OCEAN RACING CLUB OF VICTORIA

WEATHER FOR SAILORS

MODULE 2 - COASTAL SAILING (KNOWLEDGE)

ORCV OCEAN TRAINING

Weather for Sailors Module 2 – Coastal Sailing

Definitions

Anabatic winds: Upflow winds flowing on rising lands.

Baroclinic instability: in meteorology an imbalance in the levels of pressure and density in a fluid that is one of the mechanisms determining the behaviour of the earth's atmosphere. Eg the instability that causes these particular disturbances is called a baroclinic instability which occurs when the latitudinal temperature differences become too large.

Relating to a state of a fluid (atmosphere) in which surfaces of constant pressure intersect those of constant density

Barotropic: having surfaces of constant pressure which co-incide and do not intersect with those of constant density (jet sstreams?)

Extratropic: Midl atitude poleward of the tropics

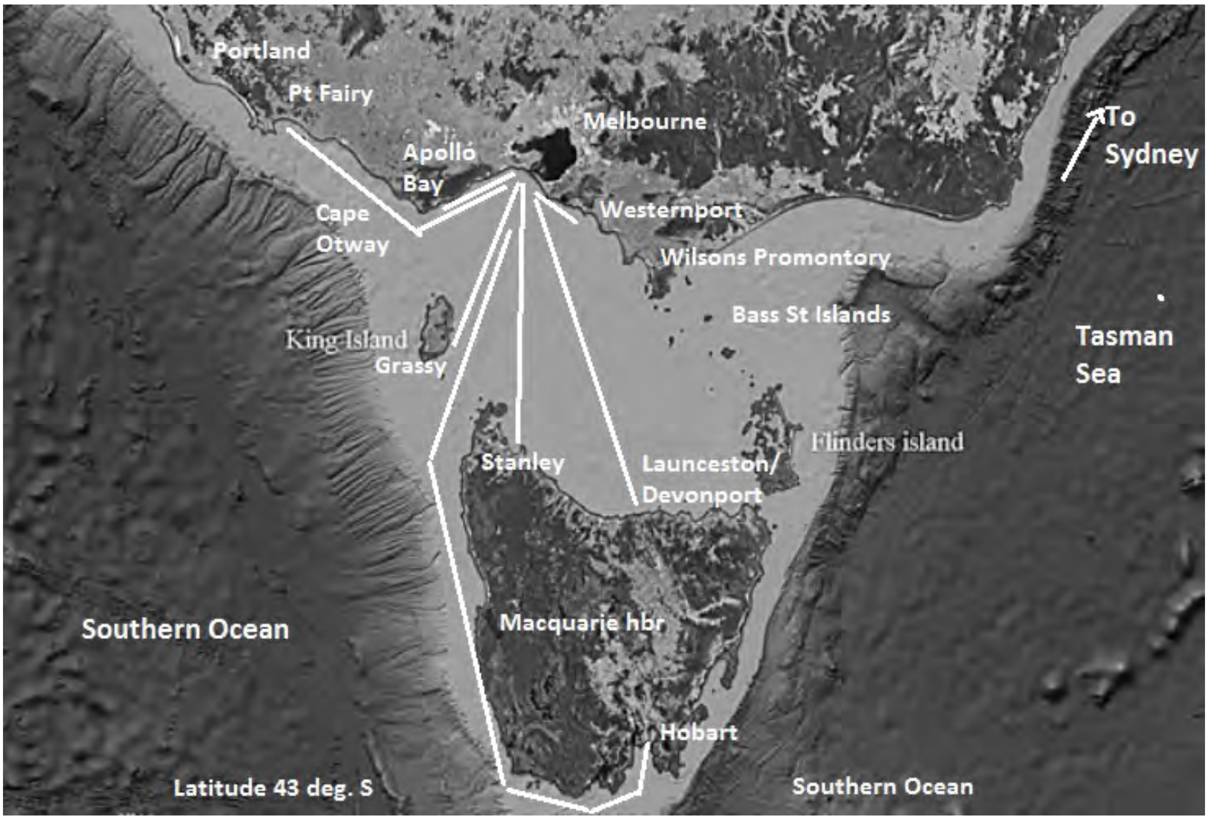
Rossby waves

Tidal Gate: An area of relatively strong tides such that a boat passing through with a favourable tide obtains a distinct advantage over a boat which traverses after the tide has turned and thereby encounters an unfavourable tide. For example between King Island and NW Tasmania, Banks St NE Tasmania, when rounding Cape Otway or Wilsons Promontory.

Tropics Latitudes between the tropics of Cancer and Capricorn

Offshore Voyages of 3-4 days

The ORCV conducts offshore events along the Victorian coast and in the Bass Strait area including to the Island state of Tasmania's northern coast and the state capital of Hobart. These areas are popular cruising grounds and contain unspoiled natural features unavailable to non-sailors. Melbourne Apollo Bay, Melbourne Port Fairy and Melbourne Portland are entirely coastal, Melbourne Launceston/Devonport, Melbourne King Island, Melbourne Stanley are across open water and Melbourne Hobart as open water plus coastal including the exposed western coast and southern ocean. Worth remembering is that all offshore races aim to finish in a safe harbor. What constitutes a safe harbor? You might ask.



Answer: An area with no wind!

As with most Australian boating conditions one still requires good weather knowledge and understanding of the excellent forecasting information available. Perhaps the best onboard investment to be made in this era of communication is internet capability although more facility for mobile phones is progressing with attendant data use. Sat phones are nowadays available for monthly hire at reasonable rates and several data options available. Part of this course module will be discussing such systems.

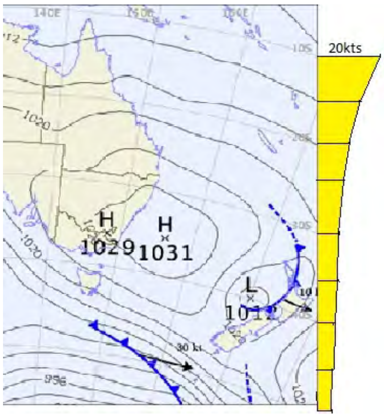
There are many delightful cruising locations within easy reach from Melbourne or the regional populations near marinas within several coastal towns. Most offshore races and cruising is conducted from mid spring to later autumn with the longest race being Melbourne-Hobart during the xmas break. Several yachts journey to Sydney for the Sydney to Hobart race and to the Queensland coastal events during the Victorian winter. These winter migrations north are usually accomplished in about three day steps stopping at the several secure refuges along the way up the Australian East coast, and weather-wise traverse the horse latitudes (where the winter Sub Tropical Ridge band of highs are) before reaching the South Eastern tradewind regions where regattas are organised. The Melbourne to Hobart race takes some 3-4 days and the northern Tasmania coast generally one and a half to two days. From all these destinations excellent cruising grounds in natural mostly unspoilt areas await the return voyage whereas much of the cruising expeditions are undertaken during late February to April. Wilsons Promontory and Refuge Cove, Deal Island , Flinders Island, Northern Tasmania ports to King Island thence Apollo Bay constitute the Bass Strait triangle. There are always challenges occurring with boating and experience best gained carefully.

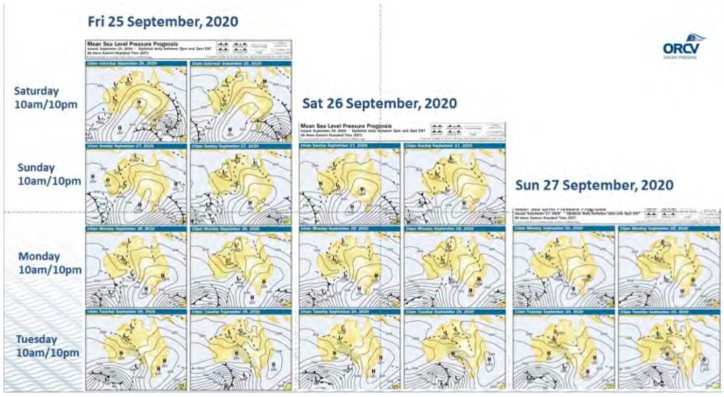
The East Australian Current flows Southwards along the coast and can reach up to 3-4 knots in some places. The current speed is very much influenced by large eddies comprised within the general flow. The Bureau of Meteorology has excellent mapping of the current and eddies which will also be visited in this course. Strong Southerly winds against the current can make uncomfortable conditions with dangerous seas and to avoid the adverse current usually requires remaining close to the land when voyaging Northwards. The trade winds can be light or fresh according to a number of factors such as the El Nino-La Nina circulations and visiting mariners often cruise in the Whitsunday Islands until the lessening of the season about October/November before returning Southwards riding the favourable current.

Especially for longer distance sailing with watch-keeping, a semi state of fatigue can easily

arise similar to jet-lag. Mal de Mer or the precursor can be especially limiting. It is therefore ideal to pre-plan as much as possible and in such a way that can be easily accessed and understood. Even when extra information can be acquired, there is a balance with the time demanded to obtain it and with ensuring the boat is performing well. Forecasts now are very reliable for the next 3 days, a little less so in spring but even then changes are not great. Along the coast there are internet available areas which allow update on board. The following is an example of one way to prepare by copying internet diagrams and pasting as a series for ready reference when onboard facilities are not available.

Copy/paste the 4-day weather map (this example looks interesting). West Australian state wind map has been selected and is copy/pasted at 12 hr intervals, in this example for three





days. The wind diagrams come in 3 hr intervals using this chart but for a demonstration 12 hrs is okay. If the maps are made fairly small, it is an easy matter to make a notation or hand written accompaniment. It is nearly always possible to find a place onshore who will provide a similar facility. If you have a laptop there is always MacDonalds? The 4 day maps are very reliable for 3 days which is enough to reach the next port.

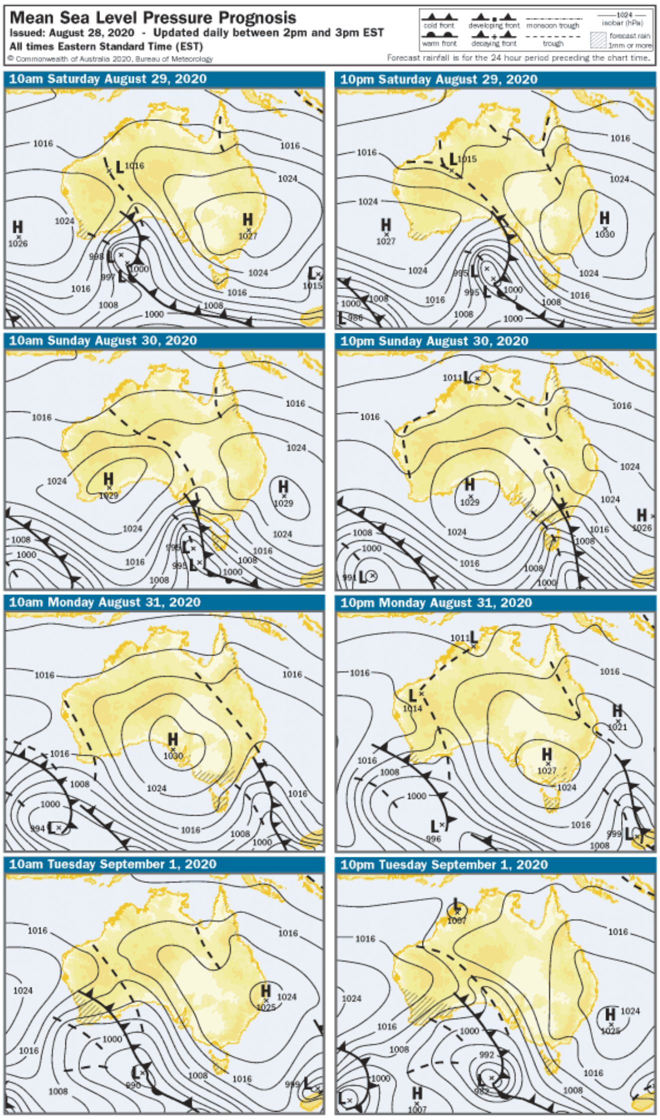
In conjunction with the increased number of VHF repeater stations now installed on most coasts, reliable radio bulletins are frequently also available. That is one way to operate on the basic or in emergency. An easy way to check forecast reliability is to down load 4 day maps each day before planning a voyage start.

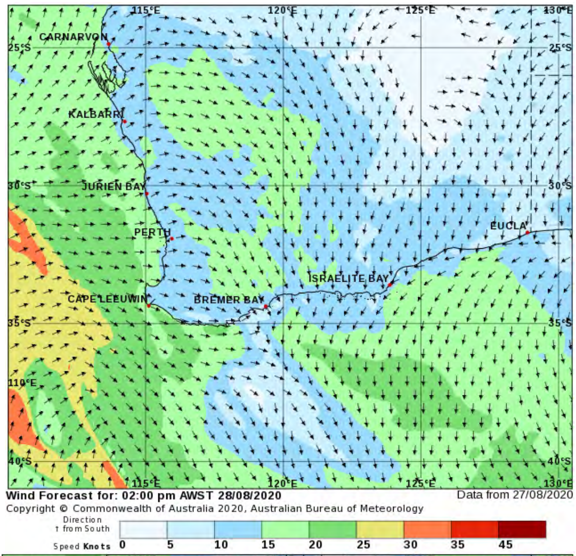
Compare the day two map from 3 days previous to the day one on the 4 days previous map?. Are they the same? Then the day 3 map from 4 days before to the day 1 before. Same? If there is not much difference then the atmosphere is stable and forecasts reliable. If there are differences then the degree of difference is a measure of reliability. Atmosphere chaotic?

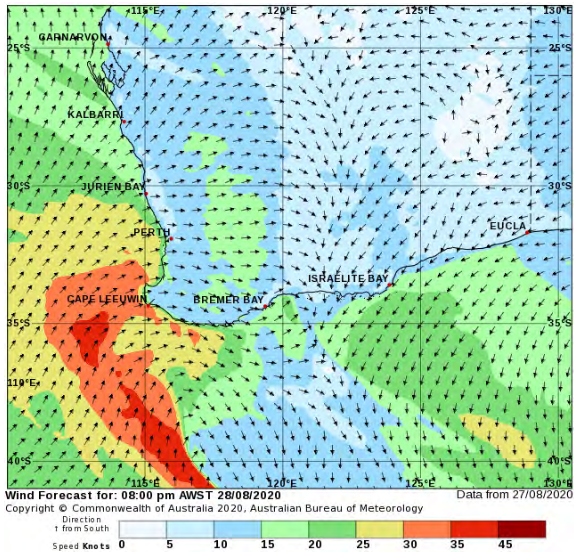
In addition, checking radio forecasts on a daily basis is advised as there can be extraordinary events which will be outlined further in this course. On board forecasting and keeping an easy to read, well set out log is best also practiced. Simply put, in lieu of technology, the most important instrument is the Mk1 eyeball. Changes of any kind? Sky?, Sea? Next would be the barometer, amount of change in a rolling three hour period. Record it hourly! In the Bass Strait region of 38-40^{O} S, 148^{O} E, a 3 hr change of 3 mb indicates a 30 kt change whether the barometer has moved up or down.

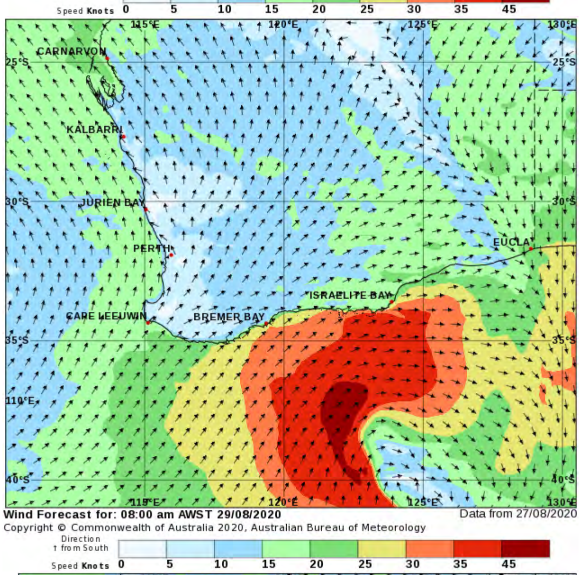
In lower latitudes the pressure changes in 3 hr for a similar wind change become progressively smaller and the further south, the larger in accordance to the weather map scaled isobar spacing diagram. Repeating earlier description in module one- for a particular latitude, the horizontal width on the 20 kt scale corresponds to the perpendicular distance between isobars adjacent to that horizontal 20 kt width. If the isobar spacing is, say, one half that of the 20 kt scale then the wind will be twice the 20 kts and if double the spacing then half the 20 kts. For a guide other proportioning is applicable. Again, the scale is only applicable to the latitude adjacent and note also the latitude parallels on the weather chart are curved.

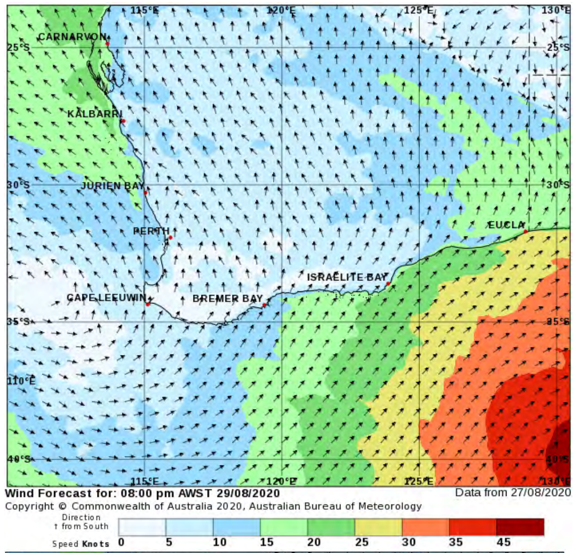
We will be studying three different weather providers in this course. BOM Australia, Windy.com and Predict Wind. BOM uses it’s ACCESS & METEYE models, Windy uses ECMF & GFS, Predict Wind uses ECMF & GFS plus its proprietary modified versions.

