia shared that the Malaysia Meteorological Department distributes their seasonal forecasts via monthly publications and their users come from the regional forecast offices, government ministries and universities. Dr. Valentina Davydova-Belitskaya from Mexico spoke about strong cooperation with the Civil Protection Agency which uses the climate information. However, there are still gaps in data preventing them from fulfilling the needs of some users. Mrs. Amelia Diaz from Peru identified manpower constraints and data coverage as main problems in their country. Dr. Flaviana Hilario from the Philippines said that accuracy of climate forecasts and timely delivery of climate information to stakeholders are gaps that need to be addressed. Dr. Dmitry Kiktev from Russia said that the power generation companies were users of long-range forecasts besides the transportation, agriculture and forestry sectors. He identified lack of qualified users capable of

interpreting probabilistic forecasts as a gap to be addressed. The Papua New Guinea delegate Mr. Kasis Inape said that the public did not fully understand the difference between climate and climate change due to lack of awareness and that climate literature was not easily translated to the local languages. Mr. John Low of Singapore gave a brief overview of the climate services at NEA and their plans to enhance their capacity through collaboration with international climate institutes and local universities. Dr. Siegfried Schubert from US NASA presented on new climate analysis products based on satellite data and their experimental seasonal forecasts. Dr. Jae-Kyung Schemm from US NOAA gave an overview of climate products available on NOAA website and spoke of new initiatives at the CPC international desk such as training opportunities. Mr. Antoyo Setyadipratikto from Indonesia highlighted delays in climate data collection, non-integration of meteorological stations, language differences as some problems and gaps to be overcome. He mentioned some planned enhancements of the monitoring network including new weather radars, automated weather stations as efforts underway.

11. Ms. Mara Baviera from APCC concluded the session with a summary of the APCC Survey on Climate Information and Disaster Preparedness. One key finding was that climate service providers did not have engagement mechanisms with the users resulting in huge disconnect between them. The users have defined good climate information as information that is accessible, timely, accurate and good utility. Some gaps identified from the user survey include the interpretation of information, accuracy, accessibility, geographical scope of provided data, mode of dissemination, and uncertainty of accuracy of the prediction information.

Working Group Session 4

12. The discussion on information sharing on regional activities was led by Dr. R.H. Kripalani. The purpose was to report on APCC participation in latest meetings, trainings and workshops, announce new initiatives from other economies in the APEC region and sharing of new features of information and communication tools such as the Virtual Center and Climate Information Toolkit (CLIK).

13. Dr. Kripalani gave a report on the activities of the APCC from 2009 to May 2010 including MOUs with Indian Institute of Tropical Meteorology (IITM), Singapore NEA, Universiti Kebangsaan Malaysia (UKM), and Korean Environment Institute (KEI). Joint research projects with University of Hawaii CliPAS, Central Research Institute of Electric Power Industry (CRIEPI) in Japan and Climate Change Projections in APEC Regions and Economies with Voeikov Main Geophysical Observatory (MGO) of Russia were briefly discussed. Conferences attended and outreach programs of APCC were also enumerated.

14. The Chairman later invited Mr. Jin-Young Heo, APCC Software Engineer, to present the latest features on Virtual Center and CLIK. Mr. Heo indicated that new APCC Website (http://www.apcc21.org) has been launched LAST March 31, 2010. The new website has improved layout with standard HTML and CSS and provides easy and compatible navigation powered by Radiant CMS RSS subscription. The new website also serves better online services in-terms of loading time, service application and integrated links functioning as a one-stop center. The old website will be officially decommissioned in July 2010.

15. Improvements have also been developed in the Virtual Center to enhance facilities for climate information sharing and technology transfer among APEC stakeholders through the TRACE - Tracking Climate and Environmental website (http://trace.apcc21.net). Mr. Heo also explained the features that have been added to CLIK. Currently, web applications only provide users with SCM method for prediction or verification and probabilistic MME forecast method for prediction. The additional feature, however, supports the probabilistic MME forecast method to generate verification. Other features will be added in the future. A second improvement that has been made to CLIK is the online statistical downscaling feature which is still under the experimental stage. This application enables users to customize downscaling via web interface. He also showed the long-term plan for CLIK development. Providing hindcast data via HTTP is on the planning stage. Finally, he concluded that the official page, CLIK, APCC Data Service System and TRACE would be integrated to form a single online service system in the future.

16. Dr. Kripalani thanked Mr. Heo for the presentation. He further requested member economies to make announcements of other initiatives, trainings, workshops and conferences in the APEC region. Dr. Jae-Kyung Schemm from the Climate Prediction Center at the US National Oceanic and Atmospheric Administration (CPC NOAA) mentioned that NOAA's 35th Climate Diagnostics and Prediction Workshop will be held from October 4-8, 2010 in North Carolina. Dr. Siegfried Schubert from the Goddard Space Flight Center in the US National Aeronautics and Space Administration (GSFC NASA) also announced that the International Drought Conference will be held in Barcelona during March 2011.

Working Group Session 5

17. The 6th Working Group Meeting ended with a discussion on the next WG meeting and APEC Climate Symposium. The Center for Ocean-Land-Atmosphere Studies (COLA) in the United States will host the APEC Climate Symposium 2011 in Washington, USA.

18. The WG members made contributions to the concept note on the symposium which will be proposed to APEC in September this year. The floor was opened to suggestions on which application sectors were most relevant to APEC economies. Dr. Prisco Nilo from PAGASA suggested that agriculture should be part of the proposal. Dr. James Renwick of NIWA New Zealand agreed with the suggestion of APCC to include coastal and marine resources. Dr. Dmitry Kiktev from HMC Russia argued that energy was more universal compared to sectors such as agriculture, which is region-specific. Dr. Hai Lin of MSC Canada said that there should be research on which sectors to target to achieve the greatest economic impact in the region. Dr. Schubert from NASA USA suggested that we should also think about the capabilities of the science and not just the needs of the economies.

19. The meeting ended at 6:00 p.m. with Working Group Chair Dr. Chin-Seung Chung expressing his thanks for the active participation of the Working Group members.

APEC Climate Symposium and US-Korea Workshop

20. The APEC Climate Symposium and US-Korea Workshop opened with a joint session on Monday, June 21, 2010. The Opening Ceremony began at 9:00 a.m. with opening remarks by Dr. Chin-Seung Chung, APCC Director and Prof. Emilia K. Jin Chair of US-Korea Workshop. Busan Regional Meteorological Administrator Mr. Il-Soo Lee gave congratulatory remarks on behalf of KMA Administrator Mr. Byung-Seong Chun. Busan City Vice Mayor Mr. Young-Gil Bae gave congratulatory remarks on behalf of Busan City Mayor Mr. Nam-Sik Hur. Remarks from Mr. Byoung-Soo Seo, member of Korean National Assembly were read on his behalf.

Session I: Joint APEC Climate Symposium and US-Korea Workshop

Keynote Presentations

21. The opening session commenced at 9:45 a.m. and consisted of keynote lectures by climate scientists. *Session I: Keynote Presentations* was chaired by Dr. Vladimir Kattsov from MGO Russia. Mr. John Low from NEA Singapore served as rapporteur for the session.

