Geophysical Research Abstracts,
Vol. 11, EGU2009-4062-3, 2009
EGU General Assembly 2009

Self-gravitating compressible Maxwell Earth models: the role of the self compression and the compositional initial density gradient

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We analyse a new class of self-gravitating Maxwell Earth models that takes the compressibility into account both at the initial state of hydrostatic equilibrium and during the deformations. By resorting to the Correspondence Principle we derive the analytical solution for a particular model with an inviscid core, a Darwin law density profile in the mantle and a continuous compositional initial density gradient. It allows to gain deep insight into the global dynamics of the Earth showing that the compressional stratification is responsible only for stable modes, namely the C0 and M0 buoyancy modes, the D-modes and the transient modes, while the compositional stratification triggers new transient modes and a denumerably set of buoyancy modes, of which the RT-modes are a particular case. We show that the model is unstable only when the square of the Brunt-Väiäsala frequency is positive and the solely unstable modes are the new compositional ones. By resorting to a numerical algorithm we extend our analysis to more general self-compressed compressible models with specific Darwin law density profiles in each layer and a compositional initial density gradient describing the density contrasts at the main Earth interfaces. We show that no buoyancy modes are due to the continuous variation of the initial density but they arise because of the density contrasts while the D-modes are substitute by a non-modal contribution always associated with the compressional relaxation times. Such results shed light on the role of the compositional stratification on the relaxation processes and allow us to deal with the issue of the Earth stability in a more consistent way compared to the past. Besides this they are relevant to model the Post-Glacial rebound and the post seismic deformations.