Observations of Mount Washington

1 Lapse Rate

The temperature profile of the atmosphere is controlled by two primary mechanisms: radiation (e.g. the sun and infrared emissions) and convection (e.g. thermals and thunderstorms). To explain the second mechanism, imagine a balloon rising through the atmosphere. The pressure inside the balloon must always be equal to the pressure outside the balloon, and the only way for this to occur is for the volume of the balloon to increase as it rises. Assuming this happens fairly quickly, the balloon does work against the environment expending some of its internal energy and cooling. The temperature decreases at some lapse rate. In the atmosphere, we think of contrived air parcels that behave analogously to a balloon. At our latitude during the summer months, convection plays an especially important role in shaping the atmospheric temperature profile.

Figure 1: Atmospheric sounding from Chatham, MA showing temperature decreasing with height.

One of the goals of the field trip is to calculate this lapse rate. Using a portable weather instrument, record the temperature, pressure, and altitude data on the observations handout as we ascend up to the summit. Calculate the lapse rate ($\Delta T/\Delta z$) in terms of $^\circ$C/km and record your calculations in the table. The standard atmospheric lapse rate is about 6.5$^\circ$C/km. Do your calculated values come close to this number?

<table>
<thead>
<tr>
<th>Endpoints</th>
<th>Lapse Rate ($\Delta T/\Delta z$)</th>
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<tbody>
<tr>
<td>Auto Road Stop ↔ Pinkham Notch</td>
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<td>Summit ↔ Auto Road Stop</td>
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2 Height of Mount Washington

Recall in the first activity, we estimated the height of the Green Building by measuring the pressure difference between the bottom and top of the building. Estimate the height of Mount Washington by plugging in the pressure difference between Pinkham Notch and the summit of Mount Washington into the following equation (RECALL 1mb = 100Pa and $\rho_o \approx 1kgm^{-3}$; you may use 670 m as the height of Pinkham Notch.)

$$\Delta z = \frac{\Delta p}{\rho_o g}$$

The summit is actually at an elevation of 1920 m (6288 ft). Is your estimated value close?

3 Wind

As you may notice when you arrive at the summit, Mount Washington is known for its strong winds. The world record wind speed\(^1\) of 231 mph (372 km/h) was recorded here on April 12, 1934. Even in August, there is about a 20% chance that the observatory will observe peak winds greater than hurricane force on a given day. Using the anemometer on the portable weather instrument, record the maximum wind speeds you observe at each stop as we ascend Mount Washington on your observation sheet.

4 Clouds

On your observation sheet, at each stop as we ascend Mount Washington, comment on the clouds you observe and their characteristics (e.g. their level, appearance, precipitation falling from their base, etc...) Refer to the cloud chart to help you identify the types of clouds.

5 Sky Temperature

We used our infrared thermometers to measure the sky temperature during the Green Building activity in Cambridge. To compare those measurements with ones taken under potentially different weather conditions, record the sky temperature at each stop as we ascend Mount Washington on your observation sheet. Think about what factors may be causing the differences in your observations.

\(^1\)Recently, a World Meteorological Organization review of Australian weather data found a wind gust that occurred during Typhoon Olivia on April 10, 1996 at Barrow Island, Australia, that surpassed the record wind recording on Mount Washington, with a wind gust of 253 mph. However, Mount Washington still holds the record for maximum non-tropical cyclone winds.
6 Flora

The type of flora observed on Mount Washington is closely related to the weather conditions. Because increasing elevation causes air temperature to drop, precipitation to increase, sunlight to decrease (more cloudy days), and wind speeds to increase, vegetation zones form according to elevation. At each stop on the trip up the mountain, use the ecological zones handout to help you classify the vegetation zone. Record your observations of the flora on the observations handout. To explore how weather shapes the vegetation on Mount Washington, choose one plant to sketch at each stop and indicate how its features (size, level, color, texture, form, position, life cycle, etc...) reflect its adaptation to the weather it experiences. Also measure the surface temperature of the (preferably sunlit) leaves of the plant using one of the infrared thermometers, and compare the leaf and air temperatures. Think about how the features of your plant and/or weather conditions affect the similarity or difference between leaf and air temperatures.