Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG04-01 Room:413 Time:May 1 14:20-14:40

Coastline as triple boundary among atmosphere, ocean and earth

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Coastline is the boundary between ocean and land (earth beyond the sea level), and the liquid-solid heat contrast there produces monsoon or sea-land breeze circulation responding revolution (annual) and rotation (diurnal) periodicity of solar heating. The coastline is also the intersection between ocean surface and bottom, and its location is determined by water budget and erosion-orogeny balance. Furthermore, the coastline is the most active ecological (and also anthropogenic) zone. Based on these geoscientific meanings of coastline, we discuss climatological characteristics of land-sea coexisting planet such as earth.

Keywords: atmosphere-ocean-land interaction, monsoon and local circulation interaction

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Cold surge event observed by the research vessele Hakuho-maru over the Pacific in December 2012

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1. Introduction

A cold surge from the Siberian High is the typical phenomenon of the Asian winter-monsoon that sometimes reaches the southeast Asian regions, such as Philippines and the Indochina Peninsula, across the Pacific and resulted in heavy rainfall there. Airmass transformation is one of the key processes for this phenomenon. However, the quantitative evaluation based on the observation has not yet been done so far. We succeeded in observing a cold surge event by radiosondes from the research vessel over the Philippines Sea in the end of December 2012. The preliminary results are reported in this paper.

2. Observation and data

We conducted radiosonde observations on board the research vessel ”Hakuho-maru” during December 21, 2012 and January 4, 2013. Figure 1 shows the observation points and the launch time of the radiosondes. We launched radiosondes with 6-hour or 12-hour intervals during 23 to 24 December between 21N and 29N along the cruise from north to south. At the southernmost point (21N, 133E), we further carried out the fixed-point observation of 3-hour intervals for about 1.5 days during 24 to 25 December.

3. Synoptic fields

The cold surge from the Siberian High was intensified during December 20 to 26. Northwesterly winds were intensified around Japan and the northeasterly was strengthened in the Pacific Ocean and the Philippine Sea. Convections were activated over the Philippines, and the precipitation also became strong in the coastal area. The cyclonic disturbance propagated westward near the equatorial region over the western Pacific. The easterly flow at the northern edge of the disturbance and the northeasterly by the cold surge formed convergence zone over the offshore of Philippines.

4. Results

Latitude-height section of potential temperature and water vapor mixing ratio obtained by the moving observation during 23 to 24 December revealed the cold air intrusion was observed in the lower layer from the surface to 2 km height. The stable layer was formed at the top of the cold air intrusion (about 2 km height). The temperature and humidity were higher in the southern area. Time-height section of potential temperature and water vapor mixing ratio obtained by the fixed-point observation during 24 to 25 December showed that the stable layer around 2 km height were gradually intensified and that below the stable layer both the potential temperature and the water vapor mixing ratio had the uniform vertical distributions, which is consistent with the well-mixed layer during the cold surge event. The transition to such a typical mixed-layer structure was captured by high temporal resolution observation.

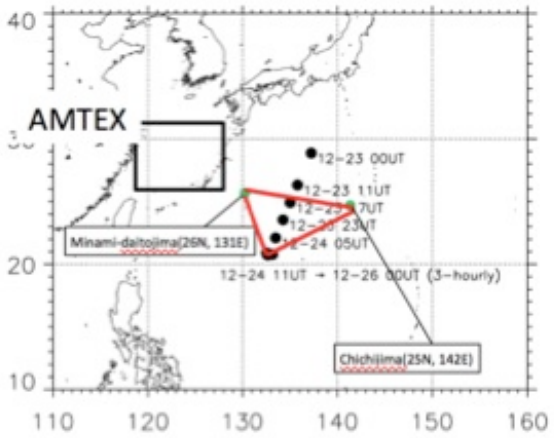
With the help of the operational radiosonde data at Minami-daitojima and at Chichijima, we performed a thermodynamic energy budget analysis and evaluated the transfer of thermodynamic energy between the atmosphere and the ocean. The result indicates that the amount of the energy transfer from the ocean to the atmosphere was even large over the Pacific remote from the Eurasian continent and compares with the one that observed near-continent area over the East China Sea by the AMTEX project (Ninomiya, 1975, JMSJ). The effect of the energy transfer to the precipitation over the Philippine area will be discussed.

