Status of KOMPSAT-1 OSMI

Yu-Hwan Ahn

Satellite Ocean Research Laboratory

Korea Ocean Research and Development Institute

A brief overview of OSMI

- The Korean Multi Purpose Satellite, KOMPSAT-1 has been operating successfully since its launch on **December 21, 1999**.
- The satellite has two earth observing sensors: **EOC**, a high-resolution panchromatic sensor mainly for land observation, and **OSMI** (Ocean Scanning Multispectral Imager), an ocean color sensor.
- The OSMI mission on the KOMPSAT-1 satellite aims to collect data globally. It has **six bands.**
- The **cross-calibration** efforts in collaboration with the NASA SIMBIOS team are successful and expected to bring more outcomes related to the ocean color research.
- **KARI** undertakes **OSMI data dissemination** to government agencies, government-supported research institutes and universities for public use.
- OSMI data are used for marine, meteorological and disaster applications, but the use of this data is limited due to **stripping patterns**.

A brief overview of OSMI

KOMPSAT-1 OSMI

Agency	KARI (Korea)
Satellite	KOMPSAT-1
Launch Date	20/12/99
Swath (Km)	800
Resolution (m)	850
No. of Bands	6
Spectral Range (nm)	400-900

OSMI nm	SeaWiFS nm	Band Width
412	412	20
443	443	20
490	490	20
	510	20
555	555	20
	670	20
765	765	40
865	865	40

OSMI characteristics and applications

OSMI Bands	Band Centre (nm)	Band width (nm)	Applications
B1	443	20	Chlorophyll absorption maximum
B2	490	20	Chlorophyll and other pigments
B3	510	20	Turbidity and Chlorophyll
B4	555	20	Turbidity
B5	765	20	Atmospheric correction
B6	865	40	Atmospheric correction

Status of OSMI data acquisition

Status of OSMI data acquisition

OSMI receiving status (2004/12/31)			
Year	Pass no.	Scene total	Korean peninsula
2000	522	3298	21
2001	724	6108	90
2002	676	5242	157
2003	654	4728	129
2004	644	4512	146
total	3220	23888	543

The OSMI data acquisition is dependent on main EOC sensor schedule. When EOC sensor is off from scanning, OSMI starts scanning

Stripping problems and De-stripping of OSMI data

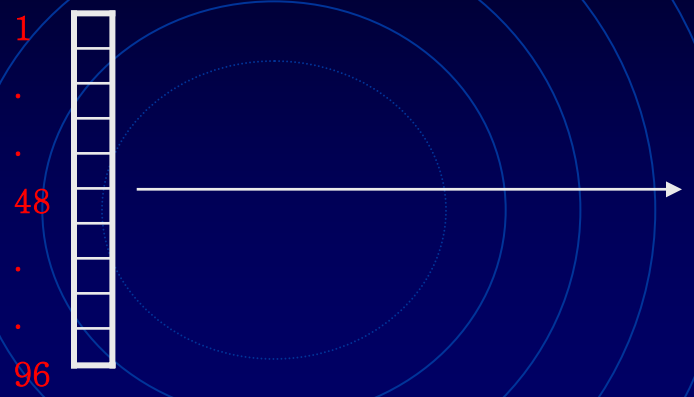
Characteristics of OSMI

- **KOMPSAT-1 OSMI**

- Whisk broom scanner

Cross-track

96 lines in 1-D CCD array



- Altitude 685 km scanning rotation angle 30º

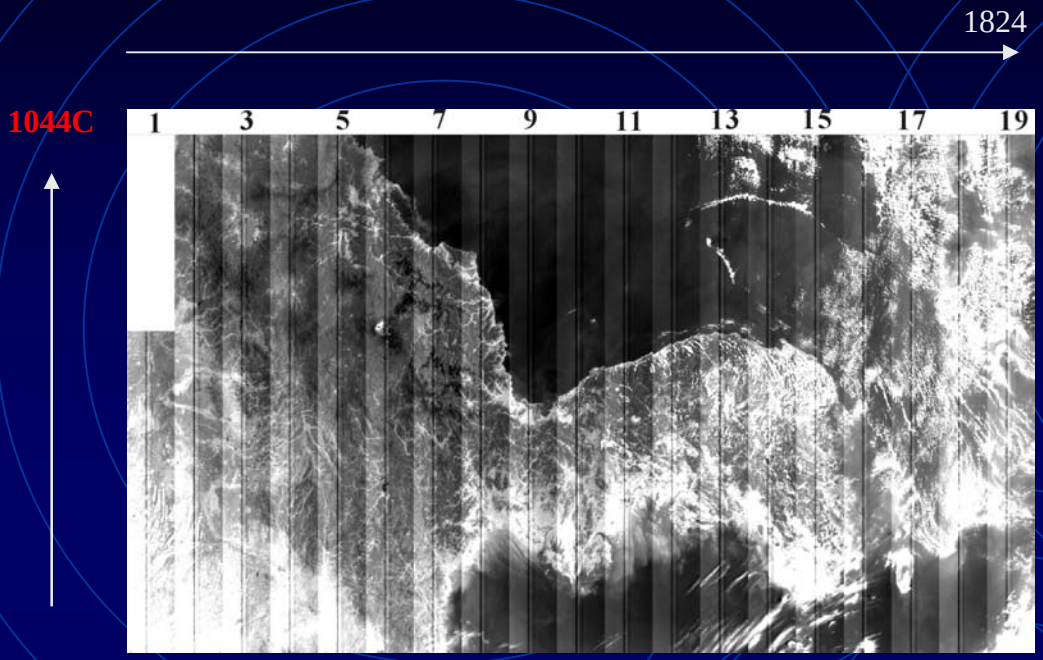
- Spatial resolution

nadir : 850 x 850 m

Left and right edge: 1000 x 1,000 m

- Observation time: 11:00 AM - ascending mode around Korean peninsula

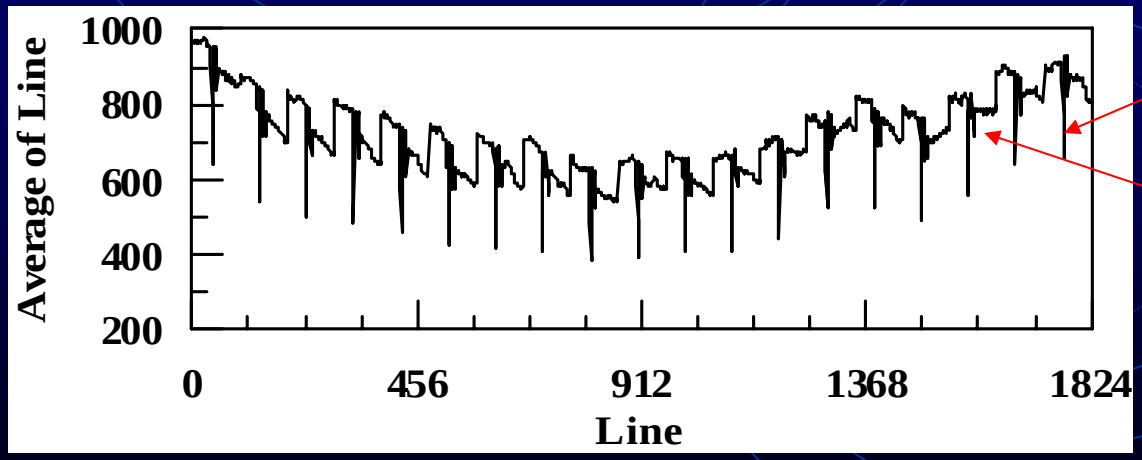
OSMI data Level-0 problem



OSMI scene: 26 Sept. 2000

1044 Column ×1824 Line

1 scanning = 96 lines (1824/96=19 strips)



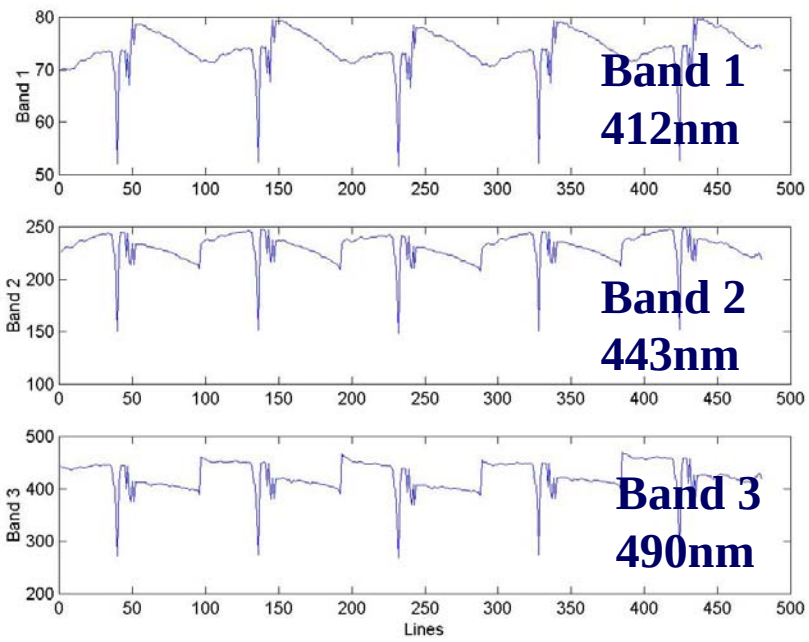
Bad lines

Bright(1-48 /CCD)

Dark part (49 – 96 /CCD)

