Warming and cooling impacts of the reclamation works in Osaka Bay on climate in Keihanshin region

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1. Introduction

It is well known that the urbanization increases the daily minimum temperature rather than the daily maximum temperature, and therefore decreases the diurnal temperature range (DTR) (e.g., Arakawa, 1938). Some numerical studies under idealized conditions indicate that reclamation works increase the daytime surface air temperature (SAT) more than the nighttime SAT (e.g., Kimura and Takahashi, 1991). The DTR observed at Osaka, one of the most urbanized cities in Japan, for the last 100 years, does not show a monotonic decrease but multi-decadal variations (Ito et al., 2008). Thus, the works on Osaka Bay may cause the increase in DTR. In this study, the effects of the land reclamation in Osaka Bay on the climate in Keihanshin region are investigated with numerical experiments.

2. Methods

Numerical experiments are conducted by Japan Meteorological Agency Non-Hydrostatic Model (JMA-NHM) under two different surface conditions, a past coastline case and a present coastline case, to assess the effects of large-scale reclamation and landfill works on Osaka Bay area on the climate in Keihanshin region. The past coastline is a coastline around 150 years ago estimated from the old maps, which is around 8 km inland compared to the present coastline. The domain of interest is a 111 km square with its center at Osaka, and is spaced at 1 km grid intervals in a nested fine grid model. The model is integrated for 30 hours from 21:00 JST for chosen 14 or 15 days in each season under clear-sky and calm wind conditions.

3. Results

Direct influences of the works appear over the reclaimed land as a warm anomaly during the daytime and as a cold anomaly during the nighttime. The warm anomaly

expands over the Keihanshin region following the sea breeze, and the expanding speed gives close agreement with the penetrating speed of the sea breeze front. The warm anomaly reaches 40 km inland in the evening in summer (Fig. 1), and is lifted up to about 1 km by the upward motion induced at the sea breeze front. The cold anomaly, in contrast, slowly expands inland against the land breeze in the early morning in cold seasons (Fig. 2). The impact of the cold anomaly is quantitatively small, but statistically significant at 99.5 % level.

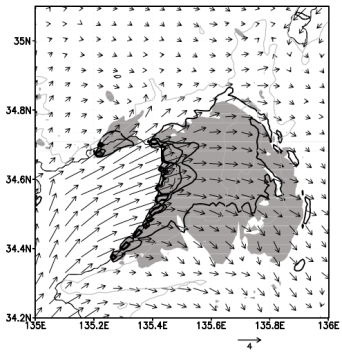

Fig. 1 SAT difference (contours) and surface wind vectors in present case (arrows), averaged over the 14 days in summer, at 16:00 JST.

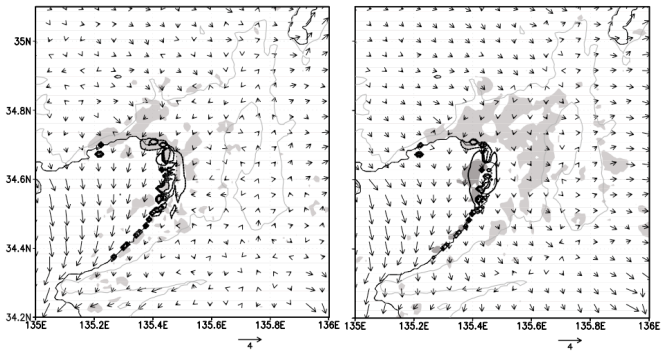

Fig. 2 Same as in Fig.1, but for 15 days in winter at 9:00 JST (left panel) and 10:00 JST (right panel).

4. Conclusion and discussion

Numerical experiments with JMA-NHM indicate that the reclamation works in Osaka Bay leads to a significant increase in SAT over the inland during the daytime and a slight decrease in SAT during the nighttime. Therefore, there is a possibility that it is one factor causing an increase in DTR observed at Osaka. In smaller and medium-size cities which are not urbanized well, the effects of the reclamation works may be more significant.

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