Acknowledgement

We would like to thank Dr. Hodaka Kawahata (The University of Tokyo), Mr. Katsura Kameo (The University of Tokyo), Mr. Ei Hatakeyama (Marine Works Japan LTD) and all the crews of Hakuho-maru for their great help with conducting the radiosonde observation on board the research vessel. We wish to express our gratitude in Drs. Kaoru Sato (The University of Tokyo), Naohiko Hirasawa and Yoshihiro Tomikawa (National Institute of Polar Research) for permitting us to use their launch

device. Part of this study is supported by The Green Network of Excellence (GRENE) program of the Japanese Ministry of Education, Culture, Sports, Science and Technology.

Keywords: cold surge, air-sea interaction



Japan Geoscience Union Meeting 2014
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ACG04-03 Room:413 Time:May 1 14:55-15:10

Lightning climatology around Jakarta, Indonesia, based on 13-years SYNOP observation and GSMaP rainfall data

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Operational observation in Indonesia, where has much amount of active convections under the tropical maritime climate with high atmospheric and sea surface temperatures and abundant water vapor supply, showed more than 100-200 days of lightning a year and more than 10 times/km2/year of lightning density. Developed convective systems with lightning (thunderstorms) often generates severe mesoscale phenomena of heavy rainfall, gusty wind, and tornados, as well as lightning strikes at the ground. Indeed, much amount and kinds of serious damages caused by thunderstorms have been reported in Indonesia, e.g., massive blackout and serious damage on electrical devices in urban areas, and forest fires and burn-out of high voltage power lines in rural regions. Although Virts et al. (2013a, 2013b) clearly documented lightning climatology over Indonesia based on TRMM LIS and the World Wide Lightning Location Network (WWLLN) observations, temporal and spatial distributions of lightning activity and their dynamics have not been examined in detail because ground-based radar and lightning locating observations are not well organized and satellite observations have deficiencies in their spatial resolution and sampling frequency.

We started three years (JFY2013-2015) program to study lightning activity mainly over Jakarta, where is the capital megacity in Indonesia and has much risk to be damaged seriously by thunderstorms especially in the social sector, to clarify its characteristics from both the points of precipitation climatological and mesoscale meteorological views based on three approaches as follows: 1) statistical analyses for lightning activity by using operational surface observation and TRMM satellite, 2) case studies on environmental conditions for severe thunderstorms based on a C-band radar and surface observation data already obtained, and 3) campaign observation by using X-band dual-polarimetric radar, VLF receiver network, and hydrometeor video soundings.

We examined 13-years SYNOP data for statistical analysis of lightning activity around Jakarta and its relation to rainfall variation based on GSMaP data as the first step. Seasonal variation of lightning frequency shows two peaks in April and November, which correspond to periods just before and after the peak of the rainy season in February around Jakarta, at most of the stations over the inland region. However, these peaks are not clearly shown at stations close to the coastline of Java Sea and one peak in February is more predominant. Because previous studies (e.g, Hattori et al. 2011, Wu et al 2007) suggested the cross equatorial northerly surge (CENS) intensify local convection around Jakarta in the boreal winter season, the effect of CENS to generate thunderstorms was limited only along the coastal region but not for inland in February. Intraseasonal variation of lightning activity based on MJO index clearly shows a major peak in the MJO phases 3 (eastern Indian Ocean) and minor one in phase 7 (western Pacific). It suggested the lightning activity was intensified at the leading and trailing edges of MJO large scale disturbance which is consistent with previous studies (e.g., Morita et al. 2006). Whereas, GSMaP data show a peak of rainfall around Jakarta in the phase 3 at the same time of lightning peak, though the previous studies showed the rainfall was peaked in the phases 4-5 (maritime continent).

We plan to examine lightning characteristics more focused around Jakarta and its relation to rainfall quantitatively by adapting the rain-yields per flash (RPF) (Williams et al 1992, Takayabu 2006) and the other parameters. More than 15-years TRMM LIS and PR data shall be used in our future study as well as Asia VLF network (AVON) and WWLLN datasets.

