Influences of Aerosol and Cloud Processes on Climate

A joint ASR Science Focus Area Research Project:
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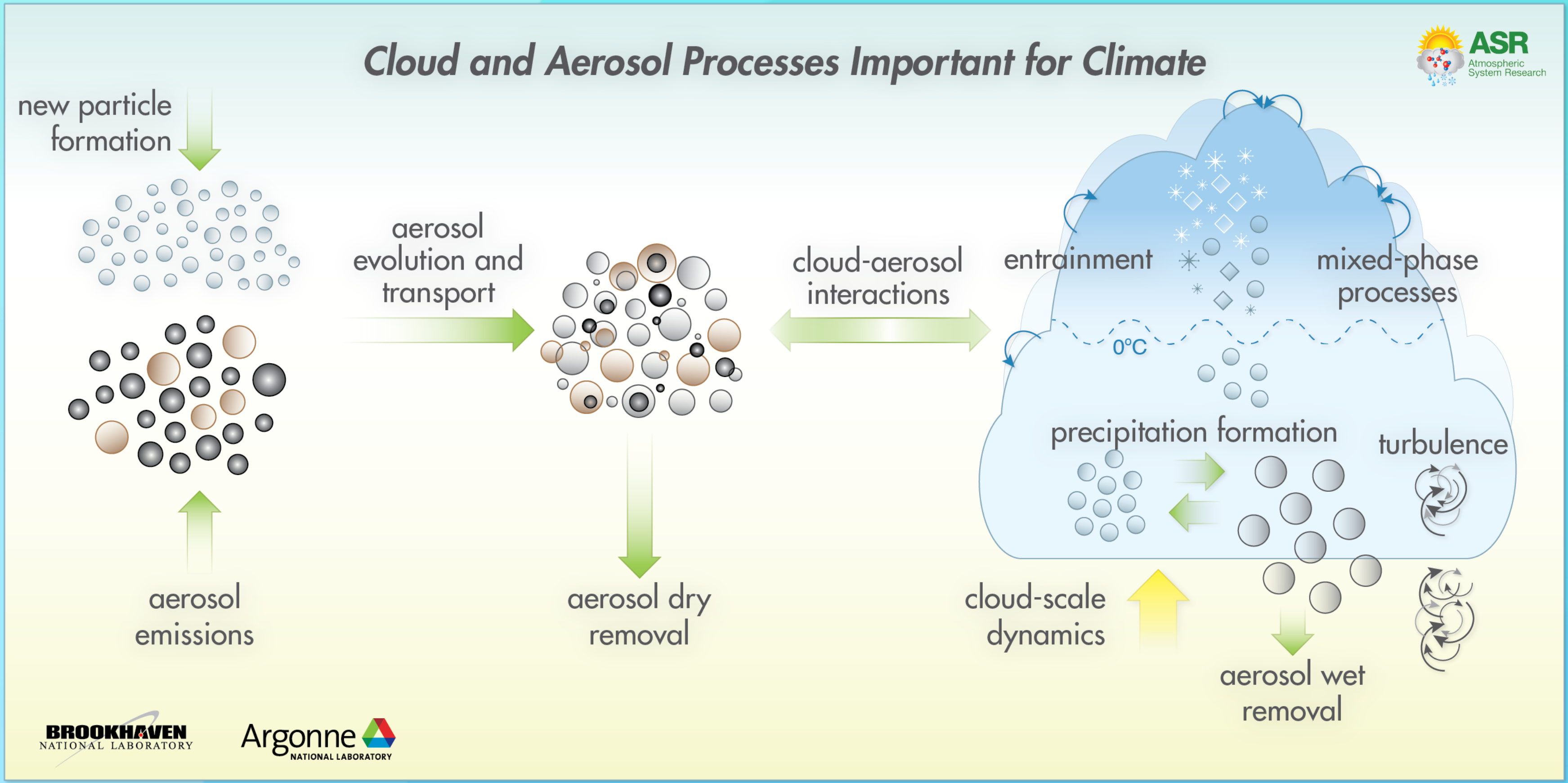

Focus on linking process-level analyses with process-scale modeling for sub-grid scales that influence cloud and aerosol lifecycle and radiative impacts.