22. Prof. Jagadish Shukla of George Mason University, USA gave a lecture entitled *On the Role of Unforced Natural Coupled Ocean-Atmosphere Multidecadal Variability in 20th century Global Warming.* He described an unforced internal component, called Internal Multidecadal Pattern (IMP) present in twentieth century IPCC climate simulations that varies on a multi-decadal time scale. Conventional statistical methods such as EOF and SSA do not identify the signal but a new procedure called Average Predictability Time (APT) is able to capture this multidecadal variation. This pattern has similarities to the Atlantic Multidecadal Oscillation (AMO). With this finding, which showed the IMP to be in the warming and cooling phases during the 1946-1977 and 1977-2008 respectively, the likely conclusion is that there is accelerated warming during 1977-2008 as compared to 1946-1977.

23. Prof. In-Sik Kang of Seoul National University, Korea followed with a presentation on Dynamical *Intraseasonal Prediction and its Predictability.* He used various climate

models and various initialization schemes to evaluate MJO predictions, in particular, the computation of the Realtime Multivariate MJO (RMM) Index. He concluded that improvement of MJO prediction can be achieved by model improvement and a suitable initialization scheme. For example, he found that using ECMWF reanalysis (ERA) produced a stronger MJO signal compared to NCEP reanalysis and that coupled models are likely to perform better than atmosphere-only models. He theorized that a higher resolution alone is not sufficient to improve MJO prediction skill.

24. Prof. Bin Wang of University of Hawaii, USA gave a talk on *Multi-institutional ISO Hindcast Experiment* where he described the 2009 launch of a coordinated Intraseasonal Oscillation (ISO) hindcast experiment. The objectives were to better understand the physical basis for intraseasonal prediction, to estimate the potential and practical predictability of ISO in a multi-model framework, to develop optimal strategies for a MME ISO prediction system with effective initialization schemes, to identify model deficiencies in predicting ISO and discover ways to improve the models' convective and physical parameterization.

25. Prof. Masahide Kimoto of the University of Tokyo gave a lecture on *Interannual Predictability of Tropical Atlantic Rainfall Variability*. He suggested that long-range predictability of rainfall variability is crucial to develop long term strategies for agriculture, water resources management. His study focused on the tropical Atlantic where rainfall variability is mainly affected by meridional migration of the Atlantic intertropical convergence zone (ITCZ) associated with the underlying sea surface temperature (SST) variability.

Session II: APEC Climate Symposium

Climate Services and Applications

26. The afternoon session of June 21 was broken up into two groups for the APCS and the US-Korea Workshop and commenced at 1:30 p.m. The APCS Session II discussed *Climate Services and Applications* and was chaired by Mr. Kiyotoshi Takahashi from JMA. Dr. Jyh-Wen Hwu from CWB Chinese Taipei and Dr. Hai Lin from MSC were appointed rapporteurs.

27. Session II was opened by Mr. Yung-Suh Park, Program Director at the APEC Secretariat, in a talk entitled *Introduction of APEC especially on Science & Technology*. Mr. Park reviewed the history of APEC, its mission statement, and APEC's economic significance. He summarized APEC's development and scope of work. He then described how APEC operates from the policy level to the working level. The theme for APEC 2010 is "Change and Action" that emphasizes regional economic integration, new growth strategy, and human security. Mr. Park described in detail APEC's sustainable growth and climate change activities and introduced the Industrial Science & Technology Working Group (ISTWG) and its key priorities. Prof. Johnny Chan asked if the ISTWG has engaged in activities related to environment and climate change. Mr. Park responded that there is no APEC fora specifically dedicated to climate change and sustainable development but that these issues are addressed in different fora (i.e. from a science and technology perspective in the ISTWG, from an energy perspective in the Energy Working Group and so on).

28. Prof. Jong-Dao Ben Jou of the Department of Atmospheric Sciences of National Taiwan University in Chinese Taipei introduced the APEC Center for Typhoon and Society, which is a concept proposed to APEC ISTWG. Dr. Jou first gave a background of the initiative, typhoons being a common threat to the Asia-Pacific region. Dr. Jou described the objectives, functions and expected outputs of the new initiative, and its relation with existing programs. ACTS would focus on data sharing, personnel training and workshops. Mr. Yung-Suh Park raised the issue of possible duplication in activities with APCC and asked what is unique about the ACTS. Dr. Jou responded that the strength of the proposed center will be on sharing of data obtained from an annual dropsonde program and satellite mapping of moisture conducted by Chinese Taipei and a cooperative program with PAGASA involving 15 automatic weather stations and installation of a Doppler radar. These two lectures by Mr. Park and Dr. Jou set the tone of discussion on regional cooperation in climate information services.

29. These presentations were followed by a talk by Dr. Daisuke Nohara from CRIEPI Japan on the *Application of Seasonal Forecast to Electric Power Companies*. Dr. Nohara showed that the monthly fluctuation of electricity demand strongly depends on monthly

temperature. He then described seasonal prediction using APCC 3-month forecast based on downscaling of multi-model ensemble. Verification using anomaly correlation was shown. It was found that the forecast skill of electricity demand depends on skill of the seasonal forecast and that more skillful seasonal forecast is required for more accurate electricity demand prediction. Prof. Johnny Chan asked how many years of data were used for downscaling. Dr. Nohara replied 20 years data were used for hindcast and forecast just starting 2009. It was remarked that results showed high correlation for hindcast but that forecast skills were not at par.

30. Dr. Tsz-Cheung Lee of Hong Kong Observatory gave a presentation entitled *Climate Prediction Services in Hong Kong*. Three types of services were introduced: 1) annual outlook of rainfall in tercile category and number of tropical cyclones with 500 km of Hong Kong which started from 2001; 2) seasonal forecast of rainfall and temperature in tercile category four times a year since 2006; and 3) experimental monthly forecast since mid-2008. Dr. Lee also described the tools and data used. The hindcast using statistical downscaling shows very good skill scores. In the question period Dr. James Renwick commented on the impressive hindcast skill. Dr. Lee replied that while hindcast skill was good, forecast using statistical downscaling still needs improvement. An EOF approach will be tested for this purpose and to see the best method of forecasting, which may take a few years to refine methods and minimize errors.

31. Mr. Kwan Kok Foo of Malaysian Meteorological Department gave a presentation on *Climate Prediction and Information for Decision Making in Malaysia*. He showed climate trends in Malaysia in annual mean temperature of four meteorological stations in Malaysia by season. He demonstrated interannual variability of rainfall anomaly in Malaysia, and related it to ENSO and IOD. He introduced projection of climate trends using statistical downscaling of dynamical models over different regions of Malaysia. Decision making and risk management based on the projection were discussed.

32. Mr. Kasis Inape of Climate and Special Services of PNG National Weather Service presented *Climate Prediction Services in Papua New Guinea*. In this talk, Mr. Inape first introduced the role and functions of the Climate and Special Services Department of PNG. He explained that PNG has a small meteorological service compared to

international standards and that the aviation sector is the main beneficiary. They engage in data collection and research, and not prediction. A simple statistical regression technique was the primary tool for climate prediction in past. Recently, a new tool called Seasonal Climate Outlooks for Pacific Island Countries (SCOPIC), a decision support system for generating probabilistic prediction of rainfall, temperature and other climate related parameters developed by the Australian Bureau of Meteorology was introduced. In the discussion period, Mr. Kiyotoshi Takahashi asked about public concern about climate and climate change. Mr. Inape indicated that there are confusions on climate, weather and climate change and that greater public education was needed.

