paper draft: supersat

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1 Introduction

introductory notes.

2 Theory + Simulation

- brief statement of quasi steady state formula
- we see agreement between actual and QSS supersaturation under the conditions (see figs 1 and 2):
  - T >273K (we're not including ice in the theory)
  - w >2 m/s (reasonably strong updrafts)
  - cloud LWC >1e-4 g/g (in the convection core)
- upon applying above filters, the distributions of SS_{QSS}, w, and LWC (cloud only) are shown in figs **??**, **??**, and **??**.

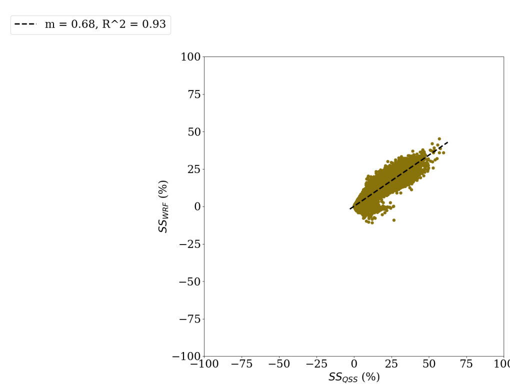

Figure 1: Actual (SS_{WRF}) vs predicted (SS_{QSS}) supersaturation in unpolluted case.

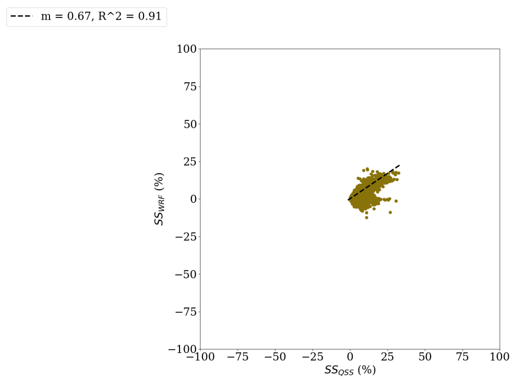

Figure 2: Actual (SS_{WRF}) vs predicted (SS_{QSS}) supersaturation in polluted case.

3 Experimental data

- using criteria from second bullet point of section 2, SS_{QSS} distribution from HALO data looks like fig 3.
- using criteria from second bullet point of section 2, SS_{QSS} distribution from CAIPEEX data looks like fig 4 (note: currently don't have raindrop data for CAIPEEX...)

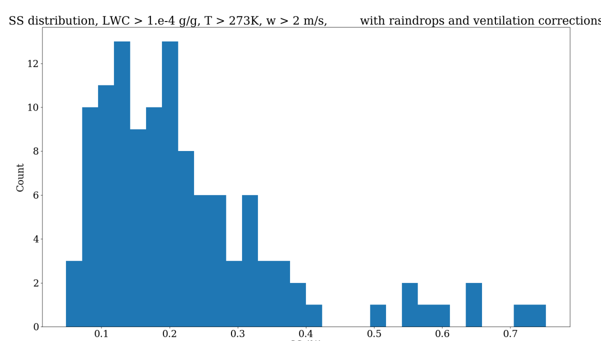

Figure 3: Predicted (SS_{QSS}) supersaturation distribution from HALO field campaign (all flight dates). Using filtering criteria outlined in section 2.

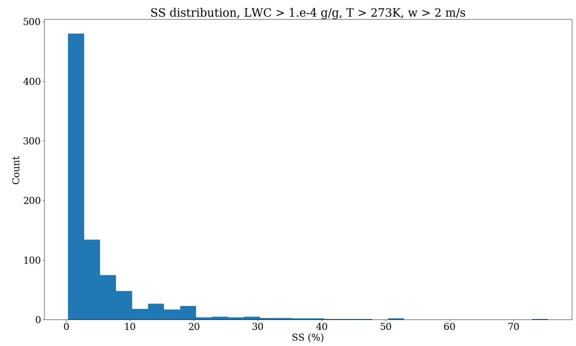

Figure 4: Predicted (SS_{QSS}) supersaturation distribution from CAIPEEX field campaign (all flight dates). Using filtering criteria outlined in section 2, but not including rain drops or ventilation corrections due to lack of data.

4 Line of argument

4.1 CLAIM

Figures 3 and 4 demonstrate that we don't observe the same high supersaturations seen in LES simulations (i.e. WRF data)

4.2 POSSIBLE COUNTERARGUMENTS

1. Experimentalists just didn't fly through strong enough convective cells / cloudy enough regions.

2. Experimental sites were too polluted to observe the high supersaturations

3. Something must be wrong because the CAIPEEX and HALO supersaturation distributions look very different

4. (more philosophical I guess) If you don't trust WRF to give you realistic supersaturation values then why do you trust it to give you the reasonable regime of validity for the QSS approximation?

4.3 POSSIBLE COUNTERARGUMENTS TO THE POSSIBLE COUNTERARGUMENTS

1. In fact in the WRF data we don't see a strong correlation (for the data filtered as described above) between SS_{QSS} and...

   - LWC (fig **??**)
   - w (fig **??**)

2. Compare experiment vs simulation for **mystery kernel** integrated over aerosol distribution

3. $\hat{\mathrm{d}}$itto but compare CAIPEEX vs HALO

4. Not sure yet.

5 Figures to include in supplementary info

- figs 3 and 4 but without lower bin cutoffs
- figs 3 and 4 but without corrections from including raindrops / ventilation factors

6 TODO / remaining questions

- error analysis for experimental data
- look into commensurate binning in simulation / experiment comparisons?
- analytical justification for why actual and QSS supersaturation is still in linear relation

This is a reference [1].

References

[1] J. Fan, D. Rosenfeld, Y. Zhang, S. E. Giangrande, Z. Li, L. A. T. Machado, S. T. Martin, Y. Yang, J. Wang, P. Artaxo, H. M. J. Barbosa, R. C. Braga, J. M. Comstock, Z. Feng, W. Gao, H. B. Gomes, F. Mei, C. Pöhlker, M. L. Pöhlker, U. Pöschl, and R. A. F. de Souza, "Substantial convection and precipitation enhancements by ultrafine aerosol particles," *Science*, vol. 359, pp. 411–418, 1 2018.