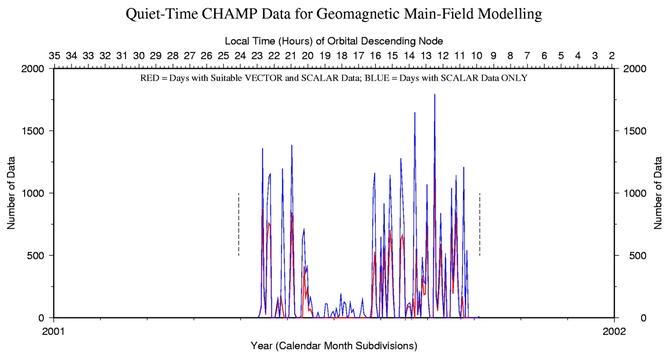
A Comparison Of CHAMP and Ørsted Main and External Field Models for 2001

Vincent Lesur and Alan W P Thomson
(British Geological Survey, West Mains Road, Edinburgh EH9 3LA Scotland. V.Lesur, A.Thomson@bgs.ac.uk)

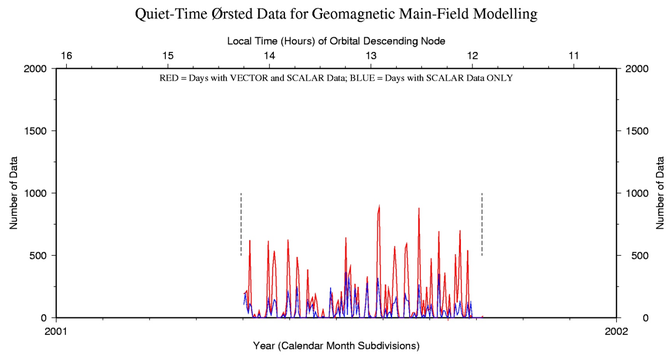
First CHAMP Science Meeting, GFZ Postdam, Germany, 22-25 January 2002

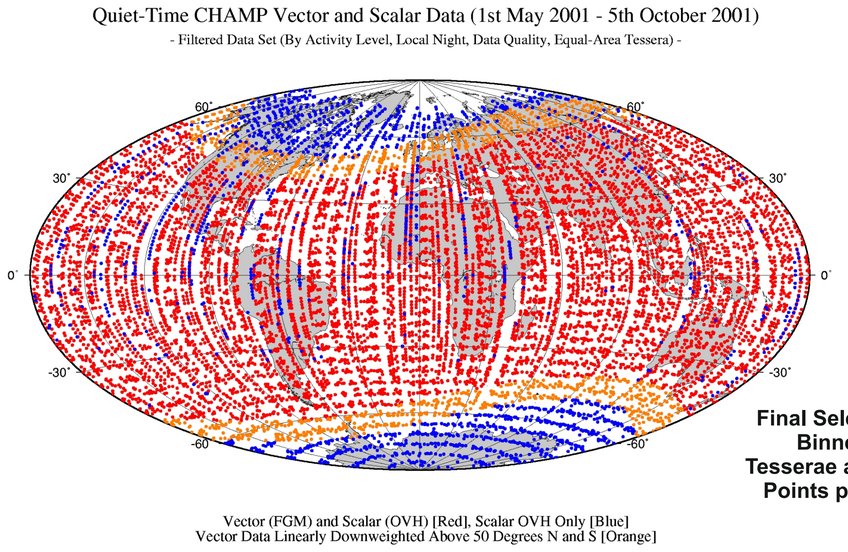
Spherical harmonic models of the Earth's magnetic field up to degree 13 internal and 2 external are constructed separately from CHAMP and Ørsted satellite data sets for epoch 2001.5. Only night side measurements on quiet days between May and October 2001 are used. Quiet times are determined from the *Kp* (typically *Kp* < 2) and *Dst* (|*Dst*| < 20) indices. Observations are made on the relative satellite data quality, as well as the data distributions in local time, latitude and longitude and the degree of model consistency for this period. Prior to a final CHAMP vector calibration, we consider the possibility of merging the two satellite data sets.

Acknowledgements: We would like to thank the CHAMP and Ørsted science teams for the provision of these data.

