Schedule

- 12 lectures
- 3 long labs (8 hours each)
- 2 homework
- 1 group project
- 4 Q&A (Geography Room 206)
- Dr. Dave Reed on CRBasics with CR5000 datalogger

08/31/17 (Lecture #1)
09/05/17 (Lecture #2)
09/07/17 (Lecture #3)
09/12/17 (4:00 – 18:30 h) (Lecture #4-5)
09/14/17 (Lecture #6): radiation
09/21/17 (Lecture #7): radiation lab & New EC tower
09/26/17 (4:00 – 18:30 h) (Lecture #8-9)
09/28/17 (Lecture #10)
10/03/17 (12:00 – 8:00 h) (Lab #1)
10/10/17 (12:00 – 8:00 h) (Lab #2)
10/20/17 (8:00 -17:00 h) (Lab #3)
10/24/17 (Q&A #1)
10/26/17 (Lecture #11)
11/07/17 (Q&A #2)
11/14/17 (Q&A #3)
11/21/17 (Q&A #4)
12/07/17 (Lecture #12): Term paper due on Dec. 14, 2017

Spectral distribution of blackbody radiation

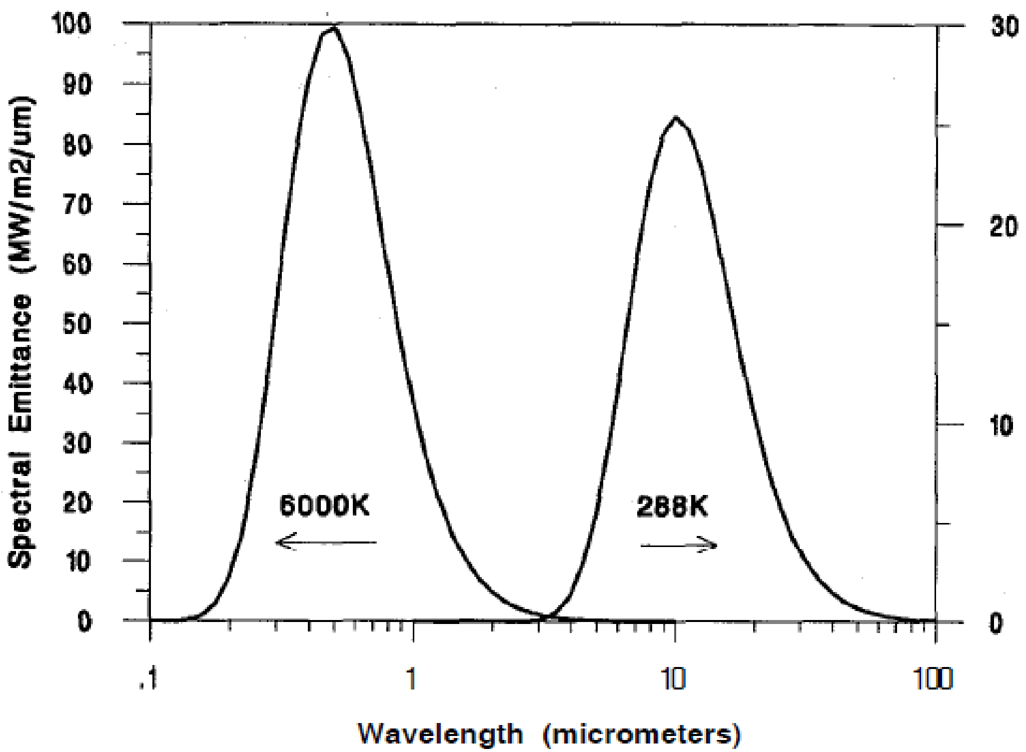
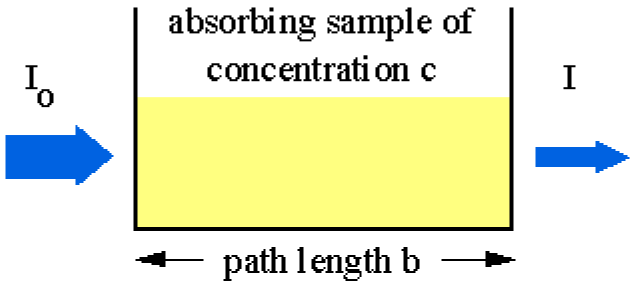


FIGURE 10.4. Emittance spectra for 6000 K and 288 K blackbody sources approximating emission from the sun and the earth.

