

GOSAT Level 3 and 4 Products

Tatsuya Yokota

**Yukio Yoshida, Isamu Morino, Osamu Uchino,
Shamil Maksyutov, and Hiroshi Watanabe**

NIES GOSAT Project

**Center for Global Environmental Research (CGER)
National Institute for Environmental Studies (NIES), Japan**

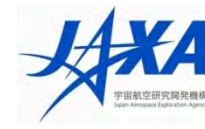
Contents

- GOSAT Outline and Product List
- GOSAT TANSO-FTS SWIR Level 2 products
- GOSAT TANSO-FTS SWIR Level 3 products
- GOSAT TANSO-CAI Level 2 product
- GOSAT TANSO-CAI Level 3 product
- GOSAT Level 4A and 4B products

GOSAT (IBUKI) launched by H-IIA F-15 vehicle on January 23, (Photo by Mitsubishi Heavy Industries, LTD)



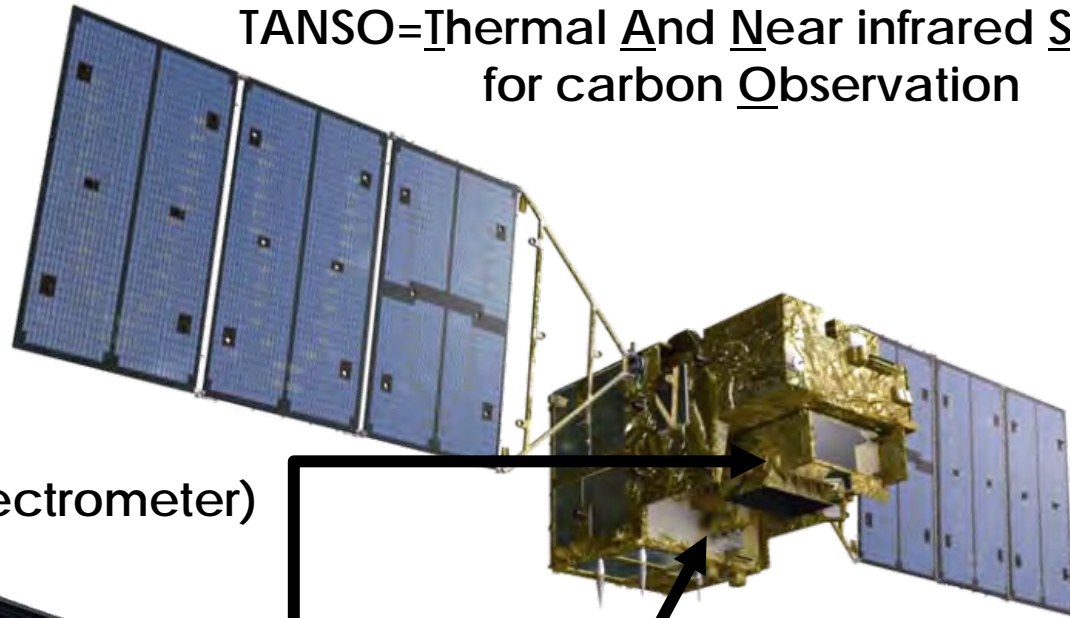
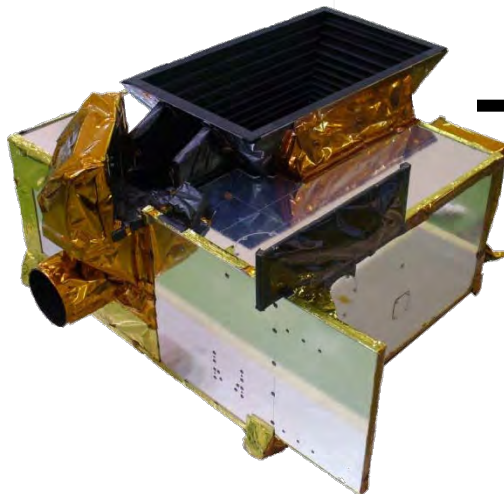
MISSION SENSORS



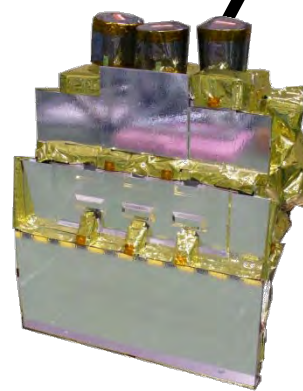
Greenhouse gases
GOSAT PROJECT
Observing SATellite

TANSO=Thermal And Near infrared Sensor
for carbon Observation

TANSO-FTS
(Fourier Transform Spectrometer)

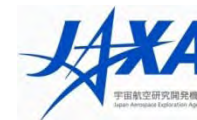


TANSO-CAI
(Cloud and Aerosol
Imager)



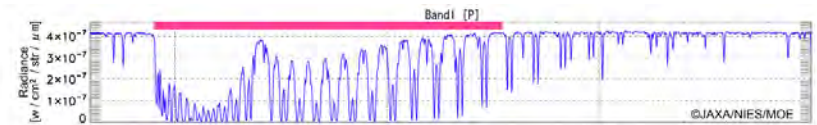
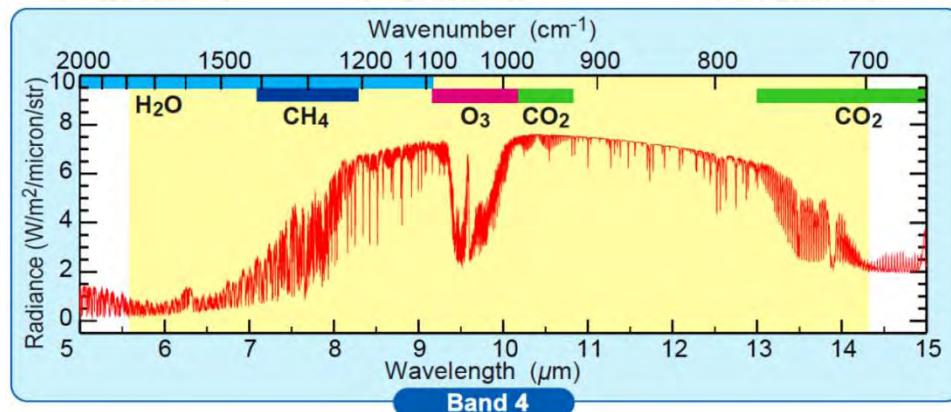
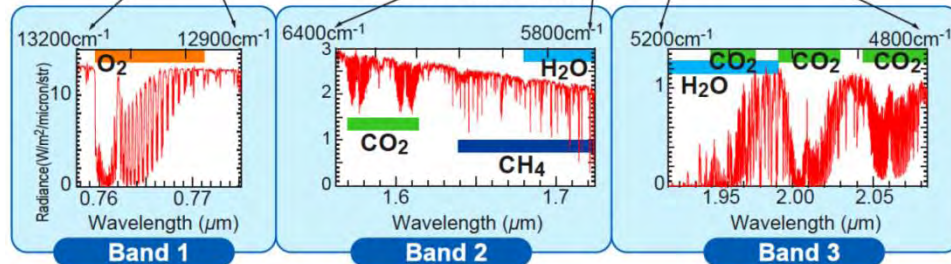
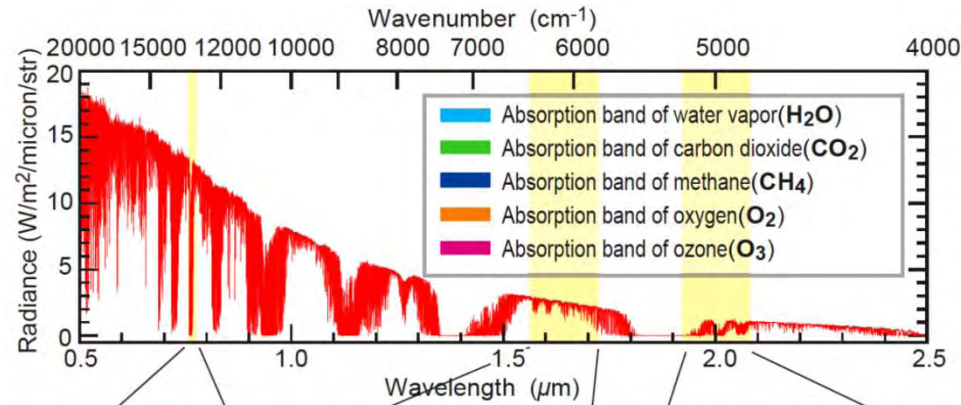


TANSO-FTS

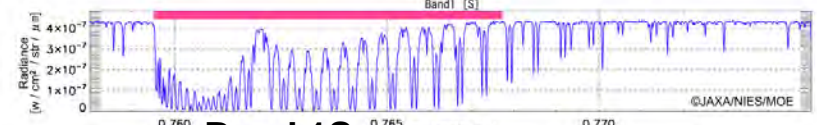


Ground Pointing Mechanism and Fore optics	Configuration	2-axes scanner (fully redundant) for ground pointing and calibration			
	Scanning	Cross Track (+/-35 deg) Along Track (+/-20 deg)			
	Field of view	IFOV <10.5 km 790 km (scan width) (latitude of 30 deg)			
Fourier Transform Spectrometer	Speed	0.25, 0.5, 1 (Interferogram)/sec			
	Spectral band	1P, 1S	2P, 2S	3P, 3S	4
	Coverage (micron)	0.75-0.78	1.56-1.72	1.92-2.08	5.5-14.3
	resolution (cm ⁻¹)	0.5	0.2	0.2	0.2
	Detector	Si	InGaAs	InGaAs	PC-MCT
	Calibration	Solar Irradiance, Deep Space, Moon, Diode Laser (1.55 micron, ILS)			Blackbody, Deep space

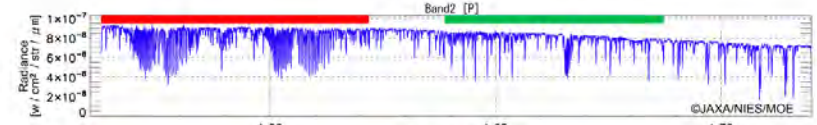
TANSO-FTS Level 1B



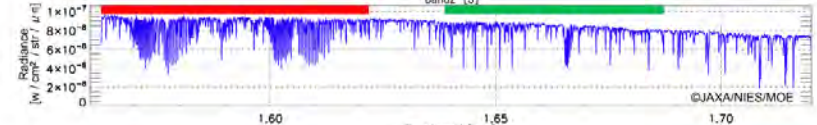
Band 1P



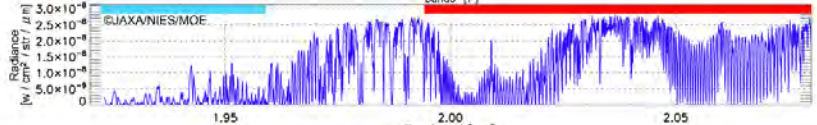
Band 1S



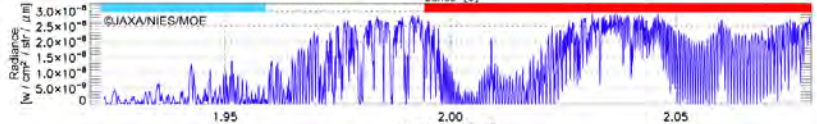
Band 2P



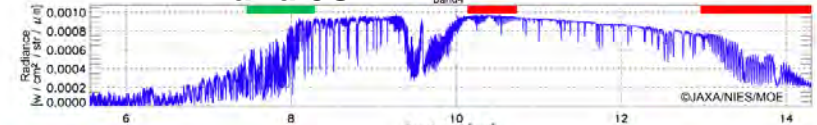
Band 2S



Band 3P



Band 3S

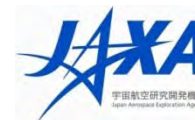


Band 4

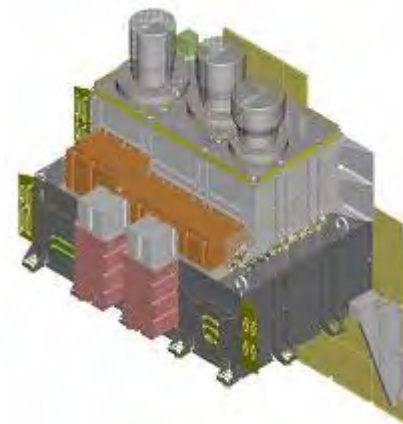
carbon dioxide methane oxygen water vapor



