

NATIONAL RADIO RESEARCH AGENCY

KOREAN SPACE WEATHER CENTER



Ministry of Science, ICT and Future Planning
National Radio Research Agency

Korean Space
Weather Center

Jinwook Han, jangsuk choi, Sukbo Hong, Seokjun Jeong, Changhyu Ko

KSWC Overview

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**KOREAN SPACE
WEATHER CENTER**

- The primary action agency of emergency measure to severe SWx, and the RWC Korea of International Space Environment Service

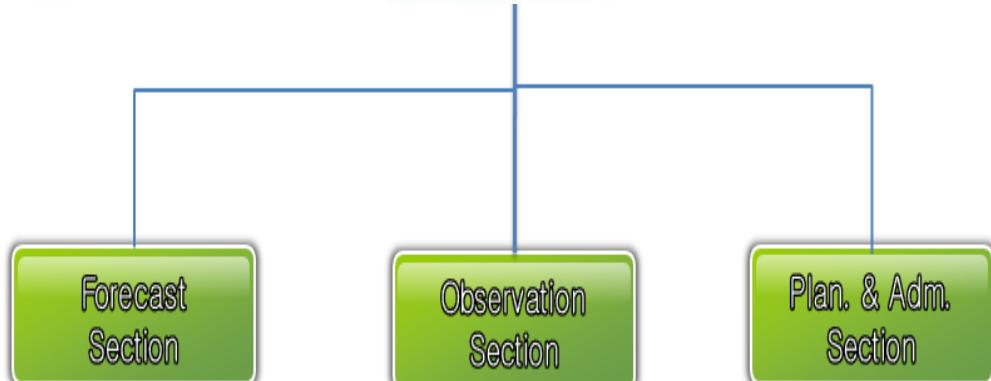
MSICT

MINISTRY OF SCIENCE,
ICT AND FUTURE PLANNING

RRA

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RESEARCH AGENCY

KSWC KOREAN SPACE
WEATHER CENTER



Member of ICTSW
ITP – SWISS Feb. 2017



Delegate for Space Weather



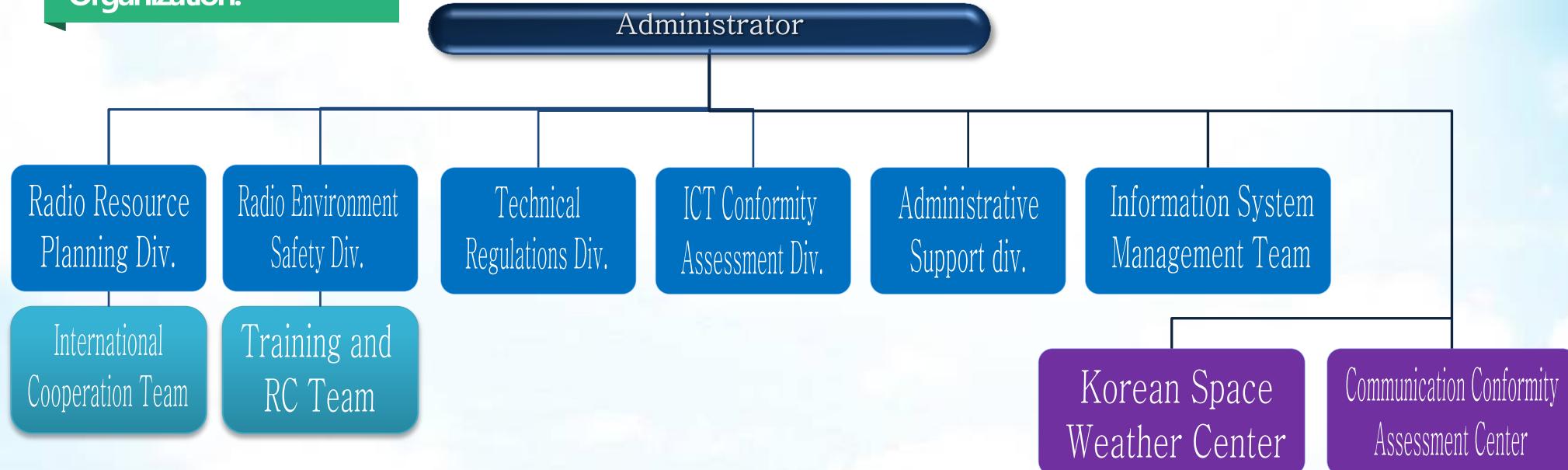
Leading Agency of ROK

Introduction of RRA

Role :

- Radio spectrum resources development and efficient use
- Safe Electromagnetic Environment Protection
- Global standardization activities of broadcasting and ICT
- Conformity assessment system operation
- **Space weather and disaster observation and forecast/alert**
- **Information service on Broadcasting and Communications and CyberSecurity management**

Organization:



Mission & Main Task of KSWC

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Mission

- Research on the technology for receiving space radio waves
- Observe and analyze radio data, solar spots, geomagnetism and ionosphere
- Give services Space Weather forecasts and warnings service

Main Task

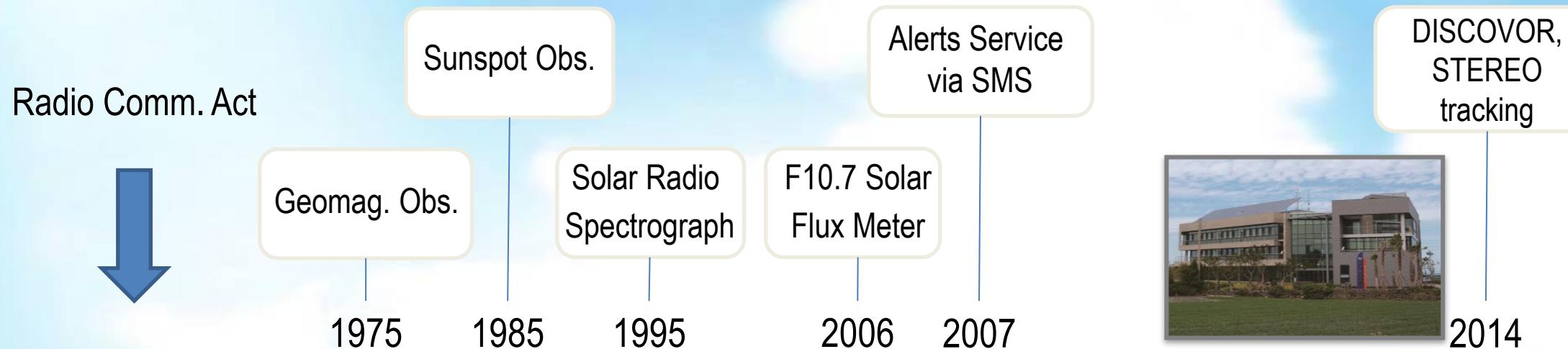
- Space weather forecast and alert services
 - Monitor and analyze solar activities 24 hours a day
 - Provide forecast and alert services to civil area
- Strengthen space weather cooperation network
 - Cooperate domestically to mitigate the space weather risk
 - Build international cooperation network with **NOAA** and **NICT** to develop more accurate prediction models and improve services



