ASR
Atmospheric System Research
Science Focus Area (SFA)

Tying in High Resolution E3SM with ARM Data (THREAD)

Examining The Diurnal Cycle of Local Convection in Doubly-Periodic SCREAM

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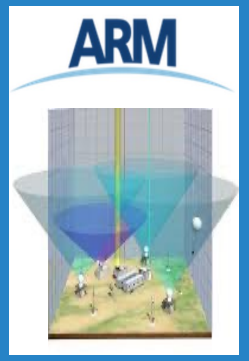

THREAD
LLNL ASR SFA

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Doubly-Periodic SCREAM

THREAD

- SCREAM = Simple Cloud-Resolving E3SM Atmosphere Model (Caldwell et al. 2021).
- Doubly-Periodic SCREAM (DP-SCREAM; Bogenschutz et al. 2023) developed as a tool to facilitate "rapid feedback" (akin to a single column model).
- SCREAM has problems aggregating convection.
- Here we use DP-SCREAM to analyze the transition from shallow-to-deep convection.

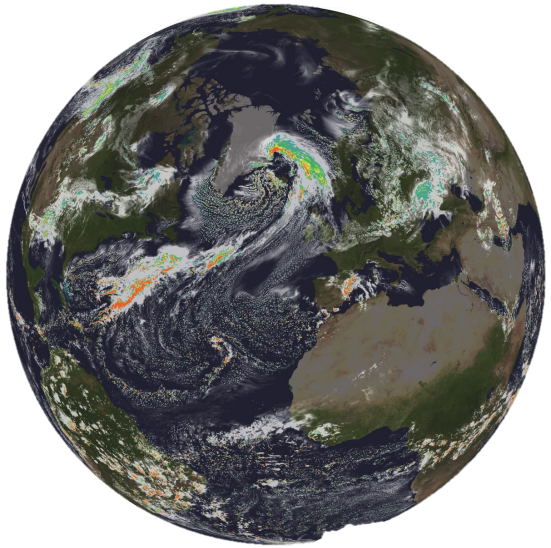


Figure courtesy Chris Terai. SCREAM DYAMOND2. White: liq+ice cloud water path. Colors: precip rate.

