CEOS 18 April 2012

The Japanese Air Pollusion Observation Missions
GMAP-Asia and APOLLO

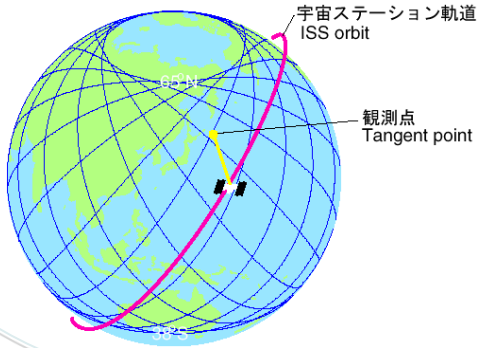
Yasuko Kasai (NICT)
And
Committee on Atmospheric Environment

Committee on Atmospheric Environment
Japan Society of Atmospheric Chemistry (JSAC)

Two mission concepts for air-quality observation in Japan

Committee on Atmospheric Environment
Japan Society of Atmospheric Chemistry (JSAC)

APOLLO on ISS



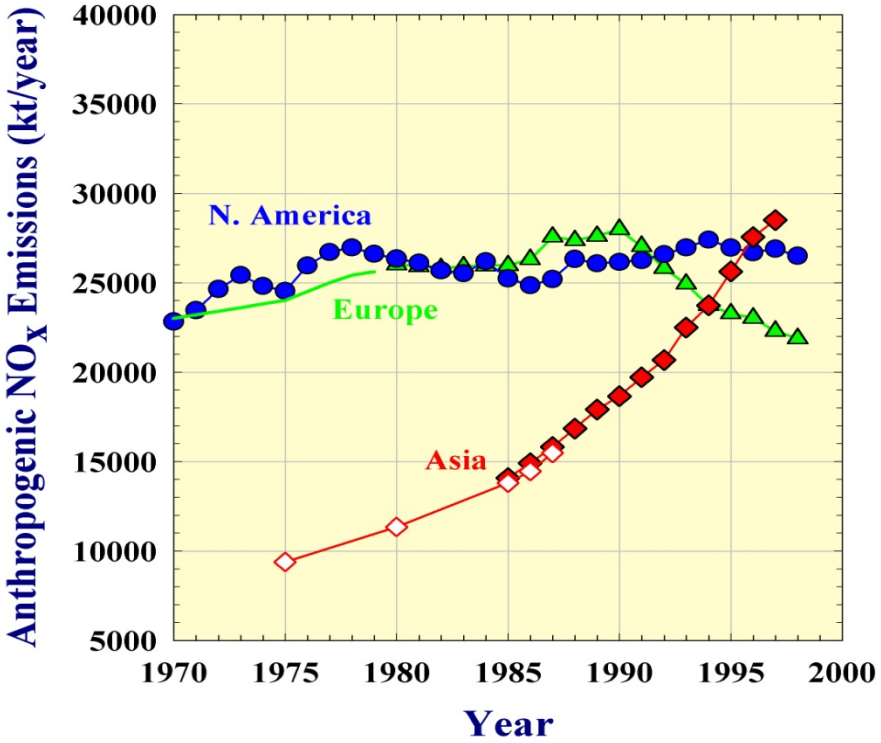
APOLLO: Air Pollution Observation Mission
GMAP-Asia: Geostationary Mission for Meteorology and Air Pollution

GMAP-Asia from Geostationary orbit

Study on imaging IR spectrometer in JAXA

Increase of Anthropogenic Emissions of NOx in Asia

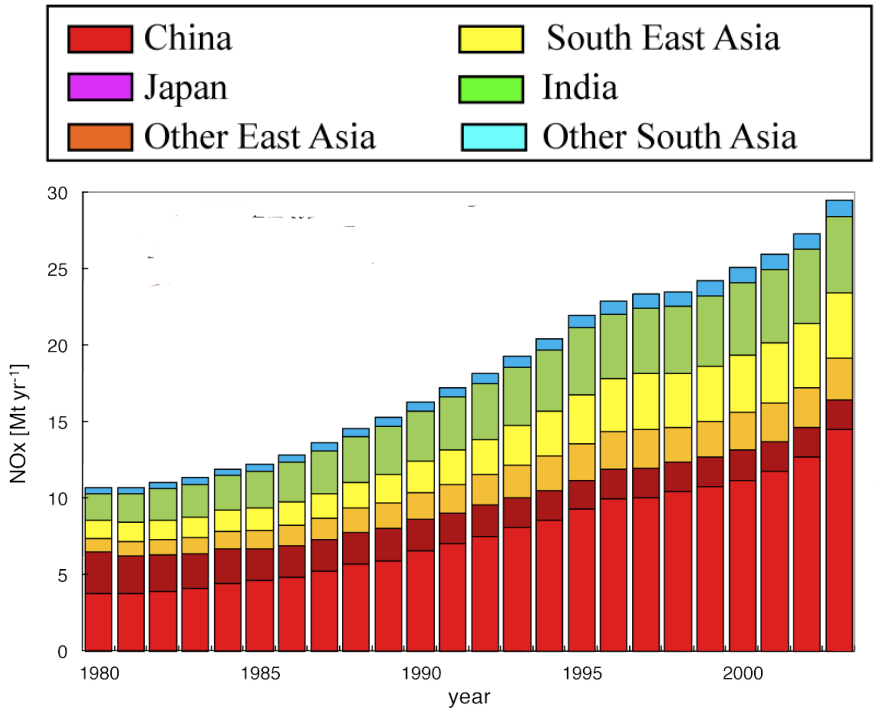
1970-2000



- Asian Emission is Overwhelming after 2000

Akimoto, Science, 2003.

