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Introductions

- **Instructors**
  - Rod Smallman
    - rod.smallman@orcv.org.au
  - **Moderator**
  - Neville Rose

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House rules & explanation

The sessions will go for approximately 2 hours including presentations, chats and exercises

There will be a 10 min break in the middle

Teams – protocols and tools

- Chat bar – student participation is very much encouraged
- Moderator – might not raise a question to the presenter if they know the topic is coming up
- Raise hand
- Audio and Video selections
- Polls, Quiz's
- Select "View" & "Focus on content" will provide a better experience

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Acknowledgements

AUSTRALIAN HYDROGRAPHIC SERVICE

PredictWind.com THE WORLD LEADER

QUANTUM SAILS TO THE NEXT CHALLENGE

NAVIONICS A Garmin Company

MUSTO 60 YEARS OF INNOVATION

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Where's MUSTO - competition

MUSTO

Count the number of "musto backpacks" throughout the course

(hint – There is 1 on this page)

PRIZE is

MUSTO ~ Essential 25lt Backpack

Valued at $160.00

- Closest to the number wins – announced at the Q&A session
- More than one – then winner will be question shootout
- The fine print about the judges(me) decision being final

This is the 1st

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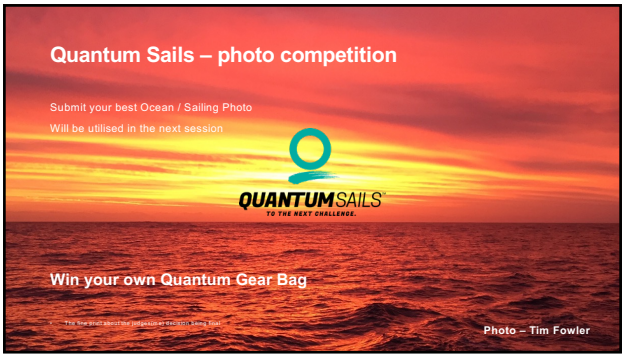

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Navigation definition

Navigation - refers to the systematic monitoring and precise control of a vessel's movement, ensuring its safe transit from one location to another.

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The role of the modern Navigator

- First Principals Navigation
  - Keeping the boat in navigable water
- Boat positioning – from a race & safety (comfort) point of view
  - Wind
  - Waves
  - Current
  - Takes advantage of forecast weather

  - This course will focus on First Principals Navigation

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Course Objectives

The Fundamental Navigation Course covers core concepts and skills required for safe navigation in 4 sections

- navigation - core concepts
- electronic charts
- navigating with GPS and chart plotters
- good practice for safe navigation

These are building blocks for our Intermediate Navigation course

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A word on Paper Charts

- The Australian Hydrographic Office, operating under the Australian Department of Defence, is responsible for creating official navigation charts for Australasia and neighboring regions. With their allocated budget, they have maintained two types of charts in the past: paper charts and S-63 ENC (Electronic Navigation Charts). However, considering the majority of their customer base consists of commercial users, the office made a decision some time ago to transition from paper charts and S-63 ENC to S-63 and the next generation S-101 ENC. As a result, paper charts have been gradually eliminated from their offerings since 2021.
- From our point of view, anyone with a phone or tablet has access to Navionics which means multiple redundancy options should the main chart plotter fail and as such – as a sailing community – we have moved away from paper charts.
- It is important to note that both paper charts and electronic charts provide the same information

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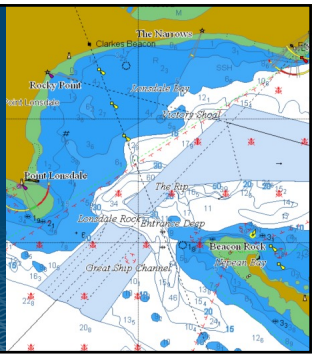
Fundamental Navigation

Session One



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Fundamental Navigation – outcomes

To provide an understanding of navigation theory and systems such that participants will be able to:

- understand common navigation terms, including the ability to interpret a nautical chart
- calculate bearings and plot positions
- recognise nearby risks and visual references
- plan simple passage routes

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Essential Requirements for Safe Navigation

You need.....