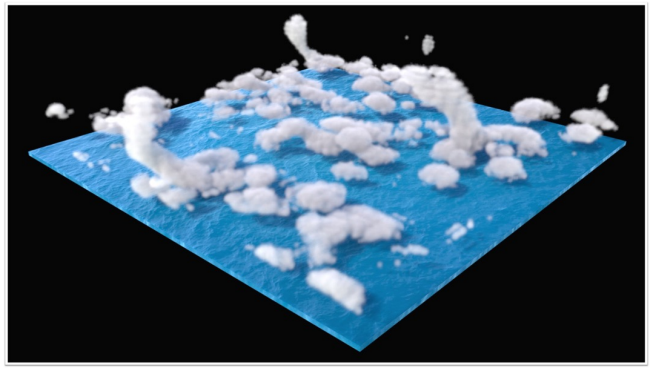
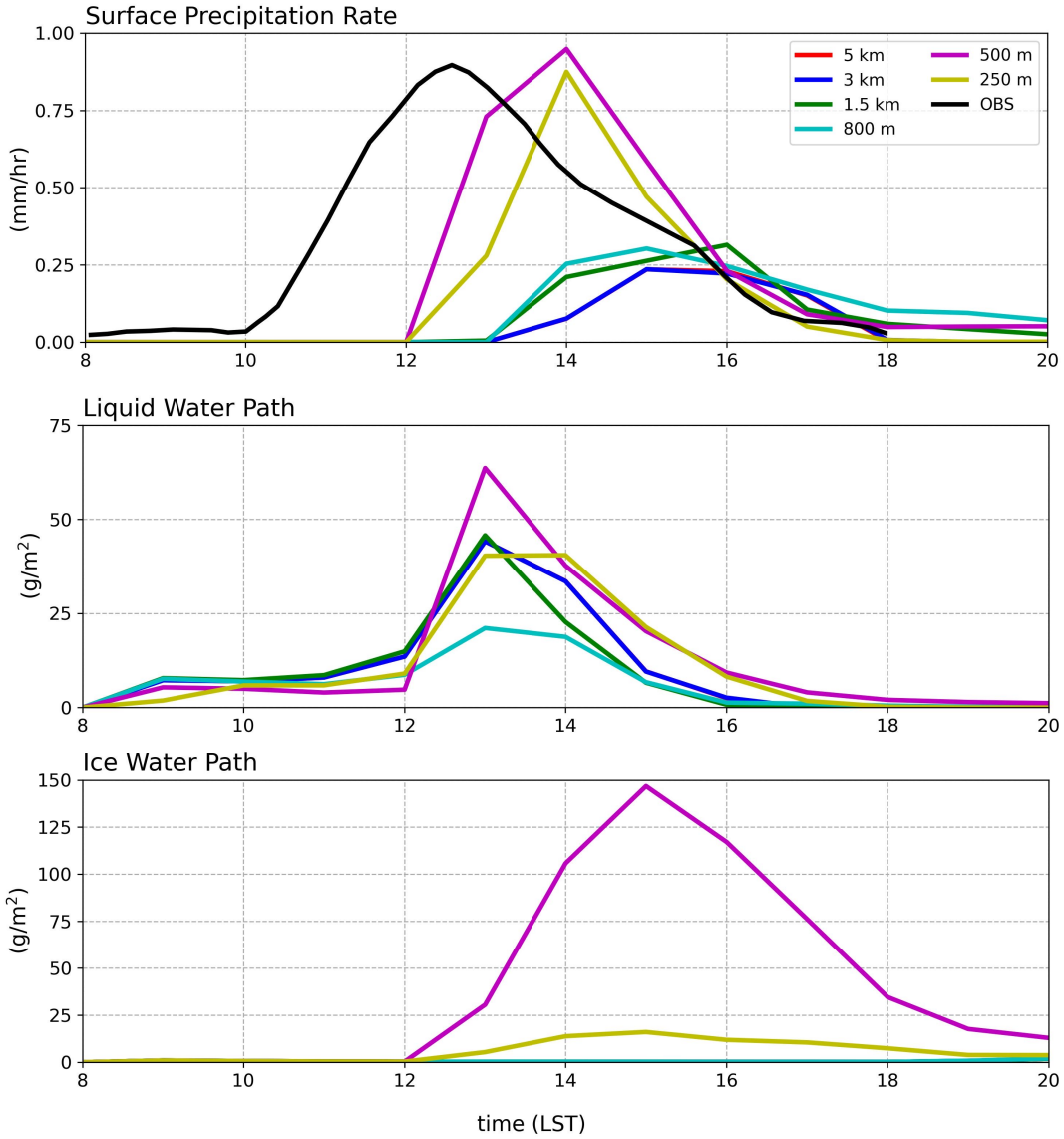
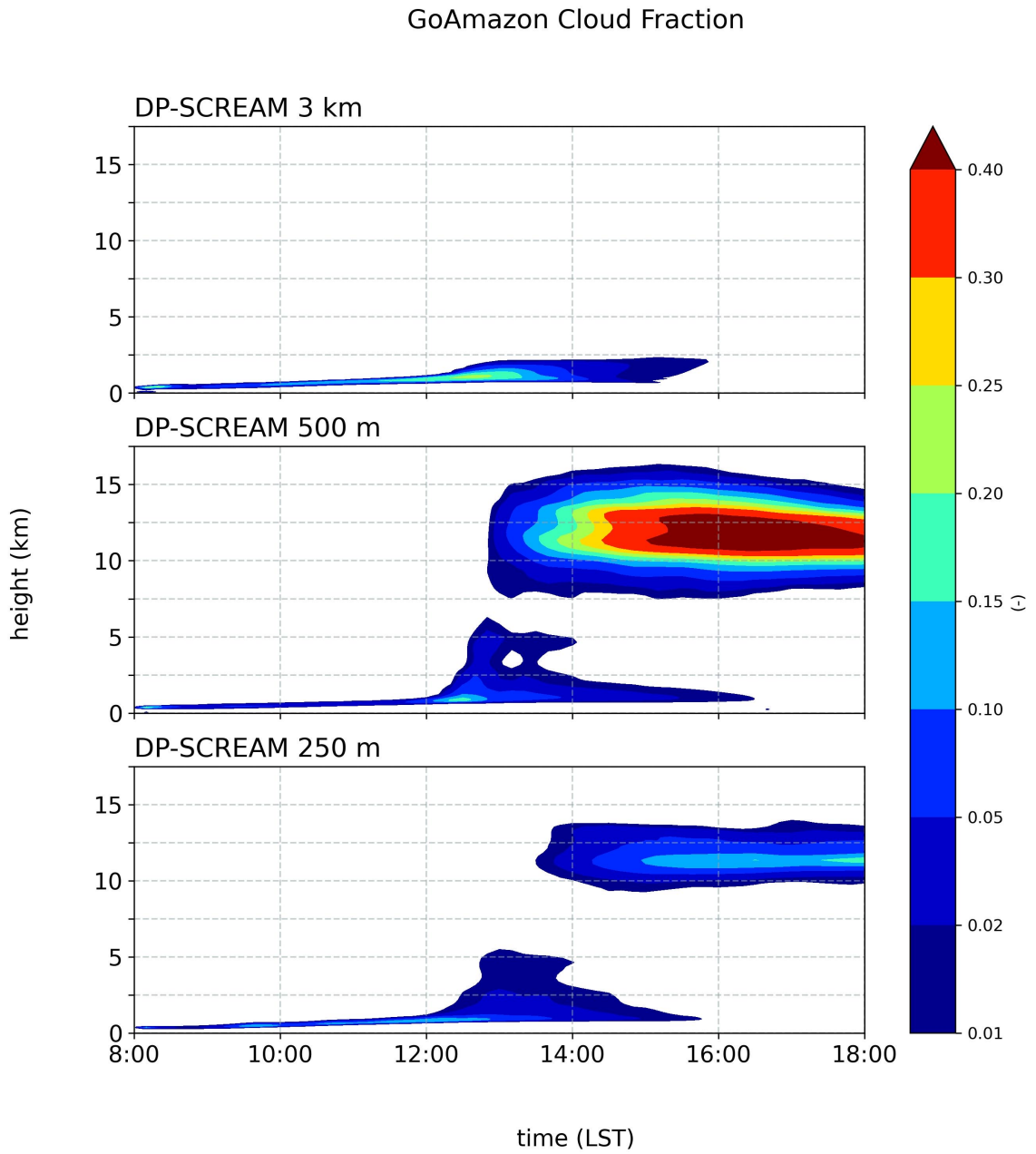