TANSO-CAI

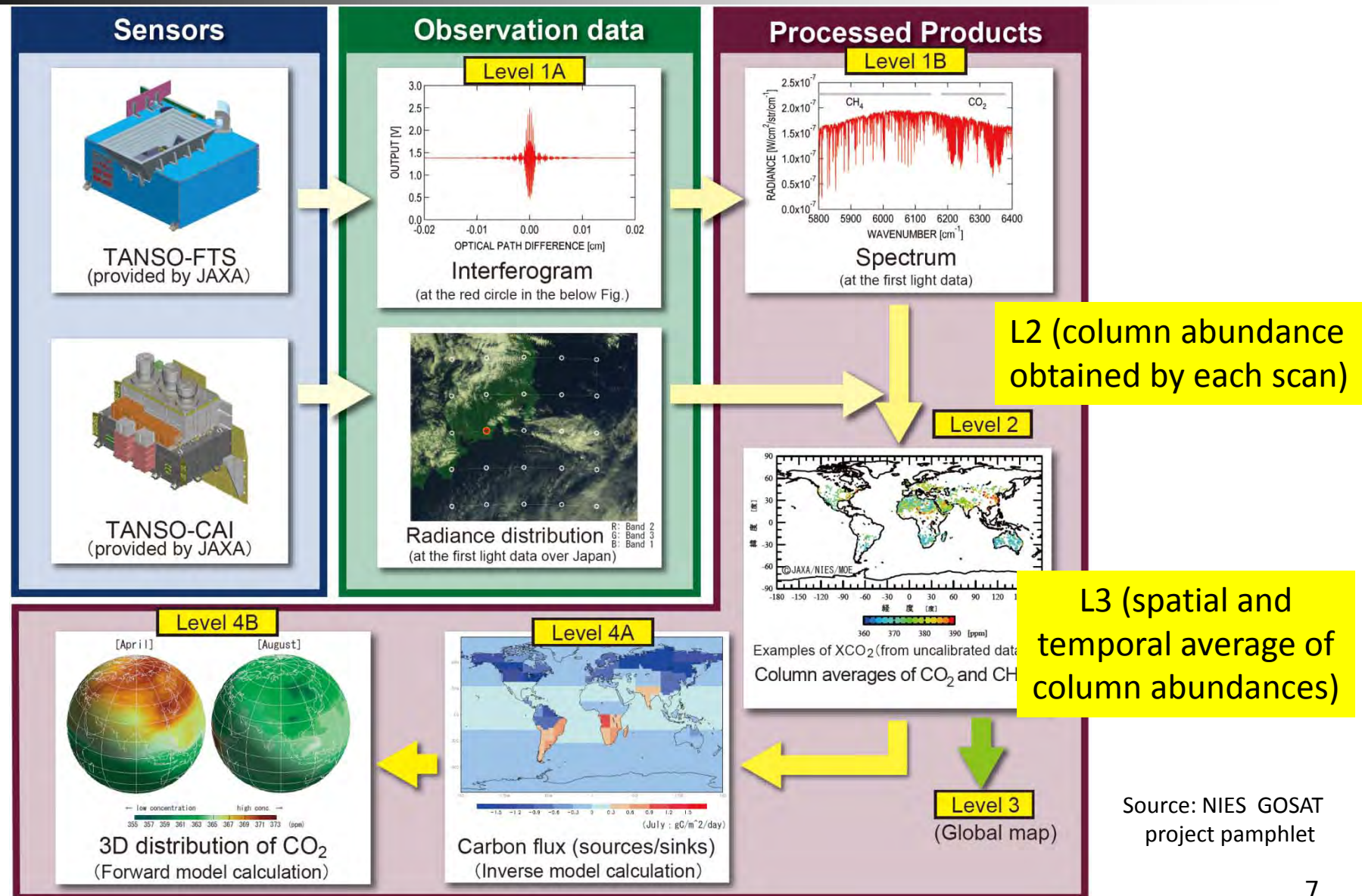


- CAI is operated together with FTS to
- detect cloud coverage
 - retrieve scattering spectral characteristics of aerosol, (aerosol parameters)



Band No.	Observation Band (nm)	Center Wavelength (nm)	Spatial Resolution (IFOV) (km)	FOV (km)	No. of Pixels (cross track)
1	372-387	380	0.5	1000	2000
2	667-680	678	0.5	1000	2000
3	866-877	870	0.5	1000	2000
4	1560-1640	1620	1.5	750	500

GOSAT Data Processing Flow



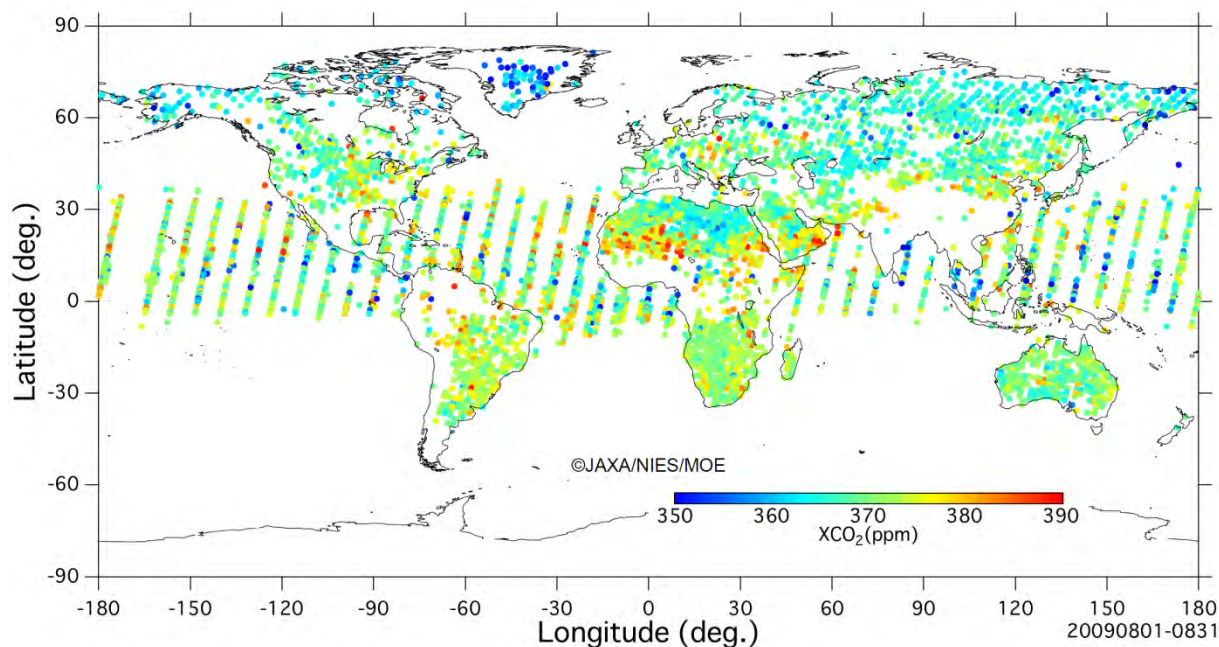
GOSAT Standard Data Products

	Product Level	Sensor / Band	Product Designation	Description	Product Provision Unit	Data Format
Level 1	L1B	FTS	FTS L1B data	Radiance spectral data obtained by performing Fourier transform on interferogram data	per FTS scene	HDF5
		CAI	CAI L1B data	Radiance data (band-to-band and geometric corrections applied / data mapping not performed)	per CAI frame	
		L1B+	CAI	CAI L1B+ data		
Level 2	L2	FTS SWIR	L2 CO ₂ column amount (SWIR)	CO ₂ column abundance data retrieved from SWIR radiance spectral data	can be selected	HDF5
			L2 CH ₄ column amount (SWIR)	CH ₄ column abundance data retrieved from SWIR radiance spectral data		
		FTS TIR	L2 CO ₂ profile (TIR)	CO ₂ vertical profile data retrieved from TIR radiance spectral data		
			L2 CH ₄ profile (TIR)	CH ₄ vertical profile data retrieved from TIR radiance spectral data		
		CAI	L2 cloud flag	Cloud coverage data	per CAI frame	
Level 3	L3	FTS SWIR	L3 global CO ₂ distribution (SWIR)	CO ₂ column-averaged mixing ratio data projected on a global map	per month (global)	HDF5
			L3 global CH ₄ distribution (SWIR)	CH ₄ column-averaged mixing ratio data projected on a global map		
		FTS TIR	L3 global CO ₂ distribution (TIR)	Monthly-averaged CO ₂ concentration at each vertical level projected on a global map		
			L3 global CH ₄ distribution (TIR)	Monthly-averaged CH ₄ concentration at each vertical level projected on a global map		
		CAI	L3 global radiance distribution	Global radiance distribution data (3 days worth, including data for cloudy segments)	per 3 days (global)	
			L3 global reflectance distribution (clear sky)	Clear-sky radiance data (composed only of clear-sky segments selected from a month worth of data)		
			L3 global NDVI	Vegetation index global distribution data (cloudy segments excluded)	per 15 days 30° × 60° (lat. × lon.)	
Level 4	L4A	-	L4A global CO ₂ flux	CO ₂ flux per each of the 64-divided global regions (monthly average)	per year (64 regions)	Text
	L4B	-	L4B global CO ₂ distribution	Three-dimensional, global distribution of CO ₂ concentration	per month 2.5° × 2.5° grid (lat. × lon.)	NetCDF

GOSAT L3 & L4 Standard Data Products

L3	FTS SWIR	L3 global CO ₂ distribution (SWIR)	CO ₂ column-averaged mixing ratio data projected on a global map
		L3 global CH ₄ distribution (SWIR)	CH ₄ column-averaged mixing ratio data projected on a global map
	FTS TIR	L3 global CO ₂ distribution (TIR)	CO ₂ concentrations at each vertical level projected on a global map
		L3 global CH ₄ distribution (TIR)	CH ₄ concentrations at each vertical level projected on a global map
	CAI	L3 global radiance distribution	Global radiance distribution data (3 days worth, including data for cloudy segments)
		L3 global reflectance distribution (clear-sky)	Clear-sky reflectance data (composed only of clear-sky segments selected from a month worth of data)
		L3 global NDVI	Vegetation index global distribution data (cloudy segments excluded)
L4A	-	L4A global CO ₂ flux	CO ₂ flux per each of 64 global regions (monthly average)
L4B	-	L4B global CO ₂ distribution	Three-dimensional global distribution of CO ₂ concentration

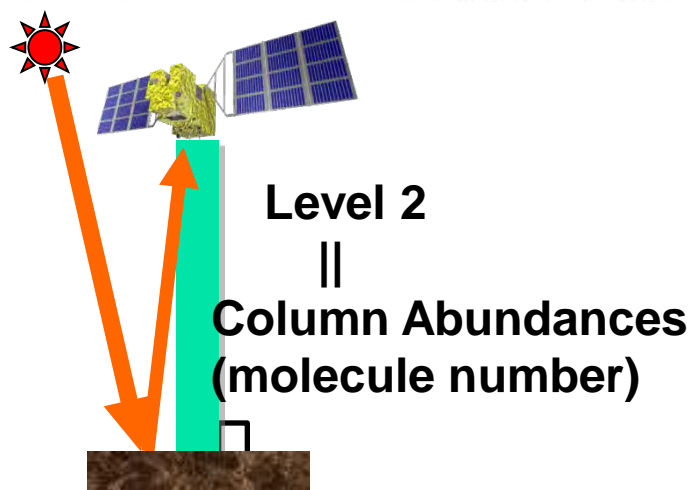
TANSO-FTS Level 2



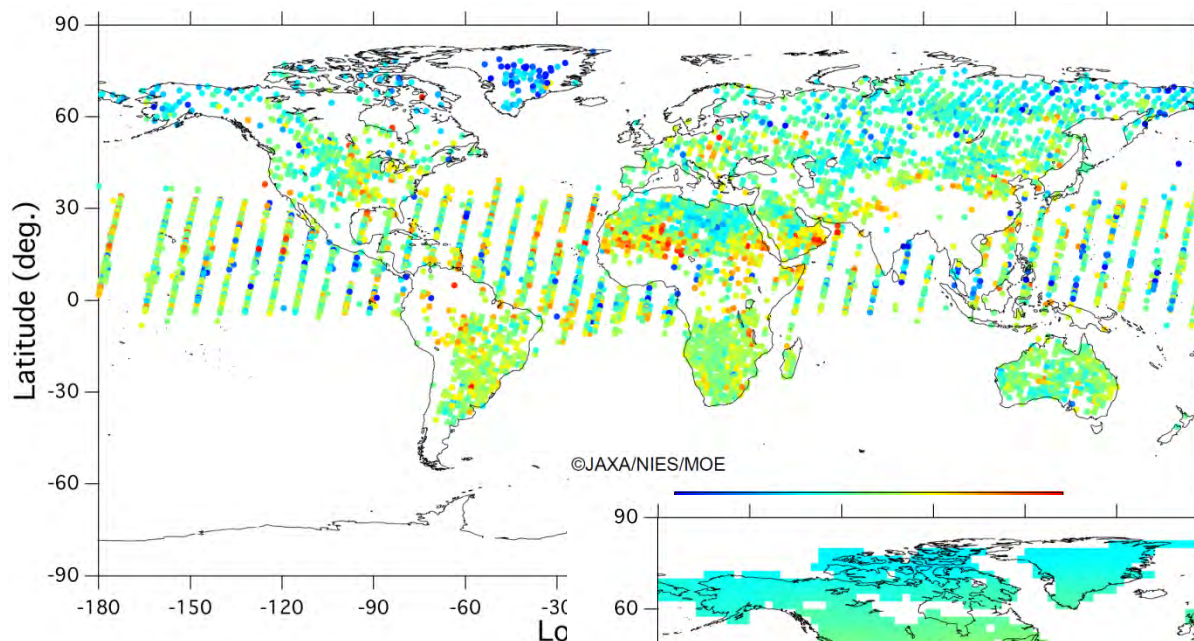
Column abundances of
CO₂ & CH₄



Column averaged dry air
mole fraction of CO₂ & CH₄
(XCO₂ & XCH₄)



