Adaptation for Climate Change and Its Social Implimentation

*Yoichi Ishikawa[1], Shingo Watanabe[1], KOJI DAIRAKU[2]

1. JAPAN Agency for Marine-Earth Science and Technology, 2. National Research Institute for Earth Science and Disaster Resilience

Adaptation for climate change is urgent issue since increasing risk of natural disaster, such as typhoon and heavy rain and harmful effect of high temperature on agriculture are expected. "National Plan for Adaptation to the Impacts of Climate Change" is formulated by Japan's government in 2015, in which the vision are given to build a secure, safe and sustainable society that is able to minimizing and avoiding damage. These actions to formulate the adaptation plan are expected to spread for local governments. For this purpose, simulation of climate change projection, downscaling technique to obtain the detailed estimation of climate change in local scale, the evaluation of risk to contribute the formulation of adaptation plan are necessary, as well as the issue for social implementation such as co-design working with stakeholders.
We will discuss the current status of the simulation modeling and knowledge gap between the scientists and stakeholders.

Keywords: Adaptation for Climate Change, Social Implementation

Social Technologies to Support Implementation of Climate Change Adaptation Technologies at Local Communities in Japan

*Kenshi Baba[1,3], Taiko Kudo[2], Shigeru Watanabe[2], Asako Iwami[3], Shun Kawakubo[3], Hiroharu Tanaka[3], Mitsuru Tanaka[3]

1. Tokyo City University, 2. Japan Weather Association, 3. Hosei University

1. Introduction

In response to recent national and international situation on climate change adaptation such as “National Plan for Adaptation to the Impacts of Climate Change” and the Paris Agreement, local adaptation strategies have been begun to examine at local governments eventually in Japan. The results of future climate projection and impact assessment have been provided in various realm and their accuracy have been improved greatly in a series of national research projects. Social Implementation Program on Climate Change Adaptation Technology (SI-CAT) of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) put high priority on utilizing climatic technologies in local governments for their policymaking. The authors are in charge of social implementation of the climatic technologies via social technologies such as risk communication, consensus building and so on.

2. Methodology

We have taken the following methodologies in SI-CAT. i) Clarifying potential needs of nationwide local governments for formulating adaptation strategies via questionnaire and interviews with local officials of environmental departments mainly. ii) Clarifying potential needs of nationwide stakeholders via online deliberation experiments. iii) Supporting development of application software on climatic technologies and preparing risk communication manual. iv) Developing narrative scenarios for future adaptive community by integrating scientific knowledge and local knowledge in some areas. v) Setting up a series of co-design workshops to match needs of local governments and seeds of climatic technologies. The paper introduce a part of results of i) and v) briefly as follows.

3. Results

The outline of questionnaire and interviews to local governments is shown in table 1. The main results demonstrate as follows. i) While some prefectures and major cities have already started preparing adaptation strategies, the majority of municipalities is yet to consider such strategies. ii) Key challenges for local governments in preparing adaptation strategies are found to be twofold: the lack of knowledge and experience in the field of climate change adaptation, and compartmentalization of government bureaus. The fact that most of the local governments in Japan are still yet to assess the local impacts of climate change which would lay the groundwork for preparing adaptation strategies suggests that co-design facilitating the circulation that technological seeds wake up needs of local government and the needs deepen the seeds, is important.

We then set up co-design workshop inviting both local governments’ officials and scientists who are developing climatic technologies to match their needs and seeds. The workshop was held in the afternoon of August 31st, 2016 and the participants were 76 people including secretariat. The participants were divided into five groups in which consisted of both scientists and local officials. The participants discussed “What is the technology development effective for policymaking of adaptation strategies”. The output was summarized in structural drawing within a poster paper for each group by the facilitator on the day. Later, they were visualized in a form of network graph by text mining and network analysis based on the minutes so that the participants get to understand the gap and common ground among them.

4. Further works

We also have conducted online deliberation experiments to clarify potential needs of nationwide stakeholders, conduct a questionnaire to the public to support developing application software on climatic technologies and preparing risk communication manual, and conducted stakeholder analysis to develop narrative scenario for future adaptive community in some areas. We plan to further interviews with local officials in each department of disaster prevention, agriculture, and health, develop narrative scenario for adaptive community and set up co-design workshop for the second time.

Keywords: local government, questionnaire, risk perception, expert knowledge, co-design, visualization

Table 1 Outline of the Questionnaire and Interview to Local Governments

	Paper-based Surveys of Major Local Governments	Interview Survey of Model Prefectures
Survey Period	February–March 2016	January–February 2016
Participants	Environmental policy divisions at 155 local governments throughout Japan, including prefectures (except for the 6 prefectures mentioned to the left), major cities with the designations of *seireishitei-toshi*, *chūkaku-shi*, and *shikōjitokurei-shi*, and cities where prefectural headquarters are located.	Bureaus for the environment, agriculture, disaster prevention, etc. of Ibaraki (coastal areas, agriculture), Gifu (environment) and Saga (environment) Prefectures ("model" prefectures participating in MEXT's Social Implementation Program on Climate Change Adaptation Technology project).
Method	Surveys distributed and collected by regular mails (When requested, an electronic file was distributed and collected by e-mail).	After approximately 2 hours of lecture and discussion, participants later completed the survey in the electronic file format and returned it via e-mail
Responses	123 (79.4%)	Heat (1), coastal areas (2), agriculture (1), all domains (28)
Survey items	—	1) Perceived policy-related external force risks, vulnerabilities, and outcomes to be prevented; 5) adaptation technology in the form of information and tools which aid in policymaking; 7) stakeholders.
	2) Climate change impact appearance status, future potential of occurrence, impact severity, countermeasure urgency, policy status, and the need for tools and information for projections on future impacts; 3) the status of investigations and developing of adaptation plans; 4) problems related to investigating and promoting adaptation strategies; 6) support expected for the investigation, promotion and social implementation of adaptation strategies; 8) Other (free response).	

