YOSHIMURA LAB.

[Climate system and Hydrology]

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Isotope hydrometeorology

How would Global Hydrological Cycle Change in Changing Climate?

The wonder of the water cycle change caused by the climate change

Water circulation on the earth, which is largely affected by Climate Change, influences human life. Thinking extensively about global hydrology, Yoshimura laboratory aims to clarify its mechanism and its relationship to climate system by various approaches, in order to contribute to our society. We especially focus on ①Development of land-surface/hydrological models and coupling with an earth system model and ②Hydrological process study using stable water isotopes ③Development of Regional Earth System Models.

1. Development of land-surface/hydrological models and coupling with an earth system model

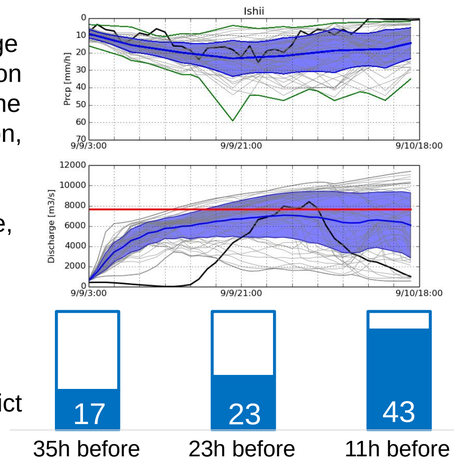
1-1. Development of ensemble flood forecasting system using numerical weather prediction data

Weather simulation, called as Numerical Weather Prediction(NWP), can now output the forecast few weeks ahead and especially the one which forecasts few days ahead has high accuracy. Land surface disaster which is caused by weather forcing, however, especially flood has only a few hours lead time despite those development in NWP.

There are so called ‘uncertainty’, which stands for the residual between real and simulation results. To consider this, it is suggested Ensemble simulation (run plural simulation with slightly different condition) should be done.

In this research, the system that calculates river discharge from land surface physical process forced by weather data. To input those NWP into this system, river discharge can be predicted from few days before. Specifically, input two NWP, ECMWF ensemble and JMA meso scale model, data into MATSIRO, land surface model. And then input those MATSIRO-outputs into CaMa-Flood, river model, to get ensemble river discharge.

Those system has adopted to Kanto/Tohoku heavy rain in 2015. In kinu and Naruse river which had flood in this event, the system could predict flood from 35 hours before.



（above）Precipitation (above) and discharge (bottom) at Ishii station in Kinu river. Black line stands for observation, blue for ensemble mean, red for evacuation discharge, grey for each ensemble members. Blue shaded part is 1sigma interval.
（bottom）How many members could predict the flood before obs. exceeds red line.

1-3. Hyper-Resolution Hydrologic Simulation Framework

To understand and predict damage caused by climate change and extreme weather, it is necessary to build hyper-resolution hydrologic simulation framework. Presently, first try to increase resolution is finished, and Fig.1 shows the difference between 1km-grid and 10km-grid. 1km shows evident finer details. Then, “Hydrologic simulation framework” means the combination of climate data as input, Land Surface Model (MATSIRO) and the river inundation model (CaMa-Flood). Finally, we can get river discharge, water depths, inundated area. Furthermore, getting input data on time and delivering the output on the Internet is expected.

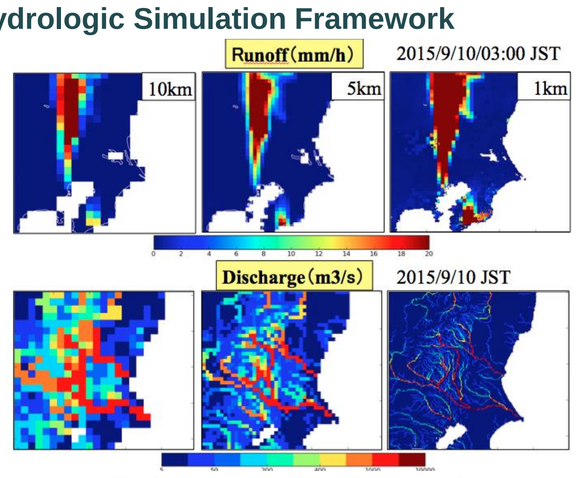
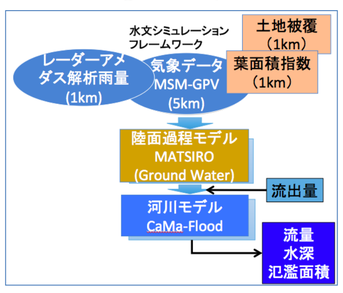


