Feb. 9, 2012

Status report of expert group on Space Weather

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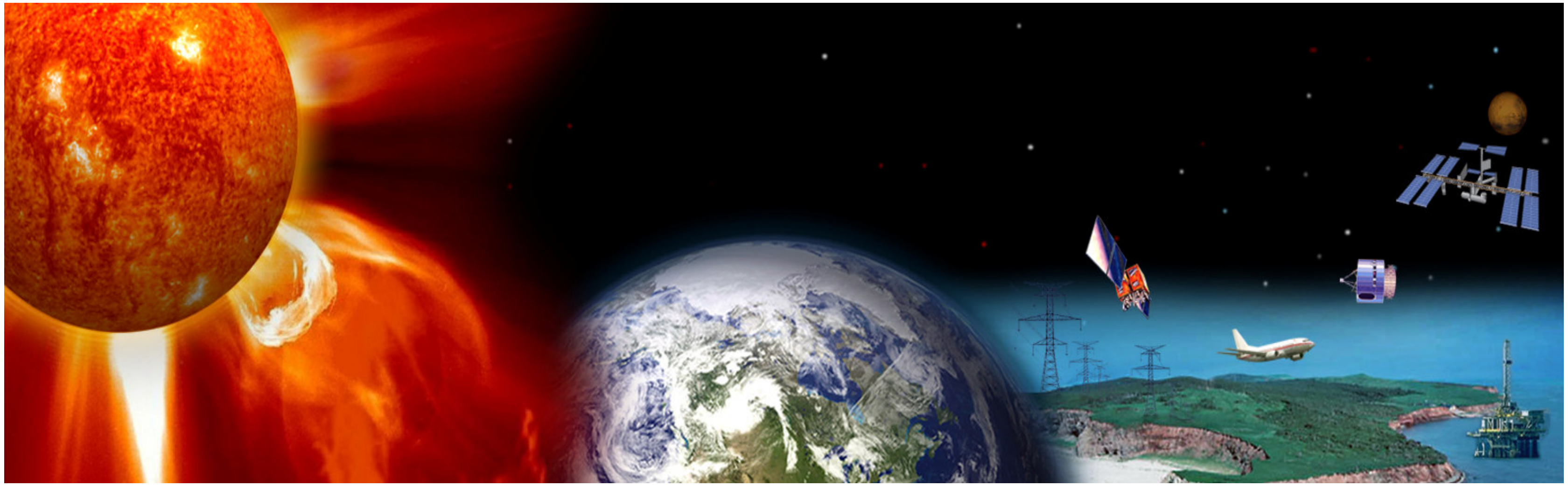


（After T.G.Onsager and J.Head)

