2. Young Faculty Members for International Joint Research

No.	Name	Project Title
2-1	**Takahiro Hosono**	Coseismic hydro-environmental changes after the 2016 Kumamoto earthquake
2-2	**Kei Ishida**	Development of Hybrid Downscaling Method of Future Climate Projections
2-3	**Mizue Munekata**	Development and Application of Simultaneous Measurement Technique of Pressure and Temperature by Luminescent Paint Using Modulated Excitation Light
2-4	**Yuta Nakashima**	Bio-sensing and bio-imaging for cellular behavior

No.2-1	Coseismic hydro-environmental changes after the 2016 Kumamoto earthquake		
Name	Takahiro Hosono		
Affiliation	Faculty of Advanced Science and Technology Email: hosono@kumamoto-u.ac.jp	Title	Professor
Research Field	Environmental Science		
Period of Travel	―		
Host Researcher	Dr. Michael Manga		
Affiliation	Department of Earth and Planetary Science, University of California, Berkeley	Title	Professor

1. Overview and significance of the international research collaboration

I made two major international research collaborations during 2021. One is the field survey in Iceland with research meeting with Prof. Dr. Sigurdur Reynir Gislason in Institute of Earth Sciences, Askja, University. The other is writing international papers with a topic shown in the title under continuous collaboration with international team. Both collaboration research achieved very good results.

2. Research achievements and progress of the international joint research

1.1. Field survey in Iceland

To understand volcano-tectonic influence on surface hydrochemical signatures, water sampling was conducted along round-trip survey in Iceland (Fig. 1) during August and September 2021 for one month. I successfully sampled many different kind of water samples such as stream waters, groundwaters, spring waters and geothermal fluids (Figs. 2 and 3) and brought them back to Japan for subsequent analysis. During my stay in Iceland I met Prof. Dr. Sigurdur Reynir Gislason, who is famous scientist widely known as one of pioneers of Carbfix project (Fig. 4), to have discussion about water-rock interactions and associated carbon fixation processes and their impact in hydrochemical evolutions. All these activities are financially supported and performed in a framework proposed by JSPS Fostering Joint International Research (A) (2020-2023, 19KK0291).

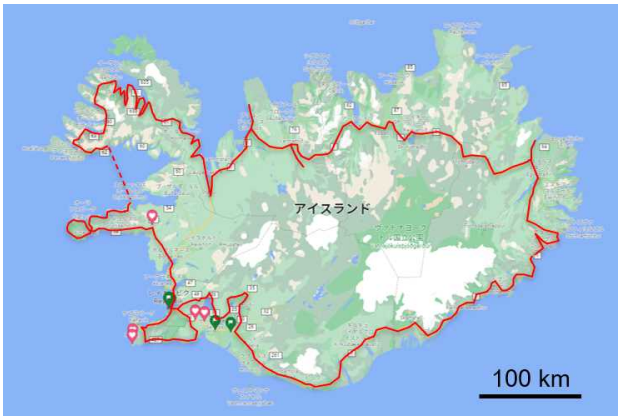


Fig. 1 Tracking route of field survey

Fig. 2 Water sampling from hot spring cave

Fig. 3 Water sampling in river

Fig. 4 Meeting with Prof. Sigurdur R. Gislason

1.2. Journal paper writing

In last year I have delivered Journal Special Issue 'Coseismic hydro-environmental changes: Insights from recent earthquakes' in the Journal of Hydrology as a head editor editing 23 papers submitted from various countries with a help of international team including Department of Earth and Planetary Science, University of California, Berkeley. I still continued writing a rest of paper for publication on separated journals such as Tanimizu et al. (2021) which we could not included in journal special issue. We successfully completed the work.

Aizawa, M., Mizota, C., **Hosono, T.**, Shinjo, R., Furukawa, Y., Nobori, Y., 2022. Lead isotopic characteristics of gun bullets prevailed during the 19th century in Japan: Constraints on the provenance of lead source from the United Kingdom and Japan. Journal of Archaeological Science: Reports, 41, 103268. https://doi.org/10.1016/j.jasrep.2021.103268

Hosono, T., Yamanaka, C., 2021. Origins and pathways of deeply derived carbon and fluids observed in hot spring waters from non-active volcanic fields, western Kumamoto, Japan. Earth, Planets and Space, 155, 73. https://doi.org/10.1186/s40623-021-01478-1

Mizota, C., Hansen, R., **Hosono, T.**, Okumura, A., 2022. Museum-archived and recent acquisition nitrates from the Atacama Desert, Chile, South America: refinement of the dual isotopic compositions ($\delta^{15}N$ vs. $\delta^{18}O$). Isotopes in Environmental and Health Studies, 58, 1-17. https://doi.org/10.1080/10256016.2021.1990913