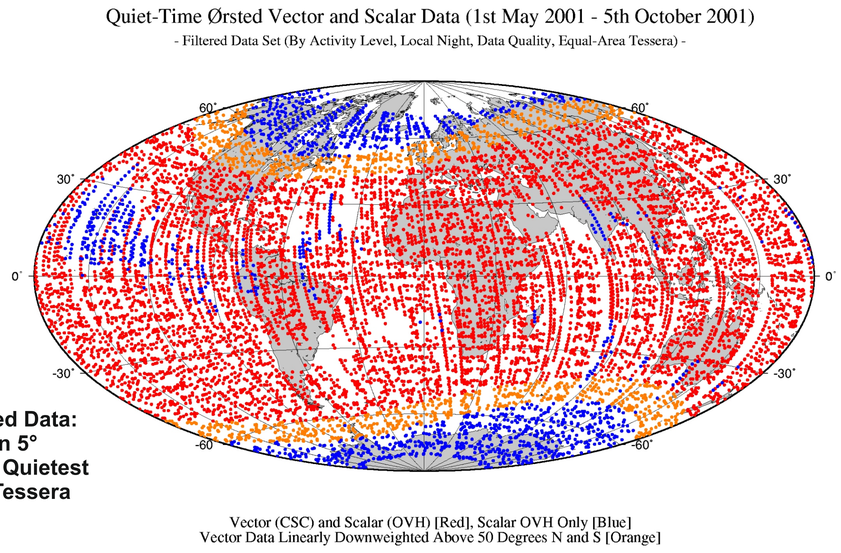


All Acceptable Data





Final Selected Data: Binned in 5° Tesserae at 7 Quietest Points per Tessera



Data Selection and Modelling

Data Filters

- **Data downloaded 12 November 2001**
- ***Kp*** **< 2, |*Dst*| < 20 nT,**
- **2000-0400 LT, 1 May to 5 October 2001,**
- **Sunlit Satellite Data Rejected,**
- **Vector Data to 60° Geomagnetic Latitude, Linearly Down-weighted above 50°,**
- **|ACE Interplanetary Field| < 5 nT in all components,**
- **ACE Solar Wind Speed < 450 km/s.**

Observations

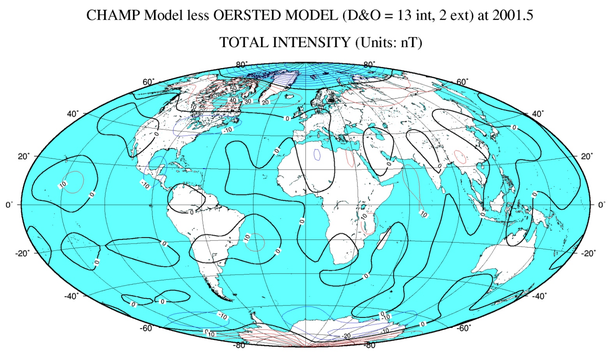
- **'Hole' over summer polar cap,**
- **More even geographical cover from CHAMP (faster orbit plane precession),**
- **More even distribution in time of vector data from Ørsted (CHAMP near dawn-dusk plane during Northern summer)**

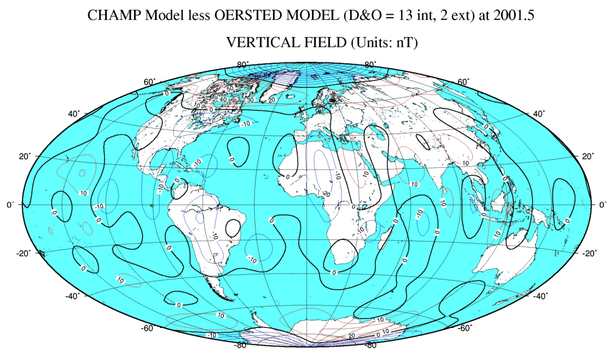
Modelling Issues

Data reduced to epoch 2001.5 by BGS secular variation model, Iterative least-squares solution used, *Dst* dependence of external dipole solved for, Anisotropic error distribution included for Ørsted.

CHAMP Data and Model Comparison with Ørsted Model

The field models are similar with differences of the order of 10-20 nT at most at lower latitudes. Larger discrepancies are found over the polar caps and Northern Canada. On a regular grid over all latitude and longitude, the *rms* difference is 8.5 nT in total field and (13.0, 12.6, 13.7) nT in (*X*, *Y*, *Z*) at the Earth's surface.





Measured CHAMP F-Component Less OERSTED Model

(At CHAMP Data Locations, Epoch 2001.5)

Positive Residuals: < +50 nT [green]; > +50 nT [blue]
Negative Residuals: > -50 nT [yellow]; < -50 nT [red]

The fit of the Ørsted model to its data is good (see figures on right and lower right). Over all latitudes and longitudes, the *rms* misfit is 4.3 nT in *F* and (6.7, 6.0, 3.9) nT respectively in (*X*, *Y*, *Z*). The misfit of CHAMP data and its model is 2 - 3 times poorer.

The fit of CHAMP data to the Ørsted model is also poorer, especially over some orbits, at high latitudes and over Northern Canada (see figures on left).

We may expect the vector fit to improve with refined data calibration.

