Alternative Leak Detection Technologies: GOSAT

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GOSAT Chief Scientist

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Nippon Steel Engineering Co., Ltd
Different target/ Different method

Components
- Air-sampling / Analysis
- IR absorption / Video etc

Local
- Remote Sensing from Aircraft
- Sampling analysis on Balloon etc

Regional
- Remote Sensing from Satellite

10cm 100m 100km
Greenhouse gases Observing SATellite

Principle of Operation
Application to Leak Detection
Data dispatch schedule
Data Policy
Principle of Operation

GOSAT

To be launched in 21\textsuperscript{st} January, 2009 by Japanese H-\textsuperscript{II}a rocket

Field of view = 10 km

Solar Radiation

Land Surface Reflection

Sun-glint over ocean
Spectra of GOSAT sensor

Wavenumber (cm$^{-1}$)

Radiance (W/m$^2$/micron/str)

Wavelength (micron)

CO$_2$, CH$_4$, O$_2$, CO, H$_2$O

2008/11/21
Spectra from the altitude of 12 km
Test of GOSAT at JAXA

TANSO = Thermal And Near infrared Sensor for carbon Observation

TANSO-FTS
(Fourier Transform Spectrometer)

TANSO-CAI
(Cloud and Aerosol Imager)
GOSAT has been shipped from Tsukuba Center (JAXA) for Tanegashima (Launch Site) on 10th November.
Greenhouse gases Observing SATellite

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Unfortunately, OCO does not cover the spectral range of CH4. So it cannot detect the methane leakage although it scans a belt suitable for our purpose.
Foot prints

Cross track

GPS receiver

Pointing Mechanism

GPS

Star Tracker

Orbit Track of OCO

cross track patters (normally 5 points)
4 seconds/spectrum

~100 km

Satellite Direction (along track)
**Target Mode**

Any pointing pattern is possible within a small area by about 7-20 points.

Satellite Direction (along track)

GPS

Star Tracker

300 km

GOSAT

GPS receiver

Pointing Mechanism
Image of Point Source observation

GOSAT

Orbit

10 km

Source

Methane Conc.

Wind direction

100km

FTS on GOSAT

Height

CH4 conc.
The observation of CH₄ in the precision of 0.25% means that the 4ppb difference in column can be detectable, which corresponds to about 10 tCH₄/day.

The minimum detectable leak rate is reduced in the calm condition, when the diffusion is slow.

There is the records of stationary leakage of 45, 79, or 0.73 tCH₄/day at compressor stations in former Soviet Union, and most of them are detectable.

The large scale leakage which is lead to explosion is easy to detect, but the lower frequency (every three days) and the sparse coverage of observation limits the chance of detection.
Greenhouse gases Observing SATellite

Principle of Operation
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# Long term schedule

## Research Phase

<table>
<thead>
<tr>
<th>Year</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
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<th>11</th>
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<tr>
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<td>Launch</td>
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<td>Final Development Review</td>
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<td>End of Operation</td>
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### Important Milestone

- **Research R&D**
  - SAC Review
  - Concept Design
  - Basic Design
  - Detail Design
  - Operational Design
  - EM/STM
  - BBM/EM

### Research Phase

1. **System design**
   - Bas system
   - Sensor system
   - Tracking/Control
   - Mission Operation
   - Calibration/Validation

### Bas system

- **Baseline Design**
  - EM/STM
  - System integration • Proto-flight Test

### Sensor system

- **Sensor Integration**
  - BBM/EM
  - Initial Check
  - Initial Cal. Test Operation Period

### Tracking/Control

- **Tracking/Control**
  - Design, Software, Analysis, Test, Training
  - Stationary Observation

### Mission Operation

- **Mission Data**: Acquisition, Recording, Processing

### Calibration/Validation

- **Preparation of Cal/Val**
- **Initial Cal/Val**
- **Calibration/Validation**

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*Greenhouse gases Observing SAtellite*
Data Distribution Schedule

<table>
<thead>
<tr>
<th>Months After Launch</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>15mths</th>
<th>60</th>
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</thead>
<tbody>
<tr>
<td>Milestones &amp; Operation Phases</td>
<td>Launch</td>
<td></td>
<td></td>
<td></td>
<td>Routine Operations</td>
<td>End of Life</td>
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<tr>
<td>Level-1 Data Distribution</td>
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<tr>
<td>Level-2 Data Distribution</td>
<td>No data</td>
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- **NIES**: National Institute for Environmental Studies
- **GOSAT-ST**: GOSAT Science Team
- **RA**: Record-Access

- Initial CAL/VAL: Uncalibrated L1 Data (to NIES, GOSAT-ST, RA-users)
- Routine Operations:
  - Calibrated L1 Data (to NIES, GOSAT-ST, RA-users)
  - Calibrated L1 Data (to ESA, General Dstr.)
- End of Life:
  - Calibrated L1 Data (to NIES, GOSAT-ST, RA-users)
  - Validated L2 Data (to GOSAT-ST, RA-users)
  - Validated L2 Data (to ESA, General Dstr.)
1. It is operated in nominal mode.
2. The spectral data is obtained in 3-5 hrs.
4. If abnormally high concentration is observed, the special operation targeting at this area is requested 2.5 days before.
5. Target mode data is obtained on the next track (every three days with 15 degrees intervals)
6. The flux is estimated from the concentration above the baseline and the wind velocity.
Greenhouse gases Observing SATellite

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1. Data is fully open and free of charge.

2. In order to access to the data in early stage, it is recommended to apply to the Research Announcement.

3. Special Targeting Operation can be requested by the RA users only.

4. Profitable application is not allowed. It is allowed as long as it is the R/D stage.
What is the next step?

GOSAT is an experimental satellite. Mission period is 5 years.

<table>
<thead>
<tr>
<th>Low altitude orbiting satellite</th>
<th>The same as GOSAT</th>
<th>Geostatic satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td>100km</td>
<td>660km</td>
<td>30,000km</td>
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<tr>
<td>Near IR cw-Lidar</td>
<td>Near IR Spectrometer</td>
<td>Near IR Spectrometer with a Telescope</td>
</tr>
</tbody>
</table>

What is the next satellite (GOSAT-II)?

- Precise location, Smaller leakage
- GHG emission inventory (large scale plants, forest fire events, big cities, etc.)
- Accident, Large leakage
  - Disaster: Tsunami
  - Air pollution: Time series

2008/11/21
Thank you