REAS: 1980-2003



- Increased by a factor of 3 in Asian total (×4 in China)

Ohara, Akimoto, et al. ACP, 2007.

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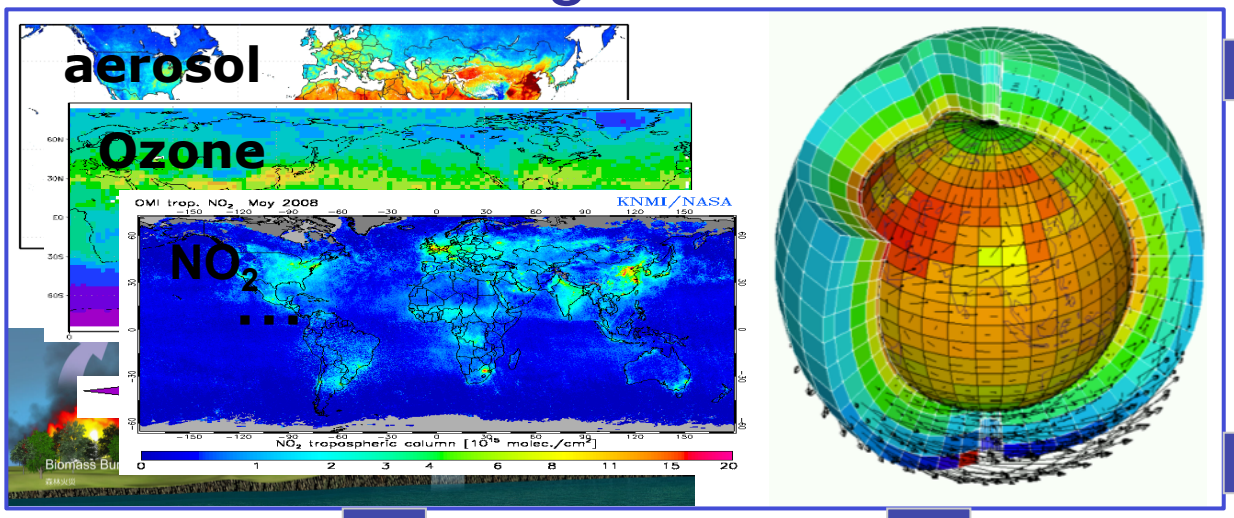
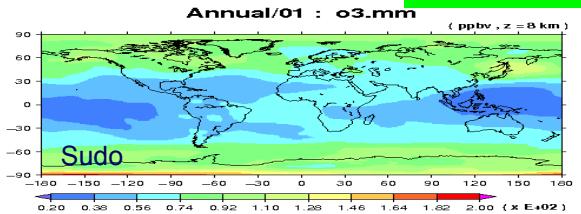
Scientific Target and Goal for Governments Politics



●More precise estimation on climate impact study

Ozone in free troposphere

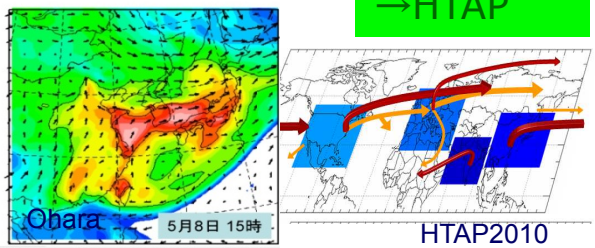
→IPCC



●Intercontinental transfer

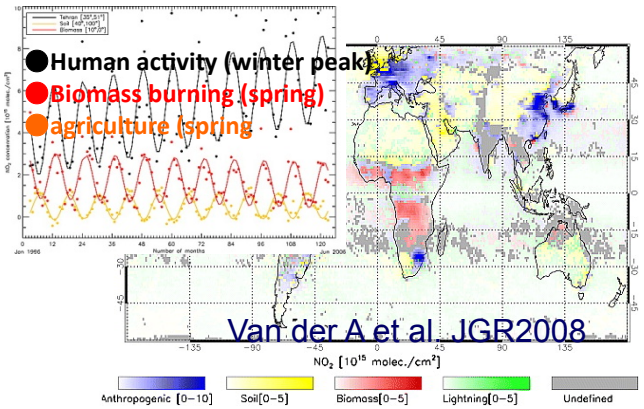
Boundary area ozone

→HTAP

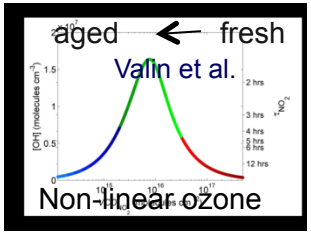


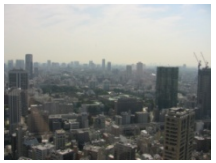
●emission inventory with human activity scale (small city, area, agriculture)

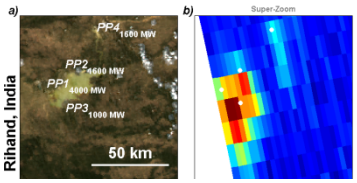
Estimation of origin type of NOx sector and its diurnal and seasonal variation

