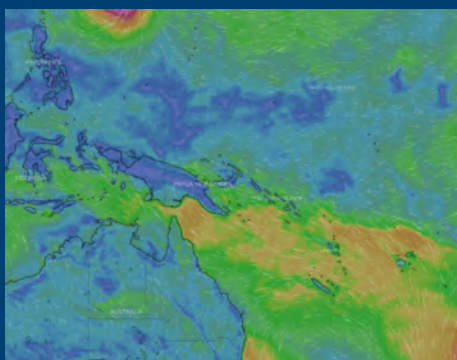
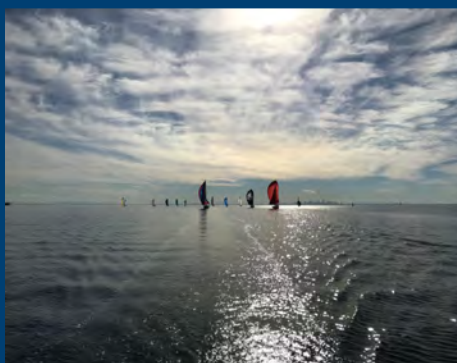




# SAFETY & SEA SURVIVAL

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## Weather Supplementary



## Notes to accompany SSSC course Racing and Weather Presentation

The Ocean Racing Club of Victoria 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  $37^{\circ} 48.8' S$  to  $44^{\circ} S$  and from longitude  $141^{\circ} 36' E$  and  $151^{\circ} E$ . 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.  $34^{\circ} N$ . Many of the members also sail along the east coast of Australia to regattas in the Whitsundays lat  $20^{\circ} S$  in the winter months.



The course is arranged for the Southern Hemisphere mid latitudes particularly but is also applicable to the Northern Hemisphere with some adjustments and is modelled according to the guidelines of World Sailing. Australia is a maritime continent as distinct from the continental climates in the largely land mass 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. Southern Australia is adjacent to the 'Roaring Forties' and 'Furious Fifties' and experiences generally larger seas than more northerly latitudes.

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). In 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. Vessel owners would be well advised to equip with internet capability as an improvement when feasible.

Above all, we wish to engage boating 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'.

### Topics

- Seasons-
- Weather systems, Global mechanisms
- The forecasting process, the weather map, models and some sources
- Weather information, how to read and use it.
- Fronts
- Weather Warnings,
- About Waves
- 4 & 7 day prognosis-maps
- Routing Software and forecasts

### Definitions and terminology

- **Back**-turns anti-clockwise.
- **Barometer**-in terms of this course is an instrument for measuring the **pressure of the air**, due to the weight of a unit column of air above it. 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 at mean sea level (MSLP) is 1013.25 mb or hpa at 15°C. A Bar is the standard atmospheric pressure represented by the height of a column of mercury in a mercury barometer. A barometer is near to essential especially for an offshore vessel.
- **Bathymetry**-Study of undersea floors or surfaces
- **Buys-Ballots Law**-In the Southern Hemisphere-Face the wind and lower 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 not discussed in this course but is a subject in ORCV weather courses.
- **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°. 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 its isobars at about 15°. 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 2°C drop in temperature per 1000 feet elevation is a general rule . You may have noticed as a jet passenger the outside is about -57°C 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.₂
- **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.

**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.

### 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, aircraft 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. New developments with satellites are increasingly providing more information and especially in remote areas.

In a basic **low pressure system**, wind circulates in a clockwise direction and crosses isobars inwards at about  $15^\circ$ . 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  $15^\circ$ . 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.

### **Cold Fronts**

A cold polar airmass usually as part of a low-pressure system has the symbol with the triangles pointing in the direction of advance. The cold air is denser and being heavier slides under the relatively warmer air to act as a wedge.



The process is mostly quite vigorous being associated with strong winds and a sudden drop in temperature accompanied by rain, a

sudden shift of wind from North-west to west and then south-west, possible thunderstorms and over water, rapid building of sea-state. Following passage of the front, cumulonimbus clouds bring squalls as they sweep in with rain, possible hail and difficult sailing conditions. The frequency of these 'storms' gradually lessens with longer intervals of clear conditions and moderation of wind.