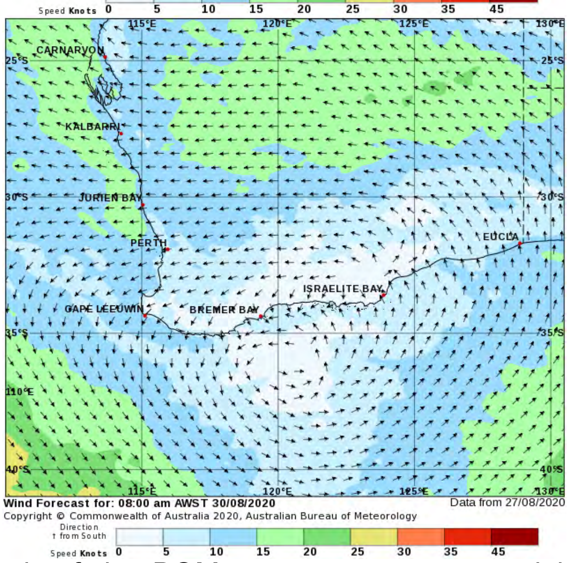


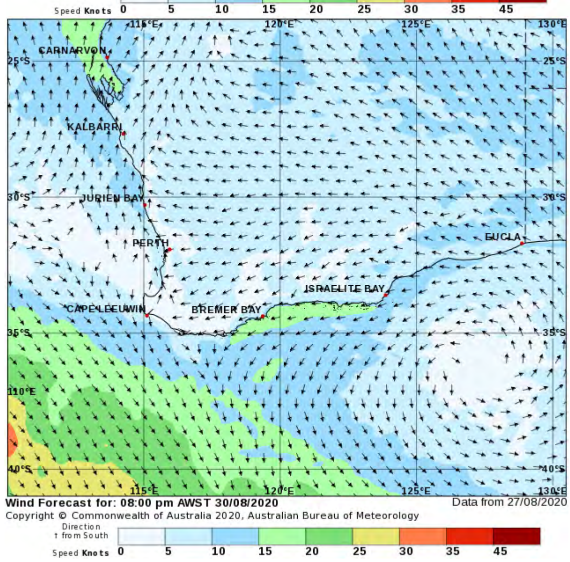






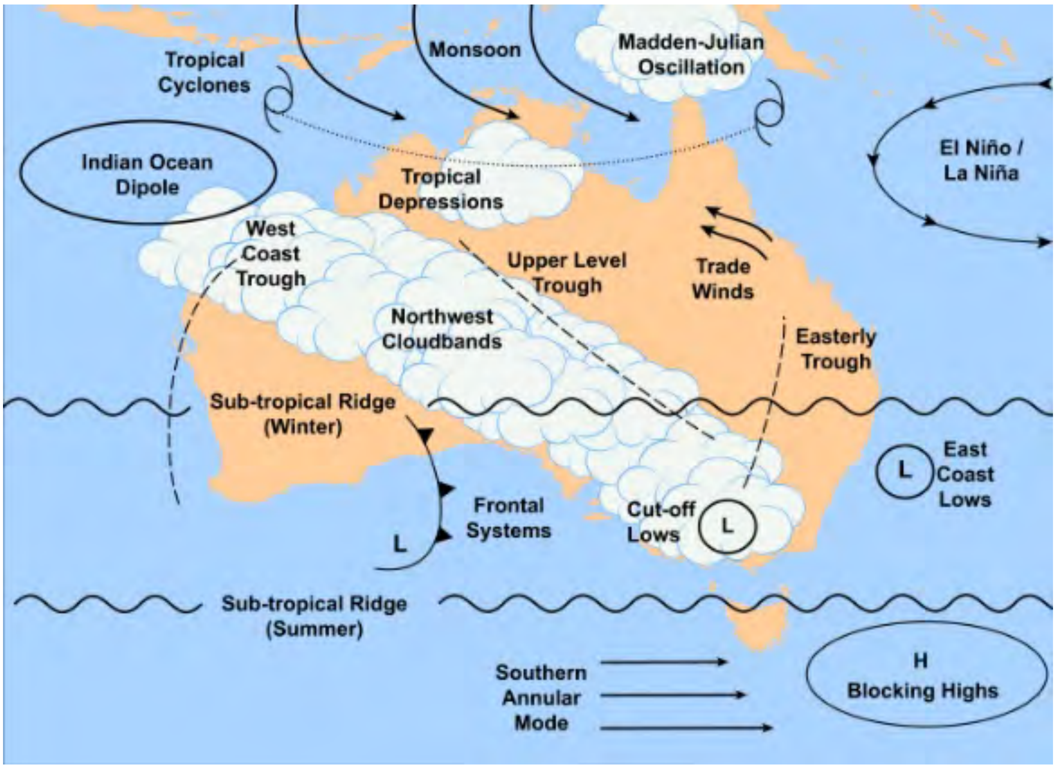




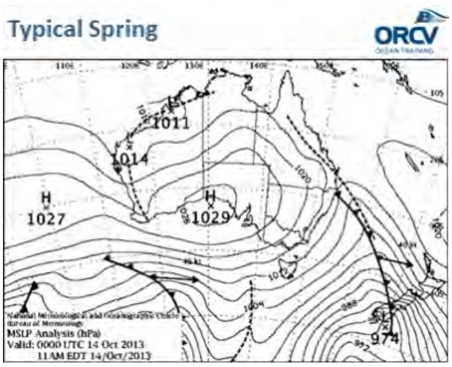


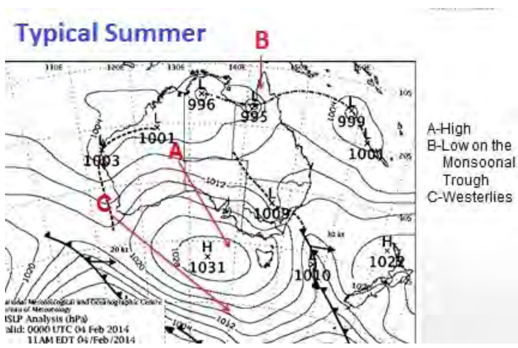
Much of the BOM pages were presented in Module 1-Enclosed waters. The additional material helpful for coastal voyages will be examined and also pages not immediately necessary.

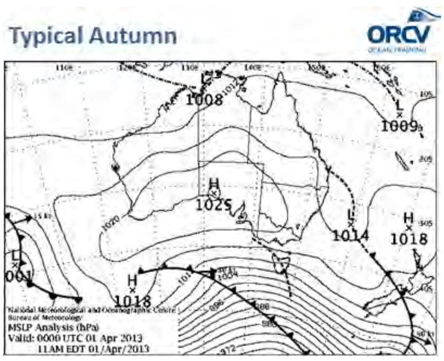
The aspects of weather around Australia are conveniently summarised in a BOM diagram following and during the course we will examine the areas outlined for boating application.

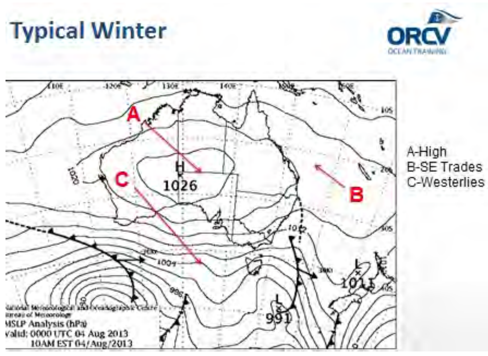


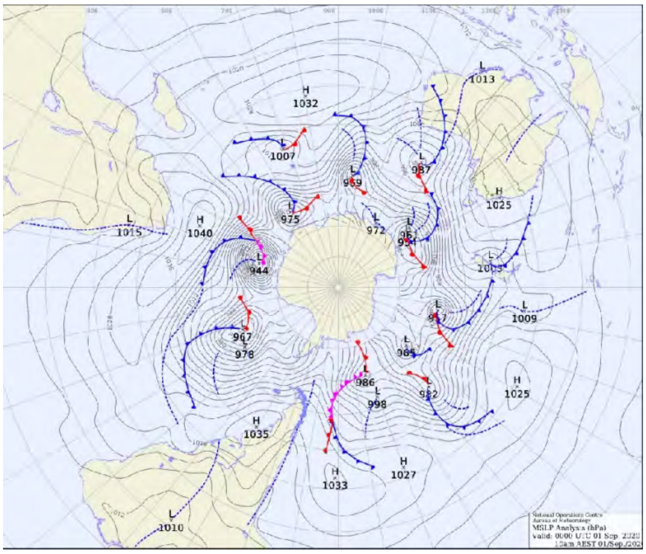
Our main boating activity area lies between the Sub-tropical Ridge (Winter) and the Sub-Tropical Ridge (Summer). The sub-tropical ridge represents the band of highs which move with the seasons as in the following typical weather maps. Of course, weather is rarely typical.











Looking at a Southern Hemisphere MSLP Analysis map from BOM Weather Maps/Southern Hemisphere, the band of highs or Sub-tropical ridge can clearly be seen within the latitude rings encircling the South Pole . The entire weather systems circle around clockwise (SH) from west to east. Very often cold fronts extend in between the separate highs arising from lows embedded in the westerlies region. Also evident on the polar map are lows, some very close to the polar Antarctic circle with fronts heralding a blast of arctic air should they reach into Victoria's winter longitudes. On the southern edge of the highs the winds expelled from the systems blow West to East contributing to the Westerlies and in our mainly maritime climate is subject to the SAM. The Southern Annular Mode.

SAM is a climate driving effect concerning the latitudinal position of the westerly wind belt commonly known as the 'Roaring Forties' and 'Furious Fifties'. In a negative SAM event other climate drivers have an influence on the SAM in some seasons. The Pacific Ocean Walker Circulation ENSO event of La Nina tends to favour a positive SAM during the spring to summer. El Nino favours a negative SAM in the spring to summer months.

A negative SAM means the westerlies are closer to Australia and in a positive SAM they move further than usual towards Antarctica.

SAM in autumn and spring (from BOM)

Climatologically, winter sees the belt of westerly winds at its northernmost position, while summer sees the belt at its southernmost position. In the other two seasons, autumn and spring, the belt of westerly winds is located somewhere in between summer and winter. In autumn, Australia's climate typically sees very little effect from SAM, while in spring, the effect on rainfall resembles a weak summer pattern.

Autumn and spring also tend to be the times of the year when SAM has greatest influence on extreme heat. In autumn and winter, northern and central Australia have double the chance of extreme temperatures occurring during a negative phase of SAM, while in spring, southern Australia has double the chance of extreme temperatures occurring during a negative phase of SAM.

(Example report) The Southern Annular Mode (SAM) is negative, and is expected to become neutral for the remainder of September. At this time of year negative SAM is typically associated with above-average rainfall across far southern parts of the country, and decreased rainfall further north. (From BOM weekly climate report). BOM has an excellent video with explanations.

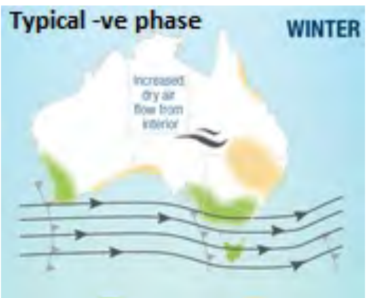
https://www.youtube.com/watch?v=KrhWsXCB3u8

'Understanding the Southern Annular Mode'

The Southern Annular Mode in winter

In winter, the usual position of the belt of westerly winds is close to Australia. Southern parts of the country typically get rainfall from cold fronts and troughs which pass over the southern reaches of Australia.

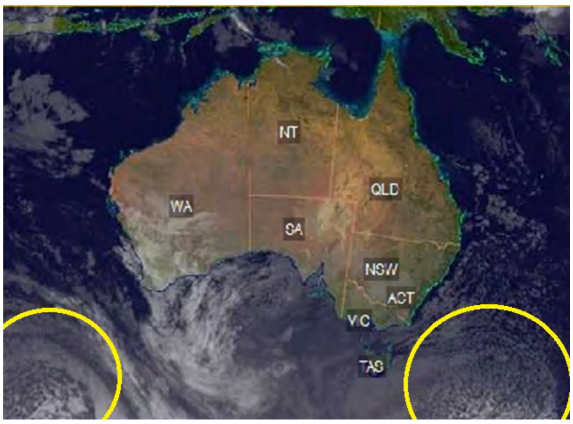
In a positive SAM phase, the belt of westerly winds contracts towards Antarctica. This results in weaker than normal westerly winds and higher pressures over southern Australia, restricting the passage of cold fronts inland. Generally, this means that there are fewer rain events in winter for southern Australia. However, in eastern Australia, the southward movement of the westerly winds means more easterly onshore flow is experienced. This wind is moist as it has just flowed from the Tasman and Coral seas and therefore typically brings more rainfall to the east.

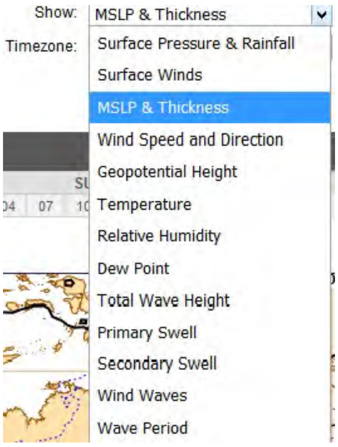


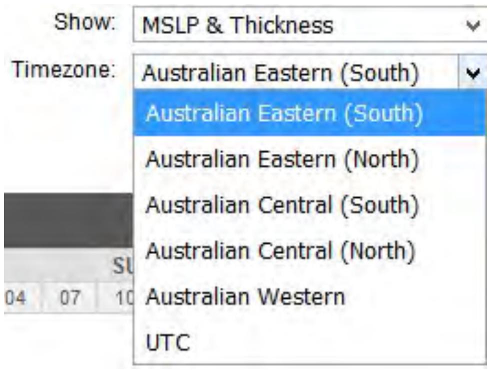
In a negative SAM phase, the belt of westerly winds expands and is positioned more northwards (towards the equator and Australia) . This results in stronger than normal westerly winds, lower atmospheric pressure, more cold fronts and more storm systems over southern Australia. Typically this means that there are more rain events in winter for southern Australia. However, in eastern Australia, the northward displacement of the westerly winds means less moist onshore flow from the east, and thus decreases rainfall for eastern Australia.

Satellite Pictures on BOM face page

At the BOM website, the first page shows a sat pic of Australia and surrounding areas. Of particular note for the mid-latitudes are the cloud formations of a cold front and the cold air pool behind it with a 'speckled' appearance. In this file picture cropped from a screenshot of a BOM internet weather page are two cold fronts with cloud bands over them and the 'speckled' cold air pools behind them. The position of the cold air pool and front depends on season, SAM and the low associated. Each of these 'speckles' is a storm with gusty winds, rain, possibly hail, and may endure from 2-3 hours to a day. Their intensity gradually decreases as the weather systems progress from west to East. Remember a system in vicinity of Perth WA takes roughly 3½ days to reach Melbourne so at a glance one can get an idea from a sat pic what's coming. It is also evident that behind the front is a 'push' mostly from south west in this example.

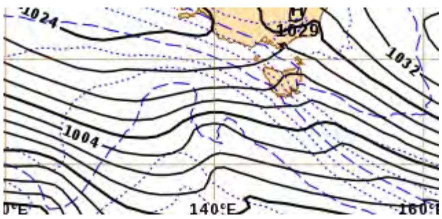


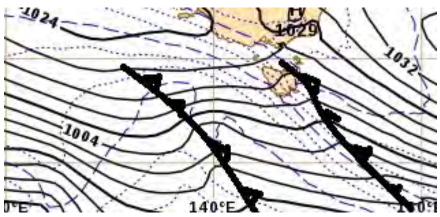




For voyaging offshore in Australia the 4 day map and the wind maps are very useful. If more information is desired, the BOM internet page and ‘Weather maps’ button will lead to the selection page as explained in Module 1 session 2. Items of interest here are particularly Satellite Images (current only) and ‘Weather Maps’ which opens to ‘Numerical Weather and Ocean Products’/Numerical Weather Prediction (NWP) Products. From here we can select MSLP thickness and later Geopotential Height. The MSLP (Mean Surface Level Pressure) thickness map requires some selections. It is a 7 day prediction map but has a 3 day option with every chance the 3 day option comes up first. There are three applicable settings. In the centre top ‘Show MSLP and thickness’, and ‘Time zone’, and on the right ‘Area and Period’. MSLP gives a computer produced 7 day map which, depending on your requirements is for 3 days, 3 hourly or 7 days, 6 hourly or combined with both. With any selection remember to press ‘Refresh View’ .

The MSLP & Thickness map has two displays, MSLP is in black and gives the latest forecast, thickness is in dashed blue and represents the height where pressure is 500 hpa. Thus the higher the thickness layer is, the warmer the air is. (Warmer = less density= higher level to be 500 hpa). Viewing the latest map and looking further to the west gives you 7 days and a guess as to what is coming from further west over the amount of mapped Indian Ocean. (10 days?). Fronts are not drawn in on a computer model. Fronts are usually where isobars are kinked.





To check what is happening in the upper atmosphere further, if desired, return to the selection for ‘Geopotential Height’, and select the appropriate height pressure level required. For example to examine for features such as jet streams, East Coast lows, Blocking highs, Upper level Convergence and Divergence suggested levels would be 500hpa and 200hpa wherein most of these events can be discerned. A jet stream can either be the cause of, or accentuate a low pressure system. It is a fast moving current of air resembling a flattened tube moving generally from west to east and can reach speeds up to 200 mph. Jets are subject to divergence and convergence, slowing and similar effects as on the surface. A divergence can cause a pressure drop which if it happens over a low pressure system (ascending air) increases the rate of ascending air effectively deepening the low and intensifying surrounding winds. Colour coding identifies jet speeds and as a rule above 80 kts is considered a jet. They can meander both horizontally and vertically.

