

e-ASIA Joint Research Program Final Report

1. Project title : Monitoring and prediction of extreme weather using lightning detection network and micro-satellites
2. Joint Research period : August 1st, 2016 ~ March 31st, 2020
3. Research Team :

■ **Japan team** (up to 6 people including the Principal Investigator)

Funding period: August 1st, 2016 - March 31st, 2020

Total Funded Amount (in Local Currency): 37,606,000 yen

	Name	Position	Affiliation	Role in the project
PI	TAKAHASHI Yukihiro	Professor	Hokkaido University	Unification
Collaborator	SATO Mitsuteru	Lecturer	Hokkaido University	Lightning analysis
Collaborator	MATSUMOTO Jun	Professor	Tokyo Metropolitan University	Weather data analysis
Collaborator	YAMASHITA Kozo	Lecturer	Ashikaga University	Lightning sensor development
Collaborator	KURIHARA Junichi	Associate Professor	Hokkaido University	Satellite development
Collaborator	ISHIDA Tetsuro	Assistant Professor	Hokkaido University	Satellite data analysis
Total number of participants including students:				

■ **Philippine team**

Funding period: N/A

Total Funded Amount (in Local Currency): N/A

	Name	Position	Affiliation	Role in the project
PI	Joel S. Marciano	Acting Director	Department of Science and Technology(DOST), Advanced Science And Technology Institute(ASTI) (DOST-ASTI)	Manager
Collaborator	Glenn Vincent Lopez	Senior Science Research Specialist	DOST-ASTI	Lightning analysis
Collaborator	Gay Perez	Associate Professor	University of the Philippines	Weather data analysis

			Diliman(UPD)	
Collaborator	Ellison Castro	Senior Science Researcher	UPD	Satellite data analysis
Total number of participants including students: 4				

■ Indonesia team

Funding period: N/A

Total Funded Amount (in Local Currency): N/A

	Name	Position	Affiliation	Role in the project
PI	Tri Handoko Seto	Head of National Laboratory for Weather Modification Technology	Agency for The Assessment and Application of Technology (BPPT)	Manager
Collaborator	Erwin Mulyana	Researcher	BPPT	Weather analysis
Collaborator	Findy Renggono	Researcher	BPPT	Software development
Collaborator	Halda Aditya Belgaman	Researcher	BPPT	Data analysis and software development
Collaborator	Faisal Sunarto	Researcher	BPPT	Cloud micro-physics analysis
Total number of participants including students: 5				

4. Summary of the joint research

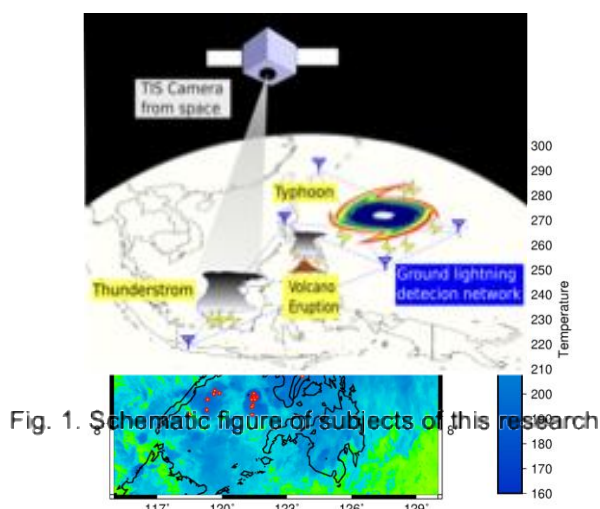


Fig. 1. Schematic figure of subjects of this research

During this joint project, we conducted cutting-edge scientific researches toward the social implementation in order to monitor and predict extreme weathers based on the data obtained by a lightning observation network and by micro-satellites. We established methodology of rapid lightning geolocation and found some essential relationship between lighting activity and thunderstorm/typhoon development. Also, we succeeded in making and calibrating new satellite-born thermal infrared camera which will be installed at Indonesian satellite and dedicated to thunderstorm measurement. Moreover, we found a close relationship between Taal volcano eruption happened

in the period of this research. Using consecutive cloud images taken by a micro-satellite we constructed the world's best 3D model of cloud.

5. Outputs and Anticipated Outcomes of Joint Research

5-1 Scientific achievements and implemented activities of the joint research

5-1-1 Construction of lightning observation networks and development of rapid calculation algorithm.

We constructed Asian lightning observation network, installing VLF radio wave receivers at 5 sites and developed a rapid calculation algorithm for lightning geolocation (Fig.2).

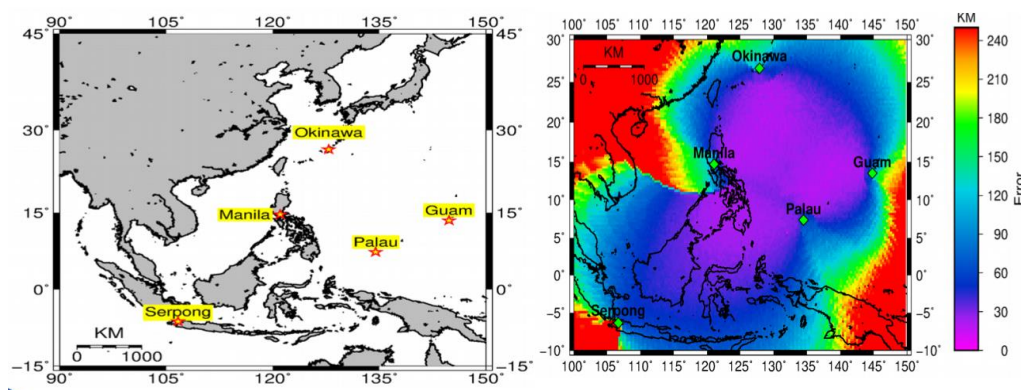
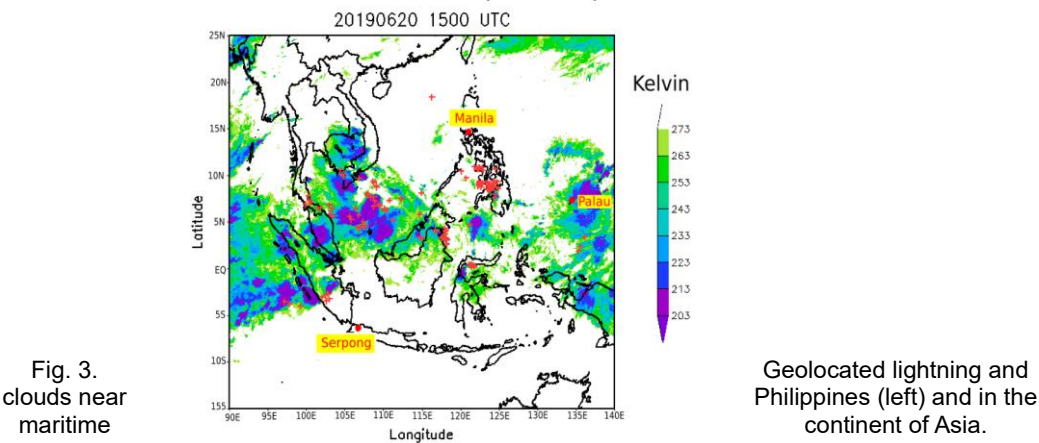


Fig. 2. Observation sites of Asian lightning network (left) and its accuracy of geolocation for lightning discharge (right).

