Density Independent Smoothed Particle Hydrodynamicsを用いた衝突・クレータリングの数値計算
Numerical Simulations of Impact and Cratering with Density Independent Smoothed Particle Hydrodynamics

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Impacts of meteorite are important phenomenon for the planetary geology. Since these processes cannot be experimented
in laboratories, numerical hydrodynamical simulations of the impact process play important role. For these processes,
particle based numerical hydrodynamical simulations have several advantages over grid-based methods, because these
processes often involve large deformation of target and oblique impacts.
The Smoothed Particle Hydrodynamics (SPH) is a widely used particle based numerical hydrodynamical scheme.
It is first developed in astrophysical field. Recently, it was adopted to the impact cratering. However,
it has been pointed out that the standard SPH formulation has difficulties in the treatment of contact
discontinuity; an unphysical repulsive force acts between two different materials, such as rock and water.
Thus, we have developed new particle based hydrodynamical, Density Independent SPH (DISPH), which overcomes
this difficulty.
We have developed a new massively parallel particle based numerical hydrodynamical simulations code by means of
DISPH. We adapted Framework for Developing Particle Simulator (FDPS), which enables us to perform high-performance
parallel particle simulations easily. We will show the results of impacts of the tuff to the water with both DISPH
and SSPH.

キーワード：衝突数値計算
Keywords: numerical simulations of impact

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全球湖リポジトリの開発と地球環境変化による水質への影響評価

Development of Global Lakes & Reservoirs Repository (GLR) and their application for predicting estimating water quality changes in lakes and estuaries induced by global climate changes.

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Global Lakes & Reservoirs Repository (GLR) was developed in order to promote better comprehension of the status of lakes & reservoirs on a global scale. Basic information for each lake is stored, together with the whole surface shape of each lake & reservoir. For some lakes, bathymetry data is stored, which enables three-dimensional numerical simulations using Biwa-3D. Using this, data three lakes (Lake Biwa, Lake Tahoe and Lake Toba) are calculated by their vertical mixing structure. The whole database is used to apply basic parameters; it is also used with simpler ecological models in order to discuss potential impacts on lakes & reservoirs of global-scale climate change. Fluxes like continental hydrological fluxes from international rivers, associated with large-scale successive reservoirs, such as the La Plata river basin, are being estimated by combining GRL with continental-scale hydrological models.

キーワード：全球湖リポジトリ、地球環境影響、貯水池
Keywords: GLR, Global Climate Changes, Reservoirs

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マルチGCMデータとパラメータを最適化した作物モデルによる気候変動が全米のトウモロコシ収量に与える影響

Effects of climate change on corn yield in the U.S. using a parameter optimized crop model with muliple general circulation models

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A detailed analysis was conducted of the effects of climate change and increased carbon dioxide (CO_2) concentrations on corn yield in the United States of America by a crop model using outputs from multiple general circulation models (multi-GCMs). To find the best attainable calibrated model parameters, the automatic multi-objective complex evolution algorithm was applied to the Environmental Policy Integrated Climate model. Corn yield was simulated for 1999–2010, the 2050s (average for 2041–2060), and the 2070s (average for 2061–2080) under representative concentration pathways 4.5 (RCP4.5) and 8.5 (RCP8.5).
Results indicated a shortening of the growing periods (GP), decreased water use efficiency in almost all regions, and increased crop available water and evapotranspiration during GP in almost all regions except for the Southern U.S. Using multi-GCMs, the simulations under both climate scenarios resulted in negative effects of climate change on yield in almost all regions during both future periods. Especially strong negative impacts were reported south of latitude 40°N due to less optimal growing conditions. On the other hand, there were relatively smaller negative impacts in high-latitude regions due to more optimal growing conditions because of larger temperature changes and less water stress compared to low- and mid-latitude regions. However, temperature stress which interferes with corn growth was notably present in almost all regions for the 2070s under RCP8.5. Higher CO_2 concentrations have the potential to increase corn yield. CO_2 effects were approximately 0.04–0.05% increase in yield per 1 ppm increase in CO_2 concentration under both future climate scenarios, but the negative impacts of increased temperatures fully outweighed the CO_2 -fertilization effects. Assessments of climate change impacts using multi-GCMs are essential for synthetic studies of uncertainties in GCMs and not just for considering particular or bounding-case scenarios. Development of an integrated crop model that includes information and mechanisms related to crop physiology, breeding, biotechnology, agronomy, climate change, and resource use efficiency is needed to address more accurately the effects of climate change, CO_2 effects, and technology development and their interactions on crop yield.

