majid ASlanPour

هواشناسی

IE ATMOSPHERE

The air around the earth is called the atmosphere. Different layers of the atmosphere are called by different names.

The chemical composition of dry air is remarkably constant everywhere over the earth's surface and up to a height of at least 19 kilometers. Chemical analysis shows that the amount of each gas is as follows:

Gas	volume %
Nitrogen	78
Oxygen	20.9
Argon	0.9
Carbon Dioxide	0.03

There are also very small amount of other gases.

Vertical structure of the atmosphere

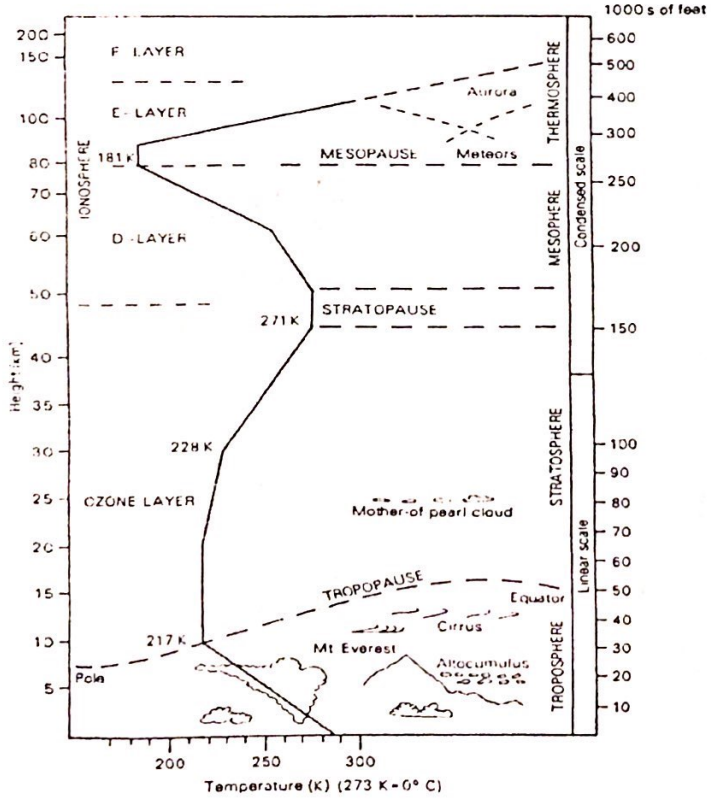
The figure illustrated the vertical structure of the atmosphere. The lowest region is called TROPOSPHERE. The properties of this layer are as follow:

-this layer contains the greater mass of air

-almost all water vapor and clouds contained

-the most important feature of this layer is that the temperature decreases with the height.

-the thickness can vary between 9 and 16 kilometers. The height is about 9 kilometers above the poles and is about 16 kilometers above the equator.



۱- واحدهای فشار

۲- همین شکل رویرو

۳- شکل فشار هوا

۴- coriolis

۵- beaufort

Higher in the stratosphere, a small quantity of ozone is found. Mainly in layer about 20 and 40 kilometers above the earth's surface. The ozone layer is important because ozone is strongly absorbs radiation of certain wave-lengths emitted by the sun. if this ozone layer was not present an excessive amount of ultra-violet radiation would reach the earth with harmful effects upon many forms of life.

Other layers of atmosphere after troposphere are stratosphere, mesosphere and thermosphere. The region between atmosphere layers is called as Pause.

The boundary between troposphere and stratosphere is called as tropopause.

The boundary between stratosphere and mesosphere is named stratopause.

The boundary between mesosphere and thermosphere is mesophause.

Adiabatic change of temperature

Change of air temperature due to increase or decrease of its volume (height) without exchange of heat with surrounding.

This is the name for change in temperature, pressure and volume which produced in a substance when no heat is allowed to reach or leave it while it is being compressed or expanded. When the air is compressed (volume decreased), its temperature rises, and when it is allowed to expand (volume increased), its temperature falls.

In one method of refrigeration, a compressed gas is allowed to escape from the cylinder and in rapid expansion, it cools enough to cause freezing.

Wet and dry air

Any parcel or sample of air that is fully saturated is called wet air or saturated air.

Any sample of air that is not fully saturated is called dry air.

DALR (Dry adiabatic Lapse Rate)

The temperature of a dry parcel of air, which is made to rise, falls at a steady rate of 10 °C for every km of ascent i.e., the adiabatic lapse rate of a dry parcel of air, or Dry Adiabatic Lapse Rate (DALR) is 10 °C per km.

SALR (Saturated Adiabatic Lapse Rate)

The temperature of a saturated parcel of air, which is made to rise, falls at a rate of approximately 5 °C per km of ascent i.e., the adiabatic lapse rate of a saturated parcel of air, or Saturated Adiabatic Lapse Rate (SALR), is about 5 °C per km.

SALR is less than DALR because, as the saturated air is cooled, its capacity to hold water vapour decreases and the excess moisture condenses into water droplets. This condensation releases latent heat that warms up the parcel of air. The temperature of the rising parcel of saturated air, therefore, falls only by about 5 °C per km instead of 10°C.

SALR is slightly variable - less at the equator and more at the poles.

ELR<SALR (stable) * سمت راست مرجع متعادل است.

Stabile of Air

Atmosphere is said to be stable when distribution of temperature and humidity with height are such that any small displacement of parcel of air by force, tend to restore the parcel to its former level.

In other words, a parcel of air which is forced upward or downward, tending to return to its original position called as stable air. It occurs when lapse rate is less than DALR and SALR

Unstable air ELR>DALR (Unstable) * سمت چپ مرجع متعادل است.

The atmosphere is said to be unstable when distribution of temperature and humidity with height are such that any small displacement of parcel of air by force, tending to move it further away from its former level.

In other words, a parcel of air which is forced upward or downward, tending to continue up or down. It occurs when lapse rate is more than DALR and SALR

Neutral equilibrium of air

When a parcel of air is forced upward or downward, it remains in the same position without any intension to move further away or return to its original place

If ELR (Environmental Lapse Rate) concide DALR when parcel is dry or with SALR when parcel is wet, then parcel of air which is displaced upward, is the same temperature of surrounding air at that level and have no tendency to return original place.

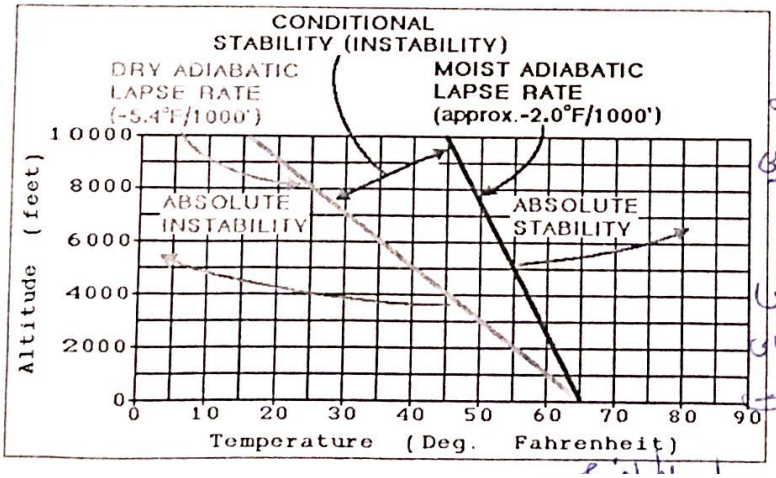
* اگر محیط خشک باشد ← Stable
* اگر محیط مرطوب باشد ← UnStable

Conditional Stability

If the environment is such that the actual lapse rate existent is less than DALR but more than SALR, conditional stability is said to exist

This means that if the parcel of air is dry, it is colder (and hence denser) than the surrounding air at the same level, and would try to return below to its original position i.e., stable equilibrium.

If the parcel of air is saturated, it is warmer (and hence less dense) than the surrounding air at the same level, and would try to continue upwards, in the direction of the original disturbance i.e., unstable equilibrium. In this case, Stability or instability depends on whether the parcel is dry or saturated; this condition is referred to as conditional stability. SALR < ELR <DALR



✓ وقتی یک بسته عرضی هوا با ELR بین (SALR) 5 و (DALR) 10 بالا یا پایین برده می‌شود (Force) بعد از 1Km، تغییر دمای متناسب با ELR خود خواهد داشت.

اگر در محیط جدید خود دمای محیط اطرافش با نسبت هوای خشک تغییر کرده باشد، دمای محیط اطرافش خنک‌تر است. در این صورت

Atmospheric temperature

The temperature of air depends on a number of factors, the first of which is amount of heat entering and leaving the atmosphere. Nearly most of heat is reaching the earth from the sun in form of wave in very small wavelength which travels through the atmosphere in light speed. No energy is lost by radiation during passage through the space. On the earth (sea and land) these waves are partly absorbed by the surface (causing increase of temperature) and partly are reflected back to the space in the form of long wave radiation. The long wave radiation is partly lost to the space and partly absorbed by the atmosphere (causing increase of temperature)

Water present in atmosphere as vapour or as cloud absorbs only a small fraction of the incoming short waves radiation but strongly absorbs the outgoing long wave radiation.

On cloudy nights, part of the outgoing radiation is absorbed by clouds and partly is reflected back again towards the surface. That's why cloudy day is warmer than clear day. (Green house effect)

The seasons

Due to tilt of the earth aixs, the angle of sun ray direction will vary by change of seasons. On beginning of spring and autumn. The angle between sun and equator is nil therefore sun will almost be on equal distance from north and south hemisphere. During northern spring and summer, the sun will be above the north hemisphere and during northern autumn and winter; the sum will be above southern hemisphere.

Diurnal variation of atmospheric temperature

It has been observed that atmospheric temperature reaches its maximum at about 1400 Hour's local time and reaches it's minimum at about half-hour after sunrise. Since this happens once per day this is called diurnal variation of atmospheric temperature

Diurnal range of atmospheric temperature

The difference between the maximum and minimum values in a day is called the diurnal range of atmospheric temperature for that day.

Diurnal range of air temperature over land is large (as much as 20°C) whereas over sea, it is very small (less than 1°C) for the following reasons:

-Land, being a solid, has a low value of specific heat so heats up or cools very quickly. But Sea, being a liquid, higher value of specific heat so heats up or cools very slowly.

- Heat received from the sun is retained by the top layer of land (only a few centimeters deep) as land is a poor conductor of heat. But at sea heat is distributed over a large mass of water by convection currents

-Evaporation of water during day causes adiabatic cooling which balances some of the Heat received from the sun.

Atmospheric pressure

Atmospheric pressure is the force exerted, per unit area, by air. It is thus the weight of the column of air above a unit area.

Units of atmospheric pressure

Pascal (Pa), equal to one Newton per square meter (N/m^2).

1 bar=100 000 pascal

1000 mb =1 bar =750.1 mm of mercury

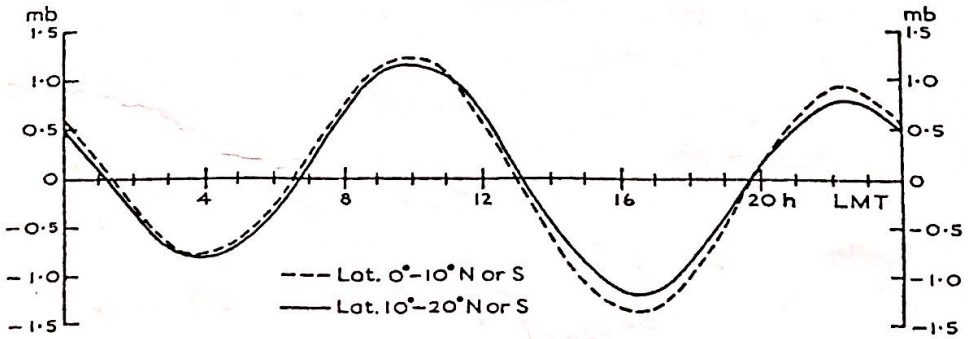
1 bar = 1.02 kg per cm2 or 10.2 t per m2

The average atmospheric pressure at the earth's surface is about 1013 mb.

Semi-diurnal variation of atmospheric pressure

Due to many causes, which are not fully understood, atmospheric pressure changes with the time of the day. It has been observed that it is maximum at about 10 & 22 hours and minimum at about 04 & 16 hours Local Mean Time. Since this happens twice a day, it is called semi-diurnal variation of atmospheric pressure.

The average semi-diurnal range is more in the tropics than in middle latitudes



Mean diurnal variation of pressure

bygage - chart - costal - construction — cargo - Stability - Rule

ORal(SB

رطوبت

Humidity

مقدار بخار Present

Humidity is the quantity of water vapour pressure in the atmosphere.

مطلق

Absolute humidity

نمونه

Absolute humidity is the mass of water vapour contained in a sample of air. It is usually expressed in grams per cubic meter (gm/m3).

Relative humidity

نسبت درصد

Relative humidity is the percentage ratio of the actual water vapour contained in a given sample of air, to the maximum quantity of water vapour that the sample can hold at that temperature.

If the temperature of the sample of air is raised, its capacity to hold water vapour increases and, assuming that no water vapour is allowed to come in or go out of the sample of air, relative humidity decreases - the air becomes relatively drier. The opposite happens if the sample of air is cooled – its relative humidity increases.

The **diurnal variation in relative humidity** is approximately inverse to the diurnal variation of temperature. That is the relative humidity will be maximum at about 1400 and minimum at about half an hour before sunrise

معکوس

min max

دما ↑ → حجم ↑ → تغییر ظرفیت → ↑ تغییر رطوبت نسبی → ↓

(هوا خشک تر)

Saturation and dew point

صدرصد

If a sample of air was progressively cooled, its relative humidity would steadily increase i.e., the air would become relatively more moist. At some temperature, the air would become wet i.e., its relative humidity would become 100%. The air is then said to be saturated and the temperature at which this occurs is called the dew point temperature of that sample of air.

شبنم

Dew point of a sample of air would depend on its temperature & relative humidity.

In other words, Dew point is the temperature at which condensation to water droplets occurs

تعریق

Sweat in a cargo hold

میعان - بخار به آب

قطرات ریز

Sweat in a cargo hold is the condensation of water vapour into droplets of water .Sweat can damage the cargo. The formations of sweat lie in the subject of meteorology when sample of air is cooled below its dew point.

برخورد با جای خیلی سرد → هوای گرم و مرطوب

برفک

Hoar frost

معادل یخ زده ی

Hoar frost is the frozen equivalent of dew. Soft white ice crystals in the form of feathers or tree roots and other surfaces after a clear, calm night, when the air next to the ground has cooled sufficiently for condensation to occur and the temperature near the ground has fallen below 0°C

ریشه درخت

Rime → برخورد → رطوبت خیلی سرد

If temperature of water droplets is below freezing point (super cooled droplets) in contact to any cold object they freeze immediately and called as rime

(Rime is the name given to a deposit of ice that forms on the windward side of an exposed object)

رو باد

High ← هوای سرد سنگین است
Low ← هوای گرم سبک است

Latent heat

Latent heat is the energy absorbed by or released from a substance during a phase change from a gas to a liquid or a solid or vice versa

Isobars

Lines joining places having the same atmospheric pressure at the time of observation.It is important to note that atmospheric pressure may change frequently. Hence, its value, when stated, holds good only for that particular time.

Isobars cannot cross or meet because one place cannot have different values of atmospheric pressure at the same time

Isotherm

Lines joining places having the same atmospheric temperature at the time of observation

Pressure gradient

Pressure gradient is the fall of pressure with distance. If the distance between consecutive isobars is small, the pressure gradient is said to be high and strong winds are expected to blow. If the distance between consecutive isobars is large, the pressure gradient is said to be small and winds of lower speed will be expected

Barometric tendency (pressure tendency) → (تغییرات فشار نسبت به زمان)

Pressure tendency is the difference between the atmospheric pressure at the time of observation and the atmospheric pressure three hours earlier. (It is rate of change of pressure with time). Pressure Tendency gives the forecaster a good idea of the rate of change of pressure, which is useful for predicting the movement of pressure systems

انحراف در نیم کره ی شمالی ← به سمت راست
نیم کره ی جنوبی ← به سمت چپ

Prediction of wind direction

Coriolis force

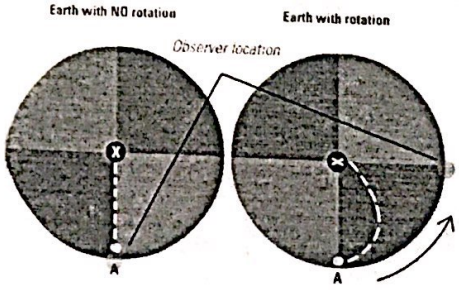
On the surface of the earth, winds always try to blow from an area of high pressure (HP) towards an area of low pressure (LP), because of gradient force

The effect is strongest at the equator than the north and south poles. Regions along the equator, therefore, have the highest temperatures all year round.

Warm equatorial air over very large areas rise up into the atmosphere (low-pressure). This space is filled with cold, dense air, flooding in from the poles (high-**pressure** system).

As the earth is constantly rotating, the winds which are blowing from the north and south towards the equator, is deflected by the earth's rotation. When moving objects are viewed in a reference frame, their path looks curved. This is the Coriolis Effect, and it is simply caused by the earth's rotation. Coriolis force always acts at right angles to the direction in which The wind is blowing. This effect makes wind system to be deflected to their right in the northern hemisphere and to be deflected to their left in the Southern hemisphere.

Coriolis force is minimum at the equator and increases as latitude increases, becoming maximum at the poles.

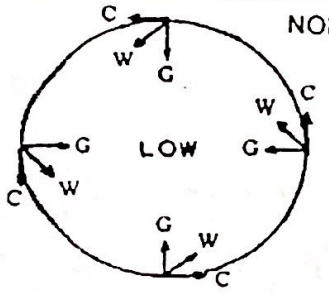


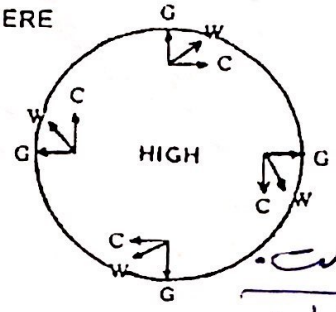
Effect of earth rotation

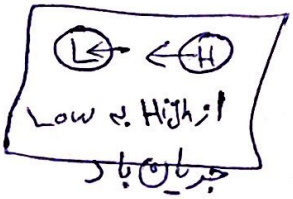
Winds actually blowing over any area are the resultant of gradient force and Coriolis force Because of this, it will be observed that:

-Winds blow spirally inwards towards Low Pressure area, anticlockwise in the N.H and clockwise in the SH

- Winds bow spirally outward from the centre of High Pressure area, clockwise in the NH and anticlockwise in the SH.







علت ایجاد طوفان Low است.

تمایلی به ایجاد طوفان ندارد. High

The effect of friction

Friction with the underline area will cause a bit change in the wind direction and also will affect on the wind speed.

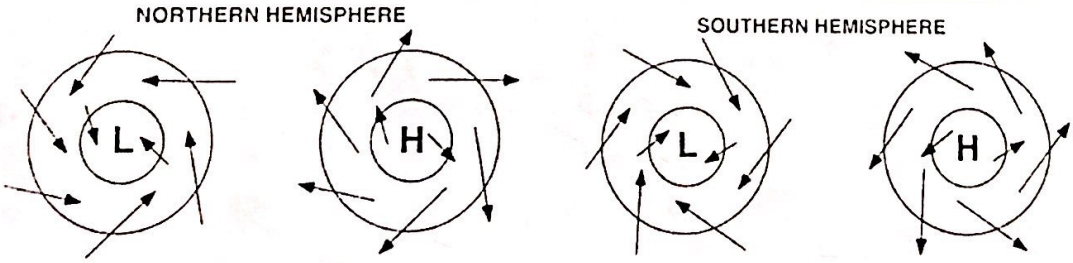
Cyclone or low pressure

Cyclone or low is an area of relatively low pressure with the closed isobars (Depression)

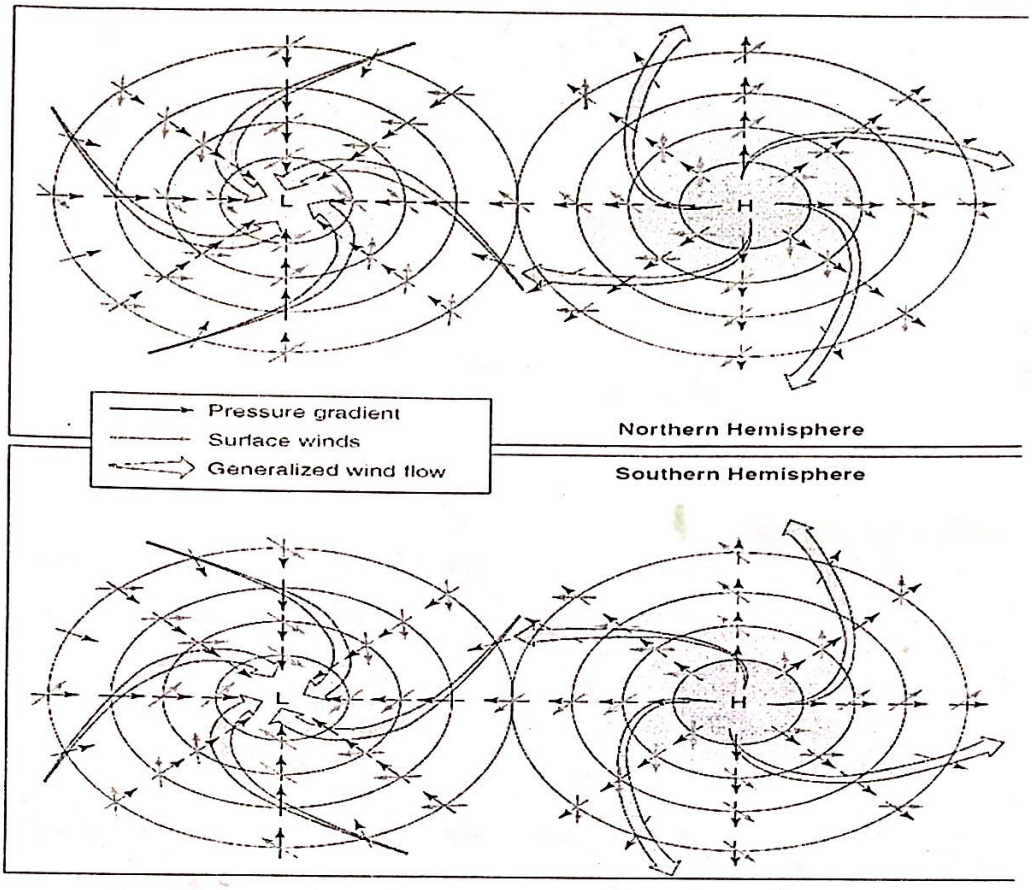
The winds blow spirally inwards, anti-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The pressure gradient is usually high, resulting in strong winds. On reaching the centre, the air moves up as a strong upward current, resulting in clouds of very high vertical extent and heavy precipitation

Anticyclone or high

Anticyclone or high is an area of relatively high pressure with closed isobars. The winds blow spirally outwards, clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere. The pressure gradient is usually low resulting in low wind speed

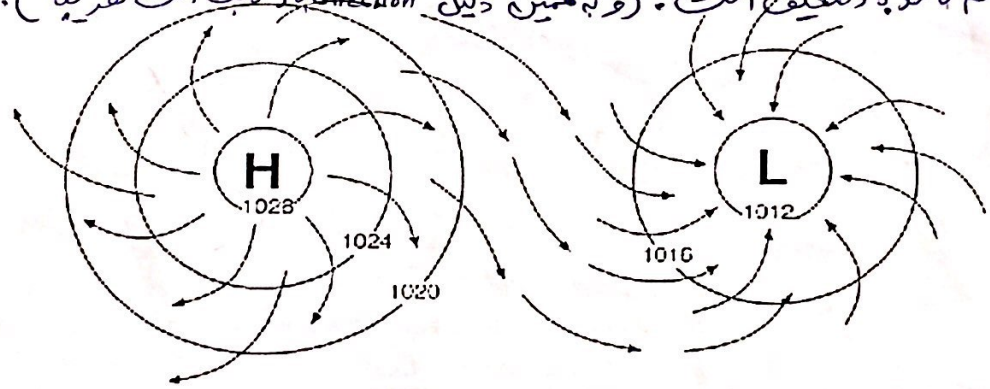


front → حد فاصل بین هوای سرد و گرم



فاصله زیاد

* هرجا که فشار گرادیان کم باشد باد ضعیف است. (و به همین دلیل direction باد ثابت است تقریباً (unchanged).



Straight isobars

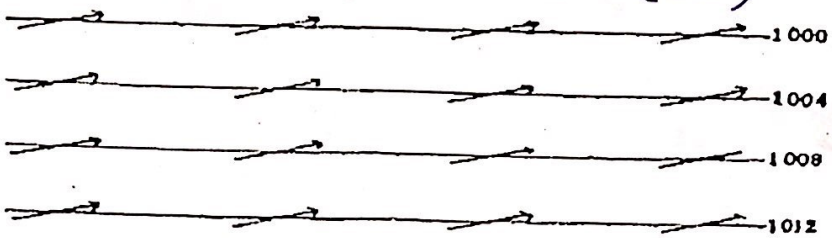
Straight isobars are said to exist when the isobars run straight and nearly parallel for a few hundred miles. The pressure gradient is usually low, resulting in low wind speeds. Wind direction and force remain constant so long as the isobars remain unchanged.

The weather associated with straight isobars cannot be defined as it depends on the properties of the air mass in which these isobars exist. The straight isobars are expected to present in the area far from center of Low or High pressure system and in the warm sector of a frontal depression.

