Response to Reviewer #1's comments to: "MagmaFOAM-1.0: a modular framework for the simulation of magmatic systems" by Brogi et al.

Manuscript submitted for publication on GMD

Description

This work describes a software library, which extends OpenFOAM, dedicated to the solution of problems typically encountered in modeling volcanic processes.

General comments

The library contains already existing subroutines (eg: SOLWCAD) and new interesting software. However, the existing software has been recoded within the same modular framework (OpenFOAM), allowing an easier use by model developer.
I have appreciated the efforts of the authors and I think that MagmaFOAM will be very useful for the volcanological community.

The authors gratefully appreciate the time and effort the referee has dedicated to provide a constructive review of the manuscript. The positive feedback pushes us to look forward with enthusiasm to future developments of MagmaFOAM that may be of interest for the volcanological community.

Below, we report the point-by-point answer to the reviewer's minor comments.

Federico Brogi, on behalf of all authors

Minor comments

Line numbers referenced below by us refer to the revised version of the manuscript.

- Of course, eq.(3) is valid for T > C

Following the reviewer's suggestion, we added in the text (line 127) that eq. 3 requires A+B/(T-C)>0. This condition in fact implies T>C as a necessary condition knowing that A is negative and B positive (see fig. 4 in Giordano et al., 2008). However, T>C requires only B/(T-C)>0 instead of B/(T-C)>-A.

line 127: *"Let us also note that eq. 3 is valid only for A+B/(T-C)>0."*

- Line 256: The Reynolds number is more often based on the bubble diameter that bubble radius.

We completely agree with the reviewer. However, we prefer to use the Reynolds number definition of Suckale et al., 2010a (with the bubble radius) in order to avoid confusion when comparing our results with the ones reported by these authors. For sake of clarity, we also added a note in the text. (line 259)

line 259: *"Let us note that to be consistent with Suckale et al. (2010a) all non-dimensional numbers here are based on the bubble radius instead of the bubble diameter, which is also commonly used in the literature (e.g. Roghair et al. 2011))."*

- Line 257: The definition of the Weber number seems incorrect. It should contain the surface tensionin the denominator. Please check.

We thank the reviewer, indeed the definition of the Weber number is wrong. It has been replaced with the correct one containing the surface tension.

line 257: *"... Weber Number* $We = \rho v_0^2 a/\sigma$ *"*

- The definition of $\Pi = \mu/\mu_g$ at line 258 seems incompatible with its value (10^{-6}) reported at line 259 and in the caption of Figure 6 (probably you mean "gas to liquid viscosity ratio" $\Pi = \mu_g/\mu$?).

We thank the reviewer, it is in fact the "gas to liquid viscosity ratio". The definition has now been corrected.

line 258: *"... and gas to liquid viscosity ratio* $\Pi = \mu_g/\mu$. *"*

- Line 257. According to the common nomenclature, you report the square of the Froude number. It should be $Fr = u_0/\sqrt{ga}$.

We agree with the reviewer. We corrected the Froude number definition (line 257) and added a comment in the caption of Figure 6 for clarity. As for the Reynolds number we use the square of Fr to be consistent with the reference study (Suckale et al., 2010a).

line 257: *"... Froude number $Fr = v_0/\sqrt{ga}$"*

Caption of Figure 6: "*Simulation of bubble rise in a basaltic melt using `interFoam` are compared with the results of Suckale et al. (2010a) (blacklines) for three different regimes: (a) No breakup (Re≈5, Fr^2≈0.4, We≈90, and Π = 10−6), (b) Gradual breakup (Re≈25, Fr^2≈0.3; We≈800 and Π=10−6); (c) Catastrophic breakup (Re≈250, Fr^2≈0.16, We≈1350 and Π = 10−6). For each regime, snapshots at different non-dimensional times are shown. To be consistent with Suckale et al. (2010a) here we use the square of the Froude number ($Fr^2 = v_0^2/ga$).*"

- Caption of Figure 7: please, can you define the symbols R_0 and S_0 ? Moreover, the dashed lines are practically superimposed to the solid lines and difficult to see. Probably you can highlight the dashed lines (eg with thicker lines) or simply indicate in the caption that the MagmaFoam and the Lyakhovsky et al. (1999) solutions practically coincide.

We have modified the caption according to the reviewer's suggestion.

Caption of Figure 7: "*Temporal evolution of bubble radius for an instantaneous decompression from p_0=150 MPa to p_L= 120 MPa. In blue the comparison between the MagmaFOAM model `multiComponentODERPShellDStatic` (solid lines) and numerical solutions from Lyakhovsky et al. (1996) (dashed lines) that practically coincide for three different values of diffusion coefficient of H_2O. The red lines represent the same simulations with 1 wt% of CO_2 added in the melt. The diffusion coefficient of CO_2 is one order of magnitude smaller than H_2O. Initial conditions and parameters (see Appendix B) in all simulations are: ρ_L= 2300 kg/m^3, μ = 5·10^4 Pa s, σ=0.06 N/m, T=1123 K, $p_G(t=0)=p_0+2\sigma/R(t=0)$, $R(t=0)=10^{-7}$ m, $S_0=2\cdot10^{-4}$ m, C^0_{H2O}= 5.3 wt%. Saturation concentration is computed using SOLWCAD (Papale et al., 2006).*"

- Line 337. The relationship between maximum volume fraction in the volcanic products and fragmentation was observed by Sparks (1978). Probably it could be appropriate to cite also Sparks (1978) together with La Spina et al., (2017).

Following the reviewer's suggestion, we added the missing reference (line 339). Moreover, we also consistently modified the notation used in the bubble growth model (Appendix B) and the model for volatile concentration at the bubble-melt interface (section 2.2).

line 339: "*... using a critical volume fraction criterion (0.5< α <0.7; e.g. Sparks 1978 or La Spina et al. 2017).*"

Reference: Sparks R. S. J. (1978) The dynamics of bubble formation and growth in magmas: a review and analysis. Journal of Volcanology and Geothermal Research 3:1–37.

Typos

- *Line 105: "con" → "can"*
- *Line 205: "wavelenght" → "wavelength"*
- *Line 389: "apporoaches" → "approaches"*
- *Line 410: "relativily" → "relatively"*
- *Line 411: "theretical" → "theoretical"*

All signalled typos have been corrected, thanks again to the reviewer for noticing them.