Bottlenecks of climate change adaptation in local municipalities: Case study of agricultural adaptation planning in Ibaraki Prefecture

*Makoto Tamura[1], Takahiro Takimoto[1], Yuji Masutomi[2]

1. Institute for Global Change Adaptation Science, Ibaraki University, 2. Faculty of Agriculture, Ibaraki University

Following the National Adaptation Plan (Cabinet decision, November 27, 2015), local Japanese municipalities are expected to make regional plans to adapt to climate change. However, there are some bottlenecks for implementation. First, there is a lack of detailed information on future climate change impacts at the regional level. Second, showing only negative impacts may make local people feel unnecessarily insecure unless plans for adaptation are proposed. Third, the priority of climate change issues tends to be lower than urgent or regional sustainability issues such as economic stability and the aging society.
The authors have attempted to identify the risks of climate change on agriculture and to establish “Agricultural adaptation plans in Ibaraki Prefecture (provisional)” as a roadmap to respond to the regional impacts of climate change The main contents of the plans will be 1) climate projections for Ibaraki, 2) climate impacts and risk assessments for agriculture, and 3) proposal of adaptations to mitigate adverse impacts. To respond specifically to the first two bottlenecks listed above, it important to identify the adverse impacts and to prepare countermeasures. So far, the authors have examined the critical temperature and sensitivity for the incidence of chalky rice kernels using crop yield and quality data from Ibaraki Agricultural Institute. As for the third bottleneck, more comprehensive collaboration with local people is required. Some challenges for Ibaraki University have also been identified.

Acknowledgement
This study was supported by the Social Implementation Program on Climate Change Adaptation Technology (SI-CAT) and a Grant-in-Aid for Scientific Research (B: 26281055) from MEXT, Japan.

Keywords: Adaptation plans, Agriculture, Local municpalties

Evaluation of uncertainty in future urban climate prediction in prefectural scale

*Masayuki Hara[1], Tomohide Shimada[1]

1. Center for Environmental Science in Saitama

Tokyo Metropolitan area (i.e., southern part of Kanto district) is known for one of the hottest areas in summer in Japan. Especially in Saitama prefecture (north of Tokyo), the daily maximum surface air temperature (SAT) at screen height sometimes reached in 40 ℃. In the last decade, the summer heat environment in Japan is getting worse, and the number of emergency transportations due to heat stroke is rapidly increasing.

The japan meteorological agency reported that increase in annual mean SAT from 1931 to 2015 is 3.2 ℃ in Tokyo, while the one averaged over 15 suburban cities is only 1.5 ℃. Increase in SAT is caused by both the global warming and urban heat island.

The increase in temperature widely discussed in COP21 (such as +1.5 and/or 2 ℃ world), is globally-averaged SAT. Under the +1.5 and/or 2 ℃ world, the increase in SAT in local scale is not 1.5 and/or 2 ℃ because of the global warming and urban heat island. We need to perform downscaling to estimate the increase in prefectural- (or provincial-) scale SAT under +1.5 and/or 2 ℃ world.

Moreover, in making environmental policies in local government, prefectural (or provincial) scale future climate information is required to estimate the cost and benefit affected by climate adaptation strategies. So, policy maker requires the climate prediction, including its uncertainty information. But the future climate information provided by climate scientists contains uncertainty from various sources.

In this study, we evaluate the due to global climate change, regional climate change and land use change. To evaluate the uncertainty in regional climate prediction, we performed a series of present climate simulations using the Weather Research and Forecasting (WRF) model with high horizontal resolution, including an urban canopy sub-model. We also analyze global future climate predictions of CMIP5 CGCMs to evaluate the uncertainty in global climate change prediction.

Keywords: urban heat island, climate change, uncertainty, adaptation strategy

Development of regional slope failure risk model due to climate change

*SEIKI KAWAGOE[1], Yosuke Saito[1], Le Thi Thuy[1]

1. Fukushima University

Effects of climate change due to global warming are discernible all over the world. Heavy disasters caused by the hazards of climate change extend significant social. The objective of this study is to develop a risk evaluation model which incorporates the General Circulation Model (GCM) out puts and digital geographical information concerning particularly on the slope failure hazards due to high intensity rainfall in future. As previous study, Kawagoe (2010) has developed the slope failure probability model to Japan. However, I needed improvement as information on practicing measure consideration because spatial resolution was rough. This study tried to develop advanced slope failure probability model as spatial resolution and geological features. Development model area is Nagano prefecture. Detail high risk areas are revealed by development advanced. This outcomes can plan the measure practicing more to pile up with sediment disaster caution zones.

Keywords: probability, sediment hazard, regional scale, heavy rainfall

Development of a simple method to use massive climate projection datasets for impact assessments: an application to the climate change signals related to tourism

*Satoshi Watanabe[1], Nobuyuki Utsumi[2], Masanori Take[3], Akiko Iida[1]

1. School of Engineering, the University of Tokyo, 2. Institute of Industrial Science, the University of Tokyo, 3. Art and design, University of Tsukuba

A Simple method to use massive climate projection datasets is developed. The simplicity of the method enables application to various impact assessment studies. In this new method, rather than projecting directly the variables of interest, we project the change of probability. This probabilistic approach enables simple assessments for issues associated with climate change. The trends in change are evaluated without considering the detailed relationship between climate and a target of assessment. The applicability of the method developed is demonstrated for the climate change signals related to tourism in Yaeyama islands, Okinawa, Japan. For this assessment, we use the database of long-term high-resolution climate ensemble experiments and a questionnaire survey conducted by local governments. The result indicates that the occurrence of severe events like heavy precipitation or strong wind will decrease in summer, and the occurrence of fine day, which most tourist prefer, will increase in winter. This result can be useful for the impact assessment of climate change. The example of application shows that the developed method can effectively project the future main changes and uncertainty for the target of assessment considering the spread of projection derived from ensemble simulations.

