SJV Field Campaign
(UAVSAR/Soil Moisture)

Ver. 04/29/10

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1. Background

The San Joaquin Valley (SJV) campaign is part of an effort to integrate observations of vegetation water content, soil moisture, and evapotranspiration into agricultural water management and better understand water balance and fluxes. Observations of vegetation, in particular vegetation water content, will be estimated using AVIRIS and supported by concurrent ground measurements. Evapotranspiration will be determined using MASTER observations of land surface temperature and flux tower measurements. Both instruments will be flown in the morning and afternoon to check for changes in evapotranspiration and vegetation water content throughout the day. Soil moisture will be retrieved from the UAVSAR and supported by concurrent ground measurements. The measurements made by the UAVSAR will also address several algorithm development issues for the NASA Soil Moisture Active Passive (SMAP) mission (http://smap.jpl.nasa.gov).

2. Experiment Investigators and Responsibilities

- Project: Yield, Nutrient and Water Relationships
    - POC: Mike Whiting, mwhiting@ucdavis.edu, 530 304-2864
    - USDA-SCRI
    - CSTARS--Susan Ustin, Mike Whiting, Jose Zarate, Sean Hogan, LiYi Xu, Alex Koltunov,and Roxana Cariadi
- Project: Continuous of Nutrient, Water and Yield Experiments at PFC orchards
    - POC: NAME, email, phone
    - Pomology—Patrick Brown, Saiful Muhammad, Ismail Siddiqui, Sebastian Saa Silva,
    - UCCE—Blake Sanden and 2 field assistants
- Project: NASA-Student Airborne Research Program (SARP):
    - POC: Rick Shetter, r.shetter@nserc.und.edu, 701-330-2126
    - CSTARS--Susan Ustin, Shawn Kefauver, and ~ 10 senior/1st year grad students
- Project: NASA Terrestrial Hydrology- Multiscale assessment of vegetation water content estimates and its impact on soil moisture for agricultural and natural vegetation (WaBa), through understanding Water Fluxes and Balance.
    - POC: David Riano, driano@ucdavis.edu, 517-914-2842
    - CSTARS--Susan Ustin, David Riano, Alex Koltunov, and Angeles Casasp
    - USDA-ARS, Beltsville--Ray Hunt
- Project: Soil Moisture Determination:
    - POC: Tom Jackson, tom.jackson@ars.usda.gov, 301-646-3260
    - USDA-ARS--NASA-UAVSAR—Team

3. Instruments and Aircraft

The three instruments involved in this campaign are AVIRIS, MASTER, and UAVSAR. AVIRIS and MASTER will be flown together in the ER-2 on two dates, MASTER will be flown alone on the DC-8 on one date and UAVSAR will be flown on the G-III when either the ER-2 or DC-8 are flown (a total of three times).

Each instrument is described in a following section.

3.1. *AVIRIS*

The Airborne Visible Infrared Imaging Spectrometer (AVIRIS) is a whisk-broom type hyperspectral instrument developed and operated by NASA's JPL (http://aviris.jpl.nasa.gov). AVIRIS has 224 contiguous bands from about 400 nm to about 2500 nm wavelength, with each band being about 10 nm wide. Actual wavelengths for each band are determined by annual calibration at JPL. The swath is 614 pixels and the instantaneous field of view is 1 milliradian. Pixel size and swath depend on aircraft altitude. For these experiments it will be flown on the NASA ER-2 aircraft (http://www.dfrc.nasa.gov), it will be flown at an altitude of 7-10 km to provide a pixel size of 7-10 m and a swath of 4.3-6.1 km.

In the past, the flight crew at Dryden for the ER-2 will go over the day's weather predictions for all sites, and pick the highest priority site with clear weather for that day's flight. Hence, due to weather conditions, sites with high priority may not be flown.

3.2. *MASTER*

MODIS/ASTER (MASTER) airborne simulator supporting the ASTER and MODIS instrument teams in the areas of algorithm development, calibration and validation. (http://master.jpl.nasa.gov/). It provides 50 channels between 0.4-13 micrometers with an IFOV of 2.5 milliradians and a TFOV of 85.92 degrees. It can be incorporated on a variety of aircraft. For the ER-2 at an altitude of 7-10 km it will provide a pixel size 17.5-25 m.

For the late June-early July flight, MASTER will be flown on the DC-8 at lower altitude of ~ 4 km to provide a pixel size of 10 m.

3.3. *UAVSAR*

The Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) is an aircraft based fully polarimetric L-band radar that is also capable of interferometry. It is currently implemented on a NASA Gulfstream-III aircraft. (http://uavsar.jpl.nasa.gov/) Details on the UAVSAR are listed in Table 1.

UAVSAR looks to the left of flight direction. The most relevant portion of the data swath for SMAP, which has an incidence angle of 40 degrees, will be data collected between 35 and 45 degrees. At an altitude of 10 km this would be a 3 km wide section of the swath offset from the flightline.

Table 1. UAVSAR Description	
Instrument	Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)
Owner	NASA/JPL/Dryden (USA)
Platform	Gulfstream III; operating altitude up to 13 km
Frequencies	L-band (1.26 GHz)
Polarizations	HH, HV, VH, VV
Spatial Resolution	80 MHz Bandwidth, 1.66 m range x .8 m azimuth SLC 3 m multi-looked (6 looks)
Scan Type	SAR with Electronically scanned active array, range swath ~20 km looking left of track between 25 and 65 degrees.
Antenna Type	Phased Array
POC/Website	Scott Hensley Scott.Hensley@jpl.nasa.gov www.uavsar.jpl.nasa.gov

3.4. *Aircraft and Instrument POC*

ER-2	Name	email	phone
DC-8	Name	email	phone
G-III	Name	email	phone
AVIRIS	Name	email	phone
MASTER	Name	email	phone
UAVSAR	Name	email	phone

4. Flight Mission Schedule Alternatives

The optimal mission scenario involves coverage during periods that have different leaf water contents. There will be three flight periods, one flight in each of the following weeks;

Option 1:
May 17: MASTER+AVIRIS on the ER-2 and UAVSAR on G-III.
June 29: MASTER on the DC-8 and UAVSAR on G-III.
Late season TBD: MASTER+AVIRIS on the ER-2 and UAVSAR on G-III.

It is critical to the science objectives that the UAVSAR fly when the other aircraft fly. At this point in time, the only conflict with UAVSAR that we are aware of is a campaign in Canada June 1-17. However, there are issues involving the other instruments that could impact the experiment and flight dates.

The MASTER instrument is being repaired and a test flight is scheduled the week of May 3. If this effort is not completed that week it would delay the first set of flights the week of May 17. This will have to be carefully tracked. If a delay in the MASTER availability pushes the flight beyond May 21th the mission might be changed.

