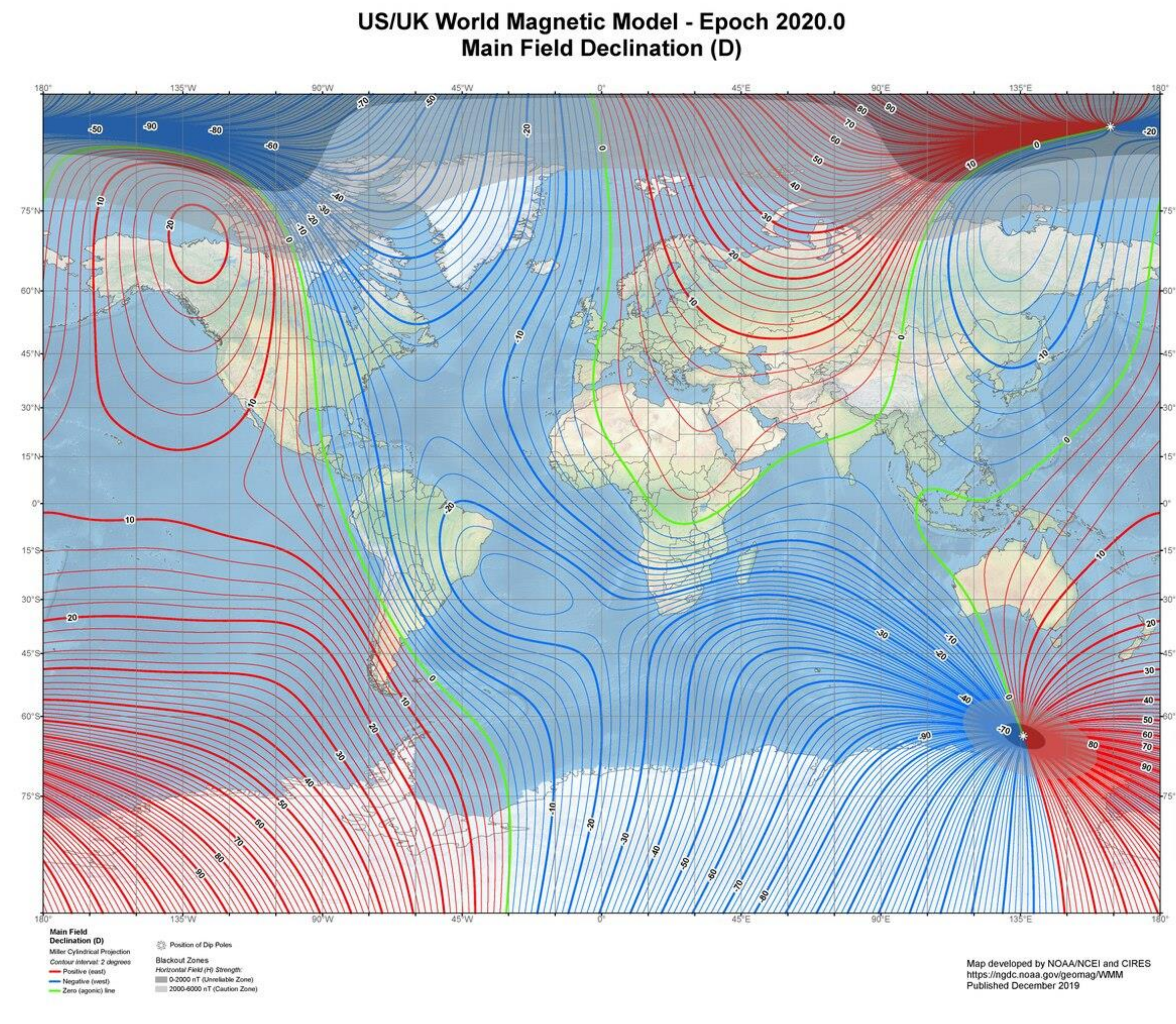
The Trailing Edge

April 2024

An Introduction To Grid Navigation

“Grid is green; grid is good.” As silly as it sounds, that was the mantra we learned in Undergraduate Navigator Training (UNT) at Mather Air Force Base in Sacramento, California in 1984. What do you do in extreme latitudes, north and south, when the magnetic compass becomes ‘unreliable?’ You “go into grid.”

