YOSHIMURA LAB.

[Climate system and Hydrology]

Department of Human and Social Systems

http://hydro.iis.u-tokyo.ac.jp/~kei/lab/

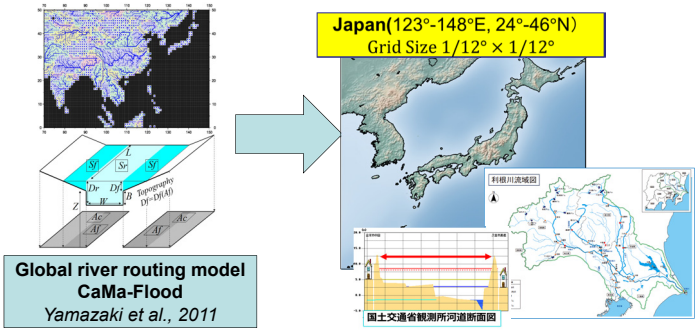
Isotope hydrometeorology

How would Global Hydrological Cycle Change in Changing Climate?

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 ② Hydrological process study using stable water isotopes.

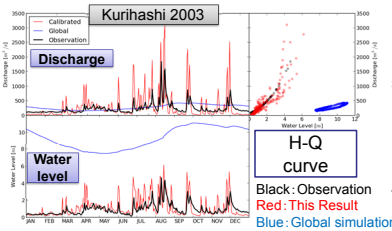
1. Development of land-surface/hydrological models and coupling with an earth system model

1-1. Validation of seamless river routing model in Japan



Global river routing model CaMa-Flood
Yamazaki et al., 2011

CaMa-Flood can express river discharge, water level and flood area in global big river basin. If this model can express river discharge etc., it is seamless model about grid size. There are two point in this study. One is to consider compound channel, and the other is to decide river channel width and depth considering with actual width and depth using MLIT dataset and Google map.



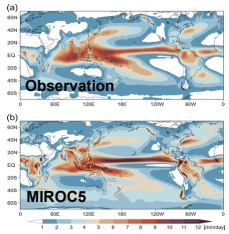
Black : Observation
Red : This Result
Blue : Global simulation

Peak timing is represented in both river depth and river discharge by using actual river cross sectional shape.

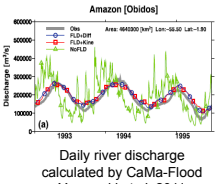
More improvement is needed such as installation of dam effect because peak discharge is over estimated in this result.

1-2. Coupling of an earth system model and a hydrological model

Rivers play a major role in the climate system. Nitrogen from the soil flowing through the rivers into oceans and flooded water from rivers influencing the amount of evaporation are some examples. In order to clarify phenomena in the climate system, knowledge of interaction between the consisting factors is essential. In this study, we couple a earth system model and a state-of-the-art river inundation model. We aim to define the role of rivers in the climate system, and clarify the mechanism of the climate system by considering realistic interactions.

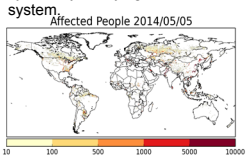


Climatology of annual mean precipitation
Watanabe et al. 2010



Daily river discharge calculated by CaMa-Flood
Yamazaki et al. 2011

We aim to improve the accuracy of short-time flood prediction system by clarifying the climate system.



Flood affected people calculated real-time
Hatono et al. 2014

2. Hydrological process study using statle water isotopes

2-1. Investigating vegetation-atmosphere water exchange by using high frequency spectroscopy vapor isotope obsevations

How much is the contribution from plant on the global hydrological cycle?

Recently studies show that renewable fresh water over continents has input from precipitation and losses to the atmosphere through evaporation(10%) and transpiration (60%). However, it is still debated owing to large uncertainties in measurements. As a result, Global climate models are poorly constrained in feedbacks of vegetation.

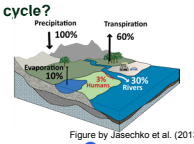
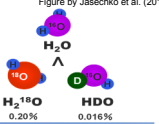
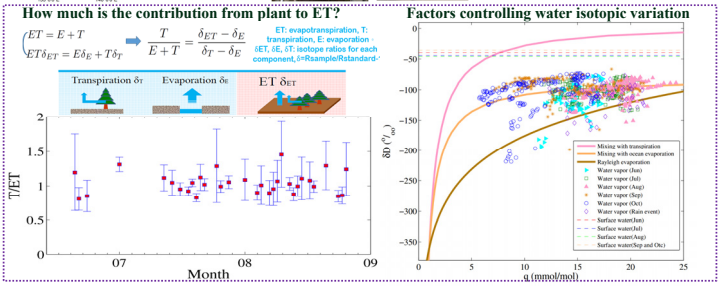


Figure by Jasechko et al. (2013)

How to assess the important of transpiration?

Differences in the rates of evaporation and condensation between heavy and light isotopologues of water create spatial and temporal variability in the isotopic composition of water in soil-vegetation-atmosphere transfer. Therefore, stable isotopes are a powerful tool for monitoring changes in terrestrial water cycling. To assess the respective important of evaporation and transpiration, a comprehensive isotopic observation in water cycling including high frequency water vapor, precipitation and soil water has been





2-2. Application of isotope enabled earth system model to paleoclimate reconstruction

Stable water isotopes record integrated hydrological processes. By analyzing climate proxy which contains past water, we can estimate paleoclimate. However it is sometimes difficult to interpret what proxy shows. We use isotope enabled earth system model to disentangle what controls the isotopic variation in the proxy

Mega-drought in West Africa

Mega-drought have frequently hit West Africa, causing severe famine. To understand what controls the precipitation amount over the area is urgent.

Fig. 1

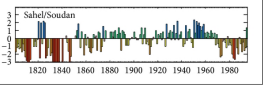


Fig 1. Annual precipitation anomaly in Sahel/Soudan (Nicholson 2012)
Fig 2. Correlation between isotope in Niamey (green dot) and precipitation in each grid, showing high correlation in Guinea Coast, which locates in the upstream of Niamey
Fig 3. Correlation between isotope and ENSO

The results suggest the possibility to reconstruct past precipitation in Guinea Coast, and the potential effect of ENSO to proxies

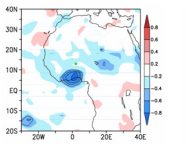


Fig. 2

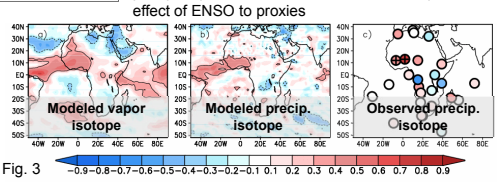


Fig. 3