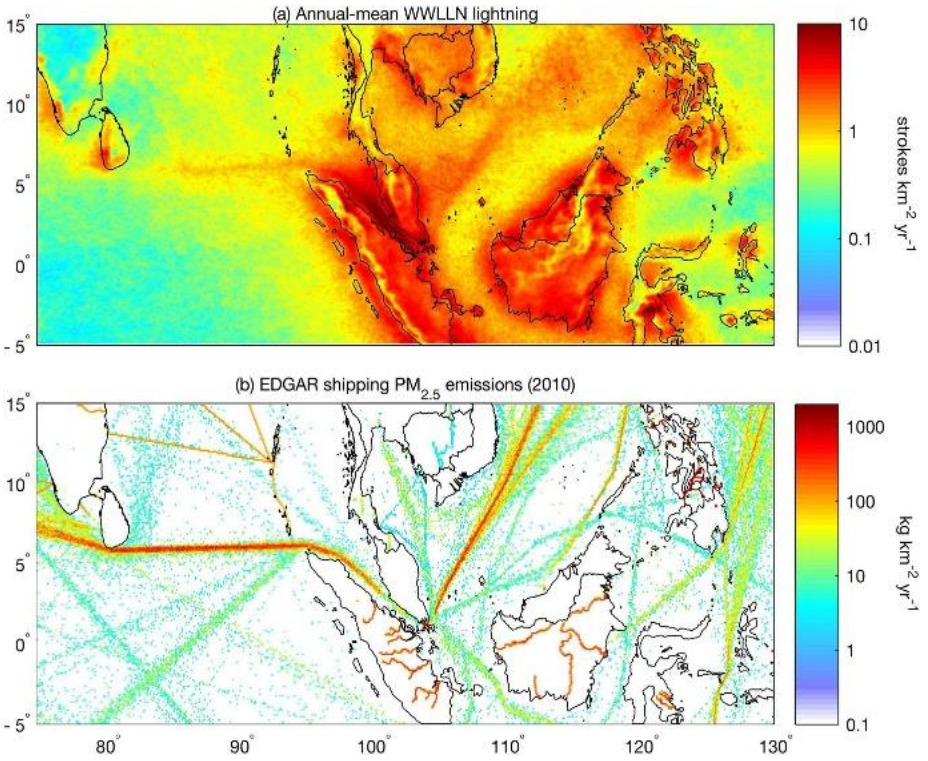
Exploring aerosol impacts on coastal storms:

What new opportunities does SCREAM offer?



Thornton et al., (2019)

Youtong Zheng

Department of Earth and Atmospheric Sciences, University of Houston

yzheng18@uh.edu

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Early Career Research Program

Exploring aerosol impacts on coastal storms:

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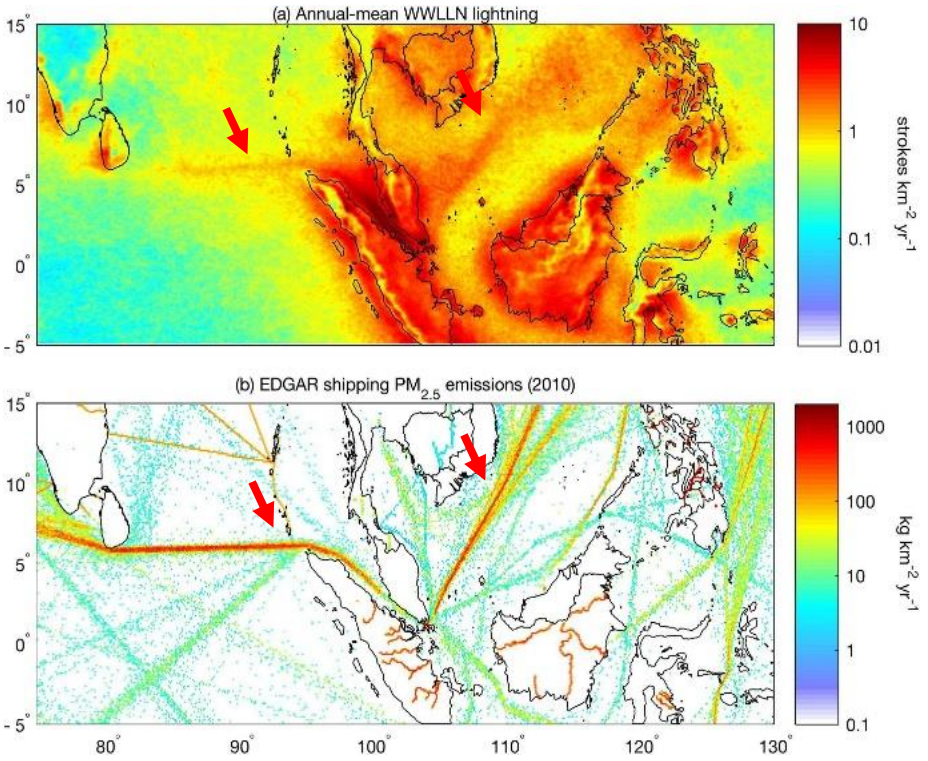

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Aerosol may intensify storms: **aerosol invigoration effect**

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HOME > SCIENCE > VOL. 359, NO. 6374 > SUBSTANTIAL CONVECTION AND PRECIPITATION ENHANCEMENTS BY ULTRAFINE AEROSOL PARTICLES

RESEARCH ARTICLE

Substantial convection and precipitation enhancements by ultrafine aerosol particles

JIWEN FAN, DANIEL ROSENFELD, YUWEI ZHANG, SCOTT E. GIANGRANDE, ZHANQING LI, LUIZ A. T. MACHADO, SCOT T. MARTIN, YAN YANG, JIAN WANG, [...], AND RODRIGO A. F. DE SOUZA +11 authors Authors Info & Affiliations

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HOME > SCIENCE > VOL. 321, NO. 5894 > FLOOD OR DROUGHT: HOW DO AEROSOLS AFFECT PRECIPITATION?