We succeeded in detecting lightning discharges with this network. The lightning locations are well consistent with individual thunderstorms (Fig.3) or clouds in typhoon.



5-1-2
thunderstorm development

Lightning and

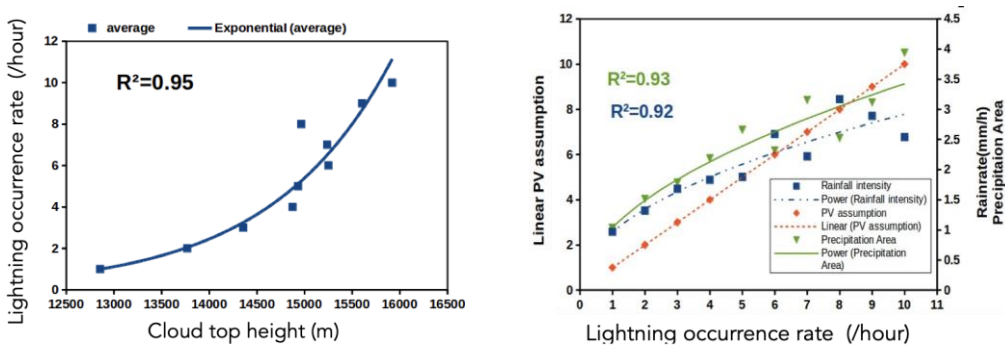


Fig. 4. Relationship between lightning activity and cloud top height (left), and precipitation (right).

It was clearly shown that cloud top height is an exponential function with lightning occurrence frequency with our lightning network, which is consistent with previous study (Fig.4). Also, it is found that the precipitation is a function of lightning occurrence rate, suggesting new monitoring system of precipitation using simple lightning network.

From the climatological point of view, lightning activity and precipitation estimated by TRMM satellite measurement were examined about local time dependency in the same period (Fig.5).

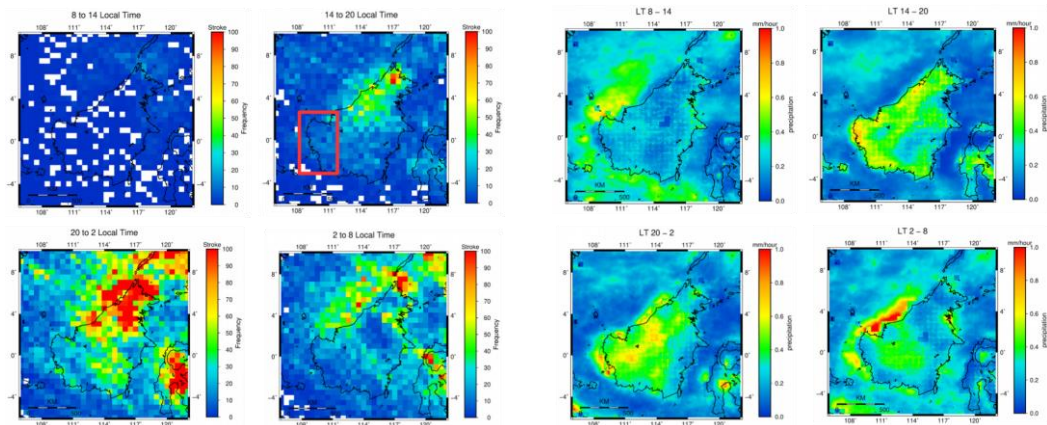
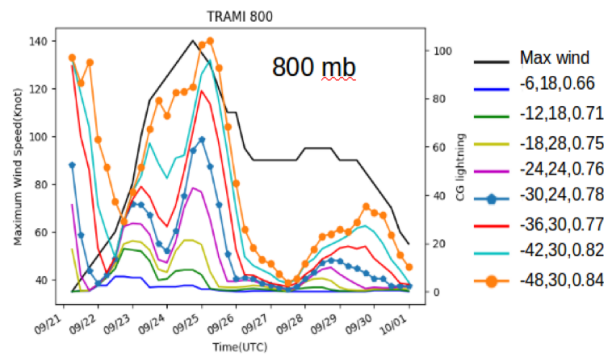


Fig. 5. Lightning activity measured by our network (left) and precipitation estimated by TRMM satellite (right) in the area of Kalimantan island, Indonesia.

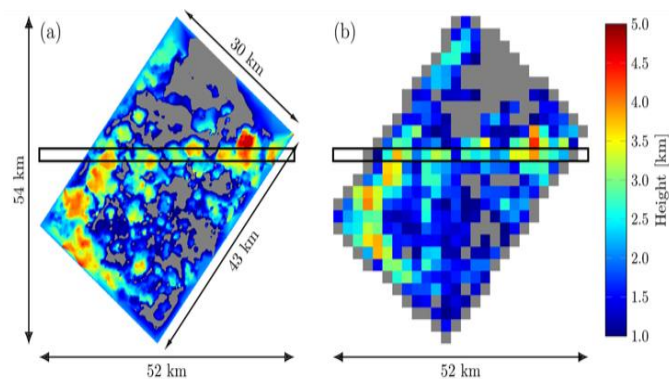
5-1-3 Lightning activity and typhoon development



The maximum wind velocity of typhoon was compared with lightning activity, using back trace calculation. It was found that if we assume some pressure level which carries latent heat, the wind velocity near the center can be reproduced. Fig. 6 is one of the example of such calculation.

Fig. 6. Max. wind velocity of typhoon and lightning activity calculated by back tracing

5-1-4 Satellite observation and data analysis



Using consecutive cloud images taken by DIWATA-1 satellite, we succeeded in reconstructing precise 3D model of clouds for the first time in the world (published in Scientific Reports).

Fig. 7. Cloud top height distribution estimated by DIWATA-1satellite (left) and by HIMAWARI-8 (right).
(10:7570 |
<https://doi.org/10.1038/s41598-020-64274-z>)

5-1-5 Instrument development

We developed thermal infrared camera which will be onboard LAPAN A-4 satellite and used for estimation of cloud top temperature, an indicator of thunderstorm development. This camera was exported to Indonesia and will be launched in 2020 or 2021 (Fig. 8.)

