

*53th COPUOS Scientific and Technical Subcommittee*

*Space Weather Expert Group  
15-17 February 2016*

NATIONAL RADIO RESEARCH AGENCY  
**KOREAN SPACE  
WEATHER CENTER**

**RRA** NATIONAL RADIO  
RESEARCH AGENCY

**KiChang Yoon, Sunhak Hong, Yongki Kwon, Gwan-sik Wi**

- 1. SWx Operations**
- 2. Tailored Services**
- 3. National Preparations**

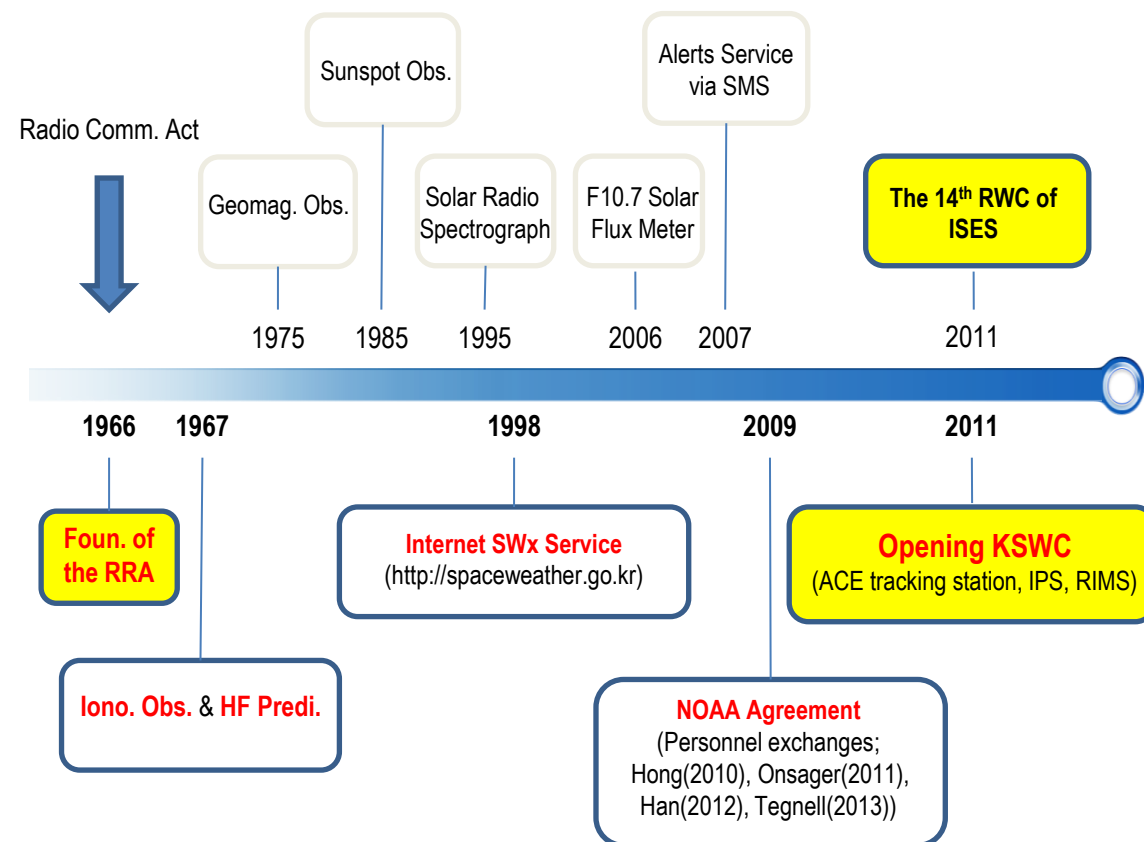
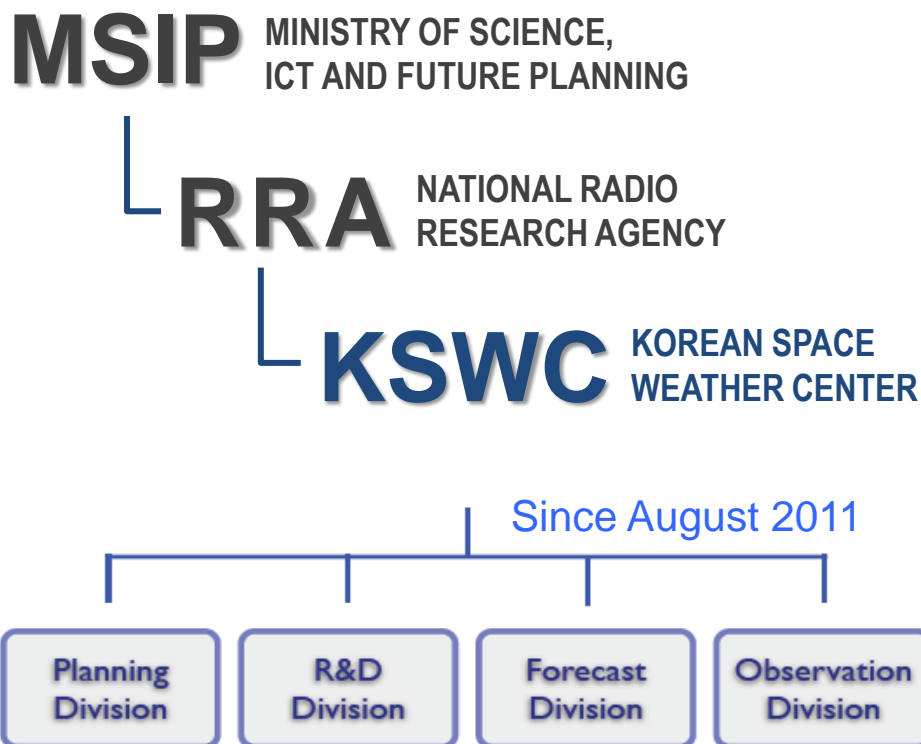


