Reviewer #1: Valdez-Grijalva et al., provide a detailed micromagnetic study of isolated greigite particles focusing on domain state transitions and blocking volumes. Importantly calculations employing the recently implemented nudged elastic band technique reveal that isolated single-domain greigite particles will be superparamagnetic at room temperature and only pseudosingle domain grains can be expected to retain a remanence over geological timescales. A further important component of the manuscript is a proposed mechanism by which pseudosingle domain grains transition into a multidomain state. This is particularly enlightening given ongoing discussions concerning domain state transitions. As such, I think this is an internationally significant piece of research that will be of interest to the readership of Earth and Planetary Science Letters.

The manuscript provides an concise introduction to micromagnetic modelling and develops a clear narrative to describe the experiments and unify the results in a coherent manner. In certain places, however, more detailed exposition is needed to help readers see the implications of these findings and their context in a broader rock magnetic and palaeomagnetic setting. I've outlined a number of points below that should help in this regard.

Isolated versus aggregated particles
The penultimate sentence of the manuscript (lines 551-553) appears to put the work in an unnecessarily negative light. It is true that in nature palaeomagnetically important greigite occurs in clusters rather than as isolated particles, but this does not invalidate your work and delaying this message right until the end of the paper gives the impression that you are somewhat trying to hide it. I would recommend that you discuss this issue in the Introduction and make it clear to the reader that this work is important as a first step towards understanding palaeomagnetic recording by greigite. I would then encourage you to consider the effects of interactions in a future study.

Agreed. The nature of this contribution is a first step towards understanding the palaeomagnetic recording fidelity of non-biogenic greigite without including the effect of the possibly important interparticle interactions. That should be made clear from the Introduction. Text has been added in lines 50–56.

Abstract
The statement that only PSD grains > 70 nm can be expected to be reliable palaeomagnetic recorders may be too strong for the Abstract. As you point out later in the manuscript, isolated greigite particles are rare in nature, but this important caveat isn't explicitly stated in the abstract, but is instead inferred by referring to non-interacting particles. Additionally, referring to greigite as a "reliable palaeomagnetic recorder" could be misleading. The literature is full of examples of greigite forming secondary remanences that confuse palaeomagnetic recording. In other words, just because a particle has a relaxation time on the order of billions of years, doesn't mean that it is providing you with a reliable record of the Earth's magnetic field.

Agreed the abstract can be improved as not to mislead readers. Changed sentence to: “It is found that, in the absence of interparticle magnetostatic interactions, the magnetisation of equant SD greigite is not stable on a geological scale and only PSD grains > 70 nm can be expected to carry a stable magnetisation over billion-year timescales, i.e., all non-interacting SD particles are essentially superparamagnetic”.

SD to PSD transition
It is important to give a clear definition of what defines PSD and how you detect its onset. My understanding from your manuscript is that the onset of PSD behaviour is marked by the formation of a vortex structure. To my mind this is entirely reasonable, but it is not a fixed definition with the rock magnetic community. Therefore it is important to state your definition.

Agreed. In this study we are concernced with the zero-field properties so in this context it makes sense to characterise the onset of PSD behaviour by the formation of a single-vortex structure. Text has been added in lines 144–146.

Cubic Anisotropy
On lines 77-78 it is stated that the K2 term is neglected because K1 is assumed to be dominant at room temperature. However, the models of the shape and size dependence of domain state in DUNLOP do not include thermal activation. Is it appropriate to assume a negligible K2 in this case?

It is appropriate. The lack of thermal activation means that effects such as thermally-activated switching and fluctuations, etc. are overlooked. However, this does not detract from the conclusion of Winklhofer et al. 2014 that their data is best fit by a negative K1 and negliglible K2 (at room temperature). It should be noted, however, that this limitation is addressed by the second half of the paper dealing with the energy barriers. This allows us to predict the relaxation times at room temperature; effectively, this is the information a thermally-activated model would provide. Determination of the blocking volumes at different temperatures or the blocking temperatures for a given shape/size are at this point impossible as the fundamental magnetic parameters of greigite are only known at room temperature.

Thermal activation
In the Results and Discussion you develop a clear nomenclature to describe the sizes at which particles change their behaviour. However, it is important to emphasise where thermal activation is included and where it is not. This could either be clearly stated in the text, or incorporated into your developed nomenclature.

Agreed. In order not to complicate the nomenclature, a short paragraph has been added in lines 173–176.

Numerical stability

On lines 385 - 386 it is stated that "the stability of the solutions is only numerical". The term "numerical stability" is then used later in the text. A clear definition of numerical stability and how it should be interpreted would be useful for readers who are less familiar with micromagnetic modelling.

Agreed. Text has been added in lines 398–402 giving a working definition of the numerical stability we are concerned with.

Minor comments

In a number of places, particles are referred to as "equidistant", should this be "equant"?

Agreed. All instances of ‘equidistant’ changed to ‘equant’.

Figures - some of the panels employ very small fonts. You should ensure that these fonts are a reasonable size in the final version.

This is difficult to achieve for figures (2a-b) and 3 as there is not much space left. Perhaps it is best to remove some of the annotations in the figure and add them as captions, instead. However, it should be noted that the latex document class elsclass with the review option makes the text width a little smaller than the final print version, so the font will be more visible in a print version. Leave these figures as they are for now and waiting to hear from the editor.

Equations - You have written your equations as part of the preceding sentence, so check your punctuation after each equation.

Punctuation has been fixed throughout.

line 52 - replace "and recording" with "and palaeomagnetic recording".

Done.

line 122 - replace "of its" with "of their".

Done.

line 335 - replace "significative" with significant.

Done.

line 484 & 492 - given that SP particles are SD, should this be SP-SSD?

Indeed, it should. Changed three instances of SP-SD to SP-SSD in that paragraph.

line 538 - replace "stron" with "strong".

Done.