Annual Report
Hydrospheric Atmospheric Research Center (HyARC)
Nagoya University

2014

Contents

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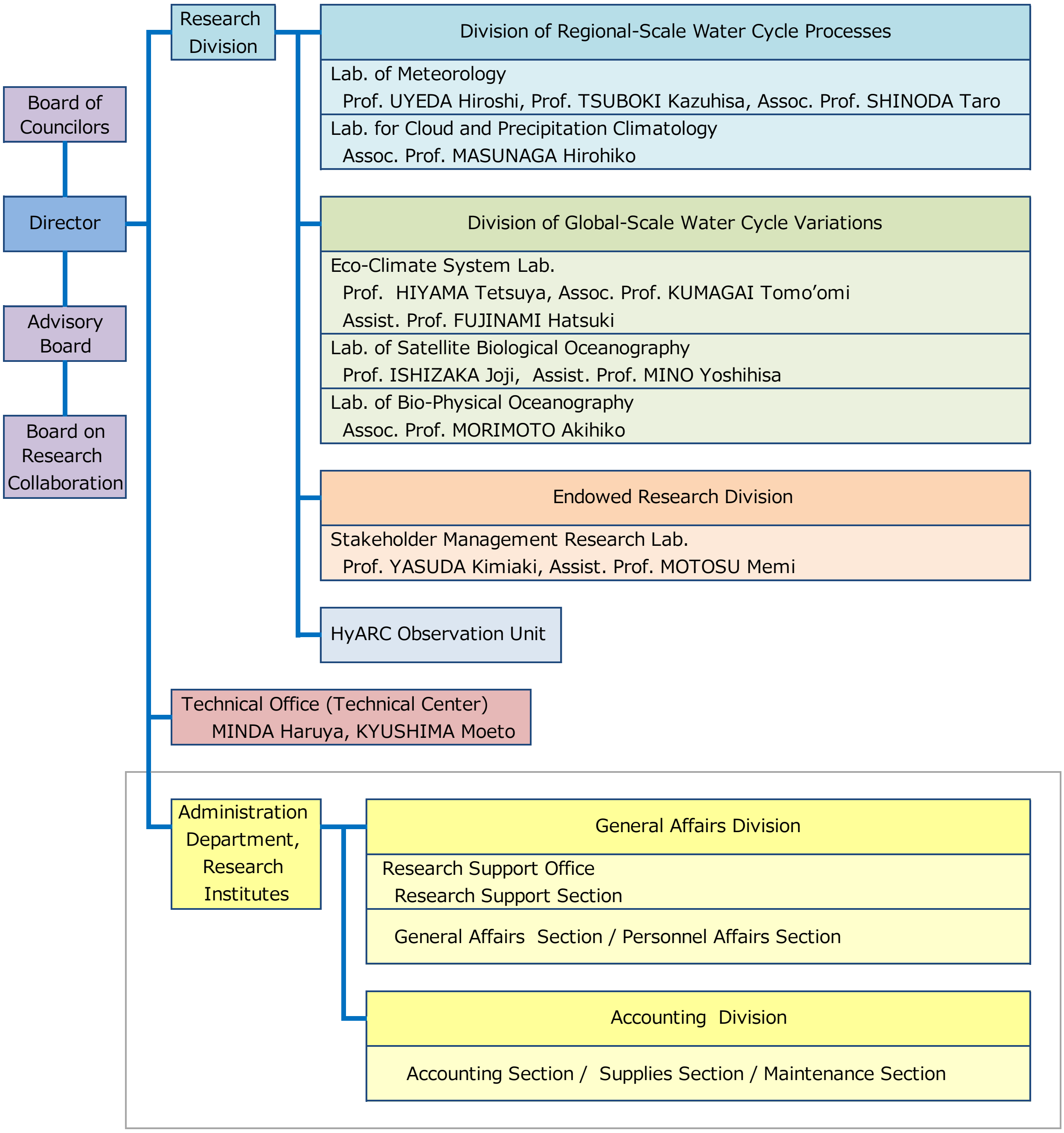

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Satellite Data Simulators and their application to numerical model evaluation

A satellite simulator is a computer program that reproduces satellite-observed radiances or radar echoes by applying radiative transfer computations to temperature and humidity profiles and cloud and precipitation fields generated by numerical models such as cloud-resolving modes and general circulation models. We develop and distribute the Satellite Data Simulator Unit (SDSU) at HyARC and, as an effort for its applications, conduct an evaluation study of the cloud microphysical schemes for CReSS. This research program is aimed at strengthening the link between the satellite simulator developers and existing and new users across the country. In this year, we continued to collaborate with the Joint-Simulator developer team lead by Prof. Masaki Satoh at AORI of University of Tokyo and the JMA Meteorological Satellite Center team in charge of the data product for the next generation Geostationary Meteorological Satellites. A participation of Dr. Yousuke Sato from RIKEN with the expertise in LES simulations of stratocumulus clouds have added a new contribution to widen the applicability of satellite simulators.

A joint workshop on GSMaP and satellite simulators was held together with the GSMaP developer group on March 2nd and 3rd, 2015. Scientists specializing in broad areas of satellite meteorology participated in this workshop, leading to further reinforcement of our confidence that HyARC are and will be playing a pivotal role in the relevant research community in Japan.

Program for Risk Information on Climate Change (SOUSEI Program)

Development of coupled ocean-atmosphere non-hydrostatic model for typhoon research

The research project has been performed as a part of the SOUSEI program since 2011. The purposes in this year are simulation experiments of observed typhoons using the coupled atmosphere-wave-ocean non-hydrostatic model and their verification, estimation of the maximum typhoon intensity in the future climate by downscale experiments, performing the daily simulation using the coupled model, and a response analysis of the ocean to typhoons by comparing simulations and observations.

The development of the coupled model has almost finished. Using the coupled model, simulations of the atmosphere and ocean are performed three times a week at present. When a typhoon occurs, a special experiment is also performed. To examine the effect of coupling, we compared the simulation experiments using the coupled model and uncoupled model. In this study, we found that the Kuroshio warm current enhances the typhoon which moved along the current.

For coupling experiments of the future climate typhoons, we are developing a method to give data of water temperature of the ocean. At present, temperature difference is used to increase the ocean temperature. Further investigation and experiments are necessary for the estimation of the temperature.

Using a regional non-hydrostatic atmospheric model, simulations of historical typhoons were performed. A rapid intensification of the historical typhoon IDA was successfully simulated. In the downscale experiments of the future climate typhoons, the most intense super-typhoon attained a central pressure of 857 hPa and a wind speed of 88 m s^{-1}. The maximum intensity of the super-typhoon was little affected by uncertainties that arise from experimental settings. This study indicates that the most intense future super-typhoon could attain wind speeds of 85–90 m s^{-1} and minimum central pressures of 860 hPa.

Laboratory of Meteorology

Future increase of supertyphoon intensity associated with climate change

Super-typhoon is the most intense tropical cyclone category in the western North Pacific, corresponding to the uppermost part of hurricane category 4 and the category 5 on the Saffir-Simpson scale. Increases of tropical cyclone intensity with global warming have been demonstrated by historical data studies and theory. This raises great concern regarding future changes in typhoon intensity. In particular, future change in severe typhoon intensity in the western North Pacific is a serious problem in the countries of East Asia, because typhoon intensity change strongly affects human societies and alters disasters as well as water resources. Disaster prevention planning should take into consideration the likely intensities of the most intense storms in the future. The present study addressed the problem to what extent super-typhoons will become intense in the global warming climate of the late twenty-first century.

Very high-resolution downscale experiments using a cloud-resolving model without convective parameterizations were performed for the 30 most intense typhoons obtained from the 20-km-mesh global simulation of a warmer climate. Twelve super-typhoons occurred in the downscale experiments and the most intense super-typhoon attained a central pressure of 857 hPa and a wind speed of 88 m s^{-1}. The increase of typhoon intensity in the downscale experiments is more clearly apparent if the typhoons are arranged in order of strength. There is a significant difference of typhoon intensity between the present and future climates (Fig. 1). To increase the reliability of the projected maximum intensity of the most intense super-typhoon in the future climate and to estimate the range of uncertainty of the intensity, we also performed several sensitivity experiments of the most intense super-typhoon in the future climate. The results indicate that the maximum intensity of the super-typhoon was little affected by uncertainties that arise from experimental settings. As a result, the most intense future super-typhoon could attain wind speeds of 85–90 m s^{-1} and minimum central pressures of 860 hPa.

From the viewpoint of disaster prevention, the tracks and landfall points of super-typhoons are serious concerns. The 12 super-typhoons in the future climate track over most regions of the western North Pacific (Fig. 2). Nine super-typhoons turned to the north or to the northeast. Six super-typhoons maintained their intensity even north of 30 °N because of the higher SST in the future climate. These results suggest that mid-latitude regions of East Asia, including Japan, are highly susceptible to the effects of super-typhoons in the future.

Reference：

Tsuboki, K., M. K. Yoshioka, T. Shinoda, M. Kato, S. Kanada, and A. Kitoh (2015), Future increase of supertyphoon intensity associated with climate change, *Geophys. Res. Lett.*, **42** , 646–652, doi:10.1002/2014GL061793.