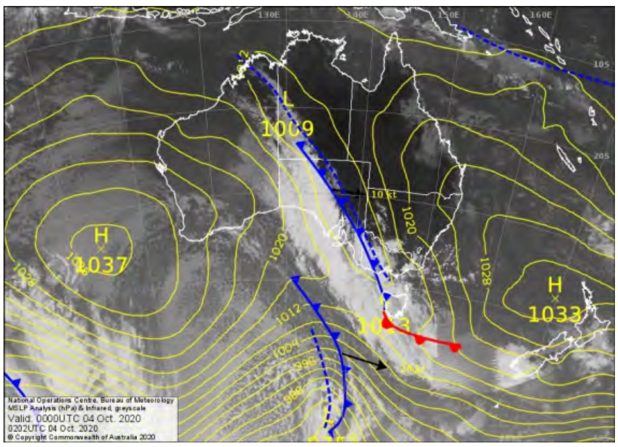
When forecasts and weather warnings mention 'developing low, deepening low, or intensifying low' there is a possibility of jet stream influence and severe weather.

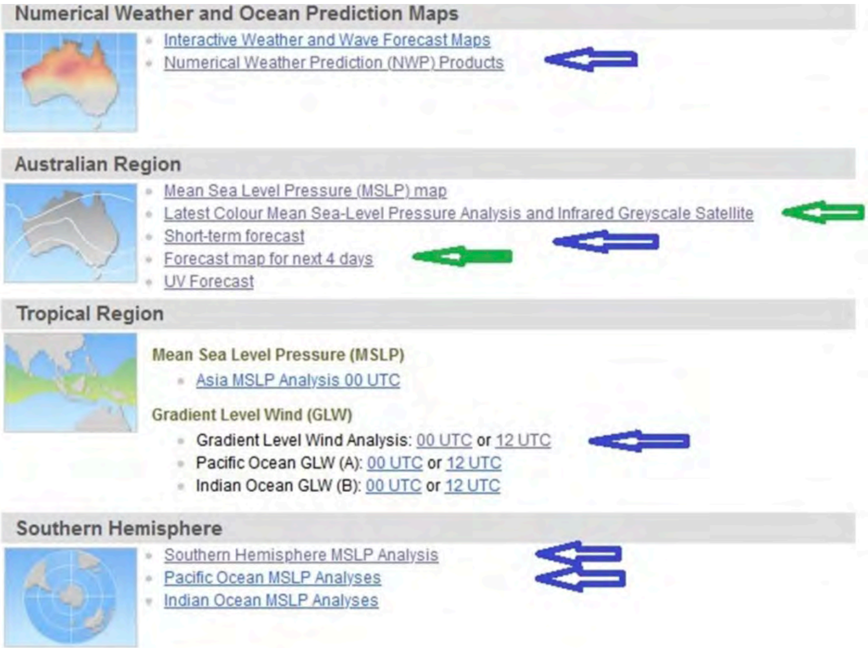
A much easier but less precise way to check is to use an aircraft SIGWX map. From the lower part of the BOM face page and 'Marine and Ocean button selection' is 'Aviation Weather Services' which when selected requires to accept a disclaimer and then a selection for 'Aviation Services' . Then select Aviation forecasts followed by SIGWX and then 'High Level SIGWX (FL250-FL630) with 4 time intervals. FL**** is flight level and requires 2 zeros after it to become altitude ie FL170 is altitude 17,000 ft.

There is not the continuity of forecasts ahead as aircraft travel in much shorter time periods but if you are stuck in a harbour somewhere wondering what is happening and how long before you can move, every bit of information helps. Selecting the map area above the sigwx FL time choices allows to inspect everywhere around the world which is very useful route monitoring for distant voyagers.

Returning to the index page for Weather Maps

After clicking the ‘weather maps’ button on the face page of the BOM site, the index page has been marked with green indicator arrows for map products of shorter term interest and blue indicator arrows for products adaptible for longer outlooks. Latest colour Mean Sea-Level Pressure Anaysis and Infrared Greyscale Satellite This map and picture has isobars and clouds shown along with the sat-pic which enables ‘at a glance’ information, but as there is no prognosis involved some experience of the west-east movement is helpful or in conjunction with other products. The following article ‘Interpreting the Gradient Wind Analysis’ is largely adapted and reprinted from one of the excellent Bureau Of Meteorology explanatory papers on many subjects and available through their website.





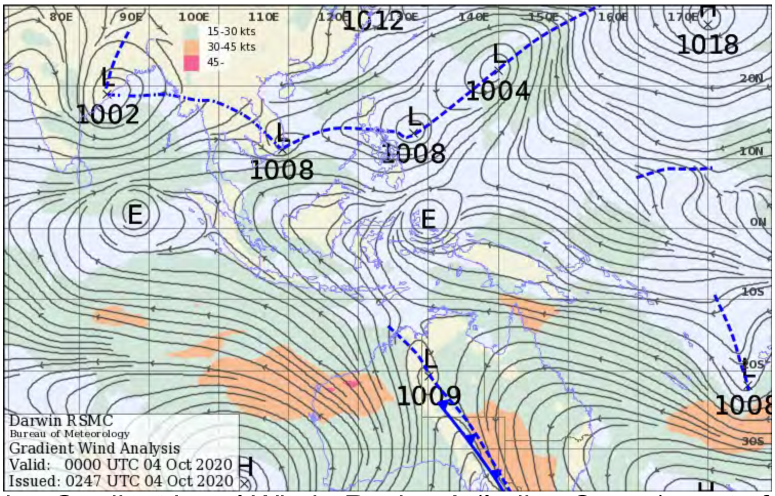
The 'Gradient level Wind Analysis is best used for the tropics and especially so for the northern Australian coastlines where the very small pressure differences render conventional weather maps of little use. Adjustment is required to reduce wind strength for friction 20% over sea and 40% over land. Wind deflections for highs and lows also must be factored in for direction varying from 10% near the equator and more further away.

The Gradient Level Wind Analysis is a snapshot of the airflow near the surface of the earth. The arrowed lines are called streamlines and represent the direction of the wind. The dashed lines are called isotachs, and connect points of equal wind speed. The standard isotach intervals are 15 and 30 knots (28 km/h and 56 km/h) - knots is the preferred unit for these charts as they complement the Bureau's marine services. Adjustment is required for windspeed friction loss at surface and deflection resulting-read below.

Current Gradient Level Wind Analysis, twice daily, 00 UTC and 1200 UTC

Asian Region Gradient Level Wind

Black and white half domain charts are also available. See below.



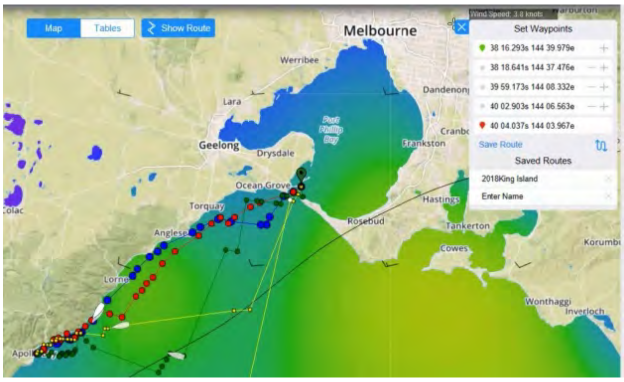
Asian Region Gradient Level Wind - Region A (Indian Ocean) west of roughly 123^{O}E

Asian Region Gradient Level Wind - Region B (Pacific Ocean) east of roughly 123^{O}E

Current MSLP

Asian Region MSLP

The gradient level lies about 1000 metres above the earth's surface, and is the level most representative of the air flow in the lower atmosphere immediately above the layer affected by surface friction. This level is free of local wind and topographic effects (such as sea breezes, downslope winds as katabatics etc) as these are significant for sailing.



Streamline charts are much more useful than isobaric pressure (Mean Surface Level Pressure MSLP) charts for showing the weather patterns over tropical areas. While MSLP charts are good for estimating wind direction and strength over mid and high latitudes, in the tropics pressure gradients are weak and often don't give a good indication of the prevailing winds. Meteorologists overcome this difficulty by drawing charts of the actual wind flow. The surface wind may be estimated by decreasing the gradient level wind speed by approximately 20% over the ocean, 40% over land and assuming a direction deviation of about 10-30 degrees. If looking along the direction of the wind, the deviation is to the right if low pressure is on your right (or if high pressure is on your left).

On streamline charts, low pressure systems (including tropical cyclones) appear as inflowing circulations - clockwise in the southern hemisphere and anticlockwise in the northern hemisphere. High pressure systems appear as outflowing circulations, with direction of rotation opposite to that of the lows. Near the equator, when the wind changes direction as it flows from one hemisphere into the other, closed eddies may appear; these are indicated by an "E" and are not associated with high or low pressure (and are often associated with clear weather).

Lows are indicated by an L symbol, highs by H , accompanied with the value of central pressure in hectoPascals. Tropical cyclones are particularly intense low pressure systems, identified by the cyclone symbol, together with information on the name, maximum wind speed (knots) , central pressure (hPa) and current direction of movement (speed in knots). In the northwest Pacific, tropical cyclones are called Tropical Storms, and the more intense systems are called Typhoons. In Australia, these systems are called Tropical Cyclones and Severe Tropical Cyclones.

The broad streams of air flowing toward the equator from the mid-latitude highs are called the trade winds: southeast winds in the southern hemisphere and northeast winds in the north; these wind streams tend to be strongest in the winter hemisphere when high pressure systems are more intense.

In the summer hemisphere, persistent winds tend to flow into the near-equatorial area from the opposite hemisphere, and are frequently associated with widespread cloudiness and heavy rain. These winds are referred to as the northwest monsoon in the southern hemisphere

(December-March) and the southwest monsoon in the northern hemisphere (June-September). The monsoon flow is on the equatorward side of an area of low pressure called the monsoon trough, and tropical cyclones often develop from lows located in this trough.

Weather Routing

The process involves two pressure called the monsoon trough, and tropical cyclones often

critical pieces of information: accurate weather forecasts, which come in the form of Gridded Binary (GRIB) files, and the vessel's performance characteristics, which come in the form of polars. Polars are developed by the manufacturer for each particular standard vessel, and predict a sailboat's speed through the water at various wind speeds and angles. Any deviation from the standard vessel will affect the supplied polars, particularly loaded displacement and rig. With Predictwind software, a range of vessels polars are supplied and a close fitting alternative can be selected. While private weather-forecasting and weather-routing services use GRIB files, the raw data for these files is typically collected by government organizations such as the National Oceanic and Atmospheric Association, which builds its free Global Forecast System, or GFS files, every six hours. The European Union's European Centre for Medium-Range Weather Forecasts (ECMWF) releases fee-based GRIBs twice daily. If racing, grib files need to be watched carefully and especially near mountainous coasts as the grid parameters used can skip detailed features which may have a bearing.

Weather routing takes into account the weather forecasts for the intended journey and plots where it thinks you'll be relative to the predicted weather because it knows your boat's predicted speeds in different conditions. Additionally, weather-routing software can help users determine the optimal departure time and routing based on user-specified parameters. These parameters can include maximum acceptable wind speeds or wave heights, as well as the percentage of time that the boat will be on a particular point of sail. While long-range GRIB files (sometimes extending out to 16 days) are available, all navigators worth their salt understand that newer forecasts always outshine old information. Also, given the size of some GRIB files and the potential data costs and downloading times involved, navigators are cautioned to only download the forecasts that they need, rather than files for an entire region.

Predict Wind

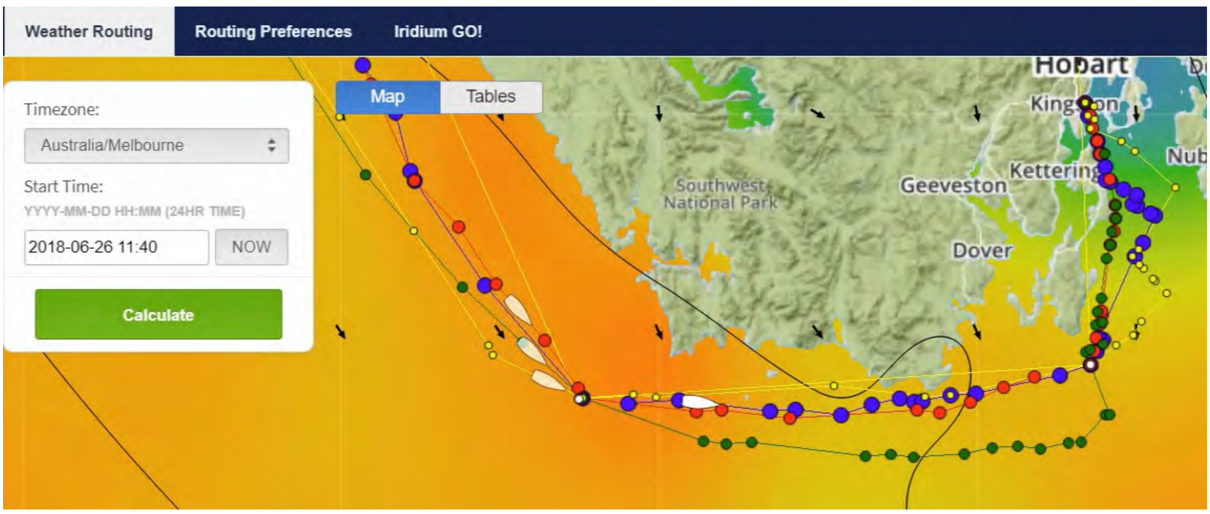
Predict Wind Weather and Maps

Four weather models are available with any two displayed side by side for comparison and evaluation. These are the American Global Forecast System (GFS) and the ECMWF System (European Centre for Medium-Range Weather Forecasts). Predict wind makes available both of these models as adjusted by their own meteorologists and then labelled as PWG and PWE. Initially select region and time and then in the selection menu are Forecast tables, Graphs, Wind maps, Gust maps, Cape maps, Wave maps, Rain maps, Clouds, Air temperature and

Sea temperature. The maps can be played as animations and paused or reversed as required. CAPE is an acronym for Convective Available Potential Energy. Its value is useful for determining the severe weather potential at a given place and time. Eg. Thunderstorms, lightning etc.

Predict Wind Offshore App .

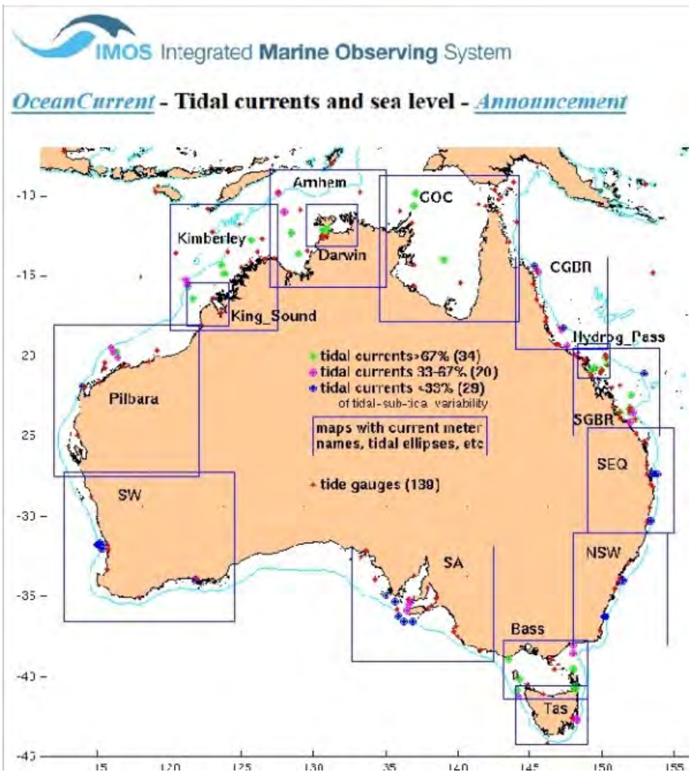
This is a sample menu for selecting and downloading a choice of grib files to program the application. Importantly it provides the file sizes of the choices as the use if required of sat-phones can be very slow to download and extremely expensive. Therefore advice is to carefully download at your residence initially and update at sea only when necessary. The menu pic shown here illustrates the selection choices as:-Grib High res, Grib Offshore, Ocean Grib, Weather Routing, Spot Forecast, GMDSS, Satellite Imagery, Next available forecast timeslot. A selection is also available to use Iridium Go satellite system if fitted. The system is too vast to describe in these notes but generally is described in preceding articles inc weather routing. The Predict wind program along with ‘Expedition’ has been used extensively by many top-flight racers and world-wide cruisers very successfully for many years now (2020). With weather routing, the capabilities to plan your voyage are very powerful and enable selections not just for racing but also for comfortable cruising with chosen parameters such as maximum



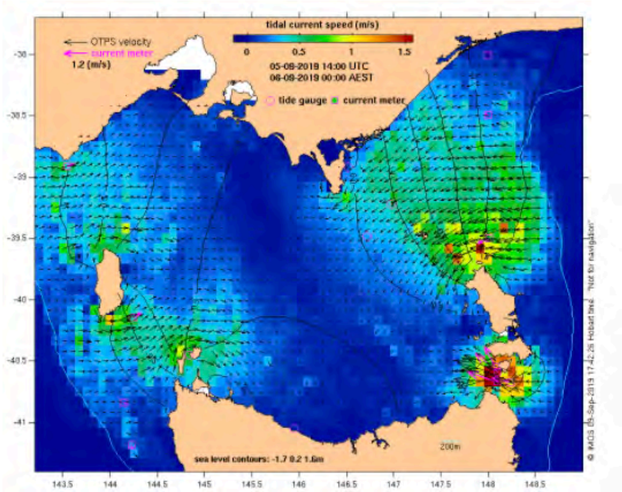
wave height, wind strength, time on the wind and similar. Other options include departure planning and a useful feature with tables and graphs for planning and analysis.