The approach of a (mares tails) some cloud. The wind north-easterlies before shifting of the front. Fronts



front is nearly always heralded by feathery cirrus cloud 30 to 36 hours before gradually thickening and looming rain sequence in the southern hemisphere begins with light followed by rising northerlies becoming warm and strong northwest with lowering ominous cloud before the arrival can move up to 40 kts in winter and maybe 20-25 kts in summer such that the passage from Australias ' west to the east varies accordingly.

### **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 troposphere, 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 come 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= $+4-6^{\circ}$ ) 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.

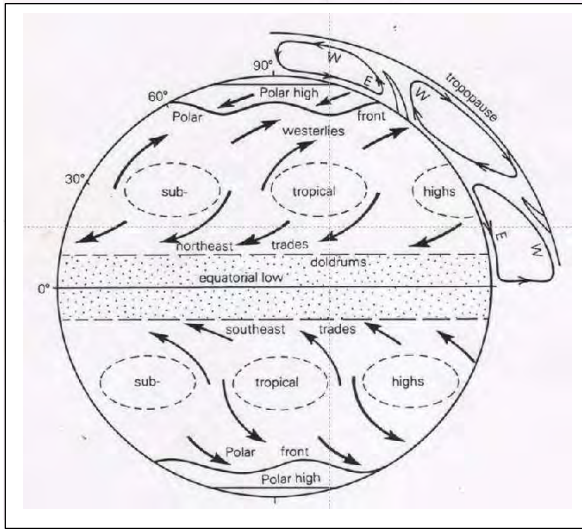
Move away from any electrical noise or sensation.

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.

## **Global Systems**

Maximum solar energy delivered to the equatorial region at an angle of incidence of  $90^{\circ}$  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 sets up 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  $30^{\circ}$  latitude depending on the season. In Summer the band of highs are centred near lat  $40^{\circ}$  and in winter nearer  $35^{\circ}$  latitude.*

The polar regions have colder, denser air which sinks to be the 'Polar High' and the relatively 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.

### **Seasons**

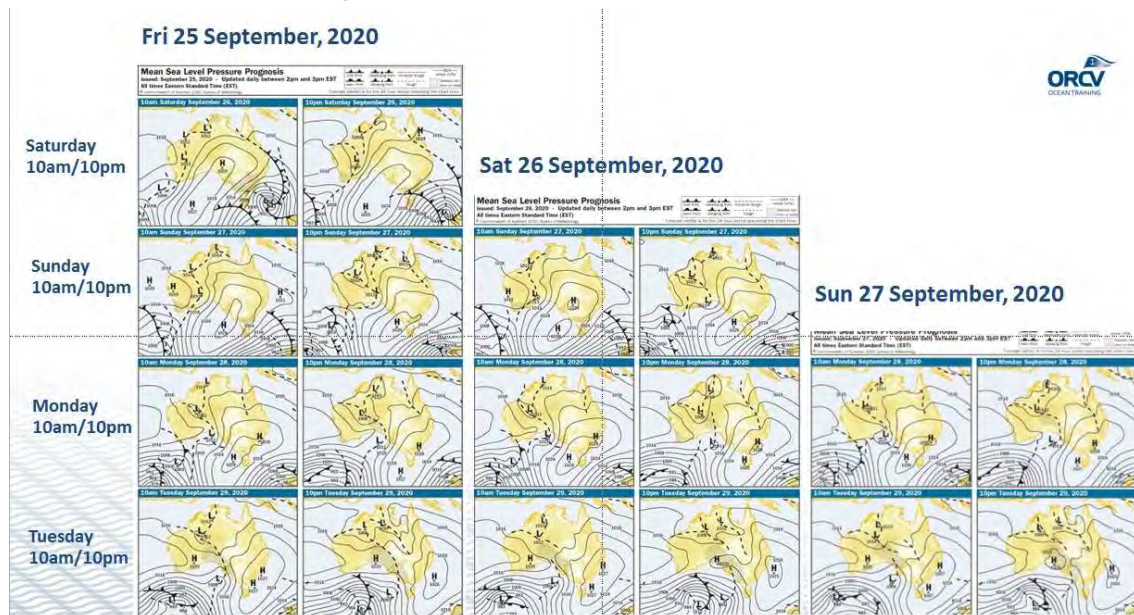
The earth has an inclined axis as it turns in its daily cycle. The inclination is responsible for the annual seasons. The earth not only spins in a daily cycle but also has an annual orbit around the sun. At the southern solstice (longest daylength), the axis through the south pole is closest to the sun while at the north pole the axis is pointing furthest away from the sun and is shadowed by the earth high latitudes to experience 24 hr darkness. 6 months later, at the southern winter solstice, the south pole has 24 hr darkness and the north pole 24 hr daylight with northern summer grading progressively to the tropics which has little day/night difference. The autumn and spring solstice has equal day/night at all latitudes.

