

NASA CCMC International Space Weather Workshop

Opportunities for NASA-KSWC Partnership

APR. 15. 2016.

RRA NATIONAL RADIO
RESEARCH AGENCY

KiChang, Yoon(Korean Space Weather Center)

Complementary Agency Missions

KSWC

- ✓ **Mission** : Official agency to deliver SWx products and services that meet the evolving needs of the nation.

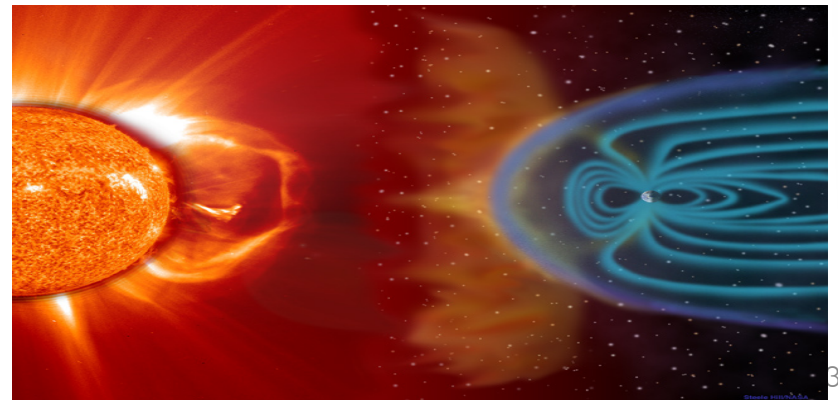
→ **Models to Support Customers**



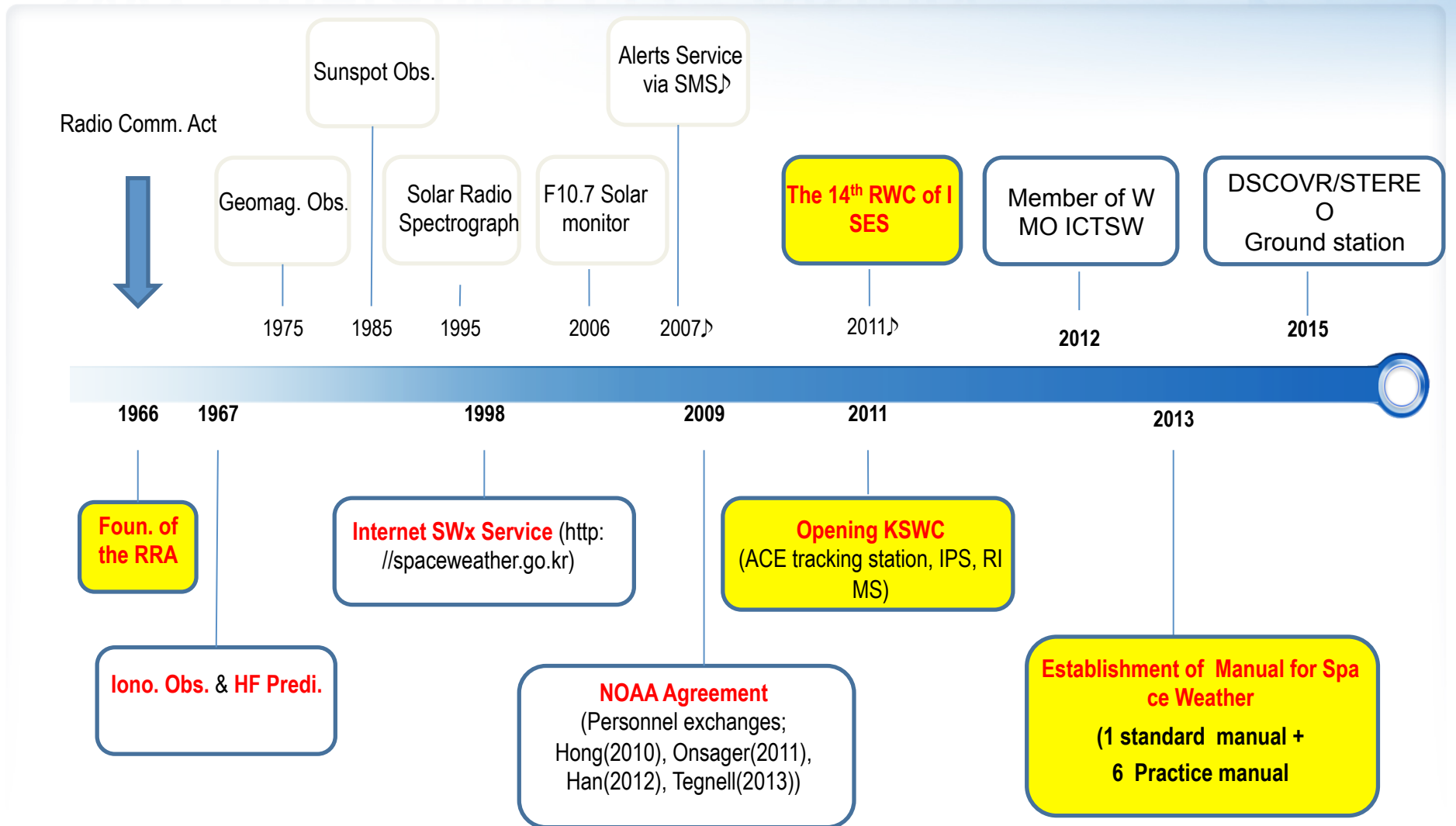
CCMC

- ✓ **Mission** : Multi-agency partnership to enable, support and perform R&D for next-generation space science and SWx models.

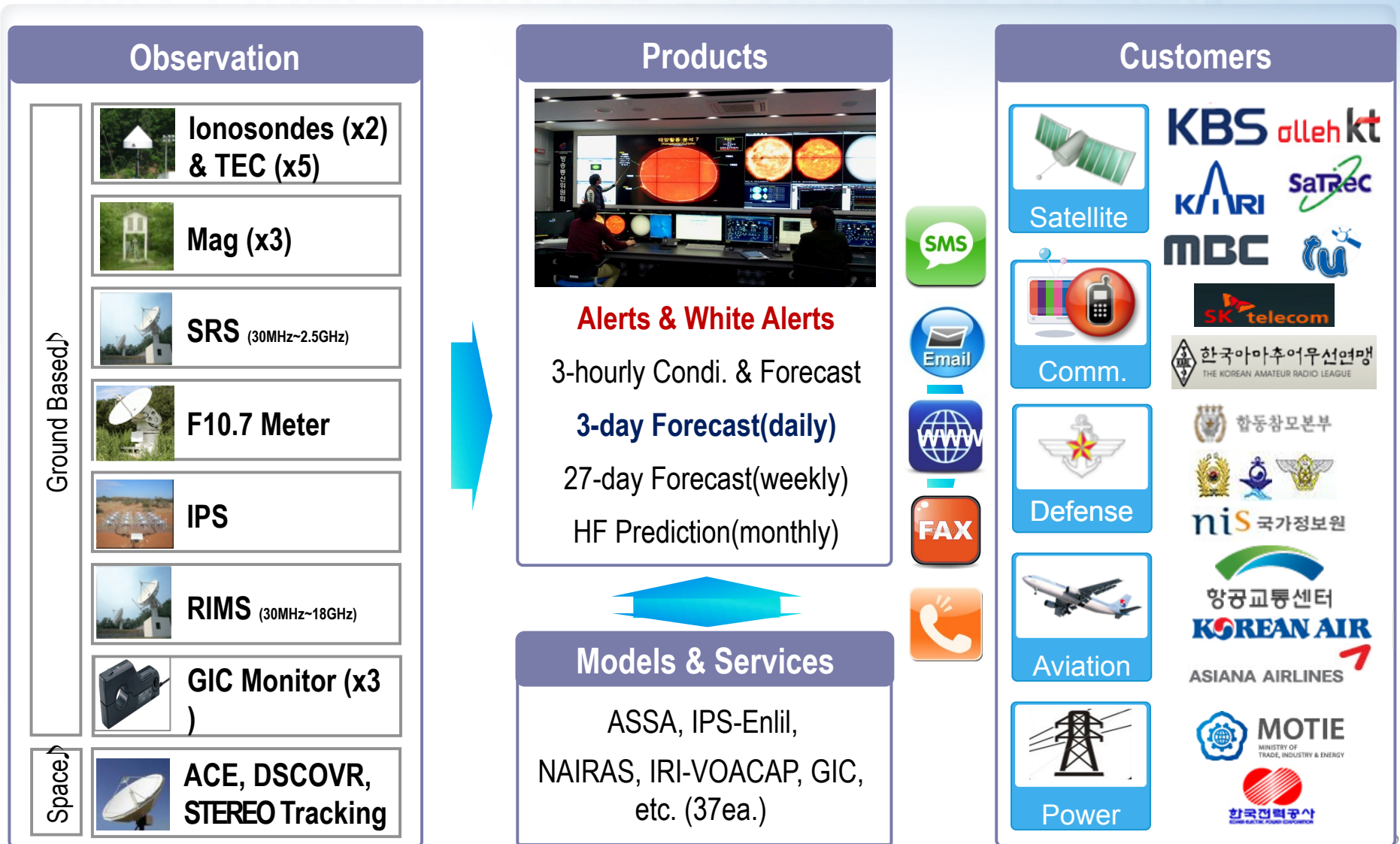
→ **Testing, Evaluating and Transitioning Models of Space Weather**