# KSWC Overview

NATIONAL RADIO RESEARCH AGENCY









**KOREAN SPACE  
WEATHER CENTER**

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



# SWx Operations – operational work flow

## Observation

Ground Based	 <b>Ionosondes (x2) &amp; TEC (x5)</b>
	 <b>Mag (x3)</b>
	 <b>SRS (30MHz~2.5GHz)</b>
	 <b>F10.7 Meter</b>
	 <b>IPS</b>
	 <b>RIMS (30MHz~18GHz)</b>
	 <b>GIC Monitor (x3)</b>
Space	 <b>ACE, DSCOVR, STEREO Tracking</b>



## Products



**Alerts & White Alerts**

- 3-hourly Condi. & Forecast
- 3-day Forecast(daily)**
- 27-day Forecast(weekly)
- HF Prediction(monthly)

## Models & Services

ASSA, IPS-Enlil,  
NAIRAS, IRI-VOACAP, GIC,  
etc. (29ea.)

- 
- 
- 
- 
- 

## Customers

 <b>Satellite</b>	
 <b>Comm.</b>	
 <b>Defense</b>	
 <b>Aviation</b>	
 <b>Power</b>	

# SWx Operations – observation network



## ➤ ACE Tracking Antenna

- ✓ global tracking network for RTSW
- ✓ 13-meter dish antenna (S-band)
- ✓ in operation since Feb 2012
- ✓ upgraded for DSCOVR

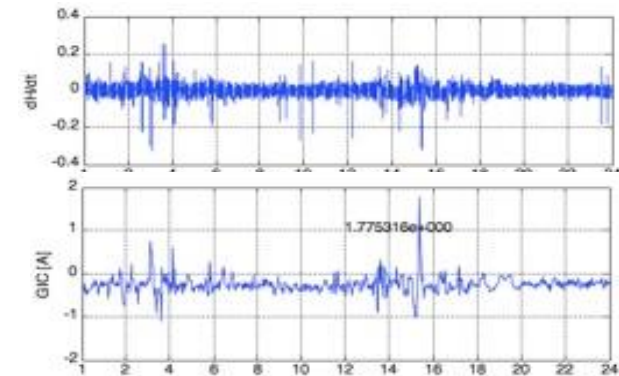
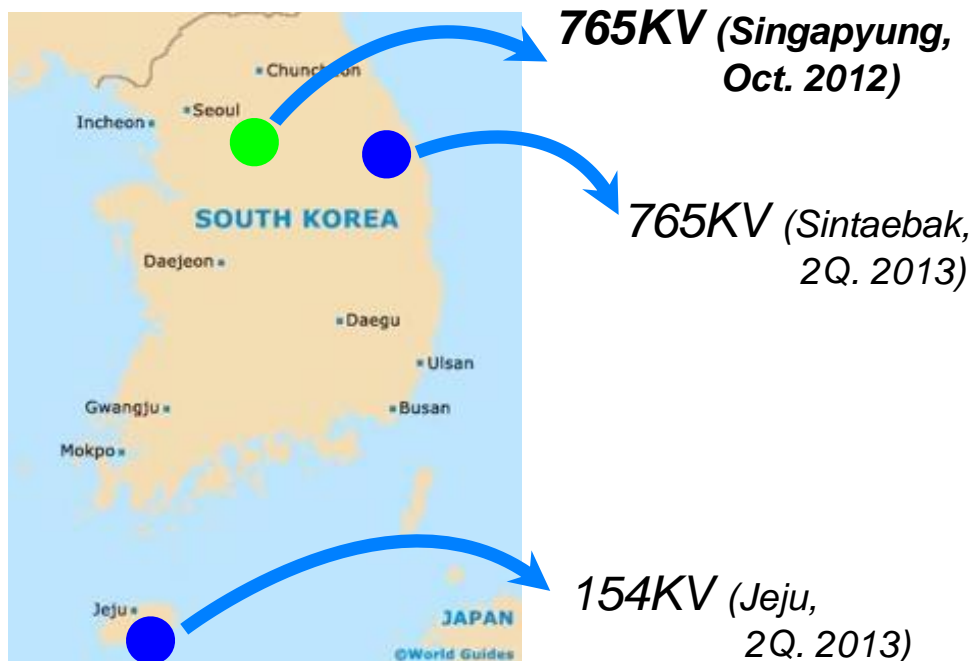
## ➤ New Tracking Antenna

