Laurea / B.A.
in Global Governance

Università di Roma Tor Vergata — dipartimento studi impresa governo filosofia igf

Plants and environments

2023| 2024

Alessandro Travaglini

1

Climatology

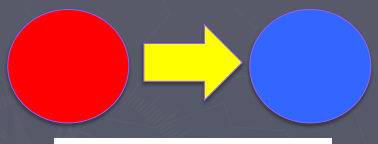
- Science that deals with the characteristics and distribution of various climatic types in the different zones of the Earth, trying to identify linkages with various geographical factors on which they depend.
- Meteorology is a sub-discipline of the broader field of knowledge known as atmospheric sciences.

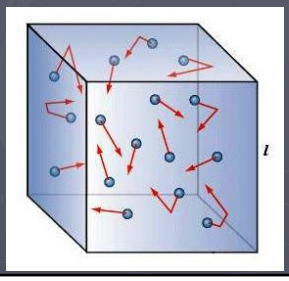
2

2

temperature

- **Temperature** is a measure of the intensity or degree of hotness in a body.





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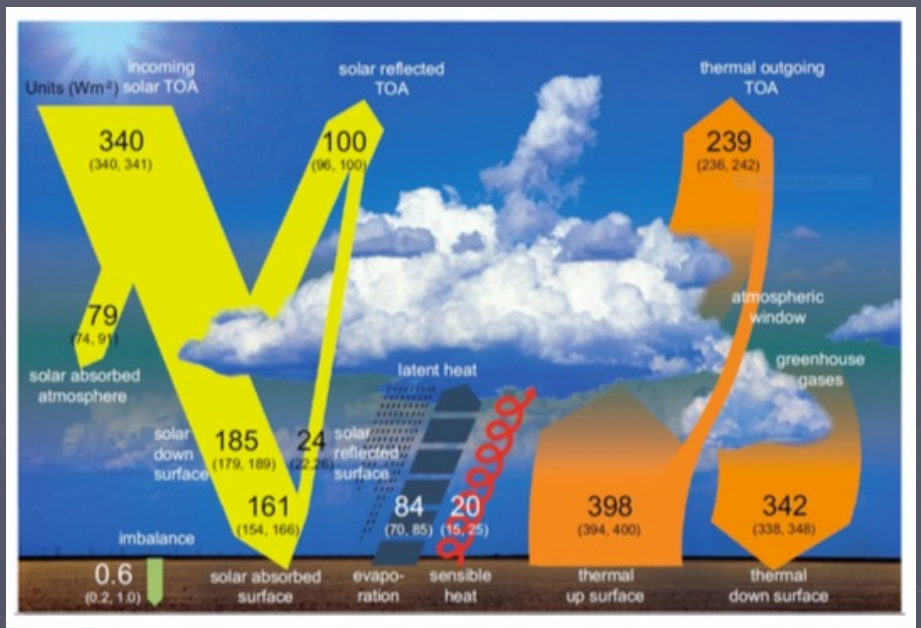


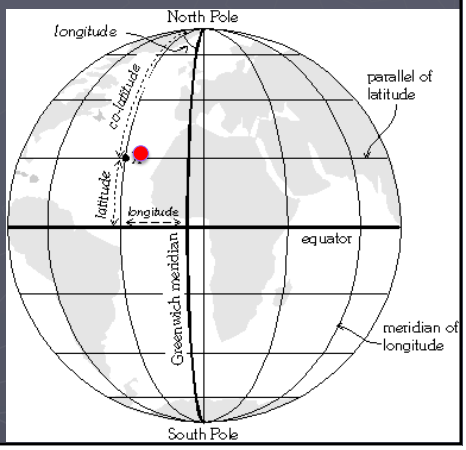
4

4

Variations of temperatures

- **Air temperature variations in space depend on:**
- **Latitude: distance of a point from Equator expressed in degrees**

Latitude is an angle which ranges from 0° at the Equator to 90° (North or South) at the poles. Lines of constant **latitude**, or parallels, run east-west as circles parallel to the equator.



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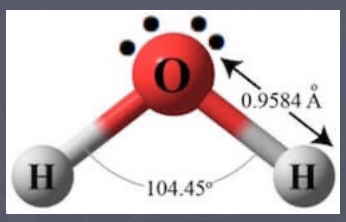
- Distribution of continental and oceanic masses
- Water has high heat capacity:
- For increasing the temperature of one gram of water of 1 degree Celsius (° C) it has to absorb 4.184 Joules of heat

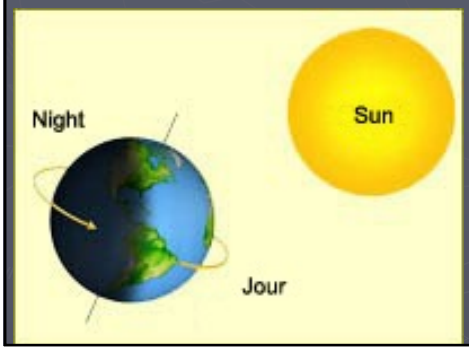


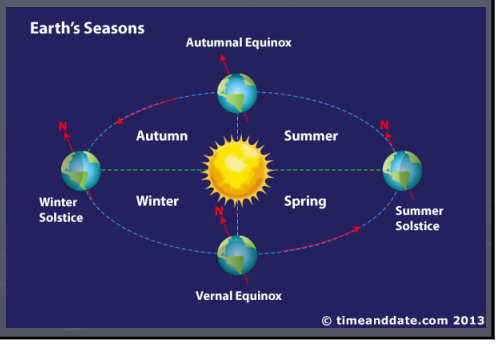
- Altitude above sea level

6

6

- **Air temperature variations, over time, depend on:**
- Alternations of Seasons
- Alternations of night and day





7

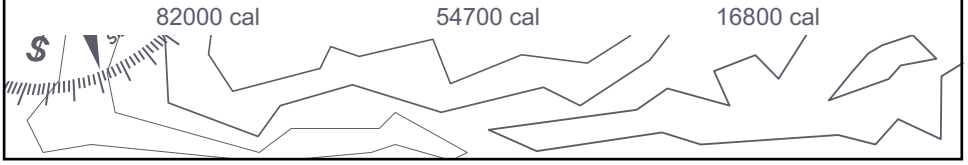
Planetary Energy Balance

The Sun Controls the Temperature

Solar energy is energy from the sun. The sun's energy reaches Earth in the form of sunlight. The temperatures we experience on Earth are directly related to how much sunlight is received.

Some areas on Earth receive more solar energy which results in higher temperatures. Areas near the equator, sometimes known as the Tropics, are examples of places where the temperatures are warmer.

Other areas on Earth receive less solar energy which results in lower temperatures. The North Pole and South Pole are good examples of places where the temperatures are colder.



8

Heat: 1200W*sq.m.-1*sec-1 when sun is at zenith

Global radiation on the ground 51%
Effective adsorbed Radiation from Earth 47%

Solar energy is adsorbed from Earth as short wave and released as long wave with heat emission

9

9

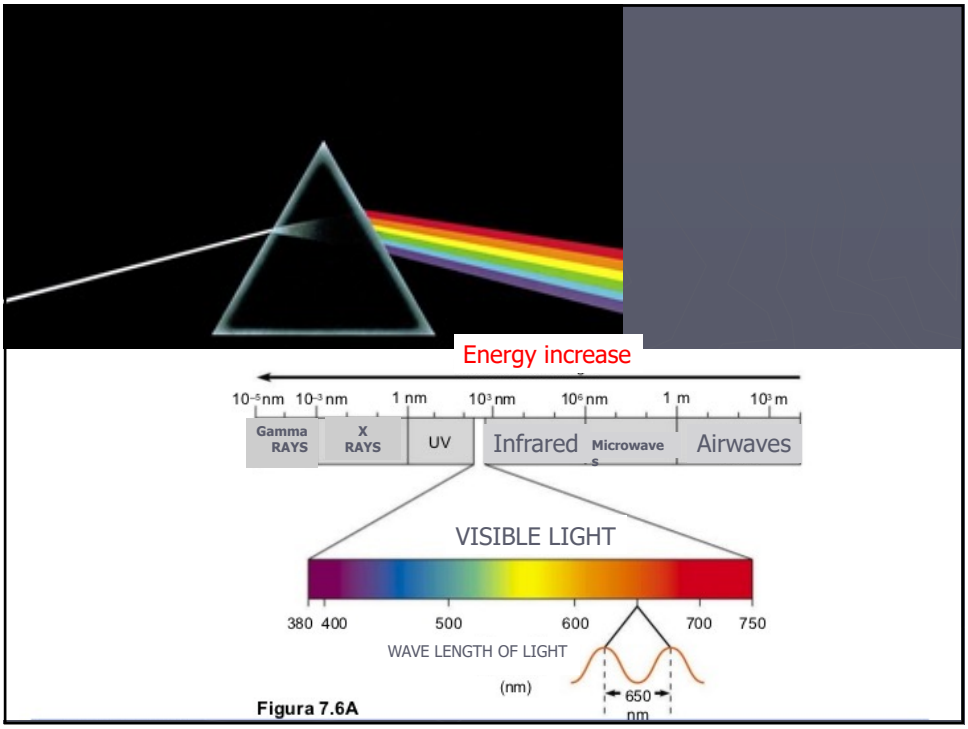


Figura 7.6A

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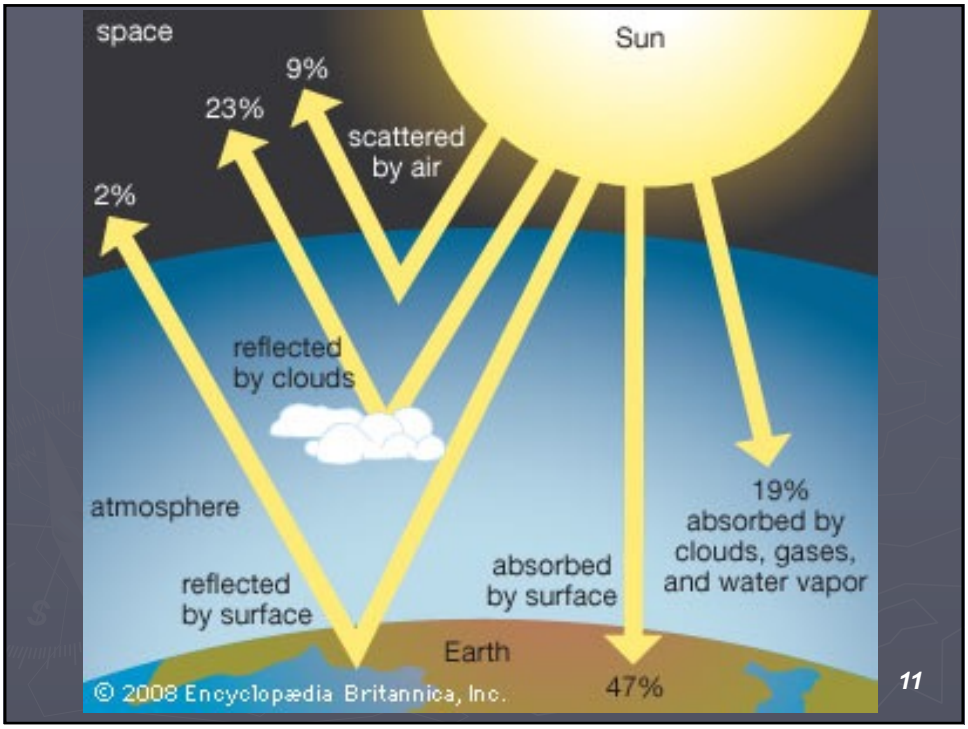
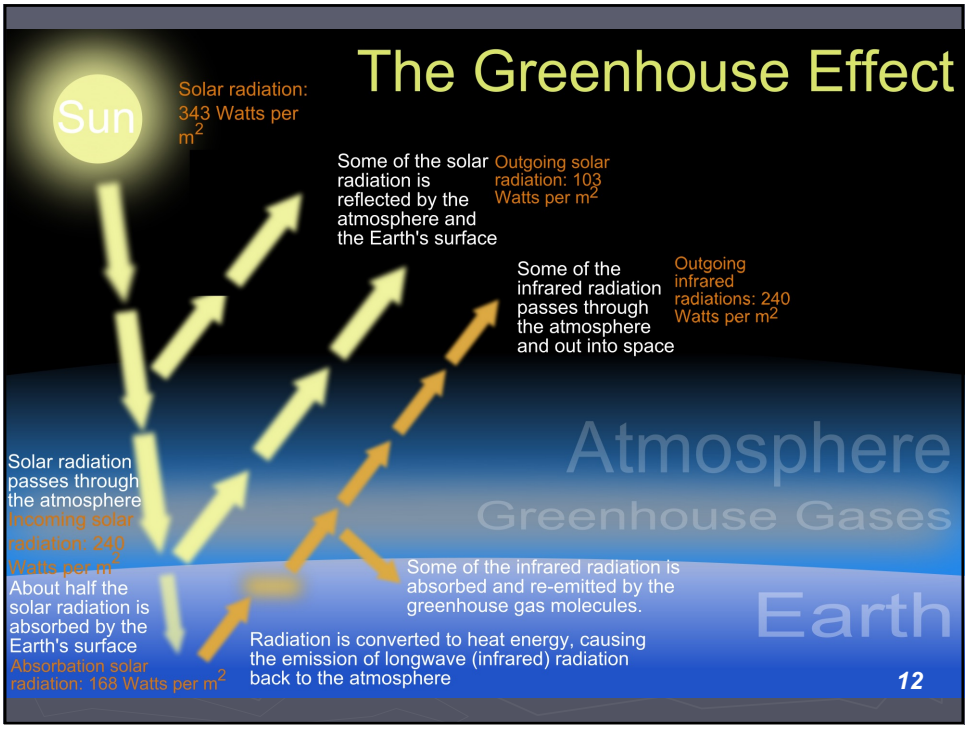
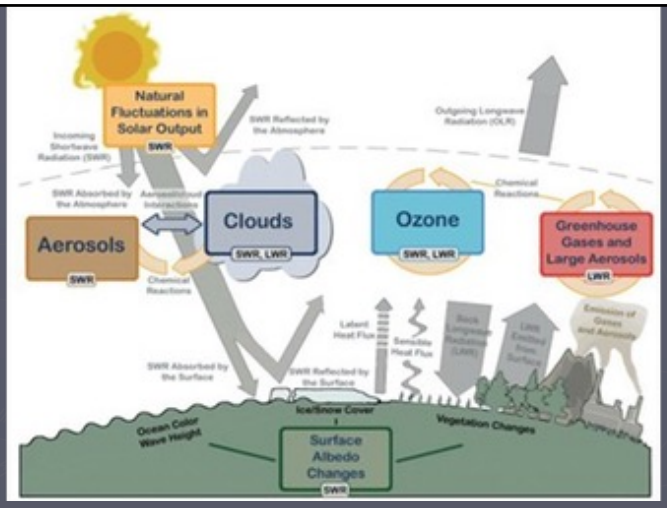

space
Sun
9%
23%
scattered by air
2%
reflected by clouds
atmosphere
19% absorbed by clouds, gases, and water vapor
reflected by surface
absorbed by surface
Earth
© 2008 Encyclopædia Britannica, Inc.
47%
11

11


The Greenhouse Effect
Sun
Solar radiation: 343 Watts per m2
Some of the solar radiation is reflected by the atmosphere and the Earth's surface
Outgoing solar radiation: 103 Watts per m2
Some of the infrared radiation passes through the atmosphere and out into space
Outgoing infrared radiations: 240 Watts per m2
Atmosphere
Greenhouse Gases
Solar radiation passes through the atmosphere
Incoming solar radiation: 240 Watts per m2
About half the solar radiation is absorbed by the Earth's surface
Absorbation solar radiation: 168 Watts per m2
Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules.
Earth
Radiation is converted to heat energy, causing the emission of longwave (infrared) radiation back to the atmosphere
12