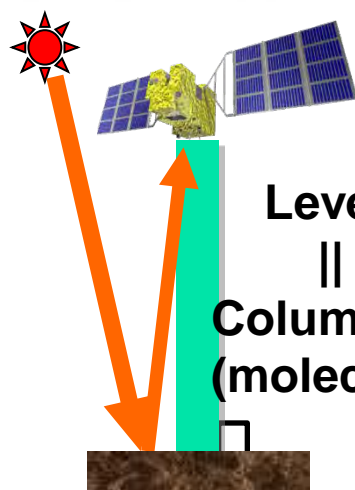
TANSO-FTS Level 2 & Level 3



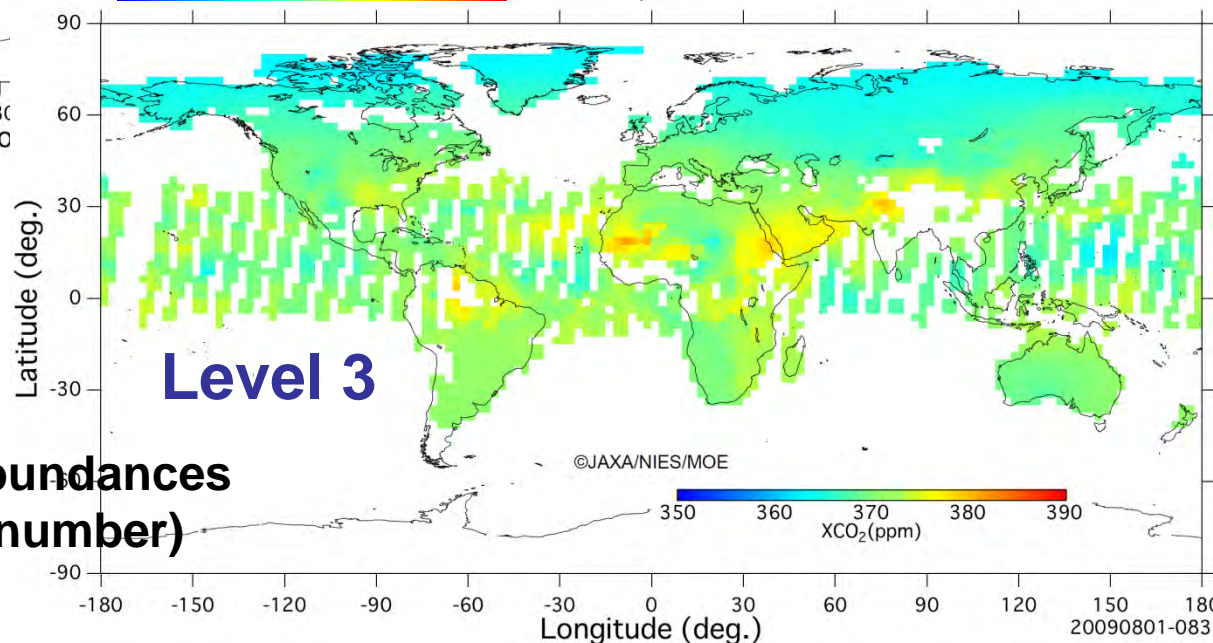
Column abundances of CO_2 & CH_4



Column averaged dry air mole fraction of CO_2 & CH_4 (XCO_2 & XCH_4)



Level 2
||
**Column Abundances
(molecule number)**

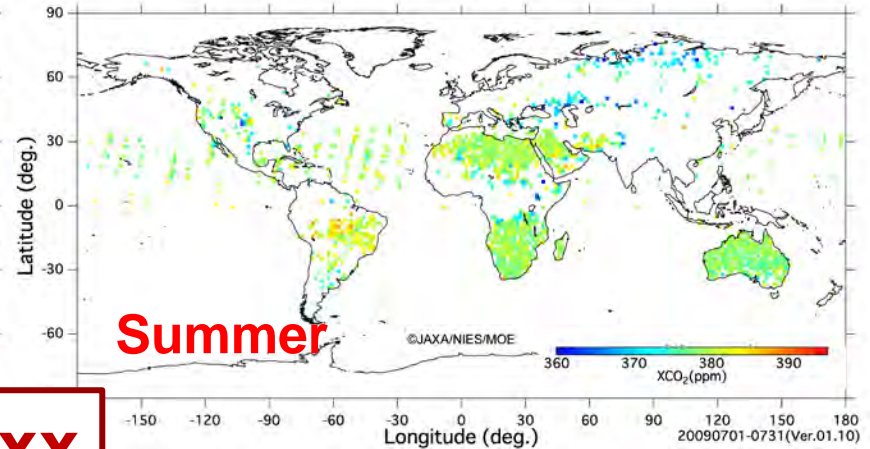
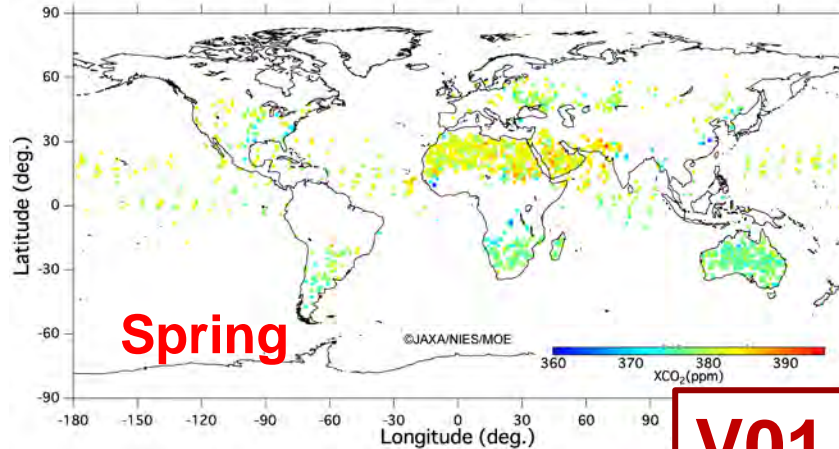


Level 3

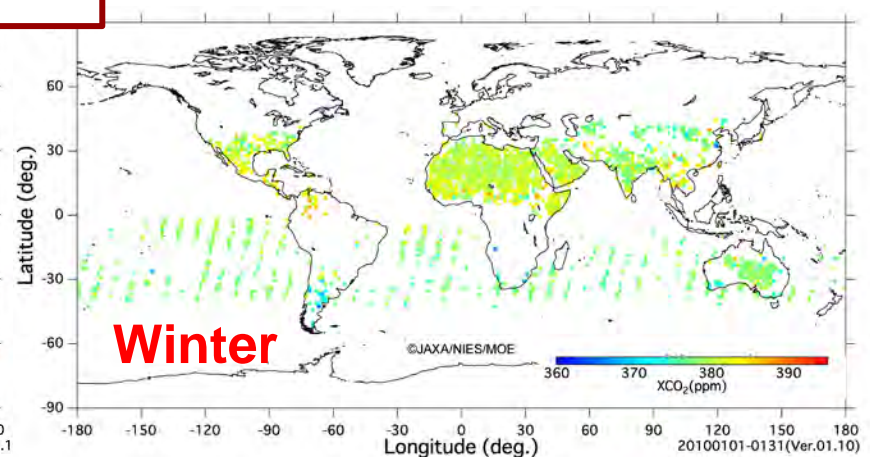
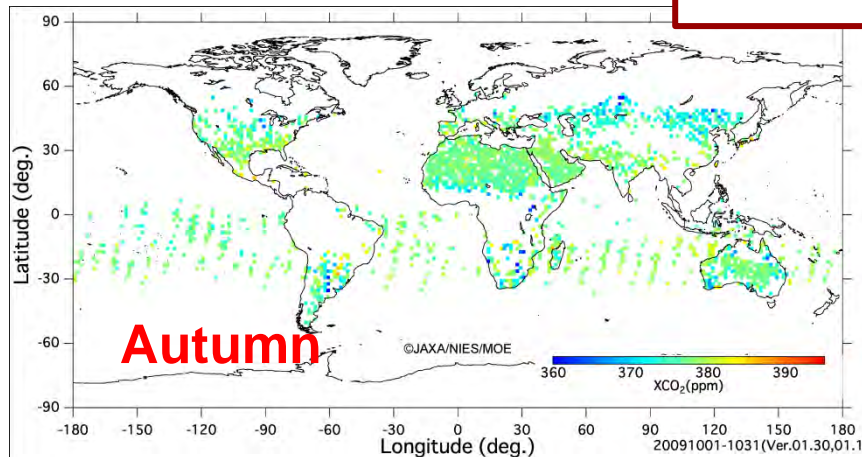
- Level 3: Global map estimated from Level 2 observational data
 - **Ultimately:** Data assimilation
 - **Simply:** Simple grid map by averaging data in each grid
 - **Intermediately:** Statistically estimated map by using geographical information (and hopefully including atmospheric transport information)
- Purposes of Level 3
 - Easy recognition by glance at the global (regional) map for general users and policy makers
 - Useful for researchers (scientific use)

- Present method: Kriging method for spatial interpolation by using semivariogram estimated from the measurement data
 - 2.5 degree mesh
 - cf. Gap filling method in AIRS and ACOS Team

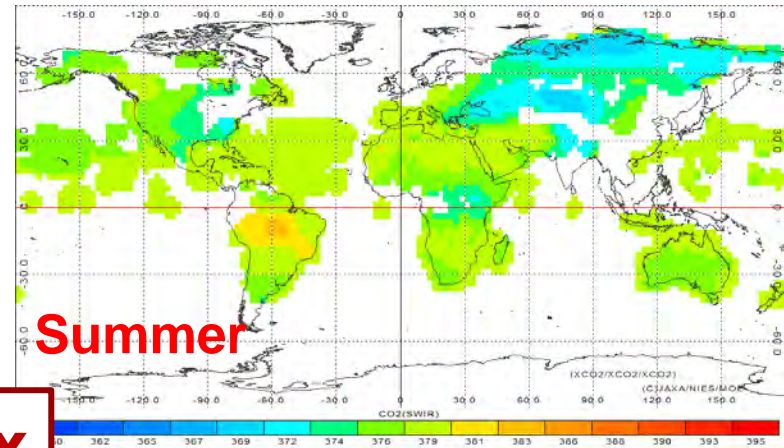
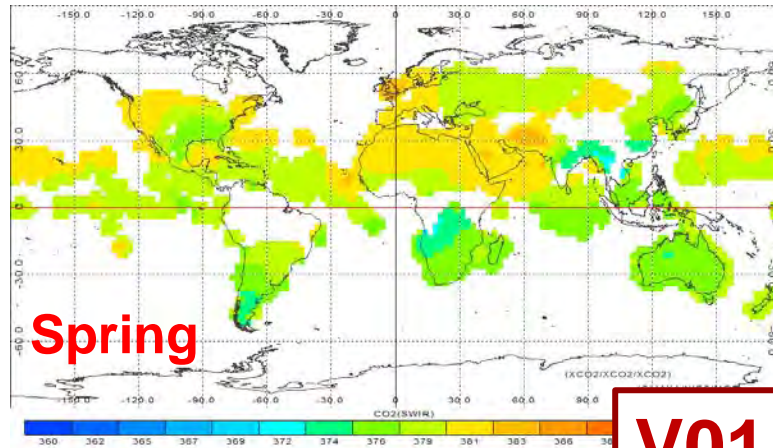
Seasonal variation of XCO₂



