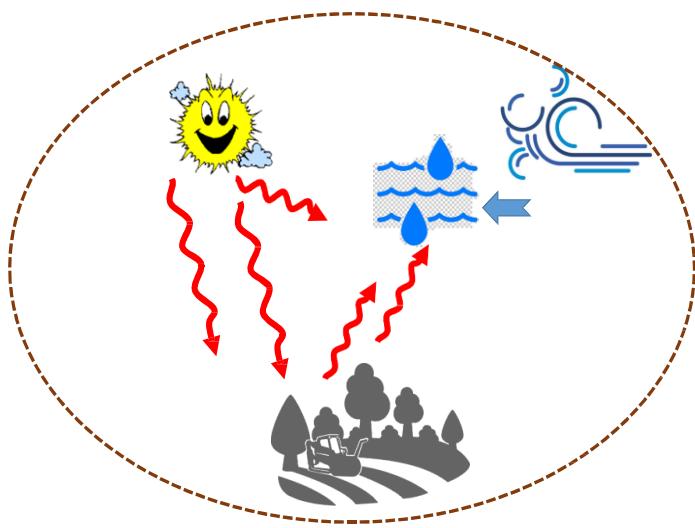


FUNDAMENTALS OF CLIMATE CHANGE AND NATURAL DISASTERS (3 ECTS)

Lecturer: Assoc. Prof. Dr. Le Anh Tuan



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Lecture notes

FUNDAMENTALS OF CLIMATE CHANGE AND NATURAL DISASTERS

Course Code: ER601

Chapter 1

BASICS ON CLIMATE SCIENCES

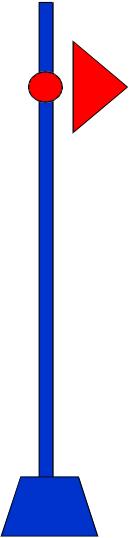
Assoc.Prof.Dr Lê Anh Tuấn

Viện Nghiên cứu Biến đổi Khí hậu – Đại học Cần Thơ

Khoa Môi trường và Tài nguyên Thiên Nhiên

Trường Đại học Cần Thơ

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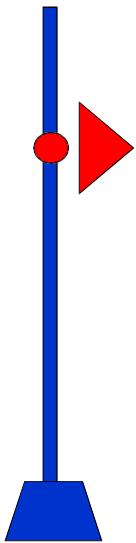
Chapter 1. Basics on Climate Sciences

1. Definitions
2. Earth's Climate System
3. Major Meteorological Factors
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Exercises and Discussion



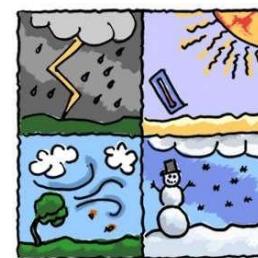
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- **Meteorology**

Meteorology is the science that studies the atmosphere, mainly about monitoring and forecasting the weather (temperature, humidity, rain, sun, wind, radiation,...)

- **Weather**

Weather is a collection of states of meteorological factors occurring in the atmosphere at a certain short period of time (day/time).

- **Climate**

Climate is average weather over a long period of time.(over 30 years – according to WMO)



**"Climate is what you would expect,
Weather is what you get"**

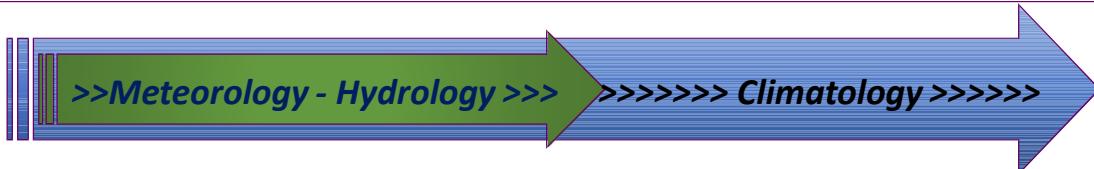
(Idioms)



Meteorology - Hydrology is a branch of science that studies:

- the properties, characteristics of formation and classification of physical phenomena occurring in the atmosphere and river flows, as well as the mutual influence of these phenomena with each other.
- describe the complex changes of nature so that we can prevent, prevent and partially avoid natural disasters, reduce risks in production life and improve living environment.

Climatology is the science that studies the laws and phenomena of the climate and predicts climate change.



SOME WEBSITES RELATED TO WEATHER – CLIMATE

<http://pclb.vnn.vn>

<http://www.nsc.org/ehc/ew/disaster>

<http://www.discovery.com/guides/weather>

<http://www.hurricanehunters.com>

<http://rsd.gsfc.nasa.gov/rsd/images>

<http://www.metoffice.gov.uk/sec6>

<http://www.stormchaser.niu.edu/chaser>

<http://weather.yahoo.com>

<https://climate.nasa.gov/>

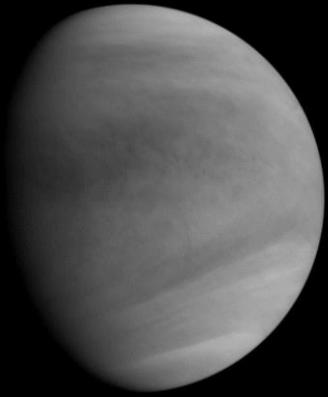
**WEATHER ON THE
EARTH IS NEVER
THE SAME FROM
ONE PLACE TO
ANOTHER**



EARTH \neq OTHER PLANETS



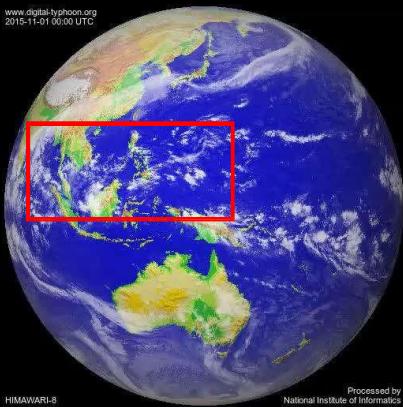
Himawari-8 2016.09.09 08:00JST



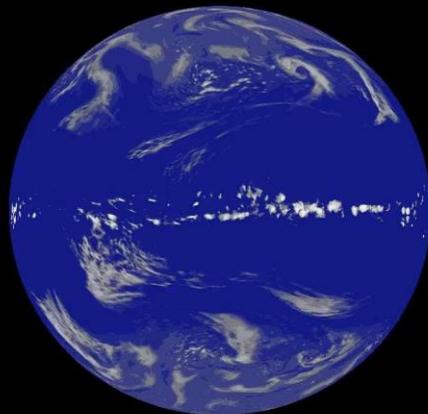
Himawari-8/JMA (1-30 Nov 2015)

NICAM/JAMSTEC (Satoh et al., 2008)

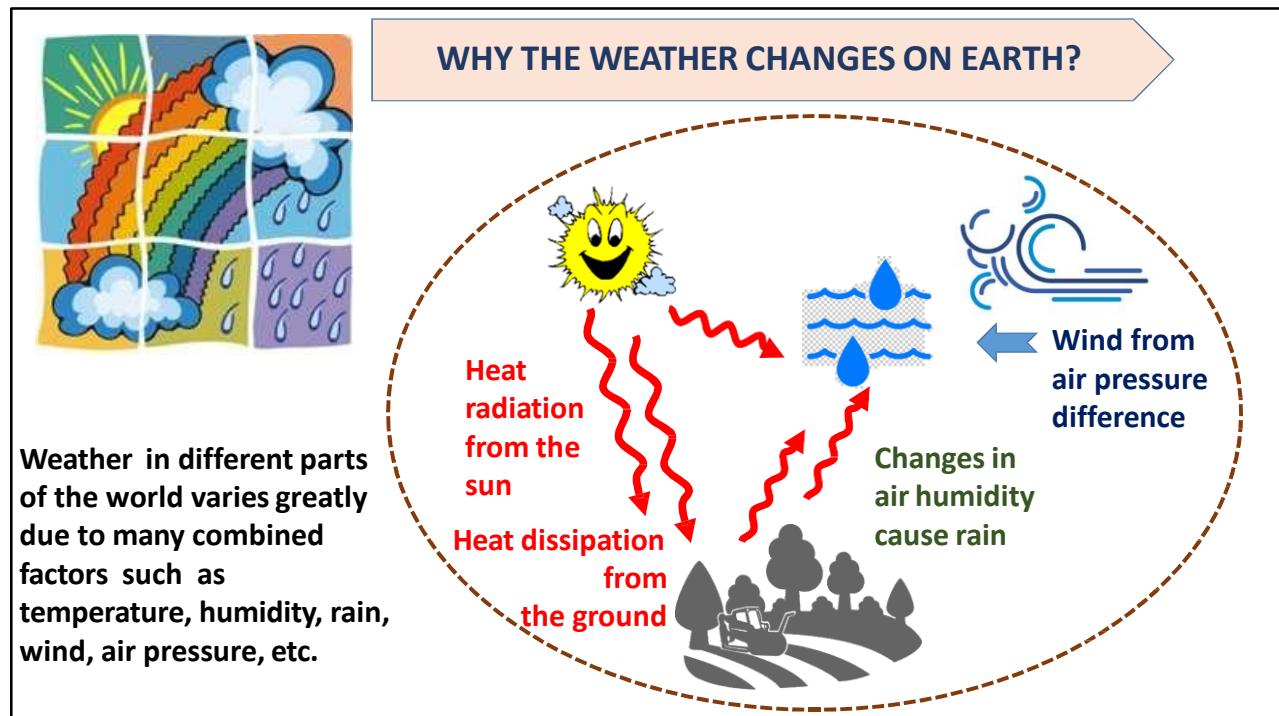
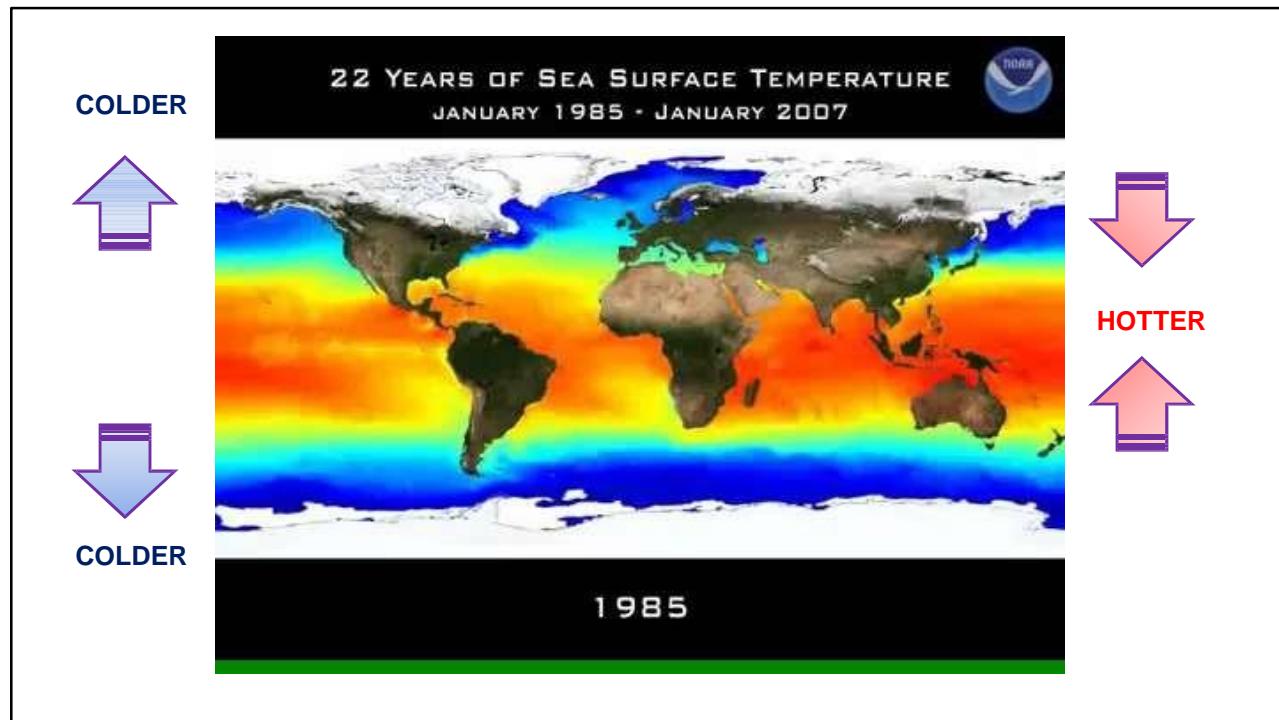
EARTH \neq EARTH WITHOUT CONTINENTS



Himawari-8/JMA (1-30 Nov 2015)

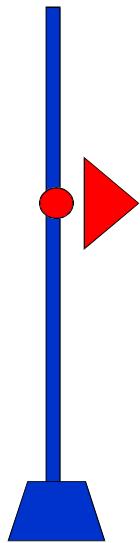


NICAM/JAMSTEC (Satoh et al., 2008)





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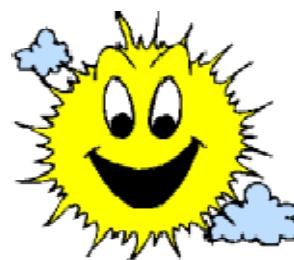
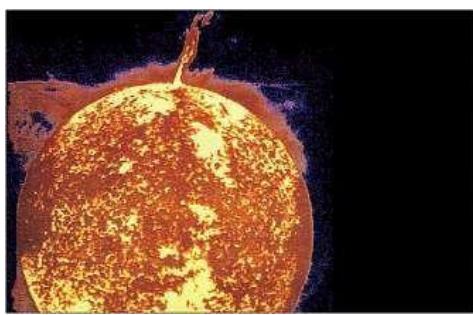
Chapter 1. Basics on Climate Sciences

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EARTH'S CLIMATE SYSTEM

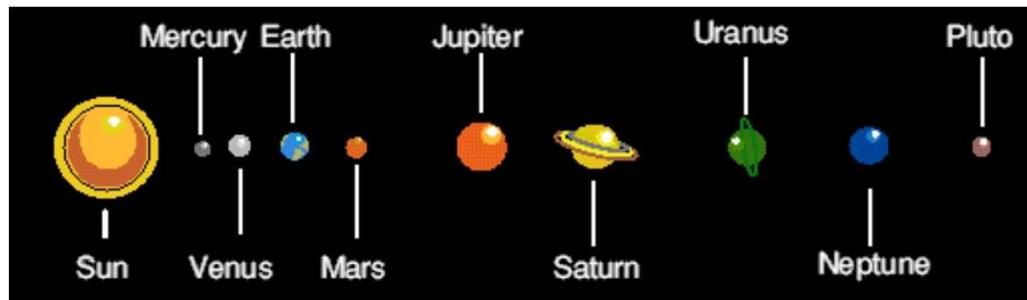
Climate is the result of a complex interaction of physical, chemical and biological processes under the influence of solar energy.