33. Mrs. Bin Chann Mony of the Climatology Office, Department of Meteorology of Cambodia gave a presentation on *Climate and Natural Disasters in Cambodia*. In this talk, Mrs. Mony introduced the general climate conditions and the main natural disasters in Cambodia being flooding along the Mekong, typhoons and drought. She introduced Cambodia Meteorological Department, including its structure, capabilities, infrastructure, foreign-funded projects and activities as well as responses to disaster events in Cambodia. Mr. Takahashi from Japan asked about the Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia. Mrs. Mony responded that it is a project funded by the UN International Strategy for Disaster Reduction which will commence in 2011. Dr. Jou from Chinese Taipei asked about infrastructure, the availability of upper air stations and real time transmission of data from rain gauges. Mrs. Mony said that Cambodia only has surface stations and manual rain gauges that transmit data in real time.

34. Dr. James Renwick of NIWA of New Zealand presented *Downscaling Approaches and Extreme Events*. In this talk, Dr. Renwick discussed different methodologies for statistical downscaling, from a very simple but robust approach to more complex multivariate approaches that capture more regional detail. He illustrated changes in extremes on rainfall with dynamical downscaling in 30-year RCM hindcasts. Similar overall patterns but significant local differences were found. It was shown that dynamical models with long time series are crucial for extremes. A combination of dynamical and statistical methods would provide a powerful tool. Dr. Hai Lin raised the issue on choice of region

in downscaling and if it would be better to use the whole southern hemisphere to pick up more information. Dr. Renwick replied that they tested the domain up to half the hemisphere but that it did not offer much help. Prof. Johnny Chan suggested multi-model ensemble approach for a robust check of regional climate models instead of a 100-year simulation from one model.

35. Dr. Dmitry Kiktev of HMC of Russia gave a presentation entitled *The Hydrometcentre of Russia: Seasonal Forecasting 2010*. In this talk, Dr. Kiktev introduced long-range forecasting system of HMC that includes SL-AV atmospheric GCM, ocean model and coupled system, and statistical postprocessing. Two versions of the atmospheric model were compared in their hindcast performance. The new version has a smaller RMS error especially in the tropics and northern hemisphere extratropics. Then, Dr. Kiktev showed that their model did exceptionally well in predicting the extreme negative Arctic Oscillation (AO) experienced in DJF 2009. He then described the ocean GCM in curvilinear coordinates, and coupled model for seasonal prediction. Finally statistical post-processing of dynamical long-range forecasting was discussed. Dr. Hai Lin asked about the source of AO skill and the model performance in hindcast period. Dr. Kiktev remarked that they were also surprised about the skill because a simple atmospheric model was used. Dr. Kryjov from HMC Russia suggested that the skill may be coming from SST in the extratropics.

36. The last presentation of this session was given by Prof. Johnny Chan of City University of Hong Kong on *Seasonal Tropical Cyclone Activity Prediction Using a Regional Climate Model*. Prof. Chan first described the regional climate model, which is a modified version of RCM version 3 (RegCM3) developed at International Centre for Theoretical Physics (ICTP). ERA40 was used as initial and lateral boundary condition, and then the model-generated tropical cyclones were analyzed and compared with the observations. It was found that the model is capable of reproducing the basic climatology, the interannual variability of tropical cyclones and tracks of individual tropical cyclones in the western North Pacific. Prof. Chan then suggested that it is possible to use RegCM3 with global model predictions as initial and boundary conditions to produce seasonal forecasts of tropical cyclone activity. In the question period, Dr. Hai Lin raised the issue

of ensemble spread and ensemble mean of tropical cyclone activity. Prof. Chan replied that the spread in general is not very large. Dr. Hilario asked if the Philippines can access the output and if training opportunities for the model is available. She also asked if results can be extended to November and December since there is still typhoon landfall during those months in the Philippines. Prof. Chan replied that it is possible to extend to December. Prof. Chan also recommended that APCC be involved and take the lead in providing resources or running such regional model in APCC. Prof. Cheng-Ta Chen said that typhoon tracks between 1997 and 1998 were very different and asked whether Prof. Chan has looked into the contrast between El Nino and La Nina regarding landfall between Philippines and Japan. Prof. Chan replied that for all years examined, tropical cyclone number was similar to the observation while landfall was fewer. The reason cited was that in the model, vortices tend to dissipate much faster than in actual cases, especially in northern latitudes.

37. The session concluded at 6:00pm.

Session III: US-Korea Workshop

Overview: Scientific Drivers and Current Status of Dynamical Seasonal Prediction

38. The US-Korea Workshop occurred simultaneously with the APCS 2010. The theme was Overview: Scientific Drivers and Current Status of Dynamical Seasonal Prediction chaired by Prof. James Kinter and rapporteured by Prof. Kyong-Hwan Seo. Eight presentations by scientists and students from the US and Korea were made. This session was followed up by a discussion on future collaborative activities between US and Korea moderated by Prof. Jagadish Shukla.

39. Prof. Kyung-Ja Ha of Pusan National University (Korea) gave a presentation on the *Contrasting Storm Track-Jet Relationships between the Pacific and Atlantic*. She showed that the Atlantic storm track is stronger than the Pacific storm track due to three factors: barotropic energy conversion, baroclinic energy conversion and moist feedback effect.

40. Prof. Bohua Huang of COLA (USA) presented the *Interannual Variability in the Tropical Indian Ocean Simulated by NCEP Climate Forecast System* suggesting that the

CFS (and CSM) simulates the major HCA modes realistically but that the HC influence is exaggerated in CFS by overly strong upwelling near the Sumatra coast. This presentation has initiated an interesting discussion on the relationship between ENSO and Indian Ocean variability associated with atmospheric responses.

41. Dr. Jong-Seong Kug of the Korea Development Institute (KORDI) presented the *Intensified El Nino Teleconnection under the Greenhouse Warming*. He showed that there have been robust changes of ENSO characteristics simulated by climate models in spite of large uncertainty on ENSO magnitude changes under greenhouse warming. Most models have simulated more frequent warm-pool El Nino with stronger teleconnection, suggesting that the warm-pool El Nino will be a more prominent climate driver in strongly affecting global climate variability. Some comments on the consideration of impact of the model's bias to simulate mean and variability of SST were made.

42. The presentation *An Assessment of CFS Hindcast and Forecast Skills over the Tropics* was made by Dr. Kenneth Sperber, Lawrence National Lab (USA) on behalf of Dr. K. Sooraj of IPRC (USA). From 6-month lead onwards, the NCEP CFS retrospective forecasts show high skill in forecasting ENSO-related SST anomalies during the developing and mature phases, including that of different flavors of El Nino. The mechanism involved in the teleconnection from the tropical Pacific to Indian Ocean and the USA Pacific Islands is well represented. Statistical significance issues and necessity of probabilistic approaches were suggested by participants, especially for the different flavors of El Nino.

