Western Region Technical Attachment
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MODEL TERRAIN: A GLIMPSE OF THE FUTURE

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As the National Weather Service progresses through modernization, the advantages of new technology are becoming apparent. For example, improvements in the accuracy and lead time in severe weather situations has been demonstrated by using WSR-88D data. The WSR-88D has also aided forecasts and nowcasts of many other types of weather situations (i.e. fronts, snowstorms, conditional symmetric instability, etc.). The next major demonstration of improved forecast accuracy will most likely be associated with the use of mesoscale models. The operational use of mesoscale models is very close to becoming reality with the mesoscale Eta model.

Although this Technical Attachment will not discuss the mesoscale Eta model in detail, one of the most obvious improvements from the early Eta, which is currently operational, is the increased horizontal resolution. The Nested Grid Model (NGM) and the early Eta both have comparable horizontal resolution (approximately 80 km across the continental United States), but differ in the physics of the model and their approach to topography representation. The early Eta's representation is generally accepted as better than the NGM; however, the mesoscale Eta increases the horizontal resolution to 30 km. A brief description of the Eta model's approach to terrain representation follows (Black 1994).

The method of resolving the terrain within the early and mesoscale Eta are exactly the same, but for purposes of example the mesoscale Eta will be used (summarized in Fig. 1). Each 30 km horizontal grid box is initially divided into 16 subboxes. Actual surface elevations are obtained from archived data and averaged for each of the 16 subboxes, resulting in a mean terrain value for each subbox. Using these values, the maximum mean value from each of the four rows and four columns are determined resulting in eight terrain values. The mean of these eight values is determined and provides an intermediate terrain height for that particular 30 km grid box (4033 feet in the Fig. 1 example). The final elevation for that 30 km grid box is determined by adjusting the intermediate terrain height up or down to coincide with the nearest model Eta level. A final adjustment must be made to the terrain height within each grid box to ensure proper representation of the wind fields. For example, a grid box cannot be surrounded on all sides by grid boxes of higher terrain heights. This creates a "hole" in which surface divergence is always zero, which does not allow any vertical communication with the grid box immediately above.

A comparison of the model representation of terrain over the Great Basin between the NGM (Fig. 2a), the early Eta (Fig. 2b), the mesoscale Eta (Fig. 2c), and the University of Utah's 10 km mesoscale model (Fig. 2d), illustrates some of the large differences. Figure 2d is presented to provide an appreciation for terrain that might be expected in a 10 km mesoscale model and will not be discussed in any detail.

For example, the Snake River Valley and the Salt Flats (in western Utah) are somewhat represented in the NGM and early Eta, but without much definition. Within the mesoscale Eta, these topographical features become much more defined with larger, more realistic gradients in terrain over central Idaho and along the western side of the Wasatch Mountains. Other significant terrain features that are absent from the NGM and the early Eta are the Colorado and San Juan River valleys over southeastern Utah (Fig. 2c).

Figure 3 provides a depiction of the terrain used within the 30 km Eta model. Although not shown, a comparison with the terrain used within the early Eta identifies improved resolution of the Sacramento and San Joaquin Valleys in California as well as other areas of the Western Region.

Of course, the real test of this increased horizontal resolution (and associated improvements with the representation of terrain) will occur as forecasters begin to see output from the mesoscale Eta and assess the model against reality.

References

Black, T., 1994: The new NMC mesoscale eta model: Description and forecast examples. *Wea. Forecasting*, **9**, 265-278.

