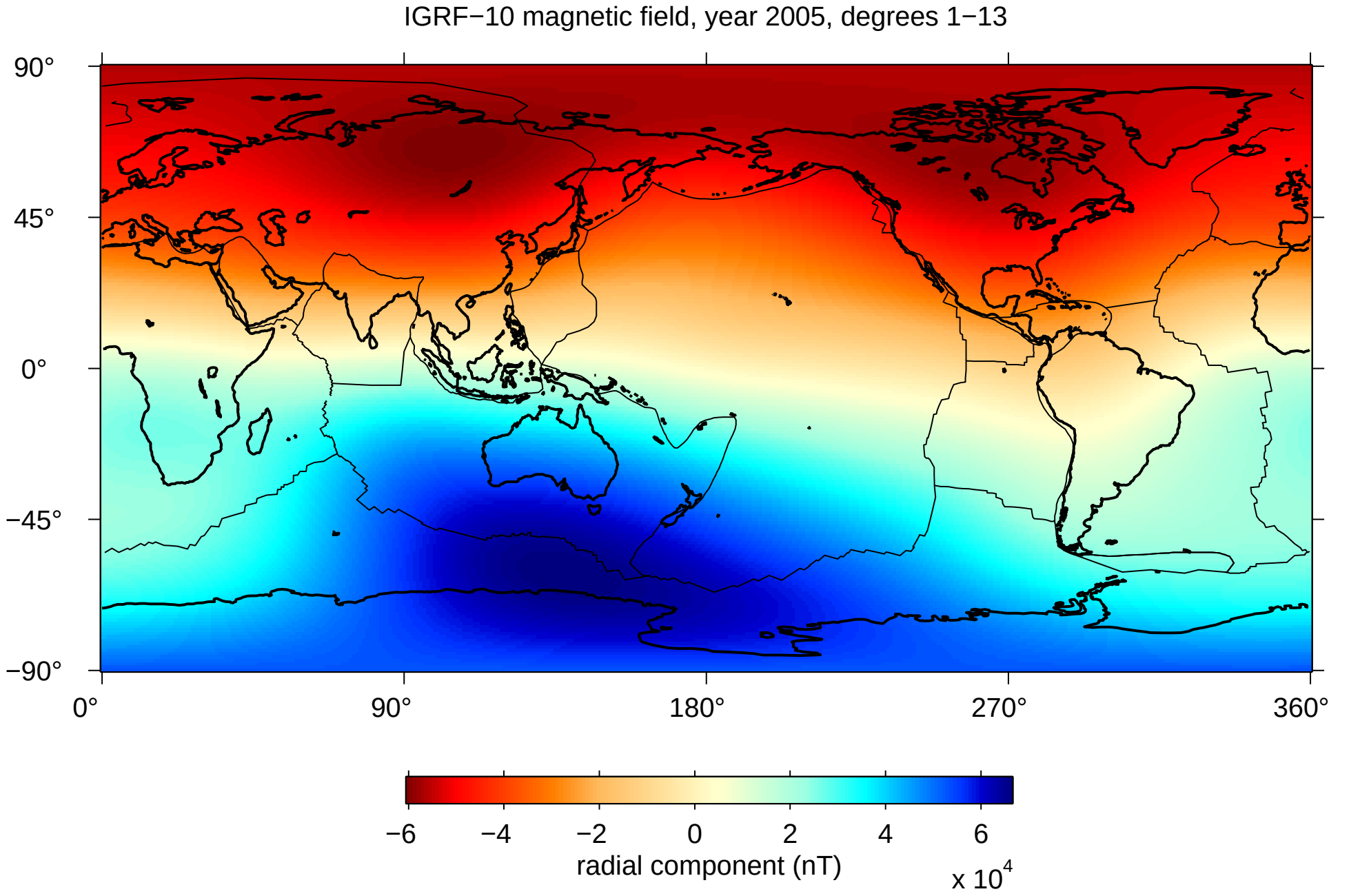
The Earth's magnetic field

Frederik J Simons

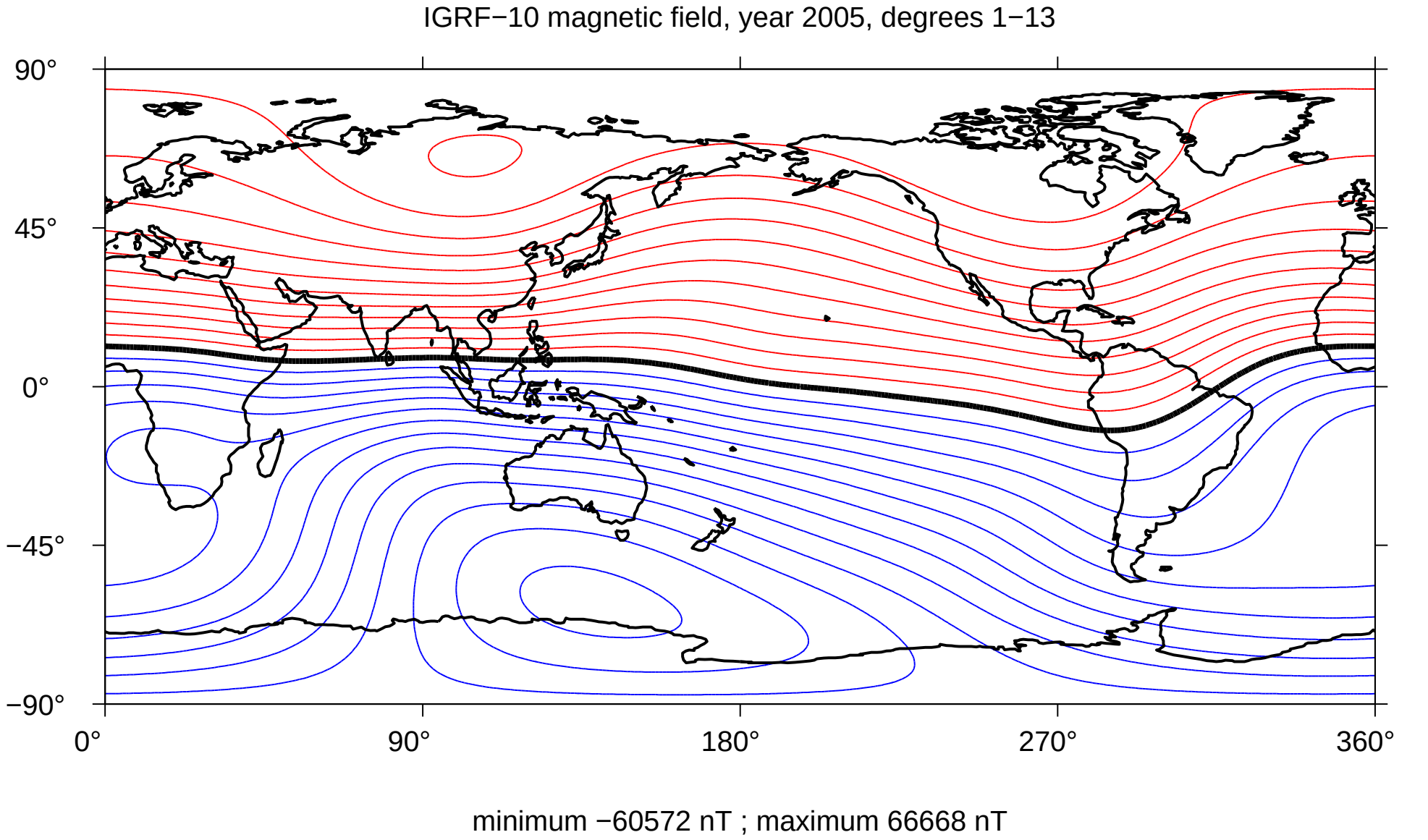
Princeton University

Source: *Halley (1702), Cook (2001)*

The main field

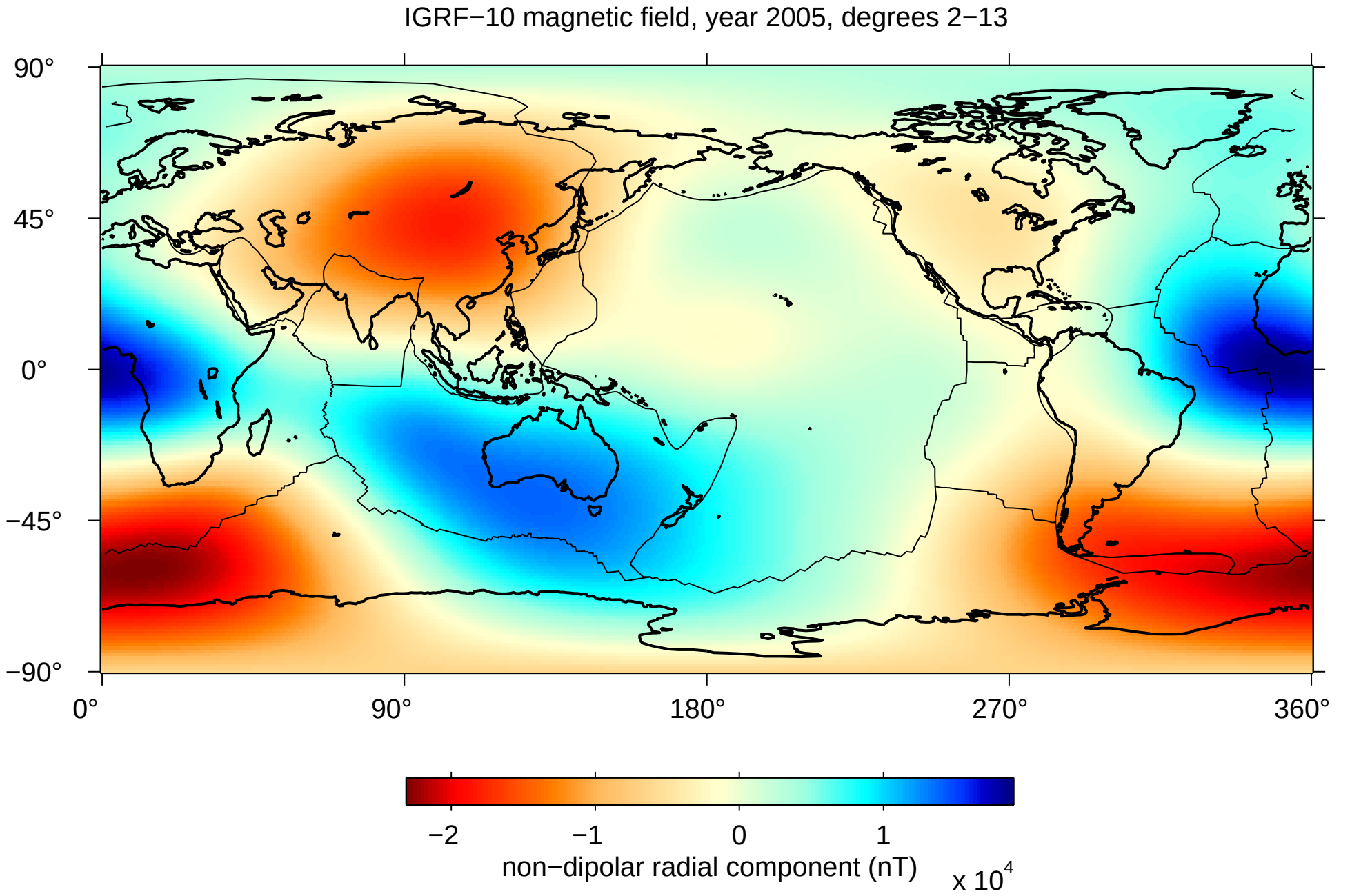


Source: *Maus et al. (2005)*

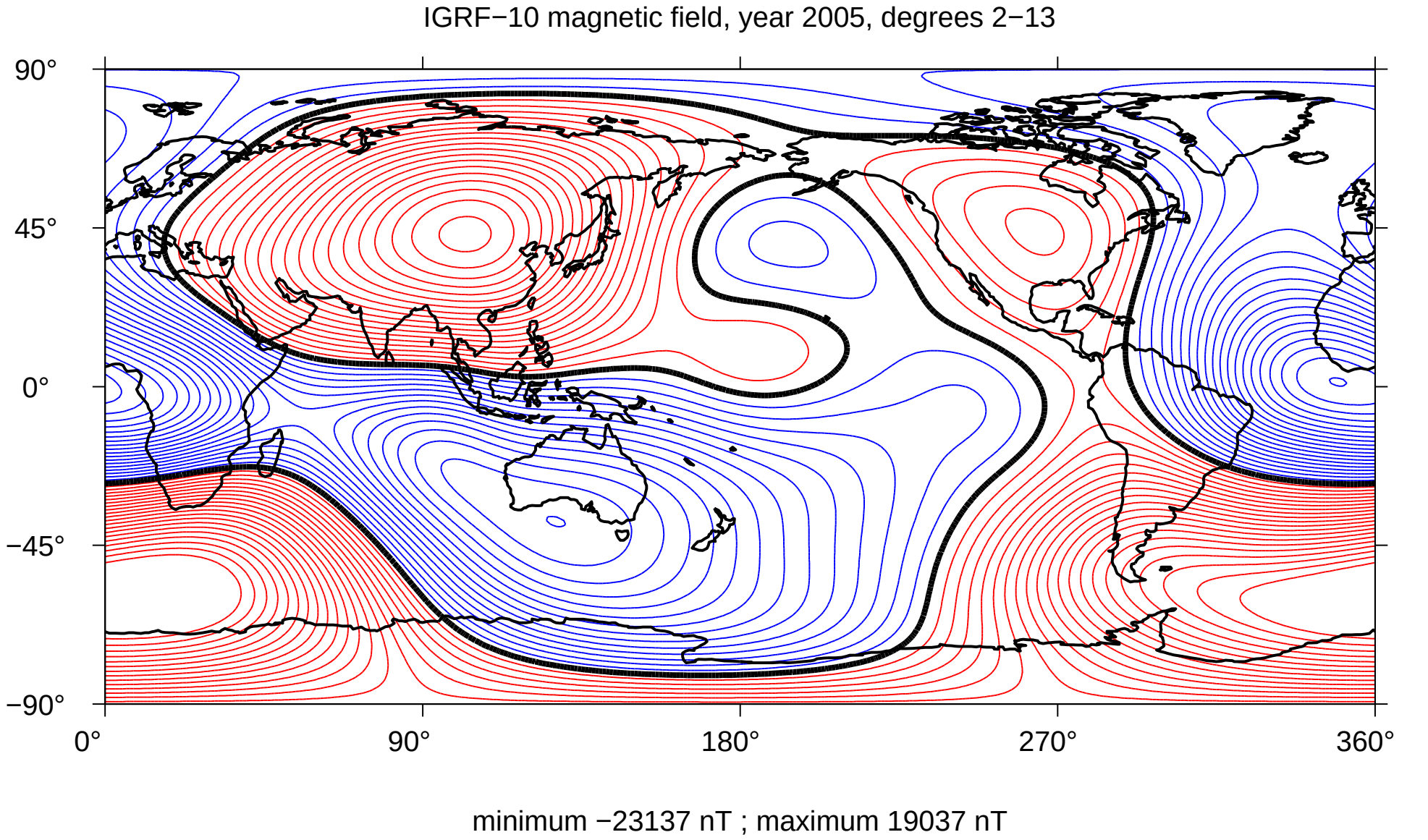


Source: *Maus et al. (2005)*

The non-dipolar part of the main field

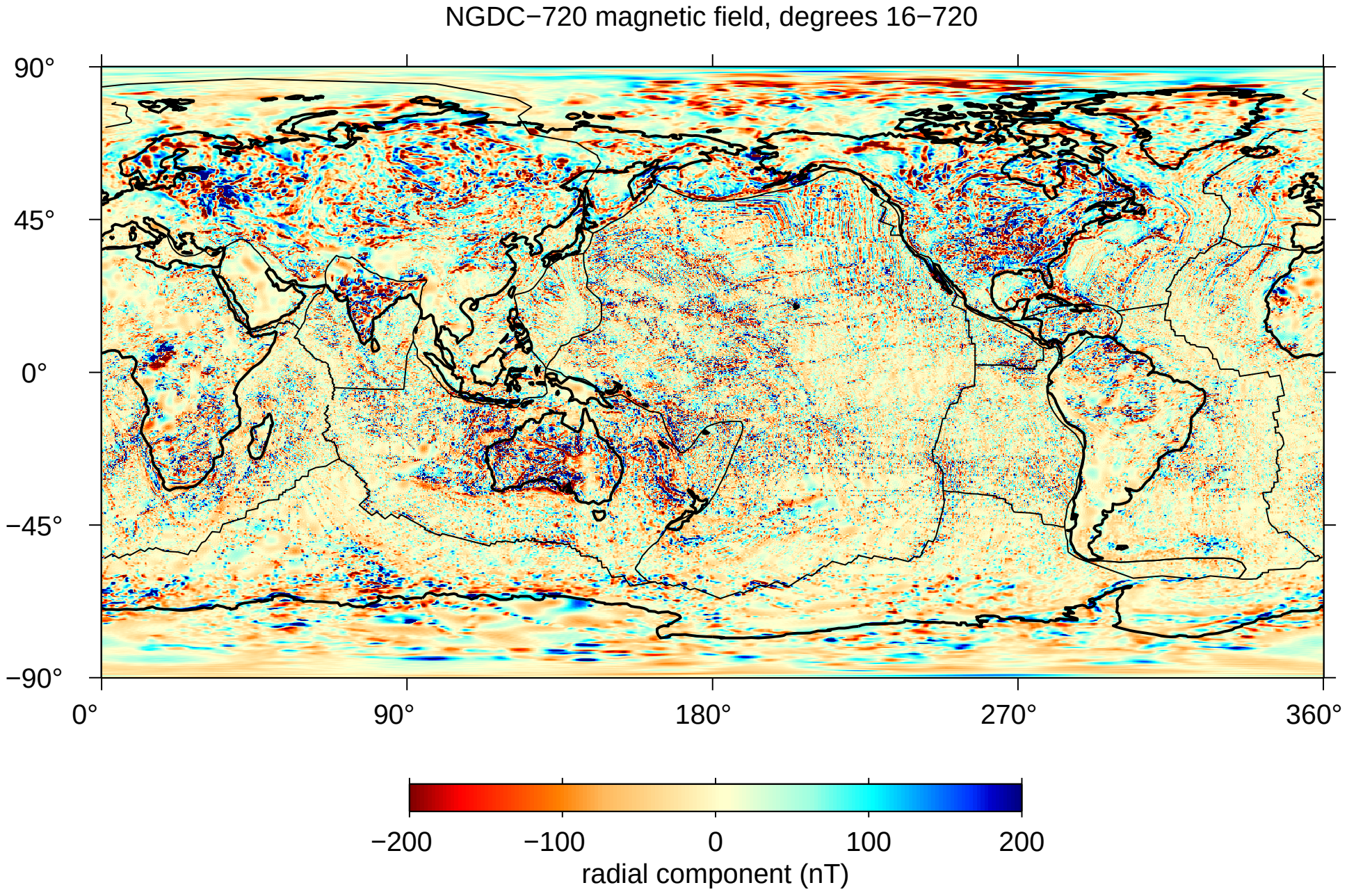


Source: *Maus et al. (2005)*



