

# EXPERIMENTAL PLAN

## Introduction

This is an initial version of an experimental plan for the DOE's Environmental Meteorology Program VTMX field campaign to be conducted in October 2000 in the Salt Lake Valley. The plan should be considered a working document. It will gradually evolve into a more detailed plan that describes what will be done (and, to some extent, why) by the program participants. At this stage, assignments of individual research groups to specific sites, the listing of criteria for selecting intensive operating periods (IOPs), the design of specific measurement strategies, etc., etc. that are contained in this draft are in no sense to be considered final. In many cases they are intended mainly to prompt a reaction, galvanize people into taking concrete action now while there is still time to plan, encourage discussions among collaborating groups, and identify things that need to be done that may or may not have made their way onto someone's "to do" list. Some questions are posed in the hope of getting some response. Some problems are identified that will require solutions that have yet to be identified. The information provided here may be incomplete (and possibly even inaccurate in some instances) and additional input is welcomed.

An effort will be made to incorporate readers' suggestions into upcoming revisions of this plan. A brief description of some presently contemplated additions is given at the end of this document; other suggestions are encouraged.

## Schedule

The field campaign will take place in October 2000. October 1 is a Sunday and participants should be prepared to make their first full set of measurements beginning that evening. October 31 is a Tuesday; people should plan to be making measurements as late as the previous evening and through the morning of the 31st.

Although some measurements can and should be made continuously during the experiment (e.g., radar wind profiler and RASS), others will only be practical on a more limited basis during IOPs. These include tracer measurements, some or all lidar operations, multiple sonde launches, some modes of operation for the U. Mass Turbulent Eddy Profiler (TEP), tethered sonde flights, and aircraft flights. Up to 10 IOPs are anticipated but the selection criteria for these remain to be determined. At least three sets of conditions are likely to be of interest: 1) clear skies and light winds at the surface and aloft; 2) clear skies and light winds near the surface but moderate to strong winds aloft; and 3) light winds at the surface and aloft but with cloudy skies. The first set would presumably produce very stable layers in the valley and the circulations would be dominated by thermally induced flows. The second set would be favorable for the generation of waves by flows over the higher terrain. The third set might result in a multiple-day cold pool that is not broken by diurnal heating. In general, IOPs would not be conducted on nights with precipitation, with moderate to strong winds near the surface, or during frontal passages.

Some discussion will be required to reach a consensus on the division of IOPs among these three (or other) sets of conditions and during which of the IOPs tracers will be released. A commitment from the various PIs on what instruments will be operated during the IOPs, in what modes, and for what times will also be necessary.

