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 a 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)

TYPES OF FOG

Fog resulting from evaporation → steam fog, Frontal Fog

Fog resulting from cooling → radiation Fog, advection ", upslope ", mixing ", barometric "

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.

Conditions favorable for radiation fog are:

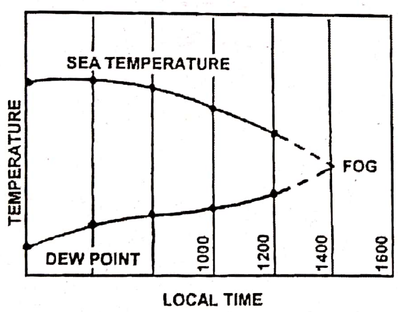
- Large moisture content in the lower layers of air.
- Little or no cloud at night.
- Light breeze at the surface.
- Cold wet surface of land.

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. 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

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.



3. **Sea smoke:**

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.
Smoke + Fog =Smog

It is a thick, black, oppressive blanket, 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
Blue sky (0 - 1/8 clouded)	b	Overcast sky (whole sky covered – unbroken cloud)	o
Sky partly clouded (1/8 - 3/8)	bc	Passing showers	p
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

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.

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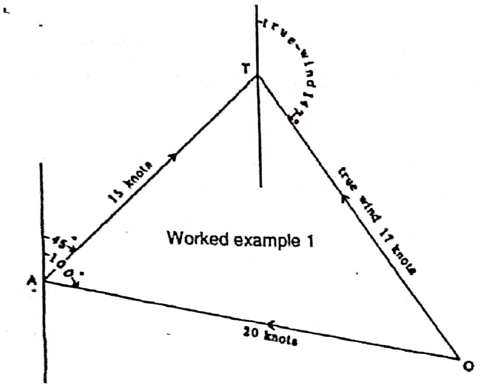
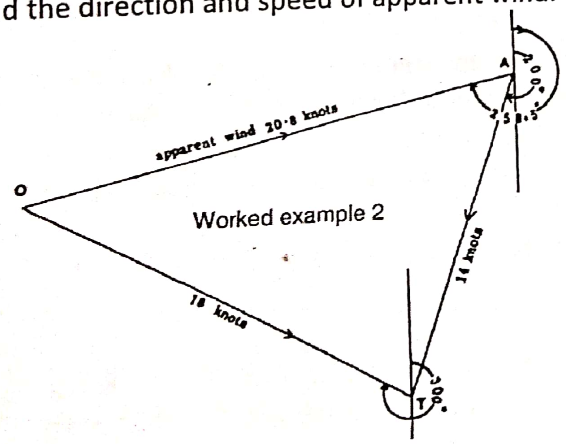


Draw a line representing North-South and take any point A on it. At "A", draw an angle equal to the course and cut off "AT" equal to ship's speed, using any convenient scale.
"AT" represents the course and speed of the vessel.
At "A", draw an angle equal to the apparent wind and cut off "AO" equal to 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.

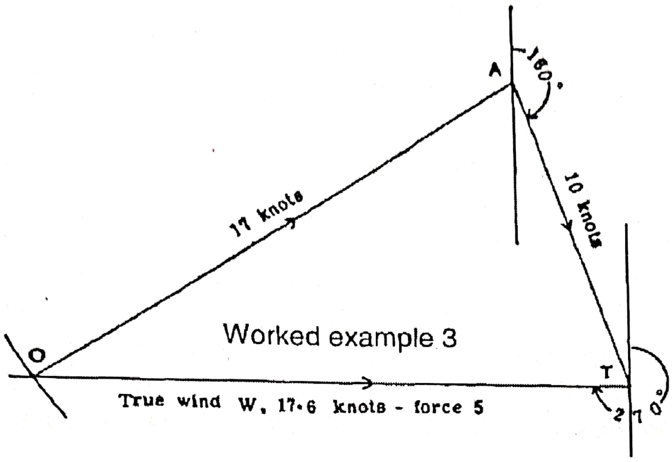
Worked example 2:
Course 200° speed 14 knots. True wind 300° at 18 knots
Find the direction and speed of apparent wind.



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?



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.

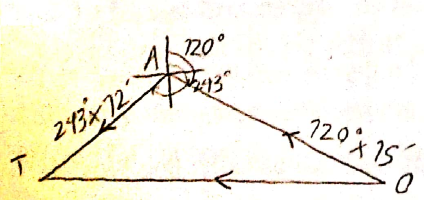
Examples for exercise

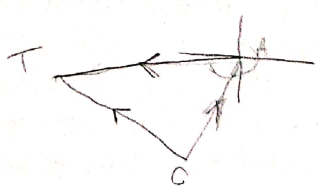
1. On a vessel steaming 346° at 15 knots, the apparent wind was observed to be NW at 22 Knots. Find the direction and speed of the true wind. (Answer 275° at 12 knots).