Every strip has stepping-like pattern

Stripping pattern in OSMI bands

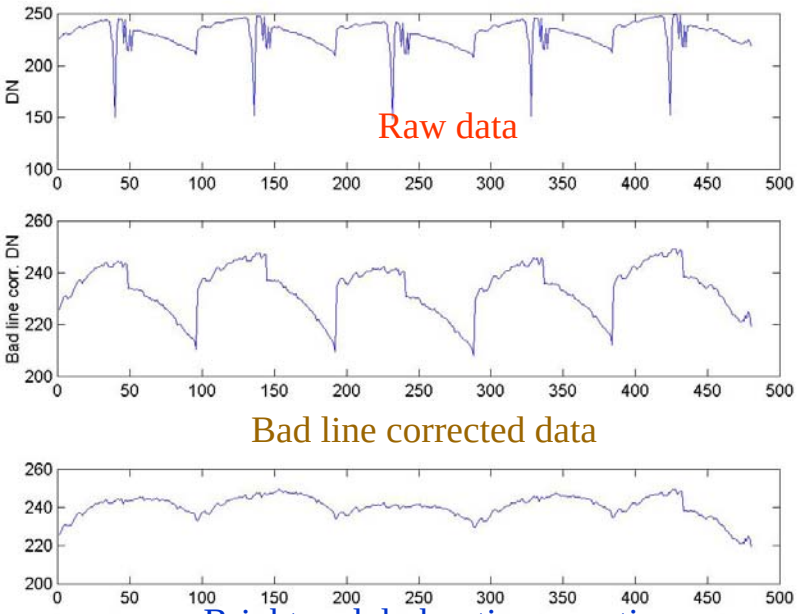


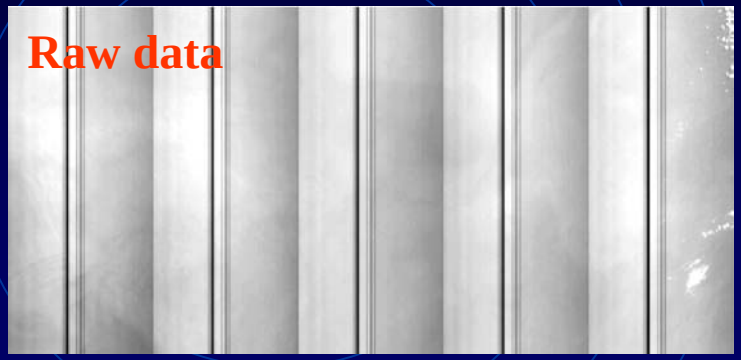
- All bad line positions are same
- Bright/Dark part
  - Band 1 : 1-48 pixel ⇒ dark
  - Band 2-6 : 1-48 ⇒ bright
- There exists slopes in Bright/Dark parts
- Every strip has different shape/slope with respect to target area and time

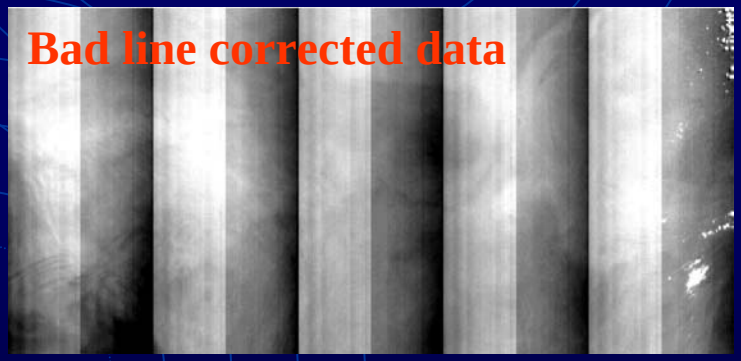
OSMI de-stripping analysis - Results

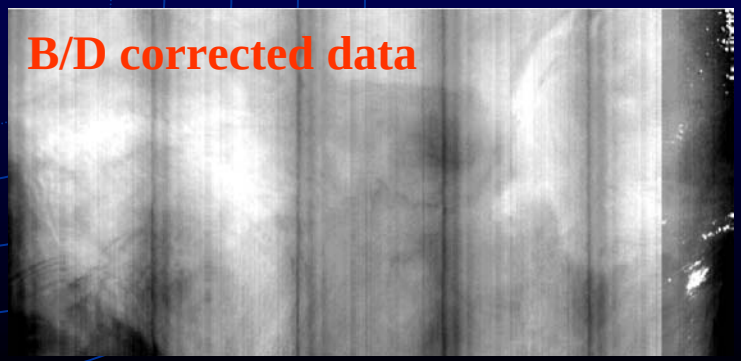
Example

Band 2









The bad line corrected image having no stripping effects is reliable for ocean environmental analysis

OSMI Applications

(SW : PC version ; OSMI-DAS / KORDI)

