

# Evaluation of Methane Flux from Natural Gas Transportation System from Satellite

- . Methane column concentration observation from GOSAT
- . Validation of GOSAT Data

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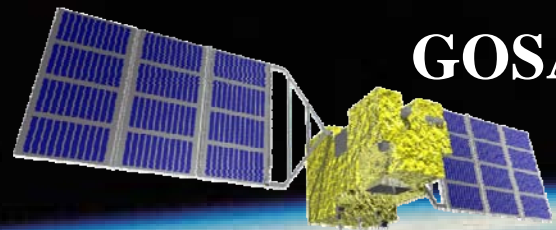
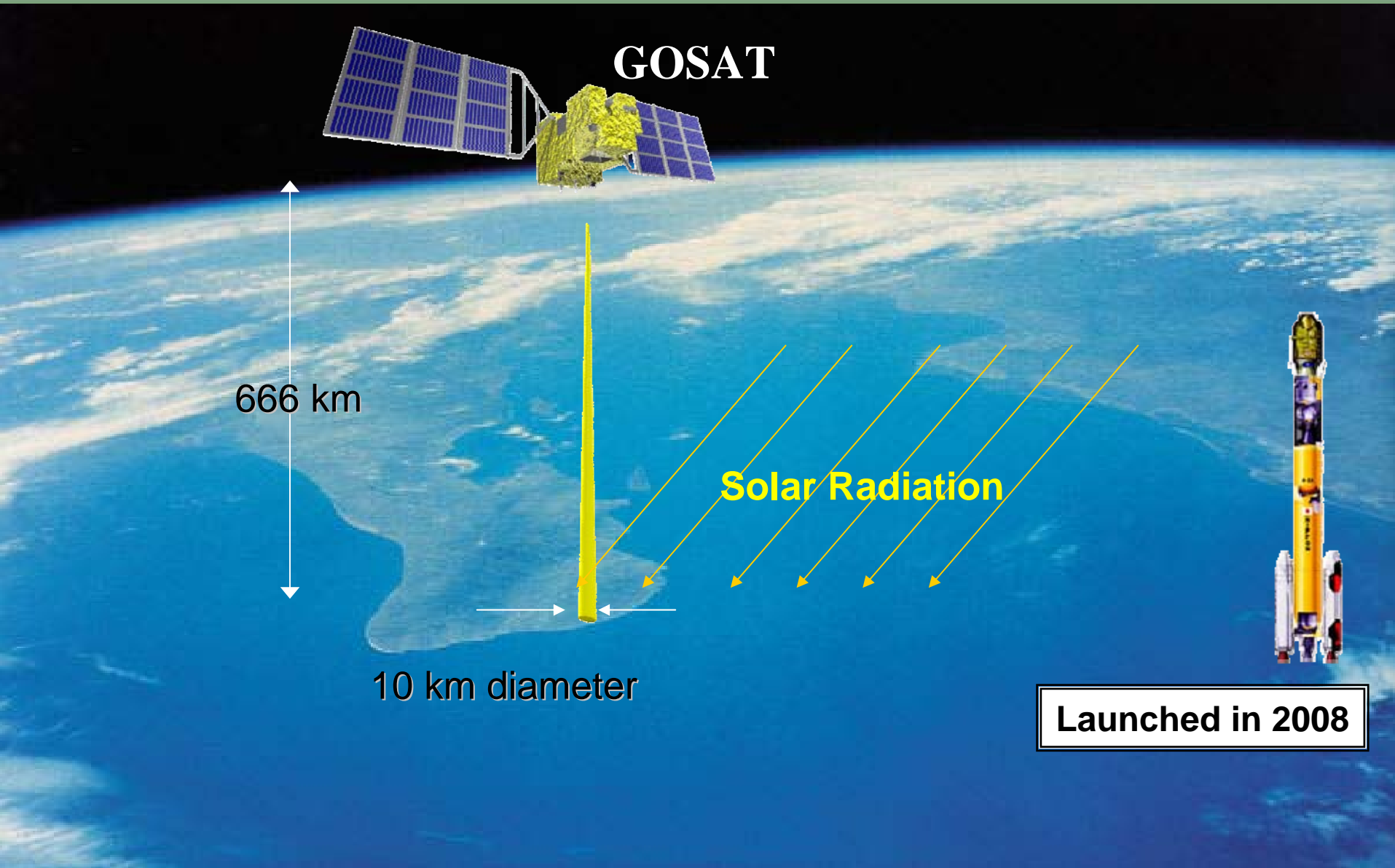


