# Wildfire WG

## Koji Nakau

## JAXA SAOC

Space Applications and Operations Center (SAOC),
Japan Aerospace Exploration Agency (JAXA)

# Topics

- ## Volcano and Wildfire Monitoring System
  - Mapping Fire locations & providing fire history
  - Utilizing multiple satellites
  - Himawari-8, GCOM-C, CIRC

- ## What kind of Layers
  - Satellite based layers
    - GCOM-C: Water Stress Trend?, Vegetation Maps?
    - GPM: GsMAP?
    - Weather: FWI? Forecast?

- ## Needs for utilization?
  - What is way to provide those data in each countries?
  - Web site?
  - Who utilizes such a data? Government? Forest companies?

# Development of Volcano and Wildfire Monitoring System

- ## Development of Volcano and Wildfire Monitoring System
  - Toward achieving both frequency and resolution, we are trying to utilize all satellites available in JAXA (including CIRC, GCOM-C, Himawari)
  - Mapping Thermal infrared and Visible channels

- ## Multiple layers can be overlaid
  - Utilizing GCOM-C and Himawari, we can overlay SST+LST, reflectance, Cloud type and so on.

| Schedule | 2017 | | | | | | | | | | | | 2018 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb |
| Event | △Contract | | | △Proto-type 2nd Meeting | | | | | Complete and Release△ | | | | | |
| | | △Proto-type 1st Meeting | | | | | | | | | | | | |
| | | | | | | | | | | | | Seminar for users△ | | |
| Prototype | | Prototype | | | | | | | | | | | | |
| Develop | | | | Development | | | | | | | | | | |
| Test | | | | | | | | | Test | Trial Operation | | | | |
| Public | | | | | | | | | | | | | Open to Public | |

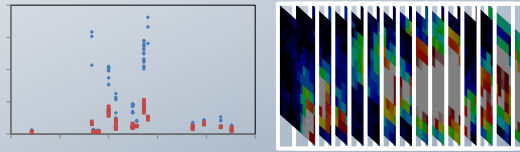# Volcano and Wildfire Monitoring System

Wildfire can be monitored using multiple sensors

Mapping HS, LST, RGB and so on.
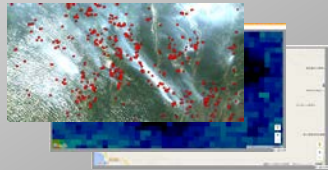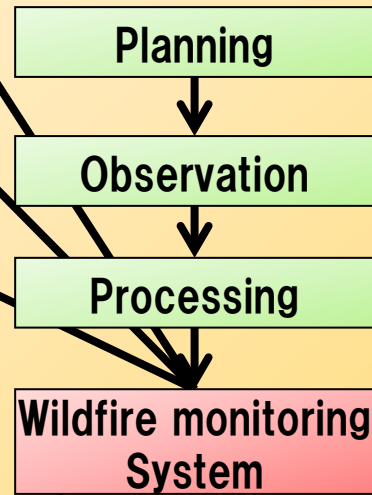
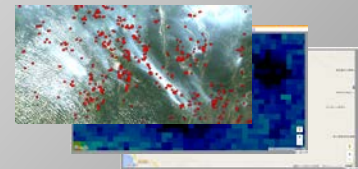Switching map and fire information

Fire history

**Other satellite**

SGLI Himawari8
EORC

ASTER
AIST

Landsat8
USGS

## CIRC Ground

Planning

Observation

Processing

**Wildfire monitoring System**

Products and map tile images to be delivered based on user requirements

Notification

End Users

| Global Users Government sections | Public Private Companies |

# Volcano and Wildfire Monitoring System Utilization of multiple sensors

- Frequent observation is necessary to facilitate utilization of IR data. In addition to 2 CIRC sensors, Combining data from GCOM-C/SGLI and Himawari, etc. is effective.

- Utilization at disaster occurrence
  - To compare IR and Visible images
  - To confirm ocean color and haze
- Utilization at detecting hotspots
  - To confirm the effect of cloud
  - To confirm the effect of haze
  - To confirm status of ocean color
- Nominal Utilization

| Sensor | GSD | Frequency |
|--------|-----|-----------|
| CIRC x 2 | 130,210m | every 8days |
| GCOM-C | 250m | every 1.7day |
| MODIS | 1km | 4 / day |
| Himawari | 2km | every 10min |

Combining multiple sensors is necessary as ground resolution and observation frequency are traded off

| Sensor | CIRC | | SGLI | Himawari |
|--------|------|------|------|----------|
| Satellite | JEM/CALET | ALOS-2 | GCOM-C | AHI |
| GSD, Wavelength | 130m@TIR | 210m@TIR | 250m@Multi | 2km@Multi |
| Frequency | Every 20 days | Every 14 days | Every 1.7days | 10min |
| Swath | 85 x 64km | 128 x 96km | 1150km/1400km | Full Disk |
| Local Sun Time | | 0:00/12:00 | 10:30/22:30 | |
| Observation Duty | 16Scines/day | 256Scines/day | All orbit | Continuously |

