1. Background and Significance

Urban basins surrounded by elevated terrain frequently experience poor air quality during stable periods (Smith et al. 1997). Increased urbanization in many elevated valleys may contribute to additional environmental and health impacts of stable periods. The general synoptic-scale conditions that lead to stable periods are well understood (Wolyn and MckKee 1989; Whiteman 1990; Fast et al. 1996; Whiteman et al. 1996; Whiteman et al. 1999): warm air advection aloft coupled with nocturnal drainage flows often lead to the development of stable layers whose lowest base lies between the valley floor and ridge crest. The Environmental Meteorology Program - Vertical Transport and Mixing (VTMX) Program will enhance our knowledge of the physical processes that lead to stably stratified conditions and poor air quality in urban basins.

Numerical studies on flow interactions in complex terrain provide a means to test hypotheses on the physical processes that control the formation and dissipation of stable layers. Four dimensional data assimilation (FDDA) has been shown to minimize overall errors in the planetary boundary layer (e.g., Stauffer et al.1991; Fast 1995), although the computational resources required to perform FDDA remain large. The Regional Atmospheric Modeling System (RAMS) has been used extensively to investigate dispersion and boundary layer evolution in complex terrain (e.g., Fast 1995; Poulos and Bossert 1995; Fast et al. 1996; Bossert 1997; de Wekker et al. 1998). Several VTMX scientists will use RAMS to study the atmospheric circulation in urban valleys at very high (less than 1km) resolution.

For the purposes of this proposal, we assume that the initial VTMX field program will take place in the Salt Lake Valley. The impact on our proposed study of an alternative site is discussed in Section 4d.

Observational studies were undertaken from the 1950's through the 1970's to assess stable boundary layers over the Salt Lake Valley beginning with the study by Dickson (1957). Clark (1975) repeated much of Dickson's work and contrasted the inversion frequency during 1973 to that during 1956-57. Both studies found that surface inversions occur on roughly two-thirds of the mornings during January with an average depth on the order of 310 m. Relying on sodar observations, Davis (1979) found multiple-layer nocturnal inversions, breakdown of the inversions during the morning, afternoon neutral conditions, and evening return to multiple layering. Wolyn and McKee (1989) found that 11% of December and January days could be characterized as having deep stable layers at Salt Lake City. In addition to these studies, the Utah Department of Environmental Quality has sponsored field programs to assess the transport and dispersion of pollutants. For example, Watson et al. (1993) document higher concentrations of carbon monoxide during winter in the urbanized eastern side of the valley relative to the central or western portions of the basin.

The Salt Lake Valley is monitored by a considerable amount of weather instrumentation upon which the initial field program can be built. The continuing development of the Utah Mesonet (Horel et al. 1999) reflects the cooperation between federal, state, and local agencies and commercial firms. The Utah Mesonet is coordinated by researchers at the NOAA Cooperative Institute for Regional Prediction (CIRP) at the University of Utah and operational personnel at the SLC National Weather Service Forecast Office (NWSFO). The Mesonet provides access to weather

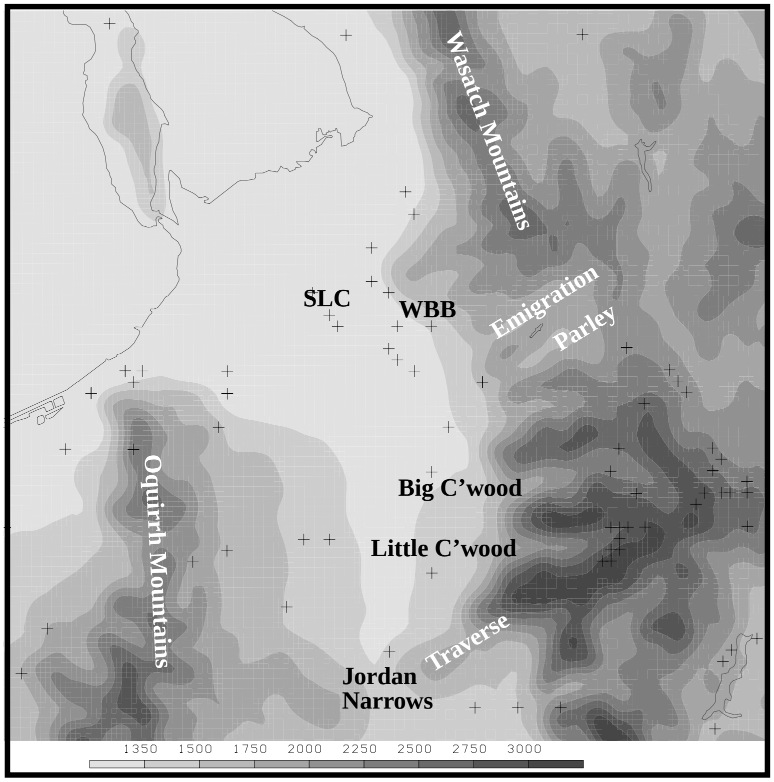

Figure 1. Terrain (m) near the Salt Lake Valley at 1 km resolution shaded according to the scale at the bottom. Utah Mesonet sites are denoted by markers.The SLC airport, University of Utah (WBB), and local terrain features are labeled.

data in Utah and surrounding states to operational forecasters, researchers, and the public.

