

# Dynamic Scale Awareness

## Switching Convection On When Assumptions Are Valid

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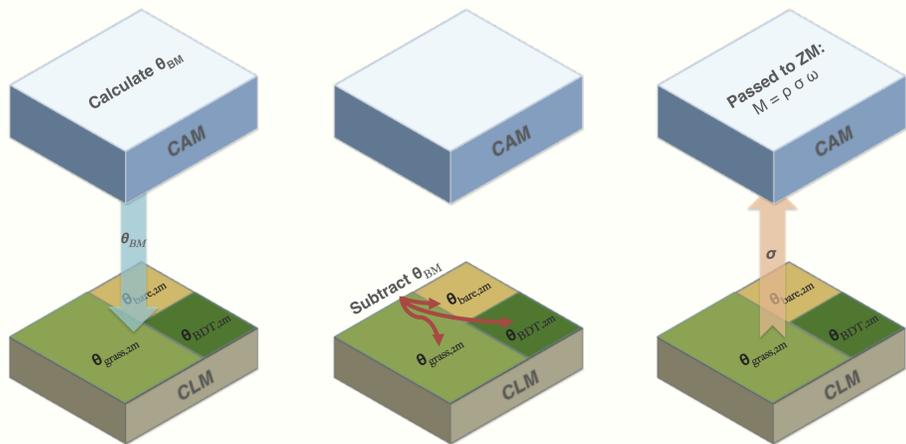
### Convective Sub-grid Trigger

#### What is the Problem?

For parameterized convection to be valid it must obey the asymptotic assumption  
**Asymptotic assumption** = convective fraction must be smaller than the grid-cell

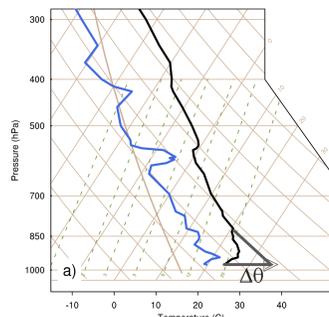
$$M = \rho * \sigma * w \rightarrow \sigma \ll 1$$

#### Explicit Sub-grid Convective Initiation



1. Calculate the convective threshold ( $\theta_{BM}$ ) in CAM
2. Subtract  $\theta_{2m}$  from  $\theta_{BM}$  for each sub-grid land tile in CLM
3. Pass the  $\sigma$  back to CAM to determine triggering

#### Building a New Convective Threshold



##### Step 1:

- Increase the near-surface temperature to create a new potential mixed layer (PML)

##### Step 2:

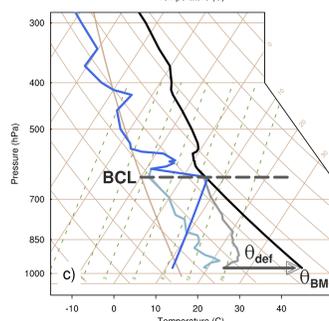
- Mix the water vapor profile from the surface to the PML

##### Step 3:

- Keep increasing near-surface temperature until saturation occurs

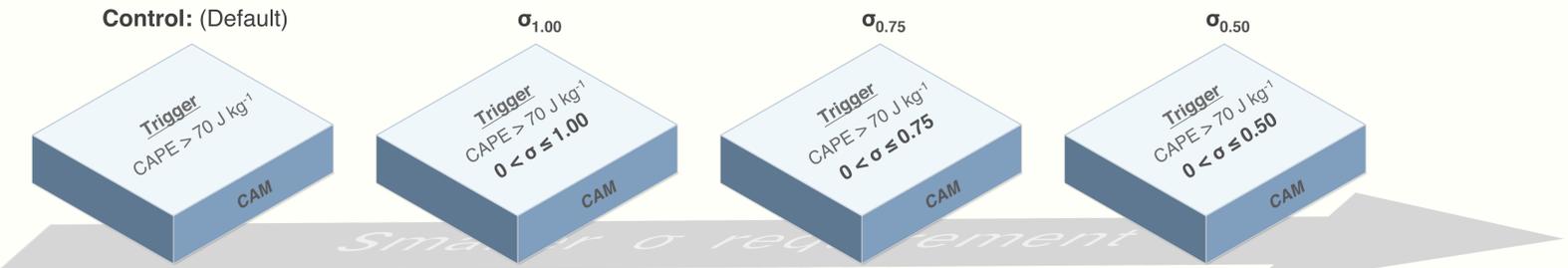
$\theta_{BM}$  = the potential temperature required to achieve convective initiation