Rahman, A.T.M.S., **Hosono, T.**, Tawara, Y., Fukuoka, U., Hazart, A., Shimada, J., 2021. Multiple-tracers-aided surface-subsurface hydrological modeling for detailed characterization of regional catchment water dynamics in Kumamoto area, southern Japan. Hydrogeology Journal, 29, 1885-1904. https://doi.org/10.1007/s10040-021-02354-8

Romero-Mujalli, G., Hartmann, J., **Hosono, T.**, Louvat, P., Okamura, K., Delmelle, P., Amann, T., Böttcher, M.E., 2022. Hydrothermal and magmatic contributions to surface waters in the Aso caldera, southern Japan: Implications for weathering processes in volcanic areas. Chemical Geology, 588, 120612. https://doi.org/10.1016/j.chemgeo.2021.120612

Tanimizu, M., Sugimoto, N., **Hosono, T.**, Kuribayashi, C., Morimoto, T., Ito, A., Umam, R., Nishio, Y., Nagaishi, K., Ishikawa, T., 2021. Application of B and Li isotope systematics for detecting chemical disturbance in groundwater associated with large shallow inland earthquakes in Kumamoto, Japan. Geochemical Journal, 55, 241-250. https://doi.org/10.2343/geochemj.2.0633

3. Prospect for further research collaboration with the visited university/institution

I am planning to make a short research stay at University of Rome, Italy during June and September in 2022, with a financial support from JSPS Fostering Joint International Research (A) (2020-2023, 19KK0291). We are planning to make a research collaboration including

seminar presentation and field survey that hopefully generate co-authoring papers.

5. List of journal papers (with IROAST affiliation) published between April 2021 and March 2022.

Shown above.

5. List of Awards, Grants, and Patents received between April 2021 and March 2022.

Awards
T. Hosono, 2020 IROAST Research Awards, 22 June 2021

Grants
T. Hosono, JSPS Fostering Joint International Research (A), 2020-2023, 19KK0291

Financial support from IROAST
T. Hosono, IROAST Research Awards, 500,000 JPY
T. Hosono, Research Support for Young Faculty Member for International Joint Research, 2,000,000 JPY

I appreciate very much for these two financial supports from IROAST. These supports were definitely efficient to promote field survey and to maintain laboratory equipment to enhance research activities using analytical machines including ion chromatography and isotope ratios mass spectrometry.

No.2-2	Development of Hybrid Downscaling Method of Future Climate Projections		
Name	Kei Ishida		
Affiliation	Center for Water Cycle, Marine Environment and Disaster Management, Kumamoto University（CWMD） Email: keiishida@kumamoto-u.ac.jp	Title	Associate Professor
Research Field	Environmental Science		
Period of Travel	―		
Host Researcher	Ali Ercan		
Affiliation	University of California, Davis	Title	Assistant Research Professor

1. Overview and significance of the international research collaboration

Climate change is a large concern in many countries in the world now. To investigate impacts of climate change, future climate projections are used. Future climate projections are basically simulated results by means of general circulation models based on future climate scenarios. However, the resolutions of future climate projections are generally too coarse for regional-scale analysis. Therefore, downscaling technique is frequently utilized to obtain the projections at a finer resolution. There are mainly two types of downscaling techniques: Dynamical downscaling and statistical downscaling. Both of them have pros and cons. Therefore, hybrid downscaling technique, which is combined approach of dynamical and statistical downscaling, is sometimes utilized. In this international joint research, we will develop a new hybrid downscaling technique to improve estimations of climate change impacts at regional-scale.

2. Research achievements and progress of the international joint research

We developed a new hybrid downscaling technique improve the accuracy of precipitation estimates at a regional scale. First, we conducted dynamical downscale by means of a regional atmospheric model. Then, we applied statistical downscaling using the convolutional neural network (CNN). The precipitation estimates obtained by the hybrid downscaling saucerful improved the accuracy of precipitation at the target area. We wrote an academic paper based on the results. The academic paper was published in an international journal, Journal of Hydrology: Regional Studies.

3. Prospect for further research collaboration with the visited university/institution

We will continue this international research collaboration. We could not have meeting in person for last two years due to COVID-19. However, we hope that we can have a meeting in person in the near future. Meanwhile, we will continue to have online meetings. Then, we will keep this collaboration to improve the hybrid downscaling technique further.