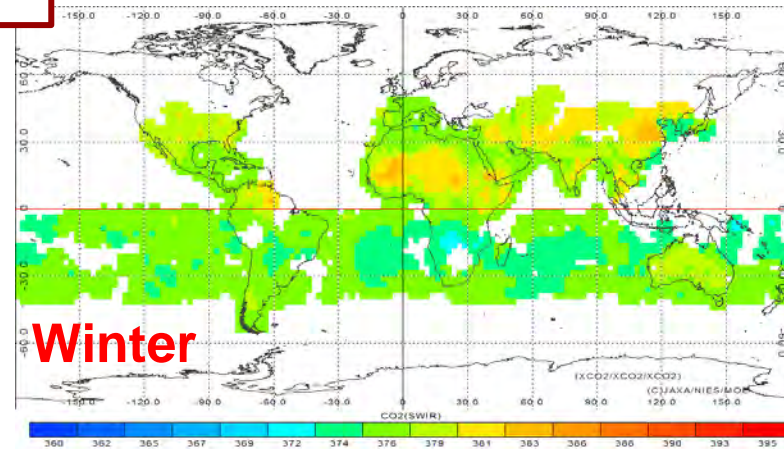
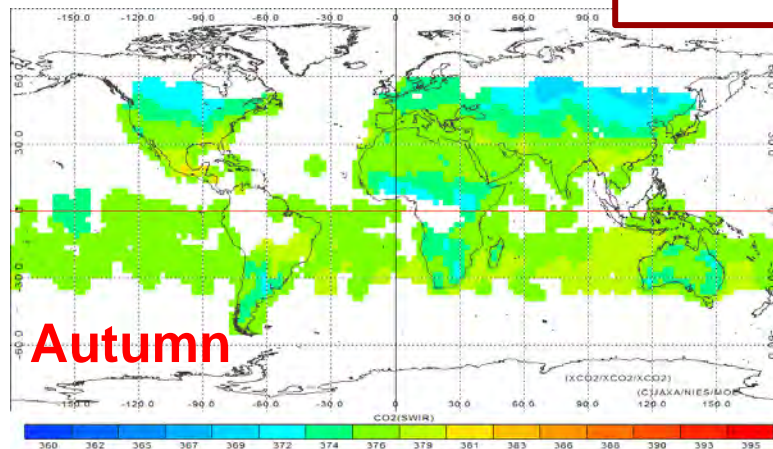
V01.xx



Seasonal variation of Level 3 XCO₂



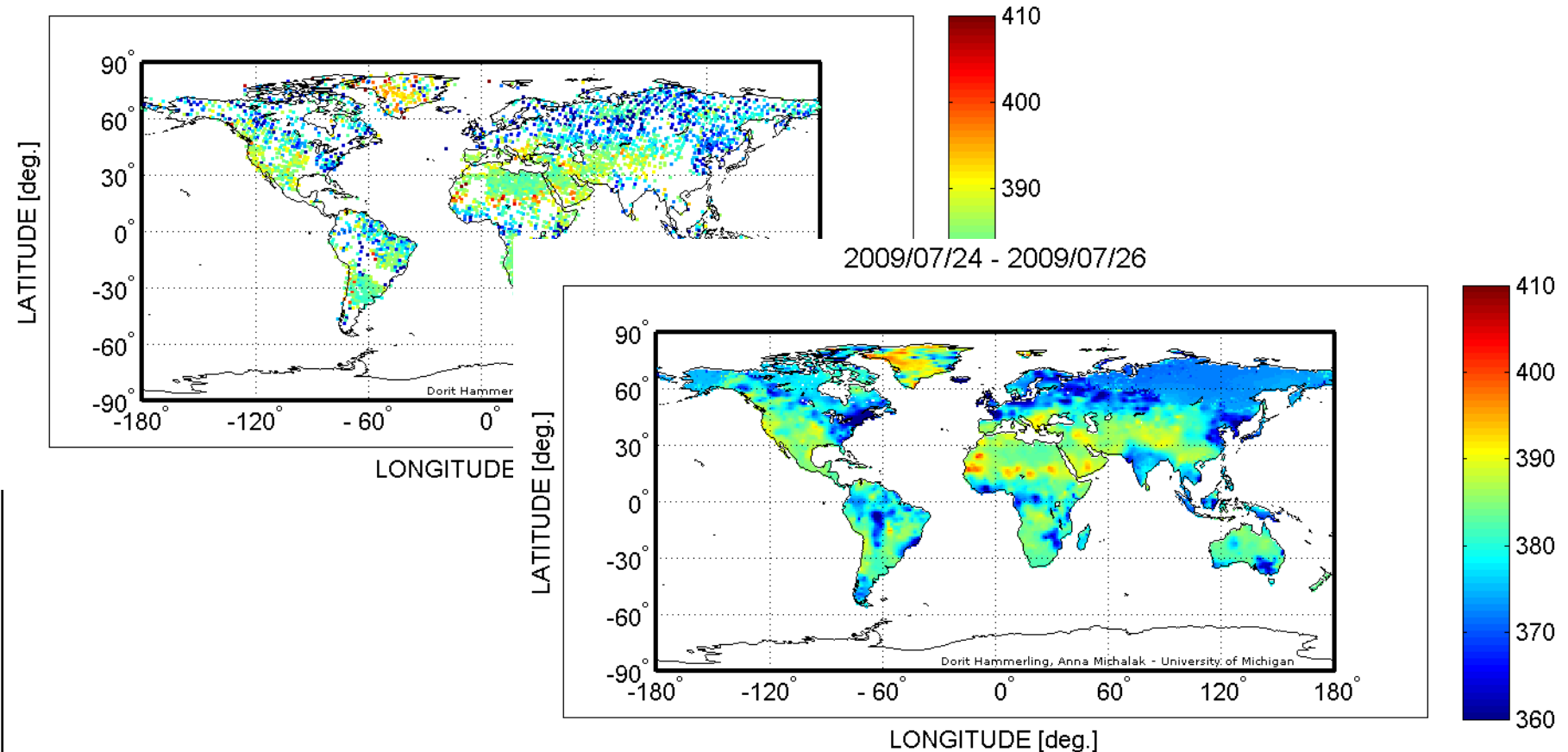
V01.xx



Sakura Matsuri – Cherry Blossom Festival Gap-Filled Maps April 2010

First version of a L3 type product – gap filled world maps.

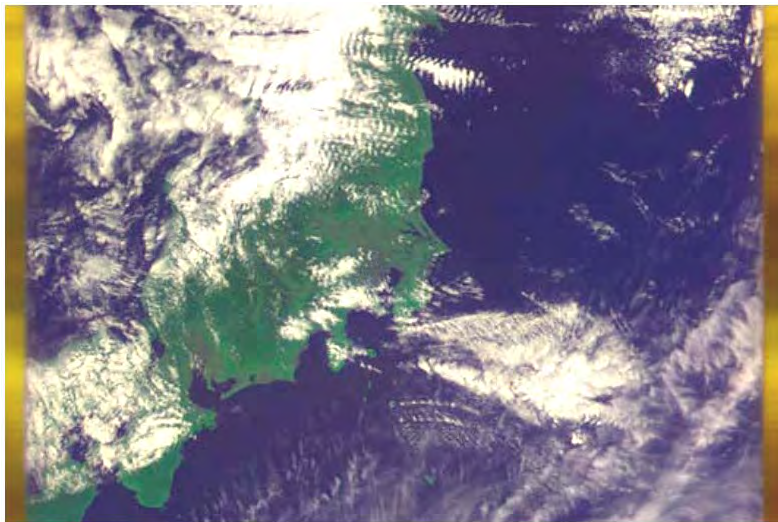
2009/07/24 - 2009/07/26



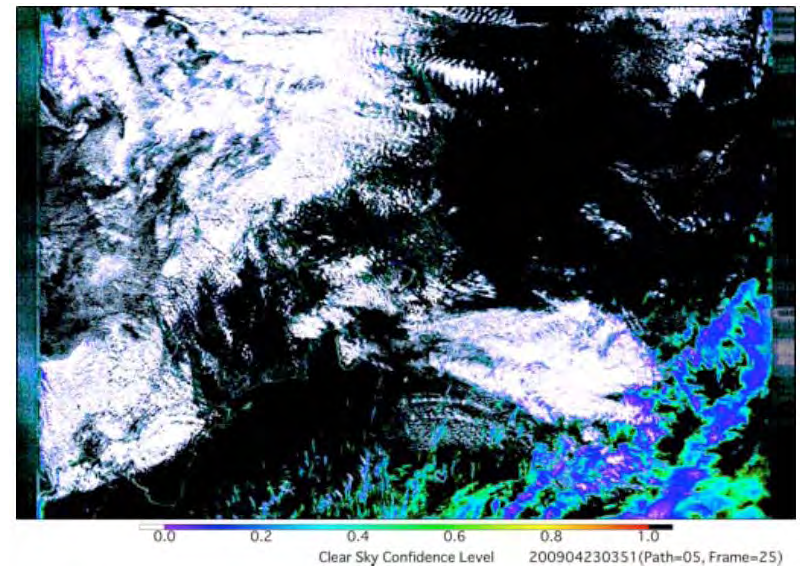
(courtesy by Anna Michalak, U. Michigan)

D. Hammerling, Univ Michigan

TANSO-CAI Level 2 (Cloud flag)



TANSO-CAI Level 1B

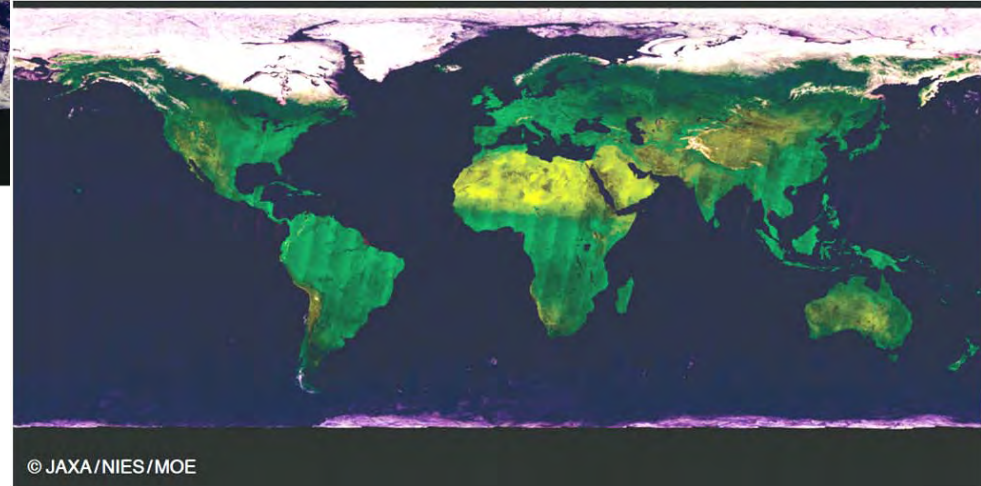


TANSO-CAI Level 2 (Cloud flag)
: Clear sky confidence level

TANSO-CAI Level 3 (Radiance, Reflectance)



The **CAI Level 3 global NDVI**, which represents vegetation index global distribution data (cloudy segments excluded)

