

SPCAM simulation of orogenic diurnal  
mesoscale convective organization in the  
lee of the Rockies

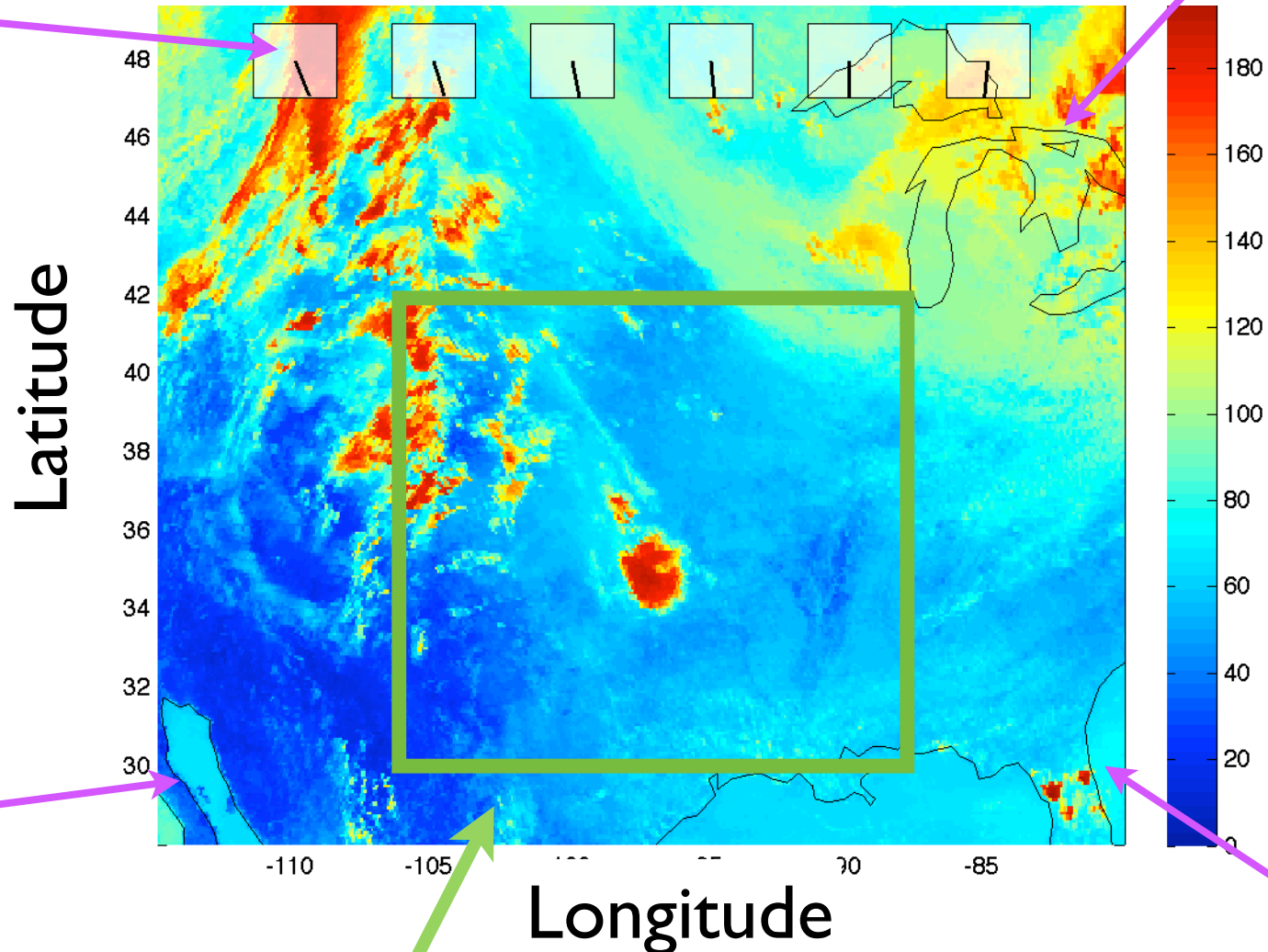
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CMMAP Team Meeting, January 13 2010  
Scripps Institution of Oceanography