# GOSAT



## Greenhouse gases Observing SATellite

- Principle of Operation



**GOSAT**

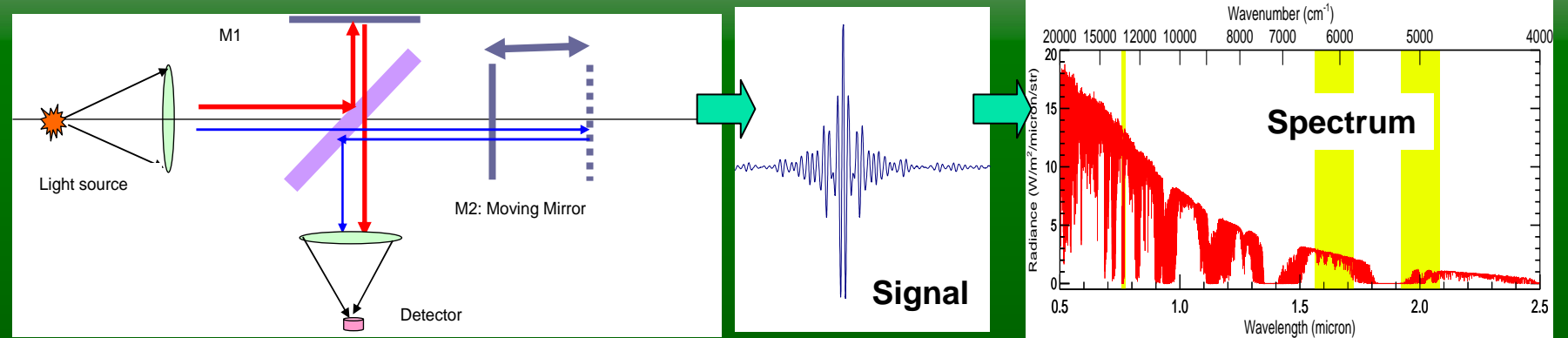
666 km

**Solar Radiation**

10 km diameter

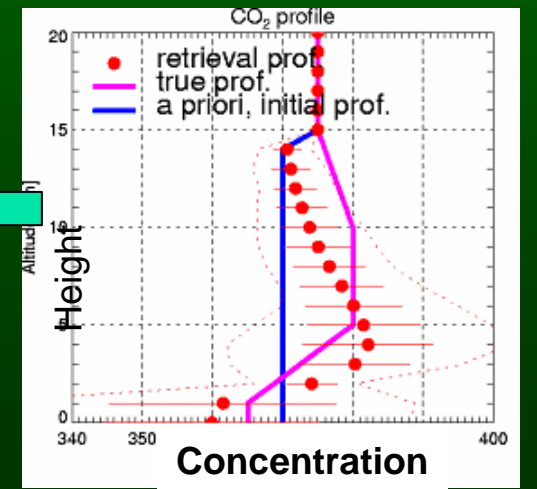
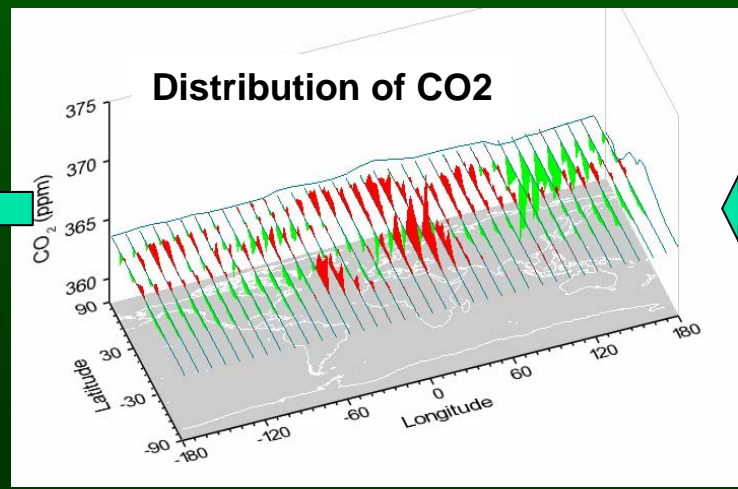
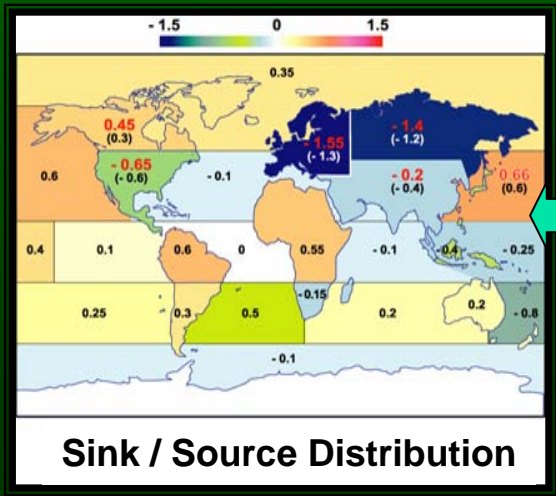