キーワード：気候変動、多目的最適化、トウモロコシ収量、マルチGCM
Keywords: Climate change impacts, Multi-objective complex evolution, Corn yield, Multiple GCMs

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Estimation of total river flux from Japanese basins to Pacific ocean and its numerical prediction using cell distributed runoff model

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1. Introduction
The demand for having simulated freshwater outflow data on the river mouths is especially conspicuous in coastal modeling where fluvial influence often makes big difference in results and in climatological modeling where fluvial influence is needed to join the oceanographic, meteorology and hydrology cycle into bigger comprehensive closed cycle to be used for more accurate climatological models. Coastal and climatological models do not usually use freshwater outflow data from river's estuaries because they either neglect the data as insignificant or have difficulties to implement these data into their models.
2. Objective and motivation
The main objective of the study is to create complete set of river outflow data from Japanese basins to western Pacific ocean, in order that the data can be used in bigger and more complex coastal and climatological models, so that these models can develop more precise calculations and expand its purposes to wider range.
Secondary objective of the study is to predict sediment runoff at the catchment scale near river mouth, in order that it can be used in river basin management for sediment related disaster risk reduction.
River discharge data likely represent the most accurate quantitative information about the global terrestrial water cycle, but this information has not been uniformly adopted in Earth Systems studies, such as GCMs or terrestrial productivity models (Fekete et al., 2002). To estimate continental discharge using the runoff fields, a river transport model that routes the terrestrial runoff into the correct river mouths is needed (Dai and Trenberth, 2002).
3. Methods and data collection
We have used cell distributed water and sediment runoff model (Sasaki, 2014) (Apip et al., 2011) to make numerical prediction of freshwater outflow and suspended sediment transport from each basin. A conceptual diagram of the sediment runoff model is shown in Figure 1.
All data was collected from online source of Ministry of Land, Infrastructure, Transport and Tourism (http://www1.river.go.jp/). For all rivers, we tried to collect the most downstream daily discharge and water level data station which was available. Our goal was to collect discharge and water level data for period 2008-2015 for all rivers, and for period 2000-2015 for two the biggest rivers Tone and Abukuma.
4. Discussions
The overview of all the collected data from 9 first class rivers on Japanese eastern Pacific coast will be discussed. Takase river had average discharge 23 m^3/s with peak 388 m^3/s. Mabechi river had average discharge 94 m^3/s with peak 1246 m^3/s. Kitakami river had average discharge 304 m^3/s with peak 3409 m^3/s. Naruse river had average discharge 45 m^3/s with peak 2198 m^3/s. Natori river had average discharge 292 m^3/s with peak 1340 m^3/s. Abukuma river had average discharge 202 m^3/s with peak 4822 m^3/s. Kuji river had average discharge 18 m^3/s with peak 1575 m^3/s. Naka river had average discharge 385 m^3/s with peak 2533 m^3/s. Tone river had average discharge 253 m^3/s with peak 7055 m^3/s.

