THREE-DIMENSIONAL SIMULATIONS OF MANTLE CONVECTION IN IO

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The Galilean moon Io has a very high heatflow, much greater than Earth's, andshould thus be undergoing very vigorous convection in its silicate mantle. We are performing simulations of Io's mantle convection both to determine the heat flux variation at the CMB as an input to a core convection calculation, and to understand the distribution of surface heat flux and its relationship to features such as volcanic centers, mountains and topography. The heat source for Io's mantle convection is non-uniform internal (volumetric) heating due to tidal dissipation. We assume the three-dimensional heating distribution calculated by Ross, Schubert and coworkers. The appropriate (internally-heated) Rayleigh number is of order (10**12), presenting a great challenge for three-dimensional numerical modeling. We follow a two-pronged approach of three-dimensional spherical calculations at greatly reduced Rayleigh number, plus two-dimensional and three-dimensional Cartesian calculations at higher Rayleigh number. The spherical results indicate a large-scale flow pattern dominated by the pattern of tidal heating, with superimposed small-scale asthenospheric instabilities which spread out the surface heat flux. The variation in long-wavelength heat flux at Io's convective vigor is estimated to be around 14%. This small but significant variation in surface heat flux may be compatible with the observed distributions of volcaniccenters and mountains.