The effect of the seasons in sailing weather is that the climate driver features such as the band of highs and the westerlies progressively change latitude and for example, the band of highs or sub tropical ridge run through Tasmania in peak summer and in winter through mid New South Wales. The westerlies and other climate drivers as shown in the BOM diagram follow suit. Typical season weather maps are presented in slide presentation notes as is the BOM diagram.

### **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 its 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 its 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, say 10°. 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 of 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 ORCV weather courses). 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.

### **Radio Forecasts**

HF & VHF forecasts are generally every 6 hours while safety warnings are issued every hour while current. An HF schedule is available from the BOM website or as listed in worldwide publications. The forecasts are issued for Australia by station VMW for the west and VMC for eastern areas. They are given in areas progressively and are for 3 days. More is available in ORCV year books. VHF forecasts are available from state coastal stations and various local volunteer groups. In all radio forecasts, one needs to understand the wind warnings terms it is good practice to mentally add the note that wind gusts can be 40% greater than wind speeds given. Thus a strong wind warning of 26-33 kts can have gusts up to 36 to 45 kts and a gale warning of 34 to 47 kts, gusts of 48 to 66 kts while for a storm warning of 48-53 kts, gusts can be 67-74 kts. During these extreme events the wave tops can be lifted off by the wind and the energy delivered brings very large waves after such a gust.

Very common in European and northern hemisphere waters is use of the Beaufort scale which describes winds according to a force scale based on sea-state. Such a forecast may be given for an area with winds 'force 4' as an example. It is useful in that observance of seas over time related to winds can enable one to know wind strength by observing the sea (if instruments on board should fail.)

### **Weather from the internet**

The importance and usefulness of weather information to the community justifies huge expenditure by Governments and output products are very varied and in many forms. Like all sciences in this information age, advances are ongoing and ever changing. Mostly all for the good! 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 with excellent support descriptions available. However other providers can suit some people and may have a different focus/presentation. Very popular with sailors worldwide is Predict Wind and for coastal and ocean voyaging-Expedition, described more fully in our weather courses. Windy.com is also useful and is free out to 10 days with a comprehensive menu selection. Information from any of these providers has presentation differences but with some familiarisation can be used in conjunction to provide a more complete outlook.

A useful routine is to look at whole of Australia using the animation forecast to get a background feel for the coming weather and then to use, Victoria for closer detail and Port Phillip area before using the Meteye system for a local vicinity. A difference with Meteye is that the system uses 'local forecasts' aggregated to the big picture as distinct from a 'big picture' expanded to a local area.

The government seems to have a preference for a more universal approach to wind speed as per land-based km/hr instead of knots but accepts it for marine use. Meteye has provision for both but any selection needs constant checking as it can revert to the other by itself.

