Convective-Stratiform-Anvil Transition (CStAT) Focus Group

Xiquan Dong, Jiwen Fan, Zhe Feng,
Ann Fridlind, Wojtek Grabowski,
Robert Houze, Mike Jensen, Sally McFarlane,
Courtney Schumacher, Wei-Kuo Tao,
Adam Varble, Christopher Williams, Ping Zhu,
and Edward Zipser

ASR Cloud Lifecycle Focus Groups

* Madden-Julian oscillation
* Convective triggering
* Deep convection lifecycle
* Heating profile
* Convective-stratiform-anvil transition

ASR Cloud Lifecycle Focus Groups

* Madden-Julian oscillation
* Aerosol effects on deep convection
* Convective-stratiform-anvil transition
  * MC3E
  * AMIE
* Convective triggering
* Entrainment
* Vertical velocity
* Ice nucleation
* Ice physical and radiative properties

DRAFT White Paper

* Motivation
  * large spread in convection-generated ice and rain properties across cloud-resolving, regional and climate models
  * differing impacts on transports of moisture and momentum, latent and radiative heating rate profiles, and large-scale circulation
* Mission
  * to advance the observational description and model simulation of convective-stratiform-anvil transition

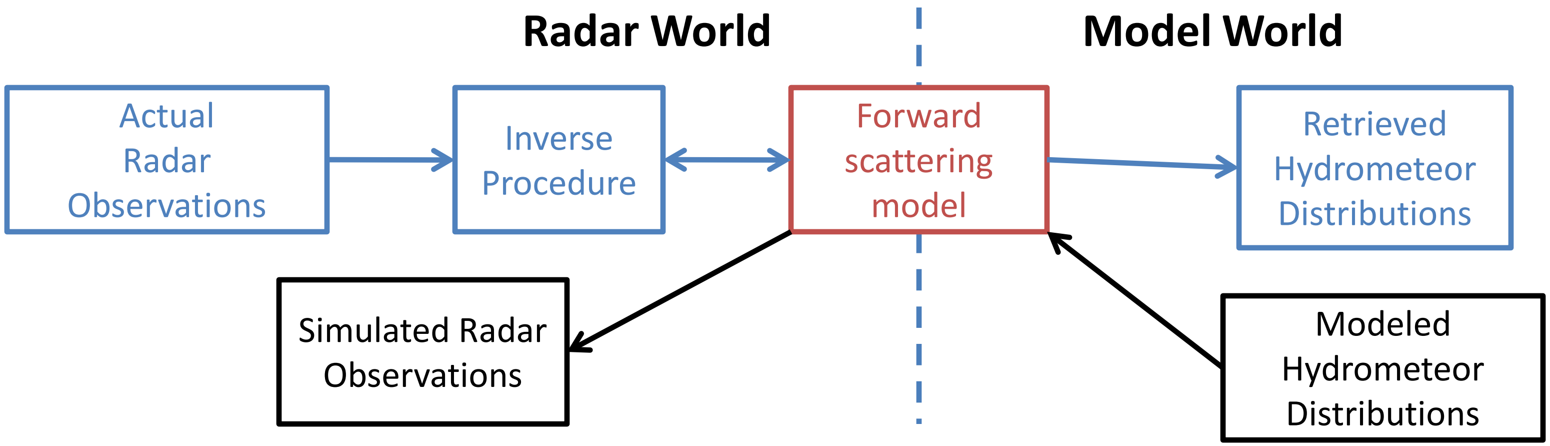
DRAFT White Paper

* Science questions
  * what structural properties should models reproduce and to what degree of accuracy?
  * what are the relative roles of environmental factors in determining structural properties?
  * how do errors impact simulated large-scale circulation?
* Objectives
  * determine important observational targets by model type
  * identify key differences between models and observations and their principal sources
  * identify key measurements, retrievals, or advances in model simulators needed to make further progress

DRAFT White Paper

- Approaches
  - close collaboration between modelers and observationalists
  - multi-observation approaches (e.g., collocated ground/satellite data, forward calculations)
  - IOP comparative case studies
  - constrain models, parameterization assumptions
- Metrics
  - "improved understanding of the factors controlling the transition from convective updrafts to stratiform precipitation to anvil"
  - "improved model simulations of deep convective cloud systems in all model types"

Proposed CStAT Task: Prototype a Single Column Instrument Simulator Module for ARM Radar Wavelengths



- Forward scattering model needed to
  - **invert** radar observations into hydrometeor distributions and
  - **convert** hydrometeor distributions into simulated radar observations

- **Propose** a task within the CStAT Focus Group:
  - Work toward developing an instrument simulator that promotes communication and synergistic activities between ARM / ASR observations and models.

- **Potential Future Application**: When the instrument simulator is good enough, model sensitivity studies could help specify ARM radar measurement sensitivities and uncertainty requirements.
  - For example, how sensitive do ARM radars need to be in order to detect aerosol cloud loading effects?

