

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2021-338

Anonymous Referee #1

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Referee comment on "Supercooled liquid water and secondary ice production in Kelvin–Helmholtz instability as revealed by radar Doppler spectra observations" by Haoran Li et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-338-RC1>, 2021

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The authors investigated the origins of supercooled liquid water and secondary ice in a stratiform precipitation event. Vertically pointing C-band and W-band radars at the Hyytiälä station, scanning C-band weather radar at Ikaalinen, and sounding at Jokioinen, provide rich information of the microphysical and dynamical properties of the mixed-phase layer embedded in the stratiform precipitation system. Radar doppler moments (reflectivity, linear depolarization ratio, Doppler velocity and spectral width) are used to explore cloud dynamics (turbulent layer and wind shear) and identify various hydrometer types (including supercooled cloud droplets, newly-formed ice columns, and background ice). Path integrated attenuation from the C/W dual-wavelength observations also provide an estimation of supercooled liquid water path. Valuable data and careful analysis provide physical insights of the formation of supercooled liquid water and secondary ice production due to a turbulent layer caused by Kelvin-Helmholtz instability: (1) Shear leads to the formation of the Kelvin-Helmholtz instability; (2) Drizzle forms in the K-H billows due to isobaric mixing; (3) Secondary ice forms in the K-H billows due to either the Hallett-Mossop process or droplet breakup during freezing, or both. The manuscript is well written, and results are quite convincing. I suggest the publication of this paper in ACP with only some minor comments below:

- Figure 4: Blank regions in the Figure (e.g., above 2.8 km at 20:55 UTC) are when liquid cloud droplet mode does not exist in Doppler spectrum? Please state it clearly in the text or caption.
- Page 14, Line 13-14: "To assess the back trajectory of ice crystals, a simulation of free-falling growing ice columns was performed." Please provide more details (e.g., literature, equations) of the ice particle growth model.
- Page 14, Line 23: " $N = \text{mass}/\text{IWC}$ ". Should it be " $N = \text{IWC}/\text{mass}$ "?