REVIEWS

Flood or Drought: How Do Aerosols Affect Precipitation?

DANIEL ROSENFELD, ULRIKE LOHMANN, GRACIELA B. RAGA, COLIN D. O'DOWD, MARKKU KULMALA, SANDRO FUZZI, ANNI REISSELL, AND MEINRAT O. ANDREAE Authors Info & Affiliations

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Article | Published: 13 November 2011

Long-term impacts of aerosols on the vertical development of clouds and precipitation

Zhanqing Li, Feng Niu, Jiwen Fan, Yangang Liu, Daniel Rosenfeld & Yanni Ding

PNAS

Microphysical effects determine macrophysical response for aerosol impacts on deep convective clouds

Jiwen Fan[a,1], L. Ruby Leung[a], Daniel Rosenfeld[b], Qian Chen[a,c], Zhanqing Li[d,e], Jinqiang Zhang[f], and Hongru Yan[e,g]

[a]Atmospheric Sciences and Global Change Division, Pacific Northwest National Laboratory, Richland, WA 99352; [b]Institute of Earth Sciences, The Hel University of Jerusalem, Jerusalem, 91904 Israel; [c]Key Laboratory for Aerosol-Cloud-Precipitation of China Meteorological Administration, Nanjing Uni of Information Science and Technology, Nanjing 210044, China; [d]State Key Laboratory of Earth Surface Processes and Resource Ecology, College of Change and Earth System Science, Beijing Normal University, Beijing 100875, China; [e]Department of Atmospheric and Oceanic Science and Earth Sys

PNAS

Intensification of Pacific storm track linked to Asian pollution

Renyi Zhang*†, Guohui Li*, Jiwen Fan*, Dong L. Wu‡, and Mario J. Molina†§

*Department of Atmospheric Sciences, Texas A&M University, College Station, TX 77843; ‡ Microwave Atmospheric Sciences, Jet California Institute of Technology, Pasadena, CA 91109; and §Department of Chemistry and Biochemistry, University of Californi La Jolla, CA 92093

Contributed by Mario J. Molina, January 23, 2007 (sent for review January 7, 2007)

Indirect radiative forcing of atmospheric aerosols by modification burning. In this report, we present ar

Science

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HOME > SCIENCE > VOL. 371, NO. 6524 > AEROSOL INVIGORATION OF ATMOSPHERIC CONVECTION THROUGH INCREASES IN HUMIDITY