# Central US summer rainfall right as a multi-scale challenge for next generation climate models

24h clock  
local time  
of day

## June 2005 GOES II micron IR (2 day loop)



Great Lakes

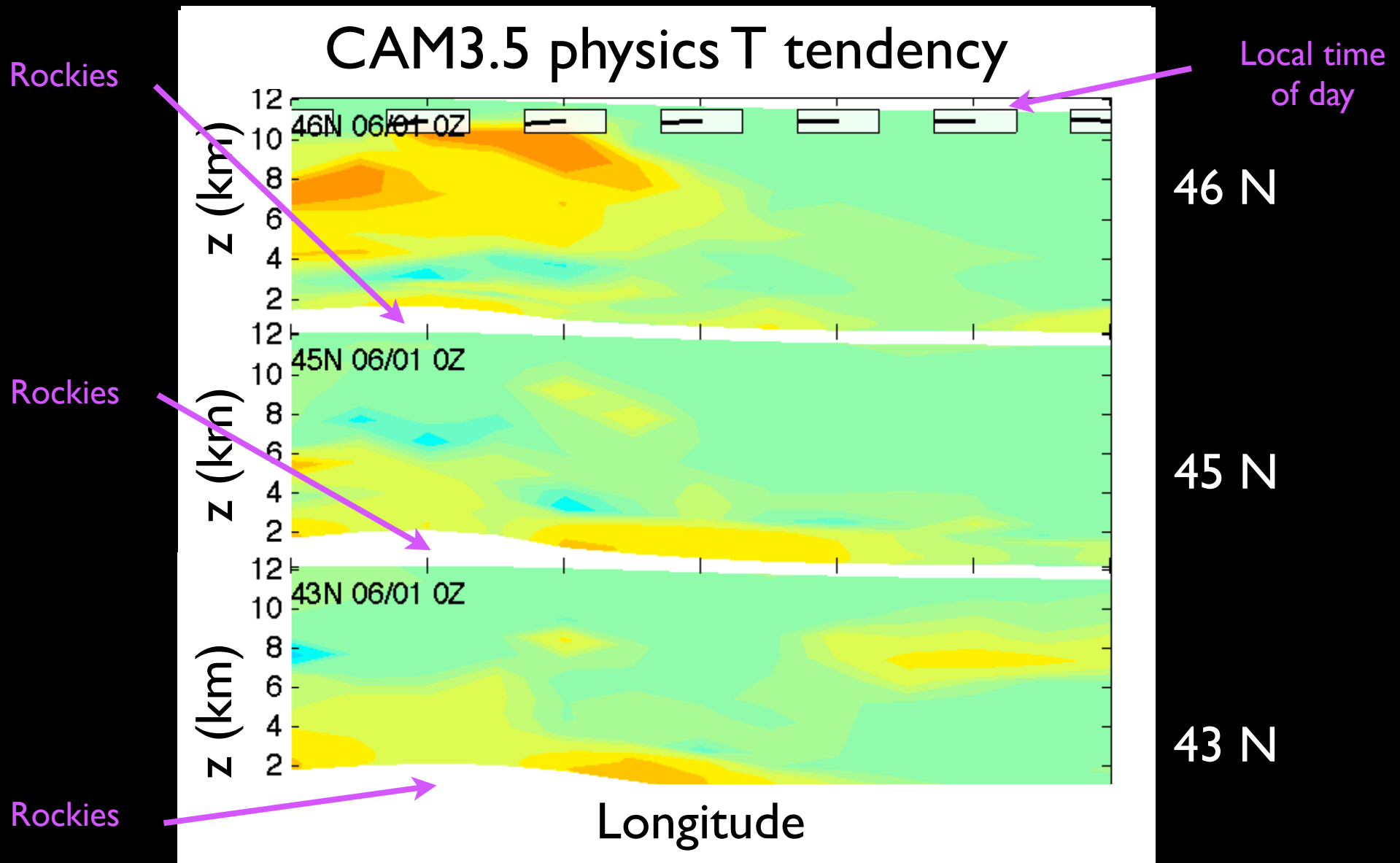
Baja

Longitude

Orogenic mesoscale organization zone

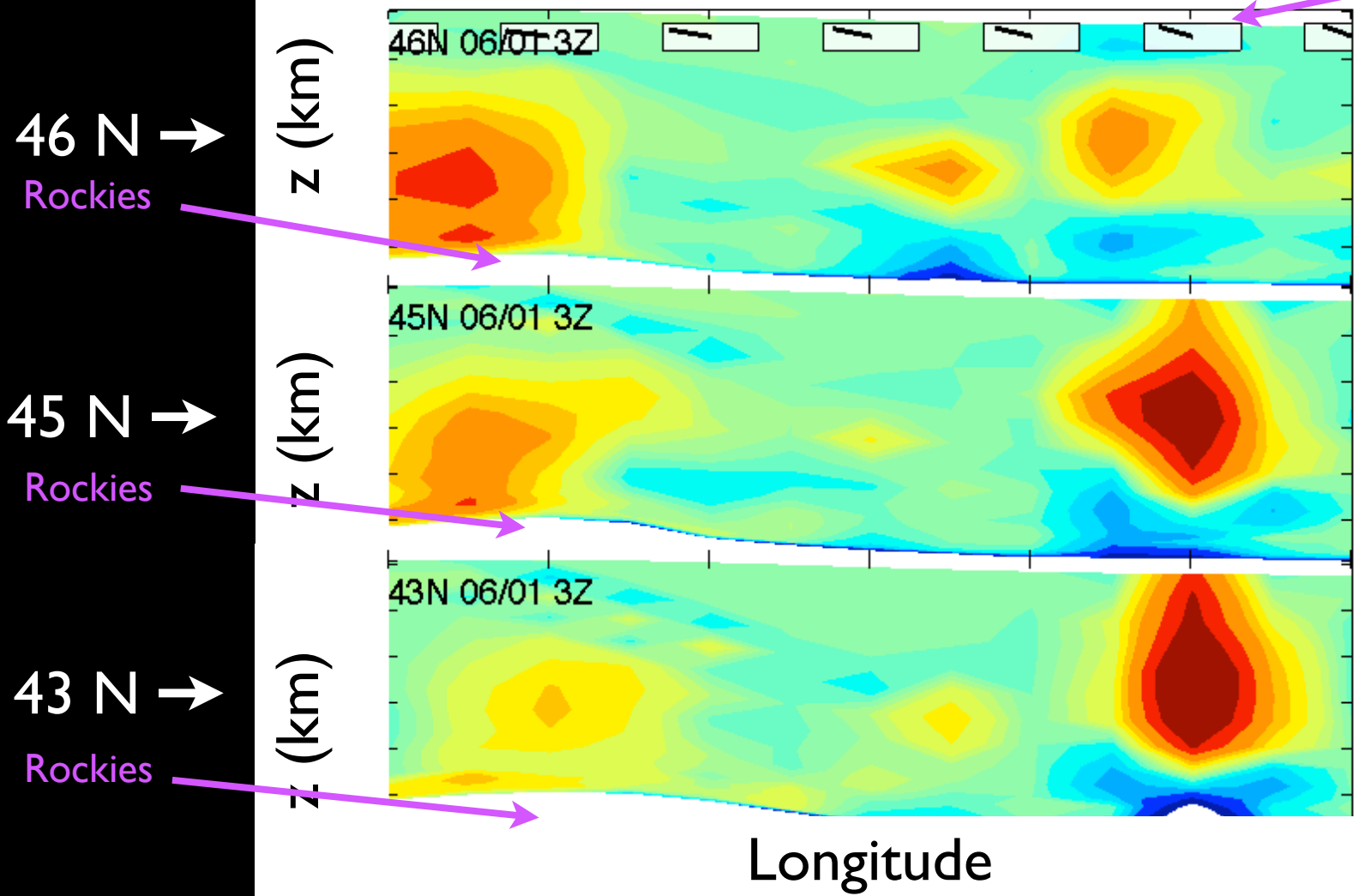
Florida

In the GCM, there are only 2 space-time modes of convective heating variability in the lee of the Rockies.