12



Principal drivers of Climate Change

Source: *Climate Change, 2013: the Physical Science Basis Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental panel on Climate Change*

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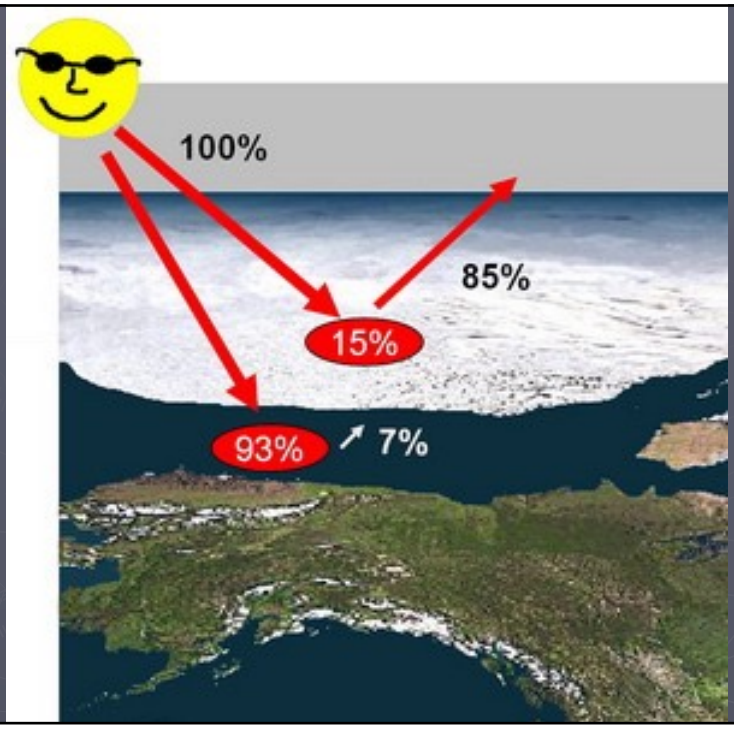

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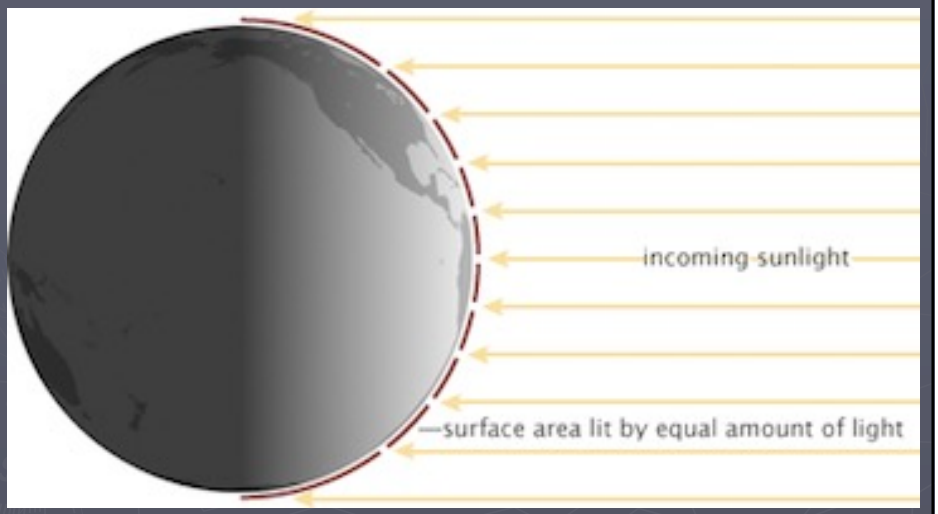
Planetary Energy Balance

The Poles are cold and the Tropics are warm because of the curvature of the Earth



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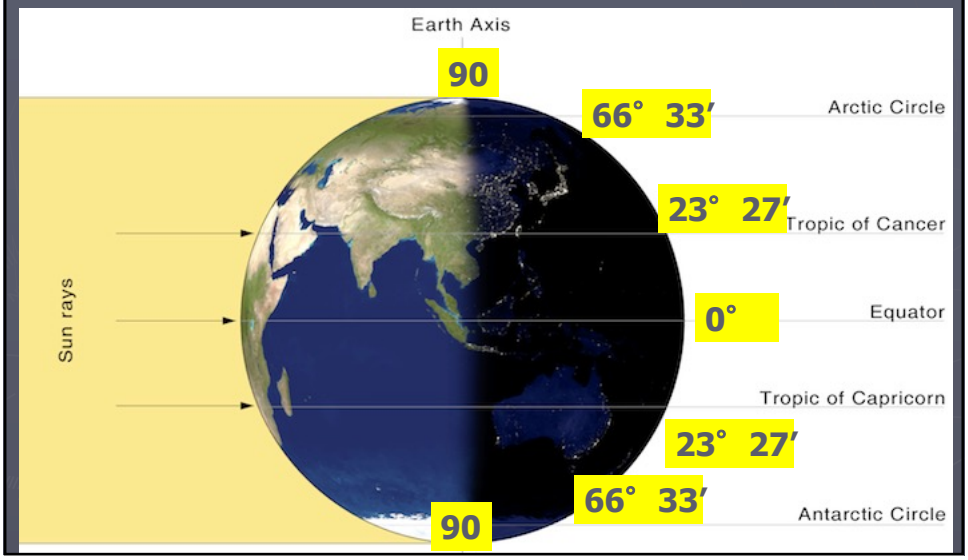
Planetary Energy Balance



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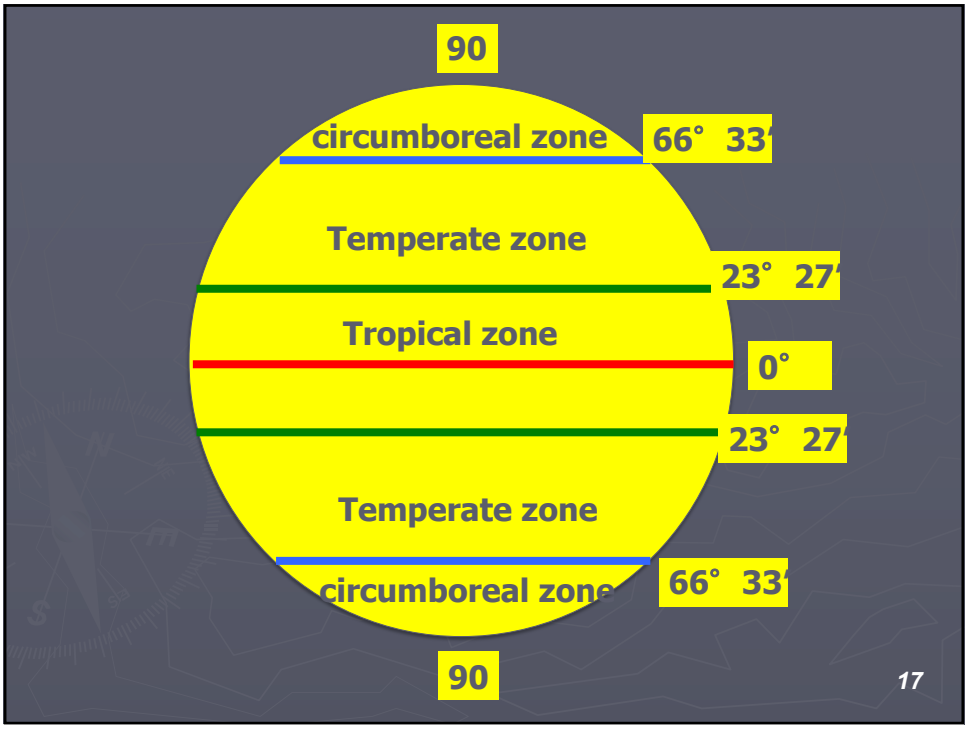

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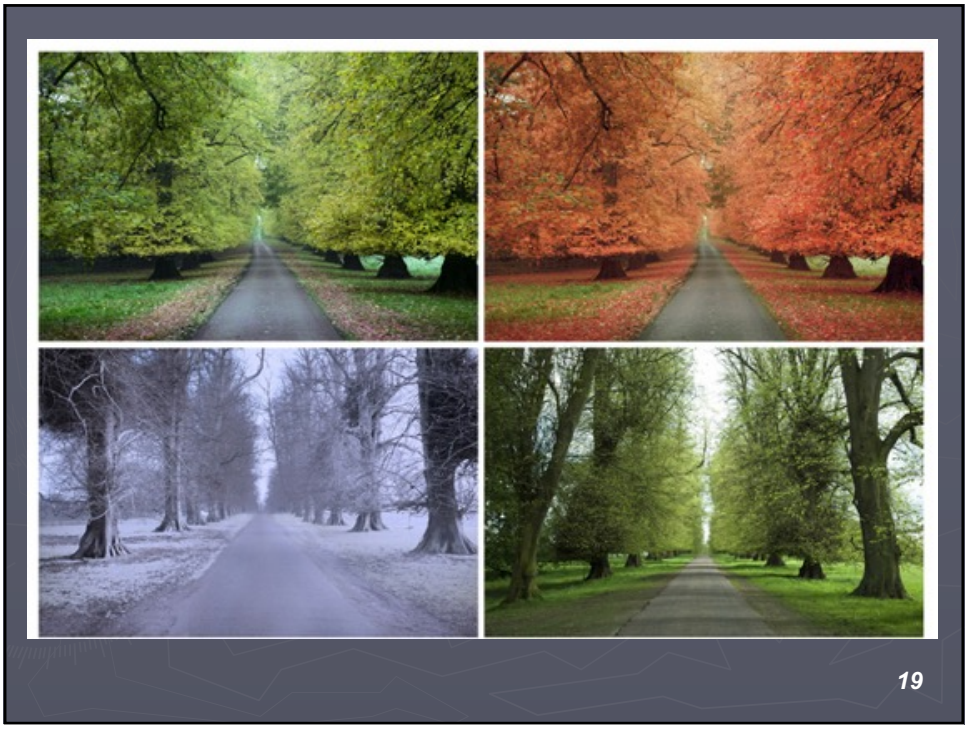
COSMIC FACTORS

- EARTH' S REVOLUTION
- TILTING EARTH AXIS, OR
- OBLIQUITY OF AXIS (Changing season)
- precession of equinox,
- Variation of eccentricity

18

18



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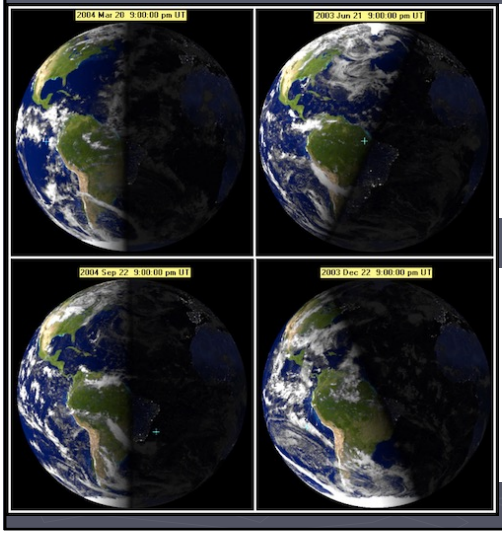
Tilting Changes the Seasons

due to the Earth's axis tilt, the angle of the sunlight striking Earth changes. This causes seasonal changes in temperatures around the globe.



As the Earth tilts away from the Sun, the Northern Hemisphere receives more sunlight and higher temperatures. This is the summer season in the Northern Hemisphere and the winter season in the Southern Hemisphere.

As the Earth tilts towards the Sun, the Northern Hemisphere receives less sunlight and lower temperatures. This is the winter season in the Northern Hemisphere and the summer season in the Southern Hemisphere.

20

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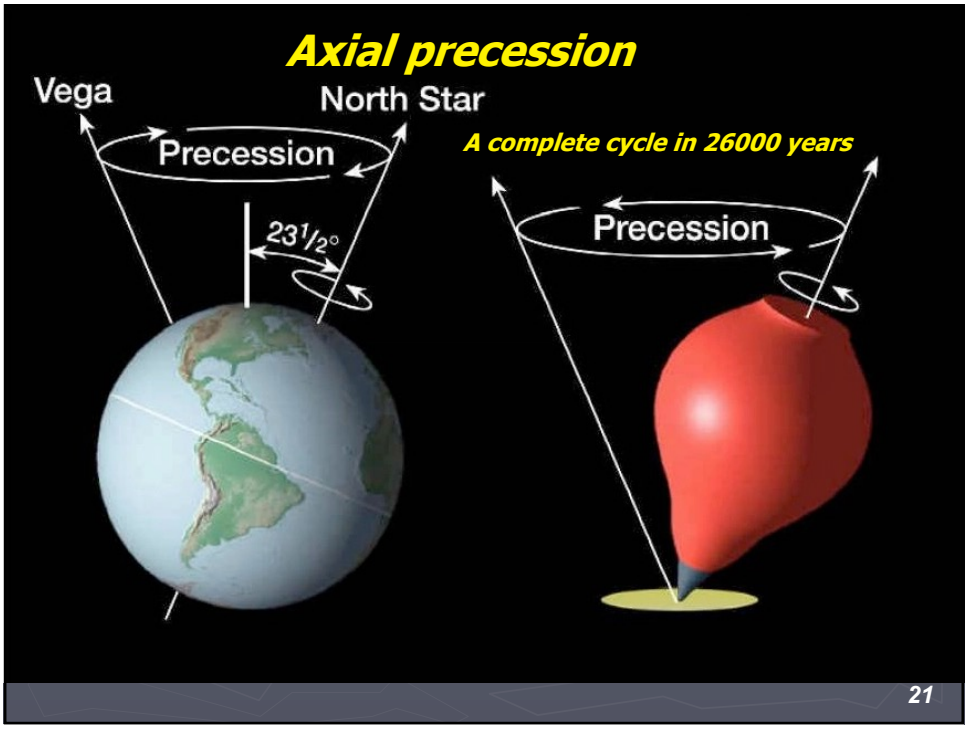
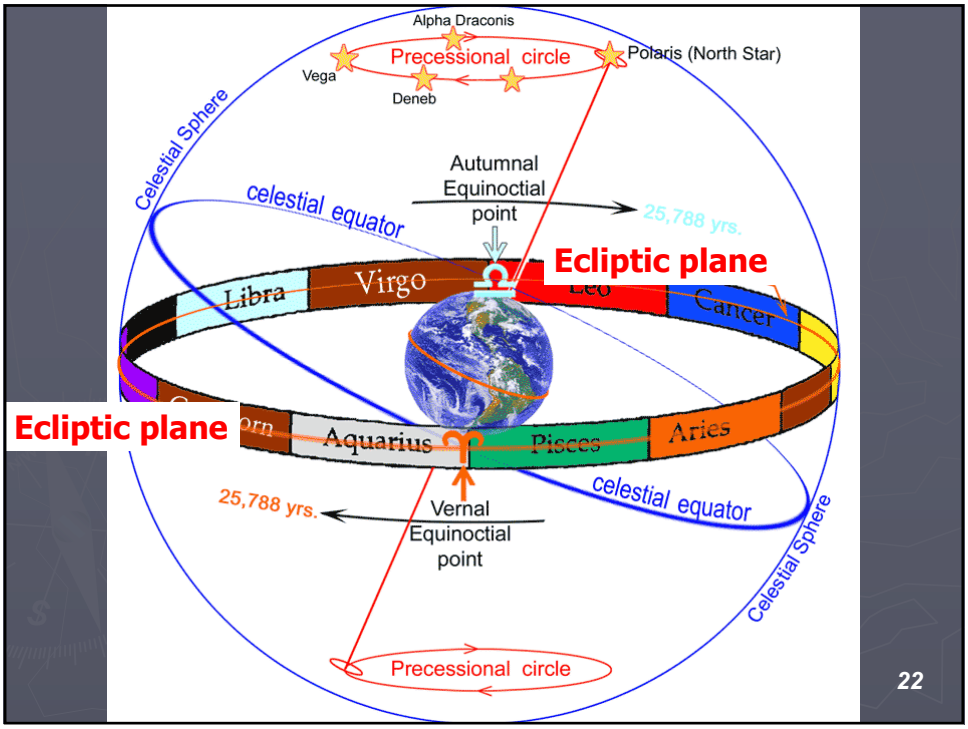
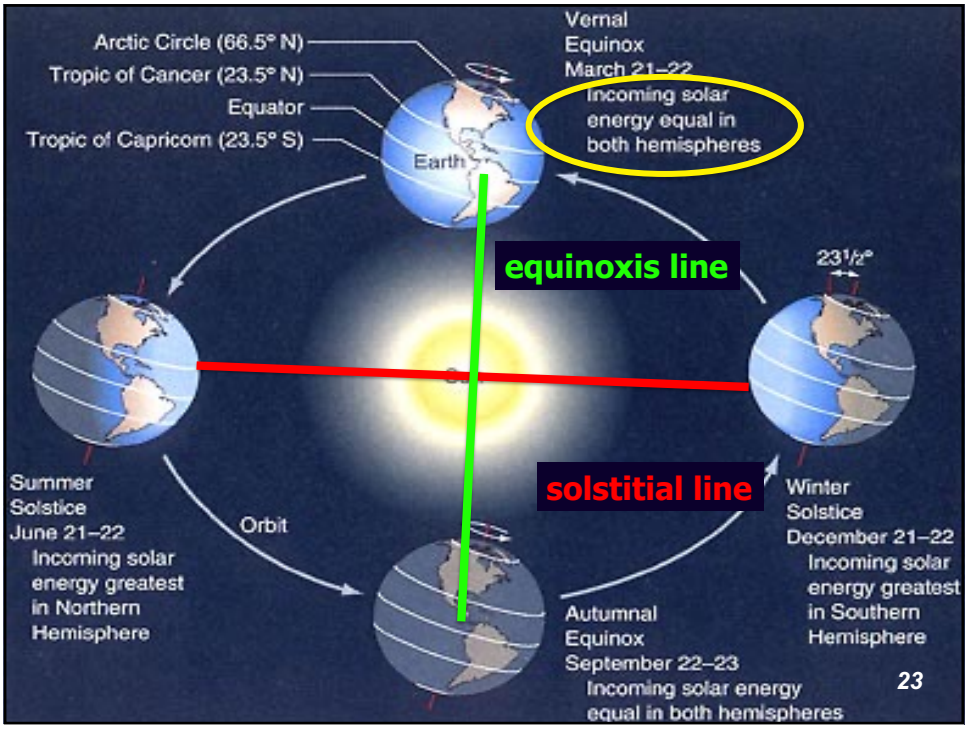

