CEOS ACC Meeting, Montreal, Canada, March 30-31, 2010

Status / Scope of GEMS

Jhoon Kim, GEMS Science Team

Global Environment Satellite Research Center
Department of Atmospheric Sciences,
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GEMS Science Advisory Group(SAG)

Chang Hoi Ho (SNU)
Jae H. Kim (PNU)
Young Joon Kim (GIST)
Jong Bum Lee (Saeasoft, Co
Kwang Mog Lee (KNU)
Young Lee (KNU)
Rokjin Park (SNU)
Seon Ki Park (EHWU)
Chul H. Song (GIST)
Jung Hun Woo (Konkuk University)
Young Sook Eom (CNU)
Sangsoon Yong (KARI)
Yunsoo Choi (NOAA)
Minho Lee, J.S. Kim (ME)
Sukjo Lee, Yuduk Hong,
Chang Keun Song (GERC, ME)
Myung H. Ahn, Millim Ou (KMA)
Yu Hwan Ahn (KORDI)
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Jay Al-Saadi (NASA HQ)
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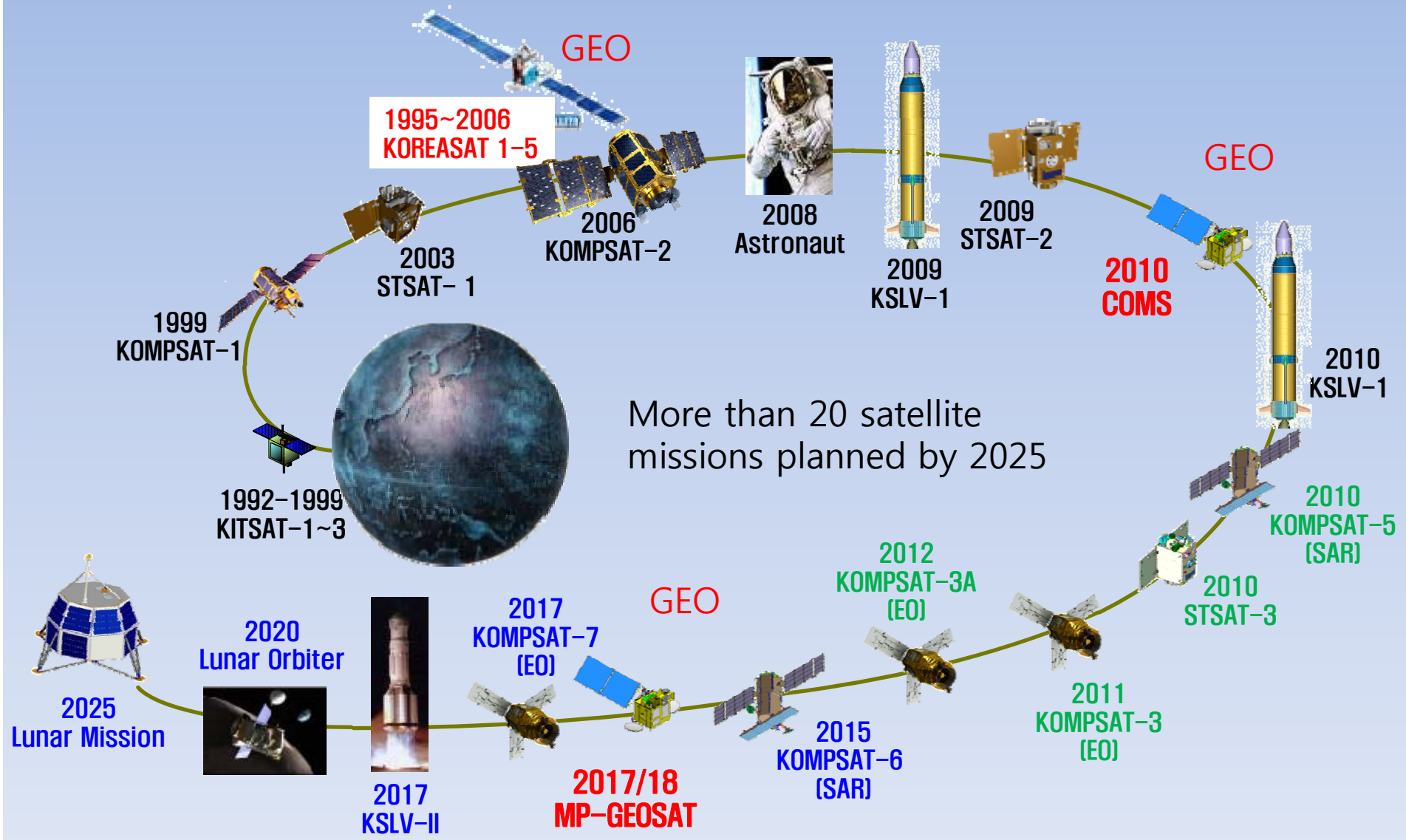
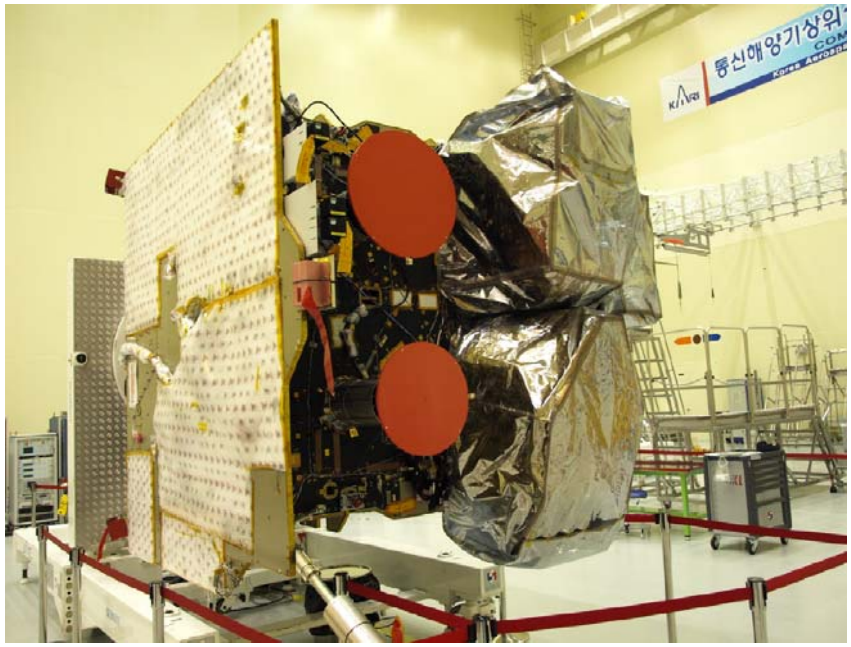
Kevin Bowman (NASA JPL)
Gregory Carmichael (Univ of Iowa)
Kelly Chance (Harvard Univ.)
Annmarie Eldering (NASA JPL)
Ernest Hilsenrath (NASA HQ)
Daniel Jacob (Harvard Univ.)
Scott Janz (NASA GSFC)
Thomas Kurosu (Harvard Univ.)
Pieternel Levelt (KNMI)
Qinbin Li (UCLA)
Xiong Liu (NASA GSFC)
Randall Martin (Dalhousie Univ.)
Mike Newchurch (Univ of Alabama)
Ullrich Platt (Univ of Heidelberg)
Jochen Stutz (UCLA)
Omar Torres (Hampton Univ.)
Dong Wu (JPL)
Ping Yang (TA&M)