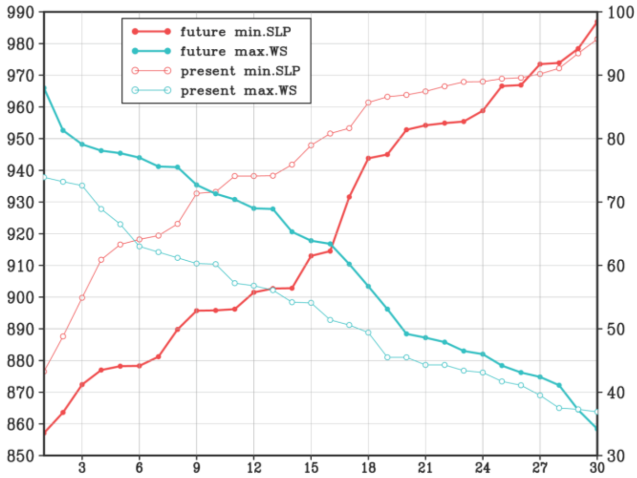

Fig. 1 : Intensity distributions of the 30 typhoons arranged in order of intensity obtained in the downscale experiments in the present climate (thin lines) and the future climate (thick lines). The red lines are minimum central sea level pressures (SLPs) and the blue lines are the lifetime-maximum wind speeds (WSs) of the typhoons.

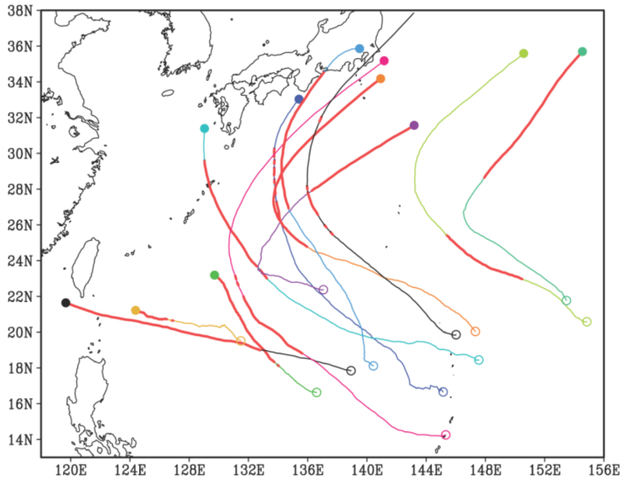

Fig. 2 : Tracks of super-typhoons identified in the downscale experiments in the future climate. The red, thick parts of the lines indicate periods when the maximum surface wind speed was greater than 66.9 m s^{-1} (130 knots), which is the threshold wind speed for a super-typhoon. Open and closed circles indicate the initial and final positions, respectively, of typhoons in the experiments.

Free-tropospheric moisture convergence and tropical convective regimes

This work searches for the key elements separating the dynamic and quiescent phases characterizing the tropical atmosphere. The analysis is performed with satellite measurements that are composited into statistical time series individually for the isolated cumulus and organized system regimes. Free-tropospheric (FT) moisture convergence, cloud-base (CB) moisture updraft, and FT precipitation efficiency (FTPE) are then derived under large-scale moisture budget constraints. Precipitation is fed primarily by FT moisture convergence while FTPE and CB moisture updraft amplify in tandem as organized systems develop (Figure 1a). In the isolated cumulus regime, FT moisture remains weakly diverging over time accompanying little change of FTPE (Figure 1b). Figure 2 presents a schematic summary illustrating the contrasting roles of FT moisture convergence between the two convective regimes. Figure 2a shows the organized system regime in its developing phase, where large-scale dynamics is explained by the first baroclinic mode. The tight coupling observed between FT moisture convergence and FTPE suggests a close collaboration between large-scale dynamics and moist convection. A thermodynamic consideration with moisture and moist static energy (MSE) convergences suggests that the organized system regime involves a self-sustaining growth of convection and large-scale updraft, giving rise to a dynamic phase. In the isolated cumulus regime (Figure 2b), the shallow mode is prevalent throughout and provides a weak but consistent FT moisture divergence. The isolated cumulus regime is speculated to be stably maintained without the ability to grow by itself, which presumably accounts for the longevity of a quiescent phase.

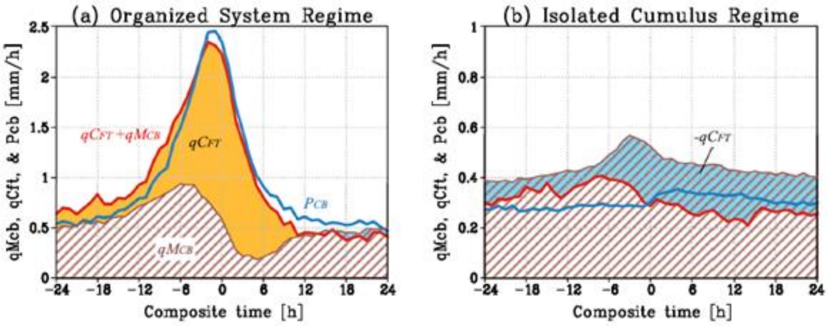

Fig. 1 : Composite time series of different moisture budget parameters (mm h^{-1}) for (a) the organized system regime and (b) the isolated cumulus regime.

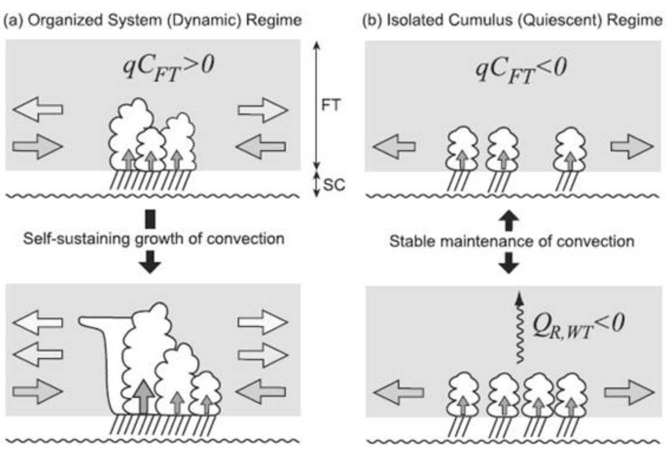

Fig. 2 : Schematic to illustrate the proposed hypothesis (see text). The free troposphere is designated by a light gray box. Horizontal arrows indicate large-scale mean moisture flow (shaded darker where more humid), and vertical arrows represent CB moisture updraft.

Reference: Masunaga, H. (2014), Free-tropospheric moisture convergence and tropical convective regimes, *Geophys. Res. Lett.*, **41**, 8611–8618, doi:10.1002/2014GL062301.

Early Evaluation of Ku- and Ka-Band Sensitivities for the Global Precipitation Measurement (GPM) Dual-Frequency Precipitation Radar (DPR)

The purpose of this study is to quantify the sensitivity of the Global Precipitation Measurement (GPM) mission core observatory Dual-frequency Precipitation Radar (DPR) with focus on the Ka-band detectability of light rain and snow in comparison with the Ku-band capability. The GPM mission core observatory was launched in February 2014. The DPR consists of two radars with the microwave frequencies of Ka band (35.55 GHz) and Ku band (13.6 GHz). A Ku-band radar has been demonstrated by the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) to be suitable for measuring moderate to heavy rains typical of the tropical and mid-latitude regions, while a Ka-band radar is expected to extend its ability to capture weak rain and snow in higher latitudes as well. In this work, storm top height (STH) is utilized exclusively as the metric of radar sensitivity. The GPM DPR standard product level 2 version 3 is used in this analysis for the period from April to August 2014. The Ka high sensitivity (HS) mode and Ku have little systematic difference in STH over a broad range of the histogram, implying that the advantage of the Ka HS mode may not be as distinct as expected. Figure 3 shows the STH histogram for three different meridional zones with oceans and lands separated. The Ka MS histogram exhibits a notable difference from the other two, where the Ka MS mode tends to miss high echo tops (4−7 km for Figs 3a, d, 7−12 km for Figs. 3b, e, 4.5−7 km for Figs. 3c, f) and is as a result biased toward low echo tops. On the other hand, the Ka HS and Ku histograms stay closely together, implying that the sensitivity advantage of the Ka HS mode may not be as distinct as expected. A closer inspection, however, reveals that the Ka HS better captures shallowest echo tops below 1.5 km than the Ku as highlighted by green and red shades in Fig. 3. Such precipitation with low STHs typically produces light rain with small raindrops and drizzles or light snow with fluffy snowflakes, which are generally difficult to capture at low microwave frequencies. Overall, the histograms suggest faint hints of the Ka superiority to the Ku in terms of sensitivity, although the differences are minor. The non-Rayleigh scattering effect may have partly offset the sensitivity advantage of the Ka HS over the Ku.