- to know your current position on the globe
- the direction in which you are moving and speed
- a good chart – where is the land, how deep is the water – relative to your position

Sounds simple but it's been a 500 year quest. For yachts:

- GPS and chart plotting technology now largely addresses the first 2 requirements
- Chart quality and user errors are currently the weakest links

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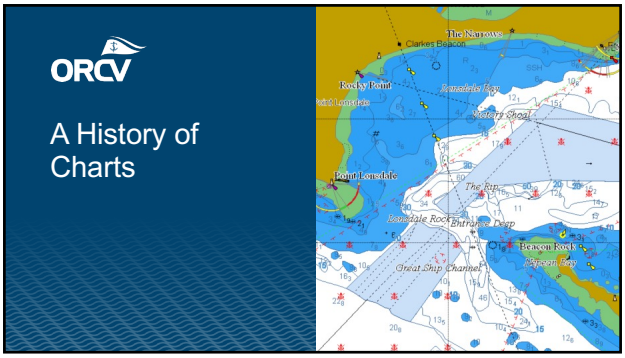

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The Global Positioning Grid

Our positioning grid was developed 500 years ago and reflects the technology of the past when:

- boat positions North and South of the equator were determined by celestial sightings – measuring the elevation of sun and stars
- for East – West positions, time was critical (earth's rotation)

The navigators had their work cut out for them since:

- the earth is not round,
- clocks were not reliable
- the earth is inclined so the stars being observed move north and south as the year progresses
- sightings subject to numerous errors – refraction, height above water, instrument errors.)

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Latitude and Longitude

We define our position by:-

- **Parallels** of Latitude
  - Rings around the globe **parallel to the equator** spaced through 180 degrees
    - 90 degrees north and 90 degrees south of the equator
- **Meridians** of longitude
  - Each meridian is half of a great circle around the globe - running from North Pole, through the equator to South Pole
  - Spaced through 360 degrees (east 180 [+] and west 180 [-] from Greenwich)
- The grid incorporates a time - distance dimension
  - 15 degrees of earth's rotation = 1 hour of time (360 degrees/24 hours=15)
    1 degree of longitude = 4 minutes
  - Each degree along a meridian (and other great circles) = 60 Nautical miles

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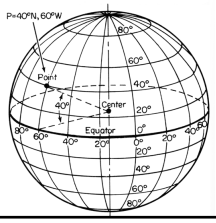
Latitude & Longitude

- Parallels of Latitude – lines running parallel to the equator (north or south) angled from the polar axis. Each degree is 60 nautical miles.
  - The 40 degree arc shown is 2400 nautical miles
- Meridians of Longitude – perpendicular to the equator, angled around the globe (360 degrees but counted east or west of Greenwich.
- Traditional units were used Degrees, Minutes, Seconds
- But be careful reading your GPS:
  - It will also offer
  - Degrees, Minutes. decimal minutes
  - or Degrees, decimal degrees

  i.e. 40° 26' 46"

  or 40° 26.770'

  or 40.4461



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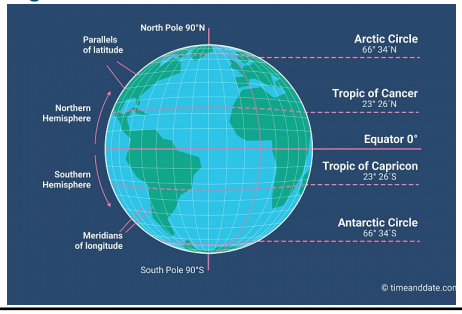
Significant Latitudes



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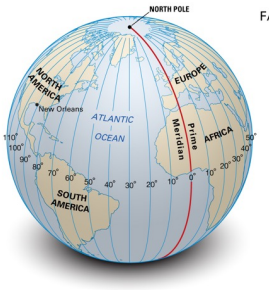
Significant lines of Longitude



FACTS ABOUT LINES OF LONGITUDE

- Are known as meridians.
- Run in a north-south direction.
- Measure distance east or west of the prime meridian.
- Are farthest apart at the Equator and meet at the poles.
- Cross the Equator at right angles.
- Lie in planes that pass through the Earth's axis.
- Are equal in length.
- Are halves of great circles.