Figure 1 shows the locations of surface observing sites in the vicinity of the Salt Lake Valley. These stations are operated and managed by over a dozen administrative entities who provide access to their data in real time. Data are collected at 15 minute intervals, processed, archived, and disseminated over the Internet (http://www.met.utah.edu/mesonet). As new observing sites become available, they are added to the Mesonet. For example, the Utah Department of Transportation will be adding at least 4 more observing sites along the freeway corridor.

As a proxy indicator for stable periods in the Salt Lake Valley, Fig. 2 shows the average number of days with reduced visibility less than 10 km during winter at the Salt Lake City (SLC) Airport. Stable conditions occur most frequently during December and January when on average 13 days experience poor visibility in the Salt Lake Valley. Strong stability near the surface leads to heavy fog, on average, 4 times per month during December and January.

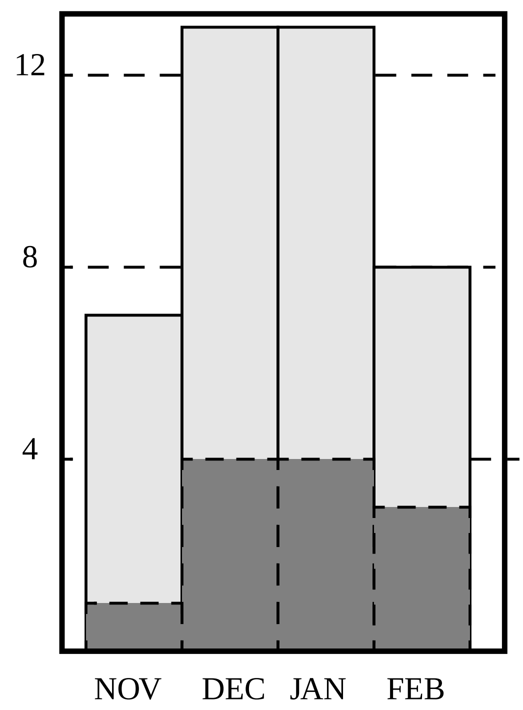

Figure 2. Average number of days with visibility at SLC airport less than 10 km (light shading) and less than .43 km (heavy shading). Data compiled by W. Alder, SLC NWSFO from records from 1928-99.

While surface-based radiational inversions develop and dissipate nearly every day during the winter, strong stable layers occur less frequently and are sensitive to interannual variations in the planetary-scale circulation. For example, year-to-year variations of heavy fog episodes at SLC are shown in Fig. 3. Conditions during recent years have been far less stagnant than those during the latter half of the 1980's and early 1990's.

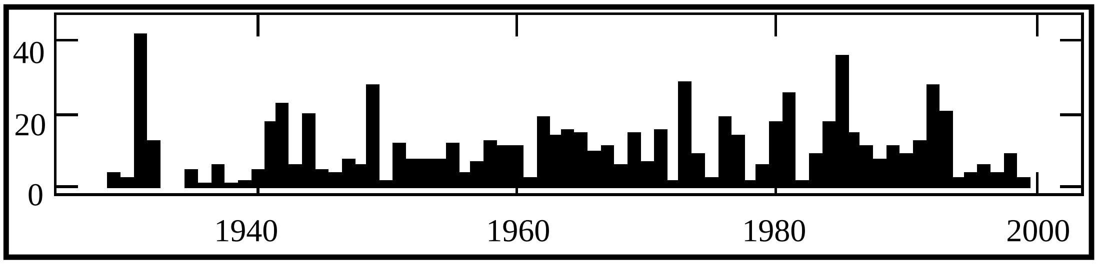

Figure 3. Total number of days during November- February winter season with at least 1 observation of visibility less than .43 km (.25 mi) at SLC airport. Data compiled by W. Alder, SLC NWSFO.

The practical experience gained from living in the Salt Lake Valley parallels the goal of the VTMX program to view urban basins as complete systems rather than as components that can be studied in isolation. Figure 1 demonstrates that the terrain near the Salt Lake Valley is complex. First, the valley is asymmetric in the east-west direction: (1) the terrain slopes more gradually on the western side of the valley than on the eastern side and (2) the western quarter of the valley tends to be less developed and contains more grassland while the eastern third is more heavily developed with taller vegetation.

The Oquirrh Mountains, which form the western boundary of the Salt Lake Valley, are narrow and steep while the higher Wasatch Mountains to the east contain a number of canyons that open into the Salt Lake Valley. The most pronounced nocturnal near-surface drainage flows occur near the entrances of Emigration and Parley's Canyons. Occasionally, during stable periods with cold air pooled in the valley and easterly flow at ridge crest, strong downslope wind storms and nocturnal drainage flows combine to yield gusts in excess of 40 m/s along the northeastern periphery of the valley (McDonald et al. 1998). These wind events rarely extend more than 1-2 km downwind of the Emigration/Parley's canyon region. In contrast, the Big and Little Cottonwood Canyons exhibit little nocturnal near-surface drainage flow and wind storms occur rarely downwind of them as a result of the blocking effects of the upstream terrain. Little is known about the above-surface drainage of these canyons.

