

Monitoring Earth's changing magnetic field

New geomagnetic field models released

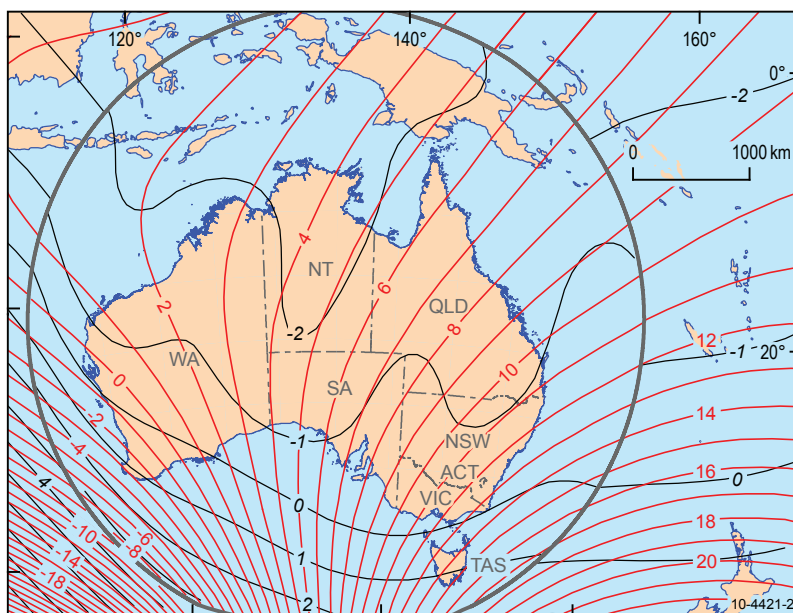
Andrew Lewis

Regional and global geomagnetic models have a wide range of applications in the general community as well as the scientific, industrial and engineering sectors. The Australian regional model is particularly useful for anyone using a compass for navigation—including bushwalkers, mariners and pilots—and other applications such as aligning satellite dishes, telescopes and solar-passive houses. Specialist applications include mineral exploration and drilling, surveying, mapping, research into the global magnetic field and its secular change, and studies of Earth's deep interior, crust, ionosphere and magnetosphere.

The geomagnetic field on or near the surface of the Earth is the sum of magnetic fields which originate from numerous magnetic sources including deep within the planet, through the atmosphere

and into space. Some of these geomagnetic sources vary in complex and unpredictable ways. Geoscience Australia continually monitors Earth's changing magnetic field in the Australian region for modelling, mapping and improving the community's understanding of geomagnetic phenomena.

Because of the dynamic nature of the geomagnetic field, mathematical models of the field need to be updated regularly to ensure they track changes and remain as accurate as possible. Consequently, new revisions of both the global and Australian regional geomagnetic field models are now available from Geoscience 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 circle are derived from IGRF-11.

Figure 1. Contours of the magnetic declination in degrees (red) and annual change of declination (black) in minutes-of-arc per year from the AGRF 2010 model at epoch 2010.0. The circular boundary shows the limit of the AGRF model, consequently contours outside the boundary are from the International Geomagnetic Reference Field Model (IGRF-11 at 2010.0).

The Australian Geomagnetic Reference Field model

The Australian Geomagnetic Reference Field (AGRF) is a mathematical model of the geomagnetic field and its predicted annual changes over the Australian region including continental Australia and nearby offshore areas, most of Papua New Guinea and parts of eastern Indonesia. The 2010 revision is a mathematical representation

of the undisturbed geomagnetic main field at epoch 2010.0 and its predicted annual changes during the period 2010 to 2015 (figure 1). The model is the sixth in the series of AGRF models and describes the field originating from internal sources using spherical cap harmonics. The main field is modelled to a nominal minimum spatial wavelength of 1500 kilometres and the annual change to 2000 kilometres.

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Extensive vector geomagnetic survey datasets were used to derive the main field model, including magnetic data from the German CHAMP satellite, high elevation airborne data, and ground based vector survey data across Australia. The main field datasets were updated to epoch 2010.0 using a secular variation model of the Australian region derived from geomagnetic observatory and repeat station data collected over the last 50 years. The secular variation model in the 2010 revision of AGRF is based on a linear extrapolation of the most recent geomagnetic observatory and repeat station data. Based on our knowledge of the past behaviour of the magnetic field, the secular variation model should be appropriate out to epoch 2015.