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)

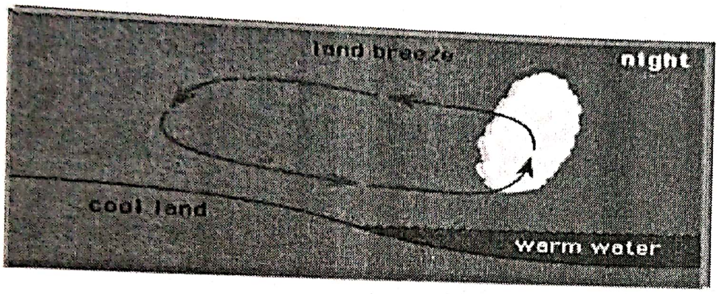




PERIODIC AND LOCAL WINDS

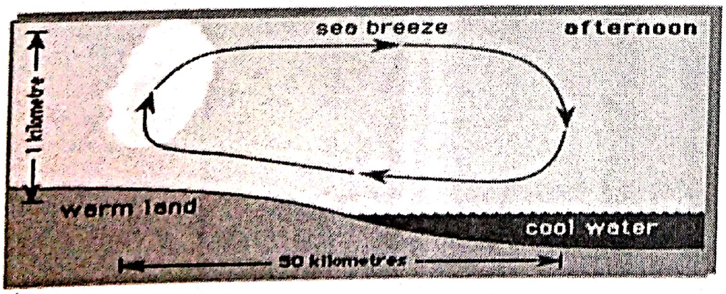
Land breeze:

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



Sea breeze:

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.



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

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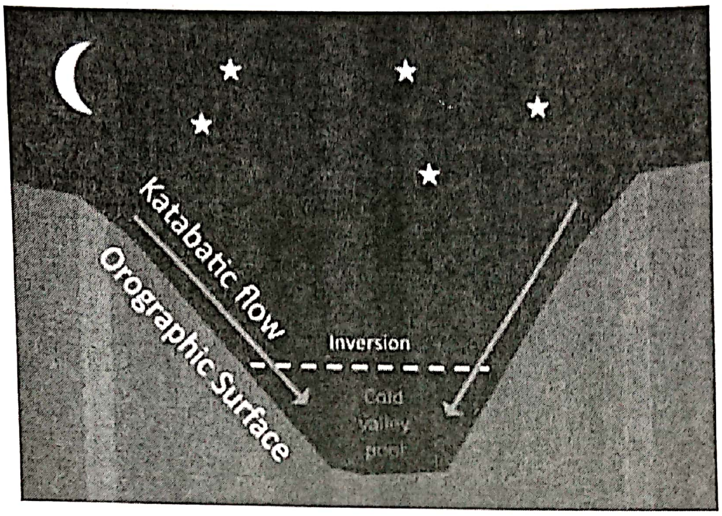
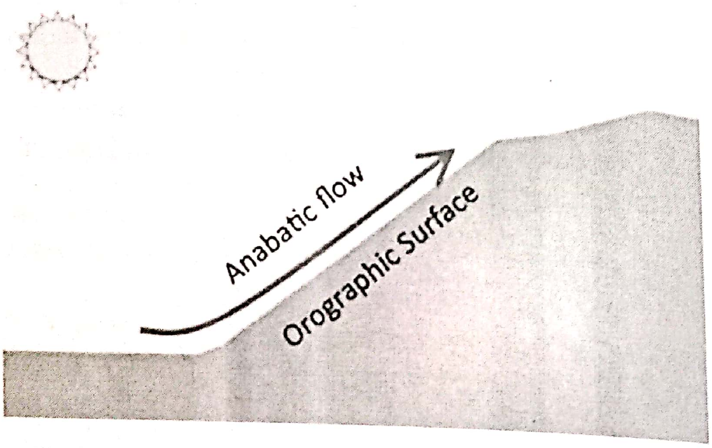
colder and hence denser than at valley .Air at the top of the hill starts sliding down due to gravitational force and is called a 'Katabatic wind' (in Greek 'Kata' means 'down')
If the mountain is high and the slope is steep, katabatic winds can reach sea level with force 7 or more in a very short while.

inversion



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 the valley. 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')