$$\lambda_m = 2897 \cdot T^{-1}$$

Beer-Lambert's Law

$$I = I_0 e^{-k * b}$$

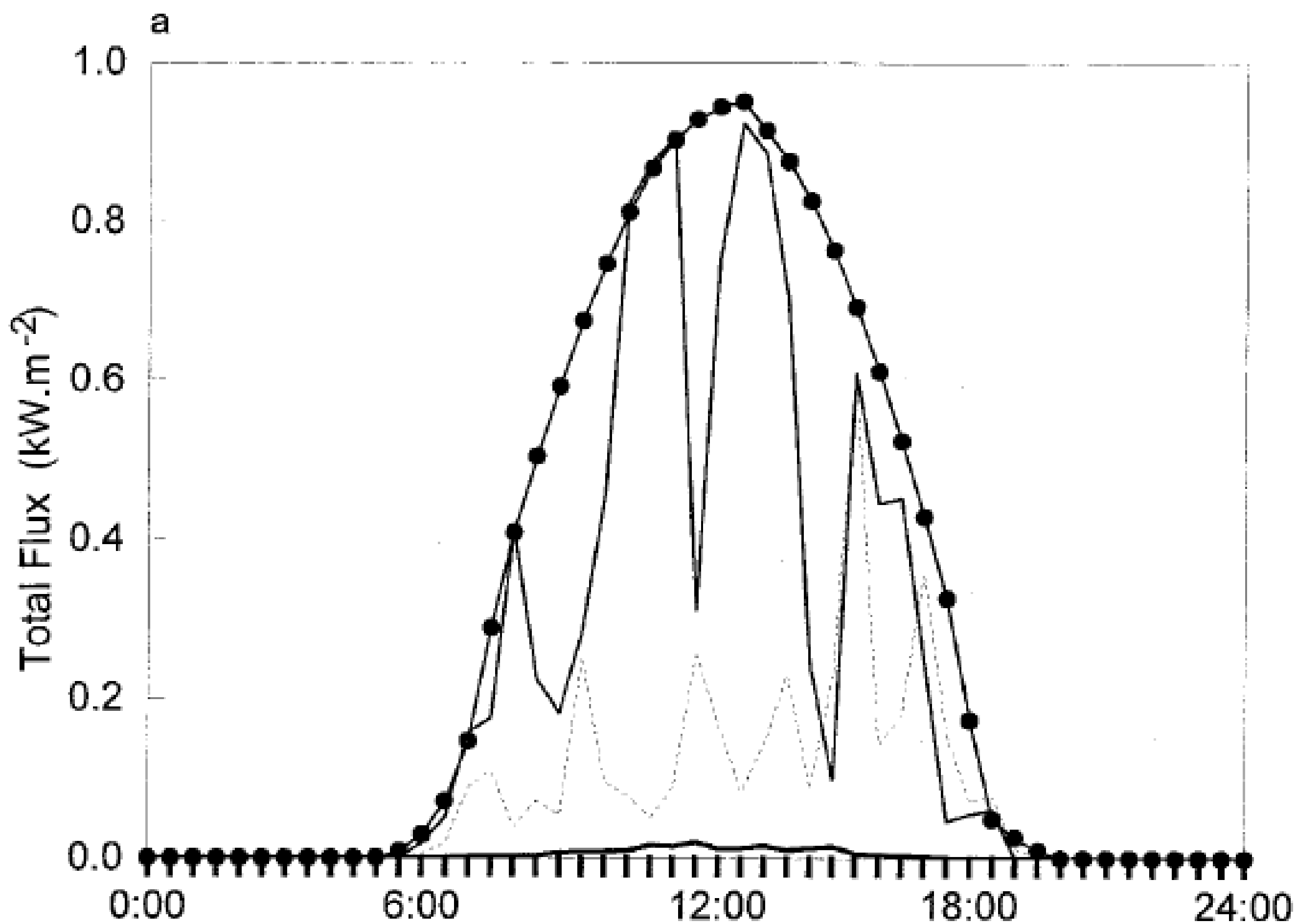


- Attenuation of radiation in a homogeneous medium
- Applies for wavebands narrow enough where ***k*** remains constant.

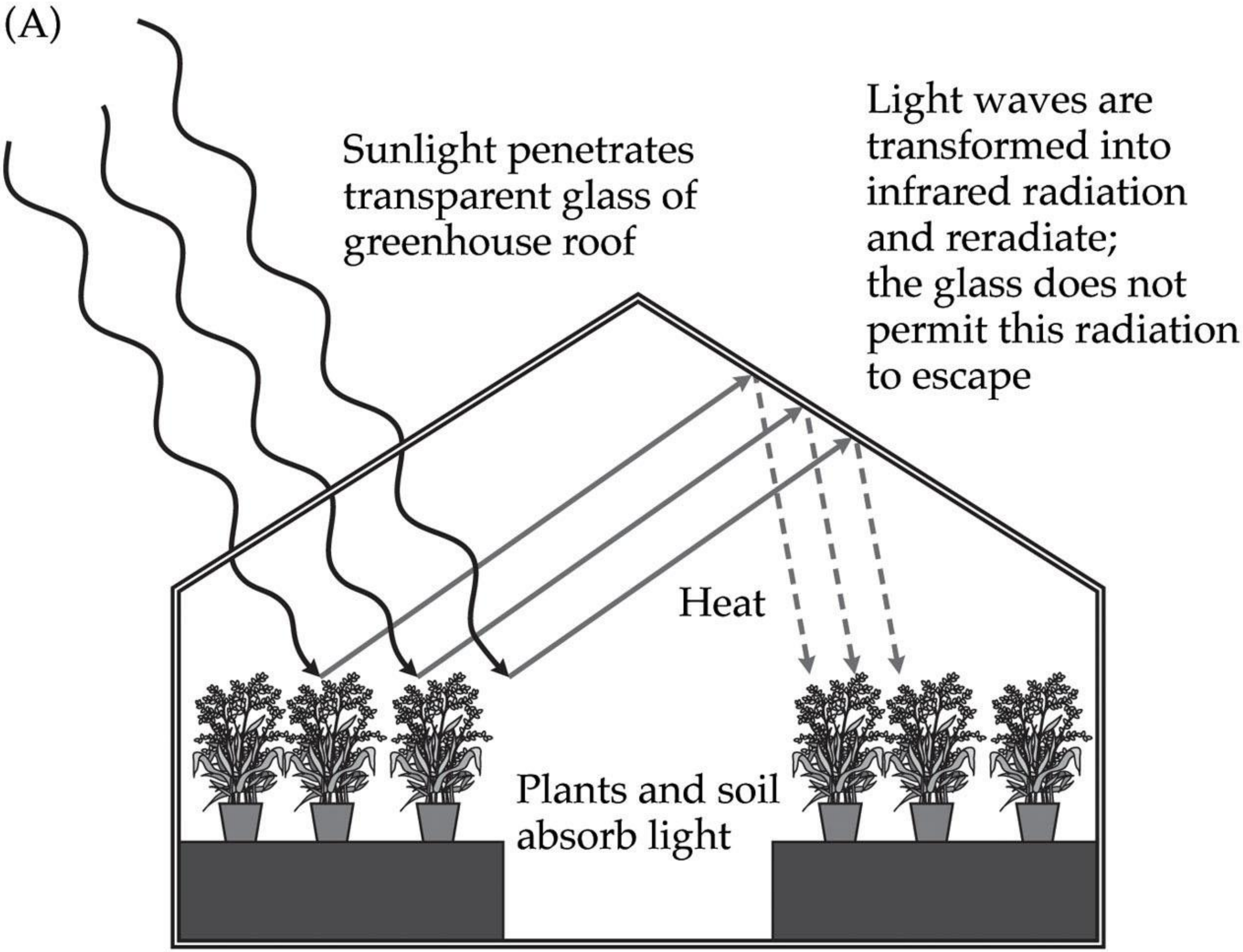
Hemispherical photos and applications: A "standard" method to characterize light environments beneath forest canopies