REPORT

Aerosol invigoration of atmospheric convection through increases in humidity

TRISTAN H. ABBOTT AND TIMOTHY W. CRONIN Authors Info & Affiliations

Coastal cities are particularly vulnerable to invigoration

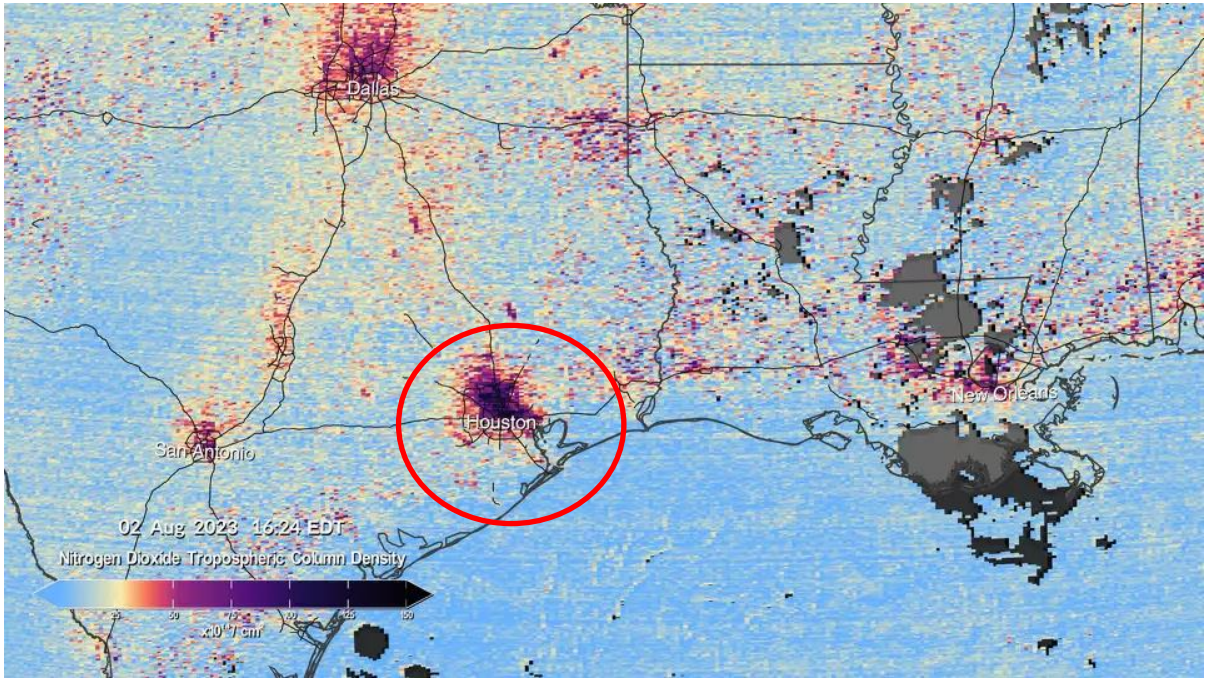


Photo credit: NASA

Insured losses from May Texas storms to exceed $1bn: Gallagher Re

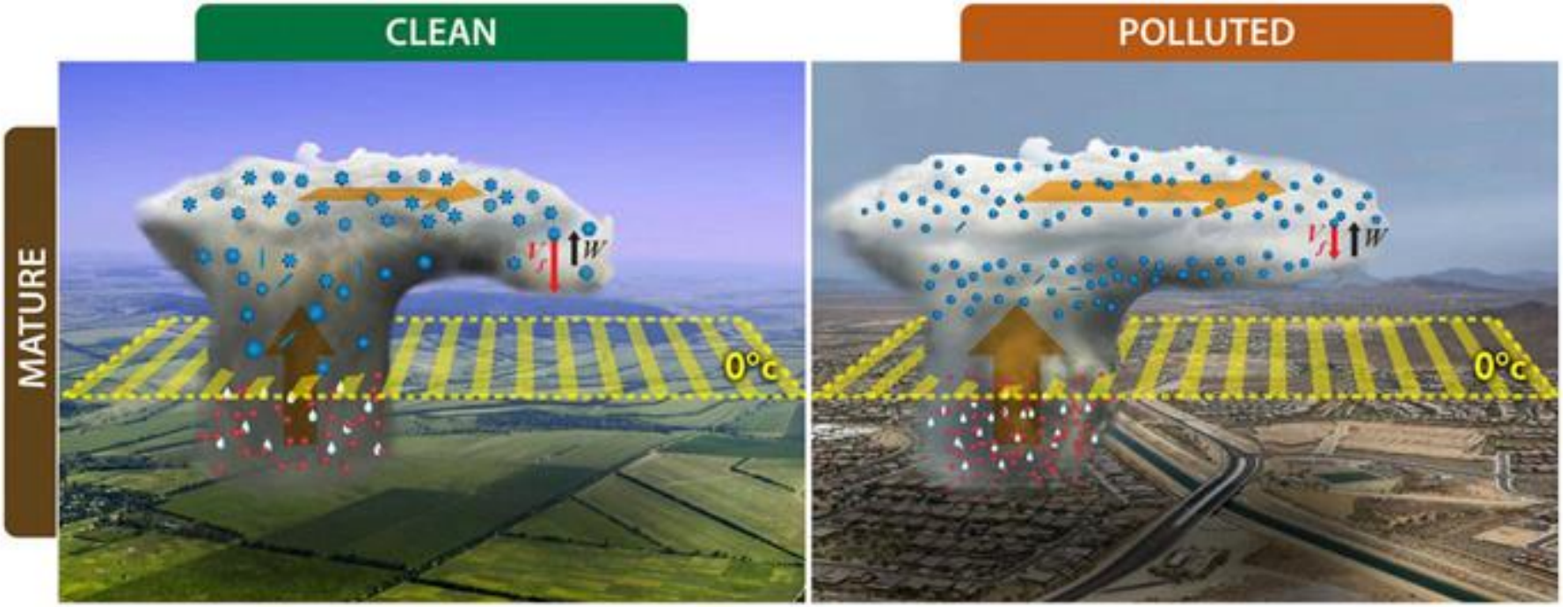
23rd May 2024 - Author: Kane Wells

Following the deadly thunderstorms that hit Houston, Texas on May 16th, economic and insured losses are each anticipated to exceed $1 billion, with the potential for total losses to be even higher, according to Gallagher Re.

The storms, which killed at least seven people, are said to have generated exceptional wind damage to both residential and commercial properties, infrastructure, and vegetation.

At the time of the event, utility tracker PowerOutage.us said that almost one million customers were without power in Texas, with the vast majority of outages in Harris County, which contains Houston and is home to more than 4.7 million people.

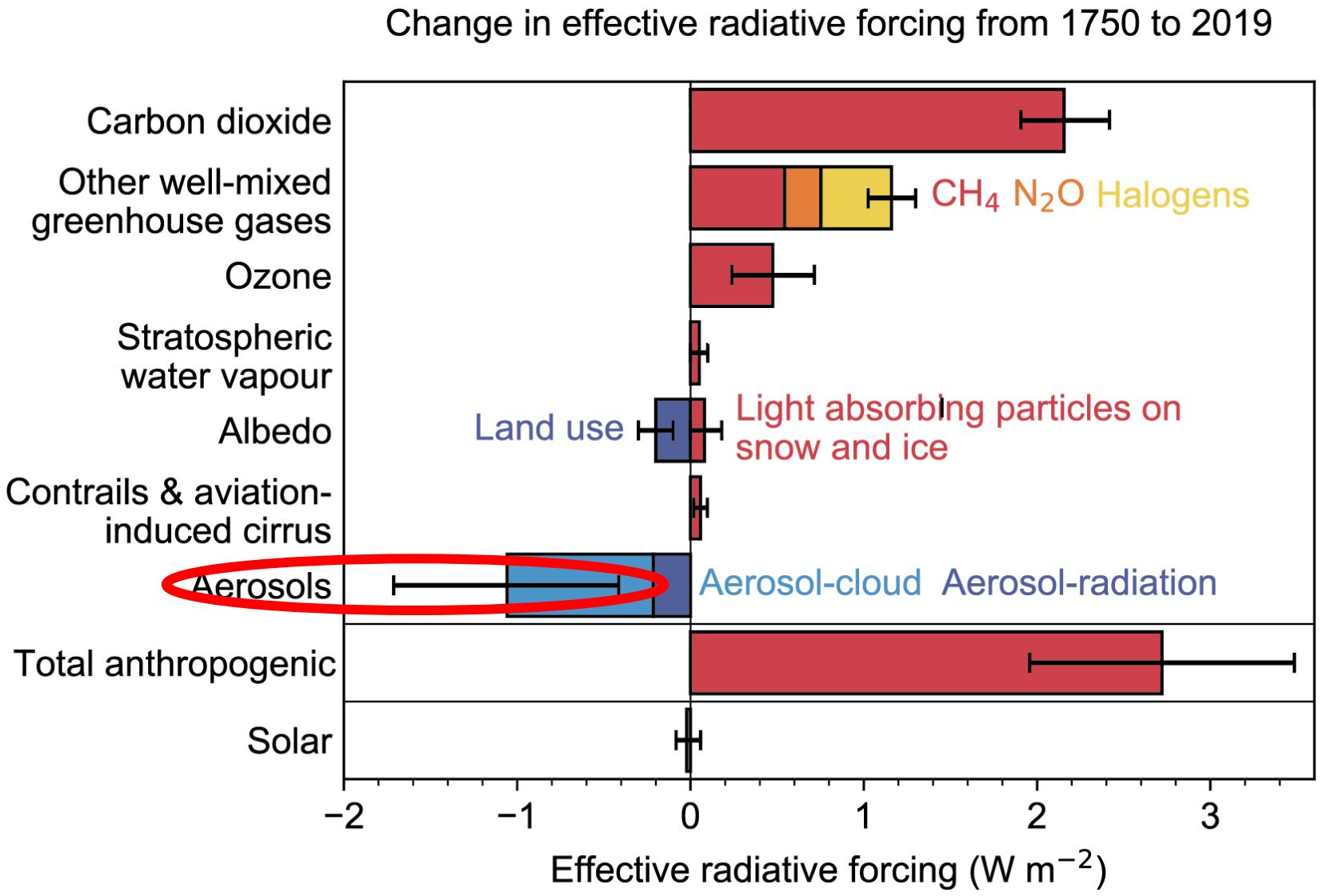
Invigoration might also affect climate change



