# Car Traverse Exercise - Instructions

**Github Version, 2016**

***In groups of two or three students, you will drive across the City of Vancouver and simultaneously measure air temperature and $CO_2$ mixing ratio. The UBC climatology truck is equipped with research instrumentation for this purpose. We are interested in the spatial temperature distribution in the context of the urban heat island (UHI) phenomena and its temporal evolution. You will drive either in the late evening, between 7:00 and 10:00 PM, when the UHI is expected to be strong, or during the afternoon between 12:00 and 16:00 when the UHI is low or absent. The traverse itself takes you approximately 2 hours. Please calculate enough time to prepare (30 min) and finish (30 min) the traverse.***

***This document summarizes the technical details you need to know to operate the climatology truck and the equipment plus some troubleshooting issues. Please read this handout carefully before you drive your traverse. For instructions on the protocol and the individual reports see the separate handout on 'Car Traverse Exercise - reports'***

## A. SYSTEM COMPONENTS

Figure 1 gives you an overview over the components of the measurement equipment.

**Sensor** - For the traverse exercise we operate a thermometer (copper-constantan thermocouple) and a closed-path infrared gas analyzer for $CO_2$ (Licor Li-820, measures carbon dioxide mixing ratios in ppm). The thermocouple and the inlet to the gas analyzer are located on the roof (driver-side) in a PVC tube to protect them. The tube is further surrounded by styrofoam insulation and covered by highly-reflective tape. To maintain a constant flow of air through the tube, the tube is ventilated by an DC blower-fan. Note: There is no need to open the insulation, unplug any cables or remove the sensor.

**Power box -** this box is located on the floor on the passenger side. It distributes power from the car battery to all other components (i.e. laptop, GPS and logger box). A number of fuses protect the different circuits of the system. Note: There is no need to remove, open the power box unless you would encounter problems (then see Section E).

**GPS -** This is a common hand-held GPS that is programmed to stream location, speed and direction directly to the laptop. It comes with an external antenna which is located on the roof for best reception of satellite signals. Note: You can run the GPS in different modes, i.e. to display position, available satellites or even a road map, just press the 'Page' button to select your mode - in any mode the GPS streams the current position to the laptop where it is stored along with the current temperature and $CO_2$ measurements. See GPS handbook for details.

**Laptop -** A PC with a special software ('LabView') for GEOB 401 that collects data from the logger and GPS and displays online graphs of both sensors along with

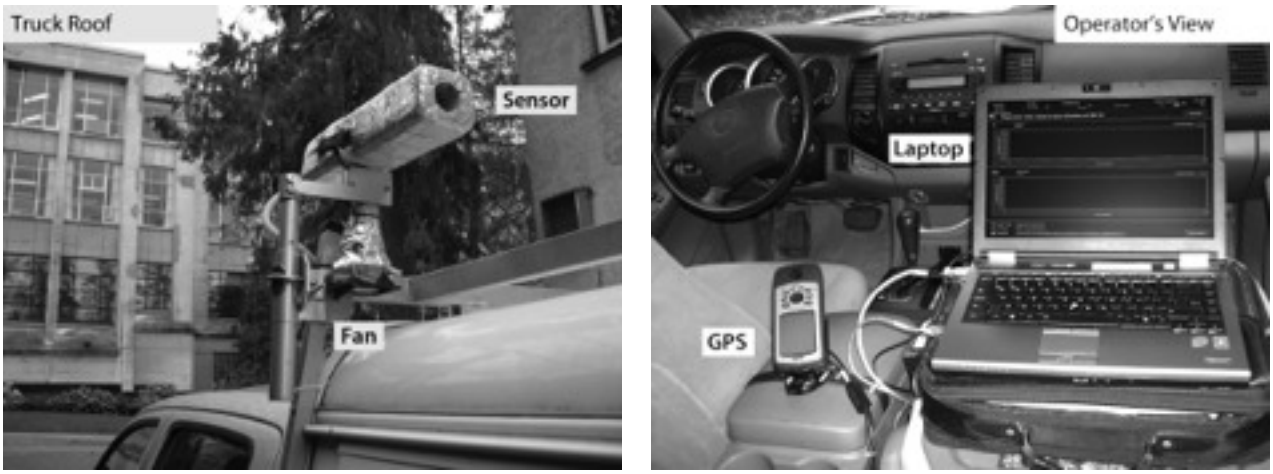



*Fig. 1 - Equipment components on truck roof and in cabin (see text for explanation)*

the GPS data. All data is merged into a single text file. See software instructions below for details.