Figure courtesy Brad Carvey. Simulation of shallow convection using DP-SCREAM with dx=dy= 100 m

GoAmazon: Locally Forced Transition

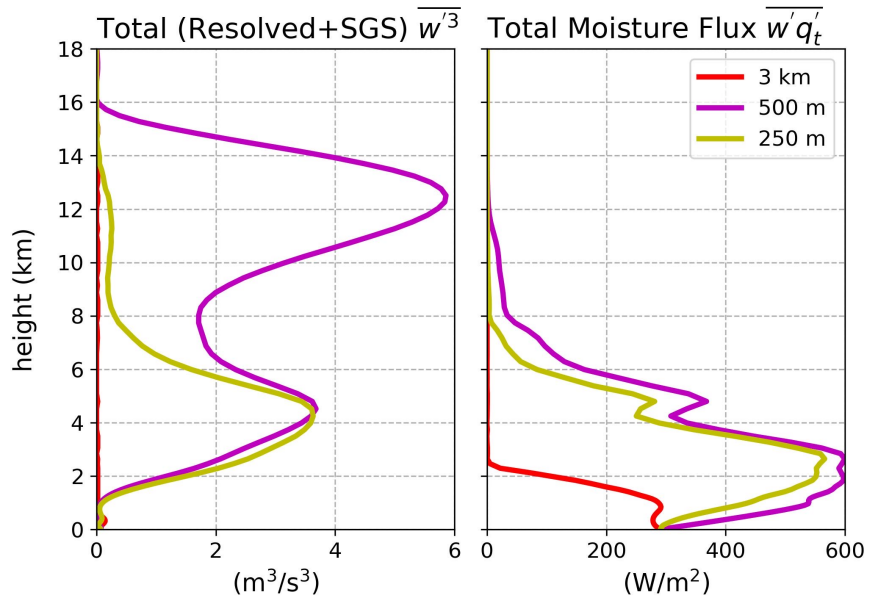
- We simulate a locally forced transition from shallow to deep convection (early single peak).
- Forcing from day 178 of GoAmazon (provided by Yang Tian).
- DP-SCREAM is run with horizontal resolutions ranging from 250 m to 5 km.
- All simulations:
  - run in a 250 km x 250 km domain.
  - use SCREAM's 128 layer grid.
  - use same code and settings (only time steps differ).





Science Questions

- Why does SCREAM 3 km fail to transition?
- Why do the high res runs fail to match the observed peak timing of precipitation?
- Why is the strength of convection so different in the 250 m and 500 m runs?



Profiles averaged over hours 12 to 15 LST

Why Does SCREAM 3 km Fail to Transition?

- *Hypothesis*: Parameterized shallow convection does not reach high enough altitude.
- *Sensitivity Test:* Increase the magnitude of the SGS buoyancy flux in cumulus layers.

$$\overline{w'\theta'_v} = \overline{w'\theta'_l} + \frac{1-\epsilon_o}{\epsilon_o}\theta_o\overline{w'q'_t} + \left[\frac{L_v}{c_p}\left(\frac{p_o}{p}\right)^{R_d/c_p} - \frac{1}{\epsilon_o}\theta_o\right]\overline{w'q'_l}$$

Liquid water flux

$$\overline{w'\theta'_v} = \overline{w'\theta'_l} + \frac{1-\epsilon_o}{\epsilon_o}\theta_o\overline{w'q'_t} + 2.0\left[\frac{L_v}{c_p}\left(\frac{p_o}{p}\right)^{R_d/c_p} - \frac{1}{\epsilon_o}\theta_o\right]\overline{w'q'_l}$$