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Significant lines of Longitude

- 0° Prime Meridian runs through Greenwich and is “Zulu time”. That is how we set the world time
- 180° is the International date line (after adjustment to avoid unnecessarily “splitting countries”)
- This is where, if you are traveling from west to east across the line, you would go back in time to the previous day

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What is a Nautical Mile?

- 1 degree of latitude (ie 60 minutes) is 60 Nautical miles.
  - ie 1 minute of arc = 1 Nautical Mile.
- However, because the earth isn't round the length varies depending on your latitude.
- A standard length of 1852m was therefore adopted at an International Convention in 1929.
- Note – on a paper chart - that a minute of longitude is only a nautical mile at the equator - the distance covered by one degree of longitude decrease towards the poles because the meridians converge at the poles.

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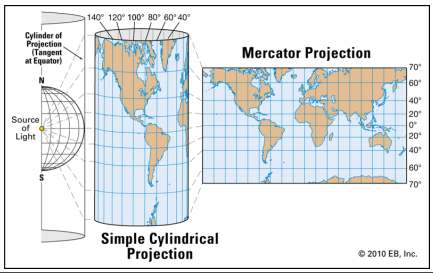
How are flat charts made of our round planet?



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Advantages of Mercator Charts

- Parallels and meridians on the Mercator chart are straight and perpendicular to each other
  - The grid lines on a Mercator chart run true north and true south
- It became the standard map projection for navigation because of its unique property of representing any course of constant bearing as a straight segment.
- The disadvantage is that land masses are distorted

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Quick Quiz #01

- Why can't you measure distance using degrees of longitude ? (yep, it's a trick question)
- How long is a degree of latitude? .... and a minute of latitude?
- Which way do the grid lines on a Mercator chart run ?

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Charts History - Recap

Latitude
Longitude
Major global lines
Measurements
Mercator charts

Questions ?

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Chart Basics

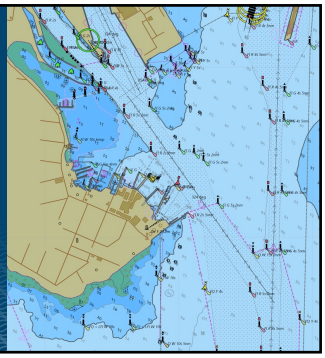

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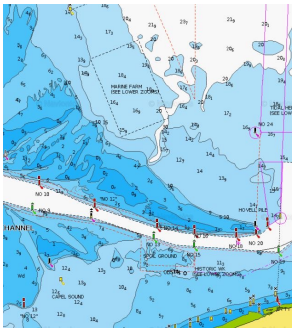
Chart Basics

- Depth – Metres
- ZOC ~ Zone of Confidence
- Lights
- Leads
- Channel Markers
- Traffic Separation Schemes
- Tides
- Features

Admiralty Chart 5011 / Chart #01

BoatBooks link



30

Reading Lights from chart

eg West Channel Pile

Fl.WR.6s 14 / 11M

Fl = Light type

WR = Color (White Red)

6s = cycle period (6 sec)

14 & 11 = visible ranges (Nm)

Description	Characteristic	Chart Abbreviation
Alternating		Alt. R.W.G.
Fixed		F.
Flashing		Fl.
Group flashing		Gp Fl.(2)
Occulting		Occ.
Group occulting		Gp Occ(3)
Quick flashing		Qk.Fl.
Very quick flashing		V.Qk.Fl.
Isophase		Iso.
Morse		Mo.(letter)