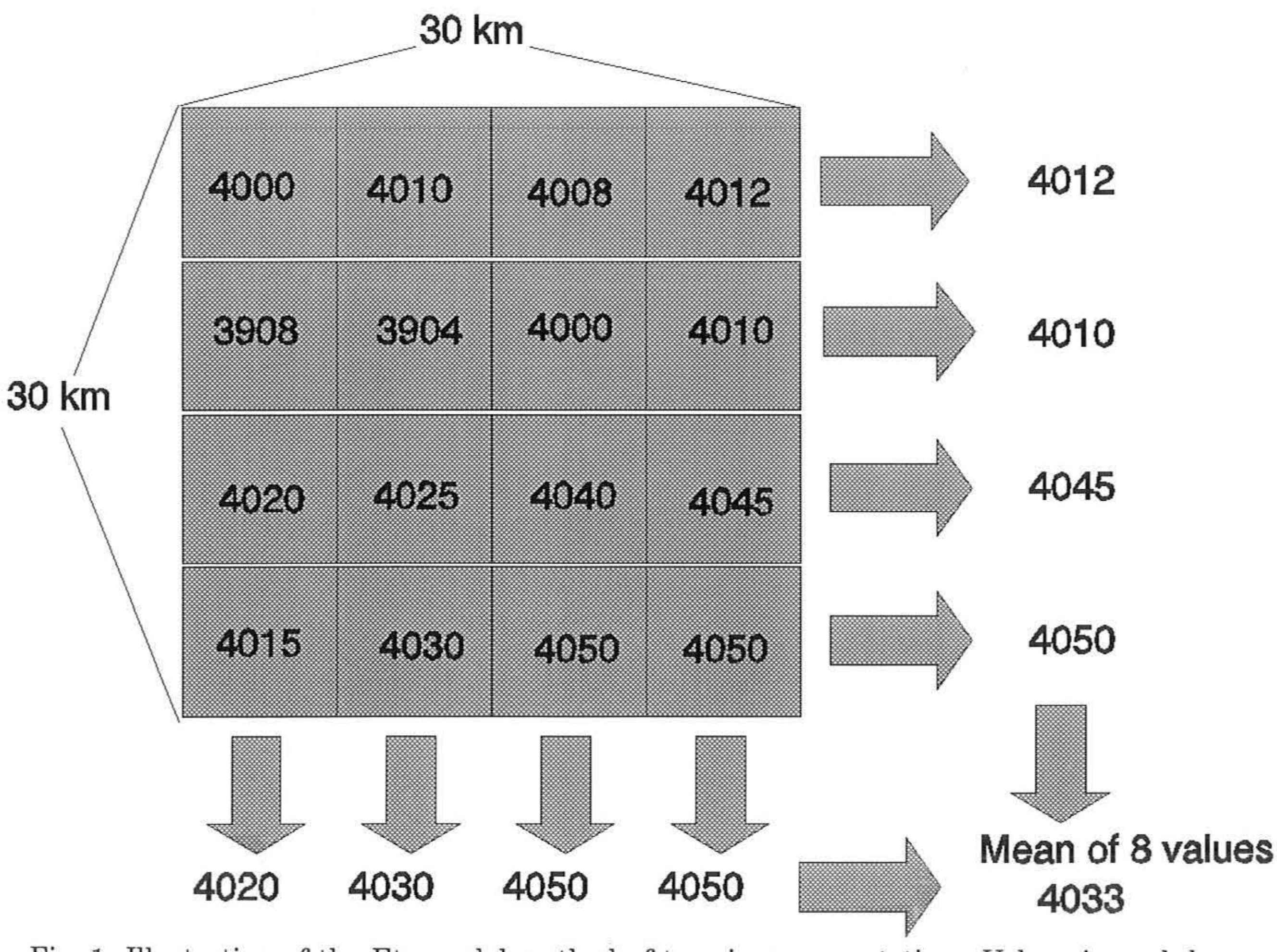

Fig. 1 Illustration of the Eta model method of terrain representation. Values in each box represent the mean terrain height (in feet) of each 7.5x7.5 km subbox.