History & Origin of KSWC

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1966 1967

**Foun. of
the RRA**



1998

Internet SWx Service
(<http://spaceweather.go.kr>)

2009

Opening KSWC
(The 14th RWC of ISES)
(ACE tracking station, IPS, SRMS)



Iono. Obs. & HF Predi.

NOAA & RRA Agreement
(Personnel exchanges);

**RRA HQs
moved to Naju**

Forecasting Office

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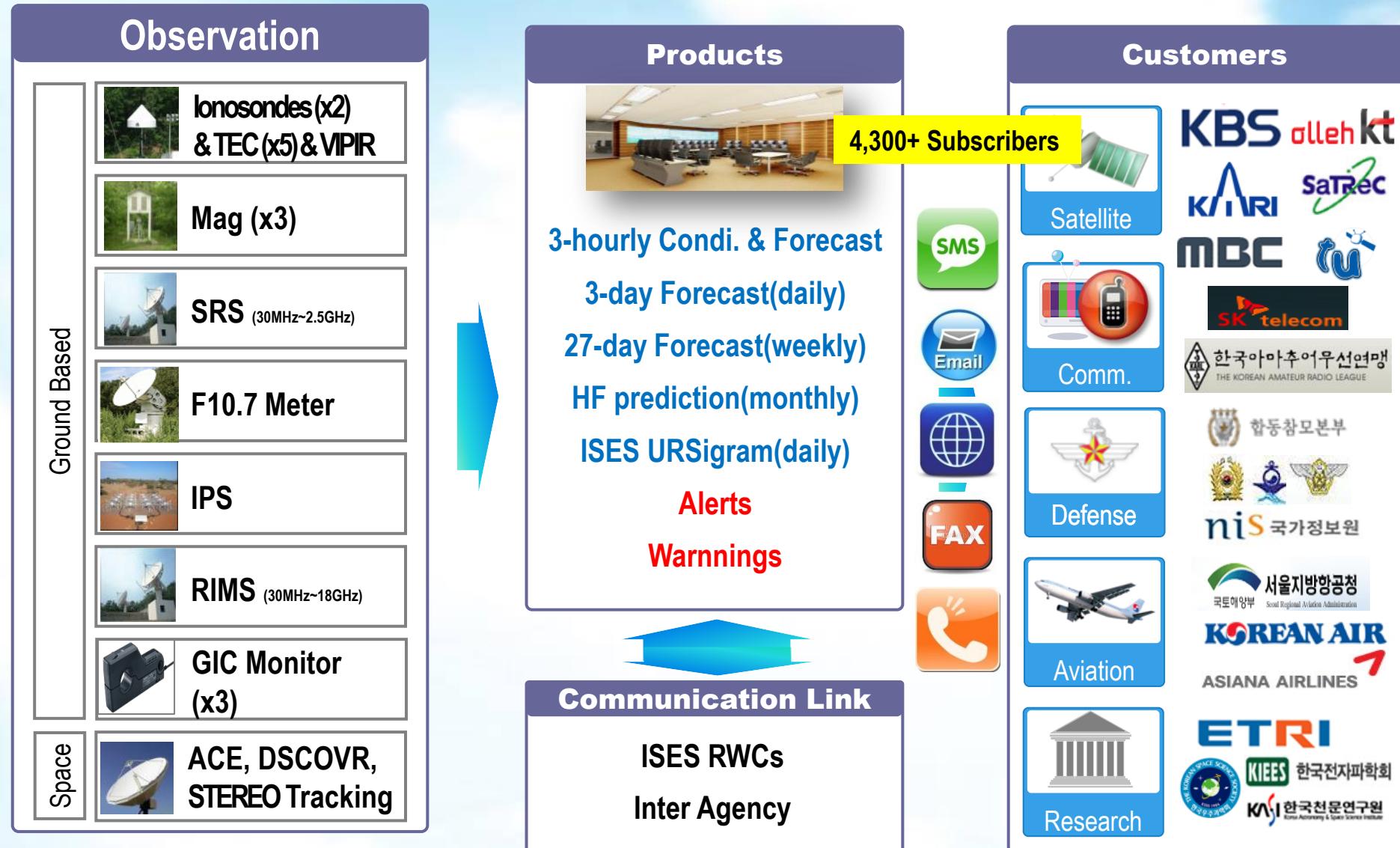
**KOREAN SPACE
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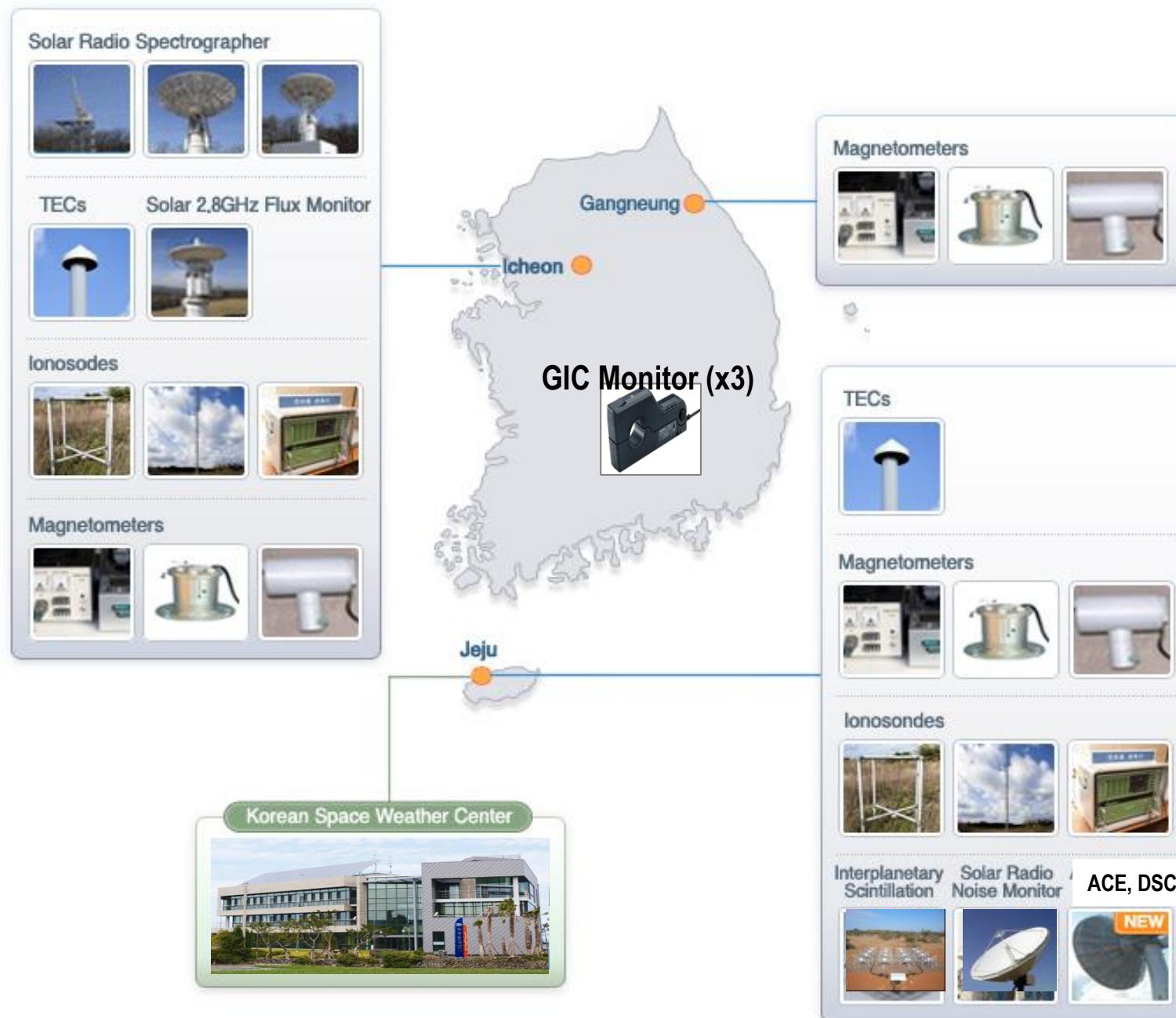
Key
Message