Demo of the solar.c model by Chen 1990.

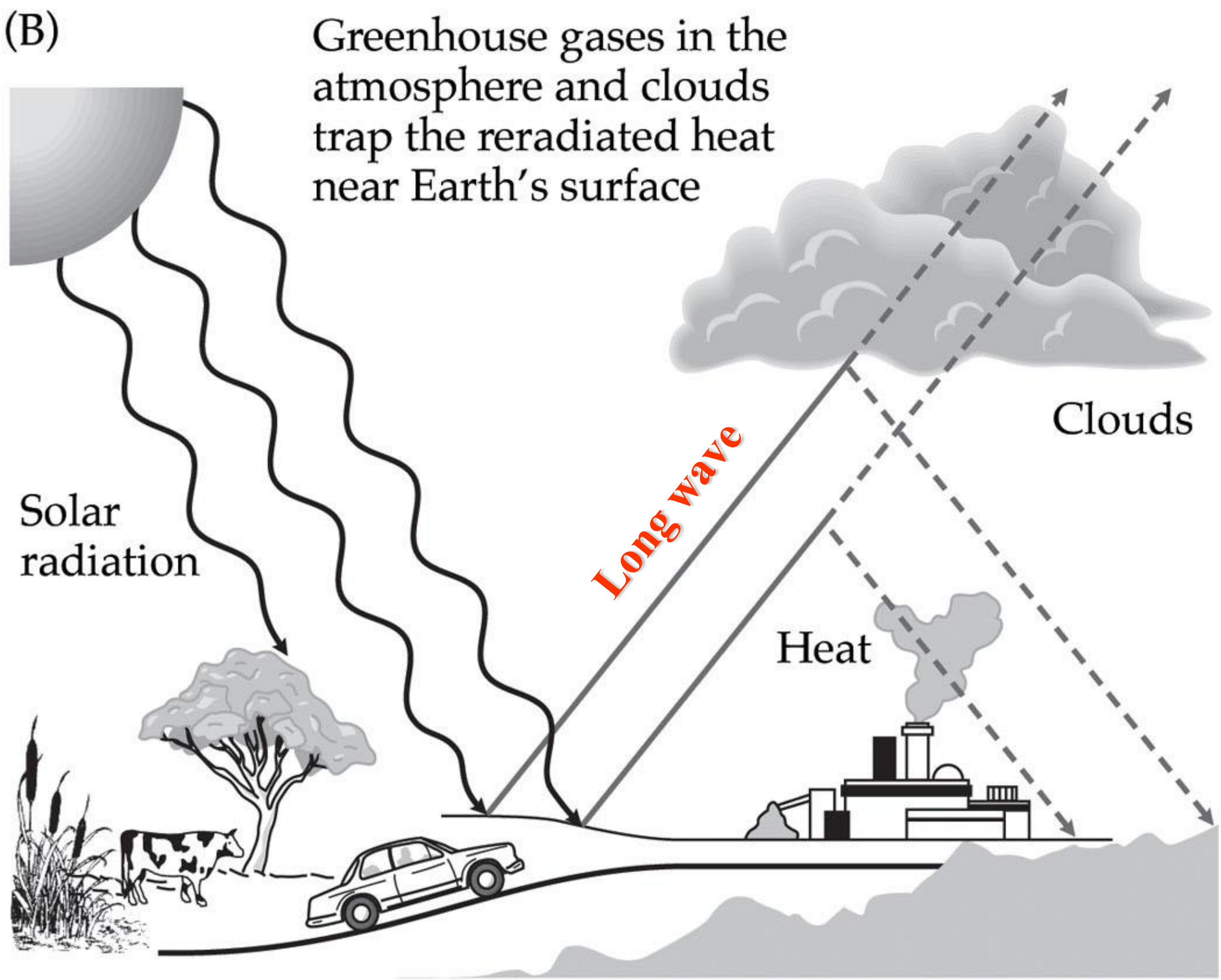
Diel change of short-wave radiation in and under forest canopies (Chen et al. 1999)



