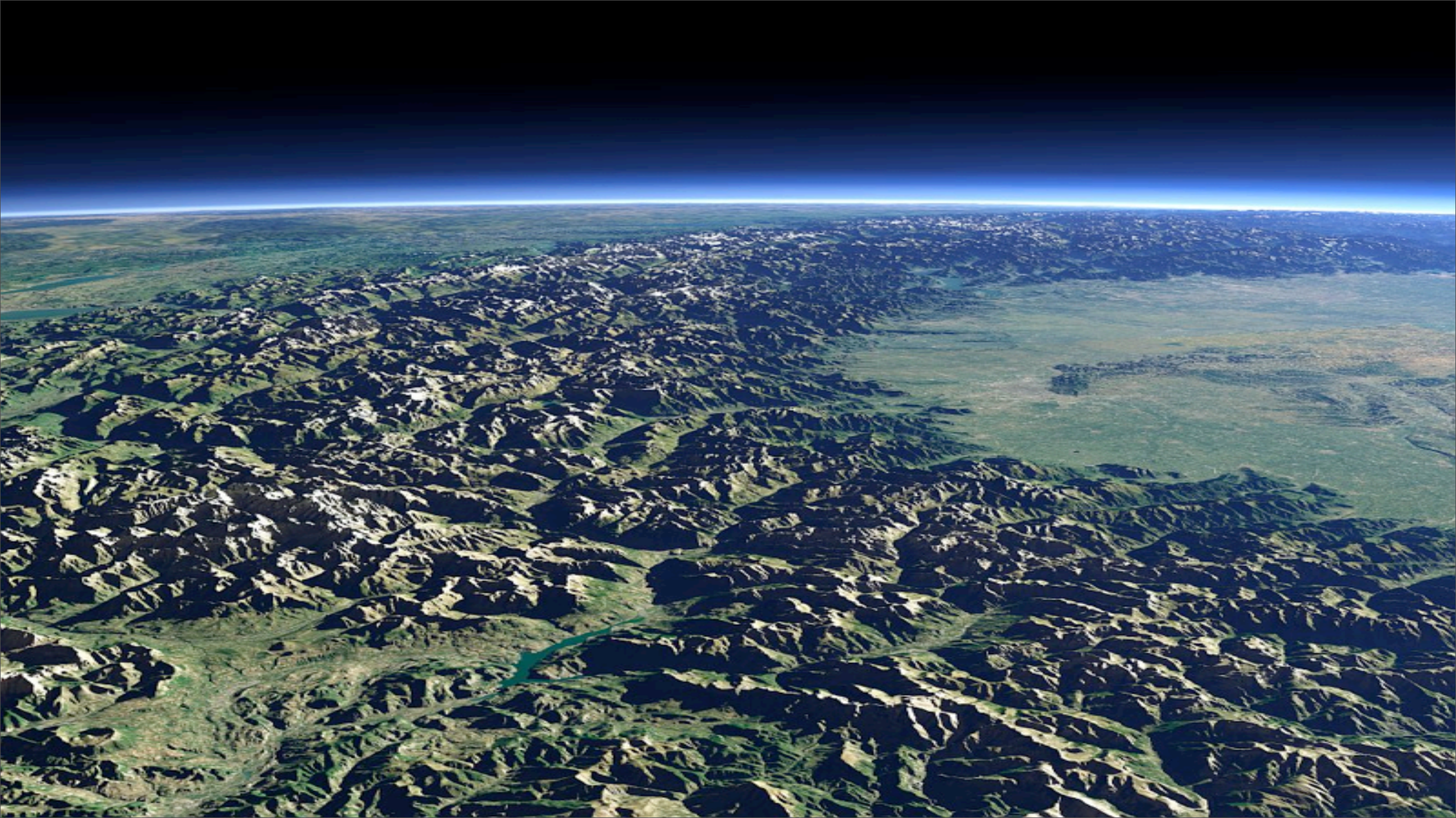
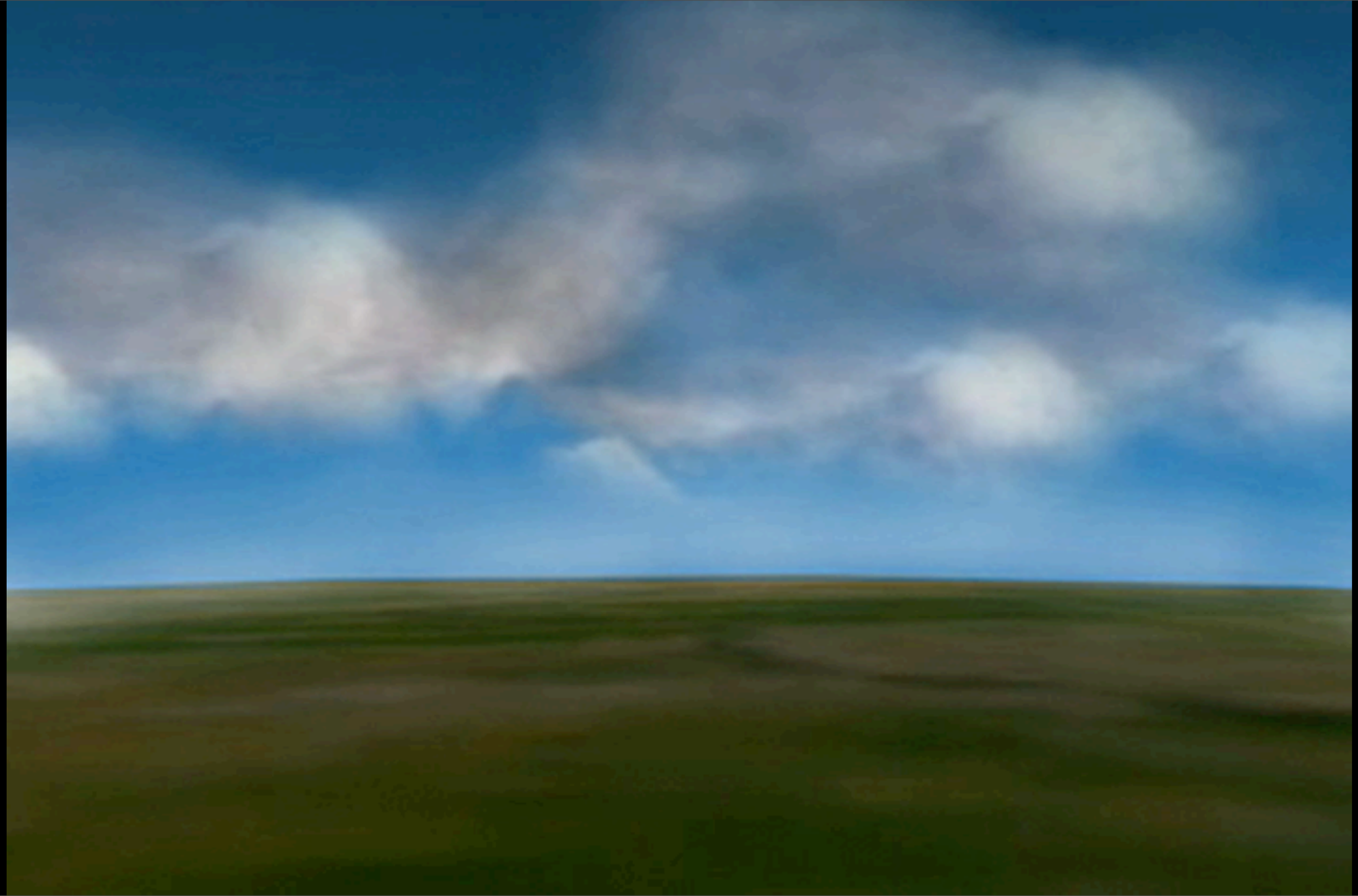


weather and climate

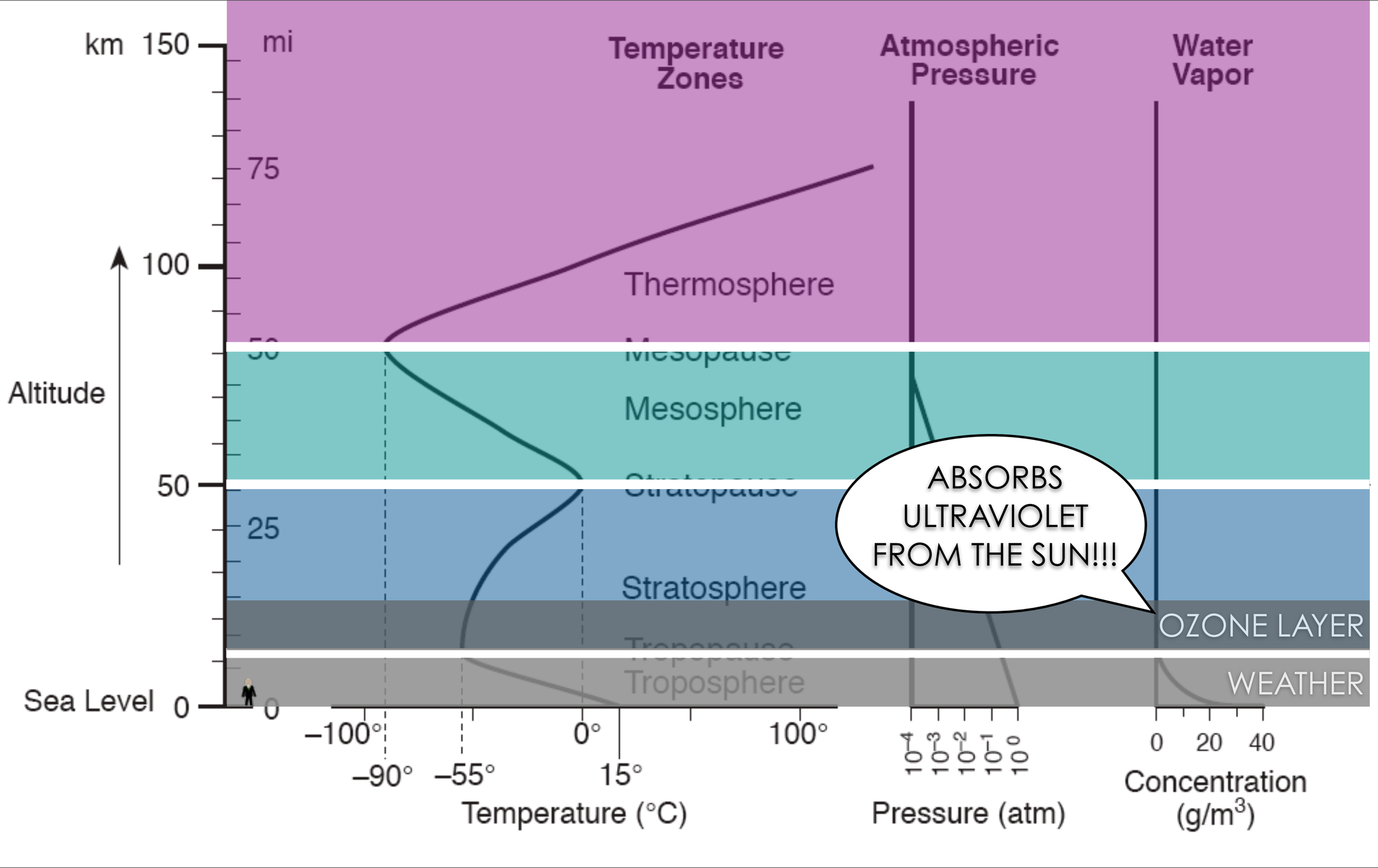
Weather is what is going on in the atmosphere in a **particular location** at a **particular time**.

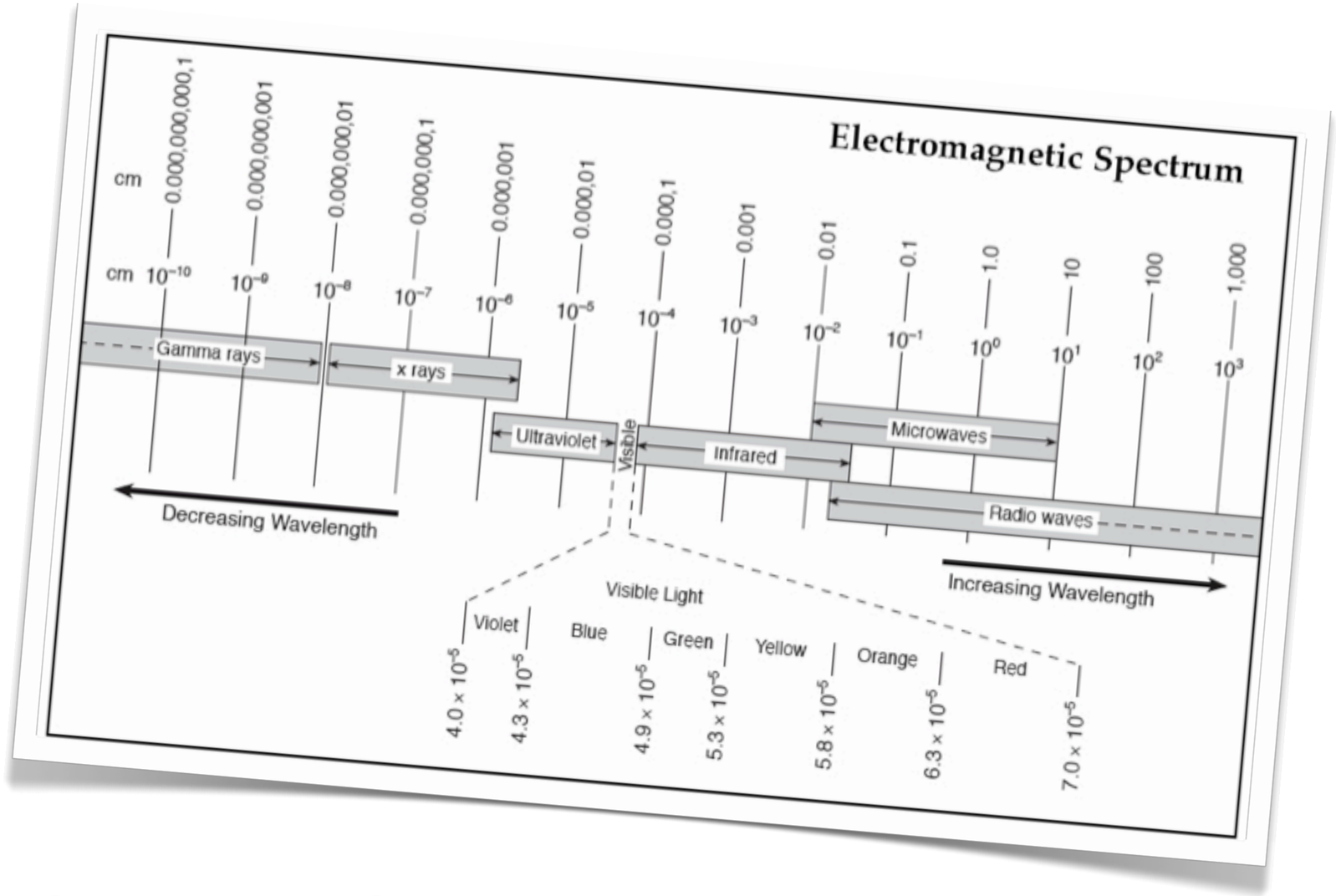




Our atmosphere formed from gasses released by volcanoes through a process known as **outgassing**.




km 150
mi
75
100
50
25
0
Altitude
Sea Level
Temperature Zones
Atmospheric Pressure
Water Vapor
Thermosphere
Mesopause
Mesosphere
Stratopause
Stratosphere
Troposphere
ABSORBS ULTRAVIOLET FROM THE SUN!!!
OZONE LAYER
WEATHER
–100°
0°
100°
–90°
–55°
15°
Temperature (°C)
10^{-4} 10^{-3} 10^{-2} 10^{-1} 10^{0}
Pressure (atm)
0 20 40
Concentration (g/m^3)



Any object with a temperature above 0°K (**absolute zero**) gives off energy



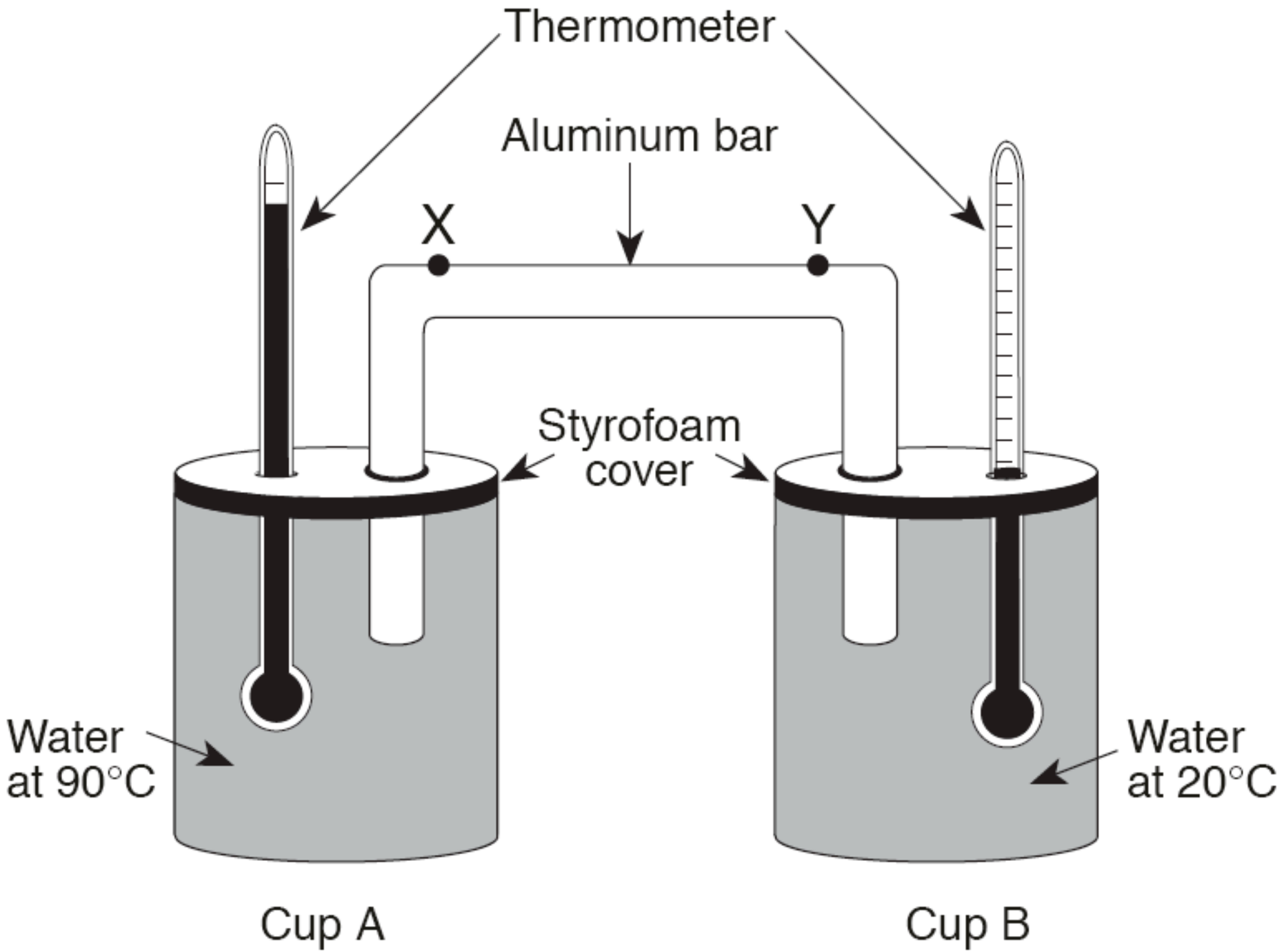
Most of the **insolation** from the Sun is in the form of **visible light**.

This energy travels from one place to another through a process called **heat transfer**.