In the MMF, there is another diurnal mode

### MMF3.5 physics tendency



Local time on 24 hr clock

46 N →  
Rockies

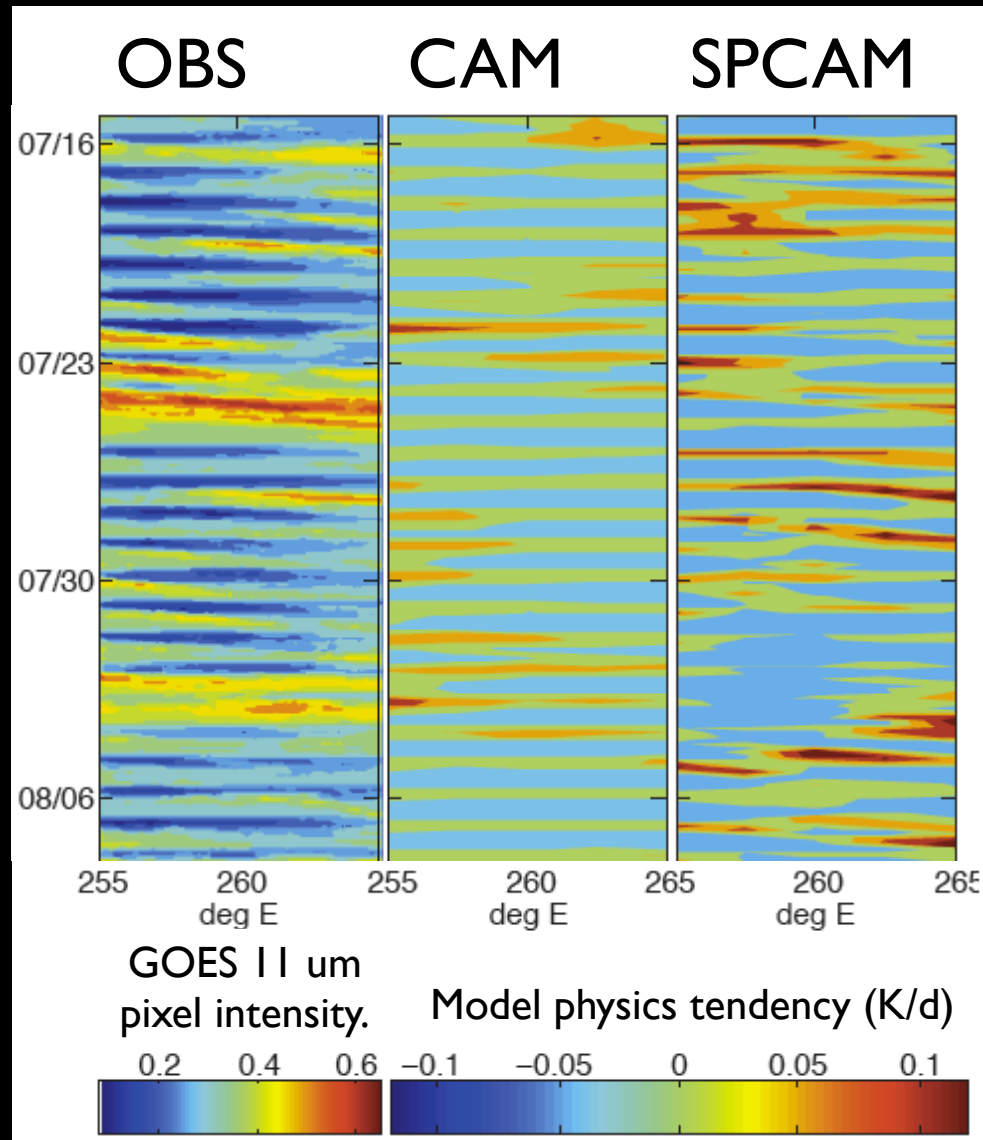
45 N →  
Rockies

43 N →  
Rockies

Longitude

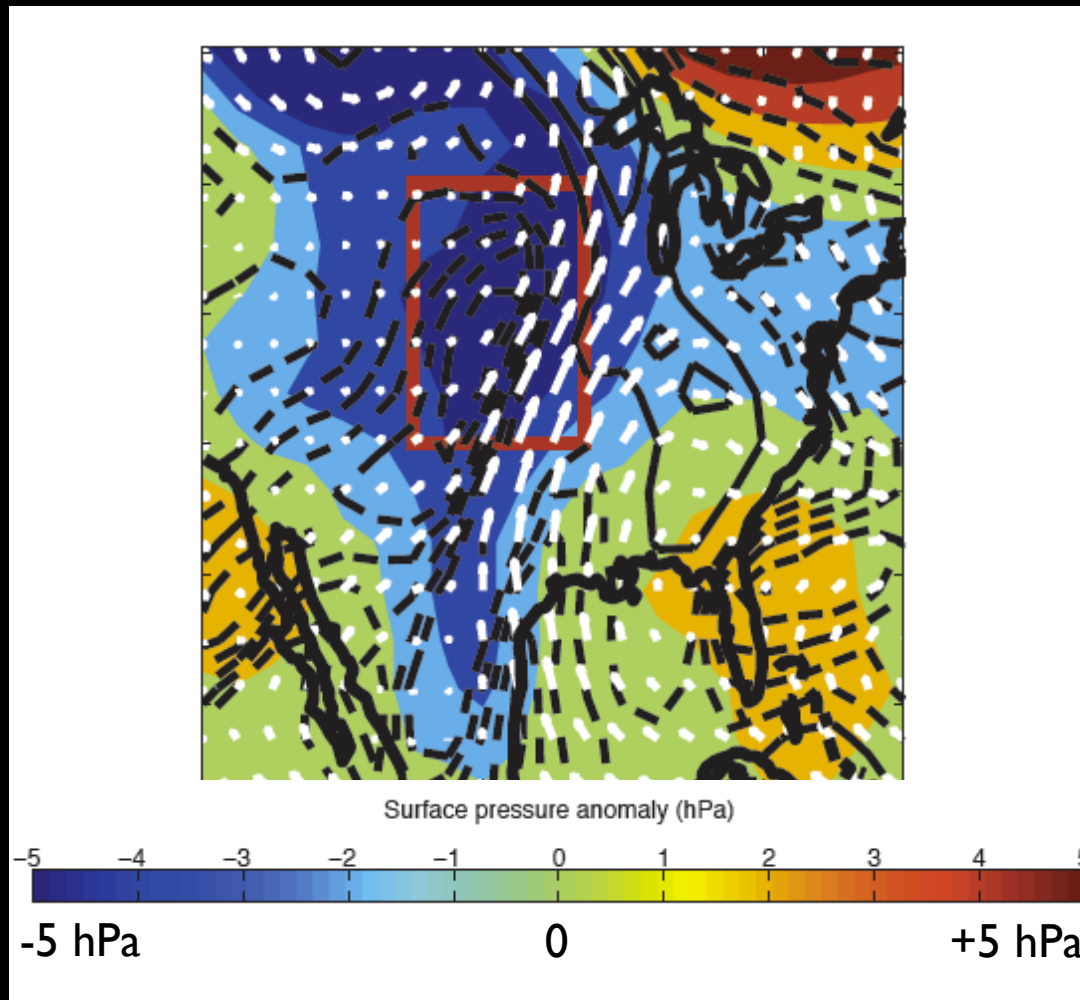
This is an improvement relative to nature.  
SPCAM is simulating episodic propagating convection.