MASTER+AVIRIS on the ER-2 and MASTER on the DC-8 will be flown twice each date, at 10 am and 2 pm solar time. The idea is to capture changes in evapotranspiration estimates using the MASTER thermal band between morning and afternoon flights.

These flights will also examine diurnal changes in vegetation water content, using AVIRIS. UAVSAR will be flown at 10 am.

AVIRIS requires less than 10% cloud cover to fly. During each deployment week, the UAVSAR should be flown on the first AVIRIS flight date.

Option 2: If the May flight does not occur, the following flights will be conducted
June 29 MASTER on the DC-8 and UAVSAR on G-III.
July 1 MASTER on the DC-8 and UAVSAR on G-III.
Late season (TBD) MASTER+AVIRIS on the ER-2 and UAVSAR on G-III.

5. Study Area and Test Fields

Site selection and study areas were driven by the priorities of the AVIRIS and MASTER and the ongoing research programs and contacts in the study region. Figure 1 shows the AVIRIS/MASTER domains. Figures 2 and 3 are enlargements of the two focus areas, referred to here as Sheely Farms and Belridge. Figure 4 is a map of the land use of the fields in Sheely Farms. Table 2 summarizes the centers of the current set of sampling sites.

Table 2. Southwest Corner Coordinates of the SJV Ground Sites

Site ID	Vegetation	Irrigation	Longitude (Deg.)	Latitude (Deg.)
01	Pistachios	TBD	-119.9503	36.2337
02	Pistachios	TBD	-119.9410	36.2337
03	Wheat	TBD	-119.9410	36.2263
04	Wheat	TBD	-119.9410	36.2177
05	Cotton	TBD	-119.9410	36.2106
06	Pistachios	Drip	-119.6809	35.5138
07	Almonds	Drip	-119.6720	35.5138
08	Pistachios	Drip	-119.6809	35.5065
09	Almonds	Fan-jet	-119.6720	35.5065
10	Almonds	Fan-jet	-119.6630	35.5065
11	Almonds	Fan-jet	-119.6720	35.4993
12	Almonds	Fan-jet	-119.6630	35.4993
13	Almonds	Fan-jet	-119.6809	35.4919
14	Pistachios	Fan-jet	-119.6630	35.4919
15	Almonds	Fan-jet	-119. 6720	35.4848
16	Almonds	Fan-jet	-119.6630	35.4848

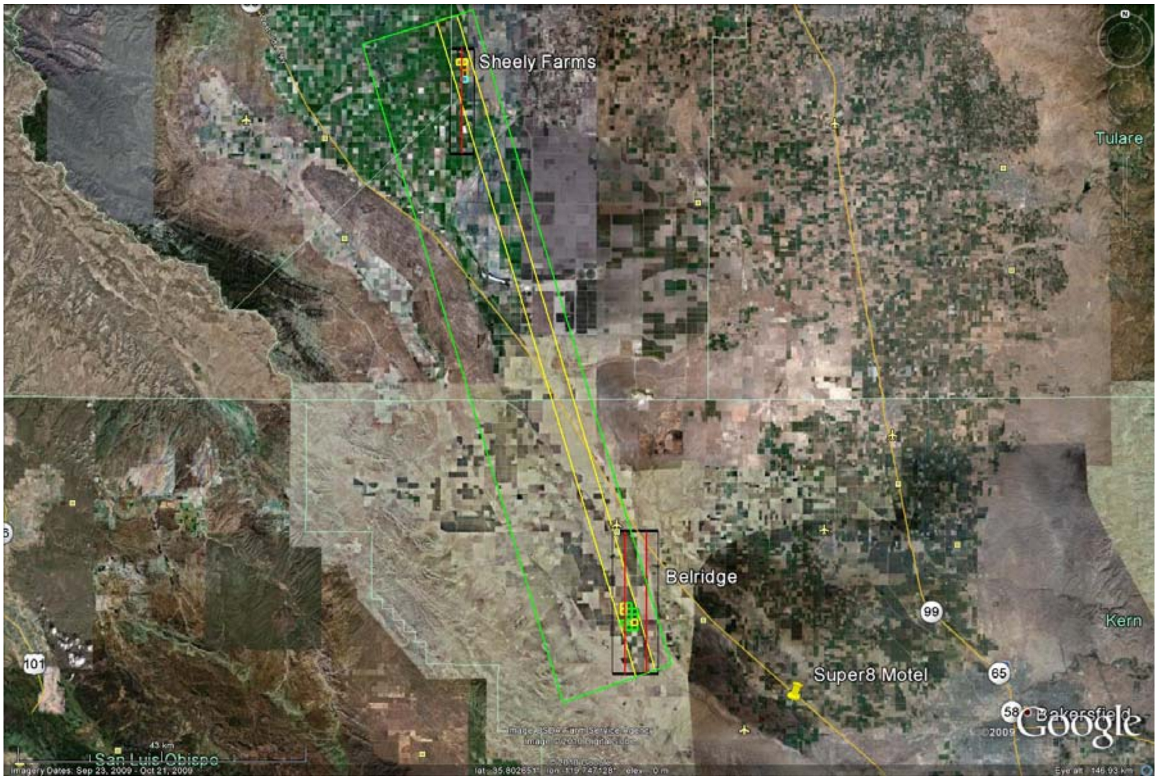

Figure 1. Photo map showing SJV sampling fields, AVIRIS/MASTER, and UAVSAR coverage (Full swath). Legend: Black boxes-AVIRIS/MASTER coverage, red lines-AVIRIS/MASTER flightline, green box-UAVSAR full coverage 25-65 deg. N heading, and yellow box-UAVSAR 35-45 deg. coverage N heading.