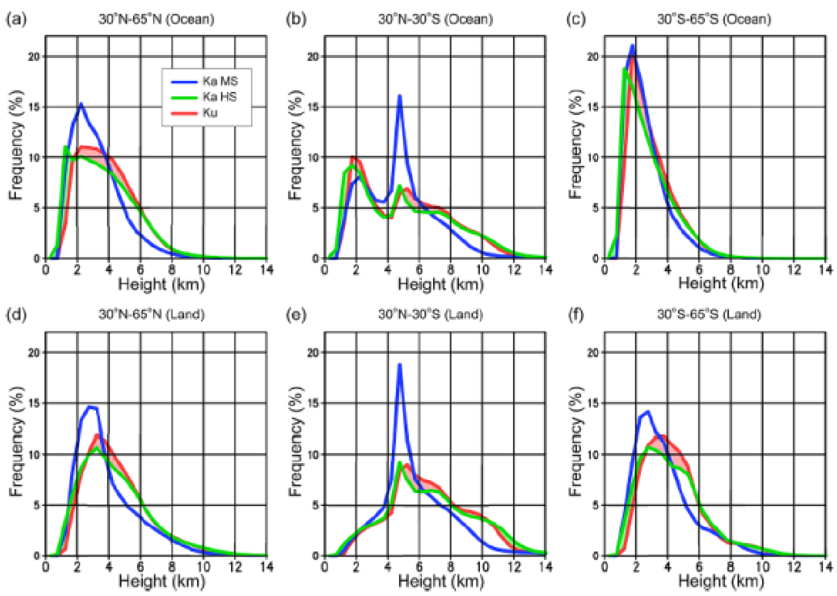

Fig. 3 : The STH histogram for Ku, Ka MS, and Ka HS for (a) 30°N−65°N ocean, (b) 30°S−30°N ocean, (c) 30°S−65°S ocean, (d) 30°N−65°N land, (e) 30°S−30°N land, and (f) 30°S−65°S land. For visual clarity, the difference between Ku and Ka HS is shaded in red where Ku exceeds Ka HS and in green otherwise.

Reference: Toyoshima, K., H. Masunaga, and F. A. Furuzawa, 2015: Early evaluation of Ku- and Ka-band sensitivities for the Global Precipitation Measurement (GPM) Dual-frequency Precipitation Radar (DPR), *SOLA*, **11**, 14-17, DOI:10.2151/sola.2015-004.

Eco-Climate System Laboratory

Trend and interannual variability of summer precipitation and the atmospheric moisture flux convergence in the Arctic circumpolar region, with an emphasis on recent increase of those around the Lena river basin in eastern Siberia

We investigated trend and interannual variability of summer (June, July and August) precipitation and the atmospheric moisture flux convergence in the Arctic circumpolar region, with an emphasis on recent increase of those around the Lena river basin in eastern Siberia. Data used in this study are an archived precipitation data (PREC/L) and two atmospheric re-analysis data (JRA-25/JCDAS, JRA-55). Previous studies have revealed a negative correlation in the summer atmospheric circulation pattern between the Lena and Ob river basins. However little is known about the atmospheric water cycles in the Arctic circumpolar region, including the Mackenzie basin. Hence we compared the trend and interannual variability of summer atmospheric water cycles in three large North Eurasian river (Lena, Yenisei, and Ob) basins together with the Mackenzie basin.

The analyzed results showed that significant increases (positive trend) in the summer precipitation were detected from 1984 to 2012 in the Lena, Yenisei, and the Mackenzie basins. However, summer precipitation showed significant decreases (negative trend) over Mongolia and Europe/Russia. This was because anticyclones dominated in these regions. The most significant enhancement of cyclonic circulation was detected from 2005 to 2008 on the Eurasian side of the Arctic Ocean. However, anticyclones appeared over Mongolia. These atmospheric circulation patterns increased moisture convergence over the Lena river basin in this period (Fig. 1). This study also showed a significant positive correlation in the summer precipitation appeared from around 1995 to 2005 between the Lena and Yenisei river basins. On the contrary, the negative correlation between the Lena and Ob river basins became unclear from 1993.

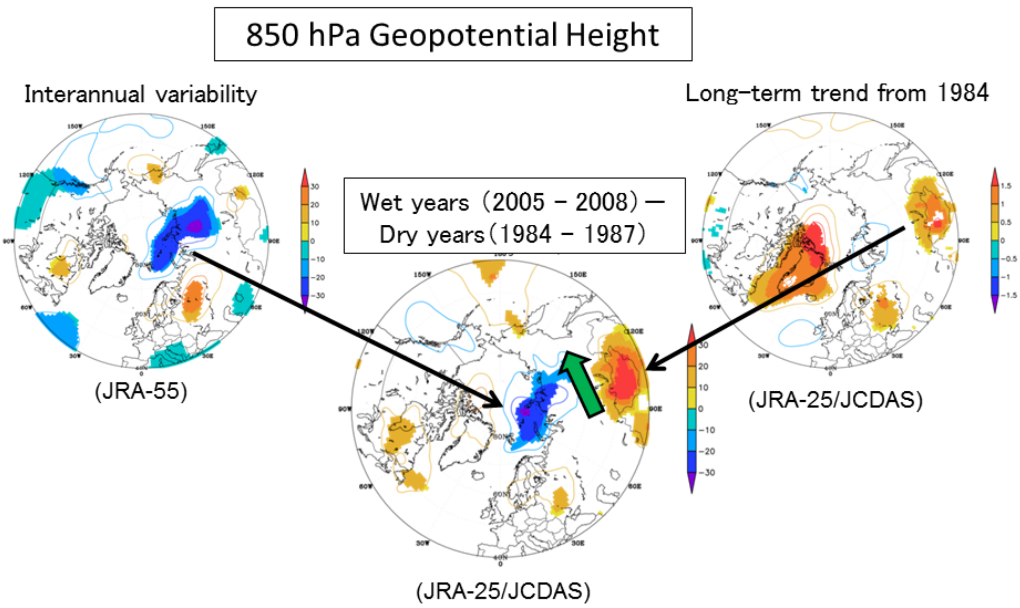

Fig1.

Changes in water environments and social adaptation under global warming at permafrost region in eastern Siberia

Meteorological data revealed high rates of summer precipitation in the upper and middle parts of the Lena river Basin from 2005 to 2008. Summer river flooding around Yakutsk, capital city of the Sakha Republic of the Russian Federation, has become a problem, severely damaging local agriculture and pastoralism. On the contrary, the spring thaw along the Lena river typically causes river ice flooding, which can be severe when low winter temperatures are followed by gradually increasing spring temperatures. Such spring floods have caused severe damages to local residents living along the river in almost every year since 1998.

We investigated local people's perceptions and local governmental adaptation strategies for both spring- and summer-river flooding. Interestingly, spring flooding has been recognized as beneficial except when it causes damages to villages along the river. This is because spring floods bring nutrient-rich water to the river islands on which the farmers cultivate pastures for cattle and horses. Summer river flooding, on the contrary is seen as a hazard, because it submerges the pasture completely in summer, and prevents getting of hay for cattle and horses.

Village relocations were adopted as one of the adaptation strategies to prevent damages from spring floods. Because local people prefer to live along the river on which their subsistence depends, they agreed, with government support, to migrate seasonally. There have been no similar adaptations to summer flooding, however. Based on our observations and analysis, we intend to promote sustainable subsistence activities in the region by proposing strategies to facilitate information transmission and improvement of feed-hay distribution networks that can aid in adaptation to spring and summer river flooding (Fig. 2).

Above-mentioned outcomes were from the research project (C-07) of the Research Institute for Humanity and Nature (RIHN), entitled "Global Warming and the Human-Nature Dimension in Siberia: Social Adaptation to the Changes of the Terrestrial Ecosystem, with an Emphasis on Water Environments".

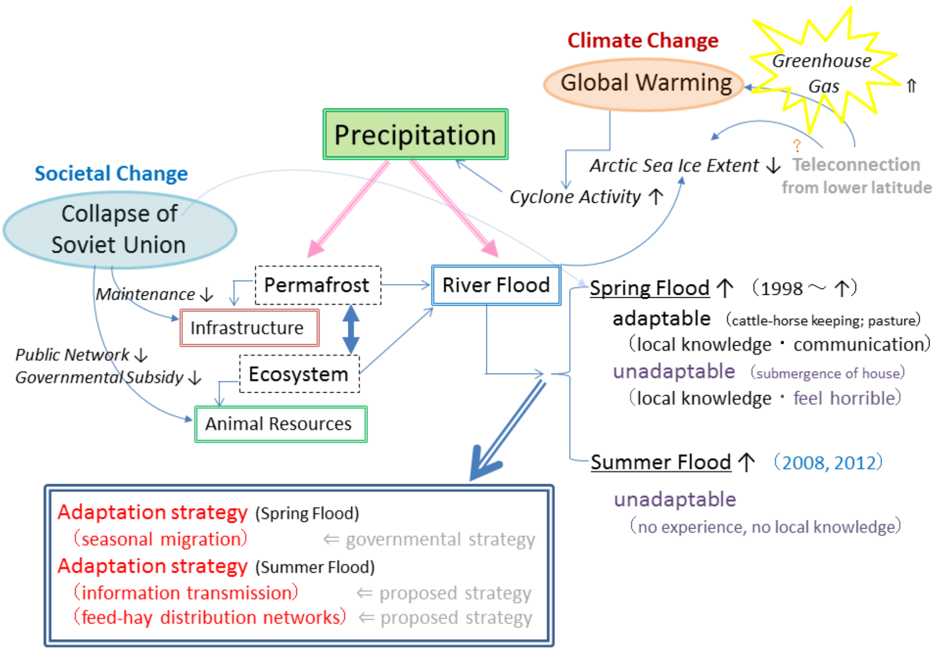

Fig 2

Characteristics of low pressure systems observed in the active phase of intraseasonal oscillation over Bangladesh

Bangladesh is the predominant area of submonthly-scale (7–25 days) intraseasonal oscillation (ISO) in the Asian monsoon regions (Fig. 3). The ISO activity can control the interannual variability of the total summer monsoon rainfall. High-amplitude active peaks of the ISO occur more frequently during wet monsoon years than during dry monsoon years. Therefore, it is important to study which processes enhance the amplitude of the active peaks. In this study, the relationship between the low pressure system (LPS) activity and the submonthly-scale ISO of rainfall over Bangladesh during the summer monsoon season (June–September) has been investigated using APHRODITE and TRMM 3B42 rainfall, and JRA-25 reanalysis data. By detecting and tracking the LPSs formed over the Indian monsoon region over a period of 29 years (1979–2007), we found that about 60 % of active peaks are related to the LPSs (Fig.4).

