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Interactive comment on "Geomagnetic field declination: from decadal to centennial scales" *by* Venera Dobrica et al.

J. Mound (Referee)

j.e.mound@leeds.ac.uk

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This work provides some new insight into the nature of geomagnetic variations over long (decadal to centennial) time scales, particularly with regards to apparent periodicities within observational time series of declination variations. This expands upon previous work by this team (and others) on whether such periods can be cleanly identified from observatory records, a task made difficult by the relatively short length of the continuous observatory time series (at best ∼150 years) compared to the suspected periods (∼30 and ∼80 years). There are also difficulties in differentiating between periodic signals of internal origin from external effects, predominantly linked the well-established solar variations with typical periods of 11 years. To attempt to disentangle these components of observed magnetic variation, the authors apply a variety of dif-

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ferent filters to 24 long geomagnetic observatory records from around the world (albeit with an unavoidable geographic bias), in particular making use of Hodrick-Prescott filtering, which to my knowledge has not been used in this context before. They also consider five very long (multi-century) reconstructions of declination variation from locations within Europe.

The results from the observatory records were quite similar to previous analyses, giving confidence in the application of HP filtering to these records, although, as in previous studies, it is very difficult to find cleanly separated and identified periods. I found the indication that the sub-centennial constituent is a coherent variation over the last several centuries particularly intriguing. However, since the five locations considered are all European, it may not be surprising that they show a similar variability, particularly within gufm1 as the spatial resolution of that model does decrease significantly towards the start of that model.

A minor addition regarding the discussion on page 3 lines 9-11 on the six-year geomagnetic signal, it should be noted that there is a corresponding six year signal in length-of-day that cannot be explained by known external sources and thus has been linked to processes in the core (this is discussed in the cited work by Gillet et al. and Home & de Viron; but see also work by Abarca del Rio et al., 2000, Annales Geophysicae; Mound and Buffett, 2006, EPSL; Duan et al., 2018, EPSL). Thus, although the mechanism responsible for the 6-year geomagnetic signal remains under debate it is almost certainly internal in origin.

Additionally, from a structural point of view, I might move that discussion so that it connects to the paragraph on page 2 lines 20-30; which ends with a discussion of these sort of inter-annual signals. The discussion on page 3 could then remain focused on the (inter)decadal and longer variations.

When applying the Butterworth filter, is there a reason to do this to the HP-filtered trend rather than applying it to the data directly? Perhaps running a filter on a filter doesn't

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make any difference in this case as all of the removed signal is at frequencies much higher than those of interest, but even if that is the case, why not simply apply the Butterworth filter to the original time series?

On page 10 lines 20-23, there is a discussion of the relative timing of geomagnetic events (which may or may not be jerks) relative to the maxima and minima of the sub-centennial variation. The two dates are said to correspond "within a few years", but in reality there is about a decade between them. Given the uncertainty on both sides of this comparison, I might be more conservative in discussing the closeness of this correspondence.

Page 12, lines 3-5. I agree that after your processing to remove suspected external signals, the time series no longer has the sharp V-shaped events, that are often used as an identifier of jerks. However, your method of removing suspected external signals is essentially to filter out high frequencies, which necessarily results in smoother time series. If you applied your filters to a "perfect" V shaped or sawtooth function with a period of 20 years, what would survive? I suspect that it would also end up looking rather smooth. I don't see any easy resolution to this problem through pure time series analysis, comparison to external field models or proxies (e.g. indices of solar activity) seem necessary to unravel the origin of the high frequency content within the geomagnetic observatory time series.

Why is the green line in figure 3 discontinuous? Presumably this reflects a suspected change in frequencies that contribute to this signal. If this is truly external signal is there any corresponding change known of in measures of the external field?

In figures 9 & 10 the amount of noise in the data and the mismatch between the data and gufm1 appears to grow significantly between about 1700 and 1800 (the exact timing of this differs between sites). Therefore I might be cautious about claiming that the sub-centennial signal is really traced all the way back to 1600.

Other minor points:

I find the lightly weighted lines (particularly the grey lines in figure 6) very hard to see in printed form, although they are ok when viewed on the computer.

last line of page 2: “seemed to characteristic in case of declination” reads oddly to me, perhaps simply “characteristic of declination” would work better.

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