No. 30 February 2016

International Newsletter

Research Institute for Sustainable Humanosphere, Kyoto University, Japan

=Foreword=

International Research Activities at the RISH in 2015

Professor Junji Sugiyama
Chair of the Academic Exchange Committee of the RISH, Kyoto University

It is with great sadness that we announce the passing of Professor Sanga-Ngoi-Kazadi, who died peacefully several months ago on June 28th, 2015, at the age of 63. As a chairman of the institutional Committee for International Academic Exchange, Professor Sanga-Ngoi-Kazadi was in the lead of activation of memorandum of previously executed cooperation. In addition, as a committee member of the university, he took the initiative in promoting new cooperation between the university and African countries. His death was indeed a great loss not only to our institute but also to our university. On September 26th, 2015, at a gathering in memory of his many achievements, more than 130 participants paid sincere tribute to the late Professor Sanga-Ngoi-Kazadi.

To continue Professor Sanga-Ngoi-Kazadi's work in maintaining a sustainable cooperative relationship with leading universities and networks in Europe, North America, and Asia, we are making efforts to strengthen our cooperation. Specifically, we have extended agreements of cooperation (MOU) between The National Institute of Aeronautics and Space of the Republic of Indonesia (LAPAN) and the Research Center for Biomaterials of the Indonesian Institute of Sciences (LIPI), and plan to execute two new such MOUs, one with the College of Material Science and Engineering of Northeast Forestry University in China, and one with the Faculty of Mathematics and Natural Sciences of Andalas University. With these agreements, the total active MOUs between the RISH and other institutions will number 21 by the end of FY2015.

Nurturing human resources is essential for the promotion of international joint research. Our institute took part in an annual educational event of the Humanosphere Science School (HSS) held in September in Jakarta, Indonesia. We were also involved in the Science and Technology Research Partnership for Sustainable Development (SATREPS) sponsored by the Japanese government, and in the JST program, Strategic International Collaborative Research Program (SICORP), both of which deal with global issues by sharing science and technology among counterparts. This year's visiting professors and scientists were essential in strengthening our international cooperation and provided synergetic and multidisciplinary interaction between staff and students. Last but not least, MU (The middle and upper atmosphere radar) was recognized in the IEEE milestones in Electrical Engineering and Computing. We extend our sincere thanks to all the people involved in these efforts.

=International Activity Report=

Humanosphere Science School - International Symposium for Sustainable Humanosphere (HSS-ISSH) 2015

Professor Mamoru Yamamoto
RISH, Kyoto University

Human activities have a significant impact on the earth, and this impact must be managed in order to ensure the sustainability of this living world. At this stage of human history, the challenges and risks are high, but the opportunities for social and environmental changes are also wide open. RISH is an institute that aims to establish a "science of the humanosphere" to solve these problems. We believe that Asia is a region where many of the problems of the humanosphere are waiting to be solved. RISH has important research collaborators in the Indonesian Institute of Sciences (LIPI) and the National Institute of Aeronautics and Space (LAPAN), with which various collaborative studies are conducted. The Humanosphere Science School (HSS) is the international meeting that RISH, LIPI and LAPAN hold to promote the science of the humanosphere. Before the HSS assumed its current form, we held a "Wood Science School" twice, in 2006 and 2007. The HSS was then founded in 2008. Since 2011, the HSS has participated in the International Symposium for a Sustainable Humanosphere (ISSH), at which young researchers and students can present their research achievements.

This year, HSS-ISSH 2015 was held on September 29–30, 2015, at LIPI in Jakarta, Indonesia. There were about 80 participants from Indonesia and Japan. In addition, one professor was invited from Malaysia. Our special guest was Prof. Takuya Marumoto who is Auditor of Kyoto University. Prof. Marumoto's main research field is agricultural soil science. At the meeting, he presented research on environmental restoration through the use of new technology for the prevention of soil erosion and revegetation in barren areas. He has developed both a mulching sheet (MS; a nonwoven fabric sheet with a three-layer structure) and a green bag (GB) made of the same material as the MS that contains seeds, mineral medium, fertilizer and mycorrhizal fungi. This ecological reforestation technology using MS, GB and mycorrhizal fungi was found to be significantly effective and useful in preventing soil erosion. Prof. Marumoto has already begun to collaborate with Udayana University in Bali to promote this technique in Indonesia.