Axial precession
Vega
North Star
Precession
23 1/2°
A complete cycle in 26000 years
Precession
21

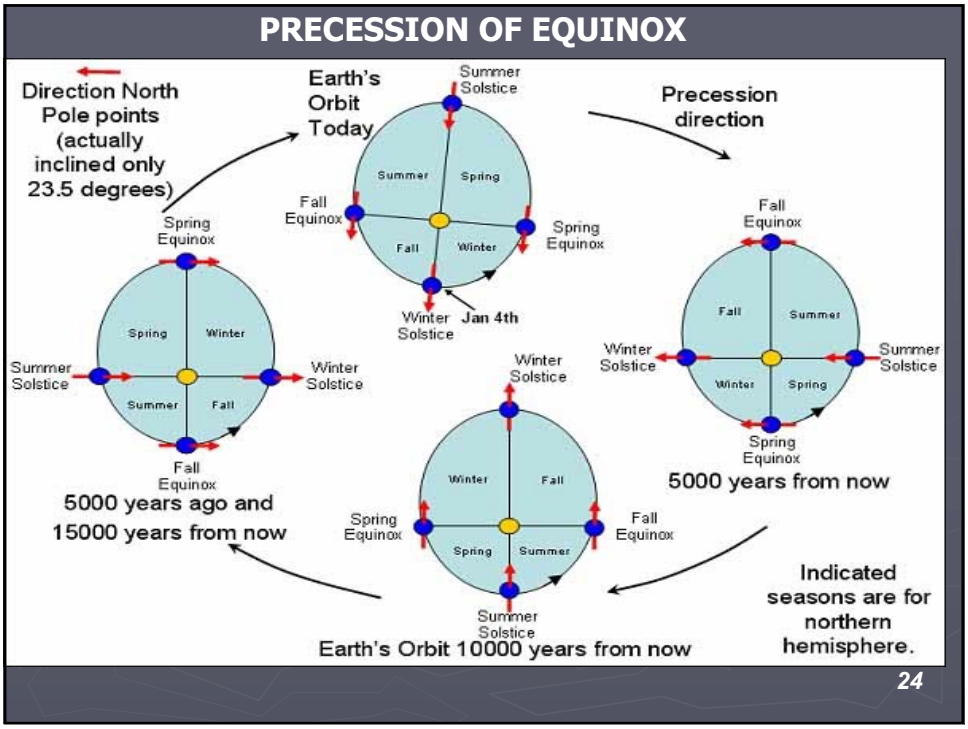
21


Alpha Draconis
Precessional circle
Vega
Deneb
Polaris (North Star)
Celestial Sphere
Autumnal Equinoctial point
celestial equator
25,788 yrs.
Ecliptic plane
Libra
Virgo
Leo
Cancer
Ecliptic plane
Aquarius
Pisces
Aries
celestial equator
25,788 yrs.
Vernal Equinoctial point
Celestial Sphere
Precessional circle
22

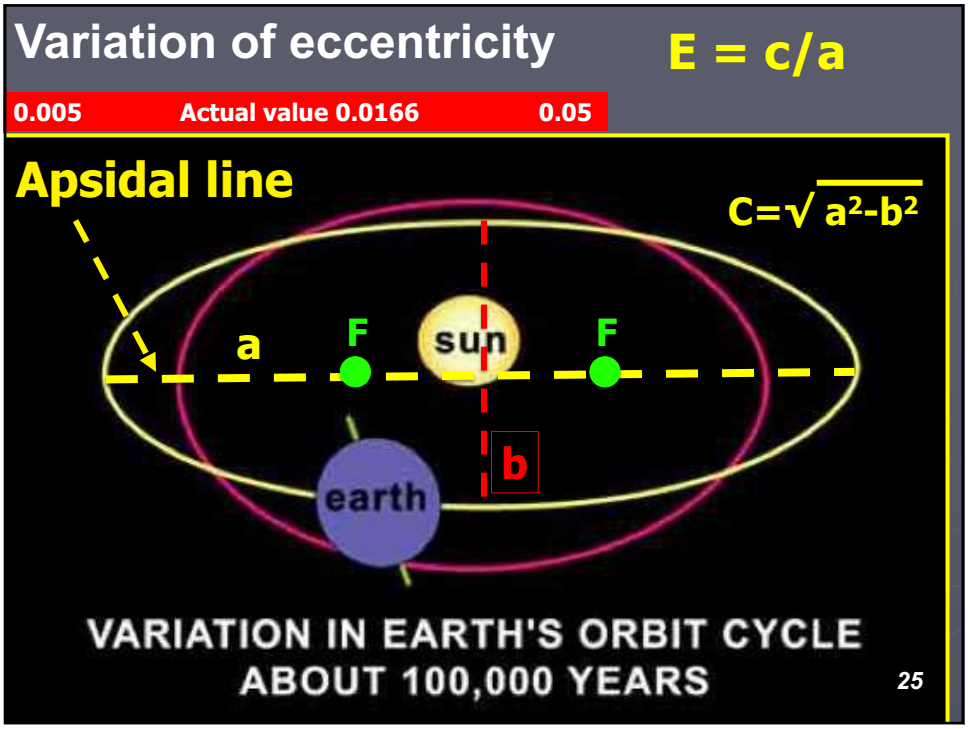
22


Arctic Circle (66.5° N)
Tropic of Cancer (23.5° N)
Equator
Tropic of Capricorn (23.5° S)
Earth
Vernal Equinox
March 21–22
Incoming solar energy equal in both hemispheres
equinoxis line
23½°
solstitial line
Summer Solstice
June 21–22
Incoming solar energy greatest in Northern Hemisphere
Orbit
Winter Solstice
December 21–22
Incoming solar energy greatest in Southern Hemisphere
Autumnal Equinox
September 22–23
Incoming solar energy equal in both hemispheres
23

23


PRECESSION OF EQUINOX
Direction North Pole points (actually inclined only 23.5 degrees)
Earth's Orbit Today
Summer Solstice
Precession direction
Summer
Spring
Fall Equinox
Spring Equinox
Fall
Winter
Winter Solstice
Jan 4th
Spring Equinox
Winter
Spring
Summer Solstice
Winter Solstice
Summer
Fall
Fall Equinox
5000 years ago and 15000 years from now
Fall Equinox
Fall
Summer
Winter Solstice
Summer Solstice
Winter
Spring
Spring Equinox
5000 years from now
Winter Solstice
Winter
Fall
Spring Equinox
Fall Equinox
Spring
Summer
Summer Solstice
Earth's Orbit 10000 years from now
Indicated seasons are for northern hemisphere.
24

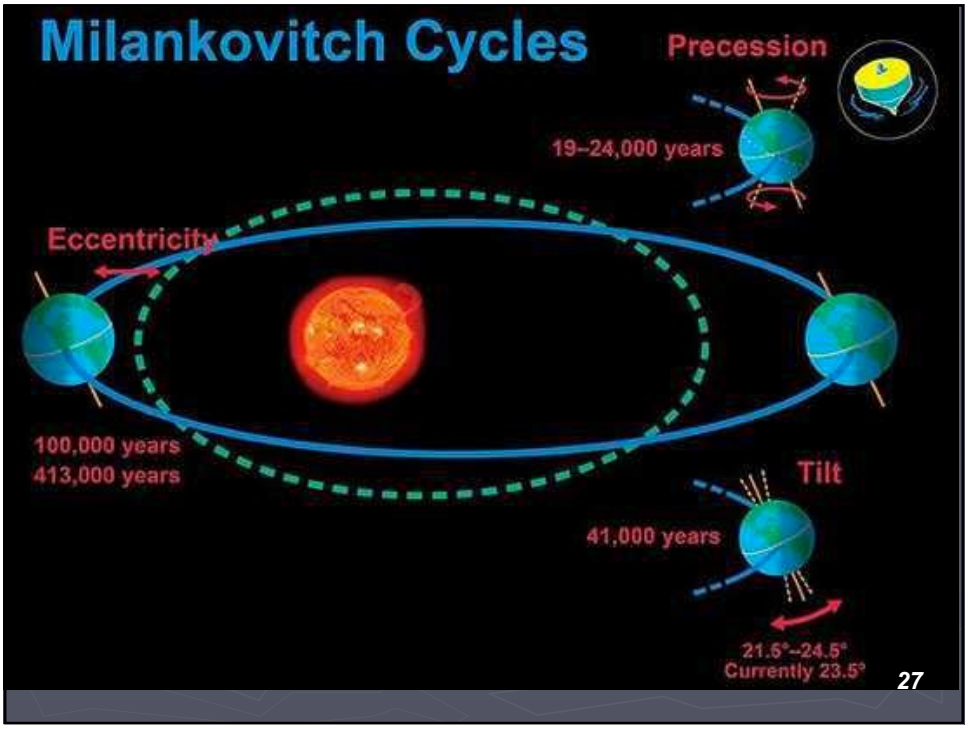
24


Variation of eccentricity
E = c/a
0.005
Actual value 0.0166
0.05
Apsidal line
C=√ a²-b²
a
F
sun
F
b
earth
VARIATION IN EARTH'S ORBIT CYCLE
ABOUT 100,000 YEARS
25

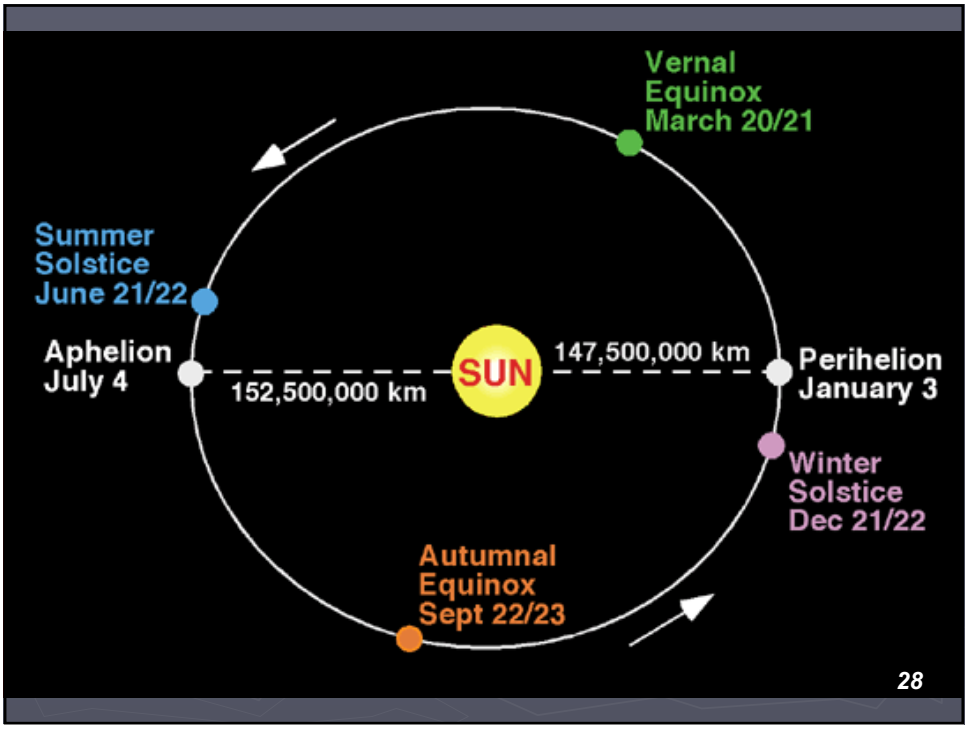
25


Milutin Milanković
28 May 1879 –
12 December 1958
26

26


Milankovitch Cycles
Precession
19–24,000 years
Eccentricity
100,000 years
413,000 years
Tilt
41,000 years
21.5°–24.5°
Currently 23.5°
27

27


Vernal
Equinox
March 20/21
Summer
Solstice
June 21/22
Aphelion
July 4
152,500,000 km
SUN
147,500,000 km
Perihelion
January 3
Winter
Solstice
Dec 21/22
Autumnal
Equinox
Sept 22/23
28

