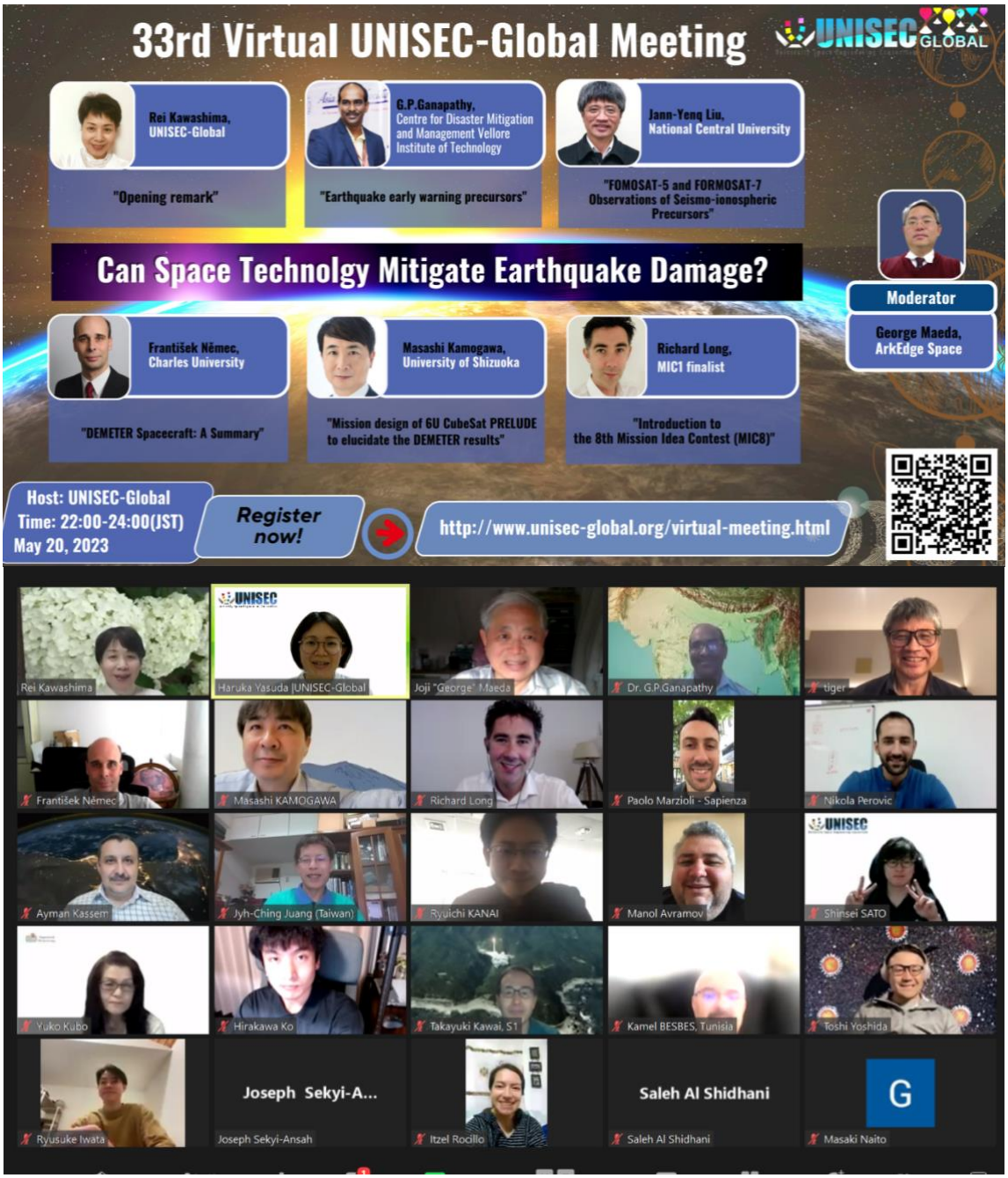
UNISEC-Global The 33nd Virtual Meeting

May 20, 2023, 22:00-24:00
(Standard Japan time GMT +9)



The following report was prepared by UNISEC-Global Secretariat
May 20, 2023
Japan

Table of Content

1. Opening Remarks

Rei Kawashima, UNISEC-Global

Rei Kawashima has contributed to micro/nano/pico satellites for education and business applications through her leadership role in UNISEC – the University Space Engineering Consortium that she co-founded in 2002. In 2013, she was appointed as the Secretary-General of UNISEC-Global, an international NGO that she co-founded in 2013 and was accepted as a permanent observer of UNCOPUOS in 2017. She organizes training programs and technology competitions to facilitate university's participation in space projects worldwide and especially in emerging countries.

