OCEAN RACING CLUB OF VICTORIA

WEATHER FOR SAILORS

MODULE 1 - THE FUNDAMENTALS (KNOWLEDGE)

ORCV
OCEAN TRAINING

Photo: Paulina Hryniewiecka

Knowledge Section

About the Ocean Racing Club of Victoria (ORCV)

Ocean Racing Club of Vic (ORCV) is dedicated to promoting ocean sailing, growing its participation, providing sea safety programs

The ORCV is based in Melbourne, capital city of the state of Victoria Australia. The club conducts yachting events in Port Phillip Bay and offshore from Victoria mainly along the coast in Bass Strait and to locations in the island state of Tasmania, it's western coast and the capital city, Hobart. This incorporates an area from Melbourne at latitude 37° 48.8' S to 44°S and from longitude 141° 36E and 151° E. In addition the club holds long distance events to Vanuatu in the Pacific and the longest South to North race to Osaka in Japan, Northern Hemisphere lat. 34° N. Many of the members also sail along the east coast of Australia to regattas in the Whitsundays lat 20° S in the winter months.

Overview

The weather course covers: Sailing in enclosed waters then migrates to coastal passage making. The final trans-oceanic journeys that is focused from between hemispheres.

The course is arranged for the Southern Hemisphere mid latitudes particularly but is also applicable to the Northern Hemisphere with some adjustments. Module three in particular encompasses the tropics. Australia is a maritime continent as distinct from the continental climates in the largely land massed Northern Hemisphere. The north of Australia is subject to monsoonal seasons and the eastern coast much influenced by the warm East Australian

Current as part of the South Pacific basin gyre. In addition, the relationship with South America bringing the El Nino and La Nina events are considerations for Australia's diverse climates.

As sailors we are very concerned with weather. Fortunately the science and technology of forecasting has been improving significantly and new research by the various world-wide Bureaus of Meteorology have made significant progress with forecasts and now achieve remarkable accuracy especially out to 4 days, also 7 days (free), 10 and even 20 days for some providers (mostly at a cost). When we first presented our courses in 2015, we outlined a new technology and advised students to be aware and watch for it. Today that technology is available on the internet and published weekly. The advent and increasing use of mobile smart-phones, sat-phones for offshore voyaging, coupled with easy to use graphics and lower data hungry products is likely to spell cessation of official HF radio. In other countries volunteer groups, or subscription services have continued HF services after government withdrawal.

These weather courses avoid mathematical prowess as sailing has a largely practical component, but we do try to explain the concepts and rule of thumb applications with some simple examples that enable understanding and visualisation. After all, a helms-person or autopilot works toward an average course or the best achievable course the conditions allow. Above all, we wish to engage safely and perform to our best whether racing or cruising. You are encouraged to keep courses content and your personal notes in a safe and handy place for later reference as being a recreational practitioner, the opportunities to experience the situations presented are limited and it does take time to encounter and be consigned to 'experience'.

There is a lot available to learn and we have divided the content into three basic modules. Although most aspects are the same for each, each module builds on the previous as a requisite and increases application and content as specifically applicable to that module.

Module 1 –Definitions, Fundamentals & Enclosed Waters: this online course covers the fundamentals of weather and applications for enclosed waters. The basics in the course are progressively advanced in the next two modules and need to be understood before advancing.

Module 2 –Coastal Sailing: this online course builds on the fundamental knowledge of Module 1 and prepares a sailor for longer coastal passages usually 3 days or more, whether that be racing or cruising including: further applications of and building on module 1

Module 3 –Trans Ocean: this online course looks at planning for much longer voyages where a high degree of self-sufficiency is required. For those contemplating a Trans-Oceanic passage this course is a must and includes especially the tropics:

<u>Pre-reading to have some awareness of terminology, not necessary to know by rote.</u>

Definitions

Adiabatic: Process-An adiabatic process is one in which no external heat enters or leaves the system under consideration. As an example when air is compressed it's temperature rises.

Air Mass: develops from slow moving air over a large area acquiring the surface characteristics below it. Usually from high pressure over the polar or sub-tropical high belts. (Developed later in the course).

Air Pressure: In terms of this course is the unit weight of the atmosphere at mean surface level (MSLP). Usually referred to as hpa (hecta-pascals) or mb (milli-bars).1 mb is a thousandth of a bar and the world standard barometric pressure is 1013.25 mb or hpa at 15ºC. A Bar is the standard atmospheric pressure represented by the height of a column of mercury in a mercury barometer.

Back-turns: anti-clockwise.

Barometer-(Aneroid): in terms of this course is an instrument for measuring the pressure of the air, due to the weight of the column of air above it. Near to essential on a voyaging vessel.

Bathymetry: Study of undersea floors or surfaces

Buys-Ballots: Law-In the Southern Hemisphere-Face the wind and low pressure will be in the direction of your outstretched left arm. In the Northern Hemisphere, with your back against the wind, low pressure is in the direction of your outstretched left arm.

Climate: is the probable weather features for a selected location or area over an extended time frame. Usually an average of records historically collected. Climate is what you expect; weather is what you get.

Coriolis force: is a scientific construct so that Newtonian Physics can be applied for problem solving and concept. There is no such force. It is a matter of spatial frame of reference ie viewed in space cf the spherical surface of the globular earth to which we commonly relate.

Equilibrium: A condition whereby all forces acting on an object are equal and opposite (in balance).

Fetch: The length of water over which wind can blow without obstruction.

Gust: A sudden and brief increase in wind speed.

High Pressure Systems: In the southern hemisphere, winds rotate anti-clockwise and outwards crossing it's isobars at about 15^{O}. In the northern hemisphere rotation is clockwise.

Inertia: the property of something to remain at rest or in uniform motion unless acted on by a force.

Isobar: a line joining places with the same atmospheric pressure.

Isotach: a line (usually dashed) joining places with the same wind strength.

Low Pressure Systems: In the southern hemisphere, winds rotate clockwise and inwards crossing it's isobars at about 15^{O}. In the northern hemisphere rotation is anti-clockwise

Momentum: the energy within a body due to it's motion..

MSLP: Mean Surface Level Pressure

Orography: The study of mountains, Orographic,-pertaining to mountains. or for our purposes mountains and hills in the topography of adjacent land.

Parcel: The concept of a small and self-contained volume of air which responds to meteorological processes as a single entity.

Pressure, Volume, Temperature relationship-is a constant, which means if one is altered, one or the other will change also. Of importance in understanding aspects in this course.

Consider the pressure volume temperature relationship with a change in pressure whereby a bicycle pump is used. Using the pump is to decrease the volume within in order to increase the pressure into a tyre. As a consequence the end of the pump is noticed to heat-up. An LPG cylinder or a pressure pack (eg Hair spray) contains gas under pressure. If the valve is opened the gas escapes into air at lower pressure. At lower pressure the gas expands to greater volume with a corresponding drop in temperature, so much so that ice can form or the can feels cold. As the air in a hot air balloon is heated, it expands, but the volume does not change. Thus some air is expelled and less air is captured within (lower density), ie. The balloon becomes lighter and 'floats' in the denser (colder) surrounding air. An aircraft or balloon ascending to some elevation has less air on top of it, thus the pressure is less. As a consequence the temperature decreases. The relationship is complicated by the presence of water vapour but a 2ºC drop in temperature per 1000 feet elevation is a general rule . You may have noticed as a jet passenger the outside is about -57ºC at 36,000 ft.

Prognosis: Expected future development.

Relative Humidity: the actual amount of water vapour compared as a percentage to the maximum that air can hold dissolved at that temperature. At 100% relative humidity it is termed saturated. If temperature is increased, relative humidity (RH) will decrease as the air can hold more vapour, and if temperature is decreased the RH will increase. Thus if an air parcel ascends to sufficient height with lower pressure (a shorter stack of air weight above it) the temperature may decrease such that saturation occurs and condensation will occur as cloud. The atmosphere can hold up to 5% water as a maxima but at very high altitudes can exist in a super-saturated condition..

Squall: A sudden onset of strong winds with speeds increasing by at least 16 knots and sustained at 22 or more knots for at least 1 minute. The intensity is longer than that of a gust.

Swell: Waves generated elsewhere that have travelled out of their generating area.

Tidal Gate: An area of strong tidal currents such that one yacht may get a following current and another may encounter an opposing current (the gate closed).

UTC: Universal Time Co-ordinate also sometimes referred to as Greenwich Mean Time or Zulu. The longitude meridian of zero passes through Greenwich in England. There are offsets denoting times at other locations. Eg Australian Eastern Standard Time is UTC + 10 hrs.

Vectors: are a graphical representation and unit measurement of some value such as knots, wind speed, force etc. They usually indicate direction as well as magnitude. They are commonly used in weather applications and can have many forms. Weather charts are a good example as wind strength may be represented by arrow size with longer equals more, or colour boundaries, or flying particles for direction and density of particles to represent intensity.

Veer: turns clockwise.

Waves: created by the direct action of local wind over water.

Wind: generally speaking, the transfer of air horizontally from high to lower pressure. A number of factors are involved such that the air does not move directly but follows a path determined by gradient pressure, coriolis force, friction and latitude.(More detail or usage rules developed later as subjects in the learning course).

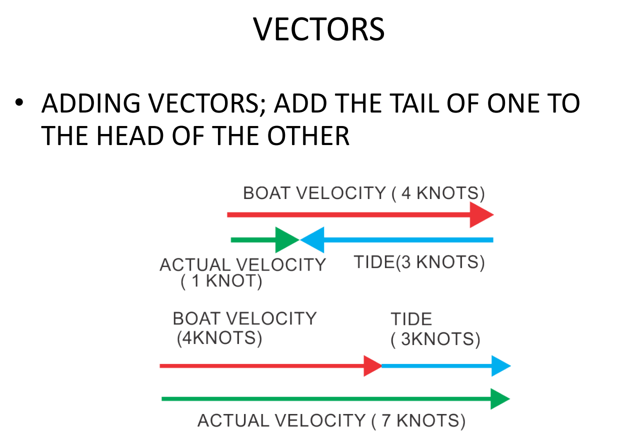
Terminology

Barometer: The aneroid barometer is a relatively inexpensive instrument for measuring air pressure. It's main purpose is not only measuring whether pressure is high or low but also the rate of change of pressure. The change rate either higher or lower indicates wind speed and the moving 3 hour movement the magnitude of the forthcoming wind irrespective of whether the instrument is correctly calibrated or not. Again, most useful is the rate of change of pressure. Generally low pressure indicates cloudy, wet weather and high pressure generally fair weather. Often taken as as low is < 1010 mb (hpa) and high is > 1010 mb. World standard mean pressure is 1013 mb at 20 deg C In America inches of mercury may be used. Calibration ports with current readings are available listed in the Bureau of Meteorology web site. If unable to present the barometer to such a location, consult the time closest weather map for approximate difference to your location. See also the later explanations of lows and highs.