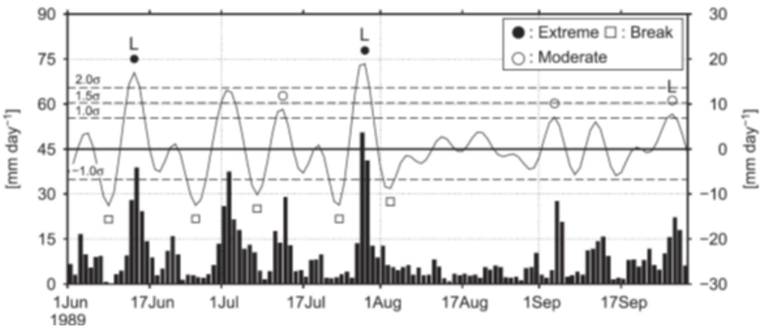

Fig3 : Time series of area-averaged rainfall in APHRODITE dataset (black bars; left axis) and 7–25-day-filtered rainfall anomaly (solid line; right axis) from 1 Jun to 30 Sep 1989. Circles denote active peaks of the ISO. The "L" indicates the active peaks associated with LPS events. Black squares denote break peaks.

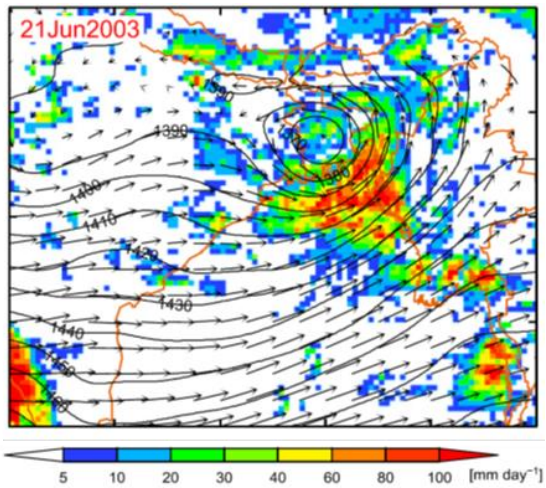

Fig4: LPS associated with an active peak of the ISO based on TRMM 3B42 rainfall (shading), 850-hPa geopotential height (contour), and wind vectors on 21 Jun 2003.

In the active peak, the locations of LPS centers are clustered significantly over and around Bangladesh. These LPSs are formed mainly over the head of the Bay of Bengal and around Bangladesh, and they tend to remain almost stationary throughout the lifetime (Fig.5). The composite structures of the LPSs indicate that the horizontal scale of the systems is about 600 km. Moreover, as an important characteristic, the maximum moisture convergence occurs on the southeast side of the LPSs. This is likely caused by interaction between the topography to the north and east of Bangladesh and the prevailing southwesterly winds from the LPSs. This result also indicates that these LPSs have significantly different structures from the so-called monsoon depressions over India. The vertical structures of the LPSs over Bangladesh show that the associated cyclonic circulation extends up to about 9km (~300 hPa) (Fig.6). The temperature fields are characterized by a well-defined cold core in the lower troposphere and a warm core in the upper levels. These vertical fields are similar to those of monsoon depressions. The most remarkable contrast is found in the field of horizontal wind divergence. In the active peak, the LPS has stronger convergence, particularly on the east side in the lower troposphere, whereas the monsoon depressions show a maximum on the west side. This contrast seems to be responsible for the difference in the propagation characteristics compared with the monsoon depression. The submonthly-scale ISO of rainfall over Bangladesh is dominated by the north–south shift of the monsoon trough; however, this study reveals the important role that the LPSs have in enhancing the amplitude of the active peaks. Furthermore, among the extreme active peaks, heavy rainfall over the lowland area of Bangladesh is more likely in the presence of an LPS than in its absence. Therefore, the prediction of the genesis and tracks of the LPSs is a crucial aspect in the prediction of seasonal rainfall over Bangladesh, and it is an important challenge for future research.

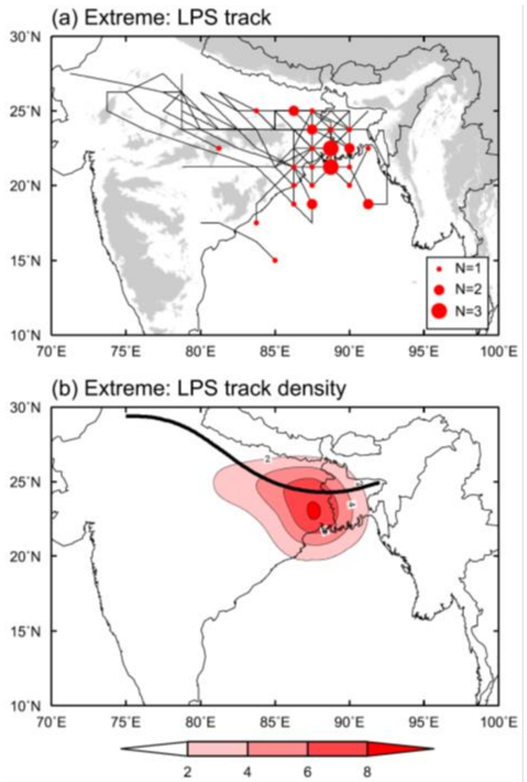

Fig5 : (a)Distributions of genesis points (red circles) and tracks (solid lines) of LPSs identified in active phase of ISO during June–September (JJAS) for the period 1979–2007. The size of red circles denotes the number of geneses in each grid point.(b) Distribution of the frequency of the LPS tracks for the active peak.

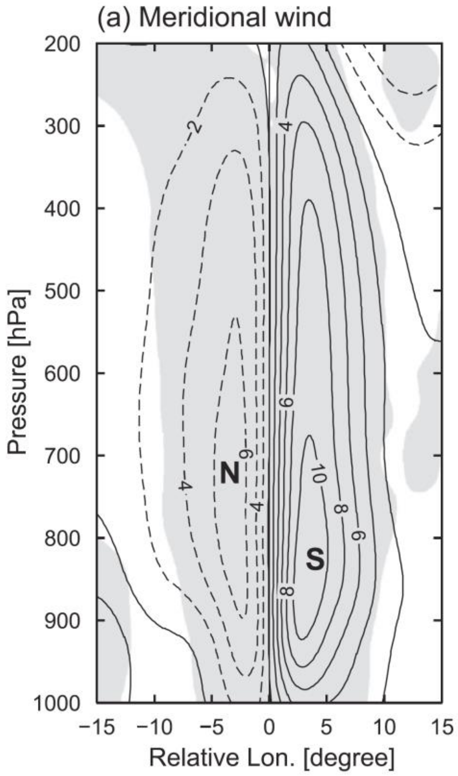

Fig6 : Composite vertical cross sections in meridional wind component for the active peak along the longitude of the LPS center.

Reference:

Hatsuzuka, D, T. Yasunari and H. Fujinami, 2014: Characteristics of low pressure systems associated with intraseasonal oscillation of rainfall over Bangladesh during boreal summer, *Mon. Wea. Rev.*, **142**, 4758-4774, DOI: 10.1175/MWR-D-13-00307.1.

Laboratory of Satellite Biological Oceanography

Influence of mesoscale eddies on spring phytoplankton bloom in the Japan Sea

Mesoscale eddies are ubiquitous features of the ocean, and play important roles in the variability of physical, chemical, and biological properties of the sea. There are many mechanisms by which mesoscale eddies influence the variability of phytoplankton; for example, vertical fluxes of nutrients through isopycnal displacement during eddy intensification, eddy decay, advection of coastal waters trapped in the eddies and transported away from the formation areas, and on the light availability through modulation of mixed layer depth.

The Japan Sea, a temperate sea with large seasonal phytoplankton variability, is known to be an eddy-rich area. Although the seasonal cycle of phytoplankton blooms in the Japan Sea is well documented by studies using ocean colour satellite data, little is known about the influence of mesoscale eddies on spring phytoplankton bloom. Therefore, the present study, based on satellite data, aimed at understanding the influence of mesoscale eddies on spatial and temporal variability of phytoplankton in Japan Sea. More specifically, the timing and magnitude of spring bloom inside and outside of anticyclonic eddies was investigated during spring of 2003 and 2004.

Sea level anomaly (SLA) data was used to obtain the information of mesoscale eddy field and to define the centre (C), outer ring (R), and outside (O) of an eddy. The temporal variation of chlorophyll a concentration (CHL) in the C, R, and O of eddies during spring was investigated using Gaussian function. Sea surface temperature (SST) temporal variation during spring time was also investigated. Moreover, *in situ* data was used to estimate the mixed layer depth in the vicinity of eddies based on a density threshold $\Delta\sigma_\theta$ threshold calculated from a fixed temperature threshold (ΔT = 0.2 ºC).