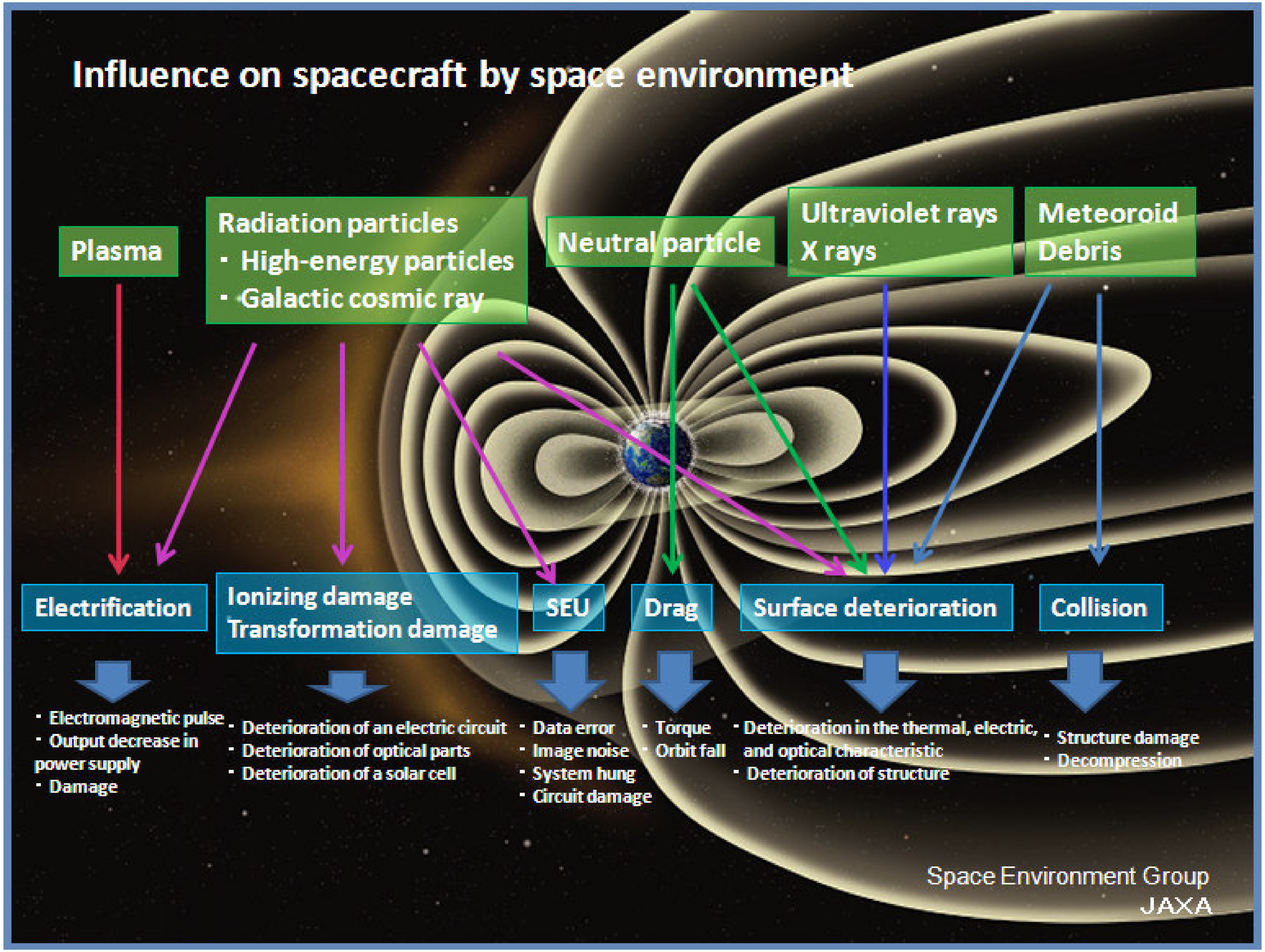
Outline of the presentation

1)Aim of expert group on space weather
and work plan

2) Status report on

- Identification of risks
- Coordination of space weather monitoring
- Development of space weather forecast tools
- Capability building of comprehensive network

3) Draft of working report contents


Influence on spacecraft by space environment
Plasma
Radiation particles
・High-energy particles
・Galactic cosmic ray
Neutral particle
Ultraviolet rays
X rays
Meteoroid
Debris
Electrification
Ionizing damage
Transformation damage
SEU
Drag
Surface deterioration
Collision
・Electromagnetic pulse
・Output decrease in power supply
・Damage
・Deterioration of an electric circuit
・Deterioration of optical parts
・Deterioration of a solar cell
・Data error
・Image noise
・System hung
・Circuit damage
・Torque
・Orbit fall
・Deterioration in the thermal, electric, and optical characteristic
・Deterioration of structure
・Structure damage
・Decompression
Space Environment Group
JAXA

Aim of the **Expert Group on space weather**

-> to contribute long-term sustainability working group by doing tasks to provide a report based on the survey of current practice and procedure and a set of guide lines which would contain the ways to reduce space weather risks and technical standards.

23 States joined by now

Scope of the **Expert Group** (after ToR)

i) Collection, sharing and dissemination of data, model and forecast tool

ii) Capabilities to provide a comprehensive and sustainable network of sources of key data in order to observe and measure phenomena related to space weather in real time or near-real time

iii) Open sharing of established practices and guidelines to mitigate the impact of space weather phenomena on operational systems

iv) Coordination among State on ground-based and space-based space weather observations in order to safeguard space activities.