Keywords: Climate Change, Massive climate projection dataset, Tourism, Yaeyama Islands

Development of hi-resolution regional climate scenarios in Japan by statistical downscaling

*KOJI DAIRAKU[1]

1. National Research Institute for Earth Science and Disaster Resilience

Climate information and services for Impacts, Adaptation and Vulnerability (IAV) Assessments are of great concern. To meet with the needs of stakeholders such as local governments, a Japan national project, Social Implementation Program on Climate Change Adaptation Technology (SI-CAT), launched in December 2015. It develops reliable technologies for near-term climate change predictions. Multi-model ensemble regional climate scenarios with 1km horizontal grid-spacing over Japan are developed by using CMIP5 GCMs and a statistical downscaling method to support various municipal adaptation measures appropriate for possible regional climate changes. A statistical downscaling method, Bias Correction Spatial Disaggregation (BCSD), is employed to develop regional climate scenarios based on CMIP5 RCP8.5 five GCMs (MIROC5, MRI-CGCM3, GFDL-CM3, CSIRO-Mk3-6-0, HadGEM2-ES) for the periods of historical climate (1970-2005) and near future climate (2020-2055). Downscaled variables are monthly/daily precipitation and temperature. File format is NetCDF4 (conforming to CF1.6, HDF5 compression). Developed regional climate scenarios will be expanded to meet with needs of stakeholders and interface applications to access and download the data are under developing. Statistical downscaling method is not necessary to well represent locally forced nonlinear phenomena, extreme events such as heavy rain, heavy snow, etc. To complement the statistical method, dynamical downscaling approach is also combined and applied to some specific regions which have needs of stakeholders.

Keywords: Downscaling, Climate Change Adaptation, SI-CAT

Future changes of surface air temperature in summer over the Japanese archipelago by d4PDF regional climate simulations.

*Yasuko Okada[1], Masayoshi Ishii[2], Hirokazu Endo[2], Hiroaki Kawase[2], Izuru Takayabu[2], Hidetaka Sasaki[2], Shingo Watanabe[1], Mikiko Fujita[1], Shiori Sugimoto[1], Sho Kawazoe[1]

1. JAMSTEC Japan Agency for Marine-Earth Science and Technology, 2. Meteorological Research Institute

Recent years, the abnormally high temperature is often generated during summer and can also cause serious damage in our life. Developing a better understanding of the features and occurrence frequency of this high temperature is an important element of prevention of drought, heat stroke and more. Various analyses by global warming prediction experiments have been carried out so far, but since the number of ensemble is small. It is not possible to fully evaluate natural fluctuation, that is, uncertainty accompanying abnormal weather such as low-frequency events. Based on such problem consciousness, numerous (up to 100 members) ensemble experiments are conducted using the 60-km-mesh global atmospheric model and the 20-km-mesh regional atmospheric model (Mizuta et al. 2016). This database called database for Policy Decision making for Future climate changes (d4PDF), which is intended to be utilized for the impact assessment studies and adaptation planning to global warming. We investigate using this dataset future changes of the surface air temperature in summer over the Japanese archipelago based on observational locations.

We use output data of the 20-km-mesh regional atmospheric model (RCM) simulations for the historical simulation (1951-2011) and +4K simulation (2051-2111) under the global-mean surface air temperature warming becomes +4K. The simulated +4K climates include the outputs obtained with six different sea surface temperature (SST) patterns. The RCM are conducted for 50 members of the historical simulation and for 90 members of the +4K simulation, and we use all members in this study. We also use the data of meteorological offices at 152 locations nationwide as observation data for each location.

In order to assessment the surface air temperature by location, bias of this model can not be ignored depending on the location. We correct by bias correction (Piani et al. 2010) using least squares method assuming between observed value and locational value of historical simulation as a linear relation. Although this method is a very simple correction method, it is able to sufficiently reduce errors at all locations. For +4K simulation, we use the correction coefficient obtained from the comparison between a locational value of observation and historical simulation.

The frequency of daily average temperature, maximum temperature and minimum temperature in summer improved better at all location with bias correction. On the other hand, hot summer days slightly overestimate depending the location. For example, hot summer days in Tokyo slightly show increase unlike observational value because it is not affected by a sea breeze. However, the difference is not significant. In +4K simulation using the correction coefficient obtained from the comparison between a locational value of observation and historical simulation, the number of hot summer days increases by about 5 times at any location compared to historical simulation. In addition, this value varies depending on the difference in SST patterns and this tendency is largest in summer.

In the Social Implementation Program on Climate Change Adaptation Technology (SI-CAT), we conduct experiment assuming a near future where the surface air temperature is increased by 2K, like +4K experiment. Using current output data, we investigate future changes of surface air temperature in each location. In the near future (+2K simulation), the number of hot summer days in summer is increased by about twice as much as the historical simulation. We confirm that the near future climate is located approximately midway between the historical climate and the future climate.

The authors were supported by the SI-CAT, the Ministry of Education, Culture, Sports, Science, and

Technology (MEXT), Japan.

