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Development of a sattelote land data assimilation system coupled with a numerical weather prediction model, WRF

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A satellite Land Data Assimilation System (LDAS-WRF) was developed by coupling the Weather Research and Forecasting Model (WRF), as an atmospheric driver, to physically introduce the soil moisture observations and improve the representation of land surface and lower boundary conditions in Numerical Weather Prediction (NWP) online. The LDAS-WRF consists of Simple Biosphere model version 2 (SiB2) as a land surface driver and a model operator of the system, a radiative transfer model (RTM) as an observation operator, and Ensemble Kalman Filter (EnKF) as a sequential assimilation algorithm. The LDAS-WRF assimilates the soil moisture heterogeneity, using passive microwave brightness temperature at the lower frequency, which has a high sensitivity to soil moisture, and the RTM treats surface and volume scattering of surface soil layer.

The LDAS-WRF was applied to a mesoscale region in the Tibetan Plateau, where the land-atmosphere interactions affect the atmospheric dynamics considerably to evaluate the capability of the system. The experimental results show that the soil moisture and land surface energy fluxes obtained by the LDAS-WRF are successfully improved compared with no assimilation case. It was demonstrated that the LDAS-WRF has ability to apply satellite land observations to estimation of land conditions with high accuracy and provide more correct lower boundary condition to atmosphere in NWP.

Keywords: data assimilation, land-atmosphere interactions, satellite observations, WRF

Spatiotemporal variability of dryness/wetness status in Japan

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Spatiotemporal variability in dryness and wetness status over Japan from 1961 to 2010 was analysed using Palmer Drought Severity Index (PDSI), which was derived based on water balance model of two soil layer. Monthly value of PDSI was calculated with monthly mean air temperature and precipitation of 136 stations. During the analysis period, number of wet months decreased and that of dry months increased throughout Japan, while decrease of wet month was remarkable at northern area and distribution of dry area expanded. We employed Empirical Orthogonal Function (EOF) analysis to PDSI dataset, and obtained following results: the first EOF (EOF1) represented a dominant pattern of increasing dryness throughout Japan. Spatial contrast between the northern and southern area of eastern part of Japan was shown by EOF2, in which drying trend in northern area and wetting (suppressing drying) trend in southern area was clear. Spatial contrast between western and eastern part of Japan, which was shown by EOF3, was probably influenced by the variability of longitudinal distribution of the sea surface temperature.

Bulk coefficients over a water surface under calm wind condition: an influence of large-scale atmospheric circulation?

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Over the Lake Kasumigaura, 10 Hz fluxes data have been obtained since June of 2007, and characteristics of the bulk transfer coefficients of momentum C_{dn} and of water vapor and heat have been studied with emphasis on the possible influence of the large-scale convection to surface fluxes. Increase of C_{dn} when mean wind speed u becomes smaller in the range of u<4 m/s was found. By applying the cospectral and ogive analyses, a possible cause of this increase was the influence of convective circulation, as manifested by the mismatch of characteristic time scale of the flux (2nd moment) and mean wind speed (1st moment). Possible solutions to this the mismatch of time scale under weak wind speed was studied which include adaptation of the effective wind speed U_e instead of the traditional vector-averaged mean wind speed. However, complete solution is not likely available since this problem arises from ill-defined nature of C_{dn} under light wind condition.

Keywords: Lake Kasumigaura, Bulk coefficients, ogive, large-scale convection, fluxes

Estimation of infiltration rate in runoff plots for various surface covers and slopes under natural rainfall in Hebei an

