MANTLE CONVECTION AND THE LARGE SCALE STRUCTURES OF THE EARTH'S GRAVITATIONAL FIELD

W.R. Peltier
Department of Physics
University of Toronto
Toronto, Ontario
Canada M5S1A7

The connection between the observed large scale structure of the earths' gravitational field, as represented by the GEM10 model, and the surface kinematic manifestations of plate tectonics, as represented by the absolute plate motion model of Minster and Jordan (1978), is explored using a somewhat novel method of analysis. Two scalar derivatives of the field of surface plate velocities, namely the horizontal divergence and the radial vorticity, are computed from the plate motion data. These two scalars are respectively determined by the poloidal and toroidal scalars in terms of which any essentially solenoidal vector field may be completely represented. They provide a compact summary of the observed plate boundary types in nature, with oceanic ridges and trenches being essentially boundaries of divergence, and transform faults being essentially boundaries of vorticity. Oceanic heat flow of course correlates extremely well with surface divergence as one would expect of a thermally forced circulation. Degree correlations of the divergence and vorticity with the field of geoid heights, reveals a rather interesting complementary structure which is suggestive of strong coupling out of the poloidal component of flow and into the toroidal component such as one would expect on the basis of mechanical arguments. The degree variance spectrum for the divergence field also very clearly reveals a strong peak at the average horizontal scale of the surface motions.