

Recent NICT activities for space weather R&O, and possible collaborative candidates with PITHIA-NRF

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Operational Space Weather forecast Services

Ionosonde
VIPIR2



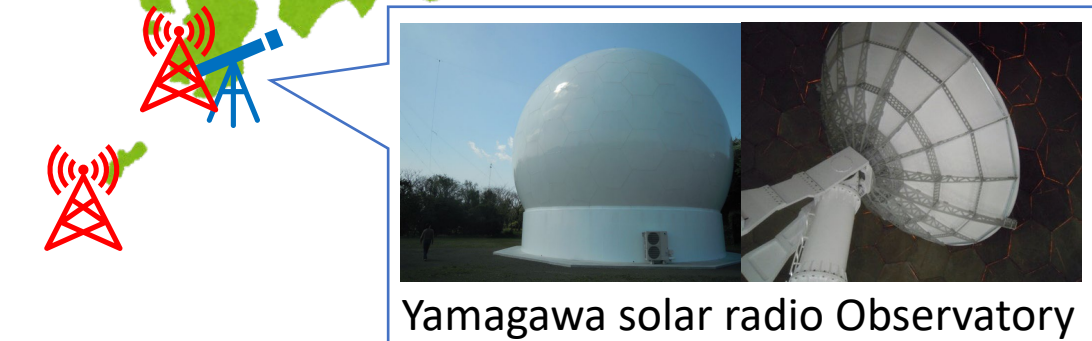
Services

Domestic users : satellite operators, aviation, electric power suppliers, radio operators, and academic use etc.

Email receivers:7000, Web70,000/month also providing by Facebook, Twitter

Robust system

- Dual obs. system
- Broadness of communication network
- Backup center in Kobe



Recent activities

- ICAO service in (since Nov. 7, 2019)
- 24/7 operation (since Dec. 1, 2019)

Consideration with Asian Countries on Space Weather Research

- ◆ Leading AOSWA activities as the secretary
- ◆ MoU with GISTDA, Thailand on Nov. 29, 2019
- ◆ Establishment of VHF radar in Chumphon, Thailand for monitoring ionosphere

Observations

- ◆ Ionosphere Observation network “SEALION”
- ◆ Establishment of VHF radar in Chumphon, Thailand on Jan. 17 2020, for monitoring ionospheric disturbance named “Plasma Bubble” which is seriously influence GNSS utility.



Chumphon VHF radar

- ▤ VHF radar
- ▤ FMCW ionosonde
- ▤ GNSS-reciever
- ▤ Magnetometer
- ▤ All-sky imager

*The “grayed-out” icons mean “observation closed”.



AOSWA

- ◆ The Asia-Oceania Space Weather Alliance (AOSWA) established in 2010 for information exchange among Space Weather organizations in Asia and Oceania.
- ◆ Members: 27 from 13 countries/regions



AOSWA-5 @ Bandung
(Sep. 19-21, 2018)