- ✓ 13-meter dish antenna
- ✓ dual RF (X-band, S-band) & triple receiver switching for STEREO, ACE & DSCOVR
- ✓ in operating from Dec 2014



## ➤ GIC Measurement & Analysis

- ✓ GIC monitoring over 765KV & 154KV transmission facilities
- ✓ the first GIC monitoring systems in Korea
- ✓ 10A GIC was recorded during G3 storm period of Oct 2012



HIOKI SENSOR UNIT  
9555-10



HIOKI UNIVERSAL  
CLAMP ON CT 9279

# SWx Operations – Obs. Facilities

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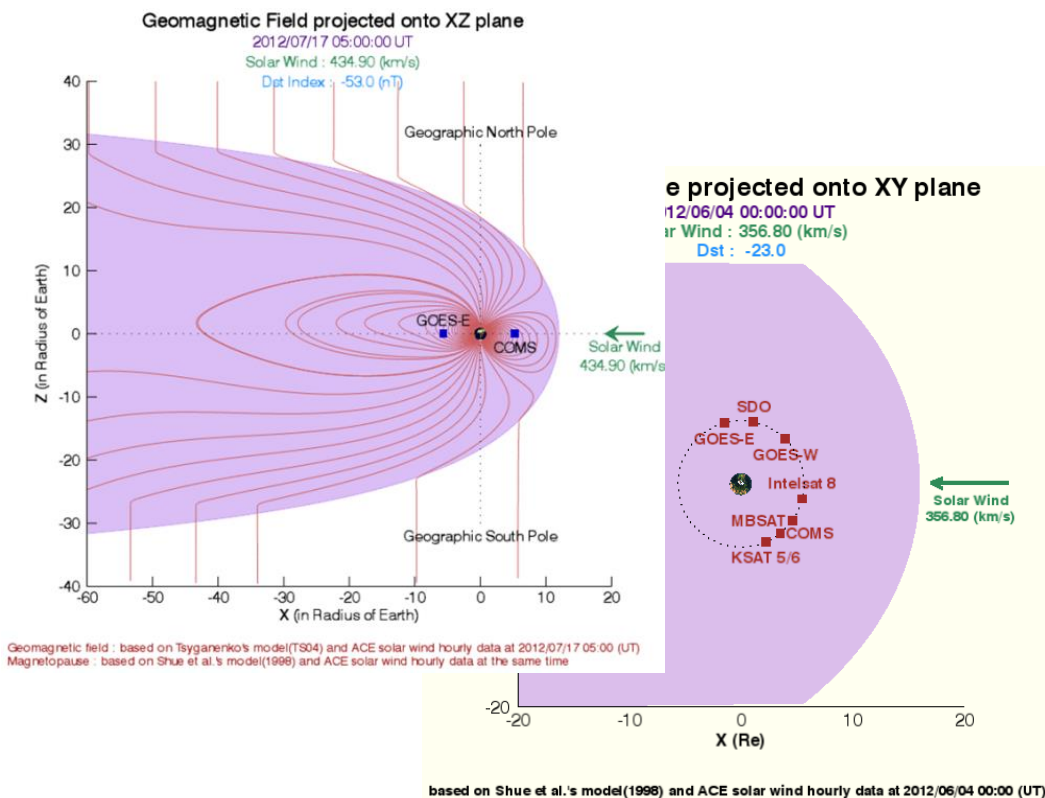
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<b>Solar Activity</b>	ASSA : Automatic Solar Synoptic Analyzer solar cycle prediction
<b>Solar Wind</b>	WSA-Enlil + Cone (Dr. Dusan Odstrcil & SWPC) IPS Solar Wind Reconstruction (Dr. Bernard Jackson & STELab. of Nagoya Univ.)
<b>Satellite</b>	<b><u>GEO environment monitor</u></b> <b><u>LEO satellite drag prediction</u></b>
<b>Aviation</b>	<b><u>polar route SWx monitor</u></b> <b><u>radiation dose prediction</u></b>
<b>Power Grid</b>	local GIC prediction local GIC map
<b>Navigation</b>	local TEC map local GPS ionospheric error map
<b>Communications</b>	<b><u>local ionospheric model</u></b> (IRI-2012 + VOACAP + local data) real-time usable HF frequency