The sun is the source of energy for life on earth and the source of energy for the climate.

<https://www.youtube.com/watch?reload=9&v=HFT7ATLQQx8>

SOLAR SYSTEM



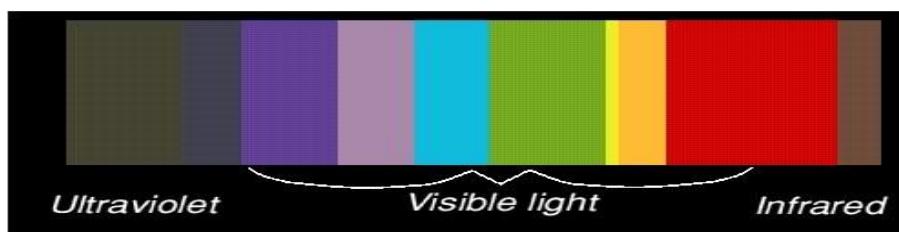
(0) **Sun**: Mát trời; (1) **Mercury**: Thủ tinh; (2) **Venus**: Kim tinh; (3) **Earth**: Trái đất;
 (4) **Mars**: Hỏa tinh; (5) **Jupiter**: Mộc tinh; (6) **Saturn**: Thổ tinh; (7) **Uranus**: Thiên vương tinh;
 (8) **Neptune**: Hải vương tinh; (9) **Pluto**: Diêm vương tinh

(Currently, astronomers do not consider Pluto as a planet in the solar system)

SOLAR SPECTRUM

Solar energy radiates in all directions as electromagnetic radiation: visible light, ultraviolet radiation, infrared radiation,...

Solar radiation is actually an electromagnetic wave that propagates through space at the speed of light, its wavelength is not the same, but it creates a spectrum.



$\lambda = 0,20 - 0,39 \mu$
ultraviolet radiation

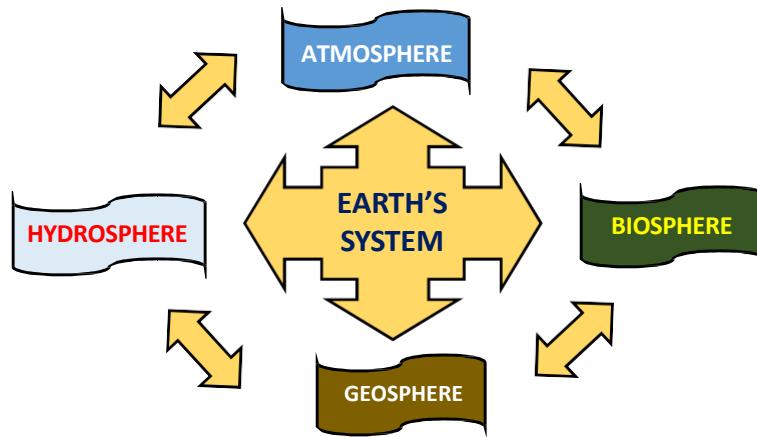
$\lambda = 0,39 - 0,76 \mu$
visible light

$\lambda = 0,76 - 24,0 \mu$
infrared radiation

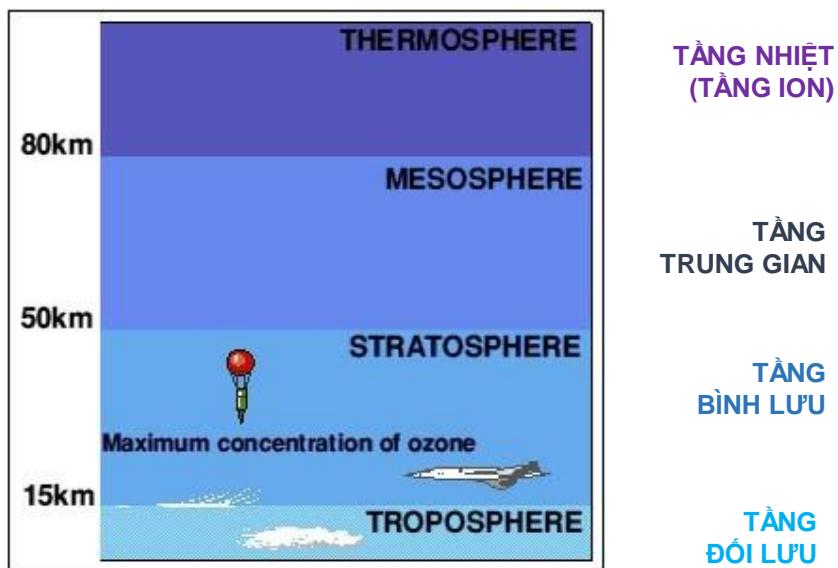
(ở là micromet = 10^{-6} metter)

EARTH'S CLIMATE SYSTEM

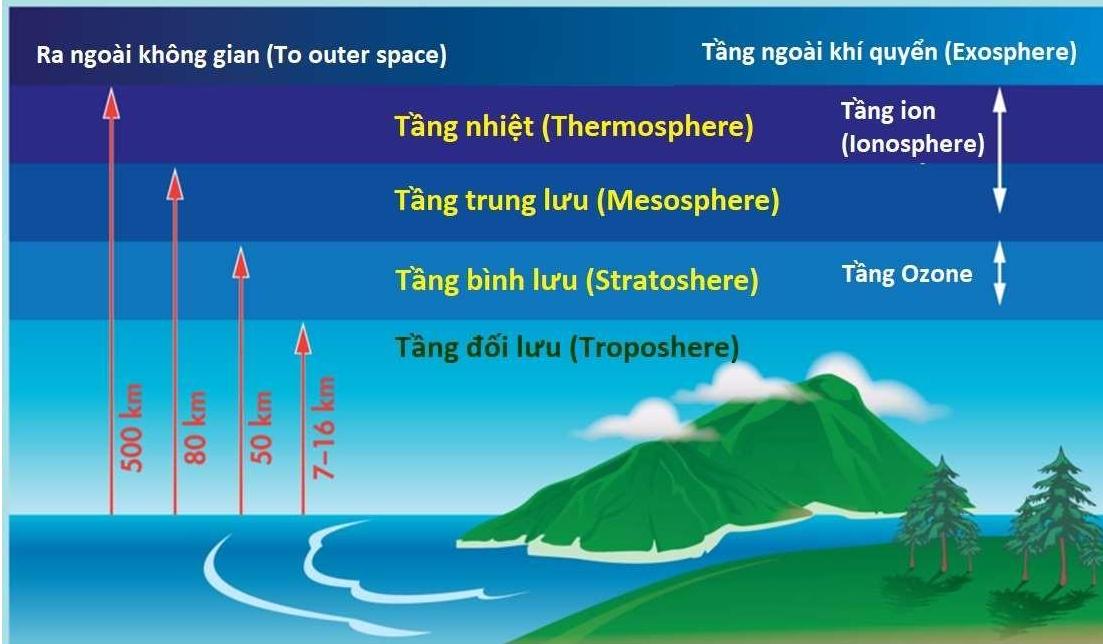
“Climate system” is the sum total of the atmosphere, hydrosphere, biosphere and geosphere and their interactions.



4 layers of atmosphere



4 TẦNG KHÍ QUYỀN



TẦNG ĐỔI LƯU (Troposphere)

- Cao độ trung bình từ mặt đất lên cao 11 km, ở 2 cực của Trái đất dày khoảng 8 - 10 km, còn ở vùng xích đạo là 15 - 18 km.
- **Mây và hơi nước tập trung dày đặc từ độ cao 1 - 8 km, tất cả các hiện tượng như mưa, gió, bão, ... đều xảy ra ở tầng này.**
- Tầng này chiếm 80% khối lượng không khí và 90% hơi nước và luôn có sự tác động qua lại giữa mặt đất, đại dương và khí quyển.
- **Không khí chuyển động theo hình thẳng đứng: dòng thăng (không khí đi từ dưới lên trên) và dòng giáng (không khí đi theo chiều từ trên xuống dưới).**

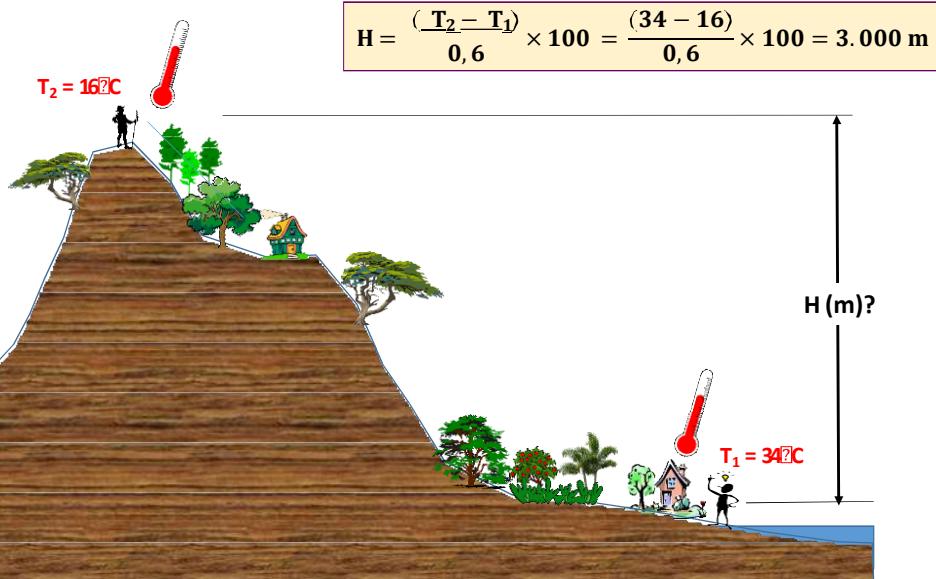
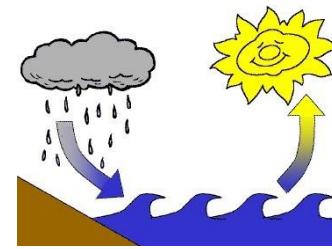


TROPOSPHERE

The movement of air produces a change in kinetic energy, which is dependent on atmospheric pressure and produces a thermal state. As the air mass moves upward, the pressure decreases and expands due to the decrease in density and causes the temperature to decrease accordingly. Conversely, as the air mass goes down, the pressure increases and the temperature also increases.

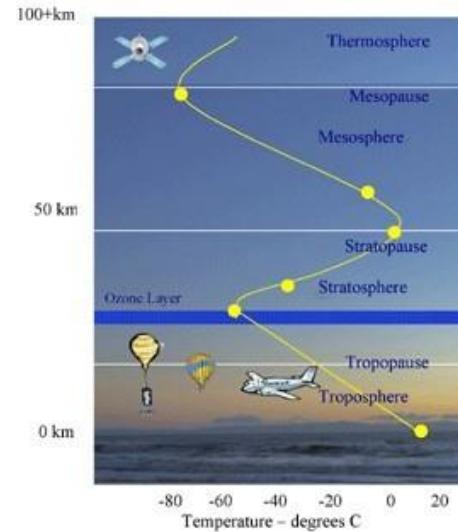
The phenomenon of vertical fluctuations (up and down) in air masses is the main cause of climate change on earth.

In the troposphere, for every 100 m elevation, the air temperature decreases by about 0.6 C. At an altitude of nearly 11 km, the air temperature can be minus 60 - 50 C



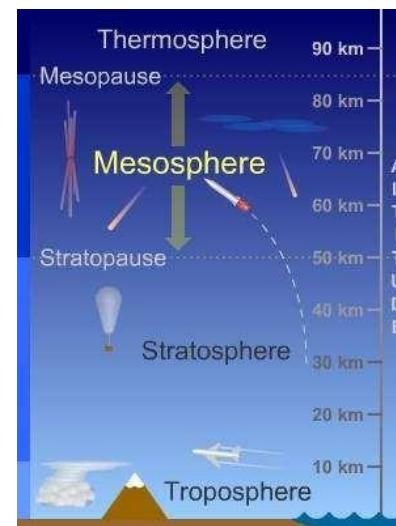
STRATOSPHERE

- The stratosphere is at an altitude of 11 km to 50 km. Here the density of water vapor is very small or negligible, so there are no clouds.
- In the stratosphere the air is less perturbed in the vertical direction. In the stratosphere, the air is very thin, the temperature changes little between 15 - 35 km, about -55°C
- In this layer, the proportion of ozone gas (O_3) is high, the stratosphere has the effect of absorbing short-wave rays of solar radiation (ultraviolet rays), significantly reducing the danger of these rays from the sun. shine on earth.



MESOSPHERE

- The mesosphere is at an altitude of about 50 - 80 km, located between the stratosphere and the thermosphere.
- The intermediate layer between the atmosphere and space (over 2000 km), the air in the extremely thin string contains only hydrogen and helium.



THERMOSPHERE

• The thermosphere, also known as the ionosphere or ionospheric layer, at an altitude of over 85 km, the air is very thin, only in the form of charged ion particles, this layer has the effect of preventing solar radiation. Heaven helps creatures on earth to survive.

