National Institute of Information and Communications Technology

Space Weather R&O activity in Japan under COVID-19

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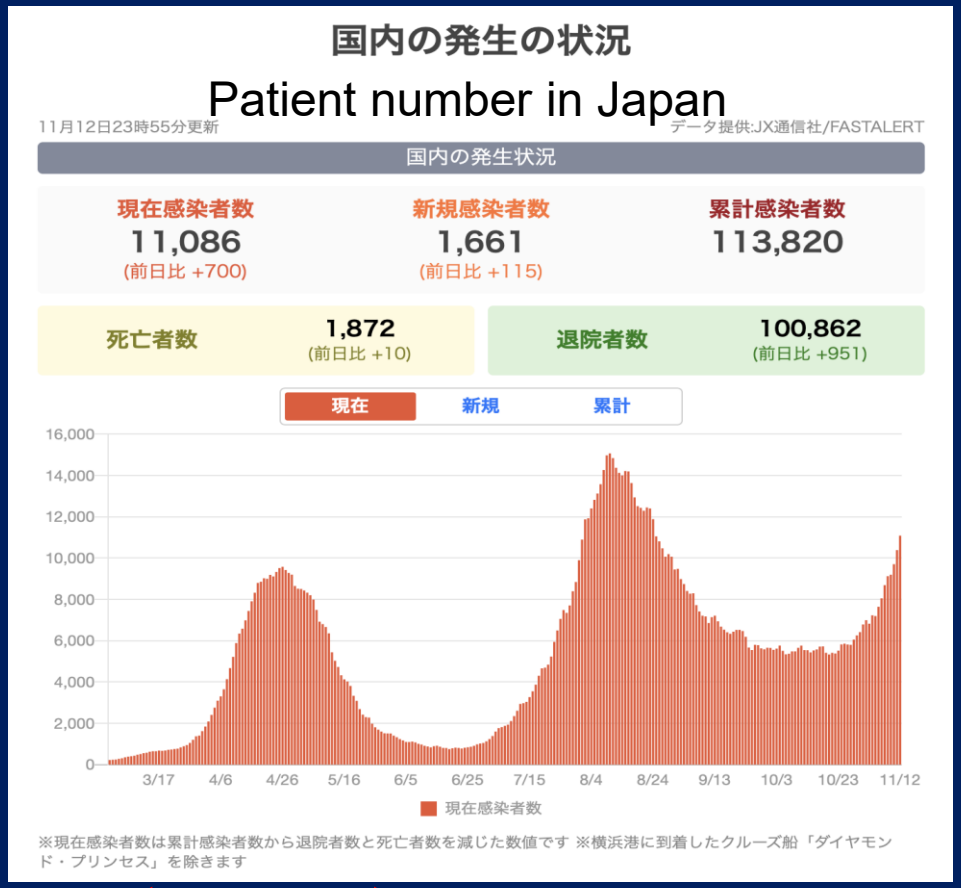
The COVID-19 situation in Japan