**Launched in 2008**

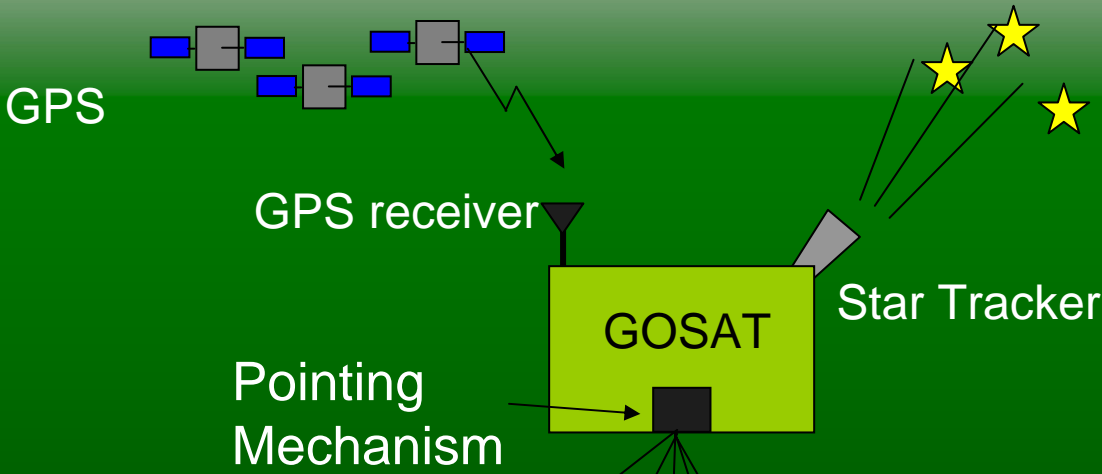


JAXA

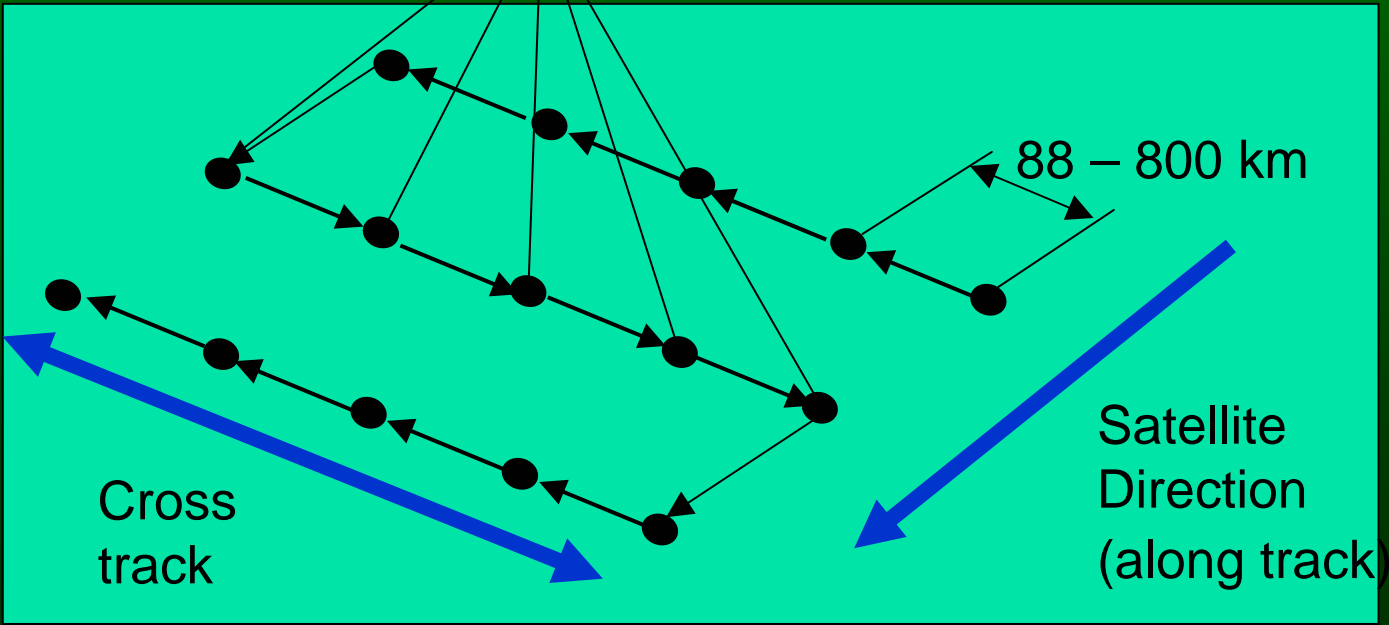
NIES/MOE

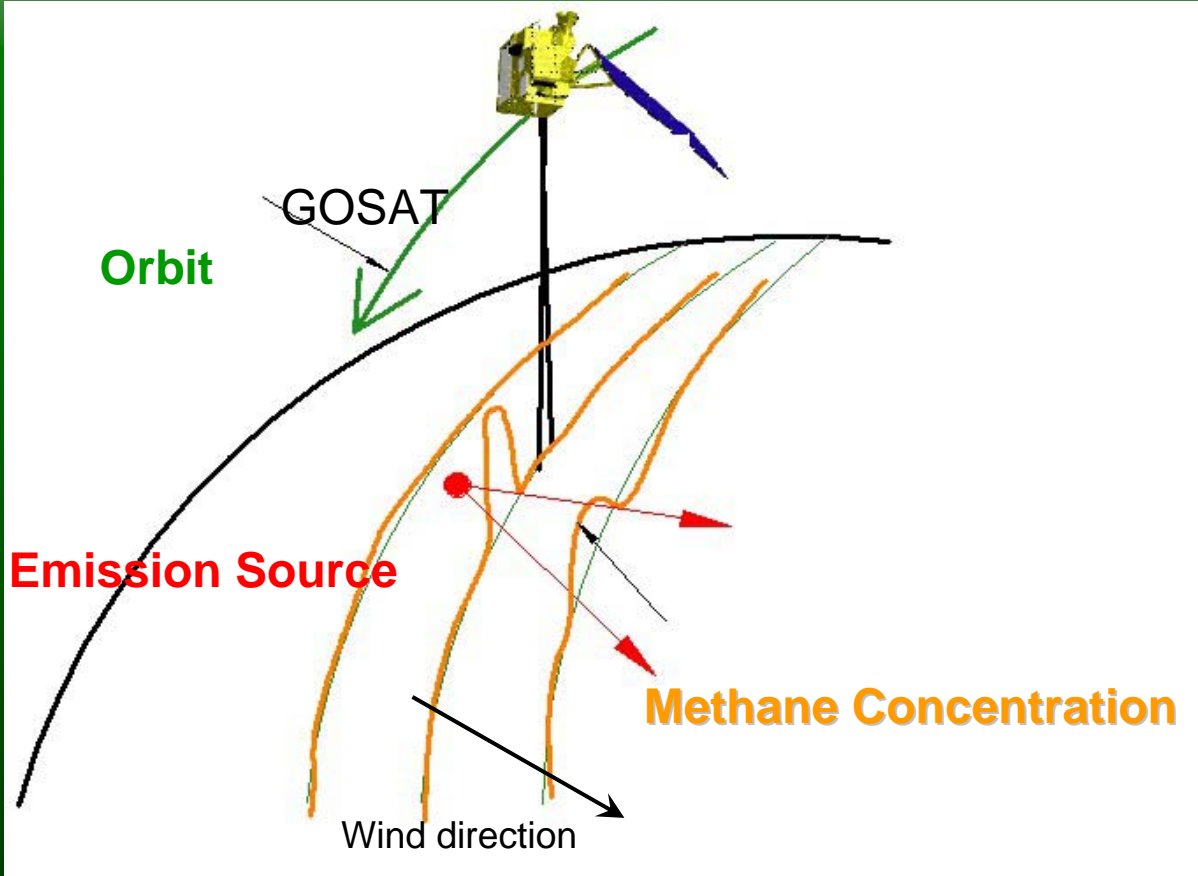


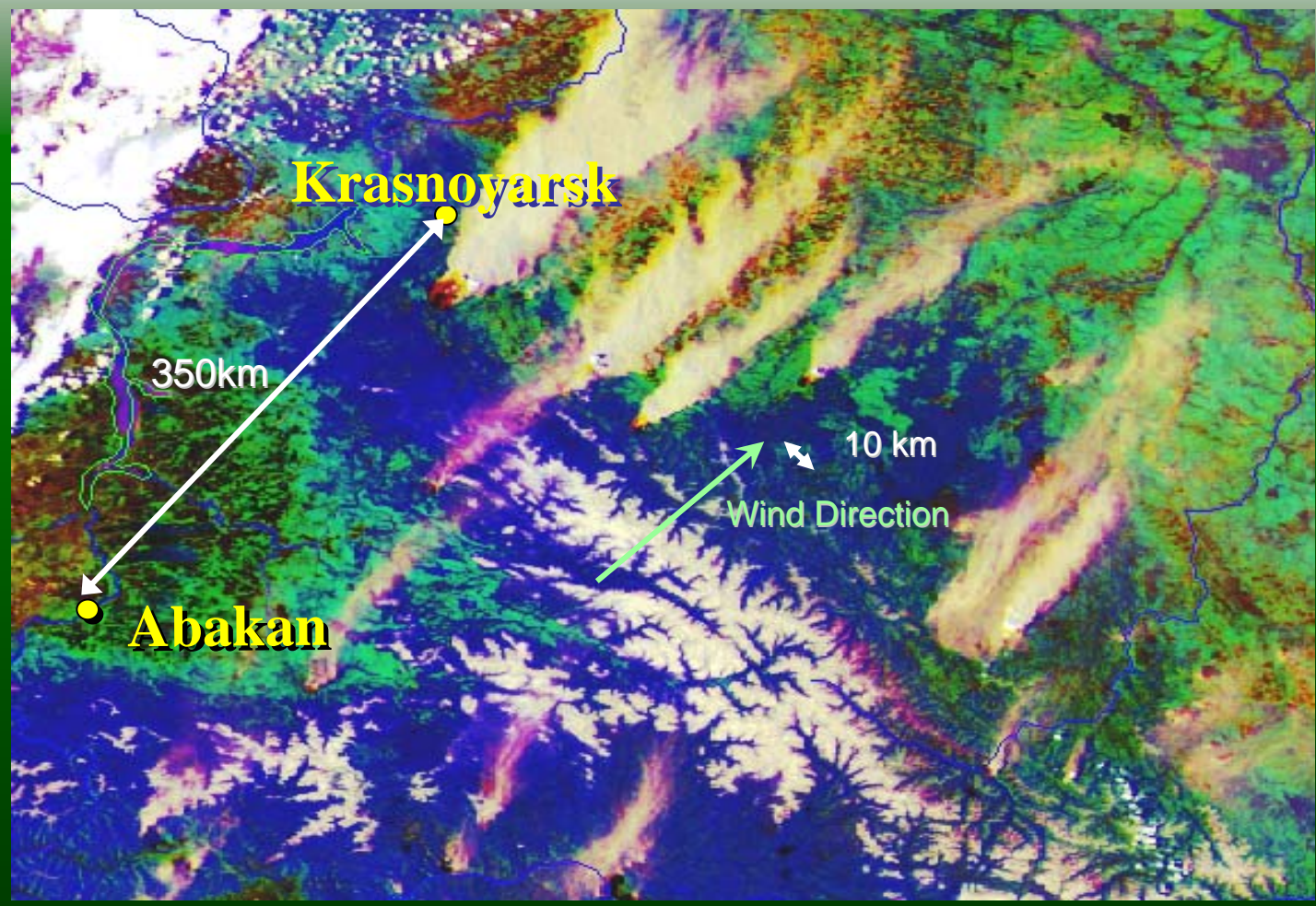
# Footprints



5 cross track patterns  