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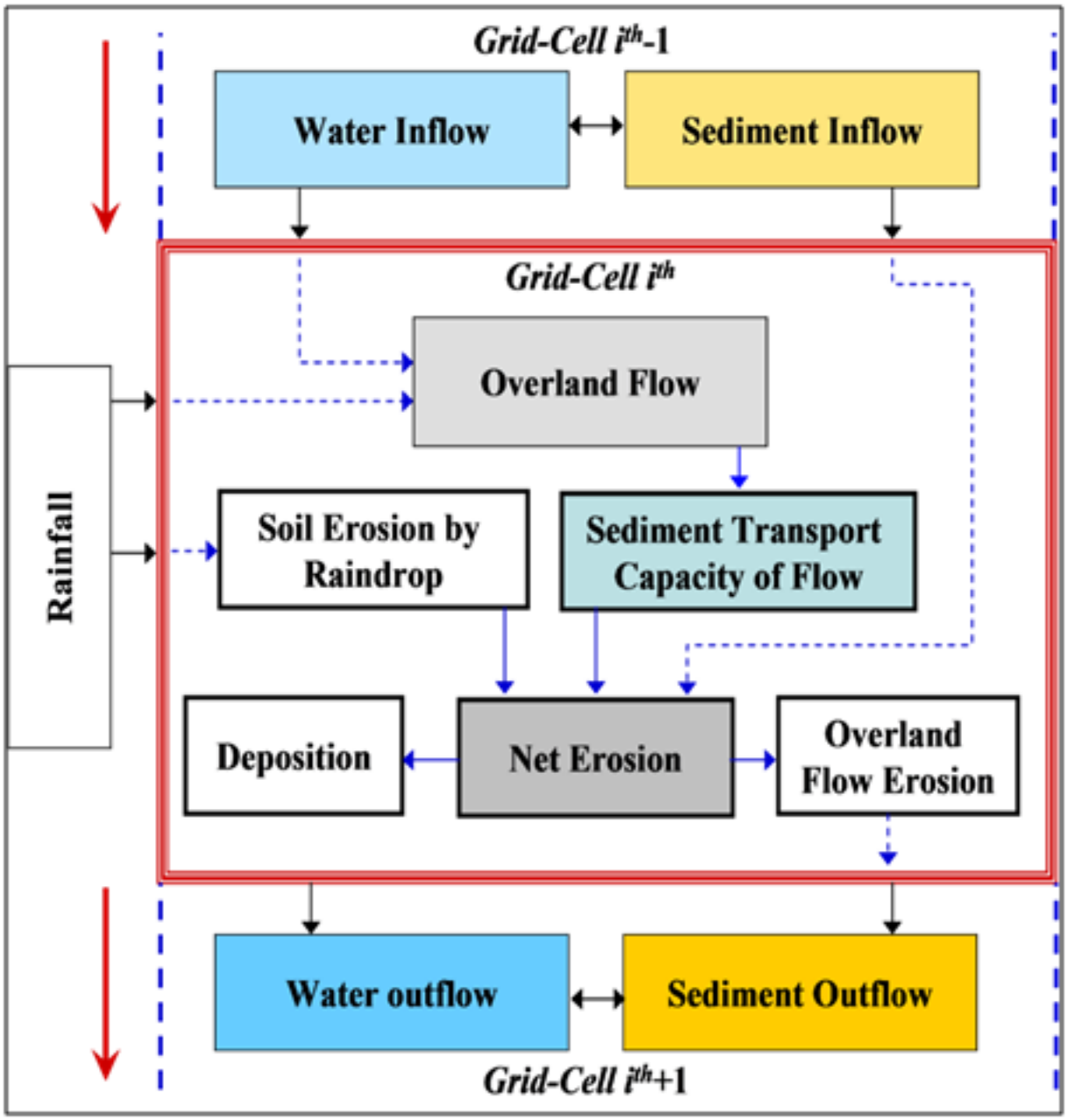
Keywords: fluvial outflow, estuary , coastal modeling, sediment runoff



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An Observing System Simulation Experiment for Lake Biwa, Japan; Test on Cyclone Man-Yi in 2013.