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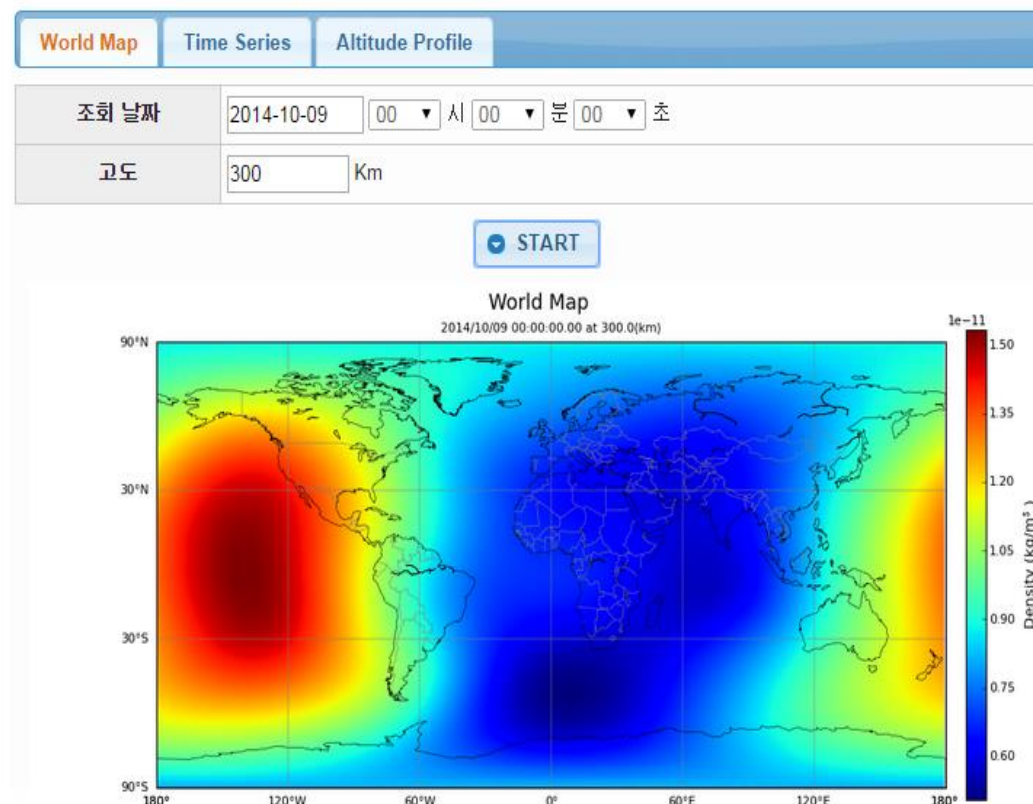
## ➤ GEOs Environment Monitor (Dev. 2012)

- ✓ Tsyganenko 2004 & Shue 1998 model
- ✓ Latest ACE SW and Kyoto Dst index
- ✓ Supports KSAT 5 & 6, COMS, MBSat, Intelsat 8, GOES, SDO



## ➤ LEOs Satellite Drag Prediction (Dev. 2013)

- ✓ Thermospheric mass density distribution
- ✓ Global map, Time series, & Vertical profile