جاهایی که می‌توان انتظار داشت Straight isobars

۱- نواحی که دور هستند از High و Low. (مناطق)

NORTHERN HEMISPHERE (Low)



Straight Isobars

Buys Ballot's Law

Face the true wind and the low-pressure area will be on your right in the Northern Hemisphere, and left in the Southern Hemisphere

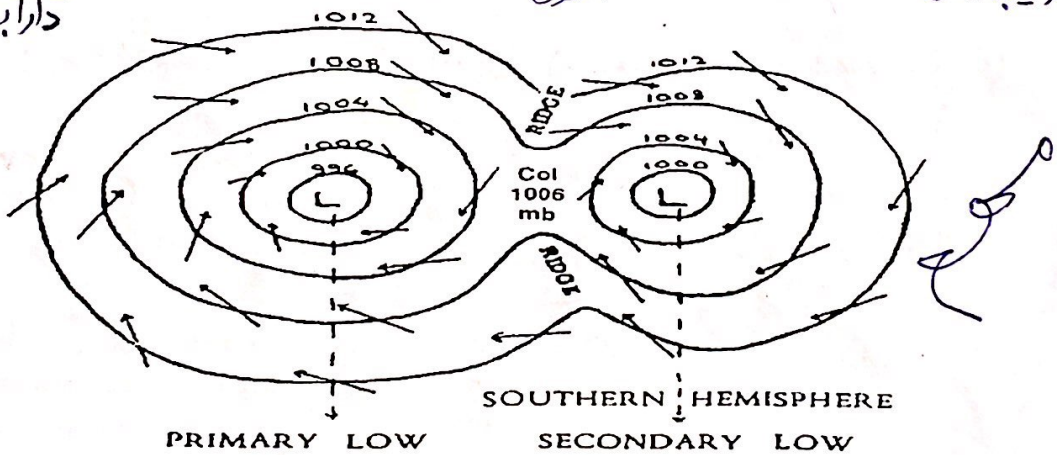
Caution when applying buys Ballot's Law

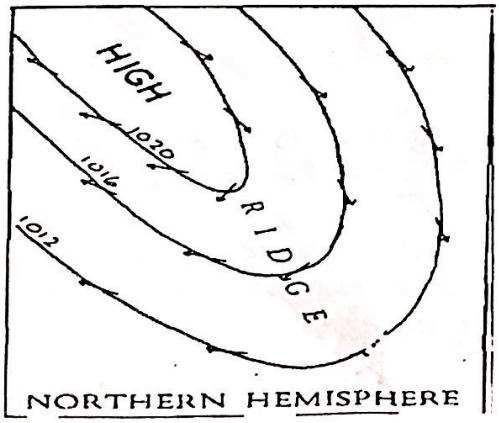
1-Near the equator: Buys Ballot's law should not be applied within a few degrees of the equator. This is because Coriolis force is negligible at the equator and therefore the winds blow directly across the isobars from HP to LP areas.

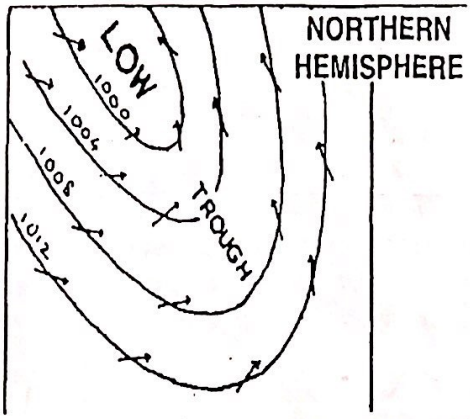
2-In the vicinity of land, the wind experienced May not be the free unobstructed wind. It may be wind deflected by the land.

Secondary cyclone or secondary low

Sometimes a low is closely followed by another, within its pattern of isobars. The first one is called the primary and the second one, the secondary. The latter is so named only because it formed later but it possesses all the qualities of the primary.







Ridge (wedge) of high pressure

An enclosed area of high pressure indicated by isobars extending out from anticyclone (high)

Through of low pressure

An enclosed area of low pressure indicated by isobars extending out from depression (low)

COL

Col is a saddle back area between two high and two low pressure systems. A Col may be situated between a primary low and secondary low

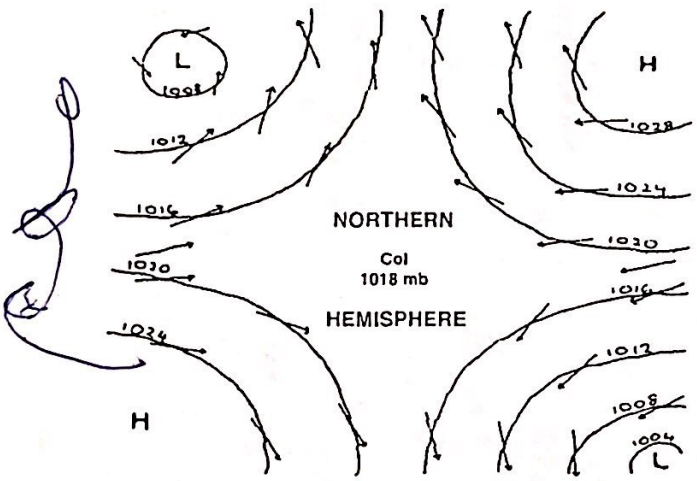
Weather associated with a COL:

-no infinite weather can be associated with a COL

-Light variable winds are experienced but not for long.

-Sudden change of weather is likely.

-Relative humidity is fairly high and lightning may be seen. Fog and thunderstorms may be experience



Beaufort scale

In 1805, Commander Beaufort, of the British Navy, devised a scale for estimating wind speed at sea based on observations of the sea surface and the effect the wind had on the sails of a war ship. He, therefore, used the words 'Wind Force' and not 'Wind Speed'. As a sailor, Beaufort felt there were 13 levels of behavior that mariners could recognize in 0 to 12.

In 1838, the Beaufort wind force scale was made mandatory for log entries in all ships of the Royal Navy.

Subsequently, the WMO (World Meteorological Organization) accepted the Beaufort Wind Scale and internationally standardized the probable wind speeds attached to each Beaufort number.

The Beaufort wind force, and hence the wind speed, may be judged by the appearance of the sea only in open, deep waters. In harbours, rivers, lakes, and other areas close to land, the actual wind speed may be much higher than that estimated by the appearance of the water.

The scale formed basis of wind force effect at sea, beaufort scale has been allotted for range of wind speed and simple conversion of wind speed to scale is possible.

Baeufort wind scale

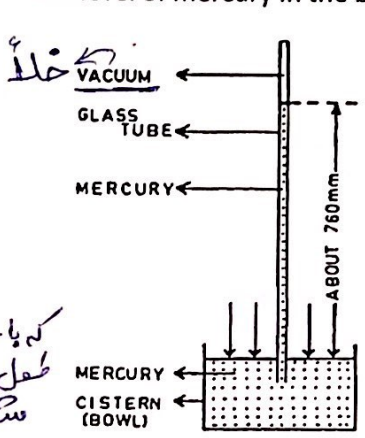
Beaufort Number	Descriptive term	Mean Wind Speed Equivalent		Deep Sea Criterion	Likely mean wave height (m) *	Sea State
		Knots	m/s			
0	Calm	<1	0-0·2	Sea like a mirror	0	0 Calm
1	Light Air	1-3	0·3-1·5	Ripples with the appearance of scales are formed, but without foam crests	0·1 (0·1)	1 Calm
2	Light breeze	4-6	1·6-3·3	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break	0·2 (0·4)	2 Smooth
3	Gentle breeze	7-10	3·4-5·4	Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses	0.6 (1·0)	3 Slight
4	Moderate breeze	11-16	5·5-7·9	Small waves, becoming longer; fairly frequent white horses	1·0 (1·5)	3-4 Slight
5	Fresh breeze	17-21	8·0-10·7	Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray)	2·0 (2·5)	4 Moderate
6	Strong Breeze	22-27	10·8-13·8	Large waves begin to form; the white foam crests are extensive everywhere (probably some spray)	3·0 (4·0)	5 Rough
7	Near Gale	28-33	13·9-17·1	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind	4·0 (5·5)	5-6 Rough to Very Rough
8	Gale	34-40	17·2-20·7	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown in well-marked streaks along the direction of the wind	5·5 (7·5)	6-7 Very Rough to High
9	Severe or Strong Gale	41-47	20·8-24·4	High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility	7·0 (10·0)	7 High
10	Storm	48-55	24·5-28·4	Very high waves with long overhanging crests; the resultant foam, in great patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; the tumbling of the sea becomes heavy and shock-like; visibility affected	9·0 (12·5)	8 Very High
11	Violent Storm	56-63	28·5-32·6	Exceptionally high waves (small and medium sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected	11·5 (16·0)	8 Very High
12	Hurricane	64 and over	32·7 and over	The air is filled with foam and spray; sea completely white with driving spray; visibility severely affected	14 and over	9 Phenomenal

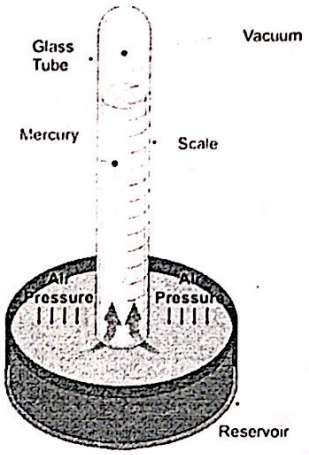
مجید اصلان پور

1 PRESSURE MEASURING INSTRUMENTS

The mercury barometer

The mercury barometer is an instrument for measuring atmospheric pressure.
In its simplest form, the mercury barometer consists of a glass tube, closed at one end, filled with mercury and inverted into a bowl containing mercury.
It will be noticed that the mercury level in the tube drops by a certain amount and then remains steady. This is because atmospheric pressure, acting on the surface of mercury in the bowl, balances the weight of mercury in the tube. Atmospheric pressure, therefore, is the weight of mercury above the level of mercury in the bowl





Reasons why mercury is used in barometers

1) Mercury has a high relative density; therefore, a mercury barometer is less than one Meter high whereas a water barometer would have to be over 10 meters high
2) Mercury does not wet the glass surface as other liquids would.
3) Mercury is easily visible.
4) Mercury has a uniform coefficient of expansion so temperature correction can easily be applied accurately.
5) Mercury cannot escape easily through the leather washer on top of the cistern during transportation of the barometer, owing to its high viscosity
6) Mercury has a low freezing point (about -39°C) and a very high boiling point (over 350°C) and hence is suitable for marine barometers.

Correction of barometric readings

All barometric readings should be reduced to a common datum - sea level in Latitude 45° with no error due to temperature. All barometric readings should, therefore, be corrected for height, latitude, and temperature and index error before making entries in the Logbook

(a) Reason for height correction:
Atmospheric pressure decreases as height increases. The reading on the bridge will, therefore, be lower than the reading at sea level. Since we have the reading on the bridge, but have to report the pressure at sea level, we have to add a correction for height to the bridge reading at the rate of 1 milli bar for every 10 meters above sea level.

(b) **Reason for latitude correction:**
Since the earth's polar radius is less than its equatorial radius, the gravitational force at the poles is greater than at the equator, therefore, weighs more at the poles than at the equator.

(c) **Reason for temperature correction:**

Each mercury barometer is constructed to show correct readings at a particular temperature called the standard temperature, which is O°C (273°K) for modern barometers The standard temperature of the barometer is' mentioned on a brass plate attached to the metal case of the barometer,

If the temperature of the barometer is different from its standard temperature, the pressure indicated by the barometer has to be corrected at the approximate rate of 1 milli bar for 6° difference. The correction is additive if the actual temperature is below the standard temperature and vice versa.

(d) **Index error:**

If a barometer does not give the correct pressure in spite of proper corrections being Applied for height, latitude and temperature, the difference between the corrected barometric pressure and the actual atmospheric pressure is called the index error of the barometer, positive if the former is less and negative if the former is more

e.g. if corrected barometric pressure is 1004.8 mb and the actual atmospheric pressure is 1005.2 mb, the index error is +0.4 mb. Index error should always be applied, as per sign, to the barometric reading.

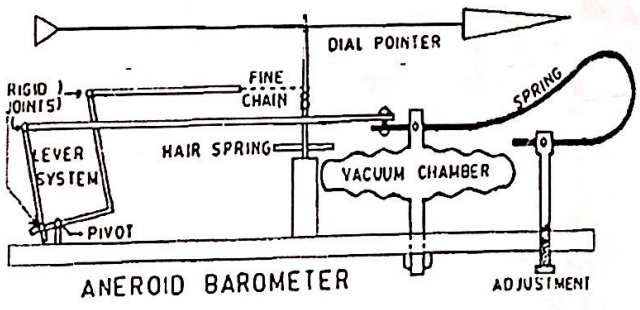
Location of a barometer on a ship

1) In the wheelhouse or chartroom for easy accessibility to the navigating officers.
2) As close to the center line of the ship as practicable
3) Away from direct gusts of wind
4) Away from direct sunlight
5) Away from draughts of air, blowers, heaters, etc. that could cause sudden or abnormal changes in temperature
6) On a bulkhead not subjected to excessive vibration.
7) Top part of marine tube should be at eye-level or a little lower to allow easy reading.

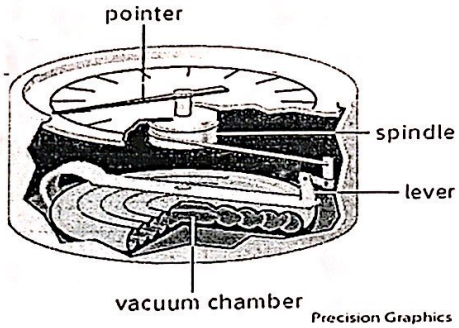
The aneroid barometer

Aneroid means without liquid. A sealed chamber made of very thin metal, having a partial vacuum inside it, is connected by a system of levers and springs to a pointer fitted over a circular, graduated scale. The thin metal has an elastic effect.

When the atmospheric pressure changed, the chamber gets compressed /expanded and the movement is transmitted mechanically to the pointer that then registers a higher/lower reading on the scale. The larger the chamber, the greater the accuracy of the aneroid barometer



ANEROID BAROMETER



Precision Graphics

Precautions when using an aneroid barometer

Tap the face of the instrument lightly to release any sticking of levers or pointer due to friction.

۱- هر ۱۵° طول جغرافیایی ۱ ساعت ۲- طلوع وغروب آفتاب ۳- با توجه به مقصد ۴- دستورکار پیمان

عواملی که با توجه به آن ها ساعت کشتی را عوض می کنیم؟

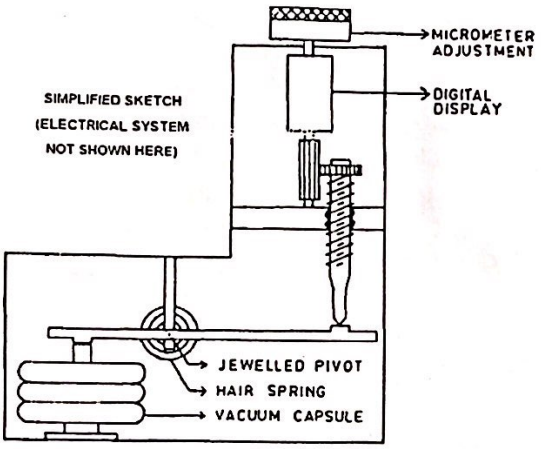
Advantages of aneroid barometer

سفت وسخت - سرحال - مقاوم

It is a robust and compact instrument. Changes of pressure are easily detectable.
For this purpose, a fixed pointer is provided, attached to the glass face of the instrument. After tapping the instrument, the fixed pointer is aligned with the dial pointer, after some time the instrument is tapped gently again. If the dial pointer now lies to the right of the fixed Pointer, the pressure has risen and vice versa. The amount of rise or fall can also be noted.

3. **The precision aneroid barometer**

This is a compact (small), robust (strong), accurate, aneroid barometer that has replaced the Large, mercury barometer that was fitted on ships in the earlier days
It has a micrometer arrangement for reading to 0.1 of a milli bar.



PRECISION ANEROID BAROMETER

Time
1- LMT → Local mean time (وقت محلی)
2- GMT (UTC) → Greenwich mean time
3- SMT → Standard mean time (زمان محلی در طول گرینویچ)
(ship's mean time)

4. **The barograph**

The barograph is an aneroid barometer that gives a continuous record of pressure on a paper chart.
Such a chart, with a continuous barograph trace on it, is called a barogram.
For climatic record purposes, the barograph is always set to UTC (GMT) not to ship's time.

Construction of the barograph

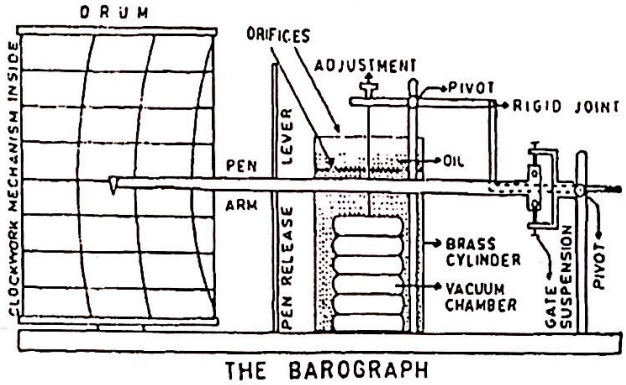
The vacuum chamber consists of a series of metal boxes arranged vertically. Change of atmospheric pressure causes the top of the chamber to ascend or descend and this movement is conveyed by a lever system to a stylus (pen) that moves up or down on the chart.
The chart is fixed on a cylindrical drum that rotates at a uniform speed of one rotation per week.
The tip of the stylus has a detachable pen that contains one drop of slow drying ink, specially Supplied for this purpose.
The entire barograph is provided with a hinged glass cover, to keep out gusts of wind and dust, and is mounted on springs and rubber pads to reduce vibration.

The chart or barogram → کاغذی که توکلاس همه‌مون دیدیم

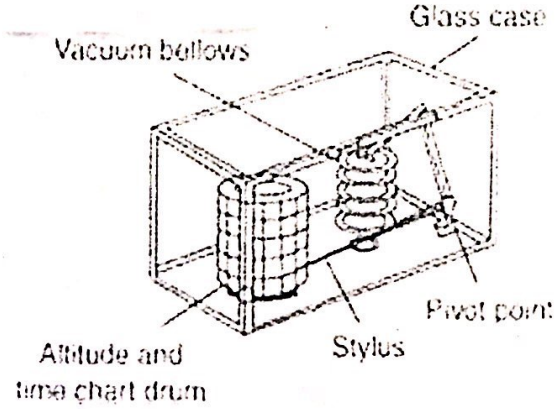
چون حول یک محور می چرخد.

The vertical lines of the barogram that indicate UTC are at two-hour intervals and are curved,
So that changes in pressure are recorded without creating an error in time.
The chart is fixed around the drum by means of two clips, one at the top and one at the bottom or one long clamp equal to the height of the drum.

The latter end of the chart should overlap its earlier end so that, in the event of the paper not being changed (due to oversight) at the end of a week, the pen will not catch on the edge of the paper and tear it.
Before handling the chart for renewal, the pen must be pulled clear of the chart by means of a pen release lever, provided for this purpose.



THE BAROGRAPH



Advantage of barograph
The barograph gives a continuous record of pressure which can easily be used to check the pressure tendency

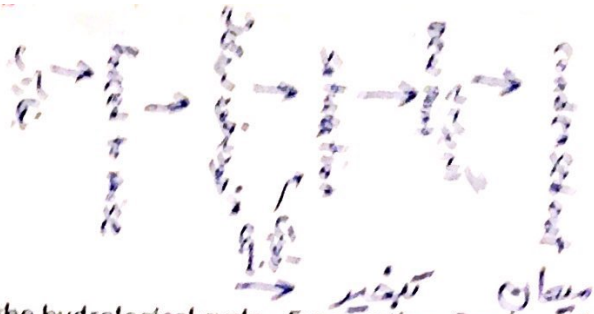
5 The thermometer
The thermometer is an instrument for measuring temperature.

Description
A tube of glass is attached to a bulb containing mercury, evacuated of air and sealed at its open end.
When heated, the mercury in the bulb expands into the tube.
When the temperature increases, the mercury in the bulb expands and the length of mercury in the column gets more. When the temperature decreases, the mercury in the bulb
Contracts and the length of mercury in the column get less.
The tube is graduated with two reference points - the freezing point and the boiling point of water.
The graduation differs from type to type.

The World Meteorological Organization has adopted the Celsius type where the freezing point of water is 0 °c and its boiling point, 100°c. The length of the tube between 0° and 100° is divided into 100 equal parts
There are two other types of graduation and they are shown here for academic interest only.
Celsius' Kelvin and Fahrenheit
Freezing point of water 0°c, 273°k, 32°f
Boiling point of water 100°c, 373°k, 212°f

Reasons why mercury is used
(i) Easily visible.
(ii) Large, uniform coefficient of expansion.
(iii) Does not wet the glass.
(iv) High boiling point (over 350°c).
(v) Fairly low freezing point (about -39°c).

THE HYDROLOGICAL CYCLE



Three main stages:

There are three main stages in the hydrological cycle - Evaporation, Condensation and Precipitation

Evaporation: is the transformation of water into water vapour. It is accelerated if the air is Warm and dry

During evaporation, latent heat is absorbed from the surrounding air and from water surface.

Condensation: is the transformation of water vapour into water. It is the opposite of Evaporation.

During condensation, latent heat is given off to the surrounding air.

Condensation occurs if air is cooled below its dew point. This is usually the result of:

- Contact with cold surface of land or sea.
- Adiabatic cooling when air rises.
- Contact with colder mass of air.

Precipitation: is the name given to water drops from clouds, which fall towards the Ground. Whilst falling through different layers of atmosphere, the water drops may freeze into soft ice (snow) or into hard ice (hail).

Mist and fog are not called precipitation because the water droplets remain suspended in the air and do not fall. Sometimes precipitation evaporates completely, during its transit through the atmosphere, and does not reach the ground, It may then be visible as vertical streamers below clouds and is called "Virga"

Drizzle: Fine drops of water, diameter less than 0.5 mm. Termed heavy or light depending on Intensity o-f precipitation

Rain: Water drops larger than 0.5 mm diameter. Termed heavy or light depending on intensity of Precipitation

Sleet: Sometimes rain and snow fall together or partly melted snowflakes fall. This is called sleet

Hail: Balls of hard ice, 0.5 to 50 mm diameter or more.

Clouds

When air is cooled below its dew point temperature, the excess water vapour condenses into Minute (very small) particles of water, which remain suspended in the air. Millions of such particles, close together, become visible as cloud.

Clouds can form at any height 'from sea level up to the tropopause, they are hence grouped According to their height of base above sea level

Low clouds consist entirely of water droplets and have their bases between sea level and 2 km height.

Medium clouds have the prefix "Alto" to their names and consist of both, water droplets and ice Particles, but more of the former.Their bases will be between 2 km and 6 km above sea level.

High clouds have the prefix "Cirro" to their names and consist entirely of ice crystals. Their bases will be between 6 km above sea level and the tropopausé.

High level clouds: Cirrus (Ci) – Cirrostratus (Cs) – Cirrocumulus (Cc)

Medium level clouds: Altostratus (As) - Altocumulus (Ac)

High level clouds: Cumulus (Cu) - Cumulonimbus (Cb)

1. **Cirrus:** Silvery, high clouds appearing like feathers or fibers. Being so high up, they always have a background of blue sky and, during twilight, often appear bright red or yellow. On dark nights, cirrus can be detected only by its dimming effect on stars.

2. **Cirrostratus:** A thin whitish veil of high cloud through which the sun or moon have a watery look. The outline of the sun and moon are sufficiently clear for altitude observations by a sextant.
3. **Cirrocumulus:** A high layer of cloud in the form of small flakes or cauliflowers, white in color with no dark shadows in between.
4. **Altostratus:** A thin greyish or bluish veil of cloud through which the sun or moon appears very dim as if seen through frosted glass. The outline of the sun and moon are hazy and not clear enough for altitude observation by a sextant.
5. **Altocumulus:** Clouds in patch, layer or sheet form, white or grey or both in colour. Have dark shadows in between and in regular patterns aligned in one, or sometimes two, directions.
6. **Stratus:** A low, even layer of dark grey cloud with light and dark patches. It has a dry look and does not cause precipitation. It resembles fog, but is not experienced at sea level. It can obscure the sun completely and can greatly weaken daylight
7. **Nimbostratus:** A low, even layer of dark-grey cloud generally uniform and threatening in Appearance with no light coloured patches. It has a wet look. If precipitation takes place it is continuous not intermittent. It can completely obscure the sun and greatly weaken daylight.
8. **Stratocumulus:** Clouds consisting of a layer or patches of globular masses which appear soft. They are grey in colour with dark shadows. The patches generally align themselves in regular patterns in one, or sometimes two, directions.
9. **Cumulus:** Brilliant white, thick clouds with flat bases and rounded cauliflower-like tops. Dark Shadows are usually seen in them. The outline of each such cloud is very clear cut
They may have very great vertical extent. Precipitation, if any, caused by even, well developed cumulus is light.
10. **Cumulonimbus:** Mass of grey, heavy cloud having its base in low cloud level, of great vertical Extent, with its top well in high cloud level
The top of a well-developed cumulonimbus cloud will have attached to it, a cap of white cirrus cloud in the shape of an anvil

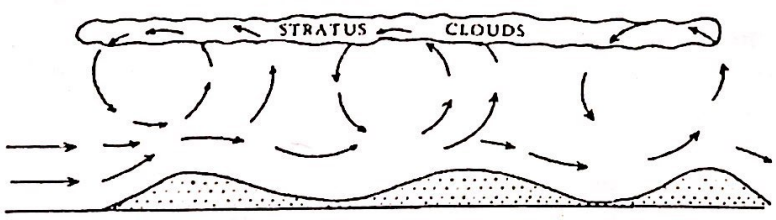
FORMATION OF CLOUDS

Clouds are formed in four main ways:

(a) **Turbulence:**

Strong winds blowing over uneven ground strike against the various obstructions and the Air gets deflected upwards. This cause thorough mixing of the air and, as the air rises, it cools Adiabatically
If during this process, the air gets cooled below its dew point, clouds will form. These clouds will be of an even, layer type (stratus) and their bases will generally be not more than 600m high.