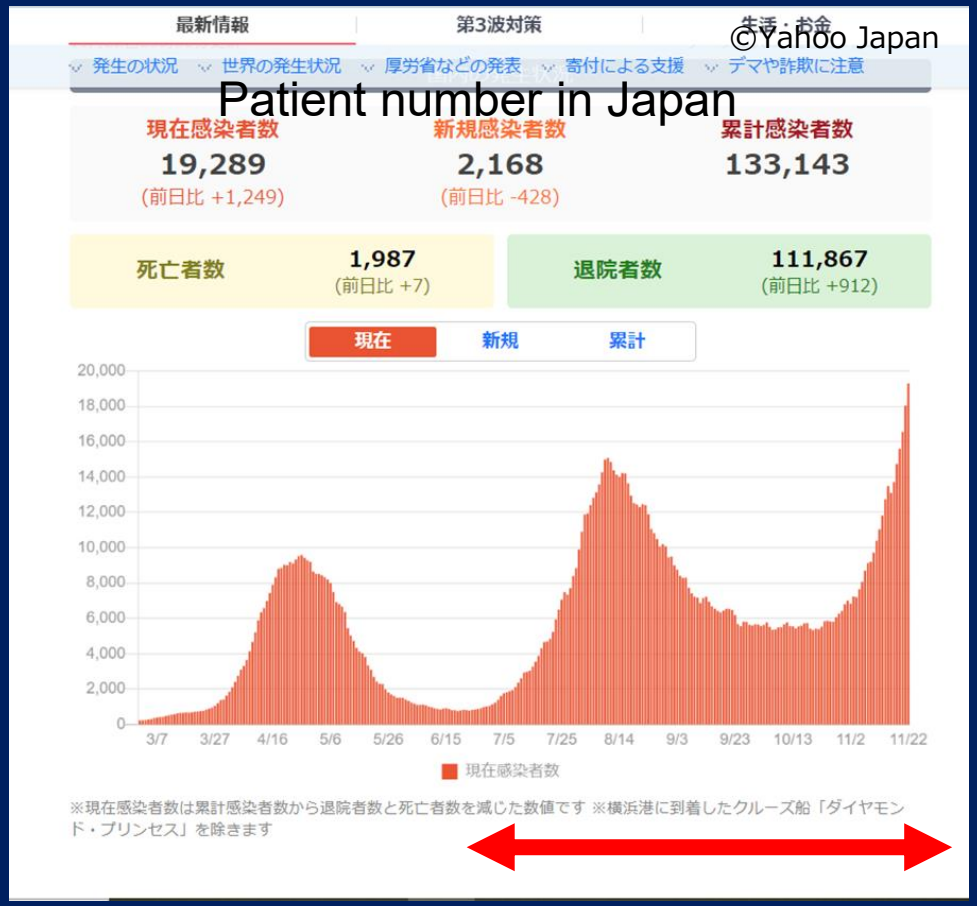
- Feb 5, the first positive case was detected on the cruise ship

- Mar 24, Tokyo Olympic Games was postponed

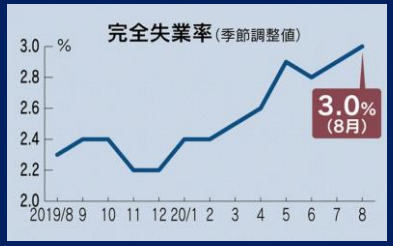
- Apr 7 – May 26 “State of emergency” was issued