4. List of journal papers (with IROAST as your affiliation) published between April 2021 and March 2022.

Kei Ishida, Masato Kiyama, Ali Ercan, Motoki Amagasaki, Tongbi Tu, "Multi-time-scale input approaches for hourly-scale rainfall–runoff modeling based on recurrent neural networks" Journal of Hydroinformatics 23(6), 1312–1324.
https://doi.org/10.2166/hydro.2021.095

Kazuki Yokoo, Kei Ishida*, Ali Ercan, Tongbi Tu, Takeyoshi Nagasato, Masato Kiyama, Motoki

Amagasaki, “Capabilities of deep learning models on learning physical relationships: Case of rainfall-runoff modeling with LSTM”, Science of The Total Environment, 802, 149876, 2022. https://doi.org/10.1016/j.scitotenv.2021.149876 (*corresponding)

5. List of Awards, Grants, and Patents received between April 2021 and March 2022.

Awards

Intelligence, Informatics and Infrastructure Outstanding Potential Paper Award (2021)
Subcommittee on AI Application in Structural Engineering
November 29, 2021

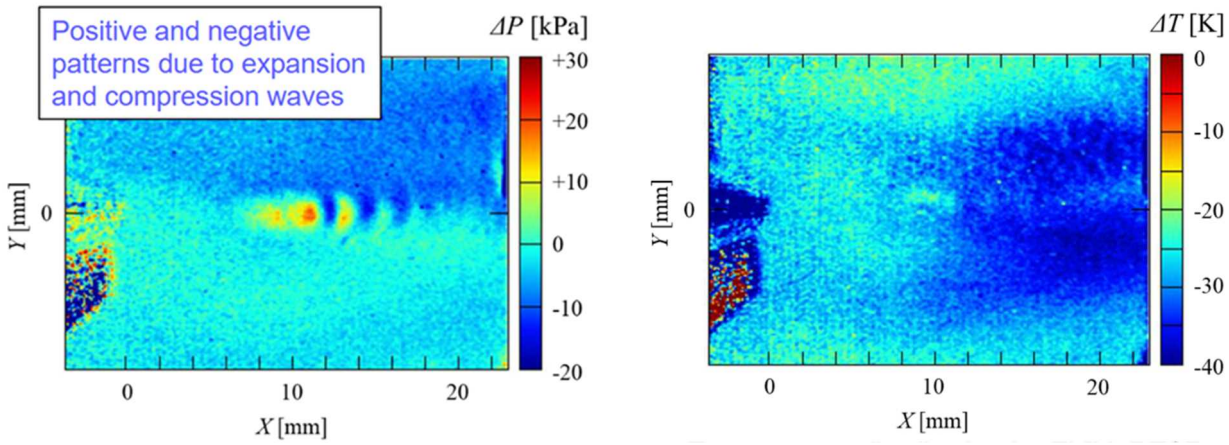
No.2-3	Development and Application of Simultaneous Measurement Technique of Pressure and Temperature by Luminescent Paint Using Modulated Excitation Light		
Name	Mizue Munekata		
Affiliation	Faculty of Advanced Science and Technology Email: munekata@kumamoto-u.ac.jp	Title	Associate Professor
Research Field	Green Energy/ Environmental Science		
Period of Travel	None		
Host Researcher	Christian Klein		
Affiliation	German Aerospace Center Institute of Aerodynamics and Flow Technology	Title	Team Leader TSP/PSP

Pressure Sensitive Paint (PSP) measurement technique is based on the dependence of the intensity or decay time of its luminescence on pressure, brought about by oxygen quenching. PSP is usually exited by light at an appropriate wavelength (e.g. UV-Light) and its pressure dependent luminescence intensity or lifetime is detected by a camera system (CCD or CMOS). In the method based on the luminescent lifetime, two basic types of measurement exist: The first type is the time-domain lifetime method, which is mostly used in various PSP applications. For this method a pulsed light is used to excite the paint and the pressure dependent time constant is determined from decay curve of luminescence intensity. The second type is the frequency-domain fluorescence lifetime imaging (FLIM) where modulated light is used to excite the paint and the PSP luminescence is simultaneously detected to calculate pressure dependent phase shift or amplitude. Only few applications were reported using this method.

Recently, a new CMOS image sensor has been developed by CSEM and PCO for frequency-domain FLIM system and equipped in the pco.flim camera for fluorescence lifetime imaging in microscopy. In this study, the frequency-domain lifetime PSP technique (FLIM-PSP) is investigated using a larger model for industrial applications.