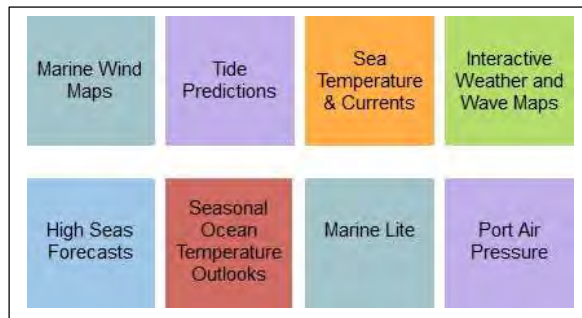
### **Being Weather Wise**

The big picture is readily available and detail excellent subject to a practical limit of 3 hour intervals without a data explosion. Port Phillip Bay for example is 745 m<sup>2</sup> and almost half is shallower than 8 m or 26 ft. A cold front from the western quadrant arrives in 4-6 hours from one side to another and temperature can drop 10-20° in 20 mins. Typically winds move from a strong northerly to NW then through West to SW with the front accompanied with rain and possible 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 are often 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 Port Phillip Bay, the shallow depth and restricted fetch makes for generally choppy conditions. North with a fetch of @26 n miles, North West fetch @21.5 nml, and South West fetch @ 23 n ml have the greatest amount of fetch which can produce seas up to 2.5 m in 30-40 kts. Only rarely are 3 m seas observed as there is insufficient depth for larger. A particular hazard is at the bay entrance from Bass strait which is only 2.5 miles wide with restricted depth and forms a barrier to tidal flow which can reach 7-8 kts on the eastern side. Particularly with ebb tide against the prevailing SW sea or swell, very dangerous conditions can exist and persist up to some 3.3 nmls into the Strait. Exit for small craft is only possible in fair conditions and at slack water as published in the tide tables (which is not at high or low tide). 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.

### **Useful BOM website products-[www.bom.gov.au](http://www.bom.gov.au)**

The screen will open with the face page showing a satellite picture over Australia and selection boxes for Rain Radar, Satellite Images, Weather Maps and Meteye. Scroll down to get the lower part of the face page to find 'Our Services' and select 'Marine and Ocean'. The following selections appear with corresponding pages, each with



respective uses. Selecting Marine wind maps takes you to the 'Australia wide wind map' with wind directions as vector arrows and colour coding for wind strengths. Above the map is a toolbar from which can be selected Day, time of day, and controls to go forward, back and 'animate' to show weather system progressions. The options selection can be used to select the state area which can also be chosen by clicking the state. Often after a new selection it is necessary to press

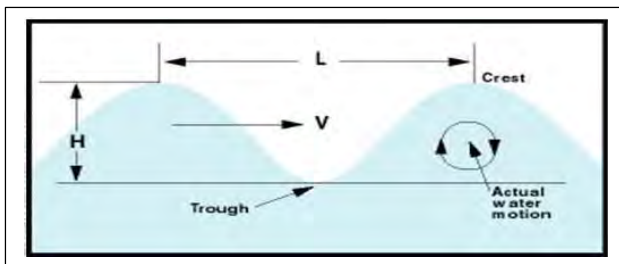
'update'. On the Victoria map, the Port Phillip area is rectangle enclosed which area can be 'click' selected.

Back to the face page 'Weather maps' which when selected brings a menu page of links to various items. Although you are encouraged to explore all these and familiarise yourself as to what may be of interest to yourself. Probably the most useful is the 'Forecast map for next 4 days. Most voyages do not last more than 4 days or can be refreshed when near a coastal site. The maps are in 12 hr intervals and checking stability of the forecast has been covered previously. The short-term forecast map combined with satellite picture is also very useful as it shows cloud conditions also. Remembering a weather system takes roughly 4 days to get to Melbourne vicinity, a glance at this map allows you to imagine the likely situation ahead. The next link of interest is the Gradient Wind-Gradient wind Analysis. This is a map of streamlines for the tropics where isobars are of little use due to very small pressure differences, Around or at the edges of various pages there are other topic panels shown. Much explanatory information can be derived from these on various subjects. For the streamline maps, there is a 2 page 'how to use' document. The ORCV weather courses cover these more technical aspects.

