

論文 / 著書情報  
Article / Book Information

題目(和文)	熱帯域大都市ジャカルタの領域スケールから微気象スケールの気象観測的研究：季節変化、海風、CO2
Title(English)	Regional to Micrometeorological Observation in Tropical Megacity of Jakarta: Season, Sea Breeze, and CO2
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種別(和文)	論文要旨
Type(English)	Summary

(博士課程)  
Doctoral Program

## 論文要旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	融合理工学系 地球環境共創	系 コース	申請学位 (専攻分野)： Academic Degree Requested	博士 Doctor of	(Engineering)
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### 要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words )

This study is an attempt to extend knowledge on urban atmospheric variabilities in Jakarta with emphasis on sea breeze variation and structure, and CO<sub>2</sub> flux exchange. The study is mainly based on multi-year surface observation in Jakarta, which utilizes a combination of fast-response and slow-response sensors. The study also employs high-resolution meso-scale modeling to complement the observation. While the grand aim is to better understand urban atmospheric condition in Jakarta, the objectives of this study are limited to three (3) objectives which are, 1) investigate the sea breeze seasonal variation and impact of the city to the variation; 2) describe the typical structure of sea breeze in Jakarta; and 3) analyze the diurnal pattern of CO<sub>2</sub> flux and concentration in Jakarta and the possible influence of the diurnal sea/land breeze circulation. The three objectives were reported in the three main chapters, alongside introduction, background theory, and a summary in the last chapter.

To accomplish the first objective, seasonal variation of the sea breeze in Jakarta is analyzed using multi-year near-surface observation data for wind, temperature, humidity, and radiation is analyzed. Observations were conducted at two urban sites in Jakarta which are located on the coast of Jakarta Bay and in the urban core, respectively. Decomposed wind observations showed a strong relationship between diurnal zonal wind and annual circulation, which was used to differentiate the dry and rainy seasons in Jakarta. The sea breeze is found to have started earlier, propagated faster, and was of shorter duration during the rainy than dry season. In the dry season, more intense radiative cooling overland will create higher temperature gradient between sea and land which produce stronger land breeze. This will make the sea breeze start later and its propagation become slower. Meanwhile, in the rainy season, the presence of clouds during the night and early morning played an important role in making a less gradient between sea and land, causing earlier sea breeze onset and faster propagation due to weaker land breeze. The existence of Jakarta urban area will prolong the sea breeze duration, especially during the dry season due to its larger thermal inertia. Furthermore, Jakarta urban area may also amplify the land breeze, induce urban heat island (UHI) circulation, or create a more intense daytime heating to the gravity current as its transe the city.

The research to fulfill the second objective is carried out using numerical simulation of 7 typical sea breeze days using WRF model with detailed urban representation. The WRF model was able to simulate sea-breeze features and boundary layer characteristic of the targeted area. A lower boundary layer over the city after sea-breeze passage is well simulated and indicates the existence of thermal internal boundary layer. The shape of the coastal line around Jakarta Bay influences the starting point of sea breeze landfall and affects the condition of the atmospheric boundary layer (ABL) above Jakarta. Different timing of arrival between sea breeze front (SBF) over Jakarta and SBF over east and west sub-urban area causing non-uniform ABL height in the east-west direction, whereas the ABL over Jakarta is lower than the sub-urban area. This variation might affect pollutant concentration in Jakarta as it was observed to CO<sub>2</sub> concentration.

The last objective is accomplished by analyzing the multi-year CO<sub>2</sub> observation in urban core area of Jakarta in relation to influence of sea and land breeze circulation discussed in previous themes. The diurnal pattern of CO<sub>2</sub> flux shows one peak in the afternoon, which differs from daily traffic condition which shows peaks in the morning and afternoon. Sea and land breeze advection strongly influence the diurnal pattern of CO<sub>2</sub> flux in Jakarta. On the other hand, daily averaged CO<sub>2</sub> concentration has strong inverse-correlation with daily averaged boundary layer height with lag time of 1-hour. A significant decrease in CO<sub>2</sub> flux is observed from 2020 to 2021 due to traffic restrictions imposed during COVID-19 pandemic. While CO<sub>2</sub> flux varies significantly because of the pandemic, CO<sub>2</sub> concentration shows less significant changes. Since the lifetime of CO<sub>2</sub> in the

atmosphere is more than 19 years, reduction of CO<sub>2</sub> emission during COVID-19 pandemic may not result in significant reduction of CO<sub>2</sub> concentration in Jakarta. On longer time scales, CO<sub>2</sub> concentration shows a steady increasing trend that is in line with the global background CO<sub>2</sub> trend, but slightly higher. The CO<sub>2</sub> concentration trend in Jakarta is 0.6 ppm year<sup>-1</sup> higher than global trend, suggesting that Jakarta can be considered as net source of CO<sub>2</sub>.

This study might be the first attempt to study the micrometeorological urban CO<sub>2</sub> flux exchange in Jakarta. It is hoped that this study will contribute to atmospheric sciences in Indonesia, especially for meso- and micro-scale meteorology. The observation results conducted in this study is also hoped to become invaluable reference for future urban micrometeorological studies in Jakarta or generally in Indonesia.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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