Review of ACP-2019-6: He et al., 'Observational evidence of particle condensational growth in the UTLS over Tibetan Plateau'

Overall, the manuscript is reasonably well written and logically constructed. The writing is certainly understandable, but does exhibit some usage and punctuation errors. The topic is appropriate for publication in ACP.

One general comment is on the use and discussion of 'condensational growth' in the context of water uptake. While perhaps technically correct, it would be better to distinguish between hygroscopic growth, a dynamic and typically reversible process, and growth of particles by accretion of additional low volatility material (e.g. H2SO4 or SOA). It is noted in the manuscript that 'the growth mechanism of the particles in the ATAL is still poorly described' and while the authors discuss observed relationships between RHi and the COBALD-derived aerosol backscatter and color index, the phenomenology does not fully constrain the mechanisms. If the elevated RHi resulted in condensational growth through enhanced chemical production, the observed relationship would break down since the dependence would be on RHi history rather than instantaneous RHi as considered here.

Specific comments:

Title: 'condensational growth' – see comment above
'over Tibetan Plateau' >> 'over the Tibetan Plateau'

P1L24: 'Water plays an important role in the growth' – see comment above. Water is important in determining the size, and therefore radiative properties, of the particles.

P1L27: 'aerosol backscattering ratio' >> 'backscatter ratio' more common and as it does appear elsewhere in the manuscript. 'aerosol' is not appropriate here since the acronym and numbers quoted subsequently are BSR, not ABSR = BSR – 1, as defined in the paper. Alternately, 'aerosol backscattering' could be used here and 'backscatter ratio' added to BSR in L30.

P1L27: 'with a balloon-borne lightweight COBALD at Linzhi' – the profiles were measured with separate COBALD instruments, so perhaps 'using balloon-borne, lightweight COBALD instruments above Linzhi'. I believe the COBALD acronym should technically be spelled out in the abstract as well as the body (as UTLS is).

P1L32: Here the CI is defined in terms of ABSR, but that is not defined—perhaps harmonize with the BSR discussion earlier in the abstract.

P2L1: delete 'dominant' >> 'indicating the prevalence of fine particles'

P2L6: as noted in the general comments above, water uptake at high RH is increasing the size of the particles (hygroscopic growth), but it is not really the case that water vapor

is playing ‘a very important role in the formation of large amounts of fine particles’ unless you are considering the role of H2O in aerosol nucleation, which is not something that is addressable through the measurements in this study.

P2L8: ‘condensational growth’ – see comment above

P2L9: ‘enhancement’ – hygroscopic growth would enhance the size, and therefore radiative effects, of the ATAL aerosol, but is really not responsible for the ATAL formation.

P2L22: ‘global warm effect from greenhouse gases.’ >> ‘global warming effect from increasing greenhouse gas concentrations.’

P2L23: ‘maximum’ >> ‘elevated’ (also in L27)

P3L5: ‘[Frey et al., 2011] proposed’ >> ‘Frey et al. [2011] proposed’

P3L9: ‘after the relative humidity’ – after it what? This sentence could be restructured to be clearer. Also, CALIOP is the lidar, CALIPSO is the satellite.

P3L8-12: related to the question of the use of ‘condensational growth’, I am unclear what is being proposed as the mechanism by which increased relative humidity would take one month to affect the size of aerosol. Beyond the role of H2O in the formation of molecular (or ion-molecule) clusters that can subsequently grow into aerosols, it would take significant supersaturations for sufficient water to condense on nanometer sized (nucleation mode) particles to produce growth, and then it would likely produce activation to large size (cloud). This could theoretically lead to growth of the underlying particles through aqueous chemistry (e.g. SO2 → H2SO4), resulting in larger residual particles after the humidity decreases, but that would not contribute to the backscatter – humidity relationship that is the core of the argument in the paper.

P3L14: ‘mechanism’ >> ‘mechanisms’

P3L15: ‘the coagulation…the nucleation’ >> ‘coagulation…nucleation’

P3L17: ‘Except for coagulation,’ >> ‘Compared with coagulation,’

P3L21: ‘the stratospheric aqueous’ >> ‘stratospheric aqueous’

P4L18: it would be better to list the years of the BATAL campaign than to say ‘More Recently’.

P4L25: ‘the vertical profiles’ >> ‘vertical profiles’

P5L7: ‘of the Compact Optical Backscatter AerosoL Detector (COBALD) particle backscatter sonde, the iMet and RS92 radiosonde, and the cryogenic frost-point hygrometer

(CFH).' >> 'of a Compact Optical Backscatter AerosoL Detector (COBALD) instrument, iMet and RS92 rediosondes, and a cryogenic frost-point hygrometer (CFH).'

P5L10: 'flew at' >> 'rose with' or 'ascended at a rate of'

P5L12: 'ascending' >> 'ascent'

P5L22: delete 'follow'

P5L27: 'scatter' >> 'scattering'

P5L29: 'raw data the blue' >> 'raw data, the blue'

P6L1: 'and the precision in an order of 1%' >> 'and a precision of approximately 1%'. Rosen and Kjome should be included in a discussion of instrument uncertainty since it, to the extent that the COBALD instrument and data treatment are functionally similar, provides a far more complete description of the instrument performance than is available in the COBALD references such as Vernier et al. (2015).

P7L10: the ATAL has been typically observed [e.g. Vernier et al. (2015)] to occupy a much narrower range of altitudes than is described here and shown Fig 1. The top here certainly extends far into the stratosphere, many km above the tropopause and into the altitude range of the Junge layer. To tie the analysis here to the ATAL it is important to discuss the nature of the layer observed during these measurements and how/why it differs so dramatically from other ATAL observations.

P9L12: 'concentration' should be 'mixing ratio' here and elsewhere (e.g. L14, L15, Fig 3 caption)

P9L15: 'convection transport' >> 'convective transport'

P10L6: 'dependency' >> 'dependence'