Radiative forcing stems from aerosol impacts on **deep convective anvils**.

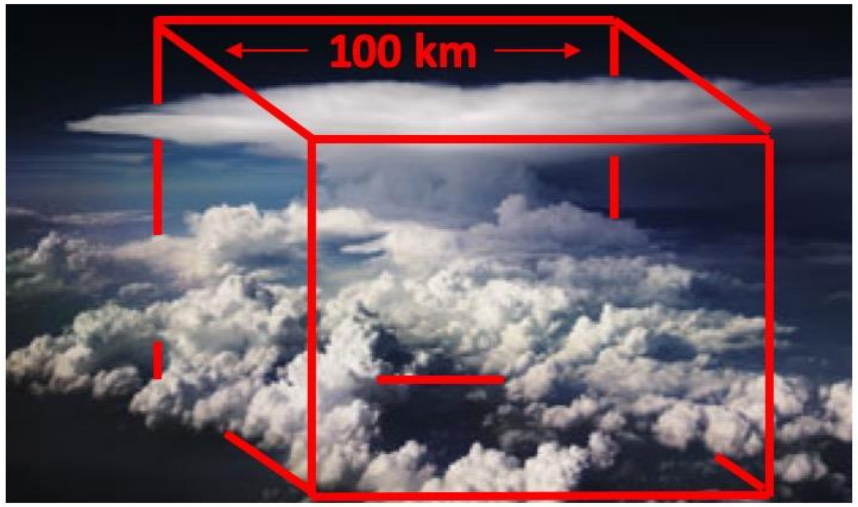
Fan et al., *PNAS*, (2013)

These impacts are not considered in GCMs



IPCC (2021)

Why? Because **convection is parameterized** in GCMs



Problem # 1

Convective dynamics is “quasi-equilibrium”.

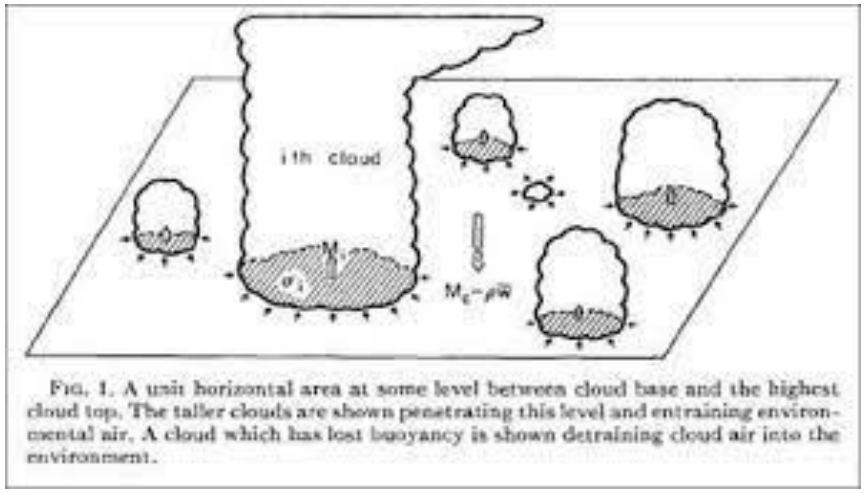


FIG. 1. A unit horizontal area at some level between cloud base and the highest cloud top. The taller clouds are shown penetrating this level and entraining environmental air. A cloud which has lost buoyancy is shown detraining cloud air into the environment.

