Australian Meteorological Association Inc

Monana

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July 2020 Edition

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No one submitted an article for this edition, so if you had submitted just a ½ page article, the Arduino or the book would have been yours.

The next PWS Edition of the Monana magazine is due to be published on the 22nd September 2020. Please submit all PWS items for publication by the 4th September 2020 to:

monana@ameta.org.au

But don't forget to also sent non-PWS items for inclusion in the more general August edition of Monana.

'We cannot understand the present or plan for the future without the knowledge of the past.'

- Prime Minister Harold Holt, National Library of Australia Stone Ceremony March 1966

A couple of months ago, the AMetA received an email from the National Library of Australia (NLA) asking for editions of the Monana magazine from February 2010. Under Australian and South Australian Law, magazines such as ours must be deposited with a range of libraries, such as the NLA and the South Australian Parliamentary Library.

The magazines of associations like the AMetA will be time capsules for future historians to study and incorporate into their models of the development of the social environment. We are history in the making, let's make the most of it.

As well as making history by providing our magazines for archiving, the AMetA through its volunteers is also making history more accessible by digitising many important meteorological records and making them available for general and scientific interests. Some of the information is associated with papers to be published, so it isn't publicly available yet, but when it is, look out for some very interesting historical information.

This edition is late because I've recently been away on my houseboat for a month and a half. Although the nights were (literally) freezing, the days were mostly warm and sunny. As a result, I spent most of my time walking the dog in the bush and arranging meetings with friends along the way at riverside wineries and hotels. It was also a sad time as I heard about the death of a friend that I first met, and worked with, when I moved to Alice Springs in the mid-80s.

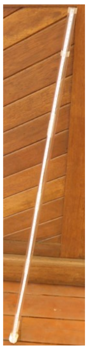
While I was away, a power glitch took out the computer that runs my website and records the readings from my weather station. Because our house sitters have no computer experience, the system stayed off-line until we returned home about a month after the system failed. The last page of this newsletter has some photos from my trip that perhaps give an indication of why I did not rush home when I found that my weather station was off-line. Life is about priorities and the weather station wasn't on the top of the list.

It is clear that the Coronavirus Pandemic situation is still volatile and it is unlikely that physical public meetings will be practical for some time into the future.

Keep Happy, Keep Safe.

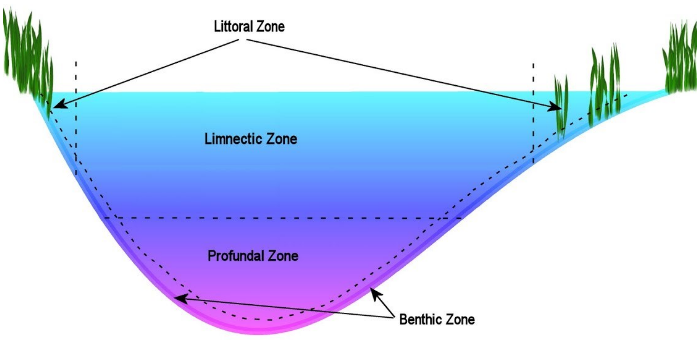
Mark Little
email: president@ameta.org.au

Measuring Water Turbidity



For the first time since last year, we went out of the marina on our houseboat. While away I decided to to play with a device that I hadn't used for a couple of years—a homemade turbidity tube. I know that some people will not have heard of a turbidity tube or what it would be used for while out on the river, so before I layout the readings, let's have a bit of a revision on turbidity and turbidity tubes.

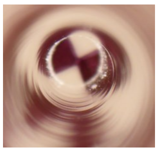
Turbidity is the cloudiness in a fluid cased by invisible particles in the water, similar to smoke or haze in the air, and is a key test of water quality. Turbidity is also applied to transparent solids such as glass or plastic, but for the purposes of this article, it will only be applied to water.



High levels of turbidity in bodies of water such as rivers can reduce the depth to which light can reach, which can inhibit the growth of aquatic plants, which can affect the species which depend on those plants. On the other hand, high turbidity can protect juvenile fish from predators and this can be important in areas such as mangrove areas along the coast. The Victorian Government fact sheet "Impacts of Carp in Wetlands" indicates that high concentrations of Carp can result in "with noticeable shifts from clear to turbid water state" and that "Increased turbidity reduces benthic light which can also affect water temperature, as well as plant growth". Benthic light is the light that reaches the lowest level of a body of water, such as an ocean, lake, stream or river.