- Monitoring space weather conditions and data collecting networks
- Producing daily forecast
- Delivering the predicted results to the public and military

Operational Flow



Observation Networks in Korea



Policy - Disaster Act of SW Risk

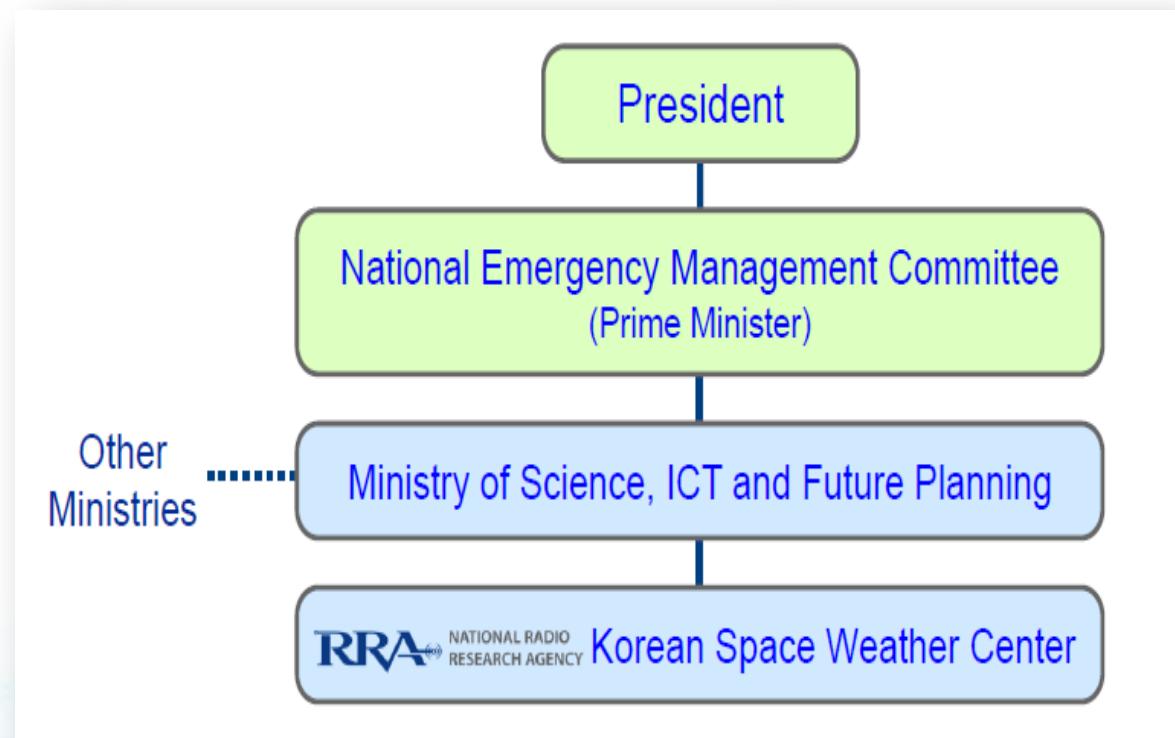
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Standard Manual for Space Weather Risk

2013.2.