43. Prof. Kyong-Hwan Seo of Pusan National University (Korea) gave a presentation on the *Global Circulation Response to Diabatic Heating associated with the Madden-Julian Oscillation*. He showed that the global circulation response to the MJO is largely determined by the wintertime large-scale background mean flow and the location of the enhanced and suppressed heating anomalies in the MJO development region. Therefore, the improved MJO simulation in CFS T126RAS improves the simulation of the extratropical circulation anomalies.

44. Dr. Kenneth Sperber, Lawerence National Laboratory (USA), presented *A New Method for Identification of Madden-Julian Events*. The comparison of the intraseasonal EOF reconstructions of space-time OLR anomalies against the validation data reveals that numerous periods of extended and/or sporadic MJO activity are falsely identified using the first two leading RMM modes of variability. He suggested a new method for identifying MJO events by incorporating the information associated with higher order (3rd and 4th) modes of variability. There was a comment on the difficulty of forecasting higher modes.

45. This presentation *Development of Monsoon ISO Diagnostics and Evaluation Metric and Application to the CliPAS ISO Hindcast Experiment* was given by Dr. June-Yi Lee, IPRC (USA) on behalf of Professor Bin Wang of IPRC, University of Hawaii (USA). A new index called 'MISO', which is defined by the first four multivariate EOF PCs of pentad OLR and U850 anomaly over the ASM region, suggests a matrix of boreal summer monsoon intraseasonal oscillation. The new index describes better northward and eastward propagating patterns in the ASM domain compared to the RMM index. A statistical forecast model for the MISO index has been developed based on multivariate lag-regression model showing a useful skill up to lead time of 15-20 days. There has been a discussion on the physical validation of index and the importance of intercorrelation among modes in a statistical model.

46. Prof. Emilia Jin of GMU/COLA (USA) presented the *Intraseasonal and Seasonal Predictability of Monsoon of High-Resolution Models*. She showed the results from the Athena project which conducted two state-of-the-art global atmospheric model runs at the highest possible resolutions using dedicated high-end computing. The cloud-system-resolving model (NICAM) outperformed the parameterized convection models (IFS) in simulating Indian monsoon rainfall in spite of a large mean state error. The ENSO-monsoon relationship shows moderate improvement in higher resolution. The spatial (orographic features) and temporal characteristics of subseasonal variability of monsoon rainfall show more realistic representation in higher resolution. There has been a discussion on the mean bias of NICAM.

Session IV: APCC and APEC Emergency Preparedness Working Group (EPWG)

Forum on Disaster Risk Preparedness

47. The session was chaired by APCC Affiliated Scientist Prof. Cheng-Ta Chen from Chinese Taipei. Dr. Flaviana Hilario from the Philippines was the rapporteur for the session. The concept for this session was developed together with the APEC Emergency Preparedness Working Group (previously called the Task Force for Emergency Preparedness or TFEP). The idea was to link climate information services and how they can help in disaster preparedness. There were five presentations for this session from distinguished heads of organizations.

48. Mr. Vincent Liu, Program Director of the EPWG gave an overview on the *Establishment of the APEC Emergency Working Group and Its Activities in 2010*. The mandate of the EPWG is to build capacity in the region to mitigate, prepare for and respond appropriately to emergencies and natural disasters, including by building business resilience and fostering private-public partnerships. Mr. Liu also discussed the relationship between EPWG and APCC particularly in recognition of the important role of climate prediction to the development and implementation of disaster and emergency management plans and significant impact of climate change on the increase in disaster frequency and intensity, and the subsequent implications for the disaster and emergency management community. At the end of his presentation, he presented the work plan of the Working Group and discussed the planned workshops.

49. Mr. Liu's presentation was followed by a lecture by Dr. Liang-Chun Chen, Director of the National Science and Technology Center for Disaster Reduction (NCDR) of Chinese Taipei. He discussed *The Impact of Extreme Events on Disaster Management: Lessons Learned from Typhoon Morakot*. The typhoon brought heavy rainfall in mountainous area amounting to over 1500 mm in 24 hours. This caused serious flooding in southern Chinese Taipei, overflowed levees, landslides and debris flows. According to Dr. Chen, reasons for flooding include torrential precipitation in a short period of time, crashed levees, low-lying terrains due to land subsidence, sedimentation of rivers, inefficient urban draining systems, and water release from reservoirs. Dr. Chen also discussed the

country's efforts on disaster prevention and rescue system and related technology development. However, the recent typhoons (Kalmaegi and Sinlaku in 2008, Morakot in 2009), with record-setting precipitation suggest that the influence of climate change may also change the nature of severe weather and extreme precipitation in Chinese Taipei. The improvement of risk communication and perception, understanding of compound disaster and countermeasures, and operation continuity of business and public sectors are required in coping with disasters that happen in Chinese Taipei. Prof. Jagadish Shukla of COLA/GMU asked whether the Central Weather Bureau was able to predict the extreme rainfall. Prof. Ben Jou of National Taiwan University said that (CWB) forecasted that heavy rainfall will occur both in the northern and southern parts of Taiwan but they did not expect the rainfall intensity of more than 2,000 mm in only a duration of 36 hours.

50. Mr. Tae-Sung Cheong on behalf of Mr. Waon Ho Yi, Director of the Korea National Institute for Disaster Preparedness (NIDP) presented on *WEB-GIS Based Typhoon Committee Disaster Information System (TCDIS) for Typhoon-Related Disaster Risk Reduction.* Dr. Cheong gave an introduction of the Typhoon Committee (TC), an inter-governmental body that promotes and coordinates sharing of typhoon-related information between TC Members. The recent catastrophic disasters associated with the occurrence of typhoons highlighted the need for a more effective WEB GIS-based TCDIS (WGTCDIS). He, then, described the development of typhoon risk assessment and application to Korea, Viet Nam and Hong Kong using Web GIS-based TCDIS technology. The purpose of the establishment of WGTCDIS is to combine the domestic DIS and TCDIS into one WEB GIS based system, to standardize climate and disaster information and to build early warning system and disaster management system to reduce the damages from extreme events by sharing information and results of research. He strongly recommended the use of WGTCDIS for collaboration between TC Members to reduce typhoon-related disaster risks. Dr. Prisco Nilo asked how the tracking of the tropical cyclone trajectory can be used in determining the damage associated with the passage of the tropical cyclone since damage is mostly associated with flooding.

51. Dr. Prisco Nilo, Director of PAGASA gave a presentation on *Typhoon Disasters in the Philippines during the 2009 El Nino Event*. As an introduction, he presented the warning

system, public storm signals and dissemination system in the Philippines with regards to typhoons. The occurrence of three devastating typhoons in 2009, namely Ketsana, Parma and Marinae was discussed. The track of Ketsana which devastated Metro Manila was accurately predicted, however, the heavy rains associated with it were not. Dr. Nilo discussed the chronology of events of the three typhoons. Typhoon Parma made landfall three times and had a very erratic movement due to its interaction with Typhoon Parma and Melor. Typhoon Marinae on the other hand had less amount of rainfall compared with the other two typhoons with 18 casualties. Dr. A.K. Sahai from the Indian Institute of Tropical Meteorology asked Dr. Nilo on what could have been done for the 12 million people affected by the heavy rainfall and flooding event. Dr. Nilo responded that rescue came a little late during Ketsana at the affected areas. Emergency response can be improved if rescue equipment and operations can be located near affected areas and if proper communication channels can be systematically put in place.