Keywords: global warming, high temperature

Development of climate change projection dataset for Nagano and Gifu prefecture by dynamical downscaling

*Takeshi Yamazaki[1], Takahiro Sasai[1], Hiroaki Kawase[2], Hidetaka Sasaki[2], Akihiko Murata[2], Masaya Nosaka[2], Toshiki Iwasaki[1]

1. Graduate School of Science, Tohoku University, 2. Meteorological Research Institute

Dynamical downscaling is available to develop high resolution projection dataset for discussing climate change adaptation especially for simulating precipitation, for which statistical downscaling is rather unsuitable. In this presentation, development of high resolution projection for climate change mainly for evaluating impact on ecosystem, water resources and ski tourism in the Northern Alps area of Nagano prefecture. Nonhydrostatic Regional Climate Model (NHRCM) developed by Meteorological Research Institute is used to make the dataset; downscaled from grid spacing of 20 km to 5 km and 1 km for present and future conditions. The simulated area covers Honshu, Kyushu, Shikoku and Japan Sea in 5 km runs, a square with one side about two hundred kilometers in length including the Northern Alps in 1 km runs. Furthermore, we will project snow depth distribution using snow-transport model with a grid spacing of 100 m for the priority area. Each ten member of 31-year is integrated for present and future conditions in 5 km experiment.
The 5 km experiment for d4PDF of present climate is almost completed. Realistic histogram of air temperature is obtained by 5 km runs as compared to 20 km boundary condition, and it becomes more similar to observation through a bias correction. Although the snow cover is underestimated with 20 km grid spacing in mountainous areas, clear contrast of snow depth between mountainous areas and basins is presented due to improvement of terrain in 5 km simulations. Moreover, it is confirmed that heavy snowfall is caused by strong northwesterlies in north part and mountainous region of Nagano prefecture and in basins it is caused by extratropical cyclones along the south coast of Japan through the analysis of pressure pattern for events with having large amount of daily snowfall. However, there are exceptions thus we have to carefully investigate how the snowfall will change due to global warming.

Keywords: nonhydrostatic model, snow cover, global warming

Assessing the quality of snow depth simulated by NHRCM in urban areas of Japan

*Rui Ito[1,2], Hiroaki Kawase[2], Koji Dairaku[1], Toshinori Aoyagi[3,2], Mitsuo Oh' izumi[4,2], Naoto Hori[5], Hidetaka Sasaki[2]

1. National Research Institute for Earth Science and Disaster Resilience, 2. Meteorological Research Institute/Japan Meteorological Agency, 3. Japan Meteorological Agency, 4. Meteorological College/Japan Meteorological Agency, 5. Yamagata Meteorological office/Japan Meteorological Agency

With an increase in horizontal resolution of numerical model, the model can resolve not only large scale urban areas but also mid- and small-scale ones. There are some relatively small urban areas scattered around snowy regions in Japan, and weather and climate in the areas are affected deeply by a snow pack during the winter season. Therefore, to provide more reliable information about climate changes in the areas, it is important that accumulating and melting of snow are accurately simulated in models. Two snow pack schemes have been introduced into a square prism urban canopy (SPUC) model (Aoyagi and Seino 2011) in a non-hydrostatic regional climate model (NHRCM) developed at MRI/JMA for a successful replication of urban snow. Scheme_S01 (scheme_S02) uses statistical methods (fluxes from the snowpack) for changes of snow temperature and melting and freezing amounts and Penman-Montieth equation (bulk equation) for sensitive and latent heat fluxes.
In this study, we assess the effects of the snow schemes on the simulated snow depth over Japanese urban areas, by comparing the depths simulated with and without SPUC to the observed depths by JMA. The model horizontal resolution is 5 km. The Japanese 55-year reanalysis data was used as initial and boundary conditions. We focus on the mean values for the period of 2006 to 2010.
The scheme_S01/S02 decreases the model bias of the annual maximum depth averaged over the five years at the urban site grids where the model without SPUC (scheme_NU) overestimates the maxima. The RMSE is reduced over the grids by the scheme_S02. The stronger spatial correlation between the simulation and the observation is shown when the snow pack schemes are used. The scheme_S02 represents the closest maxima to the observation. Seasonal variation of the depth is estimated at the 22 site grids where the peak of depth averaged over the five years is more than 10 cm and, at the about half number of the sites, the scheme_S01/S02 performs better than the scheme_NU. Comparing with the observation, the variation in scheme_NU was overestimated during the periods of snow pack. The scheme_S01/S02 suppresses the overestimation. In Morioka where the variation is improved, all the schemes represent the depth well until December. The simulated depth in the scheme_NU, however, gets separated from the observation and the other simulated depth when the daily maximum temperature reaches less than 0˚C and then the depth keeps increasing while the temperature is minus. On the other hand, the increased temperature by the scheme_S01/S02 is close to the observation in the accumulating period and thus the higher precision is shown on the variation. In Toyama with the improved variation by the scheme, because of a good accuracy of the simulated temperature, the improvement can be seen on the variation in the period of accumulating and melting. The scheme_S01/S02 promotes the melting overly after the temperature increase starts at both sites. The simulated seasonal variations at some urban site grids were degraded by the schem_S01/S02. The depth is underestimated even in the scheme_NU at the grids, and the depth is less in the scheme_S01/S02 than in the scheme_NU because of the high temperature simulated by the schemes. The effects of the schemes on the depth are indistinct in the small-scale urban areas which are expressed as one grid in the model.

Keywords: Snow depth, Urban area, Urban canopy scheme, Regional climate model

Downscaling ocean simulation of Japan coastal seas using an ocean reanalysis dataset (FORA-WNP30) in 2003-2012

*Shiro Nishikawa[1], Tsuyoshi Wakamatsu[1], Yoichi Ishikawa[1], Hiroyuki Tsujino[2], Kei Sakamoto[2], Masafumi Kamachi[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. Meteorological Research Institute, Japan Meteorological Agency

We performed a high-resolution (2km) downscaling simulation of Japan coastal seas from an ocean reanalysis dataset (10km resolution) of western North Pacific (FORA-WNP30, Usui et al. 2016), and produced the corresponding downscaling simulation dataset in 2003-2012. We examined the basic performance of the downscaling model and the reproducibility of the main oceanic structures around Japan by comparing the model results with the FORA data.

