Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AHW02-P01 Room:Convention Hall Time:May 21 18:15-19:30

Effect of the diurnal variation on the hydrological cycle over the maritime continent

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The climate of the maritime continent is characterized by huge amounts of precipitation throughout the year. The unique environment in this region with complex distribution of islands and warm pool favors the development of deep and frequent convection. The deep convection accompanied by heavy precipitation is generally observed over islands and its surrounding ocean rather than open seas. Major islands combined with surrounding warm seas, therefore, are most likely to play an important part in the energy and water cycle processes driving the complex atmospheric circulation pattern.

To understand the time-space characteristics of the hydro-climate in islands and ocean, we examined the climatological hydrological cycle from 1998-2010. The characteristics of water budget are separated between Island (including its surroundings ocean) and open seas in the maritime continent.the Seasonal variation of precipitation over Borneo and the surrounding ocean is very small compared with those over other tropics. The vertically-integrated moisture flux fields show divergence throughout the year over the Borneo, suggesting that evapotranspiration from the island surface is a major source of moisture to atmosphere. In contrast, other major islands in the maritime continent, such as New Guina, the seasonal cycle of moisture flux convergence is observed. On the other hand, the contribution of moisture flux convergence to precipitation is noticeable over the surrounding ocean of the major islands. The diurnal variance of the hydrological components is large over Island region and its surrounding oceans. Diurnal cycle of local atmospheric circulation plays an important role in exchange of water between the island and the surrounding ocean. The intraseasonal oscillation (ISO) is also a dominant mode of rainfall over this region. The influence of the ISO on the water budget appears stronger over the ocean than over the island. The vertical profile of the moisture flux and specific humidity indicate large difference in low-middle level between ocean and island.

Keywords: Diurnal cycle, Atmospheric water budget, Intraseasonal oscillation, Maritime Continent

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Water Origin over Indonesia Maritime Continent with Isotope Circulation Model

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By using the data obtained by a global Rayleigh-type circulation model with the Japanese long-term re-analysis project, we determined the seasonal changes of water sources trajectory to Maritime Continent. The model output was validated by the observation data of the Oxygen-18 and Deuterium content in precipitation at nine stations. The model performed well statistically in reproducing the simulated stable isotope in precipitation. The model demonstrates the seasonal characteristics of the water origin in three climatic patterns: (1) the semi-annual pattern, in which seasonal changes are indicated by the alternating presence of water from the northern and southern Maritime-Continent seas, (2) the anti-monsoonal pattern, represented by the alternating presence and absence of water from the southwest Pacific Ocean, southern Maritime Continent, and tropical Maritime-Continent sea, and (3) the monsoonal pattern, characterized by the alternating presence and absence of water from the northern Maritime Continent sea and Indian Ocean.

Keywords: Stable Isotope in Precipitation, Isotope Circulation Model, Water Origin, Asian-Australian Monsoon, Maritime Continent

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Monitoring of lightning activity in the Maritime Continent based on electromagnetic measurement in ELF and VLF range

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Lightning observation has been focused on as a useful way for monitoring and nowcasting of thunderstorm activity which causes extreme weather, such as torrential rain. Torrential rainfall causes flood and damages to large cities especially in the Southeast Asia. Previous studies show that spatial distribution of lightning discharge has been used as an effective proxy of the presence or absence of atmospheric vertical convection which give rise to thunderstorm.

Recent lightning observation shows that there is extremely huge lightning whose scale is more than hundreds times bigger than that of averaged event. This result indicates that not only place but also scale of each lightning discharge should be estimated for quantitative evaluation of vertical convection.

In this study, lightning observation network in the Maritime Continent is introduced. This network is designed to estimate not only spatial distribution but also scale distribution of lightning activity. This network is consisted of sensors which make it possible to record the electromagnetic waveforms radiated from lightning discharges by multipoint observation. Geolocation is determined based on time of arrival method and its accuracy is evaluated as less than 10km. Furthermore, charge moment is evaluated as a scale of each lightning discharge by using electromagnetic waveform.

We have already constructed observation stations at Tainan in Taiwan (23.1N, 121.1E), Saraburi in Thailand (14.5N, 101.0E), Pontianak in Indonesia (0.0N, 109.4E) and Los Banos in Philippines (14.18N, 121.25E). Now, we plan to install the monitoring system at Hanoi in Viet Nam. Data obtained by multipoint observation is synchronized by GPS receiver installed at each station.

At the presentation, initial result of geolocation and derivation of charge moment value based on the measurement of ELF and VLF sferics are shown.