National Space Program of Korea

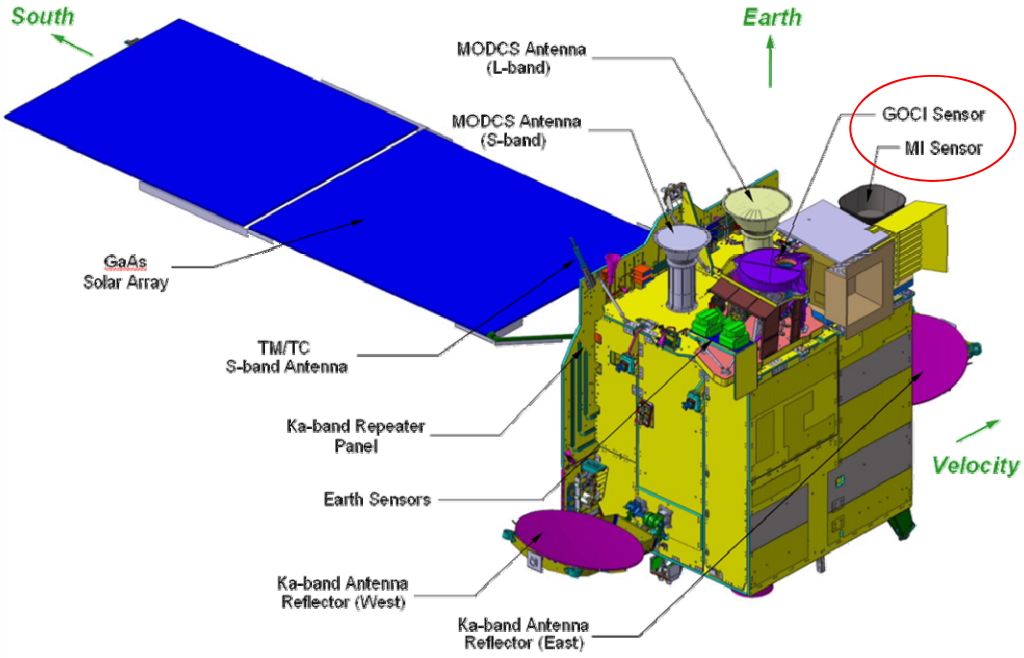


COMS

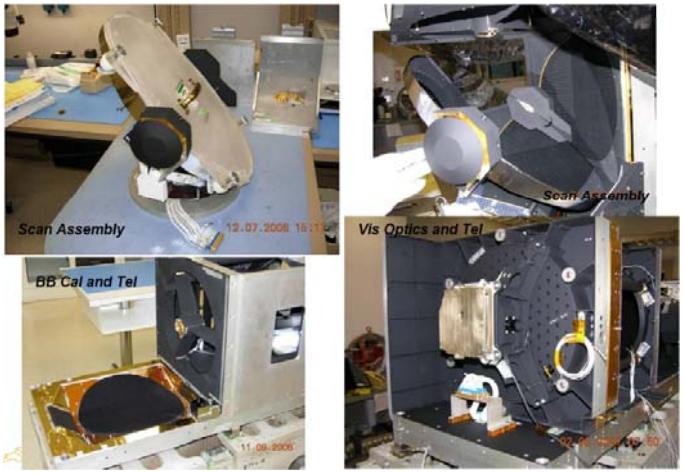


- Launch: Apr. 22, 2010
- Orbit: GEO (128.2°E)
- SI: KARI + Astrium
- Mass at launch < 2497 kg
- Operational life : 7.7 years
- Power : 2.7 kW
- Launch vehicle : Ariane 5

