

Simulation of daily precipitation time series using a new stochastic model

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Geoscientific fields such as clouds, spatial elevation data, temporal or spatial rainfall fields, and earthquake-slip fields are often modeled using fractals or multifractals. We first sought to apply fractional Brownian motion (fBm) or fractional Levy motion (fLm), which are simple fractal models, to simulate and generate time series of daily precipitation (R) at 51 stations in Japan. [1] We conducted spectrum analysis of the anomalies of R ($R_{\text{delta}}=R-R_{\text{ave}}$; where R_{ave} is the normal value of each day). However, we found that the fBm/fLm cannot be applied to the data because the relation between angular frequency ω and power $P(\omega)$ is not log-log linear, which is a necessary condition of a fractal. Therefore, we defined a new model, e-model, which describes the mutual relation between ω and $P(\omega)$. In the e-model, $P(\omega)$ is described as $A \exp(-B \omega)$, where A and B are approximation coefficients. [2] One generating fBm and fLm method is the filtering of white noise. If the white noise is Gaussian, then the model is fBm. However, if the white noise is Levy, then the model is fLm. Our model is not a fractal model such as fBm and fLm. However, the algorithm is similar to those. First, we generate white noise and filter the noise. Results show that, as for white noise for our model, the Levy noise is more appropriate than the Gaussian noise. [3] We simulate a time series of daily precipitation (R') using the e-model and Levy random number. The power spectrum of anomalies of R' (R'_{delta}), which were generated by us showed a similar relation to those of the e-model, which indicated that the daily precipitation time series can be calculated using the e-model and Levy random number. [4] We assume the negative values of R' as zero (no-precipitation) (hereinafter, these time series are R''). We conducted spectrum analysis of R'' . Results show that the power spectrum of R''_{delta} resembles those of R_{delta} . To conclude, we presented the possibility of generating the time series of daily precipitation using e-model and Levy random number, which is a method resembling the filtering method for fBm/fLm.

Keywords: stochastic model, Levy random number, e-model, daily precipitation time series, simulation, filtering

Comparative validation of the PCO₂ rates in Japanese rivers and its controls

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Previous studies showed that total carbon rates are mainly controlled only by chemical weathering and soil respiration, and therefore, PCO₂ within the river water is also characterized by these parameters. This fact is confirmed by numerous studies in a local scale, but when standing on a more macro perspective, study results are still limited. Defining the behaviors of the PCO₂ within the river waters can lead to the understanding of the role of rivers within the global carbon cycle, which, moreover, can be essential in predicting future behaviors. Based on the hydrochemical dataset by Kobayashi (1960) and the further datasets of Kobayashi (Harashima et al., 2006), the PCO₂ of the Japanese river water were mapped. Then, through a comparison with various presumable parameters, we determined the controlling factors of the PCO₂ system.

As a general result, it can be said that (1) Japanese rivers' carbon dioxide are generally supersaturated with respect to the atmosphere, with an average of 3,300% atm as its partial pressure. (2) The Japanese river PCO₂ is mainly controlled by soil respiration, as far as we stand on a short term time scale. (3) Especially, Hokkaido, Kinki area, and the Kyushu area showed high partial pressure rates in average. (4) It is highly possible that alluvial plains, marsh areas, and volcanic areas is related to raising the PCO₂ rates of the river water. Further studies to confirm these results are expected.

Keywords: Carbon cycle, Japanese rivers, Land water, PCO₂

A pilot study based on ALOS/PALSAR for Hydrological monitoring of snowy highland Oze marsh

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We have not monitored hydrological environment of highland marsh with heavy snow, because the snow has prevented from our entering it in winter. One of the most famous highland marshes, Oze, has heavy snow more than 2 m in depth every year. We have analyzed data products of a kind of L-band radar, PALSAR/ALOS, from July in 2006 to April in 2011. This analysis showed existence of a water body under the snow. Although some researchers have reported the liquid water under the thick snow, this would be the first report for seasonal change of its distribution. Because we found a larger water body in midwinter season than that in snow-melt season, this water would be squeezed out from peat layers by the load of heavy snow, not melted snow.