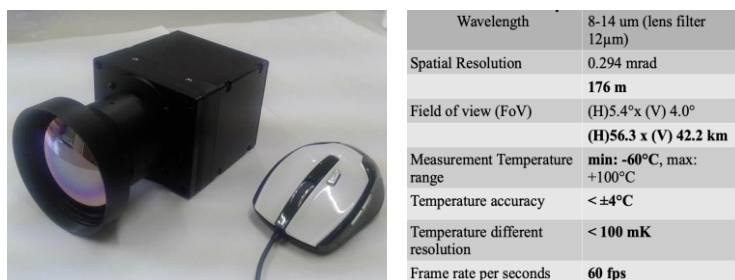


Fig. 8. A photo and specification of thermal infrared camera for LAPAN A-4 satellite.

5-2 Synergistic effects of the international joint research

5-2-1 Lightning network

The network consists of some observation sites located and operated by member countries including Indonesia and Philippines.

5-2-2 Satellite operation and development

Satellite used for 3D cloud modeling was developed and operated Philippines and thermal infrared camera will be onboard LAPAN A-4 launched and operated by Indonesia.

5-3 Broader impacts including contribution to society

5-3-1 This collaborative operation of lightning and satellite will be used for prediction of extreme weather in Asian countries.

5-3-2 Volcano eruption monitoring was carried out by lightning network which can detect electrical discharge occurring in volcanic smoke (Fig. 9).

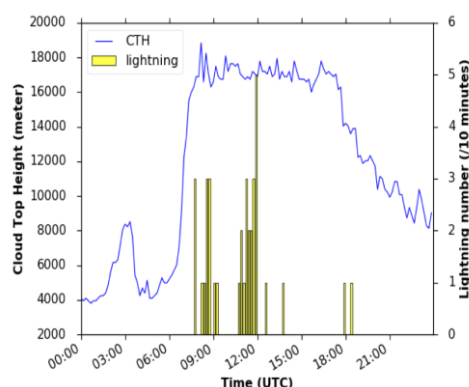


Fig. 9. Cloud top height estimated by satellite image and lightning activity.

5-4 Development and sustainability of the cooperation

This joint research accelerated activities of Asian Micro-satellite Consortium involving 9 Asian countries and promoting mutual international tasking.

6. Future Goals and Plan of Activities after the project period

We will establish the real time alert system for extreme weather in Asia and other tropical areas.

7. Scientific Achievements and Implemented Activities (Publication, Research Exchange, Workshop, etc.)

Please see the attachment file.

8. Recommendations and Comments to the Program

N/A

9. Others (agenda of workshop, photos of research teams, meetings, and etc.)



e-ASIA Kick-off Meeting @ BPPT, Indonesia (October 11th, 2016)



e-ASIA JRP final Workshop @ BPPT, Indonesia (November 27th, 2019)

Lists of Achievements and Implemented Activities

1. Original Publication of Articles etc.

1. 1 Original Publications (Articles co-authored among Research Teams)

All Authors' Names, Title, Journal Name, Volume, Edition, Page, Year of Publication	DOI Code	Publication Status	Remarks (e.g. publication in top level journals etc.)
Kubota, H., R. Shirooka, J. Matsumoto, E. O. Cayan, and F. D. Hilario, Tropical cyclone influence on the long-term variability of Philippine summer monsoon onset, Prog. Earth. Planet. Sci., 2017	DOI: 10.1186/s40645-017-0138-5.	published	
Olaguera, L.M., Matsumoto, J. Kubota, H., Inoue, T., Cayan, E.O. and Hilario, F.D., 2018. Abrupt climate shift in the mature rainy season of the Philippines in the mid-1990s. Atmosphere 9: 350.	DOI: 10.3390/atmos9090350	published	
Olaguera, L.M., Matsumoto, J., Kubota, H., Inoue, T., Cayan, E.O. and Hilario, F.D. 2018. Interdecadal shifts in the winter monsoon rainfall of the Philippines. Atmosphere 9: 464.	DOI:10.3390/atmos9120464	published	
Akasaka, I, H. Kubota, J. Matsumoto, E. O. Cayan, R.D. Guzman, F. D. Hilario, 2018: Seasonal march patterns of the summer rainy season in the Philippines and their long-term variability since the late 20th century, Prog. Earth. Planet. Sci.,	DOI: 10.1186/s40645-018-0178-5	published	

4 Total

1. 2 Original Publications (Articles by Single Team only)

All Authors' Names, Title, Journal Name, Volume, Edition, Page, Year of Publication	DOI Code	Publication Status	Remarks (e.g. publication in top level journals etc.)	Country name of the team

0 Total

ents and Implemented Activities

2. presentations at Academic Conferences etc. (Seminars, Workshops, Symposia)

2. 1 Conference Presentations (Joint Presentations among Research Teams)

Date	Type of Presentation	Speaker, "Title", Conference Name, Location, etc.
February, 2017	Oral Presentation	Mitsuteru SATO, Hisayuki KUBOTA, Kozo YAMASHITA, Jun-Ichi HAMADA, Jun MATSUMOTO, Joel MARCIANO, Gay Jane PEREZ, Ellison CASTRO, Yukihiro TAKAHASHI, "SATREPS Project, ULAT, for Development of Extreme Weather Monitoring and Alert System in the Philippines", New Dimension for Natural Hazard in Asia, An AOGS-EGU Joint Conference, Feb 2017.
April 28, 2017	Poster Session	Sato, M., Y. Takahashi, H. Kubota, E. Momota, and J. Marciano, "Operation of lightning detection network and micro-satellites for nowcast of thunderstorm and tropical cyclone activities", European Geosciences Union General Assembly 2017, EGU2017- 11468, Vienna, Austria, April 28, 2017.
May, 2017	Oral Presentation	Ellison Castro, Joel Marciano, Gay Perez, Kaye Vergel, Yukihiro Takahashi, "Readiness in DOST-ASTI for SATREPS project for development of extreme weather monitoring and alert system in the Philippines", 2017 JpGU Meeting, Makuhari, Japan, May 2017.
October 16, 2017	Oral Presentation	Mitsuteru Sato, Yukihiro Takahashi, Kozo Yamashita, Hisayuki Kubota, Junichi Hamada, Eriko Momota, and M. Joel, "Construction of lightning observation network in Asian countries for the intensity development prediction of severe weather", 142th SGPSS Fall Meeting, R005-16, Kyoto, Oct. 16, 2017.
December 12, 2017	Poster Session	Yukihiro Takahashi, Mitsuteru Sato, Ellison C Castro, Tetsuro Ishida, Joel Joseph Marciano, Hisayuki Kubota and Kozo Yamashita, "Extreme weather monitoring system with combination of micro-satellites and ground-based", American Geophysical Union Fall Meeting, NEW ORLEANS, US, Dec 12, 2017.
December 12, 2017	Poster Session	Sato, M., Y. Takahashi, K. Yamashita, H. Kubota, J. Hamada, E. Momota, and J.J. Marciano, "Development of lightning observation network in the western Pacific region for the intensity prediction of severe weather", American Geophysical Union Fall Meeting 2017, AE13A-2229, New Orleans, USA, December 12, 2017.
February, 2018	Oral Presentation	Takahashi, Y., T. Ishida, M. Sato, Y. Sakamoto, G.J. Perez, J.Marciano, and H. Kubota, "3-D cloud monitoring by the micro-satellites in SATREPS project, ULAT", New Dimensions for Natural Hazards in Asia, An AOGS-EGU Joint Conference, NH-A212, Philippines, Feb. 2018.
April 10, 2018	Poster Session	Mitsuteru Sato, Yukihiro Takahashi, Kozo Yamashita, Hisayuki Kubota, Junichi Hamada, and Joel J. Marciano, "ULAT Project: Lightning Observations in the Philippines for the Intensity Prediction of Severe Weather", European Geosciences Union General Assembly 2018, EGU2018-16395, Vienna, Austria, April 10, 2018.
May 20, 2018	Oral Presentation	Mitsuteru Sato, Yukihiro Takahashi, Hisayuki Kubota, Kozo Yamashita, Junichi Hamada, and Joel J. Marciano, "Lightning Observations in the Philippines and Western Pacific Region for the Intensity Prediction of Severe Weather", 2018 JpGU Meeting, Makuhari, Japan, May 20, 2018.
May 20, 2018	Guest/Invited Speaker	Alvin Estoquia Retamar, Joel Joseph Marciano, Glenn Vincent Lopez, Felan Carlo Garcia, and Jericho Capito, "Development of a Real-Time Thunderstorm Monitoring and Information System in Metro Manila, Philippines", 2018 JpGU Meeting, Makuhari, Japan, May 20, 2018.
May 20, 2018	Oral Presentation	Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Kozo Yamashita, Jun-Ichi Hamada, Tetsuro Ishida, Junichi Kurihara, Jun Matsumoto, Joel Marciano, Gay Perez, Status of ULAT project for development of extreme weather monitoring and alert system in the Philippines, JpGU meeting, Makuhari, Japan, May 20, 2018.

