NATIONAL WEATHER SERVICE (http://www.weather.gov)
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

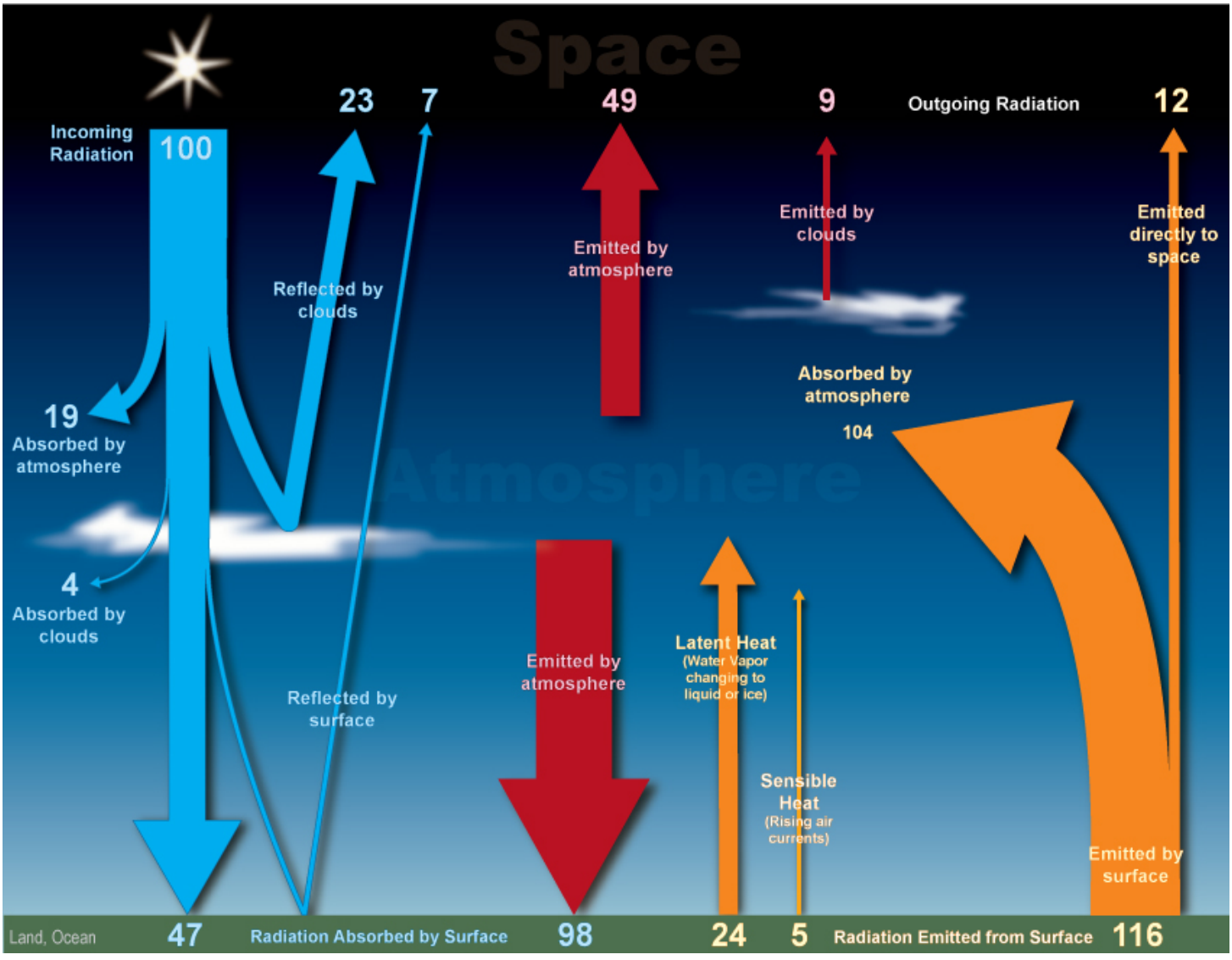
The Earth-Atmosphere Energy Balance

The earth-atmosphere energy balance is the balance between incoming energy from the Sun and outgoing energy from the Earth. Energy released from the Sun is emitted as shortwave light and ultraviolet energy. When it reaches the Earth, some is reflected back to space by clouds, some is absorbed by the atmosphere, and some is absorbed at the Earth's surface.

Learning Lesson: Canned Heat (ll_cannedheat)

However, since the Earth is much cooler than the Sun, its radiating energy is much weaker (long wavelength) infrared energy. We can indirectly see this energy radiate into the atmosphere as heat, rising from a hot road, creating shimmers on hot sunny days.

The earth-atmosphere energy balance is achieved as the energy received from the Sun *balances* the energy lost by the Earth back into space. In this way, the Earth maintains a stable average temperature and therefore a stable climate. Using 100 units of energy from the sun as a baseline the energy balance is as follows:



At the top of the atmosphere - Incoming energy from the sun balanced with outgoing energy from the earth.

Incoming energy		Outgoing energy	
Units	**Source**	**Units**	**Source**
+100	Shortwave radiation from the sun.	-23	Shortwave radiation reflected back to space by clouds.
		-7	Shortwave radiation reflected to space by the earth's surface.
		-49	Longwave radiation from the atmosphere into space.
		-9	Longwave radiation from clouds into space.
		-12	Longwave radiation from the earth's surface into space.
+100	Total Incoming	-100	Total Outgoing

The atmosphere itself - Energy into the atmosphere is balanced with outgoing energy from atmosphere.