Keywords: Oze, Hydrological Environment, PALSAR, Remote Sensing, Snow and Ice, peat

Time Series Analysis to Determine the Aquifer Properties of a Fractured Aquifer

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This study demonstrates a time series analyze method in the research well site near You-luo stream in Shinchu County, Taiwan. The rainfall, river stage, and well water table records from January 2010 to August 2012 were used for analyzing the aquifer properties, such as the hydraulic conductivity. Considering an aquifer nearby a stream, the input stress (far field rainfall) causes a rising of the water level in the stream. Wells with different distances from the stream will obtain the water table variations after the raising of water levels in the stream. The aquifer parameters can then be estimated by the time difference of the response between stream and the wells. This method were verified succeed with employed FEMWATER simulation model. Preliminary results show that the hydraulic conductivity in the well field is 2973 m/day. The scale effect may be the reason for the four times higher value than that in previous investigation.

Keywords: Time Series Analysis, Aquifer Properties, scale effect

Simple estimation method of shallow groundwater level with groundwater aeration sound

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This study provides a new method of groundwater exploration using groundwater aeration sound and reports the results of observations in Tottori sand dune, Japan. The groundwater aeration sound (GAS) is that the aeration sound generated in the vicinity of the saturated / unsaturated boundary. We have developed a device that can collect this small sound from the ground surface. The device consists of an acceleration pickup, needle, amplifying system, and level meter with a filtering function. The total weight of the device is 0.9kg; it is highly portability and workability.

On the assumption that there is a relevance to GAS level and groundwater level, we conducted a survey using the existing wells in experimental natural dune. As the results, there is the logarithmic relationship between the GAS level and groundwater level. With this relational equation, we investigated the GAS survey to estimate continuous groundwater level in Tottori sand dune. As a result, we got a valid result on hydrogeology. From these results, the estimation accuracy of groundwater level by GAS was demonstrated.

Keywords: Groundwater aeration sound, Groundwater exploration, Shallow groundwater, Tottori sand dune

Groundwater flow across divide in a headwater catchment underlain by sedimentary rocks

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Spatial distribution of springs and streams were observed to estimate groundwater flow across divide between watersheds. A total of 10 springs and 12 streams in a head water catchment underlain by sandstone and chert, Karasawasan University Forest, Tokyo University of agriculture, Eastern Japan were monitored from May 2011 to 2013. Water level monitoring observed 6 spots of springs and streams. The samples were analyzed the solute concentration, CFCs and stable isotope.

The specific discharge of springs and streams was higher in the sandstone region than that in chert region in high-flow season. The quick flow ratio (defined by Hewlett and Hibbert, 1967) to the rainfall was higher in the sandstone basins than that in the chert basins, whereas the base flow rate during low-flow season was higher in the chert basins than that in the sandstone basins. The concentration of sodium and silica in springs and streams were higher in the sandstone basins than that in the chert basins. In addition The residence time was longer in the low-flow season than that in the high-flow season on sandstone basins.

The groundwater flow across divide between sandstone and chert basins are resulted by the reversing of hydraulic gradient .

Keywords: Headwater catchment, Sandstone, Chert, Specific discharge, Quick flow ratio, CFCs

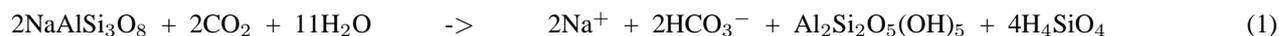
Hydrochemistry of non-volcanic hot springs around the Kofu plutonic complex

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Hot springs have great significance as local promotion and so on. A lot of hot springs have drilled in many parts of non-volcanic area in recent years, but most of the hydrochemistry of those hot springs are unclear. The purpose of this study is to explore the hydrochemistry of non-volcanic hot springs around the Kofu plutonic complex in Yamanashi prefecture. 13 samples of hot spring water were collected at 0-1500m depth to analyze major chemical components and isotopic compositions of oxygen, hydrogen and sulfur as sulfate anion.

Temperature measured onsite of water samples were from 18.8 degrees centigrade to 42.5 degrees centigrade, and pH values were from 7.3 to 10.2. Most of the sample waters were classified as Na-HCO₃ type (9 samples). The others were classified as Na-SO₄ type (3 samples), and Na-HCO₃·SO₄·Cl type (1 sample). Basic water quality of the hot spring waters in this area is the Na-HCO₃ type, and the relationships between Na⁺ and the HCO₃⁻ and the saturation index of sample waters for the kaolinite indicate that major chemical components were caused by the albite mineralization.