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We are investigating the effect of surface cover and slope on the infiltration rate in runoff plots in two provinces of China, namely; Hebei and Sichuan Provinces. Temporal rainfall measurements and discharge of runoff plots were conducted for different surface cover and slopes during the rainy season from July to October 2012. Four land uses (bare soil, forest and two grasslands) were investigated in Yi Xian with 5m * 20m plots. On the other hand, in Yan Ting Xian, we monitored four plots of 1.5m * 5m with various slopes (15, 20, 25, 30 degrees) and three plots of 5m * 20m with maize and bare soil. In order to understand the variability of the infiltration rate, the collected data was analyzed in the light of a model that integrates the spatial infiltration variabilities within a plot. The relationship between rainfall intensity and infiltration rate have been developed in previous study using rainfall simulations for similar land uses which demonstrated that the infiltration rate increases with the rainfall intensity and gradually takes an asymptotic approach to the Maximum Infiltration Rate (FIR_{max}). The effect of different slope range and various land covers will be analyzed so as to draw a profound conclusion. The infiltration rate tends to have a certain relationship between land cover and slope in runoff plots in two provinces of China.

Keywords: Infiltration rate, Natural rainfall, Runoff plot, Slope, Surface cover

Changes in throughfall and its stable isotopic compositions after stripe thinning in a Japanese cypress plantation

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We investigated changes in throughfall and its isotopic composition due to forest thinning for examining changes in canopy interception processes. For one headwater catchment in a Tochigi site which covered by 20 to 50 years old Japanese cypress and cedar plantations, 50% line strip cutting methods were conducted at December 2011 for the efficiency of timber use. Monitoring periods were from May 2010 to October 2012. Throughfall was measured and collected using twenty tipping bucket rain gauges and collectors in a 10 by 10 m area with a grid pattern. Using the relationship between cumulative gross rainfall and cumulative throughfall (Link et al. 2004), throughfall was separated into two components, direct throughfall and drains from the canopy. The isotopic composition of throughfall and open rainfall were analyzed and compared for each rainfall event. After the thinning, amount of throughfall and direct throughfall were increased. The mean difference of d^{18}O values between throughfall and open rainfall during the post-thinning periods was larger than that during pre-thinning periods; however, the difference of these values was small. Spatial variability of the throughfall rate and the d^{18}O values in throughfall were affected by canopy structure only during post-thinning periods. Changing in forest structure by thinning affect interception processes in plantations.

Keywords: canopy interception, stable isotope, stripe thinning, Japanese cypress plantation

AHW29-P06　　　　　　Room:Convention Hall　　　　　　Time:May 23 18:15-19:30

The geochemical analysis about formation of groundwater in Aso caldera, Japan

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Aso caldera is known as rich in groundwaters. Among them, it is notable wide distribution of Fe-rich groundwater (called as Akamizu) in the western part of Aso-dani (north floor of the Aso caldera) . In order to reveal relationship between the Fe-rich groundwater (Akamizu) and hot spring waters which are pumped up from aquifers in deeper depth, we studied their chemical composition.

Hot spring waters were collected from 8 sites (depth: 150 m, 400 m~1500 m) in October 2012. Temperature, pH, electric conductivity (EC) and oxidation-reduction potential (ORP) were measured *in situ*. Cations (Na^+, K^+, Mg^{2+}, Ca^{2+}, total Fe) were analyzed with ICP-AES and Rb^+, Cs^+, La^{2+} were analyzed with ICP-MS. Si was analyze by colorimetry. Anions (F^-, Cl^-, SO_4^{2-}) were analyzed by Ion Chromatography. Alkalinity was determined by acid titration. Sulfur isotopic composition of dissolved SO_4^{2-} was measured by IR-MS.

Concentrations of major cation showed positive correlation with Cl^- concentration, although total Fe did not show clear relationship. Trace elements, Rb^+ showed positive correlation with Cl^- concentration, but concentrations of Cs^+ and La^{2+} are lower than detection limit. Delta-^{34}S values showed a range of from +13.4 per-mill to +16.0 per-mill, which showed local difference tend to increasing from the east to the west.

Relationship among concentrations of dissolved ions and delta-^{34}S values in the hot spring waters are well explained by mixing between two or three end-members, one of which could be considered as a geothermal fluid. Moreover, chemical composition of Fe-rich groundwater (Akamizu) is explained by the same end-members, which suggests contribution from the geothermal fluid.

