Physical geography and the functioning of the Earth

a.1 Global climate

State of the atmosphere

ΔP = -3.3%/275 m ΔT = -6.5 deg C/1000 m

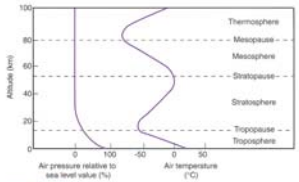
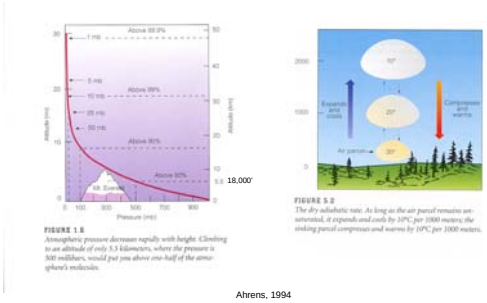


FIGURE 2.4 The atmospheric stratification of the earth and the variation in temperature and air pressure within the troposphere (after Strahler and Strahler, 1997).

Physical geography and the functioning of the Earth

a.1 Global climate

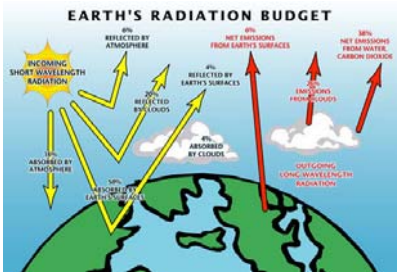


Ahrens, 1994

Physical geography and the functioning of the Earth

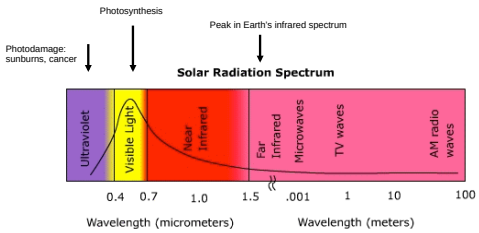
a.1 Global climate

Solar (SW) and infrared (LW) radiation



calipsooutreach.hamptonu.edu/pbl/pbl02-budget.html

Physical geography and the functioning of the Earth



www.uwsp.edu/geo/faculty/ritter/geog101/uwsp_lectures/lecture_radiation_energy_concepts.html

Physical geography and the functioning of the Earth

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

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

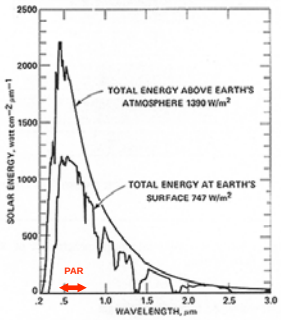


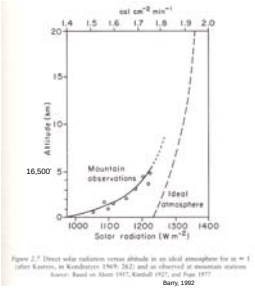
Figure 2-3.— *Solar radiation as a function of wavelength.*

www.nas.nasa.gov/About/Education/SpaceSettlement/75SummerStudy/Chapt.2.html

Physical geography and the functioning of the Earth

Solar/UV radiation as a function of elevation/altitude

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



Barry, 1992

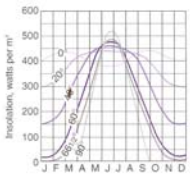
For every 1000 m increase in elevation, 12% increase in UV radiation

/www.familydoctor.co.uk/htdocs/SKINSUN/SKINSUN_specimen.html

Physical geography and the functioning of the Earth

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?

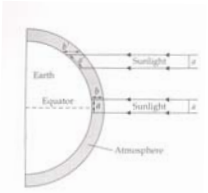
FIGURE 2.5 ~~The seasonal orbital characteristics of the earth and~~ the seasonal distribution of insolation at different latitudes (after Strahler and Strahler, 1997). Notice how at the poles (90° latitude) there is less total insolation and greater seasonal variation than at the equator (0° latitude).

NOTE: Top of Atmosphere! What else would affect surface insolation?

