Summary of the Final Report of Research Results

1) Title of the proposed research

An instrument prototype for column CO_2, CH_4 and N_2O using direct solar flux

2) Principal Investigator (PI) and Co-Investigators (Co-Is)

PI:

Dr. Masahiro Kawasaki

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3) PI's affiliation

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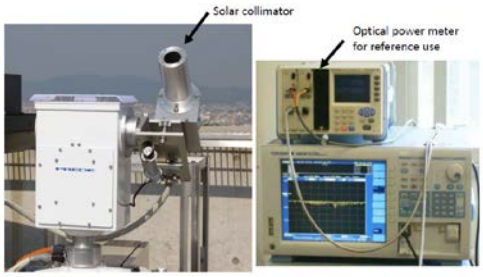
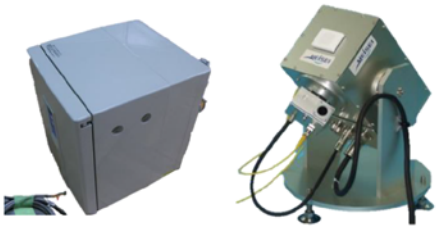
4) Summary of the Final Report of Research Results

Remotely operable compact instruments for measuring atmospheric greenhouse gas column densities have been developed in two independent systems: one utilizing a grating based desktop optical spectrum analyzer (OSA) with a resolution enough to resolve rotational lines of CO_2 and CH_4 in the regions of 1569–1575 and 1670–1680 nm, respectively; the other is an application of an optical fiber Fabry-Perot interferometer (FFPI) to obtain the CO_2 column density, which is inspired by a solid-state FFPI reported by Wilson *et al.* (Wilson, E. L., Georgieva, E. M., and Heaps, W. S.: Development of a Fabry-Perot interferometer for ultra-precise measurements of column CO_2, ***Meas. Sci. Technol.*, 18**, 1495, 2007). Direct sunlight was collimated via a small telescope installed on a portable sun tracker and then transmitted through an optical fiber into the OSA or the FFPI for optical analysis.

Optical spectrum analyzer and a solar collimator on a sun tracker with optical fiber connection



Solar Fabry-Perot interferometer in a temperature controlled box and a collimator on a sun tracker with optical fiber connection



The practical usefulness of the OSA instrument was examined in two separate measurement campaigns. The first comparison involved operating the OSA in parallel with a high resolution Fourier transform spectrometer. The second comparison is a calibration against aircraft CO_2 profiles *in situ* during a GOSAT validation campaign. The xCO_2 values in the campaign are in excellent agreement with the integrated aircraft profiles. Due to its portability, the FFPI instruments were set in central Kalimantan, Indonesia, as a part of measurement reporting validation MRV activities for CO_2 emission reduction during the forest/peatland fire season. In this campaign, two sets of the FFPI instruments were deployed parallel to the predominant wind direction at two cities, respectively. Two months of column data were automatically obtained. A large increase in xCO_2 was detected, which was caused by large scale forest and peatland fires between the two cities.

Field campaigns have shown that both instruments are promising technologies for measuring atmospheric CO_2 and CH_4 column densities at surface sites. Due to their smaller size and lower cost these instruments are expected to provide a supplemental measuring system to the existing surface site network. We are working to establish an operating structure that allows effective monitoring, especially in situations and

regions where there has not yet been sufficient data collection to quantitatively assess the greenhouse gas emissions.

5) List of publications relating to the proposed research

1. N. Kobayashi, G. Inoue, M. Kawasaki, H. Yoshioka, M. Minomura, I. Murata, T. Nagahama, Y. Matsumi, T. Tanaka, I. Morino and T. Ibuki, "Remotely operable compact instruments for measuring atmospheric CO_2 column densities at surface monitoring sites", *Atm. Measure. Tech.* **3** (4) 1103-1112 (2010)
2. M. Kawasaki, H. Yoshioka, N. B. Jones, R. Macatangay, D. W. T. Griffith, S. Kawakami, H. Ohyama, T. Tanaka, I. Morino, O. Uchino, and T. Ibuki "Usability of optical spectrum analyzer in measuring atmospheric CO_2 and CH_4 column densities: substantiation with FTS and aircraft profiles in situ", *Atmos. Meas. Tech.,* 5, 2593–2600 (2012)
3. Masahiro Kawasaki, Masafumi Ohashi and Gen Inoue, "Carbon emission measurement by a portable CO_2 column spectrometer", *SPIE Newsroom,* 10.1117/2.1201313.004659 (2013)