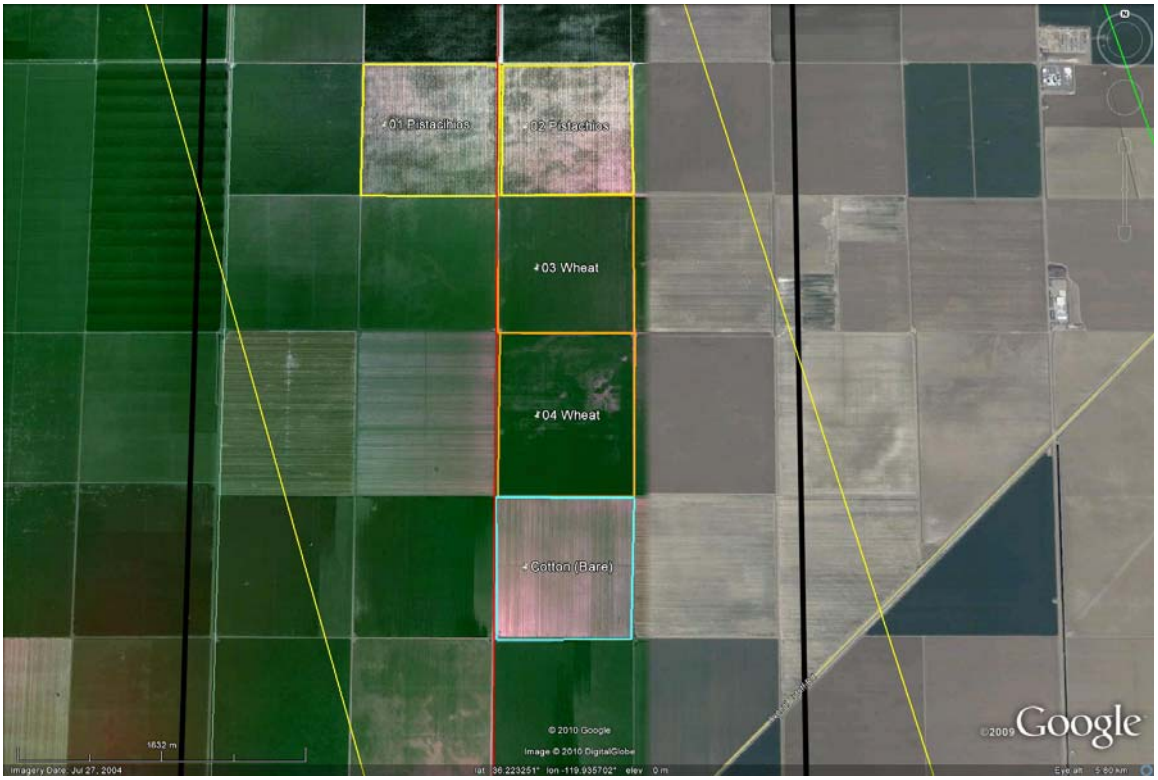

Figure 2. Photo map showing SJV-Sheely Farms sampling fields. Legend: Yellow lines-UAVSAR 35-45 deg. coverage N heading.

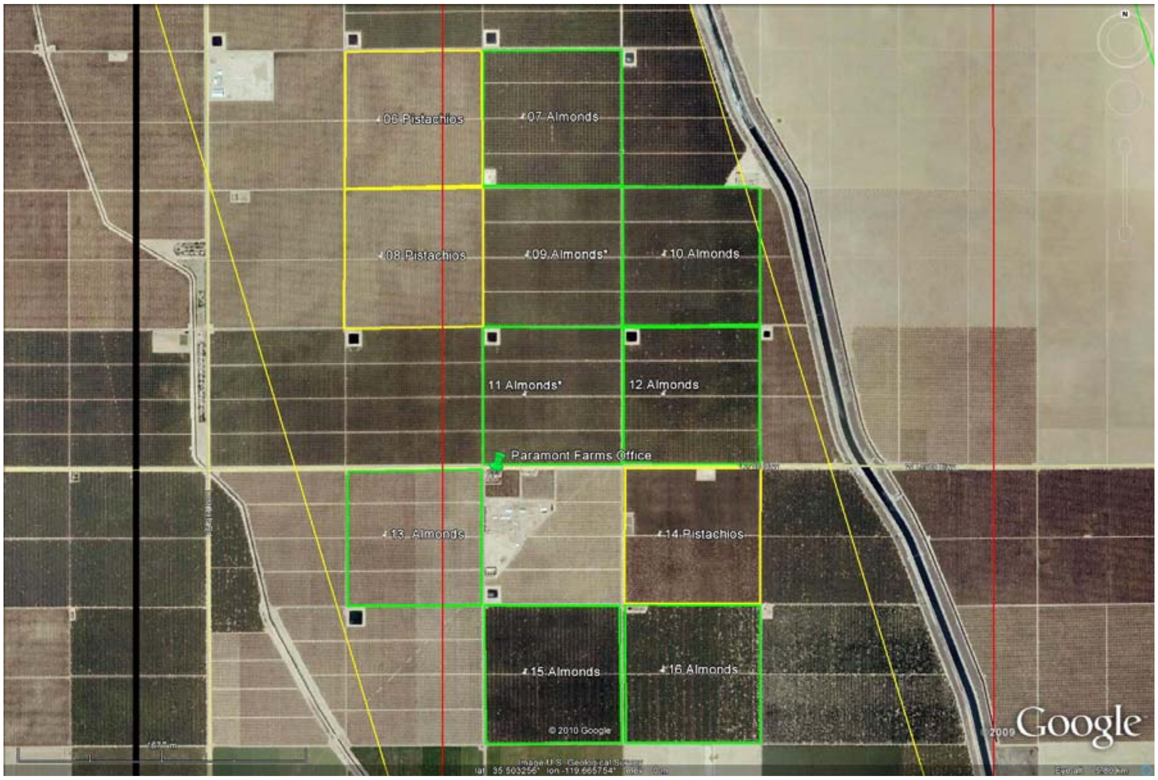

Figure 3. Photo map showing SJV-Belridge sampling fields. Legend: Yellow lines-UAVSAR 35-45 deg. coverage N heading.