Physical geography and the functioning of the Earth

Control on solar radiation: latitude

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

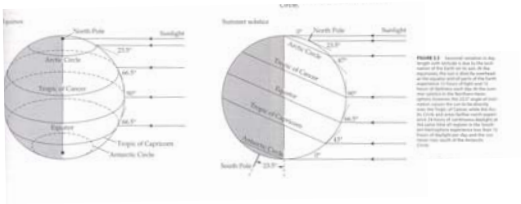


Lomolino et al., 2006

Physical geography and the functioning of the Earth

a.1 Global climate

Control on solar radiation: latitude



Physical geography and the functioning of the Earth

a.1 Global climate

Control on solar radiation: orbital characteristics

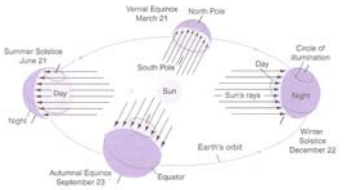
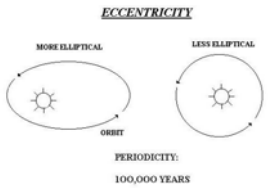


FIGURE 2.5 The seasonal orbital characteristics of the earth and the seasonal distribution of insolation at different latitudes (after Strahler and Strahler, 1997). Notice how at the poles (90° latitude) there is less total insolation and greater seasonal variation than at the equator (0° latitude).

Physical geography and the functioning of the Earth

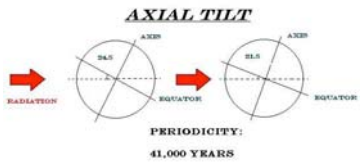
Control on solar radiation: orbital characteristics



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

Physical geography and the functioning of the Earth

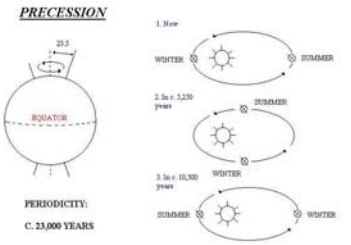
Control on solar radiation: orbital characteristics



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

Physical geography and the functioning of the Earth

Control on solar radiation: orbital characteristics



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

Physical geography and the functioning of the Earth

a.1 Global climate

Control on temperature: elevation

Decrease in T in free atmosphere <u>and</u> at higher elevation of Earth's surface

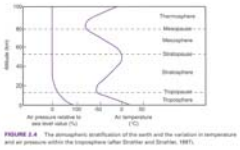


FIGURE 2.4 The atmospheric stratification of the earth and the variation in temperature and air pressure within the troposphere (after Strahler and Strahler, 1997).

Physical geography and the functioning of the Earth

a.1 Global climate

Control on temperature: elevation

TABLE 3.1 *The influence of elevation on climate*

Site	Elevation (m)	Temperature (°C) Mean January	Mean July	Lowest	Highest	Mean annual precipitation (cm)
Tuscon, Arizona	745	10.8	30.7	−9.4	46.1	27.3
Mt. Lemmon, Arizona	2791	2.3	17.8	−21.7	32.8	70.0
Salem, Oregon	60	3.2	19.2	−24.4	40.0	104.3

Source: Data from U.S. Weather Bureau.

Note: Two of the sites are near one another in Arizona; the third site is in Oregon. Note that the climate of the high-elevation site in Arizona, Mt. Lemmon, is much more similar to that of Salem, Oregon, 1700 km to the north, than to that of Tucson, only 25 km away but 2000 m lower in elevation.

Lomolino et al., 2006

Physical geography and the functioning of the Earth

Global temperature patterns

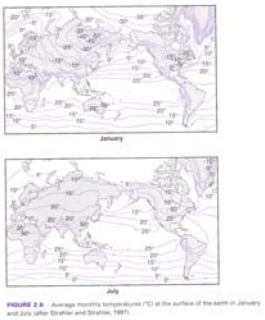
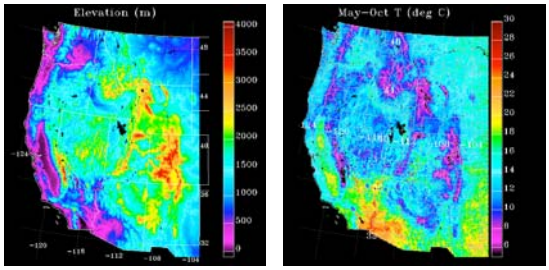


FIGURE 2.6 Average monthly temperatures (°C) at the surface of the earth in January and July (after Strahler and Strahler, 1997).