There were also many interesting presentations by invited speakers at HSS-ISSH 2015. Prof. Chow Yang Lee from Universiti Sains Malaysia (USM) gave an informative lecture on pestology and pest-control techniques. From RISH, Prof. Toshitaka Tsuda, Prof. Mamoru Yamamoto, Dr. Tomoya Imai, and Dr. Kentro Abe attended the meeting and presented their research related to the science of the humanosphere. The HSS-ISSH 2015 was a great success, which we hope to continue next year. We also note that during the meeting, RISH and the Research Center for Biomaterials, LIPI signed an extension of the MOU for the next five years.

Group photo of HSS-ISSH 2015, September 29-30, 2015 at LIPI, Indonesia.

Extension of MOU between RISH and Research Center for Biomaterials, LIPI.

=Overseas Visiting Scholar=

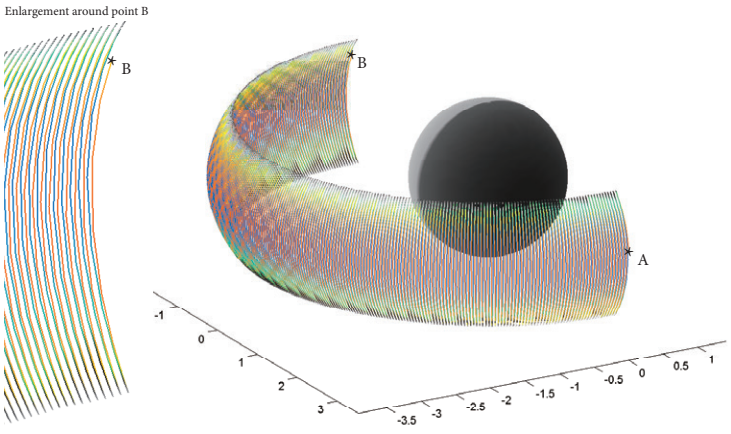
Computing trajectories of charged particles in planetary environments

Senior Research Scientist Gerard Chanteur
Centre National de la Recherche Scientifique

The purpose of my invited stay at RISH from March 1st to May 31st 2015 was to develop simulation tools to investigate the stability of the magnetospheric plasma of planet Mercury with respect to the emission of ion waves in order to make predictions about the types of waves that could be observed, and to prepare the interpretation of observations that will be made by the Plasma Wave Instrument onboard BepiColombo/MMO spacecraft.

Since 2012 we are running a global hybrid simulation programme, that we have developed at LPP and LATMOS, to compute the stationary electromagnetic field around planet Mercury under diverse interplanetary conditions. Such self-consistent electromagnetic fields will be used to move test-particles in order to determine the velocity distribution functions in different locations of the Hermean magnetosphere for given interplanetary conditions. For this purpose a robust numerical scheme is required and a controlled variable timestep would be an advantage in situations where the gyrofrequency of particles can vary by a large factor along their orbits.

A well known and largely used scheme is the one designed by Boris and Buneman more than 40 years ago. It has the simple structure of a leap-frog schema and thus does not allow a continuous adaptation of the timestep. It also involves an elegant and efficient numerical splitting of the accelerations by the electric and magnetic fields. During my visit of last spring I have developed a predictor-corrector schema based on Boris and Buneman's ideas but getting rid of the leap-frog structure to allow a continuous control of the timestep by an original procedure. This new scheme has been tested extensively by computing bounce and drift motion of protons in the terrestrial dipole, with and without the Stern-Volland convection-corotation electric field. The figure shows half of the drift shell of a 100keV proton trapped inside the inner terrestrial magnetosphere for a corotation potential of 90kV and a convection potential of 20kV typical of a very quiet magnetic activity. The color of the curve varies with the velocity of the particle parallel to the magnetic field indicating the bounce motion between its northern and southern mirror points as it drifts around the Earth with an apex varying between 3.5 and 3.7 Earth radii : colors from yellow to red indicate a northward motion of the particle meanwhile colors from green-blue to blue indicate a southward motion. The dark gray hemisphere is the nightside of the Earth.



This new code has been used to do the first simulations of bounce and drift motion of protons in a model magnetic field of planet Mercury consisting of two axisymmetric sources, a dipole and a quadripole, consistent with the recent MESSENGER magnetic data around Mercury. It is now mandatory to do test particle simulations in the stationary and self-consistent electromagnetic field computed by three-dimensional global hybrid simulations. That will be our main line of development in the near future in order to prepare the interpretation of observations that will be made by BepiColombo/MMO.