The Jordan Narrows to the south of the Salt Lake Valley strongly channel the near-surface flow. Hang gliders ascend routinely in updrafts over the Traverse ridge. The broad opening to the Great Salt Lake to the north provides for strong, thermally driven lake-valley circulations. While these thermally-driven circulations are strongest during summer when the land-lake temperature contrast is most pronounced, the lake has an impact on the local circulation throughout the year.

2. Proposed Objectives

Horizontal and vertical transport in the Salt Lake Valley is complex as a result of dynamical and radiative processes operating on a range of spatial and temporal scales. These processes drive the prevailing synoptic and mesoscale circulations, drainage flows off mountain slopes, channeled flows emanating from the canyons and the Jordan Narrows, and thermally driven circulations associated with the Great Salt Lake. We propose to analyze and simulate some of the scale interactions between valley flows and mesoscale circulations over northwestern Utah. We anticipate that these scale interactions influence the formation of stable layers and their often rapid dissipation. The specific objectives of this project that will contribute to the VTMX science objectives are:

- Provide VTMX researchers access to existing observations in the vicinity of the Salt Lake Valley. These observations are intended to serve as a foundation upon which the initial field campaign can be built.
- Evaluate the evolution of the stable boundary layer on the basis of data assimilation and short-range simulations at high spatial resolution.
- Assess the scale interactions between flows within the valley to weather features that are traveling across northwestern Utah or those that develop in situ as a result of mesoscale flow interactions with the terrain.
- Determine the relative contributions to the mass balance in the Salt Lake Valley from lake/land breezes and drainage flows.
- Test the ability of the ARPS model to simulate the evolution of the stable boundary layer.

An overview of current research activities and preliminary analyses of stable periods in the Salt Lake Valley follows in the next section. The proposed research is detailed in Section 4.

3. Preliminary Studies: Stable Periods during the 1998-99 Winter Season

Recent research at the University of Utah related to the weather of the Salt Lake Valley has focussed on the conditions associated with major snow storms. For example, Horel and Gibson (1994), Stiff (1997), and Slemmer (1998) analyze the mesoscale aspects of major winter storms while Steenburgh et al. (1999) document the composite synoptic and mesoscale circulations associated with lake-effect snow storms in the vicinity of the Great Salt Lake. A field program, Intermountain Precipitation Experiment (IPEX), on lake-effect and orographic snowfall may be held in the vicinity of Salt Lake City during February 2000. Programmatic support has been obtained for the IPEX field project from the National Severe Storms Laboratory, Desert Research Institute, and state agencies with funding from the National Science Foundation pending.

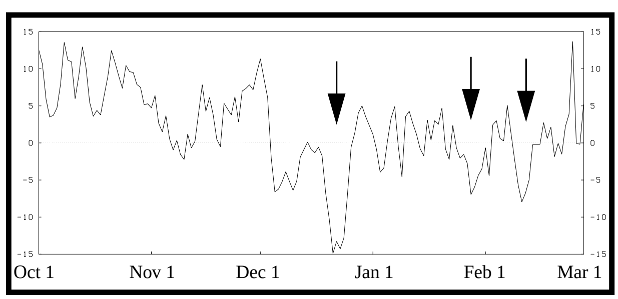

Figure 4. Daily minimum temperature (°C) on the University of Utah campus. Soundings at Salt Lake City are shown in Fig. 5 for three cold pool events delineated by the arrows.

Stable periods over the Salt Lake Valley have been monitored during the 1998-99 winter. As an example of the synoptic temporal variability of cold pool events in the Salt Lake Valley, Fig. 4 shows the daily minimum temperature on the University of Utah campus during the 1998-99 winter season. Although the winter was relatively mild, several distinct periods are evident during which cold air settled into the Salt Lake Valley.

In order to show the variability in vertical structure during stably stratified conditions, SLC soundings for three of the cold pool events are shown in Fig. 5. The coldest event occurred prior to Christmas 1998. During this 4-day period, the conditions evolved from weakly stratified to strongly capped at 700 mb as a ridge aloft moved over the area. The soundings during 28-31 January 1999 illustrate variations in the depth of the afternoon mixed layer capped by multiple stable layers aloft. A strong surface-based inversion developed during mid-February 1999 as warm-air advection developed aloft. As discussed by Whiteman et al. (1999), stable periods in the Great Basin do not necessarily have a well-defined lid below ridge-crest height nor a temperature inversion.

While surface and upper-air observations help to define the occurrence of stable periods, their three-dimensional structure can be defined more completely by an analysis that incorporates all available weather data. The Oklahoma Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS) is used to generate analyses at hourly intervals over northwest Utah for nowcasting and research applications (Lazarus et al. 1998). The ADAS system is being developed as part of research activities funded by the National Weather Service. Graphical displays derived from these analyses are available over the Internet at http://www.met.utah.edu/mesonet.