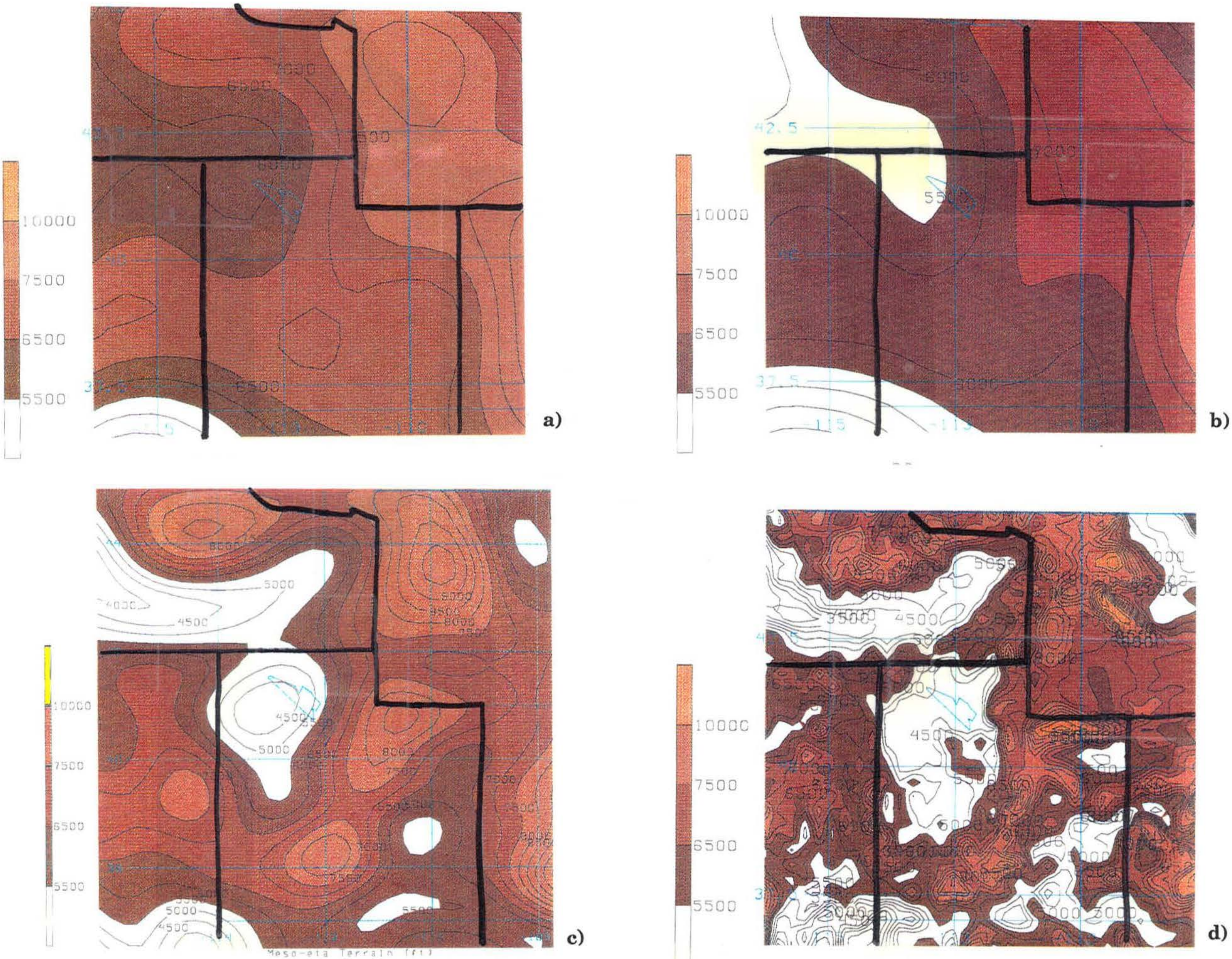

Fig. 2 Model terrain height, contoured every 500 feet, from the a) NGM, b) early Eta, c) mesoscale Eta, and d) University of Utah's 10 km mesocale model.

