






Experiment E-7 Microclimates and GPS



Objectives

- To learn about microclimates and the factors that affect them.
- To investigate different microclimates using logger sensors.
- To learn how GPS measurements can be useful to understand microclimate concepts.

Modules and Sensors

- PC + NeuLog application and Google Earth
- USB-200 module 
- BAT-200 Battery module 
- NUL-203 Temperature logger sensor 
- NUL-207 Relative humidity logger sensor 
- NUL-243 GPS logger sensor 

Notes:

- Make sure that Google Earth is installed in your computer.
- The GPS logger sensor can work as demonstrated in this experiment with any other sensor (except for the photo gate sensor).
- Make sure the battery module is fully charged (when the battery is totally discharged, it takes 3 hours for it to become fully charged).

Introduction

The Earth's tilt, rotation and land/sea distribution affect global weather patterns. Over the years, roughly the same type of weather will occur at a given location (of course there is also a process of global change). The reoccurring "average weather" in a particular place is called climate. There are several major climate categories: Tropical, Dry, Moist subtropical Mid latitude, Moist continental Mid-latitude, Polar and Highlands.

A microclimate is any climatic condition in a relatively small area. The area could be as small as a few square feet or meters or as large as many square miles or kilometers. The term usually applies to surfaces of terrestrial and glaciated environments, but it could also be relevant to the surface of oceans and other bodies of water. Microclimate complexity is necessary for the existence of a variety of life forms which tolerate different conditions. A microclimate is characterized by temperature, humidity, wind, turbulence, frost, etc.





Generally, air temperature gets cooler as one moves closer to a large body of water because of the water's heat capacity, but in certain conditions in the evenings, cooler air is present further away from a body of water. Relative humidity is high near a body of water because of evaporation (relative humidity is also affected by temperature).

Temperature values are often a few degrees higher in cities than they are in their surrounding rural areas. This phenomenon is known as the urban heat island effect. These high temperatures are present because of a greater retention of heat by buildings, concrete and asphalt.

GPS is short for Global Positioning System, a worldwide MEO (Medium Earth Orbit) satellite navigational system formed by satellites orbiting the Earth and their corresponding receivers on the earth. GPS is used for navigation and location determination. In this experiment, we will explore different microclimates which differ in temperature and relative humidity.

Procedure

Sensor setup

1. Connect the USB-200 module  to the PC.
2. Check that the temperature sensor , the relative humidity sensor , and the GPS sensor  are connected to the USB-200 module (the GPS sensor should blink 3 times with a red led after a few seconds).

Note:





The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

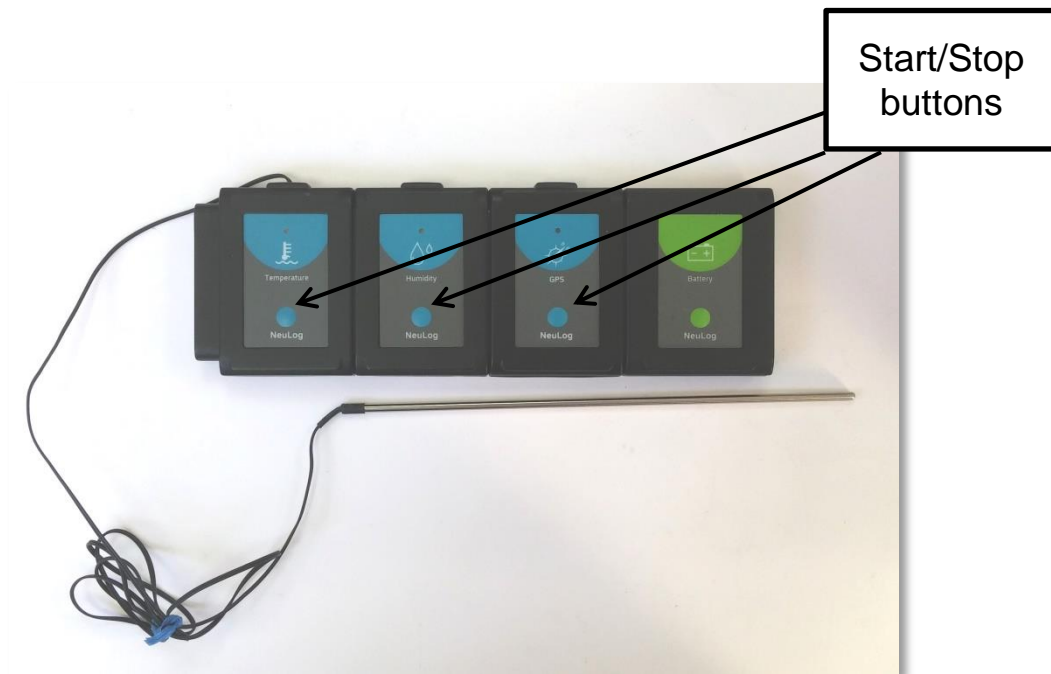
3. Run the NeuLog application and check that the sensors are identified.