Seasons: This section illustrates the annual orbit of the earth around the sun and how the tilted axis of the earth is responsible for the differing angle of incidence of solar radiation received at places of various latitudes with corresponding daylengths. Global weather is from a heat distribution mechanism as the maximum radiation of the tropic regions transfers heat to the colder polar regions of minimum radiation or nil at winter. HEAT SEEKS COLD. More in global systems.

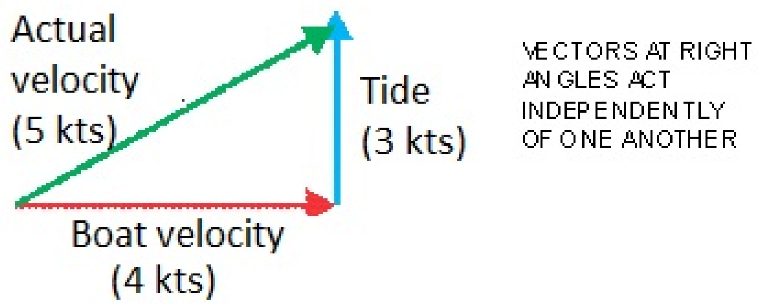
Vectors

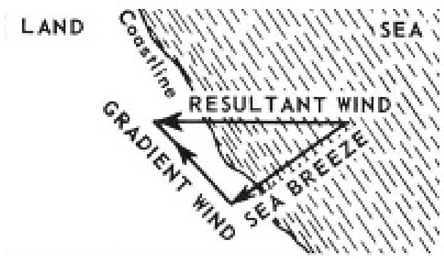
Vectors in one form or another are widely used in weather communications but may not be recognised as such. Visual TV and internet charts can use vector arrows, colours, & particle density animations for readily understood information displays. Vectors can be used as a graphical representation of directional and unit measurement of some value such as knots of wind, boat speed, time or distance and are often used by engineers and physics practitioners. The main purpose of illustrating their application in this course is that they give a means to visualise how components can interact with each other, the resultant, and that you may recognise what they are when encountered. They can be used in a precise application for an exact calculated result eg to get from A to B when a cross tide is flowing, what course to steer when the boat travels at 6 kts and the cross tide is say 2 kts. Time gone by a navigator would sit with a chart and navigation tools to lay it all out on the chart drawn and measured by vectors. More likely now you put in a waypoint, and steer to check the GPS course made good value matches. (the same calculation is done for you). The main purpose here is that you may recognise what they are when encountered.



Types of Physical Quantities

EXAMPLES OF ADDING VECTORS





Scalars: Only require a number to define their magnitude

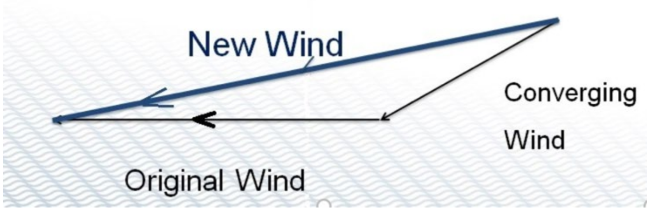
Examples: Distance, Speed, Temperature, Relative Humidity, Cloud- Cover

Vectors: Require a direction as well as a number to define them.

Examples: Velocity, Acceleration, Force, Fricton

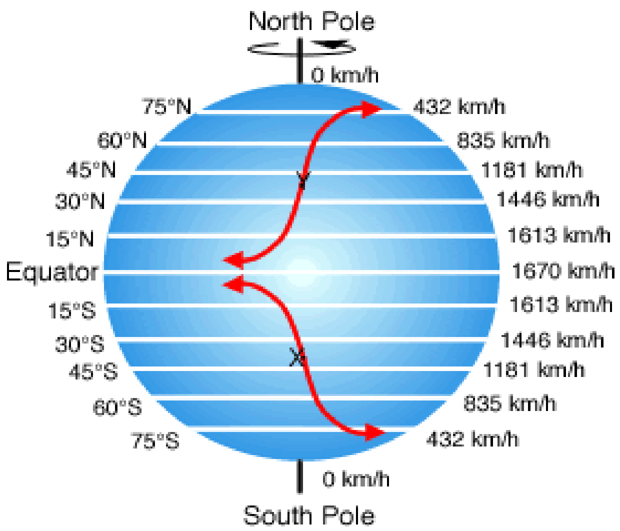
Convergence

Length of Vector = Wind Strength
Direction of Vector = Wind Direction
New Wind Vector = Strength and Direction



Coriolis and friction

The confusing concept of Coriolis force arises because we are used to and think in terms of a horizontal surface much like a flat plan whereas with weather we are looking at the atmosphere boundary layer on the global surface. As the global earth spins on it's north/south axis, any place on the surface moves one revolution each 24 hours. The distance a place travels within a revolution depends on the circumference at that latitude. The maximum circumference is at the equator and the minimum at each of the poles. In the example of Melbourne, the closer you move towards the equator the faster you are moving through space to a maximum of 903 knots at the equator. In the example of a plane setting off from Melbourne (approx. latitude 38°) towards Sydney (approx. 34° lat) for a flight time of 1 hour, Sydney will have rotated an extra distance of 37 km to the west than has Melbourne due to the larger circumference at the Sydney latitude (closer to the equator).The pilot must allow for this in his navigation by setting a course 37 km right in advance. Importantly if the plane took an extra hour (2 hrs total) to get to Sydney, it would now have to allow another 37 km extra further to the right. In other words, slow the plane and it must shift to the right. Replace the plane with wind-Slow the wind and it will change direction to the right in the southern hemisphere- (to the left in the Northern hemisphere). Friction of the air on the surface has that effect. Between latitude 5° S and 5° N the change in earth's circumference is very slight and coriolis is practically negligible. Thus tropical revolving storms do not occur in these latitudes as insufficient Coriolis exists to start the spin-up.



The friction or boundary layer of the atmosphere is generally taken to be up to 2,000-3,000 ft. (600-900m) depending on degree of stability and surface roughness. The surface wind over land may be one third to a half that aloft and over sea perhaps two thirds. Coriolis force has the effect of turning slowed wind clockwise in the southern hemisphere and anti-clockwise in the northern. Of much confusion is the frame of reference used. Many texts refer to where the wind is coming from and state the wind shifts left when slowed whereas if one looks at a vector or wind arrow, the arrow head shifts to the right. Either way in the southern hemisphere it turns clockwise or 'veers'. (Anti-clockwise is termed 'backs'). If one asks the question in the past tense "what happened to the wind direction at some place?, where it came from moved left" . For a mariner and sailor especially, a more appropriate question is" what will the wind be if I go there? Or what will the wind be when I get there? This course deals with the latter questions.

Weather Systems-Highs and Lows

The Australian Weather Bureau uses a wide range of weather information from their observations network to prepare a weather map. This includes observations from over 700 automated weather stations across Australia, Antarctica and offshore islands. They also use information provided by ships equipped with weather stations, and meteorological drifting buoys. Every day at over 30 locations they collect information on the upper atmosphere using an instrument attached to a weather balloon. International satellites supply information that helps us monitor various weather elements such as the upper air winds or temperature and moisture profiles of the atmosphere.

In a basic low pressure system, wind circulates in a clockwise direction and crosses isobars inwards at about 15^{O}. Broadly, the air in the system is also ascending into the upper atmosphere and in the SH mid-latitudes the weather systems move from West to East very roughly at about 25 kts such that a system at Perth may arrive at Melbourne 4 days later. The low system resembles a whirlpool draining into a funnel of lowest pressure with air spiralling inwards (visualise as a whirlpool upside down), but all ascending. In the southern part of Australia the air drawn into the western flank comes from the deep south and somewhat polar vicinity. Brrrrrr! On the eastern flank the air drawn into the system is a northerly from warm central Australia. The cold and the warm air masses spiral in towards the centre. Somewhat surprisingly, air masses of different temperature, density, humidity etc do not readily mix and therefore face-off at each other. The colder moist air from the maritime south is more dense and pushes against and under the warmer air as a COLD FRONT. The warmer air is 'wedged' upwards. The spiralling inwards air-flows 'concentrate' differences. The symbol for a cold front consists of a line with black triangles facing the direction of flow. If the system is not circular, the distortion may have a 'trough' designated by a hatched line and could be imagined as a 'valley' extending from the low centre.

If directly in the path of an approaching low with a barometer, an observer would see the pressure dropping steadily until the low centre passed whereupon the pressure would begin to rise and the wind dramatically change direction and be cold. The actual front would most likely contain thunderstorms, rain and squalls. The wind generated by the system is directly indicated by the spacing between and at right angles to the isobars, the closer the isobars are on a map or the greater the rate of change of pressure, the stronger will be the wind whether the barometer is rising or falling. Calculating the wind strength is possible but complicated and un-necessary given one can get it all on the internet or a radio forecast with a fairly good degree of accuracy. If one was observing the barometer but not directly in the path of the low centre, use Buys-Ballots Law to find the direction of the low centre and determine as well as possible what the pressure drop towards the centre might be.