Japan overcame the “1st wave” by prompt measures

The COVID-19 situation in Japan



- **Unemployment rate jumped up (mainly travel and restaurant industry)**



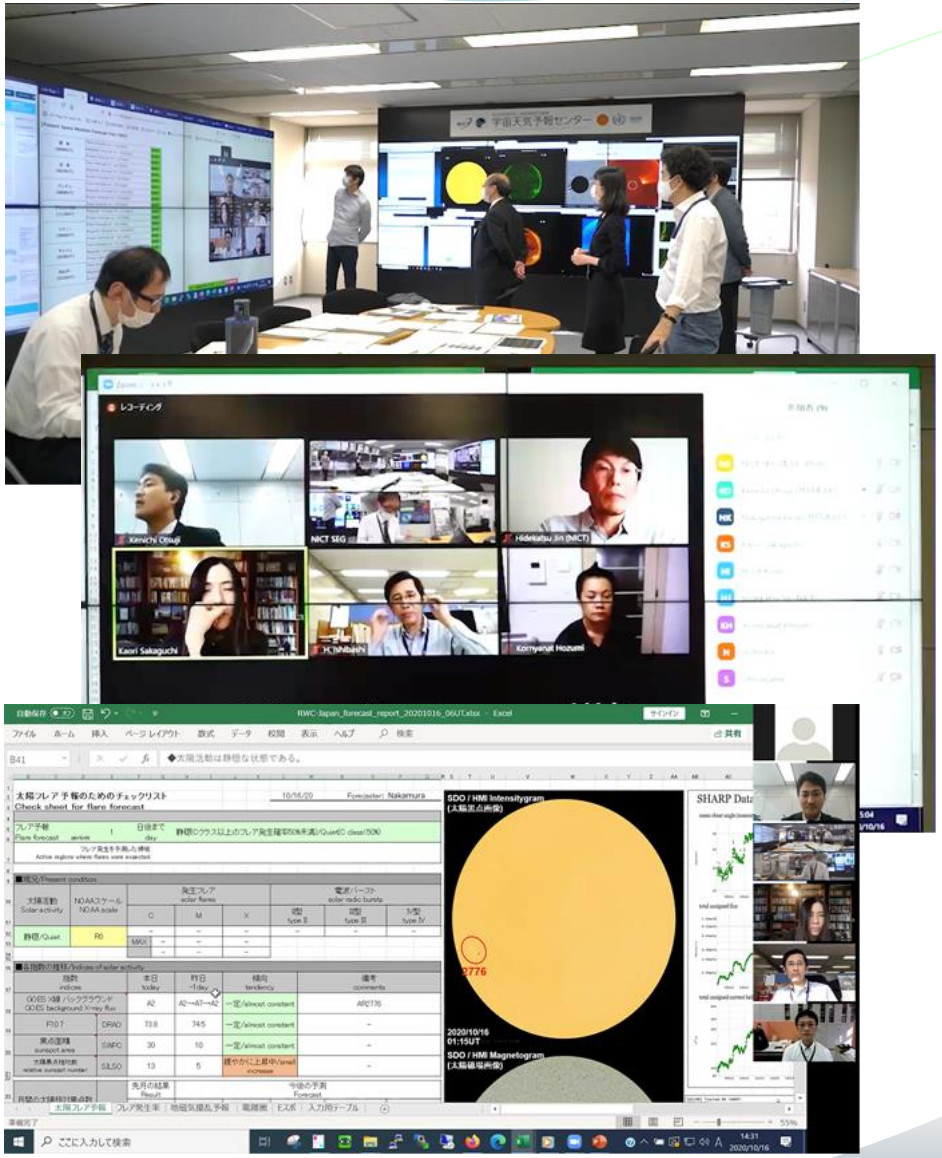
- **Jun 19, all travel restrictions was cancelled, and**
- **Jul 22, "go to travel" campaign was started as a governmental economic measure**

- **Now Japan faces the "2nd" and coming "3rd" wave**

Japan restarted economic activity and faced the "2nd wave". And now the patient number rises again. Japan should brace the coming "3rd wave".

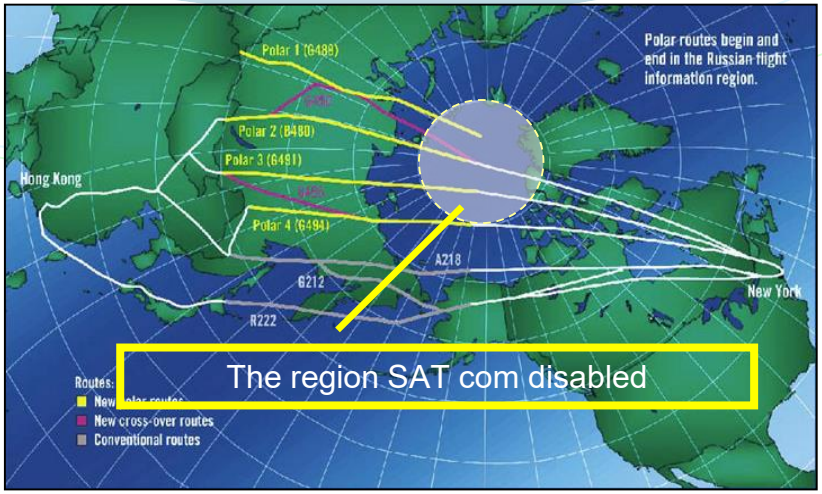
Space Weather forecast briefing under COVID-19