Settings

4. Click on the **Temperature sensor's Module** box and set the:
Experiment duration to 2 hours
Sampling rate to 1 per second
5. Click on the **Relative humidity sensor's Module** box and set the:
Experiment duration to 2 hours
Sampling rate to 1 per second
6. Click on the **GPS sensor's Module** box and set the:
Experiment duration to 2 hours
Sampling rate to 1 per second

Testing and measurements

7. Connect the battery module  to the GPS , temperature  and relative humidity  sensors.
8. Wait a few seconds until the GPS sensor blinks three times with a red LED.
9. In this experiment, you will follow a route through which the humidity and/or temperature are expected to change. The locations can differ according to factors described in the introduction or others. Keep the sensors in open space during the measurements so that the GPS can get the satellite coordinates.
10. Push on the GPS sensor's start/stop button. If there is no satellite reception, the red LED will turn on constantly.




11. Wait in place until the signal is detected and the red LED flashes every second which means the sensor has started to receive and store GPS data. In normal weather conditions, this could take between 30 seconds and two minutes.

12. Press on the other two sensors Start/Stop button. Make sure all sensor's LEDs are flashing every second.
13. Start your route (by car or on foot).

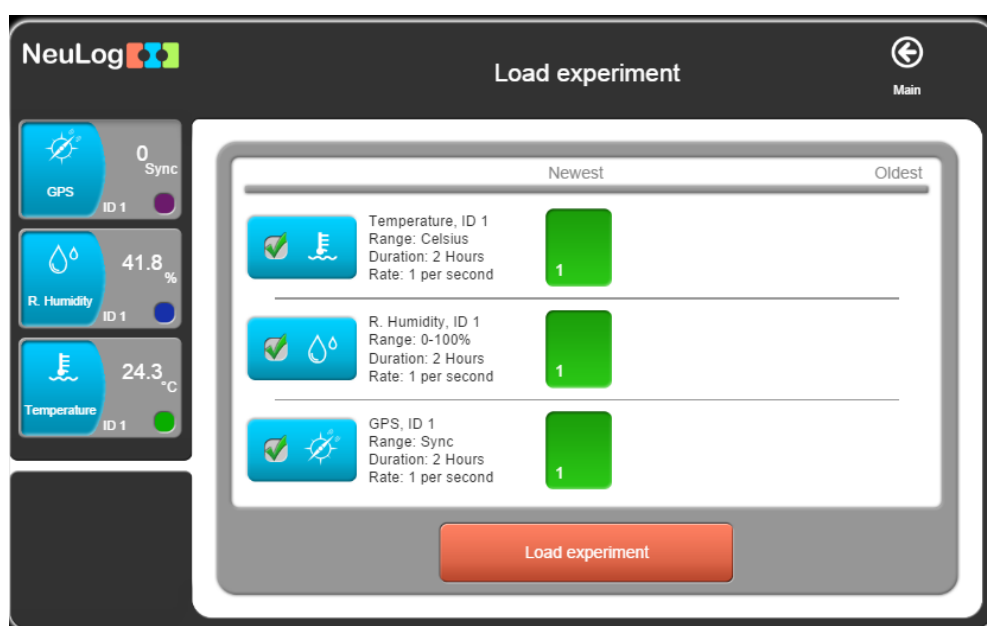
Notes:

- If, while performing the experiment, the GPS sensor's red LED turns on constantly it means it lost the satellite reception; in this case the other sensors will continue to measure as usual (the GPS sensor will record the value 0).
- If the LEDs of the GPS and the other sensors start to blink fast, it means the battery module is not charged enough and the measurement will stop.

14. At the end of your route, press the start/stop button again on all the sensors. This will stop the incorporation of data.
15. Now that you have your GPS, temperature and relative humidity data stored in the sensors, use the NeuLog application to upload it to your computer and create a file readable by Google Earth.

