Investigation of Sea Breeze Pattern and Mechanism over Ehime Region by Using Numerical Model WRF

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1. INTRODUCTION

It is now widely recognized that human activities are influenced by the weather elements such as wind, temperature, humidity, and rain. For example, the local wind circulation pattern, sea breeze gives significant impacts on the transportation of pollutants from the coastal area to inland area. The general pattern of sea breeze over Matsuyama Plain was investigated in a previous study by Miyagawa (2015). The study suggested that sea breeze has two patterns; one blows from southwest and the other blows from northwest. However, the mechanism itself has not been investigated. Because at the local scale of Matsuyama, the difference of the sea level pressure when the southwesterly sea breeze and northwesterly sea breeze occurs could not be seen. Therefore, in this study the characteristics of the local wind circulation pattern was investigated using numerical model in wider scale, Ehime region.

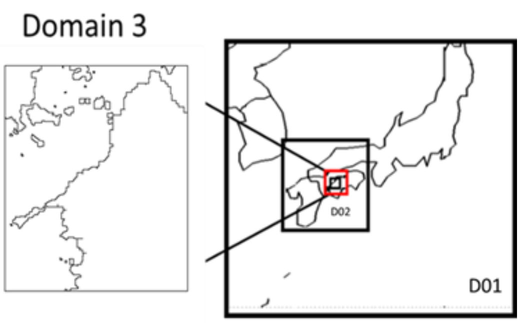

Fig: 1 Domain set up model

2. METHODOLOGY

In this study we used two approach, the first is the statistical approach and the second is numerical simulation approach. In the statistical approach, in order to classify the sea breeze pattern over Ehime Region, the hourly data observed at Automated Meteorological Data Acquisition System (AMeDAS) at several stations were used. The period investigated was August from 2006 to 2016. The sea breeze pattern was classified on cloudy days and sunny days by using the sunshine duration which is the one of the significant factors that influence the local wind circulation pattern).

In the second approach, the NCAR Advanced Research WRF (ARW) modeling system is applied in order to simulate the local sea breeze pattern and mechanism over the Ehime Region. During this study we conducted multi-nested experiment for four domains with different horizontal resolutions of 30 km (D01), 7.5 km (D02), 1.875 km (D03), and 469 km (D04), respectively. The third domain (D03) was used to simulate the synoptic situation over Ehime region. The initial and lateral boundary meteorology data which was used to run the model has been downloaded from the National Centers for Environmental Prediction (NCEP). Time integration was conducted from 1200 UTC 06 August–1800 UTC 09 August 2015 (2100 JST 06 August 2015-0300 JST 10 August 2015). The simulation result at 07

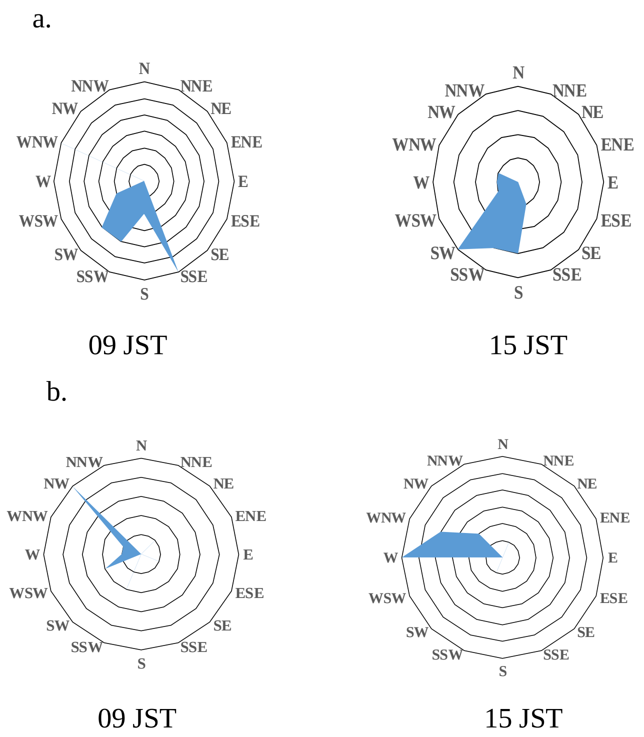

Fig 2. Statistical analysis result of wind direction over Matsuyama at **a.** cloudy days and **b.** sunny days

August 2015 was used to analyze the local wind circulation pattern at cloudy day and the result at 09 August 2015 was used to analyze local wind circulation pattern at sunny day.

3. RESULTS AND DISCUSSION

The simulated wind direction was in good agreement with observed wind direction (see Fig.2. and Fig.3.). Fig. 3a shows that at the cloudy day southeasterly land breeze blows toward Matsuyama until 0900 JST. In the afternoon, At 1500 JST the northwesterly and westerly sea breeze that blows over Matsuyama plain turned to southwesterly sea breeze.