52. Dr. Anond Snidvongs, Director of the newly-created Thailand National Climate Change Knowledge Management Center, gave a presentation on *Adaptation Options for Future Risks from Monsoon-driven Sea Level Extremes in a Coastal Agricultural Community.* He discussed the effect of sea level extremes in Bas Ko Klay, Krabi, Thailand. The study area which grows a special variety of rice which command high price in the market is located near the shore and is seldom affected by typhoons. However, during the recent years, flooding was observed to be more frequent than before. The study area is now being affected by saltwater intrusion which negatively affects rice production. Hence there is a need to look for ways to prevent or minimize this. In the study, the projected sea level of the study site was done using dynamic and statistical downscaling approach for 2010-2039, 2040-2069 and 2070-2099 with 1980-2009 as the baseline period. He also determined the projected flood frequency during those periods. With these projections, three adaptation options were identified: defense, construction of dyke and compensation and mud crab raising. He compared the benefits of these different response options. During the open forum, the question of whether uncertainty in the model output was factored in the study was raised. Dr. Snidvongs explained that uncertainty was not considered in the study but that using more models or an ensemble method can help decrease the uncertainty.

Session V: Joint APEC Climate Symposium and US-Korea Workshop

Intraseasonal and Short-Term Climate Prediction

53. The joint APEC Climate Symposium and US-Korea Workshop was held on the morning of June 23, 2010. This was chaired by Dr. Swadhin K. Behera from Japan. The rapporteur for the session was Dr. Vladimir Kryjov from Russia. The session's theme was *Intraseasonal and Short-term Climate Prediction*.

54. Dr. Siegfried Schubert from NASA began the discussions with a presentation on the *Progress towards Understanding and Predicting Weather and Short-term Climate Extremes at NASA Global Modeling and Assimilation Office*. He discussed the capabilities in global modeling, data assimilation and prediction for weather and short-term climate extremes at NASA including the Modern Era Retrospective-Analysis for Research and Applications (MERRA) Project. MERRA uses the NASA global data assimilation system to produce a long-term synthesis and provides science and application communities with state-of-the-art analyses. He used MERRA to analyze the 2003 Heat Wave, concluding that Stationary Rossby Waves play a large role in modulating monthly precipitation and Tsfc in (northern) middle latitudes during JJA. GMAO is developing ultra-high resolution global models and data assimilation systems to address weather and climate issues such as hurricane activity and assimilate high resolution satellite observations.

55. This was followed by a presentation from Dr. Jae-Kyung Schemm of NOAA on *2010 Hurricane or Typhoon Season Prediction with the NCEP T382 CFS CGM*. The T382 climate forecast system has a robust climatological cycle of tropical cyclones and fair level of skill in predicting interannual variability of tropical cyclones. The high resolution forecast runs indicate an active hurricane season for 2010 over the North Atlantic and below normal over the Eastern and Western North Pacific. A question was asked regarding the role of sea surface temperature and circulation, to which Dr. Schemm replied that circulation and wind shear were more important factors than sea surface temperature.

56. Prof. C.P. Chang from the Naval Postgraduate School in the US gave a talk on the *Change of Siberian-Mongolian High Intensity between November and December to January*. Three-month windows for seasonal forecasts are usually used and the appropriateness of this forecast method for the Asian winter monsoon region was assessed. Siberian-Mongolian High anomalies changed signs from November to December and January for the past 25 to 30 years. This may either be due to low forecast skill over the said months or the effect of circulation oscillations such as the El Nino and Arctic Oscillation. Prof. Chang concluded that a perfect NDJ seasonal forecast will have little use for November and may degrade December and January forecasts.

57. Prof. Cheng-Ta Chen presented *Dynamical Seasonal Typhoon Ensemble Simulation and Prediction over Northwest Pacific Basin* and discussed the feasibility of using high-resolution global and regional climate models for Northwest Pacific tropical cyclone prediction. Prof. Chen asserted that instead of putting in by hand the rules thought to be connecting tropical cyclones and climate, modeling systems, equations based on thermodynamics and capturing underlying physical processes offer a better way of predicting tropical cyclones as the climate changes. He concluded that global models ECHAM4 and ECHAM 5 exhibit reasonable skill in simulating seasonal cycle and interannual variability of tropical cyclones. Landfall statistics are still a major challenge. Dynamical downscaling with regional models may be used to simulate typhoon intensity. A question on the role of initial conditions in prediction was asked and Prof. Chen replied that these played a large role.

58. Dr. Hai Lin presented *Impact of the Madden-Julian Oscillation on Wintertime Surface Air Temperature and Precipitation in Canada*. Madden-Julian Oscillation activity informs extended-range forecast for Canadian winter surface air temperature and precipitation. Significant surface air temperature anomalies and high probability of above normal events in central and eastern Canada are found 5-15 days following a dipole structure of MJO convection. This causes enhanced precipitation over the Indian Ocean and reduced convective activity near the tropical central Pacific. Dipole activity also yields precipitation anomalies and the influence is strongest when the MJO forcing has a dipole structure.

59. Dr. Xiouhua Fu ended the session with a presentation on *Impacts of Initial Conditions on Monsoon Intraseasonal Forecast*. Dr. Fu examined how sensitive to different initial conditions monsoon Intraseasonal forecasting is using the University of Hawaii Hybrid Coupled Model. NCEP reanalysis was used for initial conditions, which was found to underestimate ISO. He concludes that enhanced intraseasonal signals in initial conditions significantly improves ISO prediction and that including high-frequency disturbances in initial conditions generally extends rainfall predictability by about 5 days.

Session VI: APEC Climate Symposium

Interannual, Decadal and Millennial Variability

60. The afternoon session was again broken up into the APCS 2010 and US-Korea Workshop. The APCS theme was on *Interannual, Decadal and Millennial Variabilty* and was chaired by Dr. Tsz-Cheung Lee of Hong Kong. Session rapporteurs were Mr. Kasis Inape from PNGMET and Dr. Jae-Kyung Schemm from NOAA. There were 10 presentations by scientists and representatives from NHMSs on topics ranging from El Nino, Indian Ocean Dipole, monsoon variability, climate trends, and seasonal climate prediction.

61. Prof. Yihui Ding of the National Climate Center, China presented on *Decadal Northward Shift of the Meiyu Belt and the Possible Cause*. Prof. Ding discussed the decadal movement of the Meiyu belt and its association with the East Asian atmospheric circulation for the target period 1979 - 2007. The positioning of the Meiyu belt before and after 1999 was found to be associated with a decadal shift. The main reason for this decadal shift was attributed to the distinctive tropospheric warming and stratospheric cooling trend found in the mid-latitudes of East Asia. It was also revealed that cooler SST anomalies in the tropical central and eastern Pacific may have contributed to the decadal shift of the Meiyu belt.