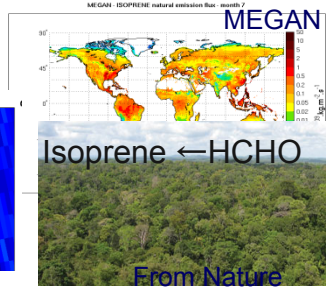


●Atmospheric chemistry



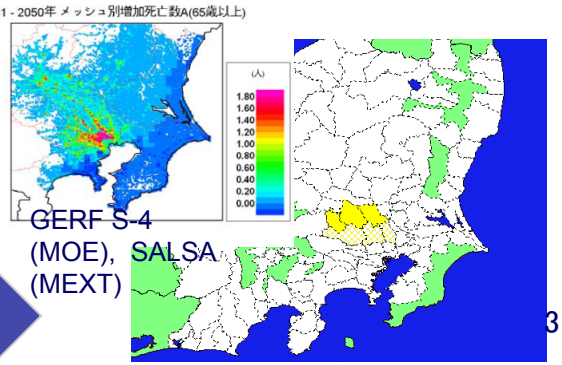


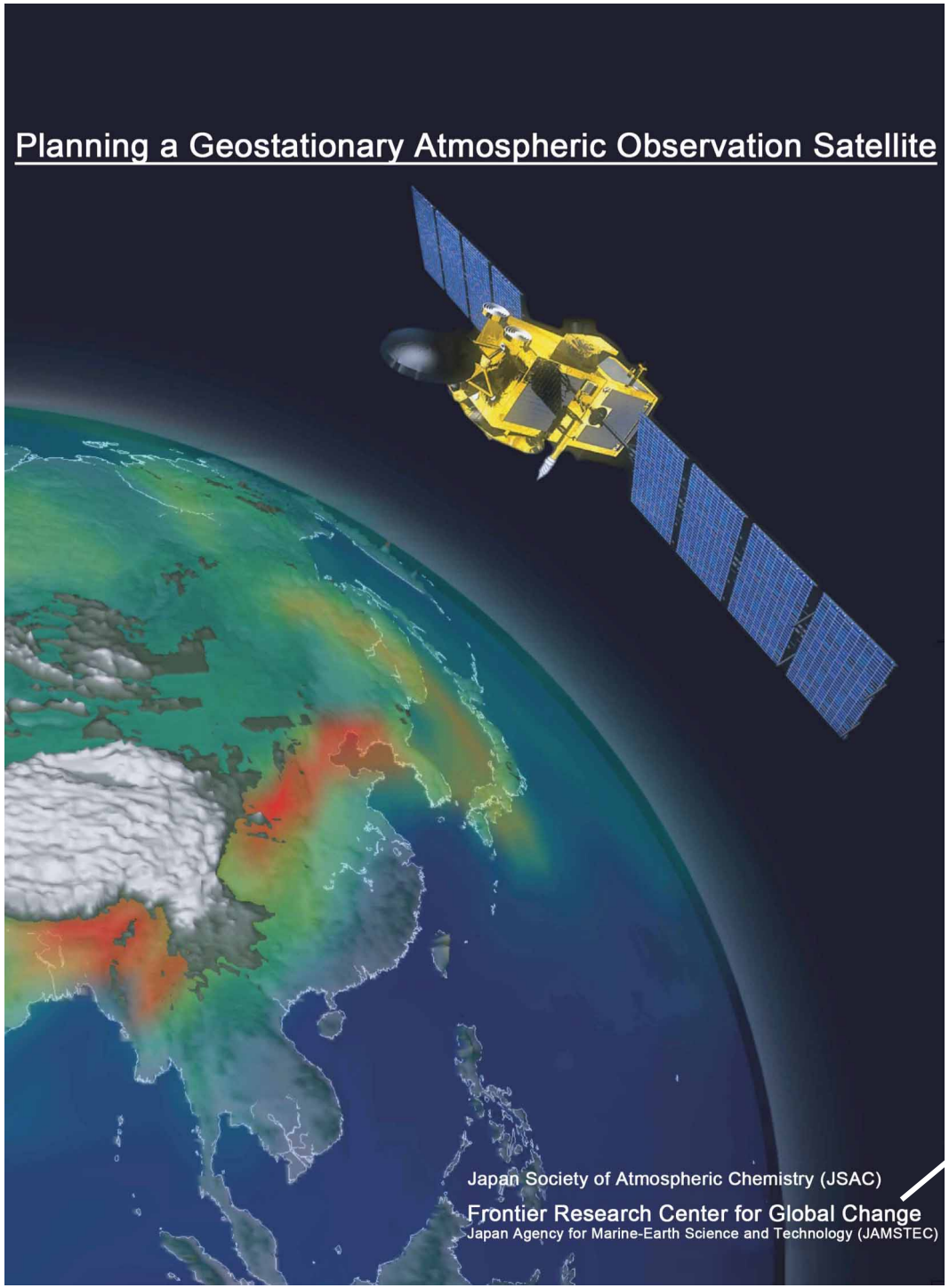




●model improvement
●assimilation

→weather/health advisory for small city scale





GMAP-ASIA

Geostationary Satellite for Asian Air Pollution

Japan Society for Atmospheric Chemistry

and JAXA

Specification of Geostationary Sensors

	UV/VIS	Thermal IR (Imaging FTS)
First Priority Target Species	O_3, NO_2, HCHO	O_3 (upper/lower Trop.) CO, HNO_3
Meteorological Parameter	Irradiance	H_2O, CO_2 (Temp.) Radiance Temp.
Aerosol	AOD	----
Diurnal Observation	Daytime only	Day and Night
Spectral Domain	280-600 nm [753-784 nm (O_2-A)]	700-1200 cm^{-1} 1600-2200 cm^{-1}
Spectral Resolution	$<$ 0.6 nm [$<$ 0.12 nm (O_2-A)]	0.6 cm^{-1}

Current Status of Geostationary Air Quality Sensor in JAXA

- December 2010: Mission Definition Review performed.