All ministries followed predefined procedures based on KSWC's SWx information !

Disaster
ACT

Framework ACT on the Management of Disaster and Safety

Addendum 3-2(Agency of risk Management)

...

(Space Weather Risk) The Ministry of Science, ICT and Future Planning

...

Radio
Wave
ACT

Article 51(Establishment & Implementation of basic plan for the management of Space Weather Risks)

The Minister of Science, ICT and Future Planning shall establish and implement a **basic plan for the management of space weather risks** including following in order to prepare, control and recover against disasters due to variation of space weather conditions in every 5 years.

1. Matters concerning **observation** and **surveillance** of variation of **space weather conditions**;
2. Matters concerning **forecasts and alerts** of space weather risks;
3. Matters concerning **R&D** (Research and Development) and **international cooperation** for the prevention of and preparing against space weather risks.
4. Other matters necessary to provide against space weather risks.

Policy - SW Disaster Management

- ✓ We take actions according to NOAA SWx scales
- ✓ If level 3+ event occurs, we provide the press release for public

NOAA
 Scales



Level	Effect	Physical measure	Average Frequency (1 cycle=11 years)
R1	<ul style="list-style-type: none"> HF radio : Week or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. Navigation : Low-frequency navigation signals degraded for brief intervals. 	10 ⁻⁶ (2000 per cycle (950 days per cycle))	
R2	<ul style="list-style-type: none"> HF Radio : Limited break of HF radio communication on sunlit side, loss of radio contact for tens of minutes. Navigation : Degradation of low-frequency navigation signals for tens of minutes. 	5x10 ⁻⁶ (350 per cycle (300 days per cycle))	
R3	<ul style="list-style-type: none"> HF Radio : Slight loss of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. Navigation : Low-frequency navigation signals degraded for about an hour. 	10 ⁻⁵ (175 per cycle (140 days per cycle))	
R4	<ul style="list-style-type: none"> HF Radio : Slight loss of HF radio communication on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. Navigation : Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours. Loss in positioning. Inertial navigation system navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side. 	10 ⁻⁴ (8 per cycle (8 days per cycle))	
R5	<ul style="list-style-type: none"> HF Radio : Complete HF (High Frequency) radio blackout on the entire sunlit side of Earth for several hours. HF radio contact lost in no radio contact with satellites and en route stations in this sector. Navigation : Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours. Loss in positioning. Inertial navigation system navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side. 	2x10 ⁻⁴ Less than 1 per cycle	

KSWC – Strategy and Action Plan

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Safe Korea from SW Disaster

5 Strategies

R

Leading of R & D

A

Vitalized
Administration

D

Enhanced Data system

I

Reinforcement of
Int'l cooperation

O

Systematic Operation

10 Action Plans

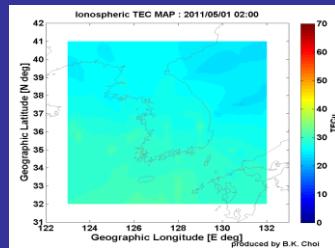
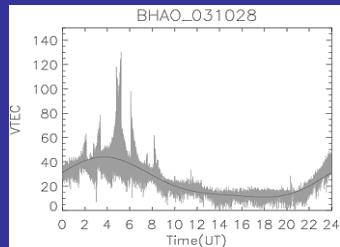
- Enhanced Space Weather analysis and prediction models
- Establishment of inter-agency cooperation
- Strengthen disaster response capacity
- Collaboration for raising data efficiency
- Developing identity of observation facilities
- Proper improvement of facilities
- International cooperation for R&D
- Diversification of international relation
- Empowerment for observation & forecast
- Expanding customers & promotion

Migration to Customer Oriented Services

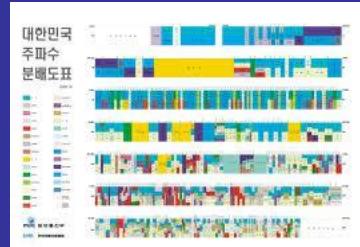
Alerts & Warnings for Global Disturbance

Customized Alerts & Warnings to Each Customer

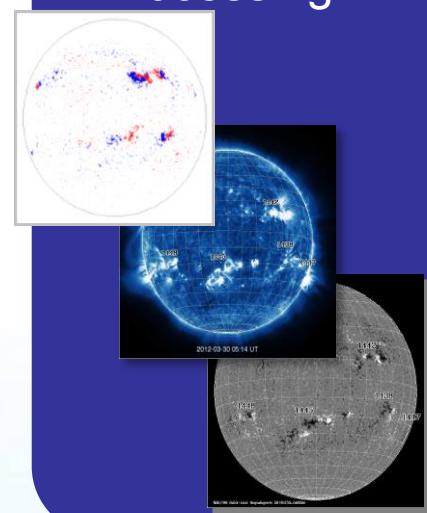
Ionospheric Disturbance Effect Prediction



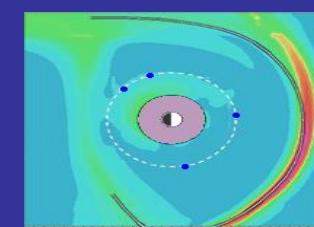
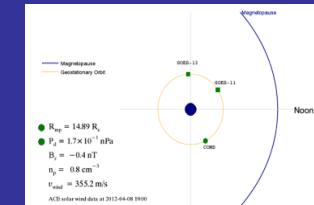
Solar Radio Noise Effect Prediction



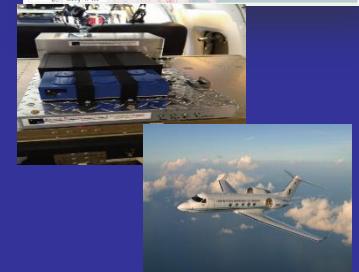
Solar Activity Prediction using Image Processing



GEO Satellite Environment Prediction



Comic radiation Prediction Model



Alerts & Forecasts | Forecast Model | Real Time Data | Space Weather a... | Instruments

2017-06-17 11:00 (KST), 2017-06-17 02:00 (UTC)