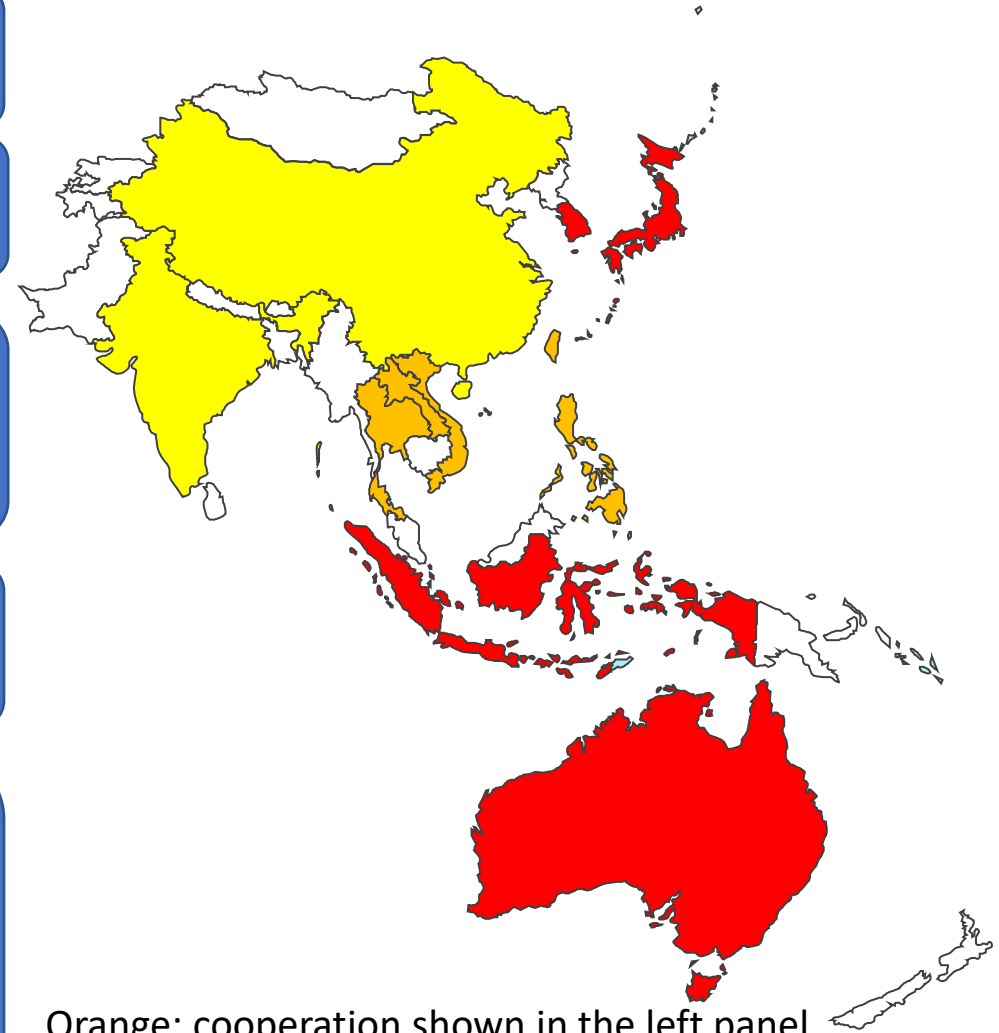
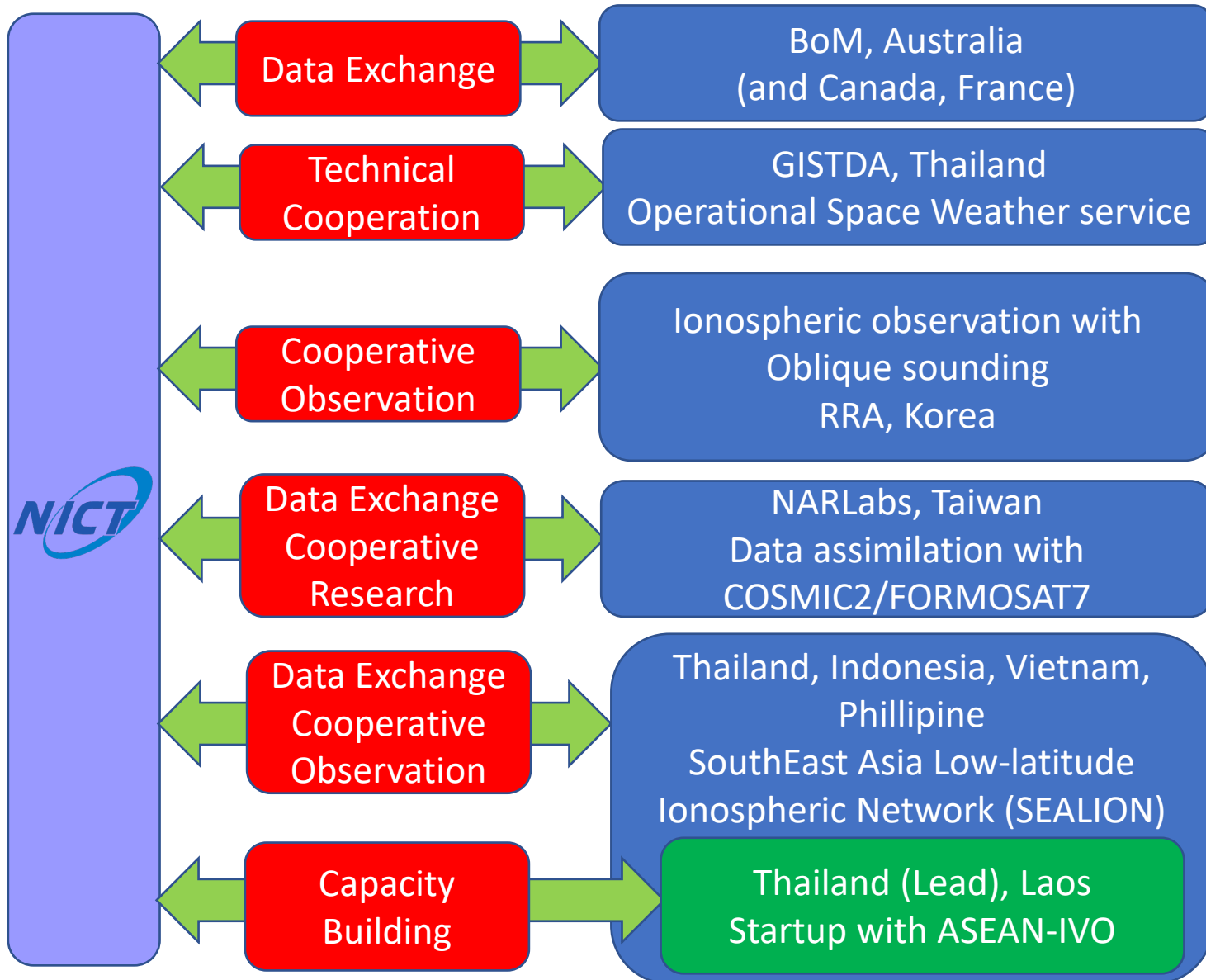
MoU with GISTDA

- ◆ NICT signed MoU with GISTDA, the national space agency of Thailand, on Nov. 29 2019, for cooperation in space weather operational services



