A decentralized approach for modeling organized convection based on thermal populations on a microgrid

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Abstract

Recent insights into the spatial organization of atmospheric convection have emphasized the importance of its correct representation in Earth System Models (ESM). This study explores new opportunities created when combining a thermal population model on a horizontal microgrid with a decentralized vertical transport model. To this purpose the recently proposed BiOMi population model (Binomials on Microgrids) is used. BiOMi mimicks a population of independent but interacting convective thermals, with their birth, movement and life cycle described as Bernoulli processes. Simple rules of interaction are introduced to reflect observed physical behavior in single cumulus clouds, such as pulsating growth and environmental deformation. Under these rules, thermals can congregate and form longer-lived coherent clusters or chains that resemble cumulus clouds. The formation and evolution of these clusters is a form of self-organization that retains convective memory. Through an online clustering method the microgrid is coupled to a spectral EDMF convection scheme, providing the cluster size distribution it needs as input. This way, the inherently 3D structure of organized convection can in principle be captured in reduced but efficient form. The system is fully decentralized in that central top-down bulk closures are avoided. The main science objective of this study is to provide proof of concept of decentralized frameworks of this kind. To this purpose the BiOMi-EDMF scheme as implemented in the DALES circulation model is tested for various LASSO cases of shallow convection at the ARM SGP site. We find that the scheme achieves stable and realistic diurnal quasi-equilibria (as shown in the figure), and that the associated self-organizing patterns on the microgrid are realistic. Impacts of spatial organization and convective memory on the parameterized transport will be investigated.

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Abstract Text:

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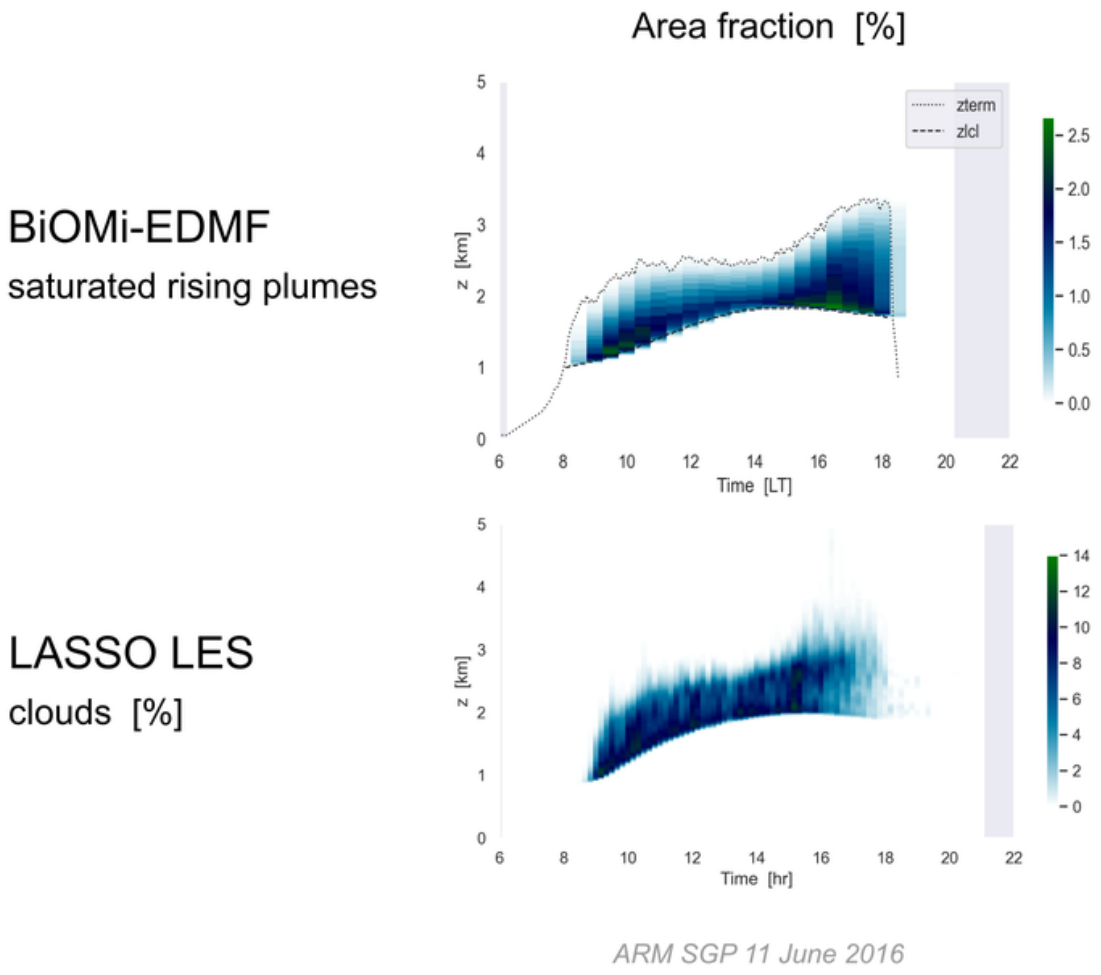

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Previously Published Material:
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