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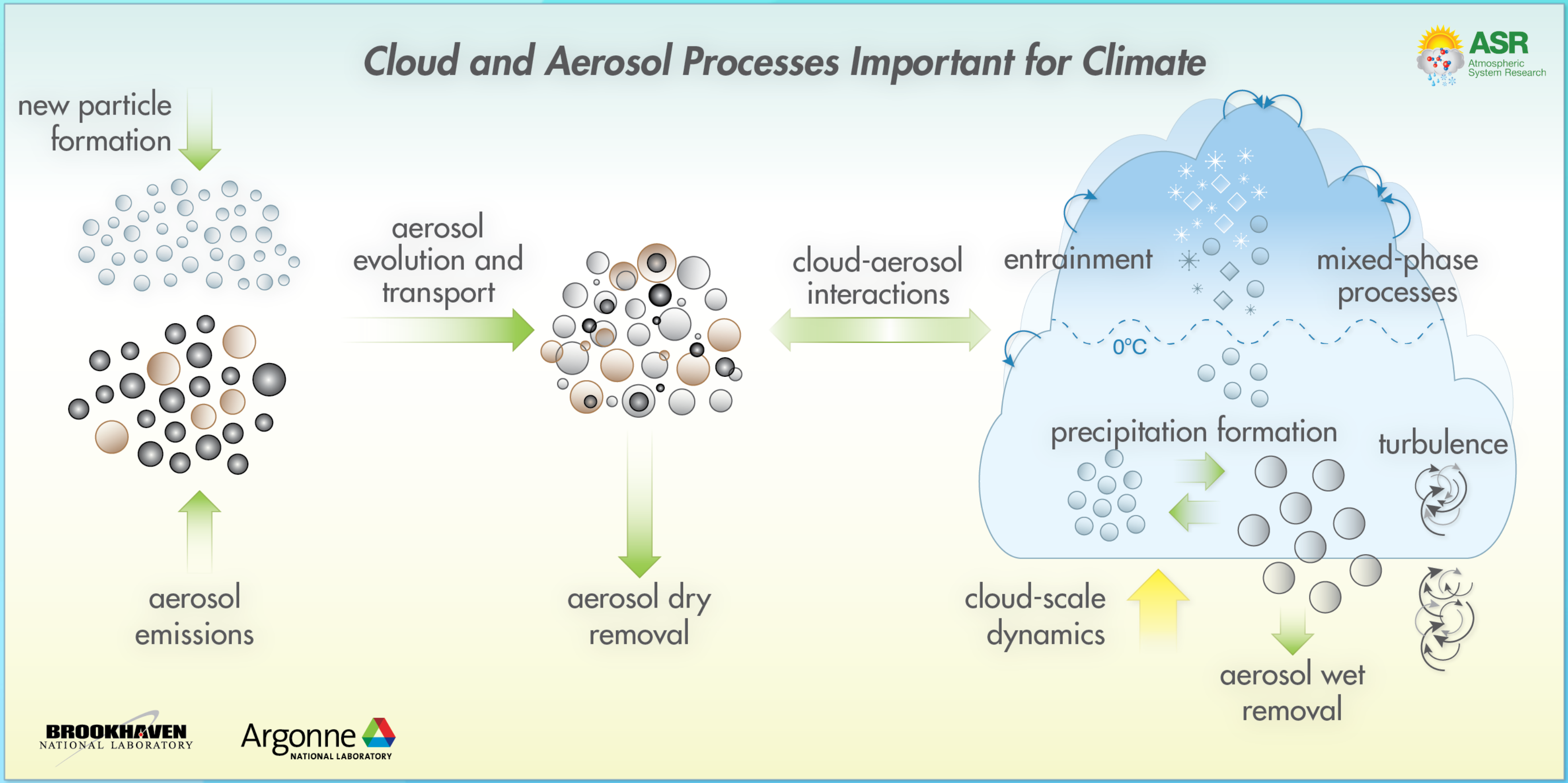