- 2011-2012: The technology development is performing for UTS sampling technology. Will continue the technical investigation after 2013.
  * Imaging FTS is Key instrument for GMAP-Asia
  * We need to use UTS sampling (Time standard sampling) for Imaging FTS (not like GOSAT FTS)

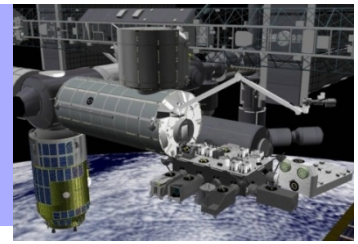
- Infrared Detector is also important. Under the searching and investigation.

GMAP-ASIA Papers

Hitoshi Iriea, Hironobu Iwabuchi, Katsuyuki Noguchi, Yasuko Kasai, Kazuyuki Kita, Hajime Akimoto
“Quantifying the relationship between the measurement precision and specifications of a UV/visible sensor on a geostationary satellite”
Advances in Space Research in press
10.1016/j.asr.2012.03.012

Katsuyuki Noguchi, Andreas Richter, Heinrich Bovensmann, Andreas Hilboll, John P. Burrows, Hitoshi Irie, Sachiko Hayashida, Yu Morino
“A feasibility study for the detection of the diurnal variation of tropospheric NO2 over Tokyo from a geostationary orbit”
Advances in Space Research, 48/ 9, 1551-1564

What is APOLLO?

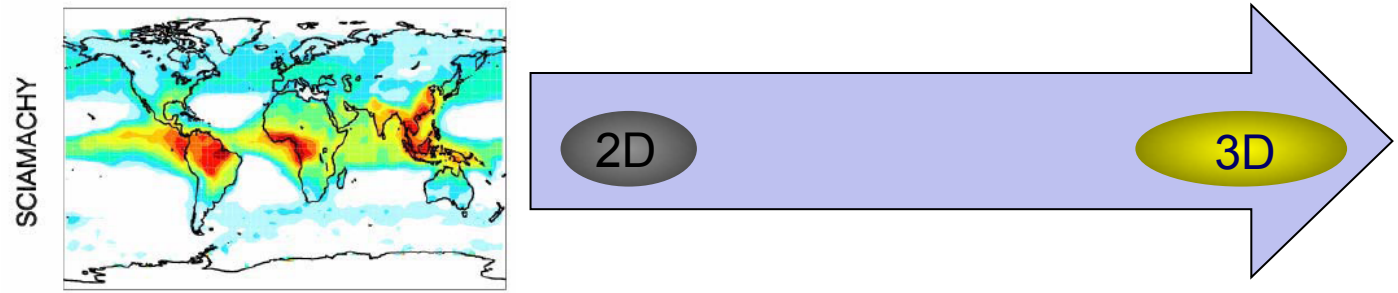


APOLLO demonstrate 3D field observation of tropospheric ozone and its precursors with 3 x 3 x 3 km resolution by synergy observation and retrieval system of “Full spectral range” (UV/VIS/IR/MW) instruments.

APOLLO is new capability opens up the following science questions / objectives:

-What are the ozone budget in the troposphere?
-What are the global surface ozone amounts and their effects on human health?

