Characterization of the Boundary Layer Structures and Local Airflow over the Complex Terrain in Taiwan using High resolution WRF model

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Introduction

Puli basin is located in the central mountainous area of Taiwan, the surrounding terrain height is about 800 to 2000m. Over the mountainous area, it is difficult to accurately simulate the development of atmospheric motions. In order to understand the characteristics of local circulation and the planetary boundary layer (PBL) structures over the complex terrain in Taiwan, the Weather Research and Forecasting (WRF) Model at fine resolution (600-m) was applied with the high resolution terrain data. In addition, two different PBL scheme (Yonsei University, YSU and Shin-Hong scale-aware, SH) were applied to study the influence of PBL physical processes on the simulated vertical structures.

Simulation results were evaluated with the surface station and observed sounding data to characterize the PBL structures and local airflow over the central mountainous area of Taiwan.

Numerical Model and Data

- **Model**: The Weather Research and Forecasting, v3.7.1
- **Simulation time**: Sep. 02-08, 2013
- **Horizontal resolution**: D01-15km, D02-3km, D03-1km & 600m
- **Initial and boundary condition**: EC_ERAS Reanalysis data (0.3°x0.3°)
- **Observation data**: CWB stations, 10m_TOW, Tether Balloon(Puli)

The NASA Shuttle Radar Topographic Mission (SRTM) in 2000 has provided digital elevation data (DEM) for over 80% of the globe. The SRTM data is available as 3 arc second (~90m resolution) and ranging from 54° to 60° N latitude.

Shin-Hong scale aware scheme

- The nonlocal transport by strong updrafts and local transport by remaining small-scale eddies are separately calculated.
- Grid size dependency P(Δx) = \(\frac{Δx}{S}\)
- Vertical profiles of \((w′)^2\)

Result

- **Comparison between Simulation and Observation**: Comparison of observed and simulated surface temperature (left panel) and wind speed (right panel) at different grid resolution during nighttime and daytime over the mountainous area. (Solid line denotes the one to one line; dash line denotes the range of one standard deviation)

- **The Structures of PBL and Local Airflow**

- **Comparison with different PBL scheme**: During the daytime, atmosphere became well-mixed and the westerly flow which is composed of sea breeze and up-valley wind prevails in the basin. During the nighttime, there is strong easterly wind produced by downslope wind in the upper level. It also interacts with the topography and causes the westerly wind in the near surface layer.

Summary

- **The use of the high resolution topographical data from SRTM**: The SGS heat transport is formulated by multiplying a grid-size dependency function with the total transport profile fitted to the Large-eddy simulation (LES) output.

- **Different topographical data**

- **Different resolution**