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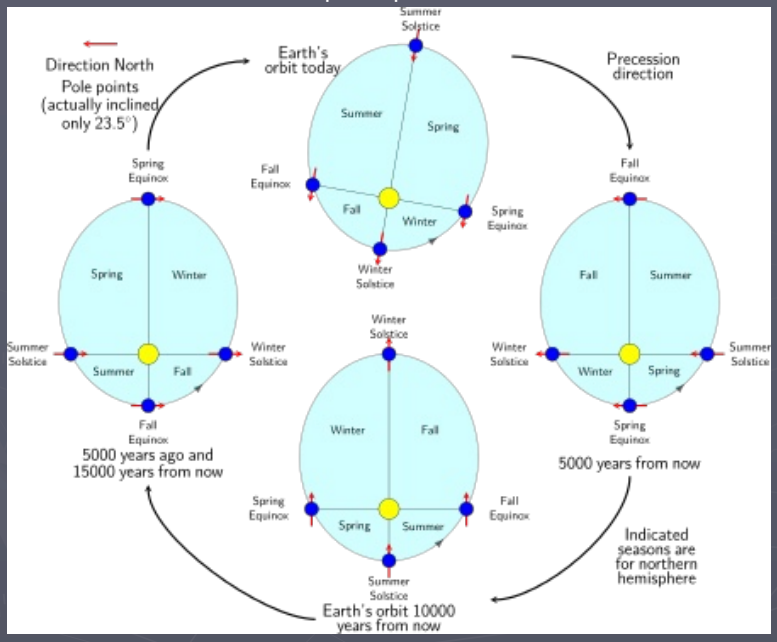
Effects of apsidal precession on the seasons



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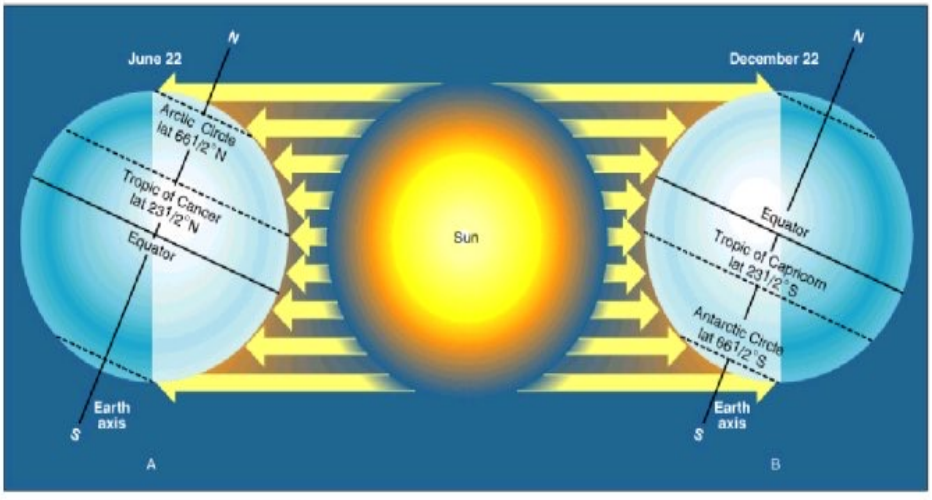

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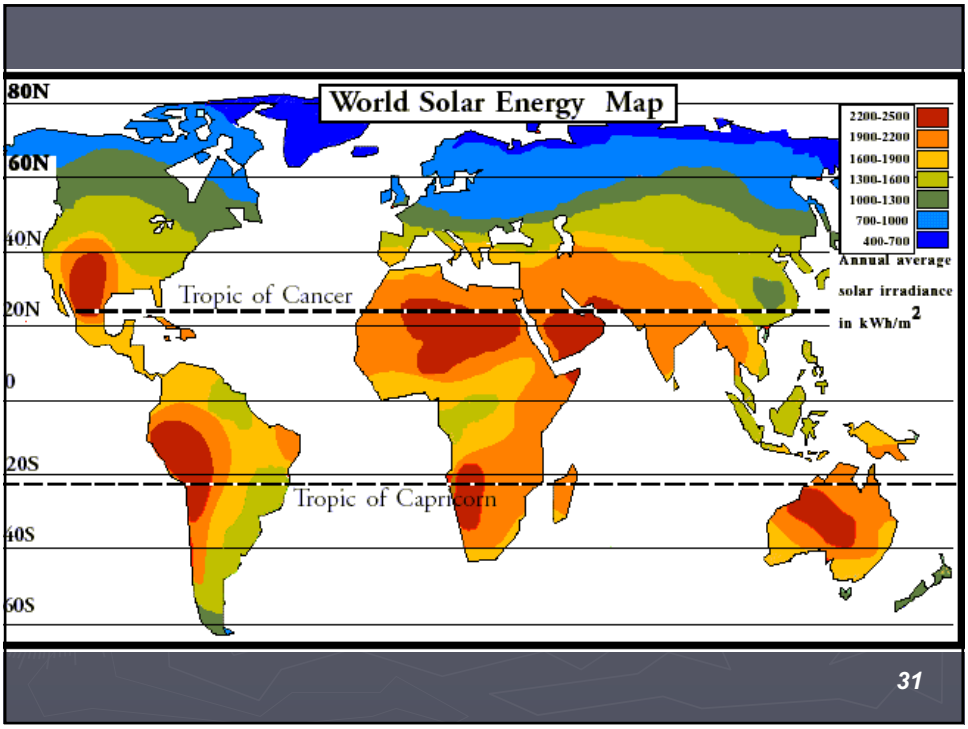
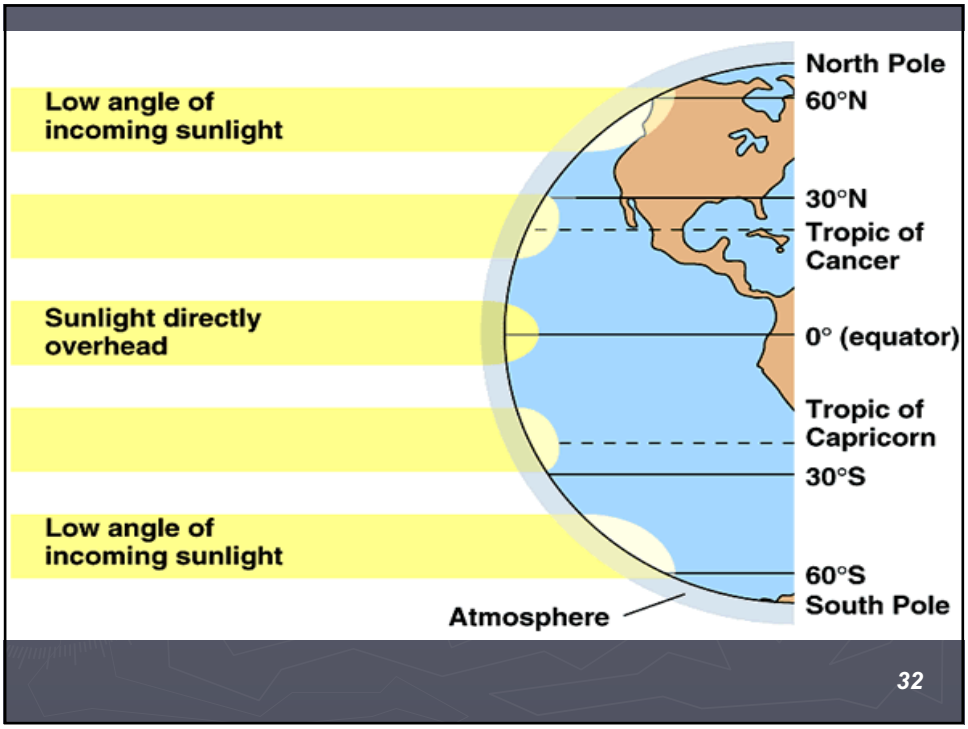

World Solar Energy Map
80N
60N
40N
20N
0
20S
40S
60S
Tropic of Cancer
Tropic of Capricorn
2200-2500
1900-2200
1600-1900
1300-1600
1000-1300
700-1000
400-700
Annual average
solar irradiance
in kWh/m2
31

31


Low angle of incoming sunlight
Sunlight directly overhead
Low angle of incoming sunlight
North Pole
60°N
30°N
Tropic of Cancer
0° (equator)
Tropic of Capricorn
30°S
60°S
South Pole
Atmosphere
32

32

Meteorological factors

33

WMO, 2007. WMO guide n. 8 – Guide to meteorological instruments and methods of observation (https://library.wmo.int/doc_num.php?explnum_id=10616)

34

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Where and how,

- The thermometer and hygrometer are placed on a turf, away from obstacles (ideally, consider placing them in the center of a grass circle with a radius of 5 m, away from obstacles at least 4 times the height of the obstacles themselves and at least 30 m away from concrete slabs or asphalted areas).
- turf is not substitutable with green plastic carpets and this for reasons related to the different surface energy balance
- (grass transpires, plastic, such as concrete and asphalt, no!)

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35

- The radiometers must be perfectly horizontal and should not receive shadows
- The rain gauges and anemometers must be sufficiently far from obstacles such as buildings and trees (ideal: 8-10 times the height of the obstacle for anemometers, 3-5 times for rain gauges)

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Height from ground of sensors

- temperature and humidity:(1.50-1.80 m)
- Wind Speed and direction: (10 m)
- global solar radiation: (1.50-1.80 m)
- rainfall (1.50-1.80 m)
- Soil temperature: (- 0.10 m).

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http://93.57.89.4:8081/temporeale/meteo/stazioni

38

38

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TEMPERATURE and LAPSE RATE:

The **lapse rate** is defined as the rate at which atmospheric temperature decreases with increase in altitude. 0,6° C/100 m 0.4 wet 0.65 dry

Factors determing temperature variation:
Incidence angle of sun rays
latitude
Changing season
Time
exposure
Land declivity
Type of surface

40

40

isotherm

- a line on a weather map or chart connecting points having equal temperature.
- Also called isothermal line
- The different extension of continents between North and South hemisphere determines a global temperature difference for which the North is a bit warmer

- **70% of water**
- **30 % of continental surface**
- **39% in north emisphere**
- **19% in south emisphere**

41

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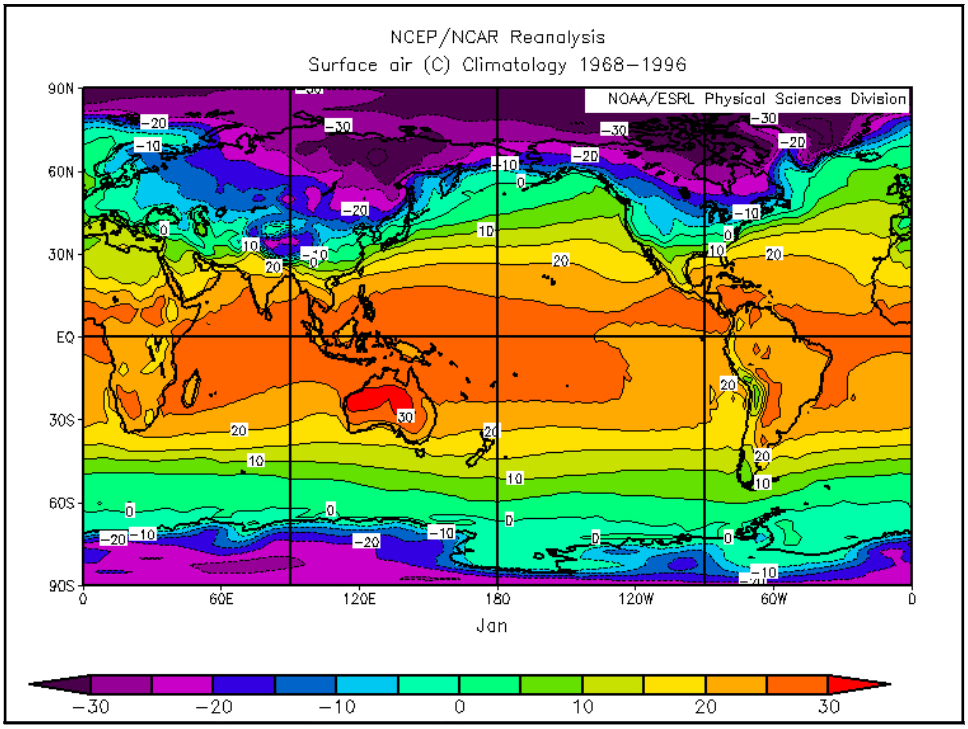
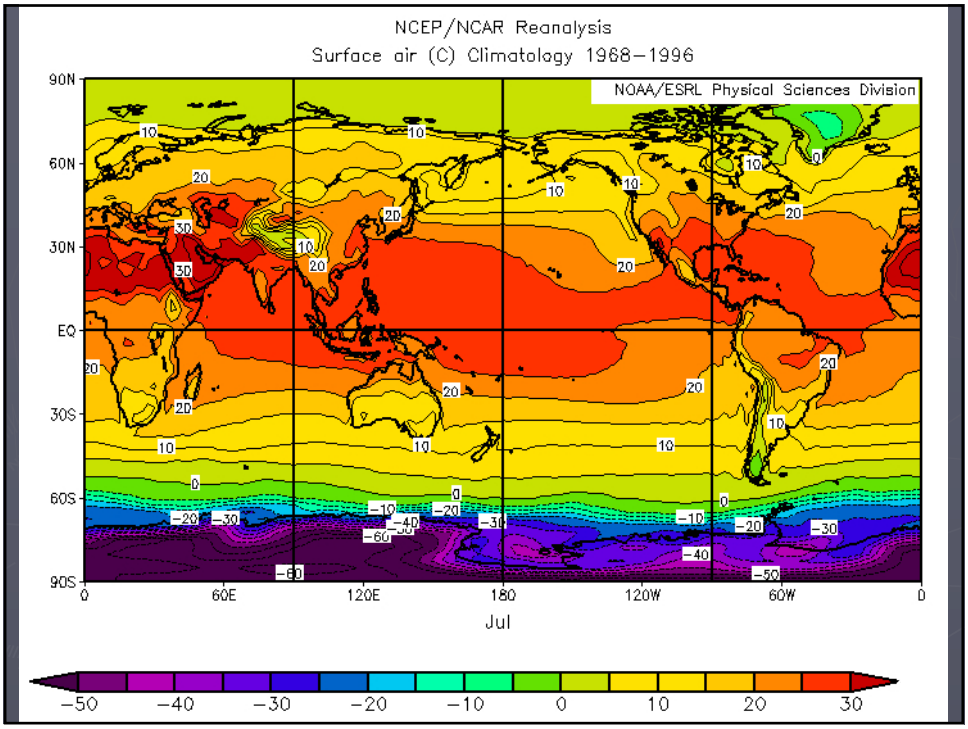
- The isotherm of 20 ° in the southern hemisphere runs above the Tropic of Capricorn
- In the northern one further north.
- Isotherms deviate to the passage from the oceans to the continents during the different seasons

42

42


NCEP/NCAR Reanalysis
Surface air (C) Climatology 1968–1996
NOAA/ESRL Physical Sciences Division
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
Jan
−30
−20
−10
0
10
20
30

43


NCEP/NCAR Reanalysis
Surface air (C) Climatology 1968–1996
NOAA/ESRL Physical Sciences Division
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
Jul
−50
−40
−30
−20
−10
0
10
20
30

44

Planetary Energy Balance

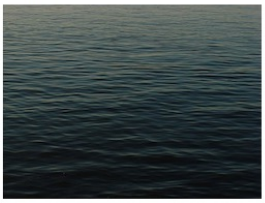
Darks Colors Absorb, Lighter Colors Reflect

Once the electromagnetic radiation reaches the earth's surface, it is absorbed or reflected, depending on the nature of the material.

Ever walked barefoot on black pavement on a hot sunny day? The pavement gets really hot! That's because dark colors absorb radiation.

When your feet get so hot you can't stand it, you jump onto the concrete sidewalk, which feels much cooler. That's because lighter colors reflect radiation.

Dark colored surfaces absorb more of the incoming visible radiation. Earth's darkest materials include ocean water, and to a lesser extent plants and trees. These areas soak up the sun's radiation and warm the earth.



