Term Projects – 2011 Advanced Hydrology

Policy –

- Please read carefully the project descriptions and choose interested topic(s) from the following, and then consult the project advisor(s) for arranging a personal meeting to understand the project(s). Your interest is the foremost important. Individual advisor will resolve he situation considerably once if more than one student are interested in the same topic.

- It is students' responsibility to contact and meet with advisor before deciding your final project by **May 31st**.

- By **July 15th**, a written mid-term report on your project progress should be submitted to your instructor for evaluation.

- Final presentation will be held on **August 4th** (and possibly also August 11th if time is not enough). A PPT file for a 10-15 minutes final presentation should be sent to your advisor at least one day before presentation.

Project List –

1. **Investigation of flood and drought occurrence in the past and under the warming future (YEH)**

In this project, we will analyze the past flood and drought occurrence over the largest river basins in the world by using historical river flow and terrestrial (land) water storage data, and we also will study how the risk of flood and drought will change under global warming by using the simulated hydrology from the latest version of the atmosphere-ocean general circulation model MIROC5 (Model for Interdisciplinary Research on Climate). Under the agreement of MIROC5 model simulation with the past observed records, we expect to project the future frequency and magnitude of water disasters over large river basins.

2. **Potential response of regional groundwater recharge and base flow to future climate change (YEH)**

In arid or semi-arid areas, Groundwater (GW) recharge is important to maintain sustainable water use and GW runoff (baseflow) is the main or only reliable water source. Also, baseflow contributes to a large fraction of river low in global average. However, both hydrologic quantities are not observable and almost no data existent. In this project, we will use water balance method along with traditional baseflow estimation method ("hydrograph separation") to estimate GW recharge and baseflow in large river basins. Meteorological information (precipitation, radiation, etc) will also be utilized to supplement the estimation. Finally, the sensitivity of estimated GW recharge and baseflow to the temperature change will be analyzed for the purpose of enhancing the projection of GW response to future climate warming, and it will be closely related to the findings of Prof. Brustaert's 2008 WRR paper.

3. Examining the sensitivity of potential and actual evapotranspiration to climate change (YEH)

Evapo-transpiration (evaporation) is the largest term just next to precipitation in the terrestrial water budget. However, it is difficult to measure and long-term observed data are not existent. Thus, most future projection of evaporation change under warming climate is purely based on hydrologic simulations seldom with suitable validation. In this project, we will analyze theoretically from the well-known evaporation estimates (Penman-Monteith equation; Presley-Taylor equation, Complementary relationship, etc) how each individual dependent variables (radiation, precipitation, soil moisture, wind speed, resistances, etc.) will possibly change in the warming climate from which we will infer the future projection of global-scale evaporation.

4. Effects of global warming on precipitation extremes (SETO)

How does global warming affect the characteristics of heavy precipitation? Recently, many studies drew relations between heavy precipitation rates and surface air temperature. Some of them suggested that the relations are governed by the Clausius-Clapeyron (C-C) relation; if precipitation rates are proportional to the saturated water vapor content, the former is expected to increase by nearly 7% with an increase in air temperature of 1 K as the latter is. You can use climate simulation datasets for this kind of analysis.

5. Characteristics of high temporal resolution precipitation dataset (SETO)

Rain gauges measure precipitation rates generally on hourly to daily time scales. However, urban flood events may occur on shorter time scales (e.g. a severe flood event occurred in Toga river (Kobe city) and killed five people in 30 minutes). To understand the characteristics of such short-time scale rainfall, 1-min AMeDAS rain gauge dataset and micro rain radar dataset are available for your study.

6. Development of a new retrieval algorithm for the dual-frequency precipitation radar (DPR) (SETO)

As a successor of the first space-borne precipitation radar (TRMM/PR), a dual-frequency precipitation radar (DPR) will be carried on the GPM core satellite in about two years. For the DPR, a new algorithm to retrieve precipitation rates is under development. Your help to the algorithm development is quite welcome.

7. Remote sensing of water quality in enclosed water area (OKI Kazuo)

Chlorophyll-a(Chl.a) and Suspended Sediments (SS)are the two major optically active factors effecting inland water quality. Chl.a is used as the primary pigment-index for various phytoplanktons in water. It is needed for estimating primary productivity, biomass etc., whereas, concentrations of SS are helpful in determining water dynamics and spread of pollutants. In the open ocean, these parameters can be effectively and easily monitored from remote sensors by constructing simple empirical algorithms at different remote-sensor bands. However, in optically complex inland water the task is much more difficult due to the presence of suspended minerals and dissolved organic matter, that vary independently of phytoplankton and can overwhelm the spectral signature of chlorophyll. This makes the transfer function a nonlinear problem and estimation of water quality parameters, especially Chl.a becomes difficult with conventional algorithms like regression analysis. In this project, a method to estimate Chl.a concentration in enclosed water area is proposed.

8. Estimation of the potential pollutant loads in river basins using remotely sensed imagery (OKI Kazuo)

The increase of nutrient loads such as nitrogen and phosphorus to a river due to land cover changes in surrounding areas has been one of the major sources of water pollution or eutrophication. Monitoring the influent nutrient load from river basins to rivers is now crucial in the management of river basin environments. The monitoring is not easy, however, because it requires spatial and temporal measurement tools for land cover changes in the river basin and water qualities, and also it requires models relating them. In this project, a method to estimate the potential pollutant loads in river basins using remotely sensed imagery is proposed.

9. Estimation of the potential pollutant loads in river basins using remotely sensed imagery (Oki Kazuo)

The transport of sediment by water in rivers plays an important role in hydrology and the ecological functioning of river floodplains and deltas. River discharge estimation is useful for describing this phenomenon. In addition, if low-cost and continuous river discharge estimation becomes available, it is expected that communities with fewer financial resources such as those in developing countries could easily use this information for constructing effective flood control infrastructure such as dams and levees. In this project, a method to estimate the river discharge using remotely sensed imagery is proposed.

10. Visualization and analyses of global/regional atmospheric hydrology from Reanalysis products (YOSHIMMURA)

There are several Reanalysis products in the world. They provide 4 dimensional geophysical states of the global atmosphere and corresponding diagnostic variables (such as precipitation, evaporation, many others) for a long period (30~50 years). In this project, participant(s) will first visualize the so-called "global hydrological cycle", similar to Oki and

Kanae (2006). Depends on his/her interest, some further analyses will be taken place. For example, interannual variability of regional precipitation associated with climate signals such as ENSO would be investigated. Participant(s) is welcome to use the climate projection products, too.

11. Dynamical downscaling using a meteorological model for hydrological studies (YOSHIMURA)

Dynamical downscaling using a regional climate model is one of the typical methods to downscale coarse data. Participant(s) of this project will learn how to use a regional model. Depends on his/her interest, the target domain, period, and resolution will be set. The model calculation will be followed by validation, and further application studies (such as stream flow simulation) are expected to be done. Some basic knowledge of UNIX-based numerical experiments is preferably required.

12. Water vapor/precipitation isotope measurement by a new laser spectroscopy instrument (YOSHIMURA)

In this project, participant(s) will measure stable oxygen and hydrogen isotope ratios (D/H and 18O/16O) in vapor and/or precipitation, which are good indicators of water transport processes, by a new laser spectroscopy instrument (Picarro L2120-i) and will learn the atmospheric and land surface processes by using the measured isotopic information. It is welcome to do the measurement in experimental fields (e.g., paddy field).