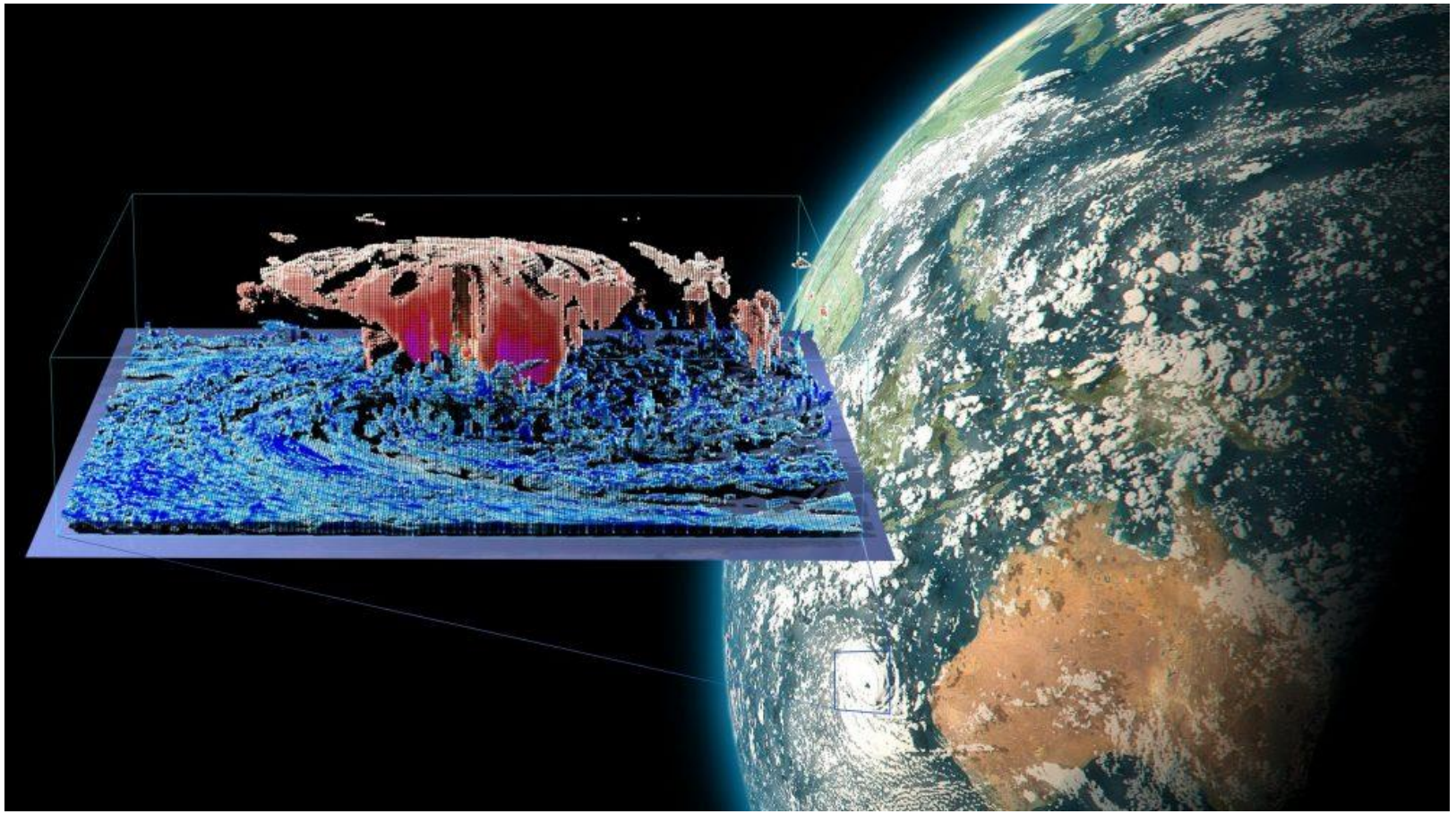
Problem # 2

Convective microphysics is too crude.

Steady-plume model as a key ingredient of mass-flux formulation (Arakawa and Schubert, 1974)

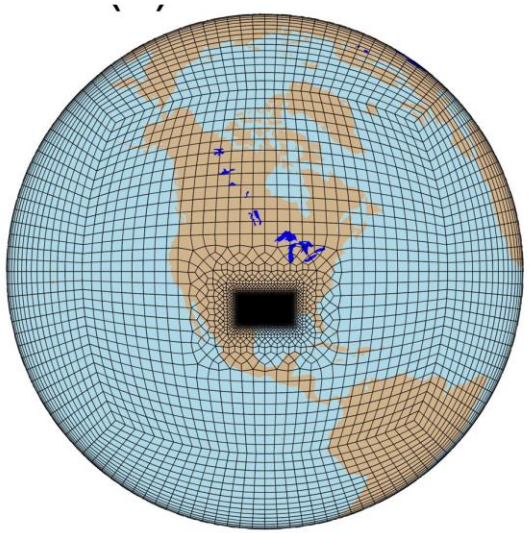
Kilometer-scale GCM (Global Storm-Resolving Model) addresses both problems

SCREAM = Simple Cloud-Resolving E3SM Atmosphere Model
(Caldwell et al., 2021)