As a youngster growing up in southern Illinois, I looked for everything I could learn about aviation. I wouldn’t be able to earnestly pursue a private pilot license for many years. Nevertheless, I built model airplanes, joined the Civil Air Patrol, and went flying with my Dad and friends whenever the opportunity presented itself. One of the things I learned about was “magnetic variation”, also called “magnetic declination”. You know your magnetic compass lies to you, right? The magnetic pole of the earth doesn’t coincide with the true pole. Do you remember the mnemonic? “TV makes dull children.” Yeah, I know there is another version of that, but I am keeping this story family friendly. The **T**rue heading plus **V**ariation gives you the **M**agnetic heading, and the magnetic heading plus **D**eviation gives you the **C**ompass heading, so “TVMDC.” Compass deviation is caused by magnetic fields generated by things on the airplane. The compass card tells you how much to adjust for that depending on your heading. It is typically only a degree or so. Magnetic variation is the difference between the direction to the true north pole and the direction to the magnetic north pole. Those isogonic lines on the sectional tell you the magnetic variation for your location.



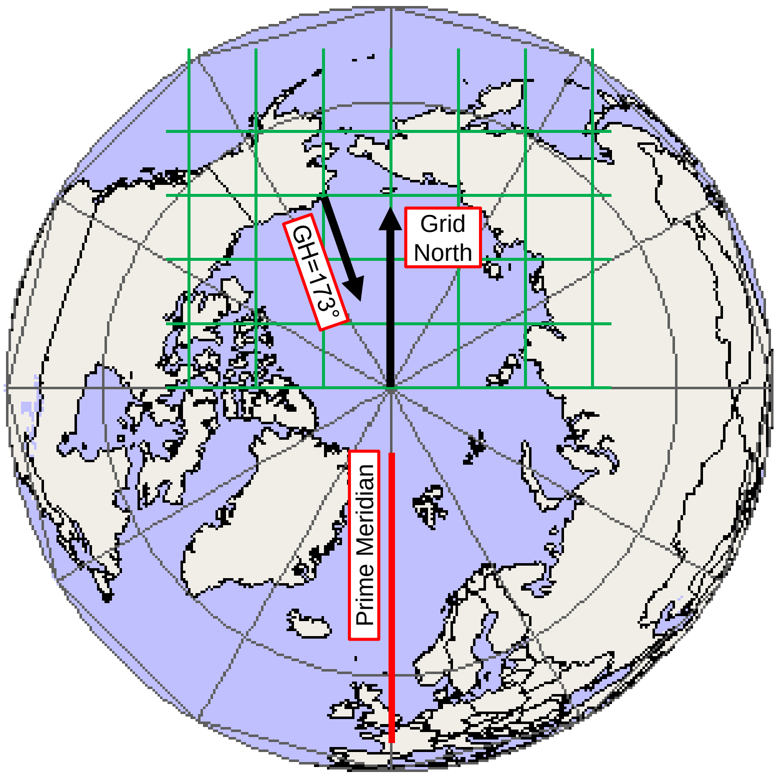
At that time and place, magnetic variation was only about one degree west. So, what's the big deal? Even now, in north Texas it is between two and three degrees, not huge. However, when I started UNT, I learned that mag var, as they called it, was closer to sixteen degrees in Sacramento. Wow! So, it can be a big deal. Later, I traveled to places such as Alaska where the mag var was even greater. Typically, it gets larger as you go nearer the north or south pole. At some point, the magnetic compass is unreliable. That is a nice way of saying the magnetic compass becomes useless. So, what then? The answer is, "Go into grid."

