North References for Navigating with Map, Compass and GPS

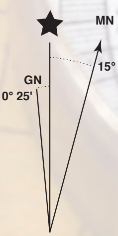
True North

The True North Pole is the axis of the earth's rotation. The North Star is used as a true north reference. It's position in the sky causes it to appear almost stationary with the other stars rotating around it. Lines or meridians of longitude can also be used as true north reference lines. Meridians of longitude converge at the True North and South Poles. The vertical edges of many maps are defined by a meridian of longitude, and can be used as a true north reference.

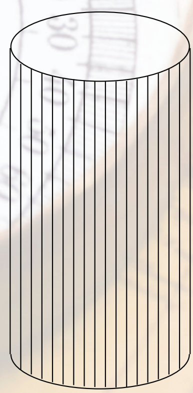
Magnetic North

The magnetic poles are aligned with the earth's magnetic field. A free floating magnetic needle in a compass will align itself with the magnetic field and thus points to the magnetic poles. Declination is the angular difference between true north and magnetic north for a given location. The Magnetic Pole may appear to be either east or west of the True North Pole. Declination changes depending on your position relative to the two poles. Declination also changes over time, because the location of the magnetic poles changes with time. Most GPS receivers will calculate the declination for their current position. This is often referred to as "automatic" north reference.

Grid North

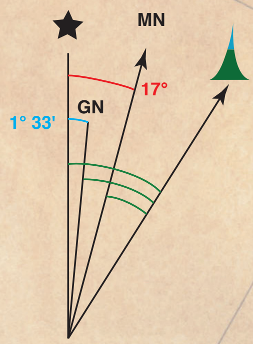


Grid north is useful because it allows you to use the UTM grid lines on your map as your north reference. Grid north is typically within 2° east or west of true north and varies with your position within a UTM zone. When minimal accuracy is all that is required, it is common to treat grid north lines as true north lines without accounting for the small difference.



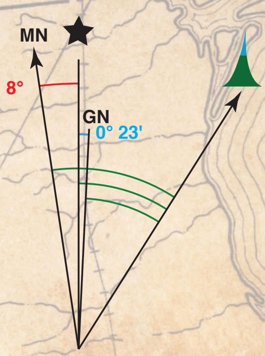
Converting Between North References

The key to converting between the three north references is to add a line representing the bearing to an imaginary target to the declination diagram. Now it is easy to see the different angles measured to the target from each of the north references. Remember the angle is measured from the desired north reference line to the target bearing line. The measured angle's zero degree value is associated with the north reference line and increases in a clockwise direction.



In the example at the right, both magnetic and grid north are east of true north. A true bearing would be 17° larger than a magnetic bearing. Thus to convert from a magnetic bearing to a true bearing you would add 17°.

The angle measured from the target to grid north is also larger than the angle measured from the target to magnetic north. The difference is the 17° angle from true north to magnetic north less the 1° 33′ angle from true north to grid north. Thus to convert from a magnetic bearing to a grid north reference you would add 15° 27′. (I would likely round this to 15 1/2°. I might even round to 15° if accuracy was not critical.)



In the example at the left, magnetic north is west of true north and grid north is east of true north. A true bearing would be 8° smaller than a magnetic bearing. Thus to convert from a magnetic bearing to a true bearing you would subtract 8°.

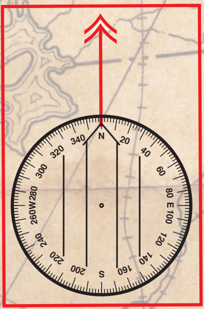
The angle measured from the target to grid north is also smaller than the angle measured from the target to magnetic north. The difference is the 8° angle from true north to magnetic north plus the 0° 23′ angle from true north to grid north. Thus to convert from a magnetic bearing to a grid north reference you would subtract 8° 23′. (I would likely round this to 8 1/2°or just 8°.)

Adjusting the North Reference on Your Compass

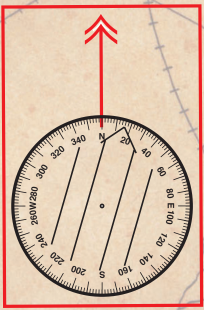
Many compasses allow you to adjust the position of the lines used to align the magnetic needle with respect to the angle measuring dial. The adjustment mechanism is typically either a gear driven one with a small slotted screw and a small brass screwdriver on the lanyard, or a simple friction fit between the capsule and the dial. The choice of adjusting the north reference or not will affect how you work with your compass and should be considered carefully.

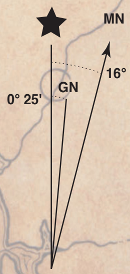
Regardless of your decision on whether to adjust the north reference or not, you must occasionally check to see that the compass is set as you expect it to be. This is particularly true for the friction fit mechanisms which may loosen with time and adjust themselves.

