Implementation of the Secondary Ice Production mechanisms in the Single Column Atmosphere Model Version 6 (SCAM6) : Results from MC3E

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Objective

• Model development of CESM global model with SCAM (Single Column Model Version6) MC3E campaign

• Improving the deep convective scheme, with realistic treatment of Ice processes

• One of the steps was to add Secondary Ice Production mechanism
Implementation

• The observation data collected during the Midlatitude Continental Convective Cloud Experiment (MC3E).

• Hybrid bin-bulk scheme for the representation of the cloud hydrometeors (cloud droplet, cloud ice, rain, snow and graupel)

• The SIP mechanisms added following Phillips 2007; 2008; 2017a; 2017b
Ice Initiation Process

- Heterogeneous ice nucleation (from aerosol species (active Ice Nuclei’s present in the atmosphere )

- Homogeneous freezing (Spontaneous freezing of the cloud droplets )
Secondary Ice Production

• Hallett-Mossop (Hallett and Mossop 1974)
  Small ice splinters break away during riming of supercooled cloud droplets larger than 24 µm, for temperatures between -3°C and -8°C.

• Ice-ice collisional breakup
  collisions involve ice crystal, snow, and graupel (Phillips et al., 2017)

• Raindrop freezing fragmentation
  Mode 1: collision between less massive ice particles and cloud droplets
  Mode 2: Collision of more massive ice particles with raindrops
Budget Analysis

Ice Number Concentration from the various microphysical process

- Primary Ice nucleation
- Ice-ice collisional breakup
- Raindrop freezing fragmentation
- Hallet Mossop
- Homogeneous freezing

Graph showing the distribution of ice number concentration with bars for each process and a pie chart indicating the contribution of each process:
- Primary Ice nucleation: 10%
- Ice-ice collisional breakup: 4%
- Raindrop freezing fragmentation: <1%
- Hallet Mossop: 2%
- Homogeneous freezing: 84%
