Maui Map Pack

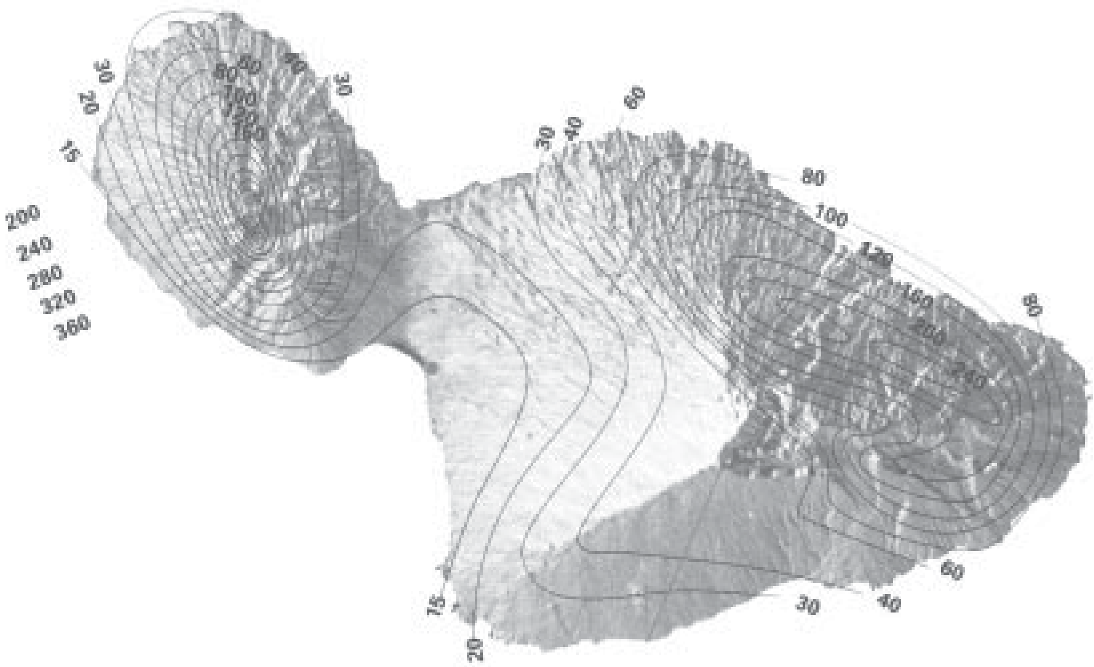
Use the maps provided in this activity sheet to answer the following questions:

1) Where does most of the rainfall occur on Maui? on Haleakalā? What might explain that pattern?

2) Rain forests generally occur where annual rainfall is greater than 203 centimeters (80 inches) per year. According to the rainfall map, what parts of Maui get enough rain to support a rain forest? (Draw an outline on the rainfall map of where you would expect to find rain forests.)

3) Other than rainfall, what other characteristics do you expect to find in the area where you think the rain forests would be? (Use all the maps provided for information.)