The ocean model used is MRI.COM (Meteorological Research Institute Community Ocean Model, version 4), basically the same as one that used for creating the FORA-WNP30 data. The model domain is 122.6E-150E and 23.7N-47.5N. The zonal and meridional grid sizes are 1/30 and 1/50 degrees (about 2km), which are 1/3 and 1/5 of those for FORA-WNP30. The method of downscaling is based on the offline nesting tool in MRI.COM: values of the main variables (temperature, salinity, horizontal velocities, surface height, etc) at the lateral boundaries are given by those of the FORA-WNP30 data. The surface forcings (3 hourly) are from the JRA-55 data, which are basically common to those of FORA-WNP30. The initial conditions were made from FORA-WNP30 at 1 January 2003, and the model was integrated for 10 years (2003 to 2012) on the Earth Simulator.

From the comparison of the 10-year simulation results with the corresponding reanalysis data (FORA-WNP30), we confirmed that the averaged features of the main ocean structures around Japan (e.g., sea surface temperature and height, subsurface temperature and salinity, Kuroshio and Oyashio currents, and throuthflows of the main straits in the Japan Sea) are basically well reproduced. We also confirmed that, because of the higher horizontal resolution with the more realistic coastal topography, the model shows higher time variability of velocities and captures abrupt flow change events in coastal regions ("Kyucho" event), which are not clear in the coarser FORA-WNP30 data. On the other hand, some differences between the model and the reanalysis data were found. Warmer subsurface and less saltier surface tendencies in the Japan Sea of the model are the example. Absence of sea ice, river flow, and tidal effects in the present model may have affected some of these. We are planing to improve the model by introducing these processes.

Keywords: Ocean downscaling, Ocean modeling, Ocean reanalysis data, Japan coastal seas

Coherent motion of turbulence structure in developing atmospheric boundary layer and its sensitivity to landuse condition

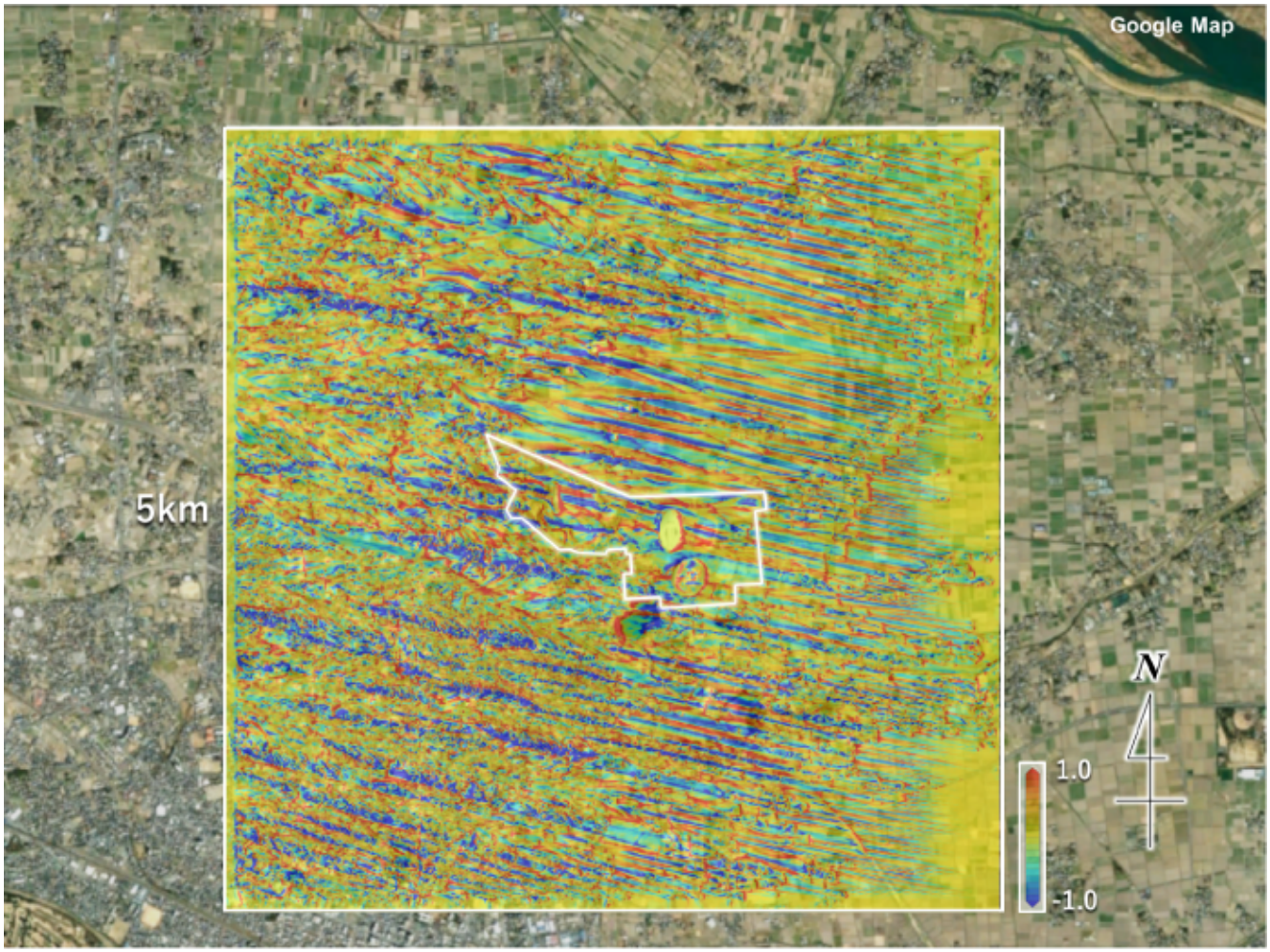
*Aiko Yakeno[1], Ryo Onishi[1], Keigo Matsuda[1]

1. Japan Agency for Marine-Earth Science and Technology

We have conducted large eddy simulation (LES) with high resolutions of 2 or 5 meter around a real city of 5.0 times 5.0 square kilometers based on GIS data. The atmospheric boundary layer develops within the computational domain over a field area in the North east and a residential area in the South west (Fig. 1). The main wind direction is the East southeast. Colored transparent contour In a center of the figure represents an instantaneous vertical velocity, vr, at the height of 10 meters from a ground. A streaky pattern of the velocity appears in the downstream. Though the coherent motion of a structure has been discussed in literature, its generation mechanism, sensitivity to landuse condition and influence on the upper scale flow characteristics are not clarified sufficiently. In the study, we consider location height, wave length of the coherent structure and factors to develop the atmospheric boundary layer. We have compared root mean square values of vertical velocity for cases of with or without heat transfer of the ground. Values were spacially averaged for each region; the upstream/downstream and residential area/grass field. Two peaks in the vertical direction are identified for whole cases. It is considered to be ralated with the internal and outside boundary layers known in a reference (1).

