IC 4.3: Microclimates Exercise

Dominant easterly surface winds in the Arkansas River Valley near Fort Smith and Russellville, Arkansas

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Overview: Light easterly surface winds are frequently observed at Fort Smith, Arkansas (KFSM), Russellville, AR (KRUE), and Sallisaw, Oklahoma (KJSV) when surrounding surface observations show strong northerly or southerly winds. The anomalous wind is frequently observed at KFSM, and less frequently at KRUE and KJSV. These METAR stations are located in the Arkansas River Valley, at altitudes between 350 feet and 550 feet MSL. To the north of the valley in Arkansas are located the Boston Mountains and Ozark Plateau, which extend as high as 2500 feet MSL. South of the valley is a series of narrow west-east oriented ridges that also reach up to 2500 feet MSL. The valley is at its narrowest point just east of KFSM, between the top of the plateau to the north and the tallest ridges to the south.

Synoptic-scale ingredients: The anomalous easterlies at KFSM, KRUE, and KJSV are sometimes observed during northerly surface flow behind a shallow cold front, but are most frequently observed during "return" flow conditions. That is, when a surface high pressure is located to the east of Arkansas, and a surface trough is forming and cyclogenesis is underway in the lee of the Rocky Mountains, pulling warm moist air northward from the Gulf of Mexico through Texas and into Oklahoma. The easterly surface winds in the Arkansas River Valley are most frequently observed during "return" flow conditions in the early morning hours.

Figure 1 illustrates the typical surface weather conditions observed in these early morning events. Overnight, nocturnal drainage flow sets up from the plateau to the north into the river valley. The more-narrow nature of the valley east of KFSM forces some of this flow to "back in" to KFSM from the east. In many cases, the air cools enough to allow fog and low clouds to form. At the same time, the nocturnal low level jet sets up in the "return" flow regime above the surface with strong south-southwesterly flow. As the sun rises, the low level jet can be easily mixed to the surface in the higher terrain, which is also frequently free of clouds and fog. The interaction of the humid, strong SSW flow with the ridge lines often leads to the formation of low mountain wave clouds, a hazard for light aircraft in the area. Meanwhile, cool easterly surface winds and foggy conditions persist in the valley despite the strong southerly winds and warmer, more humid conditions at the surrounding, higher elevation METAR sites such as Fayetteville (KFYV) and Mena (KMEZ).

Forecast considerations: NWP models with relatively low spatial resolution (i.e., 40 km or greater) have shown little skill in forecasting these conditions. Such models may forecast rapidly clearing skies, with warmer and more humid conditions, which would not be observed at these valley sites for several more hours until the nocturnal inversion is finally eroded. Such a bad forecast would greatly impact aviation operations. High-resolution (13-20 km) and very high resolution (1-4 km) models have shown better skill forecasting these conditions. Forecasters should be aware that these conditions often set up on the morning of a potential severe thunderstorm event, and objective analysis packages such as LAPS would show local maxima

and minima in mass convergence/divergence, CAPE, moisture convergence, etc. that are due to these terrain effects and not the larger synoptic system.

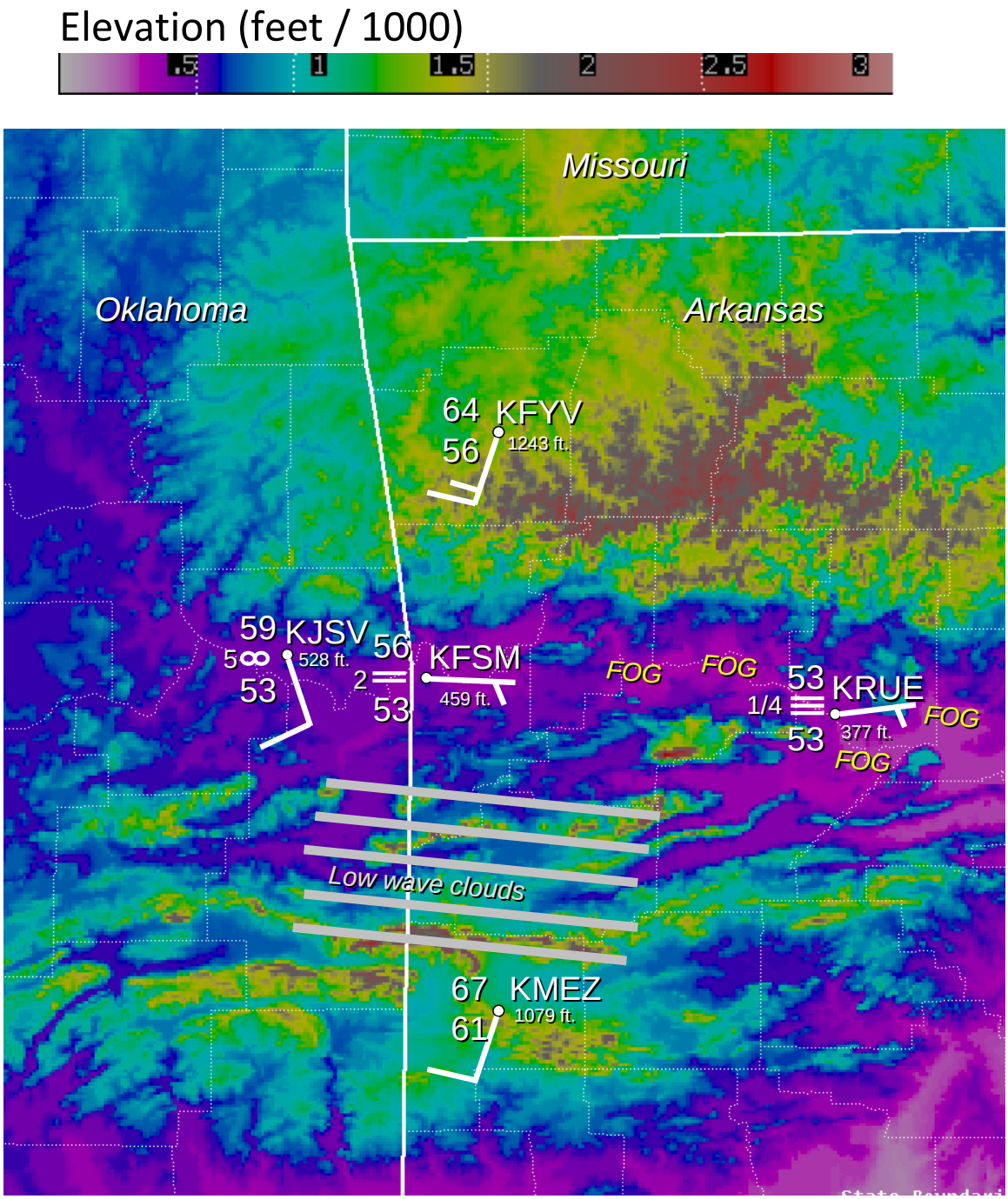

Figure 1. Terrain image map of the Arkansas River Valley in western Arkansas, with typical early morning surface weather in the study area during "return" flow conditions.