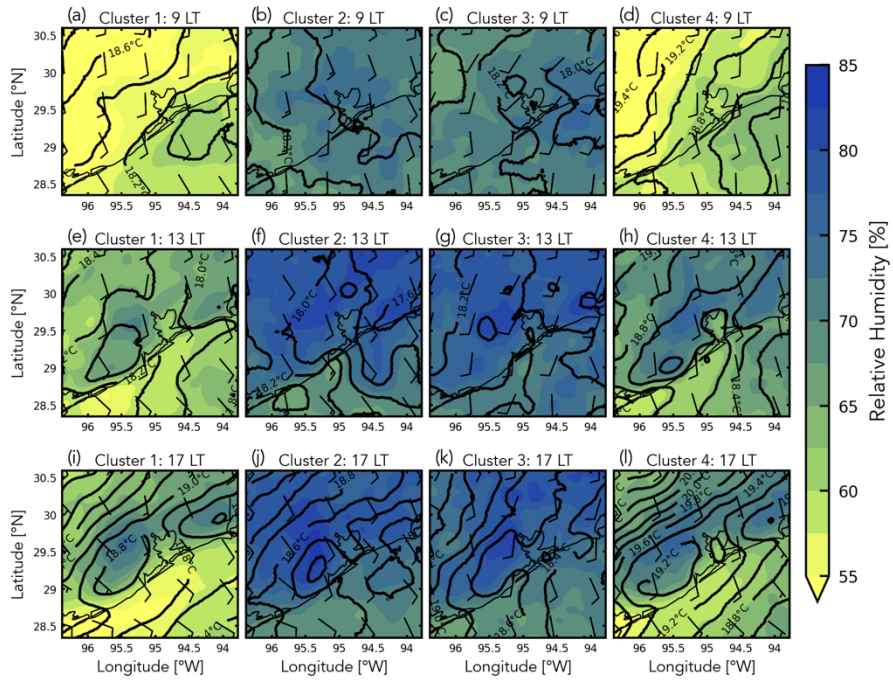
This study explores the variability of shallow convective clouds and precipitation in Houston, Texas, during the summer, utilizing data from the TRACER and ESCAPE field campaigns. Through a combination of geostationary satellite and ground-based radar observations over a 250x250 km domain, the authors identify four diurnal modes of shallow cloud fraction and analyze their spatial and temporal patterns. The study highlights the influence of land-ocean contrasts, sea breeze circulations, and local meteorology on shallow cloud properties, contributing to the understanding of cloud behavior in complex urban and coastal environments. Overall, while the study makes a contribution to understanding shallow cloud behavior in a complex urban and coastal environment, its impact is somewhat diminished by insufficient attention to physical mechanisms and scientific discussions. Addressing these issues would enhance the clarity and applicability of the findings.

Thank you to Reviewer #2 for the valuable feedback. We believe the manuscript has been improved immensely because of it. To accommodate R2's concerns, the main thing we did was provide a new figure which shows meteorological context from HRRR model output throughout the domain rather than one location's set of radiosondes.

MAJOR COMMENTS

Major Comment 1: The physical meaning of the identified regimes of shallow cumulus clouds is insufficiently addressed. While the clustering analysis identifies distinct modes, there is a lack of detailed discussion on their underlying drivers or implications for broader meteorological processes. It should explain more about the underlying differences in terms of the formation and mechanisms of different regimes.

In the new version of the manuscript, we expanded our discussion section to compare the prominent shallow cloud patterns we find to recent studies about synoptic patterns and sea breeze circulations in the region, and we provided a new figure with domain-wide meteorological context to make interpretations of our own. We wanted to provide some of our own insight while also acknowledging the many others who are looking at this region.



Major Comment 2: The variability of cloud fraction and precipitation is not thoroughly explained. Although the study presents statistical patterns, it does not adequately explore the mechanisms responsible for observed spatial and temporal differences, particularly in the context of different meteorological factors such as humidity, circulation, advection, etc.

We have added a new figure that shows composites of 850 hPa model output in each cluster, and we discuss the wind patterns, moisture, and temperature and its gradients across the domain as a function of time. We also connect our work to the recent studies done in the region identifying synoptic patterns and sea breeze circulations.

Major Comment 3: Under high precipitable water conditions, radar signal attenuation may impact cloud and precipitation detection, introducing uncertainties not discussed in the study. For instance, ARSCL faces limitations such as insect contamination and biased cloud-top heights, which could affect the reliability of the results.

This is a great point. In the revised version of the manuscript, we do not use ARSCL to inform the reflectivity threshold we chose. We only use it now to do the quick visual comparison between GOES, KHGX, and ARSCL in Figure 2 and to quantify the cloud mask's skill. In that analysis, we are only using the periods when the lidar detected a cloud base, and we are not using cloud top heights from ARSCL in any way. With regards to the S-band wavelength of KHGX, we believe any attenuation is negligible.

Major Comment 4: The key differences between the ESCAPE and TRACER campaigns are not clearly articulated. Considering their different objectives, it is helpful to explain how differences in shallow cloud backgrounds, formation processes, and meteorology between the two campaigns may influence the results for better contextualization.

We added details about the goals of the campaigns to the introduction. ESCAPE focused on convective cloud lifecycles in the broader scope of the environment: urban area, sea breeze circulation, aerosol properties, etc. TRACER focused more on aerosols and understanding aerosol impacts on convective cloud properties.

MINOR COMMENTS

Minor Comment 1: The analysis relies on a single observational location (AMF1) for meteorological measurements, which may not fully capture the variability across the domain. Briefly addressing the spatial scale of its representativeness would be helpful.

The meteorological variability figure's biggest flaw was the point location aspect, so we removed it. We agree that a result like that could misrepresent conditions across the domain, so we made our HRRR composite figure instead. The figure highlighted spatial and temporal variability in moisture, temperature, and wind at 850 hPa that correlated with our shallow and deep cloud activity.

Minor Comment 2: The lack of a sensitivity analysis for the k-means clustering approach may introduce uncertainties in the identified modes.

A sensitivity analysis would involve changing the value for k. We showed that most of the variance can be accounted for with four modes, and we did not want to introduce more complexity to the analysis by adding more modes. The fact that the results from our four modes align nicely with current studies (Wang et al. 2024) shows that k = 4 was adequate.

Minor Comment 3: The manuscript would benefit from more discussion on meteorology, sea breeze circulations, and potential urban influences, complementing the statistical results of clouds and precipitation.

We have added a new figure that shows composites of 850 hPa model output in each cluster, and we discuss the wind patterns, moisture, and temperature and its gradients across the domain as a function of time. We also connect our work to the recent studies done in the region identifying synoptic patterns and sea breeze circulations. With respect to urban influences, we did not have the aerosol data to quantify that kind of impact, and it was beyond the scope of our paper, too.