Constituent Granitoids of The Kofu plutonic complex were classified into magnetite-series and ilmenite-series granitoids based on magnetic susceptibility (e.g., Shimizu, 1986). Sample waters from magnetite-series area have positive delta ³⁴S values (1.7 to 10.0 per mill), while the water samples from ilmenite-series have negative values (-8.8 to -4.6 per mill). This tendency of heavy-light delta ³⁴S values of sample waters consist with that of the magnetite-series and ilmenite-series granitoids. These results suggest that the delta ³⁴S values of the water samples reflect the delta ³⁴S values of the granitic rock around the hot spring site.

Keywords: kofu plutonic complex, non-volcanic hot spring, chemical composition, genesis, recharge mechanisms, water-rock interaction

Seasonal change in water chemistry of stream on Asama volcano

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There are many springs in the edifice and the surround area of Mt. Asama which is one of most active volcano in Japan islands. In the southern part of the crater, the laminated sediment was deposited in the river bottom. In order to elucidate the depositional process of the laminated sediment, we observe the water chemistry and the river bottom sediment component. In this session, we present the observation results and discuss the relationship of seasonal changes between water chemistry and sediment components.

Keywords: Asama volcano, stream, sediment, water chemistry, calcite

Chemical structure of Lakes Nyos and Monoun, Cameroon

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The explosive discharge of CO₂ gas (limnic eruption) in the mid 1980s at Lakes Nyos and Monoun in Cameroon killed about 1800 people around the lakes. The driving force of the limnic eruptions was the CO₂ gas dissolved in the lake water. A good knowledge of lake water chemistry and an elucidation of lake stratification are therefore important ingredients in preventing future limnic eruptions.

Water was collected at Lakes Nyos and Monoun in 2011 and 2012. Dissolved total-CO₂ (CO₂aq + HCO₃⁻) concentration was determined by volumetric titration. The temperature, pH and dissolved O₂ of lakes was measured in situ by use of CTD.

With the temperature and chemistry, Lake Nyos was roughly divided into 3 layers. In the first layer, shallower than -10m, the temperature reaches 25C due to solar radiation, while the temperature of the second layer (-10 to -70m) lies between 21.5 and 22C. In the third layer, deeper than -70m, the temperature increases gradually with depth, reaching 25C close to the bottom (-210m). Except for near surface water, dissolved species (total-CO₂, Cl⁻, Br⁻, SO₄⁻, Na⁺, K⁺ and Mg²⁺) show depth-concentration profiles that parallel those of temperature, except Fe and Mn, which were low in the first layer, and increased abruptly from -80m. The concentration of dissolved O₂ was higher than 2 mg/L in the first and second layers, and less than 0.3 mg/L in the third layer, showing the anoxic environment.

In Lake Monoun, the first layer shallower than -10m was heated to 25C by solar radiation. The temperature of second layer (-10 to -50m) was uniform (19.5 to 20C). In the third layer (-50 to -80m), the temperature increases gradually towards the bottom. In the fourth layer (-80 to -90m) the temperature was uniform (22C). In the fifth layer, deeper than -90m, the temperature increases gradually towards the bottom of the lake at -100m. Like for Lake Nyos, depth-concentration profiles of chemical species in Lake Monoun parallel those of temperature. The dissolved O₂ concentration was higher than 1 mg/L in the first layer and less than 0.2 mg/L in the layers deeper than -10m.

