INCUS Synergy with LASSO

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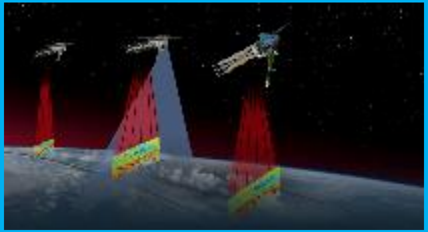
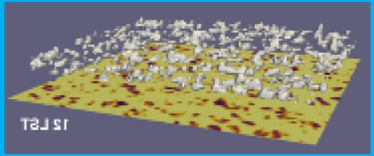
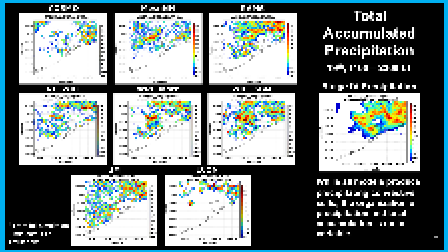


Satellite Observations
(INCUS)

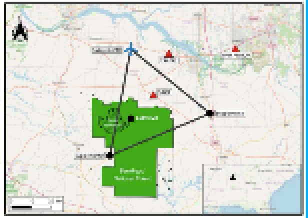


LASSO
(One Model,
Many Cases)

MIP
(Many Models,
Few Cases)



BNF Observations
(Remote & In Situ)



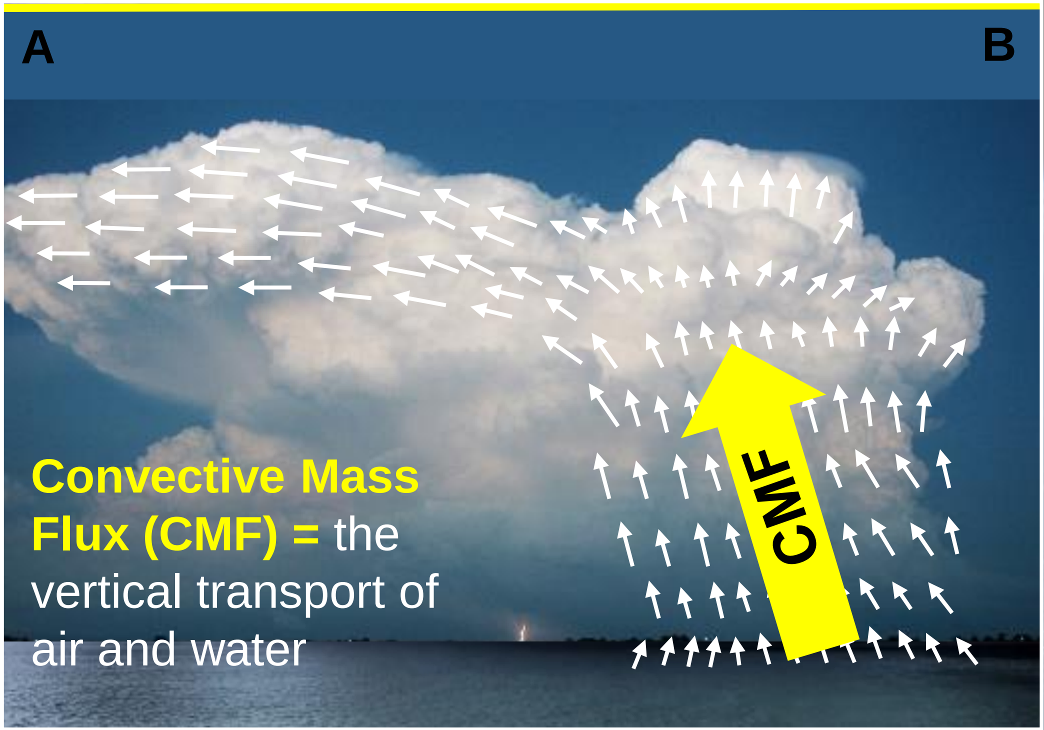
What LASSO and BNF activities could support future

Interagency collaborations (NASA INCUS)
&
Model Intercomparison Projects (BNF-MIP)?

