VH-MDX Background Information: Magnetic Declination

Version 1: Glenn Horrocks, 24 May 2014

Version 2: Glenn Horrocks, 15 August 2015

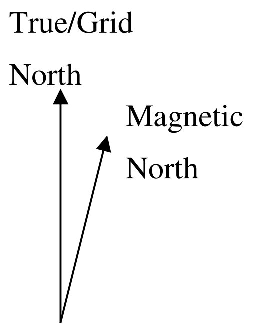
Summary

The magnetic declination at several points of interest to the disappearance of VH-MDX is:

Location	**Magnetic Declination to True North**	**Magnetic Declination to Grid North ***
Williamtown RAAF SURAD	12.066°E	11.430°E
Sydney RSR	12.198°E	11.180°E
Round Mountain	11.503°E	11.117°E
Upper Williams River	11.732°E	10.926°E

* Grid north on WGS84 datum, UTM coordinate system as used in recent 1:25000 topographic maps.

A positive declination indicates magnetic north is clockwise (or to the east) of true/grid north, as shown below.



Also:

- Be aware that the magnetic declination moves in a daily cycle of around 0.1°.
- Aviation charts use magnetic declination information which can be years out of date even on the date of publication
- Topographic maps only show an approximate magnetic declination number.

Introduction

VH-MDX was a Cessna 210 which crashed in the Barrington Tops area at approximately 7:30pm on 9 August 1981. Analysis of the VH-MDX crash is likely to rely on interpretation of the air traffic control transcripts around the time of the crash. A fundamental piece of information used in this analysis is the magnetic declination in the areas of interest at the time of the crash.

The magnetic declination model used here is the Australia Geomagnetic Reference Field (AGRF), as described on the Geoscience Australia website [1]. This is the reference model of the earth's magnetic field in the vicinity of Australia - the magnetic declination shown on maps are derived from this model. In this document the AGRF model has been used directly (rather than a derived value on a map) for the most accurate estimate of the magnetic declination possible.

VH-MDX crashed in 1981 and unfortunately the AGRF model only extends back to 1985. To extrapolate the model back to 1981, the AGRF model was used to give magnetic declinations on the 9 August of 1985, 1986, 1987 and 1988. The linearity of the result in these four years was checked and the result extrapolated to 1981. The extrapolation and the R^2 value of the linear regression fit to the four points is shown.

Williamtown RAAF Surveillance Radar (SURAD)

The position of the Williamtown RAAF SURAD system, and the origin of the radar display was S32°47'59.09", E151°49'40.70" [3]. The elevation of the ground at that location is 8m above sea level [5].

At that location and elevation the AGRF model gives the following magnetic declinations:

- 9 August 1985 = **12.202°E**
- 9 August 1986 = **12.236°E**
- 9 August 1987 = **12.270°E**
- 9 August 1988 = **12.304°E**

Figure 1 shows these magnetic declinations (to true north) plotted against time. The R^2 value for a linear regression fit through the points is 1.0 exactly, indicating the line is passing exactly through the points. As there is no declination from linearity over these four years we can extrapolate these figures to 1981 with high confidence. The extrapolated magnetic declination (to true north) for 9 August 1981 is 12.066°E.

The true north to grid north (based on the WGS84 datum on a UTM grid) angle at that location is 0°-38'5.84" [2], which makes the magnetic declination to grid north (UTM, WS84) 11.430°E.