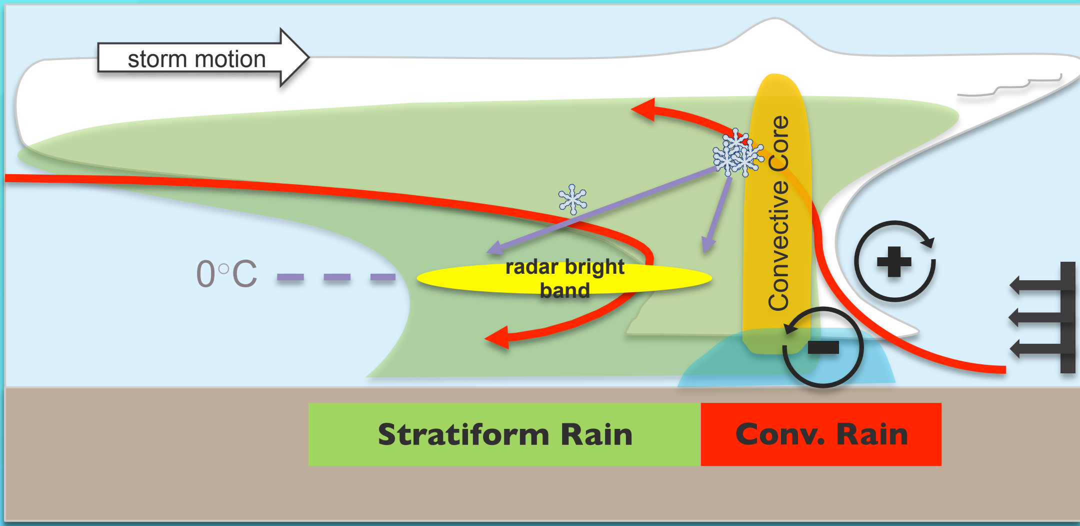
Cloud Properties and Processes Research Topics

- Warm boundary layer cloud processes (cloud-drizzle, mesoscale org., ACI)
- Controls on mixed-phase supercooled liquid fraction
- Deep convective core properties and mesoscale organization

Research Plan: Deep Convective Cores and Organization

Motivation

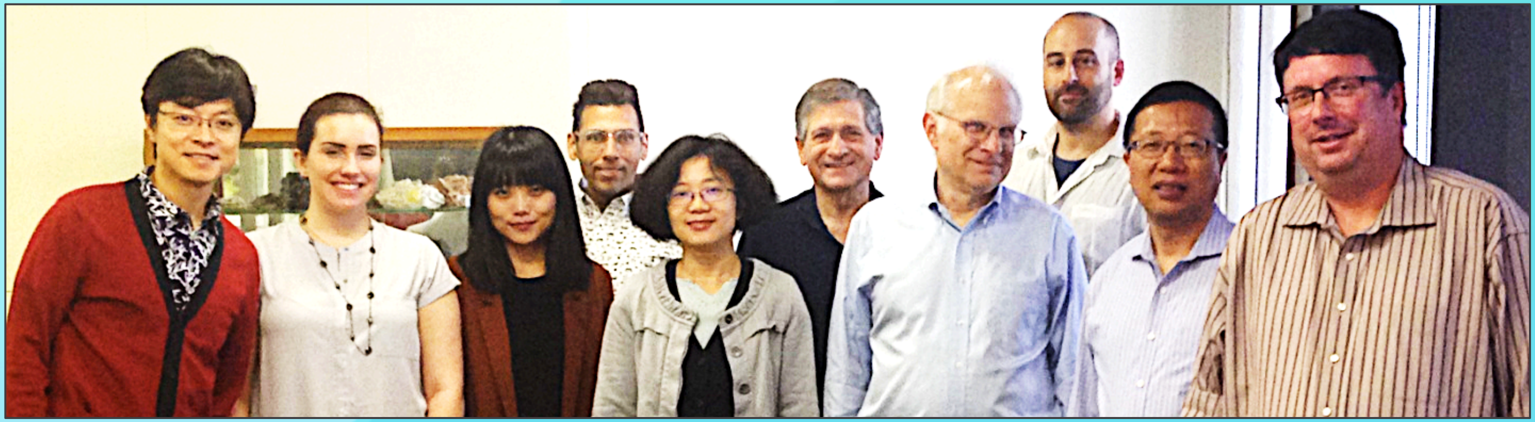
- There is a dearth of observations relating updraft core size and intensity to environmental conditions.
- Composite heating profiles provide a measure of convective organization



Approach

- Determine core size and intensity relationships for a variety of larger-scale conditions.
- Employ model studies to better understand the underlying physics of these relationships.
- Use ARM observations to determine the evolution of vertical velocity and its relation to convective plume entrainment, detrainment and changes in latent heating.
- Explore links between mesoscale organization and latent heating to refine GCM treatments

New York City-area Convective Collaboration (NYC3)



- SFA brings together local expertise in state-of-the-art observations, process analysis and convective parameterization.

- Target fundamental convective processes and dynamics that require observational grounding.