Siging ceremony of
NICT-GISTDA MoU

International activity of NICT in Asia

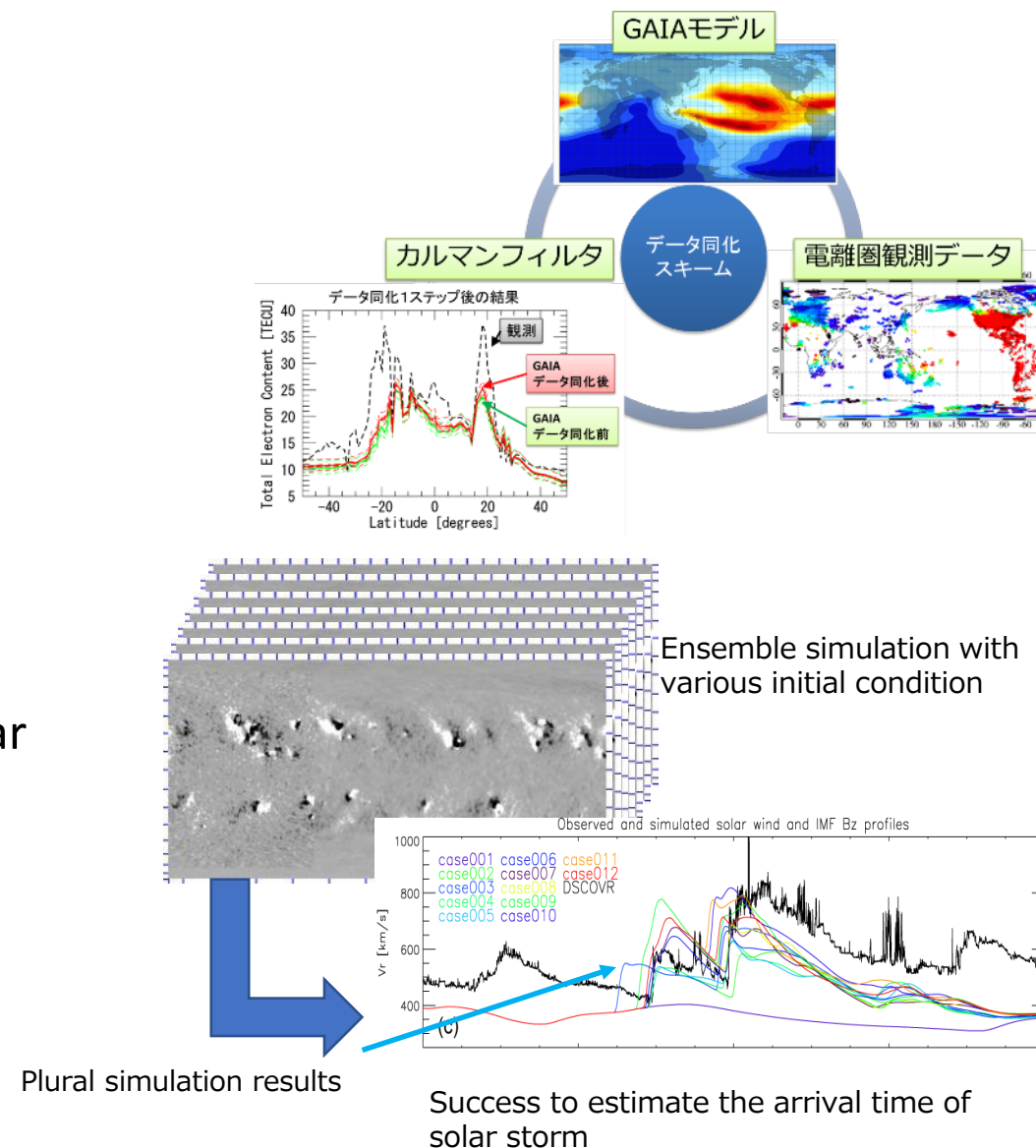


Orange: cooperation shown in the left panel
Yellow: ISES Regional Warning Centers
Red: both of above

We have been developing an atmosphere-ionosphere coupling model named “GAIA” for forecasting ionospheric condition as a part of space weather.

We succeeded to build a prototype of real-time data assimilation system using GAIA for daily space weather forecast in the last mid-term research project period. In the present period, we start the operational use of GAIA model for space weather forecast using observational data as input parameters.

We have been trying same approach in the different area, solar wind. It is important to estimate the arrival time of solar storm after solar flare for preparing against any disasters in social infrastructure. We have been developing the solar storm model named “SUSANOO” and use ensemble simulation with various initial condition for estimate the arrival time of solar storms.

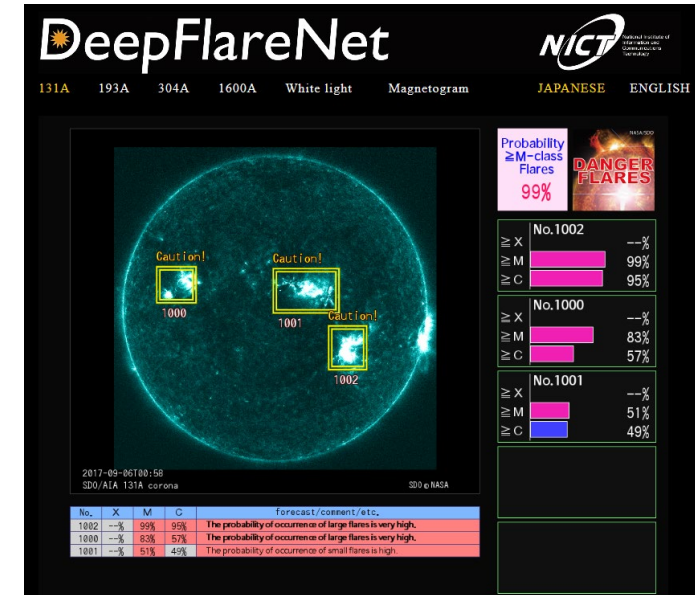


Applied AI technique in Space Weather forecast

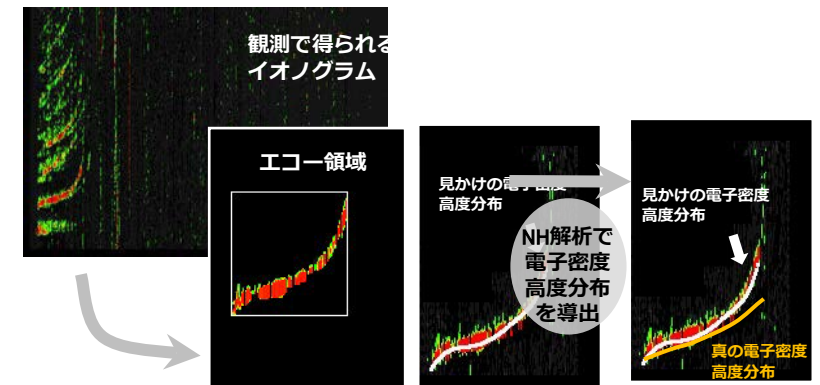
Artificial Intelligence (AI) is a powerful tool in space weather forecast. The processes in the interaction from the sun, solar wind, magnetosphere and ionosphere still have unknown parts which makes difficult the space weather forecast. On the other hand, there are an amount of observing data from the ground/satellite which can be used for teacher data in AI method.

We have been developing the solar flare prediction model “DeepFlareNet” used deep learning method on the base of SDO solar image dataset. We use this system in the discussion of operational space weather forecast.