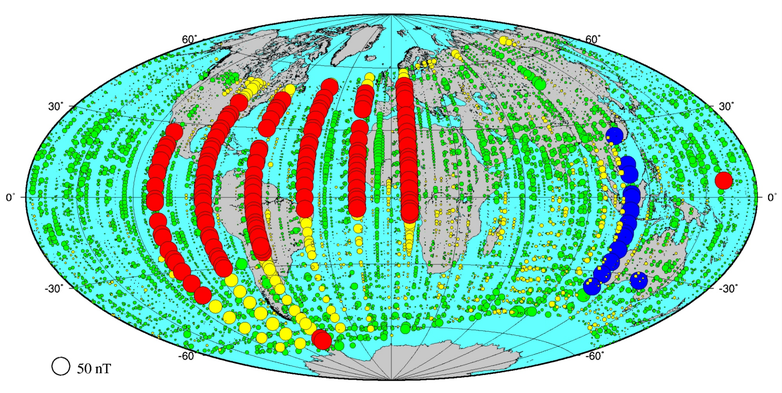
Measured OERSTED F-Component Less OERSTED Model

(At OERSTED Data Locations, Epoch 2001.5)

Positive Residuals: < +50 nT [green]; > +50 nT [blue]
Negative Residuals: > -50 nT [yellow]; < -50 nT [red]

Measured CHAMP Z-Component Less OERSTED Model

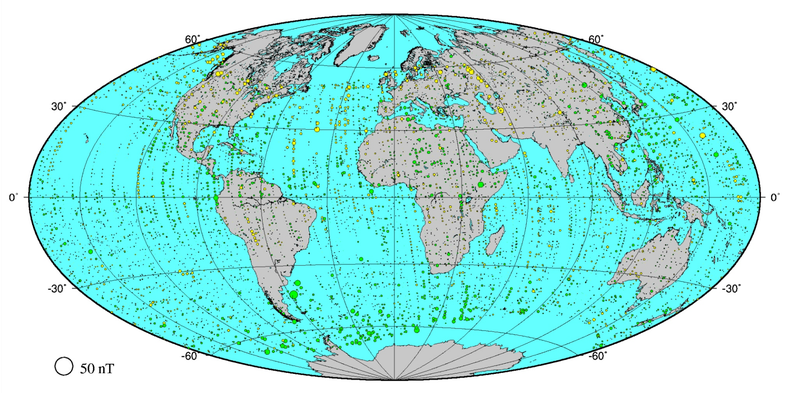
(At CHAMP Data Locations, Epoch 2001.5)



Positive Residuals: < +50 nT [green]; > +50 nT [blue]
Negative Residuals: > -50 nT [yellow]; < -50 nT [red]

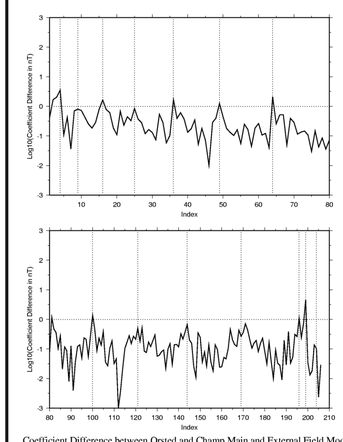
Measured OERSTED Z-Component Less OERSTED Model

(At OERSTED Data Locations, Epoch 2001.5)



Positive Residuals: < +50 nT [green]; > +50 nT [blue]
Negative Residuals: > -50 nT [yellow]; < -50 nT [red]

Other Results

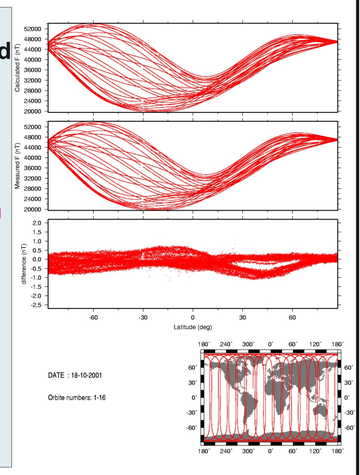


Coefficient Difference between Orsted and Champ Main and External Field Models
(Log10 of absolute difference in nT)
Based on quiet night-time data from 1st May to 31st October 2001

Coefficient differences between CHAMP and Ørsted are mainly in the even zonal harmonics, particularly g_2^0 and q_2^0.

Plot shows differences in log nT. Dashed lines separate coefficients by degree (max internal =13, max external=2). Largest coefficient indices denote external dipole, quadrupole and dipole Dst dependence.

Differences between Overhauser total field and calculated field from vector components is typically below ±1 nT in this example. These data were downloaded on 15 January 2002. The residuals are significantly smaller than corresponding data from earlier calibrations of the data, such as those used elsewhere on this poster.



Conclusions

- **Residuals (from a pre-November 2001 calibration of data) indicate unreliable vector data (on some orbits at least).**
- **CHAMP model fit to data (~12 nT *rms*) is two to three times Ørsted misfit (~5 nT).**
- **Model differences pronounced at high latitude (summer) and over Northern Canada.**
- **Zonal effect in coefficient differences noted.**

- **Anticipate further CHAMP data re-calibrations will improve self-consistency.**
- **Combining CHAMP and Ørsted data will allow 'snapshot' model construction (less secular variation error in reduction to epoch process).**
- **Current CHAMP data useful for testing existing Ørsted models.**