福島大学環境放射能研究所

福島の声：自然と人の15年

Fukushima Voices: 15 Years of Nature and Humanity

第12回 成果報告会

The 12th Annual Symposium of the IER, Fukushima University

要旨集

Abstracts

日時 Date
2026年 3月10日(火)～11日(水)
From Tue, March 10 to Wed, March 11, 2026

会場 Vanue
コラッセふくしま
CORASSE Fukushima

主催 国立大学法人 福島大学 Fukushima University
環境放射能研究所 INSTITUTE OF ENVIRONMENTAL RADIOACTIVITY

後援 福島県　筑波大学　広島大学　長崎大学　東京海洋大学
公立大学法人福島県立医科大学
国立研究開発法人量子科学技術研究開発機構

はじめに

汝人籟(らい)を聞くも未だ地籟を聞かず
汝地籟を聞くも未だ天籟を聞かず――『荘子』齊物論

本日は、第12回環境放射能研究所成果報告会「福島の声：自然と人の15年」にご参加いただき、ありがとうございます。

環境放射能研究所(IER)では、原発事故後に環境中へ放出・沈着した放射性セシウムの動態をはじめとして、事故後の自然環境を把握する研究を継続してきました。放射線量の変化や、食品を含む野生動植物中の放射性セシウム濃度、その将来予測などを通じて、危険と安全の判断に資することが、この分野の重要な役割であると考えてきました。一方で、安全性評価の観点では対象外となるほど低濃度の放射能であっても、その精密な観測から、水の動きや生物活動に伴う物質移動について、多くの知見が得られることも分かってきました。放射性物質は極めて微量でも検出可能であるため、事故によって放出された放射性セシウムの動きを追うことで、自然界における物質循環を可視化することが可能になります。

こうした環境中の放射能の動きや、生物影響に関する現象は、原発事故によって結果的に顕在化した、自然からのひびきのようなものではないでしょうか。「籟」とは、漢字辞典によれば木管楽器を意味し、転じて、風の吹き抜ける音、ひびきを指す言葉です。「地籟」は自然の形、穴やくぼみが風を受けて鳴るひびきと荘子の中で説明されています。IERの研究は、事故によって沈着した放射性物質を通して、環境中の危険性のみならず、自然の仕組みそのものの動きを捉えようとする試みであり、まさに自然のひびき、「地籟」に耳を澄ます営みとも言えます。この比喩では、風を放射性物質になぞらえることもできるでしょう。しかし、風とは単に事故由来の放射能に限らず、何らかの変化により自然が本来もっている仕組みから発せられるひびき全体を、擬人化するなら「声」を、含んでいると考えられます。人類の歴史は地球史や生命史の中ではごく短いものですが、その活動の影響は地球全体を覆うに至っており、人新世という概念に至っています。自然の側のひびきをつくりだすしくみに変化が生じているということです。2025年には、人的被害を伴うクマの出没が各地で相次ぎました。これもまた、自然の仕組みの中で何が変化した結果なのか、私たちに問いを投げかけている現象の一つです。

さて、福島大学は2025年度に、フランス国立科学研究センター(CNRS)およびフランス原子力・代替エネルギー庁(CEA)との連携研究拠点、国際共同研究所(IRL)「MITATE Lab. Post Fukushima Studies」を設立しました。IRLは日本で13番目、受入機関としては東北大学、筑波大学、東京大学、OISTに次いで福島大学が５番目となります。MITATE Lab.では、日本とフランスを中心に多様な国籍の研究者が集い、学際的研究を通じて、震災がもたらした結果とその複雑性を、人間と環境の双方の観点から探求することを目的としています。

ここで、環境と並んで掲げられている「人間」についても触れたいと思います。長期にわたる避難、除染、解体といった原発事故対策が、個々の人や社会に与えた影響についても、福島大学では継続的に取り組んできました。放射線量の上昇によって、歴史や家族、コミュニティを失い、厳しい判断を迫られた人々がいました。程度の差こそあれ、福島に住む、あるいは福島にゆかりのある多くの方々が、声を上げ、あるいは声にならない反応を示してきた15年でもありました。こうした経験や思考、沈黙も含めて、人間の側から発せられるひびきを、「人籟」と捉えることができるでしょう。人間や社会を対象とする科学もまた、災害の経験を未来に活かすために不可欠な営みです。

一方で、気候変動への対策や適応策が求められる中、国際情勢も大きく変化しています。人新世という考えに見られるような人間活動の帰結は、私たち自身の意思に伴う意図しない効果に由来するものでしょう。この先の予測に対して、私たちは何をなすべきなのか。荘子の言葉を借りるならば、私たちは人籟を聞き、地籟を聞いてきました。天籟はどうでしょう。研究者もまた、声に、ひびきに耳を澄まし、広く社会へあるいは後世へ媒介する立場にあるのだと思います。本日の発表は、それぞれが異なる籟に耳を傾けた成果です。どうぞ本日は、福島から立ち上がる「声」と「ひびき」に、共に耳を澄ませていただければ幸いです。

福島大学環境放射能研究所
所長　難波　謙二

FOREWORD

You may have heard the piping of humans, yet you have not heard the piping of earth.
You may have heard the piping of earth, yet you have not heard the piping of heaven.
— Zhuangzi, "On the Equality of Things"

Thank you very much for joining us today for the 12th IER Annual Symposium, "Fukushima Voices: 15 Years of Nature and Humanity."
At the IER, we have continuously conducted studies to understand the post-accident natural environment, including the behavior of radiocesium released and deposited into the environment following the nuclear power plant accident. we have regarded our investigations of radiocesium concentrations in the environment, plants and animals—including food products—and future projections as a central mission of this field to support decision making regarding risk and safety.
At the same time, we have come to recognize that even levels of radioactivity so low that they fall outside the scope of safety assessments can, through precise observation, yield valuable insights into how the nature is organized by knowing material transport associated with water movement and biological activity. Because radioactive substances can be detected even in extremely small quantities, tracing the movement of accident-derived radiocesium enables us to visualize material circulation within natural systems.
These phenomena related to environmental radioactivity and biological effects may be understood as something like echoes from nature—made perceptible as a consequence of the nuclear accident. According to Chinese character dictionaries, lai（籟）originally refers to a woodwind instrument and, by extension, to the piping or sound produced as wind passes through openings. In Zhuangzi, chi-lai（the "piping of earth"）is described as the resonance produced when wind flows through natural forms such as hollows and cavities.
Research at IER, through the radioactive substances deposited by the accident, seeks to grasp not only environmental risks but also the workings of nature itself. In this sense, it may be described as an endeavor to listen attentively to the sound of nature—the piping of earth. In this metaphor, radioactive substances may be likened to the wind. Yet wind need not be limited to accident-derived radioactivity alone; rather, it may be understood as encompassing all the resonances emitted from nature's inherent mechanisms as they are altered in some way—resonances that, if personified, could be called a "voice."
Although human history is extremely short in the context of Earth's history and the history of life, the impacts of human activity have come to impact the entire planet, giving rise to the concept of the Anthropocene. This implies that changes are occurring in the mechanisms that generate nature's resonances. In 2025, for example, there were a series of incidents across Japan involving bears that caused human casualties. This, too, is one of the phenomena that confronts us with the question of what has changed within the workings of nature.
In fiscal year 2025, Fukushima University established an International Research Laboratory（IRL）, "MITATE Lab. Post Fukushima Studies," in collaboration with the French National Centre for Scientific Research（CNRS）and the French Alternative Energies and Atomic Energy Commission（CEA）. This IRL is the 13th in Japan, and Fukushima University is the fifth host institution, following Tohoku University, the University of Tsukuba, the University of Tokyo, and OIST. At MITATE Lab., researchers of diverse nationalities, primarily from Japan and France, come together to explore—through interdisciplinary research—the consequences of the disaster and their complexity from the perspectives of both humans and the environment.
Here, I would like to turn our attention to the notion of "humans," which is presented alongside the environment as part of MITATE Lab. mission. Fukushima University has also continuously addressed the impacts that nuclear accident countermeasures—such as prolonged evacuation, decontamination, and demolition—have had on individuals and society. There were people who lost their history, families, and communities, and were forced to make extremely difficult decisions. For fifteen years, many people living in Fukushima, or connected to Fukushima in some way, have raised their voices — or expressed responses that could not be put into words. These experiences, reflections, and even silences may be understood as resonances that emanate from the human side—jin-lai, the "piping of humans." Sciences that focus on humans and society are likewise indispensable endeavors for carrying the lessons of disaster forward into the future.
Meanwhile, as responses and adaptations to climate change are increasingly demanded, the international situation is also undergoing major transformations. The consequences of human activity, as reflected in the idea of the Anthropocene, may be seen as unintended effects arising from our own intentions. Faced with projections of what lies ahead, what, then, should we do ?
Borrowing the words of Zhuangzi, we have listened to the piping of humans, and we have listened to the piping of earth. But what about the piping of heaven ?
Researchers, too, stand in a position, in which they listen attentively to voices and resonances, and mediate them broadly to society and to future generations. Today's presentations represent the outcomes of listening to different kinds of lai. We hope that you spend this day listening closely to the "voices" and "resonances" that rise from Fukushima.

NANBA Kenji
Director, Institute of Environmental Radioactivity, Fukushima University

Working Group for the 12th Annual Symposium of the IER, Fukushima University

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RAHMAN Ismail	(Professor)
WADA Toshihiro	(Professor)
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第12回成果報告会　ワーキンググループ

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ラハマン　イスマイル	教授
和田　敏裕	教授
髙田　兵衛	教授
脇山　義史	准教授
マキシム　グシエフ	特任准教授
松本　　徹	主任
永田　広子	研究員/国際コーディネーター
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Venue Guide Map / 会場案内

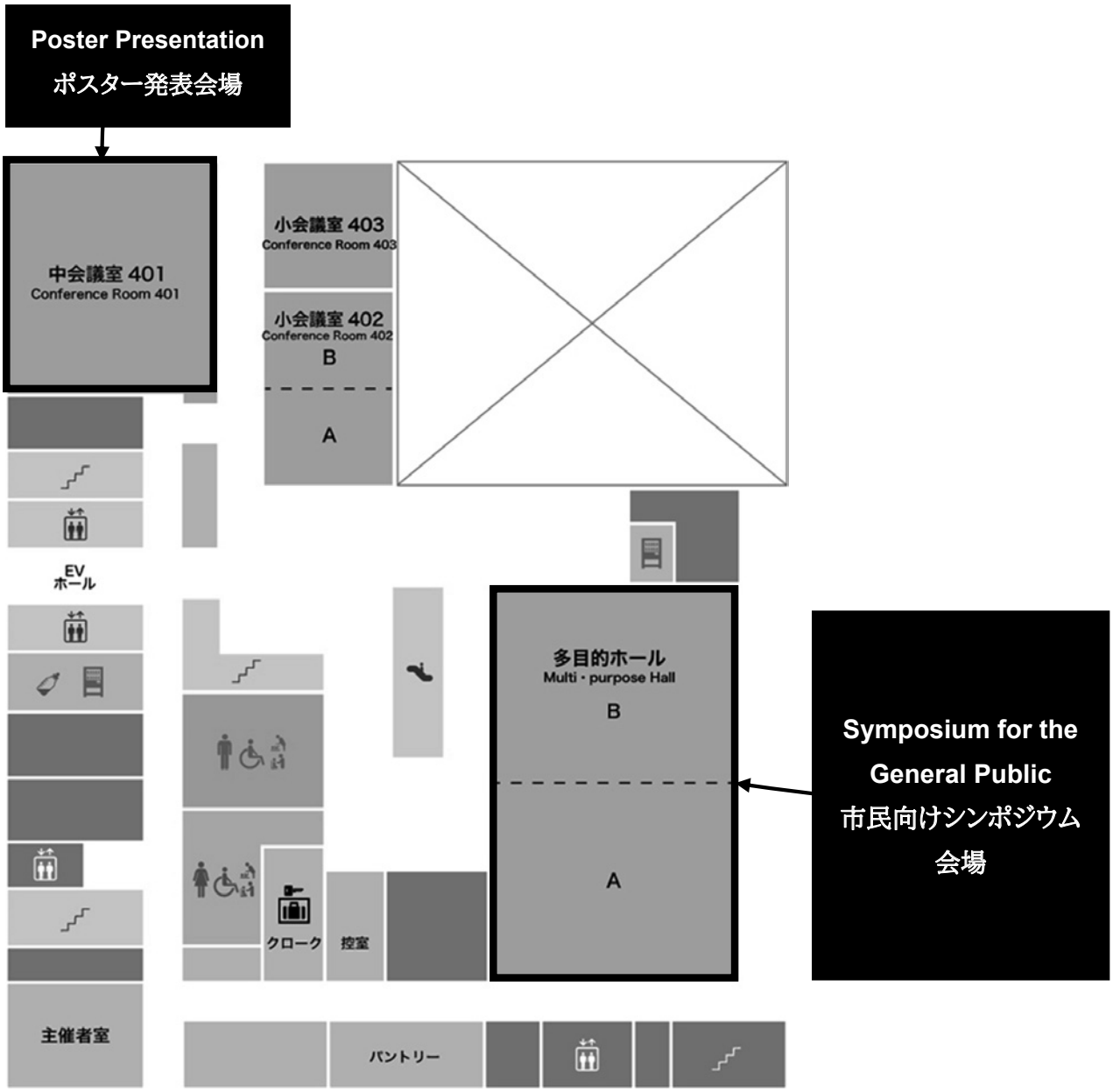
CORASSE Fukushima

1-20 Mikawaminamimachi, Fukushima City,
Fukushima Prefecture, Japan

コラッセふくしま

福島県福島市三河南町 1 番20号

Floor Guide / フロアガイド



4th Floor / 4 階

3月11日 March 11, 2026

市民向けシンポジウム / Symposium for the General Public

13:00 **開会挨拶 / Opening Remarks**
福島大学　学長　三浦浩喜 / MIURA Hiroki, President, Fukushima University

13:05 **趣旨説明 / Overview**
福島大学環境放射能研究所　所長　難波謙二
NANBA Kenji, Director, Institute of Environmental Radioactivity, Fukushima University

13:10 **S-01** **都市計画から見た福島原発事故による復興政策の課題**
浅沼＝ブリス・セシル
Issues in reconstruction policy following the Fukushima nuclear accident from an urban planning perspective
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13:35 **S-02** **福島原発事故が被災地住民に与えた心理的影響はいまも続いている**
筒井雄二
Long-term psychological consequences of the Fukushima nuclear accident for affected communities
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14:00 **休憩 / Break**

14:10 **S-03** **浜通りにおけるこれからの野生動物問題について**
望月翔太
The future of wildlife issues in Hamadori, Fukushima
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14:35 **S-04** **「福島の海」の声を聴く －あたたかくなる海と魚の変化－**
和田敏裕
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15:00 **休憩 / Break**

15:10 **S-05** **豪雨にともなう河川からの^{137}Cs流出と沿岸海域への影響**
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Rainstorm-induced fluvial ^{137}Cs transport and impacts on coastal seawater
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15:35 **S-06** **原発事故後の環境を理解する －人の声と地の声をつなぐ**
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Understanding the environment after the nuclear power plant accident — connecting human voices and the voices of the land
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16:00 **総合討論 / Discussion**

16:25 **閉会挨拶 / Closing Remarks**
福島大学環境放射能研究所　副所長/教授　ヴァシル・ヨシェンコ
Vasyl YOSCHENKO, Vice Director/Professor, Institute of Environmental Radioactivity, Fukushima University

16:30 **学生ポスター賞表彰 / Student poster awards ceremony**

Poster Presentation for Experts / 専門家向けポスター発表

Rivers and Lakes/河川･湖沼

Measurement and Analysis/計測･分析

Ecosystem and Effects/生態系・影響

Speciation Radiochemistry/存在形態

Modeling/モデリング

市民向けシンポジウム

Symposium for the General Public

S -01

Issues in reconstruction policy following the Fukushima nuclear accident from an urban planning perspective

Cécile ASANUMA-BRICE*[1,2]

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The reconstruction in Fukushima offers a reconstruction plan that does not exist anywhere in the world. The implications of this revitalization, presented as a boon, are nevertheless numerous, both on an environmental and human level. It involves drastic choices that are deeply inscribed in the landscape, without, for the moment, generating the expected dynamics. The implementation of large-scale photovoltaics is also questioned, as is the resettlement encouraged by the authorities of the population to territories surrounded by forests still unstable from the point of view of the radioactive situation. We rethink the nature of these choices, their motivations, and their consequences through quantitative and qualitative analysis enabled by monthly access to the field since time T0. Our approach allows us to embrace the complexity of the factors at play. This transition in land use entails the destruction of the historically existing landscape and entire villages. This point is also being questioned, and measures to preserve old buildings, symbols of an entire region, are being proposed.

Keywords : Fukushima nuclear disaster, landscape transition, post disaster reconstruction

S -02

Long-term psychological consequences of the Fukushima nuclear accident for affected communities

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This presentation examines the long-term psychological impact of the Fukushima Daiichi Nuclear Power Plant accident on disaster-affected residents in Fukushima Prefecture more than a decade after the event. Unlike earthquakes or tsunamis, nuclear disasters involve little visible physical destruction, while residents are exposed for extended periods to anxiety about radiation-related health risks, raising questions about conventional post-disaster mental health frameworks. Previous studies of nuclear accidents, including Chornobyl, have identified psychological effects as a major public health issue, particularly among mothers raising children at the time of the accident. The present study investigated these impacts through two surveys: a longitudinal study of mothers and children in low-dose radiation-affected areas, and a comparative study of residents from Namie Town who experienced evacuation orders and residents from other regions. Changes in radiation anxiety, psychological symptoms, and subjective well-being were examined. The results indicate that although radiation anxiety among mothers and anxiety and behavioral problems among children have changed over time, they have not fully disappeared. Psychological difficulties also remain among evacuees, including returnees after evacuation orders were lifted. These findings underscore the need for long-term psychological support specific to nuclear disasters and ongoing challenges in recovery processes.