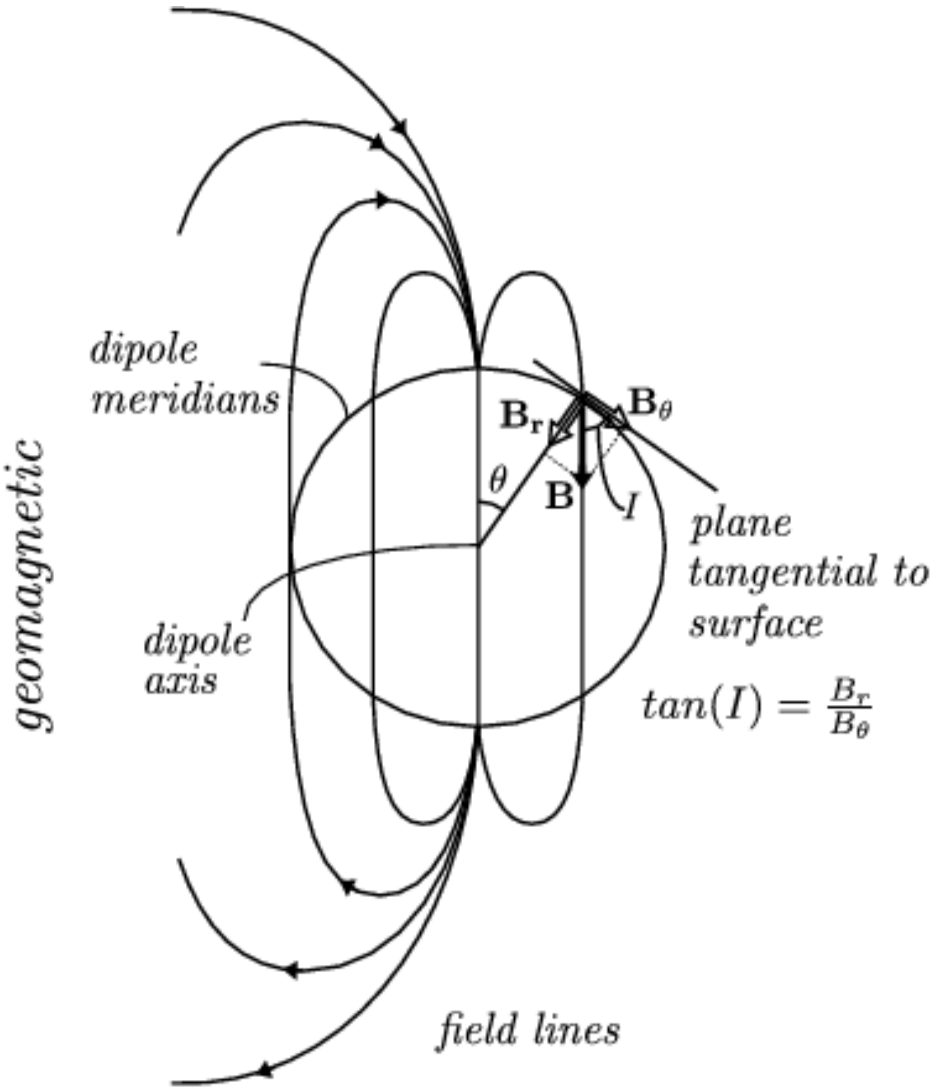
Source: *Maus et al. (2005)*

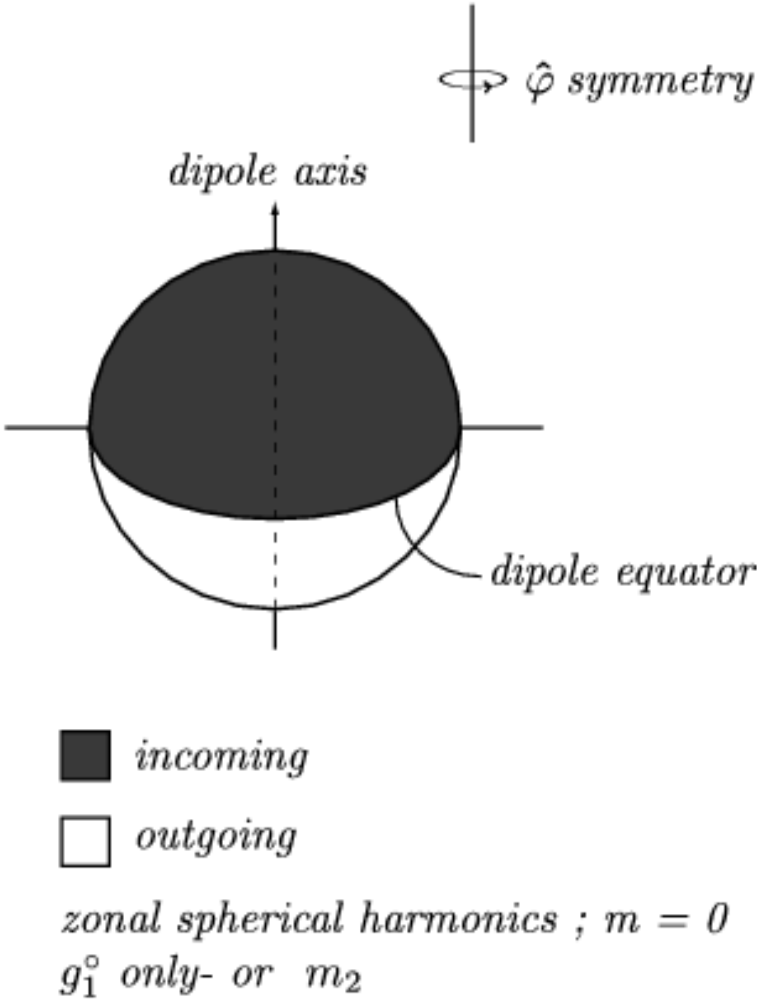
The crustal field



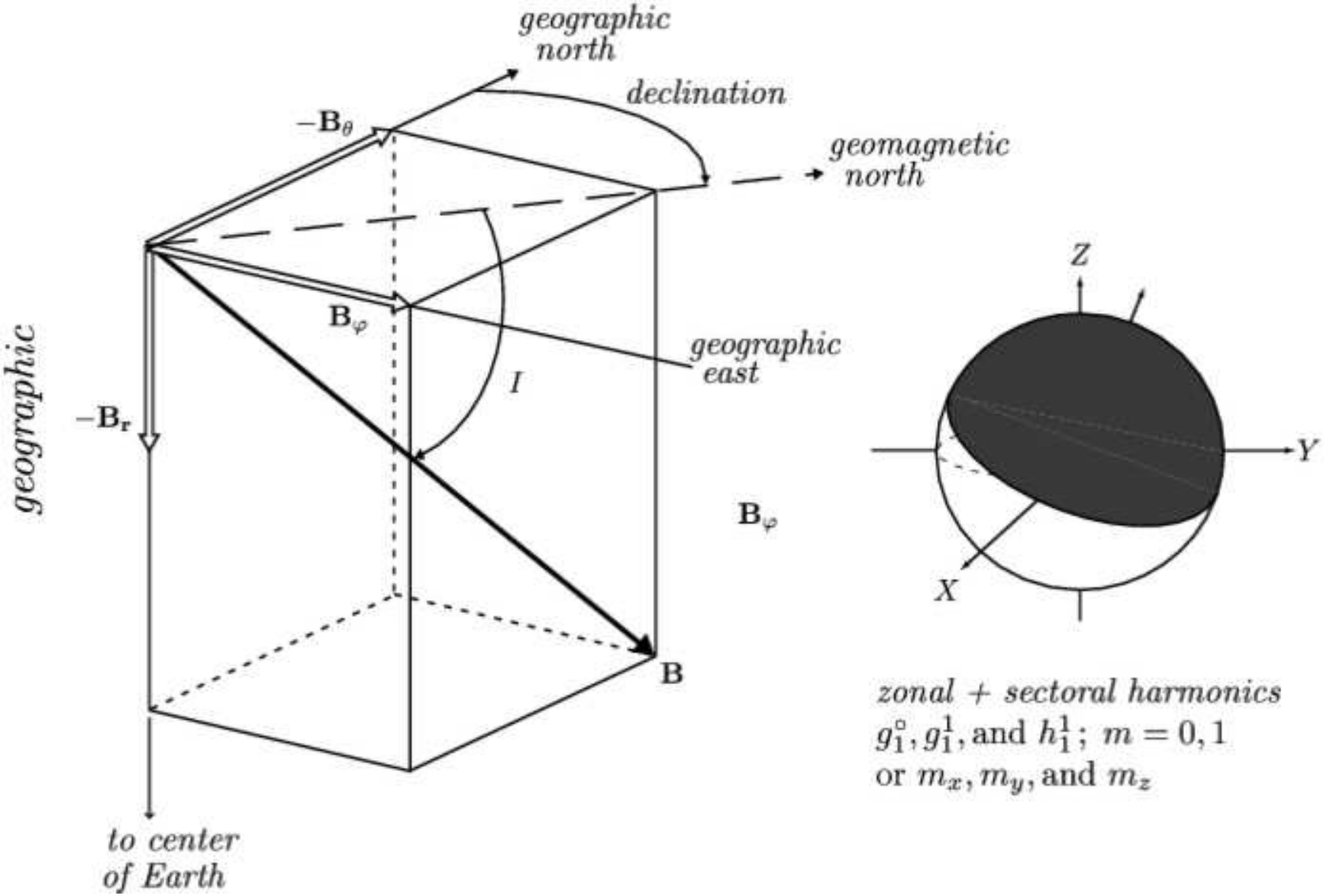
Source: *NOAA (2011)*

Inclination and declination

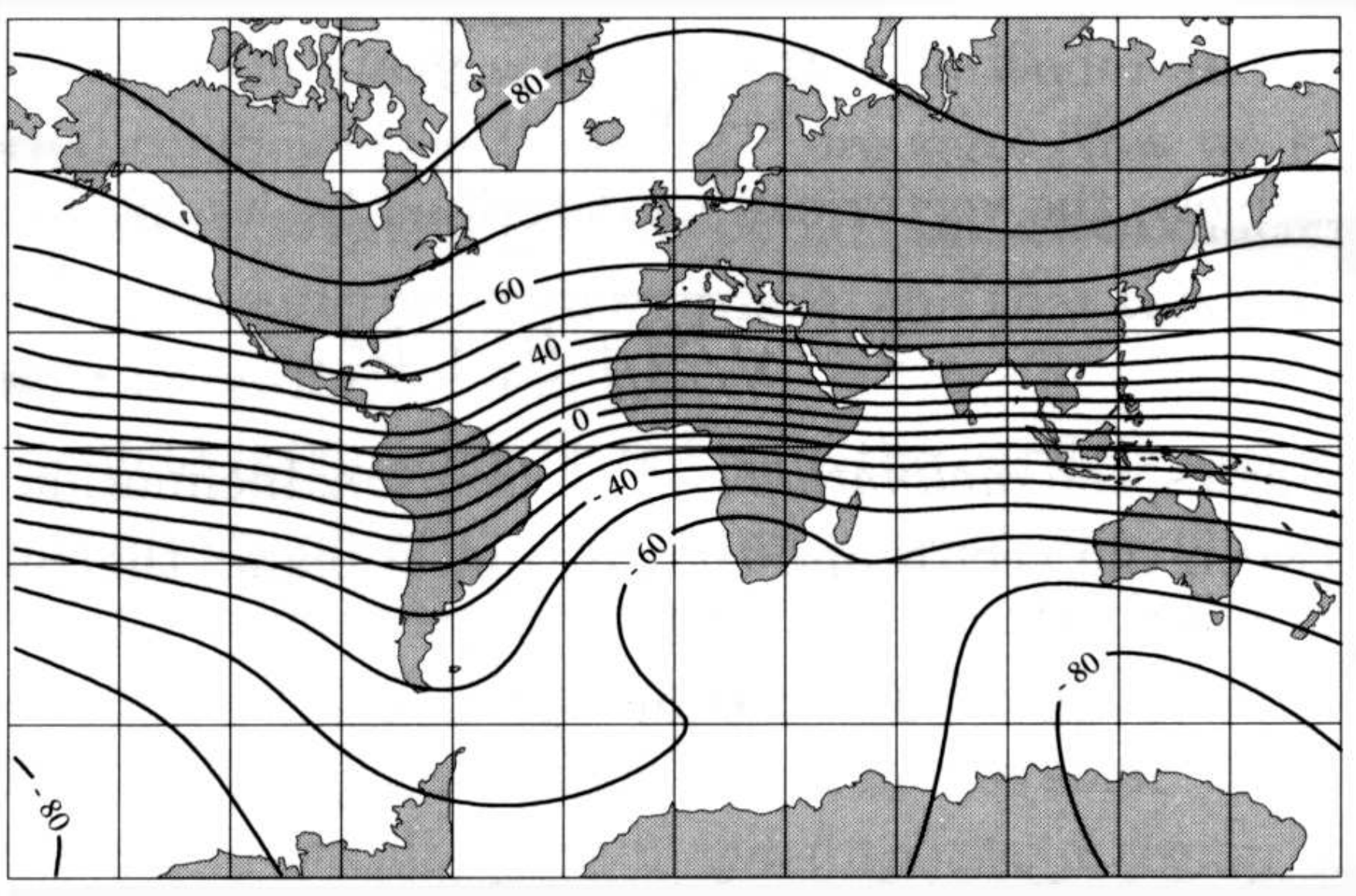




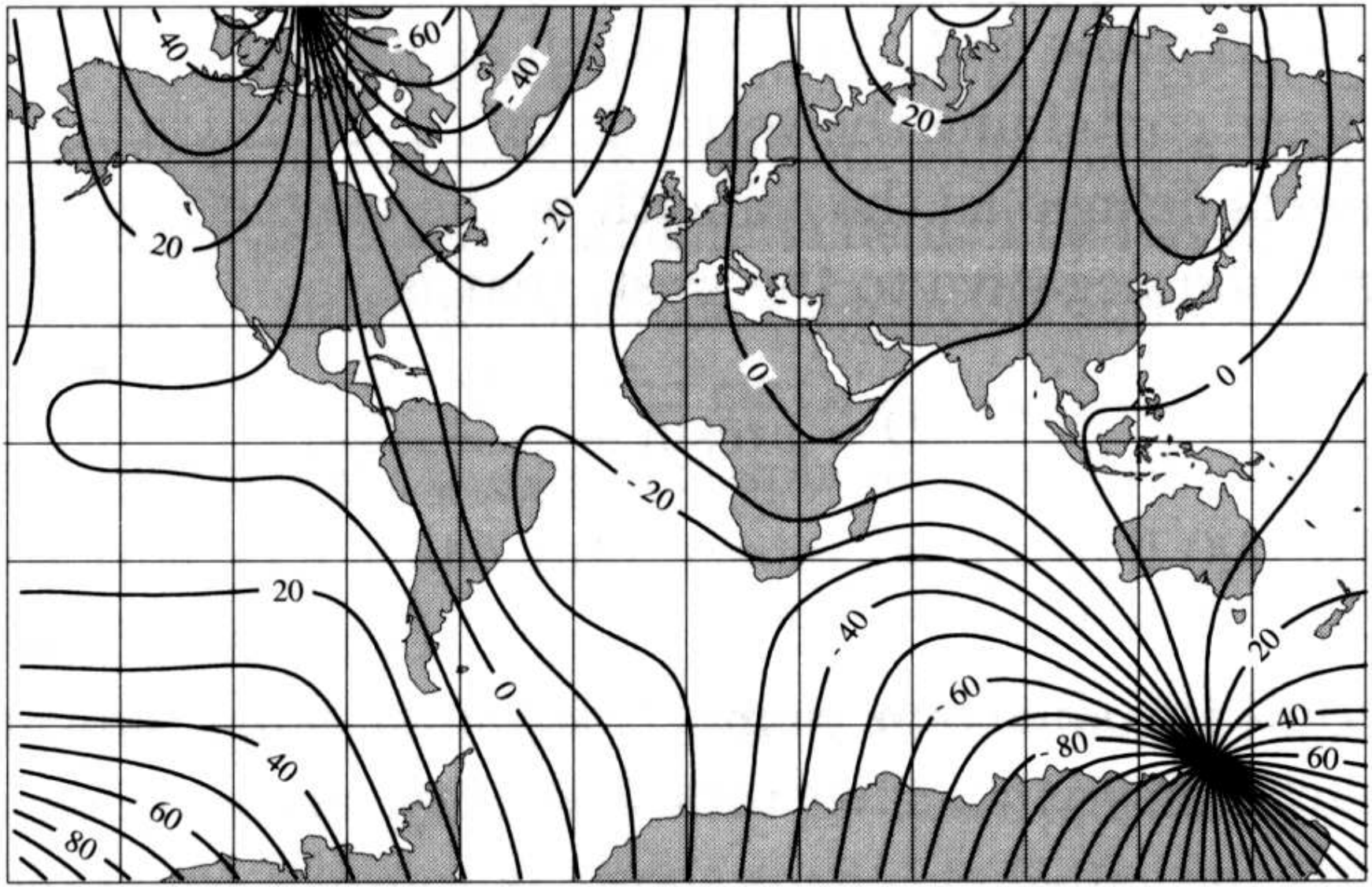
Source: *Simons (2011)*



Source: *Simons (2011)*



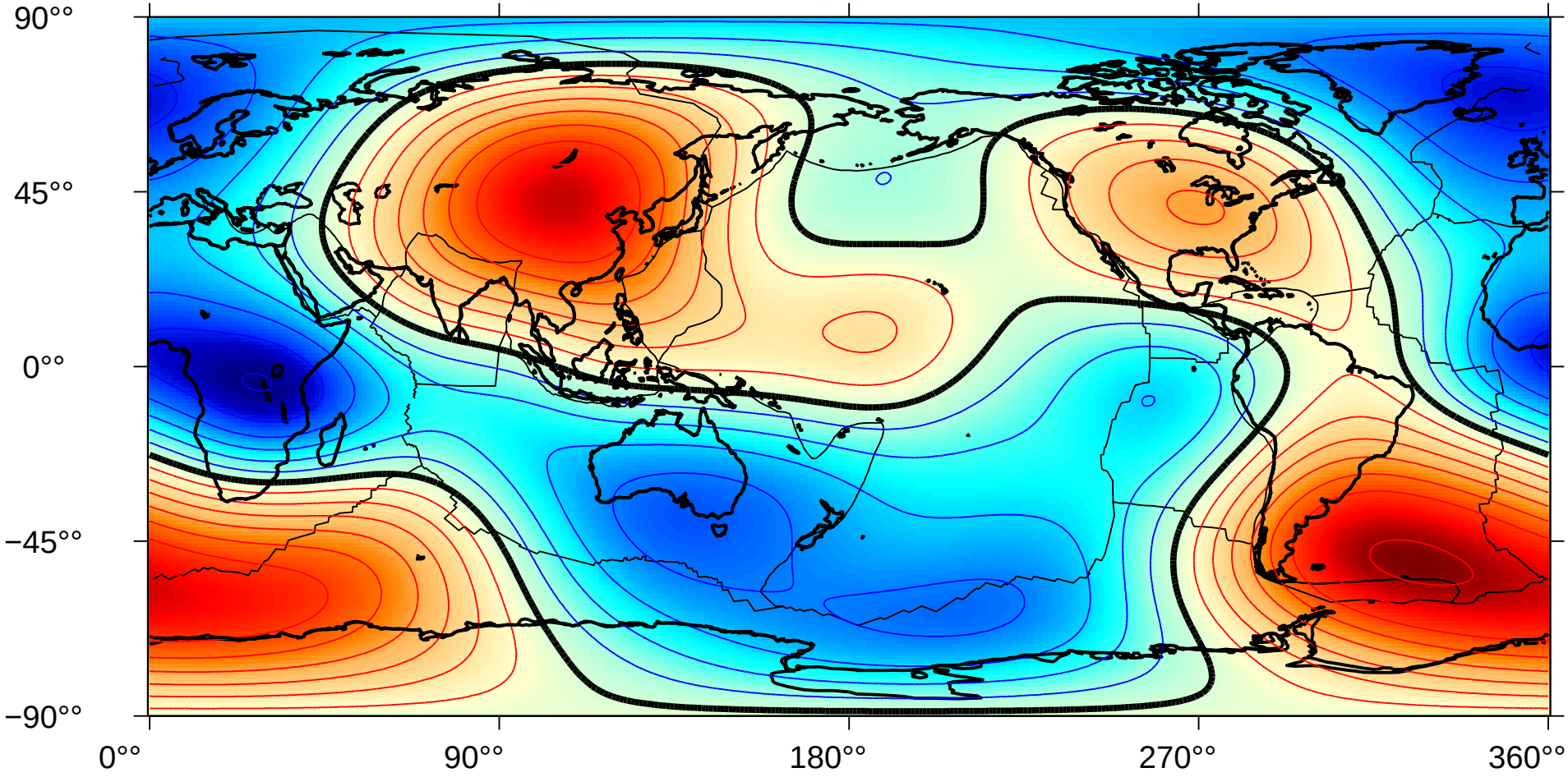
Isoclines of constant *inclination* of the geomagnetic field in 1990.