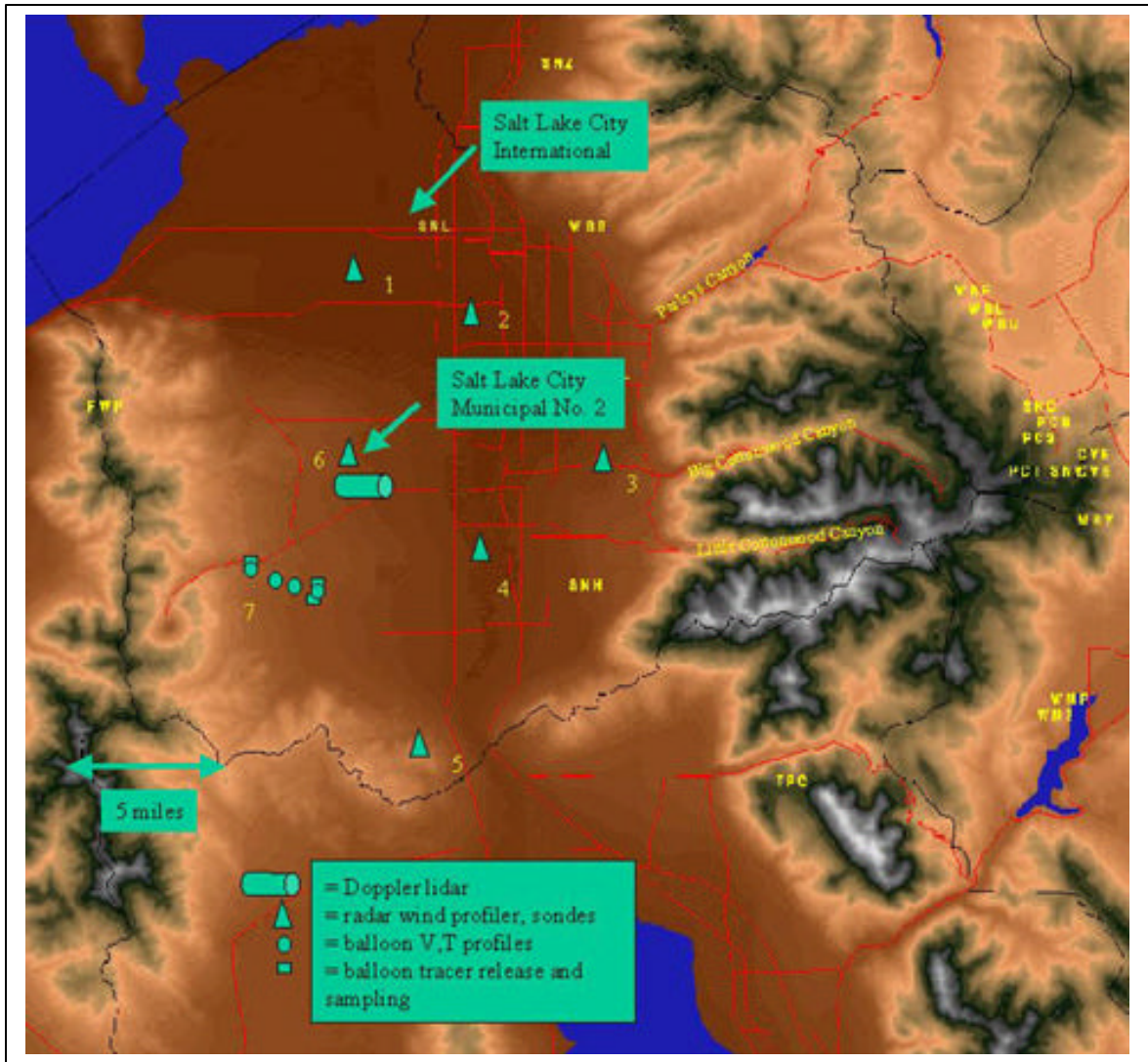
### Instruments and Locations

It might be useful to classify the proposed measurements into several categories to help see how the various components of the observational program fit together. However, many projects have a range of topics that will be addressed and it is difficult to know how to associate specific categories with a particular project. Instead, in the table given below the principal investigators are listed along with the instruments that each has proposed to deploy. This at least provides some information on the types of measurements that have been planned.

NAME	INSTRUMENT(S)
Banta	Doppler lidar (winds)
Cooper	lidars (q and T), radar wind profiler, sodar
Coulter	radar wind profiler, sodar, tethered balloon
Doran	sonic anemometer(s)
Fast	tracers, lidar (aerosols)
Fernando	tethered balloon, sonic anemometers, particle streaker sampler
Frasier	radar wind profiler (TEP)
Parsons	radar wind profiler, lidar (aerosols), rawinsondes
Nappo	instrumented aircraft, microbarographs, sonic anemometers
Shaw	radar wind profiler, sonic anemometer(s), mini-sodar
Watson	chemicals sensors (CO, particulates)
Whiteman	tracers, tethered balloons, radar wind profiler

For a more complete description of what each PI intends to deploy and why, consult the extended abstracts or the synopses of the September 1999 meeting presentations that can be found on the VTMX home page.

Initial candidate sites for the radar wind profilers were identified during the September 1999 Salt Lake City meeting. They are indicated by the triangles in Figure 1. Starting with the upper left (northwest) corner, brief descriptions of the sites, tentative assignments of PIs to those sites, and possible other equipment to be located at each are given below. Following those, possible locations for other instruments are also described.



**Figure 1**

1. The first site is just southwest of the SLC International airport and southeast of the Great Salt Lake. It is a large field in an industrial area that is being developed. There are several large lots in this area, most or all of which seem to be for sale. The U. Mass TEP would be located here, run by Steve Frasier. In addition, the Arizona State group would like to fly their tethered meteorological and particle measurement system near the TEP, and operate a sonic anemometer on a 10 m tower nearby.
2. The second site, to the south and east of the first, is another industrial area. Thus far it has not been examined as closely as the first. It is proposed that Dugway, through a subcontract with Dave Whiteman of PNNL, would operate their 924 MHz profiler and a sodar here.

