Comment on "Time evolution of the fluid flow at the top of the core. Geomagnetic jerks" by M. Le Huy, M. Mandea, J.-L. Le Mouël, and A. Pais

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In their paper on fluid flow at the core-mantle interface, Le Huy *et al.* (2000) use the model of Bloxham and Jackson (1992) to derive fluid flows back to 1690. The well-known lack of absolute magnetic intensities prior to 1832 means that it is not possible to uniquely derive the fluid flow prior to this time, as I show below. This means that the results of Le Huy *et al.*'s study prior to 1832 are nonunique and as such should be viewed with suspicion.

In deriving model *ufm2* for the period 1690–1840, Bloxham and Jackson (1992) dealt with the lack of intensities by fixing the dipole to decay from its 1840 value at the rate 15 nT/yr, a technique similar to the one employed previously by Barraclough (1974). The directional data used in the model can determine the morphology of the field, but not its amplitude at any one time.

Let the estimated radial magnetic field model (*ufm2*) be B_r^{ufm} and the true model be B_r^{true}. The two are linked at any time by

$$B_r^{\text{ufm}}(t) = B_r^{\text{true}}(t)/\alpha(t) \tag{1}$$

for any time varying function α, since the magnitude of the field cannot be determined.

Under the frozen-flux approximation the induction equation for the true field is

$$\frac{\partial B_r^{\text{true}}}{\partial t} = -\nabla_h \cdot (\mathbf{u} B_r^{\text{true}}) \tag{2}$$

or

$$\frac{\partial \alpha B_r^{\text{ufm}}}{\partial t} = \alpha \frac{\partial B_r^{\text{ufm}}}{\partial t} + B_r^{\text{ufm}} \frac{\partial \alpha}{\partial t} = -\nabla_h \cdot (\mathbf{u} \alpha B_r^{\text{ufm}}) \tag{3}$$

giving

$$\frac{\partial B_r^{\text{ufm}}}{\partial t} + B_r^{\text{ufm}} \frac{\partial \log \alpha}{\partial t} = -\nabla_h \cdot (\mathbf{u} B_r^{\text{ufm}}). \tag{4}$$

The results depend crucially on the value chosen for $\partial \log \alpha/\partial t$, and there is obviously an infinity of choices of $\alpha(t)$. The model *ufm2* of Bloxham and Jackson (1992) chose $\alpha(t)$ so that $\dot{g}_1^0$ is constant. Whilst this is a convenient device, this is, as stated above, one arbitrary choice. Moreover, it is very unlikely to give the true underlying secular variation since the rate of change of g_1^0 varied widely during the post-1840 period (see Fig. 1). The use of the frozen flux approximation in generating a field model similar to *ufm2* would be a more appropriate and consistent mechanism with which to fix the absolute value of the field B_r back in time. Such models are currently under construction.

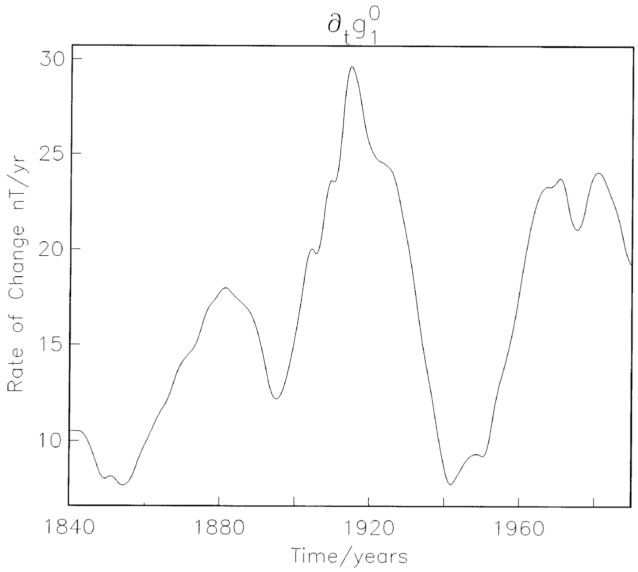

Fig. 1. Rate of change of g_1^0 for the period 1840–1990 from *ufm1*.

References

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