Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-27

Anonymous Referee #1

Referee comment on "Identifying insects, clouds, and precipitation using vertically pointing polarimetric radar Doppler velocity spectra" by Christopher R. Williams et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-27-RC1, 2021

In their manuscript „Identifying Insects, Clouds, and Precipitation using Vertically Pointing Polarimetric Radar Doppler Velocity Spectra" Christopher Williams et al describe a combination of spectral texture and LDR to discriminate insects and hydrometeors in cloud radar Doppler spectra. The introduction of the texture and the combination with the frequently used spectral LDR are novel approaches. The topic fits well into the scope of Atmospheric Measurement Techniques and is recommended for publication after minor revisions. Especially the state-of-art review and theoretical basis (scattering properties of insects) can be expanded to provide a more comprehensive overview.

Detailed comments

- P1L28: "All datasets and images are available […]". This statement is ambiguous. Are the quicklooks from the dataset available or the figures used in this manuscript?
- P2L16: "Due to their large power fluctuations […]". Are the power fluctuations the reason, why insects are detected in the power spectrum?
- P2L26: "[…] of the operational ARSCL processing is identifying and removing insect clutter" More information on the state-of-art in ARSCL is needed. How is insect filtering currently done? What thresholds are used? How does the approach differ from other well established synergistic retrievals, such as Cloudnet? Where are the gaps, this work tries to address? Please also consider showing the ARSCL insect flag for the case studies (Fig 3 and 4).
  How does your algorithm differ from the MIRA-35 insect filtering, which also relies on spectral LDR (see description in Görsdorf et al. 2015 JAOT and the therein referenced Bauer-Pfundstein and Görsdorf 2007)?
- P4L24: "Figures and algorithm descriptions use the MD mode with retrievals for the GE mode available in the ARM data archive." Does that mean the algorithms for GE are used on the MD data or is this just an additional information that the other mode would be available as well? Please clarify. Does the presented algorithm perform equally well at the GE data?
- P4 Eq. 1b and 2: Is the noise level independently estimated for SXPOL? Please provide

the depolarization decoupling of the used system (integrated cross-polarization ratio, Myagkov et al. 2015 JAOT).

- P4L26: "The KAZR 0.2° antenna beamwidth […]". Please give the diameter of the antenna. Is it covered by a radome?
- P4L35: Please provide more technical information on the lidars. What are the wavelengths, what algorithms are used for cloud base detection?
- P5 Table 1: What encoding sequence is used in the MD mode?
- Section 3 (P5L26): reads very phenomenological without addressing the underlying physics of the insect return. Is the observed texture characteristics caused by the point target scattering at individual insects? Such intermittent during the integration time of the Doppler spectrum and easily be identified by a time-frequency analysis of the IQ signal. If you have access to such low-level date it might be worth a look.
  Are the sizes of insects expected at the SGP are similar to the wavelength or much smaller?
  How does the LDR signature of point targets depend on the pulse shape in the MD mode?
- P6L5: "The abrupt omission of LDR observations above the ceilometer cloud base height appears suspicious as it produces a nearly horizontal feature in Fig. 2d." Can you exclude artefacts of the Doppler spectrum preprocessing, especially noise level estimation in SXPOL and omission of empty spectra in the data?
- P6L24: I was not able to find the mentioned spectra profiles in the supplement.
- P6L25: "This indicates that individual insects appear in the […]" What was the horizontal wind speed in that height?
- P7 Fig 2: Please mark the time of the case study (Fig 3 and 6) in that figure.
- P10L3: "The bottom panel (Fig 3d) […]" Are you referring to Fig 4d?
- P10L16: "from insects (including "atmospheric plankton")" Atmospheric plankton other than insects and its signature in cloud radar observations is not mentioned in Section 3.
- P11L1: "KAZR XPol channel is not sensitive enough to detect non-precipitating liquid cloud droplets" Liquid non-precipitating clouds should not show any LDR, regardless how sensitive the XPol channel is (at least for a single scattering process).
- P11L5: "[…] that clouds are persistent over 10's of seconds and 10's of meters" But the air velocity, which determines the spectral bin of a signal, might change a smaller timescales. Does this filtering step need to be adjusted to the turbulence conditions?
- P11 Fig 5: Please consider adding color coding to clarify the two branches. Also specify 'small regions' more exactly.
- P11L9: The heading should read "CoPol Texture Algorithm Branch" to be consistent with 4.2.
- P11 Eq 5: Is the term in the brackets a matrix or just the maximum out of two alternatives?
- P12L8: "[…] that for radars with broader beamwidths, the insect peak would broaden […]" Are the broadening processes the same as for distributed targets (e.g. Shupe 2008 JAOTech)?
- P12L20 "Interestingly, enhancements in both max texture and STD texture are visible near 1.8 and 2 km indicating that insect scattering is occurring within cloud scattering regions." Judging from Fig 2, this could be a gap in the cloud with low reflectivities and positive vertical velocity, whereas the higher reflectivity around is associated with negative velocities. Likely, 'close proximity' would be a better description.
- P15L13: "A threshold of ð□□□ð□□□ð□□□ð□□□ ð□□□ LDR threshold -15 dB clearly separates the two distributions and is indicated with a dashed line in Fig. 10b." This threshold also fits to the findings of Matrosov 1991 (JAS) and Reinking (1997 JAMC).
- P18 Section 4.4: Having a spectrally resolved mask, have you considered calculating the moments of the Doppler spectrum for each population? This could provide further insight into the co-occurrence of insects and clouds in the same volume.
- P18L19: The abbreviation QC needs to be defined.
- P19 Fig 12: What does v06 stand for? If it's just a version control flag, please consider

omitting it.

- P21L14 and P22 Fig 14: What is the additional benefit of the Doppler Lidar observations, that could not be derived from the Ceilometer? From the current content, this part of the comparison could be omitted without loosing information.
- P22L13: "[…] cautionary note for future studies is that XPol spectra observations observe fewer insects than CoPol observations". This depends strongly on the signal amplification in the XPol channel and the polarization decoupling of the system.
- P23L4: "[…] many velocity bins and several range gates". Depends on the technical configuration of the radar, please consider providing physical units (m s-1 and m respectively).
- P23L13: "There appears to be relationships between the insect activity index, radar reflectivity and cloud formation." This is a very vague statement. Please be more concrete or or consider omitting it.
- P23L32: Seeing the importance of the issue you are addressing and assuming a broad interest in the community, please consider providing the source code in an open repository similarly to your 2018 paper.