INvestigation of Convective UpdraftS (INCUS)

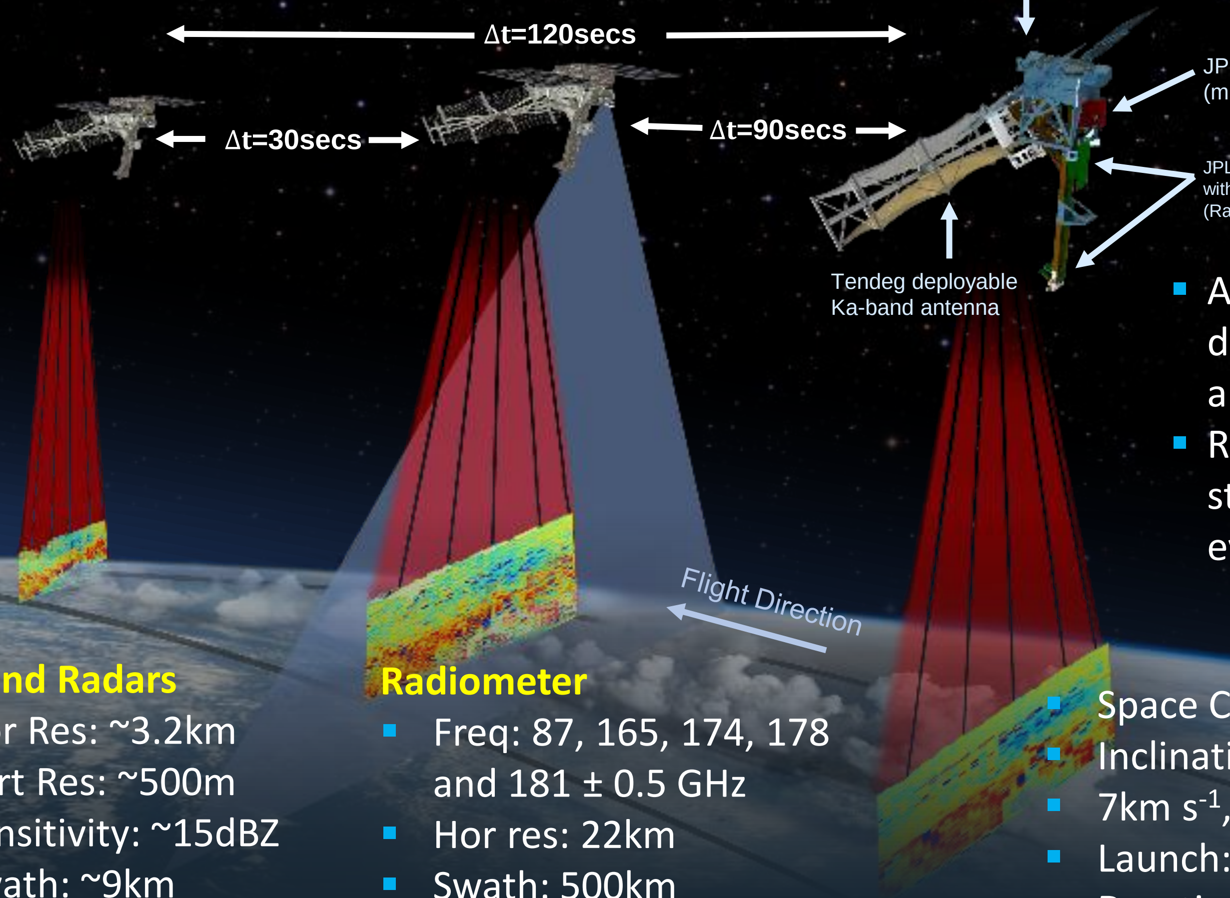
To understand why, when and where tropical convective storms form, and why only some storms produce extreme weather.