Keywords: lightning & thunderstorm, convective diurnal variation, Indonesian maritime continent

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ACG04-04 Room:413 Time:May 1 15:10-15:25

Interannual variability of rainy seasons onset over the eastern Indochina Peninsula

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The onset dates of rainy seasons over eastern Indochina Peninsula (8.5o-23.5oN, 100o-110oE) for individual years from 1958 to 2007 were objectively determined by the principal component of two first dominant empirical orthogonal (EOF) modes of the precipitation data. It is found that onset of summer rainy season (SRS), which is described by the EOF1, is in 6 May on the average, with a standard deviation of 13 days. Meanwhile, the autumn rainy season (ARS) indicated by the EOF2 has the climatological onset and standard deviation is 16 Sep and 12 days, respectively. The SRS starts simultaneously with the eastward shift of the Western North Pacific sub-tropical high (WPSH) and the evolution of summer monsoon westerlies. On the contrary, the retreat of summer monsoon over northern and central Indochina in boreal autumn indeed signifies the onset of ARS. The relationship between the onset and intraseasonal variations (ISVs): the 30?60-day (30?60DV) and the 10?20-day variation (10?20DV), are identified.

The results also insisted that ENSO has considerable influence on the onset of rainy season in the Indochina. In general, La Nina (EL Nino) years with warm (cold) sea surface temperature (SST) anomalies in the western Pacific and cold (warm) SST anomalies in the central?eastern Pacific in the preceding winter-spring have early (late) SRS onset. For an early onset year, the equatorial easterly winds are observed be stronger. Strong convective activities also occur over the southern Indochina Peninsula and the SCS in the preceding winter and spring. Whereas, the early onset of ARS is likely related to El Nino years with weaken equatorial easterly winds. It could be explained by the earlier retreat of westerlies monsoon and farther westward extension of the WPSH. Finally, the differences of ISV between early-late onset years of two rainy seasons are also discussed.

Keywords: monsoon onset, interannual variation, Indochina Peninsula, sub-tropical high, summer monsoon

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ACG04-05 Room:413 Time:May 1 15:25-15:40

How did North Atlantic Oscillation (NAO) cause drought in northwestern China at the multi-decadal to centennial scales?

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North Atlantic Oscillation (NAO) plays an important role in the Northern Hemisphere climate system. Although there is growing interest in the connection between NAO and precipitation change in China, there are few studies concerning that connection in northwestern China. Based on fine-grained historical drought disaster records and NAO proxies, we explored quantitatively their possible connection in northwestern China over the past millennium at the multi-decadal to centennial timescales. Statistical results show that NAO and drought disaster were negatively correlated, as positive modes of NAO caused northward-displaced, stronger-than average mid-latitude Westerlies with an enhanced latitudinal water vapor gradient into the central Asian drylands, resulting in reduced drought frequency and intensity in northwestern China. But, their correlation was out-of-phase during the Little Ice Age because of the southward shifting of monsoon, Westerlies, and the East Asian Jet Stream brought by long-term land surface cooling. As it has been indicated that the precipitation in northwestern China is also determined by El Nino-Southern Oscillation and North Atlantic sea surface and air temperature aside from NAO, further studies are needed to evaluate their individual roles and combined impacts upon the drought disaster there.

Keywords: NAO, Precipitation, Drought, Northwestern China

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Identifying Precipitation Sources in Northern Mongolia using Back Trajectory Analysis

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Prediction of precipitation variability and understanding of its mechanisms are essential in Northern Asia [Yatagai and Yasunari, 1994]. The objective of this study is to investigate linkages between the interannual variability of precipitation sources and that of precipitation amount in this area.

For this purpose, a back-trajectory model [Merrill et al., 1986] of atmospheric water vapor was developed and applied to the rainfall during the warm season from 2003 to 2009 at semi-arid grassland Kherlenbayan-Ulaan (KBU) in northern Mongolia, where an air parcel is tagged with the ambient potential temperature where it is precipitated, and is tracked adiabatically above the planetary boundary layer (PBL). When a parcel is tracked back into the PBL, its potential temperature is adjusted to the value at the top of PBL. In addition, diffusion process of water vapor evaporated from the ground surface into the atmosphere and the altitude raindrops are formed are calculated using the Monte Carlo simulation [Dirmeyer and Brubaker, 1999]. The model uses JRA-25/JCDAS [Onogi et al., 2007] reanalysis data set with 6hour intervals.