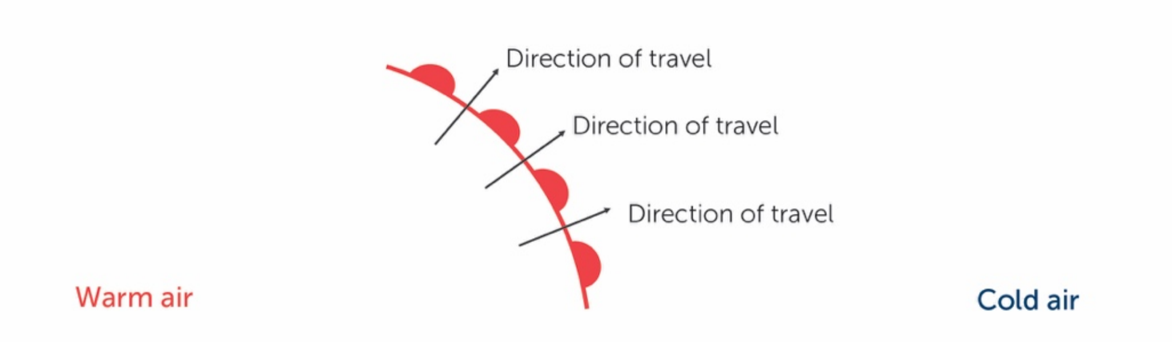
The HIGH PRESSURE SYSTEM in contrast rotates anti-clockwise in the SH and clockwise in the NH and is a descending air process spreading out upon reaching the surface crossing isobars outwards and anti-clockwise about 15^{O}. Whereas a low concentrates different air masses, the high 'evens out' with a more gentle process. The same west to east movement of the system exists and a distortion of the system shape often has a 'ridge' which may be thought of as a mountain range extending out from a mountain (the centre). Maps with a sharp isobar 'nose' at the end of a ridge often are windier areas than isobar spacing would suggest. As air in a high descends, the pressure increases and therefore warms-'increase the pressure and temperature also increases'. As the temperature increases the relative humidity decreases and any moisture present is absorbed. " The warmer air can hold more moisture' and clouds dissolve. High pressure systems therefore are likely to have clear skies and be milder weather. In contrast the low pressure system ascending air has pressure reduced (less air-weight) on top of it. 'Decrease pressure and temperature will also decrease'-Decrease temperature and relative humidity increases', and if saturation occurs the excess moisture will condense as cloud and with further cooling become rain. Thus low pressure systems commonly have overcast skies and probable rain.

Warm front

On the weather map warm fronts appear as a red line with semi-circles (originally chosen because they look like a sun rising bringing warmth). Warm fronts progressively displace cool air with warmer air. Just like a cold front, the temperature change can be quite large once a warm front moves through, although it tends to happen more gradually than a cold front.

Warm fronts appear less frequently than cold fronts over Australia but are more common in the Northern hemisphere particularly due to larger land masses. Even though they bring warmer air, this doesn't necessarily mean better weather. They can bring steady rainfall, grey skies and more humid conditions.

If a cold front catches up with a slower-moving warm front, they may form an 'occluded front'. The mix of cold and warm air associated with an occluded front typically brings rainfall.



Troughs

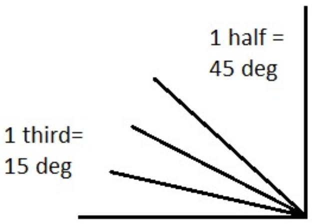
A trough appears on the weather map as a dashed blue line on the chart. It is an elongated area where atmospheric pressure is low relative to its immediate surroundings. Like cold fronts, troughs separate two different air masses (usually more moist air on one side and drier air on the other).

As the trough moves towards the moist air it lifts it. This causes cloud or even showers and thunderstorms to develop. If the trough moves back in the other direction it will drag the moist air with it. In the Australian summer the centre heat causes air expansion and the rising air of low pressure forms heat troughs. These heat troughs can be ‘rivers of tropical moisture’.

Watch for the monsoon trough which shifts over northern Australia each year. It draws in moist air from the surrounding oceans and this influx of moist air is referred to as the monsoon. The monsoon is associated with cloudy conditions, lengthy periods of heavy rain, occasional thunderstorms and squally winds.

To estimate wind direction on a weather map

Place a dot on an isobar at the chosen location on a weather chart. Determine whether the system is a high or a low. If unsure, find some values of pressure on isobars decreasing or increasing and follow the isobars along to your location and determine high or low features. Remember low rotates clockwise and high anti-clockwise SH. (Southern Hemisphere). Draw an arrow in the direction of rotation crossing about 15° over the point made on the isobar and to the right (this will be outwards for a high and inwards for a low). In the NH in the direction of rotation and crossing to the left. To help estimating 15° the procedure as in the diagram should help. Start with a right angle (90°) and divide it in half = 45° each side. Divide the lower half into three and each wedge is then 15°. It is not necessary to be precise as the purpose of finding wind direction on your weather map is to be cognisant of expected conditions. *Weather maps are produced to a world standard and can therefore be used as a guide in any country language notwithstanding.*



Global Systems

Maximum solar energy delivered to the equatorial region at an angle of incidence of 90° or directly onto the surface causes the atmosphere to heat and expand with lower density. This lighter air ascends (and ascending air =low pressure system) as we have explained previously. The area is known as the equatorial low pressure belt. The higher density air adjacent flows into this area and is known as the trade wind belts. Coriolis bends the trade winds from southerly flows to become the southern hemisphere SE Trades and the reciprocal NE trades. Colder upper atmosphere air falls downwards to replace air in the trades and descending air we know becomes a high pressure system. The rising air from the equatorial low cools aloft and setsup a circulation towards the descending air of the highs.

Thus there is a circulation of rising air from the equatorial region cooling aloft and moving to become the descending air of the highs in turn flowing as the trades to the equatorial low,

For those of us in the mid-latitude regions the high pressure systems are known as the 'Band of highs', 'Sub tropical ridge' and 'Horse latitudes' centred on 30^{O} latitude depending on the season. In Summer the band of highs are centred near lat 40^{O} and in winter nearer 35^{O}latitude.

The polar regions have colder, denser air which sinks to be the 'Polar High' and the reatively warmer ocean becomes an area of low pressure relatively with predominantly westerly air flow. In winter our region is (at least by weather) in the 'Roaring Forties'. Having awareness of these systems is very important to those of us who plan for longer voyages.

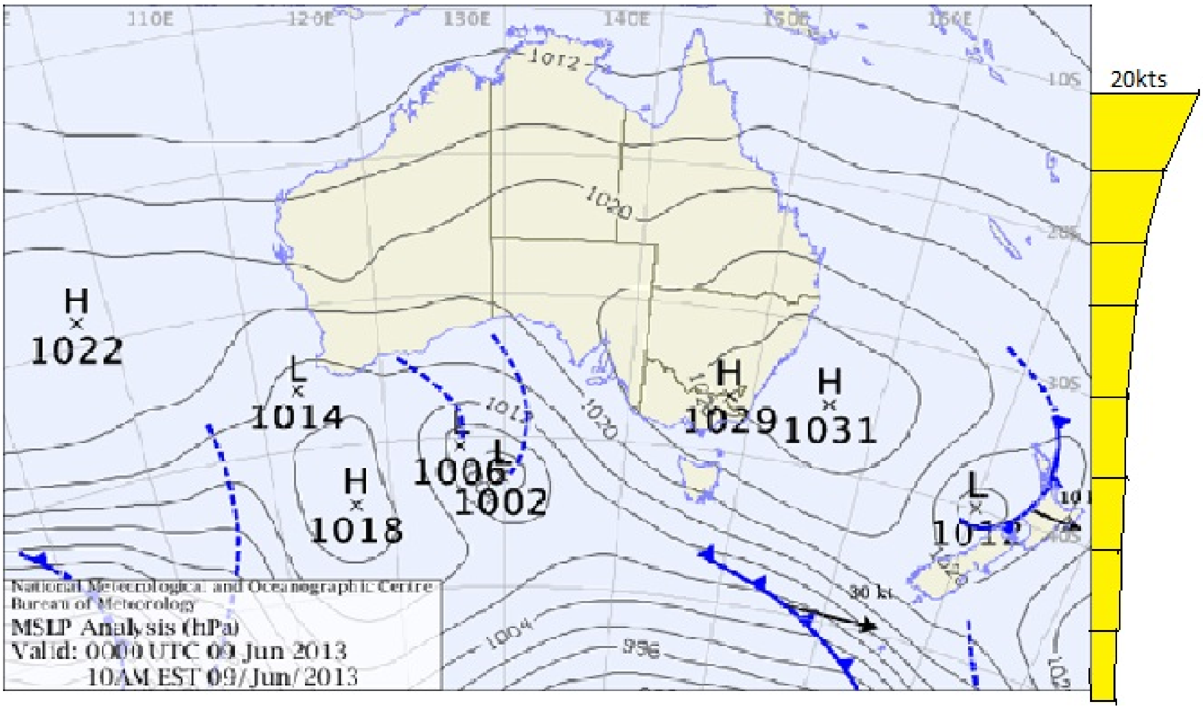
Weather Forecasting

Data collected by the weather Bureaus from before mentioned inputs and more recently special satellites, is fed into the best computer they can obtain because the more powerful, the more resolution (the detailed data grid) and the better output. Standard Bureau response for better forecasts is 'give me more data collection and computer power and no problem'. Expenditure and budgets are determined by importance and need. Therefore data is concentrated from high density population areas usually. This is worth remembering for those mariners in remote regions. Basically the forecasts are made from enormously complex fluid flow programs and then 'tweaked' by experienced meteorologists according to any known aberrations. The modelling and computer power required to run it is limited to just a few nations and other agencies 'tack on' their particular interests to the main models. These main models are the 'European community (Ecmf) the American 'GFS', Japan JMA, UK Meteo from which the Australian 'Access' model is derived and some others. There are many other models from various countries each with their own focus. By it's constitution, the American NOAA (GFS=global forecast system) must be free and therefore is picked up by many special interest providers for their subscribers. As an example the Swiss nation has a very mountainous region and applies a special routine amending the input of it's topography for it's forecasts. All modelling is very sensitive to initial starting data input to produce forecasts as very small errors can escalate to give erratic outputs. One technique to counter this is named 'Ensemble' where varied starting conditions are input and modelled conjointly to obtain several results for consideration. An initial modelled output is the 'Analysis', but by the time this is published is usually some 3 hrs old. The calculated and tweaked forecast is termed a 'prognosis' meaning 'looking ahead' and is published accordingly by the bureau, TV and radio stations and maritime agencies.

An example useful technique is to examine the popular 4 day forecast map and compare the current prognosis with the forecast from the day before, ie day 2 from yesterday should be the same as day 1 today. Similarly day 4 from a 4 days previous map should be the same as today. Any differences are a measure of confidence. For the mariner, it can be wise to determine a level of confidence by comparing different models. By experience, and at sea, one's own observations especially including a ship barometer and the Mk 1 eyeball. *Sailors need always to consider that forecasts are dependent on data density, model selection, interpolation and local effects. A forecast should be viewed as background information*

Isobar spacing, latitude and wind.