1, 3, 5, 7, 9  
points/cross track scan

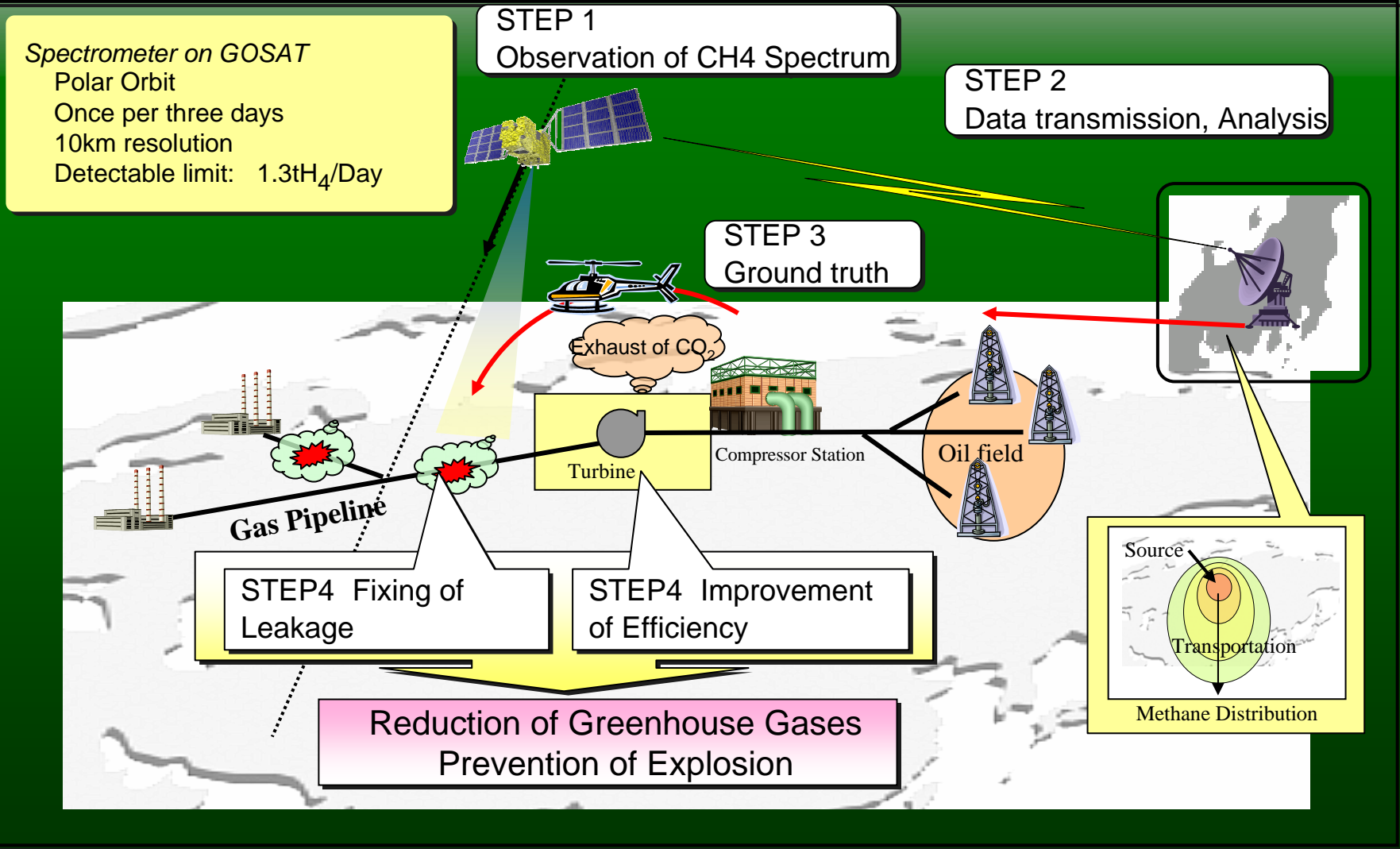






Krasnoyarsk territory, 25, May 1999

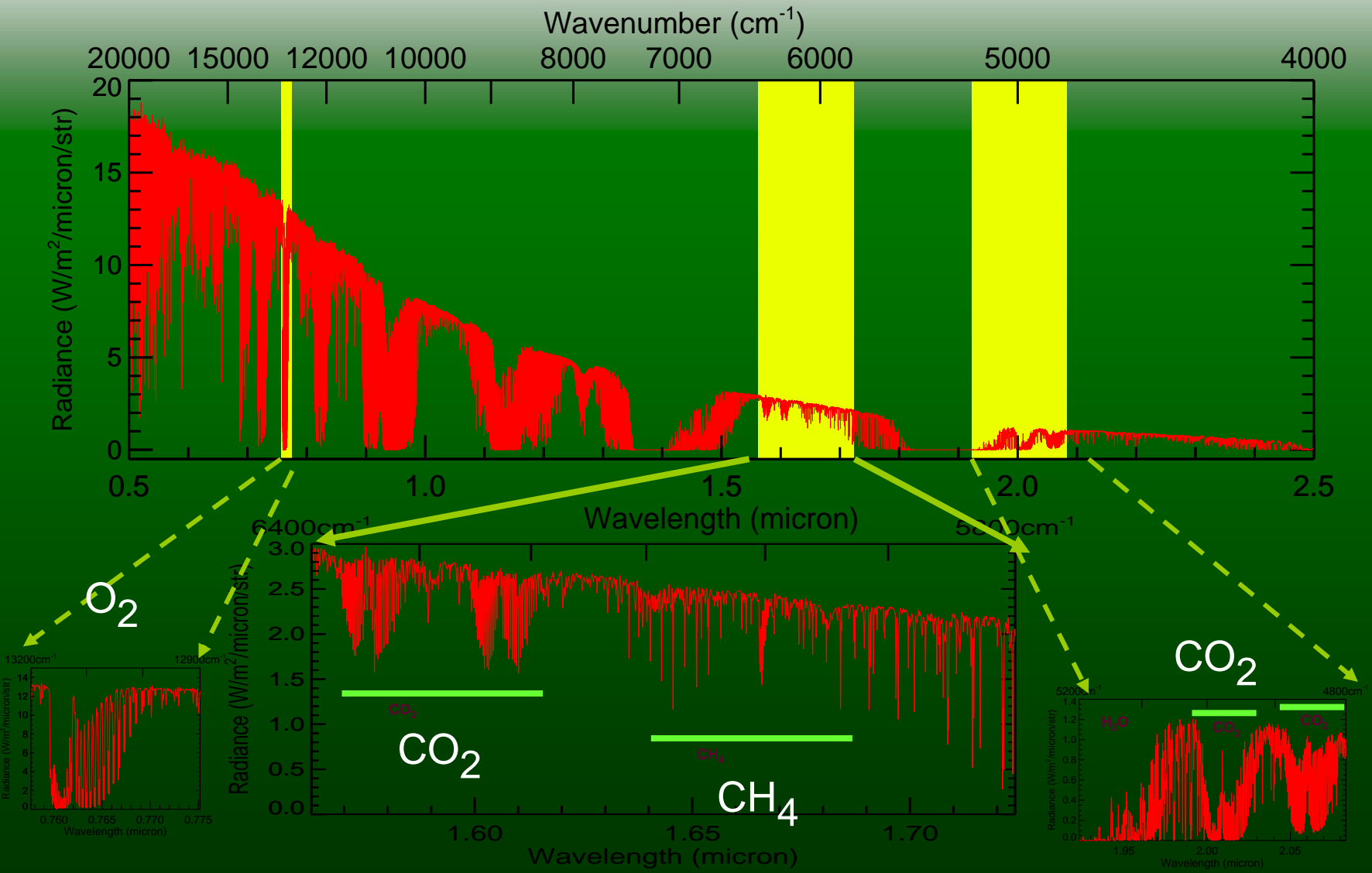
# Procedure of CH<sub>4</sub> emission reduction





