Physical geography and the functioning of the Earth

a.1 Global climate

State of the atmosphere

\[ P = -3.3\% / 275 \text{ m} \]

\[ T = -6.5 \text{ deg C} / 1000 \text{ m} \]

Ahrens, 1994

Solar (SW) and infrared (LW) radiation

calipsooutreach.hamptonu.edu/pbl/pbl02-budget.html
Photodamage: sunburns, cancer

Photosynthesis

Peak in Earth's infrared spectrum

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747/1390 = 54% of incoming solar radiation reaches Earth's surface

Why are eyes and plants adapted to 0.4-0.7 microns?

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Solar/UV radiation as a function of elevation/altitude

For every 1000 m increase in elevation, 12% increase in total solar radiation

For every 1000 m increase in elevation, 1-2% increase in total solar radiation

16,500'
8/29/08

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a.1 Global climate

Solar radiation

At poles,
- greater insolation in summer
- greater seasonal variability
- equal insolation as lower latitude (why?)

What does this mean for arctic plants and animals?

Control on solar radiation: latitude

- Latitude (in conjunction with tilt) determines solar radiation striking TOA
- Longer path through atmosphere: more absorption

NOTE: Top of Atmosphere! What else would affect surface insolation?
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a.1 Global climate

Control on solar radiation: orbital characteristics

http://www.homepage.montana.edu/~geol445/hyperglac/time1/milankov.htm

AXIAL TILT

http://www.homepage.montana.edu/~geol445/hyperglac/time1/milankov.htm
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Control on solar radiation: orbital characteristics

http://www.homepage.montana.edu/~geol445/hyperglac/time1/milankov.htm

Control on temperature: elevation

Decrease in T in free atmosphere and at higher elevation of Earth's surface

<table>
<thead>
<tr>
<th>TABLE 3.1: The influence of elevation on climate</th>
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<tbody>
<tr>
<td>Site</td>
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<tr>
<td>--------</td>
</tr>
<tr>
<td>Denver</td>
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<tr>
<td>Mt. Everest</td>
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<tr>
<td>Alps</td>
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<tr>
<td>Europe</td>
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</tbody>
</table>

Lomolino et al., 2006
Orographic influences on precipitation

Enhancement on windward side
“Rain shadow” on leeward side

Lomolino et al., 2006

Convective precipitation

rst.gsfc.nasa.gov/Sect14/Sect14_1d.html
Seasonal distribution of precipitation: % summer precip

a.1 Global climate

Precipitation (cm per year)

FIGURE 2.3 General circulation of the atmosphere and average annual precipitation (after狞ish)

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Transect across Pacific Northwest

Mean NPP (g C/m²/yr)

Biogeography
a.1 Global climate

Climate classifications: Köppen
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a.2 Microclimate

Aspect
West of Denver, CO

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a.2 Microclimate

Slope
Drainage: Boreal bog
Disturbance

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a.2 Microclimate

Vegetation

http://www.chem.ucla.edu/~alice/explorations/churchill/landscapes.htm
http://xpda.com/junkmail/junk154/PICT1778.jpg
http://photos.jibble.org/Longleat/Forest_canopy_at_Longleat
pinker.wjh.harvard.edu/photos/new_zealand/pages/meadow%20S%20Alps.htm
http://photos.jblee.org/Longpeaks/long_peaks_36474.jpg
Microclimate: Windward, leeward

Valley and Mountain Breezes:
Air follows the development of low pressure cells in local areas... upslope during the day and downslope during the night.
Cold air drainage at Mica Creek Experimental Watershed

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Cold air profile at the base of the control watershed at Mica Cr.

Microclimate: Shelter

Nurse trees

Sequoia in shade of whitebark pine

Subalpine fir in shade of subalpine fir

helios.bto.ed.ac.uk/bto/desbiome/nursery.htm

Lomolino et al. 2006
Soil provides habitat for a variety of organisms.

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Soil classification

Soil texture influences plant available water

www.maf.govt.nz/mafnet/schools/activities/swi/swi-04.htm

Soil texture influences plant available water

www.attra.org/attra-pub/soil_moisture.html

Figure 8: Relationship between soil texture, field capacity, permanent wilting point, RMWC, and SMWC. (Mary McLaren & Constance Williams)
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Soil formation interactions

Sollins, Ecology, 1998

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Soil formation

www.richardsnotes.org/archives/2004/03/

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Strong relationship between soil type and climate

Strong relationship between soil type and climate

Lamontagne et al., 2004

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Global distribution of soil types

horizons

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c. Physical Environment of Lakes

Different lake environments

Crater Lake: Secchi Disk Depth = 43'

Lago Nordenskjold, Chile

www.celebratebig.com/chile/index.htm
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c. Physical Environment of Lakes

Life zones

- *Radiation environment*

- *Thermal environment*

- barrier to mixing
  (why?)
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c. Physical Environment of Lakes

Oxygen environment

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c. Physical Environment of Lakes

Classification based on productivity

1. oligotrophic: deep, cold lakes, high amounts of oxygen and low P, other nutrients, low productivity
2. eutrophic: shallow, warm lakes, high amounts of nutrients, high productivity

Banff Nat. Park, Alberta, Canada

water.umn.edu/lwc

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What color is the ocean?
d. Physical Environment of Oceans

Life zones

State variables

Ocean temperatures
Ocean salinities
Ocean circulation
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Studies of ocean circulation

- 1990: 80,000 Nike sneakers
- 1992: 29,000 bath toys, tracked 4000 km (right)
- 1992: 28,800 plastic animals
- 2000: 10,224 Nike sandals

Ellison et al., 2007