INCUS will provide the first ever tropics-wide observations of CMF within tropical convective storms



INCUS Baseline Mission

PI: Susan van den Heever, CSU
Deputy PI: Ziad Haddad, JPL
Project Scientist: Simone Tanelli, JPL
Project Manager: Yunjin Kim



- Applies a novel time-differencing (Δt =30, 90 and 120 sec) approach
- Rapidly sample the same storm systems to provide evolution of CMF

Ka-band Radars

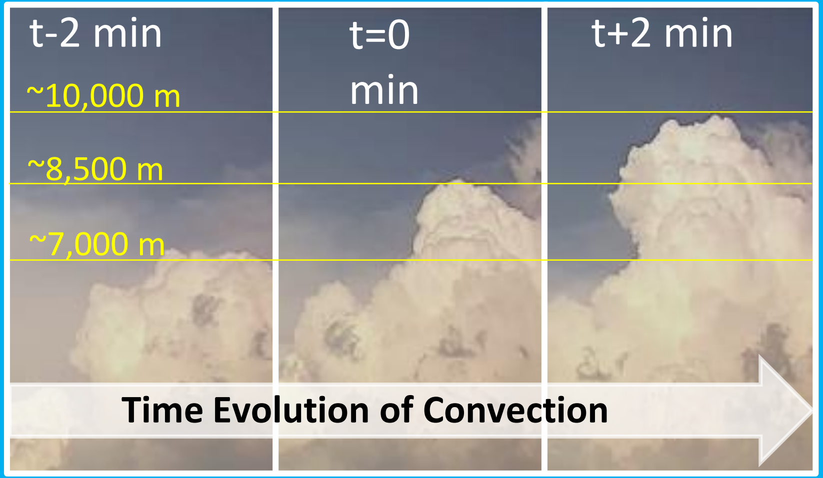
- Hor Res: ~3.2km
- Vert Res: ~500m
- Sensitivity: ~15dBZ
- Swath: ~9km

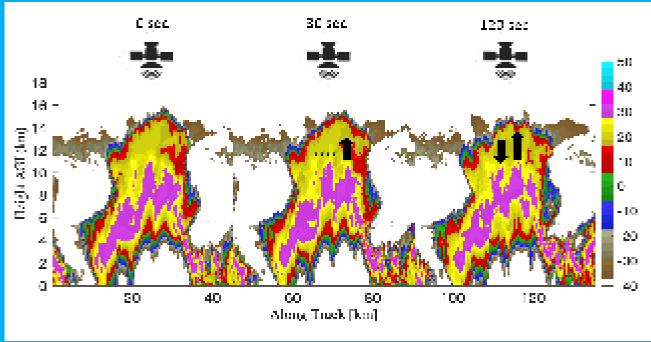
Radiometer

- Freq: 87, 165, 174, 178 and 181 ± 0.5 GHz
- Hor res: 22km
- Swath: 500km

- Space Craft: 100kg
- Inclination: tropical (35 to 39°)
- 7km s^{-1}, 95 minute orbit, 15x per day
- Launch: August 2026
- Duration: 2 years

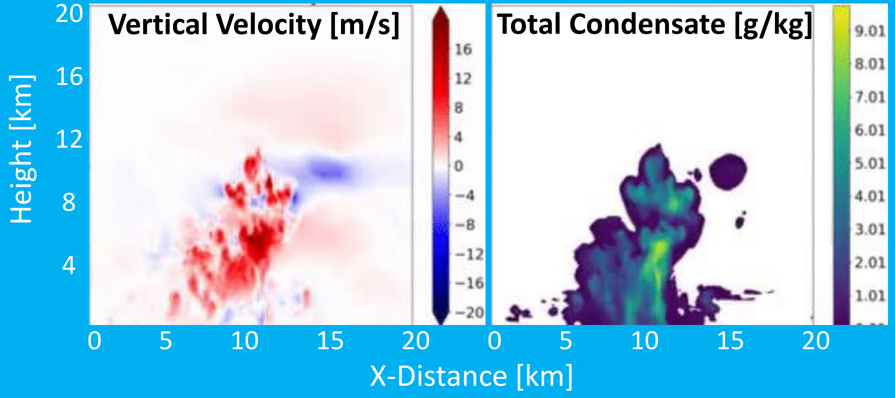
Unique Time Differencing (Δt) Approach





Observing System Simulation Experiments (OSSEs): GATE Simulation using SAM – demonstrating INCUS Δt concept (provided by Pavlos Kollias)