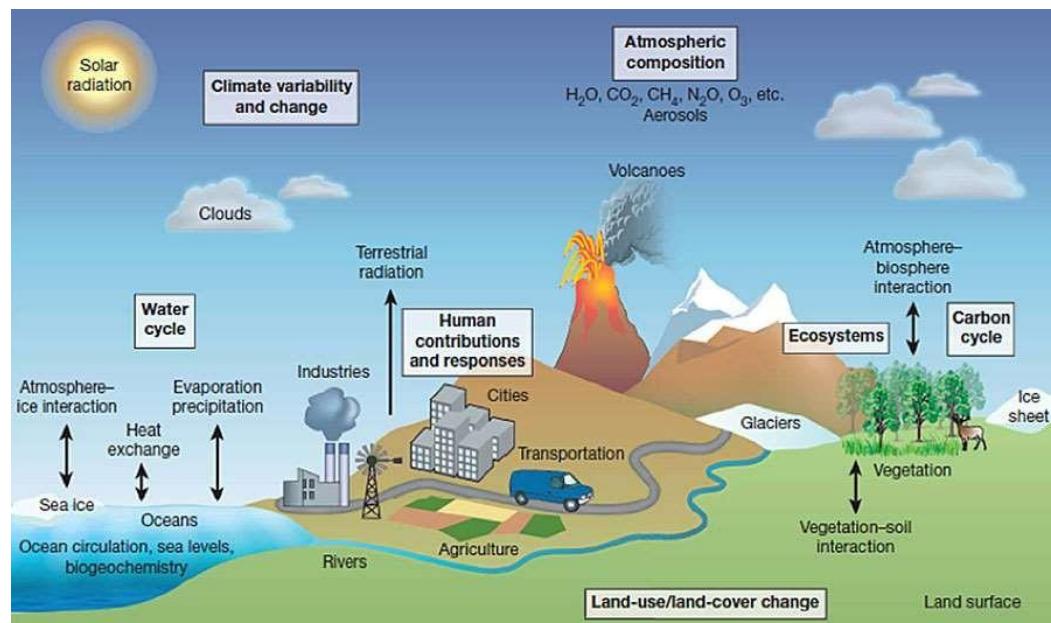
• The important feature of this layer is that the temperature is quite high and increases rapidly with altitude. At an altitude of 200 km, the temperature is 200 °C and the limit is around 2,000 °C.

• This layer has a high electrical conductivity that reflects radio waves emitted from the ground.



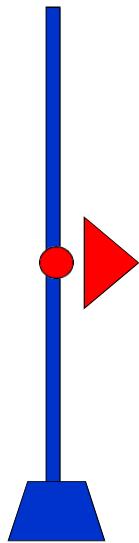
GLOBAL CLIMATE SYSTEM

The complex and continuous interactions between the Atmosphere, Hydrosphere, Geosphere and Biosphere (and part of the Icesphere)





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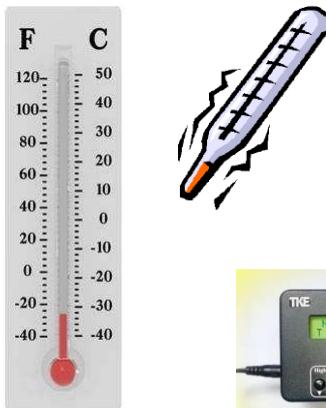
Exercises and Discussion



TEMPERATURE

- Temperature is a measure of how hot or cold a mass of gas, land, water, or object is.

- There are two types of thermometers:
 - + Celsius thermometer 
 - + Fahrenheit thermometer 

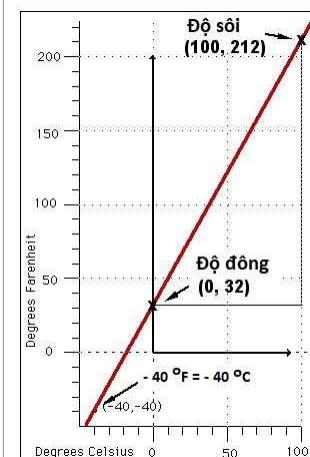
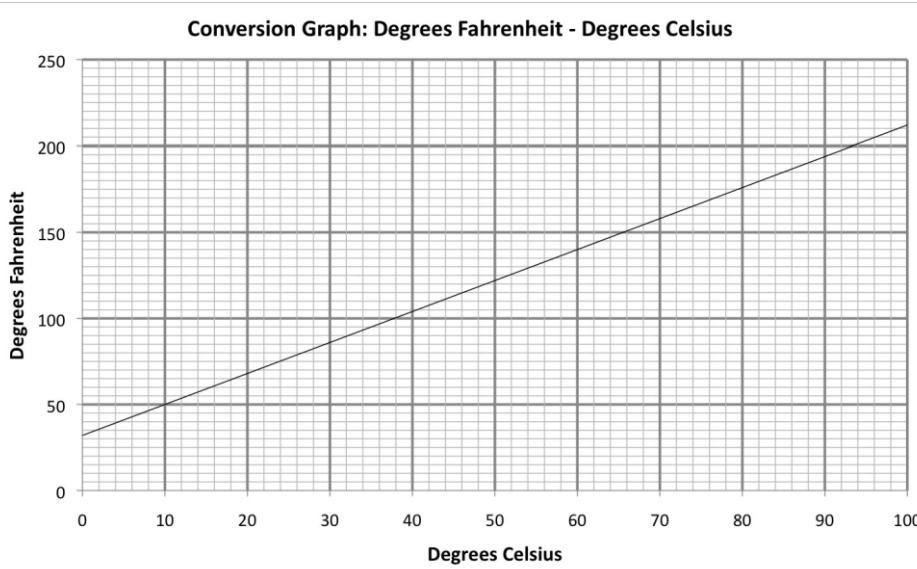


Relationship between C and F:

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$$

RELATIONSHIP BETWEEN CELSIUS TEMPERATURE AND FAHRENHEIT TEMPERATURE



AIR HUMIDITY/ MOISTURE

- Air humidity is the amount of water vapor contained in the air.
- The air layer close to the ground always has water vapor: water from lakes, rivers, seas, ... evaporates, transpiration from respiration of plants and animals and water vapor from industrial activities, the boiler emits.



Am kế cầm tay

There are 4 concepts of humidity and units of measurement:

- **Absolute humidity:** describes the amount of water vapor present in a given volume of a gaseous mixture. The common unit used to calculate absolute humidity is grams of water per cubic meter of air (g/m^3).
- **Relative humidity:** is the ratio of the present vapor pressure of any mixture of gases to water vapor to the saturated water vapor pressure, in %.
- **Saturated humidity:** also known as maximum humidity, is the amount of water vapor saturated in the air at a given time, volume and temperature, expressed in grams/m^3 .
- **Humidity ratio f:** is a quantity measured as the ratio of the absolute humidity a and the maximum humidity A of the air at the same given

$$f = (a/A) \times 100\%$$

Relative humidity (RH%) is determined as:

$$RH = \frac{e_p}{e_s} \times 100\%$$

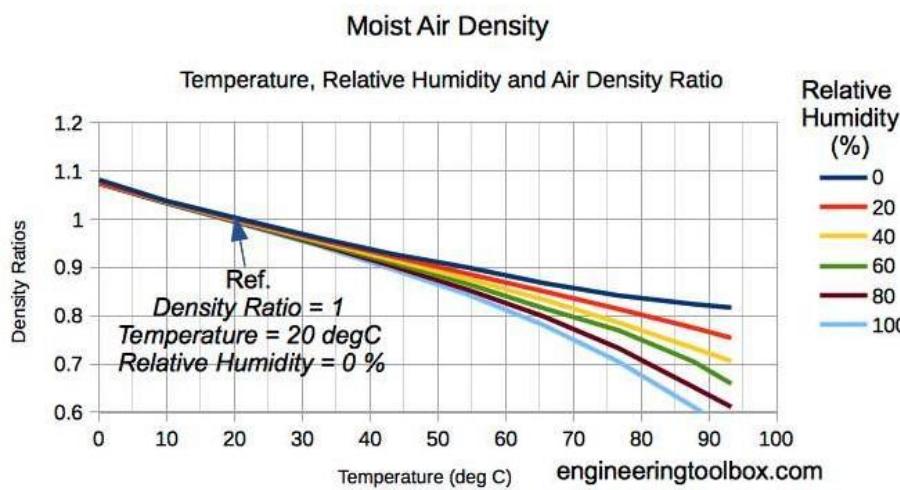
e_p – specific pressure of water and

e_s – steam pressure has been equalized.

Hygrometers usually indicate relative humidity(%).

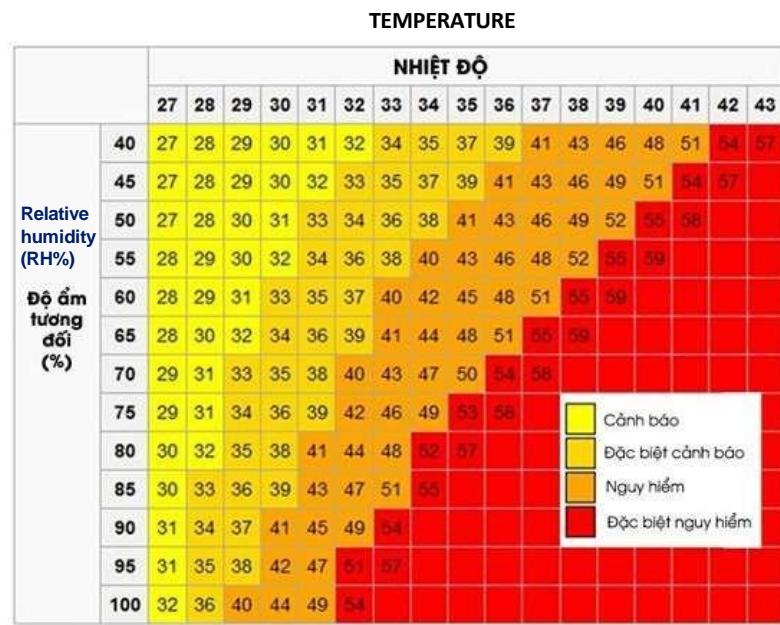


Relationship between Temperature (oC), Relative Humidity (%) and the ratio of density of water vapor in the air



WHEN HIGH HUMIDITY:

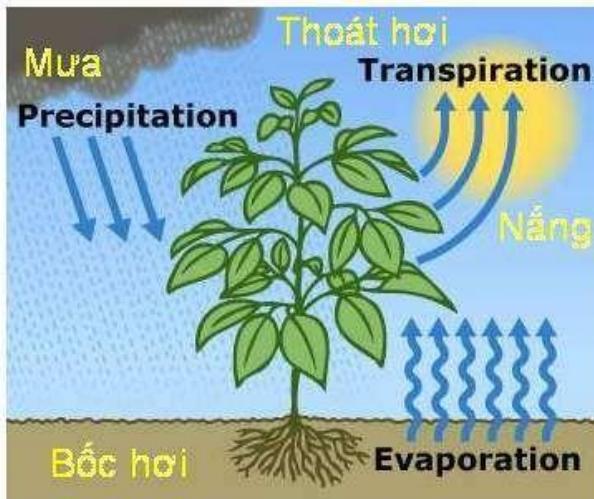
- Feeling uncomfortable, tired for the body
- Clothes take a long time to dry, appear moldy
- Floor standing water causes slippery
- Viruses, bacteria, molds, and house dust mites have the opportunity to grow.
- Increased risk of respiratory, digestive and some skin diseases.
- Irritation of the lining of the airways, leading to inflammation, increased secretion and bronchospasm leading to coughing, sneezing, difficulty breathing, etc.
- In addition, high air humidity can easily cause fire and damage to equipment.



EVAPORATION & TRANSPIRATION



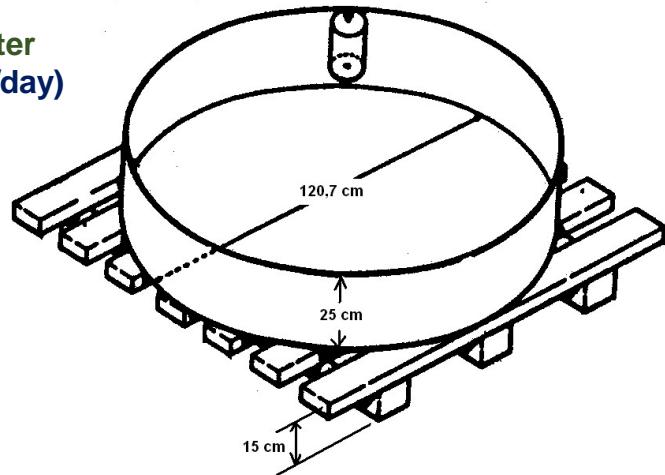
- **Evaporation** is the phenomenon of converting water molecules from liquid to vapor due to the main effect of temperature, wind and entering the air.
- **Transpiration** is evaporation that occurs at the surface of plant and animal tissues, or the ground.
- In the water balance, collectively known as **evapotranspiration**, is the total amount of water lost due to the evaporation of water from the surface of the water, the ground, through the leaves of the vegetation cover, ...
- The amount of evapotranspiration is usually calculated by the thickness of the evaporated water layer, the unit is **mm**.



$$\text{BỐC HƠI} + \text{THOÁT HƠI} = \text{BỐC THOÁT HƠI}$$

$$\text{EVAPORATION} + \text{TRANSPIRATION} = \text{EVAPOTRANSPIRATION}$$

Evaporation rate is the amount of water that evaporates in a unit of time (mm/day)



WOMEN STANDARD EVAPORATOR

Round cube, stainless steel or galvanized sheet

Diameter: 120.7 cm

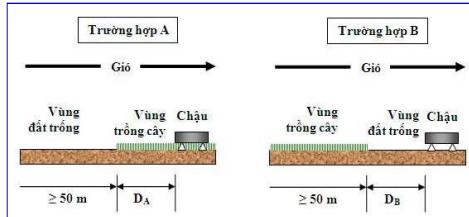
Height: 25cm, pour water 20cm high.

Place on Shelf height: 15 cm

Type A pan evaporation recording method

E_{pan} - the amount of evaporation measured directly from the pan (mm)
 K_p - pan evaporation coefficient. K_p depends on the shape of the pan (pan type, color), location of the pan, humidity and wind conditions..

