Aerosol, clouds, precipitation and self-organization of stratocumulus

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Introduction

Satellite imagery of marine stratocumulus regions often reveals the existence of cellular structures that appear to be manifestations of self-organizing properties of the cloud field. These striking features present themselves as either bright cloudy cells ringed by darker edges (closed cells) or dark cellular regions ringed by bright cloudy edeges (open cells). The starkly different reflectance patterns associated with these cellular structures are of great interest from the perspective of planetary albedo.

Observations [1, 2] and modeling studies [3-5] have implicated aerosol particles, particularly those that act as cloud condensation nuclei, as one of the controls on the self-organizing properties of stratocumulus. Non-precipitating clouds that typically exist in regions of higher background aerosol loading prefer the closed cell state, while cleaner precipitating clouds favour the open cell structure.

We will present large eddy modeling simulations over domains on the order of 100 km that explore the processes associated with the formation and growth of open cells. We will use these results to test conceptual models of the structure of open and closed cellular boundary layers. Finally, we will explore the boundary region between clean and polluted regions and show how aerosol gradients can generate mesoscale circulations that play a major role in determining cloud microphysics and morphology.

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Bacterial anaerobic methane oxidation in groundwater systems

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The redox reactions in groundwater environments are generally understood, but limited information exists on the flux of redox equivalents in metabolic networks at microbially active zones in aquifers. Recent research showed that methane produced within a contamination plume may migrate with the groundwater flow and leave the zone of formation. As a potent electron donor in other geochemical zones of a higher redox potential the methane may be microbially oxidized. However, the spatial and temporal behaviour of reduced products, their transport with the water flow and their potential to support autotrophic and heterotrophic microbial processes as electron donors is not well understood yet. To study electron transfer reactions mediated by the fluxes of methane, biological sources and sinks of methane were studied at a methanogenic field site heavily loaded with mineral oils and BTEX. Two methanogenic zones could be distinguished by isotope signatures ($^{13}C/^{12}C$; $^{2}H/^{1}H$). Detected signatures of CH4 became significantly enriched downstream of the methane sources within a sulphate reducing zone of the aquifer, suggesting a microbial methane oxidation coupled to sulphate reduction. This study shows that geochemical zones of different redox potentials can be linked by mass transport of reduced carbon compounds such as CH_4.