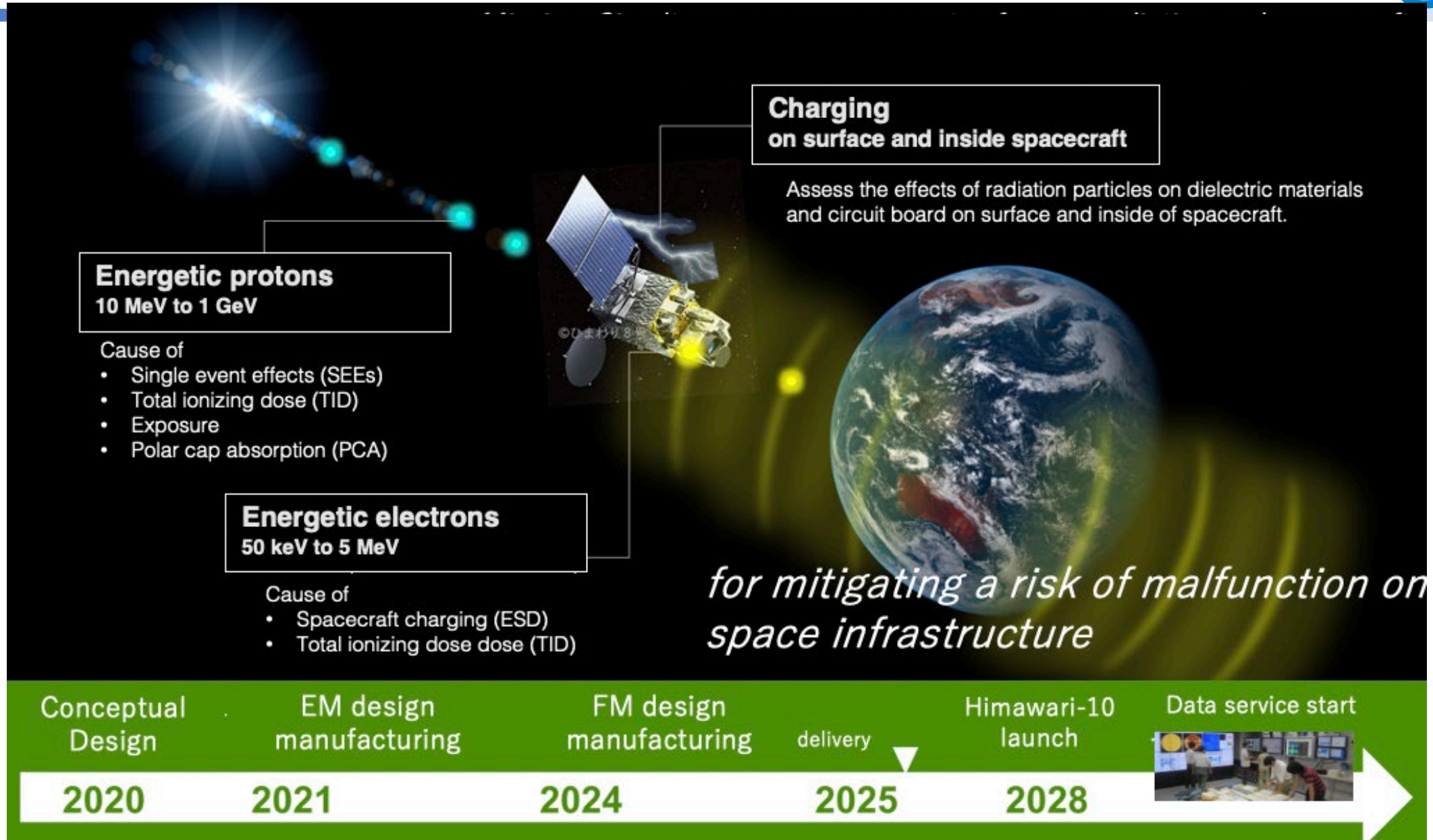
Another trial is to use AI for automatic scaling in ionogram. The ionogram is image data obtained from ionosonde observation and it is necessary to scale the image to detect any physical parameters. For many years, skilled scalers had worked the scaling, but it is difficult to obtain the data in real time. We now try to solve the issue with AI.



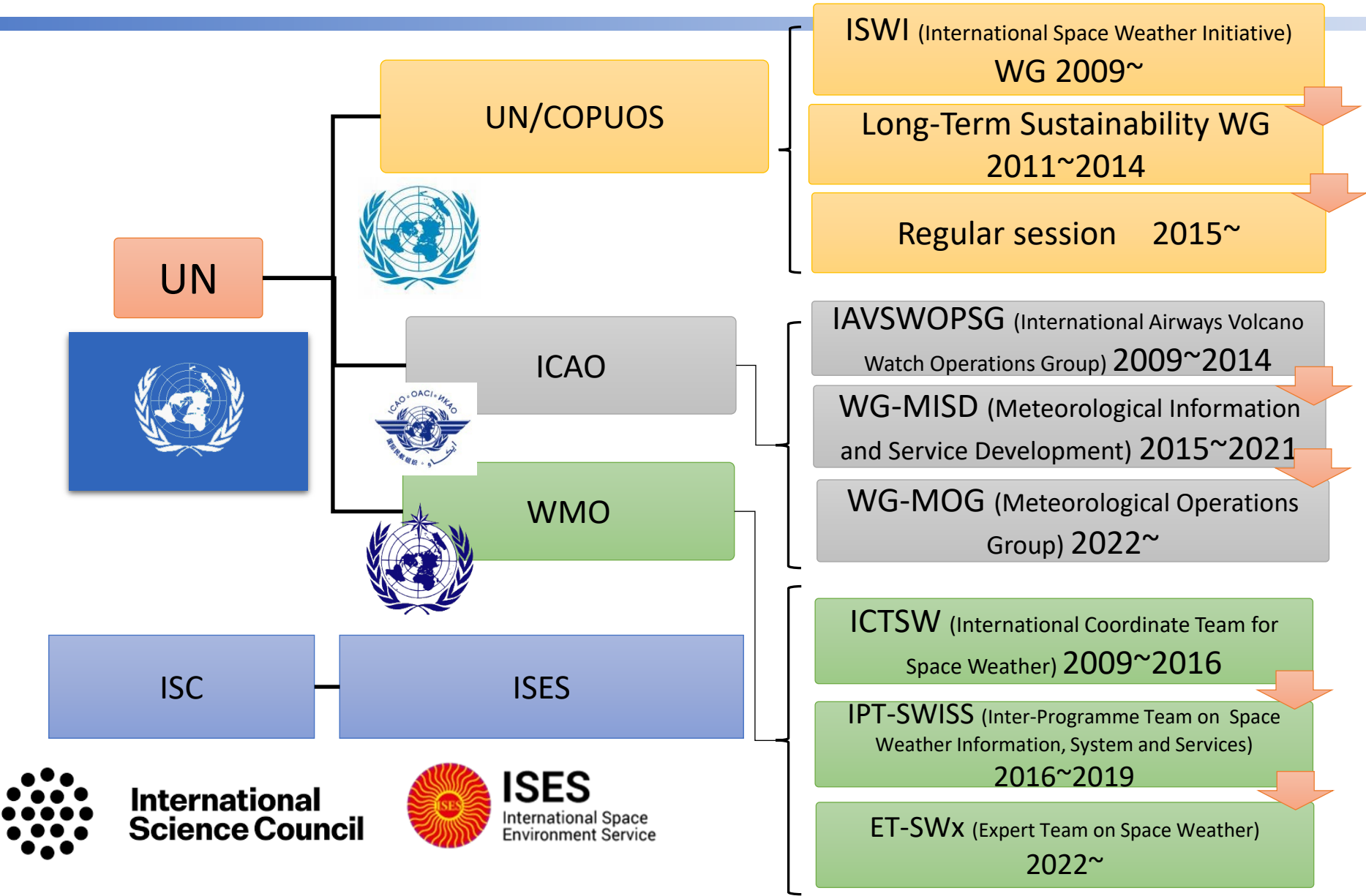
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Recent update 2: development of space Environment Sensors in GEO