Keywords： radiation anxiety, mental health, low-dose radiation contamination, return to hometown, Namie Town

福島原発事故が被災地住民に与えた心理的影響はいまも続いている

筒井雄二*[1,2]

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本発表では、福島第一原子力発電所事故が福島県民を中心とする被災地住民に及ぼした心理的影響が、事故から十年以上を経た現在も継続していることを報告する。地震や津波と異なり、原子力災害では明確な物理的破壊体験が乏しい一方、放射線被ばくによる健康被害への不安やリスク情報に長期間さらされ続けるという特徴があり、従来の災害時の心のケアの枠組みがそのまま適用できるのかが課題となっている。チョルノービリ事故などの先行研究では、公衆衛生上の重要な問題の一つが心理的健康への影響であり、とくに事故当時に子育てをしていた母親に長期的影響が残ることが指摘されている。本研究では、福島県民が事故によって被った心理的被害を二つの調査で検討した。具体的には、①低線量放射線汚染地域で暮らす母子を対象とした縦断調査と、②避難指示を受けた浪江町住民と県内外住民との比較調査である。これらの調査を通じて、放射線不安、精神症状、主観的幸福感などの心理的影響の推移を調べた。その結果、低線量放射線汚染地域で暮らす母親の放射線不安や子どもの不安・行動上の問題は時間とともに変化しつつも完全には消失していないこと、また避難指示解除後も帰還者を含む避難経験者に心理的困難が残存していることが示された。これらの知見は、原子力災害に特有の長期的・構造的な心理的支援の必要性を示唆するとともに、今後の復興のあり方における課題を示している。

キーワード：放射線不安、精神的健康、低線量放射線汚染、帰還、浪江町

S -03

The future of wildlife issues in Hamadori, Fukushima

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Since the Great East Japan Earthquake in 2011, the Hamadori region has faced severe conflicts with wildlife due to environmental changes. While management systems for wild boars are becoming established, the region is now confronting a new phase of wildlife issues: emerging threats from Japanese macaques and Asian black bears. Unlike boars, these species possess high learning and climbing abilities, requiring different countermeasures.
This presentation first outlines the basic ecology and behavioral characteristics of these animals to foster a proper understanding of the risks. Subsequently, we focus on the Asian black bear, presenting the latest analytical results based on sighting data from 2018 to 2025. We employed Kernel Density Estimation (KDE) to visualize the transition of sighting hotspots. Furthermore, we conducted a distance analysis to measure the proximity of sightings to human settlements and infrastructure. This quantitative approach reveals how significantly bears have encroached upon human living spheres over the past eight years.
We will discuss how the knowledge and community networks built through wild boar management can be adapted to these challenges. Our goal is to provide scientific evidence to guide residents in understanding the changing reality and implementing effective safety measures.

Keywords：Asiatic black bear, spatial analysis, phase shift

浜通りにおけるこれからの野生動物問題について

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東日本大震災と原発事故による避難指示は、浜通り地域の生態系に大きな変化をもたらした。長年、住民の帰還や営農再開を阻む大きな壁となっていたイノシシ問題だが、地域ぐるみの対策により、その管理体制は一定の成果を上げつつある。しかし今、我々は「獣害のフェーズ移行」という新たな局面を迎えている。近年、浜通りではニホンザルやツキノワグマの出没が急増している。イノシシとは異なり、高い学習能力や木登り能力を持つこれらの動物は、従来の防護柵だけでは防ぎきれない。特にクマは突発的な人身被害のリスクが高く、対策にはその習性を正しく知ることが不可欠である。
本講演では、まずこれら野生動物の基本的な生態や行動特性について解説し、なぜ今、里に出没するのかを紐解く。その上で、研究成果として浜通り地域におけるツキノワグマの最新動向を報告する。2018年から2025年までの目撃情報を基に、カーネル密度推定法を用いて「目撃集中エリア」の変遷を可視化した。さらに、各目撃地点と集落・道路との距離を計測する「距離解析」を行うことで、クマが年々どれほど人間の生活圏に接近しているのかを定量的に明らかにする。
「山奥の動物」が「隣人」となりつつある今、データが示す現実を直視する必要がある。イノシシ対策で培った経験とネットワークをどう活かし、正しく恐れ、対処すべきか。科学的根拠に基づき、住民と共にこれからの地域づくりを考える。

キーワード：ツキノワグマ、空間解析、フェーズ移行

S -04

Hearing the voices of the Fukushima sea — ocean warming and its impact on fish —

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Fifteen years after the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident, radiocesium concentrations in marine products from the coast of Fukushima Prefecture have declined substantially. In monitoring surveys conducted by Fukushima Prefecture in 2025, all samples except one were below the detection limit. In the same year, analyses of fish collected within the port of the FDNPP by Tokyo Electric Power Company showed that all samples were below the regulatory limit of 100 Bq/kg. In recent years, ^{137}Cs concentrations in major commercial species have generally been below 1 Bq/kg, indicating that the radiation exposure risk associated with seafood consumption has decreased to a negligible level. Despite this improvement, coastal fisheries landings in Fukushima Prefecture remain at only about 25% of pre-disaster levels. While increasing catches in accordance with the plans of fisheries cooperatives is an important goal, a new challenge–changes in the marine environment–has emerged over the past 15 years. Rapid warming of coastal waters has altered species composition along the Fukushima coast, resulting in shifts in fishery catches. This lecture outlines recent trends in seawater temperature rise in the coastal waters off Fukushima and highlights species that have increased (e.g., tiger puffer, cutlassfish, and spiny lobster) as well as those that have declined (e.g., sand lance, snow crab, and chum salmon). By listening to the signals conveyed by fish, this talk aims to provide a basis for discussion on future directions for fisheries recovery in Fukushima.

Keywords： ^{137}Cs, marine products, species composition, fishery catches, global warming, ocean warming

「福島の海」の声を聴く ― あたたかくなる海と魚の変化 ―

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福島第一原子力発電所事故から15年が経過し、福島県沿岸の海産物に含まれる放射性セシウム濃度は著しく低下している。2025年に実施された福島県のモニタリング検査では、１検体を除きすべてが不検出であり、同年の東京電力による福島第一原発港内の魚類の分析においても、すべての検体が基準値100 Bq/kgを下回った。近年、主要な漁獲対象種における^{137}Cs濃度は概ね１Bq/kg未満で推移しており、海産物摂取に伴う被ばくリスクは無視できる水準にまで低下したと評価できる。一方、福島県の沿岸漁業の漁獲量は震災前の約25％程度にとどまり、本格的な回復には至っていない。今後、各漁業協同組合の計画に基づき漁獲量の増大を図ることが重要であるが、震災後の15年間には「海の変化」という新たな課題が顕在化してきた。近年の海水温上昇に伴い、福島県沿岸では魚種組成の変化や、それに起因する漁獲量の増減が生じている。本講演では、福島沿岸海域における近年の水温上昇の特徴を紹介するとともに、増加傾向にある魚種(トラフグ、タチウオ、イセエビ等)および減少傾向にある魚種(コウナゴ、ズワイガニ、サケ等)を取り上げる。魚を通して見えてくる「福島の海」の現状に耳を傾け、今後の漁業復興の在り方について議論する契機としたい。

キーワード： ^{137}Cs、海産物、魚種組成、漁獲量、温暖化、水温上昇

S-05

Rainstorm-induced fluvial ^{137}Cs transport and impacts on coastal seawater

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During heavy rainfall events such as typhoons, large quantities of ^{137}Cs are discharged into the sea via rivers, along with substantial amounts of suspended solids. The author has carried out observations in several river water systems in Fukushima for better understanding of the dynamics of ^{137}Cs in rivers and coastal waters during high-flow events. An observation on the Ukedo river system showed that an approximately 190 GBq of ^{137}Cs was discharged due to intensive rainfall on 8 September 2023. Particulate and dissolved ^{137}Cs concentration in coastal seawater collected at the seashore 5 hours after the peak discharge were 2.2 Bq/L and 0.4 Bq/L, respectively. These concentrations were relevant to about 40 and 80 times higher than those before the discharge, respectively. An observation on the Abukuma river system showed that an approximately 76 GBq of ^{137}Cs was discharged due to intensive rainfall on 17 August 2024 when the typhoon *Ampil* approached. Although particulate ^{137}Cs concentration in coastal seawater increased at the seashore to 0.060 Bq/L, approximately 9 times higher than those before the discharge one day after the discharge peak, dissolved ^{137}Cs concentration was 0.0046 Bq/L, lower than those before the discharge. These differences suggest that response in coastal seawater to ^{137}Cs exportation depends not only on magnitude of the exportation, but also on various factors of catchment and seawater conditions. In the symposium, based on analyses of carbon and nitrogen stable isotope ratios and speciation (exchangeable, organic, and particle-bound fractions) in suspended solids, findings concerning the relationship between catchment characteristics and the dynamics of ^{137}Cs will be presented.

Keywords：catchment, desorption, stable isotope, suspended solids, typhoon

豪雨にともなう河川からの^{137}Cs流出と沿岸海域への影響

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台風などの豪雨時には、河川を通じて多量の懸濁物質とともに^{137}Csが海域に流出する。発表者はこれまでに河川および沿岸海域における^{137}Csの動態解明を目的として、福島のさまざまな河川を対象として観測を行ってきた。請戸川水系における観測では、2023年９月８日の集中豪雨により、河川から約190 GBqの^{137}Csが流出し、流出ピークの５時間後に採取した沿岸海水の懸濁態^{137}Cs濃度は2.2 Bq/L、溶存態^{137}Cs濃度は0.4 Bq/Lであり、それぞれ平水時の約40倍と80倍となった。阿武隈川では2024年８月17日に台風７号接近にともなう降雨により約76 GBqの^{137}Csが流出し、流出ピークから１日後に懸濁態^{137}Cs濃度が平水時の約９倍の0.060 Bq/Lに上昇したが、溶存態^{137}Cs濃度については0.0046 Bq/Lであり、平水時より低かった。以上の結果からは、^{137}Cs流出に対する沿岸海域での応答は、流出量のみではなく、流域および海域のさまざまな条件に左右されることが示唆される。このほか、懸濁物質の炭素・窒素安定同位体比や存在形態(交換態・有機態・粒子結合態)の分析結果を基に、流域特性と^{137}Cs動態の関係について得られた知見を報告する。

キーワード：流域、溶脱、安定同位体、懸濁物質、台風

S -06

Understanding the environment after the nuclear power plant accident — connecting human voices and the voices of the land

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Research on environmental radioactivity has provided an essential foundation for safety during post-accident recovery and has made significant contributions. At the same time, it is clear that approaches based solely on the natural sciences are insufficient if the experience of a nuclear accident is to be applied to the future. The accident also prompted a reconsideration of the relationship between the environment, human beings, and society. Long-term evacuations, changes in everyday life, and transformations of towns and villages point to the need for research that considers humans and the environment. Although the emergence of *Homo sapiens* occupies only a brief moment in Earth's history, human activities have unintentionally left traces across the planet—an era often described as the Anthropocene. Clarifying the mechanisms underlying environmental formation, material cycles, biodiversity and its changes, as well as the increasing frequency of disasters, and using this knowledge to anticipate the future and present options for social implementation, is one important role for experts. While science is widely used in policy and public measures, expert interpretation can also shape how people perceive the world. Biological concepts such as evolution and the struggle for existence have at times been linked to arguments that undermined human rights, whereas ideas of coexistence and biodiversity have also been connected to inclusive and affirmative contemporary values. Drawing on the experience of Fukushima after the nuclear accident, this presentation explores how the voices of people and the voices of the land can be connected, and what this connection means for our understanding of nature and human society.

Keywords： Anthropocene, human-environment relations, science and society

原発事故後の環境を理解する － 人の声と地の声をつなぐ

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環境放射能研究は、原発事故後の復興の過程において安全性を判断するための重要な基盤となり、一定の貢献を果たしてきた。一方で、原発事故の経験を将来や他の場面に活かすには、理系的アプローチだけでは十分ではない。原発事故は環境と人間やその社会との関係を改めて考えさせる出来事でもあった。長期にわたる避難生活と元のまちやむらの変容と再構築といった側面を含め、人間と環境の両方を視野に入れた研究が求められる。現在、気候変動への対策や適応策が求められている。ヒトの登場は地球や生命誕生の歴史から見ればごく短い。しかし、人間活動は地球上に多様な痕跡を意図せず残しており、人新世という概念によって捉えられている。物質循環を含む環境の成り立ちや生物多様性、その変化の仕組み、さらには災害の増加などに関わるメカニズムを解明し、将来を予測し、社会実装の選択肢を示すことは、専門家が担う役割だろう。科学が施策に活かされるという流れとは別に、環境や生物についての知見や、専門家による解釈のあり方が、人の感じ方や価値観に作用することもある。進化論や生存競争といった生物学的概念が時に人権を侵害する論理と結びついた歴史もある。一方、共生や生物多様性といった考え方が、現代的肯定的な価値観に繋がる例もある。本発表では、原発事故後の福島の経験から、人の声と地の声をつなぐということを手がかりに、自然理解と人間の側の両面から考えてみたい。

キーワード：人新世、ヒトと環境、科学と社会

Poster Presentation for Experts

専門家向けポスター発表

P-01

Comparison of radiocesium behavior and distribution coefficients (Kd) in river water between Fukushima and Europe

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Long-lived radionuclides released by nuclear accidents continue to migrate through river systems over long periods. This study investigates the controls on dissolved ^{137}Cs concentrations and solid-liquid partitioning in river water by comparing catchments in Fukushima affected by the Fukushima Daiichi accident with major European rivers influenced by the Chornobyl accident. Seasonal river-water sampling was conducted from 2021 to 2024 in the Yamakiya and Kuchibuto catchments, Fukushima Prefecture, measuring dissolved ^{137}Cs, ^{133}Cs, K^+, NH_4^+, and dissolved organic carbon (DOC). Statistical analyses were combined with GIS-based evaluations of catchment characteristics, and long-term data from nine European river catchments were also analyzed. In Fukushima headwater catchments, dissolved ^{137}Cs concentrations increased from summer to autumn with enhanced K^+ supply, accompanied by lower distribution coefficients (Kd). Regression analysis identified ^{133}Cs and K^+ as key controls on Kd, indicating dominant ion-exchange processes, while DOC had a minor influence. In contrast, European rivers showed persistently higher dissolved ^{137}Cs and lower Kd values, with DOC and ^{133}Cs playing more important roles.

Keywords： ^{137}Cs, FDNPP, river water, dissolved ^{137}Cs, ^{133}Cs, Kd

福島およびヨーロッパ河川水における放射性セシウムの動態と分配係数(Kd)の比較

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原子力事故により環境中へ放出された長半減期放射性核種は、河川を介して長期的に移行・循環する。本研究では、福島第一原発事故後の福島県内河川と、チョルノービリ原発事故の影響を受けたヨーロッパ主要河川を対象に、河川水中の溶存態^{137}Cs濃度および固相—液相間の分配係数(Kd)の違いを比較し、その支配要因を解明することを目的とした。2021～2024年に福島県山木屋および口太川流域で季節的に河川水を採取し、^{137}Cs、^{133}Cs、K^+、NH_4^+、DOC等を分析した。得られたデータに統計解析とGIS解析を組み合わせ、流域特性との関係を評価した。さらに、欧州９流域の長期モニタリングデータと比較解析を行った。その結果、福島の源流域では夏季から秋季にかけてK^+供給の増加に伴い溶存態^{137}Cs濃度が上昇し、Kdが低下する傾向が認められた。重回帰分析から、^{133}CsおよびK^+がKd変動の主要因であり、イオン交換による溶出が支配的であることが示された。一方、DOCとの関連性は弱かった。欧州河川では高い溶存態^{137}Cs濃度と低Kdが長期間維持され、DOCおよび^{133}CsがKdを規定する主要因であった。これらの結果は、粘土鉱物との結合強度や水質構成の違いが河川水中^{137}Cs濃度とKdに大きく影響することを示し、放射性物質の環境動態評価に重要な知見を提供する。

キーワード： ^{137}Cs、福島第一原子力発電所、河川水、溶存態^{137}Cs、^{133}Cs、Kd

P-02

^{137}Cs concentrations in river periphytic algae and the influence of Cs-bearing microparticles (CsMPs)

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To clarify radiocesium contamination in river ecosystems, it is essential to understand the transfer of radiocesium through food webs. In this study, periphytic algae, which serve as primary producers in river ecosystems, were collected at three sites from upstream to downstream in the Tomioka River, located in the Hamadori region of Fukushima, Japan. We measured ^{137}Cs concentrations in the algae and investigated the influence of Cs-bearing microparticles (CsMPs), which are particles with high radiocesium activity in suspended solids in river water, on ^{137}Cs concentrations in periphytic algae through their incorporation into the algal samples. The presence of CsMPs in the algal was evaluated using autoradiography with imaging plates. The detected CsMPs were removed, and then ^{137}Cs concentrations were remeasured to compare values before and after removal. The ^{137}Cs activity of individual CsMPs was also estimated. CsMP-like particles were detected in 10 out of 54 samples, with estimated ^{137}Cs activities ranging from 0.012 to 0.42 Bq. The contribution of CsMPs to total ^{137}Cs activity in periphytic algae varied from 5% to 86% , depending on algal ^{137}Cs concentration and biomass. At sites where triplicate samples were collected, large within-site differences in ^{137}Cs concentrations (>1000 Bq/kg) were associated with the presence of high-activity CsMPs. CsMP contamination is likely to cause an apparent increase in the ^{137}Cs concentration of periphytic algae and to enhance within-site variability.