Model Evolution of Convection



W of 15 $m.s^{-1}$ corresponds to ~1$km.min^{-1}$

Rapidly sampling of cloud system in time provides information on storm motion and CMF

INCUS Science Objectives

Objective 1: ENV → CMF

Determine environmental properties controlling CMF

Objective 2: CMF → High Clouds

Determine relationship between CMF and high anvil clouds

Objective 3: CMF → Current and Future Weather

Determine CMF relationship to type and intensity of convection

Objective 4: CMF in Models

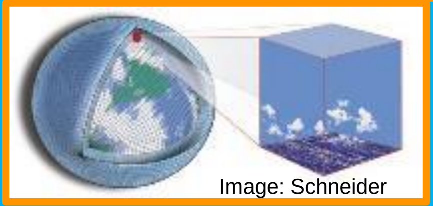
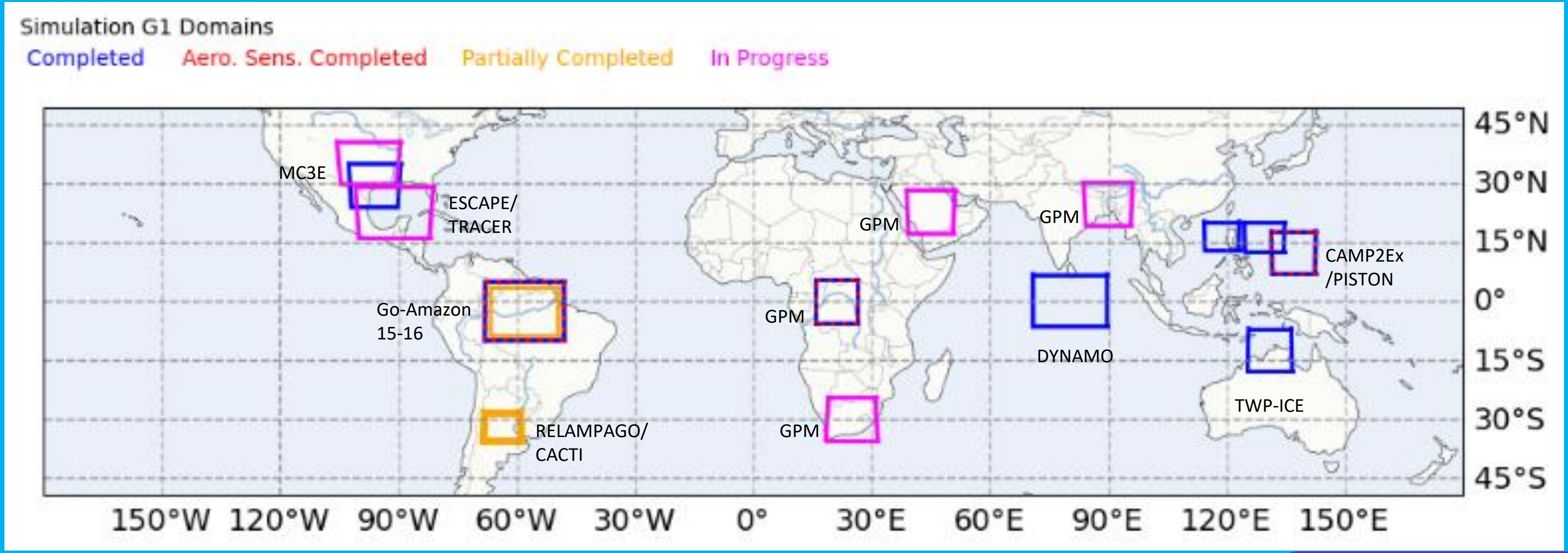
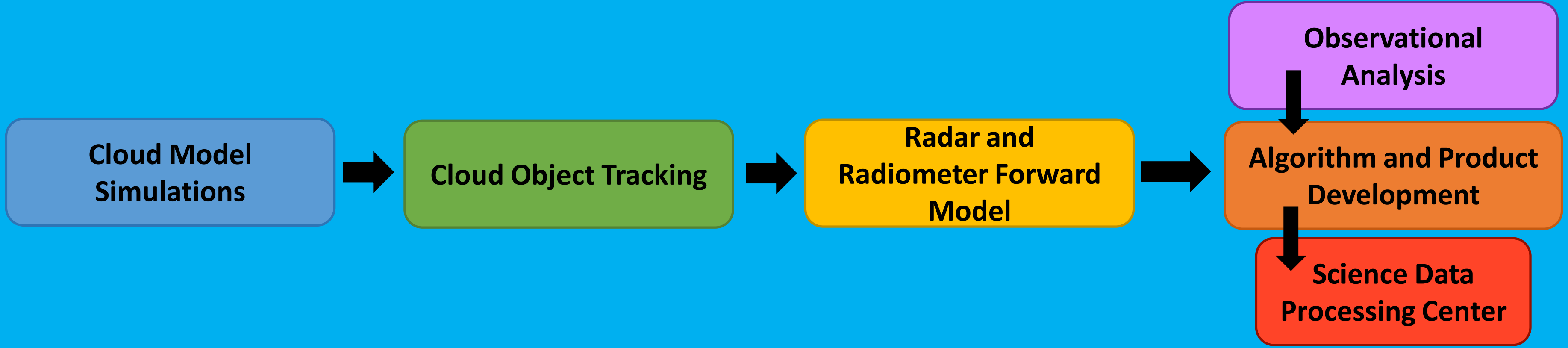