TURBULENCE CLOUD



(b) Orographic lifting:

When a warm, moist wind blows against a mountain range, it begins to climb up the mountainside. During this ascent, it cools adiabatically and after cooling below its dew point, Orographic clouds are formed. These are of the stratus type. If the mountain is quite high, further Ascent results in nimbostratus and continuous precipitation.

On the windward side of the mountain peak, Clouds are forming steadily whereas on the leeward Side, they are dissipating at the same rate

(c) Convection:

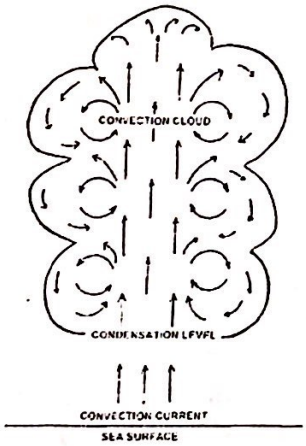
When a parcel of air gets heated due to any local cause, it expands, becomes less dense than surrounding air, and rises. This is called convection current. This local heating can be caused by contact with warm sea or ground. So long as the parcel is warmer than the surrounding air at each level, it will continue to rise (unstable condition of air).

During this ascent, the rising air cools adiabatically and, when cooled below its dew point, condensation takes place resulting in convection clouds

That is why a large island (more than about 10 miles long) in mid ocean may be seen to have a stationary cumulus cloud above it during daytime.

It is for the same reason that, during daytime, the coastline of A large landmass may have a long line cloud above it, parallel to the coast

The greater the ascent of air, the greater the vertical extent of the cloud



(d) Frontal lifting:

Where a warm air-mass and a cold air-mass are in contact, their line of separation, at sea Level, is called a front. The boundary between them is not vertical. It is inclined towards the colder air mass because the cold air, being denser, acts like a wedge and lifts up the warm air.

Visibility

Visibility is the transparency of the atmosphere and is defined as the maximum distance at which an object can be clearly seen and distinguished in normal daylight.

Visibility can be reduced by liquid or solid particles in the air as in the following cases:

(a) Mist or fog (b) Precipitation (c) Spray (d) Smoke (e) Dust, etc.

Mist/Fog

Mist is said to exist when visibility is reduced by water particles that have condensed on dust, minute particles of salt, etc., but are so small that they remain suspended in the air. If mist becomes dense and reduces visibility to 1 km or less, it is called fog. Mist can occur when relative humidity is an low as 80%

Mist is always experienced before and after fog.

Haze

If visibility is reduced by solid particles such as dust, sand, volcanic ash, etc., in suspension in the air, Haze is said to exist. Haze can, in rare cases, reduce visibility to 200 meters or less.

Spray

Spray is the name given to small droplets of water driven by the wind, from the tops of waves. Spray affects visibility when the wind force is 9 or more (wind speed of over 40 knots).

Fog ← دما سرد باشد رطوبت باشد

Majid AslanPoor
هواشناسی

Visibility (n.m) شفاف

Visibility is the transparency of the atmosphere and is defined as the maximum distance at which an object can be clearly seen and distinguished in normal daylight.

Visibility can be reduced by liquid or solid particles in the air as in the following cases:
(a) Mist or fog (b) Precipitation (c) Spray (d) Smoke (e) Dust, etc.

Mist/Fog مه / بخار

Mist is said to exist when visibility is reduced by water particles that have condensed on dust, minute particles of salt, etc., but are so small that they remain suspended in the air. If mist becomes dense and reduces visibility to 1 km or less, it is called fog. Mist can occur when relative humidity is an low as 80%

Mist is always experienced before and after fog.

Haze ← غبار

If visibility is reduced by solid particles such as dust, sand, volcanic ash, etc., in suspension in the air,

Haze is said to exist. Haze can, in rare cases, reduce visibility to 200 meters or less.

Spray پاشیدن قطرات ریز آب

Spray is the name given to small droplets of water driven by the wind, from the tops of waves. Spray

Affects visibility when the wind force is 9 or more (wind speed of over 40 knots)

TYPES OF FOG

1. Radiation fog

Also called land fog because it forms only over land, not over sea. During the night, land gives off its heat very quickly. On clear nights, the radiation of heat from the land surface into space is quicker as it is unobstructed by clouds. The air in contact with the ground thus gets cooled and if cooled below its dew point, a large quantity of dew is deposited. If, however, a light breeze is blowing, turbulence causes the cold from the land surface to be communicated to the air a couple of meters above the ground and shallow fog called 'ground fog' results. The visibility at eye level above this ground fog may be good but, in the fog, it may be only a couple of hundred meters or less. If the wind is a bit stronger, radiation fog may extend up to a height of about 150 meters or so above the ground. Strong winds cause too much turbulence, resulting in low clouds (stratus type) and no fog.

Radiation fog, which can form over land only, may drift on to rivers, harbors, lakes and other coastal regions. For example: fog on the Thames River, Dover Straits, the Sand heads of the Hooghly, etc.

Radiation fog forms over land because of the large diurnal range of air temperature over land. It does not form over sea because of the very small diurnal range of air temperature over sea.

Radiation fog reaches its maximum about half hour after sunrise because air temperature is at its lowest at that time. It generally dissipates after the sun has shone for a few hours and the land surface has warmed up.

* هوای گرم و مرطوب می خوره به سطح سرد، کم کم شروع می کنه به خنک شدن.

Conditions favorable (مناسب) for radiation fog are:

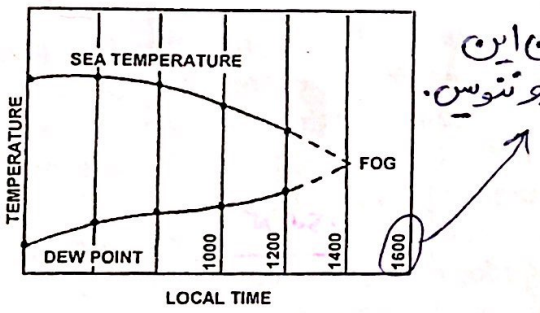
- Large moisture content in the lower layers of air.
- Little or no cloud at night.
- Light breeze at the surface.
- Cold wet surface of land.

2. Advection fog.

Is also called sea fog because it is mostly found over sea. It can, however, form over land also. It is formed when a moist wind blows over a relatively cold surface of sea or land. When the most air is cooled below its dew point, the excess water vapour condenses into small droplets of water on dust or minute particles of salt, resulting in advection fog.
Wind causes advection fog to form and also to spread (انتشار). If the wind is quite strong, turbulence causes advection fog to form to considerable depth. However, very strong winds carry the moisture too high, resulting in low clouds (Stratus type) and no fog (strong wind)

The possible time of occurrence of advection fog can sometimes be predicted by plotting the Temperature of the sea surface and the dew point temperature of the air as two separate curves against ship's time as shown in the following figure

In the case illustrated, it is observed that the two curves appear to converge. By extending the two lines as shown in dotted lines, it is noticed that the curves would intersect at about 1400 hours. We can then expect to experience advection fog at about 1400 hours.



* واسه اینکه بخواهیم یک جبهه هوای گرم (خیلی گرم) را خنک کنیم تا به dew برسه، مقدار رطوبتش برای ما مهم است.

تو امتحان این ساعتاش رو بنویس.

90% 70°C → 60°C

50°C → 10°C 20%

3. Sea smoke (برخلاف مورد قبل اینجا هوا خیلی سرد است)

When very cold, dry air passes over a relatively warm sea surface, the water vapour, evaporating from the sea surface, is quickly condensed into water-droplets and it appears as if vertical streaks of smoke are rising from the sea surface. This is called steam fog or sea Smoke .it is commonly seen in the Arctic Ocean.

4. Smog is radiation fog mixed with smoke (قابل مشاهده)

Smoke + Fog =Smog

It is a thick, black, oppressive (فشرده) blanket (لایه ای), which not only wets all exposed surfaces but also Makes them black due to carbon particles in the smoke

5. Hill fog or orographic fog: When a wind comes against a mountain range and begins To climb over it, it progressively cools adiabatically. After dew point is reached, any Further cooling causes the excess moisture to condense into water droplets forming hill fog Or orographic fog

Wind

Buys Ballot's Law

Face the true wind and the low-pressure area will be on your right in the Northern Hemisphere, left in the Southern Hemisphere.

Beaufort weather code

Weather	Beaufort letter	Weather	Beaufort letter
1 Blue sky (0 - 1/8 clouded)	b	4 Overcast sky (whole sky covered – unbroken cloud)	o
2 Sky partly clouded (1/8 - 3/8)	bc	Passing showers	p
3 Cloudy (> 3/8 clouded)	c	Squally weather	q
Drizzle	d	Rain	r
Wet air (without precipitation)	e	Sleet	rs
Fog	f	Snow	s
Gale*	g	Thunder	t
Storm#	G	Thunderstorm with rain	tlr
Hail	h	Thunderstorm with snow	tls
Precipitation in sight of ship	jp	Ugly threatening sky	u
Line squall	kq	Unusually good visibility	v
Storm of drifting snow	ks	Dew	w
Sandstorm or dust storm	kz	Hoarfrost	x
Lightning	l	Dry air	y
Mist	m	Haze	z

حروف و توضیح حفظ شود!

True and Apparent Wind

The direction and force of wind experienced on a moving ship is the apparent wind. This is the resultant of true wind and ship's *reversed* movement. For making log entries and weather reports, it is true wind that is required, not apparent wind.

Important note: Wind is named by the direction from which it comes.

Imagine a vessel steaming 000 (T) at 20 knots:

1. If there was no true wind at all (calm), the observer on the vessel would feel the apparent wind coming **from** North at 20 knots. Actually, the air is still but the ship's movement causes this apparent wind to be experienced.

2. If the true wind was coming from North at 10 knots, the apparent wind, to an observer on the vessel, would be from North at 30 knots.

3. If the true wind was coming from South at 12 knots, the apparent wind, to an observer on the vessel, would be from North at 8 knots.

4. If the true wind was coming from South at 20 knots, the apparent wind, to an observer on the vessel, would be nil (calm).

5. If the true wind was coming from South at 24 knots, the apparent wind, to an observer on the vessel, would be from South at 4 knots.

Out in open sea, the direction and force of true wind can be judged easily. The direction of true wind would be at right angles to the line of waves.

Note:

(1) A shipboard anemometer measures speed of apparent wind.

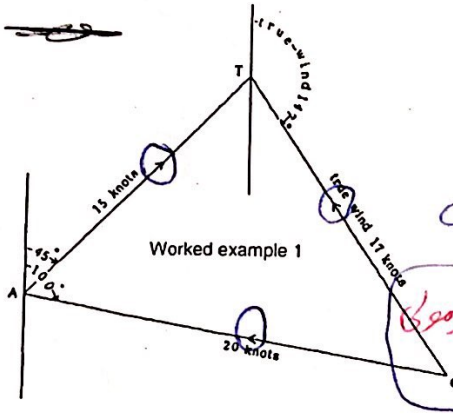
(2) The direction of wind obtained by observing the line of waves is the direction of true Wind

(3) Direction of smoke from the funnel on a moving vessel is direction of relative wind

Worked example 1:

Course 045° speed 15 knots, Apparent wind 100° At 20 knots. Find the direction and speed of true wind.

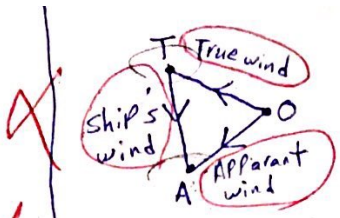
Consider a triangle OA T where,
AT is the course and speed of the vessel
OT is the direction and speed of true wind
OA is the direction & speed of apparent wind.



$\overrightarrow{OT} + \overrightarrow{TA} = \overrightarrow{OA}$

$\overrightarrow{OT} = \overrightarrow{AT} - \overrightarrow{OA}$

بادکشتی − بادنسبی = بادواقعی



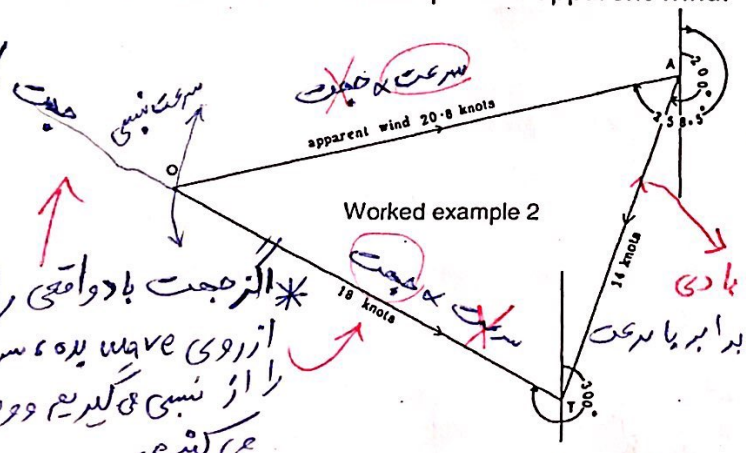
weather Report → True
line of wave → True
Anemometer → Apparent

* برای محاسبه فقط نقاله و خط کش لازم است. اون فرمول که پایین صفحه است نیازی به استفاده ندارد.

Draw a line representing North-South and take any point A on it. At "A", draw an angle equal to the course and cut off "AT" equal to ship's speed, using any convenient scale.
"AT" represents the course and speed of the vessel.
At "A", draw an angle equal to the apparent wind and cut off "AO" equal to the apparent wind speed, using the same scale.
"OA" now represents the apparent wind.
Join OT and this represents the true wind. Using the same scale as before, convert distance "OT" into knots
To obtain the direction of true wind, draw a North-South line through "T" and read off the angle between it and "OT".
In the example, the true wind in this case is 147° at 17 knots.

Worked example 2:
Course 200° speed 14 knots. True wind 300° at 18 knots
Find the direction and speed of apparent wind.

* بادواقعی، از آخر با دنسبی به اول بادکشتی یا به عبارتی، بادواقعی به T (اول بادکشتی) ختم می‌شود.

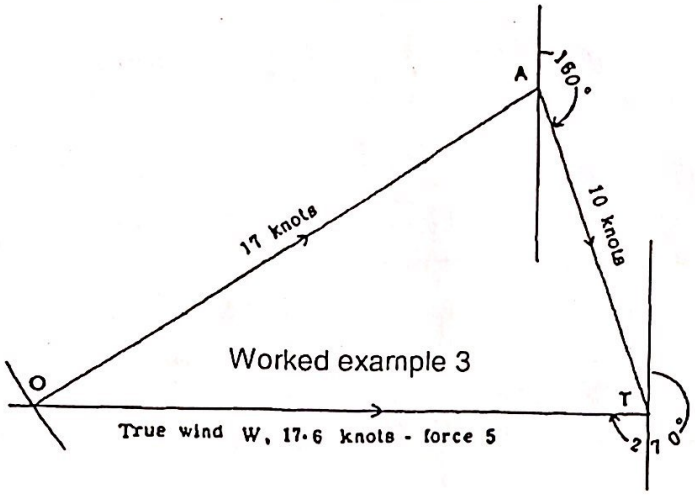


* اگر جهت خلاف AT رو عوض کنیم، می‌شه بادی که باعث حرکت کشتی ایجاد می‌شود (همان برابر با سرعت کشتی و در خلاف جهت)

* الزجهت بادواقعی را ازروی wave یاد، سرعت را از نسبی می‌گیریم و وصل می‌کنیم.

Draw a North-South line and take any point A on it. Draw AT equal to course and speed of vessel (200° at 14 knots), using any convenient scale. At T draw a North-South line and insert the true wind OT (300° at 18 knots), using the same scale.
Join OA, which now represents the apparent wind.
Using same scale, · convert distance OA into knots. The angle that OA makes with the North-South line at A is the direction of the apparent wind. Apparent wind in this case is 258.5° at 20.8 knots.

Worked example 3:
Course 160° speed 10 knots. Direction of wind (obtained by observing line of waves) was 270°. Wind speed by shipboard anemometer was 17 knots. What direction and force of wind is to be entered into the ship's logbook?



Worked example 3

Draw AT = Course & speed = 160° at 10 knots. At T, draw a North-South line and insert direction of true wind, 270°. Centre A, radius =apparent wind speed of 17 knots, cut off the arc AO. OA now represents the apparent wind and OT, the true wind. Distance OT Converted into knots is the speed of true wind.

Examples for exercise

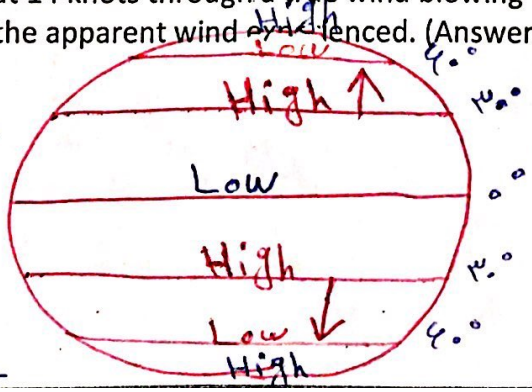
1. On a vessel steaming 346° at 15 knots, the apparent wind was observed to be NW at 22 Knots. Find the direction and speed of the true wind. (Answer 275° at 12 knots).

2. From a vessel on a course of 243° at 12 knots, the apparent wind was observed to be 120° at 15 knots. Find the direction and speed of the true wind. (Answer 095° at 23.8 knots).

3. On the monkey island of a ship doing 117 at 16 knots, an anemometer and wind vane Showed 15 knots and 036°
Find the direction and speed of wind required to be mentioned in the weather report. (Answer 344.5° - 20 knots).

4. A vessel is steaming 267 at 14 knots through a true wind blowing from SE at 11 knots. Find The direction and speed of the apparent wind experienced. (Answer 216° at 10.5 knots)

General distribution of Pressure



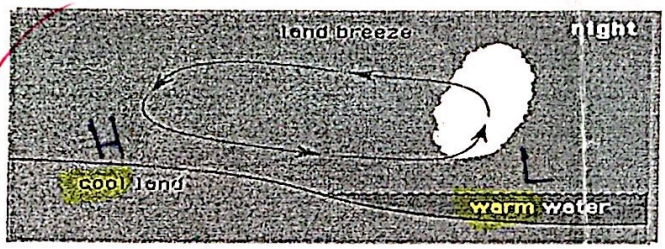
* خشکی زودتر از دریا گرم می شود.
* خشکی زودتر از دریا خنک (سرد) می شود.

PERIODIC AND LOCAL WINDS

Land breeze: از خشکی به دریا

During the night, the land gives off its heat very quickly and the air in contact with it also cools rapidly resulting in a high pressure over the land. The temperature of the sea surface, and hence the temperature of the air in contact with it, remains fairly constant resulting in a relatively low pressure over the sea.
The isobars run roughly parallel to the coast. Since the distance between the HP over land and the LP over sea is small, the wind blows directly across the isobars "from the land towards the sea".
The land breeze sets in a couple of hours after sunset and blows until about half-hour after sunrise

نکته
High pressure
H ← پرفشار ← سنگین ← هوای سرد
L ← کم فشار ← سبک ← هوای گرم
Low pressure

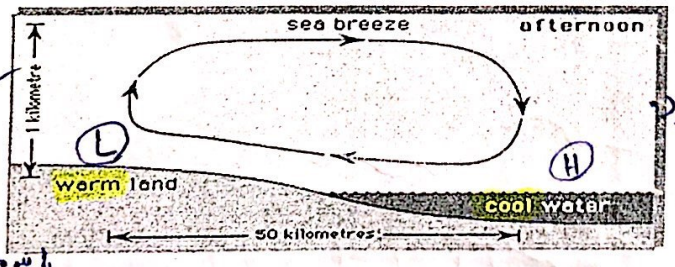


* عامل اصلی ایجاد P sea و land
اختلاف دما ← اختلاف فشار

Sea breeze: از دریا به خشکی

During the day, the land gets extremely hot and the air in contact with it gets heated, resulting in a low pressure over land. The temperature of the sea surface, and hence the temperature of the air over it, remains fairly constant resulting in a relatively high Pressure over sea
The isobars run roughly parallel to the coast. Since the distance between the high and The low pressure areas is quite small and the pressure gradient is fairly high, the wind blows directly across the isobars from the HP over the sea, towards the LP over land.
The sea breeze usually sets in by about 1000 or 1100 hours local time, reaches a maximum Force of 3 to 4 by about 1400 hours and dies down about sunset. In rare cases, sea breezes have been detected as far away as 100 miles from the coast.

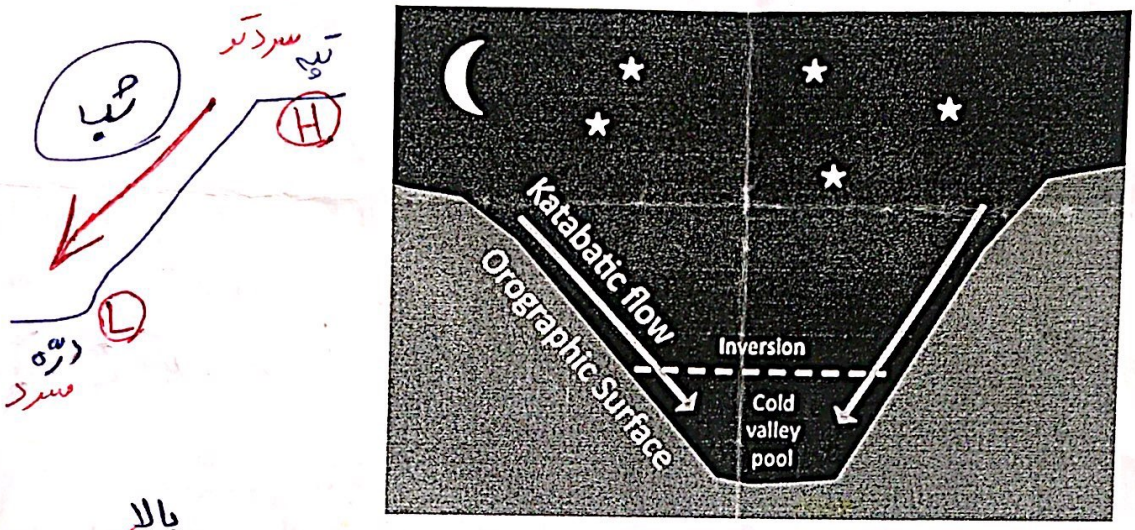
* وقتی H و L کنار هم جا باشند باد بوجود می آید. باد هم همیشه از H به L می وزد به خاطر gradient (اختلاف فشار)



پایین
Katabatic wind:

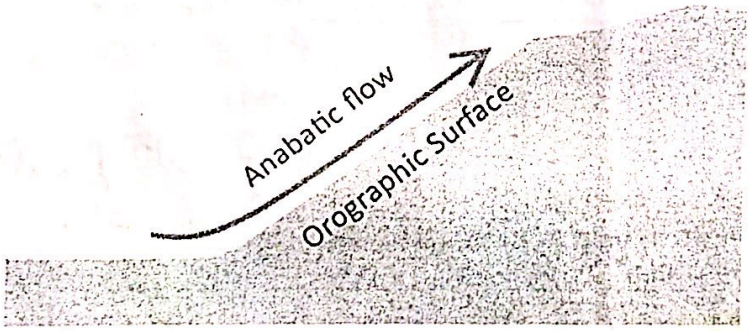
On clear nights, the land surface radiates its heat into space very quickly resulting in a cold layer of air next to the land surface. If the ground is sloping, the air on top of mountain is

colder and hence denser than at the hill .Air at the top of the hill starts sliding down due to gravitational force and is called a 'Katabatic wind' (in Greek 'Kata' means 'down')
If the mountain is high and the slope is steep, katabatic winds can reach sea level with force 7 or more in a very short while.