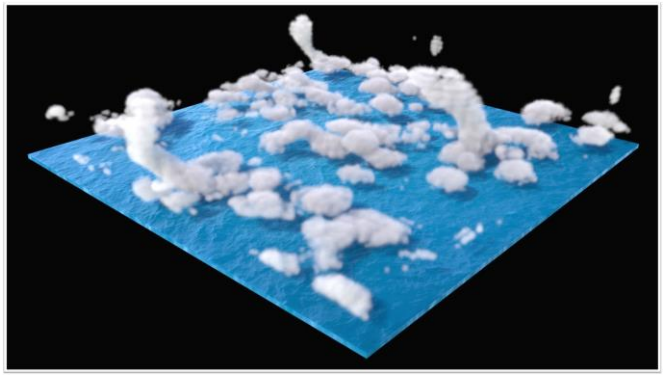


3.25 km horizontal resolution

Overview of the project

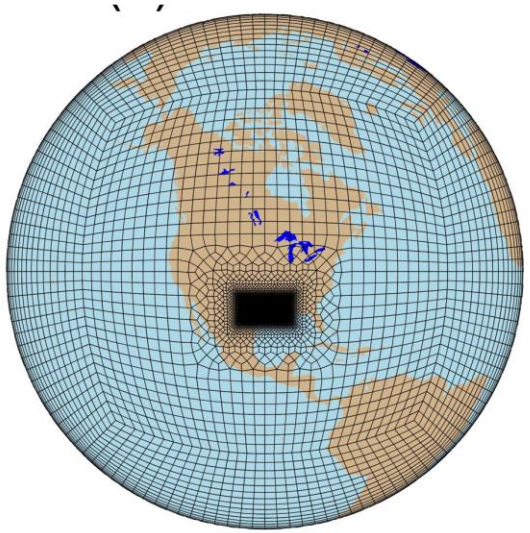


Regionally Refined SCREAM

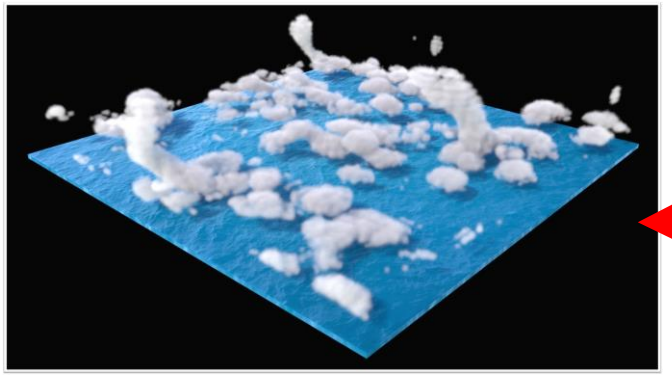


Doubly Periodic SCREAM

Overview of the project



Regionally Refined SCREAM

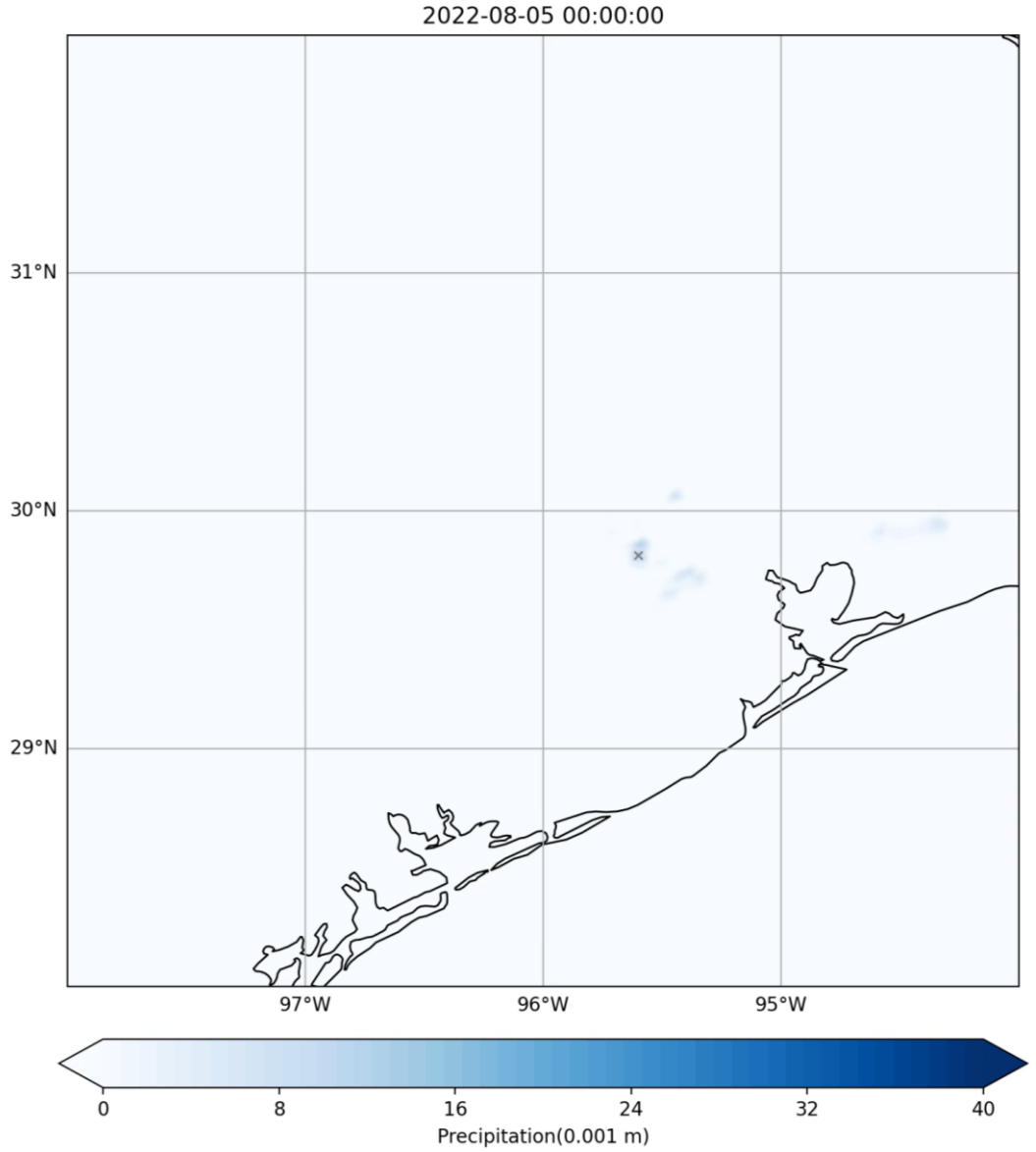


Doubly Periodic SCREAM

ARM TRACER field data

