Preface

Welcome to HESSS4, the fourth International Conference on Hydrology delivers Earth System Science to Society! This is not an ordinary conference organized by scientific societies or unions, but is an exciting opportunity to participate in cross-disciplinary discussions and to be acquainted with researchers from different fields, organized by a small voluntary group in an ad hoc setting.

The first HESSS was held in late February 2007 in Tsukuba, Japan, and motivated the bridge between hydrometeorological sciences and social demands, applying the latest scientific knowledge for solving global water issues. Estimation and reduction of uncertainty in simulations were identified as key leverage points along with an appropriate use of observational datasets in validation and data assimilation. It was the dawn of applying social-ecological modeling into the global scale hydrological modeling system, which incorporates reservoir operation and anthropogenic withdrawals in natural hydrological cycle modeling.

In contrast to HESSS1, which was mainly focused on hydrological sciences, HESSS2 consists of wider cross-disciplinary sciences ranging from plot-scale ecosystem science to global radiation budget studies. HESSS2 was jointly organized by the Global Soil Wetness Project (GSWP) under the Global Land/Atmosphere System Study (GLASS), the AsiaFlux under FLUXNET, the LandFlux-EVAL under the LandFlux initiative of the GEWEX (Global Energy and Water Cycle Experiment) Radiation Panel, and CEOP (Coordinated Energy and Water Cycle Observations Project) under GEWEX.

HESSS3 was held at Seoul National University, Seoul, Korea in August 2013. It was jointly organized with AsiaFlux and Korean Society of Agricultural and Forest Meteorology under the slogan of "Communicating Science to Society: Coping with climate extremes for resilient ecological-societal systems". Three plenary sessions and 18 breakout sessions were hosted, and a vision was set up: a community where science and technology work more directly for sustainable ecological-societal systems.

To synthesize and advance knowledge of climate change impacts, land surface processes, and global energy and water cycles in a further comprehensive manner, the HESSS4 gathers contributions from communities across wider disciplines such as GEWEX/ World Climate Research Programm (WCRP), Coupled Model Intercomparision Project (CMIP)/WCRP, Climate and Cryosphere (CliC)/WCRP, Inter-Sectoral Model Intercomparison Project (ISIMIP), International Land Model Intercomparison Project (ILAMB), Jet Propulsion Laboratory (JPL)/NASA, Earth Observation Research Center (EORC)/JAXA, Data Integration and Analysis System (DIAS), and Half a degree Additional warming Prognosis and Projected Impacts (HAPPI).

It is expected this conference will provide an agora to strengthen synergies between research communities of climate monitoring, modeling, and impacts and to discuss how to deliver scientific achievements to our society. It will provide a chance for early career researchers as well those from developing countries to engage with frontier earth system science approaches to dealing with these problems. A particular scientific focus of the meeting will be on climate extremes and their impacts, acknowledging the importance of these events in a changing climate.

Finally, the meeting organizers would like to acknowledge our supporters from nstitute of Industrial Science, the University of Tokyo (IIS UTokyo SYMPOSIUM No.90), Japan Society for the Promotion of Science (JSPS, 16H06291), International Association of Meteorology and Atmospheric Sciences (IAMAS)/ International Union of Geodesy and Geophysics (IUGG), and Global Energy and Water Cycle Exchanges (GEWEX).

Let's enjoy the HESSS4!

Hyungjun Kim,
Co-chair of the Organizing Committee for HESSS4
Specially Appointed Associate Professor, IIS, the University of Tokyo, Japan

Taikan Oki,
Co-chair of the Organizing Committee for HESSS4
Professor, IIS, the University of Tokyo, Japan

On behalf of the Organizing Committee for HESSS4
May 16th, 2017

Organizing Committee

Scientific Committee

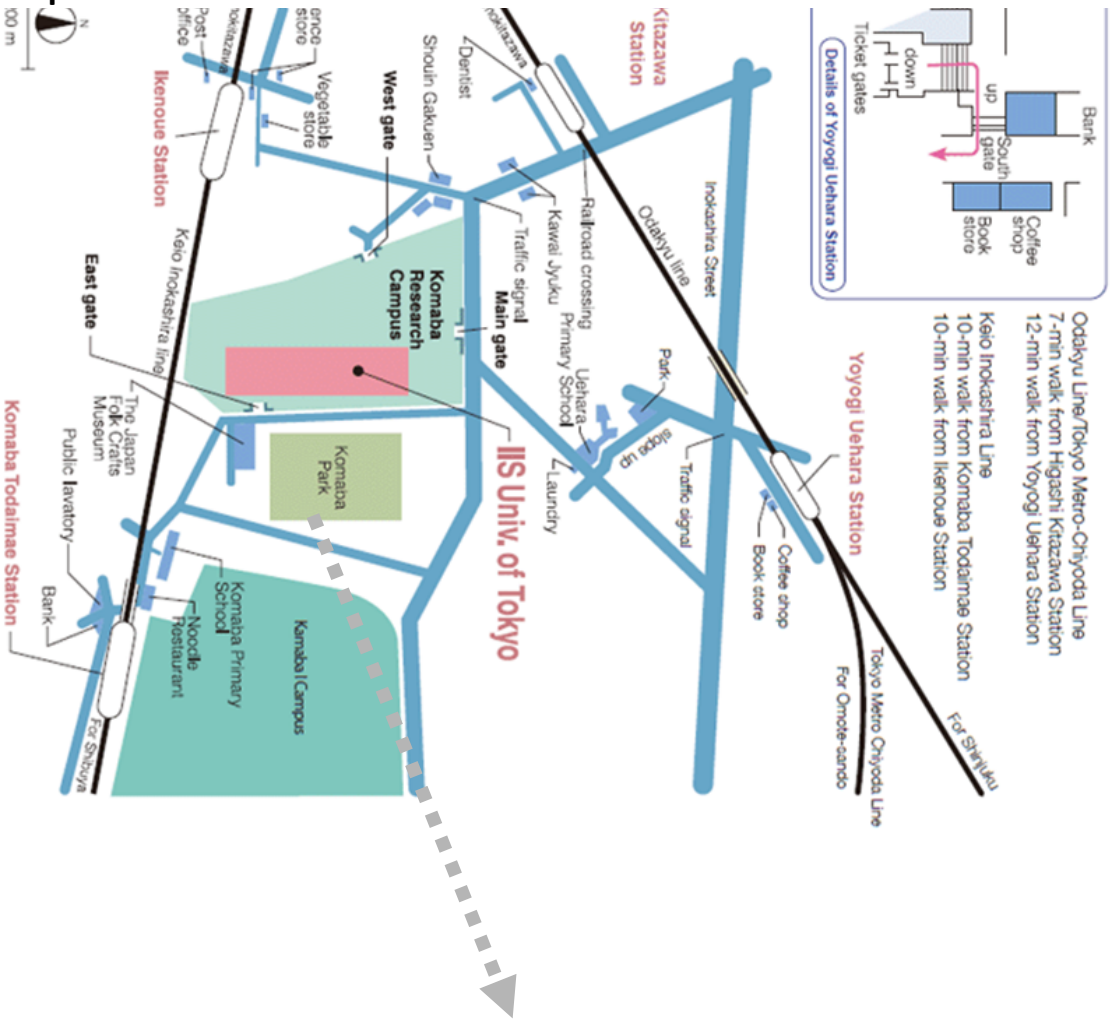
Hyungjun Kim — *The University of Tokyo, Japan* *(Chair)*
Jacob Schewe — *Potsdam Institute for Climate Impact Research, Germany*
Gab Abramowitz — *University of South Wales, Australia*
Michael Ek — *NOAA/NCEP/EMC, USA*
Aaron Boone — *CNRM Meteo-France/CNRS, France*
Sonia Seneviratne — *ETH, Switzerland*
Forrest Hoffman — *Oak Ridge National Laboratory, USA*
James Famiglietti — *NASA Jet Propulsion Laboratory, USA*
Toshiyuki Nakaegawa — *Meteorological Research Institute, Japan*
Taikan Oki — *The University of Tokyo, Japan*

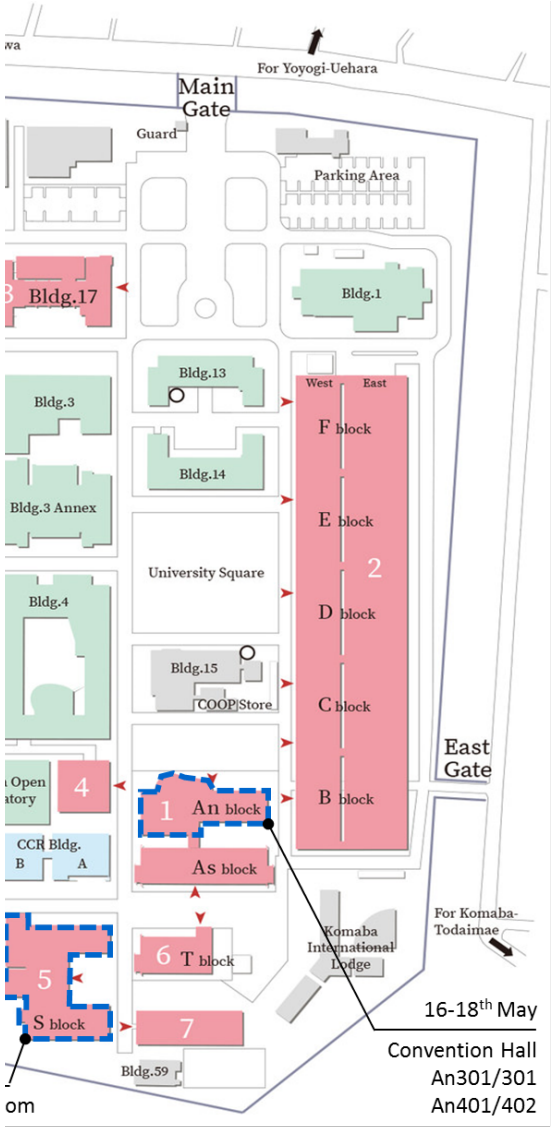
Local Organizing Committee

Ayako Kurosawa, Yuki Tsukada, Yukihiko Onuma, Tomoko Nitta, Dai Yamazaki, Takao Yoshikane, Toshiyuki Nakaegawa, Masashi Kiguchi, Kei Yoshimura, Yukiko Hirabayashi, Hyungjun Kim and Taikan Oki

The University of Tokyo, Japan

Venue Map

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Main Gate
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University Square
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COOP Store
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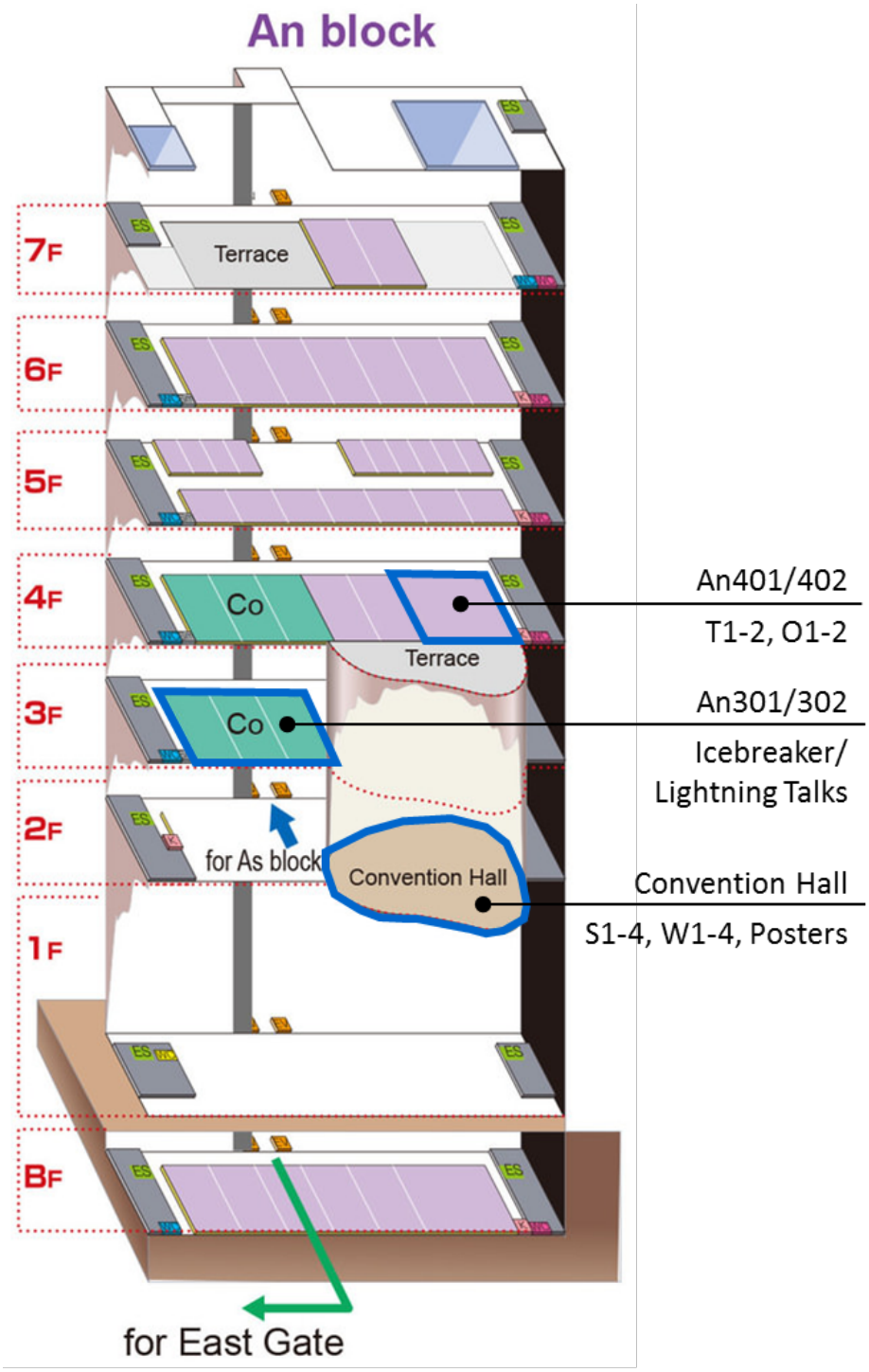
Komaba International Lodge
For Komaba-Todaimae
Bldg.59
16-18th May
Convention Hall
An301/301
An401/402



EV	Elevator & Stairs	WC	WC (Handicapped)
ES	Emaergency Stairs	K	Kettle Room
WC	WC (Men)	Sm	Smoking Room
WC	WC (Women)	Co	Conference Room

Program

05.16 TUE - *DAY1*		
15:00 – 16:00	Registration *@ An401/402*	
16:00 –	Ice breaker / *Lightning talks *@ An301/302*	
05.17 WED - *DAY2*		
08:00 – 08:50	Registration *@ Convention Hall*	
08:50 – 09:00	Welcome address *@ Convention Hall*	
09:00 – 10:30	**S1. Changes of Climate Forcing and Terrestrial Feedback** *@ Convention Hall*	
10:30 – 11:00	*Poster core-time / Coffee break	
11:00 – 12:30	**S2. Changing Climate and Natural-Human System** *@ Convention Hall*	
12:30 – 14:00	Lunch	
14:00 – 15:30	**W1** *@ Convention Hall*	**T1** *@ An401/402*
15:30 – 16:00	*Poster core-time / Coffee break	
16:00 – 17:30	**W2** *@ Convention Hall*	**O1** *@ An401/402*
05.18 THU - *DAY3*		
08:30 – 09:00	Registration *@ Convention Hall*	
09:00 – 10:30	**S3. Satellite Remote Sensing and Model Integration** *@ Convention Hall*	
10:30 – 11:00	*Poster core-time / Coffee break	
11:00 – 12:30	**S4. Dealing with Uncertainties in Model Simulations** *@ Convention Hall*	
12:30 – 14:00	Group Photo / Lunch	
14:00 – 15:30	**W3** *@ Convention Hall*	**T2** *@ An401/402*
15:30 – 16:00	*Poster core-time / Coffee break	
16:00 – 17:30	**W4** *@ Convention Hall*	**O2** *@ An401/402*
17:30 –	Banquet	
05.19 FRI - *DAY4*		
09:00 – 10:30	**S5. Delivering Science to Society** *@ S Block Presentation Room*	
10:30 – 11:00	Poster core-time / Coffee break	
11:00 – 12:30	**S6. General Discussion & Closing Remarks** *@ S Block Presentation Room*	
12:30 – 15:30	**Joint Project Meeting** *(invitation only) @ An401/402*	

* Poster should be prepared in portrait layout which sizes up to A0.
* All poster presenters are invited to Lightning talks session to introduce their posters in 2-min.