Anabatic wind:

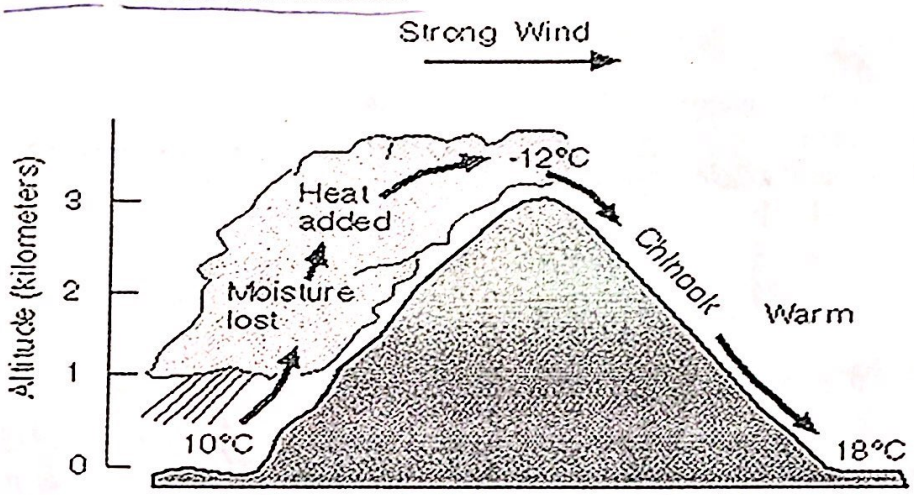
During daytime, the land surface gets heated quickly, resulting in a layer of warm air next to the land surface. The air on top of the hill is warmer and hence less dense than at top of the hill. The relatively colder air moves upward, thus displaced from the valley, slides gently up the mountain side. This is called an Anabatic wind (in Greek 'Ana' means 'up')



Fohn wind effect

Fohn Wind Effect is an effect whereby the leeward side of a mountain range is drier and warmer than the windward side. This would be more pronounced if the wind was blowing from sea towards a coastal mountain range, as the air would then be moist. Fohn wind effect is the direct result of the difference between the DALR and the SALR of air as illustrated Below:

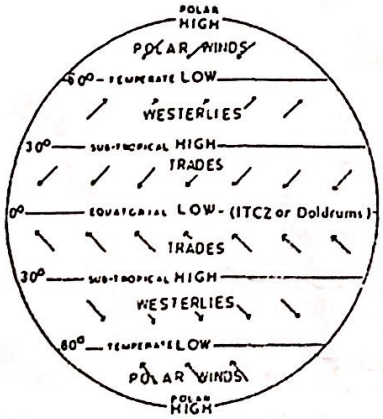
When moist air blowing against a mountain, it begins to ascend and its temperature drops by 5° C per km height (SALR). As the air temperature reduces, the relative humidity will increase. On reaching a certain height, the air will be saturated and condensed out
The excess moisture in the air is given off as orographic cloud and then heavy rain falls on the windward side
While descending on the leeward side, the temperature of the air would increase at 10°C per km (DALR). This is because; the air has lost its humidity and now is dry
The result will be so that on the leeward side of the mountain, the air will be drier and warmer than the windward side

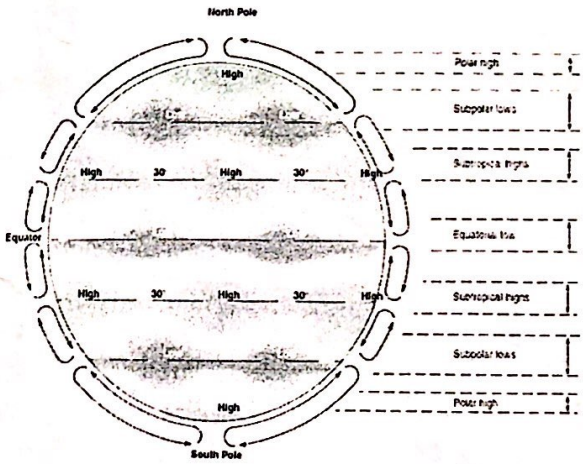


GENERAL PRESSURE AND WIND DISTRIBUTION

The figure gives the general pressure and wind systems which would exist if the entire surface of the earth was water only. Since such is not the case, variation of the above conditions occurs over large areas of land.

The ideal condition





-permanent low at equator (1012 mb)
-permanent high at 30 north and south
-permanent low at 60 north and south
Permanent high at north and south poles

0-30°N / 0-30°S

Trade winds: Are S.E and N.E winds blowing from subtropical area towards equatorial area in N and S hemisphere

نیمه استوایی

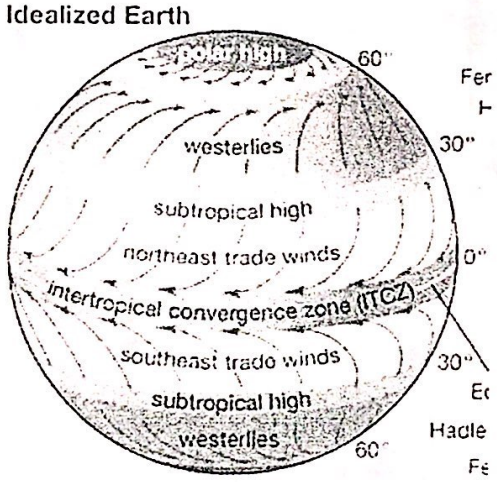
Doldrum:(ITCZ=intertropical convergence zoon)

Area of permanent low on the equator. The Doldrums are located a little north of the equator, but the effects can be felt from 5 degrees north of the equator to 5 degrees south of it. The trade winds border the Doldrum both to the north and south. Air rises straight up rather than blow horizontally. The result is little or no wind

Sea swells
موج مرده

۱- عامل ایجاد موج (باد) بر طرف شده است.
۲- عامل ایجاد موج در ناحیه خیلی دورتر است.

Idealized Earth



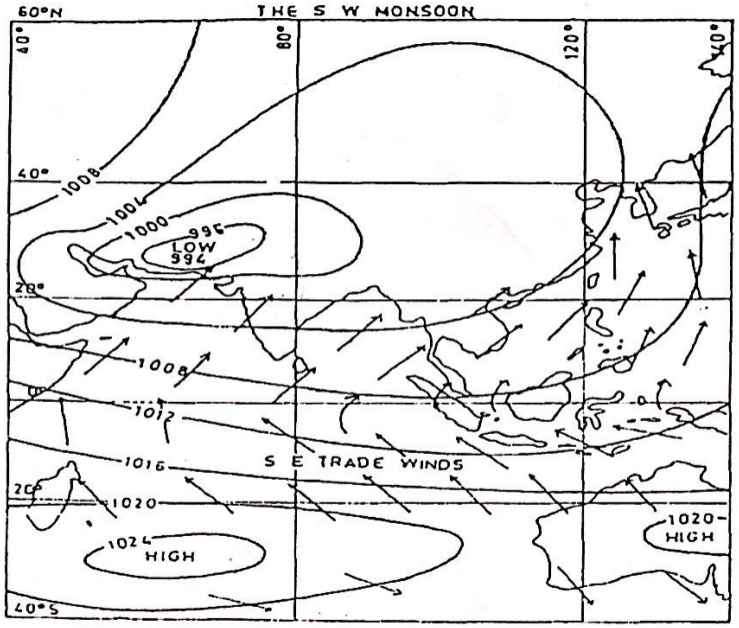
Monsoons of the Indian Ocean (South West Monsoon)

During northern summer, the continent of Asia gets very warm and the resultant low pressure over with a pressure of about 994 mb. This low is considerably lower than the equatorial low of 1012 mb and hence a pressure gradient exists from the equator towards NW India. The SE Trade winds, blowing from the oceanic high of 30° S towards the equatorial low, cross over the equator and blow, as a strong SW wind called the SW Monsoon, towards the Low over NW India The SW direction is the result of gradient force and Coriolis force. The SW Monsoon blows from June to October and brings heavy rain to The West Coast of India, West Bengal, Bangladesh and Myanmar. The wind force is about 7 or 8 in the Arabian Sea and about 6 or 7 in the Bay of Bengal. The same SW Monsoon is also experienced in the China Sea (and all over the world but its effect is greatest in Arabian Sea, that is why, SW monsoon is mainly named for Arabian Sea and Indian Ocean)

باد SW یا باد ترکیب شده از استوا عبور می کند

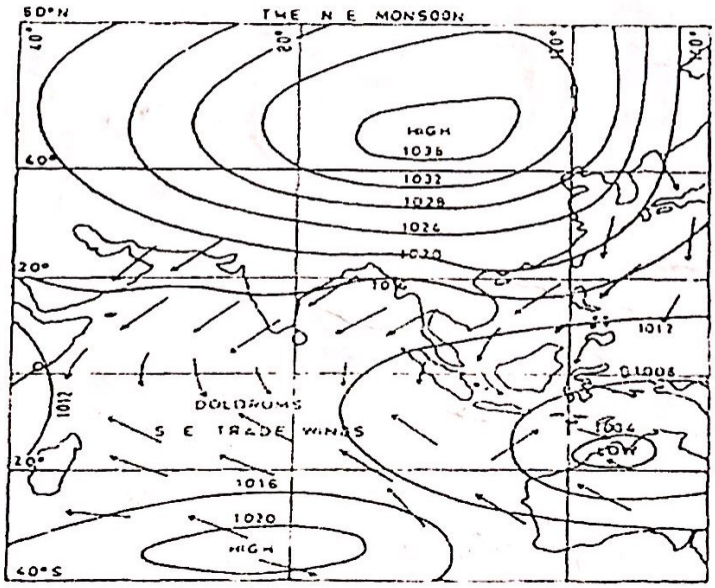
موسم تابستانه

* این موسوم در تمام جاهای نیم کره ی شمالی وجود دارد ولی هوا در شبه قاره گرمتر است



The North East Monsoon

During northern winter, the continent of Asia gets cold and the resultant high pressure over it centers over Siberia with a pressure of about 1036 mb.
The equatorial low of 1012 mb. Remains practically unaffected by the change of season. The anticyclonic winds, around the Siberian high, reach the Bay of Bengal and Arabian Sea as the NE Monsoon with a force of 3 to 4. Heavy rain falls on the East Coast of India. The NE Monsoon blows from December to April.
In the China Sea the pressure gradient is larger, resulting in wind force between 5 and 7. The wind direction in this region is between north and northeast.



۱- چین سردتر ⟵ H تر.
۲- اصطکاک روی سواحل چین بسیار ناچیز است نسبت به بالای ایران.
پس در نتیجه نمی تواند قدرت بادهای H را که از چین می آیند بگیرند.

شروع ترم دوم

wick → چیزی که به جای فتیله به کار می رود.

The hygrometer

The hygrometer is an instrument for obtaining the relative humidity and/or dew point temperature of air.
The type in use at sea on merchant ships is called the Mason's hygrometer or wet-and-dry-bulb hygrometer or psychrometer.

Description ماسان - برابر - همانند
The hygrometer consists of two identical Celsius thermometers, one called the dry bulb thermometer and the other, the wet bulb thermometer.
The wet bulb thermometer has a thin, single layer of muslin or cotton tied around the bulb by a few strands of cotton wick. The extra length of the strands of wick is immersed in a bottle of distilled water. Both the thermometers are enclosed in a special, ventilated, wooden box called the Stevenson screen.

Principle خاصیت موئینگی
Because of capillary action, the muslin always remains damp - water is drawn upwards, from the Bottle through the strands of wick.
If the atmosphere is dry, rapid evaporation takes place from the muslin. Since evaporation causes cooling, the wet bulb thermometer will show a much lower reading than the dry bulb thermometer.
If the atmosphere is humid, evaporation from the muslin will be slow, and less cooling of the wet bulb will take place. The reading of the wet bulb thermometer will then be not much lower than that of the dry bulb thermometer.
In other words, the difference between the readings of the wet bulb and the dry bulb Thermometers (called the depression of the wet bulb), gives an indication of the relative humidity of the air
The greater the difference, the lower the relative humidity and vice versa) Dep ↑ → ↓ Relative humidity

To find relative humidity and dew point

Meteorological tables, entered with dry bulb reading on one axis and the depression of the wet bulb on the other axis, give the relative humidity or the dew point of the air. Separate tables are provided for relative humidity and for dew point. Separate tables are provided for use with the hygrometer and with the whirling psycrlrometer.

Precautions when using a hygrometer

-The Stevenson's screen should be on the windward side, in open air, away from artificial Sources of heat (heaters or blowers)
-It should be about 1.5 m above the deck for the convenience of the observer. راحتی
-Sunlight falling on the Stevenson's screen is permitted but not directly on thermometers.
-It should be far away from metal bulkheads ,etc., which will cause heat radiations that can Affect the readings.

-In any case, the muslin and strands of wick must be changed once a week. This is because solid particles are left behind by the evaporating water. These particles subsequently Prevent free evaporation and the wet bulb reading will be higher than the correct reading. That is why distilled water is used. Even then, the distilled water available is rarely as pure as We would like it to be.

-The muslin should be only just damp. Too much water on it, or too little, will cause error in wet Bulb reading. This can easily be rectified by adjusting the number of strands of wick leading into the water bottle.
-The water bottle should be washed and the distilled water in it renewed once a week.
-The dry bulb should be clean and clear of drops of condensed water.

Wet bulb reading higher than dry bulb

This can happen only under the following circumstances:

-Insufficient evaporation taking place from the wet bulb due to dust, salt or other impurities on the muslin, or due to no water on the muslin.

-Insufficient time interval allowed after shifting of Stevenson's screen to windward, addition of distilled water, renewal of wick or water, etc.

-Difference in the sensitivity of the thermometers whereby one of them is slow in recording sudden changes of temperature.

-Faulty or broken thermometers.

The Stevenson screen

This is a wooden box specially constructed to house a hygrometer. It was invented by Thomas Stevenson
It is a wooden cupboard with a hinged door. The door, the back and the two sides, are all fitted with slats which let air circulate freely without letting in direct solar radiation or re-radiated heat from ship's structure. The slats also keep out rain and spray. There are various types of Stevenson's screens. The type found on ships is the portable type.
If sunlight is allowed to fall directly on the thermometer it will get very hot and the reading Shown by it will be the temperature of the instrument itself, not that of the atmosphere. Inside the screen, the thermometer will show the temperature of the atmosphere because of The shade and the free circulation of air

During the night, if the thermometer was out in the open, its bulb would radiate out its Heat very quickly, much quicker than the air and would thus show a lower than true reading of atmospheric temperature. The thermometer will then show the temperature of the Instrument itself, not that of the atmosphere.

The whirling psychrometer

This is a very efficient type of hygrometer. Hence its basic principle is the same as hygrometer

Description and use

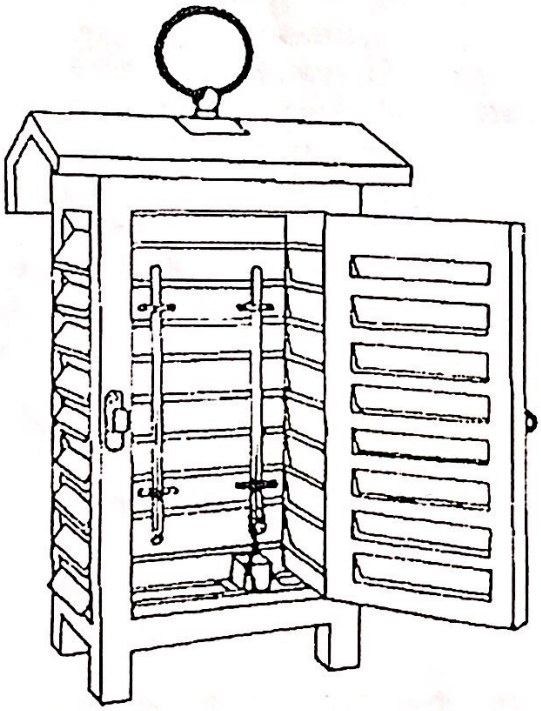
It consists of a light wooden frame, pivoted to revolve smoothly around a handle. The frame has two identical Celsius thermometers mounted on it. One of them has a layer of thin muslin tied firmly around its bulb, and is called the wet bulb thermometer.

When required, the frame is held horizontal and, using a dropper, one drop of distilled water is made to fall on the muslin to make it damp.

The frame is then whirled around in open air for at least two minutes before reading off the wet and dry bulb temperatures.

By entering meteorological tables with the dry bulb reading on one axis and the depression Of the wet bulb on the other axis, the dew point and/or the relative humidity are obtained.

Different tables are used for the whirling psychrometer and for the hygrometer in the Stevenson's screen because of their different rates of evaporation



THE STEVENSON SCREEN

Dep ↑ → Relative humidity ↓

Dry Bulb (°C)	Number of degrees difference between the wet- and dry-bulb readings (°C)									
	1	2	3	4	5	6	7	8	9	10
10	88%	77	66	56	45	35	26	16	7	--
11	89	78	67	57	47	38	28	19	11	2
12	89	79	68	59	49	40	31	22	14	5
13	89	79	69	60	51	42	33	25	16	9
14	90	80	70	61	52	43	35	27	19	11
15	90	80	71	62	54	45	37	29	22	14
16	90	81	72	63	55	47	39	31	24	17
17	91	82	73	64	56	48	41	33	26	19
18	91	82	73	65	57	50	42	35	28	21
19	91	82	74	66	58	51	44	37	30	24
20	91	83	75	67	59	52	45	38	32	26
21	91	83	75	68	60	53	47	40	34	27
22	92	84	76	69	61	54	48	41	35	29
23	92	84	77	69	62	56	49	43	37	31
24	92	84	77	70	63	57	50	44	38	32
25	92	85	77	71	64	57	51	45	40	34
26	92	85	78	71	65	58	52	46	41	35
27	93	85	78	72	65	59	53	47	42	37
28	93	86	79	72	66	60	54	49	43	38
29	93	86	79	73	67	61	55	50	44	39
30	93	86	80	73	67	61	56	50	45	40
31	93	86	80	74	68	62	57	51	46	41
32	93	87	80	74	68	63	57	52	47	42
33	93	87	81	75	69	63	58	53	48	43
34	93	87	81	75	69	64	59	54	49	44

AIR-MASSES AND FRONTS

Air-mass may be defined as a quantity of air with dimensions of about 500 nautical miles or so, With little or no horizontal variation of any of its properties, especially temperature Because the temperature of air depends almost entirely on contact with the earth's surface, the air over Polar Regions will be cold, while that over the tropics will be warm. Air-masses are named by the sources 'from which they originate.

For an air-mass to change its temperature by 10° to 20°C, it may take weeks

Factors affecting the properties of an air-mass

1. Its source region.
2. Its track over the earth's surface.
3. The extent of convergence and divergence.
4. Its age.
5. Its rate of travel.

Source region:

Essential characteristic of air mass is uniform distribution of temperature and humidity in horizontal plane. The air masses are formed over the regions where the earth's surface temperature is nearly uniform and the wind is comparatively light. These factors ensure that air can remain in the region long enough to acquire the characteristics and properties.
The area in which an air mass originated is called source region in theses area the pressure gradient is generally slight and the horizontal movement of air is slow. Thus allowing plenty of time for the surface characteristics (temperature and humidity) to penetrate upward to considerable heights

Track over the earth's surface:

If it passes over large expanses of water, it will be moist and if it passes over land, it will be dry

The extent of convergence and divergence:

Convergence at lower levels (as in depressions) causes air at the center to ascend.
Divergence at lower levels (as in anticyclones) causes air from above to descend. Both convergence and Divergence cause vertical movement of air resulting in proper mixing of the air of different levels and thus they influence the properties of the air-mass, especially relative humidity and temperature lapse rates.

Age:

The age of an air-mass is the number of days it has spent in its source region. The longer it Has stayed there, the greater it is influenced by the climate of that place

Rate of travel:

Consider an air-mass moving over an area outside its source region. If it moves quickly, the area over which it blows does not have sufficient time to significantly influence the

properties of the air-mass. Hence a quick moving air-mass retains most of its original characteristics.
If the air-mass moves slowly, the area over which it blows has sufficient time to influence the properties of the air-mass. Hence the characteristics of a slow moving air-mass may be somewhat different from its original characteristics.

Classification of air-masses

The air masses are classified as follows:
a) An absolute classification based on principal source regions in which the following descriptive terms are used to describe the air masses

-arctic (A)
-maritime polar (mP)
-continental polar (cP)
-maritime tropical (mT)
-continental tropical (cT)
-Equatorial (E)

b) Relative classification based upon the temperature of the air relative to the land or sea surface temperature in the area under consideration.
-Cold air masses are those whose temperature near the surface is below the temperature of the underlying land or sea surface
-warm air masses are those whose temperature near the surface is above the temperature of the underlying land or sea surface.

Since the temperature of the underlying surface will vary according to the weather recently experienced in the area considered, it will be understood that what is termed "cold" on one occasion may be termed "warm" on another.

Life history of air masses

As soon as it leaves a source region the properties of an air mass begin to be modified. These modifications mainly result from changes in the nature of the underlying surface. The effect of these influences depends upon the time which has elapsed since the air mass Left the source region

Madid AslanPoor

Air mass & Frontal depression

An air mass is a large body of air, with a reasonably uniform temperature, humidity and pressure. It can have a horizontal extension of thousands square miles and adopts the characteristics of the surface below it. It acquires its properties from the earth surface, while spending days to weeks over the same part of the Earth. Air mass tends to move as a unit by itself. Once an air mass moves out of its source region, it is modified as it encounters surface conditions different than those found in the source region. Such as, if air mass near North Pole moves southward, then it encounters warmer land masses and consequently, it is heated by the ground below. Air masses typically collide in the Middle latitudes, produces various weathers.

The best source regions for air masses are large flat areas (over sea, land or icecap) with uniform temperature and light wind. This type of earth surface ensures that the air remains in this area long time, to acquire the underlying surface characteristics. The resulting air mass becomes virtually homogeneous throughout and its properties become uniform at each level.

It is classified either maritime or continental. Maritime air originates over oceans and is generally humid, whereas continental air originates over land and is relatively dry. Air masses are also classified according to their approximate environmental origins, such as Polar, Tropical or Equatorial, which are described as below.

Polar region is the area of the globe, surrounding the poles. The North Pole and South Pole being the centers, these regions are dominated by the polar ice caps, covering Arctic Ocean and the continent of Antarctica. This region receives less solar radiation, as the sun's energy arrives at an oblique angle, with more absorption, scattering and reflection for longer distance through the Earth's atmosphere.

It is the source region for Arctic air mass (A), Antarctic air mass (AA), Polar Continental air mass (Pc) and Polar Maritime air mass (Pm),

1. Arctic air mass (A) is an air mass from the region, which is north of the Arctic Circle (66° 33'N) and around the Earth's North Pole.

(Approximate location for Arctic air mass is around 60o - 90o N). This area includes the Arctic Ocean (which overlies the North Pole) and parts of Canada, Greenland, Russia, Alaska, Iceland, Norway, Sweden and Finland. It consists of a vast, ice-covered ocean. There is a permanent high-pressure area in the vicinity of this area. In this region, gentle flow of air over the polar ice fields, allows an arctic air mass to form.

This air mass is characteristically dry aloft and very cold and stable in the lower altitudes.

2. Antarctic air mass (AA) originates over the Antarctic ice-cap and the surrounding ice shelves and pack ice. It is extremely cold and dry. Its temperature is colder the arctic air mass. Approximate location for Antarctic air mass is 60o - 90o S.

3. Continental polar air mass (cap) originates over the regions consist of all land areas, dominated by the Canadian and Siberian highpressurecells. In the winter, these regions are covered by snow and ice.

Due to extreme cold and the absence of water bodies, very little moisture is available here. So it is a cold and dry air mass, but warmer than the arctic air mass located to the north.N.B. The polar air masses do not include all the airs at the poles (some areas are covered by Arctic air and Antarctic air). So polar air masses are generally found in latitudes between 40 and 60 degrees.

4. Maritime polar air mass (MP) is the air mass originates on the maritime polar source regions; consist of the open unfrozen polar sea areas, in the vicinity of 60° latitude, north and south. It is a cool and moist air and brings mild weather to coastal locations. Maritime polar air is warmer than continental polar air in the winter, as the surface temperature of the ocean is higher; similarly opposite phenomena happens during the summer

Tropical region is seated in the equatorial regions of the world, are limited in latitudes by 23°26'N of northern hemisphere and 23°26'S of southernhemisphere.It is the source regions for Continental tropical air mass (cT) and Maritime tropical air mass (mT). Approximate location for these Tropical air masses are15o to 35o N or S.

1. Continental tropical air mass (cT) originates over the continental tropical source regions. Generally these tropical regions are located between latitudes 25°N and 25°S. The large land areas located in these latitudes are usually desert regions (such as, Sahara, Kalahari etc). The air over these land areas is hot and dry. It has extremely low humidity.

2. Maritime tropical air mass (mT) originates over the large zones of open tropical sea, along the belt of the subtropical anticyclones. These air masses are warm and moist. These are responsible for most of the precipitations at east of the Rocky Mountains in the United States.

Equatorial region is the area at approximately equidistant from the North Poland South Pole, which divides the Earth into Northern Hemisphere and Southern Hemisphere. Here the temperatures are higher year round, with some exceptions during the wet seasons. Convergence of the trade winds from both hemispheres and the intense insolation over this region, causes lifting of the unstable, moist air to high levels. The surface of the Earth at the equator is mostly ocean. It is the Source regions for Equatorial air mass (E*).*

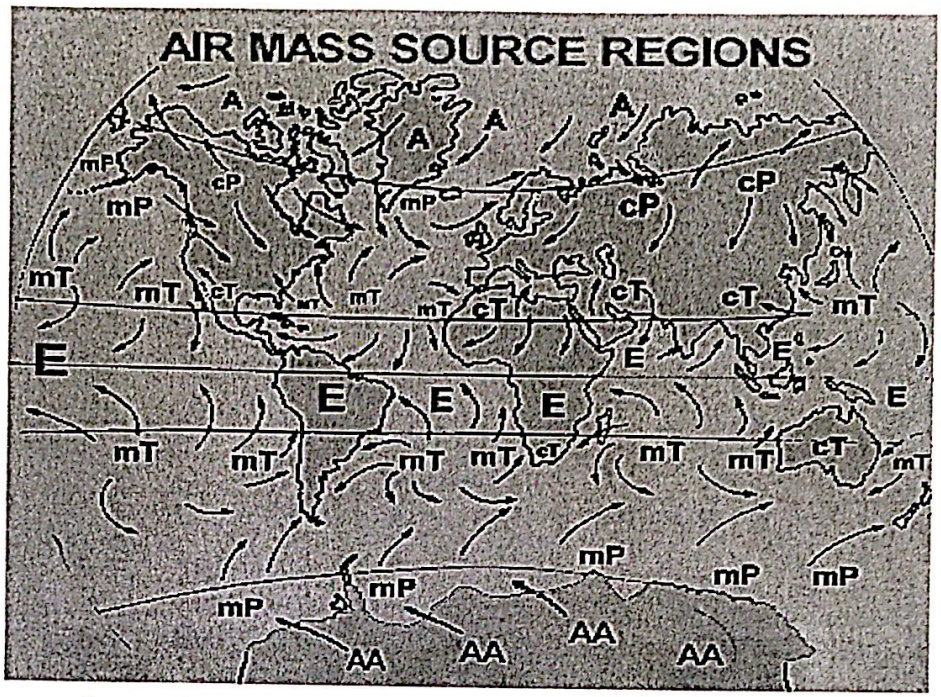
1. Equatorial air *mass* (E*)* is warm and has high moisture content. Approximate location for Equatorial air mass is 15o N to 15o S.

Classifications of air masses:

a. As per source regions, air masses are 7 types, as below,

1. Arctic air mass (A)
2. Antarctic air mass (AA)
3. Continental polar air mass (cP)
4. Maritime polar air mass (mP)
5. Maritime tropical air mass (mT)
6. Continental tropical air mass (cT)
7. Equatorial air mass (E)

Below diagram shows the source regions of 7 types of air mass, including directions of their passages, above earth surface.