62. Dr. Vladmir Kattsov of the Voeikov Main Geophysical Observatory of Roshydromet of St Petersburg, Russia gave a presentation entitled *APCC Extending its scope over Decadal through Centennial Time Scales?* His discussion was centred on the necessity for APEC economies to obtain readily available climate change impact assessment

information based on CMIP5 model outputs for IPCC AR5. He also made some recommendations for APCC to address the complex environmental problems of the APEC economies.

63. Dr. Swadhin K. Behera from the Research Institute of Global Change, JAMSTEC, Japan presented on *The Unusual El Niño of 2009*. Dr. Behera pointed out that the 2009 El Niño event was quite unusual compared with past events as there was wide spread warming across the whole of Tropical Pacific during the summer of 2009, unlike the colder SST anomalies normally observed close to the dateline. These equatorial SST anomalies in turn altered the position of the major rainbands that drive the atmospheric circulation and the associated teleconnections across the Pacific basin. As a result several parts of Japan suffered from floods whilst India experienced one of the worst droughts on record.

64. Dr R. H. Kripalani of APCC presented on *Indian Ocean Dipole Mode: a Possible Precursor for the East Asian Summer Monsoon*. His composite and correlation analysis of the Indian Ocean Dipole (IOP) revealed that the peak of the positive phase of the IOD mode during autumn could suppress the following summer monsoon activity by 3 seasons later, over the Korea-Japan sector, South China and the West Pacific region. He further mentioned that the autumn positive phase of the dipole could induce heavy snow over Eurasia and the north of the Korea-Japan peninsula in the following winter and spring seasons.

65. Prof. Jian Liu of the Nanjing Institute of Geography and Limnology in the Chinese Academy of Sciences presented on *Monsoon Variability in the Last Millennium: a Model Study,* which was done as part of her research work in IPRC. Her paper focused on the millennial timescale on the variation of Global Monsoon (GM) and East Asian Summer Monsoon (EASM). Her study showed that the centennial and millennial variations of the GM and EASM before the industrial age were essentially a forced response to the external radiative forcing. The upward trend in the GM precipitation in the last century and the strengthening of the GM could possibly be due to the increase in the anthropogenic greenhouse gas forcing.

66. The presentation *Predictability of Summer Northwest Pacific Climate and Possible Role of the Tropical Indian Ocean: Analysis of Eleven Coupled Model Hindcasts* was done by Mr. Jasti S. Chowdary of the International Pacific Research Centre, University of Hawaii. Eleven CGCMs were investigated for their predictability of seasonal rainfall and circulation anomalies over the Northwest Pacific especially in the summer months (JJA). The EOF1 mode of SLP was closely linked to EOF2 mode of rainfall variability over the NW Pacific in summer. Furthermore, the correlation coefficients were also very high.

67. Dr. Flaviana Hilario of PAGASA presented *Climate Trends in the Philippines*. Studies of historical records show signals of climate change are already evident in the Philippines. The average annual temperature has risen by 0.6^{o}C during the last 50 years since 1960. There is also clear evidence that hot days are getting hotter and nights are getting warmer. Furthermore, there has generally been an increase in rainfall amounts and number of rain days during both the wet and dry seasons whilst there is no significant trend in the number of tropical cyclone forming or entering the Philippines.

68. This presentation *The Preliminary Verification of the CWB Seasonal Climate Forecast System* was made by Dr Jyh Wen Hwu of the Research and Development Centre, Central Weather Bureau (CWB), Chinese Taipei. Since 2006, CWB has been issuing experimental forecasts of precipitation and 2m temperature for Taiwan. This two-tier dynamical forecast shows that CWB seasonal climate forecast tend to have reasonable predictability skill for rainfall and temperature.

69. Mr. Antoyo Setyadipratikto of the Climate Research and Information Division of the BMKG, Indonesia looks at the prediction of seasonal onset of 10 day rainfall using Hy-BMG method in Pacitan. The general observation was that the onset of rainy season in Pacitan derived from the model was better than the dry season. Similarly, the correlation coefficient with the onset of rainfall season was very good (r=0.69) which implies that SST can be a very useful predictor for wet season rainfall for Pacitan and the surrounding areas. The title of his presentation is *The Hy-BMG Method for Onset of Seasonal Prediction in Pacitan, East Java Province of Indonesia.*

70. Dr Andrea Alessandri of the Euro-Mediterranean Centre for Climate Change (CMCC) in Bologna presented on *Seasonal Climate Activity at CMCC: Developments and Latest Results*. The CMCC-INGV SPS displayed a good skill in predicting the seasonal tropical cyclone activities and exhibited realistic geographical distribution. He also mentioned that the latest version of the CMCC-INGV SPS contributed to the implementation of the new European multi-model seasonal prediction system developed during the EU Ensemble project.

Session VII: US-Korea Workshop

Strategies for Improvement of Dynamical Seasonal Prediction

71. The US-Korea Workshop had the theme Strategies for Improvement of Dynamical Seasonal Prediction and was chaired by Prof. Kyung-Ja Ha. The session's rapporteur was Prof. Adam Sobel. There were 9 presentations from scientists and students from US and Korea. This was again followed by a discussion of collaborative activities between the two countries moderated by Prof. Shukla.

72. Dr. James Kinter, Director of COLA (USA), gave an overview on Dedicated High-end Computing to Revolutionize Climate Modeling: An international collaboration describing the Athena project, in which a dedicated supercomputer was used for high-resolution climate simulation using the NICAM and ECMWF IFS models at horizontal resolutions from 7-125km. The high resolution reduces some biases (e.g., blocking frequency, snow, tropical geopotential) while increasing others (e.g., mean tropical rainfall, monsoon circulation), and causes changes in 21C-20C climate change projections. Tropical cyclones and many other features were apparent in the animation of the results.

73. Dr. Joe Tribbia of NCAR (USA) presented the New Developments in Climate Prediction at NCAR. He focused on ensemble Kalman filter data assimilation for decadal predictions as part of AR5 CMIP5 decadal predictions and initial and boundary value problems. He also briefly described the development of the new CCSM4.0/CESM1.0 models and showed new results from a high resolution simulation (1/8 degree atmosphere, 1/10 degree ocean) using spectral element cubed sphere numerics, also with beautiful animation.

74. This presentation Assimilating Snow Cover Fraction Observations into CLM was done by Ms. Kristi Arsenault of GMU/CREW (USA). She described a project in which MODIS observed snow cover fractions were assimilated into the Community Land Model version 2 for a domain including Washington state, USA. An ensemble Kalman filter method was shown to be superior to direct data insertion. However, the improvement in agreement with observations with assimilation compared to without assimilation was small because of uncertainties in the observations and the conversion of observed variables to model snow states. Forcing error (e.g., from imposed precipitation rates) may also be responsible.

75. Dr. Yign Noh from Yonsei University (Korea) gave a presentation on the LES of the Ocean Mixed Layer with the Application to its Parameterization in a Climate Model designed to test sub-gridscale closures and their underlying hypotheses. He focused on the role of Langmuir circulation and of wind stress in deepening of the mixed layer. He showed weaknesses in the Niiler-Kraus and PWP schemes, and suggested modifications to remedy these weaknesses.