The K_p value is usually in the range of 0.35 - 0.85, on average, $K_p = 0.70$ can be selected.



| Châu A | Trường hợp A: đặt trên thảm cỏ | | | Trường hợp B: đặt trên mặt đất khô ráo | | | | |
|------------|--------------------------------|--------------------|----------------|--|-----------|----------------|----------|------|
| | Độ ẩm RH trung bình (%) | Thấp < 40 | Tr. Bình 40-70 | Cao > 70 | Thấp < 40 | Tr. Bình 40-70 | Cao > 70 | |
| | Vận tốc gió (m/s) | D _A (m) | | D _B (m) | | | | |
| Nhẹ | 1 | 0.55 | 0.65 | 0.75 | 1 | 0.7 | 0.8 | 0.85 |
| < 2 | 10 | 0.65 | 0.75 | 0.85 | 10 | 0.6 | 0.7 | 0.8 |
| | 100 | 0.7 | 0.8 | 0.85 | 100 | 0.55 | 0.65 | 0.75 |
| | 1000 | 0.75 | 0.85 | 0.85 | 1000 | 0.5 | 0.6 | 0.7 |
| Trung bình | 1 | 0.5 | 0.6 | 0.65 | 1 | 0.65 | 0.75 | 0.8 |
| 2-5 | 10 | 0.6 | 0.7 | 0.75 | 10 | 0.55 | 0.65 | 0.7 |
| | 100 | 0.65 | 0.75 | 0.8 | 100 | 0.5 | 0.6 | 0.65 |
| | 1000 | 0.7 | 0.8 | 0.8 | 1000 | 0.45 | 0.55 | 0.6 |
| Mạnh | 1 | 0.45 | 0.5 | 0.6 | 1 | 0.6 | 0.65 | 0.7 |
| 5-8 | 10 | 0.55 | 0.6 | 0.65 | 10 | 0.5 | 0.55 | 0.65 |
| | 100 | 0.6 | 0.65 | 0.7 | 100 | 0.45 | 0.5 | 0.6 |
| | 1000 | 0.65 | 0.7 | 0.75 | 1000 | 0.4 | 0.45 | 0.55 |
| Rất mạnh | 1 | 0.4 | 0.45 | 0.5 | 1 | 0.5 | 0.6 | 0.65 |
| > 8 | 10 | 0.45 | 0.55 | 0.6 | 10 | 0.45 | 0.5 | 0.55 |
| | 100 | 0.5 | 0.6 | 0.65 | 100 | 0.4 | 0.45 | 0.5 |
| | 1000 | 0.55 | 0.6 | 0.65 | 1000 | 0.35 | 0.4 | 0.45 |

(Nguồn: FAO, Irrigation and Drainage paper No. 50)

Blaney – Crridle Method

$$ET_o = p(0.48T + 8)$$

T - average daily temperature (|C);

p - percentage of annual average lighting hours for days of the month in an irrigation cycle. The value of p depends on the geographical latitude of the place of consideration and the calculation time for the crop season, determined according to table 3.1.

| Vĩ độ | Tháng | | | | | | | | | | | | |
|-------|------------|----------|------------|-----------|---------|---------|-----------|----------|------------|-----------|---------|---------|-----------|
| | Bắc Nam | I VII | II VIII | III IX | IV X | V XI | VI XII | VII I | VIII II | IX III | X IV | XI V | XII VI |
| 60° | 0.15 | 0.20 | 0.26 | 0.32 | 0.38 | 0.41 | 0.40 | 0.34 | 0.28 | 0.22 | 0.17 | 0.13 | |
| 55° | 0.17 | 0.21 | 0.26 | 0.32 | 0.36 | 0.39 | 0.38 | 0.33 | 0.28 | 0.23 | 0.18 | 0.16 | |
| 50° | 0.19 | 0.23 | 0.27 | 0.31 | 0.34 | 0.36 | 0.35 | 0.32 | 0.28 | 0.24 | 0.20 | 0.18 | |
| 45° | 0.20 | 0.23 | 0.27 | 0.30 | 0.34 | 0.35 | 0.34 | 0.32 | 0.28 | 0.24 | 0.21 | 0.20 | |
| 40° | 0.22 | 0.24 | 0.27 | 0.30 | 0.32 | 0.34 | 0.33 | 0.31 | 0.28 | 0.25 | 0.22 | 0.21 | |
| 35° | 0.23 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 | 0.32 | 0.30 | 0.28 | 0.25 | 0.23 | 0.22 | |
| 30° | 0.24 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 | 0.31 | 0.30 | 0.28 | 0.26 | 0.24 | 0.23 | |
| 25° | 0.24 | 0.26 | 0.27 | 0.29 | 0.30 | 0.31 | 0.31 | 0.29 | 0.28 | 0.26 | 0.25 | 0.24 | |
| 20° | 0.25 | 0.26 | 0.27 | 0.28 | 0.29 | 0.30 | 0.30 | 0.29 | 0.28 | 0.26 | 0.25 | 0.25 | |
| 15° | 0.26 | 0.26 | 0.27 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.27 | 0.26 | 0.25 | |
| 10° | 0.26 | 0.27 | 0.27 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.27 | 0.26 | 0.26 | |
| 5° | 0.27 | 0.27 | 0.27 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.27 | 0.27 | 0.27 | |
| 0° | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | |

Example 3.1: Calculate ETo reference evapotranspiration according to Blaney – Criddle for April in the 25°North latitude region. The average daily temperature in April is 21.5 °C

At latitude 25° North in April there is $p = 0.29$ (table 3.1). With $T = 21.5^{\circ}\text{C}$ the reference evapotranspiration will be:

$$\text{ET}_o = p(0.48T + 8) = 0.29 (0.48 \times 21.5 + 8) = 5.2 \text{ mm/day}$$

| | | Bảng 3.1: Bảng tra hệ số p trong công thức Blaney-Criddle | | | | | | | | | | | |
|-------|------|---|------|------|------|------|------|------|------|------|------|------|-----|
| Vĩ độ | | Tháng | | | | | | | | | | | |
| Bắc | Nam | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| 60° | 0.15 | 0.20 | 0.26 | 0.32 | 0.38 | 0.41 | 0.40 | 0.34 | 0.28 | 0.22 | 0.17 | 0.13 | |
| 55° | 0.17 | 0.21 | 0.26 | 0.32 | 0.36 | 0.39 | 0.38 | 0.33 | 0.28 | 0.23 | 0.18 | 0.16 | |
| 50° | 0.19 | 0.23 | 0.27 | 0.31 | 0.34 | 0.36 | 0.35 | 0.32 | 0.28 | 0.24 | 0.20 | 0.18 | |
| 45° | 0.20 | 0.23 | 0.27 | 0.30 | 0.34 | 0.35 | 0.34 | 0.32 | 0.28 | 0.24 | 0.21 | 0.20 | |
| 40° | 0.22 | 0.24 | 0.27 | 0.30 | 0.32 | 0.34 | 0.33 | 0.31 | 0.28 | 0.25 | 0.22 | 0.21 | |
| 35° | 0.23 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 | 0.32 | 0.30 | 0.28 | 0.25 | 0.23 | 0.22 | |
| 30° | 0.24 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 | 0.31 | 0.30 | 0.28 | 0.26 | 0.24 | 0.23 | |
| 25° | 0.24 | 0.26 | 0.27 | 0.29 | 0.30 | 0.31 | 0.31 | 0.29 | 0.28 | 0.26 | 0.25 | 0.24 | |
| 20° | 0.25 | 0.26 | 0.27 | 0.28 | 0.29 | 0.30 | 0.30 | 0.29 | 0.28 | 0.26 | 0.25 | 0.25 | |
| 15° | 0.26 | 0.26 | 0.27 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.27 | 0.26 | 0.25 | |
| 10° | 0.26 | 0.27 | 0.27 | 0.28 | 0.28 | 0.29 | 0.29 | 0.28 | 0.28 | 0.27 | 0.26 | 0.26 | |
| 5° | 0.27 | 0.27 | 0.27 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.27 | 0.27 | 0.27 | |
| 0° | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | |

Blaney – Corrected Modified Formula

(Doorenbos và Pruitt, 1977)

$$\text{ET}_o = N \left(\frac{a}{K_5} + bP \left[\frac{T}{K_1} + K_2 \right] \right)$$

- N - number of watering days in 1 irrigation cycle (10 ≤ N ≤ 30) (day);
- a - experience factor, dependent on RH_{\min} (%) and ratio n/N ;
- b - experience factor, dependent on RH_{\min} , n/N and U_d ;
- RH_{\min} - minimum relative humidity (%);
- n/N - the ratio of actual hours/hours of maximum sunshine;
- U_d - daily average wind speed (m/s);
- P - percentage of average lighting hours, taken from table 3.1;
- T - average daily temperature during the irrigation period ($^{\circ}\text{C}$);
- K_1, K_2, K_5 – adjustment factors, can take $K_1 = 2.19$; $K_2 = 8.13$; $K_5 = 1$.

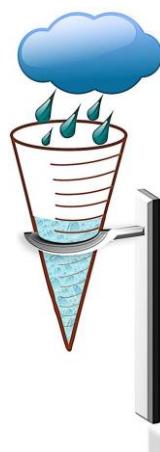
PRECIPITATION/ RAINFALL

Precipitation is the result of condensation of water vapor in the atmosphere, the process by which water changes from a vapor state to a liquid (rain, dew) or solid state (hail, snow) and falls to the ground.

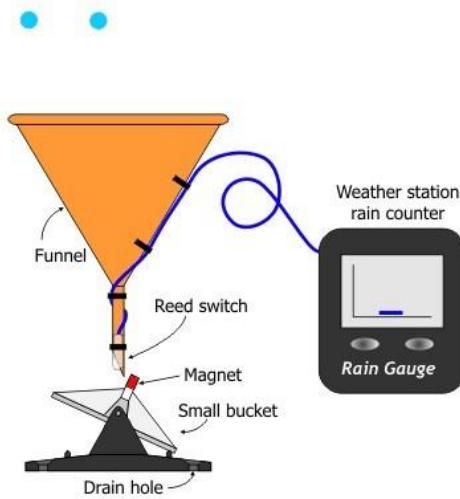
In an approximate concept in our country, the amount of precipitation and the amount of rain falling (rainfall) have almost the same value.



RAINFALL Recorders



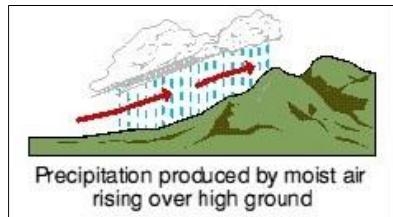
Rain gauges in the form of funnels



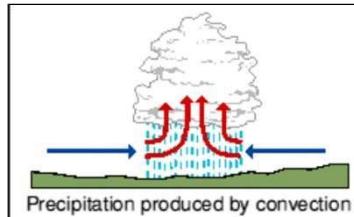
Automatic rain gauge by count type

PRECIPITATION/ RAINFALL

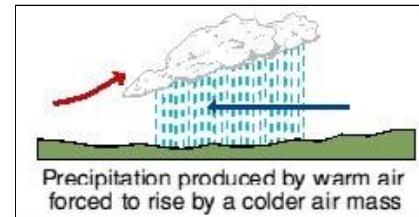
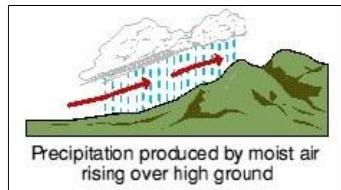
3 types of precipitation

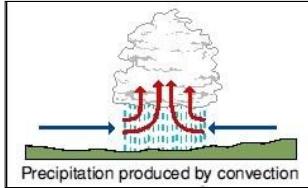
**Mưa địa hình**

Orographic precipitation

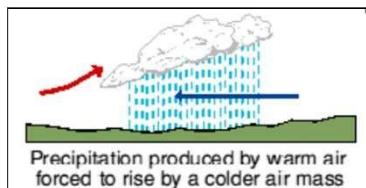
**Mưa đối lưu**

Convective precipitation

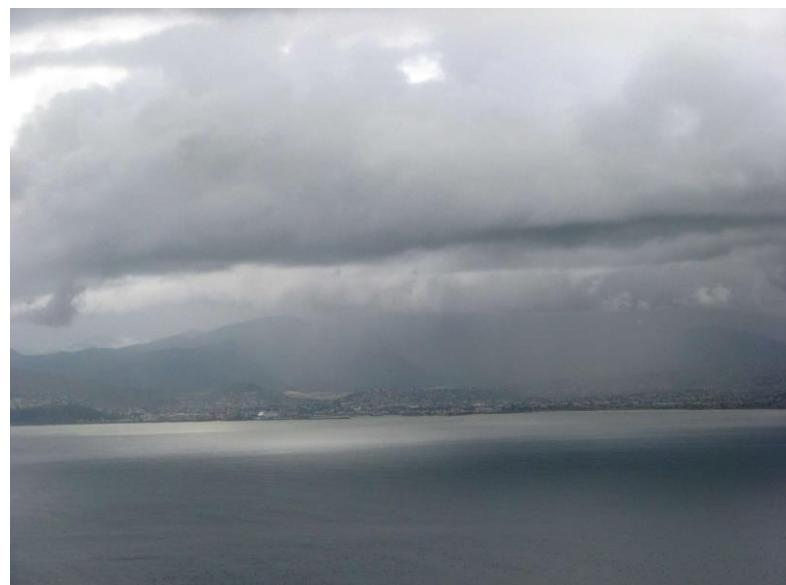
**Mưa front****Orographic precipitation**



Convective precipitation



Front



CÁC QUI ĐỊNH GỌI MƯA TRONG CÁC BẢN TIN THỜI TIẾT

Lượng mưa được tính bằng chiều dày đo bằng mm của lớp nước rơi trên một mặt phẳng nằm ngang, không bốc hơi, không thấm và chảy tràn đi. Cường độ mưa là lượng mưa tính ra mm rơi trong 1 phút. Cường độ mưa vượt quá 1 mm/phút gọi là *mưa rào*.

Tên gọi

- *Mưa vài nơi* Số trạm có mưa $\leq 1/3$ tổng số trạm đo mưa khu vực.
- *Mưa rải rác* Số trạm có mưa $> 1/3$ hoặc $= 1/2$ tổng số trạm đo mưa khu vực.
- *Mưa nhiều nơi* Số trạm có mưa $> 1/2$ tổng số trạm đo mưa khu vực.

Tên gọi

- *Mưa không đáng kể* Lượng mưa từ 0,0 - 0,5 mm.
- *Mưa nhỏ* Lượng mưa từ 0,5 - 10,0 mm
- *Mưa vừa* Lượng mưa từ 10,0 - 50,0 mm
- *Mưa to* Lượng mưa từ 50,0 - 100,0 mm
- *Mưa rất to* Lượng mưa $> 100,0$ mm

Qui định về diện mua (khu vực mua)

- Số trạm có mưa $\leq 1/3$ tổng số trạm đo mưa khu vực.
- Số trạm có mưa $> 1/3$ hoặc $= 1/2$ tổng số trạm đo mưa khu vực.
- Số trạm có mưa $> 1/2$ tổng số trạm đo mưa khu vực.