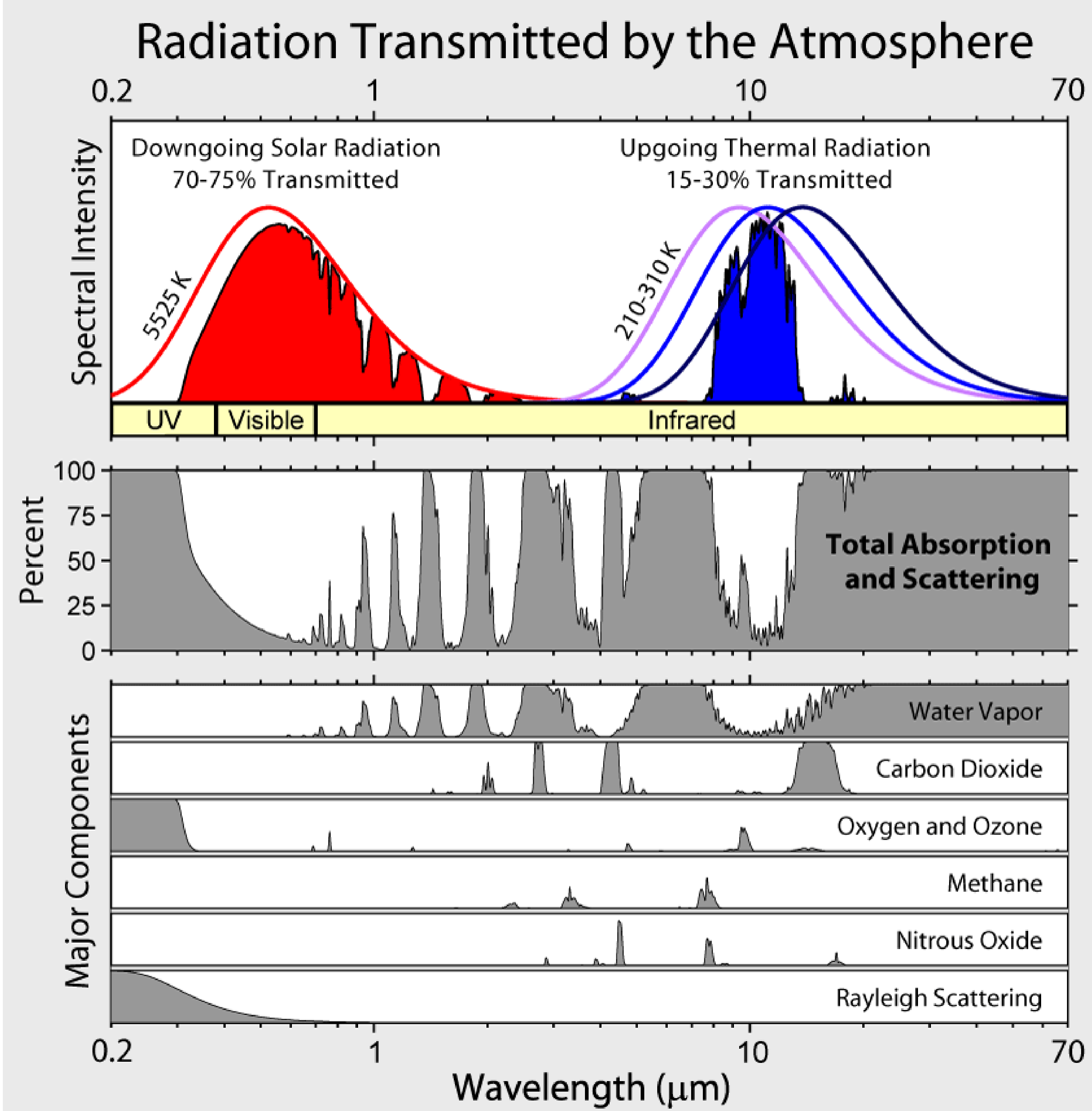
Greenhouse Effect



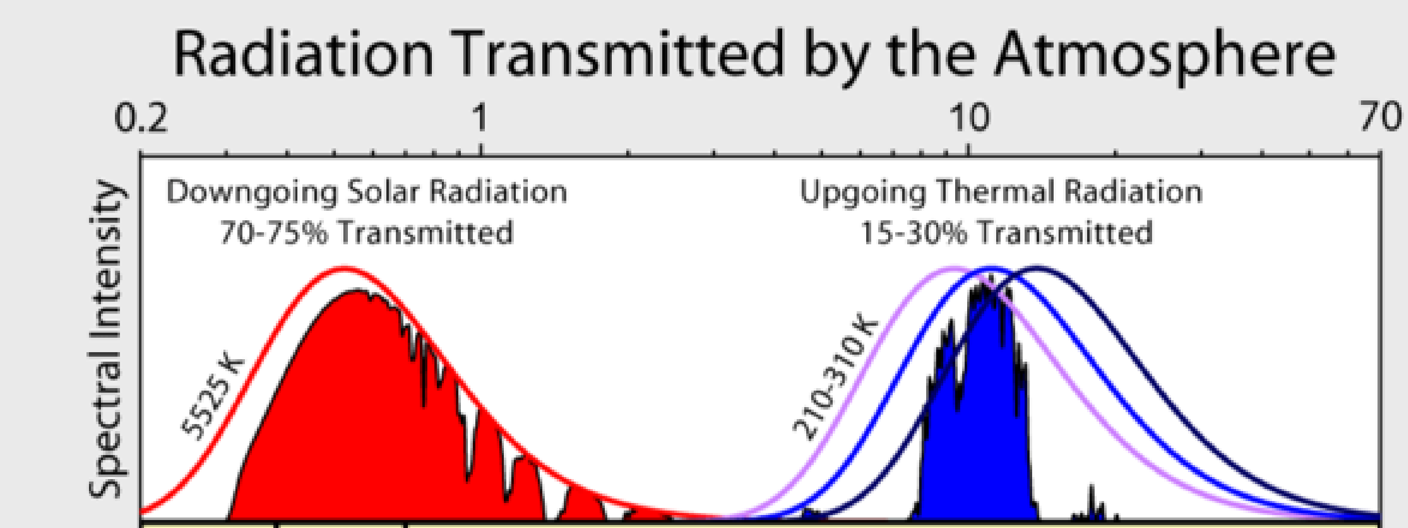
PRINCIPLES OF CONSERVATION BIOLOGY, Third Edition, **Figure 10.1 (Part 1)**