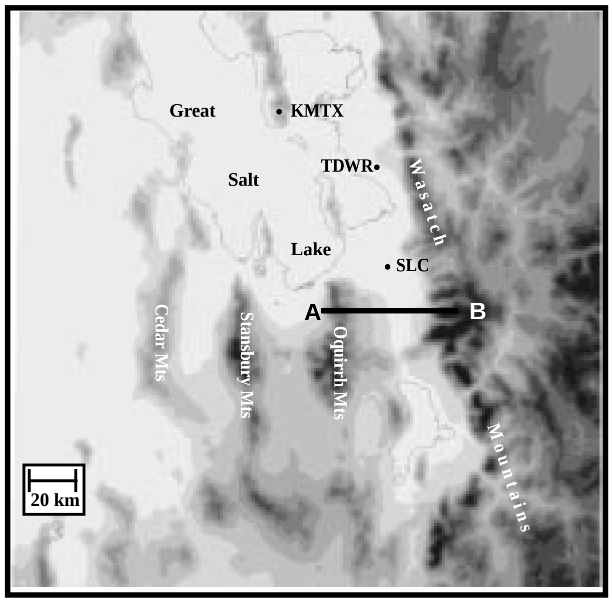

Figure 6. Domain of the ADAS analyses over northwest Utah. Darker shading denotes higher terrain. The cross-section in Fig. 7 follows the line A-B.

The ADAS domain presently covers a 218 km x 218 km area over northwest Utah (Fig. 6). The grid spacing is 1 km in the horizontal and a terrain-following stretched vertical coordinate is used with 9 m spacing between levels near the surface and 600 m spacing at the domain top. To the best knowledge of the Principal Investigators, no other operational or research modeling group in the United States is routinely computing hourly analyses at 1 km resolution.

The ADAS analysis (Brewster et al. 1995) uses the National Centers for Environmental Prediction Rapid Update Cycle Version 2 (RUC2) 40-km analysis for the initial background field. ADAS relies upon a successive correction technique (Bratseth 1985) that takes into account the relative observation-to-background errors and spatial inhomogeneities in the data. This approach is also less sensitive to variations in local data density. While generally less accurate than FDDA, the optimal interpolation technique used by ADAS can be applied efficiently and routinely to

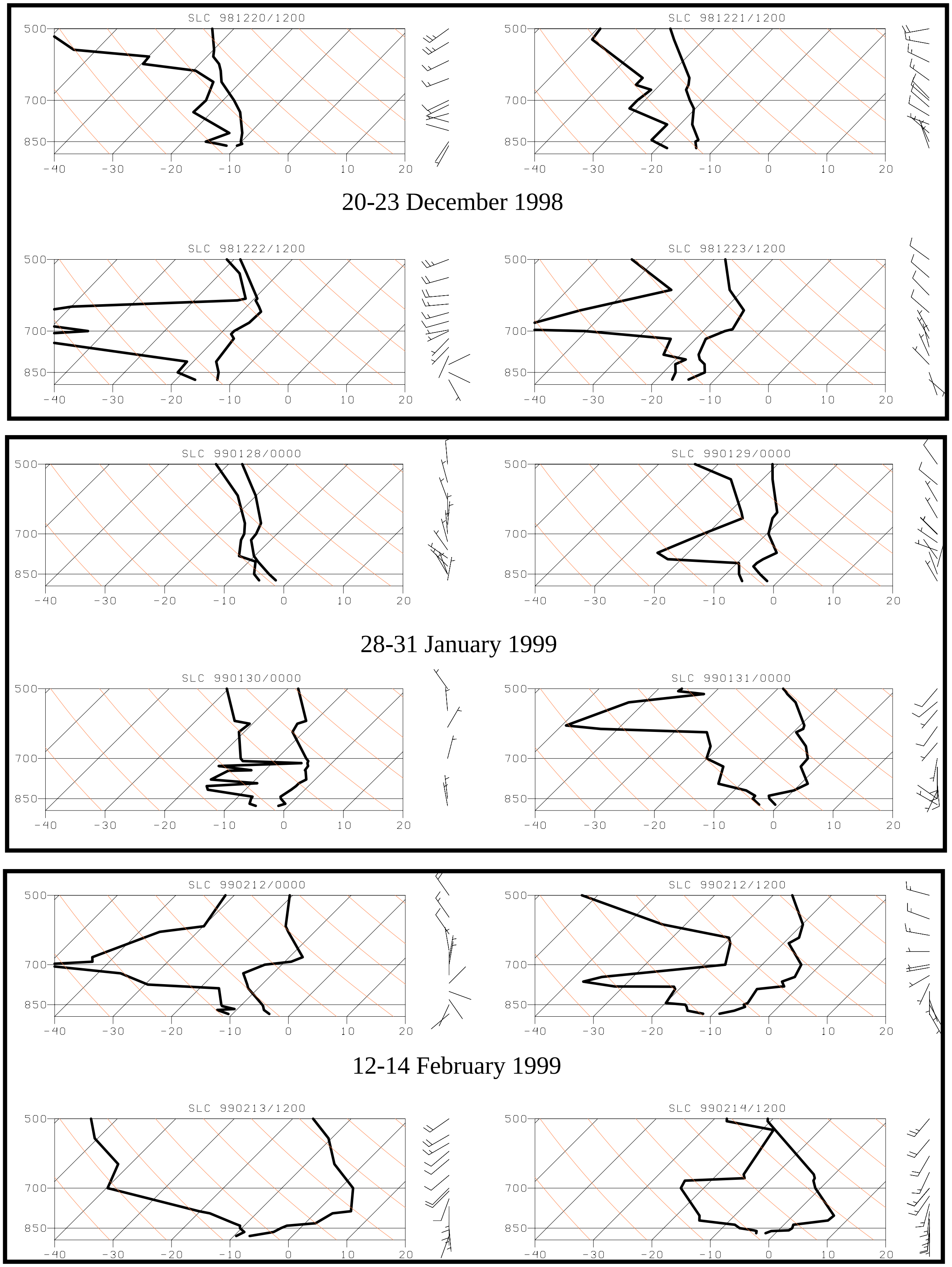

Figure 5. Vertical profiles of temperature (°C) dewpoint temperature (°C) and vector wind (m/s) at SLC during three stable periods in the Salt Lake Valley.

large numbers of weather situations. Ciliberti et al. (1999) illustrate the added value of the ADAS analyses compared to the RUC2 analyses for the passage of a strong cold front. (The extended abstract is included as an Appendix to this proposal.)