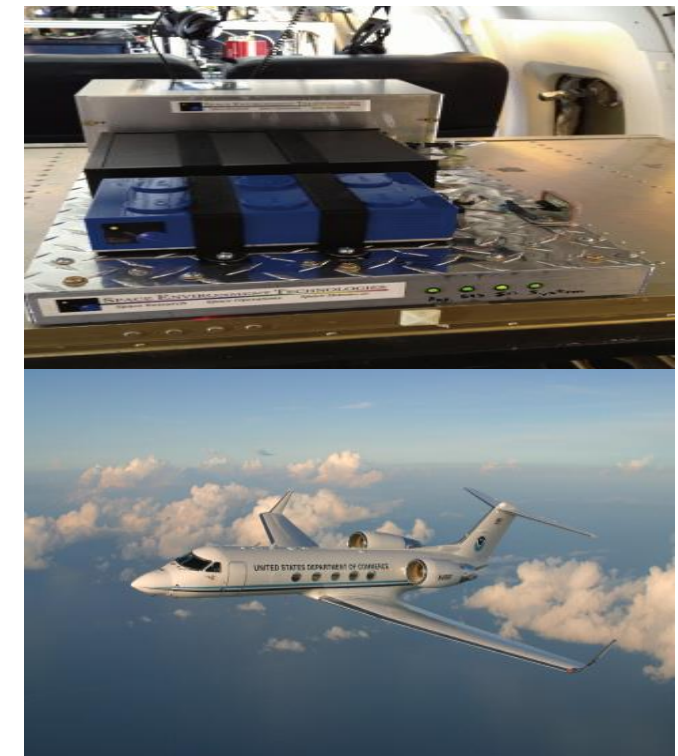
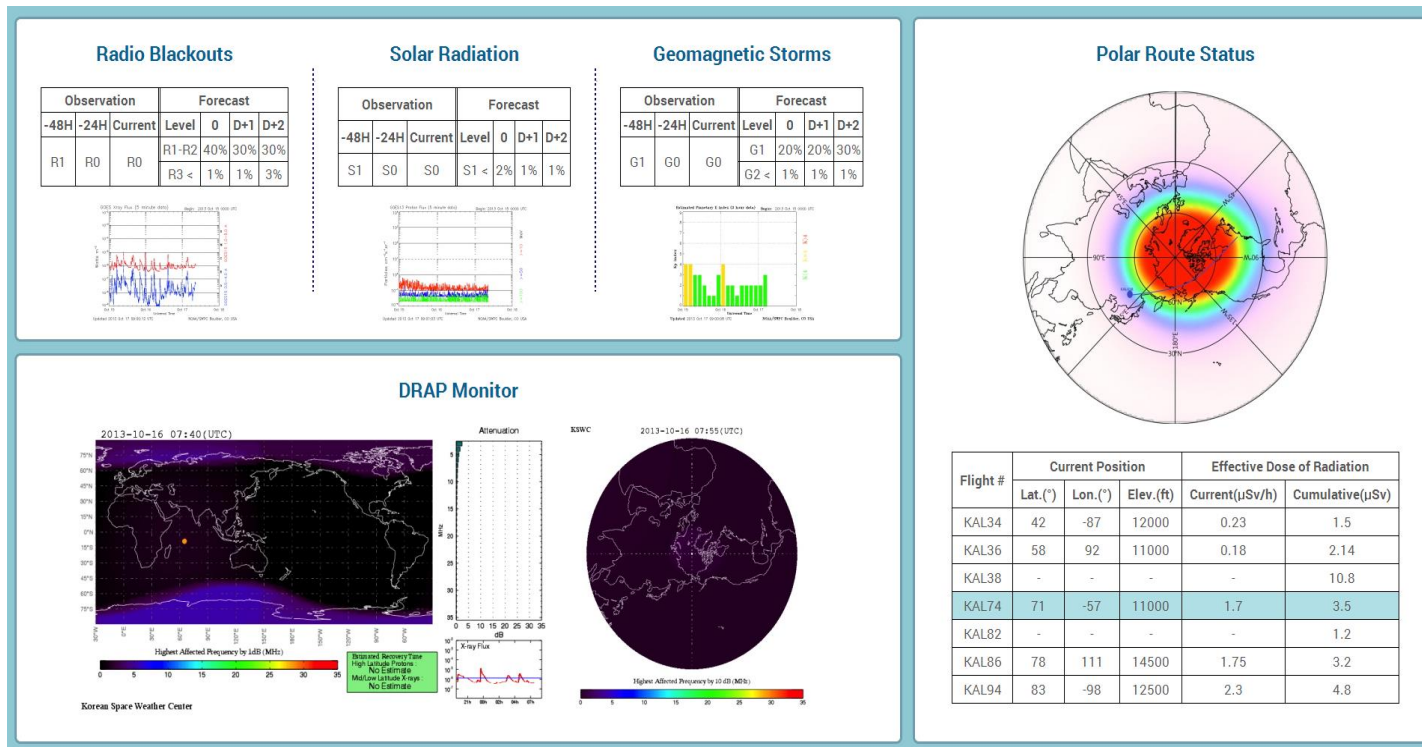


## ➤ Polar route SWx monitor (Dec 2013~)

- ✓ live flight position tracking for each flight number (for Korean Air & Asiana Air)
- ✓ provide HF attenuation (D-RAP+PCA) & radiation dose rate (CARI-6+NIRAS)