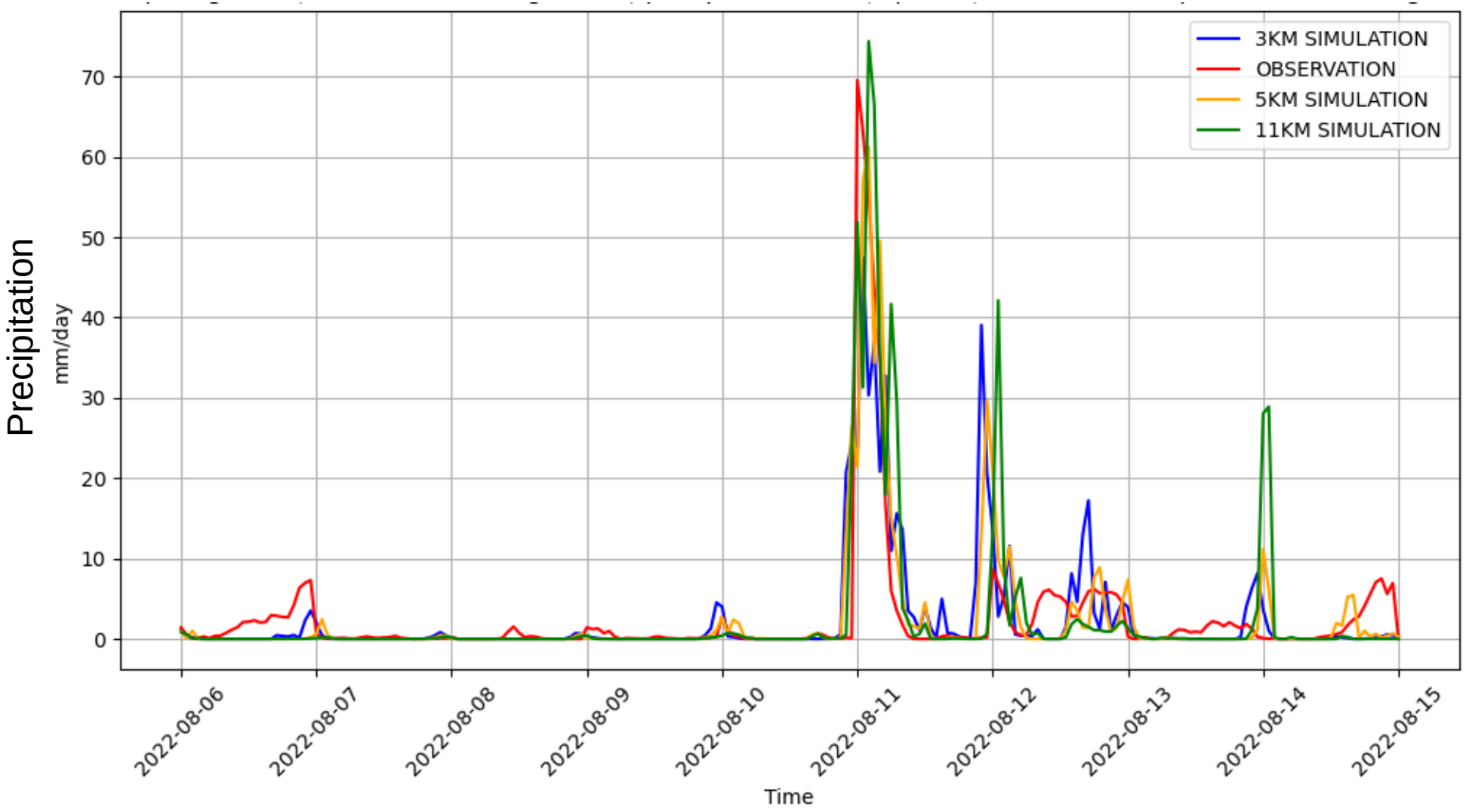
- How skillful is SCREAM in reproducing observed coastal storms?
- Is the invigoration effect present in the SCREAM?
- If yes, what are the mechanisms?

Preliminary result: 10-day case study during the ARM TRACER campaign



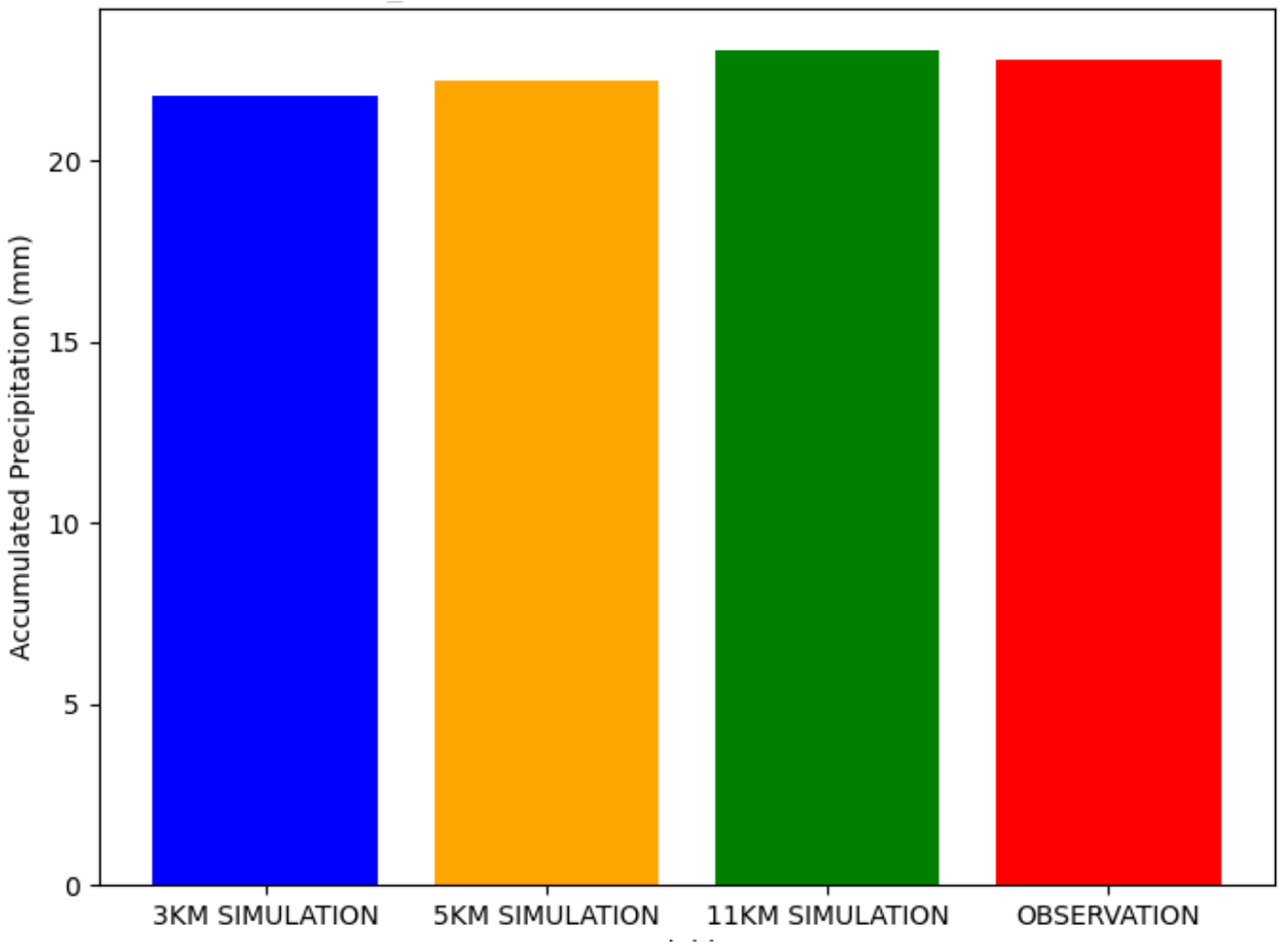
NEXRAD radar precipitation

Doubly Periodic SCREAM simulations at resolutions of 3 km, 5 km, and 11 km.