The Sun now

The Sun now

1 day Forecasts | 3 day Forecasts | Monthly Radio Wave

Forecast condition Date updated 2017.06.16. KST

Radio Blackouts

	0-24hr	24-48hr	48-72hr
R1 - R2	1%	1%	1%
R3 or higher	1%	1%	1%

Solar Radiation Storms

	0-24hr	24-48hr	48-72hr
S1 - S2	1%	1%	1%
S3 or higher	1%	1%	1%

Geomagnetic Storms

	0-24hr	24-48hr	48-72hr
G1 - G2	50%	50%	40%
G3 or higher	10%	10%	1%

Notice

지자기교란 경보 및 예보 정보

지자기교란 : 2017-06-17 02:00

지자기교란 :

Real time data

Click the image

Ionosphere

Icheon Ionosphere (FeF2) Jeju Ionosphere (FeF2) Icheon Ionosphere (ionogram) Jeju Ionosphere (ionogram) Icheon TECs

Geomagnetic activity

Icheon geomagnetic Gangneung geomagnetic Jeju geomagnetic Kp Index Kt Index

The Sun

Sunspot activity (28GHz) Solar radio activities Solar Radio Noise Monitor

Solar Wind

SOLAR WIND Mag field & Plasma Low Energy Electrons & Protons Solar Wind Ground scope for Solar Wind

Contact Us

198-6, Gwidae-ro, Gwidae-gu, Daejeon, Korea 305-806
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Alerts & Forecasts | Forecast Models | Real Time Data | Space Weather | Instruments | About the Center

2017-06-17 11:07 (KST)
2017-06-17 02:07 (UTC)

Korean Space Weather Center

Forecast Model

for kids

Current Scales

Space Weather Scales GO

Radio Blackouts

- ASSA
- Wireless-SNR
- Automatic CME analysis model
- Satellite Drag Model
- 3D Solar Active Region Monitor
- Prediction of long-term solar activity at 2.8GHz
- Displaying automatically CME type detection using observed solar radio flux data

Solar Radiation Storms

Geomagnetic Storms

Ionosphere Activity

Detected Sunspot Groups (displayed on SDO 1-min Continuum at 2017 Jun 17 0100 UTC)

C-Flare : 15 %
M-Flare : 1 %
X-Flare : 0 %

2009.1.6x 0002.7.1x 2003.12.1 0001.1.6x

Detected Sunspot Groups (displayed on SDO 1-min Magnetogram at 2017 Jun 17 0100 UTC)