- Topics of focus include:
  - Vertical Velocity
  - Latent Heating
  - Convective Organization

<u>SFA Deep Convective Researchers</u>
Scott Giangrande
Mike Jensen
Usama Aber (Postdoc)
Die Wang (CMDV Postdoc)

Convective Processes:
Mesoscale Convective System (MCS) Updraft and Downdrafts

Poster A1-103

Motivation

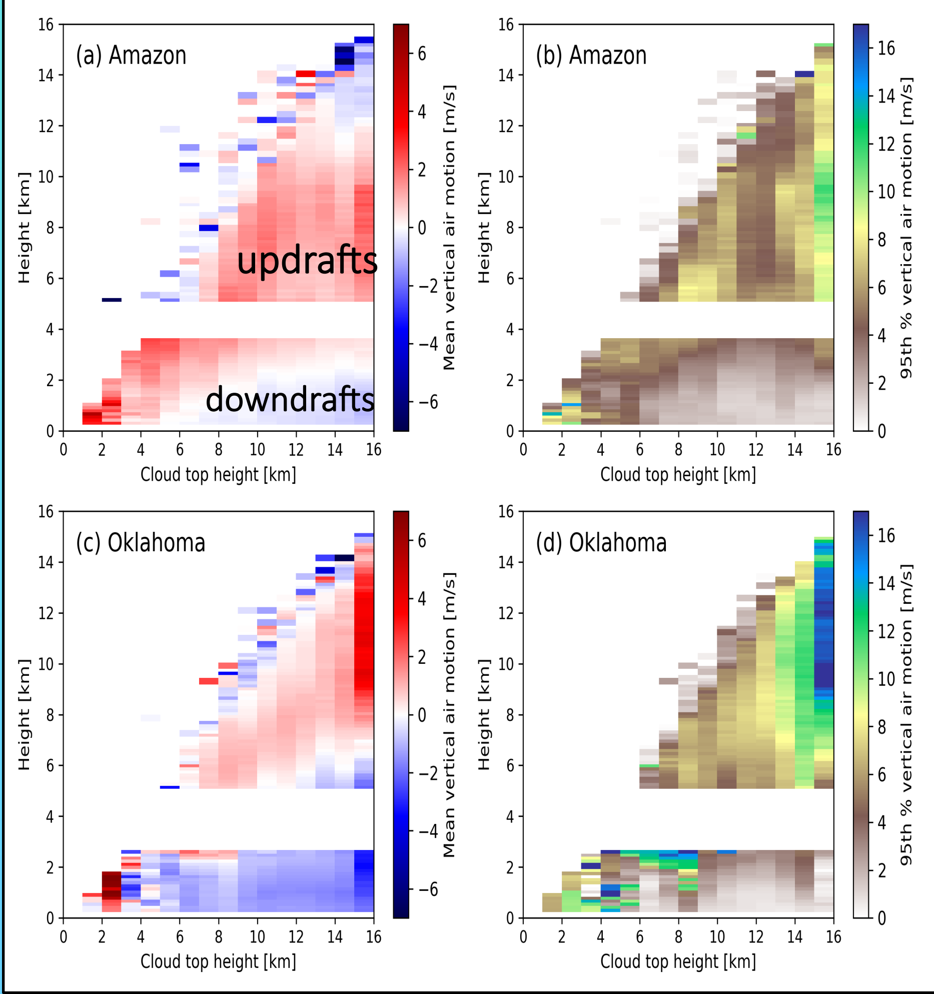
- Investigate MCS kinematic structure using unique ARM RWP datasets and contrast MCSs observed during tropical and midlatitude deployments.

Approach

- Compare the kinematic structures, cold pool properties, and precipitation associated with mature MCSs over SGP and MAO.
- These efforts couple RWPs, surface measurements, and radiosondes.

Results

- MCSs at MAO and SGP often share similar rainfall rate, cold pool properties, and inferred mixing rates for low-level downdrafts.
- SGP systems show more intense up- and downdrafts, and downdrafts originating at higher altitudes.



Wang, D., **Giangrande, S. E.**, Schiro, K.**, Jensen, M. P.**, Houze, R. A., 2019, The characteristics of tropical and midlatitude mesoscale convective systems as revealed by radar wind profilers. *JGR: Atmospheres*, 124, 1–19. doi:10.1029/2018JD030087