Qui định về lượng mua

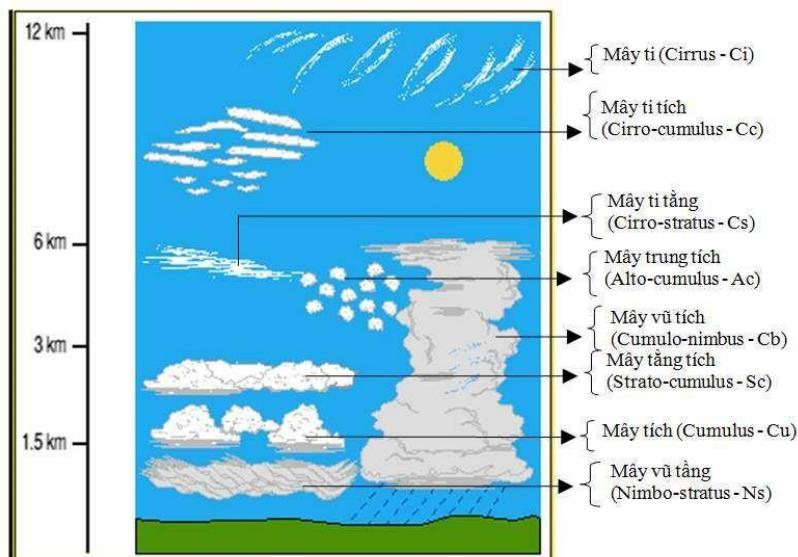
- Lượng mưa từ 0,0 - 0,5 mm.
- Lượng mưa từ 0,5 - 10,0 mm
- Lượng mưa từ 10,0 - 50,0 mm
- Lượng mưa từ 50,0 - 100,0 mm
- Lượng mưa $> 100,0$ mm



CLOUDS

SHAPES AND LOCATIONS OF CLOUDS

Clouds are visible masses of condensed water droplets or ice crystals suspended in the atmosphere above Earth.

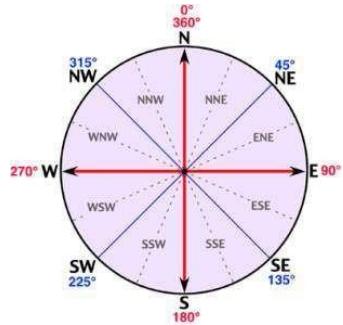


WIND

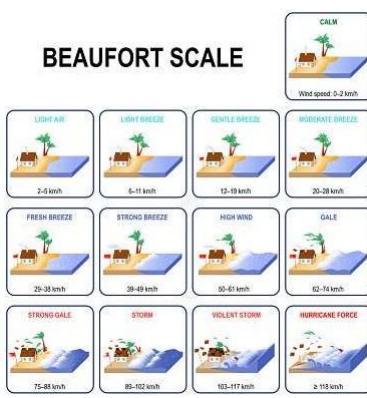
The horizontal movement of air relative to the ground is called wind.

Air tends to move from areas of high pressure to areas of low pressure. It is the movement of the air that creates the wind.

Wind is represented by wind speed and wind direction.



BEAUFORT SCALE



Bảng cấp gió (Beaufort Scale)

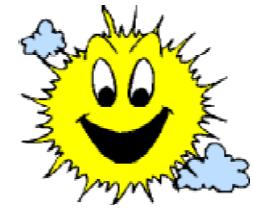
| Cấp gió | Tốc độ (m/s) (km/g) | Phân hạng | Mô tả |
|---------|-------------------------------|--------------|--|
| 1 | 0 - 0,2 (0 - 2,9) | Lặng gió | Mọi vật yên tĩnh, khói lên thẳng, hồ nước phẳng lặng như gương |
| 2 | 0,3 - 1,5 (3,0 - 8,9) | Gió rất nhẹ | Khói hơi bị rối động, mặt nước gợn lên như vẩy cá |
| 3 | 1,6 - 3,3 (9,0 - 15,9) | Gió nhẹ | Mặt cầm thấy có gió, lá cây xao xạc, sóng gợn nhung không có sóng vỗ |
| 4 | 3,4 - 5,4 (16,0 - 23,9) | Gió nhỏ | Lá và cành cây nhỏ bắt đầu rung động. Cờ lay nhẹ. Sóng rất nhỏ |
| 5 | 5,5 - 7,9 (24,0 - 33,9) | Gió vừa | Bụi và mảnh giấy nhỏ bắt đầu bay. Cành nhỏ lung lay, sóng nhỏ và dài hơn |
| 6 | 8,0 - 10,7 (34,0 - 43,9) | Gió khá mạnh | Cây nhỏ có lá lung lay, mặt nước hồ ao gợn sóng. Ngoài biển sóng vừa và dài |
| 7 | 10,8 - 13,8 (44,0 - 54,9) | Gió mạnh | Càng lớn lung lay, dây điện ngoài phố thôi vi vu. Ngọn sóng bắt đầu có bùi nước bắn lên |
| 8 | 13,9 - 17,1 (55,0 - 67,9) | Gió khá to | Cây bị rung chuyền, khó đi bộ ngược chiều gió. Sóng khá cao |
| 9 | 17,2 - 20,7 (68,0 - 81,9) | Gió to | Cành nhỏ bị bẻ gãy. Không đi ngược gió được. Ngoài biển sóng cao và dài |
| 10 | 20,8 - 24,4 (82,0 - 95,9) | Gió rất lớn | Làm hư hại nhà cửa, giật ngói trên mái nhà. Sóng lớn có bọt dày đặc. Hạn chế ra khơi |
| 11 | 24,5 - 28,4 (96,0 - 109,9) | Gió bão | Làm bật rễ cây. Phí đỗ nhà cửa. Sóng rất lớn và reo dữ dội. Cầm tàu thuyền ra khơi |
| 12 | > 28,5 (> 110,0) | Gió bão to | Sức phá hoại rất lớn. Sóng cực kỳ lớn, có thể phá vỡ các tàu nhỏ, thiệt hại lớn và rất lớn |



WIND SUPPLY, TROPICAL LOW PRESSURE AND STORM IN ADDITIONS

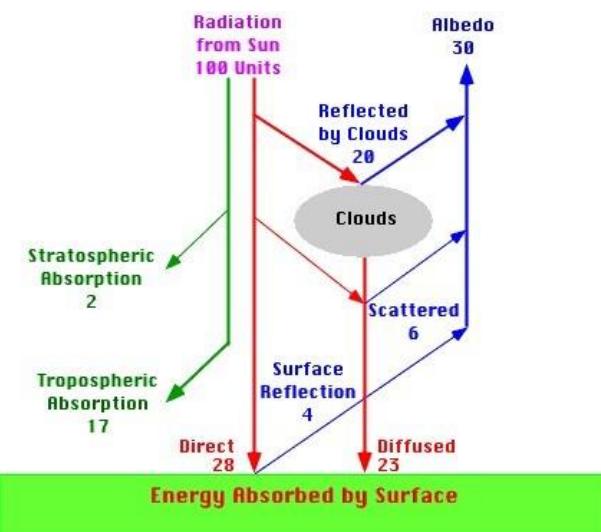
| Cấp gió | Cấp bão | Tốc độ gió | | Độ cao sóng TB (m) | Mức độ nguy hại | Cấp gió | Cấp bão | Tốc độ gió | | Độ cao sóng TB (m) | Mức độ nguy hại |
|---------|---------|-------------|---------|--------------------|--|---------|----------|-------------|-----------|--------------------|--|
| | | m/s | km/h | | | | | m/s | km/h | | |
| 0 | - | 0 - 0,2 | < 1 | - | - | 10 | Bão | 24,5 - 28,4 | 89 - 102 | 9,0 | - Lật đổ cây cối, nhà cửa, cột điện. Gây thiệt hại rất nặng |
| 1 | - | 0,3 - 1,5 | 1 - 5 | 0,1 | - Gió nhẹ không gây nguy hại | 11 | mạnh | 28,5 - 32,6 | 103 - 117 | 11,5 | - Biển động dữ dội. Làm đắm tàu biển |
| 2 | - | 1,6 - 3,3 | 6 - 11 | 0,2 | - Cây nhỏ có lá bắt đầu lay động, ánh hướng đèn lúu đang phơi màu | 12 | | 32,7 - 36,9 | 118 - 133 | | |
| 3 | - | 3,4 - 5,4 | 12 - 19 | 0,6 | - Biển hơi động. Thuyền đánh cá bị chao nghiêng, phải cuộn bớt buồm | 13 | | 37,0 - 41,4 | 134 - 149 | | |
| 4 | - | 5,5 - 7,9 | 20 - 28 | 1,0 | - Cây cối rung chuyển. Khó đi ngang gió | 14 | rất mạnh | 41,5 - 46,1 | 150 - 166 | 14,0 | - Sức phá hoại cực kỳ lớn |
| 5 | - | 8,0 - 10,7 | 29 - 38 | 2,0 | - Biển động. Nguy hiểm đối với tàu, thuyền | 15 | | 46,2 - 50,9 | 167 - 183 | | - Sóng biển cực kỳ mạnh. Đánh chìm tàu biển có trọng tải lớn |
| 6 | ATND | 10,8 - 13,0 | 39 - 49 | 3,0 | - Gió làm gãy cành cây, tốc mái nhà gây thiệt hại về nhà cửa. Không thể đi ngược gió | 16 | Siêu bão | 51,0 - 56,0 | 184 - 201 | | |
| 7 | | 13,9 - 17,1 | 50 - 61 | 4,0 | - Biển động. Nguy hiểm đối với tàu, thuyền | 17 | | 56,1 - 61,2 | 202 - 220 | | |
| 8 | Bão | 17,2 - 20,7 | 62 - 74 | 5,5 | - Gió làm gãy cành cây, tốc mái nhà gây thiệt hại về nhà cửa. Không thể đi ngược gió | ≥ 18 | Siêu bão | > 61,3 | > 221 | > 14,1 | - Sức phá hoại cực kỳ nghiêm trọng. |
| 9 | | 20,8 - 24,4 | 75 - 88 | 7,0 | - Biển động rất mạnh. Rất nguy hiểm đối với tàu, thuyền | | | | | | - Gây thiệt hại về nhà và các phương tiện lưu thông trên đất liền. |

SUNSHINE/ SOLAR RADIATION

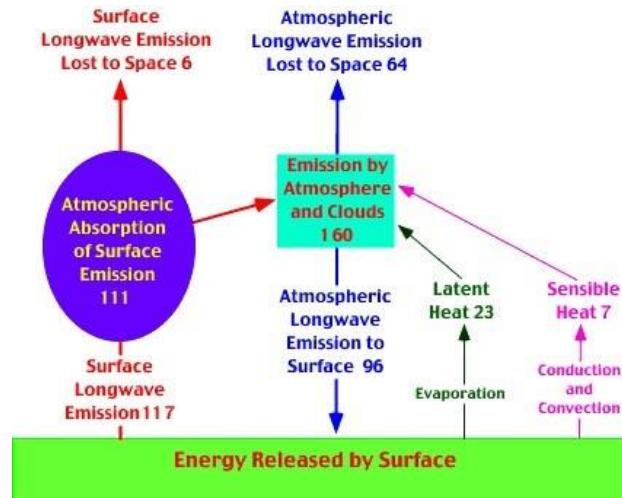


Sunshine is expressed by the number of hours of light per day.

Solar radiation can be expressed as the energy emitted by the sun per unit area in a day (Kcal/cm²/ngày)



Global shortwave radiation cascade
(Pidwirny, 2006)



Global longwave radiation cascade
(Pidwirny, 2006)

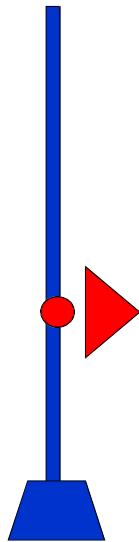
CONTENTS



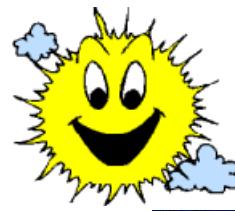
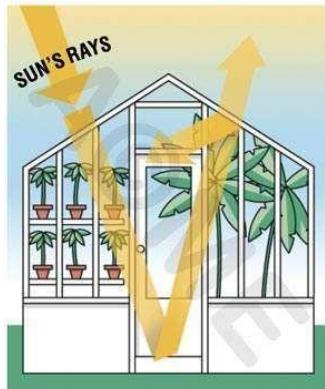
Chapter 1. Basics on Climate Sciences

1. Definitions
2. Earth's Climate System
3. Major Meteorological Factors
4. Greenhouse effects
5. Weather Monitoring and Forecasting

Exercises and Discussion



GREENHOUSE EFFECT

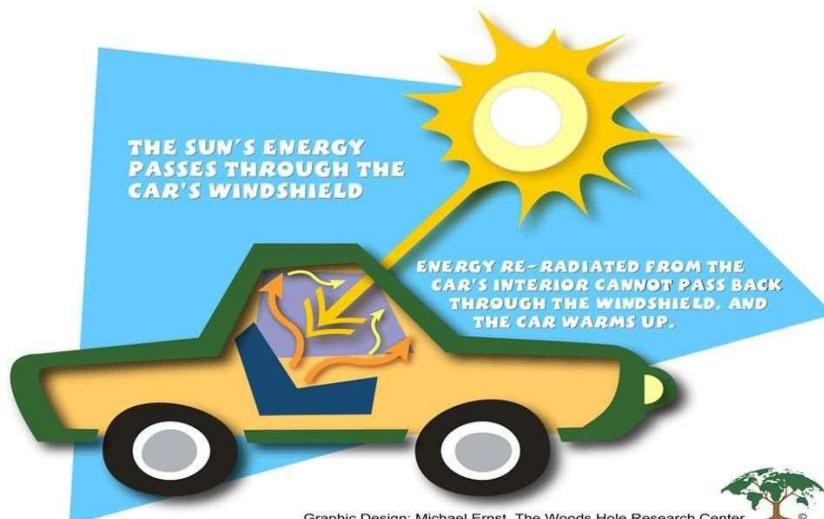


The greenhouse effect causes the temperature of the interior of a greenhouse made of glass to rise when the sun hits it.