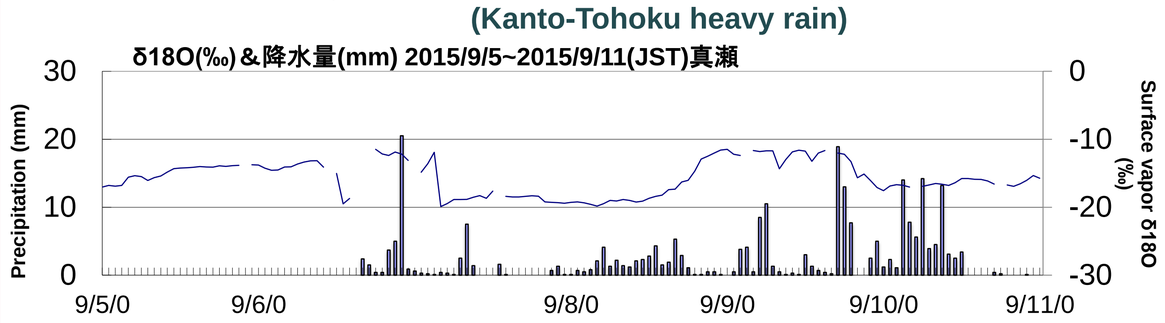
Fig.1 Compare 10km 5km and 1km

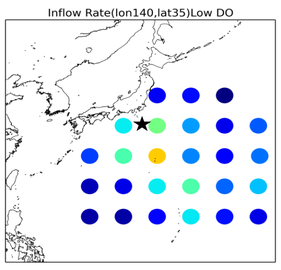


(left) Fig.2
Outline of Hydrologic Simulation Framework

2. Hydrological process study using stable water isotopes

Study about Water vapor transport Using Stable Isotope (Kanto-Tohoku heavy rain)

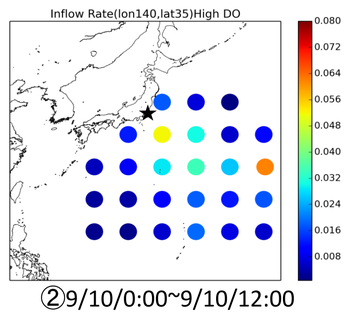




(left) The inlet flow of water vapor to Mase station.
9/9/0:00-18:00

①9/9/0:00~9/9/18:00

(right) The inlet flow of water vapor to Mase station.
9/10/0:00-12:00

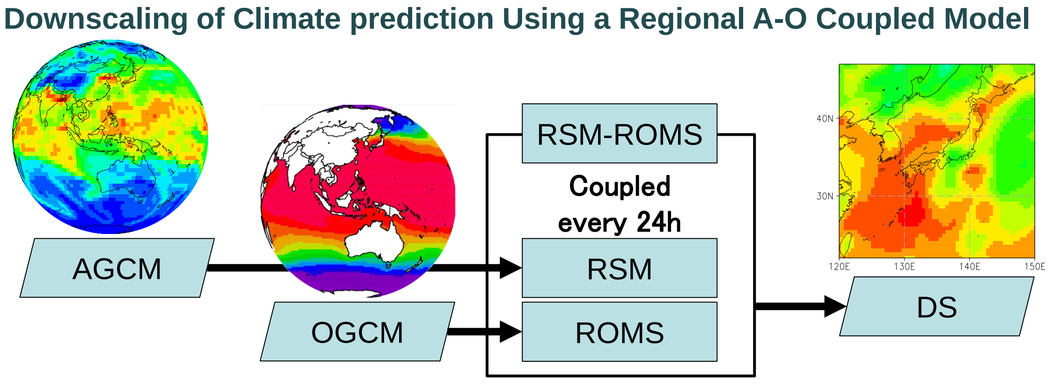


②9/10/0:00~9/10/12:00

The isotope ratio of vapor was heavier (around -11‰) for 0JST to 18JST on Sep. 9 and lighter (around -16‰) for 18JST on Sep9 to 12JST on Sep. 10.

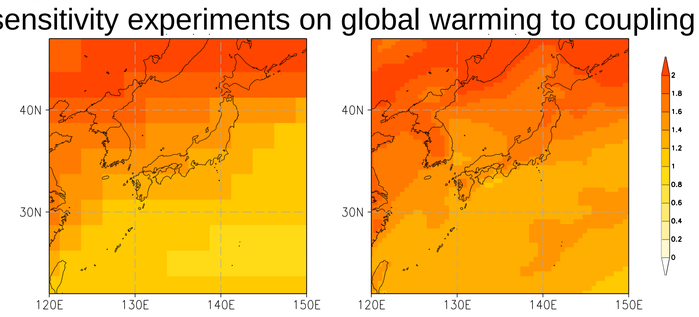
Water vapor origins changed from Sep. 9 12:00 to Sep10 6:00.The isotope ratio of vapor was heavier for period ① and lighter for period ②. Simulations of VWTs are consistent with passages of TCs contributed Kanto-Tohoku heavy rain.

3. Downscaling of Climate prediction Using a Regional A-O Coupled Model

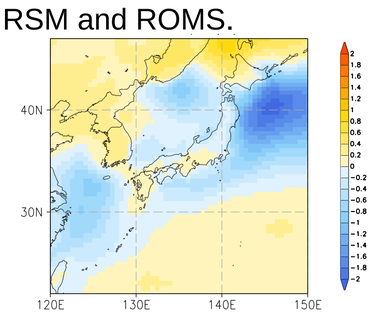


Previous studies have some problems like that the model resolution are coarse and mesoscale atmosphere ocean interaction understanding are insufficient. It is important to solve these problems for performing an impact assessment of the climate change in island countries such as Japan.

Therefore the objective of this study is to perform impact assessment of crop production to climate change, we conducted Downscaling Simulation (***DS***) using Regional Atmosphere-Ocean Coupled Model RSM-ROMS. At first we performed sensitivity experiments on global warming to coupling of RSM and ROMS.



Left：Global warming prediction using GSM [K]
Right：Global warming prediction using RSM−ROMS [K]



Global warming difference of coupled/uncoupled run [K]