Proposed CStAT Task: Prototype a Single Column Instrument Simulator Module for ARM Radar Wavelengths

Objective

Prototype an **Instrument Simulator Module** that converts model generated hydrometeor distributions into simulated radar profiles at ARM radar wavelengths.

Scope

In order to show **proof-of-concept**, this task will ingest profiles of model hydrometeor distributions and simulate radar observations at 0.915, 35 and 94 GHz.

Inputs

Model hydrometeor distributions (e.g. size, habit, density)

Outputs

At ARM radar wavelengths, output will include **spectra** (effective reflectivity Doppler velocity spectral density, Ze(v)), **moments** (effective reflectivity, mean Doppler velocity, and spectrum width), and **attenuation** characteristics.

Prior Work

This task **will build off of previous radar simulators** developed within ASR to work toward a common Instrument Simulator Module available for the ASR community.

Method:

1) Convert model hydrometeor distributions at each model level into simulated radar obs.

2) Construct simulated profiles accounting for attenuation throughout the column

Radar Data Sets

MC3E field campaign radar observations at 0.915, 2.8, and 35 GHz (94 GHz in post-MC3E).

Model Data Sets

TBD

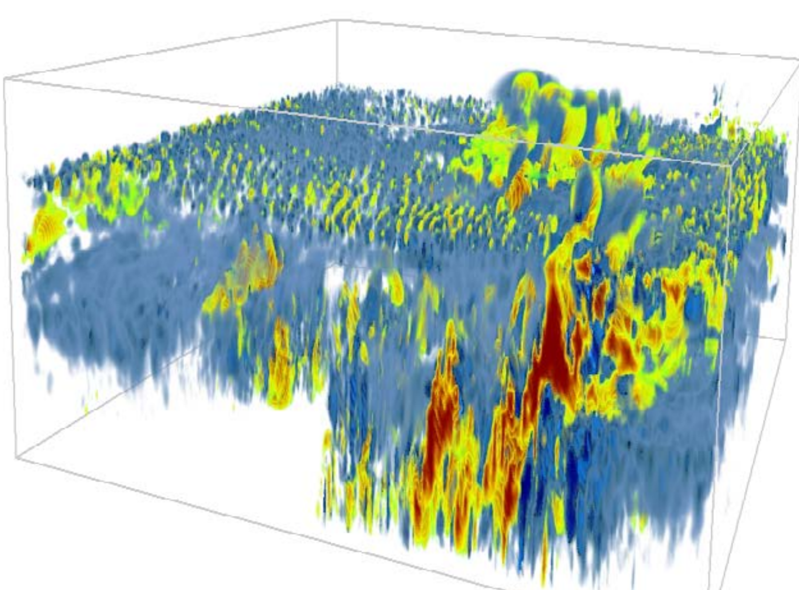
Investigators

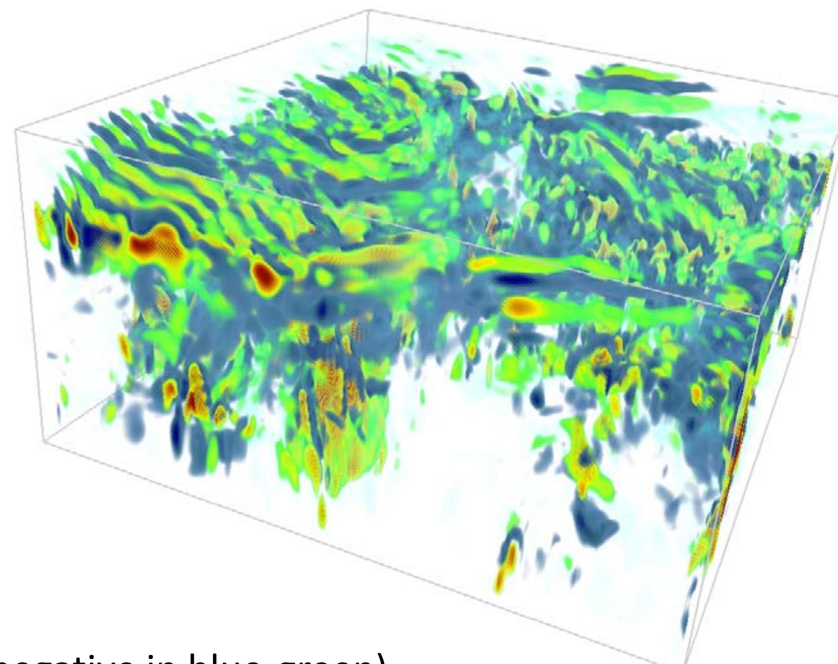
CR Williams invites 1-2 radar-users and 1-2 modelers to participate in developing prototype

Application of an isentropic analysis of convective motions* for filtering gravity waves

