P2.16 FOOTPRINTS OF OROGRAPHIC FLOWS OVER THE SOUTHERN APPALACHIAN MOUNTAINS

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1. INTRODUCTION

A two-month numerical simulation using the PSU/NCAR MM5 version 3.5 modeling system was conducted over the period of February 25 through April 26, 2002. The purpose of the simulation was to study mesoscale characteristics of low-level winds over the Tennessee valley during cold season when winds are typically strong and to identify footprints of air flow over complex terrain for support of the TVA wind energy development program.

2. TENNESSEE VALLEY TOPOGRAPHY

There are three distinct geographical features in the Tennessee Valley region: (a) The uniform plains in western Kentucky, western Tennessee and western Mississippi; (b) the rolling hills and plateaus of the central areas of Kentucky and Tennessee, northeastern Mississippi and northern Alabama; and (c) the southern Appalachian Mountains in the eastern region. A major sub-area is the Great Valley of the Tennessee River from northeastern Tennessee through northwestern Georgia and into central Alabama. The area is bounded by the Cumberland Plateau to the west and Southern Appalachian Mountain to the east. The elevation of the Tennessee Valley varies from 200 feet near the Mississippi river to over 6500 feet at the peak of the Great Smoky Mountain. These complex topographic features create unique weather and climate patterns in the Tennessee Valley (Mueller et al. 1996; Mao et al. 2000)

3. MODELING APPROACH

The MM5 was configured with a 27-km resolution coarse domain and a 9-km resolution nested domain. The coarse domain covers eastern half of the United States and the nested domain covers Tennessee and the surrounding states. There were 31-sigma layers in the vertical. The model was initialized with NCEP/Eta 00Z analysis and run for total of 61 days.

4. RESULTS AND DISCUSSIONS

Composite three dimensional wind data from the hourly model output were analyzed to depict characteristics of air flows over complex terrain in the Tennessee valley, especially over the southern Appalachian Mountains and the Cumberland Plateau. The 61-day simulations were first divided into three groups based on weather types: Group-A represents days of fine weather; Group-B represents days when cold fronts were observed in the Tennessee valley; and Group-C represents the rest. Composite hourly wind data were then created by averaging winds over the number of case days in each group. It is found by comparing results of Group-A with those of Group-B that low-level winds exhibit quite different diurnal patterns over east Tennessee and the southern Appalachian Mountains (Figure 1). In the absence of cold front activities, strong winds are identified east of the southern Appalachian Mountains and light winds are visible in the great valley of the Tennessee River especially at night (Fig. 1c and 1d). In the presence of the cold fronts, however, strong winds are found over Cumberland Plateau and east of the Appalachians, with a wind channeling effect clearly shown north of the Great Smoky Mountain (Fig. 1e and 1f). The overall footprints of the air flow were dominated by Group-B (Fig. 1a and 1b). The study demonstrates that the footprints of orographic flows over complex terrains may be used effectively for identifying wind energy resources in the region.

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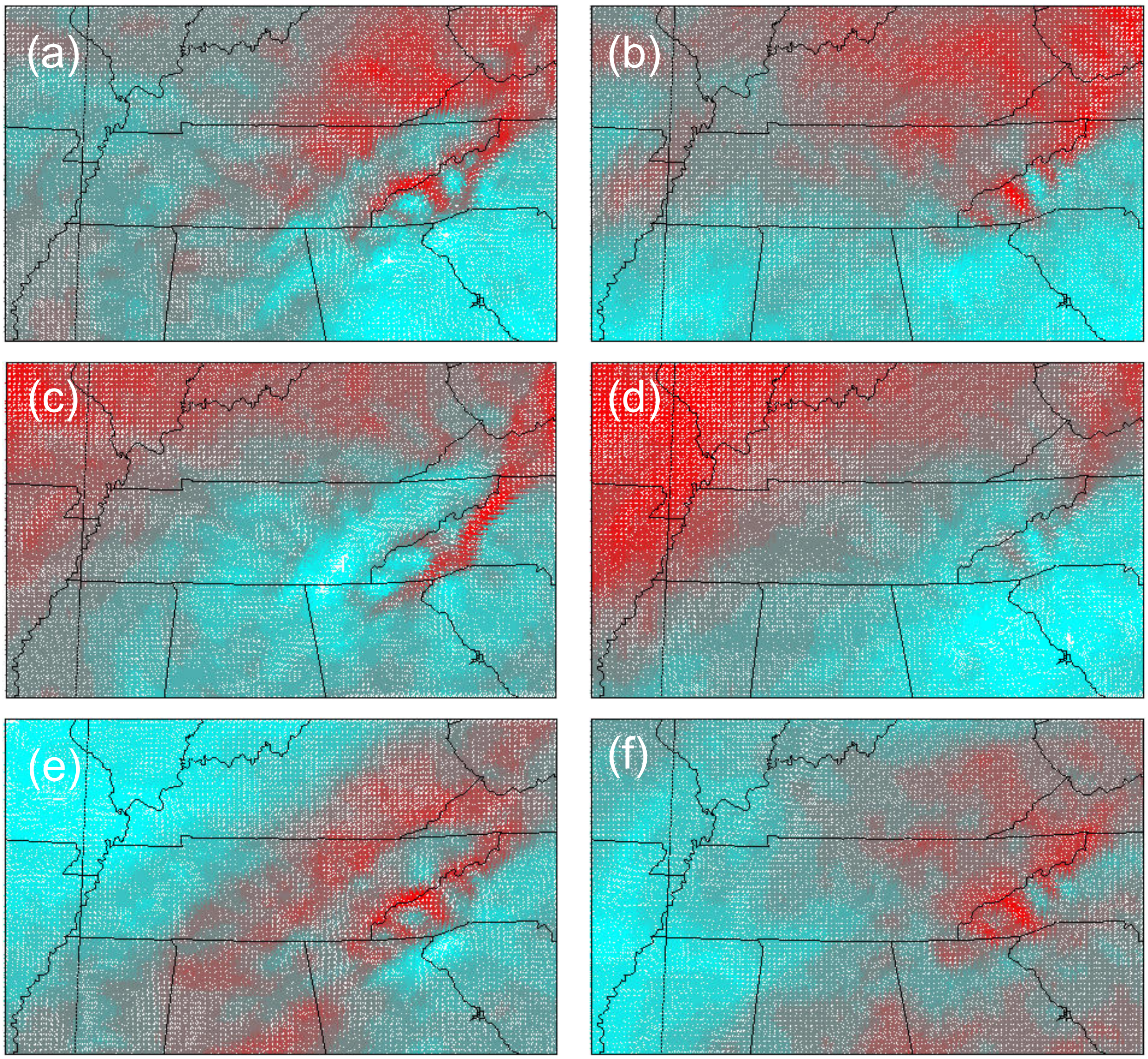

FIG. 1 Simulated mean air flow patterns near 50 meters above the surface over the period of February 25, 2002 through April 26, 2002. Panels on the left and right are for 00 CST and 12 CST, respectively. Panels (a) and (b) represent the composite of all types of weather during the period; (c) and (d) for fine weather; and (e) and (f) for cold-front weather only.