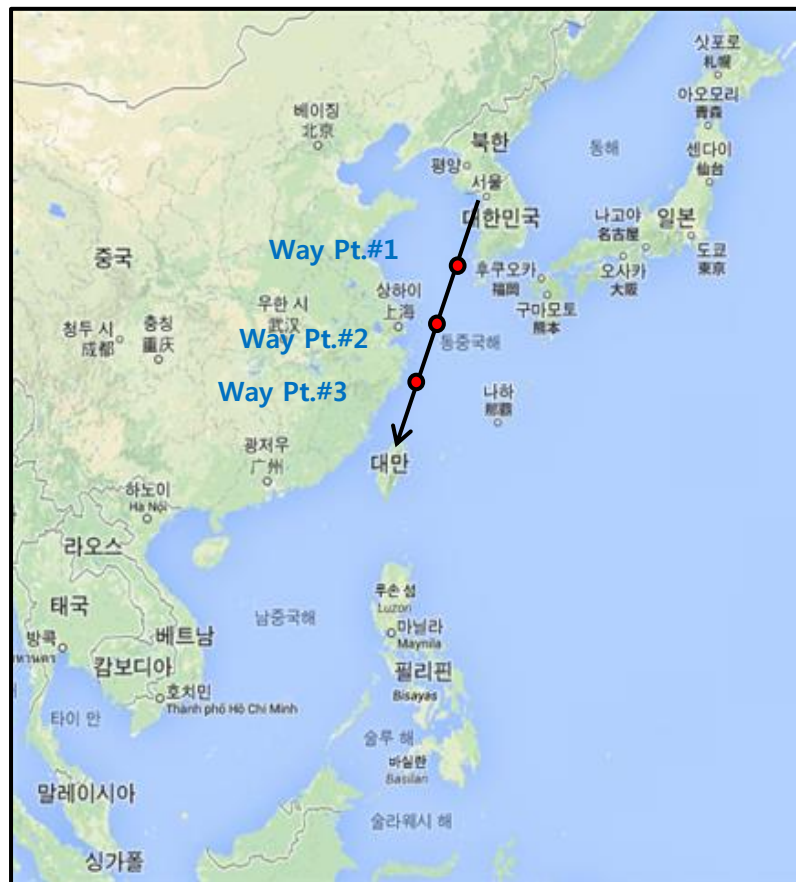
## ➤ ARMAS-Lite Project (2014~)

- ✓ Automated Radiation Measurements for Aviation Safety
- ✓ fly with airplanes of NOAA & NCAR
- ✓ comparison with NAIIRAS model

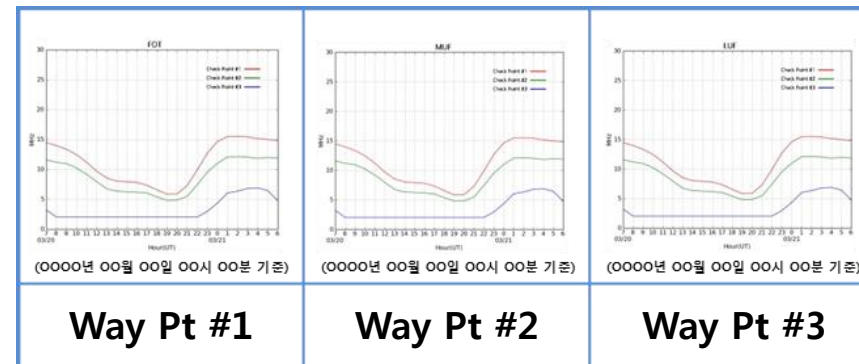


## ➤ Ionosphere & HF Model (Dev: 2013~2014)

- ✓ IRI-2012 (empirical) + VOACAP (propagation) + Ionosonde data assimilation
- ✓ real-time usable HF frequency for airlines, ships, military, etc
- ✓ Data assimilation coverage is expended to East Asia in 2014



출발지: 서울 - Incheon International Airport → 도착지: 타이페이 - Taoyuan Int'l Airport (T)



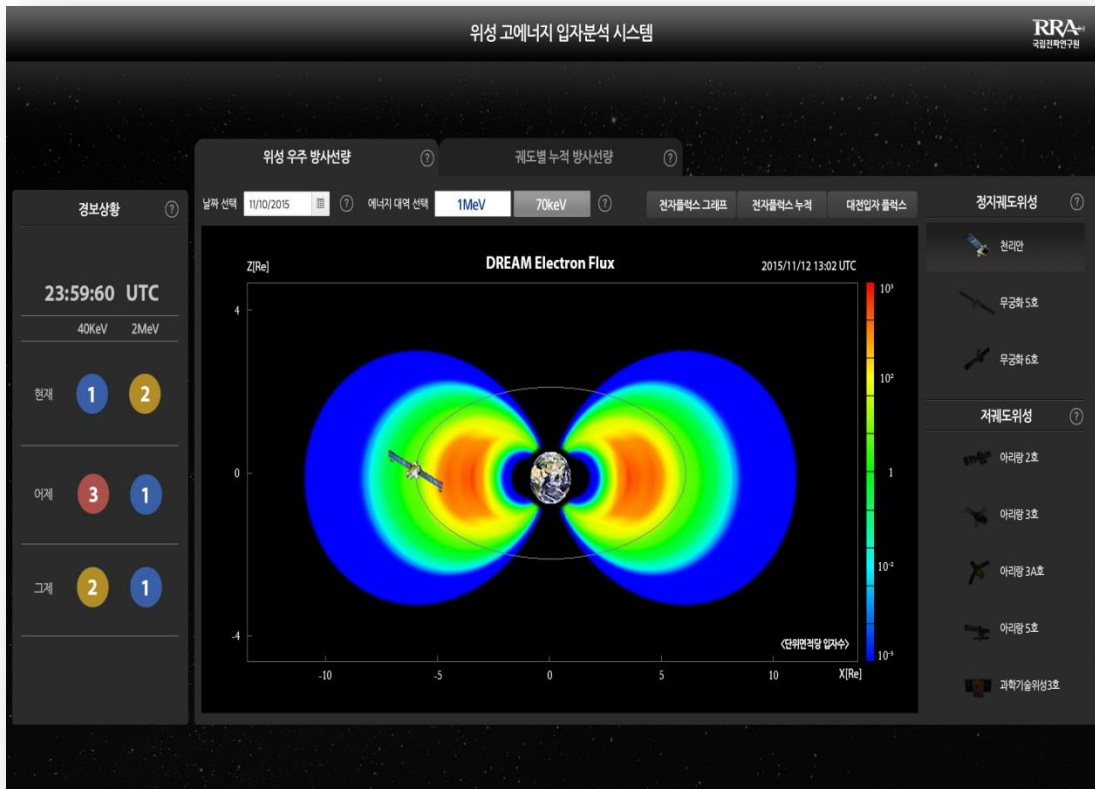
	Tx			Rx
	Way Pt #1	Way Pt #2	Way Pt #3	Seoul Radio Station
Lat. (°)	00.00	00.00	00.00	00.00
Lon. (°)	000.00	000.00	000.00	000.00

