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Inter-Annual Torsional Oscillations and Angular Momentum Exchange

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Torsional oscillations of the fluid core consist of rigid rotations of concentric fluid cylinders, coupled by the cylindrically radial magnetic field that threads through them; these oscillations have long been associated with variations in the magnetic field and the length of day (e.g. Braginsky, 1970). In particular, decadal variations in the magnetic field and length of day have been attributed to the periods of torsional oscillation normal modes. Another signal in length of day with a period of six year has been interpreted as the period of an oscillation of the inner core and mantle in which gravitational coupling provides the restoring force (e.g. Mound and Buffett, 2006). The interpretation of these variations as normal mode periods has been used to estimate physical properties of the core mantle system, such as magnetic field strength within the core and the viscosity of the inner core and also to draw inferences on the mechanisms of core-mantle coupling. However, recent studies have found that the magnetic field strength within the core is sufficiently strong that torsional oscillation normal modes would have periods much shorter than the decades required to match the observations (Gillet et al, 2010; Buffett, 2010). Therefore, it is necessary to reevaluate previous constraints on core-mantle coupling and physical parameters of the system. We adapt previous models of torsional oscillations to investigate the dynamics and structure of inter-annual torsional oscillations within the core and how the angular momentum associated with the six-year oscillation in length of day can be transferred between the core and mantle. Since the periods of torsional oscillation normal modes are considerably shorter than decadal for the new estimates of magnetic field strength, decadal variations in length of day and the geomagnetic field must have an alternate (and unknown) origin.