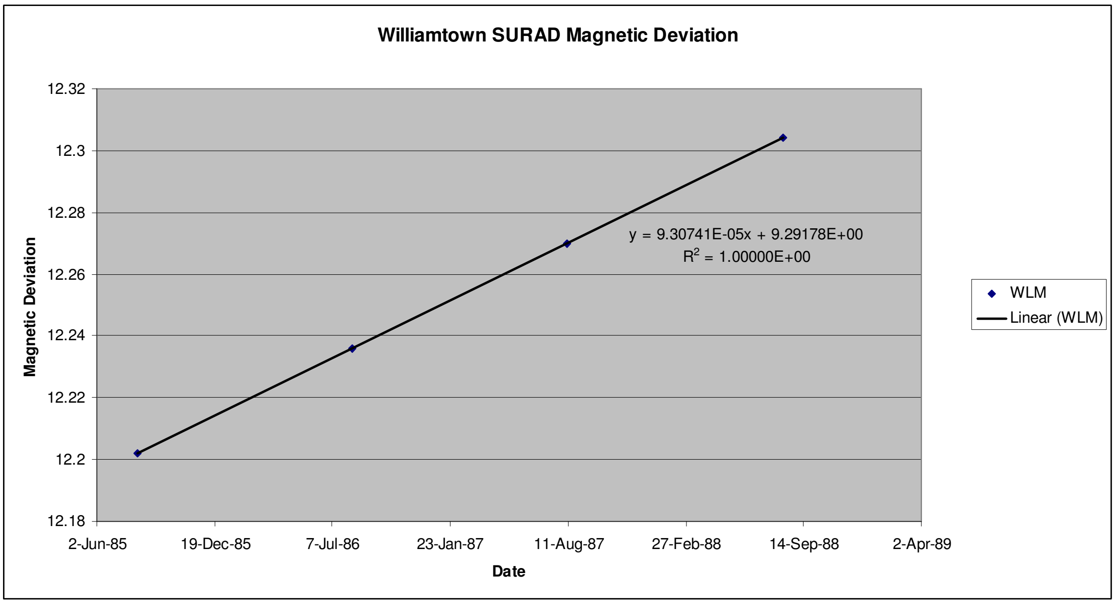


Figure 1 - Magnetic declination at Williamtown RAAF SURAD

Sydney Route Surveillance Radar (RSR)

The position of the Sydney RSR is S33°56'38.78", E151°11'09.49" [4]. The elevation of the ground at that location is 4m above sea level [5].

At that location and elevation the AGRF model gives the following magnetic declinations:

- 9 August 1985 = **12.344°E**
- 9 August 1986 = **12.380°E**
- 9 August 1987 = **12.417°E**
- 9 August 1988 = **12.453°E**

Figure 1 shows these magnetic declinations (to true north) plotted against time. The R^2 value for a linear regression fit through the points is 0.99996, indicating the line is passing almost exactly through the points. As there is insignificant declination from linearity over these four years we can extrapolate these figures to 1981 with high confidence. The extrapolated magnetic declination (to true north) for 9 August 1981 is 12.198°E.

The true north to grid north (based on the WGS84 datum on a UTM grid) angle at that location is -1°0'47.38" [2] , which makes the magnetic declination to grid north (UTM, WS84) 11.180°E.

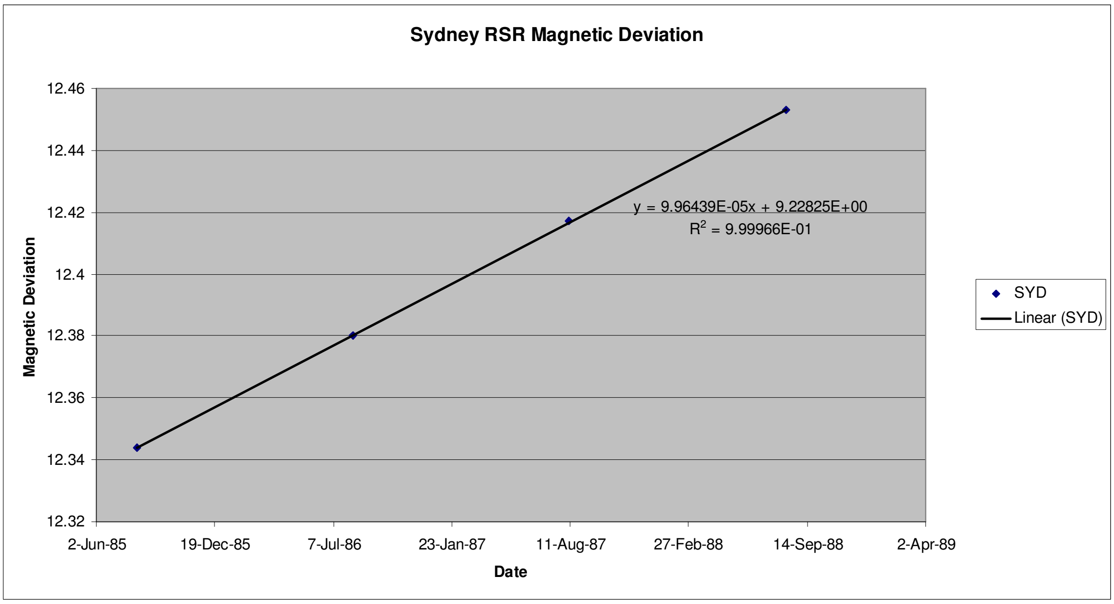


Figure 2 - Magnetic declination at Sydney RSR

Round Mountain Route Surveillance Radar (RSR)

The position of the Round Mountain RSR is S30°26'15.92", E152°14'24.84" [4]. The elevation of the ground at that location is 1575m above sea level [5].