So, now that we have the basics of turbidity, how does the turbidity tube measure turbidity? It is really simplicity itself.

At the base of the turbidity tube is a simple target. To measure turbidity, it is simply a matter of carefully pouring the water into the tube until you can just no longer see the target be looking down the top of the tube towards the bottom. Make sure that you don't cause bubbles when you pour in the water but if you do, wait until the bubbles disappear.



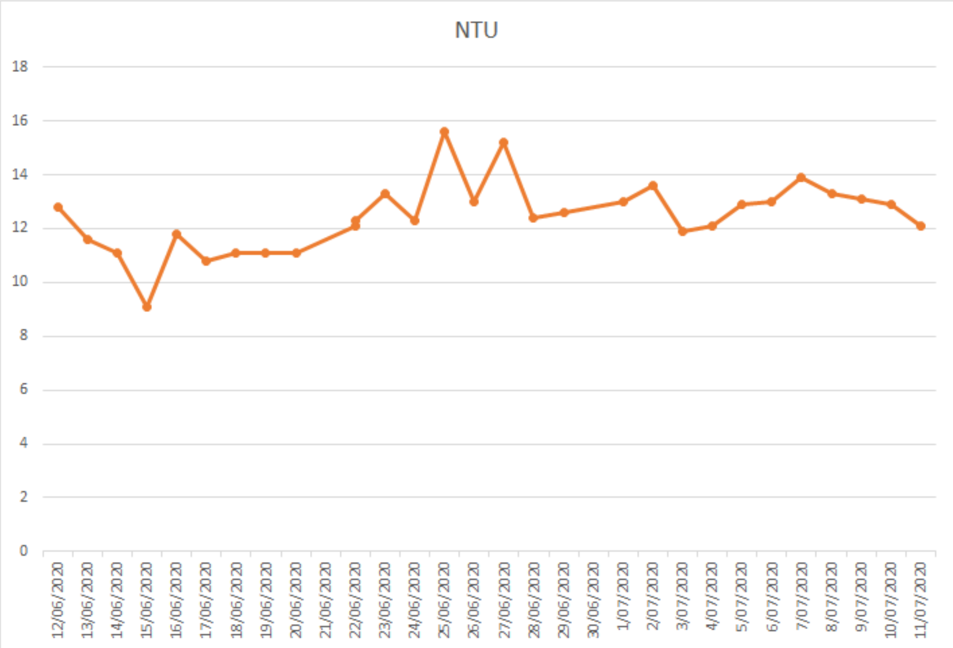
When you have finished pouring in the water, hold up the tube, making sure you are in a light position. Make sure that the tube is not directly lit the Sun, by standing so that something blocks the direct sunlight on the tube. Read the depth of the water in the tube using the attached tape measure. One of the common units for measuring turbidity is called the NTU (Nephelometric Turbidity Units) which measures the amount of light scattered at 90° by the particles in the water. Because this is quite different from measuring the height of a column of water obscures the target, a conversion is needed to convert the height to NTU. The measured height of the column is subjective and influenced by the visual acuity of the measurer. The conversion is also influence by a number of factors and there are a number of conversion tables that are slightly different from each other. The IDFL conversion table is used in this experiment. Because of the height measurement and a conversion table that is only approximate, the turbidity measurement using a turbidity tube is only approximate.

Now that there is simple means of estimating water turbidity, it is time to look at the relevance of the NTU readings. Accordingly to the Australian Drinking Water Guidelines, water turbidity of 5 NTU can just be detected in a glass of water, although the target value is less 0.2 NTU for the filtration of Cryptosporidium and Giardia. Less than 1 NTU is the target for effective disinfection. I can see clearly details on the bottom of my swimming pool at the deep end (2 metres), so using the IDFL conversion table, that would appear to give a reading of less than 1 NTU by the time I got a column of water long enough not to be able to see the target. The water in the Murray River is quite a different issue. It is only on a couple of occasions in the 16 years that we have been houseboating in South Australia has it been possible to clearly see the bottom when the depth is anywhere near 1 metre deep. On the other hand, if a glass of water is scooped from the river, it just has a slightly milky appearance.