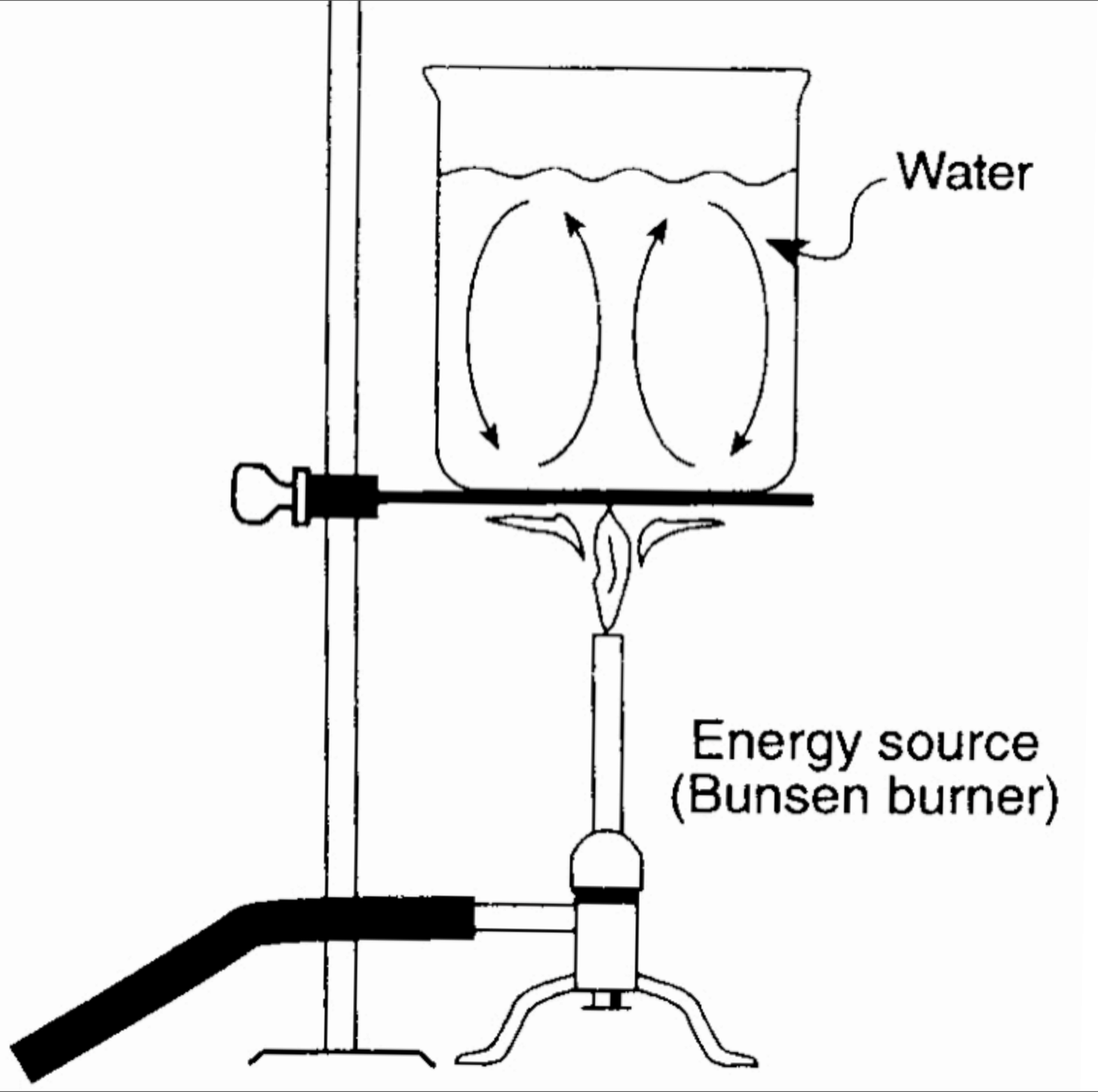
Heat Transfer

- ✓ Conduction
- ✓ Convection
- ✓ Radiation

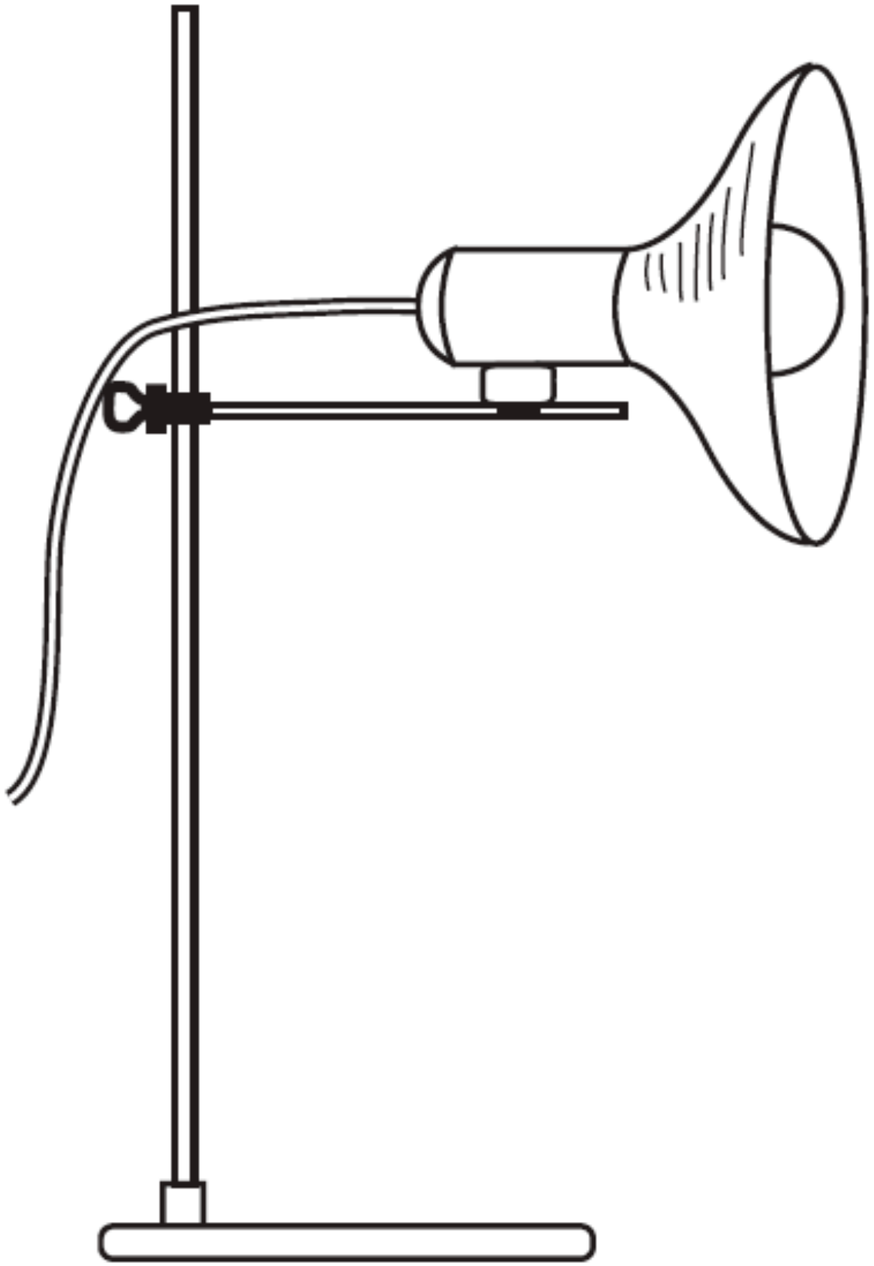
CONDUCTION

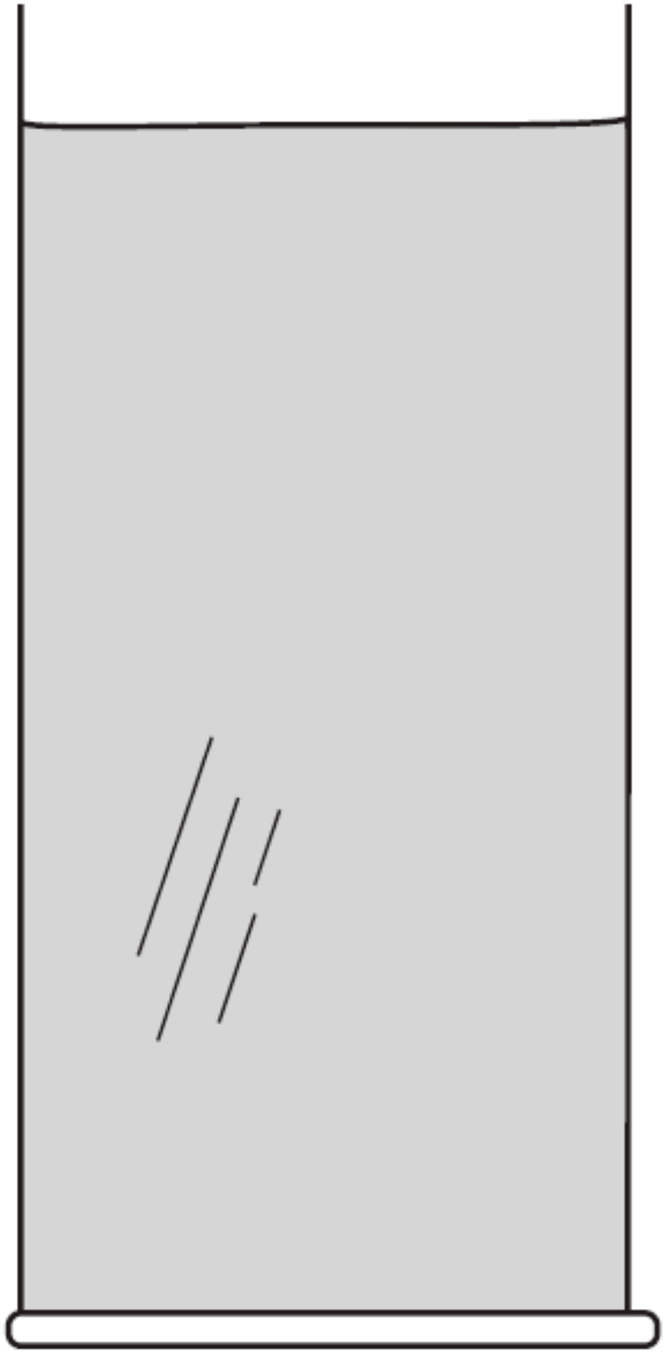

Thermometer
Aluminum bar
X
Y
Styrofoam
cover
Water
at 90°C
Water
at 20°C
Cup A
Cup B

CONVECTION



RADIATION





Key Terms

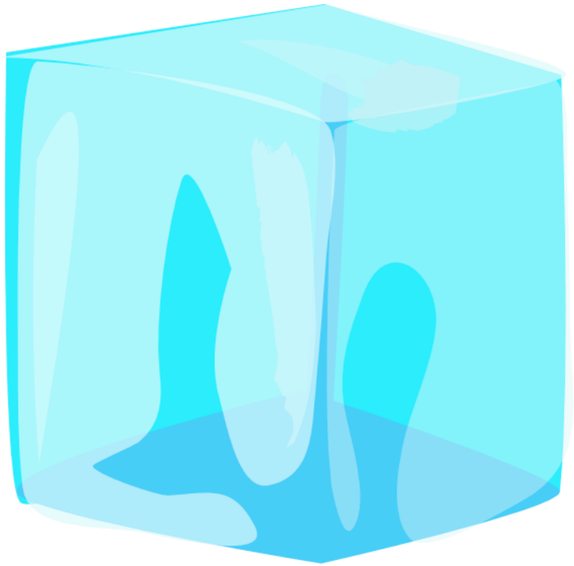
Conduction
"CONTACT"

Radiation
"WAVES"

Convection
"DENSITY"

Heat always flows from hot to cold (source to sink)



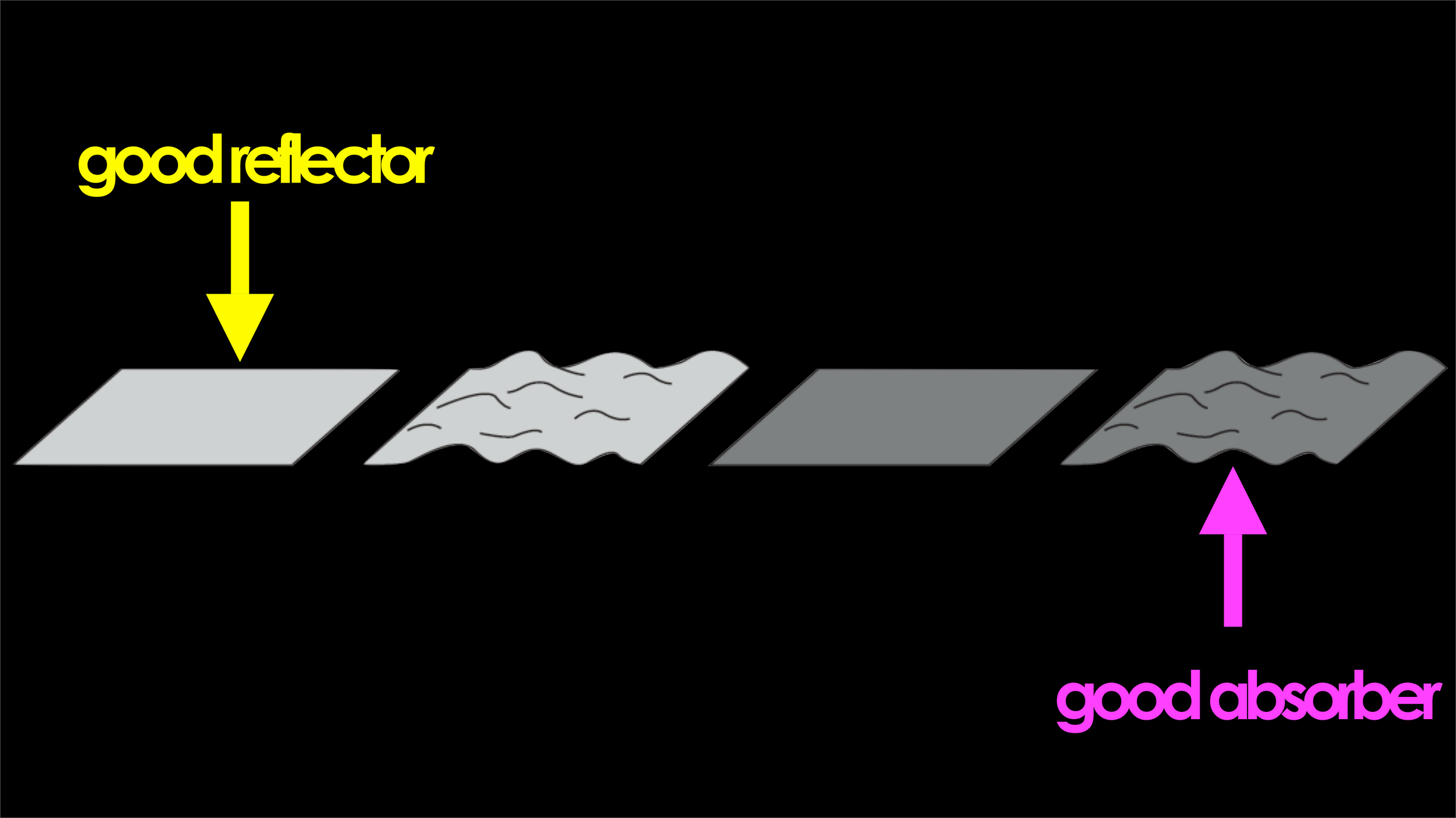


DARK and ROUGH surfaces absorb energy

(good absorber, good radiator, bad reflector)

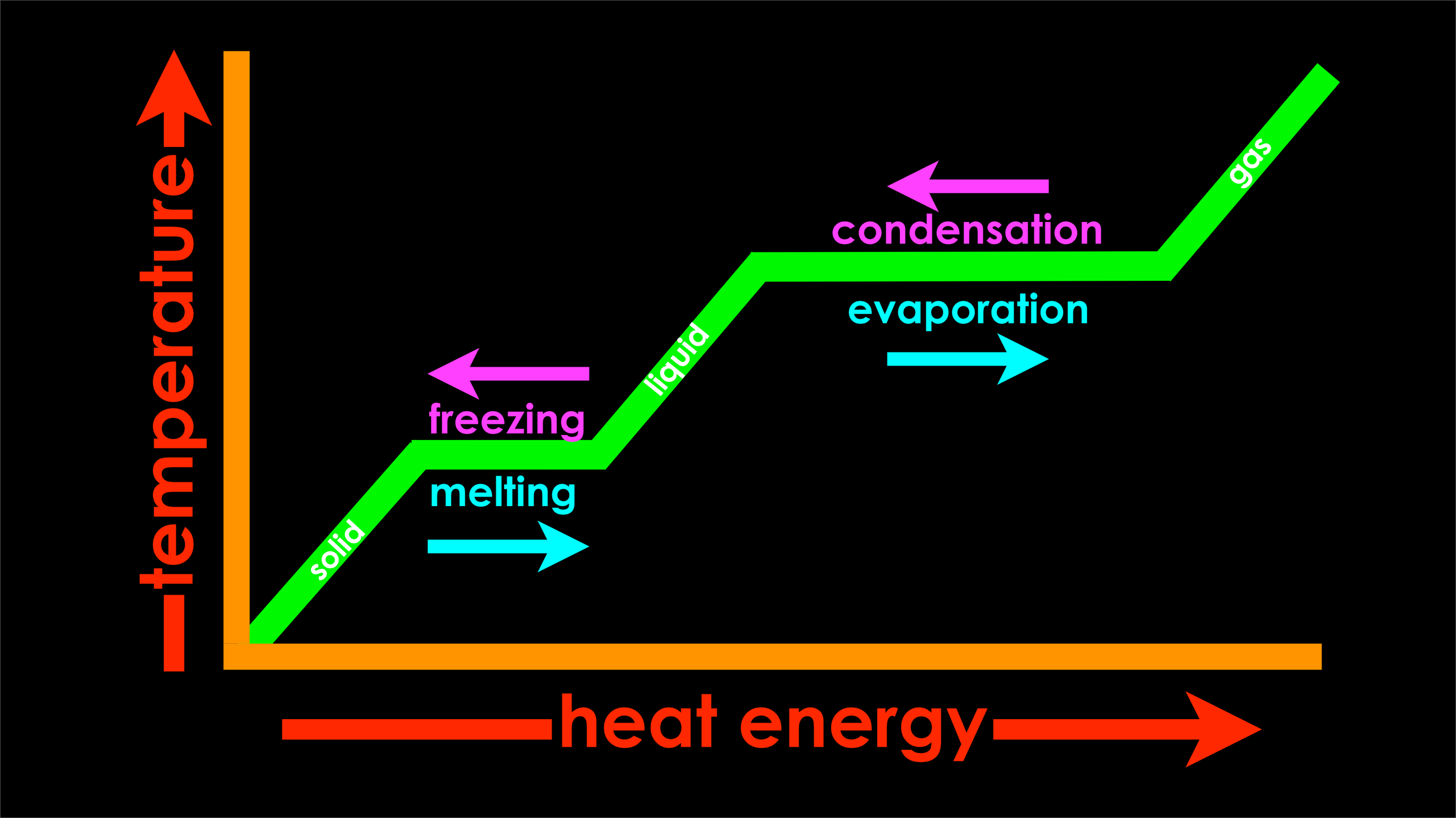
LIGHT and SMOOTH surfaces reflect energy

(good reflector, bad absorber, bad radiator)

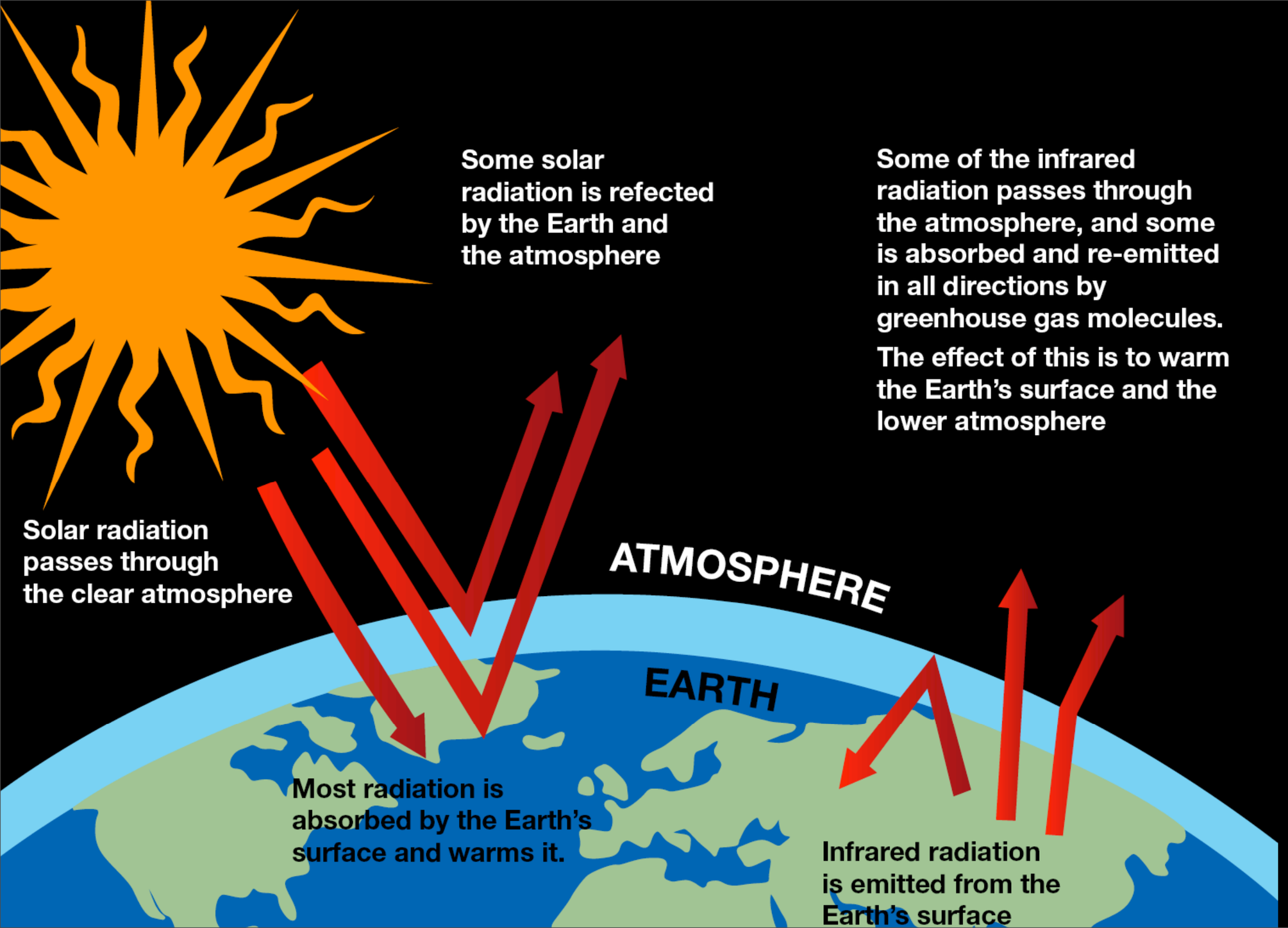

good reflector
good absorber

Properties of Water

Energy gained during melting	80 calories/gram
Energy released during freezing	80 calories/gram
Energy gained during vaporization	540 calories/gram
Energy released during condensation	540 calories/gram
Density at 3.98°C	1.00 gram/milliliter