- Mission:
  - Communication
  - Ocean Color
  - Meteorology



Payloads for COMS



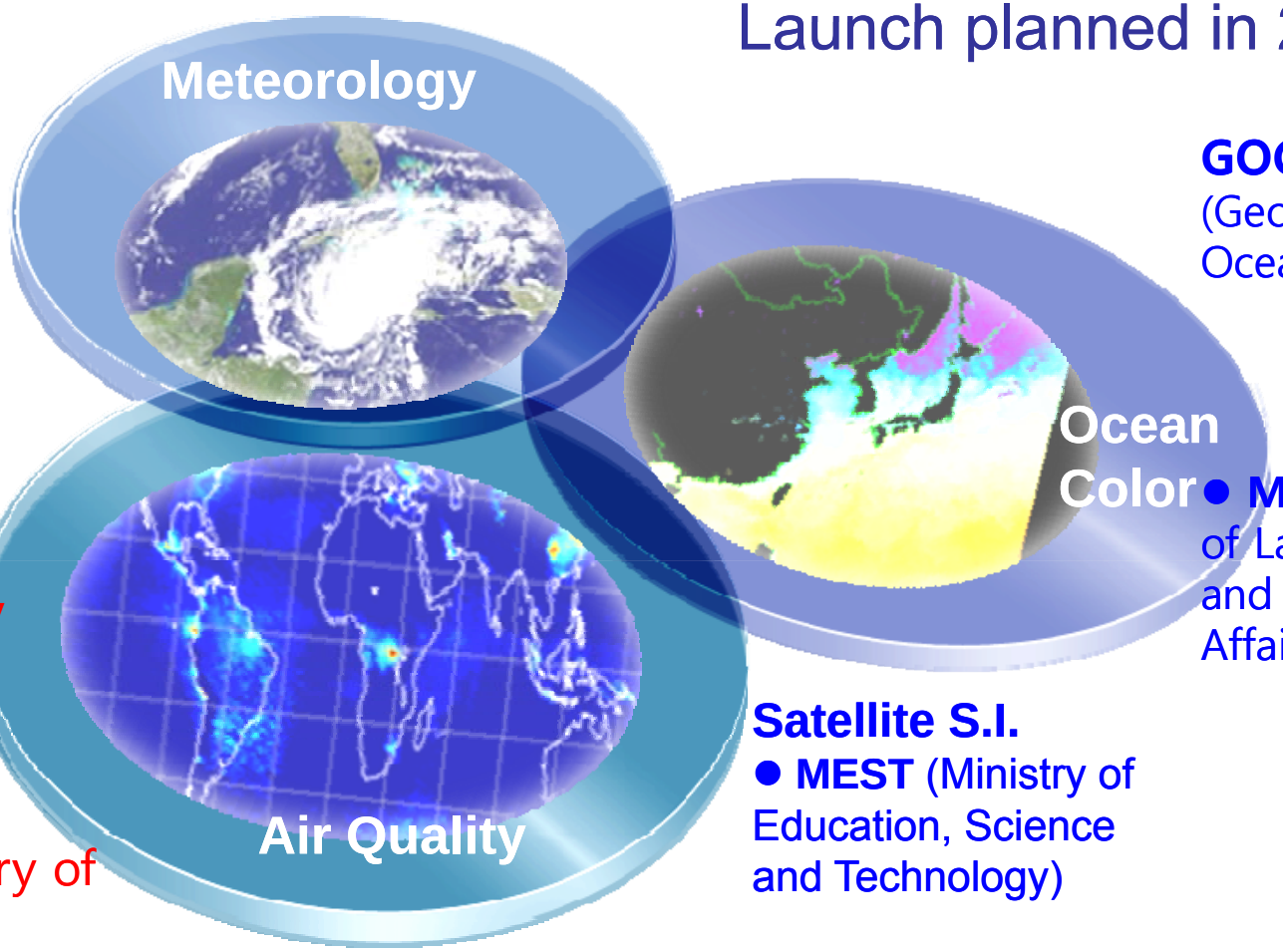
	MI	GOCI
Mass	144.6 Kg	83.3 Kg
Volume	1300x900x800 mm^3	1000x800x800 mm^3
Spectral Band (μm)	0.63(0.55-0.75) 3.91(3.8-4.0) 6.7(6.5-7.0) 10.7(10.2-11.2) 12.0(11.5-12.5)	412, 443, 490, 555, 660, 680, 745, 865 nm (8) 20 nm (B1~B5, B7) 10 nm (B6), 40 nm (B8)
Spatial Resolution	1 km (VIS) 4 km (IR)	500 m x 500 m
Coverage	Global	East Asia near Korea
SNR	~	~1000
Temporal Resolution	30 min.	1 hour (8/day)
Products	Cloud, snow cover, CSR, OLR, AMV, SST, LST, TPW, Fog, CTT, CTP, rain rate, AOD	Yellow substance turbidity Chlorophyl suspended sediment Vegetation AOD, aerosol size, type

Mission of MP-GEO Sat

MP-GEO SAT: follow-up mission after COMS

Launch planned in 2017/18

ABI
- 16 channels
- Vis - IR
- 0.5, 1, 2 Km resolution
- **KMA** (Korea Meteorological Administration)

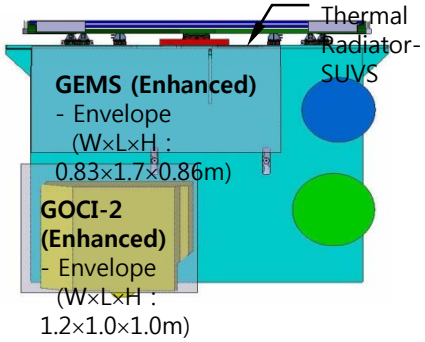


GOCI-2
(Geostationary Ocean Color Imager)
- 13 channels
- VIS ~ NIR
- 250 m resolution
- **MLTM** (Ministry of Land, Transport and Maritime Affairs)

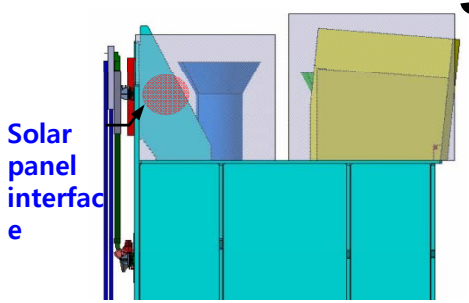
GEMS
(Geostationary Environmental Monitoring Spectrometer)
- UV/Visible
- **ME** (Ministry of Environment)

Satellite S.I.
- **MEST** (Ministry of Education, Science and Technology)

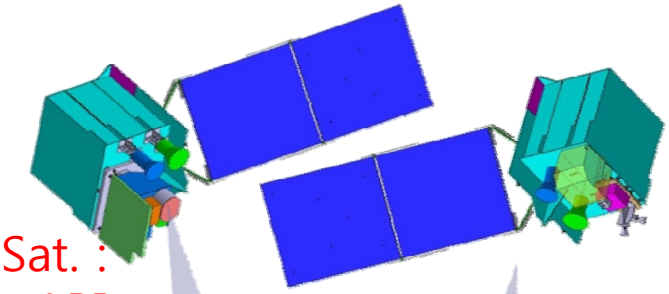
MP-GEO SAT Configuration



MP-GEOSat (Earth view)



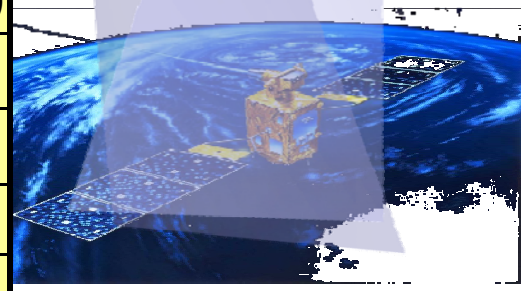
MP-GEOSat (side view)

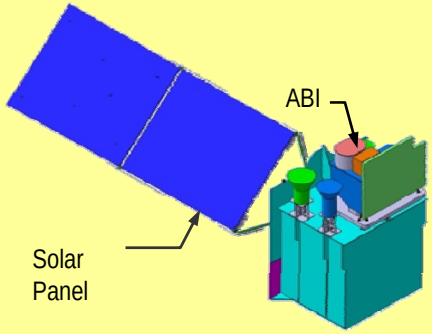
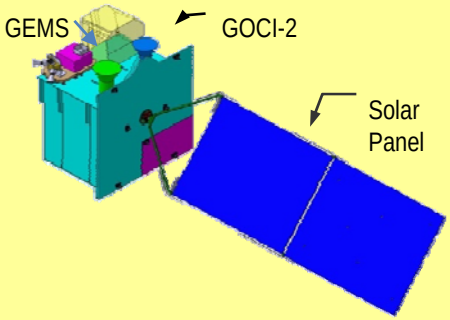