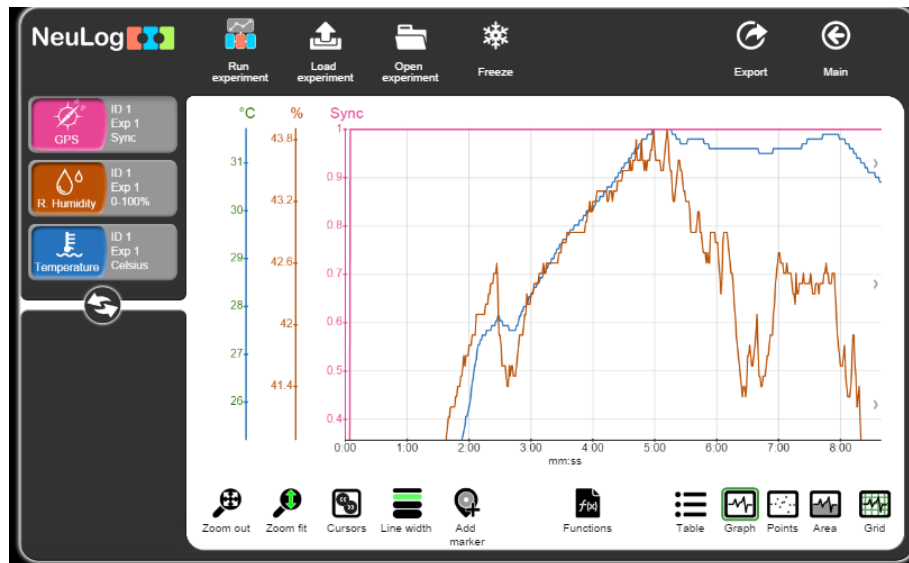
16. Connect all the sensors to the USB module; connect this module to the computer through a USB cable.
17. Make sure that the Google Earth program is installed on the computer.
18. Run the NeuLog application.
19. After the sensors have been found, you will see their module boxes on the left side of the screen.
20. Click on the **Load Experiment** icon .

The menu shows a list of stored experiments in the sensor's memory (up to 5).



21. Click on the **Load experiment** button.

22. Click on the **Zoom fit** icon .



23. Click on the **Export** Icon  and then on the **Save value table (.CSV)** button to save your graph.

24. Click on the **Save GPS (.KML)** button on the Export experiment menu.

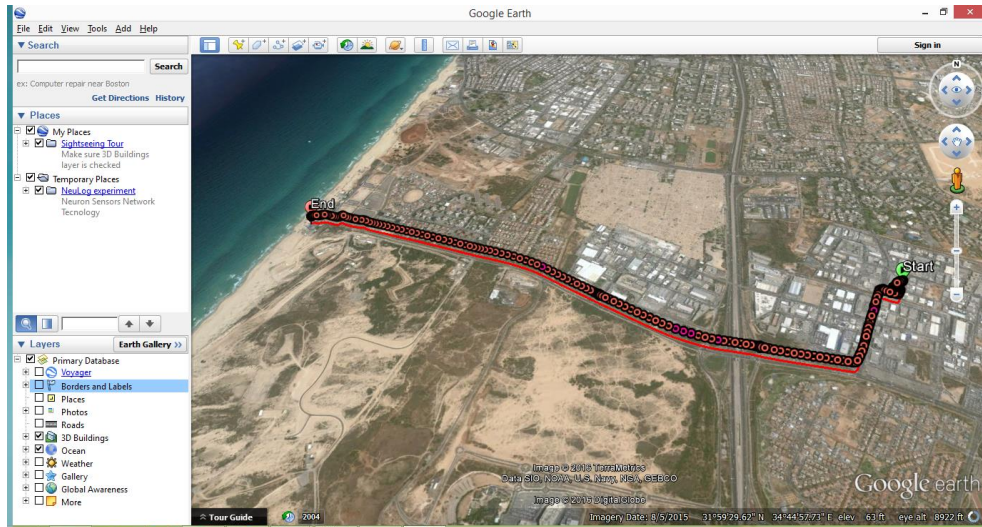
25. The saved file can be opened by Google Earth.

Note:

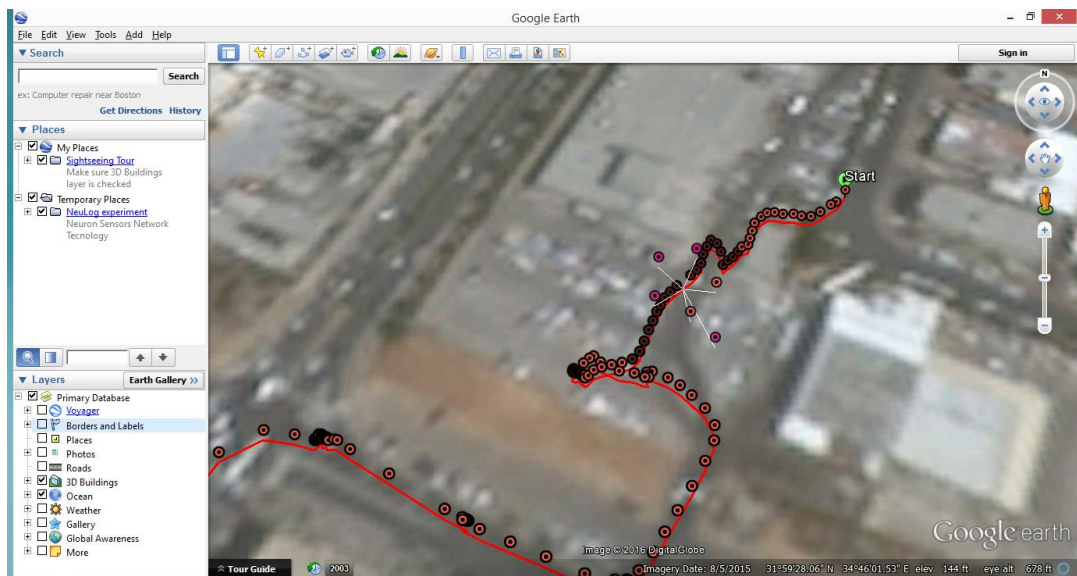
KML (Keyhole Markup Language) is a notation for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers.

26. Observe the following example:

You can see the route on the map, every circle represents a point in which the two other sensors recorded data (every second).



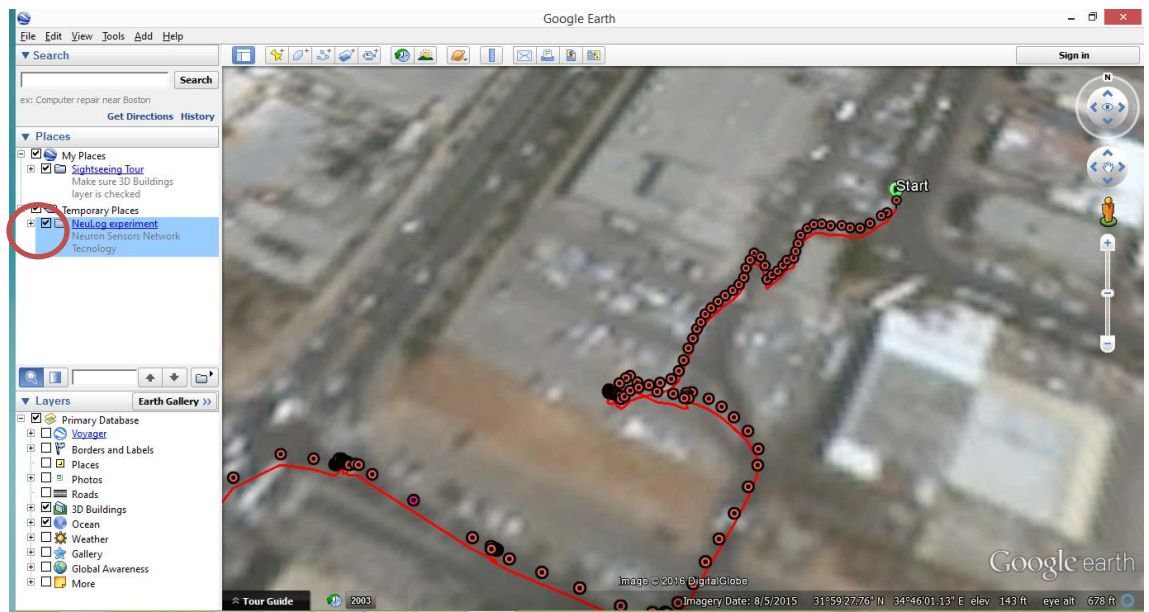
When zooming in to the starting point and clicking on one of the dots, we can see that it splits into many different dots; this is because we moved very slowly and data was picked up from the same point.