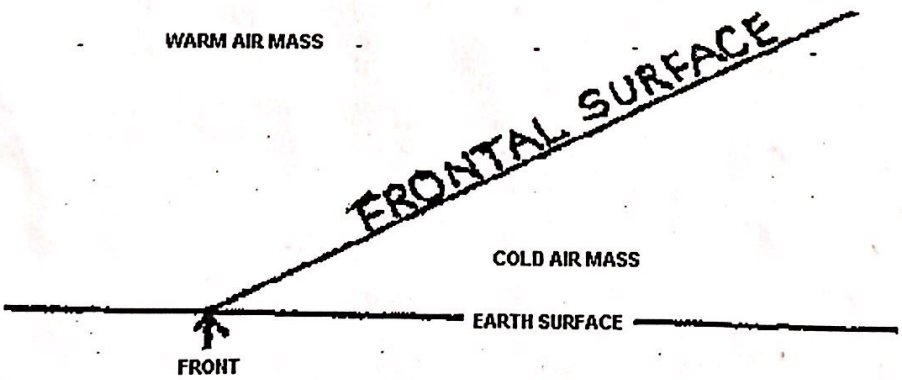


b. As per temperature, air masses are 2 types, as below,

1. Cold air mass: whose temperature near the surface is below the temperature of the underlying land or sea surface? It may come from polar region and normally moves toward lower latitude.

2. Warm air mass: whose temperature near the surface is above the temperature of the underlying land or sea surface? It is usually of tropical origin and normally moves toward higher latitudes.

Front is defined as the boundary between two air masses of different density, humidity and temperature, on the earth surface. Its top is extends not only in the horizontal direction, also in the vertical direction. Normally this is inclined towards the colder air mass, which is around 0.5º to 1º with the earth surface.
This inclined or sloppy surface of the front is called Frontal surface.



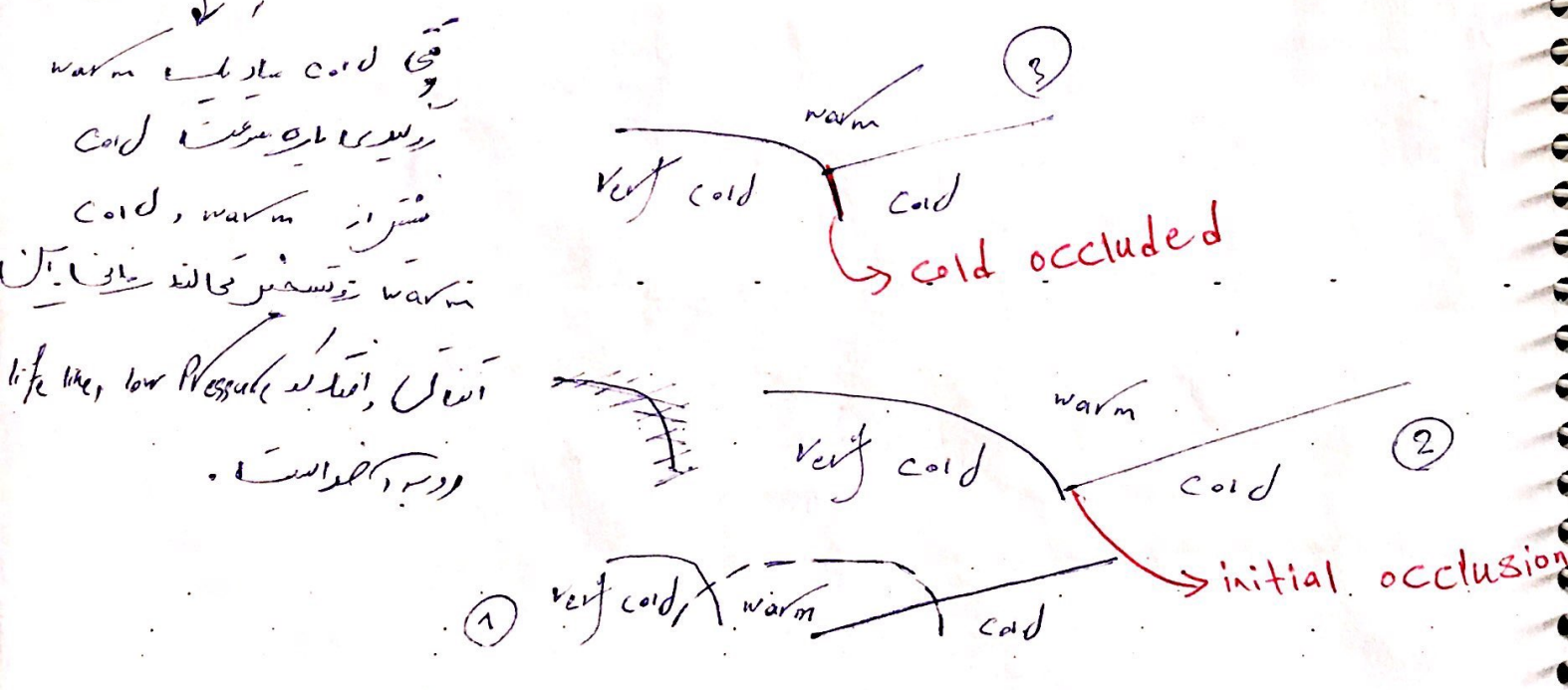
Fronts are generally moves with winds movements, but do not move as quickly as wind. In the Northern Hemisphere Cold fronts and occluded fronts usually travel from the northwest to southeast and warm fronts travel from southwest to northeast. In the Southern Hemisphere, the reverse happens. This movement is caused by the pressure gradient force (horizontal differences in atmospheric pressure) and the Coriolis Effect. Frontal zones can be slowed down by geographic features, like mountains and large bodies of warm water.

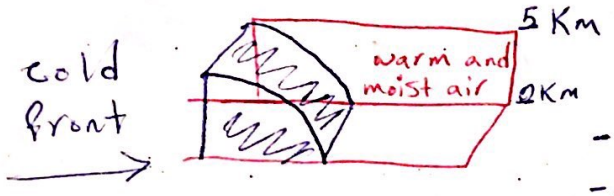
Cold front devolves, when cold air mass replaces relatively warm air mass. After cold front passes over a place, the temperature becomes lower then it was before. Cold fronts can move up to twice as fast and produce sharper changes in weather than warm fronts. On weather maps, the surface position of the cold front is marked with the symbol of a blue line of triangle-shapes, pointing in the Direction of travel.

Warm front devolves, when warm air mass replaces relatively cold air mass.After cold front passes over a place, the temperature becomes higher than it was before. A warm front moves more slowly than the cold front, because cold air is denser and harder to remove from the earth's surface. On weather maps, the surface location of a warm front is marked with a red line of semi-circles, pointing in the direction of travel.

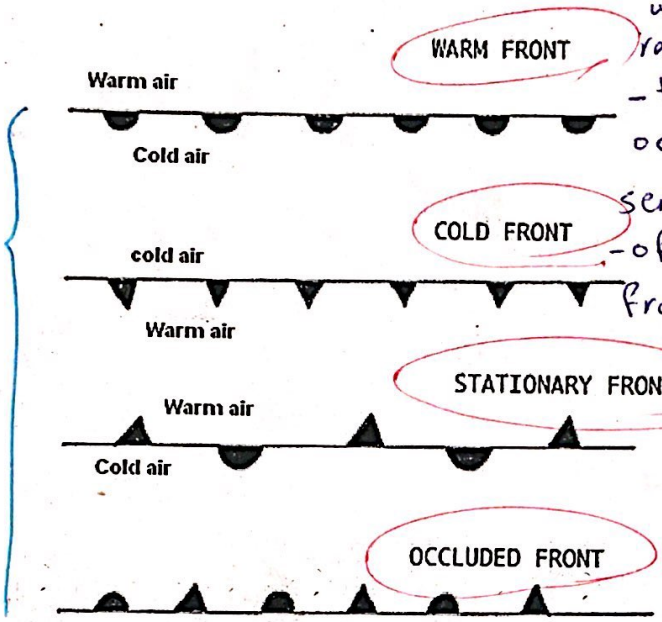
Stationary front is a non-moving boundary between two air masses; both are not strong enough to replace each other. They tend to remain essentially in the same area for extended periods of time, usually moving in waves. Stationary fronts are marked on weather maps with alternating red half-circles and blue spikes, pointing in opposite directions, indicating no significant movement.

Occluded front is formed, when a cold front overtakes a warm front. It lies within sharp trough, but the air mass behind the boundary can be either warm or cold. Occluded fronts are indicated on a weather map by a purple line with alternating half-circles and triangles pointing in direction of travel. Occluded fronts usually form around mature low-pressure areas. Below are the symbols of four types of fronts.



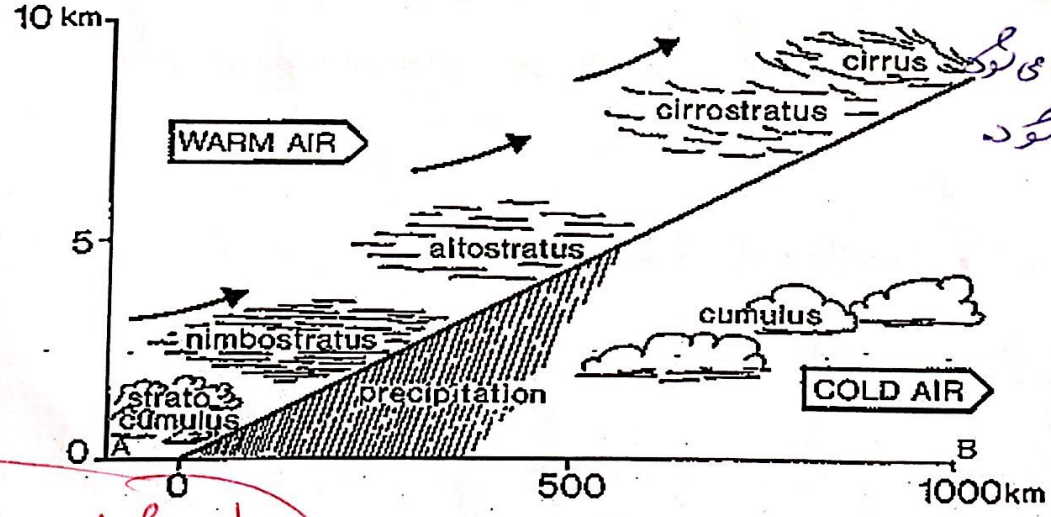


- Cold air is more dense than warm air.
- As the dense, cold air moves into the warm air region, it forces the warm air to rapidly rise just ahead of the cold front
- this result in deep convective clouds, occasionally producing strong to server thunderstorms.
- often the precipitation along a code front is a very narrow line of thunder storms.



Below chart and diagram are describing the weather experiences during the passages of a warm front.

بالا خیلی سرد است، dew point کمتری دارد



هرچه ارتفاع کم می شود بیشتری شود Dew Point

Stationary fronts.

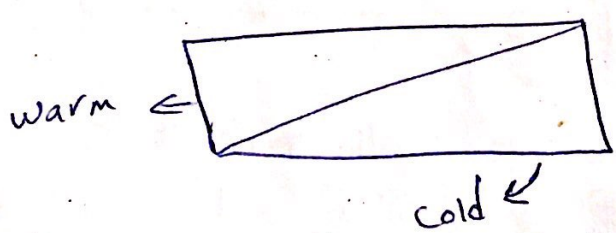
- No movement of the temprature gradiant. Front is stalled.
- But there is still convergence of wind, and forcing for cent, and often precipitation in the vicinity of a stationary front

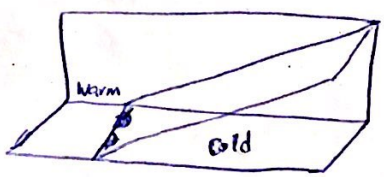
Warm Front

Elements	Before front passage	During front passage	After front passage
Temperature	Steady or slow rise	Warming	Warming, then leveling off
Pressure	Decreasing steadily	Decreasing stopped	Slight rise, then decrease
Winds (northern hemisphere)	Increasing and some times backing.	Veering in direction and speed decreases	Direction steady
Precipitation	Showers, snow, sleet, or drizzle	Light drizzle	Usually none, sometimes light rain or showers
Clouds	Cirrus, cirrostratus, altostratus, nimbostratus in succession	Low Nimbostratus.	Clearing with scattered stratus.
Visibility	Good, during precipitation poor	Poor, but improving	Poor or hazy
Dew Point	Steady rise	Steady	Rise, then steady

Below chart and diagram are describing the weather experiences during the passages of a cold front.

Backing → تغییرات جهش وزش باد برخلاف عقربه ساعت

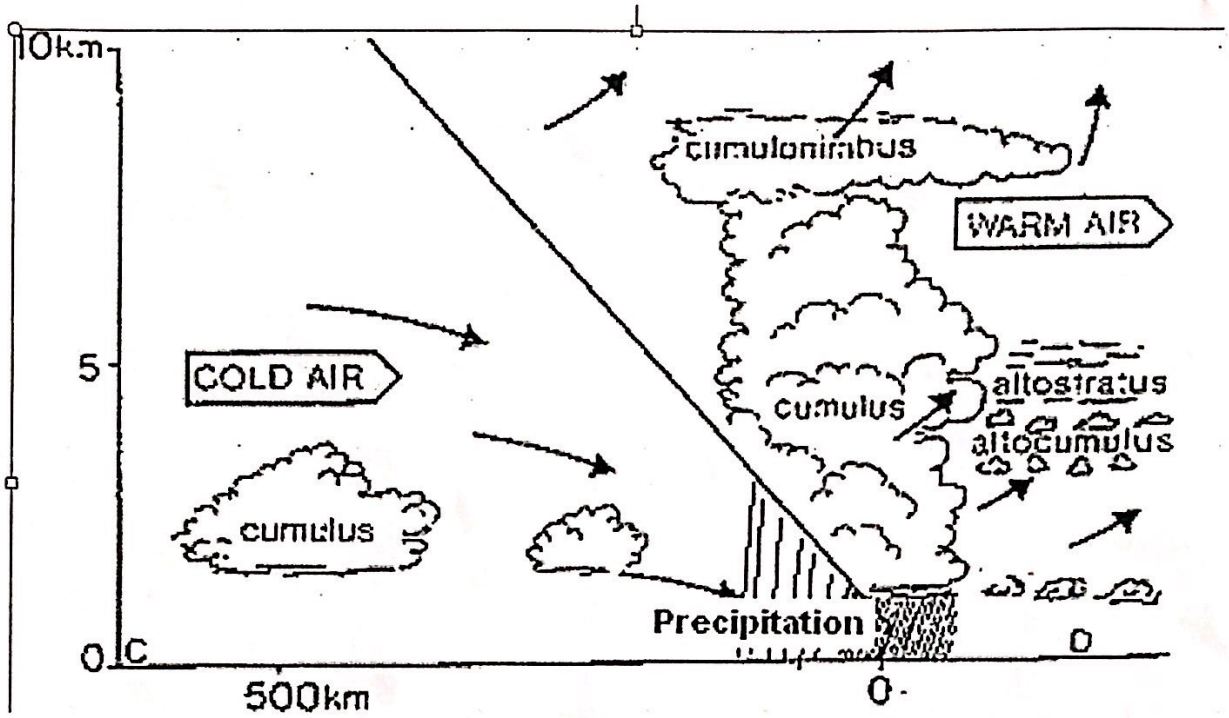




Cold front

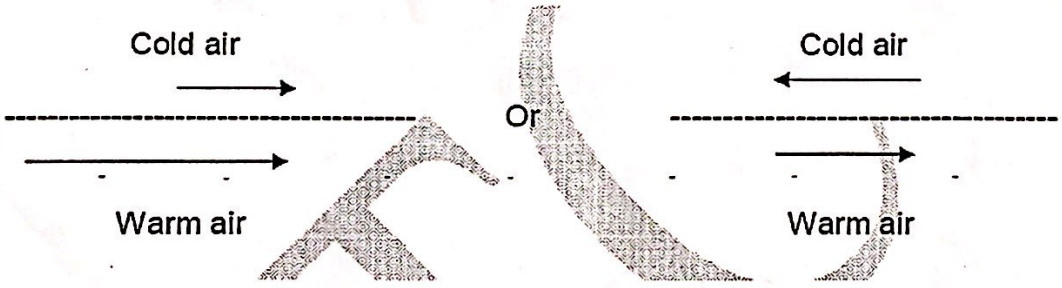
Elements	Before front passage	During front passage	After front passage
Temperature	Steady	Cooling suddenly	Steadily cooling
Pressure	Decreasing steadily	Lowest, then sudden increase	Increasing steadily
Winds (northern hemisphere)	Increasing and backing, sometimes becomes squally	Sudden veering, Gusty	Backing a little after squall, then may steady or veer further in a little squall
Precipitation	Showers	Thunderstorms, sometimes severe	Showers, followed by clearing
Cloud	Altocumulus or Altostratus	Cumulonimbus, Cumulus	Cumulus
Visibility	Fair to poor in haze	Poor, but improving	Good, except in showers
Dew Point	High, steady	Sudden drop	Falling

یحو شدید شدن باد

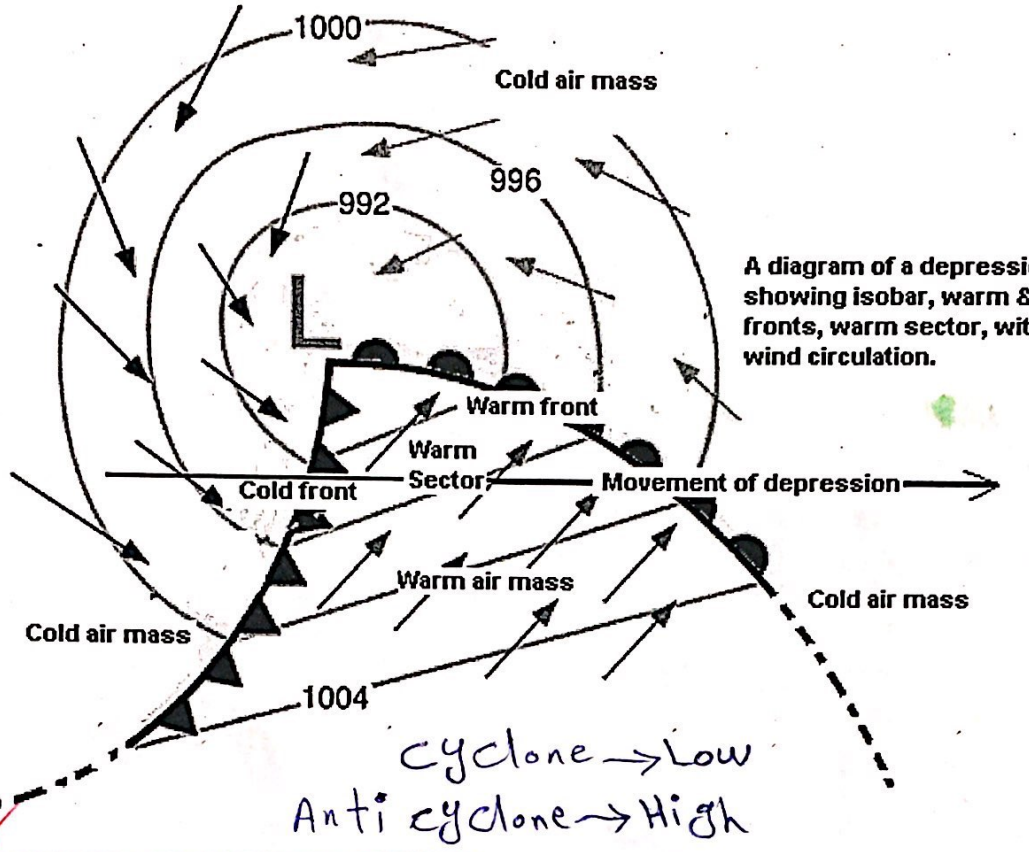


Depressions, sometimes called mid-latitude cyclones, are areas of low atmospheric pressure, located at areas between 30° and 60° latitude. It develops, when warm air from the sub-tropics meets with cold air from the Polar Regions. It usually has well defined warm and cold fronts. Depressions, along with fronts have a lifetime with birth and death. Diameter of a depression various from200 to 2,000 miles; they may be deep when pressure at their center is very low and the isobars are tightly packed.

Depressions are formed at the boundary between two different air masses. This depression is normally associated with cloudy, rainy and windy weather. This occurs, when warm air is forced to rise over cold air. Here warm air is traveling faster than cold air or warm air travels in opposite direction, which are described as below,



Since this depression is formed at frontal area of different air masses, it is also known as **Frontal depression**. The formation process of this depression is called Frontogeneses; similarly decay or weakening of a depression is called Frontolysis. On a weather chart (synoptic or prognostic) a depression appears as a set of closed curved isobars, with wind circulation anticlockwise in the northern hemisphere (as below diagram), clockwise in the southern hemisphere.



A diagram of a depression showing isobar, warm & cold fronts, warm sector, with wind circulation.

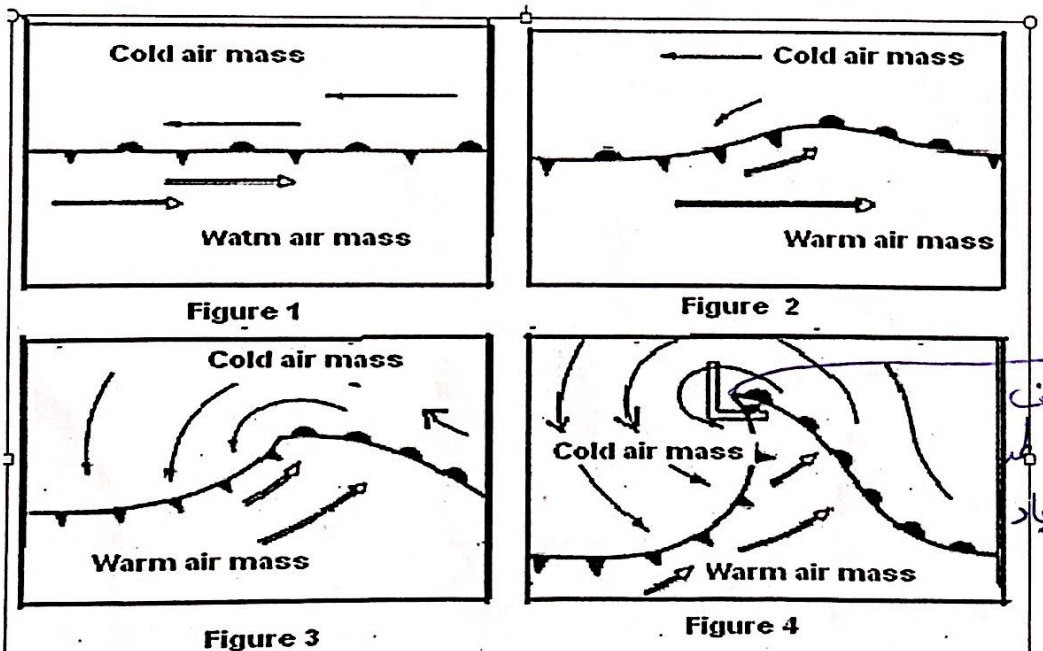
cyclone → Low

Anti cyclone → High

Life cycle of a polar front depression:

The front, being the interface of two different air masses, becomes a wave form. This wave undergoes a cycle, which finally generates a depression. Life cycle of this polar front depression has four stages.

چرخه زندگی



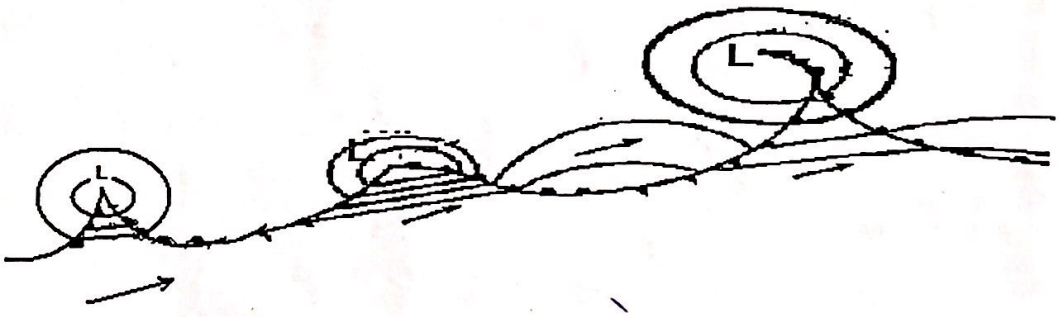
دارای حول یک محور
ی می خن - هوای اطراف
تسستگی ایجاد می کنه به طا هم
همین Low Pressure ایجاد
می شود.

