Progress towards IGRF-11

Div V - WG Mod - IGRF Task Force

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[With corrections included by C.F. 26/8/2009]

Report to Div V-Mod at IAGA 2009, Sopron

Call for IGRF-11

- Draft call prepared by Chris Finlay and Stefan Maus distributed to Task force on 26th Feb 2009.

- Comments from task force memebers received by 16th March 2009.

- Task force voted on 21st April 2009 (by a majority of 5 to 3) to keep the truncation level for predictive SV in 2012.5 at N=8.

- Call was finalized and issued to the wider community via gpmag mailing list on 12th May 2009 for:
  - Internal field (main field) for 2005.0 to degree and order 13.
  - Internal field (main field) for 2010.0 to degree and order 13.
  - Predicted average SV for 2010.0-2015.0 to degree and order 8.

Changes compared to IGRF-10

- Each team of workers should submit only one candidate model per product.

- Every lead institution can have only one team, and every individual can lead only one team.

- Submission of submitted candidate models to 0.01nT.

Teams with confirmed intent to submit candidates

- CHAOS 2 Team (Leader Nils Olsen - DTU Space)

- GFZ Team (Leader Vincent Lesur - GFZ)

- NGDC/GFZ Team (Leader Stefan Maus - NGDC).

- IPGP Team (Leader Erwan Thébault - IPGP)

- BGS Team (Leader Brian Hamilton - BGS)

- IZMIRAN Team (Leader Vadim Golokov - IZMIRAN)

- ELLI Team (Leader Aude Chambudot - EOST)

- MoSST-DAS Team (Leader Weijia Kuang - NASA) (SV only)

Strategies of confirmed teams I

- **CHAOS 2 Team (Leader Nils Olsen - DTU Space)**
  - **Other team members:** M. Mandea, T. Sabaka, L. Toffner-Clausen.
  - **Data:** 10 years of Oersted, CHAMP and SAC-C data, Observatory monthly means.
  - **Method:** Derived from CHAOS-2s model. Quiet time data selection following CHAOS model criteria, co-estimation of core field, lithospheric field, large scale magnetospheric field and pointing directions, order 5 B-splines, 6 month knot spacing running to 2010, temporal regularisation based on second time derivative of squared magnetic field intensity at CMB.

- **GFZ Team (Leader Vincent Lesur - GFZ)**
  - **Other team members:** M. Hamoudi, M. Mandea, M. Rother, I. Wardinski.
  - **Data:** CHAMP satellite to July 2009 and hourly mean observatory vector data.
  - **Method:** Derived from GRIMM-2x model. Quiet time selection, co-estimated core, lithosphere, large scale external and induced counterpart. Uses 6th order B-splines in time. Averaged over 1 year around 2005 for DGRF. SV is estimated as average GRIMM-2x between 2007.5 and 2008.5. 2010 model is extrapolation of 2008 model with SV.

- **NGDC-GFZ Team (Leader Stefan Maus - NGDC)**
  - **Other team members:** NGDC staff in collaboration with GFZ.
  - **Data:** CHAMP satellite and possibly Oersted data.
  - **Method:** Derived from POMME-6 model. Estimates static field to degree 60, SV to 16, SA to 16. Magnetospheric field is represented in SM and GSM coordinates. Uses EST/IST and IMF-By dependent contributions.

Strategies of confirmed teams II

- **IPGP Team (Leader Erwan Thébault - IPGP)**
  - **Other team members:** A. Chulliat, A. Chambodut, B. Langlais, M. Mevielle, G. Hulot.
  - **Data:** CHAMP satellite data 2000- Sept/Oct 2009.
  - **Method:** Est/Ist parameterisation of magnetospheric field variations, degree 2 static external field, correction for crustal field. Linear main field variation around 2005 for DGRF and linear, quadratic or splines to 2010, linearly extrapolated to 2015.

- **BGS Team (Leader Brian Hamilton - BGS)**
  - **Other team members:** S. Macmillan, A. Thomson.
  - **Data:** quiet time vector data from Oersted/CHAMP and observatories 1999-2009.
  - **Method:** Degree 60 for internal field, time dependent to degree 20, degree 1 external field with polynomial time dependence and dependence on vector magnetic disturbance index and terms representing 24hr, semi-annual and annual periodicities. Noise estimators used for weighting, equal area tesseral weighting. Interpolation for 2005 model, extrapolation to 2010 and 2015 and augmentation with predictions form observatory annual means.