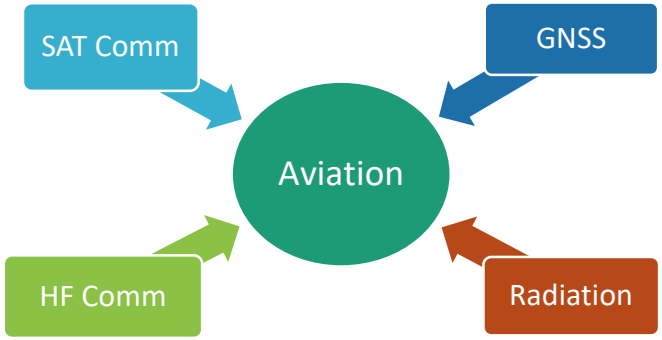
- After the state of emergency on April 7, 2020, all operations in NICT moved to tele-work after April 8.
- We prepared infrastructure for space weather forecast briefing with web conference because of 24/7 monitoring.
- We had not fixed schemes so we had some troubles on the beginning. But space weather forecast information service continuously.
- Web conference has been used for forecasters' hand over for avoiding spread of COVID-19.
- SWx user committee (Oct.20) and users' forum （Nov.11) were held woth ZOOM and the participants increased from the past.

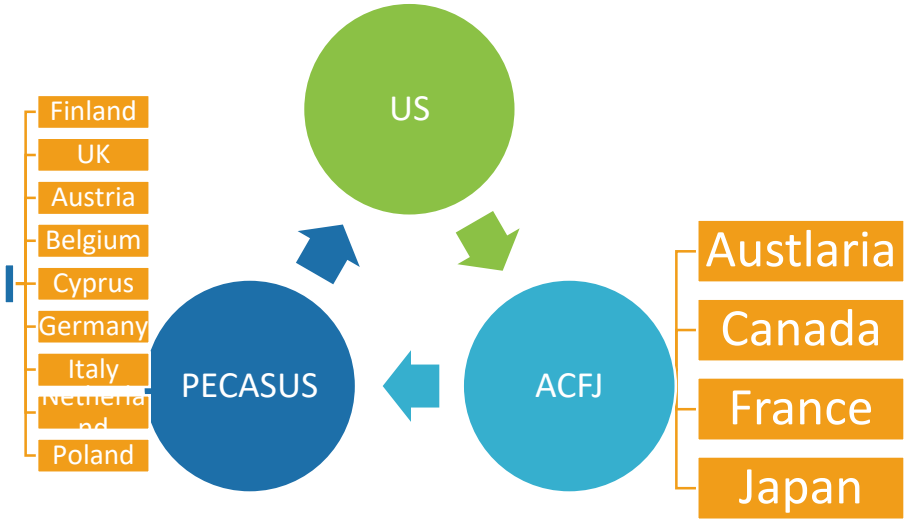


ICAO Space Weather Services

- ICAO, International Civil Aviation Organization started to provide space weather services since Nov. 2019 with three global centers (US, European consortium named PECASUS and ACFJ which is a consortium of Australia, Canada, France and Japan) with rotating their responsibility every two weeks.
- These global centers use their own observational data and models for monitoring and forecasting the ionosphere, which can cause inconsistency of official space weather forecast.
- NICT hosts data archive for collecting and sharing ICAO space weather center data for harmonizing and improving space weather forecast services.
- The system will establish on Dec. 2020 and the service will begin on Jan. 2021.







The three centers rotate their duty every two weeks.
The regular service started on November 7, 2019.