Isogons of constant *declination* of the geomagnetic field in 1990.

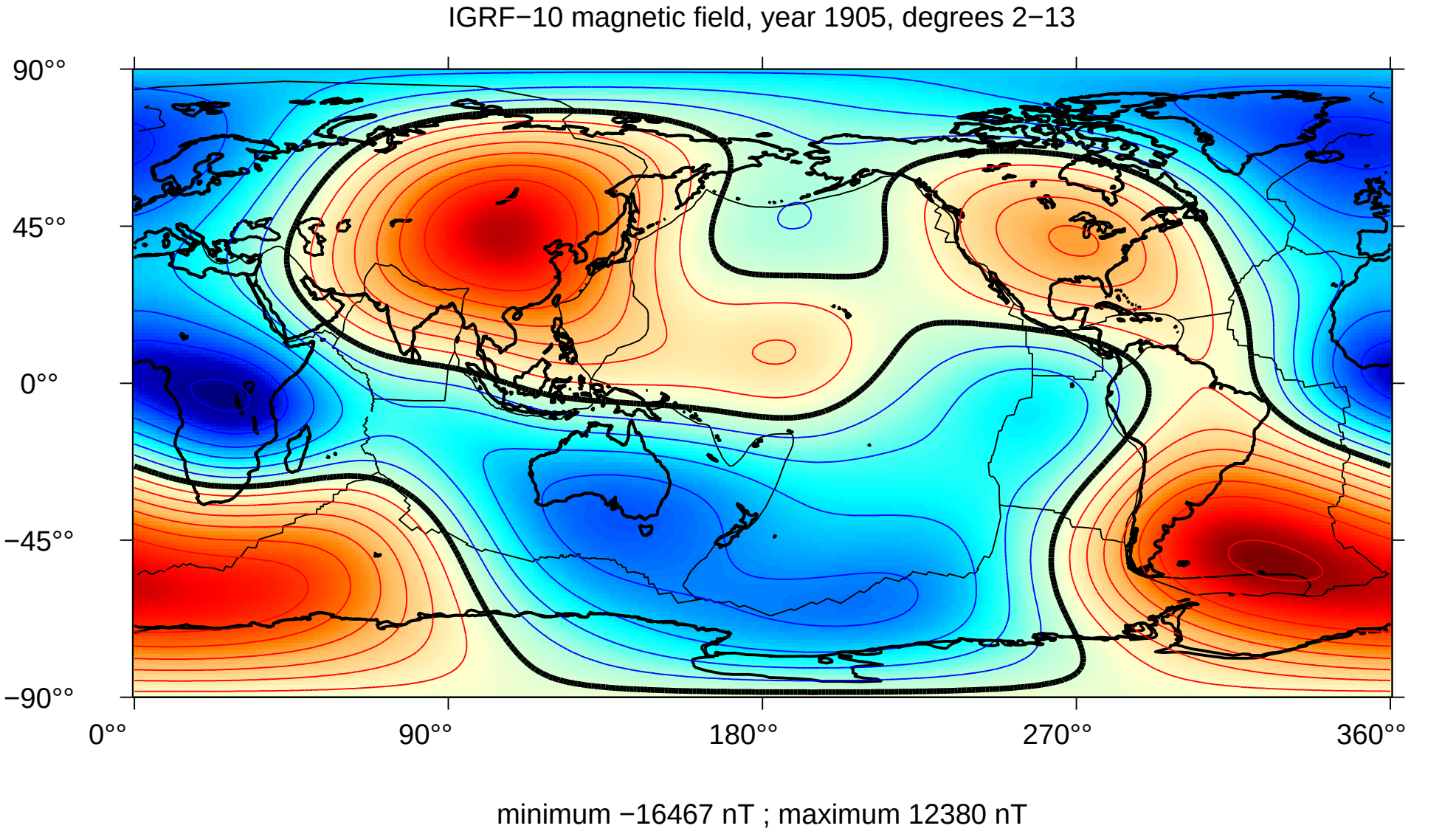
Secular variation

IGRF−10 magnetic field, year 1900, degrees 2−13

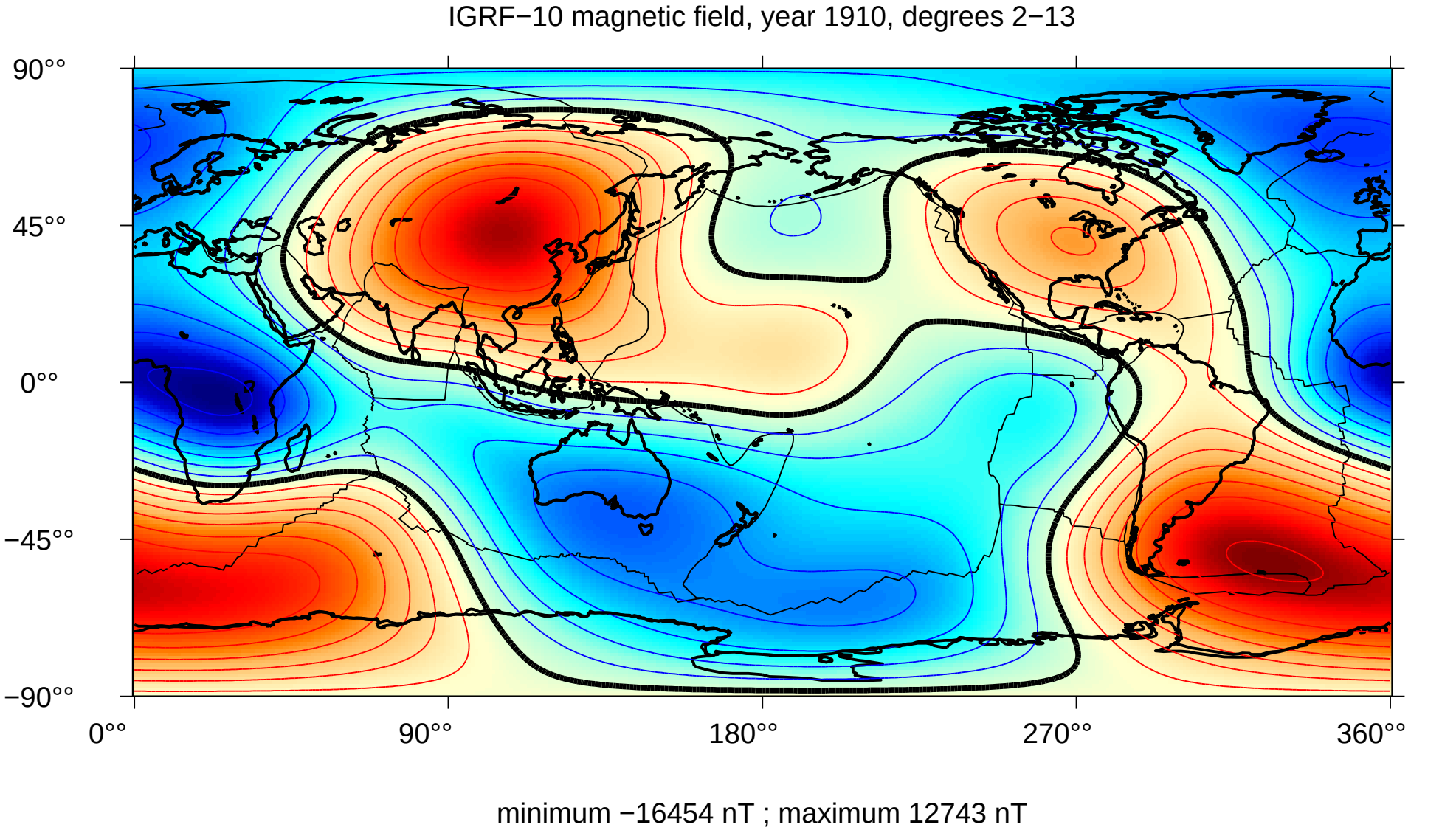


minimum −16475 nT ; maximum 12097 nT

Source: *Maus et al. (2005)*

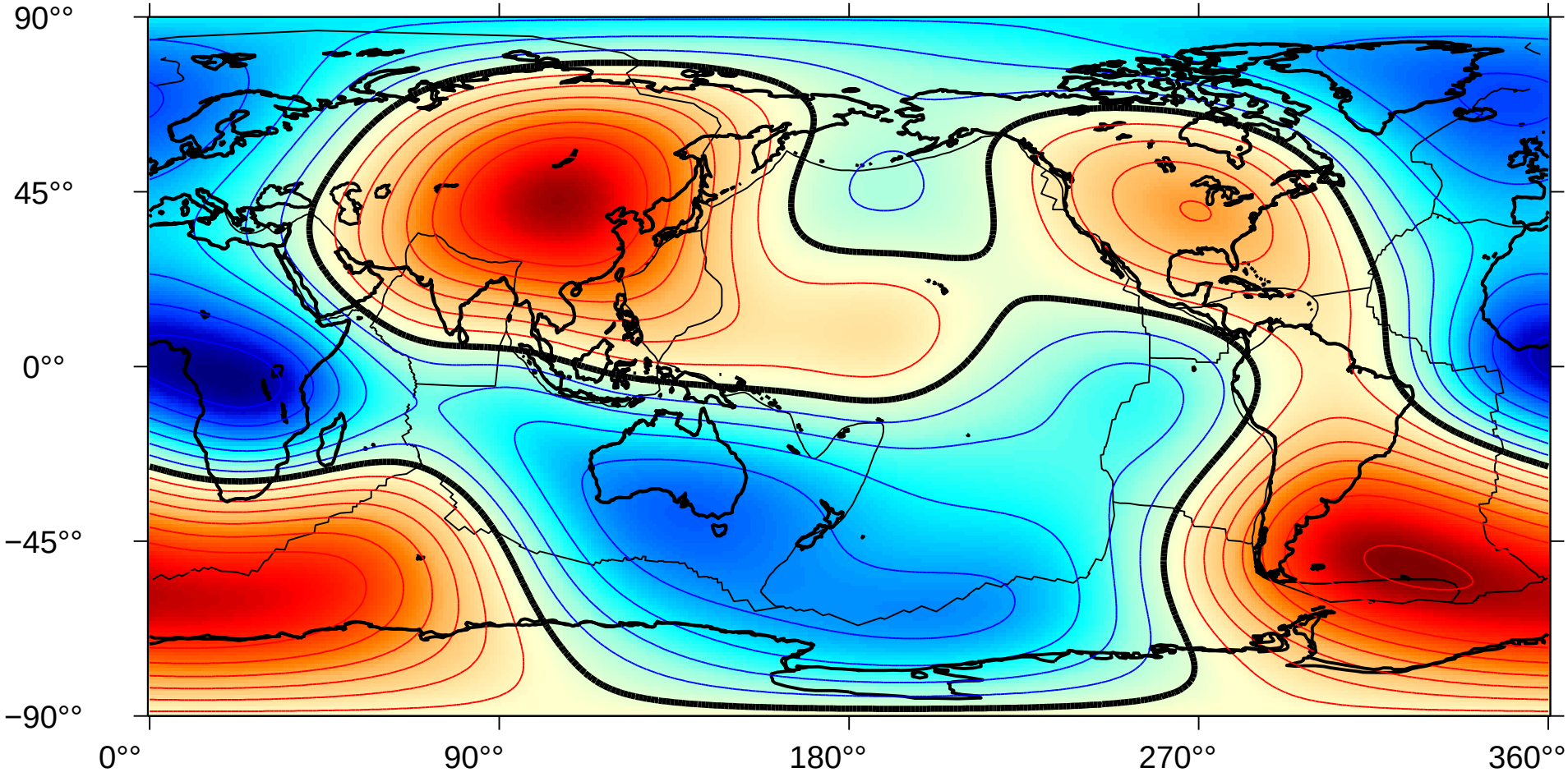


Source: *Maus et al. (2005)*



Source: *Maus et al. (2005)*

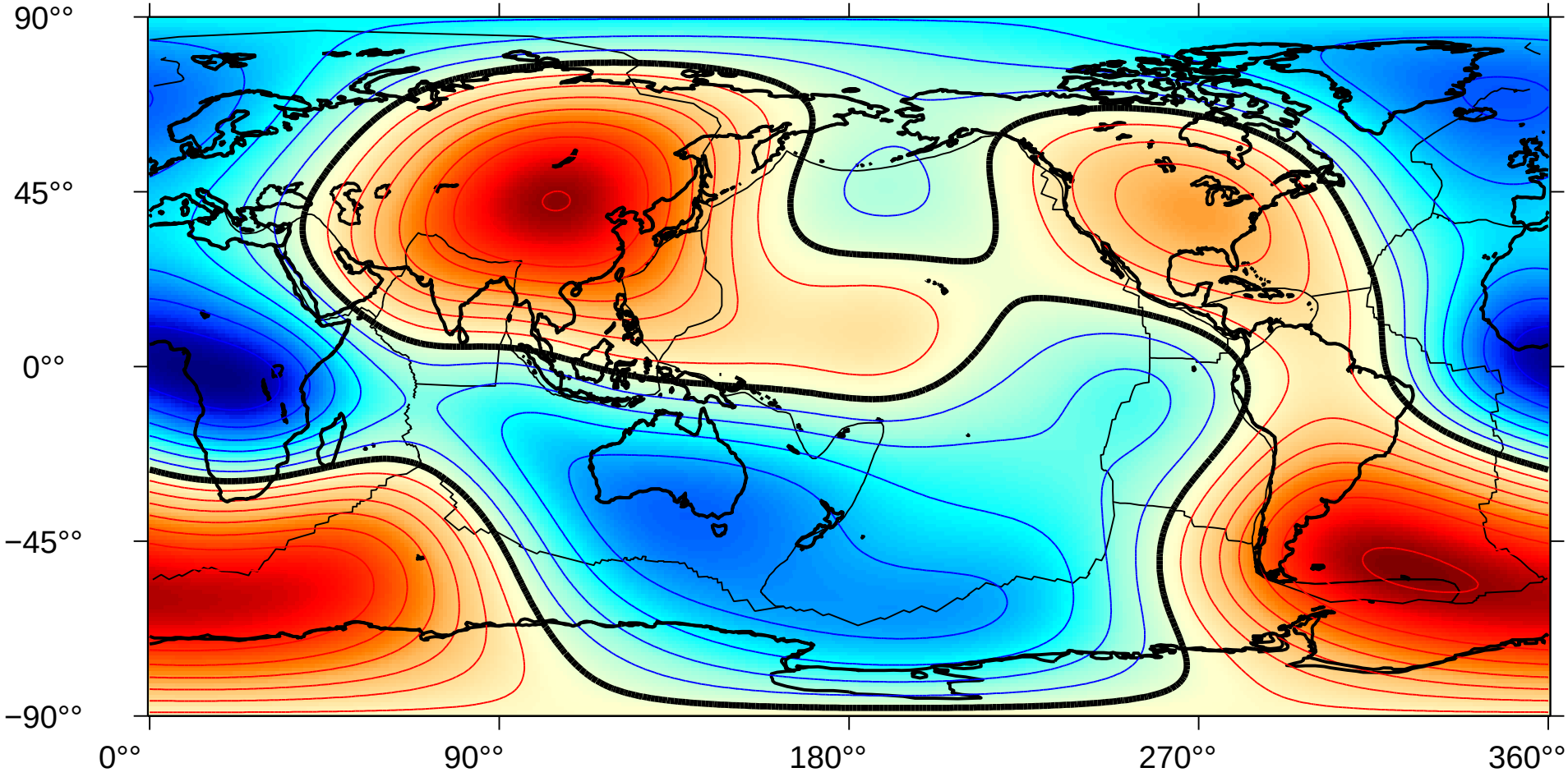
IGRF−10 magnetic field, year 1915, degrees 2−13



