

論文 / 著書情報
Article / Book Information

題目(和文)	静止衛星画像の数値処理による都市域の海風フロント検出
Title(English)	Detection of Sea-breeze Inland Penetration over Coastal Urban Region using Geostationary Satellite Images
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第11494号, 授与年月日:2020年3月26日, 学位の種別:課程博士, 審査員:神田 学,木内 豪,高木 泰士,中村 恭志,稲垣 厚至
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第11494号, Conferred date:2020/3/26, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

系・コース : Department of, Graduate major in	Transdisciplinary Science and Engineering	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)

Atmospheric-boundary layer (ABL) is the lowest part of the atmosphere which is directly interacting with the earth's surface. Within the ABL, sea breeze is a common process which is detrimental to the sustainability of the coastal-urban environment. Meanwhile, the advancement in temporal and spatial resolution of the next-generation geostationary satellite provides potential benefits of deeper understanding the ABL processes including sea breeze.

The study aims to construct a framework to derive a two-dimensional distribution of sea-breeze front (SBF) using geostationary satellite images. The framework includes the application of morphological snake algorithm into visible band images for automated detection of the cumulus cloud-lines associated with SBF. Verification was undertaken by comparing the passage time of the cloud-line with the arrival time of the SBF estimated from ground observation.

The research work consists of three steps. The first is the cloudiness classification and the sea-breeze days (SBD) screening. Cloudiness was classified into cumulus cloud-line, cumulus rolls, irregular and clear-sky pattern. SBD was detected based on the existence of the land-breeze and sea-breeze mode. Both modes should show stable flow at least in four consecutive hours in early morning and afternoon, respectively.

The second step is the application of the morphological snakes algorithm in the visible-band satellite images to detect the cumulus cloud-line automatically. The visible band measures the albedo or reflectivity of the object such as ocean and land surface, vegetation and clouds. In this study, the albedo values were normalized using solar and satellite zenith angle. And the threshold for cloud was 0.3. Based on this threshold, the binary images of all cloud-line cases were created. The edge of these cloud-lines were then detected automatically using the morphological snakes.

The final step is the verification of the SBF arrival using the ground observation. We first applied the framework over Jakarta, Indonesia. The results show that the cloud-line was reasonably able to represent the arrival time of the SBF with a bias time of 20 minutes and within a distance of 3 km. The mean penetration speed obtained from the cloud-lines passage was slightly slower than that estimated from the arrival time of SBF (1.4 m/s and 1.5 m/s, respectively). In certain cases, the cloud-lines passage was found to be behind the SBF more than 5 km, particularly in the city center. This finding suggests the presence of enhanced updrafts due to urban-heat-island (UHI) circulation which potentially delays cloud-line propagation under certain prevailing wind condition.

In order to evaluate the framework's global applicability, it was further tested in Tokyo, Japan. In Tokyo, two sea-breeze systems were detected. The average sea-breeze inland penetration speed was estimated to be ~ 2.8 m/s and ~ 1.8 m/s from Sagami Bay and Tokyo Bay, respectively. Compared to Jakarta case, the overall inland penetration speed of SBF over Tokyo was slightly larger than Jakarta. The main reason for this, the magnitude of the mean wind and the orientation of the synoptic prevailing wind to the direction of the sea-breeze

penetration can be considered. However, similarly to Jakarta case, the long-lasting cumulus cloud appeared over urbanized area of Tokyo. Moreover, the different penetration speed of SBF over urbanized area and less-urbanized area can be verified from both the observation and the estimated passage time of the cloud-lines. The current results support previous findings regarding the impact of synoptic-regional wind, UHI, and urban roughness to the inland penetration of sea breeze and the associated cloud formation.

This work contributes to the detection of SBF at high temporal and spatial scales (10 minutes, 500-m). Accurate estimating SBF serves a broad purpose including thermal and pollutant dispersion within and outside of cities. It is to be noted, however, that the method will undergo further developments in the future. Currently, the method is only applicable to sea-breeze events accompanied by cumulus cloud-line formation. Nevertheless, considering that sea breeze events with cloud-lines are frequently observed both in the tropics and mid-to-high latitude areas, the method can be applicable to a big percentage of coastal regions covered by all available geostationary satellites all over the world.

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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