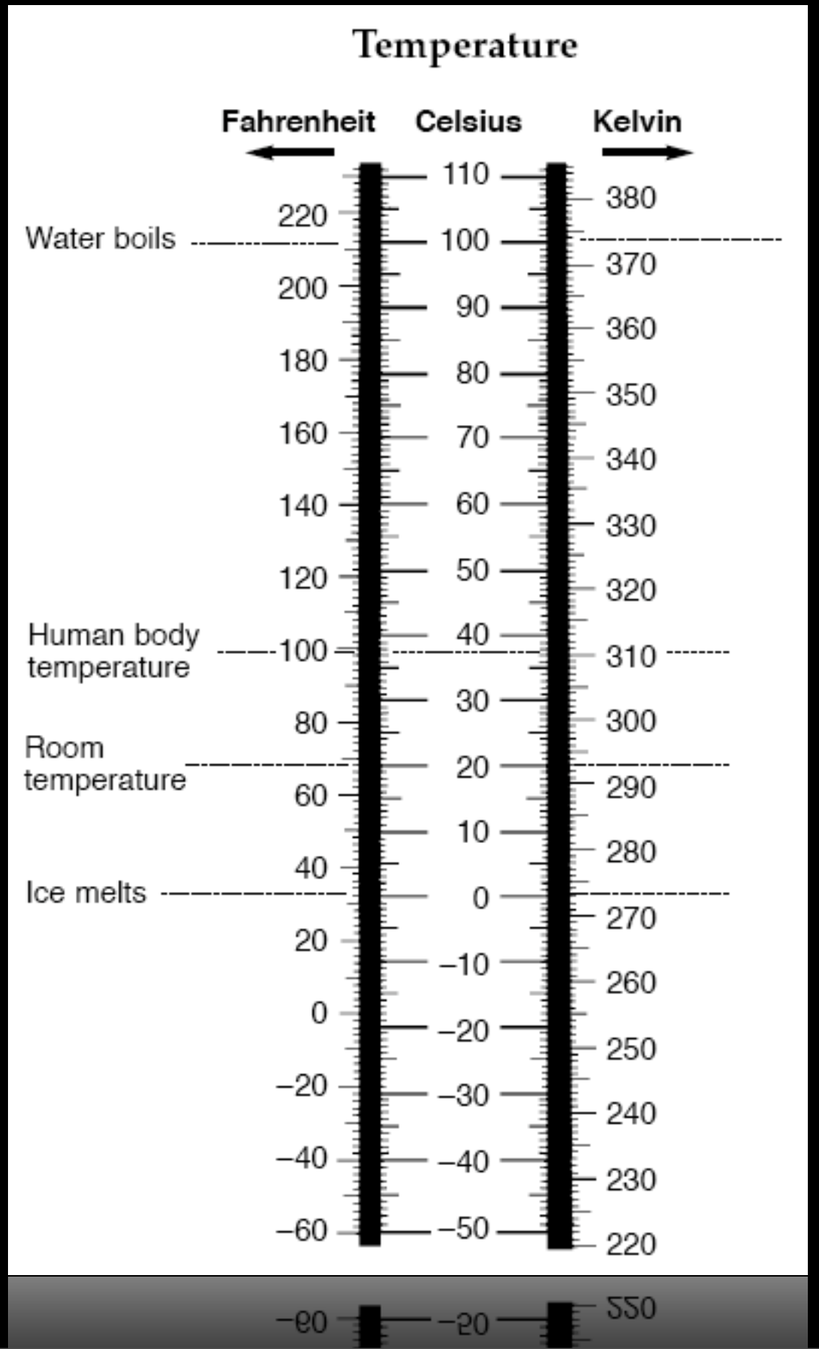

temperature
heat energy
solid
liquid
gas
freezing
melting
condensation
evaporation

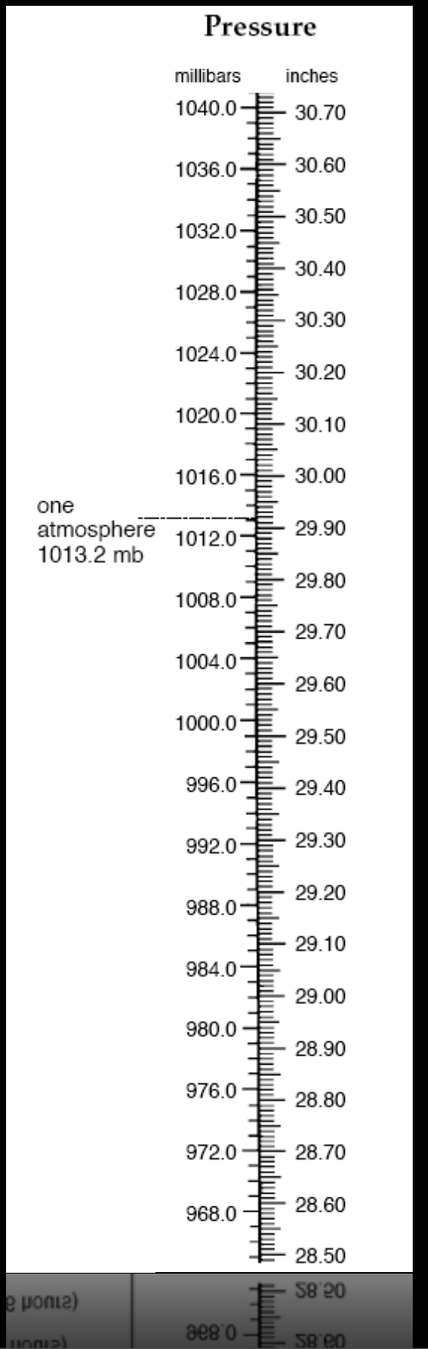
GREENHOUSE EFFECT




In as visible...
...out as infrared
Greenhouse gases ( ) absorb
the infrared, it gets hotter.
CO_2
Methane
Water Vapor

Weather Instruments

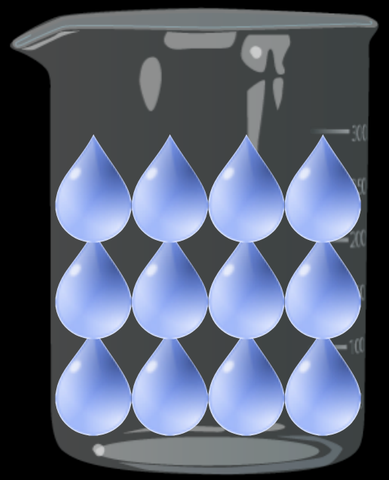

Temperature
Fahrenheit
Celsius
Kelvin
Water boils
Human body temperature
Room temperature
Ice melts
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
−50
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220


Pressure
millibars
inches
one atmosphere 1013.2 mb
1040.0
1036.0
1032.0
1028.0
1024.0
1020.0
1016.0
1012.0
1008.0
1004.0
1000.0
996.0
992.0
988.0
984.0
980.0
976.0
972.0
968.0
30.70
30.60
30.50
30.40
30.30
30.20
30.10
30.00
29.90
29.80
29.70
29.60
29.50
29.40
29.30
29.20
29.10
29.00
28.90
28.80
28.70
28.60
28.50

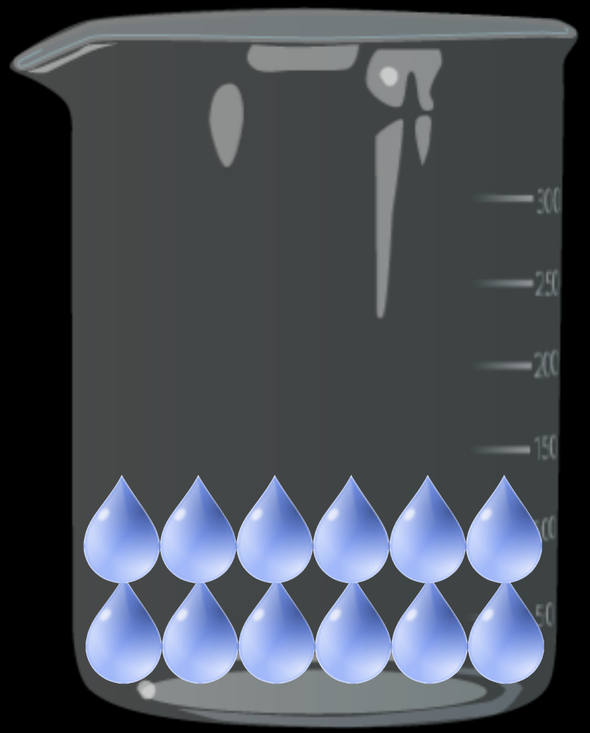
The higher the temperature, the more space there is for water vapor.

HUMIDITY…

Same absolute humidity...
but the cold air has a higher relative humidity

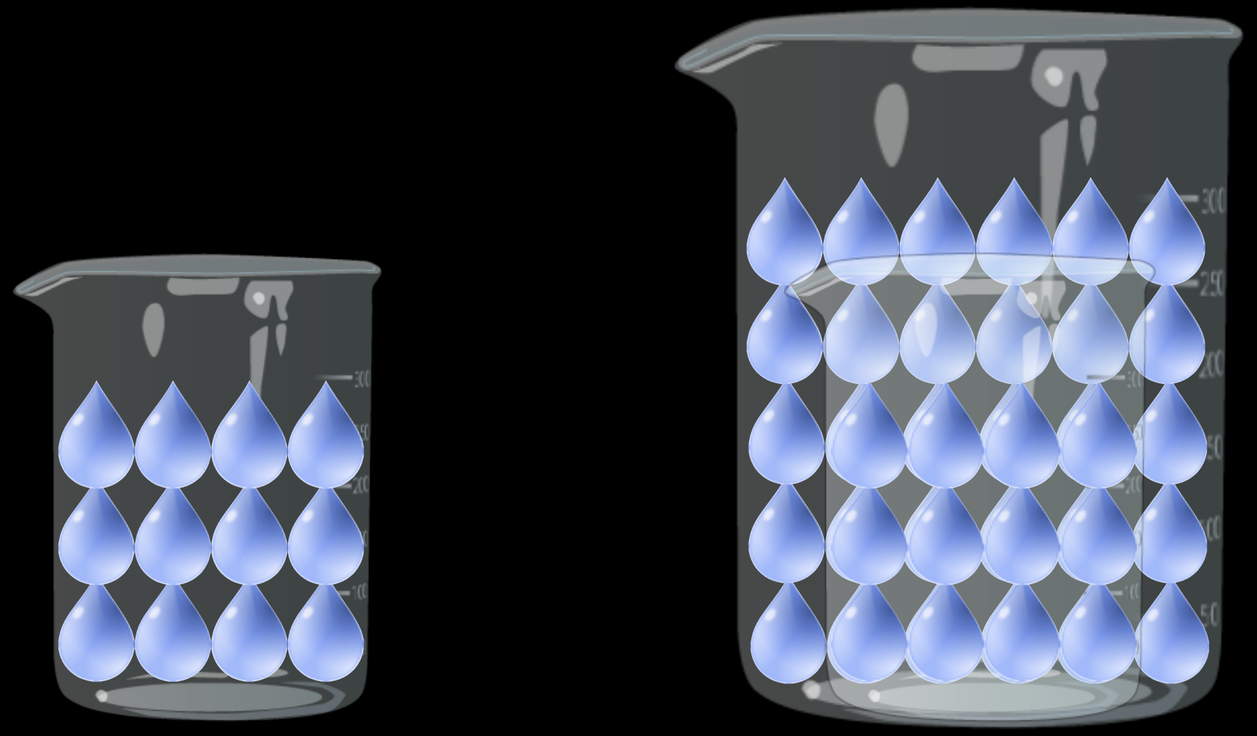


cold air



warm air

How could we change the experiment to make it more equal?



How do we calculate the relative humidity or the dewpoint?



WET-BULB

DRY-BULB

Dewpoint Temperatures (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−28													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

Relative Humidity (%)

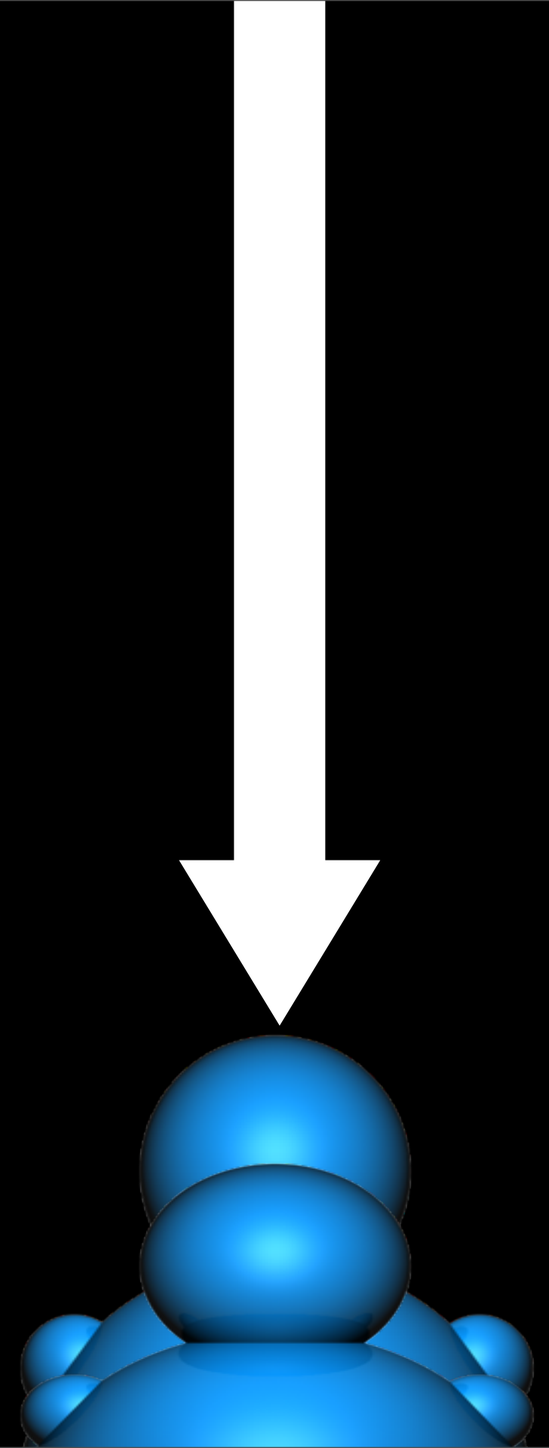
Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

AIR PRESSURE...



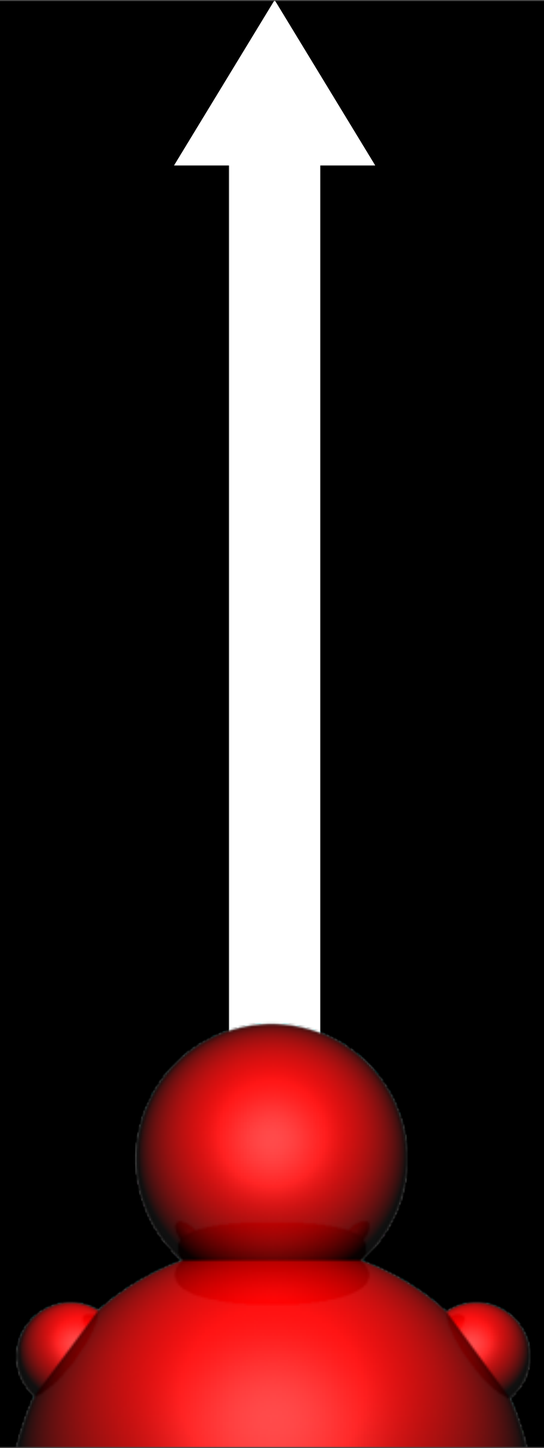
Sinking air =

HIGH Pressure



Rising air =

LOW Pressure

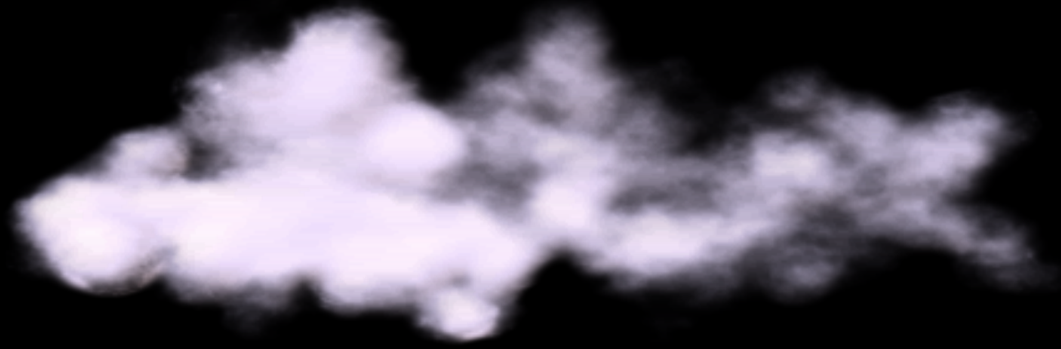


HIGH = HAPPY (dry)

But... why?

LOW = LOUSY (wet)

When air rises…

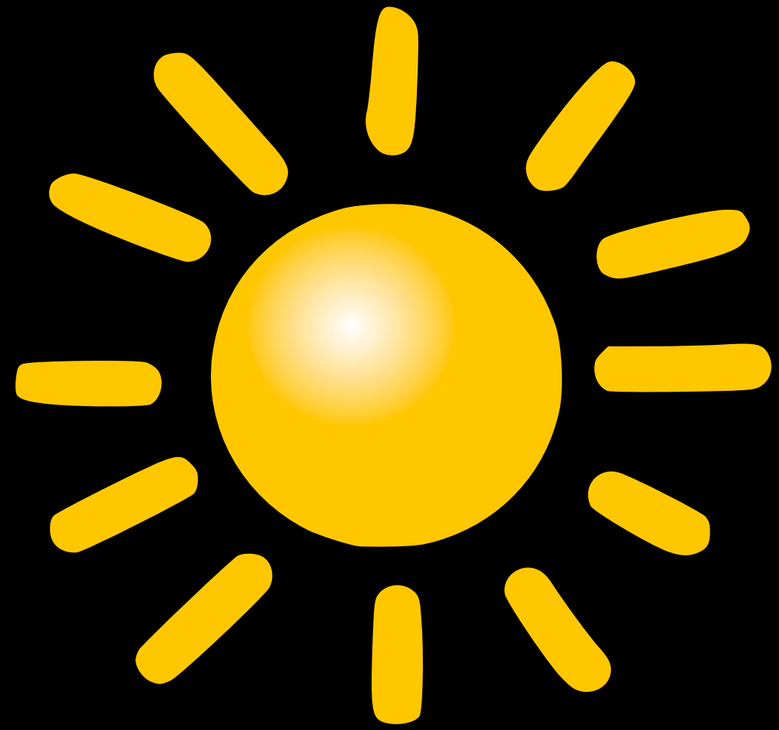


1. it expands
2. it cools to it's dewpoint
3. it condenses on to condensation nuclei
4. a cloud is born