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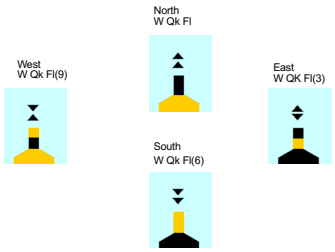
Cardinal Marks



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Other Key Marks

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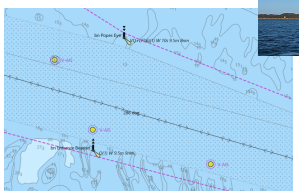
Channel Markers

Entrance Beacon – South Channel



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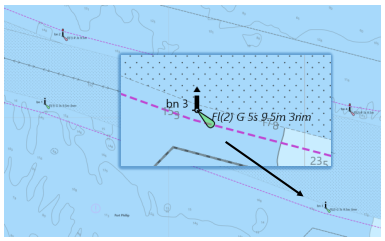
Channel Markers

Port Phillip Bay – South Channel



Port Phillip Bay
South Channel
Lights count up each time
(SC only)
Ie Fl(1), Fl(2), Fl(3), Fl(4)
Resets each 4
Note:
Recommended track

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Direction of Buoyage

Direction of Buoyage: The direction of buoyage is that taken when approaching a harbor from seaward. Along coasts, the direction is determined by buoyage authorities, normally clockwise around land masses.

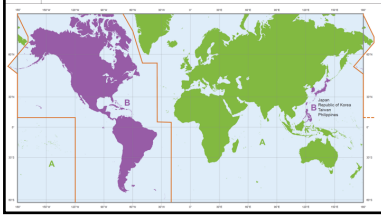
Symbols showing direction of buoyage where it is not obvious

INT

General symbol for direction of buoyage

IALA Region A
on multicolored charts

IALA Region B
on multicolored charts



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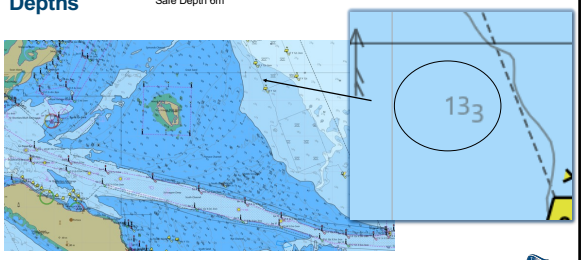
Depths

Safe Depth 6m



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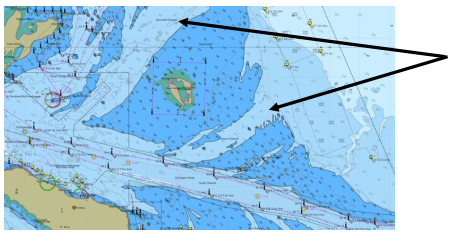
Depths

Safe Depth 5m



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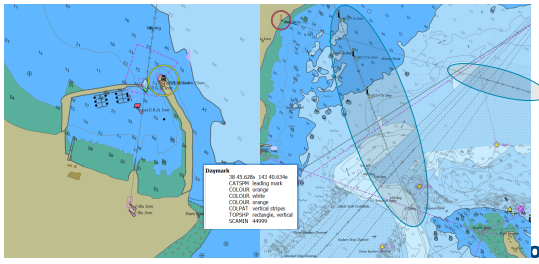
Leads & Transits (recommended tracks)



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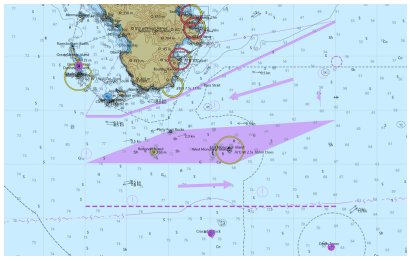
TSS – Traffic Separation Scheme



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ZOC
Zones of Confidence

Category	% area of English Channel	% area of Singapore & Malacca Straits	% area of world's coastal ENC (32 nations)
A1 (6 stars)	3.6%	1.4%	0.7%
A2 (5 stars)	9.4%	0.2%	1.0%
B (4 stars)	62.9%	2.5%	30.5%
C (3 stars)	21.3%	76.2%	21.8%
D (2 stars)	2.8%	1.1%	20.5%
Unassessed (U)	0.0%	18.5	25.4%