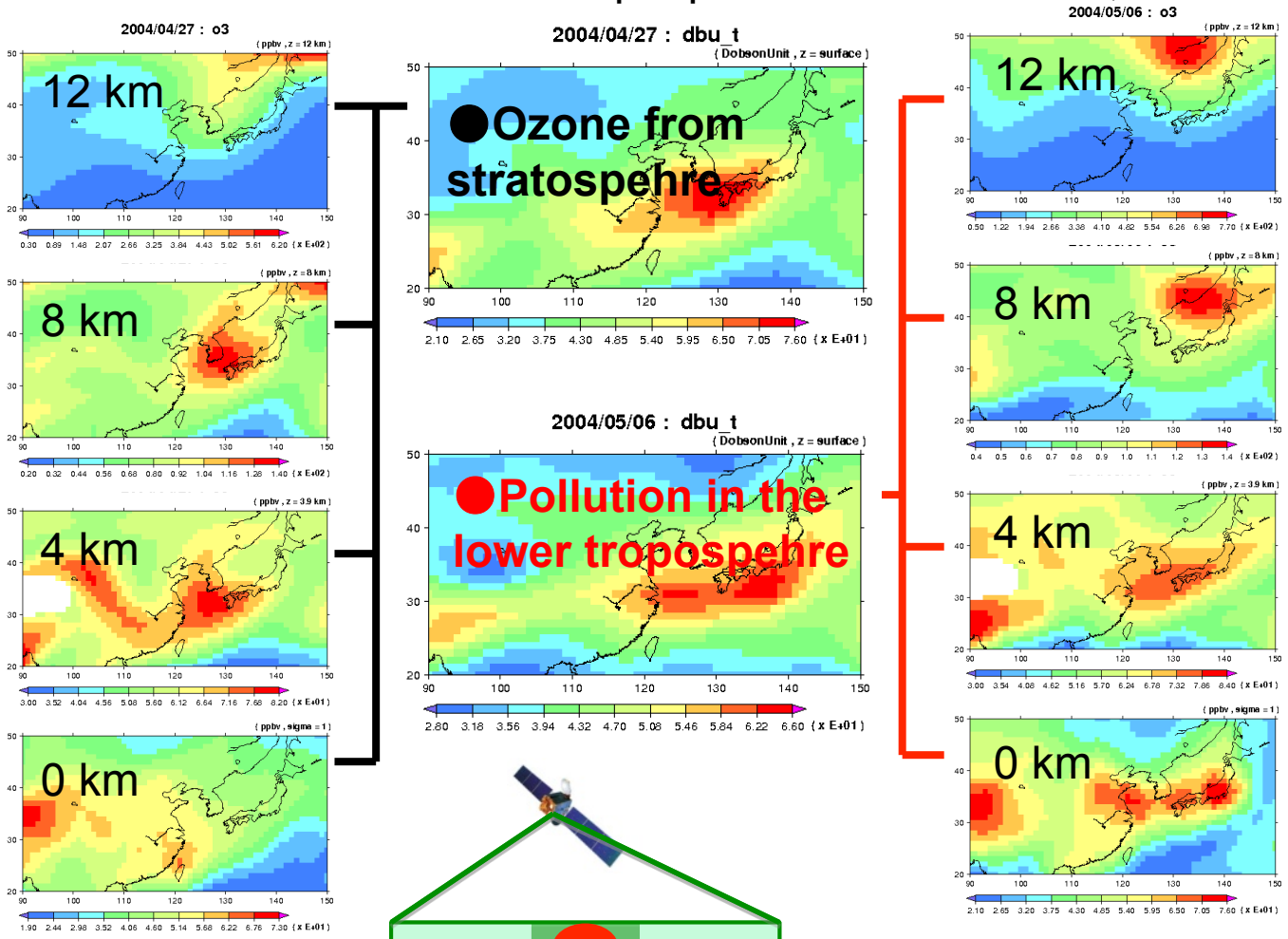
Having the Apollo mission would address all of these important questions as it would measure not just near surface ozone but many of the ozone pre-cursors with the spatial/ temporal coverage to also characterize the dynamical influences.

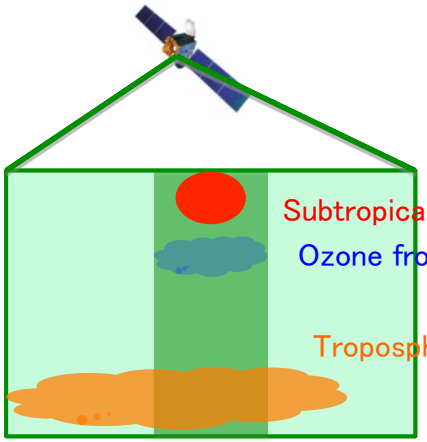


Tropospheric ozone has different role

KANAYA

●Similar distribution for tropospheric column ozone, BUT

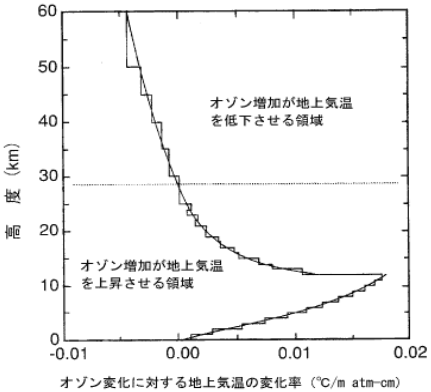




CHASER model : http://chaser.env.nagoya-u.ac.jp/simulation.php、sudo、2011

◎UT/LS Ozone

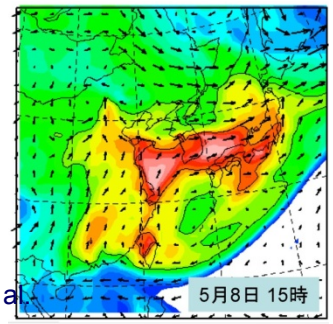
→Climate change



参考３：オゾン変化に対する地上気温の変化率の高度依存性
高度１０Km 付近の上部対流圏のオゾン増加が、地上気温の上昇に最も有効である。

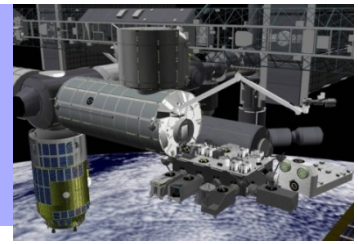
◎Lower tropospheric ozone

→ Pollution and Human Health



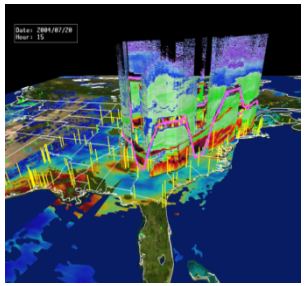
Ohara et al.