Pictured: Rei Kawashima providing the opening remarks

Highlights:

- Today's theme is earthquake damage and mitigation
- Over 90% participants state space technology can mitigate earthquake damage
- Personally, I am not sure whether space technology can really mitigate
- Japan suffers from earthquake both historically and now
- Hanshin Awaji earthquake on 17 Feb, 1995 at 5:45 JST
    - City of Kobe, very personal since personal family members lived there
    - 6k killed, 40k injured, 330k number of infrastructures damaged
- Tohoku Earthquake and Tsunami on 11 March, 2011 at 14:46 JST
    - 16k killed, 2k missing (90% died due to drowning)
    - 6k injured, 1 million buildings affected
    - Nuclear power plant failure in Fukushima
    - MIC 1 was organized three days after the earthquake coincidently
- Asked Dr. Kamogawa to present "Earthquake Pre-Cursor Study with NanoSatellite"
- MIC 2 final presentation at UN/Japan Nano-satellite Symposium, came 2nd place
- Turkey-Syria Earthquake on 6 Feb, 2023 at 04:17 TRT
    - 50k killed, 297 missing, 107k injured
    - 4 million buildings destroyed
- Seismic monitor: http://ds.iris.edu/seismon/index.phtml
- Red means <24 hours, the monitor shows activity all around the world
- Nankai Trough Earthquake
    - 30% chance in next 10 years, 70-80% in 30 years, 90% in 40 years
    - Tsunami will be triggered in 3 minutes
    - Can we detect earthquake 30 minutes earlier?
- Today's presenters are world class at earthquake precursor studies

2. Presentation on "Earthquake Early Warning Precursors"

Ganapathy Pattukandan Ganapathy, Vellore Institute of Technology

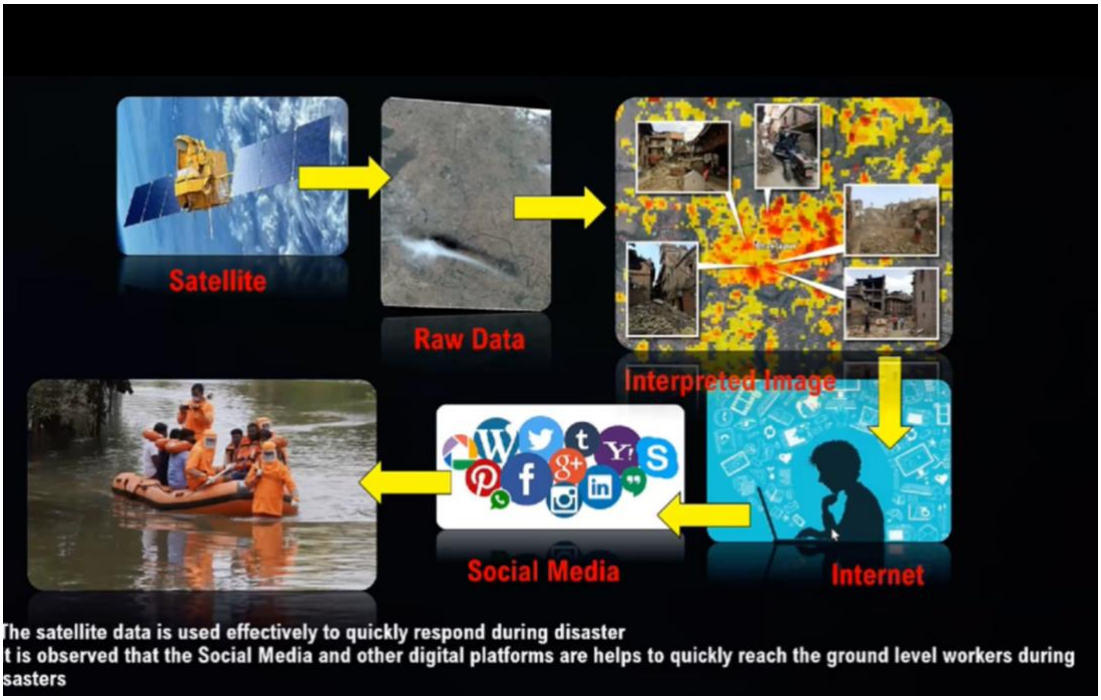
Dr. G.P.Ganapathy, graduated from the Anna University, Chennai, India in the year 1997 and completed his Masters from the same university in Applied Geology Discipline. He completed his Doctoral Research in Earthquake Microzonation for Chennai City at Anna University. Dr.Ganapathy has served for Centre for Disaster Mitigation and Management, Anna University for eight years as a scientist and carried out research studies the field of earthquake hazard assessment, earthquake monitoring, seismic micro-zonation, landslide hazard zonation, liquefaction hazard mapping, soil bio engineering for slope stabilization, environment impact assessment and management. He moved to Centre for Disaster Mitigation and Management, Vellore Institute of Technology (VIT), Vellore, Tamil Nadu, India. Dr. Ganapathy Served as Director for Centre for Disaster Mitigation and Management, Vellore Institute of Technology (VIT), Vellore, Tamil Nadu, India from the year 2015.