Keywords: Aso, hot spring, groundwater, isotope

AHW29-P07   Room:Convention Hall   Time:May 23 18:15-19:30

On the underground water flow circulation system in Tottori sand dune based on the geo-electircal method

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The purpose of this study is to clarify and construct the underground water circulation system beneath whole Tottori sand dune symbolized by the generation mechanism of oasis in the sand dune having a high natural cultural value, through the investigation research based on the geoelectrical method.

Tottori sand dune is positioned in the Sanin Kaigan National Park. A good condition of the natural coast can be preserved and the information of a wide variety of natural phenomena such as the interaction of wind and sand and the history of special topography formation has been accumulated since long ago, there. A small spring area called oasis naturally formed in the sand dune is seen as one of valuable natural phenomena in Tottori sand dune. This oasis is positioned right under a big slope called Umanose and plays an important role as a landscape factor forming the natural scenery of Tottori sand dune.

What is the carrier of underground water such as oasis spring? Referring to the Tottori sand dune columnar section shown by Akagi (1991), in Tottori sand dune, a volcanic ash layer, including Daisen-Kurayoshi pumice originating from Diasen volcano, exists above the bedrock as a key bed and the sand dune is separated into two parts by this layer as a border, the upper part of New sand dune and the lower part of old sand dune. In the volcanic ash layer, an impermeable layer that water can hardly penetrate, consisting of clayey volcanic ash soil, clayey loam and clayey soil, and a permeable layer consisting of pumice are found. In this paper, as a candidate, the volcanic ash layer can be assumed as an impermeable layer an aquifer. If the underground water surface were formed by such mechanism, a linear relation between the difference of self potential measured on the two points in the sand dune and the layer thickness from the surface to the underground water level on the two points should be expected from the observation values.

In this study, a Self Potential (SP) measurement was implemented in the whole Tottori sand dune including the oasis spring area and the volcanic ash exposing area to attain the study purpose. The SP measurement result generally shows that the SP in a high altitude area becomes low and that in a low altitude area becomes high. As mentioned above, it is known that such a relation is found when an electrokinetic phenomenon (streaming potential) caused by underground water flow with undulations of topography is observed. In the sand dune, the same measurement result was obtained. Examined the relation between SP (mV) and altitude (m), a clear correlation having a streaming potential coefficient that appears to be -3mV/m was found. However, it was found there was a big difference in the coefficient between around the volcanic ash exposing area, especially the area where volcanic ash is expected to exist beneath, and the area where it is not expected.

Assuming the predicted result mentioned above could be effective, the underground water level in the sand dune area was estimated by using the SP measurement result. The equation (14) of Zlotnicki and Nishida(2003) was used as the one to find the underground water level. In the sand dune area, as a few academic borings have been done so far, the validity of the estimated result in this study was examined by using the data in the past borings. Examined and compared the results about the four points near the measurement points where the borings were done, the both was found to almost accord. We would like to discuss about the effectiveness of the SP method applied to the underground water distribution investigation under Tottori sand dine by comparing with the resistivity structure obtained from other methods such as an electrical investigation, hereafter.

Keywords: Tottori sand dune, underground water, geoelectrical method

Mechanism of occurrence of "Ikenotaira"-pond appear from time to time in the Misakubo town, Shizuoka Prefecture

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1.Introduction

There is a pond told to appear in a cycle of about seven years in the basin located in 654m above sea level of Misakubo Town, Hamamatsu City, Shizuoka Prefecture.

It is a basin without water usually and covered with artificial plantations, such as a Japan cedar and a cypress.

It is a lot of rain checked before the pond appear.

Sugimori (2001) etc. reported geological features and rain influence the groundwater level and appear pond.

Moreover, although it hands down that it had appeared 400 years or more before, it is not known that it is detailed.