LOW = LOUSY



When air sinks…



1. it compresses
2. it warms
3. humidity drops

HIGH = HAPPY

Winds blow from H → L



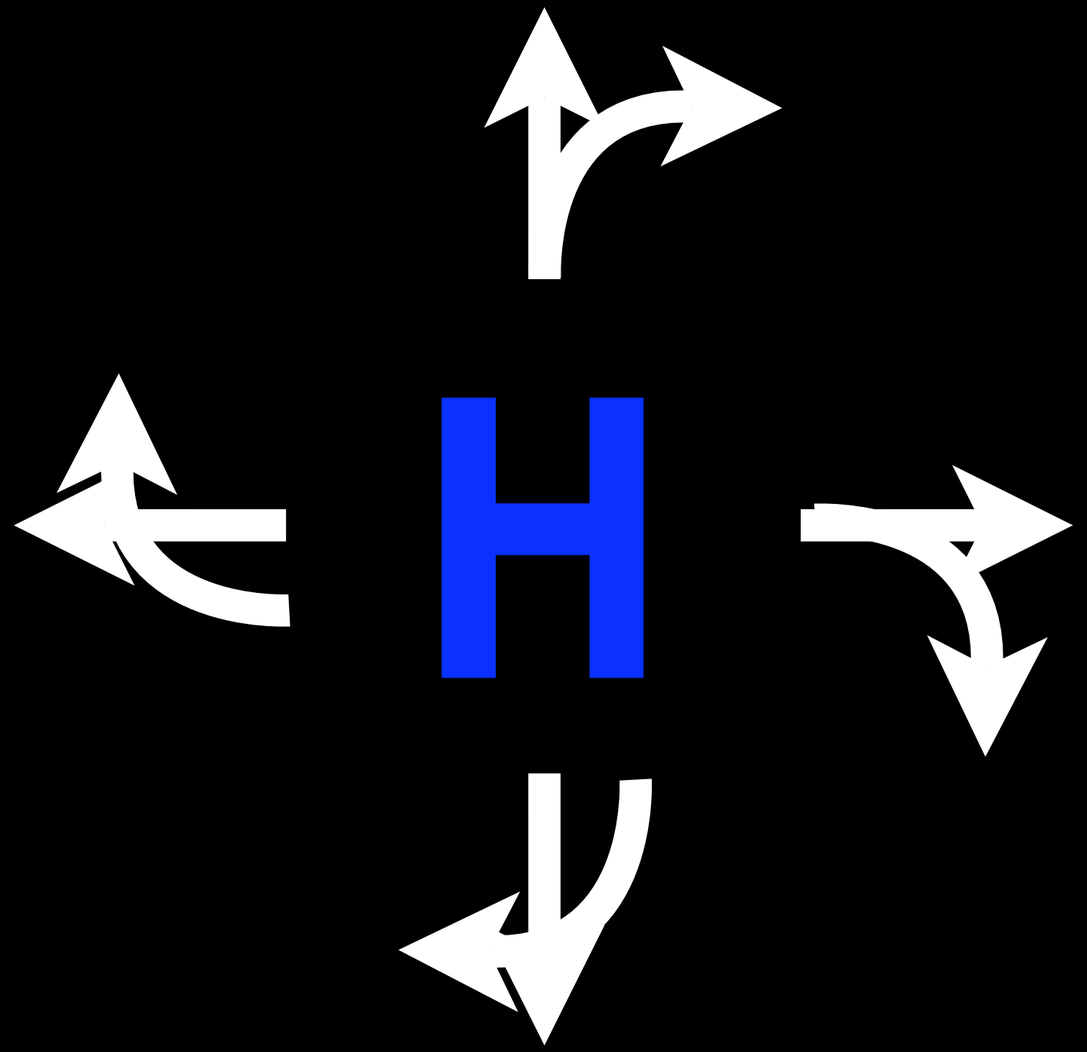
Coriolis Effect

Winds and ocean currents curve due to the rotation of the Earth

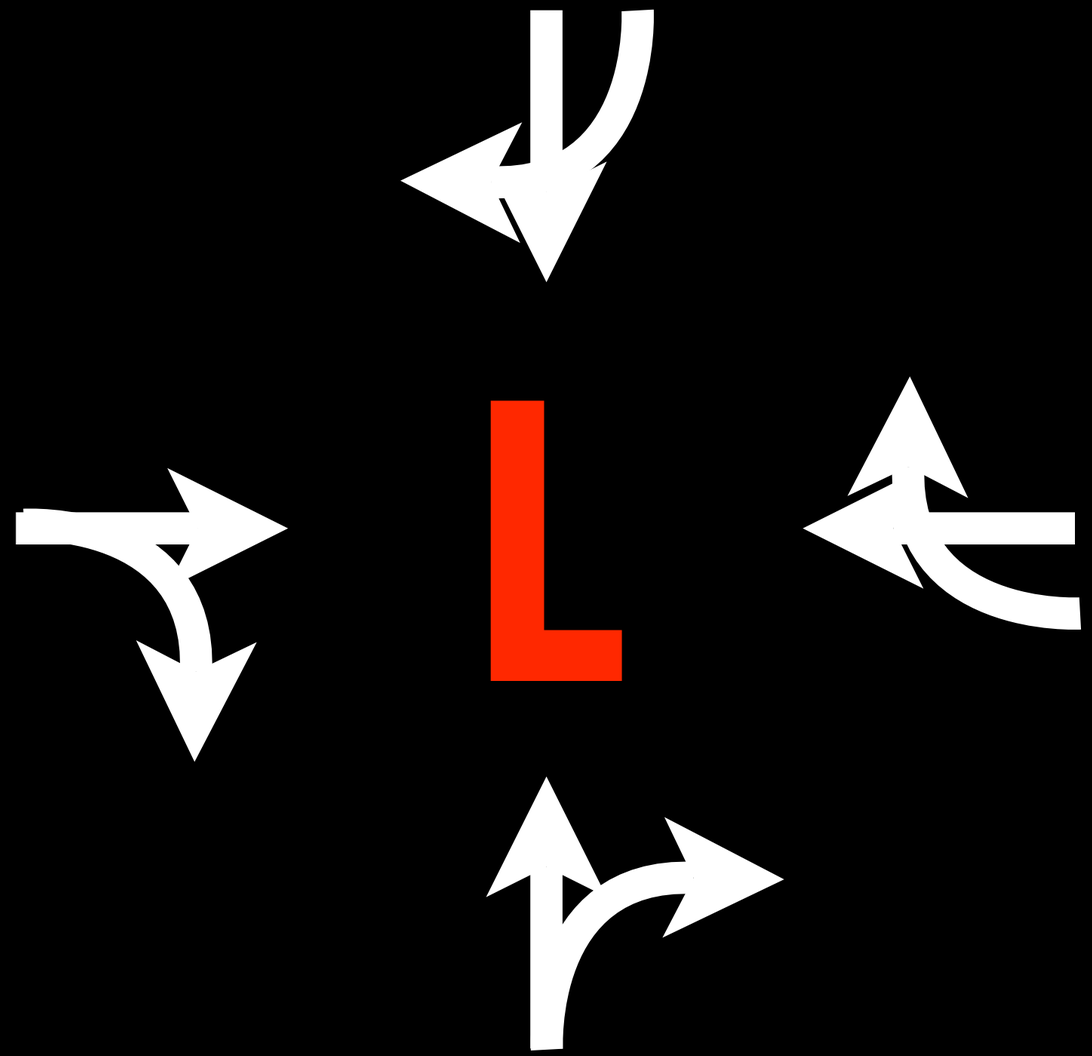


NOTE*

CORIOLIS PROVES ROTATION



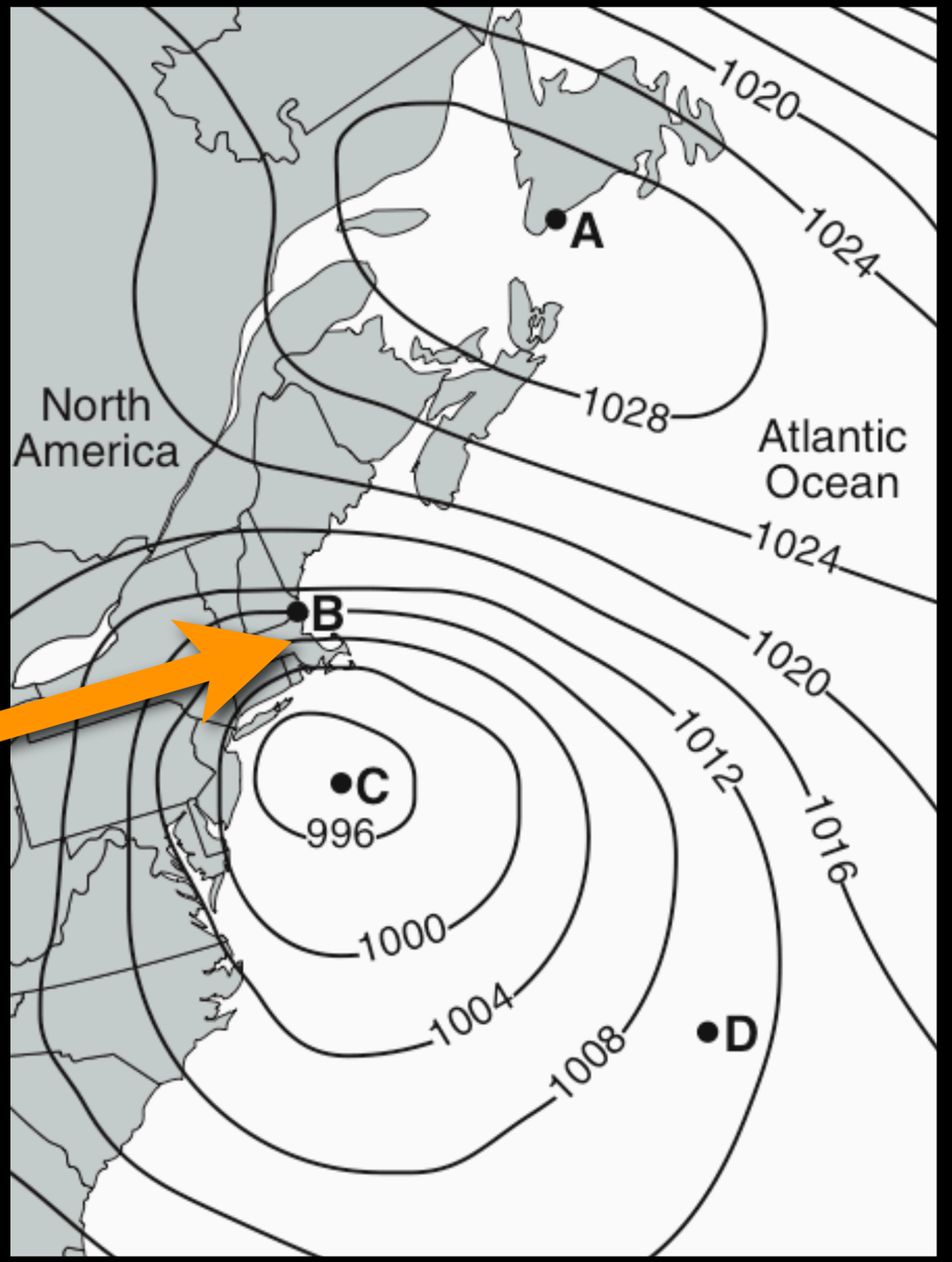
Clockwise and **Away**



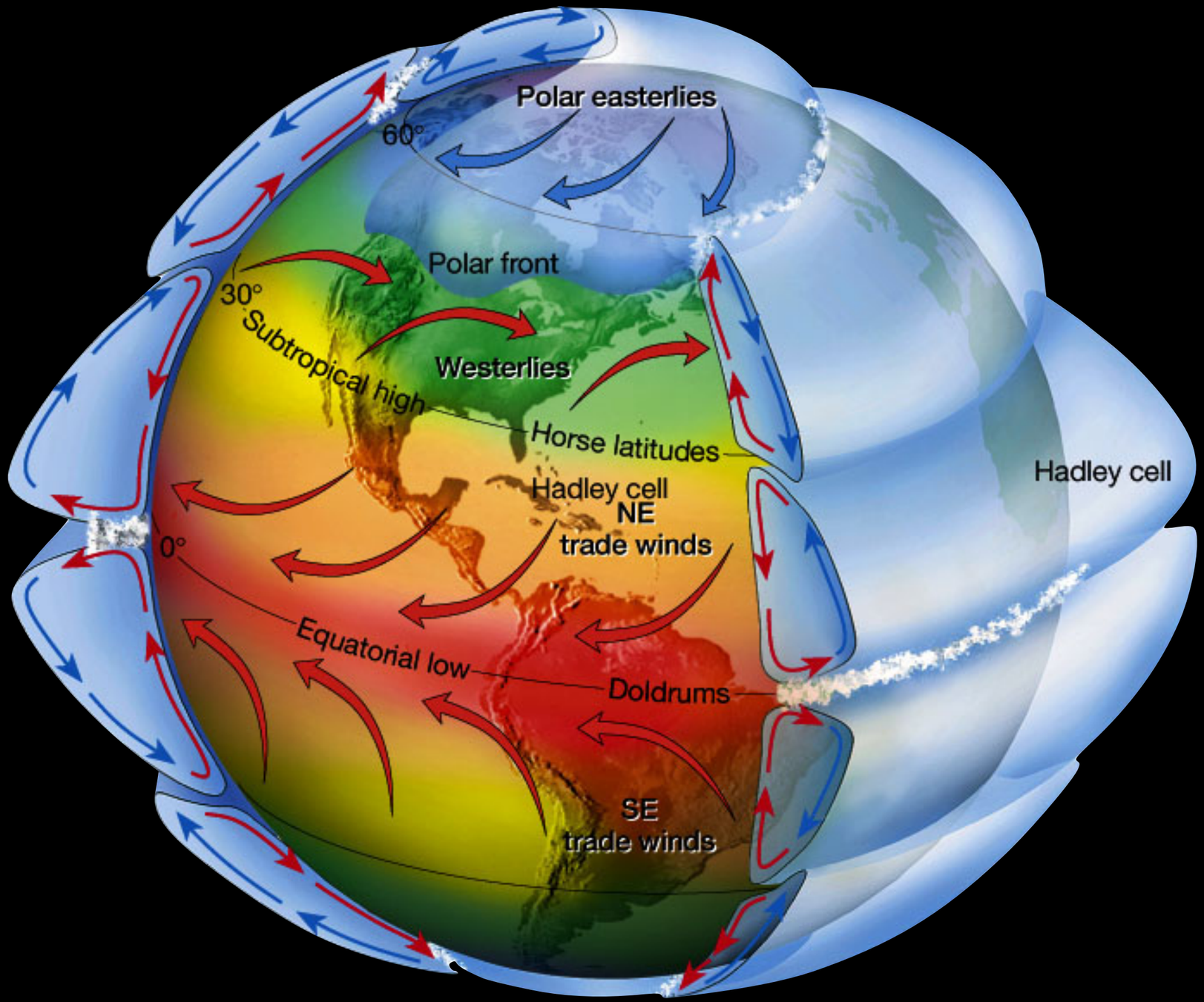
Counter-clockwise and Towards

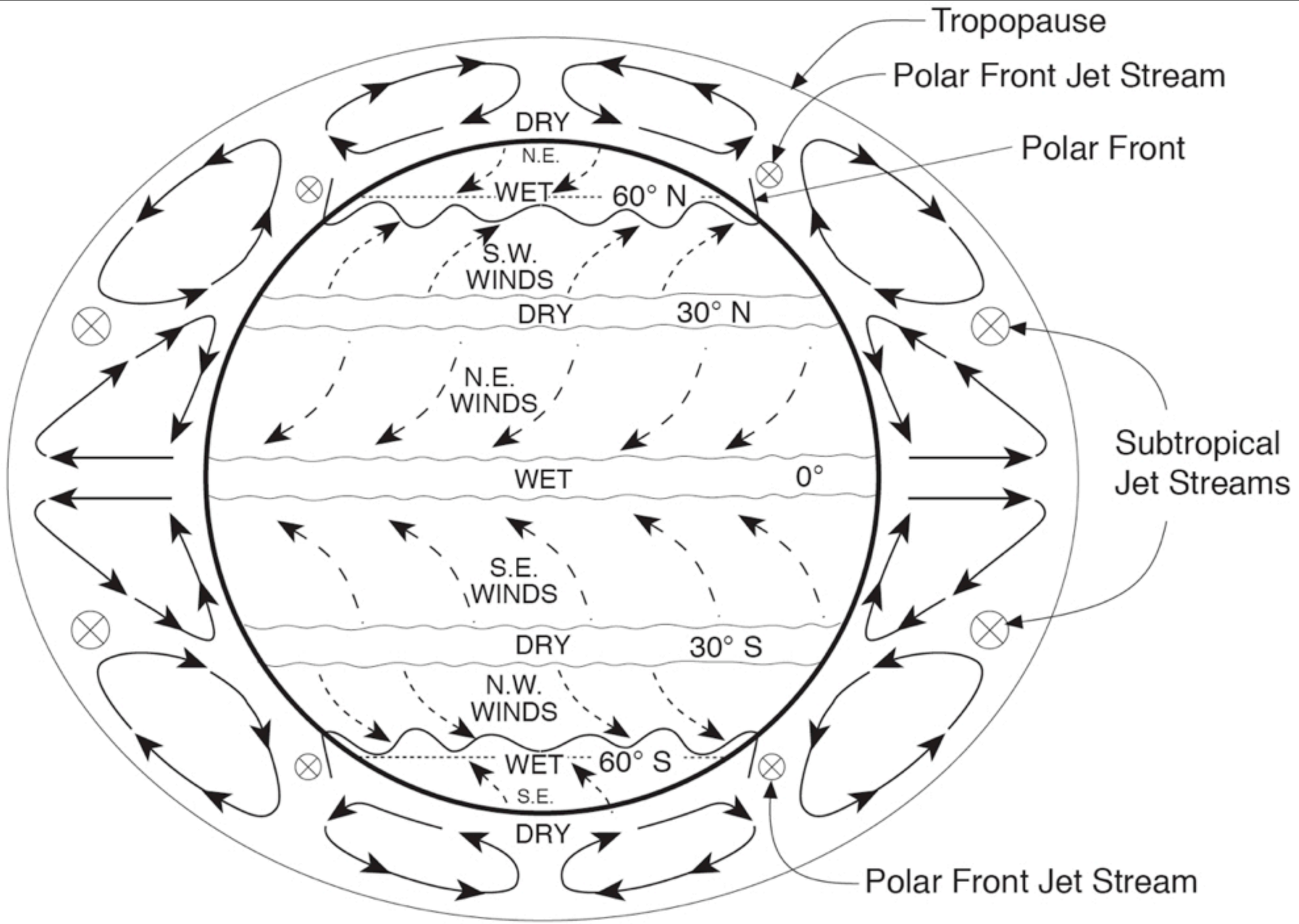
ISOBARS

The closer the isobars, the higher the wind speed



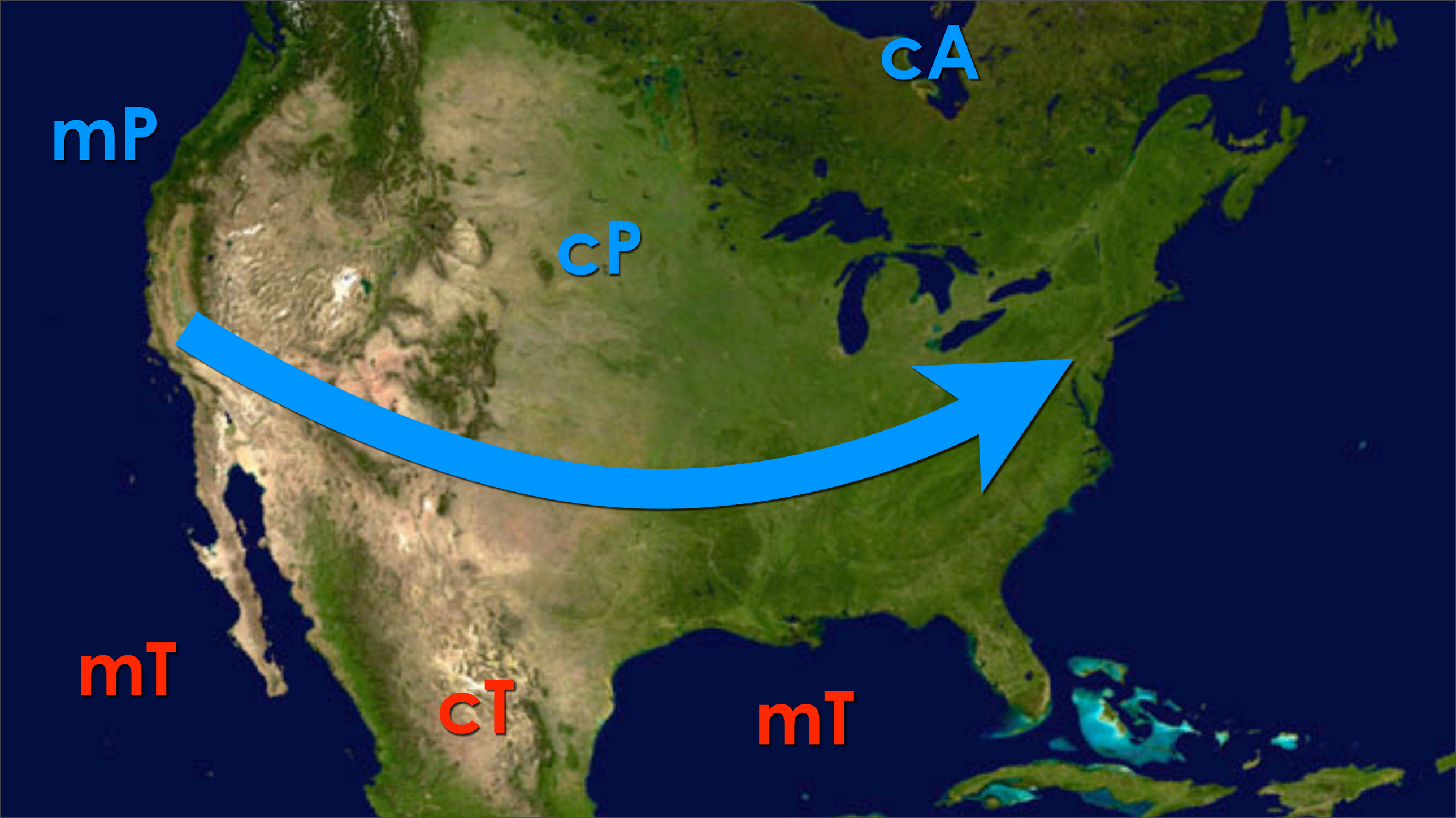
global winds




Tropopause
Polar Front Jet Stream
Polar Front
DRY
N.E.
WET
60° N
S.W.
WINDS
DRY
30° N
N.E.
WINDS
WET
0°
S.E.
WINDS
DRY
30° S
N.W.
WINDS
WET
60° S
S.E.
DRY
Subtropical
Jet Streams
Polar Front Jet Stream

AIR M SES...