76. Mr. Baoqiang Xiang, University of Hawaii (USA) gave a presentation on *Understanding the Impacts of Mean State Biases on the ENSO Amplitude in the Coupled "POEM" Model (ECHAM/POP)*. He showed that coupling strength and thermal damping feedback improved with mean state correction. In the uncorrected model, Ekman-driven divergence is too weak in upper ocean (too strong below). Thus, mean upwelling is too weak as a result of too much vertical mixing, too little shear and too little stress. This reduces the thermocline and zonal advection feedbacks, resulting in a very weak ENSO. All this is a result of cold tongue bias.

77. Prof. Adam Sobel of Lamont-Doherty Earth Observatory/Columbia University (USA) presented the *Modulation of Tropical Cyclones by Natural Climate Variability*. He showed that the QBO is not significantly correlated with tropical cyclones in the Atlantic with longer record and developed new index for tropical cyclone genesis. The performance of the new index using clipped vorticity has improved incrementally on the Emanuel GPI suggesting the important physics of genesis, which is the environmental vorticity ceases to be a rate-limiting factor in genesis once it is sufficiently large.

78. Ms. Liwei Jia of GMU (USA) discussed the *Optimal Detection of Multi-Year Predictability over Land* using the average predictability time (APT). She showed that surface air temperature is predictable from 1-10 years (depending on what model is used for the computation of APT). Predictability reaches decadal timescales in the northeast Atlantic and Greenland. Multi-year predictability is present in the other continents, and multi-year predictability of precipitation—related to ENSO—is as well in all continents but Europe.

79. Prof. David Straus, Chairman of Department of Atmospheric, Oceanic, and Earth Sciences of GMU (USA), gave a presentation on the *Circulation Regimes: Bridging Weather and Climate Predictability*. Looking for multi-modality in the large-scale circulation due to feedback from baroclinic synoptic disturbances to quasi-stationary planetary waves, he explicitly linked low and high frequency eddy statistics using a singular vector analysis. The patterns show statistically significant relationships between the mean state and the eddies, and there is some sign of predictability of frequency of regime occurrence based on SST.

80. The presentation *How Predictable is the Northern Hemisphere Summer Upper-Tropospheric Circulation?* was made by Dr. June-Yi Lee of IPRC (USA). Focusing on 200 hPa geopotential height, the predictability was quantified by fractional variance accounted for by predictable leading modes, which were identified using observation and multi-model ensemble hindcasts. The two leading modes closely linked to ENSO have captured a large fraction of the total variance suggesting substantial potential predictability. However, models overpredicted the fraction of variance, especially the second mode in the extratropics.

Session VIII: Tutorial Session

81. Dr. Saji Hameed prepared the curriculum for the Tutorial Session on Multi-model Ensemble Forecast and Downscaling. More than 30 scientists from APEC economies and APCC scientists participated in the tutorial session. Mr. Sudir Sabade gave a lecture on K-means on behalf of Dr. R.H. Kripalani. The topics covered were:

a. NCL Crash Course

(1) Reading and writing netcdf data
(2) Performing simple meteorological calculations
(3) Visualization

b. Recreating Super Synthetic Ensemble MME in NCL

(1) Introduction to Super Synthetic Ensemble (SSE)
(2) Coding practice

c. Forecast and Hindcast Skill

(1) Introduction to skill metrics
(2) Coding to generate skill metrics for SSE forecasts and hindcasts
(3) Visualization of results

d. Introduction to Downscaling Tools

(1) Brief introduction to downscaling libraries
(2) Practice of downscaling using Aphrodite data and NCEP reanalysis
(3) Introduction to K-means clustering
(4) Redo downscaling after clustering station data based on K-means clustering

e. Introduction to SOM Clustering Approach

(1) Introduction to SOM algorithm
(2) Applying SOM-based clustering to station data derived from Aphrodite

Session VIII: Science Advisory Committee Meeting

82. The Science Advisory Committee (SAC) meeting commenced at 9:40 am and concluded at 12:30 pm with Prof. Jagadish Shukla and Prof. In-Sik Kang co-chairing the session. Also in attendance were Prof. Yihui Ding, Prof. Masahide Kimoto, Dr. Vladimir Kattsov, Dr. Swadhin K. Behera, Prof. Bin Wang, Prof. C.P. Chang, Dr. Chin-Seung Chung, Dr. Chung-Kyu Park, Dr. R.H. Kripalani and Dr. Hyun-Kyung Kim. Dr. June-Yi Lee and Ms. Mara Baviera recorded the meeting proceedings.

83. Dr. Chin-Seung Chung, Director of APCC and Dr. Chung-Kyu Park, Director of KMA Climate Research Department were invited to give opening remarks. Dr. Chin-Seung Chung thanked the SAC for their presence and expressed that he is ready to hear the suggestions and ideas to develop APCC. Dr. Chung-Kyu Park expressed support for APCC in his position at KMA.

84. Prof. Shukla gave his opening remarks, focusing on three main points on what makes a great institution: an idea, people and resources.

The Idea

APCC has made a name, considering limited resources, with its unique product: the multi-model ensemble forecast. APCC has concentrated in the past years on seasonal to interannual climate prediction and it was time that APCC's functions be extended to provide climate change information to society. This will help address societal problems that require decadal and multidecadal scenarios. He proposes that APCC mission to start in this area with the agreement of the SAC and APCC.

People

Institutions need good leaders and APCC has been lucky to have Dr. Park, whose dream it was to develop APCC. The new Director has also made an impression on Prof. Shukla upon hearing his ideas on how to make APCC relevant to society and to provide socio-economic information applications to health, agriculture and other sectors.

Resources

During his visit, Prof. Shukla got the impression that the APCC management was challenging the SAC to come up with good ideas, and not to worry about the resources. Good ideas and good scientists will fetch resources.

85. There is also a need to give credit to APCC scientists who have accomplished so much with so few in numbers. Prof. Shukla felt that SAC had not done enough to help APCC get more scientists. He encouraged the SAC to become more proactive in helping APCC instead of just limiting its activities in their annual meeting. In addition to reviewing the

past activities of APCC, Prof. Shukla suggested that the time could be spent discussing how to advance the mission of APCC.

86. Prof. In-Sik Kang, agreed with Prof. Shukla that the idea for APCC is clear with the uniqueness of the largest MME system. His evaluation is that APCC has been very successful so far but that we also need a new direction.

87. Dr. Kripalani presented the work which APCC has done in the past year, the action taken on SAC 2009 recommendations, and the work that will be continued.

88. The Science Advisory Committee made the following recommendations:

Need to focus on well-defined projects: Prof. Shukla mentioned that there are a lot of projects and that there are only a few scientists. There is a need to narrow down on some well-defined projects where efforts should be focused on.

Feedback mechanisms on APCC products: Prof. Shukla identified three main products that APCC was working on: rolling monthly seasonal climate outlooks which are posted on the website, downscaling work for KMA Korea, and the 6-month tier one forecast. He mentioned that there is a need to have feedback mechanisms on our products. There is also a need to inform the global community on the products and activities of APCC. It was suggested that the SAC Co-chairs could write an article promoting the work of APCC in publications of international organizations such as CLIVAR Exchanges.

Extend to climate change issues: Prof. C.P. Chang raised that discussion on climate change issues were started in the past years. Dr. Kattsov presented a slide from his presentation "APCC extending its scope over decadal through centennial time scales?" He identified key areas that APCC could work on.