Keywords： autoradiography, imaging plate, Tomioka river, Fukushima Dai-ichi Nuclear Power Plant accident

河川の付着藻類に含まれる^{137}Cs濃度とCsMPの影響

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河川生態系の放射性セシウム汚染を明らかにするためには、食物網を介した物質の移動に伴う、放射性セシウムの移動を明らかにすることが重要である。そこで、河川生態系にて一次生産者の役割を担う付着藻類を、福島県浜通りの富岡川で、上流から下流までの３サイトで採取した。また、河川水中の懸濁物質に含まれる、放射性セシウムのアクティビティが高い粒子(CsMP)が付着藻類に混入することによる、^{137}Cs濃度の影響を明らかにした。付着藻類にCsMPが含まれているか、イメージングプレートを用いたオートラジオグラフィーにて判定し、含まれていると認められたら、CsMPを除去して^{137}Cs濃度を再測定し、除去前の濃度と比較した。さらに、CsMPのアクティビティを推定した。調査の結果、54サンプル中、10サンプルからCsMPとみられる粒子が検出された。推定されたCsMPの^{137}Csアクティビティは0.012～0.42 Bqであり、付着藻類中の全^{137}CsアクティビティにCsMPが占める割合は、付着藻類自体の^{137}Cs濃度と重量によって変化するが、５～86％であった。３サンプルずつ付着藻類を採取した各サイトにて、^{137}Cs濃度がサイト内で1000 Bq/kg以上異なる場合、高濃度のサンプルでCsMPとみられる粒子が認められた。CsMP混入は、付着藻類の^{137}Cs濃度を見かけ上、増加させるだけでなく、サンプル間で混入の有無が生じると、サイト内の誤差を大きくする要因になり得る。

キーワード：オートラジオグラフィー、イメージングプレート、富岡川、福島第一原子力発電所事故

P-03

Comparison of ^{137}Cs behavior in urban waters between under high-flow and low-flow conditions

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It is known that ^{137}Cs is released from river in large quantities when rivers overflow due to rainfall, but there are few observations of ^{137}Cs in urban rivers under high-flow conditions, and many aspects of its behavior remain unknown. In this study, water samples were collected three times under low-flow condition from August 2023 to 2024 and high-flow conditions from May to July 2024 at five locations in Koriyama City. The average normalized particulate ^{137}Cs concentration was 0.0211 m^2kg^{-1} under low-flow conditions and 0.0335 m^2kg^{-1} under high-flow. Meanwhile, the average normalized dissolved ^{137}Cs concentration was 11.8 × 10^{-5} m^{-1} under low and 7.43 × 10^{-5} m^{-1} under high, contrary to previous studies on forest rivers. The normalized particulate ^{137}Cs concentration showed a positive correlation with heavy metals such as Pb and Cu in the SS, and the average values of the metal enrichment factor (EF), which indicates a relationship with human activity, were higher than the benchmark value of 1 for Pb and Cu, while Ni and Cd showed no correlation and the average EF values were lower than 1. These results suggest that ^{137}Cs moves together with substances related to human activity, such as Pb and Cu. Furthermore, we report on the characteristics of ^{137}Cs behavior under high-flow condition in urban areas.

Keywords： urban area, ^{137}Cs concentration, under high flow condition

都市水域における増水時と平水時の^{137}Csの挙動の比較

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降雨に伴う河川の増水により、流域から^{137}Csが集中的に流出することが知られているが、都市河川における増水時の観測例は少なく、その挙動には不明の点が多い。本研究では、郡山市内の５か所において2023年８月から2024年８月にかけて平水時に３回、2024年５月から７月にかけて増水時に３回の採水を行い、溶存態・懸濁態^{137}Cs濃度の比較を行った。正規化懸濁態^{137}Cs濃度の平均値は、平水時が0.0211m^2kg^{-1}、増水時が0.0335 m^2kg^{-1}であり、増水時で高かった。正規化溶存態^{137}Cs濃度の平均値は、平水時11.8×$10^{-5}m^{-1}$、増水時7.43×$10^{-5}m^{-1}$であり、平水時で高かった。この溶存態^{137}Csの結果は、森林河川を対象とした既往研究と逆であった。懸濁物質を分離し、有機炭素/窒素濃度を測定すると増水時に低かった。更に懸濁物質中の重金属(Pb, Cu, Ni, Cd等)の含量を測定すると、PbやCuの正規化懸濁態^{137}Cs濃度と正の相関を示したが、NiやCdは相関を示さなかった。人間活動との関連を示す金属濃縮係数(EF)の平均値は、PbやCuは目安となる１より高く、逆にNiやCdは１より低かった。これらの結果は、^{137}CsがPbやCuなどの人間活動に関連する物質と共に動いていることを表している。この他、^{137}Cs濃度が懸濁態、溶存態ともに他の地点と比較して、特異的に高い地点が見られ、その原因について、SSの分析結果、水質の比較より考察する。それらの結果より、都市域の増水時の^{137}Cs挙動の特徴について報告する。

キーワード：都市水域、^{137}Cs濃度、増水時

P-04

Changes in Cesium-137 concentration in water in decontaminated ponds and elucidation of contributing factors

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Water stored in irrigation ponds is used for agriculture. Following the 2011 Fukushima Daiichi Nuclear Power Plant accident, irrigation ponds within Fukushima Prefecture were also contaminated with radioactive cesium. This study aims to clarify the effects of decontamination on irrigation ponds. Observations were conducted at multiple ponds. Based on comparisons with past long-term observation data, changes in the concentration of ^{137}Cs in stored water before and after decontamination were tracked. Inter-site comparisons were used to discuss differences in long-term changes and their contributing factors. The study sites are three ponds in Okuma Town, Fukushima Prefecture (Inkyozaka, Suzuuchi, and Funasawa 2) and one pond in Futaba Town (Shimofukazawa). The Funasawa 2 pond underwent decontamination via sediment removal in the latter half of fiscal year 2023. At Funasawa 2 pond, compared to the year before decontamination (February to October 2023), the average ^{137}Cs concentration in suspended solids decreased by approximately 70% and the average dissolved ^{137}Cs concentration decreased by about 60% during the period from May to September 2025. At the undecontaminated Inkyozaka pond during the same period, the average ^{137}Cs concentration in suspended solids decreased by about 20％, while the average concentration of dissolved ^{137}Cs showed no significant change. Analysis will continue, including consideration of catchment characteristics and water quality, to clarify the factors affecting ^{137}Cs fluctuations in each pond.

Keywords：decontamination, pond, ^{137}Cs

除染後のため池における水のセシウム137濃度変化およびその要因の解明

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ため池に貯留される水は主に農業利用される。2011年の福島第一原発事故により、福島県内のため池も放射性セシウムに汚染された。本研究ではため池における除染の影響を明らかにすることを目的として、複数のため池における観測を行い、過去の長期観測データとの比較に基づいて除染前後の貯留水中^{137}Cs濃度変化を追跡し、地点間比較により長期変化の違いとその要因について議論する。対象地は福島県大熊町にあるため池３か所(隠居坂・鈴内・鮒沢第二)及び双葉町にあるため池１か所(下深沢)である。鮒沢第二ため池は2023年後半に底質除去による除染が行われている。鮒沢第二ため池では、除染前の1年間(2023年２月～10月)と比較して2025年(５月～９月)には、懸濁物質の^{137}Cs濃度平均値が約７割減少し、溶存態^{137}Cs濃度平均値は６割ほど減少した。未除染の隠居坂ため池では、同期間で、懸濁物質の^{137}Cs濃度平均値は約２割減少した一方で、溶存態^{137}Cs濃度平均値は、大きな変化がみられない。今後も集水域の特性や水質を含めて解析を行い、各ため池における^{137}Csの変動要因を明らかにする。

キーワード：除染、ため池、^{137}Cs

P-05

Inter-habitat variation in ^{137}Cs concentrations in sediments in the waters around Matsukawa-ura lagoon：causes and controlling factors

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We investigated the impact of land-originated radiocesium released from the Fukushima Daiichi Nuclear Power Plant accident on Matsukawa-ura, a shallow brackish lagoon, and its coastal areas via riverine transport. Between May 2021 and February 2024, sediment samples were collected at 13 locations in five water bodies inflowing rivers：Matsukawa-ura, inflowing rivers, their estuaries, the bay mouth, and the coast. After dehydration, samples were measured for ^{137}Cs concentrations and converted to dry-weight-based ^{137}Cs concentrations using the dry fraction. Particle size distributions were measured using a laser diffraction/scattering particle size analyzer, and specific surface area (surface area per unit mass) was calculated based on the particle size composition. Furthermore, based on Yoshimura et al. (2015), ^{137}Cs concentrations were standardized to specific surface area for each sample to remove the effect of particle size, and the results were compared among the water bodies. The results showed that standardized ^{137}Cs concentrations in sediments were higher in the rivers, similar in the estuaries and at the bay mouth, and lower along the coast. The decrease in the standardized ^{137}Cs concentrations in sediments from rivers to estuaries is thought to be due in part to the desorption of ^{137}Cs from particles associated with increased salinity (Takata et al., 2020), whereas the decrease from the bay mouth to the coast is thought to be due to other factors such as the influence of the open sea.

Keywords：radiocesium, sediment, Matsukawaura, land area

福島県松川浦周辺における堆積物の^{137}Cs濃度の地域差とその要因

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我々は、東京電力福島第一原発事故に起因する陸域の放射性Csが、河川を経由して松川浦やその沿岸域に及ぼす影響を調査している。2021年５月～2024年２月に、松川浦、流入河川、河口、湾口、沿岸の５水域13地点で堆積物試料を採取した。試料は脱水処理後に^{137}Cs濃度を測定し、乾土率を用いて乾重量あたりの^{137}Cs濃度に換算した。また、レーザー回折/散乱式粒子径分布測定装置により粒度を計測し、その組成から比表面積(単位質量あたりの表面積)を算出した。さらに、Yoshimura et al.(2015)を参考に、比表面積を用いて各検体からの粒度の影響を除いた補正^{137}Cs濃度を算出し、水域ごとに比較した。その結果、堆積物の補正^{137}Cs濃度は、河川で高く、河口、浦内及び湾口は同程度、沿岸では低い値を示した。堆積物の補正^{137}Cs濃度の河川→河口での低下は、塩分上昇による粒子からの^{137}Csの溶脱(Takata et al.、2020)が要因の一つと考えられるが、湾口→沿岸での低下は別の要因(外海の影響等)があるものと考えられる。

キーワード：放射性Cs、堆積物、松川浦、陸域

P-06

Efficacy of dietary Prussian Blue and water salinity on ^{137}Cs bioaccumulation in Japanese Dace (*Pseudaspius hakonensis*)

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This study investigated the efficacy of dietary Prussian Blue (PB) additive and water salinity in reducing the bioaccumulation of radiocesium (^{137}Cs) in Japanese dace (*Pseudaspius hakonensis*), an important euryhaline fish species for inland fishery in Fukushima prefecture.

Over a 56-day uptake phase, five fish groups were fed (1% of total fish mass per day) with radiocesium contaminated feed (303.9 Bq/kg) combined with various treatments. Control freshwater and salinity groups received only Cs feed, while other three groups received daily 0.8% (Cs feed) + 0.2% (supplemented feed) = total 1% of feed from total mass simultaneously. Treatments included PB supplemented feed (1.0% and 0.1% of PB) and clean feed. Excretion 70-day phase of experiment included two previously contaminated (by feeding Cs feed for 56 days) groups – freshwater and half seawater. During this phase, fish were fed with clean feed (1% of total fish mass).

One-compartment kinetic model, which takes into account growth dilution effect (Niizeki et al., 2020) was used to evaluate assimilation efficiency (AE) from ^{137}Cs containing feed and, thus, effect of treatments and water salinity. The AE was most effectively reduced by the 1% PB treatment to 0.26, yielding a reduction factor ($RF = AE_{(control)}/AE_{(treatment)}$) of 2.12 compared to the control ($AE = 0.55$, $p < 0.001$). The 0.1% PB group followed with an AE of 0.32 ($RF = 1.70$, $p < 0.001$), while clean feed and 16 psu salinity showed AEs of 0.51 and 0.434 ($p < 0.01$), respectively. The excretion rate constant (k_e) was significantly higher in 16 psu water (0.0061 day^{-1}) compared to freshwater (0.00095 day^{-1}). This resulted in a significantly shorter biological half-life excluding growth dilution effect T_{b-exg} of 114 days in 16 psu water compared to more than 700 days in freshwater.

Our findings are consistent with previous studies on cyprinid fish, though natural variability between individual fish or differences between species cause variations in kinetic parameters. Further research with longer experimental durations is needed to evaluate half-lives more precisely. Furthermore, excretion experiments should be conducted using Prussian Blue-supplemented feed–rather than clean feed alone–to evaluate its potential to further accelerate excretion rates for Japanese dace.

Keywords：^{137}Cs, assimilation efficiency, *Pseudaspius hakonensis*, Prussian Blue

P -07

Determination of rare earth elements (REEs) and Nd isotopic composition in water samples from urban and mining areas in Central Mongolia

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Surface waters such as streams and rivers are vulnerable to contamination, which is affected by both human activities and natural processes, and industrial effluents from sectors such as mining, agricultural runoff, and the direct release of untreated sewage into rivers have significantly degraded water quality, posing risks to aquatic ecosystems and human health. This study examines the hydrogeochemical properties of river water in Central Mongolia by analyzing rare earth elements (REEs) concentrations and Nd isotopic compositions across three river basins with varying geochemical conditions and human influences. REEs were preconcentrated from the water samples using a chelating resin (InertSep ME-2), and their concentrations were determined using ICP-MS 7700 (Agilent, USA). Light rare earth elements (LREEs) concentrations were higher than those of heavy rare earth elements (HREEs), mainly in the upstream of rivers. Gadolinium anomalies (Gd/Gd*) were consistently positive, indicating the impact of human activity and urbanization. In the semi-arid region of Mongolia, understanding the influence of rock weathering processes on river water dynamics is crucial for long-term hydrochemical monitoring.

Keywords: rare earth elements, Nd isotopes, river water, mining, Mongolia

P-08

Vertical distribution of primordial radionuclides in soil profiles in Doon Valley, Garhwal Himalaya, India

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Naturally occurring radionuclides (^{226}Ra, ^{232}Th, and ^{40}K) in soil have been the subject of significant research worldwide. Several studies have been conducted on the distribution of natural radionuclides in soil, including the Garhwal Himalaya, India. These studies aimed to provide an overview of typical radionuclide levels in topsoil and to assess whether there was a radioprotection concern. However, studies on the vertical distribution of radionuclides in soil profiles were lacking in the Garhwal Himalaya. The understanding of the vertical distribution is crucial for several reasons, including radionuclide exploration, source delineation, and gaining insights into geological processes. This project aimed to study the vertical distribution of radionuclides in different soil profiles across neutral and vegetated lands in the Doon Valley of the Garhwal Himalaya, India. Since groundwater serves as a primary source of drinking water for a large population residing in the region's rural areas, the study also aimed to measure uranium and other potentially toxic elements in the region's soil and groundwater and to investigate the correlation between soil and groundwater contaminants. Uranium and other potentially toxic elements were observed below the guideline values in the analyzed groundwater samples. However, fieldwork for soil sample collection was delayed by continuous rainfall in the region. Therefore, gamma-ray spectroscopy and ICP-MS analyses of soil samples are in progress. It is aimed to complete the experimental analysis of soil samples by June 2026. The results of measurements of uranium and other potentially toxic elements in groundwater will be presented in the symposium.

Keywords：radionuclides, vertical distribution, soil profiles, neutral and agricultural lands, groundwater contaminants, Garhwal Himalaya

P -09

Characterization and biological uptake assessment of radioactive contamination in river Nitelva

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Since the 1950s, the Norwegian river Nitelva has received both planned and unplanned releases of radioactive waste from the nuclear reactors at IFE Kjeller, leading to elevated concentrations of radionuclides in the sediments, including plutonium-239. As all nuclear activities at Kjeller are now being decommissioned, detailed characterization of remaining contamination is essential for safe restoration of the area. This site-specific study investigates the bioavailability of Pu-239 in Nitelva sediments. In October, sediment cores were collected both within and upstream of the contaminated zone. The cores were sliced into 1cm layers and screened using a Ge detector. Layers containing americium-241 were further analyzed using NaI detection, ICP-MS, and autoradiography, confirming the presence of Pu-239. Sediments with varying Pu-239 concentrations were subsequently used in an exposure experiment with *Daphnia magna* to assess whether small aquatic crustaceans ingest contaminated sediment particles and are thereby exposed to alpha-emitting plutonium. The experimental setup was based on the OECD 202 Acute Immobilisation Test, modified to evaluate biological uptake rather than immobilization. The results will indicate whether sediment-bound plutonium can be associated with filter feeding organisms, such as *Daphnia magna*, and thus contribute to the risk for the filter feeders or organisms higher up in the food chain feeding on crustaceans, providing valuable insight into the current environmental risk and the long-term behavior of radionuclides in the Nitelva system.

