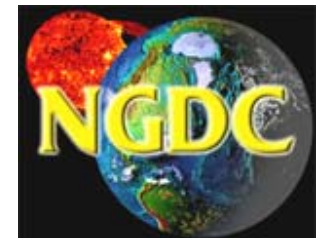


Overview of global models relevant to geomagnetism

- Geomagnetic field models
- Climatological models
- Physics-based models
- Assimilative models

Stefan Maus (CIRES, NGDC)



Historical main field models

CALS7K Paleomagnetic model (to 7000 BC)

<http://www.gfz-potsdam.de/pb2/pb23/Models/>

- From archeo- and paleomagnetic data
- Available: Model, software, maps

UFM (1650-1990)

Model and software available from Andy Jackson
and Jeremy Bloxham

IGRF

Main field model to degree 13 with SV to degree 8

<http://www.ngdc.noaa.gov/IGGA/vmod/igrf.html>

- Updated every five years
- Coefficients, Software
- Online calculator get 2000 hits per day

Should not be used to compute residuals from magnetic satellite or observatory data!

World Magnetic Model

Main field model to degree 12 with SV to degree 8

<http://www.ngdc.noaa.gov/seg/WMM/DoDWMM.shtml>

- Updated every five years
- Format and timely update guaranteed
- Software, maps, GIS shape files, online calculator
- Supported by NGDC

Should not be used to compute residuals from magnetic satellite or observatory data!

CHAOS

Magnetic field model without ionosphere

<http://www.spacecenter.dk/files/projects/oersted/models/>

<http://www.gfz-potsdam.de/pb2/pb23/Models/CHAOS/>

- Internal field to SH degree 50
- Spline representation of coefficients in time
- SV to degree 18 and SA to degree 14
- Available: model coefficients

Comprehensive Model

Quiet time magnetic field model for all local times

<http://core2.gsfc.nasa.gov/CM/>

- Based on data from 1960 to 2002.5
- Internal field to degree 65
- Spline SV to degree 13
- Magnetospheric and ionospheric fields for all LTs
- Coefficients, software and online calculator

POMME

Magnetic field model without ionosphere

<http://www.gfz-potsdam.de/pb2/pb23/Models/>

<http://geomag.colorado.edu/model.html>

- Internal field: degree 90 (above 24 from MF4),
- Secular variation and acceleration to degree 18
- Magnetosphere and induced fields to degree 2
- Combined model: External, core and crustal fields estimated from different data sets
- Available: Model and Software

BGS Global Geomagnetic Model (BGGM)

Proprietary model of the British Geological Survey

<http://www.geomag.bgs.ac.uk/bggm.html>

- Has main field, crustal field and external field components
- Used in the oil industry for directional drilling
- Can incorporate local geomagnetic observations or surveys

MoSST Core Dynamics Model

A dynamo model for magnetic field generation in the Earth's core.

<http://mosst.gsfc.nasa.gov/index.html>

- Is being used for an assimilative core field model (not yet available)
- Extensive web site (partly under construction)
- Available soon: Source code

Antarctic Reference Model (ARM)

Regional spherical-cap reference field model for the
Antarctic

<http://www.ingv.it/arm/>

- Validity: South of 60 degrees of latitude South
- From 1960 to present
- Available: Online calculator

Crustal field model MF4

Crustal magnetic field model without ionosphere

<http://www.gfz-potsdam.de/pb2/pb23/Models/>

<http://geomag.colorado.edu/model.html>

- Crustal field: degree 16-90
- Available: Model, grids, images, animations, software on Pomme web site

Ocean tidal induced fields

Magnetic fields generated by tidal ocean flow

http://www.gfz-potsdam.de/pb2/pb23/SatMag/ocean_tides.html

- 1x1 degree grids of the predicted global magnetic field for each of the eight major tidal constituents, computed by Alexei Kuvshinov

Ionosphere/thermosphere/magnetosphere

Space physics models overview:

http://modelweb.gsfc.nasa.gov/models_home.html

The Community Coordinated Modeling Center (CCMC):

<http://ccmc.gsfc.nasa.gov/>

Earth System Modeling Framework (ESMF)

<http://www.esmf.ucar.edu/>

Center for Integrated Space Weather Modeling (CISM)

<http://www.bu.edu/cism/>

Naval Research Lab

http://uap-www.nrl.navy.mil/models_web/

Climatological models

A climatological model describes the mean behavior of the Earth system, as a function of season, solar activity, ring current strength, etc

NRLMSISE-00 Model

The MSIS empirical models provide thermospheric temperature and density

- based on in-situ data from seven satellites and numerous rocket probes.
- provide estimates of temperature, and the densities of N₂, O, O₂, He, Ar, and H.
- major variations described by low-order spherical harmonics through out the atmosphere including latitude, annual, semiannual, and simplified local time and longitude variations.
- Available: model, software, online-calculator

http://uap-www.nrl.navy.mil/models_web/msis/msis_home.htm

Horizontal Wind Model (HWM)

