Introduction

- CHAMP, GRACE and soon GOCE provide new opportunities for constraining mass distribution and transport within the Earth.
- In geological and geophysical applications, the data have two main advantages. They provide gravity information:
  1. For areas previously lacking data or where data are inaccessible.
  2. That is continuous and consistent across natural and artificial boundaries.
- This poster summaries issues that need to be addressed for geological and geophysical applications and highlights some key applications.

Bouguer gravity

- Current global geopotential models (GGMs) are provided as free-air anomalies or disturbances.
- Geological and geophysical applications require Bouguer disturbances at the Earth’s surface. Such models are currently not available.
- Fig. 1 shows a global map of Bouguer disturbances computed without terrain corrections and using a flat-slab approximation (density offshore 1640 kg/m³, onshore 2670 kg/m³).

What can be resolved?

- Gravity predicted from existing 3D density models can be compared to satellite gravity to give insight into the resolving power of the new data.
- These density models can also be used to simulate gravity gradients. This would provide an indication of the degree to which GOCE data will resolve specific lithospheric structures.

Petrological validation

- Density can be determined independently of gravity data using compositionally-constrained thermodynamic modelling (Fig. 2) and tested using satellite gravity data.

Continental studies

- Uniform global coverage means that new GGMs are useful for regional syntheses, tectonic reconstructions (Fig. 5) and computation of lithospheric rigidity for entire continents (Fig. 6).

Subduction zones

- Asperity mapping: residual gravity in subduction zones could indicate where (not when) the plate interface will rupture to produce great earthquakes (Song & Simons, 2003, Science 301).
- New satellite-only models may be useful for identifying subduction-zone asperities (i.e. by using the satellite data for regional-residual field separation - see Fig. 8).
- Time-variable gravity from GRACE appears to resolve co-seismic deformation from the largest earthquakes (e.g. Han et al., 2006, Science 313).
- Current GGMs including GRACE data probably have sufficient resolution to constrain the large-scale structure of subduction zones (Fig. 7).

Regional-residual field separation

- The long-wavelength nature of current GGMs (λ > 100 km) can be a disadvantage.
- However, the long-wavelength satellite-only field may be useful as a regional gravity field.
- This would allow residual gravity to be computed without the subjective application of polynomial filtering, fitting or isostatic modelling (Fig. 8).

Frontier regions

- New satellite data can be used for interpretation and modelling in regions where little data exist or where data are not available (Figs. 3 and 4).