(1) Garratt, J. R., “The internal boundary layer - a review”, Boundary-Layer Meteorology, Volume 50, Issue 1, pp. 171-203 (1990).

Keywords: atmospheric boundary layer, turbulence, canopy



Examination of “Yamase” events using d4PDF climate ensemble simulations.

*Sho Kawazoe[1], Shiori Sugimoto[1], Mikiko Fujita[1], Yasuko Okada[1], Shingo Watanabe[1]

1. Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

“Yamase”, are defined as cold, northeasterly winds periodically observed in Hokkaido and Tohoku region of northern Japan. Because Yamase conditions are most pronounced during the summer, prolonged events can and have resulted in substantial damages to rice crops, especially during the ripening phase (late-July to mid-August). During the strong Yamase year of 1993, the eastern Tohoku region experienced nearly a 70% deficit in rice yield. In 2003, the same region experienced a 35% deficit, despite the expanded use of cultivators such as “Hitomebore”, which were implemented to withstand lower temperatures. With projected average temperature increases in northeastern Japan ranging anywhere from 2.8 –5.0 ˚C at the end of the 21st century, agricultural practices will need to adapt in order to mitigate the impacts of a warmer climate. However, it is equally important that events such as Yamase be taken into consideration when climate change information is provided to stakeholders and policy makers.

This study aims to evaluate the ability climate models have in replicating Yamase events seen in observations, their changes in the future climate, and how regionally downscaled models provide important physical characteristics not captured at coarser resolutions. To accomplish this, we use large member ensemble of global (GCMs) and regional climate models (RCMs) from the Meteorological Research Institute (MRI), as part of the “database for Policy Decision-making for Future climate change (d4PDF)”. GCM results come from MRI-AGCM3.2, resolved at 60km horizontal resolutions, while RCM results come from the NHRCM, which is regionally downscaled to a horizontal resolution of 20km. For scenario climates, global mean surface air temperature is prescribed to be either 2K or 4K warmer than the pre-industrial climate, equivalent to emission scenarios from the Representative Concentration Pathways, RCP4.5 and RCP8.5, respectively. The performance of these models is evaluated using observational data from AMeDAS, and from the JRA55 and ERA-interim reanalysis datasets.

d4PDF models general reproduce well the environmental characteristics of Yamase events seen in observations. This consists of an enhancement of Okhotsk high and the weakening of the western Pacific high, easterly/northeasterly surface winds near the eastern Tohoku region, and negative temperature anomalies across eastern Japan, especially near the coastline. These characteristics remain relatively unchanged in future climates, as well as the frequency of Yamase events. The lack of substantial differences between current and future Yamase events highlights the importance not to neglect such events and will be the focus of this talk.

Keywords: Yamase, d4PDF, Climate change

Risk evaluation and prevention of complex flood disaster with earthquake subsidence and storm surge in Kagami river of Kochi plain.

*kouhei yoshimura[1], Seigo Nasu[1]

1. Kochi University of Technology

After the Great East Japan Earthquake, it was widely recommended that disaster phenomena have to be evaluated as multiple integrated disasters with complexity. Flood prevention law has also revised to assume extreme flood event in response to recently frequent shiver flood. So we should change the assumption which has been thought of as a single event.
In this research, we simulated complexly integrated multiple disasters with flood. Sea surge and earthquake subsidence which is expected as Nankai Trough Earthquake by using discharge model and river channel model were integrated.
This model is including distributed discharge model and river channel model. In low yield area river channel, this model can represent the effect of seatide and sea storm surge.
According to this model, the effect of seatide and sea storm surge is severe for flood preventation. And flood risk is exacerbated by earthquake subsidence becoming a phenomena of lost river channel capacity. Earthquake is predicted, and the remaining time is small, so it is difficult to build new Flood control facilities to avoid this complex risk.
Now dam limits discharge as fixed rate according to operation rule. We suggest new operation rule that dam limit discharge strongly for sea tide and sea surge. This rule is effective to reduce sea-tide effect and disaster damage with the same flood control volume.
This method is reasonable from the aspect of “time”, because earthquake subsidence is temporary and permanent facilities can be wasted. Dam operation rule optimization is adaptive measure.
On the other hand, climate change is severe problem for flood risk. According to previous studies, maximum discharge may not increase but frequency of historical maximum level flood will increase in Kagami river basin.
If we consider only a single flood risk, “maximum discharge may not increase” is “good news” ,because flood control facilities is in place for historical maximum level flood, and these facilities can prevent flood damage.
But if we consider the risk of complex flood disasters, “frequency of historical maximum level flood will increase” is “bad news”. It is because the probability of floods when the flood control facilities lost function by the earthquake disaster.
This is new perspective that flood risk does not increase by only climate change, but risk will increase with complex disasters with earthquakes.