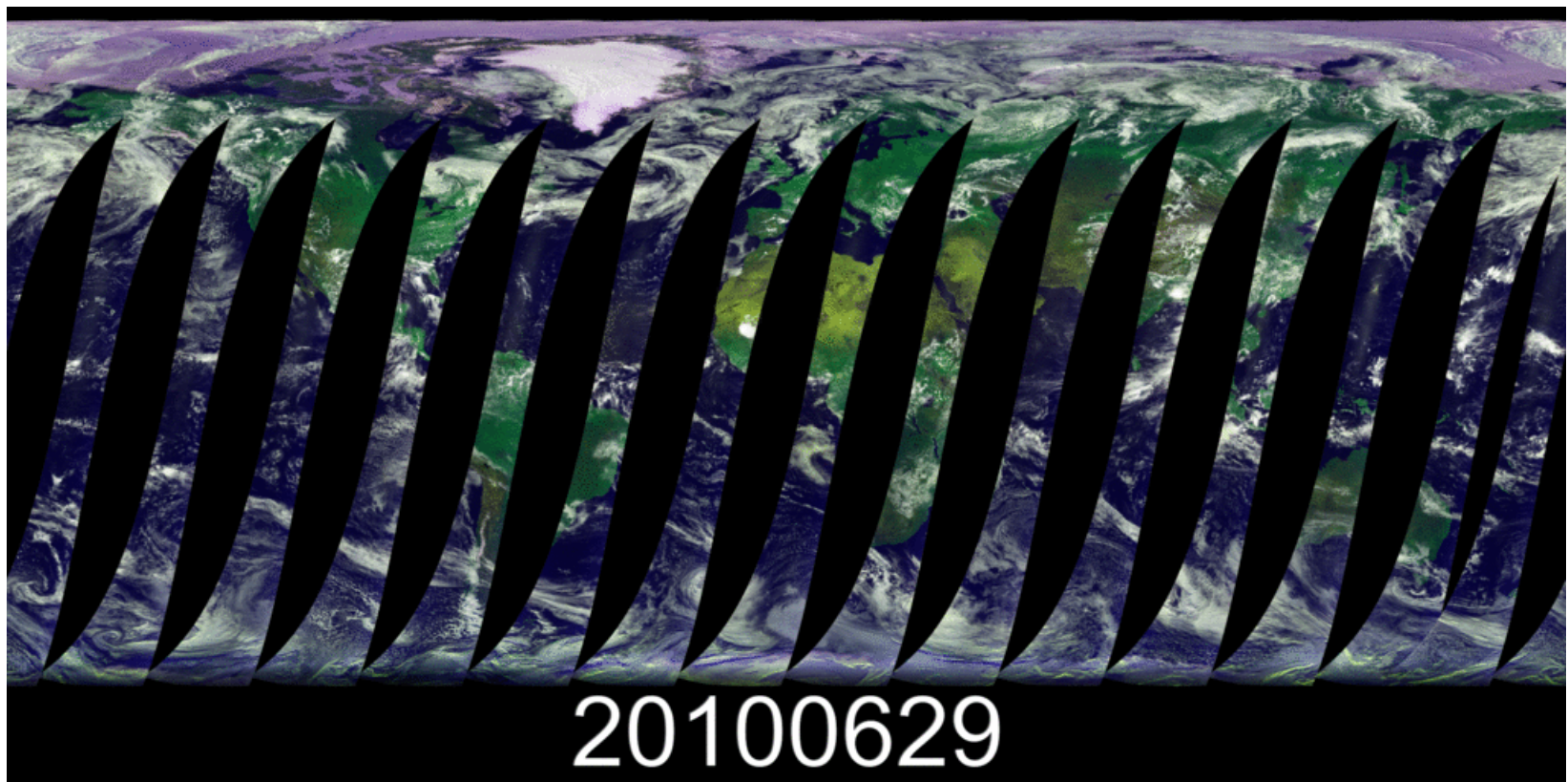


CAI image data (equivalent to **the CAI Level 3 radiance data**) obtained between June 25 and 27, 2009.

This image was produced by assigning colors (blue, red, and green) for the signals in Band 1, 2 and 3.

CAI image data (equivalent to **the clear-sky CAI Level 3 reflectance data**) synthesized from cloud-free data obtained between April 23 and May 22, 2009.

- **TANSO-CAI Image for everyday
(June 29 - Aug.1, 2010)**

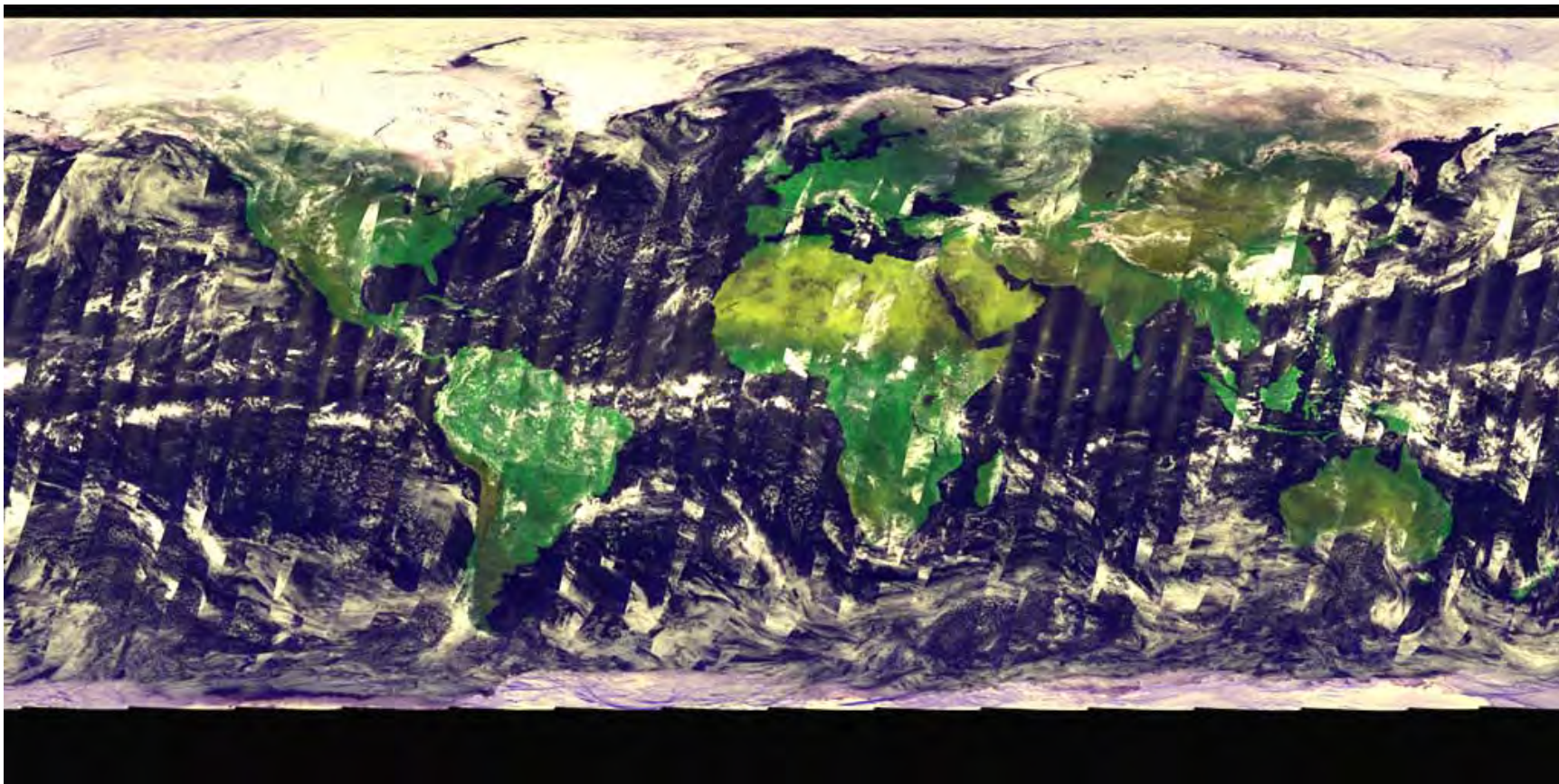


Red: Band 2 (0.67 μ m) Green: Band 3 (0.87 μ m) Blue: Band 1 (0.38 μ m)

GOSAT TANSO-CAI False Color Image

April 23 - 25, 2009

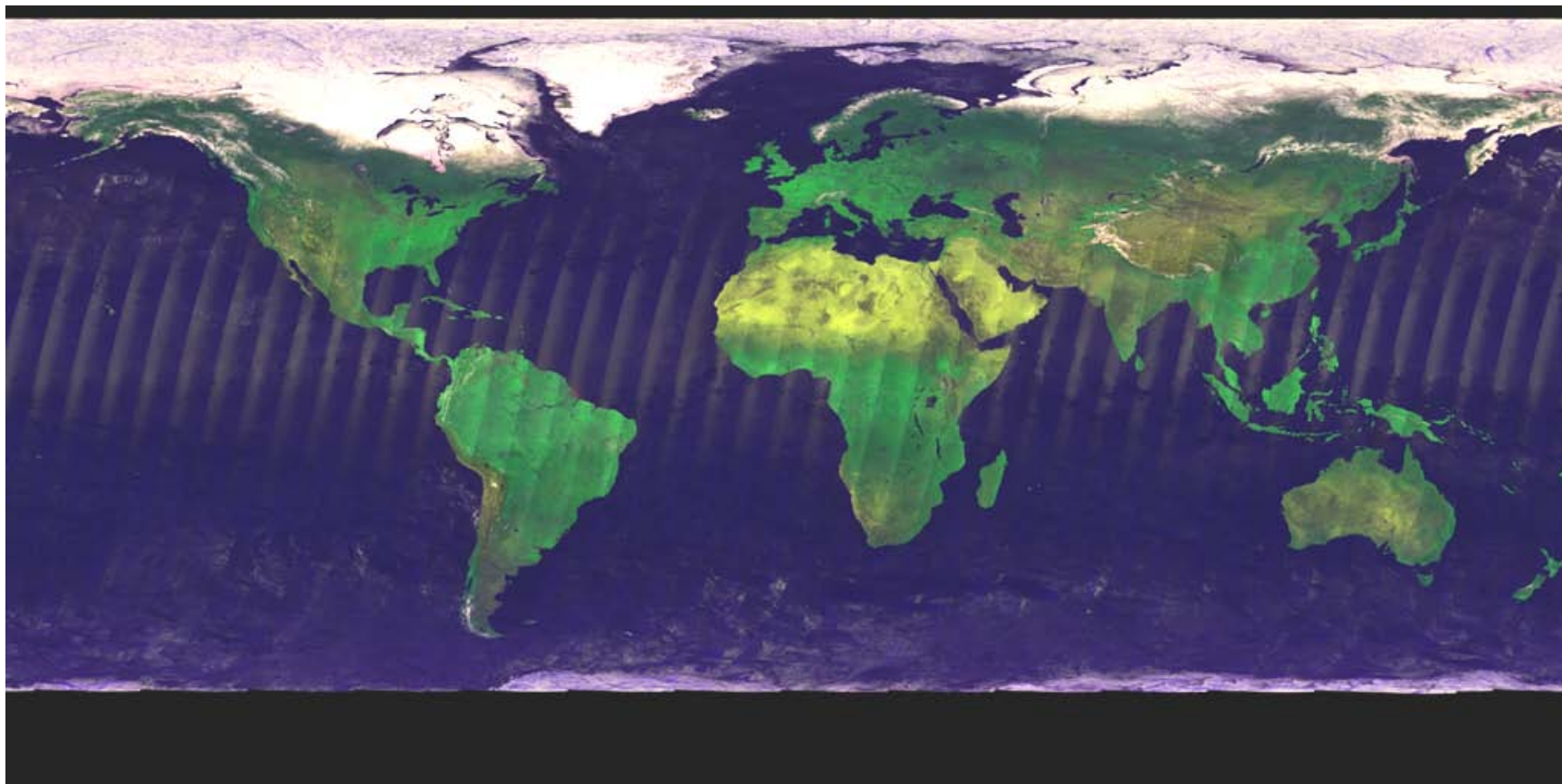
Red: Band 2 (0.67 μ m) Green: Band 3 (0.87 μ m) Blue: Band 1 (0.38 μ m)