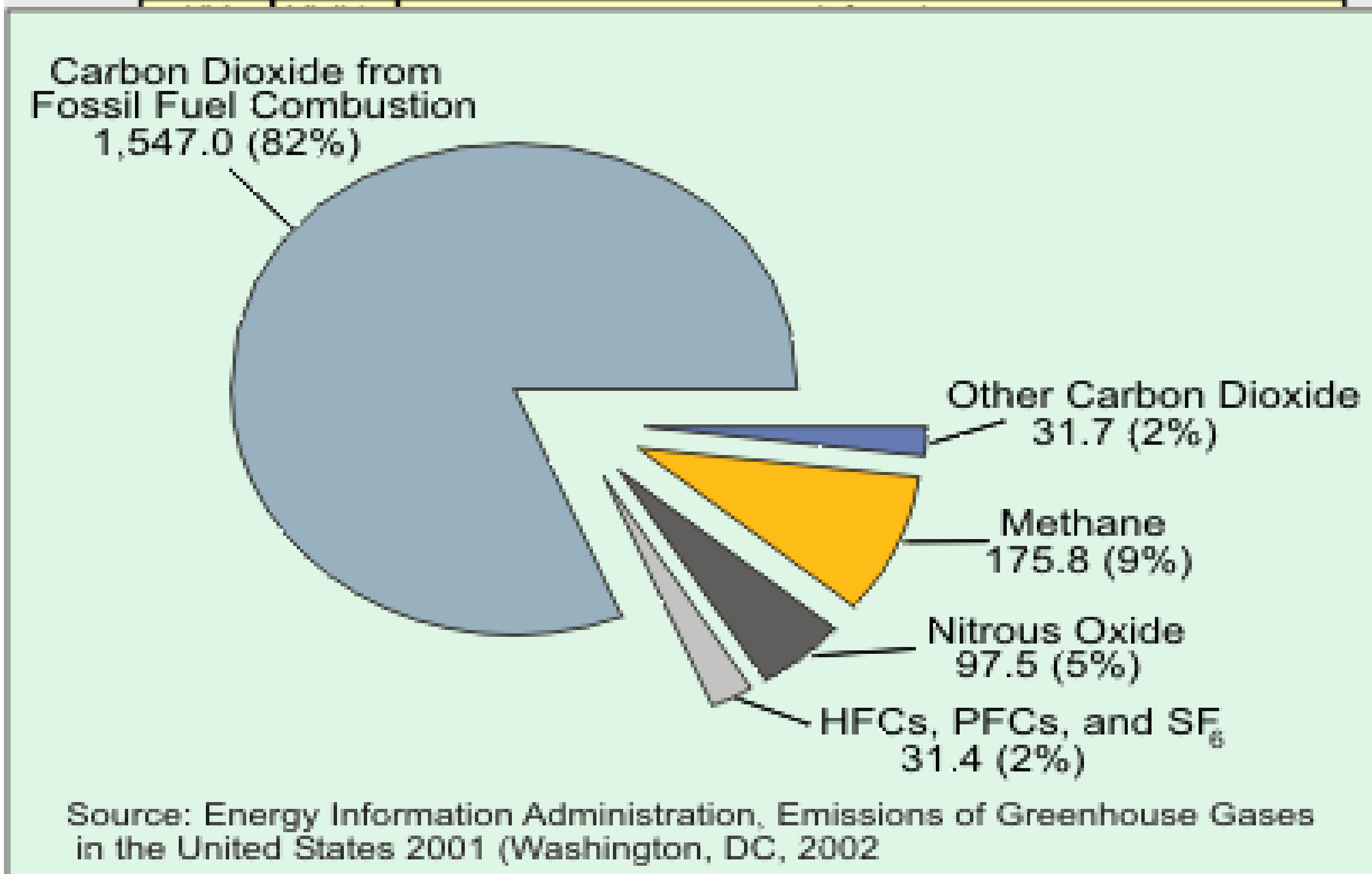


Light waves are transformed into infrared radiation reflected back to Earth by clouds and reradiated