Keywords: climate change, hydrological model, earthquake, complex disaster, Ground subsidence, dam management

Development of a database system for near-future climate change predictions

*Yujin Nakagawa[1], Shintaro Kawahara[1], Fumiaki Araki[1], Daisuke Matsuoka[1], Yoichi Ishikawa[1], Shingo Watanabe[1]

1. Japan Agency for Marine-Earth Science and Technology

A database for Policy Decision making for Future climate change (d4PDF) is a large volume of simulation data about 2 PB produced by Program for Risk Information on Climate Change. The d4PDF is published on Data Integration and Analysis System Program (DIAS). Analyses of ensemble data of the d4PDF are quite useful in order to produce probabilistic effect prediction of climate change. Considering that a data volume of the d4PDF is too large to download to a local computer of users, a user-friendly system is required to search and download data which satisfy requests of the users.

We develop “a database system for near-future climate change predictions” for providing functions to find necessary data for the users under Social Implementation Program on Climate Change Adaptation Technology (SI-CAT). The database system for near-future climate change predictions mainly consists of a relational database, a data download function and user interface. The relational database using PostgreSQL is a key function among them. Temporally and spatially compressed data are registered on the relational database. As a first step, we develop the relational database for precipitation, temperature and track data of typhoon according to requests by SI-CAT members. The data download function using Open-source Project for a Network Data Access Protocol (OPeNDAP) provides a function to download temporally and spatially extracted data based on search results obtained by the relational database. We also develop the user interface for using the relational database and the data download function. The database system for near-future climate change predictions will be released on DIAS in fiscal year 2017. Techniques of the database system for near-future climate change predictions might be quite useful for simulation and observational data in other research fields.

Keywords: Climate Change, Relational Database

Development of the North Pacific Ocean Model for Near-Future Projection of Ocean State

Tsuyoshi Wakamatsu[1], *Shiro Nishikawa[1], Hiromichi Igarashi[1], Hiroshi Ishizaki[1], Yoichi Ishikawa[1]

1. Japan Agency for Marine-Earth Science and Technology

Near-future projection of ocean state is one of the key products in the MEXT sponsored project, Social Implementation Program on Climate Change Adaptation Technology (SI-CAT). In this project, we are aiming at producing projected ocean state around Japan coast under near-future climate change using the North Pacific Ocean circulation model. During the first one year of SI-CAT, we have conducted extensive survey with our project partner from local governments, Ibaraki, Tottori and Saga, and other research institutes. Based on the feedback from our partners, we identified key variables to be assessed under near-future condition. The most desired variable is sea level along Japan coast and we have implemented tools to diagnose impact of atmospheric change on coastal sea level change from atmospheric external forcing based on Sverdrup theory. Using the tools we have selected a subset of atmospheric forcing models based on d4PDF and CMIP5 data. In this presentation, we will make a report on preliminary results from our near-future ocean state projection experiments.

Keywords: Near-future ocean prediction, North Pacific ocean model, Sea level, CMIP5

Long-term impact assessment of storm surges around the southeastern Korean Peninsula based on a large-ensemble of climate projection of d4PDF

*Jung-A Yang[1], Sooyoul Kim[2], Nobuhito Mori[3]

1. Graduate School of Enginerring, Kyoto University, 2. Graduate School of Enginerring, Tottori University, 3. Disaster Prevention Research Institute, Kyoto University

This study examine long-term impact assessment of storm surges due to typhoons around the southeastern area in Korean Peninsula considering climate change. The analysis is carried out by using outputs of large-ensemble experiments so-called d4PDF for a past and +4K future climate conditions over 5000 years by MRI-AGCM3.2H with 60 km spatial resolution to obtain probabilistic future changes in low-frequency of extreme storm surge events. The historical climate simulation from 1951 to 2010 was conducted with 100 ensemble members and the future climate simulation from 2051 to 2110 was conducted with 90 ensemble members considering warmer +4℃ global mean temperature in d4PDF. The characteristics of tropical cyclones (typhoons) which may directly and indirectly have an effect on Korean Peninsula from d4PFD for past and future climate condition is extracted. The reproducibility of historical typhoon and storm surge is evaluated by comparing with the observed data. The typhoon properties extracted from d4PDF are employed as the driving force to simulate storm surges. The extreme storm surge heights with specific return periods are examined. It was found that the potential future changes of the extreme storm surges along the southeastern area in the Korean Peninsula have a strong regional dependency.

Keywords: storm surge, climate change, large-ensemble climate projection, d4PDF

Does a RCM add value to its driving parent GCM simulated extreme precipitations linked to temperature over Japan?

*Sridhara Nayak[1], KOJI DAIRAKU[1], Noriko N. Ishizaki[1]