Dr. Vladimir Kattsov presented a slide on APCC going into climate change projections. He emphasized that societal demands based on the WCC3 were towards this direction. Moreover, the speeches at the opening ceremony of the Symposium by the Busan

Metropolitan City and the representative from the National Assembly were also focused on information on climate change.

Dr. Kattsov also remarked that APCC needs to keep an eye out for international activities such as the Global Framework for Climate Services and position itself in these initiatives. In WCC-3, APCC was late in the process. Prof. Kimoto reminded the body of APCC's mission of service and while it does not have the capability to do large-scale research, there is a need to make connections with research groups and hire researchers.

Monitoring and forecast of tropical cyclones: Prof. Bin Wang strongly recommended the increase of products in tropical cyclone forecasts and monsoon indices, which are not difficult to do. This has important societal applications. It was noted that there are already a lot of bodies doing work on this and that perhaps it might be better to write editorial articles and provide links to the websites. This would increase the web content of the APCC website. Prof. C.P. Chang mentioned that it would be a good idea to have a one-stop reference for tropical cyclone and monsoon products. Prof. Shukla remarked that updating and monitoring work could be done instead of prediction of tropical cyclones.

There was a lot of discussion during the meeting regarding the initiative of Chinese Taipei and the Philippines on setting up an **APEC Center for Typhoon and Society (ACTS)**. Prof. C.P. Chang reported to the body that it has a very high chance of going through and being approved by the APEC. Chinese Taipei is one of the most important places to study tropical cyclones. However, it is not a member of WMO. The ACTS would not be an operational center but instead will be a research center for tropical cyclones and their societal impacts. Prof. Chang informed the body that text about collaborating with APCC was included in the resolution of the 2010 Asia-Pacific Typhoon Workshop held in Manila, Philippines last January that discussed the ACTS initiative. Around 60 scientists from a dozen APEC economies attended the workshop. It was debated whether APCC should also write some text as part of the SAC meeting proceedings as a reference for future collaboration. Delineating the scope of ACTS and APCC was also debated. The major points were that if there needs to be a clear delineation, i.e. ACTS to do work on short-term prediction of typhoon, while APCC will

continue to work on seasonal prediction including seasonal prediction of typhoons and climate. The Science Advisory Committee has agreed that,

"The APEC Climate Center (APCC) would like to welcome the initiative of Chinese Taipei, the Philippines and co-sponsoring APEC Economies to establish the APEC Center for Typhoon and Society (ACTS). APCC shall work in close collaboration with the ACTS on joint initiatives on tropical cyclone research and prediction, provision of tropical cyclone information services and related societal impacts. In particular, APCC will be pleased to provide the seasonal outlook for typhoon activities based on multi-model ensemble forecasts of APCC."

ISO forecasting: Prof. Shukla suggested that, if resources are limited, instead of going to 9-12 months forecast, it would be much more useful to continue intraseasonal to seasonal forecasting. Prof. Bin Wang wished to know how to implement ISO prediction operationally and commented that we can begin with a statistical model first then go on to a long term multi model seasonal forecast. This would require data over 10-day intervals for a 6-8 week forecast. There were some concerns raised on where the hindcast data would be stored, which is currently housed in Hawaii. If this initiative would push through then the hindcast data would need to be located in APCC. Prof. Shukla raised that having intraseasonal predictions on a routine and operational basis would require additional resources. APCC would need to develop a climate information system and determine what kind of information it is committing to provide.

Climate Information: Climate services are now becoming central to weather services of countries so there may be a reaction from NHMSs regarding this. APCC was recommended to be the depository of high-resolution climate information available from Coordinated Regional Climate Downscaling Experiment (CORDEX) that will come out in a few years. High-resolution atmosphere model outputs (time-slice experiments) for selected climate change scenarios should also be archived at APCC. This will help APCC create unique regional climate change information.

Prof. C.P. Chang also informed the Committee of the stalled initiative on creating an APEC El Nino Monitoring Center in Peru with SENAMHI, citing that Gen. Wilar Gamarra has stopped responding to communications.

An agreement was entered into with NASA for high-resolution hurricane data and the progress of this needs to be followed up, including allocation of computer space in KMA.

Capacity Building within APCC: The Committee discussed how to start building capacity within APCC. It was noted that APEC has two kinds of economies: developed and developing. NHMSs can approach APCC in looking for help in climate services. There is a need to be realistic on what APCC can do.

APCC, as a depository of information, needs in-house experts in areas for different sectors including agriculture, health, etc., hosting workshops in the center for sector-based applications, visualization systems. In-house experts are necessary to produce real knowledge. Prof. C.P. Chang raised that in addition to in-house experts, there may be a list of consultants that may or may not be in APCC. APCC can maintain a list of experts who can be approached for sectoral issues. There would need to be some criteria on who would be on that list and that it should be comprehensive.

It was suggested that there should be separate research and operation divisions in APCC to attract good scientists who are connected with research groups around the world. Prof. C.P. Chang raised that APCC is doing good operations but research is done outside in CLIPAS and George Mason University (GMU). Perhaps collaborative research projects with these institutions should be more advertised to highlight the role of APCC.

Prof. Shukla raised that APCC needs to hire both good leaders and junior scientists. To attract scientists, there needs to be a competitive salary package, good facilities and conditions (housing, relocation allowance, etc), good academic environment and mentoring, more effort in requesting recommendations from scientists, and linkage with Pusan National University for possible concurrent positions in PNU and APCC. Prof. Bin Wang emphasized strengthening the academic environment by having a strong visiting scientist program or senior scientist program. Prof. Kang recommended improving the

affiliated scientist program with no more than five people who can spend one or two months a year to work in APCC. Prof. Shukla mentioned that these scientists can also help bring in students and post-docs to APCC. It was also raised that good Korean scientists could be recruited in APCC. There must also be a good recruitment team to manage this. Dr. Chung commented that there is a good fit between his thinking and the recommendations of the SAC and that he would need recommended names for APCC to approach and negotiate with. APCC needs to make resource allocations accordingly.

Prof. In-Sik Kang suggested that APCC allocate a budget item for SAC members to visit APCC. Prof. Shukla encouraged SAC members to visit APCC. SAC members could also use other external research grants to fund visits to APCC.

Session X: US-Korea Discussion

89. The discussion was opened by remarks from Prof. Jagadish Shukla and Prof. In-Sik Kang. While there have been a lot of collaboration between the two countries for the past few decades, this was mainly done on the personal initiatives of Korean and American scientists. It is hoped that through discussions, this collaboration will be formalized through specific projects. Prof. James Kinter and Prof. Emilia Jin led the discussion on collaborative activities. The group then broke out into four groups to develop project proposals, which were then presented to the body.

Annex: Participants List

NO.	TITLE	FULL NAME	INSTITUTION	Economy
1	Mrs.	Bin Chann Mony	Climatology Office	Cambodia
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30	Prof	Jong-Bae Ahn	Pukyong National University	Korea
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32	Prof.	Kyong-Hwan Seo	Busan National University	Korea
33	Prof.	Myong-In Lee	Ulsan National Institute of Science and Technology	Korea
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35	Dr.	Won-Tae Kwon	National Institute of Meteorological Research	Korea
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