Bright surfaces such as ice and snow, and to a lesser degree desert sand, reflect most incoming radiation. Reflected radiation passes back through the atmosphere and into space without warming the earth.

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Thermal excursion

Difference between average temperature of warmer month and average temperature of colder month

In northern hemisphere it corresponds to the difference between average temperature in January and in July

If average temperature T in July – average temperature in January > 20° continental climate
If average temperature T in July – average temperature in January < 10° oceanic climate

If difference value is between 10 and 15 suboceanic climate
If difference value is between 15 and 20 subcontinental climate

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Temperature Scales

A number of measurement scales have been invented to measure temperature.
Table describes important temperatures for the three dominant scales in use today.

Measurement	Steam Point of Water	Ice Point of Water	Absolute Zero
Fahrenheit	212	32	-460
Celsius	100	0	-273
Kelvin	373	273	0

48

48

Conversion factor

Measurement	Steam Point of Water	Ice Point of Water	difference
Fahrenheit	212	32	180 units
Celsius	100	0	100 units

74° F = ° C ?
74-32= 42
42/1.8 = 23° C

30° C= F?
° F =(Cx1.8) +32
° F= (30x1.8) + 32 = 86 F

49

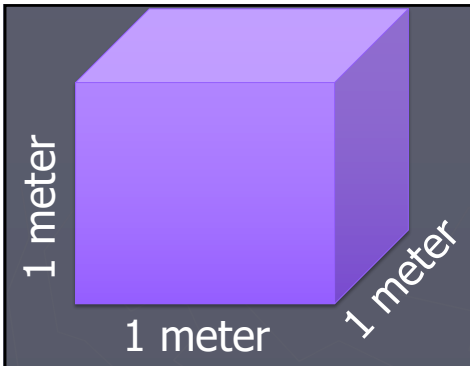
49

Precipitation

- Rainfall is measured with
- **rain gauge**
- Expressed as mm/sm equivalent liter per square meter

50

50



1 meter =1000 mm

1 mm of rain per square meter= 1 liter

(1000 x 1000 x 1000) mm= 1000 liters

1000 liters = 1000 Kg= 1 ton per s. m.

51

51

- Precipitation can be

solid

Liquid

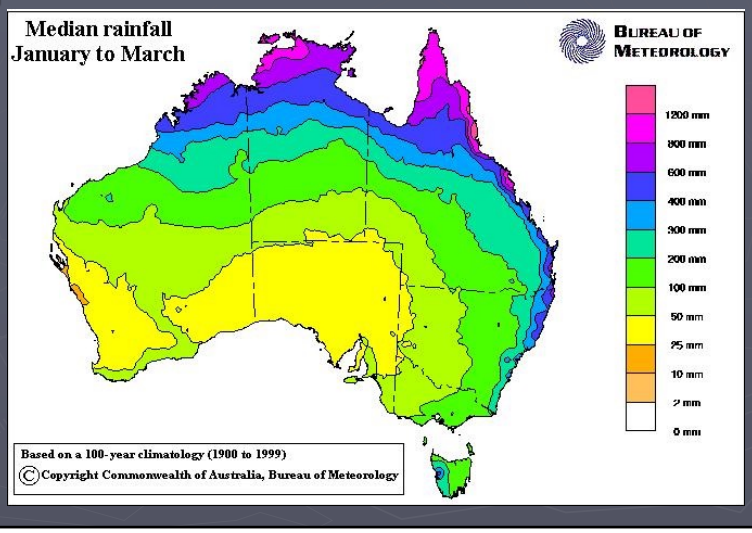
- Pluviometric regime
- distribution over time, number of days with rainfall ≥ 1mm
- Isohyet

52

52

Isohyet

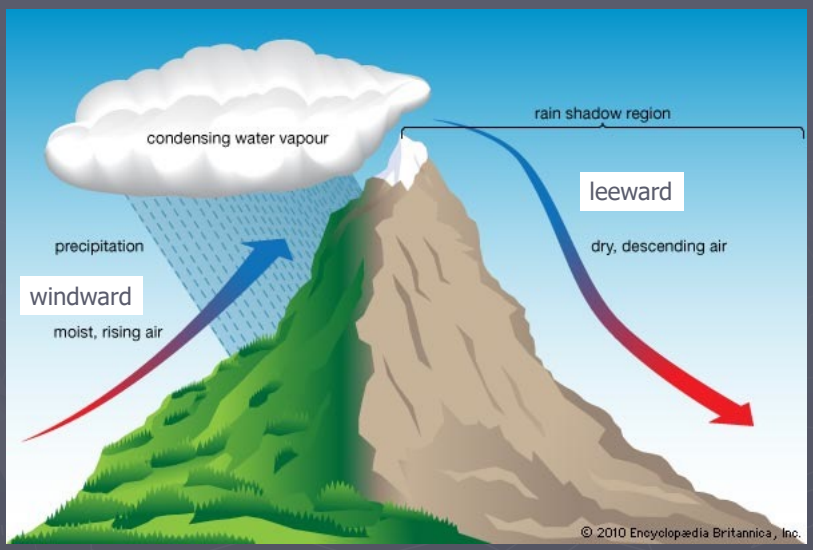
- a line on a map or chart connecting areas of equal rainfall



53

53

orographic precipitation

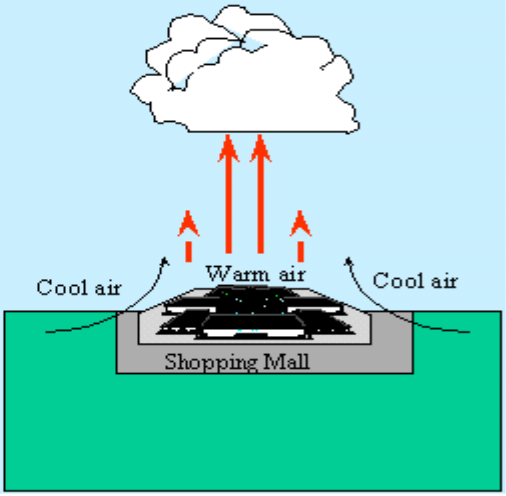


54

54

CONVECTIONAL PRECIPITATION

- Unequal heating at the earth's surface creates a local hot spot.
- Air in contact with the hot spot expands and rises.
- Rising air cools adiabatically to dew point temperature.



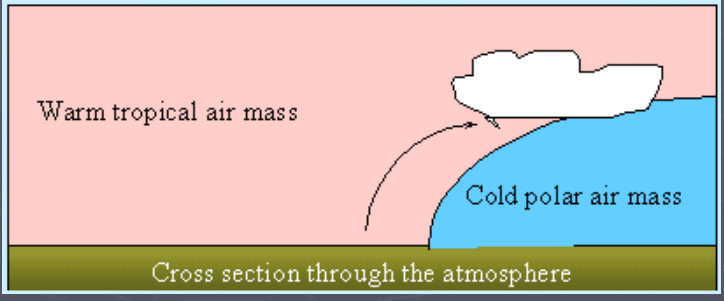
55

55

CYCLONIC OR FRONTAL PRECIPITATION

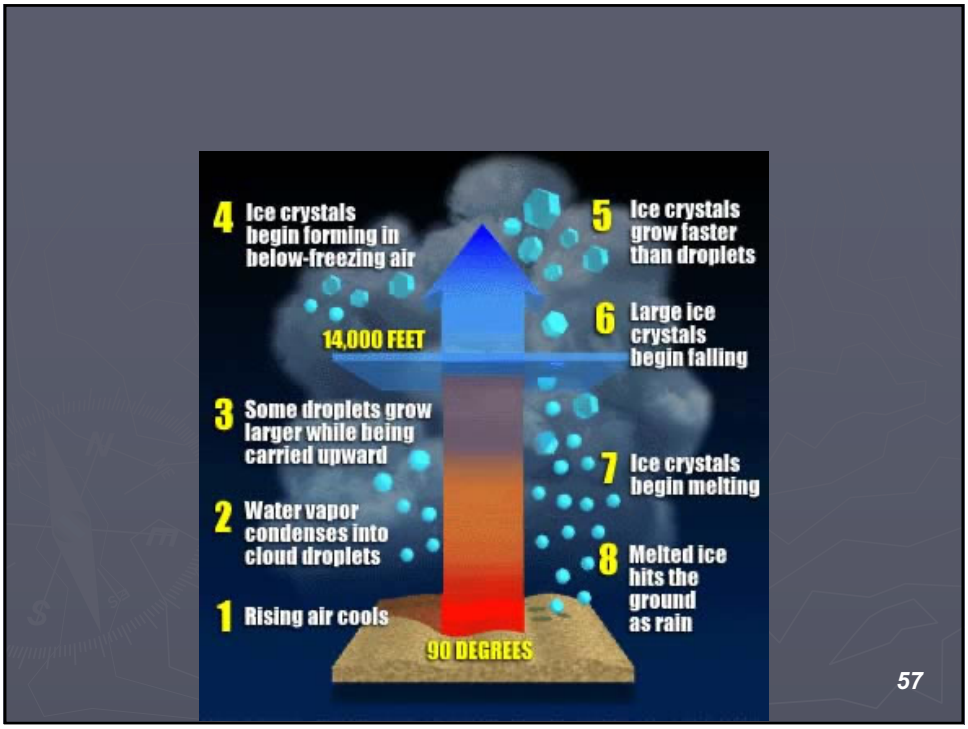
Cyclonic or Frontal Precipitation

- Warm air in contact with cold air rises.
- As it rises, it cools
- Moist air condenses and forms clouds.

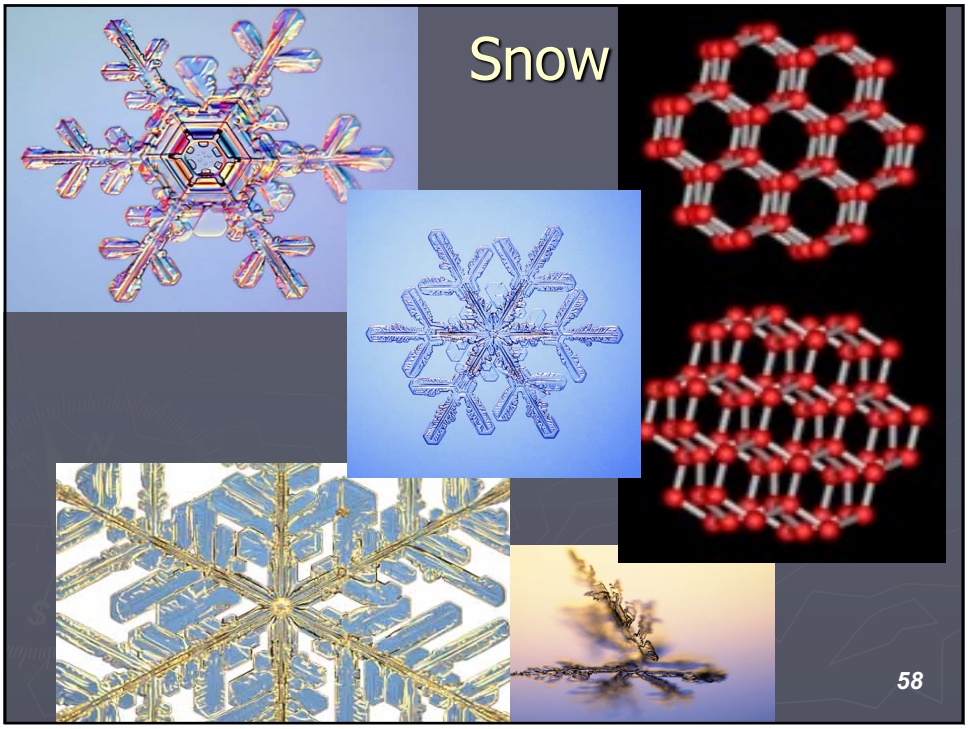


56

56

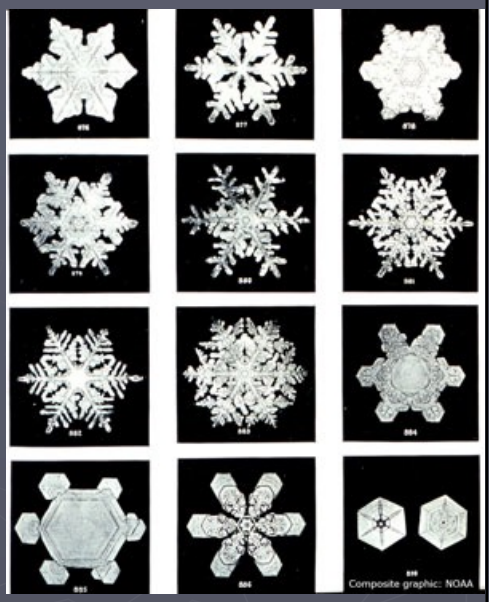

4 Ice crystals begin forming in below-freezing air
5 Ice crystals grow faster than droplets
14,000 FEET
6 Large ice crystals begin falling
3 Some droplets grow larger while being carried upward
7 Ice crystals begin melting
2 Water vapor condenses into cloud droplets
8 Melted ice hits the ground as rain
1 Rising air cools
90 DEGREES
57

57


Snow
58

58

- individual snowflakes all follow slightly different paths from the sky to the ground — and thus encounter slightly different atmospheric conditions along the way. Therefore, *they all tend to look unique*, resembling everything from prisms and needles to the familiar lacy pattern.