Symposium Sessions /* All Invited */

S1. Changes of Climate Forcing and Terrestrial Feedback

<Day2>

9:00-9:20	Assessment of land-climate feedbacks and systematic biases of LSMs: Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP) - *Hyungjun Kim (The University of Tokyo, Japan)*
9:20-9:40	Earth System Model-Snow Model Intercomparison Project (ESM-SnowMIP) - *Gerhard Krinner (LGGE, France)*
9:40-10:00	Advancing our understanding of the impacts of historic and projected land use in the Earth System: The Land Use Model Intercomparison Project (LUMIP) - *Dave Lawrence (NCAR, USA)*
10:00-10:30	Discussion

S2. Changing Climate and Natural-Human System

<Day2>

11:00-11:20	Inter-Sectoral Impact Model Intercomparison Project (ISIMIP): Modeling climate impacts across sectors - *Jacob Schewe (PIK, Germany)*
11:20-11:40	Opportunities and constraints for improved water resources management using different lenses and scales - *Yoshihide Wada (IIASA, Austria)*
11:40-12:00	Specifying sources of humans' water abstraction by using the H08 global hydrological model - *Naota Hanasaki (NIES, Japan)*
12:00-12:30	Discussion

S3. Satellite Remote Sensing and Model Integration

<Day3>

9:00-9:20	Delivering Hydrologic Science to Society:Successes and Challenges in the Western United States - *James Famiglietti (JPL/NASA, USA)*
9:20-9:40	Satellite Remote Sensing and Model Integration in JAXA - *Riko Oki (EORC/JAXA, Japan)*
9:40-10:00	DIAS Contributing to Climate Change Analysis and Disaster Risk Reduction - *Akiyuki Kawasaki (The University of Tokyo, Japan)*
10:00-10:30	Discussion

S4. Dealing with Uncertainties in Model Simulations

<Day3>

11:00-11:20	Systematic Evaluation of Land Surface Models Using the International Land Model Benchmarking (ILAMB) Package - *Forrest Hoffman (Oak Ridge National Laboratory, USA)*
11:20-11:40	Protocol for the Analysis of Land Surface models (PALS) and modelevaluation.org - *Gab Abramowitz (University of South Wales, Australia)*

11:40-12:00 Targeted experiments to assess the Paris Agreement on Climate Change - *Daniel Mitchell (Bristol University, UK)*

12:00-12:30 Discussion

S5. Delivering Science to Society

<Day4>

9:00-9:20 Global Hydrology in the Anthropocene and SDGs - *Taikan Oki (The University of Tokyo, Japan)*

9:20-9:40 Socio-hydrology: Use-inspired Basic Science in the Age of the Anthropocene - *Murugesu Sivapalan (University of Illinois Urbana Champaign, USA)*

9:40-10:00 Sustainable Development Goals (SDG) Lab: Rural Systems Visioneering - *Joon Kim (Seoul National University, Korea)*

10:00-10:30 Discussion

S6. General Discussion & Closing Remarks

<Day4>

11:00-12:30 Reports/Discussion/Closing remarks

Rapporteur: Aaron Boone (Meteo-France, Franch), Ahmed Tawfik (NCAR, USA), Kurt Solander (Loa Alamos National Lab., USA)

Workshop Sessions

W1. Climate Extremes

<Day2>

14:00-14:15 /* Invited */ Climate change and adaptation strategies for flood control plan in Hokkaido, Japan - *Tomohito Yamada (Hokkaido University, Japan)*

14:15-14:30 /* Invited */ California's water cycle extremes: from drought to deluge - *Jin-Ho Yoon (Gwangju Institute of Science and Technology, Korea)*

14:30-14:45 Impacts of climate change on hydrologic extremes under 1.5/2.0C degrees global warming - *Satoshi Watanabe (The University of Tokyo, Japan)*

14:45-15:00 Convection and Land Cover Change: Interpreting simulations, gaps, and moving forward – A*hmed Tawfik (NCAR, USA)*

15:00-15:15 Future projection of extreme precipitation events linked to temperature over Japan under different future scenarios - *Sridhara Nayak (National Research Institute for Earth Science and Disaster Resilience, Japan)*

15:15-15:30 Recent extreme events: What's predictable, what's not, and what to do - *Simon S.-Y. Wang (Utah State University / Utah Climate Center, USA)*

W2. Interaction between Nature and Society

<Day2>

16:00-16:15 /* Invited */ Local and remote climate response to deforestation in Maritime Continent - *Min-Hui Lo (National Taiwan University, Taiwan)*

16:15-16:30 /* Invited */ Historical socio-hydrology in Japan: capturing the regime shifts and phenomena in the modern era - *Shinichiro Nakamura (Nagoya University, Japan)*

16:30-16:45 Multi-Model Regional Simulation of Climate Change Impacts on Agriculture and Ecosystems in the Southwestern United States - *Seung Hee Kim (Chapman University, USA)*

16:45-17:00 100-year Global Warming Potential of Rice Crop Intensity - *DIM Wanndet (Tokyo Institute of Technology, Japan)*

17:00-17:15 Evaluation of the application of the ISI-MIP bias-correction method of future simulations of climate over Indonesia for the implementation of Climate Change Adaptation Plans - *Martin Gomez Garcia (Nippon Koei Co., Ltd. R&D, Japan)*

17:15-17:30 Modeling Impacts of Irrigation on Land Surface Hydrology and Subseasonal Forecast - *Yadu Pokhrel (Michigan State University, USA)*

W3. Hydrologic Forecast and Data Assimilation

<Day3>

14:00-14:15 /* Invited */ Development of global and regional flood forecasting system and their validation - *Kei Yoshimura (The University of Tokyo, Japan)*

14:15-14:30 Sensitivity analysis of historical weather documents for reconstructing past climate - *Panduka Neluwala (The University of Tokyo, Japan)*

14:30-14:45 The Computable Catchment: Interactive media for model-data sharing with implications for scientist-stakeholder access and participation - *Christopher Duffy (Penn State University, USA)*

14:45-15:00 Hydrologic Sciences for Flood Disaster Mitigations: Integration of Local Information and Flood Modeling - *Takahiro Sayama (DPRI, Kyoto University, Japan)*

15:00-15:15 Towards ecohydrological drought monitoring and prediction using a land data assimilation system - *Yohei Sawada (Meteorological Research Institute, Japan Meteorological Agency, Japan)*

15:15-15:30 The performance of land surface and cumulus convection scheme in the simulation of Indian Summer Monsoon using RegCM4 - *Suman Maity (Indian Institute of Technology Kharagpur, Malaysia)*

W4 Satellite Remote Sensing for Extreme Monitoring

<Day3>

16:00-16:15 /* Invited */ Progress in understanding hydrologic flooding using GRACE - *John Reager (NASA JPL, USA)*

16:15-16:30 Distribution of debris thickness and its effect on glacier melt at large

scale - *Yukiko Hirabayashi (The University of Tokyo, Japan)*

16:30-16:45 Reconstructing climate-driven water storage variability - *Vincent Humphrey (ETH Zurich)*

16:45-17:00 Local Ensemble Transform Kalman Filter (LETKF) data assimilation of altimetry data for SWOT mission - *Jean-Francois Vuillaume (The University of Tokyo, Japan)*

17:00-17:15 Global distribution of groundwater-vegetation spatial covariation - *Sujan Koirala (Max Planck Institute for Biogeochemistry)*

17:15-17:30 Heavy rain prediction applying satellite-based cloud data assimilation over land - *Rie Seto (Tokyo Institute of Technology, Japan)*

Tutorial Sessions

T1. ILAMB Model Benchmarking Package I

<Day2>

14:00-15:30 Description, Installation, and Basic Operation - *Nathan Collier (ORNL, USA)*

T2. ILAMB Model Benchmarking Package II

<Day3>

14:00-15:30 User issues, Package Design, and Advanced Usage - *Nathan Collier (ORNL, USA)*

Open Science Sessions

O1. Open GLASS/GEWEX Session

<Day2>

16:00-16:15 TBD
Petrus J van Oevelen (Int. GEWEX Project Office, USA)

16:15-16:30 WCRP and GEWEX science of relevance to GLASS
Sonia Seneviratne (ETH, Switzerland)

16:30-16:45 The current status of activities in the GEWEX Global Land/Atmosphere System Study (GLASS)
Mike Ek (NCEP, USA)

16:45-17:00 GSWP3 as a liaison across communities
Hyungjun Kim (The University of Tokyo, Japan)

17:00-17:30 Discussion

O2. Open ISIMIP Session

<Day3>

16:00-16:15 Simulating the impacts of climate extremes: the case of the 2003 European heat wave - *Jacob Schewe (Potsdam Institute for Climate Impact Research, Germany)*

16:15-16:30 Benchmarking carbon fluxes of the ISIMIP2a biome models - *Jinfeng CHANG (LOCEAN-IPSL, France)*

16:30-16:45 Impact simulations for ISI-MIP with a process-based biome model,

VISIT - *Akihiko Ito (National Institute for Environmental Studies, Japan)*

16:45-17:00 Human impact parameterization in global hydrological models improves estimates of monthly discharges and hydrological extremes: a multi-model validation study - *Ted Veldkamp (VU University Amsterdam, Netherlands)*

17:00-17:30 Discussion

Joint Project Meetings

<Day4>

12:30-15:30 Joint Project Meetings /* invitation only */

Poster Session

01. Regional climate downscaling for risk information -Establishment of CORDEX Asia Empirical-Statistical Downscaling (ESD) Group - *Koji Dairaku (National Research Institute for Earth Science and Disaster Resilience, Japan)*
02. Do Soil Water Limitations Suppress Convection? - *Ahmed Tawfik (NCAR, USA)*
03. Evaluation of high latitudes land climate simulated by MIROC5 AGCM and a wetland scheme - *Tomoko Nitta (The University of Tokyo, Japan)*
04. Current Status of Global and Regional CO2 Budgets - *Masayuki Kondo (Center for Environmental Remote Sensing (CEReS), Chiba University, Japan)*
05. Reconciliation of top-down and bottom-up CO2 fluxes in Siberia larch forest - *Kumiko Takata (National Institute for Environmental Studies, Japan)*
06. Hydroclimatic intensity in 1.5 & 2.0 °C warmer world - *Gavin Madakumbura (The University of Tokyo, Japan)*
07. Analysis of negative emission application status in South Korea Forest. - *Nahui Kim (Korea University, Korea)*
08. Statistical Evaluation of Soil Wetness Changes in Future Climate in CMIP5 Multi-Model Ensembles in East Asia - *Tosiyuki Nakaegawa (Meteorological Research Institute, Japan)*
09. Dynamical downscaling simulation over East Asia using a coupled atmosphere-ocean regional climate model RSM-ROMS - *Xiaojun GUO (The University of Tokyo, Japan)*
10. Valuation Irrigation water by yield comparison approach: global scale - *Sobhan Afraz (The University of Tokyo, Japan)*
11. The Community Water Model (CWATM) - Development of a community driven global water model - *Yusuke Satoh (International Institute for Applied Systems Analysis, Austria)*
12. Global-scale river flood vulnerability in the last 50 years - *Masahiro TANOUE (The University of Tokyo/ Institute of Industrial Science, Japan)*
13. Understanding the soil moisture-climate coupling in irrigation regions of the India through satellite and assimilation data sets - *Zohaibi Muhammad (Sungkyunkwan University, Korea)*
14. Long-term projections of global water use for electricity generation - *Sayaka YOSHIKAWA (Tokyo Institute of Technology, Japan)*
15. Interaction of water, land use, and ecosystem in Integrated Terrestrial Model: a bio-

geophysical land surface model with human components - *Tokuta Yokohata (National Institute for Environmental Studies, Japan)*

16. Impacts of Large-scale Solar Photovoltaic Deployment on Global Climate Variability - *Masahito Omori (The University of Tokyo, Japan)*
17. Intercomparison of regulated river discharge among multiple hydrological models - *Yoshimitsu Masaki (Hirosaki University, Japan)*
18. Springtime trans-Pacific transport of Asian pollutants related to the Western Pacific teleconnection - *Ja-Ho Koo (Yonsei University, Korea)*
19. Uncertainty Of Rainfall Amount And River Discharge In Mountainous Catchments Associated With Spatial Distribution Of Rainfall Observation And Meteorological Prediction - *Konosuke Shibata (Hokkaido University, Japan)*
20. Classification and forecast of heavy rainfall in northern Kyushu during Baiu season using Self-Organizing Maps (SOM) - *Dzung Nguyen-Le (Faculty of Engineering, Hokkaido University, Japan)*
21. Estimation of Flood Discharge by Assimilating Water-Level and Rating Curve into Quasi-2D Hydraulic Model - *Tsuyoshi Hoshino (Hokkaido university, Japan)*
22. Development of a Eulerian global river water temperature model - *Daisuke Tokuda (The University of Tokyo, Japan)*
23. Effect of an exponential decay of saturated hydraulic conductivity on equilibrium soil moisture and water table depth in MAT-GW - *Natsuki Yoshida (The University of Tokyo, Japan)*
24. Benchmarking strategy for multi-model ensemble simulations and optimization of ensemble mean - *Ryotaro Doi (The University of Tokyo, Japan)*
25. Estimating Evapotranspiration with limited climate data in Andong Dam Watershed using FAO56 Penman-Monteith methodology - *Sea Jin Kim (Korea University, Korea)*
26. Evapotranspiration processes are evaluated in global models (hydrological and Land Surface Models) using the iLAMB system and using a new metric to which quantifies different time scales of drying after a rain event - *Eleanor Blyth (Centre for Ecology and Hydrology, UK)*
27. Impacts of soil moisture initialization on boreal summer subseasonal forecasts in the GloSea5 prediction system - *Eunkyo Seo (UNIST, Korea)*
28. Hot Droughts and Hotter Extremes: Investigating Changes in Extreme Hydrology in the Colorado River Basin, USA- *Kurt C. Solander (Los Alamos National Lab., USA)*
29. Interannual variability of snow properties in an upper reach basin of Sapporo area between 2005 and 2017. - *Atsushi Nunokawa (Graduate school of Engineering, Hokkaido University, Japan)*
30. Sea Spray Characteristics under Air-Sea Boundary Layer - *Hiroki Okachi (Hokkaido University, Japan)*
31. Meteorological Characteristics Of A Heavy Snowfall Event Based On Multi-Doppler Radars Over Sapporo Area In 2015 - *Yuta Ohya (Hokkaido University, Japan)*
32. Correction of the rain rate estimates of ground radar using GPM/DPR data - *Tatsuya Shimozuma (Nagasaki University, Japan)*

33. High resolution, high accuracy global topography map for land hydrology modeling - *Dai Yamazaki (The University of Tokyo, Japan)*
34. Impact analysis of meteorological factors and SWI on monthly forest NDVI values - *Dongfan Piao (Korea University, Korea)*

Abstract

Assessment of land-climate feedbacks and systematic biases of LSMs: Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP)

S1

Hyungjun Kim
The University of Tokyo

The solid and liquid water stored at the land surface has a large influence on the regional climate, its variability and its predictability, including effects on the energy and carbon cycles. Notably, snow and soil moisture affect surface radiation and flux partitioning properties, moisture storage and land surface memory. Recently, the Land Surface, Snow and Soil-moisture Model Intercomparison Project (LS3MIP) was initiated as an intercommunity effort between Global Energy and Water Cycle Exchanges Project (GEWEX) and Climate and Cryosphere (CliC) to contribute to the 6th phase of Coupled Model Intercomparison Project (CMIP).

The experiment structure of the LS3MIP was designed to provide a comprehensive assessment of land surface, snow, and soil moisture feedbacks on climate variability and climate change, and to diagnose systematic biases in the land modules of current Atmospheric-Ocean General Circulation Models and Earth System Models with the following objectives:

- evaluate the current state of land processes including surface fluxes, snow cover and soil moisture representation in CMIP6 DECK runs;
- estimate multi-model long-term terrestrial energy/water/carbon cycles, using the surface modules of CMIP6 models under observation constrained historical (land reanalysis) and projected future (impact assessment) conditions considering land use/land cover changes;
- assess the role of snow and soil moisture feedbacks in the regional response to altered climate forcings, focusing on controls of climate extremes, water availability and high-latitude climate in historical and future scenario runs;
- assess the contribution of land surface processes to the current and future predictability of regional temperature/precipitation patterns.

The outcomes of the LS3MIP will eventually contribute to the improvement of climate change projections by reducing the systematic biases and representing better feedback mechanisms in coupled models.

Further, the impacts of climate change on hydrological regimes and available freshwater resources including extreme events, such as floods and droughts, will be assessed based on multi-model ensemble estimates of long-term historical and projected future changes in energy, water, and carbon cycles over land surfaces. Those achievements will contribute to the next cycle of the Intergovernmental Panel on Climate Change.

Corresponding email: hjkim@iis.u-tokyo.ac.jp

ESM-SnowMIP

S1

Gerhard Krinner
IGE/CNRS

Snow has been recognized as an important source of climate feedbacks for a long time. Already in the very first three-dimensional climate simulations, snow caused a substantial drift in the simulated climate, and even today, snow is a sustantial source of inter-model spread in coordinated climate modeling exercises. The ESM-SnowMIP coordinated modeling exercise is a complementary effort to LS3MIP in which we pursue several goals. The first goal is to assess the fitness for purpose of current snow modules in the Earth System Models participating to CMIP6. This is primarily done through site-scale and global-scale uncoupled simulations. On the site scale, the ESM land surface models are compared with (putatively) more elaborate specific snow models in order to identify the optimum complexity and the minimum set of snow-related processes that need to be represented in current-generation Earth System Models. On larger scales, the offline simulations are extensions to LS3MIP simulations that specifically aim at assessing snow-related model performance. A second goal is to better quantify snow-related land surface feedbacks in the Earth System. The required simulations are tightly linked to relevant LS3MIP simulations.

Corresponding email: gerhard.krinner@cnrs.fr

Advancing our understanding of the impacts of historic and projected land use in the Earth System: The Land Use Model Intercomparison Project (LUMIP)

S1

David Lawrence
National Center for Atmospheric Research

Human land-use activities have resulted in large changes to the Earth surface, with resulting implications for climate. In the future, land-use activities are likely to expand and intensify further to meet growing demands for food, fiber, and energy. Â The Land Use Model Intercomparison Project (LUMIP) aims to further advance understanding of the impacts of land-use and land-cover change (LULCC) on climate, specifically addressing the questions: (1) What are the effects of LULCC on climate and biogeochemical cycling (past-future)?Â (2) What are the impacts of land management on surface fluxes of carbon, water, and energy and are there regional land-management strategies with promise to help mitigate against climate change? Â In addressing these questions, LUMIP will also address a range of more detailed science questions to get at process-level attribution, uncertainty, data requirements, and other related issues in more depth and sophistication than possible in a multi-model context to date. There will be particular focus on the separation and quantification of the effects on climate from LULCC relative to all forcings, separation of biogeochemical from biogeophysical effects of land-use, the unique impacts of land-cover change versus land management change, modulation of land-use impact on climate by land-atmosphere coupling strength, and the extent that impacts of enhanced CO2 concentrations on plant photosynthesis are modulated by past and future land use.Â LUMIP involves three major sets of science activities: (1) development of an updated and expanded historical and future land-use dataset, (2) an experimental protocol for specific LUMIP experiments for CMIP6, and (3) definition of metrics and diagnostic protocols that quantify model performance, and related sensitivities, with respect to LULCC.Â In this manuscript, we describe the LUMIP activity (2), i.e., the LUMIP simulations that will formally be part of CMIP6.Â These experiments are explicitly designed to be complementary to simulations requested in the CMIP6 DECK and historical simulations and other CMIP6 MIPs including ScenarioMIP, C4MIP, LS3MIP, and DAMIP.Â LUMIP includes a two-phase experimental design.Â Phase one features idealized coupled and land-only model simulations designed to advance process-level understanding of LULCC impacts on climate, as well as to quantify model sensitivity to potential land-cover and land-use change. Phase two experiments focus on quantification of the historic impact of land use and the potential for future land management decisions to aid in mitigation of climate change. We will present the experimental protocol, explain the rationale, outline plans for analysis, and describe a new subgrid land-use tile data request for selected variables (reporting model output data separately for primary and secondary land, crops, pasture, and urban land-use types).

Corresponding email: dlawren@ucar.edu

ISIMIP: Modeling climate impacts across sectors

S2

Jacob Schewe
Potsdam Institute for Climate Impact Research

In this talk I will present the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP, www.isimip.org). ISIMIP is a community-driven climate-impacts modelling initiative, bringing together teams from different disciplines including hydrology, ecology, or environmental economics. ISIMIP offers a consistent framework for cross-sectoral, cross-scale modelling of the impacts of climate change. The key goal of ISIMIP is to contribute to the comprehensive (cross-sectoral) understanding of the impacts of politically and scientifically-relevant climate-change scenarios. I will outline the project structure, show some selected results, and give an outlook on the upcoming, third phase of ISIMIP. Most importantly perhaps, I will explain how people can participate in ISIMIP, and how it can link to other community initiatives.

Corresponding email: jacob.schewe@pik-potsdam.de

Opportunities and constraints for improved water resources management using different lenses and scales

S2

Yoshihide Wada
International Institute for Applied Systems Analysis

The quest for water security has been a struggle throughout human history. Only in recent years has the scale of this quest moved beyond the local, to the national and regional scales and to the planet itself. Absent or unreliable water supply, sanitation and irrigation services, unmitigated floods and droughts, and degraded water environments severely impact half of the planet's population. Over the past few years, water insecurity has become recognized in the World Economic Forum global risk studies as one of the greatest threats that business leaders themselves see that they face in the future, both in terms of likelihood and scale. The scale and complexity of the water challenges faced by society, particularly but not only in the world's poorest regions, are now recognized, as is the imperative of overcoming these challenges for a stable and equitable world. How can we ensure the well□being of all people and ecosystems with the water, human, technological, and financial resources available? In the framework of the Sustainable Development Goals water has to be managed more effectively and wisely by unlocking scientific, managerial, and business capabilities; breaking out of technological lock-in; and innovative and adaptive portfolios of solutions have to be developed while removing barriers to progress on sound water governance. IIASA's Water Futures and Solutions Initiative (WFAS) is an unprecedented inter-disciplinary scientific initiative to identify robust and adaptive portfolios of optional solutions across different economic sectors, including agriculture, energy and industry, and to test these solution-portfolios with multi□model ensembles of hydrologic and sector models to obtain a clearer picture of the trade□offs, risks, and opportunities. The results of WFaS scenarios and models will provide a basis for long□term strategic planning of water resource development. And given the complexity of the water system, WFaS will uniquely provide policy makers with optional sets of solutions that work together and that can be easily adapted as circumstances change in the future. Water is also all about relationships. As WFaS progresses, it will establish a network involving information exchange, mutual learning and horizontal cooperation across teams of researchers, public and private decision makers and practitioners exploring solutions at regional, national and local scales. The initiative includes a major stakeholder consultation component, to inform and guide the science and to test and refine policy and business outcome.