C-Flare : 15 %
M-Flare : 1 %
X-Flare : 0 %

2009.1.6x 0002.7.1x 2003.12.1 0001.1.6x

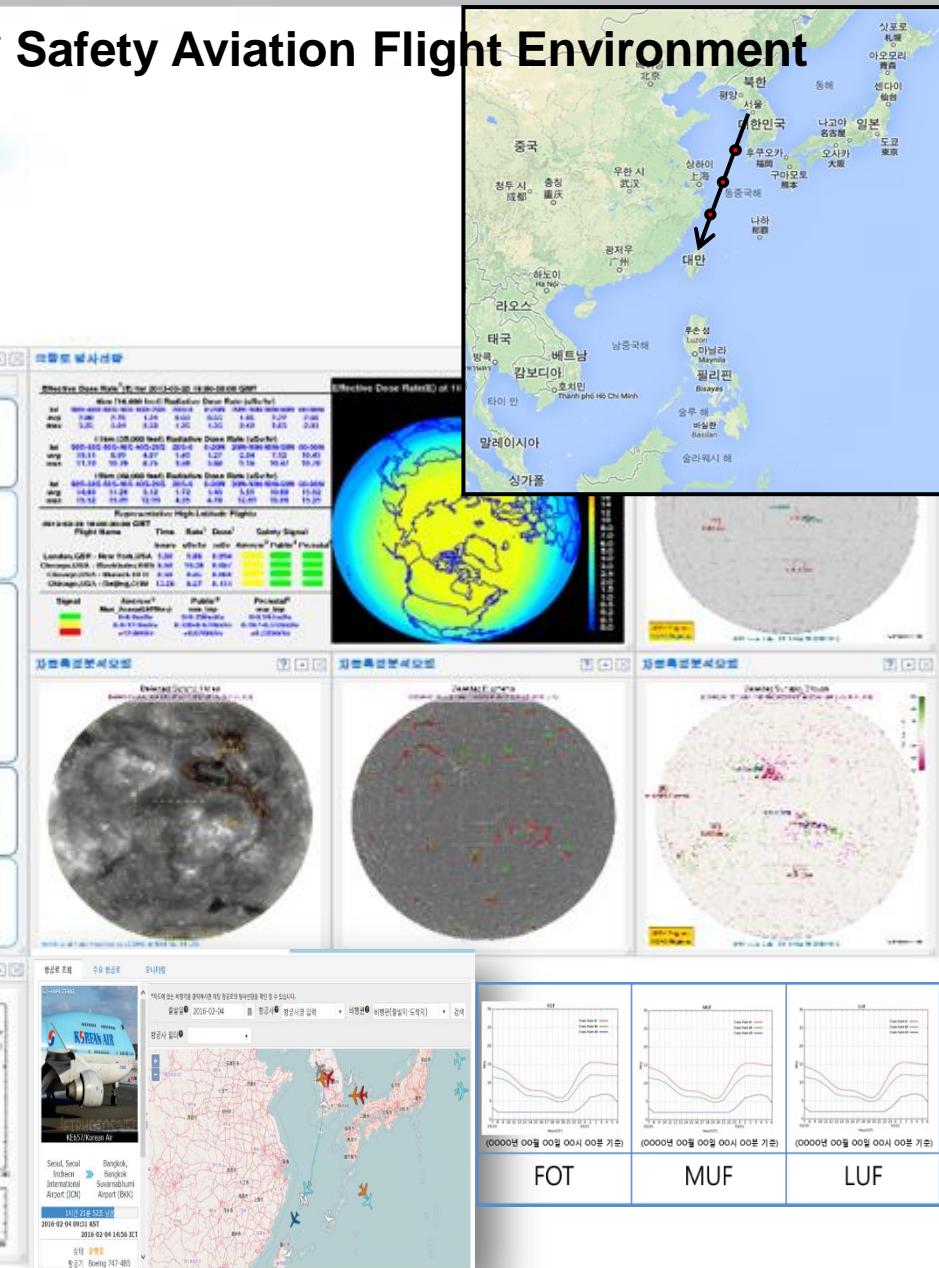
Observation Data

Space Weather Report

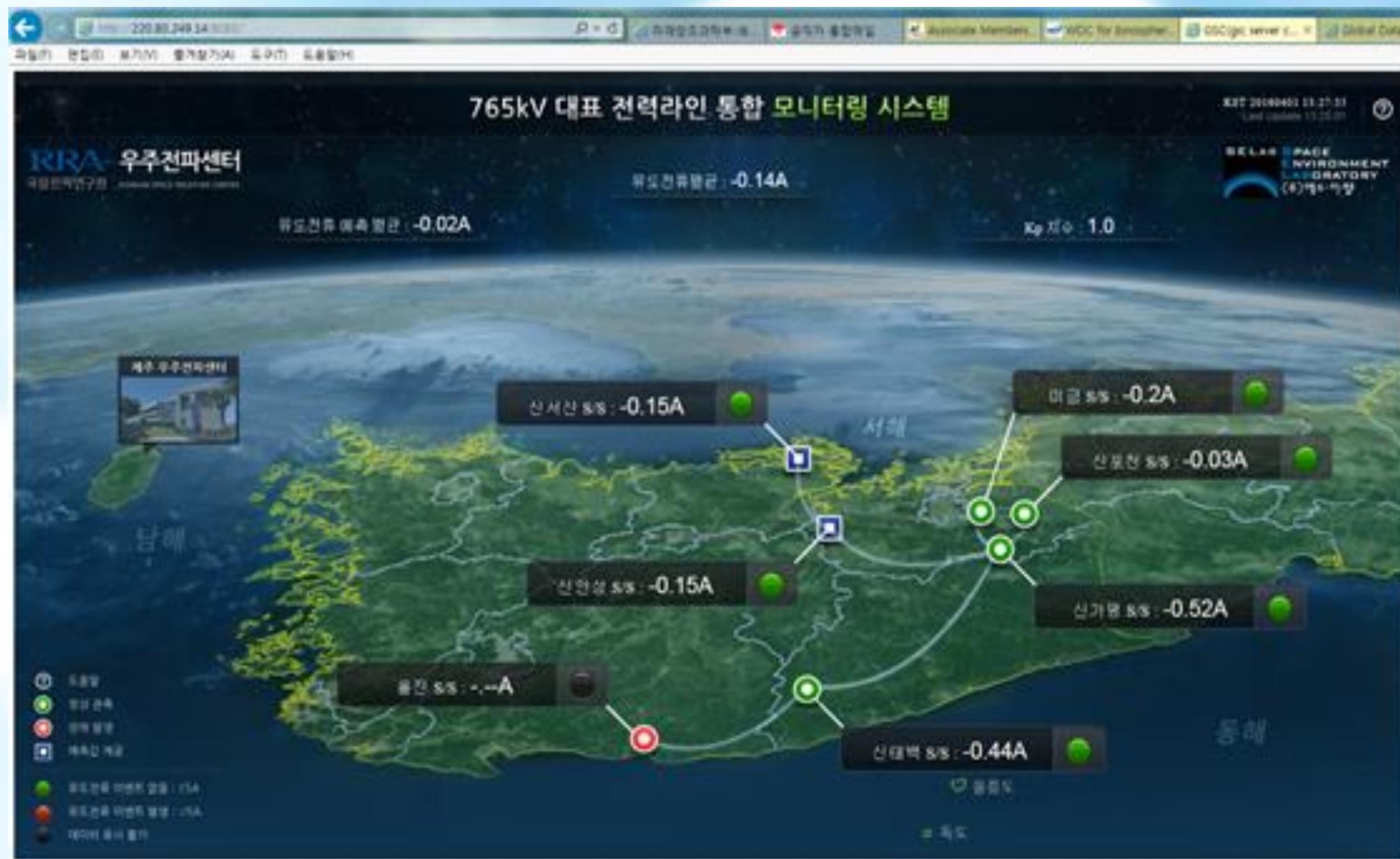
15/17

Customer Oriented Web Services

* Safety Aviation Flight Environment



Geomagnetism Induced Current monitoring



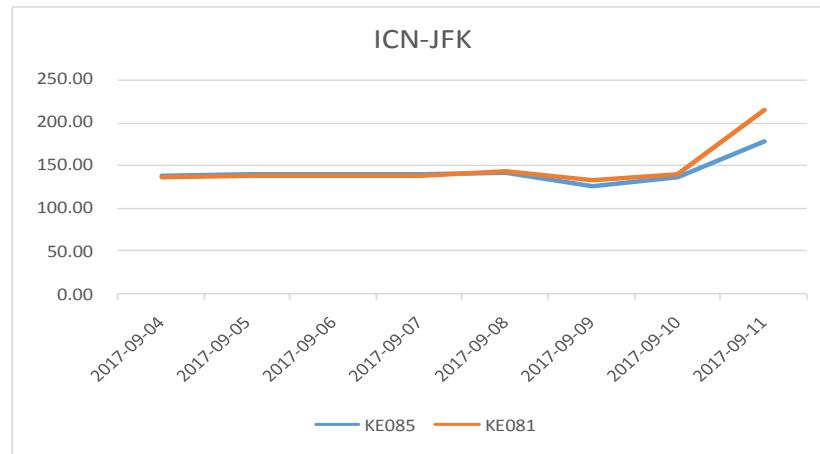
SAFE Results : S3, 11. Sept. 2017

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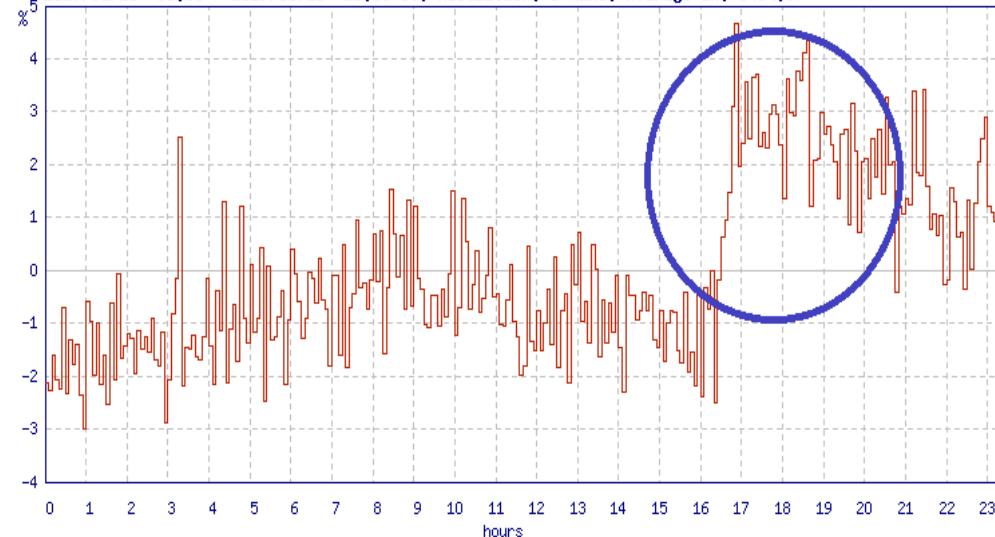
SAFE System Results

* Safety Aviation Flight Environment

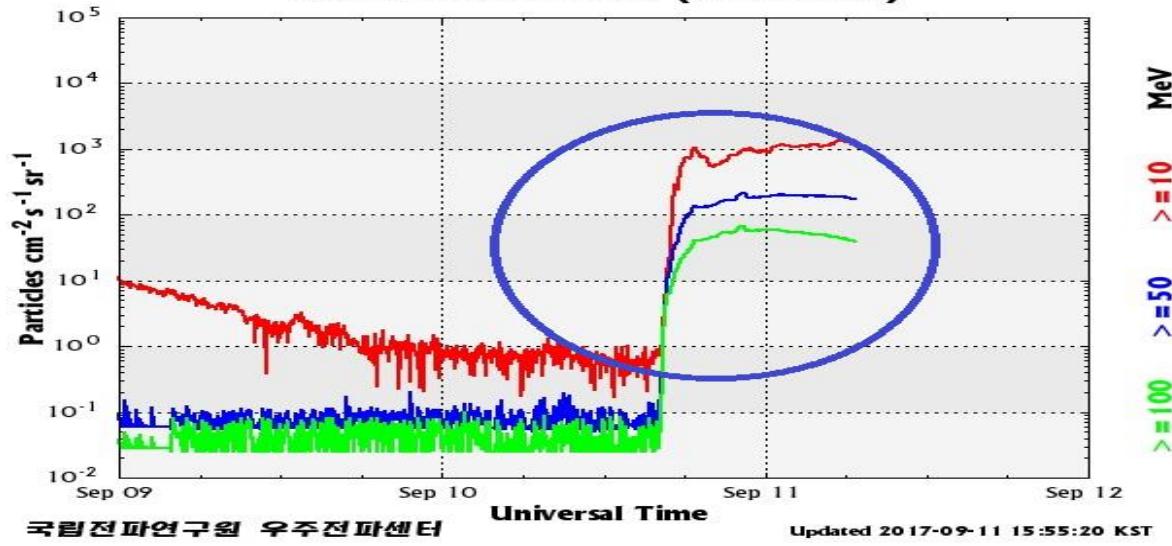


Oulu Neutron Monitor

2017/09/10 00:00 - 2017/09/10 23:30 UT, Resolution: 5 mins, Average CR: 6464.67



GOES Proton Flux (5 minutes)



Date	KE081(uS) v)	KE085(uS) v)
2017-09-06	139.05	139.05
2017-09-07	139.05	139.05
2017-09-08	144.48	142.41
2017-09-09	133.19	125.97
2017-09-10	139.38	136.91

R & D - SW Forecast Models

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	Radio Blackouts	Solar Radiation Storms	Geomagnetic Storms
Forecast Model	<ul style="list-style-type: none">- ASSA (Automatic Solar Synoptic Analyzer)	<ul style="list-style-type: none">- Solar Proton Event Prediction	<ul style="list-style-type: none">- Enlil, IPS, IPS-driven Enlil