IMOS (Integrated Marine Observing System)

http://oceancurrent.imos.org.au/tides/index.htm

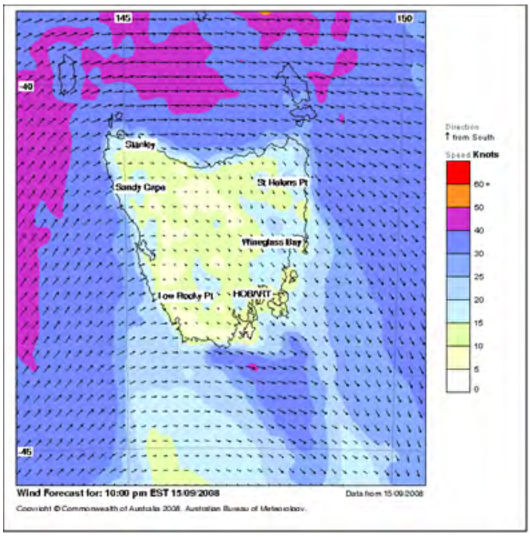


Within this site for tidal currents is excellent information on ocean currents around Australia. This scientific organisation based in Tasmania is constantly adding information and scientific material including tidal data. Sufficient data is presented for tides to form the basis for calculated information in a graphical manner and several animations are presented which can be played for concept or paused as required. Ocean currents www.oceancurrent.imos.org.au. There are also excellent information pieces and definitions to accompany an enquirer,



Topography and Mountainous Coasts

Coastal Voyages and races are influenced to a very large extent by adjacent topography and tides. In trans Ocean voyages the emphasis is on strategy with wind directions and currents. Melbourne- Launceston, Melbourne-King Island, Melbourne-Stanley as across open water and Melbourne- Hobart as open water plus coastal whereas Melbourne-Apollo Bay, Melbourne-Port Fairy, and Melbourne-Portland, Melbourne to Port Lincoln S.A, and Australia East coast voyages would be entirely coastal. In all these events the start and finish destination at least is influenced by the land in some way and the coastal topography is a major influence on the weather conditions to be encountered. When sailing near a coast, a careful study of the land topography can identify where winds might be bent, stopped or accelerated. Areas where sea breeze, land breeze or katabatics are possible etc. Examining these and other possibilities further can assist greatly.



This picture above shows acceleration around Tasmania with funneling in Bass St. and the effect of wind with an obstruction of high mountains. The centre of the low pressure system a little further south and lee side wind shadow. Rather than lift over the Tasmanian highlands the wind accelerates around the obstructions for an easier path with system wind flow. It then has to squeeze between Tasmania, King and Flinders Islands as well as Cape Otway and Wilsons Promontory resulting in storm force winds.

Mountainous coasts eg, Cape Otway, steep cliffs and high hills affect winds over the sea in similar ways but depending on direction and the stability of the atmospheric conditions. It does one well to remember that wind will always go around an obstruction rather than go over it if it can. The principles involved apply to any coast but are well well illustrated by the Port Fairy race usually held in Autumn when more stable conditions can be expected.

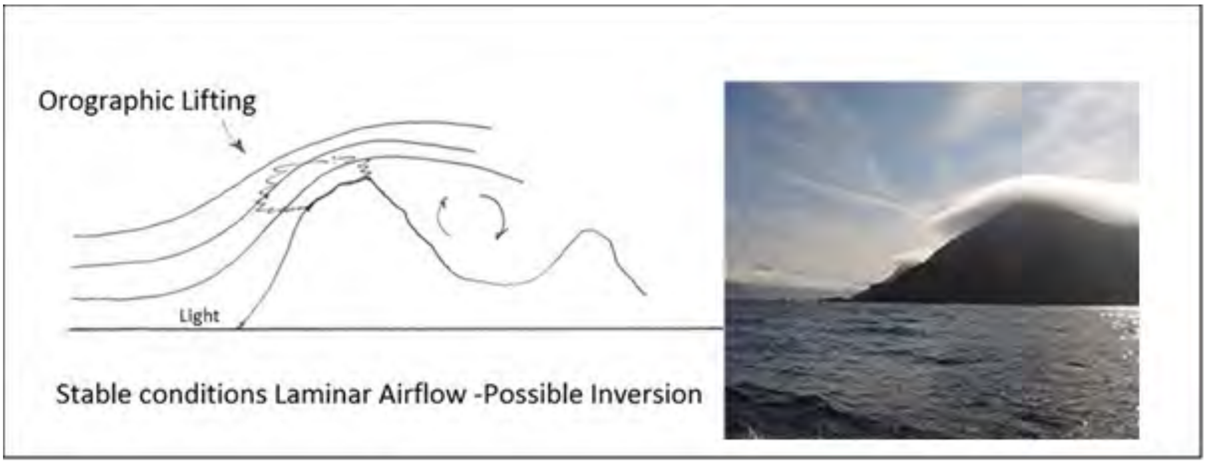
Autumn background

Considering summer when maximum solar radiation is received, the earth acts like a giant heatbank. Although radiating heat out at night the loss is less than received during the day and heat accumulation occurs. By the autumn solstice the radiation out and received equalize and as the days shorten, gradually more radiates out than received. In these circumstances the 'heat bank earth' begins to radiate out heat according to the differential. The huge volumes of water surrounding Australia assist with this effect. Thus autumn weather is more moderate and at the same time in our latitude, the band of highs is usually centred overhead with high pressure system weather more common. Water in particular, has a high specific heat index and is a much greater influence than land in moderating temperature.

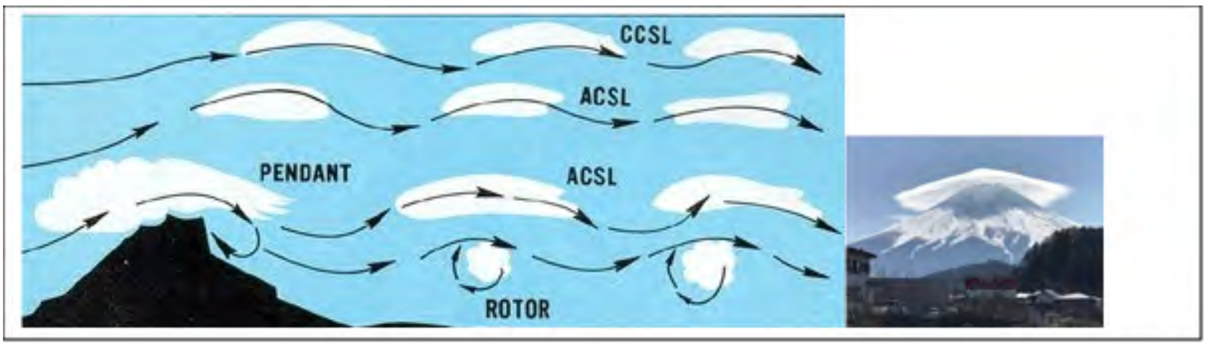
With cooler nights and less cloud, stable morning conditions with light winds are very likely and downward temperature inversions more prevalent. Weather conditions are therefore more stable and in addition the downward air of the band of highs at this time of year, keeps a lid on the surface generally. Severe weather is still possible but less frequent.

By the winter solstice the radiation received begins to improve but radiation out is in excess of that in so the ‘heat bank earth’ is still decreasing until minimum late July. It then again starts to increase such that by the September equinox radiation out and in equalize although ‘heat bank earth’ requires a further month before accumulating excess. Contrasting spring is that the water is only gradually heating and at a much slower rate than the shallow land with therefore greater daily differences. The greater the temperature differences the more difference in weather.

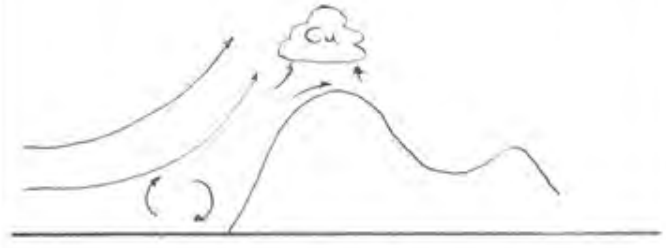
In stable autumn conditions, orographic lifting on a high coast can force air above saturation level forming cap cloud or very often lenticular clouds which often last only a short while forming a lens shaped cap but are an important indicator.



Lenticular, and wave cloud particularly, are developed when relatively stable faster moving air is forced up over a barrier creating a gravity wave downwind. If sufficient moisture is present at that height the up wave crest expands and cools reaching dew point while the downwave warms below dew point. The cloud does not move with the air but appears constant as new air is forced upwards. It is the cap cloud shape that indicates laminar flow and wave clouds indicating somewhat stable and faster air aloft.



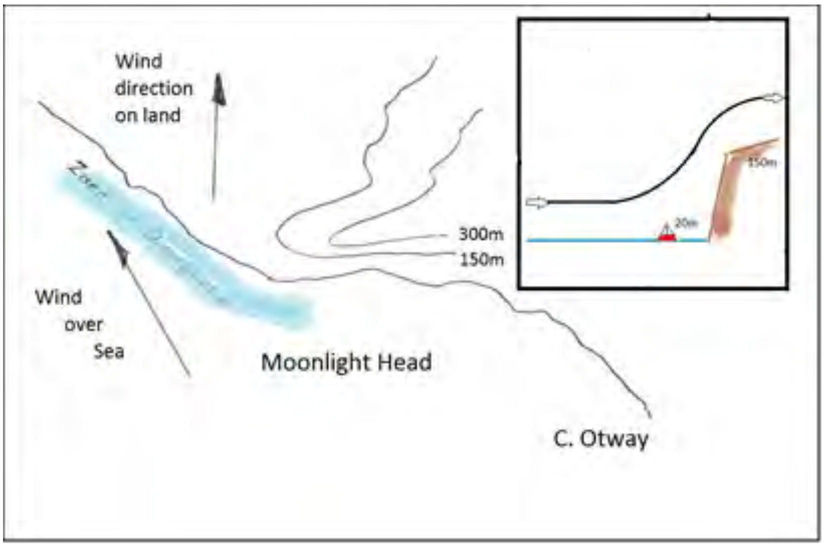
CCSL-Cirrocumulus standing lenticular
ACSL-Altocumulus standing lenticular.



Convection breaks laminar flow -Rotors form seaward

Laminar flow can still exist with no cloud. It has been known for two yachts sailing in the same direction some distance apart and on opposite tacks. They were therefore one on a rotor, the other in gradient wind. Wind strengths can vary depending on where one is in the system.

Laminar flow can still exist with no cloud. It has been known for two yachts sailing in the same direction some distance apart and on opposite tacks. They were therefore one on a rotor, the other in gradient wind. Wind strengths can vary depending on where one is in the system. This diagram can be reversed to apply South Easterly or Northerly at C Otway. As the day progresses and the land warms, the presence of cumulus cloud firstly on the peak indicates stability breaking down and unstable conditions developing. Instability changes sailing conditions as thermals provide turbulence and mixing. Sail settings alter to suit less twist and stronger breezes. Sailing positioning will be more in line with sea or tidal current. Bullets occur in hilly areas such as the Whitsundays, or locally as an example, Bass Strait Erith Island in strong North-Westerlies. Here the wind is obstructed and piles up more vertically due to wind momentum until gravity forces the wind to break somewhat like a wave. Think of water flowing in a channel against an obstruction to visualize.

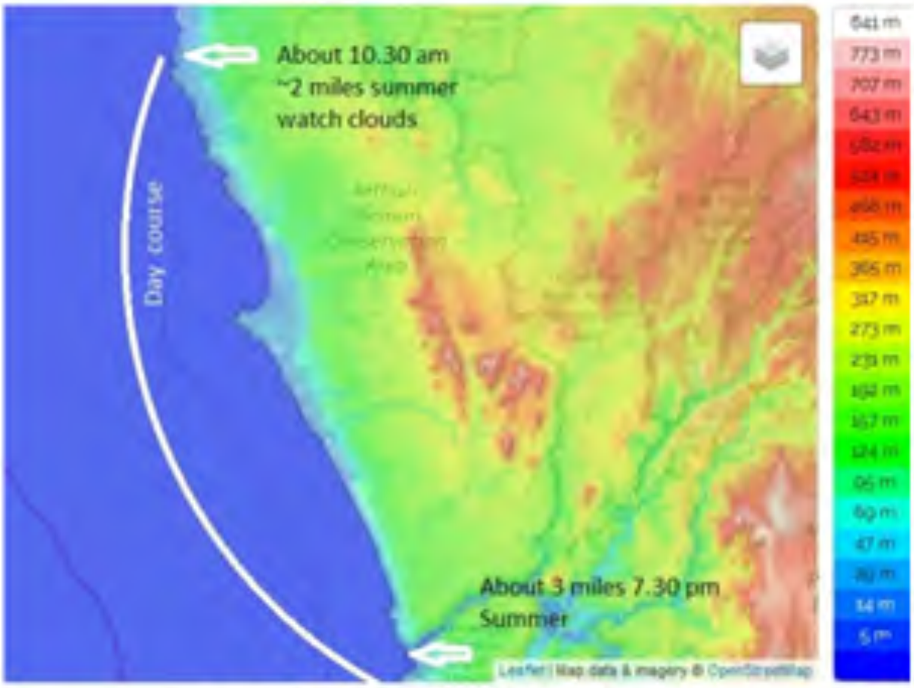


Parking Lots

More so in stable conditions and laminar flow, air streams can establish which pass smoothly over high and steep cliff faces and hills such that close too underneath is an almost windless area. Recognising cloud formation as key to stable or unstable conditions and topography is key to avoiding this type of situation. Even in unstable conditions, wind can 'pile up' in front of a cliff or steep hill and thus be stationary =no wind. Have you seen documentary movie clips of salmon fish swimming upstream in swift rivers to spawn? The fish 'parks' behind an obstruction in the water current, where there is a stationary area it can rest and not have to swim against current. In reverse, wind off the land 'skips' over the area close-in with confused eddies or a 'suction'. Moonlight head, some 20 miles west of Cape Otway is a notorious parking lot with many yachts having to 'park' up to a half day watching others sail past. The land behind rises smoothly which aids the laminar flow to establish smooth streamlines over the cliff. The coast westwards has many such cliff faces almost vertical and with similar reputations.

Sea breezes

The coastal sea-breeze is especially important with light gradient winds and can give rise to strengths of up to around 23 knots. Of first importance is to recognize possible areas likely, and secondly the signs of formation. The tell-tale Cumulus (Cu) clouds over the land are usually first indications and can be accompanied by a small drop in barometric pressure if one is close to land. (Air expanding with less density). If wind pressure is desired and the likely sea breeze direction suitable, a key point is to remember the breeze starts mostly perpendicular and close to the coast, say 2 miles. Thus one needs to do the sums of distance and time to get there in terms of reward versus where one currently is. As the sea breeze develops, the 'sink' will appear offshore as a cloudless area in the sky because it is the descending air of the circulation, and the Cu clouds will slowly move towards it and gradually diminish next to the clear sky. In action the sea



Tasmania West Coast Vicinity Sandy Cape

breeze has two ‘fronts’. Firstly a calm for maybe one to one and a half hours close to shore which then moves out to sea. This sea-breeze front moves out fairly rapidly depending on the heating available, to become the calm under the sink. If you are further out to sea when the sea-breeze is developing, your breeze will gradually decay and the same calm will trap you for the same period as if you were near shore (it is the downwards moving air of the circulation) until the seabreeze itself reaches you, (downward air) in front of it and depending on strength may move out some 30 miles. There is always a calm or transition for a short period before the wind is encountered. The other front (ascending air) moves out over the land bringing cooler air behind it. The tell-tale Cu clouds move inland with the front.

The further out from the coast, the longer it takes the front to arrive while you are in light winds, and thus the later the breeze appears. Similarly, as the heat over the land diminishes towards evening, the sea-breeze will die at its’ outermost and shrink back towards the shore. The weather map and forecast is therefore quite important for tactics in positioning especially in light weather. Cloud identification in regard to blanket cover and heating conjoins with topography and the gradient wind to identify the most likely areas. For example sand areas, dry grasslands, and sparsely covered hills or mountains gain or lose temperature more rapidly and green forested areas more slowly. Especially in light gradient winds a predominantly clear sky will allow the land to cool rapidly favouring a **land breeze** formation. Again, a very light regime or calm will occur before breeze arrives. Land breeze is cool and the layer of wind usually not more than 100m vertically. It generally starts one to one and a half miles from shore about 1 am and does not move out very far but has been recorded in some European areas to 25 km. Generally expect up to 6kts.

Katabatics or downslope winds.

A katabatic (downslope wind) is very similar to a land breeze but in the sailing sense is more related to downslope into a valley or river valley. In terrains that are hilly or mountainous, in a near cloudless sky, the high land radiates heat out into space, and the already cool air from elevation in contact with the high land cools more becoming more dense. This heavier air begins to slide downslope into valleys gathering heat adiabatically as it descends but losing heat overall due to continued contact with the cold ground. The cold air gathers momentum as it drains down the valley, eventually reaching the coast and spreading out seaward. Given favourable conditions, velocities to around 20 knots can be encountered sometimes reinforced by land breeze. They generally dissipate by two miles offshore. The most famous katabatics are the Mediterranean mistral, the Bora and the Antarctic wind off Mount Erabus which reaches 100 knots. A relatively smooth and long downward slope enhances strength. Gains of 30-40 miles in a night over a competitor are possible. Usually those 5-10 miles out to sea.