Corresponding email: wada@iiasa.ac.at

Specifying sources of humans' water abstraction by using the H08 global hydrological model

S2

Naota Hanasaki
National Institute for Environmental Studies

Humans abstract water from various water sources to sustain their livelihood and society. Some of global hydrological models include explicit schemes of humans' water abstraction, but their representations and performances are still largely limited. Here we substantially enhanced the water abstraction schemes of the H08 global hydrological model. It enabled us to estimate water abstraction from six major water sources, namely, streamflow regulated by global reservoirs (i.e. reservoirs regulating the flow of the world major rivers), aqueduct water transfer, local reservoirs, seawater desalination, renewable groundwater, and non-renewable groundwater. In a standard setup, the model covers the whole globe at the 0.5Â°Ã—0.5Â° of spatial resolution, and the calculation interval is a day. Water balance is always closed at any calculation grid-cells and time intervals. A global hydrological simulation was conducted to validate the performance of model for the period of 1979-2013. The simulated water fluxes on water abstraction were extensively validated with those reported in earlier publications and showed good and fair agreement at the global and country scale respectively. The simulated monthly river discharge and terrestrial water storage of six heavily human-affected river basins in the world were compared with the observation at river gauging stations and a satellite product of the Gravity Retrieval and Climate Experiment mission (GRACE). The results indicated that in circa 2000, of total 3628 km3yr-1 freshwater requirement globally, 2839 km3yr-1 was taken from surface water, 789 km3yr-1 from groundwater. Streamflow, aqueduct water transfer, local reservoir, and seawater desalination accounted for 1786, 199, 106, 1.8 km3yr-1 of surface water respectively. For remaining 747 km3yr-1 of surface water requirement was unmet, or surface water was not available when and where it is needed in our simulation. Renewable and non-renewable groundwater accounted for 607 and 182 km3yr-1 of groundwater respectively. Each source differs in renewability, economic costs for development, and environmental consequences for usage. The model would be useful to enhance the global water resources assessments by adding the aspects of sustainability, economy, and environment.

Corresponding email: hanasaki@nies.go.jp

Delivering Hydrologic Science to Society:Successes and Challenges in the Western United States

S3

Jay Famiglietti
California Institute of Technology, NASA Jet Propulsion Laboratory

Delivering hydrologic science to society is a noble cause that our community should engage in. However, while the delivery of hydrologic information is straightforward, its uptake and use by stakeholders and the general public is more challenging. Our team at the University of California, Irvine, and at Caltech's NASA Jet Propulsion Laboratory, has been deeply engaged in such efforts for nearly a decade. From the local water district to federal levels, and from the everyday citizen, to regional water managers and to the U. S. Congress, we continue to traverse the water landscape to inform, educate, and share important data, observations and methods. In this presentation I will share some of our success and failures, while highlighting critical challenges that our community must face in its efforts to better address societal needs.

Corresponding email: James.Famiglietti@jpl.nasa.gov

Satellite Remote Sensing and Model Integration in JAXA

S3

R. Oki, T. Kubota, M. Kachi, K. Yoshimura
The Japan Aerospace Exploration Agency

The Japan Aerospace Exploration Agency (JAXA) Earth Observation Research Center provides various kinds of dataset from JAXA Satellite Monitoring for Environment Study (JASMES) [http://kuroshio.eorc.jaxa.jp/JASMES/], Global Satellite Mapping of Precipitation (GSMaP), and Himawari-Monitor [http://www.eorc.jaxa.jp/ptree/]. These datasets are based upon observations from JAXA's "SHIZUKU" or the Global Change Observation Mission - Water (GCOM-W) satellite, Global Precipitation Measurement (GPM) mission, the JMA's Himawari-8, and so on. Data from the Second Generation Global Imager (SGLI) for the future GCOM – Climate (GCOM-C) mission and Earth Cloud, Aerosol and Radiation Explorer (EarthCARE) will be also used when it becomes available after their launches.

Users can access those data by searching sensor/satellite names and at the same time they can find datasets by topic by topic. In recent years, multi sensor/satellite data processing becomes more common. For example, JAXA processes GSMaP, which is a blended Microwave-IR precipitation product and has been developed in Japan toward the GPM mission.

Progress in satellite remote sensing data and model integration area is remarkable. JAXA/EORC is developing both global and local (Japan area) land surface simulation systems, called the Yesterday's Earth at EORC (YEE), in collaboration with the University of Tokyo for water cycle research. Satellite observation data is used as inputs to the land surface model as well as objective analysis or forecast data of meteorological parameters at the surface. GSMaP is also used as input for YEE. In addition, GSMaP will be used for data assimilation in NICAM-LETKF developed by RIKEN for short range weather forecast.

These datasets can contribute to global water cycle studies. Furthermore, the JAXA/EORC is developing Joint-Simulator (Joint Simulator for Satellite Sensors) with universities and research institutes, which is helpful for evaluations of climate models with satellite data.

DIAS Contributing to Climate Change Analysis and Disaster Risk Reduction

S3

Akiyuki Kawasaki
The University of Tokyo

In 2015, global attempts were made to reconcile the relationship between development and environmental issues. This led to the adoption of key agreements such as the Sustainable Development Goals. In this regard, it is important to identify and evaluate under-recognized disaster risks that hinder sustainable development: measures to mitigate climate change are the same as those that build resilience against climate-related disasters. To do this we need to advance scientific and technical knowledge, build data infrastructure that allows us to predict events with greater accuracy, and develop data archives. For this reason we have developed the Data Integration and Analysis System (DIAS). DIAS incorporates analysis, data and models from many fields and disciplines. It collects and stores data from satellites, ground observation stations and numerical weather prediction models; integrates this data with geographical and socio-economic information; then generates results for crisis management of global environmental issues. This presentation gives an overview of DIAS and summarizes its application to climate change analysis and disaster risk reduction. DIAS aims to initiate cooperation between different stakeholders, and contribute to the creation of scientific knowledge. DIAS provides a model for sharing transdisciplinary research data that is essential for achieving the goal of sustainable development. In the presentation, following the introduction of DIAS, the Coupled Model Intercomparison Project 5 (CMIP5) analysis tool will be introduced for supporting climate change analysis. Then, the Asia Water Cycle Initiative (AWCI) and International Flood Initiative (IFI) and its related activates were summarized as data sharing and networking for social problem solving. Analysis on climate change and flood risk reduction in Asian and African countries will be demonstrated as a case study.

Corresponding email: kawasaki@hydra.t.u-tokyo.ac.jp

Systematic Evaluation of Land Surface Models Using the International Land Model Benchmarking (ILAMB) Package

S4

Forrest M. Hoffman
Oak Ridge National Laboratory

As Earth system models (ESMs) become increasingly complex, there is a growing need for comprehensive and multi-faceted evaluation of model predictions. To advance understanding of biogeochemical processes and their interactions with hydrology and climate under conditions of increasing atmospheric carbon dioxide, new methods are needed that use observations to constrain model predictions, inform model development, and identify needed measurements and field experiments. Improved process parameterizations are needed to constrain energy and water predictions in land surface models and better representations of biogeochemistry–climate feedbacks and ecosystem processes in ESMs are essential for reducing uncertainties associated with projections of climate change during the remainder of the 21st century. The International Land Model Benchmarking (ILAMB) project seeks to 1) develop internationally accepted benchmarks for land model performance, 2) promote use of benchmarks for model intercomparison projects, 3) strengthen linkages between experimental, remote sensing, and modeling communities, and 4) support the design and development of an open source benchmarking software system. Leveraging work on past model evaluation studies, we have developed two generations of such benchmarking software packages that assess model fidelity on 24 variables in four categories from about 45 data sets; produce graphical global-, regional-, and site-level diagnostics; and provide a hierarchical scoring system. The ILAMBv2 package, publicly released in May 2016, has become an integral part of model verification workflow for rapid model development and calibration cycles for the U.S. Department of Energy's Accelerated Climate Modeling for Energy (ACME) model and the Community Earth System Model (CESM). We will present results from model analysis using the ILAMB packages, discuss techniques for routine model evaluation, propose coordinated evaluation of the Sixth Phase of the Coupled Model Intercomparison Project (CMIP6) output, and describe new metrics that integrate across carbon, surface energy, hydrology, and land use disciplines.

Corresponding email: forrest@climatemodeling.org

Protocol for the Analysis of Land Surface models (PALS) and modelevaluation.org

S4

Gab Abramowitz
UNSW Sydney

The first phase of the PALS web application provided benchmarking and evaluation of land surface models at around 40 flux tower sites using a fixed set of metrics. PALS was used for the PALS Land sUrface Model Benchmarking Evaluation pRoject (PLUMBER, a model intercomparison experiment), which used out of sample empirical models as benchmarks, defining model performance expectations a priori. The modelevaluation.org project builds on the strengths of PALS, focusing on benchmarking and workflow traceability in an online environment, while expanding the scope of potential experiments. It is designed to able to utilise different packages as analysis 'engines', such as ILAMB, LVT or ESMValTool, as well it's own package based around the PALS R package, but expanded to regional and global analyses. The distributed design of the application also means that analysis engines can be set up in virtual machines colocated with large model outputs, with users still maintaining a single interface with the main web application. In this new system, the nature and scope of an experiment is controlled by users, meaning that global gridded analyses function in the same way as site-based flux tower analyses, or indeed any other application outside climate or ecosystem modelling. This allows for relatively easy use of the system for both team-based model development and international MIPs, in an environment that stores ancillary information, aiding reproducibility and allowing the potential for data mining of ancillary information as part of analyses. This presentation will detail the design and workflow of the modelevaluation.org system.

Corresponding email: gabriel@unsw.edu.au

Targeted experiments to assess the Paris Agreement on Climate Change

S4

Dann Mitchell
University of Bristol

The Intergovernmental Panel on Climate Change (IPCC) has accepted the invitation from the UNFCCC to provide a special report on the impacts of global warming of 1.5C above pre-industrial levels and related global greenhouse gas emission pathways. Many current experiments in, for example, the Coupled Model Inter-comparison Project (CMIP), are not specifically designed for inform- ing this report. Here, we document the design of the Half a degree Additional warming, Projections, Prognosis and Impacts (HAPPI) experiment. HAPPI provides a framework for the generation of climate data describing how the climate, and in particular extreme weather, might differ from the present day in worlds that are 1.5C and 2.0C warmer than pre-industrial conditions. Output from 10 participating climate models includes variables frequently used by a range of impact models. The key challenge is to separate the impact of an additional approximately half degree of warming from uncertainty in climate model responses and internal climate variability that dominate CMIP-style experiments. Large ensembles of simulations (>50 members) of atmosphere-only models for three time slice experiments are proposed, each a decade in length; the first being the most recent observed 10-year period (2006-2015), the second two being estimates of the a similar decade but under 1.5 and 2C conditions a century in the future. We use the Representative Concentration Pathways 2.6 (RCP2.6) to provide the model boundary conditions for the 1.5C scenario, and a weighted combination of RCP2.6 and RCP4.5 for the 2C scenario.

Corresponding email: d.m.mitchell@bristol.ac.uk

Global Hydrology in the Anthropocene and SDGs

S5

Taikan Oki
The University of Tokyo

Due to the high temporal and spatial variabilities in hydrological cycles, human beings has been required to develop facilities to regulate water resources in order to mitigate the seasonally uneven distribution of available freshwater resources by averaging the temporal variation with millions of artificial reservoirs, lakes, and ponds in the world, and the geographically uneven distribution by physically transferring water through enormous lengths of canals and channels, sometimes tans-boundary manner, even though only 10% of maximum available blue water and 30% of green water resources are used globally at present. Consequentially, real hydrologic cycles on the current Earth is not natural anymore and we see a lot of traces of human interventions on hydrologic cycles even on the global scale. Further, owing to the water's comparatively low price per weight and the cost of transportation, it is rarely transported by itself over long distances more than 500 km (with the exception of bottled water), and water is an absolutely local resource without a single international price. On the contrary, the prices of agricultural products are sufficiently high compared to transportation costs, and their trades are feasible. From water resources management point of view, the international trade in water-intensive commodities between water-abundant and water-poor countries can help water-poor countries save resources, and this process is called as "virtual water trade". Based on the latest estimate of the virtual water trade, it can be illustrated that rich but water-scarce countries tend to reduce local water consumption by importing virtual water. In addition, it was prevailed from an analysis that nations characterized by net virtual water exports have higher water resources and income per capita and that no countries fall below a certain threshold with respect to both GDP and water resources. These points suggest that the virtual water trade is explained by economic characteristics of water and that sustainable development depends on promoting the co-development of poverty alleviation and water resource development. In the era of the 2030 Agenda of the United Nations, water is not only the 7th Goal of the Sustainable Development Goals (SDGs) but one of key cross-cutting issues among many SDGs. The comparatively low price, huge amount of daily consumption, and natural recycling characterize water as a unique natural resources and we should promote developing more scientific and technological capacity on monitoring, understanding, predicting, and managing water to support achieving SDGs.

Corresponding email: taikan@iis.u-tokyo.ac.jp

Socio-hydrology: Use-inspired Basic Science in the Age of the Anthropocene

S5

Murugesu Sivapalan
University of Illinois at Urbana-Champaign

We are well and truly in the Anthropocene. Humans can no longer be considered as mere external drivers or boundary conditions in water and environmental systems. The interactions and feedbacks between human actions and water cycle dynamics are throwing up a range of emergent ''big problems.'' Understanding and offering sustainable solutions to these ''big problems'' require a broadening of the water sciences to embrace the perspectives of both social and natural scientists. The new science of socio-hydrology was introduced with this in mind and deals with the dynamics arising from the bi-directional feedbacks between coupled human-water systems. How the water system responds to human alterations or interferences is governed by natural laws and has been well studied through decades of hydrologic research. How the human system responds to hydrologic variability and change involves human choices and/or tradeoffs governed loosely by societal laws. Tradeoffs can be of many kinds: between humans and the environment, between different sectors using water, or between different groups in society. Within the prevailing environmental and resource milieu, tradeoffs are mediated by human values and norms, which are in turn shaped by the dynamics of the human-water system and must therefore be treated as endogenous to the system. Values and norms can vary along upstream-downstream, urban-rural, humid-arid, rich-poor, or technological-green society gradients. In this way tradeoffs can have a spatial dimension, and over a period of time can manifest in patterns of legacy effects recorded in the land/human-scapes. Bringing together the perspectives of both social and natural scientists dealing with water is good for water sciences, having the salutary effect of revitalizing them as use-inspired basic science. It is good for management too, in that the broader, holistic perspectives provided by socio-hydrology can help recognize potential ''big'' problems that may otherwise be unforeseen and, equally, identify potential ''alternative'' solutions to otherwise intractable problems.

Corresponding email: sivapala@illinois.edu

Sustainable Development Goals (SDG) Lab: Rural Systems Visioneering

S5

Joon Kim
Seoul National University

To make breakthroughs on the Sustainable Development Goals (SDG) Labs initiatives, we are establishing the 'Rural Systems Visioneering (RSV)' SDG Lab in the Arusha region in northern Tanzania. 'RSV' SDG Lab will focus on clean water and sanitation (SDG 6), affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12) and life on land (SDG 15) by (1) co-creating innovative sustainability science & technology necessary for the renewable energy-based electrical, climate-smart agricultural, and resilience-based educational fields with the 'Tanzania-Korea Innovative Energy Technology (IeT) Center' through cooperation with the local 'Nelson-Mandela African Institute of Science and Technology and (2) co-growing with rural villages in Arusha through visioneering - a triad of governance, management and monitoring for sustainable rural-urban systems. To mobilize rural people and villages, the following applications will be supplemented to the already initiated Tanzania-Korea IeT Center: (1) the conceptual framework of 'self-organizing hierarchical open systems with visioneering', (2) sustainability education with focuses on nurturing the basic and key competences for sustainability (e.g., systems thinking, normative, strategic, and anticipatory competences), (3) climate-smart agriculture and its quantitative assessment based on biotic/network/thermodynamic indicators by monitoring and modeling energy-matter-information flows in and out of rural systems using (eventually inexpensive) flux measurement, computer modeling and remote sensing, (4) multiagent-based systems analysis for emergent solutions for better productivity and profit for heterogeneous smallholder farmers, and (5) linking the above-mentioned efforts to the rural communities with feedback loops (i.e., guided self-organization process) to create profit, to promote businesses, and to nurture entrepreneurship with stewardship that ensures sustainability. The main objective of this presentation is to introduce 'RSV' SDG Lab initiative to the HESSS community and to share critical information and potential resources for collaborations.

Corresponding email: joon@snu.ac.kr

Climate change and adaptation strategies for flood control plan in Hokkaido, Japan

W1

Tomohito Yamada
Hokkaido University

The modern history with modern hydrological technologies in Japan was started from Meiji modern era (1868-1912) with import of Dutch river engineering. After this technological revolution, Japanese society had been rapidly changed from “green society” to “technological society” (Di Baldassarre et al., 2015) within just a century. During this changing, in general, Japan had also faced some of typical socio-hydrological phenomena which observed in other countries and basins: levee effect, pendulum swing, lock-in situation etc. However, these phenomena have not been explained in the context of socio-hydrology and quantitative analysis with historical dataset. Then, our research group has been tried to develop the historical dataset related human-flood dynamics in the Japanese modern era and capture historical regime shifts in the society. In this presentation, we show that Japanese modern era is separated into three specific historical classifications with socio-hydrological regime shifts, and a typical phenomenon in this rapid changing society, “levee growth”, which is observed by our historical spatial analysis with using old maps.

Corresponding email: tomohito@eng.hokudai.ac.jp

California's water cycle extremes: from drought to deluge

W1

Jin-Ho Yoon
Gwangju Institute of Science and Technology

More climate extreme events have occurred in recent years, including the continual development of extreme drought in California, the severe cold winters in the eastern U.S. since 2014, 2015 Washington drought, and excessive wildfire events over Alaska in 2015. In case of California and the Western United States, this severe drought is changing to extreme flood condition in the winter of 2016-17. These have been casually attributed to global warming. However, a need for further understanding of mechanisms responsible for climate extremes is growing. In this presentation, we'll use sets of climate model simulation that designed to identify the role of the oceanic feedback in increasing climate extremes under global warming.