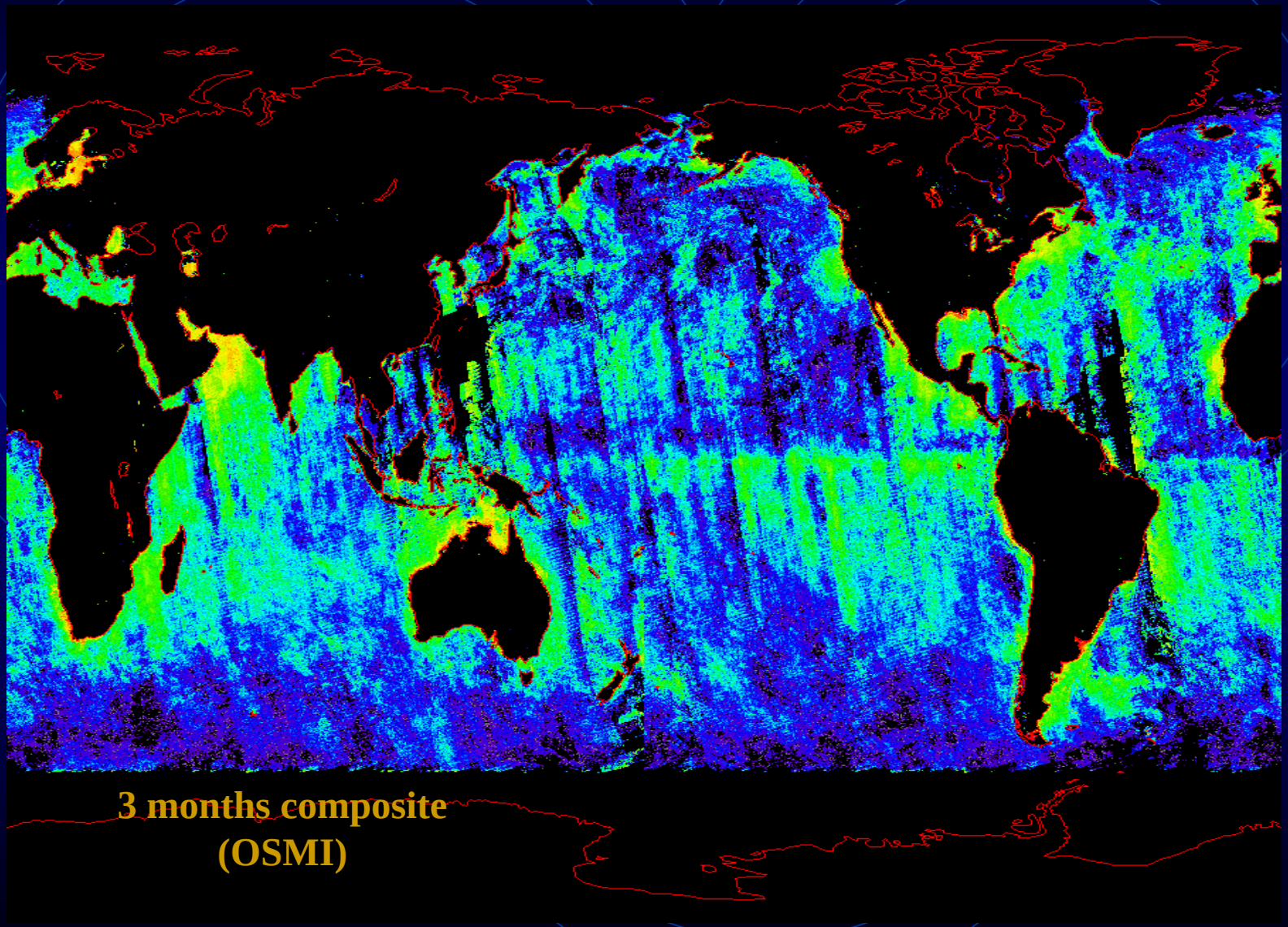
→ Marine applications

→ Disaster applications

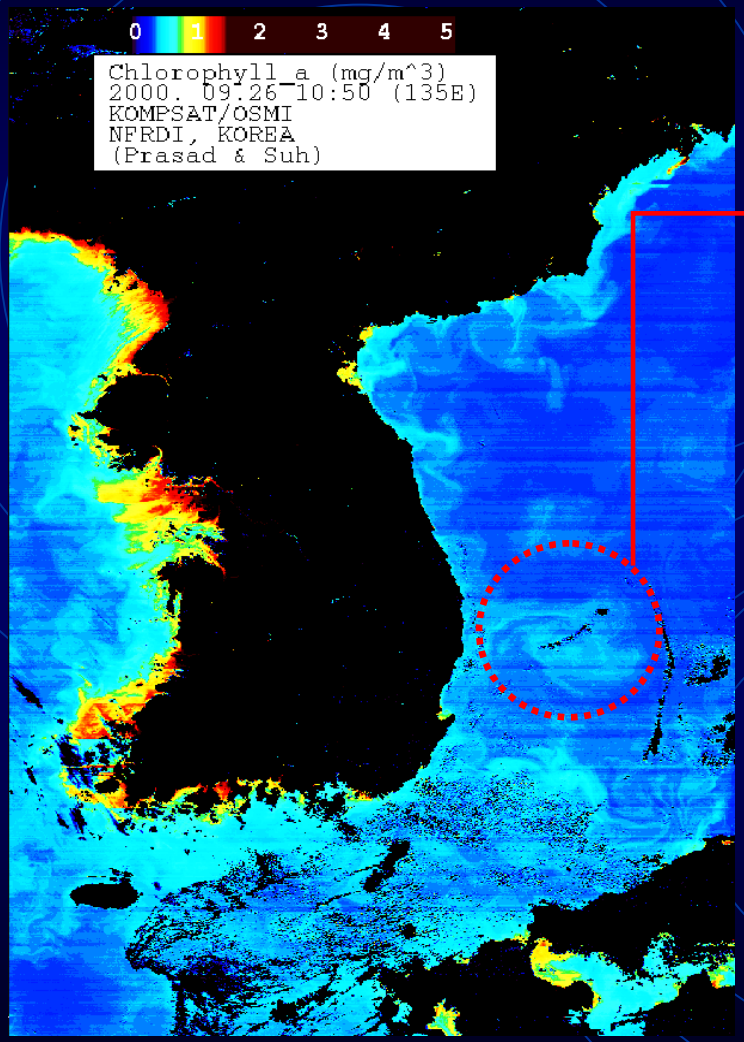
→ Meteorological applications

→ Land applications

Marine Applications - Global distribution of chlorophyll-a

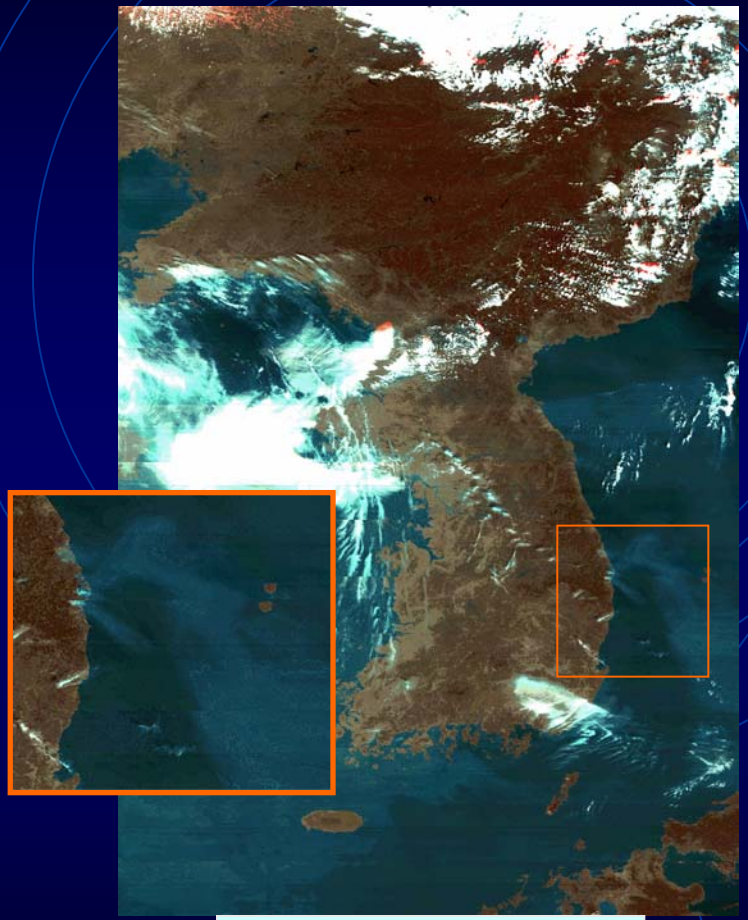


Fisheries applications



Monitoring of Fisheries

Disaster monitoring

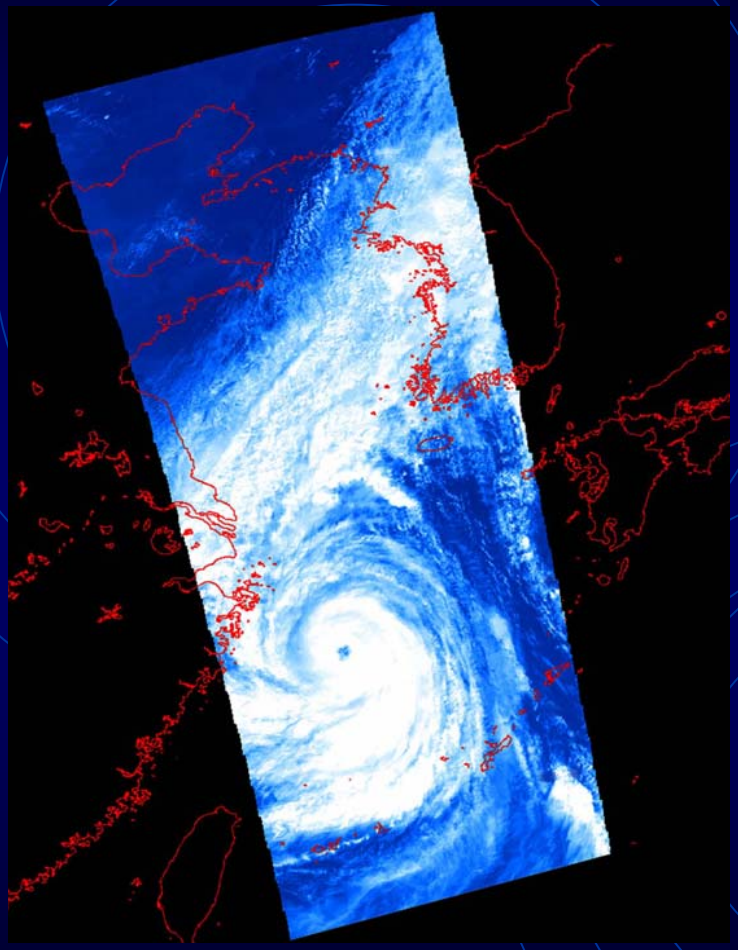


April 13, 2000

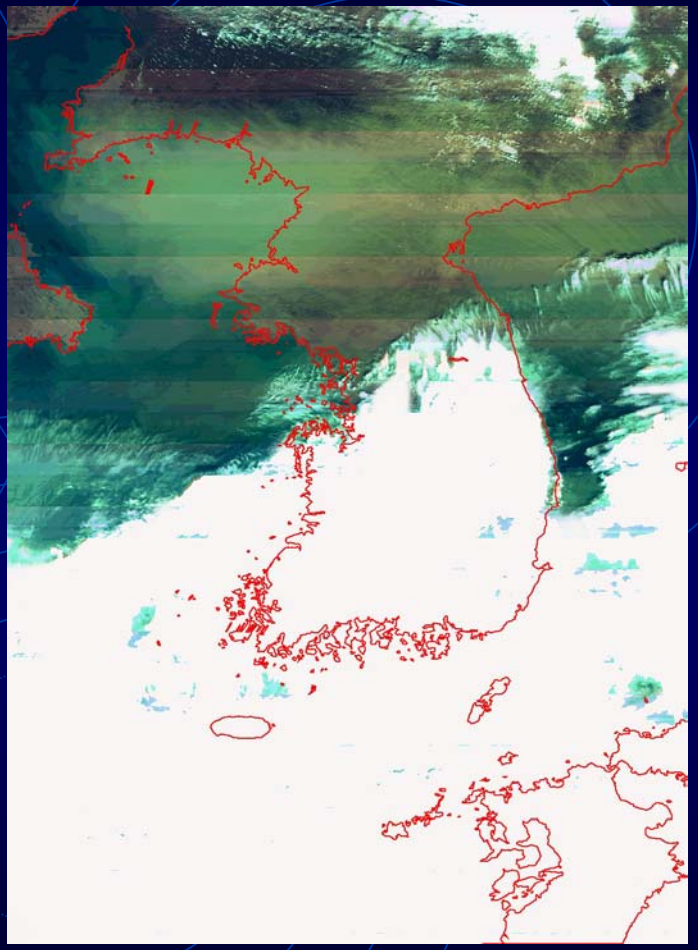
March 13, 2002

Forest Fires in Korea

Meteorological applications

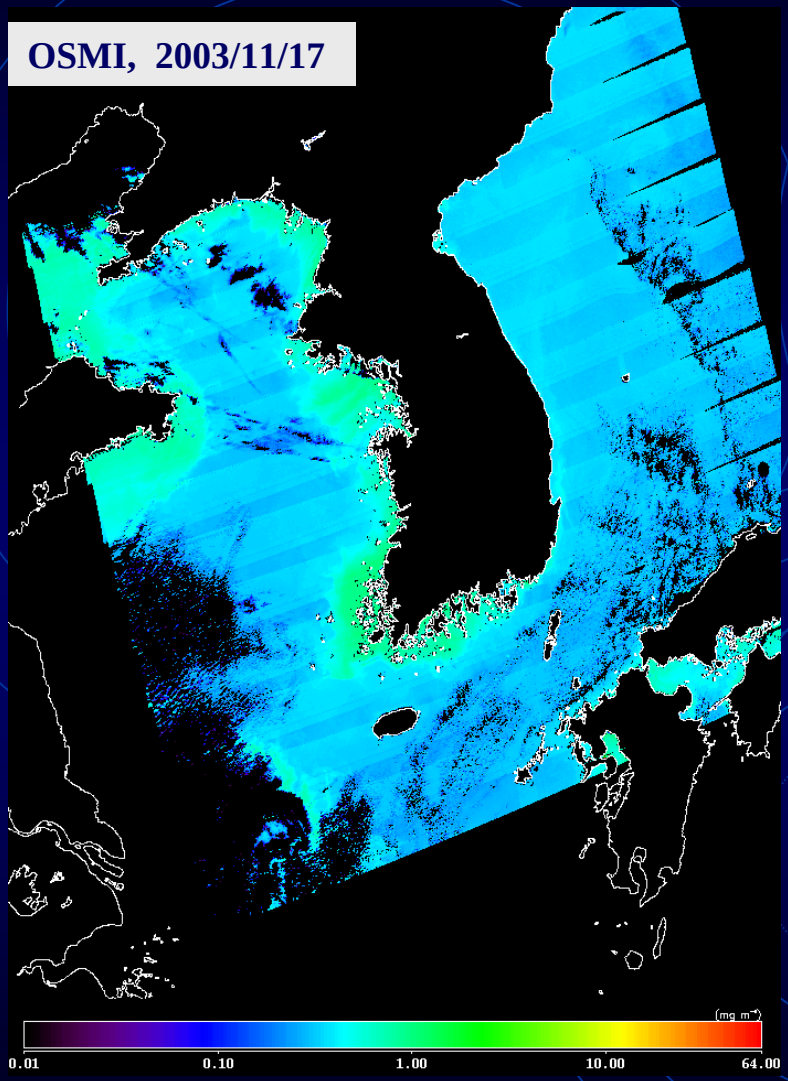


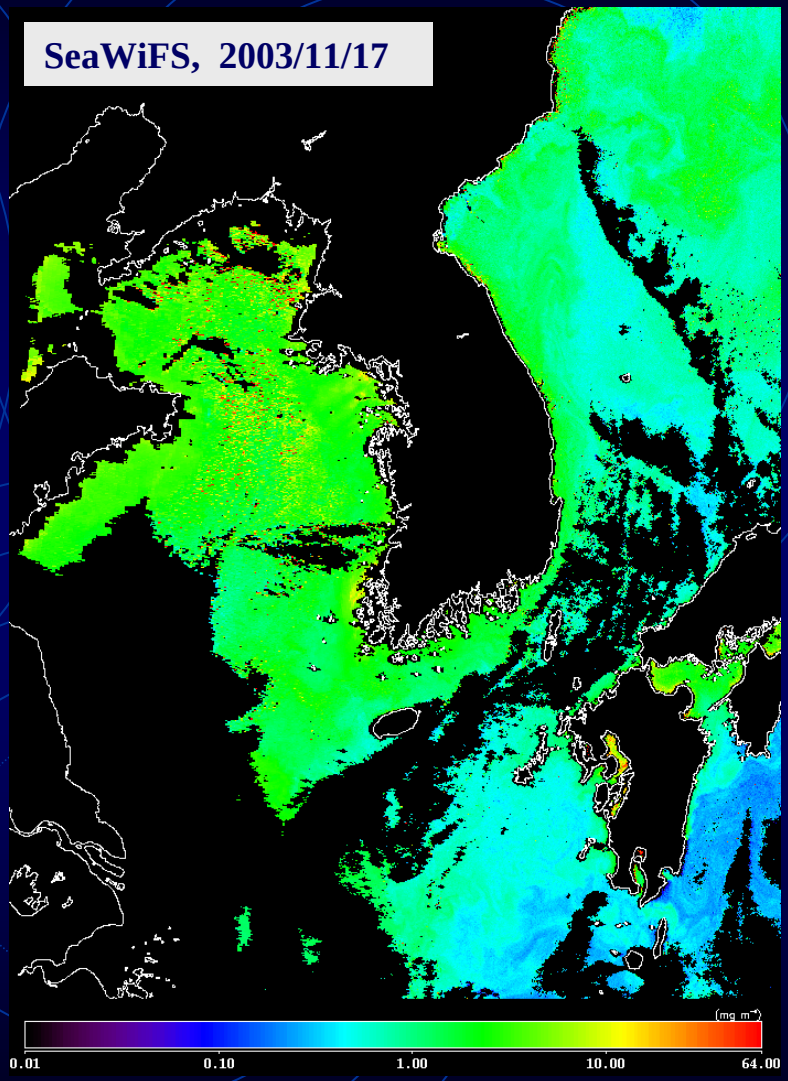
Typhoon Saomai
Sept. 14, 2000



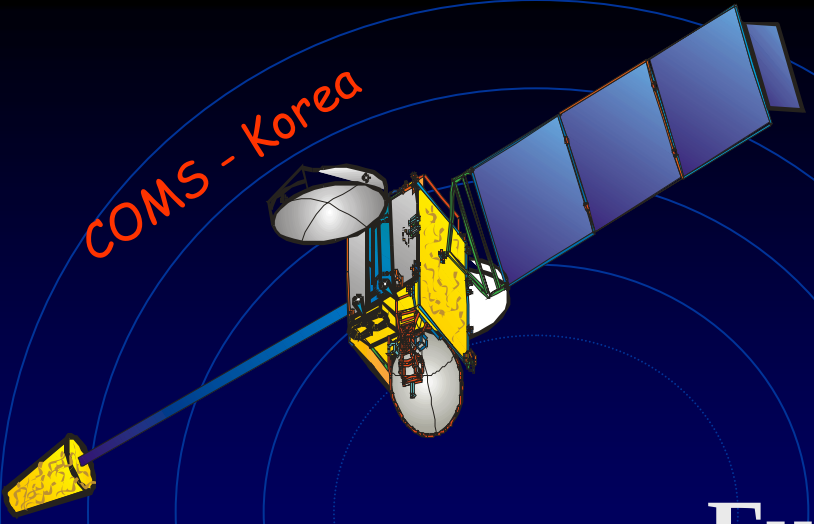
Yellow Dust
March 22, 2002

Comparison of OSMI/OSMDAS and SeaWiFS/SeaDAS





Chlorophyll image

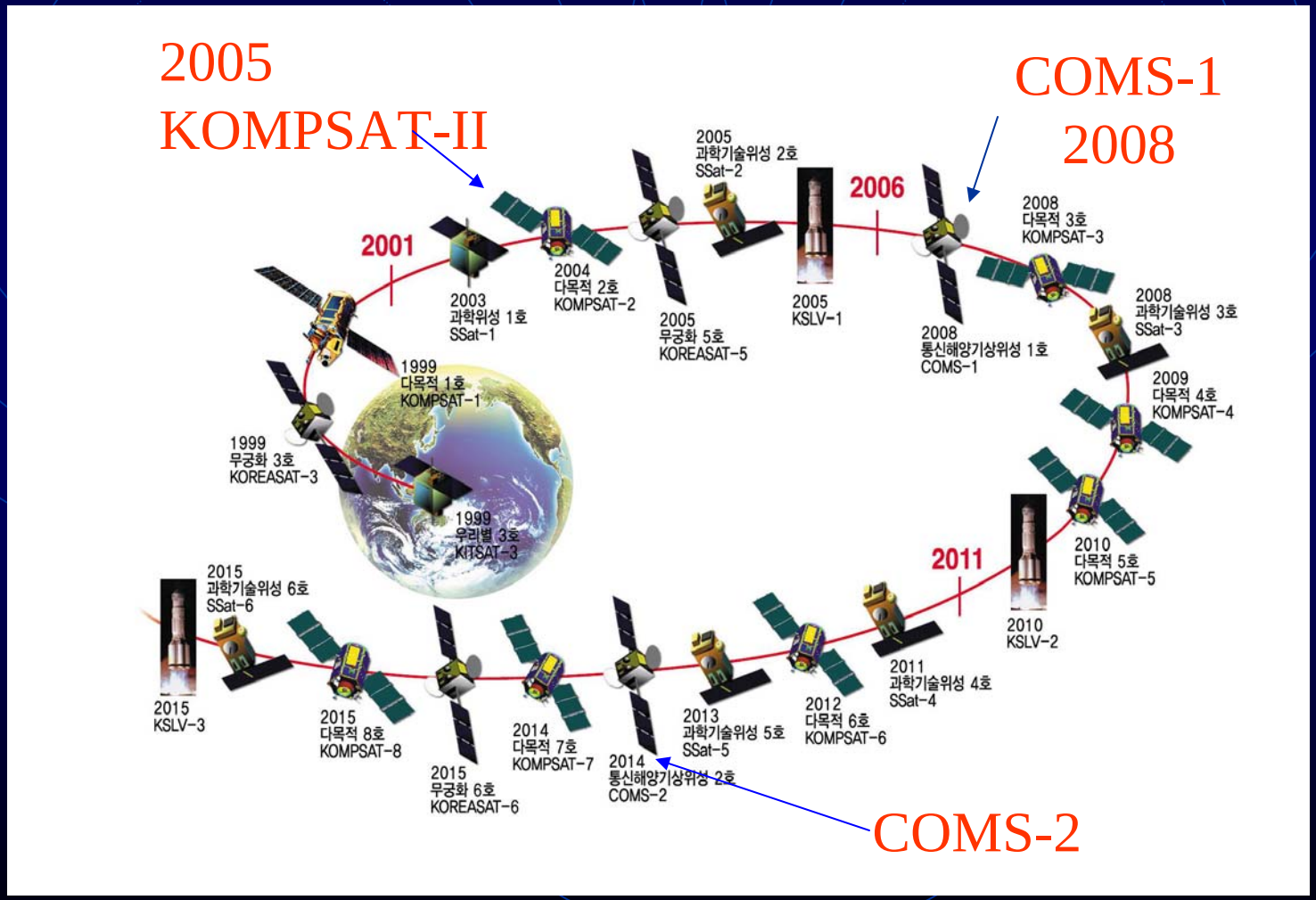


Future Mission

Geostationary Ocean color Imager (GOCI) on COMS

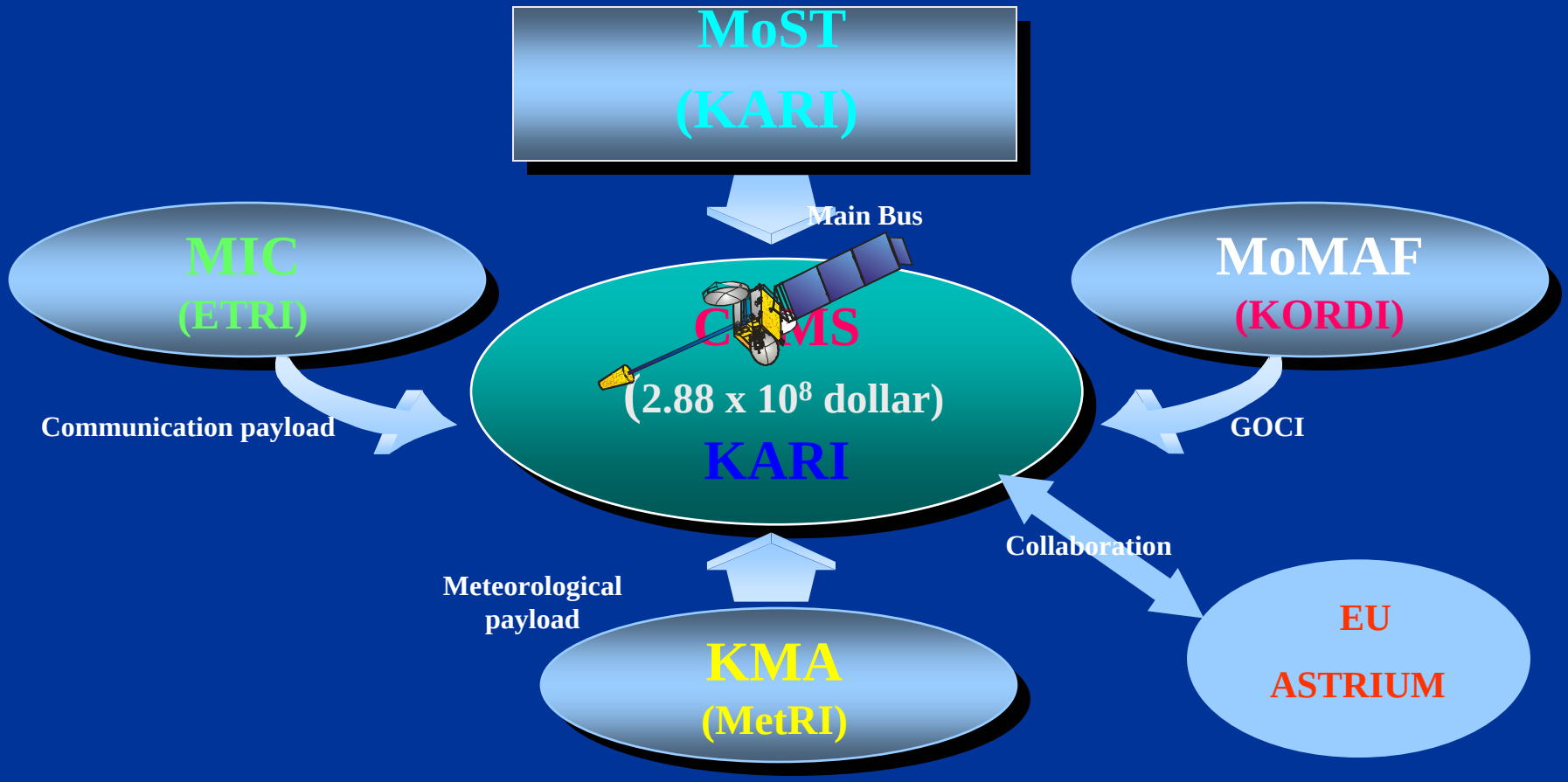
Background of GOCI

