The Compass

The compass, an essential navigational aid. Learn all about Variation, Deviation, True and Magnetic bearings and how to convert from one to the other.

The compass

The Earth has a magnetic field which is roughly aligned with the north and south poles. A magnet allowed to rotate freely will align itself with these magnetic poles. The modern magnetic compass actually consists of several parallel magnets mounted to a compass card. This assembly pivots around a jeweled bearing and is usually built within a fluid filled container designed to dampen it's movement. These instruments give us the ability to accurately and consistently steer our boat on a desired course.

Compass Error

Anything that affects our compass reading, that is, anything that alters it from the direction of true north, is called compass error. We need to understand what forces will do this so that we can correct these errors and derive our actual heading. There are two different types of compass error:

- Variation
- Deviation

Variation

The magnetic poles correspond closely with the actual geographical poles. but not quite close enough. The north magnetic pole is located at approximately 78.9°N latitude and 103.8°W , over 600 miles from the geological north pole. And whilst your compass doesn't point exactly towards the north magnetic pole, it does point to a location near to it.

The problem that's created here is that a compass will point to a direction other than true north, the difference between the two depends on where on the Earth the compass is. This error is called Variation, and it's the angular difference between true north and magnetic north. This variation varies depending where you are in the world but in the UK it is

about 7º West. This means that the North the compass is indicating is 7º West of True North.

Clearly if our chart suggests we travel true North i.e., 0º then we must steer using out compass a course of 7º to compensate for the difference.

An area's local variation can be found within the Compass Rose of your nautical chart. It changes a very slight amount every year due to the slow migration of the Earth's magnetic poles so check the year that your chart was printed and note the annual increase or decrease in variation.

Variation only affects devices that rely on the Earth's magnetic field to work. Gyroscopic compasses, radio direction finders, and global positioning instruments are not effected by variation.

As previously mentioned variation changes through time and location. It can also be affected by other factors:

- **Secular** which is due to the movement of the poles,
- **Solar** which is slight but caused as the sun moves around the Earth
- **Lunar** which is very small due to the Moon but larger effect than the sun,
- **Magnetic Storms** which are caused when the Sun sends out plasma during Solar flare which interferes with the Earth's magnetic field.
- **Coastal Irregularities** such as the presence of large amounts of magnetic material can distort the **magnetic isogonic lines** (these are lines showing positions of equal magnetic variation over the earth's surface).

Deviation

Another force that acts upon your compass to create error is deviation. Deviation is the influence of the immediate environment upon your compass. Being a magnet, your compass will be attracted to (or repelled by) iron bearing metal and other magnets (including magnetic fields created by flowing electricity). Unlike variation, deviation is not

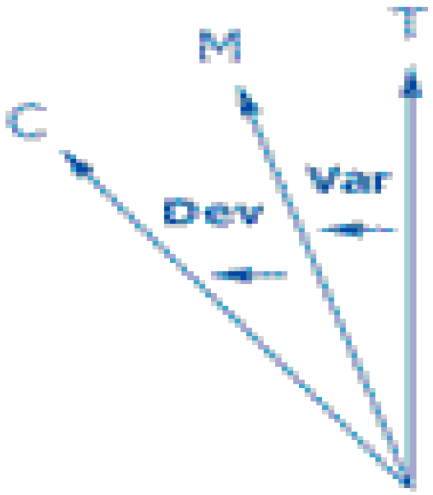
constant, it's different in every boat, and it's even different within the same boat, depending on which direction she's heading. Deviation is measured by the angular difference between the magnetic heading and the compass heading.

The navigator should know what the deviation is on his vessel. While it is beyond the scope of this tutorial to describe the process, most quality compasses can be adjusted to eliminate most, if not all deviation error. What deviation remains can be found and documented on a Deviation Card. This card or graph will list the deviation for various compass courses and is referred to by the navigator when compass courses need to be corrected.

Don't forget about everyday objects that you take on and off your boat particularly cylinders.

T=True
Var = Variation
M = Magnetic
Dev = Deviation
C = Compass

Error relationships



Correcting Compass Error

To correct for compass error, there are two aid memoirs that you need to know:

1. **T**rue **V**irgins **M**ake **D**ull **C**ompanions = True Variation Magnetic Deviation Compass.
2. Error West- compass best, error East - compass least

This is how they work:

Example 1. Your chart says you must travel due East. You have a local variation of 7º and a 1º E deviation. What direction on the compass should you steer?

True	Variation	Magnetic	Deviation	Compass
90º	7º W		1º E	

Find out the magnetic bearing by "error West so the compass is best" this means that the compass bearing must be higher, therefore 90+7=97

True	Variation	Magnetic	Deviation	Compass
90º	7º W	97º	1º E	

Deviation is "error East so the compass is least. This means the compass bearing must be less so you take off the 1º .

True	Variation	Magnetic	Deviation	Compass
90º	7º W	97º	1º E	96º

Example 2. Your boat compass is telling you you are traveling due south. What direction are actually traveling?

True	Variation	Magnetic	Deviation	Compass
	7º W		1º E	180º

To get the magnetic bearing - "error East is compass least", so the compass bearing must be less that the Magnetic, therefore magnetic must be

True	Variation	Magnetic	Deviation	Compass
	7º W	181º	1º E	180º

To get to True, "error West so the compass is best", therefore the True bearing must be less, i.e., 174º

True	Variation	Magnetic	Deviation	Compass
174º	7º W	181º	1º E	180º

Swinging the compass

A ships steering compass must be swung year to check the deviation card. To do this, anchor the boat, tie a long pole to the centre rear of the craft. Tow the vessel round using another vessel to the new positions. The steering compass is noted every 20° and the vessel held in position whilst the hand bearing compass is used to take the bearing of the pole and centre bow. By comparing the two bearings the deviation can be found. The compass should also be re-swung when one of the following conditions occur:

- Standing for an extended period (say six months).
- If the vessel is struck by lightning.
- If the engines are changed.

A typical deviation card for a boat

Hand Bearing compass

Hand bearing compasses enable you to take a magnetic bearing on a distant object. This bearing has many uses:

- You can plot lines of position from identifiable land objects for coastal navigation.
- You can check the relative bearing to another vessel to see if a collision is probable. If the bearing doesn't change over time, ALTER COURSE!
- You can take bearings to mark a wreck or dive site.

Both traditional and electronic hand bearing compasses are available. Traditional models have a compass card and a sighting system that allows you to see the desired object and the compass card at the same time. Electronic bearing compasses provide bearings in a numerical readout. They are easy to read, and can store multiple bearings until you get a chance to plot the LOPs. However, they are just as affected by poor aiming, steel rimmed glasses, and other sources of error as traditional compasses.

There are several ways to line up your target with the aiming mechanism on the compass. Traditionally, compasses were held at arms' length, and the navigator looked across sighting vanes on the top of the compass. By lining up the sighting vanes with the desired object, and then glancing at the compass card, reasonably accurate bearings could be taken. The problem is that it is difficult to keep everything lined up on a moving boat .

When using a hand-bearing compass keep it away from any ferrous objects particularly cylinders and steel rimmed spectacles. Allow the card to settle (unless using a fluxgate compass). Keep the top part of your body free to counter the motion of the vessel. Take bearings in a short a time as possible. Call out the bearings for another crew member to write down. Use three or more bearings. Take the bearing on the beam last (it changes quickest when moving). Fixed objects are better than buoys.