(excludes ports)

ZOC	ZOC Symbol	Position Accuracy	Depth Accuracy	Seafloor Coverage
A1		± 5 m + 5% depth	0.50 + 1%d	Full area search undertaken. Significant seafloor features detected4 and depths measured.
A2		± 20 m	= 1.00 + 2%d	Full area search undertaken. Significant seafloor features detected[1] and depths measured
B		± 50 m	= 1.00 + 2%d	Full seafloor coverage not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.
C		± 500 m	= 2.00 + 5%d	Full seafloor coverage not achieved, depth anomalies may be expected
D		Worse than ZOC C		Full seafloor coverage not achieved, large depth anomalies may be expected.
U	U	Unassessed - The quality of the bathymetric data has yet to be assessed		

ZOC A1 and A2 areas - mariners should be able to navigate with confidence

ZOC B areas - it is also unlikely that an uncharted danger affecting surface navigation exists

ZOC C areas - mariners should exercise caution since hazardous uncharted features may be expected, particularly in or near reef and rocky areas

ZOC D areas - a very high degree of caution is required as these areas contain either very sparse data or may not have been surveyed at all

ZOC U areas - it is good practice to treat ZOC U areas with the same degree of caution as ZOC D areas

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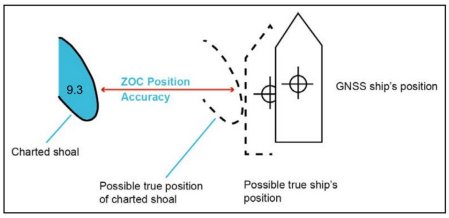
ZOC
Zones of Confidence



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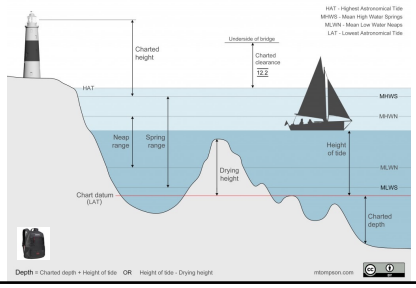
About tides and depth



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Multitude of Sources for Tide Predictions

We recommend

Australian Government Bureau of Meteorology http://www.bom.gov.au/australia/tides/

NAVIONICS A Garmin Brand https://www.navionics.com/

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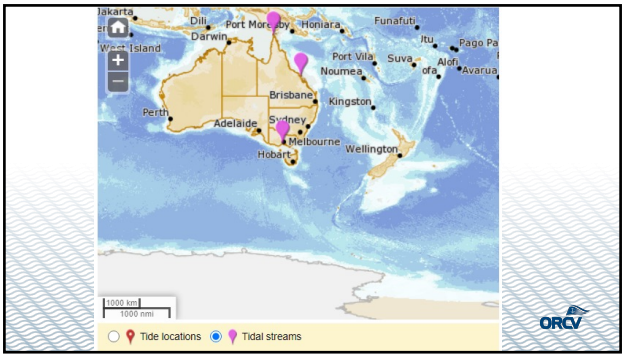

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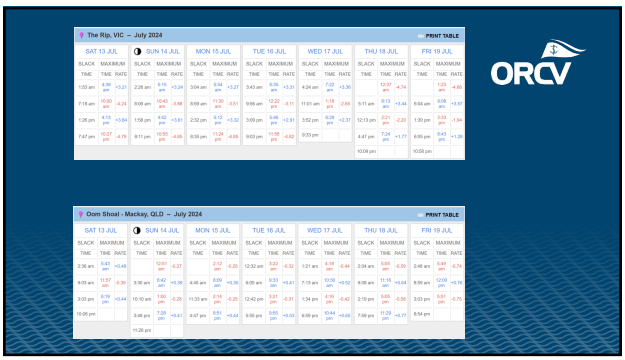