Air Masses
cA continental arctic
cP continental polar
cT continental tropical
mT maritime tropical
mP maritime polar

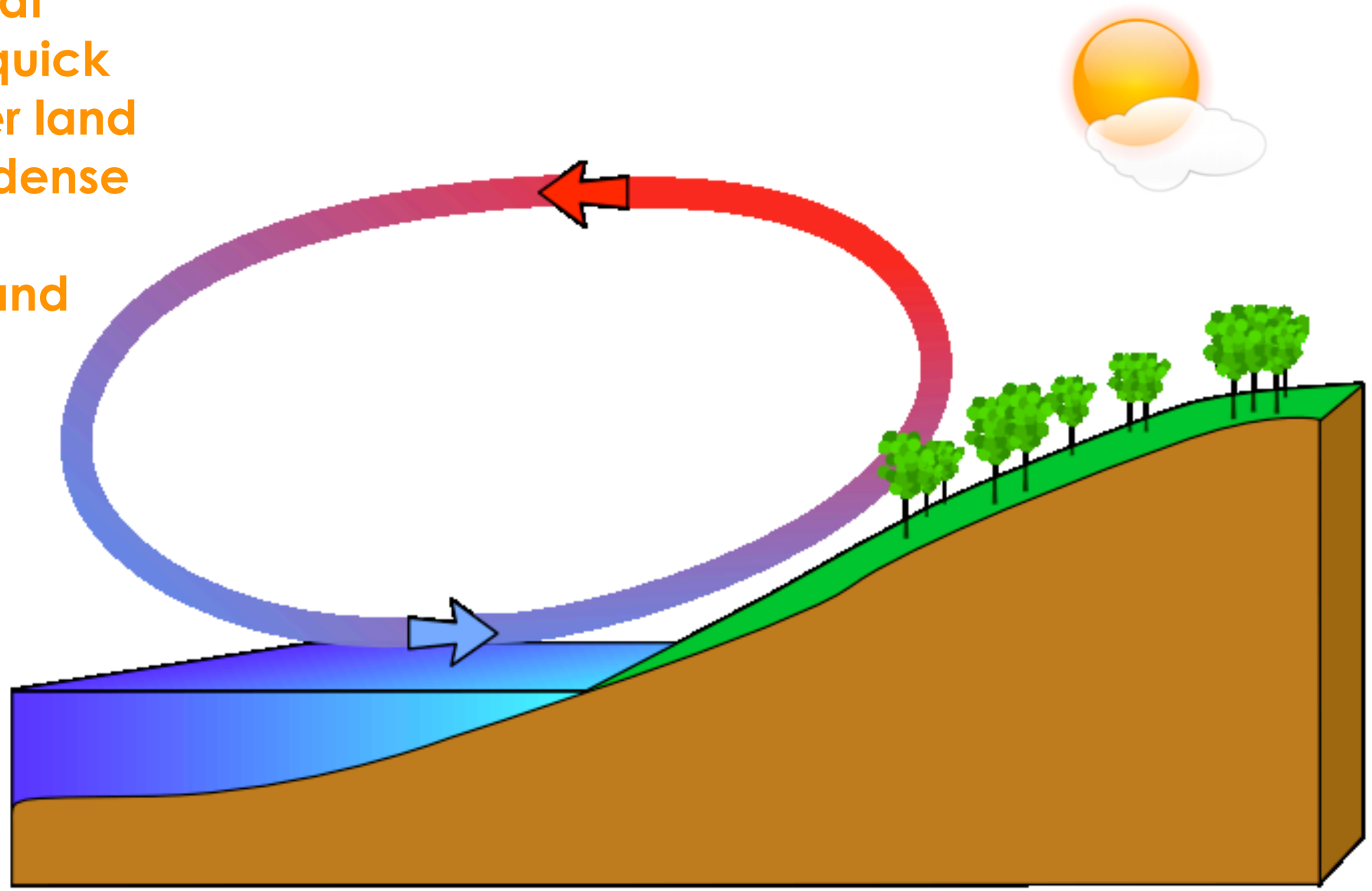

cA
mP
cP
mT
cT
mT

So…Why does air rise?

1. Heat
2. Mountains
3. Fronts

sea breeze

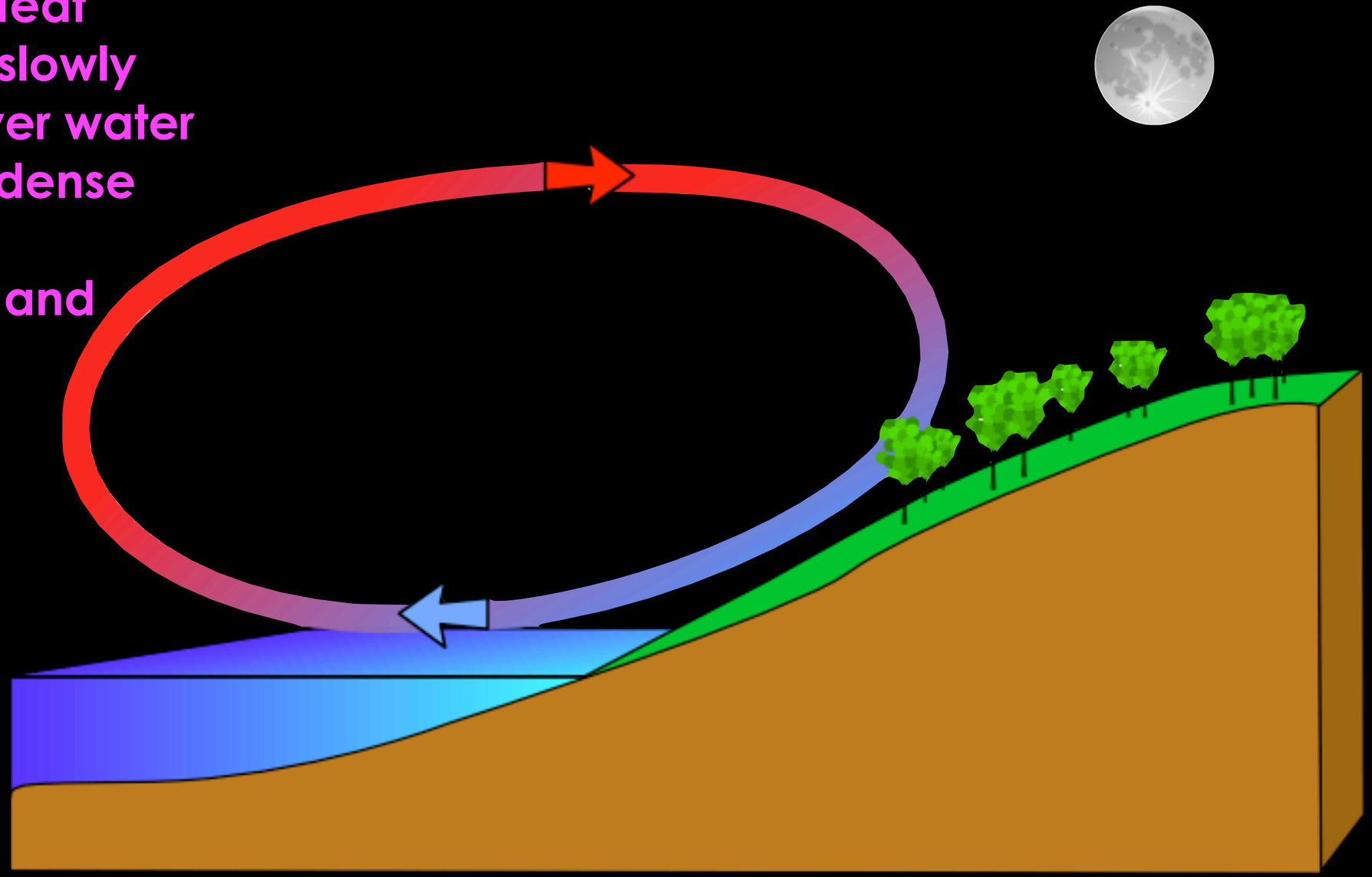
- Land= Low Specific Heat
- Gets hot quick, cools quick
- During the day, air over land warms, becomes less dense and rises
- Air sinks over the sea and rushes back to land

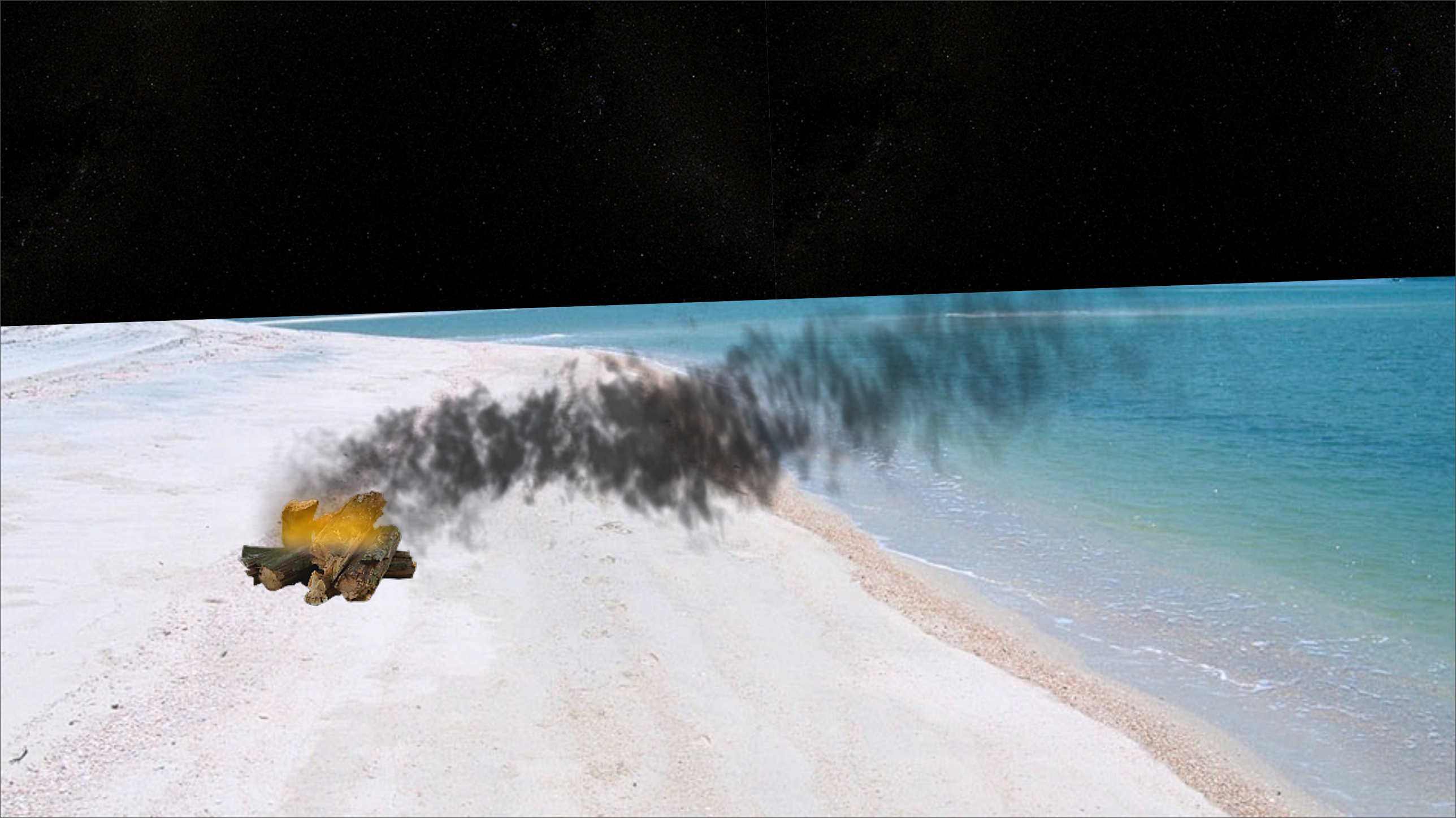




land breeze

- Water= High Specific Heat
- Gets hot slowly, cools slowly
- During the night, air over water warms, becomes less dense and rises
- Air sinks over the land and rushes back to sea

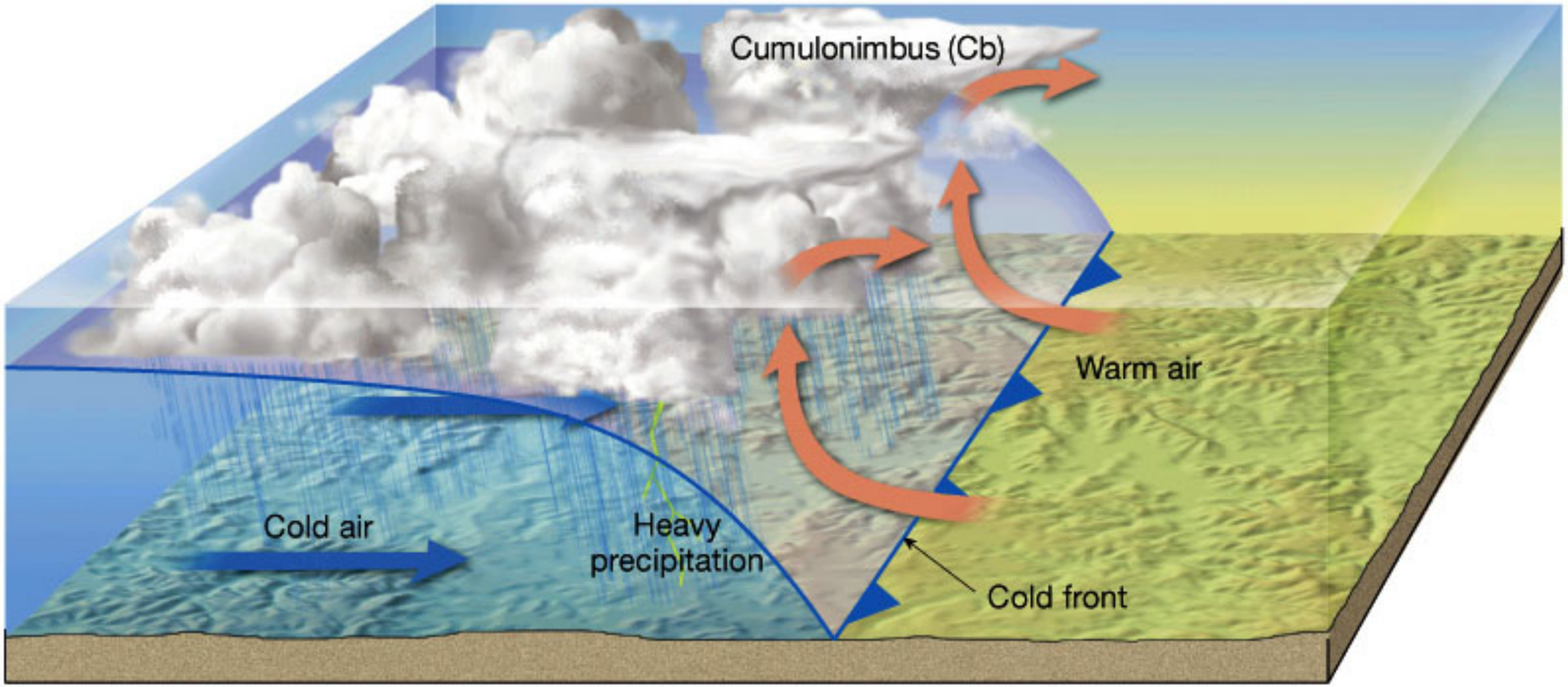




Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (calories/gram • C°)
Water (solid)	0.5
Water (liquid)	1.0
Water (gas)	0.5
Dry air	0.24
Basalt	0.20
Granite	0.19
Iron	0.11
Copper	0.09
Lead	0.03

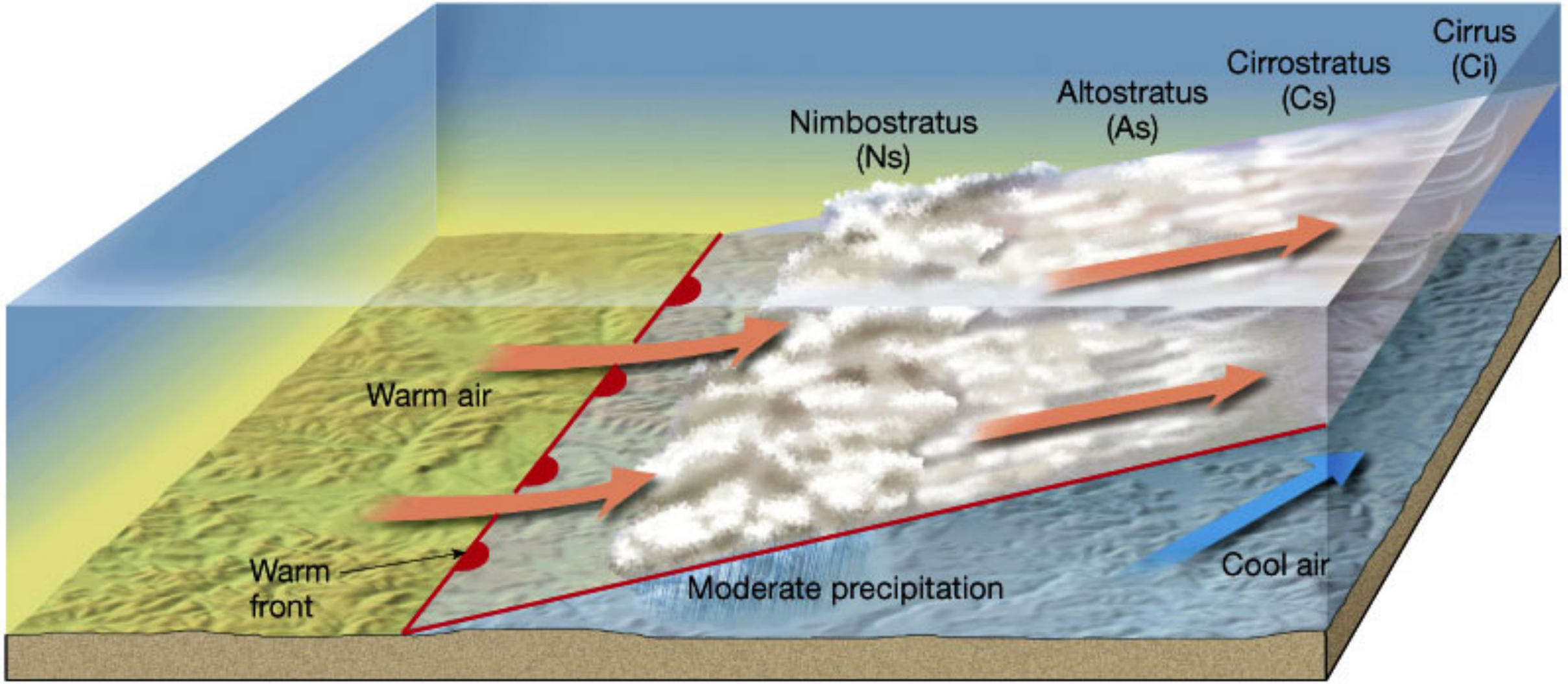
cold front


Cumulonimbus (Cb)
Warm air
Cold air
Heavy
precipitation
Cold front

cold front-

A short period of heavy precipitation right along the front

warm front


Cirrus
(Ci)
Cirrostratus
(Cs)
Altostratus
(As)
Nimbostratus
(Ns)
Warm air
Warm
front
Moderate precipitation
Cool air

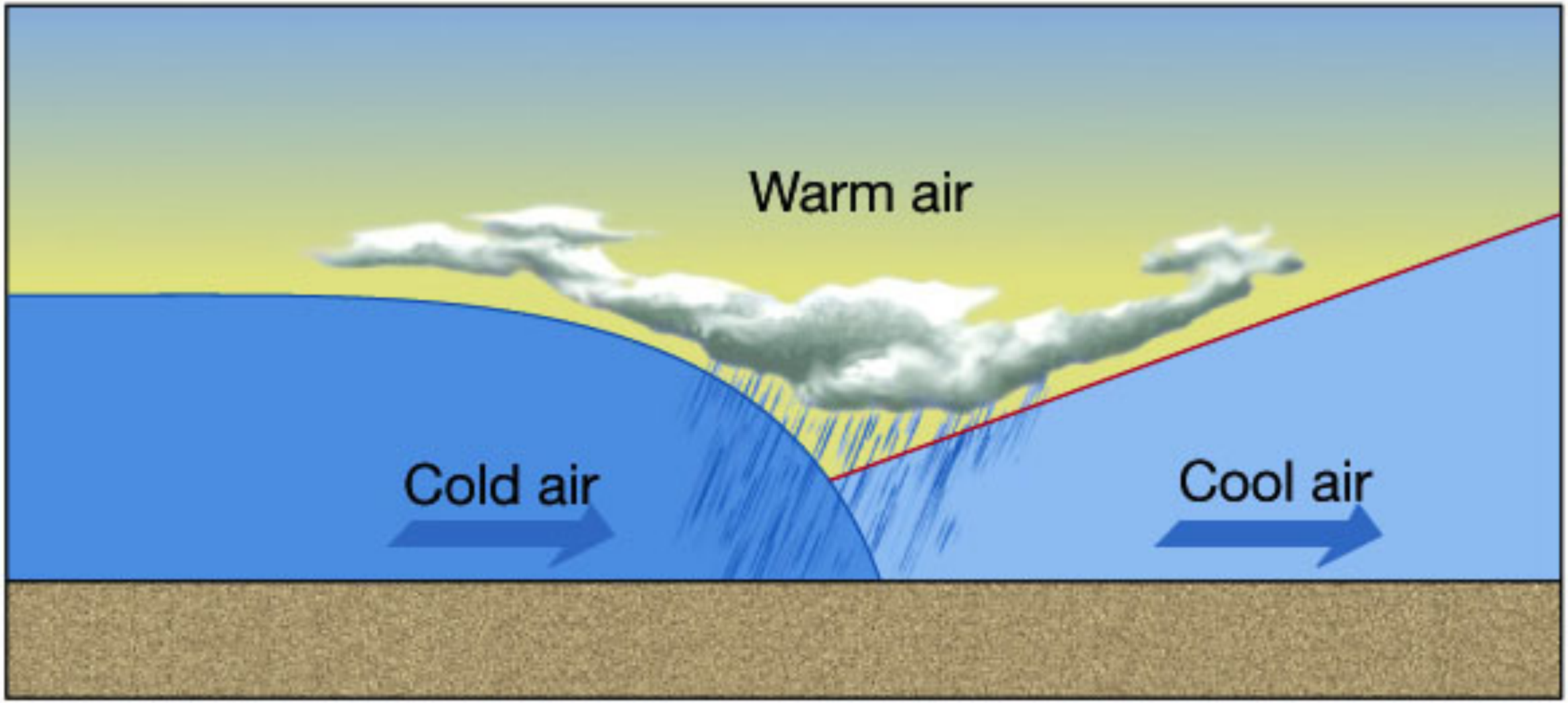
warm front-

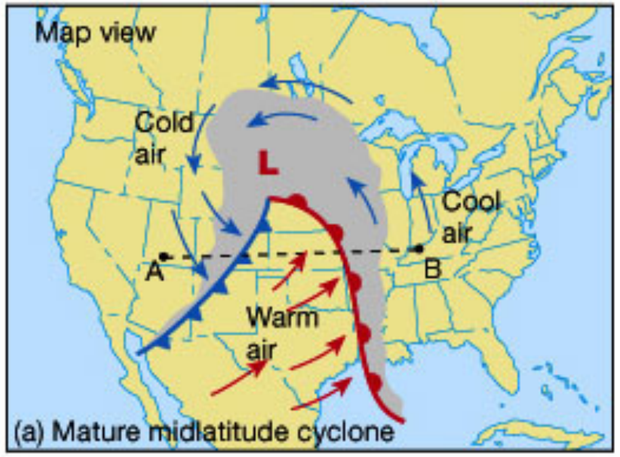
A long period of light precipitation ahead of the front