In 2003, two anticyclonic eddies were identified around the Yamato Basin (**Y03**, 134º E, 38 ºN) in the west coast of Japan and Ulleung Basin (**U03**, 131 ºE, 38.3 ºN) in the east coast of Korean peninsula during spring. In 2004, three anticyclonic eddies were identified, around Yamato Basin (**Y04**, 135.5 ºE, 37 ºN), Ulleung Basin (**U04**, 131 ºE, 38 ºN), and off Peter the Great Bay (**B04**, 131 ºE, 41 ºN) throughout the spring. Sea surface temperature (SST) was relatively higher in the centres during winter (January-February), the difference decreased with warming, and the outside became warmer than the centres in summer. Large SST difference between the centre and the outside was observed in **B04** that moved from near Ulleung Basin to a colder region around 41ºN in January.

High CHL (> 0.5 mg m^{-3}) appeared first in the outside in early March, then in the outer rings in mid and late March, and finally in the centres in late March and April (Fig. 1). The initiation of spring bloom was later in the centre of eddies than in the outside except in **B04**. *In situ* data showed deeper mixed layer in the centres than in the outside of eddies. CHL started to increase from outside, in the regions of shallower mixed layer, suggesting that late spring bloom initiation was caused by the deeper mixed layer in the centres through influence on light availability. However, the earlier initiation of spring bloom in the centre of **B04** suggested the northward movement of this eddy set early stratification. The magnitudes of CHL peaks were similar between the centre and the outside of **Y03**, **Y04**, and **U03**, while in **B04** and **U04** the peaks were much higher than the outside and the centres of all other eddies. The large peaks in the centres of **B04** and **U04** were suggested to be associated with entrainment of coastal water that is high nutrients levels. CHL peak in **Y04** was lower than the centres of other eddies because it was influenced by the Tsushima Current.

These results indicated that the spatial and temporal variability of spring bloom is largely influenced by the presence of mesoscale eddies in the Japan Sea. In general, the centre of anticyclonic eddies seemed to support high phytoplankton blooms comparable to the outside waters in spring. The timing of the spring bloom was generally later in the centres than outside of eddies due to deeper mixed layer depth within them. However, large variability of spring bloom magnitude and timing associated with eddies might be influenced by Tsushima Current and other physical processes related to the eddy activity.

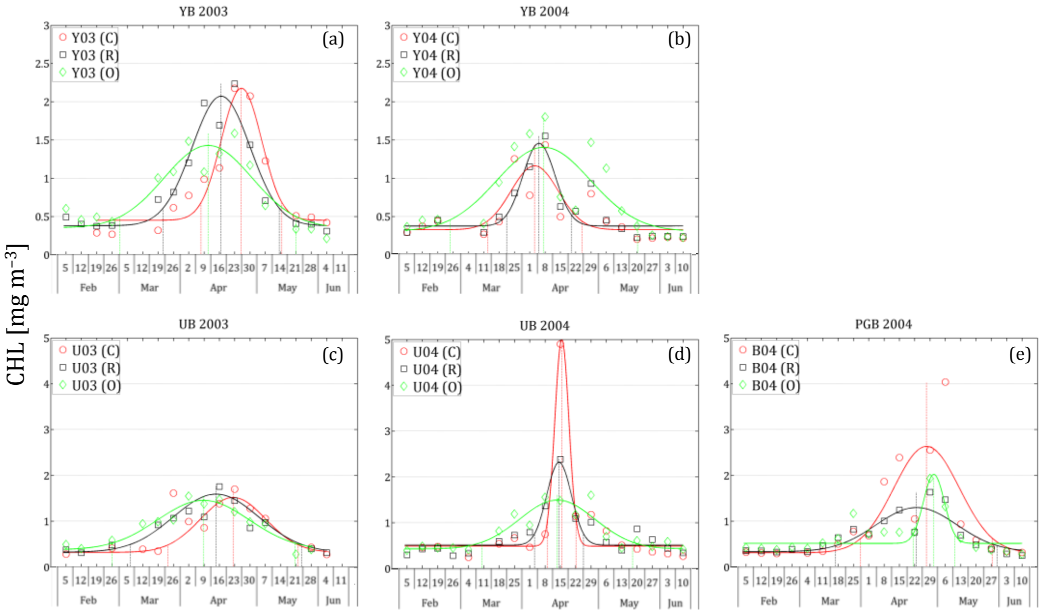

Fig1 : Time series of weekly (7-day) composites of satellite derived chlorophyll a concentration (CHL) in the centre (C), outer ring (R) and outside (O) of the eddies. The letters (Y, U and B) and numbers (03 and 04) indicate eddies in Yamato Basin (YB), Ulleung Basin (UB) and Peter the Great Bay (PGB) and 2003 and 2004, respectively. Dashed lines indicate the standard deviation for each times series.

Phytoplankton Distribution in Tsushima Strait and the East China Sea during Summer in 2011 and 2012 derived by Pigments Analysis

Phytoplankton as a major primary production in marine ecosystem can respond fast to the variations of physical and chemical properties in both coastal and open ocean waters. The East China Sea (ECS) is strongly influenced by the Changjiang Diluted Water (CDW) in the eastern side and Kuroshio water (KW) in the west. Water in Tsushima Strait is originated from the ECS water and a branch of Kuroshio. Influenced by the different water masses, phytoplankton compositions should be highly variable in these two areas. Few studies have investigated phytoplankton in these areas, and information on spatial variations of phytoplankton compositions is still limited. In this study, different water masses were recognized by temperature, salinity and nutrient distributions. Phytoplankton pigment samples at surface and subsurface chlorophyll maxima (SCM) were collected during Nagasaki-maru cruises in summer season, and they were measured by High Performance Liquid Chlomatogaphy (HPLC). Chlorophyll a concentration (Chl a) of each sample was proportioned into nine phytoplankton groups based on pigment analysis using CHEMTAX program.

Spatial variations on phytoplankton communities during summer from west of Kyushu to southwest of Jeju Island in 2011 and to the Tsushima Strait (TS) in 2012 were compared (Fig. 2). In 2011, KW was observed at the west of Kyushu and low salinity water of CDW was identified in the western ECS. In 2012, high temperature and high salinity KW was observed at the west of Kyushu, and temperature was lower and salinity was also slightly lower in the TS; however CDW was not observed. N:P ratios in 2012 were lower than the Redfield ratio (<16) in most areas; whereas abnormal N:P ratios (>100) was observed in the CDW region in 2011 reflected the oversupply of nutrients, especially nitrogen from Changjiang discharge. Chl a was low (~0.25 m m^{-3}) in Kuroshio water, higher in TS, and very high (>2 mg m^{-3}) in CDW.

Phytoplankton composition was also different in KW, TS and CDW. Phytoplankton was mainly composed by prymnesiophytes and cyanobacteria in the KW and prochlorophyte at the west of Kyushu were influence of KW was high. Diatom was high in the coastal region of Japan in TS. Diatom and cryptophyte were high in CDW region. As a result of vertical stratification in summer, nutrients were depleted at surface layers except CDW region. SCM was observed at all stations except KW. Patchy distribution of different groups in SCM was found in CDW; whereas the SCM phytoplankton was similar to surface water in TS.

In conclusion, significant differences of phytoplankton community distribution in the ECS and TS were shown, and the distribution patterns were highly related to the different water masses. High N:P ratio in the western ECS indicating over loading of nitrogen from Changjiang River may be one of the causes in large difference of phytoplankton compositions between ECS and TS.

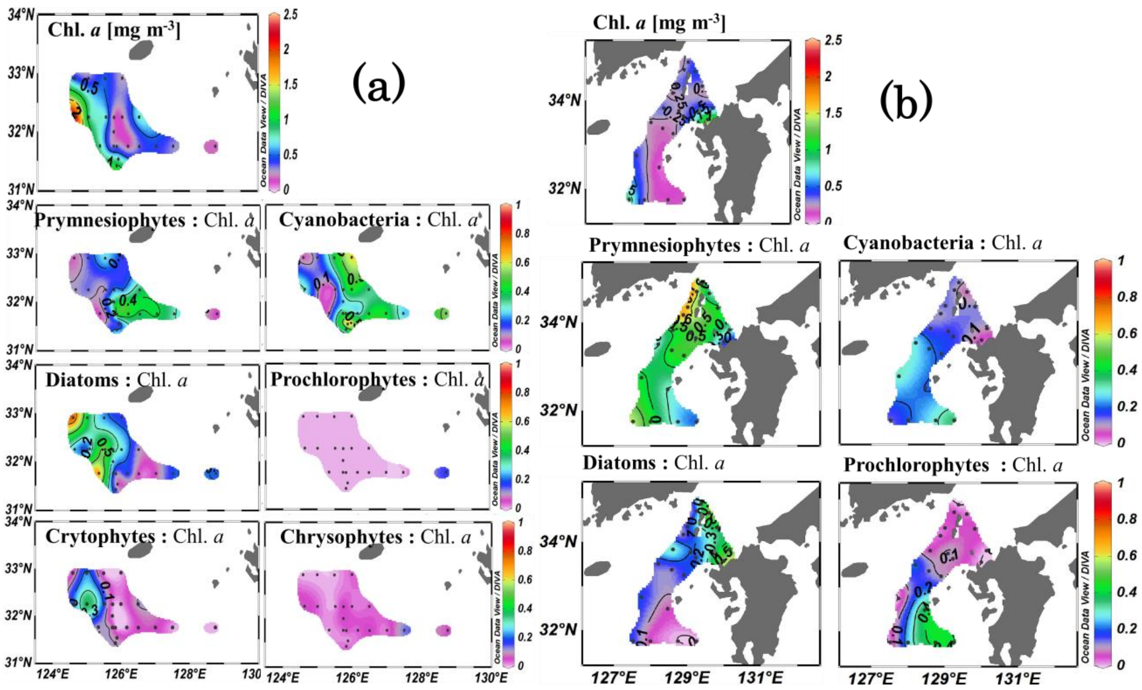

Fig2 : Surface distributions of Chl. a concentration (mg m^{-3}) and major phytoplankton groups in 2011 (a) and 2012 (b). Phytoplankton groups less than 10% of Chl. *a* are not shown. Black dots are sampling stations.