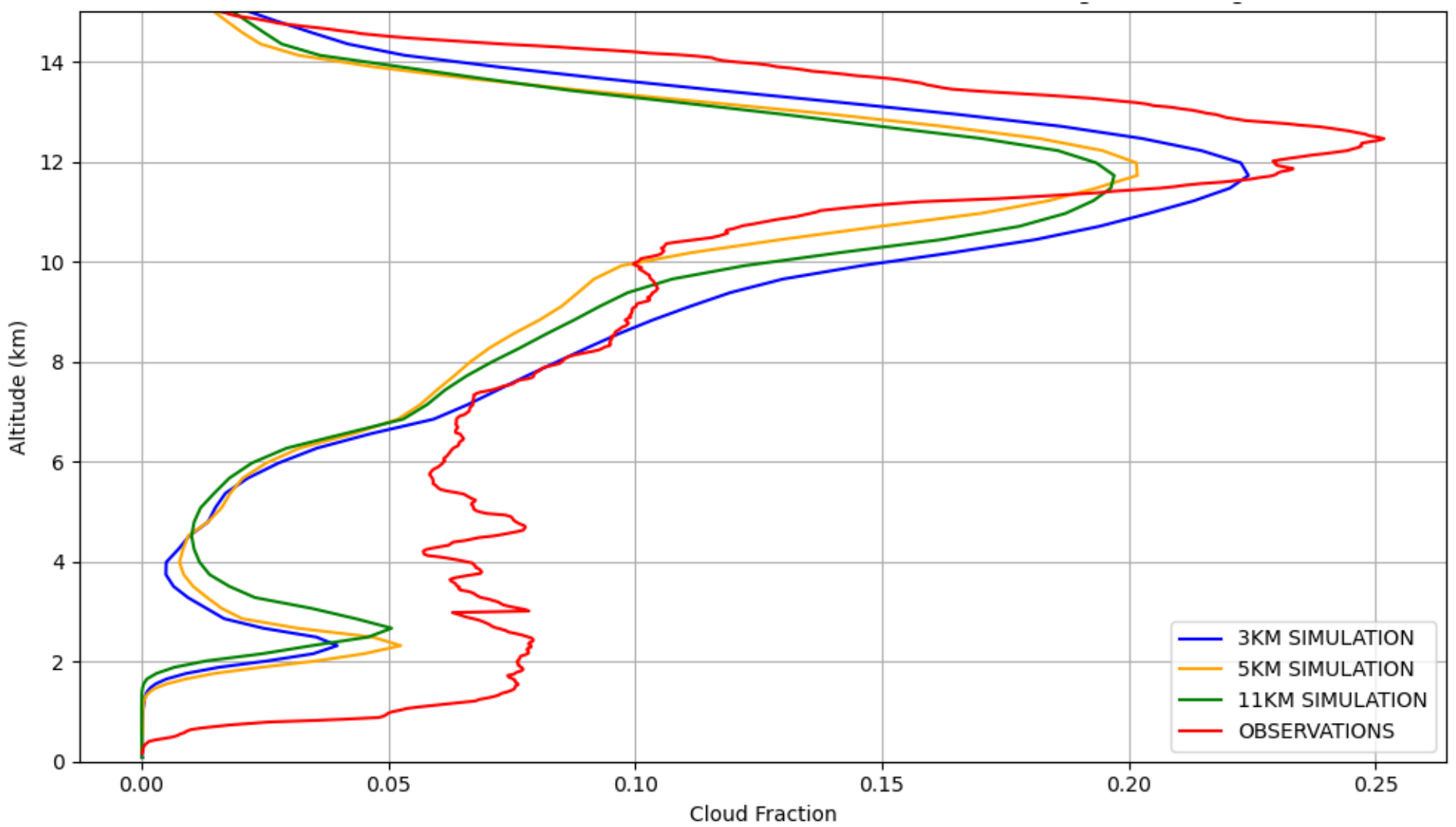


10-day DP-SCREAM simulation

10-day accumulated surface precipitation



Liquid clouds are considerably underestimated



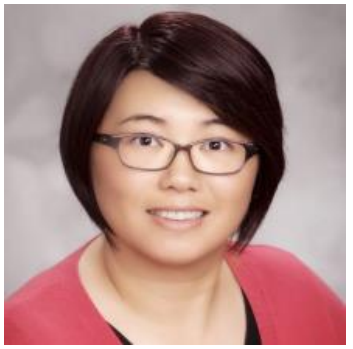
Nex step: How about the more realistic RRM SCREAM?

The RRM simulations are finished and we are analyzing them.

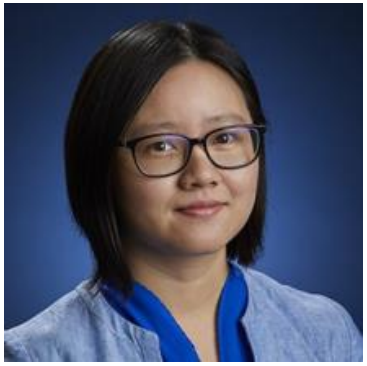
Acknowledgement to DOE early career program and unfunded collaborators

Peter Andrew Bogenschutz, LLNL

Hsi-Yen Ma, LLNL



Yunyan Zhang, LLNL



Cheng Tao, LLNL

Shaocheng Xie, LLNL

Rich Fiorella, LANL

and more …

A user survey: we need your input !!

DOE ARM User Executive Committee (UEC):
Enhancing Communicating with Modeling Subgroup

The survey only takes 5 mins