Above are the 4 stages of the life cycle of a polar front depression (for Northern Hemisphere)

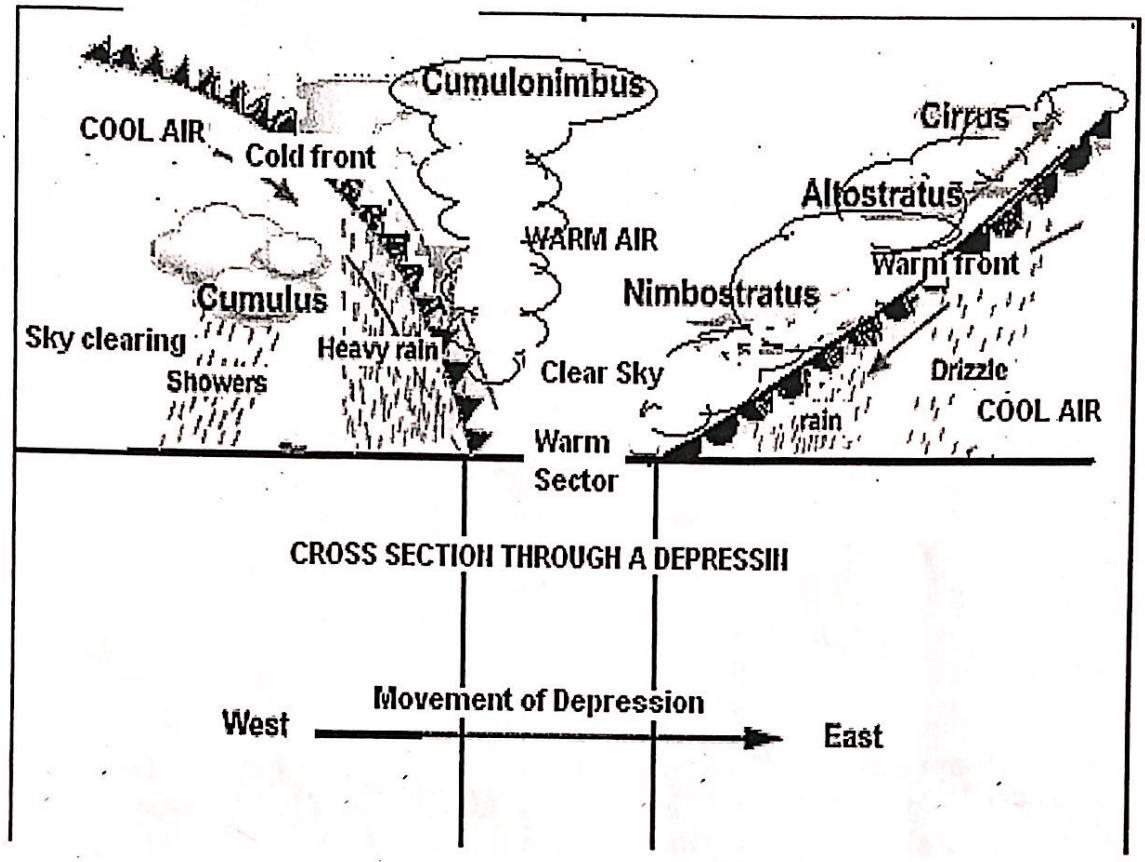
1st stage (Figure 1): Two different air masses are traveling at opposite directions. They meet along a line, which is called frontal boundary.
2nd stage (Figure 2): A small wave-like disturbance develops on the frontal boundary between the two air masses.

3rd stage (Figure 3): The system is about developed and two distinct fronts (warm & cold front) are formed as part of the system.
4th stage (Figure 4): The cycle is completed and the depression is formed, with wind circulation anticlockwise and inward direction to low pressure (as it is for northern hemisphere)

Family of depression:
Before we have considered the formation of a wave-like disturbance, along small section of a front. But sometimes with each outbreak of an air mass develops a series of waves along the front and each wave forms its own wavelike disturbance. So from two or three to five depressions can form along particular front. The initial depression is called primary and others are called secondary depression. These secondary depressions sometimes grow very quickly into intense low with almost same characteristics as primary low. Primary along with another or a series of secondary depressions is termed as **Family of depression**, which is shown as below figure.



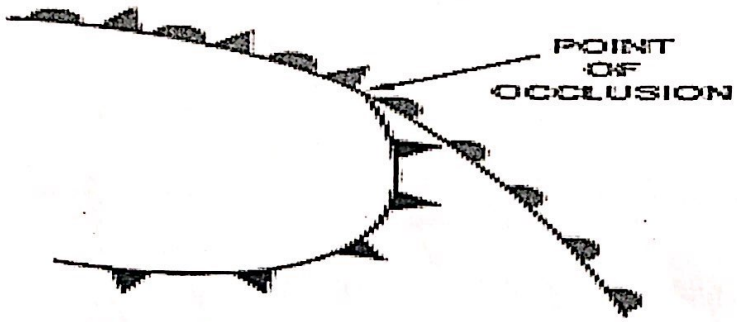
Below diagram and chart are showing the cross-section through a depression, which is providing the weather conditions (cloud, precipitation, visibility, temperature etc.)



At cold front	Warm Sector	At warm front
Wind very squally and veers	Wind steady	Wind increasing and backing.
Thick cloud with cumulonimbus	Pressure steady	Temperature continues to rise.
Heavy rain, sometimes with hail, thunder or sleet	Occasional showers or clear sky	Nimbostratus cloud building and thickening
Air pressure falls near the front then suddenly rises	Poor visibility.	Rain becoming heavier.
Visibility poor	Temperature is mild.	Air pressure falling
Temperature is cold.	cloud may thin and break	Visibility deteriorating
Behind the cold front		**Forward of warm front**
Strong and gusty wind		Altostratus and cirrus clouds.
Clear skies for a while or cumulus cloud.		Rain turns to drizzle.
Air pressure steady.		Air pressure steadies
Visibility good.		Wind veers
		Visibility is poor.

سبقت گرفتن سرانجام - عاقبت

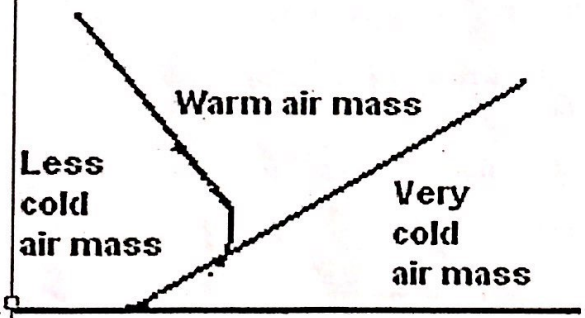
Cold fronts travel more quickly than warm fronts and eventually the cold front catching up the warm front, which causes the warm air to be undercut and lifted up from the surface. When this occurs, then it is called **occluded front** or **occlusion of depression.** Occluded fronts or occlusion of depressions are indicated on a weather map by a purple line with alternating semicircles and triangles (as below diagram) pointing in the direction of travel. They usually form around mature low pressure areas.



There are two types of occlusion,

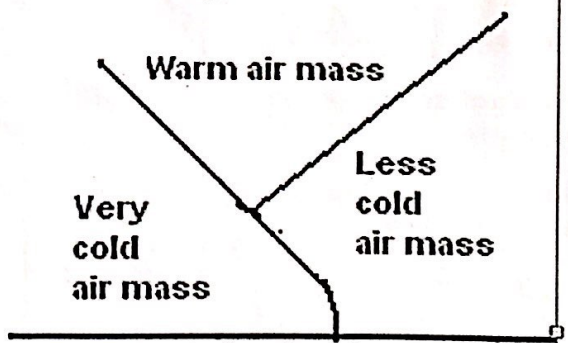
1. Warm occlusion: In a warm occlusion (figure 1), less cold air mass, which is overtaking the warm front, rides over the very cold air mass, while lifting the warm air mass. After passage of warm occlusion, the air temperature becomes higher than the before.
2. Cold occlusion: In a cold occlusion (figure 2), the less cold air mass, which is ahead of the warm front, rides over the very cold air mass, while lifting the warm air mass. After passage of cold occlusion, the air temperature becomes lower than the before.

Figure 1



WARM OCCLUSION

Figure 2



COLD OCCLUSION

Weather sequence of occlusion: It is more or less same as depression, except frontal weather conditions, as here front occurs once. Common characteristics associated with occluded fronts have been listed in the table below.

Elements	Before Passing	While Passing	After Passing
Winds	Southeast to south	Variable	West to northwest
Temperature	cold	Dropping (for cold occlusion) Rising ((for warm occlusion)	Colder (for cold occlusion) Warmer (for warm occlusion)
Pressure	Falling	Lower temperature	Rising
Clouds	Ci, Cs, As, Ns	Ns and Cb	Ns, As or scattered Cu
Precipitation	Light, moderate or heavy precipitation	Light, moderate or heavy continuous precipitation or showers	Light to moderate precipitation followed by general clearing
Visibility	Poor during precipitation	Poor during precipitation	Improving, after precipitation.

متعادل ملايم

Within a few days of occlusion, frontal depression fills up and is no longer recognizable.

Instability line is a narrow, non-frontal line or band of convective activity. It forms in moist, unstable air. It develops ahead of a cold front and sometimes series of these lines move out, ahead of the front.

Dry line or **Dew Point Front** is a boundary, which separates a moist air mass from a dry air mass. Here a sharp change in dew point temperature is also observed. These are most commonly found at places like Rocky Mountains (eastside of it), Texas, New Mexico, Oklahoma, Kansas etc. At night and early morning, fog and low-level clouds are often existed on the moist side of the line, while generally clear skies are marked at the dry side.

Majid Aslan Poor

Tropical Revolving Storm (TRS)

شرایط تشکیل
- warm, moist air
- Sea temp 26°-27°
- 500 Km (300 nm) far from equator (5°)
- affected by corlios force

Tropical revolving storm (TRS) is a warm-core, low-pressure system, around which the air circulation is anti-clockwise, in the Northern Hemisphere (NH) and clockwise, in the Southern Hemisphere (SH). It consists of a rotating mass of warm and humid air and creates thunderstorms with strong winds, flooding rain, high waves, damaging storm surge etc. It devolves over large bodies of warm water and normally dies, when moves over land. For this reason, coastal regions
Receive significant damages from a tropical cyclone; whereas inland regions are relatively safe from this.
The diameter of a tropical storm is normally less than 500 nm even can be only 100 nm at its early stage of development.
TRS is common in various places of the world, but they can be called as below local trams,

1. "Cyclones" is used in the Bay of Bengal and Arabian Sea.
2. "Hurricane" is used in the western side of north Atlantic and south Pacific.
3. "Cordonazo" is used in the eastern side of North Pacific.
4. "Typhoon" is used in the western side of North Pacific.
5. "Willy - willy" is used in the eastern side of South Indian Ocean.

On the night of 29th April 1991, a powerful tropical revolving storm struck the coast of Bay of Bangle, at Chittagong, Bangladesh, with wind speed of around 250 km/h. This storm forced a storm surge of 6 meter, over a wide area and killed at least 138,000 people, with heavy damage of estimated amount 1.5 billion US dollars. The high velocity wind and the storm surge completely crushed the large coastline, houses, lands, structures etc.
Cyclone Sidr was another strongest TRS for Bangladesh. It formed in the central Bay of Bengal and quickly strengthened to reach winds of 260 km/h and finally hit the land of Bangladesh on 15th November, 2007. As per Red Crescent society report, the estimated number of deaths was 10,000. The large areas of Patuakhali, Barguna and Jhalokati districts were hit by the storm surge of over 5 meters. About a quarter of the world heritage sites of Sundarbans ware seriously damaged. Total damages of this Sidr were approximately 450 million US dollars.

At Bay of Bengal, tropical revolving storms are most likely to develop in May, October and November but may occur in any month. The following terms are used to describe the cyclones.
1. Low pressure are or low, where winds are less than or equal to 17 Kts.
2. Well marked low, where winds are within 18 Kts to 21 Kts.
3. Depression, where winds are within 22 Kts to 27 Kts, with radius of disturbances 44 km.
4. Deep Depression, where winds are within 28 Kts to 33 Kts, with radius of disturbances 48 km.
5. Cyclonic Storm, where winds are within 34 Kts to 47 Kts, with radius of disturbances 54 km.

6. Severe Cyclonic Storm, where winds are within 48 Kts to 63 Kts, with radius of disturbances 64 km.

7. Severe Cyclonic Storm with a Core of Hurricane wind, where winds are within 64 Kts to 118 Kts, with radius of disturbances 74 km.

8. Super Cyclone, where winds are 119 Kts or more, with radius of disturbances 84 km.

Prediction of cyclonic storm in the Bay of Bengal and issuance of timely warning is the job of the Storm warning centre (National weather forecasting centre),Dhaka. The cyclone warning system is well known in Bangladesh. Following information are normally included in each warning,

1. Position of storm centre.
2. Direction and rate of movement.
3. Areas likely to be affected with the names of Upazillas (administrative unit in Bangladesh), if possible.
4. Approximate time of commencement of storm.
5. Maximum wind speed expected.
6. Approximate height of storm surge/tide.

Storm Warning Signals in Bangladesh: The meteorological department uses separate codes of signals, for maritime and river ports. Code of signals, which are used at maritime ports of Bangladesh, are as follows,

Code of storm signals	Weather forecasting
Distant cautionary signal 1	There is a region of squally weather in which a storm may be forming.
Distant warning signal 2	A storm has formed.

Local cautionary signal 3	Port is threatened by squally weather.
Local warning signal 4	Port is threatened by a storm, but danger not yet sufficiently great to justify extreme precautionary measures.
Local danger signal 5	Port will experience severe weather from a storm of slight or moderate intensity. Storm expected to cross the coast to the south of the port.
Local danger signal 6	Port will experience severe weather from a storm of slight or moderate intensity. Storm expected to cross the coast to the north of the port.
Local danger signal 7	Port will experience severe weather from a storm of slight or moderate intensity. Storm expected over or near the port.
Local Great danger signal 8	Port will experience severe weather from a storm of great intensity. Storm expected to cross the coast to the south of the port.
Local Great danger signal 9	Port will experience severe weather from a storm of great intensity. Storm expected to cross the coast to the north of the port
Local Great danger signals 10	Port will experience severe weather from a storm of great intensity. Storm expected over or near the port.

Basic requirements to form tropical storms: There are six main requirements to develop tropical revolving storms. These are the basic requirements, but do not give any guarantee of forming such cyclones.

1. Sufficiently warm temperatures: Normally an ocean temperature of 26.5°C is the minimum requirement for TRS formation. Warm ocean water must exist over a sufficient depth of at least 50 meter. These warm waters are necessary to fuel the heat engine of the tropical cyclone.

2. Potentially unstable atmosphere: There must be an atmosphere that cools quickly with height, so that it becomes potentially unstable. If the air is unstable, then it will continue rising and the disturbance will grow. This is required to maintain convection for an extended period of time.

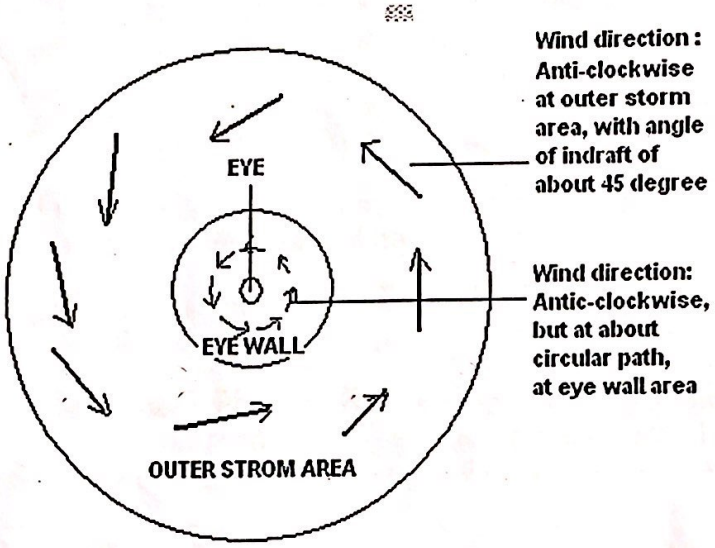
3. High relative humidity : A necessary amount of relative humidity must be present in the lower to middle levels of the troposphere. The required amount of humidity is about 50 to 60%.

4. Adequate value of Coriolis Effect: It has been observed that TRS does not form within 3 degrees latitude from the equator, as Coriolis Effect is negligible at the equator. So a minimum distance of 500 km from the equator is normally needed to from TRS.

5. Largest low pressure: Pressure must be lowered with largest amount and this LP area must be surrounded by areas of HP, which is required for preexisting near-surface disturbance.

6. Limited vertical wind shear: Limited vertical wind shear can be positive for tropical cyclone formation. This amount should be less than 10 m/s between the surface and the tropopause. On other hand, strong wind shear can blow the tropical cyclone apart.

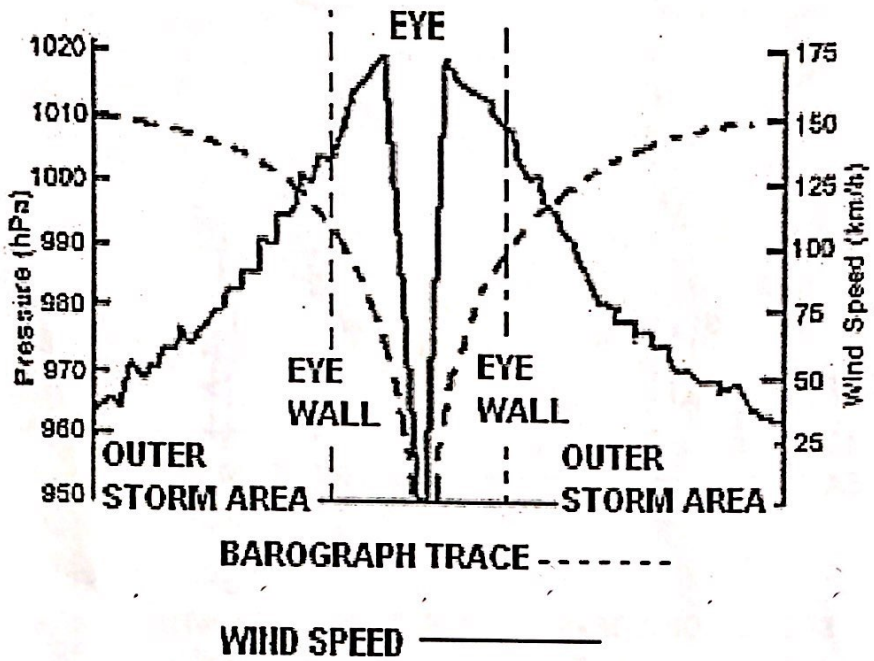
Structure: Parts of a tropical storm are described as below,



BIRD'S EVE VIEW OF A TRS OF IIH

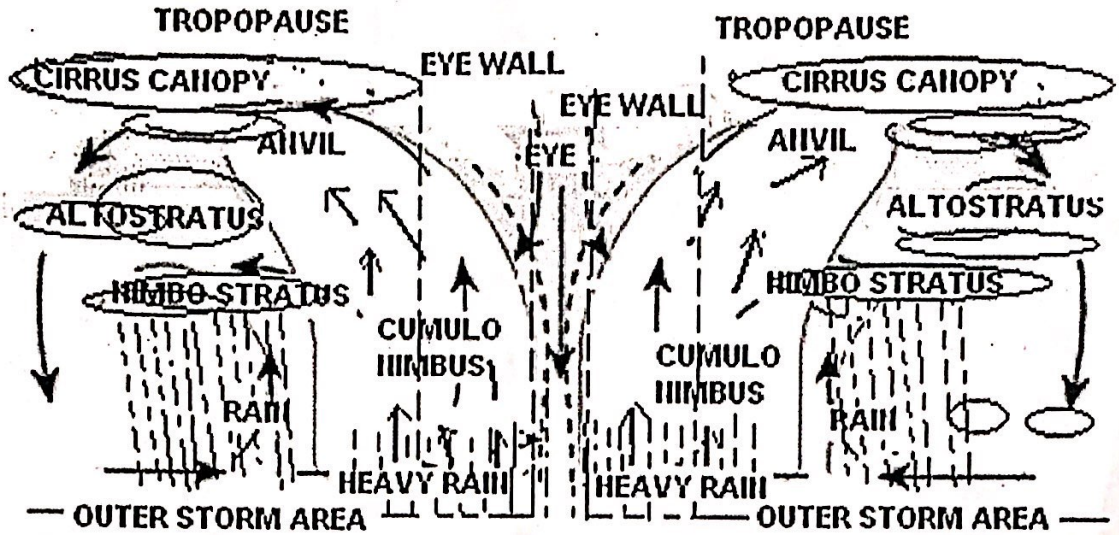
Eye or **vortex** is a roughly circular area of comparatively light winds and fair weather, available at the center of a severe tropical cyclone. Weather in the eye is normally calm but the sea can be extremely violent. There is little or no precipitation and sometimes blue sky or stars can be seen. The eye is the region of lowest surface pressure than the surrounding environment. The diameter of an eye can be around 40 km and also can range from under 10 km to over 100 km.
In severe cyclones, the eye usually looks like a circular hole in the central cloud mass.

Eye wall consists of a dense ring of cloud and tall thunderstorms that produces heavy rains and usually the strongest winds (about force 6 or 7) at about circular path. This wall is about 15 km in height, with diameter between 100 mile or more, into the atmosphere. Changes in the structure of the eye and eye wall can cause changes in the wind speed, which is an indicator of the storm's intensity. The pressure gradient in the eye wall is very steep and barograph trace will show as near vertical curve line. (Shown at below figure)



Outer storm area is the area, which is out side of the eye-wall and can extend up to 1000 km from the cyclone center and contain heavy rain and wind squalls with wind force 6 to 7, as well as tornadoes. Here pressure gradient is much less than eye wall.
Here angle of in draft of wind is about 45º and this gradually decreases to 0º in the eye wall. In this area, the cirrus cloud can be form of strands or filaments with aligned conditions and points towards the storm center. Here visibility is excellent, except in occasional shower's areas.

Cirrus Canopy (in other words **CDO** or **Central dense overcast)** is a massive outflow of cirrus cloud in the upper atmosphere, which is produced by the extremely vigorous uplift of moist air, within the clouds of the eye wall. This forms a huge canopy over the cyclone, making satellite location of the TRS system center difficult during the early development stages, before the eye shows through the canopy.

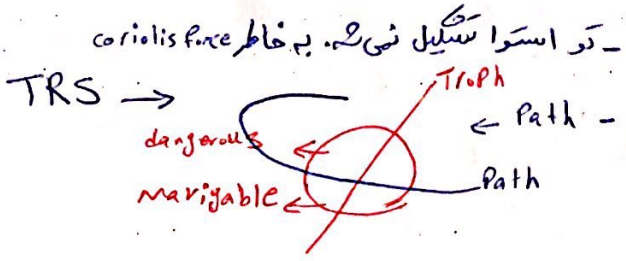


VERICAL CROSS SECTION OF A TROPICAL REVOLVING STROM CREATED AT NORTHERN HEMISPHERE

Route of TRS: Most of the TRS systems form between 10 and 30 degrees away of the equator and 87% form no farther away than 20 degrees of latitude, on both hemispheres. On the other hand, due to negligible Coriolis effect, tropical cyclones rarely form or move within about 5 degrees of the equator. Tropical cyclones move slowly westward when near equator and then intensify as they move further.

Initially TRS travels between W and WNW in the NH and between W and WSW in the SH. During their passages, they curve away from the equator, which are N,then NE in NH and S, then SE in SH. These recurving are normally done at about 30º N and 30º S. Again sometimes a TRS does not recurve at all and continues on same route, until cross the coast line.

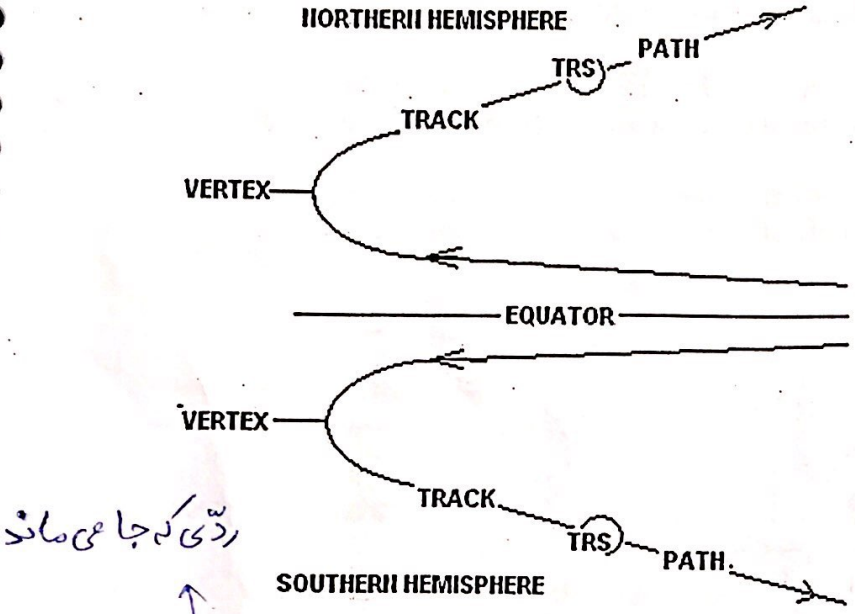
The of speed of TRS is usually about 10 knots in their early stages, which increases a little with latitude, but it seldom exceeds 15 knots before recurving, but thereafter 20 to 25 in usual, though speed of 40 knots or even more have been reported.