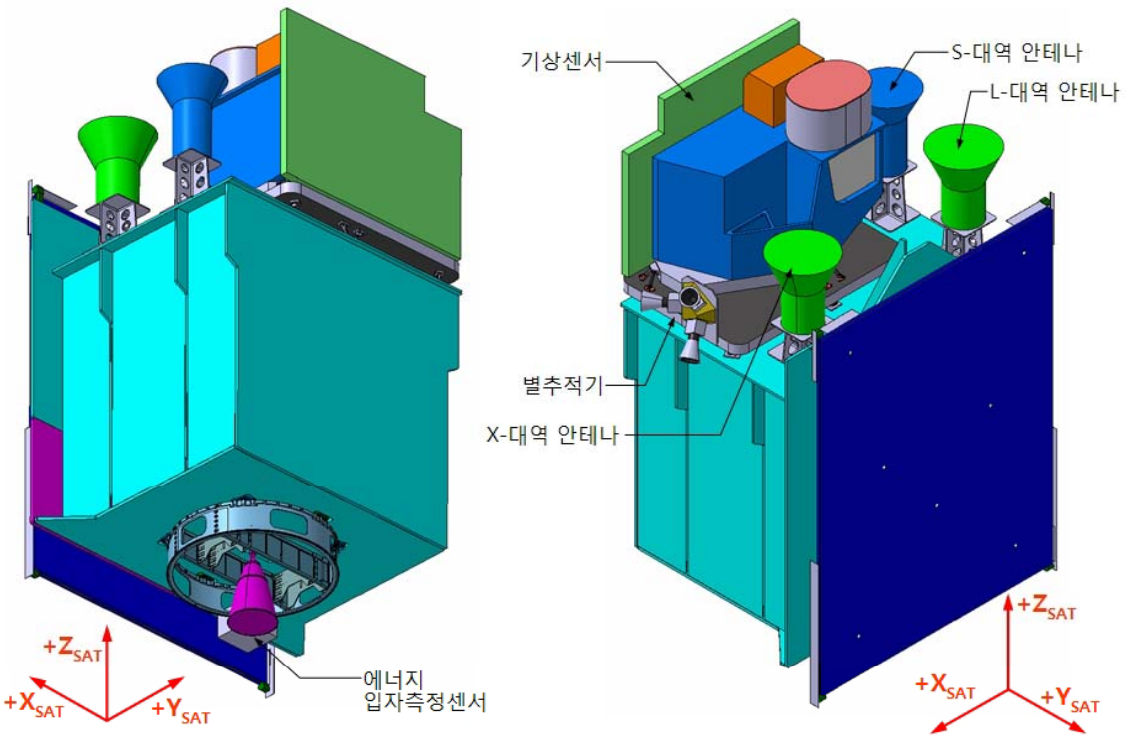
2A Sat. : ABI

2B Sat. : GEMS, GOCI-2

(Twin Satellites)



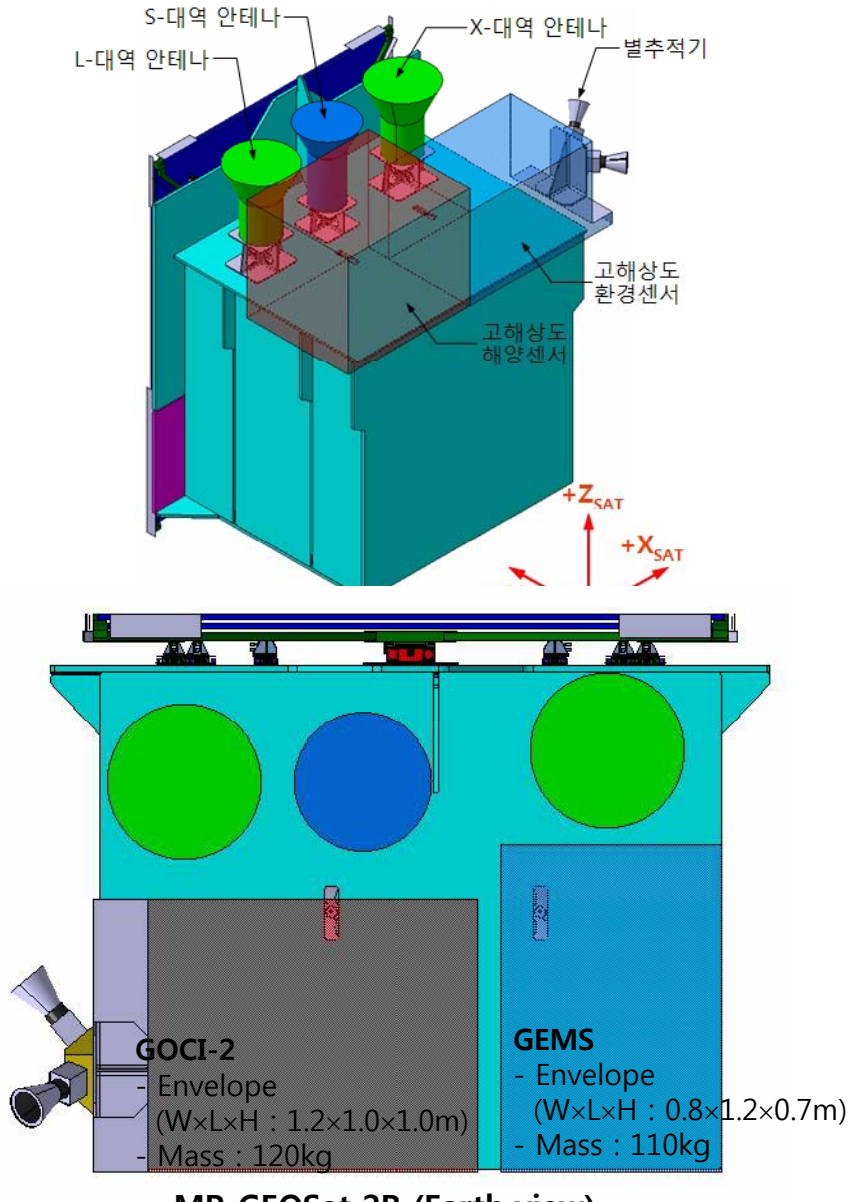
	2A	2B
Satellite configu-ration w/pay-loads		
Resolu-tion	• VIS : 0.5, 1 km • IR : 2 km	• GOCI-2 : 250 m / 500 m • GEMS : 5 km(NS), 15 km(EW)
Life time	10 years	10 years
Launch Mass	2823.1kg	2342.1kg (TBD)
Power	1744W (in orbit)	1323W (in orbit)
Orbit	GEO @ 128.2±0.05 E	GEO @ 128.2±0.05 E



Mass budget

Subsystem / unit	mass (kg)
Payload	**377.3**
ABI	371.8
Space Environment detector	5.5
Bus	**963.9**
Scientific Data Telemetry	40.7
Structure	343.6
Propulsion	120.4
Power Control	183.1
Attitude Control	80.1
Telecommand	53.6
Thermal control	59.1
Harness	83.3
System margin	**20.0**
Dry mass	**1,361.2**

Satellite-2B



MP-GEOSat 2B (Earth view)