Keywords: lightning, severe weather, ELF, VLF, sferics

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Spatiotemporal variability and trends of rainfall extremes in the Philippines: Linkage with ENSO and monsoon

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Due to the recent extreme rainfall events that led to disaster in the Philippines, long-term trend and variability of rainfall extremes in the country are investigated using daily rainfall data from 35 meteorological observing stations during 1951?2010. Seven extreme precipitation indices that characterize daily rainfall in terms of intensity, accumulation and duration in a seasonal perspective are used. The non-parametric Mann?Kendall test is implemented in combination with moving block bootstrap to detect significant trends. Results indicate a tendency toward wetter condition during boreal summer (July?September, JAS) while a drying condition during boreal fall (October?December, OND) in the Philippines. The influence of El Nino?Southern Oscillation (ENSO) and Western North Pacific (WNP) summer monsoon on the extreme precipitation indices are further explored by means of composite analysis and rank correlation technique. Around 20%?60% drier (wetter) condition is associated with El Nino events during OND (JAS); however, ENSO influence is more pronounced during OND as compared to JAS. On the other hand, strong WNP summer monsoons are generally associated with high values of wet extreme precipitation indices during JAS, specifically at stations located on the western section of the Philippines. A weak strengthening of the WNP summer monsoon is detected; however, the spatial incoherency of trends found in extreme precipitation indices, and the influence of tropical cyclones and other tropical disturbances with short temporal-scale suggest that found trends could not be attributed to a single factor but to combinations of several factors directly or indirectly affecting extreme precipitation over the Philippines.

Keywords: rainfall extremes, ENSO, monsoon, long-term trend, Philippines

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Climatological onset date of summer monsoon in Vietnam

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The objectives of this study are to investigate the summer monsoon onset date in Vietnam by using 5-day averaged of 1) observed rainfall, maximum temperature, minimum relative humidity at 54 selected meteorological stations in the region and 2) horizontal winds, temperature, specific humidity and geopotential height at pressure levels form JRA25 reanalysis data during the 1979-2003 period. The averaged convective activity is also examined by the OLR (Outgoing Longwave Radiation) data provided by NOAA (National Oceanic and Atmospheric Administration).

The result suggested that the summer monsoon onset date varies considerably among sub-climatic regions in Vietnam. The earliest onset is generally found in the northwestern mountainous region around late April. Later, the westerlies summer monsoon start dominating over the Indochina Peninsula in mid-May, bringing the rainy season in the Red river delta in the north and Mekong river delta in the south of Vietnam. In case of central coastal area, being very different from others, as a result of Foehn wind, from mid- to late- May, sudden increase of temperature and gradual decrease of minimum relative humidity are indicted as summer monsoon onset date for this region. Over the Indochina and SCS (South China Sea) region, the most significant changes of convective activity and 850-hPa circulation fields occur in 28th pentad (16-20 May). Moreover, there is clear linkage between the beginnings of Meiyu season with the onset of summer monsoon in the SCS. In addition, in the upper atmosphere (200-hPa level), the retreat northward of sub-tropical westerly jet and the formation of TSE (Tropical Strong Easterly), consequence from the difference in heating over Indian inland and cooling over ocean, also play an important role in summer monsoon circulation.

Keywords: summer monsoon, monsoon onset, tropical strong easterly, Meiyu front, Vietnam, Foehn wind

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Recent Interdecadal Variations of Autumnal Precipitation in Vietnam

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In some parts of Southeast Asia, (e.g., central Vietnam), a large amount of rainfall occurs in boreal autumn to early winter (September-December: SOND). In the present study, we investigate interdecadal variations of rainfall in SOND in Vietnam and its vicinity for the period 1961-2010, based on rain gauge observational data obtained from the Southeast Asian countries. As a result, it is very obvious that rainfall have increased [decreased] to the south [north] of 17N along the coastal area of Vietnam. There are many stations with statistically significant decrease over the Red River Delta region (north of 20N; denoted as region A hereafter). In this region, SOND rainfall has decreased since late 1980s. In northern part of central Vietnam (17-20N; denoted as region B), the rainfall decrease has been observed since late 1990s. In southern part of central Vietnam (12-17N; denoted as region C), on the other hand, SOND rainfall has largely increased since late 1990s. From comparison of seasonal marches of rainfall over the 3 regions between 25-year averages of 1961-85 and 15-year averages of 1996-2010, we find that the amount of rainfall in region A has clearly decreased in August-October, indicating the recent earlier withdrawal of summer rainy season. In region B, rainfall has decreased during a whole rainy season in boreal autumn. In region C, on the other hand, the rainfall increase is very obvious and long-lasting during a whole period of August to December. Atmospheric circulation changes based on some gridded datasets suggest that recent stronger lower-tropospheric cyclonic circulation over the southern part of the South China Sea might be responsible for the recent increasing trend of rainfall over region C, though the significance of the atmospheric changes varies between the gridded datasets.