Keywords：plutonium, freshwater sediments, *Daphnia magna*, radionuclide contamination

P-10

Ten years of research to understand the redistribution of radiocesium in Fukushima rivers (2011-2025)

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Artificial radionuclides including radiocesium were released into the environment following the Fukushima Dai-ichi nuclear power plant accident in March 2011. These particle-bound substances deposited on soils of north-eastern Japan, located predominantly within a 3000-km^2 radioactive fallout plume and drained by several coastal rivers to the Pacific Ocean. This presentation will summarize one decade of collaborative research (2011–2025) involving both French and Japanese scientists to quantify and understand the redistribution of radiocesium in Fukushima rivers through the analysis of radionuclides in sediment deposits collected twice per year after floods between 2011 and 2015 and then annually from 2016 to 2025. It will also show spatial and temporal changes in sediment sources based on sediment fingerprinting applied to sediment deposits and sediment cores collected from dam reservoirs of the region (e.g., Mano Dam Reservoir). The implications of these results for future redistribution of radiocesium across Fukushima landscapes will finally be discussed.

Keywords : soil erosion, radiocesium, sediment transfer, coastal rivers, sediment sources

P-11

Development of an omnidirectional detector for neutron imaging with fractal geometry

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We have been developing a radiation imager that detects the distribution of β and γ ray sources with a fractal geometry, Sierpinski tetrahedron shape. A tetrahedral radiation sensor is considered as one unit, and 16 sensors are arranged in a Sierpinski tetrahedron shape, with the space between the sensors filled with γ-ray shielding. This detector was used to measure radiation distribution within the site of the Fukushima Daiichi Nuclear Power Plant (FDNPP) and in the environment contaminated by the FDNPP accident. Since the nuclear fuel and debris contained in the reactor pressure vessel (RPV) will be removed in the future, it is extremely important to identify neutron sources originating from nuclear fuel in high-dose rate areas for criticality management and radiation protection of workers. Therefore, we are developing a compact omnidirectional neutron imager to locate neutron sources in the reactor building. This sensor consists of thin triangular scintillators for neutron detection attached to a tetrahedral acrylic surface and arranged in a Sierpinski tetrahedron shape, with a neutron shielding material filled between the sensors. The design and detector experiments for the development of this omni-directional neutron imager are reported.

Keywords： neutron imaging, omnidirectional detector, Sierpinski Tetrahedron, fractal geometry

全方位計測可能な中性子イメージャーの開発

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これまで、β・γ線源分布を測定するフラクタル構造の一種であるシェルピンスキー四面体形状の放射線イメージャーを開発してきた。正四面体の放射線センサーを１ユニットとみなし、16個のセンサーをシェルピンスキーの正四面体形状に配置し、センサー間の空隙をγ線遮蔽材で充填している。この検出器を福島第一原子力発電所(1F)構内や事故によって汚染された環境における放射線分布の測定に用いてきた。今後進められる原子炉圧力容器(RPV)内の核燃料デブリの取り出しにあたって、デブリ由来の中性子源を特定することは、臨界管理及び作業員の放射線防護の観点から極めて重要である。そこで我々は、原子炉建屋内の中性子源を特定するための小型の全方向性中性子イメージャーを開発している。このセンサーは中性子検出用の薄い正三角形のシンチレータを正四面体のアクリルの表面に取り付けてシェルピンスキーの四面体形状に配列し、センサー間に中性子遮蔽材を充填している。本発表では、全方向性中性子イメージャーの開発に向けた設計と中性子照射実験について報告する。

キーワード：中性子イメージング、全方位計測、シェルピンスキーの四面体、フラクタル形状

P-12

Porous manganese-magnesium ferrite ($Mn_{0.5}Mg_{0.5}Fe_2O_4$) powders : A magnetic sorbent for the selective separation of zinc isotopes from aqueous matrix

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Binary spinel ferrites AB_2O_4 are magnetic mixed-metal oxides where divalent A and trivalent B cations are distributed across tetrahedral and octahedral lattice sites. In recent years, these materials have attracted increasing attention as alternative sorbents for wastewater treatment due to their magnetic properties, chemical stability, and separation efficiency, overcoming the limitations of conventional sorbents, such as low sorption capacity, high operational costs, and difficult post-treatment recovery. This study focuses on the synthesis and application of a novel, porous manganese-magnesium spinel ferrite ($Mn_{0.5}Mg_{0.5}Fe_2O_4$) for the selective separation of zinc isotopes from aqueous environments. Structural characterization by XRD analysis confirmed a single-phase cubic spinel structure with an average crystallite size of 20 nm. The elemental composition and functional groups were determined using EDX and FTIR analyses, while SEM observations revealed a porous surface morphology favorable for sorption. The synthesized ferrite exhibited selective sorption of zinc ions in a mixed-metal system. Batch sorption experiments were carried out to examine the effects of pH, contact time, sorbent dose, initial concentration, and temperature. Maximum zinc removal efficiency of 91% was obtained at pH 6. Sorption equilibrium data were fitted to both Langmuir and Freundlich isotherm models, yielding a maximum sorption capacity of 2.18 mg g^{-1}, while the kinetic analysis followed a pseudo-second-order model. With a high saturation magnetization of 56.33 emu g^{-1}, the sorbent allows for rapid magnetic separation, effectively reducing operational time and secondary waste. These findings highlight the significant potential of $Mn_{0.5}Mg_{0.5}Fe_2O_4$ as an efficient and selective sorbent for the removal of zinc isotopes from aqueous systems.

Keywords : spinel ferrites, sorbents, wastewater, toxic metals, zinc isotopes

P-13

Competitive effects of potassium, rubidium, and ammonium on cesium uptake by Japanese knotweed grown hydroponically

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Plants show strong potential for the phytoremediation of radioisotopes from contaminated soils, particularly radiocesium (r-Cs), a major contaminant whose removal can limit entry into the food chain and reduce risks to higher organisms. In this study, stable cesium (Cs^+) was employed as a chemical analogue of r-Cs to investigate the uptake behavior of Japanese knotweed under controlled hydroponic conditions. Japanese knotweed was cultivated for three months in a hydroponic system under controlled conditions using an illuminated incubator. Seeds were initially germinated under three conditions：(i) a control treatment, (ii) Nutrient solutions containing potassium (K^+) at 2 mM (NS1) and 6 mM (NS2), and (iii) nutrient solutions containing both K^+ and Cs^+. After germination and early growth, seedlings were transferred to cultivation bottles and grown under two treatments：(i) control conditions and (ii) nutrient solutions with varying concentrations of K^+. Japanese knotweed showed the highest seed germination rates in nutrient solutions with low K^+ concentrations and without Cs^+, whereas germination was reduced in Cs^+ containing solutions and under control conditions. In contrast, higher K^+ concentrations significantly enhanced root and shoot growth, leading to increased plant height. The highest Cs^+ accumulation in the roots was observed in NS1 + Cs^+ + NH_4^+, where more than 80% of the absorbed Cs^+ was retained in the roots compared with the aerial parts. These findings suggest that lower K^+ availability in combination with NH_4^+ promotes preferential retention and compartmentalization of Cs^+ in the roots of Japanese knotweed, thereby limiting its translocation to above-ground parts.

Keywords：Japanese knotweed, nutrient solution, hydroponic, cesium, root uptake

P-14

Health implications of uranium in drinking water of a tectonically active zone in Garhwal Himalaya, India

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Uranium is a naturally occurring radioactive element that can harm human health through both its radiation and chemical toxicity. In India and around the world, groundwater is a major source of drinking water, but it is increasingly threatened by industrial pollutants and Potentially Toxic Elements (PTEs). This study systematically analyzes uranium levels in drinking water from the Tons Valley, a tectonically active region in the Garhwal Himalayas. Using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), we found that uranium levels in all samples were well within the WHO safety limits. Consequently, the health risks for the local population are minimal. These findings help us understand how uranium spreads in Himalayan aquifers and provide a crucial baseline for future environmental monitoring.

Keywords：uranium, drinking water, radiotoxicity, chemical toxicity, Tons Valley

P-15

Design and realization of a smart survey meter based on low-cost electronic components for the ambient equivalent dose rate measurement and radon concentration calculations

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This study reports the radon tracing using a low-cost, locally manufactured smart electronic device developed for radiation protection and nuclear security. The proposed device consists of a ZP 1200 Geiger-Müller (GM) tube detector, low-cost components namely the Arduino microcontroller board, the temperature (T) and relative humidity (RH) sensor, and XBee-based IoT wireless transmission modules. The RadonEye reference instrument that measures indoor radon concentration, temperature, and relative humidity is used for a comparison. Typically, the developed device provides data of atmospheric parameters and the ambient dose equivalent rate. From the ambient dose equivalent rate (μSv/h), radon activity concentration (in Bq/m^3) is calculated using standard and recognized conversion coefficients. The coefficients vary according to the ambient radiation strength and are ranging from 5500 to 8900 $(Bq/m^3)/(\mu Sv/h)$. The developed device and the reference instrument were exposed for 24 hours during one month in several dwellings in the city of Yaoundé-Cameroon. For the evaluated period, the average values are 27.51 ℃ (developed device) and 26.19 ℃ (RadonEye) for T, 74.10 % (developed device) and 73.00 % (RadonEye) for RH, and 1499.19 Bq/m^3 (developed device) and 1464.91 Bq/m^3 (RadonEye) of cumulated radon activity concentrations. Statistical analyzes carried out on the results of the two devices provide a linear regression coefficient of R^2 =0.9978 demonstrating the perfect agreement between the developed device and the reference instrument.

Keywords：radon tracing, radon monitoring, relative humidity sensor, temperature measurement

P-16

Quick and low-cost chemometric approach to identify specific NIR (Near-Infrared) spectral bands associated with various land-use types in contaminated catchments of Fukushima prefecture

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The study of spectral signatures is nowadays a common technique to analyze soils/sediments for understanding suspended sediment properties in rivers, especially in contaminated catchments. However, Near-InfraRed (NIR) spectroscopy has been less studied on sediment/soil samples, particularly for associating spectral bands of a specific land use and chemical interpretations. Therefore, this study aims to precisely determine the NIR spectral bands associated with each of the environments studied for two main reasons. First, to better understand the chemical structures of the different soils (and subsoils) in Fukushima Prefecture. Secondly, to improve the sediment fingerprinting methods already used.
This study presents a chemometric workflow designed to identify key NIR spectral bands of materials sampled from different locations (e.g., forest, cropland, subsoil, etc.) and applied to the Fukushima Prefecture catchments. The methodology combines global partial least squares regression (PLSR) to identify regions with geochemical importance using VIP (Variable Importance in Projection) score. Then, interval PLS (IPLS) is applied on each of these identified regions to pinpoint the most significant spectral bands relevant for a geochemical interpretation. These methods make it possible to trace the origin of a sample based on its stable physicochemical characteristics between the time of source displacement and deposition.

Keywords : NIR spectroscopy, chemometrics, PLSR, IPLS, Fukushima, land-use, sediment source, environment

P-17

Analytical methods for measuring actinide nuclides in the environment

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This study aims to establish a mass spectrometric method for the determination of curium (Cm) isotopes in environmental samples, motivated by the significant activity contribution of Cm to actinide releases from the Fukushima Daiichi Nuclear Power Plant accident and the limitations of conventional α-spectrometry. The α-spectrometry for Cm analysis requires complex chemical separation and cannot resolve the closely spaced α-energies of ^{243}Cm and ^{244}Cm. Additionally, the lack of an appropriate Cm spike has further hindered precise analysis. To address these issues, this work focused on (1) the production of a Cm spike for mass spectrometry and (2) the development of an efficient chemical separation methods for spike production and for Cm analysis. A long-lived isotope, ^{248}Cm, produced by the α-decay of ^{252}Cf, was investigated as a potential spike. Separation experiments using Ln resin and nitric acid eluents demonstrated that Cm could be completely separated from Cf under all tested conditions, with optimal performance achieved using 0.4 M HNO_3 at room temperature. This result indicates the feasibility of recovering ^{248}Cm from used ^{252}Cf neutron sources. In contrast, the separation of Am and Cm, required to avoid isobaric interference in mass spectrometry, was unsuccessful under all experimental conditions, despite promising results from analogue element studies. Further work using alternative resins and eluents is therefore necessary to achieve effective Am–Cm separation.

Keywords： curium, americium, spike

環境中のアクチノイド核種測定のための分析法検討

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本研究では、福島第一原子力発電所事故により環境中へ放出されたアクチノイドの中でも、放射能寄与が大きいと推定されるキュリウム(Cm)同位体に着目し、質量分析法による測定手法の確立を目的とした。従来用いられてきたα線スペクトロメトリーは、化学分離操作が煩雑であることに加え、^{243}Cmと^{244}Cmのα線エネルギーが近接しており識別が困難であるという課題を有していた。また、Cmの質量分析のための適切なスパイクが存在しないため、測定精度や分析手法にも制約があった。そこで、Cmのスパイクとして^{252}Cfのα壊変により生成する長半減期核種^{248}Cmに着目し、使用済み^{252}Cf中性子源からのCm分離法について検討した。また、質量分析を行う上で必須となるAm–Cm分離に関する条件の検討を行った。Ln resinと硝酸溶離系を用いた化学分離実験の結果、0.4 M硝酸・室温条件においてCmをCfから完全に分離可能であり、^{248}Cm回収の有効性が示された。一方、質量分析における同重体干渉を回避するために必要なAmとCmの分離においては、いずれの条件においても達成されなかった。今後は、異なる樹脂や溶離系を用いた分離条件の最適化が必要である。

キーワード： キュリウム、アメリシウム、スパイク

P-18

Spent fuel：burden or benefit? Exploring radionuclide recovery and circular economy opportunities in Norwegian nuclear decommissioning waste management

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Over the next two decades, about 200 nuclear reactors are expected to be decommissioned, including Norway's two research reactors. The Norwegian research reactors were designed with little consideration for long-term sustainability or resource recovery, and current decommissioning strategies treat spent fuel primarily waste rather than as a potential source of valuable radionuclides. In collaboration with Norwegian Nuclear Decommissioning (NND), this study examines to what extent radionuclide inventories from Norwegian research reactor spent fuel may be relevant for applications beyond waste disposal, particularly in radiopharmaceutical production and cancer research. The investigation of medically relevant alpha-emitting radionuclides will be based on Thorium-based research fuel from the joint NEA-OECD Halden Reactor Project experiment and the Halden Boiling Water Reactor (HBWR). In addition, potential quantities will be estimated, alongside an assessment of the radiochemical separation processes required for their recovery. By applying principles of circular economy, this work assesses whether selective radionuclide recovery could reduce waste burdens while supporting sustainability, radioecology, and resource efficiency in Norwegian nuclear decommissioning.

Keywords：waste management, sustainability, spent fuel, resource recovery, radiochemistry, radiopharmaceuticals

P-19

Transfer of radiocesium to arthropod and fish communities in river and riparian ecosystems of Fukushima

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To assess the food-web transfer of radiocesium (cesium-137, ^{137}Cs) following the nuclear power plant accident, we surveyed three rivers in Fukushima Prefecture (Ukedo, Takase, and Kuma) from 2020 to 2023, spanning multiple sites from forested headwaters to downstream inhabited areas across seasons and years. We collected aquatic and riparian arthropods, freshwater fish, and environmental samples (river water, primary producers, litter, and soil). ^{137}Cs concentrations were measured with a germanium semiconductor detector, and stable isotope ratios (δ^{13}C and δ^{15}N) were analyzed using an elemental analyzer coupled to an isotope-ratio mass spectrometer. Accumulation patterns differed among sample types and functional groups. Temporal declines in ^{137}Cs were limited, indicating continued forest-associated radiocesium supply to animal communities even roughly a decade after the accident.

Keywords：radiocesium, food-web transfer, river and riparian ecosystems, stable isotope ratio analysis

福島の河川・河畔生態系における節足動物および魚類群集への放射性セシウムの移行

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原子力発電所事故によって放出された主要核種である放射性セシウム(^{137}Cs)は、健康影響や生態系機能保全の観点から重要なモニタリング対象である。本研究では、生物種(および機能群)ごとの^{137}Cs濃度特性を規定する要因を検証し、放射線生態リスク評価へ応用することを目的とした。2020～2023年に、福島県の帰還困難区域を流域に含む３河川(請戸川・高瀬川・熊川)において、上流の森林域から下流の生活圏にかけて複数のサンプリング地点を設定し、水域および河畔の陸域で節足動物(水生昆虫、甲殻類、陸生昆虫、クモ類など)、淡水魚、ならびに環境試料(河川水、一次生産者、リター、土壌)を採集した。各試料の^{137}Cs濃度はゲルマニウム半導体検出器で測定し、炭素安定同位体比(δ^{13}C)と窒素安定同位体比(δ^{15}N)は元素分析計付き同位体比質量分析計により分析した。その結果、試料タイプおよび生物の機能群によって^{137}Csの蓄積傾向は異なった。また、時間経過に伴う^{137}Cs濃度の低下は限定的であり、事故から約10年を経た後も、森林生態系を中心として動物群集への^{137}Cs移行が継続していることが示された。

キーワード：放射性セシウム、食物網移行、河川・河畔生態系、安定同位体比分析

P-20

Radiocesium (^{137}Cs) as a tracer of river use in Japanese seabass

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Fifteen years after the Fukushima Dai-ichi Nuclear Power Plant accident, ^{137}Cs concentrations in marine fish have markedly decreased whereas fish utilizing riverine habitats still exhibit elevated ^{137}Cs levels. Japanese seabass (*Lateolabrax japonicus*) is an amphidromous species migrating among freshwater, brackish, and coastal habitats, and individual differences in river use may affect ^{137}Cs accumulation. This study examined the relationship between river use and muscle ^{137}Cs concentrations using ^{137}Cs as a tracer. Fish were collected from the Ukedo and Mano river systems and adjacent coastal waters in northern Fukushima. Body size, carbon and nitrogen stable isotope ratios, muscle ^{137}Cs concentrations, and otolith Sr/Ca transects were analyzed. Muscle ^{137}Cs concentrations were higher in individuals collected from rivers, particularly in smaller individuals and in rivers with higher ^{137}Cs deposition (maximum: 169 Bq/kg; Ukedo River individual, 26.4 cm in standard length). These results suggest that ontogenetic differences in river use are reflected as individual variation in muscle ^{137}Cs concentrations in Japanese seabass.