Empirical neutral wind model

- Empirical model of the horizontal neutral wind in the upper thermosphere, based on wind data obtained from the AE-E and DE 2 satellites
- Available: source code

[\[www.nrl.navy.mil/models_web/hwm/hwm_home.htm\]\(http://www.nrl.navy.mil/models_web/hwm/hwm_home.htm\)](http://uap-</u></p></div><div data-bbox=)

<http://modelweb.gsfc.nasa.gov/atmos/hwm.html>

International Reference Ionosphere

Provides ionospheric plasma density, composition and temperature

<http://modelweb.gsfc.nasa.gov/ionos/iri.html>

– Available: Model, software, online calculator

Tsyganenko magnetospheric model

Empirical model of the magnetospheric magnetic field

<http://modelweb.gsfc.nasa.gov/magnetos/data-based/modeling.html>

- cross-tail current, symmetric and partial ring current, region-1 and region-2 field aligned currents, IMF-controlled interconnection field
- Available: Model, software and animations

Weimer Ionosphere Models

Weimer models are statistical electric potential models for the high-latitude ionosphere

– Available: online calculator, source from author?

<http://www-ssc.igpp.ucla.edu/gem/poster/weimer/ggcm/>

http://ccmc.gsfc.nasa.gov/models/ion_weimer.html

Physics-based models

Compute global properties based on given input conditions

GSWM: Global Scale Wave Model

Atmospheric tides

<http://web.hao.ucar.edu/public/research/tiso/gswm/gswm.html>

- Numerical Model of Planetary Waves and Solar Tides in the Earth's Atmosphere
- Available: Tables with model results

Ionosphere Forecast Model (IFM)

Ionospheric electron and ion densities

<http://www.spacenv.com/~vince/ifm/index.html>

— Availability?

Thermosphere Ionosphere Electrodynamics General Circulation Model(TIEGCM)

The model simulates the upper atmosphere, its dynamics, chemistry, energy, and electrodynamics.

- self consistent large scale model which includes the aurora, but also other features of the upper and middle atmosphere, like the ozone layer.
- Availability: Sample runs, use of model requires collaboration with NCAR
- <http://web.hao.ucar.edu/public/research/tiso/tgcm/tgcm.html>

SAMI2 Low-to-Mid-Latitude Ionosphere Model

Calculates the evolution of the low- to mid-latitude ionosphere

<http://wwwppd.nrl.navy.mil/sami2-OSP/index.html>

- Open source project of the Naval Research Lab
- Model runs available at
<http://ccmc.gsfc.nasa.gov/models/ionThermoSami2.html>

Coupled Thermosphere/Ionosphere Plasmasphere (CTIP)

Thermosphere-ionosphere-plasmasphere densities

<http://ccmc.gsfc.nasa.gov/models/ionThermoFullerRowell.html>

Consists of three distinct components:

- A global thermosphere model;
- A high latitude ionosphere model;
- A mid and low-latitude ionosphere/plasmasphere model.
- Output: Neutrals and ion densities
- Available: online-calculator

Rice Convection Model

Physical model of the inner and middle magnetosphere that includes the coupling to the ionosphere.

- self-consistently computed electric field
- specified magnetic field.
- Includes Field aligned currents to and from the conducting ionosphere. The RCM computes these currents and the associated electric fields self-consistently. It assumes perfectly conducting field lines and employs a pre-computed time-dependent magnetic field with associated induction electric fields.
- Web site?

Assimilative models

Physics based data assimilative models of the ionosphere

- inputs: GPS TEC and occultation, ionosonde, UV limb and nadir, in-situ electron density, magnetic observatory data
- outputs: Plasma density, composition and temperature, electric fields and currents, magnetic fields

Assimilative Mapping of Ionospheric Electrodynamics (AMIE)

Optimally constrained, weighted least-squares fit of electric potential distribution to diverse types of atmospheric observations.

- Availability: Sample runs, use of model requires collaboration with NCAR

http://web.hao.ucar.edu/public/research/tiso/amie/AMIE_head.html

AMIE was run for a full solar cycle at NGDC. Output may be available on request (contact Eric.A.Kihn@noaa.gov)

JPL/USC GAIM

Solves for ion and electron volume densities

<http://iono.jpl.nasa.gov/gaim/index.html>

- output is plasma density and composition
- all links to model output are defunct

Utah State University Global Assimilation of Ionospheric Measurements (USU-GAIM)

Physics-based data assimilation models of the ionosphere

<http://gaim.cass.usu.edu/>

- Online model runs to compute plasma densities available at: <http://ccmc.gsfc.nasa.gov/>

Summary

Many models which are frequently presented at conferences do not seem to have web sites

However, many models and source code are openly available

Omissions? Corrections?
to Stefan.Maus@noaa.gov