Pictured: Dr. Ganapathy outlines some of the precursor for earthquakes

Highlights:

- Historical earthquakes include Allepo in 1138, Shaanxi in 1556, Tangshan in 1976, Latur in 1993
- Death toll has reduced over time by using different technologies
- Space technology is an effective tool to mitigate earthquake, very good pre-cursors
- If we can merge precursors and technology, we can have a very good tool for early warning system
- The building, infrastructure creates the major hazard during the earthquake
- Two types of earthquake: inter-plate and intra-plate
- Intra-plate earthquakes can be mitigated which happens due to movement of tectonic plates
- Effects include shaking, liquefaction, faults, land subsidence, landslides, tsunamis
- Can we cause earthquakes and can we prevent earthquakes?
- Human activities can cause earthquakes, there are examples
- Foreshocks: earthquakes that happen before the main/larger earthquake in the same location
- Aftershocks: smaller earthquakes that happen after the main earthquake in the same location
- Swarms: mostly small earthquakes with no particular main earthquake
- The increase in earthquake is because of the increased instruments that are available for measurment
- No scientific evidence that people can "detect" through natural occurring symptoms
- Faults do not open during earthquakes
- Rains after prolonged droughts might have effects in seismic activity due to ground recharge
- **Prediction has 1) date and time 2) location 3) magnitude**
- Animals have also shown to show signs of relative unrest before earthquakes, no evidence

- Physical dilation where ground goes up and down can a precursor
- Seismic Quiescene, also known as the “calm before the storm” in earthquake science
- This relates to the suspension of normal seismic activity before the major event
- Fault creep and continuous strain can also be one of the precursors
- Observation of seismic activity in particular area, with relative intensity increasing
- Changes in ground water level fluctuation, others are included in the next point:
- Anomalous Geochemical Observation, seismic wave velocity, ground vibration, geochemical anomaly
- To mitigate earthquakes
    - Hazard assessment
    - Rapid visual screening of buildings
    - Damage scenario using Hazus Methodology
    - Damage heatmap on analyzed satellite data
    - Rapid damage mapping
- Traditional architecture can play a major role in reducing damage



Pictured: Dr. Ganapathi showing the process post-earthquake rapid response analysis using satellite data

3. Presentation on “The Seismo-ionospheric Precursors Observed by FORMOSAT-7/COSMIC-2

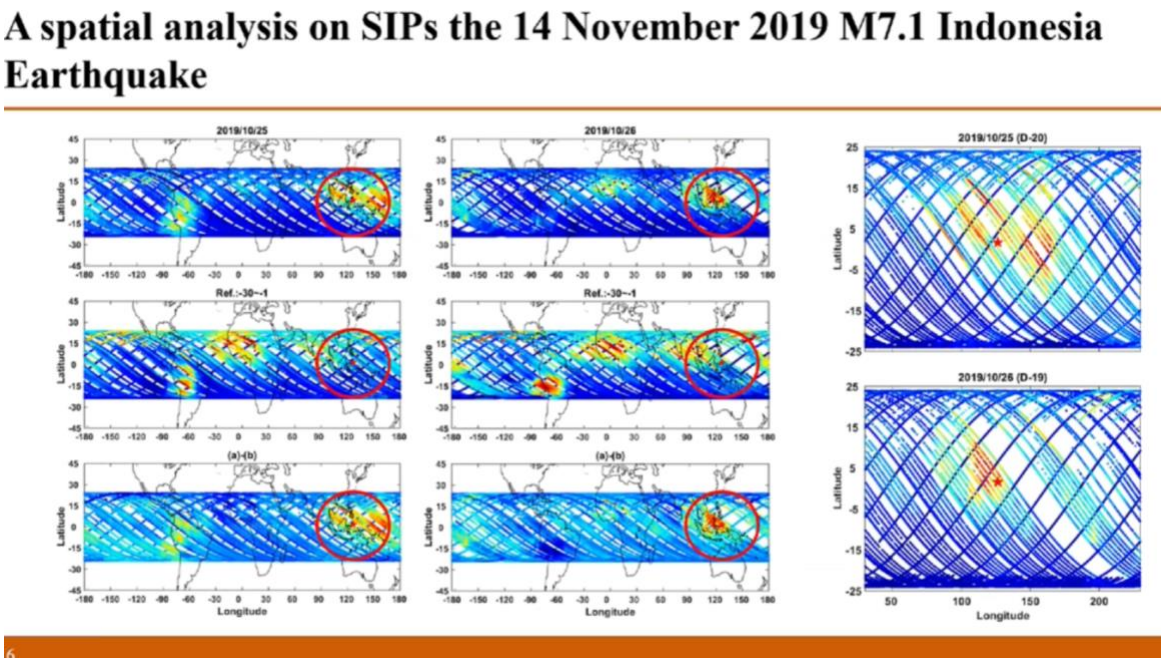
Jann-Yenq Lui, National Central University