To take advantage of a Land breeze or katabatic.

Know the topography for presence of valleys and relatively smooth slopes from hilly terrain. It requires a preferably gentle to moderate outfall slope of at least moderate length and mainly relative smoothness. Eg heavily tree'd growth or roughness inhibits the process.

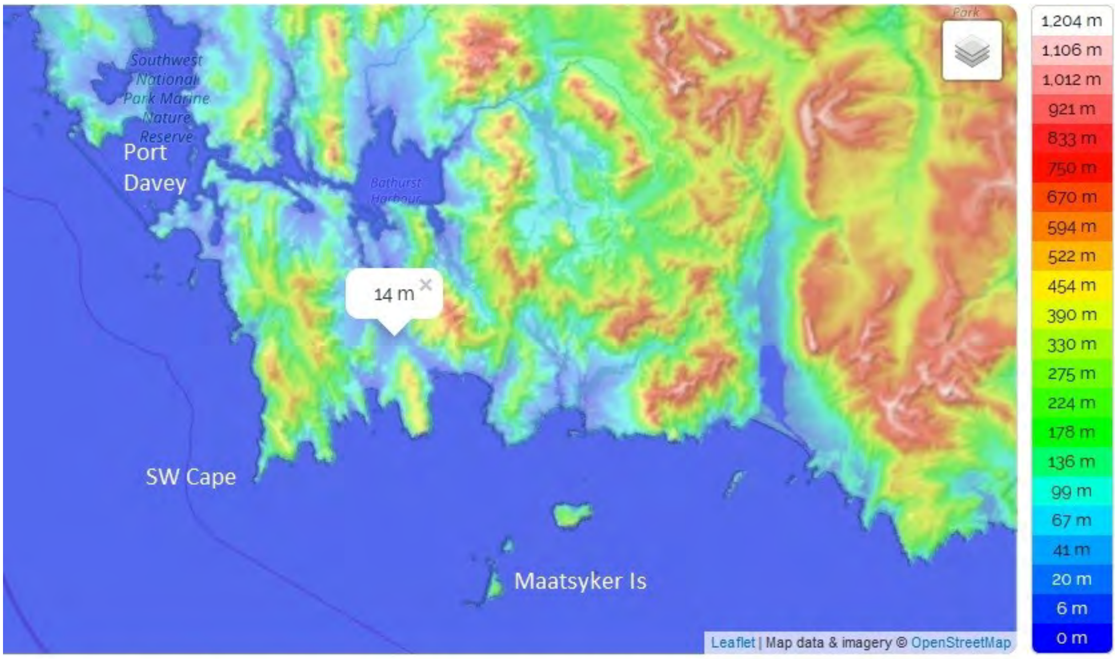
Be in the right place by 1 am to 9 am. And less than 2 miles from shore. It is very frustrating to know the right conditions will be present but not be there at the right time.

The sky must have been and be clear.

The gradient wind is preferably light.

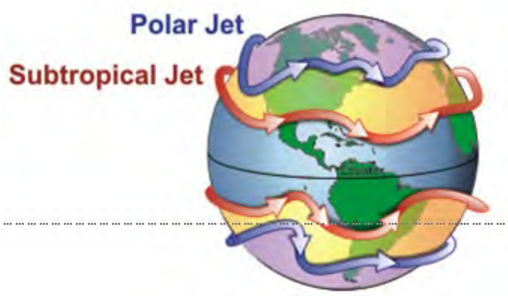
Rivers are usually associated with a valley which is a primary indicator of where a katabatic may be found -Yarra Valley Vic., Derwent River Tas. and Tweed Heads. Queensland come to mind. The other consideration with rivers is the outflow. If the river water has a differential temperature to the sea water and depending on the sea state (turbulent mixing), there can be marked differences with currents, waves and in light winds. It can pay to check recent rainfall.

Reading: Wind Strategy-D Houghton. So for a keen sailor it pays to examine the planned coastal voyage for suitable areas where sea-breezes, katabatics and land breeze might occur. Modern technology with a satellite process called 'Altimetry' has made this task much simpler. A combination of photography and measurements of surface heights gives almost 3-dimensional displays. In the example altimetry map, the elevations and valleys can be easily ascertained.

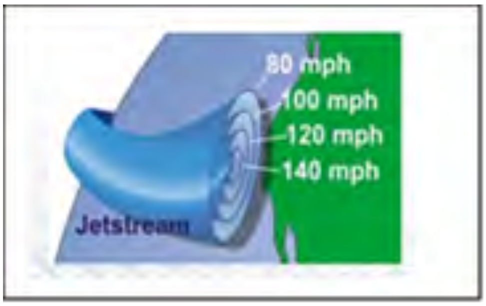


Tasmania, Australia Maatsyker Is. 43 deg 39.1' S, 146 deg 16.6'E

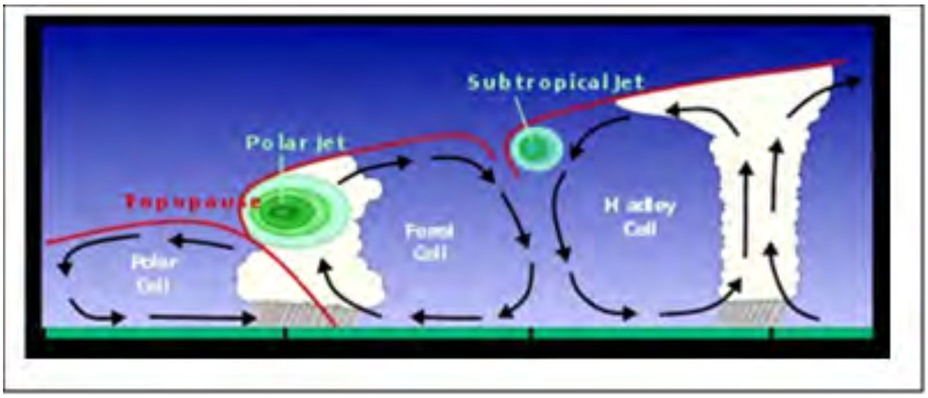
Deepening or intensifying lows



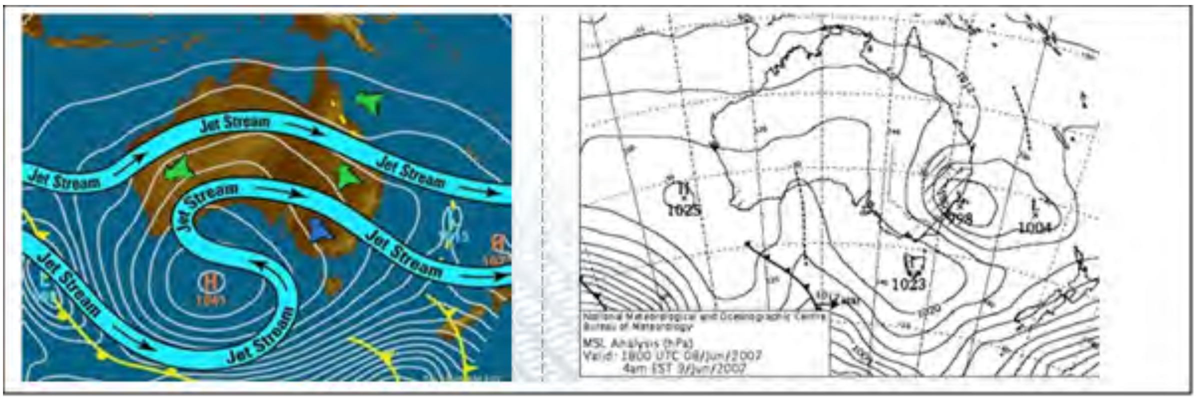
Two principal jet streams exist in each hemisphere, the polar and the subtropical jets. The location of low and high pressure systems and air temperature all affect when and where a jet stream travels. Jet streams form a border between hot and cold air. Because air temperature influences jet streams, they are more active in the winter when there are wider ranges of temperatures between the competing Antarctic and tropic air masses.



Temperature also influences the velocity of the jet stream. The greater the difference in air temperature, the faster the jet stream, which can reach speeds of up to 250 mph (402 kph) or greater, but average about 110 mph (177 kph).



They may be thought of as frontal zones separating warm and cold vertical cell boundaries. They tend to move with seasonal shifts of the cells (Hadley, Ferrel & Polar) but normally at equinox the Subtropical jet is about 20-30º latitude and the Polar jet about 50-60º latitude. The Hadley cell operates with tropical warm, less dense air which is therefore of greater altitude, the STJ (Sub Tropical Jet) is 6.2 to 9.9 miles altitude. The PJ (Polar Jet) with colder, more dense air is about 4.3 to 7.5 miles altitude. These altitudes typically correspond to the 250 hpa level in the atmosphere, maps mostly used with aviation. Jet streams can have meanders in direction. If so, the meander will have a west to east drift at considerably lesser speeds than their constituent jet wind speed.



A loop in the polar jet can bring unseasonal very cold air with it and remain so for some time. Similarly a loop polewards of the STJ will bring unusually hot weather to higher latitudes it encompasses. In this diagram note the anticlockwise loop enhancing a very strong high and the clockwise loop associated with the later depression which slammed Newcastle and drove the bulk ship PASHA BULKER ashore. The depression was classified as an East Coast Low.

In our area of interest, their possible effect in enhancing or deepening a low is of primary interest. When a low is map observed or warned to be ‘deepening, intensifying or developing’ it can be well to check for a jet presence, as if so serious bad weather can result and the sailors maxim of ‘AVOID, AVOID, AVOID’ is best followed. As a low is an ascending air system, a divergence (spreading out) in upper levels creates ‘suction’ which pulls air up faster and thus reduces surface pressure levels intensifying the low. Much more upper level weather is associated with jets but for coastal purposes is not warranted. Also comparing the BOM ‘Interactive weather and wave maps’ 200 hpa & 500 hpa maps noting isotachs (lines of equal wind strength) 60+ is useful when considering west to east movement of features. Surface winds are roughly half of that shown on a 500 hpa map and a third of that on 200 hpa. On the positive side, the STJ prevents cyclones from continuing below 20º latitude as it tears the top of the cyclone system thus removing its’ source of power. Perhaps this kind of analysis is better suited to being in a secure harbour pondering when to leave on another coastal leg. The available forecasts should give sufficient warning when at sea to reach a suitable refuge and if internet availability allows, a quick check on aviation charts SIGWX may assist. (As described earlier).

Jet Streams and the weather edited from Wikipedia

Jets streams play a key role in determining the weather because they usually separate colder air and warmer air. Jet streams generally push air masses around, moving weather systems to new areas and even causing them to stall if they have moved too far away.

While they are typically used as one of the factors in predicting weather, jet streams don’t generally follow a straight path — the patterns are called peaks and troughs — so they can shift, causing some to point at the poor forecasting skills of meteorologists.

Climatologists say that changes in the jet streams are closely tied to global warming, especially the polar jet streams, because there is a great deal of evidence (2015) that the North and South poles are warming faster than the remainder of the planet. Also some recent research suggesting that the ITCZ (Intertropical Convegence Zone is shifting N about 0.9º Lat per decade along with the SAM (Southern Annular Mode) . When the jets streams are warmer, their ups and downs become more extreme, bringing different types of weather to areas that are not accustomed to climate variations. If the jet stream dips north, for example, it takes the colder air masses with it.

Jet streams also have an impact on air travel and are used to determine flight patterns. An airplane can travel much faster, and save fuel, by getting “sucked up” in the jet stream. That can also cause a bumpy flight, because the jet stream is sometimes unpredictable and can cause sudden movement, even when the weather looks calm and clear.

Subtropical jet

A second factor which contributes to a concentrated jet is more applicable to the subtropical jet which forms at the poleward limit of the tropical Hadley cell, and to first order this circulation is symmetric with respect to longitude. Tropical air rises to the tropopause, and having cooled aloft, moves downhill poleward before sinking; this is the Hadley cell circulation. As it does so it tends to conserve angular momentum, since friction with the ground is slight. Air masses that begin moving poleward are deflected eastward by the Coriolis force (true for either hemisphere), which for poleward moving air implies an increased westerly component of the winds (note that deflection is leftward in the southern hemisphere). Confused? This statement is the opposite of trade winds which are moving from poleward towards the equator but is the same deflection.

Polar front jet stream, also called polar front jet or mid-latitude jet stream, a belt of powerful upper-level winds that sits atop the polar front. The winds are strongest in the tropopause, which is the upper boundary of the troposphere, and move in a generally westerly direction in mid-latitudes. The vertical wind shear which extends below the core of this jet stream is associated with horizontal temperature gradients that extend to the surface. As a consequence, this jet manifests itself as a front that marks the division between colder air over a deep layer and warmer air over a deep layer. The polar front jet can be baroclinically unstable and break up into Rossby waves. Rossby waves, also known as planetary waves, naturally occur in rotating fluids. Within the Earth's ocean and atmosphere, these waves form as a result of the rotation of the planet.

Atmospheric Rossby Waves

According to the NOAA, atmospheric Rossby waves form primarily as a result of the Earth's geography. Rossby waves help transfer heat from the tropics toward the poles and cold air toward the tropics in an attempt to return atmosphere to balance. They also help locate the jet stream and mark out the track of surface low pressure systems. The slow motion of these waves often results in fairly long, persistent weather patterns.

Systems to avoid.

There are some severe weather systems which have a history of trouble for mariners. These mostly are a product of cold air masses brought up from well south and inter-reacting with moist warm weather of a near tropical nature. A common feature is a rapid drop in barometric pressure signalling a very descriptive term “explosive cyclogenesis”. When offshore, particular attention to the barometer and the rate of change in 3 hourly running intervals is highly recommended. Remember again if the barometer has been knocked such that its’ setting has changed, record the new value and continue logging again. It is the rate of change primarily important. Of course it helps to have a reasonably accurate setting but our course notes have described how to set and obtain values to do so in Module 1.

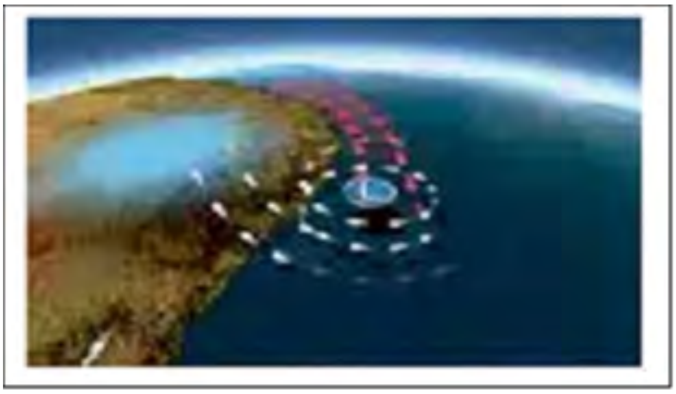
East Coast Lows

EC Lows – Especially May to September, the area of NSW coast and Queensland around the border should be watched on weather maps and a listening watch kept for warnings. Particularly a barometer drop of 6 to 10 hpa in 24 hrs with 10 hpa signaling a ‘bomb’. Particularly the southern sector extending some 80 miles has the more severe winds, some recorded to 70 knots. East coast lows typically form after a low or deep trough intensifies in the upper atmosphere over eastern Australia. A low pressure system then develops at sea level near the coast to the east of the upper level system, often intensifying rapidly. These cells of low pressure are typically quite small relative to the broad synoptic features, but can interact with developing high pressure systems to the south to produce severe gale conditions over periods of up to several days. These storm systems draw their energy from a combination of strong ocean temperature gradients, coastal convergence, uplift and a supply of moist sub-tropical air at the surface. The East Australian Current and the Great Dividing Range are principal players in the development of these storms, the circulation centres of which often track very close to the coast over considerable distances. Adapted from EAST COAST LOW RISKS Bruce Harper and Ken Granger

Australian east coast lows (known locally as east coast lows and sometimes as east coast cyclones are *extratropical cyclones* (extratropical means poleward of the tropic of capricorn) the most intense of these systems have many of the characteristics of *subtropical cyclones* They develop between 25˚south and 40˚south and within 5˚ long. of the Australian coastline, typically during the winter months. Each year there are about ten "significant impact" maritime lows. *Explosive cyclogenesis* is seen on average just once per year, but these storms cause significant wind and flood damage when they occur. Australian east coast cyclones vary in size from *mesoscale* (approximately 10 km to 100 km) to *synoptic scale* (approximately 100km to 1,000km). These storms which mostly affect the south east coast should not be confused with *Australian region tropical cyclones* which typically affect the northern half of the continent.

Australian east coast lows often intensify rapidly overnight making them one of the more dangerous weather systems to affect the NSW coast. Refer to excellent BOM video

Ask BOM:What is an Eastcoast Low. https://www.youtube.com/watch?v=FCgULsMi9iQ



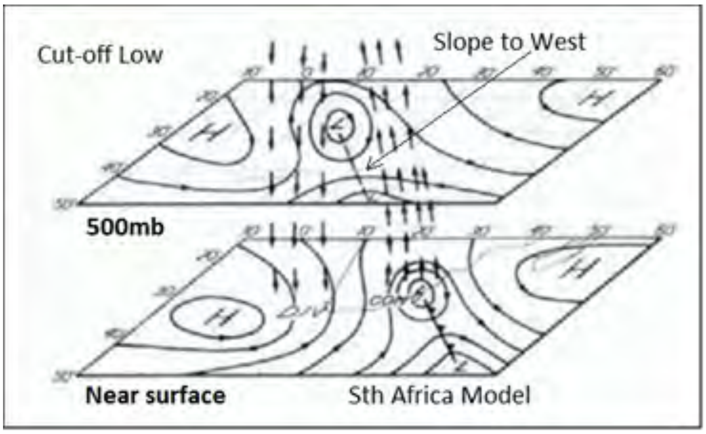
The pool of cold air (light blue) early shows in a 500mb map as -20ºC or colder and is a warning. The diagram shows the moist tropical air over the EAC feeding into the system.