At that location and elevation the AGRF model gives the following magnetic declinations:

- 9 August 1985 = **11.616°E**
- 9 August 1986 = **11.644°E**
- 9 August 1987 = **11.672°E**
- 9 August 1988 = **11.701°E**

Figure 1 shows these magnetic declinations (to true north) plotted against time. The R^2 value for a linear regression fit through the points is 0.99993, indicating the line is passing almost exactly through the points. As there is insignificant declination from linearity over these four years we can extrapolate these figures to 1981 with high confidence. The extrapolated magnetic declination (to true north) for 9 August 1981 is 11.503°E.

The true north to grid north (based on the WGS84 datum on a UTM grid) angle at that location is 0°-23'5.7" [2] , which makes the magnetic declination to grid north (UTM, WS84) 11.117°E.

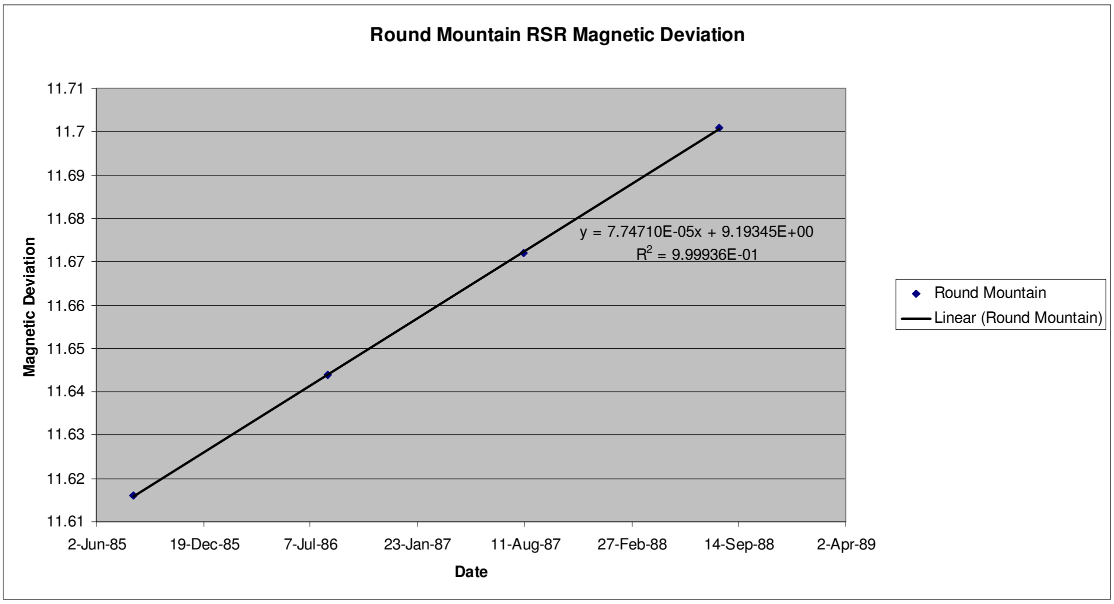


Figure 3 - Magnetic declination at Round Mountain RSR

Upper Williams River

The position of the Upper Williams River is S32°4'38.02", E151°29'5.51" [5]. The elevation will be taken as 6000 feet, or 1828m above sea level. This altitude is representative of the altitude VH-MDX was at in the final minutes before it crashed.

At that location and elevation the AGRF model gives the following magnetic declinations:

- 9 August 1985 = **11.859°E**
- 9 August 1986 = **11.891°E**
- 9 August 1987 = **11.923°E**
- 9 August 1988 = **11.954°E**

Figure 1 shows these magnetic declinations (to true north) plotted against time. The R^2 value for a linear regression fit through the points is 0.99993, indicating the line is passing almost exactly through the points. As there is insignificant declination from linearity over these four years we can extrapolate these figures to 1981 with high confidence. The extrapolated magnetic declination (to true north) for 9 August 1981 is 11.732°E.