Prof. Jann-Yenq Liu received BS from Atmospheric Physics Department, National Central University, Taiwan in 1980, as well as MS and PhD from Physics Department, Utah State University, USA in 1988 and 1990 respectively. He was Associate Professor at Institute of Space Science, as well as Center for Space and Remote Sensing Research, National Central University, Taiwan during 1990-1997, and has been professor since 1997. He also served as Chief Scientist of National Space Organization (NSPO) in Taiwan during 2011-2015. Jann-Yenq Lui is currently the chair professor at Department of Space Science and Engineering, as well as Director of Center for Astronautical Physics and Engineering, National Central University Taiwan. His research specialty is ionospheric radio, GNSS geoscience applications, ionospheric modeling, and lithosphere-atmosphere-ionospheric coupling.

Pictured: Prof. Lui presenting about precursors observed by FORMOSAT-7/COSMIC-2

Highlights:

- Ion Velocity Meter (IVM) and Radio Occultation (RO) observation all over the earth
- IVM measures ion density, ion temperature and ion velocity
- Observing Equatorial Ion Anomaly could be one of the precursors
- Subionospheric Point (SIP) detection about 14-15 days prior to earthquake
- Shown using the example of 14 Nov, 2019 M7.1 Indonesia earthquake
- The anomaly only appeared right above the earthquake point (epicenter) about 19-20 days
- If D=0 is the day of the earthquake, D-20 to D-19: 27/28 which is 96.4%
- Payload developed called “CIP” to place it on CubeSats
- Global Ionospheric Specification (GIS) is an electron density map
- Based on the 2019 M7.1 Indonesian earthquake
    - Significant increase in ion density 19-20 days before event, can predict before 2 weeks
    - Eastward electric field has been enhanced during SIP days
    - The seismo-generated electric fields are 0.34-0.64 mV/m eastward



Pictured: SIPs and increase of ion density during the M7.1 Indonesian earthquake

4. Presentation on “DEMETER Spacecraft: A Summary”

František Němec, Charles University

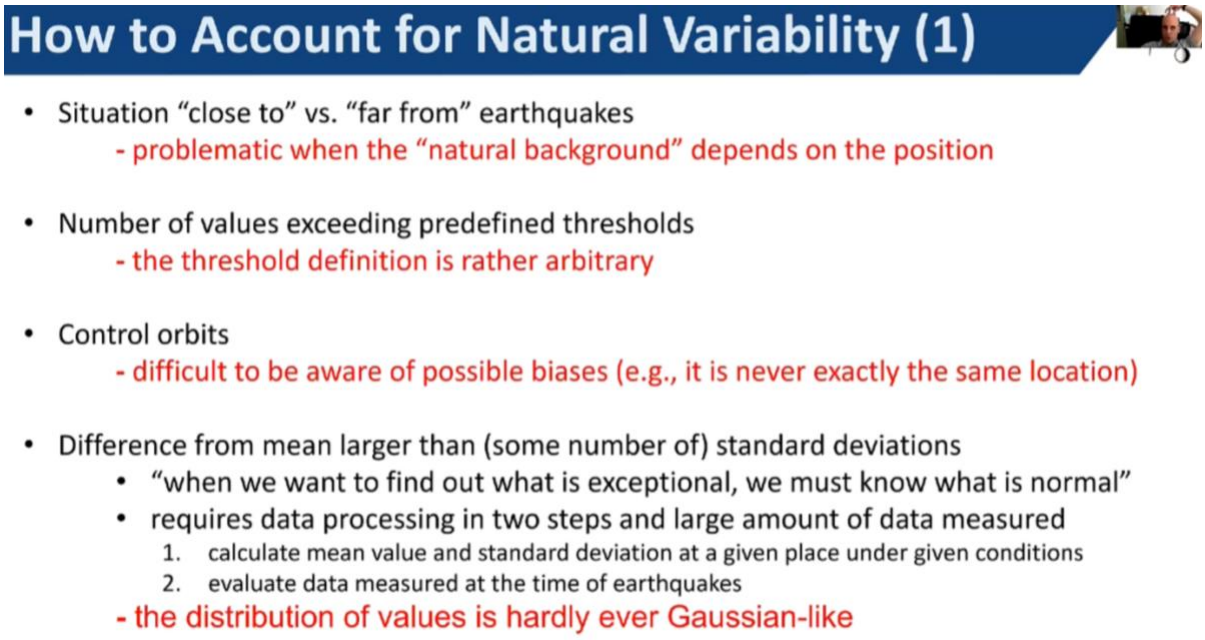
Dr. František Němec did his PhD in Plasma Physics from Charles University and University of Orleans in 2009. Since 2019, he has been working as an Associate Professor at Faculty of Mathematics and Physics at Charles University, Prague, Czech Republic. He specifically works for the Space Physics Group at the Department of Surface and Plasma Science at the faculty. He previously worked for Czech Academy of Sciences and University of Iowa.

