OVERVIEW OF GOSAT (Greenhouse-gases Observing SATellite) PROJECT

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ABSTRACT

GOSAT is a satellite to measure the column densities of CO_2 and CH_4 from space globally, and it is scheduled to be launched in 2008. It has a short wavelength infrared (SWIR) Fourier transform spectrometer (FTS) which measures both the ground surface scattered solar light over land and the right reflected light (sun-glint) over ocean. Column densities of CO_2 and CH_4 will be retrieved from the SWIR (i.e. 1.6 μm and 2.0 μm bands) data and the optical path length from oxygen *A*-band (0.76 μm). A cloud and aerosol sensor composed of three spectral image sensors (0.380, 0.678 and 1.62 μm) is equipped, viewing the wider area than FTS. This is a joint project among Ministry of Environment of Japan (MOE), National Insitutite for Environmental Studies (NIES) and Japan Aerospace Exploration Agency (JAXA).

INTRODUCTION

The understanding of the carbon cycle at present and the prediction of its future change, especially on the carbon dioxide, are the common issue among both climate research scientists and policy makers. The activities to monitor the greenhouse gases have been enhanced in recent years, but the ground-base monitoring stations are sparsely distributed and there is a serious gap in tropical and southern hemisphere. It is recommended "to develop a flexible yet robust strategy for deploying global systematic observations of the carbon cycle over the next decade" (IGOS-IGCO). The observation from space provides a global and dense data stream from a single sensor, but no carbon dioxide observation satellite to fill the above requirement is realized yet at this moment. The pioneering challenge to evaluate the carbon dioxide column abundance is under process using the data from SCIAMACHY, but it is marginal for CO2 due to instrument performance problem.

SATELLITE

The orbit of the satellite is a sun synchronous polar orbit with the inclination angle of 98.05 degrees. The recurrent rate is every 44 orbits and the orbits per day are 14+2/3, which results in three days revisit. This relatively high recurrent rate was chosen to make a global observation in a short period of time, although the observation is at every 10 degrees in longitude and it is rather sparse. This value is much shorter than the orbit of OCO; 16 days of A-train (http//:www.oco.jpl.nasa.gov/). The local time of the observation (equator crossing time) is set at a 1:00 (+/- 0:15) p.m., so that the observed column concentration over land is close to the day-averaged value, and the cloud coverage of a day is not significant. It is the same as that of OCO. The altitude of the orbit is chosen to be 666 (+/- 40) km, as the balance of a low altitude preference from the better performance of sensor and a high altitude from the long term operation of the satellite.

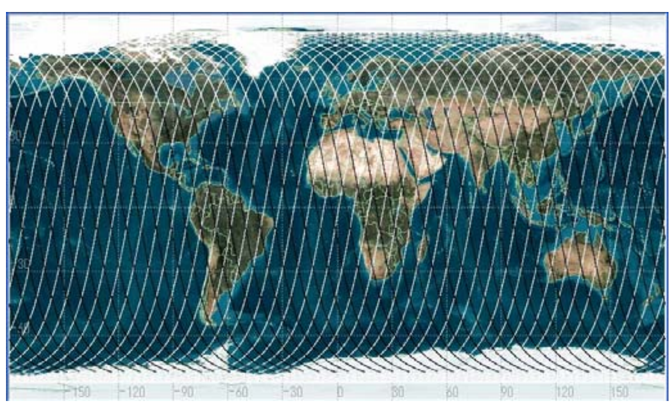

Fig.1. Orbit of GOSAT in tree days (one cycle) White lines shows the daytime track, when the observation is made.

The weight of the satellite will be 1,560 kg, and it will be launched in 2008 by a Japanese rocket; H2A202 in 2008. The mission of satellite is five years; 2008-2013.

The survivability is the important design philosophy. The failures of ASEOS and ADEOS-II were at power supply systems and two solar battery panels are equipped on GOSAT to guarantee the minimum operation even a power supply trouble occurs, for example.