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Fourteen million people drink water supplied from Lake Biwa, in the Osaka-Kyoto region of Japan. Sewage treatment plants surround the lake, atomic power stations lie within 40 km on the Japan Sea, and tropical cyclones hit the region every year. Thus there is significant risk of pollution triggered by earthquakes and/or typhoons.
The North Basin's dimensions of roughly 20x40 km, and maximal depth of 104 m, facilitate geostrophic gyres during the stratified season. If continuously available nowcasts were available for the three-dimensional circulation of the lake, and associated pollutant or nutrient motion, they could support management of water quality both during emergencies, and in normal times. Accordingly, our group is developing a nowcasting system to track the fields of flow, temperature, etc in Lake Biwa. Simulations are performed by the unstructured-mesh ocean model SUNTANS. The Local Ensemble Transform Kalman Filter (LETKF) scheme assimilates available data streams. The forecast system integrates an ensemble of seven state vectors: one unperturbed state plus six perturbed states generated using bred vectors.
We will present the assessment of performance of the nowcasting during typhoon Man-Yi, which struck our region in September 2013. We chose this event due to the strong wind and sediment discharge associated with record rainfall.
To quantify the forecast skill, we first performed a "Nature Run", i.e. a fine-scale simulation of the Lake Biwa’s circulation. The consistency of the simulation was confirmed by in-situ temperature data at six depth levels for the vertical consistency, and space borne satellite estimates of SST. We also used near-infrared satellite data to analyse the propagation of turbidity after the typhoon.
After confirming in this way that the original simulation was consistent with observations, we performed an Observing System Simulation Experiment (OSSE), in which artificial data streams from the simulation are assimilated into a virtual nowcasting system. We will show the results of the reanalysis of the typhoon ManYi using the nowcasting system. We will also discuss instabilities identified during and after the typhoon by the bred vectors.

Keywords: Lake Biwa, Typhoon, Nowcasting, Data Assimilation

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阿武隈川河口域に堆積した放射性セシウムの起源と沈積プロセス
The origin of radioactive cesium deposited in the Abukuma River estuary and its sedimentation process

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Abukuma River was through contaminated area by radiocesium released from the Fukushima Daiichi Nuclear Power Station accident, flows into Pacific Ocean at Miyagi Prefecture. Abukuma River plays an important role in the transport process of radioactive material into the ocean from the radioactive contamination area. In this study, spatiotemporal distribution of radiocesium in the sediment collected from the Abukuma River estuary was investigated. We have estimated the spill source and transport process of radiocesium absorbed onto sedimentary material deposited in Abukuma River estuary.
Sampling site was set up 22 points in the 500 m mesh in the Abukuma estuary. The sediment samples were collected from 19 sites on March 20, 2013, and 22 sites on September 2, 2013, and 6 sites on January 26, 2014. It was to evaluate the depositional environment of the sediment from the time change of the water quantity in the Abukuma River estuary. Water level of Abukuma River in past 3 months from March 2013 and January 2014 was almost constant. On the other hand, water levels were varied drastically by “Heisei 25 Yamagata Heavy Rain” before 2 months from September 2013. In this result, it is assumed that the sediment collected on March 2013 and January 2014 was deposited in Abukuma River estuary during steady-state. Although the sediment collected on September 2013 was precipitated in the estuary are probably transferred from the land by flood. The concentration of radiocesium of sediment that may have precipitated at the flooding was high. On the other hand, that in steady-state showed a lower. Therefore, we investigated the relationship between the particle size of sediment and radiocesium concentration. The flood sediment had a small particle size, but particle size of steady-state sediment was large than flood sediment. Relationship of the concentration of radiocesium and the particle size of sediment in Abukuma River estuary was in accordance with the inverse square law.
This suggest the radiocesium is absorbed on the specific surface area of the sediment particle. It is not contradictory that the radiocesium penetrate to the surface layer of particle such as clay mineral and absorbed with ion exchange. The particle size of typical flood sediment was 10-70 μm and the concentration of radiocesium was 300-10000 Bq/kg. On steady-state sediment, it was 100-600 μm and 10-800 Bq/kg. From the result, the atom numbers of radiocesium adsorbed on the sediment particle was calculated. The values were $0.8\text{-}8\times10^{10}$ n/m^2 in the particle of 10-20 μm average diameters, and $0.2\text{-}3\times10^{10}$ n/m^2 in 100-200 μm. The atom numbers of radiocesium adsorbed for the individual particles was also calculated. The number was 3-500 atoms in the particle of 10-20 μm average diameters, and 300-10000 atoms in 100-200 μm particle. The adsorption atom numbers of radiocesium per the specific surface area of the sediment particles differed clearly in the steady-state sediment and the flood sediment. It means that the outflow origin of the flood sediment and the steady-state sediment deposited in the Abukuma River estuary is different. The outflow origin of radioactive contaminated particles from the catchment area of Abukuma River was estimated by the geochemical method. The concentration of some major and minor elements such as

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iron, calcium, titanium, mercury and lead between the flood sediment and the steady-state sediment was much different. It was considered that this difference reflects the difference of outflow source in comparison with the Geochemical Map. The major source of radiocesium accumulated in the Abukuma River estuary was estimated to be highly contaminated particles in the middle basin in which was transferred in the flood caused by heavy rain. In the steady state, a highly contaminated particles is blocked in many dams in the river.