The true north to grid north (based on the WGS84 datum on a UTM grid) angle at that location is 0°-48'17.16" [2] , which makes the magnetic declination to grid north (UTM, WS84) 10.926°E.

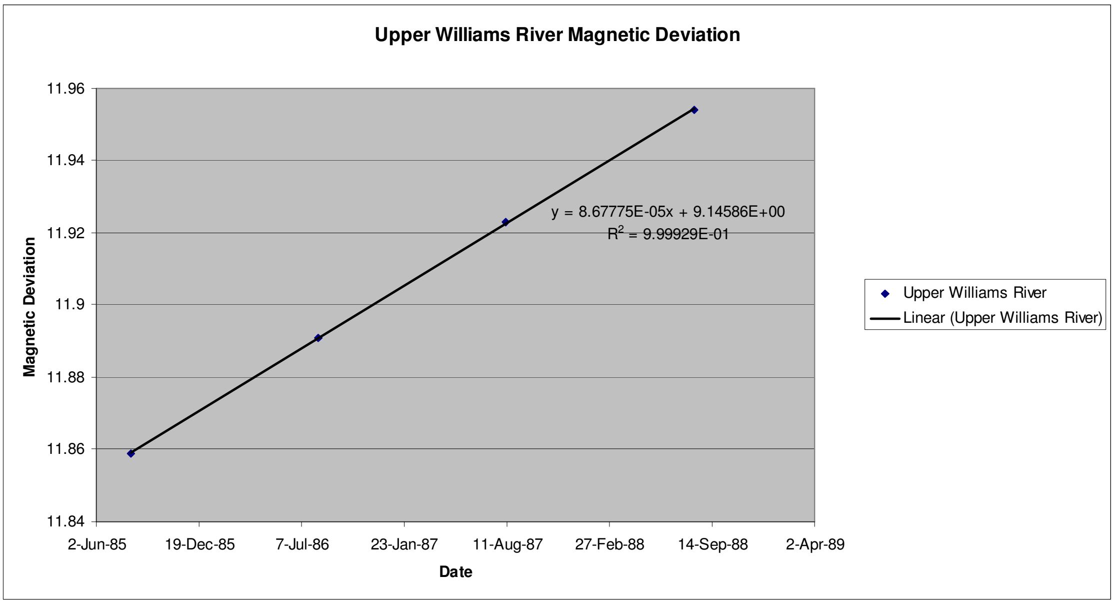


Figure 4 - Magnetic declination at the Upper Williams River

Daily Magnetic Declination Cycle

The magnetic declinations reported here are accurate to 5 significant figures according to the Australian Geomagnetic Reference Field. While these are the best figures to base analysis on, the reader should be aware that the earth's magnetic field is dynamic and constantly changing. The field direction changes about 0.1° on a daily cycle caused by interaction of the earth's magnetic field, the solar wind and the magnetosphere [6]. An example of this typical daily variation is shown in Figure 5.

Figure 5 - Magnetic field observations from Canberra over 16-18 May 2014, from [6].

There are also occasional magnetic anomalies (such as solar flares) which can cause larger declinations at random times.

Magnetic Declination Marked on Maps

The magnetic declination marked on many aviation charts are years out of date. For instance, the two charts shown in Figure 6 and Figure 7 are using magnetic variation information which is 6 years and 2 years out of date. This means aviation charts do not appear to have accurate magnetic declination information on them as the data they are using is years out of date.