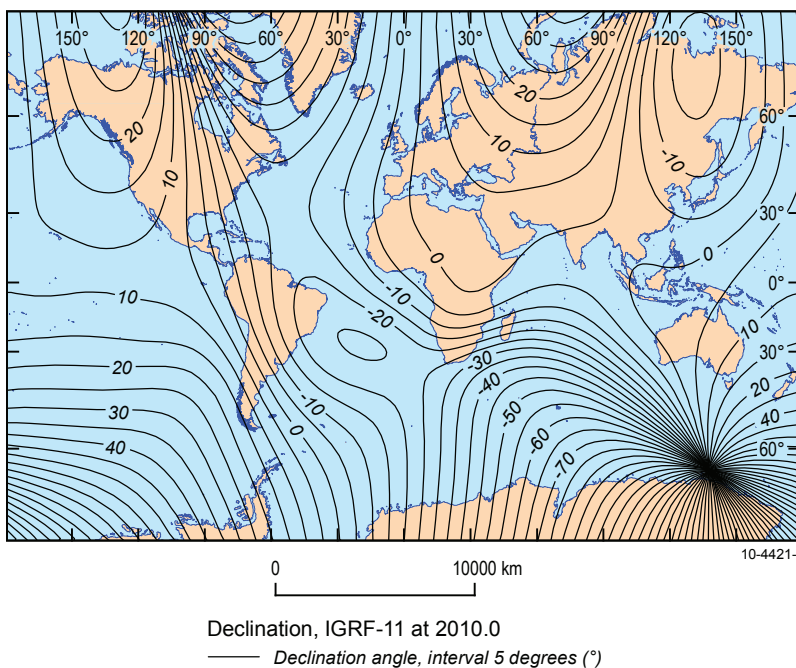


Figure 2. Isogons derived from the IGRF-11 model for epoch 2010.0, the declination contour interval is 5 degrees.

The extensive regional data sets used in developing the AGRF model make it the most accurate available model for the Australian regional magnetic field for the interval 2010 to 2015.

The 2010 AGRF model is based on the recently released eleventh revision of the International Geomagnetic Reference Field, which is a global spherical harmonic model of the geomagnetic field.

An on-line calculator for the AGRF is available through the Geoscience Australia website. Software to evaluate the AGRF at a single point or a grid of points is available on request from Geoscience Australia.

The International Geomagnetic Reference Field

The eleventh generation of the International Geomagnetic Reference Field (IGRF-11) was released by the International Association of Geomagnetism and Aeronomy (IAGA) in late December 2009. This release adds a definitive main field model for 2005.0, a new model for 2010.0 and a secular variation model for the period between 2010 and 2015.

IGRF-11 allows the undisturbed long wavelength geomagnetic field originating from sources internal to Earth to be calculated at any location on, or near, the surface of Earth during the period 1900 to 2015 (figure 2). The spherical



harmonic degree and order 13 coefficients of IGRF-11 have modelled the main field at 2010 to a minimum nominal spatial wavelength of 3000 kilometres. The degree and order 8 secular variation coefficients model the rate of change of the field to a minimum nominal spatial wavelength of 5000 kilometres.

The development of the IGRF is the result of international collaboration between magnetic field modellers and the scientific institutions and government agencies that undertake satellite magnetic surveys and operate geomagnetic observatories.

The full set of spherical harmonic coefficients for IGRF-11 can be downloaded in several formats from the International Association of Geomagnetism and Aeronomy (IAGA) V-MOD web site. There are several online IGRF calculators available, including those at the British Geological Survey and the National Geophysical Data Centre in the United States of America. Links to these websites are provided below. Software to calculate IGRF-11 at a single point or a grid is also available on request from Geoscience Australia.

Related websites/articles

Online calculator for the Australian Geomagnetic Reference Field available through the Geoscience Australia website.

www.ga.gov.au/oracle/geomag/agrfform.jsp

International Association of Geomagnetism and Aeronomy (IAGA) V-MOD website

www.ngdc.noaa.gov/IAGA/vmod/igrf.html

British Geological Survey online IGRF calculator

www.geomag.bgs.ac.uk/gifs/igrf_form.shtml

National Geophysical Data Centre (United States) online IGRF calculator

www.ngdc.noaa.gov/geomagmodels/IGRFWMM.jsp

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