Corresponding email: yjinho@gist.ac.kr

Impacts of climate change on hydrologic extremes under 1.5/2.0C degrees global warming

W1

Satoshi Watanabe
The University of Tokyo

The changes of hydrological extremes under 1.5/2.0C degrees global warming are estimated based on the multi-model super ensemble experiments. After the Paris agreement, the importance of projection for 1.5/2.0C degrees global warming is emerging. This study projects hydrological cycles under 1.5/2.0C degrees warmer climates and assess the associated impacts. Since the estimation of uncertainty is indispensable in the assessment of extreme, using a large set of ensemble simulations is a straightforward way to deliver appropriate information. In this study, the results of Half a degree Additional warming, Prognosis and Projected Impacts (HAPPI) project are used. In total, 400 ensemble experiments from four climate models are prepared for each warming condition (i.e., historical, 1.5C, and 2.0C warming). To effectively use the super ensemble experiments at the affordable computational costs, we adopt a strategy to directly use the original runoff projections by climate models in contrast to the typical approach running a hydrological model forced by atmospheric boundary conditions by climate models. In this study, we suggest to correct bias of the runoff projected by climate models rather than meteorological variables. The proposed method adjusts the bias based on the runoff simulated by the previous study which aims to reproduce historical hydrology. Hydrological projections based on the bias adjusted runoff from super ensemble experiments reveal the impact of climate change on hydrology, especially for extremes, under 1.5/2.0C degrees global warming.

Corresponding email: stswata@sogo.t.u-tokyo.ac.jp

Exploring the propagation of uncertainty in rainfall extremes through to a range of hydrological outcomes: floods, droughts, soil moisture, evapotranspiration, surface runoff and groundwater recharge

W1

Eleanor Blyth
Centre for Ecology and Hydrology

Rainfall data is the most important and the most uncertain of all the climate variables when considering hydrological impacts. This is true both of observations and of model forecasts of rainfall. This uncertainty drives many initiatives: new satellite products are newly available which may improve information about rainfall in data-sparse areas and numerical weather prediction is continually improving. But how good is 'good enough' in terms of rainfall for predicting hydrological outcomes such as floods, droughts and water resources? Uncertainties relating to total amounts, spatial and temporal distributions of intensity and specific locations especially in extreme rainfall events all have a different impact. Here we explore the issue of 'how good is good enough' in terms of precipitation data provided at large scales (25km). We use a suite of land surface and hydrology models to explore how uncertainty in the rainfall propagates through the land to essential hydrological outputs: floods, droughts, soil moisture, evapotranspiration, surface runoff and groundwater recharge. We will examine this issue over Iberia by studying the outputs of an ensemble of models run by a suite of distributed rainfall products that sample the uncertainty of rainfall amounts in this area. All the models are run with the same meteorological forcing data including a 20-member ensemble of rainfall created from satellite data products which samples the uncertainty in that region. This study is part of the European Union FP7 EartH2Observe project. We will analyse the convergence or divergence of the model outputs in terms of the hydrological outputs. This analysis will indicate the accuracy of the rainfall amount needed for various hydrological applications. We will expand the analysis to the global scale by analysing the results from a set of models run with a range of global satellite derived products. The resulting analysis will indicate what accuracy is needed in terms of precipitation for use in different hydrological impacts. The conclusions will inform both the satellite data-retrieval community and atmospheric model community as well as land surface and hydrology modellers.

Corresponding email: emb@ceh.ac.uk

Future projection of extreme precipitation events linked to temperature over Japan under different future scenarios

W1

Sridhara Nayak
National Research Institute for Earth Science and Disaster Resilience

A number of studies have suggested that the extreme precipitation events are increased in many regions across the world (IPCC 2007, 2012) due to atmospheric warming. This argument is based on the Clausius-Clapeyron (CC) relationship which states that atmosphere can hold more moisture at a rate of 7% per degree rise in temperature (Trensberth, 2003). In our study, we analyzed multi-GCMs/RCMs ensemble experiment results to provide the possible scenarios of extreme precipitation events linked temperature in past 50 years and their future changes in coming 100 years under difference future scenarios (A1B, RCP4.5, 4K warming). We analyzed 167 ensemble results [140 experiments with the NHRCM (50 experiments for present climate: 1951-2010 & 90 experiments for future climate: 2051-2110, 4K warming) and 27 experiments with the NHRCM, WRF, NRAMS (15 experiments for the current: 1981-2000; 9 for the future: 2081-2100, RCP4.5 and 3 experiments with A1B scenario)]. Precipitation intensities of wet days (defined as â‰¥ 0.05 mm/d) are stratified to different bins with 1Â°C temperature interval and different percentiles (50%, 75%, 85%, 90%, 95%, 97%, and 99%) of precipitation are computed in each bin. The results of the current climate are validated against APHRODITE and AMeDAS observations. The results indicate that all percentiles of precipitation intensities basically follow the CC relationship and increase with temperature up to a certain degree (~19-21Â°C), above which further increases of temperature cause decreases of precipitation intensities. The range of uncertainty varies with the percentile of extreme events and greater uncertainty correlates to a higher percentiles. However, observations are almost within the range of uncertainty of one standard deviation. Extreme precipitation intensities are significantly increased by 5-15 mm/d in future climate for temperatures above ~21Â°C in under SRES A1B, while the same is increase by 5 mm/d for temperatures above ~21Â°C under RCP4.5 scenario and by ~30 mm/d for the temperatures above ~24Â°C under 4K warming. The rates of change of extreme precipitation intensities are noticed to be consistent under all future scenarios and are increased by ~2%/Â°C in future. We find that the increase of extreme precipitation intensities is associated with strong upward motion of air (which is found to be stronger in future) and substantial increase of water vapor under the future scenario.

Corresponding email: sridharanayakiitkgp@gmail.com

Recent extreme events: What's predictable, what's not, and what to do

W1

Simon S.-Y. Wang
Utah State University / Utah Climate Center

Increasing extreme weather and climate events have resulted in tremendous loss of life and property worldwide. Record-breaking extreme heat and heavy precipitation events are steadily growing, driving a significant surge of academic interest in projection and attribution analyses of such extremes. Emerging new theories regarding the increased weather/climate extremes present an exciting new development in science; however, newly proposed mechanisms can contradict each other or be overgeneralized. Controversial theories (such as recent debates regarding Arctic amplification) can confuse the public and concerned stakeholders who are not familiar with meteorology and climate dynamics. Likewise, overgeneralized concepts do little to advance the prediction of extreme events. This presentation is designed to highlight the different pathways that climate mechanisms engender extreme events as well as harness that information to improve extreme event prediction. This presentation will illustrate recent studies of flood events in North America, including the 2017 California flood (that dramatically reversed the unprecedented drought), 2016 Louisiana flood (that rivals Hurricane Katrina), 2015-2016 Texas floods, 2016 West Virginia flood (an event exceeding 1-in-1000-year probability), and the great 2011 Missouri River flood (a success story!). The goal of this talk is to be inclusive of the diverse theories by (a) integrating the different views and approaches in research of climate extremes and, (b) transitioning the systematically acquired scientific knowledge to benefit the potential in forecasting from a meteorological perspective.

Corresponding email: simon.wang@usu.edu

Local and remote climate response to deforestation in Maritime Continent

W2

Min-Hui Lo
National Taiwan University

Deforestation in tropical regions would lead to changes in local energy and moisture budget, resulting in further impacts on regional and global climate. Previous studies have indicated that the reduction of evapotranspiration dominates the influence of tropical deforestation, which causes a warmer and drier climate. Most studies agree that the deforestation leads to an increase in temperature and decline in precipitation over the deforested area. However, unlike Amazon or Africa, Maritime Continent consists of islands surrounded by oceans so the drying effects found in Amazon or Africa may not be the case in Maritime Continent. Thus, our objective is to investigate the local and remote climate responses to deforestation in such unique region. We conduct deforestation experiments using NCAR Community Earth System Model (CESM) and through converting the tropical rainforest into grassland. The preliminary results show that deforestation in Maritime Continent leads to an increase in both temperature and precipitation, which is not predicted by earlier studies. We will further perform moisture budget analysis to explore how the precipitation changes with the deforestation forcing.

Corresponding email: minhuilo@ntu.edu.tw

Historical socio-hydrology in Japan: capturing the regime shifts and phenomena in the modern era

W2

Shinichiro Nakamura
Nagoya University

Socio-hydrology, which is a new science proposed by Sivapalan et al. (2012), aims to understand a coupled human-water system dynamics. In this new field, historical analysis has been recognized as one of fundamental way to seek the coupled system because analysis of the past at different locations helps to discover principles or regularities behind the systems. Therefore, Pande and Sivapalan (2016) defined the historic way of socio-hydrological research as “historical socio-hydrology” with the other two pathways. Although purpose of the historical socio-hydrology is to capture a couple system from its distant past with using historical dataset, we recognized that the limitation of long historic data is a big barrier to conduct this research because such data had often been documented in historical narratives and not in format. The further study of historical socio-hydrology and capturing the coupled systems with long historical dataset is needed.
The modern history with modern hydrological technologies in Japan was started from Meiji modern era (1868-1912) with import of Dutch river engineering. After this technological revolution, Japanese society had been rapidly changed from “green society” to “technological society” (Di Baldassarre et al., 2015) within just a century. During this changing, in general, Japan had also faced some of typical socio-hydrological phenomena which observed in other countries and basins: levee effect, pendulum swing, lock-in situation etc. However, these phenomena have not been explained in the context of socio-hydrology and quantitative analysis with historical dataset. Then, our research group has been tried to develop the historical dataset related human-flood dynamics in the Japanese modern era and capture historical regime shifts in the society. In this presentation, we show that Japanese modern era is separated into three specific historical classifications with socio-hydrological regime shifts, and a typical phenomenon in this rapid changing society, “levee growth”, which is observed by our historical spatial analysis with using old maps.

Corresponding email: shinichiro@civil.nagoya-u.ac.jp

Multi-Model Regional Simulation of Climate Change Impacts on Agriculture and Ecosystems in the Southwestern United States

W2

Seung Hee Kim
Chapman University

Natural and agricultural ecosystems play a major role in various processes in the earth system including the carbon, energy and water cycles. To understand climate impacts in the next several decades, it is essential to couple the regional processes to the overall global climate system. In this study, we employed a system utilizing regional modeling to downscale from the global to regional levels and to capture the potential impacts of climate variability and change on agroecosystem. To assess climate variability and change impacts on agricultural system, we employed Agricultural Production Systems sIMulator (APSIMregions) process-based crop model, having ability of regional scale assessment, to evaluate maize yield potential and assess proper adaptation strategies in the future. The sensitivity of maize yields to the regional climate in the Southwestern U.S. (SWUS) showed that potential crop production responded nonlinearly to variations in Tmax, Tmin, and downwelling solar radiation at the surface. Future projection based on RCP8.5 scenario shows significant decrease of maize yield potential over the warmer climate region but the increased temperature appears to be beneficial in cooler region. The results also indicate that the yields are highly sensitive to planting dates both spatially and interannually, depending on local climates. In the study region, daily temperatures are positively affected by North American Oscillation (NAO) during the early warm season. The results imply that NAO is associated with both optimal planting date and water resources in the region by modulating timing and period of snow melting in the region. The results also emphasize that interdisciplinary collaborations across different fields are needed to better understand future climate change and its impacts.

Corresponding email: sekim@chapman.edu

100-year Global Warming Potential of Rice Crop Intensity

W2

DIM Wanndet
Tokyo Institute of Technology

The complex nexus between the food balance and climate change currently essential to have a better understanding the food security challenge and production in term of climate change mitigation. Most recently study is the life cycle assessment (LCA) methods where provides a way to quantify the climate impacts of a food product by accounting for all greenhouse gas (GHG) emissions associated with its production, including upstream and downstream from the farm. The main characterization factor reported by the midpoint impact LCA is the 100-year global warming potential (GWP), based on carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O); and expressed as kgCO2-equivalent. Here, the main aspect is by using the existing data from global crop-specific circa 2000: i) to spatial the different emissions composition of GHG emissions and ii) estimates GWP100, in rice crop intensity in two specifications as per area and production units. Rice production has received significant attention in the global climate change discourse due to its uniqueness among cultivated crops for emitting both CH4 and N2O, two GHGs are more potent than CO2 in driving climate change. CH4 and N2O emission were converted into CO2 equivalent using the IPCC 4th report of global warming potential (GWP) coefficient of 25 and 298, respectively. CH4 had the highest contribution to global warming with more than a 50% of CO2 equivalent. CH4 comprise roughly 90% of the GWP of field emissions in flooded rice systems.

Corresponding email: wanndetdim@gmail.com

Evaluation of the application of the ISI-MIP bias-correction method of future simulations of climate over Indonesia for the implementation of Climate Change Adaptation Plans

W2

Gomez Garcia Martin1, Ogawada Daikichi1, Matsumura Akiko1, Takahashi Kiyoshi2, Hanasaki Naota2, Fukushi Kensuke3
1 Research and Development Center, Nippon Koei Co., Ltd. 2 National Institute for Environmental Studies (NIES) 3 Integrated Research System for Sustainability Science (IR3S), University of Tokyo

The second volume of the Fifth Assessment Report of the IPCC, which focuses on impact, adaptation and vulnerability, highlights the fact that it differs from previous reports in the inclusion of topics aimed to evaluate the interactions between climate change and biophysical and societal stressors. This kind of new analysis has the objective of providing information from scientific research that can be used to design adaptation plans that also include human security and livelihoods. As part of the national development framework of Indonesia, the National Action Plan for Climate Change Adaptation (RAN-API) was formulated, and has been supported by The Japan International Cooperation Agency (JICA). The RAN-API is integrally coordinated by all the involved stakeholders, including the government, and community organizations from both the private and public sector. More recently, the Ministry of the Environment (MOE) of Japan has launched a new project for supporting the development of provincial adaptation plans in Indonesia adhered to the RAN-API. Four institutes in Japan, the Integrated Research System for Sustainability Science of the University of Tokyo, College of Agriculture in Ibaraki University, the National Institute for Environmental Studies and the Nippon Koei Co., Ltd. Research and Development Center, have formed a consortium for executing the MOE-funded project. This consortium has conducted in the FY2016 studies for the adaptation to climate change and the consequent vulnerabilities in North Sumatra, East Java, and Bali Provinces. The studies encompass food production (mainly rice), health-related problems like heat stress and water-borne diseases caused by flood, and ocean-related problems like negative impacts on fishery, shrimp farms and rise of sea level. Because Indonesia has a fast development of human activity caused by the growth of population, the estimation of the future impacts may carry great uncertainty. Having reliable estimates of future climate (precipitation, minimum/maximum/mean daily temperature, downward shortwave radiation and humidity) becomes a major concern in climate-change-adaptation studies. Therefore, a process of bias-correction of several climate models was carried out based on the ISI-MIP approach developed by Hempel et al. (2013). The objective of this report is to show the results at a regional level, but most importantly to share the setbacks found during the application of the methodology to the required meteorological variables. The correction was done by comparing data of a set of preselected GCM models (CMIP5) to forcing datasets based on re-analysis data (WFDEI). The preselection was considered necessary since not all models are able to reproduce the local annual climatology, and the ISI-MIP approach is meant to statistically correct systematic deviations. This method attempts to adjust the mean-trend as well as the distribution of daily variations by analyzing both datasets in a historical period. The procedure makes a distinction between variables that should be corrected additively (e.g., temperature) or multiplicatively (e.g., precipitation). The correction of specific humidity and downward short-wave radiation is not detailed explicitly, therefore, a similar correction was developed following the same assumptions/considerations done for rainfall and temperature. Even though there is a short explanation for the correction of maximum/minimum daily temperature, the results were quite unreal, thus, an alternative procedure was implemented to adjust the distributions of the differences of mean daily temperature and maximum/minimum daily temperatures. The outcome helped realize the mean meteorological changes that are expected across the Indonesian Archipelago. The results were also evaluated by observing the frequency and magnitude of extremes. The ISI-MIP approach assumes

that the distributions of deviations of both datasets are of the same kind, consequently, extreme values are hardly adjusted in many cases. The observation of these results suggests that an improvement of the adjustment-methodology of daily variations is necessary to reduce the uncertainty of meteorological information of future simulations. The differentiated analysis performed within this report revealed statistical conditions of each meteorological variable that may be useful to design alternative ways of correcting the daily deviations, considering the possibility that the deviations from both datasets have different probability distributions."

Corresponding email: gomez-mr@n-koei.jp

Modeling Impacts of Irrigation on Land Surface Hydrology and Subseasonal Forecast

W2

Yadu Pokhrel
Michigan State University

Irrigation alters land surface water and energy balances, consequently affecting soil-vegetation processes and land-atmosphere interactions over a range of spatial and temporal scales. In recent years, there has been increased attention in studying irrigation impacts using observations record and modeling; however, irrigation still remains crudely represented in large-scale hydrological and climate models. In this study, we use an improved irrigation scheme to examine the impacts of irrigation on land surface hydrologic water balance, water availability and use, and subseasonal forecast over the continental US. Results from a regional water cycle model and an atmospheric general circulation model (AGCM) indicate that irrigation significantly alters the partitioning of sensible and latent heat and results in substantial surface cooling over the irrigated areas. Furthermore, results of subseasonal forecast suggest that incorporation of irrigation in the model largely improves forecast skills of the AGCM. Finally, we perform a comparative analysis of results from two sets of simulations, one with and the other without irrigation, to identify the regions where irrigation-induced soil moisture change plays a key role in land-atmosphere coupling.

Corresponding email: ypokhrel@egr.msu.edu

Development of global and regional flood forecasting system and their validation

W3

Kei Yoshimura, Yuta Ishitsuka, Kenshi Hibino, Misako Hatono, Hyungjun Kim, Misako Kachi, Takuji Kubota, Riko Oki, Taikan Oki*
** Institute of Industrial Science, The University of Tokyo*

Even now, we are suffering from floods all over the world. Japanese Kinugawa flood in 2015 due to a torrential rain associated with two typhoons was a typical example. Whereas it is highly anticipated that current warming climate would increase the risk of floods, early flood warning, in addition to resilient infrastructural flood control, is needed to avoid flood damage and casualty. Here, we have developed a prototype of global and regional flood warning system using our land surface model, MATSIRO, and hydrological model, CaMa-Flood. For the regional system, we tested a hindcast experiment for the Kinugawa flood using atmospheric forcing data from JMA's mesoscale forecast data (MSM-GPV) and ECMWF's global ensemble forecast precipitation data. The system with horizontal resolution of 5km-mesh covering Japanese domain well reproduced the flood event with slight earlier peak of the river discharge. Moreover, it was revealed that the system had a skill of ensemble forecast, i.e., 17, 23, and 43 members out of 51 members predicted the river water height would exceed the criteria of "highly dangerous level of water level" in 35, 23, and 11 hours before the actual flood event started (2015/9/10 2AM JST), respectively. We also tested a 1km-mesh regional system for east side of Japan using newly developed atmospheric forcing data, i.e., assimilated regional forecasting product, provided from JAXA/MRI. The global system with horizontally 10-km mesh was also validated and compared with GloFAS system by ECMWF.