Convection is triggered when  $\theta_{2m} \geq \theta_{BM}$



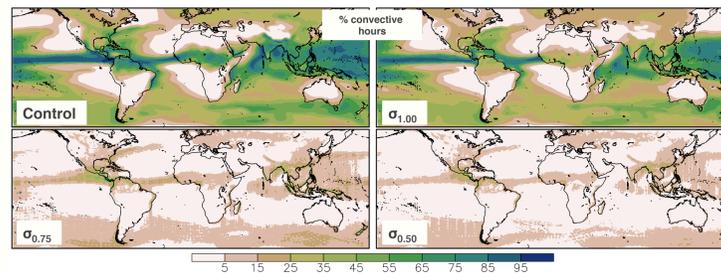
### Simulations and Findings

#### Three simulations with Different Fractions



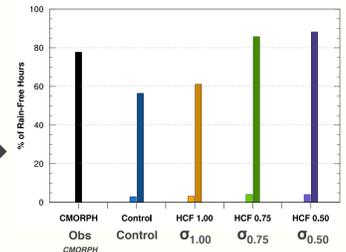
CAM v5.3 and CLM v4.0 using a spectral element dynamical core (CAM-SE)  
 Resolution of  $1^\circ \times 1^\circ$  in AMIP configuration; each simulation is at least 10-years long  
 Only **July** results are shown

#### How often is the convective parameterization active?

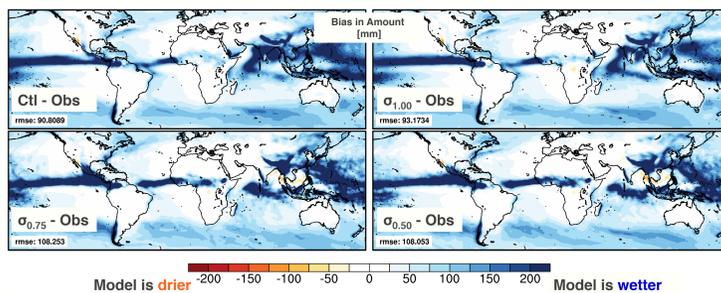


The % of hours where convection is active is reduced by > 40% when  $\sigma$  is less than 0.75

- Better represents rain-free hours when applying appropriate  $\sigma$
- Note that the large-scale precip is rain-free < 5% of hours

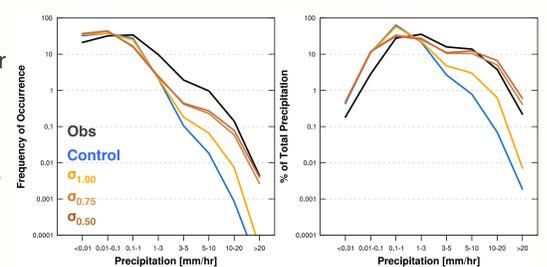


#### How does precipitation amount and intensity change?

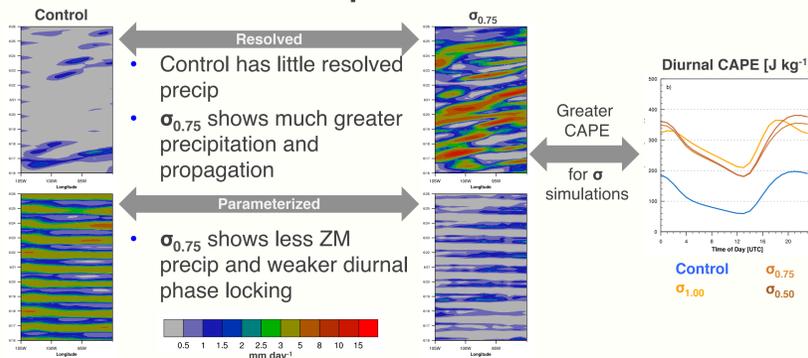


Improvements over India and Arabia; Degraded over tropical Pacific

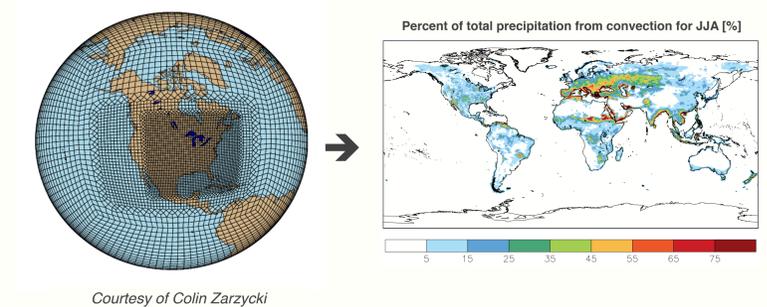
- Applying appropriate  $\sigma$  gives more intense precipitation and captures observations better



#### Resolved versus parameterized: Plains



#### Scale awareness for regional meshes



Courtesy of Colin Zarzycki