**Title**

Clouds in HARMONIE: The role of shallow convection parametrization on meso-scale cloud organization

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**Date**

2023-08-25

**Abstract**

Clouds play a crucial role in Earth’s systems, influencing the radiation budget and the hydrological cycle. However, their dynamics are poorly represented in climate models, leading to uncertainties in predicting global temperature changes. To better understand cloud dynamics and improve model parametrizations, the large-scale field campaign EUREC4A focused on studying cloud organization and its potential impact on climate feedback in the North Atlantic trade-wind region, where shallow marine cumulus clouds are prevalent. Within the EUREC4A framework, this study focuses on cloud fields and organization in the HARMONIE weather model to assess the impact of shallow convective parametrizations on its outputs. By comparing three experiments denominated as ’HARMONIE noHGTQS’, HARMONIE noHGTQS noSHAL’ and ’HARMONIE noHGTQS noUVmix’ one can identify discrepancies and determine what the impact of the various shallow convective parametrizations are. Several cloud organization metrics have been computed for the HARMONIE experiments as well as GOES-16 satellite snapshots. The results show that none of the experiments precisely capture the observed diurnal patterns successfully. There exist disparities in cloud cover, cloud quantity, cloud sizes, and the organization index. Removing shallow convective parametrization partly improves the representation of clouds. It exhibits a stronger correlation with the observed cloud cover data from ceilometer measurements and demonstrates a higher capability to replicate the amount of
cloud entities seen in observations in comparison to the other experiments. Furthermore, disabling shallow convection leads to instability and deeper clouds. On the other hand momentum mixing alone has a small impact on clouds, yet it alters wind patterns, resulting in reduced speeds, and little production of precipitation. Overall the model struggles to reproduce detailed cloud patterns such as sugar, mainly due to its coarse resolution. However, it does exhibit a
degree of day-to-day variability in cloud patterns. To gain a deeper understanding on the role of parametrized shallow convection, further investigation into model configurations, momentum mixing dynamics, and hybrid approaches are proposed.