When observing isobar spacing on a weather chart, the spacing for different latitudes must needs be confined to a smallish latitude range. Due to the earth's shape it happens that spacing in the tropics is very much larger for a given wind strength than at higher latitudes. That is to say that pressure differences are fairly small for a given wind strength cf high latitudes. So much so that weather maps are almost unusable from about 10° latitude up to the equator. Another map named the Gradient Wind Analysis is produced to cater for these regions. (More in later modules). To be useful, weather map isobar spacing as an indication of wind is best restricted to a latitude range of, say, 10°. This is sufficient for most outlook purposes considering the west to East movement of systems. In the map shown with a sidebar diagram, the sidebar width corresponds to the perpendicular width between isobars in the adjacent latitude for a 20kt wind. If you compare the sidebar width 10° lat and say 40° lat it should explain, If a spacing is double, the adjacent sidebar, half the 20kt. If spacing is half the sidebar double the 20 kts.



Published weather information & internet

The importance and usefulness of weather information to the community justifies huge expenditure by Governments and output products are very varied in many forms. Like all sciences in the current information age, advances are ongoing and ever changing. Mostly all for the good. There is nothing as constant as change! The products outlined in this course are mostly from the Australian Weather Bureau as are specialised for Australia and found to be of good accuracy. However other providers are not without merit and popular with sailors world-wide is Predict Wind and for coastal and ocean voyages-Expedition (more in our modules 2 & 3. Windy.com is also useful, free and it's extensive menu is well worth exploring. The information presented by any of these providers is approached differently and takes time to be familiar with but with practice becomes much the same. In general a routine approach might be to use animation or steps to examine how large scale weather is expected to advance to get a 'feel' for expectation, Then zero in for a closer look particularly at the region of interest and finally at the detail area of interest. Example-Australia overall to Victoria state to Port Phillip Bay to a suburb and local club. A similar approach for offshore. A difference with the Meteye system is that it is built up from small area local forecasts rather than expanded from a large model output and is useful therefore for a detail location. The Australian government seems to have a preference for a more universal system approach using kilometres/hour for wind speed is land based but for marine use accepts knots is mostly utilised. The two systems are presented but need to be checked when viewed as to having not changed during use.

Being Weather Wise

The big picture is easily available and widely reported and the detail presented ever better. It is impractical to have actual forecasts specifically for an afternoon marine outing. Port Phillip Bay for example is 745 mls², and about half shallower than 26ft or 8m. A cold front from the western quadrant arrives in about 4-6hrs from one side to another and temperature can drop 10-15^{O} in 20 mins. Typically winds move from a strong Northerly to NW. Perhaps but not necessarily a lighter breeze then a strong South West with the front accompanied with rain and thunderstorms. There is not anything precise officially in the time scale of these events and as mariners are particularly interested in the immediate 2 miles vicinity around them, the Mk 1 eyeball is invaluable. In these circumstances a barometer will fall until about 20 mins before the change. In lake waters which often are surrounded by hills and vegetation, the situation is even more pronounced as winds funnel through and around the landscape. There are three particular winds which can make dangerous seas in the enclosed waters of the bay, the shallow depth and restricted fetch makes for generally choppy conditions. North @26 nmiles, North-West @21.5 nmiles , and South-West winds @23 nmiles have the greatest amount of fetch and can produce seas up to 2.5m in 30-40 kts, only rarely are seas to 3 m observed, there is not enough depth for larger. A particular hazard is at the entrance to Port Phillip from Bass Strait which is only 2.5 miles wide with a restricted depth and forms a barrier to tidal flows which at peak can be up to 7-8 kts. Particularly with ebb tide against the prevailing SW sea or swell, very dangerous conditions exist and persist up to3.5 miles out into Bass Strait. Exit in small craft is only possible in fair conditions at slack water as published in the tide tables (which is not High or Low water). This tricky entrance (known as the Rip) has an infamous history but nowadays is also well signposted with navigation markers. The Ocean Racing Club of Victoria conducts regular instructional waterborne tours for familiarisation.

Squalls, Updrafts & Thunderstorms

Thunderstorms are initiated by some form of lifting mechanism. An advancing cold front wedging under warmer air, a cumulus cloud rising in a strong thermal updraft or orographic lifting from a mountain or similar are examples. As the air is forced upwards and cools, water vapour turns to liquid and releases latent heat energy providing further lifting. Under strong updrafts the water droplets are carried higher turning to ice and release more latent heat fueling even stronger updrafts. Development requires near vertical structure to maintain updraft whereas strong wind aloft blowing sideways destroys the lifting process.. Eventually the system reaches the upper level of the troposphere where the temperature inversion layer prevents further cooling. The top then spreads sideways into the classic anvil shape. Updrafts can be strong enough to carry and hold ice pieces which aggregate until gravity overcomes the lifting and it falls as hail dragging cold air and rain with it. The downdraft resulting spreads out like an inverted mushroom as it reaches the ground and the horizontal motion of the storm combines with the forward edge of the downdraft to become the gust front.

Shelf clouds and roll clouds are usually seen above the leading edge of a squall, also known as a thunderstorm's gust front. From the time these low cloud features appear in the sky, one can expect a sudden increase in the wind in less than 15 minutes.

The leading area of a squall line is composed primarily of multiple updrafts, or singular regions of an updraft, rising from ground level to the highest extensions of the troposhere, condensing water and building a dark, ominous cloud to one with a noticeable overshooting top and anvil (thanks to synoptic scale winds). Because of the chaotic nature of updrafts and downdrafts, pressure perturbations are important. As thunderstorms fill into a distinct line, strong leading-edge updrafts - occasionally visible to a ground observer in the form of a shelf cloud- may appear as an ominous sign of potential severe weather.

Beyond the strong winds because of updraft/downdraft behavior, heavy rain (and hail) is another sign of a squall line. In the winter, squall lines can occur, albeit less frequently – often bringing thunder and lightning.

On Port Phillip with a summer thunderstorm the dangers are the gust front, a strong blast of wind, and the downdraft of possible hail and very heavy rain. There can be a circular effect with wind around the clock, rain and little visibility such that keeping view of the compass is required to prevent disorientation. The rain flattens the sea but the wind can comes from every which way until the system passes in perhaps a half hour. Thunderstorms follow heat (assists thermal uplift) such that they usually pass around the top of the bay, Altona-to the City-(with heat island effect=+4-6^{o}) and on to the Dandenongs mountainous region to the east of the bay, or else jump across the bay from Bellarine to Mornington (the shortest distance from hot land to hot land. The Bureau has systems in place for thunderstorm warnings to be issued but they usually only get 2-3 hours' notice as to where.

Lightning

There have been lightning strikes experienced on the bay and the following precautions apply

Firstly the vessel should have radios and electronic items well earthed and mast/rigging well grounded -but using electrical items is best avoided.

Swimming or being in a dinghy or small vessel is best avoided.

Holding metal rods or fishing can be a risk.

Do not stand on an exposed deck.

Move away from any electrical noise or sensation.

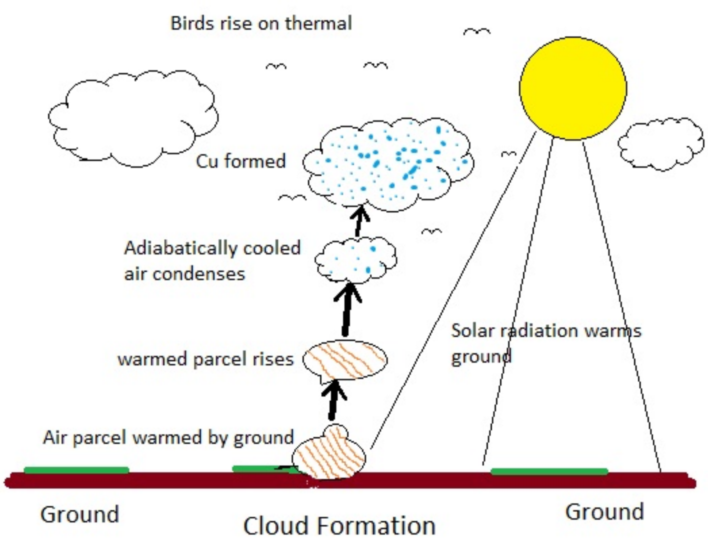
Avoid holding items such as a steering wheel with two hands. If a strike should occur the danger is current passing from one arm across the chest to the other and through the heart.

There are dissipaters available which can be fitted to mast-tops but not commonly seen in southern waters as distinct from eg Darwin where strikes to yachts are relatively common.

Clouds, Signs in the Sky

The simplest cloud formation requires some form of lifting-in this diagram thermal. Other means are orographic whereby air flows up the side of hills or mountains, air mass interaction such as a front or air turbulence.

Physical categories of clouds



Clouds are commonly grouped into physical categories that can be up to five in number: cirriform, cumuliform, cumulonimbiform, stratocumuliform, and stratiform. These designations distinguish a cloud's physical structure and process of formation.

What to look for with clouds.

- Stability indicates local expectations of weather parameters.
- The base indicates the condensation level
- A flat top indicates an inversion layer or stability aloft
- Cumulus indicates instability and associated weather parameters.
- Sloping cumulus is an indication of wind aloft
- Lenticular cloud indicates stability and/or wave form

* Cumulonimbus heralds thunderstorms and possibly lightning
* Darkened water and white crests with a background of dark menacing cloud with possibly ragged *fractus* (broken) indicating a front.

Some meanings of terminology Cumulus=heaped, stratus=sheet or layer, nimbus-rain bearing, cirrus=hair-like

Low Clouds-<6.5km. Have water or if cold in right areas, Snow. Stratus are grey sheets which block sunlight, often bring drizzle or light snow if cold enough. Stratocumulus do not bring precipitation, do not entirely cover sky and may be in rows.

Nimbostratus and cumulo nimbus bring rain. Cumulus- fair weather if not vertical growth-if vertical growth then showers or CuNi possible. CuNi-Anvil points in direction of movement. Rain hail lightening squalls.