The reason for clear generating conditions or mechanism not being solved but appearing periodically now, still now of this pond is also still unknown.

In this study, it aimed at solving an appearance mechanism based on the natural conditions of precipitation or a spot.

This time, we report the result of having performed the lake basin survey in the field and the water quality analysis in July and December,2012.

2. Research Region

Ikenotaira pond is in the basin of the place which went down about 200m the Mt.Kamenoko peak in Oryoke, Misakubo Town.

The path has been in the state near ruin road since the Sakuma Dam was constructed.

The path has many collapsed parts and it can observe that the whole mountain is a landslide place.

3. Investigation / Research Technique

We ran the basin survey, geological features survey using soil auger, sampled the spring water and stream water.

We measured electrical conductivity, ORP, pH, and water temperature there.

We run ingredients of inorganic ion analysis of brought sampling and the pond water using ion chromatography.

4. Result and Consideration

As a result of the lake basin survey near the 654 m above sea level and showing a depth contour, the maximum length of this pond is 130m, the maximum breadth of 50m, the circumferences is 130m, the area is 4325m^2, and the capacity is 11375m^3.

As a result of water quality analysis, the sample(2010) became clear that same as rain because each mass of dissolved ingredients are poor.

It compares the sampling go down 100m from the water quality analysis of pond and the sampling(2010), showed that each mass of dissolved ingredients are higher and especially the value of Ca+ is 6.73ml/g.

5. Future task

We constructed the automatic water level gauge in basin and rainwater sampler and tipping bucket rain gauge in Misakubo Towm Hall for the occurrence mechanism elucidation.
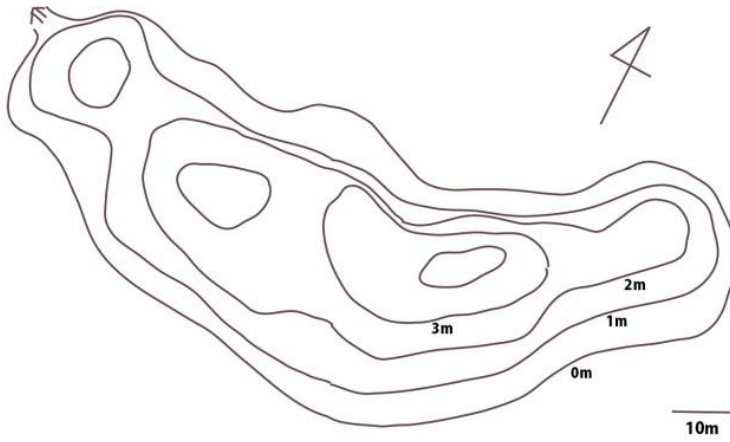
It is a plan to estimate the cultivation source using technique of the isotope hydrology.

Keywords: Ikenotaira, lake basin, water quality, hydrology

3m

2m

1m

0m

10m

A Method for Creating Inland Flooding Hazard Map Based on Topographical and Geographical Characteristics

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In Tokyo Metropolis, especially in wards district, inland flooding has caused much damage. Recently, many local-scale floods have been induced repetitively by torrential downpours. Thus, we focused on topographical and geographical characteristics of the flooded areas. In this study, we analyzed topographical and geographical characteristics of flooded areas in Shinjuku, Toshima and Bunkyo wards and made a simple hazard map based on this analysis In these wards, inland flooding has occurred frequently and repeatedly in recent years.

According to the records of flooding that were compiled by Tokyo Metropolitan Government, there were 107 inundations between 1989 and 2009 in the study area. We classified these flooded areas into three groups: lowland type, upland type and valley on upland type, and extracted topographical and geographical parameters: depression depth, depression volume, catchment area, land coverage of catchment area, mean slope of catchment, mean slope from a flooded area to a discharge point of catchment, difference between these two slopes, length from upper most of catchment to a flooded area, length from a flooded area to a discharge point of catchment, difference between these two lengths, valley depth, valley width, of the flooded areas by using ArcGIS 10. These parameters were examined by principal component analysis (PCA) to evaluate topographical and geographical characteristics of the flooded areas.