According to national space development project, we will launch COMS-1 satellite in 2008 and COMS-2 in 2013.



Communication Ocean & Meteorological Satellite (COMS) (2003-2008)

MOST : Ministry of Science and Technology : Main Bus
KMA : Korea Meteorological Agency : Meteo. Sounding sensor
MOMAF : Ministry of Maritime Affairs and Fisheries : Ocean color sensor
MIC : Ministry of Information and Communication : C&B payload



GOCI /COMS

- What's GOCI?

  - Geostationary satellite (location :116E or not 127E/ Equatorial)
  - Earth observation satellite
  - Ocean color satellite.(6bands /visible, 2 bands/NIR)
  - Environmental monitoring satellite

- The difference between polar orbit satellite
  - P.O.S : Observing period ; 1~2 time/day - 1 time /week
  - GOCI : Possible all moment observation
    Wide area observation
    Strong by cloud mask
    Short /Long term monitoring

Budget for GOCI

- GOCI payload ： **2.0 ~2.5 x 10^7 dollar**
- Launch portion for GOCI /COMS ： **1.0 x 10^7 dollar**
- Main bus system portion for GOCI /COMS： **1.2 x 10^7 dollar**
- GOCI data processing system(SW) ： **4.0 x 10^6 dollar** **/KORDI**
- GOCI Ground System (without building)： **6.3 x 10^6 dollar** **/KORDI**
  (Ocean Satellite Center)

Scope of the Geostationary Ocean Color Imager (GOCI)

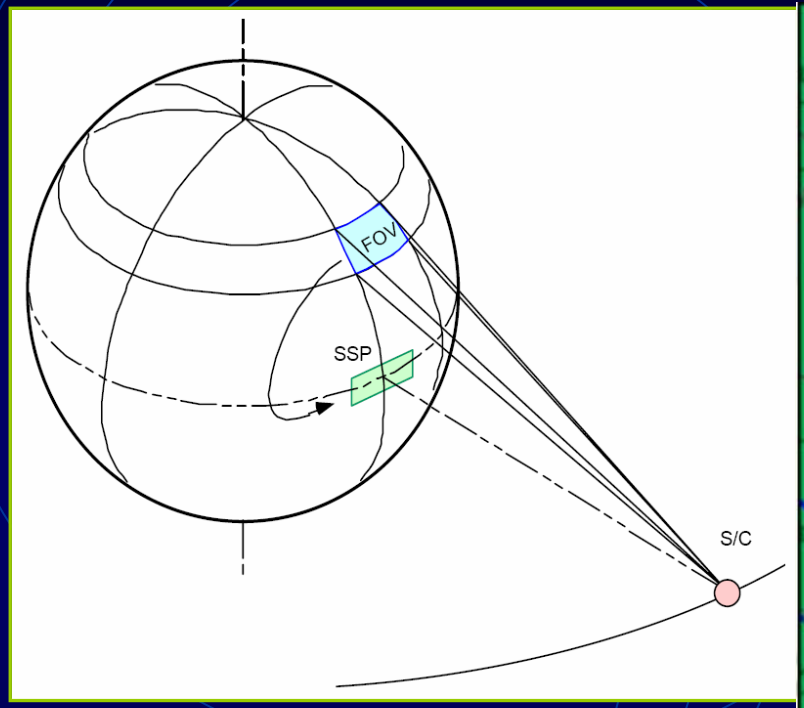
The basic scopes of the GOCI mission include

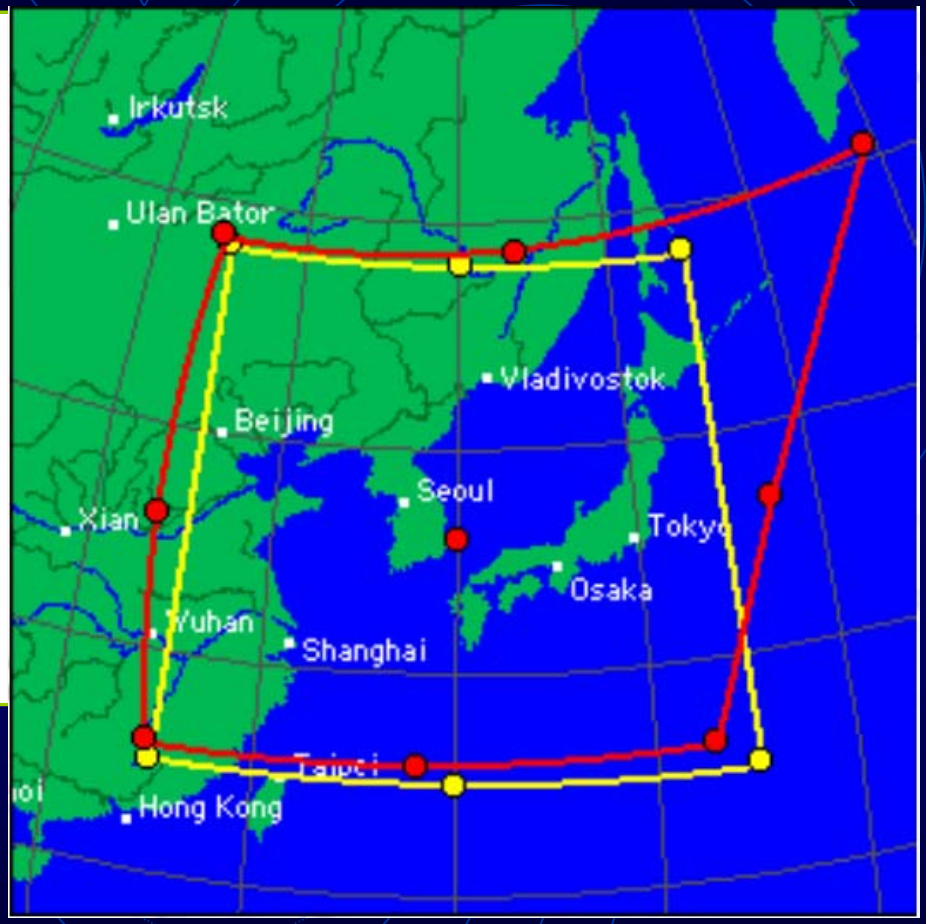
- **Detecting, monitoring and predicting short term physical and biological phenomena**
- **Studies on biogeochemical variables and cycle**
- **Detecting, monitoring and predicting noxious or toxic algal blooms of notable extension**
- **Monitoring health of the marine ecosystem**
- **Assessing geological and biological response to physical dynamics**
- **Coastal zone and resource management**
- **Producing an improved marine fisheries information to the fisherman communities**