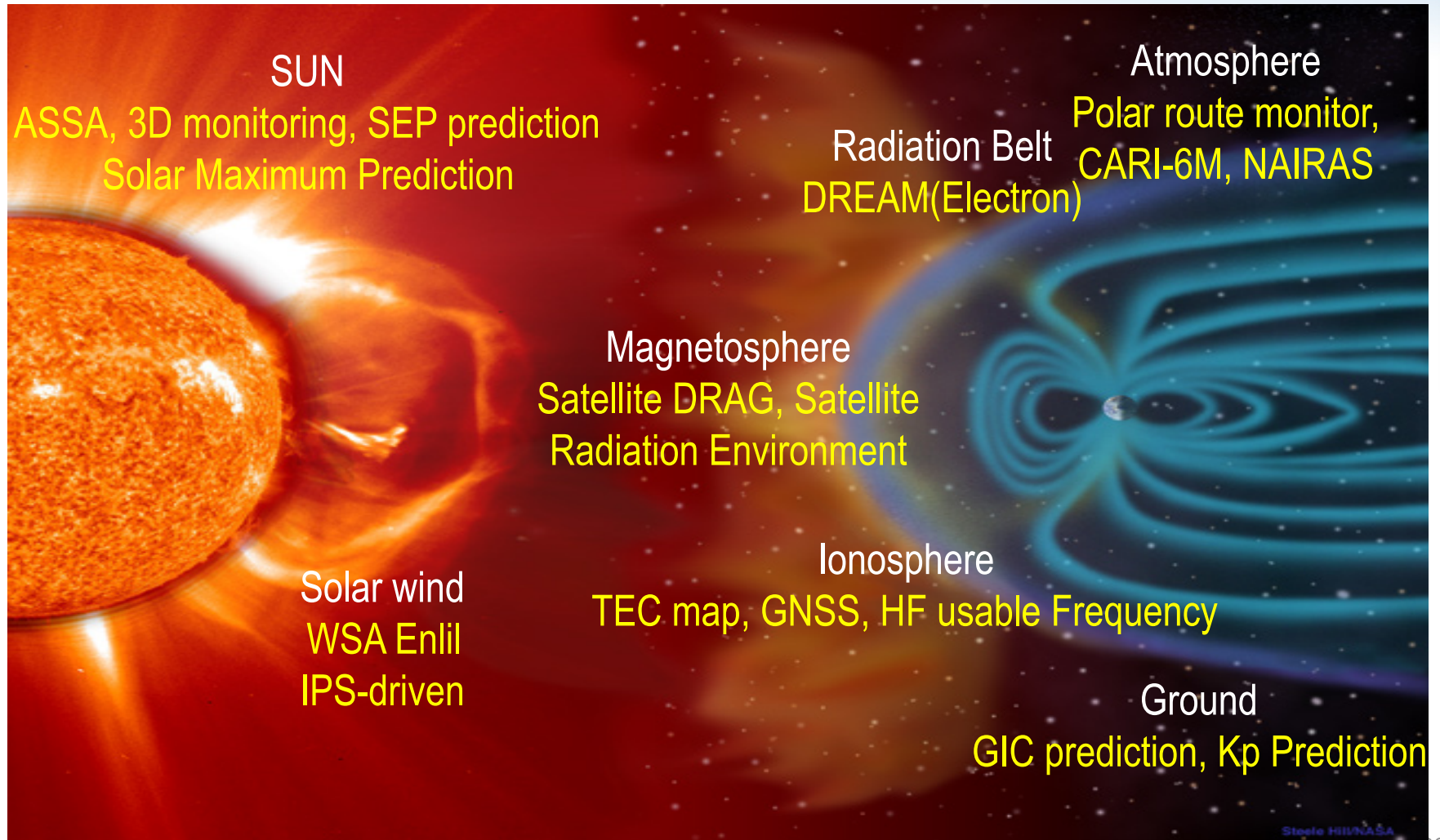
SWx Operation (1) - History



SWx Operation (2) - Forecast & alert



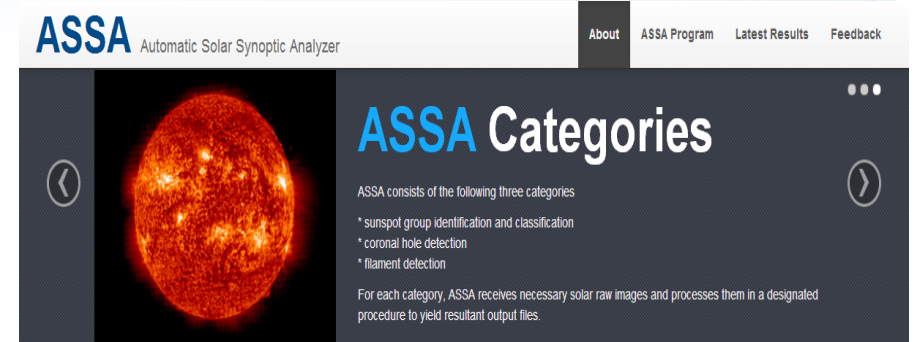
SWx Operation (3) - R & D



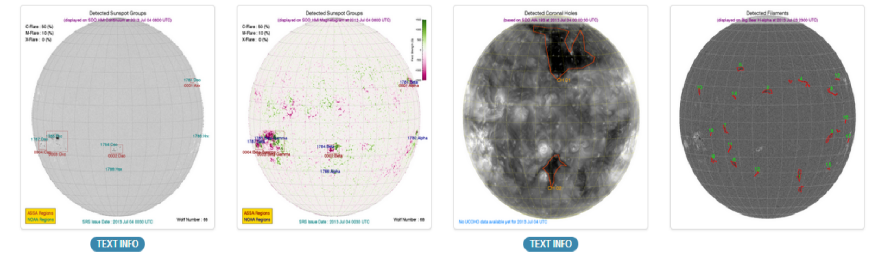
Past Collaborations (1) - Solar activity

ASSA Improvement

- ✓ Numerous partnerships contribute to the success of this model
→ E.S. Masha ! Thank you.
- ✓ CCMC led registration & evaluation, in collaboration with KSWC & modelers
→ We got a lot of good feedback from all over the world
- ✓ CCMC leads the collaboration on Flare forecast comparisons
→ Very good attempt !



Latest Results



<http://www.spaceweather.go.kr/assa>

Real-time Forecasting Methods Validation: Flare Scoreboard

CCMC is in the implementation phase of the "Flare Scoreboard" together with Sophie Murray of the UK Met Office and the international research community. The flare scoreboard is an automated system such that model/method developers upload their predictions automatically uploaded to an **anonymous ftp** which will be parsed by the system. The forecasts are shown on an interactive display of SDO/AIA or HMI images, and will also be displayed together on a graph of probability vs. time.

Please email Sophie Murray, Masha Kuznetsova, and Leila Mays with your feedback which will be shared with the flare scoreboard planning group.

Flare scoreboard planning group:

Leads: Sophie Murray (UK Met Office), Jesse Adries, Andy Devos (SIDC)

Mike Terkildsen, Graham Steward (Australia Bureau of Meteorology, Space Weather Services), K.D. Leka (NWRRA), Jordan Guerra, Shaun Bloomfield (Trinity College Dublin), Yoon (KSWC), Masha Kuznetsova, M. Leila Mays (CUA/GSFC)

Participating partners:



Past Collaborations (2) - CME Scoreboard

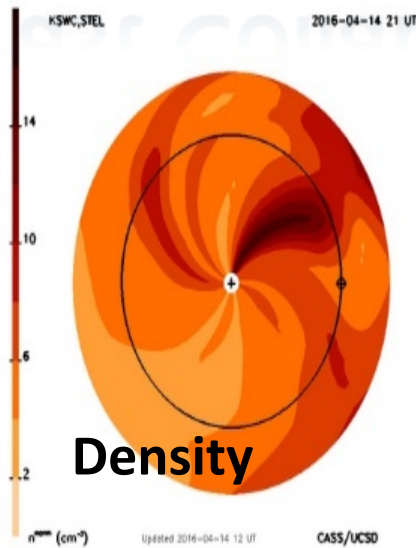


Fig1. Solar Wind Density

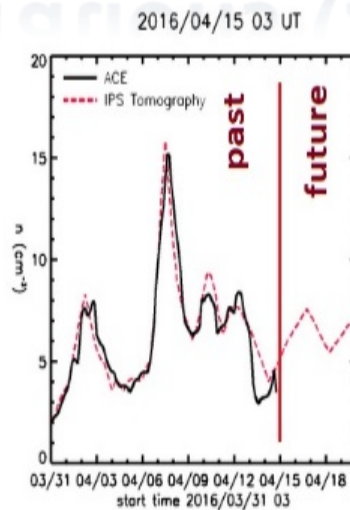
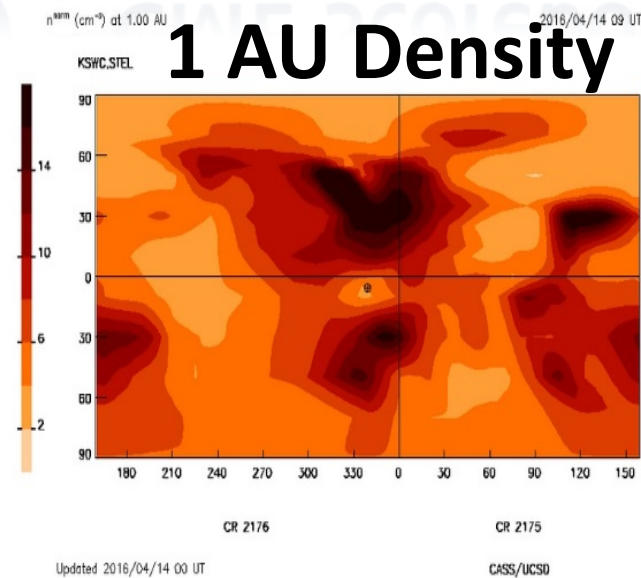
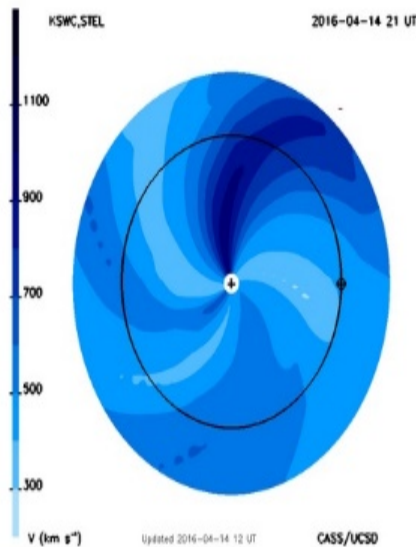


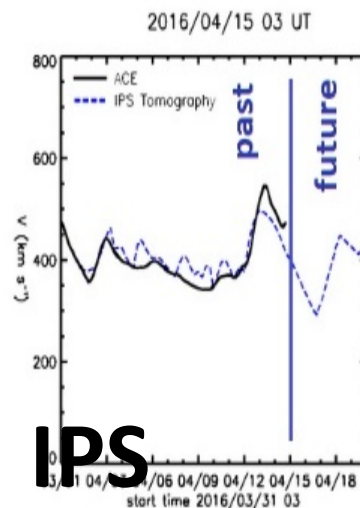
Fig2. Solar wind Density compared with ACE



1 AU Density

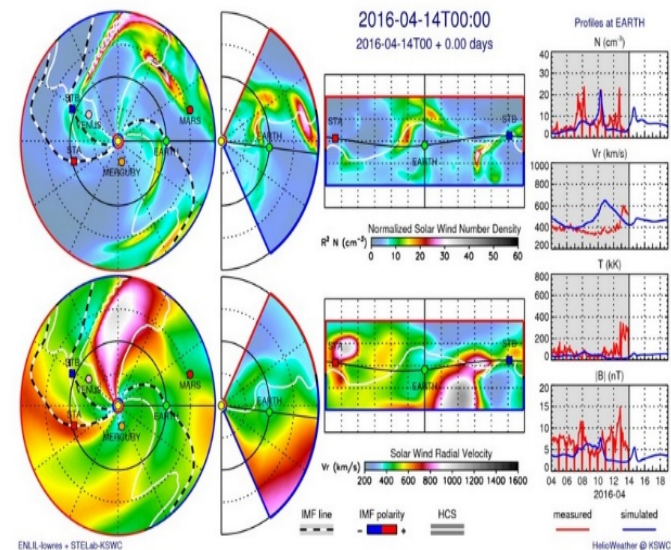


Velocity



IPS (current)

IPS-driven ENLIL

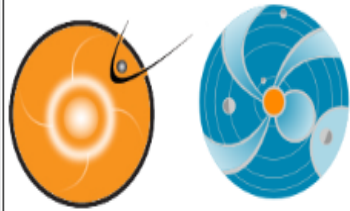


ENLIL-1000s - STELab-KSWC

HeloWeather © KSWC

<http://spaceweather.rra.go.kr/models>

Past Collaborations (3) - CME Scoreboard



CME ScoreBoard

Prediction for CME (2015-06-22T18:36:00-CME-001)

CME Observed Time: 2015-06-22T18:36Z
CME Note: from AR 12371
CME Shock Arrival Time: 2015-06-24T12:57Z
Observed Geomagnetic Storm Parameters due to CME:
Max Kp: 6.0

Latest update

Predicted Arrival Time: 2015-06-24T15:00Z
Prediction Method: WSA-ENLIL + Cone (KSWC)
Prediction Method Note:

KSWC ENLIL settings:
ENLIL version: 2.7e
Resolution: low (256x30x90)
Ambient settings: a5b1
WSA version: 2.2

