Comparison of Objectively Analyzed Single-Column Model Forcing Fields with Assimilated Data from the June 1993 Intensive Observation Period for Various Siting Scenarios

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Introduction

The objective analysis method used for deriving Single-Column Model (SCM) forcing fields with Atmospheric Radiation Measurement (ARM) data has been evaluated for a variety of observation siting scenarios (Leach et al. 1996). Our purpose was to assess the capability of the various siting scenarios to provide representative data for objective analysis and subsequent SCM forcing fields. That evaluation was performed with analytically prescribed input data so that the results of the objective analysis could be compared with known analytic values. Here we extend that evaluation by using observed meteorological fields assimilated in a mesoscale model.

Approach

Radiosonde, wind profiler, and surface meteorological data from the 10-day June 1993 Intensive Observation Period (IOP) have been assimilated using a mesoscale model (Dudhia 1993) with 6.67-km horizontal resolution. The IOP (6/16-6/25/93) included two major frontal passages, with a variety of cloud conditions and four rain events. Several nights had well-defined low-level jets, with two nights having wind maxima above 25 m/s. We expect that data from this IOP represent a reasonable range of meteorological conditions that provides a good basis for evaluating the siting scenarios.

From the assimilated data, synthetic soundings have been extracted for various siting scenarios for the observation stations and used as input to the Lawrence Livermore National Laboratory's (LLNL) objective analysis scheme. Station locations for the 16-station and 5-station scenarios are shown in Figure 1. The objective analysis domain is also indicated and is interior to all station scenarios to eliminate extrapolation.

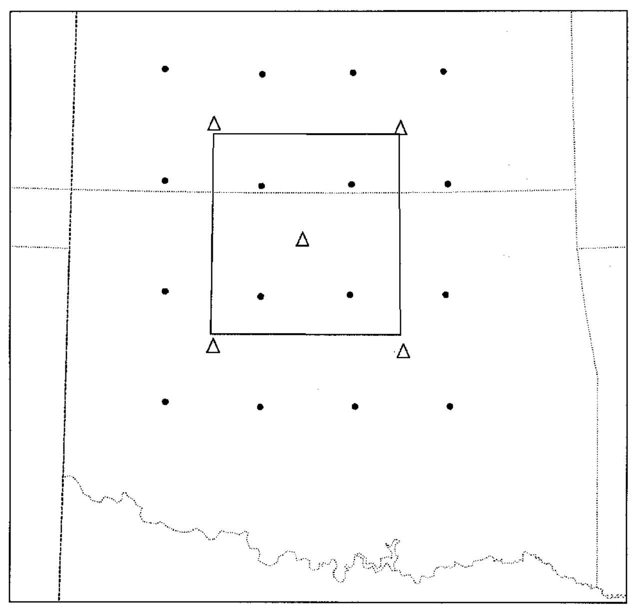

Figure 1. Location of synthetic soundings for the 16-station (dots) and 5-station (triangles) scenarios; SCM objective analysis domain is outlined.

Results

As in our previous study, results are compared using the 16-station scenario as the reference since it is the densest siting scenario. Correlation coefficients (r^2) are calculated for each of the 27 horizontal levels over the 241 hours of the IOP and then vertically averaged for each variable. These coefficients are given in Table 1. They show that the mean quantities are represented well regardless of the number of stations. Quantities involving gradients, however, are represented better when data from more stations are available.

We investigated whether the representativeness versus number of stations was dependent on height. Our expectation is that the meteorological fields have more spatial variation near the ground and hence require more stations for the same degree of representativeness as those at higher heights, especially for gradients. Comparisons of mean and gradient quantities between 16-station and 5-station scenarios are made at four pressure levels (300, 500, 700, and 900 mb). Correlation coefficients for the two siting scenarios are given in Table 2 for mean and gradient quantities. The mean quantities are horizontal wind components, temperature, and specific humidity. The gradient quantities are temperature and moisture advective tendencies and horizontal wind divergence. The mean quantities obtained from either 5 or 16 stations are highly correlated, with no systematic variation with height. Quantities involving gradients are more sensitive to the number of stations available, with the least sensitivity at 500 mb. It is probable that gradients across the site are smallest at this pressure level.

Summary

Surface and upper-air meteorological data from a 10-day IOP have been assimilated in a mesoscale model. Synthetic soundings have been extracted from the gridded model results, and used as input in the LLNL objective analysis scheme. The sensitivity of SCM forcing fields derived by objective analysis to the various siting scenarios has been evaluated. Mean quantities show little sensitivity to siting scenarios, nor to pressure level. Quantities involving spatial gradients vary systematically with decreasing number of observation stations. There is also a slight dependence with pressure level, with the least sensitivity to siting scenario occurring at the 500-mb level.

Table 1. Correlation coefficients for station siting scenario study.

	Mean quantities				Quantities with gradients		
Siting comp	**u**	**v**	**temp**	**sp hum**	**t-adv**	**q-adv**	**div**
13 vs. 16	0.96	0.98	0.97	0.92	0.74	0.63	0.70
9 vs. 16	0.94	0.96	0.95	0.86	0.68	0.58	0.62
7 vs. 16	0.94	0.96	0.96	0.88	0.60	0.49	0.57
5 vs. 16	0.92	0.95	0.94	0.84	0.54	0.39	0.40
4 vs. 16	0.89	0.94	0.90	0.74	0.52	0.38	0.40

Table 2. Vertical variation of correlation coefficients for 5 vs. 16 stations.

	Mean quantities				Quantities with gradients		
Pressure level	**u**	**v**	**temp**	**sp hum**	**t-adv**	**q-adv**	**div**
300 mb	0.93	0.97	0.94	0.81	0.63	0.39	0.47
500 mb	0.97	0.97	0.95	0.84	0.68	0.50	0.58
700 mb	0.91	0.95	0.98	0.92	0.52	0.37	0.17
900 mb	0.93	0.96	0.90	0.78	0.41	0.29	0.31

Work is continuing on the comparison with the 1993 IOP data assimilation. Detailed comparisons will be made between mean values and advective tendencies obtained by objective analysis and those obtained directly from the mesoscale model.

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References

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