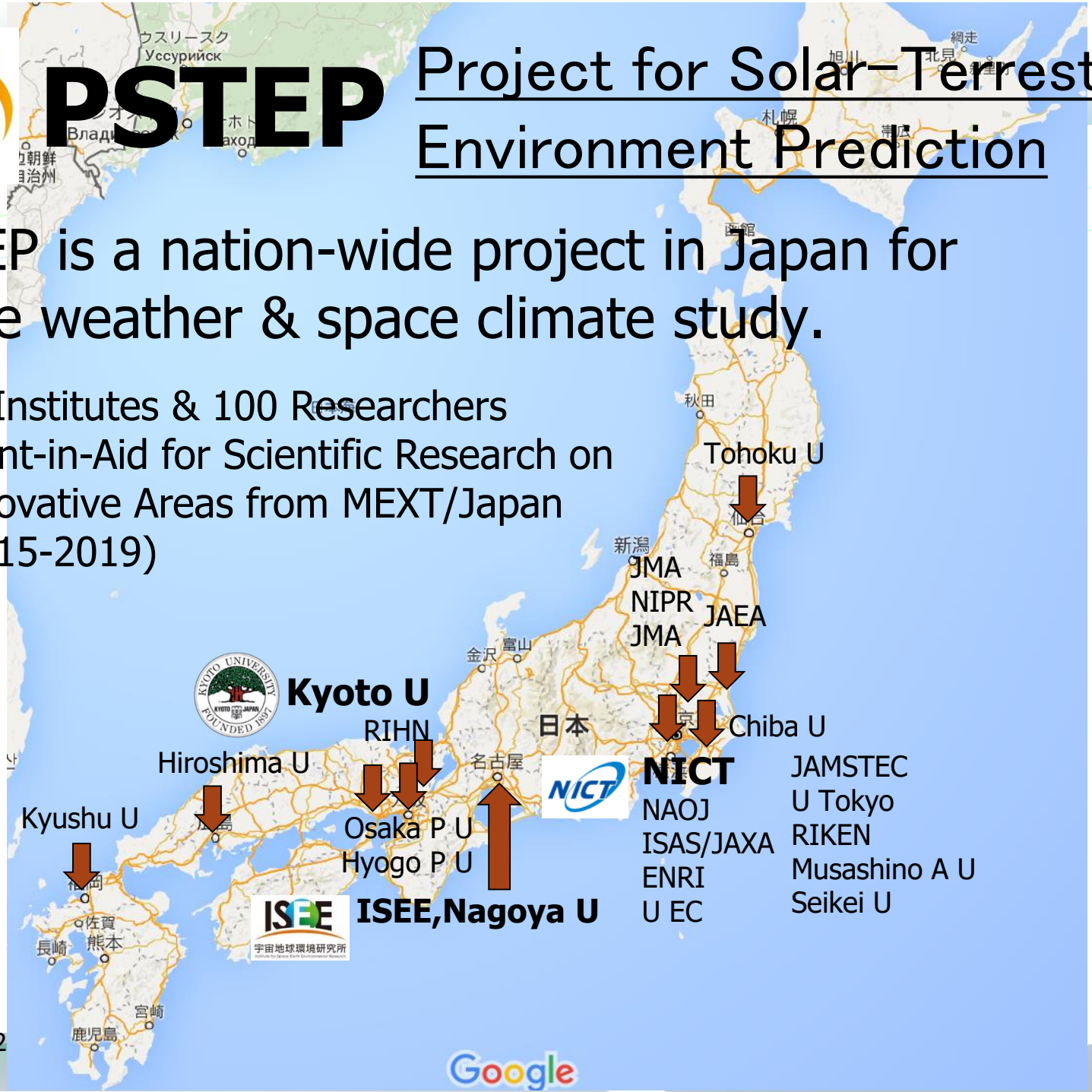
VHF radar was installed in Chumphon city, Thailand on Jan. 2020

PSTEP

Project for Solar-Terrestrial Environment Prediction

PSTEP is a nation-wide project in Japan for space weather & space climate study.