minimum −16420 nT ; maximum 13144 nT

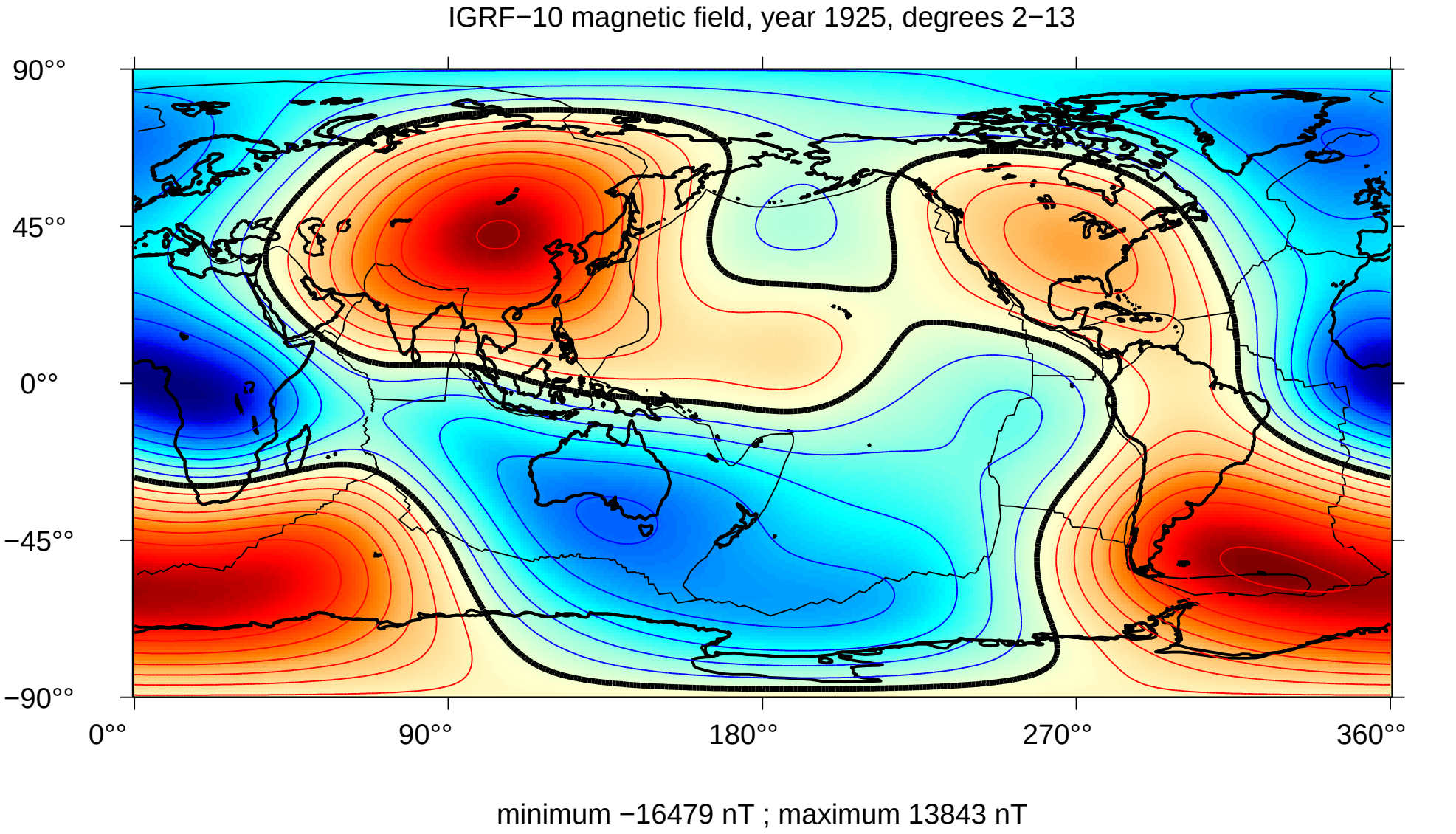
Source: *Maus et al. (2005)*

IGRF−10 magnetic field, year 1920, degrees 2−13



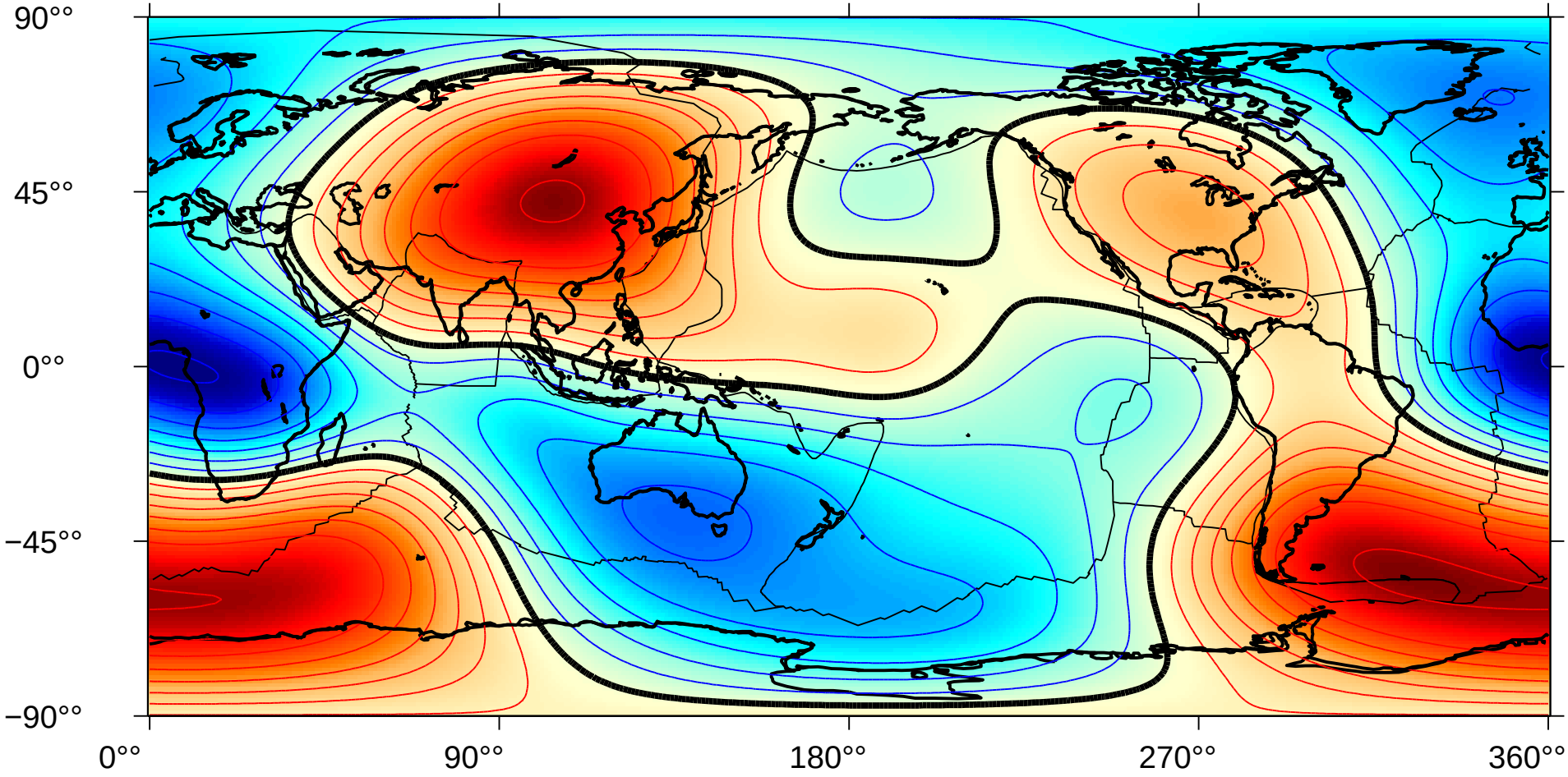
minimum −16413 nT ; maximum 13497 nT

Source: *Maus et al. (2005)*



Source: *Maus et al. (2005)*

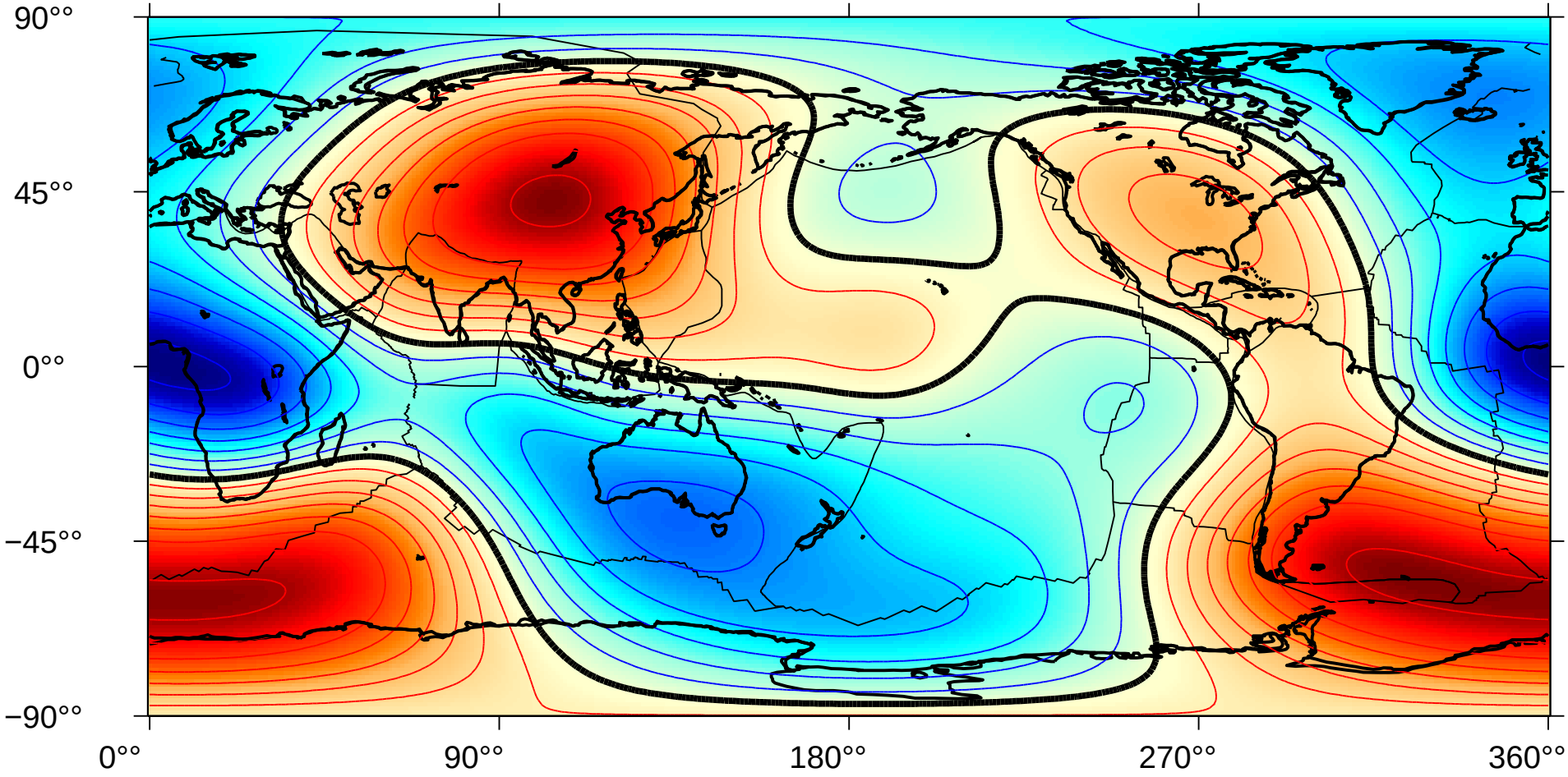
IGRF−10 magnetic field, year 1930, degrees 2−13