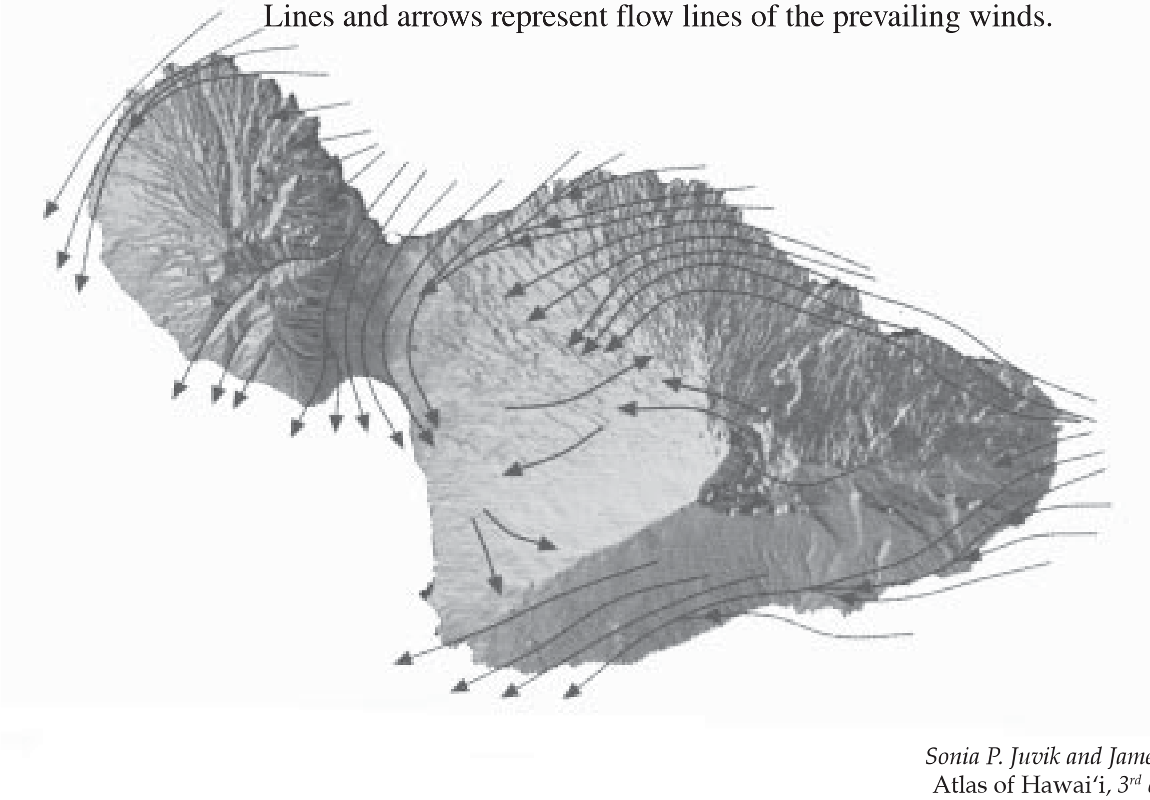
Average Annual Rainfall on Maui (inches)



Sonia P. Juvik and James O. Juvik (eds.),
Atlas of Hawai'i, *3rd ed., University of*
Hawai'i Press, Honolulu, 1998.

Prevailing Wind Patterns on Maui

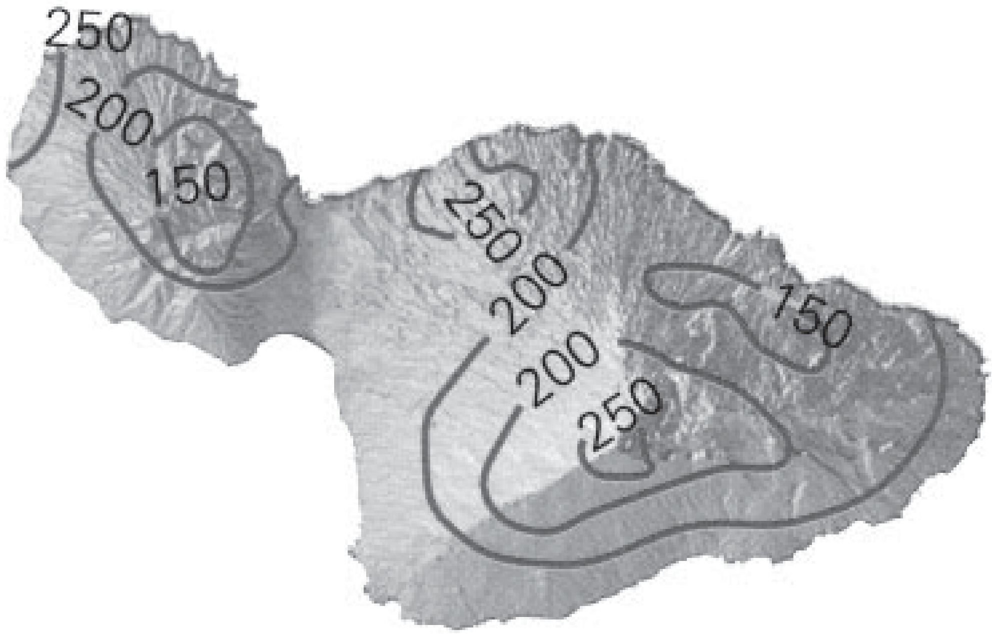
Lines and arrows represent flow lines of the prevailing winds.



Sonia P. Juvik and James O. Juvik (eds.),
Atlas of Hawai'i, *3rd ed., University of*
Hawai'i Press, Honolulu, 1998.

Average Annual Solar Radiation Intensity (Watts/Meter^2)

Solar radiation is the amount of energy from the sun
that reaches the surface of the earth.



Sonia P. Juvik and James O. Juvik (eds.),
Atlas of Hawai'i, *3rd ed., University of Hawai'i Press, Honolulu, 1998.*

Why Does It Rain on the Rain Forest?

