

EGU2020-13229

<https://doi.org/10.5194/egusphere-egu2020-13229>

EGU General Assembly 2020

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Satellite Observations of Organizational Regimes in Low-Level Mixed-Phase Clouds over the Southern Ocean

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On average stratocumulus clouds cover about 23% of the ocean surface and are important for Earth's radiative balance. They typically self-organize into cellular patterns and thus are often referred to as mesoscale-cellular convective (MCC) cloud systems. In the Southern Ocean (SO), low-level clouds cover between 20% to 40% of the ocean surface in the mid-latitudes where they exert a substantial radiative cooling. In a previous study, McCoy et al (2017) demonstrated that different MCC regimes may be associated with different cloud albedos and thus different cloud radiative forcing.

Many of the MCC clouds in the SO are not pure liquid but contain a mixture of liquid and ice. Here we investigate whether the formation of ice within these mixed-phase clouds influences MCC organization and thus the cloud-radiative effect.

To investigate the cloud phase we use the raDAR-lIDAR (DARDAR) data product (version 1) from Cloud-Aerosol-Water-Radiation Interactions (ICARE) Data and Services Center which provides collocated data from Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), CloudSat and Moderate Resolution Imaging Spectroradiometer (MODIS). The "Simplified DARMASK Categorization Flag" of DARDAR is used to categorize the vertically resolved cloud phase into a single cloud phase per data point: clear, multi-layer, liquid, mixed or ice. In order to distinguish between open and

closed MCC regimes, we collocate the DARDAR product with an MCC classification data set from McCoy et al (2017) which is based on a neural network algorithm applied to MODIS Aqua data.

Our preliminary results confirm previous ground-based observations that most mixed-phase clouds are composed of a supercooled liquid top and ice underneath. Furthermore, our preliminary analysis suggests open MCCs occur more frequently as mixed-phase clouds (57% (DJF), 55% (JJA)) in the SO compared to liquid clouds (39% (DJF), 37% (JJA)) during both summer (DJF) and winter (JJA). In contrast, closed MCCs are more likely to appear as liquid clouds (58%) in comparison to mixed-phase clouds (40%) during winter, whereas during summer there seems to be no tendency for closed MCCs to be either liquid (51%) or mixed (49%).