CME input parameters
Time at 21.5Rs boundary: 2015-06-22T21:03Z
Radial velocity (km/s): 1273
Longitude (deg): 11.8
Latitude (deg): 3.7
Half-angular width (deg): 45

Notes:

Lead Time: 11.37 hour(s)
Difference: -2.05 hour(s)

Prediction submitted by RWC Jeju (KSWC) on 2015-06-24T01:35Z

- ✓ Very Good approaches for sharing information on SWx situation in real-time and exploring prediction method
- ✓ Especially, Anyone can access & easy to participate in.
- ✓ It is already contributing to SWx research & operations

Past Collaborations (4) - CME Scoreboard

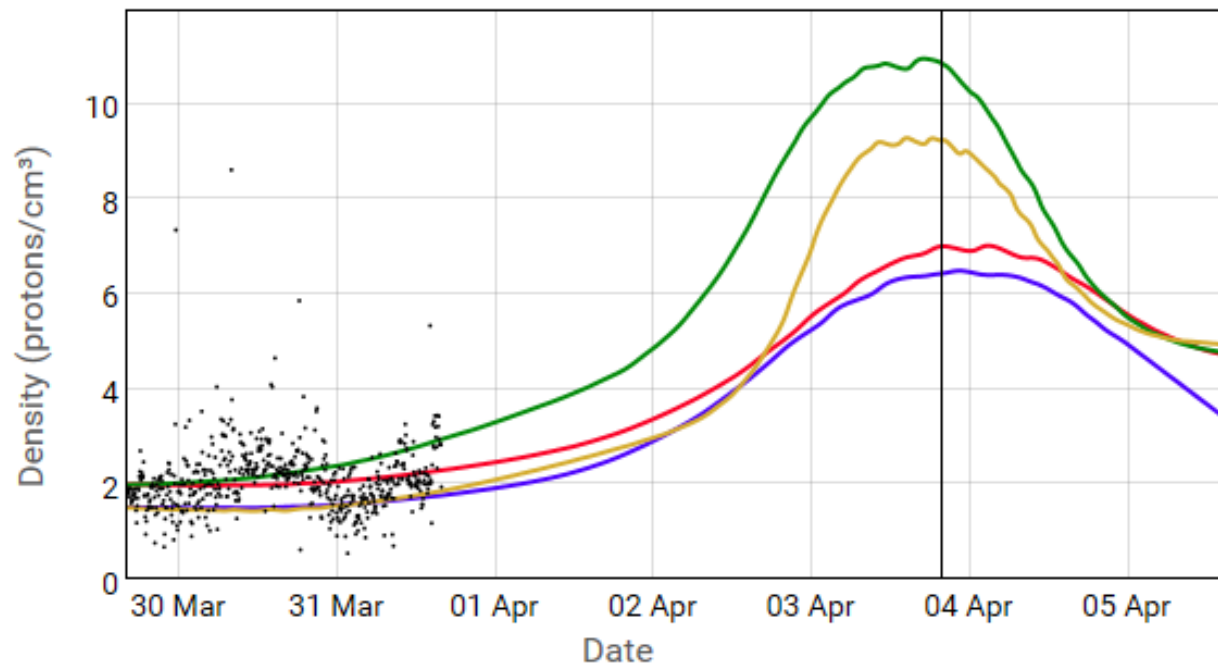


ISES

International Space
Environment Service

<http://www.ises-spaceweather.org>

ENLIL Composite PLOT (Gong Obs.: 2016-03-31 16Z)



· · · ACE — AUS_BOM — KOR_KSWC — UK_MetOffice — USA_NOAA

Lesson Learned

- ✓ **Model still need improvement**
 - Often missed / Sometimes accurate
 - For KSWC, Flare / SEP / Bz prediction is the first priority
 - ✓ **Model developer(R2O) should consider operational situation**
 - Model results should be timely delivered.(eg, Enlil(4 hour))
 - KSWC forecasters are operating about 40 models per every forecast. (automatic calculation is preferred)
 - ✓ **Model Verification & Evaluation are emerging issues**
 - There are few space weather validation tools
 - Differences in model performance from event to event and forecaster to forecaster
 - Different way to evaluate empirical/physical based model
- **But, model is Only and Powerful tool to aid SWx operation**

Now, We are...