Over the open ocean near Maui, between 56 and 71 centimeters (22-28 inches) of rain falls in an average year. In 1994, a rain gauge placed at 1650 meters (5412 feet) in the rain forest on the windward flank of Haleakalā measured more than 14 meters (45.92 feet or 551 inches) of rainfall *in one year*! What accounts for this difference?

One factor that accounts for this difference is Haleakalā itself. Trade winds blowing across the ocean from the northeast hit the mountain broadside and are forced upward. Some of the wind is deflected to the sides, flowing around the mountain. But much of the moist air is forced up the mountain's steep slopes in a phenomenon known as "orographic lifting." As the air travels upward it cools. As it reaches the "dew point," or condensation point, clouds form along the mountain slope. The moisture from these clouds and the "orographic rain" that falls from them is what accounts for the rain forest climates on windward Haleakalā.

The elevation at which clouds begin to form is called the "lifting-condensation level." In other words, this is the level at which air that is orographically lifted reaches its condensation point.

So now you know how the clouds are formed that make the rain that enables the rain forest to thrive. There is more to the picture, though, if you want to understand why the rain forest occurs in a belt along the northeastern flank of Haleakalā. Why isn't there rain forest all the way to the summit?

The answer to that question has to do with the trade wind "inversion layer." When the rising and cooling clouds meet the warm descending air in the Hadley Cell (see Figure 2, p. 31), the inversion layer is formed. The warm air overlying the

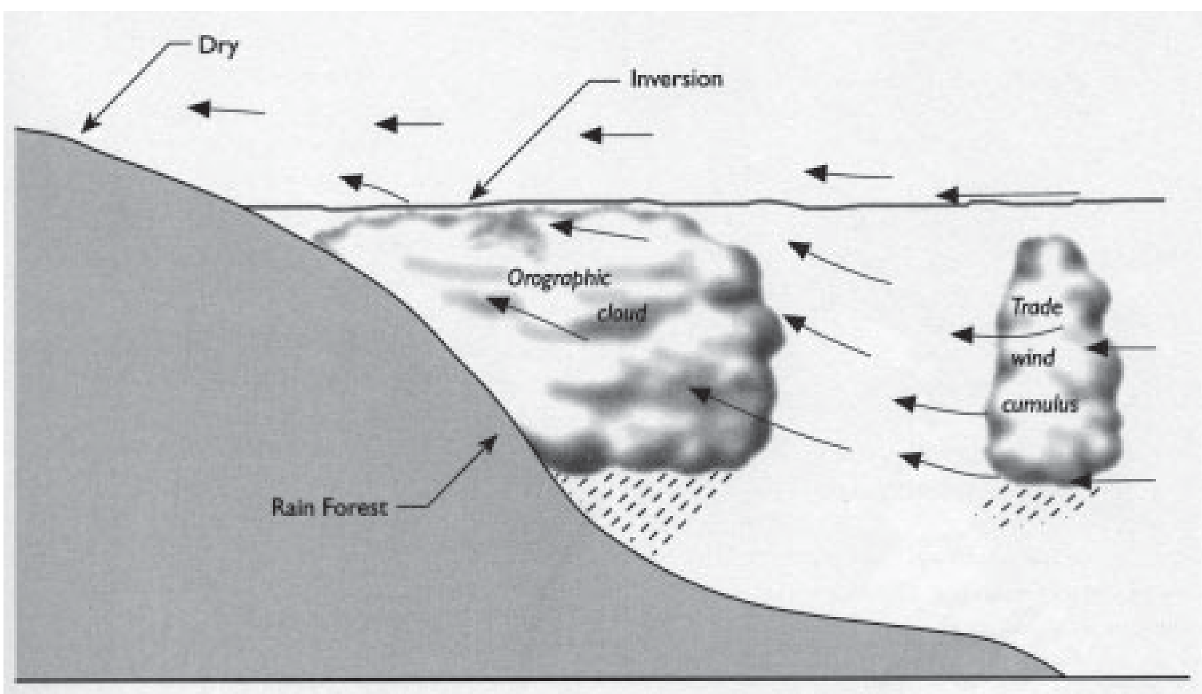


Figure 1: General weather patterns on windward Haleakalā (Marie Sanderson (ed.), Prevailing Trade Winds, *University of Hawai'i Press, Honolulu, 1993.)*

cooler air forms a barrier to clouds—any cloud that is forced through the inversion layer rapidly evaporates in the dry air above it.

Figure 1 (p. 30) illustrates the general pattern of trade wind weather on windward Haleakalā.