Function	Identify solar active regions, filament channels and coronal holes	Predict the intensity and occurrence of the solar radiation storm	Calculate geo-effectiveness of solar wind using IPS data & Coronagraph
Upgrade Plan (Future)	<ul style="list-style-type: none">+ Tracing filaments using SDO 304+ Analyzing the magnetic field configuration of sunspots	<ul style="list-style-type: none">+ Predicting the peak time and the end time of the solar proton event	<ul style="list-style-type: none">+ CME analysis improvement using data of STEREO and L5 satellite+ Predicting IMF Bz+ Automatic CME analysis

R & D - SW Effect Analysis Models

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	Satellite	Aviation	Navigation	Power Grid	Comm.
Analysis Model	- DREAM	- SAFE	- GNSS signal monitoring analysis	- GIC measurement	- Real time HF Mapping
Function	Calculate high energy particles on the radiation belts	Calculate cosmic radiation doses during aviation flight	Monitor GNSS signal status according to solar activity	Measure GIC induced by Space Weather disturbance	Predict usable HF based on ionospheric assimilation
Upgrade Plan (Future)	+predict electron density distributions for 3 days using deep-learning	+predict cosmic radiation doses on flight routes		+predict GIC and K index for 3 days in Korea	+accuracy improvement using portable observational devices for ionosphere