APOLLO Characteristics



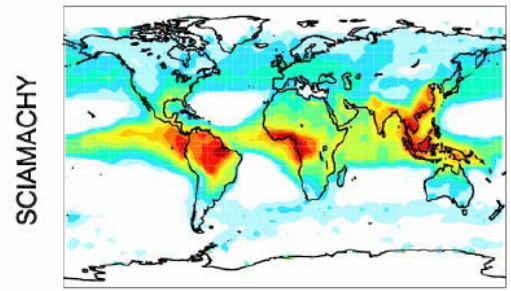
1. Vertical resolution(3km): First 3D observation of the tropospheric ozone and its precursors (O_3, CO) by use of full frequency coverage (UV/VIS, IR, Sub-mm, mm)
   - Synergetic design to observe "same point" from various instruments
   - Development of full retrieval algorithm system

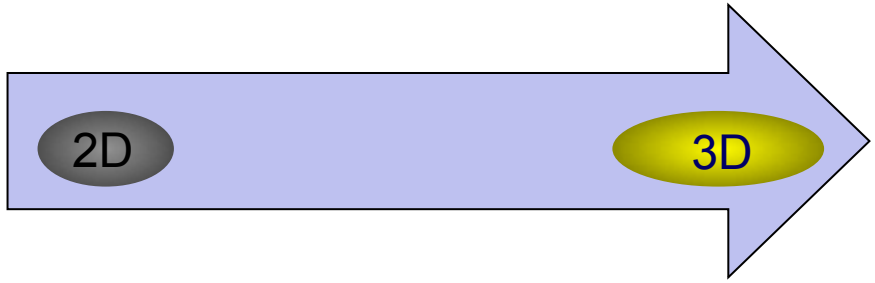
ISS will provide

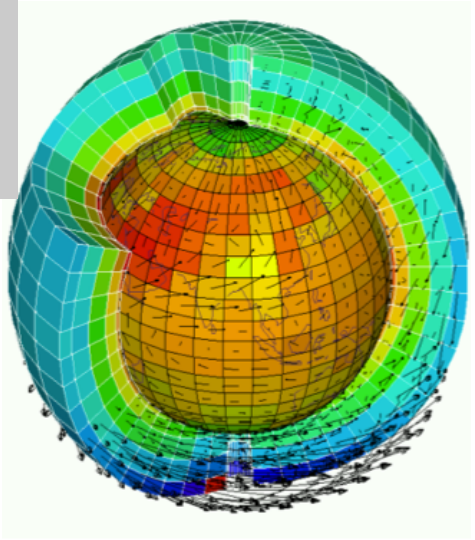


2. Higher horizontal resolution
   (Current 8-25km →APOLLO 1-6km): by low ISS altitude
3. Various local time dependence because of ISS orbit
4. International corporation. **"International Earth Observatory on ISS"**

Dis-advantage:
1) Trade-off of Horizontal resolution and Full global cover/1day
2) Mixture of LT characteristics and seasonal variation. Need model analysis to separate it.







APOLLO Characteristics

ISS altitude will give higher horizontal resolution than any of past/future missions