Keywords: climate variations, Vietnam, precipitation

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Rainfall pattern in the middle of Indochina Peninsular during 2009-2010 summer monsoon

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Rainfall patterns during summer monsoon in 2009 and 2010 in the middle of Indochina Peninsular (ICP) are investigated using daily radar rainfall (DRR). The DRR is calibrated using rain gauge data before proceeding to further analysis. The empirical orthogonal function (EOF) analysis applied to DRR shows that the first three modes explain 40% of the total rainfall variance. The first mode shows only positive value over the radar observation area with high value near the foot of Annam range in the east of radar site. The second and third EOF show dipole patterns and explain 7% and 6% of total variance, respectively. The Cumulative Density Function (CDF) is applied to the score of the EOF results in order to find a physical meaning of EOF modes. A composite analysis of reanalysis data is employed by selecting dates above and below 90% and 10% of CDF in each EOF modes. The first and second modes are consistent with vorticity and wind directions. The third EOF mode indicates a suppression of rainfall by topography.

Keywords: monsoon, indochina peninsular, rainfall pattern, radar rainfall, EOF

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

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Future Water Stress under a Warming Climate over the Indochina Peninsula

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We focused to estimate water stress over the Indochina Peninsula. Trends in the total population under high water stress now and in the future (we call this total HWSP) and the population exposed to high water stress in the future but not now (we call this add-HWSP) are dependent on differences in each scenario, not the temperature increase. We indicated the sensitivities of climate change, water withdrawal, and population growth on total HWSP and add-HWSP to separate the influences of climate change and socio-economic change. Climate change and socio-economic factors (water withdrawal and population growth) decreased and increased add-HWSP, respectively. Because these factors are related to anthropogenic activities, it is necessary to consider the change in water withdrawal and population when we discuss how to avoid high water stress in the future.

Keywords: SRES, IPCC, uncertainty, water stress assessment

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

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Interannual variation in the summer monsoon onset dates over South China sea

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Kajikawa and Wang(2012) pointed out an advance in the onset dates for 15 years average on the South China Sea summer monsoon around 1993/94. In this study, we compare meteorological fields around South China Sea in the change of onset dates not only for 15 years averages but also the annual variability. For analysis, we use the 850hPa horizontal wind from the JRA-25/JCDAS and OLR (Outgoing Longwave Radiation) from NOAA. We define South China Sea monsoon onset date as th area averaged zonal wind changed from easterly to westerly over 5-15 degrees north latitude, 110-120 degrees east longitude. 4 groups divided by 1979-1993 (prior period) and 1994-2008 (later period) and by 3 years early onset dates and 3 years late onset dates are compared the meteorological fields around South China Sea.

In the result, in the group of early onset dates in prior period, the convective activity in Bay of Bengal are strong in late April, but the genesis of convection in the South China Sea are delayed after the onset. And, the variation of South China Sea summer monsoon onset dates is different defined as OLR between zonal winds.

Keywords: monsoon

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Interdecadal variability of the atmospheric circulations at the onset of the western North Pacific summer monsoon

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The low-frequency variability with periods of interdecadal variations or longer was examined for the atmospheric circulations associated with the onset of the western North Pacific summer monsoon (WNPSM). The region of WNPSM, (138?-160?E, 15?-25?N), is first determined in the western North Pacific (WNP) as the region with positive values in precipitation difference between the periods before (mid-July) and after (late July) the WNPSM onset (after - before). The time series analysis is then performed for the areal mean precipitation rate of the region after removing the linear trend. To extract the components with periods longer than 11 years, we employed the harmonic analysis and summed the components of wave numbers 1-3 for the time series of 1979-2010 (32 years). The low-frequency variability clearly shows the interdecadal tendency concurrent with the Pacific decadal oscillation (PDO) in the North Pacific even in boreal summer. In the first positive phase after 1979, i.e., 1985-93, the WNPSM begins in its own region, while the region shifts westward off the Philippines in the following negative phase of 1994-2000. In the next positive phase in 2001-07, the WNPSM is again established in its own region. The positive, negative, and positive SST anomalies in and around the WNPSM region with the PDO induce such interdecadal tendency in atmospheric circulations around the WNPSM onset. The linear trend removed, i.e., the lower-frequency variability, shows a tendency that the precipitation before the WNPSM onset increases, while it after the onset is almost unchanged in and around the WNPSM region. The similar tendency is identified in the tropical cyclone activity: it is stronger before the onset. It is confirmed that the onset of WNPSM has been unclear during the latest few decades.