Mass Budget

Subsystem / Unit	Mass (kg)
Payload	**253.0**
GOCI-2	132.0
GEMS	121.0
Bus	**940.5**
Scientific Data Telemetry	40.7
Structure	309.5
Propulsion	120.4
Power Control	183.1
Attitude Control	80.1
Telecommand	64.3
Thermal Control	59.1
Cable	83.3
System Margin	**20.0**
Dry mass	**1,213.5**

Status of MP-GEOSAT Mission

- Feasibility studies at subsystem and system level (2008-2009)
  - Recommended measurements of SO_2, NO_2, O_3 and aerosol using UV/Visible spectrometer from Geostationary Orbit
  - As an option, recommended measurements of CO, CO_2 and CH_4 using IR FTS from GEO
  - Finished feasibility studies of meteorological(2007) and ocean color monitoring(2008) mission
  - Recommended Atmospheric Environmental Monitoring Mission, together with Meteorological and Ocean Color Monitoring

- Conceptual studies an GEMS Program Office
  - Established GEMS Program Office inside ME and GEMS Research Center at Yonsei University in 2009
  - Started preliminary study in 2009 to setup requirements and instrument concept design by ME
  - First GEMS Workshop planned in August 23-24, 2010

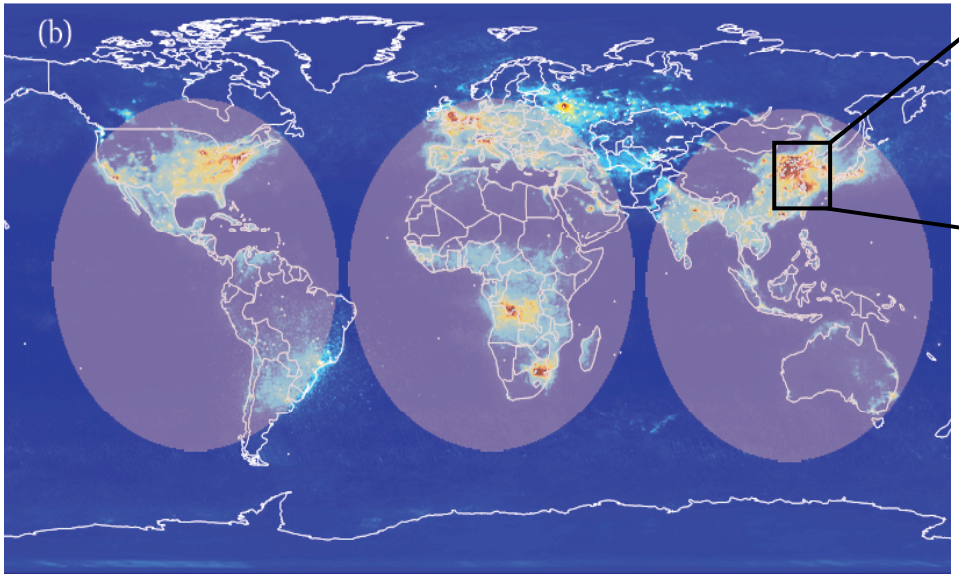
- Budget
  - Right after the launch of COM2 in April, 2010, the budget request will be proposed for the Government review in May, 2010,
    - Expect to have decision by the end of this year

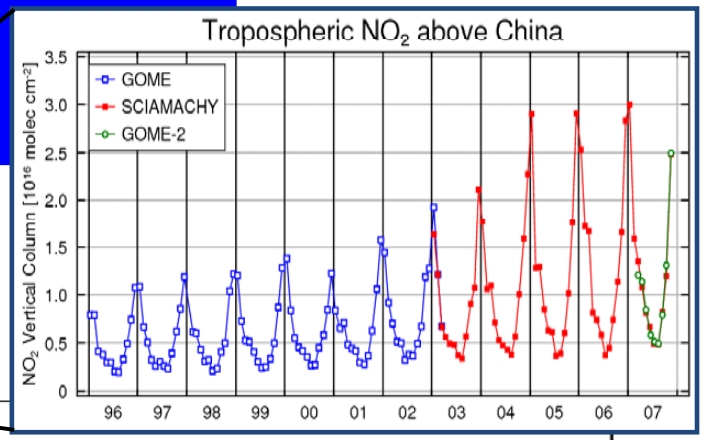
Mission Objectives of GEMS

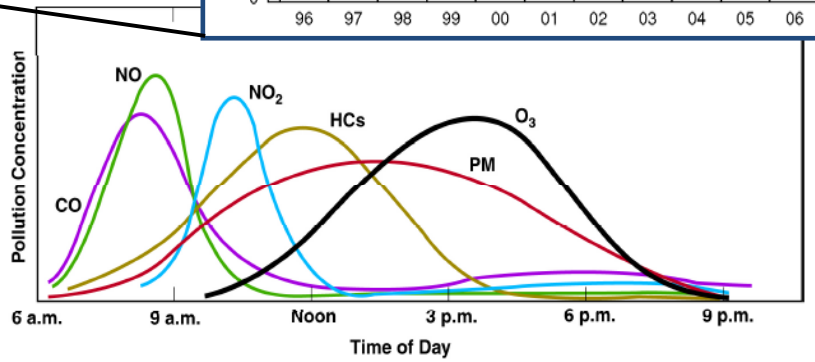
GEMS Objectives

1. To provide atmospheric chemistry measurements in high temporal and spatial resolution over Asia
2. To monitor regional transport events: transboundary pollution and Asian dust
3. To enhance our understanding on interactions between atmospheric chemistry and meteorology
4. To better understand the globalization of tropospheric pollution
5. To improve air quality forecast by:
   - Constraining emission rates
   - Data assimilation of chemical observations

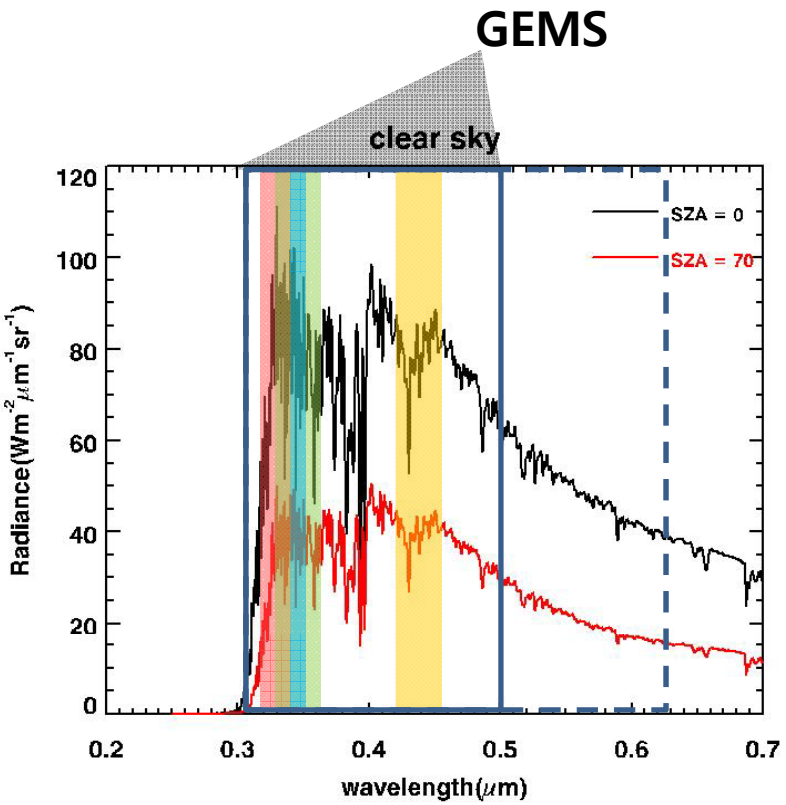
[Richter et al.]