The results show that the major precipitation sources of rainwater at KBU are the local area of Mongolia and the central and the western Asia. Water vapor evaporated from the local area of Mongolia is approximately 20% of the total summer precipitation, and this ratio is particularly higher in Mongolia in compared with the other area on the globe [Dirmeyer et al., 2009]. This result consists with Yatagai and Yasunari, [1995] which suggested that the variability of precipitation in the arid areas in the northeastern Asia has higher correlation with the local atmospheric circulation, and Sato et al., [2007]. Moreover, this paper clearly exhibits that this ratio is fairly constant over the years in spite that the total precipitation varies.

Moreover, it was found that water vapor supply from the central and the western Asia is approximately 30% of the total summer precipitation at the target point, and therefore, the central and the western Asia may explain a major portion of the summer total precipitation.

In addition, the year 2003 and 2004 were found to here, anomalous relation. It is discovered that larger precipitation in the autumn of 2003 [Hirata et al., 2008] was followed by the increased contribution of the local evaporation to the precipitation in the following 2004. Shinoda et al., [2011] claimed that the cold season climate with low evapotranspiration and strong soil freezing acts to prolong the decay time scale of autumn soil moisture anomalies to the next spring over the eastern part of Mongolia. Therefore, it is considered that soil moisture at the local region in the autumn may be preserved during the winter up to the next spring and contribute to precipitation in summer in northern Mongolia.

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Philippine summer monsoon onset -Intensive observation PALAU2013 and data rescue for 109 years-

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The Philippines is an archipelago country which is located in the western side of tropical western Pacific. There are distinct summer monsoon in the western side and winter monsoon in the eastern side of the country. This study focuses on the onset of summer monsoon in the western Philippines during May to July. Intensive observation of Pacific Area Long-term Atmospheric observation for Understanding of climate change (PALAU2013) was conducted by launching additional upper-air observation in Cebu, Laoag, and Puerto Princesa during May to August 2013. We captured the onset of summer monsoon in June 10, 2013. Low level strong southwesterly wind associated with moistening air was penetrated in the central Philippines during the onset. We compared the behavior of Philippines summer monsoon onset when there was no continuous upper-air observation in reanalysis data. The recovery of historical station back to 1903 called 'Data rescue' was performed using Monthly Bulletins of Philippine Weather Bureau from 1903 to 1940. We created rainfall dataset in the Philippines from 1903 to 2012 by connecting recovered data and PAGASA station data. Summer monsoon onset was defined by using 8 station rainfall data in the western Philippines. The onset date becomes earlier after 1990s and tends to occur in middle May. Early onsets were also seen in early 20th century.

Keywords: Philippines, monsoon onset, data rescue, Asian summer monsoon

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Relationships between heavy rainfall in East/Southeast Asia and track, intensity, duration patterns of tropical cyclones

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Tropical cyclones (TCs) have considerable impacts to many areas in East/Southeast Asia. For instance, TCs accompanied with heavy precipitation could cause floods, and the strong winds of TC also could induce huge damages on their track and surrounding environment. In addition, Intergovernmental Panel on Climate Change (IPCC) 5th assessment report mentions possible increasing of both global mean tropical cyclone maximum wind speed and rain rates. Thereby, it would be very important to deepen our understanding on the relation between TCs and their impacts to local climate in East/Southeast Asia.

This study aims to extract observed TC patterns by employing a nonlinear classification method, and also examine relations between extracted TC patterns and heavy rainfall in East/Southeast Asian cities. The classification method used in this study is the self-organizing maps (SOM). The SOM has been recently used in climate science and have shown significant performance for analysis of high dimensional climate data.

In this study, we utilized the TC data provided by JTWC (Joint Typhoon Warning Center). The data period used in this study is 62 years from 1951-2012. Then, we extracted longitude, latitude, maximum sustained wind speed, and duration from TC genesis in order to make input for the SOM. Consequently, each TC is represented as 39 dimension vector, and total 1,837 TCs are utilized as input for the clustering by the SOM. We set the map size of the SOM as 3x3 hexagonal grids.

By the SOM algorithm, total 1,837 TCs were classified in nine nodes (i.e. nine patterns). As a result, several distinguishable TC patterns were extracted by the SOM, according to their track, intensity and duration. Then, we extracted the TCs classified in each pattern, and subsequently examined relations between the extracted TC patterns and rainfall at 21 meteorological stations in East/Southeast Asian cities. Our analysis confirmed clustering method is quite useful in identifying TC properties. The result also suggested extracted TC patterns are highly related with heavy rainfall in some of the target cities.