The incidence of these types of storms can be seen to fluctuate quite widely from one year to the next, with none in some years and the highest incidence being twelve in 1978/79. Another feature of east coast low development is the tendency for clustering of events when conditions remain favourable. For example, near Brisbane, almost one third of events occur within 20 days of a preceding event. Correlations of east coast cyclones with the inter-annual differences of the *Southern Oscillation Index* (SOI) indicate a strong preference for these storms to form just after a large swing from negative to positive Southern Oscillation index values and especially between swings from negative SOI the year before and positive SOI the year after. This suggests a preference for formation of east coast cyclones between extreme events of the Southern Oscillation Index. Adapted from Wikipedia.

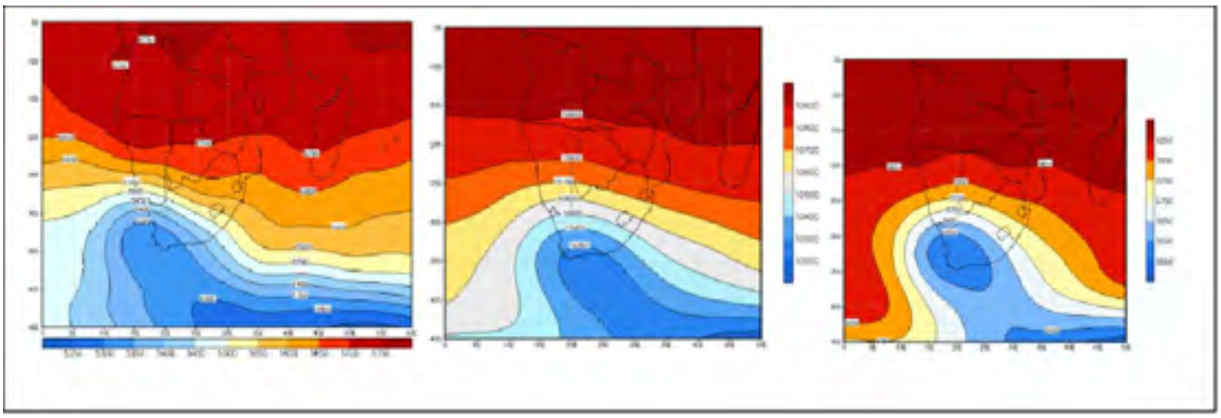
Cut off Low

A closed upper-level low which has become completely displaced (cut off) from basic westerly current, and moves independently of that current. Cutoff lows may remain nearly stationary for days, or on occasion may move westward opposite to the prevailing flow aloft (i.e., retrogression).

"Cutoff low" and "closed low" often are used interchangeably to describe low pressure centers aloft. However, not all closed lows are completely removed from the influence of the basic westerlies. A cut-off low usually begins as a **trough in the upper-air flow**, which becomes a closed circulation and then extends down to the **surface**.

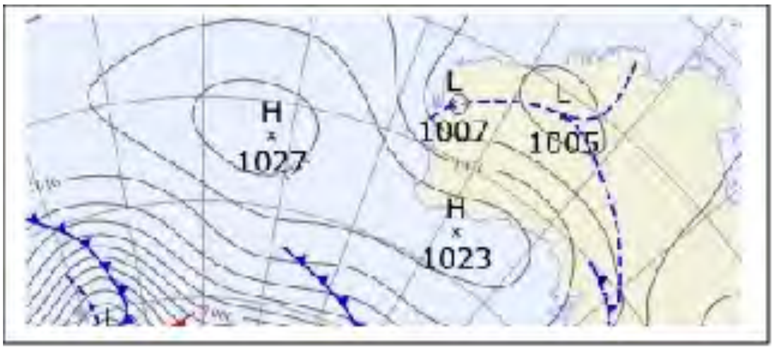


A Cut-Off Low (COL) is a low pressure system that develops stemming from the main westerly trough systems of cold air. As the COL develops, it deepens into a defined closed system that extends to the surface and which also becomes displaced equator-ward of the main westerly flow . A COL system usually prevails over an area for more than a day , and can last up to 6 days. The COL moves slowly over a confined region leading to heavy rainfall. COL's are unstable, baroclinic systems that slope to the west with height and are associated with strong convergence and upward motion, particularly while they are deepening. The source of major divergence necessary to act together with the surface convergence to produce deep uplift that is observed in COL's occurs at a level which is much higher than 500hPa. Its' depth is from 200mb to a surface low with probably a cold front and a high ridge possible. They mostly move from West to East but reversal is possible. They are a cold cored system and are possible anytime of the year but most likely March , April and May.



Cut Off Low Development at 500mb. (South Africa).

Persistent winds

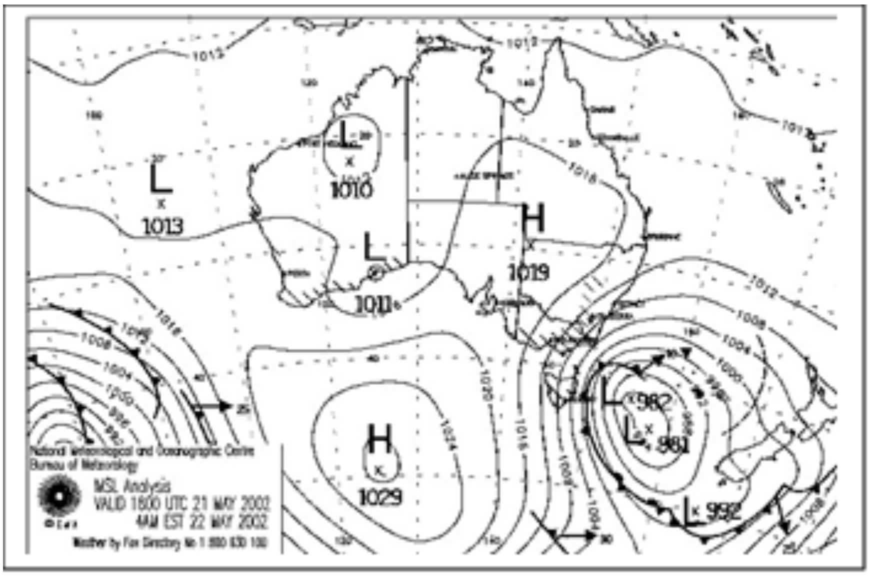


When observing pressure maps over the southern hemisphere on the Bom or weather-fax, the structure of the polar cap can sometimes have unusual 'nodes' or 'troughs' which persist for some time with strong winds over an extended period. The cap features can cause blocking systems or sequences of pressure systems over extended periods beyond usual. Thus observation of the polar maps can be useful. From the BOM site/weather maps/Southern hemisphere/Southern hemisphere MSLP map, two long highs are shown with very little pressure difference between them which can lead to an extended period of time with westerlies in the map shown. Depending on the season and SAM the positioning of such a configuration or narrower can lead to extended periods of consistent westerlies or similar easterlies.

Blocking Highs

When these occur they block the passage of oncoming lows in the normal west to east flow causing such systems to become quasi-stationery with their associated weather. Principally originating from upper atmosphere conditions delivering strong and persistent downwards high pressure mass cradling an area in the southern region of Australia the block usually lasts up to five to seven days. A low to the north of the high can bring widespread rain and persistent weather to Queensland and northern NSW . Such a low often becomes a cut-off low while frontal systems in the south usually slow and weaken as they slide further south and below the blocking high.

According to a BOM article Blocking highs have a wide range of impacts depending on their location and strength. A blocking high can produce a hot spell, a cold spell, dry conditions or wet conditions depending on it's location and the systems around it. Blocking highs can also be associated with greater probabilities of fog and frost occurrence.



Areas under the influence of a blocking high could experience dry and stable conditions, however areas to the west of the high could experience wet conditions as the frontal systems approaching become very slow moving. If the high was associated with a cut-off low forming a blocking pattern, then affected areas could experience sustained heavy rainfall. Regions on the northwestern side of the blocking high may experience warmer than average conditions under a northwesterly wind flow, whilst areas on the southeast of the high could experience cooler than average conditions as cold air is brought up from the far south.

Waves

Place a marker pen dot on the bottom edge of a bottle. Roll the bottle on a flat surface and the dot will move in a wave form. A study of sea and swell waves reveals patterns which are fairly common.

Swell with sea has a regular pattern including sets of three larger waves.

Swell across sea 'cross sea' gives a vessel an unpleasant, uncomfortable (offerings to the sea gods), irregular movement . Especially with three systems, mal de mer flourishes.

Swell against sea makes for a dangerous combination creating freak waves and unusual heights.

Refraction against breakwaters and steep cliffs creates 'clapotic' waves where the reflected wave travels back into the oncoming waves. If the oncoming wave strikes the barrier at an angle then the refracted wave will travel across the incoming seas. Also the driven waves are generally resulting from differing wind speeds giving rise to irregular patterns and heights. Normal deep sea waves are maximum 12-15m. Waves travel at speeds approximately 70% of wind strength and if one considers a front travelling from west to east in mid-latitudes, the wind-blown 'sea' generated will set up a swell next day accordingly in that direction. The system however, has moved on and sets up a swell from the new location some 600 miles further away. Thus we have two swells from two locations which will cross each other. When crest meets crest, they add together and when crest meets trough they cancel each other. This results in varying wave heights and by extension, some other swells presenting can add further height. It is quite common and especially in Bass St. to observe this process and use the pattern to utilise a flatter patch in strong winds for a difficult manoeuvre such as a gybe. Another type of wave is termed a 'galloping' wave. When a weather system creates a wave and some time later increases in strength (eg 30 t0 40kts), the generated faster wave overtakes the slower to again provide an add and subtract process,

Once again, every boat is different and each has a synchronization where a particular set of conditions can harmonise with the boat to cause dangerous rolls. Usually varying any factor will break the tendency.

The longer the fetch and the faster the wind speed, the more wind energy is imparted to the water surface and the larger the resulting sea state will be.

A 10 knot wind requires about 10 miles fetch to reach it's maximum size whereas a 20 or more knot wind has a limiting distance of about 40 miles. This gives a concept of sea conditions relative to a coastline.

Conditions Necessary for a Fully Developed Sea at Given Wind Speeds, and the Parameters of the Resulting Waves					
Wind Conditions			Wave size		
1 Direction Wind Speed	Fetch	Duration	Avg Height	Avg Length	Period/Speed
10 kts	10nm	2 hrs	0.27 m	8.5 m	3sec/5.6 kts
20 kts	75nm	10 hrs	1.5 m	34 m	5.7sec/12 kts
30 kts	280nm	23 hrs	4.1 m	76.5 m	8.6sec/17.8 kts
40 kts	710nm	42 hrs	8.5 m	136 m	11.4sec/23.8 kts
50 kts	1420nm	69 hrs	14.8 m	212m	14.3sec/30 kts

Deep water waves need depth greater than one half of their wavelength else they 'feel' the bottom whence water particles change from a circular motion to an orbital motion. Much of Bass Strait is too shallow to allow deep water wave formation in winds over 40 knots. Waves touching the bottom become shorter hence 'choppy seas' of Port Phillip.

Bathymetry

As preparation for voyages it can be useful to examine undersea contours. Some electronic charts can display underwater features but it can be readily achieved on a paper chart by drawing contours using the depths shown. In the following example, the contours have been drawn to continue with the coastline charted 10 and 20m contours as is usual and now drawn 30 and 40m. Examining the line AA in the modified Cape Otway chart portion as an underwater profile and then at BB, a fairly flat seafloor rising prominently to the coast can be determined. Tides and currents flow slower due to friction effects in shallow waters or near the shore as against deep channels but in reality behave as other fluids (air, wind.) Current tends to flow against this under-water cliff.

As a rule, in the Western end of Bass Strait, wind driven currents are from the West from May to December and from the East January to April. They can be up to one and a half knots

Considerations are:-Tides

Current

Stability/instability of the current weather

Wind direction

As this Cape is also another 'sharp' corner, some attention to the seabed reveals a probable tidal influence as a 'gate' given next course is to or from WNW and winds can be severe in

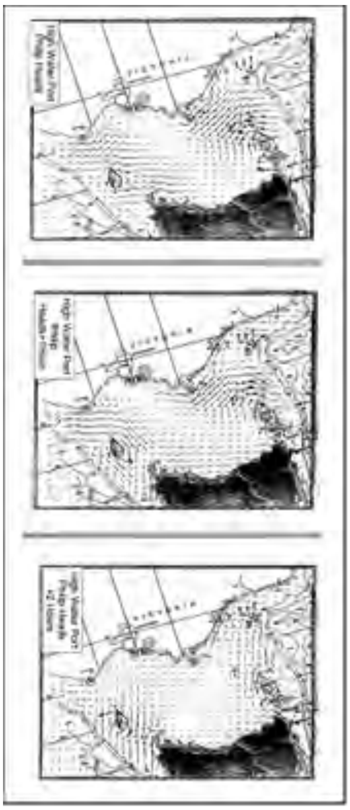
this area. Ships have lost several containers here! Noting the bathymetry suggests to not cut the corner and indeed the sea breaks badly on the outlying reef. Off course the Navionics or other similar programs can be easier. Another interesting area is the eastern entrance to Bass Strait and also considering prevailing swell. Examination shows the continental shelf tucked in towards the entrance. Thus there are 3 swells which shallow abruptly in this area. SE from the Tasman, W-SW from Bass Strait and NE from the southern pacific. Add to this the seabed rises from 1,000's of metres ocean depth to Bass St. of 80 m and then mix in an EAC eddy- interesting! The effect of current is to lengthen or shorten a wave base so that a SW wave travelling northwards up the NSW coast against the current becomes steeper and rougher whereas a wave from the N or NE has the base lengthened by the current and becomes smoother.

Undersea projections

Sailing close to shore can present another hazard with shallows or innocent-appearing projections due to tidal effects. Examining bathymetry of the seabed can be enlightening! In the following example, the location is close to a harbour and the depth is sufficient but the undersea profile has an effect on the sea such that a quite disturbed motion can present difficulties. Not a sharp corner but similar effect.

Tidal effects

Using ORCV Bass Strait tidal model



A study was made of the Bass Strait tidal flows to aid the Oil Rigs with operations back in the 80-90s'. A number of variables were found to influence the flows such as weather systems and celestial phenomena. For example a prolonged westerly system can fill and then set up currents through Bass Strait as distinct from a frontal system . A model exists which can take all these influences into account. The charts in the ORCV yearbook are a composite of many model outputs with differing conditions. As such they are not completely accurate but have been tested to be roughly within an hour. They have been referenced to High & Low water at Port Phillip Heads for convenience. The diagrams comprise vectors to indicate relative strength and direction. The strongest flows at Cape Wickham can reach 6 knots whereas maximum flows along the East coast of King Island have been measured at three knots and only very occasionally up to 4 knots. By examining tidal predictions at the heads, the range between High & Low can give an indication of stronger or lesser flows.A convenient method of use is to construct a table commencing with, say, a High water time at Port Phillip Heads and then hourly advances corresponding to successive diagrams. Eg. For the King Island race in 2014, corrected to AEST for 8/3/14

HW 0433	1.53m	Diagram High Water

0533		High Water + 1
0633		High Water + 2
0733		High Water + 3
0833		High Water + 4
0933		High Water + 5
LW 1036	0.17m	Low Water
1136		Low Water + 1
1236		Low Water + 2
1336		Low Water + 3
1436		Low Water + 4
1536		Low Water + 5
HW 1629	1.5m	High Water

On Saturday 15/3/14 LW is 0412 0.74m and HW 1037 1.16m, a tidal range of 0.42m compared to the table above with a range of 1.36m. Thus tidal currents on 8th. Could be three times stronger than the interval on the 15th.

The objective is to have a local time table which corresponds to the sequence of hourly maps. If it is desired to know the tide flows occurring at a particular instant, one simply looks at the local time table for the appropriate tide map to get a picture. Once again, it is important to pre-plan where-ever possible as if difficult mental tasks are required with any amount of mental fatigue, mistakes can occur.

Be careful of the Sea Temperature and Currents pages on the BOM site or similar sites which give loops for a week in 24 hr snapshots but do not show 6 hr tidal patterns. Instead prepare with port predictions as a guide, especially by considering adjacent ports.

As a rule, in the Western end of Bass Strait, wind driven currents are from the West from May to December and from the East January to April. They can be up to one and a half knots.