Middle clouds 6.5-16 km, water and ice block sunlight. 3 fingers space between cloud cells = alto Cu. Alto stratus precedes inclement weather. When looking up at sky, if sun is visible then probably clouds are high, if they are thick then poor weather in 1 or 2 days depending on speed of movement observable. If clouds cover entire sky but some sky visible is probably alto Cu. Contrast with white and grey =rain within one half day.cf next slide. Alto cu in morning then possible thunderstorms pm.

High clouds 16-43km mainly ice crystals, and therefore white. Jet aircraft altitude. Generally do not block sunlight. Hold one finger up to match to spaces between cloud cells to determine if cirrocumulus or alto cumulus (three fingers as previous slide). Cirrus indicates fair weather or approaching front in 24-36 hrs. Streaks indicate direction of disturbance. If the cirrus can be observed moving whilst standing observing without reference to any fixed features such as poles, trees, buildings etc then the upper wind speed is 80 kts and 30-40kts ground speed can be expected very roughly a day later. Also indicates severity of an approaching front. Cirro stratus covers sky but sun is visible through cloud then indicates moist weather within 12-24 hrs. Cirro cumulus indicates fair weather in near future but in the tropics may indicate approaching Tropical storm or cyclone. Green in sky indicates sun through ice or hail. Generally high clouds blanket the earth and keep warmth in. Low clouds cool the earth.

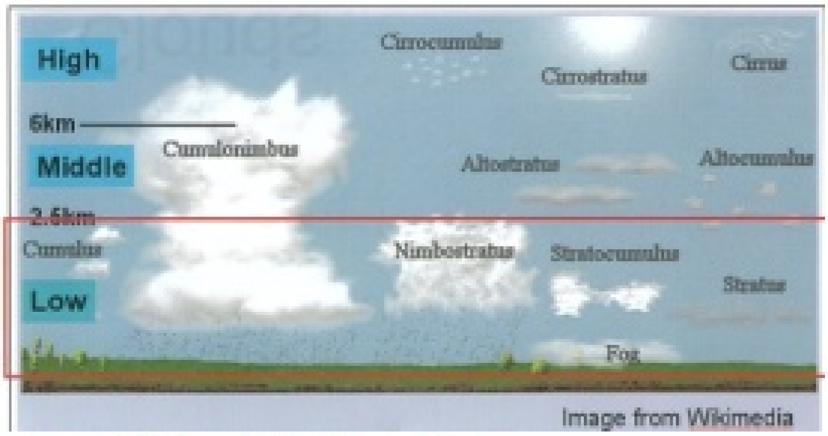
Lenticular clouds- indicate stability in the atmosphere, flow and possibly wave form. *Lenticular= lens like or form such as a magnifying glass lens and laminar flow as in smooth layers.* Sailing conditios are quite different with stable conditions.

Some low-level clouds

Lumpy	Layered	Lumpy and layered
Cumulus	Fog / stratus	Stratocumulus

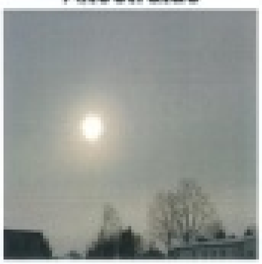


Cumulonimbus

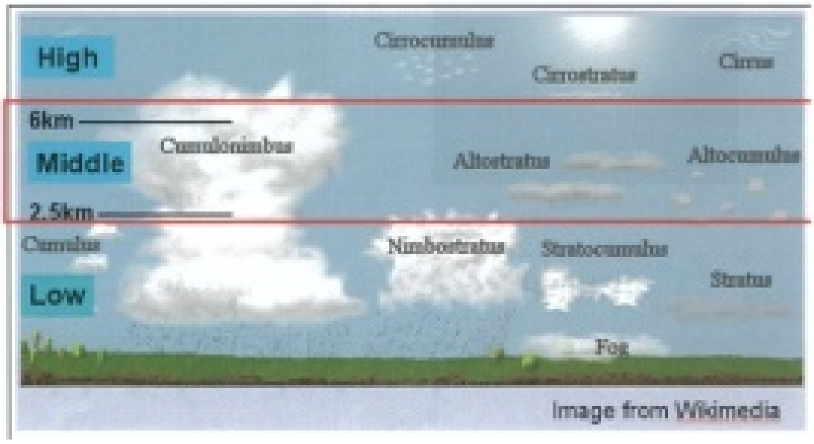



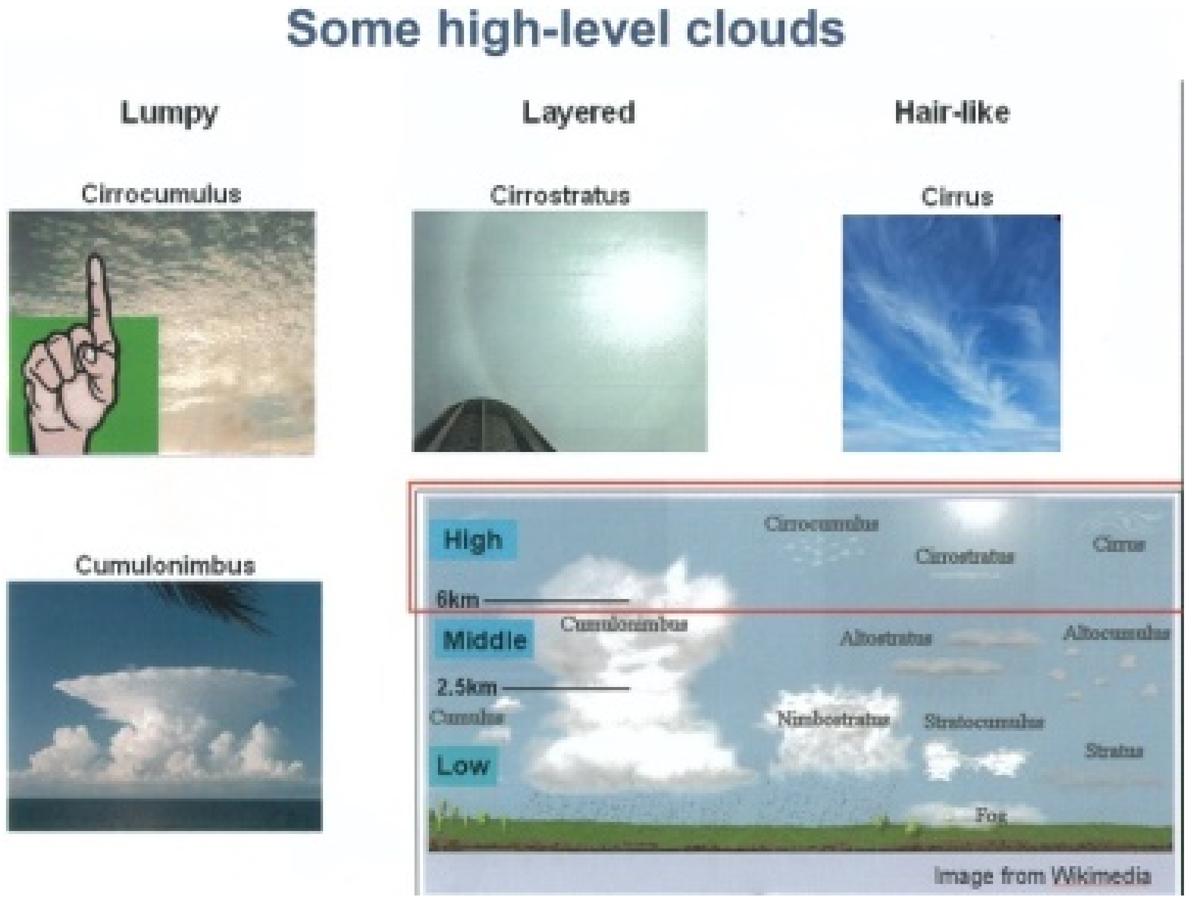
Some mid-level clouds

Lumpy	Layered	
Altocumulus	Altostratus	Altostratus


Cumulonimbus



Altocumulus clouds usually form by convection in an unstable layer aloft, which may result from the gradual lifting of air in advance of a cold front. The presence of altocumulus clouds on a warm and humid summer morning is commonly followed by thunderstorms later in the day. Not precipitation clouds but usually can signal the approach of a warm front.

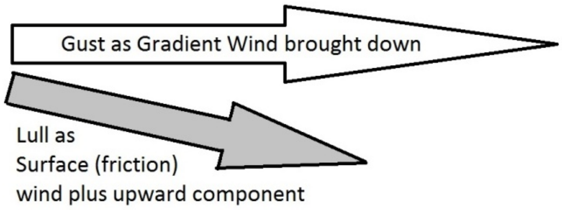
Mammatus, meaning "mammary cloud", is a cellular pattern of pouches hanging underneath the base of a cloud, typically cumulonimbus rainclouds, although they may be attached to other classes of parent clouds. The name mammatus is derived from the Latin mamma. Comprised of melting ice and usually under a thunderstorm base. For an observer on the ground, the location is difficult to ascertain due the overall size of the cloud structure.

Frame of reference

Repeated from section on Coriolis . Coriolis force has the effect of turning slowed wind clockwise in the southern hemisphere and anti-clockwise in the northern. Of much confusion is the frame of reference used. Many texts refer to where the wind is coming from and state the wind shifts left when slowed whereas if one looks at a vector or wind arrow, the arrow head shifts to the right. Either way in the southern hemisphere it turns clockwise or ‘veers’. (Anti-clockwise is termed ‘backs’). If one asks the question in the past tense “what happened to the wind direction at some place?, where it came from moved left” . For a mariner and sailor especially, a more appropriate question is” what will the wind be if I go there? Or what will the wind be when I get there? This course deals with the latter questions.

Stability and Instability

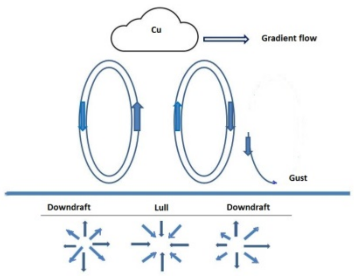
Stability and instability refer to vertical motion in the atmosphere. Warmed air expands and rises due to lower density and it's place is taken by cooler air. Stable air is often cool such as is found under the centre of a high pressure system, the downward movement putting a 'lid' on the layer. Air in contact with a cool surface also tends to acquire stable character whereas if in contact with warm or heated surface promotes mixing and instability. Observing the current situation as stable or unstable assists in determining sailing conditions. Often stable conditions exist in early morning and persist until sufficient solar heating has provided enough warming for air parcels to rise and cause turbulence. Cloud formation and type are indicators.