Image: Schneider

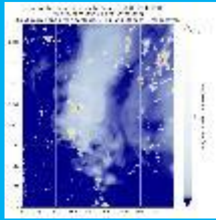
Evaluate CMF observational relationships in models.

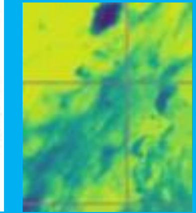
INCUS LES Simulation Database



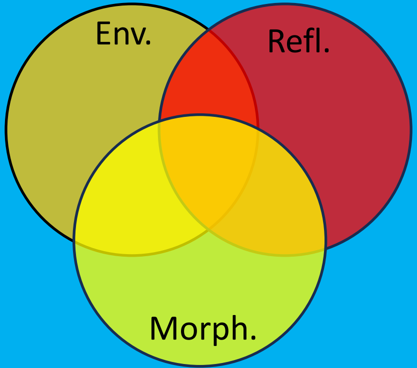


INCUS Model Evaluation Plan



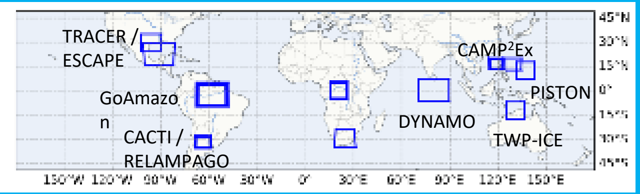


- 1. Individual Simulation Evaluation
  - Are we reproducing desired convective features from targeted cases?
  - Quick assessments built into modeling workflow



- 2. INCUS LES Model Database Evaluation
  - Are there gaps in the INCUS Model Database that will impact INCUS algorithm development
  - Different perspectives (e.g., environments, morphologies, reflectivity)

- 3. Case Study Analyses
  - Can we exploit our simulations and observations to advance our science understanding and/or models
  - For subsequent, convergent science



Model Intercomparison Projects

For aerosol-cloud interactions:
(ACPC-MIP, TRACER-MIP)