http://www.epa.gov/climatechange/emissions/usinventoryreport.html

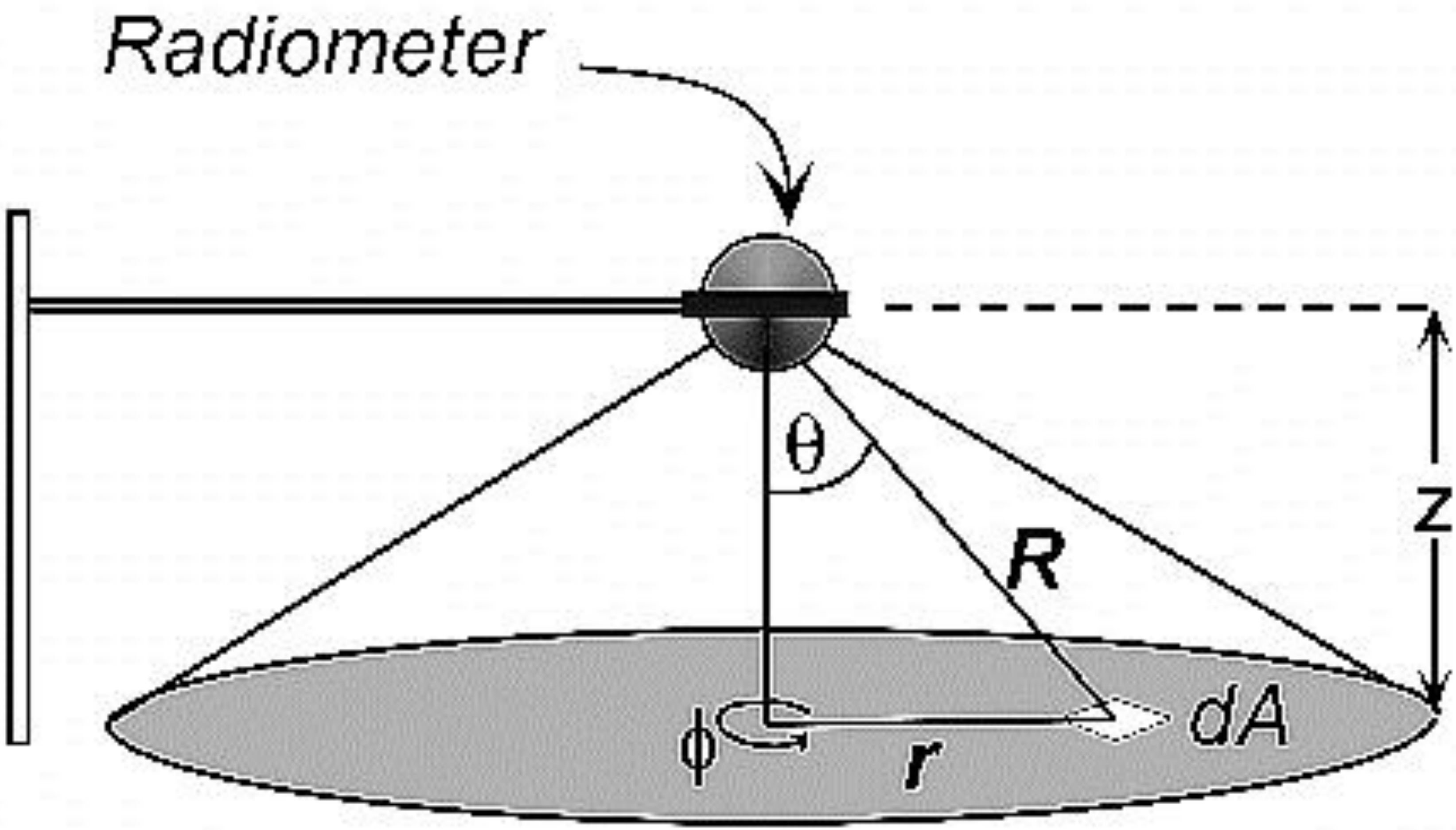

Radiation Transmitted by the Atmosphere
0.2
1
10
70
Spectral Intensity
Downgoing Solar Radiation
70-75% Transmitted
Upgoing Thermal Radiation
15-30% Transmitted
5525 K
210-310 K


Carbon Dioxide from
Fossil Fuel Combustion
1,547.0 (82%)
Other Carbon Dioxide
31.7 (2%)
Methane
175.8 (9%)
Nitrous Oxide
97.5 (5%)
HFCs, PFCs, and SF_6
31.4 (2%)
Source: Energy Information Administration, Emissions of Greenhouse Gases
in the United States 2001 (Washington, DC, 2002

Radiometers

- Pyranometer: Global shortwave radiation
- Pyrheliometer: direct beam of solar radiation
- Pyrgeometer: measurement of longwave radiation
- Net radiometer: difference between incoming and outgoing radiation
- Diffuse radiation: pyranometer and shadow bands
- Hemispherical photos:

The geometrical arrangement of a radiometer above a flat, horizontal surface. Refer to the text for definitions of the geometrical elements.

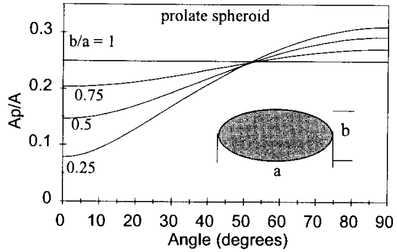


View factors

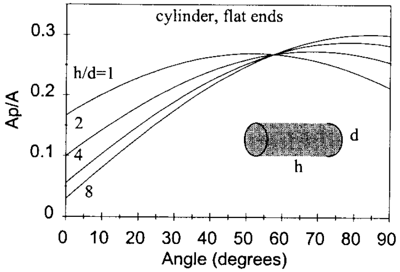
- Radiation from one object gets intercepted by another
- View factor = average flux density over the entire surface of the object divided by flux density on a flat absorbing surface facing the source.
- For beam radiation this is numerically equal to the ratio of projected area (in the direction of the source of the radiation) to total surface area
- The sum of view factors of an object to its surrounding environment is **1**

- For canopy, $F_r = F_g = 0$; $F_a = F_d = (1+\cos g)/2$; $F_e = 1$
- For leaf, $F_p = 0.5 \cos q$; $F_a = F_d = F_r = F_g = 0.5$; $F_e = 1$
- $q = f$\{zenith angle; azimuth angle; aspect angle; inclination angle\}

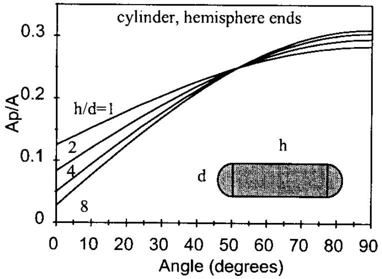
View factors



$$\frac{A_p}{A} = \frac{\sqrt{1+(x^2-1)\cos^2\theta}}{2x + \frac{2\sin^{-1}\sqrt{1-x^2}}{\sqrt{1-x^2}}} \quad ; \quad x=b/a$$