## Hov-Muller 255-265E



The propagation episodes in SPCAM are triggered by the appropriate synoptic forcing.

## Single event synoptic anomaly



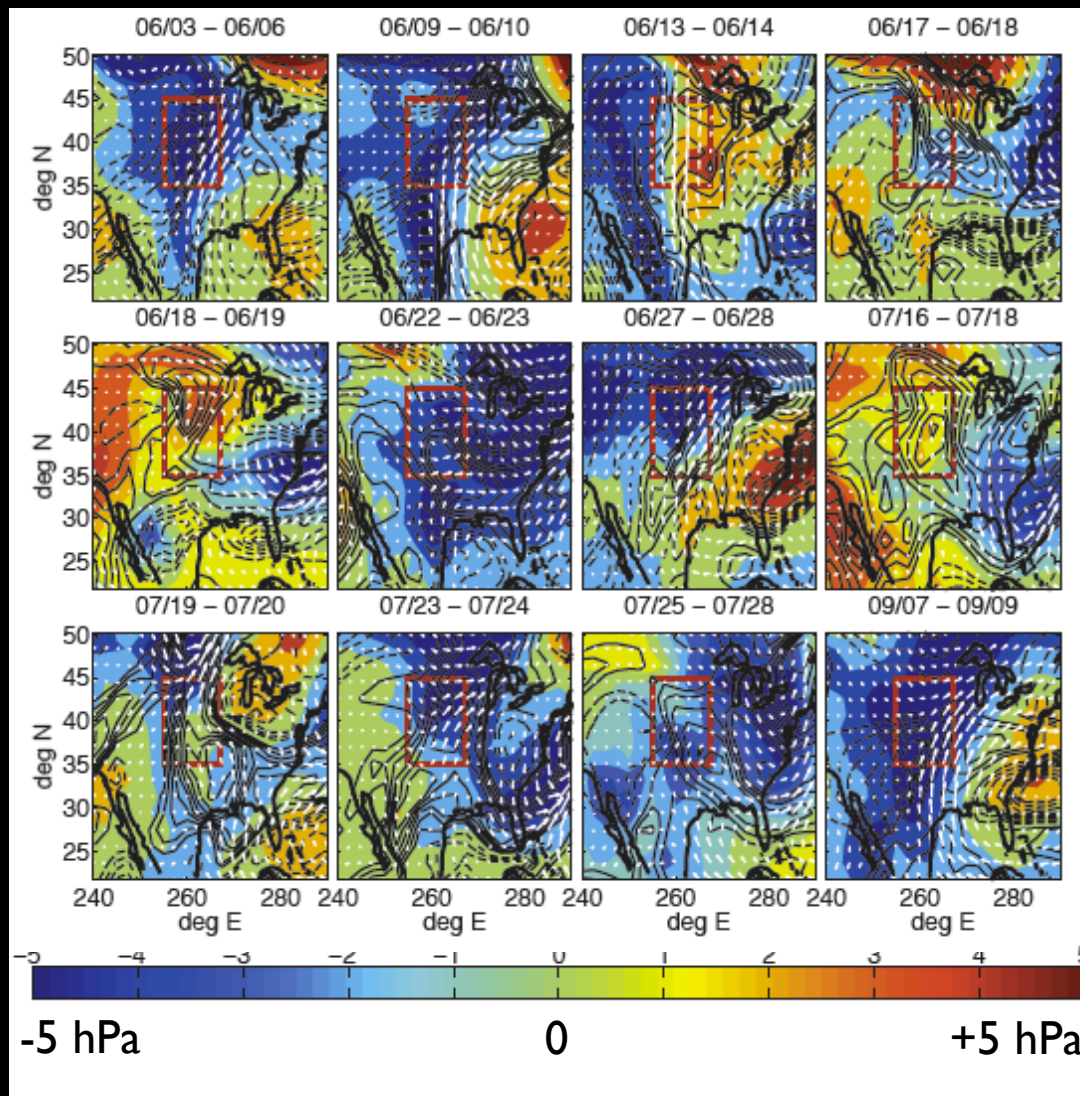
Colors are the surface pressure anomaly

Contours are the column water vapor anomaly

Vectors are the column water vapor transport anomaly

Episodes associated with low pressure, high vapor content, and nocturnal jet-like vapor transport.