Gusts-Eventually, patterns of cumulus cloud appear as turbulence increases. The rising air producing the cloud has a corresponding downdraft supplying cooler air from aloft to replace it. The down draft brings gradient wind level (above the friction layer) strength and direction with it as a gust. Over sea the rising air and associated cloud often forms a pattern whereas over land the surface is too rough and variable. At night there is less heating and stability becomes more probable as the upper air mixes down less. The sea heats much slower than land and friction is generally much less such that surface air is turned about-15º while over a forest on land it may be 40º or more, even 90º in light, stable air.

A gust can appear as a darkened area on the water moving across the surface and when sailing with a spinnaker under load, it is well to have an observer call the gust progress to warn the helm and trimmers. The darkened water is due to the change in reflection but a similar process occurs with wind against current and this needs to be borne in mind. In light conditions Channels for example, can appear as having stronger wind. Some careful thinking is required with gradient wind brought down to surface. Thinking about air having weight and therefore momentum takes some getting used to. Existing surface air is friction modified for direction and is already veered or turned right (SH). Gradient wind from above the friction layer brought down has not been friction veered initially and momentum assists short term such that a gust will appear to be further left (SH) as remnant of gradient wind direction and higher speed aloft.

Gusts with Clouds



Rising thermal air cools with lower pressure and vapour condenses to form cumulus cloud moving with the gradient air stream. The rising air is replaced by descending cooler air around the thermal. Effectively there is a circulation upwards under the cloud and downwards from the cloud edges which spreads over the surface flattening as an inverted mushroom. The upwell under the cloud draws air inwards caught up in the rising thermal and to a sailboat has little horizontal component, presenting as a lull. Conversely and particularly on the downstream downdraft side, gradient wind combined with air from the flattened downdraft presents as a gust. Positioning your vessel to remain in the gust or windlull depends on your desired direction , boat characteristics & c, but ther are opportunities. As the prevailing Windstream presents also as a friction veered direction , it is possible to sail along a predominant cloud line (known as a cloud street) close hauled on port tack for some time. With wind blowing over a hot surface such as sand, dry grass or rocky plain, a thermal can form to be replaced by cooler air which in turn warms on the hotter surface to become another thermal &c. This process forms a series of clouds in a line –cloud street.

Friction

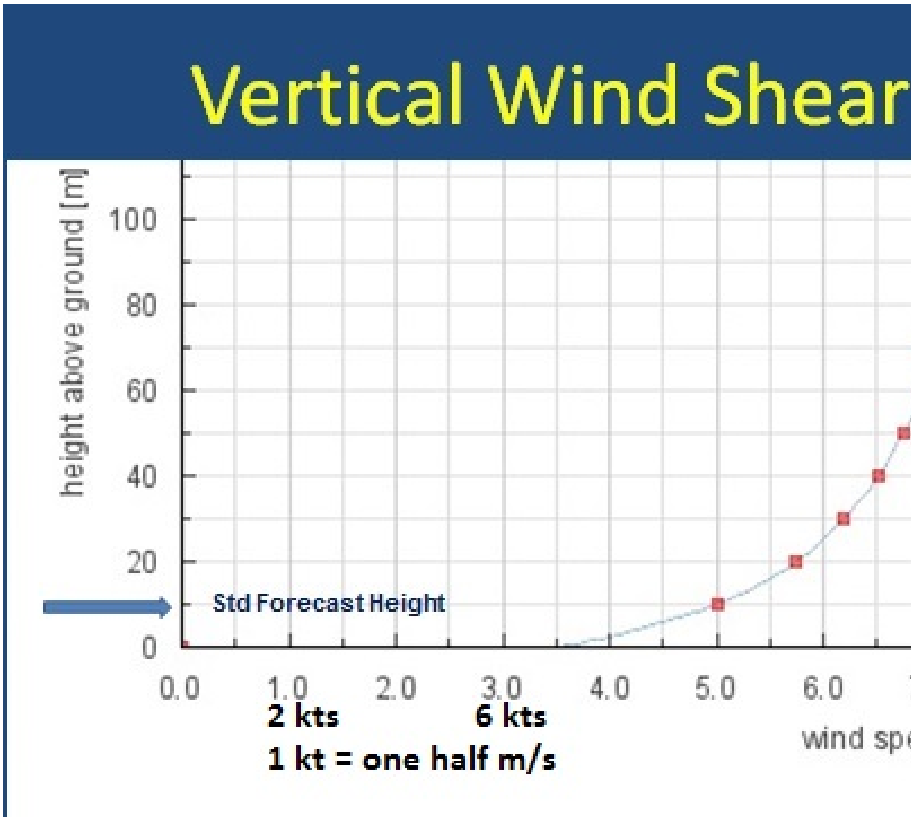
The effects of friction are far more critical in lighter wind conditions and slower speeds up to 6-7 kts because airflow is likely to be smoother and more stratified with differences between lower and higher level air speeds more pronounced. The lighter the breeze, the more critical the friction, and amount of veer. Also at lower levels surface roughness is a large factor. The veer over water is usually about 15^{O} and over land up to even 50^{O} but may be more depending on surface roughness as will be explored further later. These effects are important and although they will seem repetitive, will be re-enforced wherever possible. In stronger winds there is more turbulence and stratified air layers are more likely mixed such that surface friction is somewhat less.

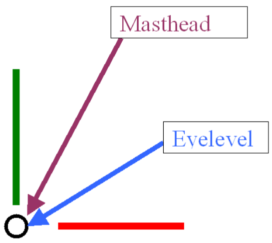
. A wind of 5 kts at 2m can increase to 10 kts at 10m whereas in unstable weather the difference is more likely 5%. With stability, increases are typically logarithmic. High wind shear-indicator is if a sailing boat is better on port tack (SH). Possible in extreme to have top of sail on opposite tack to lower sail. The explanation concerns the upper part of the sail plan driving and the lower part being drawn through no wind as friction has stopped the lower air altogether.

Hence extreme yacht sails with segments and battens as ‘booms’.

Twist

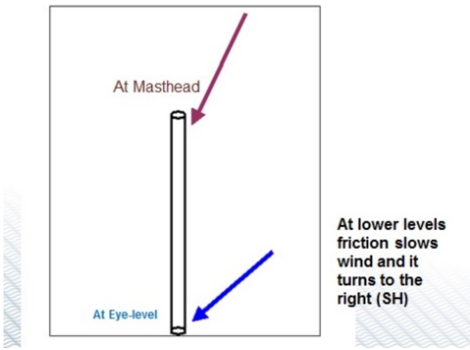
In the Southern hemisphere, increased friction at lower levels causes wind to turn clockwise. Breeze at 10m is forecasts standard level or top of mast is as forecast or measured (where instruments are located). At surface level, the wind has turned more clockwise.

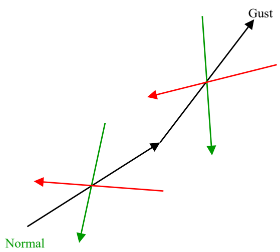




Looking vertically down on mast.

- Green-direction of starboard tack
- Red-direction of port tack
- Burgundy-wind direction mast head
- Blue –wind direction eye level.





Starboard tack-move car forward, closed head & open foot

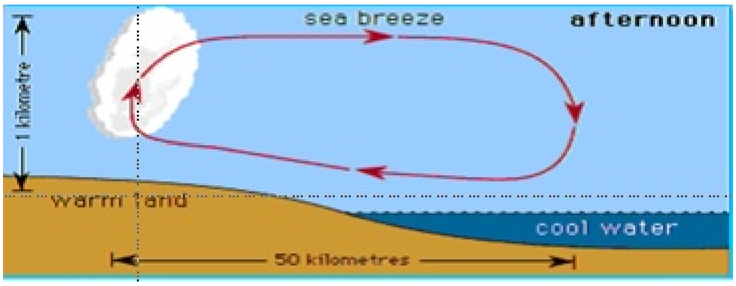
Port tack- move car aft, open head and close foot.

In gust wind moves anti-clockwise about 5%. Port tack lifts, starboard tack knocks.

*Exception f*or large sail and heavier yachts which do not tack readily and do not accelerate quickly, it is likely to be better for the helm to maintain speed and follow sail setting and wind as a tack consumes more time than a 5º short lift can provide.

Sea breezes, Local & Ocean

The sea breeze effect consists primarily of water's capacity to warm or cool only very slowly and that of land relatively quickly. It takes much solar energy and time to accumulate enough heat to be noticeable and similarly only loses heat very slowly. This factor also has a considerable bearing on different characteristics of maritime and continental climates. Thus the spring ocean temperature of Bass Strait and the Australian southern coast remains cold from winter cooling whilst the land warms with increasing solar radiation fairly rapidly. In autumn as the land is cooling from less radiation the sea is still holding it's summer store of heat only slowly cooling to a month after the winter solstice. For forecasters the spring period is their most difficult time. Thus land and sea temperature differences are larger in spring-summer and smaller in autumn –winter. The strength of a sea breeze depends on the differential temperature between land and sea. Around the shores of a bay or lake as land begins to heat, the insulating properties of land enable, say, the surface 100 mm to increase temperature compared to the water where mixing distributes heat throughout the water mass and temperature change is negligible short term. Air over the warming land expands as it gains heat and begins to rise. Denser air over the water begins to move to the lower pressure rising air over land while air from aloft descends to replace the air moving to the shore. This sets up a vertically shallow circulation with a breeze crossing the shore perpendicular to it. This not a strictly correct explanation but serves to illustrate the construction. An offshore breeze to assist the upper air flow out to sea aids formation.