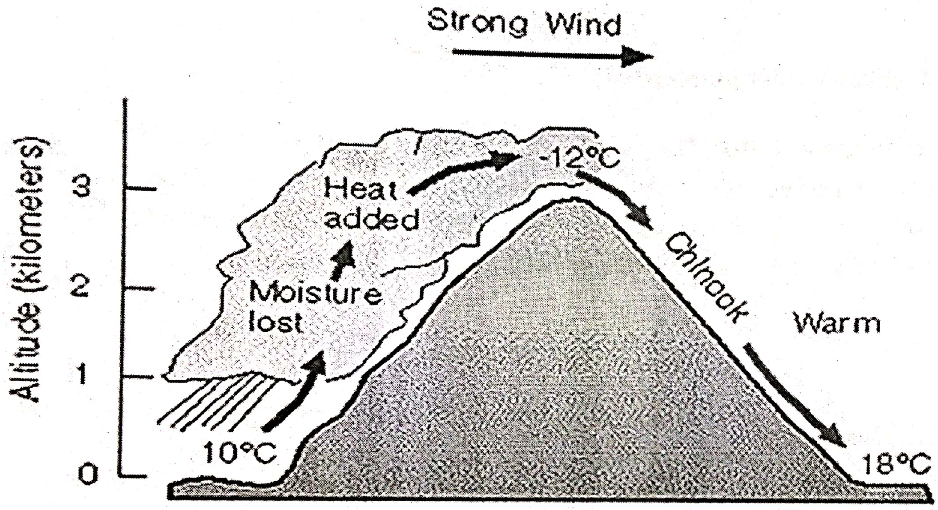


Fohn wind effect
Fohn Wind Effect is an effect whereby the leeward side of a mountain range is drier and warmer than the windward side. This would be more pronounced if the wind was blowing from sea towards a coastal mountain range, as the air would then be moist. Fohn wind effect is the direct result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

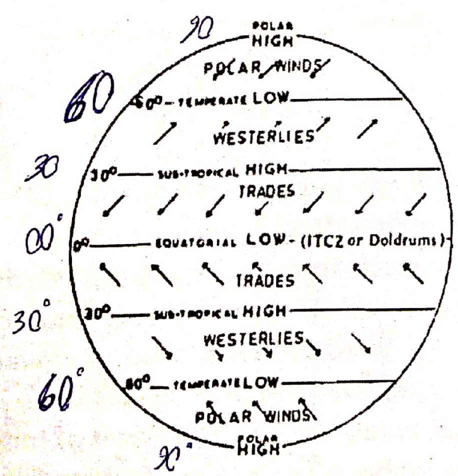
The result will be so that on the leeward side of the mountain, the air will be drier and warmer than the windward side

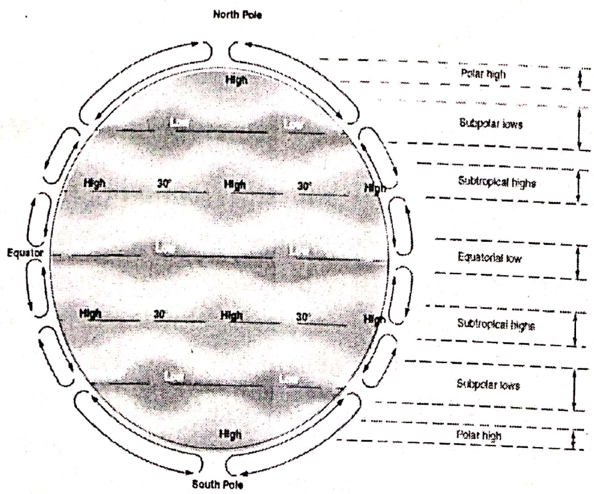


GENERAL PRESSURE AND WIND DISTRIBUTION

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





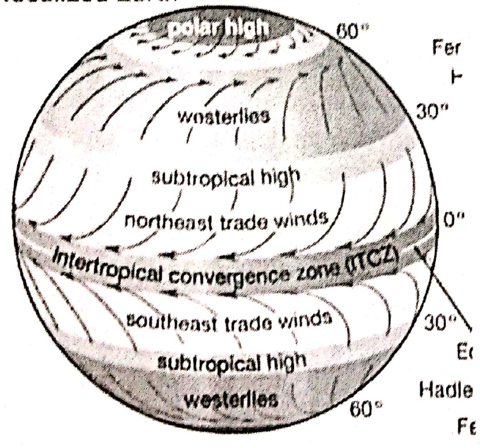
-permanent low at equator
-permanent high at 30 north and south
-permanent low at 60 north and south
Permanent high at north and south poles

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

Doldrum:(ITCZ=intertropical convergence zoon)

