Initiation of deep convection by boundary-layer convergence lines during TRACER

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1. Introduction

- Deep convective initiation involves multiple nonlinear processes across scales, including energy buildup (CAPE), inhibition (CIN), and turbulent dynamics.
- Organized convergence lines generate stronger and wider updrafts, enhancing cloud development compared to common turbulent thermals.
- Proposed mechanisms include reduced dry entrainment, stronger cloud-base vertical motions, and sustained updrafts leading to less diluted, buoyant clouds.
- Current NWP and GCM models struggle to resolve the fine-scale processes of DCI, often leading to delayed or inhibited convection in simulations.
- Objectives:
    1. *Determine the impact of convergence lines on the dynamics and thermodyamical structure of updrafts they trigger.*
    2. *Assess the impact of convergence lines on the entrainment experienced by associated updrafts.*
    3. *Quantify preconditioning by updrafts triggered by convergence lines*

2. Methodology

Our analysis uses numerical models with a combined Eulerian and Lagrangian approaches:

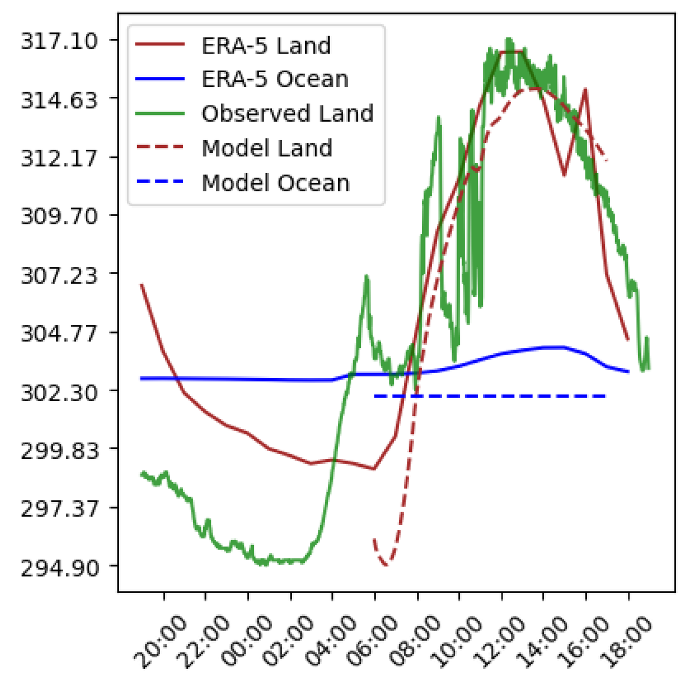
CM1:
- Nonhydrostatic, nonlinear mesoscale model using a height-based vertical coordinate.
- Suitable for LES of dry and moist convection with flexible lateral boundary conditions.
- Offers efficient integration at high resolution with inline passive tracer and parcel-tracking capabilities.
- Provides detailed momentum and thermodynamic budget outputs.

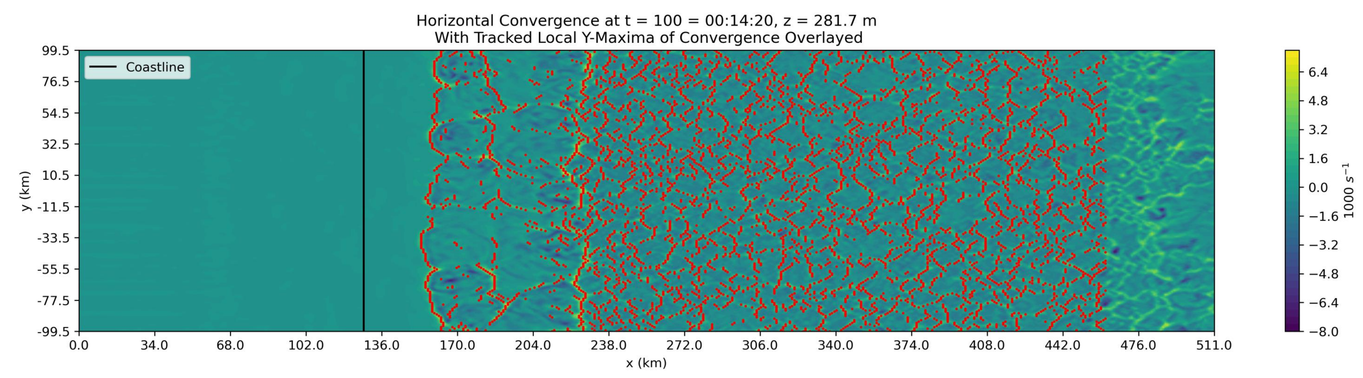
Lagrangian Particle Dispersion Model (LPDM):
- Tracks Lagrangian particles to study mesoscale and cloud-related circulations.
- Inline coupling with CRM models allows for high-resolution process studies.
- Planned integration with WRF leverages prior successful implementations and minimizes development time.
- Equipped to handle large datasets, with dedicated storage and analysis tools already in place.