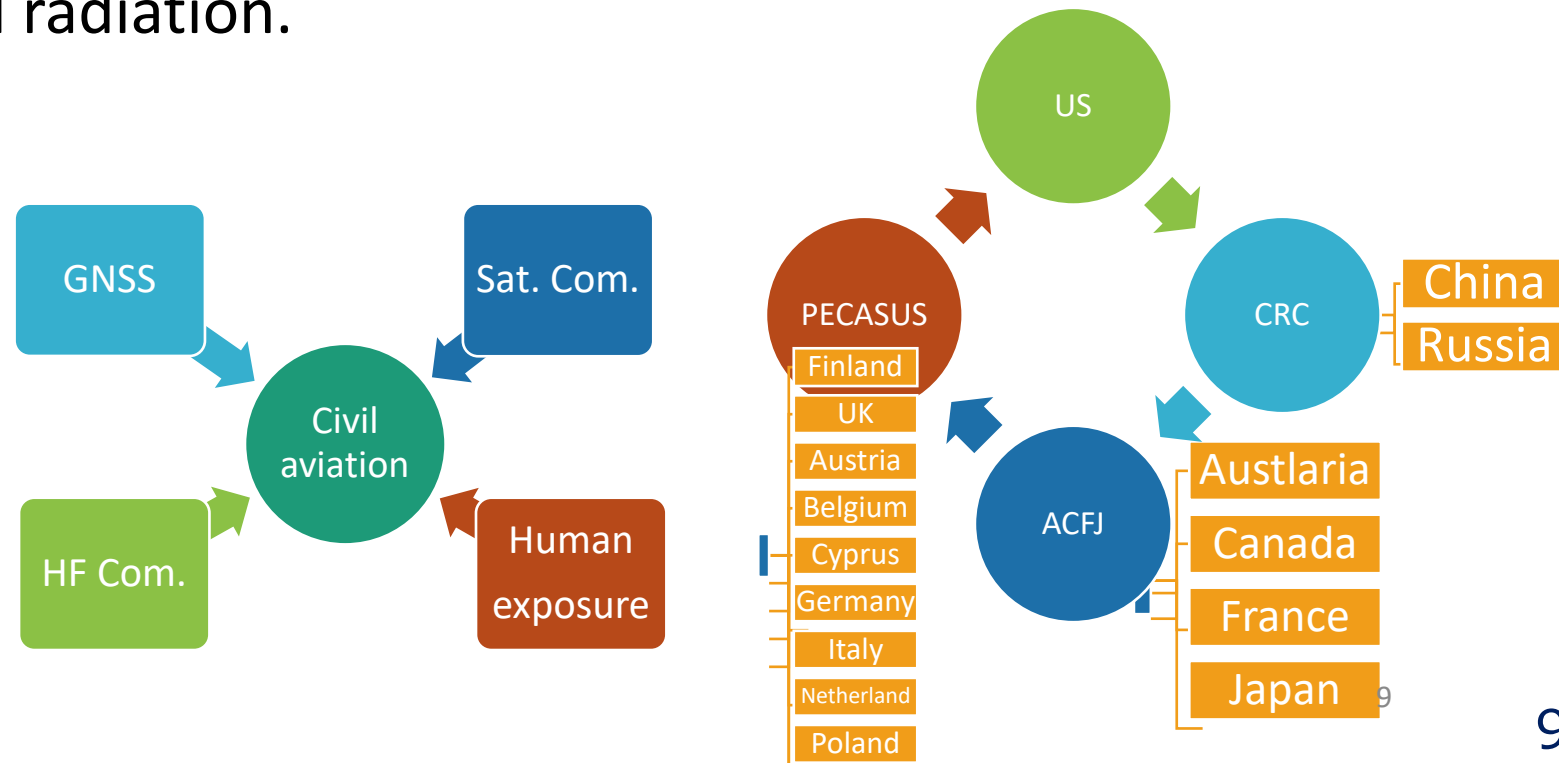
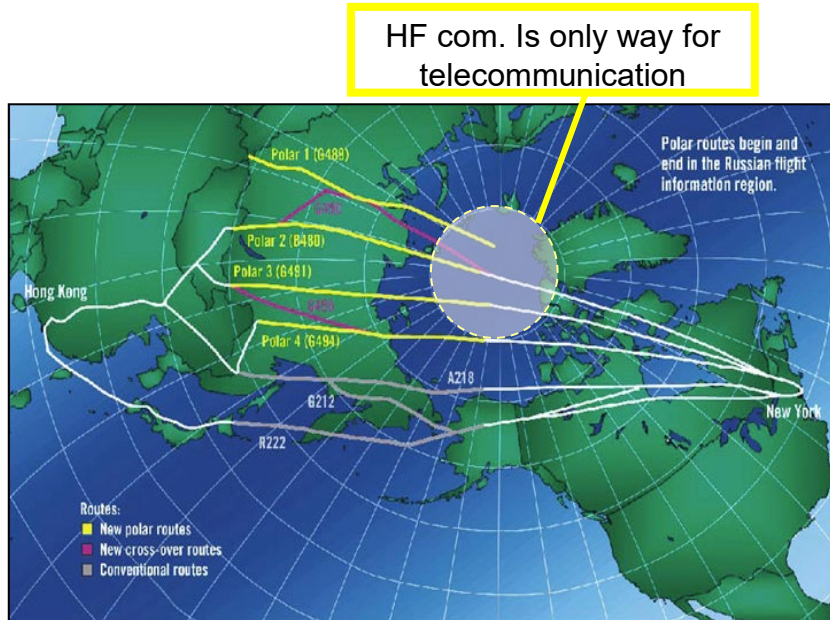