Laboratory of Bio-Physical Oceanography

Observation of the Tsushima Warm Current using Long Range Ocean Radar

The Tsushima Warm Current (TWC) flows into the Japan Sea through the Tsushima Straits (TS), and it is suggested that the TWC separates a few branches after through the TS. However it is difficult to figure out paths of the TWC from observed data because spatial variation in the TWC is large and tidal currents are dominate in the area where the TWC might separate. In addition, since EEZ between Japan to Korea exists around separation area of the TWC, we cannot conduct systematic observation there. Therefore, we have planned observation of the variation in the TWC paths using Long Range Ocean Radar (LROR) which observes sea surface currents with high spatial-temporal resolution. Transmitting frequency of the LROR is 9.2 MHz, and we can observe radial current velocity in the area of 200 km from a radar site every 30 minutes. We deployed the LROR at 2 station, Tsushima and Aishima Islands, to obtain current vectors. LROR observation is carried out from June 11 to September 8 in 2014, and hydrographic and mooring observations were conducted in June and July in 2014 for validation of the LROR.

Figure 1 denotes a mean current during the LROR observation period. Observed area of the LROR covers 1st and 2nd branch of the TWC which flow along 100 m isobaths and shelf break, respectively. However we cannot recognize both branches in Fig. 1 because wind-driven and tidal currents have not been removed the LROR data yet. Figure 2 shows comparison between current velocities 10-m below sea surface observed by moored ADCP and radial velocities of the LROR in Tsushima. Correlation coefficient and RMS at St. TRBM1 that is located head on Tsushima radar are 0.59 and 16.7 cm/s, respectively. On the other hand, correlation coefficient and RMS at St. CROM1 that is located side of Tsushima radar are smaller and lager than those at St. TRBM1, respectively. It is concluded that the LROR has an enough accuracy around head of the radar but the accuracy is decreased side area of the radar. This is because there might be any problems data processing of the LROR, spatially digital beam forming. We will develop a new data processing system based on antenna pattern and current velocity data.

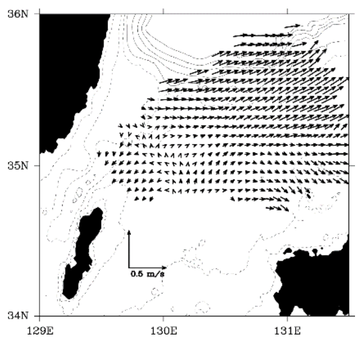

Fig. 1 : Mean sea surface current from June 11 to September 8.

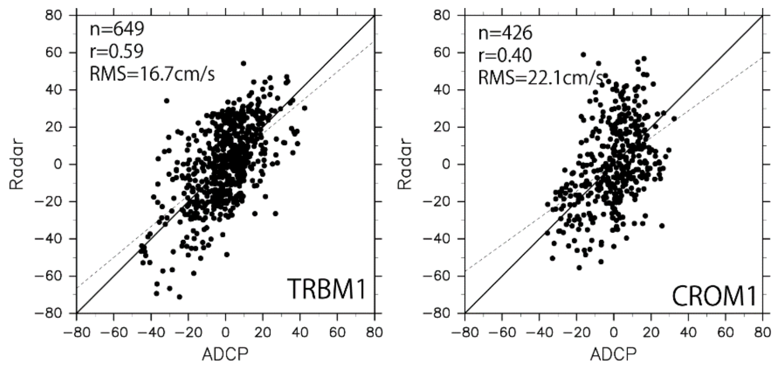

Fig.2 : comparison between current velocities 10-m below sea surface observed by moored ADCP and radial velocities of the LROR in Tsushima.

Endowed Research Division

Stakeholder Management Research Laboratory

In the years since the Great East Japan Earthquake, we have seen a greater push to expand the use of renewable energy sources in Japan, with a particular focus on abundant offshore wind resources. Setting up offshore facilities requires the approval of those working in the fishing industry. However, it is difficult to reach consensus with fishermen, because the impact that constructing offshore wind farms has on fisheries includes uncertainty. Not only is cooperation from the fishing industry absolutely essential to the success of these projects, the rapidly expanding scale of offshore wind farm initiatives means that project involvement now goes beyond fishermen to include port and harbor facility stakeholders, regional tourism associations, and a wide variety of other players. Region-wide cooperation is needed to move forward. In coastal areas, there are regional issues such as population decline and the aging of local fishermen. The revitalization of fishing communities is an important issue to sustain regional communities. Under these circumstances, this study aims to promote and suggest offshore wind projects as not only the purposes of supplying power but also means of resolving issues among regional and fishing communities.

In this study, we participated in the early stages of domestic offshore wind projects and primarily conducted fieldwork involving consensus building among regional stakeholders. In 2014, we supported the creation of a promotion committee and study groups composed of local stakeholders for an offshore wind project, as well as conducted classes at elementary schools regarding the offshore wind projects and lectures for local residents. In relation to selecting wind developers from the public for the offshore wind projects off the coast of Iwafune in Murakami city, Niigata Prefecture, we provided advice regarding the establishment of a business evaluation committee and the evaluation methods to be used. Additionally, in regards to the creation of regional benefits, we investigated initiatives in regional revitalization and benefit restoration methods used in Europe, as well as discussed the implementation of community funds in Japan with local stakeholders. To enable the implementation of these methods in the future, we plan on continuing these discussions with both local stakeholders and wind developers.

In Research and Development of Wind and Renewable Energy Technology - Research and Development of Offshore Wind Power Technology - Basic Research For Local Co-Existence with Offshore Wind Farms (FY2013-2014), a NEDO funded research program, we conducted hearing surveys to fishermen, local governments, and port and harbor facility stakeholders. As methods for offshore wind farms to co-exist with local communities, business cooperation with fishermen in terms of ocean surveys and maintenance and inspection works as well as conservation of fishery resources using offshore wind farms were derived and reported in the final report.

The study results were presented in Grand Renewable Energy 2014 (GRE2014) international conference and Journal of Wind Energy, the academic journal of Japan Wind Energy Association. In addition, we spoke on rules for marine utilization such as fishing rights and science communication under uncertainty in the stakeholder management workshop in Svolvaer, Norway, Norway-Japan Marine Seminar 2014, Norway-Japan round table meeting on communicating science hosted by the Norwegian Embassy.

In terms of university educational initiatives, we ran Environmental Innovation as part of the Education for Sustainable Development (ESD) Program managed by the five graduate schools of environmental studies. Visiting researchers and others in our endowed research division offered lectures on energy-centered initiatives in the private sector.

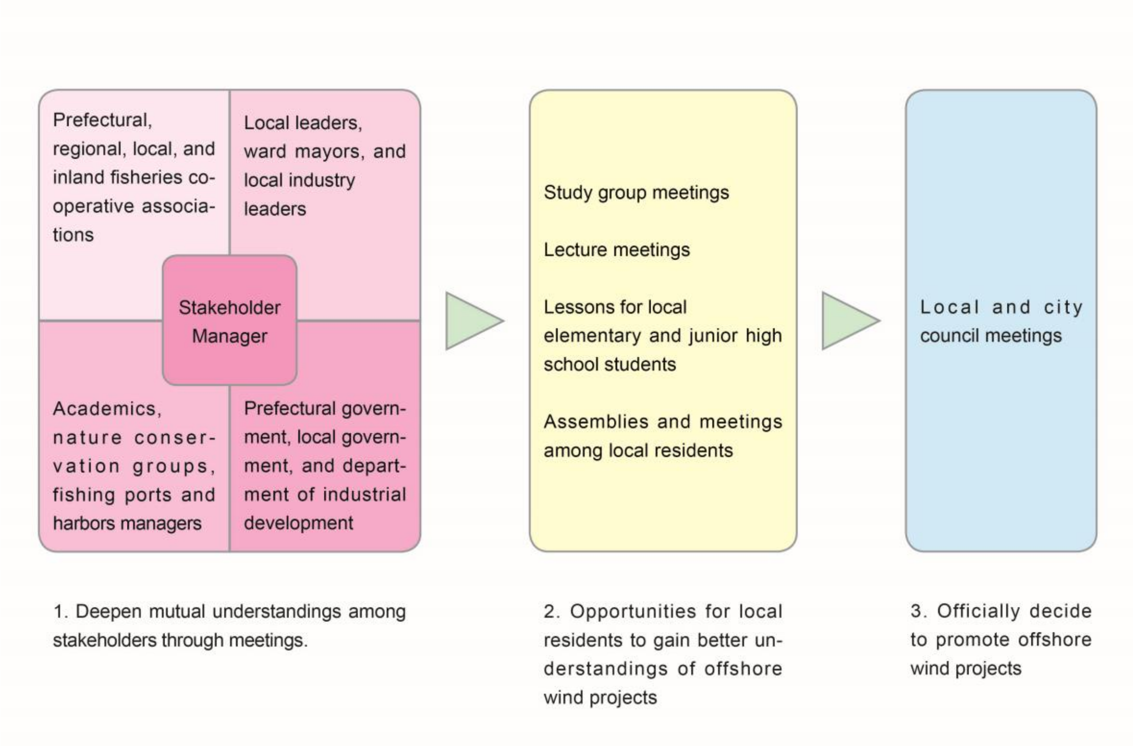

Fig. 1 : Procedure of consensus building for full scale offshore wind farms in general sea areas

Fig.2 : Presentation for local residents

Fig. 3 : Workshop at a local elementary school

List of Publications

*:Staffs, students and research fellows in the HyARC.

