

Interactive comment on “On the CCN [de]activation nonlinearities” by S. Arabas and S. Shima

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The paper is dedicated to stability and bifurcation analysis of diffusion growth equation in its complete form, which includes curvature term and chemical composition term. Authors show that critical point on the Kohler curve is the point of saddle-node bifurcation. The time scale associated with this point which can be interpreted as time scale of aerosol activation is estimated analytically. Also the analysis of the more complicated case when the aerosol growth is accompanied by decrease of surrounding humidity has been done. The second saddle-node point was found in this analysis. At last the numerical calculation of hysteresis profiles of supersaturation and aerosol wet radius in adiabatic vertically-oscillating air parcel has been done. The article is interesting and I recommend it for publication

C1

in NPG after two additions.

We thank the reviewer for the positive evaluation of the paper and the helpful comments addressed in detail below. We enclose a revised version of the paper.

Firstly I recommend adding some elementary mathematical explanation what saddle-node bifurcation and cusp catastrophe are. May be authors will write a separate Appendix on this topic. This will help the reader to better understand the article.

Following the reviewer's advice, we have added relatively verbose explanations of the key nonlinear dynamics nomenclature used in the text. Instead of creating a separate appendix, the introductory material is included in a rewritten and substantially extended section on the saddle-node bifurcation. We have also added a new figure (Figure 1 in the revised manuscript) which is intended to be a graphical aid in interpretation the mathematical considerations implied in the fixed point analysis.

Secondly I recommend to compare the results obtained in Sections 6, 7 and Fig.4 with results of study by Pinsky et al., (2013: J. Atmos. Sci., 70, 2778-2793). In this study some analytical investigation of monodisperse droplet spectra evolution as well as parcel model investigation are carried out. Possibly the matching of equations from this study and the ones in the reviewed one can bring some new results.

We have added a reference to the suggested work when mentioning studies that addressed the hysteretic behaviour of the system due to the kinetic limitations. The focus of our work is on the hysteresis occurring close to equilibrium – at negligible vertical velocities (small fractions of centimetres per second, if an air-parcel framework is used).

C2

We have not found a direct link between the phase-relaxation timescales derived in the study of Pinsky et al. with the activation timescale derived herein.

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