Keywords： ^{137}Cs, Japanese seabass, amphidromy, tracer

放射性セシウム(^{137}Cs)をトレーサーとした福島県におけるスズキの河川利用評価

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福島第一原子力発電所事故から15年が経過した現在、海産魚類の^{137}Cs濃度は著しく低下している。一方、河川を利用する魚種では^{137}Cs濃度が相対的に高い状態が現在も認められている。スズキは淡水域・汽水域・沿岸海域を移動する両側回遊魚であり、個体ごとの河川利用の違いが^{137}Cs濃度の蓄積に影響を与える可能性がある。本研究は^{137}Csをトレーサーとして用いることでスズキの河川利用と^{137}Cs濃度の関係を明らかにすることを目的とした。福島県沿岸北部の請戸川および真野川流域、福島県沿岸海域においてスズキを採捕し、体サイズおよび炭素・窒素安定同位体比、筋肉中^{137}Cs濃度を測定した。加えて、一部の個体について耳石Sr/Ca比の線分析を行い淡水域の利用履歴を評価した。その結果、河川で採捕された個体では筋肉中^{137}Cs濃度が相対的に高く、この傾向は体サイズの小さい個体ほど顕著であり、^{137}Csの沈着量が高い河川の個体でより強く認められた(最高169 Bq/kg、体長26. 4cmの請戸川個体)。スズキは若齢期に淡水域利用頻度が高い個体群があることが知られており、本研究の結果は、個体の成長段階に応じた河川利用の違いが、筋肉中^{137}Cs濃度の差として現れることを示している。したがって、スズキ筋肉中^{137}Cs濃度は採集地点の環境条件に加え、個体の成長段階および河川利用履歴を踏まえて評価する必要がある。

キーワード：^{137}Cs、スズキ、両側回遊、トレーサー

P-21

Seasonal changes in diet and ^{137}Cs concentrations of masu salmon revealed by a year-round survey of two rivers

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The accident at the Fukushima Daiichi Nuclear Power Plant in 2011 caused large amounts of radioactive materials to be dispersed and deposited in inland aquatic environments. As a result, high concentrations of ^{137}Cs are still detected in salmonid fishes, particularly masu salmon, inhabiting the Ukedo River system. This study aimed to clarify seasonal changes in diet composition and ^{137}Cs concentrations of masu salmon based on a year-round survey conducted in two tributaries of the Ukedo River system, the Kodeya River and Ogaki-shita. From June 2023 to June 2024, masu salmon were collected seasonally at both rivers using an electrofisher. Fish bodies and stomach contents were analyzed, stomach contents were identified to taxonomic groups, and ^{137}Cs concentrations in edible portions of fish and stomach contents were measured using a high-purity germanium semiconductor detector. The dominant prey items varied seasonally and between rivers. In summer, terrestrial Hymenoptera accounted for more than half of the total diet in both rivers. In autumn, terrestrial Diptera dominated in the Kodeya River, whereas terrestrial Lepidoptera were the primary prey in Ogaki-shita. In winter and spring, the proportion of aquatic insects increased in both rivers. Fish ^{137}Cs concentrations showed a common seasonal pattern, increasing approximately four- to sixfold from summer to autumn in age-1 individuals. Mean concentrations were lowest in summer (610 Bq/kg in the Kodeya River and 2,200 Bq/kg in Ogaki-shita) and highest in autumn (3,700 Bq/kg and 13,000 Bq/kg, respectively), then decreased from winter (1,800 and 4,300 Bq/kg) to spring (430 and 3,400 Bq/kg). These results indicate that seasonal changes in ^{137}Cs concentrations of masu salmon are closely linked to shifts in the dietary contributions of terrestrial and aquatic insects and suggest that the autumnal increase in ^{137}Cs concentrations is strongly influenced by the consumption of terrestrial insects.

Keywords：freshwater fish, river, diet, ^{137}Cs, seasonal changes

２河川の周年調査によるヤマメの食性と^{137}Cs濃度の季節変化

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2011年に発生した福島第一原子力発電所事故により、大量の放射性物質が陸水域へ拡散・沈着した。その影響として、請戸川水系ではサケ科魚類、特にヤマメから現在においても高濃度の^{137}Csが検出されている。本研究では、請戸川水系の２河川（小出谷川、大柿下）を対象に周年調査を行い、ヤマメの食性と^{137}Cs濃度の季節による変化を明らかにすることを目的とした。2023年６月から2024年６月まで、季節ごとに請戸川水系２河川において電気ショッカーを用いてヤマメを採捕し、魚体および胃内容物を分析した。胃内容物は分類群ごとに同定した。Ge半導体検出器を用いて魚体および胃内容物の^{137}Cs濃度を測定した。その結果、ヤマメの主な餌生物は季節や河川によって異なり、夏季は両河川で陸生ハチ目が全摂食量の過半を占めた。秋季には小出谷川で陸生ハエ目が優占し、大柿下では陸生チョウ目が主要餌生物であった。また、冬季、春季には両河川とも水生昆虫の割合が増加した。一方、魚体の^{137}Cs濃度は、両河川に共通して1歳の夏季から秋季にかけ急激に上昇し（約４～６倍上昇）、平均値は夏季に最小（小出谷川：610 Bq/kg、大柿下：2,200 Bq/kg）、秋季に最大（各3,700 Bq/kg、13,000 Bq/kg）となった。また、冬季から春季にかけ低下する傾向を示し、平均値は冬季に各1,800 Bq/kg、4,300 Bq/kg、春季に430 Bq/kg、3,400 Bq/kgであった。以上より、ヤマメの^{137}Cs濃度の季節変化は、陸生・水生昆虫の利用割合の変化と密接に関連しており、特に秋季の^{137}Cs濃度の上昇には陸生昆虫の影響が大きいことが示された。

キーワード：淡水魚、河川、食性、^{137}Cs、季節変化

P-22

Environmental factors influencing ^{137}Cs transfer to the Japanese eel (*Anguilla japonica*) along the Ukedo River system

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Radiocesium (^{137}Cs) deposited after the Fukushima Daiichi Nuclear Power Plant accident has been transferred to fish through food webs, hindering the recovery of inland fisheries in Fukushima Prefecture. Body size effects and uptake inhibition by potassium (K^+) in water have been proposed as factors affecting ^{137}Cs transfer to fish. This study used the Japanese eel (*Anguilla japonica*) as an indicator species to evaluate ^{137}Cs transfer across the Ukedo River system from brackish to freshwater environments, together with multiple environmental factors. Eels were collected at four sites (the estuary, middle and lower reaches, and a tributary) in the Ukedo River system from July 2024 to August 2025 (n = 117). Air dose rate and ^{137}Cs concentrations in river water, periphytic algae, and sediments, as well as K^+ concentration in river water, were measured. A generalized linear model with AIC-based selection showed strong support for models including body length, forest cover, and periphytic algal ^{137}Cs concentration, whereas the contribution of K^+ concentration was limited. These results indicate that dietary pathways reflected by terrestrial and aquatic indicators are more important for ^{137}Cs transfer to eels than ambient water chemistry.

Keywords：Japanese eel, size effect, ^{137}Cs, K^+

請戸川水系河口域から中流域におけるニホンウナギへの^{137}Cs移行とその環境要因

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福島第一原子力発電所事故により環境中に沈着した^{137}Csは、食物網を通じて魚類へ移行し、福島県における内水面漁業の復興を妨げている。魚類への^{137}Cs移行傾向の説明要因として、サイズ効果や環境水中のK^+の競合による取込抑制効果が報告されている。本研究では、広塩性および定位性の高さの観点からウナギ(*Anguilla japonica*)を^{137}Cs移行傾向の指標種と位置づけ、汽水域から淡水域にかけた^{137}Cs移行を環境要因とともに評価した。2024年７月から2025年８月にかけて、請戸川河口域、下流域、中流域および支流の４地点においてウナギを採集した(n = 117)。各地点で空間線量率を測定するとともに、河川水、付着藻類、床堆積物の^{137}Cs濃度および河川水中のK^+濃度を測定した。ウナギの^{137}Cs濃度を応答変数とし、全長、付着藻類の^{137}Cs濃度、K^+濃度および森林被覆率を説明変数とした一般化線形モデルを構築し、AICに基づき候補モデルを比較した。その結果、全長、森林被覆率および付着藻類中の^{137}Cs濃度を含むモデルが相対的に最も支持され、K^+濃度を加えてもモデル適合の改善は限定的であった。なお、K^+濃度を含むモデルでは、K^+濃度の回帰係数は負であった。本研究の結果から、請戸川に生息するウナギにとって環境水由来のK^+による影響は限定的であること、森林被覆率が陸域由来の餌資源の寄与を、付着藻類中の^{137}Cs濃度は水域由来の餌生物の寄与を反映する環境指標として機能した可能性が示唆された。

キーワード：ニホンウナギ、サイズ効果、^{137}Cs、K^+

P-23

Variations in ^{137}Cs concentrations in pond smelt in a dam reservoir

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Due to the effects of the Fukushima nuclear accident, the transfer of ^{137}Cs to freshwater fish has continued to this day. This study aimed to clarify the relationship between ^{137}Cs concentrations in pond smelt, lake water, and zooplankton collected from the Yokokawa Dam reservoir in the Ota River system between 2017 and 2025 by comparing them over time. The concentration ratio (CR) of ^{137}Cs between pond smelt and lake water was calculated. While the ^{137}Cs concentration in pond smelt decreased over time, individuals exceeding the Japanese regulatory limit of 100 Bq/kg were still confirmed in recent years. The dissolved ^{137}Cs concentration in lake water also showed a decreasing trend but exhibited significant fluctuations, suggesting the influence of ^{137}Cs supply from sediments due to lowered water levels. The CR remained generally stable (1,140 L/kg), except in December 2019 after a typhoon, when it reached a high value of 7,230 L/kg. This is thought to be because the lake water's ^{137}Cs concentration decreased sharply due to factors like massive inflow of rainwater accompanying the typhoon's passage, while the pond smelt's ^{137}Cs concentration did not decrease immediately. Furthermore, a significant correlation was observed between the ^{137}Cs concentrations in pond smelt and zooplankton, and between zooplankton and lake water. Based on the above, it is considered that fluctuations in the lake water's ^{137}Cs concentration, associated with water level changes and typhoon passage, influenced the ^{137}Cs concentration in pond smelt via the plankton.

Keywords： ^{137}Cs, pond smelt, zooplankton, lake water, water level changes, typhoon

ダム貯水池に生息するワカサギの^{137}Cs濃度変動

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原発事故の影響により、現在も一部の淡水魚への^{137}Cs移行が続いている。本研究では、太田川水系横川ダム貯水池において、2017～2025年に採取したワカサギ、湖水、動物プランクトンの^{137}Cs濃度を時系列的に比較し、その関係性を明らかにすることを目的とした。ワカサギ、湖水および動物プランクトンはGe半導体検出器により^{137}Cs濃度を測定した。さらに、ワカサギと湖水の^{137}Cs濃度比(concentration ratio：CR)を算出した。ワカサギの^{137}Cs濃度は経年的に低下したが、近年でも基準値100 Bq/kgを超える個体が確認された。湖水の溶存態^{137}Cs濃度も低下傾向を示したが変動が大きく、水位低下に伴う底質からの^{137}Cs供給の影響が示唆された。CRは概ね安定していたが(1,140 L/kg)、台風後の2019年12月のみ7,230 L/kgと高い値を示した。これは、台風通過に伴う雨水の大量流入等により、湖水の^{137}Cs濃度が急激に低下したが、ワカサギの^{137}Cs濃度は直ちに低下しなかったためと考えられる。また、ワカサギと動物プランクトン間、動物プランクトンと湖水間の^{137}Cs濃度には有意な相関が認められた。以上より、水位変化や台風通過に伴う湖水の^{137}Cs濃度変動が、プランクトンを介してワカサギの^{137}Cs濃度に影響したと考えられる。

キーワード： ^{137}Cs、ワカサギ、動物プランクトン、湖水、水位変化、台風

P-24

Inter-species and inter-site comparison of ^{137}Cs concentrations and growth models in two salmonid species

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Fish growth patterns influence the accumulation and dilution of ^{137}Cs; therefore, understanding these patterns is essential for elucidating ^{137}Cs transfer mechanisms to fish. From 2017 to 2024, two salmonid species (white-spotted charr and masu salmon) were collected from the upper Ota River near the FDNPP at a downstream site (St.1) and an upstream site (St.4). Total length, age (from otoliths), and whole-body ^{137}Cs concentrations were measured. Six growth models–the Gompertz, logistic, and von Bertalanffy models and their seasonal extensions–were compared using AIC. At the same age, individuals at St.1 were larger than those at St.4, and masu salmon were larger than white-spotted charr at both sites. Masu salmon also had higher ^{137}Cs concentrations, suggesting that higher food intake and faster growth enhance ^{137}Cs accumulation. The periodic function-extended von Bertalanffy model best fit the data for both species at St.1 and for white-spotted charr at St.4; only masu salmon at St.4, where the von Bertalanffy model was selected due to the limited sample size. These results indicate that incorporating seasonality improves growth models and that rapid growth during the growing season may influence seasonal variation in ^{137}Cs concentrations.

Keywords： ^{137}Cs concentrations, growth models, white-spotted charr, masu salmon

サケ科２種の^{137}Cs濃度と成長モデルの魚種間・地点間比較

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魚類の成長様式は^{137}Csの蓄積や希釈に影響を及ぼすため、その理解は魚類への^{137}Cs移行メカニズムの解明に有用である。本研究は、2017～2024年に原発近傍の太田川上流域において、下流側St.1および上流側St.4でサケ科２種（イワナとヤマメ）を採捕し、全長測定、耳石による年齢査定、魚体の^{137}Cs濃度測定を行った。成長モデルには、ゴンペルツ式、ロジスティック式、ベルタランフィ式、それらに季節変動を加味した周期関数拡張モデルの計６種を適用し、AICをもとにベストモデルを選択した。その結果、両魚種ともに同年齢ではSt.1の個体の方が全長が大きく、また両地点においてヤマメの方がイワナよりも全長が大きかった。^{137}Cs濃度もヤマメの方が高かったことから、イワナよりも摂食量が多く成長の良いヤマメの方が^{137}Cs濃度が高くなる可能性が示唆された。成長モデルの比較では、採集個体数の少ないSt.4のヤマメを除き（ベルタランフィ式）、St.1のイワナ・ヤマメ、St.4のイワナで周期関数拡張ベルタランフィ式がベストモデルとなった。これは、成長モデルに季節性を加味することで適合度が向上することを示すとともに、成長期における高成長が、^{137}Cs濃度の季節変動に影響する可能性がある。

キーワード： ^{137}Cs濃度、成長モデル、イワナ、ヤマメ

P-25

Effects of soil moisture on ambient dose rates in Fukushima forests

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Ambient dose rates in forested areas of Fukushima Prefecture have generally decreased since the Fukushima Daiichi Nuclear Power Plant accident, yet pronounced short-term fluctuations persist. Rainfall can increase dose rates through wet deposition of radionuclides, whereas increased soil moisture may reduce dose rates by shielding radiation emitted from the ground. This study investigates how effective rainfall (Rw) and soil moisture dynamics control temporal variations in ambient dose rates in contaminated forest environments.

Field observations were conducted at the Iitoi and Fuyuzumi sites in Fukushima, where ^{137}Cs deposition is approximately 720 kBq m^{-2} and 900 kBq m^{-2}, respectively. Soil moisture at depths of 5 cm and 15 cm and ambient dose rates at 1 m height were continuously monitored. Soil moisture conditions were represented using effective rainfall indices with short-term (2h), medium-term (optimal solution for effective rainfall half-life), and long-term (168h) response times.

The results clearly demonstrate that soil moisture variations at both shallow and deeper layers exert a strong control on ambient dose rates. Effective rainfall successfully reproduced the observed short-term decreases and increases in dose rates following rainfall events at both sites. In particular, combining multiple temporal scales improved the agreement between estimated and observed dose rate variations. This approach provides a cost-effective alternative to direct soil moisture measurements and offers a practical framework for correcting ambient dose rates in forested radioactive environments.

Keywords：ambient dose rate, soil moisture, effective rainfall, forest ecosystem, Fukushima Daiichi nuclear accident

P-26

Uptake of CsMPs by earthworms in Fukushima forests and their contribution to ^{137}Cs body concentration

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Earthworms, as major soil animals, serve as important indicator organisms for understanding ^{137}Cs dynamics in forest ecosystems. While the presence of radioactive cesium-rich microparticles (CsMPs) in environments has attracted attention in recent years, the uptake of CsMPs by earthworms and its impact on their ^{137}Cs body concentration remain largely unclear. In this study, we measured ^{137}Cs concentrations and performed autoradiography analysis on earthworms collected from forests in radioactively contaminated areas of Fukushima Prefecture (Iitate Village, Namie Town, and Okuma Town). The analysis revealed the presence of CsMPs in some individuals, with a significant contribution of CsMPs to the total ^{137}Cs concentration of the individual, averaging 27% (maximum 98%). Although ^{137}Cs concentrations in earthworms is typically lower than those in the soil, individuals that had CsMPs at the sampling site in Namie Town exhibited high concentrations exceeding the soil ^{137}Cs level. These results suggest that, in elucidating the mechanisms of redistribution of radioactive cesium by soil animals in forest ecosystems, it is necessary to consider the contribution of CsMPs in addition to dissolved and clay-bound ^{137}Cs.