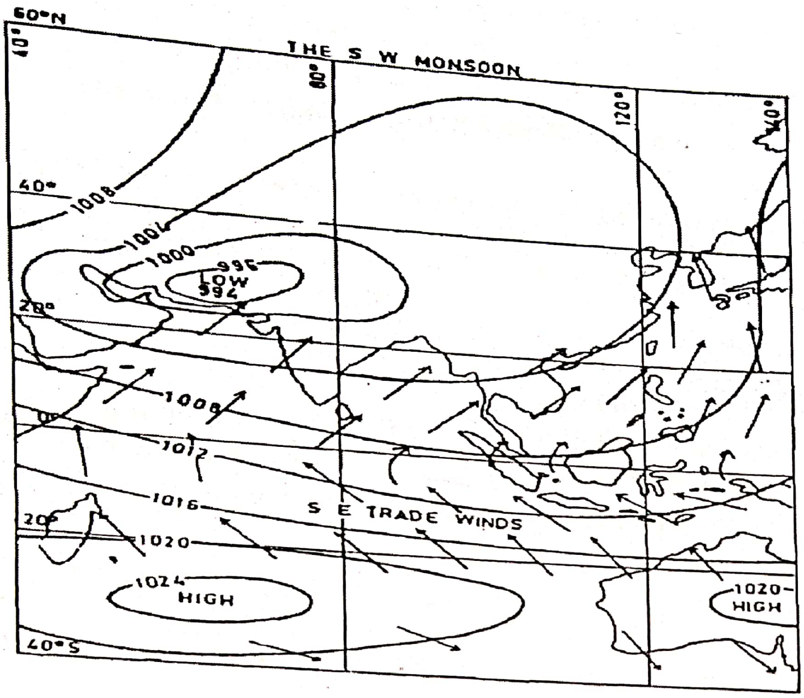
Area of permanent low on the equator. The Doldrums are located a little north of the equator, but the effects can be felt from 5 degrees north of the equator to 5 degrees south of it. The trade winds border the Doldrum both to the north and south. Air rises straight up rather than blow horizontally.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

Idealized Earth



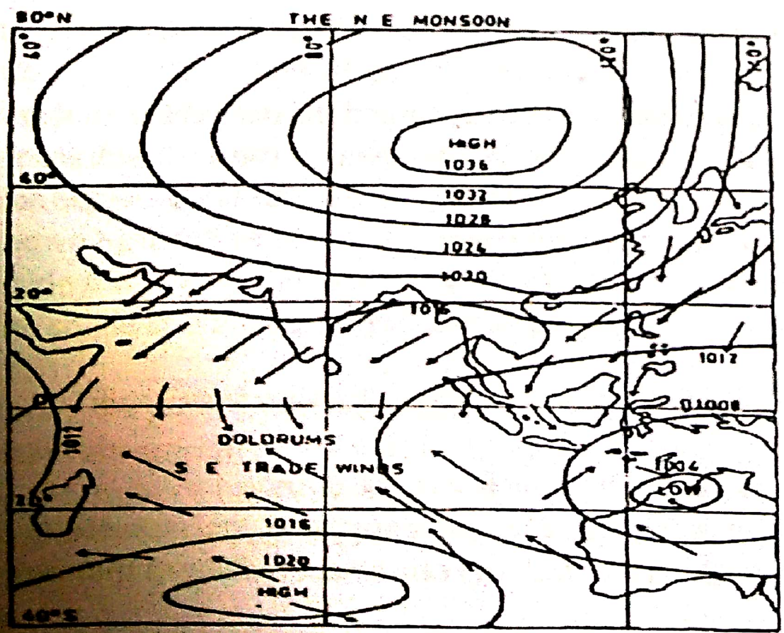
Monsoons of the Indian Ocean (South West Monsoon)

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)



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.



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

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

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

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.
-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. برطرف کردن

-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.

-Faculty 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

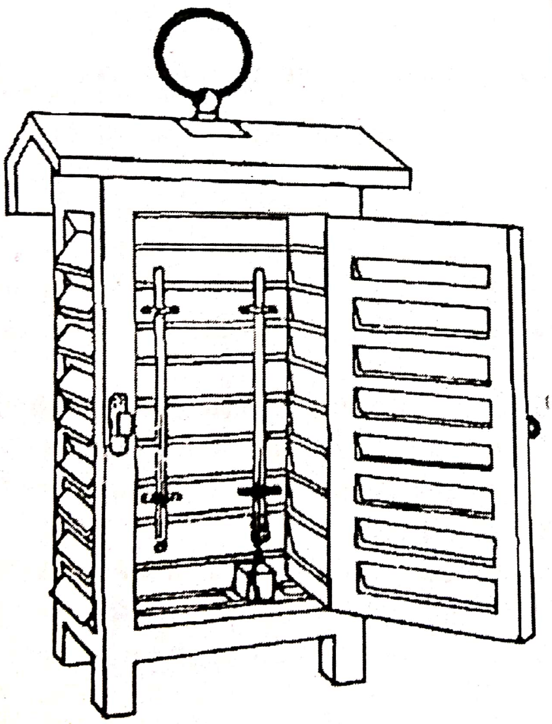
It consists of a light wooden frame, pivoted to revolve smoothly around a handle. The frame has two identical Celsius thermometers mounted on it. One of them has a layer of thin muslin tied firmly around its bulb, and is called the wet bulb thermometer.

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

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