LASSO SGP Ensembles VS. ACPC MIP

One Model , Many Cases

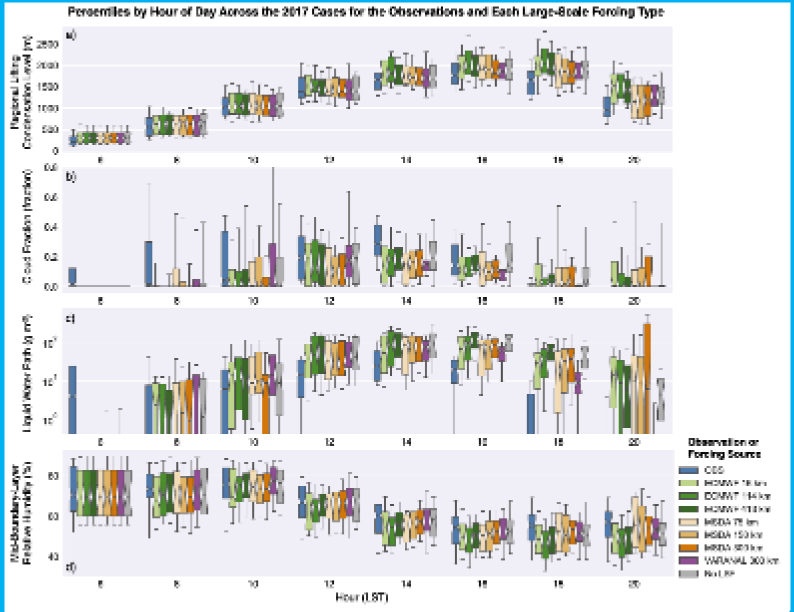


Fig. 7. Percentiles by hour shown as box-and-whisker plots for the observations and LES results across the 30 case dates from 2017. Variables shown are (a) the LCL (m), (b) cloud fraction (fraction), (c) in-cloud LWP (g m⁻²), and (d) mid–boundary layer relative humidity (%). Observations are in blue and the large-scale forcings for the LES are shown by color as follows: different ECMWF forcing scales in green, different MSDA

Gustafson et al. (2020,BAMS)

One Case , Many Models

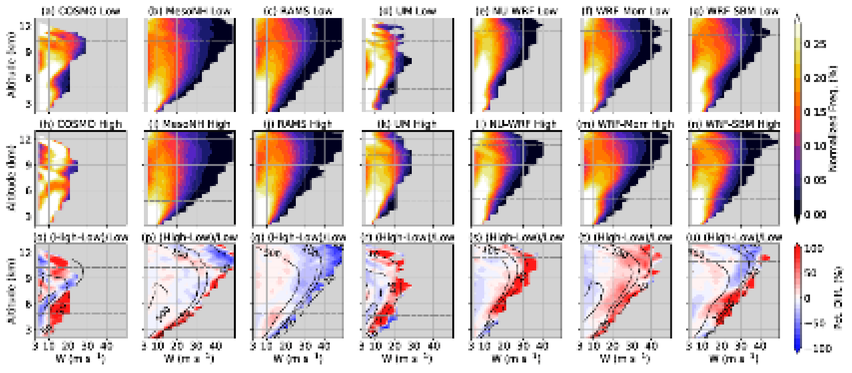
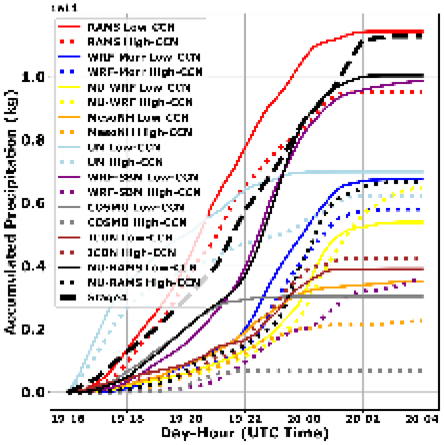


FIG. 9. CFADs of vertical velocities within the deep convective updrafts, as defined in the text. As in Fig. 7, except that the frequencies are normalized for the total number of grid points at that altitude.

Marinescu et al. (2021,JAS)