GOCI Requirements

No of Channel	8 channels (6-Visible and 2-NIR)
Spatial resolution (IFOV)	500m × 500m
Coverage	2500 × 2500 Km
Spectral coverage	400 – 865nm (for 8 bands)
Digitization	12 bits
Data integration, readout and download rate	< 30 minutes
Image capturing	Staring method (frame capture)
Scheduled for launch	Dec. 2008

Scene Observation Coverage of GOCI

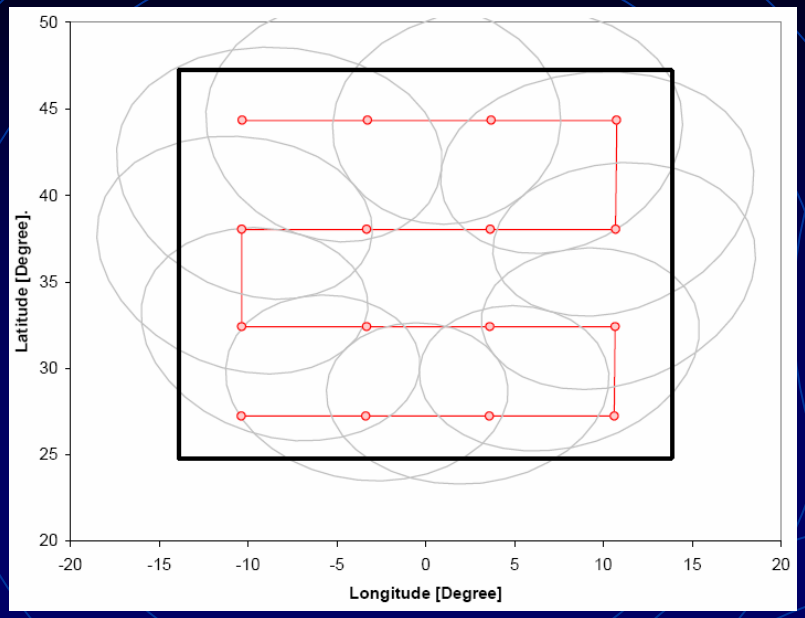




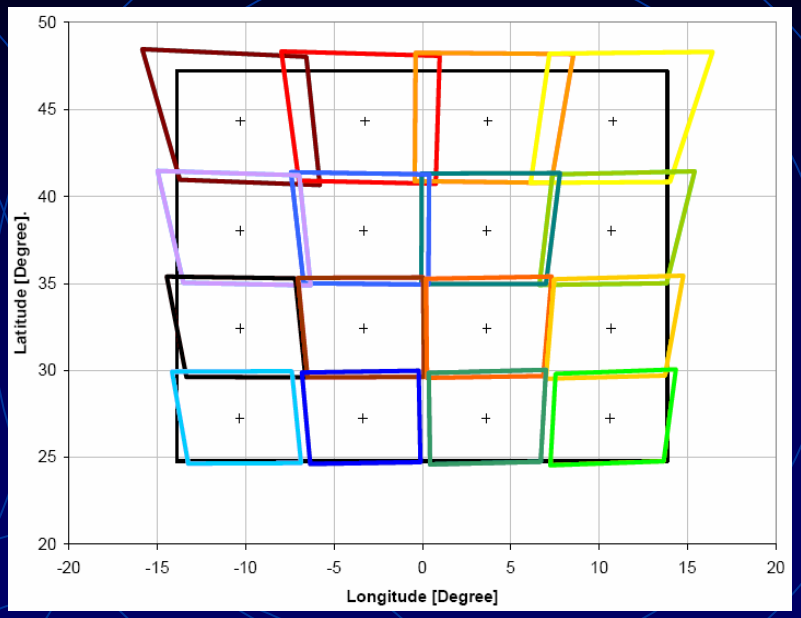
→The nominal instrument Field of View centered at Korean Seas: 36°N and 130°E

→ This corresponds to an area defined by GOCI location ; 116E(red line), 127E(Yellow line)

Scene Observation Coverage of GOCI



Selection of the scan mechanism positions



Field of View (FOV)/127E

The coverage of the specified FOV is obtained by 16 slots; additional slots can also be added to increase overlapping

Duty cycle and operation of the GOCI

- Image acquisition during day time: 10.00am – 17.00pm
- Time interval between successive images: 1 hour (8 images/day)

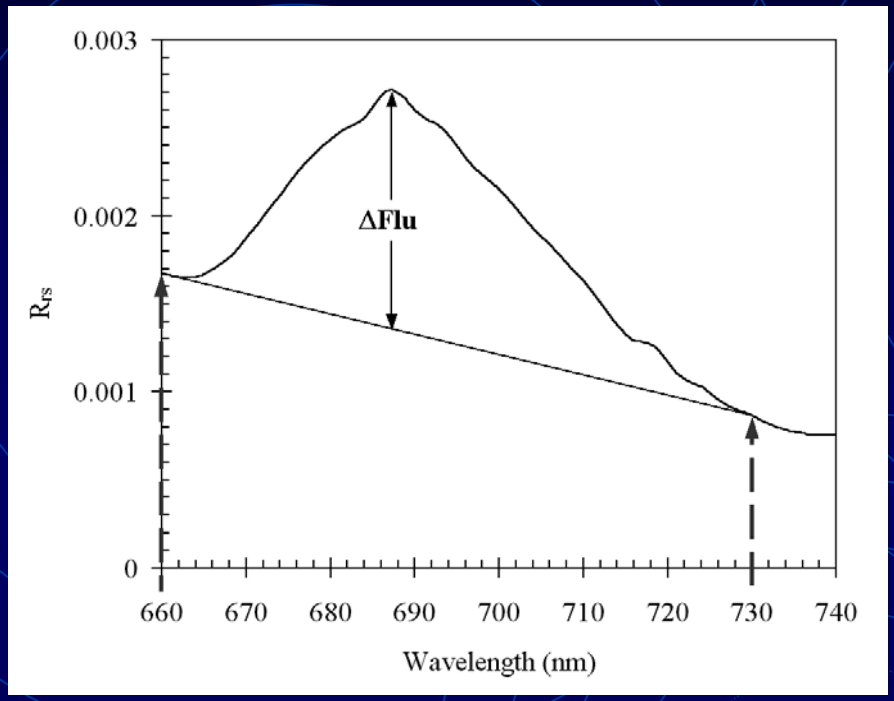
GOCI requirement and characteristics

Highlights of the GOCI		Characteristics and applications of the GOCI				
Paramete	Requirement	Channel	Wavelength (nm)	FWHM (nm)	IFOV (m)	Primary use
Number of Channel	8 channels	Channel 1	412	20	500	Yellow substance and turbidity
Spatial resolution (IFOV)	500m × 500m	Channel 2	443	20	500	Chlorophyll absorption maximum
Coverage (FOV)	2500Km × 2500Km	Channel 3	490	20	500	Chlorophyll and other pigments
Spectral coverage	400 – 900nm	Channel 4	555	20	500	Turbidity, suspended sediment
Digitization	12 bits	Channel 5	660	20	500	Fluorescence base1, Chlorophyll, suspended sediment
Data integration and download rate	< 30 minutes	Channel 6	680	10	500	Fluorescence signal, atmospheric correction
Image capturing	Staring method 2axis	Channel 7	745	20	500	Atmospheric correction and Fluorescence base2
Scheduled for launch	2008	Channel 8	865	40	500	Aerosol optical thickness, vegetation, water vapor reference over the ocean

Difference with SeaWiFS : 510nm not included, 670nm -> 660nm

*** Chlorophyll estimation => Previous & Flu. techniques**

Fluorescence technique



Band triplets for Flu.