Acknowledgments: This research was supported by the Environment Research and Technology Development Fund (S-10) of the Ministry of the Environment, Japan and the Research Program on Climate Change Adaptation (RECCA) of the Ministry of Education, Culture, Sports, Science and Technology, Japan.

Keywords: typhoon, western North Pacific, heavy rainfall, Self-Organizing Maps

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ACG04-09 Room:413 Time:May 1 16:50-17:05

Application of pseudo global warming method and dynamic downscaling for typhoons approaching to Japan

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Results of global warming experiments indicate that an intensity of typhoon will be magnified in future climate. In this study, reproductive simulation of typhoons which approach to Japan are made. At the same time, pseudo global warming conditions are composed of a reanalysis product and multiple global warming experiments. Then, numerical simulations using the pseudo global warming conditions were conducted for each actual typhoon and variations of typhoons in future climate were investigated by comparing the reproductive simulation and the runs with pseudo global warming conditions. Results of a typhoon in summer showed significant variations in tracks. When a track deflects eastward, a typhoon goes over the ocean and its center pressure remarkably decreases. In addition, wind speed around the typhoon increases very much. Geopotential height in lower troposphere showed lower anomaly over the Pacific Ocean. Decreasing Pacific high is thought to be a cause of the change in typhoon tracks. In another typhoon in summer, although variations in tracks and center pressure were smaller, total precipitation in the typhoon increased in future. However, another typhoon in summer showed decreasing precipitation with small variation in tracks and center pressure. Results for another typhoon in autumn showed smaller variation in tracks and center pressures, and total precipitation increases in results of future climate. Such characteristics in future variations were found in other typhoons in autumn. On the other hand, hourly precipitations were not necessarily increased in future climate both in summer and autumn. These results indicate that extremely strong rainfall does not necessarily occur in short time, but modestly strong rainfall continues longer time. Even if no significant variation in center pressure, or intensity is similar to current climate, precipitation will increase in future climate.

Keywords: global warming, typhoon, numerical weather prediction, downscaling

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ACG04-10 Room:413 Time:May 1 17:05-17:20

Assessment of GSMaP satellite rainfall products in Asian monsoon region

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Satellite rainfall products provide the spatial and temporal distribution of rainfall estimates over the ungauged regions where no ground-based measurements with rain gauges and/or meteorological radars are available. For the regions, the satellite products have special importance in, for example, hydrological and agricultural applications such as flood forecasting/warning and water resources management. The Global Satellite Mapping of Precipitation (GSMaP) products have high resolution in space and time (0.1 deg. and 1 h); besides the near-real-time version of GSMaP opens to the public within four hours after measurements. They are thus highly expected to be in operational use in many countries and regions. There are the problems in accuracy and precision of the products due to the limitations on measuring principles, time intervals of sampling and others. However, the above-mentioned strengths of the products are considerable. Therefore, the performance of the GSMaP products needs to be investigated in various areas for the appropriate and effective use; moreover, through the investigation, it can be expected that the knowledge useful for improving the performance will be obtained. The present study investigates the performance of two GSMaP products, GSMaP_MVK and GSMaP_Gauge (a gauge-adjusted GSMaP_MVK), in the four river basins located from the tropics to mid-latitudes in the Asian monsoon region, including: the Solo Basin (16,100 km^2) in Jawa, Indonesia; the Thu Bon – Vu Gia Basin (10,350 km^2) in central Vietnam; the Pampanga Basin (9,759 km^2) in Luzon, the Philippines; and the Tone Basin (16,840 km^2), Japan. The study is ongoing and intermediate results mainly for the Solo and Thu Bon – Vu Gia river basins are discussed at this session.

Keywords: Asian monsoon, precipitation, satellite

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INTERIOR FLOOD DAMAGE IN JAPAN: PRESENT AND FUTURE

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The assessment of flood risk and its future prediction under anthropogenic climate change are important to policy makers for future preparedness and adaptation planning. Almost all countries in the world including major cities suffer from flood damage every year due to large exposed population and property. The intensity of damage amount varies as per the level of their preparedness. The case of Japan is also similar, having about 100 billion yen annual damage due to interior flood. Flood losses are increasing more rapidly during late 20c and is expected to increase in future too. Another major factor contributes to future climate events like floods and its losses will be anthropogenic climate change. But due to lack of robust analytical framework to estimate future losses and lack of long term damage data; future projections of flood loss still have many uncertainties.