The METEYE selection begins with an Australia map and a toolbar to type-in your location of interest. This opens to a 7 day selection panel which when any day is selected produces a detail 3 hr conditions table with (if desired) selections such as humidity, rain etc. as well as wind direction and strength, once again don't forget to check for kts.

The Marine Lite selection is again for light, slow, or expensive data usage devices such as sat-phones and maybe mobile phones.

### **About Waves**



**King or rogue waves** are waves greater than twice the total wave height. These very large waves occur when ocean currents run opposite to the prevailing sea and swell, and waves overrun each other. This generates steep and dangerous seas. Mariners should prepare for a rogue

wave encounter.

**Sea state** refers to the combination of sea and swell waves. Sea state descriptions are provided in the tables below.

**Sea waves** are generated by the local prevailing wind. Their height depends on the length of time the wind has been blowing, the fetch (the distance the wind has blown over the water), and the water depth. They may also be referred as **seas** in marine text forecasts and **wind waves** in map displays.

**Significant wave height** is the statistical basis for all wave heights presented in text forecasts and map displays. Wave heights are variable over time. The statistical definition

is calculated as the average height of the highest one-third of the waves experienced over time.

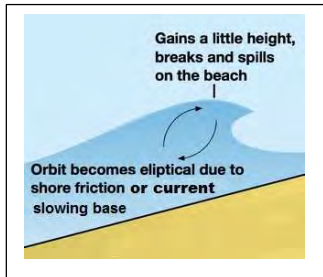
**Swell waves** are the regular, longer period waves generated by distant weather systems. They may travel over thousands of kilometres. There may be several sets of swell waves travelling in different directions, causing crossing swells and a confused sea state. Crossing swells may make boat handling more difficult and pose heightened risk on ocean bars. See more information about the [second swell](#). There may be swell present even if the wind is calm and there are no sea waves. There are two methods for identifying multiple swells.

### Deep Water Waves

Deep-water waves are waves traveling across a body of water where depth is greater than half the wavelength ( $D > 1/2 L$ ). Deep-water waves include all wind-generated waves moving across the open ocean. Unless influenced by current, deep-water waves have a regular formation.

### Shallow Water Waves

Where depth is less than one half of wave length. A shore often has a slope 1:20 and a rule of thumb is that a wave will break if depth is less than 1.3 times wave height.



at the surface move in a circular motion of diameter equal to wave height and when shallow water is encountered or an adverse current, bottom friction causes the circular motion to become elliptical leaning in the direction of travel almost as if the bottom half of the wave has slowed and the upper half continues at the original velocity. There is also water surface movement towards a shore and return flow close to the bottom which can form 'undertows'.

The Bureau's AUSWAVE wave model identifies individual swells based on their energy. The AUSWAVE model outputs a **primary** and **secondary swell** to refer to the height and direction of the swell with the highest (and second highest) energy component.

- Direction-based identification: The Bureau's MetEye map displays swell forecasts that are assigned either **Swell1** or **Swell2** according to a pre-determined direction convention for the Australian coastline. This means Swell1 may not always represent the highest swell conditions.

**Total wave height** is the combined height of the sea and the swell that mariners experience on open water. It may also be referred as the **combined sea and swell** or **significant wave height**. The probable **maximum wave height** can be up to twice the total wave height.

Description	Wave Length	Period	Wave Height
Low swell of short or average length	0 - 200 m	Less than 11 sec	0-2 m
Long, low swell	over 200 m	Greater than 11 sec	0-2 m
Short swell of moderate height	0-100 m	Less than 8 sec	2-4 m

Average swell of moderate height	100-200 m	Greater than 8 sec, < 11 sec	2-4 m
Long swell of moderate height	over 200 m	Greater than 11 sec	2-4 m
Short heavy swell	0-100 m	Less than 8 sec	over 4 m
Average length heavy swell	100-200 m	Greater than 8 sec, < 11 sec	over 4 m
Long heavy swell	over 200 m	Greater than 11 sec	over 4 m