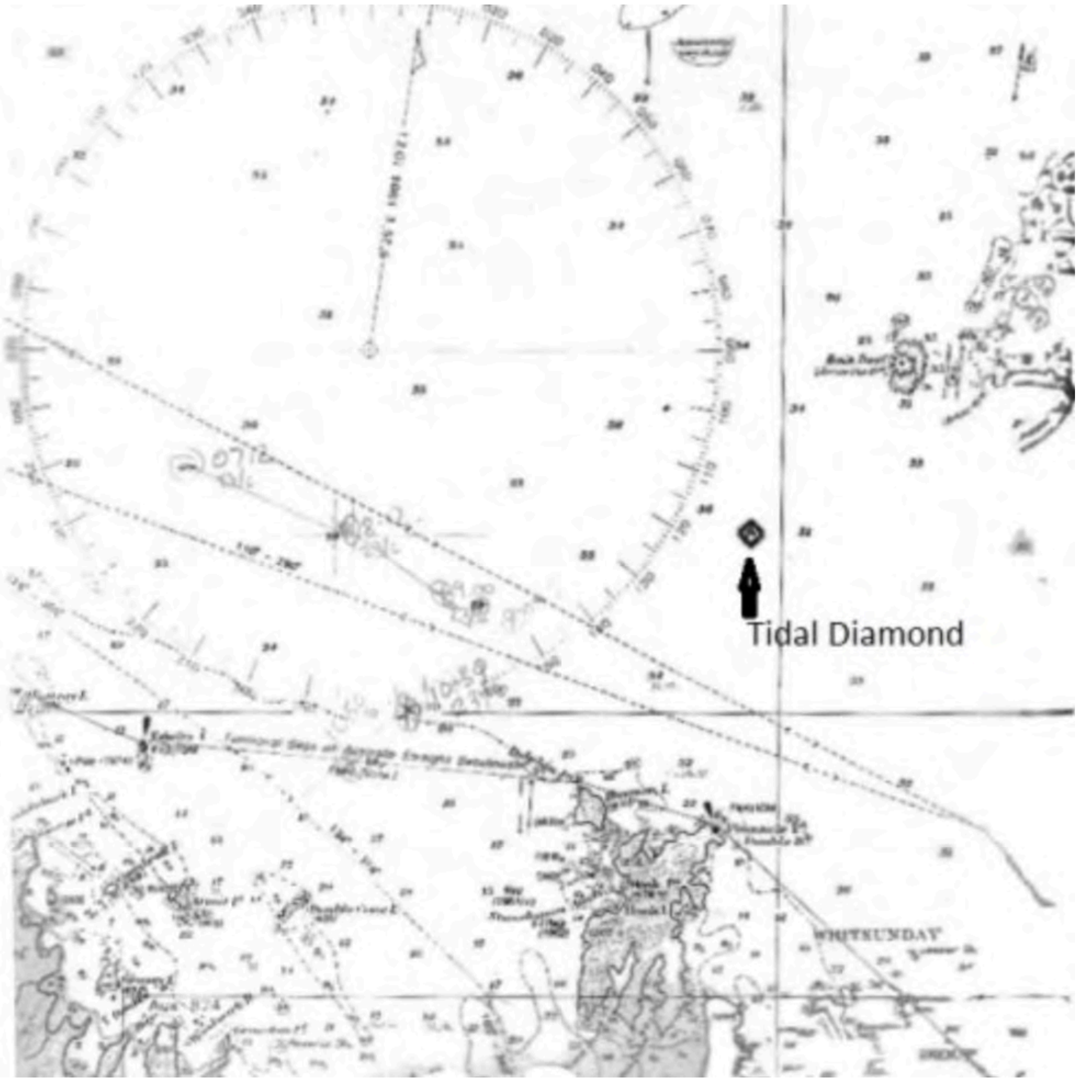
If constructing tidal charts for some other locality, be careful to find a prominent published reference port used for adjacent localities. For example, the Whitsundays area is referenced to Townsville. Westernport is referenced to Devonport, Tasmania. Sufficient information is available on the IMOS site to do so but some programs such as Navionics are a modern facility if comms are available.

Tidal Diamonds

On some paper charts where strong tidal patterns exist in the area, there are one or more diamond shaped outlines with a letter (A,B,C,etc). Usually somewhere on the chart is a table with columns under the diamond reference with tidal stream information such as direction and strength and also referencing the time from High Water etc. There will also be a reference to a port published tide tables in order that one may align the times. Navigation programs with electronic charts such as Navionics or similar contain the same information in a more convenient form and also it is expected that hardcopy charts will be made obsolete to some degree in the next 5 years. Many mariners will continue to use paper charts however and therefore the system has been included in this document.

Tidal Streams referred to H.W. at TOWNSVILLE

		A 19°54'0S 148°59'0E			B 19°52'5S 148°24'4E			C 19°31'2S 148°02'0E			D 19°16'0S 147°30'5E	
		Rate (kn)			Rate (kn)			Rate (kn)			Rate (kn)	
Hours	Dir^{n}	Sp.	Np.	Dir^{n}	Sp.	Np.	Dir^{n}	Sp.	Np.	Dir^{n}	Sp.	Np.
Before H.W. Townsville 6	313°	0·5	0·2	295°	0·4	0·1	310°	0·7	0·2	310°	0·5	0·2
5	294°	0·5	0·2	285°	0·4	0·1	298°	0·7	0·2	297°	0·5	0·2
4	280°	0·2	0·1	265°	0·3	0·1	292°	0·4	0·1	280°	0·5	0·2
3	210°	0·1	0·0	248°	0·2	0·1	278°	0·2	0·1	245°	0·3	0·1
2	155°	0·2	0·1	160°	0·1	0·0	200°	0·2	0·1	200°	0·3	0·1
1	147°	0·4	0·2	140°	0·2	0·1	154°	0·4	0·1	150°	0·4	0·1
H.W.	142°	0·5	0·2	134°	0·3	0·1	142°	0·5	0·2	130°	0·5	0·2
After H.W. Townsville 1	130°	0·4	0·2	123°	0·7	0·2	130°	0·6	0·2	118°	0·5	0·2
2	108°	0·3	0·1	093°	0·3	0·1	115°	0·5	0·2	103°	0·4	0·2
3	040°	0·2	0·1	040°	0·2	0·1	092°	0·4	0·1	080°	0·3	0·1
4	355°	0·3	0·1	005°	0·2	0·1	005°	0·3	0·1	020°	0·2	0·1
5	332°	0·4	0·2	313°	0·3	0·1	330°	0·4	0·1	330°	0·4	0·1
6	318°	0·5	0·2	300°	0·4	0·1	315°	0·6	0·2	318°	0·5	0·2



Windy.com

Windy is a Czech company based in Prague providing interactive weather forecasting services worldwide. Registration is free and serves to hold your preferences and settings but is not required. The site has many options and an external user has arranged a you tube video which is not only highly informative but is also educational. The portal was founded by Ivo Lukačovič in November 2014. Currently, weather forecasts are based on data from the GFS models, ECMWF, and NEMS model from the Swiss company Meteoblue. Initially, the portal focused on wind animation, currently there are other basic meteorological parameters such as temperature, pressure, relative humidity, cloud base and additional panels with more advanced data. The wind animation is based on the open sources project of Cameron Beccario. Ivo is an airline pilot with interests in his hobbies of kite surfing and programming. The site is especially produced with visually easy to understand graphics and although perhaps lacking in detail for some academic purposes, has been engaged by many Government agencies. It operates with a staff of 18 and like most weather sites is still developing enhancements. There are smartphone apps available (iOS & Android) from the usual sites. (Windy.app: wind forecast, wind map, marine weather). Offline Mode.-You can see the forecast on the map and on favourite spots even with no internet connection - just activate the offline mode. Before going to sea (or elsewhere with no connection), open the app to download the forecasts automatically and then use them offline.

How to view the weather models like a pro using Windy -Recommended 33min. Somewhat 'hollywood' in style but very instructive.

https://www.youtube.com/watch?v=gjpXKyKH9tg

Clouds

Clouds can take on all sorts of shapes and sizes, ranging from thin wispy clouds (cirrus) to large, dark menacing clouds (cumulonimbus). While there are several factors that influence and affect the formation of clouds, the sun plays a major role in producing clouds.

To help understand basic cloud formation, Consider a field at sunrise. In the morning, the field is relatively cool. The sun begins to heat up the field, and throughout the day, the field becomes warmer and warmer. Certain areas of the field may begin to heat up more quickly than others due to the terrain or surrounding conditions (for example, bare soil heats up more quickly than vegetation). When this happens, a thermal (also known as an updraft) can form. A thermal can be thought of as a rising "blob" of warm air due to unequal heating of the earth's surface. When the thermal forms at the surface, it is warmer than the surrounding air. Warm air has a tendency to rise while cold air sinks, and since the thermal is warmer than the air around it, and therefore less dense, the air in the thermal will rise. As it rises, it will begin to expand and cool, and will continue to do so until its temperature is the same as the surrounding air temperature.

Although we can't see thermals with our eyes, we can feel and observe their effects. For example, many birds will use thermals to fly higher in the air. By catching a thermal, they do not have to expend as much energy to gain altitude since the rising air will carry them upwards.

The process of thermals forming in the atmosphere is a form of convection. Convection is basically the transfer of heat (in this case, through thermals) from one area to another. In our example, the heat was transferred from the surface into the atmosphere.

So how does convection help in the formation of clouds? As mentioned earlier, when a thermal rises, it begins to cool and expand. But why does it cool and expand as it rises?

Have you ever tried boiling water on a mountain? You may have noticed that the water boils faster on a mountain than as compared to boiling water at sea level. The air pressure is lighter on a mountain than at sea level, so water actually starts to boil below 100ºC! Air pressure decreases with height, and as the thermal rises, there is less pressure on it. Additionally, the internal energy inside the thermal wants to expand it. So as the pressure decreases while the thermal is rising, the thermal is able to expand more easily. However, by doing this, the thermal will begin to cool as its temperature is proportional to its internal energy.

As the parcel cools and expands, it eventually reaches the saturation point where the relative humidity is 100 percent and condensation starts to occur. When water condenses, it goes from a gas to a liquid.

The droplets that form in clouds, though, are very tiny (unlike the ones that form on the glass) and are light enough to float in the air. Once the air reaches saturation (the point at which the water vapor condenses), clouds can begin to form. Sometimes, thermals do not become fully saturated and never produce clouds. In this case, dry convection is taking place. Warmer air at the surface is being transported into the cooler air in the atmosphere, but no clouds form.

Cirriform

Cirriform category clouds generally have a wispy fibrous appearance and form at high tropospheric altitudes along the very leading edges of a frontal or low-pressure weather disturbance and often along the fringes of its other borders. They are composed of ice crystals and appear white. In general, they are non-convective but occasionally acquire a tufted or turreted appearance caused by small-scale high-altitude convection. These high clouds do not produce precipitation as such but are often accompanied or followed by lower-based clouds that do. Formation is as the tops of very high Cb blown away by strong upper level winds, hence ‘streaks’. Can be associated with:-

A low pressure system and associated cold front being an advance warning from 20-36 hours.

As first signs of an approaching warm front, especially in tropical areas.

A jet stream. (pic)

A tropical revolving storm (Cyclone in the southern hemisphere)

Indication:- When in conjunction with a regular drop in barometric pressure along with other signs such as increasing swell and followed by a typical cloud sequence heralds the arrival of a cold front in 20-36 hours. The trail points usually to the phenomena of cause.

Cirrocumulus Cc –One finger rule-formed when Ci is subjected to upward air movement giving classic 'Buttermilk Sky' and as 'Mackerel Sky' when lifting becomes more organized developing further to definite organized 'Ribs' which if arranged in across streaks can be jet stream cloud. All signing to an approaching low or front. Old Sailor rhymes-Mackerel sky, dry then wet, wet then dry. And Mackerel sky, four days wet then four days dry.

Cirrostratus:

Cs Ice cloud although at a slightly lesser height than Ci, seen as a 'halo' or 'veil' with the sun or moon.

Indication:- Approaching cold front.

Cumuliform

Cumuliform clouds typically have flat bases and puffy domed tops. They are the product of localized but generally free-convective lift and can vary in vertical extent depending on the stability characteristics of the air mass where they are forming. The smallest fair weather cumuliform types occur with only minimal instability (cotton wool or cauliflower) and can therefore be considered clouds of limited convection. Incoming short-wave radiation generated by the sun is re-emitted as long-wave radiation when it reaches Earth's surface. This process warms the air closest to ground and increases air mass instability by creating a steeper temperature gradient from warm or hot at surface level to cold aloft. Moderate instability allows for the formation of cumuliform clouds of moderate size that can produce light showers if the airmass is sufficiently moist. The more the air is heated from below, the more unstable it tends to become. This may cause large towering cumuliform clouds to form in the lower half of the troposphere with tops growing into the upper levels. These buildups can cause moderate to occasionally heavy showers. They tend to be more concentrated and intense when they are associated with fast-moving unstable cold fronts.

Indication:- Small cu clouds are fine weather whereas large increasing mounds bring showers and possibly develop into thunderstorms Cb or otherwise can become the leading edge of a front.

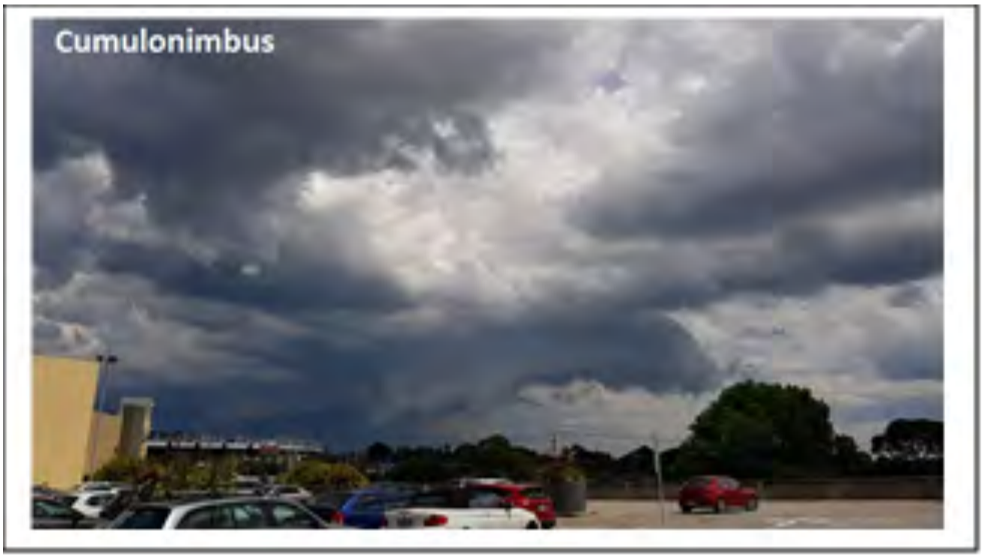
Stratocumulus

Sc Associated with inversions either as high pressure sinking air or as gently rising air trapped by the inversion.

Indication:-Generally light to moderate winds, possible drizzle.

Cumulonimbiform

The largest free-convective cumuliform clouds occur in very unstable air and often have complex structures that include cirriform tops and multiple accessory clouds and are sometimes classified separately as cumulonimbiform. At maturity, they have very strong updrafts that can penetrate the tropopause. They can produce thunderstorms and a variety of types of lightning including cloud-to-ground that can cause wildfires. Other convective severe



weather may or may not be associated with thunderstorms and include heavy rain or snow showers, hail, strong windshear, downbursts and tornadoes.

Indication:- Usually shortlived but just one of a ‘family’.Strong irregular winds, gusty, heavy showers with possible hail and lightning. Tornadoes do not usually descend to ground in Australia but can happen as with waterspouts.

Mammatus

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 several uncertain descriptions of formation but generally as warning of a stronger system. Forward flank of Cn (CumuloNimbus)

Stratiform

In general, stratiform-category clouds have a flat sheet-like structure and form at any altitude in the troposphere where there is sufficient condensation as the result of non-convective lift of relatively stable air, especially along warm fronts, around areas of low pressure, and sometimes along stable slow moving cold fronts. In general, precipitation falls from stratiform clouds in the lower half of the troposphere. If the weather system is well-organized, the precipitation is generally steady and widespread. The intensity varies from light to heavy according to the thickness of the stratiform layer as determined by moisture content of the air and the intensity of the weather system creating the clouds and weather. Unlike free convective cumuliform and cumulonimbiform clouds that tend to grow upward, stratiform clouds achieve their greatest thickness when precipitation that forms in the middle level of the troposphere triggers downward growth of the cloud base to near surface level. Stratiform clouds can also form in precipitation below the main frontal cloud deck where the colder air is trapped under the warmer airmass being forced above by the front. Non-frontal low stratiform cloud can form when advection fog is lifted above surface level during breezy conditions.

Altostratus:-

As Thick layers of blue-grey or grey can sometimes have a horizontally striped or layered appearance. If the sun can be seen, has a 'frosted' look.

Indication:-Front due in 6-12 hours, possible thunder and rain with falling barometer and strong wind soon.

Nimbostratus

Ns The typically recognised rain cloud formed by the lowering and thickening of Altostratus.-

Nimbus meaning rain bearing.

Indication:-Wind with a low pressure system becoming maximum with heavy rain and ‘scud’ low cloud expected.

Stratocumuliform

Clouds of this physical structure have both cumuliform and stratiform characteristics and generally form as a result of limited convection in slightly unstable air. They can form at any altitude in the troposphere wherever and whenever there is sufficient moisture and lift.

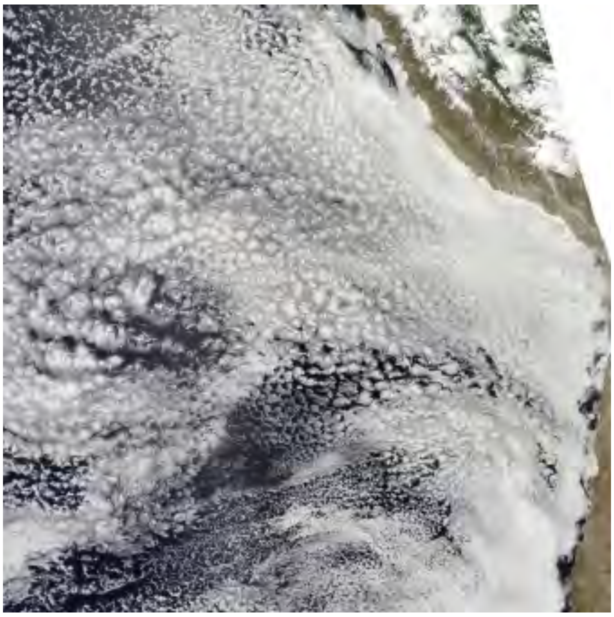
High stratocumuliform clouds also tend to show some cirriform characteristics or form in association with cirriform clouds. If a poorly organized low-pressure weather system is present, virga or weak intermittent precipitation may fall from those stratocumuliform clouds that form mostly in the low and lower-middle height ranges of the troposphere.-(Adapted from Wikipedia)

Cirrostratus-One finger rule, Altocumulus-Three finger rule. Refers to the spacing of individual cloudlets when the hand is upstretched to the sky.