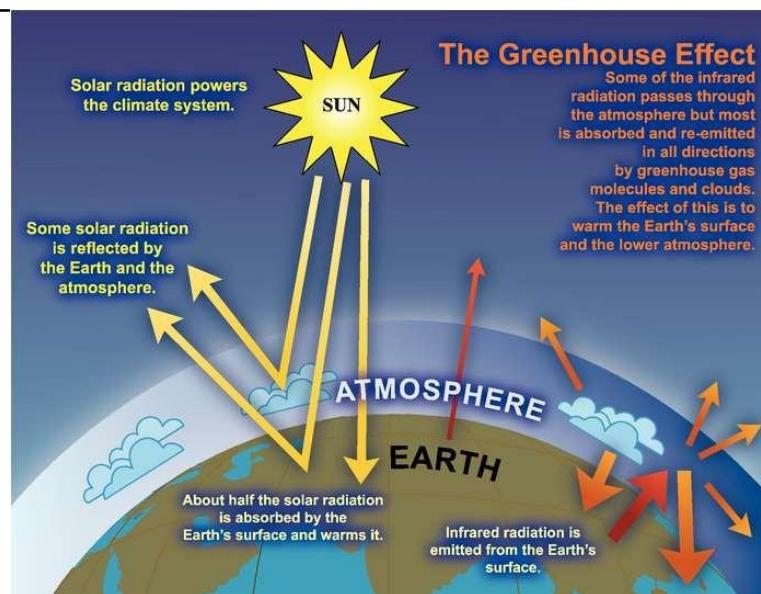
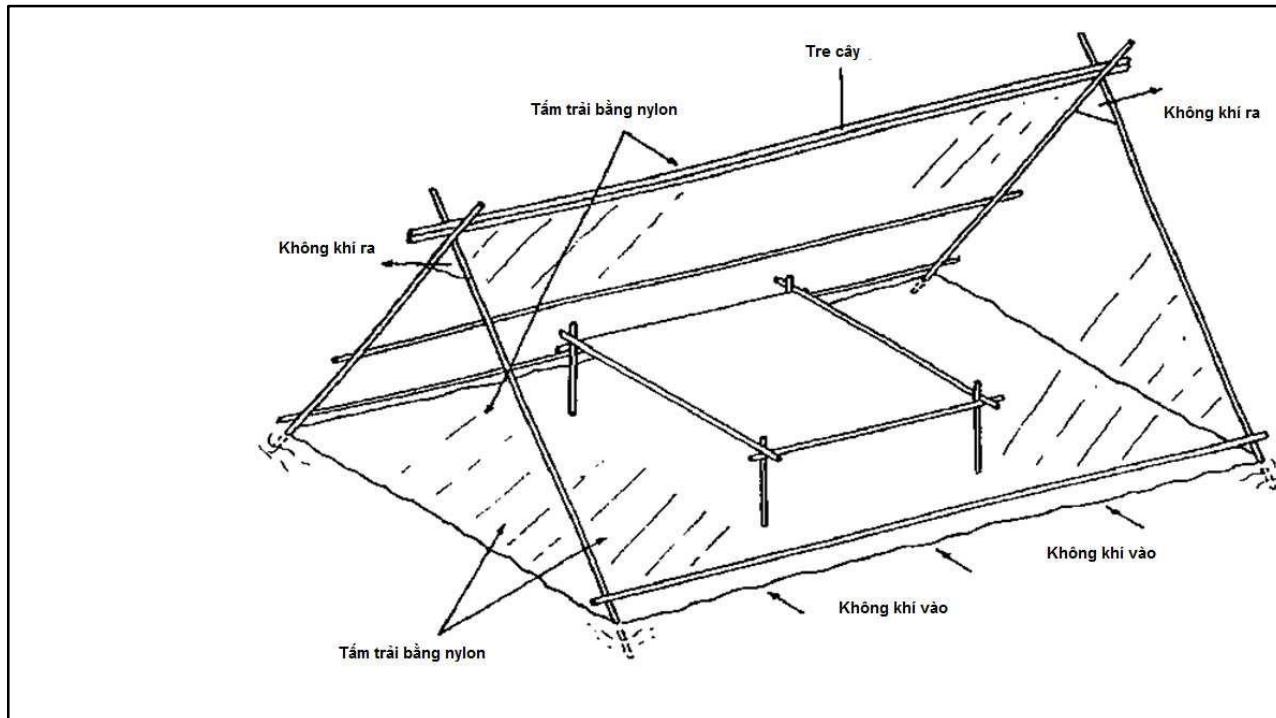
Thanks to this warmth, plants can sprout, flower and bear fruit sooner.

A Greenhouse Effect we can all relate to!

EXAMPLE ILLUSTRATION
THE GREENHOUSE EFFECT IN A
CAR THAT'S BEEN OUT IN THE SUN

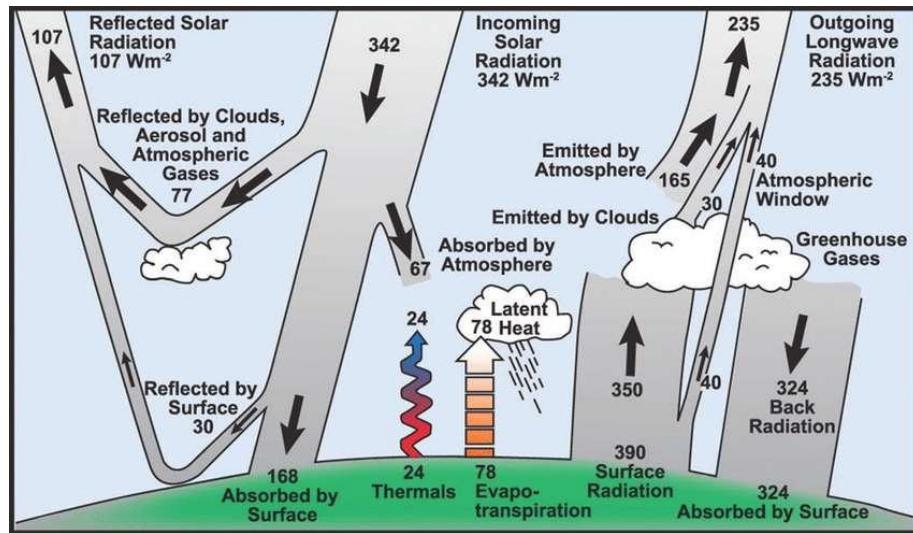




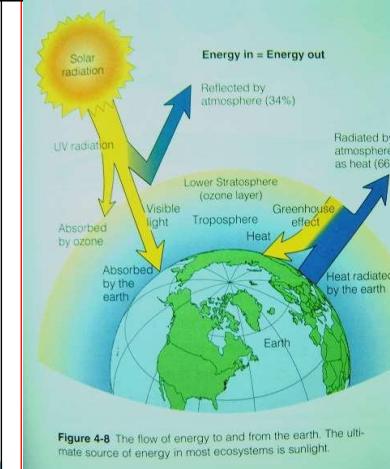
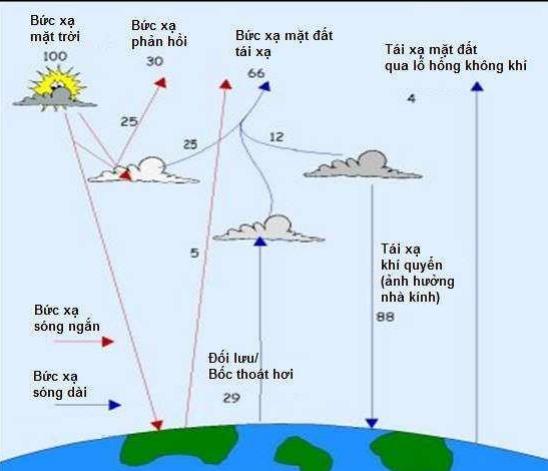


The greenhouse effect is also the phenomenon of heat blocking in the atmosphere of the Earth illuminated by the Sun is the atmospheric greenhouse effect.

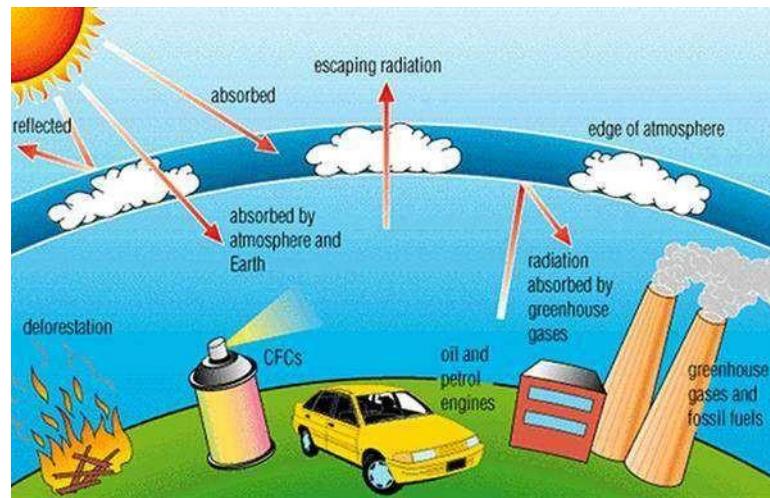
GLOBAL RADIATION BALANCE



Source: Kiehl and Trenberth, 1997



$$\left\{ \begin{array}{l} \text{Energy from the} \\ \text{Sun's radiation} \\ \text{reaching the Earth} \end{array} \right\} = \left\{ \begin{array}{l} \text{Energy} \\ \text{absorbed} \\ \text{by the Earth} \end{array} \right\} + \left\{ \begin{array}{l} \text{Energy lost back} \\ \text{to Space.} \end{array} \right\}$$

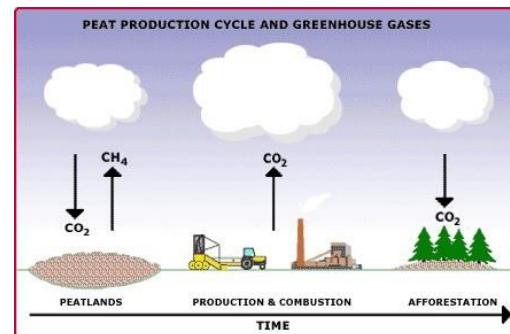


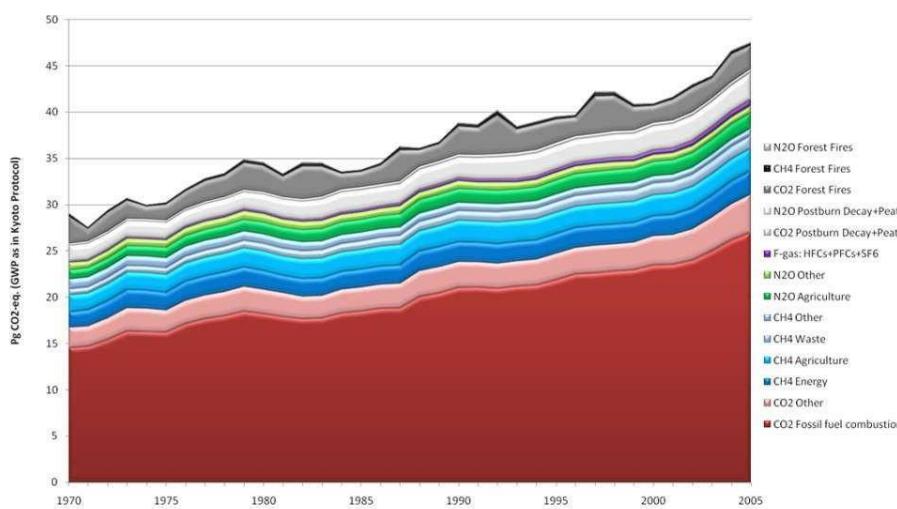
When the atmosphere layer has too much CO₂, CFCs, CH₄ and water vapor, the Earth becomes a heat-retaining sphere, absorbing a lot but giving off less heat.

Gases that contribute to greenhouse effect:

- Dioxidecarbon (CO₂)
- Metane (CH₄)
- Nitrous Oxide (N₂O)
- Ozon (O₃)
- Cholorofluorcarbons (CFCs)
- Water vapor (H₂O)

The cause of the increase in the temperature of the earth's surface, the rapid increase is mainly (more than 90%) due to the increased content of CO₂ and other greenhouse gases released into the atmosphere by human activities..





Source: EDGAR 4.0 (JRC/PBL, 2009)

Source: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR), release version 4.0. <http://edgar.jrc.ec.europa.eu>, 2009