- 20 Institutes & 100 Researchers
- Grant-in-Aid for Scientific Research on Innovative Areas from MEXT/Japan (2015-2019)



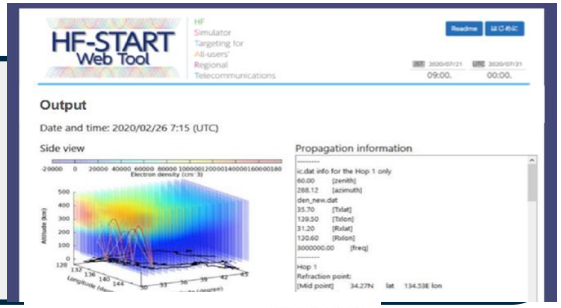
Outputs of PSTEP

Purpose: One of the purposes of PSTEP is to have close and both-way communications between users of space weather information and scientists, which makes us to provide useful applications for users, and to set clear scientific goals for scientists.
Plans :

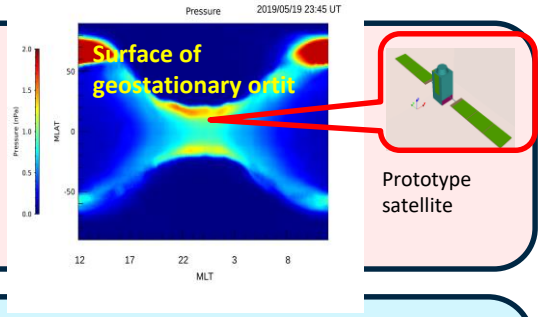
- With gap analysis between needs and seeds of space weather information service, we discuss and set goals of services, and develop the applications.
- We find critical parameters for improving space weather forecast precision with discussing integration of models for prediction.
- We set continuous communication between users and scientists for reflecting the opinions from both sides.

Developed Applications

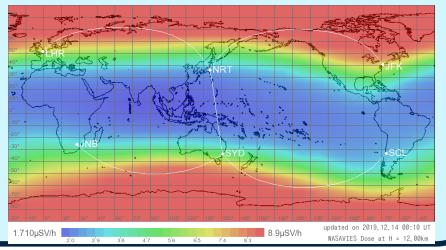
- An interactive HF propagation simulator was developed and will published on the Web
- Several ionospheric models and 3D real time ionospheric electron density deduced from observation are available for use



- Magnetospheric condition on the surface of geostationary orbit is estimated.
- We developed a system monitoring charged condition in the prototype satellite at any position on the surface of geostationary orbit.

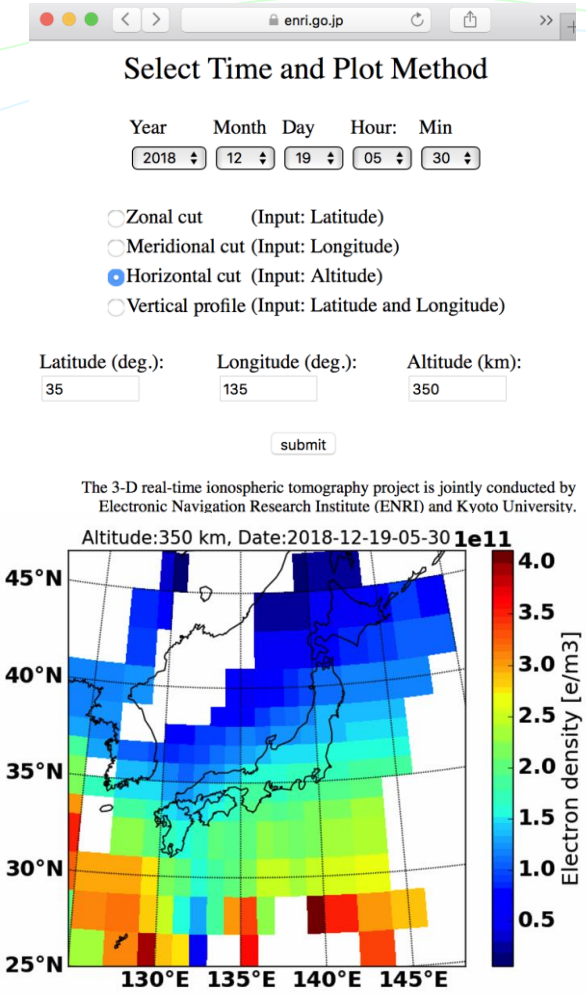


- Radiation dose at aviation altitude is estimated from high energy particle observation and show global map.
- Altitude profile is also available along routes from Japan
- Used in ICAO global space weather services