The result of PCA gave two major components in lowland type, three major components in upland type and four major components in valley on upland type. We calculated these PCA scores in the whole study area. Then, we extracted the area that each PCA score was higher than the lowest score of the flooded areas and the total of all PCA scores was higher than the lowest ones of the flooded areas as the one that has risk of inside water inundation.

Risk map was made from this extracted area. We classified the area that has risk of inland flooding into two classes: very strong type and strong type. Very strong type is the area that at least one PCA score is ranked in the top 50%. Strong type is the area that all PCA scores are not ranked in the top 50%.

Keywords: inland flooding, urban area, topographical and geographical characteristics, principal component analysis, hazard map

Properties of humic acid fraction of northern Ariake Sea estuarine and riverine surface sediment

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Estuarine field has high bioproductivity, and is important for many living organism to spawn and spend a larval stage of life. Riverine and terrigenous organic material are precipitated and accumulated at the estuarine field. Further, coastal marine organic materials and the organic molecules produced by the estuarine living organism are added to form higher molecular organic material such as humic-like substances. However, the knowledge for the structural feature of the estuarine humic substances is not enough because of high complexity of the organic molecule and the relation of sedimentation rate and higher molecular organic material formation at the field.

We have investigated to the structural feature of humic acid fraction of the sedimental organic material at the surface sediment of northern part of Ariake Sea estuarine field. Now, it is summarized the fundamental characteristics of the structural feature of humic acid Chicago River downstream and corresponding estuarine field. A certain relationships were observed between the several fundamental analytical data of organic material and environmental factor about the estimation of the contribution of terrigenous organics, formation of higher organic material from the terrigenous organics, and several environmental factors.

Samples were obtained at the surface (~ 5 cm) sediment of estuarine field (3 stations) and downstream field (2 stations) at and around the Chikugo River at May, August, and November 2012. The sediments were dried and humic acid fraction was extracted and fractionated along with the method for the terrestrial humic acid extraction protocol. Elemental analysis and molecular ratio estimation (O/C, H/C, C/N) from the analytical data, UV absorption spectra and the ratio of the two characteristic UV- visible absorbance (270 and 407 nm, (A_2/A_4)), carbon and nitrogen isotope ratio was measured. And the relation of the data and the several geographical and environmental factors such as distance from the river mouse, the formation of high-molecular organic material such as humic acid with the counterclockwise ocean current were investigated.

The C/N ratio and carbon isotope ratio is well-known indicator of the contribution of terrigenous organic material at temperate zone. Our data also shows the similar trend for the distance from the river mouse and changes of the two data and good correlation were observed. Further, the ratio of the UV-visible absorbance (A_2/A_4 ratio) and C/N ratio, carbon isotope ratio show a similar trend about the influence of terrigenous compound and good correlation to the change of values of the three. It indicates the A2/A4 ratio is alternative for the estimation of contribution of terrigenous organics at a certain river and river-mouse estuarine system.

In July 14th 2012, northern Kyushu field hit by a massive flood and heavy damages around the Chikugo River basin were occurred. At the samples from August 2012, increasing of terrestrial organic were observed for several data. The surface sediment of the system may be influenced by such an accidental event. The results also suggest that organic portion of the organic material deposited in terrestrial estuaries are those that have been caused by higher huminification.

Pyrolysis gas chromatography of the degradation products will be conducted to the precise structural analysis of their extracted humic acid. Also, we will continue the collection of the samples and extraction in February 2013, and seasonal changes observation will be reported at the presentation.