59

59

hail

- **Hail** is solid precipitation that falls from thunderstorms as round or irregular balls of ice or ice-pellets, generally taken to be 5mm in diameter or larger

Hail stone size classification

SIZE CODE	DIAMETER	DESCRIPTION	INTENSITY RANGE
1	5 to 10 mm	pea	H0 - H2
2	11 to 15 mm	mothball, bean	H0 - H3
3	16 - 20 mm	cherry, five pence coin (new), penny	H1 - H4
4	21 to 30 mm	walnut, one pound or two pence coin	H2 - H5
5	31 to 45 mm	golf ball, table tennis ball	H3 - H6
6	46 to 60 mm	hen' s egg, billiard ball	H4 - H7
7	61 to 80 mm	tennis ball, orange	H5 - H8
8	81 to 100 mm	grapefruit, softball	H6 - H9
9	101 to 125 mm	melon	H7 - H10
10	over 150 mm	coconut	H8 - H10

60

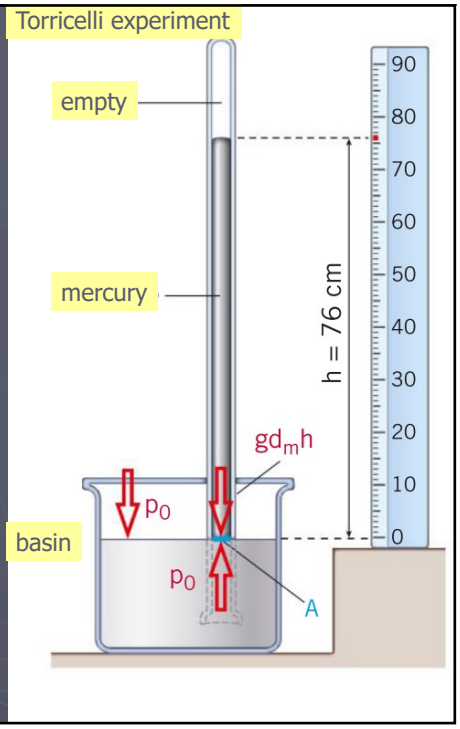
60

61

62

atmospheric pressure

- also called barometric pressure, force per unit area exerted by an atmospheric column (that is, the entire body of air above the specified area).
- Atmospheric pressure is measured using an aneroid barometer



63

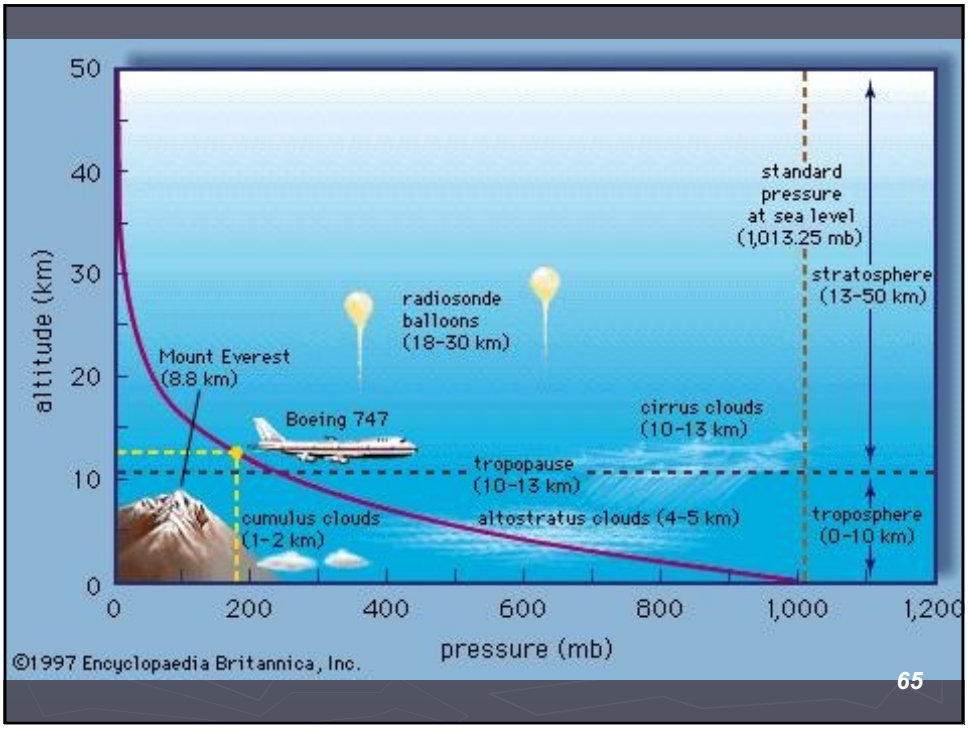
- **The standard atmosphere** (symbol: **ATM**) is a unit of **pressure equal to 101325 Pa or 1013.25 hectopascal or millibars.**
- **Equivalent to 760 mmHg (torr), 14.696 psi.**

	pascal	bar	atm	psi
1 pascal	1	0,00001	0,00000986923	0,000145038
1 bar	100000	1	0,986923	14,5038
1 atm	101325	1,01325	1	14,695949
1 psi	6894,76	0,0689476	0,068046	1

- **The Pascal is a Newton per square meter or in terms of I.S. base units, kilogram per meter per second-squared)**

64

64


altitude (km)
50
40
30
20
10
0
0
200
400
600
800
1,000
1,200
pressure (mb)
standard pressure at sea level (1,013.25 mb)
stratosphere (13-50 km)
troposphere (0-10 km)
radiosonde balloons (18-30 km)
Mount Everest (8.8 km)
Boeing 747
cirrus clouds (10-13 km)
tropopause (10-13 km)
cumulus clouds (1-2 km)
altostratus clouds (4-5 km)
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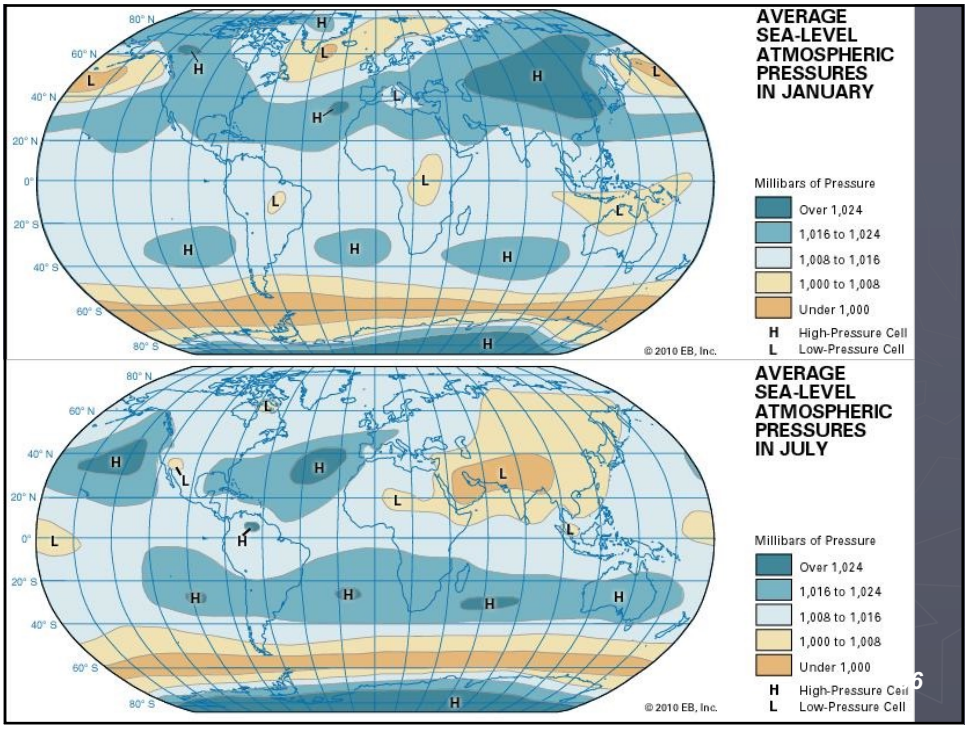
65

65


AVERAGE SEA-LEVEL ATMOSPHERIC PRESSURES IN JANUARY
Millibars of Pressure
Over 1,024
1,016 to 1,024
1,008 to 1,016
1,000 to 1,008
Under 1,000
H High-Pressure Cell
L Low-Pressure Cell
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AVERAGE SEA-LEVEL ATMOSPHERIC PRESSURES IN JULY
Millibars of Pressure
Over 1,024
1,016 to 1,024
1,008 to 1,016
1,000 to 1,008
Under 1,000
H High-Pressure Cell
L Low-Pressure Cell
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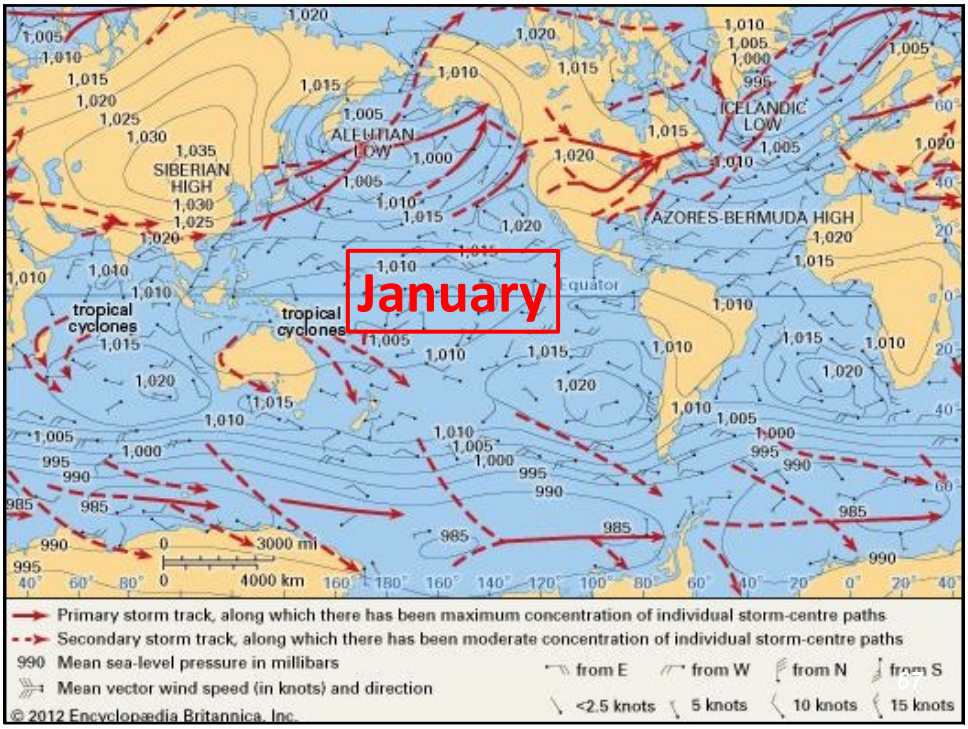
66


January
ALEUTIAN LOW
SIBERIAN HIGH
ICELANDIC LOW
AZORES-BERMUDA HIGH
tropical cyclones
tropical cyclones
Equator
3000 mi
4000 km
Primary storm track, along which there has been maximum concentration of individual storm-centre paths
Secondary storm track, along which there has been moderate concentration of individual storm-centre paths
990 Mean sea-level pressure in millibars
Mean vector wind speed (in knots) and direction
from E
from W
from N
from S
<2.5 knots
5 knots
10 knots
15 knots
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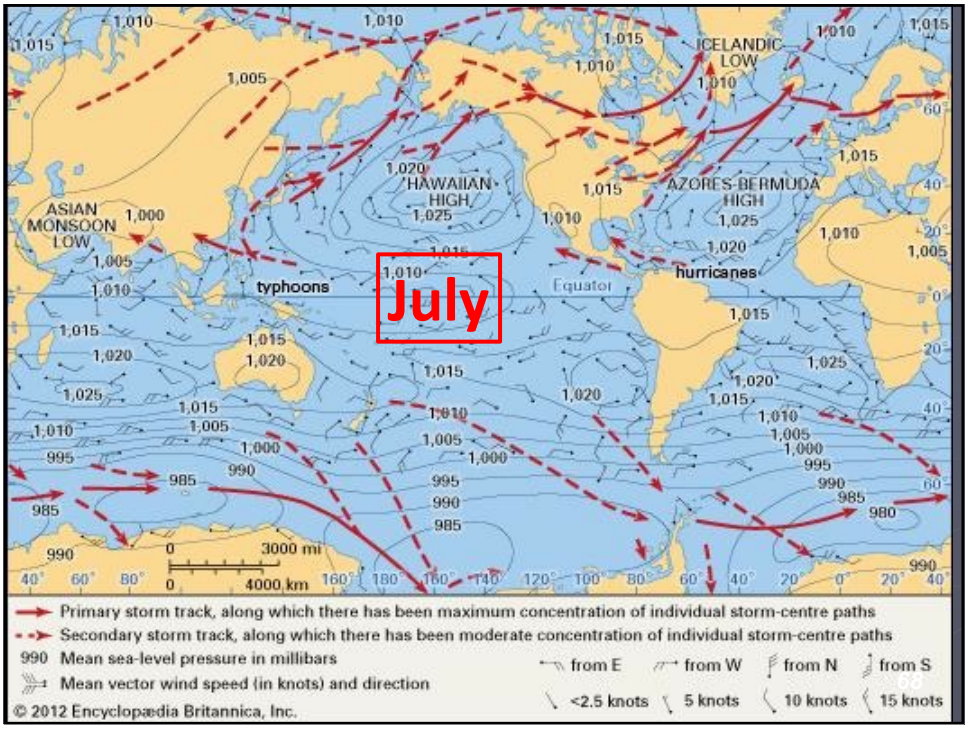
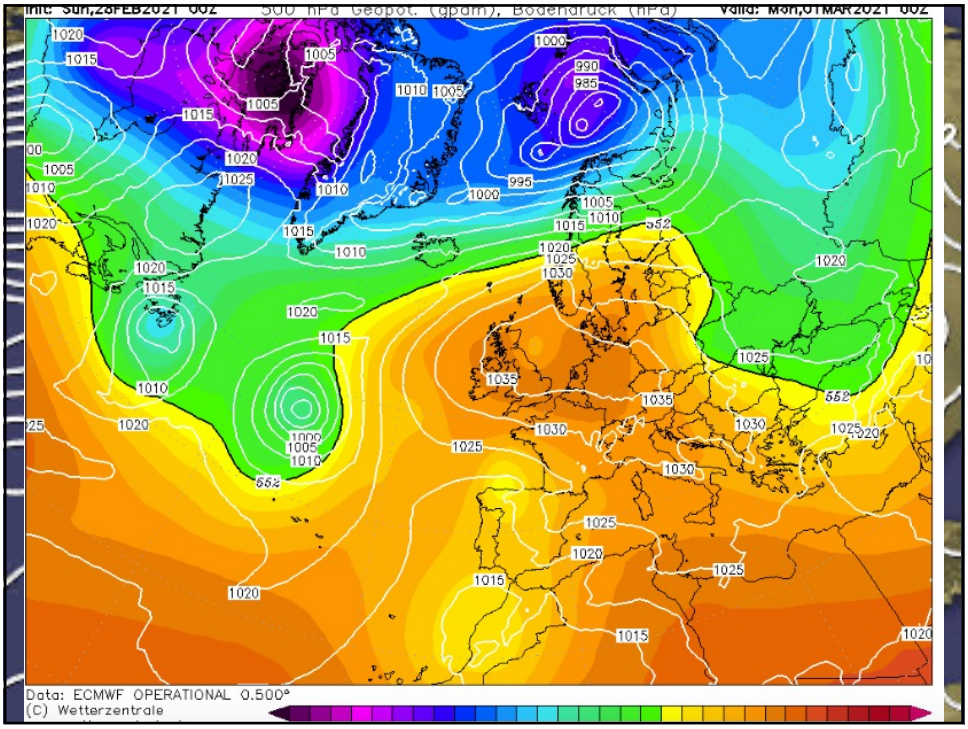
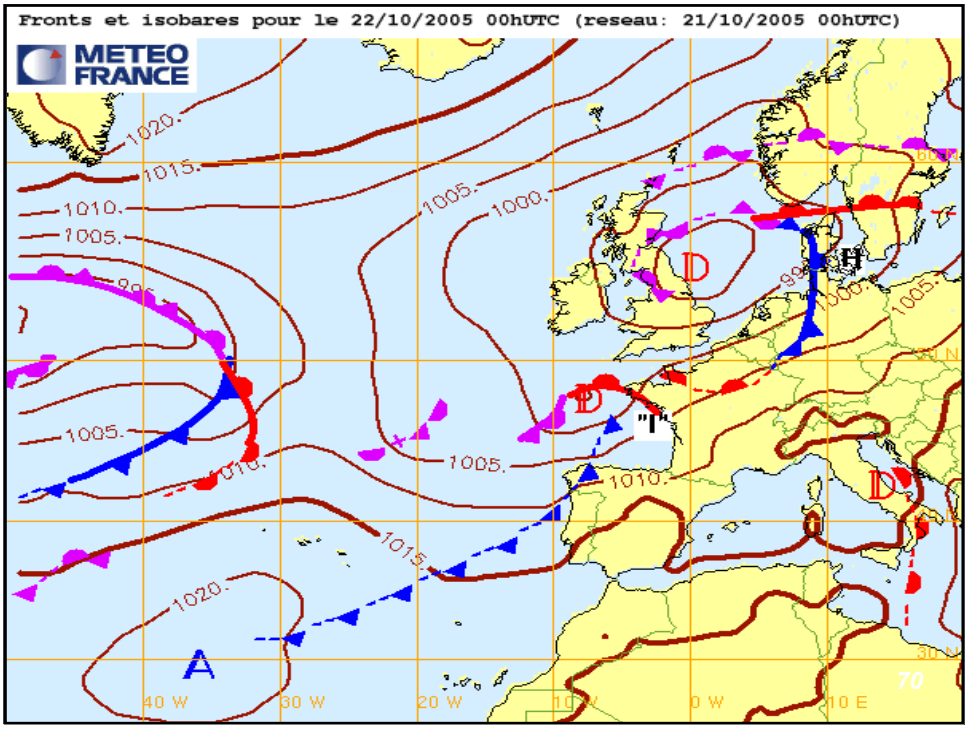
67


July
ASIAN MONSOON LOW
HAWAIIAN HIGH
ICELANDIC LOW
AZORES-BERMUDA HIGH
typhoons
hurricanes
Equator
3000 mi
4000 km
Primary storm track, along which there has been maximum concentration of individual storm-centre paths
Secondary storm track, along which there has been moderate concentration of individual storm-centre paths
990 Mean sea-level pressure in millibars
Mean vector wind speed (in knots) and direction
from E
from W
from N
from S
<2.5 knots
5 knots
10 knots
15 knots
© 2012 Encyclopædia Britannica, Inc.