Keywords: western North Pacific summer monsoon, PDO, accumulated cyclone energy

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Possible factors affecting interannual variability of spring rainfall over southeastern

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We examined the possible impacting factors controlling interannual variability (IAV) of the spring rainfall (SPR) over southeastern China using the NCEP-NCAR reanalysis data and APHRODITE precipitation data from 1951 to 2007. The SPR amount accounts for about 35-40% in the annual rainfall amount over southeastern China. Therefore, the IAV of SPR is important as well as the IAV of summer monsoon rainfall. The IAV of SPR is dependent on the moist southwesterly over southwestern China at the lower troposphere. This southwesterly is mainly induced by the east-west gradient between the western pacific and the Indochina peninsula. As a result of correlation analysis, the IAV of SPR is associated with the El Nino-Southern Oscillation (ENSO) via the variability of the western Pacific subtropical high. However, we found the clear difference in the ENSO effect on the IAV at different stage of SPR. Based on the correlation analysis using the 10-day mean precipitation over eastern China and Southern Oscillation Index (SOI), we separate in to two periods; the first part (Feb. 10 to Mar. 20) and the second part (Apr. 1 to May. 10) on the SPR period. This correlation analysis denotes the significant negative correlation during first part and the nearly no correlation in second part. Thus, the mechanisms for the modulating the east-west gradient are different between first part and second part in the SPR period.

Keywords: Spring rainfall, East Asia, Interannual variability

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(May 19-24 2013 at Makuhari, Chiba, Japan)

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Back-trajectory Analyses of Water Vapor Precipitated in Northern Mongolia

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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 30-40% of the total summer precipitation at the target point, and has larger interannual variations that is consistent with those of the total summer precipitation. Therefore, the central and the western Asia may explain a major portion of variations in the 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.

Keywords: trajectory analysis, precipitation source, water vapor

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Long-Term Variability of Extreme Low-Temperature in Winter in Mongolia

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The characteristics of extreme low-temperature events in Mongolia are examined using JRA-25/JCDAS reanalysis data for 1979-2010. In this study, Extreme Cold Day (ECD) which is an index to evaluate low-temperature events is defined by a daily mean surface air temperature difference lower than -10 degree within 2 days at each grid point.

The geographical distribution of winter mean ECD frequencies differs for every winter and are limited at the northern Eurasian Continent. Interannual variations in the area-averaged frequency of ECD in Mongolia during the 1980s-1990s showed decreasing trends. But in the 2000s, some year with high frequency existed.

The number of occurrence of ECD every ten years was changing spatially. In the 1980s,it mainly occurred over western part of Mongolia. On the other hand, in the 2000s,northern part of Mongolia had high number of occurrence. When cold surge in Mongolia which brings ECD occurred, atmospheric circulation tended to localized in the 2000s, compared with the 1980s. This may cause of limitation of the occurrence areas.

Japan Geoscience Union Meeting 2013
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Estimation of mass change of glaciers using a precipitation data set with fine spatial resolution in High Mountain Asia

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In High Mountain Asia, estimates of glacier mass change using reanalysis, glacier models or GRACE still have uncertainty. To estimate glacier mass change in High Mountain Asia glacier models have important roles because there are sparse mass balance observations of glacier and also this region is intensive irrigated area.

Results of glacier models are critically sensitive to the quality of precipitation input. In addition, accumulation of glaciers in High Mountain Asia is driven more by high precipitation than other colder regions. Although, there are large spatial variations of precipitation on glacier mountain areas, reliable precipitation data is not well established in these areas because this remote region lacks a dense gauge network.

In this study, we developed a precipitation data set with high spatial resolution as input precipitation for a glacier model. And we calculated glacier mass change using the glacier model and evaluated the effect of spatial distribution of precipitation for glacier mass change. The precipitation data set with fine special resolution from 1998 to 2007 at daily time scales using satellite radar observation and rain gauge observation has developed. We basically used satellite observed precipitation data with 4-km spatial resolution, which directly estimates precipitation well even in high mountain area. And then we combined the satellite based data and gridded data on the basis of rain gauge observation with daily time step. Finally, we will show the results of examination of glacier mass change calculation by different precipitation data sets.

Keywords: glaciers, mass change, precipitation radar, spatial resolution