The CO₃⁻ concentration can be thermochemically estimated based on the total-CO₂ and pH. The estimated concentration was multiplied with Fe concentration to make the product, Q (a_{Fe}·a_{CO₃}), which was compared with K, the solubility product of FeCO₃. The water of Lake Nyos was estimated to be under-saturated in terms of FeCO₃ in the first and second layers but oversaturated in the third layer. In Lake Monoun, the water deeper than -30m was oversaturated thoroughly. In Lake Nyos, the deep water has been lifted up to surface by the degassing pipes and Fe(OH)₃ precipitate was generated, making the color of lake red after April 2011. The Fe(OH)₃ precipitate sinks to third layer then dissolved to be Fe²⁺ ion due the anoxic condition. The increased Fe²⁺ ion meets with the high carbonate ion, resulting in the condition of oversaturation in terms of FeCO₃

Keywords: Lake water, Chemistry, Cameroon, CO₂, Limnic eruption

Characteristics and runoff responses of DOM during rainfall events in the Kumaki River in Noto Peninsula, Japan

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Introduction

The management of SATOYAMA is important to sustain material cycle and ecosystem. Recently, SATOYAMA faces to degradation of ecosystem caused by the abandonment of forest and farmland and then influence chemical properties of water in soil and river. Humic substances being high-molecular organic acid is concerned with the coastal biological productivity. The change in SATOYAMA environments caused by deforestation and unmanagement of forests and paddy fields may reduce transport of organic matter from watershed to coastal area. Therefore, we need to elucidate the migration behavior of humic substances on a scale not only local, but also watershed. The purpose of this study was to elucidate the variation of structural properties, concentration and migration behavior of organic matter caused by abandonment of farmland and forest area. We also assess the impact of the abandonment to ecological system in river - coastal environment. This study investigated at the Kumaki River and Nanao Bay, which is located on the Noto Peninsula in Ishikawa Prefecture. The coastal biological productivity is high in the Noto Peninsula, and the abandonment of forest and farmland has been progressing. In this presentation, we report characteristics and runoff responses of humic substances in the Kumaki river waters collected during the rainfall events from 2009 to 2011.

Study sites and Methods

River water samples were collected at Kumaki River during the rainfall events in 13 July 2009, 27-28 July 2009 and 7-8 July 2011. Water samples were filtered through GF/F filters and then filtered samples were kept under freezing until analysis for three-dimensional excitation emission matrix (3D EEM) spectroscopy and high-performance size exclusion chromatography (HPSEC). Precipitation and water level data was provided by Ishikawa Prefecture River Total Information System (Ishikawa Prefecture, Civil Engineering Division).

Results and Discussions

Three rainfall events were different in variation of water level with amount and duration of rainfall. The humic-like materials concentration showed two to three times different values by the rainfall amount and water level. However the concentrations and characteristics of humic-like materials showed similar variations by the rainfall events as follows.

Humic-like peaks were detected at Excitation (Ex.) / Emission (Em.) wavelength of 300-340 / 430-465 nm for 3D EEM spectra in all river water samples. Relative fluorescence intensities (RFI) of humic-like peaks were high values with elevation of water level in the rainfall events, and decreased with downward water level after the rainfall. To understand characteristics of humic-like materials, the river water samples were analyzed by HPSEC with detection wavelength of Ex. / Em. of 320 / 430 nm corresponding to humic fluorescence peak. Three sharp peaks were detected among retention values ranged from 8.4 to 9.7 ml (Peak 1-Peak 3), and Peak 2 was highest peak intensity. Peak intensity of Peak 2 was highest with elevation of water level in rainfall event, and decreased with downward water level after the rainfall. These demonstrate that there is a large contribution of humic-like materials with higher-molecular weight runoff to river.

As compared fluorescence spectra of river water with the normal condition and rainfall events, humic-like peak was detected at higher wavelength in fluorescence spectra at the rainfall events. However in low water level after the rainfall, fluorescence spectra show similar features at normal condition. Moreover, peak height ratio of Peak 2 and 3 detected HPSEC was almost twice higher than that of normal condition. This result shows that runoff of humic-like materials with higher molecular weight occurred by the rainfall events. After the rainfall events, concentrations and molecular weight of humic-like materials decreased to those of the normal condition.

Keywords: Noto Peninsula, DOM, Humic substances, 3-D EEM spectroscopy, HPSEC, Rainfall event

Catchment environmental changes inferred from reservoir sediment in northern area of Noto Peninsula

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This study aims to reveal the sedimentation records and the transport processes of organic matter in the reservoir-catchment system in Noto Peninsula in the central Japan. This area confronts the catchment environmental changes (vegetation and land use changes, etc.) related to change in human activities (population decrease and ageing, etc.) expected to affect the material transport. In Nanao Area, the central part of Noto Peninsula, our previous study suggested that the discharge of organic matter from the catchment was influenced by the deforestation of broadleaf forest and the cedar plantation during 1970s. In this study, the reservoir with the different vegetation history was investigated.

