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INTEGRATION OF DATA FROM MANY SOURCES FOR OBJECTIVE ANALYSES OF THREE-DIMENSIONAL METEOROLOGICAL FIELDS IN THE SALT LAKE CITY AREA

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1. INTRODUCTION

The October 2000 Vertical Transport and Mixing eXperiment (VTMX) in the Salt Lake Basin involved more than a dozen different organizations, collecting data with many different kinds of meteorological instruments. The variety of instrumentation and data formats represented by the VTMX field data presents difficult problems of synthesis and analysis, which the remainder of this paper discusses, along with the approaches that were taken to solve them.

2. DATA CONSOLIDATION

2.1 Surface Data

Surface data differed among sources in one of four categories, 1) averaging time, 2) reported variables 3) coordinate systems and 4) formats. The stations in Northeastern Utah from the Mesowest system (Horel et al, 2002) were augmented with numerous automated observing stations operated by VTMX. Most mesonet wind data represented 2-minute time periods defined by guidelines for surface observations (NOAA, 1998; USAF, 1996), but some VTMX stations reported 1-or 5-minute averages that were combined into 10 or 15-minute averages. Data in the "rectangle," between latitudes 39°N and 42°N, and longitudes 110°W and 114°W were subjected to simple quality control measures, e.g. ignoring station pressures that differed from the standard atmosphere by more than 450m.

2.2 Upper Level Data

Radiosondes, tethersondes, a 915-MHz boundary layer wind profiler and radio acoustic sounding system (RASS, Angevine et al.,1998), NCAR's MAPR (Multiple Antenna Profiler Radar, Cohn et al,, 1997) and Doppler sodars observed meteorological conditions aloft. The altitudes reached by these instruments ranges from a few hundred meters for sodars and tethersondes to thousands of meters for radiosondes, and averaging times range from seconds for the tethersondes to an hour for profilers and one sodar. Thus, in preparing the consolidated data files, it was appropriate to average data that represented shorter time periods. Tethersonde data were average over 15-minute intervals, and either averaged in 10 m altitude "bins" or smoothly interpolated. When radiosonde data were reported at altitude intervals of less than 10 m, some observations were not retained so that the final sounding was for altitude intervals of 10 m or greater. Finally, data from the Argonne National Laboratory (ANL) sodar, and high and low power profilers were merged into a single wind profile.

2.3 Temporal Merging

Separate programs were written for each source, because formats were not consistent from station to station. Data from the different sources were processed to have uniform formats and similar temporal and vertical resolutions, then it was possible to merge the upper air and surface data into files that serve as inputs to an objective analysis program. We first found all upper air files that represented a time within 15 minutes of a time for which surface observations were available.

2.4 Formatting and other information

The merged files were written in ASCII to make them easier for others to use. The files include all station coordinates (including elevation), both Universal Transverse Mercator (UTM) and latitude/longitude. They begin with date and nominal time information, number of surface stations, number of wind profiles and number of temperature profiles. Column labels identify parameters. Surface data are followed by all the wind profiles; with site coordinates, number of sounding levels and labeled columns. Temperature profiles have a similar format.

3. ANALYSIS TECHNIQUES

We are using a modified version of the Winds on Critical Streamline Surfaces (WOCSS) approach to objective wind field analysis (Ludwig et al., 1991) to generate wind fields at selected levels. Very briefly, the original WOCSS approach defines surfaces where the potential energy

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gained by lifting a parcel of air in a stable atmosphere never exceeds the kinetic energy of the wind at the lowest levels on the same surface. Winds are interpolated to these “flow surfaces;” Where they intersect the terrain, the winds are held to zero during an iterative adjustment of the flow toward 2-dimensional nondivergence. The adjustment forces stable flow to pass around terrain obstacles. Wind and lapse rates are estimated at each grid point, providing a basis for calculating Richardson number.

The original versions of the WOCSS code had some assumptions with regard to what was expected of the wind and temperature input profiles. It was assumed that winds and temperatures profiles would be co-located and that most would reach the top of the analysis domain, typically about 3000 m above the lower terrain. However, the available VTMX data has required some important modifications to accommodate the differences discussed earlier. Horizontal interpolation is now used to estimate lapse rates and winds above the heights reached by tethersondes, but below the tops of the other profiles. Figure 1 is an example of a wind field generated by WOCSS analysis of consolidated VTMX data

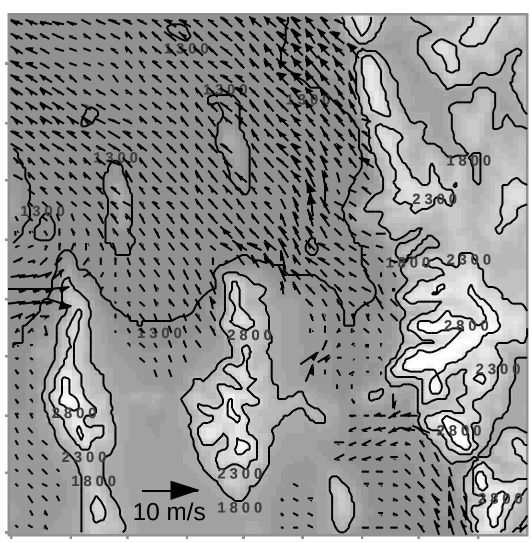

Fig. 1 Flow at 1400 m ms, l9 Oct 2000 0315 UT

4. CONCLUSIONS

The data collected during the VTMX campaign provide a basis for very detailed analyses of atmospheric flow in the Salt Lake Valley during nighttime stable situations. However, it has taken a major effort to integrate the data from so many different instruments into a coherent archive. The effort has produced inputs suitable for detailed objective analysis and comparison with modeling studies now underway (Chen, et al. 2002)

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