minimum −16605 nT ; maximum 14214 nT

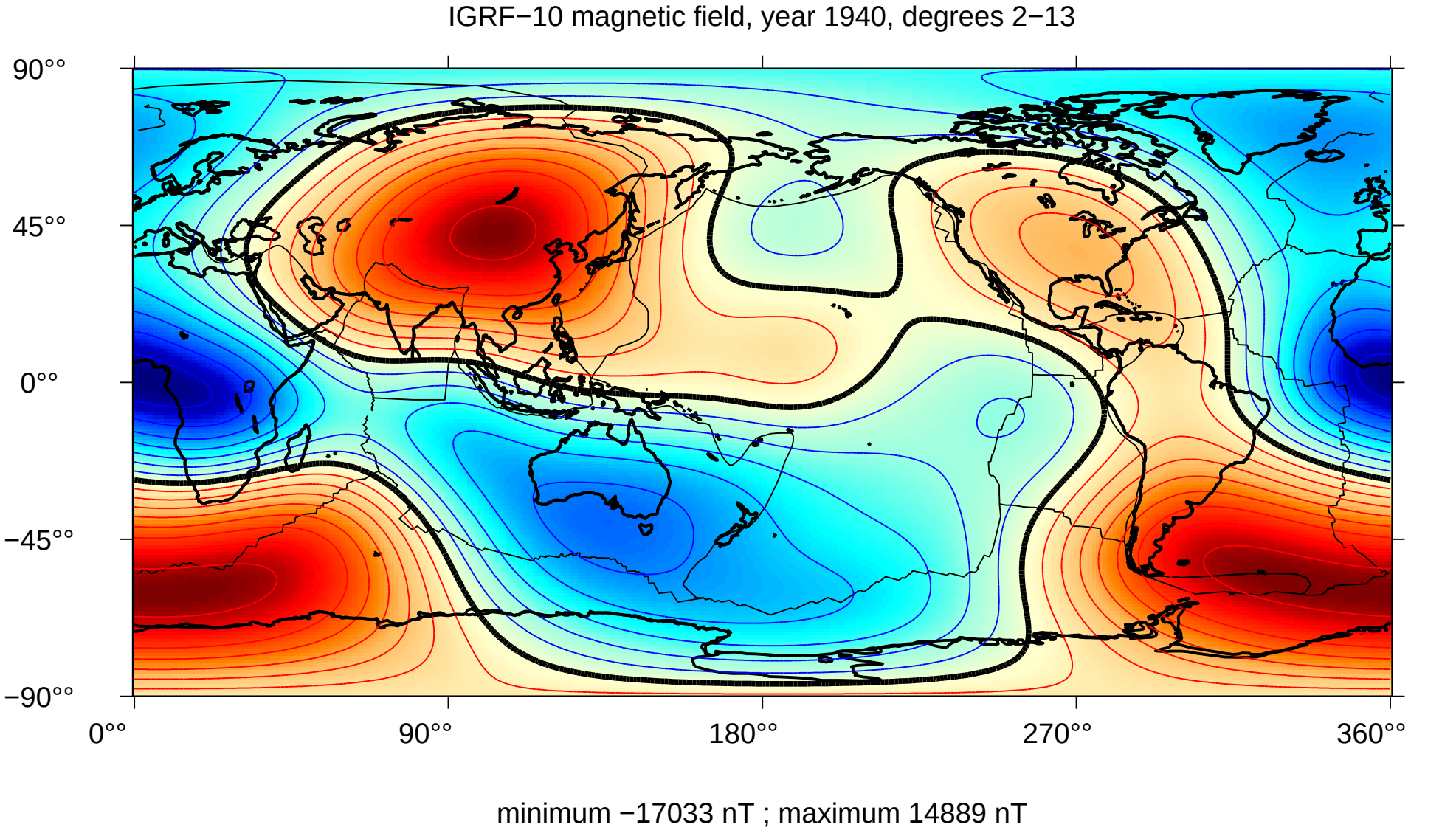
Source: *Maus et al. (2005)*

IGRF−10 magnetic field, year 1935, degrees 2−13

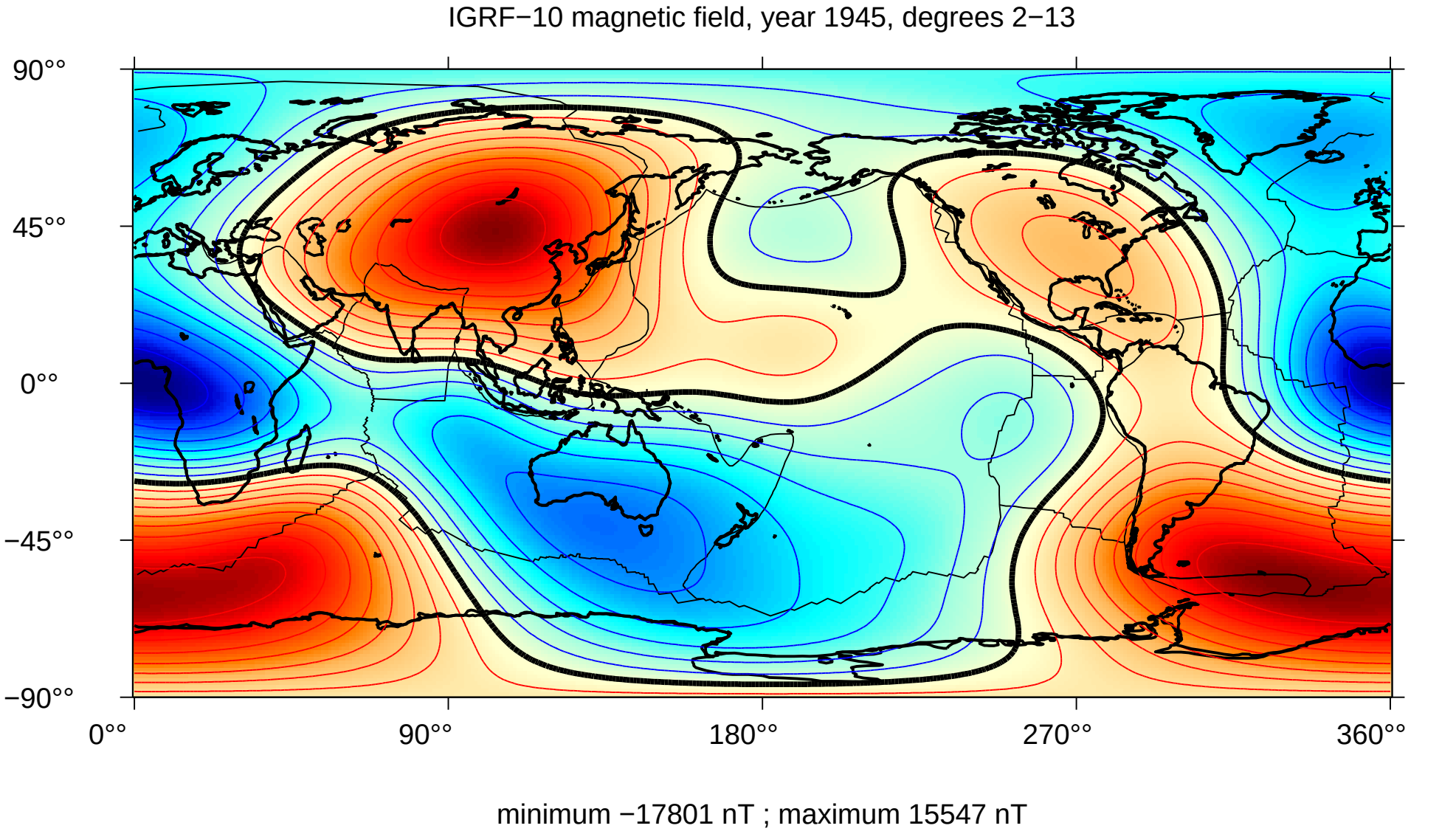


minimum −16786 nT ; maximum 14556 nT

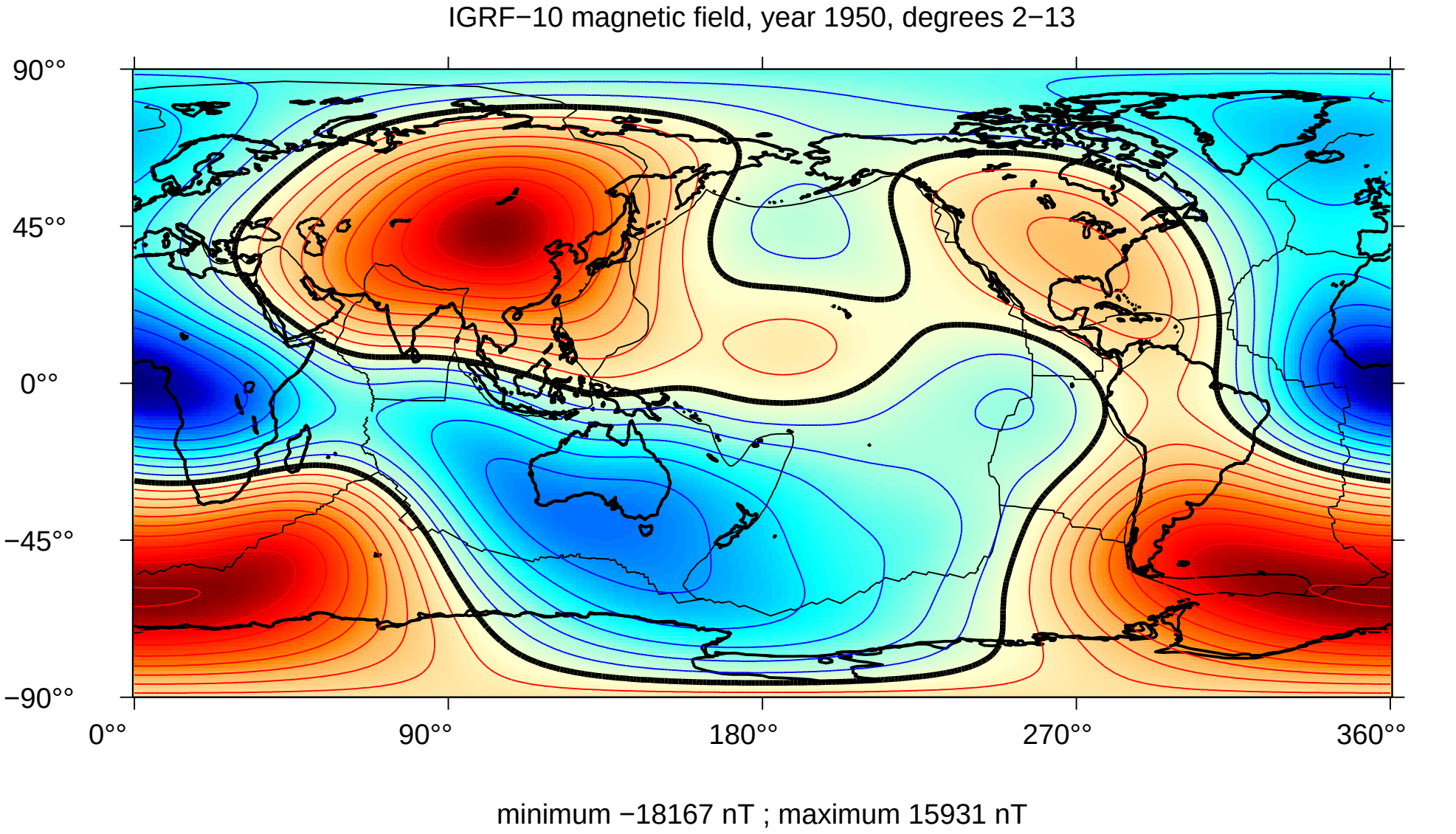
Source: *Maus et al. (2005)*



Source: *Maus et al. (2005)*

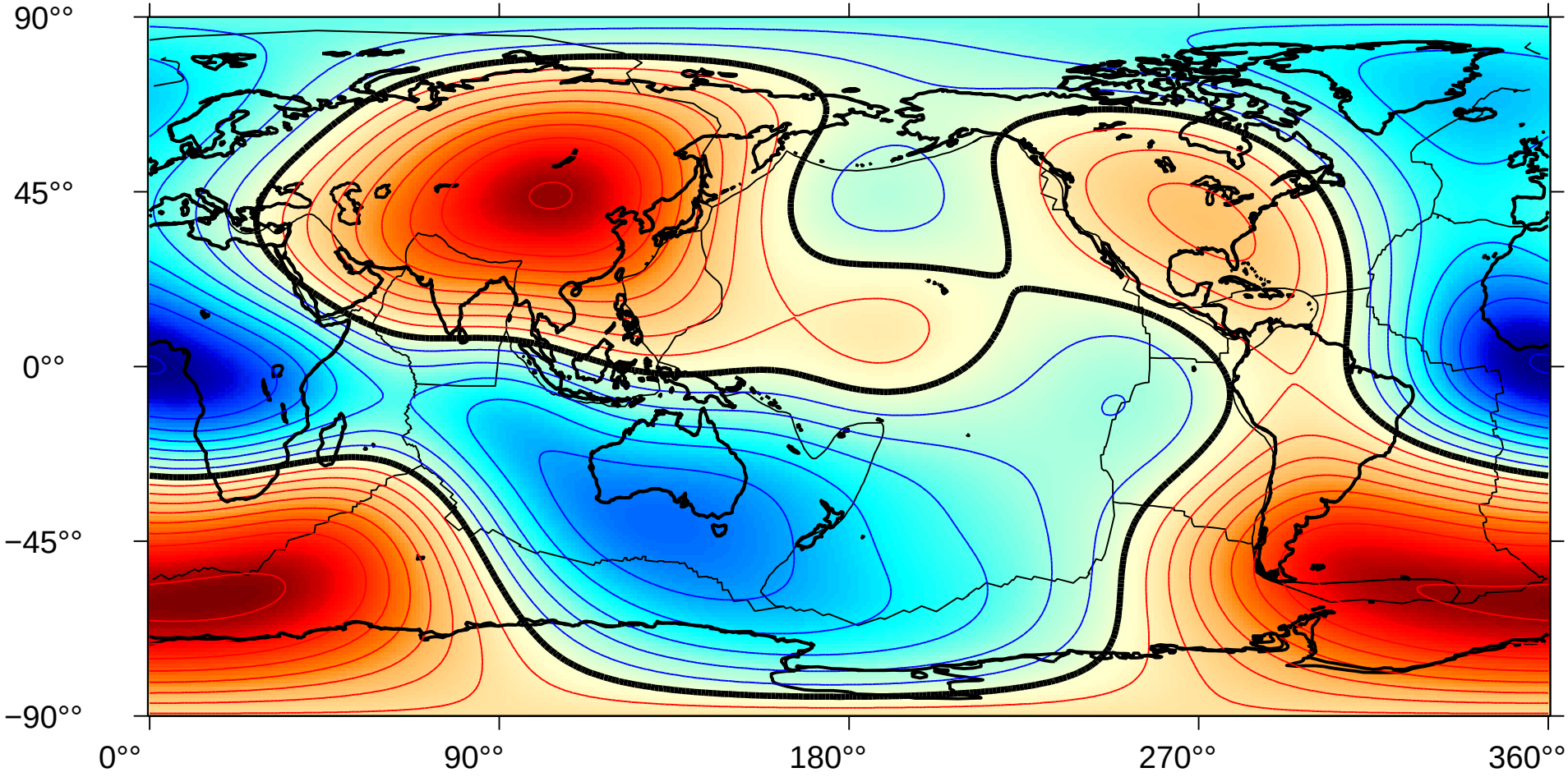


Source: *Maus et al. (2005)*



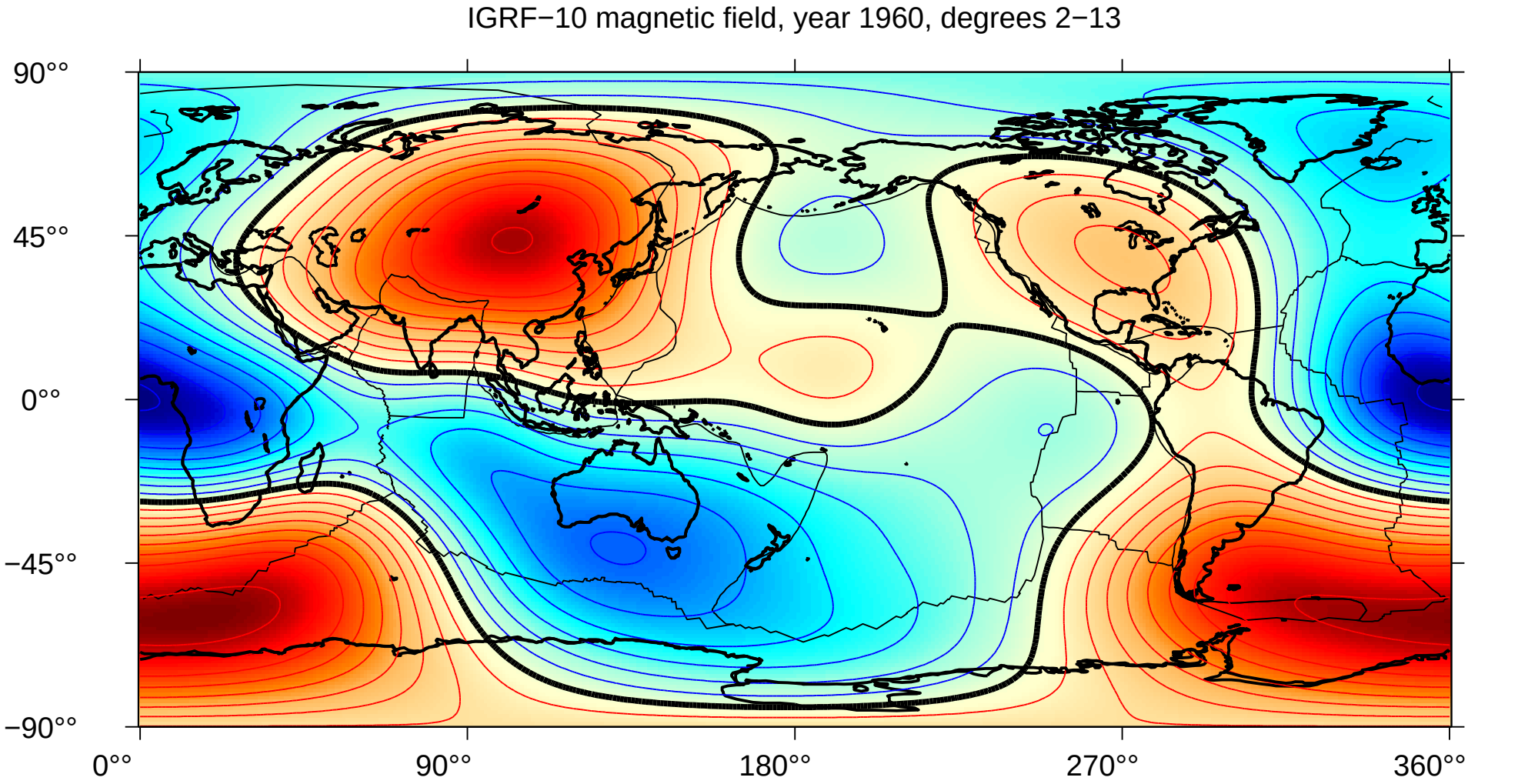
Source: *Maus et al. (2005)*

IGRF−10 magnetic field, year 1955, degrees 2−13



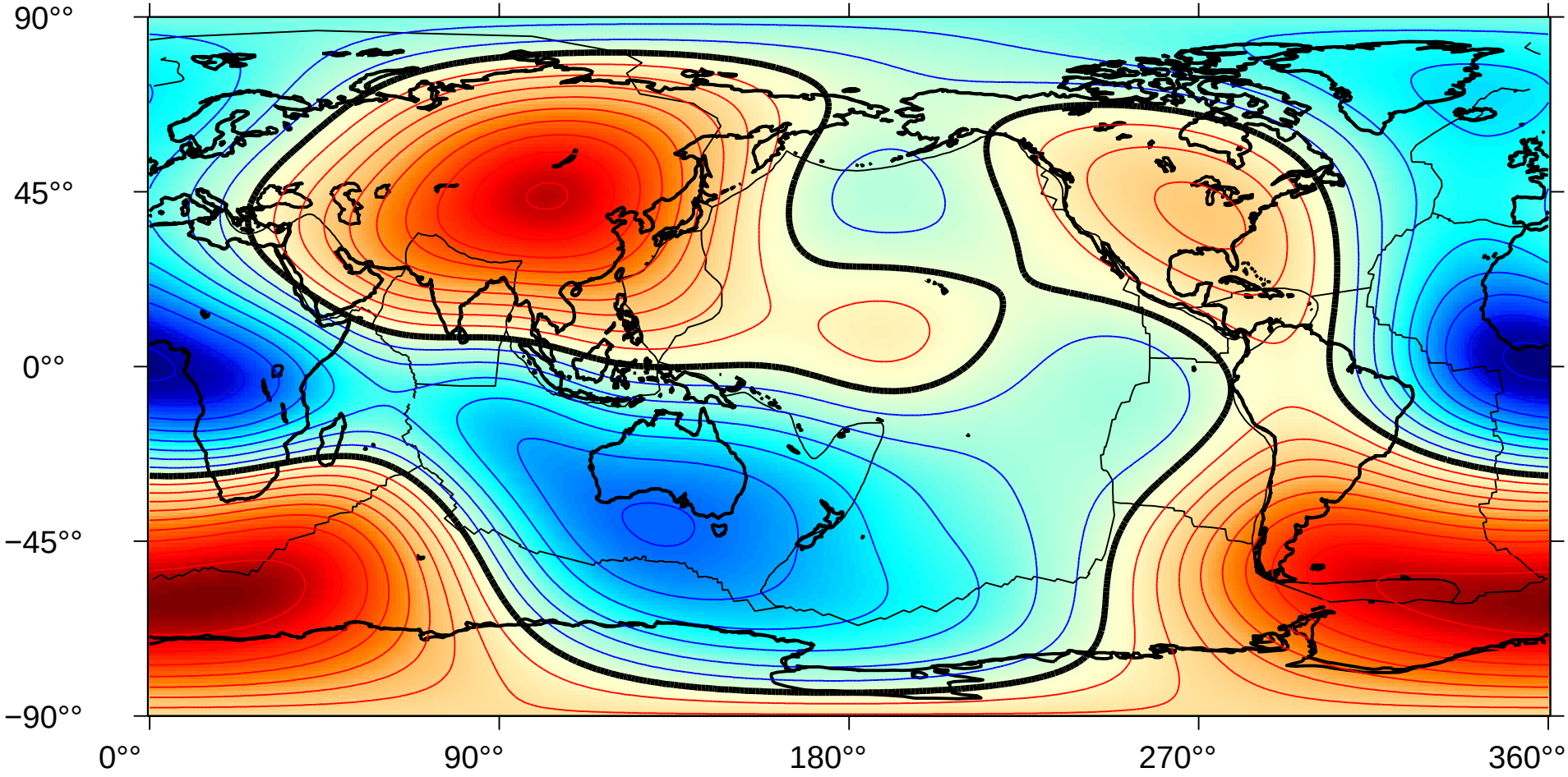
minimum −18661 nT ; maximum 16125 nT

Source: *Maus et al. (2005)*



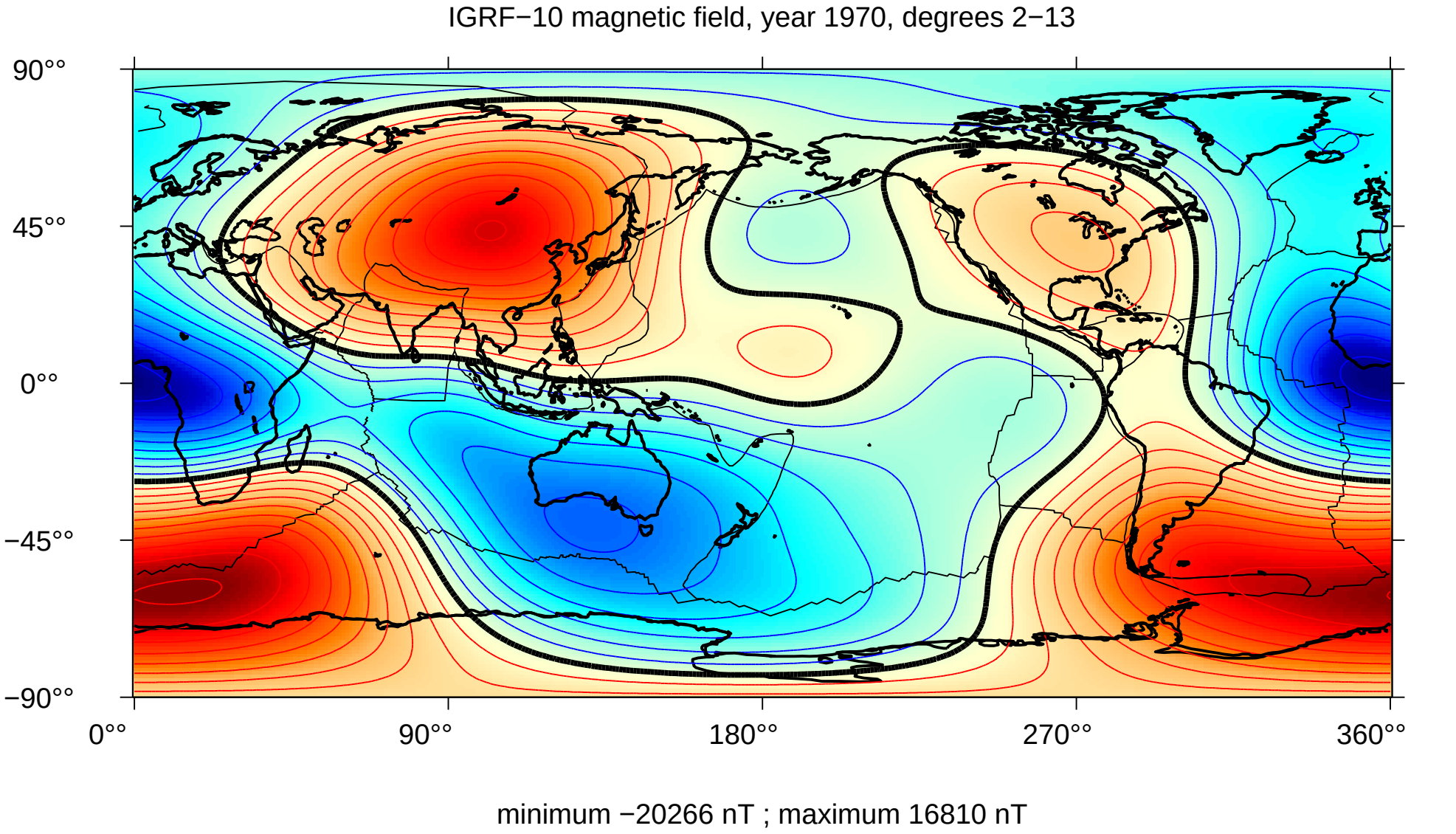
Source: *Maus et al. (2005)*

IGRF−10 magnetic field, year 1965, degrees 2−13

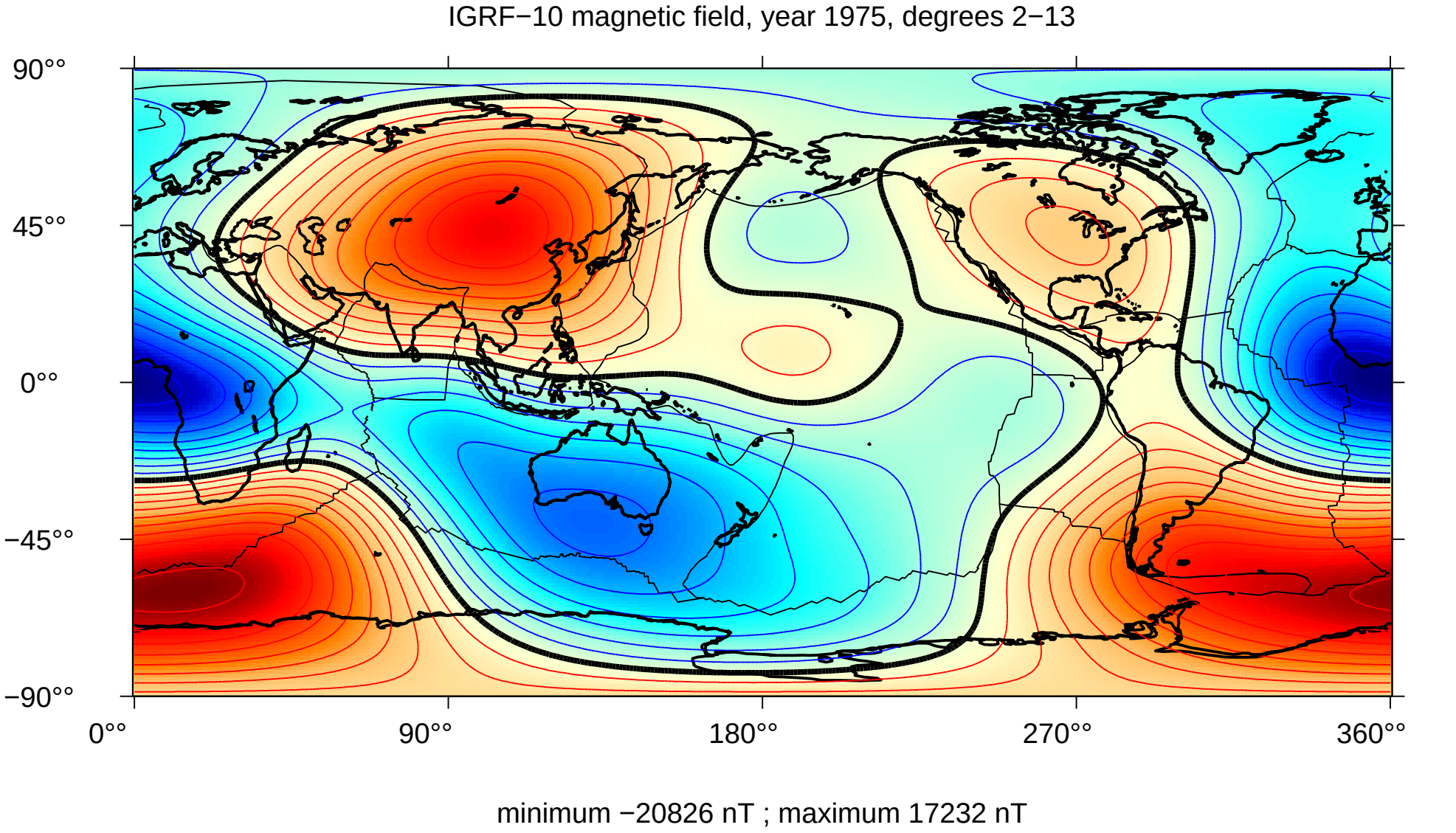


minimum −19708 nT ; maximum 16479 nT

Source: *Maus et al. (2005)*

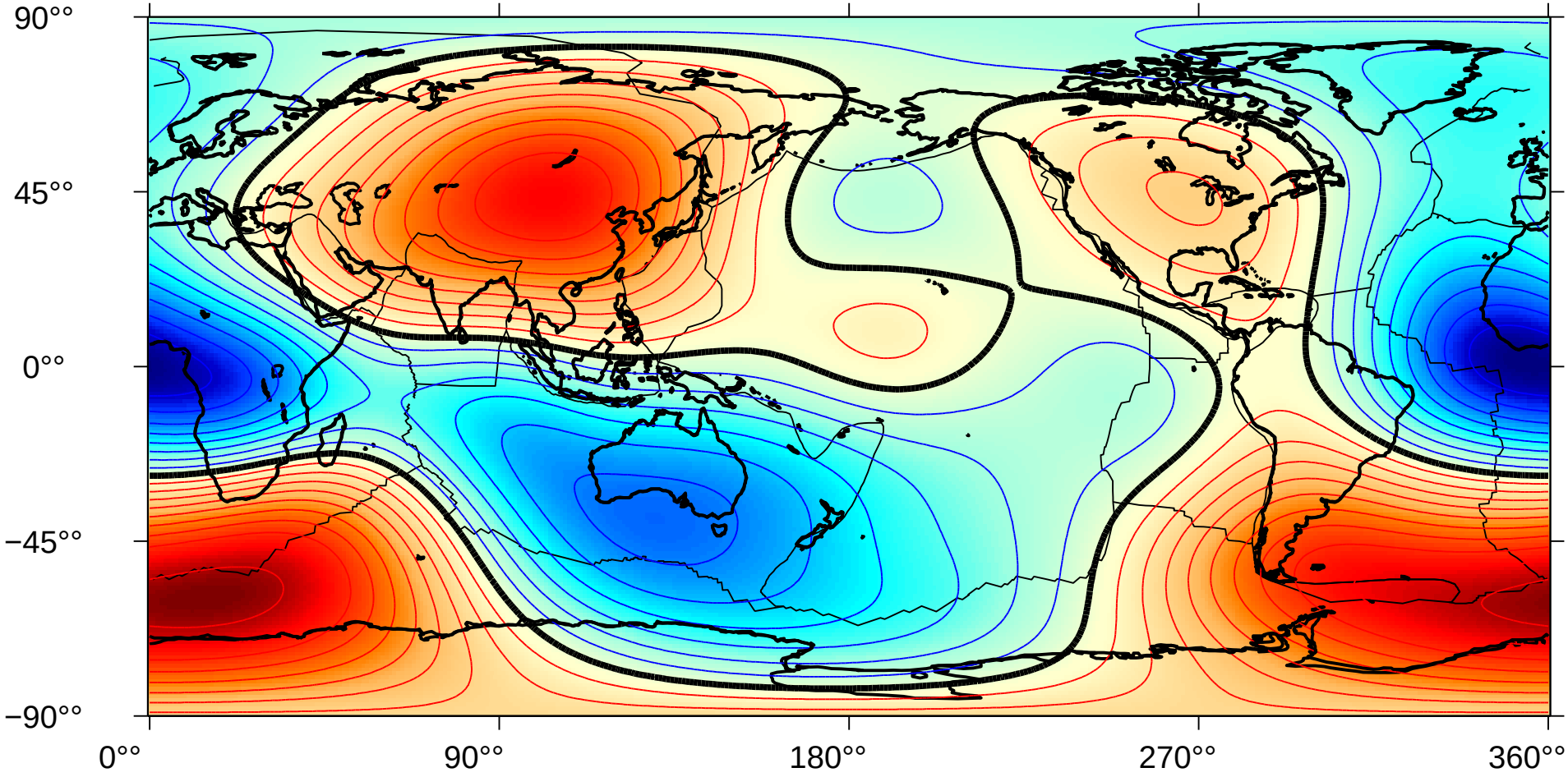


Source: *Maus et al. (2005)*



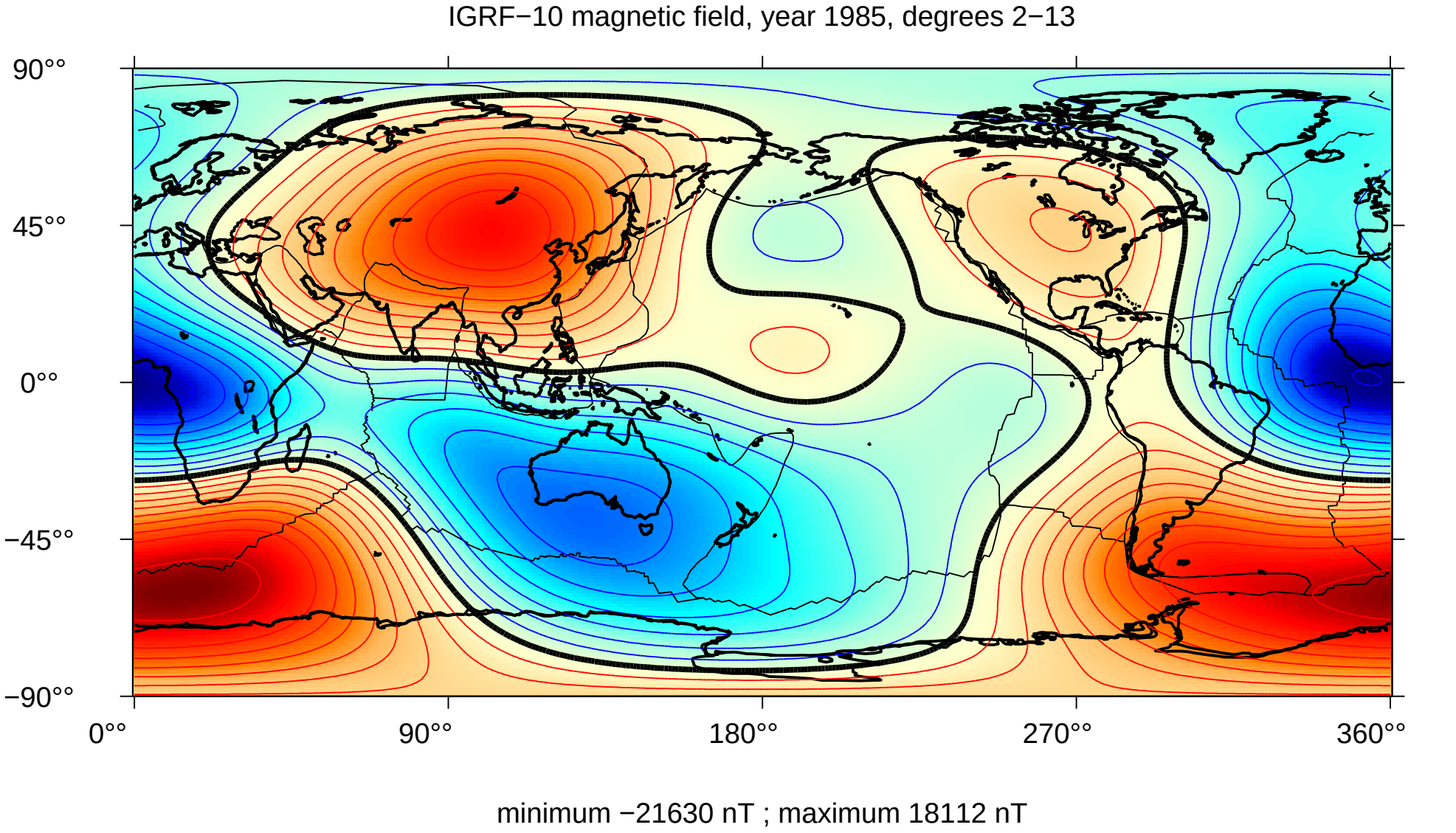
Source: *Maus et al. (2005)*

IGRF−10 magnetic field, year 1980, degrees 2−13

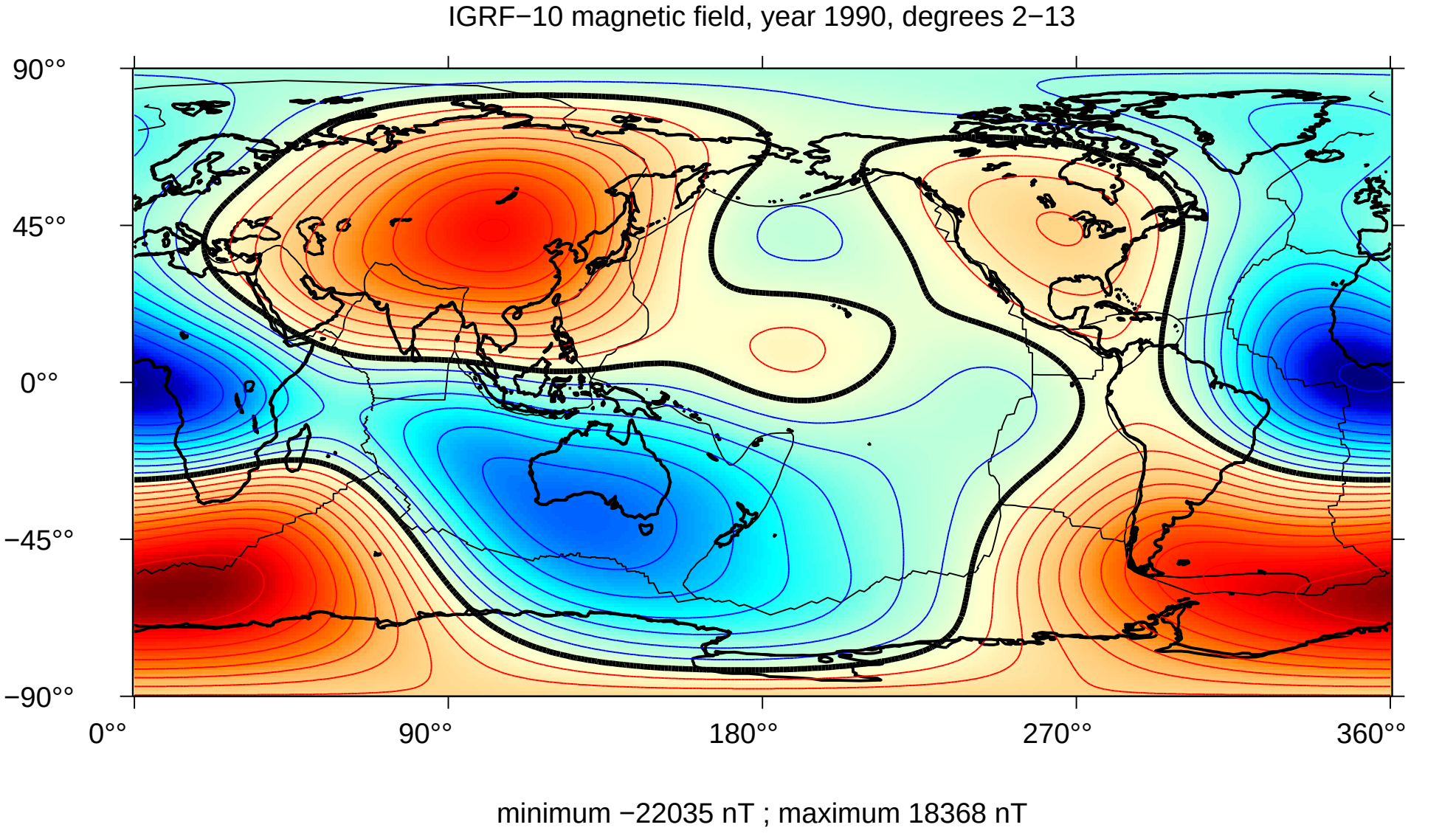


minimum −21225 nT ; maximum 17732 nT

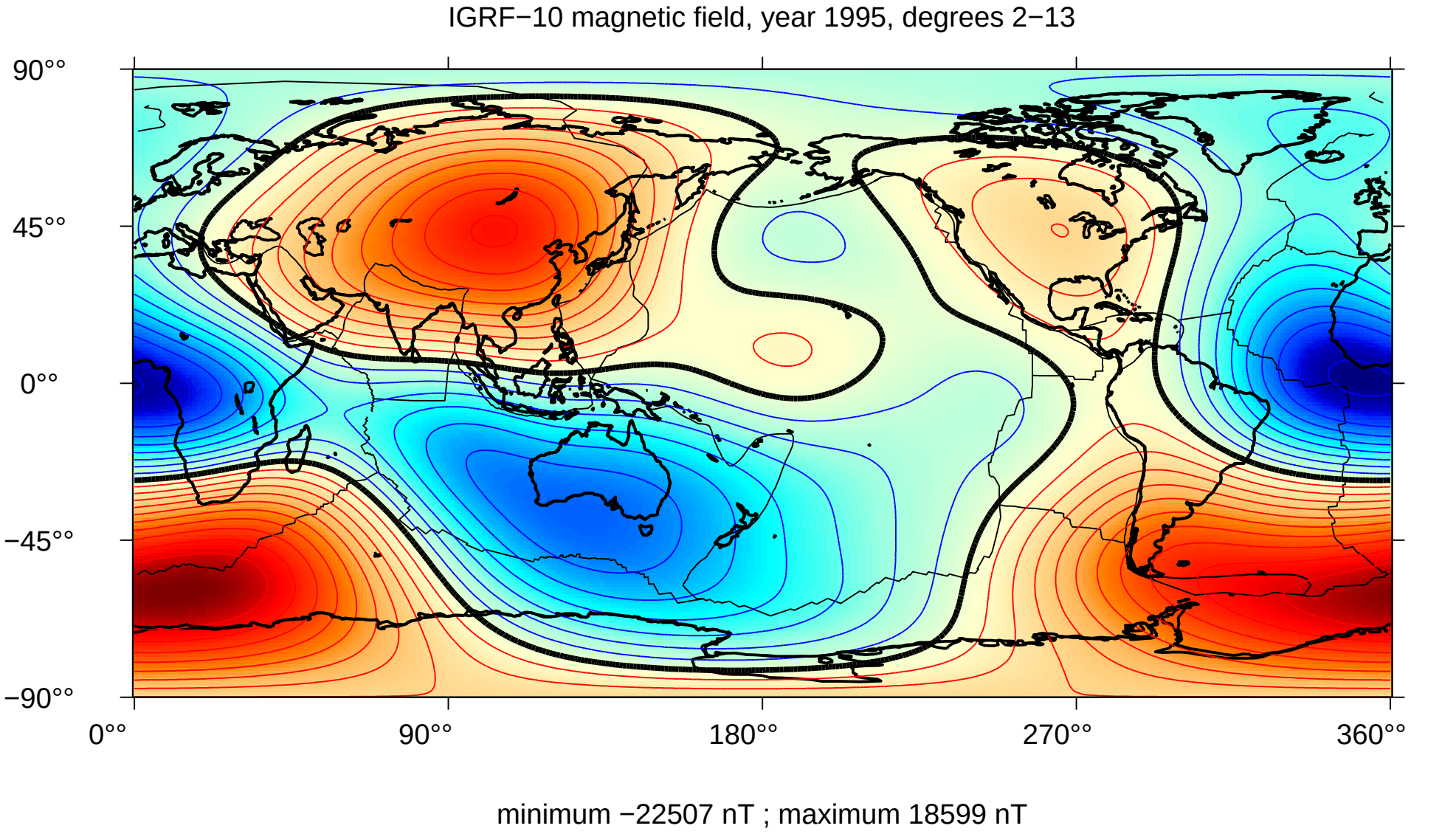
Source: *Maus et al. (2005)*