Methodology – time line (after ToR)

Year	2012			2013			2014	
Month	2	6	10	2	6	10	2	6
Space Weather Expert Group Meeting	△	△	△	△	△	△	△	△
Expert Group Repot	*Out Line*	*1-st draft*	*2-nd draft*	***Final Report***				
Guide Line Paper				*Out Line*	*1-st draft*	*2-nd draft*	***Final Report***	

Identification of risks (1/3)

	Item	Influence and concern
1	Level and Trend of Solar Activity	General space environment risk evaluation.
2	Solar X-ray Radiation	Solar X-ray radiation is the widely used indicator for solar activity level and flare and associating disturbance harmful for space systems.
3	Solar High Energy Particle	Onboard computer malfunction due to upset of semiconductor devices, deterioration of SAP, electric devises, optical sensor etc…
4	Solar Flare and CME	Solar flares and associating CME are a major source of space environment disturbances. Generally, long duration and strong flares are thought to be important for risk evaluation on satellite operation sources of geomagnetic storms
5	Coronal Holes	Coronal holes are a major source of high speed solar wind, which produces geomagnetic storm.

Identification of risks (2/3)

	Item	Influence and concern
6	Galactic Cosmic Rays	Onboard computer malfunction due to upset of semiconductor etc…
7	Solar wind plasma	Geomagnetic storm and Sub-storm caused by high speed wind stream are the potential causes of satellite malfunction.
8	K-index of geomagnetic field	General space environment risk evaluation.
9	Dst-index of geomagnetic field	General space environment risk evaluation.
10	Low energy electrons at GEO	KeV electron is considered major driver of satellite surface charging and following discharging. The surface charging and discharging is one of the major cause of GOE satellite malfunction.
11	High energy electrons at GEO	High energy (>MeV) electron is considered a major driver of satellite charging and following discharging including component and harness inside spacecraft. The charging and discharging is one of the major cause of GOE satellite malfunction.

Identification of risks (3/3)

	Item	Influence and concern
12	Low energy electrons at LEO	KeV electron is considered major driver of satellite surface charging and following discharging. The surface charging and discharging is one of the major causes of LEO satellite malfunction.
13	High energy protons at SAA	Onboard computer malfunction due to upset of semiconductor devices, deterioration of SAP, electric devises, optical sensor etc…
14	Solar EUV proxy index	The proxy called f10.7 is used as solar EUV proxy parameter to deduce satellite drag on satellite orbital analysis. Abrupt increase of the proxy may cause severe trouble due to drastic changes of satellite drag.
15	Auroral Electro jet index	The AE is used to atmospheric density model, which leads to satellite drag on satellite orbital analysis. Abrupt increase of AE may cause severe trouble due to drastic change of satellite drag.
16	Ionospheric Disturbances	Operation of satellite at various altitude and ground communications by using radio waves are influenced by the ionospheric condition.

Space weather monitoring (1/2)

	Item	Measurement in Japan (for example)
1	Level and Trend of Solar Activity	f10.7 radio index (NICT)
2	Solar X-ray Radiation	None
3	Solar High Energy Particle	In-situ measurement by satellite sensor (JAXA)
4	Solar Flare and CME	Ground-base observation (NICT)
5	Coronal Holes	Remote measurement by satellite sensor (JAXA)
6	Galactic Cosmic Rays	Measurement by satellite sensor (JAXA)
7	Solar wind plasma	Measurement by satellite sensor (JAXA)
8	K-index of geomagnetic field	Ground based magnetometer observation network and its real-time data circulation (SERC)
9	Dst-index of geomagnetic field	Ground based magnetometer observation network and its real-time data circulation (SERC)
10	Low energy electrons at GEO	None

Space weather monitoring (2/2)

	Item	Measurement in Japan (for example)
11	High energy electrons at GEO	In-situ measurement by satellite sensor (JAXA)
12	Low energy electrons at LEO	None
13	High energy protons at SAA	In-situ measurement by satellite sensor (JAXA)
14	Solar EUV proxy index	None
15	Auroral Electro jet index	Ground based magnetometer observation network and its real-time data circulation (SERC)
16	Ionospheric Disturbances	Ground based magnetometer observation network and its real-time data circulation (SERC)

Space weather forecast (1/1)

	Item	Forecast
1	Sunspot	
2	Coronal hoes	
3	Flare/CME	*ISES/Flare forecast
4	Solar proton	*ISES/Solar proton forecast
5	Solar wind	Solar wind models
6	Geomagnetic field disturbance (Dst)	*ISES/Storm forecast
7	Geomagnetic field disturbance (AE)	*ISES/Substorm forecast
8	Radiation belt	Radiation belt models
9	Aurora	Aororal oval prediction models
10	Ionosphere	Ionosphere models
11	Radio wave propagation	Disturbance models

Comprehensive network

International Ursigram and World Days Service (IUWDS)
-> 1996 International Space Environment Service (ISES)