A. Mrowiec, O. Pauluis, A. Fridlind, A. Ackerman, J. Fan, A. Varble
(*funded by the DOE FASTER project)*

- Convective motions generate gravity waves that are spatially and temporally collocated with them
- When quantifying fluxes within convective and stratiform structures it is difficult to extract wave-free signal

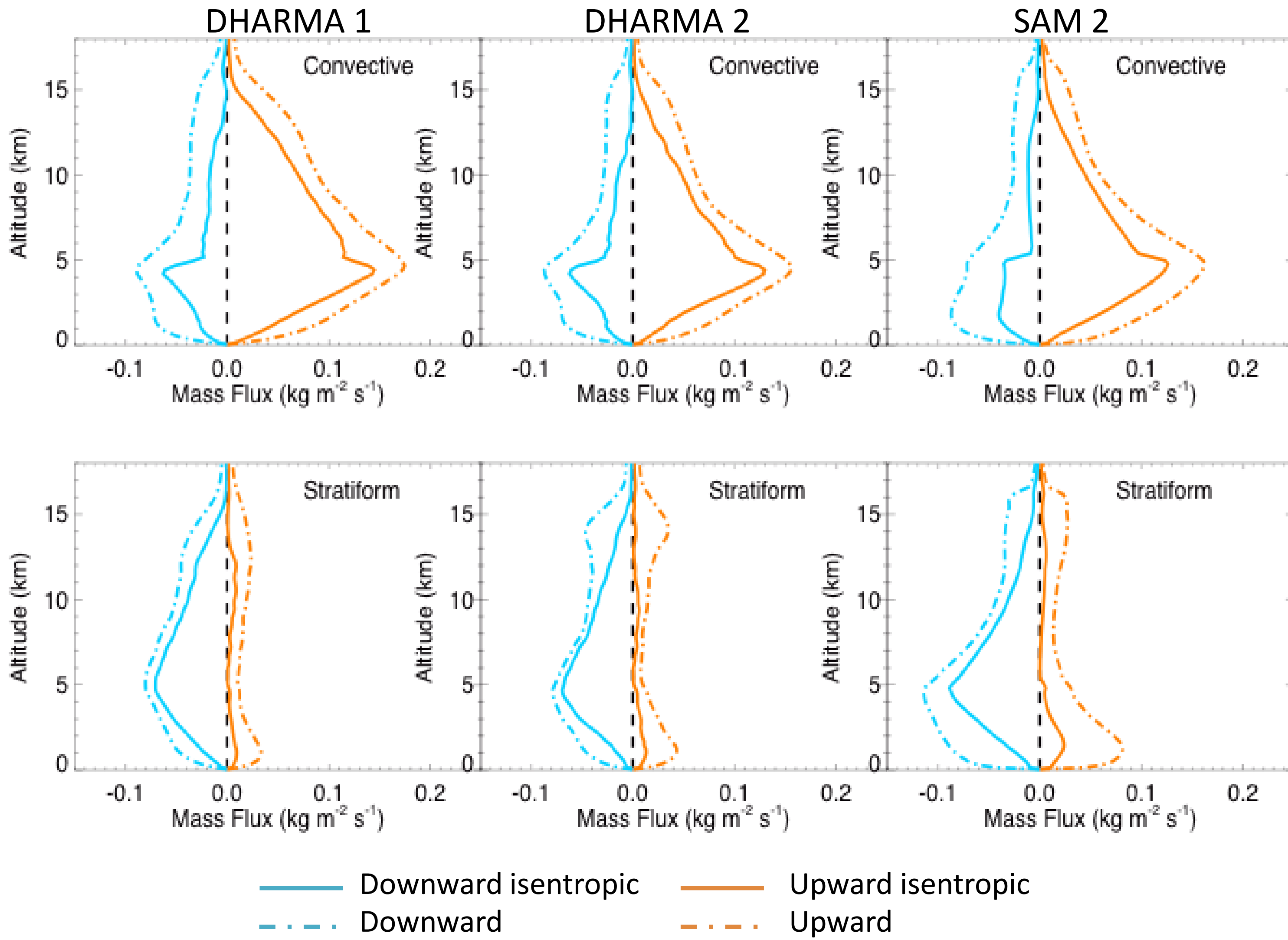




Model SAM 2, examples of convective motions
Vertical velocity field (positive in red – yellow, negative in blue-green)

* "Isentropic analysis of convective motions", O. Pauluis (in preparation)

Time averaged upward and downward mass flux in regular and isentropic framework



Mrowiec et al. (in preparation)

Discussion

- ASR focus groups
  - Need specific plans with tangible details and milestones
  - Clear prioritization of activities
  - Should have documented participation (who is participating and what will they be doing)
  - Need to facilitate work that would not otherwise occur and that is larger than a specific PI effort
- What opportunities do we see to develop joint projects or collaboratively reach goals (specific projects)
- What problems appear over and over + what could we do to address them? (also white papers; unified voice to advocate advancement of specific instruments, VAPs, IOPs, modeling, theory)