

## **Toward realistic cloud transitions during cold air outbreaks in ModeE**

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Cold air outbreaks (CAOs) often transition from near-overcast cloud streets into broken, open-cellular clouds downwind. NASA's ACTIVATE campaign collects in-situ and remote sensing observations of atmospheric constituents during CAOs in the NW Atlantic. We simulate CAOs in DHARMA LES and ModeE SCM, each using a domain following the marine boundary layer (MBL) flow and provided with MERRA-2 boundary conditions and in-situ observed aerosol profiles.

Using LES, we show that transitions are initiated by substantial rain, acting to stratify the MBL and deplete cloud condensation nuclei (CCN). We investigate the role of frozen hydrometeors to accelerate cloud transitions and further show several meteorological drivers of transitions that can vary both across and within CAO cases. Lastly, we show a first evaluation of SCM's ability to capture transition-initiating rain and CCN depletion and note outstanding uncertainties in warm and cold precipitation formation.