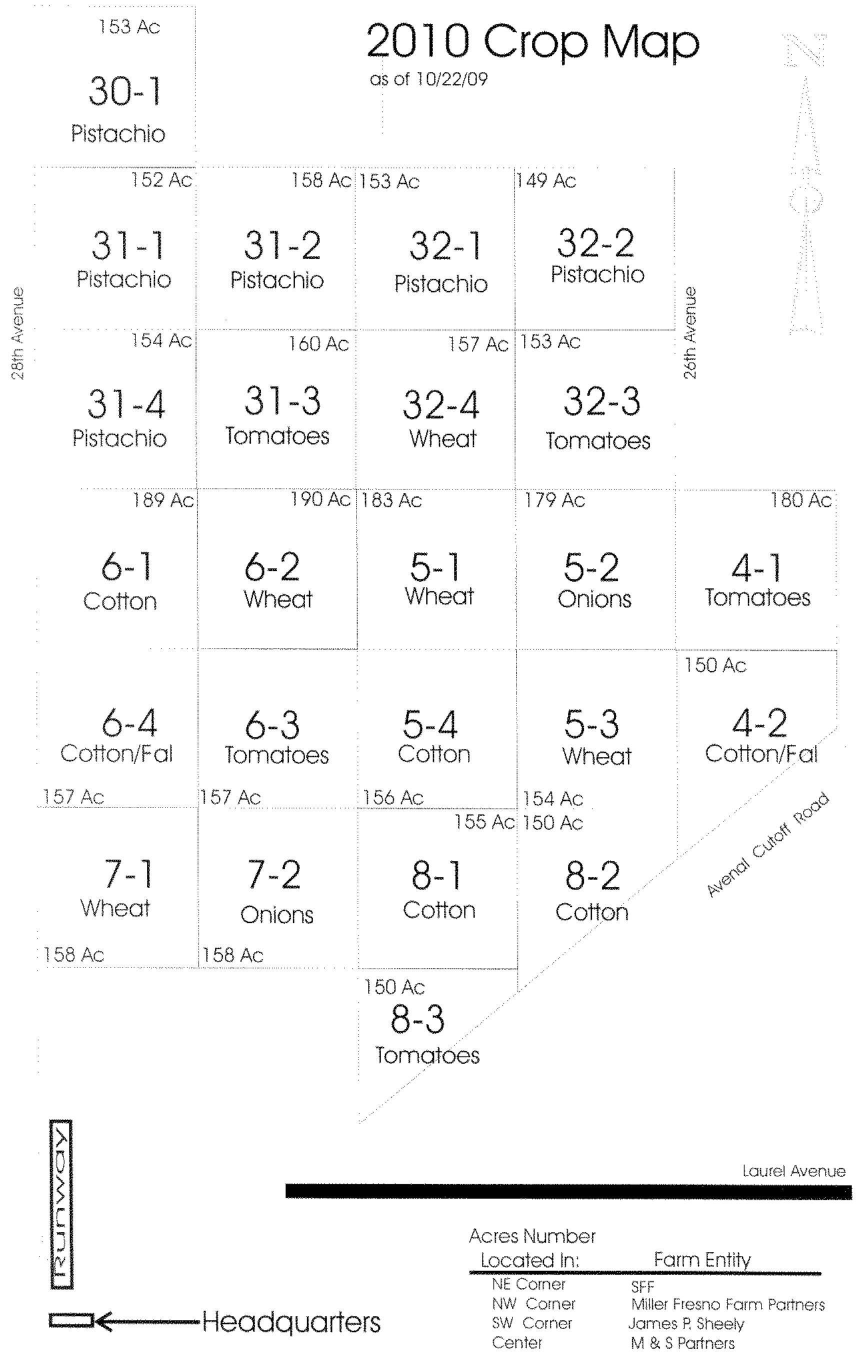

Figure 4. Crop map of the SJV-Sheely Farms area.

6. UAVSAR Flightlines and Coverage

As noted earlier, a primary objective of the UAVSAR flights is to provide data to support SMAP radar-based soil moisture retrieval algorithm development. Therefore, the mission design is based upon covering sites in which we sample soil moisture with the radar observations similar to the SMAP instrument. The priority is to provide coverage of this line at an incidence angle of 40 degrees with coordinates listed in Table 3.

Table 3. Coordinates of the SJV UAVAR coverage at 40 degrees.

	Longitude (Deg.)	Latitude (Deg.)
South End	-119.63915	35.42829
North End	-119.96569	36.29514

The heading will be S to N. The second priority will be to cover this same line at 40 degrees with the reverse heading.

We are also requesting coverage of this same line at two other incidence angles 30 and 50 degrees (North heading). The purpose of these flights is to support the understanding of SMAP radar algorithms in the context of current (ALOS Palsar) and future (SAOCOM) satellite L-band radar products. These additional angles will also allow us to explore more refined and site specific soil moisture retrieval algorithms.

7. Ground Based Soil Moisture Sampling Plan

Ground based soil moisture observations will be made by teams supported by USDA, NASA JPL, NASA GSFC, UC Santa Barbara, UC Davis and others. On the day of the flight, teams will use Theta Probes to measure the 0-6 cm volumetric soil moisture at multiple points as described below. The locations used by the vegetation teams for sampling will be factored into the sampling plan. Walking between sampling points is time consuming and the design suggested attempts to minimize this by using transects. A basic design used in numerous previous investigations will be adapted based upon the sites selected and current field conditions (i.e. if furrows are flooded or sprinklers are active it will not be possible to sample).

Based upon logistics, resources and potential science return a decision was made to focus the ground-based soil moisture sampling in the Belridge area orchards. The Sheely Farms sites will be sampled less intensively by the vegetation team.

Although it is desirable to use two-person teams, the estimates of time required per sample location are higher in the SJV sites than in previous campaigns. It is estimated that it will require approximately 15 minutes to sample a point and travel to the next location. Based on three transects per field consisting of 4 locations each and 11 field, the total sample locations will be 132. With 8 people this will require each to sample 16-17 locations. Therefore, the minimum total time for sampling is estimated at 4-5 hours.

The soil moisture team is relying on the vegetation teams to fully characterize the biophysical and structural properties of the canopy. The requested measurements are:

- The day of the flight and some additional plots the day after the flight:
  - Leaf water per unit of leaf area (EWT) with gravimetric methods
  - Dry matter per unit of leaf area (DM), with gravimetric methods
- To be carried out two days after the flight:
  - LAI with LAI2000 and fish eye photos
  - EWT*LAI= Wet biomass (kg/m2)
  - DM*LAI= Dry biomass (kg/m2)
  - Canopy height
  - Field photos with a reference scale that show leaf distribution and angles
  - Stem (which stems?)/trunk diameter (DBH)
  - Leaf dimensions
- NDVI
- NDWI (or other)

In addition, the surface roughness should be characterized. A photograph of a pin profiler or a reference grid board is typically used.

The soil moisture probes are more reliable if some localized calibration is done. This might involve taking gravimetric samples at a subset of the points. These samples would need to be weighed and dried.

8. San Joaquin Valley (SJV) Soil Moisture Sampling Protocol

8.1. *General Guidance on Field Sampling*

- The following approach is designed assuming that the field is an orchard. Other cover conditions will require some modification.
- The precise location of the sampling location within the domains described (field/set/part) is not critical and can be adjusted to coincide with a vegetation sampling; however, it is desirable to locate samples along the same tree row (within a field/set.
- Although gravimetric sampling is destructive, try to **minimize your impact** by filling holes. Leave nothing behind.
- Always sample or move through a field along the **row direction** to minimize impact on the canopy.
- Sampling will be performed individually!! **CARRY A CELL PHONE!**

8.2. *Field Layout*

Each field is typically a quarter section (800 m X 800 m). Please make adjustments (scale accordingly), if your sampling field is not exactly a quarter section.

The orchard fields at the SJV test sites are irrigated periodically in sets. Each **FIELD** is divided into **THREE SETS,** which for the Belridge area happen in the East-West direction. Tree row direction in all the test fields is N-S. Each set is irrigated on a different schedule. Figure 5 shows the layout of the sets in the field. Each **SET** can be divided into several **PARTS** that are separated by access lanes that run EW.

Label your sampling locations as shown in Figure 5. The fields are numbered B06 to B16. The sets are named X, Y or Z from west to east. The sampling locations within a set are numbered 1-4 from north to south. Gravimetric samples will be taken at only one sampling location per set. In the example shown in Figure 1, sampling location B11X2, B11Y2 and B11Z2 will be used for gravimetric sampling.

Figure 6 shows the schematic layout of the sampling locations and their distances from the edge of the field. The rows selected should be marked at the road (paint or tag) and the tree row number recorded. The nearest tree selected for the sampling location should also be tagged (tape) and labeled.