There is an electronic turbidity sensor available for use by home enthusiasts, but how good it is remains to be seen, because it is designed to be used in an appliance like a washing machine. I have obtained one of those sensors and when I get time I will get around to connecting it up, along with a means of automatically drawing water into the measurement container.

But for now, let's look at the measurements taken, along with when and where they were taken. In summary, the readings were taken in the River Murray between Blanchetown and Waikerie. The readings were taken approximately 19 meters from the river bank (from the swim deck at the rear of the houseboat). Some of the readings were taken in the marina, some moored in townships and some in the middle of nowhere.

As may be expected, the turbidity readings varied from day to day. This is to be expected as the Murray River is fed by water flowing through sedimentary soils that can be added to the river by rainfall runoff.



The flow in the lower Murray is also a combination of water flowing from a variety or rivers such as the Darling and the Murrumbidgee.

The turbidity readings varied depending on location which some readings obviously worse because of organic material coming out of backwaters just upstream from where we were mooring.

So, what was the overall assessment of the experiment? The first thing was that the homemade turbidity tube really wasn't optimal. The tube was 1 metre long, but the largest column of water was only 320 mm long. This made it more difficult to detect whether the target at the bottom of the tube was visible through the river water. Not only that, in sunny weather, droplets on the tube above the water often created shadows that were hard to distinguish from the target. The ability to detect the target varied noticeably between sunny days and over cast days—a constant light level illuminating the tube would have been preferable.

I was unable to find any "official" readings to compare against my observations, so I have no idea how they would compare against a calibrated instrument. About all I could do is compare my readings with the visual observations of the water quality and see whether the plot seemed to reflect those obvious variations. The two readings between 15 and 16 were associated with water coming out of a lagoon near our mooring that had a noticeable green tinge as well as floating weeds. The single low reading around 9 was taken in the marina where the water is relatively still and just after rain. While on the river, the rain did not seem to have any significant effect on the readings, but the current in the river was significantly higher.

It was an interesting experiment, but not one that I would bother to do again. This is not to say that this is the end of my interest in water turbidity. I have an electronic turbidity sensor, but for that one, I will be more interested in exploring the water in my swimming pool to see if I can detect increases in water turbidity. One of the biggest costs of having a home swimming pool is running the pump and chlorinator. It would be good to know how much the running of the pump can be reduced (especially in winter) to reduce costs, but still keep the pool clean.

How Spooky!!

By Mark Little

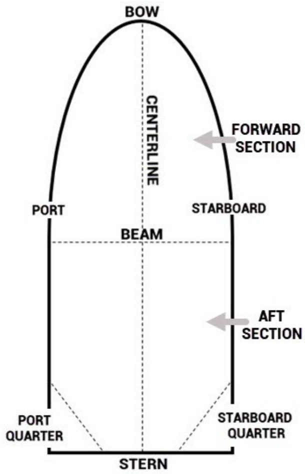
On my houseboat, I found an old USB microscope unit for XP/Windows 7 that I used to use to look at insects, plants and fossils that I found along the river. It looked like it would install on my current laptop, so I got out a CD/DVD drive and set about installing it. I was absolutely astounded. It gave an example of using filters and the "lens ruler" with a virus as the example. *The virus was a Coronavirus, HOW DID THEY KNOW THAT WOULD CAPTURE OUR ATTENTION???* Not <u>*THE*</u> COVID-19 Coronavirus, of course, but still spooky. However, before you start racing to find that old USB microscope, at 120 nano-metres, it is impossible to see a virus with ***any*** optical microscope, no matter how good. You would need an electron microscope to see it.

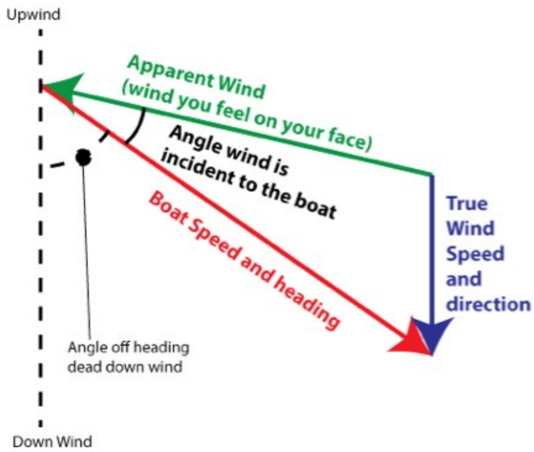
Houseboat Weather Station

I used to have a weather station on my houseboat, but a power supply failure did it irreparable damage. It is now time to install a new weather station on the houseboat, although this time, it will be linked to other sensors to provide more information than my old station did. It will do this by communicating with a small computer called a "Raspberry Pi", similar in size to the Arduino computer that has been mentions in previous articles.

