Estimation of anthropogenic CO2 emission from Kanto region, include Tokyo

Y. Arai(1), R. Imasu(1), Q. Wang(1), H. Kondo(2)

1:Atmosphere and Ocean Research Institute (AORI), The University of Tokyo, 2:National Institute of Advanced Industrial Science and Technology (AIST)

About CO2 emission sources and sinks in Kanto region

- In Kanto region, CO2 emissions from anthropogenic and plant activities are complicated (Fig.1, Fig.2).
- It has been reported that there are problems with CO2 emission sources and sinks for many models.
- Attempts have already been made to improve the emission sources and sinks of CO2 from plant activity (Wang et al., 2021).
- This study focuses on improving anthropogenic CO2 emissions.

Created by processing 「National Land Information (Urban area land use subdivision mesh data, Power generation facility data)」(Ministry of Land, Infrastructure, Transport and Tourism of Japan)
About anthropogenic CO₂ emissions

ANTHROPOGENIC CO₂ EMISSION INVENTORY (2000, IN REGION)

**Fig.3:** Monthly anthropogenic CO₂ emissions within the model area

- The time scale of emissions differs depending on the each inventory (such as monthly average emissions, annual average emissions) (Fig.3).
- Grid size depends on each inventory (Fig.4).
- ODIAC (v2019, TIFF) has the most detailed grid size. However, since ODIAC is monthly average data, EAGrid 2000 JAPAN, which is the amount of emissions for each month and each time, had been used in this study.

EAGrid: The East Asian Air Pollutant Emissions Grid Database (Kannari et al., 2007)
About AIST-MM model and the method to estimate CO$_2$ emission

AIST-MM: National Institute of Advanced Industrial Science and Technology - Mesoscale Model (Kondo et al., 2001), MSM-GPV: MesoScale Model-Grid Point Value, ANTHROPOGENIC HEAT (Kayaba et al., 2010; Hokari et al., 2015), NCEP: National Centers for Environmental Prediction, RTG SST HR: Real-Time Global Sea Surface Temperature High Resolution (Gemmill et al., 2007), LETKF: Local Ensemble Transform Kalman Filter (Miyoshi et al., 2007), WDCGG: The World Data Centre for Greenhouse Gases, CONTRAIL: Comprehensive Observation Network for TRace gases by AIrLiner (Machida et al., 2008)

The error model for each member was created by anthropogenic CO$_2$ emission which was given about ± 10% error. LETKF method was adapted in this calculation part.
GOSAT observations exist in the northern part of the region (Fig.6), but anthropogenic CO₂ emissions were hardly improved due to the small spread of CO₂ column mass concentration errors (Fig.8).

Anthropogenic CO₂ emission correction rate around Tokyo Bay has been larger than other area due to the relationship among observation position (Fig.6) and the spread of anthropogenic CO₂ emission errors (Fig.7) and the spread of CO₂ column mass concentrations errors (Fig.8).
Anthropogenic CO₂ emissions were improved due to the relationship among observation position (Fig.10) and the spread of anthropogenic CO₂ emission errors (Fig.11) and the spread of CO₂ column mass concentrations errors (Fig.12). Especially, as there were many OCO-2 observation numbers, anthropogenic CO₂ emissions were improved strongly.

As OCO-2 observations didn’t exist in the western and southern part of the region (Fig.10), anthropogenic CO₂ emissions in the area weren’t improved.
Assimilation using CONTRAIL observation or in-situ observation,

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Anthropogenic CO$_2$ emissions were improved very weakly in case to use CONTRAIL observations (fig.14, fig.15).
Anthropogenic CO$_2$ emissions were improved very strongly in case to use in-situ observations (fig.16, fig.17).

It was because that anthropogenic CO$_2$ emissions, which were given errors, existed almost near ground surface. So the higher observation altitude was, the smaller the spread of the CO$_2$ concentration error was.

- It has become possible to estimate anthropogenic CO$_2$ emissions by assimilation calculation using various observations.
- The parameters used in the assimilation calculation must be adjusted.
- The AIST-MM model itself needs further improvement.