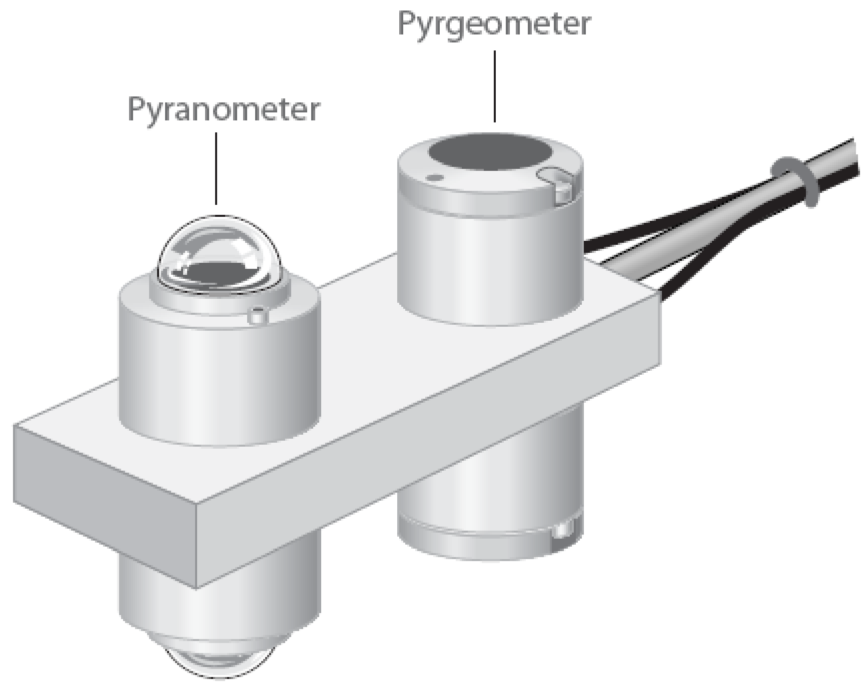
$$\frac{A_p}{A} = \frac{\cos\theta + \frac{4h\sin\theta}{\pi d}}{2 + \frac{4h}{d}}$$



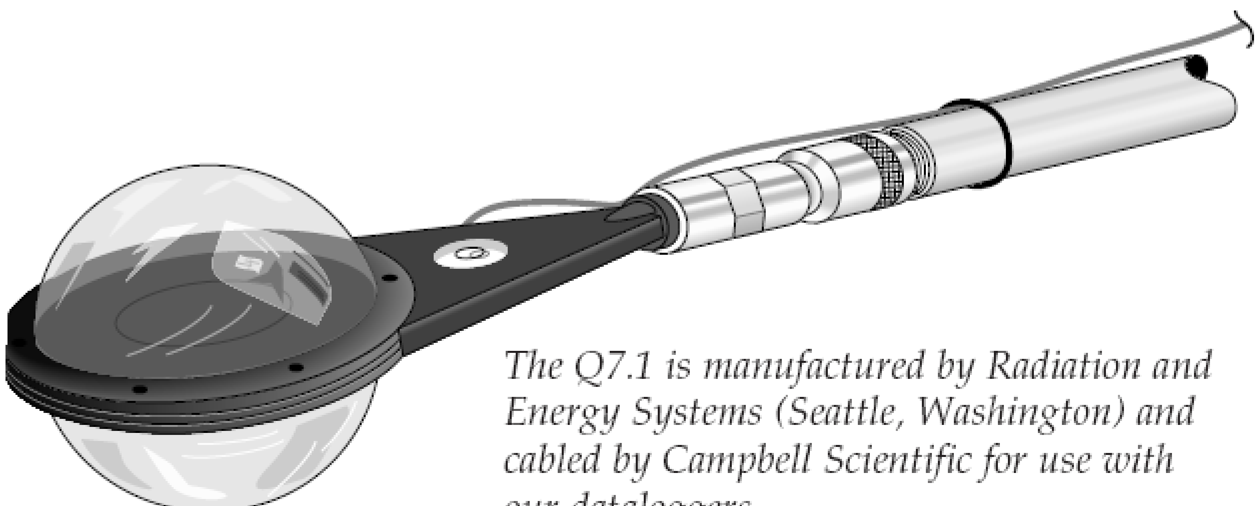
$$\frac{A_p}{A} = \frac{1 + \frac{4h\sin\theta}{\pi d}}{4 + \frac{4h}{d}}$$

FIGURE 11.6. Ratios of shadow area on a surface perpendicular to the solar beam to total surface area for three simulated animal shapes. The angle indicated is the angle between the solar beam and the longitudinal axis of the solid.

The CNR1 net radiometer is manufactured by Kipp & Zonen for applications requiring research-grade performance. The radiometer measures the energy balance between incoming short-wave and long-wave infrared radiation versus surface-reflected short-wave and outgoing long-wave infrared radiation. The CNR1 consists of a pyranometer and pyrgeometer pair that faces upward and a complementary pair that faces downward.