Why will it be connected to a Raspberry Pi and what additional sensors will be included? The most obvious difference between a weather station mounted on a boat is that the boat moves. Not only does it move location, but it changes direction as it travels. To complicate things further, because of the effects of cross winds, the bow of the boat is not always pointing in the same direction that the boat is moving. While this does not affect the temperature, humidity or pressure, it does play havoc with the actual wind speed and direction.

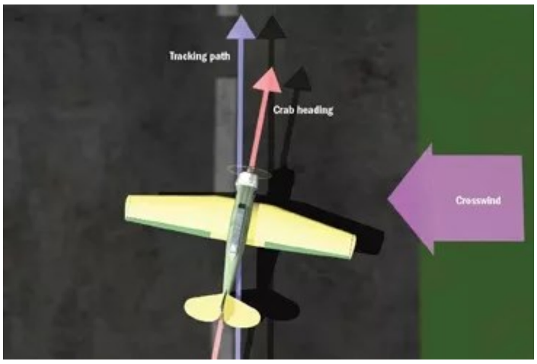
Normally, a weather station on a boat is oriented so that the weather station North is aligned to the centreline of the boat, facing towards the bow. This means if the apparent wind is coming towards the bow, the weather station will read 0°. From the starboard, it will read 90°, 180° if it is coming from the stern, and so on. You may have noticed that I used the term "apparent wind" when describing the wind. This is because when a boat is moving, the wind speed and direction perceived by a person on the moving boat is different to the actual wind speed and direction.





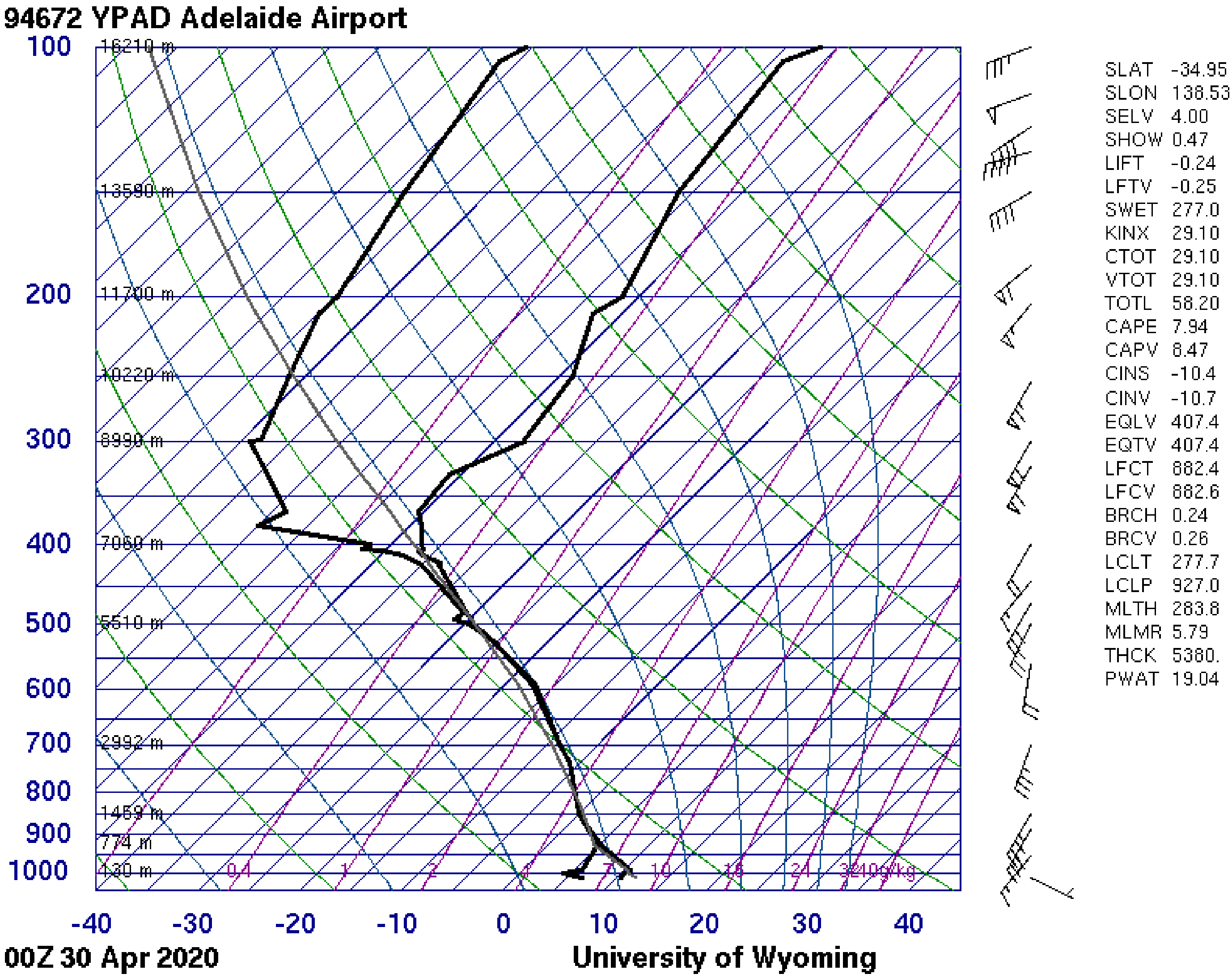
This difference in the wind on the boat is what can allow a sailing boat to travel faster to the wind. To understand how this can happen, we need to resort to a bit of vector analysis, but the diagram to the left should give a pretty good explanation. Click on the image to read the full explanation of apparent wind.