## All-event synoptic anomaly



Colors are the surface pressure anomaly

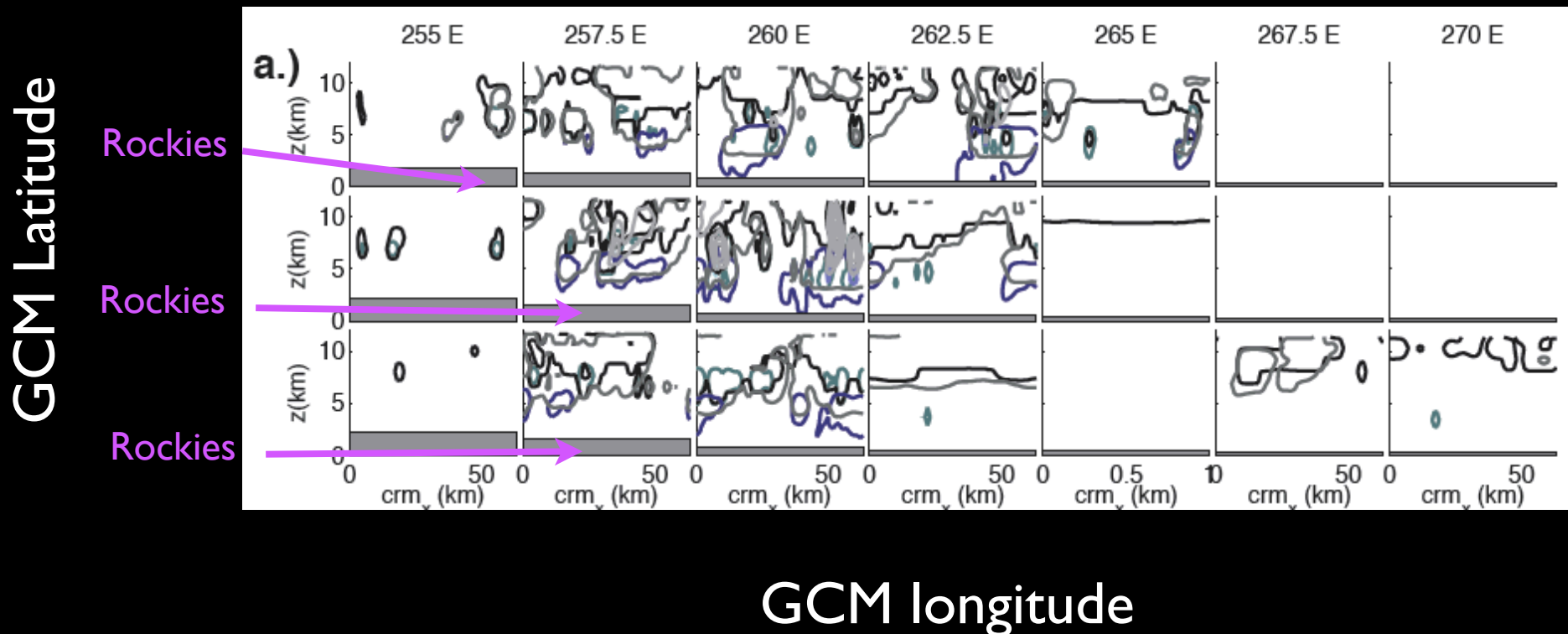
Contours are the column water vapor anomaly

Vectors are the column water vapor transport anomaly

Organized condensate “meta-structures” transcend the MMF grid separation scale.

5  $\mu\text{m}$

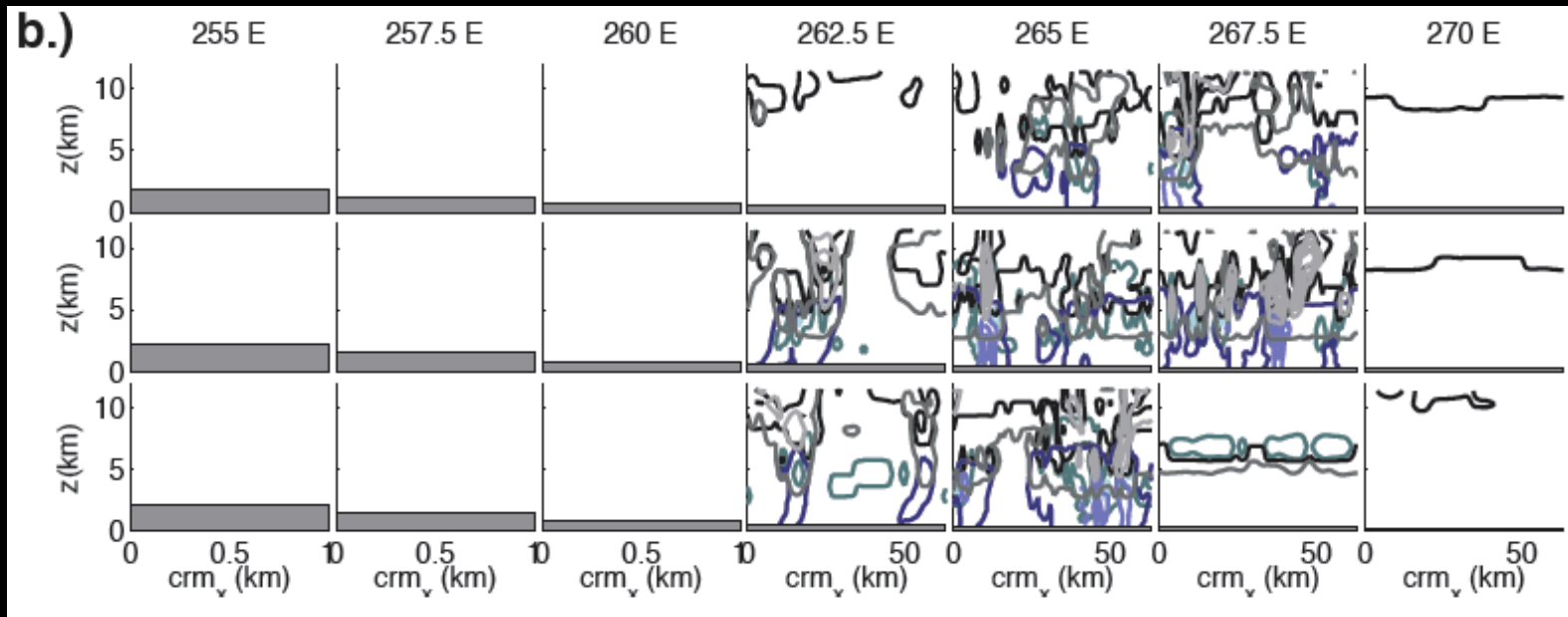
Each subplot is an x-z snapshot of the embedded CRM