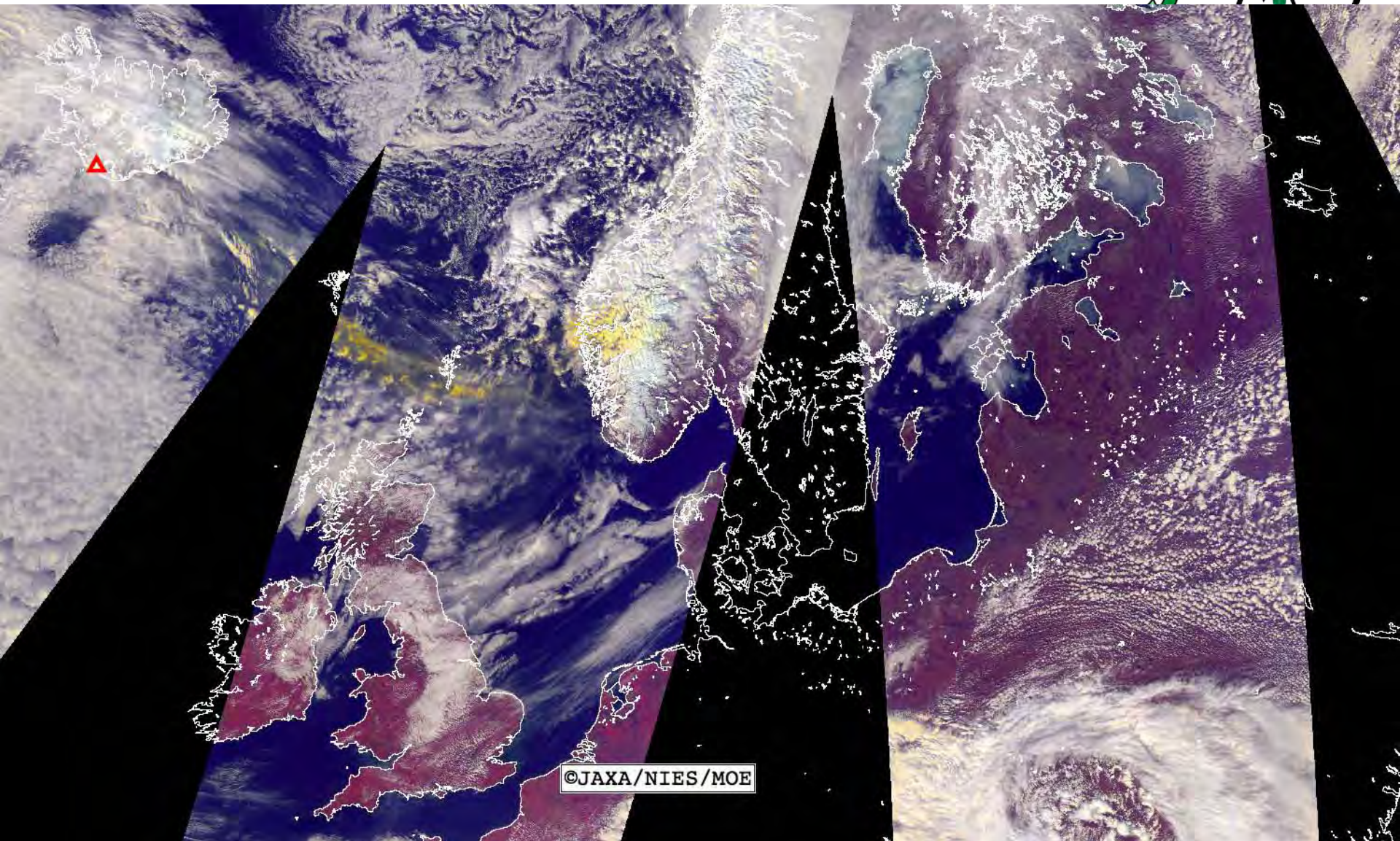


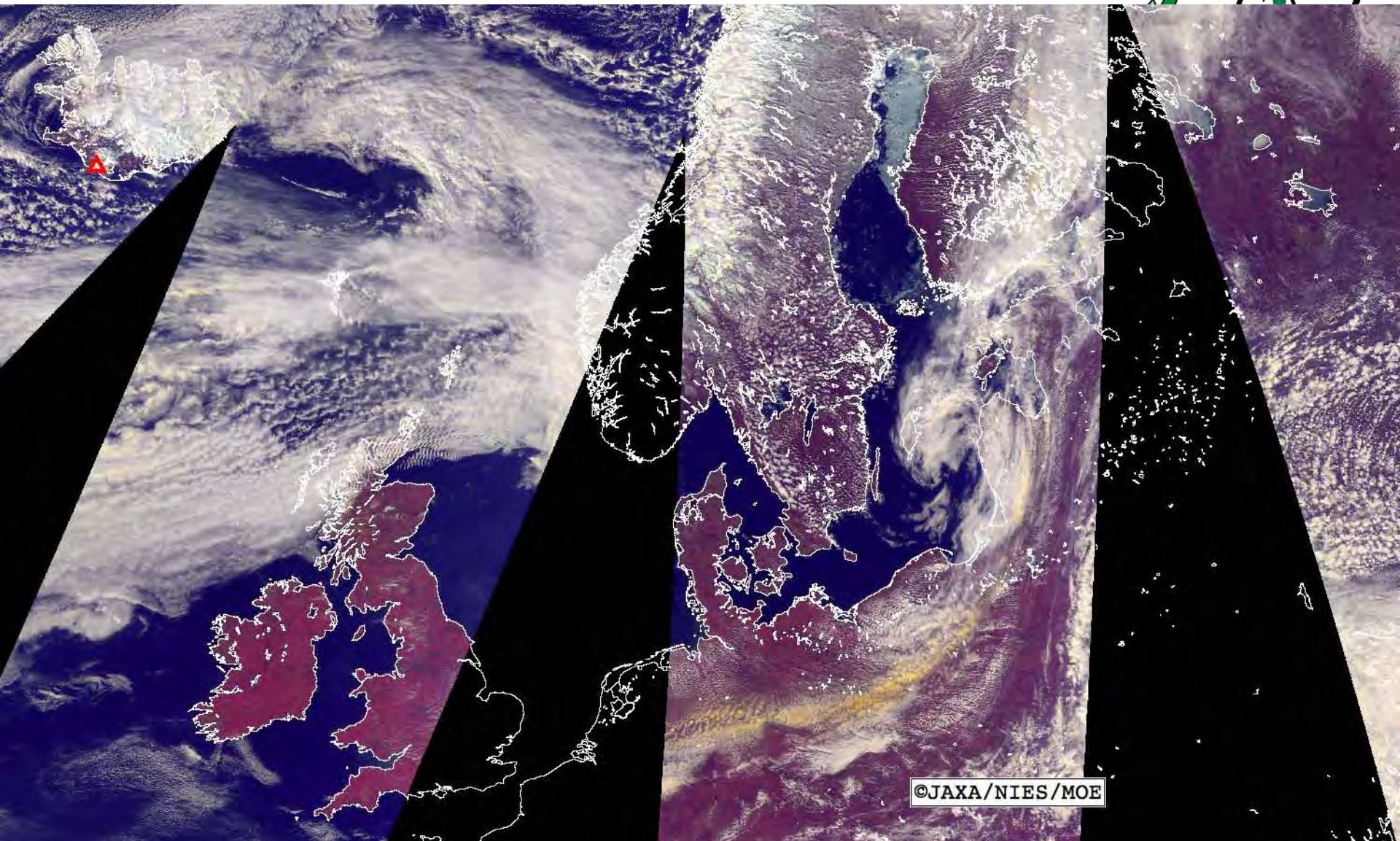
Minimum Surface Reflection Image for a Month

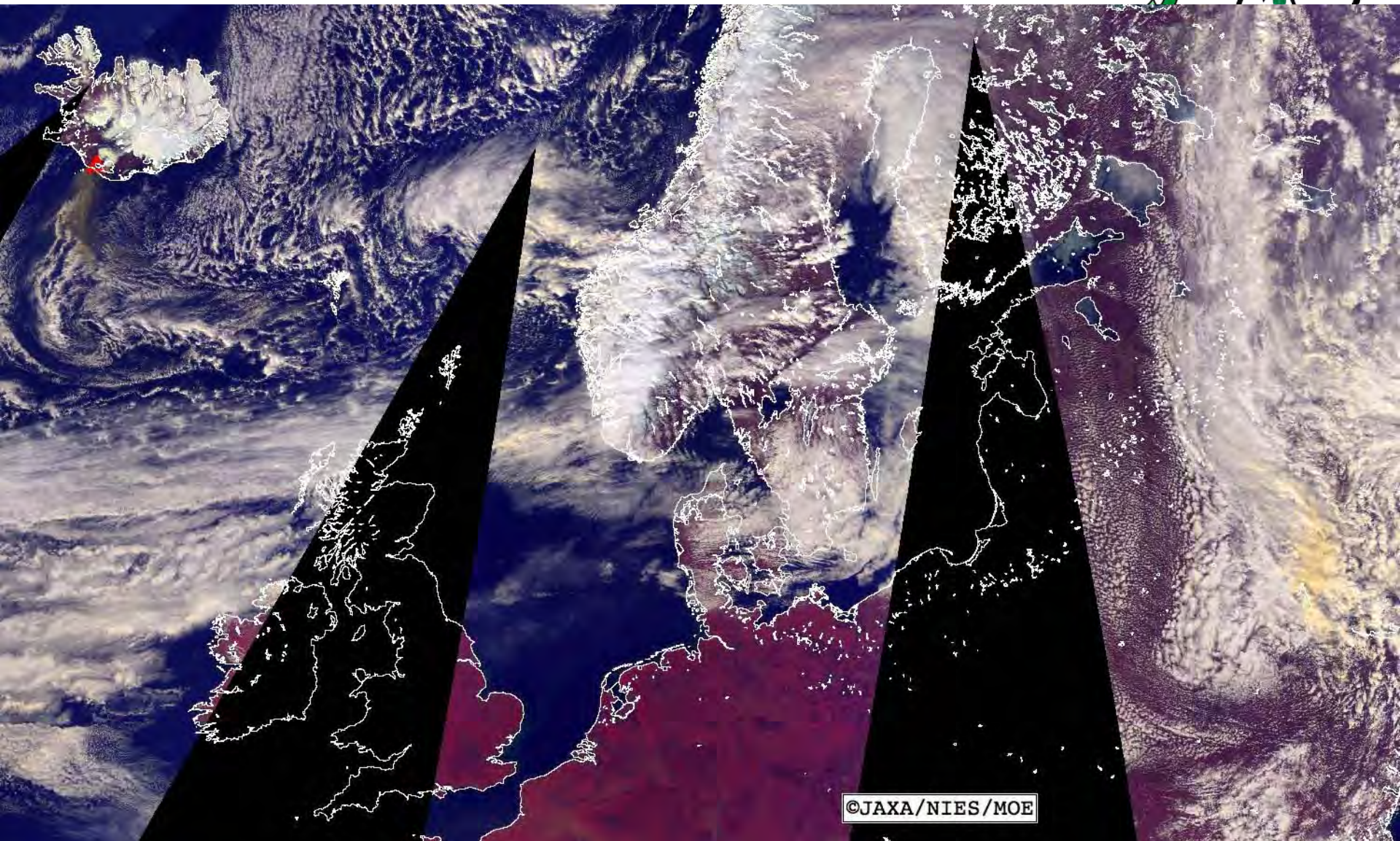
from April 23 - 22 May 2009

Red: Band 2 ($0.67\mu\text{m}$) Green: Band 3 ($0.87\mu\text{m}$) Blue: Band 1 ($0.38\mu\text{m}$)