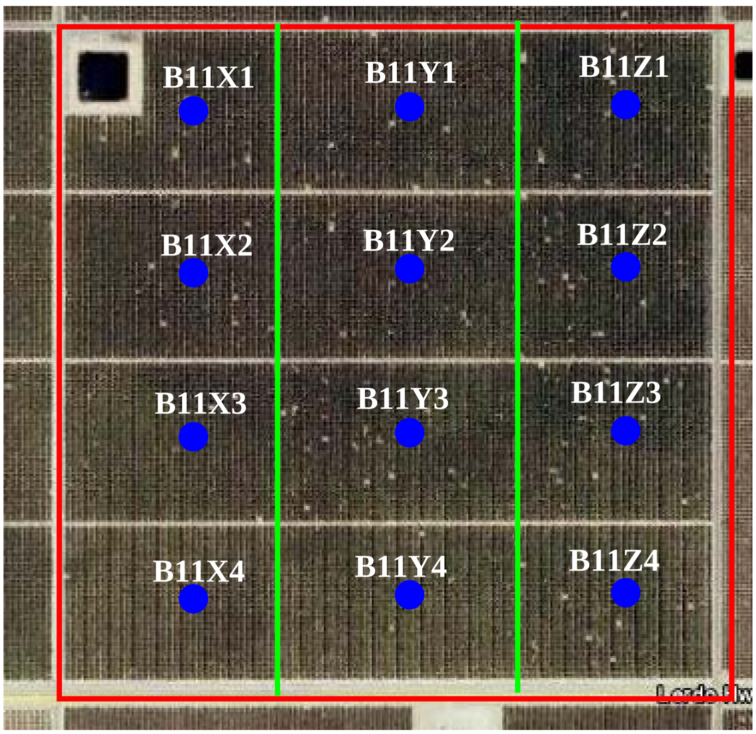

Figure 5. Layout of a typical sampling field. The field boundary is marked in red. The three sets are divided by the green lines. The blue circles are the sampling locations.

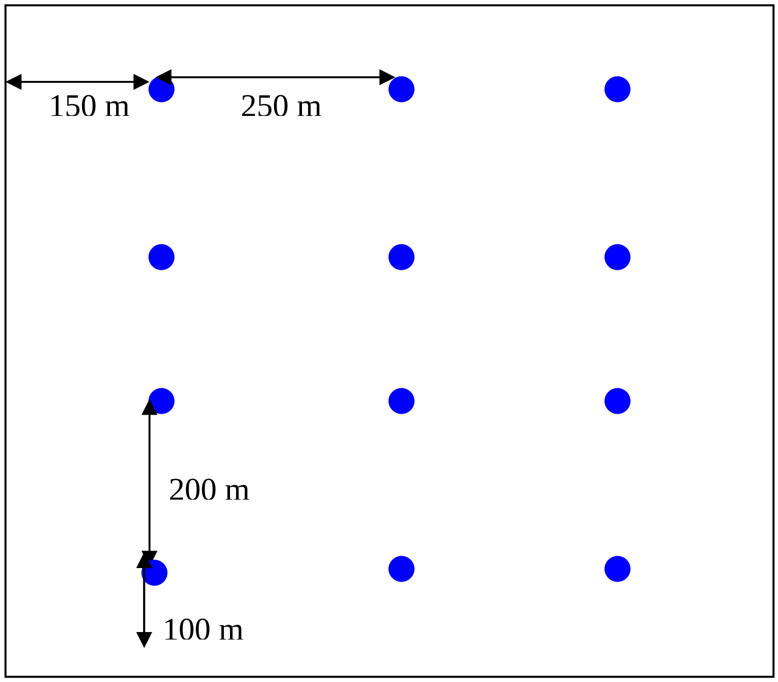

Figure 6. Schematic layout of the sampling locations within a field. Distances are nominal and do not have to be exact.

8.3. *Layout of the Sampling Location*

All sampling locations should be recorded by GPS. Five theta probe measurements will be made at each sampling location. The layout of the sampling points at a location are shown in Figures 7 and 8. Sampling points are marked with a red X. The sampling points are labeled A-E. Gravimetric samples will be taken at points A and C only (gravimetric samples will be taken only at the second sampling location). There will be 2 gravimetric samples and 20 theta probe observations per set.

The sampling point A is ~one-fourth the distance between the two trees. Sampling points A, C and E are in a straight line across the rows. Sampling points B, C and D are in a straight line along the rows. The sampling points forms an approximate plus "+" sign. A few specifics issues;

- Drip irrigation: Move sampling point "A" one feet away from the location of the drip pipeline.
- Fanjet irrigation: Move sampling point "A" halfway between the fanjet and the tree along thee row.
- Do not locate your sampling point next to the irrigation pipeline.
- Do not sample the roots of the tree.
- Alternate sampling locations in a set between the west and east side of row.

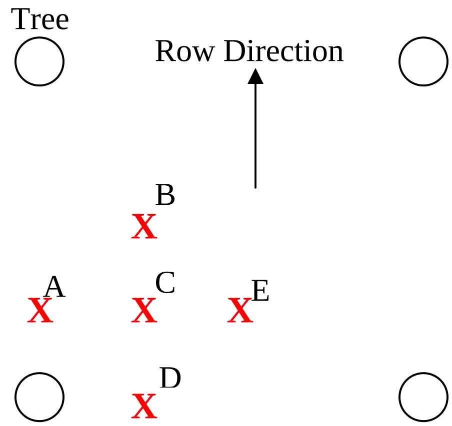

Figure 7. Layout of the sampling location. The location of the trees is marked with a circle. The sampling points are marked with a red X. The sampling points are labeled A-E.

