The manuscript presents an interesting approach to evaluate the halo ratio from all-sky imaging and using infrared brightness temperature measurements to identify cirrus clouds. However, the method description lacks some information and is partly not coherent. Moreover, several conclusions drawn from the presented case studies are not supported by the observations. Also some misconceptions occurred:

- Abstract, Page 2, line 32 and especially Page 6, line 20:
  The term “scattering phase function” should not be used in this context. It seems that the analysis in this study is based on the measured brightness distribution of the camera which includes multiple scattering rather than the actual scattering phase function, which is a single scattering property.

- Page 3, line 9:
  “...the reflectivity is inversely proportional to the HR.” and line 14: “The asymmetry parameter […] is expected to be positively correlated with HR”
  These statements are based on observations (Ulanowski et al., 2006; Gayet et al., 2011; Ulanowski et al., 2014) with most HR values < 1, i.e. no 22° halo, which has to be emphasized in this context. Since it is questionable whether differentiating values HR<1 is meaningful at all, the relationship between HR and asymmetry parameter should be explained here first without assumptions:

  In general, the reflectivity is primarily determined by the asymmetry parameter which depends on the ice crystal surface roughness and aspect ratio in a U-shaped manner. The HR of the scattering phase function increases for ARs ranging from plates over compact crystals to columns. This implies an ambiguity in the relationship between HR and asymmetry parameter and thus also on the reflectivity.
  See
  - van Diedenhoven 2012: Remote sensing of ice crystal asymmetry parameter using multi-directional polarization measurements – Part 1: Methodology and evaluation with simulated measurements
  - van Diedenhoven 2014: The prevalence of the 22° halo in cirrus clouds
  - van Diedenhoven 2014a: A Flexible Parameterization for Shortwave Optical Properties of Ice Crystals

- Many abbreviations and acronyms, especially in Sections 2.7 and 3, make the paper difficult to read.

In the following more detailed comments:

1. **Introduction:**
   The Introduction mainly focuses on cloud detection using all-sky imagers. Are these methods relevant for the presented study?

2. **Section 2.2.1:**
   - Please provide some references for the calibration method using the coordinates of stars.
   - How does the fit to a bi-cubic function work? Please provide the complete camera model used for the calibration.
   - Which kind of distortion is corrected – tangential or radial or both?
   - How many pictures are used for the calibration?

- What is the effect of increasing the lens aperture on the accuracy of the geometric calibration?

3. **Section 2.2.2:** The authors state a reprojection error of “mostly <0.1° aside from portions of […] trajectories for which larger discrepancies, up to 0.38°, were observed” . How large is the error in the region of interest, i.e. where the 22° halo occurs? Is the accuracy sufficient for this study?

4. **Section 2.5:** Using sun photometer measurements to estimate the vignetting effect of the camera is an interesting approach, but some issues are not discussed.
   - Page 7, line 20: What is the spectral response of the blue channel? The influence of Rayleigh scattering in the blue channel is much stronger compared to the red channel and small deviations in the considered wavelengths might cause larger errors in the radiance distribution. Why not use all 3 (RGB) channels? What is the required accuracy of the vignetting correction?
   - Page 7, line 23: “...by neglecting pixels such that z is greater than approximately 20° over the meridian containing the sun...”. Why are these pixels neglected?
   - Page 7, line 27: “...the presence of a peak located roughly 8° from the zenith was investigated...To form a correction function symmetric about the zenith, the original curve was "mirrored" about the zenith..” Based on which assumption? Is this peak is related to the camera or the sun photometer data? Was this peak observed at a different time as well?
   - Are the measurements interpolated to the same time? How long did the sun photometer scan take?
   - Is the vignetting correction determined in the principal plane applied to the whole camera image? If yes, under which assumption?
   - Fig. 6: Why is the calibrated brightness distribution (black dashed line) smoothed compared to the original data (red dashed line)?

5. **Section 2.6:** What is the purpose of the air mass correction? Is the applied method of Rapp-Arraras and Domingo-Santos (2011) applicable to cloudy scenes as well? What is the error in this case?