**CO2 analyzer box -** this box is hidden in the canopy, it contains the gas analyzer for $CO_2$ and a programmable data logger (Campbell Scientific 21X) that measures the analog signals from the connected thermocouple and the analyzer and streams digital data to the laptop in the cabin. Note: There is no need to open the canopy or the logger box unless you would encounter problems (then see Section E).

Please handle all equipment carefully. It includes some expensive and sensitive parts and electronics.

**B. INSTALLATION INSTRUCTIONS**

**B 1. Get keys -** Make sure you get the truck keys, the laptop and the GPS on the day of your traverse.

You should pick-up the following items: (1) truck keys, (2) laptop, (3) GPS, (4) hard-copy of a mapbook. The mapbook and the GPS are typically inside the main compartment of the laptop case. There should be also a memory stick on the keychain.

**B 2. Meet your team and organize material -** For list of traverse teams see: http://www.geog.ubc.ca/courses/geob401/traverse.html. It is also helpful if one of you brings a *cellphone* (for emergencies), a *notepad or field book*, a *pen*, and *cash, credit or debit card* in case you have to fuel up the truck (you would be reimbursed).

**B 3. Get truck**

**B 4. Install laptop and GPS on truck -** You can do this in the music building parkade or on the outdoor lot. Be aware that at night, UBC security might sometimes show up and ask for IDs. So carry your student IDs.

Carefully follow instructions in exactly the given order below. This installation will take about 10-20 minutes.

B 4.1. *Install laptop* - Place laptop firmly on the folded passenger seat. Connect the laptop power cable (black cable ❷ (see Fig. 4). Secure laptop. Do not start laptop yet.

B 4.2. *Install and connect GPS* - Connect the 4-pin GPS cable ❸ and plug it into the back of the GPS (plug is below the rubber protector, see Fig. 3). Connect the GPS external antenna cable ❹ carefully to GPS (see Fig. 4). Then, put the GPS into the corresponding dash mount (tilt it towards the back seats).