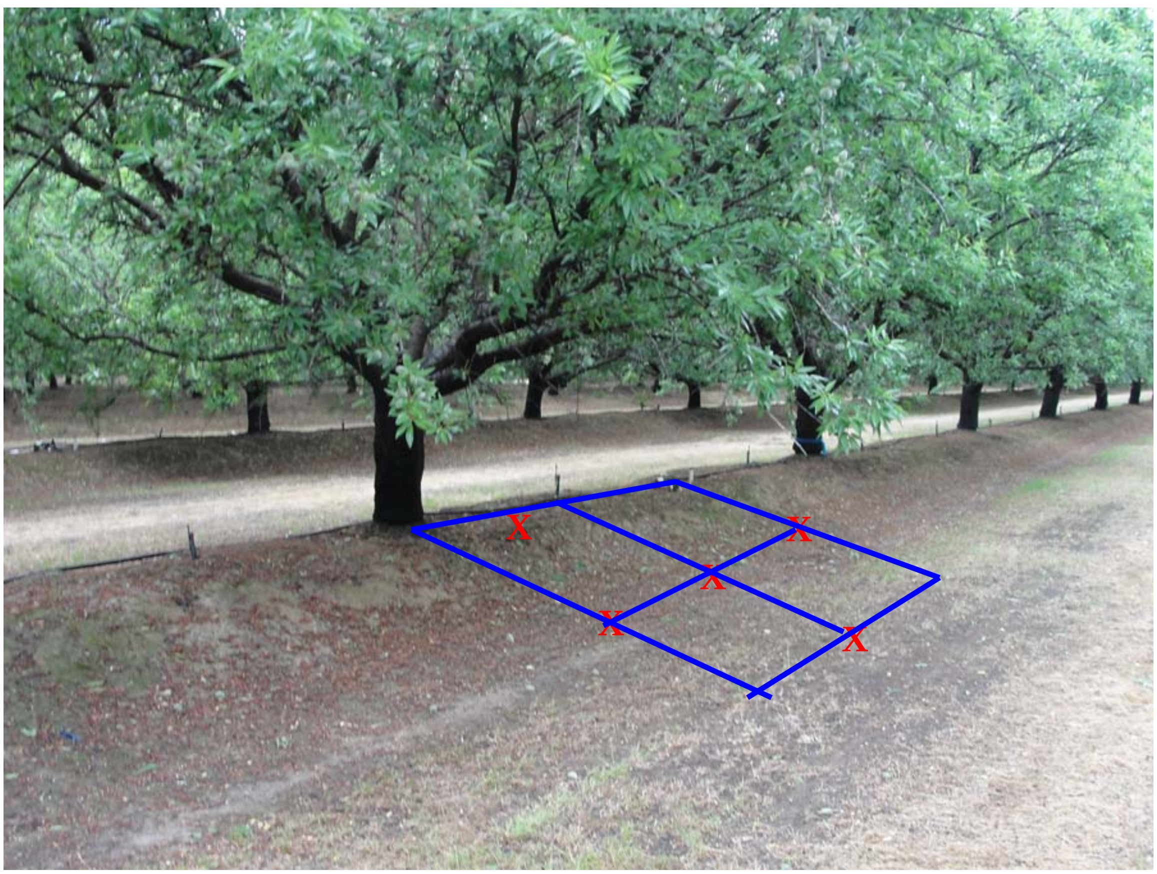

Figure 8. Layout of the sampling points in a fanjet irrigated Almond field.

8.4. Surface Soil Moisture Sampling

Soil moisture sampling of the sites is intended to estimate the field/set average and standard deviation. Sampling will take place between 8:00 am and 1:00 pm. The variables that will be measured or characterized are:

- 0-6 cm soil moisture using the Theta Probe (TP) instrument
- 0-6 cm gravimetric soil moistures using the scoop tool
- GPS locations of all sample locations (4 per set)

Preparation

- Sampling tools
  - Theta Probe and data logger
  - Smity
  - Camera
  - Scoop tool
  - Hammer
  - Spatula and chisel
  - Notebook
  - Marker Pen
  - Pen
  - Plastic Oven bags and zipper bags
  - GPS unit

- For the set, each person should take 2 plastic oven bags.
- Verify that your TP and data logger are working.
- All sample points should be located with a GPS. Points will be referenced by Site "B06X" and Point "#".
- Use a new **notebook** page for each set. Take the time to draw a good map and be legible. These notebooks **MUST** be turned in at the end of the day.

Procedure

- Upon arrival at a site, **VERIFY** the field ID, note site id, your name(s) and start time in notebook. Draw a schematic of the field.
- From a reference point for the site (usually a corner), measure 150 m along one side to locate the first transect.
  - Transects should be parallel with the row direction.
- From this location initiate a sampling transect across the field. Take the first sample at 100 m and repeat every 200 m until you are 100 m from the edge of the site. For a standard quarter section site this will result in 4 samples along the set.
  - Alternate your sample location between right and left side.
  - At all sampling locations make five TP observations as suggested in Figure 3.
  - At points labeled B##X2, B##Y2, B##Z2 in Figure 1 collect

  - Two 0-6 cm gravimetric soil moisture samples using the scoop (at sampling point locations A and C), enter entire sampling site location (Site # + set # + location ID: B##X2A) on the bag. Seal the plastic bag and place it in your backpack away from any other instruments, so that the bags don't rip.
- Exit the field before attempting to move to the second set.
- As you move along the transect note any anomalous conditions on the schematic in your notebook, i.e. standing water.
- Try to keep the soil bags away from direct heat.
- There will be a map and route to follow for sampling and coordination of vehicles will be done at the beginning of the day. You may only sample one set in a particular field, but assignments are arranged to minimize walking and vehicle coordination.
- Lavatory facilities will be available (do not improvise) and bring water with you.

Modification of Field Sampling for the Sheely Farms Sites

The fields at the Sheely Farms site will include a mix of wheat and pistachios in May. It is suggested that for the orchard fields that the location protocol be followed at each vegetation sampling location, which we expect will be six points in a field. For the wheat fields five points near each of the vegetation samples should be selected.

Sample Data Processing

- For each site, weigh the gravimetric samples and record on the data sheets that will be provided. Use a single data sheet per set.
- Transfer all the data to data sheets (same sheet used for GSM).
- Clean your equipment.

8.5. *Theta Probe Soil Moisture Sampling and Processing*

There are two types of TP configurations; Type 1 (Rod) (Figure 9) and Type 2 (Handheld) (Figure 10). They are identical except that Type 1 is permanently attached to the extension rod. Each unit consists of the probe (ML2x) and the data logger or moisture meter (HH2). The HH2 reads and stores measurements taken with the ThetaProbe (TP) ML2x soil moisture sensors. It can provide milliVolt readings (mV), soil water (m3.m-3), and other measurements. Readings are saved with the time and date of the reading for later collection via a PC.

The HH2 is shown in Figure 11. It applies power to the TP and measures the output signal voltage returned. This can be displayed directly, in mV, or converted into other units. It can convert the mV reading into soil moisture units using conversion tables and soil-specific parameters. Tables are installed for Organic and Mineral soils, however, greater accuracy is possible by developing site-specific parameters. For SJV, all observations will be recorded as VSM and mV using the Mineral setting.