For houseboats, the practical effect of the wind is that to keep the houseboat on course, the houseboat needs to pointed in a direction off course to keep the wind from blowing the boat off-course and is called "crabbing". The effect is most apparent when planes come into land in a high cross wind. They are being blown sideways, so adjust their heading so that the movement into the wind balances the sideways movement caused by the force of the wind. The difficulty is that at the last moment, the plane needs to straighten up just before touch down, or they would spear off the runway. Click on the image to the right for a more complete explanation.



If you want to measure the actual wind speed and direction, the effects of apparent wind and the crabbing direction must be removed from the apparent wind measurements taken by the weather station. To get the direction that the houseboat is moving, it is possible to use a GPS receiver to figure out the speed and direction that the boat is moving, but a compass is needed to determine which direction the bow of the houseboat is pointing due to any possible crabbing. If the Raspberry Pi is reading the weather station, a GPS receiver and an electronic compass, then it can be used to adjust the measured wind speed and direction to the actual wind speed and direction, and record those values. The GPS position will also be recorded so that the location of the reading can be saved as well. Although most Internet weather sites assume that the weather station is in a fixed location, there are some that accept reading from ships and accept a location field in the observation. Because COVID-19, we are unable to have physical PWS meetings, so I should have extra time to dedicate to this project. After all, it will also be an excuse to go to the houseboat more.

Improving Cloud Observations With The Skew-T Diagram (Part 1)



Above is the outcome of a balloon flight plotted to produce what is called a "Skew-T Diagram". The reasons for that name will become clear later. This plot was available from the University of Wyoming within a few hours of the flight in Adelaide.

You may be wondering what upper air balloon flights have to do with having a Personal Weather Station (PWS). After all, your weather station is only providing information about the first few metres of the atmosphere. However, if you have a sky camera (or you just look up out the window at the clouds), the situation is quite different—you are looking at a slice of the upper atmosphere. Unfortunately, balloon flights only happen a couple of times a day, but that can still help us learn to make better observations at those times, so that our understanding of the sky will be more accurate at all times.

The moodle course on Cloud Observation Study Guide chapter on Performing a Cloud Observation indicates that a cloud observation consists of three things: identifying the types, the amount of each type and the height of the cloud bases. While I was training to go to Macquarie Island, each day we used to stand on the roof of the BOM training school building and estimate the type of clouds and the base height of those clouds. At first, I was utterly terrible, but by doing repeated cloud observations and being corrected with actual types and heights, my observations skills improved (that was 45 years ago and my cloud observations are currently rubbish, in case you were wondering).