During my stay I have also given two seminars about planet Mercury at the Computer Science Laboratory of RISH on May 15 and 22nd. The last week of my stay I attended the JpGU annual conference in Tokyo.

I would like to acknowledge the support provided by Kyoto University for this invited stay, and express my sincere thanks to Professors Tsuda and Omura for this invitation to work at RISH in the Computer Science Laboratory. I had stimulating discussions with Professor Y. Omura and his team. I am also grateful to Mrs Nitto for her efficient help during my stay.

=Overseas Visiting Scholar=

Research on topics of public importance

Senior Research Scientist Nanan Balan
University of Sheffield

My stay at RISH, one of the world leading research institutions, as a Visiting Professor for five months in November-March 2014-2015 were pleasant and fruitful thanks to the excellent help and cooperation of my ghost professors (Yoshiharu Omura and Yusuke Ebihara), their students and other professors and staff. This news article gives a brief summary of our research activities which are on topics of importance for the scientific community and general public, such as Severe Space Weather (SvSW) that can cause serious social and economic disturbances in the High-Tech society costing up to 1 to 2 trillion US Dollars, and effects of Cosmic Rays on Climate and Weather.

In our first collaborative paper [*Balan et al., JGR,* 2014] we showed that the impulsive energy at the CME (coronal mass ejection or solar storm) front and orientation of the north-south (Bz) component of the interplanetary magnetic field (IMF) at the CME front determine the severity of space weather. CMEs having high front velocity (ΔV) and IMF Bz southward at the front can cause SvSW at the Earth including all known electric power outages and telegraph system failures such as those during the famous Carrington event of 1859, Finland event of 1958, Quebec event of 1989, New Zealand event of 2001 and Halloween event of 2003. The higher the front velocity (ΔV) the more severe the space weather like faster weather fronts and tsunami fronts causing more severe damages through impulsive action. In a continuation paper [*Balan et al., JGR,* 2015], we show that the product of *ΔV* and *mean Bz* at ΔV can be used for forecasting SvSW, which at present is possible up to 35 minutes in advance. The forecasting time can be extended when V and Bz are measured further ahead of the first Langrangian (L1) point between the Sun and Earth, where the present V and Bz measuring satellite ACE (advanced composition explorer) is located. These studies have also provided a new geomagnetic activity index (mean Dst_{MP}) (Figure 1) which can help in further understanding the science of SvSW.

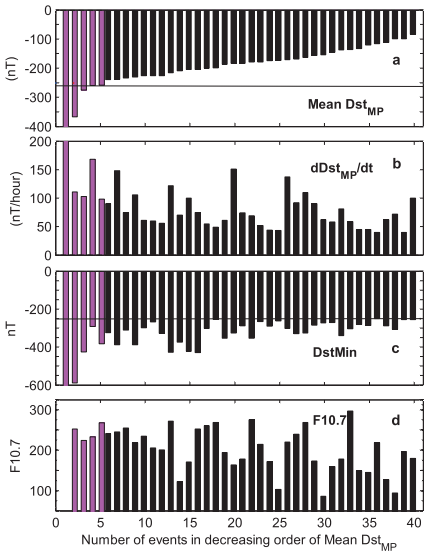


Fig. 1: *Mean* Dst_{MP}, *DstMin*, $dDst_{MP}/dt$ and F10.7 corresponding to the super storms since 1957. Red color indicates SvSW.

In another study carried out with my colleagues in India [*Anilkumar et al., JGR,* 2015] we show that low level cloud formation (at heights < 3 km) and show-fall in Antarctica in 2001-2009 are positively correlated with the intensity of galactic cosmic rays (GCR), with the lowest correlation being at high solar activity (2001) and highest correlation (0.35) at the long deep solar minimum (2007-2009). In another collaborative paper with my colleagues in Taiwan [*Rajesh et al., JGR,* 2015] we investigate the global distribution of the anomalous nighttime enhancements in the mid latitude ionospheric total electron content.

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Anil Kumar, C. P., N. Balan, et al., Effects of cosmic rays on clouds and snow-fall rates in Antarctica, *J. Geophys. Res., Atmospheric,* 2015JD023426, 2015 (under revision).

Rajesh, P. K., J. Y. Liu, N. Balan, C. H. Lin, Y. Y. Sun and S. A. Pulinets, Morphology of mid-latitude electron density enhancement (MEDE) using total electron content, J. *Geophys. Res., 120,* 2015JA021162, 2015, (under revision).