GOCI: 660-680-745

MODIS: 667-678-748

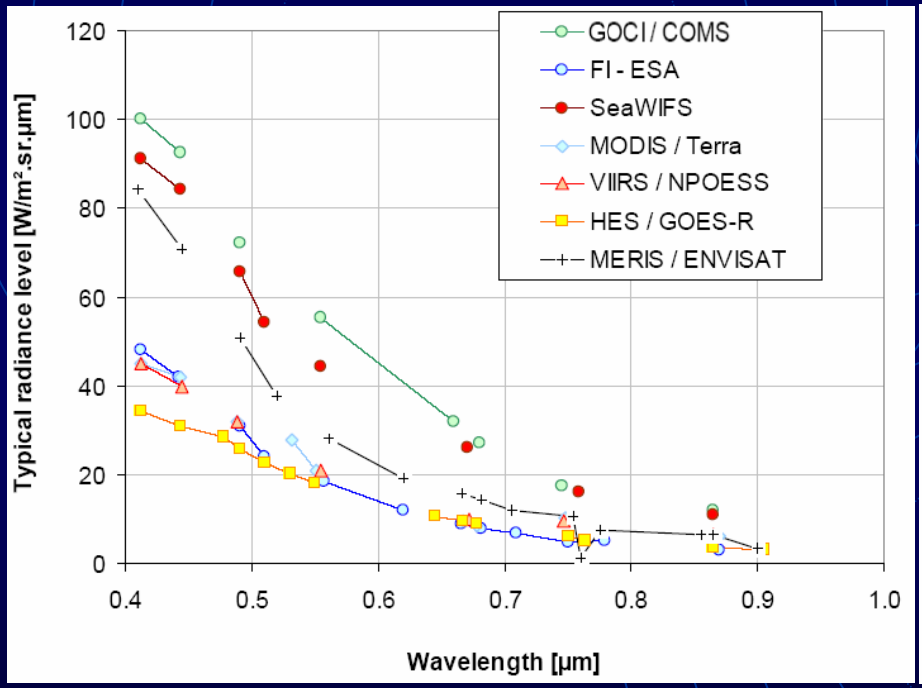
MERIS: 665-681-705

GLI: 666-680-710

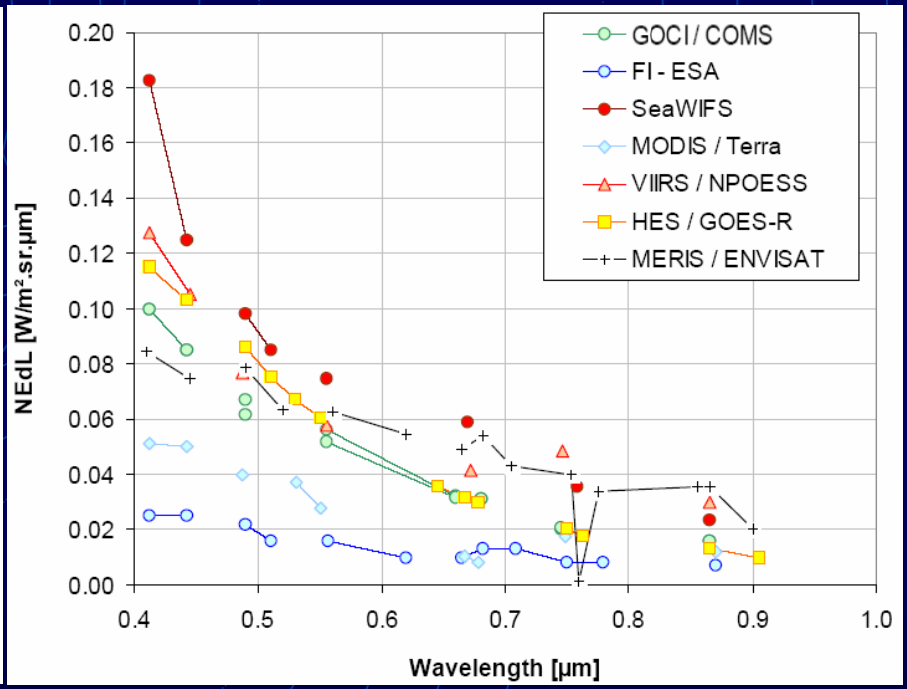
The GOCI will provide band triplets for the measurements of sun-induced chlorophyll-a fluorescence signal from the ocean. GOCI fluorescence bands will avoid the oxygen and water vapor absorption features pronounced at 687nm and 730nm

Radiance and noise level requirements for the GOCI

The radiance and noise level requirements for the GOCI as defined in RFP are compared with the available ocean color imagers.

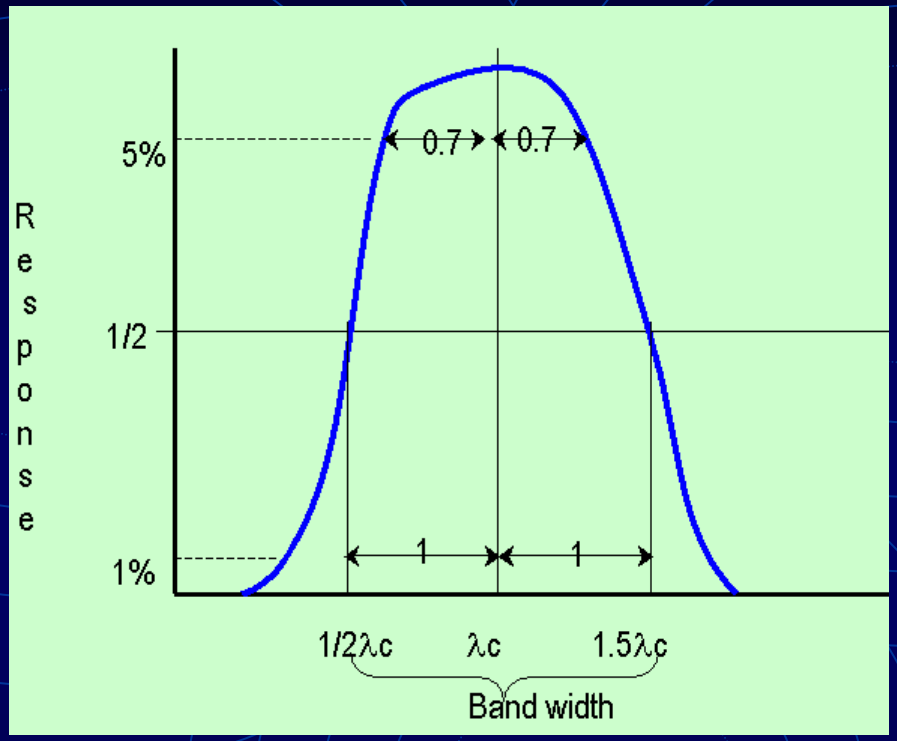


Specified saturation radiance levels for "ocean + atmosphere".



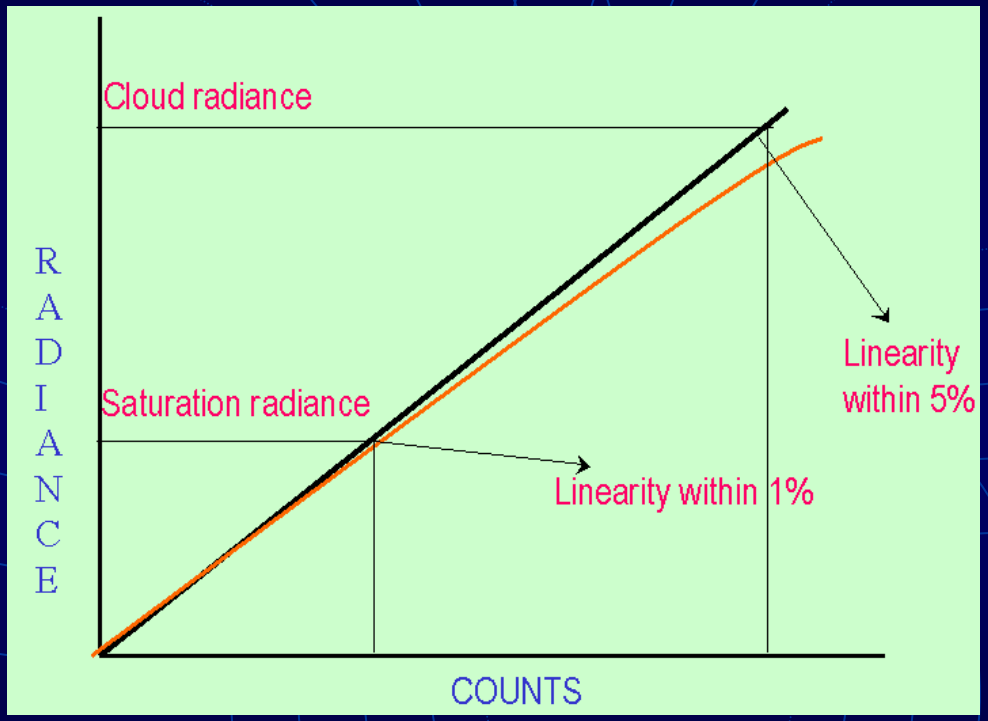
Specified noise levels

Band tolerances and band edge specifications



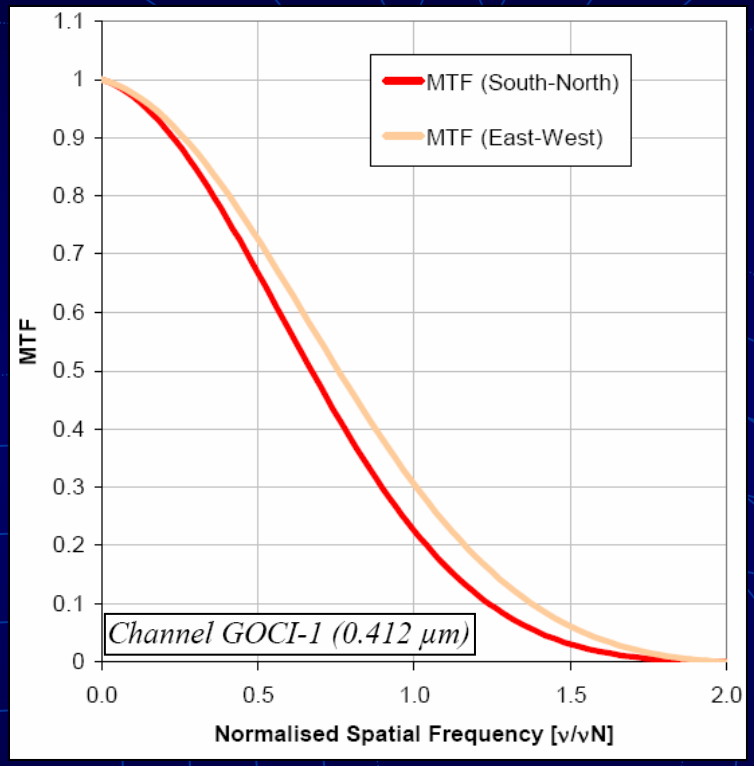
The location of the band edges shall be stable to less than ±0.5nm. The edge shall not exceed 50% of the bandwidth in any spectral band. The location of the band center shall be stable to less than ± 0.5nm. Band edges: ≤ 50% of maximum sensor response at Band Center ± (Bandwidth ×0.5) nm. L & U band edges: ≤ 5 % of maximum sensor response at Band Center ± (Bandwidth ×0.7) nm. L & U band extended edges: ≤ 1% of maximum sensor response at Band Center ± (Bandwidth) nm

Dynamic range



The GOCI shall be designed to operate over a dynamic range that can extend from the noise levels (NEdL) in each spectral band to the maximum levels (L_{clouds})

Spatial performance



It is the normalized spatial frequency response of this system. In the GOCI, MTF shall be larger than 0.3 @ Nyquist frequency. The MTF specifications shall be satisfied for modulations between dark and L_{ocean} and between dark and L_{max}, for every detector element in each spectral band.