- ✓ KSWC transitioning LANL DREAM model to operation
 - Developing transition plan / open to the public(May, 2016)
 - Model installed and tested on the KSWC server
 - Working with LANL(Jeff, Morley, Reiner...)
 - Evaluating methods for electron flux(RBSP, GOES data)
 - Providing radiation dose information with 7 Korean satellites

- ✓ KSWC is providing SAFE(Radiation Dose) with public
 - Received model (CARI-6M + NAIRAS) + IT technology
 - Developing SEP prediction based on Kalman filter
 - Developing solar maximum prediction model
 - Will measure radiation does in commercial flight(FY 2017)

Future Collaborations (1) - Satellite

DREAM Operation

- ✓ LANL-RRA-NOAA + ESA will join
- ✓ DREAM (LOS Alamos National LAB) + New physical model (KSWC)
- ✓ RT Electron flux in Radiation Belt
→ R2O & verification

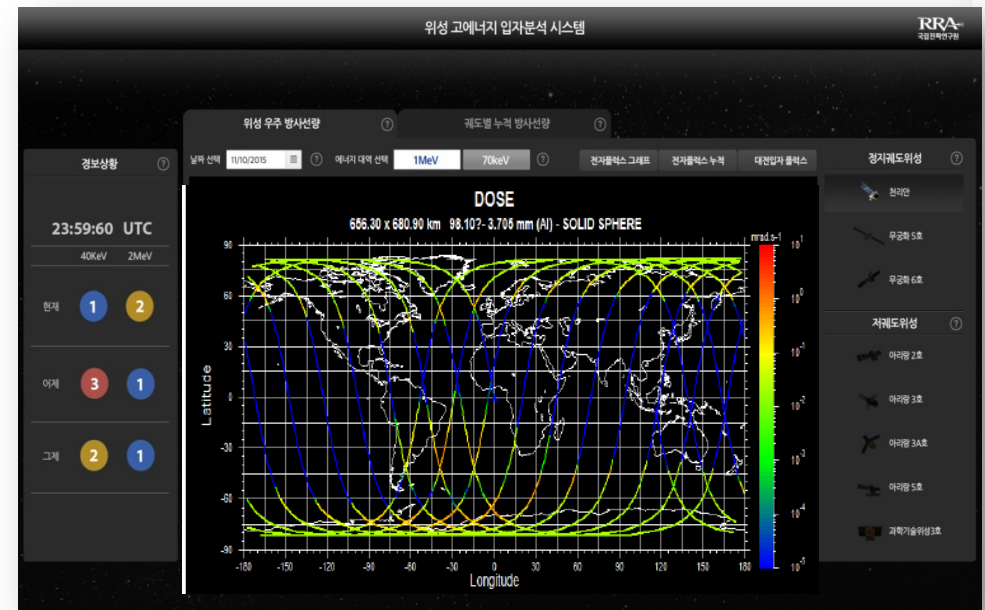
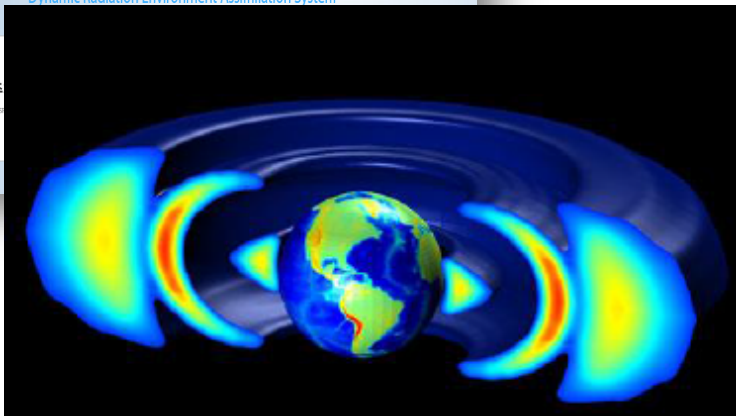
Satellite Service

- ✓ Radiation Dose for ROK Satellites
 - COMS, ARIRANG 2,3,3A & KSAT 5 & 6,
 - Radiation Hazard Warning



Dynamic Radiation Environment Assimilation System

RRA 우주
국립원천연구원



Future Collaborations (2) - Aviation

SAFE(SAFETY Aviation Flight Environment)

- ✓ NAIRAS (NASA) + CARI-6M(FAA)
- ✓ Radiation Dose of all flights
- ✓ Input : flight Time, airport, airline
- ✓ Adopted by all domestic airlines

Space Radiation Measurement

- ✓ **ARMAS-Lite Project**
 - * Automated Radiation Measurements for Aviation Safety
 - KSWC, SET, NOAA/SWPC, NASA, NSF
 - fly with NOAA & NCAR airplanes
- ✓ Will **measure real-time space radiation** for commercial aircrafts
 - Study on **radiometer's airworthiness**