May 20, 2018	Oral Presentation	Purwadi, Yukihiro Takahashi, Kozo Yamashita, Mitsuteru Sato, Observation system for thunderstorm development using ground lightning detection network and thermal infrared camera onboard micro-satellites, JpGU meeting, Makuhari, Japan, May 20, 2018.
May 24, 2018	Poster Session	Ellison CASTRO, Tetsuro ISHIDA, Yukihiro TAKAHASHI, Kaye Kristine VERGEL, and Francisco Miguel FELICIO, "Reconstructing Three-dimensional Models of Clouds by the Philippines' First Microsatellite, DIWATA-1", JpGU meeting, Makuhari, Japan, May 24, 2018.
May 24, 2018	Poster Session	Ellison Caparas Castro, Tetsuro Ishida, Yukihiro Takahashi, Kaye Kristine Vergel, Francisco Miguel Felicio, Reconstructing Three-Dimensional Models of Clouds by the Philippines' First Microsatellite, DIWATA-1, JpGU meeting, Makuhari, Japan, May 24, 2018.
June 5, 2018	Oral Presentation	Mitsuteru Sato, Yukihiro Takahashi, Hisayuki Kubota, Kozo Yamashita, Junichi Hamada, and Joel J. Marciano, "ULAT Project: Lightning Observations in the Philippines and Western Pacific Region for the Intensity Prediction of Severe Weather", Asia Oceania Geosciences Society (AOGS) 15th Annual Meeting, Honolulu, Hawaii, June 5, 2018.
June 22, 2018	Poster Session	Mitsuteru Sato, Yukihiro Takahashi, Hisayuki Kubota, Kozo Yamashita, Junichi Hamada, and Joel J. Marciano, "Development of Lightning Observation Network in the Western Pacific Region for the Intensity Prediction of Severe Weather and Tropical Cyclone", 16th International Conference on Atmospheric Electricity, Nara, Japan, June 22, 2018.
October 25, 2018	Oral Presentation	Mitsuteru Sato, Yukihiro Takahashi, Kozo Yamashita, Hisayuki Kubota, Junichi Hamada, and Joel J. Marciano, "Relation between typhoon intensity and lightning activity measured by the Asian lightning detection network", 144th SGPSS Fall Meeting, Nagoya, Nov. 25, 2018.
December 10, 2018	Poster Session	Mitsuteru Sato, Yukihiro Takahashi, Hisayuki Kubota, Kozo Yamashita, Junichi Hamada, and Joel J. Marciano, "Relation between Lightning and Typhoon Activities in the Western Pacific Region", AGU Fall Meeting 2018, AE13B-2723, Washington D.C., Dec 10, 2018.
December 13, 2018	Poster Session	Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Kozo Yamashita, Tetsuro Ishida, Ellison Castro, Loren Jay Estrebillon, Doreena Karmina Pulutan, Purwadi, New strategy for monitoring of tropical cyclones and thunderstorms with micro-satellites and ground-based lightning network, 2018 AGU fall meeting, Washington DC, Dec 13, 2018.
April 11, 2019	Poster Session	Sato, M., Y. Takahashi, H. Kubota, K. Yamashita, J. Hamada, and J.J. Marciano, "Relation between lightning and typhoon activities (typhoon LAN) in the western Pacific region", European Geosciences Union General Assembly 2019, EGU2019-11961, Vienna, Austria, April 11, 2019.
May 28, 2019	Oral Presentation	Sato, M., Y. Takahashi, H. Kubota, K. Yamashita, J. Hamada, and J.J. Marciano, "Relation between lightning and typhoon activities (typhoon YAGI) in the western Pacific region", JpGU meeting, Makuhari, Japan, May 28, 2019
July 11, 2019	Oral Presentation	Olaguera, L. M., J. Matsumoto, H. Kubota, T. Inoue, E.O. Cayan, and F.D. Hilario, 2019, Decadal Climate Shifts in Summer and Winter Monsoon Seasons in the Philippines, 27th International Union of Geodesy and Geophysics General Assembly, IUGG19-0445. Montreal, July 11, 2019.
July 31, 2019	Poster Session	Olaguera, L. M., J. Matsumoto, H. Kubota, E. Cayan, and F. Hilario, 2019: Interdecadal shifts in the winter monsoon rainfall of the Philippines, Asia Oceania Geosciences Society 2019, AS03-A001. Singapore, July 31, 2019
August 2019	Guest/Invited Speaker	Sato, M., Y. Takahashi, H. Kubota, K. Yamashita, J. Hamada, and J.J. Marciano, "Prediction of the typhoon intensity development by monitoring lightning activity", Asia Oceania Geosciences Society (AOGS) 16th Annual Meeting, AS47-A006, Singapore, August 2019
October 26, 2019	Oral Presentation	Sato, M., Y. Takahashi, H. Kubota, K. Yamashita, J. Hamada, and J.J. Marciano, "Relation between lightning activities measured by the V-POTEKA network and intensity development of 2018 Pacific typhoons", 146th SGPSS Fall Meeting, Kumamoto, Oct 26, 2019.

