EGU21-13307, updated on 24 Oct 2021
https://doi.org/10.5194/egusphere-egu21-13307
EGU General Assembly 2021

Exploring microphysical properties of marine boundary layer clouds through network analysis

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Aerosol-cloud interactions remain the largest uncertainty in assessments of anthropogenic climate forcing, while the complexity of these interactions require methods that enable abstractions and simplifications that allow their improved treatment in climate models. Marine boundary layer clouds are an important component of the climate system as their large albedo and spatial coverage strongly affect the planetary radiative balance. High resolution simulations of clouds provide an unprecedented understanding of the structure and behavior of these clouds in the marine atmosphere, but the amount of data is often too large and complex to be useful in climate simulations. Data reduction and inference methods provide a way that to reduce the complexity and dimensionality of datasets generated from high-resolution Large Eddy Simulations.

In this study we use network analysis, (the δ-Maps method) to study the complex interaction between liquid water, droplet number and vertical velocity in Large Eddy Simulations of Marine Boundary Layer clouds. δ-Maps identifies domains that are spatially contiguous and possibly overlapping and characterizes their connections and temporal interactions. The objective is to better understand microphysical properties of marine boundary layer clouds, and how they are impacted by the variability in aerosols. Here we will capture the dynamical structure of the cloud fields predicted by the MIMICA Large Eddy Simulation (LES) model. The networks inferred from the different simulation fields are compared between them (intra-comparisons) using perturbations in initial conditions and aerosol, using a set of four metrics. The networks are then evaluated for their differences, quantifying how much variability is inherent in the LES simulations versus the robust changes induced by the aerosol fields.