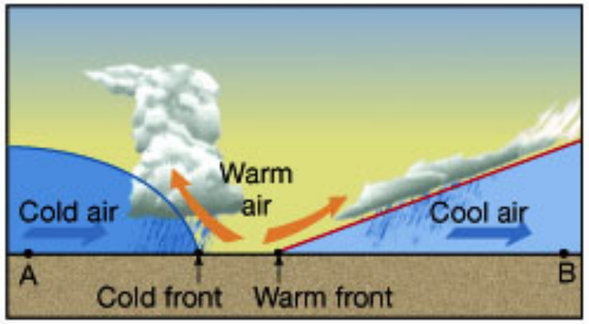
occluded front-

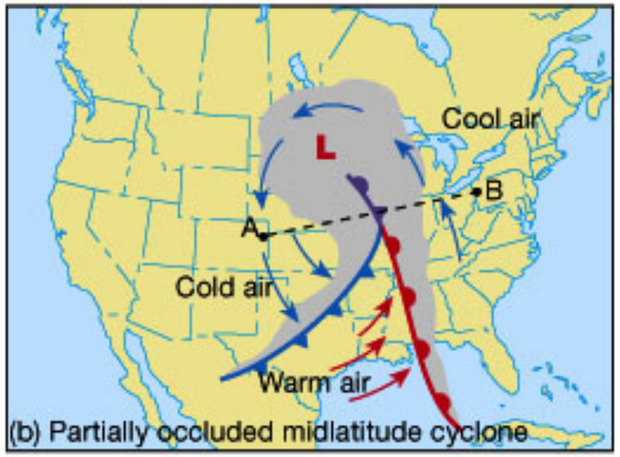
When a cold front catches up to a warm front