Pictured: Dr Němec presenting about DEMETER Spacecraft and the science behind precursors

Highlights:

- PhD supervised by Dr. Michel Parrot
    - Dr. Parrot is the PI of DEMER satellite
    - Research of natural and artificial electromagnetic wave signals
    - Always up-to-date with latest research
- DEMETER is shortened form of Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions
- Study of ionospheric disturbances in relation to seismic activities, post-pre effect study
- Anthropogenic activities were studied, also natural relating such as lightning
- Launched 29 June 2004, mission ended in December, 2010
- Micro-satellite with a weight of 130 kg
- Sun Synchronous Orbit, two modes of operation included burst and survey
- Links
    - http://demeter.cnrs-orleans.fr/
    - http://sipad-cdpp.cnes.fr/
- Instruments onboard included
    - ICE: 3 electric sensors from DC up to 3.5MHz
    - IMSC: 3 magnetic sensors from few Hz up to 18 kHz
    - IAP: ion analyzer
    - IDP: energetic particle detector
    - ISL: Langmuir probe
    - RNF: Neural network for whistle detection
- Measurement of freq. were ULF, ELF, VLF and HF with combination of burst, survey
- Mix of electric and magnetic field measurements in frequency ranges
- Plasma (1-4s), Energetic Particle Measurements (about 1s)
- Onboard implementation of neural network that could detect high resolution data
- High resolution data is not transmitted and is removed

- For every 0.1s time interval, the neural network identified the number of whistlers
- Very new concept implementation of neural network for early 21st century
- Didn't completely work properly, but was a good experiment
- Seismic related effects are still not clear
- Problems include multi-layer propagation and strong natural background
- Placing on space could over the entire earth
- Not clear what point the spacecraft needs to "see" on earth for seismic activity
- Important question is how do we account for natural variability
    - Natural background is extremely variable, threshold is arbitrary, no exact same position, therefore, not appropriate
    - Use statistical methods, using large sets of data, mean and standard deviations
    - However, the value distribution is never Gaussian like
- Best way is to use a method called "normalized probabilistic intensity"
- Nemec et al., GRL, 2008 paper showed seismic effects results, VLF
    - Demonstration for M greater or equal to 4.8
    - Demonstration for M greater or equal to 5.0
    - Within 330km of the earthquake shallower than 40km, Nightime only
- Any VLF above 1.7 kHz, earth-ionospheric wavelength propagation
- Measurement in changes of wavelength, that allows us to understand earthquakes
- Ionospheric density changes have also shown to be precursors
- DEMETER satellite was extremely successful
- Existence of seismic related precursors are still questionable but statistics is improving it
- Elaborate statistical analysis needed



Pictured: Dr. Němec outlining some of the challenges in accounting for natrual variability in precursors

5. Presentation on “Mission Design of 6U CubeSat PRELUDE to Elucidate the DEMETER Results”

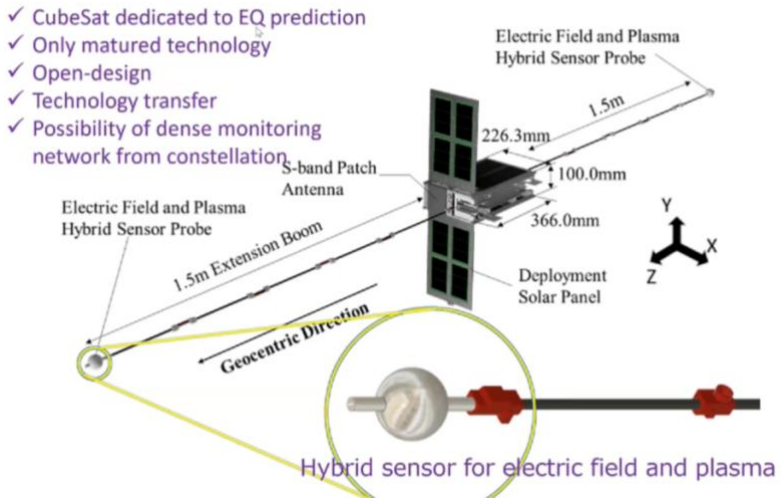
Masashi Kamogawa, University of Shizuoka