=Oversears Visiting Scholar=

Studies of Mesospheric Gravity Waves with the MU Radar

Research Scientist Dennis Riggin
Global Atmospheric Technologies and Science Inc

Starting in November 2014, I made a 5-month visit to the Research Institute for Sustainable Humanosphere (RISH). I came at the invitation of Prof. Toshitaka Tsuda. We have worked together in the past and I have had the pleasure of visiting RISH several previous times. During my stay I worked in a close-knit group with Prof. Tsuda, Dr. Atsuki Shinbori, and student, Mr. Naoki Matsumoto. The focus of our work was on gravity waves and their effects in the upper atmosphere.

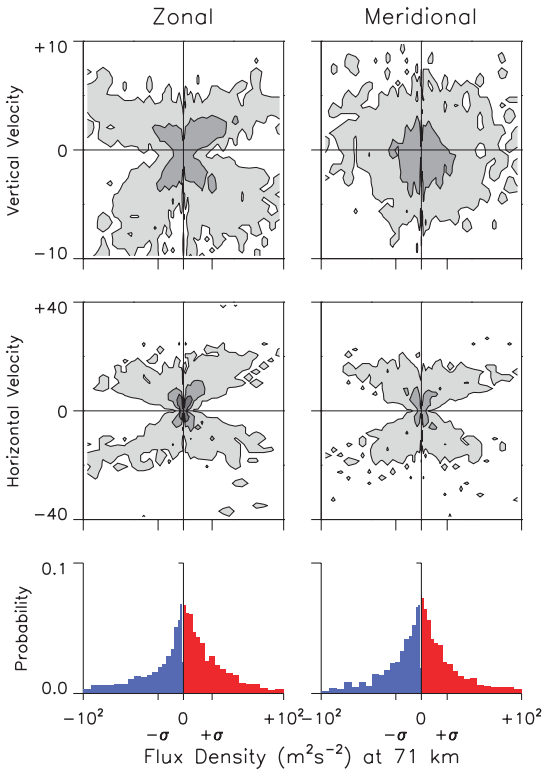
Recently a database has been developed by Kyoto University in cooperation with several other institutions. IUGONET (Inter-university Upper atmosphere Global Observation NETwork) provides a convenient way to access and analyze data from many scientific instruments, particularly in Asia. Data from the MU radar has been compiled over many years in IUGONET to allow comprehensive studies. My own work dealt with gravity wave momentum fluxes. Momentum flux is a mechanism by which momentum can be transported from the lower atmosphere to the mesosphere (above 50 kilometers). In this way, waves are a key factor in driving the mean winds in the upper mesosphere (sometimes called the general circulation). There are only a few radar systems world-wide other than MU that can make this difficult measurement. I looked for ways to understand the wave field, since the momentum flux is comprised of many waves propagating in all directions.

A paper is in preparation looking at the details of the wave distribution. We are interested in the question of what waves contributed to momentum flux. The figure show a probability distribution function of momentum flux from data over 19 days. In the bottom row, the x-axis has values of momentum flux and then blue/red bars show the probability that momentum flux any particular value of momentum flux occurs. The upper panels show the horizontal and vertical velocity perturbations that compose the momentum flux in the bottom panel. This information may be useful for modelers who want to prescribe the gravity wave field in a model. Note that there are both positive (red) propagating waves and negative (blue) propagating wave with near cancellation in the two directions.

In future we hope to publish results showing a multi-year climatology. The MU radar has been operating since 1986 and thus provides one of the longest datasets of this type in existence.

My work along with that of my colleagues was done in collaboration. Dr. Shinbori carried out a climatological study of stratospheric winds and wind variances (high frequency fluctuations). Mr. Matsumoto led a study of gravity wave momentum fluxes using equatorial radars using an innovative analysis technique. His paper has been submitted for publication and is currently under review.

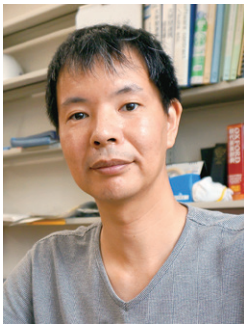
Besides acknowledging my kind host, Prof Tsuda, I must mention the help provided by secretaries, Mrs. Sachiko Shikata, and Mrs. Hiroko Nitto.



