Geophysical Research Abstracts
Vol. 19, EGU2017-1555, 2017
EGU General Assembly 2017

Structure and organization of Stratocumulus fields: A network approach

Franziska Glassmeier (1,2) and Graham Feingold (2)
(1) National Research Council, USA, (2) Chemical Sciences Division, NOAA-ESRL, Boulder, USA

The representation of Stratocumulus (Sc) clouds and their radiative impact is one of the large challenges for global climate models. Aerosol-cloud-precipitation interactions greatly contribute to this challenge by influencing the morphology of Sc fields: In the absence of rain, Sc are arranged in a relatively regular pattern of cloudy cells separated by cloud-free rings of down welling air ('closed cells'). Raining cloud fields, in contrast, exhibit an oscillating pattern of cloudy rings surrounding cloud free cells of negatively buoyant air caused by sedimentation and evaporation of rain ('open cells'). Surprisingly, these regular structures of open and closed cellular Sc fields and their potential for the development of new parameterizations have hardly been explored. In this contribution, we approach the organization of Sc from the perspective of a 2-dimensional random network.

We find that cellular networks derived from LES simulations of open- and closed-cell Sc cases are almost indistinguishable and share the following features: (i) The distributions of nearest neighbors, or cell degree, are centered at six. This corresponds to approximately hexagonal cloud cells and is a direct mathematical consequence (Euler formula) of the triple junctions featured by Sc organization. (ii) The degree of individual cells is found to be proportional to the normalized size of the cells. This means that cell arrangement is independent of the typical cell size. (iii) Reflecting the continuously renewing dynamics of Sc fields, large (high-degree) cells tend to be neighbored by small (low-degree) cells and vice versa. These macroscopic network properties emerge independent of the state of the Sc field because the different processes governing the evolution of closed as compared to open cells correspond to topologically equivalent network dynamics. By developing a heuristic model, we show that open and closed cell dynamics can both be mimicked by versions of cell division and cell disappearance and are biased towards the expansion of smaller cells.

As a conclusion of our network analysis, Sc organization can be characterized by a typical length scale and a scale-independent cell arrangement. While the typical length scale emerges from the full complexity of aerosol-cloud-precipitation-radiation interactions, cell arrangement is independent of cloud processes and its evolution could be parameterized based on our heuristic model.