13 States:
(Aug. 2011)

Draft of the outline of the expert group repot

1) Identification of Risks
2) Current practice and procedures
   - Observations
   - Models
   - Tools of Space weather prediction
   - Engineering approach to mitigate space environment effects
3) Capabilities to provide a comprehensive network
   to support space weather services
4) Recommendation on Coordination among States on
   space weather observations to safeguards space activities
5) Key findings and technical standards regarding SW

Appendix

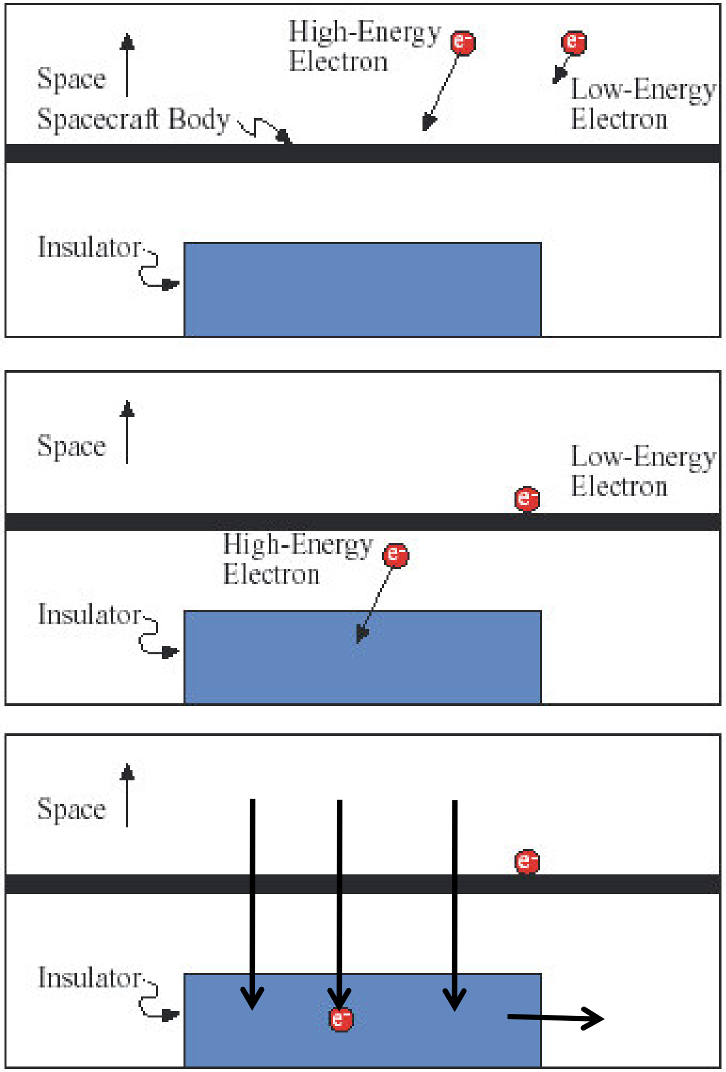
Conclusion for EG-C

The "International Space Weather Warning Service" is expected to be continued and improved.

It is still need to make efforts for modeling, monitoring, forecasting, warning, design measures, operational actions against the risk from the natural environment.

(after technical presentation by Dr. A. Kato /JAXA)

Preventive Actions	Modeling, Monitoring, Forecasting	Models of natural environment are being developed in ISO and other organizations. Some satellite have a monitoring sensors. Research is being done to forecast with higher precision.
	Design Measures	Design standards, radiation hardness design as example, are being applied, and need to be developed more, .
Detection of risk	Monitoring Detection Sending Alert / Warning	Monitoring and warning services are available by the ISES. Provide space weather forecasting and send alert / warning if needed. They are expected to be developed more.
Corrective Action	Risk Avoidance	In case of warned situation, operation mode will be shifted to safe-mode. Space crew will hide behind shielded area.
Permanent Action	Monitoring, Analysis	On-ground and in-orbit monitoring and sharing observation data are encouraged.
	Failure Analysis	In-orbit failures should be analyzed for its causes, and if they would be induced by the natural environment , design standards will be modified.



Low-energy electrons "stick" to the spacecraft surface.

High-energy electrons penetrate the satellite and can get embedded in insulating materials.

If electrons escape faster, charging and discharging will NOT occur.