Memory properties in Cloud-Resolving Simulations of the Diurnal Cycle of Deep convection

Model description and simulations setup

MONC (the new Met Office NERC Cloud Model)

\[ X \times Y \times Z = 100 \times 100 \times 20 \text{ km}, \ \Delta Y = \Delta X = 0.2 \text{ km} \]

Surface fluxes are horizontally uniform. Half sine function for \( t = 0 - 12 \text{ h} \) and set to 0W/m² for \( t = 12-24 \text{ h} \). Peak values at \( t = 6 \text{ h} \).

Peak SHF=130 W/m², peak LHF= 400 W/m², and prescribed RC =−1.75 K/d

Memory within the convective system:

\[ M(A,t_0,\Delta t)= P[R(A,t_0)\cap R(A,t_0-\Delta t)] - P[R(A,t_0)] \times P[R(A,t_0-\Delta t)] \]

The probability of finding rain at time \( t_0 \) and at an earlier time \( t_0 - \Delta t \)

The probability of finding persistent rainfall by random chance (or the expected probability given no memory)

Memory function

Fig.1: Memory function for \( A=4 \times 4 \text{ km}^2 \) for different times after triggering \( (t_0) \). Control simulation

Fig.2: Memory function for different areas and \( t_0 = 3 \text{ hours} \) after triggering. Control simulation

The memory is strongest at grey-zone scales of \( 4 - 10 \text{ km} \) and has 3 phases; a 1st phase (persistence of convection for about 1 hr), a 2nd phase (suppression of convection in regions which were raining 1 to 3 hours previously), and subsequently, a 3rd phase (a secondary enhancement of precipitation in regions which were previously suppressed).

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Impact of initial thermodynamic variability

Homogenization, \[ \frac{\partial x_{ij}^k}{\partial t} = -\frac{1}{\tau} (x_{ij}^k - \bar{x}_i^k) \] is applied:

- to temperature and specific humidity of water vapour between hours 15-24
- at all vertical levels (greatest impact when applied below 4km)
- The evolution of convection on the next day, following homogenization (H), is compared to that in the control simulation (C)

Impact of initial thermodynamic fluctuations residing in the lower troposphere.