2. 2 Conference Presentations (by Single Team)

Date	Type of Presentation	Speaker, "Title", Conference Name, Location etc.	Country name of the team
May 24, 2016	Oral Presentation	Sato, M., C. Shimizu, F. Tsuchiya, N. Honma, Y. Hongo, and Y. Takahashi, "Future observations of lightning-exciting ELF waves in Asian region for the nowcasting of eevere weather development", Japan Geoscience Union Meeting 2016, HDS07-06, Chiba, May 24, 2016.	
May, 2016	Oral Presentation	Shimizu, C., M. Sato, Y. Takahashi, F. Tsuchiya, Y. Hongo, S. Abe, and A. Yoshikawa, "Relation between charge amounts of lightning discharges derived from ELF waveform data and severe weather", Japan Geoscience Union Meeting 2016, HDS07-05, Makuhari, May 2016.	
August 3, 2016	Poster Session	Yukihiro Takahashi, "Monitoring of thunderstorm and typhoon using lightning detection network and micro-satellites in Southeast Asia", AOGS 13th Annual Meeting, Beijing, August 3, 2016.	
September 8, 2016	Guest/Invited Speaker	Yukihiro Takahashi, Nex generation earth monitoring system using micro-satellite constellation, Proceedings of 60th Space Sciences and Technology Conference, Hakodate, 2016/9/8	
September 8, 2016	Oral Presentation	Tetsuro Ishida, New earth and space measurements explored by micro-satellite constellation, Proceedings of 60th Space Sciences and Technology Conference, Hakodate, 2016/9/8	
October 5, 2016	Guest/Invited Speaker	Yukihiro Takahashi, "The scientific scope of microsatellite projects and Venus observations with Akatsuki and ground-based telescopes", Astronomy Special Colloquium , National Central University, Taiwan, October 5, 2016.	
October 18, 2016	Guest/Invited Speaker	Yukihiro Takahashi, "Great Possibility of Micro-satellite", Geo Smart Asia 2016, Kuala Lumpur, Oct. 18. 2016.	
November, 2016	Poster Session	C. Shimizu, M. Sato, Y. Takahashi, F. Tsuchiya, Y. Hongo, S. Abe, and A. Yoshikawa, "Predictability of the downburst occurrences using the charge amounts of lightning discharges derived from ELF observation data", 140th SGPSS Fall Meeting, R005-P02, Fukuoka, Nov, 2016.	
November 17, 2016	Guest/Invited Speaker	Yukihiro Takahashi, "Development of Philippine Scientific Earth Observation Micro- Satellite", Special session (Small Satellites for Innovation), APRSAF-17, Manila, Philippines, November 17, 2016.	
November 15, 2016	Guest/Invited Speaker	Yukihiro Takahashi, "Next-generation disaster management using micro-satellites and ground observation network", APRSAF-17, Manila, Philippines, November 15, 2016.	
November 16, 2016	Guest/Invited Speaker	Yukihiro Takahashi, "Collaborative Promotion of Micro-satellite Utilization by International Consortium", APRSAF-17, Manila, Philippines, November 16, 2016.	
December 14, 2016	Poster Session	Yukihiro Takahashi, "Nowcast of thunderstorm and typhoon activity based on lightning detection and flexible operation of micro-satellites", AGU(American Geophysical Union) fall meeting, San Francisco, Dec. 14, 2016.	
December 15, 2016	Guest/Invited Speaker	Joel Joseph S. Marciano Jr., "Space Activities in the Philippines", APRSAF-17, Manila, Philippines, November 15, 2016.	
January, 2017	Oral Presentation	C. Shimizu, M. Sato, Y. Takahashi, F. Tsuchiya, Y. Hongo, S. Abe, and A. Yoshikawa, "Estimation of charge amount of lightning using ELF observation data and predictability of the downburst occurrences", The 95th conferece of the Society of Atmospheric Electricity of Japan, Kobe, Jan. 2017.	
May, 2017	Guest/Invited Speaker	Kubota, H., Y. Takahashi and M. Sato, 2017: Heavy rainfall observation in Metro Manila, Philippines for understanding the relation of lightning activity and tropical cyclone, Japan Geoscience Union Meeting 2017, Japan, May 2017.	
May, 2017	Poster Session	Kaye Kristine Vergel, Yukihiro Takahashi, "Readiness in DOST-ASTI for SATREPS project for development of extreme weather monitoring and alert system in the Philippines", 2017 JpGU Meeting, Makuhari, Japan, May 2017.	