# Volcano and Wildfire Monitoring System Utilization of Himawari-8&9

- **Geostationary Visible Multi Channel**
  - IR 12 bands
  - Resolution：2km
  - Temporal Resolution: every 10min

- **JAXA Himawari Monitor Parameters**
  - Providing Land Reflection Ratio and Sea Surface Temperature (SST)

> Visible image, clouds, aerosol, etc. can be seen when hotspots are detected. GCOM-C research results are applied to Himawari and open to the public on JAXA web



| Ch | WL[μm] | Res[km] |
|----|--------|---------|
| 1  | 0.47   | 1       |
| 2  | 0.51   | 1       |
| 3  | 0.64   | 0.5     |
| 4  | 0.86   | 1       |
| 5  | 1.6    | 2       |
| 6  | 2.3    | 2       |
| 7  | 3.9    | 2       |
| 8  | 6.2    | 2       |
| 9  | 6.9    | 2       |
| 10 | 7.3    | 2       |
| 11 | 8.6    | 2       |
| 12 | 9.6    | 2       |
| 13 | 10.4   | 2       |
| 14 | 11.2   | 2       |
| 15 | 12.4   | 2       |
| 16 | 13.3   | 2       |

# Access to GCOM-C Data (Draft)

- Hotspots detection, land surface temperature, and reflection ratio are to be displayed on a map for wildfire monitoring.
  - Land surface temperature will be available as a near real time product
  - Land surface reflection ratio will be displayed on a map as a standard product.
- Flow of GCOM-C related data from Volcano and Wildfire Monitoring System (draft)
  - Global:
    - ✓ Received data at Svalbard station will be sent to Japan, and near real time products will be processed approximately 6 hours after the reception*.
    - ✓ Approximately 3 hours after that, the system will process and release the data.
      * Global average time. It depends on downlink time, areas and regions. In addition, it may be delayed during calibration phase.
  - e.g. Night temperature and day reflection ratio will be available next morning.



Sample scenes — Equator — Nighttime area — Daytime area



Coverage of Japan st.
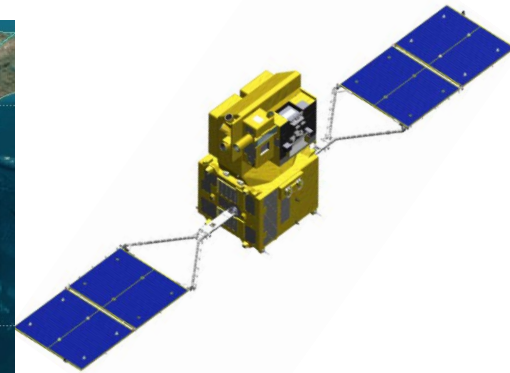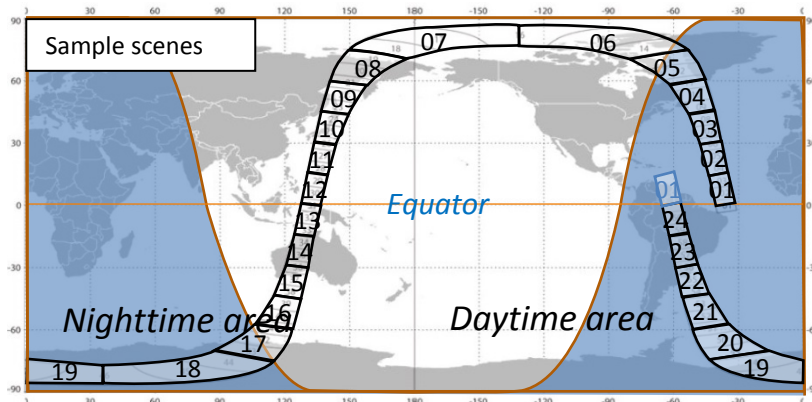
# GCOM-C Products for
# Volcano and Wildfire Monitoring System

We would like to ask user requirements to GCOM-C data

*Red: will be available at the system*
*Blue: Confirming requirements for future*

| Category | Product |
|---|---|
| Common | Observed radiation brightness（L1B） |
| Land | Precise geometric corrected radiance (LTOA) |
| | *Land atmospheric corrected reflectance (LSRF)* |
| | *Vegetation Index (VGI)* |
| | Above-ground biomass (AGB) |
| | Vegetation roughness index (VRI) |
| | Shadow Index (SI) |
| | Fraction of absorbed PAR (FAPAR) |
| | Leaf area index (LAI) |
| | *Land surface temperature (LST)* |
| Atmos-phere | *Cloud flag (CLFG)* |
| | Classified cloud fraction (CLFR) |
| | Cloud top temp/height (CLTTH) |
| | Water-cloud optical thickness & effective radius (CLOTER_W) |
| | Ice-cloud optical thickness (CLOT_I) |