## Greenhouse gases Observing SATellite

- Principle of Operation
- Precision of Measurement

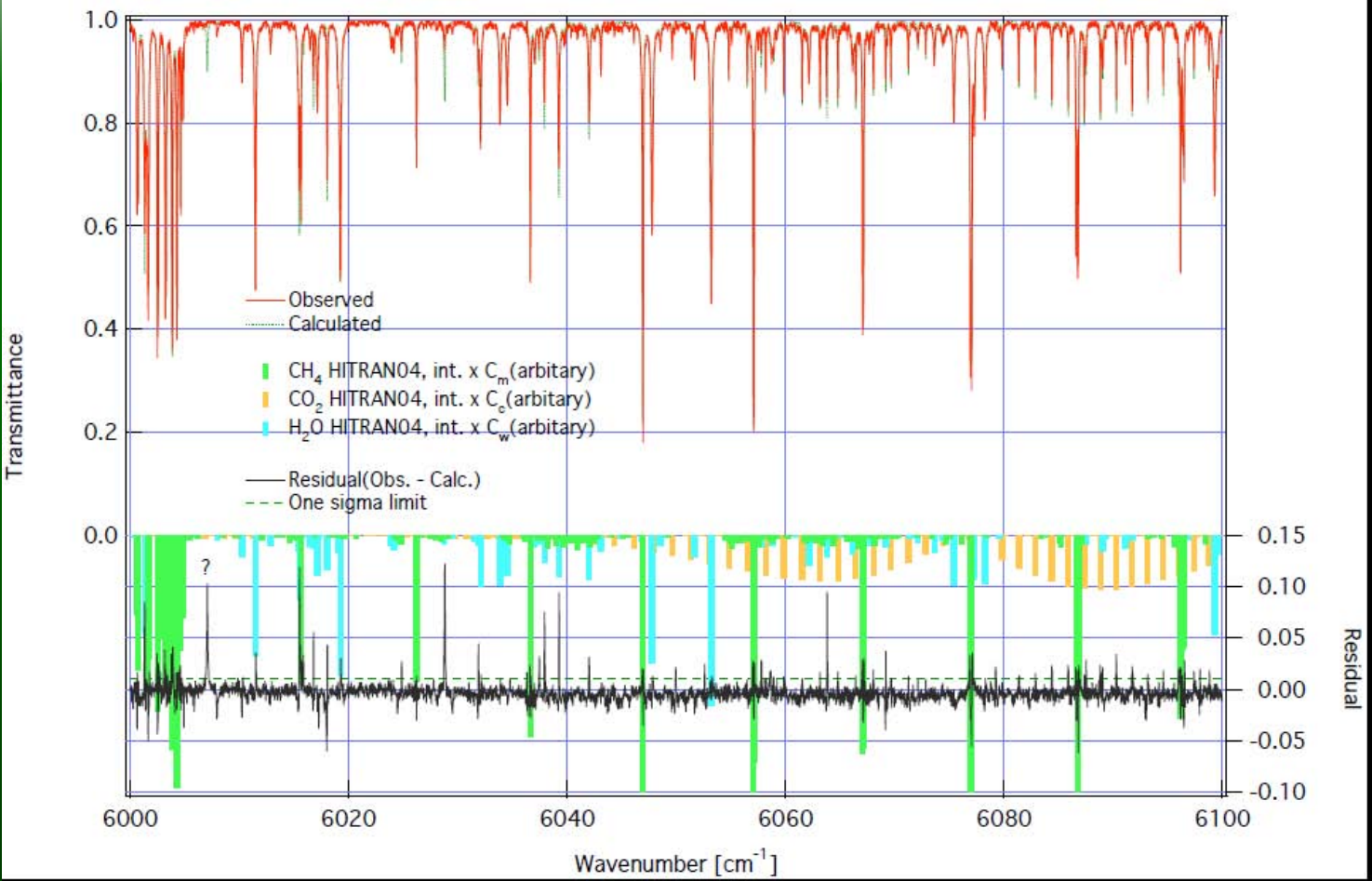


(1) 0.76  $\mu\text{m}$  band

(2) 1.6  $\mu\text{m}$  band

(3) 2.0  $\mu\text{m}$  band

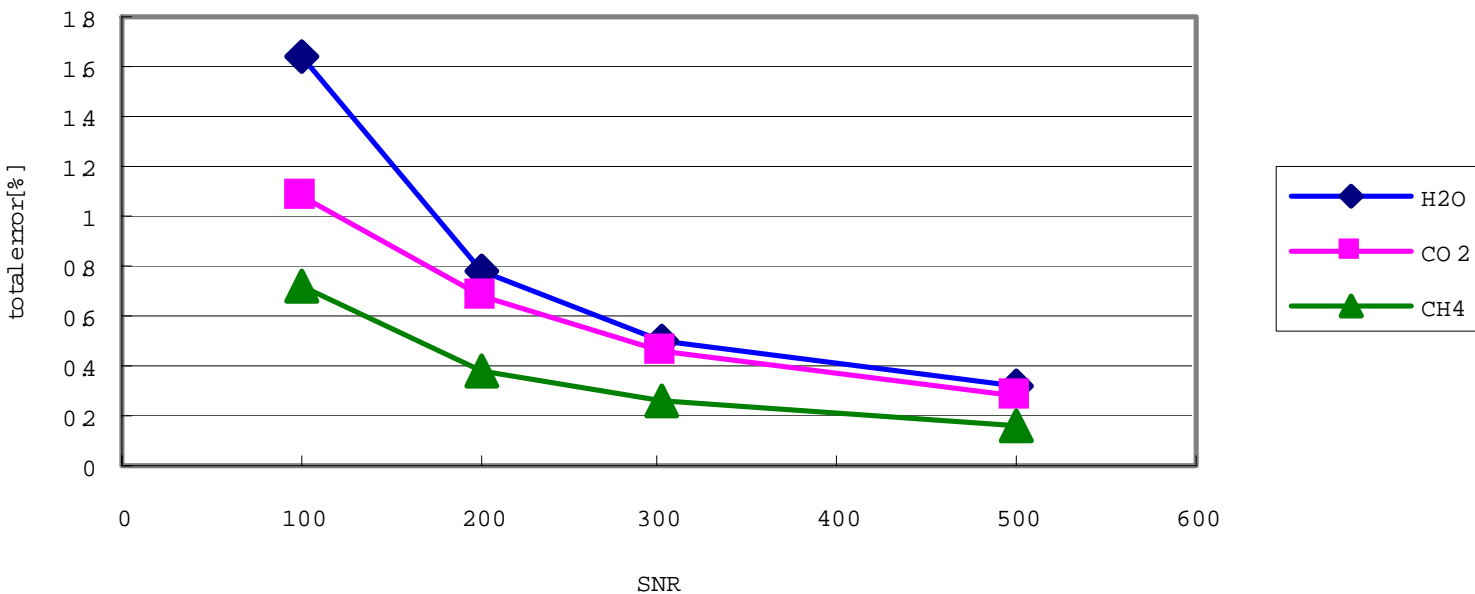
# Spectra of Methane



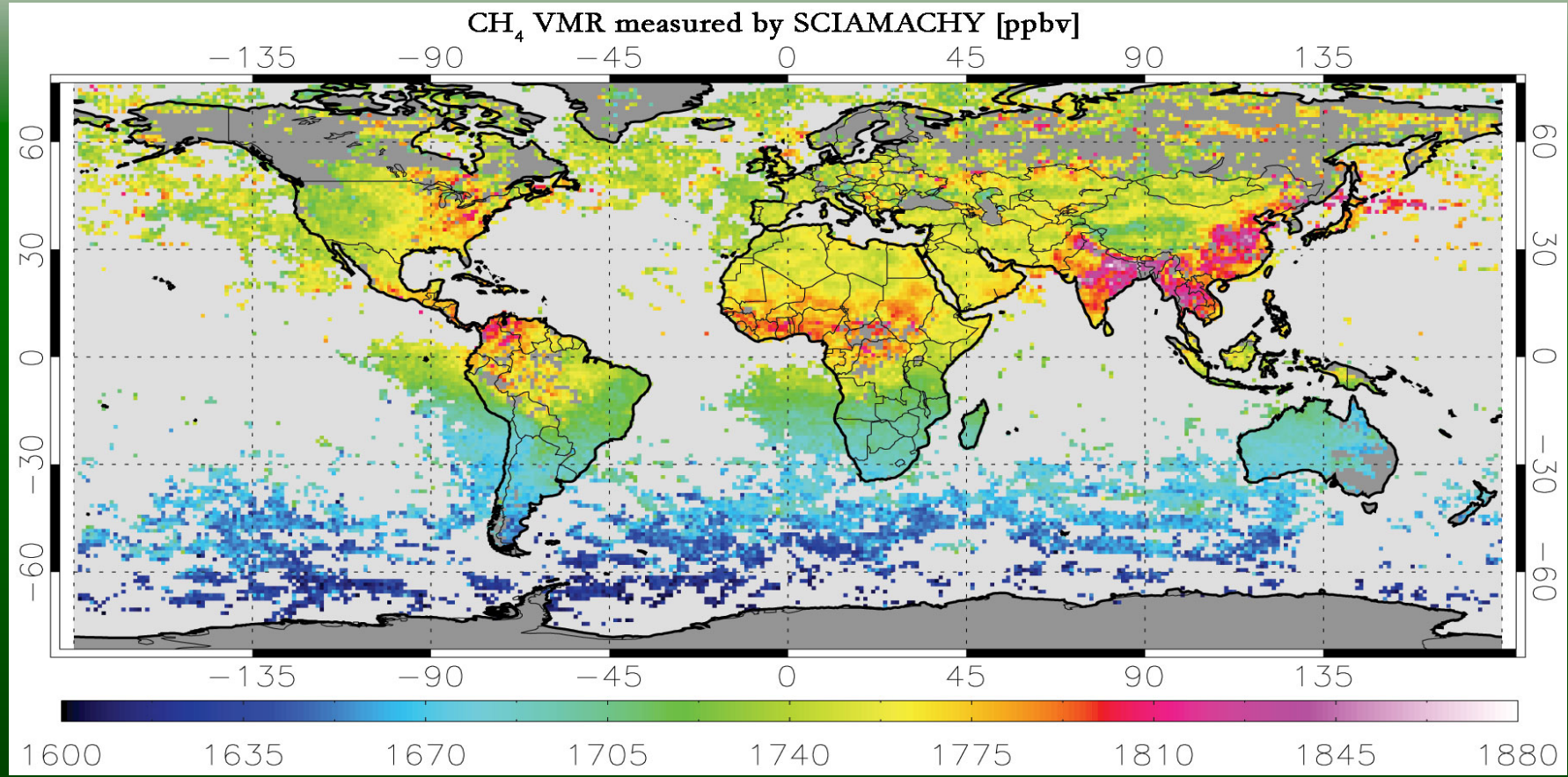
Ground  
Observati  
on Data

Position of  
CH<sub>4</sub>,CO<sub>2</sub>  
and H<sub>2</sub>O  
absorption

Difference  
between  
Observati  
on and  
Analysis



- Precision is dependent on the Signal to Noise Ratio and the Spectral Resolution.
- In case of GOSAT,  $SNR > 300$ , and  $\Delta\nu = 0.2 \text{ cm}^{-1}$