Keywords: humic acid, estuarine, Ariake Sea, carbon isotope, UV absorption

Effect of Carbide on Adsorption of Dissolved Organic Matter Contained in Under Drainage of Reclaimed Land

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The object of this study was to examine the effect of carbide on adsorption of dissolved organic matter contained in under drainage of reclaimed land. From the batch test, the carbide adsorbed the dissolved organic matter quickly, and then reached the equilibrium state in a few hours. On the other hand, the adsorption effect could not be observed in the chaff and sand, which are generally used as a filter material for under drain. These results described above suggest that we couldn't got much effect of the under drain constructed generally on removing dissolved organic matter discharged from the under drain of the reclaimed land. Concentration of the total organic carbon in the under drainage of reclaimed land was 10.1 mg/L on average, and dissolved organic matter comprised 97% of the total. Application of the carbide which has a strong effect on the adsorption to purifying materials is considered to be an effective measure for water conservation.

Keywords: batch test, total organic carbon, water conservation measure

Characterization of dissolved organic matter using FT-ICR MS and fluorescence spectrometry in a Japanese cypress forest

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In forest ecosystem, DOM plays important roles such as: being a main energy source of microorganisms which control material cycles in the pedosphere; making complex with iron, aluminum, other trace metals, or organic pollutants and affects their mobility or toxicity in the hydrosphere. Thus, DOM is one of the important materials for water quality. In Japan, forest covers about 70% of the land and stores large amount of freshwater supporting human life. Forest also stabilizes the freshwater supply to river and controls the water quality. Therefore, it is important to study the chemical characteristics of DOM and its alteration processes in forest ecosystem. Recently, Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS) was developed and applied to molecular-level study of DOM. FT-ICR MS has quite high resolution power and makes it possible to calculate the molecular formula from the charge to mass ratio (m/z) of the peaks detected. We further can estimate the molecular class of the each peak from its elemental ratio of O/C and H/C. The objective of this study was to apply FT-ICR MS to the DOM in a cypress forest ecosystem and try to elucidate the cycling of DOM and alteration processes in the ecosystem. Samples were collected from Shiso, Hyogo-pref., Japan in July 2011. Main vegetation of the experimental field was 50 years' Hinoki cypress (*Chamaechparis obtusa*) and the soil type was Andosol. We collected rainfall, throughfall, stem flow, soil waters (middle of A-horizon: 10 cm, bottom of A-horizon:25 cm, middle of B-horizon: 40 cm, bottom of B-horizon: 60 cm), and stream waters. All samples were filtered by precombusted GF/F filters. The filtrated samples were subjected to dissolved organic carbon (DOC) measurement and three dimensional excitation-emission matrix fluorescence spectroscopy analysis. After C18 solid phase extraction, FT-ICR MS analysis was applied. We calculated the expected molecular formula for m/z values of the peaks and made the van Krevelen diagrams by plotting the atomic ratios of H/C and O/C of the formula. In rainfall samples, low DOC concentration (1.3 mgC/L) and no clear fluorescence peak were observed. Both of these increased at throughfall (13.0 mgC/L), stem flow (31.7 mgC/L) and middle of A horizon (28.7 mgC/L). Both DOC concentration and humic-like peak intensity decreased greatly from the middle to bottom of A horizon (2.5 mgC/L). The active aluminum in A horizon consists of Andosol likely adsorbed DOM especially humic substances and removed it from the soil water. From the van Krevelen diagrams, especially in throughfall, stemflow, and soil water samples, great number of mass peaks appeared in the lignin region(0.7 < H/C < 1.5, 0.1 < O/C < 0.67) with high relative intensities. The number of mass peaks which corresponded to the protein region (1.5 < H/C, 0.3 < O/C < 0.67) decreased as the water percolated deeper through the soil. Polar molecules with high O/C ratios might be decomposed more rapidly or removed preferentially by adsorption. In contrast, mass peaks in the lignin and the lipid regions (1.5 < H/C, 0.1 < O/C < 0.3) remained even in deeper B horizon soil water.

Keywords: Dissolved organic matter, Forest ecosystem