Convective Processes:
Entrainment in Deep convection Over the Amazon

Poster A1-066

Motivation

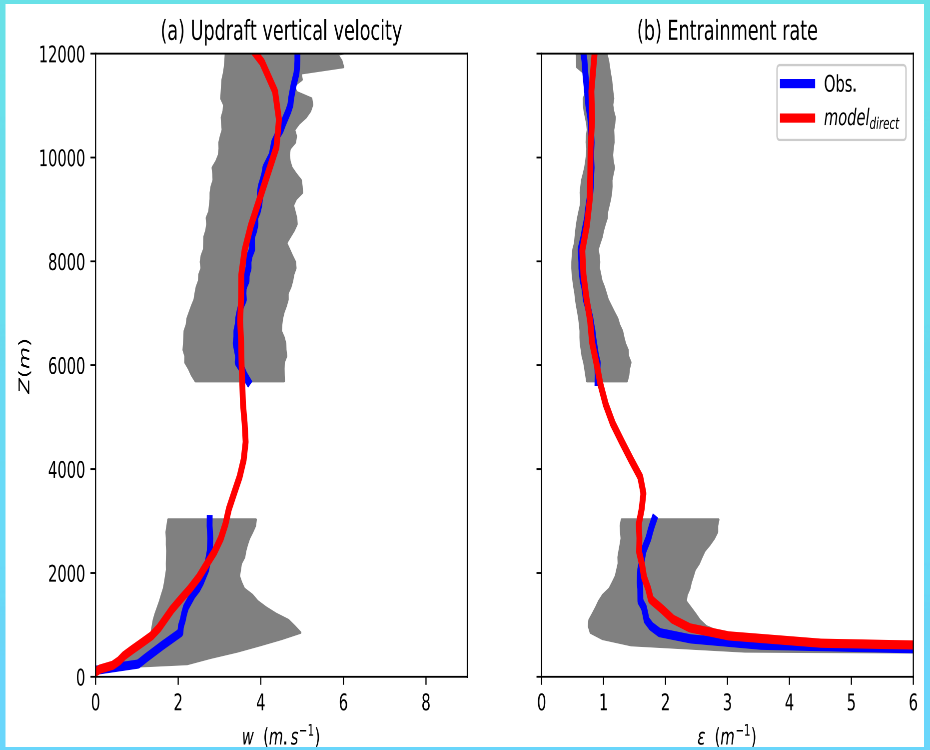
- Seek relationships between convective entrainment and environmental or cloud-scale variables

Approach

- Combine CRM simulations with observations from GoAmazon 2014/15

Results

- Entrainment scales inversely with the strength of the updraft vertical velocity (w)
- Entrainment rate profile can be inferred from the observed w



Advocate relationship between entrainment and updraft vertical velocity

Anber, U., S. E. Giangrande, L. J. Donner, and **M. P. Jensen**, 2019: Updraft Constraints on Entrainment: Insights from Amazonian Convection. *J. Atmos. Sci.*, doi:10.1175/JAS-D-18-0234.1.

Convective Processes:
LNB, Mass Detrainment, and Entrainment in Tropical Deep Convective Clouds

Poster A1-084

Motivation

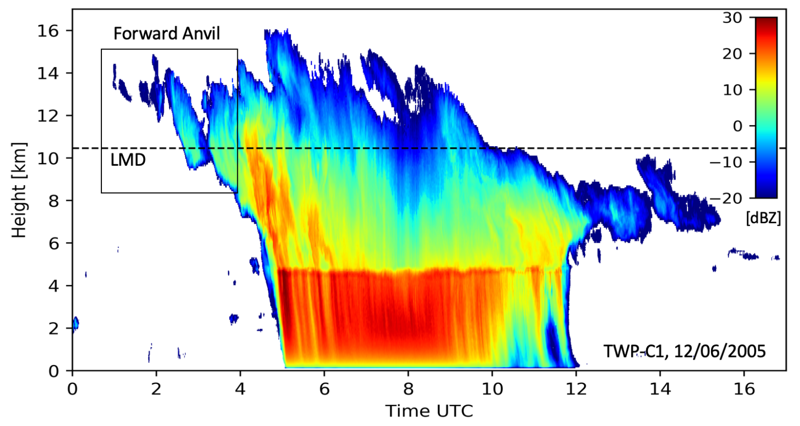
- To investigate the bulk entrainment rate of deep convective clouds using ARM observations, and how these related to environmental properties.