May, 2017	Oral Presentation	Matsumoto, J., Marcelino, V., and Kubota, H. 2017. Changes in extreme rainfall in the Philippines for the 100-year period (1911–2010). Japan Geoscience Union Meeting 2017: MIS05–09, May, Chiba.	
May, 2017	Poster Session	Olaguera, L. M. P., and Matsumoto, J. 2017. Characteristics of the rainfall over Luzon during the summer monsoon of the Philippines. Japan Geoscience Union Meeting 2017: ACG44–P03, May, Chiba.	
May 22, 2017	Poster Session	Sato, M., Y. Takahashi, H. Kubota, and C. Shimizu, “Deployment Plan of ELF observation system in Asian countries to monitor severe weather development”, Japan Geoscience Union Meeting 2017, MIS05–P09, Chiba, May 22, 2017.	
May 22, 2017	Poster Session	Shimizu, C., M. Sato, and Y. Takahashi, “Characteristics of Downburst Occurrences Derived from Ground-based Lightning and Meteorological Observations”, Japan Geoscience Union Meeting 2017, MIS05–P08, Makuhari, May 22, 2017.	
May 22, 2017	Oral Presentation	Kubota, H., Y. Takahashi, and M. Sato, “Heavy rainfall observation in Metro Manila, Philippines for understanding the relation of lightning activity and tropical cyclone”, Japan Geoscience Union Meeting 2017, MIS05–08, Makuhari, May 22, 2017.	
May 22, 2017	Poster Session	Hamada, J.-I., J. Matsumoto, S. Mori, M. Katsumata, F. Syamsudin, and K.Yoneyama. “An observational study on lightning activities over the coastal region of Sumatra, Indonesian maritime continent”. Japan Geoscience Union Meeting 2017, MIS05–P06, Makuhari, May 22, 2017.	
May, 2017	Poster Session	Yamashita, K., H. Kojima, Y. Komori, H. Ohya, Y. Takahashi: Monitoring of lightning activity with the combination of radio observation in ELF–VLF band and electrostatic measurement, JpGU–AGU Joint Meeting 2017, MIS05–P07, May 2017	
May, 2017	Poster Session	Yukihiro Takahashi, Hisayuki Kubota, Mitsuteru Sato, Jun Matsumoto, Kozo Yamashita and Kazuya Yoshida, “Development of monitoring and information sharing system for extreme weathers in the Philippines using lightning observation network and micro-satellites”, MSJ Autumn Meeting, May 2017.	
June 15, 2017	Guest/Invited Speaker	Yukihiro Takahashi, “Next-generation Earth Monitoring System with Micro-satellites and Ground-based Networks”, 17th Conference of the Science Council of Asia, Manila, Philippines, June 15, 2017.	
July 7, 2017	Guest/Invited Speaker	Yukihiro Takahashi, “Extreme weather monitoring and marine observation using micro-satellite, Research meeting of ISEE/Nagoya University “Marine observations with small flying object”, Nagoya Univ., July 7, 2017	
August 21, 2017	Guest/Invited Speaker	Matsumoto, J., Villafuerte II, M.Q., Endo, N. and Nguyen–Thi H.A. 2017. Changes in extreme rainfall in Southeast Asia. International Workshop on the Asian Monsoon in a Warmer World, (21 August), Chengjiang, China.	
August 23, 2017	Guest/Invited Speaker	Yukihiro Takahashi, “Next-generation remote sensing and applications realized by micro-satellite and its international collaboration”, 1st IAA North–East Asia Symposium on Small Satellites, Ulaanbaatar, Mongolia, Aug 23, 2017.	
October, 2017	Poster Session	K. Yamashita, H. Ohya, J. Hamada, H. Iwasaki, Y. Wakatsuki, Y. Takahashi, J. Matsumoto: Monitoring of electrification and discharge in thunderstorm based on simultaneous observation of ELF–VLF waves and electrostatic field, SGPSS Fall Meeting, R005–P35, Oct. 2017.	
November 26, 2017	Guest/Invited Speaker	Yukihiro Takahashi, “Another–dimension disaster prevention information provided by micro-satellite”, Bousai Kokutai Meeting, Sendai, Nov. 26, 2017.	
November, 2017	Oral Presentation	Kubota, H., Y. Takahashi, M. Sato, K. Yamashita, and J. Hamada, “Development of extreme weather monitoring and information sharing system in Metro Manila”, UNESCO–JASTIP Joint Symposium on Intra–Regional Water Security and Disaster Management, Manila, November 2017.	
November, 2017	Oral Presentation	Kubota, H., Y. Takahashi, M. Sato, K. Yamashita, and J.-I. Hamada, 2017: Development of extreme weather monitoring and information sharing system in Metro Manila, UNESCO–JASTIP Joint Symposium on Intra–Regional Water Security and Disaster Management, The 3rd Symposium on JASTIP Disaster Prevention International Cooperation Research, Philippines, Nov. 2017.	
December, 2017	Poster Session	Yamashita, K., H. Ohya, Y. Takahashi, M. Sato: Monitoring of lightning activity based on simultaneous measurement of electric field and electric field-change in the Tokyo metropolitan area, AGU Fall Meeting, AE23B–2480, Dec 2017	
January, 2018	Oral Presentation	K. Yamashita, H. Iwasaki, H. Ohya, Y. Takahashi, Evaluation of lightning monitoring network using VLF waves in Kanto area, The 96th conferece of the Society of Atmospheric Electricity of Japan, Tokyo. Jan 2018.	

February, 2018	Oral Presentation	HISAYUKI KUBOTA ¹ , YUKIHIRO TAKAHASHI ¹ , MITSUTERU SATO ¹ , JUN-ICHI HAMADA, "Heavy rainfall in Metro Manila, Philippines during the summer monsoon associated with tropical cyclone", New Dimension for Natural Hazard in Asia, An AOGS-EGU Joint Conference, Feb 2017.	
March 15, 2018	Oral Presentation	Yukihiro Takahashi, "Status of ULAT and related projects in Asia", The International Post-MAHASRI Planning Workshop, Akihabara, Japan, March 15, 2018.	
April 9, 2018	Oral Presentation	Jun Matsumoto: From integration of arts and sciences to sustainable future –Contribution of Japan to the world–, JSPS Open symposium, Tokyo, April 9, 2018.	
May 18, 2018	Oral Presentation	Matsumoto, J., Villafuerte II, M.Q. and Kubota, H. 2018. Changes in extreme rainfall in the Philippines from the early 20th century. Asian Extremes: Climate, Meteorology and Disaster in History, May 18, Singapore.	
May 20, 2018	Poster Session	Olaguera, L.M., Matsumoto, J., Kubota, H., Inoue, T., Cayan, E.O. and Hilario, F.D. 2018. Abrupt climate shift in the mature rainy season of the Philippines in the mid-1990s. JpGU Meeting 2018, A-CG37-P01, May 20, 2018	
May 20, 2018	Guest/Invited Speaker	Kubota, H., Y. Takahashi, M. Sato, K. Yamashita, J.-I. Hamada, 2018: Observation study of the relationship between lightning activity and tropical cyclone intensity in the Philippine Sea, Japan Geoscience Union Meeting 2018, MIS04-03. Makuhari, May 20 2018	
May 20, 2018	Oral Presentation	Masa-yuki Yamamoto, Infrasound multi-site observation of thunders 2: test results for SATREPS, JpGU meeting, Makuhari, Japan, May 20, 2018.	
May 20, 2018	Oral Presentation	Jun-Ichi Hamada, Jun Matsumoto, Kozo Yamashita, Yukihiro Takahashi, Monitoring for lightning activities and thunder cloud developments over the Tokyo metropolitan area based on electrostatic field and electromagnetic measurements, JpGU meeting, Makuhari, Japan, May 20, 2018.	
May 20, 2018	Poster Session	Kozo Yamashita, Yukihiro Takahashi, Mitsuteru Sato, Development of electric field mill kit for multiple measurement of thunderstorm electrification, JpGU meeting, Makuhari, Japan, May 20, 2018.	
May 20, 2018	Poster Session	Rikuto Noguchi, Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Estimation of electric charge structure in cumulonimbus in ULAT project in Philippines, JpGU meeting, Makuhari, Japan, May 20, 2018.	
June 4, 2018	Guest/Invited Speaker	Kubota, H., Y. Takahashi, M. Sato, K. Yamashita, J.-I. Hamada, 2018: Observation study for understanding the relationship between lightning activity and tropical cyclone intensity in the Philippine Sea, Asia Oceania Geosciences Society 2018, AS31-A084. Honolulu, Jun. 4 2018	
June 4, 2018	Oral Presentation	Yukihiro Takahashi, Micro-satellite and its Constellation as a New Platform for Space Remote-sensing, AOGS annual meeting, Hawaii, US, June 4, 2018.	
July 20, 2018	Guest/Invited Speaker	Yukihiro Takahashi, Let's make "innovation in space", The Philippines Crossing the Atmospheric Borders, National Science and Technology Week (NSTW) Celebration, July 20, 2018.	
October, 2018	Oral Presentation	Y. Sakamoto, T. Kuwahara, K. Yoshida, T. Ishida, J. Kurihara and Y. Takahashi, International cooperation and results of the operation in the project of 50-kg satellite "DIWATA-1" making use of ISS release opportunity, The 62th Space Sciences and Technology Conference, Kurume, Oct, 2018	
October 31, 2018	Oral Presentation	Yukihiro Takahashi, Hisayuki Kubota, Mitsuteru Sato, Jun Matsumoto, Kozo Yamashita, Kazuya Yoshida and Junichi Hamada, ULAT: Project for Development of Extreme Weather Monitoring and Information Sharing System in the Philippines, MSJ Autumn Meeting, Sendai, Oct. 31, 2018.	
December 6, 2018	Oral Presentation	Yukihiro Takahashi, On-demand image acquisition system by micro-satellite constellation under international consortium, The 18th Science Council of Asia Conference, Tokyo, Japan, Dec 6, 2018.	
March 11, 2019	Oral Presentation	Yukihiro Takahashi, DEVELOPMENT OF SPECTRAL IMAGING FOR REMOTE SENSING, 1st International Conference on Joint Research Program in Mongolia (ICJPM 2019), Ulaanbaatar, March 11, 2019.	
March 20, 2019	Oral Presentation	H. Kubota, J. Matsumoto, I. Akasaka, M. Zaiki, S. Kobayashi, 2019: Asian summer monsoon variability study developed by data rescue of rainfall in the Philippines, Abstract of Spring meeting 2019, The Association of Japanese Geographers, 505. Tokyo, Mar. 20, 2019.	