## ➤ Satellite Radiation Environment (Dev:2015)

- ✓ DREAM model(LOS Alamos National LAB)
- ✓ Electron flux & Radiation Dose
- ✓ Supports KSAT 5 & 6, COMS, ARIRANG 2,3,3A & 5

## ➤ SAFE(Safety Aviation Flight Environment) (Dev:2015)

- ✓ NAIRAS (NASA) + CARI-6M(FAA)
- ✓ Estimate Radiation Dose of all flights
- ✓ Input : Time(Dept.), air route(Departure-arrival airport), airline



항공로 조회    주요 항공로    모니터링

© Goeul chang

\*지도에 있는 비행기를 클릭하시면 해당 항공로의 방사선량을 확인 할 수 있습니다.

출발일 2016-02-04    항공사 0    항공사명 입력    비행편 0    비행편(출발지-도착지)    검색

항공사 필터 0

2016-02-04 14:56 ICT

KE657/Korean Air

상태 **운행중**

항공기 Boeing 747-4B5

속도 1306.01 km/h

고도 34000 ft

비행거리 4175.32 km

**NAIRAS 순간 방사선량 1.7117  $\mu$ Sv/hr**

상세보기

NAIRAS 누적 방사선량 0.0067 mSv

CARI-6 순간 방사선량 4.3526  $\mu$ Sv/hr

CARI-6 누적 방사선량 0.0200 mSv

[www.spaceweather.go.kr/SAFE](http://www.spaceweather.go.kr/SAFE)

Alerts & Forecasts

Forecast Models

Real Time Data

Space Weather

Instruments

About the Center

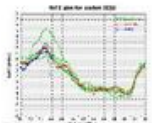
### Real time data

[ Click for more detailed images ]

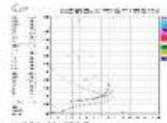
#### • Ionosphere



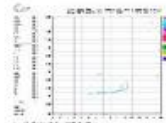
Icheon Ionosphere (foF2)



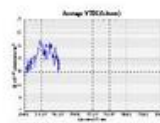
Jeju Ionosphere (foF2)



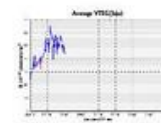
Icheon Ionosphere (ionogram)



Jeju Ionosphere (ionogram)

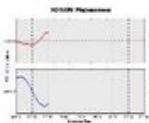


Icheon TECs

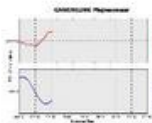


Jeju TECs

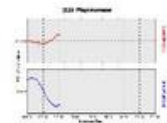
#### • Geomagnetic activity



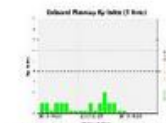
Icheon geomagnetic



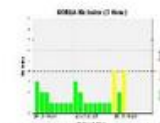
Gangneung geomagnetic



Jeju geomagnetic

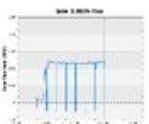


K<sub>p</sub> Index

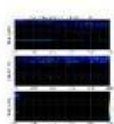


K<sub>x</sub> Index

#### • The Sun



Sunspot activity (28GHz)

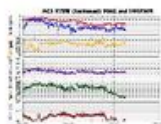


Solar radio activities Icheon | Jeju

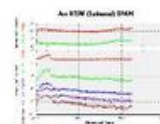


Solar Radio Noise Monitor

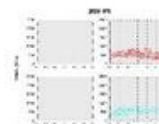
#### • Solar Wind



SOLAR WIND: Mag field & Plasma



Low Energy Electrons & Protons



Solar Wind Ground scope for Solar Wind



Would you like to know the impact of space weather on the Earth?