Keywords： ^{137}Cs, radioactive cesium-rich microparticles (CsMPs), earthworm

福島県内の森林に生息するミミズにおけるCsMPsの取り込みとその^{137}Cs体中濃度への寄与

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森林生態系における^{137}Cs動態の理解において、大型の土壌動物であるミミズは重要な指標生物である。近年、環境中の高濃度放射性セシウム含有粒子(CsMPs)の存在が注目されているが、ミミズによるCsMPsの取り込みとそれが体中^{137}Cs濃度に及ぼす影響については未解明な点が多い。本研究では、福島県内の放射能汚染地域内(飯舘村、浪江町、大熊町)にある森林にて採取したミミズを対象に、^{137}Cs濃度測定およびオートラジオグラフィ解析を実施した。解析の結果、一部の個体からCsMPsが検出され、それらの個体の全^{137}Cs濃度に対するCsMPsの寄与率は平均27%(最大98%)と高かった。通常、ミミズの^{137}Cs濃度は土壌の^{137}Cs濃度よりも低い傾向にあるが、浪江町の調査地点ではCsMPsを取り込んだ個体が土壌の^{137}Cs濃度を上回る高い値を示した。この結果は、森林生態系における放射性セシウムの土壌動物による再分配のメカニズムを明らかにする上で、溶存態や粘土粒子に収着された^{137}Csに加えて、CsMPsの寄与を考慮する必要性を示唆するものである。

キーワード： ^{137}Cs、高濃度放射性セシウム含有粒子、ミミズ

P-27

Preferential flow increases the spatial heterogeneity of ^{137}Cs in a cedar forest andosol

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Preferential flow in soil is one of the mechanisms of downward migration of ^{137}Cs that has not been sufficiently studied. Accurate estimation of the downward migration is important for using ^{137}Cs as an environmental tracer and for evaluating air dose rate after a nuclear accident, but it tends to be underestimated especially at deeper soil layers, suggesting the influence of preferential flow. Therefore, we visualized preferential flow by an artificial rainfall experiment using the dye tracer in a cedar plantation forest in the former evacuation zone of Fukushima Prefecture, investigated the relationship among soil physicochemical properties, preferential flow and ^{137}Cs. The results showed that the ^{137}Cs concentration was approximately 3.3 times higher in the soil stained by the dye tracer, and that the variation was also greater, demonstrating that preferential flow contributes to the downward migration of ^{137}Cs and the increase in spatial heterogeneity of ^{137}Cs. The variation in ^{137}Cs inventory on a centimeter scale was related to bulk density, which is associated with the occurrence of preferential flow, while weaker relationship was found with the radiocesium interception potential (RIP) which indicates ^{137}Cs sorption capacity. These tendencies were especially clear at a soil depth of 10–20 cm, indicating that this large spatial variation of ^{137}Cs is likely the reason why previous monitoring of ^{137}Cs in forests could not clearly detect the migration downward deeper than 10 cm.

Keywords：selective flow, artificial rainfall experiment, dye tracer, radiocesium interception potential (RIP)

選択流がもたらすスギ林黒ボク土中^{137}Csの空間的不均一性

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土壌中の選択流は、未だ研究が不十分な^{137}Cs下方移行メカニズムの1つである。下方移行を精度高く推定することは、^{137}Csをトレーサーとして利用する上でも、原子力災害後の空間線量を評価する上でも重要であるが、深層で過小評価される傾向にあり、選択流の影響が示唆されている。そこで福島県の旧避難区域のスギ人工林において染料トレーサーを用いた人工降雨実験によって選択流を可視化し、土壌物理化学性と選択流、^{137}Csの関係を調査した。その結果、染料トレーサーで染色された土壌では^{137}Cs濃度が約3.3倍高く、その変動も大きかったことから、選択流が^{137}Csの下方移動と空間的不均一性の増大に寄与していることが示された。^{137}Csインベントリのセンチメートルスケールでの変動は、選択流の発生に関連するかさ密度と相関が見られたが、^{137}Csの吸着能力を示す放射性セシウム捕捉ポテンシャル(RIP)との相関は弱かった。これらの傾向は特に土壌深さ10～20cmで顕著であり、この^{137}Csの大きな空間変動が、従来の森林モニタリングで10cm以深への^{137}Cs移行を明確に検出できなかった理由である可能性が示唆された。

キーワード：選択流、人工降雨実験、染料トレーサー、放射性セシウム捕捉ポテンシャル

P-28

Environmental monitoring using bryophytes in Fukushima Prefecture

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The bryophytes are one of the most widely used organisms for biomonitoring including radioactive contamination due to their small bodies in direct contact with soil. We measured the concentrations of ^{134}Cs and ^{137}Cs in the moss *Calohypnum plumiforme* at approximately 30 localities in Fukushima Prefecture from 2013 to 2014. We revisited these areas in 2025 to observe the changes in radioactive contamination over the 10-year period. Furthermore, in 2025, we revisited five localities in Fukushima Prefecture and five locations in Hiroshima Prefecture where we analyzed the composition of symbiotic microbiota of the hornworts (*Anthoceros agrestis*) in 2024, and re-investigate the composition of symbiotic microbiota. In addition to microscopic observation of the inside of the plant body, we performed amplicon analysis of the 16S rRNA V3/V4 region of the bacteria and the ITS1 region of the fungus to analyze the symbiotic microbial community. In this study, we report on the changes over time in radioactive contamination within a moss colony that appears to be the same as it was 10 years ago and the results of comparative analyses of the microbiota within and between the bryophyte populations and discuss the effectiveness of comprehensive biomonitoring using bryophyte.

Keywords： bryophytes, hornworts, biomonitoring, radiation effect, 16S rRNA, ITS, microbiome analysis

福島県をフィールドとしたコケ植物を用いた環境モニタリング

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分布域が広く、地面を覆うように生育し、植物体が小さいコケ植物は放射能汚染を含む生態系のバイオモニタリングに適した生物として知られている。我々は、2013年から2014年にかけて福島県の約30地点でコケ植物セン類のハイゴケ(*Calohypnum plumiforme*)に含まれる^{134}Csと^{137}Csの濃度を測定した。2025年にこれらの地域を再訪し、10年間の放射能汚染状況の経時変化を観測した。さらに、2024年にナガサキツノゴケ(*Anthoceros agrestis*)の共生微生物叢の組成を解析した福島県内の浜通り地域を含む５ヶ所、広島県内の５ヶ所について2025年に再調査した。ナガサキツノゴケ植物体内の顕微鏡観察に加え、細菌の16S rRNA V3/V4領域、真菌のITS1領域のアンプリコン解析を行い、細菌と真菌を含む微生物叢解析を行った。本研究では、10年前と同一と思われるコケ植物コロニー内の放射能汚染の経年変化、さらに各集団内と集団間での微生物叢の比較解析の結果について報告し、コケ植物を用いた総合的なバイオモニタリングの有効性について考察する。

キーワード：コケ植物、ツノゴケ、生物モニタリング、放射線、16S rRNA、ITS、細菌／真菌叢解析

P -29

Long-term transfer trend of radiocesium in Fukushima and European forests

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We integrated long-term monitoring data collected since 2011 in experimental forest stands in Fukushima with published European studies (including Chornobyl-affected forests) to compare ^{137}Cs cycling rates and forest–water interactions. Following initial deposition, ～80% of canopy-intercepted ^{137}Cs was transferred to the forest floor within 2011; rainwater-driven pathways dominated, while litterfall became more important from the second year onward. After 10 years, the transfer flux declined to <1% of the initial fallout. Tree compartments generally showed self-decontamination faster than the physical half-life of ^{137}Cs, but newly emerged leaves of deciduous broadleaved trees showed little decline, and decreases in outer-bark ^{137}Cs slowed around 7-8 years after deposition. In Fukushima, where the forest-floor organic layer has low retention capacity, long-term migration of leached ^{137}Cs to biota and aquatic systems remains a concern; however, coniferous stands showed limited transfer to current-year foliage and thus slower internal cycling. In contrast, deciduous broadleaved stands suggested cycling dynamics closer to those in European forests with hydrophobic soils. Stemflow may also exhibit broadly similar concentration levels and attenuation trends between Fukushima and Europe, emphasizing the need for continued monitoring and data accumulation to establish robust long-term trajectories.

Keywords： radiocesium, Fukushima, Europe, forest, distribution, transfer component

福島及びヨーロッパの森林における放射性セシウムの長期移行傾向

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福島県の試験林分で2011年以降に継続取得してきた長期モニタリングデータと、ヨーロッパ(チョルノービリ等)の既存研究を統合し、森林内^{137}Csの循環速度と森林–水相互作用を比較した。初期沈着後、樹冠捕捉分の約80％が2011年中に林床へ移行し、主要経路は雨水、２年目以降は落葉が寄与した一方、10年後には移行フラックスは初期沈着の１％未満まで低下した。樹体では概ね半減期より速い自浄化が進むが、落葉広葉樹の新葉は濃度低下が乏しく、外樹皮では７～８年後に減少率の鈍化が示された。林床有機層の保持能が低い福島では、溶脱^{137}Csの生物・水系への長期移行が懸念されたが、針葉樹では当年葉への移行が小さく循環が遅いことが示唆された。一方、落葉広葉樹ではヨーロッパの湿性土壌林分に近い循環が示唆された。さらに樹幹流は福島と欧州で類似の濃度・減衰傾向の可能性もあり、長期トレンド確立のため継続観測とデータ蓄積が重要である。

キーワード：放射性セシウム、福島、ヨーロッパ、森林、分布、移行経路

P-30

Investigation of decomposition and residual processes of organic matter for estimating residual ratio of organically bound tritium (OBT) in seawater

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Tritium (^{3}H), a major anthropogenic radionuclide, is released from nuclear facilities to the environment, especially to the ocean. Most tritium in the ocean transfers and disperses as tritiated water (HTO) in seawater, meanwhile parts of this radionuclide alter to organically bound tritium (OBT) through phytoplanktonic organic matter (OM) production. The decomposition and residual processes of this OBT have been scarcely investigated. Elucidation of these processes is essential for a comprehensive understanding of the fate of tritium in the ocean. The present study conducted a bacterial decomposition experiment of phytoplanktonic OM in seawater with deuterium (^{2}H, D) tracer. Deuterium is a stable isotope of hydrogen and an alternative to tritium. Additionally, bacterial activity is the dominant factor for decomposing organic matter in seawater. During this experiment, particulate phytoplanktonic OM labeled by deuterium decreased with time progress. At the same time, dissolved OM (DOM) labeled by deuterium increased in the early stage (within 1 week) of phytoplanktonic OM decomposition and somewhat decreased but kept a certain concentration over two months. These results suggest that DOM may be a potential fate of tritium in seawater.

Keywords：organically bound tritium (OBT), phytoplanktonic organic matter, dissolved organic matter (DOM)

海中における有機結合型トリチウムの残存率推定に向けた有機物の分解・残存過程の解明

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主要な人為起源放射性核種の一つであるトリチウム(^{3}H)は、原子力施設から環境、特に海洋へ放出されている。海洋のトリチウムの大部分はトリチウム水(HTO)として海水中へ移行・拡散し、その一部は植物プランクトンの有機物生成を通じて有機結合型トリチウム(OBT)に変化する。これまで、海水中のHTOの移行・拡散や植物プランクトンによるOBT生成は研究されている一方、このOBTの分解および残留プロセスについてはほとんど調査されていない。海洋におけるトリチウムの行方を十分に理解するためには、これらのプロセスを解明する必要がある。本研究では、重水素(^{2}H, D)トレーサーを用いた海水中の植物プランクトン有機物の微生物分解実験を行った。重水素は水素の安定同位体であり、トリチウムの代替となる。また、微生物活性は一般的に海水中における有機物分解の主要因である。本実験では、重水素標識された粒子状植物プランクトン有機物が時間経過と共に減少した。一方、重水素標識された溶存態有機物(DOM)は植物プランクトン有機物の分解初期(１週間以内)に増加し、その後２ヶ月間は若干減少しつつ、一定濃度を維持した。この結果はDOMが海水中トリチウムの潜在的プールである可能性を示す。

キーワード：有機結合型トリチウム(OBT)、植物プランクトン有機物、溶存態有機物(DOM)

P-31

Uptake of ^{137}Cs from seawater by spotted halibut in captivity

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The concentration of radioactive cesium-137 (^{137}Cs) in fish and shellfish from the coastal areas of Fukushima Prefecture shows an overall downward trend, but aspects of its accumulation mechanism remain unclear. Specifically, since ^{137}Cs within fish bodies is influenced by multiple factors such as seawater, prey organisms, and habitat, verifying the accumulation mechanism through surveys in natural environments is often difficult. Therefore, to clarify the process by which marine fish and shellfish take up ^{137}Cs from seawater, a rearing experiment was conducted using spotted halibut in seawater containing ^{137}Cs. The experiment was conducted twice, varying the rearing period：84 days (December 2023 to March 2024) and 140 days (March to August 2025). In each trial, one-year-old spotted halibut were reared in seawater adjusted to approximately 1 Bq/L by adding a litter extract solution, and test fish were periodically removed. The ^{137}Cs concentration in the muscle tissue of each removed test fish was measured. The concentration of ^{137}Cs in the muscle tissue of spotted halibut tended to increase over the rearing period. The ^{137}Cs concentration was 5.59 Bq/kg-wet in the 84-day test and 12.9–16.4 Bq/kg-wet in the 140-day test. These results suggest that ^{137}Cs taken up by spotted halibut from seawater is concentrated within their bodies.

Keywords：spotted halibut, rearing experiment, ^{137}Cs

飼育環境下におけるホシガレイの海水からの^{137}Csの取込

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福島県沿岸域の魚介類の放射性セシウム(^{137}Cs)濃度は全体的に低下傾向にあるが、その蓄積メカニズムには不明な部分がある。特に、魚体内の^{137}Csは海水、餌生物、生息場所等の複数の要因から影響を受けるため、天然環境での調査では蓄積メカニズムを検証することは困難である場合が多い。そこで、海産魚介類が海水から^{137}Csを取り込む過程を明らかにするために、^{137}Csを含む海水を用いたホシガレイの飼育試験を行った。試験は飼育期間を変えて84日間(2023年12月～2024年３月)と140日間(2025年３月～８月)の２回実施した。それぞれ、ホシガレイ１歳魚をリター抽出液の添加によって約1 Bq/Lに調整した海水で飼育し、定期的に供試魚を取り上げた。取り上げた供試魚は１個体ごとに筋肉中の^{137}Cs濃度を測定した。ホシガレイの筋肉中の^{137}Cs濃度は飼育期間の経過とともに上昇する傾向がみられ、^{137}Cs濃度は84日間の試験では5.59 Bq/kg-wet、140日間の試験では12.9～16.4 Bq/kg-wetであった。以上の結果から、ホシガレイが海水から取り込んだ^{137}Csは体内で濃縮されることが示唆された。

キーワード：ホシガレイ、飼育試験、^{137}Cs

P-32

Assessment of the quasi-equilibrium levels of ^{137}Cs in a typical Japanese cedar forest

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In this study, we analyzed the dynamics of the concentration ratios of Fukushima-derived radiocesium (^{137}Cs) and stable natural cesium isotope (^{133}Cs) in aboveground biomass compartments of a typical mature Japanese cedar forest during 2014-2020. At the end of the observation period, the ^{137}Cs concentrations correlated well with the equilibrium concentrations of ^{133}Cs entering the aboveground biomass from the soil, indicating that the quasi-equilibrium distribution of radiocesium had been achieved after a period of removal of initially intercepted radiocesium from the biomass compartments. Moreover, the isotope concentration ratio ^{137}Cs/^{133}Cs in biomass as of 2020, 3.6×10^{-5} (μg kg^{-1}) (μg kg^{-1})$^{-1}$ (95% CI：1.6×10^{-5} - 5.6×10^{-5}), was close to the ^{137}Cs/^{133}Cs inventory ratio in the 5-cm topsoil, $(2.52\pm2.39)\times10^{-5}$ (μg kg^{-1}) (μg kg^{-1})$^{-1}$, confirming that root uptake became the main contributor to the ^{137}Cs inventories in the tree biomass. The total radiocesium inventory in aboveground biomass stabilized between 2017 and 2020 at the level of (3.1 + 1.7) % of its total inventory in the ecosystem.

Keywords：radiocesium, stable cesium, isotope concentration ratio, quasi-equilibrium distribution, root uptake, Japanese cedar

P-33

Revisiting radiocesium retention in Japanese cedar：implications for post-accident forest recovery

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The long-term management of contaminated forest landscapes depends not only on declining environmental inventories of radiocesium (^{137}Cs), but also on how this radionuclide is retained within commercially important tree species. Japanese cedar (*Cryptomeria japonica*), which underpins much of Japan's plantation forestry, exhibits an unusual internal distribution of ^{137}Cs within wood (stem), marked by preferential accumulation in heartwood rather than sapwood. This pattern challenges conventional assumptions about radionuclide behavior in woody tissues and raises questions about the processes controlling internal redistribution and retention. This study synthesizes current knowledge on radial radiocesium dynamics in Japanese cedar, focusing on anatomical, physiological, and environmental factors that may drive these observations. Key uncertainties are identified, and directions for future research are outlined to improve predictive capability and inform risk-based decisions on the utilization of forest timber in post-accident environments.