The clouds and rainfall are restricted to elevations below the level of the inversion layer. On windward Haleakalā, a good way to estimate the typical elevation of the inversion layer is to look at the upper limits of the rain forest, which are at about 1900 meters (6232 feet).

Before humans settled on Maui, the native rain forest extended all the way to the coastline along much of the northeast coast of Haleakalā. This entire area receives more than enough rain to support a rain forest. Now, however, in most of the lower elevation areas, there are only scattered remnants of native rain forest. It is still wet and lush, as a drive along the Hāna Highway will prove. But ever since the time of Polynesians, these lower reaches of the rain forest have been favored for human settlement, farming, and other activities. This activity has dramatically changed the ecosystem from one dominated by native rain forest species to one dominated by nonnative rain forest species. In some areas, such as around Hāna, the native rain forest did not extend all the way to the coast, even before human settlement. Looking at the rainfall map will show you one reason why this is the case.

Use the information and graphics provided in this article along with what you already know to answer the following questions about how the interaction of climate and topography forms the limits to the rain forest on Haleakalā.

The Hadley Cell

The Hadley Cell is a part of the large-scale circulation of the earth's atmosphere. Warm air rises near the equator and moves toward the north pole at high altitudes. As it reaches 30° N latitude, the air sinks and circulates back toward the equator completing the Hadley Cell.

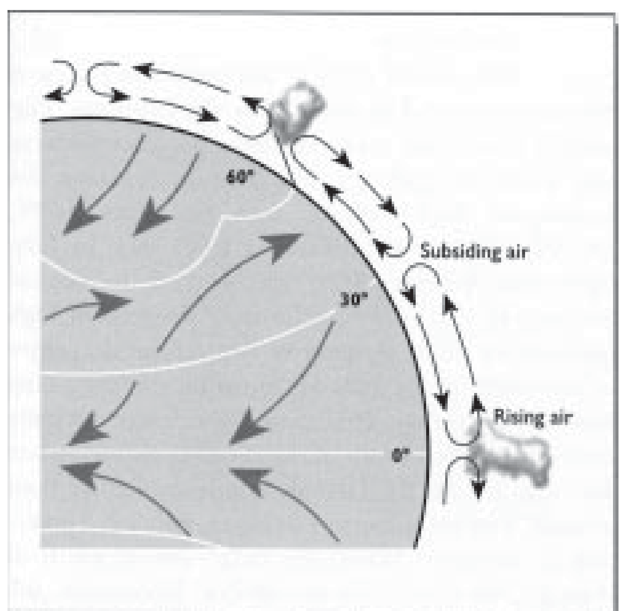


Figure 2: Idealized Hadley Cell, showing vertical and horizontal wind patterns (Marie Sanderson (ed.), Prevailing Trade Winds, *University of Hawai'i Press, Honolulu, 1993.)*

Questions

1) On Figure 1of the reading (p. 30):
   a) Indicate the approximate altitude of the inversion layer.
   b) Draw a line indicating the approximate lower limits of the rain forest.

2) Would the native rain forest extend all the way to sea level in this image? Why or why not?

3) Part of the rain forest on Haleakalā is a zone called the “cloud forest.” The cloud forest zone is almost always enshrouded in clouds that hug the side of the mountain. It gets moisture directly from the clouds as well as from rainfall. On Haleakalā, the cloud forest zone is between about 1000 meters (3280 feet) and 1900 meters (6232 feet).
   How do you think the lower limit of the cloud forest zone relates to the lifting-condensation level?

4) On Figure 1 of the reading (p. 30), draw a line that indicates the approximate lifting condensation level. If you are able to estimate the elevation of that level, do so on Figure 1 and explain your reasoning below. If you are not able to estimate its elevation, what additional information do you need?

5) Would the lifting-condensation level always be at exactly the same elevation? Explain your reasoning.

6) *‘Ōhi‘a* (*Metrosideros polymorpha*) and *koa* (*Acacia koa*) are the two main tree species in the rain forest canopy on Haleakalā. *‘Ōhi‘a* tends to dominate in the wettest part of the rain forest. *Koa* tends to dominate where it is drier, sometimes in a mixed-species canopy along with *‘ōhi‘a*. More commonly, the *koa* will grow taller than the *‘ōhi‘a*, sometimes forming a distinct upper canopy layer above the *‘ōhi‘a*.

On Figure 1 of the reading (p. 30), indicate where you expect *‘ōhi‘a* to be the dominant tree in the rain forest and where you would expect *koa* to dominate. Is there any place where the two species might co-dominate? Explain your reasoning below.