=RISH Mission Research Fellow=

Research on solar-terrestrial environmental variation using various kinds of observation database

Dr. Atsuki Shinbori



The earth's atmosphere is divided into four regions, the troposphere, stratosphere, mesosphere, and thermosphere, according to characteristics of temperature variation. The atmosphere above 100 km is known as the upper atmosphere, and various atmospheric phenomena observed in this region are generated by complicated physical processes under the influence of both solar activity and atmospheric waves propagating from the lower atmosphere. Therefore, in order to understand the mechanism of long-term variation in the upper atmosphere, we need to carry out a comprehensive analysis that combines various kinds of observation data obtained from global observation networks. However, since these observation databases are created and maintained in many different universities and institutes, and most observation data are used only in a particular institute or domain, and many data are undisclosed, it is difficult for to effectively find and make use of the various kinds of observation data in order to promote interdisciplinary research. In order to solve these problems, the Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project initiated in 2009 provides a new research platform that enables researchers to share metadata extracted from ground-based observation data, which IUGONET institutes (Tohoku University, National Institute of Polar Research, Nagoya University, Kyoto University and Kyushu University) have been archiving since the International Geophysical Year (1957-1958) (Fig. 1). In addition, IUGONET has developed an analysis software to access and analyze data in an integrated fashion. IUGONET activity has not only led to the establishment of a research platform to better understand global upper atmospheric phenomena, but has also helped to facilitate interdisciplinary research.

In my study, in order to understand the physical mechanism of long-term variation in the upper atmosphere and ionosphere, I investigated the characteristics of long-term variation in the amplitude of geomagnetic solar quiet (Sq) daily variation, utilizing the IUGONET data analysis system. The Sq variation of the geomagnetic field observed on the ground is a regular variation with a fundamental period of 24 h during a solar quiet day, and it depends on the local time, latitude, season, and solar cycle. Since Sq variation is produced primarily by ionospheric currents flowing in the E-region of the ionosphere around 105 km, investigations of the long-term variation in the Sq amplitude are important for understanding the physical mechanisms of long-term variation in the upper atmosphere that are related to solar activity and other effects such as secular variation of the ambient magnetic field. Here, I analyzed 1-h geomagnetic field data obtained by 69 geomagnetic observation stations from 1947 to 2013, and investigated the characteristics of long-term variation of the Sq amplitude. The Sq amplitude at all investigated stations showed a clear dependence on the 10-12 year solar activity cycle and tended to be enhanced during each solar maximum phase. Sq amplitude was the smallest around the minimum solar cycle 23/24 in 2008-2009. This phenomenon can be interpreted as a significant decrease in ionospheric conductivity due to the significant reduction in solar extreme ultraviolet (EUV) radiation, which is responsible for the formation of the ionosphere. In order to remove the effect of solar activity seen in long-term variation in Sq amplitude, I calculated a linear or second-order fitting curve between the solar F10.7 index and Sq amplitude during the 1947-2013 period, and ex-

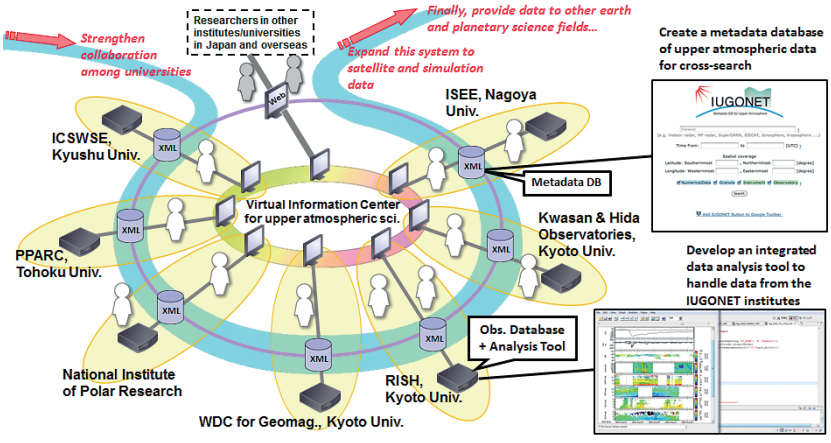


Figure 1. Schematic view of the IUGONET project.

amined the residual Sq amplitude, which is defined as deviation from the fitting curve, finding that the majority of trends in the residual Sq amplitude showed negative values over a wide region. This tendency was relatively strong in Europe, India, the eastern part of Canada, and New Zealand. The relationship between the magnetic field intensity at an altitude of 100 km and the residual Sq amplitude showed an anti-correlation for about 71% of the geomagnetic stations. Furthermore, the residual Sq amplitude at the equatorial station was anti-correlated with the absolute value of the magnetic field inclination. This suggests movement of the equatorial electrojet due to the secular variation of the earth's main magnetic field.