Dr. Masashi Kamogawa is an Associate Professor at Division of Earthquake Prediction Research, Global Center for Asian and Regional Research, University of Shinzouka. He is also the Executive Director and General Secretary for Mount Fuji Research Station. He is the Director of UNISEC. Dr. Kamogawa is primarily a physicist and researcher of earthquakes, tsunami, and lightning.

Pictured: Dr Kamogawa presenting about 6U CubeSat PRELUDE

Highlights:

- So far, it has been difficult to predict earthquake using precursors but the community is trying
- Electron density increases within 4 hours for earthquakes that are greater or equal to M 4.8
- Night time detection by satellites, the chance is about 20-30%
- After DEMETER by CNES France, there have been significant satellites launched
    - CSES by China Earthquake Administration, China National Space Administration
    - CSES plans to launch 5 satellites, 1 launched in 2018 and planned to launch others in 2023
    - KazSciSat-1 is a 3U using UHF amateur band, only magnetic field measurement
- PRELUDE is a 6U CubeSat selected to be launched using Epsilon rocket, expected JFY 2024
- Using S-band, so called Cloud Ground Station
- Lightning-origin EM waves are used as a natural radar for precursor monitor
- Cloud ground-stations provide real-time precursor monitoring
- Burst mode (waveform sampling) clearly identifies the precursor
- During night time, the electric field is measured by
    - Survey mode which is continuous measurement at 1Hz
    - Burst mode which can measure continuously at 40Hz
- With GNSS TEC, Langmuir Probe and House Keeping (HK) data, the total data per day is 103.5MB
- DEMETER only measured in high seismic regions
- PRELUDE aims to measure double the number of earthquake that DEMETER did
- Over 100 earthquake events expected to measure per year
- Satellite is designed and developed by Nihon University, data analysis by University of Shinzouku
- WEL Research boom development, LATMOS/CNRS of France Electron Emitter
- Infostellar provides ground stations and UNISEC other supports
- Mature technologies used on the CubeSat, for instance the hybrid sensor that was used in DEMETER
- Open Design, possibility for dense monitoring network using constellation
- 3U volume set aside for boom and sensors, other 3U for BUS system
- Aim is to observe 100+ large earthquakes M>7.0 in the next 12 years



Pictured: PRELUDE 6U CubeSat dimensional overview

6. Presentation on "Introduction to the 8th Mission Idea Contest"

Richard Long, MIC1 Finalist

Richard Long received the third place for his "Distributed Multispectral Imaging System" in Mission Idea Contest 1 (MIC1) held in Japan and organized by UNISEC. The abstract was then applied through Surrey Satellite Technology Limited.

Pictured: Richard Long gives an introduction to MIC 8 to the UNISEC community

Highlights:

- MIC 8 theme is "Missions by Multiple Nano-satellites"
- Multiple satellites made out of 6U or smaller
- Has to have at least 2 satellites so that the mission can be called a constellation
- Has to have clear benefits of having two or more satellites in orbit simultaneously
- Constellations (with no intersatellite link) or Formation Flying (with intersatellite link)
- Abstract is due June 30, 2023
- Notification by August 8, 2023
- Full paper submission due by October 3, 2023
- Final presentation on November 23. 2023 in Tokyo, Japan
- Link for MIC8: http://www.spacemic.net
- MIC was launched in 2010 to explore innovation in small satellites
- People from wide range of fields involved in MIC
- 7 MICs and 4 Pre-Workshops successfully organized between 2011-2022
- 4 books published as IAA book series
- MIC 1: Distributed Multi-Spectral Imaging System Supporting Disaster Monitoring and Relief
    - Constellation of 3U x3 CubeSats
    - Case study of monitoring and remote
    - Up to 20 observation opportunities for 3 planes of 4 satellites over 2 days
- Wide range of topics have been proposed, imagination is the key
- Evaluation criteria:
    - [25] Originality: how novel is the concept, the concept is very open
    - [25] Impact: how will this impact the society at large
    - [20+15] Engineering: technical description and solutions and Operations, userbase and output
    - [15] Feasibility: realistic cost, development schedule, supply chain, infrastructures and risks
- MIC Coordinators include mentoring, coordinating and networking
- Reasons for joining the MIC include
    - Capacity building, looking for meaningful missions, free lectures, exposure, technical upgrade
    - Excellence will be awarded and prizes will be given
- More information here: info@spacemic.net
- The end of MIC is just the beginning; ideas are validated and the actual satellite building takes place