Band-to-band registration

The GOCI specification requires that the IFOVs from all spectral bands shall be co-registered to within 0.5 pixel accuracy.

Polarization

The polarization requirement is an important driver of the instrument optical system: the polarization is defined as

$$PF = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$$

I_{max} – maximum signal of linearly polarized incoming light

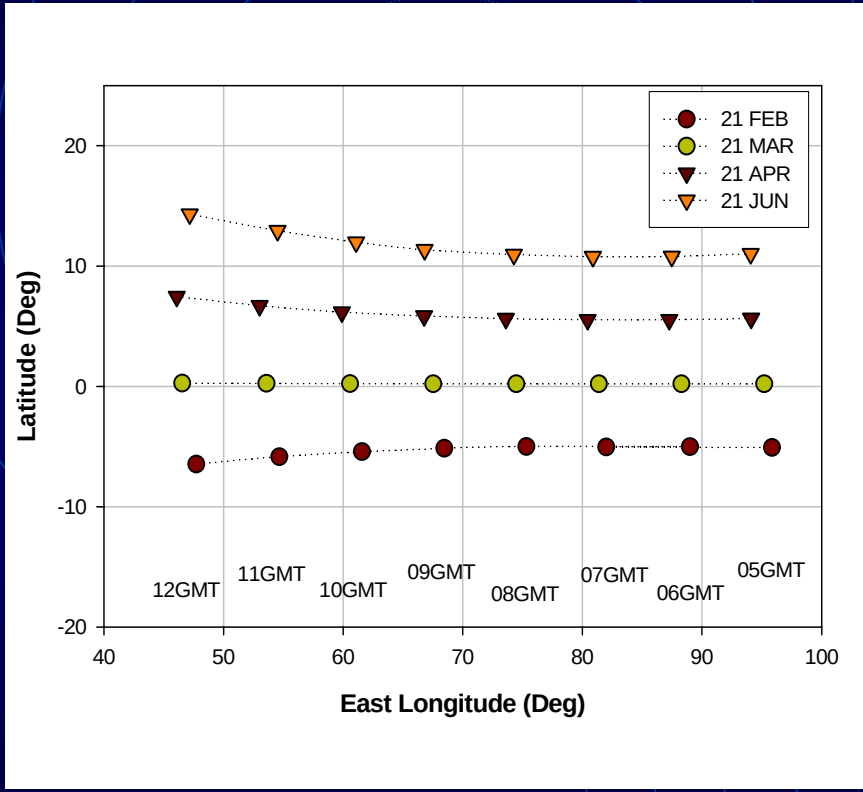
I_{min} – minimum signal of linearly polarized incoming light

The polarization factor (*PF*) shall be less than 2% for the GOCI.

Band-to band stability

The relative amplitude stability between all pairs of spectral bands shall be better than ±0.5% measured at full-scale, and ±1% at half scale.

The effect of sun-glint at Geostationary orbit



We found that there will be no sunglint influence around the target area.

Seasonal(N-S) and diurnal (E-W) excursion of sun-glint regions in this study (83.5E)

Calibration

The accuracy of radiometric measurement of the sensor largely depends on instrument calibration during the orbit-phase.

→ Solar Diffusers (transmitted radiance) was proposed for GOCI

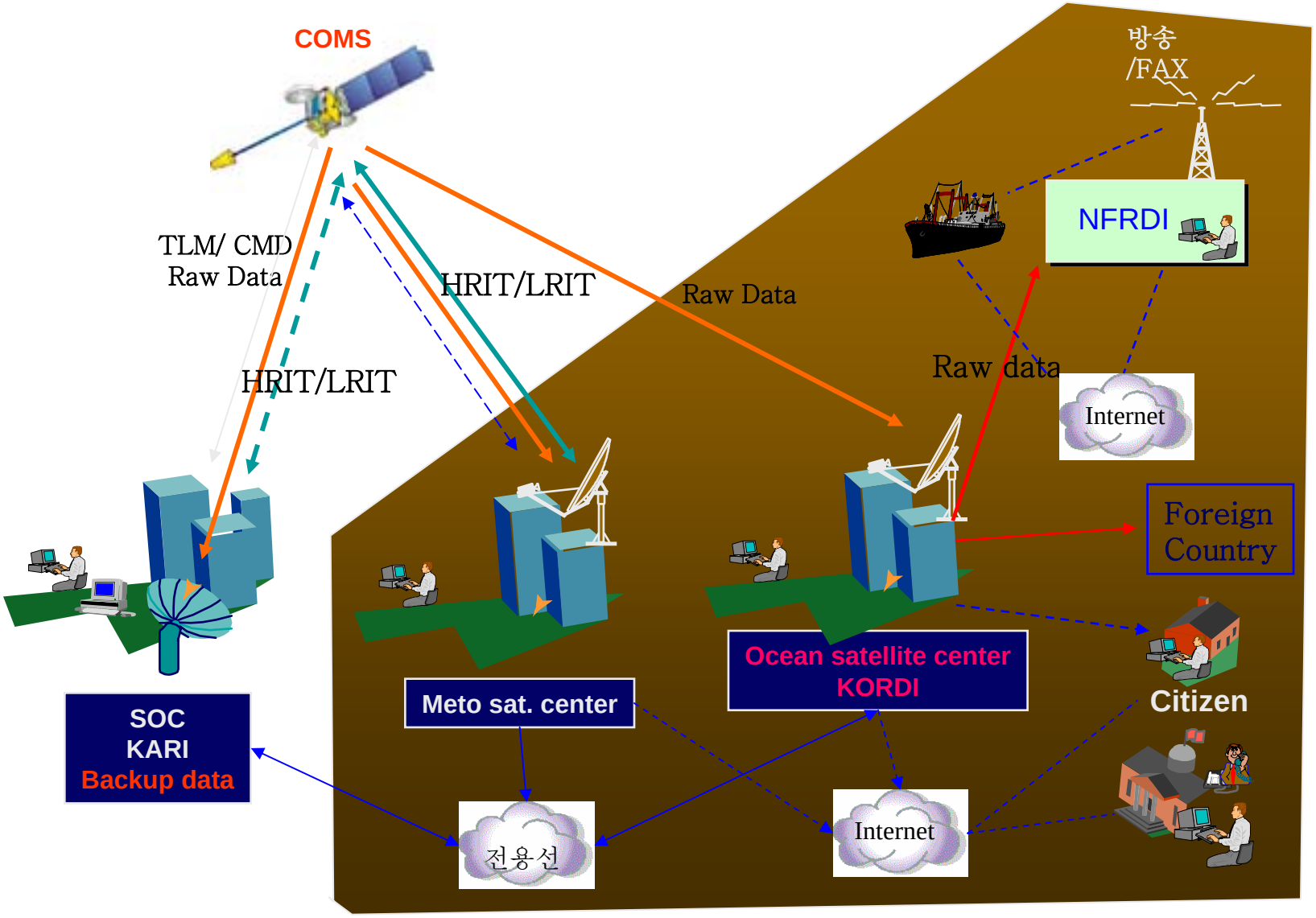
- Absolute radiometric accuracy shall be less than 4%
- Rate of change in degradation of sensitivity estimated to within 2% per year
- And less than 10% sensitivity degradation over life time of the mission

Auxiliary data

Minimum set of auxiliary data that support observations must include

- → Calibration coefficients (solar, temperature)
- → Gain values
- → Date and time (both GMT and local)
- → Solar zenith and azimuth angles
- → Map projection information
- → Image coordinates (Pixel locations easting, northing)
- → Spacecraft position for each pixel in the image
- → Minimum and maximum detected radiance levels within the scene for the corresponding bands

Ground stations for COMS



Mission of Korea Ocean Satellite Center

- → Research Supporting /KOSC/MOMAF
- → Development of Ocean color techniques
- → Future ocean satellite development
- → **Ocean environmental monitoring and information service**
- → **International collaboration**
- → **Ocean satellite data service**

KARIS's roll for COMS

- → **COMS (GOCI) operation and control**
- → **Data backup**
- → **Sensor calibration**

Difference of OSMI & GOCI

	OSMI	GOCI
Proposal	TRW (?)	KORDI
Development Support	MOST	MOMAF
Requirement	TRW(?)	KORDI
Data reception	KARI	KORDI/KARI(Backup)
Data distribution	KARI	KORDI
Satellite control	KARI	KARI/KORDI
Operation/Support	KARI/MOST	KORDI/MOMAF

THANK YOU