Corresponding email: kei@iis.u-tokyo.ac.jp

Sensitivity analysis of historical weather documents for reconstructing past climate

W3

Panduka Neluwala
The University of Tokyo

Reconstruction of historical climate is an essential issue for a better understanding of the future climate. Lack of historical observation is a challenge for this task. Thus, several research have been carried out to reconstruct historical climate using climate proxies (e.g., tree-ring, and isotope data) as an alternative data source. As a result, reconstructing long-term extreme events such as the little ice age could be achieved. However, these studies are limited to annual or decadal scale temporal resolution due to the properties of the proxies. Therefore, the personal diary records that have a course details of daily weather such as 'sunny', 'cloudy' or 'rainy' can be employed. Many diaries during 16th - 19th century have been collected over japan to extract weather information and converted into a digitized from. The ultimate goal of our research is to incorporate these data and overcome uncertainty associated with these data to investigate the impact of the climate on society in past. The course details mentioned in the diaries can be converted to usable fields such as cloud cover, radiation, and precipitation. A recent study with idealize experiments using modern total cloud cover observations has shown the possibility of assimilating the historical course details using a Data Assimilation scheme. In this study, we follow a similar approach to further investigate the sensitivity of assimilating other fields which can be retrieved from diary records. The Japanese daily data is randomly distributed over japan with an average number of 17 spots. In order to mimic the uncertainty of diary information, a total of 17 observation stations from Japan Meteorological Agency (JMA) over Japan were selected. A random error to the JMA data was added to consider uncertainty. Global Spectral model (GSM) of National Centers for Environmental Prediction (NCEP) was used as the climate model with the Local Ensemble Kalman filter (LETKF) as the data assimilation scheme. Daily average values of observations from the selected fields are assimilated daily at 3 pm. The sensitivity of these observation fields will be shown in this presentation.

Corresponding email: neluwala@gmail.com

The Computable Catchment: Interactive media for model-data sharing with implications for scientist-stakeholder access and participation

W3

Christopher Duffy
Penn State University

This paper demonstrates the development of an interactive document designed to integrate geospatial data, watershed modeling, data analytics and scenario visualization that is approachable by experts and non-experts alike. The objective of the research is a sharable, interactive open-source document that summarizes and documents the underlying modeling concepts, provides linkage to describing scientific software metadata (http://www.ontosoft.org), and implements the Geoscience Standard Names Ontology schema for describing computational models and data sets (http://www.geoscienceontology.org). The notebook provides simple access to the Essential Terrestrial Variable geospatial data (ETV) from HydroTerre (www.hydroterre.psu.edu), a data service that provides fast access to high resolution national data sources for soils, hydrogeology, climate, land cover and topography at the HUC-12 scale (30m resolution) for CONUS (Leonard and Duffy, 2015). In addition to the ETV's the notebook makes accessible US reanalysis climatic data (NLDAS-2, hourly 1979-present) for interactive model-data visualization and analysis. An executable document for each HUC-12 is stored in the cloud with automatic provisioning and a unique identifier allowing collaborative model and data enhancements for historical reconstruction and/or future landuse or climate change scenario development. The executable document is based on Wolfram CDF or Computable Document Format with an interactive open-source reader accessible by any modern computing platform. The CDF file and contents are available on GitHub and shared as a normal pdf-style document except that it maintains all interactive features and links to national models and data. The Computable Catchment concept represents one application of an extensible document that combines theory, models, data and analysis that can be digitally shared, documented and reused among research collaborators, students, educators and decision makers. Applications are presented for catchments subject to a range of landuse, climatic and ecosystem settings.

Corresponding email: cxd11@psu.edu

Hydrologic Sciences for Flood Disaster Mitigations: Integration of Local Information and Flood Modeling

W3

Takahiro Sayama
DPRI, Kyoto University

Flood plains provide tremendous benefits for human settlements. Since olden days people have lived with floods and attempted to control them if necessary. Modern engineering works such as building embankment have enabled people to live even in flood prone areas, and over time population and economic assets have concentrated in these areas. In developing countries also, rapid land use change alters exposure and vulnerability to floods and consequently increases disaster risk. Flood hazard mapping is an essential step for any counter measures. It has various objectives including raising awareness of residents, finding effective evacuation routes and estimating potential damages through flood risk mapping. Depending on the objectives and data availability, there are also many possible approaches for hazard mapping including simulation basis, community basis and remote sensing basis. In addition to traditional paper-based hazard maps, recent advancement in Information and Communication Technology (ICT) promotes more interactive hazard mapping such as real-time hazard mapping for effective disaster responses and safe evacuations. This study presents recent advancement of flood hazard modeling using a Rainfall-Runoff-Inundation Model and its application to Japanese case studies as well as in Asian countries. It introduces also the integration of local information from flood affected areas and the simulation for real-time hazard mapping. The advancement and deliver of hydrologic science is expected to contribute in the mitigation flood disasters.

Corresponding email: sayama.takahiro.3u@kyoto-u.ac.jp

Towards ecohydrological drought monitoring and prediction using a land data assimilation system

W3

Yohei Sawada
Meteorological Research Institute, Japan Meteorological Agency

Despite the importance of the ecological and agricultural aspects of severe droughts, no drought monitoring and prediction framework based on a land data assimilation system (LDAS) has been developed to monitor and predict vegetation dynamics in the middle of droughts. In this study, we applied a LDAS that can simulate surface soil moisture, root-zone soil moisture, and vegetation dynamics to the Horn of Africa drought in 2010-2011 caused by the precipitation deficit in two consecutive rainy seasons. We successfully simulated the ecohydrological drought quantified by the model-estimated soil moistures and leaf area index (LAI). The root-zone soil moisture and LAI are good indicators of prolonged droughts because they reflect the long-term effects of past precipitation deficit. The precipitation deficit in 2010 significantly affected the land surface condition of the next rainy season in 2011, which indicated the importance of obtaining accurate initial soil moisture and LAI values for prediction of multi-seasonal droughts. In addition, the general circulation model (GCM)-based seasonal meteorological prediction showed good performance in predicting land surface conditions of the Horn of Africa drought.

Corresponding email: ysawada@mri-jma.go.jp

The performance of land surface and cumulus convection scheme in the simulation of Indian Summer Monsoon using RegCM4

W3

Suman Maity
Indian Institute of Technology Kharagpur

An attempt has been made to investigate the sensitivity of Indian Summer Monsoon (ISM) to land surface model (LSM) and cumulus convection scheme (CCS) using RegCM4. Seasonal (May-September) simulations of ISM are conducted using with two LSM viz., Biosphere Atmosphere Transfer Scheme, Community Land Model-CLM 3.5 (NCAR) and five CCS viz. MIT, KUO, GRELL, and two mixed scheme (GO_ML and GL_MO) for three consecutive years: 2007, 2008 and 2009. Some of the important synoptic features of ISM viz., Heat low, Somaly jet, Tropical easterly jet (TEJ), Sub-tropical westerly jet (STWJ), Tibetan anticyclone etc. including monsoon rainfall are validated systematically using CRU, NCEP and TRMM datasets. It is observed that seasonal surface temperature is reasonably well simulated by model with MIT, GO_ML and GL_MO scheme with slight warm bias while significant cold bias is noticed with KUO and GRELL scheme using both the LSM. Although the model is able to simulate the Somaly jet, TEJ, STWJ using each of the combinations but location and strength of the jets varies combination-wise and is better simulated using MIT scheme with slight weaker (stronger) Somaly jet (TEJ and STWJ). Seasonal rainfall is not well simulated by the model with none of the combinations. Significant underestimation is observed over Central and North West India with each combination. Spatial distribution of seasonal rainfall is better simulated by the model with MIT followed by GO_ML scheme in combination with CLM although it overestimates over heavy precipitation zones. Monthly rainfall over five homogeneous zones is not represented with none of the combinations. However, in terms of spatial distribution and accuracy in predicting magnitude of the rainfall, performance of the model varies region-wise. Considering overall performances, RegCM4 shows better skill in simulating ISM with MIT scheme using CLM.

Corresponding email: suman.buie@gmail.com

Progress in understanding hydrologic flooding using GRACE

W4

John Reager
NASA JPL

GRACE data have been shown to capture the extreme hydrologic conditions associated with floods â€” as the land surface becomes saturated, the capacity of soils to hold more water decreases â€” an important hydrologic mechanism in many inland flood events. Recent research and progress on this topic will be presented, including results and analysis from three projects: (1) evaluation of a model-data fusion approach for high-resolution GRACE downscaling; (2) a coupled analysis of land water storage and high-resolution river storage to estimate the runoff generation process and the contributions of baseflow to streamflow; and (3) a global assessment of the historic flood occurrence data base, to determine the frequency of flood intensity based on storage. These results demonstrate the extent to which knowledge of storage conditions can help in flood prediction, and explores the range of conditions, scales and intensities for which storage-driven flood processes are relevant and observable by satellite gravity.

Corresponding email: john.reager@jpl.nasa.gov

Distribution of debris thickness and its effect on glacier melt at large scale

W4

Yukiko Hirabayashi
IIS, The University of Tokyo

Supraglacial debris affects the response of glaciers to climate change by altering the reflectivity of solar radiation and conductive heat flux. To accurately assess the contribution of glacier melts to sea level rise, water resources and natural hazards, it is important to account for the effects of debris. However, due to the practical difficulties of global-scale field measurements, information regarding the spatial distribution of the thickness and thermal properties of debris on glaciers is limited; hence, the effects of debris on glacier melting are not explicitly taken into account in current global glacier models. In this study, we developed a dataset of the thermal resistance of debris on glaciers at 90-m resolution derived from multi-temporal satellite images and satellite-derived radiation data at the global scale, excluding Greenland, Antarctica, and some of the Arctic. We found that supraglacial debris with thermal resistance > 0.10 m2KW^-1 covered 16.8% of the entire glacial area analyzed. The highest debris cover percentage occurred in New Zealand, and the lowest was in Iceland. The derived debris thickness information was then applied to energy balance glacier mass model at globally distributed 51 glaciers where long-term observation was available. The results indicated that the insulation effect of thick debris was larger than the acceleration effect of thin debris at most analyzed glaciers and the insulation effect was large in glaciers in Alaska and Central Europe.

Corresponding email: hyukiko@rainbow.iis.u-tokyo.ac.jp

Reconstructing climate-driven water storage variability

W4

Vincent Humphrey
ETH Zurich

Since 2002, the Gravity Recovery and Climate Experiment (GRACE) mission has provided unprecedented observations of global terrestrial water storage (TWS) changes. However, there is still a limited number of independent sources for the pre-2002 period. Before GRACE observations were available, traditional approaches to retrieve past TWS relied on either global hydrological models or basin-scale water balance estimates. While these approaches can provide reliable figures for certain regions, they do not take advantage of the full information content brought by the current GRACE record. Here, we reconstruct past TWS changes using first-order process approximations and Bayesian inference to identify relationships between GRACE observations and the main atmospheric drivers (e.g. daily precipitation and temperature). The resulting gridded estimates of monthly sub-decadal climate-driven TWS changes range from 1985 to 2015 and their robustness is assessed through a comparison with a set of global hydrological and land surface models*. At midpoint between GRACE observations and hydrological models, this data-driven approach represents a new opportunity for studying climate-driven TWS variability as well as potentially bridging data gaps between GRACE and the GRACE Follow-On mission. As an ongoing development, we also present a 1901-2010 gridded reconstruction of climate-driven TWS using GSWP3 forcing. We discuss the potential (and limitations) of using such statistical reconstructions for documenting rare extreme events (e.g. megadroughts) or benchmarking hydrological and climate models. *Humphrey, V., L. Gudmundsson, and S.I. Seneviratne, 2017: A global reconstruction of climate-driven subdecadal water storage variability, Geophysical Research Letters, 44, 2300-2309.

Corresponding email: vincent.humphrey@env.ethz.ch

Local Ensemble Transform Kalman Filter (LETKF) data assimilation of altimetry data for SWOT mission

W4

Jean-Francois Vuillaume
IIS, The University of Tokyo

"Jean-Francois Vuillaume1, Dai Yamazaki1, Daiki Ikeshima2, Shinjiro Kanae2 1 IIS, The University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan 2 Department of Civil and Environmental Engineering, Tokyo Institute of Technology 2-12-1-M1-6 O-okayama, Meguro-ku, Tokyo 152-8552, Japan The Surface Water and Ocean Topography (SWOT) mission projected to be aunched in 2021 is expected to provide high spatial resolution altimetry data (from 50 to 100m) for river surface. The prime advantage of this mission is the use of an interferometric radar known as KaRIN (Ka-band Interferometer) which will provide a 120 km swath. Several studies have been conducted to evaluate the potential of such observation on hydro model quality improvement in the US, Ohio river (Andreadis., 2007), Niger (Pedinotti., 2014, Munier 2015), Amazon (Paiva., 2013) and Tennessee River Basin (Yoon., 2013) but with different assimilation data, methods and results even if all of them show discharge forecast measurement improvement. In this study, we use the global flood model CaMa-Flood (Yamazaki et al., 2014) and the global data assimilation model developed by Ikeshima (2017). The model used a Local Ensemble Transform Kalman Filter (LETKF) scheme with 20 ensemble members. In our experiments, we assimilate the anomaly of river elevation to remove the bias error of the topography and channel bathymetry of river elevation. We evaluate the global performance of the model and in particular the Amazon river basin to improve discharge computation. The framework of the study is based on a twin experiment to simulate (1) the ""true"" system state and then (2) an ensemble of corrupted model states. The virtual SWOT observations of river equivalent to the CaMa-Flood global hydrological model level high were assimilated into the model with a repeat cycle of 21 days to assimilate the elevation anomaly of the pseudo SWOT observations over the Amazon basin. Finally, the performance of the assimilation is discussed in term of seasonality, upstream-downstream localization and observation assimilation. In addition, we compare (1) non-assimilated, assimilated and the ""true"" CaMaFlood forecast. (2) the performance of the assimilation of both the absolute and the anomalies of water elevation."

Corresponding email: vuillaume@rainbow.iis.u-tokyo.ac.jp

Global distribution of groundwater-vegetation spatial covariation

W4

Sujan Koirala
Max Planck Institute for Biogeochemistry

Groundwater is an integral component of the water cycle, and it also influences the carbon cycle by supplying moisture to ecosystems. However, the extent and determinants of groundwater-vegetation interactions are poorly understood at the global scale. Using several high-resolution data products, we show that the spatial patterns of ecosystem gross primary productivity and groundwater table depth are correlated during at least one season in more than two-thirds of the global vegetated area. Positive relationships, i.e., larger productivity under shallower groundwater table, predominate in moisture-limited dry to mesic conditions with herbaceous and shrub vegetation. Negative relationships, i.e., larger productivity under deeper groundwater, predominate in humid climates with forests, possibly, indicating a drawdown of groundwater table due to substantial ecosystem water use. Interestingly, these opposite groundwater-vegetation interactions are primarily associated with differences in vegetation than with climate and surface characteristics. These findings put forth the first evidence, and a need for better representation, of an extensive and non-negligible groundwater-vegetation interactions at the global scale.

Corresponding email: skoirala@bgc-jena.mpg.de

Heavy rain prediction applying satellite-based cloud data assimilation over land

W4

Rie Seto
Tokyo Institute of Technology

For accurate flood prediction, warning systems, and optimized dam control, information of positional relationship between rain areas and river basins is crucial. This requires very fine precision in the prediction of rainfall areas. Assimilation of satellite-based microwave observation of cloud has great potential to improve precipitation areas because it can directly obtain information on rainfall locations as well as amount of cloud. However, it is difficult to observe clouds over land using satellite microwave remote sensing, because land emissivity is much stronger and more heterogeneous than that of cloud. To overcome this challenge, appropriate representation of heterogeneous land emissivity is needed. Thus, We developed a Coupled Atmosphere and Land Data Assimilation System with the Weather Research and Forecasting model (CALDAS-WRF), which can assimilate soil moisture, vertically integrated cloud water content over land, and atmospheric variables such as heat and moisture within clouds simultaneously. The CALDAS-WRF assimilates soil moisture, using passive microwave brightness temperature at lower frequency, which has a high sensitivity to soil moisture, and then assimilates cloud and atmosphere within clouds, using higher-frequency brightness temperature and optimized emissivity of land surface as a background information. The assimilation algorithms in the CALDAS-WRF are Ensemble Kalman Filter (EnKF) for land and one-dimensional variational data assimilation (1dVar) for cloud and atmospheric variables. We applied this system to heavy rain events in Japan. Results show that the system effectively assimilated cloud signals and produced very accurate cloud and precipitation distributions with appropriate intensity. Also, the local atmospheric fields are modified appropriately around the area of assimilated clouds. Furthermore, by using operationally analyzed dynamical and moisture fields as initial and boundary conditions, the system improved prediction of precipitation duration. The results demonstrate the method's promise in dramatically improving predictions of heavy rain and consequent flooding.

Corresponding email: seto.r.ac@m.titech.ac.jp

Simulating the impacts of climate extremes: the case of the 2003 European heat wave

O2

Jacob Schewe
Potsdam Institute for Climate Impact Research

Extreme climate or weather events, such as droughts or floods, can affect society through multiple channels; e.g. by impacting crop yields, infrastructure, ecosystem services, the spreading of diseases, etc. Sophisticated numerical models exist of some of the related processes, but a systematic evaluation of their performance for extreme conditions is missing, as is an understanding of the extent to which the aggregate impact of a given extreme event can potentially be anticipated by combining these models. Here we use a well-documented instance of widespread extreme weather conditions - the 2003 European heat wave and drought (EHW) - to test, for the first time, a suite of impact models covering several major sectors of the human environment and economy: Agriculture, freshwater, terrestrial ecosystems, electric energy generation, marine ecosystems and fisheries, and health. In each sector, several different impact models (only one model for health) are forced with observations-based historical climate data. The simulated impacts are compared with major observed impacts of the 2003 EHW. Since events like the 2003 EHW are widely seen as harbingers of more extreme future climate conditions, our results have important implications for our understanding of future climate change impacts in general, and specifically our ability to quantify expected impacts related to extreme weather regimes. Moreover, our study could provide useful insights for the further development of impact models.

Corresponding email: jacob.schewe@pik-potsdam.de

Benchmarking carbon fluxes of the ISIMIP2a biome models

O2

Jinfeng Chang
LOCEAN-IPSL

The purpose of this study is to evaluate the eight ISIMIP2a biome models against independent estimates of long-term net carbon fluxes (i.e., Net Biome Productivity, NBP) over terrestrial ecosystems for the recent four decades (1971-2010). We evaluate modeled global NBP against 1) the updated global residual land sink (RLS) plus land use emissions (ELUC) from the Global Carbon Project (GCP), presented as R+L in this study by Le QuÃ©rÃ© et al. (2015), and 2) the land CO2 fluxes from two atmospheric inversion systems: Jena CarboScope s81_v3.8 and CAMS v15r2, referred to as FJena and FCAMS respectively. The model ensemble-mean NBP (that includes seven models with land-use change) is higher than but within the uncertainty of R+L, while the simulated positive NBP trend over the last 30 years is lower than that from R+L and from the two inversion systems. ISIMIP2a biome models well capture the interannual variation of global net terrestrial ecosystem carbon fluxes. Tropical NBP represents 31 Â± 17% of global total NBP during the past decades, and the year-to-year variation of tropical NBP contributes most of the interannual variation of global NBP. According to the models, increasing Net Primary Productivity (NPP) was the main cause for the generally increasing NBP. Significant global NBP anomalies from the long-term mean between the two phases of El NiÃ±o Southern Oscillation (ENSO) events are simulated by all models ($p < 0.05$), which is consistent with the R+L estimate ($p = 0.06$), also mainly attributed to NPP anomalies, rather than to changes in heterotrophic respiration (Rh). The global NPP and NBP anomalies during ENSO events are dominated by their anomalies in tropical regions impacted by tropical climate variability. Multiple regressions between R+L, FJena and FCAMS interannual variations and tropical climate variations reveal a significant negative response of global net terrestrial ecosystem carbon fluxes to tropical mean annual temperature variation, and a non-significant response to tropical annual precipitation variation. According to the models, tropical precipitation is a more important driver, suggesting that some models do not capture the roles of precipitation and temperature changes adequately.