Physical geography and the functioning of the Earth

Orographic influences on temperature



Physical geography and the functioning of the Earth

frontal precipitation

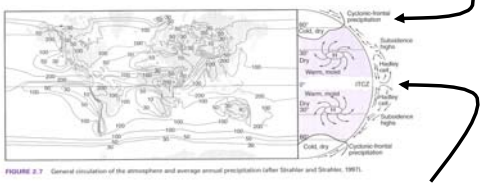


FIGURE 2.7 General circulation of the atmosphere and average annual precipitation (after Strahler and Strahler, 1997).

precipitation due to convergence: ITCZ

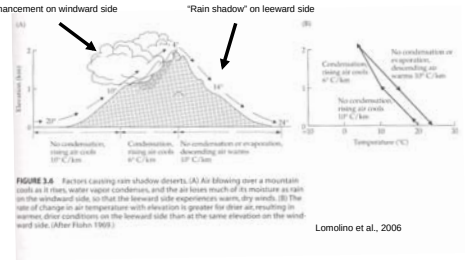
Physical geography and the functioning of the Earth

a.1 Global climate

Orographic influences on precipitation

Enhancement on windward side

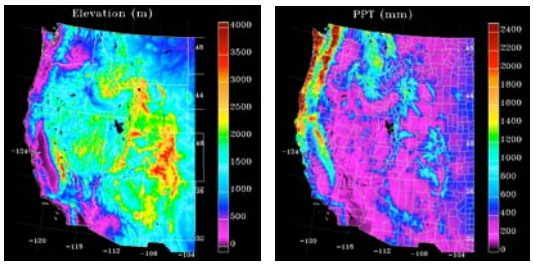
"Rain shadow" on leeward side



Lomolino et al., 2006

Physical geography and the functioning of the Earth

Orographic influences on precipitation



Physical geography and the functioning of the Earth

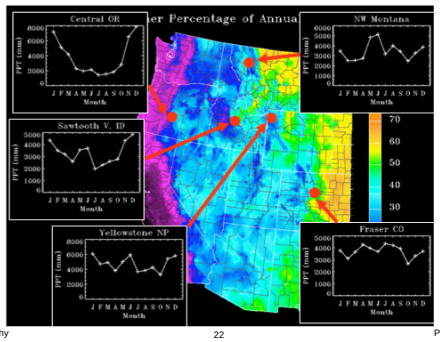
a.1 Global climate

Convective precipitation

rst.gsfc.nasa.gov/Sect14/Sect14_1d.html

Physical geography and the functioning of the Earth

Seasonal distribution of precipitation: % summer precip



Physical geography and the functioning of the Earth

a.1 Global climate

Precipitation (cm per year)

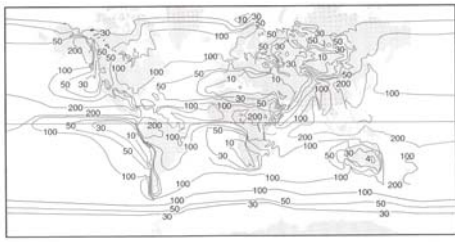
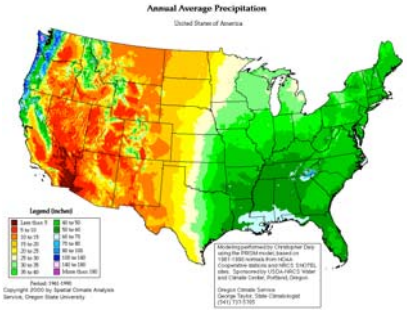
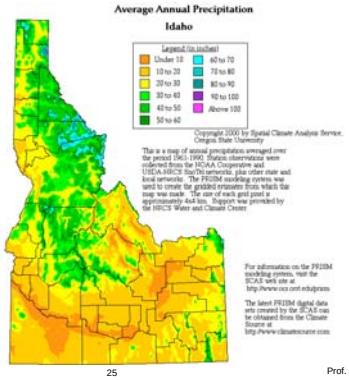


