2. Humidity, Comfort and the Weather

Humidity and Comfort

To ensure that it functions properly, the human body has a system that controls its temperature very precisely (*homeostasis*), i.e., within a range of only 1ºC, i.e., 36 to 37 ºC. The effects of temperatures outside these limits on the human body can range from mild discomfort to death. For example, *fever* is attained at body temperatures greater then 37ºC and at temperatures greater than 40ºC, the dangerous state of *hyperthermia* is reached. The first signs are irritability, headache, dizziness or vertigo, mental confusion and loss of motor coordination. The body tries to decrease its temperature by means of *transpiration*, and this leads to loss of water, which -- in turn -- results in increased blood viscosity, that may produce a heart attack. Above 41.5ºC brain damage occurs. A dramatic example of such an occurrence is the more than 10,000 deaths in France, in the summer of 2003, attributed to the many days of temperatures of 40ºC with – most likely – even higher indoor temperatures.

On the other extreme, the state of *hypothermia* is reached when the body temperature is below 35ºC. In this state, the nervous system loses the capacity of temperature regulation, the heartbeat frequency decreases, respiration is slower and blood vessels are constricted, increasing blood pressure. Loss of consciousness (fainting), cooling of body extremities and heart failure may occur.

An important mechanism that the body uses to keep its temperature under control is the *transpiration* that not only keeps the skin moist, but also by bringing water to the surface of the body, helps water evaporate, a process that results in the cooling of the body. It must be kept in mind that the rate of evaporation depends directly on the air humidity. If the humidity is high -- more than 70% -- the evaporation is slow, and the body feels hard to regulate its temperature, This slowdown of evaporation is responsible for the sensation of higher temperatures with increased humidity. Vice-versa, at low humidity -- less than 30% -- the sensation is of lower temperatures because the skin cools faster.

Problems due to humidity	
Too much humidity (> 70%)	**Too little humidity (< 30%)**
Condensation on windows	**Chapped skin and lips**
Wet stains on walls and ceilings	**Asthma or bronchitis attack**
Moldy bathroom	**Scratchy nose and throat**
Musty smells	**Breathing problems**
Problems with electronic equipment	**Static and electrical sparks**
Fast rusting of iron materials	**Increased chance of fire**
Hotness sensation	**Coolness sensation**
Irregular deformation of hygroscopic materials (e.g. paper)	
Damage to furniture and other items	
Allergic reactions	
Discomfort	

To reduce indoor humidity, air-conditioning equipment and dehumidifiers are used, whereas water vaporizers (humidifiers) are used to increase it. Humidity is measured by humidity meters (hygrometers, psychrometers).

In the temperate and cold regions of the globe, during the cold periods of the year, the outdoor temperatures go below 0ºC and the water content of the air is low. To maintain a comfortable indoor temperature, heating is required, and humidifiers are used to bring the indoor humidity to comfortable levels.

Indicators of comfortable levels of temperature and humidity has been proposed. For example, a "Temperature-Humidity Index" (THI), developed by the U.S. National Weather Service, gives a single numerical value as a measure of comfort (or discomfort), based on the readings of the dry bulb temperature (ambient temperature) and the wet bulb temperature of a psychrometer (humidity meter). The THI is defined as follows:

THI = 40.6 + 0.72 (dry-bulb temperature ºC + wet-bulb temperature ºC)
THI = 15.0 + 0.40 (dry-bulb temperature ºF + wet-bulb temperature ºF)

The table below is an example of a usual indicator of thermal comfort (from NOAA).

It must be noted that "comfort" is a subjective concept. For example, while 30ºC could be acceptable for an inhabitant of Sao Paulo (Brazil), it would be very uncomfortable for an Inuit from the Northern part of Canada. The same could be said about humidity: People living near beaches are accustomed to higher humidity levels than those living at higher altitudes. It seem that at latitudes of 20º to 50º, near sea level, the acceptable levels of temperature are 20ºC to 30ºC, and 30% to 70% for humidity. For comparison, the temperature in commercial airplanes while in flight, is kept around 20ºC.