International Organizations related to Space Weather Services

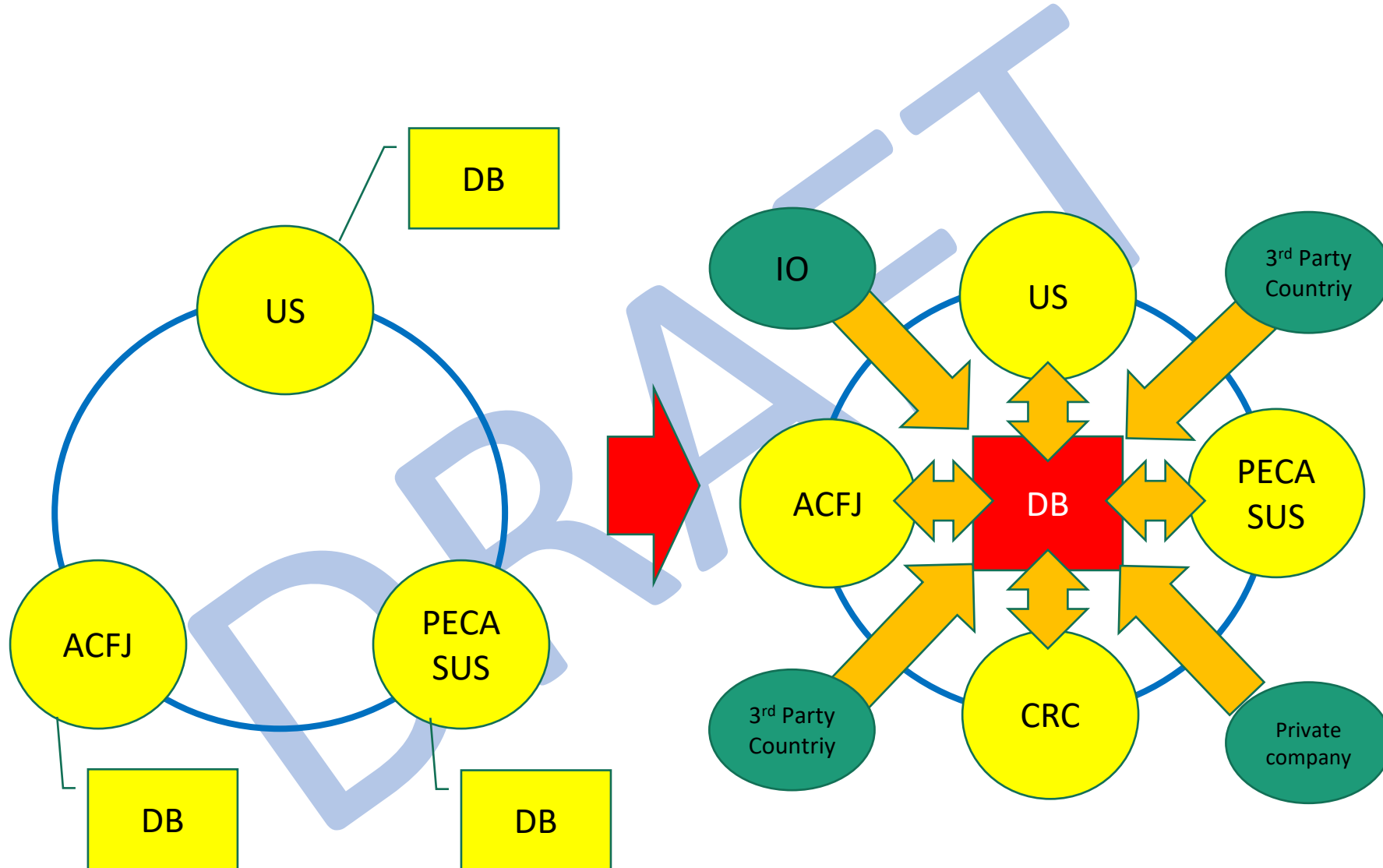


Operation of ICAO global space weather centers

- Since the beginning of 21st century, the use of polar route has been increasing with economic activity growing in East Asia. On the other hand, Polar region is known as high-risk area against space weather events.
- ICAO started space weather information services on Nov. 7, 2019. Now four global centers work on duty with two-week rotation.
- The centers monitor space weather phenomena which affect on GNSS, HF and satellite communication, and radiation.