- Precision of 3 ppb or better is expected.



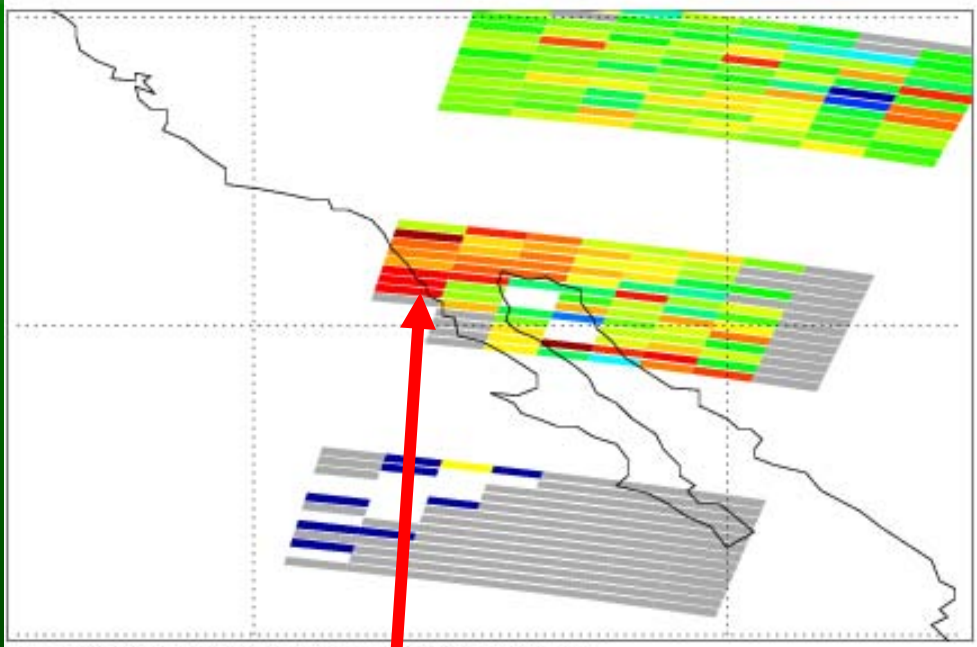
SCIAMACHY(6cm-1) 20 ppb resolution

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Miranda van den Broek, Sander Houweling, Ilse Aben  
Netherlands Institute for Space Research - SRON

# SCIAMACHY/WFM-DOAS CO columns

CO SCIA/WFMD 20031026

VC [ $10^{18}$  molec/cm<sup>2</sup>]



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**Fires in Southern California Oct/Nov 2003**

**Modis/Terra 20031026**



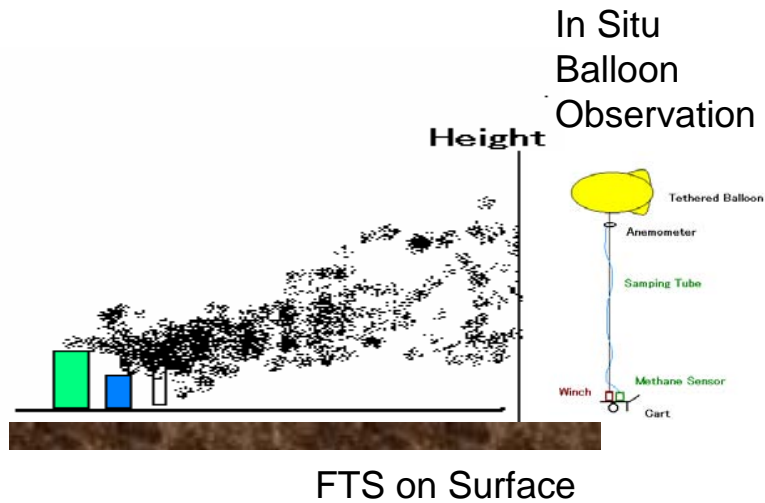
**San Diego:**  
**CO plumes from fires**