Study site is a small reservoir Shin-ike located in the northern part of Noto peninsula. Surface sediment core (31 cm length) was collected from the reservoir using a HR type core sampler (Rigo, Japan) in October, 2009. The contents of total organic carbon (TOC) and total nitrogen (TN), carbon and nitrogen isotope ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$), and grain size were analyzed for 1 cm interval. Vertical profiles of radionuclide activity concentration (^{210}Pb and ^{137}Cs) were also measured to estimate sedimentation rate and age of the core.

The present vegetation of the Shin-ike catchment mainly consists of broadleaf and pine tree forest. The cedar plantation is not significant in this site. The observation based on the aerial photos suggests that vegetation has developed and not disturbed since the small deforestation in 1960s.

The age of the core were estimated at about 90 years based on the ^{210}Pb method. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of organic matter were constant from 1920s to 1950s. They decreased with some fluctuations since 1950s and then the $\delta^{15}\text{N}$ slightly increased since 1970s. These fluctuations may be attributed to the decreasing contribution of soil organic matter and the increasing contribution of plankton to reservoir sediment. These results suggest that the discharge of organic matter from the catchment has changed related to the vegetation development in the Shin-ike catchment since 1950s.

Keywords: reservoir sediment, organic matter, carbon and nitrogen isotope ratios, Noto Peninsula

Transport and sedimentation of terrestrial particulate organic matter in Lake Akkeshi

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The sources of organic matter in estuarine and coastal sediments and their distribution are important to the understanding of global biogeochemical cycles. In these transitional systems, primary production generates large amounts of organic matter of which a significant portion sinks through the water column. Therefore, these areas show the complex nature of organic matter in estuarine sediment. A variety of parameters ($\delta^{13}\text{C}$, C/N ratio, biomarkers) have been used to determine the sources of organic matter. The objective of this study is to elucidate the transport and sedimentation of terrestrial organic matter from a wetland region to coastal ocean using carbon isotopic signatures.

Field experiments were carried out at a small river, Bekanbeushi River, along a low moor in Bekanbeushi Moor, and a brackish lake, Lake Akkeshi located in eastern Hokkaido, Japan during 2004-2011. We collected suspended solids in river waters from the Bekanbeushi River and surface sediments in Lake Akkeshi. Stable carbon isotopic ratio of a sample and the VPDB standard used for normalization were made by analyzing a triple collector mass spectrometer with a precision of ± 0.05 permil as $\delta^{13}\text{C}$ value. Radiocarbon was determined using accelerator mass spectrometry at the National Institute for Environmental Studies and the Japan Atomic Energy Agency. Radiocarbon values were reported as $\Delta^{14}\text{C}$ corrected for sample $\delta^{13}\text{C}$ with absolute error less than 10 permil.

Organic matter in riverine suspended solids shows almost constant: -29.1 permil to -28.7 permil for $\delta^{13}\text{C}$ value. In contrast, the $\Delta^{14}\text{C}$ value shows wide variations from -103 permil during snowmelt event to +9 \pm 16 permil during summer and winter. The river mouth sediments show wide variations in carbon isotopes. The $\delta^{13}\text{C}$ value increases from -27.3 permil at the river mouth to -21.5 permil at off the mouth. On the other hand, the $\Delta^{14}\text{C}$ value decreases with increasing the distance from the river mouth, ranging from -44 permil to -157 permil. The surface sediments in Lake Akkeshi show a small variation in $\delta^{13}\text{C}$ value from -20.0 to -18.7 permil and $\Delta^{14}\text{C}$ value from -168 to -139 permil. These results indicate that the sedimentation of particulate organic matter derived from wetland occurs at the restricted area near the river mouth. However, major part of terrestrial organic matter may be transported from Lake Akkeshi to Akkeshi Bay.

Keywords: river water, radiocarbon, suspended solids, coastal marine sediments, terrestrial organic matter, land-ocean interaction