April, 2014～March, 2015

№	Author	Title	Journal	Volume	Page doi	Date
1	Fedorov, A. N., P. P. Gavriliev, P. Y. Konstantinov, T. Hiyama, Y. Iijima and G. Iwahana	Estimating the water balance of a thermokarst lake in the middle of the Lena River basin, eastern Siberia.	Ecohydrology	7	188-196 doi: 0.1002/eco.1378	2014/4/1
2	Komatsu, T., S. Mizuno, A. Natheer, A. Kantachumpoo, K. Tanaka, A. Morimoto, ST. Hsiao, EA. Rothausler, H. Shishidou, M. Aoki, T. Ajisaka	Unusual distribution of floating seaweeds in the East China Sea in the early spring of 2012.	Journal of Applied Phycology	26(2)	1169-1179 doi: 10.1007/s10811-013-0152-y	2014/4/1
3	Terauchi, G., R. Tsujimoto, J. Ishizaka, H. Nakata	Preliminary assessment of eutrophication by remotely sensed chlorophyll-a in Toyama Bay, the Sea of Japan.	Journal of Oceanography	70(2)	175-184 doi: 10.1007/s10872-014-0222-z	2014/4/1
4	Wang, S. Q., J. Ishizaka, H. Yamaguchi, S. C. Tripathy, M. Hayashi, Y. J. Xu, Y. Mino, T. Matsuno, Y. Watanabe and S. J. Yoo	Influence of the Changjiang River on the light absorption properties of phytoplankton from the East China Sea.	Biogeosciences	11(7)	1759-1773 doi:10.5194/bg-11-1759-2014	2014/4/3
5	Fujiki, T., K. Matsumoto, Y. Mino, K. Sasaoka, M. Wakita, H. Kawakami, MC. Honda, S. Watanabe, T. Saino	Seasonal cycle of phytoplankton community structure and photophysiological state in the western subarctic gyre of the North Pacific.	Limnology and Oceanography	59(3)	887-900 doi: 10.4319/lo.2014.59.3.0887	2014/5/1
6	Kanada, S., H. Tsuguti, T. Kato, F. Fujibe	Diurnal Variation of Precipitation around Western Japan during the Warm Season.	SOLA	10	72-77 doi: 10.2151/sola.2014-015	2014/5/14
7	Chen, J., T. Cui, J. Ishizaka, C. Lin	A neural network model for remote sensing of diffuse attenuation coefficient in global oceanic and coastal waters: Exemplifying the applicability of the model to the coastal regions in Eastern China Seas.	Remote Sensing of Environment	148	168-117 doi:10.1016/j.rse.2014.02.019	2014/5/25
8	Katayama, A., T. Kume, H. Komatsu, M. Ohashi, K. Matsumoto, R. Ichihashi, T. Kumagai and K. Otsuki	Vertical variations in wood CO2 efflux for live emergent trees in a Bornean tropical rainforest.	Tree Physiology	34(5)	503-512 doi: 10.1093/treephys/tpu041	2014/5/29

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9	Hiyama, T., T. Suzuki, M. Hanamura, H. Mizuochi, J. R. Kambatuku, J. N. Niipele, Y. Fujioka, T. Ohta and M. Iijima	Evaluation of surface water dynamics for water-food security in seasonal wetlands, north-central Namibia.	IAHS Publication	364	380-385	2014/6/1
10	Fedorov, A.N., R.N. Ivanova, H. Park, T. Hiyama and Y. Iijima	Recent air temperature changes in the permafrost landscapes of northeastern Eurasia.	Polar Science	8	114-128 doi: 10.1016/j.polar.2014.02.001	2014/6/1
11	Kubota Y., T. Hirao, S. Fujii, T. Shiono, B. Kusumoto	Beta diversity of woody plants in the Japanese ar-chipelago: the roles of geohis-torical and eco-logical processes.	Journal of Biogeography	41(7)	1267–1276 doi: 10.1111/jbi.12290	2014/7/1
12	Mei, K., LL. Liao, YL. Zhu, P. Lu, ZF Wang, RA. Dahlgren, MH. Zhang	Evaluation of spatial-temporal variations and trends in surface water quality across a rural-suburban-urban interface.	Environmental Science and Pollution Research	21(13)	8036-8051 doi: 10.1007/s11356-014-2716-z	2014/7/1
13	Miyazawa, Y., M. Tateishi, H. Komatsu, V. Ma, T. Kajisa, H. Sokh, N. Mizoue and T. Kumagai	Tropical tree water use under seasonal waterlogging and drought in central Cambodia.	Journal of Hydrology	515	81-89 doi: 10.1016/j.jhydrol.2014.04.049	2014/7/16
14	Kawai, Y., H. Tomita, MF. Cronin, F. Meghan, F. NA. Bond	Atmospheric pressure response to mesoscale sea surface temperature variations in the Kuroshio Extension region: In situ evidence.	Journal of Geophysical Research-Atmospheres	119(13)	2013JD021126 doi: 10.1002/2013JD021126	2014/7/16
15	Mori, N., M. Kato, S. Kim, H. Mase, Y. Shibutani, T. Takemi, K. Tsuboki, T. Yasuda	Local amplification of storm surge by Super Typhoon Haiyan in Leyte Gulf.	Geophysical Research Letters	41(14)	5106-5113 doi: 10.1002/2014GL060689	2014/7/28
16	Yokoyama, C., YN. Takayabu, S. Kanada	A Contrast in Precipitation Characteristics across the Bain Front near Japan. Part I: TRMM PR Observation.	Journal of Climate	27(15)	5872-5890 doi: 10.1175/JCLI-D-13-00350.1	2014/8/1
17	Atkinson, CT., RB. Utzurrum, DA. Lapointe, RJ. Camp, LH. Crampton, JT. Foster, TW. Giambelluca	Changing climate and the altitudinal range of avian malaria in the Hawaiian Islands - an ongoing conservation crisis on the island of Kaua'I.	Global Change Biology	20(8)	2426-2436	2014/8/1
18	Okuro, A., M. Kubota, H. Tomita, T. Hihara	Inter-comparison of various global sea surface temperature products.	International Journal of Remote Sensing	35(14)	5394-5410 特別号 doi: 10.1080/01431161.2014.926415	2014/8/8
19	Suzuki, T., T. Ohta, T. Hiyama, Y. Izumi, O. Mwandemele, M. Iijima	Effects of the introduction of rice on evapotranspiration in seasonal wetlands.	Hydrological Provesses	28(17)	4780-4794 doi: 10.1002/hyp.9970	2014/8/15

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20	Mizuochi, H., T. Hiyama, T. Ohta, K. N. Nasahara	Evaluation of the Surface Water Distribution in North-Central Namibia Based on MODIS and AMSR Series.	Remote Sensing	6	7660-7682 doi: 10.3390/rs6087660	2014/8/19
21	Gao, L., D. Li, J. Ishizaka	Stable isotope ratios of carbon and nitrogen in suspended organic matter: Seasonal and spatial dynamics along the Changjiang (Yangtze River) transport pathway.	Journal of Geophysical Research Biogeosciences	119(8)	1717-1737 doi:10.1002/2013JG002487	2014/8/29
22	Minda, H., T. Makino, N. Tsuda	Performance of a New Low-Cost Laser Disdrometer with Rainfall Intensity Correction in Heavy Rainfall.	IEEJ Transactions on Electrical and Electronic Engineering	9(5)	542-547 doi: 10.1002/tee.22003	2014/9/1
23	Nakai, T., H. Iwata, Y. Harazono, M. Ueyama	An inter-comparison between Gill and Campbell sonic anemometers.	Agricultural and Forest Meteorology	195	123–131 doi: agrformet.2014.05.005	2014/9/15
24	Kanemaru, K. and H. Masunaga	The Potential roles of background surface wind in the SST variability associated with intraseasonal oscillations.	Journal of Climate	27(18)	7053-7068 doi: 10.1175/JCLI-D-13-00774.1	2014/9/15
25	Masunaga, H. and T. L'Ecuyer	A Mechanism of Tropical Convection Inferred from Observed Variability in the Moist Static Energy Budget.	Journal of the Atmospheric Sciences	71(10)	3747-3766 doi: 10.1175/JAS-D-14-0015.1	2014/10/1
26	Sukigara, C., T. Suga, K. Toyama, E. Oka	Biogeochemical responses associated with the passage of a cyclonic eddy based on shipboard observations in the western North Pacific.	Journal of Oceanography	70(5)	435-445 doi 10.1007/s10872-014-0244-6	2014/10/1
27	Oue, M., K. Inagaki, T. Shinoda, T. Ohigashi, T. Kouketsu, M. Kato, K. Tsuboki and H. Uyeda	Polarimetric Doppler Radar Analysis of Organization of a Stationary Rainband with Changing Orientations in July 2010.	Journal of the Meteorological Society of Japan	92(5)	457-481 doi:10.2151/jmsj.2014-503	2014/10/1
28	Jang, SM., DI. Lee, JH. Jeong, SH. Park, S. Shimizu, H. Uyeda, YS. Suh	Radar reflectivity and wind fields analysis by using two X-band Doppler radars at Okinawa, Japan from 11 to 12 June 2007.	Meteorological Applications	21(4)	898-909 doi: 10.1002/met.1427	2014/10/1
29	You, CH., MY. Kang, DI. Lee, H. Uyeda	Rainfall estimation by S-band polarimetric radar in Korea. Part I: preprocessing and preliminary results.	Meteorological Applications	21(4)	975-983 doi: 10.1002/met.1454	2014/10/1
30	Fujinami, H., T. Yasunari, A. Morimoto	Dynamics of distinct intraseasonal oscillation in summer monsoon rainfall over the Meghalaya-Bangladesh-western Myanmar region: covariability between the tropics and mid-latitudes.	Climate Dynamics	43(7-8)	2147-2166 doi: 10.1007/s00382-013-2040-1	2014/10/1