Keywords：Japanese cedar, radiocesium, forest ecosystems, Fukushima

P-34

Effect of radioactive contamination on population characteristics of *Rodentia* in the Chornobyl Exclusion Zone

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Mammals of the order *Rodentia* are widely used as model organisms for assessing the negative environmental impacts, such as the long-term radioecological effects following the Chornobyl Nuclear Power Plant accident. Rodents are highly abundant species, have a short life cycle, and remain in constant contact with components in terrestrial ecosystems they inhabit. Our study assessed the impact of radioactive contamination of the territory on the population parameters and species diversity of representatives of the order *Rodentia* in the Chornobyl Exclusion Zone (Ukraine). Fieldwork was conducted in 2024 on 8 sites with contrasting levels of radioactive contamination (0.06-0.24 μSv/h in the control areas and 0.5-41.6 μSv/h in the areas with high levels of contamination). Trapping was carried out using Sherman live traps, followed by determination of species composition, sex, and weight, as well as non-invasive measurement of ^{137}Cs activity. The results did not reveal statistically significant differences between the ratio of males to females as well as between the abundance of background and rare species.
Our results indicated no statistically significant effect of radioactive contamination in the above-mentioned range on the species diversity and population parameters of *Rodentia*.

Keywords：Chornobyl Exclusion Zone, model organisms, rodents, *Rodentia*, radioactive contamination

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Evaluation of root uptake of ^{137}Cs in Japanese red pine and investigation of influencing factors

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Radioactive cesium-137 (^{137}Cs) deposited due to the Fukushima Daiichi Nuclear Power Plant accident is retained long-term in forest soils while circulating within the forest ecosystem. It can still exert effects through root uptake by vegetation. This study is focused on Japanese red pine trees in the Tsushima Village in Fukushima Prefecture, examining the root uptake of radioactive cesium to elucidate the mechanism and derive related equations. Post-deposition trees, germinated after the initial deposition, were used as study subjects. This approach eliminated the effects of initial deposition, such as canopy closure at the time of deposition, allowing for a direct evaluation of the uptake process from the soil.
The total amount of ^{137}Cs in vertically stratified soil samples will be measured to determine its vertical distribution and total soil inventory. The tree samples from the same location were analyzed by biomass compartment to determine the total ^{137}Cs content in each compartment. Soil chemical properties will be assessed by measuring exchangeable ^{137}Cs concentration, exchangeable potassium ion (K^+) concentration, and pH value, which is related to bioavailability. The mobility and bioavailability of radioactive cesium will be interpreted from the perspective of Cs–K competition and pH-dependent adsorption behavior. The aggregated transfer factor, T_{ag}, will be used as an evaluation index for root uptake T_{ag} is defined as "^{137}Cs concentration in each tree biomass compartment / total ^{137}Cs deposition in soil." The relationship between T_{ag} and exchangeable ^{137}Cs, K^+ concentration, and pH will be analyzed, and the mechanism of the root uptake will be interpreted considering fluctuations in exchangeable pools and depth-dependent retention characteristics. Future work will include adding measurement items such as cation exchange capacity (CEC) to generalize the relationship equations.

Keywords：radioactive cesium (^{137}Cs), root uptake, forest ecosystems

P -36

The post-Fukushima energy transition through the lens of territorial ecology

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After the March 11, 2011 disaster, Fukushima Prefecture redirected its energy trajectory toward a mix composed entirely of renewable energy by 2040. By 2024, the region hosted a large number of solar power plants, accounting for 80% of its renewable energy capacity. While these plants-initially driven by local initiatives-developed with relative ease in the post-disaster context, they have since become the subject of growing controversy and increasing regulatory efforts by local public authorities. Their governance and their impacts on humans and non-humans raise questions : beyond the promises of renewed energy governance, they may simultaneously serve as vehicles for liberal extractivist logics that transform disaster into an economic and political opportunity. Through the study of several salient cases, this research project seeks to examine the energy justice of renewable energy infrastructures within a specific territorial context. To this end, it mobilizes a theoretical framework inspired by industrial and territorial ecology, as well as the anthropology of energy. This study analyzes a metabolic system composed of interactions and flows among humans, between humans and non-humans, and among non-humans. Within this system, energy ensures the functioning of this metabolism-responding to primary needs and associated practices such as heating and lighting-while simultaneously constituting a medium for the expression of power, or “energo-power.” Thus, questioning changes in the energy system entails questioning changes in the forms through which power is expressed.

Keywords : energy transition, sustainability, solar energy, metabolism

P-37

Study of pesticide migration in the soil-plant (tea) system using radiolabeled pyraclostrobin

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The control of tea diseases and pests mainly relies on chemical methods, supplemented by agricultural and biological approaches. This study provides an assessment of the migration behavior pesticide in tea using radiolabeled pesticide. Methods： autoradiography and liquid scintillation spectrometry. Plants： leaves collected at different heights from the tea bush (*Azorean Camellia sinensis*). Pesticide： pyraclostrobin labeled with ^{14}C (15 kBq/m^2). Soils： mainly fertile, acidic, volcanic soils with good drainage, rich in organic matter (layers 0-10 cm, 10-20 cm, 20-30 cm). Radiolabeled pesticides in solutions (1) with surfactants and (2) without surfactants were added in the soil around the plant. After the incubation during 60 days, massive labelling of the cell walls of all leaves in the lower part of the bush was detected, while in the upper part, the labelling occurred in less than 10 % of the leaves. The walls of the more internally located cells of the leaf tip differ in some respect from those of the epidermal cells; this difference is noticeable in permanganate-fixed material viewed with the electron microscope, since the walls of the latter cells are stained heavily, unlike the walls of the internal cells. The distribution of ^{14}C between the soil layers was as follows： 0-10 cm ~ 40 % activity, 10-20 cm ~ 30 % activity and 20-30 cm ~ 10 % of the total activity added in the soil. We did not observe any significant difference in labelling of the cell walls between the experiments using the pyraclostrobin-^{14}C with and without surfactants.

Keywords： migration, pesticides, radiolabeled substance

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Sr-90 and Cs-137 activity concentrations in soil samples collected from the Fukushima exclusion zone

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Radiometric methods were used to evaluate the activity concentrations of Sr-90 with a half-life of 28.8 years and Cs-137 with a half-life of 30.2 year. In this study, 76 soil samples (soil, rain gutter deposit, roadside sediment and litter) were obtained from the Fukushima exclusion zone in 2013, 2015, 2016, 2017, and 2018. The activity concentrations of Sr-90 and Cs-137 were found to fall within the range of 3 to 1,050 $Bq \cdot kg^{-1}$ (with a median of 82 $Bq \cdot kg^{-1}$) and 0.7 to 6,770 $kBq \cdot kg^{-1}$ (with a median of 890 $kBq \cdot kg^{-1}$), respectively (decay correction date：March 15, 2011). Strong positive correlation was observed between Sr-90 and Cs-137 activity concentration while Sr-90 shown higher mobility in Japanese soil samples. A total of 85 percent of the samples were found to have an activity ratio of Sr-90/Cs-137 that fell between the range of 5.0×10^{-5} to 5.0×10^{-4}, with a median value of 1.2×10^{-4}. This median value can be used to distinguish between the Fukushima Daiichi Nuclear Power Station (FDNPS) accident and global fallout contaminations of Sr-90. Practically, below the Cs-137 activity concentration of 100 $kBq \cdot kg^{-1}$, the FDNPS accident origin Sr-90 is at a similar level to the global fallout (some $Bq \cdot kg^{-1}$) in Japanese soil samples. The Sr-90/Cs-137 activity ratios obtained in this work implied that around 0.3-20 TBq of Sr-90 was released into the atmosphere. This amount is insignificant when compared to the Chornobyl Nuclear Power Plant accident, which was estimated to be over 10 PBq, or any other nuclear accident contamination. As a result, considerable Sr-90 contamination above the background level cannot be expected in agricultural, forestry, or urban areas within the Fukushima exclusion zone, as well as in all other parts of Fukushima Prefecture or any other Japanese prefecture. Cs-137 is still considered the principal contaminant from the FDNPS accident in terms of radioecology and radiation safety.

Keywords：Sr-90, Cs-137, activity ratio, soil samples, Fukushima nuclear accident

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Multi-scale onshore-offshore dynamic and nutrient transport of Kuroshio onto the outer shelf of the East China Sea quantified using multi-chemical tracers

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The East China Sea (ECS) provides essential biological resources for its local fishery and contributes to biodiversity in its surrounding seas of the Yellow and Japan Seas, mainly through the Kuroshio Current (KC), which regulates cross-shelf material transport. Using a spatial and temporal basis, this study aims to identify and quantify multiple water mixing processes and related nutrient transport in the bottom water of the outer shelf of the ECS. In this study, traditional tracers of temperature and salinity and modern tracers of Heavy Rare Earth Elements (HREEs), and Nd and Ra isotopes were employed in the water and mass mixing model. Additionally, shipboard and moored data from the Acoustic Doppler Current Profiler (ADCP), microstructure profilers, and satellite-derived observations were utilized to help interpret physical forces further. Preliminary results are：(1) Hydrodynamic processes influence the distribution of chemical and physical properties in the bottom water of the East China Sea on an hourly basis; (2) Reintroduction of deep Kuroshio Intermediate Water during the onshore flow was also notable for its high nutrient content, resulting in net Dissolved Inorganic Nitrogen (DIN) and Dissolved Inorganic Phosphate (DIP) fluxes from the KC region 5.59 and 6.69 times larger, respectively, compared to the DIN and DIP fluxes from the continental shelf water.

Keywords：Kuroshio current, East China Sea, REEs, Nd, Ra, nutrient transport

P-40

Assessment of the effects of ionizing radiation in bees – BEERAD

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The risk assessment of environmental radiocontamination following a nuclear accident is a major ecological issue. However, it remains surrounded by controversy over the real impact of such events on the flora and fauna inhabiting the targeted zones. Moreover, the underlying mechanisms of ionizing radiation's action are poorly understood. Therefore, it is important to acquire data on the potential effects of ionizing radiation (IR) on ecosystems both in experimental and realistic conditions.
The objective of the BEERAD project is, using a pluri-disciplinary approach, to increase the knowledge of effects and mechanisms of action of IR on physiology and populations of honeybees in the context of chronic exposure (i.e., exposure of a significant period of time relative to the lifespan of exposed organisms) and at low dose rates (sublethal ecotoxicity) in realistic conditions, i.e., on the field and in the laboratory. However, very few data exists on this subject, and it is important to conduct studies that will serve as a basis for better evaluating the impacts of IR on animal health using honeybees.
In 2023 and 2024, hives were installed in April on six sites around the Fukushima Daiichi Nuclear Power Plant：2 in Okuma (high dose), 1 in Namie, 1 in Futaba (low dose), and 2 in Minamisoma (controls). Hives were sampled at different time points for Cs measurement and biomarker analyses. Honey was also collected for the measurement of radiocesium and pesticide content. In July 2024, queens were also sampled for analyses.
Regarding the laboratory experiments, one irradiation experiment on early life stages was conducted in April 2025. The irradiation experiment lasted 21 days, after which the emerging bees were placed in control conditions for 10 days. Larvae, nymphs, and bees were sampled at the end for biomarker analyses. Mortality and development were also monitored.
The poster will present the main results obtained to date, both from field and laboratory experiments.

Keywords：ionizing radiation, honeybee *Apis mellifera*, physiology, biomarkers, Fukushima NPP

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Transfer and accumulation of ^{137}Cs in the Antarctic ecosystem

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Antarctica is the continent least affected by human activity. However, large-scale radiological studies of the Antarctic ecosystem conducted in 2011-2012 showed the presence of anthropogenic radionuclides resulting from high-altitude nuclear tests and nuclear accidents and incidents around the world. In 2011 and 2022, a total of 93 samples were taken and analyzed from all parts of the Antarctic ecosystem. Nine months after the Fukushima nuclear accident, no ^{134}Cs was found in any sample. These results were confirmed in 2022. This proves that radioactive contamination from Fukushima has not reached Antarctica. At the same time, ^{137}Cs from nuclear tests in the Northern Hemisphere since the mid-20th century has been found in lichens, mosses, algae, grass, soil, volcanic ash and sediments. The average concentration of ^{137}Cs in moss was between 6 and 9 for 2011-2012 and between 3.5 and 11 Bq/kg for 2022. In lichens, the concentrations were between 5 and 8 in 2011-2012 and between 1 and 6 Bq/kg in 2022. In soil samples, ^{137}Cs concentrations decreased from 8.1 in 2011 to 0.5 Bq/kg in 2022. For the 10-year study period, no significant decrease in the concentrations of ^{137}Cs in plant samples was recorded. The main reason is the heterogeneous spatial distribution (or deposition) of radionuclides from atmospheric fallout and melting of glaciers, which slowly released the ^{137}Cs that had accumulated in them in the past. In this way, ^{137}Cs is reintroduced into the cycle of substances and the food chain.

Keywords：anthropogenic radioactive pollution, Antarctic ecosystem, ^{134}Cs, ^{137}Cs

P-42

Volume reduction of radionuclide-contaminated aqueous waste using a charcoal-ceramic composite：Process optimization and application

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The management of large volumes of aqueous waste contaminated with long-lived radionuclides, particularly cesium-137, remains a critical environmental challenge following the largest nuclear accidents at Fukushima and Chornobyl. This research utilizes a novel charcoal-ceramic composite sorbent derived from Japanese cedar and cypress sawdust modified with ceramic components to efficiently reduce the volume of radioactive liquid waste. Batch sorption experiments were conducted to optimize process parameters. The material demonstrated robust selectivity in complex matrices and maintained performance within an optimal pH window of 6–8. The sorption behavior was well described by the Langmuir isotherm and the pseudo-second-order kinetic model, indicating chemisorption on a monolayer surface. Validation experiments using actual radioactive wastewater from *Suzuuchi* Pond (Fukushima) achieved ～99 % removal of Cs-137. The proposed mechanism involves a combination of ion exchange, electrostatic interaction, and surface complexation. Future work will focus on scaling up to continuous column-flow systems and conducting Life Cycle Assessments (LCAs).

Keywords：cesium-137, charcoal-ceramic composite, volume reduction, leaching, safe disposal

P-43

Wildfires oppositely modify radiocesium speciation in forest litter and soils：evidence from radiologically contaminated areas in Fukushima

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Wildfires in radiologically contaminated areas have raised concerns about radionuclide redistribution and increased radiation exposure. Most radionuclides, such as radiocesium (^{137}Cs), remain in the charred residues and burned soil even after wildfires. This study investigated the impact of wildfires on ^{137}Cs speciation in forest litter and soils following the Fukushima nuclear disaster. Extraction tests of ^{137}Cs from unburned litter and soil artificially combusted at 250, 375, and 500 ℃ were conducted. ^{137}Cs leaching from charred residues and burned soil collected from the field after the wildfires was tested. Sequential extraction was performed on soil obtained after the fire. The results indicated that water-soluble ^{137}Cs from burned litter increased with combustion temperature. However, in artificially combusted soil, the release of water-soluble ^{137}Cs was significantly reduced. In the field, ^{137}Cs leaching from charred residues was lower than that from unburned litter. The fraction of water-soluble ^{137}Cs in burned soil did not differ significantly from that in unburned soil. This suggests that the combustion temperature was relatively low and insufficient to promote significant leaching or soil drying. Furthermore, the combustion of soil organic matter may have altered the exchangeable form of ^{137}Cs. Overall, these findings suggest that wildfires enhance ^{137}Cs retention in soil, potentially delaying its release.

Keywords：wildfire, radionuclides, radioactive contamination

放射能汚染地域における森林火災が森林リターおよび土壌中の放射性セシウムの化学形態を変化させる

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放射能汚染地域における山火事は、放射性核種の再分布と放射線被ばく量の増加に関する懸念を引き起こしている。本研究では、福島原発事故後の森林落葉層および土壌における^{137}Csの形態別分布に対する山火事の影響を調査した。未燃焼落葉層および土壌を250、375、500℃で人工燃焼させ^{137}Csの抽出試験を実施した。山火事後に現地で採取した炭化残渣および燃焼土壌に対して^{137}Csの溶出試験を行った。炭化残渣からの水溶性^{137}Csは燃焼温度の上昇に伴い増加した。しかし、燃焼土壌では水溶性^{137}Csの割合が著しく減少した。現地で採取された炭化残渣からの^{137}Cs浸出量は未焼損落葉よりも低かった。焼土壌中の水溶性^{137}Csの割合は未焼土壌と有意差を示さなかった。これは燃焼温度が比較的低く、著しい浸出や土壌乾燥を促進するには不十分であったことを示唆する。さらに、土壌有機物の燃焼が^{137}Csの交換性形態を変化させた可能性がある。総合的に、これらの知見は山火事が土壌中の^{137}Cs保持を促進し、その放出を遅延させる可能性を示唆している。

キーワード：林野火災、放射性核種、放射能汚染

P-44

Lithium enrichment in high radiogenic geothermal systems originating from lithospheric water due to water-rock interactions

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Hot springs with radiogenic activity and high lithium enrichment have an important role in storing energy extracted from geothermal water. In Bangka Island, Indonesia, such springs occur in a non-volcanic region, prompting this study to investigate the mechanism of lithium enrichment in radiogenic hot springs, with a focus on the influence of water-rock interactions. The results show that the hot springs are classified into three categories : geothermal hot spring water systems with a predominance of sodium-carbonate water (Pemali, Terak, Keretak, and Nyelanding), with a high contribution of meteoric water; a predominance of sodium chloride water (Dendang) and sodium chloride water (Permis), where the high lithium enrichment comes from lithospheric water due to the interaction between water and rock, with the influence of seawater. Reservoir temperature estimation using quartz (63–89℃) and multicomponent geothermometers (88–111 ℃) reveal distinct reservoir depths and fluid origins. Our findings confirm that Dendang hot springs originate from older hydrothermal reservoirs with lithospheric water enriched in lithium through water-rock interactions. In contrast, Permis hot spring is influenced by shallow aquifers with seawater intrusion and heated by reservoirs at shallow depths, contributing to lithium enrichment. These findings highlight the potential of radiogenic hot springs in non-volcanic regions as unconventional sources of lithium, contributing to the development of energy storage solutions and advancing the utilization of geothermal resources.