Current 8-25 km → APOLLO 3 km

Air quality sensors

GOME2
OMI
SCIAMACHY
Korean GEMS
TROPOMI
Sentinel4/5
TES
IASI
CrIS
TRAQ

APOLLO

Horizontal resolution

10000km 1000km 100km 10km 1km

Mega-city

Cities

Area for
-Agriculture
-Residential
-Business

Hemispheric Pollution

Intercontinental Transfer pollution

Area pollution

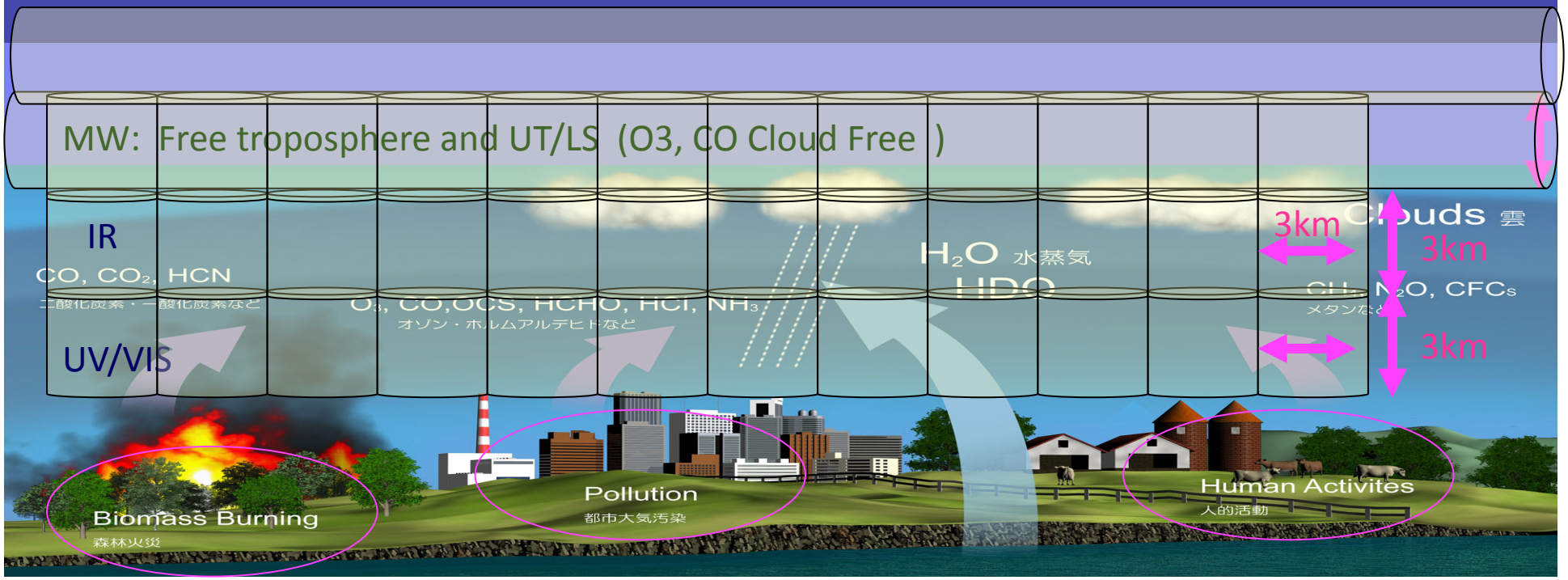
APOLLO with 3 km horizontal resolution

Origin

Plants, Forest fire、volcano, pipe/funnel, 、ship/transportation

APOLLO Characteristics

Observation of Ozone and CO with 3 layers in the troposphere



*JEM/ISS total: 500kg, 800W

Instrumental Candidates

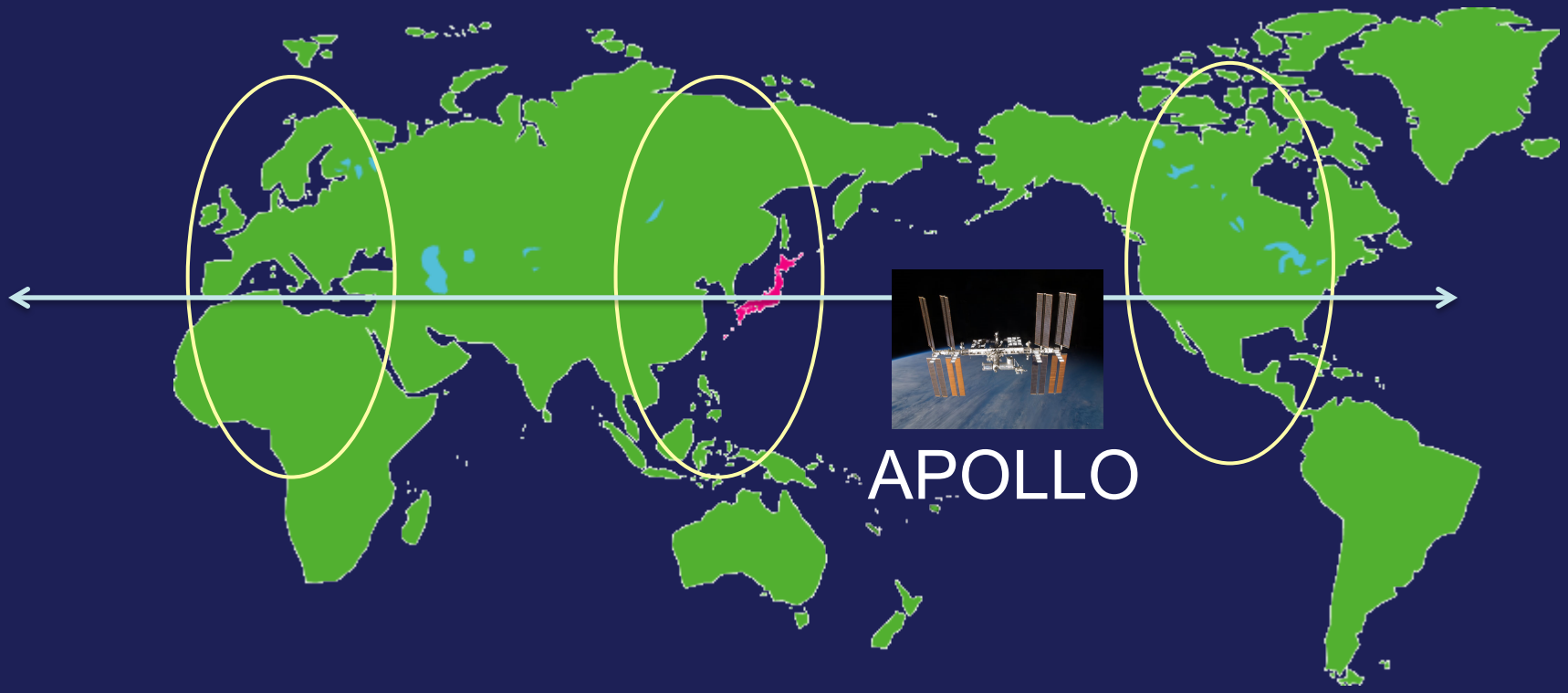
		UV/VIS /NIR/SWIR SCIA-ISS	IR	MW MLS-ISS/SMILES-II
		JAXA or U. of Bremen	JPL	NICT/JAXA/JPL
Role in APOLLO		Surface O3, CO, NO2	Mid trop O3, CO, HNO3	Upper trop O3, CO
Frequency range		300-360, 420-600nm	2.27-2.44, 7.1-11.1μm	180, 240, 350, 500, 600GHz
Geometry		Nadir		Limb/Nadir
Obs. Species Target	Minimum success	O_3, NO_2 , H_2O, CH_4, Aerosol , O4, CO2	CO , O_3, CH_4, H_2O, HNO_3,	CO , O_3, H_2O, isotopes, Ice cloud
	Full success	SO_2, CO, HCHO , CHOCHO	Aerosol	ClO, HCl, HCN, HNO3, CH3CN, BrO,
	Extra success	IO, BrO, HONO	Aromatic hydrocarbon, NH_3 , HONO, NO_3, C_nH_m	HCHO,
Diurnal var.		Day time	24hours	24hours
Horizontal res.		3 km		
Vertical res.		3 km		
Mass, Power		50kg, 100W	100kg, 1-200W	150kg, 200W
Region		Equator and mid-latitude (50S – 50N)		
Coverage		Full global cover/1day		

Aerosol may observe by ISS-CATS (USA/Goddard) and SPEX (EU/SRON)