April 9, 2019	Oral Presentation	Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Kozo Yamashita, Tetsuro Ishida, Ellison Castro, Loren Jay Estrebillon, Purwadi, Monitoring of typhoon and thunderstorms using micro-satellites and ground-based lightning networks, EGU GA , April 9, 2019.	
May 15, 2019	Oral Presentation	H. Kubota, J. Matsumoto, I. Akasaka, M. Zaiki, S. Kobayashi, 2019: Asian summer monsoon variability study developed by data rescue of rainfall in the Philippines, Abstract of Spring meeting 2019, The Meteorological Society of Japan, A106. Tokyo, May 15, 2019.	
May 18, 2019	Oral Presentation	H. Yamada, K. Tsuboki, T. Shinoda, H. Kubota, Y. Takahashi, N. Nagahama, K. Shimizu, T. Ohigashi, K. Ito, T. Nakazawa, M. Yamahiko, 2019: Variability of inner structure typhoon Trami in 2018 by aircraft observation, Abstract of Spring meeting 2019, The Meteorological Society of Japan, B452. Tokyo, May 18, 2019.	
May 18, 2019	Oral Presentation	K. Tsuboki, H. Yamada, Y. Takahashi, Ben D. Jou, T. Shinoda, T. Ohigashi, M. Yamaguchi, H. Kubota, K. Ito, T. Nakazawa, N. Nagahama, K. Shimizu, M. Kato, S. Kanada, M. Yoshioka, N. Takahashi, 2019: Dropsonde observation of center pressure through the aircraft measurement penetrated typhoon eye, Abstract of Spring meeting 2019, The Meteorological Society of Japan, B451. Tokyo, May 18, 2019.	
May 18, 2019	Oral Presentation	H. Kubota, K. Tsuboki, H. Yamada, Y. Takahashi, T. Shinoda, T. Ohigashi, M. Yamaguchi, K. Ito, T. Nakazawa, N. Nagahama, K. Shimizu, Purwadi, M. Sato, 2019: Warm core during the mature stage of typhoon Trami in 2018 observed by aircraft, Abstract of Spring meeting 2019, The Meteorological Society of Japan, B453. Tokyo, May 18, 2019.	
May 20, 2019	Poster Session	I. Akasaka, M. Zaiki, H. Kubota, J. Matsumoto, 2019: Seasonal variation of wind direction and precipitation in Manila during the latter half of the 19th century, Abstract of Spring meeting 2019, The Association of Japanese Geographers, P016. Tokyo, May 20, 2019.	
May 28, 2019	Guest/Invited Speaker	Kubota, H., K. Tsuboki, H. Yamada, Y. Takahashi, T. Shinoda, T. Ohigashi, M. Yamaguchi, K. Ito, T. Nakazawa, N. Nagahama, K. Shimizu, Purwadi, and M. Sato, 2019: Airborne observation of Super Typhoon Trami in 2018 for understanding the intensity of tropical cyclone in the Philippine Sea, Japan Geoscience Union Meeting 2019, MIS05-03. Makuhari, Japan, May 28, 2019.	
May 28, 2019	Oral Presentation	M. Yamaguchi, T. Ishibashi, T. Nakazawa, K. Ito, H. Yamada, T. Ohigashi, N. Nagahama, K. Shimizu, H. Kubota, Y. Takahashi, M. Kato, S. Kanada, M. Yoshioka, T. Shinoda, N. Takahashi, K. Tsuboki, 2019: Observational system experiment of typhoon Trami in 2018 using T-PARCI dropsonde observation and JMA global numerical weather prediction system, Program of JpGU meeting 2019, JpGU, ACG41-03. Makuhari, May 28, 2019.	
May 28, 2019	Oral Presentation	K. Tsuboki, H. Yamada, Y. Takahashi, T. Shinoda, T. Ohigashi, M. Yamaguchi, H. Kubota, T. Nakazawa, N. Nagahama, K. Shimizu, M. Kato, S. Kanada, M. Yoshioka, N. Takahashi, 2019: Direct observation of center pressure of typhoon using dropsonde observation, Program of JpGU meeting 2019, JpGU, ACG41-01. Makuhari, May 28, 2019.	
May 28, 2019	Oral Presentation	Kubota, H., K. Tsuboki, H. Yamada, Y. Takahashi, T. Shinoda, T. Ohigashi, M. Yamaguchi, K. Ito, T. Nakazawa, N. Nagahama, K. Shimizu, Purwadi, and M. Sato, 2019: Airborne observation of Super Typhoon Trami in 2018 for understanding the mature stage of tropical cyclone in the Philippine Sea, Asia Oceania Geosciences Society 2019, AS14-A037. Makuhari, Japan, May 28, 2019.	
May 28, 2019	Oral Presentation	Yamada, H., K. Tsuboki, T. Shinoda, H. Kubota, Y. Takahashi, N. Nagahama, K. Shimizu, T. Ohigashi, K. Ito, M. Yamaguchi and T. Nakazawa, 2019: A change in the inner-core structure of Typhoon Trami (2018) as observed through upper-tropospheric aircraft reconnaissance of T-PARCI, Japan Geoscience Union Meeting 2019, AAS02-07. Makuhari, Japan, May 28, 2019.	
May 28, 2019	Oral Presentation	Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Kozo Yamashita, Tetsuro Ishida, Ellison Castro, Loren Jay Estrebillon, Purwadi, Quasi real-time observation of typhoon and thunderstorms by the system of micro-satellites and ground-based lightning sensors, 2019 JpGU Meeting, Makuhari, May 28, 2019.	
August 1, 2019	Oral Presentation	Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Kozo Yamashita, Tetsuro Ishida, Ellison Castro, Loren Jay Estrebillon, Purwadi, Kazuhisa Tsuboki, Hiroyuki Yamada, Quasi real-time observation of typhoon and thunderstorms using micro-satellites and ground-based lightning networks, 2019 AOGS, Singapore, August 1, 2019.	
December 4, 2019	Guest/Invited Speaker	Yukihiro Takahashi, Earth monitoring with spectral imager onboard micro-satellite, Optical Society of Japan, OPJ Symposium, Osaka Univ., Dec. 4, 2019.	

