

## Referee Comments

The Study of Liu et al. report the influence of atmospheric conditions on the role of a perfluorocarboxylic acid, namely trifluoroacetic acid (TFA) in sulfate-based aerosol formation. This study readily complements a previous study from the same authors (Lu et al. 2020) by extending the local atmospheric conditions to worldwide atmospheric conditions. They used density functional theory and dynamics simulation to show that the particle formation rate and the contributions of sulfuric acid – dimethylamine – TFA clusters to the cluster formation pathways can be effectively enhanced, especially in cold and mildly polluted regions. This study highlights the influence of the use of Freon alternatives on air quality and climate, and is of great interest for researchers in various fields within atmospheric and aerosol sciences. The study is well conducted and the approach is sound. I recommend publication in Atmospheric Chemistry and Physics after the comments below have been addressed.

### General comments

It is well known from previous studies that plain SA-DMA clusters are insensitive to humidity. However, have the authors thought whether this situation may change if TFA is present in the cluster?

### Specific comments

- Line 22: Include much earlier references including references from the same author and his group.
- Lines 22-23: SA-DMA nucleation has been observed in various places around the World. Why do the authors choose to constrain this fact solely to the urban city, Shanghai, China?
- Lines 24-25: A number of studies have identified earlier that some species (including methane sulfonic acid, sulfamic acid and glyoxylic acid) may enhance SA-based particle formation as well. You could list some of these studies to further put your study aim into context.

### Technical corrections

- Line 28: “Due to the worldwide...” should be “Due to their worldwide...”
- Line 40: “Whereas TFA...” should be “However, TFA...”
- Line 43: “...with distances to the corresponding...” should be “...with distances to corresponding...”
- Lines 76: the publication year should be added to the reference Lu and Chen. No need to cite that same reference at line 78.
- Line 91: “It shows that the  $\Delta G$  decreases...” should be “It shows that  $\Delta G$  decreases...”
- Line 93: “...a cluster with monomer molecule...” should be “...a cluster with monomer molecule...”
- Lines 100-102: “The reason for this is that the influence of temperature variation on the evaporation coefficients ( $\gamma$ , where the temperature dependence is exponential (McGrath et al., 2012) is much greater than that on collision coefficients ( $\beta$ , where the dependence is in the square root of the temperature (McGrath et al., 2012)).” should be “The reason for this is that

the influence of temperature variation on the evaporation coefficients ( $\gamma$ , where the temperature is in the exponential term (Eq. (3))) is much greater than that on collision coefficients ( $\beta$ , where the temperature is in the square root term (Eq. (2))).”

-Line 131: “...most of the year.” should be “...most parts of the year.”

-Line 132: “...This can be attributed to that the ...” should be “...This can be attributed to the fact that the ...”

-Line 135: “This can be attributed to that temperature in spring and winter is relatively lower than other time all the year-round, respectively.” should be “This can be attributed to the fact that the temperature in spring and in winter is relatively lower than in other seasons all the year-round.”

-Line 140: “...at the common temperatures...” should be “...at common temperatures...”

-Line 178: Unit should be  $\text{cm}^{-3} \text{s}^{-1}$ .

-Line 184-185: “...in the polluted atmosphere are shown in Figs. S1 and S2 in the Supplement, respectively.” should be “...in the polluted atmosphere are respectively shown in Figs. S1 and S2 in the Supplement.”

-Line 195: “...at the moderate value of...” should be “...at moderate values of...”