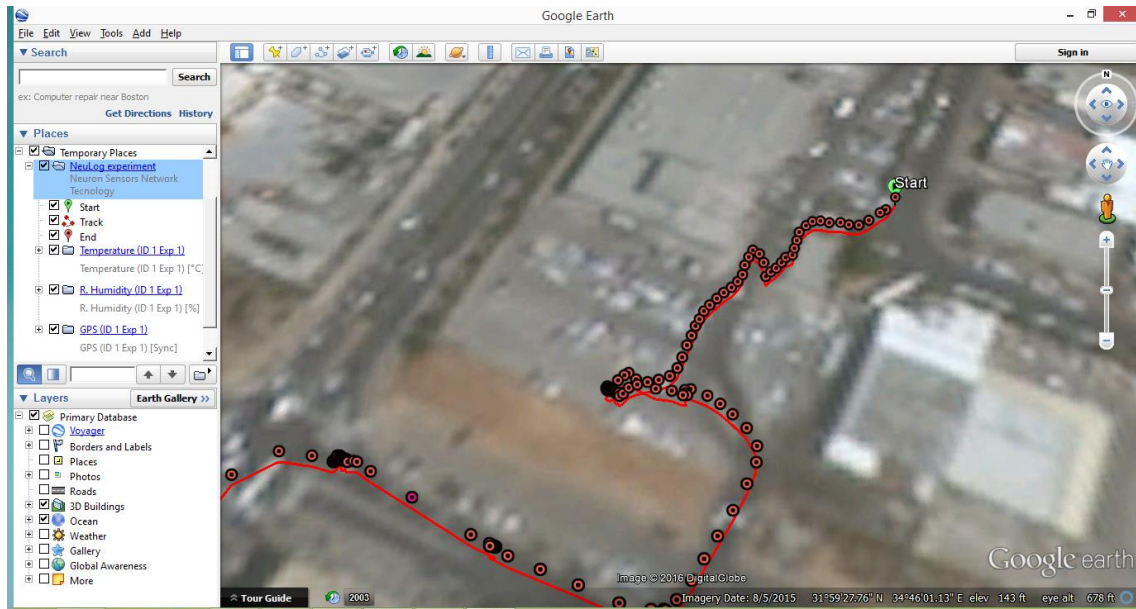


When we pick a different point (where we moved fast enough) and click on one of the points, we can see that it splits into two points. One point represents the relative humidity and the other the temperature measurement.

When clicking on the “+” sign next to **NeuLog experiment** you will see these options:

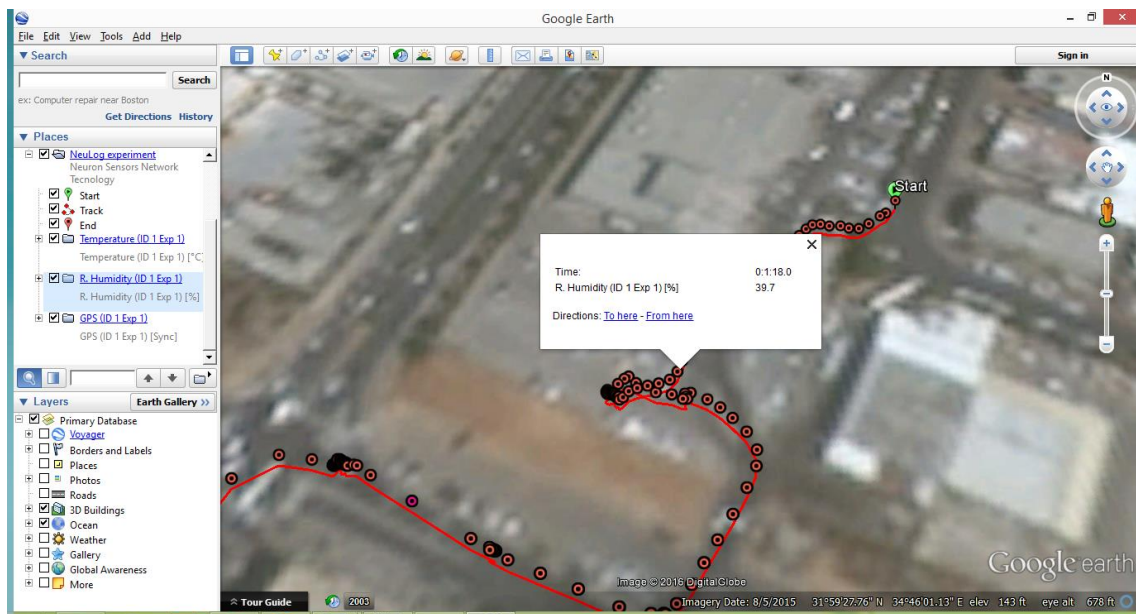
- a. Start position
- b. Track
- c. End position
- d. Temperature
- e. Rel. Humidity





You can cancel the appearance of each option by clicking on the box on their left.

When clicking on one of the points, the time of the measurement and the sensor's value appear:



You can cancel the appearance of one sensor and see only the other one on the screen.

Summary questions

1. Describe the different climates in your experiment. Use the data collected from the sensors in your description.
2. Suggest two other sensors that could be used with the GPS logger sensor and explain your choice.