A compass that is not adjusted will read zero degrees when it is aligned with magnetic north. All bearings taken with this compass should be referred to as "magnetic bearings." Since the compass is a magnetic device this is an intuitive result. It is also the result provided by compasses that cannot be adjusted. To plot a magnetic bearing onto your map you will likely need to convert the bearing to either a true or grid north reference by adding or subtracting the declination for your current location. A baseplate compass can be used as a protractor to plot the bearing on the map. There is no need to change the adjustment based on your location.

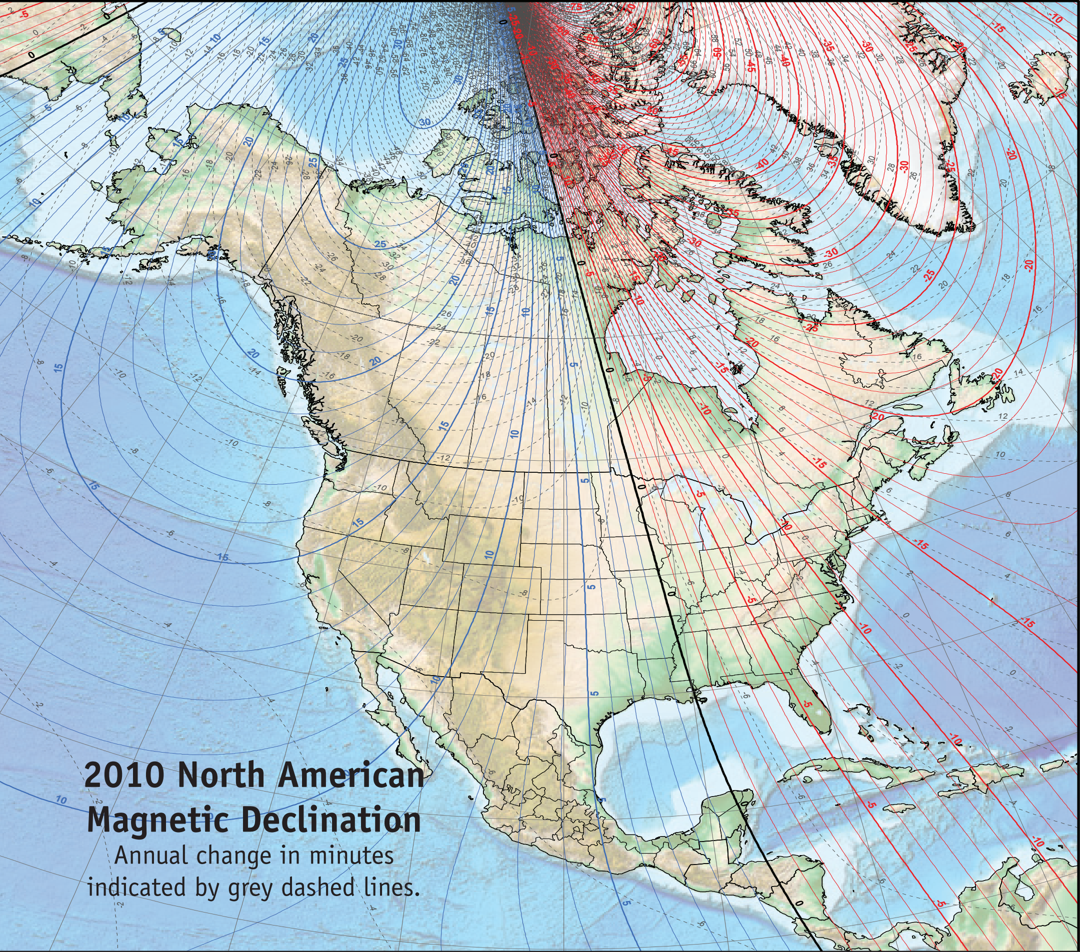


A compass that is adjusted will resemble the declination diagram. The parallel lines in the capsule will be aligned with magnetic north while the zero degree mark on the dial is aligned with either true or grid north. All bearings taken with this compass should be referred to as either "true bearings" or "grid bearings" depending on the north reference you have adjusted to. You will not need to add or subtract values to plot the bearing onto your map. However your baseplate compass cannot be easily used as a protractor to plot or measure on the map, since the parallel capsule lines are not aligned with zero degrees. You will likely want to use a separate protractor. You will also need to remember to change the adjustment to match your current location.





A common trap for beginners occurs when someone adjusts their compass for them, and then they forget what was done and why. An incorrectly adjusted compass is useless for anything beyond a general sense for where north is and may be worse than no compass at all.



2010 North American Magnetic Declination

Annual change in minutes indicated by grey dashed lines.

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800-275-7526

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