SENSOR SYSTEM

The principle of operation is the surface scattered light observation in short wavelength near infrared (Fig. 2). The sensor system is composed of one Fourier transform spectrometer (FTS) and a cloud- aerosol sensor system. The spectral resolutions are set at 0.2 cm^{-1} for near-infrared and thermal bands, and 0.5 cm^{-1} for oxygen band. Seven detectors are equipped on the FTS slicing the IR beam by filter reflectors, and both P and S polarizations are observed simultaneously except the thermal band. The expected spectra in near infrared are shown in Fig.3. The field of view is rather large, 10.5 km in diameter, which was chosen from the request of good signal to noise ratio of more than 300, although the risk of cloud contamination in the view will be large. There is a mechanical scanning mirror system to point across track, covering 790 km at the latitude of 30 degrees. The along the truck scanning is 20 degrees, and the viewing point can be fixed during the scan of FTS, which is 4 second normally. Combining these mechanism, sun-glint observation is planned below 40 degrees in latitude over ocean. The on-board calibrations are made observing solar scattered light by a diffuser reflector or observing the noon for the spectral response, a semi-conductor laser light for the spectral resolution, and dark current by deep space.

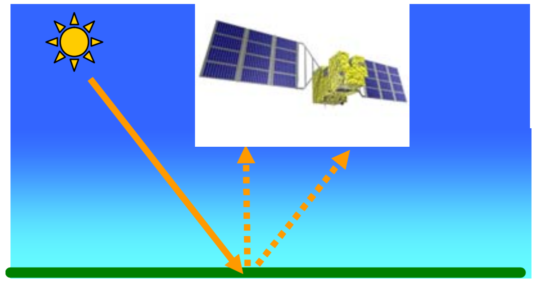

Fig.2. Configuration of satellite observation

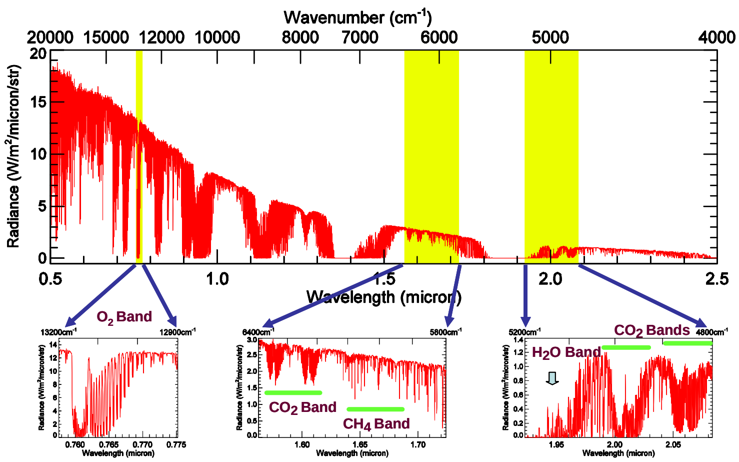

Fig.3. Spectral bands of GOSAT sensor in near infrared.

RETRIEVAL

The concentrations of CO_2 and CH_4 are obtained form the spectra by so called retrieval analysis. At the present stage, the synthesized spectrum calculated using HITRAN spectral data base is mixed with a white noise, and then analyzed. The precision of 0.3 % or better is expected in clear sky condition. One of the sources of error exists in the molecular optical parameter; errors in the intensities and wavelengths of absorption lines or the pressure broadening parameters. Those of CO_2 are fairly reliable, but those of methane are far from satisfactory. Another source of error is the path-radiance problem coming from the cloud and aerosol. The analysis of spectrum with thin cirrus clouds is presented in the following poster. The surface altitude and surface albedo are another source of error, in addition to the problem of mosaic surface condition within a large field of view of FTS. Data analysis needs to be made based on the multiple data from other sources.

VALIDATION

The concentrations obtained from the satellite data should be compared with reliable data, such as *in situ* measurement or more reliable remote sensing data. The directly comparable *in situ* data are obtained from the aircraft observations; the frequent observation by use of JAL passenger aircraft over some cities in East Asia. There is an on going aircraft observation program over three cities in Siberia. The column above the aircraft is about 10 %, and the variation of CO_2 concentration in it is expected to be small. So the model calculation value can be used. The other validation experiment is the high resolution observation of direct solar radiation on surface, in which the sources of error such as cloud or aerosol is small, and the SNR is excellent, but the error from the same sources such as the absorbance parameter are common.