3. Site 3 is a parking area next to a golf course just outside the entrance to Big Cottonwood Canyon. Rich Coulter of ANL would operate a suite of instruments here, including a 915 MHz profiler, a sodar, a scintillometer, and a tethered balloon.
4. Site 4 is to the southwest of the third site and approximately due west of the entrance to Little Cottonwood Canyon. It is apparently a reclaimed toxic waste site. Will Shaw of PNNL wants to operate a 915 MHz profiler here. A sonic anemometer on a 6-10 m tower and a mini-sodar would also be installed at this location.
5. Site 5 is near the southern end of the Salt Lake Valley near the Traverse Range. Several possible locations are under consideration, including sites just north and south of the gap through which the Jordan River flows. NCAR will operate their multiple antenna wind profiler radar (MAPR), a sodar, and a backscatter lidar, and they hope to launch rawinsondes from this area as well.
6. The last profiler site is near the Salt Lake City Municipal Airport No. 2. Los Alamos would install a 915 MHz radar wind profiler and sodar at this location. Bob Banta of NOAA/ETL is also considering this site as a promising one at which to install a Doppler infrared lidar system to measure radial velocities over a large portion of the Salt Lake valley.
7. There is another group of symbols on the lower slopes of the Oquirrh Mountains to the southwest. Dave Whiteman of PNNL plans to run a tracer experiment in this area, with tracers to be released and sampled with balloon borne sensors. Ground sensors will also be used, as will 4 tethered balloons to measure wind speeds and temperatures. Dan Cooper of LANL hopes to deploy his lidars for measuring water vapor and temperatures in this area as well. The site is a large, open area with a very gentle slope to the west and south. Arizona State will also have a sonic anemometer located nearby.
8. Carmen Nappo of NOAA/ATDD is planning a series of flights by a LongEZ aircraft. Various flight plans were discussed at the SLC meeting without reaching a final conclusion. One strong candidate was a series of flights over a path from site 7 diagonally to the north and east to a point opposite Parley's Canyon or a bit north, and return. Some modifications to this plan to enable the plane to pass some of the profilers more closely were also discussed.
9. Jerome Fast will be releasing tracers from 4 or 5 points in the Salt Lake Valley. Two or three are likely to be in the downtown urban area, while other possible sites include Parley's Canyon and a basin site to the south of the main urban area. He will distribute approximately 50 sampling sites over the region, most of which are concentrated in the more urban areas of the city.
10. Jerome Fast is also hoping to obtain additional funding to deploy NOAA/ETL's DABUL lidar system to measure aerosol layers over the valley. A site for this has

not been definitely identified yet but the Municipal Airport No. 2 is a good candidate.

11. Chris Doran of PNNL, along with Carmen Nappo and Greg Poulos of CoRA, would like to see a network of sonic anemometers and/or other moderately fast response ( $\sim 1$  Hz) wind and temperature sensors deployed around the valley to look for episodes of intermittent turbulence. Likely sites include those at which the radar wind profilers will be installed as well as other locations. The network configuration will depend on the number of sonics available.
12. Carmen Nappo has also proposed bringing a set of microbarographs to the experiment but locations for his proposed array have not been chosen.

In addition to these instruments, there are possibilities of deploying several more. Greg Poulos and Joe Fernando both have NSF funding for projects that can be considered closely related to VTMX issues. They may be able to obtain approval to use (for free) some equipment from NCAR that could otherwise only be provided at a cost the program cannot afford. In particular, a number of flux sampling stations and a 55 m tower may become available but a decision on this is not expected before April of 2000. Chris Doran has looked into the possibility of deploying a network of up to 20 surface meteorological stations owned by Dugway but that seems to be only a remote possibility at this time.

At the Salt Lake meeting in September a suggestion was made that radiosondes be launched at frequent intervals and several locations, at least during IOPs, to get information on the temperature and moisture structure in the valley that would not otherwise be measured. A number of investigators agreed to pay up to \$5K each from their projects to purchase the necessary sondes and balloons if a mechanism could be identified to do this efficiently. This mechanism has not yet been found and further action has been put off until we hear from the FAA about what balloon flights will be allowed. Inquiries into this have been initiated. A preliminary indication of what we'll be allowed to do is expected in early December but final approval will have to wait until we have the exact locations of our sonde releases pinned down. If the NCAR facilities request is approved, sonde systems may also be available from NCAR. Given the possibility of obtaining these systems from NCAR, it might be unwise to order sondes from Vaisala (who have bought out AIR) at this time. The difficulty is that only the old model AIR sondes are compatible with a number of the ground receiving stations currently owned by VTMX investigators, and if these sondes are not ordered soon, they may not be available at all. At this point, we are still trying to gather more information on Vaisala's plans (if any) to support the old AIR platforms.

If there are other instruments that have not been identified here and that may be available, that information should be passed on to the program participants.

## **Site Permissions**

Individual investigators will ultimately be responsible for securing permission to install instruments on specific sites. Chris Doran at PNNL and John Horel at the University of Utah are willing to assist when possible but PIs should be taking the initiative. John might be able to identify a local contact but can't be expected to do all of the actual legwork required. Chris is willing to visit people and/or sites when he is in the Salt Lake area; contact him for possible help in this area.