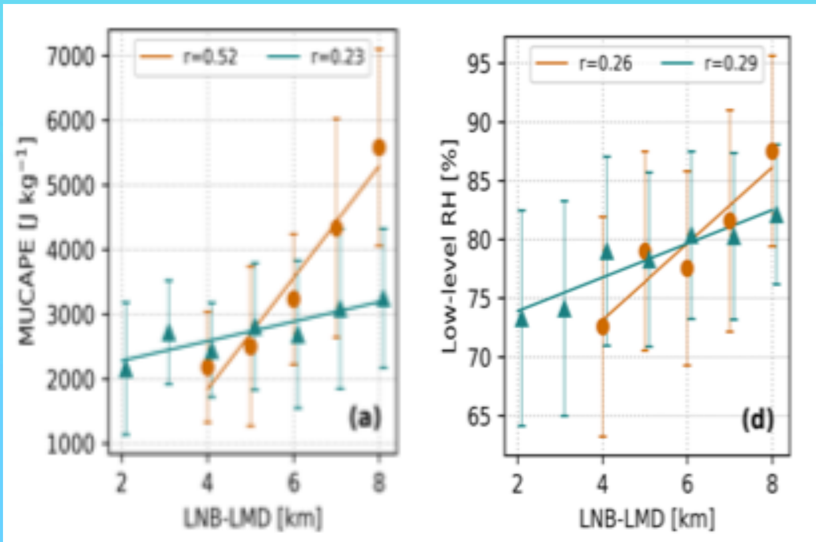
Approach

- Estimate LMD from radar observations and LNB for deep convective events.
- Six ARM sites in the Tropics (TWP-Manus, TWP-Nauru, TWP-Darwin, AMF-NIM, AMF-GAN, AMF-MAO)
- (LNB-LMD) is used as a proxy for bulk entrainment rate.

Results

- Entrainment tends to be more efficient for the events having larger CAPE, lower CIN (flatter ELR), and higher low-level RH.
- Deep convective cases that have stronger cold pools are less affected by the entrained air.
- Continental cases show higher correlations over all, compared to oceanic counterparts.





Impacts of Observational Error Sources on Multi Doppler Radar Vertical Air Motion Retrievals

Motivation

Evaluate uncertainties in multi-Doppler retrievals of convective vertical velocities.

Approach

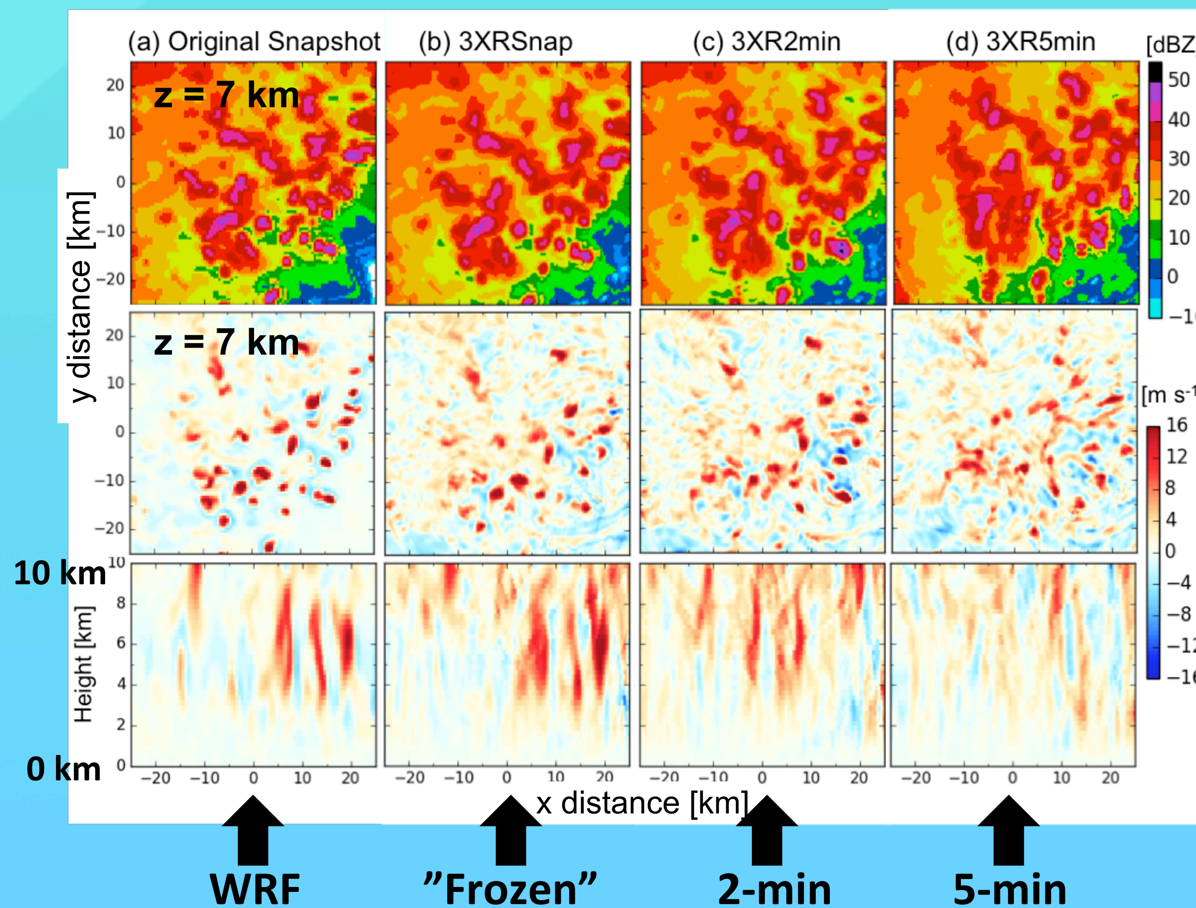
Quantify uncertainties from observational sampling limitations in 3D wind retrievals using CR-SIM