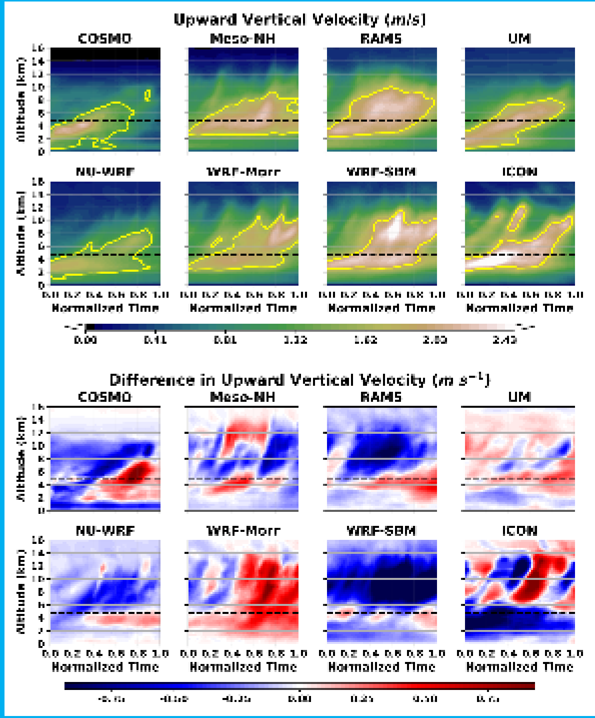
van den Heever et al. (2025,BAMS)

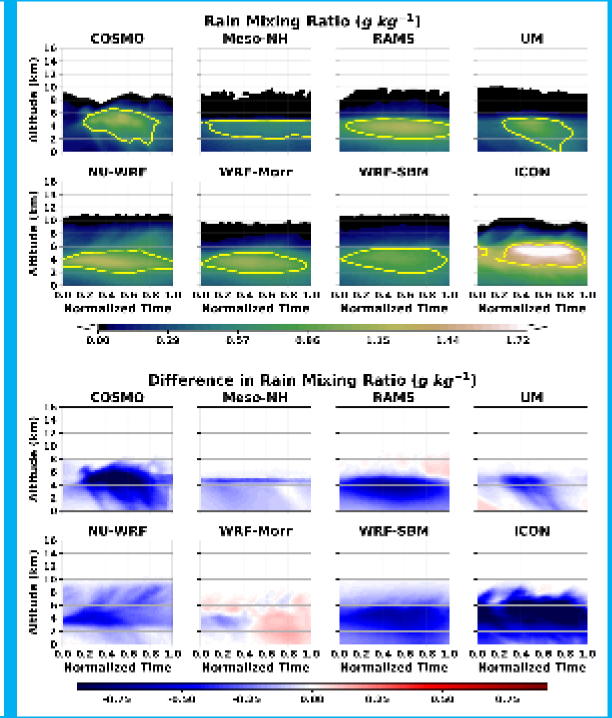
ACPC-MIP Composites of Deep Convective Cells

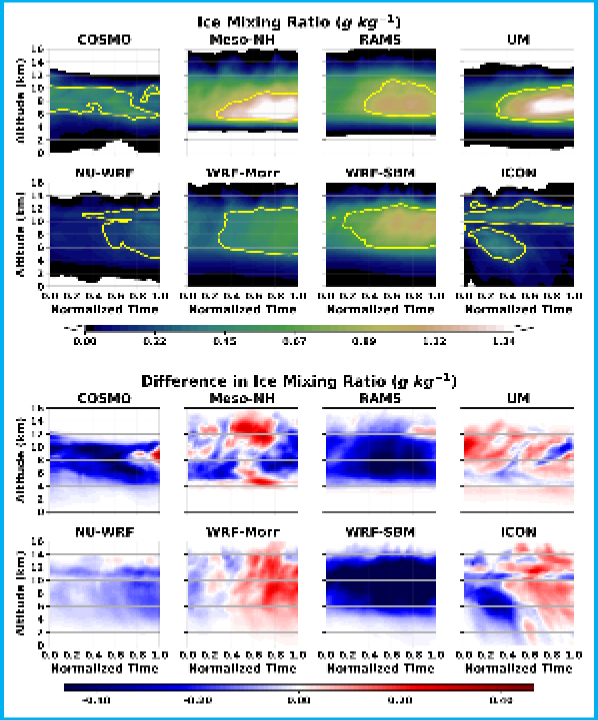
(each subplot is a Time-Height composite of identified convective cells normalized by cell lifetime)