Sources of greenhouse gases



Agricultural cultivation



Landfills



Industrial pollution



Chemical spray



Sources of greenhouse gases



Fossil fuel



Deforestation



Volcanoes



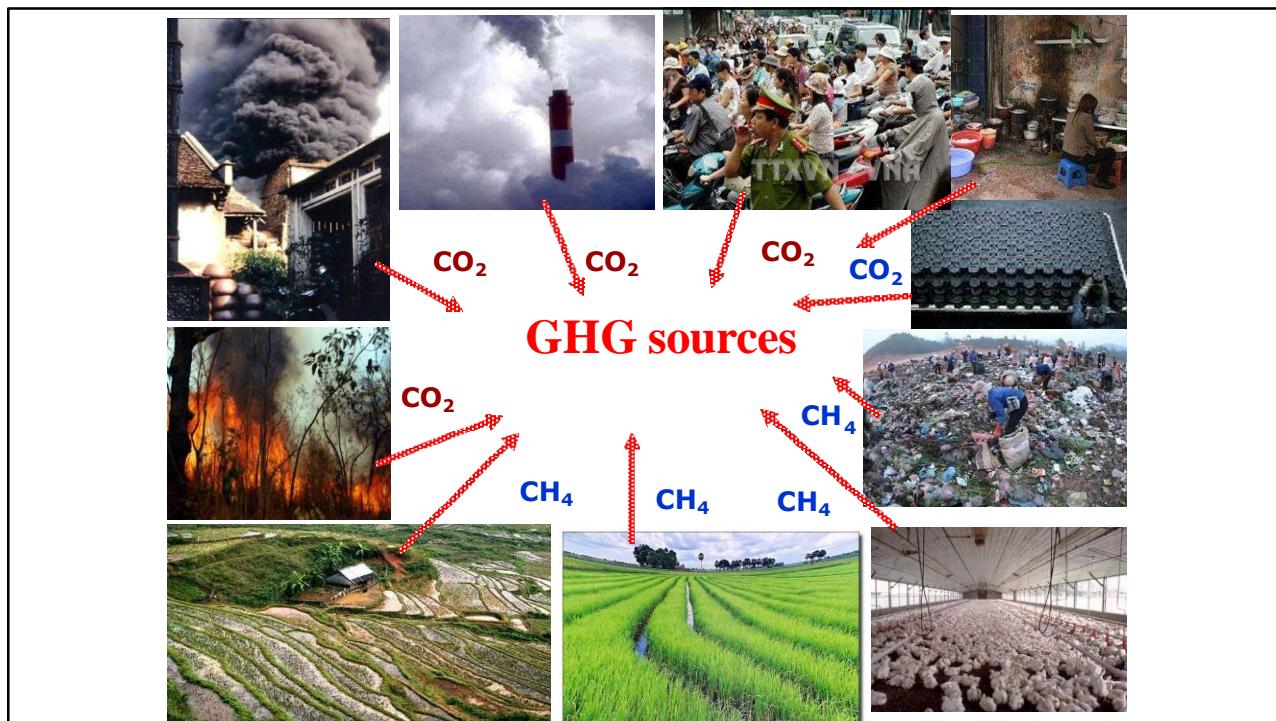
Traffics

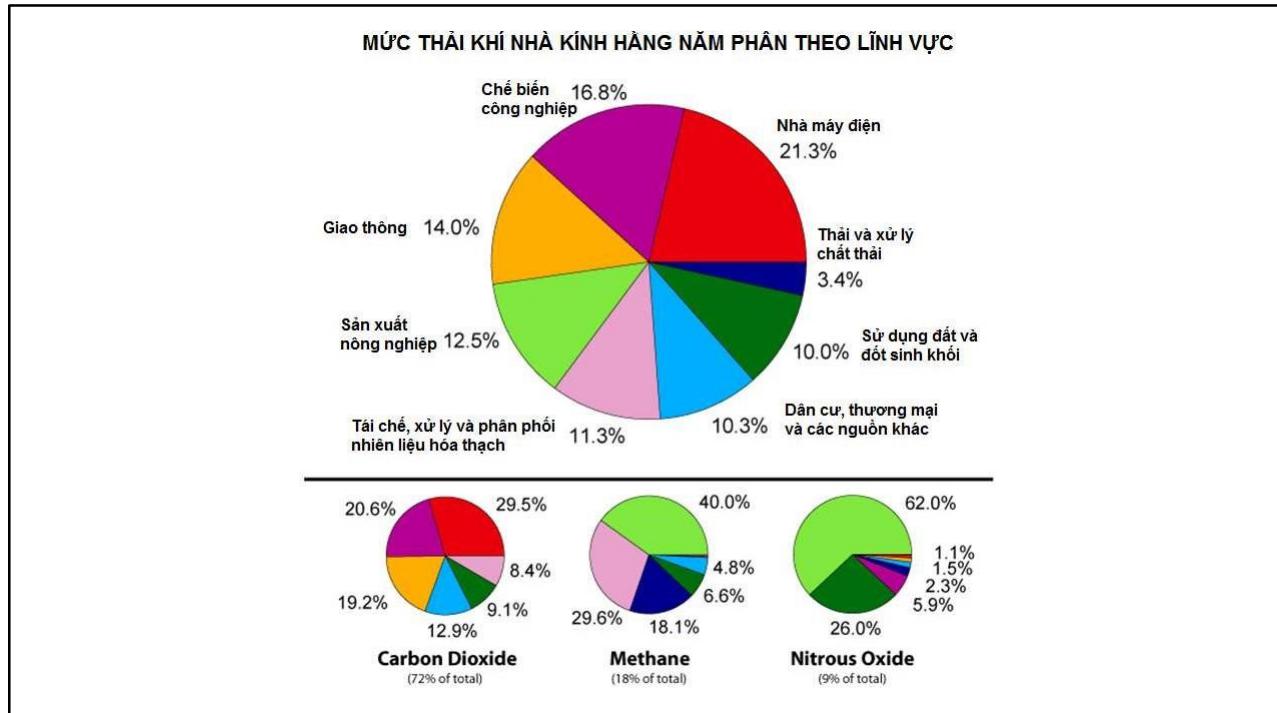
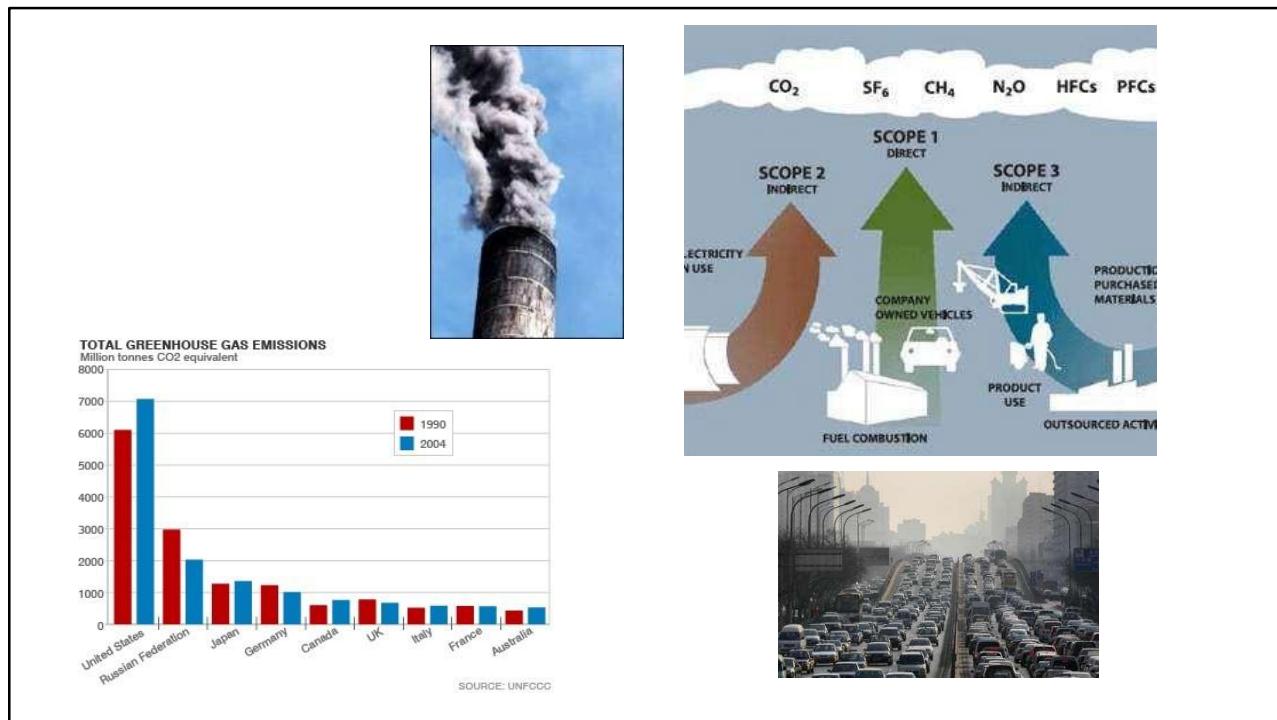


Animal husbandry



Forest fires





| Name of fuel | CO ₂ emission rate (lbs/10 ⁶ BTU) |
|------------------------|--|
| Than đá (anthracite) | 227 |
| Than cốc | 225 |
| Than non | 215 |
| Than cặn từ nhựa đường | 213 |
| Than nhựa bitum | 205 |
| Gỗ và mạc cưa | 195 |
| Vỏ xe hơi | 189 |
| Dầu đốt | 161 |
| Kerosene | 159 |
| Xăng xe hơi | 156 |
| Xăng máy bay | 153 |
| Khí đốt | 139 |
| Khí hóa lỏng | 139 |
| Khí tự nhiên | 117 |



Based on the structure of the molecules, some gases are more efficient at trapping heat and staying in the atmosphere longer.

The gas that retains heat better and stays in the atmosphere longer is more likely to warm the earth..

Based on the ability of CO₂ to warm the earth as a standard to compare with other trace gases.

- Use CO₂ as a unit of measure for **Global Warming Potential (GWP) = 1**.
- Methane (CH₄) has a GWP = 23 (measured over a 100-year period).
- Other gases with longer atmospheric retention times, for example sulfur hexafluoride have a GWP = 22,000 after 100 years.

Global Warming Potential (GWP)

US EPA's "[Greenhouse Gases and Global Warming Potential Values](#)"

| Gas | Global Warming Potential |
|-----------------------------------|--------------------------|
| Carbon Dioxide (CO ₂) | 1 |
| Methane (CH ₄) | 21 |
| Nitrous Oxide (N ₂ O) | 310 |
| HFC-23 | 11,700 |
| HFC-125 | 2,800 |
| HFC-134a | 1,300 |
| HFC-143a | 3,800 |
| HFC-152a | 140 |
| HFC-227ea | 2,900 |
| HFC-236fa | 6,300 |
| HFC-4310mee | 1,300 |
| CF ₄ | 6,500 |
| C ₂ F ₆ | 9,200 |
| C ₄ F ₁₀ | 7,000 |
| C ₆ F ₁₄ | 7,400 |
| SF ₆ | 23,900 |

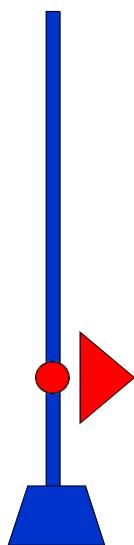
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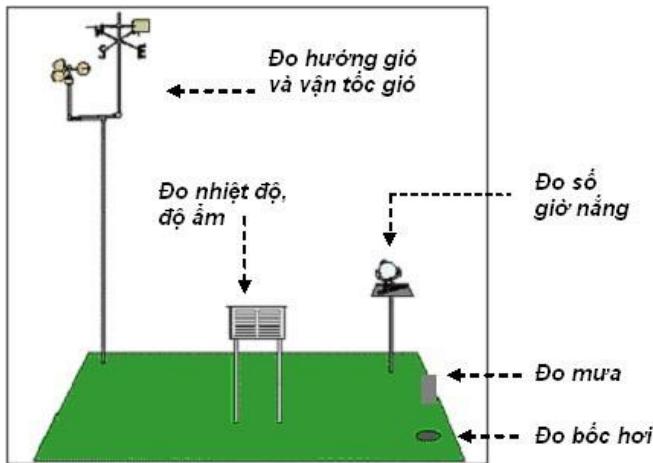
Chapter 1. Basics on Climate Sciences

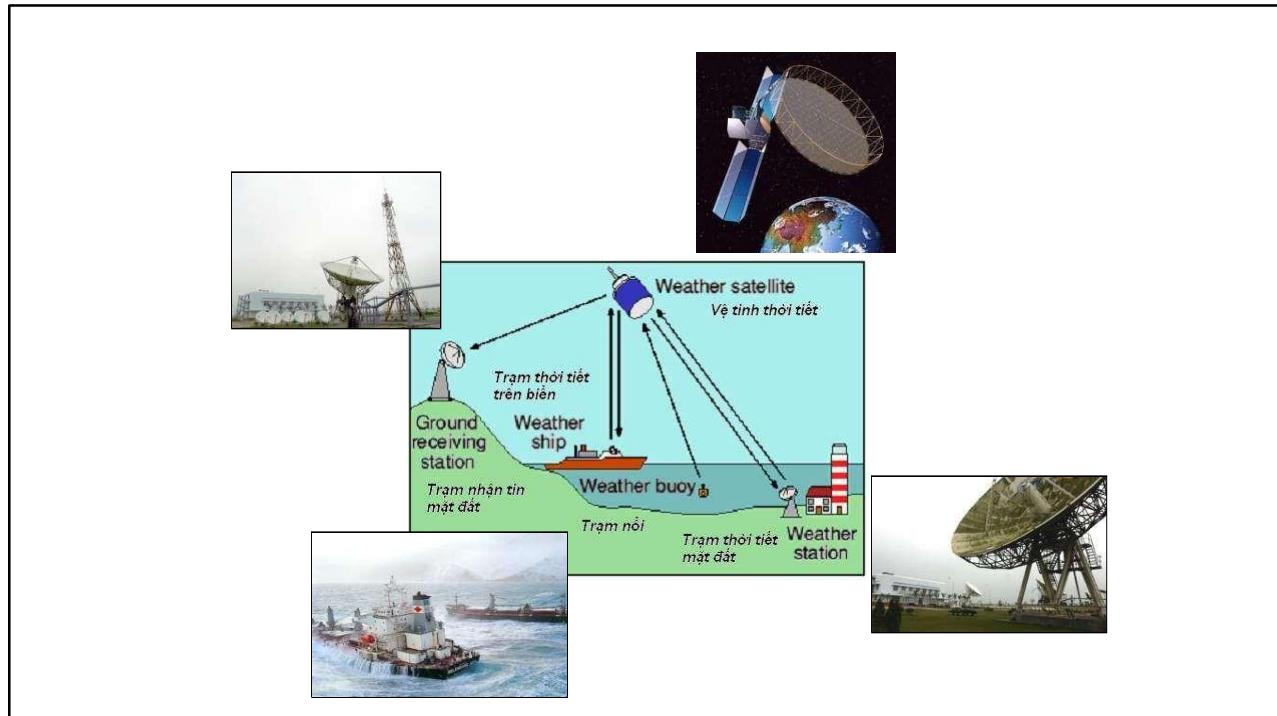
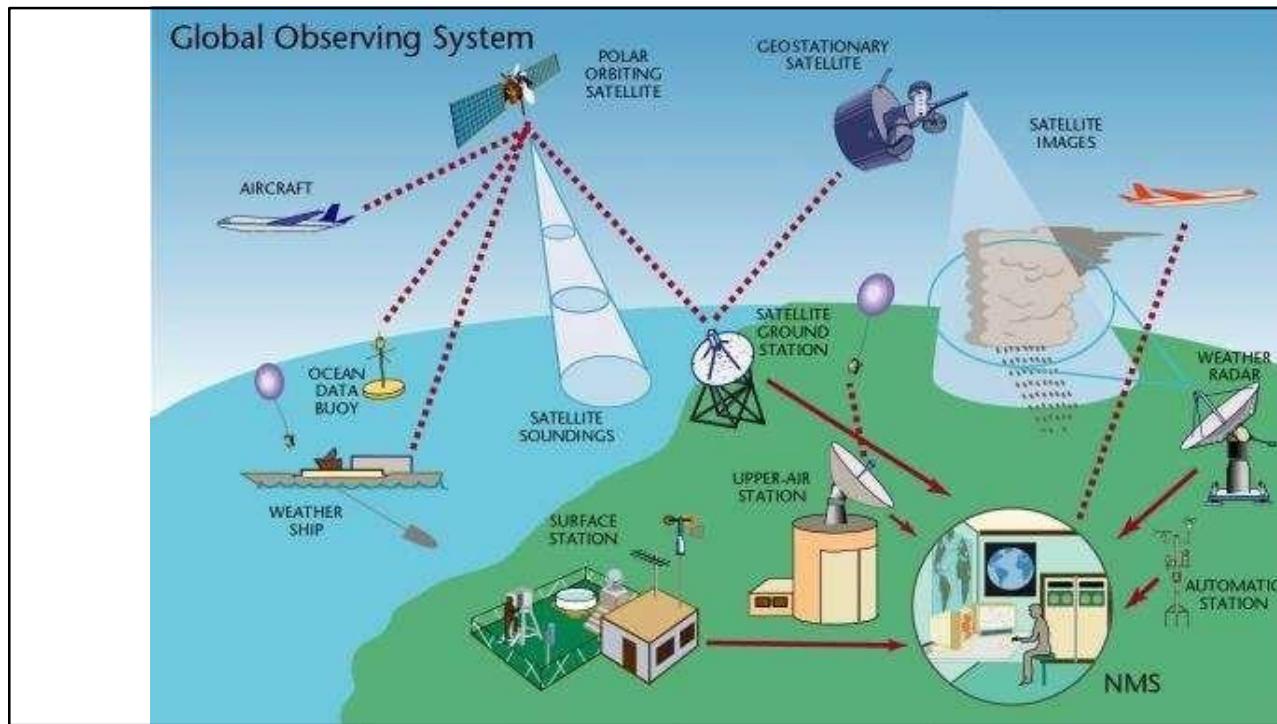
1. Definitions
2. Earth's Climate System
3. Major Meteorological Factors
4. Greenhouse effects
5. Weather Monitoring and Forecasting