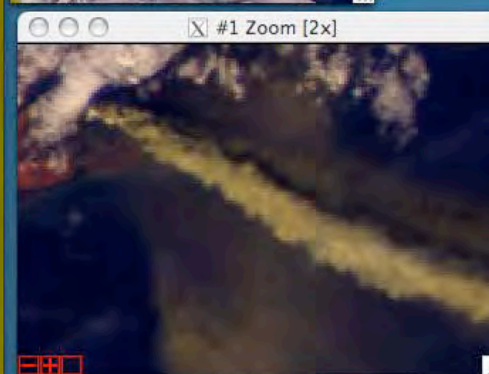
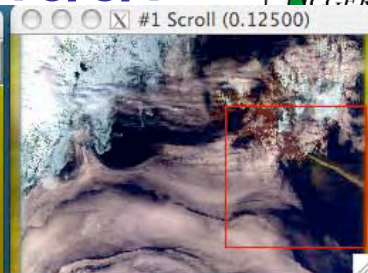
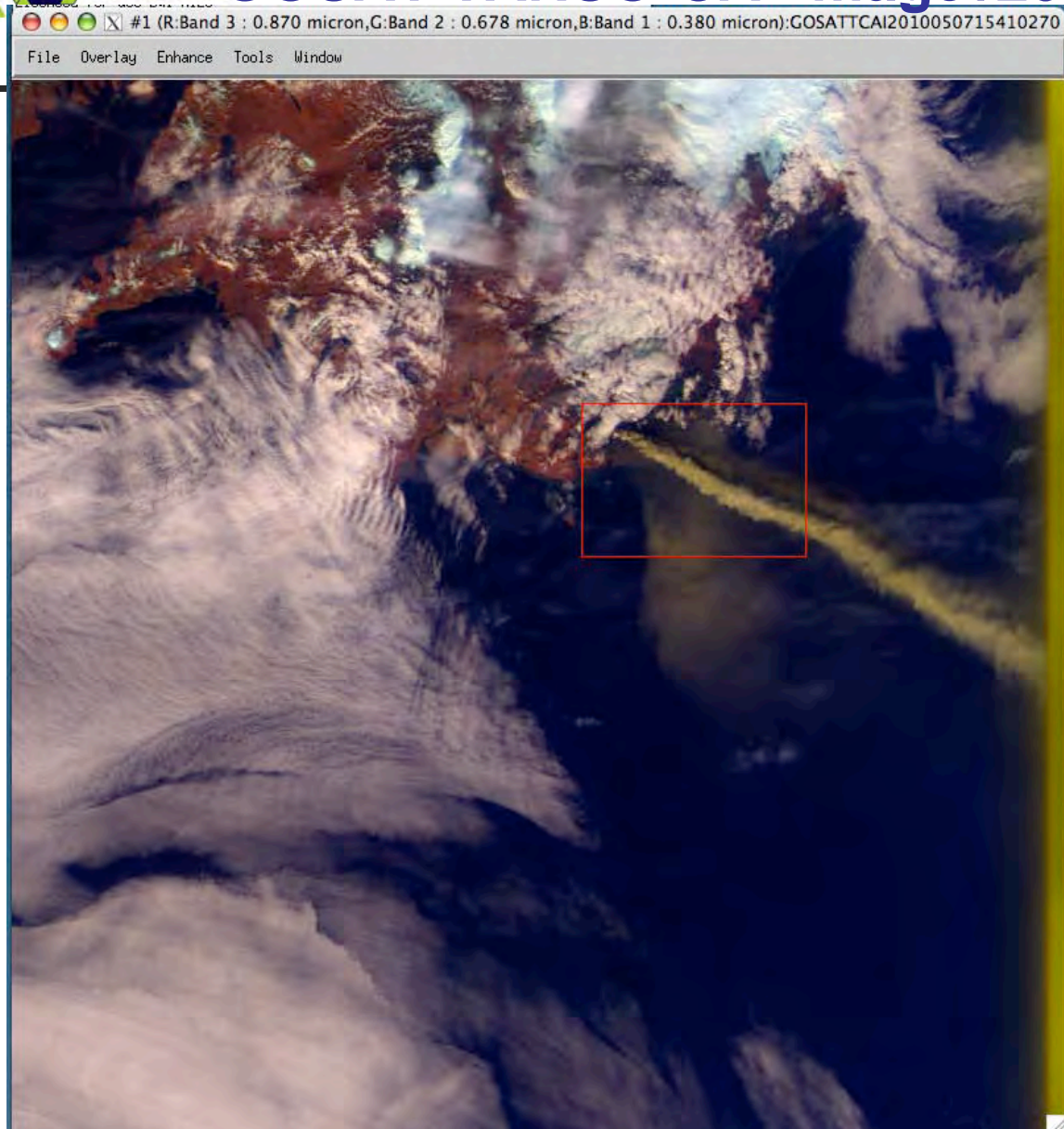