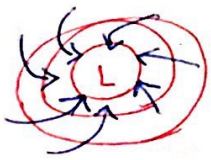
جهت باد ← از H به L

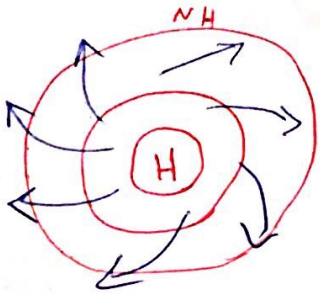
L ← cyclone

↳ Anti-cyclone



NH → Northern hemisphere





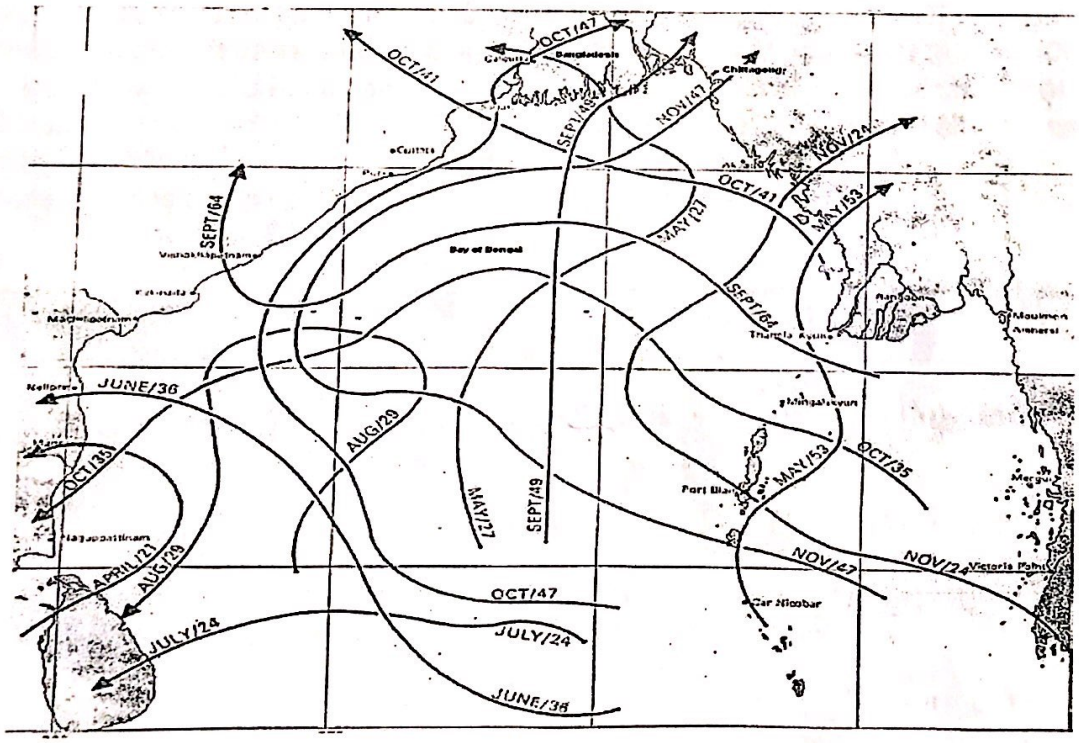
رد پی که جا می ماند

Route of a TRS is 2 types,

1. Track – The route over which a TRS is already passed.
2. Path – The predicted route, over which, there is a possibility of the TRS passing at near future.

راهی که قراره بره

Another point on route is called the **Vertex**, which is the western most point, of the TRS, when recurving takes place. Above attitude of speed and route, is not 100% correct for all storms. Some examples of abnormal track of TRS are given at next diagram, (Source: Bay of Bengal Pilot)



آگر در RHSC با ثیم تغییرات جهت باد در جهت عقربه ساعت ← veering

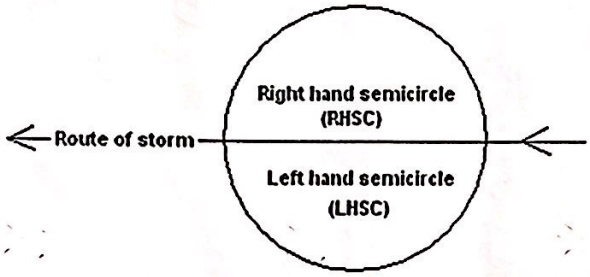
آگر در LHSC با ثیم تغییرات جهت باد در خلاف عقربه ساعت ← backing

← NH در

Semi circles: If a storm is divided along the route, at which the storm is passing, then we get 2 parts, which are,

1. Right hand semicircle (RHSC): It is the half of the storm, which lies to right of the observer, who faces along the route of storm. For a stationary observer, here the wind veers steadily.

2. Left hand semicircle (LHSC): It is the half of the storm, which lies to left of the observer, who faces along the route of storm. For a stationary observer, here the wind backs steadily.



In the northern hemisphere (NH), conditions on the right-hand side of storms are more severe than those on their left-hand sides. For that reason, in NH, RHSC is called the "dangerous semicircle" and LHSC is called the "navigable semicircle".

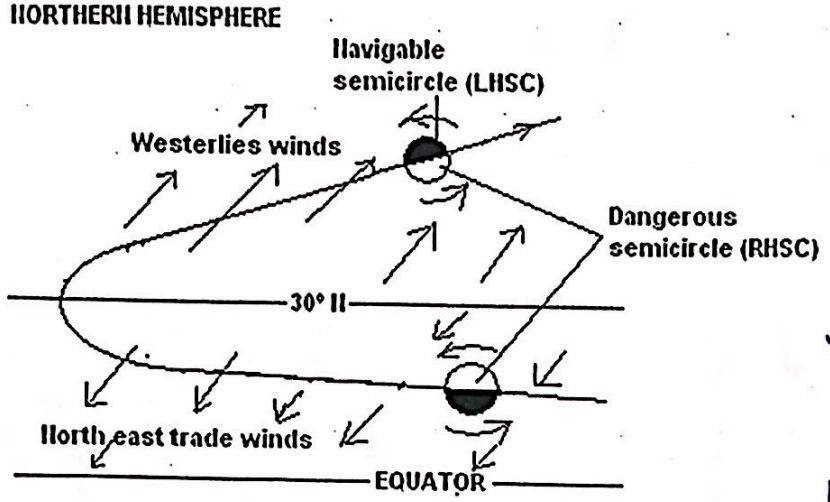
There are several reasons to make these conditions of dangerous and navigable situations.

In NH, normally a TRS forms at latitudes between 5º and 20º N and recurves at about latitudes 30º N. On the other hand, both westerly's and north-east trade winds blow from 30º N at NH. So if we look to below diagram, then we can see both winds are about in line with the wind

Direction of right hand semicircles and against the wind direction of left hand semicircles.

* بیشتر بدانید: این ۳ تا option را باید داشته باشی تا کشتی seaworthy باشد

1. Documentaly
2. Technically
3. Personally

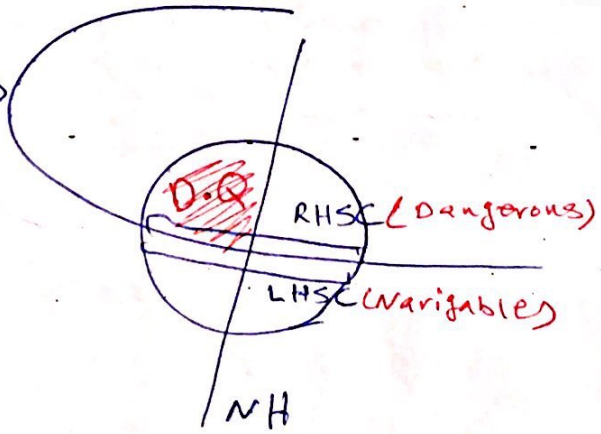


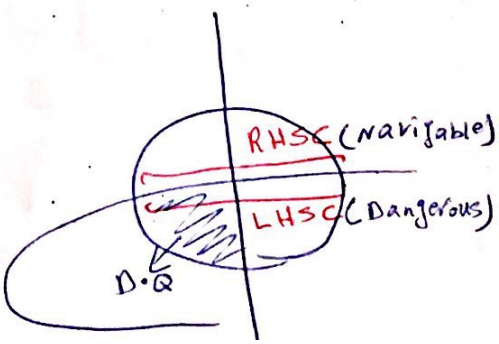
The TRS spins and travels at the same time, which also creates stronger wind conditions on RHSC for NH. In the SH, the situation is reversed. So again, as per navigator's judgment, semicircles are two types, which are,

1. **Navigable semicircle**— It is the side of a tropical cyclone, which lies to the left of the direction of movement of the storm in the Northern Hemisphere (to the right in the Southern Hemisphere), where the winds are weaker and better for the navigation purpose, although all parts of TRS are more or less dangerous to mariners.
2. **Dangerous semicircle**— It is the side of a tropical cyclone, which lies to the right of the direction of movement of the storm in the Northern Hemisphere (to the left in the Southern Hemisphere), where the storm has the strongest winds and heaviest seas.

Below is one more term, which is also used for safe navigation purpose at TRS.

Dangerous quadrant: It is the forward quadrant of RHSC in NH and LHSC IN SH. In this quadrant, the wind's rotation pulls us toward the center, with maximum apparent wind speed.





Majid AslanPoor

How to Read Weather Maps

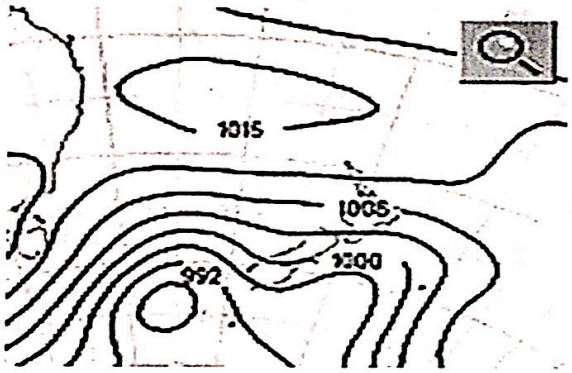
Weather maps as they appear on TV, in a newspaper or here are called 'surface charts' or, more correctly, 'Mean Sea Level' (MSL) charts. They show what is happening at a set time where most of us need it - at the Earth's surface. They do NOT show what is happening at higher levels, where the wind flow may be doing something entirely different.

The Isobars

Those plain lines that curve across the map are called isobars (iso = equal, bar = pressure). They join together places with the same mean sea level air pressure (weight per square area of air above). Some have numbers on them showing this value in hectoPascals.

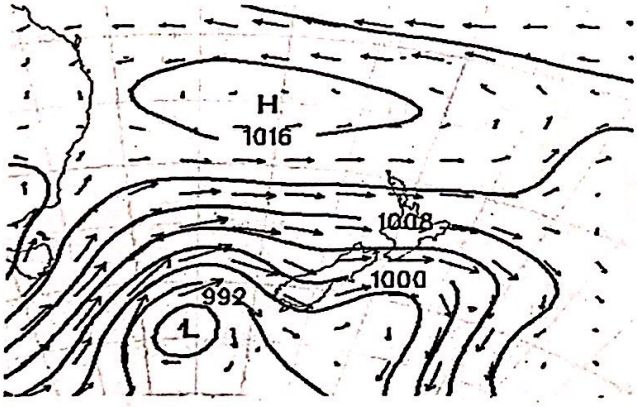
Isobars and the wind

Isobars can tell us about the wind. Christopher Buys-Ballot (1818-90), who was a Dutch meteorologist, made the vital link between isobars and wind in 1857. In the Southern Hemisphere, his rule is as easy to remember as three L's: If you LOOK into the wind, the LOW pressure is on your LEFT



So from the isobars you can estimate the winds, but it is not quite as easy as Buys-Ballot's law. Here are **five** wind tips:

1. **Winds blow almost directly (but not quite) along the isobars.** This is just another way of giving Buys-Ballot's law. In the Southern Hemisphere the flow is CLOCKWISE around LOWS and COUNTER-CLOCKWISE around HIGHS. In the Northern Hemisphere the flow is the other way around. In the picture to the right, the wind direction is given by the red arrows.



Pressure gradiant → Distance between 2 Isobars.

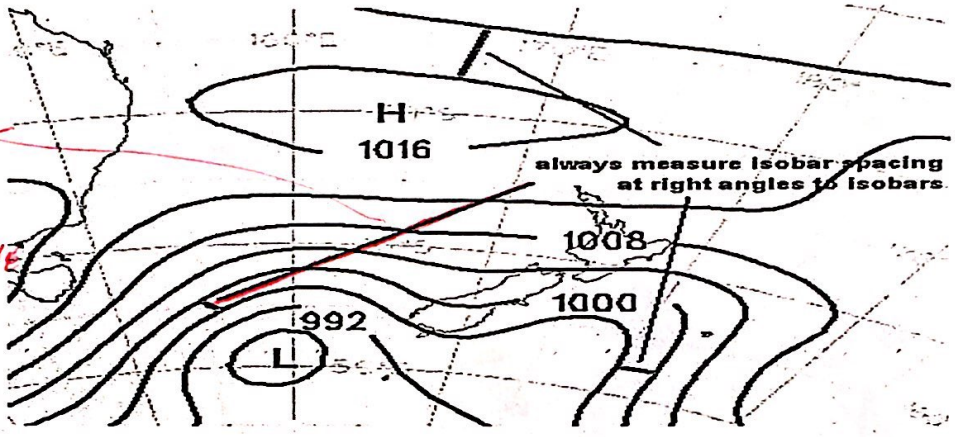
2. The closer the isobars, the stronger the winds.

This varies with latitude ... on a weather map with isobars 4 hectoPascals apart, a spacing of about two degrees latitude (with straight isobars) means fresh winds about Auckland but a gale over Fiji.

3. Surface wind 'leaks' across the isobars towards low pressure, by about 15 to 20 degrees over the open sea, but by as much as 30 to 90 degrees over and around land. This time, the red arrows show the wind directions as they are more likely to be - gently flowing across the isobars towards lower pressure

wind direction

Low Pressure سمت راست ها است.



4. Because of the 'spin-out' effect when turning corners, the wind speed can be:

-Up to 20% higher than the isobar spacing would suggest as the air turns around (and out of) a High

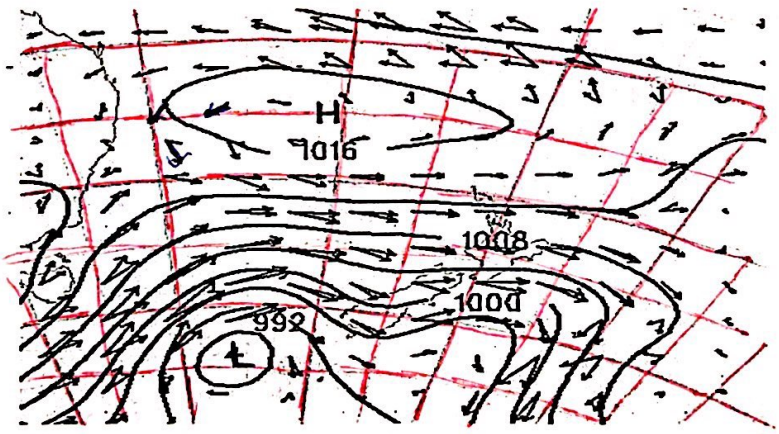
-As much as 20-40% lighter than the isobar spacing would suggest as the air turns around (and into) a Low.

-The blue arrows show the wind as it is likely to be; the red arrows show how the wind would be if it flowed parallel to the isobars. The longer the arrow, the stronger the wind.

-Where the flow curves strongly around the High, the blue arrow is longer than the brown arrow, meaning the wind is stronger than the isobar spacing suggests.

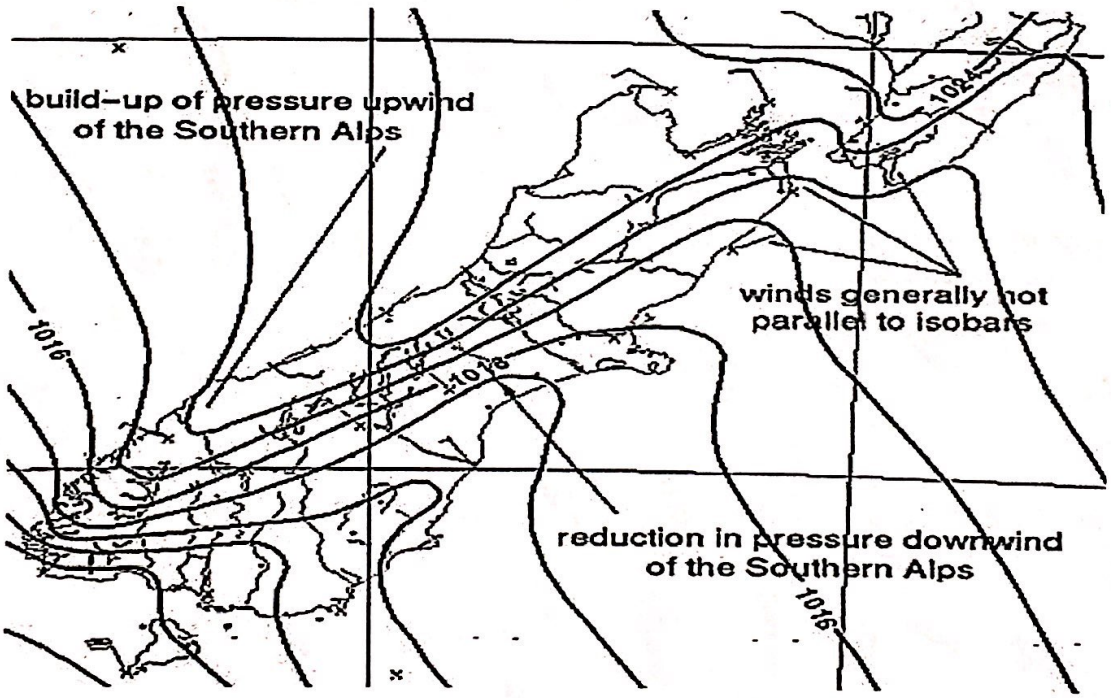
-Where the flow curves strongly around the Low, the brown arrow is longer than the blue arrow, meaning the wind is weaker than the isobar spacing suggest

فلش ها همه آبی رنگ اند.
فلش های یک طرفه آبی و قهوه ای اند.



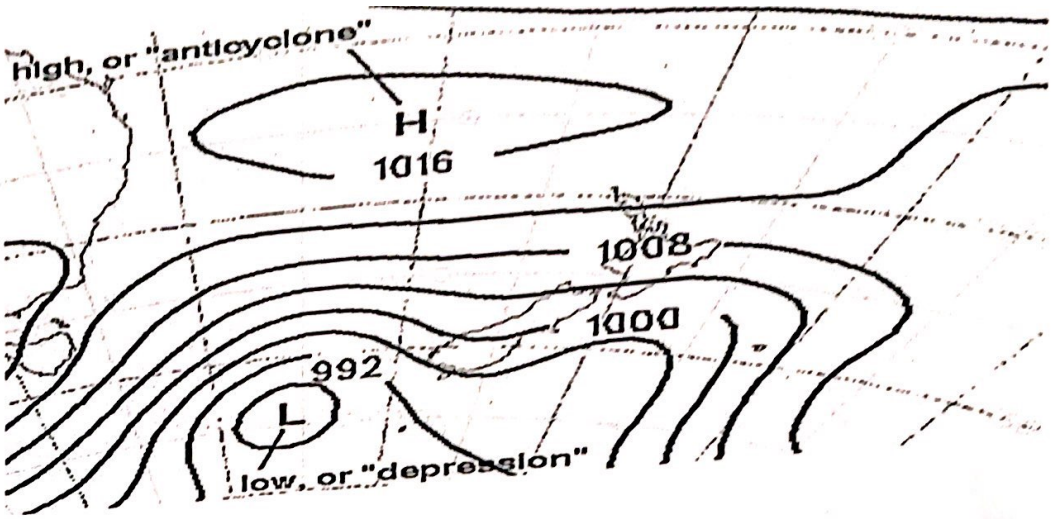
5. Isobars are only smoothed-out approximations and only tell about the general wind flow, not the details. Wind flow over land is not simple ... it is like water flowing over a rocky brook, eddying around corners and rushing between boulders. Actual wind accelerates down valleys, bends around headlands, bumps about abutments, is contorted by the coastline, dips and dives over hills and dales, eddies behind mountains, and gallops through gaps. There is a natural reluctance for surface wind to move over land in the cool of the night or near dawn, and it may be drawn onshore during a hot day (sea breeze), or offshore at night (land breeze). Mountain air cooled at night sinks down valleys and flows out to sea (katabatic wind). These effects do not show up in the isobars on the weather map but can halve or double the local wind speed, and distort its direction (always towards low pressure).

One terrain effect does show up on the weather map: chains of mountains distort isobars crossing them. In the example to the upper right, the Southern Alps buckle the isobars coming in from the Tasman Sea, with a build-up of pressure on the windward side and a counter-balancing drop of pressure down-wind from the mountains. Because of this distortion, avoid trying to use isobars over mountains to work out wind direction. Also, in general, avoid using isobars to work out wind flow over high ground. Also shown in the example to the upper right, in red, are observations of the surface wind at Met Service stations for the same time as the isobars. The "long" part of the wind arrow shows the direction. As can be seen, some winds line up nicely with the isobars and others are almost at right angles to them.



The Highs

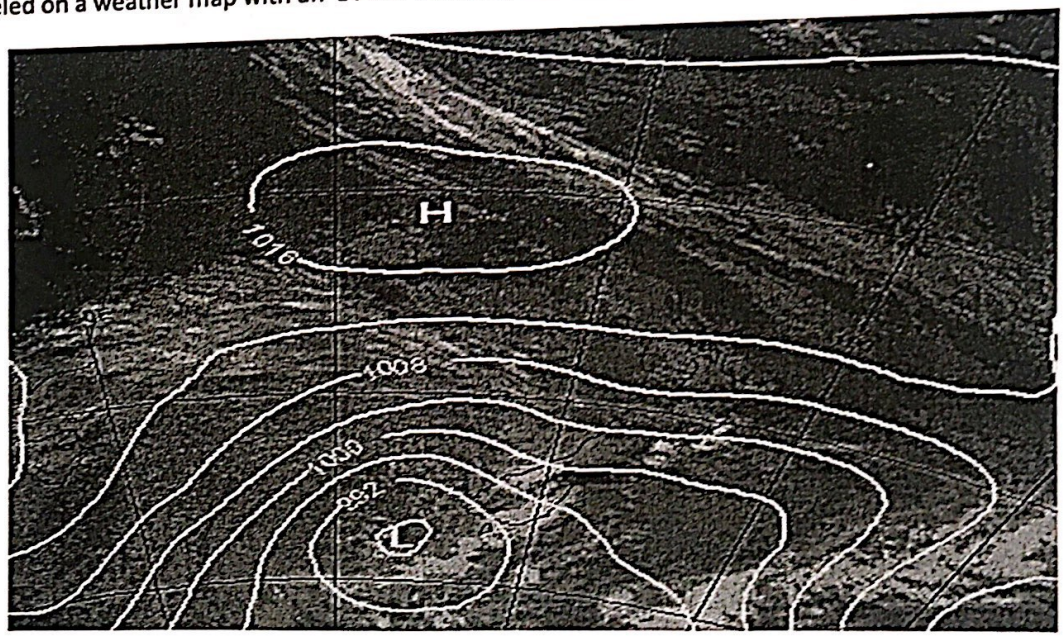
When isobars enclose an area of high pressure this is called a High or anticyclone and its center is labeled on a weather map by an 'H'. The term 'anticyclone' is a bit of meteorological jargon.



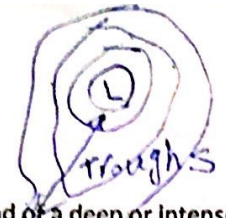
The central pressure of a weak High is about 1015hPa, while a strong or intense High has a central pressure above about 1030hPa. An intensifying high has a rising central pressure, while a weakening high has a falling central pressure. Near a High's center are light winds and sometimes areas of low cloud called anti-cyclonic gloom. Round the edge of a High, the winds are sometimes strong. Intense Highs tend to squeeze the isobars together creating areas of strong winds. Winter Highs often bring frost; summer Highs may bring thunderstorms and hail. The bigger Highs are, the slower they tend to move, sometimes 'blocking' the fronts that are trying to follow them.

The Lows

Isobars make shapes and patterns. When they enclose an area of low pressure this is called a 'Low' or 'depression' and its Centre is labeled on a weather map with an 'L'. The term depression is a bit of meteorological jargon.



A low pressure system is like a giant funnel of wind spiraling inwards and upwards forcing warmish air in the center to rise. As air rises it cools and clouds form. The central pressure of a shallow Low is above 1000 hPa, of a moderate Low



Low گستگی های
به بیرون

980-1000 hPa, and of a deep or intense Low below 980hPa. If there are two or more centers the Low is said to be complex. If the central pressure is rising the Low is said to be filling or weakening. If the central pressure is falling the Low is said to be intensifying or deepening. The satellite picture to the upper right (from the satellite GMS-5, courtesy of the Japan Meteorological Agency) shows cloud patterns fairly typical of those associated with Highs and Lows

Air Masses

An air flow originating from a prescribed location (warm, cold, moist or dry) is called an air-mass. Air-masses are named according to where they have come from and each has its own characteristic temperature and humidity.

- A tropical air-mass consists of air flowing from the tropics (WARM)
- A polar air-mass consists of air flowing from polar regions (COLD)
- A maritime air-mass is one flowing over a large sea area (MOIST)
- A continental air-mass is one flowing over a large land area (DRY)

The air-masses reaching New Zealand are generally either maritime polar or maritime tropical.

Fronts, Troughs and Convergence Zones

A front marks the boundary between two air-masses, and appears on the weather map as a line with triangles or semicircles attached.