Sentinel-4

Asian Mission
- Korea (GEMS)
- Japan (GMAP-Asia)

GEO-CAPE



APOLLO

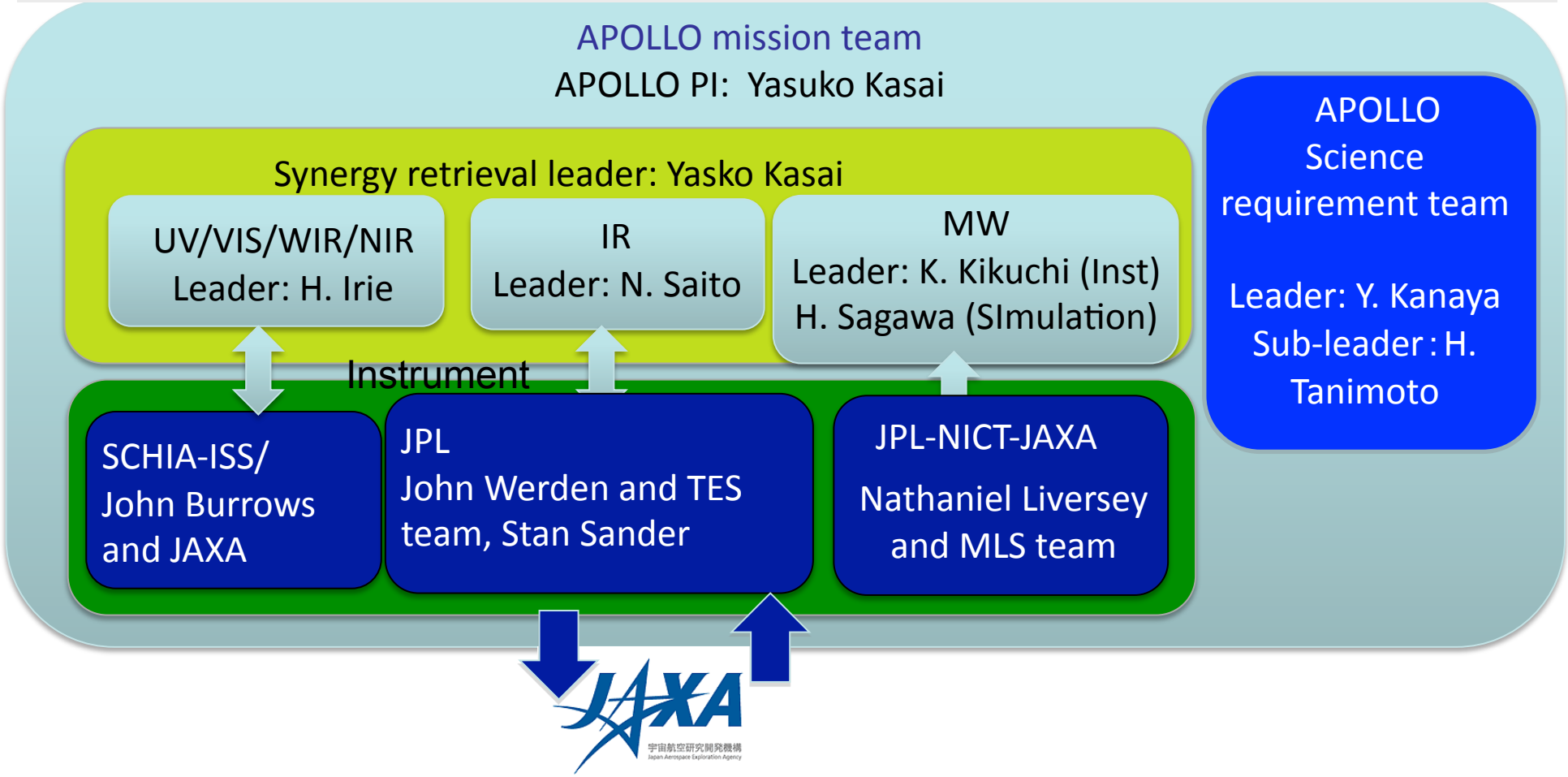
Members and Structure

Japan Society of Atmospheric Chemistry (JSAC)

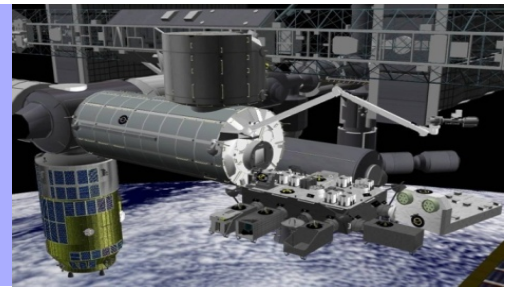
Mitsuo Uematsu (U . Of Tokyo)

Committee on Atmospheric Environment

Kazuyuki Kita (Ibaraki U.)



Summary



1. Japanese team are investigating two concepts for the air quality mission. One is GMAP-Asia from geostationary satellite, one is APOLLO on ISS. IR imaging spectrometer is under the investigation for GMAP-Asia.

2. APOLLO demonstrate 3D observation of tropospheric ozone and its precursors with 3 x 3 x 3 km resolution by synergy observation of “Full spectral range” (UV/ VIS/IR/MW) instruments. Plan to have MDR at coming summer.

3. This new capability opens up the following science questions / objectives: such as

- What are the dynamical and photochemical controls on surface ozone?
- What are the global surface ozone amounts and their effects on human health?