1. National Research Institute for Earth Science and Disaster Resilience

The frequency of extreme precipitation events are now of serious concern which are expected to increase in a warmer climate (IPCC 2012), because atmosphere can hold more water vapor in warmer air temperature according to the principle of Clausius-Clapeyron (CC) relationship (~7% per degree rise in temperature). As a consequence, more extreme precipitation events may occur under warmer climate and may impact on agriculture, the economy, the human health and also animal habitats. Simulations by Regional Climate Models (RCMs) are often used for impact assessments because they are presumed to simulate the regional climate, especially extreme events, better than their driving General Circulation Models (GCMs). Thus there is a growing debate on the added value by RCMs to their driving GCMs over various regions. Our study explores whether a RCM reproduces the extreme precipitation linked to temperature over Japan better than its driving parent GCM by analyzing 330 ensemble experiments [140 experiments with NHRCM at 20km (50 experiments for current climate: 1951-2010 & 90 experiments for future climate with 4˚C warming: 2051-2110) and 190 experiments with the MRI-AGCM at 60km (100 experiments for current climate & 90 experiments for future climate)]. We find that the extreme precipitations linked to temperature basically follow the CC relationship over Japan for a certain temperature (for instance ~24˚C) and a further increase of temperature decreases the precipitation intensity. These results are consistent with AMEDAS station observations and the past research conducted over various regions. All the individual ensemble experiment results of RCM and GCM show a similar qualitative behavior. Further we find that RCM ensemble experiments overestimated the extreme precipitation intensities for the temperatures above 24˚C, while GCM underestimated the same particularly at the peaks (18-26˚C). However, for the temperatures between 20-24˚C RCM added ~35% to the extreme precipitations linked to temperature over Japan compared to GCM ensemble experiments. The overestimation of precipitation intensity at higher temperatures simulated by RCM is associated with strong vertical velocity (i.e. upward motion of air) and much availability of water vapor, while the underestimation of the same by the GCM is associated with weak vertical velocity and less availability of water vapor compared to the RCM. This may lead to contribute the added value by RCM over GCM. Additions to this, the zonal and meridional winds in RCM are noticed stronger compared to that in GCM at higher temperatures. This may bring more moisture from the ocean towards Japan land and cause more precipitation in RCM. Furthermore, all ensemble experiment results in RCM and GCM show a significant increase of precipitation intensities (~30mm/d in RCM and ~15mm/d in GCM) for the temperatures roughly above 24-26˚C under future climate scenario over Japan and RCM added ~15mm/d amount of precipitation intensity to this future change. This increase of extreme precipitation intensities at higher temperature may be due to the increase in temperature under future climate (4˚C warming). The added value of RCM will be further discussed through the column-averaged total kinetic energy and column integrated moisture flux convergence by spectral analysis.

Keywords: Extreme precipitations, Clausius-Clapeyron relationship, Ensemble experiments, Added value, Spectral analysis

Numerical Simulation of Urban Heat Island in Sendai City with Land Use of the Potential Natural Vegetation, 1850s and 2000s

*Lidia Lazarova Vitanova[1], Hiroyuki Kusaka[2]

1. Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan, 2. Center for Computational Sciences, University of Tsukuba, Japan

This study examines the impact of urbanization over the past 150 years in Sendai City for three different land use cases: potential natural vegetation (PNV), 1850s, and 2000s. The Weather Research and Forecasting (WRF) model with 1 km horizontal resolution was used and the following results were obtained. Firstly, results of the control simulation were verified against observations. The WRF model reproduced well the observed temperatures in Sendai City and five additional locations in Miyagi prefecture. The bias is from -0.55 ºC to -1.30 ºC in August and from -0.02 ºC to -1.37 ºC in February. Secondly, impacts of urbanization were evaluated. The effect of urban heat island (UHI) in 1850s was almost not found even the existence of the small urban area of Sendai city. The sensitivity experiment, where the land use was replaced to PNV, was conducted and showed there was a slight temperature difference between 1850s and PNV. Thirdly, the simulated monthly mean temperature was compared between 1850s and 2000s land-use experimental cases. The results indicate that the monthly mean temperature in August (February) in 2000s is 1.4 ºC (1.5 ºC) higher than that in 1850s. Moreover, the considerable nocturnal temperature increase of 2.0 ºC (2.1 ºC) during the past 150 years was found in August (February).

Keywords: Urban heat island, urbanization, potential natural vegetation, land-use change

Uchimizu: A cool(ing) tradition to locally mitigate the urban heat island

*Anna Solcerova[1], Tim van Emmerik[1], Koen Hilgersom[1], Frans van de Ven[1,2], Nick van de Giesen[1]

1. Delft University of Technology, Water Resources Management, Stevinweg 1, 2628CN Delft, The Netherlands, 2. Deltares, P.O. Box 177, 2600 MH Delft, The Netherlands

Urban heat island was first described 200 years ago but ways to mitigate heat in urban areas reach much further into the past. Uchimizu is a 17th century Japanese tradition, in which water is sprinkled around houses to cool the ground surface and the air by evaporation. Unfortunately, the number of published studies that have quantified the cooling effects of uchimizu is limited, and only use measurements of the surface temperature, or air temperature at a single height, as a measure of the cooling effect. In this research, a dense three-dimensional Distributed Temperature Sensing (DTS) setup was used to measure air temperature with high spatial and temporal resolution within once cubic meter of air above an urban surface. Six experiments were performed to systematically study the effect of (1) applied water amount, (2) initial surface temperature, and (3) shading on the cooling effect of uchimizu. The measurements showed a decrease in air temperature up to 1.5 K at 2 m height, and up to 6 K for near-ground temperature. Strongest cooling was measured for the experiment performed in the shade. For an amount of water applied of 1 mm and 2 mm, there was no clear difference in cooling effect, but after application of a large amount of water (>5 mm), the strong near-ground cooling effect was approximately twice as high as when only 1 mm of water was applied. The dense measurement grid used in this research also enabled us to detect the rising turbulent eddies created by the heated surface.

Representation of Southern African Monsoon In A High-Resolution AGCM and Its Future Projections

*Jerry Raj[1], Georgiy Stenchikov[1]

1. King Abdullah University of Science and Technology

A monsoon circulation exists over the southern part of the African continent during the austral summer with precipitation maximum stretching from Angola on the west coast of southern Africa to Madagascar. In some locations, southern African monsoon lasts up to six months. Studies about this monsoonal circulation are surprisingly sparse. To understand the mechanism involved in the development of Southern African Monsoon and its controls, the present study uses a high-resolution AGCM, High-resolution Atmospheric Model (HiRAM) which is developed at GFDL. Accurate simulation of the migration of ITCZ is crucial in the simulation of rainfall over Southern Africa. HiRAM simulations, which are conducted at ~25 km horizontal resolution, can simulate the structure and migration of ITCZ with sufficient accuracy. The seasonal cycle, spatial structure, and the associated dynamic features are examined. The study incorporates observations, gridded datasets, reanalysis products, and GCM simulations for this purpose. Additionally, the future projections using representative concentration pathways RCP 4.5 and RCP 8.5 are also conducted and analyzed.

Keywords: Regional Climate , Africa, Southern Indian Ocean