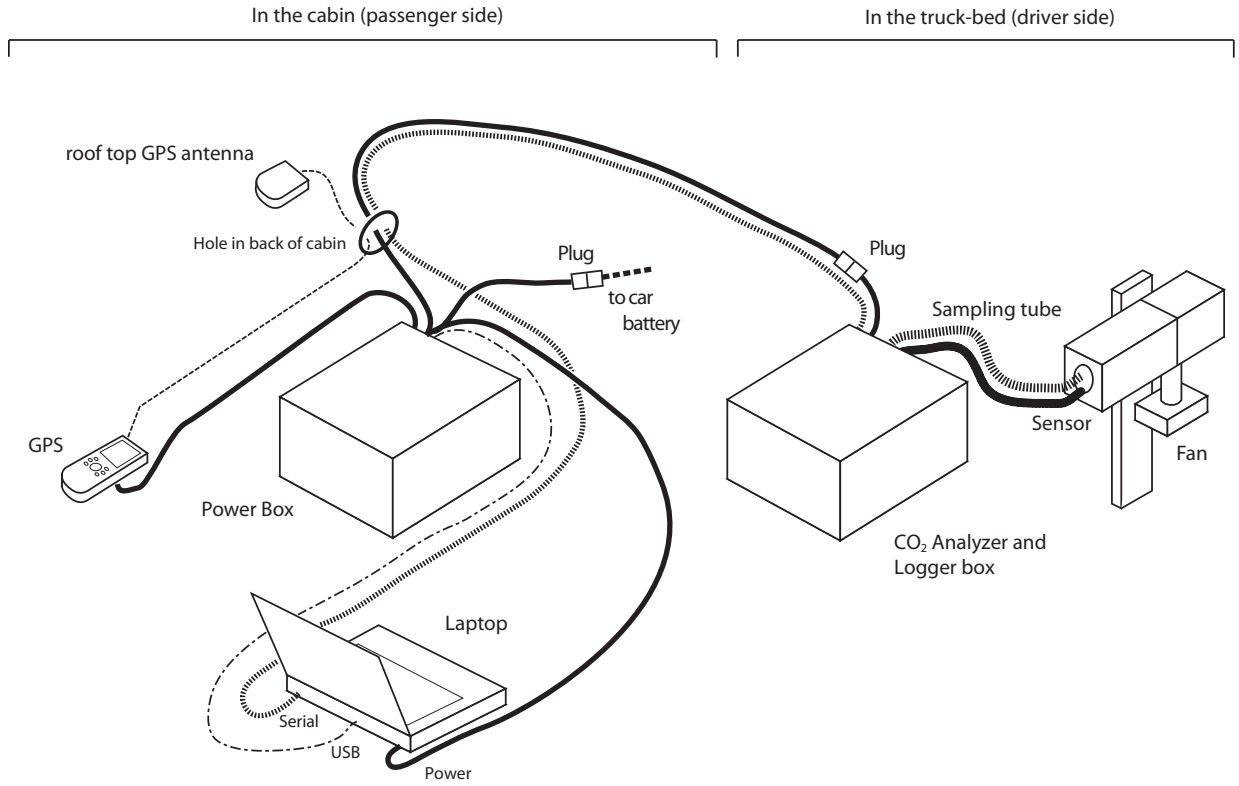



*Fig. 2 - Schematic of the complete system (see text for explanation). Please note that Power Box, Logger Box, GPS Antenna and Sensor all are installed in/on the truck.*

B 4.3 *Connect GPS cable to laptop*. Connect the transparent GPS data cable ❺ to the USB connector on the left side of the laptop (see Fig. 4).


*Fig. 3 - Connections on the back of the GPS unit.*

B 4.4. *Connect data cable to laptop* - Connect the data cable (with a 9-pin plug ❻) to the laptop's serial port (COM-port, on the left side of the laptop).

B 4.5. *Power-up the system* - Turn the white power timer to 3 hours. System will then start up. First, ensure the fan on the instruments is running. Turn on GPS by pressing the red light button for approx. 1 sec. GPS display will start up. Press 'Page' to dismiss startup messages. You can turn on a backlight on the GPS by hitting the red light button (not too long - otherwise it will turn off again).
→ If problems occur see troubleshooting section E.

**B 5. Start Software on Laptop**

B 5.1. *Turn on the laptop* and log-in as user 'geob401' (no password). The GEOB 401 account automatically starts the traverse program ('LabView'). Please be patient and do not interrupt the process. This can take 1-2 minutes.

B 5.2. After the 'LabView' splash screen disappears you will get a dialog welcoming you to the GEOB 401 traverse (Fig. 5). Do not change settings and just click 'Start'.

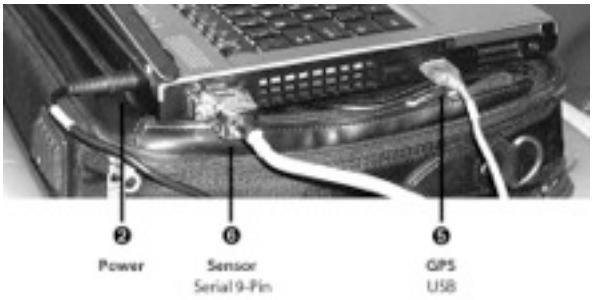
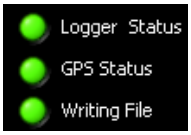



*Fig. 4 - Cabling of the laptop (side view).*


*Fig 5. Welcome screen of the traverse software*

B 5.3. Next, you should get a screen full of real-time data from the GPS and the data logger (for details - see next page). It might take up several minutes until the GPS gets a correct information (based on satellite reception) and up to 60 seconds for the logger data to appear on the screen.