MIC Winners' Mission Ideas

	Proposed idea	Country
MIC 1 (2011,Tokyo) (constellation)	Integrated Meteorological / Precise Positioning Mission Utilizing Nano-Satellite Constellation	Japan (professional)
MIC 2 (2012,Nagoya) (Satellite Design)	SOLARA/SARA:Solar Observing Low-frequency Array for Radio Astronomy/ Separated Antennas Reconfigurable Array	USA (student)
MIC 2 (2012,Nagoya) (Business model)	Underground and surface water detection and monitoring using a microsatellite	South Africa (student)
MIC 3 (2014, Tokyo)	Clouds Height Mission	Germany, Italy, Slovenia (professional)
MIC 4 (2016, Bulgaria)	CubeSat constellation for monitoring and detection of bushfires in Australia	Australia(student)
MIC 5 (2018, France)	Smallsat Ionosphere Exploration at Several Times and Altitudes,	Taiwan, USA, India (student)
MIC 6 (2019, Tokyo) (ISS-IceCube)	MUSA: An ISS Experiment for research of a dual culture for Panama Disease	Costa Rica(student)
MIC6 (2019, Tokyo) (ISS-iSEEP)	Spectrum Monitoring from Space with i-SEEP (SMoSiS)	Philippines (professional)
MIC7 (2022, Tokyo)	PARS: Precursor Asteroid Remote Survey	Turkey (student)

Pictured: TELNET's involvment in wide ranging activities including space and telecom

7. Announcement and Acknowledgement

Haruka Yasuda, UNISEC-Global

Pictured: Yasuda-san announcing the latest updates from UNISEC

- **New POC of Montenegro**
  - Nikola Perovic, co-founder of SESA which aims to improve and educate people in space
  - Specialization in robotics, involved in first Montenegrian satellite called "Luca"

Pictured: Nikolo Pervoic is the new UNISEC POC for Montenegro

- **CLTP-12 (CanSat Leadership Training Program-12)**
  - August 21 – September 1, 2023
  - Nihon University, Chiba, Japan
  - For full/partial scholarship: May 23, 2023
  - For self-funded: June 1, 2023
  - Online assessment details will be provided
  - Notification of acceptance for full/partial scholarship: June 14, 2023
  - For self-funded, the notification will be on June 28, 2023
  - Website: http://cltp.info/index.html
  - Email: secretariate@cltp.info

- **9th UNISEC-Global Meeting**
  - Venue: Tokyo, Japan, in-person event
  - November 27 – December 1, 2023
  - Details: to be announced
  - J-Cube Workshop during the same time
  - Same time as 8th Mission Idea Contest final presentation, will be held during meeting

- **MIC 8 Overview**
  - Theme: "Missions by multiple nano-satellites"
  - Constellation mission or formation flying, constellation should be 6U or smaller
  - Clear benefits of having each satellite
  - Abstract submission due: **June 30, 2023**
  - Notification: August 8, 2023
  - Full Paper submission due: October 3, 2023
  - Final presentation: TBD (Nov or Dec, 2023, in Japan) at 9th UNISEC-Global Meeting
  - Full information: http://www.spacemic.net
  - Local competitions can be held in their own topics as well

- **J-CUBE**
  - Special discount launch opportunities for 1U-3U (almost 1/3rd discount)
  - Need to collaborate with UNISEC-Japan's university
  - Technical support will be provided
  - Full information: http://unisec.jp/services/j-cube
  - Contact: info-jcube@unisec.jp

- **34th Virtual Meeting**
  - Date: June 17, 2023 22:00 – 24:00 (JST)
  - Theme: Per Aspera ad Astra: Student and Experimental Activities within the New Space Scenario
  - Host: UNISEC-Italy
  - Moderator: Paolo Marzioli (Co-POC of Italy)
  - Virtual UNISEC-Global Meetings takes place third Saturday of almost every month of 2023
  - Seeking local chapters for July 15