FIGURE 2.7 General circulation of the atmosphere and average annual precipitation (after Strahl

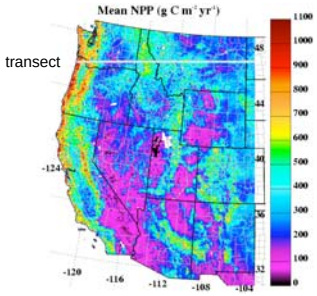
Physical geography and the functioning of the Earth



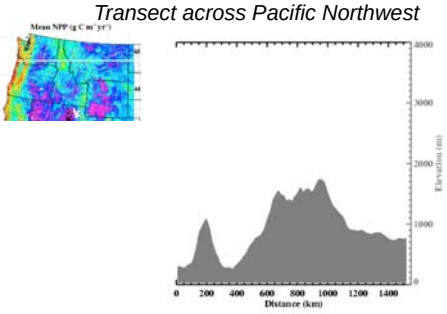
Physical geography and the functioning of the Earth



Physical geography and the functioning of the Earth
Transect across Pacific Northwest

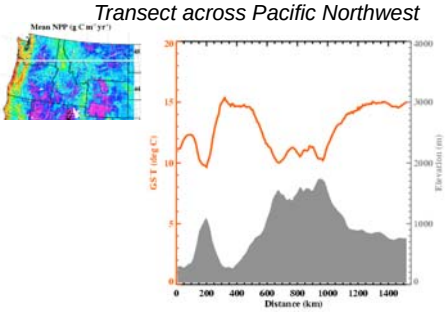


Physical geography and the functioning of the Earth
Transect across Pacific Northwest



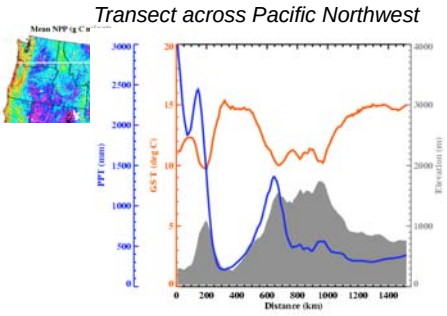
Physical geography and the functioning of the Earth

Transect across Pacific Northwest



Physical geography and the functioning of the Earth

Transect across Pacific Northwest



Physical geography and the functioning of the Earth

a.1 Global climate

Climate classifications: Köppen

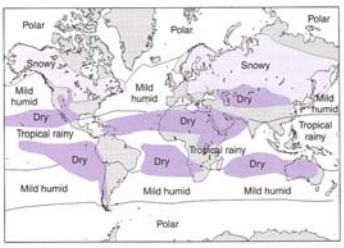


FIGURE 2.8 Simplified Köppen climate classification (after Strahler and Strahler, 1997).

Physical geography and the functioning of the Earth

a.2 Microclimate

Aspect

West of Denver, CO

Physical geography and the functioning of the Earth

a.2 Microclimate

Slope

Drainage: Boreal bog

http://www.chem.ucla.edu/~alice/explorations/churchill/landscapes.htm

Disturbance

http://xpda.com/junkmail/junk154/PICT1778.jpg

Physical geography and the functioning of the Earth

a.2 Microclimate

Vegetation

pinker.wjh.harvard.edu/photos/new_zealand/pages/meadow%20S%20Alps.htm

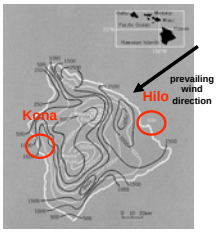
http://photos.jibble.org/Longleat/Forest_canopy_at_Longleat