We don't have access to the BOM instructors, but we can try to learn a bit about the Skew-T diagrams to understand what information is available to us to improve our understanding of the clouds—and if that fails, we can get advice from the meteorological experts in the Association. ☺

At first glance, the Skew-T Diagramcan seem just like a jumble of weird scales, a couple of plot lines and a whole lot of "stuff" on the right hand side of the graph. Before attempting to delve deeply into the diagram, it is best to just look over the image and see what makes sense at a glance.

In the upper left corner, the plot is rather obviously identified as being for the Adelaide Airport, but there are two fields before the name that also identify the plot as relating to the Adelaide Airport. The first field "94672" is the World Meteorological Organization (WMO) Station Index. Information about this station can be found by searching the WMO Country Profile Database. The second identifier "YPAD" is the International Civil Aviation Organisation (ICAO) identifier.

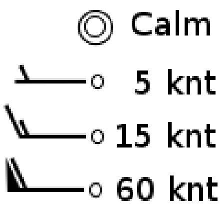
Shifting to the bottom of the image, the time of the balloon flight is recorded as 00:00 30-April-2020 UTC. For those not familiar with the military, Zulu (Z) is the military title for Universal Time Coordinated (UTC). Since the 30th April is outside of Daylight Saving Time (DST) in Adelaide (South Australia), this flight was nominally launched at 09:30 on the 30th April 2020.

The flagging of University of Wyoming on the bottom line does not indicate that it ran the balloon flight, but it does indicate that the image was created using one of their programs. The data was originally provided by the Bureau Of Meteorology (BOM).

The left hand vertical axis is the atmospheric pressure in hectopascals (hPa) - in the past this was also know as millibars (mb or mbar). The atmospheric pressure scale is a logarithmic scale, because the density of the atmosphere reduces in an exponential manner. Additional information can be found in the article "Reading Atmospheric Pressure" in the May 2020 Edition of Monana (which is available on the AMetA website.

Assuming that the balloon lift was such that the average rate of ascent was 300 metres per minute (as per information from the balloon manufacturer), the flight would have run off the end of the chart (16,210 metres) about 54 minutes after the balloon was launched. When the balloon reaches at least 400 hPa (from this flight, about 7000 metres), it is considered to have reached the minimum acceptable altitude for a successful flight. The upper right hand side of the chart has a whole bunch of abbreviations and readings. This time, we will only look at the first two "SLAT" and "SLON". Anyone with a passing experience with GPS location will recognise the numbers as they give the rounded Latitude and Longitude of Adelaide.

However, the main focus for this article is the column to the left of that list of figures and to the right of the graph. These symbols are called "Wind Barbs" and are a convenient way to show the both wind speed and direction. The first thing to remember is the wind direction is defined by the direction from which the wind is blowing, not the direction it is blowing to. So, picking the bottom wind barb to the right, if you start at the end of the line with no additional lines (barbs) and look towards the barbs, that is the direction that the wind is coming from. So, since maps are normally oriented so that up is North, the 60 knot wind is blowing ***from the West***.



Decoding the speed is also simple. As is obvious from the diagrams above, there are three types of barb that can be added to the direction line. The short line is represents 5 knots, the long line represents 10 knots and the pennant represents 60 knots. In the days when these symbols were hand drawn, it may not be obvious whether a wind speed barb is 5 knots or 10 knots. To reduce any potential confusion, note that the 5 knot barb is not drawn at the end of the direction line, but if speed was 10 knots, the barb would be at the end. The pennant represents 50 knots. If a different speed needs to be displayed it can be combining multiples of the three types of barb, with a resolution of 5 knots.

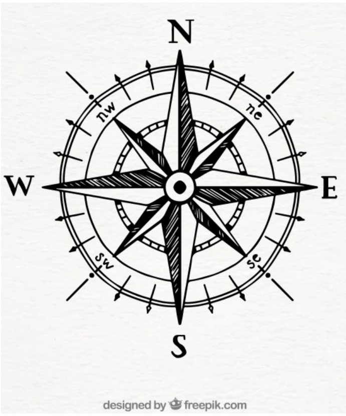
So, let's take a really complicated example and see how it works out. Starting at the end without the barbs (the dot in this case and looking to the other end would indicate on a map that the wind was coming **from the North-West**. Now, there are two (2) pennants which each represent 50 knots, four (4) long barbs that each represent 10 knots each and one (1) short barb that represents 5 knots. **Wind$_{speed}$ = 2 * 50 + 4 * 10 + 1 *5 knots = 145 knots**.