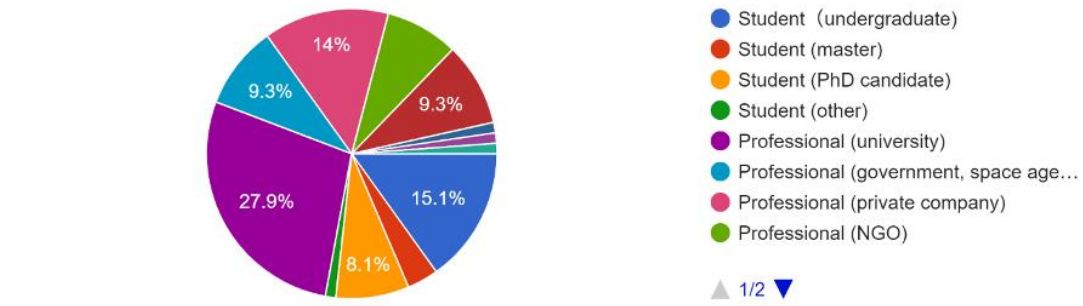
8. Participant Statistics

86 registered participants from **34** countries and regions for the 33rd Virtual UNISEC-Global Meeting.

Country/Region	Number of registrations	Country/Region	Number of registrations
Australia	1	Mexico	2
Bangladesh	2	Montenegro	1
Bosnia and Herzegovina	1	Namibia	1
Bulgaria	3	Nepal	1
Canada	1	Oman	1
Chile	1	Paraguay	2
Colombia	1	Philippines	3
Czech Republic	1	Romania	1
Dominican Republic	1	Russia	1
Egypt	3	Sudan	1
Ghana	1	Taiwan	2
India	4	Tunisia	5
Indonesia	1	Turkiye	1
Italy	1	USA	1
Japan	27	Uganda	2
Kenya	6	UK	3
Kazakhstan	2	Luxembourg	1

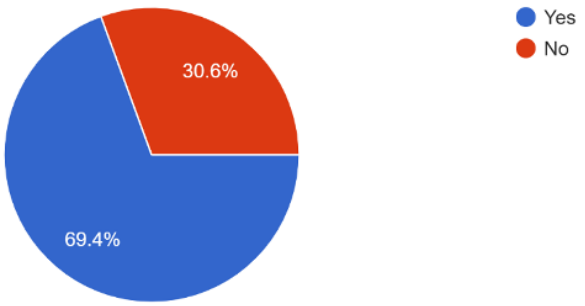
Student or professional?

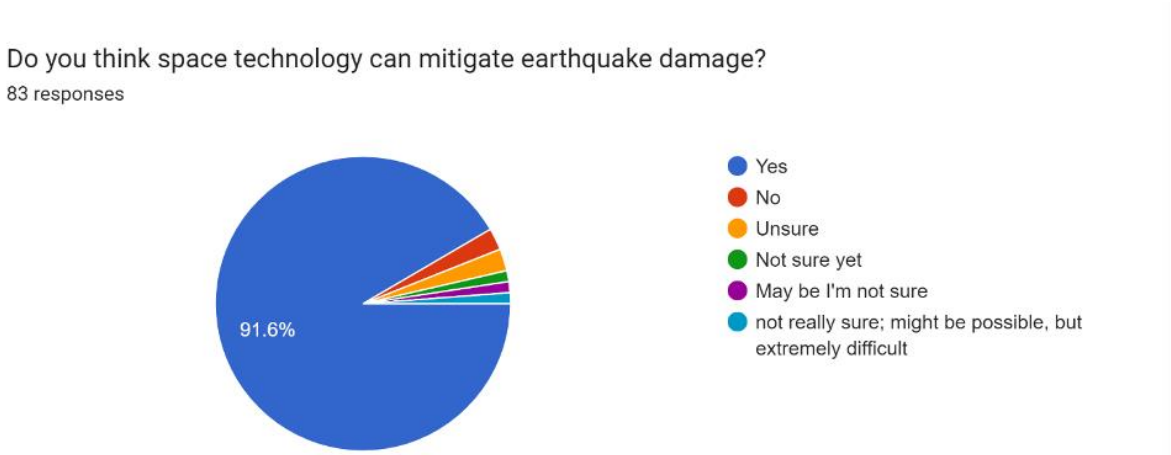
86 responses



Have you participated in the UNISEC-Global Meeting previously?

85 responses




Do you think space technology can mitigate earthquake damage?
83 responses
91.6%
Yes
No
Unsure
Not sure yet
May be I'm not sure
not really sure; might be possible, but extremely difficult


UNISEC-Global Social network accounts
@unisecglobal
https://www.facebook.com/unisecglobal/
@unisec_global
https://www.instagram.com/unisec_japan/
Linked in
https://www.linkedin.com/groups/8982613/
© 2020 UNISEC. All rights reserved.
6
UNISEC GLOBAL

Thank you