At the bottom you will see the system status with three color 'lights'. If all three 'lights' are green (the last 'Writing file' should flash green approximately every 15 seconds) then the system is working correctly. If one of the lights stays red for more than a couple of minutes, please see → troubleshooting section E3.




**C. TRAVERSING**

**C 1. General Rules**

There are three jobs for each of the students: (1) Driver, (2) Navigator, (3) System Operator

(1) **Driver** (front seat)- concentrates only on safe driving. Do not watch the laptop screen! Others can tell you what is going on.

(2) **Navigator** (left back seat) - aids driver in following the set route (use map book and markers). Write any special circumstances on your protocol together with any weather and surface observation along the route (e.g. fog, flags blowing, chimney plumes, changing road wetness, snow distribution, leaf state of trees) or special traffic conditions (e.g. extra long delays).

(3) **System Operator** (right back side) - observes system status and graphs on laptop, and inserts manual markers by pressing the enter-key on the laptop keyboard whenever passing a marker.

You may swap driver, navigator and system operator jobs through the route if additional drivers have a valid BC driver's license. But please note, all three students must be present during the whole extent of the exercise. You are not allowed to do any part of the exercise alone.

**C 2. Traversing Instructions**

C 2.1. First, drive to an open spot outdoors on UBC and park with fan and engine running. We will use this data to determine the cooling rate during the traverse (you will come back to the same point at the end of the traverse). Press enter-key on the laptop to insert marker ('Press enter when ready to start calibration at UBC lot').

C 2.2. Stay at the open spot for 5 minutes. During calibration please record on your protocol: the date, time, names of the traverse team, general state of weather (especially descriptive statements of cloud

**Manual markers** allow you to insert the predefined marker points into the data-set when pressing the enter key on the keyboard. Text always display the next (upcoming) marker.

**Low speed indicator** displays if GPS speed is less than 5 km/h. This might be useful for filtering data.

**GPS data** displays date, time, and if satellite reception is good also psoition, direction and speed.


**Temperature data** with current measurement (numeric) and graph of the last 8 minutes. Axes adjust dynamically.

**Carbon dioxide data** with current measurement (numeric) and graph of the last 8 minutes. Axes adjust dynamically.

**Status text** gives textual messages and errors on the logger, GPS and the file that is currently written.

**End traverse** quits the program

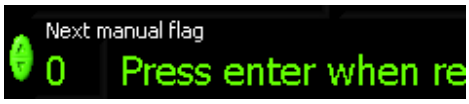
**Status lights** indicate if the different components (Logger, GPS) are working correctly (green) or if there are any problems (red). 'Writing file' should flash green approximately every 15 seconds.

cover, cloud height, and wind) and state of the ground (road wetness, vegetation state, snow). Monitor data on screen. After 5 minutes, press enter again to mark the end of the calibration in the data set ('Press enter to finish calibration at UBC lot').

C 2.3. Now, you are ready to start driving the route. Drive at a normal speed but never greater than 80 km $h^{-1}$. Your first marker is 'West-Mall / NW Marine (lights / turn right)'. When you reach this point press enter. Follow to the next marker (see map) and hit enter-key again. Go on the same way for the entire traverse.

**C 3. Some frequently asked questions:**

**What to do if we have forgotten to insert a marker? -** Don't worry, do not drive back. Just click on the little green arrows next to the manual flag number on the screen and adjust (skip) to the next marker. Alternatively, insert two markers the next time you pass a marker point and write this down in your protocol, so we can manually remove it later.




**What to do if we got lost / got on a wrong road? -** If possible drive back to the nearest point of the route and continue to drive the route from there. Note this in your protocol.

**Error 'GPS connection lost'** - Don't worry. This typically happens at the beginning (up to 10 minutes) or if you are under a bridge or in a narrow street canyon and there are not enough satellites in the field of view of the GPS antenna. Continue traverse without GPS - it should come back later.