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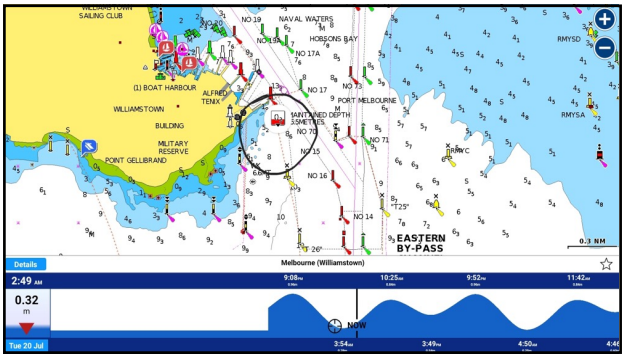

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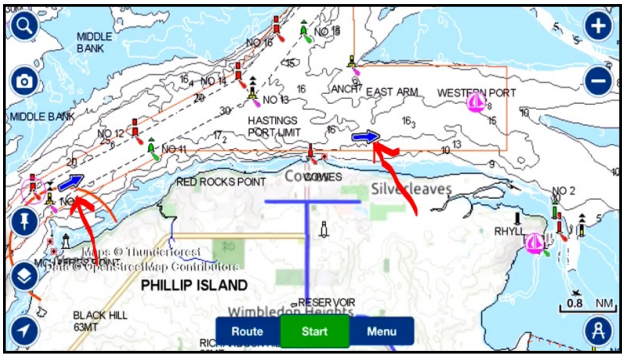

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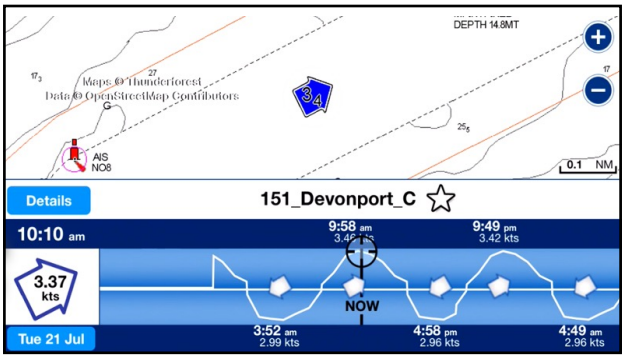

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More on tides

- More detailed information on tides is discussed in the intermediate course
- If you are not participating in the intermediate course, it is highly recommended that you become very familiar with tides and currents

ORCV – fundamental navigation resource page

Fundamentals of Navigation - ORCV

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Chart Basics - Recap

- Depth – Metres
- ZOC ~ Zone of Confidence
- Lights
- Leads
- Channel Markers
- Traffic Separation Schemes
- Tides
- Features

Admiralty Chart 5011

BoatBooks link

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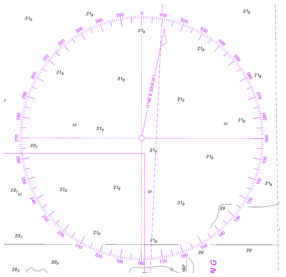
Compass

- Charts can be set to "True" or "Magnetic" direction
- Compasses show "Magnetic" direction
- The difference is "magnetic variation" (declination)
- If the declination is East, "compass is least". So, if you want to head due north steer less than 360 magnetic
- Magnetic variation varies across the globe
- In Melbourne, its approx. 11 degrees
- Some compasses also have deviation - the error induced in a compass by local magnetic events; engine block, steel boats, electric motors.



