

気候変動への適応とその社会実装

Adaptation for Climate Change and Its Social Implimentation

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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.

キーワード：気候変動適応、社会実装

Keywords: Adaptation for Climate Change, Social Implementation

気候変動適応技術の地域社会での実装へ向けた社会技術

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

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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.

キーワード： 地方自治体、質問紙調査、リスク認知、専門知、コデザイン、可視化

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 <i>seireishitei-toshi</i> , <i>chūkaku-shi</i> , and <i>shikōjitokurei-shi</i> , 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).

地域での気候変動適応の隘路と打開策：茨城県での農業適応計画の事例から

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

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2015年11月に「気候変動の影響への適応計画」が閣議決定され、今後は各自治体における適応計画策定が見込まれる。しかしながら、地方自治体での気候変動適応策の社会実装に向けては幾つかの隘路がある。第一に、地域単位の気候変動の影響予測に関する科学的知見が不足している点である。第二に、影響予測とともに具体的な適応策を提案していかないと地域住民に不安を煽る結果となってしまうことである。第三に、地域において気候変動はその重要性は認識されつつも、経済状況、少子高齢化などの喫緊の課題や地域の持続可能性に関わる課題に比べると優先順位が低くなりやすいことである。

こうしたなか、筆者らは茨城県の農業の現状と気候変動に関する将来的なリスクを同定し、農業適応計画策定に必要な項目を抽出することで、そのロードマップとなる「茨城県農業における温暖化適応総合計画(仮)」の作成を目指している。本適応計画に盛り込む主要な内容は、以下の3つを考えている。すなわち、①茨城県における温暖化の予測、②農作物に対する定量的な影響とリスク、③影響軽減のための適応策パッケージである。これらは上記で掲げた第一、第二の隘路への打開策を意図しており、影響予測と適応策の双方を提示することが重要である。これまでに茨城県農業総合センターから生育データ等の提供を受けて、コメの白未熟粒発生割合推定モデルの構築と広域推定などを試みてきた。第三の隘路に対しては気候変動に限らない地域との協働が求められており、茨城大学での取組事例を紹介する。

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キーワード：適応計画、農業、地方自治体

Keywords: Adaptation plans, Agriculture, Local municipalities

都道府県スケールでの都市気候の将来予測における不確実性の評価 Evaluation of uncertainty in future urban climate prediction in prefectural scale

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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 °C. 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 °C in Tokyo, while the one averaged over 15 suburban cities is only 1.5 °C. 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 °C world), is globally-averaged SAT. Under the +1.5 and/or 2 °C world, the increase in SAT in local scale is not 1.5 and/or 2 °C 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 °C 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.

キーワード：都市ヒートアイランド、気候変動、不確実性、適応策

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

気候変動に伴う地域実践型の斜面崩壊リスクモデルの開発

Development of regional slope failure risk model due to climate change

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気候変動に伴う降水の極端化に起因して、短時間降雨量の増大や豪雨頻度の増加が見込まれ、多降雨に対する一層の災害対策の強化が必要とされている。被害を軽減するための予測技術が進展している一方で、気候変動をターゲットとした場合、定性的かつ巨視的な予測評価になる事例が多く、対策の社会実装上で具現化した議論が進めにくい側面を持つ。よって、防災の最前線で活動しなければならない地方自治体でも活用できる地域重点型の定量的な評価モデルの開発が切望される。本取り組みは、人的被害の多い斜面崩壊現象に着目した地域適用型の気候変動も含めたリスクモデルの開発を目的としている。起伏の大きな地形かつ複雑な地質構造を成している長野県をモデルエリアに設定し、斜面崩壊の予測モデル開発は進められた。また、成果として土砂災害警戒区域、危険区域との融合になる対策実践度の高い結果の導出を試みている。

キーワード：発生確率、土砂災害、地域スケール、豪雨

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

大規模気候予測データベース利用手法の提案と影響評価研究への適用：八重山諸島における観光業への影響を例に

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

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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.