Radio Propagation Simulator:HF-START Open to public

Japanese GNSS Tomography

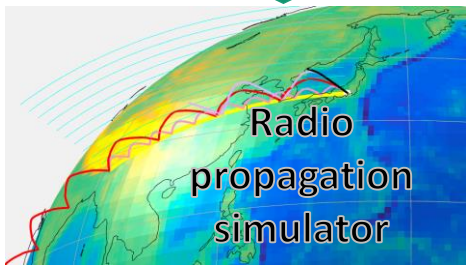


Basic domestic option

Input from user

Tx | Rx | Date | Time | Frequency

Search for interpolated tomography data (Near real-time capability)



Output for user

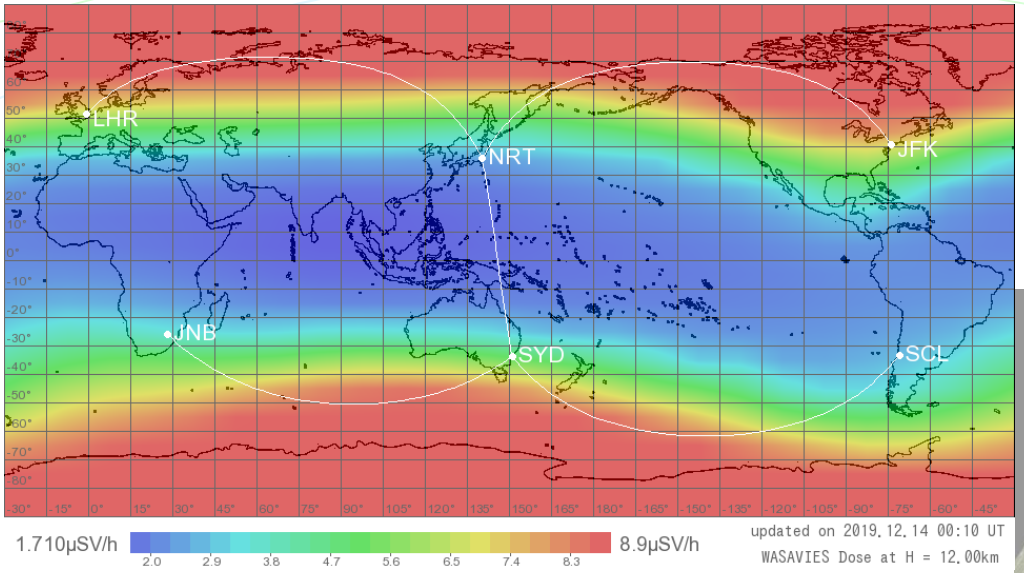
MUF-LUF map for specified propagation link

Specified frequency is usable or should be avoided.

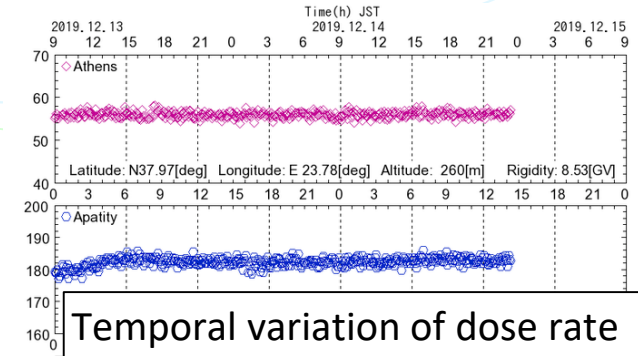
Tomography: https://www.enri.go.jp/cnspub/tomo3/plotting.html