# GOSAT

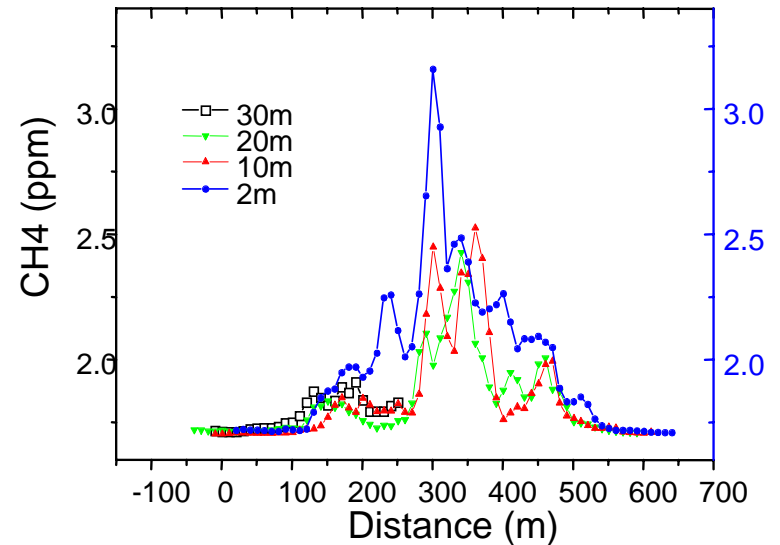
## Greenhouse gases Observing SATellite

- Principle of Operation
- Precision of Measurement
- Validation

$$\text{Flux} = \text{Concentration} \times \text{Wind speed}$$

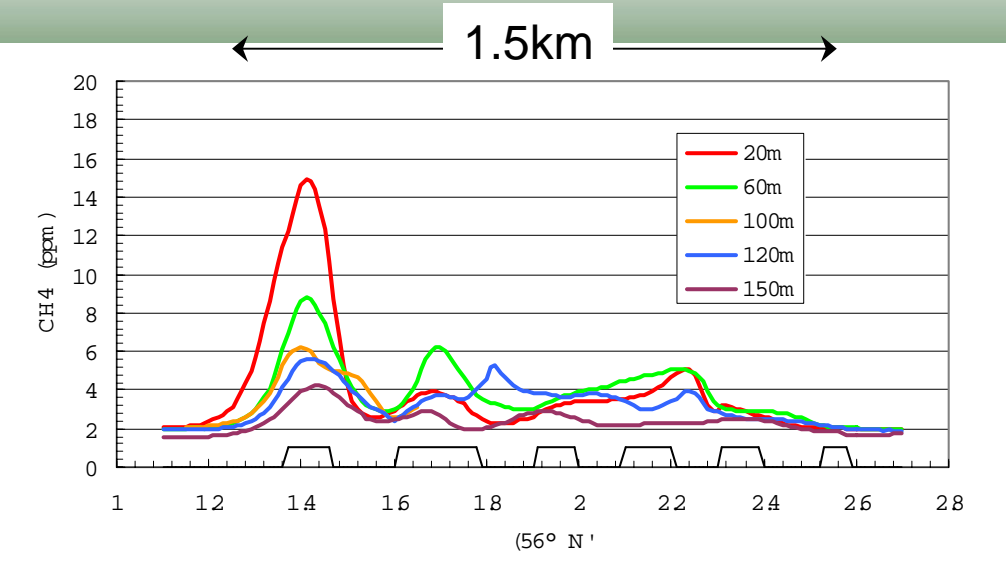


Continuous leak rate observed in East Europe

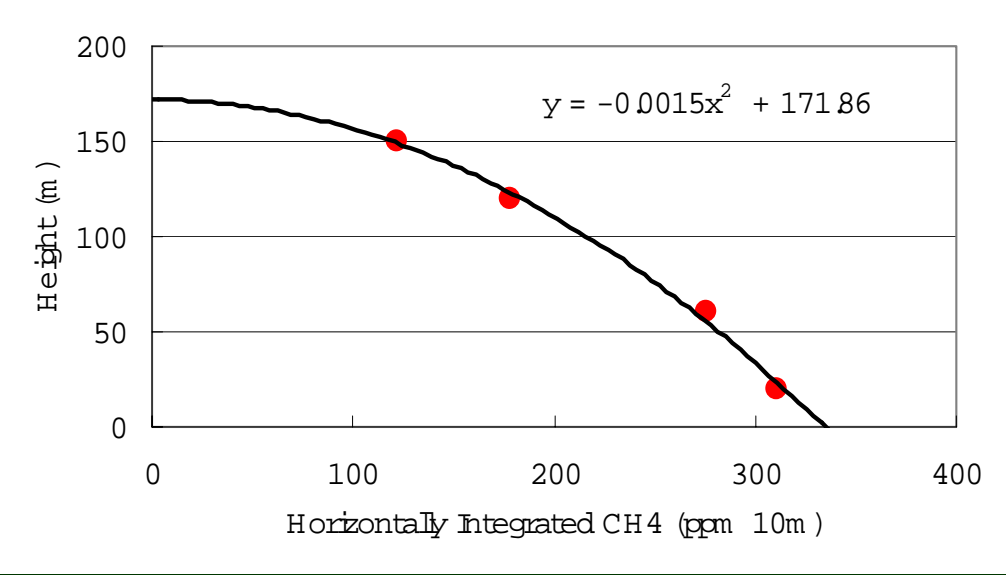




# Example of Ground observation

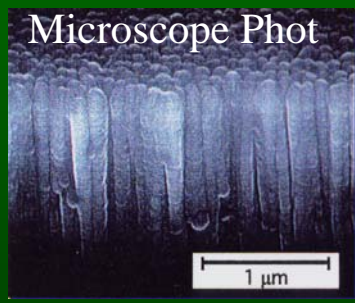
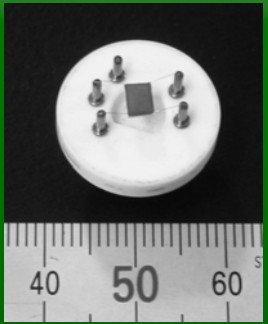
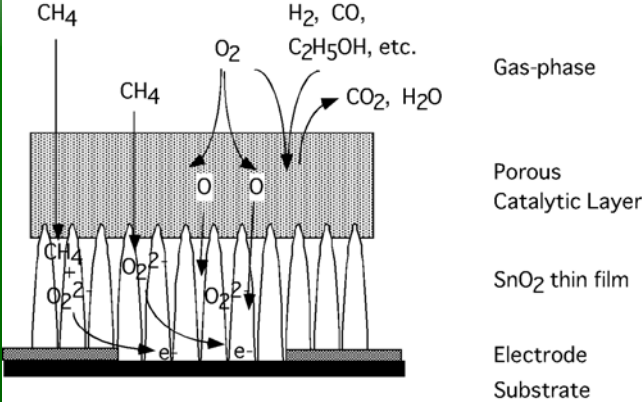


CH<sub>4</sub> concentration was observed at 500 m downstream of compressors. When it expands to 8 km in width, and 100m in height, the concentration will be about 4ppm.