6. **Section 2.7:**
   - The cirrus BT threshold is based on an optically thick cirrus. 22° halos are only visible in thin cirrus. What is the effect of a decreasing optical thickness on the BT threshold?
   - How sensitive is the presented threshold method on variations of cloud cover in the scene?
   - The DFA threshold was estimated empirically to 0.02. This value is much lower than the values found by Brocard et al. 2011 (~0.1 for clear sky, ~0.5 for stratiform cirrus, ~1 for broken cirrus), why?

7. **Section 3.1:**
   - Page 9, line 28: “...between 8 and 10 am… Over this time window […] the behaviour of the BT and the solar irradiance suggests that the HR increases with the optical thickness τ (see Fig. 10, middle and bottom plots)” This is not clearly visible in Fig. 10. The HR increases from 8:12 until 8:30 am but clearly decreases towards 10 am. How is the optical thickness derived from the displayed data?
   - Page 9, line 31: Kokhanovsky 2008 showed that the halo contrast is linearly decreasing with increasing optical thickness since molecular and aerosol scattering are neglected. Only **the radiance distribution is increasing up to $\tau=3$ and decreasing for $\tau>3$.**

- Page 10, line 2: “Between about 8 and 8:20 am the HR, mostly <1, shows a maximum and a minimum at about 8:06 and 8:12 am, respectively, when a relatively faint 22° halo is visible”
  How can the HR be <1 but the image shows a 22° halo? The 22° halo in the image at 8:54 appears brighter than at 8:06 but the HR is smaller. Why? Is this an effect of averaging over the complete 22° halo scattering angle region? If so, the HR might be primarily a measure of cloud fraction in this case.

8. **Section 3.2:**
   Page 11, line 11: “... we conjecture that in order to observe the HR maxima measured for the two cases discussed here a certain minimum fraction of smooth hexagonal ice columns had to be present. ~~If multiple scattering were to be accounted for, such a fraction could be an underestimation of the actual one.~~” The second sentence is now redundant.

9. **Conclusions:**
   - Page 11, line 29/30: “ Overall the HR is shown to be sensitive to the halo status of cirrus as it is well correlated with halo visibility.” Can you provide a quantitative statement?

   - Page 12, line 3-9: Discrimination between cloud and clear sky seems to work well using the halo ratio alone, without additional DFA threshold test. Discrimination between cirrus and broken cumulus or other clouds seems necessary. How (well) does it work?

   - How does the presented method perform compared to the methods presented in the Introduction for cloud type discrimination and halo detection? (e.g. Shields et al. 2013, Forster et al. 2017)

   - Page 12, line 26: “We argue that when the 22° halo was visible a percentage of at least 20% of regular ice crystals had to be present if molecular, aerosol and multiple scattering in addition to surface albedo are accounted for, together contributing to a reduction of the halo contrast.” What is the basis of this argument? Please explain.

   - Page 12, line 28: “We have also conjectured that when the HR reached its absolute maxima the fraction of such pristine crystals is likely to have been much larger than 20%.” See previous comment.
     “The remaining fraction could have been composed of irregularly shaped, complex, rough or small ice crystals.” In Sections 3.1 and 3.2 fluctuations of the HR are explained only by variations of the cloud optical thickness, now the argument is based on the ice crystal microphysical properties. This is not consistent.

   - Page 13, line 1: should be “...e.g. the presence of sun dogs and the 46° halo indicates the presence of aligned plates and **randomly oriented hexagonal crystals**, respectively.”

   - Page 13, line 3: “The utilisation of the all-sky cameras to transform the measured light intensity into the scattering phase function and, on a limited extent, the cirrus detection algorithm, are the particularly novel aspects of this work; this has not been done previously to the best of our knowledge.” The term “cirrus detection algorithm” appears only in the Abstract and Conclusions. Where is this algorithm explained? The method described in Section 2.7 is not new and was already published by Brocard et al., 2011.

   - Page 13, line 10: “ The combined use of these two methods, allows relatively inexpensive halo observations and the retrieval of information pertaining to ice particles size and texture.” How can particle size an texture be retrieved?