Dear Referees,

We would like to thank you for the comments and suggestions, which allow us to improve the presentation of the paper. Now, we reply on them step by step.

We have corrected text of our paper and submitted it as a supplement to the Authors' Comment. We did not change any figures.

Reply to Ref.1 G. Wake

1) p.3 eqn (1). This is not autonomous with "t" on the RHS. Is this a mistake? If not there is no steady state.

Initial equations (1)-(3) are written exactly as in [Iverson et al. (2006)]. But in our paper, we consider only the autonomous case.

Below formula (5), we have added the phrase

“In present paper, we focus on the autonomous case, when $\kappa=0$.”

2) *eqn (4): do not use F_o for both the function and the constant in the last expression.*

To avoid confusion, we have changed notations in formulas (4),(5).

3) *p.4 eqn (5): surely it is |u| , not u, in the two regions.*

Corrected.

4) *line 81: write down the expressions for the steady-state...they are simple enough.*

Required expressions have been added to the paragraph below formula (5).

5) *p.4 line 99: The phase spac is three dimensional, so the figures in #2 will be projections. This makes it harder for the idea of a separatrix to be applicable. Need to rethink this.*

Red line in Fig.2 is not a separatrix in a standard sense. So, we write everywhere “pseudo-separatrix”.This is a projection of some surface which separates flows of trajectories in a local zone considered here.

6) *p.6 eqn (6): this is not the usual way to write a stochastic d.e. It should be du = ...dt + ...dxi Now it is autonomous. What ensured this?*

As we know, SDE is usually written with stochastic differentials of Wiener processes in mathematical journals mainly. In this paper, we follow standards of physical journals and use Gaussian white noise.

We have specified it by the following :

“… standard Gaussian white noise with parameters <\xi(t)>=0, <\xi(t)\xi(\tau)>=\delta(t-\tau), …”

Reply to Ref.2 C. Michaut

1) *But the manuscript, as is written, is too hard to follow, especially for readers that are not familiar with stochastic approaches and formalism.*

We have added a useful reference (Gardiner, C.: Stochastic Methods: A Handbook for the Natural and Social Sciences, Springer, Berlin, 2009) and clarification concerning parameters of standard Gaussian noise used in our paper:

“… standard Gaussian white noise with parameters <\xi(t)>=0, <\xi(t)\xi(\tau)>=\delta(t-\tau), …”

2) *More physical explanations of the processes that are occurring are necessary and some paragraphs should be rewritten. More discussion on the effects of noise on the occurrence or not of drumbeat earthquakes should be added as well.*

Some more detailed explanations concerning the process under consideration and parametric noises are introduced in the manuscript.

3) *All the symbols used in the equations must be described.*

Now all symbols used in the manuscript are described.

4) *What could be at the origin of noise in the friction force? Could this be consistent with frictional melting (Kendrick et al, Nature Geoscience 7 2014) for instance ?*

The friction force noise can be connected with different physical phenomena and, in particular, with the effect of frictional melting. So, among others, the sources of noises can be connected with deviation of the real friction force from expression (4) suggested by Iverson et al. (2006) and used in the present manuscript.

We have added to the text:

“Such disturbances simulate the influence of different physical processes and phenomena leading to variations in the friction force behavior (e.g. the effects of frictional melting, temperature-dependent friction, and so on).”

5) *An interesting conclusion, of value of the volcanological community, could be to describe the set of parameters and amplitude of noise that are the most favorable, and least favorable, for stick-slip motion and drumbeat earthquake to develop, i.e. predict a range of values and amplitude of noise for the model parameters (plug mass, injection rate, friction force and epsilons) for stick slip motion to occur.*

It is extremely complicated to study the problem under consideration for all physically reasonable amplitudes of noises of all system parameters. Therefore, in the present study, we consider a parametric stochastic forcing only. Moreover, we study the role of noises in two main system parameters, F and Q, which can undergo stochastic fluctuations due to different external processes. As a first step in study of noise influence, in present paper, we consider a standard Gaussian white noise. In addition, since exact expressions and/or values of these parameters are variable and, as a consequence, are unknown, their stochastic fluctuations represent the model estimates of their real magnitudes. In order to develop the stick-slip motions and drumbeat earthquakes we found that the F-noise intensity is of the order of 10^{-6} – 10^{-4} whereas the Q-noise intensity is about unity.

6) *What would be the direct consequences of a dome collapse?*

The process of dome collapse is not considered in the present paper.

7) *What would be the consequences of strain localization and weakening on the stick-slip / drumbeat periodicity (i.e. F slowly decreasing with time) as well as on its probability to occur?*

The effect of localization of F in the vicinity of F_0 at sufficiently small u and its weakening with increasing u is studied in the present paper. This leads to the phase portrait shown in figure 2 in the case of deterministic dynamics. In the case of stochastic forcing the phase portraits are demonstrated in figures 4,5,6 and 8. The friction force is a decreasing function of u (see figure 3 in Supplementary Information of Iverson et al. (2006)). Therefore, in regions where u increases with time t, F represents a decreasing function of time. The system dynamics in these regions is shown in many figures of the present manuscript.

8) *What if the plug mass remains constant with time? Indeed, solidification of magma and erosion seem both too slow to induce changes of the plug mass with time over timescales much larger than the timescale of drumbeat earthquakes.*

We absolutely agree with this comment. The plug mass is constant in our calculations. However, the plug mass in Eq. (1) is written out in a more general form after Iverson et al. (2006).

9) *The periods of drumbeat of earthquakes seem to slowly shift with time (Iverson et al, 2006). Could you provide and explanation for this shift with this model?*

Time shifts of the periods of drumbeat of earthquakes can be explained by changes in the noise intensity (Fig. 5c).

10) *l. 27, p. 1737 dacite (remove p) l. 9, p. 1738 p instead of rho l. 15-20 are hard to follow but essential, p. 1741 p. 1743 l. 10-15 are not understandable. What about the plug mass?*

Some lines on pages 1737 and 1738 are corrected. P. 1743: Some phrases are extended and changed. The plug mass is constant in our analysis.