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On the possible long term effects of the outer core flow on the Earth's rotation

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The rotation rate of the Earth, and thus the length of the day(LOD), is varying with time. Many physical phenomena contribute to these variations. Over long periods of time two principle mechanisms are known to affect the LOD. The first one is the tidal friction. By deforming the Earth's surface, tidal forces are inducing a dissipation of energy in the Earth-Moon system. As a consequence, the rotation rate of the Earth is decreasing. The second phenomenon influencing the long term variations in LOD is the glacial isostatic adjustment (GIA). When accumulating on the polar caps over the last glaciation period, ice was compressing the mantle, inducing an increase of the Earth's oblateness. When the ice melted, the mantle tend to regain its initial shape. This process, which is still ongoing, induces a continuous decay of the Earth's oblateness, and so a shortening of the LOD.

Recently, another effect, which is expected to slow down the rotation rate of the Earth, has come into play: the global sea level rise due to the melting of polar ice and glacier. However, the combination of tidal friction, GIA and global sea level rise, cannot explain the observed variations in LOD over the last century. Here we show that the coupling between the outer core and the mantle, which is already known to influence the decadal fluctuations of the LOD, is likely to be the missing ingredient to describe the rotation rate of the Earth over long periods of time.