Input to the ADAS analysis includes surface observations from the Utah Mesonet, upper air soundings from the SLC NWSFO at 00 and 12 UTC, and radial velocity and reflectivity from the WSR-88D radar located at Promontory Point, Utah (KMTX in Fig. 1). ACARS aircraft reports of temperature and wind are obtained from the Forecast Systems Laboratory and their availability is dependent upon commercial travel periods. Permission to access the Federal Aviation Authority Terminal Doppler Weather Radar (TDWR in Fig. 6) has been granted. The TDWR radar will provide information on boundary layer winds in the Salt Lake Valley that are missed by the KMTX radar as a result of its high base elevation and scanning strategies.

The large variations in surface elevation within the analysis domain present a challenge to any analysis procedure. Surface air and dew point temperature from 3-dimensional linear regression/Barnes analyses are used to replace the RUC2 first guess fields at the surface. Examples of these surface analyses may be viewed at http://www.met.utah.edu/mesonet. Mass conserving wind fields that reflect topographical influences are nearly ready to replace the coarse RUC2 first guess wind field (Ludwig et al. 1991). These objective analyses help to specify the background field by incorporating current surface conditions and local terrain features and reduce discarding observations that deviate significantly from the RUC2 first guess values. Also, the vertical weights in the Bratseth analysis were modified to compensate for the strong terrain gradients within the domain. This approach allows for observations at high elevations to influence data-void locations in nearby mountain ranges while limiting their effect on the free atmosphere adjacent to the mountains.

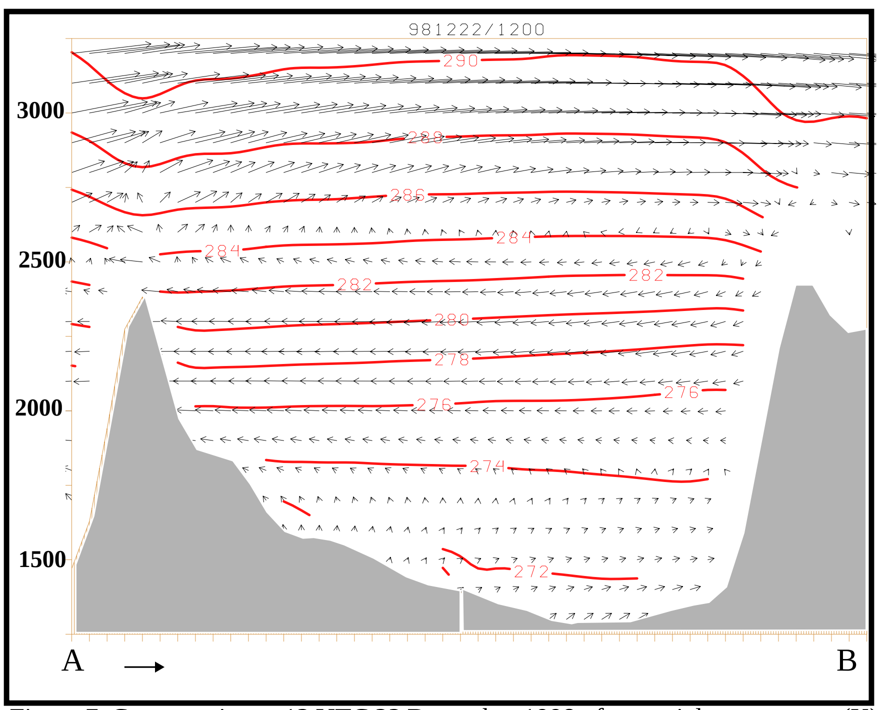

Figure 7. Cross section at 12 UTC 22 December 1998 of potential temperature (K) and vector wind (m s^{-1}) across the Salt Lake Valley as a function of height along the path AB in Fig. 6. The vector at the bottom denotes a wind speed of 5 m s^{-1}.

As an example of the ADAS analyses during stable episodes, Fig. 7 shows a vertical cross-section through the Salt Lake Valley at 1200 UTC, 22 December 1998. The SLC sounding at this time (which was included as part of the ADAS analysis) is shown in Fig. 5. Weaker stability near the valley floor with stronger stability beginning around 2000 m is evident. The southerly winds near the valley floor shift to light easterly winds aloft. The flow above the boundary layer is from the west.