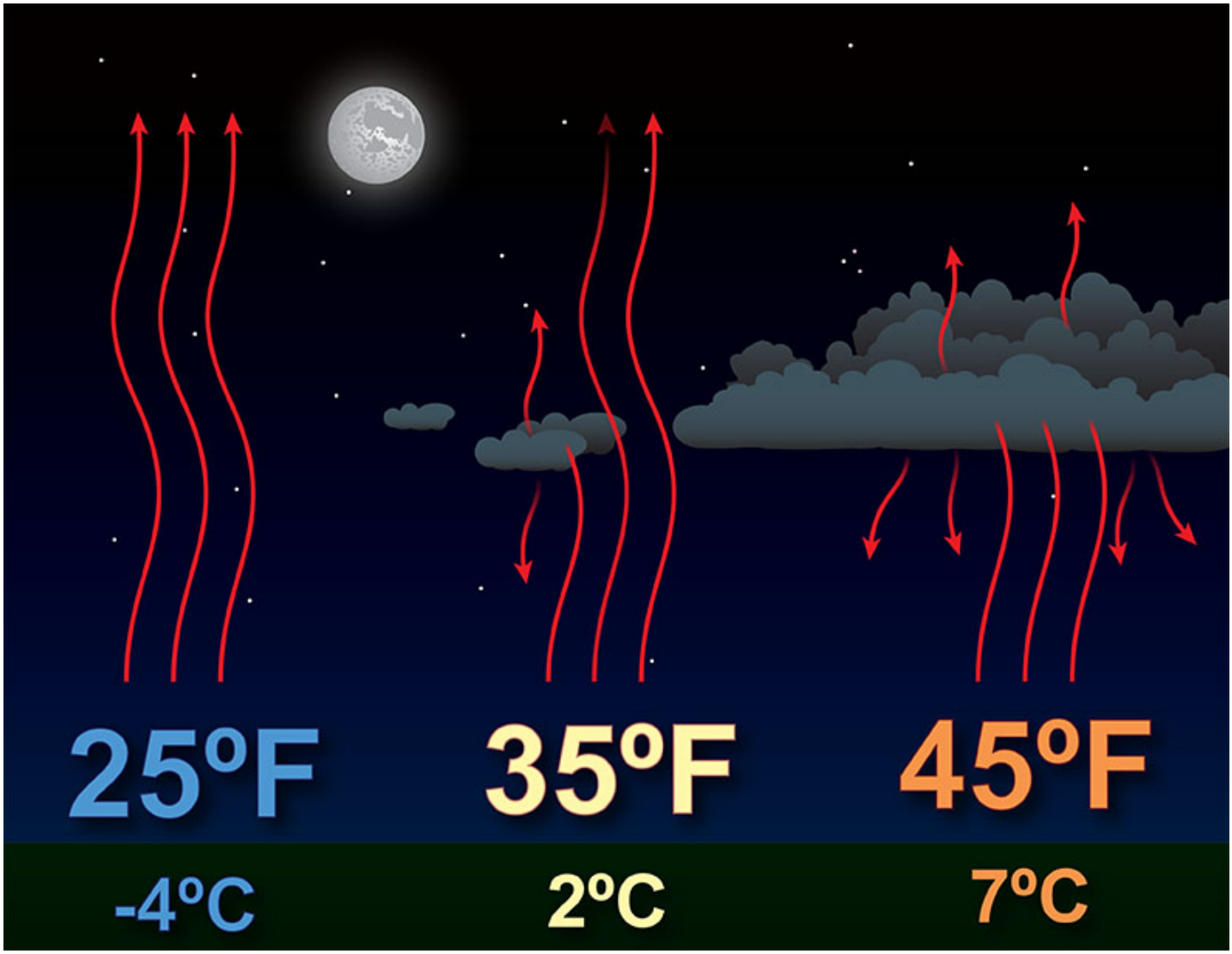
Incoming energy		Outgoing energy	
Units	**Source**	**Units**	**Source**
+19	Absorbed shortwave radiation by gases in the atmosphere.	-9	Longwave radiation emitted to space by clouds.
+4	Absorbed shortwave radiation by clouds.	-49	Longwave radiation emitted to space by gases in atmosphere.
+104	Absorbed longwave radiation from earth's surface.	-98	Longwave radiation emitted to earth's surface by gases in atmosphere.
+5	From convective currents (rising air warms the atmosphere).		
+24	Condensation /Deposition of water vapor (heat is released into the atmosphere by process).		
+156	Total Incoming	-156	Total Outgoing

At the earth's surface - Energy absorbed is balanced with the energy released.

Incoming energy		Outgoing energy	
Units	**Source**	**Units**	**Source**
+47	Absorbed shortwave radiation from the sun.	-116	Longwave radiation emitted by the surface.
+98	Absorbed longwave radiation from gases in atmosphere.	-5	Removal of heat by convection (rising warm air).
		-24	Heat required by the processes of evaporation and sublimation and therefore removed from the surface.
+145	Total Incoming	-145	Total Outgoing

The absorption of infrared radiation trying to escape from the Earth back to space is particularly important to the global energy balance. Energy absorption by the atmosphere stores more energy near its surface than it would if there was no atmosphere.

The average surface temperature of the moon, which has no atmosphere, is 0°F (-18°C). By contrast, the average surface temperature of the Earth is 59°F (15°C). This heating effect is called the greenhouse effect.



Greenhouse warming is enhanced during nights when the sky is overcast. Heat energy from the earth can be trapped by clouds leading to higher temperatures as compared to nights with clear skies. The air is not allowed to cool as much with overcast skies. Under partly cloudy skies, some heat is allowed to escape and some remains trapped. Clear skies allow for the most cooling to take place.