December 9, 2019	Oral Presentation	Yukihiro Takahashi, Mitsuteru Sato, Hisayuki Kubota, Kozo Yamashita, Tetsuro Ishida, Ellison C. Castro, Loren Joy Estrebilllo, Purwadi, Meryl Algodon, Gay Jane P Perez, Joel Joseph Marciano, Jun Matsumoto, Jun-Ichi Hamada, Kazuhisa Tsuboki and Hiroyuki Yamada, Development of observation system for typhoon and thunderstorms with micro-satellites and ground-based lightning network, AGU Fall meeting, San Francisco, Dec 9, 2019.	
December 9, 2019	Poster Session	SATO, M., Y. Takahashi, H. Kubota, K. Yamashita, J. Hamada, S. Niwa, L. J. Estrebilllo, and Purwadi, "Relation between lightning activities measured by the V-POTEKA network and intensity development of 2018 Pacific typhoons", AGU Fall Meeting 2019, AE11A-3194, San Francisco, Dec 9, 2019.	

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Total

Lists of Achievements and Implemented Activities

3. Workshops, Seminars, Symposia and Other Events (Organized by the Project)

Event duration	Name of Organizer	Title of the Event	Location (Country, City, Venue)	Number of Participants (Including Team Members)	Overview
Oct 11, 2016	Hokkaido University	e-ASIA Kick-off Meeting	Indonesia, Jakarta, BPPT	25	
Nov 27, 2019	Hokkaido University	e-ASIA JRP final workshop	Indonesia, Serpong, BPPT	20	

2

Total

Lists of Achievements and Implemented Activities

4. Record of Research Exchanges

Date of Departure	Date of Return	Last Name & First Name	Country of Affiliation	Affiliation	Position	Exchange Destination (Country, City, Research Organization etc)	Description of Exchange Content/Purpose	Duration of Exchange (autocompleted)
October 10, 2016	October 13, 2016	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Indonesia, Jakarta, BPPT	To attend the kick-off meeting of the project	4
October 10, 2016	October 13, 2016	Mitsuteru Sato	Japan	Hokkaido University	Lecturer	Indonesia, Jakarta, BPPT	To attend the kick-off meeting of the project	4
October 10, 2016	October 13, 2016	Eriko Momota	Japan	Hokkaido University	Program Coordinator	Indonesia, Jakarta, BPPT	To attend the kick-off meeting of the project	4
June 6, 2017	June 9, 2017	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Indonesia, Jakarta, BPPT&LAPAN	To have meeting on the thermal infrared camera and the Collaborative Research Agreement(CRA)	4
September 3, 2017	September 7, 2017	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Indonesia, Jakarta, BPPT&LAPAN	To have meeting on the thermal infrared camera and the Collaborative Research Agreement(CRA)	5
2018/7/23	July 27, 2018	Hiroyo Ohya	Japan	Chiba Univrsity	Assistant Professor	Philippines, Los Banos, PAGASA	Field Servey	5
June 17, 2019	June 22, 2019	Purwadi	Japan	Hokkaido University	DC2	Indonesia, Serpong, BPPT	Installation of the lightning sensor	6
July 1, 2019	July 4, 2019	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Indonesia, Serpong, BPPT&LAPAN	Meeting and hand-over the infrared camera	4
September 23, 2019	September 27, 2019	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Myanmar, Meiktila, MAEU	Meeting on the Lightning sensor	5
November 10, 2019	November 12, 2019	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Philippines, Manila, DOST-ASTI	Meetings	3

November 25, 2019	November 28, 2019	Yukihiro Takahashi	Japan	Hokkaido University	Professor	Indonesia, Serpong, BPPT	To attend the kick-off meeting of the project	4
November 25, 2019	November 28, 2019	Eriko Momota	Japan	Hokkaido University	Program Coordinator	Indonesia, Serpong, BPPT	To attend the final workshop of the project	4
November 26, 2019	November 28, 2019	Lopez Glenn Vincent	Philippines	The Advanced Science and Technology Institute (DOST-ASTI)	Senior Science Research Specialist	Indonesia, Serpong, BPPT	To attend the final workshop of the project	3
November 26, 2019	November 28, 2019	Castro Ellison	Philippines	University of the Philippines Dilliman	Researcher	Indonesia, Serpong, BPPT	To attend the final workshop of the project	3
November 25, 2019	November 30, 2019	Purwadi	Japan	Hokkaido University	DC2	Indonesia, Serpong, BPPT	To attend the final workshop of the project	6
December 8, 2019	December 15, 2019	Yukihiro Takahashi	Japan	Hokkaido University	Professor	USA, San Francisco, Mosco center	To give a presentation of the project result and to get information from other researches	8
January 27, 2020	January 30, 2020	Eriko Momota	Japan	Hokkaido University	Program Coordinator	Philippines, Manila, DOST-ASTI&UPD	Meetings	4

Total (Person) 17

Total (Person-day) 76

Lists of Achievements and Implemented Activities

5. Patent Applications

5. 1 Independent Applications by Single Team

Application Number	Name of Patent/Patent Name	Application Date	Patent Applicants (Fill in All Members)	Publication Number (leave blank if unpublished)	Inventor	Country of Application	Registration Number (leave blank if unregistered)	Country Name of the Team

0

Total (Number of Application)

0

Total (Number of Registration)

5. 2 Joint Applications

Application Number	Name of Patent/Patent Name	Application Date	Patent Applicants (Fill in All Members)	Publication Number (leave blank if unpublished)	Inventor	Country of Application	Registration Number (leave blank if unregistered)

0

Total (Number of Application)

0

Total (Number of Registration)

Lists of Achievements and Implemented Activities

6. Awards

Date of Award	Name of Award	Recipient	Remarks	Country Name of the Team

0

Total