キーワード：気候変動、大規模気候予測データ、ツーリズム、八重山諸島

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

ダウンスケーリングによる高解像度地域気候シナリオの開発

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

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異常気象に伴う風水害の頻度や規模など気候変動リスクについて影響、適応及び脆弱性評価のための基盤的な気候情報サービスが大きな関心事となっている。地方自治体など多様な関係当事者のニーズに応えるため、2015年12月に気候変動適応技術社会実装プログラム（SI-CAT）が開始された。全球気候モデル（GCMs）や全球大気モデルと地域気候モデルを用いた大規模アンサンブル実験（d4PDF）、力学／統計ダウンスケーリング手法を用いて、地域の気候変動に対して地方自治体における適切な適応策の検討・策定を支援するために、基準地域メッシュ（3次メッシュ, 水平格子間隔1km）のアンサンブル地域気候シナリオを開発している。

異なる気候モデルによって生じる構造的不確実性を気候変動リスク評価で包括的に扱うために、CMIP5 RCP8.5シナリオの5つの

GCMs（MIROC5、MRI-CGCM3、GFDL-CM3、CSIRO-Mk3-6-0、HadGEM2-ES）をBias Correction Spatial Disaggregation（BCSD）法で統計ダウンスケーリングを行った。ダウンスケーリングは、月平均、日単位の気温と降水量について、現在気候（1970～2005年）および近未来の気候（2020～2055年）の期間で行い、出力ファイル形式はNetCDF4（CF1.6、HDF5圧縮に準拠）である。この地域気候シナリオは、関係当事者のニーズに応えるために拡大中であり、また、データベースにアクセスするためのインターフェイスも開発中である。

統計ダウンスケーリング手法は、豪雨や大雪などの局所的に強制される非線形現象、極端事象を必ずしも上手く表現できない。力学的手法と統計的手法を適切に組み合わせ、関係当事者のニーズがある特定地域への適用を試みている。また、ダウンスケーリングによる付加価値についても検証を進めている。地域気候シナリオに対する現在の取り組みと課題、今後に向けた取り組みについて議論する。

キーワード：ダウンスケーリング、気候変動適応、SI-CAT

Keywords: Downscaling, Climate Change Adaptation, SI-CAT

領域気候d4PDFモデルにおける日本列島陸域夏季地上気温の将来変化 Future changes of surface air temperature in summer over the Japanese archipelago by d4PDF regional climate simulations.

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近年、異常気象と呼ばれるような事象が頻発し我々の生活に甚大な被害を及ぼしている。地球温暖化の進行に伴う気候変化とこのような異常気象との関係に対する関心は高まる一方である。これまで地球温暖化予測計算による様々な解析が実施されているが、アンサンブル数が少ないため、自然変動、すなわち低頻度事象である異常天候や極端気象に伴う不確実性を十分に評価することができなかった。このような問題意識から、高解像度全球大気モデルおよび高解像度領域大気モデルを用いて多数（最大100メンバー）のアンサンブル実験が実施され、「地球温暖化対策に資する気候予測データベース（d4PDF）」が作成された（Mizuta et al. 2016）。領域大気モデルは格子間隔20kmである。将来実験は、産業革命以前より全球気温が4°C昇温した場合を想定しており、CMIP5の6種SST将来変化の空間パターンを与えている。本研究では、d4PDF領域大気モデルの出力結果を用いて、日本域の夏季の地上気温を地点別に評価した。

本研究では領域気候d4PDFモデルの地上気温データを使用する。使用したメンバー数は、過去実験（1951~2011年）を50メンバー、将来4°C昇温実験（2051~2111年）を6種SST×15メンバーである。また地点ごとの観測データとして全国152地点の気象官署のデータを使用する。