Challenge for forecast/data quality harmonization



Information sharing infrastructure in WMO

WIGOS

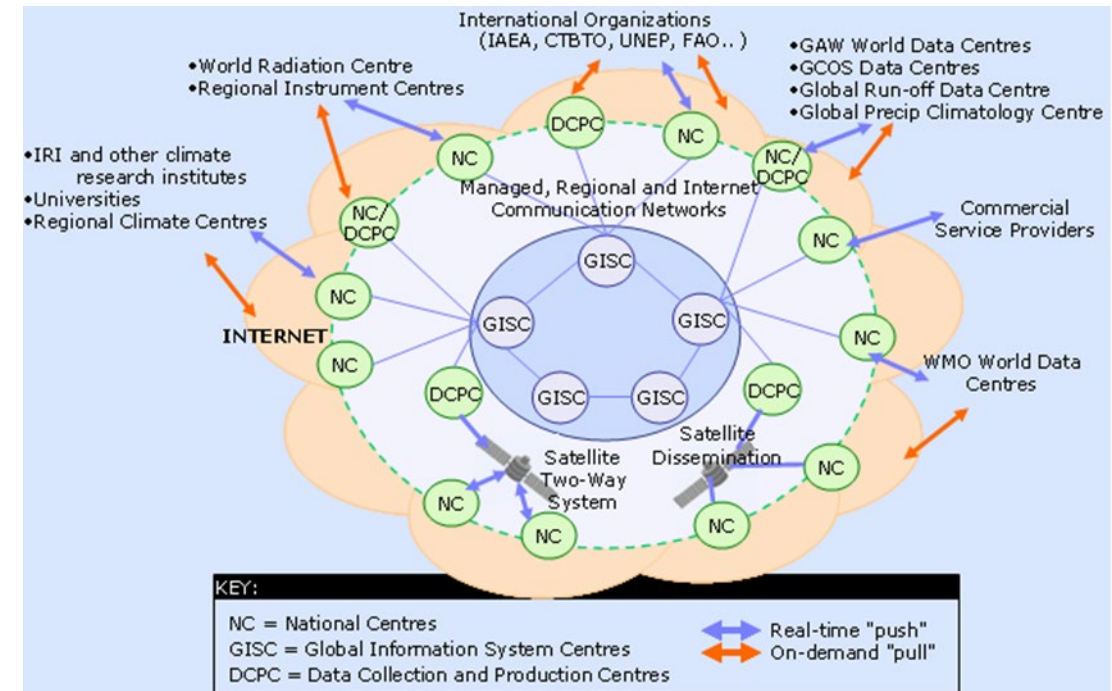
- The **WMO Integrated Global Observing System (WIGOS)** is one of WMO's top priorities as the new overarching framework for all WMO observing systems.
- Current global challenges demand a significant worldwide upgrade of space- and surface-based observations and predictions. In response, WIGOS provides a new, integrated approach incorporating the most recent scientific and technical advances.

WIS

- The WMO Information system (WIS) is a coordinated global infrastructure responsible for telecommunications and data management functions and is owned and operated by WMO Members. WIS provides an integrated approach suitable for all WMO Programmes to meet the requirements for routine collection and automated dissemination of observed data and products

OSCAR

- OSCAR is a resource developed by WMO in support of Earth Observation applications, studies and global coordination.



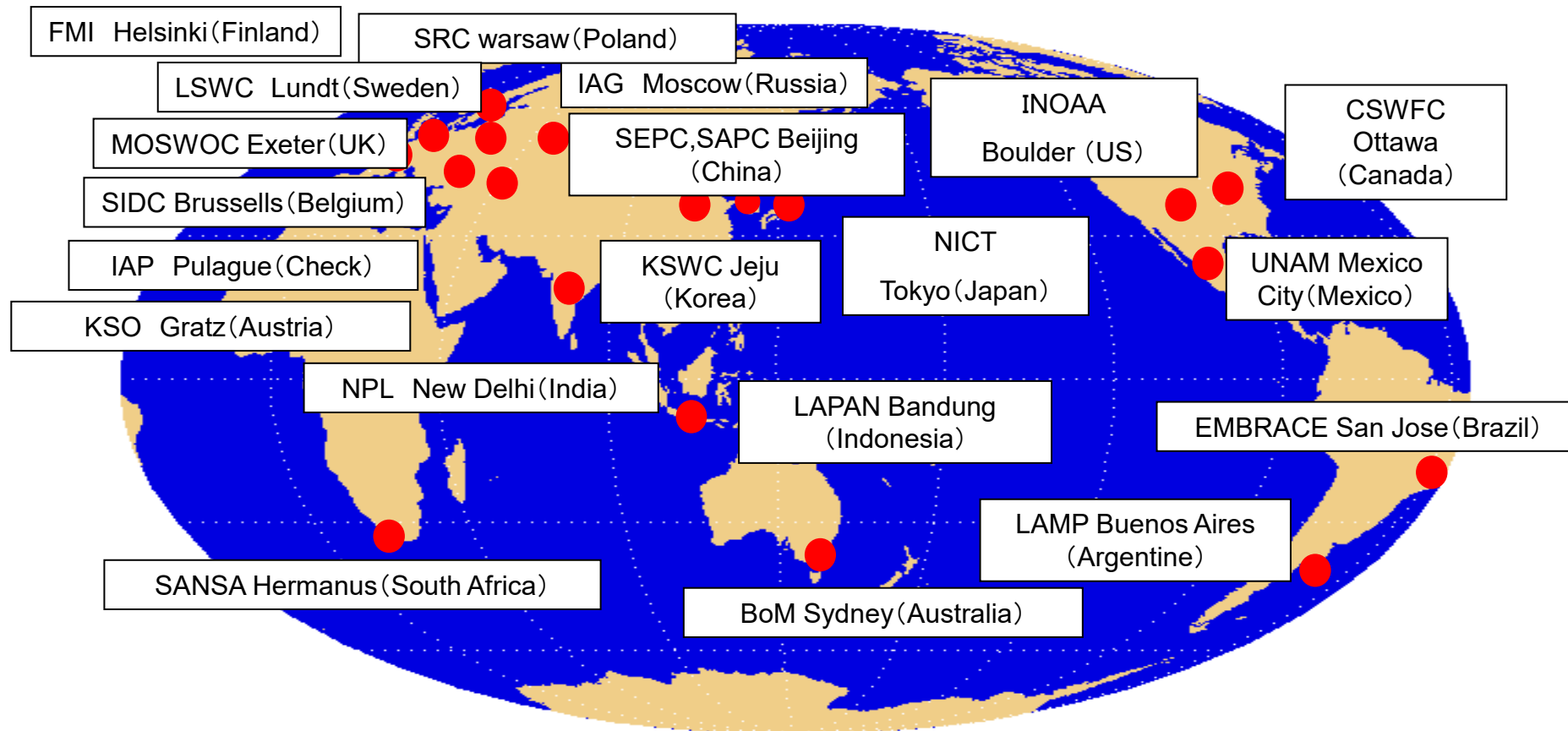
- File format for disseminating data/model results
- For example for ionospheric information...
 - Ionosonde/Ionogram
 - Standard Archiving Output (SAO) Format
 - JSON (JavaScript Object notation) ...
 - GNSS
 - IONEX format
 - RINEX format
 - GTEX format
 - SCINTEX format ...