**What to do if the fuel indicator is low (less than 20%) -** drive to to the next gas station and fill up with regular fuel. Turn off the car engine, but keep the equipment running during fueling. Pay for the fuel, and keep the receipt so that we can reimburse you. Talk to Andreas the next lecture how to do this.

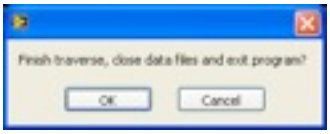
**What to do if road conditions are unsafe? -** In case of snow, freezing rain, flooding, extremely heavy rain or any other hazard please do not start the exercise or abort the exercise and return to UBC (if possible). Report this to Andreas the next lecture. This has no implications on your grades. Safety goes first.

→ For more problem solving see troubleshooting section E.

**D. BACK AT UBC**

**Second calibration -** Drive back to exactly the same open spot outdoors on UBC where you did your first calibration earlier this evening. Start a second calibration ('Press enter when ready to start calibration at UBC lot'). Again, stay at the same location for 5 minutes. During calibration manually record: the date, time, general state of weather (especially descriptive statements of cloud and wind) and state of the ground (road wetness, snow). After 5 minutes, you must hit the enter-key again to insert end of calibration ('Press enter to finish...').

**Stop software and download data -** After pressing the enter key, click on the button 'End traverse' in the lower right corner on the screen and confirm to exit the software.




Click on the short-cut icon to the GEOB 401 data located on the desktop (Your data file(s) is (are) located at: C:\Documents and Settings\geob401\My Documents\GEOG 401 Data\YYYY_MM_DD \YYMMDDHHMMSS.txt,

where YY or YYYY is the year, MM the month, DD the day of month, HH the hour, NN the minute and SS the seconds of your file start). Save your data on the memory stick. Do not delete any files on the laptop, just copy them. Within the next 3 days, you must send your data file(s) along with your protocol, and the weather data from the airport by email to Andreas (see separate handout for details).

**Turn-off power -** Completely turn off laptop (do not hibernate). Turn off the GPS by pressing the light-button for more than a few seconds. Then turn off the white timer (move it to zero). Check, fan and GPS should now be off.

**Remove equipment -** Disconnect all cables from laptop (power cable ❷, USB ❺, and grey data cable ❻). Disconnect cables ❸ and ❹ from GPS. Put laptop, GPS, and mapbook in laptop case. Please clean-up the truck neatly for the next group.

**Park the truck -** in the Music Building underground lot stall #30, fill in the truck log book (milage / GEOB 401), and make sure the truck is locked. Before leaving please ensure the headlights and interior lights are off!

**Return the keys and laptop** - return keys either same or following working day to the main office in Geography (latest by 4:00 pm following day)

**E. TROUBLESHOOTING**

Read this section if you encounter any problems with the truck (section E1), the software (section E2) or the sensor and/or GPS (section E3).

**E1. Truck Troubleshooting**

**E1.1 Truck cannot be started -** Likely, somebody has left the light on and the battery is empty.

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**E1.2 What to do if the truck has problems -** If you would be unable to drive the truck for any reason, call your instructor and we will pick you and the equipment up. Hopefully, this will not happen! In any case report any problems related to the truck to your instructor during or after the traverse by email.

**E1.3 What to do if the fuel indicator is low (less than 20%) -** drive to to the next gas station and fill up with regular fuel. Turn off the car engine, but keep the equipment running during this time. Keep the receipt so that we can reimburse you. Talk to your instructor the next lecture how to do this.

**E2. Software Troubleshooting**

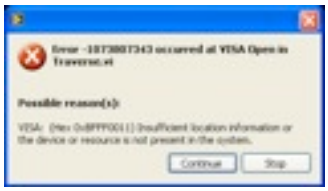
**E2.1 Screen is turning black -** most likely the power save mode / screen saver has been activated or not enough power. Try and hit any key to resume. If that does not help, check if laptop is powered (light in the right hand side). If you have to restart the PC - hold the on-off button for several seconds.