=RISH Mission Research Fellow=

Antiviral compounds from plant biomass

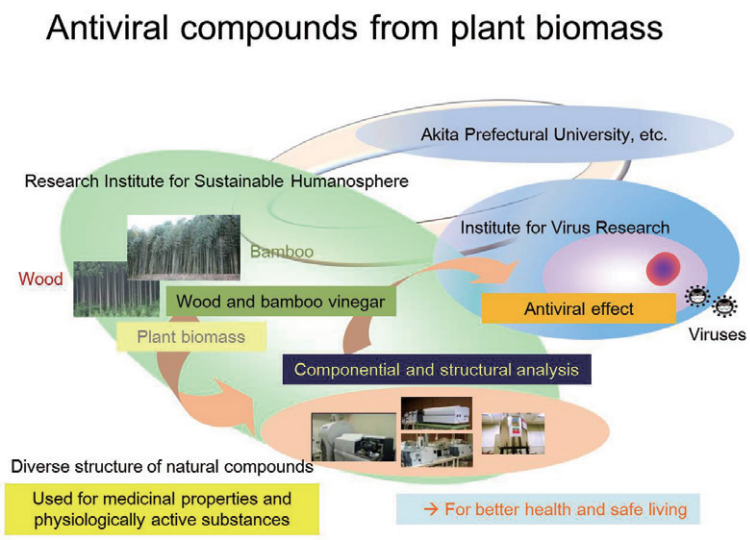
Dr. Ryo Narita

Biomass is a purely renewable organic resource. How to best put woody biomass to use as a chemical resource is a global challenge that must be met for the prevention of global warming and development of a sustainable society.

Pyroligneous acid (PA) is the crude condensate smoke generated during the process of making wood charcoal, and it consists of a pyrolyzate of cellulose, hemicelluloses and lignin. Wood and bamboo PA, pyrolysis products from biomass, have been used for various physiological applications, such as sterilization, food additives and smoke flavoring. However, the physiological activity of PA against viruses remains to be determined.

Plants produce various natural compounds as secondary metabolites. The biological functions of such secondary metabolites in humans have been well investigated, and many of the compounds are used as medicines, flavorings, or recreational drugs. However, there have been fewer studies of the antiviral activity of these chemicals. We focus on the antiviral effect of shikonin, a natural pigment obtained from a medicinal herb, *Lithospermum erythrorhizon*, and berberine, an alkaloid extracted from various medicinal plants used in Chinese traditional medicine.

In this study, we aim to analyze the antiviral activity of plant biomass-derived pyrolysis, products, PA, and natural bioactive compounds such as shikonin and berberine.



To evaluate the antiviral activity of PA, we used the encephalomyocarditis virus (EMCV) as a model, which belongs to the family Picornaviridae. Picornaviruses are non-enveloped with an icosahedral capsid. They contain a single-stranded, positive sense RNA genome. Their genome ranges between 7.1 and 8.9 kb in length. The capsid is an arrangement of 60 protomers in a tightly packed icosahedral structure. EMCV is characterized by its small size (20-30 nm diameter) and resistance to lipophilic germicides. It is stable over a wide range of pH (pH 3-9). For antivirus assay, 10 μl of PA was mixed with 10 μl of medium containing EMCV for 1 h on ice, and the mixture was added to L929 cells. After 6 h, the cells were collected and total RNAs were isolated. After cDNA synthesis, the RNA level of EMCV in infected cells was measured by quantitative real-time PCR.

Treatment of EMCV with PA produced from moso bamboo (*Phyllostachys Pubescens*) severely decreased the RNA level of EMCV in the infected cells. However, neutralized bamboo PA did not affect EMCV replication. This suggests that bamboo PA contains compound(s) that

inhibit EMCV replication under acidic conditions. To characterize the antiviral compounds in bamboo PA, we fractionated bamboo PA and analyzed it by GC-MS. We discovered that phenol is an antiviral compound that synergistically inactivates EMCV with acetic acid, a major component of bamboo PA.