More detailed information for the nonprofessional on space weather, radio communications and satellites etc.

GO

Educational cartoons on space weather for kids



GO



Observation Data

Go

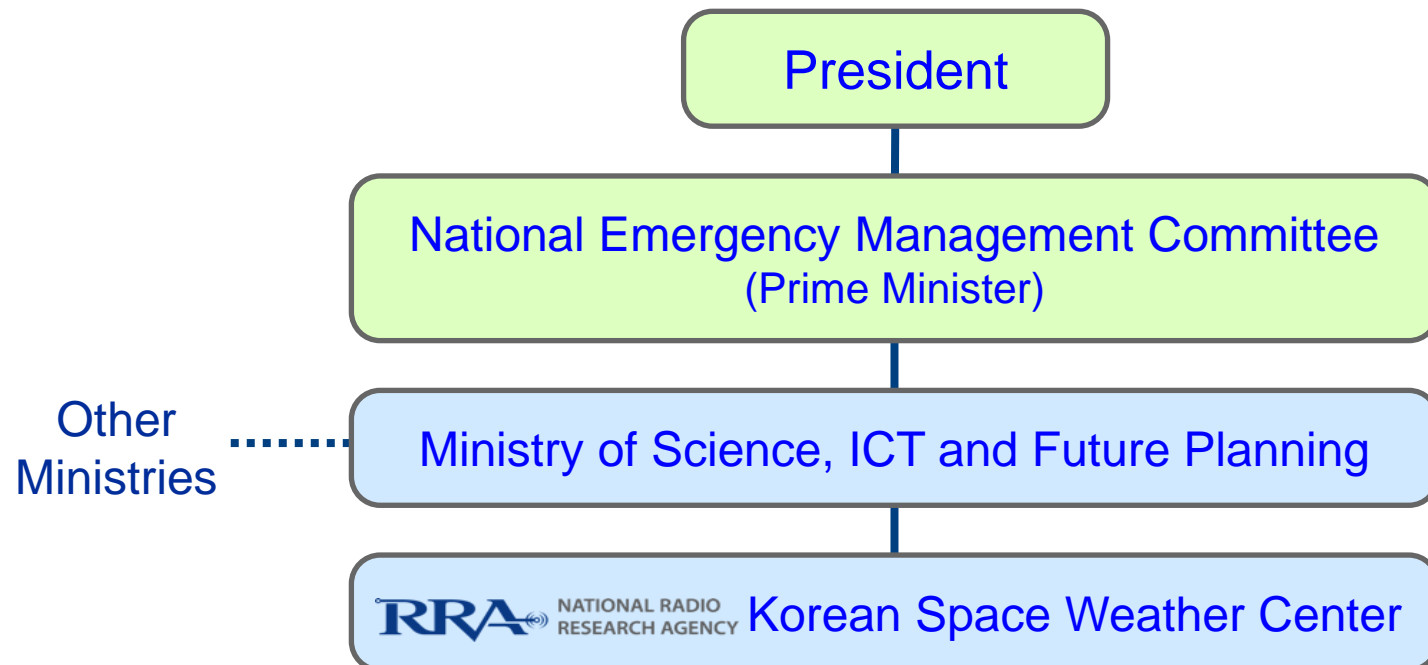


Space Weather Report

Go

- **Space Weather Response Guideline (2012)**
  - ✓ describes possible damages due to space weather
  - ✓ suggests example actions to prevent/mitigate damages
  - ✓ 5 areas : satellite, airline, navigation, power grid, communications
  
- **National Plan for Space Weather (2012)**
  - ✓ vision : “Safe Korea without Space Weather Risk”
  - ✓ 5-year plan (2013-2017)
    - provides accurate forecasts & real-time alarms
    - develops advanced models
    - expands observation networks
    - space weather awareness-raising

- **Risk Management Manual for Space Weather** (Feb. 2013)
  - ✓ space weather was included in the national risk profile
  - ✓ the government's official manual was approved
    - describes the roles & responsibilities of related ministries and agencies
    - removing confusion & increasing efficiency among different organizations





# 4<sup>th</sup> Asia-Oceania Space Weather Alliance Workshop

1~4 Nov, 2016

Jeju, Republic of Korea

# 6<sup>th</sup> Space Weather Conference

31 Oct, 2016

Welcome !



NATIONAL RADIO RESEARCH AGENCY

# KOREAN SPACE WEATHER CENTER

# Thank you!

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Sunhak Hong (sunhak.hong@korea.kr)



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