Ci-Cirrus
Cs-Cirro-stratus
Cirro-cumulus
As-Alto-stratus
Ac-Alto-cumulus
Ns-Nimbo-stratus
Cb-Cumulo-nimbus
Cu-Cumulus
Sc-Strato-cumulus
St-Stratus

Structure.

Stratocumulus clouds are typically 200–400 m thick and usually occur at the top of the boundary layer below a thermal inversion. It is remarkable that such a thin cloud can extend practically unbroken for a thousand kilometers, but strong negative feedbacks exist to constrain cloud thickness.



Stratocumulus clouds usually form from a layer of stratus cloud breaking up. They are indicators of a change in the weather and are usually present near a warm, cold or occluded front. The definitional difference between these two is the height at which they occur. Stratocumulus are low-level clouds that will have their bases below 6500 feet whereas Altocumulus cloud bases are between 6500 and 20,000 feet making them mid-level clouds

A stratocumulus cloud, occasionally called a cumulostratus, belongs to a genus-type of clouds characterized by large dark, rounded masses, usually in groups, ...

Precipitation cloud?: Uncommon

Appearance: Much like Cumulus clouds, except ...

Altitude: 500-2,000 m; (2,000-7,000 ft)

Species: Castellanus; Floccus; Lenticularis; Str...

Appendix

Bureau of Meterology – Marine Wind Warning

Marine Wind Warnings form part of the coastal and local waters forecasts. They are broadcast on marine radio (VHF and HF), published on the Bureau's website, and available in the warnings section of the BOM Weather app. Checking for wind warnings is the most important of the Five Vital Weather Safety Checks. When a Marine Wind Warning is issued, these are the key features that you should consider.

1. When will the wind warning conditions start?

The warning indicates the period covered. Marine Wind Warnings are issued as much as 42 hours in advance and are then updated every 6 hours. However, if conditions develop rapidly, warnings can be issued and updated at any time.

Skippers already on the water should assess if they have enough time to get back to port before the wind picks up or take precautions and seek shelter.

2. What speed will the wind reach?

The wind strengths associated with the different categories of wind warnings issued by the Bureau are presented in the table below. As a skipper, you need to be aware of what wind conditions your vessel can handle, and take steps to avoid stronger winds.

Remember that the wind speeds mentioned in forecasts and warnings are averages, and that wind gusts can be 40 per cent stronger, and stronger still in the vicinity of thunderstorms and squalls.

Strong wind warning	Winds averaging from **26 knots and up to 33 knots.**
Gale warning	Winds averaging from **34 knots and up to 47 knots.**
Storm force wind warning	Winds averaging from **48 knots and up to 63 knots.**
Hurricane force wind warning	Winds averaging **64 knots or more.**

3. What area is the wind warning for?

The Marine Wind Warning Summary lists which coastal and local waters areas are affected. You should be familiar with the Bureau's coastal and local waters areas and which ones overlap with your location.

Coastal and local waters forecasts also indicate a wind warning is current for that area, and can indicate which areas may be more impacted (e.g. inshore or offshore). The Bureau's graphical forecast tool MetEye also enables you to get more detail for the area you are planning to operate in, showing three-hourly forecasts for 6km2 grids across all coastal waters areas.

4. What direction will the wind be from?

The Bureau's forecasts will indicate what direction the wind will be coming from. With passing fronts or low pressure systems, wind directions may change suddenly. If you are seeking shelter, be prepared to move your vessel when the wind direction changes for safety.

5. Is there any bad weather expected?

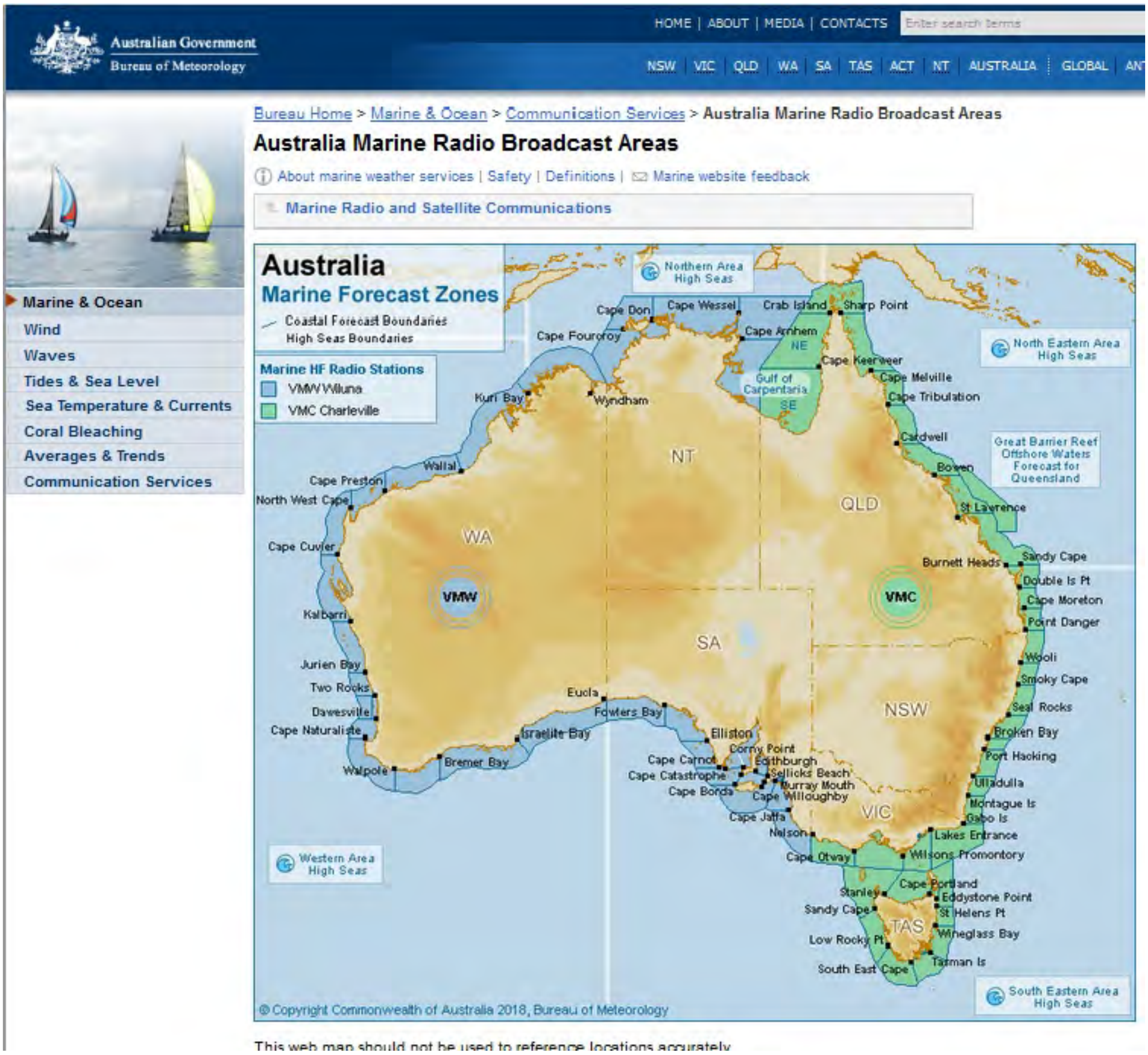
Upon hearing of a wind warning, skippers should seek further information from the Bureau's forecasts via marine radio (VHF or HF) or the Bureau's website. Coastal and local waters forecasts provide additional important information, including if bad weather is also expected. A cold front or thunderstorm may be associated with other hazards such as squalls, heavy rain, or lightning.

Skippers should always exercise additional caution for local effects and in case conditions worsen suddenly.

6. When will the warning conditions cease?

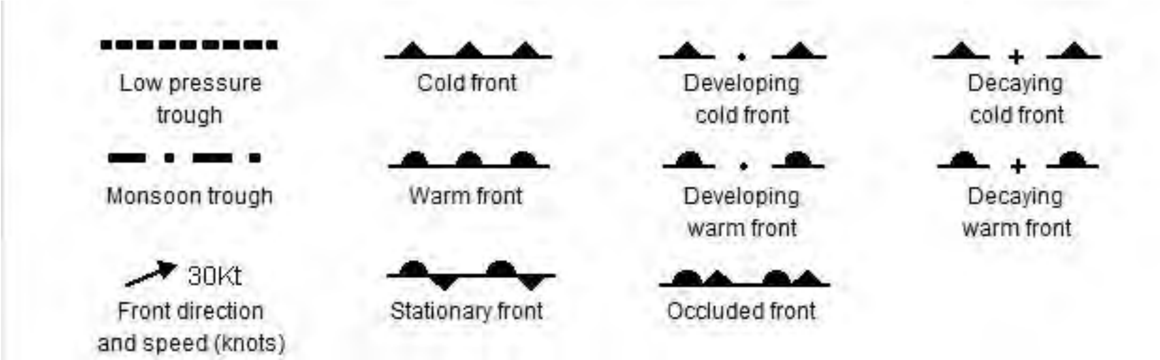
The wind warning and forecast indicate when winds are expected to ease, or if the warning has been cancelled. Knowing how long the wind warning may last will help skippers determine their risk management plans.

Bureau of Meterology – Australian Marine Radio Broadcast Areas



Bureau of Meterology – Marine Forecast Areas

Marine Weather Map Symbols



What is an East Coast Low? BOM pamphlet.

East Coast Lows (ECL) are intense low pressure systems which occur, on average, several times each year off the eastern coast of Australia, in particular southern Queensland, NSW and eastern Victoria. Although they can occur at any time of the year, they are more common during autumn and winter with a maximum frequency in June. East Coast Lows will often intensify rapidly over a period of 12-24 hours making them one of the more dangerous weather systems to affect the eastern coast. East coast lows are also observed off the coast of Africa and America and are sometimes known as east coast cyclones.

How do they form?

East Coast Lows may form in a variety of weather situations. In summer they can be ex-tropical cyclones. At other times of the year, they will most often develop rapidly just offshore within a pre-existing trough of low pressure due to favourable conditions in the upper atmosphere in combination with warm sea surface temperatures. ECLs may also develop in the wake of a cold front moving across from Victoria into the Tasman Sea. The sea surface temperature gradients associated with the warm eddies of the East Australian Current are an important contributor to the development of the lows.

The gales and heavy rains often occur south of the low centre, while to the north of the low there can be clear skies. The challenge for forecasters is to accurately predict the location, movement and intensity of the centre of the low.

Why are they dangerous?

ECLs can generate one or more of:

Gale or storm force winds along the coast and adjacent waters

Heavy widespread rainfall leading to flash and/or major river flooding

Very rough seas and prolonged heavy swells over coastal and ocean waters which can cause damage to the coastline.

Falling trees and flash flooding have caused loss of life on the land, many small craft have been lost off the coast and larger vessels have run aground during these events.

How often do they form and is there a trend?

The Bureau has a detailed database of these lows beginning in 1973. Each year there are about ten "significant impact" maritime lows. Generally, only once per year do we see "explosive" development. Looking at all the lows since 1973 there is no evidence of a trend.

What's the difference between an East Coast Low and a tropical cyclone?

Tropical cyclones develop over very warm tropical waters where the sea surface temperature is greater than 26°C. They have relatively long life cycles, typically about a week, and severe tropical cyclones (Category 3 or greater) can produce significant property damage with wind speeds over 180km/h near the centre, heavy rainfall and coastal inundation through storm surge. Tropical Cyclone *Justin*, which affected the Queensland Region in March 1997, lasted for 18 days!

East Coast Lows generally have much shorter lifetimes than tropical cyclones and last only a few days. They develop over the Tasman Sea close to the east coast and can intensify rapidly in the overnight period. Unlike tropical cyclones, where the warm seas provide the energy source, East Coast Lows are driven by a dynamic interaction between cold air in the high levels of the atmosphere over the continent, and the surface temperature gradient between the land and the relatively warm Tasman Sea air. They can produce gale to storm-force winds, very heavy rainfall and in some cases coastal inundation.

While maximum wind speeds recorded are typically lower than severe tropical cyclones, a gust of 165 km/h was recorded in 1974 at Newcastle associated with the East Coast Low that sunk the bulk carrier *Sygna*—the wind speed equivalent of a Category 3 severe tropical cyclone. The wreck of the *Sygna*, driven onshore during the storm, still lies on Stockton Beach, near Newcastle.

In June 2007, when the bulk carrier *Pasha Bulker* ran aground on Nobbys Beach at Newcastle, gusts of 135 km/h were recorded. Similarly, in April 2015 peak wind gusts during an ECL reached 135km/h at Nobbys Head (Newcastle), Norah Head (Central Coast) and Wattamolla(Illawarra).

Photo: Shelf cloud over Sydney on 25 April 2015, by Daniel Tran Photography. A slow-moving East Coast Low brought severe weather and flooding to much of coastal New South Wales between 20 and 23 April 2015.

Recent major East Coast Lows

DATE	STRONGEST WIND GUST	HIGHEST 24 HOUR RAINFALL	DETAILS
4–6 June 2016	133km/h at Maria Island (Tas), 117km/h at Sydney Harbour (NSW)	365mm at Robertson (Illawarra, NSW), 248mm at Yolla (Tas)	Event coincided with a king tide, resulting in severe coastal erosion around Collaroy, NSW. Major flooding across northern river basins in Tasmania.
20–23 April 2015	135km/h at Nobbys Head, Norah Head and Wattamolla (NSW)	307.5mm at Maitland Belmore Bridge (Hunter River, NSW)	Flash flooding in township of Dungog, NSW, saw four homes swept away in flood waters.
8–9 June 2007	135 km/h at Norah Head (Central Coast, NSW)	293.6mm at Mangrove Mountain (Central Coast, NSW)	76,000 tonne bulk ore carrier *Pasha Bulker* grounded on Newcastle Beach.

What warnings does the Bureau issue for East Coast Lows?

Over land areas Severe Weather Warnings are used to warn of the dangerous winds, damaging surf, abnormally high tides that can cause coastal erosion, and heavy rain leading to flash flooding. If needed, Flood Warnings are also issued to warn of river flooding, and Severe Thunderstorm Warnings may also be issued. Over the sea the standard Marine Wind Warnings are used.

For the latest warnings always check www.bom.gov.au and listen to advice from emergency services.

How often do they form and is there a trend?

On average, the eastern seaboard sees seven significant East Coast Lows each year. Climate change projections suggest that increasing greenhouse gas concentrations will lead to fewer East Coast Lows late in the century. This is consistent with an observed trend towards reduced storminess in eastern and southern Australia since 1890

Table of Contents

WEATHER FOR SAILORS MODULE 2 – COASTAL SAILING 1

DEFINITIONS 1
ANABATIC WINDS: 1
BAROCLINIC INSTABILITY: 1
BAROTROPIC: 1
EXTRATROPIC: 1
TIDAL GATE: 1
TROPICS LATITUDES 1

OFFSHORE VOYAGES OF 3-4 DAYS 2

SAM IN AUTUMN AND SPRING (FROM BOM) 8
'UNDERSTANDING THE SOUTHERN ANNULAR MODE' 9
SATELLITE PICTURES ON BOM FACE PAGE 9
WEATHER ROUTING 15
PREDICT WIND 16
PREDICT WIND WEATHER AND MAPS 16
PREDICT WIND OFFSHORE APP 16
IMOS 17
TOPOGRAPHY AND MOUNTAINOUS COASTS 18
AUTUMN BACKGROUND 18
PARKING LOTS 21
SEA BREEZES 21
KATABATICS OR DOWNSLOPE WINDS. 23
DEEPENING OR INTENSIFYING LOWS 24
JET STREAMS AND THE WEATHER EDITED FROM WIKIPEDIA 26
SUBTROPICAL JET 26
ATMOSPHERIC ROSSBY WAVES 27
SYSTEMS TO AVOID. 27
EAST COAST LOWS 27
CUT OFF LOW 29
PERSISTENT WINDS 30
BLOCKING HIGHS 31
WAVES 32
BATHYMETRY 33
WIND DIRECTION 33
UNDERSEA PROJECTIONS 34
TIDAL EFFECTS 34
TIDAL DIAMONDS 35
WINDY.COM 37
CLOUDS 37
CIRRIFORM 39

CIRROSTRATUS: **40**
STRATOCUMULUS 41
CUMULONIMBIFORM 41
MAMMATUS 42
STRATIFORM 43
ALTOSTRATUS: 44
AS **44**
NIMBOSTRATUS 44
STRATOCUMULIFORM 45
STRUCTURE. **46**
APPENDIX **47**
BUREAU OF METEROLOGY – MARINE WIND WARNING 47
BUREAU OF METEROLOGY – AUSTRALIAN MARINE RADIO BROADCAST AREAS 48
BUREAU OF METEROLOGY – MARINE FORECAST AREAS 49
MARINE WEATHER MAP SYMBOLS 50
WHAT IS AN EAST COAST LOW? BOM PAMPHLET **51**
HOW DO THEY FORM? 51
WHY ARE THEY DANGEROUS? 51
HOW OFTEN DO THEY FORM AND IS THERE A TREND? 51
WHAT'S THE DIFFERENCE BETWEEN AN EAST COAST LOW AND A TROPICAL CYCLONE? 51
WHAT WARNINGS DOES THE BUREAU ISSUE FOR EAST COAST LOWS? 53
HOW OFTEN DO THEY FORM AND IS THERE A TREND? 53

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

Follow us on

ORCV Office 3 Aquatic Drive Albert Park VIC 3206
orcv@orcv.org.au