



# Essentials of the Earth's Climate System

## Roger G. Barry and Eileen A. Hall-McKim

### Solutions – Chapter 2

**1. The layer of the atmosphere where most of the world's weather occurs**

(d) Troposphere

**2. The tropopause is highest at the north and south poles**

(b) False

**3. Contrast the vertical gradients of temperature, pressure, and vapor content.**

Temperature decreases nearly linearly with altitude at an average rate of about  $6.5^{\circ}\text{C}/\text{km}$ ; pressure and vapor pressure decrease exponentially.

Air pressure is half that at the surface at 500 mb and only 10 percent at 15 km. Vapor content is about 5-10 g/kg at the surface and 10 percent of that at 500 mb.

**4. Compare the exchanges of solar radiation and terrestrial infrared at the surface.**

Incoming solar radiation is partially reflected by the surface according to its albedo. The balance is absorbed by the surface, warming it. The surface emits infrared radiation in proportion to its temperature and this is partly absorbed in the atmosphere and partly transmitted to space. The absorption by the atmosphere warms it and in turn the atmosphere radiates infrared radiation back to the surface and upwards to higher atmospheric layers and space.

**5. What is meant by the “Greenhouse Effect”.**

Incoming solar radiation passes through the atmosphere and is partly absorbed at the surface. The surface emits infrared radiation, which is mainly absorbed in the atmosphere by greenhouse gases (water vapor, carbon dioxide, methane etc). This absorption leads to a rise in temperature.

**6. Discuss the sources of error in precipitation measurements.**

There are errors due to airflow over the gauge rim, especially for falling snow where there can be major undercatch. The wind may be affected by the surrounding topography and vegetation causing eddies. Increasing height of the gauge top above the ground leads to undercatch. There may be errors due to wetting of the gauge interior that retains some of the rainfall. There may be splash out or into the gauge from the surrounding surface. There may also be errors in the reading of the catch.

**7. Compare the different methods of measuring evaporation and examine their limitations.**

There are three main methods. One is the evaporation pan where changes in water level are determined. The pan can overestimate the loss when the pan is exposed in an arid area. A mesh is needed to prevent animals and birds from consuming the water. Pan evaporation can be used to estimate losses from lakes. A weighing lysimeter can give a good estimate of evapotranspiration; larger installations are more precise. Eddy correlation measurements are reasonably reliable in light to moderate winds but overall they underestimate the evaporation.

**8. The Bowen ratio is  $> 1$  when the surface is dry. True or false?**

True

**9. Over a dry surface  $LE > H$ . True or false?**

False

**10.  $G$  is minor compared to  $H$ . True or false?**

True