If we knew the cloud heights, we would be able to determine the direction they are travelling and the speed at which they were moving. Conversely, if we can estimate the direction and speed that the clouds are moving, we may be able use that to better estimate the height of the clouds, especially if we know the cloud types.

The Skew-T graph can provide extra information that can help us to better determine the heights and types of the clouds that we can see in our sky cameras, or by just looking out the window, but more of that in later articles.

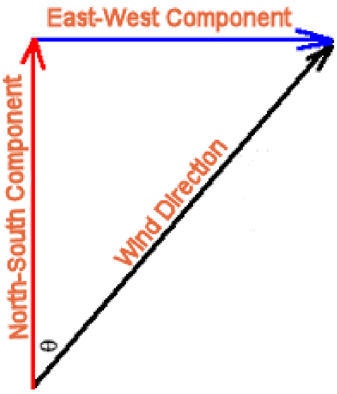
The Wind Rose

Data Analysis with SQL (Part 2)



For many meteorological measurements, getting the maximum value, the minimum value and the average value can tell you a lot about what was going on. It is very simple process to find the minimum value, the maximum value and to calculate the average value by adding up all the values and dividing by the number of values counted.

If we are looking at wind speed, the same process can be applied to get the minimum wind speed, the maximum wind speed and the average wind speed. However, calculating the average wind direction is not as simple. Consider just two samples. The first is North-West (315°) and the second is North-East (45°). If we add the two values together we get 360° and if we divide by 2, then the calculated average will be 180° (South). Clearly, this is wrong, because the average direction should be halfway between NW and NE, which is N(orth).

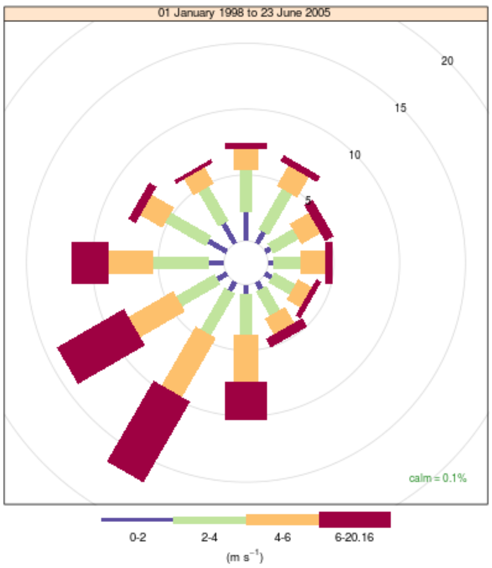


We could say that NW was actually –45° and when the two directions are added together and divided by 2, the answer will be 0°, or North. Unfortunately, the problem is not fixed, only moved. Try averaging SW (-135°) and SE (135°) and you will find the calculated average is 0°, or North.

If we want to do this averaging so that it works every time, we need to think of the wind direction as a vector with a North-South component and an East-West component, as shown by the figure to the left. If we assume that an identical Wind is coming from the South-West, we will have equal N-S and E-W components. If the second wind is from the South-East, it will have the same N-S component, but the E-W component will be a negative value. Adding those together and averaging, the first and second E-W components will cancel each other out and only the N-S component will remain, hence the average wind will be from the South, as we expect.

$$Direction_{avg} = \arctan\left(avg\left(\sin\left(Wind_{direction}\right)\right), avg\left(\cos\left(Wind_{direction}\right)\right)\right)$$

Now that we can do the calculation, the question needs to be asked whether it is really useful to know, because the average wind direction can turn out to be a direction that the wind hardly ever blows from. For this reason, the Bureau of Meteorology (BOM) chooses to use another method of indicating information about the long term wind speed and direction—the Wind Rose.



The Wind Rose displays the wind speed and direction graphically. Not unexpectedly, wind direction is displayed on a circular graph, but the rings aren't wind speed as you might initially expect, but percentage of the readings over the period being measured. The pollution wind rose on the left uses segments of 30° to group the wind readings, while the BOM wind roses use compass points to group the winds. Some other wind roses plot every degree around the circle.