12am

Each subplot is an x-z snapshot of the embedded CRM

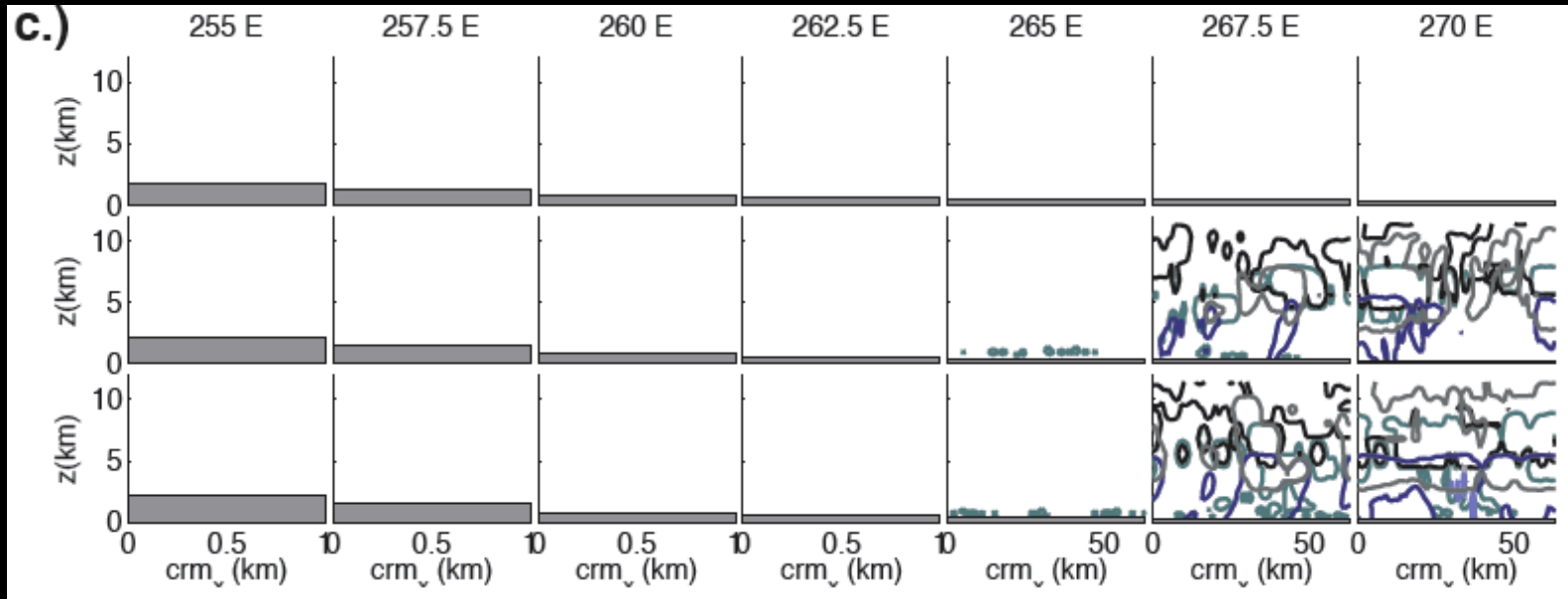


GCM longitude

GCM Latitude

11 am

GCM Latitude



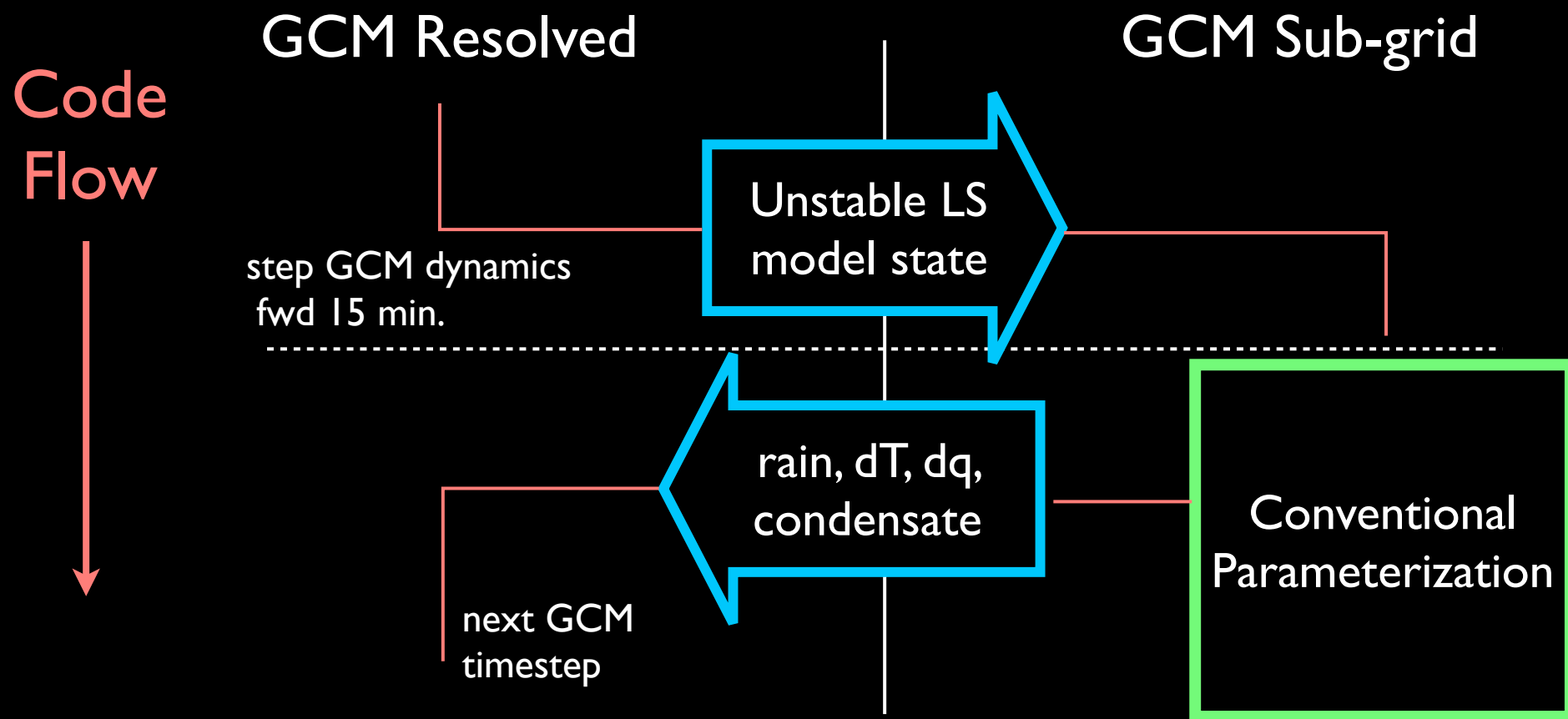
GCM longitude

This result was a surprise.