Low Aerosol Sims

High - Low Aerosols







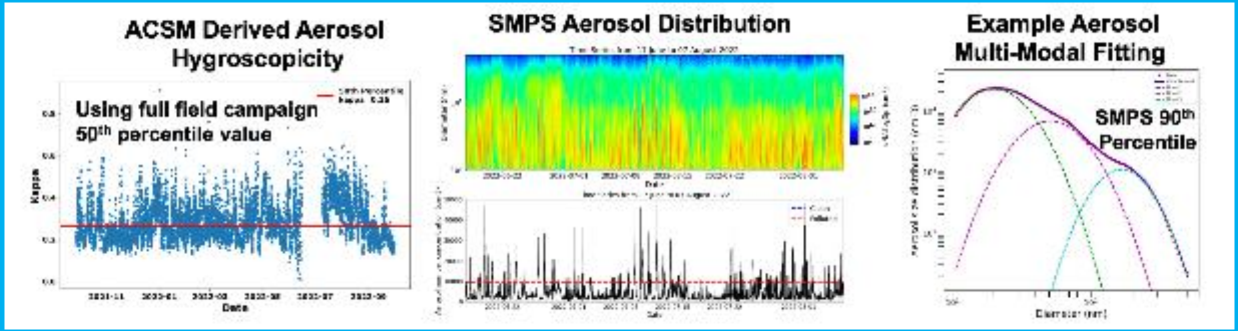
ACPC-MIP: Greater variability among models in updrafts and ice compared to liquid phase.

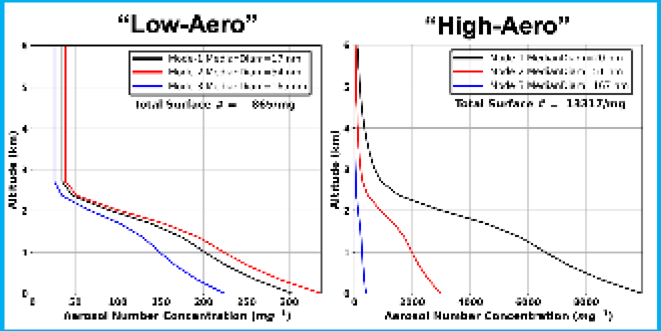
TRACER-MIP: Focused on W, Ice, and related process rates that impact aerosol-convection interactions.

Challenges related to organizing the TRACER - MIP:

- *Choosing optimal events (need available data for model initialization and validation).*
- *Converting data into a model ingestible product.*
- *Finding modeling teams that can volunteer their time and finding an agreeable timeline.*
- *Finding a data storage solution that is reliable and easy to access.*

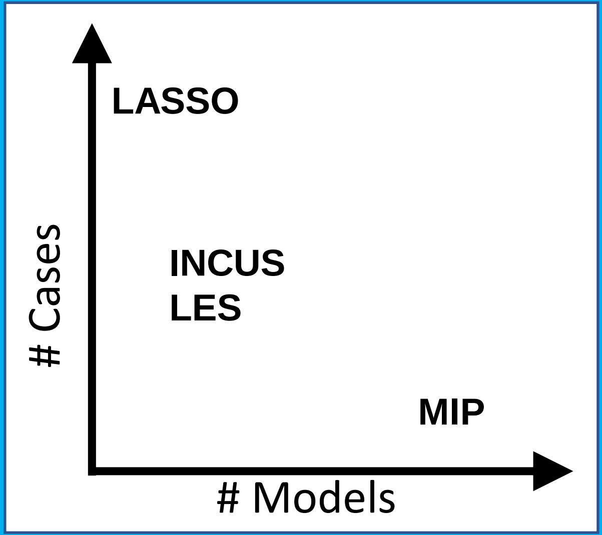
→ Path from aerosol observational data to model initialization aerosol profiles →





What LASSO and BNF activities could support future Model Intercomparisons (BNF-MIP) & Interagency collaborations (NASA-INCUS)?

- ➢ *LASSO deep convective statistics compared to satellite (INCUS) obs over the same region.*
- ➢ *LASSO used to choose cases for future MIPs, and BNF obs provide initialization and validation data.*



Relevant goals include improved prediction of:

- ➢ *Convective updrafts and mass flux (impact on anvils).*
- ➢ *Ice hydrometeor characterization and ice microphysics process rates.*
- ➢ *Aerosol impacts on the quantities above.*