Corresponding email: jinfeng.chang@locean-ipsl.upmc.fr

Impact simulations for ISI-MIP with a process-based biome model, VISIT

O2

Akihiko Ito
National Institute for Environmental Studies

As a contribution to ISI-MIP, we have applied a process-based terrestrial biome model, VISIT (Vegetation Integrative SImulator for Trace gases), to climate change impact simulations. In the Fast Track phase, we submitted our simulation results for different RCPs and climate projections, contributing to uncertainty assessments. In addition to global analyses, we conducted several regional analyses, focusing on impacts on ecosystem functions in Monsoon Asia and in the Arctic. In the benchmarking (ISIMIP2a) phase, we submitted simulation results on the basis of different historical climate data and conducted benchmarking of gross primary production simulated by biome models. In this phase, impacts of extreme events such as large volcanic eruption and El NiÃ±o were discussed. Now, in the ISIMIP2b phase, we are conducting simulations for the assessment on 2-degree or 1.5-degree target of the Paris Agreement. These targets are around the RCP2.6 projections, and therefore climatic impacts may not be so serious. However, we should focus on remaining impacts in potentially vulnerable regions such as high-latitudes and alpine areas. Through the participation in ISIMIP, we obtained useful implications on model characteristics and sources of uncertainty, encouraging further model development and in-depth analyses for future climate risks, resilience, and adaptation.

Corresponding email: itoh@nies.go.jp

Human impact parameterization in global hydrological models improves estimates of monthly discharges and hydrological extremes: a multi-model validation study

O2

Ted Veldkamp
VU University Amsterdam

Human impacts on freshwater resources and hydrological features form the core of present-day water related hazards, like flooding, droughts, water scarcity, and water quality issues. Driven by the societal and scientific needs to correctly model such water related hazards a fair amount of resources has been invested over the past decades to represent human activities and their interactions with the hydrological cycle in global hydrological models (GHMs). Use of these GHMs - including the human dimension - is widespread, especially in water resources research. Evaluation or comparative assessments of the ability of such GHMs to represent real-world hydrological conditions are, unfortunately, however often limited to (near-)natural river basins. Such studies are, therefore, not able to test the model representation of human activities and its associated impact on estimates of freshwater resources or assessments of hydrological extremes. Studies that did perform a validation exercise - including the human dimension and looking into managed catchments - either focused only on one hydrological model, and/or incorporated only a few data points (i.e. river basins) for validation. To date, a comprehensive comparative analysis that evaluates whether and where incorporating the human dimension actually improves the performance of different GHMs with respect to their representation of real-world hydrological conditions and extremes is missing. The absence of such study limits the potential benchmarking of GHMs and their outcomes in hydrological hazard and risk assessments significantly, potentially hampering incorporation of GHMs and their modelling results in actual policy making and decision support with respect to water resources management. To address this issue, we evaluate in this study the performance of five state-of-the-art GHMs that include anthropogenic activities in their modelling scheme, with respect to their representation of monthly discharges and hydrological extremes. To this end, we compared their monthly discharge simulations under a naturalized and a time-dependent human impact simulation, with monthly GRDC river discharge observations of 2,412 stations over the period 1971-2010. Evaluation metrics that were used to assess the performance of the GHMs included the modified Kling-Gupta Efficiency index, and its individual parameters describing the linear correlation coefficient, the bias ratio, and the variability ratio, as well as indicators for hydrological extremes (Q90, Q10). Our results show that inclusion of anthropogenic activities in the modelling framework generally enhances the overall performance of the GHMs studied, mainly driven by bias-improvements, and to a lesser extent due to changes in modelled hydrological variability. Whilst the inclusion of anthropogenic activities takes mainly effect in the managed catchments, a significant share of the (near-)natural catchments is influenced as well. To get estimates of hydrological extremes right, especially when looking at low-flows, inclusion of human activities is paramount. Whilst high-flow estimates are mainly decreased, impact of human activities on low-flows is ambiguous, i.e. due to the relative importance of the timing of return flows and reservoir operations. Even with inclusion of the human dimension we find, nevertheless, a persistent overestimation of hydrological extremes across all models, which should be accounted for in future assessments.

Corresponding email: ted.veldkamp@vu.nl

Regional climate downscaling for risk information -Establishment of CORDEX Asia Empirical-Statistical Downscaling (ESD) Group-

P01

Koji Dairaku
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 in Asia, the CORDEX Asia Empirical-Statistical Downscaling (ESD) Group was established in November 2016. ã€€ã€€Scientific vision of the WCRP CORDEX is to advance and coordinate the science and application of regional climate downscaling through global partnerships. In Asia, several CORDEX activities for Dynamical Downscaling (DDS) such as CORDEX-East Asia, Southeast Asia, South Asia, and Central Asia are on-going. The DDS needs relatively large computer resources to resolve small scale phenomena. On the other hand, the ESD does not need much computer resources and not necessarily well represent locally forced nonlinear phenomena, extreme events such as heavy rain, heavy snow, etc. The DDS and ESD can complement each other. The CORDEX Asia ESD group is mainly for enhancing and integrating the science and application of downscaling activities in Asia. Our ESD outputs based on a standard experimental set-up and a common framework will provide a benchmark for Dynamical Downscaling and also make it possible to further integrated analyses of the added values of statistical/dynamical downscaling methods. The main activities and goals of the CORDEX Asia ESD group are; 1. to produce regional climate statistical downscaling information based on a common protocols for a common benchmark for investigating uncertainty of regional climate scenarios. 2. case studies in small domain for developing and improving the methods where sufficient observation is available (e.g., city, coastal areas, agricultural lands, etc.) and for obtaining best/good practices of co-production /coordination with IAV community. 3. to improve reference data for improving ESD and DDS skills by collecting better observational data and its update. 4. training workshops to share and exchange knowledge and techniques. ã€€ã€€We would like to enhance well-coordinated downscaling activities in Asia to provide regional climate information and service which is required for risk assessment on sub-national scale for climate change adaptation and IPCC AR6.

Corresponding email: dairaku@bosai.go.jp

Do Soil Water Limitations Suppress Convection?

P02

Ahmed Tawfik
NCAR

Isolating the influence of the land surface on convection and precipitation has larger been quantified using either Earth System Models (ESMs) or some statistical techniques. Unfortunately each of these methods have their shortcomings. In the case of ESMs, it is unclear whether the feedbacks between soil moisture and precipitation are a consequence of a particular model's parameterizations or reflect a "true" feedback process. Statistical approaches on the other hand return an overall soil moisture-precipitation signal but the actual process chain generally remains unclear, and therefore the utility for how to improve models remains unclear. Here we present a new process-based methodology that clearly isolates the role of surface energy fluxes on convective initiation. Using the Heated Condensation Framework (HCF) a surface flux-convective initiation (termed the flux-CI equation) equation is derived that allows for the surface sensible and latent heat flux contributions to be separated. Specifically, the flux-CI equation has separate sensible and latent heat flux terms in addition to other factors that contribute directly to CI, such as moisture convergence. We use the flux-CI equation to explore whether increasing latent heat flux, through removing soil moisture supply limitations, tends to increase the number of convective initiation events. Essentially the latent heat flux is replaced with the equivalent potential evaporation estimates thereby removing soil water limitations. The analysis is performed using the North American Regional Reanalysis from 1979-2015 and focuses on May-September. We find that convective initiation occurs 10-20% more often across the Plains when evaporation is not limited by soil water. The Gulf coast of the US also shows increases in CI in July and August of less than 10%. This provides the first observed quantification of how soil water limitations may be inhibiting convective initiation. Future work will extend this analysis to the joint effects of increasing evaporation and reducing sensible heat flux.

Corresponding email: abtawfik@ucar.edu

Evaluation of high latitudes land climate simulated by MIROC5 AGCM and a wetland scheme

P03

Tomoko Nitta
The University of Tokyo

Within the global climate system, land areas exhibit complex processes in the cryosphere, hydrosphere, and the land surface itself, which all interact with the climate system through complex feedback. One of the issues inherent in climate modeling is model bias. The warm bias in the surface air temperature over land during the boreal summer is well known from many climate modeling experiments. In this study, we evaluated high latitudes land climate simulated by the Model for Interdisciplinary Research on Climate 5 (MIROC5) atmospheric general circulation model (AGCM) using multiple recent reference datasets. In the Minimal Advanced Treatments of Surface Interaction and RunOff (MATSIRO) land surface model in MIROC5, a scheme representing a snow-fed wetland, in which snowmelt can be stored with consideration of sub-grid terrain complexity, was implemented. We conducted two kinds of simulations with and without the wetland scheme. The experiment showed not only a better surface hydrology but also a weaker land-atmosphere coupling strength and larger (smaller) latent (sensible) heat flux due to the delayed snowmelt runoff. The mean absolute error (MAE) of 2-m air temperature and precipitation over land at 45–90 °N in summer decreased by 19% and 4%, respectively. Thus, through the representation of wetlands in a climate model, it was revealed that the summer warm and dry bias could be partially improved over snowy and flat areas, particularly over much of western Eurasia and North America, without an apparent deterioration of simulated surface hydrology and climate over the rest of the land in the other seasons. The next step of model development will involve implementing an explicit representation of sub-grid scale surface water fraction and related processes. (e.g. wetland fraction, water and energy budget).

Corresponding email: t-nitta@iis.u-tokyo.ac.jp

Current Status of Global and Regional CO2 Budgets

P04

Masayuki Kondo
Center for Environmental Remote Sensing (CEReS), Chiba University

Terrestrial ecosystems play a critical role in formation of a feedback loop of carbon dioxide (CO2) in atmosphere by interacting with atmospheric reservoir and climate, and thus directing a course of the future projection of climate change. The research community has spent significant efforts to understand behaviors of terrestrial ecosystems under a steady rise in atmospheric CO2 concentration and temperature during the recent decades and deepen knowledge about the regional and global patterns of terrestrial CO2 sinks and sources. Currently, two principal approaches are used to estimate terrestrial CO2 exchange: top-down and bottom-up approaches. The top-down approach estimates the terrestrial CO2 exchange that is optimally consistent with atmospheric CO2 concentration measurements, via atmospheric inversion models. This method uses a forward-running atmospheric transport model and a priori initial estimates of the surface fluxes to predict observed concentrations and to estimate the terrestrial CO2 exchange, while seeking consistency between simulated and observed CO2 concentrations. The bottom-up approach estimates the terrestrial CO2 exchange using ecosystem models, which simulate the ecosystem-scale carbon cycle by considering the internal biogeochemical mechanisms of carbon flows for each prescribed vegetation type and soil. However, the current estimates of terrestrial CO2 exchange by the bottom-up and top-down approaches remain inconsistent. As illustrated in the recent IPCC Assessment Report (AR5), the top-down approach tends to indicate stronger CO2 sinks in temperate and boreal regions than the bottom-up approach does. Furthermore, the two approaches exhibited contrasting CO2 sink-source patterns in the tropics; the bottom-up approach indicated CO2 sinks and the top-down approach CO2 sources. As illustrated by these inconsistencies, a consensus on the geographic distribution of the terrestrial CO2 exchange has yet to be established among the research community. In this study, we elaborate the current status and issues of terrestrial CO2 flux estimations by the top-down and bottom-up approaches. Specifically, we compare the bottom-up estimate from dynamic global vegetation models that are forced by interannual variations of CO2 concentration, climate and land use changes, with the top-down estimate from atmospheric CO2 inversions. We show an improved level of agreement between the two estimates in relation to regional and global budgets, since the IPCC AR5. We also discuss the remaining issues causing inconsistency between the two estimates.

Corresponding email: redmk92@gmail.com

Reconciliation of top-down and bottom-up CO2 fluxes in Siberia larch forest

P05

Kumiko Takata
National Institute for Environmental Studies

Carbon dioxide (CO2) fluxes by different methods vary largely at global, regional and local scales. The net CO2 fluxes by three bottom-up methods (tower observation, biogeochemical models, and a data-driven model), and an ensemble of atmospheric inversions (top-down method) are compared in Yakutsk, Siberia for 2004-2013. The region is characterized by highly homogeneous larch forest on a flat terrain. The ecosystem around Yakutsk shows a net sink of CO2 (0.0598 kg-C m-2 mon-1 by tower observation). The monthly-mean seasonal cycles agree among the four methods within the range of inter-model variations. The peak-to-trough amplitude of the seasonal cycle is greater for the inverse models than bottom-up methods. The ensemble mean of the interannual variability estimated by the inverse models is more similar to the tower observation, as well as the reduction in CO2 uptake after 2008 due to unusual waterlogging, than those by the biogeochemical models and the data-driven model. The results of the data-driven model at various scales show the local influence of exceedingly mature forest around the site, indicating a potential to fill the scale gaps between top-down and bottom-up estimates.

Corresponding email: takata.kumiko@nies.go.jp

Hydroclimatic intensity in 1.5 & 2.0 °C warmer world

P06

Gavin Madakumbura
The University of Tokyo

The momentous Paris agreement of 2015 was adopted at the 21st conference of parties to pursue efforts to limit the global average temperature increase to well below 2 °C potentially even 1.5 °C above pre-industrial levels. Many previous climate model experiments such as Coupled Model inter-comparison Project (CMIP) are not designed to cater a comparative evaluation of impacts of 1.5 °C and 2 °C warming. To overcome this drawback, half a degree additional warming, prognosis and the projected impacts (HAPPI) project was conducted to quantify the relative risks associated with 1.5 °C and 2 °C of warming. Large ensemble simulations of atmosphere-only global climate models for two-time slices (2006-2015, 2106-2115) where two climate projections corresponding to 1.5 °C and 2 °C warming were associated with the future time period. In this study, we utilized the HAPPI multi-model (i.e., MIROC, NorESM, CanAM4 and CAM4) large ensemble experiments (100 ensembles per experiment per model) to investigate the hydroloclimatic intensity changes in different regions of the world with the warming climate. Hydroclimatic intensity (HY-INT; Giorgi et al. 2011), as the multiplication of dry spell length (DSL) and precipitation intensity (PINT), was found significantly different between 1.5 °C and 2 °C warmer climates for different regions of the world. PINT indicated an increase globally under 2 °C warmer climate whereas DSL showed an increase in regions such as South America and Europe while a decrease was observed in North Africa and East Russia. Europe showed increased HY-INT owing to the increases in both DSL and PINT (except for Scandinavia). The probability distribution of variables in each region indicated that despite the differences in magnitudes, for most of the regions, DSL, PINT and HY-INT showed a similar change from historical to 1.5 °C to 2 °C climates. Furthermore, the linearity of these changes and the possible reasons were also investigated during the study.

Corresponding email: gavindayanga09@gmail.com

Analysis of negative emission application status in South Korea Forest.

P07

Nahui Kim
Korea University

In 2015, United Nations Framework Convention on Climate Change (UNFCCC) agreed on establishing post-2020 climate change regime system to limit global average temperature rise to below 2Â°C. The amount of Green House Gas (GHG) reductions goal was voluntarily established by each country and National Determined Contributions (NDCs) had respected the goal. South Korea has to reduce the GHG by 37% from Business As Usual (BAU) levels. Korean government identified 3 methods to achieve the ambitious goal but they require much efforts. Negative emission (NE) is a technology that directly isolates carbon from the atmosphere and it is recognized as a new method to achieve the NDCs. Thus, the quantity and quality improvement of forest can result in the expansion of the carbon sink which increase the NE rate. This study analyzed the recent NE application status in South Korea in regard to the post-2020 climate change regime and suggested the possible application of NE in South Korea.

Corresponding email: nahee0o0@naver.com

Statistical Evaluation of Soil Wetness Changes in F uture Climate
in CMIP5 Multi-Model Ensembles in East Asia

P08

Tosiyuki Nakaegawa
Meteorological Research Institute

The present study explores a simple understanding of changes in surface soil moisture in the late 21st century under a global warming based on the statistical significance aside from complicated mechanisms. Significant increase in surface soil moisture in the multi-model analysis is confined at two eastern edge areas, while significant decrease in surface soil moisture is seen in an inland area of southern China and a northern area. Significant changes in evaporation among the 3 water flux variables: precipitation (P), evaporation (E), and total runoff (R): explains only 10% of the total area with significant change in surface soil moisture. Significant changes in P-E among the 3 2-combined water flux variables: P-E, E+R, and P-R is identified as a dominant variable but no overlapped area is found between significant changes in P-E and the significant change in surface soil moisture. Respective analysis reveals that significant increases in evaporation, P-R, and E+R explain 26%, 13% and 9% of the area with the significant decrease in surface soil moisture as MME mean respectively. This indicates that ensemble mean of MME may hinder the geophysical understanding of mechanism between surface soil moisture and water flux variables.

Corresponding email: tnakaega@mri-jma.go.jp

Dynamical downscaling simulation over East Asia using a coupled atmosphere-ocean regional climate model RSM-ROMS

P09

Xiaojun GUO

** Institute of Industrial Science, The University of Tokyo*

The climate over East Asia in 2006 is evaluated using a coupled regional climate model RSM-ROMS at a resolution of 25 km. The result shows that the coupled model can better capture the spatial patterns of rainfall and effectively reduce the heavy precipitation over some areas of the ocean compared to the uncoupled one. In addition, it can better reproduce the amount of released latent heat flux from ocean than the uncoupled one. The major components contributing to the negative net heat flux bias are shortwave and latent heat flux. Compared to the observation, the coupled model exhibits prominent systematic cold bias in sea surface temperature (SST) over Indian Ocean and Northwest Pacific Ocean. As for the subsurface ocean state simulation, it is also evident that the coupled model tends to display poor simulation of the ocean variables in the mixed layer. The ocean temperature in the upper 100m of the ocean is underestimated while the salinity and density are overestimated. The negative (positive) SST bias is well consistent with deeper (shallower) mixed layer depth over Northwest Pacific Ocean. Further analysis indicates that more upward latent heat flux caused by the stronger near-surface wind speed, less net heat flux and stronger wind-driven equatorial and coastal upwelling motion are mainly responsible for cold SST bias over Indian Ocean in summer.

Corresponding email: guoxjblicy@gmail.com

Valuation Irrigation water by yield comparison approach: global scale

P10

Sobhan Afraz
The University of Tokyo

Water scarcity is a major global issue. During the last few decades, it has become evident that because of a steadily increasing demand, freshwater scarcity is becoming a threat to sustainable development of human society. In its most recent annual risk report, the World Economic Forum lists water crises as the largest global risk in terms of potential impact. Clean Water and Sanitation and climate action are SDGs goals. So increasing efficiency of irrigation water use is very important, in hydro-economic models, water allocation between competitive uses is based on the economic benefits they generate (Harou et al., 2009). Taking into account the economic value of water enables not only to allocate water to the most valuable uses, but also to estimate the direct costs of water scarcity, in terms of unrealized economic benefits. To do so, a first step is to measure the benefits of water in its different uses, i.e. to determine the economic value of water (Young, 2005). Then assessing the missing quantity of water gives the corresponding unrealized economic benefits. Knowing water value in its different uses, it is possible to manage the available water so as to minimize the economic costs of scarcity. The aim this study is how much benefit we can gain from using of unit amount of water in irrigation sector. Maximize the economic benefits of the allocated water can help reduce the costs of future water scarcity under global changes in the world. In this study irrigation and rain-fed yield and its revenue comparison will be applied for some crops to define which crops with which method has the best economic revenue.