68


Data: ECMWF OPERATIONAL 0.500°
(C) Wetterzentrale

69


Fronts et isobares pour le 22/10/2005 00hUTC (reseau: 21/10/2005 00hUTC)
METEO FRANCE
A
H
40 W
30 W
20 W
10 W
0 W
10 E

70

Wind is simply the air in motion.

- The vertical component of the wind is typically very small (except in thunderstorm updrafts) compared to the horizontal component, but is very important for determining the day to day weather.
- Rising air will cool, often to saturation, and can lead to clouds and precipitation.
- Sinking air warms causing evaporation of clouds and thus fair weather.

71

71

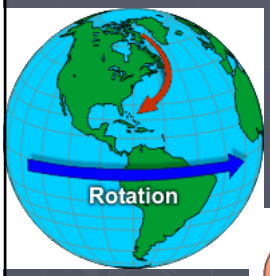
- Pressure gradient is the *difference* in pressure between high and low pressure areas.
- Wind speed is *directly proportional* to the pressure gradient.
- This means the strongest winds are in the areas where the pressure gradient is the greatest.

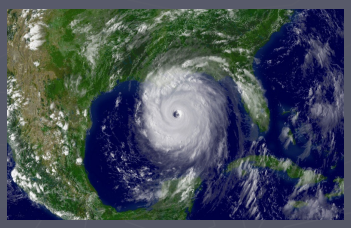
72

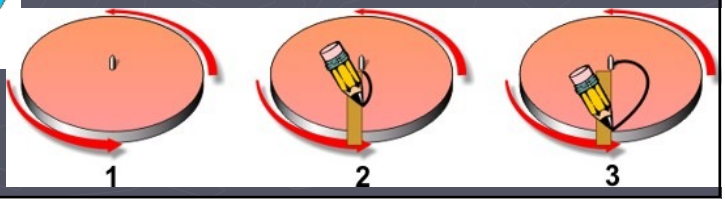
72

the **Coriolis force (or effect)**

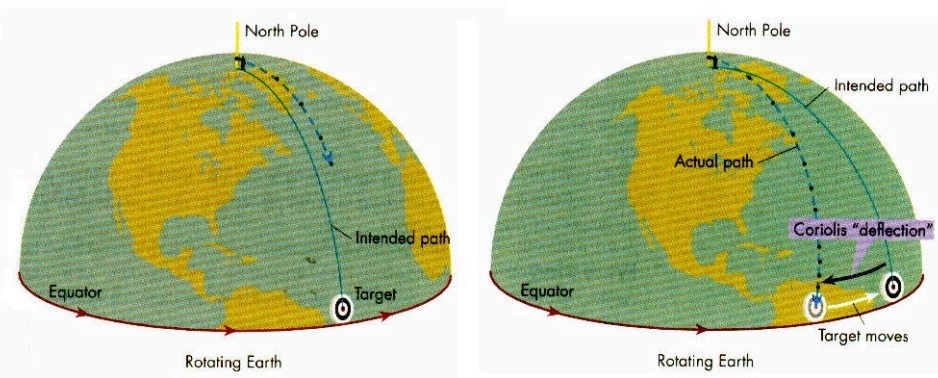
- because of the earth's rotation, there is second force, the **Coriolis force** that affects the direction of wind flow.







73



74

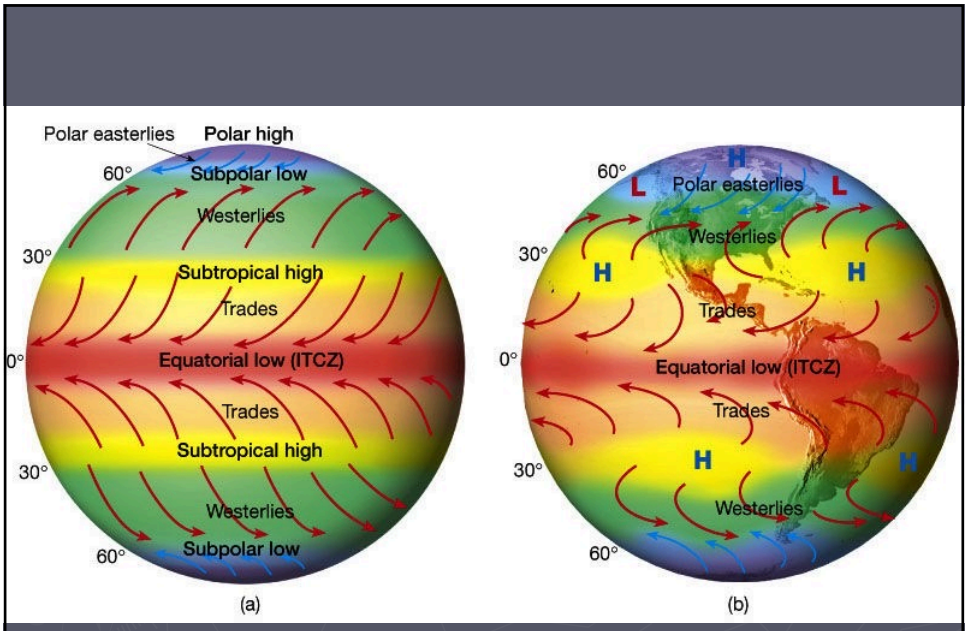
74

wind

- It is the movement of air caused by the uneven heating of the Earth by the sun.
- It does not have much substance—you cannot see it or hold it—but you can feel its force. It can dry your clothes in summer and chill you to the bone in winter.
- High pressure system Low pressure system

75

75



76

76

Wind Zones

- The Earth contains five major wind zones: polar easterlies, westerlies, horse latitudes, trade winds, and the doldrums.

- **Polar easterlies** are dry, cold prevailing winds that blow from the east. They emanate from the polar highs, areas of high pressure around the North and South Poles. Polar easterlies flow to low-pressure areas in sub-polar regions.

77

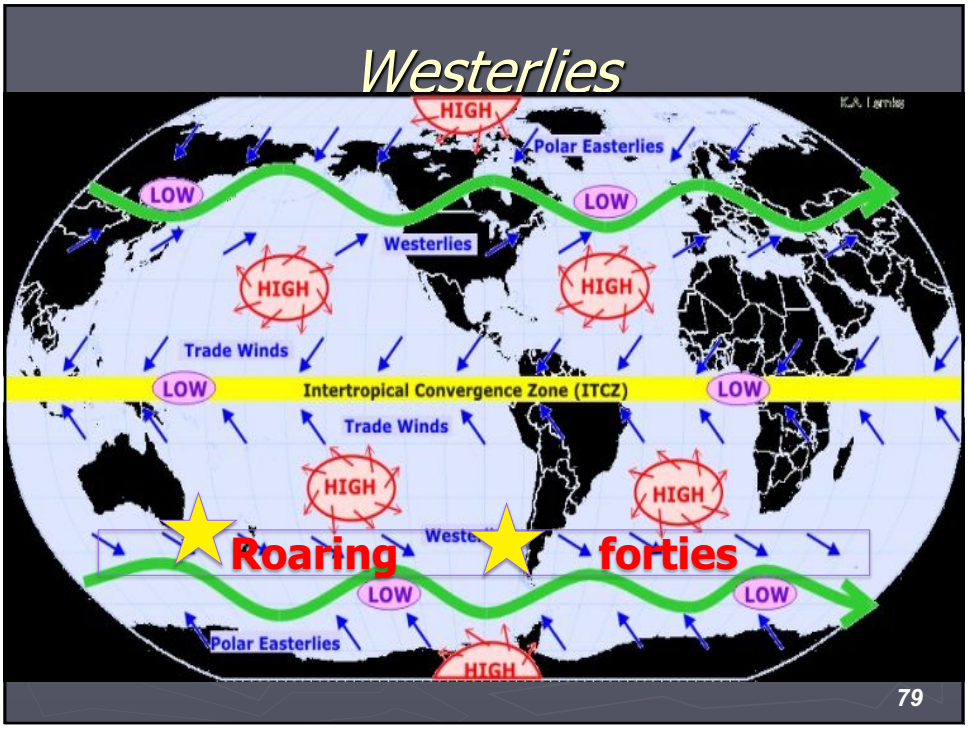
77

Westerlies

- Westerlies are prevailing winds that blow from the west at mid latitudes. They are fed by polar easterlies and winds from the high-pressure horse latitudes, which sandwich them on either side.
- Westerlies are strongest in the winter, when pressure over the pole is low, and weakest in summer, when the polar high creates stronger polar easterlies.

78

78


Westerlies
HIGH
Polar Easterlies
LOW
LOW
Westerlies
HIGH
HIGH
Trade Winds
LOW
Intertropical Convergence Zone (ITCZ)
LOW
Trade Winds
HIGH
HIGH
Roaring
forties
LOW
LOW
Polar Easterlies
HIGH
79

79

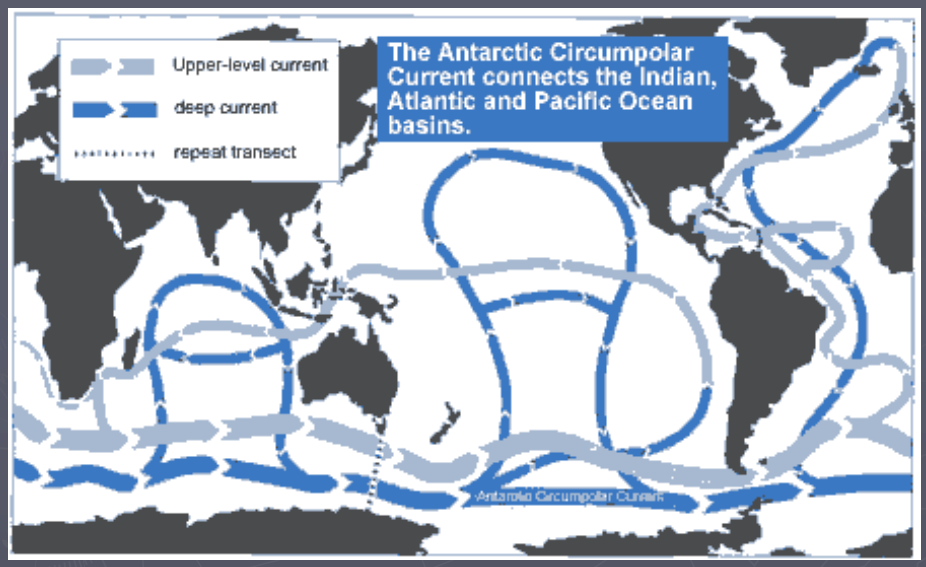

Atlantic
Ocean
Pacific
Ocean
Pacific
Ocean
Indian
Ocean
Equator
St. Paul Rock
Trinidade
Cape of Good Hope
Tristan da Cunha
Cape Agulhas
Cape Leeuwin
Perth
Melbourne
Sydney
South East Cape
South West Cape
Roaring
Forties
Furious
Fifties
Cape Horn

80

- Westerlies have an enormous impact on ocean currents, especially in the Southern Hemisphere. Driven by westerlies, the powerful **ANTARCTIC CIRCUMPOLAR CURRENT** (ACC) rushes around the continent (from west to east) at about 4 kilometers per hour. In fact, another name for the Antarctic Circumpolar Current is the **West Wind Drift**. The **ACC** is the largest ocean current in the world, and is responsible for transporting enormous volumes of cold, nutrient-rich water to the ocean, creating healthy marine ecosystems and food webs.

81

81



82

82

ACC controls climate in three ways:

- 1. By connecting the world's oceans, the ACC redistributes heat and other properties influencing the patterns of temperature and rainfall.
- 2. The vertical movement of water, caused by Antarctic freezing during the winter and warming during summer, controls the renewal of deep water in the world's oceans.
- 3. There is an exchange of gases, such as oxygen and carbon dioxide, with the atmosphere at the sea surface. The ocean contains 50 times more carbon than the atmosphere, so the rate at which carbon dioxide is absorbed by the Southern Ocean can directly affect climate change.

83

83

Horse Latitudes

- The Horse latitudes a a narrow zone of warm, dry climates between Westerlies and trade winds. Horse latitudes are about 30 and 35 degrees north and south.
- Many deserts, from rainless Atacama of south America to the arid Kalahari desert of Africa, are part of the horse latitudes

84

84

Trade Winds

- Trade winds are the powerful prevailing winds that blow from the east across the tropics. Trade winds are generally very predictable. They have been instrumental in the history of exploration, communication, and trade. Ships relied on trade winds to establish quick, reliable routes across the vast Atlantic and, later, Pacific Oceans. Even today, shipping depends on trade winds and the ocean currents they drive. Monsoon

85

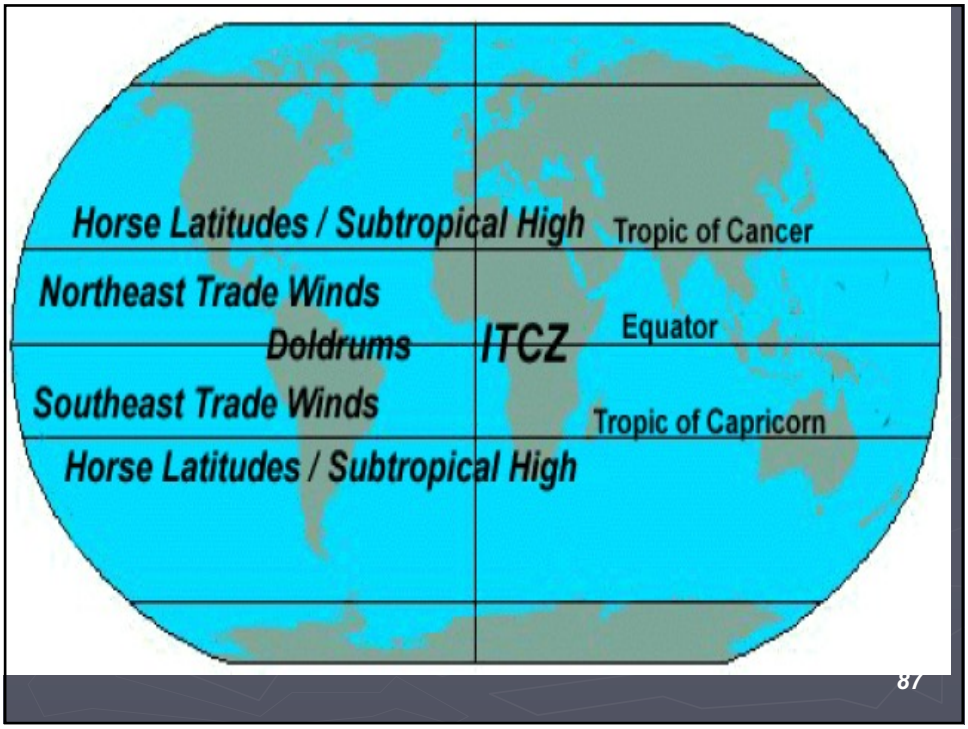
85

Doldrums

- The place where trade winds of the two hemispheres meet is called the **intertropical convergence zone** (**ITCZ**). The area around the **ITCZ** is called the doldrums. Prevailing winds in the doldrums are very weak, and the weather is unusually calm.