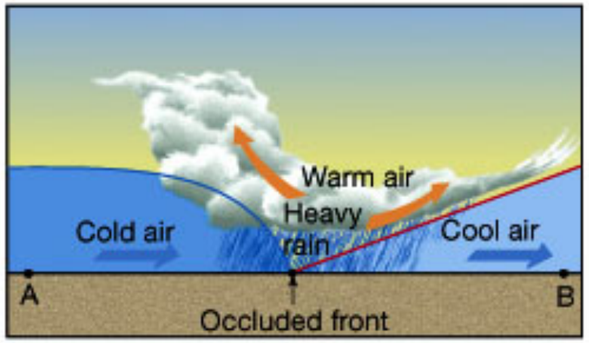
occluded front

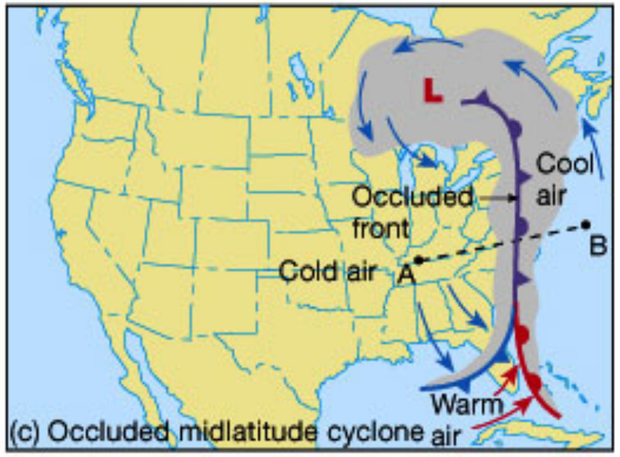


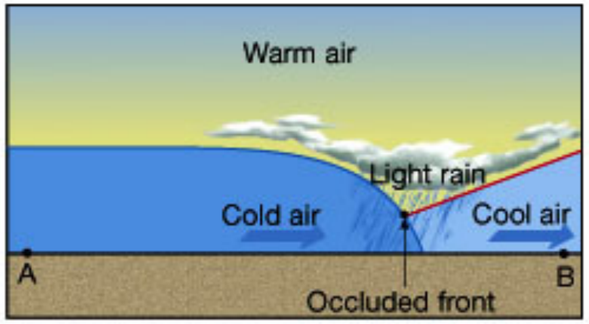

Map view
Cold air
L
Cool air
A
B
Warm air
(a) Mature midlatitude cyclone

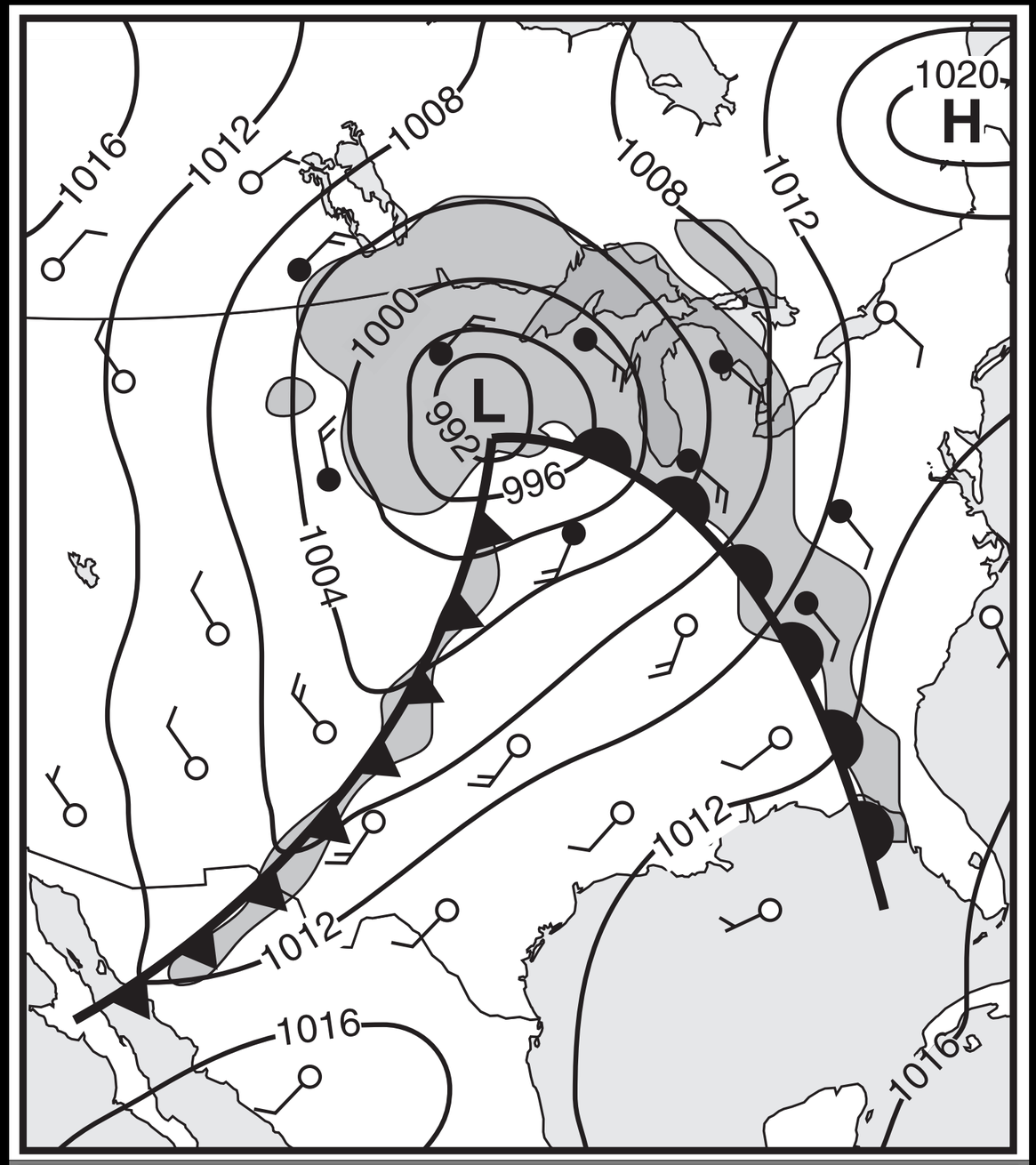

Warm air
Cold air
Cool air
A
B
Cold front
Warm front

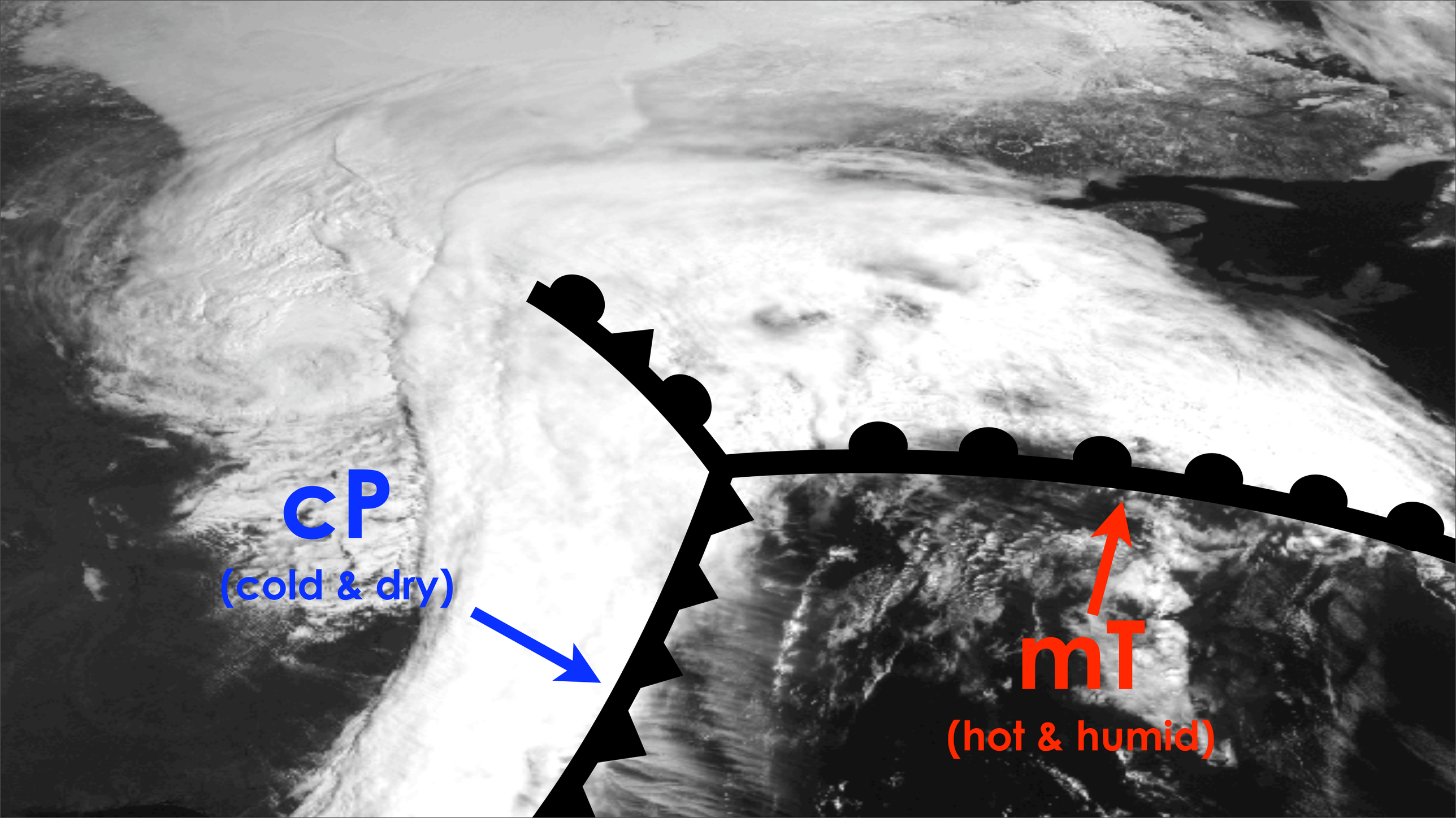

Cool air
L
B
A
Cold air
Warm air
(b) Partially occluded midlatitude cyclone

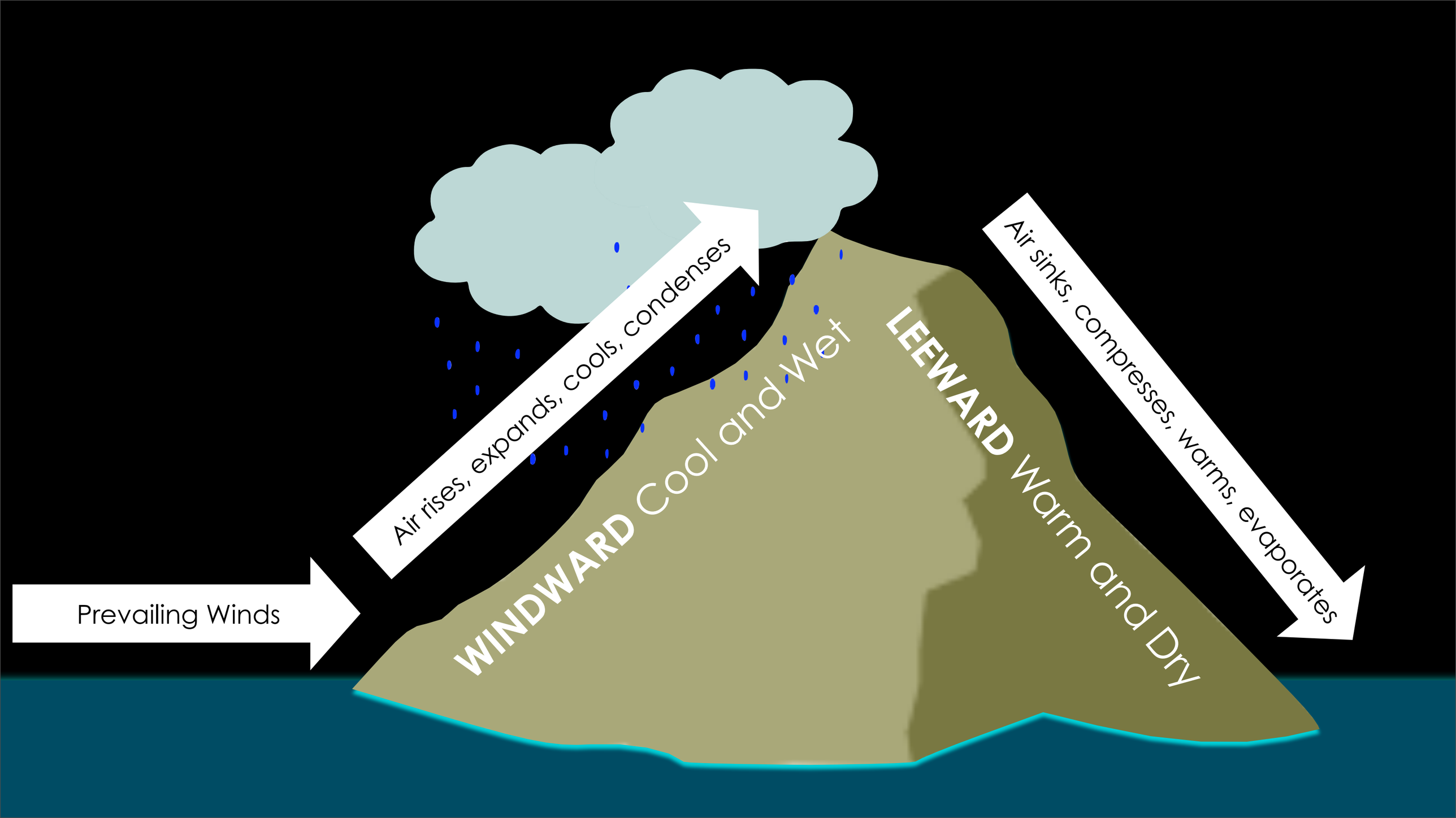

Warm air
Heavy rain
Cold air
Cool air
A
B
Occluded front

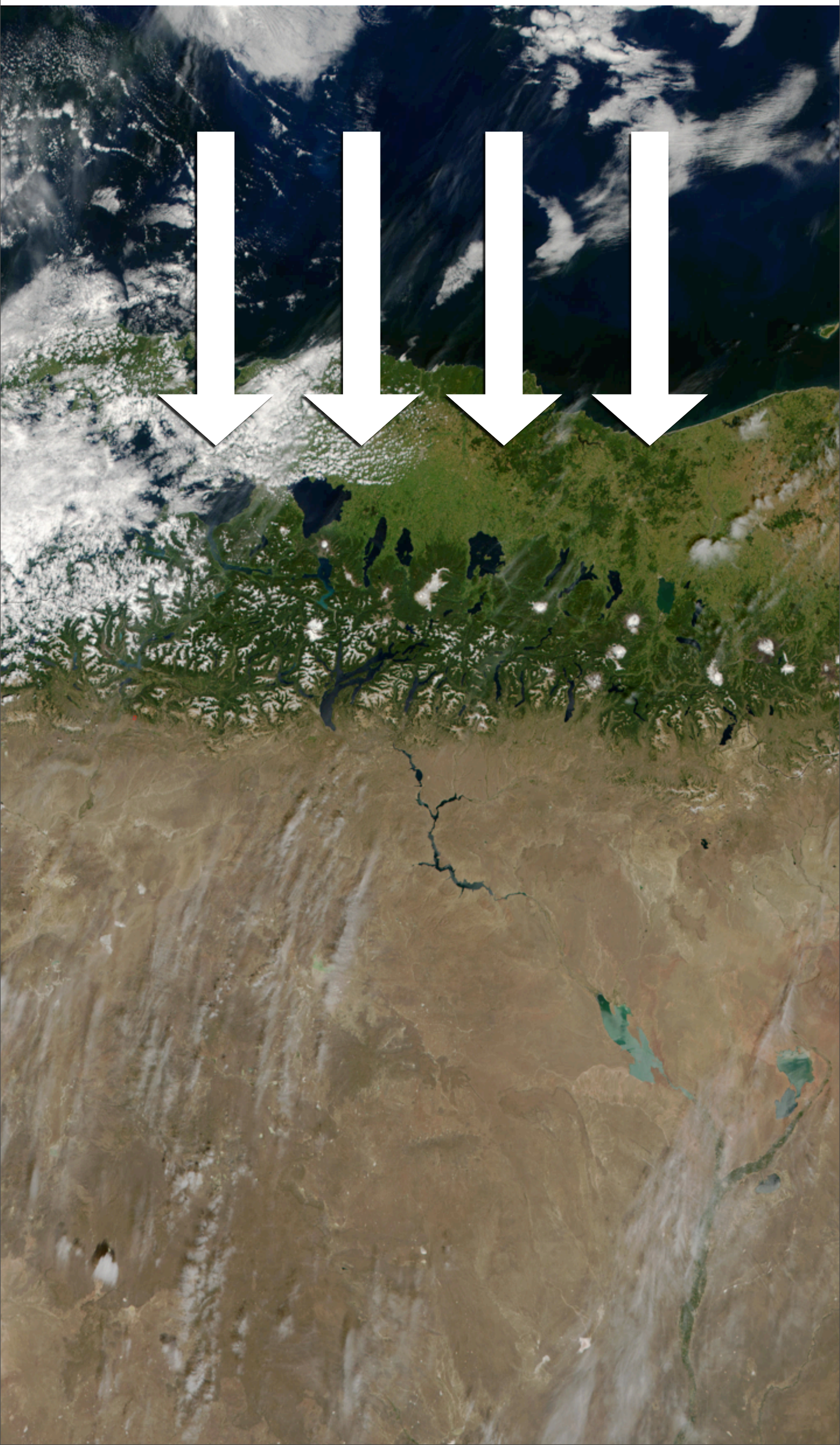

L
Cool air
Occluded front
B
Cold air
A
Warm air
(c) Occluded midlatitude cyclone

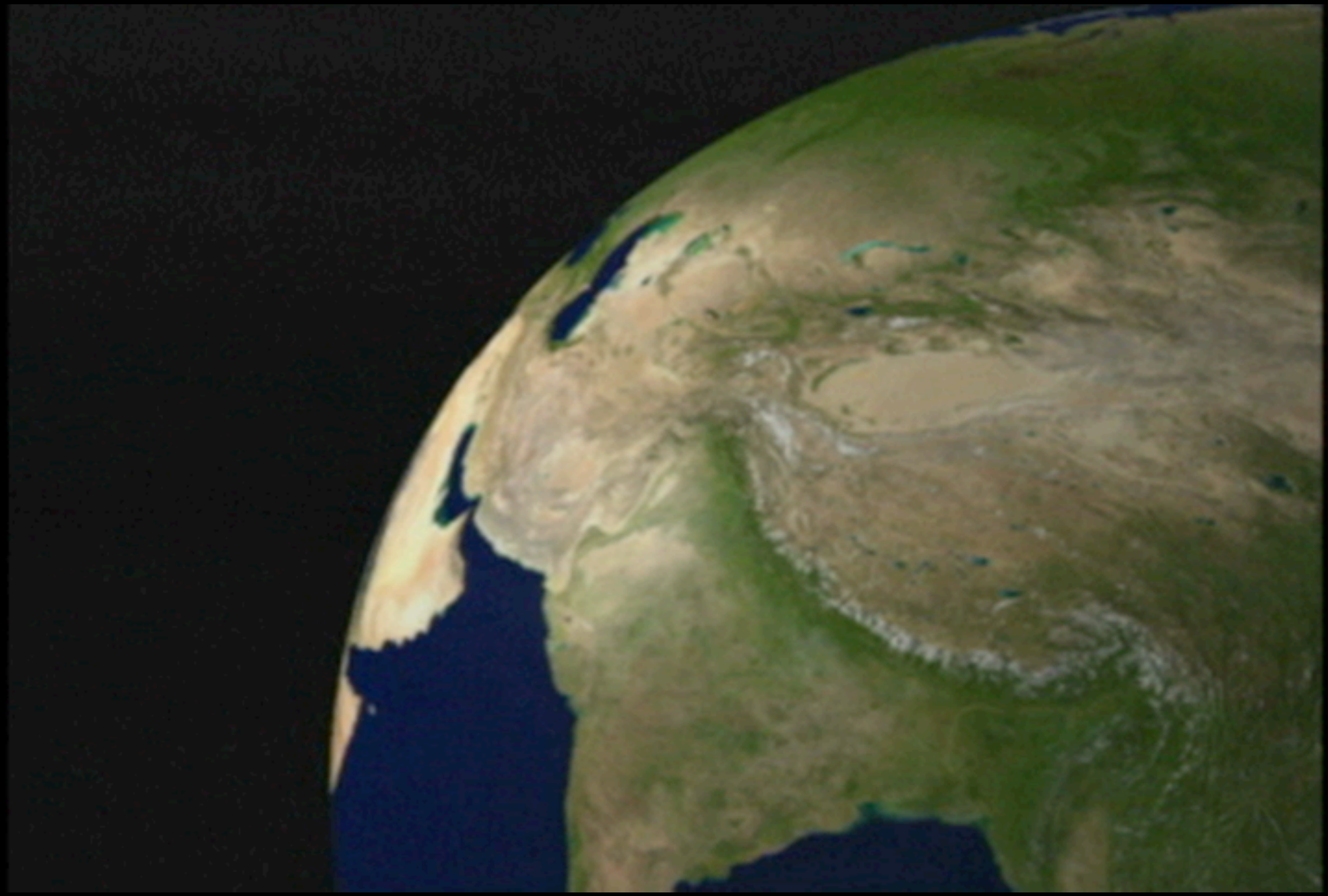

Warm air
Light rain
Cold air
Cool air
A
B
Occluded front


1020
H
1016
1012
1008
1008
1012
1000
L
992
996
1004
1012
1012
1016
1016


cP
(cold & dry)
mT
(hot & humid)


Air rises, expands, cools, condenses
Air sinks, compresses, warms, evaporates
Prevailing Winds
WINDWARD Cool and Wet
LEEWARD Warm and Dry



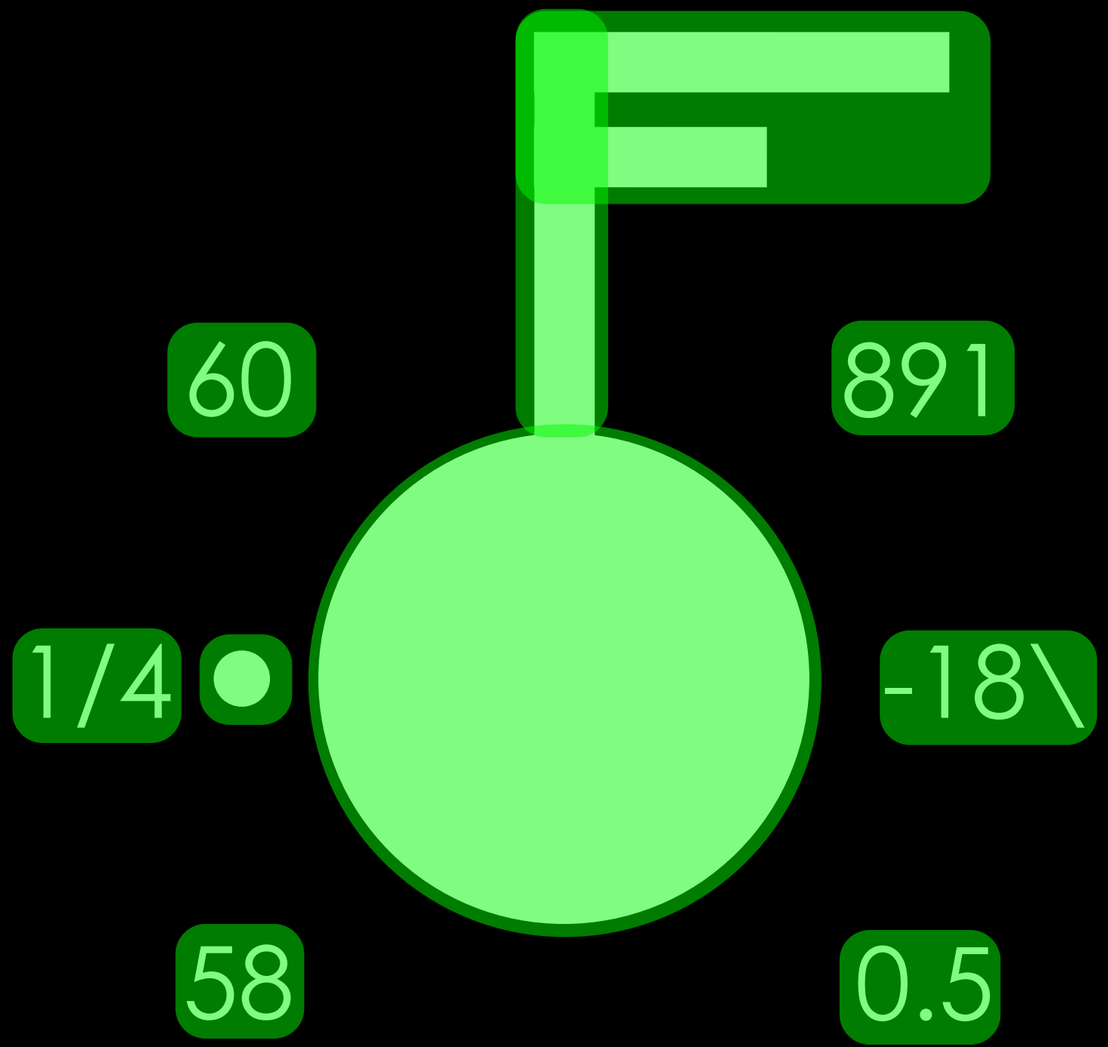


Hurricanes

Form in Stre






60
891
1/4
-18\
58
0.5

Converting air pressure...

From short to long:

- *less than 500, add a 10*
- *more than 500, add a 9*
- *add a decimal point*
- *add units*

1956 → 1095.4 mb

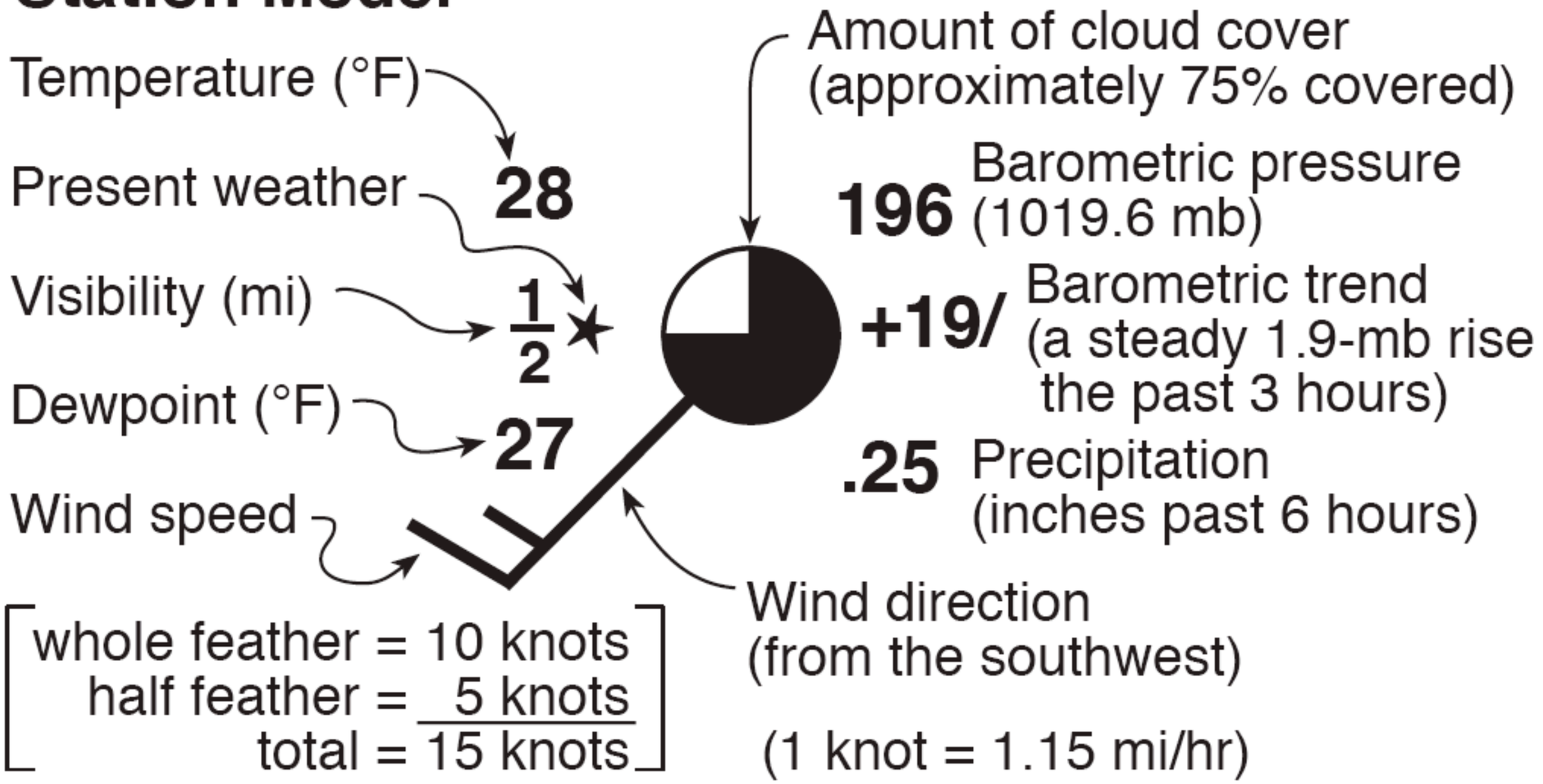
Converting air pressure…

From long to short:

- *drop the “9” or “10”*
- *drop the decimal point*
- *drop the units*

1004.9 mb ⇒ 049

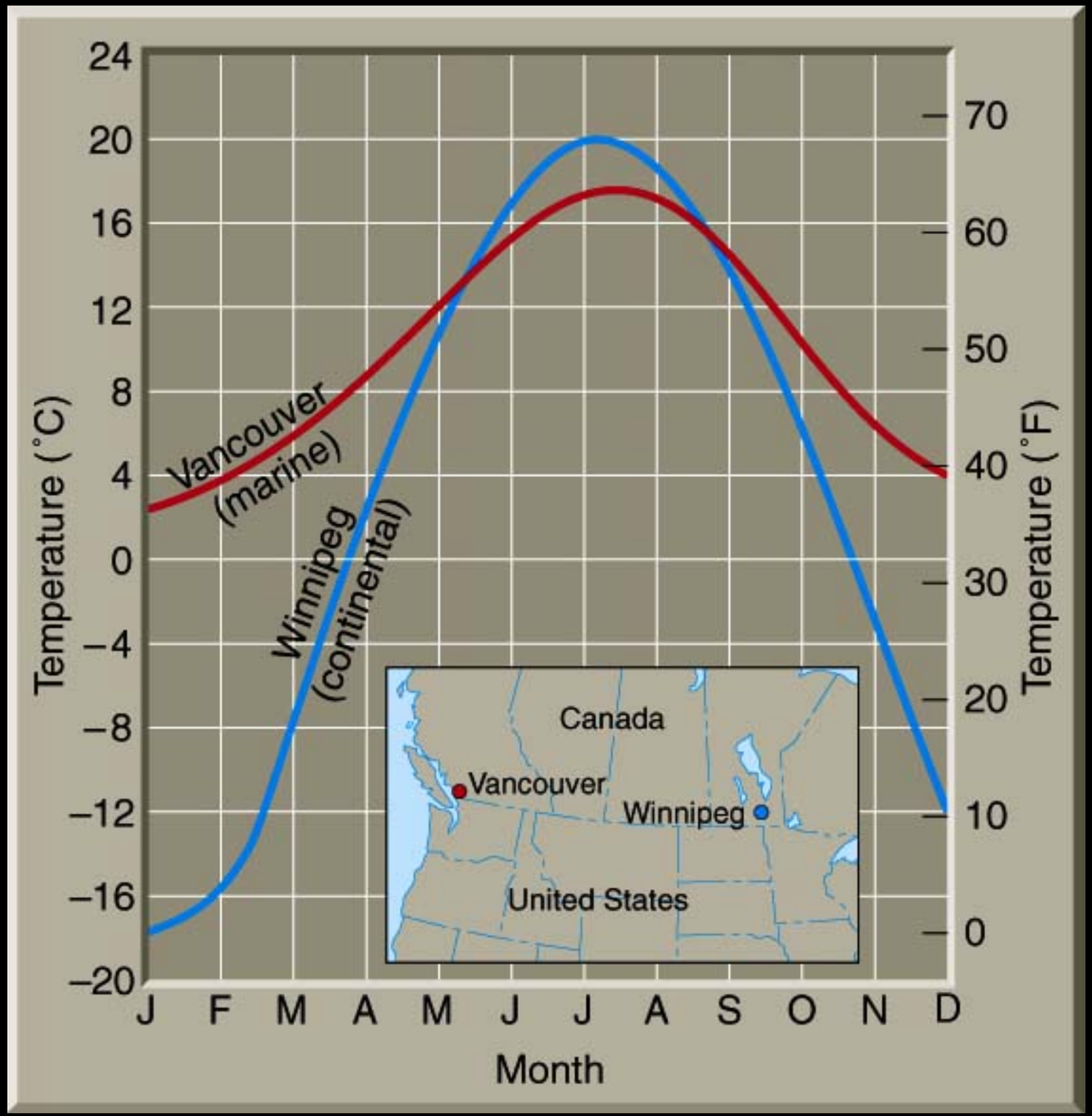
Station Model



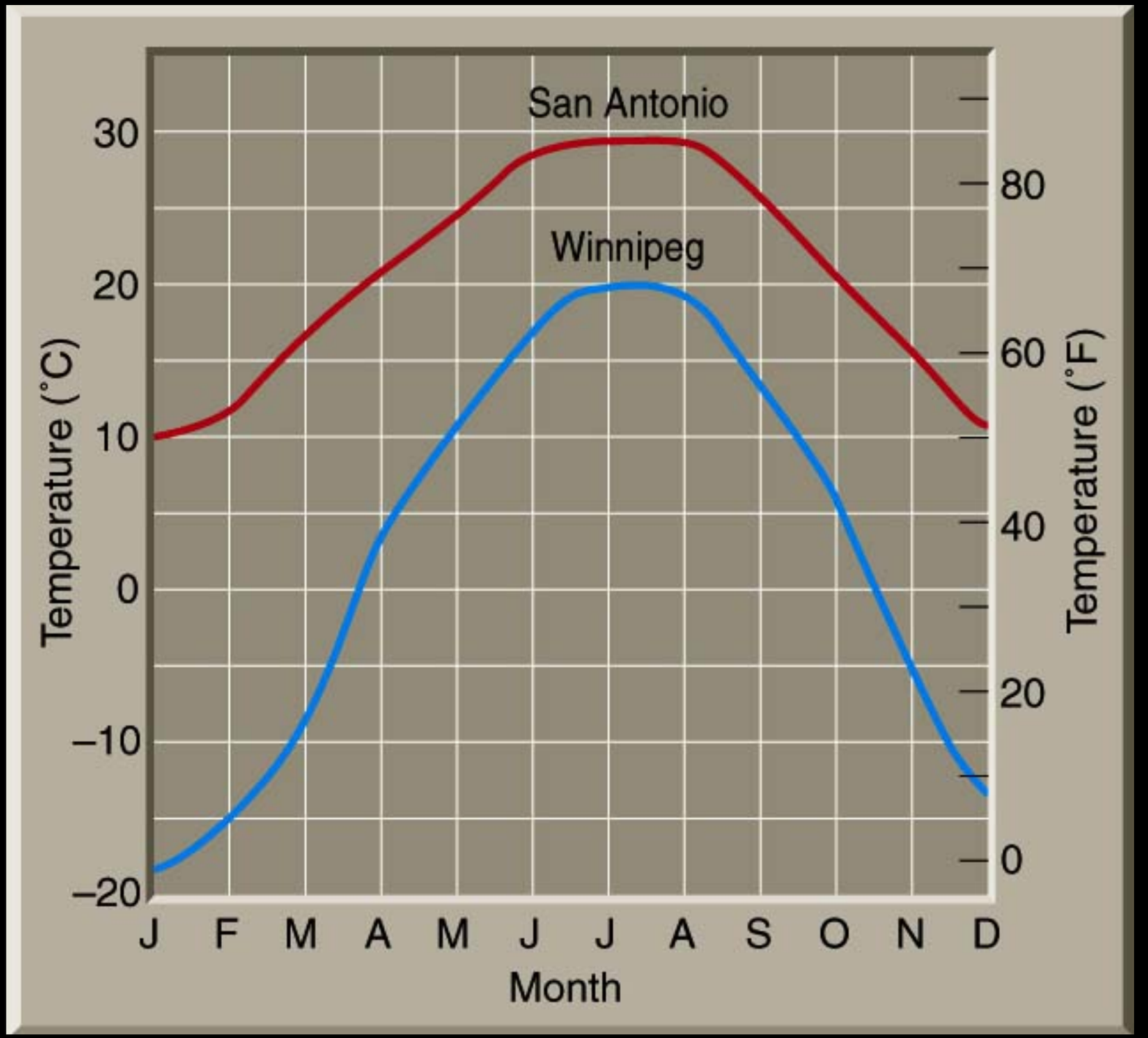
CLIMATE:

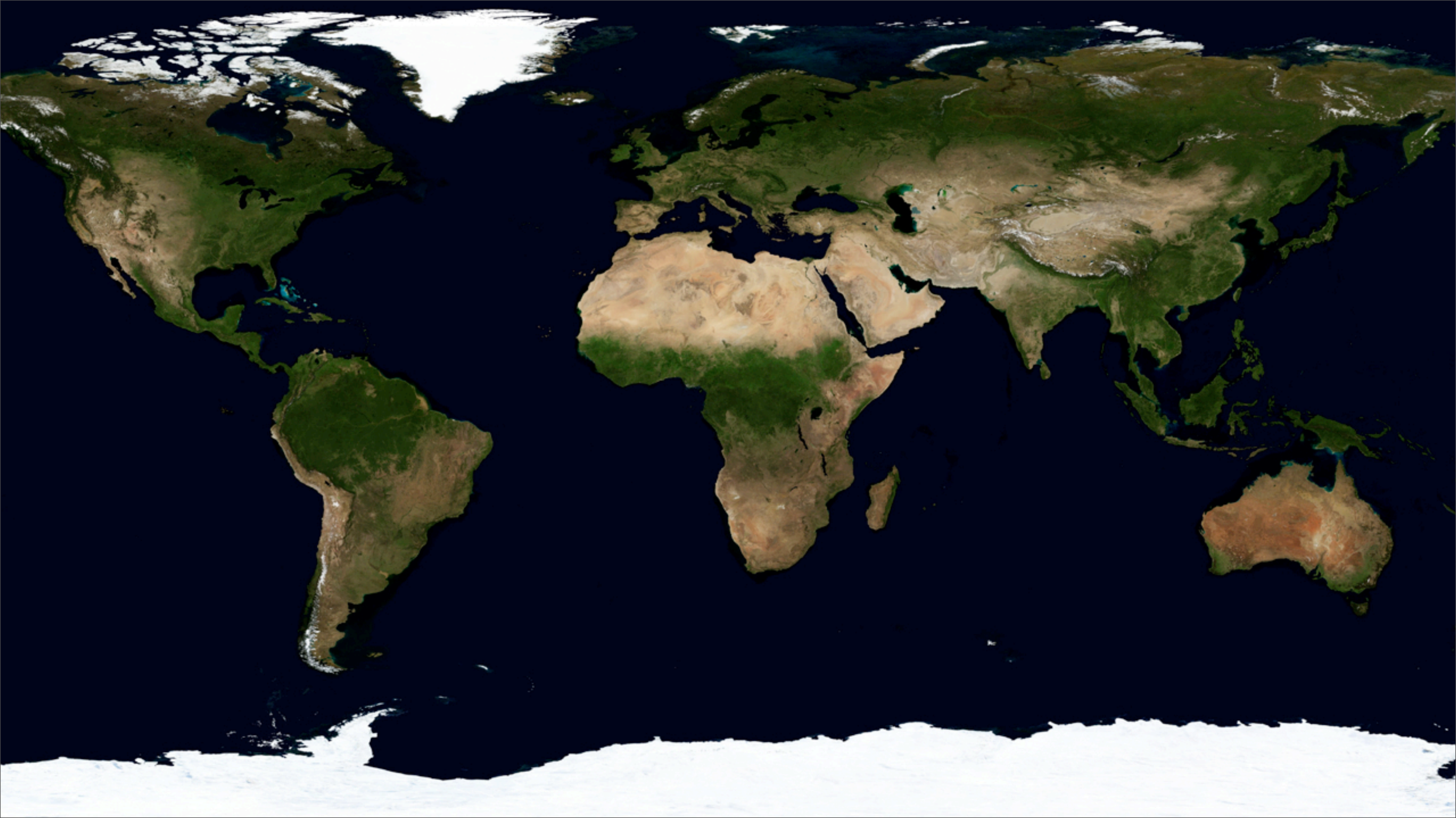
The average weather conditions (temp/moisture) for a large region over a long period of time.