| Category | Prouct |
|---|---|
| Atmos-phere | *Aerosol over the ocean (ARNP)* |
| | *Land aerosol by near-UV (ARNP)* |
| | *Aerosol by Polarization (ARPL)* |
| Ocean | *Normalized water leaving radiance (NWLR)* |
| | Atmospheric Correction Parameter (ACP) |
| | Photosynthetically Available Radiation (PAR) |
| | Chlorophyll-a concentration (CHLA) |
| | *Total Suspended Matter concentration (TSM)* |
| | Colored dissolved organic matter (CDOM) |
| | *Sea Surface Temperature (SST)* |
| Cryos-phere | *Snow and Ice covered area (SICA)* |
| | Okhotsk sea-ice distribution (OKID) |
| | *Snow and ice surface Temperature (SIST)* |
| | Snow grain size of shallow layer (SNGSL) |

# CIRC（small IR camera） Overview

## CIRC is a medium resolution uncooled infrared array detector（microbolometer）.

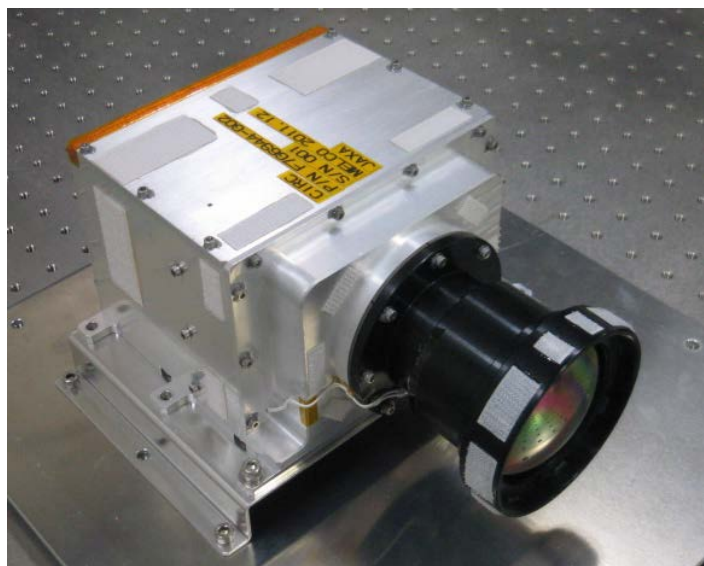| Timely observation is necessary because temperature situation is constantly changing. | → | Frequent IR observation will be available if the cost is reduced and many CIRS would be on many satellites. | → | The cost is reduced by employing COTS, athermal optics and a shutter-less system. |

## CIRC Specification

### CIRC Sensor on ALOS-2



| Detector | Microbolometer SOI diode IR FPA (MELCO) |
|---|---|
| Size and Mass | 11 x 18 x 23cm, approx. 3kg |
| Wavelength | 8 – 12μm |
| Spatial Resolution | 210m (ALOS-2) 130m (CALET) |
| Pixel Array | 640 x 480*,  12°  x  9° |
| Dynamic Range | 180 K – 400 K |
| NEdT, FPN | 0.2 K , 0.3K @300 K |
| Temperature Accuracy | 4 K (goal: 2 K@300K) |
| Power | < 20 W |

2017/2/15

* Biggest uncooled infrared array detector for EO satellites ever.

# Multiple Sensors Utilization for Volcano and Wildfire Monitoring System

Volcano and wildfire should be monitored by 2 wavelength with 100m resolution every hour. However, JAXA's satellites can hardly meet the requirement.
To demonstrate combination of CIRC and other satellites is important and it will bring about future ideal IR observation.

## CIRC on ALOS-2

**Every 7 days**



**Launched in 2014**

Resolution: 210m
Wavelength: IR

## CIRC on CALET

**Every 4 days**



**Launched in 2015**

Resolution: 130m
Wavelength: IR

## GCOM-C/SGLI

**Every 0.6 days**



**To be launched in JFY2017**

Resolution: 250m
Wavelength: TIR+2.2µm

## Future

**More Frequent Higher Resolution**

Geostationary Satellite?

Small Satellite Constellation?

Resolution: ~100m
Wavelength: TIR+4µm

# Conclusions

- JAXA has started to develop Volcano and Wildfire Monitoring System
  - The system will be released in January 2018.
  - By using Himawari data, the system can detect hotspots every 10 minutes.
  - By using GCOM-C data in near future, the system will detect hotspots in 250m resolution.
  - Anyone can access the system through the internet.

- Your comments will be most welcome for better development
  - WG members will be invited for their comments individually.
  - Comments from outside of WG will be also most welcome.

- JAXA looks for opportunities to collaborate with international projects and achieve actual wildfire monitoring
  - It would be appreciated if you can let us know the opportunities.