Results

Multi-Doppler retrievals have considerable limitations above 6 km (lack of measurements) and beyond 2 min. sampling.

Increasing the number of high elevation tilts improves the retrievals

Simulated radar reflectivity and vertical velocity



Software and documentation available at: https://www.bnl.gov/CMAS/cr-sim.php

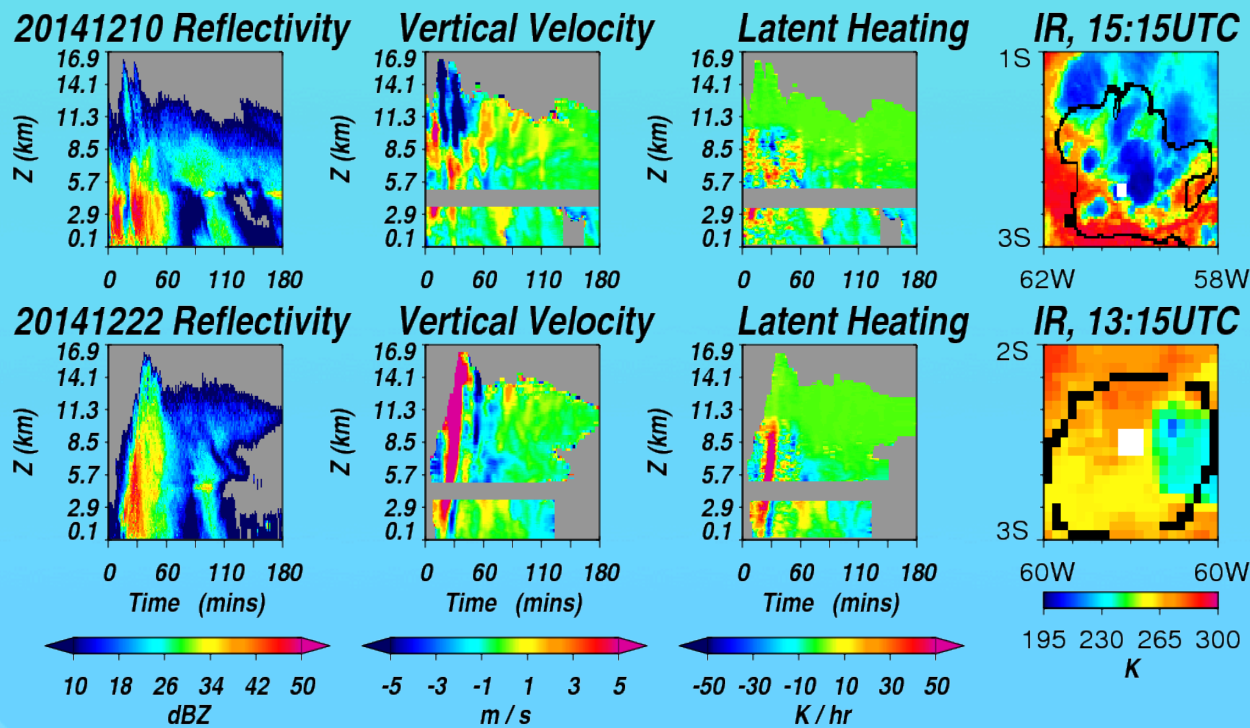
Oue, M., P. Kollias, A. Shapiro, A. Tatarevic, and T. Matsui, 2019: Investigation of observational error sources in multi-Doppler-radar three-dimensional variational vertical air motion retrievals, *Atmos. Meas. Tech.*, **12**, 1999-2018, doi:10.5194/amt-12-1999-2019.