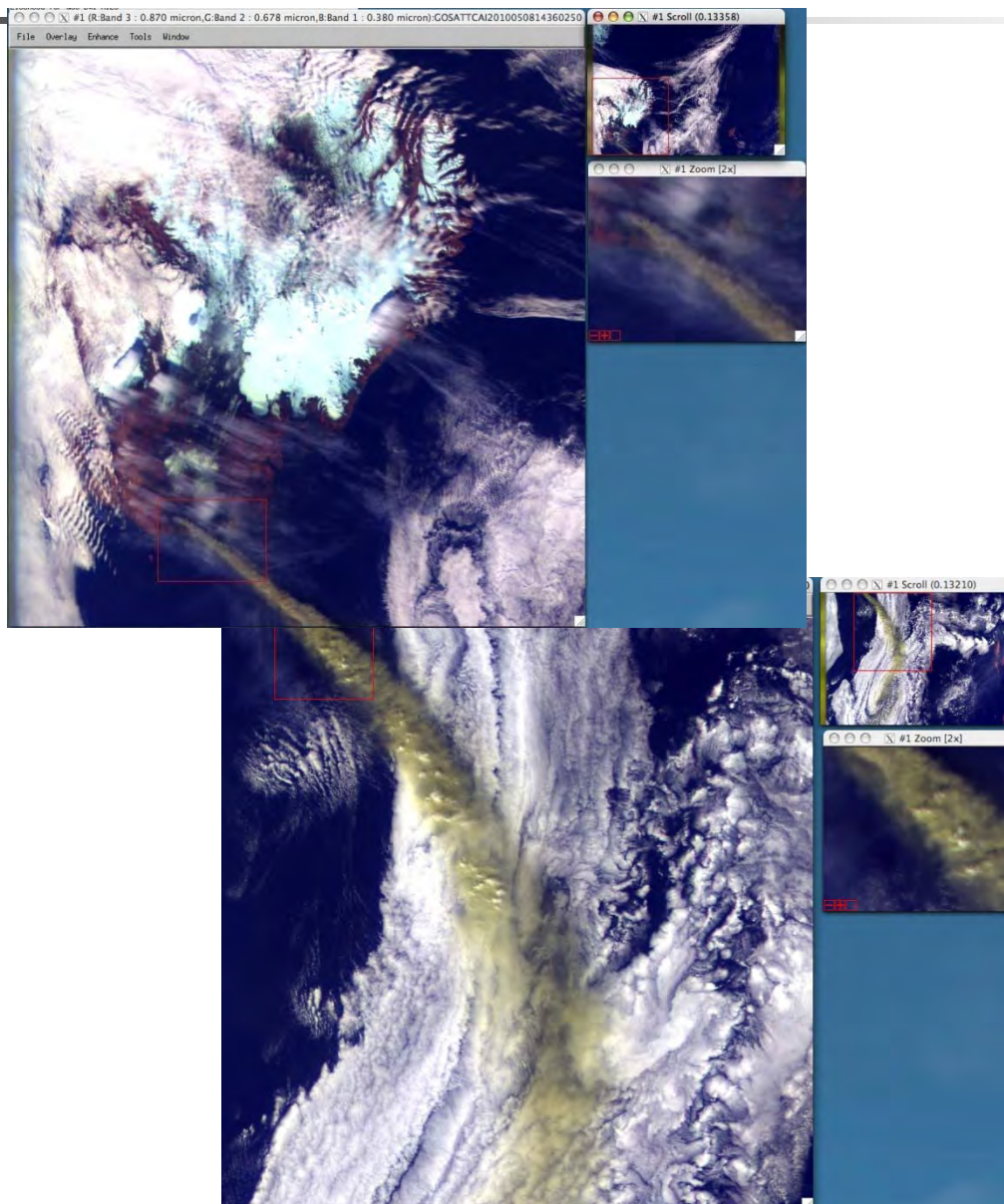


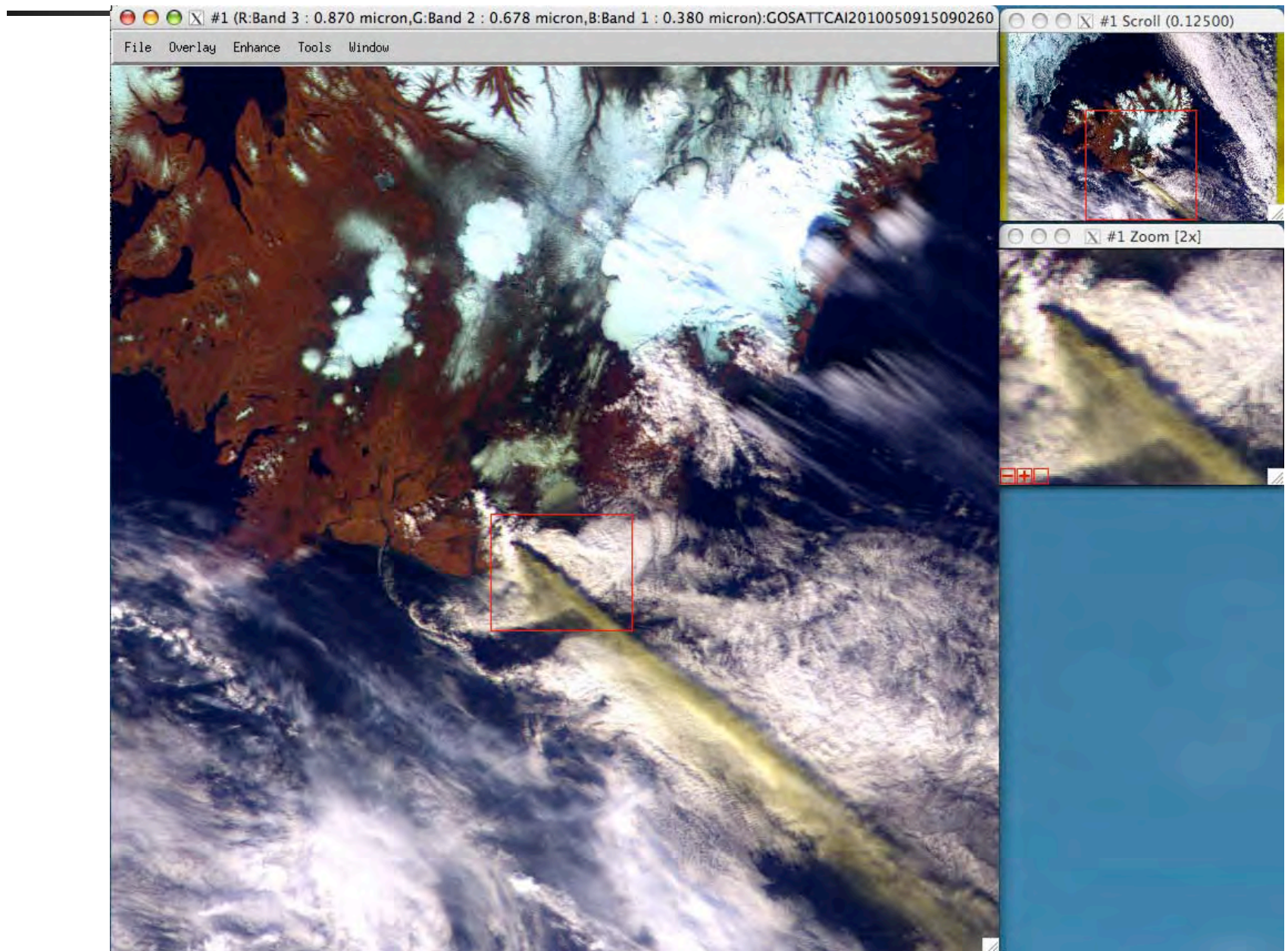




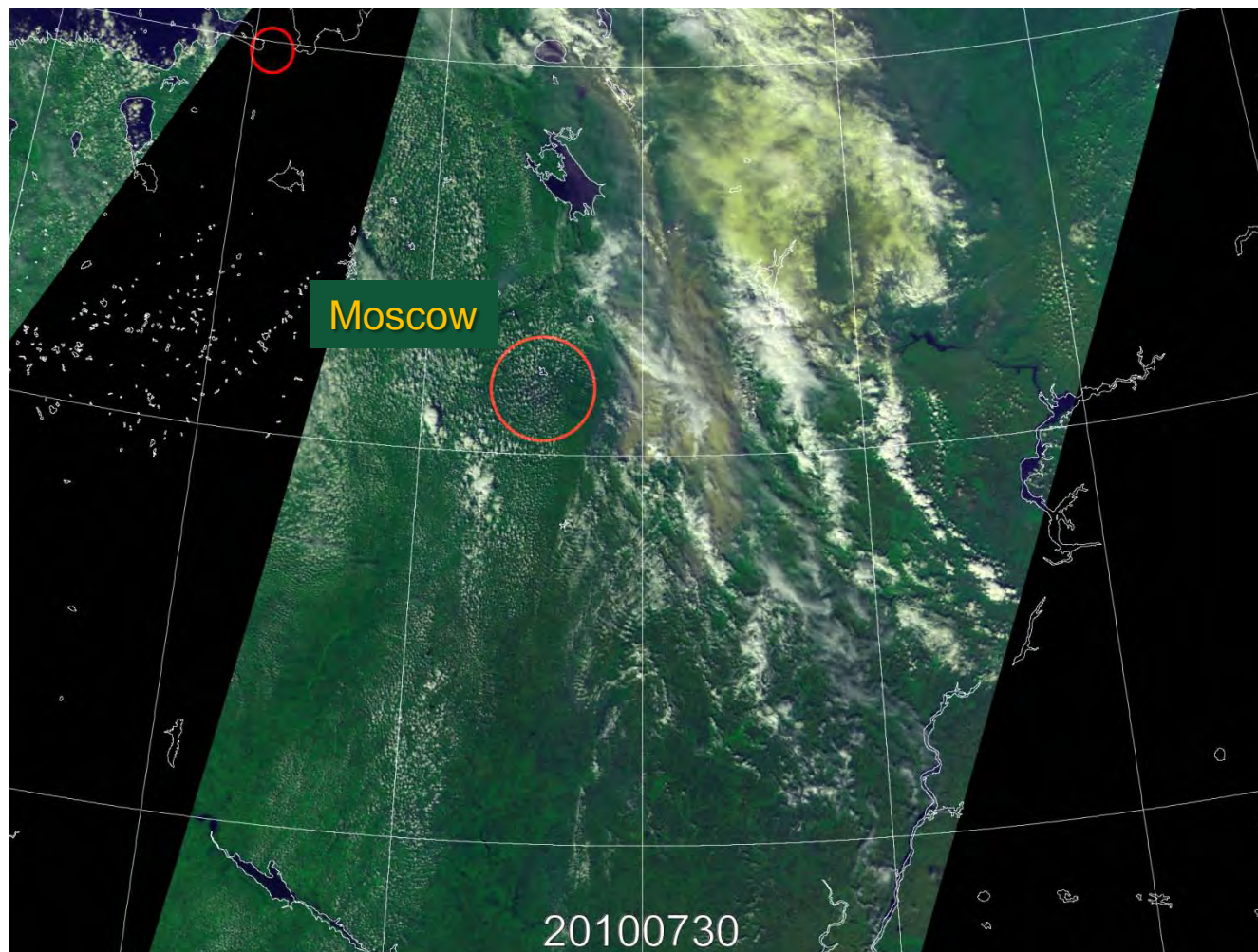
GOSAT TANSO-CAI Image: 2010/5/7





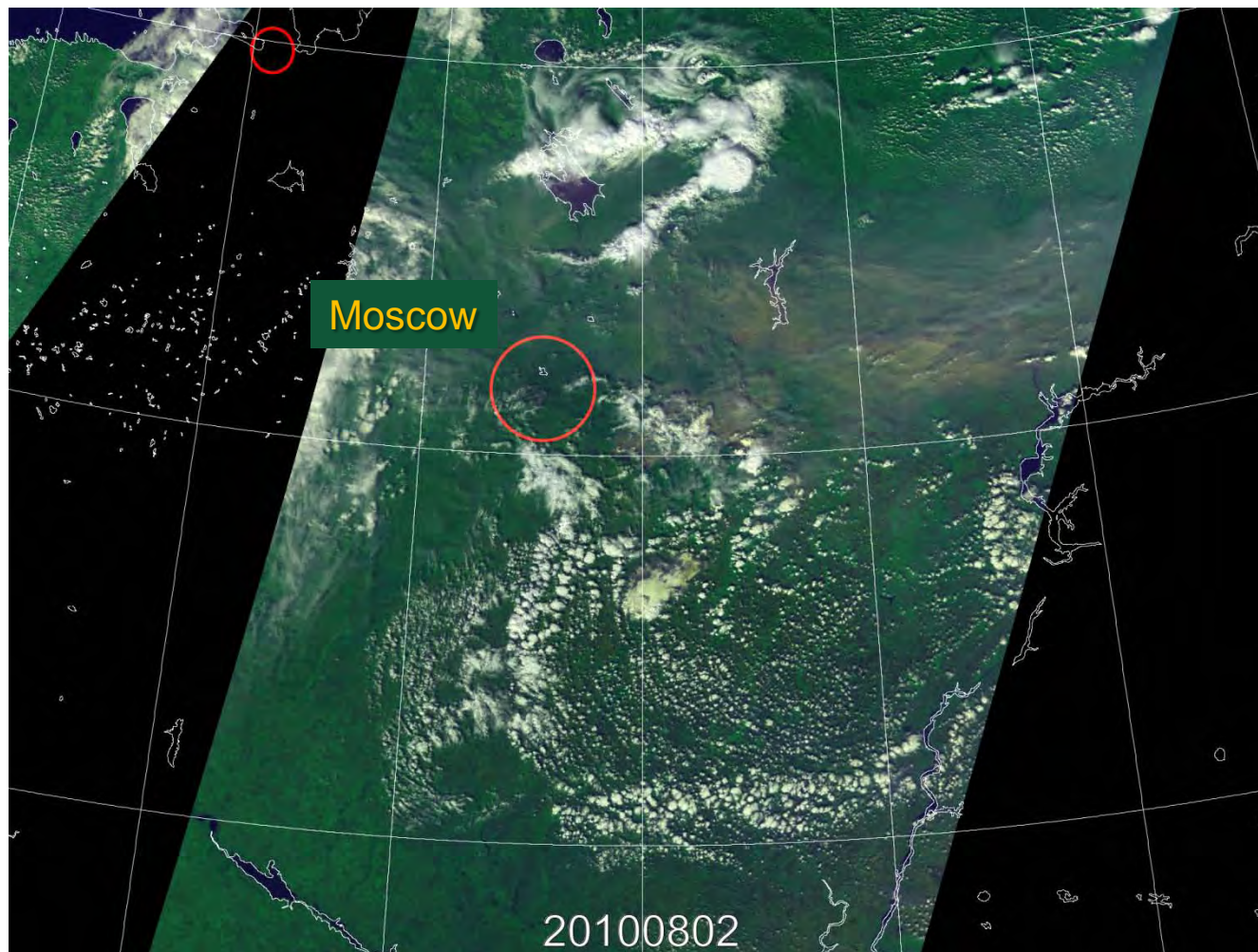


Forest Fire in West Siberia, Russia



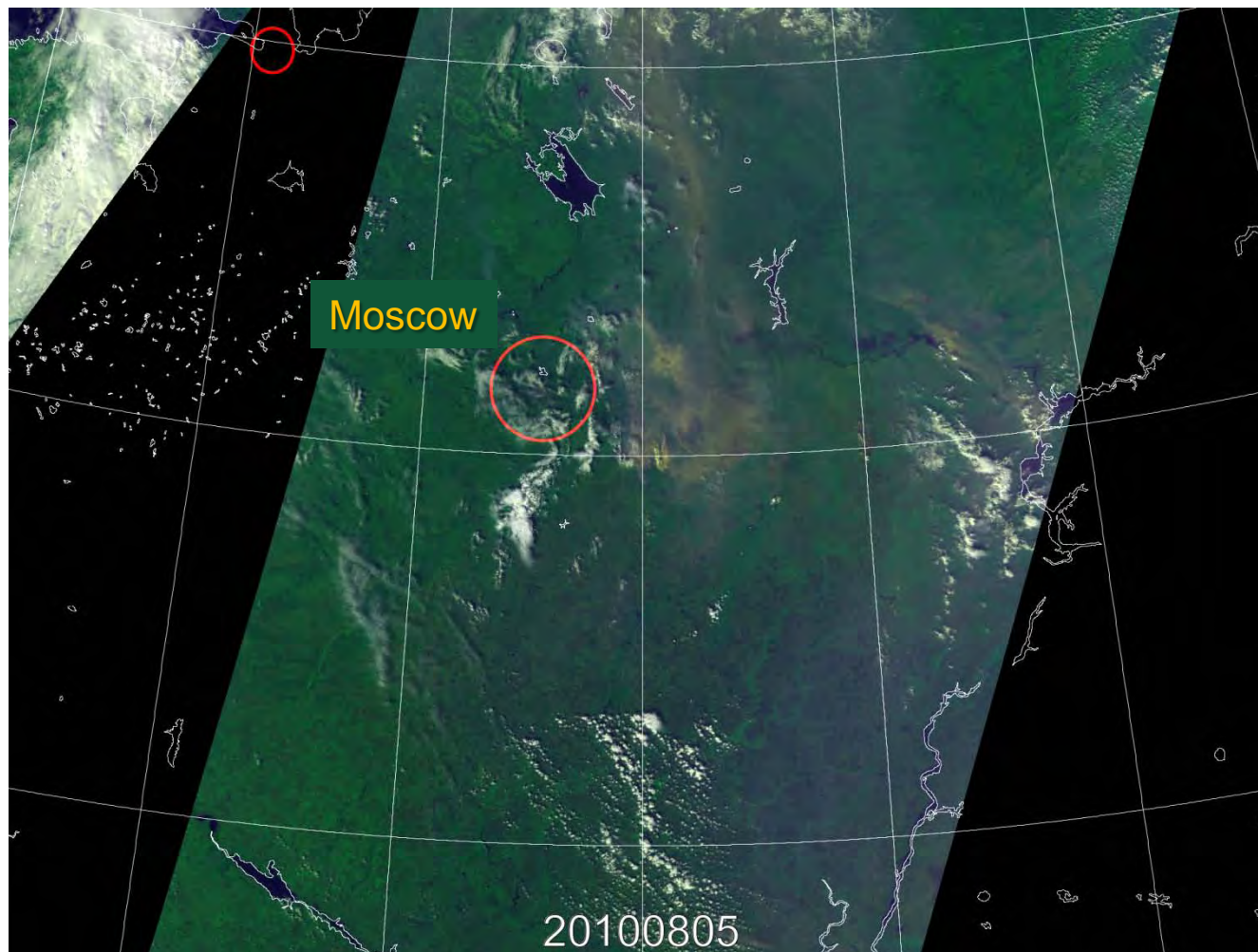
July 30, 2010

Forest Fire in West Siberia, Russia



August 2, 2010

Forest Fire in West Siberia, Russia



August 5, 2010

Forest Fire in West Siberia, Russia

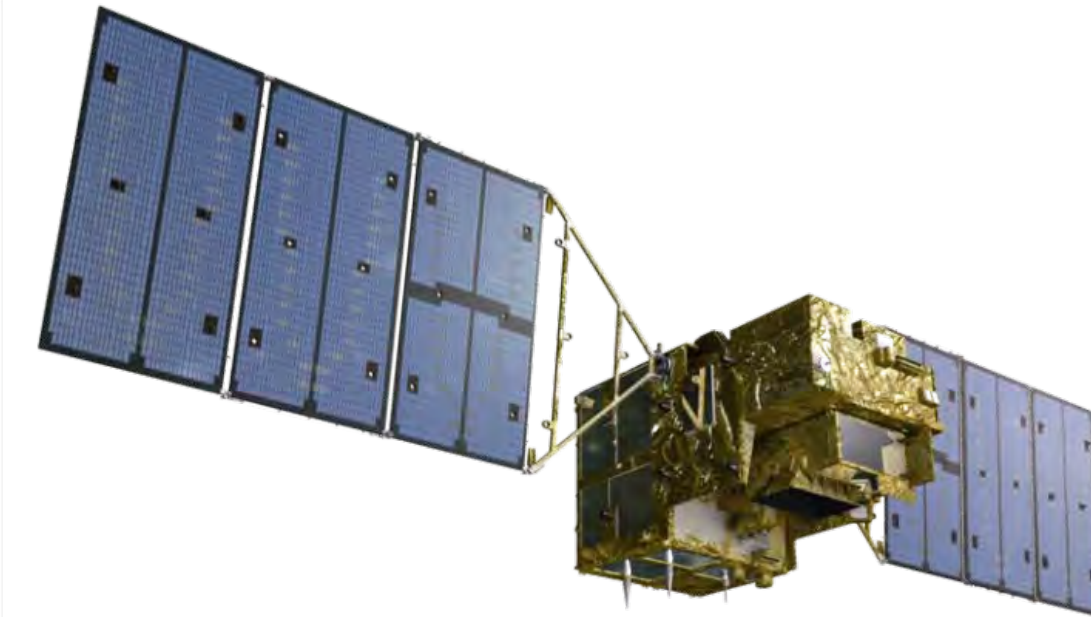


August 8, 2010



- GOSAT Level 4A & 4B
(separate slides)

- GOSAT has continued observations more than one year.
- Level 3 data product of TANSO-FTS SWIR XCO₂ & XCH₄ (Ver.01.xx) will be available soon.
- GOSAT Level 4A product (monthly CO₂ flux) estimated from TANSO-FTS SWIR L2 (V01.xx) and ground monitoring station data from June 2009 for about one year will be reported in 2011.
- The 3rd GOSAT Research Announcement has been released on August 20, 2010.



END