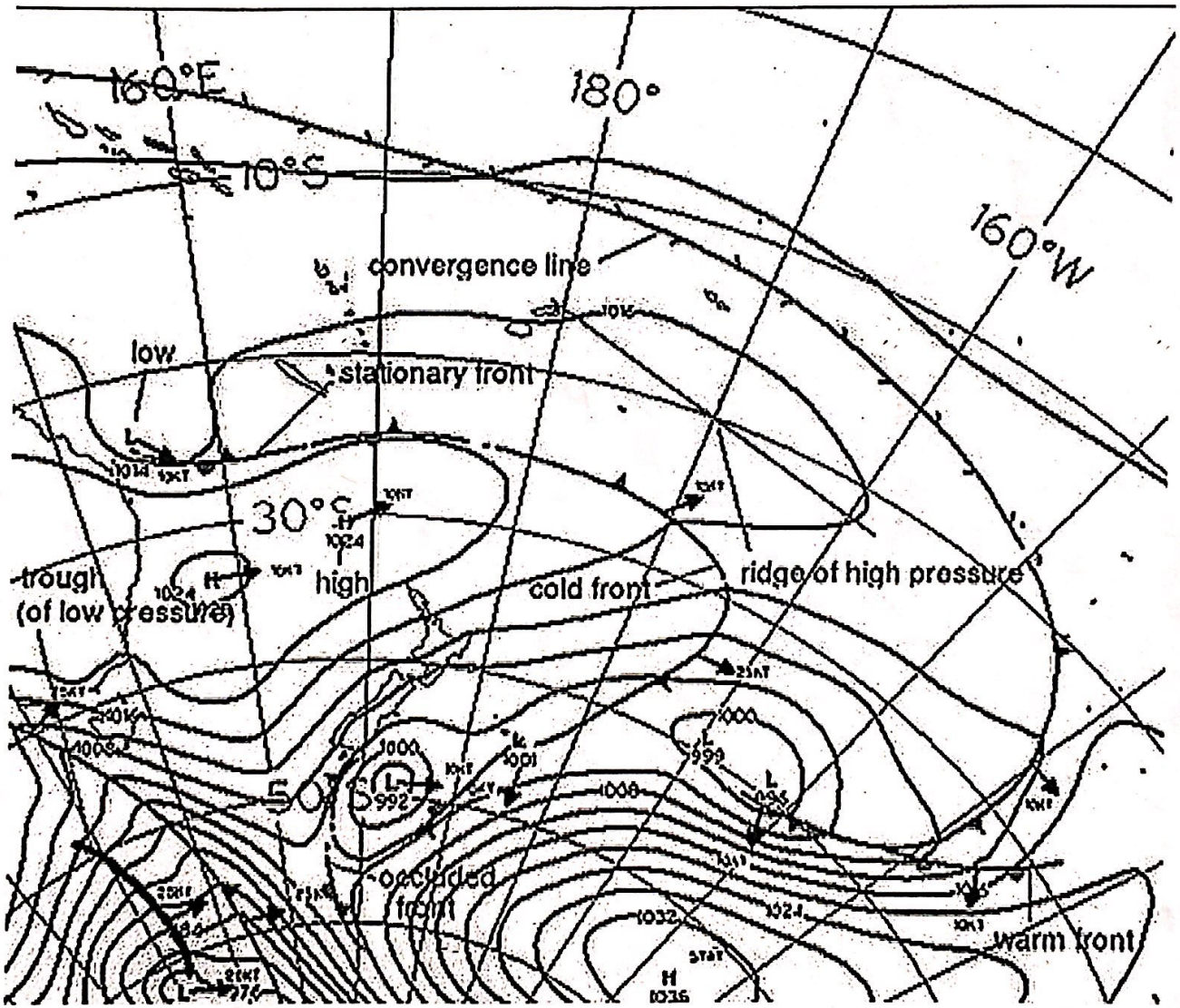
A cold front is the leading edge of an invading colder air-mass and is marked by a line with triangles pointing to where it is moving. Cold fronts push in underneath the warmer air ahead of them, forcing the warm air upwards and making cloud and areas of rain. The cloud band is usually about 50 to 400 kilometers (30 to 200 nautical miles) wide. As a cold front passes by: any rain clears but showers may appear, humidity drops, air temperature usually drops, pressure rises and the wind changes direction.

An occluded front or occlusion occurs when a cold front overtakes a warm front, so that all that remains of the original warm air is trapped above, where it cools making dense cloud and rain. It is marked by a line with triangles and semicircles on the same side, pointing to where the front is moving. As an occluded front passes by: any rain becomes patchy, wind eases, the rate of pressure fall may level out but air temperature does not change much.

A stationary front is one which has lost its impetus for movement, so that neither air-mass is making much progress. It is marked by a line with alternate triangles and semicircles on opposite sides ... the triangles protruding into the warmer air-mass and the semicircles protruding into the cooler air-mass. It takes a while for a stationary front to pass by: any rain clears only slowly and temperature and pressure do not change much.

When isobars make a sharp bend around a Low, this bend area is called a trough of low pressure or simply a trough. Troughs are also often shaped like tongues and usually contain weather similar to lows and fronts.

Horizontal convergence is the coming together of two flows of air. When these two flows of air are from different air masses and significant cloud and weather result, the resulting line of convergence is commonly



Warm, occluded and stationary fronts weather map showing:

-Highs and Lows

-Troughs of low pressure and ridges of high pressure

-Convergence lines

→ H ولی واسه troughs مثل

Five Different Types of Weather Maps

Weather maps show different weather indicators to tell about prevailing weather conditions in an area. Weather maps come in different types, telling a different weather story with each one. Some may show the atmospheric pressure, or temperature. Some also show multiple types of data in order to give a well-rounded indication of the weather conditions in a particular area.

Pressure Maps

Pressure maps are measured in millibars, and tell the reader where there is high atmospheric pressure, as compared to average sea-level pressure, and where there is low atmospheric pressure. In general, high pressure areas mean that the air is very stable, and usually denotes good weather conditions. Low pressure on the other hand, means that the air is less stable, clouds can form and rain or storms could ensue. According to Weather Questions (see Reference 3) low and high air pressure systems are caused by the heating and cooling of air masses; they vary daily.

Station Model Maps

Station-model maps show the weather conditions at a particular weather station. They report on all kinds of weather conditions, such as temperature, humidity, air pressure, cloud cover or wind speed. Station-model maps are written in meteorological symbols that denote the different weather elements, and larger area maps are made by combining the station-model maps from multiple stations.

Aviation Maps

Aviation maps are live weather maps specifically containing information necessary for the safe flight or aircraft. Information such as wind speed and direction, dew point readings, flight advisory information, temporary flight restrictions, cool and warm weather fronts and icing areas are all displayed on aviation maps. This information is updated in real time so that pilots have an exact map of weather conditions and flight conditions and can safely navigate the skies.

Temperature Maps

Temperature maps show the current temperature in either a color scale or by temperatures in numbers on the map surface. Temperature maps are one of the most common types of weather maps and often combine with cloud cover and precipitation to give a basic weather indication for newspapers and news programs.

Streamline Maps

Streamline maps show the wind patterns in particular areas. Streamline maps use isobaric pressure readings as part of the process but combine and convert the data into much more useful images of actual wind patterns rather than just a pressure reading at different points. According to the Australian Bureau of Meteorology (see Reference 5) a streamline chart is particularly useful in tropical locations, given that the pressure gradients in the tropics are weak and don't give good indications of wind condition.

Madid AslanPoor

CONVERGENCE AND DIVERGENCE

Convergence is the accumulation of air in a region or layer of the atmosphere, while levels. Coincidently, this is also the layer of maximum winds in the atmosphere; cores of jet streams are usually found here. These high-speed winds are directly related to convergence and divergence. The combined effect of wind direction and speed (velocity) is what produces convergent and divergent air flow.

IMPORTANCE OF CONVERGENCE AND DIVERGENCE

The importance of convergence and di-vergence is related to pressure changes at the surface and height changes of the constant-pressure levels. As the air accumulates in the 300-200-mb stratum over a region, greater pressure is exerted throughout the atmosphere. It's like inflating a tire.

As the air flows into the stratum, the pressure increases. Barometric pressure at the surface rises, as do the heights of the constant-pressure levels. Put another way, we say that upper-level con-vergence causes pressure and height rises. The exact opposite effect takes place when air is depleted from the 300-200-mb stratum. This is where we deflate the tire. As the air flows out of this stratum, pressure is lost. Barometric pressure at the surface falls, as do the heights of the constant-pressure levels. We say that upper-level divergence causes pressure and height falls.

Convergence and divergence aren't the only processes at work in the atmosphere that can cause pressure and height changes, but you're going to hear these terms with increasing regularity as you progress up the AG rate ladder. They are primarily used by forecasters to explain why systems are expected to fill or deepen during the forecast period. Since the upper winds are the producer of convergence and divergence, you should be able to recognize the flow patterns associated with their production. The flow patterns range from simple to complex.

CONVERGENCE AND DIVERGENCE (SIMPLE MOTIONS)

In order for convergence to take place, the winds must be such as to result in a net inflow of air into a layer or region. At the surface, low-pressure systems are associated with con-vergent flow. The winds cross isobars toward thecenter of the low and push the air in the center upward into the atmosphere. The currents are illustrated in figure 1. The upward vertical motion is a prime contributor to the occurrence of precipitation. In meteorology, convergence is classified as horizontal or vertical, because there are horizontal and vertical currents occurring in the atmosphere.

In order for divergence to take place, the winds must be such as to result in a net outflow of air from a layer or region. High-pressure systems are associated with divergent flow. The winds cross isobars, flowing out from the high'scenter and depleting the air within the high. The air above the high sinks to replace the outflow of air at the surface. This downward vertical motion (subsidence) is associated with dry air. Divergence can also be classified as horizontal or vertical, depending on the wind's axis. See figure 1.

The simplest form of convergence and di-vergence is the type that results from wind direction alone. Two flows of air brought together, no matter what the angle, result in convergence. Where the air flow splits and winds go in different directions, divergence is occurring. Figure 2 illustrates these types of convergent and divergent air flow.

Wind speed in relation to wind direction is also a contributor to convergence and divergence. If the wind speed decreases downstream, there's a net inflow of air into the region, and convergence takes place. If wind speeds increase downstream, there's a net outflow of air from the region, and divergence occurs. In an area of uniform wind speeds, if the winds fan out (split), divergence occurs. If these same winds are brought together, convergence occurs. See figure 2, view B.

The fact that contours converge or diverge doesn't necessarily indicate convergence or divergence, because wind speeds must also be considered. If wind speeds increase downstream and the contours spread apart, supergradientwinds are said to be occurring. This com-bination of wind direction and speed produces divergence. On the other hand, if wind speeds decrease downstream and the contours converge,

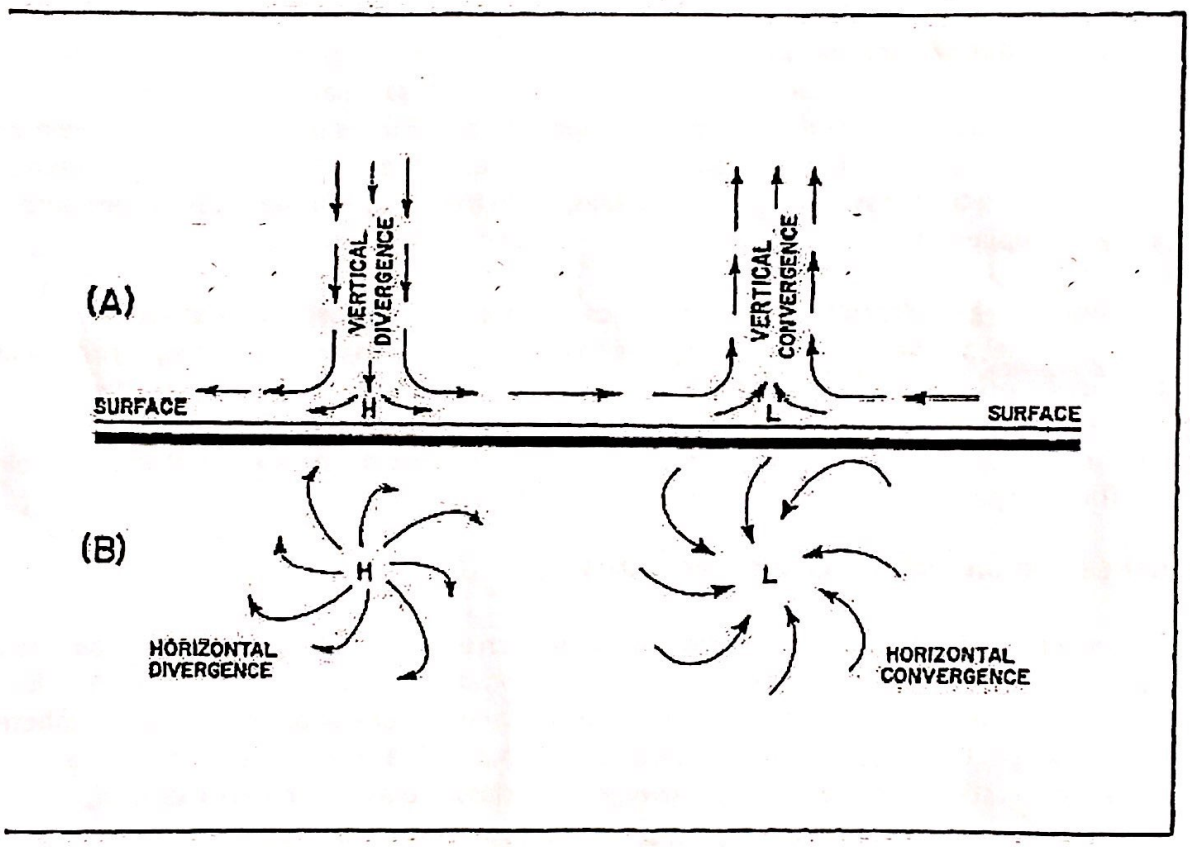


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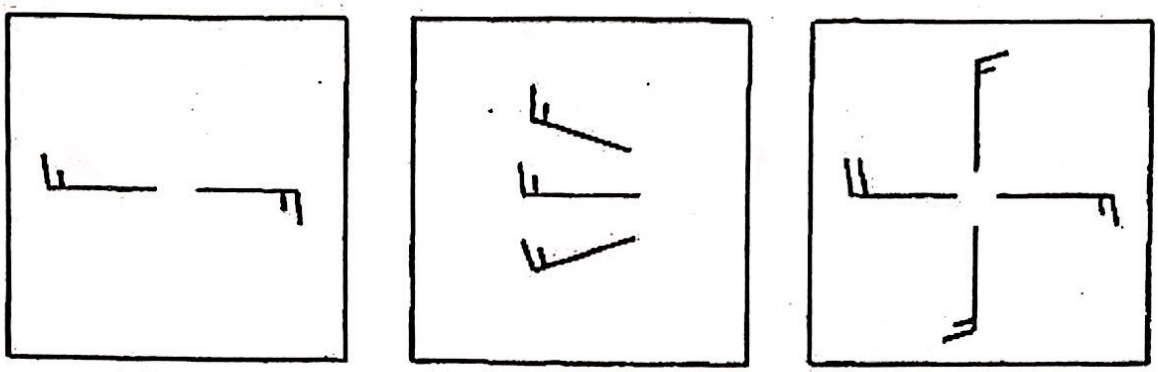
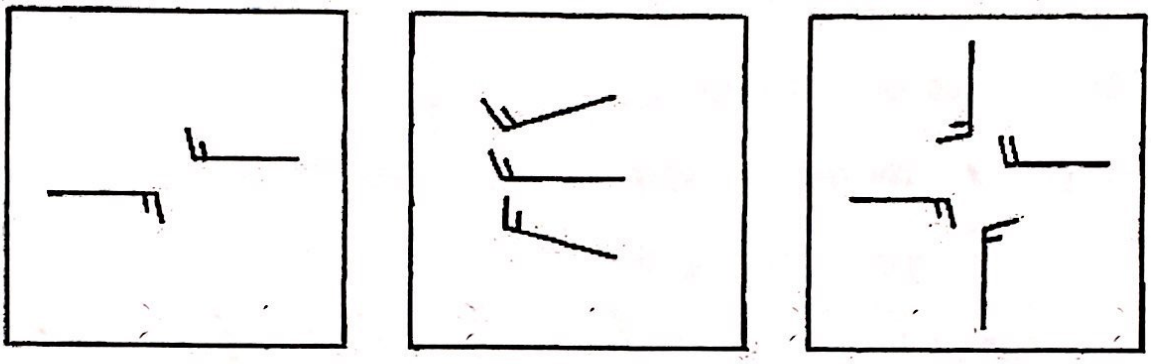
Figure 1.—Convergence and divergence. (A) Vertical perspective; (B) Horizontal perspective (Northern Hemisphere).

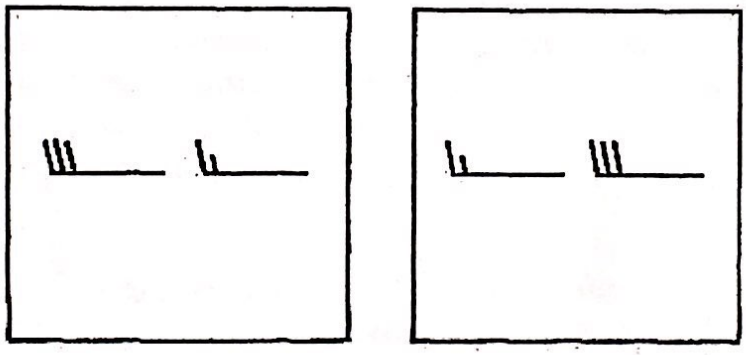


CONVERGENCE DUE TO WIND DIRECTION



DIVERGENCE DUE TO WIND DIRECTION

(A)



SPEED CONVERGENCE

SPEED DIVERGENCE

(B)

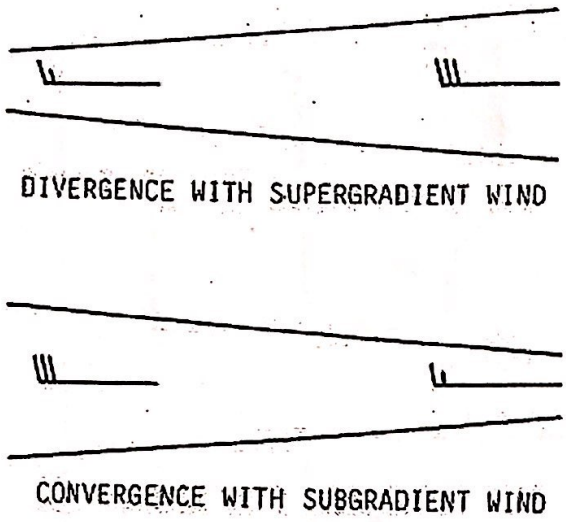


Figure 3.—Convergence and divergence in supergradient and subgradient air flow.

subgradient winds are occurring. This combina-tion produces convergence. See figure 3.

There are other cases where it is difficult to tell whether divergence or convergence is taking place. When wind speed decreases downstream and the contours spread apart, both convergence and divergence are indicated. The wind speed suggests convergence, but the spreading contours suggest divergence. A similar situation arises when wind speeds decrease downstream and the contours converge. Here, we're looking at speed divergence and directional convergence. These are complex motions, however, and a special evaluation is required to determine the net inflow or outflow.

Madid Aslan Poor

فشار گرادیان ← اختلاف فشار بین ۲ منطقه - هرچی ایزوبارها نزدیک باشند این فشار بیشتره یعنی باد شدیدتره.

PART A – ANTICYCLONES AND DEPRESSIONS

High Low

stable condition

High Pressure Systems → Isobar are far from each other

A high pressure system, also known as an anticyclone occurs when the weather is dominated by stable conditions. Under an anticyclone air is descending, forming an area of higher pressure at the surface. Because of these stable conditions, cloud formation is inhibited, so the weather is usually settled with only small amounts of cloud cover. In the Northern Hemisphere winds blow in a clockwise direction around an anticyclone. As isobars are normally widely spaced around an anticyclone, winds are often quite light.
Anticyclones can be identified on weather charts as an often large area of widely spaced isobars, where pressure is higher than surrounding areas.

condensation ← علت تشکیل مه یا ابر

Winter Anticyclones
In winter the clear, settled conditions and light winds associated with anticyclones can lead to frost and fog. The clear skies allow heat to be lost from the surface of the earth by radiation, allowing temperatures to fall steadily overnight, leading to air or ground frosts. Light winds along with falling temperatures can encourage fog to form; this can linger well into the following morning and be slow to clear. If high pressure becomes established over Northern Europe during winter this can bring a spell of cold easterly winds to the UK.

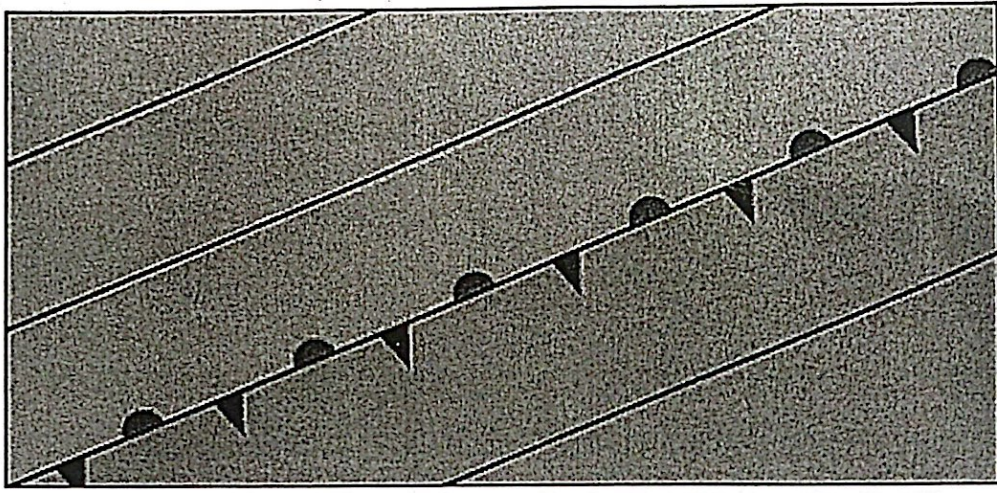
Summer Anticyclones
In summer the clear settled conditions associated with anticyclones can bring long sunny days and warm temperatures. The weather is normally dry, although occasionally, very hot temperatures can trigger thunderstorms. An anticyclone situated over the UK or near continent usually brings warm, fine weather.

Low Pressure Systems
A low pressure system, also known as a depression occurs when the weather is dominated by unstable conditions. Under a depression air is rising, forming an area of low pressure at the surface. This rising air cools and condenses and helps encourage cloud formation, so the weather is often cloudy and wet. In the Northern Hemisphere winds blow in anticlockwise direction around a depression. Isobars are normally closely spaced around a depressions leading to strong winds.
Depressions can be identified on weather charts as an area of closely spaced isobars, often in a roughly circular shape, where pressure is lower than surrounding areas. They are often accompanied by fronts.

PART B – LIFE CYCLE OF A DEPRESSION

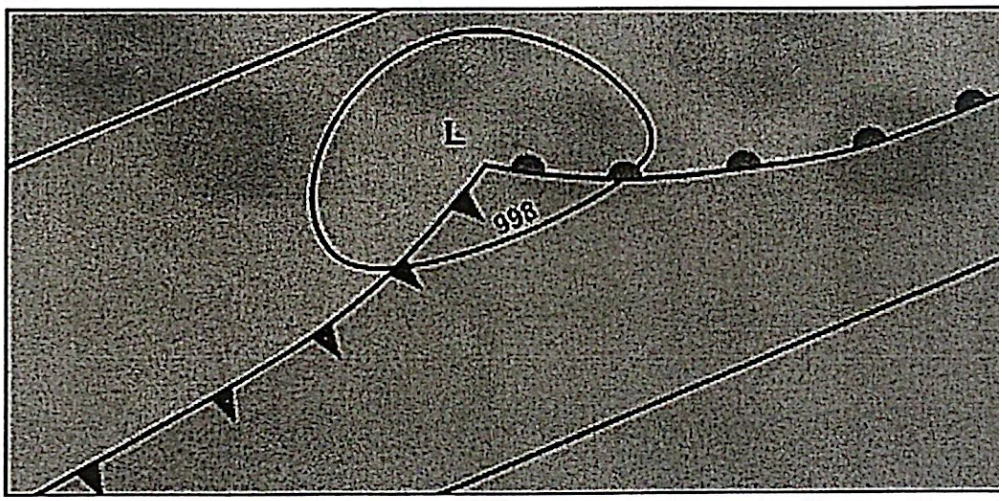
Origin and Infancy

Initially a warm air mass such as one from the tropics, meets a cooler air mass, such as one from the polar regions. Depressions which affect the UK normally originate over the Atlantic Ocean.



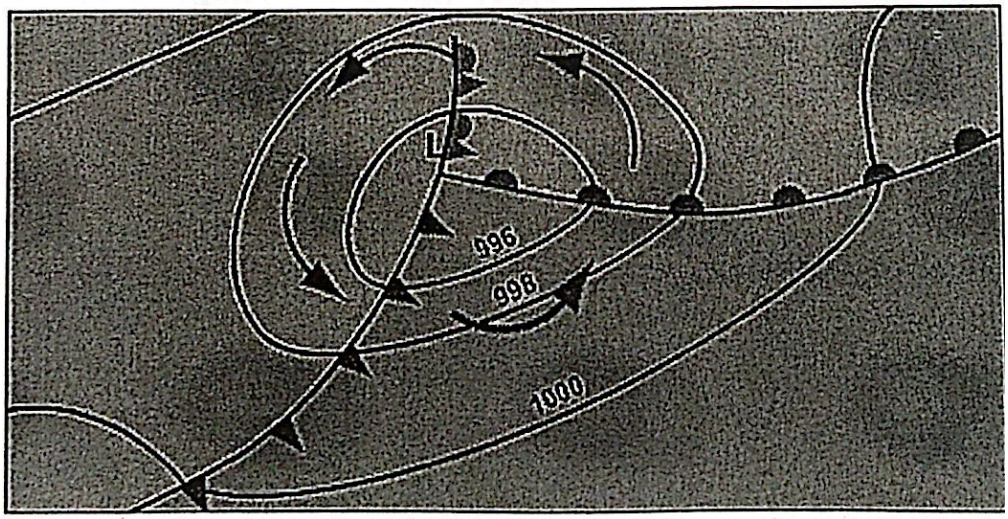
Maturity

The warm air rises up over the colder air which is sinking. A warm sector
warm and cold fronts. The mature stage of a depression often occurs ov



Occlusion

The cold front travels at around 40 to 50 miles per hour, compared to t
travels at only 20 to 30 miles per hour. Therefore the cold front eventu
warm front. When this occurs an occlusion is formed.



Death

Eventually the frontal system dies as all the warm air has been pushed up from the surface and all that remains is cold air. The occlusion dies out as temperatures are similar on both sides. This stage normally occurs over Europe or Scandinavia.

PART C – DEPRESSION CROSS SECTION AND WEATHER SEQUENCE

Cross-section through a Classic Depression

Most depressions have a warm and cold front, more mature depressions may also have an occluded front. The diagram below shows a cross-section through a depression, showing the warm and cold fronts and an indication of the associated weather.