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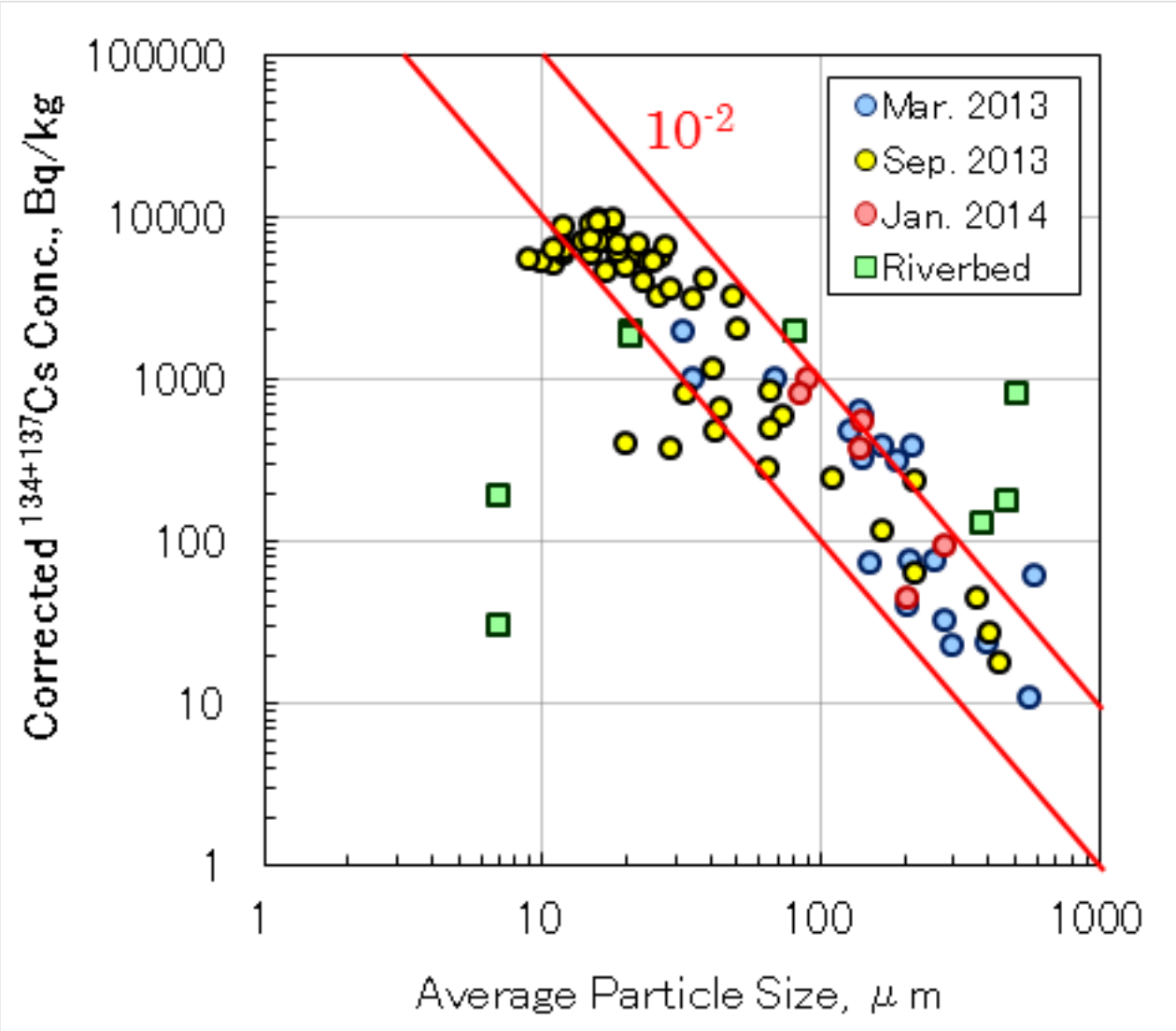
キーワード：放射性セシウム、粒径、堆積物、阿武隈川、福島第一原子力発電所
Keywords: Radioactive Cesium, Particle Size, Sediment, Abukuma River, Fukushima Daiichi Nuclear Power Station