Humidity and the Weather

Water makes possible the life on Earth (see the "Water Cycle" below). On average, of the total rainfall, 25% falls on land and 75% into the oceans. Each human being receives an average 44 cubic meters of rainfall each day.

Heat Index

Temperature & Humidity

SOURCE: http://www.srh.noaa.gov/fwd/media/media/appendix/hindexthf.htm

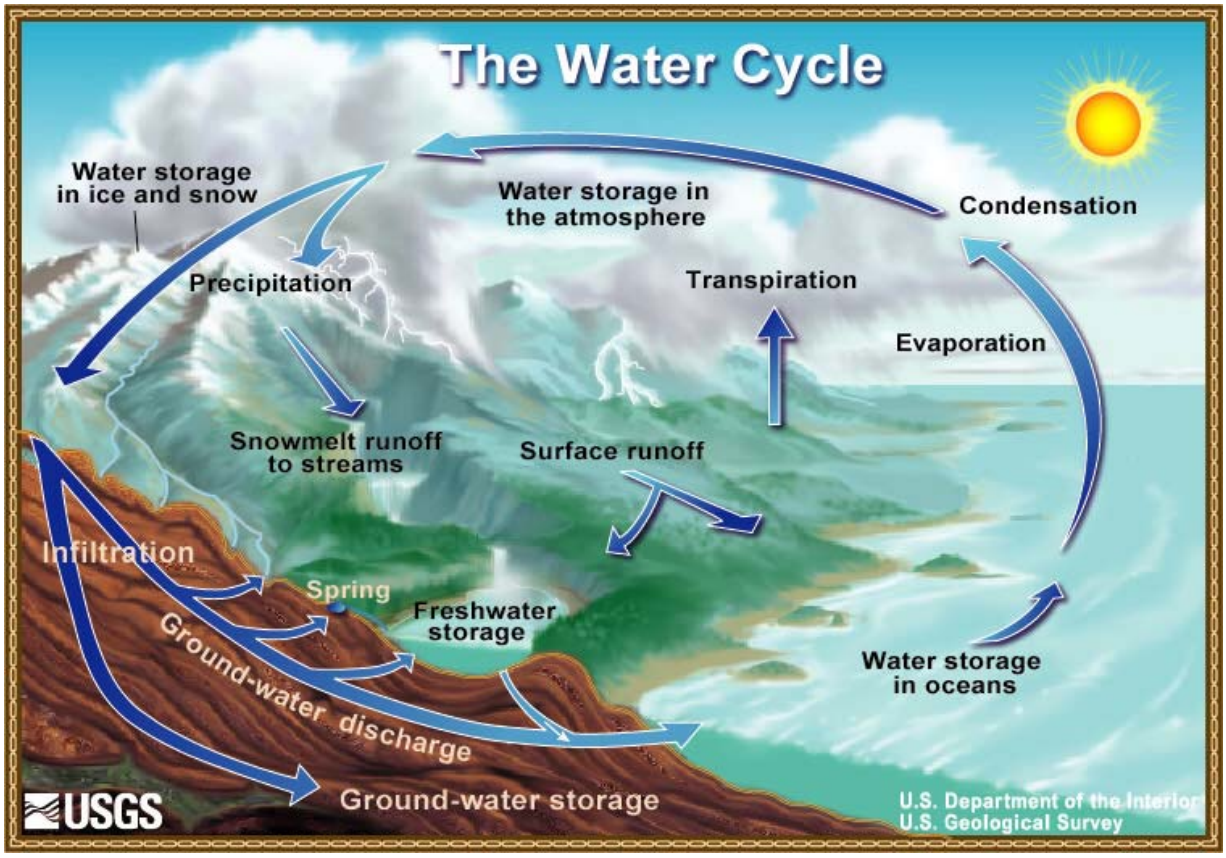
Heat Index	Possible Heat Disorder
130°F or greater	Heat stroke highly likely with continued exposure.
105°F to 129°F	Sunstroke, heat cramps, and heat exhaustion likely, and heatstroke possible.
90°F to 104°F	Sunstroke, heat cramps and heat exhaustion possible.
80°F to 89°F	Fatigue possible with prolonged exposure and physical activity.
< 80°F	Comfortable