Most studies regarding flood damage assessment have been done for river flood which always excludes interior flood damage usually caused by rainfall inside city area due to poor or insufficient drainage facilities. Also some extreme events corresponding to large return period is usually taken for damage assessment, which always exclude the damages caused by high frequency events, but reported as equal as an extreme event. In this study, we present a robust methodology for interior flood damage assessment exclusively; taking all daily rainfall events into account and its application to future climate.

We use recorded historical daily damage data in Japan that was archived in Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Government of Japan to produce functions namely damage occurrence probability function and damage cost function. Our statistical approach gives the probability of damage following every daily rainfall event and thereby the annual damage as a function of rainfall, population density, topographical slope, and gross domestic product. Our results for Japan show reasonable agreement with area-averaged annual national damage for period 1993?2002 in calibration and 2003-2009 in validation. The flexibility of this method leads to future projection of interior flood damage in Japan.

Multiple climate models in different resolution with different convective schemes, sea surface temperature (SSTs) and future climate scenarios to predict the future interior flood damage amount in monetary term are being used. For Japan, we use high resolution Meteorological Research Institute (MRI) atmospheric general circulation models (MRI-AGCM) for present and future precipitation. The precipitation parameters are calculated from 1979-2009 in present and 2075-2099 in future using MRI-AGCM with two mesh sizes (20 km and 60 km) and three different convective schemes (Yoshimura Scheme, Arakawa-Schubert scheme & Kain-Fritsch scheme) which give multi-physics ensemble. The future sea surface temperature (SST) is as per the multi-model ensemble mean change of CMIP3 and CMIP5 with A1B and RCP8.5 scenario respectively. Moreover to consider uncertainty of future SST due to geographical SST distribution, three different clusters SST are also taken for future damage assessment.

Initial results for annual average interior flood damage in Japan shows 13.25% increase in average for future [2083- 2099] from the base period [1993-2009] for A1B scenario and 10.08 % increase for RCP8.5 scenario. The range of future estimate of average annual interior flood damage for A1B scenario is 68.17 billion yen to 117.81 billion yen and for RCP8.5 scenario, it is 78.93 billion yen to 119.06 billion yen in 2005 price. Another important notice in the result is future largest annual damage in A1B scenario seems quite same as present largest annual damage, but for RCP8.5, some year shows the largest damage will double than the present.

We will add different models and CMIP5 results and will describe more features of future interior flood damage in our presentation.

Keywords: interior flood damage, damage occurrence probability, damage cost function, preparedness, economic losses, climate change

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ACG04-12 Room:413 Time:May 1 17:35-17:50

Application of performance metrics to climate models to project future river discharge in the Chao Phraya River basin

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Future river discharge in the Chao Phraya River basin was projected, taking into account the performance of multiple General Circulation Models (GCMs). Future hydrological simulations using outputs from multiple GCMs are important for assessing the uncertainty in the projections. In addition, consideration of the spread of GCM projections should be included in the analysis to appropriately evaluate extremes, as there can be significant differences among projections. This study, therefore, developed a bias-corrected dataset for multiple GCMs outputs and a performance metrics to evaluate each GCM in order to project future river discharge more appropriately.

To develop a bias-corrected future climate dataset, an advanced bias correction method is applied, in which the trend of variables from the reference to the projection period is preserved. Then, future river discharge was projected by the H08 hydrological model. The newly developed future climate dataset enabled us to conduct a projection that considered the spread of projection derived from multiple GCMs.

Several metrics to evaluate the performance of each GCM to reproduce monsoon precipitation were proposed to estimate performance-based projection because evaluation of GCM performance in simulating monsoon behavior is important for projecting future discharge in the Chao Phraya River basin. This study was performed to investigate the effects of performance metrics and to estimate the spread of projections derived from the differences in multiple performance metrics.

Multiple future projections using available GCM outputs were conducted in the Chao Phraya River basin and multiple weighted ensemble means were obtained using the proposed multiple metrics related to monsoon precipitation. We compared the projected results obtained and discuss the characteristics of each projection. The performance-based projections indicated that the future river discharge in September is increased by 60%?90% of the retrospective simulation. Our results highlight the importance of appropriate evaluation for the performance of GCMs.

Keywords: Climate Change, River discharge