Corresponding email: sobhan.afraz@gmail.com

The Community Water Model (CWATM) - Development of a community driven global water model

P11

Yusuke Satoh
International Institute for Applied Systems Analysis

With a growing population and economic development, it is expected that water demands will increase significantly in the future, especially in developing regions. At the same time, climate change is expected to alter spatial patterns of hydrological cycle and will have global, regional and local impacts on water availability. Thus, it is important to assess water supply, water demand and environmental needs over time to identify the populations and locations that will be most affected by these changes linked to water scarcity, droughts and floods. The Community Water Model (CWATM) will be designed for this purpose in that it includes an accounting of how future water demands will evolve in response to socioeconomic change and how water availability will change in response to climate. CWATM represents one of the new key elements of IIASA's Water program. It has been developed to work flexibly at both global and regional level at different spatial resolutions. The model is open source and community-driven to promote our work amongst the wider water community worldwide and is flexible enough linking to further planned developments such as water quality and hydro-economic modules. CWATM will be a basis to develop a next-generation global hydro-economic modeling framework that represents the economic trade-offs among different water management options over a basin looking at water supply infrastructure and demand managements. The integrated modeling framework will consider water demand from all sectors, investment needs to alleviate future water scarcity, and will provide a portfolio of economically optimal solutions for achieving future water management options under the Sustainable Development Goals (SDG) for example. In addition, it will be able to track the energy requirements associated with the water supply system e.g., pumping, desalination and interbasin transfer to realize the linkage with the water-energy economy. In a bigger framework of nexus - water, energy, food, ecosystem - CWATM will be coupled to the existing IIASA models including the Integrated Assessment Model MESSAGE and the global land and ecosystem model GLOBIOM in order to realize an improved assessments of water-energy-food-ecosystem nexus and associated feedback. Our vision for the short to medium term work is to introduce water quality (e.g., salinization in deltas and eutrophication associated with mega cities) into CWATM and to consider qualitative and quantitative measures of transboundary river and groundwater governance into the integrated modelling framework.

Corresponding email: satoh@iiasa.ac.at

Global-scale river flood vulnerability in the last 50 years

P12

Masahiro Tanoue
The University of Tokyo/ Institute of Industrial Science

The impacts of flooding are expected to rise due to population increases, economic growth and climate change. Hence, understanding the physical and spatiotemporal characteristics of risk drivers (hazard, exposure and vulnerability) is required to develop effective flood mitigation measures. Here, the long-term trend in flood vulnerability was analysed globally between 1960 and 2013, calculated from the ratio of the reported flood loss or damage derived from a disaster database to the modelled flood exposure using a global river and inundation model. A previous study showed decreasing global flood vulnerability over a shorter period using different disaster data. In accordance with the study, flood vulnerability to mortalities and economic losses showed a decreasing trend, and inverse relationships were found between flood vulnerability and gross domestic product per capita, indicating an improvement in flood vulnerability at the global scale since 1960 associated with economic growth. However, although a significant negative trend in global flood vulnerability to mortalities was seen across the whole analysis period, the vulnerability for the most recent period did not show a statistically significant trend. This result highlights the importance of the analysis period, as well as uncertainties, when calculating flood vulnerability. The long-term analysis demonstrated for the first time that flood vulnerability to economic losses in upper-middle, lower-middle and low-income countries shows an inverted U-shape, as a result of the balance between economic growth and various historical socioeconomic efforts to reduce damage, leading to non-significant upward or downward trends. We also show that the flood-exposed population is affected by historical changes in population distribution, with changes in flood vulnerability of up to 48.9%. Both increasing and decreasing trends in flood vulnerability were observed in different countries, implying that population growth scenarios considering spatial distribution changes could affect flood risk projections.

Corresponding email: masatano@rainbow.iis.u-tokyo.ac.jp

Understanding the soil moisture-climate coupling in irrigation regions of the India through satellite and assimilation data sets

P13

Zohaibi Muhammad
Sungkyunkwan University

"The understanding of coupling between the land surface and the atmosphere is essential in order to predict the weather and climate patterns. The linkage between the land surface and the atmosphere takes place through water, energy, and carbon fluxes. These fluxes are significantly governed by the soil moisture (SM), known as one of the key variables in the earth's climate system. The nature of land processes and the feedback loop is complex over the globe due to significant heterogeneity of the natural land cover and its temporal variability. Moreover, human-induced modifications also influence the nature of land-atmosphere coupling by changing the surface conditions. Especially, irrigation, defined as the artificial application of water to land or crops, is a well-known anthropogenic activity to alter the natural land surface processes, thereby largely influencing the regional and global water balance. In this study, the land-atmosphere coupling is analyzed in the irrigation regions of the India by the correlation analysis of the SM with the surface temperature (ST) and evapotranspiration (ET). The relationship between these variables are widely used to identify the direction of land-atmosphere coupling. Generally, negative SM-ET and positive ST-ET relationships are found in the humid regions under energy-limited conditions, whereas positive SM-ET and negative ST-ET relationships are prominent in the arid regions under water-limited conditions. The findings of this study will help to understand the land-atmosphere coupling in the irrigation regions. Moreover, the results will also give an insight into the incorporation of the irrigation activities in the land surface and climate models.

Keywords: Irrigation, Land-Atmosphere coupling, Soil Moisture, Evapotranspiration, Surface Temperature"

Corresponding email: zohaib557@skku.edu

Long-term projections of global water use for electricity generation

P14

Sayaka Yoshikawa
Tokyo Institute of Technology

Electricity generation may become a key factor that accelerates water scarcity. In this study, we estimated the future global water use for electricity generation from 2005 to 2100 in 17 global sub-regions. Twenty-two future global change scenarios were examined, consisting of feasible combinations of five socioeconomic scenarios of the Shared Socioeconomic Pathways (SSPs) and six climate mitigation scenarios based on four forcing levels of representative concentration pathways (RCPs) and two additional forcing levels, to assess the impacts of socioeconomic and climate mitigation changes on water withdrawal and consumption for electricity generation. Climate policies such as targets of greenhouse gas (GHG) emissions are determined by climate mitigation scenarios. Both water withdrawal and consumption were calculated by multiplying the electricity generation of each energy source (e.g., coal, nuclear, biomass, and solar power) and the energy source-specific water use intensity. The future electricity generation dataset was derived from the Asia-Pacific Integrated/Computable General Equilibrium (AIM/CGE) model. Estimated water withdrawal and consumption varied significantly among the SSPs. In contrast, water withdrawal and consumption differed little among the climate mitigation scenarios even though GHG emissions depend on them. There are two explanations for these outcomes. First, electricity generation for energy sources requiring considerable amounts of water varied widely among the SSPs, while it did not differ substantially among the climate mitigation scenarios. Second, the introduction of more carbon capture and storage strategies increased water withdrawal and consumption under stronger mitigation scenarios, while the introduction of more renewable energy decreased water withdrawal and consumption. Therefore, the socioeconomic changes represented by the SSPs had a larger impact on water withdrawal and consumption for electricity generation, compared with the climate mitigation changes represented by the climate mitigation scenarios. The same trends were observed on a regional scale, even though the composition of energy sources differed completely from that on a global scale.

Corresponding email: yoshikawa.s.ad@m.titech.ac.jp

Interaction of water, land use, and ecosystem in Integrated Terrestrial Model: a bio-geophysical land surface model with human components

P15

Tokuta Yokohata
National Institute for Environmental Studies

Future climate changes possibly affect eco-system services, water resources, food production, energy supply, etc. It is important to understand the interaction between the changes in these complicated factors. In the present study, we develop an integrated terrestrial model which describes the natural biogeophysical environment as well as human activities. In the integrated model, a global vegetation model VISIT (Ito et al. 2012), water resource model H08 (Hanasaki et al. 2008, Pokhrel et al. 2012), crop growth model PRYSBI2 (Sakurai et al. 2015), and land use model TeLMO (Kinoshita et al., in preparation) are coupled to a land surface model MATSIRO (Takata et al. 2003, Nitta et al. 2014), which is a component of global climate model MIROC (Watanabe et al. 2010). Output variables of each sub-model are passed to other sub-models during the time integration. The time intervals of variable exchange are from hourly to monthly or yearly. For example, the crop yields [ton/ha] calculated by PRYSBI2 is used in TEMO which calculate the land use change (crop or natural vegetation area) of next year. The projected land-use map is used in all other sub-models. The water resource model H08 considers the irrigation process (water withdrawal from rivers) as well as dam operations in large rivers, which affects the state of the soil moisture and the river flows in the land surface model. We will present the state of the model development, and results from the historical and future simulation. In the historical simulation, we validated the model output such as river flow, irrigated water, crop yield, and ecosystem productions by comparing to the observed or reanalysis data. Based on the future simulation, we also assessed the risk of future climate change by investigating the relationship of possible cropland area expansion and crop productions and so on.

Corresponding email: yokohata@nies.go.jp

Impacts of Large-scale Solar Photovoltaic Deployment on Global Climate Variability

P16

Masahito Omori
The University of Tokyo

Considering the impact of fossil fuel combustion CO2 emission on the global warming and the projected depletion, it is expected that renewable energy will play an important role in the future. However, most of the previous researches have demonstrated climate consequence of renewable energy deployment within regional scales. In this research, it is aimed to estimate impacts of solar photovoltaics deployment on climate variability at the global scale. A general circulation model (GCM), Model for Interdisciplinary Research on Climate (MIROC) 5.0 is used in an atmospheric GCM mode for 10-year experiment span (1998-2007). As expected, temperature decreased in regions where solar photovoltaics were installed, but at the same time, remote impacts were also found in some regions. Especially, temperature increase in western Russia and temperature decrease in western Canada were observed, which is speculated as because of anomalous shift of Rossby Wave. This indicates that some areas are subject to a shift of mean state change in temperature, which urges to take the impacts on global climate into consideration before large-scale solar photovoltaic deployment.

Corresponding email: omori@rainbow.iis.u-tokyo.ac.jp

Intercomparison of regulated river discharge among multiple hydrological models

P17

Yoshimitsu Masaki
Hirosaki University

We performed an intercomparison of river discharge regulated by dams among multiple hydrological models by simulation under the framework of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) 2a. This is the first multimodel intercomparison study on dam-regulated river flow. We examined river discharge on a longitudinal section of two case-study river channels to investigate the effects of dams on simulated discharge, especially at the seasonal time scale. We found that the magnitude of dam regulation differed considerably among the hydrological models. The difference was attributable not only to dam operation schemes but also to the magnitude of simulated river discharge flowing into dams. Intermodel discrepancies tended to decrease toward the lower reaches of these river basins, which means model dependence is less significant toward lower reaches. These case-study results imply that, intermodel comparisons of river discharge should be made at different locations along the river's course to critically examine the performance of hydrological models because the performance can vary with the locations.

Corresponding email: ymasaki@hirosaki-u.ac.jp

Springtime trans-Pacific transport of Asian pollutants related to the Western Pacific teleconnection

P18

Ja-Ho Koo
Yonsei University

Springtime trans-Pacific transport of Asian pollutants has been examined to understand its properties. Based on the satellite pollutant measurements and reanalysis meteorology data, this study focus on how the springtime trans-Pacific transport relates to the Western Pacific (WP) pattern, one of northern-hemispheric teleconnections. Positive WP patterns well indicate the strenghened dipole structure between the northern Aleutian Low and the southern Pacific High over the North Pacific. We find that the TOMS/OMI Aerosol Index (AI) and MOPITT CO show the enhancement of trans-Pacific pollutant transport during periods of positive WP pattern, especially 40-50N latitudes. This pattern is also confirmed by high correlations of WP index with AI and CO. To evaluate the effect of the WP pattern, we investigate several cases of trans-Pacific transport reported in previous studies. As a result, we reveal that most trans-Pacific transport cases are associated with the positive WP pattern. For the period of negative WP pattern, however, cyclonic wave breaking is consistently found over the western North Pacific, which inhibits the horizontal air-mass transport. Some cases show the trans-Pacific transport of CO in the period of negative WP pattern, implying that the WP pattern is more influential on the transport of particles (e.g., Asian dust) mostly emitted near ~40N. This study shows the possibility to utilize WP pattern as a proxy to predict the extent of springtime Asian particle transport across the Pacific.

Corresponding email: talc45@hotmail.com

Uncertainty of Rainfall Amount and River Discharge in Mountainous Catchments Associated with Spatial Distribution of Rainfall Observation and Meteorological Prediction

P19

Konosuke Shibata
Hokkaido University

ã€€Four sequential typhoons, which recorded precipitation equal to annual precipitation, caused serious disasters such as severe floods over many river basins, mudslides, bridges collapse, and inundation of agricultural lands in Hokkaido during the middle to latter half of August in 2016. This study discusses uncertainty of rainfall amount and river discharge associated with spatial distributions of rainfall observation in the basin of Kanayama dam, located in the upper Sorachi river basin, where a flood occurred by the collapse of the embankment by heavy rainfall due to the typhoon number 10. The river improvement plans and the measures to deal with natural disasters are mainly based on the ground rainfall observations. Rainfall is observed by tipping bucket rain gauges with 20cm diameter. There is an average of one gauge per 114 ãŽ¢ in the basin of the first-class river in Hokkaido. However, uncertainties associated with the basin representativeness for spatial distribution of the gauge exist, because of the few-kilometers spatial scale of cumulonimbus and the characteristic of high deviation of time and space in rain-fall intensity due to topography in mountainous areas. The rainfall data used on this study is from C-Band radars of MLIT Transport (Ministry of Land, Infrastructure and Transport), C-Band radars of the Meteorological Agency, the ground rainfall gauges (by AMeDAS (Automated Meteorological Data Acquisition System) and MLIT) and analyzed rainfall data. Analyzed rainfall data is rainfall data revising the plane region data observed on radar compared with the ground rainfall with good confidence in quantity. We ran rainfall to run-off model by using observations by the ground rainfall gauges and C-Band radars of the Meteorological Agency as input conditions and conducted run-off calculation for three sub-basins in the Ikutora basin. And also we ran the rainfall to run-off model at a upper reach of Sorachi river basin using the results of the ensemble forecast of typhoon number 10 with the domain climatic model as the input data.A similar analysis regarding the uncertainty over 235 catchments all over Japan was investigated. The results suggest that the recognition of total rainfall amount for the top 10 rainfall events during the last 11 years (January 2006 - August 2016) highly depends on the spatial density of rainfall observations by AMeDAS and MLIT. Furthermore, uncertainty in river discharge associated with the spatial distribution of rainfall observation is larger than its of the ensemble forecast from 2 days in advance by weather forecast model.

Corresponding email: calib.nosu-0213@i.softbank.jp

Classification and forecast of heavy rainfall in northern Kyushu during Baiu season using Self-Organizing Maps (SOM)

P20

Dzung Nguyen-Le
Faculty of Engineering, Hokkaido University

In this study, the Self-Organizing Maps in combination with K-means clustering technique are used for classification of synoptic weather patterns inducing heavy rainfall exceeding 100 mm/day during the Baiu season (June-July) of 1979-2010 over northern Kyushu, southwestern Japan. It suggests that these local extreme rainfall events are attributed to four clustered patterns, which are primarily related to the Baiu front and the extratropical/tropical cyclone/depression activities and represented by the intrusion of warm and moist air accompanied by the low-level jet or cyclonic circulation. The classification results are then implemented with the analogue method to predict the occurrence (yes/no) of local heavy rainfall days in June-July of 2011-2016 by using the prognostic synoptic fields from the operational Japan Meteorological Agency (JMA) Global Spectral Model (GSM). In general, the predictability of our approach evaluated by the Equitable Threat Score up to 7-day lead times is significantly improved than that from the conventional method using only the predicted rainfall intensity from GSM. Although the False Alarm Ratio is still high, it is expected that the new method will provide a useful guidance, particularly for ranges longer than 2 days, for decision-making and preparation by weather forecasters or end-users engaging in disaster-proofing and water management activities.

Corresponding email: dzungnl@gmail.com

Estimation of Flood Discharge by Assimilating Water-Level and Rating Curve into Quasi-2D Hydraulic Model

P21

Tsuyoshi Hoshino
Hokkaido University

River discharge is important information to grasp water movement in a river basin, because river discharge has a close relation with time space distribution of precipitation and runoff characteristics. However, flood discharge information has low reliability because of difficulty of discharge observation. Observation of river discharge has some difficulties. First, observation at multipoint is generally difficult since observation of river discharge requires expensive equipment and human labor as compared with observation of water level. Second, rainfall outflow time is short In a steep river and it is difficult to capture the rise of discharge. Third, safe observation is difficult when a rise in water level approaches the embankment height. For these reasons, a relational expression between water level and discharge (rating curve) are built, and river discharge is often estimated from observation results of water level. However, water level and discharge don't necessarily have a fixed relationship because of non-stationarity of a flood. Moreover, It is expected that the applicability of the rating curve is low, especially in the case of an inexperienced big flood. In order to solve such problems, authors developed a discharge estimation method which is a hydraulic model with data assimilation. The developed method is consist of quasi-2D flood computation as a hydraulic model and particle filter as a data assimilation method. The estimation target by data assimilation is conveyance, because conveyance is a basis of a rating curve and reliable discharge can be obtained through reliable conveyance. Conveyance is constituted by a cross sectional area of a river channel and a roughness coefficient which have uncertainty because it is difficult to measure them during a flood. Observation data which used to assimilation are water level and discharge derived from a rating curve. In order to express uncertainty of rating curve, it was assumed that the reliability of a rating curve decreases with the increase of discharge. Authors applied the discharge estimation method to the flood of 2011 in the Shinano river. Compared to the case without using data assimilation, the estimated discharge was high in agreement with some observed discharge data during the flood period. Also, the trajectory of the time variation of the water level and discharge was reasonable. From the above, the discharge estimation method used in this study is an effective method, and it can contribute to grasping time space distribution of precipitation and the runoff characteristics of a river basin. Authors will apply the method to the floods of 2016 in Hokkaido region.

Corresponding email: hoshino@eng.hokudai.ac.jp

Development of a Eulerian global river water temperature model

P22

Daisuke Tokuda
The University of Tokyo

River water temperature is a physical quantity which affects not only ecology and water quality such as disolved oxygen but also water resources such as cooling water of industrial activities electricity generation. It is known that there are regional differences in response of river water temperature due to climate change and human activities such as reservoir construction, regulation and water intake. There have been few efforts to estimate these phenomena on a global and long-time scale. In this presentation, we introduce a global river water temperature model based on Eulerian description. The difference from the existing semi-Lagrangian global model is that it is superior in heat conservation, and it is easy to apply to complex boundary conditions (topography such as confluence, lakes and so on) and the situation where it flows down at different flow velocities instead of having restrictions on the stability of calculation. This model also deals with physical processes such as water phase change (i.e. river ice) and heat balance in flood plains. The phase change amount is calculated to satisfy the mass and heat conservation law, and the heat balance in the flood plain is expressed by calculating the average absorption rate of short wave radiation on the floodplain. We validated this model using global observation data collected by GEMS/Water and compared reproducibility of river water temperature with and without flood plain consideration in the Mekong river basin. This results indicates that not only the flow rate and heat capacity but also the hydrological process of flooding affects the river water temperature. And from the heat balance analysis, we discuss the influence of heat conduction from river bed on river water temperature. From these results, it is considered that the hydrological process not only flow rate, heat capacity but also flooding is affecting the river water temperature. This model seems to have a potential in extrapolating simulation as climate change and impact assessment of human activity.