We had good reasons to think that MMFs should not admit this level of multiscale physics:

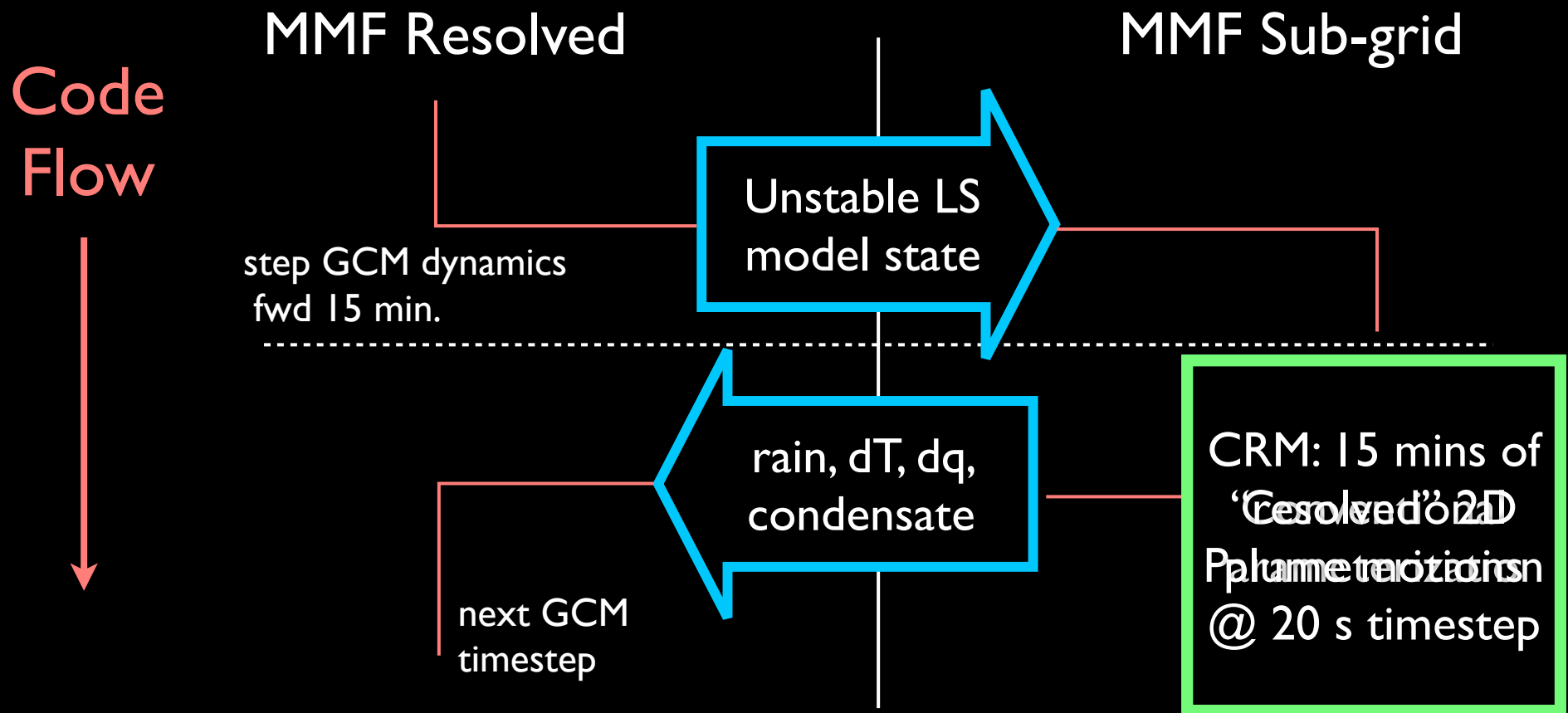
- 1) Isolated, periodic CRMs
- 2) Two dimensionality in CRM
- 3) Lack of momentum scale coupling

We were used to thinking about the scale separation interface as in normal climate models