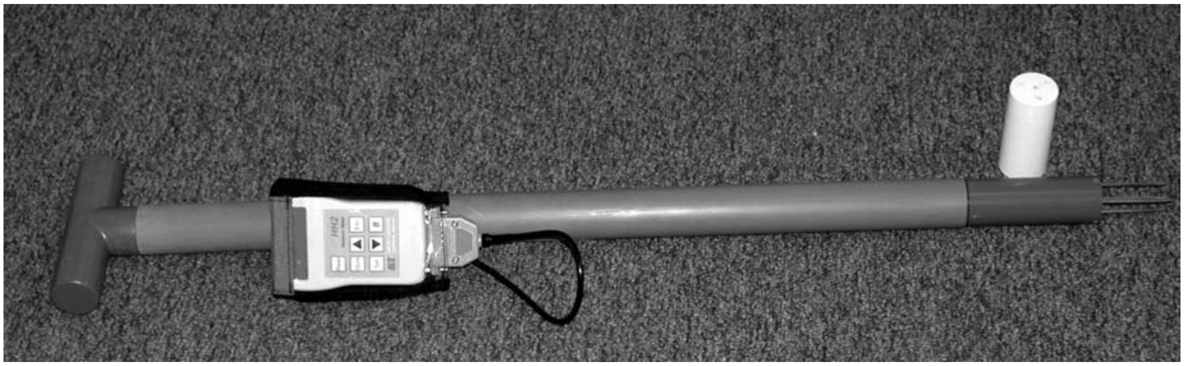

Figure 9. Theta Probe Type 1 (with extension rod).

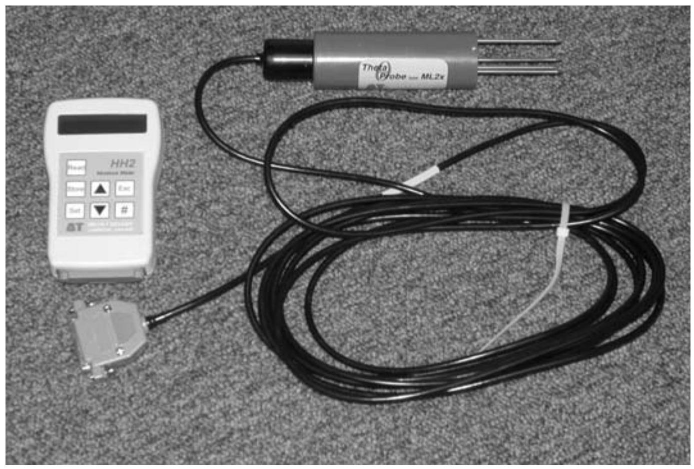

Figure 10. Theta Probe Type 2.

Figure 11. HH2 display.

Theta probes are expensive. Use them with care. The theta probe tines are fragile and prone to breakage. Keep your theta probe tines straight. Replace the theta probe tine, if it bends. Do not try to bend it back. It will break inside the probe. Do not put excessive pressure to try to push the theta probe into the soil. The soil in the fields can be very hard. We have provided each team with a *SMITY*.

Occasionally, the soil is too hard to successfully insert a TP; therefore, a jig (Soil Moisture Insertion Tool – SMITY) has been constructed, shown in Figure 12. This is a tool used to make holes in hard or difficult soils to ease the stress on the TP. To use, place the slider plate (Figure 13) on the surface to be probed. Using pressure, or a hammer, drive the SMITY into the ground. Avoid any side-to-side movement, to avoid faulty measurements. Once the SMITY is completely in the ground, hold the slider plate on the surface and pull straight up on the SMITY. Holding the slider plate to the ground should maintain the surface for proper TP insertion. Clean the SMITY and proceed with the TP measurement. Insert the TP probe exactly into the holes created by the SMITY. The TP tines are slightly larger than the holes, but will be much easier to insert than without the SMITY.

Figure 12: SMITY, Soil Moisture Insertion Tool, with slider extended and retracted.

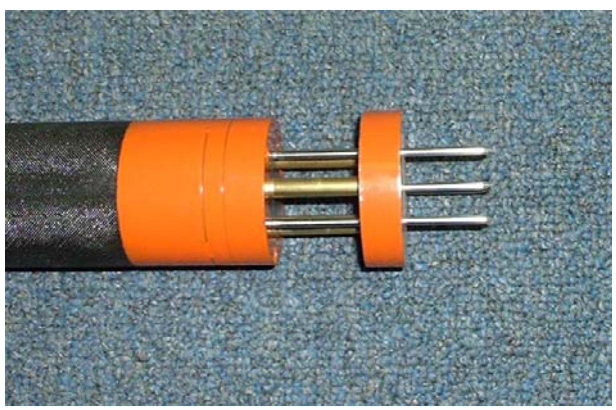

Figure 13: Close-up of the SMITY slider.

Use of the TP is very simple - you just push the probe into the soil until the rods are fully covered, then using the HH2 obtain a reading. Some general items on using the probe are:

- One person will be the TP coordinator. If you have problems see that person.
- A copy of the manual for the TP and the HH2 will be available at the field HQ. They are also available online as pdf files at http://www.dynamax.com/#6, http://www.delta-t.co.uk and http://www.mluri.sari.ac.uk/thetaprobe/tprobe.pdf.
- Each TP will have an ID, use the same TP in the same sites each day.
- The measurement is made in the region of the four rods.
- Rods should be straight.
- Rods can be replaced.
- Rods should be clean.
- Be careful of stones or objects that may bend the rods.
- Some types of soils can get very hard as they dry. If you encounter a great deal of resistance, use the SMITY or stop using the TP in these fields. Supplemental GSM sampling will be used.
- Check that the date and time are correct and that Plot and Sample numbers have been reset from the previous day.
- Disconnect sensor if you see the low battery warning message.
- Protect the HH2 from heavy rain or immersion.
- The TP is sensitive to the water content of the soil sample held within its array of 4 stainless steel rods, but this sensitivity is biased towards the central rod and falls off towards the outside of this cylindrical sampling volume. The presence of air pockets around the rods, particularly around the central rod, will reduce the value of soil moisture content measured.
- Do not remove the TP from soil by pulling on the cable.
- Do not attempt to straighten the measurement rods while they are still attached to the probe body. Even a small degree of bending in the rods (>1mm out of parallel), although not enough to affect the inherent TP accuracy, will increase the likelihood of air pockets around the rods during insertion, and so should be avoided. See the TP coordinator for replacement.