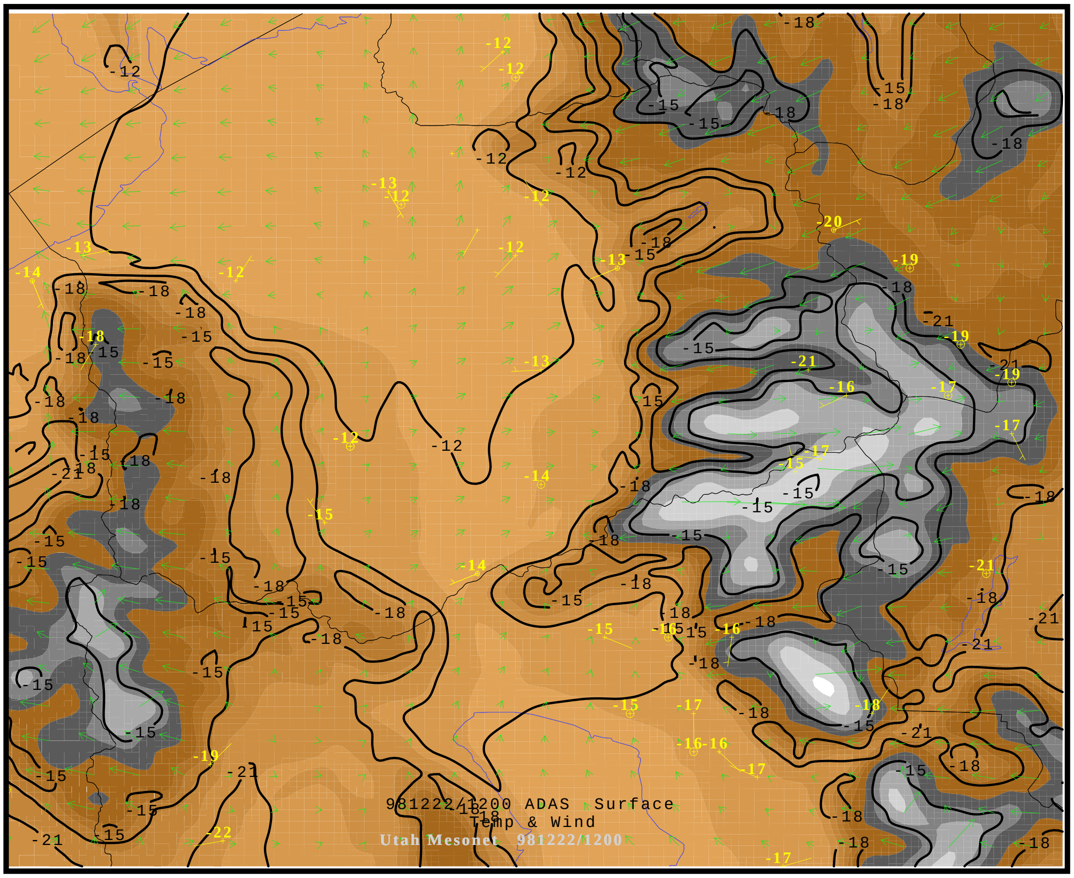

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Figure 8. ADAS analysis of surface temperature (3°C interval) and vector wind (m/s; vector at bottom denotes 2.5 m/s wind speed) at 12 UTC 22 December 1998 superimposed on terrain background. Surface temperature and wind observations from the Utah Mesonet are also plotted.

The ADAS surface analysis of 2-m temperature and 10-m wind is shown in Fig. 8. The Utah Mesonet surface observations help to define the light surface winds on this occasion. Colder temperatures in the Provo and Cedar Valleys along the southern edge of the figure compared to those in the Salt Lake Valley demonstrate the enhanced pooling of the cold air in these smaller basins while the Great Salt Lake helps to moderate the temperatures in the northern end of the Salt Lake Valley. Note that the analysis produces colder temperatures than were likely observed on the data-void western slopes of the Salt Lake Valley. This analysis artifact is a direct result of the weighting scheme, which is designed to distribute laterally the cold temperatures observed at a similar elevation in the nearby Tooele, Rush, Cedar, and Provo Valleys.

4. Research Design and Methods

a. Contributions to initial field program

While the focus of this research will be on research related to numerical analyses and simulations of the basin circulation, we intend to contribute to the field program in a number of ways:

- •Archive and provide access to the following existing operational data resources for the VTMX science team:
  - —Surface observations at several hundred locations in Utah and surrounding states that comprise the Utah Mesonet
  - —Soundings at SLC and other sites in the west
  - —Wind and temperature profiler at Dugway Army Proving Grounds
  - —ACARS aircraft reports enroute and on ascent and descent into the SLC Airport
  - —NIDS images and Level II archive of KMTX WSR-88D radar products
  - —Radial wind and reflectivity images from the FAA TDWR radar at Layton, Utah
  - —Sodar observations from Utah Department of Air Quality in Salt Lake City and in Utah Valley
  - —Visible, infrared, and water vapor satellite imagery and satellite soundings of water vapor
  - —NCEP operational analysis and forecast products from regional models
  - —research analyses and simulations developed at the University of Utah
- •Deploy 2 additional portable surface observing stations as needed
- •Coordinate with Science Team members and local contacts in federal, state, and local agencies and commercial firms to deploy field equipment in the Salt Lake Valley
- •Provide visiting Science Team members with temporary office space prior to and during the field program
- •Provide conference and briefing facilities for Science Team meetings during the field program
- •Encourage undergraduate and graduate students to participate in the field program and work with Science Team mentors in the field

As mentioned in the Budget Section, supplemental funds (not included in the budget) are requested during the second year in order to cover some of the costs during the first 2 years of local coordination activities by CIRP Director and co-PI T. Potter.

b. Numerical studies of the evolution of the stable boundary layer

1. ADAS analyses

ADAS analyses based on available surface and upper-air observations are being generated every hour over northwestern Utah. These analyses will continue to be created as part of other research projects and will be accessible to VTMX scientists via the Internet whether this proposed project is funded or not. However, some weather information is not available in real time, e.g., data from some weather stations are collected only once per day even though the station may record information at 5 minute intervals. In addition, many diagnostics relevant to stable periods are not computed.