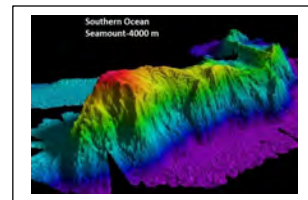
**Wave trains-**

The sort of swells we are likely to observe on a fair-weather day at the beach will commonly arrive in groups of 12 to 16 waves. That range, coupled with the tendency of wave groups to bundle their tallest waves in the center of the pack, provides a possible basis for the surfers’ seven-wave claim. A group will 'modulate' the wave amplitude; it's like another long wave on top. So the first wave in a group is tiny, the next one is bigger and so on until you get the biggest one in the middle of the group. Then they get smaller again. The last one is tiny, so the biggest wave in the group is in the middle, and if there are 14 waves in a group, the seventh wave is the biggest.

At sea, regular wave patterns can be observed and when difficult tasks in heavy conditions are required, such as a gybe, it can be useful to prepare personnel and wait until a more benign pattern begins and then to perform the operation.

Average height of 100% of waves	0.625% of significant wave ht
Average height of 50% largest waves	0.88%
Average height of 33% largest waves	100% = significant wave height
14% of waves(1 in 7)	Larger than significant .wave hgt
Average height of 10% largest waves	127%
Average height of 1% largest waves	167%
Average height of 0.1% largest waves	186% of significant wave ht

Oceans are not just large



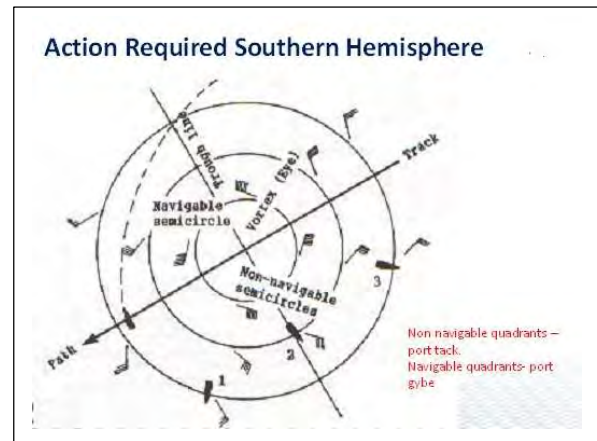
homogenous expanses of water. Looking at any chart will show the presence of numerous undersea reefs and submerged masses called seamounts. Currents and wind-driven currents react with these structures to cause up-wellings, deviations and similar to whirlpools,

all of which affect wave-forms in the vicinity.