The flux estimated is Q=73tCH<sub>4</sub>/day

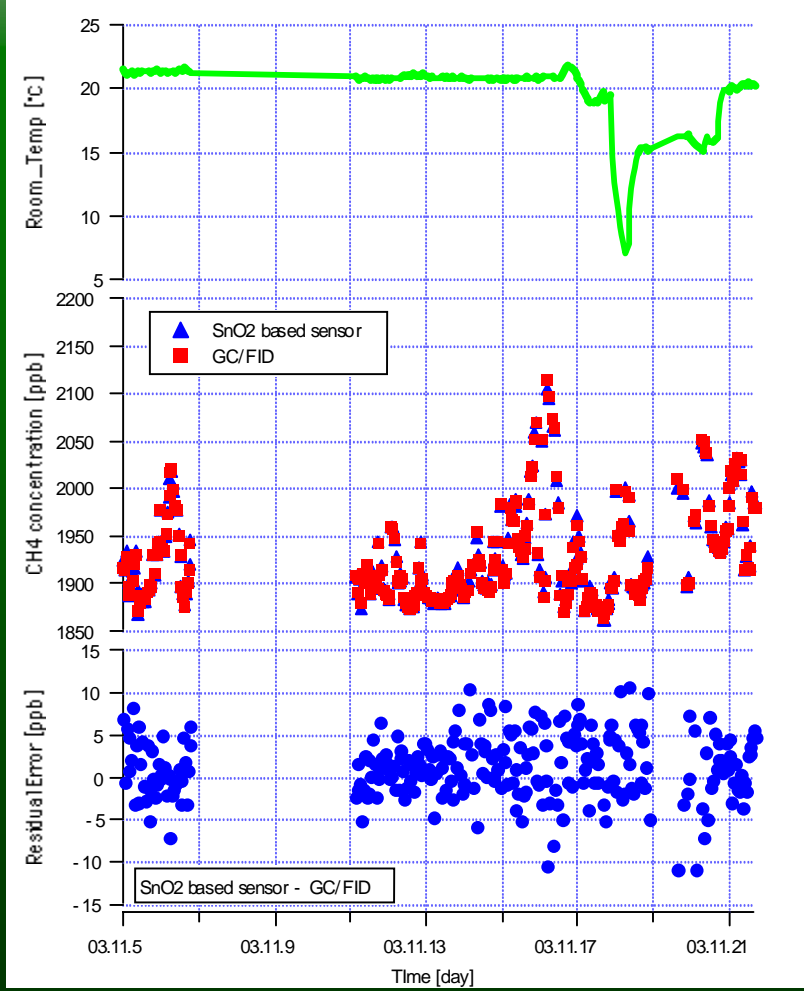
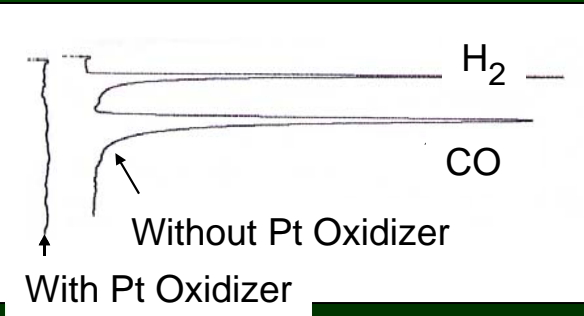
Flammable gas reacts with  $O_2^-$  and release electron



1. Sensitized by multi-pole structure

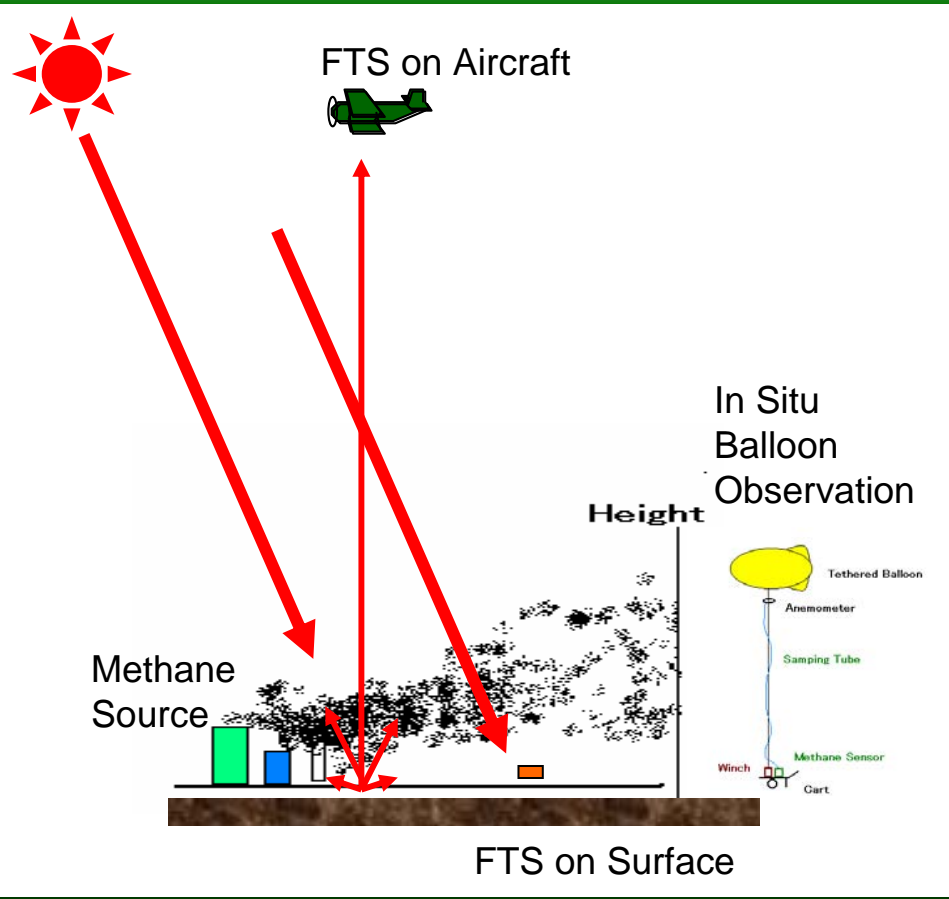
2. Nano-particles of Pt remove CO and H2

3. Water vapor was removed completely

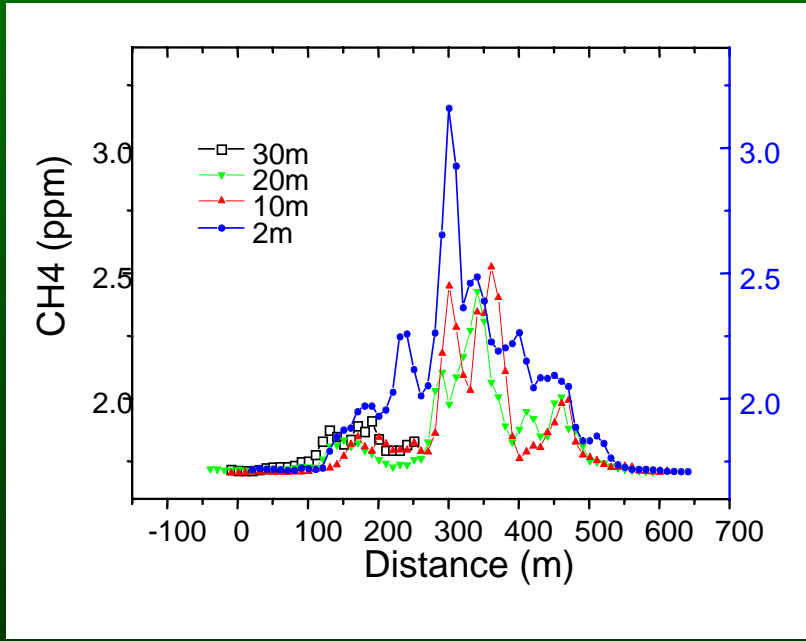


Precision is 3 ppb

# Ground observation



Continuous leak rate observed in East Europe  
 $1 \text{ ppm} \times 100\text{m} / \text{total CH}_4 \text{ column} = 0.1\% \text{ precision}$





Window to be replaced by quartz



IL-76

Wing span=50m, Length = 47m  
Cruising speed = 750-800 km/hr  
Flight distance = 5,000 km  
Payload = 40 t    Seven crews

Cessna 206

Wing span=11m, Length = 9m  
Cruising speed = 272 km/hr  
Flight distance = 1,260 km  
Payload = 0.7 t

## Conclusion

- The observation of CH<sub>4</sub> in the precision of 0.25% means that the 4ppb difference in column can be detectable.
- If the field of view is 10 km<sup>ϕ</sup>, the total mass of air is 0.8x10<sup>(12)</sup>kg in it. The amount of 4 ppb corresponds to 3 tCH<sub>4</sub> in 10 km square. If the transportation is 100 km/day, the leak of 30 tCH<sub>4</sub>/day is detectable. If it is calm, the minimum detectable leak rate decreases.
- There is the records of leakage 45, 79, or 0.73 tCH<sub>4</sub>/day stationary at compressor stations, and some of them are detectable.
- The leakage which is lead to explosion is more than this amount.