3. Case Study

We selected a case study from TRACER observations that showcased a clearly defined convergence line, serving as an ideal example for our analysis:

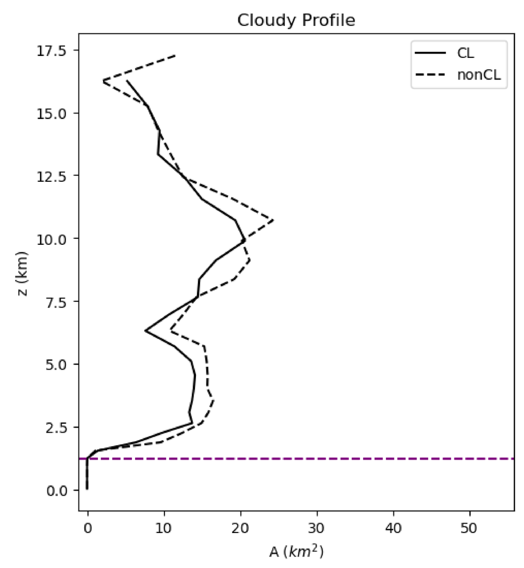
- CM1 is initialized and forced at the boundary with data from TRACER.
- This allows us to closely replicate the observed convergence line and its role in triggering convection.
- Model and observations compare well.
- We created a tracking algorithm that leverages horizontal wind convergence to identify and track the convergence line

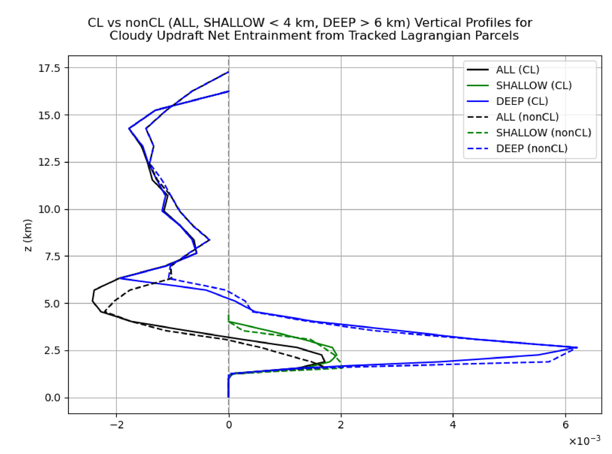


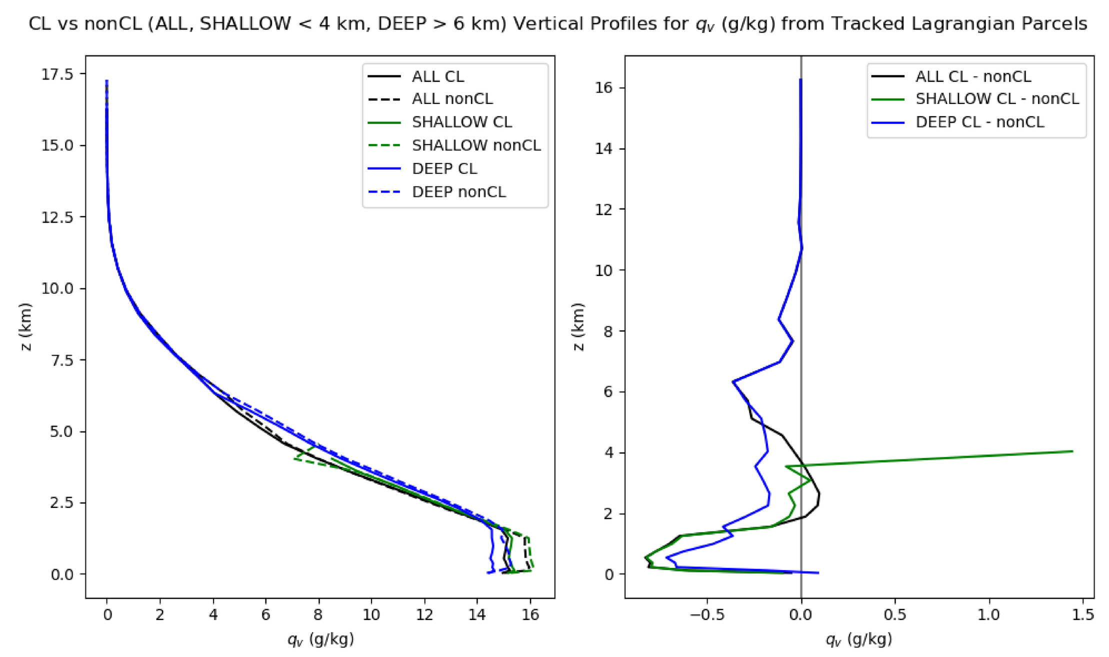


4. Preliminary Results

- We distinguish between particles that enter clouds after interacting with convergence lines in the PBL (CL) and those that are not affected by convergence lines (nonCL).
- Clouds containing CL particles are overall smaller than those with nonCL particles
- CL particles are also drier by as much as 0.5 g/kg than nonCL particles, consistent with mechanical forcing by the gust front of convergence lines.
- Net entrainment rates between the two categories are overall similar.







Acknowledgments

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