Physical geography and the functioning of the Earth

Microclimate: *Windward, leeward*

	Hilo - East - Windward		Kona - West - Leeward	
	daylight (F)	Rain (" / month)	daylight (F)	Rain (" / month)
Jan-Mar	79 / 62	11	80 / 62	4
Apr-Jun	80 / 62	15	81 / 65	2
Jul-Sep	82 / 70	10	82 / 68	0
Oct-Dec	80 / 65	15	81 / 63	1

http://www.hawaii.islands-holiday.com/weather.html



www.mlo.noaa.gov

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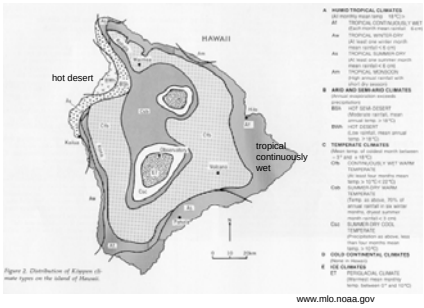
Physical geography and the functioning of the Earth

Microclimate: *Windward, leeward*



www.mlo.noaa.gov

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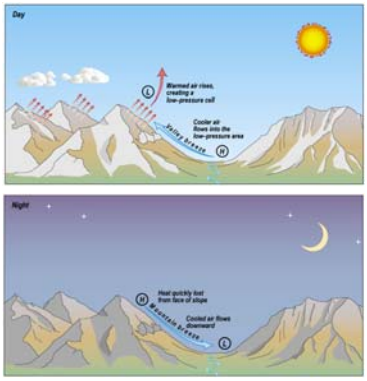
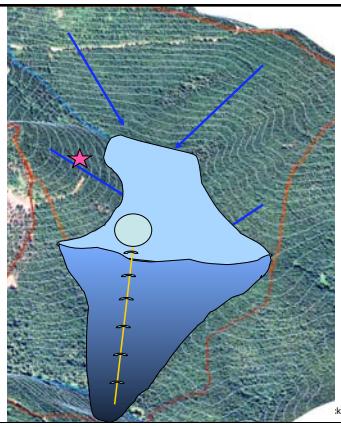


Valley and Mountain Breezes:

Air follows the development of low pressure cells in local areas… upslope during the day and downslope during the night

36

Cold air drainage
at Mica Creek
Experimental
Watershed

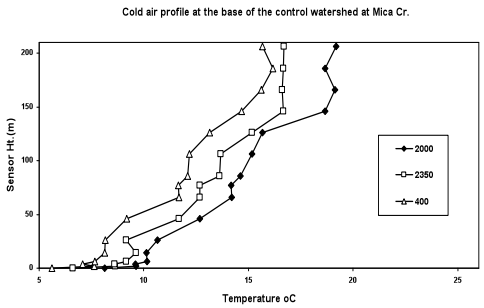


slide courtesy of K. Kavanagh

Biogeography

:ke

Physical geography and the functioning of the Earth



slide courtesy of K. Kavanagh

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Physical geography and the functioning of the Earth

Microclimate: *Shelter*

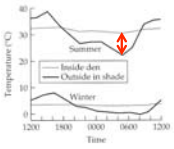


FIGURE 3.18 Temperatures inside and outside the den of a bushy-tailed woodrat (*Neotoma cinerea*) and a deep crack between large boulders in the high desert of southeastern Utah during midsummer and midwinter. Because the den (where the animal spends most of its time) experiences much less variation than the macroclimate outside, it affords vital protection from stressfully high and low temperatures in summer and winter, respectively. (After Brown 1968.)

Lomolino et al. 2006

Nurse trees

Saguaro in shade of limber bush

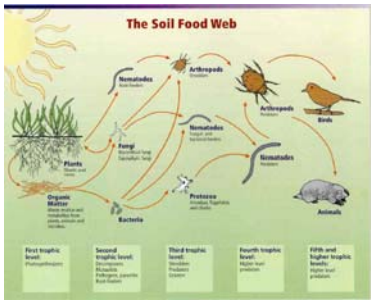
Subalpine fir in shade of whitebark pine

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

Biogeography 39 Prof. J. Hicke

Physical geography and the functioning of the Earth

Soil provides habitat for a variety of organisms



soils.usda.gov

Physical geography and the functioning of the Earth

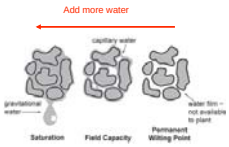
Soil classification

Figure 5.7 | A soil texture chart, which shows the percentages of clay (below 0.002 mm), silt (0.002–0.05 mm), and sand (0.05–2.0 mm) in the basic soil texture classes. For example, a soil with 60 percent sand, 30 percent silt, and 10 percent clay would be classified as a sandy loam.