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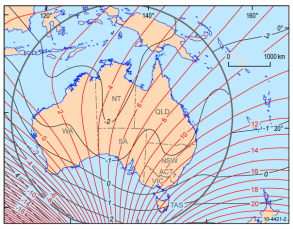
Magnetic variation Australia



Declination, Australian Geomagnetic Reference Field model 2010 at 2010.0

- *Declination angle (°)*
- *Annual rate of change of declination (°/year)*
- *AGRF model area*

Contours outside the plots are derived from AGRF-10

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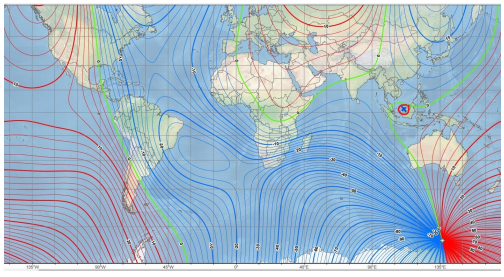
Magnetic variation (declination)



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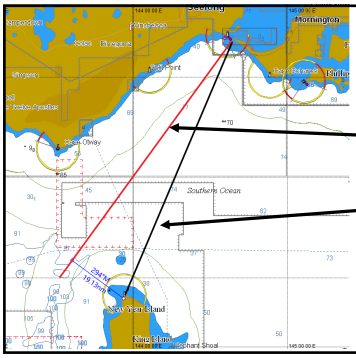

True / Magnetic

203° MAGNETIC bearing from Port Phillip Heads to King Island

203° TRUE bearing from Port Phillip Heads to King Island

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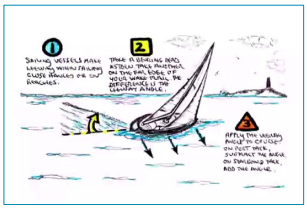
Leeway

How can we Estimate it?

How can we Measure it?

How can we Apply it to predict our course



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Leeway

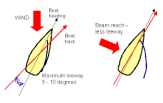
Leeway – estimate typically 5 to 10°

(for a yacht when the wind is forward of the beam)

Measure

Sight wake with hand compass

Use GPS course over ground vs compass heading.



Predict:

- Wind from Port side: Water track - Leeway angle = course to steer.
- Wind from Starboard side: Water track + Leeway angle = course to steer.

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Leeway

A handy "divide by 60 rule of thumb" to remember;

- 5 degrees is 5/60 or 1/12 meaning that for every 12 miles forward you slip one mile to leeward.
- 3 degrees is roughly 3/60 or 1/20 so then for every 20 miles forward, one mile slipped to leeward.
- You get the idea! Works best for small angles

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Exercise #01

- Plot the following three positions, what is located there ?
  - A: 37 56.9S 144 55.6E
  - B: 38 06.4S 144 44.2E
  - C: 38 11.6S 144 45.4E
- What is the distance between B & C

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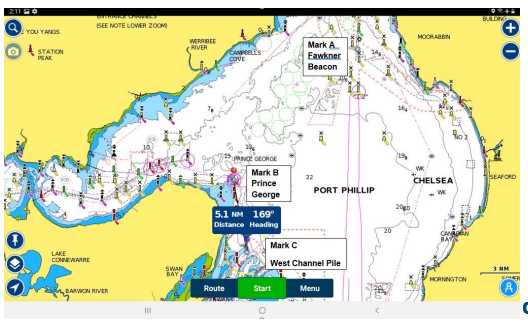

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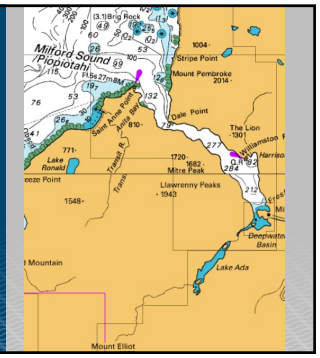
Electronic Charts



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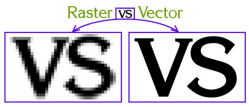
Electronic chart types

- **RNC**
- Raster Navigational Chart
- Essentially a photocopy - georeferenced
- **C-map & Navionics**
- Vector charts, Seamless
- Interactive and user defined
- **ENC**
- Electronic Navigational Chart
- Vector
- S-57: S63(encrypted) and in a few years S-101
- ONLY official charts can be called ENC



Why should you have more than one source ?

Why should they be up to date ?