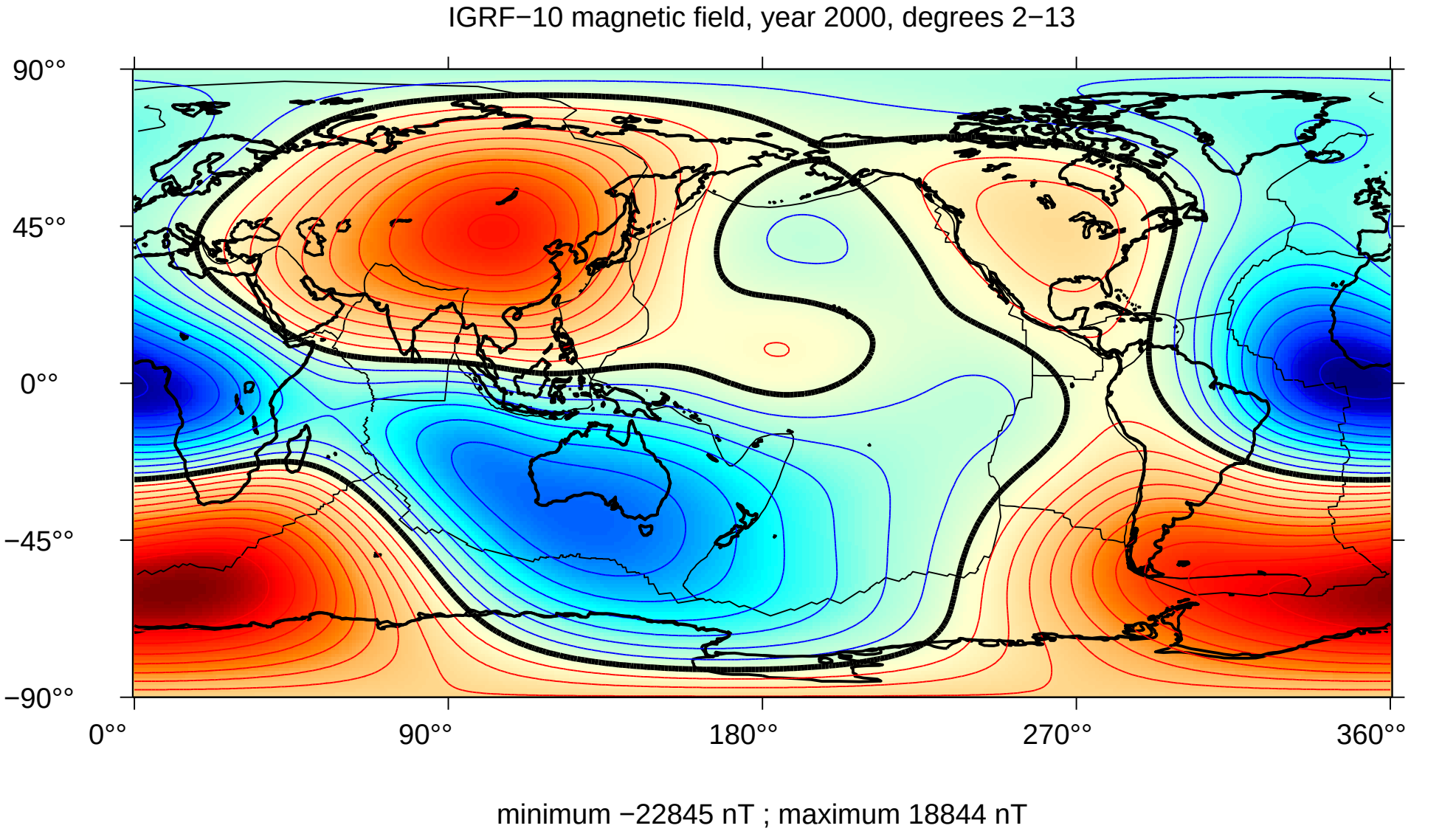
Source: *Maus et al. (2005)*



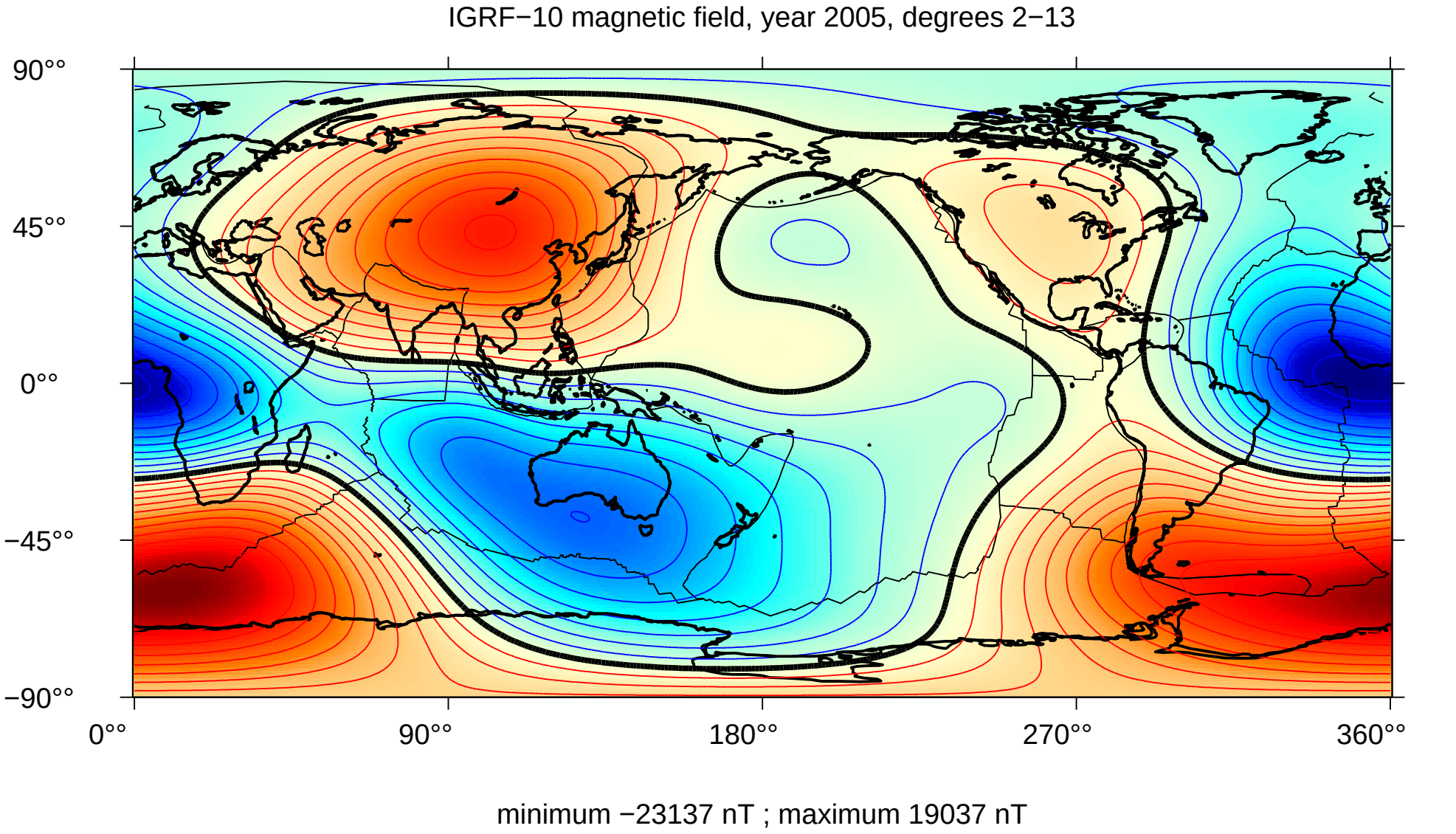
Source: *Maus et al. (2005)*



Source: *Maus et al. (2005)*

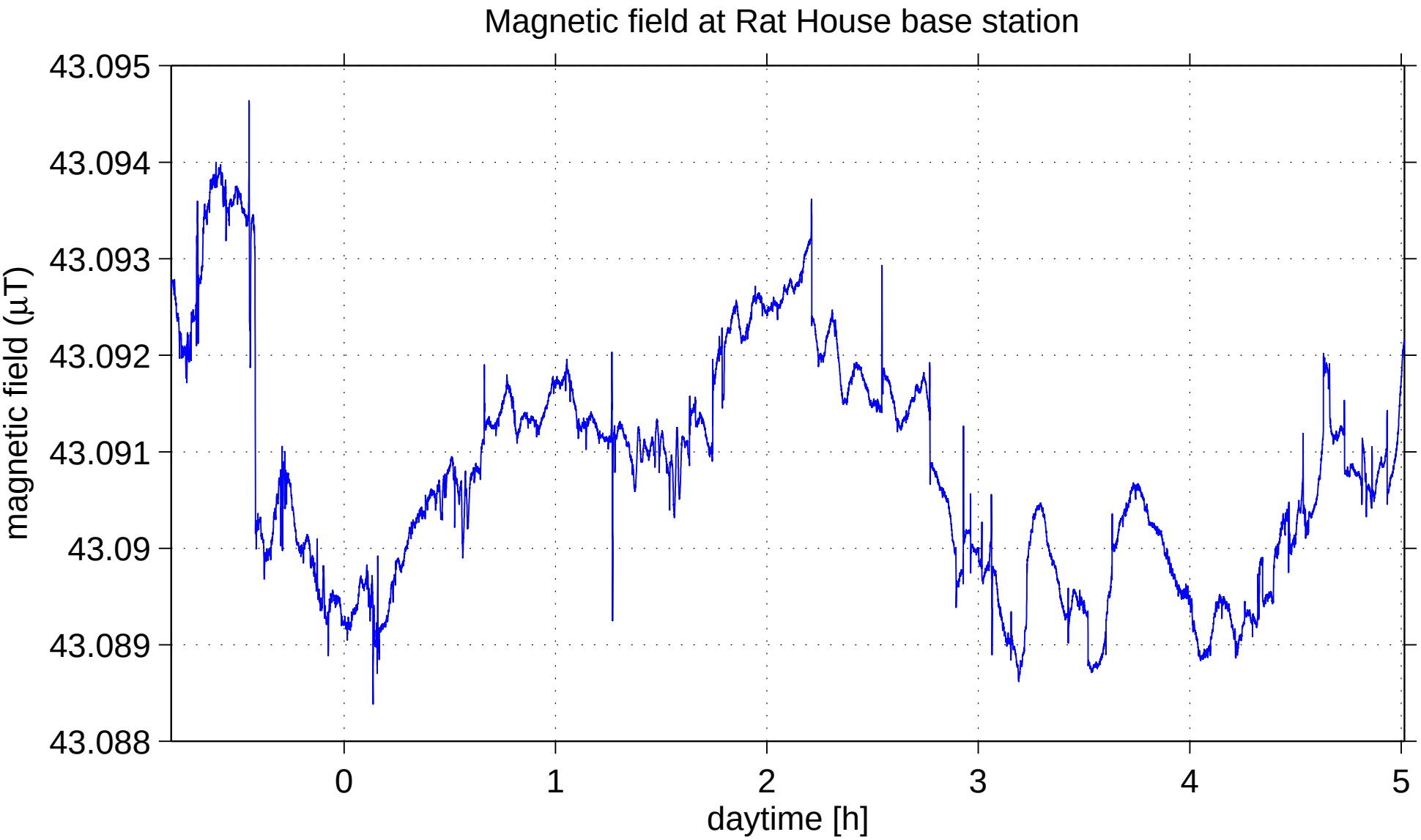


Source: *Maus et al. (2005)*



Source: *Maus et al. (2005)*

Diurnal variation



Source: *Simons & Maloof (2011)*

The geodynamo

In simple terms :

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If nothing *actively* maintained the field, it would disappear

in a mere few thousand years by *Ohmic decay*;

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Convection in the electrically charged *outer core* powers the *geodynamo*;

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Convection in the electrically charged *outer core* powers the *geodynamo*;

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If nothing *actively* maintained the field, it would disappear in a mere few thousand years by *Ohmic decay*;

Convection in the electrically charged *outer core* powers the *geodynamo*;

The *mantle* cools the outer core;

Freezing grows the *inner* core; this *expels light elements* and releases *latent heat*;

In simple terms :