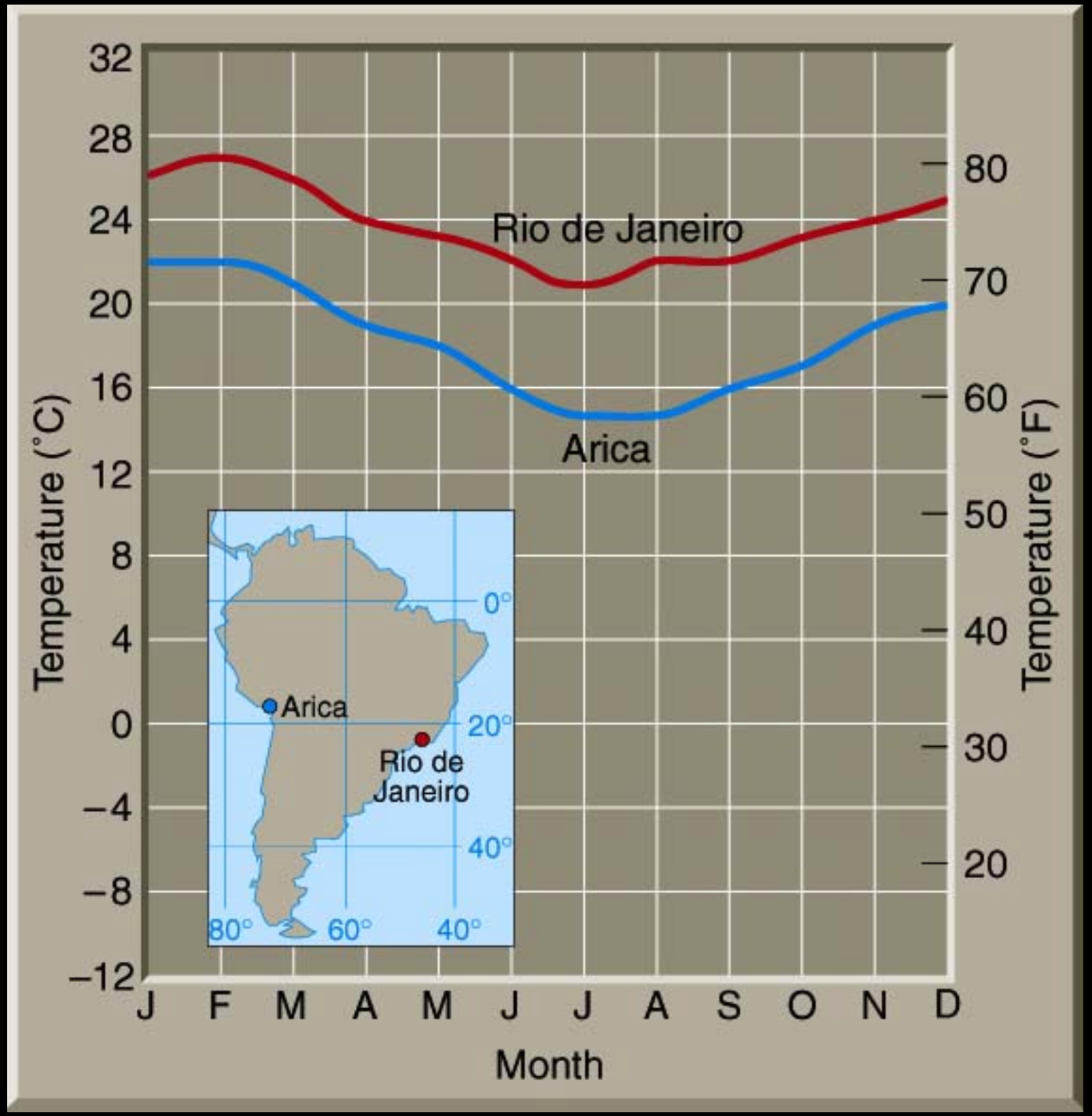
- **Latitude**- *The higher your latitude, the colder your climate.*
- **Altitude**- *The higher your altitude, the colder your climate.*
- **Mountain ranges**- *Windward- cool/wet, Leeward- warm/dry*
- **Oceans/Large Bodies of Water**- *The closer you are to water, the less severe your climate (warmer winters and cooler summers).*
- **Ocean Currents**- *Locations near warm water currents will have warmer climates, locations near cold water currents will have colder climates.*
- **Planetary Wind Belts**- *On-shore winds will cause wet climates, off-shore winds will cause dry climates (monsoon winds).*


24
20
16
12
8
4
0
−4
−8
−12
−16
−20
Temperature (°C)
70
60
50
40
30
20
10
0
Temperature (°F)
Vancouver (marine)
Winnipeg (continental)
J F M A M J J A S O N D
Month
Canada
Vancouver
Winnipeg
United States

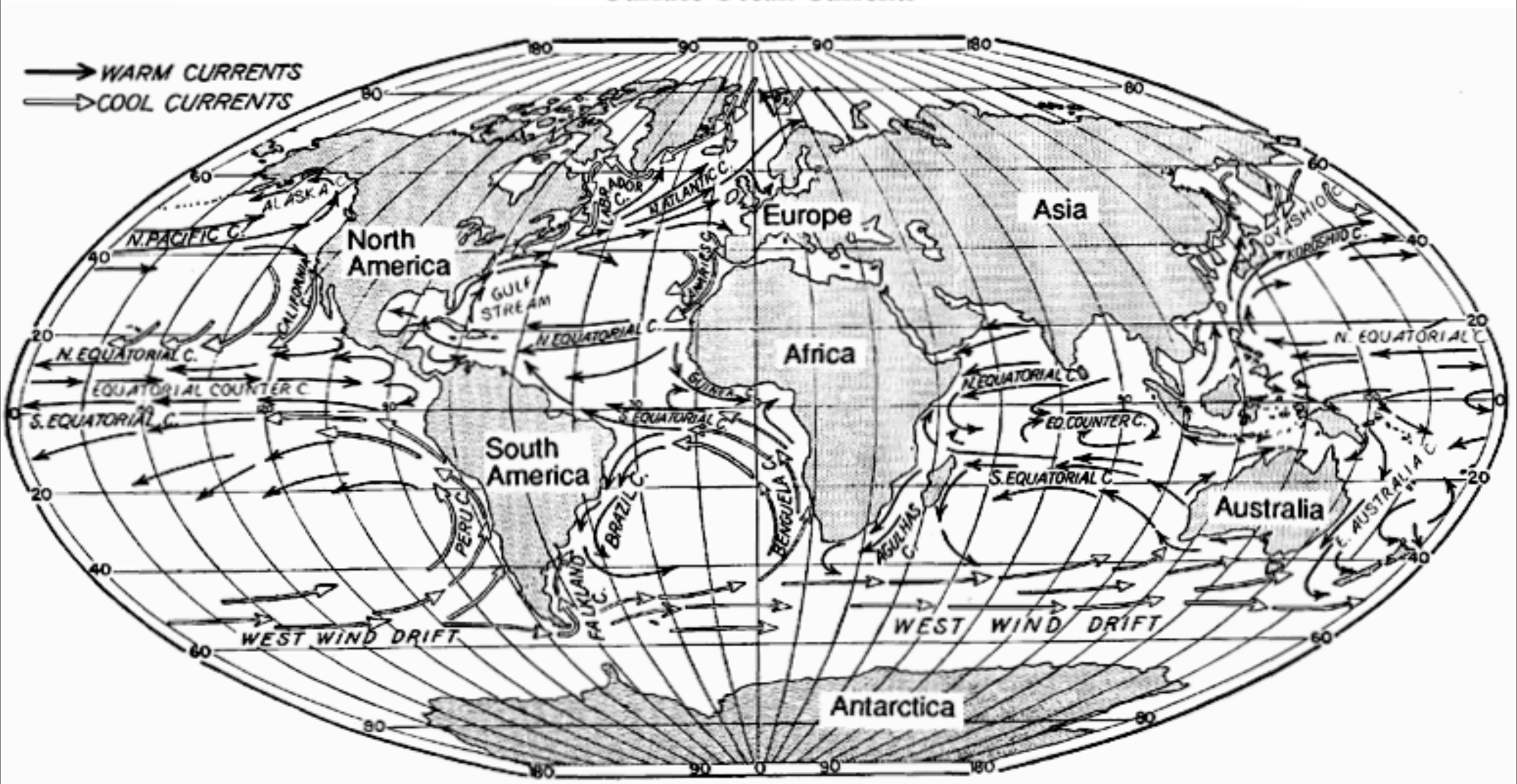

Winnipeg
San Antonio

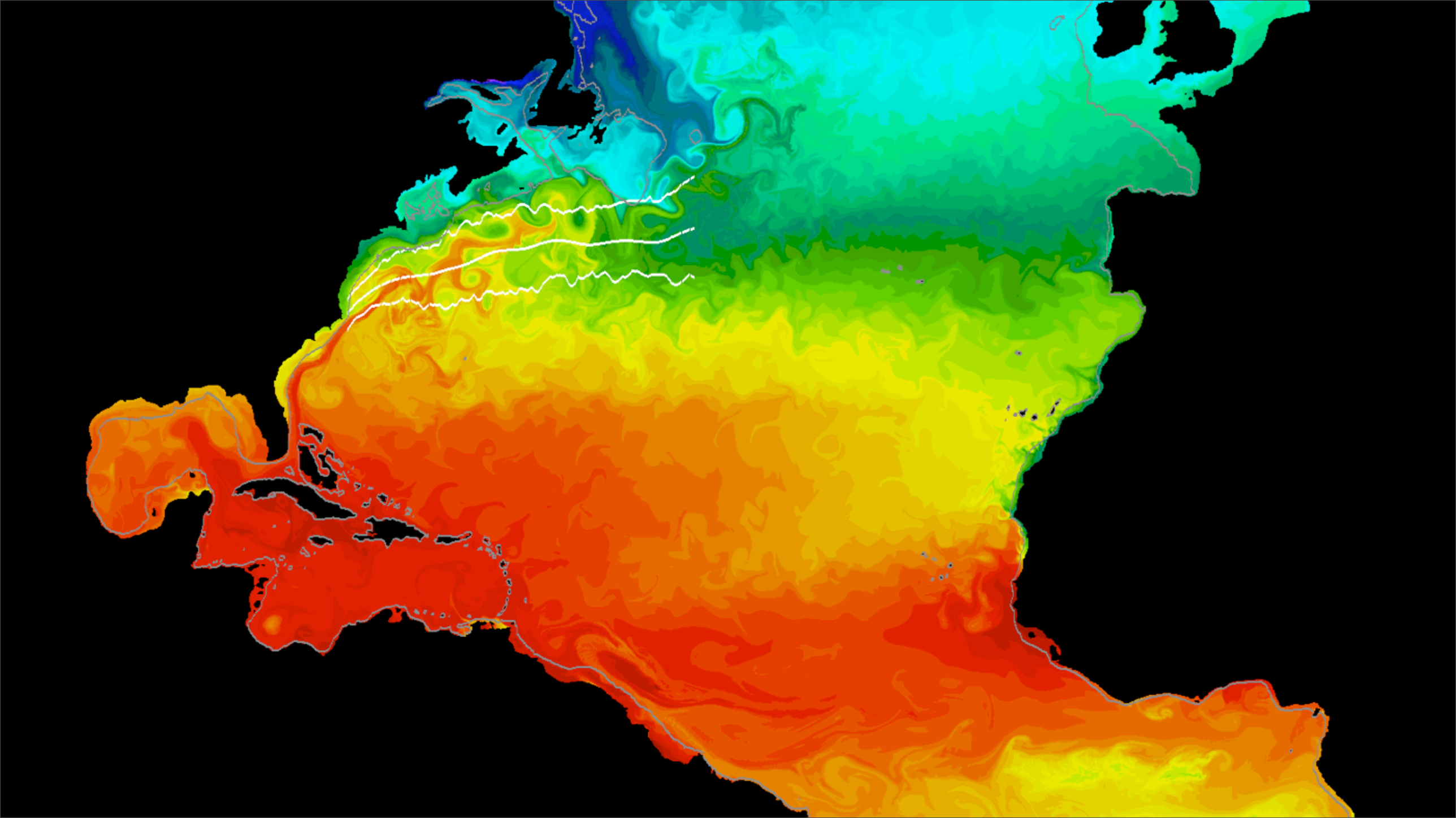

San Antonio
Winnipeg
30
20
10
0
–10
–20
Temperature (°C)
80
60
40
20
0
Temperature (°F)
J F M A M J J A S O N D
Month

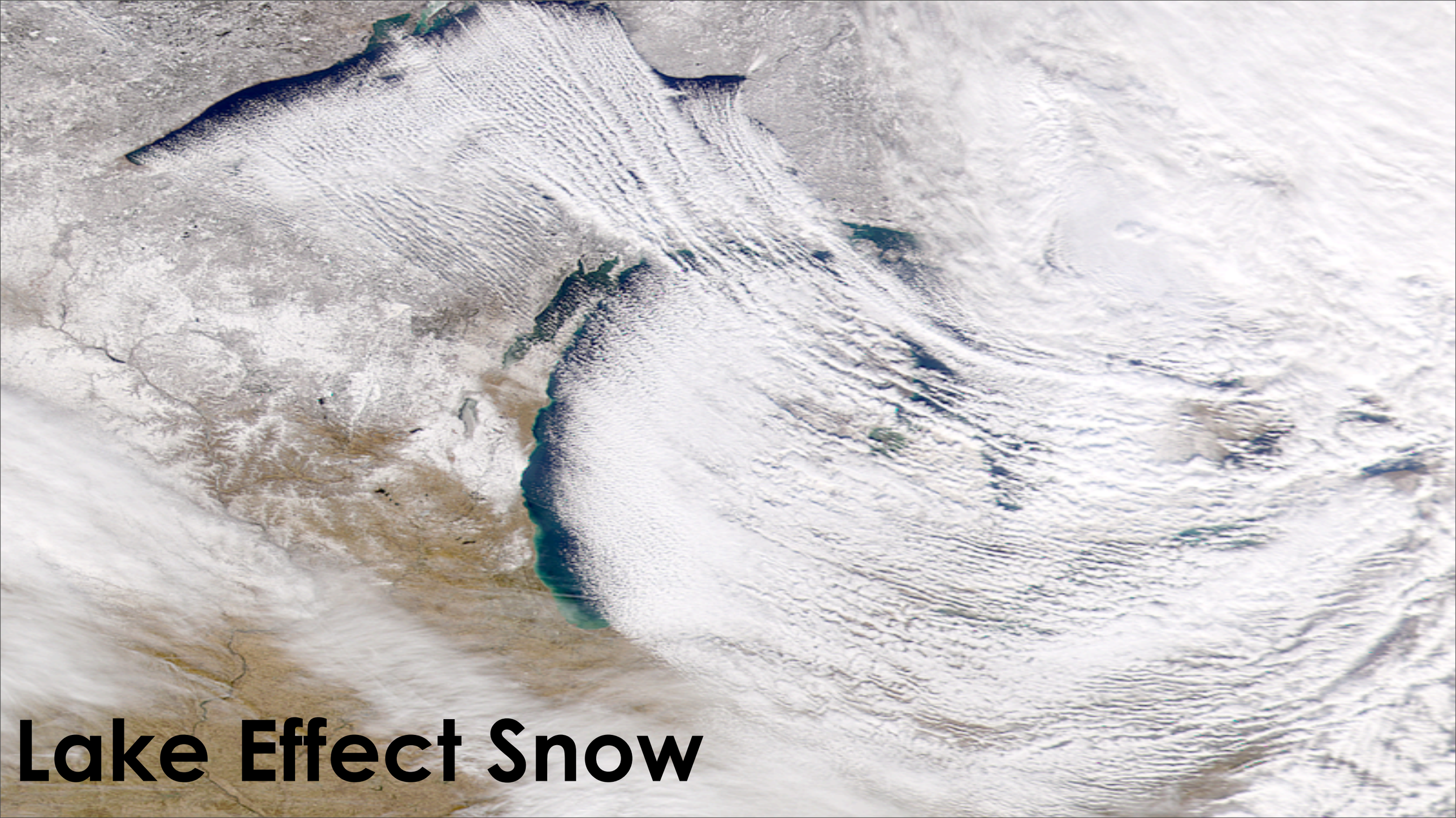


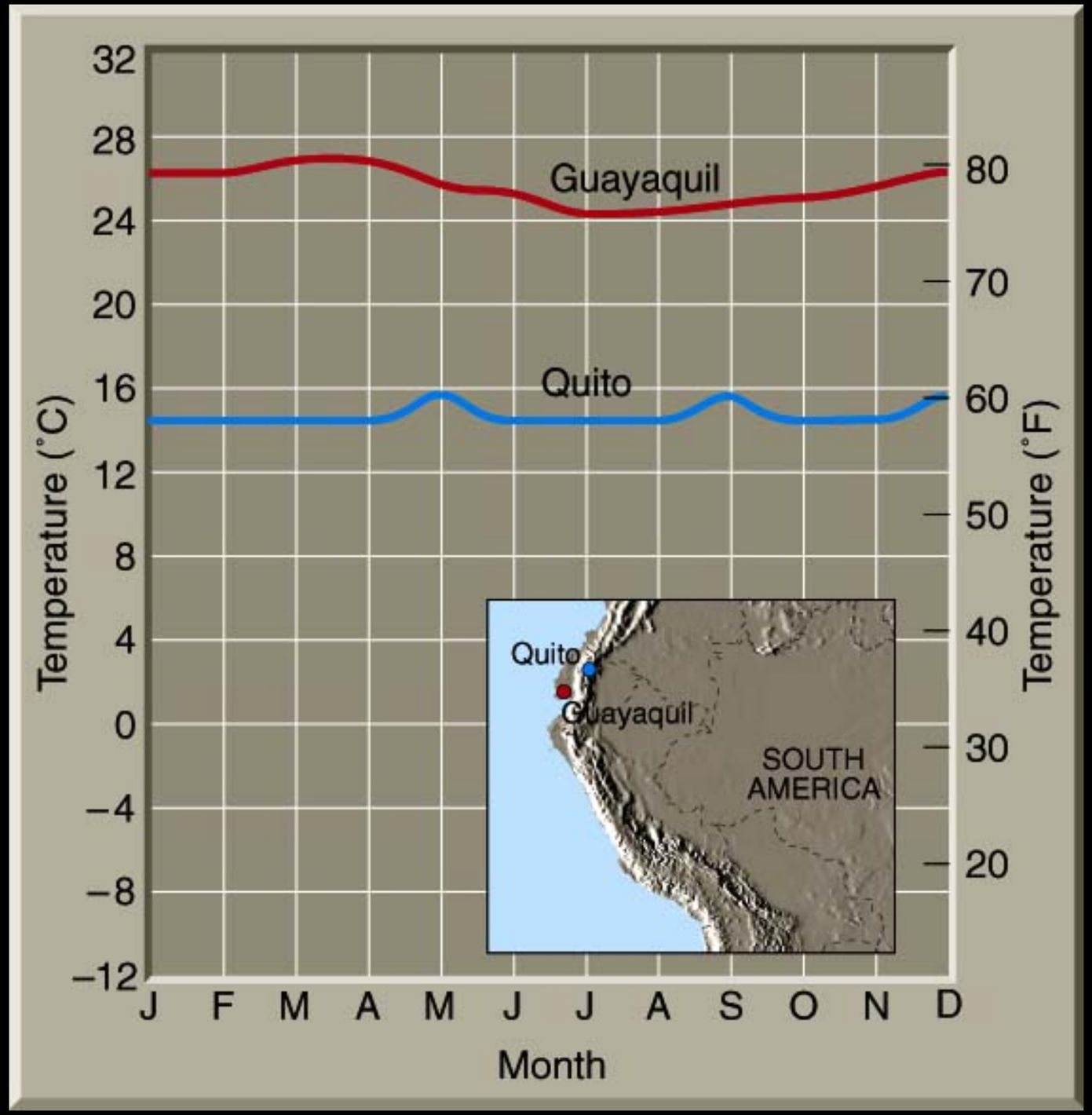

32
28
24
20
16
12
8
4
0
−4
−8
−12
Temperature (°C)
80
70
60
50
40
30
20
Temperature (°F)
Rio de Janeiro
Arica
J F M A M J J A S O N D
Month
0°
20°
40°
80°
60°
40°
Arica
Rio de Janeiro

Surface Ocean Currents






Lake Effect Snow


32
28
24
20
16
12
8
4
0
−4
−8
−12
Temperature (°C)
80
70
60
50
40
30
20
Temperature (°F)
Guayaquil
Quito
J F M A M J J A S O N D
Month
Quito
Guayaquil
SOUTH AMERICA