We also analyzed the antiviral activity of PA produced from Japanese cypress (*Chamaecyparis obtusa*). Interestingly, neutralization of wood PA did not decrease its EMCV-inactivating ability, indicating that wood PA contains compound(s) that shows antiviral activity under neutral conditions. In future research, we will fractionate and analyze wood PA components to identify their antiviral compound(s).

List of international MOU in FY2015

No.	Institution	Country
1	Nanjing Forestry University	China
2	Centre National de la Recherche Scientifique, Centre de Recheerches sur les Macromolecules Vegetales	France
3	The National Institute of Aeronautics and Space of the Republic of Indonesia (LAPAN)	Indonesia
4	School of Biological Sciences, Universiti Sains Malaysia	Malaysia
5	VTT Technical Research Centre of Finland	Finland
6	Zhejiang Forestry University	China
7	The Centre for Research in Earth and Space Science (CRESS) of York University	Canada
8	The College of Atmospheric and Geographic Sciences, the University of Oklahoma	USA
9	National Atmospheric Research Laboratory (NARL) Department of Space, Govt. of India	India
10	Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences	Bulgaria
11	Southwest Forestry University, Wood bioscience and technology, science of environment	China
12	National Cheng Kung University, Science and engineering	Taiwan
13	Tanjungpura University, Faculty of Foresty	Indonesia
14	Research Center for Biomaterial Indonesian Institute of Sciences (LIPI)	Indonesia
15	Faculty of Science, Chulalongkorn University	Thailand
16	University of Riau	Indonesia
17	College of Forest and Environmental Sciences, Kangwon National University	Korea
18	The Research Institute for Human Settlements Agency for Research and Development Ministry of Public Works	Indonesia
19	Faculty of Civil Engineering and Planning, Islamic University of Indonesia	Indonesia
20	Material Science and Engeneering College, Northeast Forestry University	China
21	Faculty of Mathematics and Natural Sciences Andalas University	Indonesia

Visiting Professors of RISH 2015

Name and Affiliation	Research title	Period
Solomon TESFAMARIAM Assosiate Professor, University of British Columbia	Seismic Risk Assessment of Hybrid Buildings	16 January 2015-31 August 2015
Gerard CHANTEUR Senior Research Scientist, Centre National de la Recherche Scientifique	Simulation study of Hermean magnetospheric plasma	1 March 2015-31 May 2015
Saip NAMI Kartal Professor, Forestry Faculty, Istanbul University	Performance of novel nano-micronized wood preservatives	20 July 2015-20 October 2015
Yuliati INDRAYANI Lecturer, Faculty of Forestry, Tanjungpura University	Development of Novel Baiting Strategies against Dry-wood Termites with Waste Materials	16 October 2015-15 January 2016
Richard WILSON Associate Professor, LATMOS, University Pierre and Marie Curie	Synergy of in situ and radar measurements for a better characterization of atmospheric turbulence	7 April 2015-31 July 2015
Tung-Yuan HSIAO Assistant Professor, Department of Information Technology, Hsing Wu University	Study of low-latitude ionosphere by menas of network observations of satellite-ground beacon	1 August 2015-31 October 2015
Khan-Hyuk KIM Professor, Department of Astronomy & Space Science, Kyung Hee University	Losses of outer radiation belt electrons during quiet geomagnetic conditions	1 March 2016-31 August 2016

International Symposium 2015

Theme	Place	Period
Japan Geoscience Union Meeting 2015 (285th RISH symposium)	Makuhari Messe, Chiba city	24-28 May 2015
Radio Science Symposium on Earth and Planetary Atmospheres (287th RISH symposium)	Nara Women's University	1 June 2015
International Symposium on Earth-Science Challenges (ISEC) (295th RISH symposium)	Oklahoma University, USA	20-23 September 2015
Innovation in Science and Technology towards Sustainable Future (296th RISH symposium)	Jakarta city, Indonesia	29-30 September 2015
The 6th International on Sustainable Future for Human Security (SustaiN) 2015 (300th RISH symposium)	Sanur Paradise Plaza Hotel, Bali, Indonesia	17-19 November 2015

The Committee of Academic Exchange
Junji Sugiyama (Chair), Tsuyoshi Yoshimura, Yoshiharu Omura, Toshimitsu Hata, Hiroshi Nishimura, Noriko Shiga
Published by T. Tsuda (Director of RISH)

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