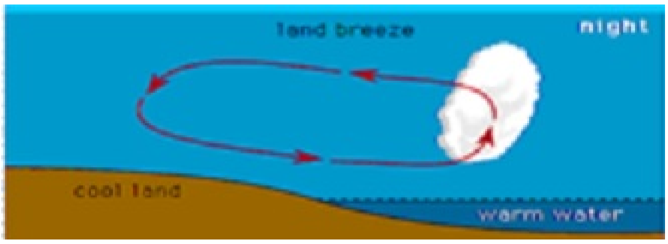
Around Port Phillip Bay, the City of Melbourne like most cities around the world has a human activity 'heat Island' effect and housing development in the west and north west warms rapidly and skews the local sea breeze somewhat. A local or lake sea breeze has an 'around the shoreline construction with light breezes mostly 4-7 knots and is more common in autumn or early winter with mild temperatures and relatively warm waters. The rising air around the shore forms a characteristic cloud shape pattern which is a guide to sailing conditions. The cloud forming over land moves with the offshore upper circulation out to sea. Where the circulation has descending air over the water is evident as the descending and warming air dissolves cloud moisture which then presents a clear window in the sky to be known as 'the sink'. There is practically no wind under the sink. In Autumn-winter there is insufficient solar radiation to maintain land temperatures beyond about 3.30 pm and the local sea breeze dies with a period of calm before the gradient wind returns.

The summer sea breeze is common around the Australian coasts and at its best starts about 11 am in Melbourne as a local sea breeze rapidly becoming an ocean sea breeze from the shoreline of Bass Strait and blowing mostly at right angle to the coast generally. It changes from a short-lived local sea breeze to then rapidly move from a south west to south to south-easterly up to 23kts before dying slowly from about 5pm and decaying shifting further to the east. When an ocean sea breeze commences the lifting air is close to the coast and a period of an hour or so has a relative calm until the circulation establishes. The ocean sea breeze circulation establishes with two fronts, land based with it's front moving inland and a seawards front moving further offshore as the 'sink'. As the heat of the day begins to fade, these two fronts recede back towards shore.

The basic mechanism is responsible for larger scale formations not covered in this course but worth noting.- monsoons, walker pacific circulations

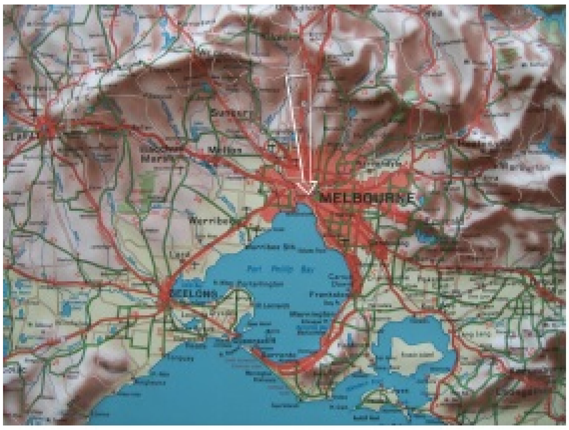
The land breeze

As night progresses, the land cools rapidly from radiation compared to lake or inlet/bay. By about 1am land has cooled sufficiently such that the water is relatively warmer and cool air



above it gains relative heat and begins to rise with cooler air off the land moving in to replace the rising air. A calm will precede the process. The land breeze is essentially a shallow system due to the cold and dense air off the land. It begins a mile or less off the shore and then proceeds with a front moving out to sea but in Port Phillip not usually more than 2 miles and decaying by about 9 am. The requirements for formation are a warm day, clear skies and light winds. First signs are a smell of land, smoke and clear sounds. Cold dense air moving seawards conducts sound much better so the sailors rule is "go in until you hear the dogs barking" just be sure of your navigation, it will be night. Surface land roughness is a factor such as large trees or city skyscrapers inhibit light breeze flow.

Katabatics



Sometimes referred to as downslope winds. Air at height is cooler than that at lower levels. In light gradient wind conditions at night with a cloudless sky, the land loses further heat by radiation and the air in contact becomes more dense as it loses heat. Particularly in hilly or mountainous conditions, by about 1am the adjacent, now more dense air, begins to slide down the slope by gravity to valleys or the coast. It warms as it descends (increased pressure) but at the same time loses heat due to constant contact with cool ground as it descends. The cooler air flows from valleys as in a river and usually dissipates about one and a half miles from the coast. For lakes, the cold air from many hills will drain into any network of channels to the lake or valley where it may persist as fog until sufficient day's heat has accumulated to dissolve or thermally mix the air,-often 2.30pm. Surface roughness such as large trees inhibits the process. In cases where a land breeze is operating, it will re-inforce to become of moderate strength but otherwise is usually light. In late autumn/early winter in the right conditions a katabatic runs from the Yarra Valley from Mt Macedon and the Alps thence along the North eastern bay shore passing Brighton and when coupled with a northerly gradient wind in stable conditions, can reach to over 25 kts but by 9-9.30am reverts to the gradient wind. Easy to observe early and then later find a nice day.

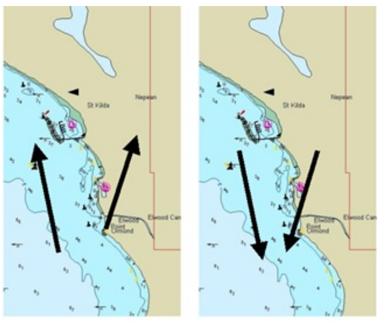
Obstructions

Here is a tip! Depending on how keen you are, either make yourself some model hills or islands say 2-3 cms high and about 7-8 cms long or else find some broken brick pieces or stones. Then on a rainy day with water flowing in the road gutters, place your models in the water stream to see what happens-very enlightening! Air is just another fluid and behaves as a liquid in turbulent or laminar flow. If you do not have local knowledge, observe the landscape in question and consider that air will flow around the obstruction in a path of least resistance without going over the obstruction if it can. Air has weight and will not lift easily. It also has momentum and that push is also a factor. A hill or obstruction of 1 km length and ½ km wide with an air layer of 10m thickness has a 'blanket' of air weighing 6,000 tons. Air would rather go around than lift over! (Hard to believe? 1km = 1000m x500m wide x10m thick = cubic metres x density of 1.2041 kg/ cubic meter @ $20^{O}C$ = 6,000 tons and a breeze of 10 kts 50 m high x 50m wide has a momentum of 60 tons/ sec.- Air would rather go around than lift over!). The variables involved are:

- Stability (laminar or turbulent airflow)
- Frontal and rear slope (likelihood of air flow following the surface or detaching as turbulence).
- Surface roughness (smooth as in grassy, rough as trees-attach or detach).
- Colour and composition (as in greenery = cool, brown or sandy = warm)= thermal mixing.
- Coriolis deflection of air flow.

If sailing fairly regularly in an area, relief or contour maps can assist in assessing likely flow conditions around the obstruction, or better still armed with the variables listed acquire local knowledge. In stable conditions with relatively steep upwind or downwind surfaces, a rotor or calm can form under air 'skipping' the area against a steep slope but will follow the surface if gently sloped. If cumulus cloud is observed laminar flow will not exist and unstable conditions will be present. If the obstruction is quite high and fairly long such that there are few opportunities for air to flow around the obstruction, momentum will force the air to mount up on the windward face until gravity overcomes the heaped up 'wave' releasing it as a 'bullet' or strong gust and the process can recommence.

Convergence, Divergence, Islands



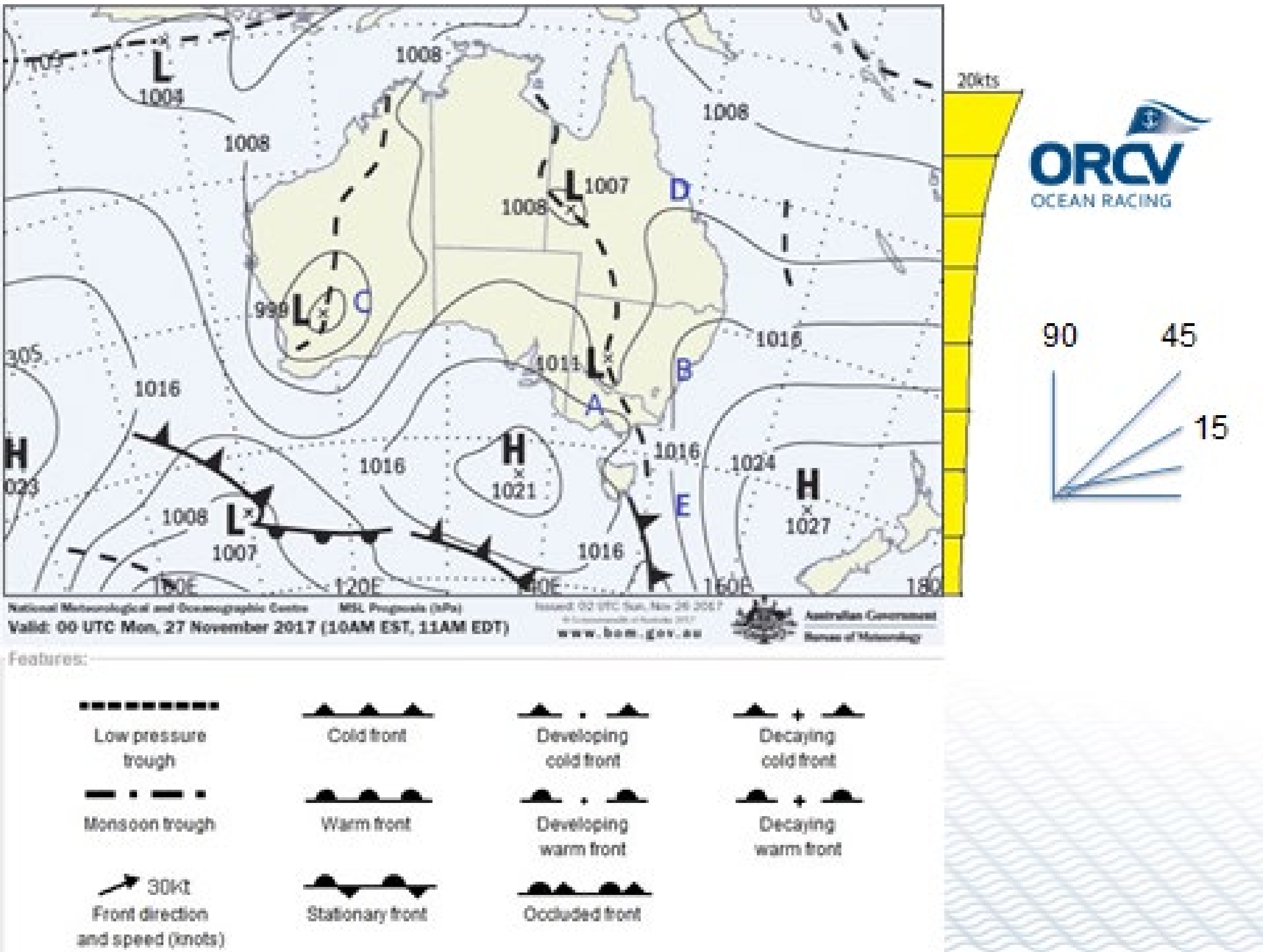
East Shore Divergence   East Shore Convergence

The wind blowing along a shoreline has two components of interest. That over water being unobstructed and that on the shoreline land encountering varying obstacles such as trees, buildings etc. Wind blowing over land and encountering roughness as mentioned will be slowed and subject to the Coriolis effect. Turning right (SH, left NH) and especially so in light laminar flow conditions, (the lighter the wind, or the rougher the surface, the more the angle of deflection). If the shore is on your right when facing the wind, a veered wind from the shore will merge with wind over water to have a resultant direction and strength as in the vector example of convergence.The resultant effect diminishes slowly moving offshore until becoming prevailing wind.If the shore is on your left when facing the wind, the over shore wind will be deflected away from the over water wind resulting in a lighter condition known as divergence. Islands and longer capes In enclosed waters are likely to be of moderate height and size. The wind will be deflected by the Coriolis effect to the right (SH) and to the left (NH) to converge with regular wind and be stronger on that side of the island with a corresponding divergence and weaker wind on the other side. Wind at a cape will have a similar situation but also the possibility of an eddy down stream of a longer cape.