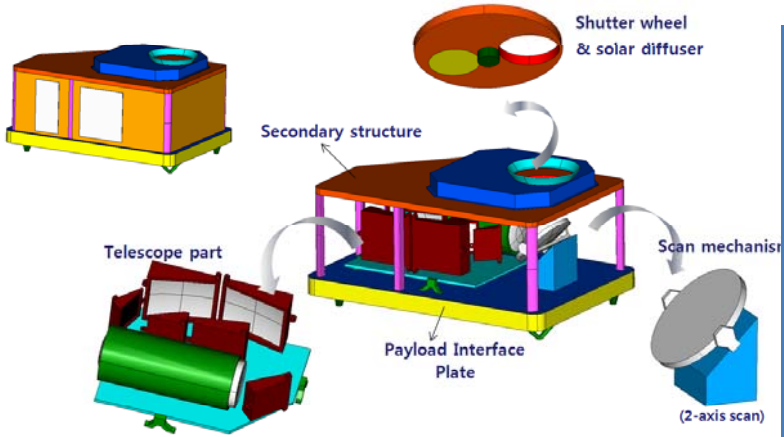


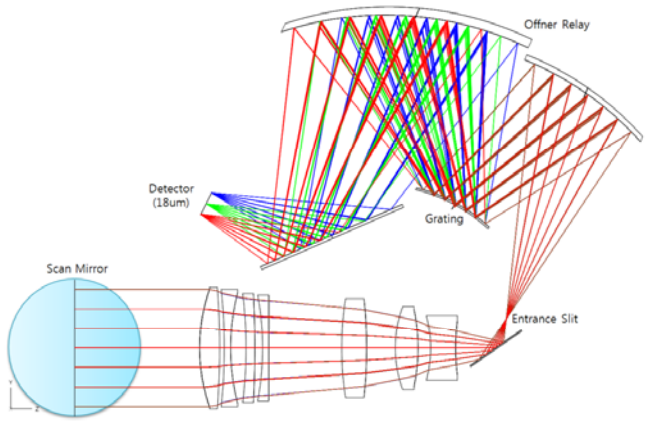
Radiance spectrum

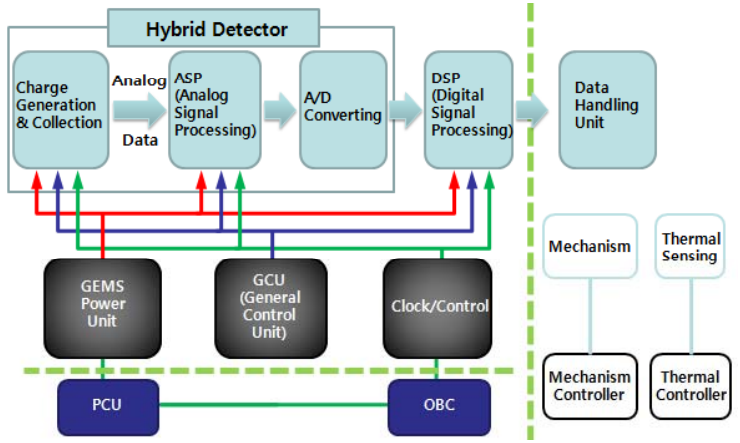


Prod-uct	Impor-tance	Min	Max	Accu-racy	Spectrl window (nm)
NO_2	Ozone precursor	$3.0x10^{13}$ cm^{-2}	$1.0x10^{17}$ cm^{-2}	5% [TBC]	425 - 450
SO_2	Aerosol precursor	$6.0x10^{8}$ cm^{-2}	$1.0x10^{17}$ cm^{-2}	10% [TBC]	310 – 330
HCHO	Proxy for vocs	$1.0x10^{15}$ cm^{-2}	$3.0x10^{16}$ cm^{-2}	$1.0x10^{15}$ cm^{-2}	327 – 357
O_3	Oxidant, pollutant	$4.0x10^{17}$ cm^{-2}	$1.0x10^{18}$ cm^{-2}	2% or 6 DU	300-340 Chappuis band ?
AOD	PM, type,	0.0	4.0	30% or 0.1@ 400nm	300-500

GEMS Requirements







Life time	> 7 years
Reliability	> 0.85 @ EOL
Spectrometer	Coverage: 300-500[620] nm Bandpass: 0.8 nm (3 samples/bandpass)
Telescope	f/2 system Focal length: 200 mm Aperture: 100 mm
Detector	1K x 1K UV-enhanced CCD
Spatial	Coverage: N-S 5000 km (5[2.5] km at nadir), Northern Hemisphere E-W selectable (15[7.5]Km FWHM Gaussian PSF with 5 km sampling) Resolution: 5 km x 15 km [2.5 km x 7.5 km]
Ground sampling	5 km [2.5 km]
Temporal resolu'n	1 hour
SNR	720 at 320 nm, 1500 at 430 nm
Power	< 100 Watts [250 W]
Mass	40 kg [110 kg]
Volume	0.4 x 0.4 x 0.2 m^3 [0.8 x 1.2 x 0.7 m^3]
Data rate	~ 10 Mbps [40 Mbps]
Duty cycle	8 images during daytime
MTF	> 0.3 at Nyquist frequency

Ocean Color Imager (GOCI-2)