地点別の地上気温を再現するには粗い格子間隔20kmの本モデルでは、そのバイアスは地点によって無視できない大きさを持つ。そこで、観測値と過去実験の格子点の値を線形関係と仮定して最小二乗法を用いるバイアス補正方法（Piani et al. 2010）で補正を行った。非常に単純な補正方法ではあるものの、この方法ではすべての地点で十分に誤差を軽減することができた。また、4°C昇温実験については観測値と過去実験の比較から求めた補正係数を適用する。

バイアス補正を実施したモデル出力値の夏季の日平均気温、日最高気温および日最低気温は、どの地点もよりよく改善された。一方で、真夏日日数などはわずかだが過大評価される地点が生じる。たとえば、東京の真夏日は観測値よりわずかに増加を示す。これはモデル出力値が観測値と異なり、海の影響を受けていないためと考えられる。しかし、この差は有意ではない。過去実験同様に補正を施した4°C昇温した将来では、真夏日の日数は過去実験と比べどの地点も5倍程度増加した。この値はSSTの違いにより大きなばらつきを持つ。そしてこの傾向は夏季が最も大きい。

SI-CATでは、4°C昇温した将来実験と同様に2°C昇温した近未来を想定した実験を実施している。現在出力されているデータを用いて、4°C昇温実験と同様に各地点の将来変化を確認した。2°C昇温した近未来では、真夏日の日数は過去実験に比べどの地点も2倍程度の増加がみられる。そして+2°Cの近未来の気候が、過去の気候と+4°Cの将来の気候のほぼ中間に位置していることを確認した。

本研究は、文部科学省委託事業気候変動適応技術社会実装プログラムのもとで行われた。

キーワード：地球温暖化、異常高温

Keywords: global warming, high temperature

長野・岐阜を対象とした力学的ダウンスケーリングによる近未来気候変動予測データの創出

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

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気候変動への適応を議論するための高解像度予測データセット作成に力学的ダウンスケーリングが用いられている。特に統計的ダウンスケーリングに適さない降雨・降雪現象を扱う上では有効である。この発表では長野県の北アルプス周辺の生態系、水資源、スキー産業などへの気候変動の影響を評価することを主目的とした、積雪をはじめとする高解像度気候変動予測データの作成について報告する。データの作成には気象庁気象研究所の非静力学地域気候モデル (Nonhydrostatic Regional Climate Model:NHRCM) を用い、現在気候と将来気候に関して水平解像度20kmから5km、1kmへとダウンスケーリングを実施する。計算領域は5kmでは本州、九州、四国、日本海をほぼ覆う領域とし、1kmでは北アルプスを含む約200km四方とする。さらに、重要領域については積雪の質量再配分モデルを用いて積雪の100m分解能での予測データを目指す。5km実験は31年分を1メンバーとして現在、将来ともに10メンバー程度の計算を行う。

これまでにd4PDFの現在気候を用いた5km実験をほぼ完了した。5km計算値では20km境界値に比べ、より観測に近い地上気温の頻度分布が得られ、バイアス補正を施すことによりさらに観測に近い頻度分布を再現できた。また、20kmでは山岳域の積雪がかなり少なくなっていたが、5kmでは地形の再現性の向上に伴い盆地と山岳域での明瞭な積雪深コントラストを表現できた。さらに日降雪量が多い事例について、長野県内の地域による降雪をもたらす気圧配置の相違について検討し、北部や山沿いでは冬型、盆地では南岸低気圧で大雪になることを確認した。ただし、これらには例外もあり、温暖化により降雪がどのように変化するのか注視する必要がある。

キーワード：非静力学モデル、積雪、温暖化

Keywords: nonhydrostatic model, snow cover, global warming

NHRCMを用いた日本都市域における積雪再現の精度評価

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

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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.

キーワード：積雪深、都市域、都市キャノピースキーム、領域気候モデル

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

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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 throughflows 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 planning to improve the model by introducing these processes.

キーワード：海洋ダウンスケーリング、海洋モデリング、海洋再解析データ、日本近海

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

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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, v_r , 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 related 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).

キーワード : 大気境界層、乱流、キャノピー

Keywords: atmospheric boundary layer, turbulence, canopy