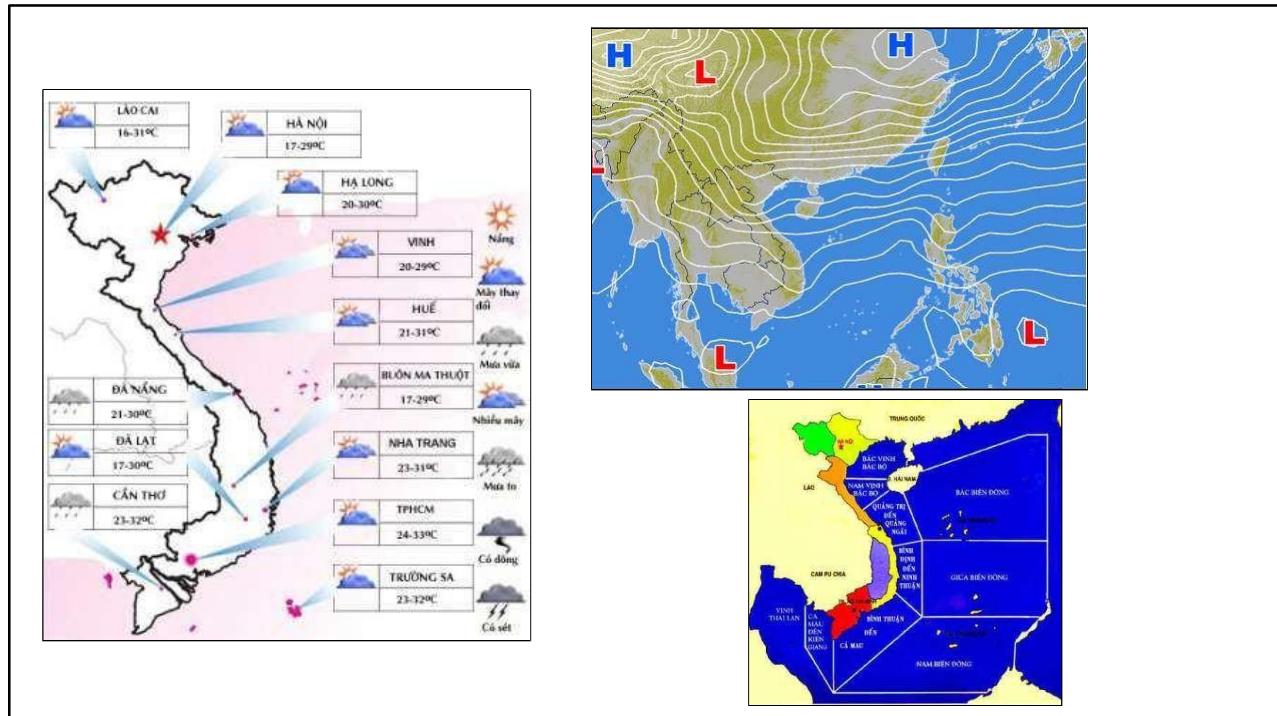
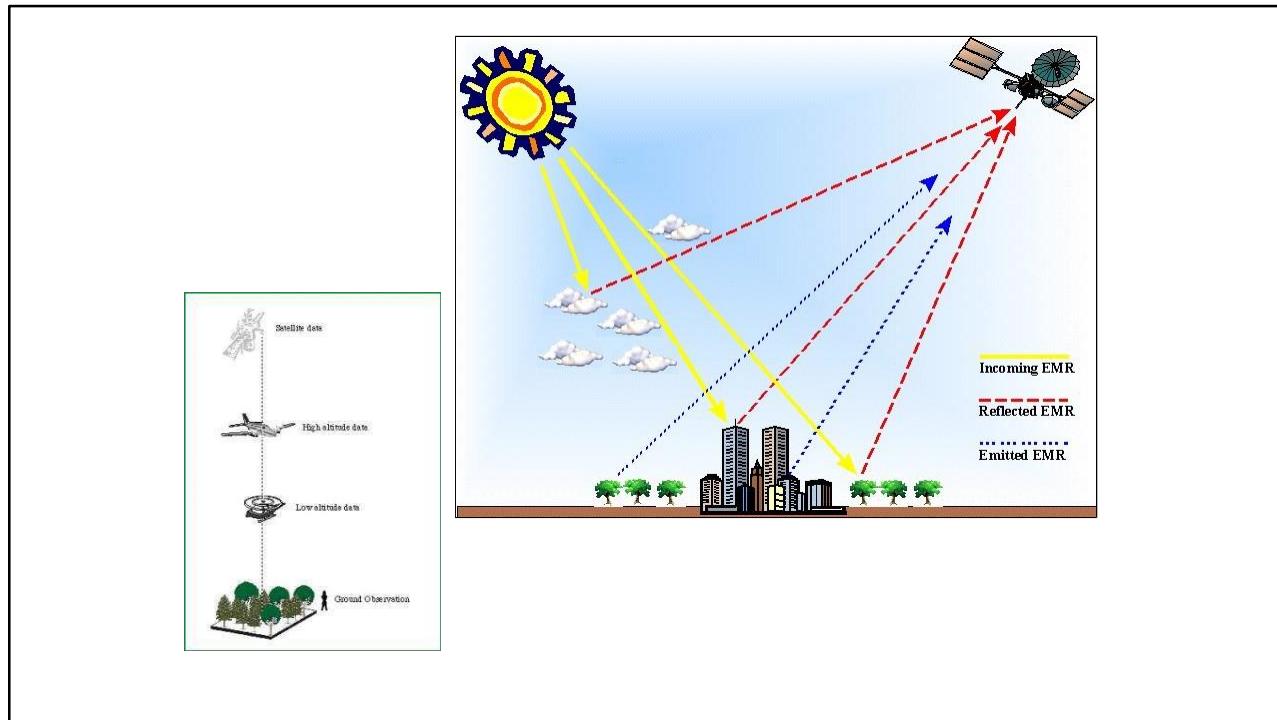
Exercises and Discussion

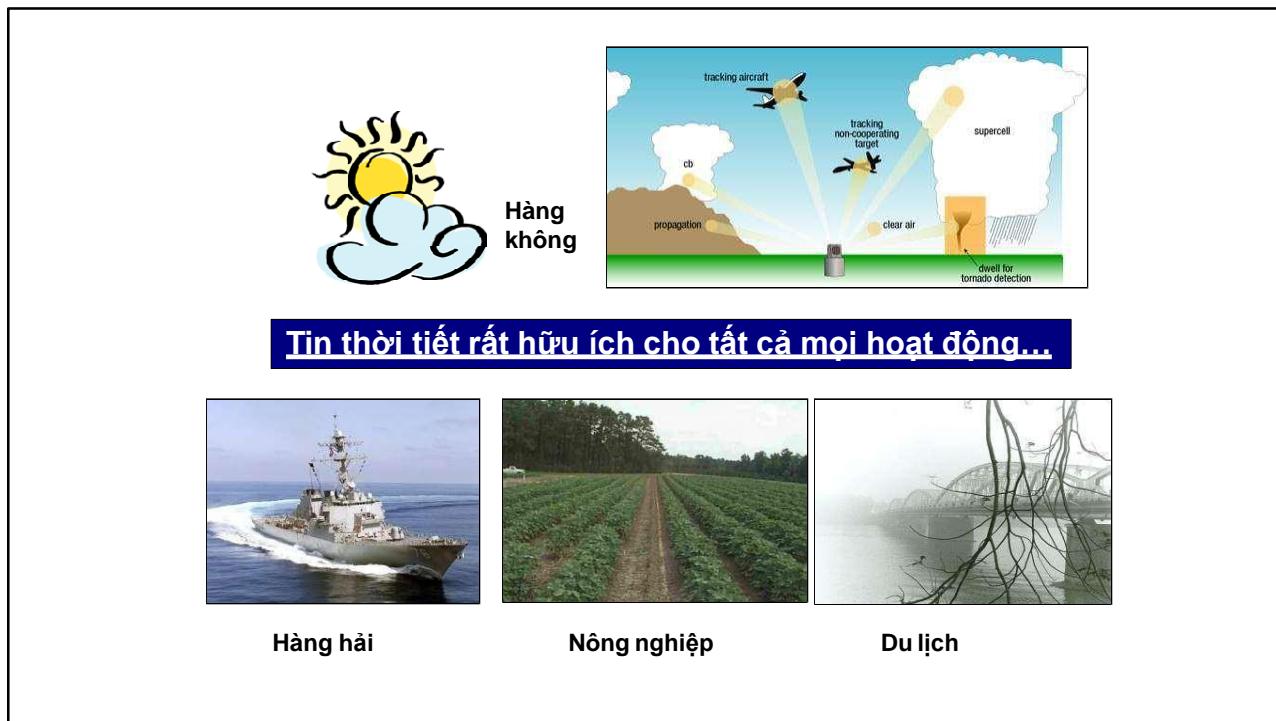
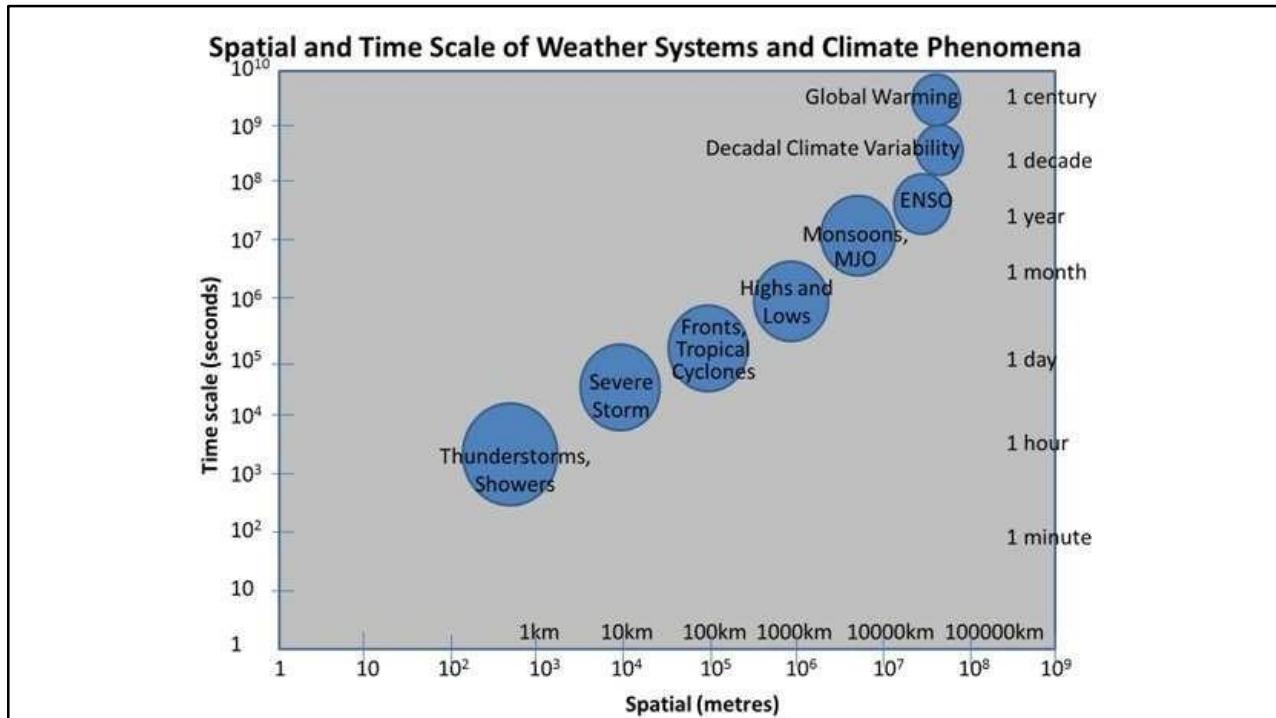


Monitoring and forecasting the weather





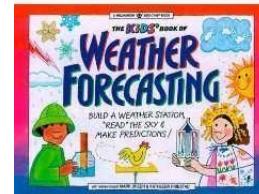
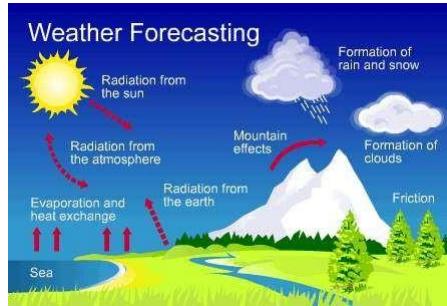




Monitoring and forecasting the weather

Weather forecasting is an applied science and engineering that predicts the state of the weather in a certain place in the future.

Forecasting must be done by collecting quantitative data of atmospheric parameters at the present time and using meteorological equations and laws to predict atmospheric changes in the coming time.





EXERCISE

Think about measures or actions at the **family and community scale** to reduce greenhouse gas emissions.