Note, data is written every 15 seconds to the hard drive and your data should not be affected when restarting the laptop (for whatever reason). If you restart the program during the traverse you will end up with two or more files at the end of your traverse. Don't worry, we can merge them together later. Copy both.

**E2.2. Traverse program crashes -** you can try and restart the traverse program by clicking on the shortcut icon 'Restart GEOG 401 traverse' on the desktop. If this does not solve the problem, you must restart the laptop (see also E2.1). If you can not solve the problem or the program crashes repeatedly then you must abort the exercise and drive back to UBC. Report this immediately to Andreas the next day and write down error message.


**E2.3 What to do if you get a VISA Error -** When you get an error message at 'VISA Open' (see figure) it means most likely that the GPS or the logger communication are not set-up properly or

experienced an error. Click 'Continue' (maybe several times in a row). If that does not solve the problem, click 'End traverse' or reboot the PC. Before, check carefully if both cables ❺ and ❻ are connected properly to the laptop. Reboot the computer if needed and try again.



**3. Logger and GPS troubleshooting**

Generally: If you can get data from the logger but not from the GPS the traverse makes still sense and we will use your manual markers but not the GPS. If you can only sample the GPS but not the logger, you must abort the exercise. Without temperature and/or $CO_2$ data it makes no sense to drive. Report any serious problems immediately to Andreas the next day.

**E 3.1 Logger data transfer failed -** means the communication between the laptop and the logger-box is not working properly. Check the following (1) is the fan running? (if not, check power, see section B), (2) open the lid of the logger box and check if the display of the logger displays any numbers or letters (if not, check power cabling and maybe replace fuse in power box), (3) if display of logger is working, press [*] and then [0] on the keypad of the logger to reset logger. If you still encounter problems, try to reboot the whole system (reboot laptop, then unplug main power ❼). If you cannot solve the issue you must abort the exercise and return to UBC.

**E 3.2 Logger data works but temperature and/or $CO_2$ data seems unrealistic** - Temperature: Maybe thermocouple is broken. If $CO_2$ is still OK - continue traverse with $CO_2$ only and without temperature reading. $CO_2$ sensor: Check fuse in logger box - replace fuse (if you know how to do this). If $CO_2$ is not working but temperature reading is OK, continue traverse without $CO_2$. If both sensors are not realistic, reboot system (unplug power) and reboot laptop. If both are not working properly you must abort the exercise and return to UBC.

**E 3.3 GPS off / communication error** - Check if GPS is turned on ,i.e. if it is connected properly (both at the GPS and the laptop side, i.e. check cables ❸, ❹ and ❺) and if the switch 'GPS on/off at the power-box is turned on. Try to reboot GPS (using the GPS on/off switch at the power box) and then laptop if needed. If you cannot solve issue, continue traverse without GPS.

**E 3.4 GPS displays a single line instead of a map / data** - Recently we found that there is a possibility that the GPS system does not boot properly and displays a single line on the display instead of the map / data. In this case, all buttons are non-functional. As a work-around you can reboot the GPS using the switch labeled 'GPS on/off' at the power-box until the GPS runs properly.

**E 3.5 GPS connection lost** - Don't worry. This just means that you are under a bridge or in a narrow street canyon and not enough satellites are in the field of view of the GPS antenna. Continue traverse. If error persists for logger time (more than 10 minutes) check external antenna on roof and its connection to the GPS. If external antenna is problem, try to remove antenna and run GPS from dash. If you cannot solve issue, continue traverse without GPS.

**4. Daylight saving time offset or not?**

No - All data collected during the traverse exercise will be reported in PST, i.e. without any daylight saving offset. This is correct (as it is the practice for weather and climate stations). Please keep all data in PST, and do NOT change the time on the laptop or in your files to PSDT. If you are writing your protocol on the car traverse, please indicate if you are referring to PST (without daylight saving time) or PSDT (with daylight saving time). Both is OK, but please indicate.