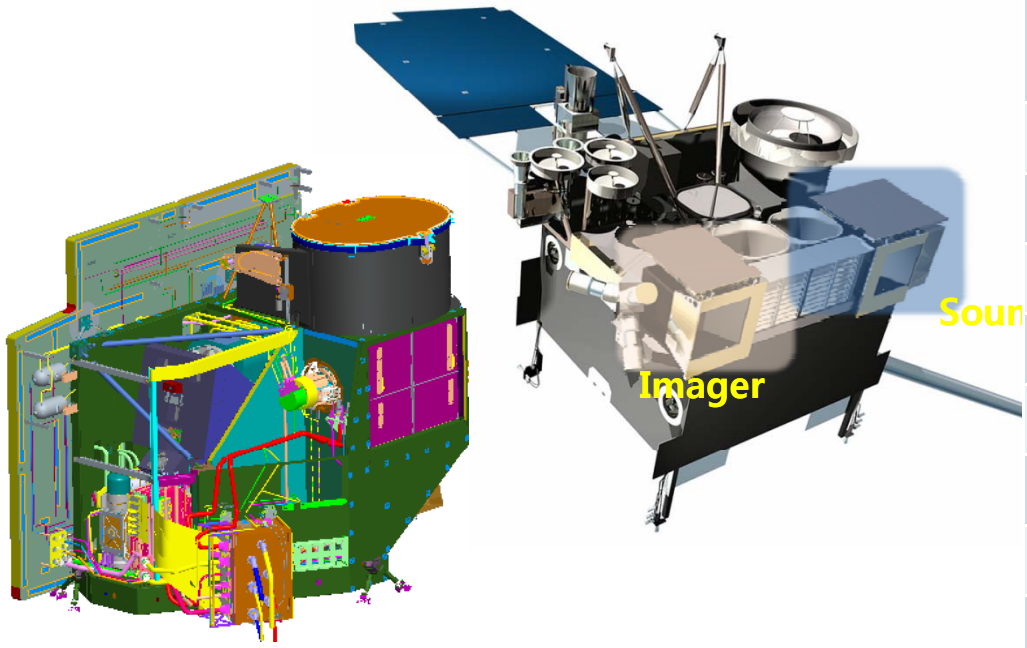
- **Requirements**
  - **Band: 13 Bands** (GOCI-1 : 8 Bands)
    - Phytoplankton type verification, Nighttime Observation, Enhanced Atmospheric Correction Accuracy
  - **Spatial resolution: 250 m / 1 km** (GOCI-1 : 500 m)

Radiance : W/m^2/um/sr

Band	Heritage	Band Center	Band width	Nominal Radiance	Maximum Ocean Radiance	Saturation Radiance	Maximum Cloud Radiance	NEdL	SNR	Primary use
1	GOCI-B1	412nm	20nm	100.0	150.0	152.0	601.6	0.100	1000	Yellow substance and turbidity
2	GOCI-B2	443nm	20nm	92.5	145.8	148.0	679.1	0.085	1090	Chlorophyll absorption maximum
3	GOCI-B3	490nm	20nm	72.2	115.5	116.0	682.1	0.067	1170	Chlorophyll and other pigments
4	(KGOCI)	520nm	20nm							Red Tide
5	GOCI-B4	555nm	20nm	55.3	85.2	87.0	649.7	0.056	1070	Turbidity, suspended sediment
6	(KGOCI)	625nm	20nm							SS & Red Tide
7	GOCI-B5	660nm	10nm	32.0	58.3	61.0	589.0	0.032	1010	Baseline of fluorescence signal, Chlorophyll, suspended sediment
8	GOCI-B6	685nm	10nm	27.1	46.2	47.0	549.3	0.031	870	Atmospheric correction and fluorescence signal
9	GOCI-B7	745nm	20nm	17.7	33.0	33.0	429.8	0.020	860	Atmospheric correction and baseline of fluorescence signal
10	(KGOCI)	765nm	20nm							Aerosol Properties, Atmospheric Properties
11	GOCI-B8	865nm	40nm	12.0	23.4	24.0	343.8	0.016	750	Aerosol optical thickness, vegetation, water vapor reference over the ocean
12		905nm	40nm							Atmospheric Properties, Cloud Properties
13		650nm	500nm	6.5E-6						Night Band (Night time fishing boat activities)

(Ahn, Yu Hwan)

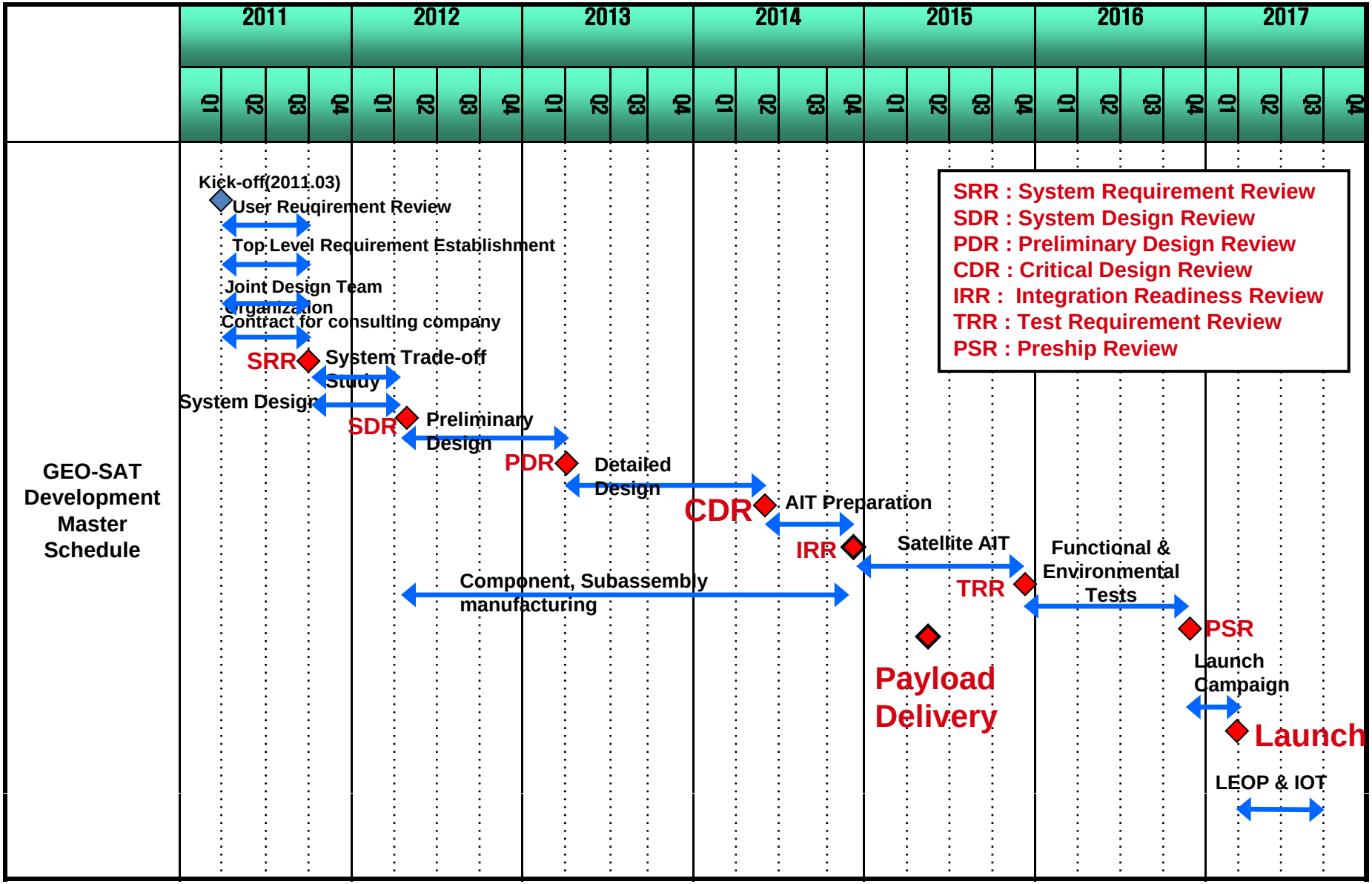
ABI (Advanced Baseline Imager)