To be able to create a wind rose from our data, the first thing we need to do is understand how the data is displayed. As indicated before the rings represent the percent of the readings. The wind speed is indicated by the thickness and colour of the lines radiating out at the directions being measured.

The first thing to look at is the blank circle in the middle. The distance from the centre of the plot to the first line represents the percentage of the readings where the wind was calm. That is, there was a zero wind speed in any direction. The blue lines represent the percentage of the readings in each direction that are greater than 0, but no more than 2 metres per second. As the range of wind speeds increase, the thickness of the line increases and changes colour. This graph gives a much better picture of what the wind is doing than just a simple average could ever do. The question now is how do we go about extracting that information from the database.

Unlike the previous example of trying to find the average wind, this time all that is needed is to decide how many "petals" the rose will have and this will determine what range of wind directions get groups together to be displayed as one (1) line on the wind rose. If we use the 16 compass points (N, NNE, NE, ENE, …, W, WNW, NNW), then the lines will cover a range of 360°/16 (22.5°).We also need to know the total number of readings are going included in the wind rose. Although we are going to do this manually, normally the SQL queries would be used by a program that is calculating the wind rose readings and then plotting it on a graph.

The first thing we do is count the number of readings that will be used to calculate the percentage shown on the rose. The query "**select count(wind_speed) from observations**" is used. To simplify the example, we are going to include all wind recordings, but normally it would be restricted to a period such as an hour or a day. We need to use this number a lot, so it would be stored for later use.

Because the wind rose petals are 22.5° apart (see above), the petal includes the winds from 11.25° before the compass point to 11.25° after the compass point. For example, for the North-North-East (22.5° bearing) petal that would be 11.25° to 33.75°, and so on around the compass until we get to North which would start at 348.75° and go round to 11.25°. To count all of the wind speeds from that range of directions, we would use a query like "**select count(wind_speed) from observations where wind_direction >= $start_direction and wind_direction < $end_direction**". Using the NNE example, $start_direction would be 11.25 and the $end_direction would be 33.75. Unlike the problems with trying to calculate the average wind direction because of the values to the east and west of North, the query above works for North (0°). I will leave it to you to confirm that the correct range of directions is selected if the query is "**select count(wind_speed) from observations where wind_direction >= 348.75 and wind_direction < 11.25**".

So, now we can count all of the times that the wind was blowing from the desired range of directions—the compass points. What we need to do now is determine the number of times that the wind was at a particular speed. A similar query can be used to group the wind speeds together like was done for the wind directions. Simply changing wind direction to wind speed will do it. We can do that with a query like this "**select count(wind_speed) from observations where wind_speed >= $start_speed and wind_speed < $end_speed**". This will count all of the readings into wind speed brackets, but we need to combine the direction and speed concepts together to group the wind speed brackets into the compass point direction groups.

We do that by making a combined direction and speed selection to give a query like "**select count(wind_speed) from observations where wind_speed >= $start_speed and wind_speed < $end_speed and wind_direction >= $start_direction and wind_direction < $end_direction**".

It may look like we are done, the query above will read the data from the entire observations data. If we are looking for a wind rose that covers a particular hour, day, week, month or year, we need to tell the query the range of date/times that the wind rose should cover. We use the same scheme to set the range of observations that should be used. To demonstrate, lets add a date/time (also known as timestamp) to the query that counts the total number of observations "**select count(wind_speed) from observations where $start_timestamp >= obs_timestamp and $end_timestamp < $obs_timestamp".** Now only the wind observations between the desired date/times will be counted as would normally be expected. So, let's add the date to the query above for each bar on the wind rose.

"**select count(wind_speed) from observations where wind_speed >= $start_speed and wind_speed < $end_speed and wind_direction >= $start_direction and wind_direction < $end_direction and $start_timestamp >= obs_timestamp and $end_timestamp < $obs_timestamp**".

Luckily, selecting the start and end time for the observations does not increase the number of times that queries have to be run. In a later edition, we will convert these queries into actual SQL statements and generate the information that is needed to generate real wind roses.

Houseboat Trip Photos

"Parrot Art Versus The Real Thing"

Kookaburra Watches the "My Lady" Mooring

The "Murray Princess" aground in a Shallow Section of the River

"My Lady" Moored Near Waikerie