Convective Processes:
Convective Mass Flux and Latent Heating Profiles

How do convective mass flux and latent heating profile structures relate to the current spatial extent (and subsequent change) of the convective system cloud shield?

Approach

- RWP used to estimate convective and stratiform vertical velocities.
- VV combined with reflectivity enables direct parameterization of the condensation-evaporation and latent heating. shows evolving MCS cloud shields for six cases (Min et al. 2013).
- Ongoing collaboration with Greg Elsaesser, NASA GISS.



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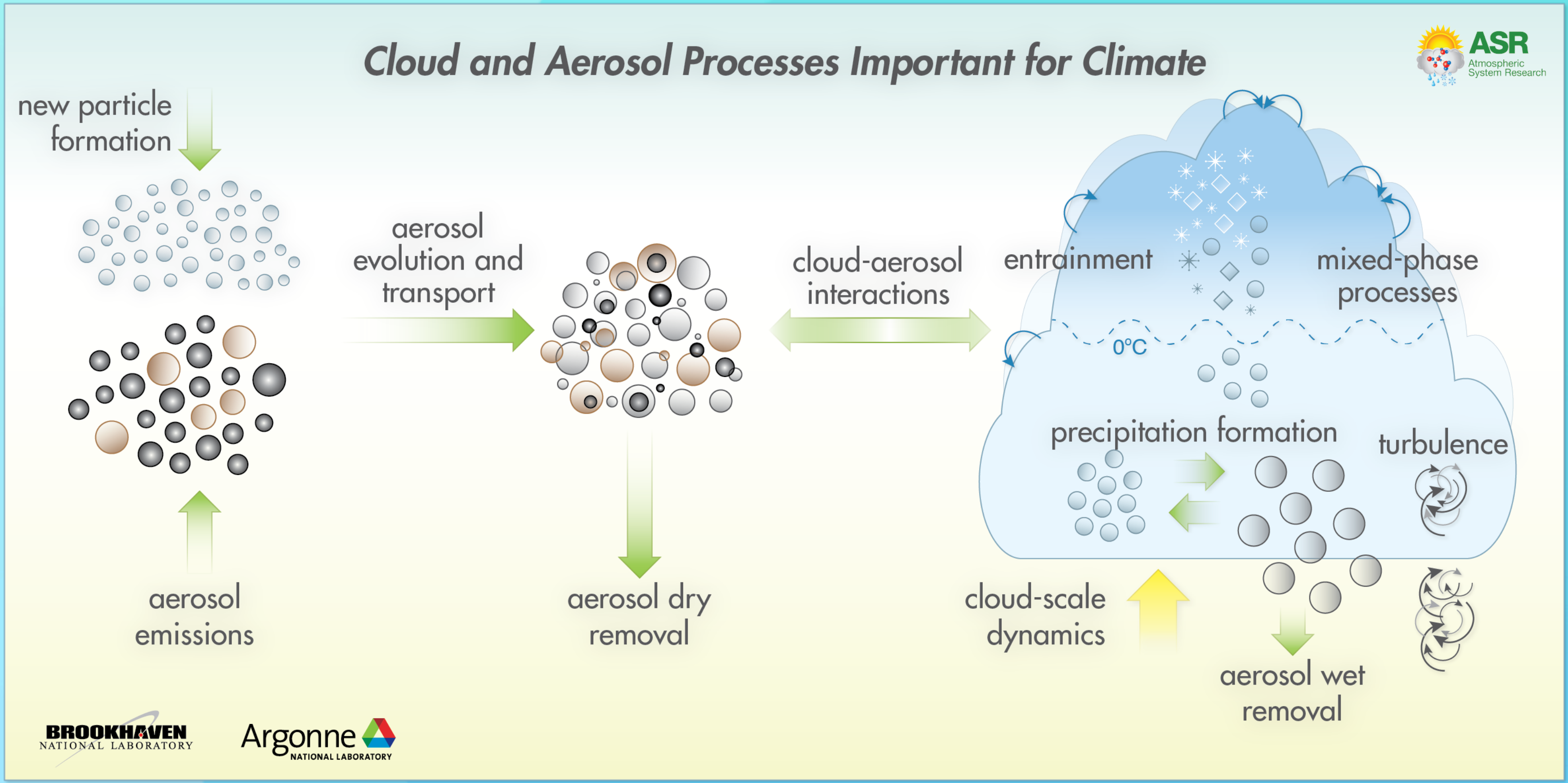

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