Channels (μm)	0.47, 0.64, 0.865, 1.378, 1.61, 2.25, 3.9, 6.19, 6.95, 7.34, 8.5, 9.61, 10.35, 11.2, 12.3, 13.3
Products	AMV, aerosol, cloud, moisture, SPM, fire, snow, ice, vegetation, LST, SST, rain rate, TPW, radiance, albedo etc.

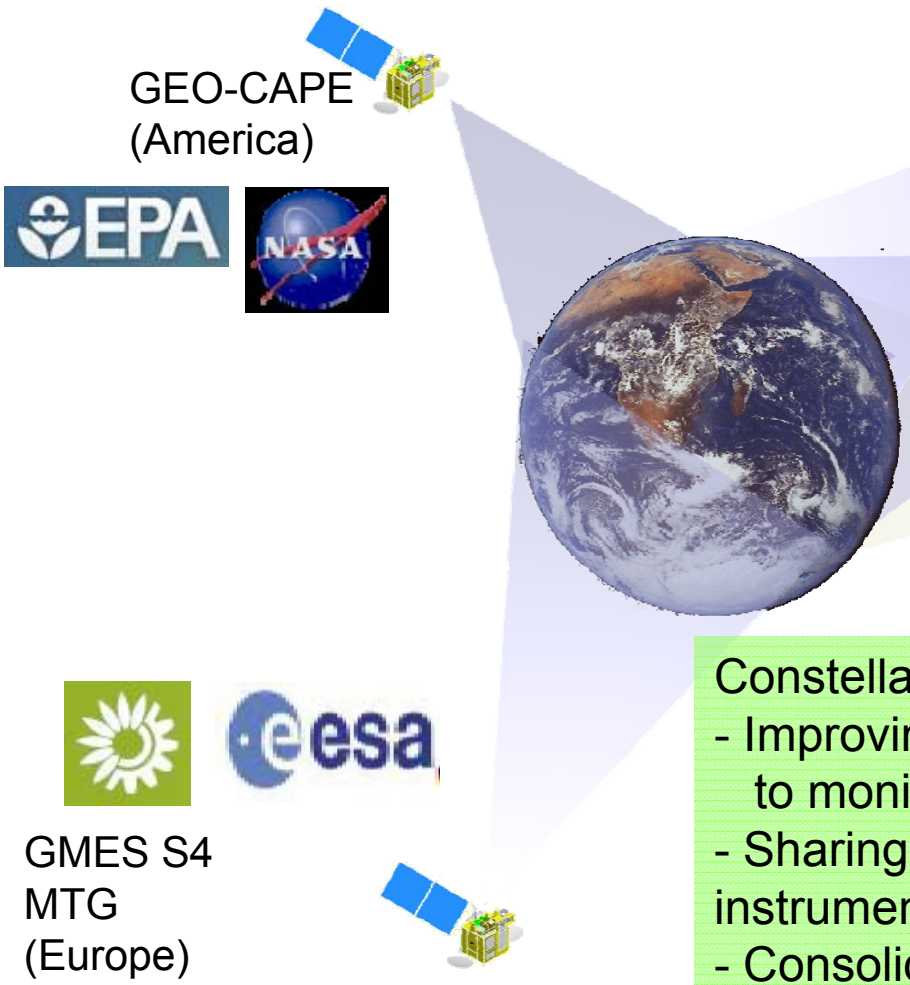
Parameter	ABI
Size(m)	1.75 x 1.20 x 1.50
Mass (kg)	338
Power (W)	450
Resolution (km)	0.5, 1, 2
Channels	16
Full disk (min)	5
Data rate (Mbps)	66.6
Compression	Lossless
Field of regard (deg)	22 circular
Full disk size (deg)	17.76 circle
CONUS size (deg)	4.8 x 8.0
Meso size (deg)	1.6 x 1.6
NS pixel grid (μrad)	14, 28, 56
EW pixel grid (μrad)	14, 8, 56
Full disk scan time (min)	5

Master Schedule of MP-GEO SAT



Global Environmental Monitoring

Constellation of GEO Mission to study Air Quality



GEO-CAPE
(America)

EPA

NASA

Japanese GEO
(Asia Pacific)

JAXA

GEMS
MP-GEO Sat
(Asia Pacific)

KARI

me

Chinese GEO?
(Asia)
UV+IR hyperspectral

GMES S4
MTG
(Europe)

esa

Constellation synergy
- Improving spatial and temporal coverage
  to monitor globalized pollutants
- Sharing basic requirements on data products and instrument to maintain data quality
- Consolidating socio-economic benefit analysis
- Supporting QA and CAL/VAL

Summary

- Status and Scope of GEMS
  - ME of Korea and KARI is planning a geostationary mission in 2017/2018 time frame to monitor air quality in Asia-Pacific region to provide high spatial and temporal measurements of O_3, SO_2, NO_2, HCHO and aerosol, as collaborative efforts with the GEO-CAPE, the Sentinel-4, and Japanese GEO planned in 2017-2020 time frame.
  - With the funding from ME, studies are ongoing for science and instrument requirements, conceptual design of instruments, development of retrieval algorithms, evaluate social benefit analysis, and so on.
  - Recent allocation of extra volume and mass can be used to either increase the spatial resolution of the UV-VIS instrument, or host another instrument from foreign organization.
  - Following the launch of COMS in next month, preparations are ongoing to submit proposal for budget review of MP-GEOSat.
- GEMS as CEOS ACC
  - For the synergy of global air quality monitoring from GEO, harmonized dataset are required which can be realized by comparable requirement of instrument based on common science objective.
  - ACC can provide synergistic framework in outcome of both science and social benefit, and can also act as leverage to secure the program by respective government.
  - Development of ‘standard’ methodology in areas including the evaluation of social benefit, estimation of emission rates etc. are desirable for the success of missions.

THANK YOU FOR YOUR ATTENTION !