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スーパコンピュータ京を用いた豪雨の高解像度実験

High resolution simulation of heavy rainfall event with the super computer K

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In Japan, heavy rainfalls cause severe disaster every year. To mitigate these disasters, a collaboration between a numerical weather prediction (NWP) model and a hydrological model is very important.
Generally, many of hydrological models require precipitation data that horizontal resolutions are several 10 to 100 meter scales. On the other hand, many of NWP models employ several kilometers scales horizontal resolutions because finer resolution NWP models require huge computational resources such as the K computer. Therefore, it was difficult for hydrological models to use NWP models precipitation data directly.
The authors conducted high-resolution experiments with the Kcomputer and the Japan Meteorology Agency Non-hydrostatic model (JMA-NHM). In this study, an impact of grid spacings (up to 250 m), different model domain sizes (1600x1100 km, and 200 km square), and terrain data were tested in two heavy rain events in Izu Ohisma 2013 and Hiroshima 2014.
The results showed that 250-m resolution model with large domain showed the best performance in both of the heavy rain events. The precipitation data of the 250-m models have been provided to a debris flow research using the Hydrodebris-2D, the research may presents in a different session.

キーワード：豪雨、数値予報モデル、京コンピュータ
Keywords: Heavy rain, Numerical Wheater Prediction Model, the K computer

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Gaining novel insight into Fukushima Daiichi Nuclear Power Plant derived fallout.

Gaining novel insight into Fukushima Daiichi Nuclear Power Plant derived fallout.

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It has now been five years since the events at the Fukushima Daiichi Nuclear Power Plant (FDNPP) contaminated a large portion of eastern Japan with a range of radionuclides. Despite the wide assortment of reactor products released by the incident - the medium-lived fission product isotopes of caesium; ^{134}Cs and ^{137}Cs, with half-lives of 2.065 and 30.2 years respectively have been the subject of the most scientific study due to the significant yield produced and their contribution to the activity measured. Lesser studied have been the longer-lived fission and activation products as well as the actinide fuel material itself. With the levels of caesium in the environment declining rapidly, it is expected attention will shift to these “more exotic” or “frequently forgotten” radionuclides.
Work at the University of Bristol has focused on the analysis of surface materials contaminated with these species from the FDNPP. Sediment and other organic material (mosses and grass) from various locations around Fukushima Prefecture have first been analysed using automated high-resolution scanning electron microscopy and energy dispersive spectroscopy (EDS) to identify particles of interest. Fragments of material found within these samples were then individually removed using a nano-manipulation system onto supporting tungsten or glass capillary needles, attached via an electron-beam hardening adhesive (described fully in Martin et al, 2016 [1]). With samples removed from the bulk material it has been possible to conduct a range of analytical techniques on these particles. Of primary interest currently are those particles containing the chemically toxic and slowly decaying alpha emitter, uranium. Results from X-ray absorption spectroscopy (XAS) conducted at the Diamond Light Source Synchrotron (UK) have confirmed the nano- and micron-scale particulate to be analogous to uraninite (UO_2) with a sub-angular appearance. These fragments are comparable in size to those analysed in work by Abe et al [2] found to exist at the centres of spherical cesium-bearing particles, suggesting their common provenance from the Fukushima Daiichi plant.
Currently undertaken are a range of dissolution experiments on these extracted particles to assess their stability and behaviour within the natural environment. Through the use of high resolution-transmission electron microscopy (HR-TEM), additional current work will seek to examine the physical structure of the ejecta material and how this will impact on its environmental behaviour. Results of these current analyses will be presented. The analysis of initial particles sourced from Iitate Village (Grid Ref) via ICP-MS has highlighted a non-natural compositon of material, strongly supporting its provenance from one of the FDNPP reactors.
The small size of these uranium particles has strong implications for both humans and animals in the affected regions, with their size being conducive to inhalation and the internal exposure. Future work will seek to analyse material sourced from additional areas as well as the other radionuclides present within the samples. As for the case at Chernobyl, as the levels of radiocesium begin to subside, the focus will turn to the other, longer lasting, but still concerning isotopic species.