Air °C	Air °F	Relative Humidity (%)																				Air °F	Air °C
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100		
51.7	125	107	114	122	130	140	151																125	51.7
48.9	120	105	110	116	122	130	139	148															120	48.9
46.1	115	103	106	110	115	121	127	135	143														115	46.1
45.6	114	102	105	109	113	119	125	132	140														114	45.6
45.0	113	102	104	108	112	117	123	129	137	145													113	45.0
44.4	112	101	104	107	111	115	121	127	134	142													112	44.4
43.9	111	101	103	106	109	114	119	125	131	139	147												111	43.9
43.3	110	100	102	105	108	112	117	122	129	136	143												110	43.3
42.8	109	100	101	104	107	110	115	120	126	133	140												109	42.8
42.2	108	99	101	103	105	109	113	118	124	130	137	144											108	42.2
41.7	107	99	100	102	104	107	111	116	121	127	134	141											107	41.7
41.1	106	98	99	101	103	106	109	114	119	124	130	137	145										106	41.1
40.6	105	97	98	100	102	104	108	112	116	122	127	134	141										105	40.6
40.0	104	97	97	99	100	103	106	110	114	119	124	131	137	145									104	40.0
39.4	103	96	97	98	99	102	104	108	112	116	122	127	134	141									103	39.4
38.9	102	96	96	97	98	100	103	106	110	114	119	124	130	137	144								102	38.9
38.3	101	95	95	96	97	99	101	104	108	112	116	121	127	133	140								101	38.3
37.8	100	94	94	95	96	98	100	102	106	109	114	118	124	130	136	143							100	37.8
37.2	99	93	93	94	95	96	98	101	104	107	111	116	121	126	132	139	146						99	37.2
36.7	98	92	92	93	94	95	97	99	102	105	109	113	117	123	128	134	141						98	36.7
36.1	97	92	92	92	93	94	95	97	100	103	106	110	115	119	125	130	136	143					97	36.1
35.6	96	91	91	91	92	93	94	96	98	101	104	108	112	116	121	126	132	138	145				96	35.6
35.0	95	89	90	90	91	92	93	94	97	99	102	105	109	113	118	123	128	134	140				95	35.0
34.4	94	88	89	89	90	90	92	93	95	97	100	103	106	110	114	119	124	129	135	141			94	34.4
33.9	93	88	88	89	89	89	90	92	93	95	98	101	104	107	111	116	120	125	131	136	142		93	33.9
33.3	92	87	87	88	88	88	89	90	92	94	96	99	101	105	108	112	116	121	126	131	137	143	92	33.3
32.8	91	86	87	87	87	87	88	89	91	92	94	97	99	102	105	109	113	117	122	127	132	137	91	32.8
32.2	90	85	85	86	86	86	87	88	89	91	93	95	97	100	103	106	110	113	118	122	127	132	90	32.2
29.4	85	81	82	82	82	82	82	83	84	84	85	87	88	89	91	93	95	97	99	102	104	107	85	29.4
26.7	80	77	78	78	78	79	79	79	80	80	80	81	81	82	82	83	84	84	85	86	86	87	80	26.7
Air °C	Air °F	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	Air °F	Air °C
		Relative Humidity (%)																						

The clouds, the source of rain, are formed when moist air -- mostly above oceans -- become saturated at high altitudes, where the air is cool and the Dew Point -- the temperature of condensation -- is reached. The mechanism of cloud formation is complex and still not well understood. For a better insight on this subject, there is an interesting article from Environment Canada (Project Atmosphere Canada):

http://www.ec.gc.ca/edu_e.html
http://www.msc.ec.gc.ca/education/teachers_guides/module7_clouds_e.html

Recommended reading: G. Tyler Miller, Jr., "Living in the Environment", Brooks Cole Publ., 12th ed., 2002, ISBN 05 3437 6975.


The Water Cycle
Water storage in ice and snow
Precipitation
Water storage in the atmosphere
Condensation
Transpiration
Evaporation
Snowmelt runoff to streams
Surface runoff
Infiltration
Spring
Freshwater storage
Ground-water discharge
Ground-water storage
Water storage in oceans
USGS
U.S. Department of the Interior
U.S. Geological Survey