Tides

In the southern hemisphere, bay circulations tend to be in a clockwise direction (Anti-clockwise NH). In inlets constricted by narrow channels sharper radii cause currents to be on the outside of bends due to centrifugal force and shallower estuaries with deep channels have concentrated flow due to friction in shallower areas. The presence of an entrance bar accelerates tidal currents with local effects.

Tides are a product of gravitational pull from primarily the moon, secondarily the sun, and planets as a minor component. When the moon and sun are aligned, their gravitational pull are combined and also when they are directly opposed as water moves on the opposite side as a result of centrifugal force. By examining the tide tables one can see that the range of tidal heights varies progressively as the factors move into alignment or not. Simply the bigger the range the stronger the currents. Similarly there is often a daily variation in range. Other factors which can have an influence are prolonged southerly or northerly quadrant strong winds which 'push' into or out of the bay and barometric pressure movements. Tide tables therefore are a guide depending on……Again, heavy rains can cause considerable discharge from the Yarra river which flows into the Northern end of the bay, sweeping towards St. Kilda and along the north east coast at Brighton and further dissipating inwards by Black Rock in the east. A weak eddy or gyre exists across to the western side where the incoming flow is fairly weak due to the large area available. When strong streams at the heads exist, Sandringham on the eastern bayside has known up to a half knot ebb. In some other areas the tidal current direction and land effects can be an influence, as around Arthurs Seat in the south. Consider both. At the Southern end of the bay, tides particularly at the western end of the South Channel can reach up to 2 kts but at the Eastern end dissipates fairly quickly after leaving the south channel at the Hovell shipping turning mark and proceeding North Easterly whereas at flood it enters from the North. The Geelong channel is fairly mild except between Point Henry and Point Lillias at the entrance to Corio bay in the west where acceleration over the bar can result in 1 kt at peak in the channel. Tides generally are not very large being restricted by the narrow entrance through the 'heads'. Small vessel operators in shallow waters need to be familiar with the rule of twelfths well documented elsewhere.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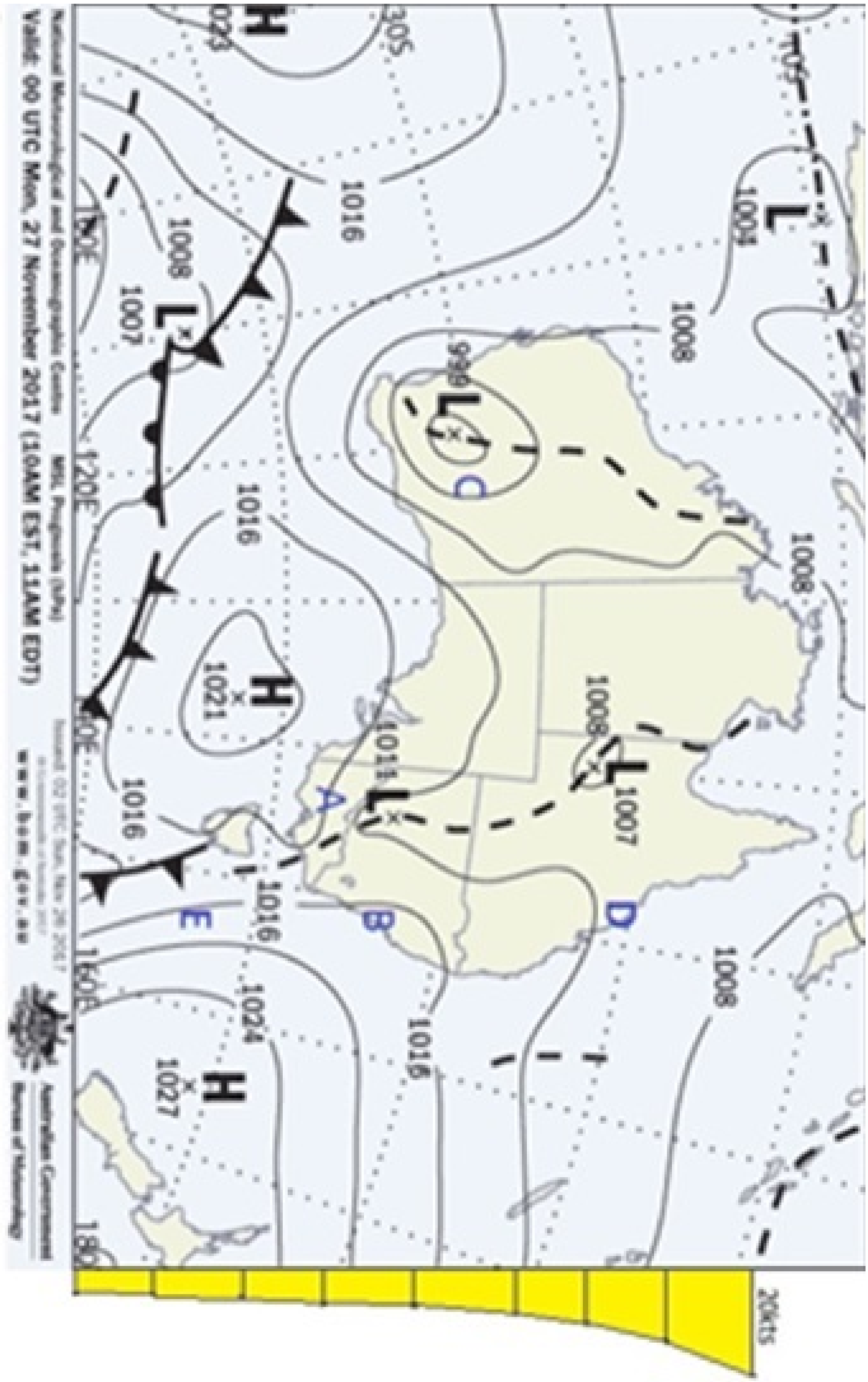
National Meteorological and Oceanographic Centre
MSL Prognosis (hPa)
Valid: 00 UTC Mon, 27 November 2017 (10AM EST, 11AM EDT)
www.bom.gov.au
Australian Government
Bureau of Meteorology
Features:
Low pressure trough
Cold front
Developing cold front
Decaying cold front
Monsoon trough
Warm front
Developing warm front
Decaying warm front
30kt
Front direction and speed (knots)
Stationary front
Occluded front

ORCV OCEAN RACING

Worksheet Map



You've completed the first of 3 modules.

Continue your journey of learning by booking into Modules 2 and 3 by visiting www.orcv.org.au and booking your place to attend.

Module 1 – Definitions, Fundamentals and Enclosed Waters

Fundamentals of weather terminology. Definitions.

- The Barometer
- Vectors in sailing
- Seasons
- Coriolis
- Weather systems, Global mechanisms
- The forecasting process, the weather map,
- Weather information, how to read and use it. iindex
- Fronts
- Weather Warnings
- Waves & Tides
- An introduction to Clouds and their signs.
- Gusts, lulls, and coriolis.
- Sea breezes-local- -autumn, winter, summer. Land breezes, katabatics.
- Obstructions
- Topography, land effects &Bathymmetry

Pre-requisites:There are no pre-requisites to attending this course

Module 2– Coastal Sailing (Voyages 3+ days).

For 2 nights, this online course builds on the fundamental knowledge of Module 1 and prepares a sailor for longer coastal passages usually 3 days or more, whether that be racing or cruising including:

- 4 & 7 day prognosis-maps
- Routing Software and forecasts
- Topography-sea breezes-land breezes-katabatics-timings, clouds-temperatures-airmasses
- Other land effects, headlands, indents, rivers, mountains, cliffs, islands, wind directions
- Thunderstorms etc
- Jet streams briefly
- Bathymetry, tides, currents, (and shallows) moon passage, tidal nodes, using port data
- Using ORCV Bass Strait tidal model
- Gribs
- Coastal tides & Currents
- Severe weather systems
- Sailing the tropics

Pre-requisites: A sound understanding of weather terminology and basics of Module 1

Module 3 Trans Ocean

- Planning,-wind roses-world circulations,trades-Internet sites
- Seasonal variations and timing-monsoon
- The Gradient wind analysis
- Ocean circulations
- Cyclones, typhoons (tropical revolving storms).
- Gribs-w/fx-polar maps, Satellite pictures.
- Time limitations
- Bathymetry-undersea mounts,-currents
- Continent influences-southern/ northern hemisphere
- Technology-prediction programs etc w/fx-sailmail-comms-HF cf sat phones, Predict wind, windy, expedition

Pre-requisites: A sound understanding of both the Fundamental and Coastal courses content is a must to attend this course.

ORCV
OCEAN RACING

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ORCV is dedicated to promoting ocean sailing, growing its participation, providing sea safety programs and value to our members.

Support the ORCV by joining as a member
www.orcv.org.au/join

Learn more about the ORCV Programs

Racing Calendar
Safety & Sea Survival Courses
Weather Courses
Navigation Courses
Other Courses
Membership

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