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31	Ueyama, M., K. Ichii, H. Iwata, E.S. Euskirchen, D. Zona, A. V. Rocha, Y. Harazono, C. Iwama, T. Nakai, W. C.	Change in surface energy balance in Alaska due to fire and spring warming, based on upscaling eddy covariance measurements.	Journal of Geophysical Research: Biogeosciences	119	1947–1969 doi: 10.1002/2014JG002717	2014/10/9
32	Y. Miyazawa, M. Tateishi, H. Komatsu, F. Iwanaga, N. Mizoue, V. Ma, H. Sokh and T. Kumagai	Implications of leaf-scale physiology for whole tree transpiration under seasonal flooding and drought in central Cambodia.	Agricultural and Forest Meteorology	198	221-231 doi: 10.1016/j.agrformet.2014.08.013	2014/11/1
33	Fujiki, T., H. Takagi, K. Kimoto, A. Kurasawa, T. Yuasa, Y. Mino	Assessment of algal photosynthesis in planktic foraminifers by fast repetition rate fluorometry.	Journal of Plankton Research	36(6)	1403-1407 doi: 10.1093/plankt/fbu083	2014/11/1
34	Akter, N., K. Tsuboki	Role of synoptic-scale forcing in cyclogenesis over the Bay of Bengal.	Climate Dynamics	43(9-10)	2651-2662 doi: 10.1007/s00382-014-2077-9	2014/11/1
35	Yoshifuji, N., Y. Igarashi, N. Tanaka, K. Tanaka, T. Sato, C. Tantasirin, M. Suzuki	Inter-annual variation in the response of leaf-out onset to soil moisture increase in a teak plantation in northern Thailand.	International Journal of Biometeorology	58(9)	2025-2029 doi: 10.1007/s00484-013-0784-2	2014/11/1
36	Tanaka, N., D. Levia, Y. Igarashi, K. Nanko, N. Yoshifuji, K. Tanaka, C. Tantasirin, M. Suzuki and T. Kumagai	Throughfall under a teak plantation in Thailand: a multifactorial analysis on the effects of canopy phenology and meteorological conditions.	International Journal of Biometeorology	online first	doi: 10.1007/s00484-014-0926-1	2014/11/14
37	Nakai, T., G.G. Katul, A. Kotani, Y. Igarashi, T. Ohta, M. Suzuki and T. Kumagai	Radiative and precipitation controls on root zone soil moisture spectra.	Geophysical Research Letters	41(21)	7546-7554 doi: 10.1002/2014GL061745	2014/11/16
38	Kusumoto, B., T. Shiono, M. Miyoshi, R. Maeshiro, S. Fujii, T. Kuuluvainen, Y. Kubota	Functional re-sponse of plant communities to clearcutting: management im-pacts differ be-tween forest veg-etation zones.	Journal of Applied Ecology	52(1)	171-180 doi: 10.1111/1365-2664.12367	2014/11/18
39	Ziegler, AD., SG. Benner, C. Tantasirin, SH. Wood, RA. Sutherland, RC. Sidle, N. Jachowski, MA. Nullet, LX. Xi, A. Snidvongs, TW. Giambelluca, JM. Fox	Turbidity-based sediment monitoring in northern Thailand: Hysteresis, variability, and uncertainty.	Journal of hydrology	519	2020-2039 doi: 10.1016/j.jhydrol.2014.09.010	2014/11/27
40	Hatsuzuka, D., T. Yasunari and H. Fujinami	Characteristics of Low Pressure Systems Associated with Intraseasonal Oscillation of Rainfall over Bangladesh during Boreal Summer.	Monthly Weather Review	142	4758-4774 doi: 10.1175/MWR-D-13-00307	2014/12/12

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41	Masunaga, H.	Free-trospospheric moisture convergence and tropical convective regimes.	Geophysical Research Letters	41(23)	8611-8618 doi: 10.1002/2014GL062301	2014/12/16
42	Komatsu, H., Y. Shinohara, T. Kumagai, T. Kume, K. Tsuruta, Y. Xiang, R. Ichihashi, M. Tateishi, T. Shimizu, Y. Miyazawa, M. Nogata, S. Laplace, T. Han, C.-W. Chiu, A. Ogura, T. Saito and K. Otsuki	A model relating transpiration for Japanese cedar and cypress plantations with stand structure.	Forest Ecology and Management	334	301-312 doi: 10.1016/j.foreco.2014.08.041	2014/12/25
43	Hiyama, T., N. Saigusa, K. Yagi	Preface to the special section "Soil and plant aspects in the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS)".	Soil Science and Plant Nutrition	61(1)	1-1 doi: 10.1080/00380768.2015.995754	2015/1/2
44	Tsuboki, K., MK, Yoshioka, T. Shinoda, M. Kato, S. Kanada, A. Kito	Future increase of supertyphoon intensity associated with climate change.	Geophysical Research Letters	42(2)	646-652 doi: 10.1002/2014GL061793	2015/1/28
45	Ishizu, M. C. Sukigara, T. Suga, K. J. Richards	Estimating the nitrate concentration from the dissolved oxygen concentration and seawater temperature in the Kuroshio extension, Oyashio, and mixed water regions.	Journal of Oceanography	71(10)	19-26 doi 10.1007/s10872-014-0257-1	2015/2/1
46	Takahashi, G. H., H. Fujinami, T. Yasunari, J. Matsumoto and S. Baimoung	Role of tropical cyclones along the monsoon trough in the 2011 Thai flood and interannual variability.	Journal of Climate	28	1465-1476 doi: 10.1175/JCLI-D-14-00147.1	2015/2/1
47	Toyoshima, K., H. Masunaga and F. A. Furuzawa	Early Evaluation of Ku- and Ka-Band Sensitivities for the Global Precipitation Measurement (GPM) Dual-Frequency Precipitation Radar (DPR).	Scientific Online Letters on the Atmosphere	11	14-17 doi 10.2151/sola. 2015-004	2015/2/5
48	Sakai, T., S. Hatta, M. Okumura, T. Hiyama, Y. Yamaguchi and G. Inoue	Use of Landsat TM/ETM+ to monitor the spatial and temporal extent of spring breakup floods in the Lena River, Siberia.	International Journal of Remote Sensing	36	719-733 doi: 10.1080/01431161.2014.995271	2015/2/5
49	Shimizu, T., T. Kumagai, M. Kobayashi, K. Tamai, S. Iida, N. Kabeya, R. Ikawa, M. Tateishi, Y. Miyazawa and A. Shimizu	Estimation of annual forest evapotranspiration from a coniferous plantation watershed in Japan (2): Comparison of eddy covariance, water budget and sap-flow plus interception loss.	Journal of Hydrology	522	250-264	2015/3/1

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50	Kim, W., A. Miyata, A. Ashraf, A. Maruyama, A. Chidthaisong, C. Jaikaeo, D. Komori, E. Ikoma, G. Sakurai, H. Seoh, I. Son, J. Cho, J. Kim, K. Ono, K. Nusit, K. Moon, M. Mano, M. Yokozawa, M. A. Baten, M. Sanwangsri, M. Toda, N. Chaun, P. Polsan, S. Yonemura, S. Kim, S. Miyazaki, S. Kanae, S. Phonkasi, S. Kammales, T. Takimoto, T. Nakai, T. Iizumi, V. Surapipith, W. Sonklin, Y. Lee, Y. Inoue, Y. Kim, T. Oki	FluxPro as a realtime monitoring and surveilling system for eddy covariance flux measurement.	Journal of Agricultural Meteorology	71	32–50 doi: 10.2480/agrmet.D-14-00034	2015/3/10
51	Saito, T., K. Yamamoto, M. Komatsu, H. Matsuda, S. Yunohara, H. Komatsu, M. Tateishi, Y. Xiang, K. Otsuki, T. Kumagai	Using airborne LiDAR to determine total sapwood area for estimating stand transpiration in plantations.	Hydrological Processes	Accepted Manuscript	doi: 10.1002/hyp.10482	2015/3/11
52	Igarashi, Y., T. Kumagai, N. Yoshifuji, T. Sato, N. Tanaka, K. Tanaka, M. Suzuki and C. Tantasirin	Environmental control of canopy stomatal conductance in a tropical deciduous forest in northern Thailand.	Agricultural and Forest Meteorology	202	1-10 doi: 10.1016/j.agrformet.2014.11.013	2015/3/15

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