Keywords : lithium, lithospheric water, radiogenic geothermal, water-rock interaction, hot springs

P-45

Long-term decline of ^{137}Cs apparent distribution coefficient K_d in Fukushima water bodies as a result of CsMPs decomposition

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The apparent distribution coefficient K_d of Fukushima-derived radiocesium, as shown in previous studies, is declining with time, which is unusual and unexpected, and was never observed for Chornobyl, PA "Mayak" contaminated area or nuclear weapon's tests derived radiocesium. Typically, K_d slightly increases in the initial period after an accident due to radiocesium fixation by micaceous clay minerals, and thereafter the mean annual K_d value becomes more or less constant. We hypothesize that the long-term decline in the K_d of Fukushima-origin radiocesium in freshwaters can be due to the slow decomposition of glassy hot particles (CsMPs), leading to radiocesium leaching. The goals of this work are：1) to suggest a process-level model of ^{137}Cs species transformation in water bodies with allowance for ^{137}Cs leaching from CsMPs; 2) to test the proposed model using available data on Okuma ponds in the close vicinity to the FDNPP and Abukuma River; and 3) to estimate the critical model parameters such as the equilibrium distribution coefficient Kd^{∞}; initial fraction of CsMPs in deposition α, and rate constant of radiocesium leaching from CsMPs k_l for the water bodies under study. Since ^{137}Cs incorporated in CsMPs is not involved in exchange with the solution, the solid-liquid equilibrium is established only for the mobile fraction of ^{137}Cs in deposition. With time, after all, CsMPs decompose even though very slowly, and radiocesium is leaching from CsMPs, resulting in the reestablishment of quasi-equilibrium. Accordingly, the fraction of dissolved ^{137}Cs increases, and the apparent K_d decreases. Using observational data on K_d decline, the rate constant for radiocesium leaching from CsMPs has been estimated using a simplified approach. Because CsMPs decomposition in the soil-water environment is very slow, the rate constant for ^{137}Cs leaching from CsMPs has been estimated to range from 0.02 to 0.03 year^{-1} in Okuma ponds and the Abukuma River, and it appears comparable to the rate constant for ^{137}Cs radioactive decay. Note that the long-term decline of ^{137}Cs apparent distribution coefficient K_d occurs at locations where the fraction of CsMPs in deposition $\alpha > 50\%$, with their influence being insignificant elsewhere. A slower decline in K_d (^{137}Cs) in the Abukuma River, compared to Okuma ponds, is supposedly not associated with slower CsMPs decomposition but, most likely, can be explained by a lower CsMPs fraction deposition on the Abukuma River catchment.

Keywords：Fukushima, radiocesium, apparent distribution coefficient, Cs microparticles, ponds, Abukuma River

P-46

Understanding the implications of competitive ions on the leachability of radiocesium from removed soil

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Millions of cubic meters of soil contaminated by fallout radionuclides were removed through decontamination in Fukushima after the 2011 Fukushima Daiichi Nuclear Power Plant accident. Soil minerals adsorb radiocesium (rCS). When K^+ and $NH4^+$ ions are in soil pore water, they compete with Cs^+ for adsorption sites because their hydrated radii are similar to that of Cs^+ (0.33nm). The Japanese Government plans to recycle 75% of the removed soil contaminated with rCs, at levels of 8,000 Bq/kg or lower, into public works, such as embankments. To ensure human safety against exposure to rCs from road embankment constructed with removed soil, it is important to quantitatively evaluate the impact of coexisting ions on the leachability of rCs from removed soil. Leaching experiments using KCl and NH_4Cl solutions were conducted on two soils in Fukushima to examine the effects of K^+ and $NH4^+$ on rCs leaching behavior. Results showed $K^+/NH4^+$ affects rCs leaching when its concentration exceeds 10^{-3} M. The rCs leaching ratio was below 1% and approached zero as KCl and NH_4Cl concentration fell below 10^{-3} M. Thus, negligible rCs leaching is expected from road embankment constructed with removed soil if $K^+/NH4^+$ concentration is within 10^{-3} M.

Keywords：removed soil, leaching, radiocesium, ammonium, potassium

P-47

Comparison of activity concentration of Sr-90 in seawater, sediment and fish samples between the South China Sea - Vietnam and Fukushima Prefecture - Japan

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In this research, investigations were conducted to determine the activity concentrations of Sr-90 in seawater, marine sediments, and fish collected from various sites in the South China Sea, Vietnam. The Sr-90 activity concentrations measured in the South China Sea are much lower than those reported for coastal waters off Fukushima Prefecture following the 2011 nuclear accident and are consistent with global fallout background levels. This comparison indicates no detectable influence of Fukushima-derived Sr-90 in the study area, with the observed distributions mainly controlled by conservative marine behavior and long-term atmospheric deposition. The activity concentrations of Sr-90 were measured in surface seawater, sediments, and fish collected from Ninh Thuan, Phu Quy, Vung Tau, and Phu Quoc in the South China Sea, Vietnam, in 2025. The Sr-90 activity concentrations ranged from 0.99 to 1.18 mBq/L in seawater, from 0.44 to 0.53 Bq/kg dry weight in sediments, and from <0.03 to 0.04 Bq/kg fresh weight in fish. These results are consistent with the ranges reported in previous studies conducted in Vietnam. Pearson correlation analysis shows that Sr-90 activity concentrations in seawater exhibit moderate negative correlations with pH ($r = -0.67$) and electrical conductance ($r = -0.53$); however, these relationships are not statistically significant ($p > 0.05$). The absence of significant correlations with salinity and other physicochemical parameters suggests that Sr-90 behaves largely conservatively in the marine environment, with its distribution primarily reflecting background inputs from global atmospheric fallout rather than being controlled by local seawater chemistry. In addition, correlations between Sr-90 activity concentrations and organic carbon content in sediments were examined, revealing a weak relationship, suggesting a limited influence of organic matter on Sr-90 accumulation.

Keywords：removed soil, leaching, radiocesium, ammonium, potassium

P-48

Radiation risk perception of science students in the US and Japan

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On April 2021, the Government of Japan announced its intention to discharge the Advanced Liquid Processing System (ALPS)-treated water from the Fukushima Daiichi Nuclear Power Plant (FDNPP) site starting in August 2023, prompting East Asian countries to impose restrictions on the Tohoku region seafood imports, exaggerating the risks from tritium (H-3) and other discharged radionuclides (Anderson et al., 2025). This study addresses the issue of exaggerating risks by combining social science survey methods with a reliable assessment of risk associated with radionuclides to evaluate science students' understanding of the actual seafood consumption risks due to on-going ALPS-treated water discharge. In our study, we utilized simulated H-3 values (Cauquoin et al., 2025) and the Linear No-Threshold model 5.5% increase in risk of mortality from solid cancer per 1 Sv radiation exposure (ICRP, 2007) to compare the additional health risk with the risks from consumption of Fukushima rice and fruits after the FDNPP accident (FASSAP, 2025). From November 17 to December 10, 2025, an online survey was conducted using Google Form with 30 multiple-choice, Yes/No and open-ended type questions in both Japanese and English among 82 Tokyo University of Science and 10 Colorado State University students. In case of Japanese students, the online survey was followed by an invited lecture that provided a detailed explanation of the correct answers. As a result of applying these combined methods, we gained the insights from young-adult age groups on the better methods for bridging knowledge gaps regarding the perception of health risks and the interpretation of factors related to disaster risks and recovery efforts. In summary, this pilot study may become a catalyst initiating scientific curiosity among Japanese and foreign university students by giving them a role of science ambassadors in risk communication.

Keywords：natural and artificial radioactivity, tritium, risk perception, food safety

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Development of a portable monitoring system for short-term variations of atmospheric HTO

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Advanced environmental monitoring of radionuclides is essential for the peaceful use of nuclear energy resources. Following the 2011 Fukushima Daiichi Nuclear Power Plant accident, many studies have assessed the environmental impact of radiocaesium and, more recently, tritium released into the ocean. However, terrestrial tritium monitoring remains limited, which hinders comprehensive impact evaluation. This study focuses on the atmospheric transport of tritiated water (HTO), the fastest pathway for tritium to reach terrestrial organisms. A key challenge is the lack of atmospheric HTO monitoring systems that operate without the need for commercial power. To address this issue, we developed a portable sampling system to capture short-term variations in atmospheric HTO concentrations. Unlike conventional long-term systems, this device offers enhanced insights into short-term HTO dynamics. Preliminary field measurements near Fukushima, along with monthly conventional monitoring of atmospheric and precipitation HTO, confirmed the stable operation of portable batteries. The observed atmospheric HTO levels were slightly above the recent Japanese background but within historical ranges. Importantly, the system detected short-term fluctuations that were undetectable by monthly monitoring, demonstrating its effectiveness in assessing the environmental impact of tritium near its source.

Keywords：tritiated water vapor, portable system

大気中HTOの短期変動モニタリングのための可搬型観測システム開発

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放射性核種の高度な環境モニタリングは、原子力エネルギーの平和利用に不可欠である。2011年の福島第一原子力発電所事故以降、放射性セシウムの環境影響や、近年では海洋へ放出されたトリチウムの影響について多くの研究が行われてきた。しかし、陸域におけるトリチウムのモニタリングは依然として限られており、包括的な環境影響評価の妨げとなっている。本研究では、トリチウムが陸上生物に到達する最も迅速な経路である大気輸送に着目した。そこで、大気水蒸気中トリチウム(HTO)濃度の短期的変動を把握することを目的として、可搬型の観測システムを開発した。本装置は、従来の長期モニタリングシステムとは異なり、大気中HTO濃度の短時間スケールでの変動を観測可能とするものである。福島における試験的な現地観測の結果、月平均値に基づく従来のモニタリングでは検出できなかった短期的な時間変動を捉えることができた。

キーワード：大気水蒸気中トリチウム、可搬型観測システム

P-50

Oceanic behavior of anthropogenic radionuclides as potential climate change tracers

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We examine the use of the anthropogenic radionuclide ^{137}Cs to evaluate how differences in external forcing associated with climate variability affect ocean circulation. ^{137}Cs originates predominantly from atmospheric nuclear weapons testing and was supplied pulse-like to the ocean surface in the early 1960s, with only minor additional inputs thereafter, making it an effective tracer of advection–diffusion processes. Using the ocean circulation model CESM2-POP2, simulations were conducted under two forcing conditions： a climatological forcing（NYF） and a forcing including interannual variability（GIAF）. The differences between these simulations were analyzed to extract decadal-scale circulation responses. The results indicate that regions such as the surface North Pacific and the intermediate to deep North Atlantic are particularly sensitive to changes in external forcing, demonstrating that ^{137}Cs is a useful tracer for detecting climate-driven changes in ocean dynamics.

Keywords：climate change, tracer, ^{137}Cs

気候変動の潜在的トレーサーとしての人為起源放射性核種の海洋挙動

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気候変動の潜在的トレーサーとしての利用可能性を調べるため、人為起源放射性核種^{137}Csを用いて、気候変動に伴う外部強制力の違いが海洋循環に与える影響を評価した。^{137}Csは主に大気圏核実験由来で、1960年代初頭にパルス的に海洋表層へ供給された後、追加供給が小さいため、移流拡散過程を反映する有効なトレーサーとなる。海洋循環モデルCESM2-POP2を用い、平年場外部強制（NYF）と年々変動を含む外部強制（GIAF）の２条件で計算を行い、その差分から10年規模の循環応答を抽出した。その結果、北太平洋表層や北大西洋中深層など、外部強制力の変化に敏感な海域が特定され、^{137}Csが気候変動に伴う海洋動態変化の検出に有効であることが示された。

キーワード：気候変動、トレーサー、^{137}Cs

P-51

Variability of radiocesium concentrations in seawater in the coastal waters of Aomori Prefecture

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Radiocesium (Cs-137) released by the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident in March 2011 has been widely detected across the North Pacific. Most observed concentrations have been recognized as pre-accident levels. Nevertheless, approximately 15 years after the accident, radiocesium concentrations in waters surrounding Fukushima remain higher than in other regions. Studies addressing the spatial extent of its influence are still limited. In terms of the operation of the reprocessing facility in Rokkasho Village, Aomori Prefecture, it is important to understand the background (BG) levels of radiocesium in surrounding coastal water before the planned releases.
In this study, seawater samples were collected along a latitudinal transect extending from the Aomori region to the Fukushima and the Ibaraki regions. Radiocesium concentrations in seawater samples were measured to assess the spatial extent of the influence of the FDNPP accident, and identify BG levels in the Aomori region.
Radiocesium concentrations in the Fukushima region were higher than those in other regions; however, it decreased rapidly with distance from the FDNPP, suggesting that the impact of accident-derived cesium is small. Radiocesium concentrations in the Aomori region, as BG levels, were comparable to concentrations observed in other regions.

Keywords：Fukushima Daiichi Nuclear Power Plant, radiocesium, ocean

青森県海域における海水中の放射性セシウム濃度変動について

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2011年３月に発生した福島第一原子力発電所(FDNPP)事故により放出された放射性セシウム(Cs-137)は北太平洋で広域に観測されているが、そのほとんどは事故前の濃度レベルであることが分かってきた。しかし、事故から約15年が経過した現在、福島を中心とした海域では未だに放射性セシウム濃度が他の海域と比較して高いことが分かっているものの、その影響範囲に関する研究は限られている。一方で、青森県六ケ所村の再処理施設稼働を見据え、管理放出前の周辺海域における放射性セシウムのバックグラウンド(BG)を把握することも重要である。
本研究では、青森海域から福島海域、茨城海域にかけて縦断的な採水を行い、海水中の放射性セシウム濃度を測定し、濃度分布の空間変動、FDNPP事故の影響範囲の評価、ならびに青森海域における管理放出前のBGの特定を行った。
福島海域では他の海域と比べて放射性セシウム濃度が高いことが認められたが、FDNPPから離れるにつれて急激に低下しており、事故由来の影響は局所的であることが示唆された。一方、管理放出前のBGとして、青森海域の放射性セシウム濃度は大きな年変動もなく、また同時期に観測した他海域と同レベルであった。

キーワード：福島第一原子力発電所、放射性セシウム、海洋

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Verification of the spatial distribution reproducibility of Rn-222 and decay products in East Asia

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Atmospheric transport models are effective for assessing the impact of the atmospheric dispersion of radioactive materials following a nuclear accident, but validation with observational data is essential to ensure accuracy. Rn-222, with a half-life of 3.82 days, originates from land and has a time scale comparable to synoptic-scale phenomena, making it a suitable tracer for model validation. SCALE, developed by RIKEN, is capable of calculations ranging from low resolution to ultra-high resolution on the order of O(10 m), enabling detailed discussion of radon transport associated with atmospheric phenomena. However, validation of the Rn-222 transport process using SCALE has been insufficient. Therefore, in this study, we analyzed the spatial distribution of Rn-222 and its decay products using numerical simulations and observational data, with the aim of verifying the reproducibility of SCALE. Concentrations were calculated using the regional meteorological model SCALE-RM. The calculations were performed from August 22 to November 30, 2021, using Schery and Wasiolek (1998) for the Rn-222 exhalation rate, with a horizontal resolution of 30 km (400 × 300 grids) and 52 vertical layers. Rn-222 concentrations at Fukushima Airport and Wakasa Heliport were used as observations. The diurnal cycle of variation observed in the observations at both locations was successfully reproduced by the calculations. The use of aircraft monitoring observations was considered to verify the reproducibility of the vertical distribution.

Keywords：Rn-222, atmospheric transport model

東アジア域におけるRn-222と壊変生成物の空間分布再現性の検証

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原発事故に伴う放射性物質の大気拡散の影響評価には大気輸送モデルが有効であるが、精度の担保には観測データによる検証が不可欠である。半減期3.82日のRn-222は陸域起源で総観規模現象と同程度の時間スケールを持ち、モデル検証に適したトレーサーである。理化学研究所が開発しているSCALEは低解像度からO(10m)程度の超高解像度な計算が可能であり、大気現象に伴うラドンの輸送を詳細に議論できるが、SCALEを用いたRn-222輸送過程の検証は十分でない。そこで本研究では、数値計算と観測値を用いてRn-222および壊変生成物の空間分布を解析し、SCALEの再現性検証を目的とした。本研究では領域気象モデルSCALE-RMを用い、濃度を計算した。Rn-222散逸率にはSchery and Wasiolek(1998)を与え、2021年８月22日～11月30日を対象に、水平解像度30 km(400×300格子)、鉛直52層で計算した。観測値には福島空港および若狭ヘリポートのRn-222濃度を用いた。両地点において観測値でみられた日変動周期を計算でも再現することができた。鉛直分布の再現性の検証のために航空機モニタリング観測値の利用を検討した。

キーワード：Rn-222、大気輸送モデル


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