Strategies of confirmed teams III

- **IZMIRAN Team (Leader Vadim Golokov - IZMIRAN)**
  - **Other team members:** T. Bondar, T. Zvereva, T. Chernova.
  - **Data:** CHAMP data Jan 2004-April 2009 and data from 153 observatories.
  - **Method:** Daily average SH (degree 13) for 4 day intervals are expanded in natural orthogonal components (NOCs). NOC method allows the separation of SV, SA, Dst and seasonal variation. Continuation of NOC1 (SV- almost linear) combined with Taylor series expansion of observatory data. provides the extrapolation to 2010 and 2015. No data selection applied.

- **ELLI Team (Leader Aude Chambudot - EOST)**
  - **Other team members:** M. Menvielle, B. Langlais, E. Thébault, A. Chulliat, G. Hulot.
  - **Data:** Oersted and CHAMP data and observatory monthly means.
  - **Method:** Short model around 2005 for DGRF candidate, and close to 2010 for IGRF candidate. External contributions minimized using new 15min external activity indices. For 2010, 2015 models, observatory monthly means will be extrapolated using long term trends and periodicities.

- **MoSST-DAS Team (Leader Weijia Kuang - NASA)**
  - **Other team members:** MoSST collaborators including R. Holme.
  - **Data:** Based on MF models to 2010 (e.g. CHAOS-2s)
  - **Method:** Sequential data assimilation combining numerical geodynamo model with field models derived from satellite and observatory measurments. Provides predictive SV only.

Evaluation of candidates

- The candidate models will be assessed by the IGRF task force in co-operation with representatives from the teams submitting the candidate models.

- Any scientifically plausible method of testing/analysis/validation is acceptable.

- See Maus, Macmillan, Lowes and Bondar (2005) for a summary article on the evaluation of the previous IGRF-10 candidate models.

Test models and future improvements of IGRF

- As pointed about in discussions within Task Force (esp. by F. Lowes, S.McLean) it is important that IGRF moves forward and progresses.

- Difficult to make decisions on those improvements that would be beneficial without specific test models for evaluation.

Test models and future improvements of IGRF
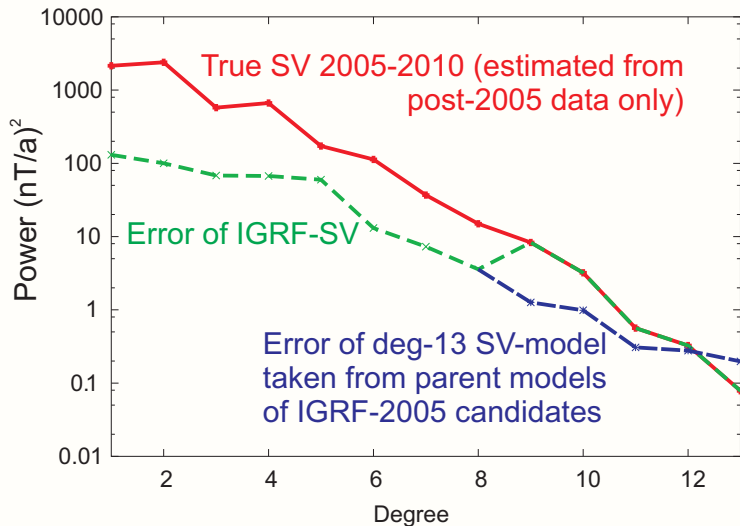
From L. Silva *et al.* presentation 507-WED-O1645-1119

Test models and future improvements of IGRF

- ▶ Therefore teams are strongly encouraged to submit test candidates with experimental extensions of present IGRF format for testing over next 5 years.

- ▶ These test candidates will be made freely available on IGRF webpage in a manner similar to availability of submitted candidate models.

Reminder of IGRF-11 Deadlines

- For candidate model submissions (including model information): October 1st, 2009

- For evaluating the candidate models: November 15th, 2009.

- Manuscript submissions to the EPS special issue: November 30th, 2009.

- Plan to publish IGRF-11 in late 2009, EPS issue to follow in early 2010.