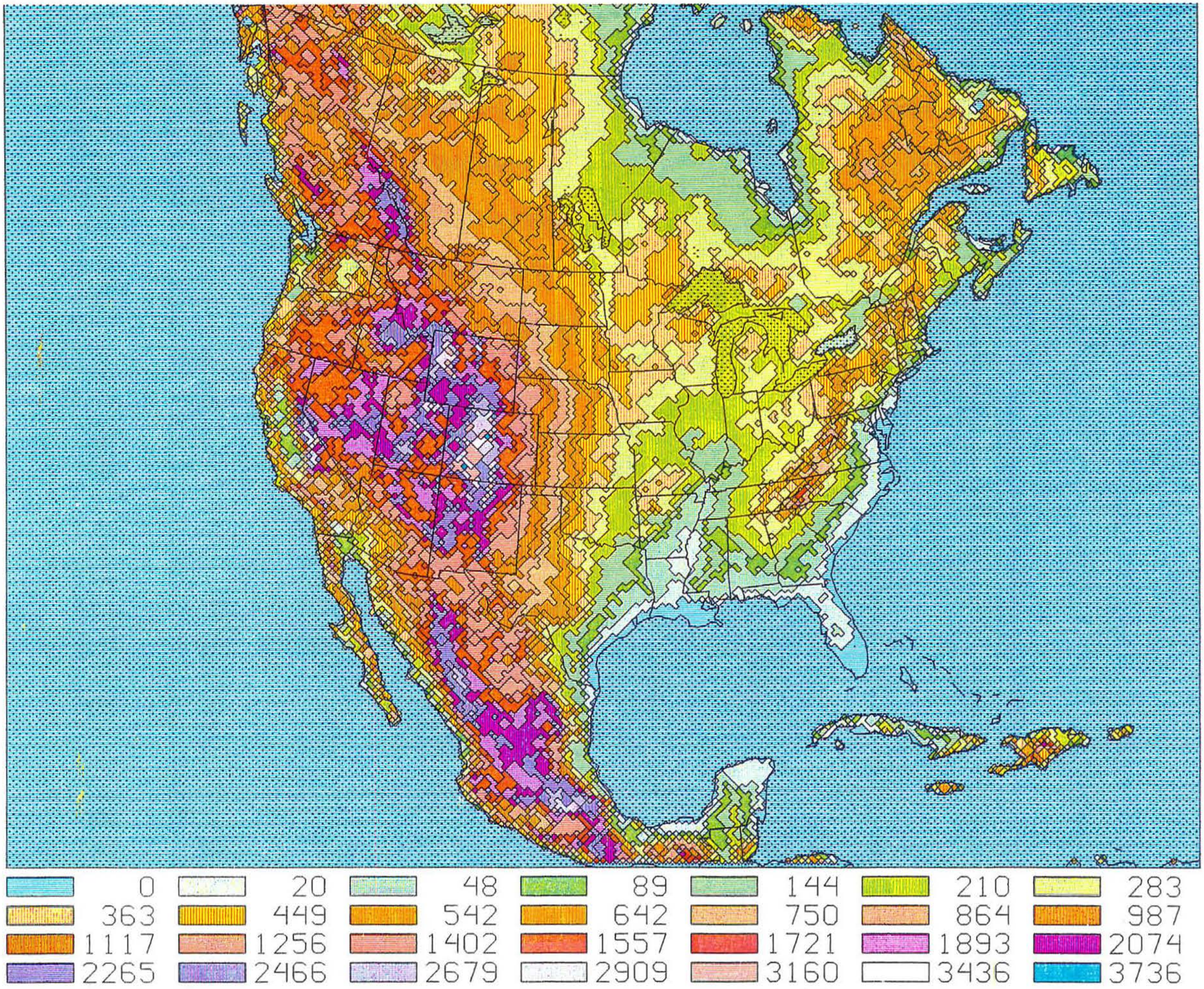

Fig. 3 Mesoscale (30 km) Eta model terrain across the United States.