If nothing *actively* maintained the field, it would disappear in a mere few thousand years by *Ohmic decay*;

Convection in the electrically charged *outer core* powers the *geodynamo*;

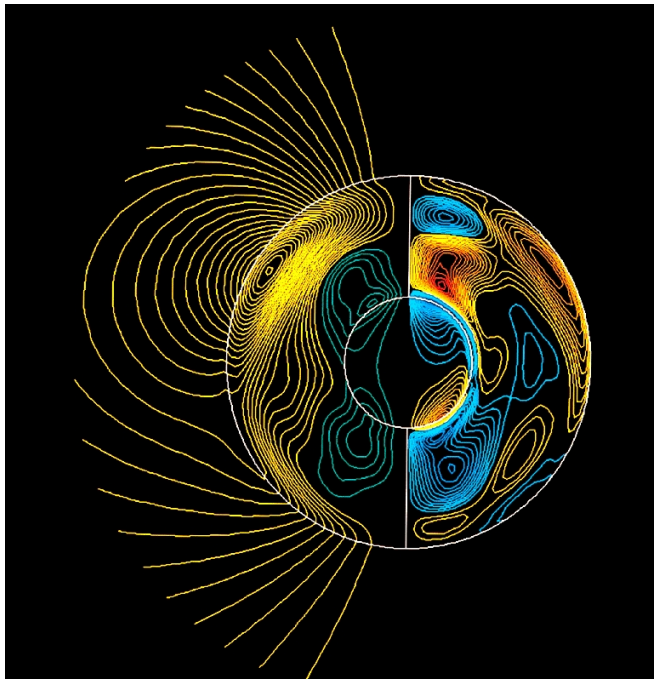
The *mantle* cools the outer core;

Freezing grows the *inner* core; this *expels light elements* and releases *latent heat*;

There may be some *radioactive heating*.

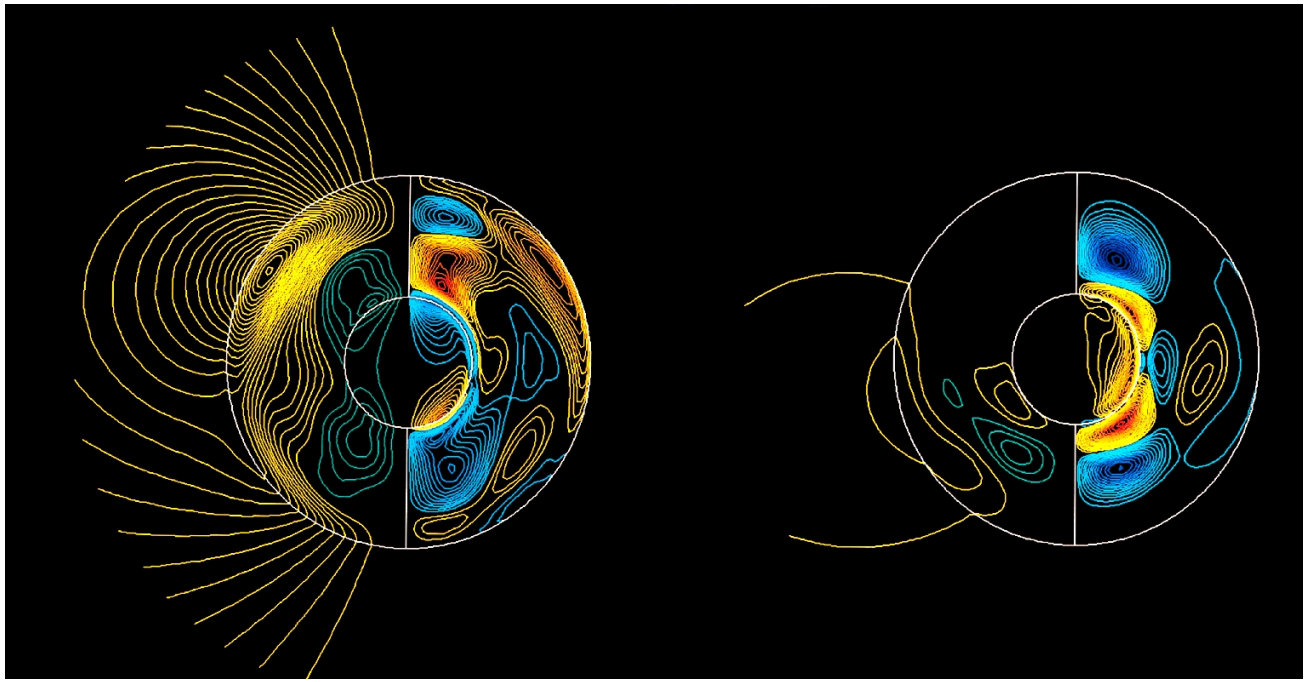
Simulated geomagnetic reversals

Simulated geomagnetic reversals



9000 years before

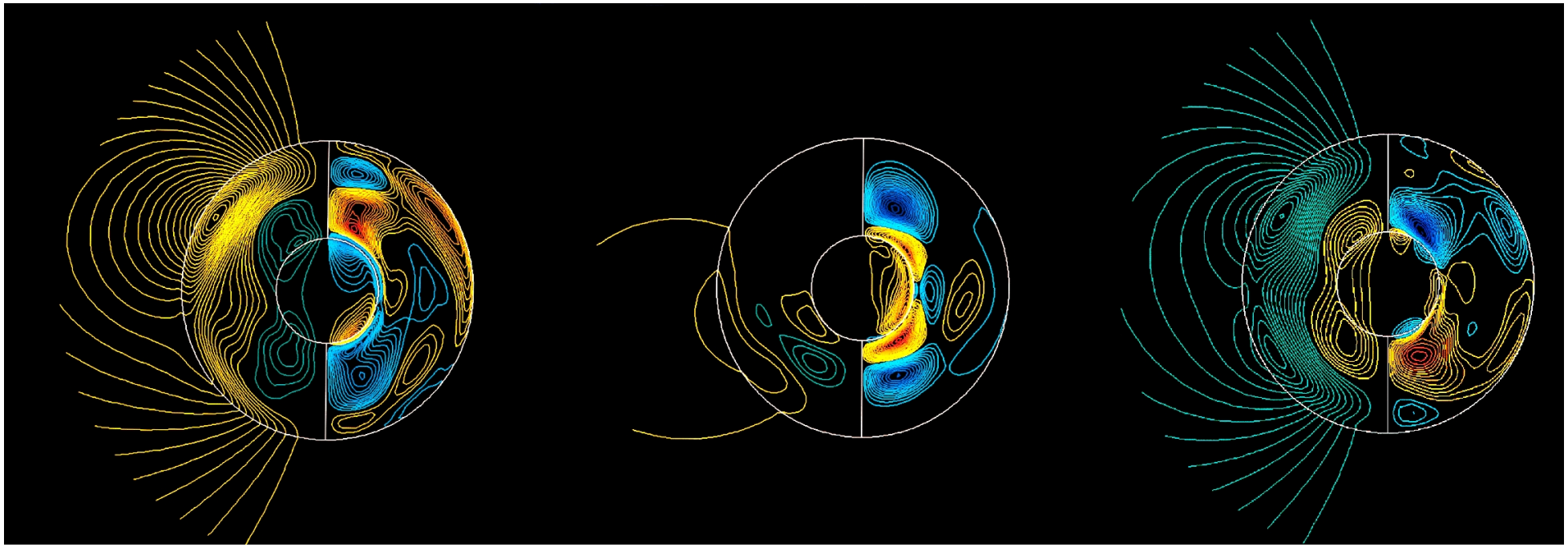
Simulated geomagnetic reversals



9000 years before

during

Simulated geomagnetic reversals



9000 years before during 9000 years after

Source: *Glatzmaier & Roberts (1995)*

To the same level of detail:

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Shakespeare's *Hamlet* is about a man named Hamlet;

To the same level of detail:

Shakespeare's *Hamlet* is about a man named Hamlet;

The story is set in *Denmark*;

To the same level of detail:

Shakespeare's *Hamlet* is about a man named Hamlet;

The story is set in *Denmark*;

Hamlet is *mad*;

To the same level of detail:

Shakespeare's *Hamlet* is about a man named Hamlet;

The story is set in *Denmark*;

Hamlet is *mad*;

People *die*.