**Tropical Revolving Storms**

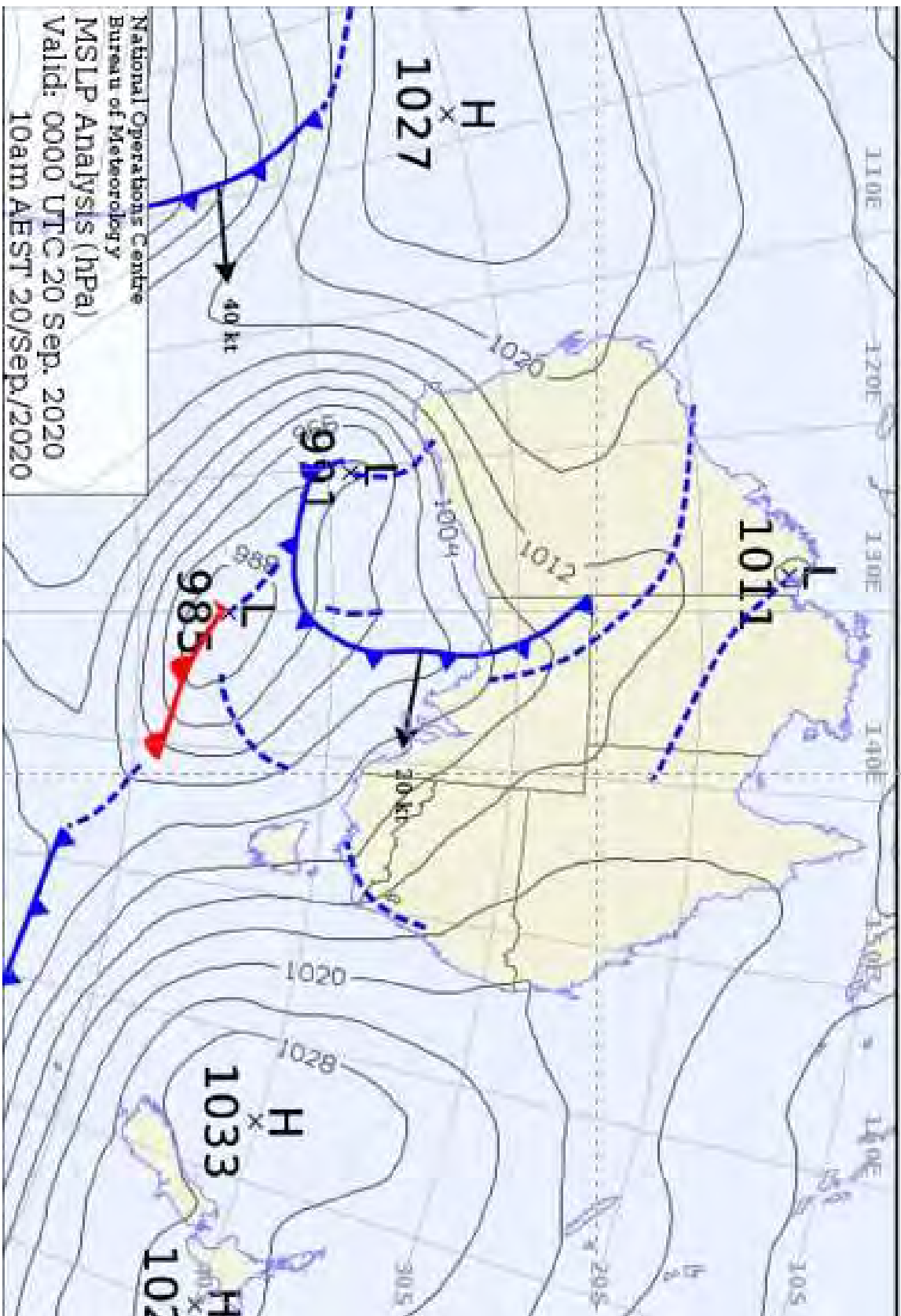
Cyclones, Typhoons, Hurricanes are all the same tropical revolving storms, just different names and rotations depending on their location. In Australia, they are cyclones and occur in northern tropics of Australia. Their formation requires sea temperatures of 26.5°C+, moisture in the atmosphere and low wind shear (light horizontal winds aloft). They do not form within 5° latitude either side of the equator as the conditions are not present to allow 'spin-up'. They are more likely in La Nina years in the presence of an MJO event and develop often from a tropical low on the monsoon trough. (This topic is covered in more detail in the ORCV weather course Module 3.) Of course there are warnings made but in the unfortunate event of being caught in one, it requires getting as far as possible away from the centre (strongest winds) and to the rear of the system. To do this requires determining if you are, or likely to be, in the navigable or non-navigable sector. Buys Ballots Law for the Southern Hemisphere states to face the wind and your outstretched left hand will be pointing to the low pressure (centre of the system).

In the navigable semi-circle the wind is against the system track speed which results in lesser winds. Sailing on port gybe takes you away from the centre to the outer edge and to the system rear. (Any course in the system front means it will keep you in it until a disaster.) If you are unfortunately in the non-navigable semi-circle it requires sailing on port tack to again get to the outer edge and behind.



Exercise map

Analysis for 00:00 UTC on Sunday 20 September 2020





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

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ORCV Office 3 Aquatic Drive Albert Park VIC 3206

[orcv@orcv.org.au](mailto:orcv@orcv.org.au)