We planned to test the FLIM-PSP technique with the pco.flim camera for industrial models in Germany. However, we could not test it because of COVID-19. Therefore my team in Kumamoto Univ. have developed a new technique with FLIM for measurement of temperature and pressure.

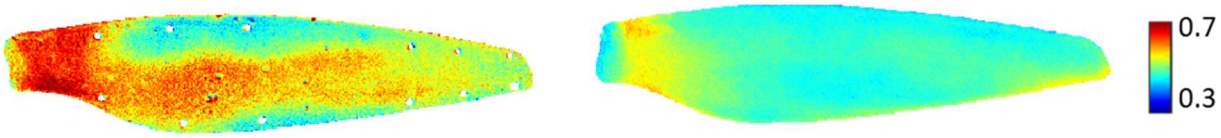
The simultaneous measurement of temperature and pressure with FLIM technique is named FLIM-PTSP. The FLIM-PTSP technique is more effective, because it is the life time method by a high speed camera (CMOS) . We have succeeded in developing and verifying the simultaneous measurement method of pressure distribution and temperature distribution(FLIM-PTSP) by the wall imping jet model[(1)] without using temperature sensor. However, in order to apply it to the industrial model, it is necessary to investigate to further increase the temperature sensitivity and temperature sensitivity. We hope to have collaboration tests using the FLIM camera at DLR in Germany in the near future.



(a) Pressure distribution (b) Temperature distribution

Fig.1 Simultaneous measurement of pressure and temperature by FLIM-PTSP

On the other hand, we tried PSP coating on a 3D model by a 3D automatic coater to coat uniformly. Hand spray is used generally to coat on models. Applying to a uniform thickness requires considerable training. However, by constructing a program for automatically applying by inputting shape information into the operation program of the 3D automatic coater, it was possible to develop a coating method with good reproducibility and to show its effectiveness[(2),(3)]. In the future, we will measure the pressure distribution on the surface of the propeller during drone flight using a propeller coated with PSP paint with the 3D automatic coater, and try to evaluate the pressure distribution characteristics of the drone and develop a highly efficient propeller.



(a) Hand spray (b) 3D automatic coater

Fig.2 Distributions of pressure sensitivity on the propeller surface; The standard deviation of pressure sensitivity is 9.3% for hand spray and 1.9% for 3D automatic coater.

(1) Moriya, T., Tsutsumi, K., Jinwaki, N., Munekata, M., Yoshikawa, H., “A study on pressure and temperature distribution measurement by FLIM technique”, Proceedings of the 49th symposium of visualization, No.058, 2021.
(2) Munekata, M., Kobayashi, Y., Michiuchi, D., Nakatsuma, K., Miyaji, K., Masumoto, K., Yoshikawa, H., “Pressure-sensitive paint coating with 3D automatic coater”, 17th Interdisciplinary Molecular Imaging Forum, P18, 2021.
(3) Nakatsuma, K., Michiuchi, D., Munekata, M., Kobayashi, Y., Miyaji, K., “Coating device and coating method”, Japanese Patent Application No. 2022-007423, January 20, 2022.

No.2-4	Bio-sensing and bio-imaging for cellular behavior		
Name	Yuta Nakashima		
Affiliation	Faculty of Advanced Science and Technology Email: yuta-n@mech.kumamoto-u.ac.jp	Title	Associate Professor
Research Field	Advanced Green Bio		
Period of Travel	―		
Host Researcher	Dr. Douglas A. Coulter Dr. Hajime Takano		
Affiliation	The Children's Hospital of Philadelphia & University of Pennsylvania（UPenn）	Title	Professor Assistant Professor

The objective of this project is to develop the palm-size medical diagnostic devices apply to detection of disease and post-surgical management based by cell behavior. The development of the desired medical devices is need to fundamental technique shown below.

* Microfabrication technique for fabricating cell size and palm-size structure.
* Cell handling technique
* Sensing technique for cell produced signals such as protein, exosome, RNA, etc. on the devices.
* Imaging technique for detecting the morphology, movement, behavior, etc. of cells on the devices.

In my laboratory, microfabrication technique and cell handling technique are already possessed. Host researchers has a lot of knowledges about in vitro and in vivo sensing/detection/imaging techniques for cell and tissue evaluation. We will promote joint research to achieve the objective medical devices by integrating our technologies.

In this season, we discussed how to proceed with our collaborative research through multiple web meeting. While we were able to gain understanding of each other's current status (including COVID-19), further discussion was needed to discuss the study and its details. The inability to discuss while looking at actual equipment and technology was a major obstacle to promoting collaborative research. On the other hand, introduction of measuring instruments, development of sensing technique, and fabrication of microdevices were carried out for preparing the collaborative research. In the next fiscal year, we would like to promote collaborative research overseas to further deepen our research.