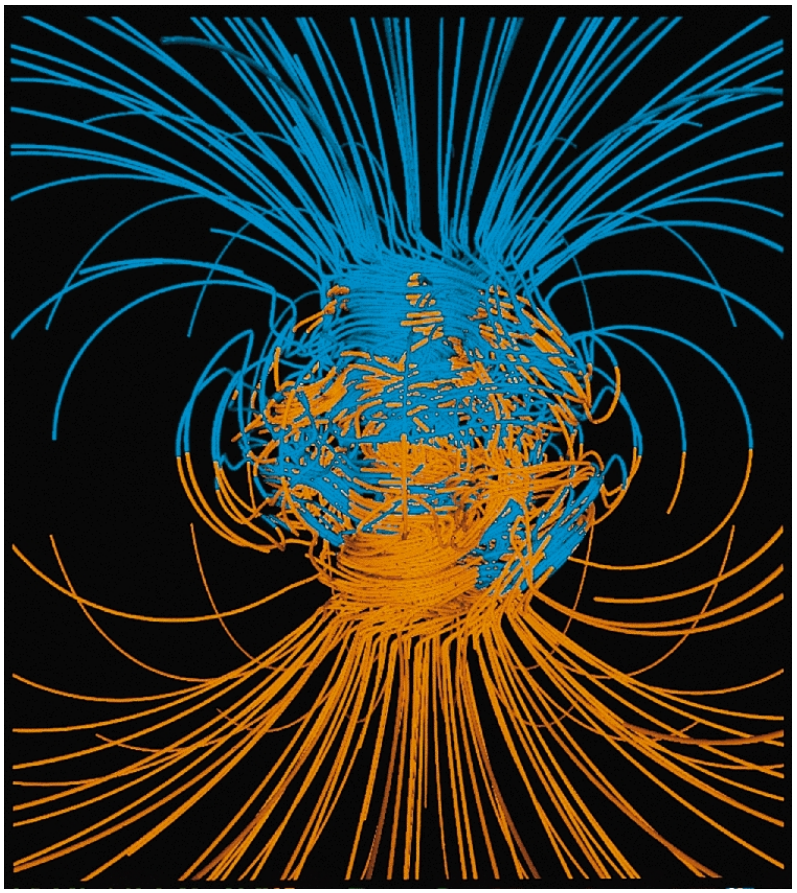
Hamlet vs The Geodynamo:

Hamlet vs The Geodynamo:

Hamlet

Hamlet vs The Geodynamo:

Hamlet

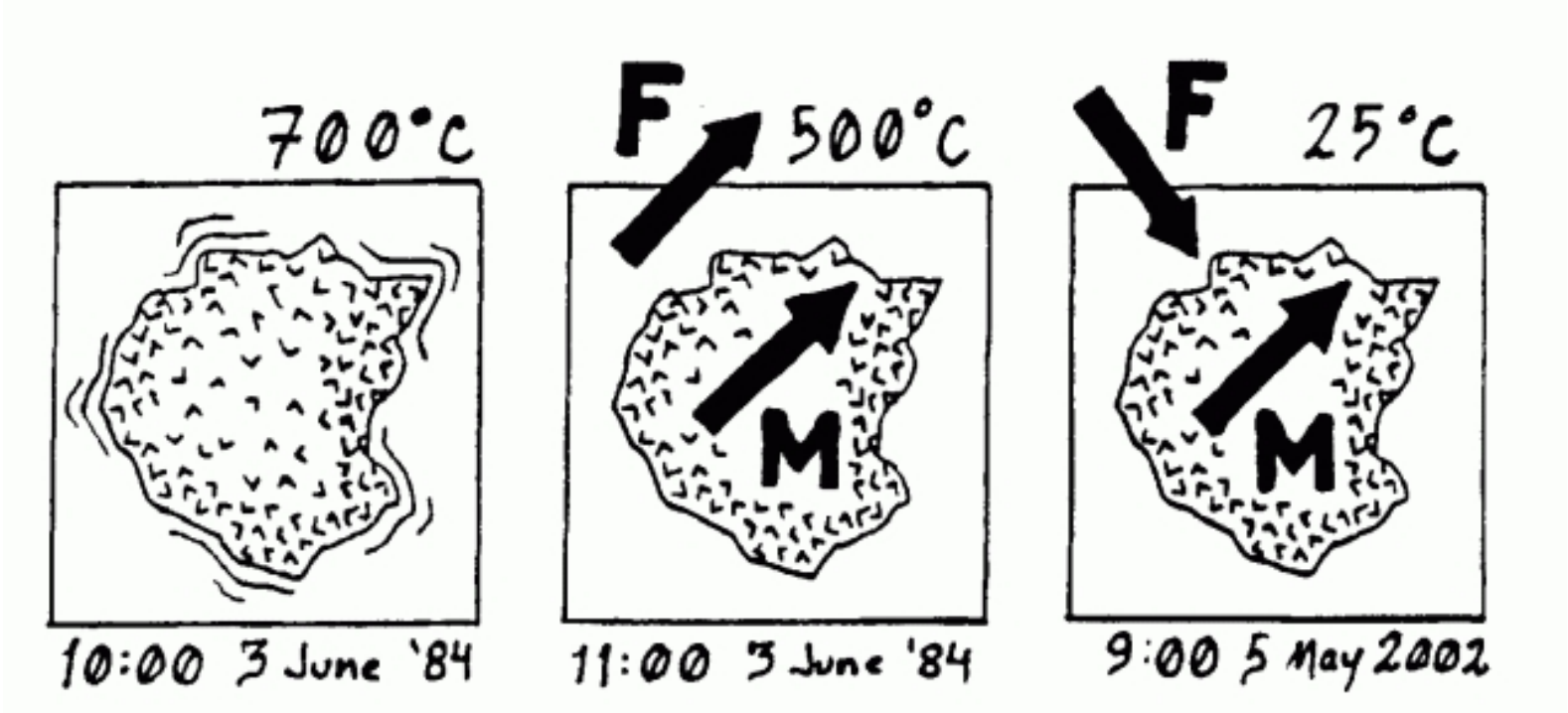


Geodynamo

Rock magnetism

Thermal Remanent Magnetism (TRM)

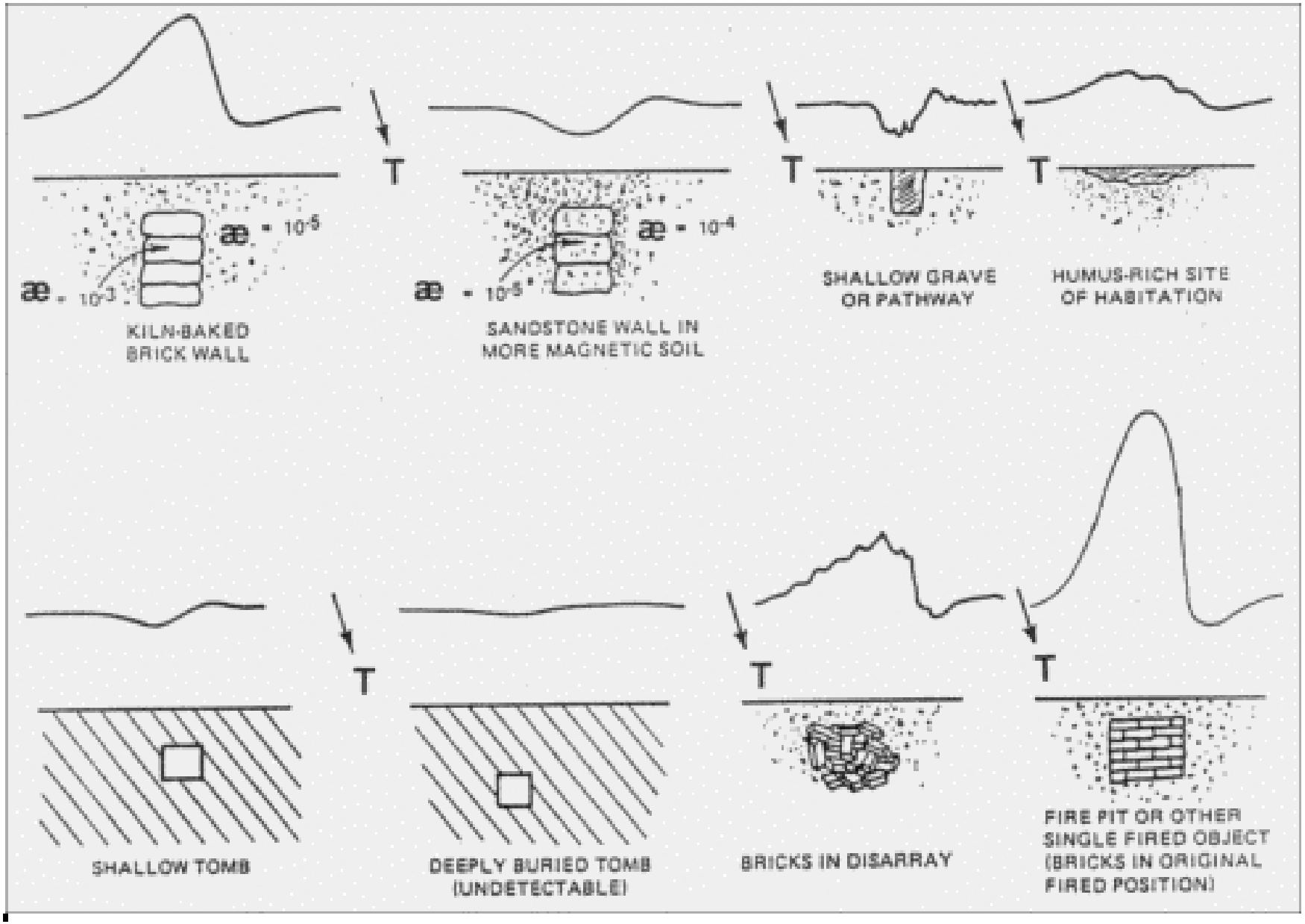
Thermal Remanent Magnetism (TRM)



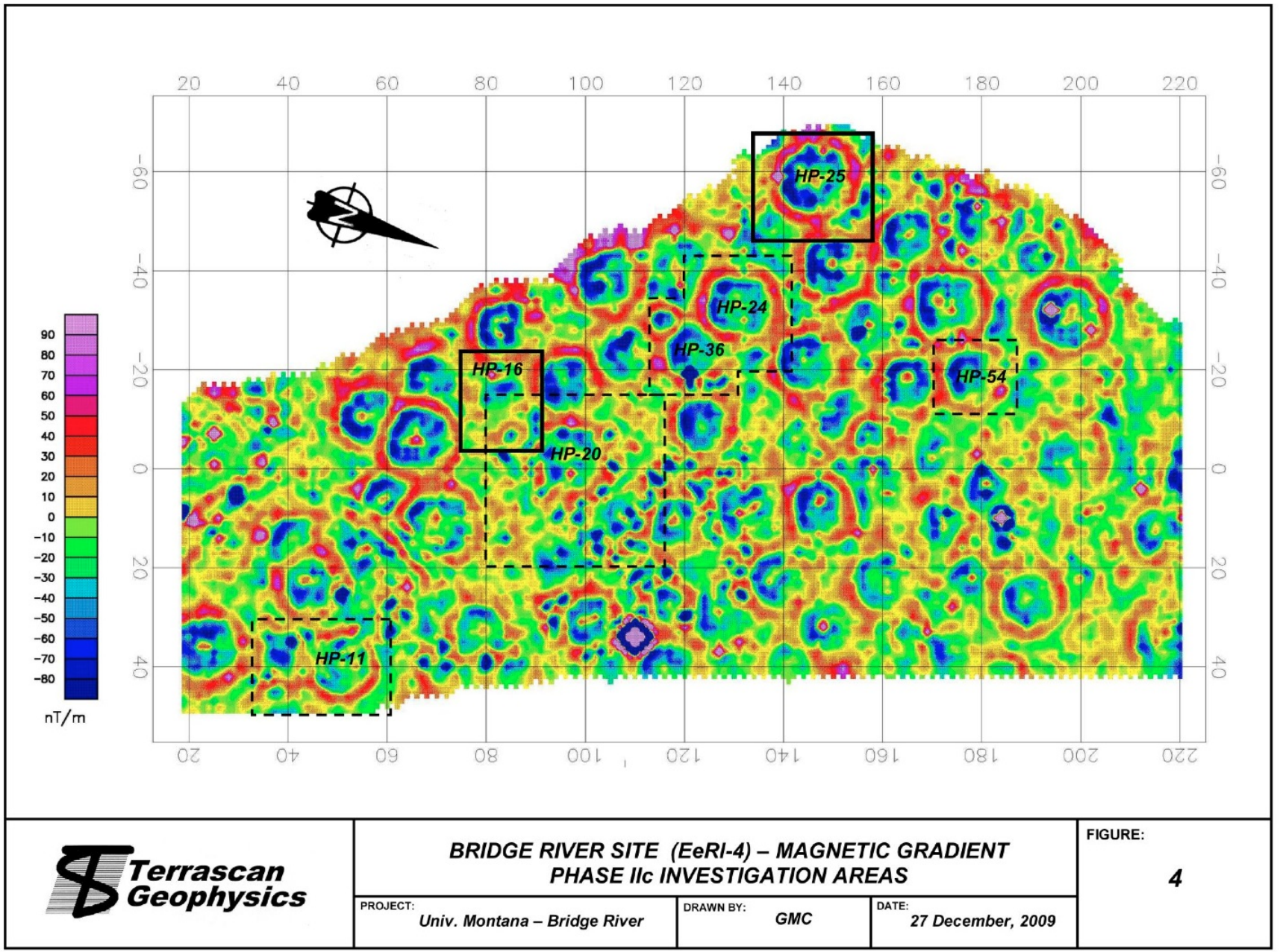
Source: *Cox & Hart (1986)*

The magnetometer


GEOMETRICS



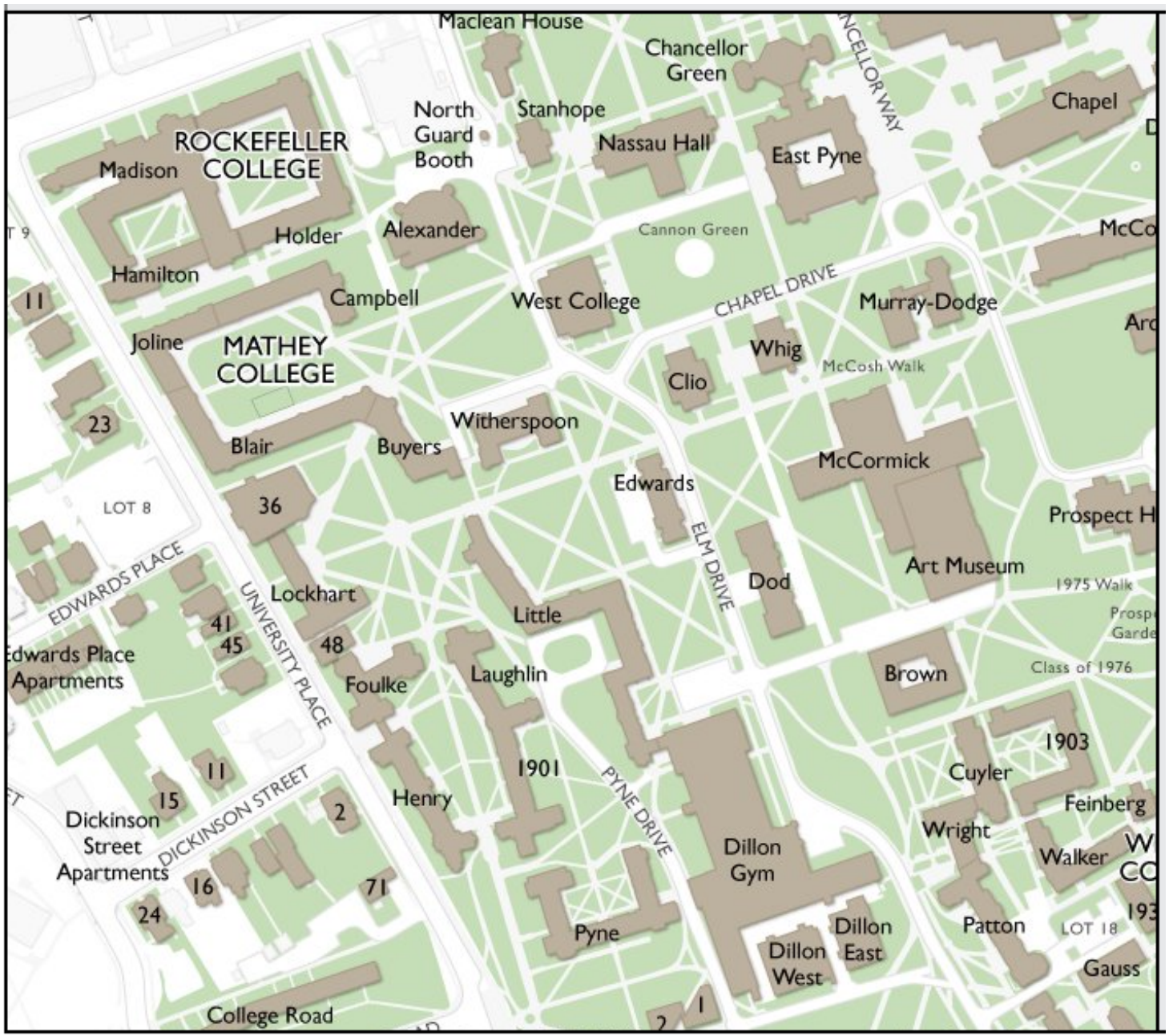
Source: *http://www.gemsys.ca, accessed October 12, 2011*



Terrascan Geophysics	BRIDGE RIVER SITE (EeRI-4) – MAGNETIC GRADIENT PHASE IIc INVESTIGATION AREAS			FIGURE: 4
	PROJECT: Univ. Montana – Bridge River	DRAWN BY: GMC	DATE: 27 December, 2009	

Source: http://qmackie.wordpress.com/2010/11/02/bridge-river-geophysics, accessed October 12, 2011

Campus Tunnel Search


Maclean House
Chancellor Green
CHANCELLOR WAY
Chapel
North Guard Booth
Stanhope
Nassau Hall
East Pyne
ROCKEFELLER COLLEGE
Madison
Holder
Alexander
Cannon Green
McCo
Hamilton
Campbell
West College
CHAPEL DRIVE
Murray-Dodge
11
Joline
MATHEY COLLEGE
Whig
McCosh Walk
Clio
Witherspoon
23
Blair
Buyers
McCormick
Edwards
LOT 8
36
Prospect H
EDWARDS PLACE
ELM DRIVE
Art Museum
Dod
1975 Walk
Lockhart
UNIVERSITY PLACE
Little
41
45
48
Edwards Place Apartments
Foulke
Laughlin
Brown
Class of 1976
1903
1901
Cuyler
Feinberg
15
11
Dickinson Street Apartments
DICKINSON STREET
Henry
PYNE DRIVE
Wright
Dillon Gym
Walker
2
16
71
24
Pyne
Dillon East
Patton
LOT 18
Dillon West
Gauss
College Road
1