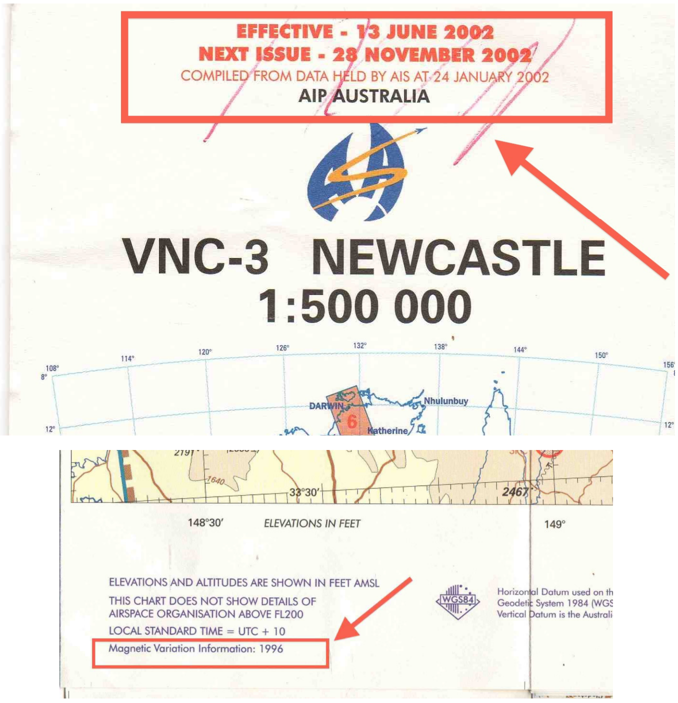


Figure 6 - Visual Navigation Chart 3 (VNC-3) Newcastle [7] is effective 13 June 2002, but the magnetic variation used on the chart dates from 1996.

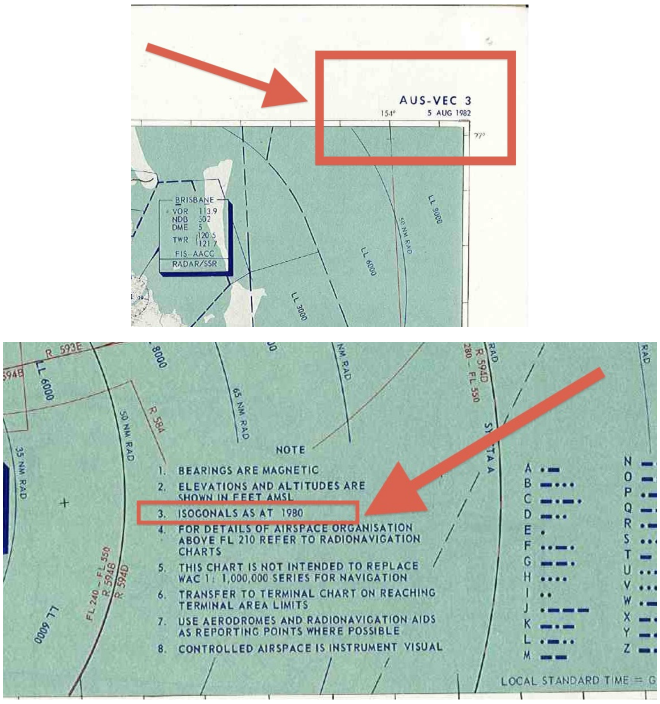


Figure 7 - Australian Visual Enroute Chart 3 (AUS-VEC 3) [8] is dated August 1982, but the magnetic variation dates from 1980.

The Barrington Tops 1:25000 topographic map (first edition) [9] states that the magnetic declination in the centre of the map (approximately 10km west of the Upper Williams point analysed above) is 10.5°E and it is an additional 0.9° to true north. It also states:

> *True north, grid north and magnetic north are shown diagrammatically for the centre of the map. Magnetic north is correct for 1975 and moves easterly by 0.1° in approx. three years.*

Applying these adjustments implies the magnetic declination in 1981 is 10.7°E. This is in error by 0.2° as the correct declination has been shown to be 10.926°E.

This shows that the magnetic declination information shown on maps is sometimes out of date, and always approximate. The magnitude of the error is irrelevant to the normal use of the maps in navigation, but will make a small difference to the VH-MDX analysis - so you might as well use the most accurate numbers available.

References

1. http://www.ga.gov.au/oracle/geomag/agrfform.jsp, Geoscience Australia, accessed May 2014.
2. http://www.ga.gov.au/geodesy/datums/redfearn_geo_to_grid.jsp, Geoscience Australia, accessed May 2014.
3. *RAAF Williamtown Air Traffic Control 1981*, Glenn Strkalj, May 2014
4. *Sydney Air Traffic Services and Radar*, Glenn Strkalj, May 2014

5. Google Earth
6. http://www.ga.gov.au/oracle/geomag/gafoyer.jsp?dc=D&iaga=CNB&submitFrom=multicom&scrwidth=1620&scrheight=960&plotDone=1&periodChoice=72, Geoscience Australia, accessed May 2014.
7. *VNC-3 Newcastle,* Effective 13 June 2002, Airservices Australia, Canberra.
8. *Australian Visual Enroute Chart 3 (AUS-VEC 3)*, 5 August 1982, Department of Transport.
9. *Barrington Tops 1:25000 Topographic Map 9133-I-N*, Central Mapping Authority of NSW, printed 1980.