Smith and Smith, 2006

Physical geography and the functioning of the Earth

Soil texture influences plant available water



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

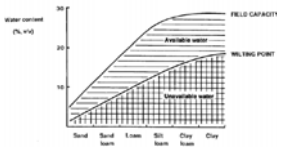


Figure 8:

Relationship between soil texture, field capacity, permanent wilting point, RAWC and TAWC. (Source: McLaren & Cameron)

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

Physical geography and the functioning of the Earth

Soil formation interactions

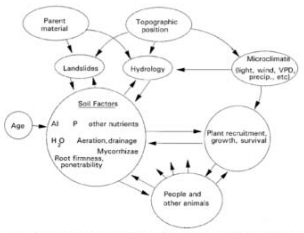


FIG. 1. Direct and indirect controls on soil formation in the humid tropics. (VPD = vapor-pressure deficit.)

Sollins, Ecology, 1998

Physical geography and the functioning of the Earth

Soil formation

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

Physical geography and the functioning of the Earth

Strong relationship between soil type and climate

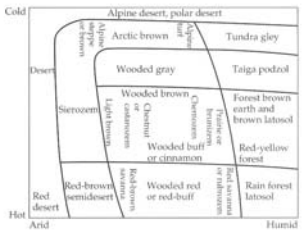
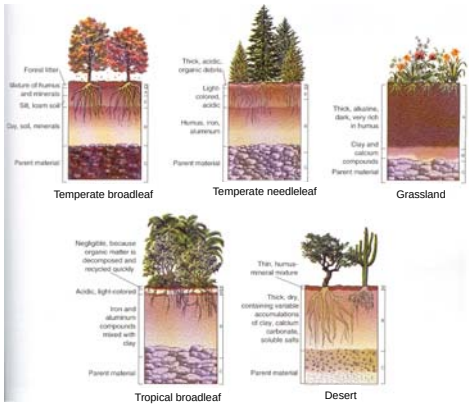


FIGURE 3.11 Schematic diagram depicting the relationships between major soil types and climate, showing that different combinations of temperature and precipitation cause the formation of distinctive soil types. (After Whitaker 1975.)

Lomolino et al., 2006



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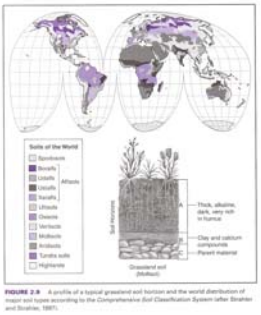
Physical geography and the functioning of the Earth

Global distribution of soil types



horizons

Biogeography 47 Prof. J. Hicke

Physical geography and the functioning of the Earth

c. Physical Environment of Lakes

Different lake environments

Crater Lake: Secchi Disk Depth = 43'

www.nps.gov/crla/student/student1.htm

www.news.ucdavis.edu/search/printable_news.lasso?id=6120&table=news

Lago Nordenskjold, Chile

www.celebratebig.com/chile/index.htm

Biogeography 48 Prof. J. Hicke

Physical geography and the functioning of the Earth

c. Physical Environment of Lakes

Life zones

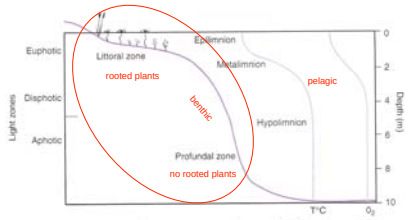


FIGURE 2.10 Life zones, light, temperature, and oxygen distributions in a small lake during summer.

Physical geography and the functioning of the Earth

c. Physical Environment of Lakes

Radiation environment

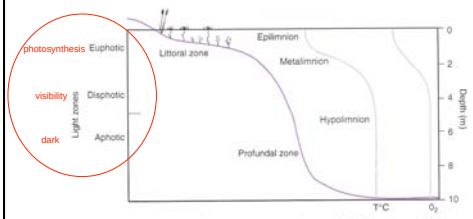


FIGURE 2.10 Life zones, light, temperature, and oxygen distributions in a small lake during summer.