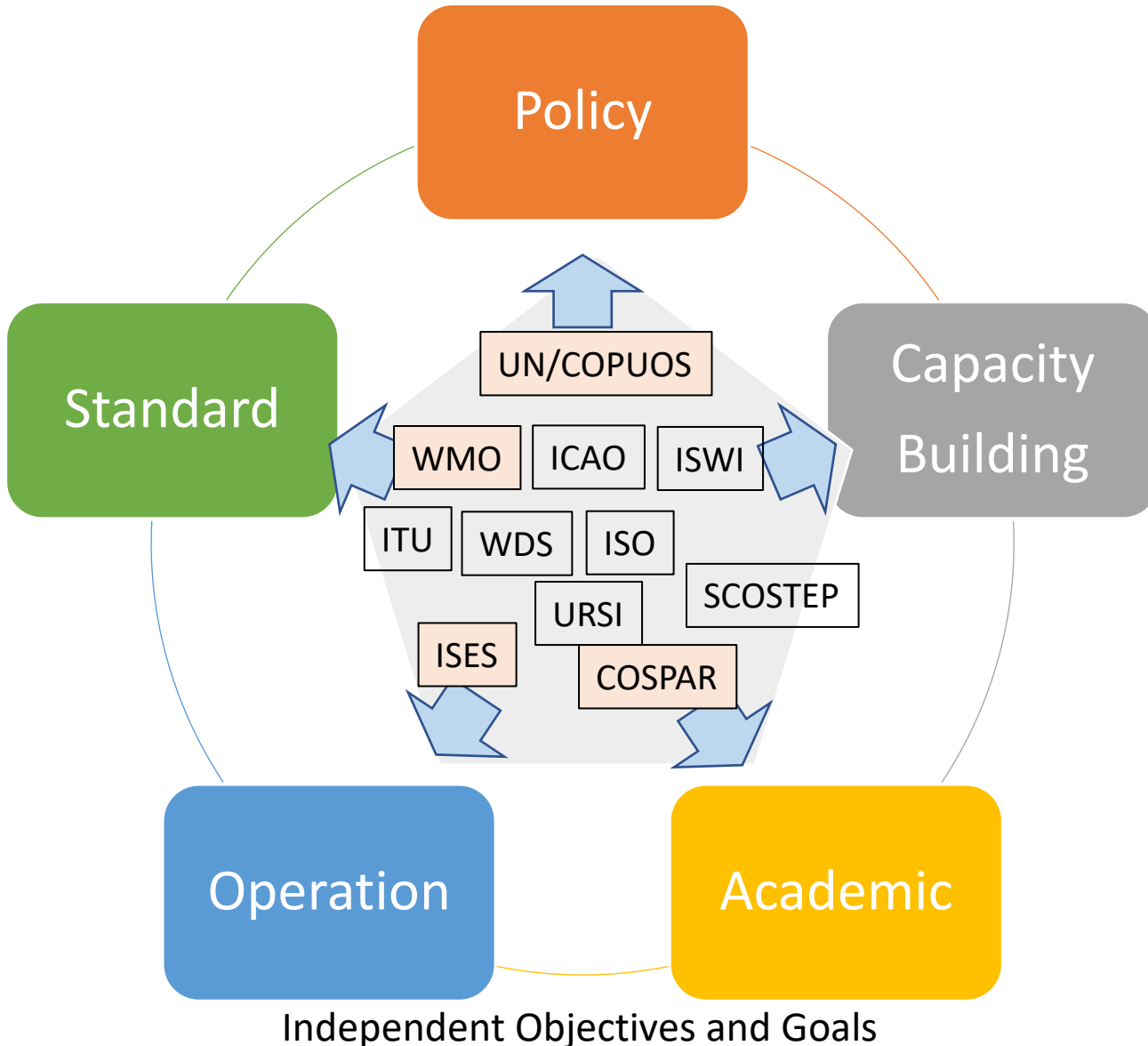
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JSON format for Ionogram

International Space Environment Services(ISES)

- Consortium of organizations who operate Space Weather forecast services
- Discuss the sharing observational data and forecast information, build up forecast skill and data format standard
- 21 member states and ESA as a Collaborative Expert Center





- There are many international organizations (IOs) related to space weather research and operation.
- Their purposes are different from each other and/but action items are often overlapped.
- How do we make a solution to have the most **effective way** for all players?
 - Each IO has original object and goal which should be respected.
 - Some of action plans can be collaborated among IOs, avoiding duplicate works.
 - Logistics: Meeting periods can be coordinated among IOs.

WMO-ISES-COSPAR Collaboration

United Nations
Committee on the
Peaceful Uses of
Outer Space



ISES
International Space
Environment Service



WMO

- UN/COPUOS STSC issued recommendations on space weather services in February 2022
- COSPAR-ISES-WMO is required to lead space weather related activities, and has begun to consider
- September 2022, two representatives from each institution participated in the study at the University of Coimbra, Portugal.
- A draft of the "Coimbra Declaration" has been prepared and is currently being discussed by related organizations.
 - Confirmation of the direction of the three institutions
 - Agree on framework, consider MoU
 - Pilot projects, regular meetings, round tables, etc.