86

86



87

Jet Streams

Jet streams are geostrophic winds that form near the boundaries of air masses with different temperatures and humidity. The rotation of the Earth and its uneven heating by the sun also contribute to the formation of high-altitude jet streams.

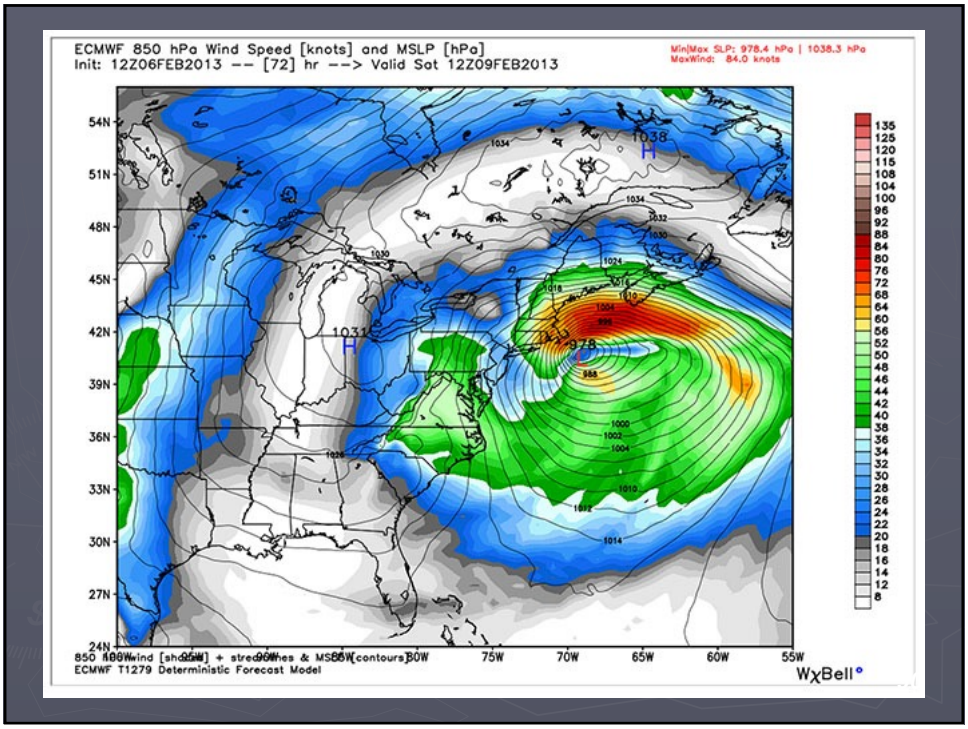
These strong, fast winds in the upper atmosphere can blow 480 kph. Jet streams blow through a layer of the atmosphere called the stratosphere, at altitudes of 8 to 14 kilometers above Earth's surface.

88

88


Nor'easters and Blizzards
AMBULANCE
KEEP BACK
89

89


ECMWF 850 hPa Wind Speed [knots] and MSLP [hPa]
Init: 12Z06FEB2013 -- [72] hr --> Valid Sat 12Z09FEB2013
Min|Max SLP: 978.4 hPa | 1038.3 hPa
MaxWind: 84.0 knots
1038
H
1031
H
978
L
54N
51N
48N
45N
42N
39N
36N
33N
30N
27N
24N
90W
85W
80W
75W
70W
65W
60W
55W
850 hPa wind [shaded] + streamlines & MSLP contours
ECMWF T1279 Deterministic Forecast Model
WxBell

90

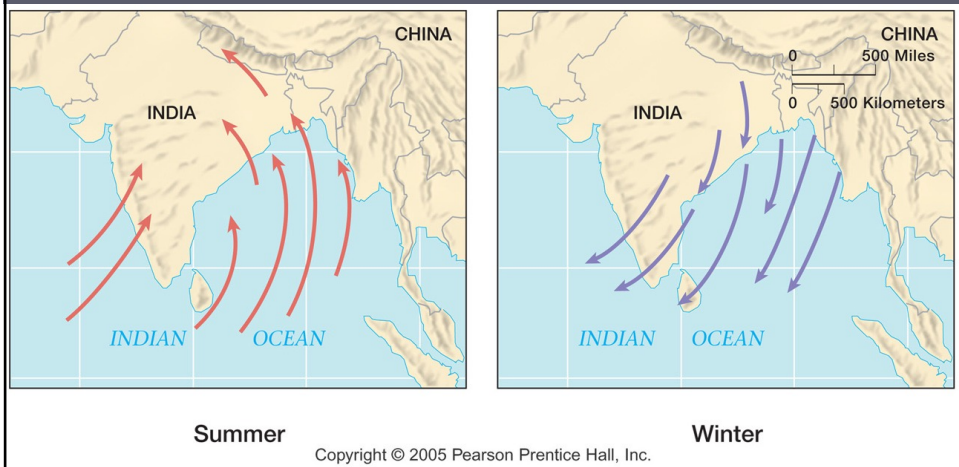
Monsoon

- A monsoon is a seasonal change in the prevailing wind system of an area. They always blow from cold, high-pressure regions. Monsoons are part of a yearlong cycle of uneven heating and cooling of tropical and mid-latitude coastal regions.

91

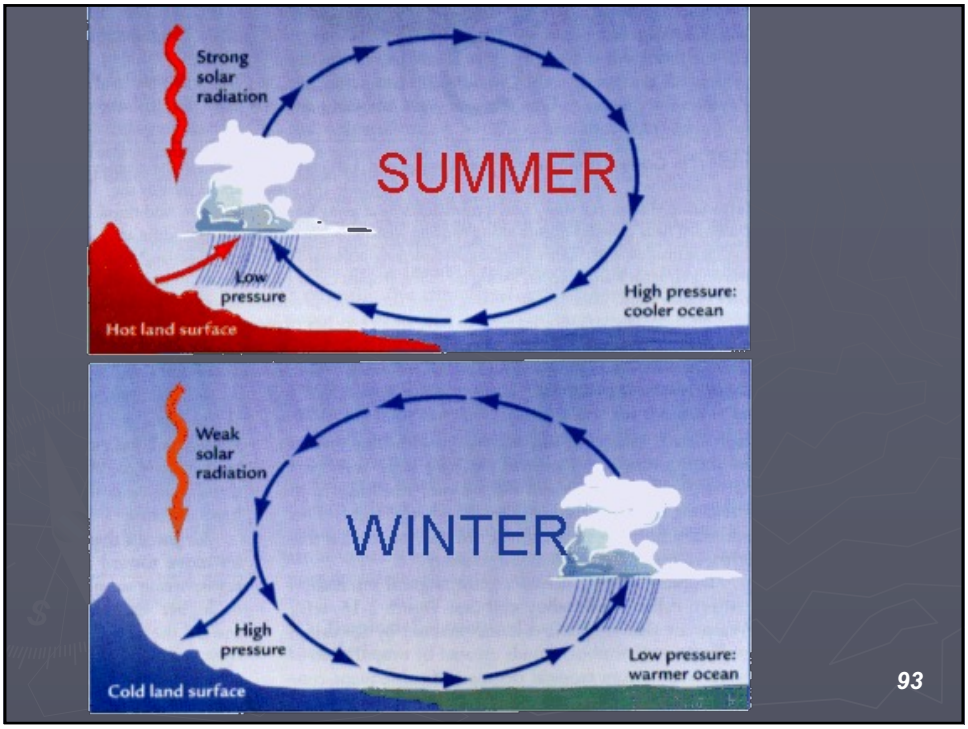
91

monsoon

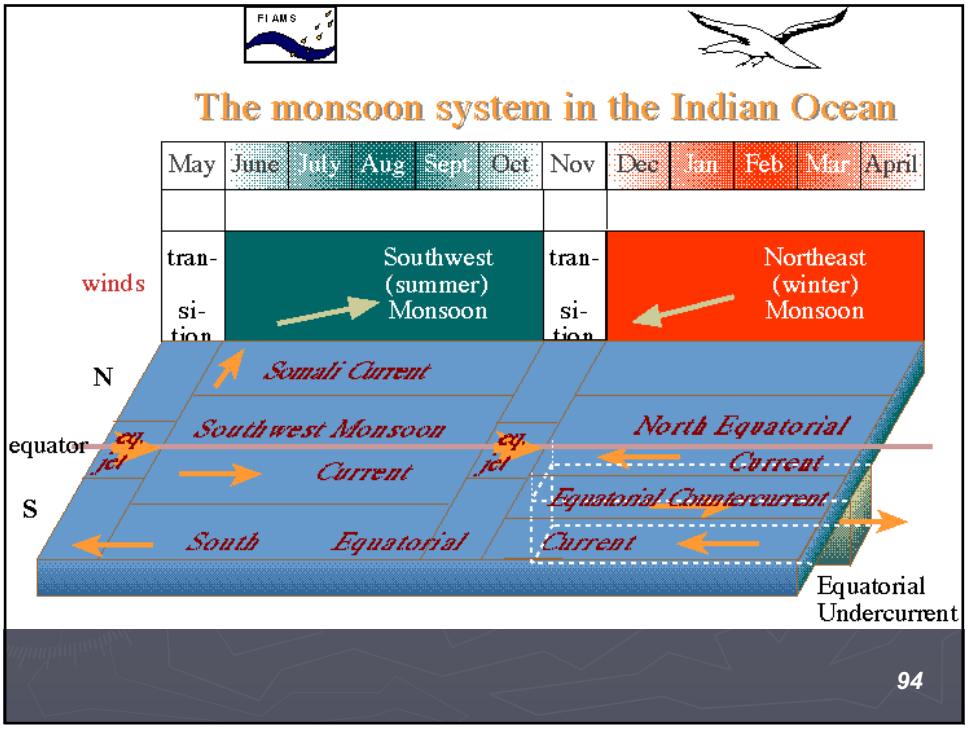


92

92


Strong solar radiation
SUMMER
Low pressure
High pressure: cooler ocean
Hot land surface
Weak solar radiation
WINTER
High pressure
Low pressure: warmer ocean
Cold land surface
93

93


FIAMS
The monsoon system in the Indian Ocean
May
June
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
winds
tran-si-tion
Southwest (summer) Monsoon
tran-si-tion
Northeast (winter) Monsoon
N
equator
S
Somali Current
Southwest Monsoon Current
eq. jet
eq. jet
North Equatorial Current
Equatorial Countercurrent
South Equatorial Current
Equatorial Undercurrent
94

94

Measuring Winds

- Wind is measured in meters per second. Under normal conditions, the winds move much faster higher in the atmosphere, creating high wind shear in high altitudes.

95

95

The Beaufort scale

Beaufort Number	Wind Speed (miles/hour)	Wind Speed (km/hour)	Wind Speed (knots)	Description	Wind Effects on Land
0	< 1	< 1	< 1	Calm	Calm. Smoke rises vertically.
1	1-3	1-5	1-3	Light Air	Wind motion visible in smoke.
2	4-7	6-11	4-6	Light Breeze	Wind felt on exposed skin. Leaves rustle.
3	8-12	12-19	7-12	Gentle Breeze	Leaves and smaller twigs in constant motion.
4	13-18	20-28	11-16	Moderate Breeze	Dust and loose paper are raised. Small branches begin to move.
5	19-24	29-38	17-21	Fresh Breeze	Small trees begin to sway.
6	25-31	39-49	22-27	Strong Breeze	Large branches are in motion. Whistling is heard in overhead wires. Umbrella use is difficult.
7	32-38	50-61	28-33	Near Gale	Whole trees in motion. Some difficulty experienced walking into the wind.
8	39-46	62-74	34-40	Gale	Twigs and small branches break from trees. Cars veer on road.
9	47-54	75-88	41-47	Strong Gale	Larger branches break from trees. Light structural damage.
10	55-63	89-102	48-55	Storm	Trees broken and uprooted. Considerable structural damage.
11	64-72	103-117	56-63	Violent Storm	Widespread damage to structures and vegetation.
12	> 73	> 117	> 64	Hurricane	Considerable and widespread damage to structures and vegetation. Violence.

96

Beaufort scale

- The amount of force that wind is generating is measured according to the Beaufort scale.
- It has 17 levels of wind force.
- "0" describes conditions that are so calm the smoke rises vertically.
- "12" is hurricane

97

97

DEW

- is a type of precipitation where water droplets form on the ground, or on objects near the ground in a process called condensation of moisture

DEW POINT

98

98

fog

- The term "fog" is typically distinguished from the more generic term "cloud"
- Fog is low-lying, and the moisture in the fog is often generated locally (such as from a nearby body of water, like a lake or the ocean, or from nearby moist ground or marshes).

99

99

- By definition, fog reduces visibility to less than 1 kilometre (0.62 mi), whereas mist causes lesser impairment of visibility

100

average diameter is varying between 0.01mm and 0.1mm

100

Mist

- **Mist** is a phenomenon caused by small, microscopic droplets of water suspended in air
- Droplets are smaller than in fog
- Physically it is one instance of a dispersion.
- It is most commonly seen where warm, moist air meets sudden cooling, such as in exhaled air in winter.

- visibility with mist is better than with fog. It exceeds 1 kilometre (0.62 mi)

101

101

102

Under clear frosty nights in winter soft ice crystals might form on vegetation or any object that has been chilled below freezing point by radiation cooling.
This deposit of ice crystals is known as *hoar frost* and may sometimes be so thick that it might look like snow. The interlocking ice crystals become attached to branches of trees, leafs, hedgerows and grass blades and are one of the most prominent features of a typical 'winter wonderland' day

10 3

103

Rime

- It is formed by the freezing of steam around the surfaces exposed to radiation night.
- it is therefore frosting.
- Sublimation is the opposite.
- Steam ⟶ Ice. The ice that is formed on a glass is therefore always frost.
  Ice crystal-looking generally in the form of flakes, needles, feathers.
-

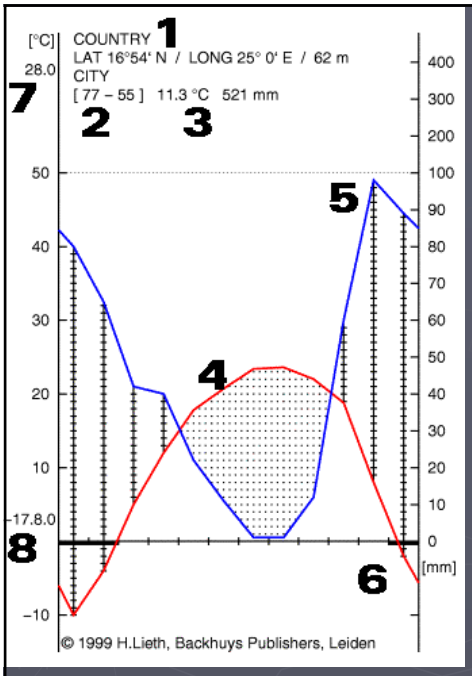
104

Climate Diagrams

- Climate diagrams are brief summaries of average climatic variables and their time course

105

105



- 1 Country name, station location and elevation, station name
- 2 Period of observation of temperature (77 years) and precipitation (55 years)
- 3 Annual average of temperature and annual precipitation sum
- 4 (red) Temperature curve
- 5 (blue) Precipitation time series
- 6 Indication of frost periods
- 7 Mean daily max. temperature of the warmest month
- 8 Mean daily min. temperature of the coldest month

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