We propose to run ADAS hourly at 1 km horizontal resolution for the domain shown in Fig. 6. Analyses during the winter half of the year (15 September-15 March) during three successive winters (1999-2000, 2000-2001, 2001-2002) will be computed the following day in order to incorporate all available data. Analyses for a large sample of stable periods under varying planetary and synoptic scale conditions will be available during this 3 year period to all VTMX scientists.

For field campaign periods during the 2000-2001 winter season, hourly reanalyses will be computed after all of the supplemental data has been collected by the Science Team and made available to us. The reanalyses will be compared to FDDA analyses to be created by other VTMX scientists. Such intercomparisons will help to provide a benchmark that will help to lead to improvements in analysis design. Other modeling groups, including those intending to run large eddy simulations, may wish to use the ADAS reanalyses for initialization.

2. Diagnostic studies

One of the fundamental questions to be addressed by this study is: what interactions develop between valley flows and the mesoscale circulation over northwestern Utah? The area of analysis depicted in Fig. 6 reflects a compromise determined by the distribution of observations and remote sensing resources and the likely scales of influence relevant to vertical transport in the Salt Lake Valley. As discussed by Whiteman et al. (1999), stable layers often develop over a few days as warm air advects aloft over the Valley. However, cold air advection aloft and turbulent mixing at the top of the stable layer as troughs approach often lead to the rapid breakdown of stable conditions in a matter of hours. What factors control this rapid breakdown? We hypothesize that the synoptic and mesoscale pressure gradients are deformed locally by the higher terrain of the Wasatch Mountains and other ranges to the east. This blocking leads to flow channeled over the Traverse Ridge and through the Jordan Narrows.

As a means to synthesize the voluminous data generated by ADAS (i.e., 80 mbytes of model output per hour) and address the above question, we plan to develop ‘quick-look’ images and diagnostics during all 3 winters that will be applicable to a wide range of users. Images will include plan views of surface and upper-air fields, soundings at locations around the valley, and cross sections. These images will be posted routinely to a Web page and archived. Analysis diagnostics will be computed hourly over the area or volume of the Salt Lake Valley as appropriate. Both spatial averages and standard deviations will be computed in order to define the mean conditions and spatial variability around the valley, respectively. These diagnostics will include:

- mixed layer depth and vertical profile of potential temperature,
- horizontal and vertical wind profile,
- vertical profile of mixing ratio and cloud water,
- occurrence and intensity of deep stable layers as defined by Wolyn and McKee (1989),
- number of distinct stable layers in the vertical,
- heating required to destroy stable layers in the basin as defined by Whiteman et al. (1998),
- downward solar and net radiative fluxes at the surface.

The images and diagnostics will be used to define the onset and demise of stable periods. Compositing studies will utilize the full 3-dimensional grids from ADAS to define the typical diurnal cycle and evolution of these episodes on the mesoscale while RUC2 analyses will be used to define the synoptic-scale circulation. The composite analyses will be used to assess how migrating upper-level ridges and troughs develop and erode stable layers. The ADAS analyses will be particularly helpful to diagnose the relative roles of horizontal advection and turbulent mixing to the breakdown process.

While composite studies will provide information on the aggregate characteristics of stable episodes, case studies of selected events during the field campaign will be necessary to understand the role of vertical mixing. Trajectories derived from the ADAS reanalyses at hourly intervals will be computed for comparison to passive tracer releases. The ability of the ADAS analyses to diagnose the Lagrangian motion within the Valley will be assessed by the comparison of the observed and simulated trajectories.

Although ADAS analyses are not constrained to be in thermodynamic or dynamical balance (which is a notable deficiency of the optimal interpolation approach compared to FDDA), it will be possible to develop estimates of the mass budget of the Salt Lake Valley during stable periods as long as the net mass flux is monitored. The mass budget will help to define the relative amount of inflow/outflow through the boundaries of the Valley, e.g., the vertical transport into the basin at crest level and the horizontal transport from the north from the direction of the Great Salt Lake and from the south over the Traverse Ridge and through the Jordan River Narrows. Estimates of the flow channeled into the Valley through the Emigration/Parley’s and Big/Little Cottonwood canyon complexes will be made during all three winters; however, it is likely that accurate estimates of the total mass budget will be practical during the field campaign periods only.

