Microenvironments

Aboveground environment

Belowground environment

Edaphic factors – soil environment

Climate & scale

Macroclimate

Mesoclim ate

Microclimate

Microclimate factors

Precipitation

Solar Energy

Temperature

Water vapor

Carbon dioxide

Wind

Measuring a Microclimate

Microclimates VARY

I. In Time

Long time scales

Annually

Seasonally

Hourly

Min - Sec

II. In Space

Factors can change rapidly or gradually through space

Variation in space often controlled by how “well-mixed” the environment is
Mean values of climate factors are often of limited value

<table>
<thead>
<tr>
<th>Station</th>
<th>Ecoregion</th>
<th>Elevation (ft)</th>
<th>Mean annual (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonasket</td>
<td>Doug-fir / Grand fir</td>
<td>960</td>
<td>49.4</td>
</tr>
<tr>
<td>Darrington</td>
<td>Western Hemlock</td>
<td>550</td>
<td>49.1</td>
</tr>
<tr>
<td>Snoqualmie Falls</td>
<td>Western Hemlock</td>
<td>440</td>
<td>50.4</td>
</tr>
<tr>
<td>Republic</td>
<td>Doug-fir / Grand fir</td>
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<td>43.2</td>
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<tr>
<td>Greenwater</td>
<td>Western Hemlock</td>
<td>1,700</td>
<td>45.6</td>
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<tr>
<td>Snoqualmie Pass</td>
<td>Western Hemlock</td>
<td>3,000</td>
<td>42.1</td>
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</table>

Data from the Western Regional Climate Center: http://www.wrcc.dri.edu/

Greater temperature extremes for similar mean values

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<thead>
<tr>
<th>Station</th>
<th>Ecoregion</th>
<th>Elevation (ft)</th>
<th>Mean annual (°F)</th>
<th>Mean Jan min (° F)</th>
<th>Mean Jul max (° F)</th>
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<tbody>
<tr>
<td>Tonasket</td>
<td>Doug-fir / Grand fir</td>
<td>960</td>
<td>49.4</td>
<td>22.7</td>
<td>87.2</td>
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What are the effects of this difference in temperature extremes on precipitation?

Continuous monitoring is important

Datalogger on Snowshoe Mountain

Measuring Temperature

1. General considerations
   A. Thermal mass of measurement instrument influences
      • Temperature of object being measured
      • Speed of measurement response
   B. Size & exposure of device influences
      • Effects of radiative heating
      • Boundary layer impedance to thermal coupling
        Okay, in English: larger objects have larger layers of still air around them which causes them to "uncouple" from the temperature of the surrounding air.
   C. Measurements of media that are not well mixed require much sampling in space (e.g., soil)

2. Thermometers
   • Liquid expansion – Hg or EtOH in glass
   • Bimetallic coils
   • Max-min thermometers

3. Thermocouples
   • Seebeck effect (see handout)

4. Thermistors
   • Electronic – variable resistance
   • Bulkier but cheaper & easier than thermocouples

5. Hygrothermographs
   • Bimetallic strips – differential thermal expansion
Radiation

The nature of radiation

- Solar shortwave radiation
  - UV < 400 nm
  - Visible: 400 – 700 nm
  - Infrared: 700 – 3,000 nm
  - Longwave: > 3,000 nm

Measuring Radiation

1. Photosensitive Paper Stacks
   - Cheap, relative measures of shortwave (blueprint paper)

2. Electronic (Current) Cells
   - Filtered Silicon Cells
     - Pyranometer: Shortwave solar energy (Thermal Questions)
       - 400 – 2000 nm
     - Quantum Sensor: PPFD (Photosynthesis, Growth Questions)
       - 400 – 700 nm
   - Gallium Arsenide Phosphide Photodiodes (GaAsP)
     - Tiny, leaf-mounted, inexpensive, approximate PPFD

3. Bimetallic Actinograph
   - Differential absorption of radiation by black & white painted metallic surfaces, produces different metal temperatures and resulting differential metal expansion

4. Epply Pyranometer
   - Often weather station standard

5. Spectroradiometer
   - Diffraction grating and sensitive photomultiplier tubes – precise measures of specific wavelengths

Measuring Wind

1. Cup Anemometers
   - Inexpensive, standard, but bulky and insensitive, inertia problems

2. Vane Anemometers
   - Inexpensive, but insensitive, inertia problems

3. Hot Wire Anemometers
   - Micromeasurements, rapid response

4. Venturi Tubes & Pressure Transducers
   - Usually higher speed laminar fluxes

5. Sonic Anemometers
   - Complex 3-D wind patterns for canopy CO₂ flux modeling
Measuring Humidity

1. Wet Bulb / Dry Bulb Psychrometers
   Sling & Aspirated Types

2. Hygrothermograph
   Expansion of blond human hair (convenient recording, accuracy?)

3. Electronic Sensors
   Capacitance & resistance sensors (convenient but may need freq. calibration)

4. Dew Point Mirrors
   Optical detection of water formation on cooled mirror (highly accurate; $$$)

Measuring Precipitation

1. Standard Rain Gauge

2. Recording Rain Gauges
   Tipping Bucket & Weighing

3. Wet Fall/Dry Fall Gauges
   Precipitation-activated covering mechanism (nutrient cycling studies)

4. Snow Gauges
   Weighing pillow
   Sonic & optical measures of surface distance

5. Evapotranspiration
   Weighing lysimeters

Microclimate analysis can help you understand the effects of logging patterns on remaining habitat

Effects of an opening on forest microclimate

Different microclimates
Different habitats
How effective is your forest patch for interior habitat?
How much true forest habitat is there?

Chen et al. 1995
Each student team of 4 will conduct one transect.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measurement heights</th>
<th>Replicates at each height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
<td>10 cm; 1 m</td>
<td>4</td>
</tr>
<tr>
<td>Surface Temperature</td>
<td>0 cm</td>
<td>4</td>
</tr>
<tr>
<td>Soil Temperature</td>
<td>-10 cm</td>
<td>4</td>
</tr>
<tr>
<td>Wind Speed</td>
<td>10 cm; 1 m</td>
<td>4</td>
</tr>
<tr>
<td>RH</td>
<td>10 cm; 1 m</td>
<td>4</td>
</tr>
<tr>
<td>PPFD</td>
<td>10 cm; 1 m</td>
<td>4</td>
</tr>
<tr>
<td>Leaf Temperature</td>
<td>10 cm; 1 m</td>
<td>4</td>
</tr>
</tbody>
</table>