Before Taking Readings for the Day, Check and configure the HH2 settings

1. Press **Esc** to wake the *HH2.*

<u>*Check Battery Status*</u>

2. Press **Set** to display the **Options** menu
3. Scroll down to **Status using** the **up** and **down** keys and press **Set.**
4. The display will show the following
   Mem %   Batt %
   Readings #.
   - If Mem is not 0% see the TP coordinator.
   - *If Battery is less than 50% see TP coordinator for replacement. The HH2 can take approximately: 6500 TP readings before needing to replace the battery.*
   - If Readings is not 0 see the TP coordinator
5. Press **Esc** to return to the start-up screen**.**

Check Date and Time

6. Press **Set** to display the **Options** menu
7. Scroll down to **Date and Time using** the **up** and **down** keys and press **Set.**
8. Scroll down to **Date** using the up and down keys and press **Set** to view. It should be in DD/MM/YY format. If incorrect see the TP coordinator or manual.
9. Press **Esc** to return to the start-up screen**.**
10. Press **Set** to display the **Options** menu
11. Scroll down to **Date and Time using** the **up** and **down** keys and press **Set.**
12. Scroll down to **Time** using the up and down keys and press **Set** to view. It should be local (24 hour) time. If incorrect see the TP coordinator or manual.
13. Press **Esc** to return to the start-up screen**.**

Set First Plot and Sample ID

14. Press **Set** at the start up screen to display the **Options** Menu**.**
15. Scroll down to **Data** using the **up** and **down** keys and press **Set.**
16. Select **Plot ID** and press **Set** to display the **Plot ID** options.
17. The default ID should be A. If incorrect scroll through the options, from A to Z, using the **up** and **down** keys, and press **Set** to select one.
18. Press **Esc** to return to the main Options menu**.**
19. Scroll down to **Data** using the **up** and **down** keys and press **Set**
20. Scroll down to **Sample** and press **Set** to display available options. A sample number is automatically assigned to each reading. It automatically increments by one for each readings stored. You may change the sample number. This can be any number between 1 and 2000.
21. The default ID should be 1. If incorrect scroll through the options, using the **up** and **down** keys, and press **Set** to select one.
22. Press **Esc** to return to the main Options menu.

Select Device ID

23. Each HH2 will have a unique ID between 0 and 255. Press **Set** at the start up or readings screen to display the main **Options** menu**.**
24. Scroll down to **Data** using the **up** and **down** keys and press **Set.**
25. Select **Device ID** and press **Set** to display the **Device ID** dialog.
26. Your ID will be on the HH2 battery cover.
27. Scroll through the options, from 0 to 255, and press **Set** to select one.
28. Press **Esc** to return to the main menu.

To take Readings

1. Press **Esc** to wake the *HH2.*
2. Press **Read**
   If successful the meter displays the reading, e.g.-
   ML2 Store?
   32.2%vol
3. Press **Store** to save the reading.

The display still shows the measured value as follows:

ML2
32.2%vol

Press **Esc** if you do not want to save the reading. It will still show on the display but has not been saved.

ML2
32.2%vol

4. Press **Read** to take the next reading or change the optional meter settings first. such as the Plot ID. Version 1 of the Moisture Meter can store up to 863 if two sets of units are selected.

Troubleshooting

Changing the Battery

- *The HH2 unit works from a single **9 V PP3** type battery. When the battery reaches 6.6V, (~25%) the HH2 displays :*

  ***Please Change**
  Battery

- On receiving the above warning have your data uploaded to the PC next, or replace the battery. Observe the following warnings:
  - ***WARNING 1: Disconnect the TP, immediately on receiving this low battery warning. Failure to heed this warning could result in loss of data.***
  - ***WARNING 2: Allow HH2 to sleep before changing battery.***
  - ***WARNING 3: Once the battery is disconnected you have 30 seconds to replace it before all stored readings are lost.*** If you do not like this prospect, be reassured that your readings are safe indefinitely, (provided that you do disconnect your sensor and you do not disconnect your battery). The meter will, when starting up after a battery change always check the state of its memory and will attempt to recover any readings held. So even if the meter has been without power for more than 30 seconds, the meter may still be able to retain any readings stored.

Display is Blank

- The meter will sleep when not used for more than 30 seconds. This means the display will go blank.
- First check that the meter is not sleeping by pressing the Esc key. The display should become visible instantly.
- If the display remains blank, then try all the keys in case one key is faulty.
- Try replacing the battery.
- If you are in bright light, then the display may be obscured by the light shining on the display. Try to move to a darker area or shade the display.

Incorrect Readings being obtained

- Check the device *is connected to the meter correctly.*
- Has the meter been set up with the correct device.

Zero Readings being obtained

- If the soil moisture value is always reading zero, then an additional test to those in the previous section is to check the battery.

<u>*Settings Corrupt Error Message*</u>

- *The configurations such as sensor type, soil parameters, etc. have been found to be corrupt and are lost. This could be caused by electrical interference, ionizing radiation, a low battery or a software error.*

<u>*Memory Failure Error Message*</u>

- The unit has failed a self-test when powering itself on. The Unit's memory has failed a self test, and is faulty. Stop using and return to HQ.

<u>*Some Readings Corrupt Error Message*</u>

- Some of the stored readings in memory have been found to be corrupt and are lost. Stop using and return to HQ.

<u>*Known Problems*</u>

- When setting the date and time, an error occurs if the user fails to respond to the time and date dialog within the period the unit takes to return to itself off. (The solution is to always respond before the unit times out and returns to sleep).
- The Unit takes a reading but fails to allow the user to store it. (This can be caused if due to electrical noise, or if calibrations or configurations have become corrupted. An error message will have been displayed at the point this occurred.

8.6. *Logistics of Ground-based Soil Moisture Sampling*

Ground-based soil moisture sampling will take place within +/- two hours of the UAVSAR flight, although this may be relaxed if necessary. The ground team will be made up of people that are traveling in from the East coast, Pasadena, Santa Barbara, and Davis, CA. All of these locations are about four hours from the study site. The East coast team will fly into the area the day before the flight and stay locally at a motel (Kettleman City?).

Travel, sampling, and breaks are likely to make this a 14 hour day for California-based teams. It will be up to these teams whether they wish to stay the night before and/or the night after the flight.

All field equipment will be with the JPL team.

It is very important that good communications be established between the aircraft and ground teams. Since some of the flights are scheduled for Mondays, we are concerned about this issue. The ground crew would like to have the following as a minimum:

- 7 days prior-confirmation of schedule
- 24 hours prior to flight-confirmation of flight
- 8 am day of flight-confirmation of flight (go/no go sampling decision)
- Anytime following this-notice of flight cancellation

Hotels (see Figures 14 and 15)

Super 8 Buttonwillow
20681 Tracy Ave
I-5 & Hwy 58 Exit
Buttonwillow, CA 93206-9782 US
Phone: 661-764-5117
$50/night + Tax
Ask for inner courtyard to avoid traffic noise from the interstate.

The motel is located one exit south of the exit that should be used to reach the Belridge sites.

Figure 15. General location of motel and Belridge site.

Figure 16. Buttonwillow Motel area.

8.7. *Local Contacts On Site Access.*

All of the Belridge sites are owned/operated by Paramont Farms, which has an office onsite.

Michael L. Whiting
CSTARS / LAWR University of California Davis
cell: 530 304-2864

David Riano
CSTARS / LAWR University of California Davis
517-914-2842

Paramont Farms- Earl Surber, Joe Voth, Pete Ramirez
21707 Lerdo Highway
Mc Kittrick, CA
(661) 797-2410

UC-Farm Advisor-Blake Sanden

8.8. *Emergency Contacts*

Mercy Hospitals of Bakersfield
400 Old River Road
Bakersfield, CA
(661) 663-6050