WASAVIES（WArning System for AVIation Exposure to Solar energetic particle

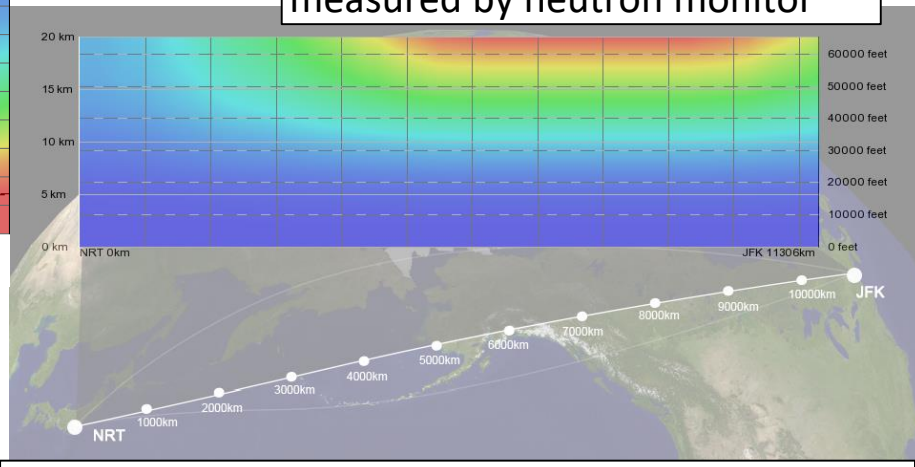
https://wasavies.nict.go.jp/about.html



Global map of dose rate on the aviation altitude



Temporal variation of dose rate measured by neutron monitor



Dose rate along aviation route （Narita-New York）

Web site was opened on Nov. 7, 2019

- WASAVIES is a dose rate estimation system at any point with the real time data of GOES Proton flux and neutron monitor.
- Update once in a day in usual case and once in five minute with GLE occurs.
- The temporal variation of dose rate can be monitored since the event occur GLE.

Space Weather benchmark in Japanese society

Space weather impact matrix

Field	Hazardous	Space Weather Phenomena	Occurrence and Impact				
			Often-sereval times in a year	1/1 year	1/10 year	1/100 year	1/1000 year
Power grid	Shutdown of electricity	GIC					
Satellite operation	Surface charge	High energetic particles					
Communication/Broadcast	HF utility	Negative ionospheric storm					
		Radio black out					
		Polar Cap Absorption					
		Equatorial Plasma Bubbles					
	VHF utility	Sporadic E layer					
Satellite Positioning	Decline of positioning precision	Positive ionospheric storm					
		Equatorial Plasma Bubbles					
		Ionospheric scintillation					
Aviation	Decline of communication	Radio black out					
		Polar Cap Absorption					
		Equatorial Plasma Bubbles					
		Sporadic E layer					
	Decline of positioning precision	Positive ionospheric storm					
		Equatorial Plasma Bubbles					
		Ionospheric scintillation					
	Human exposure	Solar Energetic Particles					
Human in space	Human exposure	Solar Energetic Particles					
Human on the ground	Human exposure	Solar Energetic Particles					

scale

Imacts are negligible	Caution and need to prepare backup system	Dificult to operate

Conclusions

- NICT is only organization to provide space weather forecast information operationally in Japan.
- We have been struggling to keep and open the observed and analyzed data in COVID-19 situation.
- Followings are open database managed by NICT
  - Ionosphere observation data recorded on micro-films since IGY (1957) in Japan and overseas http://wdc.nict.go.jp/IONO/index_E.html
  - Ionospheric hand-drawn data (1936-1954) http://wdc.nict.go.jp/IONO/wdc/index.html
  - Solar optical and radio observation data observed at Hiraiso (1996-2016) and Yamagawa (2016-present) http://solarobs.nict.go.jp/
- Japan contributes to ICAO as a part of space weather global centers. The service started on Nov. 7, 2019.
- NICT has national (e.g., PSTEP) and international (e.g., AOSWA) collaboration for improving space weather observation and forecast framework.

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