Fig. 3b shows that at sunny day, the sea breeze onset at the typical sunny day was faster than typical cloudy day. The northwesterly and westerly sea breeze already penetrate Matsuyama at 0900 JST. At 1500 JST, unlike at cloudy day, at sunny day the westerly sea breeze still continuously blows toward Matsuyama.

The difference of the sea breeze onset at typical cloudy day and sunny day was caused by differential daytime heating as a consequence of long sunshine duration at typical sunny day (Fig.4). The difference in sea breeze direction at 1500 JST was caused the difference in sea level pressure pattern at typical cloudy day and sunny day (Fig.5). At typical cloudy day sea level pressure in Mastuyama was lower than in Nanyo area, whereas at typical sunny day the sea level pressure in Matsuyama is higher than in Nanyo area. This is because at the typical sunny day temperature in Nanyo area, exactly in Ozu basin was higher than that in Matsuyama as a result of the combined effect of heating from the urban surface and subsidence heating associated with the cross-valley circulation.

4. CONCLUSION

Sea breeze onset on sunny days seems to be faster than that on cloudy days. That difference was caused by differential daytime heating as a consequence of long sunshine duration on sunny day.

And the difference in sea breeze direction at 15 JST was caused by the difference of sea level pressure pattern on sunny day and cloudy day.

REFERENCE

Miyagawa, Kohsuke. *Study on the relationship between invasion behavior of sea breeze and the concentration of air pollutant in Matsuyama Plain* [Thesis]. Ehime University, 2015.

ACKNOWLEDGEMENT

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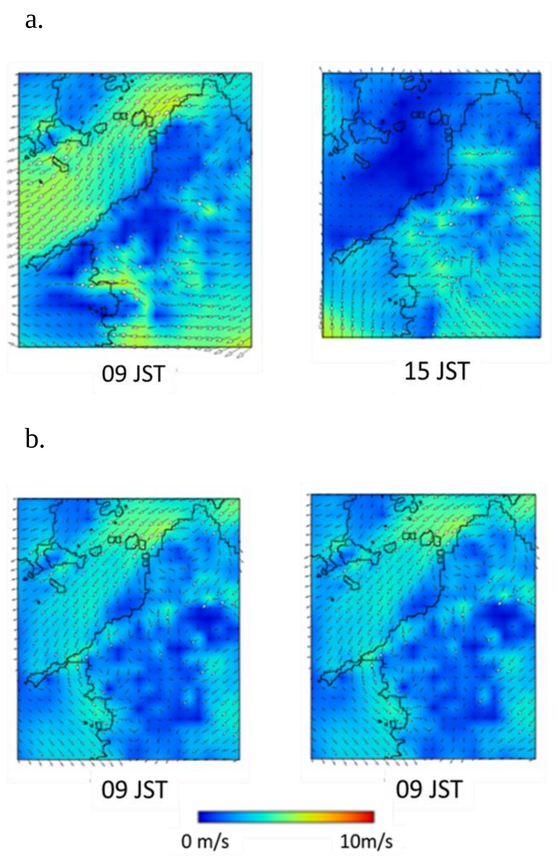

Fig 3. Simulation result of wind speed and wind direction at **a**. cloudy day(7 Aug 2015) and b. sunny day (9 Aug 2015)

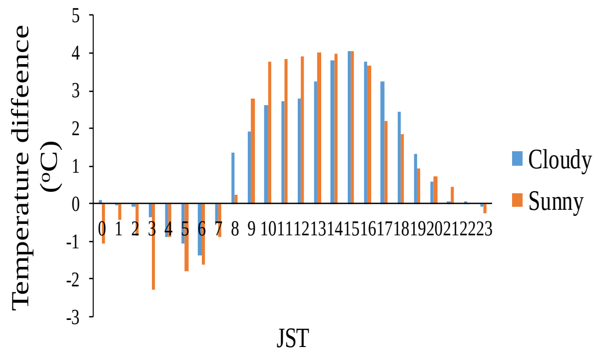

Fig 4. The near surface temperature difference between the inland area (Matsuyama) and above the sea region

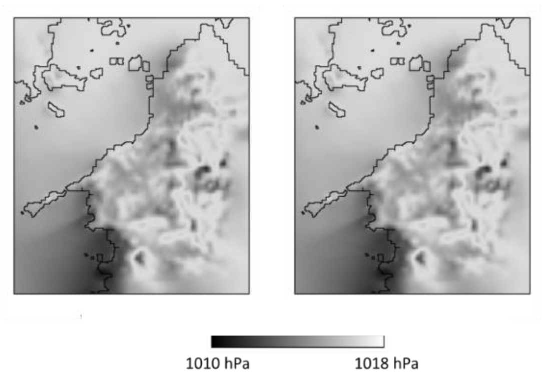

Fig 5. Sea level pressure at 1500 JST at a. cloudy day (7 Aug 2015) b. Sunny day (9 Aug 2015).