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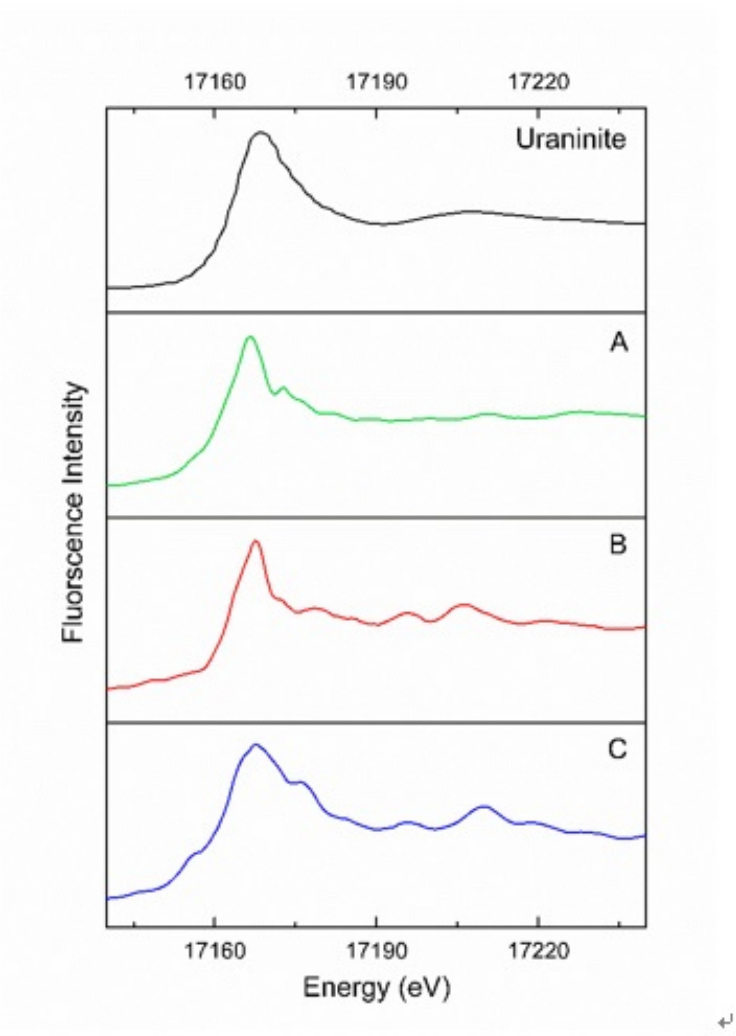

Results of μ-XANES analysis of three particles (A, B and C) at the uranium L_3 edge demonstrating the presence of uranium in all three particles. A reference spectra for uraninite (UO_2) is shown for comparison [1].

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The Unusual wet summer of 2014 in Southern Europe

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Southern Europe (Italy and the surrounding countries) experienced an unusual wet summer during 2014. The monthly total rainfall in July 2014 was 84% higher (about three standard deviation) than normal with respect to the 1982-2013 July climatology. This caused heavy damages to agriculture, tourism and overall economy of the region. In this study, we tried to understand the mechanisms for such abnormal weather using various datasets. The anomalously high precipitation over Italy is related to the sea surface temperature (SST) anomalies in the tropical Pacific through the atmospheric teleconnections. Rossby wave activity flux analysis of the upper-level circulation shows an anomalous tropospheric quasi-stationary Rossby wave from the Pacific reaching to southern Europe and maintaining there an anomalous cyclonic circulation. This anomalous cyclonic circulation is barotropic in nature so it extends to lower atmospheric levels, weakening the seasonal high and causing heavy precipitation over the Southern Europe.

Keywords: Wet summer, Southern Europe, Pacific Ocean, teleconnection

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