Corresponding email: daisuke@rainbow.iis.u-tokyo.ac.jp

Effect of an exponential decay of saturated hydraulic conductivity on equilibrium soil moisture and water table depth in MAT-GW

P23

Natsuki Yoshida
School of engineering,the university of Tokyo, Research Fellow of Japan Society for the Promotion of Science DC

Appropriate initial soil moisture and water table depth reduces uncertainty in hydrological simulation. The role of groundwater on land surface process have been discussed recently and soil moisture have a connection with groundwater. There is a problem that initialization needs long time simulation at arid region in land surface model with representation of water table dynamics, and this relates to hydrological question that how terrestrial equilibrium soil moisture and water table depth is determined by climate conditions. Finding one of answer to this question contributes to hydrological knowledge and also leads to solve the above problem. To answer the question, obtaining appropriate simulated soil moisture and water table depth at global scale is needed at first. This study quantify the accuracy of annual soil moisture and water table depth in land surface model with representation of water table dynamics (MAT-GW) at first. Second, an exponential decay of saturated hydraulic conductivity was adopted into MAT-GW and effect of an exponential decay of saturated hydraulic conductivity on soil moisture and water table depth was examined. Soil process in MAT-GW was calculated by Clapp and Hornberger equation. Simulated soil moisture on surface soil layer(0-0.05m) at Africa and China shows high spatial correlation coefficient with in situ observation in both simulation, while simulated water table depth shows low consistency at especially deep area in control simulation. An exponential decay of saturated hydraulic conductivity on soil moisture improved simulated water table depth at deep area, while similar water table depth were simulated in both simulation at shallow area because exponential profile of saturated hydraulic conductivity was adopted below 1.5m.This result shows that the exponential profile of saturated hydraulic conductivity is reasonable to simulate water table depth at deep area in land surface model with representation of water table dynamics. The impact of exponential profile of saturated hydraulic conductivity on runoff will be examined and shown at conference.

Corresponding email: yoshida@rainbow.iis.u-tokyo.ac.jp

Benchmarking strategy for multi-model ensemble simulations and optimization of ensemble mean

P24

Ryotaro Doi
The University of Tokyo

There is a growing interest in standardization of model evaluation for increasing number of multi-model based research initiatives such as Couple Model Intercomparison Project (CMIP). The performance of a model, however, can be evaluated with different scopes depending on various skill scores (e.g., Taylor's S-score (Taylor, 2001)). In order to characterize those metrics, 15 model outputs on evapotranspiration from The Inter-Sectoral Impact Model Intercomparison Project 2 (ISIMIP2) are validated against multiple reference observations and the skill scores are calculated using the International Land Model Benchmarking (ILAMB) package. Model performances are evaluated differently depending on metrics. For example, RMSE metric from ILAMB package gives a high score to a model including outliers, while Spatial Distribution metric from ILAMB package gives a low score to the same model. To study the potential of skill scores for ensemble averaging, ensemble averages are calculated using each skill scores as weights. It is found that the weighted ensemble average tends to mark higher performance compared to a single member and also the simple arithmetic mean of the ensemble. Taking into account more numbers of variables such as terrestrial water storage anomaly and discharge, the difference of model performances depending on variables needs to be studied.

Corresponding email: doi@rainbow.iis.u-tokyo.ac.jp

Estimating Evapotranspiration with limited climate data in Andong Dam Watershed using FAO56 Penman-Monteith methodology

P25

Sea Jin Kim
Korea University

This study is conducted to estimate potential evapotranspiration in Andong Dam Watershed with FAO56 Penman-Monteith (FAO56 PM) methodology using the climate data from 2013 to 2014 of 10 weather stations. Also, the potential evapotranspiration were estimated when there was no solar radiation, humidity or wind speed data by FAO56 PM and the results were evaluated to discuss whether the methodology is applicable when climate dataset is not available. As to compare the potential evapotranspiration estimated from the complete climate dataset and that estimated from limited dataset, statistical analysis was performed using the Root Mean Square Error (RMSE), and the coefficient of determination (R2). From the result, even when the climate data is limited, FAO56 PM showed a relatively high accuracy in calculating potential evapotranspiration by estimating the climate data.

Corresponding email: bluegulcy@gmail.com

Evapotranspiration processes are evaluated in global models (hydrological and Land Surface Models) using the iLAMB system and using a new metric to which quantifies different time scales of drying after a rain event

P26

Eleanor Blyth
Centre for Ecology and Hydrology

One of the key properties of the land is how it dries out after a rainfall event. It affects how warm the land becomes between the rain storms, how much water is available for growing food, how much water is received by the rivers. This drying is due to many factors: the type of land cover, the efficiency of the drying due to wind and sunshine, the response of the soils. This process of drying is referred to as Evapotranspiration and many models and dataset aspire to quantify it for all climate types and across all ecosystems. As part of the EU FP7 project EartH2Observe, a suite of 10 models were used to simulate global hydrology including evapotranspiration. All the models were given the same driving data and all of the models reproduced their estimates of evapotranspiration (as well as soil moisture, surface runoff and drainage: the key water balance components of a model grid). All of the models treat the processes leading to the eventual evapotranspiration slightly differently and the results were surprisingly varied as will be presented here. The second stage of the study is to evaluate the models. This is not straightforward as there are no globally available observed datasets of evapotranspiration. Instead there are options to evaluate the models against proxies of evaporation such as soil moisture, or an independent model, or at a range of sites where direct observations have been made. In this presentation, we demonstrate the many methods of evaluating the models. Firstly, we use the iLAMB benchmarking system. Initially using the data sets already in the system (GRACE for the total soil water, GLEAM for a satellite driven model of evaporation), the system was then expanded to include Soil Moisture (using the ESA-CCI soil moisture product). New metrics were also developed to evaluate a specific evaporation processes: the speed of dry-down after rainfall. For this, we used a set of flux tower sites that provides half-hourly evapotranspiration data and represents different land covers and climates around the world. We analysed the dry-down at two key timescales: the interception time scale (hours) and the transpiration time scale (days). The dry-down analysis characterizes different models on their medium time-scale response to water limited conditions and their interception fraction. We show that this analysis with the flux data provides an important new potential constraint on the models.

Corresponding email: emb@ceh.ac.uk

Impacts of soil moisture initialization on boreal summer subseasonal forecasts in the GloSea5 prediction system

P27

Eunkyo Seo
UNIST

This study examines the contribution of soil moisture initialization with Global Seasonal Forecast System version 5 (GloSea5; MacLachlan et al. 2015) to the improving prediction skill of surface temperature focused on boreal summer season. Two sets of Atmospheric Model Inter-comparison Project (AMIP) style hindcast experiments perform for 15 years (1996-2010) either with non-realistic soil moisture condition from GloSea5 long-term AMIP integration or realistic one which is not reanalysis land condition but JULES (Best et al. 2011) offline Land Surface Model (LSM) simulation driven by data assimilated atmospheric forcing dataset (Sheffield et al. 2006). For a given 15-year period, the two set of hindcasts are commonly performed with 7-member ensemble simulations. We put the variation of the initial soil moisture condition from the offline LSM on AMIP statistics in order to avoid climate drift by coupling with atmospheric component (Dirmeyer 2000; Koster and Suarez 2003; Koster et al. 2004). This study adapted a soil moisture initialization methodology, Standard Normal Deviate Scaled (SNDS; Koster et al. 2004), where the variation of the simulated soil moisture by JULES offline experiment is rescaled onto GloSea5 AMIP statistics. Results reveal statistically significant increase in forecast skill of surface temperature particularly in the mid-latitude land area where background soil moisture condition is the transitional region between relatively wet and arid regimes. The 10-15 % grid points among total become skill increasing, in which the squared forecast skill difference between soil moisture initialized experiment and without initialization is over 0.1. The initialization highly contributes to modulate the heat wave developing processes for 2003 European and 2010 Russian extreme heat wave events. In contrast, although the realistic soil moisture is initialized in the GloSea5 model experiment, there is limitation to modulate the realistic degree of surface anomaly conditions in extreme events. The problem is associated with the difficulty resolving realistic precipitation by the dynamical model even though the anomalous incoming radiation strongly amplify the extreme climate.

Corresponding email: ekseo90@gmail.com

Assessing uncertainty of environmental models to predict stream water quality

P28

Shirin Karimi
University of Tehran

In recent decades, the importance of water quality in human life development, especially in arid and semi-arid countries facing lack of freshwater resources such as Iran, is more perceived. Modeling the relationship between water quality parameters and physical attributes of catchment play a significant role for the integrated watershed management. Moreover, considering the uncertainty analysis of model outputs to predict their effects on decision-making is essential. This study focused on the probabilistic uncertainty analysis using Monte Carlo simulation. In order to obtain the relevance of physical attributes of 50 catchments located in southwest of the Caspian Sea and in-stream water quality parameters, stepwise Multiple Linear Regression was applied. According to the regression analysis and the coefficient of determination, seven water quality parameters, with R squared coefficients higher than or equal to 0.5, were selected, which are as follows: SAR (r2= 0.68, p

Corresponding email: Shirin.karimi@ut.ac.ir

Interannual variability of snow properties in an upper reach basin of Sapporo area between 2005 and 2017.

P29

Atsushi Nunokawa
Graduate school of Engineering, Hokkaido University

Hokkaido, the northernmost prefecture of Japan, has one of the heaviest snowfalls of the world. Snow often causes severe effects such as avalanche and blizzards. Water resources in Sapporo city highly depends on snow amount in its upper reach basin. Continuous hydrological observation in the upper catchment of Sapporo including some snow properties has been conducted by the Civil Engineering Research Institute for Cold Region (CERI) from 2005 to present. In addition to these observations, the authors started to measure the volumetric water content, the volumetric ice content, snow density and snow water equivalent at three vertical levels by a sensor associated with dielectric constant at the same observation site. In this presentation, we will discuss about interannual variability of snow properties at this site. Furthermore, interseasonal characteristics of snow properties will be analyzed associated with the cross-sectional observation of snow.

Corresponding email: peachtennenyyy@gmail.com

Sea Spray Characteristics under Air-Sea Boundary Layer

P30

Hiroki Okachi
Hokkaido University

Sea spray is a carrier which exchanges momentum and enthalpy between air-sea interaction. Influence of sea spray to the intensification of typhoon has been discussed in previous studies. The sea surface is completely covered by the two-phase environment during wind speeds exceeding 25-30 m/s. The 10-m drag coefficient has a maximum value for wind speeds between 30 to 40 m/s and decreases with stronger wind speed. This study has two approaches, these are field observation and wind-tunnel experiment, which are used to estimate the sea spray size distribution. In performing the field observation, we installed optical disdrometer on the observation tower. This is usually used for rain observation. The observation site is located in Tanabe bay, Wakayama-prefecture, where typhoon often hits. We got data when it was not rainy and blew strong wind. Measuring the droplet remains elusive because of two reasons. Firstly, when droplets fall through the edges of the laser, the size of droplet is underestimated. Secondly, droplets disperse as it hits the disdrometer (Katja and Stephanie 2013). In this study, we discussed how to estimate the sea spray size distribution and rain size distribution. By performing the wind-tunnel experiment, we investigate the droplets' vertical distribution and its dependence on wind speed and height. In this poster, I will present the results of the field observation and the wind-tunnel experiment, respectively.

Corresponding email: hokachiroki@gmail.com

Meteorological Characteristics of a Heavy Snowfall Event Based on Multi-Doppler Radars over Sapporo Area in 2015

P31

Yuta Ohya
Hokkaido University

ã€€It is possible to discuss three-dimensional fields of atmosphere by using multi-doppler and variational principle. This study adopted two X-band multi-parametric radars installed and managed by Ministry of Land, Infrastructure, Transport and Tourism, and analyzed meteorological fields for a heavy snowfall event which was associated with a small low pressure system over Ishikari Bay resulting in local heavy snowfall which is difficult to be predicted from weather map. ã€€The variational method used in this study has been developed for airborne-type and adjusted to be applied for ground-based radars. This method based on calculating with three terms to get high quality precision of base line between radars. These terms are improved for low convective cloud in winter from original system. First term is fit term which interpolates observation value from polar coordinates to rectangular coordinates. Least squares method is used by this study. Second term is mass conservation which using mass flux. When there is deep convective cloud over a flat plane, we can use continuous system. Third term is filter term which smooth wind vector using differential operator. The differential operator showed the second and third differential calculus, and excluded the third differential calculus by this research. ã€€Numerical model of the Meteorological Agency which assimilated from observation value around Japan shows small vortex on the Ishikari Bay. Results of radar analysis showed that wind vector conversantly and horizontal wind convergence was detected in lower troposphere over a coastal zone of Ishikari Bay which is northwesterly located from Sapporo area. In addition, stronger reflectivity propagates to southeasterly direction including Sapporo area and showed horizontal advection of snowfall. Wind vectors obtained in the variational method was validated with those in radiosonde observation, respectively.

Corresponding email: saving_energy@eis.hokudai.ac.jp

Correction of the rain rate estimates of ground radar using GPM/DPR data

P32

Tatsuya Shimozuma
Nagasaki University

Correction of the rain rate estimates of ground radar using GPM/DPR data 1. Introduction and objective of this study Accurate and high-resolution distributed rainfall dataset is required to calculate the return period of previous heavy rainfall events and to simulate possible rainfall events under the climate change. Japan Meteorological Agency (JMA)'s precipitation analysis dataset â€œRadar AMeDASâ€ was used in a previous study. By using ground radar data with superior resolution, it is possible to create high-resolution spatial rainfall data. In this study, Japan Ministry of Land, Infrastructure, Transport and Tourism (MLIT)'s X-band multi-polarimetric Radar Information Network (XRAIN) is used to produce high-resolution spatial rainfall data. XRAIN has higher spatial and temporal resolutions of 250m and 1 minute, but there are some problems: 1) XRAIN is more subject to rain attenuation than C-band radars. 2) XRAIN sometimes shows false heavy rain estimates at specific area. To reduce the error in XRAIN, Dual-frequency Precipitation Radar (DPR) on the Global Precipitation Measurement (GPM) mission's core satellite is used. 2. Decide the correction object grid (1) Method First, the rain rate estimates of XRAIN and DPR are compared to decide the correction object grids. Here, the correction object grids are area where the difference of the XRAIN and DPR's rain rate is large. The study is focused on XRAIN radars to be operated in Kanto regions. As DPR and XRAIN make different observation area, their match-up data that satisfy the several conditions were extracted: 1) The observation area is overlap. 2) Some degree of the rain rate is observed. 100 matchup cases of DPR and XRAIN are found between March 2014 and June 2016. 5km grids are created throughout the Kanto region, and compare the XRAIN and DPR's rain rate in each grid by interpolation. The DPR's rain rates at the clutter free bottom which is stored as the variable name of [precipRateNearSurface] is used. And the product version of DPR is V04A. (2) Result As a result of comparing the rain rate between XRAIN and DPR, XRAIN>DPR tendency is confirmed in mountainous areas of Mt. Fuji, Gunma prefecture, Niigata prefecture, Tochigi prefecture, Fukushima prefecture and the plain of Kanto. The tendency of XRAIN>DPR in the mountainous areas is considered to be caused by ground clutter. However, ground clutter is unlikely to cause XRAIN>DPR tendency in the plain of Kanto. Therefore, the correction object grids are decided by following condition, altitude is over 500m, and grid with XRAIN/DPR>2.0 at over 50% of all rain cases. As a result, correction object grid concentrate in the mountainous area. 3. Correction of the XRAIN's rain rate (1) Method XRAIN's rain rate is corrected from the correction object grids and examine the difference of the rain rate between before and after correction. In this study, using the data of XRAIN in 2015, the sum and maximum rain rate before and after correction are calculated. In the correction method, XRAIN's rain rate in the correction object grid is divided by the correction coefficient. However, if the rain rate is corrected uniformly in the case where the rain is widely distributed, the rain rate suddenly change at the grid boundary. Therefore, the 0.5km grid is defined to cover the observation area, and the average rain rate of the correction object grid (R1) and four surrounding grids (R2) are calculated, and correction is performed only when the ratio of both are over 2.0 (R1/R2>2.0). The smaller value of "XRAIN/DPR ratio of the rain rate" and "ratio of the rain rate between correction object grid and surrounding grids" is used as the correction coefficient. (2) Result As a result of comparing the rain rate before and after correction, the rain rate estimates are decreased about 10% in the mountainous area. Particularly, areas where the ratio of after/before correction is small, around the bukuma highland of Fukushima prefecture, Mt. Fuji and Nikko of Tochigi prefecture. Each areas are located between radar site and the high altitude mountain, and it is considered that the each area is subject to the ground clutter. The ratio of after/before correction of each area is about

0.42 : Abukuma highland of Fukushima prefecture, about 0.45 : Mt. Fuji and about 0.60 : Nikko of Tochigi prefecture. From the above result, it is suggested that the correction can improve the XRAIN's overestimation by the ground clutter. 4. Conclusions and future work MLIT's XRAIN is corrected by the GPM/DPR to produce high-resolution spatial rainfall data. In this study, to mitigate the overestimation of the XRAIN's rain rate, the correction object grids are decided by following condition, altitude is over 500m, and area where the difference of the rain rate is large between XRAIN and DPR. XRAIN's rain rate of 2015 is corrected based on the correction object grid. As a result, it is suggested that the correction can improve the XRAIN's overestimation by the ground clutter. The future work is to increase the match-up cases between XRAIN and DPR and to improve the correction method.

Corresponding email: shimozuma@nagasaki-u.ac.jp

High resolution, high accuracy global topography map for land hydrology modeling

P33

Dai Yamazaki
The University of Tokyo

Global-scale Digital Elevation Models (DEMs) are essential for many studies, such as land surface hydrology modelling, flood inundation modelling, and terrain analysis. While precise airborne DEMs are available in developed regions, most parts of the world rely on spaceborne DEMs which include non-negligible height errors. Here we show the most accurate global DEM to date at ~90m resolution by eliminating major error components from the SRTM and AW3D DEMs. Using multiple satellite data and multiple filtering techniques, we addressed absolute bias, stripe noise, speckle noise and tree height bias from spaceborne DEMs. After the error removal, significant improvements were found in flat regions where height errors were larger than topography variability, and landscapes features such as river networks and hill-valley structures became clearly represented. We found the topography slope of the previous DEMs was largely distorted in most of world major floodplains (e.g. Ganges, Nile, Niger, Mekong) and swamp forests (e.g. Amazon, Congo, Vasyugan). The developed DEM will largely reduce the uncertainty in both global and regional land hydrology modeling.

Corresponding email: yamadai@rainbow.iis.u-tokyo.ac.jp

Impact analysis of meteorological factors and SWI on monthly forest NDVI values

P34

Dongfan Piao
Korea University

Climate change is now an issue in many areas, such as forest ecosystems, marine ecosystems and wetland ecosystems, and the impacts have become serious. In order to identify the impacts of climate change on forests, predicting NDVI by analyzing the correlation between NDVI value of forests and environmental factors in Northeast Asia was conducted in this study. Seasonal correlation between monthly NDVI values of Northeast Asian forests and the meteorological factors, and seasonal correlation between monthly NDVI values and the Soil Wetness Index (SWI) were analyzed. As a result, factors eliminating solar radiation and precipitation had high significance with NDVI values (P

Corresponding email: pdf0920@gmail.com