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Analysis of WRF-simulated thermally driven diurnally periodic boundary-layer wind signals in Eastern China

Yu Du (1,2), Richard Rotunno (2), and Qinghong Zhang (1)

(1) Laboratory for Climate and Ocean-Atmosphere Studies, Department of Atmospheric and Oceanic Sciences, School of Physics, Peking University, Beijing, China (yudu@pku.edu.cn; qzhang@pku.edu.cn), (2) National Center for Atmospheric Research, Boulder, Colorado, USA. (rotunno@ucar.edu)

Using hourly model data for the period June 2006-2011 simulated with the Weather Research and Forecasting (WRF) mesoscale model with full physics, the low-level diurnal winds for different locations of eastern China and the characteristics of thermally driven diurnally periodic wind signals off the east coast of China are studied.

A simple 1D model, including both diurnal thermal forcing and diurnally varying boundary-layer friction, is found to explain important features of the WRF-simulated diurnal boundary-layer winds in eastern China. For example, in northeastern China, at a similar latitude, the maximum velocity parallel to the coastline at a longitude over the ocean occurs earlier than the maximum velocity parallel to the inland chain of coastline-parallel mountains at a longitude over land. This difference can be identified with the well-known Blackadar effect over the land. Off the east coast of China, the diurnal winds for different latitudes over the ocean vary in both phase and amplitude, consistent with expectations based on the simple 1D model.

Analysis of WRF model data indicates low-level diurnally periodic wind signals propagate eastward off the southeast coast whereas diurnal wind variations off the northeast coast are nearly in phase. It is found that a simple 2-D linear land-sea-breeze model with friction can capture this main difference in propagation character with respect to latitude. Idealized simulations using a simplified version of the WRF model that includes surface heating and terrain are found to explain certain features not captured by the present linear theory such as the absolute time phase and cross-coast location of the maximum amplitude of the diurnally period winds.