3. ARPS simulations

Preliminary simulations over northwestern Utah have been completed to test the University of Oklahoma ARPS forecast model (Xue et al. 1995). The model equations are nonhydrostatic and fully compressible with a generalized terrain-following coordinate with grid stretching in the vertical. Prognostic equations are formulated in terms of wind, perturbation potential temperature and pressure, subgrid-scale turbulent kinetic energy (and boundary layer height), and mixing ratios for water vapor, cloud water, rainwater, cloud ice, snow, and graupel/hail. Model physical parameterizations include:

- 1.5 order turbulent kinetic energy subgrid scale closure scheme,
- Modified surface flux model,
- Soil-vegetation model developed by Noilhan and Planton (1989) and Pleim and Xiu (1995) that takes into account the surface fluxes of latent and sensible heat as well as surface radiative fluxes,
- Longwave/shortwave radiation parameterization that accounts for cloud interaction and terrain gradient effects,
- Adaptive mesh refinement interface (Skamarock et al. 1989).

ARPS simulations have been completed over the ADAS domain depicted in Fig. 6 in order to determine the computational resources required to run ARPS at 1km resolution and test the sensitivity of the model to the specification of the underlying terrain. Existing computational resources are more than adequate to perform research simulations that are not constrained to be completed in real time.

We intend to test the ability of the ARPS model to simulate the evolution of the stably-stratified boundary layer. The formulation and parameterization of turbulence in the ARPS model is comparable to that used in other operational and research models. ARPS simulations will be restricted to field campaign events during which there will be additional data to initialize the 3-dimensional circulation in the Salt Lake Valley. An inner nest at 1 km resolution as shown in Fig. 6 will be initialized from the ADAS analyses. An outer domain at 3 km resolution will encompass much of the intermountain region and will be initialized from RUC2 analyses with lateral boundary conditions updated hourly from the RUC2 analyses. Thus, these numerical experiments will not be forecasts; rather they are intended to assess the degree to which the ARPS model is capable of simulating the stable boundary layer and to identify its deficiencies. Error characteristics will be contrasted to those obtained from RAMS in order to identify strategies for improvement.

Sensitivity experiments will also be performed in order to examine the physical processes that affect the maintenance of stable layers. For example, pairs of experiments will be completed in which the Great Salt Lake is omitted in one member of each pair, i.e., the observed lake conditions (areal extent, temperature, and salinity) will be specified in one experiment while the lake surface area will be replaced by desert in the other. Changes in the intensity of the valley circulation between the members of each simulation pair will be used to identify the role of the Great Salt Lake upon the diurnal evolution of the stable boundary layer.

c. Linkages to other VTMX projects

Principal Investigators funded at DOE national laboratories have been contacted; no formal collaborative ties have been established at this time. Initial feedback suggests that we will have considerable interaction with several members of the VTMX science team. D. Whiteman and X. Bian, Pacific Northwest Laboratory, intend to use the Utah Mesonet extensively for their regional-scale analyses of cold pool formation. We will focus more narrowly on cold pool formation in the Salt Lake Valley and its relationship to the surrounding mesoscale circulations.

Graduate student Craig Clements has applied for a DOE Graduate Research Environmental Fellowship program; D. Whiteman has agreed to be Craig's DOE mentor if he is approved for this program. Craig has already conducted independent research on mountain-valley circulations (Clements 1999).

Our work is intended to complement the numerical studies underway by J. Fast and S. Zhong, Pacific Northwest Laboratory and J. Bossert, Los Alamos Laboratory. Those efforts will use RAMS and other models to simulate the valley circulation at higher resolution than our study. Intercomparison of numerical results will help to determine the sensitivity of simulations of the stable boundary layer to horizontal and vertical resolution and differences in the treatment of turbulent processes.

Mutual research interests have also been discussed with other prospective Principal Investigators. For example, researchers at the Field Research Division, NOAA Air Resources Laboratory intend to conduct tracer studies that would provide information on transport and dispersion in the Salt Lake Valley. This information could be used to validate the ADAS analyses and ARPS simulations.

d. Project schedule

During the first year, we will compute the ADAS analyses for the 1999-2000 winter and begin diagnostic studies of stable events. These analyses will be used as well to identify deficiencies in the observational network to aid in the deployment of field equipment. We intend to assist team scientists with siting of field equipment during this period.

Assuming that the initial field campaign will be held in the Salt Lake Valley during the 2000-2001 winter half of the year, our efforts will shift to assisting in the field campaign and computing the ADAS analyses for the entire winter half of the year. Special attention will be placed on ensuring all available operational data streams are archived as well as diagnostics of stable episodes.

During the final year of the project, ADAS reanalyses incorporating all available field data will be created. ARPS simulations for selected field days will be initialized from the ADAS reanalyses. Composite studies of stable periods during all 3 winters will be completed.

While the proposal has assumed that the initial field program will take place in the Salt Lake Valley, the decision on the field site will not be made until later this year. Our primary research activities could be carried out for any urban basin. We are collaborating with staff of the Sceintific Services Division, National Weather Service Western Region to port the ADAS code to other forecast offices in the west. If another site were selected, our role in local coordination would not be necessary, but we would still be able to provide many of the data resources listed in Section 4a.

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Facilities and Resources

This research will be conducted within facilities of the NOAA Cooperative Institute for Regional Prediction/Department of Meteorology at the University of Utah. The Institute is located in the Intermountain Network and Scientific Computational Center that provides high-speed connectivity to the national research community and state-of-the-art networking within the building.

Existing computer resources (over 2 dozen Sun workstations, disk drives and printers) will be used to process and archive data. Additional computer time will be requested from the University of Utah Center for High Performance Computing to develop the analyses and simulations.