## **Power, Etc.**

When permission to use a site has been secured, arrangements will also have to be made for any necessary power drops, delivery of portable toilets, rental of mobile office space, etc. Again, this will be the responsibility of individual PIs but Chris can help coordinate various requests. Each PI should start preparing a detailed list of what facilities or services will be required.

## **Housing**

There are several housing options that we can consider. One is for individuals to simply identify motels they would like to stay in and have them make their own arrangements. A second possibility is to find a "base" hotel and try to negotiate a reduced rate for those planning to stay there. A third option is to look for a block of apartments that we might be able to rent. Perhaps some combination of these three would work. In any event, people should now begin to think about when they would plan to arrive in Salt Lake for the experiment, when they would leave, how many people would be coming, and what housing arrangements they would prefer. While a final decision won't be required for several months, early indications would be useful. Send your best guess to Chris Doran at PNNL as soon as possible.

## **Environmental Concerns**

There are a number of possible barriers to our ability to conduct some of our measurements in areas that are culturally, ecologically, or historically sensitive. The basic issue is whether any of our activities would have an adverse impact in any of these categories. The overwhelming likelihood is that we will not have any such effects, but as an added precaution inquiries are being made about possible areas that we should avoid. Some generally useful guidelines are given here.

In performing work under this program, the Project Managers (PM) and all project staff should perform work safely, in a manner that ensures adequate protection for staff, the public, and the environment, and should be accountable for the safe performance of work. The PM and all project staff should exercise a degree of care commensurate with the work and the associated hazards. The PM and all project staff should comply with all applicable federal, state and local laws and regulations and should cooperate with Federal and non-Federal agencies having jurisdiction over applicable activities and issues

associated with the work. Requirements to consider include, but are not limited to, applicable regulations of the Federal Aviation Administration, the Endangered Species Act, the National Historic Preservation Act, the National Environmental Policy Act, the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, etc.

### **Unresolved Issues and Action Items**

These are listed in no particular order. Readers should take heed of those items that are relevant to their individual operations.

1. Radar wind profiler operators should ensure that they have whatever license or clearance is required to operate their profilers in the Salt Lake Valley.
2. There is a lot of air traffic in the region. Some consideration should be given to how to remove unwanted radar echoes from these hard targets.
3. RASSes or sodars will obviously have to be located in areas where they do not incur the wrath of those nearby. Some detailed explorations of the areas surrounding proposed sites would be useful.
4. PIs should be taking steps to secure permission to set up their instruments in their chosen locations. They should follow up with arrangements for power, trailers, and other facilities that may be required.
5. Lidar operators should ensure that their instruments do not pose an eye hazard to anyone. If an instrument is not eye safe, a detailed safety plan should be prepared and followed to eliminate any possible problems. Please send a copy of this plan to Chris Doran.
6. How many radiosondes to fly, at what time intervals, from where, and by whom needs to be determined. This will depend, among other things, on the availability of sondes and ground receiving stations, FAA approval, and the willingness of people to stay up all night launching the sondes.
7. Some instruments, such as the U. Mass TEP and the LANL lidars, can collect huge amounts of data in fairly short times. Some of this data may be of interest primarily to the PIs but some may be of great interest to other investigators as well. A discussion needs to be initiated among those who desire data and those who are able to acquire it to arrive at some reasonable operating strategy. This is also true, to a lesser extent, with other instruments, but a similar type of discussion, understanding, and agreement must be established for these instruments as well. It would be unfortunate to collect a lot of data that no one bothers to look at. It would be even worse to fail to collect data that were really needed by someone in the program.
8. Flight plans for the LongEZ have to be worked out.

9. The perfluorocarbon tracers apparently do not require any permits for their release but this should be confirmed by those planning to release them.
10. There may be vandalism or other security issues to consider when deploying instruments. This is a concern that should be explicitly factored into everyone's planning.

### **Future Meeting**

A meeting some time in late February was discussed briefly last September. Whether such a meeting takes place at that time will depend on how much progress people have made in their preparations and what issues need to be and can be resolved in such a meeting. The meeting would presumably be somewhat smaller than the September one and may be easier to put together, but a decision should be made at least a month before any proposed dates. One possibility is to set aside a week in Salt Lake, with the first day or two devoted to more site visits, contacting land owners, power companies, etc.. The next day or two could be devoted to discussing the status of people's presentations, and identifying and resolving issues that have arisen.

Send any suggestions or comments to Chris Doran.

### **Future Additions**

It would be nice to include a brief description of what each PI hopes to measure (and why) with the particular instruments and the particular location that is settled on. This description would be much shorter than what was included in the extended abstracts but would help interested readers get, in one document, an overall picture of the experimental campaign. An effort will be made to have this information in a future version of the plan.

A status report on where we stand with regard to FAA approval, site access, and other logistical issues will be added.