List of journal papers

*Corresponding author

[1] Yuta Nakashima*, Mami Akaike, Masaki Kounoura, Keita Hayashi, Kinichi Morita, Yuji Oki, Yoshitaka Nakanishi, “Evaluation of osteoblastic cell behavior upon culture on titanium substrates photo-functionalized by vacuum ultra-violet treatment,” Experimental Cell Research, 410, 112944, 2022.

[2] Yoshitaka Nakanishi, Hajime Yamaguchi, Yusuke Hirata, Yuta Nakashima, Yukio Fujiwara, “Micro-abrasive glass surface for producing microplastics for biological tests,” Wear, 477, 203816, 2021.

[3] Hajime Yamaguchi, Katsunori Higuchi, Koshi Sakata, Tetsuya Akiyama, Keiji Kasamura, Yuta Nakashima, Yoshitaka Nakanishi, “Hydrophilic sealing material for live centers in machine tools,” Wear, 477, 203838, 2021.

[4] Souichiro Fukuyama, Seitaro Kumamoto, Seiya Nagano, Shoma Hitotsuya, Keiichiro Yasuda, Yusuke Kitamura, Masaaki Iwatsuki, Hideo Baba, Toshihiro Ihara, Yoshitaka Nakanishi, and Yuta Nakashima*, "Detection of cancer cells in whole blood using a dynamic deformable microfilter and a nucleic acid aptamer," Talanta, 228, 122239, 2021.

List of books

[1] 中島雄太, "第 14 章　インキュベータ内での培養動物細胞リアルタイムモニタリング," 動物細胞の培養システム～技術と市場～ (監修 : 井上國世), pp. 162-168, 2021. ISBN978-4-7813-1619-2

List of grants

[1] JST FOREST, ¥ 20,000,000-, Apr. 2022 – Mar. 2025. (Principal Investigator)
[2] Gap Funding, 九州・大学発ベンチャー振興会議, ¥ 1,500,000-, 2021. (Principal Investigator)
[3] Research and Development Grants, Fukuoka Financial Group, ¥ 1,500,000-, Dec. 2020 – Mar. 2022. (Principal Investigator)
[4] Gap Funding, Higo Bank, ¥ 5,000,000-, Sep. 2020 – Mar. 2023. (Principal Investigator)
[5] KAKENHI (Grant-in-Aid for Challenging Research (Exploratory)), ¥ 6,370,000-, Apr. 2020 – Mar. 2021. (Principal Investigator)
[6] KAKENHI (Grant-in-Aid for Scientific Research (B)), ¥ 17,420,000-, Apr. 2019 – Mar. 2023. (Principal Investigator)
[7] KAKENHI (Grant-in-Aid for Challenging Research (Exploratory)), ¥ 600,000-, Apr. 2021 – Mar. 2023. (Co-Investigator)
[8] KAKENHI (Grant-in-Aid for Scientific Research (B)), ¥ 1,800,000-, Apr. 2020 – Mar. 2023. (Co-Investigator)
[9] Environmental Restoration and Conservation Agency of Japan, ¥ 9,100,000-, Apr. 2019 – Mar. 2022. (Co-Investigator)
[10] KAKENHI (Fund for the Promotion of Joint International Research (Fostering Joint International Research (B))), ¥ 2,500,000-, Apr. 2019 – Mar. 2025. (Co-Investigator)

List of social contributions

[1] Committee Member
Research for Innovation & Synthesis of Technology in Kumamoto
Jun 23, 2021 – Mar. 31, 2022
[2] Editorial committee
38th Sensorsymposium, IEEJ (The Institute of Electrical Engineers of Japan)
Mar. 23, 2021 – Dec. 31, 2021.
[3] Steering committee
Micro-Nano Science & Technology Division, The Japan Society of Mechanical Engineers
Apr. 14, 2021 – Mar. 31, 2022.
[4] Representative
Micro-Nano Science & Technology Division, The Japan Society of Mechanical Engineers
Apr. 14, 2021 – Mar. 31, 2022.
[5] Advisory board of Doctoral course students
Kyushu University (Graduate School of Information Science and Electrical Engineering)
Jun 12, 2019 – Mar. 31, 2022.

List of patents

[1]発明の名称：導光ユニット、吸光度測定装置、およびインキュベータ

出願番号：特願 2022-007939
出願日：令和 4 年（2022 年）1 月 21 日
発明者：中島雄太
出願人：国立大学法人熊本大学、西川計測株式会社