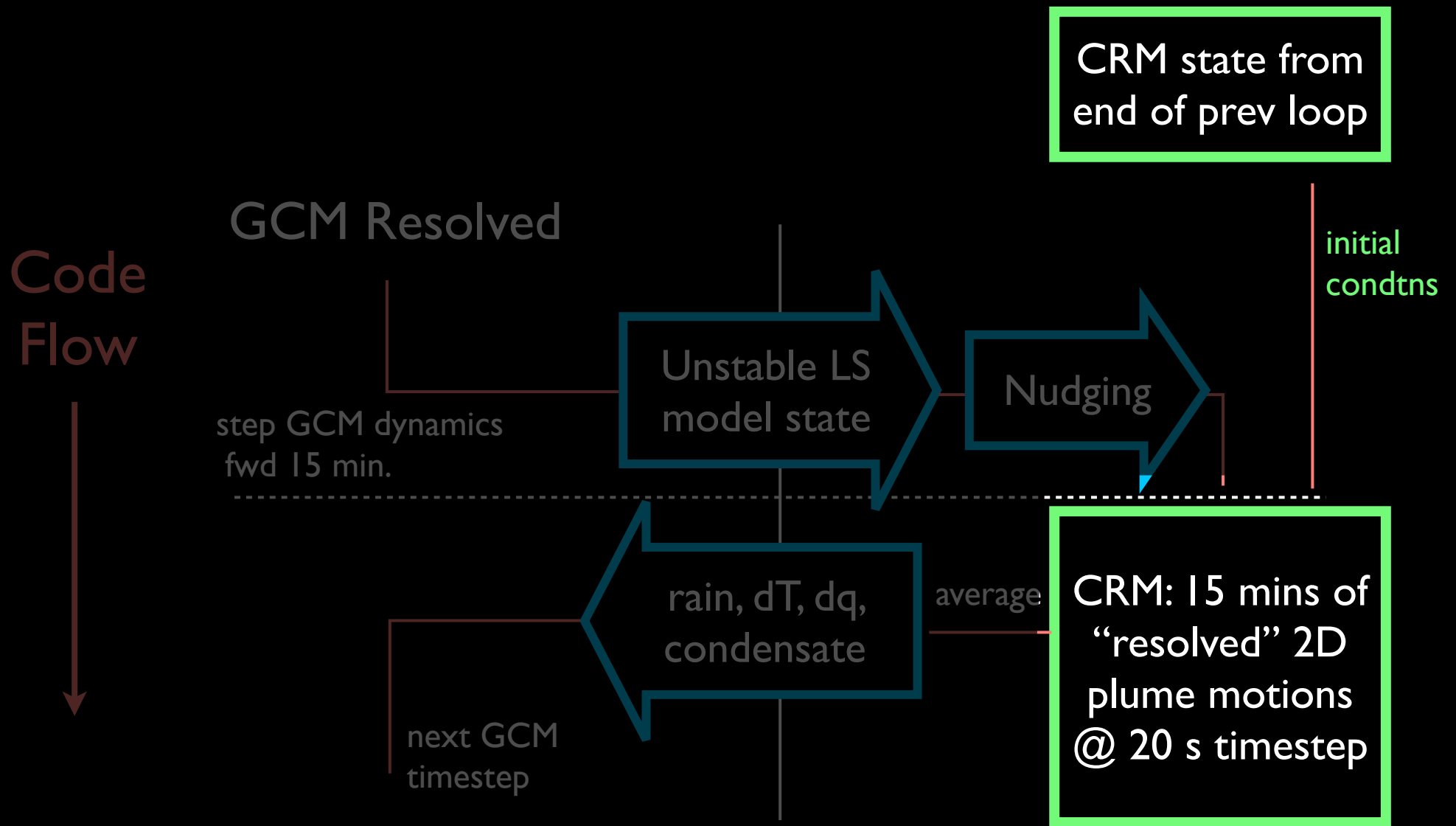


The GCM scale interaction is self contained in space and time

It is tempting to think of MMFs as simply switching out the module that does the sub-grid calculation



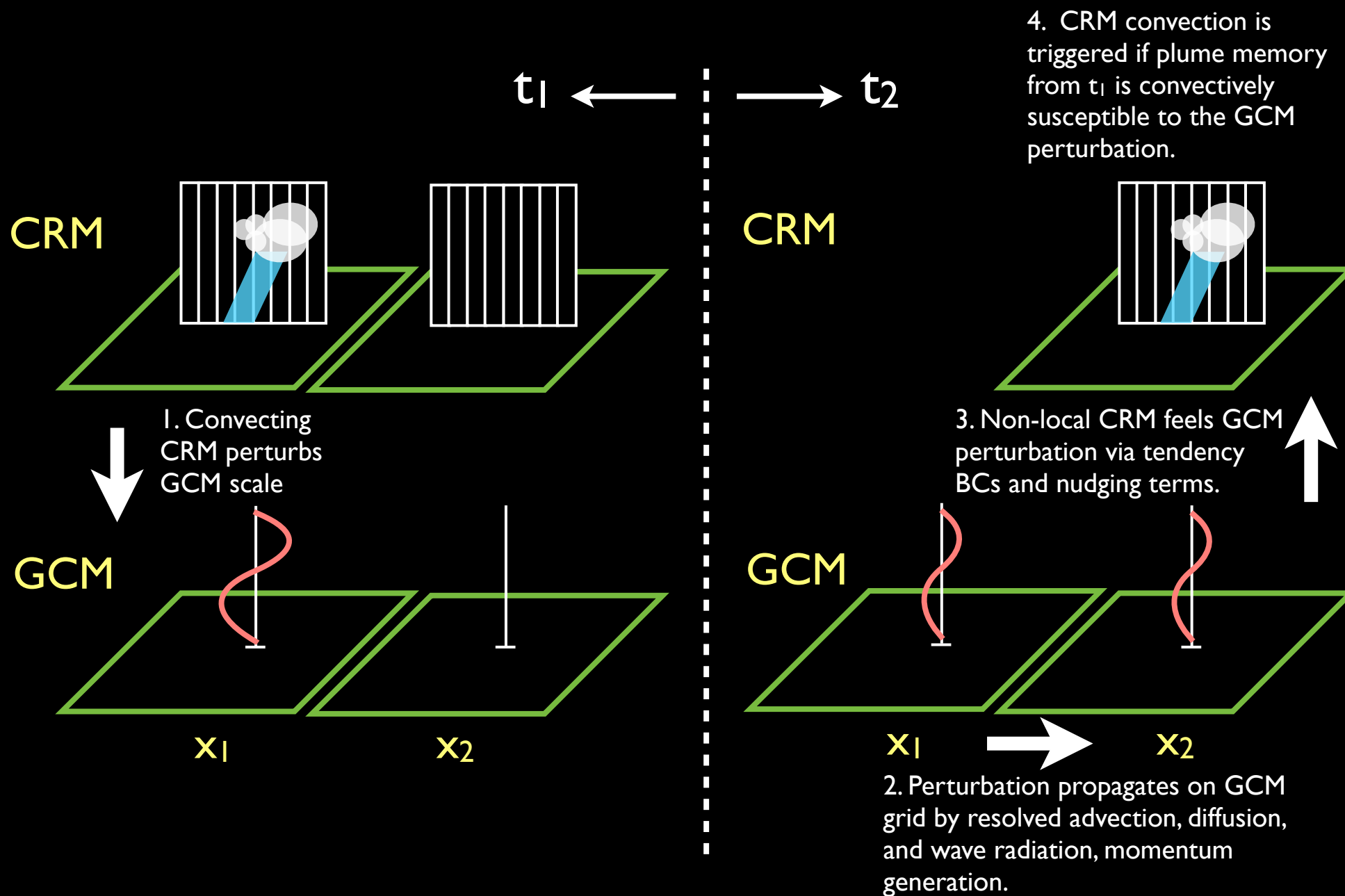
# But the scale interface wiring is also radically different



The MMF scale interface is not self-contained in time.  
It contains **memory** in its smallest resolved scale.

ICs for  
next step

# An example of how SPCAM propagation could occur



Dual-scale budget calculations could track actual mechanism