항공로 조회 주요 항공로 모니터링

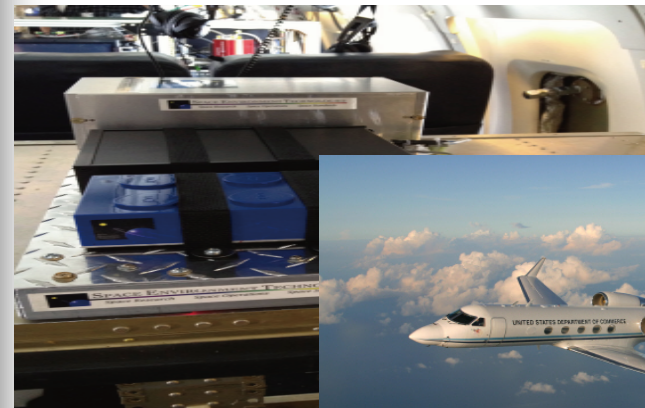
출발일 2016-02-04 항공사 항공사명 입력 비행편 비행편(출발지-도착지) 검색

항공사 필터

2016-02-04 14:56 ICT

상태	운행중
항공기	Boeing 747-4B5
속도	1306.01 km/h
고도	34000 ft
비행거리	4175.32 km
NAIRAS 순간 방사선량	1.7117 $\mu\text{Sv/hr}$
	상세보기
NAIRAS 누적 방사선량	0.0067 mSv
CARI-6 순간 방사선량	4.3526 $\mu\text{Sv/hr}$
CARI-6 누적 방사선량	0.0200 mSv

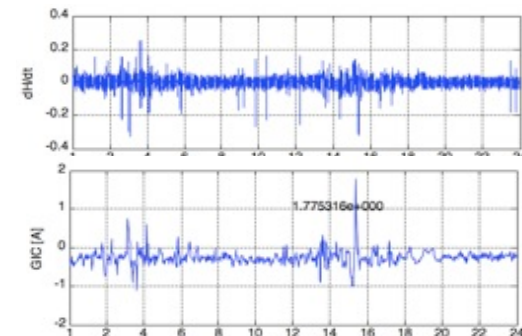
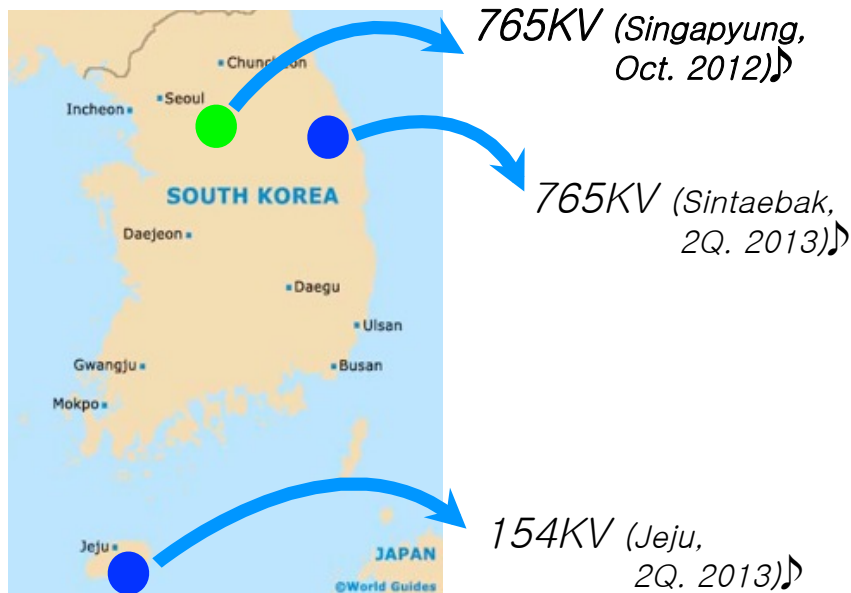
www.spaceweather.go.kr/SAFE



Future Collaborations (3) - Power grid

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
- Improved Bz prediction is required



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CLAMP ON CT 927

Conclusions

- ✓ Collaboration and partnership with CCMC, and other agencies are essential and valued.
 - ✓ CCMC collaborations with KSWC and model developers will contribute the R2O of newly developed models at KSWC
 - Skill & Expertise regarding Space Weather model operation
 - advanced model operation via CCMC website
 - Deliver customer needs & feedback
 - ✓ Performance metrics/Verification methods are required
 - KSWC has a plan to verify all SW models (FY 2017-20)
 - Standard format to evaluate models are needed
- CCMC can lead and support these works



AOSWA...

**4th Asia-Oceania
Space Weather Alliance Workshop**
- Possible risk of Space Weather -
24-27 Oct, 2016

Welcome !



NATIONAL RADIO RESEARCH AGENCY

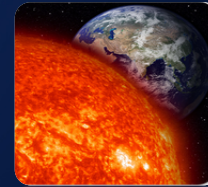
**KOREAN SPACE
WEATHER CENTER**

Thank You

kijitoper@gmail.com



www.facebook.com/rwcjeju



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