As a student pilot in an era when GPS was not even an idea, I learned to fly with a directional gyro (DG) for heading. Of course, we had to set the DG to the magnetic heading on the whiskey compass before takeoff. On a cross country, it was necessary to reset the DG every fifteen minutes or so. The DG in little airplanes would precess. Left unchecked, it would drift away from the setting. This occurred for two reasons. First, a spinning mass will drift. One way to understand that is to realize that a spinning mass gyroscope will resist a force that tries to move it off axis. If there is no force, nothing keeps it from moving ever so slowly away from its original position. Second, there is earth rate presession. While we are flying along, the earth is rotating beneath us at about fifteen degrees per hour, making a complete rotation in roughly twenty-four hours. Depending on your latitude, some of that shows up as precession of the DG. I mention this effect on little airplanes because the more elegant systems in military, commercial, and some bigger general aviation planes have a slaved compass. There is a system in the plane that measures the magnetic field of the earth and constantly pushes or "slaves" the DG toward the correct magnetic setting. Glass cockpit displays in little airplanes use a magnetometer to measure heading, probably with some heavy damping, and draw a compass on the screen.

What do you do with that slaved compass system when you are over northern Canada and the whiskey compass is spinning like a top? You turn off the slave feature and set the compass to a reference heading. Should that be true north? It could be. However, if you are that far north, the true heading reference will be changing rapidly as you click along, crossing the lines of longitude every few minutes. Let's pick a reference that won't be changing so quickly. Turn the compass so that it aligns with the prime meridian, that line that runs from the north pole to the south pole where the longitude is zero. To do that, begin by selecting a visible celestial object (the sun, the moon, a planet, or a star) and computing the altitude (angle above the horizon) and Zn (bearing from your position to the object). With that, at the precomputed time, you can use the sextant to measure the true heading of the aircraft. This is the same procedure you used for your heading check of the compass systems and inertial navigation systems (INS) earlier in the flight. After you determine the true heading of the aircraft, apply the convergence angle to convert that to the grid heading and turn the compass systems to that heading. When you have done that, you are in grid. Now, for navigation, you have to compute the grid heading for your desired course. Flying with the US Air Force, we used either a Jet Navigation Chart (JNC) or a Global Navigation Chart (GNC). The scale of the JNC is 1:2,000,000, and the scale of the GNC is 1:5,000,000. Those charts include green lines that parallel the prime meridian, or grid north. The charts that cover subpolar areas also have green grid lines. With those, it is possible to go into grid at any latitude for training - or to satisfy the sadistic mind of the black hearted evaluator on one of those ever-recurring check rides.

I know you want to ask about the convergence angle. What is that? How do I know what number to use? The convergence angle is the angle between your local longitude and the Prime Meridian, our reference direction for the grid nav system. If you are far enough north or south to be using GNC 1 (North Pole region) or GNC 26 (South Pole region), those charts are transverse Mercator projection. Therefore, the convergence angle is equal to your current longitude. If you are somewhere else on the globe, your chart (GNC or JNC) will be a Lambert conformal conic projection. If you are using one of those charts, there is a table somewhere in the margin that you can use to determine your convergence angle. If you stripped your chart to keep only the portion along your route, go dig the rest of the chart out of the trash. I used to cut out the convergence angle table and the chart number and edition designations and paste those things onto my stripped chart. I went through a lot of glue sticks. It made my mother, an elementary school art teacher, proud when I told her I was using the cut and paste skills I learned from her in my professional life.

The best part of flying in grid was watching the reaction of the pilots as I spun the compass around and gave them a heading that seemed to make no sense. For example, coasting out over Point Barrow, the northernmost part of Alaska, driving north toward the north pole, the grid heading would typically be about 173. It required a level of trust that made pilots nervous.



What does grid navigation mean today? For those of us zooming around in the moderate latitudes of the continental United States (CONUS), I'd say it means nothing. How about those international flights that follow a great circle route to and from Europe over the North Atlantic? Those folks have the flight plan loaded into the Flight Management System (FMS). The autopilot is following the GPS and the INS and happily cruising along, likely showing an ever-changing true heading. However, most of those systems have a green pointer on the compass or a three-digit number in green that shows the current grid heading. It's all handled in the wizardry of the FMS and the GPS. That's just one more reason no one needs a navigator on the crew anymore. The trust issue has been resolved.

- Scott "Stormy" Weathers