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c. Physical Environment of Lakes

Thermal environment

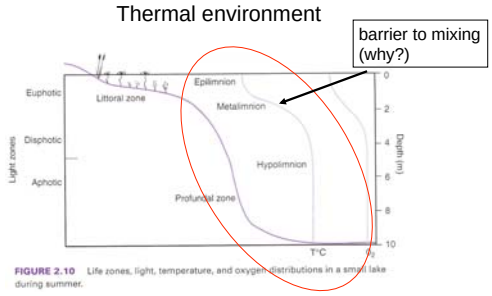

FIGURE 2.10 Life zones, light, temperature, and oxygen distributions in a small lake during summer.

Physical geography and the functioning of the Earth

c. Physical Environment of Lakes

Oxygen environment

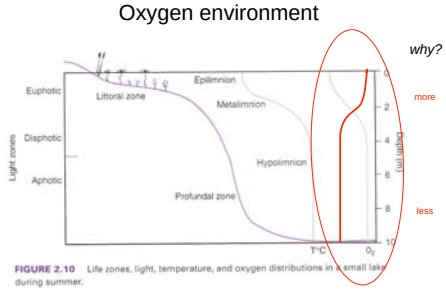

FIGURE 2.10 Life zones, light, temperature, and oxygen distributions in a small lake during summer.

Physical geography and the functioning of the Earth

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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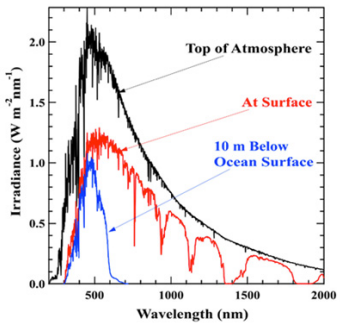


What color is the ocean?

lasp.colorado.edu/sorce/sim_print.html

Physical geography and the functioning of the Earth

d. Physical Environment of Oceans

Life zones

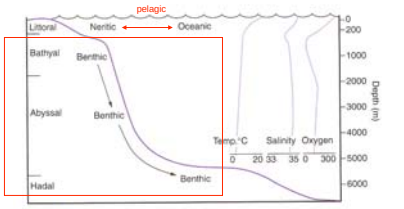


FIGURE 2.11 Marine life zones, salinity, temperature, and oxygen distributions in the ocean.

Physical geography and the functioning of the Earth

d. Physical Environment of Oceans

State variables

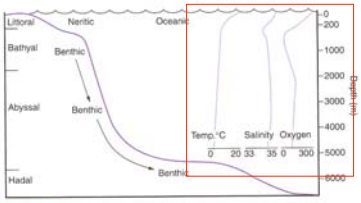


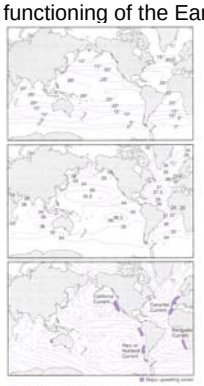
FIGURE 2.11 Marine life zones, salinity, temperature, and oxygen distributions in the ocean.

Physical geography and the functioning of the Earth

Ocean temperatures

Ocean salinities

Ocean circulation



Physical geography and the functioning of the Earth

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

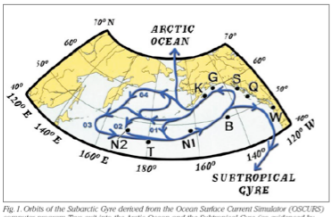


Fig. 1. Orbits of the Subarctic Gyre derived from the Ocean Surface Current Simulator (OSCURS) computer program. Toys exit into the Arctic Ocean and the Subtropical Gyre (as evidenced by toys found in Washington state). Legend: B, drifters released at Ocean Weather Station P; G, temperature and salinity measurements; K, sandals at Kodiak and Kattmai eruption; N1, 1990 sneaker spill; N2, sandals spilled in 2000; O1–O4, orbits 1–4; Q, toys in the Queen Charlotte Islands; S, toys at Sitka; T, 1992 toy spill; and W, toys in Washington.

Ebbesmeyer et al., 2007