ORCV

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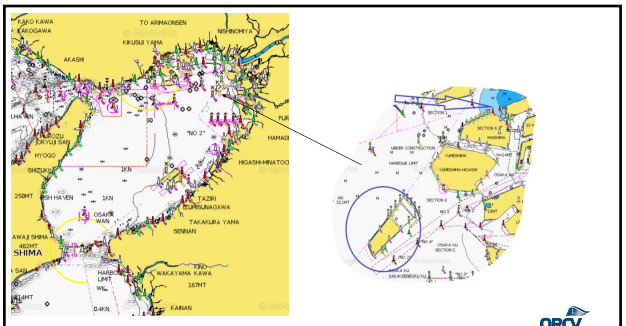

ORCV

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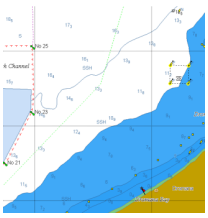
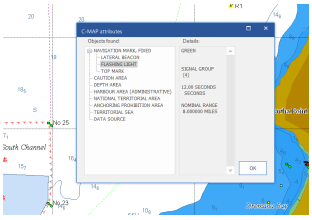
C-map





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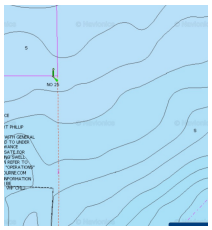
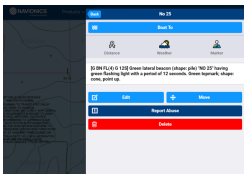
Navionics





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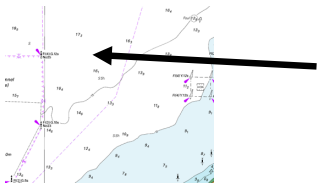
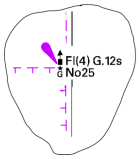
RNC





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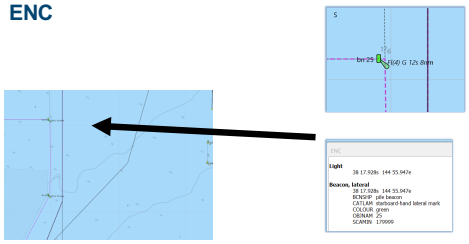
ENC



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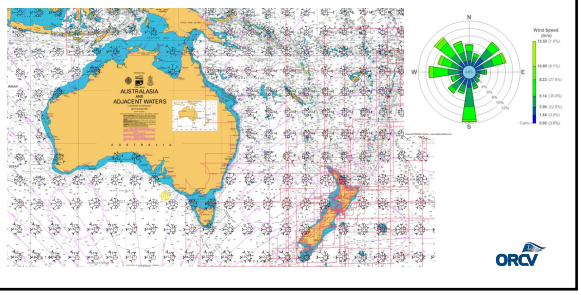
SeaPilot Charts



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Questions

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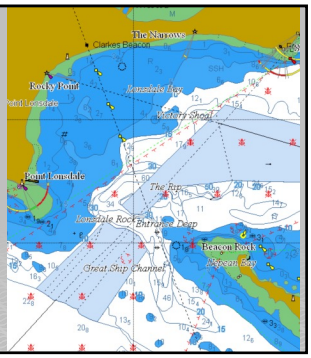

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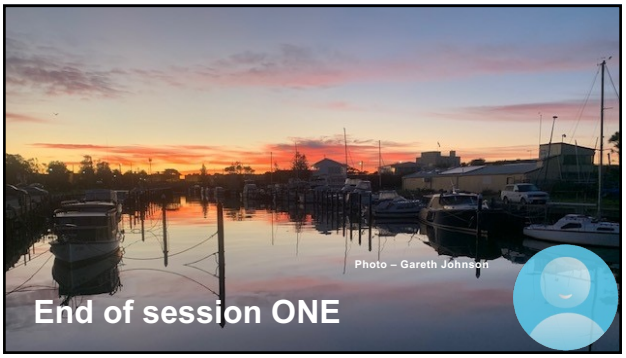

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