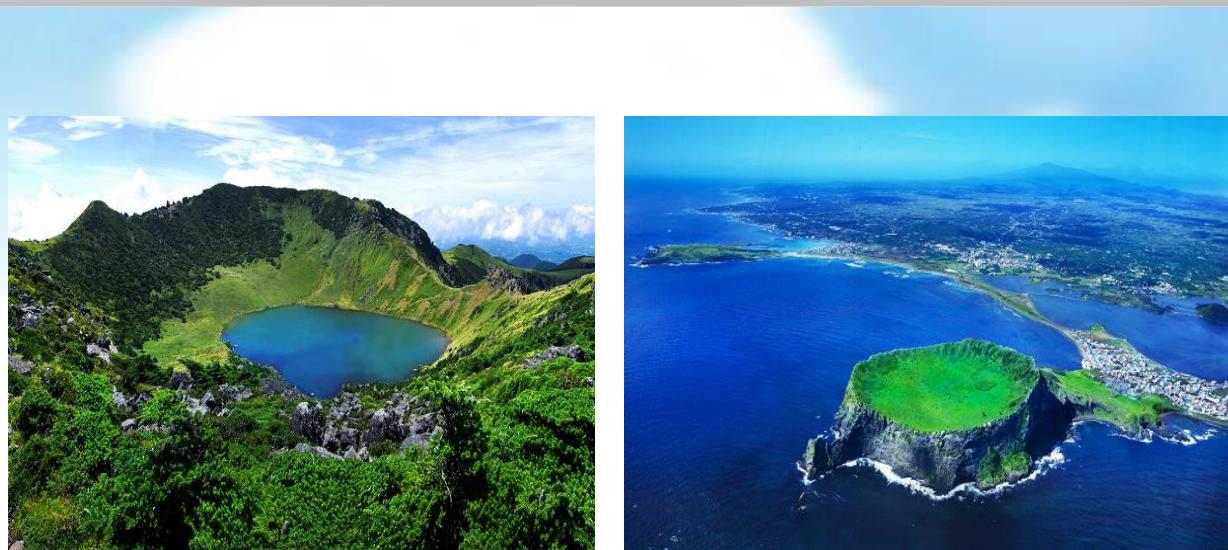
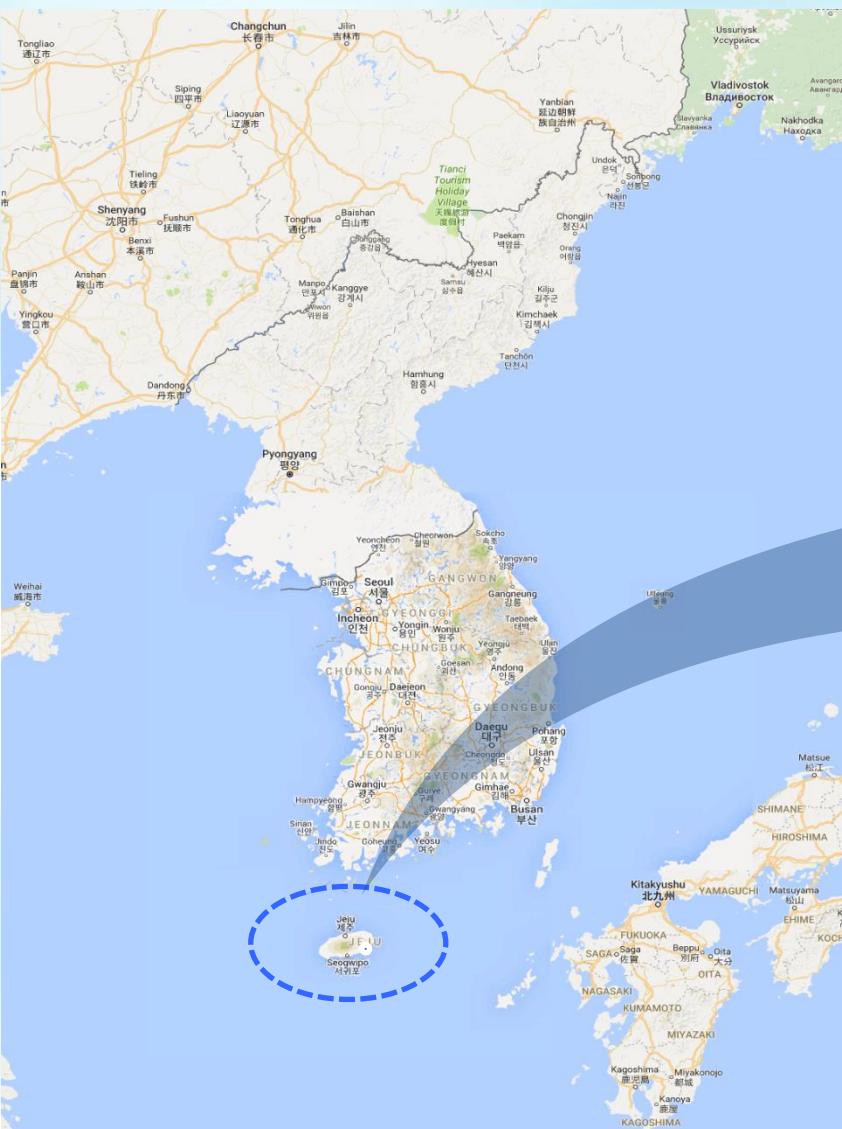
R&D - International Cooperation (MOU)

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Country	Organization	Date	Main Subject	
US	UCSD Univ.	'15.06.17.	Introduction of solar wind prediction model Research on the interplanetary space	
	NOAA	'15.2.9.	Space weather forecasting	
Japan	NICT	'14.5.8.	Cooperation observation of ionosphere	Done
	Nagoya Univ.	'16.10.26.	Research on the solar physics Exchange of observed data for solar activities analysis	
China	IGGCAS	'16.8.26.	Cooperation observation of ionosphere in Northeast Asia	
UK	Met Office	'16.10.7.	Participation in the construction of the receiving station which can store and analyze the data from L5 satellite in real time.	
US	NASA		Accuracy estimation on forecasting models of space environment	Future
	Los Alamos		Research on the prediction of electron density distribution	
Taiwan	NCU		Cooperation observation of ionosphere	

Jeju



Population

0.68 million (1.3% of whole Korea)

Visitors(2017)

14.8 million (Foreigner 3.3 million)

Hallasan

1,950 m (Baekdusan 2,744m)

“UNESCO Triple Crown, Jeju”

-  **Biosphere Reserve** (2002)
-  **World Natural Heritage** (2007)
-  **Global Geopark** (2010)

“The New7Wonders (2011)”

Thank you!



www.facebook.com/rwcjeju



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