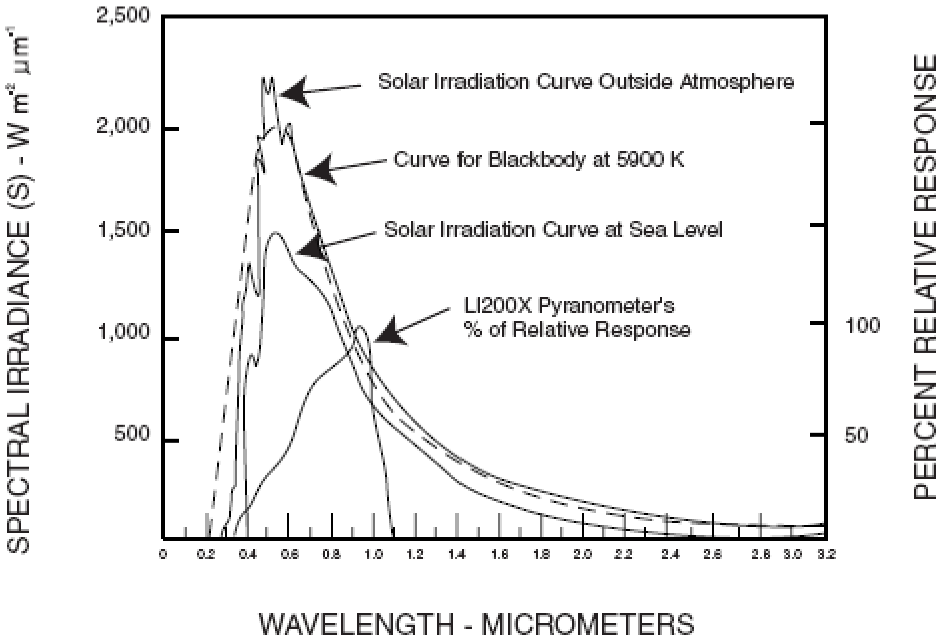


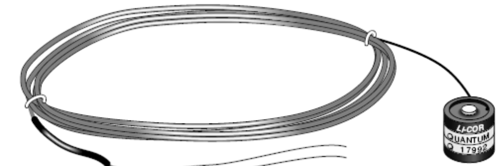
The Q7.1 is an high-output thermopile sensor that generates a millivolt signal proportional to the net radiation level. The sensor is mounted in a glass-reinforced plastic frame with a built-in level. A ball joint is supplied on the stem to facilitate leveling. The sensor surface and surrounding surfaces are painted flat black to reduce reflections within the instrument and to achieve uniform performance over reflective and non-reflective surfaces.



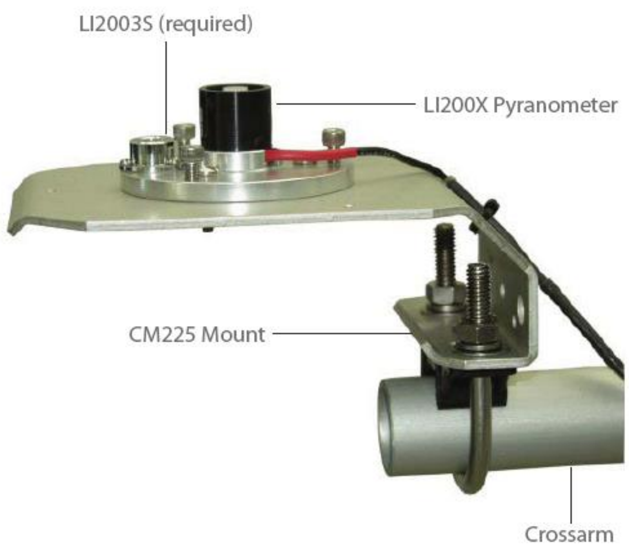
The Q7.1 is manufactured by Radiation and Energy Systems (Seattle, Washington) and cabled by Campbell Scientific for use with our dataloggers.

LI200X Spectral Response





The LI190SB Quantum Sensor is shown above. The LI200X has a similar appearance.



LI190SB Spectral Response

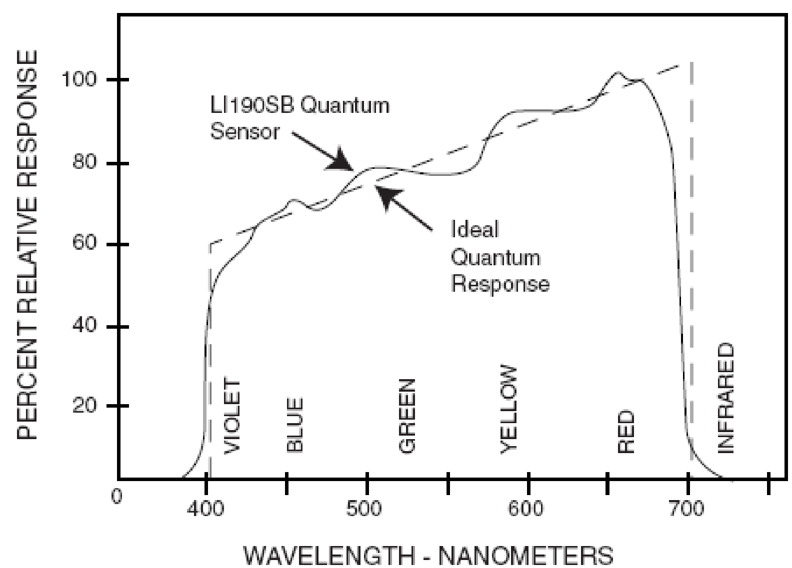


Figure 1: Photo of two different pyronometers for measuring global horizontal solar radiation. The foreground instrument is a Black and White pyronometer and the deeper one is a Precision Spectral pyronometer. Photo by T. Stoffel. Source of photo DOE/NREL.

Figure 2: Photo of several pyrheliometers for measuring direct solar radiation. Photo by T. Stoffel. Source of photo DOE/NREL

Fig. 1.38 Pyranometer and occulting ring according to a design by Horowitz (1969).

Programming with radiometers

- LI190SB: PAR
- Q7.1: net radiometer
- CNR 4: 4-way radiometer

Tasks and Assignment fir the EC tower on Baker Hall

- Overall Design: BJ
- Logistics: Gabriela
- Programming: Cheyenne
- Testing & Mounting: Chase